

Instruction Manual



TAS 455 & TAS 465 Analog Oscilloscopes

070-8523-05

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.

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Preface

This is the Instruction Manual for the TAS 455 and TAS 465 Analog Oscilloscopes. This manual provides you with both operation and module-level service information.

Use the *Introduction* section to learn what the TAS 455 and TAS 465 Analog Oscilloscopes can do and about the available options and accessories.

Use the *Getting Started* section to learn about applying power. This section also contains brief examples of how to use the controls.

Use the *Operation* section to learn about each of the front panel controls and how to perform certain tasks to help you understand typical steps involved to obtain stable, usable displays and take measurements.

Use the *Specifications* section as a reference for all nominal, warranted, and typical characteristics for the TAS 455 and TAS 465 Analog Oscilloscopes.

Use the *Theory* section to help you understand the operation of the oscilloscope to the block level.

Use the *Performance Verification* section to verify the functionality and warranted characteristics of the oscilloscope.

Use the *Adjustment* section to bring the TAS 455 and TAS 465 Analog Oscilloscopes into conformance with the warranted characteristics listed in the *Specifications* section. You should adjust the oscilloscope if indicated by the *Performance Verification* procedures.

Use the *Maintenance* section to learn how to perform general maintenance and troubleshoot your instrument to the module level. Procedures to replace mechanical parts and electrical modules are also located in this section.

Use the *Replaceable Parts* section for a list of the mechanical parts and modules.

Use the *Appendices* section to learn about each of the menus. The *Appendices* also contains a list of the controls affected when using the **AUTOSET** feature.

Related Manuals

Other documentation for the TAS 455 and TAS 465 Analog Oscilloscopes include:



- The *Reference* (Tektronix part number 070–8522–XX) gives you a quick overview of how to operate your TAS 400 Series Analog Oscilloscopes.
- The *Service* manual (Tektronix part number 070–8524–XX) provides extended service information not contained in the Instruction manual. Items included are a detailed Theory of Operation, Schematics, and a complete electrical and mechanical parts list.
- The *XYZs of Analog and Digital Oscilloscopes* (Tektronix part number 070–8690–XX) provides you with a basic understanding of oscilloscopes and their use.

Safety Summary

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

Symbols and Terms

These two terms appear in manuals:

-  statements identify conditions or practices that could result in damage to the equipment or other property.
-  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 TAS 455 and TAS 465 Analog Oscilloscopes or equipment connected to them.

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 TAS 455 and TAS 465 Analog Oscilloscopes are 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 Oscilloscope

The TAS 455 and TAS 465 Analog Oscilloscopes 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 oscilloscope.

Without the protective ground connection, all parts of the TAS 455 and TAS 465 Analog Oscilloscopes 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. It must be identical in type, voltage rating, and current rating.

Do Not Remove Covers or Panels

To avoid personal injury, do not operate the TAS 455 or TAS 465 without the panels or covers.

Do Not Operate in Explosive Atmospheres

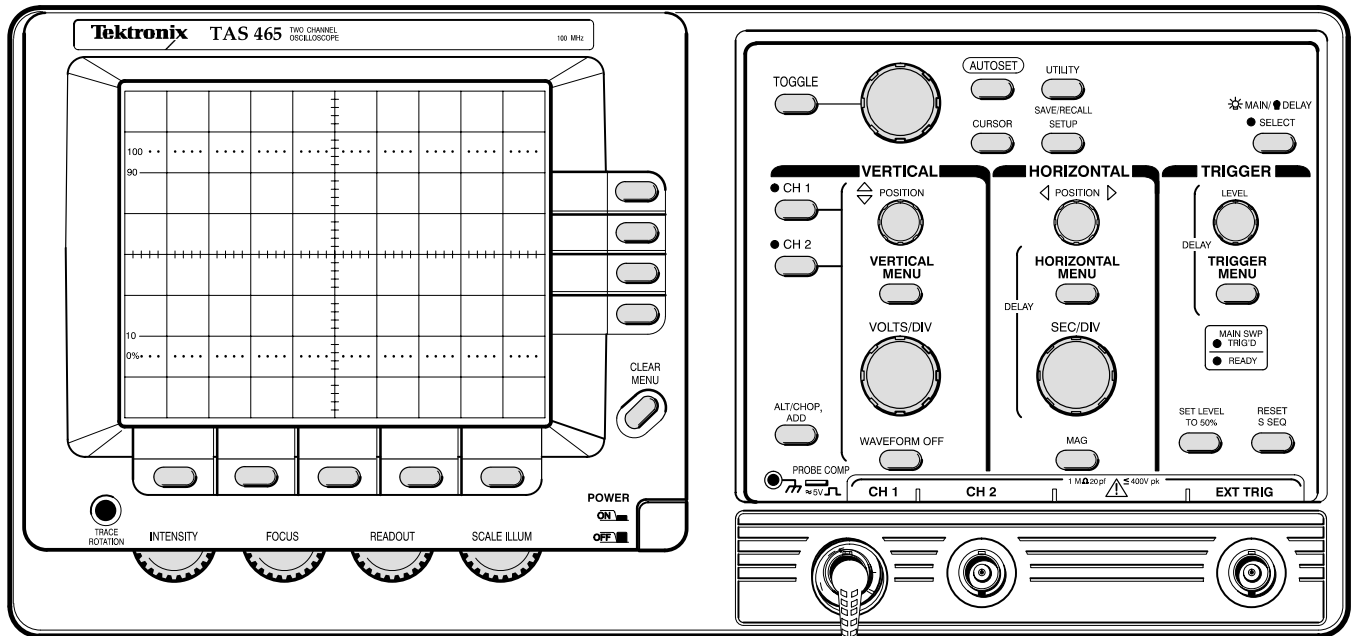
The TAS 455 or TAS 465 provide no explosion protection from static discharges or arcing components. Do not operate the TAS 455 or TAS 465 in an atmosphere of explosive gasses.

Electric Overload

Never apply a voltage to a connector on the TAS 455 or TAS 465 that is outside the range specified for that connector.

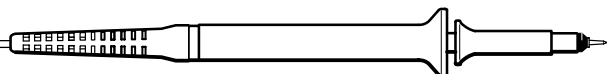
Introduction

Product Description



Your Tektronix TAS 455 and TAS 465 Analog Oscilloscopes are superb tools for processing and displaying electrical signals. Their performance addresses the needs of both benchtop and portable applications with the following features:

- 60 MHz minimum bandwidth (TAS 455)
100 MHz minimum bandwidth (TAS 465)
- Two-channel input
- Complete cursor measurement system
 - Voltage
 - Time
 - Frequency
- Delayed time base
- AUTOSSET feature
- Front panel setup memory
- External trigger input



The features of the TAS 455 and TAS 465 Analog Oscilloscopes are briefly described here to help get you acquainted with the operating systems.

User Interface

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

AUTOSET

The **AUTOSET** button provides you with a usable, triggered display of a signal applied to an input channel. Many instrument controls and menus are set to a pre-defined state, providing you with a known starting point for your measurements. Page A-9 lists the actions taken by pressing the **AUTOSET** button.

Menus

Those functions for which control settings changed less often, such as vertical coupling and trigger mode, are set indirectly. That is, pressing a front-panel button, such as **VERTICAL MENU**, displays a menu of functions at the bottom of the screen related to that button. (For the button **VERTICAL MENU**, the menu displayed contains functions such as coupling and bandwidth.) The buttons below this main menu select a function, such as coupling and displays a sub menu of settings for that function, such as DC, AC, or GND, at the right side of the screen. The buttons to the right of the menu select a setting, such as DC.

General Purpose Knob and TOGGLE

Some menus assign the General Purpose Knob to a selected adjustment. The method employed is the same as for *selecting* a function, except the final selection in the side menu causes the General Purpose Knob to *adjust* some function, such as the position of measurement cursors on screen. Pressing the **CLEAR MENU** button clears the assignment of the General Purpose Knob except when assigned to adjust cursors or delay time.

The **TOGGLE** button works in conjunction with the General Purpose Knob when positioning cursors. Each press of the **TOGGLE** button switches which cursor is active, and therefore controlled by the General Purpose Knob.

Save/Recall Setups

You can store up to four complete front panel setups in memory. Once you complete a complex setup and then save it in one of the four memory locations, you can retrieve it at any time. Saved front panel settings do not include the assignment of the General Purpose Knob.

Vertical System

The vertical system provides two vertical channels with calibrated vertical scale factors from 2 mV to 5 V per division.

Both channels can be displayed, vertically positioned, bandwidth limited (to either Full or 20 MHz), inverted, and vertical coupling specified.

Besides the two channels, a math waveform is available for display. (A math waveform results when you add the two channels.)

Horizontal System

There are three horizontal display modes: main, delayed, and XY.

The main display is the standard horizontal display mode with calibrated sec/div scales.

The delayed display can be delayed by time with respect to the main trigger. The delayed display can also be set to display at the first valid trigger after the delay. The delayed display also has a calibrated sec/div scale.

XY mode is useful to measure the phase difference of two signals.

Trigger System

The triggering system comprises a complete set of features for triggering the horizontal system. You can configure trigger for source, slope, coupling, mode, and holdoff. Video triggers are available for triggering on video signals.

You can adjust the trigger level or automatically set it to 50% of the trigger signal with the press of a button.

Measurement Cursors

Once you have set up to take your measurements, the cursors can help you take those measurements quickly.

The TAS 455 and TAS 465 Oscilloscopes have two types of cursors for taking measurements on the displayed waveforms: delta (difference) and absolute. The General Purpose Knob controls the placement of the cursors. The **TOGGLE** button selects which cursor is active.

Delta voltage measures the voltage between the horizontal bar cursors. Delta time measures the time between vertical bar cursors. These are delta measurements; that is, measurements based on the difference between two cursors.

Absolute voltage measures the voltage position of a single horizontal bar cursor. The displayed voltage level readout is made with respect to the ground reference level of the channel.

The bar cursors remain displayed even if you change the function of the General Purpose Knob. This allows you to use them as reference points or markers to easily identify if measurement signals remain within the parameters set by the cursors. Remove the cursor display by turning the cursor measurement off.

Options

Several options are available for the TAS 455 and TAS 465 Analog Oscilloscopes. A description of each option follows.

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. See Table 1-1.

Table 1-1: 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

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:** Tektronix provides five years of warranty/remedial service.
- **Option M3:** Tektronix provides five years of warranty/remedial service and four oscilloscope calibrations.
- **Option M8:** Tektronix provides four calibrations and four performance verifications, one of each in the second through the fifth years of service.

Option 3R: Rackmounted

With this option, Tektronix ships the oscilloscope with a rackmount kit, providing all the necessary hardware to adapt the oscilloscope for installation into a standard 19 inch instrument rack. Customers with instruments can order a rackmount kit (Tektronix part number 016–1166–00) for conversion with instructions.

Option 02: Front Cover and Pouch

With this option, Tektronix ships a protective front cover to prevent damage to the front panel of the oscilloscope while not in use. An attachable pouch (attaches to the instrument top) provides storage for the manuals and probes supplied with your oscilloscope plus other additional accessories you may want to keep with your oscilloscope.

Option 23: Additional Probes

With this option, Tektronix ships two P6129B 1X — 10X switchable passive probes in addition to the two standard-accessory P6109B probes normally shipped with the instrument.

Option 9C: Certificate of Calibration and Test Data Report

Tektronix ships a Certificate of Calibration that 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 U.S. MIL-STD-45662A. This option also includes a test data report for the instrument.

Accessories

This section provides a list of both standard and optional accessories for the TAS 455 and TAS 465 Analog Oscilloscopes.

Standard Accessories

Table 1-2 lists the standard accessories included with the TAS 455 and TAS 465 Analog Oscilloscopes.

Table 1-2: Standard Accessories

Accessory	Part Number
Instruction Manual	070-8523-XX
Reference	070-8522-XX
XYZs of Analog and Digital Oscilloscopes	070-8690-XX
U.S. Power Cord	161-0230-01
Fuse (250 V, 3 A Fast)	159-0277-00
Probes (quantity two), 10X Passive; 100 MHz	P6109B (single unit)
P6109B Probe Manual	070-7849-XX

Optional Accessories

Table 1-3 lists a few of the optional accessories available for use with the TAS 455 and TAS 465 Analog Oscilloscopes.

Table 1-3: Optional Accessories

Accessory	Part Number
Oscilloscope Cart	K212
Rack Mount Kit (for field conversion)	016-1166-00
Service Manual	070-8524-XX
Accessory Pouch	016-1159-00
Fuse (250 V, 1.5 A Fast for Serial Number B020099 and below)	159-0311-00
Fuse (250 V, 3.15 A Fast)	159-0190-00
Front Cover	200-3232-00
Oscilloscope Camera	C-9 Option 06
Oscilloscope Camera Adapter	016-1154-00
Soft-sided Carrying Case	016-1158-00
Transit Case	016-1157-00

User manuals for the TAS 455 and TAS 465 Oscilloscopes and the *XYZs of Analog and Digital Oscilloscopes* are available in several languages. Table 1-4 provides a list of these manuals.

Table 1-4: Available Languages

Manual	Language	Part Number
TAS 455 and TAS 465 Analog Oscilloscopes User Manual	French	070-8830-XX
	Spanish	070-8828-XX
	German	070-8829-XX
XYZs of Analog and Digital Oscilloscopes	French	070-8070-XX
	Spanish	070-8819-XX
	German	070-8071-XX

Accessory Probes

The following is a list of optional accessory probes to enhance the use of your oscilloscope:

- P6046 Active, differential probe, 100 MHz
- P6007 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)
- P6101B 1X, 15 MHz, Passive probe
- P6129B 1X — 10X switchable, 100 MHz, Passive probe
- P6408 20 MHz, 17 bit, Word Recognizer/Logic probe
- TVC 501 Time-to-Voltage Converter (time delay, pulse width, and period measurements)
- P6021 AC Current probe, 120 Hz to 60 MHz
- P6022 AC Current probe, 935 kHz to 120 MHz
- AM 503S — DC/AC Current Probe System, AC/DC (uses A6302 Current Probe)

Getting Started

Power On

Before you begin using the TAS 455 and TAS 465 Analog Oscilloscopes, ensure proper installation.

Installation

Perform this procedure to properly install and power on the TAS 455 and TAS 465 Analog Oscilloscopes.

1. Check that you have the proper electrical connections. The rear label lists power requirements for all possible voltage inputs
2. For serial numbers B020099 and below, check that the Line Voltage Range switch (Figure 2-1) is at the proper setting for your power system. For serial numbers B020100 and above, no line voltage setting is required.
3. Check the fuse to ensure it is the proper type and rating (the rear panel provides you with this information). The TAS 455 and TAS 465 Analog Oscilloscopes are shipped with the UL approved fuse installed. Figure 2-2 illustrates how to open the fuse drawer.
4. Connect the proper power cord from the rear-panel power connector (Figure 2-1) to the power system.

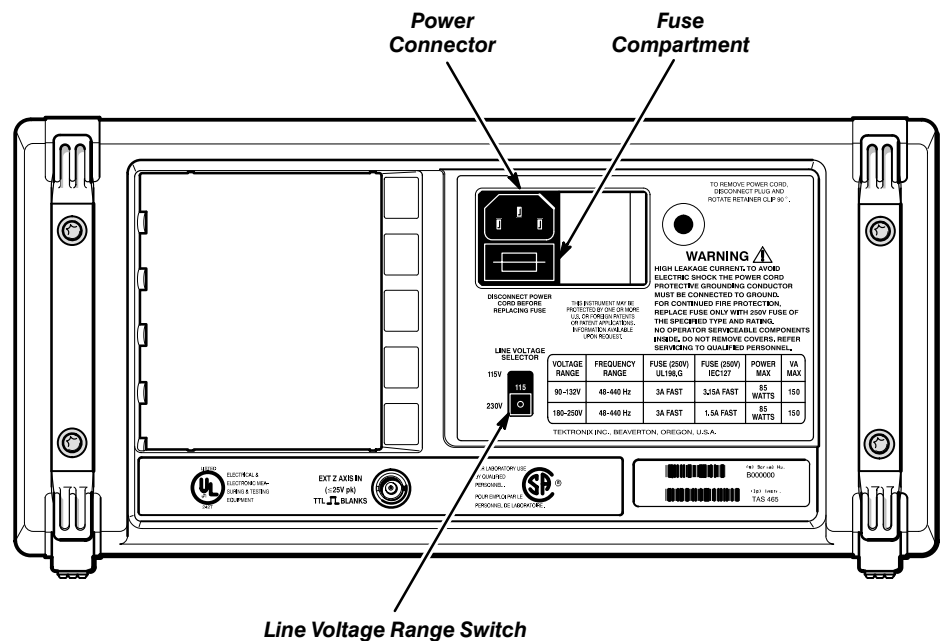


Figure 2-1: Rear Panel for B020099 and Below

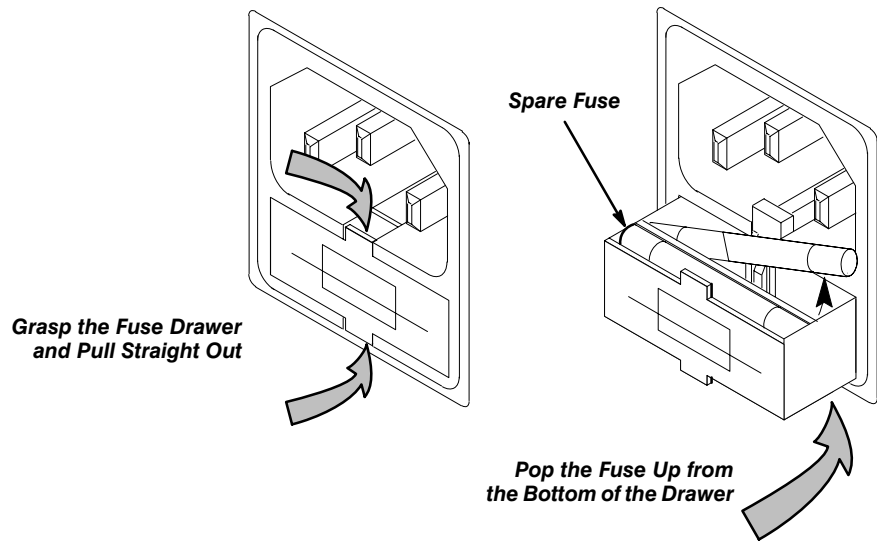


Figure 2-2: Fuse Compartment

5. Be sure you have the appropriate operating environment. Specifications for temperature, relative humidity, altitude, vibrations, and emissions are in Section 4, *Specifications*.
6. Leave space for cooling. Do this by verifying that the air intake and exhaust holes on the sides of the cabinet are free of any airflow obstructions. Leave at least 5.1 cm (2 in.) free on each side.
7. Press the **POWER** button to power on the oscilloscope.

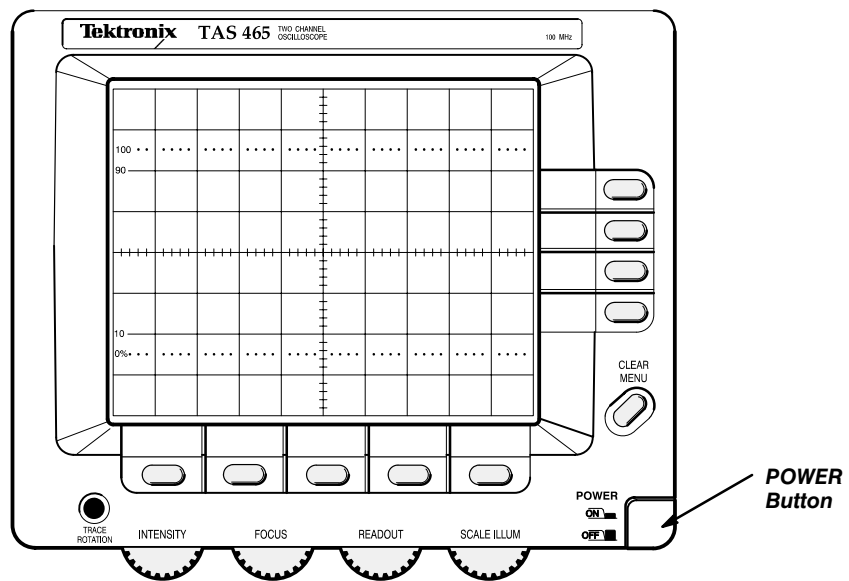


Figure 2-3: POWER Button

Quick Start

This section helps you get acquainted with basic controls and operating systems of the TAS 455 and TAS 465 Analog Oscilloscopes once you have power applied. Review *At a Glance* in Section 3 if you want an overview of all controls and connectors.

Selecting and Deselecting Input Channels

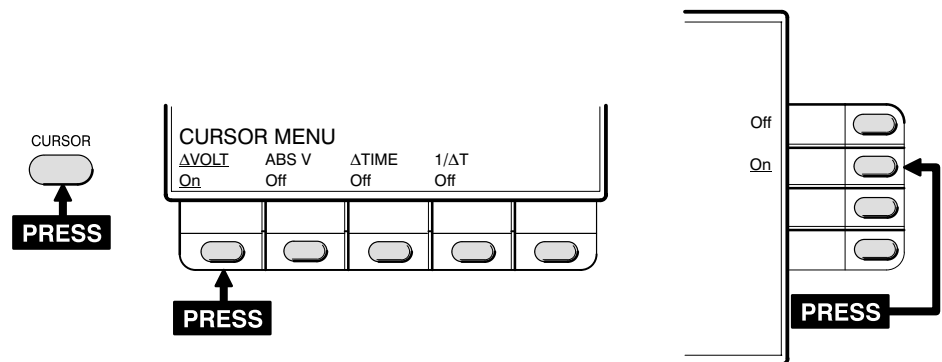
The TAS 455 and TAS 465 Oscilloscopes have two input channels. You can display the channels separately or simultaneously. The following steps demonstrate how to select and deselect channels for display.

1. Power on the oscilloscope and wait for the self tests to complete.
2. Press the **CH 1** button located on the front panel. The **CH 1** indicator lights, channel 1 is displayed, and vertical controls and menus are assigned to channel 1.
3. Press the **CH 2** button located on the front panel. The **CH 2** indicator lights, channel 2 is displayed, and controls and menus are assigned to channel 2.
4. Press the **CH 1** button, assigning control to channel 1.
5. Press the **WAVEFORM OFF** button, removing channel 1 from the display and leaving channel 2 displayed.

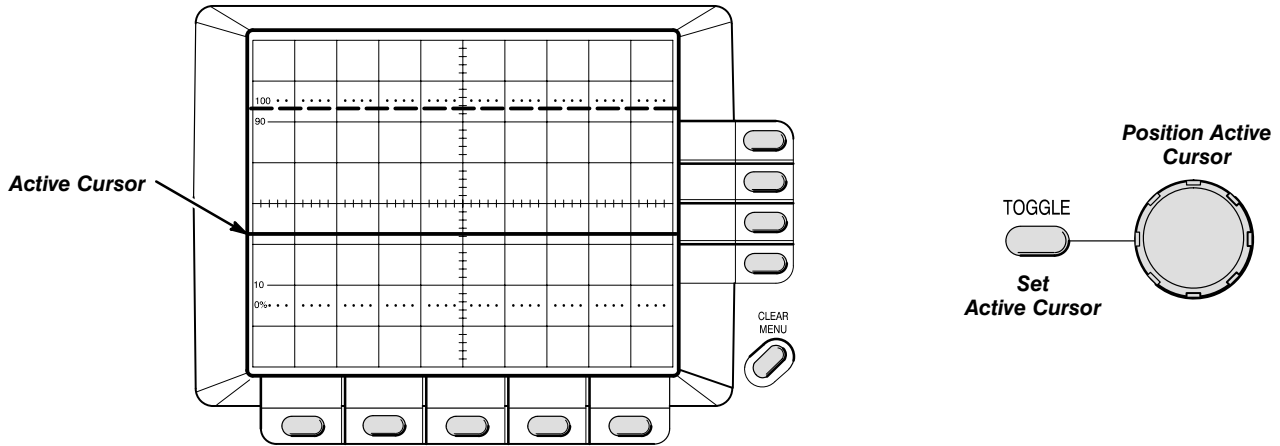
Using the Menus

The TAS 455 and TAS 465 Oscilloscopes use menus for many instrument settings. In the following steps, you will set only channel 1 on and turn the cursors on.

1. Press the **WAVEFORM OFF** button until only channel 1 is displayed.
2. Press the **CURSOR** menu button.
3. Set the delta volts (Δ VOLT) cursors on (using the following guide).



- Now two horizontal bar cursors are displayed. The active (movable) one is a solid line and the inactive one is a dashed line. Use the General Purpose Knob to move the active cursor and use the **TOGGLE** button to select which cursor is active.



Connecting a Signal

The TAS 455 and TAS 465 Oscilloscopes accept signals through the front panel input connectors labeled **CH 1** and **CH 2**. The probes you use for taking measurements should only be those supplied with the TAS 455 and TAS 465 Oscilloscopes. Connecting signals to the TAS 455 and TAS 465 Oscilloscopes is also possible with the use of 50 Ω coaxial cables.

Before using any probe to take measurements, compensate the probe to match the input channel. See *Compensating the Probe* on page 2-5.

Using AUTOSET

The **AUTOSET** feature of the TAS 455 and TAS 465 Oscilloscopes automatically sets most of the front panel controls.

- Connect the probe compensation signal (from the **PROBE COMP** connector on the front panel) to either channel of the oscilloscope and display that channel (see Figure 2-5). Turn all other channels off.
- Press the **AUTOSET** button on the front panel. Wait one to three seconds to allow the instrument to adjust all the control settings.

The instrument will trigger on the waveform, display at least one complete cycle, and center it horizontally on the CRT. The baseline of the waveform will be at the center horizontal graticule line. The intensity level is increased if set too low for a viewable display.

See Table A-2 on page A-9 for a complete list of **AUTOSET** default control settings.

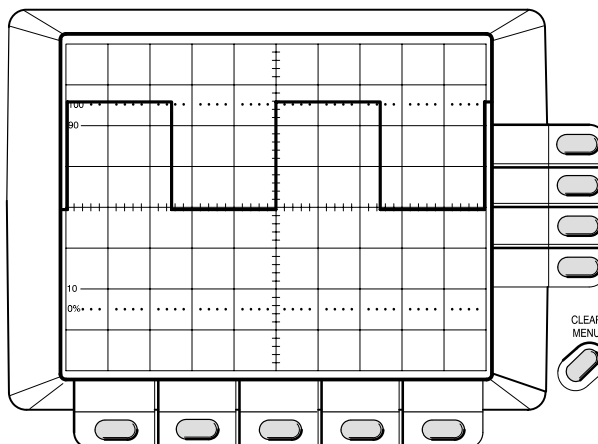


Figure 2-4: Probe Compensation Signal Displayed after AUTOSET

Compensating the Probe

Passive probes require compensation to ensure maximum distortion-free input to the TAS 455 and TAS 465 Oscilloscopes. Before taking any measurements using a probe, first check the compensation of the probe and adjust it to match the channel inputs. The signal source for this check is the front-panel **PROBE COMP** signal (Figure 2-5).

1. Attach the probe to either the **CH 1** or **CH 2** input connectors along the lower right of the front panel.
2. Attach the probe tip to the **PROBE COMP** connector.

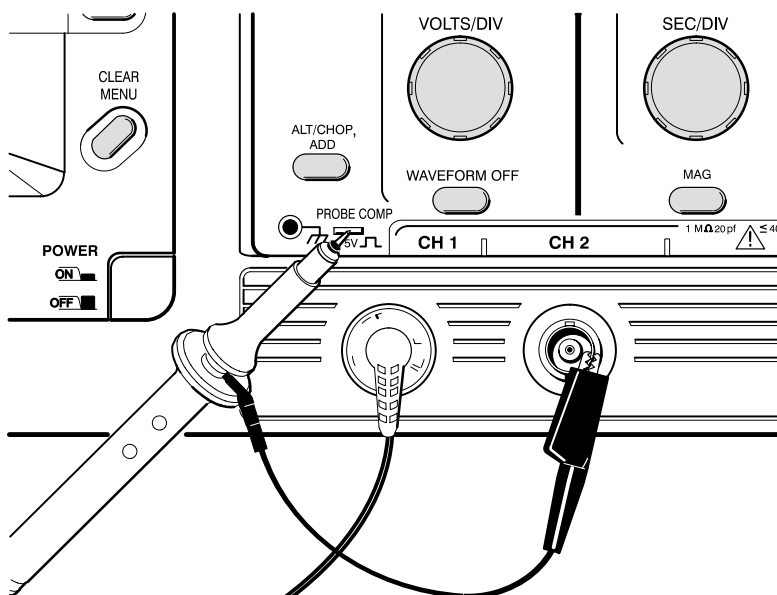
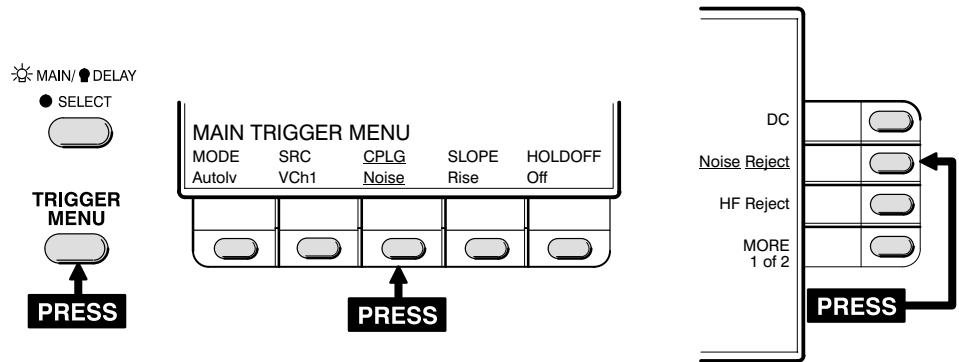
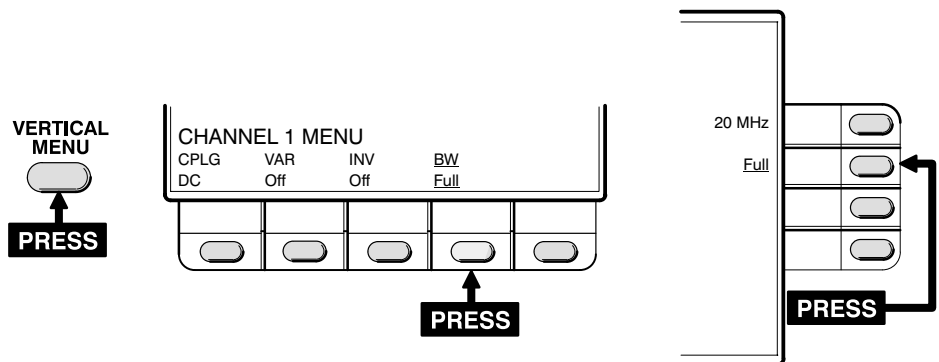


Figure 2-5: Connections for Compensating a Probe

3. Select the appropriate input channel, channel 1 or channel 2, by pressing the **CH 1** or **CH 2** front-panel button.
4. With the probe attached between an input channel and the probe compensation output of the oscilloscope, press the **AUTOSET** button on the front panel.
5. Set the vertical scale to 1 V using the **VOLTS/DIV** control.
6. Center the waveform vertically using the vertical **POSITION** control.
7. Set the horizontal scale to 200 μ s using the **SEC/DIV** control.
8. Set the trigger coupling to **Noise Reject** (use the following guide).



9. Set the vertical bandwidth to **Full** (use the following guide).



10. Check that the displayed waveform is a square wave with flat tops and bottoms. See Figure 2-6 for illustrations indicating proper and improper probe compensation.

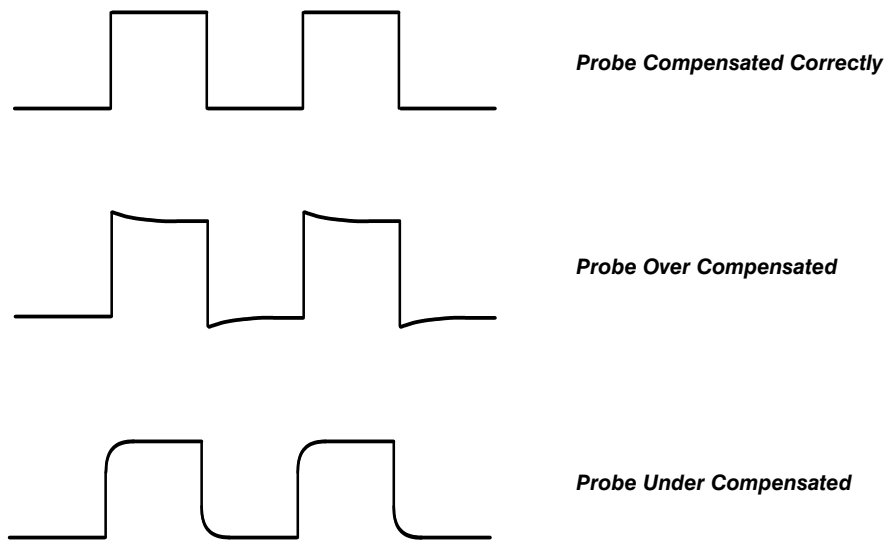


Figure 2-6: How Probe Compensation Affects Signals

11. Adjust the low frequency compensation adjustment, located in the probe body, for the best possible square wave. See Figure 2-7 for the location of the low frequency adjustment.

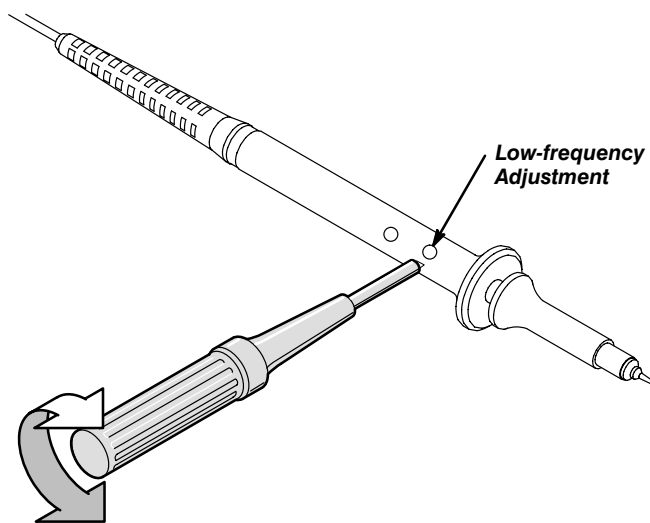


Figure 2-7: Location of Probe Head Adjustment

Adjusting Your Display Environment

You need to consider three oscilloscope operating systems to obtain the best possible display. **AUTOSET** adjusts many of these features for you with the press of a button.

Vertical System

You can change the vertical components of the displayed waveform by adjusting several features of the vertical operating system. Consider the following when setting up the vertical system for display:

- Vertical scale (volts/div)
- Input coupling
- Signal invert
- Input bandwidth

Horizontal System

You can change the horizontal components of the displayed waveform by adjusting several features of the horizontal operating system. Consider the following when setting up the horizontal system for display:

- Horizontal scale (sec/div)
- Magnification

Trigger System

You can modify the triggering system in a variety of ways to create the best possible triggered display, depending on the components of the input waveform. Consider the following when setting up the triggering system:

- Mode
- Source
- Coupling
- Slope

Operation

At a Glance

The TAS 455 and TAS 465 Oscilloscopes were designed for ease of use. To reduce the clutter of knobs and buttons on the front panel, many instrument control functions are now menu driven. The menus access instrument functions typically set once before taking measurements. The front panel controls access instrument functions you might need to adjust during measurements.

The menus are easy to use. For example, pressing the **VERTICAL MENU** button displays the menu choices for the vertical operating system.

This section of the manual illustrates each control and connector and contains a brief description of its use or function. Figure 3-1 shows the front panel of the TAS 465 Analog Oscilloscope.

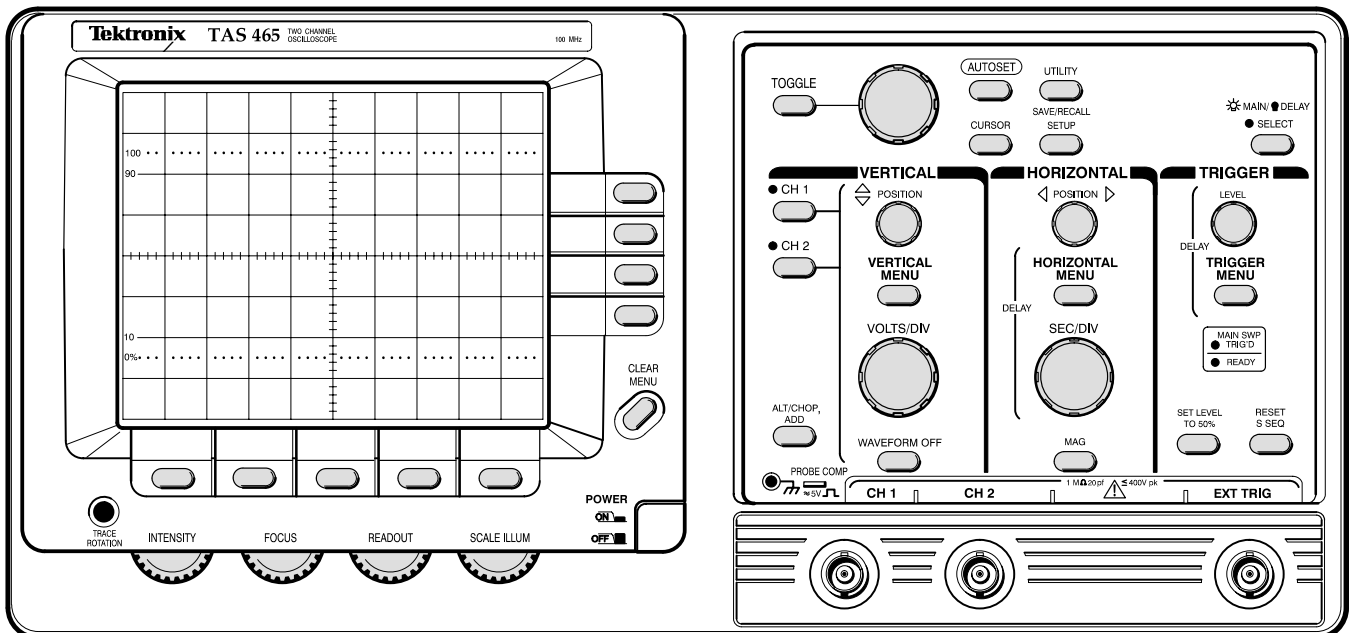
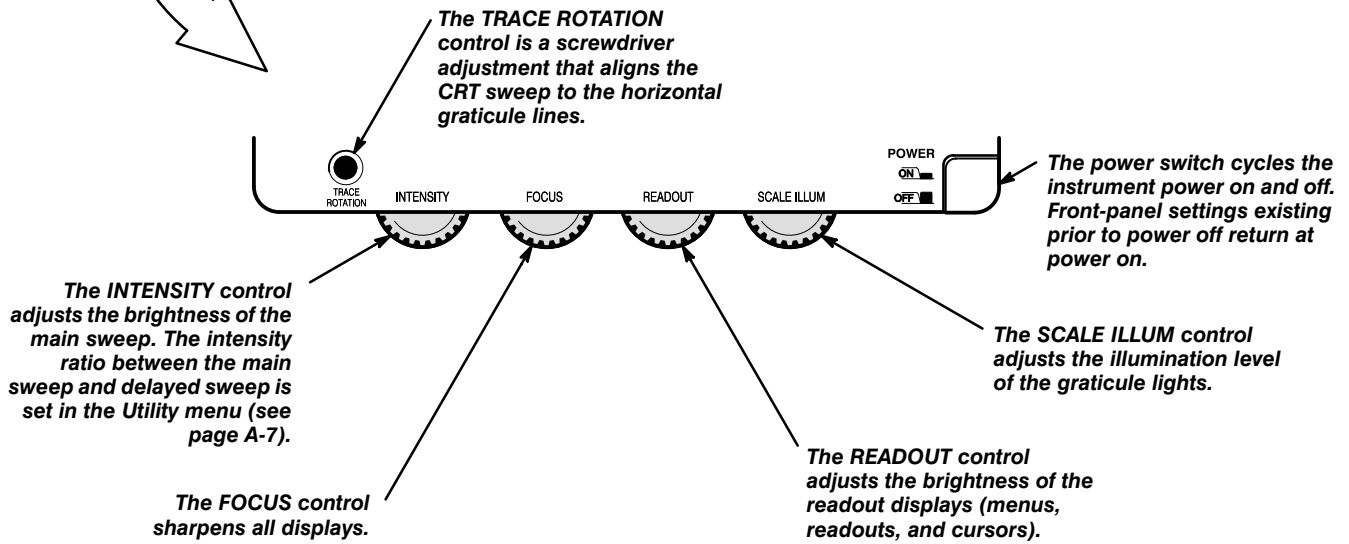
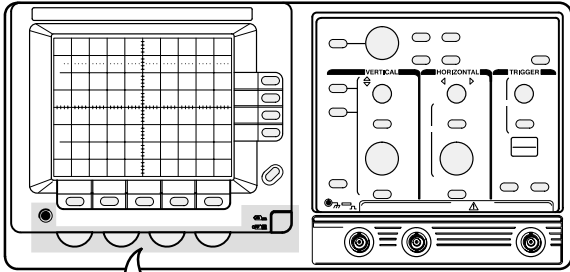


Figure 3-1: The TAS 465 Analog Oscilloscope Front Panel

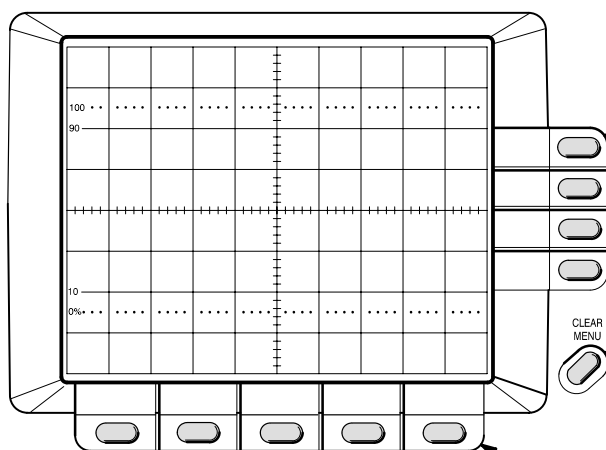
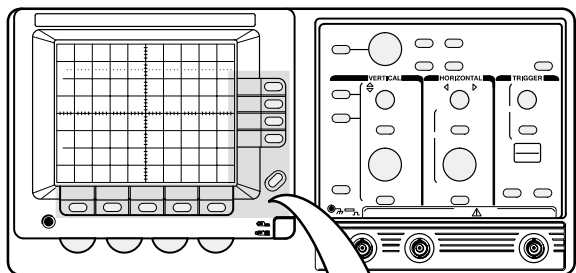
Power and Display Controls

The power and display controls allow you to cycle the power on and off and adjust the CRT display.



Menu Select Buttons

Use the menu buttons to choose corresponding items from the menus when displayed.



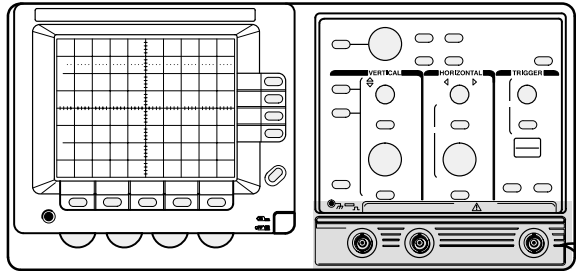
The submenu buttons select items from a corresponding list on the display.

The CLEAR MENU button clears the displayed menus.

The main menu buttons select items from a corresponding list on the display.

Signal Inputs and Outputs

Use the input connectors to apply signals to the TAS 455 and TAS 465 Oscilloscopes. The outer contact rings on the **CH 1**, **CH 2**, and **EXT TRIG** connectors recognize attenuation factors of coded attenuator probes. A probe compensation signal and a chassis ground contact are also provided.



The **PROBE COMP** signal provides a 5 V, 1 kHz square wave signal (into a 1 MΩ load) for compensating voltage probes. See page 2-5 for further information.

This connector provides contact with the chassis ground.

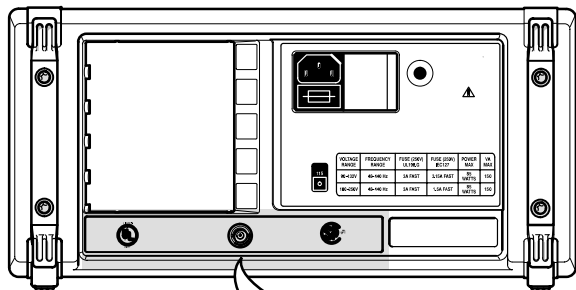
The **CH 1** input connector connects signals to the input of the channel 1 vertical system.

A signal connected to the **CH 1** input connector produces the horizontal deflection (X-axis) when horizontal mode XY is selected.

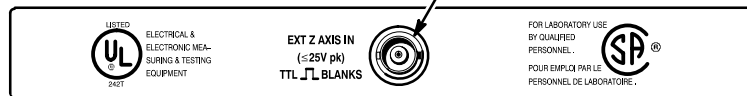
The **CH 2** input connector connects signals to the input of the channel 2 vertical system.

A signal connected to the **CH 2** input connector provides the vertical deflection (Y-axis) when horizontal mode XY is selected.

The **EXT TRIG** input connector allows the application of an external signal to use as the trigger source rather than a trigger signal generated from a vertical input channel. The input coupling is DC and the attenuator factor can be set to either 1 or ÷ 10.

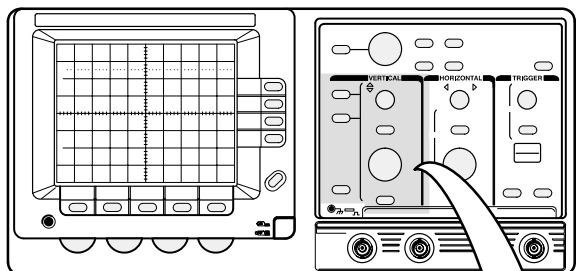


The **EXT Z AXIS IN** connector allows the application of an external signal to modulate the display intensity.



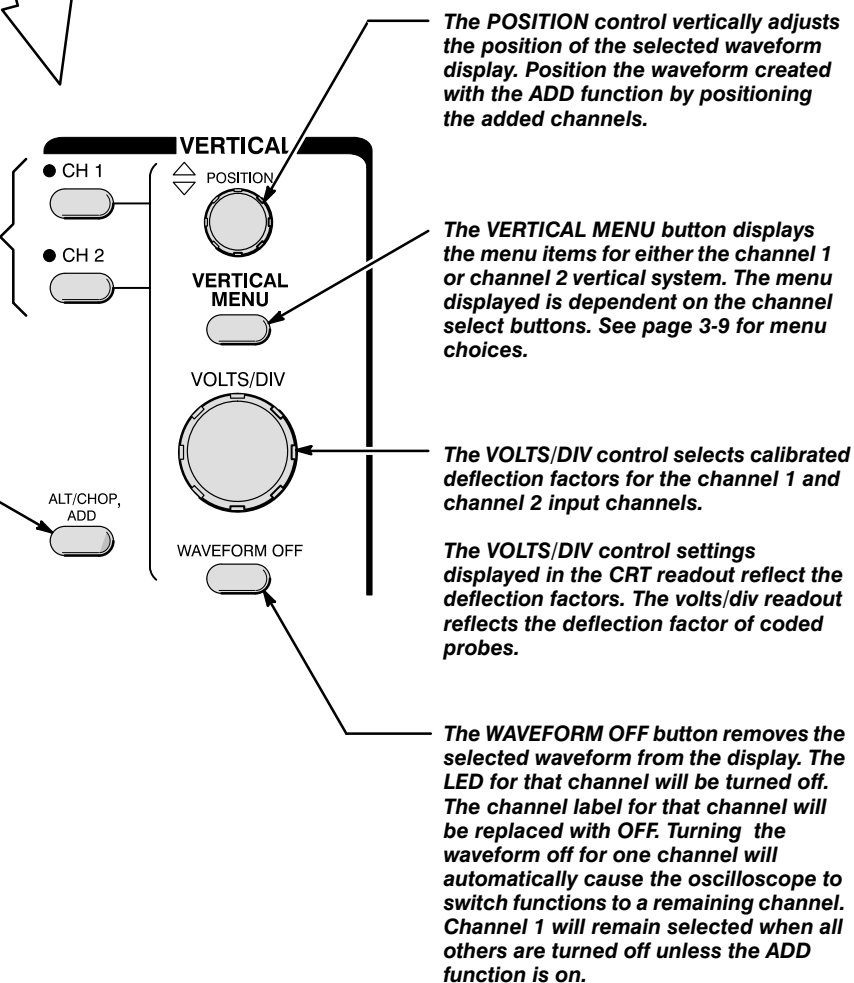
Vertical Controls

Use the vertical controls to access the features of the vertical operating system.



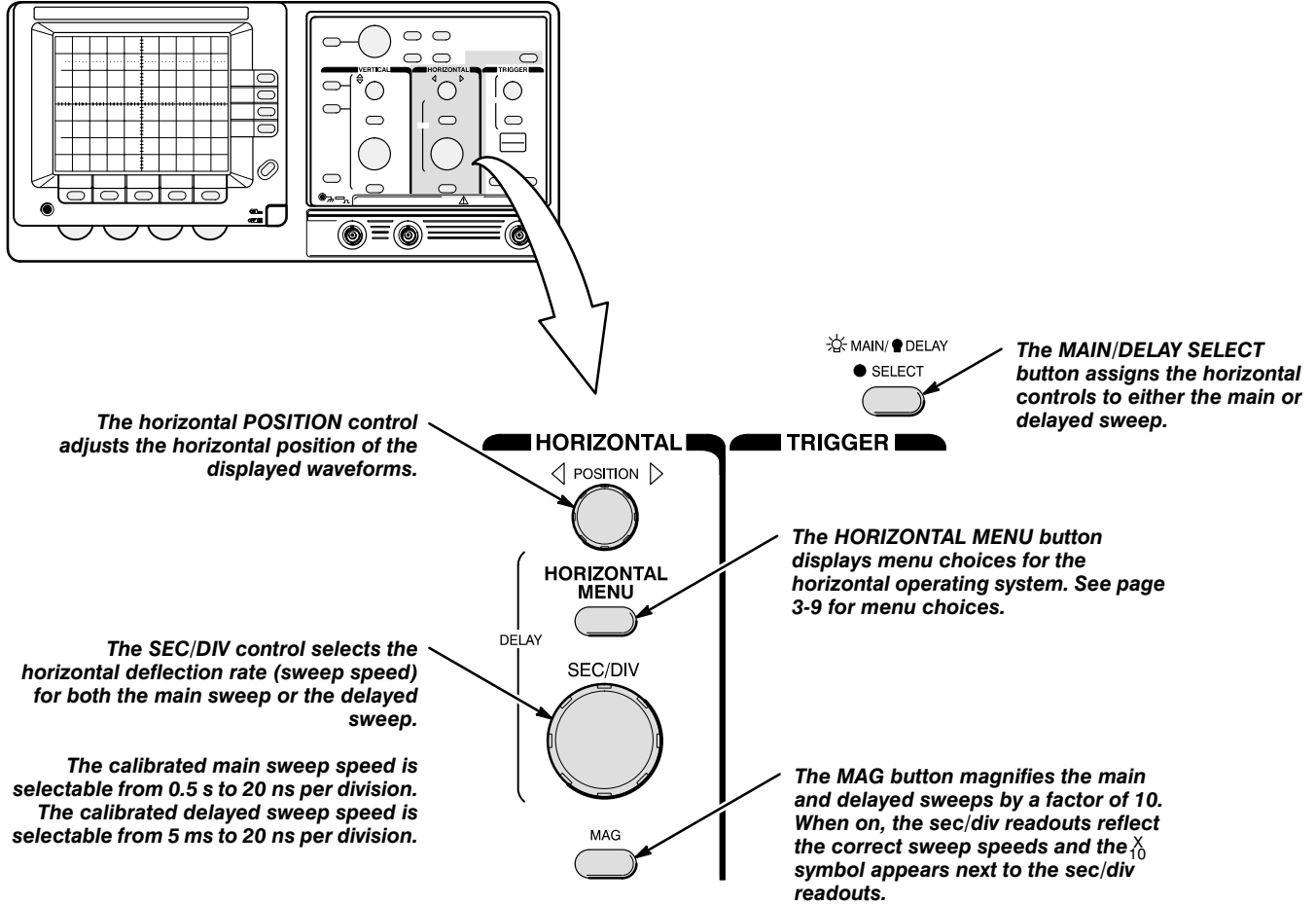
The channel select buttons determine which channel is currently selected for control. A lighted LED next to the channel button indicates the selected channel. Multiple channels may be displayed but only one channel may be controlled at a time.

The ALT/CHOP, ADD button displays the menu choices for multiple channel display and math operations. See page 3-9 for menu choices.



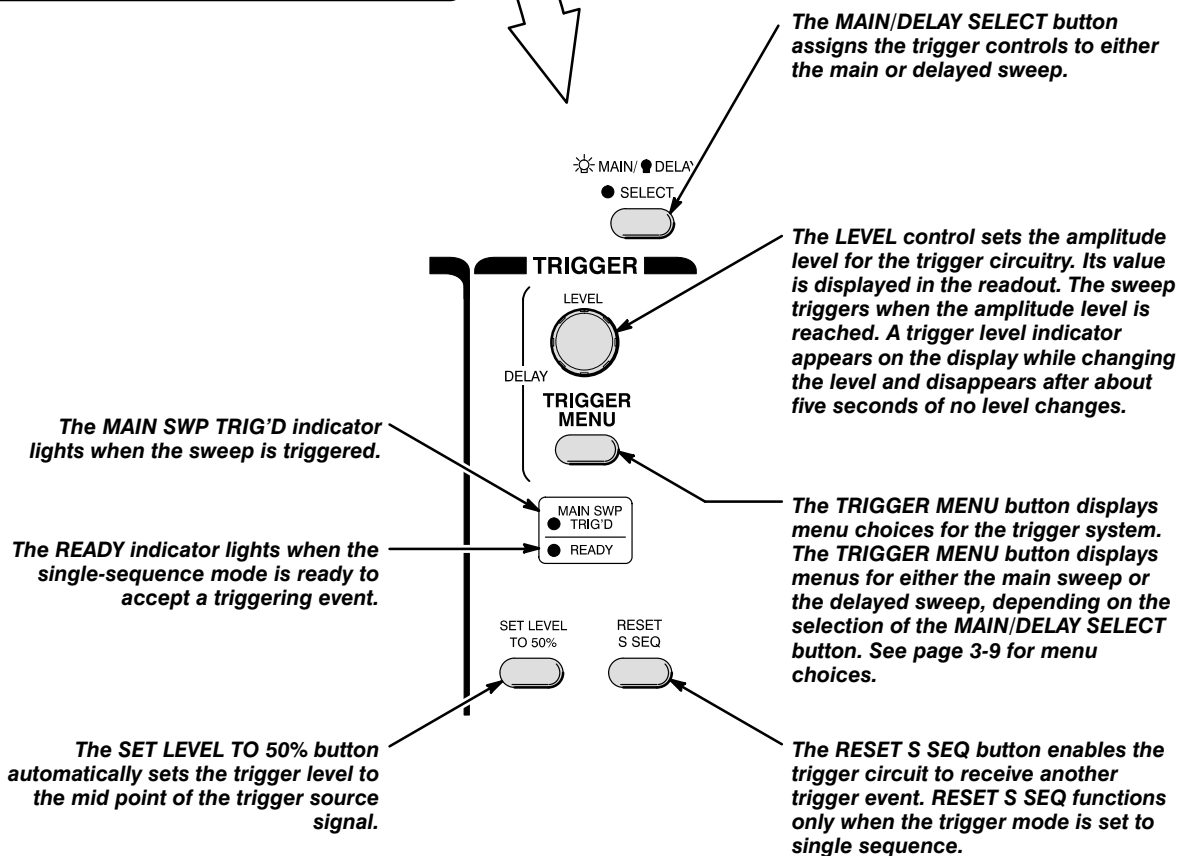
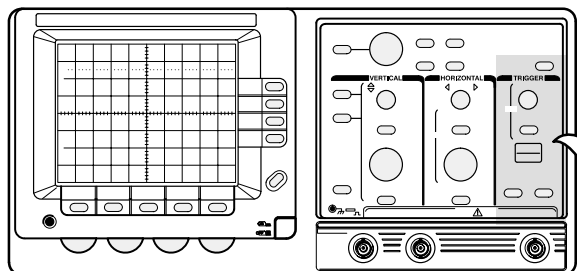
Horizontal Controls

Use the horizontal (sweep) controls to access the features of the horizontal system for both the main and delayed sweeps.



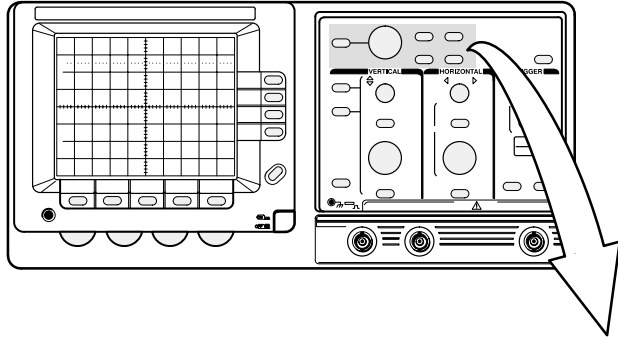
Trigger Controls

The trigger controls provide access to the features of the trigger system for both the main and delayed sweeps.



Miscellaneous Controls

The buttons described here either have a relationship with many instrument functions or perform specific tasks.

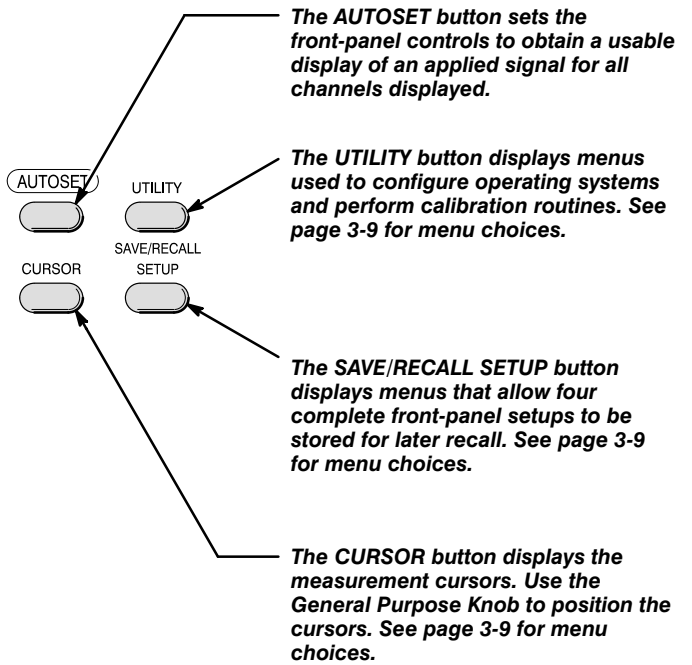


The **TOGGLE** button selects which cursor the General Purpose Knob controls.

The **General Purpose Knob** is assigned to various operations, depending on the last applicable menu operation:

- Positioning cursors
- Adjusting time for delay events
- Variable volts/div and sec/div
- Delayed trace separation
- Calibration routines

If no menu is visible, the knob controls the last applicable menu selection.



The **AUTOSET** button sets the front-panel controls to obtain a usable display of an applied signal for all channels displayed.

The **UTILITY** button displays menus used to configure operating systems and perform calibration routines. See page 3-9 for menu choices.

The **SAVE/RECALL SETUP** button displays menus that allow four complete front-panel setups to be stored for later recall. See page 3-9 for menu choices.

The **CURSOR** button displays the measurement cursors. Use the General Purpose Knob to position the cursors. See page 3-9 for menu choices.

Menu Map

Figure 3-2 is a complete map of the menus; it will help you locate menu driven functions and their available settings. Refer to *Detailed Menu Descriptions*, beginning on page A-1, for operating information about each menu.

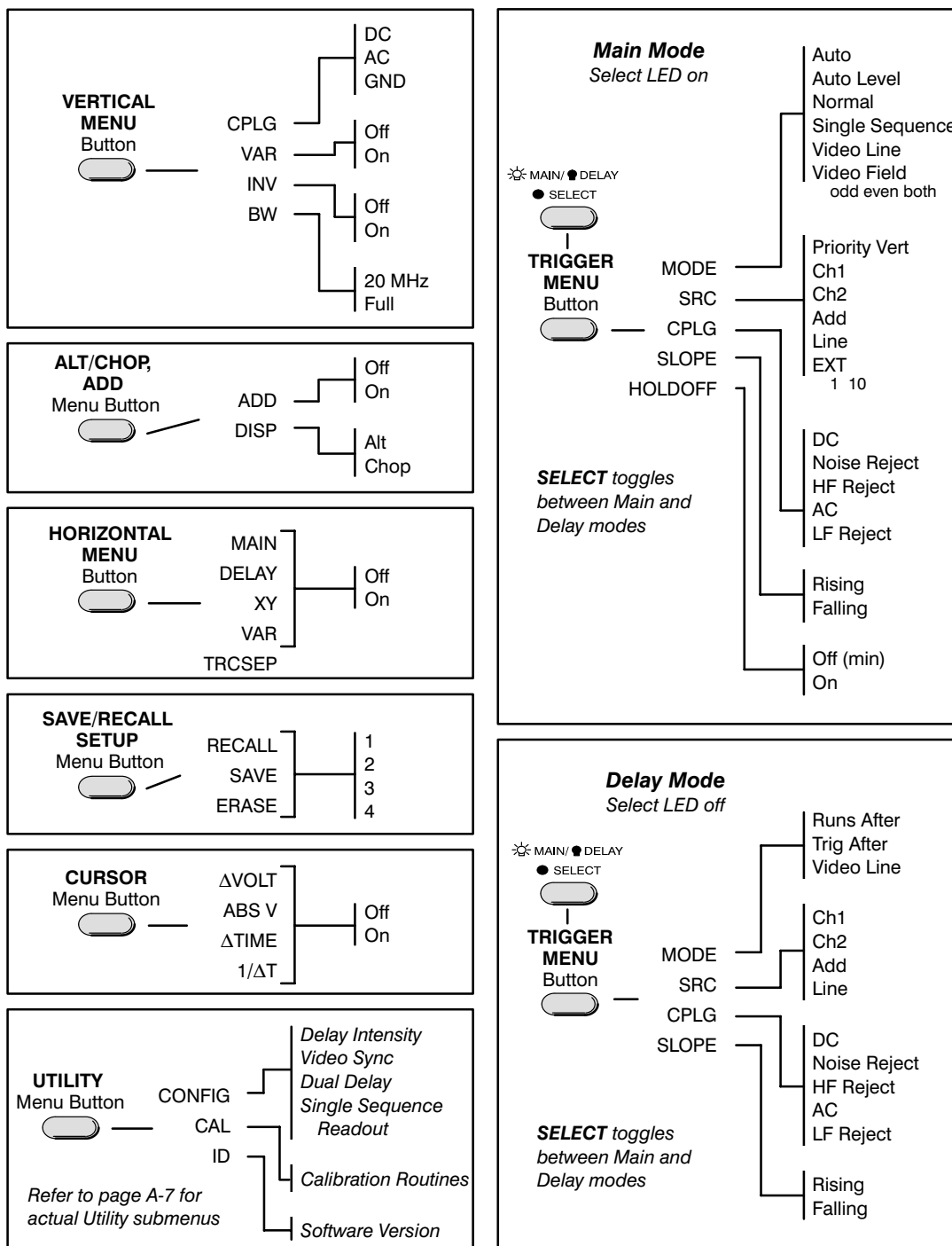
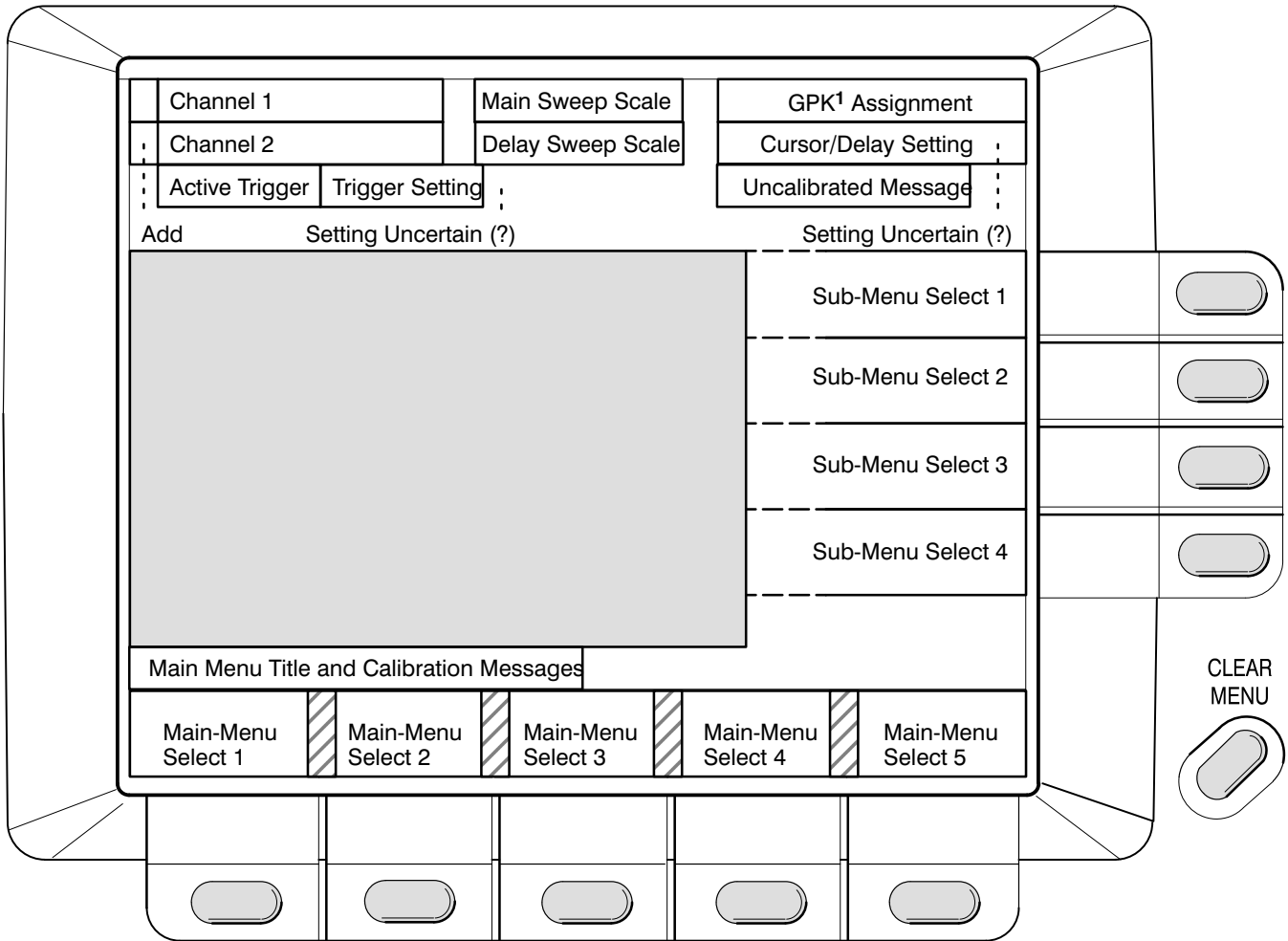


Figure 3-2: Menu Map

Readout Display

The CRT displays information about instrument settings, menus, and measurement values. Figure 3-3 illustrates where on the CRT you can find the information. Figure 3-4 illustrates the types of indicators that appear on screen and what they mean. Figure 3-5 illustrates the waveform reference indicators and measurement cursors.



¹GPK is the abbreviation for General Purpose Knob.

Figure 3-3: Readout Display Map

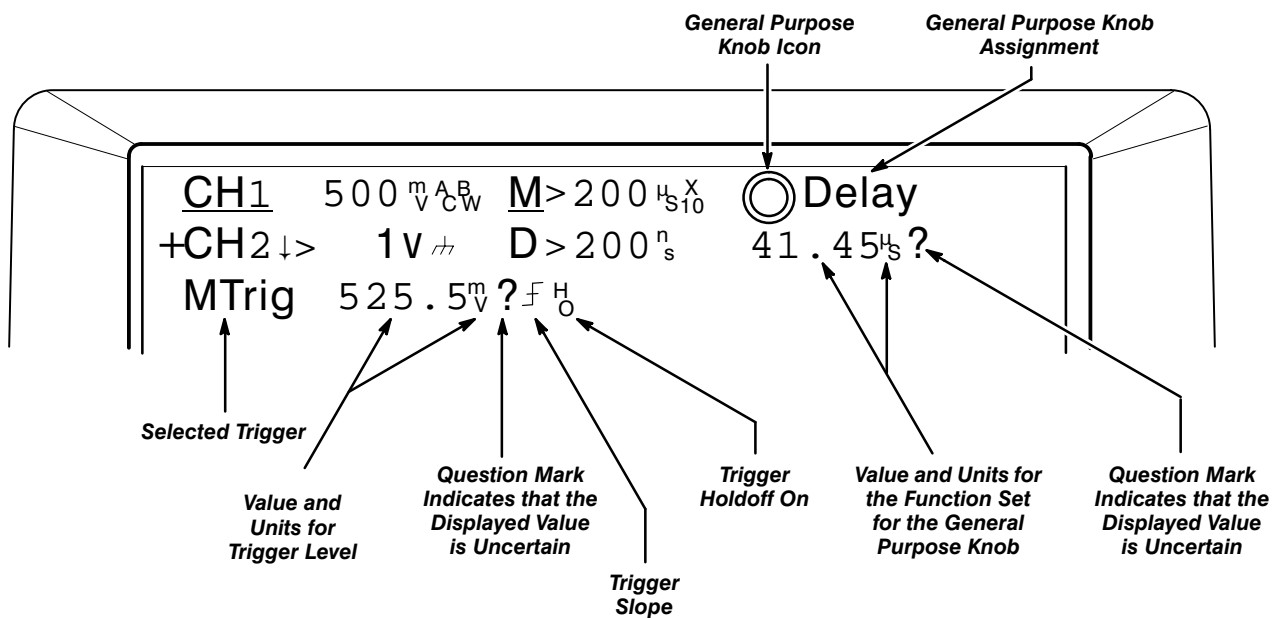
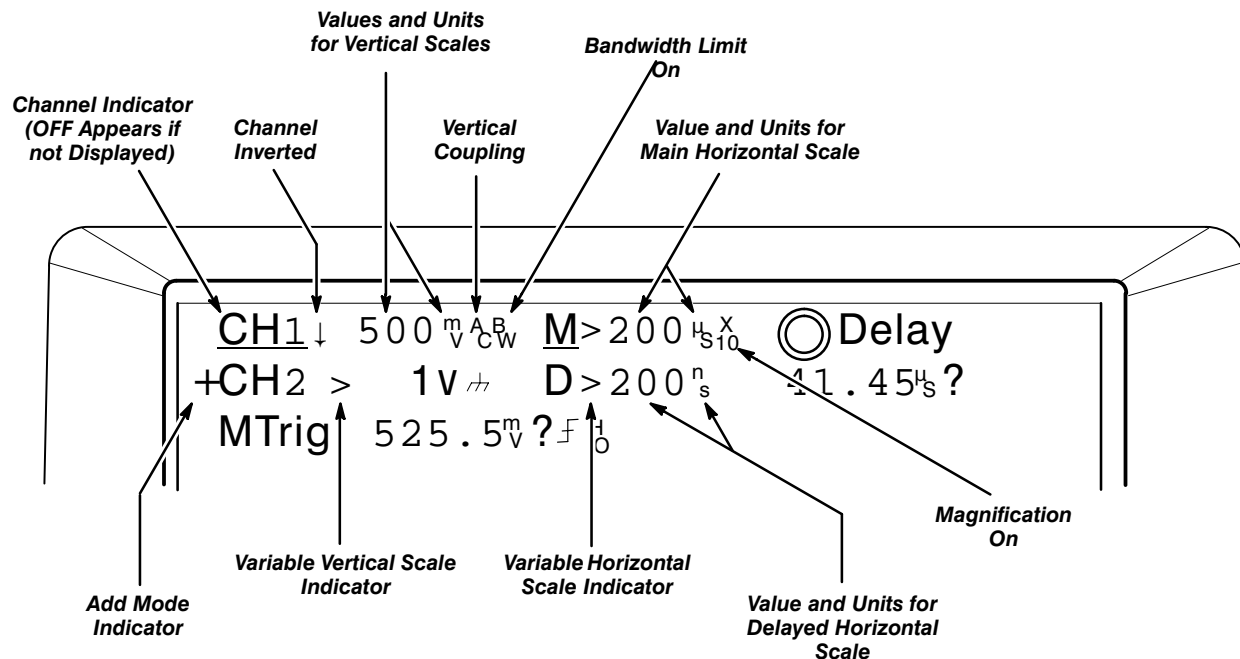


Figure 3-4: Readout Indicators

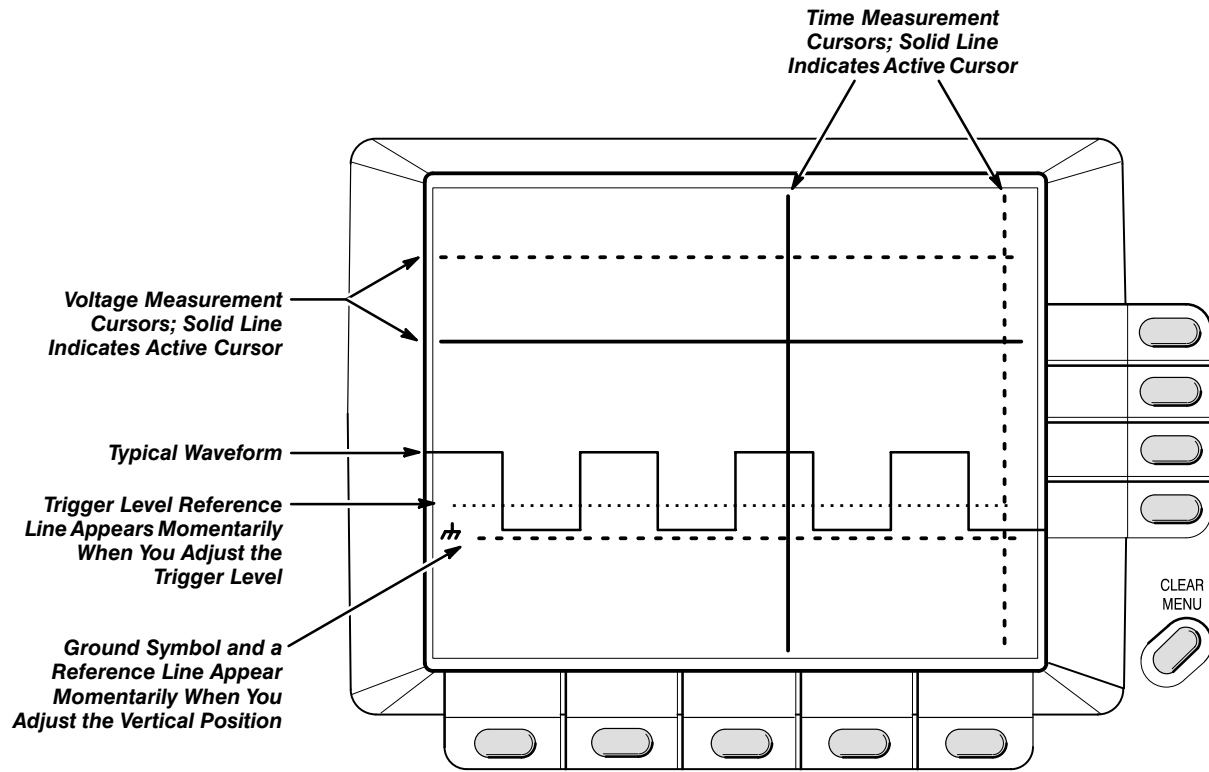


Figure 3-5: Waveform References

Using Basic Features

This section provides step-by-step instructions for using several basic features of the TAS 455 and TAS 465 Analog Oscilloscopes.

Displaying Repetitive Signals

Repetitive signals have a recurring pattern, where the amplitude and frequency do not change from one cycle to the next. The following steps describe how to display a repetitive signal, although pressing the **AUOTSET** button performs these tasks for you.

1. Adjust the vertical **POSITION** control to display the waveform at vertical center and the **VOLTS/DIV** control to provide the resolution desired.
2. Press the **TRIGGER MENU** button and set your triggering environment as desired from the menu choices.
3. Press the **VERTICAL MENU** button and set your vertical environment as desired from the menu choices.
4. Adjust the horizontal **POSITION** control to center the display horizontally and adjust the **SEC/DIV** control to display at least one complete cycle of the waveform.

Magnifying Your Signal

The **MAG** button horizontally magnifies the sweep by a factor of ten. This can be very useful in viewing a fast signal transition.

1. Connect the probe to the **PROBE COMP** output on the front panel and press **AUTOSET**.
2. Adjust the volts/div scale to obtain one complete cycle of the waveform for every horizontal division.
3. Press the **MAG** button, expanding the waveform horizontally by a factor of ten.

Take all measurements as usual, noting that the displayed readout for the sec/div scale has now increased by a factor of ten and the $\times 10$ indicator appears next to the sec/div scale. Refer to Figure 3-6.

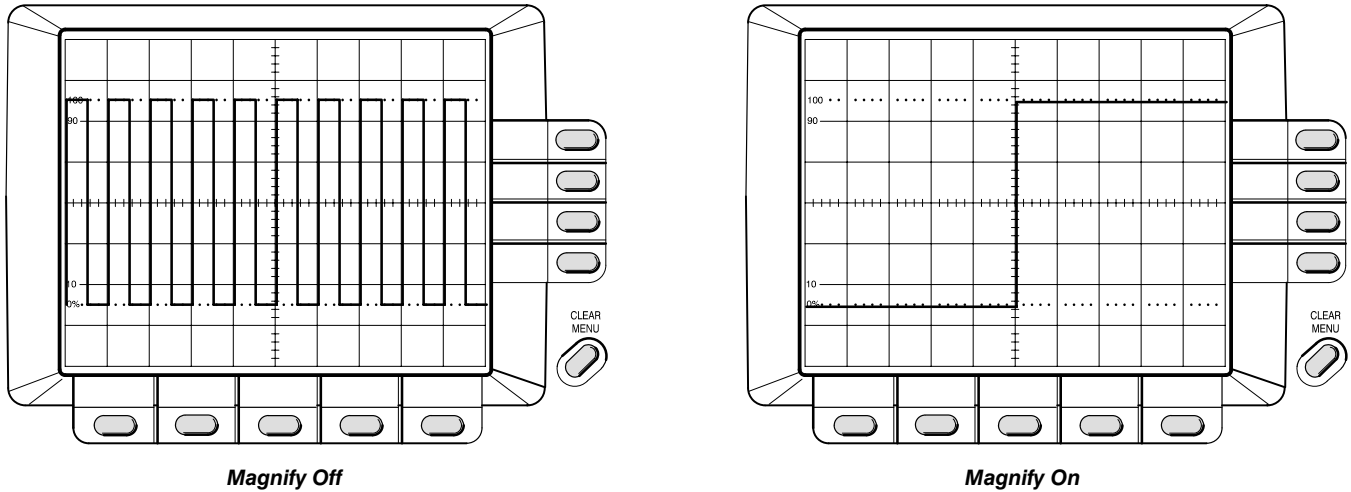
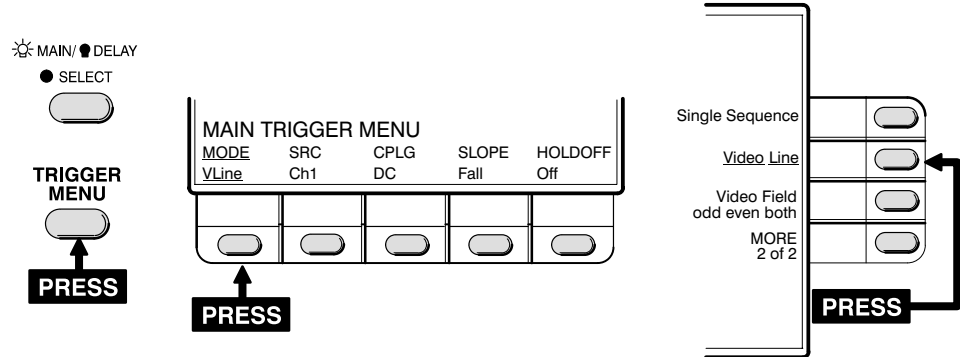


Figure 3-6: Horizontal Magnification

Displaying Video Signals

Video signals contain both horizontal and vertical sync pulses. The trigger system has modes to identify either of these pulses and produce a trigger.

1. Set the trigger mode to video line or video field (use the following guide).



2. Set the **SRC** to the appropriate trigger source.
3. Set the **SLOPE** to **Falling** for a standard composite video signal. Select **Rising** for inverted video signals.
4. Set the vertical and horizontal controls to produce the desired display. Figure 3-7 illustrates a typical triggered TV signal.

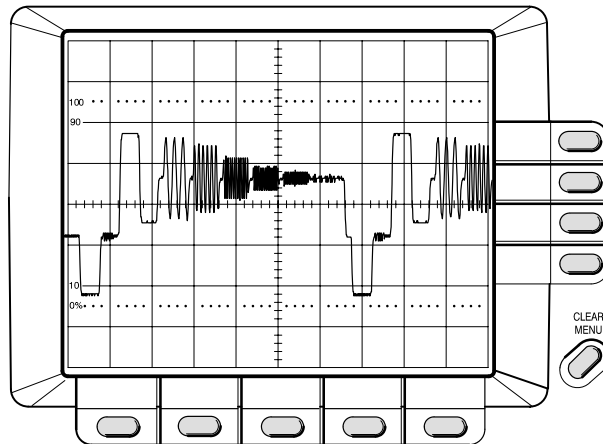


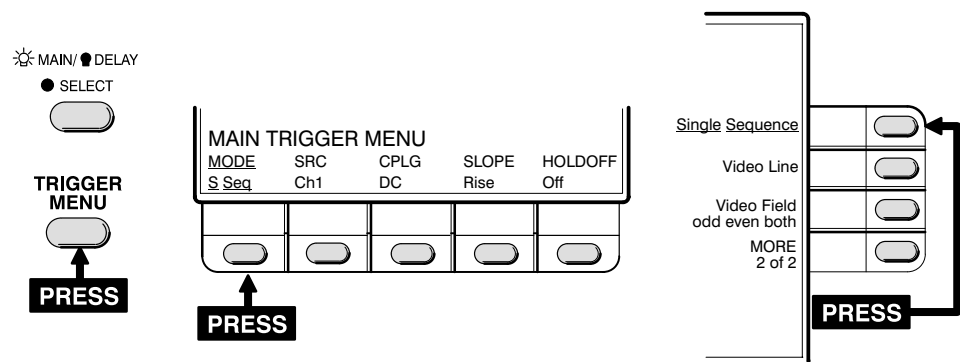
Figure 3-7: Multiburst Signal Triggered in TV Line

Using Single Sequence

The single sequence trigger mode allows one sweep of all displayed channels to occur for each trigger event. Another sweep cannot occur until the trigger circuit is re-armed.

Use single sequence mode to display and photograph either nonrepetitive signals or signals that cause unstable displays.

1. Set the vertical and horizontal controls as desired.
2. Press the **TRIGGER MENU** button to display the trigger menu choices and set the **MODE** to **Single Sequence** (use the following guide).



3. Set the readout and cursors display options by pressing the **UTILITY** button and selecting the appropriate choices with the menu select buttons. See page A-7 for a description of the utility menus.
4. Press the **RESET S SEQ** button, lighting the **READY** LED. The LED will remain lit until the instrument receives an appropriate trigger signal.

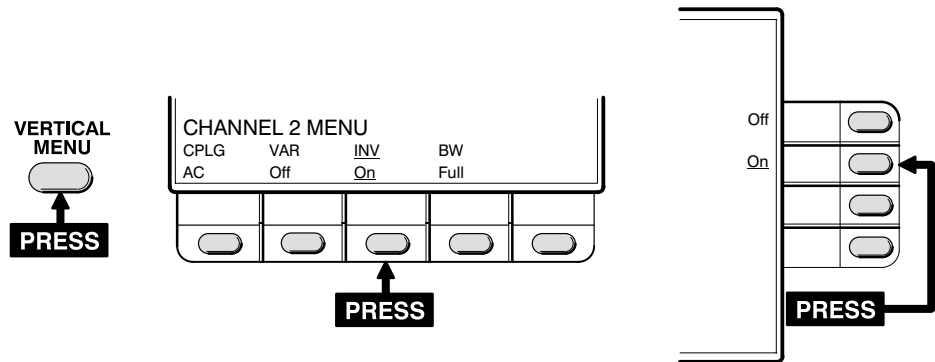
The **MAIN SWP TRIG'D** LED lights to indicate an adequate trigger signal is present for the main sweep.

Performing Waveform Math

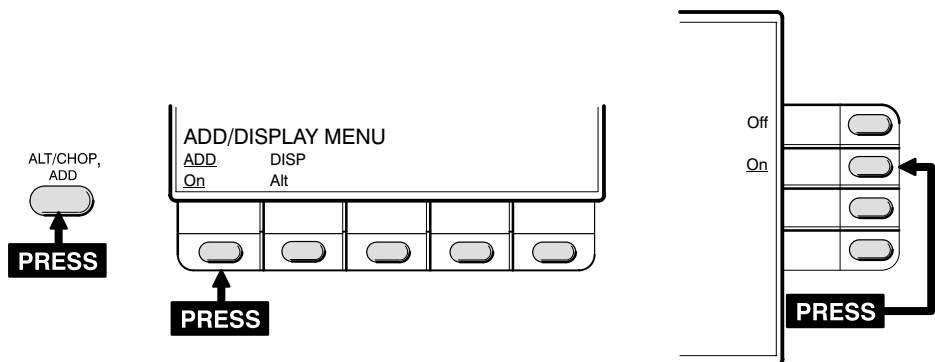
The TAS 455 and TAS 465 Oscilloscopes provide a feature that allows you to add two separate signals, creating a third signal. With this feature you can see the results of adding two signals together or removing unwanted components of a signal. A + symbol appears to the left of the channel 2 readout when add mode is on.

This procedure demonstrates how to use the add feature of the TAS 455 and TAS 465 Oscilloscopes by solving a common problem of having an AC line-frequency component mixed with another signal.

1. Using channel 1, obtain the signal containing the unwanted AC line-frequency component mixed with another signal.
2. Using channel 2, obtain the AC line-frequency component only.
3. Invert the channel 2 signal (use the following guide). The invert indicator ↓ appears in the channel 2 readout display.



4. Set add mode to on (use the following guide).



The instrument displays a third waveform that shows the result of adding the two waveforms together. Figure 3-8 shows an example of subtracting (using invert) waveforms.

Vertical position of the added waveform is affected by the vertical position of the added channels.

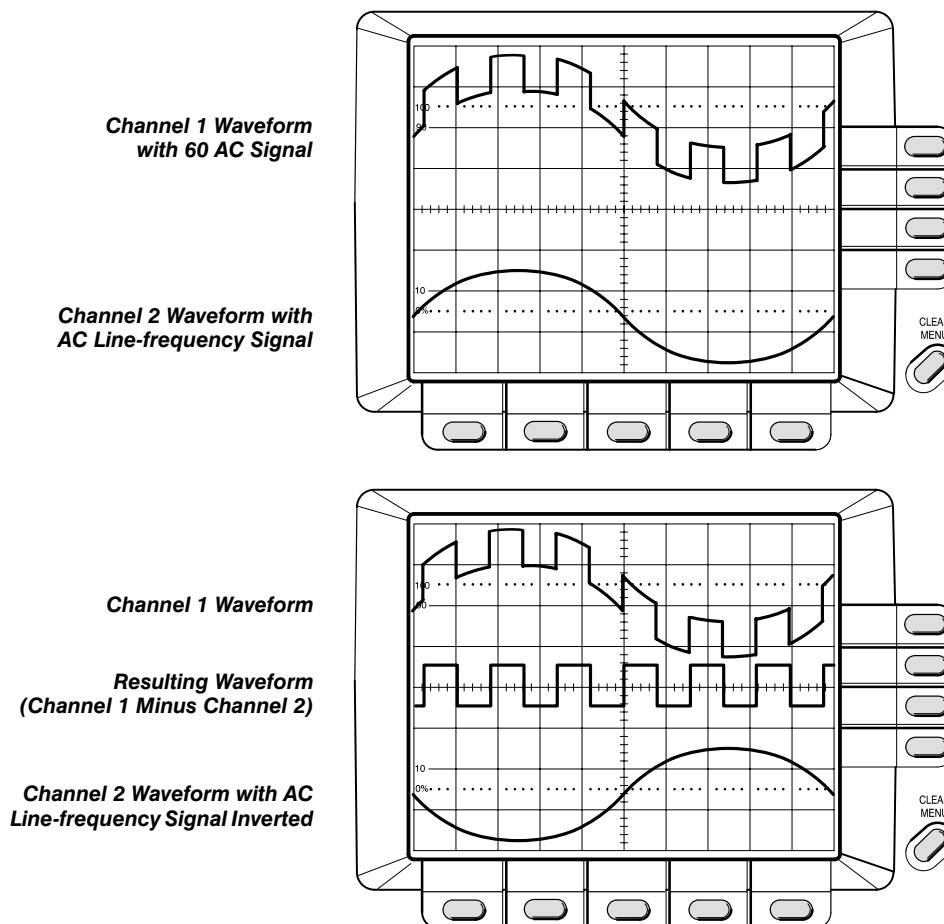
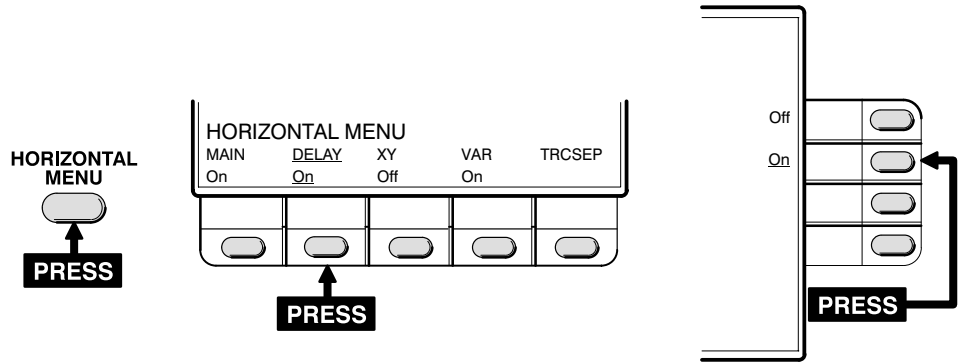


Figure 3-8: Subtracting Components of a Waveform

Using the Delayed Sweep with Delayed Triggering

Delayed triggering allows you to set a time delay from the triggering event for the main sweep to start the delayed sweep. This enables you to effectively increase the resolution of a portion of the main sweep by displaying a segment of the main sweep using the delayed sweep.

1. Connect **CH 1** to the **PROBE COMP** signal using the standard accessory probe.
2. Press the **AUTOSET** button.
3. Use the **SEC/DIV** control to set the sec/div scale to 2 ms.
4. Turn the delayed sweep on (use the following guide).

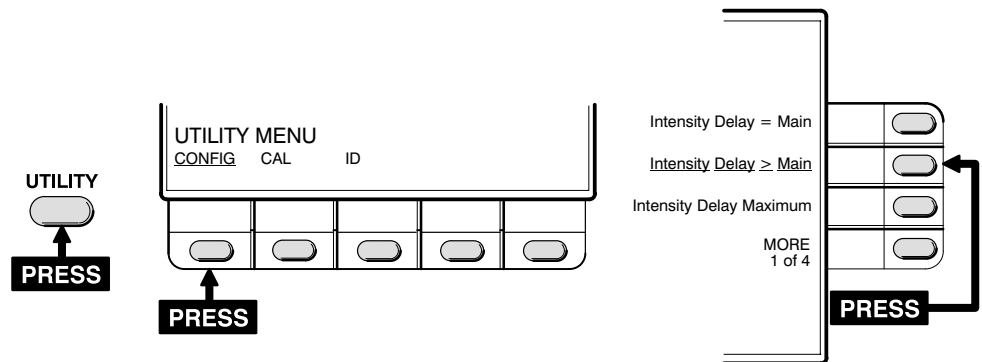


This extinguishes the LED for the **MAIN/DELAY SELECT** button, indicating that the trigger and horizontal controls are now assigned to the delayed sweep.

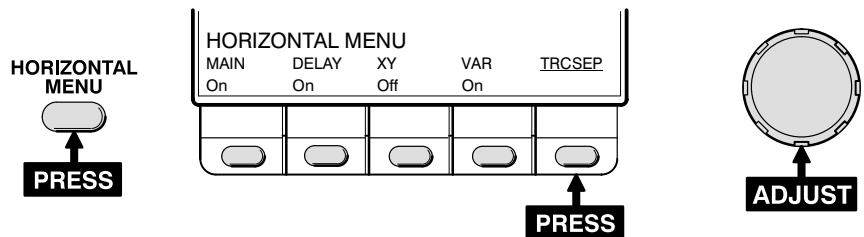
NOTE

The intensity ratio between the two sweeps can be set to help differentiate between them. See the Utility functions on page A-7 to set this ratio.

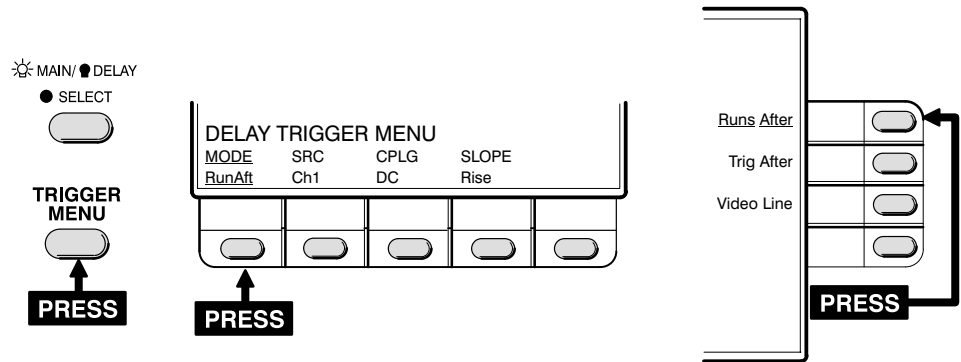
5. Press the **UTILITY** button and select **CONFIG** from the main menu.
6. Select **MORE** until you can select the intensity level ratio for the delayed sweep (use the following guide).



7. Adjust the trace separation to vertically separate the main and delayed sweeps (use the following guide).

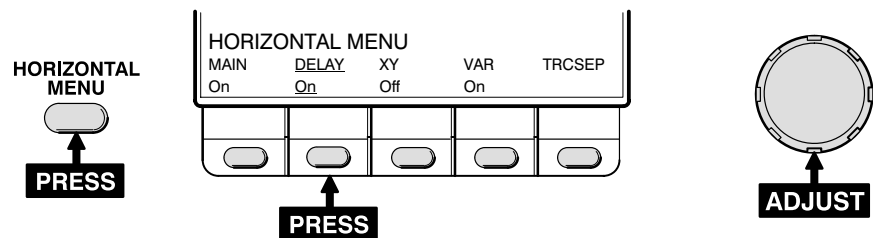


8. Set the trigger mode to runs after (use the following guide).



This causes the delayed sweep to start after the time delay setting regardless of a trigger.

9. Use the **SEC/DIV** control to set the delayed sec/div scale to 200 μ s.
 10. Adjust the delay time (move the intensified zone) using the General Purpose Knob. Use the following guide.



You now have a display that consists of the main sweep with an intensified portion and a delayed sweep of the intensified portion (see Figure 3-9).

NOTE

You cannot set the delayed sweep sec/div scale to a slower speed than the main sweep. When the delayed sweep scale matches the main sweep scale, further reduction of the delayed sweep scale also affects the main sweep scale. When the main sweep scale matches the delayed sweep scale, further increases of the main sweep scale also affects the delayed sweep scale.

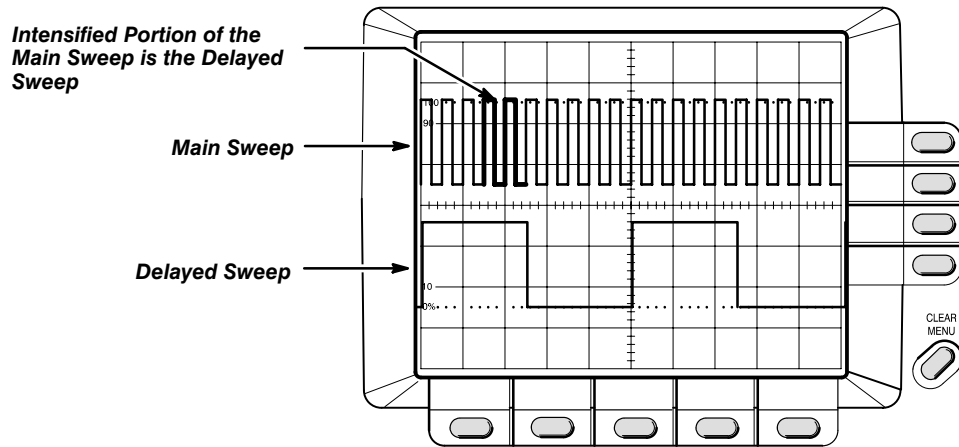
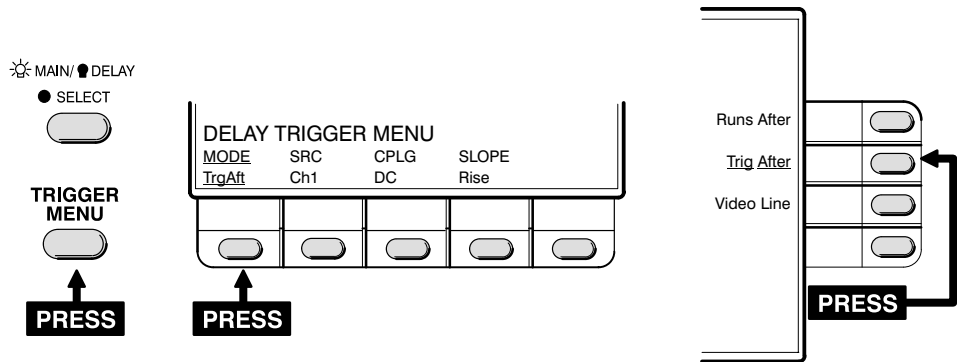


Figure 3-9: Using the Delayed Sweep

- Set the trigger mode to trig after, causing the delayed sweep to start after the delay setting and an appropriate trigger (use the following guide).

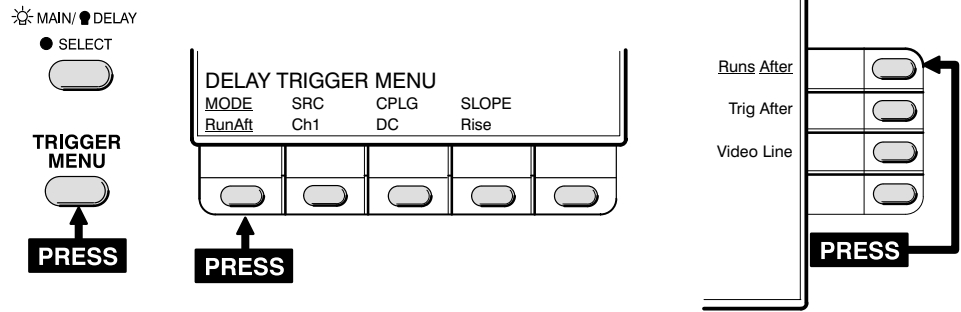


At this point, the two waveforms are still displayed, since an appropriate trigger signal is available. Adjusting the trigger **LEVEL** control out of the range of the waveform causes the delayed sweep to stop, since an appropriate trigger signal is no longer available.

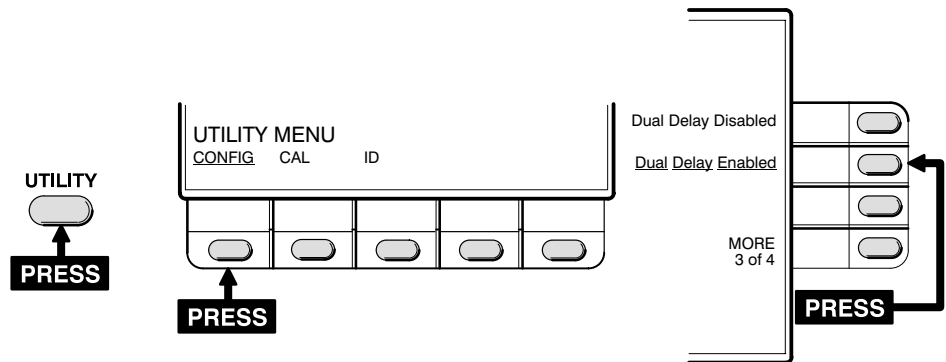
Using Dual Delay

Dual delay displays two intensified zones on the main sweep, each defining the start point of a delayed sweep. This method more accurately measures time between two points on the main sweep than obtained with the measurement cursors.

- Set the trigger mode to runs after (use the following guide).

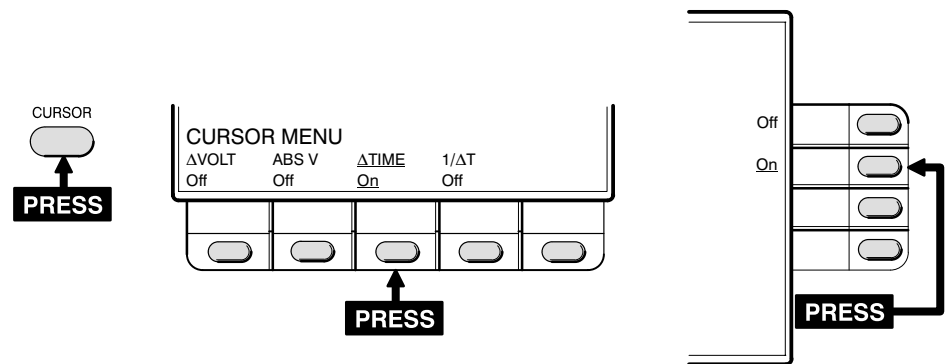


2. Press the **UTILITY** button and select **CONFIG** from the main menu.
3. Select **MORE** until you can select **Dual Delay Enabled** (use the following guide).



4. Press the **CURSOR** button and set Δ TIME to **On** (use the following guide).

Notice that turning a measurement cursor on automatically turns a previously selected measurement cursor off.



5. Set the delay sec/div scale to 100 μ s.
You now have two intensified zones displayed on the main sweep.
6. Adjust the position of the intensified zones using the General Purpose Knob. Use the **TOGGLE** button to select which zone to move.

Notice that the delayed sweep now consists of two delayed sweeps, each representing one of the intensified zones. When the two delayed sweeps appear as one, the intensified zones are at exactly the same position of the cycle of the main sweep. Figure 3-10 shows the intensified portions on the main sweep and the delayed sweeps positioned together.

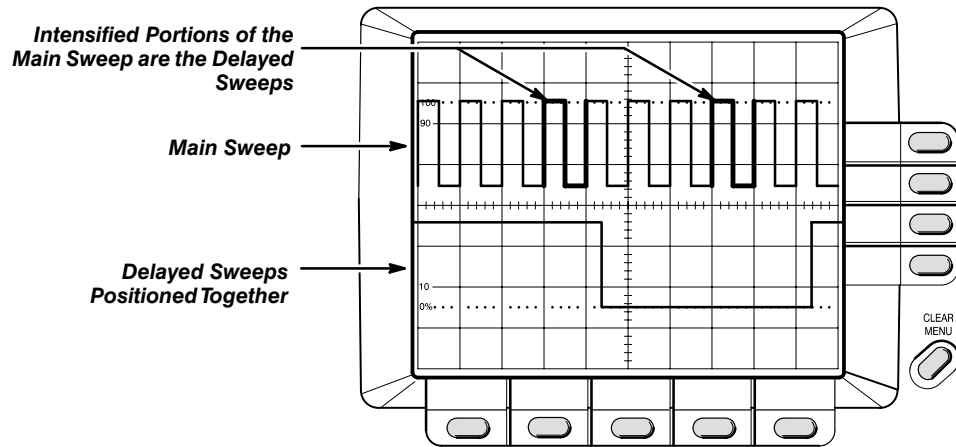


Figure 3-10: Using Dual Delay

Saving and Recalling Front Panel Setups

The TAS 455 and TAS 465 Oscilloscopes provide four locations for you to store front-panel settings. This feature is very helpful when you have completed a complex front panel setup and you want to be able to recall the setup later.

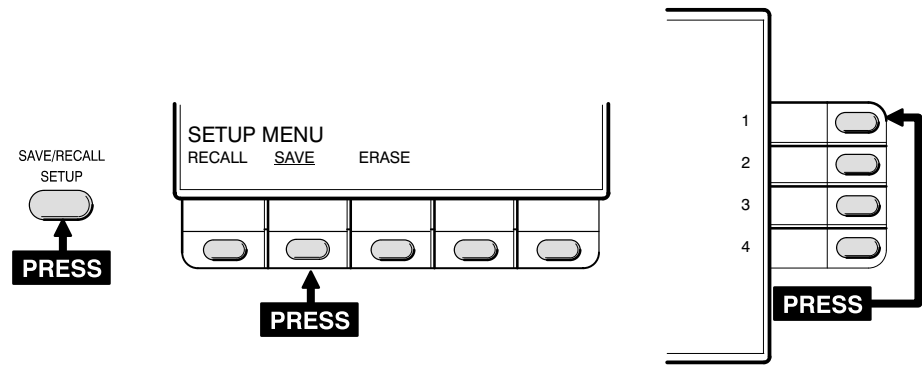
Saving a Setup

Use this procedure to save a front-panel setup.

1. Press the **SAVE/RECALL SETUP** button to display the setup menu.
2. Select **SAVE** and memory location **1**, placing the setup in memory location one (use the following guide).

NOTE

Selecting a location previously used will replace the old settings with the new settings. Setup locations underscored contain a stored front-panel setup.



Once you have saved a particular front-panel setup, you can change the settings as you wish, knowing that you can retrieve the original setup at any time.

Recalling a Setup

Use this procedure to recall a front-panel setup.

1. Press the **SAVE/RECALL SETUP** button to display the setup menu.
2. Select **RECALL** with the menu buttons.
3. Select the location from which you want to retrieve the front-panel settings (setup 1 through setup 4). Setup locations underscored contain a front-panel setup.

The oscilloscope returns the front-panel settings to those in the selected setup location.

Erasing a Setup

If you wish, you can erase any setup location.

1. Press the **SAVE/RECALL SETUP** button to display the setup menu.
2. Select **ERASE** with the menu buttons.
3. Select the location you wish to erase (setup 1 through setup 4). Setup locations underscored contain a front-panel setup.

The selected setup location is now empty.

Taking Measurements

This section provides procedures for taking several different types of measurements related to time and voltage. Since the cursor measurement system takes measurements easily and quickly, all measurements discussed in this section use the cursors.

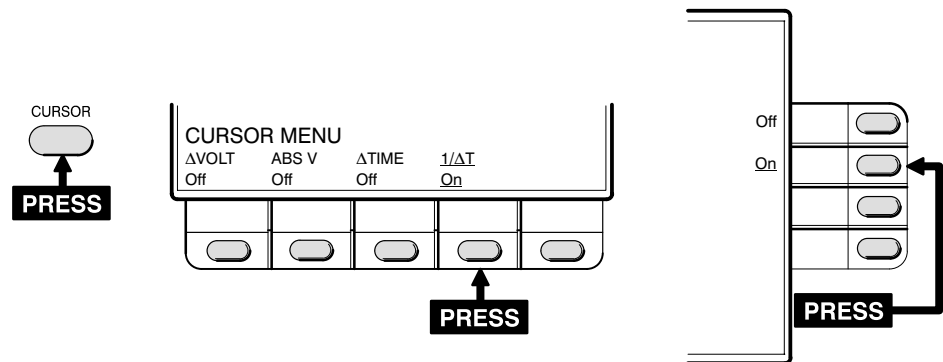
Taking Time Related Measurements

You can take frequency, period, and time between event measurements with the cursor measurement system. The following procedures provide you with quick and easy methods to take these measurements.

Measuring the Frequency and Period

Measuring the frequency and period of a waveform are both time related measurements. You measure frequency in hertz (Hz) and period in seconds.

1. Obtain a stable display with at least one complete cycle of the waveform displayed.
2. Turn the $1/\Delta T$ cursors on to measure frequency (use the following guide).



3. Using the General Purpose Knob, move the active cursor along the waveform to a starting point for the measurement. A good place for this first cursor is midway on the rising portion of the waveform.
4. Press the **TOGGLE** button to activate the second cursor. Using the General Purpose Knob, move this second cursor to the same position on the waveform that is one complete cycle away. See Figure 3-11 for placement of cursors.
5. After you place the cursors, read the frequency of the waveform displayed in Hz on the CRT.

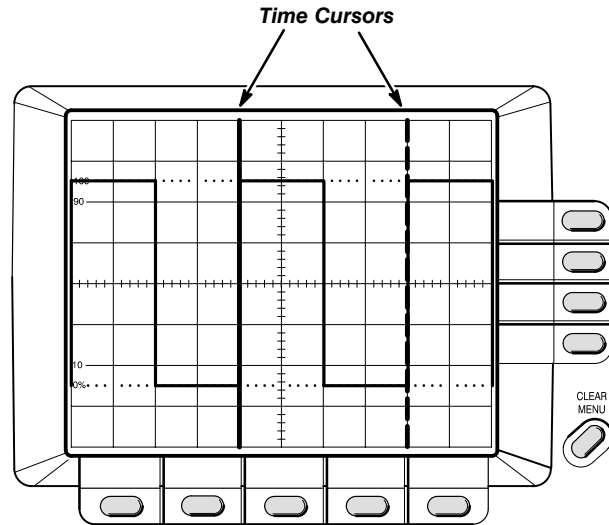
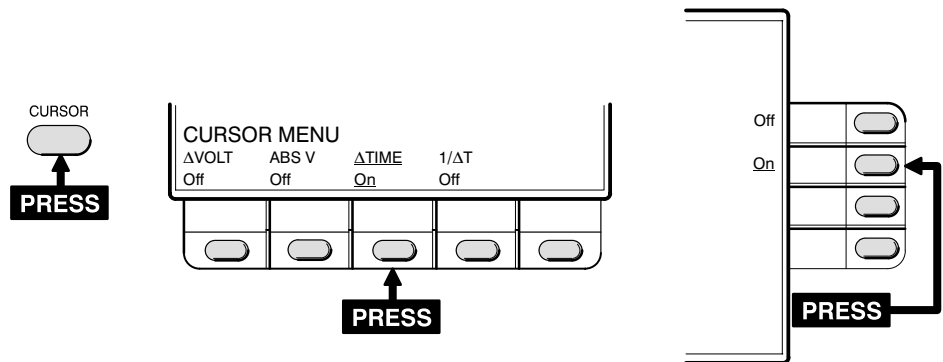


Figure 3-11: Measuring the Frequency of a Waveform

6. Change the displayed measurement from frequency to time by turning the Δ TIME cursors on (use the following guide).



NOTE

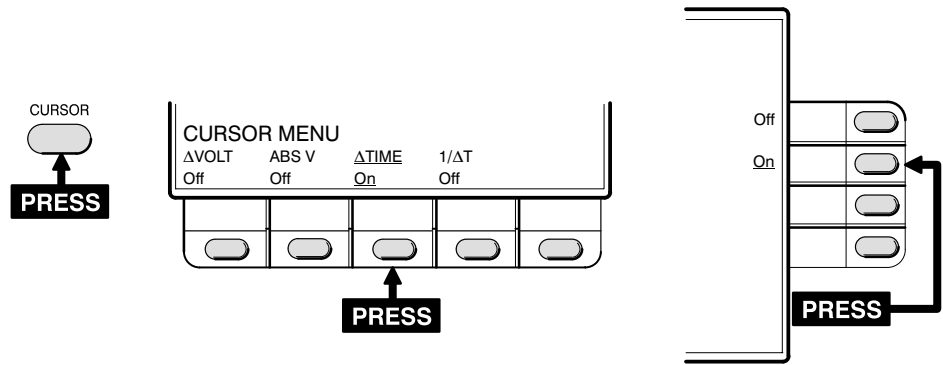
Do not move the placement of the cursors. Use the same waveform and cursor placement, as used in the frequency measurement, to measure the period.

7. Read the period of the waveform displayed in seconds on the CRT.

Measuring Pulse Width

You can measure a pulse width with the time measurement cursors.

1. Obtain a stable display with at least one complete cycle of the waveform displayed.
2. Turn the Δ TIME cursors on (use the following guide).



- Use the General Purpose Knob to move the active cursor along the waveform to a starting point for the measurement.
- Press the **TOGGLE** button to activate the second cursor. Use the General Purpose Knob to move this second cursor to the place on the waveform where you want to measure time in relation to the first cursor.

Placing the cursors at the rising edge and the falling edge gives the pulse width measurement. See Figure 3-12 for placement of cursors.

- The time (pulse width) in seconds appears on the CRT.

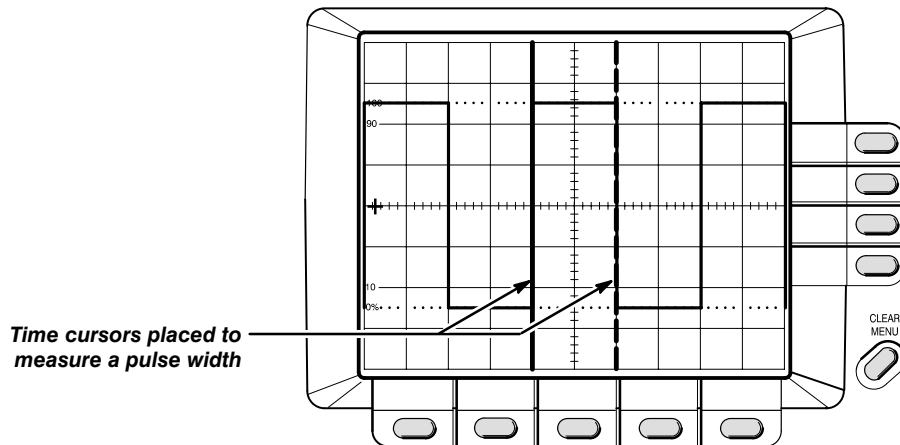


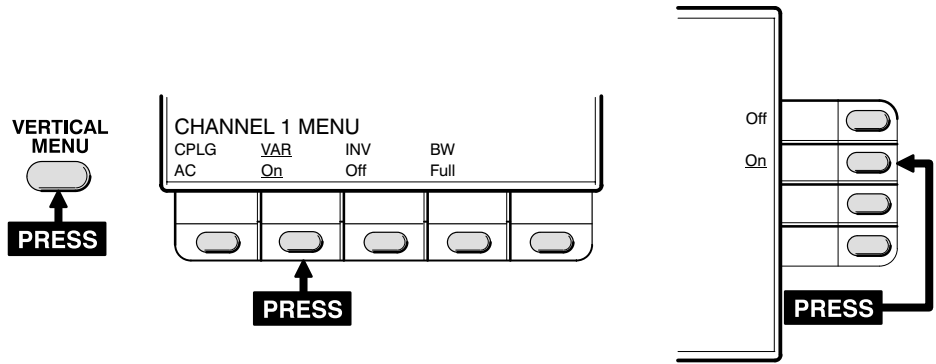
Figure 3-12: Taking Time Measurements

Taking Rise/Fall Time Measurements

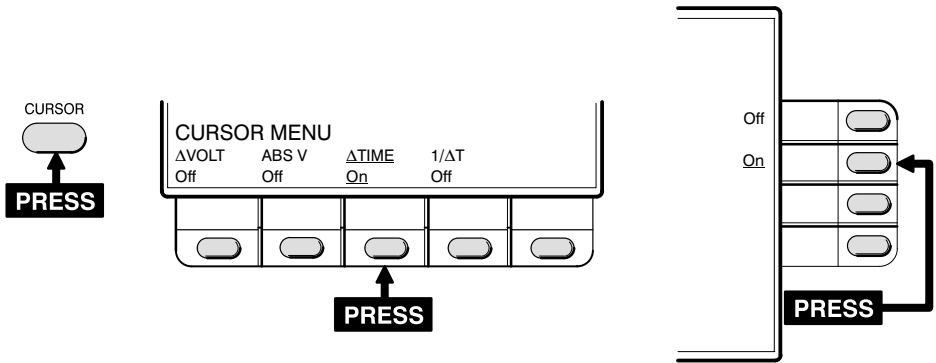
Typically, you measure the rise and fall times between the 10% and 90% portions of the waveform. See Figure 3-13 to help take these measurements.

- Obtain a stable display with at least one complete cycle of the waveform displayed.
- Adjust the sec/div scale to display the rising or falling edge of the waveform.

- Set the variable volts/div to on (use the following guide).



- Adjust the volts/div scale, vertical position, and the General Purpose Knob (to adjust the variable gain) to obtain a centered six-division signal.
- Set the time measurement cursors on (use the following guide).



- Use the General Purpose Knob to move the active cursor to the point on the waveform where it crosses the 10% location of the waveform. This location is marked on the CRT graticule. See Figure 3-13 for placement of cursors.

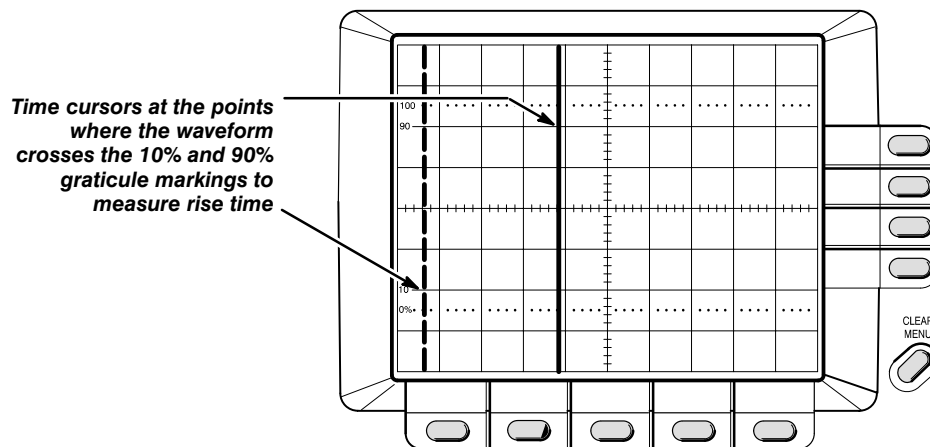


Figure 3-13: Taking Rise/Fall Time Measurements

7. Press the **TOGGLE** button to activate the second cursor. Using the General Purpose Knob, move this second cursor to the 90% location of the waveform. This location is marked on the CRT graticule.
8. The rise time in seconds appears on the CRT.

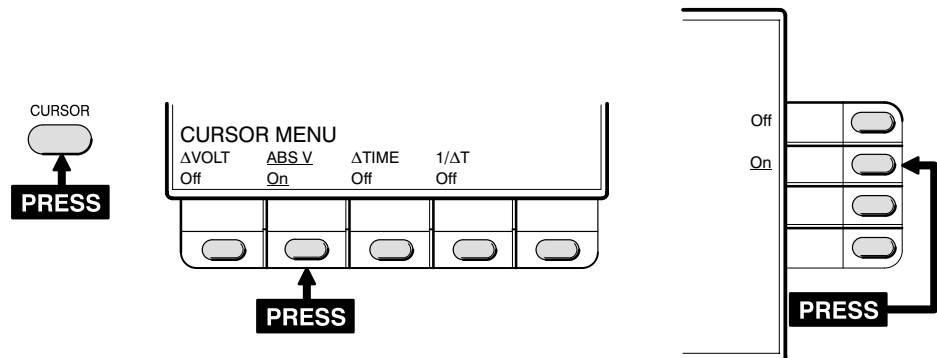
Taking Voltage Related Measurements

You can take voltage measurements either as an absolute value or a differential (delta) value. Absolute voltage measurement is the voltage referenced to ground. Differential voltage measurement is the difference between the two cursors, typically referred to as the delta (Δ) value.

Absolute Voltage Measurement

The absolute volts measurement measures the DC value of a signal or a plain DC voltage. Only one cursor is active for this type of measurement.

1. Obtain a stable display.
2. Set vertical coupling to DC and adjust the volts/div scale and position to view the waveform.
3. Set the cursors to measure the absolute voltage (use the following guide).



4. Using the General Purpose Knob, move the cursor along the waveform to obtain the DC voltage level referenced to ground. See Figure 3-14 for placement of cursor.
5. The voltage appears on the CRT.

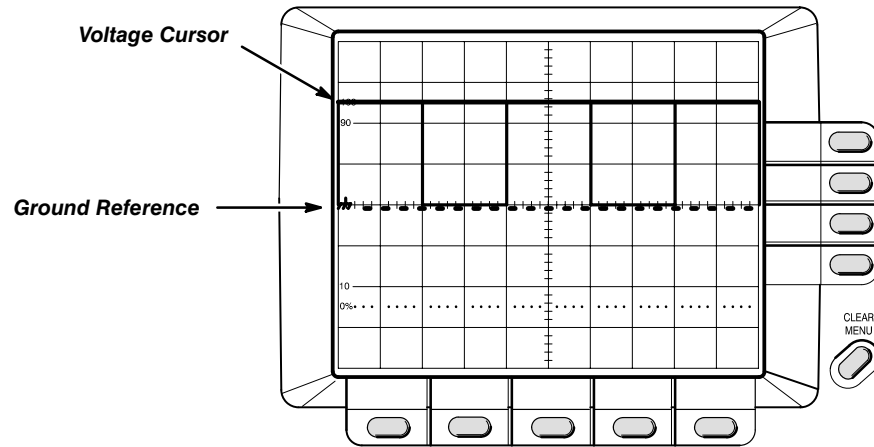
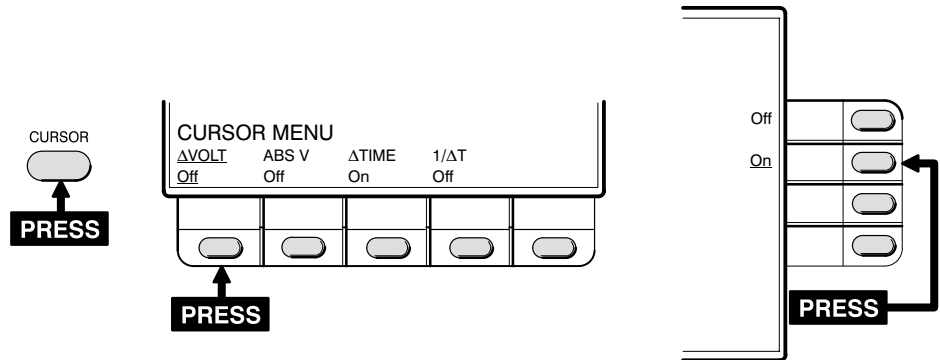


Figure 3-14: Taking an Absolute Voltage Measurement

Delta Voltage Measurement

The delta volts measurement measures the volts between the two horizontal cursors.

1. Obtain a stable display.
2. Set the cursors to measure delta volts (use the following guide).



3. Use the General Purpose Knob to move the first cursor along the waveform as a reference point for the measurement.
4. Press the **TOGGLE** button to activate the second cursor. Use the General Purpose Knob to move this second cursor along the waveform to the point where you want to make the measurement in reference to the placement of the first cursor. See Figure 3-15 for placement of cursors.
5. The delta voltage appears on the CRT.

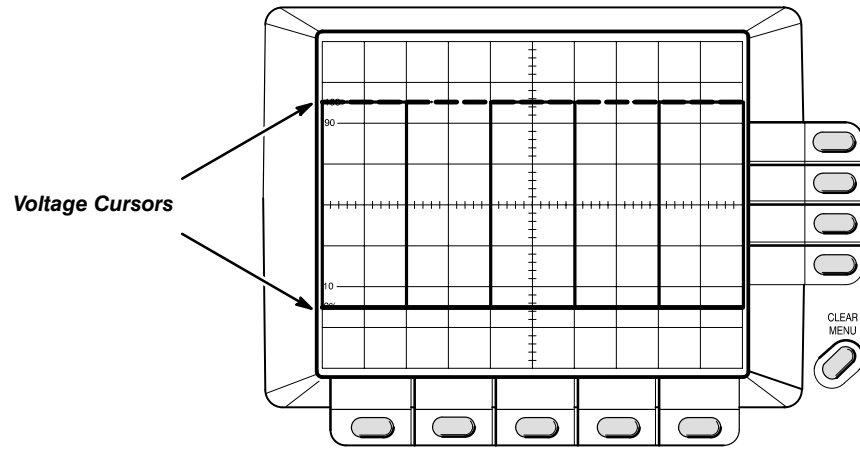


Figure 3-15: Taking a Delta Voltage Measurement

Taking Measurements

Specifications

Nominal Traits

This subsection contains a collection of tables that list the various *nominal traits* that describe the TAS 455 and TAS 465 Analog Oscilloscopes. Included are electrical and mechanical traits.

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

Table 4-1: Nominal Traits — Vertical Deflection System

Name	Description
Number of Input Channels	Two, both identical, called CH 1 and CH 2.
Input Coupling	DC, AC, or GND. GND input coupling disconnects the input connector from the attenuator and connects a ground reference to the input of the attenuator.
Sensitivity Range	2 mV/div to 5 V/div. The sensitivity ranges from 2 mV/div to 5 V/div in a 1–2–5 sequence.
Trace Separation Control Range	≥ ±4 divisions.
Bandwidth Selections	20 MHz and FULL, selected independently for each channel.
TAS 455 Rise Time	≤ 5.8 ns. Nominal rise times are calculated from the following formula: $Rise\ Time\ (ns) = \frac{350}{BW\ (MHz)}$
TAS 465 Rise Time	≤ 3.5 ns. Nominal rise times are calculated from the following formula: $Rise\ Time\ (ns) = \frac{350}{BW\ (MHz)}$
Vertical Position Range	≥ ±10 divisions from graticule center.
TekProbe Interface	Detects 1X, 10X, and 100X attenuator probes.

Table 4-2: Nominal Traits — Time Base System

Name	Description
Main Seconds/Division Range	20 ns/div to 0.5 s/div. The seconds/division ranges from 20 ns/div to 0.5 s/div in a 1–2–5 sequence of settings. The X10 magnifier extends the maximum sweep speed to 2 ns/div.
Delayed Seconds/Division Range	20 ns/div to 5 ms/div. The seconds/division ranges from 20 ns/div to 5 ms/div in a 1–2–5 sequence of settings. The X10 magnifier extends the maximum sweep speed to 2 ns/div.
Sweep Length	> 10 divisions.
Delay Control Range	0.15 division to 10 times the Main seconds/division setting. The maximum value can not exceed the end of the Main sweep.
Delta Time Control Range	0 to 10 divisions to the right of setting of the delay control, but maximum value does not exceed end of the Main sweep.

Table 4-3: Nominal Traits — Triggering System

Name	Description										
Trigger Level or Threshold Ranges	The ranges are as follows:										
	<table border="1"> <thead> <tr> <th>Source</th> <th>Range</th> </tr> </thead> <tbody> <tr> <td>Internal</td> <td>±15 divisions from center of screen with ground at center graticule.</td> </tr> <tr> <td>External 1X</td> <td>±1.5 V.</td> </tr> <tr> <td>External 10X</td> <td>±15 V.</td> </tr> <tr> <td>Line</td> <td>±400 V.</td> </tr> </tbody> </table>	Source	Range	Internal	±15 divisions from center of screen with ground at center graticule.	External 1X	±1.5 V.	External 10X	±15 V.	Line	±400 V.
Source	Range										
Internal	±15 divisions from center of screen with ground at center graticule.										
External 1X	±1.5 V.										
External 10X	±15 V.										
Line	±400 V.										

Table 4-4: Nominal Traits — Video Triggering System

Name	Description
Slope Selection	Slope selection must match the polarity of the sync (i.e., for negative going sync, negative slope must be selected). A default slope selection for TV trigger modes can be entered in the scope configuration menu.

Table 4-5: Nominal Traits — Cursors

Name	Description
Cursor Functions	Δ Time, $1/\Delta$ Time, Absolute Volts, Δ Volts, Track Trig Level, Ground.

Table 4-6: Nominal Traits — XY Operation

Name	Description
Sensitivity Range	Same as Vertical Deflection System. Volts/div variables in calibrated settings.

Table 4-7: Nominal Traits — Setup Memory Characteristics

Name	Description
Nonvolatile Setup Memory	4 Setups.

Table 4-8: Nominal Traits — Power Fuse (Serial Number B020099 and Below)

Name	Description									
Fuse Rating (Serial Number B020099 and Below)	Either of two fuses may be used. Fuse types are as follows:									
	<table border="1"> <thead> <tr> <th><i>Voltage Range</i></th> <th><i>Fuse (250 V) UL 198.6 (5 × 20 mm)</i></th> <th><i>Fuse (250 V) IEC 127 (5 × 20 mm)</i></th> </tr> </thead> <tbody> <tr> <td>90 — 132 VAC</td> <td>3 A Fast.</td> <td>3.15 A Fast.</td> </tr> <tr> <td>180 — 250 VAC</td> <td>3 A Fast.</td> <td>1.5 A Fast.</td> </tr> </tbody> </table>	<i>Voltage Range</i>	<i>Fuse (250 V) UL 198.6 (5 × 20 mm)</i>	<i>Fuse (250 V) IEC 127 (5 × 20 mm)</i>	90 — 132 VAC	3 A Fast.	3.15 A Fast.	180 — 250 VAC	3 A Fast.	1.5 A Fast.
	<i>Voltage Range</i>	<i>Fuse (250 V) UL 198.6 (5 × 20 mm)</i>	<i>Fuse (250 V) IEC 127 (5 × 20 mm)</i>							
	90 — 132 VAC	3 A Fast.	3.15 A Fast.							
180 — 250 VAC	3 A Fast.	1.5 A Fast.								

Table 4-9: Nominal Traits — Power Fuse (Serial Number B020100 and Above)

Name	Description						
Fuse Rating (Serial Number B020100 and Above)	Either of two fuses may be used. Fuse types are as follows:						
	<table border="1"> <thead> <tr> <th><i>Voltage Range</i></th> <th><i>Fuse (250 V) UL 198.6 (5 × 20 mm)</i></th> <th><i>Fuse (250 V) IEC 127 (5 × 20 mm)</i></th> </tr> </thead> <tbody> <tr> <td>90 — 250 VAC</td> <td>3 A Fast.</td> <td>3.15 A Fast.</td> </tr> </tbody> </table>	<i>Voltage Range</i>	<i>Fuse (250 V) UL 198.6 (5 × 20 mm)</i>	<i>Fuse (250 V) IEC 127 (5 × 20 mm)</i>	90 — 250 VAC	3 A Fast.	3.15 A Fast.
	<i>Voltage Range</i>	<i>Fuse (250 V) UL 198.6 (5 × 20 mm)</i>	<i>Fuse (250 V) IEC 127 (5 × 20 mm)</i>				
	90 — 250 VAC	3 A Fast.	3.15 A Fast.				

Table 4-10: Nominal Traits — Mechanical

Name	Description
Weight	Weights that follow are nominal: <ul style="list-style-type: none"> ■ 7.7 kg (17 lbs.), stand-alone instrument. ■ 9.3 kg (20.5 lbs.), with front cover, accessories and accessories pouch installed. ■ 13.6 kg (30 lbs.), when packaged for domestic shipment.
Overall Dimensions	Dimensions that follow are nominal: Height: <ul style="list-style-type: none"> ■ 191 mm (7.5 in.), when feet and accessories pouch are installed. ■ 165 mm (6.5 in.), without the accessories pouch installed. Width: <ul style="list-style-type: none"> ■ 362 mm (14.25 in.), with handle. Depth: <ul style="list-style-type: none"> ■ 471 mm (18.55 in.), stand-alone instrument. ■ 490 mm (19.28 in.), with optional front cover installed. ■ 564 mm (22.20 in.), with fully handle extended.
Cooling Method	Forced-air circulation with no air filter.
Finish Type	Tektronix Blue textured paint finish on an aluminum cabinet.
Construction Material	Chassis parts constructed of aluminum alloy; front panel constructed of plastic laminate; circuit boards constructed of glass-laminate. Tektronix Blue textured paint finish on an aluminum cabinet. Plastic parts are polycarbonate.
Weight of rackmounted instrument and the rackmount conversion kit	Weights that follow are nominal: <ul style="list-style-type: none"> ■ 4.5 kg (10 lbs.), for the rackmount conversion kit only; 7.9 kg (17.5 lbs.), when kit is packaged for domestic shipping. ■ 7.3 kg (16 lbs.) plus weight of rackmount Parts, for the rack-mounted instrument (option 3R). ■ 15.4 kg (34 lbs.), when the rackmounted instrument is packaged for domestic shipment (no manuals tray).
Overall Dimensions of the rackmount instrument	Dimensions that follow are nominal: <ul style="list-style-type: none"> ■ Height: 178 mm (7 in.). ■ Width: 483 mm (19 in.). ■ Depth: 472 mm (18.6 in.). Including handles: 517 mm (20.35 in.).

Warranted Characteristics

This subsection lists the various *warranted characteristics* that describe the TAS 455 and TAS 465 Analog Oscilloscopes. Included are electrical and environmental characteristics.

Warranted characteristics are described in terms of quantifiable performance limits which are warranted. This subsection lists only warranted characteristics. A list of *typical characteristics* starts on page 4-13.

NOTE

*In these tables, those warranted characteristics that are checked in the Performance Verification procedure, found in Section 6, appear in **boldface type** under the column Name.*

Performance Conditions

The electrical characteristics found in these tables of warranted characteristics apply under the following conditions:

- The oscilloscope has been adjusted at an ambient temperature between +20° C and +30° C
- A warm-up period of at least 20 minutes has occurred
- The operating temperature is between –10° C and +55° C (unless otherwise noted)
- The Temperature Compensation Calibrations (signal path compensation) have been performed

Table 4-11: Warranted Characteristics — Vertical Deflection System

Name	Description						
Input Impedance, DC Coupled	1 MΩ ±1% in parallel with 20 pF ±2.0 pF.						
Variable Range	Increases deflection factor by ≥ 2.5:1.						
DC Gain Accuracy	The limits are as follows:						
	<table border="1"> <thead> <tr> <th><i>Condition</i></th> <th><i>Accuracy</i></th> </tr> </thead> <tbody> <tr> <td>+15° C to +35° C</td> <td>±2.5% over the center 5 divisions after signal path compensation.</td> </tr> <tr> <td>–10° C to +15° C and +35° C to +55° C</td> <td>±3.5% over the center 5 divisions after signal path compensation.</td> </tr> </tbody> </table>	<i>Condition</i>	<i>Accuracy</i>	+15° C to +35° C	±2.5% over the center 5 divisions after signal path compensation.	–10° C to +15° C and +35° C to +55° C	±3.5% over the center 5 divisions after signal path compensation.
<i>Condition</i>	<i>Accuracy</i>						
+15° C to +35° C	±2.5% over the center 5 divisions after signal path compensation.						
–10° C to +15° C and +35° C to +55° C	±3.5% over the center 5 divisions after signal path compensation.						

Warranted Characteristics

Table 4-11: Warranted Characteristics — Vertical Deflection System (Cont.)

Name	Description								
TAS 455 Bandwidth at the BNC input and probe tip, using the Standard-Accessory Probe	60 MHz.								
TAS 465 Bandwidth at the BNC input	100 MHz.								
TAS 465 Bandwidth at the probe tip, using the Standard-Accessory Probe	The limits are as follows:								
	<table border="1"> <thead> <tr> <th><i>Condition</i></th> <th><i>Bandwidth</i></th> </tr> </thead> <tbody> <tr> <td>+15° C to +35° C</td> <td>100 MHz.</td> </tr> <tr> <td>-10° C to +15° C and +35° C to +55° C</td> <td>90 MHz.</td> </tr> </tbody> </table>	<i>Condition</i>	<i>Bandwidth</i>	+15° C to +35° C	100 MHz.	-10° C to +15° C and +35° C to +55° C	90 MHz.		
<i>Condition</i>	<i>Bandwidth</i>								
+15° C to +35° C	100 MHz.								
-10° C to +15° C and +35° C to +55° C	90 MHz.								
Lower Frequency Limit, AC Coupled	<p>≤ 10 Hz with 1X probe.</p> <p>The AC Coupled Lower Frequency Limits are reduced by a factor of 10 when 10X, passive probes are used.</p>								
TAS 455 Crosstalk (Channel Isolation)	≥ 50 dB at 10 MHz, ≥ 35 dB at 60 MHz.								
TAS 465 Crosstalk (Channel Isolation)	≥ 50 dB at 10 MHz, ≥ 35 dB at 100 MHz.								
Delay Between Channels, Full Bandwidth	≤ 200 ps between channels 1 and 2 for equal volts/div and coupling settings.								
Common-mode Rejection Ratio (CMRR)	≥ 10:1 at ≤ 50 MHz.								
Trace Shift	The limits are as follows:								
	<table border="1"> <thead> <tr> <th><i>Condition</i></th> <th><i>Allowable Trace Shift</i></th> </tr> </thead> <tbody> <tr> <td>Changing volts/div settings</td> <td><±(0.1 division + 0.2 mV).</td> </tr> <tr> <td>Selecting invert</td> <td>≤ 0.5 division.</td> </tr> <tr> <td>Changing from bandwidth limit to full bandwidth</td> <td>≤ 0.1 division.</td> </tr> </tbody> </table>	<i>Condition</i>	<i>Allowable Trace Shift</i>	Changing volts/div settings	<±(0.1 division + 0.2 mV).	Selecting invert	≤ 0.5 division.	Changing from bandwidth limit to full bandwidth	≤ 0.1 division.
<i>Condition</i>	<i>Allowable Trace Shift</i>								
Changing volts/div settings	<±(0.1 division + 0.2 mV).								
Selecting invert	≤ 0.5 division.								
Changing from bandwidth limit to full bandwidth	≤ 0.1 division.								
Maximum Input Voltage	±400 V (DC + peak AC); derate at 20 dB/decade from 100 kHz to 13 V at 3 MHz.								
Low Frequency Linearity	Within ±5%.								

Table 4-12: Warranted Characteristics — Time Base System

Name	Description
Time Base Accuracy, Magnify Off	The limits are as follows:
	<i>Conditions</i> <i>Time Measurement Accuracy</i>
	+15° C to + 35° C ±2%.
	–10° C to + 15° C and +35° C to + 55° C ±3%.
	Sweep accuracy applies over the center eight divisions. Excludes the greater of either the first ¼ division or 25 ns from the sweep start of the magnified sweep and anything beyond the 100th magnified division.
Time Base Accuracy, Magnify On	The limits are as follows:
	<i>Conditions</i> <i>Time Measurement Accuracy</i>
	–10° C to + 55° C
	Excluding 5 ns/div and 2 ns/div ±3%.
	+15° C to + 35° C
	5 ns/div and 2 ns/div ±4%.
–10° C to + 15° C and +35° C to + 55° C	
5 ns/div and 2 ns/div ±5%.	
	Sweep accuracy applies over the center eight divisions. Excludes the greater of either the first ¼ division or 25 ns from the sweep start of the magnified sweep and anything beyond the 100th magnified division.
Horizontal Position Control Range	The position control is able to move the start of the sweep to the right of the center vertical graticule and able to move a time mark corresponding to the tenth division on an unmagnified sweep to the left of the graticule center.
Variable Control Range	Continuously variable between calibrated seconds/division settings. Extends both the Main and Delayed sweep seconds/division settings by a factor of 2.5 times.
Delay Accuracy, Main Sweep Trigger Point to Start of Delayed Sweep	±(0.5% of reading + 5% of 1 division of the Main sweep + 25 ns).
Delta Delay Accuracy	±(0.5% of reading + 5% of 1 division of the Main sweep + 10 ns).

Table 4-13: Warranted Characteristics — Triggering System

Name	Description		
TAS 465 Edge-Type Trigger Sensitivity, DC Coupled	The limits are as follows:		
	<i>Trigger Source</i> <i>Sensitivity</i>		
	Internal, Any Channel	0.30 division from DC to 25 MHz, increasing to 1 div at 150 MHz.	
	External X1	35 mV from DC to 25 MHz, increasing to 100 mV at 150 MHz.	
External X10	350 mV from DC to 25 MHz, increasing to 1 V at 150 MHz.		
TAS 455 Edge-Type Trigger Sensitivity, DC Coupled	The limits are as follows:		
	<i>Trigger Source</i> <i>Sensitivity</i>		
	Internal, Any Channel	0.30 division from DC to 25 MHz, increasing to 1 div at 100 MHz.	
	External X1	35 mV from DC to 25 MHz, increasing to 100 mV at 100 MHz.	
External X10	350 mV from DC to 25 MHz, increasing to 1 V at 100 MHz.		
Trigger Level or Threshold Accuracy	The limits are as follows for signals having rise and fall times ≥ 20 ns:		
	<i>Coupling</i> <i>Source</i> <i>Accuracy</i>		
	DC	All except Line and External	$\pm(5\%$ of reading + 0.4 division + 1 mV)
		External (X1)	$\pm(5\%$ of reading + 40 mV)
		External (X10)	$\pm(5\%$ of reading + 400 mV)
	Noise Reject	All except Line and External	$\pm(5\%$ of reading + 1.1 division + 1 mV)
		External (X1)	$\pm(5\%$ of reading + 110 mV)
		External (X10)	$\pm(5\%$ of reading + 1.1 V)
	HF Reject	All except Line and External	$\pm(5\%$ of reading + 0.35 division + 1 mV)
		External (X1)	$\pm(5\%$ of reading + 35 mV)
External (X10)		$\pm(5\%$ of reading + 350 mV)	

Table 4-13: Warranted Characteristics — Triggering System (Cont.)

Name	Description
Delay Difference Between Ext Input and Any Channel	<2 ns.
External Trigger Input Impedance	1 M Ω \pm 2% in parallel with 20 pF \pm 2.0 pF.
Maximum Input Voltage	\pm 400 V (DC + peak AC); derate at 20 dB/decade from 100 kHz to 13 V at 3 MHz.

Table 4-14: Warranted Characteristics — Video Triggering

Name	Description
Sensitivity	0.75 divisions of composite sync will achieve a stable display.
60 Hz Rejection	Stable video trigger with up to 4 divisions of 60 Hz on the video signal.
Sync Offset	Stable video trigger if sync tip is \pm 15 divisions, referenced to input ground.
Sync Separation	Stable trigger on positive or negative composite horizontal sync (lines) video, for all 525/60 and 625/50 video systems which include: NTSC, PAL, and SECAM.
Field Interval	Stable trigger on vertical sync interval >20 μ s.

Table 4-15: Warranted Characteristics — Cursors

Name	Description						
ΔTime Cursor to Signal Accuracy	Same as Time Base Accuracy + 0.1 division.						
1/ΔTime Accuracy	Readouts calculated using Δ Time cursor difference.						
Absolute Volts Accuracy	Accuracies are as follows:						
	<table border="1"> <thead> <tr> <th>Condition</th> <th>Accuracy</th> </tr> </thead> <tbody> <tr> <td>-10° C to +30° C</td> <td>\pm(1% of reading + 2% of one vertical division + HF display errors + 0.5 mV + trace shift errors).</td> </tr> <tr> <td>+30° C to +55° C</td> <td>\pm(1% of reading + 2% of one vertical division + HF display errors + 4 mV + trace shift errors).</td> </tr> </tbody> </table>	Condition	Accuracy	-10° C to +30° C	\pm (1% of reading + 2% of one vertical division + HF display errors + 0.5 mV + trace shift errors).	+30° C to +55° C	\pm (1% of reading + 2% of one vertical division + HF display errors + 4 mV + trace shift errors).
Condition	Accuracy						
-10° C to +30° C	\pm (1% of reading + 2% of one vertical division + HF display errors + 0.5 mV + trace shift errors).						
+30° C to +55° C	\pm (1% of reading + 2% of one vertical division + HF display errors + 4 mV + trace shift errors).						
ΔVolts Cursor to Signal Accuracy	\pm (1.6% of reading + 2% of one vertical division + HF display errors).						

Warranted Characteristics

Table 4-16: Warranted Characteristics — XY Operation

Name	Description
XY Accuracy	$\pm 4\%$.
X Bandwidth	DC to at least 3 MHz.
Phase Difference Between X and Y Amplifiers	$\pm 3^\circ$, DC to 150 kHz.

Table 4-17: Warranted Characteristics — Power Requirements (Serial Number B020099 and Below)

Name	Description
Source Voltage and Frequency	90–132 VAC _{RMS} continuous range for 48 through 440 Hz. 180–250 VAC _{RMS} continuous range for 48 through 440 Hz.
Power Consumption	≤ 85 watts (150 VA).

Table 4-18: Warranted Characteristics — Power Requirements (Serial Number B020100 and Above)

Name	Description
Source Voltage and Frequency	90–132 VAC _{RMS} continuous range for 48 through 440 Hz. 90–250 VAC _{RMS} continuous range for 48 through 63 Hz.
Power Consumption	≤ 85 watts (150 VA).

Table 4-19: Warranted Characteristics — Environmental and Safety

Name	Description
Third Party Certifications	This product shall conform to and be certified where appropriate according to the following requirements: <i>Certification</i>
	Underwriter’s Laboratories (UL) Listed or Recognized Component, Electrical and Electronic Measuring and Testing Equipment UL 1244.
	Canadian Standards CSA Association (CSA) Category Certified Electronic Development and Test Equipment, CSA 22.2 no. 231.

Table 4-19: Warranted Characteristics — Environmental and Safety (Cont.)

Name	Description
	Self-Certification International Electro-Technical Commission (IEC) Self-certified by Tektronix to comply with IEC 348 recommendation.
Temperature: Operating and Nonoperating	Operating: -10°C to $+55^{\circ}\text{C}$. Nonoperating: -51°C to $+71^{\circ}\text{C}$.
Humidity: Operating and Nonoperating	To 95% relative humidity at or below $+40^{\circ}\text{C}$ to 75% relative humidity form $+41^{\circ}\text{C}$ to $+55^{\circ}\text{C}$. A more sever test than stated in MIL-T-28800E, para. 4.5.5.1.1.2.
Altitude: Operating and Nonoperating	Operating: To 4572 m (15,000 ft.). Nonoperating: To 12192 m (40,000 ft.).
Random Vibration: Nonoperating	2.46 g_{RMS} , from 5 to 500 Hz, 10 minutes each axis.
Random Vibration: Operating	0.31 g_{RMS} , from 5 to 500 Hz, 10 minutes each axis.
Emissions	The instrument meets or exceeds the EMC requirements of the following standards: <ul style="list-style-type: none"> ■ VFG 243. ■ FCC Code of Federal Regulations, 47 CFR, Part 15, Subpart B, Class A.
Electrostatic Discharge Susceptibility	IEC 801-2.

Warranted Characteristics

Typical Characteristics

This subsection contains tables that lists the various *typical characteristics* that describe the TAS 455 and TAS 465 Analog Oscilloscopes.

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

This subsection lists only typical characteristics. A list of warranted characteristics starts on page 4-5.

Table 4-20: Typical Characteristics — Vertical Deflection System

Name	Description	
Upper-Frequency Limit, 20 MHz Bandwidth Limited	20 MHz.	
Trace Shift Leakage	The typical amount of trace shift while changing the input coupling between GND and 1 MΩ DC is as follows:	
	<i>Condition</i>	<i>Typical Trace Shift</i>
	−10° C to +35° C	<0.5 mV
	+35° C to +55° C	<8 mV
Variable Volts/Div Offset	0.5 division trace shift while changing the variable volts/div setting.	
Chop Mode Clock Rate	>500 kHz, <1 MHz.	
	Chop mode is allowed from 0.5 s to 10 μs sec/div settings.	
Noise (measured tangentially)	≤ 0.06 div at ≥ 10 mV/div (600 μV).	
	≤ 0.10 div at 5 mV/div (500 μV).	
	≤ 0.14 div at 2 mV/div (280 μV).	

Table 4-21: Typical Characteristics — Time Base System

Name	Description
Time Base Linearity	±5%.
	Sweep linearity applies over the center eight divisions. Excludes the greater of either the first ¼ division or 25 ns from the sweep start of the magnified sweep and anything beyond the 100th magnified division.
Delay Jitter	≤ 1 part in 10,000 (20,000 for 1 ms and slower) + 2 ns, peak-to-peak during a two-second time interval. Exclude the first 0.15 divisions of the Main sweep.

Table 4-22: Typical Characteristics — Triggering System

Name	Description
TAS 465 Edge-Type Trigger Sensitivity, Not DC Coupled	The typical sensitivities are as follows:
	<i>Trigger Source</i> <i>Typical Signal Level for Stable Triggering</i>
	Noise Reject 1.2 divisions from DC to 25 MHz, in- creasing to 2.2 divisions at 150 MHz. 0.5 division or less will not trigger.
	HF REJ 0.30 division from DC to 10 kHz; attenu- ates signals above the upper –3 dB cut- off frequency of 50 kHz.
	LF REJ 0.30 division from 100 kHz to 25 MHz, increasing to 1.0 division at 150 MHz; attenuates signals below the lower –3 dB cutoff frequency of 50 kHz.
	AC 0.30 division from 350 Hz to 25 MHz, increasing to 1.0 division at 150 MHz; attenuates signals below the –3 dB cut- off frequency of 160 Hz.
Typical signal levels for External Triggering are derived by convert- ing divisions to volts, where 1 division equals 100 mV of trigger signal level.	
TAS 455 Edge-Type Trigger Sensitivity, Not DC Coupled	The typical sensitivities are as follows:
	<i>Trigger Source</i> <i>Typical Signal Level for Stable Triggering</i>
	Noise Reject 1.2 divisions from DC to 25 MHz, in- creasing to 2.2 divisions at 100 MHz. 0.5 division or less will not trigger.
	HF REJ 0.30 division from DC to 10 kHz; attenu- ates signals above the upper –3 dB cut- off frequency of 50 kHz.
	LF REJ 0.30 division from 100 kHz to 25 MHz, increasing to 1.0 division at 100 MHz; attenuates signals below the lower –3 dB cutoff frequency of 50 kHz.
	AC 0.30 division from 350 Hz to 25 MHz, increasing to 1.0 division at 100 MHz; attenuates signals below the –3 dB cut- off frequency of 160 Hz.
Typical signal levels for External Triggering are derived by convert- ing divisions to volts, where 1 division equals 100 mV of trigger signal level.	

Table 4-22: Typical Characteristics — Triggering System (Cont.)

Name	Description
Lowest Frequency for Successful Operation of “Set Level to 50%” Function	50 Hz with 1 division.
Holdoff Control Range	Increases Main sweep holdoff time by a factor of 10.

Table 4-23: Typical Characteristics — Video Triggering System

Name	Description
Field Separation	Stable trigger on odd or even fields in interlaced video systems with line rates between 12 kHz and 17 kHz.

Table 4-24: Typical Characteristics — Z-Axis

Name	Description
Sensitivity	The sensitivity is as follows:
	<i>Condition</i> <i>Sensitivity</i>
	DC to 2 MHz Positive voltage decreases intensity; +2 V blanks a maximum intensity trace.
	2 MHz to 20 MHz +2 V modulates a normal intensity trace. +2 V (DC to 20 MHz) blanks a 1 μA CRT beam.
Rise Time	<15 ns.
Input Resistance	10 kΩ ±10%.
Maximum Input Voltage	±25 V peak; 25 V _{p-p} AC at 10 kHz or less.

Table 4-25: Typical Characteristics — Probe Compensator

Name	Description
Probe Compensator Output Voltage and Frequency	The limits are as follows:
	<i>Characteristic</i> <i>Limits</i>
	Output Voltage 5 V (base-top) ±10% into a 1 MΩ load.
	Frequency 1 kHz ±5%.

Table 4-26: Typical Characteristics — Setup Memory

Name	Description
Nonvolatile Memory Retention Time	Internal batteries, installed at time of manufacture, have a life of ≥ 10 years when operated and/or stored at an ambient temperature from 0° C to +50° C. Retention time of the nonvolatile memories is equal to the remaining life of the batteries. Battery life can be reduced when the instrument is stored for extended time above +50° C. Retained data may be lost when stored for extended time below 0° C.

WARNING

The following servicing instructions are for use only by qualified personnel. To avoid injury, do not perform any servicing other than that stated in the operating instructions unless you are qualified to do so. Refer to all Safety Summaries before performing any service.

Theory of Operation

Theory of Operation

This section describes the theory of operation of the Tektronix TAS 455 and TAS 465 Analog Oscilloscopes, using major circuit blocks.

This section has two main parts:

- **Service Strategy** describes the scope of the theory of operation with respect to the level of service supported by this manual.
- **Block Level Descriptions** describes circuit operation from a functional-circuit block perspective.

Service Strategy

This manual supports the maintenance and repair of the TAS 455 and TAS 465 Analog Oscilloscopes to the module level. Circuit descriptions and diagrams are provided to enable the user to isolate and replace a faulty module. If you require detailed component level documentation, please order the optional *Service Manual* listed in the *Replaceable Parts* section of this manual.

Block Level Descriptions

This overview describes the basic operation of each functional circuit block as shown in Figure 5-1.

General

The Tektronix TAS 455 and TAS 465 Analog Oscilloscopes are portable, two-channel instruments. Each channel provides a calibrated vertical scale factor.

Input Signal Path

A signal enters the oscilloscope through a probe connected to a BNC on the A1 Analog board.

Attenuators — Circuitry on the attenuator hybrid, including the vertical preamplifier IC, selects the input coupling, attenuation factor, variable gain, and the invert function. The processor system controls and calibrates the attenuators.

Probe Coding Interface — Probe coding interface signals pass through the A1 Analog board to the A5 CPU board and then to the A4 Front Panel board. The probe interface signals are digitized on the Front Panel board and communicated to the processor system.

External Trigger — A high impedance buffer is used to interface the external trigger signal to the analog acquisition hybrid.

A1 Analog Board — The input signals are routed to the highly integrated analog acquisition hybrid which does the analog processing required to provide vertical, horizontal, and z-axis signals to the A3 Display Driver board. Under control of the processor, the hybrid provides vertical signal processing, triggers, sweeps, sequencing logic, and intensity control.

A5 Processor System

The processor board is a microcontroller design. It consists of a microcontroller as the core of the circuit, operating at 16 MHz. The primary function of the processor is to receive input from the front panel, display the readout, and control the Analog board.

A3 Display Assembly

All information (waveforms, text, and cursors) is displayed by the A3 Display Driver board. It generates the high voltages necessary to drive the CRT. It also contains the vertical and horizontal amplifier circuitry.

A4 Front Panel

The processor system sends and receives information to and from the A4 Front Panel board. The Front Panel board reads the front-panel controls and changes in their settings are reported to the processor system. The Front Panel Processor turns the LEDs on and off, generates the probe compensation signal, and processes the probe coding interface signals.

Menu Switches — Front-panel menu switches are read by the Front Panel board and changes in menu selections are sent to the processor system.

Rear Panel

The External Z-Axis connector provides the ability to modulate the z-axis amplifier circuit on the A3 Display Driver board, thus modulating or blanking the intensity of the CRT display.

A63 Power Supply

The power supply is a switching power converter. It supplies power to all oscilloscope circuitry.

Two versions of power supplies were produced. The early version requires the operator to configure it to the incoming line voltage; the later version automatically adjusts to the incoming line voltage and has no external adjustments.

If an early model power supply is replaced with a later version, check with your local Tektronix representative about obtaining the necessary firmware upgrade.

The **POWER** switch, located on the front panel, controls all power to the oscilloscope including the power supply.

Fan

The fan provides forced air cooling for the oscilloscope. It connects to +12 V on the A63 Power Supply board.

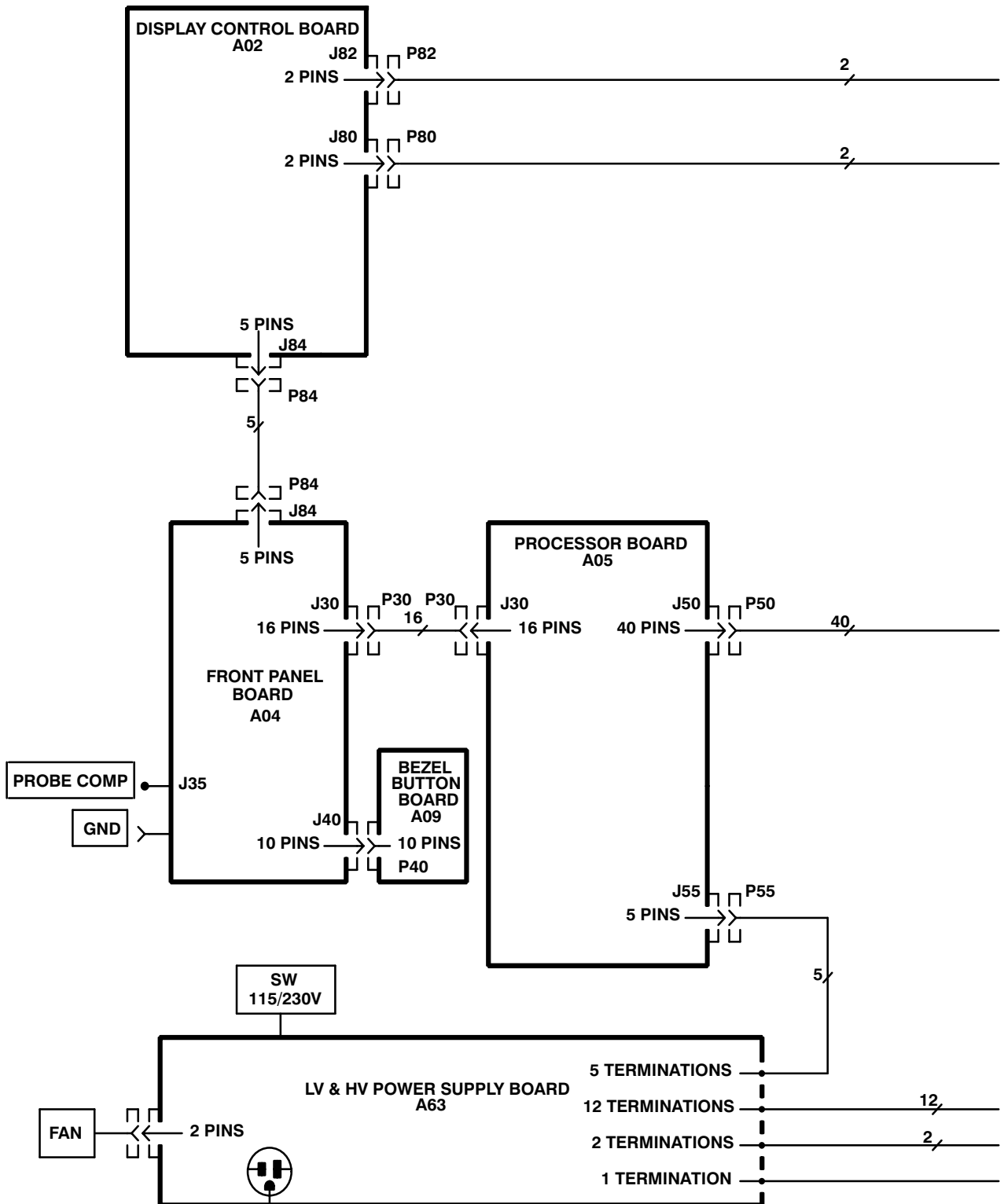


Figure 5-1: Block Diagram (B020099 and Below)

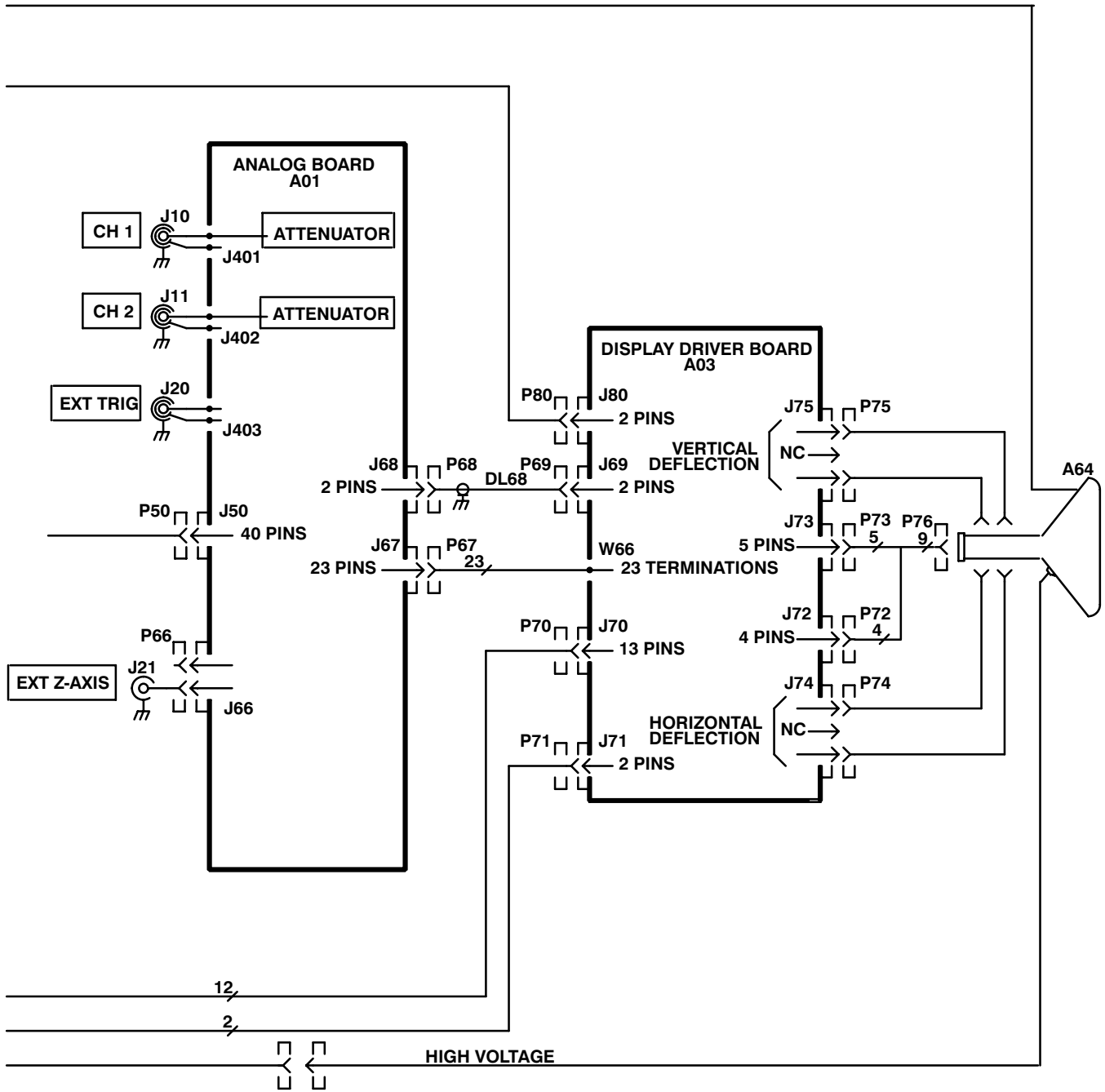


Figure 5-1: Block Diagram (B020099 and Below) (Cont.)

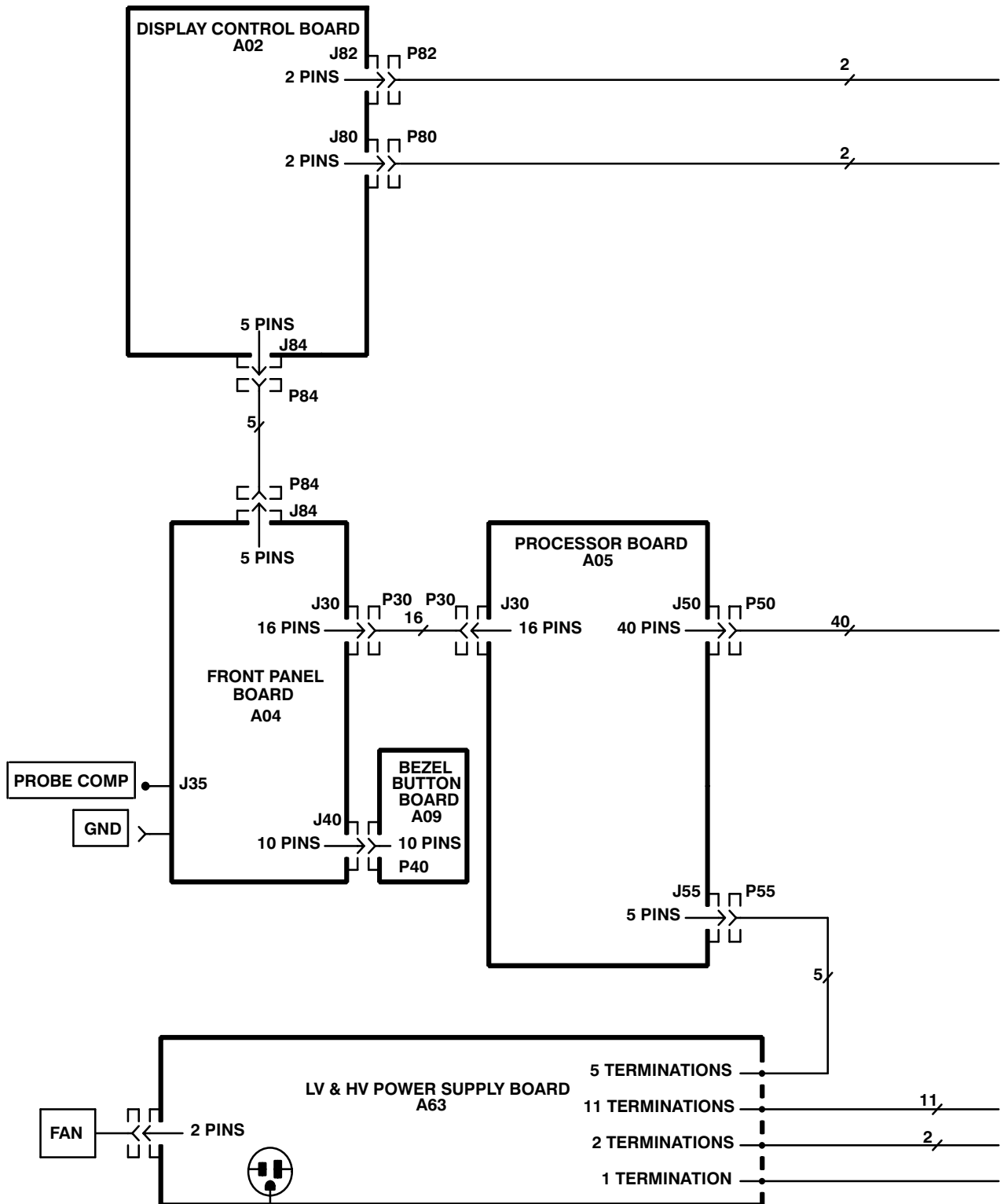


Figure 5-2: Block Diagram (B020100 and Above)

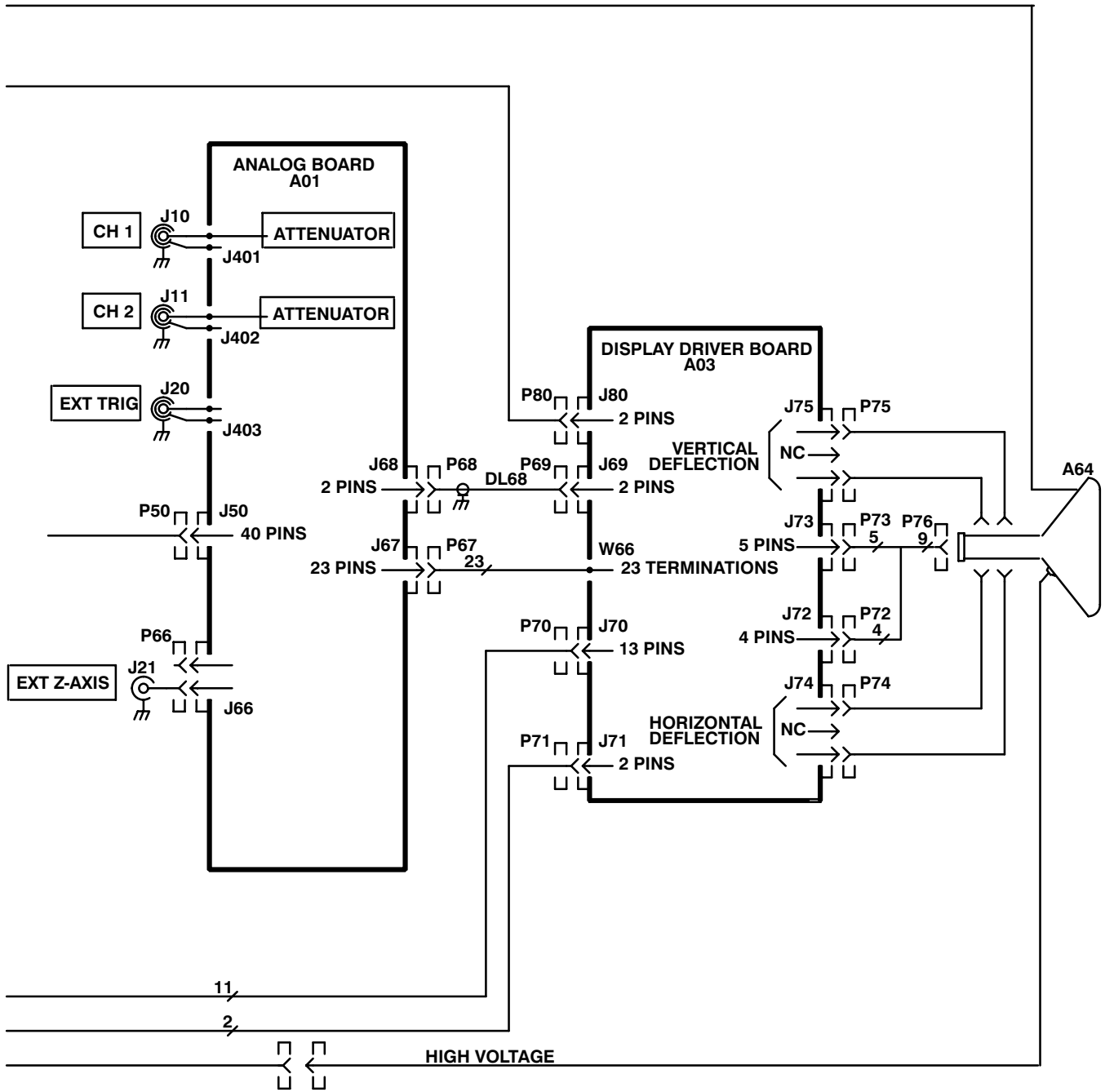


Figure 5-2: Block Diagram (B020100 and Above) (Cont.)

Performance Verification

General Instructions

This Performance Verification section is divided into two subsections, *Brief Performance Checks* and *Performance Tests*.

The *Brief Performance Checks* section contains procedures to verify the operation of the TAS 455 and TAS 465 Analog Oscilloscopes.

The *Performance Tests* section contains procedures to confirm the performance of the TAS 455 and TAS 465 Oscilloscopes to its warranted specifications.

If you are not familiar with operating this oscilloscope, read Section 2, *Getting Started* in this manual to acquaint you with the use of the front-panel controls and the menu system.

Figure 3-3 on page 3-10 provides a display map of the CRT to familiarize you with the readout locations for the TAS 455 and TAS 465 Oscilloscopes.

Using the Brief Performance Checks Procedures

The *Brief Performance Checks* contain three procedures: Power-On Self Tests, Functional Tests, and Temperature Compensation Calibrations. Completing these checks takes approximately one hour.

The *Self Tests* are performed each time the oscilloscope is powered on.

The *Functional Tests* use the probe compensation output on 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.

To rapidly confirm that this oscilloscope functions and was adjusted properly, perform the procedures in the *Functional Tests* section, which begin on page 6-3.

Advantages: These procedures are quick to do, require no external equipment or signal sources, and provide high confidence that the oscilloscope will perform properly. These procedures also provide hands-on experience to become familiar with the controls and menus.

The *Temperature Compensation Calibrations* allow you to adjust the display accuracy of the oscilloscope.

Using the Performance Tests Procedures

The *Performance Tests* confirm that the TAS 455 and TAS 465 Oscilloscopes perform as specified. The *Performance Tests* begin on page 6-13. Completing these tests takes approximately two hours and requires suitable test equipment. (See *Equipment Required* on page 6-13.)

Advantages: These procedures add direct checking of warranted specifications.

Conventions

The procedures in this section provide the following information:

- Title of test
- Equipment required (if applicable)
- Procedure

Where instructed to use a front-panel control or select from a menu, the name appears in boldface type. For example, “press **VERTICAL MENU**;

then “set **CPLG** to **DC**.”



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

These procedures make references to the graticule lines. For example, “position the cursor to the second vertical graticule line.” Figure 6-1 shows how to interpret the references.

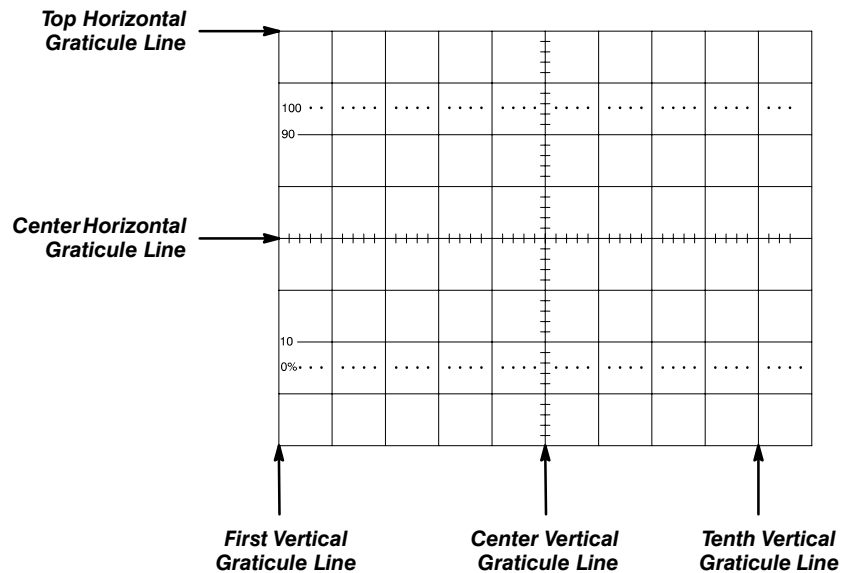


Figure 6-1: Graticule References

These procedures may ask you to check for a stable display. A stable display is consistent. The display should not have its trigger point switching slopes (double trigger) nor should it “free-run.” The **MAIN SWP TRIG'D** LED should remain lit.

Brief Performance Checks

This section contains three brief procedures: two that verify the operation of the TAS 455 and TAS 465 Analog Oscilloscopes and one to perform a brief calibration to compensate for temperature variances.

The *Power-On Self Tests* use internal routines (performed at each power on) to confirm basic functionality and proper adjustment.

The *Functional Tests* further verify that the oscilloscope functions properly. These tests utilize the front panel **PROBE COMP** signal and a standard accessory probe.

The *Temperature Compensation Calibrations* use internal routines and actions from you to adjust the display accuracy of the oscilloscope. These adjustments are typically necessary only when the operating temperature and the last calibration temperature differs by more than 5° C. However, performing these compensations before making a critical measurement ensures optimum accuracy.

If any of these tests return a failed message or do not perform as stated, contact your local Tektronix service center or sales engineer for more information.

Power-On Self Tests

These tests verify that the internal power-on diagnostics passed by confirming no error messages are reported on-screen.

Functional Tests

The purpose of these procedures is to confirm that this oscilloscope functions properly. The only equipment required is a standard accessory probe.



These procedures verify function; that is, they verify that oscilloscope *operates*. They do *not* verify that it operates 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”, do *not* interpret the quantities given as limits. Operation within limits is checked in *Performance Tests*, which begin on page 6-13.



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

Functional Tests Prerequisites

1. Power on the oscilloscope and allow a 20 minute warm-up before performing this procedure; adjust the **READOUT** control to display the readout and the **INTENSITY** control to display waveforms.
2. Disable the dual delay with the following menu selections.
 - a. Press the **UTILITY** button and select **CONFIG** from the main menu.
 - b. Select **MORE** until you can select **Dual Delay Disabled**.
3. Press the **ALT/CHOP, ADD** button and set **ADD** to **Off**.
4. Install the probe on **CH 1**. Connect the probe tip to **PROBE COMP** on the front-panel; connect the probe ground to the ground barrel of an unused input BNC (see Figure 6-2).

Some functional checks require that you install the probe on connectors other than **CH 1**. All functional checks use the **PROBE COMP** on the front-panel as the signal source.

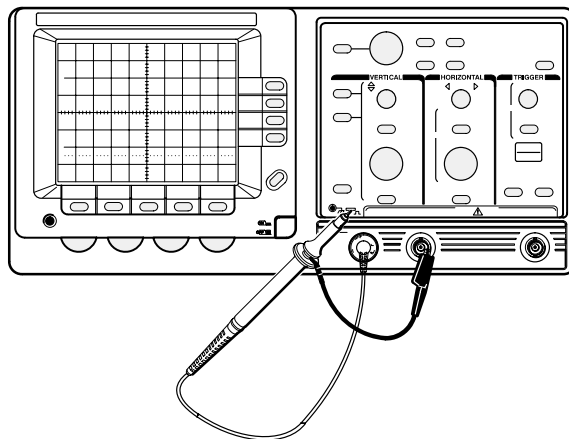


Figure 6-2: Test Hookup for Functional Tests

Verify the Probe Compensator Output

1. Press the **WAVEFORM OFF** button until the readout indicates that only channel 1 is selected.
2. Press the **AUTOSET** button.
3. Press the **VERTICAL MENU** button and set **CPLG** to **DC**.
4. Set the volts/div scale to 1 V and vertically center the display.
5. Set the sec/div scale to 500 μ s.
6. Press the **CURSOR** button and set **Δ VOLT** to **On**.
7. Align the active cursor to the top of the signal using the General Purpose Knob.

8. Press the **TOGGLE** button and align the active cursor to the bottom of the signal using the General Purpose Knob.
9. Verify that the Δ Volts readout is about 5.2 V.
10. Set **1/ Δ T** to **On**.
11. Align the active cursor to a rising edge of the signal using the General Purpose Knob.
12. Press the **TOGGLE** button and align the active cursor to the next rising edge of the signal using the General Purpose Knob.
13. Verify that the $1/\Delta T$ readout is about 1 kHz.
14. Set **Δ TIME** to **On**.
15. Verify that the Δ Time readout is about 1 ms.

Verify the Input Channels

1. Display the channel to be verified and turn all others off.
2. Install the probe on the channel to be verified.
3. Press the **AUTOSET** button.
4. Press the **VERTICAL MENU** button and set **CPLG** to **DC**.
5. Verify that the channel is operational, confirming the following statements are true.
 - The vertical scale readout is set to 2 V for the channel under test and a square wave signal about 2.6 divisions in amplitude is on-screen.
 - Pressing the **SET LEVEL TO 50%** button sets the trigger level readout to approximately 2.7 V.
 - The vertical **POSITION** control moves the signal up and down the screen when rotated. Return the bottom portion of the displayed waveform to the center horizontal graticule line.
 - Turning the **VOLTS/DIV** control counterclockwise and clockwise decreases and increases the amplitude of the waveform. Return the volts/div scale to 2 V.
6. Press the **VERTICAL MENU** button and select **CPLG**. Select the following coupling types and verify the display.
 - Select **DC** coupling and verify that the waveform amplitude is positive-going from the center horizontal graticule line.
 - Select **AC** coupling, press the **SET LEVEL TO 50%** button, and verify that the waveform is centered at about the center horizontal graticule line.
 - Select **GND** coupling and verify that a straight line is displayed (no waveform).

7. Return the coupling to **DC** and press the **CLEAR MENU** button.
8. Repeat this procedure until all input channels are verified.

Verify the Alt/Chop and Add Functions

1. Install the probe on **CH 1**.
2. Press the **WAVEFORM OFF** button until the readout indicates channel 1 is the only selected channel.
3. Press the **AUTOSET** button.
4. Press the **CH 2** button and then position the channel 2 trace to the bottom horizontal graticule line.
5. Press the **WAVEFORM OFF** button, removing the channel 2 display.
6. Press the **ALT/CHOP, ADD** button and set **ADD** to **On**.
7. Verify that a second waveform of approximately 2.6 divisions amplitude has been added to the display.
8. Set **DISP** to **Chop**.
9. Set the sec/div scale to 100 ms.
10. Verify that the two waveforms are displayed simultaneously.
11. Set **DISP** to **Alt**.
12. Verify that the two waveforms are displayed alternately.
13. Set **ADD** to **Off**.
14. Press the **CLEAR MENU** button.

Verify the Time Base

1. Press the **WAVEFORM OFF** button until the readout indicates channel 1 is the only selected channel.
2. Install the probe on **CH 1**.
3. Press the **AUTOSET** button.

4. Verify that the main time base is operational, confirming the following statements are true.
 - One period of the square wave is about five horizontal divisions.
 - Rotate the **SEC/DIV** control clockwise and verify that the waveform expands (more horizontal divisions per period of waveform) and that counterclockwise rotation contracts it.
 - Set the sec/div scale to 1 ms and verify that approximately one period of waveform per horizontal division is displayed.
 - Rotate the horizontal **POSITION** control and verify that the waveform moves left and right on-screen.
 - Pressing the **MAG** button changes the sec/div scale from 1 ms to 100 μ s and one period of the square wave is about ten horizontal divisions. Return to a non-magnified display by pressing the **MAG** button again.
5. Press the **HORIZONTAL MENU** button and set **DELAY** to **On**.
6. Set the delayed sec/div scale to 500 μ s.
7. Press the **TRIGGER MENU** button and set **MODE** to **Runs After**.
8. Press the **HORIZONTAL MENU** button.
9. Select **TRCSEP** from the main menu and vertically position the delayed time base below the main time base using the General Purpose Knob.
10. Select **DELAY** from the main menu.
11. Verify that the delayed time base is operational, confirming the following statements are true.
 - The main sweep has an intensified zone of approximately 5.5 horizontal divisions. Adjust the **INTENSITY** level if necessary to view the entire intensified zone.
 - Rotating the General Purpose Knob clockwise moves the intensified zone to the right on-screen. Position the intensified portion to the center of the screen.
12. Adjust the delayed sec/div scale to 200 μ s.
13. Set **MAIN** to **Off** and confirm that only the delayed sec/div scale is displayed and the period of the square-wave signal is about five horizontal divisions.
14. Set **MAIN** to **On** and **DELAY** to **Off**.

Verify the Trigger System

1. Press the **WAVEFORM OFF** button until the readout indicates channel 1 is the only selected channel.
2. Press the **AUTOSET** button.

3. Set the sec/div scale to 1 ms.
4. Press the **TRIGGER MENU** button and set **MODE** to **Auto**.
5. Verify that the main trigger is operational, confirming that the following statements are true.
 - Rotating the trigger **LEVEL** control changes the main trigger level readout.
 - Rotating the trigger **LEVEL** control through its range triggers and untriggers the display. Leave the signal untriggered.
 - Pressing the **SET LEVEL TO 50%** button triggers the signal and the trigger level readout indicates approximately 2.7 V.
6. Press the **HORIZONTAL MENU** button and set **DELAY** to **On**.
7. Set the delayed sec/div scale to 500 μ s.
8. Verify that the delayed sweep is operational, confirming that an intensified zone appears on the main sweep.
9. Press the **TRIGGER MENU** button and set **MODE** to **Trig After** and **SRC** to **Ch1**.
10. Verify that the delayed trigger is operational, confirming that the following statements are true.
 - Rotating the trigger **LEVEL** control changes the delayed trigger level readout.
 - Rotating the trigger **LEVEL** control through its range triggers and untriggers (intensified zone displayed and not displayed) the delayed sweep. Leave the signal untriggered.
 - Pressing the **SET LEVEL TO 50%** button triggers the signal, the trigger level readout indicates approximately 2.7 V, and the intensified zone is displayed.
11. Press the **HORIZONTAL MENU** button and set **DELAY** to **Off**.
12. Set the sec/div scale to 50 ms.
13. Press the **TRIGGER MENU** button and set **MODE** to **Single Sequence** and confirm the following statements are true.
 - There is no waveform displayed.
 - Pressing the **RESET S SEQ** button causes one sweep of the waveform display to occur.
14. Set the sec/div scale to 1 ms.
15. Set **MODE** to **Auto Level**.
16. Disconnect the probe from the oscilloscope.

Verify the External Trigger

1. Press the **TRIGGER MENU** button; set **MODE** to **Normal** and **SRC** to **EXT <1>**. Confirm that no sweep is displayed.
2. Install the probe on the **EXT TRIG** connector. Connect the probe tip to **PROBE COMP** on the front-panel; connect the probe ground to the ground barrel of an unused input BNC.
3. Press the **SET LEVEL TO 50%** button.
4. Verify that the main sweep is triggered and a single trace is displayed.
5. Press the **AUTOSET** button.
6. Disconnect the probe from the the oscilloscope.

Temperature Compensation Calibrations

The procedures that follow allow you to quickly compensate the calibration of the oscilloscope for any external temperature variations. This ensures the most accurate measurements. No test equipment is required to perform these procedures.



Optimum instrument performance depends on the recommended 20 minute minimum warm-up time prior to performing the following calibration routines. All calibration routines require a successful completion (no “failed” message).



The Temperature Compensation Calibrations affect the accuracy of the display system; therefore, they should only be performed by a qualified technician.

Horizontal Sweep Path

1. Press the **AUTOSET** button.
2. Press the **UTILITY** button and select **CAL** from the main menu.
3. Select **Horizontal Sweep Path** from the sub menu, initiating the routine.

The **Horizontal Sweep Path** routine takes about 20 seconds to complete its initial calibrations.



The following information (up to and including step 14) applies to Firmware versions prior to V2.10. For instruments with V2.10 and above, skip to step 15 on page 6-11.

Once the **Horizontal Sweep Path** routine is complete, two dots are displayed. The displayed dots are used for the next horizontal calibration steps.

NOTE

*The following steps use both the General Purpose Knob and the **TOGGLE** button to make adjustments. The General Purpose Knob performs two functions: to adjust gain and centering. Pressing the **TOGGLE** button selects the function of the General Purpose Knob.*

4. Use a combination of the **TOGGLE** button and the General Purpose Knob to position the two dots eight divisions apart, centered horizontally (see Figure 6-3).

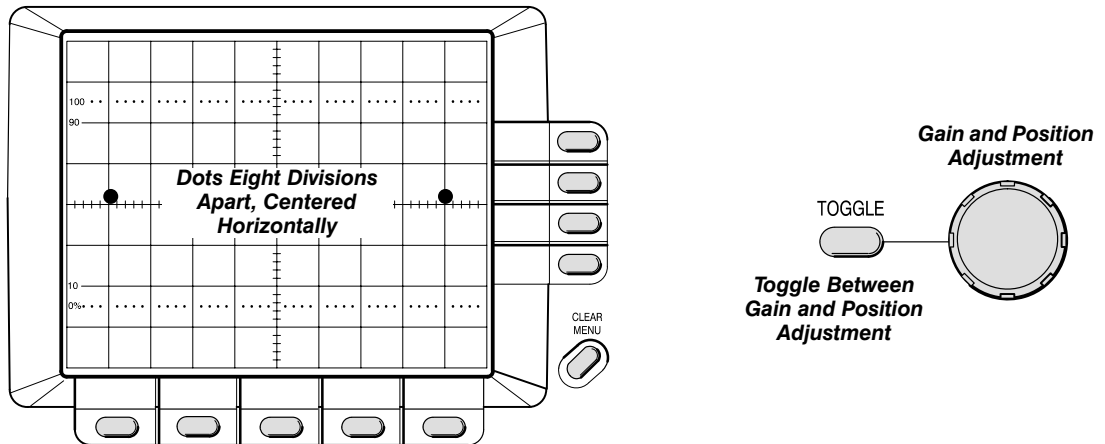


Figure 6-3: Horizontal Adjustments (One)

5. Select **Done** when you have the appropriate display.
6. Again, use a combination of the **TOGGLE** button and the General Purpose Knob to position the two dots eight divisions apart, centered horizontally (see Figure 6-3).
7. Select **Done** when you have the appropriate display.
8. One dot is now displayed.
9. Use a combination of the **TOGGLE** button and the General Purpose Knob to horizontally center the single dot at the center of the screen (see Figure 6-4).

Continue to press the **TOGGLE** button and adjusting the dot to center screen with the General Purpose Knob until the dot stays horizontally centered while pressing the **TOGGLE** button.

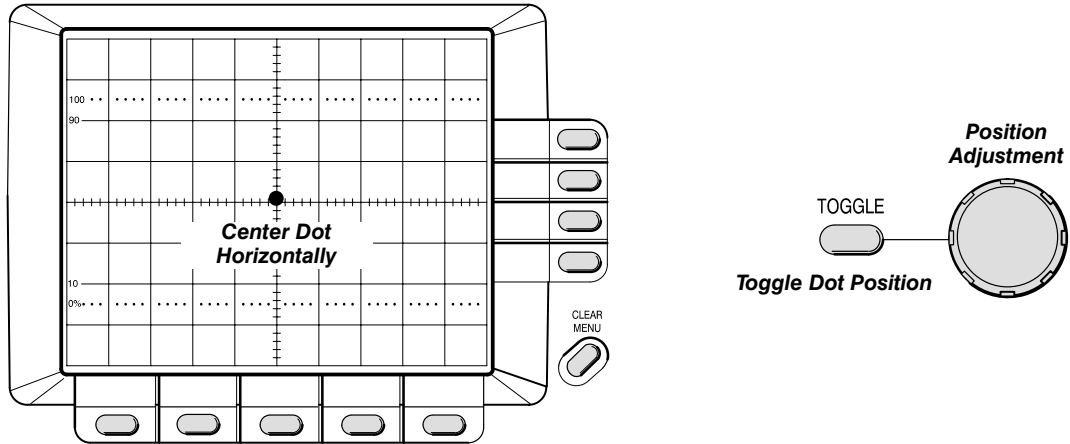


Figure 6-4: Horizontal Adjustments (Two)

10. Select **Done** when you have the appropriate display.
11. Two vertical lines are now displayed.

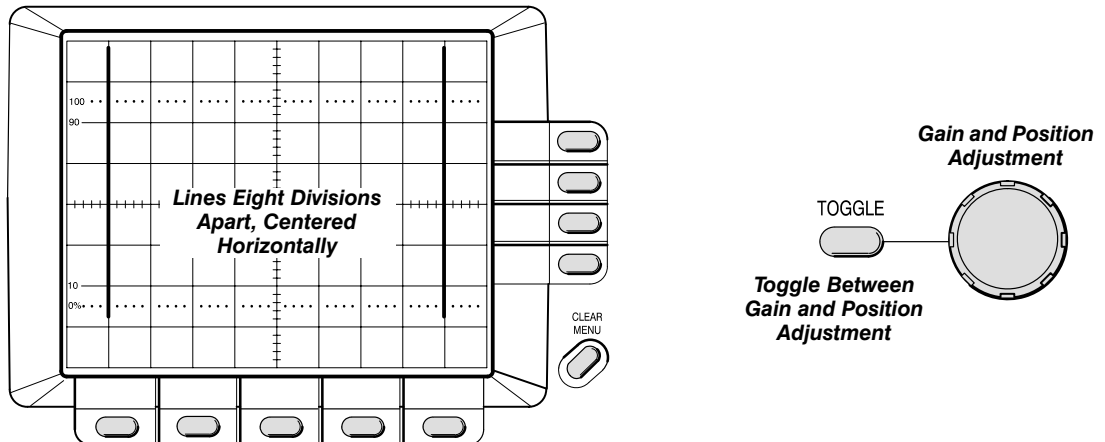


Figure 6-5: Horizontal Adjustments (Three)

12. Use a combination of the **TOGGLE** button and the General Purpose Knob to position the two lines eight divisions apart, centered horizontally (see Figure 6-5).
 13. Select **Done** when you have the appropriate display.
 14. A **pass** or **failed** status appears on the screen.
- The remaining step applies to all firmware versions.**
15. Select **Done** to exit the routine, displaying a **Calibration Finished** message.

Vertical Signal Path

1. Press the **AUTOSET** button.
2. Press the **UTILITY** button and select **CAL** from the main menu.
3. Select **Vertical Signal Path** from the sub menu, initiating the routine.
4. Remove any input signals from the oscilloscope.
5. Select **Done**.

The **Vertical Signal Path** routine takes about one minute to complete. When finished, a *pass* or *failed* status will appear on the screen.

6. Press **Done** to exit the routine, displaying a **Calibration Finished** message.
7. Press the **CLEAR MENU** button.

Performance Tests

This subsection contains procedures to verify that the TAS 455 and TAS 465 Analog Oscilloscopes perform as warranted.

The procedures are arranged in three logical groupings: *Vertical Checks*, *Horizontal Checks*, and *Trigger Checks*. They check all the characteristics that are designated as checked in Section 4, *Specifications*. (The checked characteristics appear in **boldface** type under *Warranted Characteristics* in Section 4.)

These procedures *extend* the confidence level provided by the *Brief Performance Checks* in this section.

Performance Tests 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 oscilloscope.
- The *Power-On Self Tests* show no failures.
- You must have completed the *Temperature Compensation Calibrations*, beginning on page 6-9.
- The oscilloscope must have an operating warm-up period of at least 20 minutes at an ambient temperature between -10°C and $+55^{\circ}\text{C}$.
- Set the **INTENSITY** and **READOUT** controls for nominal viewing levels.
- Set the delayed sweep intensity to **Intensity Delay > Main** in the Utility Configure menu.

Related Information — Read *General Instructions* that start on page 6-1. If you are not familiar with operating this oscilloscope, read Section 2, *Getting Started*, before performing these procedures.

Equipment Required

These procedures use external, traceable signal sources to directly check warranted characteristics. Table 6-1 lists the required test equipment.

Table 6-1: Test Equipment

Item Number and Description	Minimum Requirements	Example	Purpose
1 Attenuator, 5X ³	Ratio: 5X; Impedance 50 Ω ; Connectors: female BNC input, male BNC output	Tektronix part number 011-0060-02	Signal attenuation
2 Attenuator, 10X	Ratio: 10X; Impedance 50 Ω ; Connectors: female BNC input, male BNC output	Tektronix part number 011-0059-02	Signal attenuation
3 Termination, 50 Ω (two required)	Impedance 50 Ω ; Connectors: female BNC input, male BNC output	Tektronix part number 011-0049-01	Signal interconnection
4 Termination, 75 Ω	Impedance 75 Ω ; Connectors: female BNC input, male BNC output	Tektronix part number 011-0102-01	Signal interconnection, video
5 Cable, Precision Coaxial	50 Ω , 36 in, male-to-male BNC connectors	Tektronix part number 012-0482-00	Signal interconnection
6 Cable, Coaxial	75 Ω , 36 in, male-to-male BNC connectors	Tektronix part number 012-1338-00	Signal interconnection, video
7 Coupler, Dual-Input	Female-BNC-to-dual-male-BNC	Tektronix part number 067-0525-02	Signal interconnection
8 Generator, Leveled Sine Wave	200 kHz to 250 MHz; Variable amplitude from 5 mV to 4 V _{p-p} into 50 Ω	TEKTRONIX SG 503 Leveled Sine Wave Generator ¹	Trigger and bandwidth checks
9 Generator, Time Mark	Variable marker frequency from 10 ms to 10 ns; accuracy within 2 ppm	TEKTRONIX TG 501A Time Mark Generator ¹	Timing accuracy checks
10 Generator, Pulse	High Amplitude pulse with variable amplitude of 60 V to 100 V	TEKTRONIX PG 506A Calibration Generator ^{1,2}	Gain accuracy checks
11 Generator, DC Calibration	DC voltage levels from 100 mV to 10 V	TEKTRONIX PG 506A Calibration Generator ^{1,2}	Gain accuracy checks
12 Probe, 10X, included with this instrument	Standard accessory probe	TEKTRONIX P6109B	Signal interconnection

Table 6-1: Test Equipment (Cont.)

Item Number and Description	Minimum Requirements	Example	Purpose
13 Generator, Video Signal	Provides NTSC compatible outputs	TEKTRONIX TSG 100	Video trigger check
14 Multimeter, Digital	DC voltage to 10 V	TEKTRONIX DM 2510	Power Supply Adjustment (B020100 and above)
15 Adjustment Tool ³	0.1 inch hex on both ends	GC Electronics #8606	Internal adjustments

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

² The PG 506A must have the internal Square-Wave/DC switch repositioned depending on the requirements of the procedure.

³ This item is used only when performing the Adjustment Procedures.

Vertical System Checks

These procedures check those characteristics that relate to the vertical system and are listed as checked under *Warranted Characteristics* in Section 4, *Specifications*.

Check DC Gain and Voltage Measurement Accuracy

Equipment Required: One pulse generator (item 10) and one precision coaxial cable (item 5).

1. Display the channel to be verified, turning all others off.
2. Press the **AUTOSET** button.
3. Set the sec/div scale to 500 μ s.
4. Press the **TRIGGER MENU** button and set **CPLG** to **Noise Reject**.
5. Press the **CURSOR** button and set Δ **Volt** to **On**.
6. Press the **VERTICAL MENU** button and make the following selections:
 - Set **CPLG** to **DC**
 - Set **BW** to **20 MHz**
7. Set the volts/div scale to 2 mV.
8. Position the trace three divisions below the center horizontal graticule line.
9. Connect the standard amplitude output of the pulse generator to the input of the channel to be verified as shown in Figure 6-6.

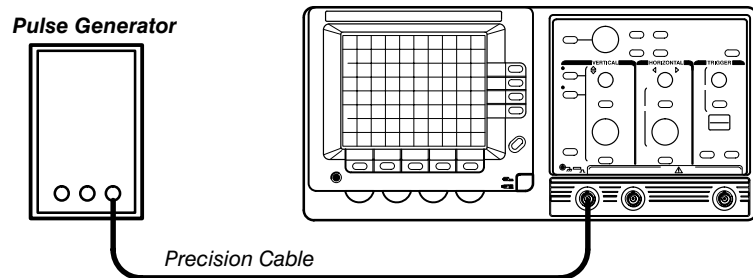


Figure 6-6: Gain and Voltage Test Setup

10. Set the pulse generator for 10 mV amplitude output.
11. Use the General Purpose Knob and **TOGGLE** button to precisely align the cursors to the signal peaks.
12. Check the Displayed Signal Accuracy and Volts Readout Accuracy while setting the Volts/Div Scale and the Input Amplitude given in Table 6-2.

Table 6-2: DC Gain and Delta Volts Accuracy

Volts/Div Scale	Input Amplitude	Displayed Signal Accuracy	Delta Volts Readout Accuracy
2 mV	10 mV	4.87 to 5.13 div	9.80 mV to 10.2 mV
5 mV	20 mV	3.9 to 4.1 div	19.6 mV to 20.4 mV
10 mV	50 mV	4.87 to 5.13 div	49.0 mV to 51.0 mV
20 mV	0.1 V	4.87 to 5.13 div	98.0 mV to 102 mV
50 mV	0.2 V	3.9 to 4.1 div	196 mV to 204 mV
100 mV	0.5 V	4.87 to 5.13 div	490 mV to 510 mV
1 V	5 V	4.87 to 5.13 div	4.90 V to 5.10 V

13. Return the volts/div scale to 2 mV and set the pulse generator for 10 mV amplitude output.
14. Press the **VERTICAL MENU** button and set **VAR** to **On**.
15. Check that rotating the General Purpose Knob counterclockwise reduces the displayed signal amplitude to two divisions or less. Set **VAR** to **Off**.
16. Disconnect the test setup from the oscilloscope.
17. Repeat this procedure until you have verified all input channels.
18. Press the **CURSOR** button and set Δ **Volt** to **Off**.

Check Trigger Level Accuracy

Equipment Required: One DC calibration generator (item 11) and one precision coaxial cable (item 5).

1. Display channel 1, turning all others off.
2. Press the **AUTOSET** button.
3. Set the sec/div scale to 500 μ s.
4. Press the **TRIGGER MENU** button and make the following selections:
 - Set **CPLG** to **DC**
 - Set **SLOPE** to **Rising**
5. Press the **VERTICAL MENU** button and make the following selections:
 - Set **CPLG** to **DC**
 - Set **BW** to **20 MHz**
6. Set the volts/div scale to 50 mV.
7. Position the trace three divisions below the center horizontal graticule line.

8. Connect the DC calibration generator to the **CH 1** input as shown in Figure 6-7.

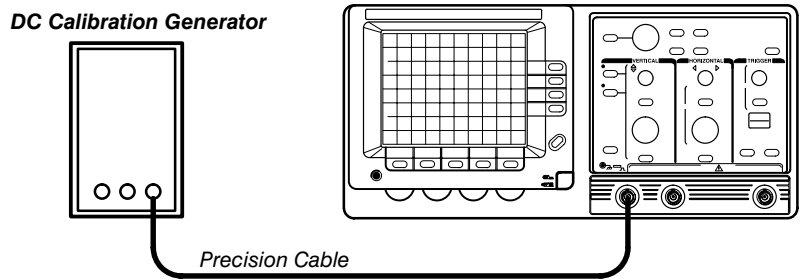


Figure 6-7: Trigger Level Test Setup

9. Set the DC calibration generator for a 200 mV output.
10. Press the **SET LEVEL TO 50%** button.
11. Check that the Trigger Level Accuracy readout is in the range of 169 mV to 231 mV.
12. Press the **TRIGGER MENU** button and set **SLOPE** to **Falling**.
13. Press the **SET LEVEL TO 50%** button.
14. Check that the Trigger Level Accuracy readout is in the range of 169 mV to 231 mV.
15. Press the **MAIN/DELAY SELECT** button, displaying the delay trigger menu.
16. Set **MODE** to **Runs After** and **SRC** to **Ch1**.
17. Press the **SET LEVEL TO 50%** button.
18. Check that the Trigger Level Accuracy readout is in the range of 169 mV to 231 mV.
19. Disconnect the test setup from the oscilloscope.
20. Press the **MAIN/DELAY SELECT** button and set **SLOPE** to **Rising**.
21. Press the **HORIZONTAL MENU** button and set **DELAY** to **Off**.

Check DC Coupling Bandwidth

Equipment Required: One leveled sine wave generator (item 8), one precision coaxial cable (item 5), and one 50 Ω termination (item 3).

1. Display the channel to be verified, turning all others off.
2. Connect the output of the sine wave generator to the channel to be verified as shown in Figure 6-8.

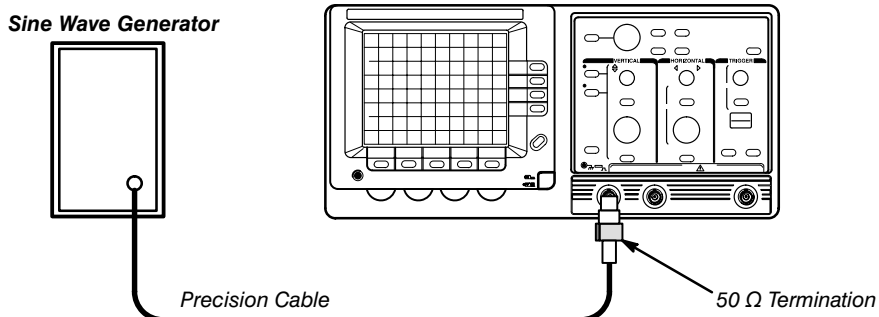


Figure 6-8: Bandwidth Test Setup

3. Press the **AUTOSET** button.
4. Set the volts/div scale to 2 mV.
5. Set the sec/div scale to 200 μ s.
6. Set the sine wave generator for a 50 kHz reference frequency and adjust the amplitude for a six division display.
7. Press the **TRIGGER MENU** button and set **CPLG** to **Noise Reject**.
8. Use the following substeps (a to c) and the settings and limits given in Table 6-3 to confirm the bandwidth of the input channels.
 - a. Set the volts/div scale as indicated.
 - b. Set the signal generator for the specified amplitude at the reference frequency.
 - c. While confirming the Display Amplitude remains greater than the minimum number of divisions, increase the signal generator frequency to 60 MHz or 100 MHz, depending on the instrument model.

Table 6-3: DC Coupled Bandwidth

Volts/Div Scale	50 kHz Reference Amplitude	Display Amplitude	
		TAS 455 To 60 MHz	TAS 465 To 100 MHz
2 mV	6 division	≥ 4.2 division	≥ 4.2 division
5 mV	6 division	≥ 4.2 division	≥ 4.2 division
10 mV	6 division	≥ 4.2 division	≥ 4.2 division
20 mV	6 division	≥ 4.2 division	≥ 4.2 division
50 mV	6 division	≥ 4.2 division	≥ 4.2 division
100 mV	6 division	≥ 4.2 division	≥ 4.2 division
1 V	5 division	≥ 3.5 division	≥ 3.5 division

9. Disconnect the test setup from the oscilloscope.
10. Repeat this procedure until all input channels are verified.

Check X-Axis Gain

Equipment Required: One pulse generator (item 10) and one precision coaxial cable (item 5).

1. Display channel 1, turning all others off.
2. Connect the output of the pulse generator to the **CH 1** input as shown Figure 6-9.

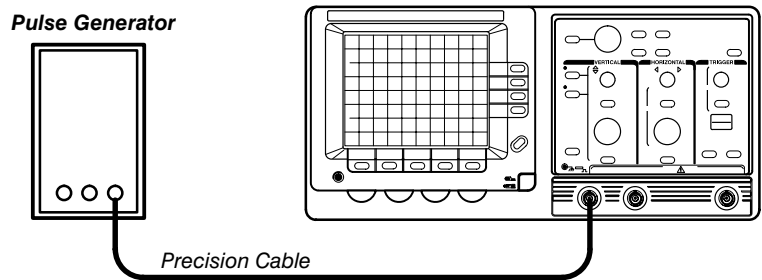


Figure 6-9: X-Axis Gain Test Setup

3. Set the output of the pulse calibration generator for 50 mV.
4. Press the **AUTOSET** button.
5. Set the volts/div scale to 10 mV.
6. Center the display using the vertical **POSITION** control.
7. Press the **HORIZONTAL MENU** button and set **XY** to **On**.
8. Check that the amplitude of the X-axis signal is 4.8 to 5.2 divisions.
9. Set **XY** to **Off**.
10. Disconnect the test setup from the oscilloscope.

Horizontal System Checks

These procedures check those characteristics that relate to the horizontal system and are listed as checked under *Warranted Characteristics* in Section 4, *Specifications*.

Check Time Base and Time Cursor Accuracy

Equipment Required: One time marker generator (item 9), one precision coaxial cable (item 5), and one 50 Ω termination (item 3).

1. Display channel 1, turning all others off.

2. Connect the output of the time marker generator to the **CH 1** input as shown in Figure 6-10.

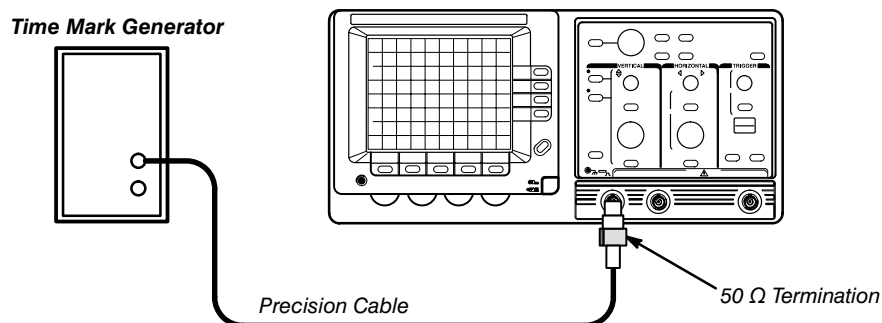


Figure 6-10: Timing Test Setup

3. Set the output of the generator for 20 ns markers.
4. Press the **AUTOSET** button.
5. Set the sec/div scale to 20 ns.
6. Set the volts/div scale to 500 mV.
7. Center the time mark display vertically.
8. Press the **CURSOR** button and set Δ TIME to **On**.
9. Position the rising edge of the second time mark to the second vertical graticule line.
10. Align the active cursor to the second time mark at the point the rising edge intersects the center horizontal graticule line using the General Purpose Knob.
11. Press the **TOGGLE** button and align the second cursor to the tenth time mark at the point the rising edge intersects the center horizontal graticule line using the General Purpose Knob.
12. Check that the Time-mark to Graticule Accuracy and the Time Cursor Readout Accuracy over the center eight divisions are within the limits shown for each Sec/Div Scale listed in Table 6-4.

Table 6-4: Time Base and Cursor Accuracies (Mag Off)

Sec/Div Scale (Mag Off)	Time Mark Setting	Time-mark to Graticule Accuracy	Time Cursor Readout Accuracy
		Over Center 8 Divisions	2nd and 10th Time Marks
20 ns	20 ns	±0.16 division	157 ns to 163 ns
50 ns	50 ns	±0.16 division	392 ns to 408 ns
100 ns	0.1 μs	±0.16 division	784 ns to 816 ns

Table 6-4: Time Base and Cursor Accuracies (Mag Off) (Cont.)

Sec/Div Scale (Mag Off)	Time Mark Setting	Time-mark to Graticule Accuracy	Time Cursor Readout Accuracy
		Over Center 8 Divisions	2nd and 10th Time Marks
200 ns	0.2 μ s	± 0.16 division	1.57 μ s to 1.63 μ s
500 ns	0.5 μ s	± 0.16 division	3.92 μ s to 4.08 μ s
1 μ s	1 μ s	± 0.16 division	7.84 μ s to 8.16 μ s
2 μ s	2 μ s	± 0.16 division	15.7 μ s to 16.3 μ s
5 μ s	5 μ s	± 0.16 division	39.2 μ s to 40.8 μ s
10 μ s	10 μ s	± 0.16 division	78.4 μ s to 81.6 μ s
20 μ s	20 μ s	± 0.16 division	157 μ s to 163 μ s
50 μ s	50 μ s	± 0.16 division	392 μ s to 408 μ s
100 μ s	0.1 ms	± 0.16 division	784 μ s to 816 μ s
200 μ s	0.2 ms	± 0.16 division	1.57 ms to 1.63 ms
500 μ s	0.5 ms	± 0.16 division	3.92 ms to 4.08 ms
1 ms	1 ms	± 0.16 division	7.84 ms to 8.16 ms
2 ms	2 ms	± 0.16 division	15.7 ms to 16.3 ms
5 ms	5 ms	± 0.16 division	39.2 ms to 40.8 ms

13. Set Δ TIME to **Off**.
14. Set the time mark generator to 20 ns.
15. Set the main sec/div scale to 20 ns.
16. Press the **HORIZONTAL MENU** button and set **DELAY** to **On** and **MAIN** to **Off**.
17. Set the delayed sec/div scale to 20 ns.
18. Set the delay time to 3 ns using the General Purpose Knob.
19. Position the edge of the second time mark to the second vertical graticule line.
20. Check that the Time Mark to Graticule Accuracy over the center eight divisions are within the limits shown for each sec/div scale listed in Table 6-4 (disregard the Time Cursor Readout Accuracy column).
21. Set **MAIN** to **On**.
22. Set the main sec/div scale to 20 ns.
23. Set **MAIN** to **Off**.

24. Press the **MAG** button, turning magnification on.
25. Set the time mark generator for 5 ns markers.
26. Set the volts/div scale to 200 mV.
27. Check that the timing accuracies at the beginning, middle, and end of sweep over the center eight divisions are within the limits shown for each of the sec/div scales given in Table 6-5. Exclude the first and last five divisions of the magnified sweep for accuracy measurements.

Table 6-5: Time Base Accuracy (Mag On)

Sec/Div Scale (Mag On)	Time Marker Setting	Time Mark to Graticule Over Center 8 Divisions
2 ns	5 ns ¹	±0.32 division ²
5 ns	5 ns ¹	±0.32 division
10 ns	10 ns	±0.24 division
100 ns	0.1 μs	±0.24 division
100 μs	0.1 ms	±0.24 division

¹ Change the volts/div scale as necessary to maintain vertical amplitude.

² At this setting, two cycles of the signal are displayed for every five horizontal divisions.

28. Set **MAIN** to **On** and **DELAY** to **Off**.
29. Set the sec/div scale to 2 ns.
30. Set the time mark generator for 5 ns markers.
31. Check that the timing accuracies at the beginning, middle, and end of sweep over the center eight divisions are within the limits shown for each Sec/Div Scale given in Table 6-5. Exclude the first and last five divisions of the magnified sweep for accuracy measurements.
32. Press the **MAG** button, turning magnification off.

Check Dual Delay Accuracy

Equipment Required: One time marker generator (item 9), one precision coaxial cable (item 5), and one 50 Ω termination (item 3).

1. Display channel 1, turning all others off.
2. Connect the output of the time marker generator to the **CH 1** input as shown in Figure 6-11.

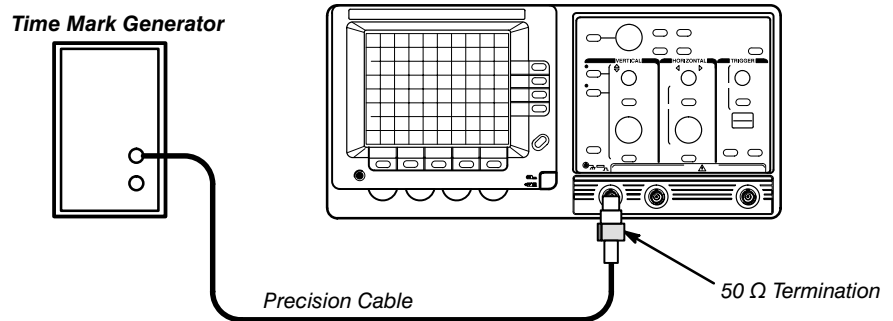


Figure 6-11: Dual Delay Test Setup

3. Set the output of the time marker generator for 0.5 ms markers.
4. Press the **AUTOSET** button.
5. Set the sec/div scale to 500 μ s.
6. Set the volts/div scale to 500 mV.
7. Position the time marker display to the upper half of the graticule and align the first time marker to the second vertical graticule line.
8. Press the **TRIGGER MENU** button and then the **MAIN/DELAY SELECT** button.
9. Set **MODE** to **Runs After**.
10. Set the delayed sec/div scale to 50 μ s.
11. Press **HORIZONTAL MENU**.
12. Select **TRCSEP** and position the delayed time marker display to the lower half of the graticule using the General Purpose Knob.
13. Select **DELAY**.
14. Using the General Purpose Knob, position the intensified zone on the main sweep to the second time marker; then, slightly adjust the General Purpose Knob until the delayed sweep time marker is at the graticule center.
15. Press the **UTILITY** button and select **CONFIG** from the main menu.
16. Select **MORE** until you can select **Dual Delay Enabled** from the sub menu.
17. Press the **CURSOR** button and set Δ **TIME** to **On**.
18. Using the General Purpose Knob, position the second intensified zone on the main sweep to the third time marker; then, slightly adjust the General Purpose Knob to superimpose the delayed sweep time markers at the graticule center. Press the **TOGGLE** button to assign the General Purpose Knob to the second intensified zone if necessary.
19. Check the Dual Delay Accuracy Reading for each time marker pair listed in Table 6-6.

Table 6-6: 500 μ s Dual Delay Accuracy

Time Markers Intensified	Dual Delay Accuracy Reading Limits
Second and third	473 μ s to 527 μ s
Second and fourth	970 μ s to 1.03 ms
Second and sixth	1.97 ms to 2.03 ms
Second and tenth	3.96 ms to 4.04 ms

20. Press the **MAIN/DELAY SELECT** button and set the main sec/div scale to 200 ns.
21. Press the **MAIN/DELAY SELECT** button and set the delayed sec/div scale to 20 ns.
22. Set the time mark generator for 0.2 μ s markers.
23. Using the General Purpose Knob, position the second intensified zone on the main sweep to the tenth time marker; then, slightly adjust the General Purpose Knob to superimpose the delayed sweep time markers at the graticule center.
24. Check the dual delay accuracy (Δ Time) reading is in the range of 1.58 μ s to 1.62 μ s.
25. Press the **CURSOR** button and set Δ TIME to **Off**.
26. Press the **UTILITY** button and select **Dual Delay Disabled**.
27. Press the **HORIZONTAL MENU** button and set **DELAY** to **Off**.
28. Disconnect the test setup from the oscilloscope.

Trigger System Checks

These procedures check those characteristics that relate to the trigger system and are listed as checked under *Warranted Characteristics* in Section 4, *Specifications*.

Check Trigger Sensitivity

Equipment Required: One sine wave generator (item 8), one 10X attenuator (item 2), one precision coaxial cable (item 5), one dual-input coupler (item 7), and two 50 Ω terminations (item 3).

Low Frequency — The following steps check trigger sensitivity at 25 MHz.

1. Display channel 1, turning all others off.
2. Connect the output of the sine wave generator to the **CH 1** and **EXT TRIG** inputs as shown in Figure 6-12.

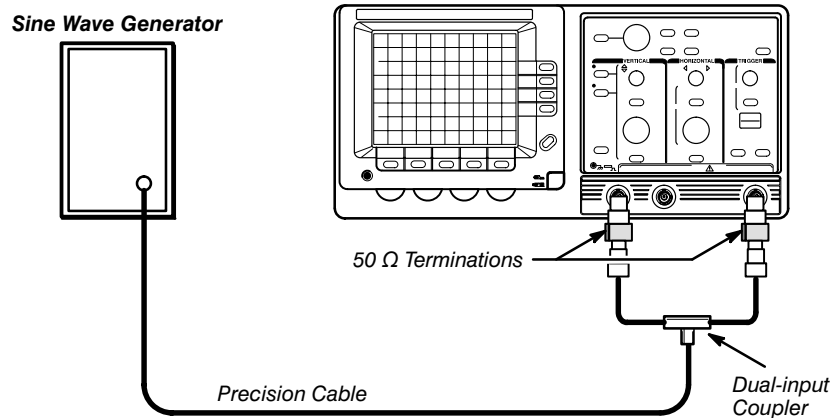


Figure 6-12: Trigger Sensitivity Test Setup (One)

3. Set the frequency of the sine wave generator to 25 MHz.
4. Press the **AUTOSET** button.
5. Set the volts/div scale to 50 mV.
6. Set the sec/div scale to 100 ns.
7. Press the **VERTICAL MENU** button and set **CPLG** to **DC**
8. Press the **TRIGGER MENU** button and make the following selections from the main trigger menu:
 - Set **MODE** to **Auto**
 - Set **SRC** to **Ch1**
 - Set **CPLG** to **DC**
 - Set **SLOPE** to **Rising**
9. Press the **MAIN/DELAY SELECT** button and make the following selections from the delay trigger menu:
 - Set **MODE** to **Runs After**
 - Set **SRC** to **Ch1**
 - Set **CPLG** to **DC**
 - Set **SLOPE** to **Rising**
10. Set the delayed sec/div scale to 50 ns.
11. Press the **HORIZONTAL MENU** button and select **DELAY**.
12. Set the delay time to 15 ns using the General Purpose Knob.
13. Set **DELAY** to **Off**.
14. Adjust the sine wave generator amplitude for a three division display.
15. Add a 10X attenuator to the test setup as shown in Figure 6-13.

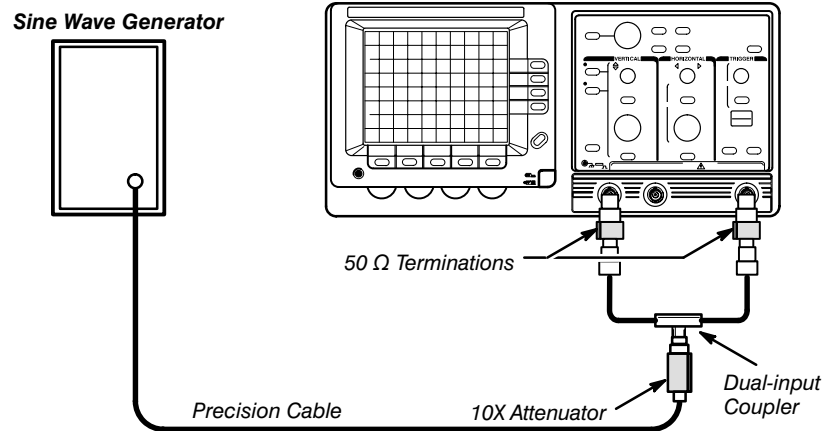


Figure 6-13: Trigger Sensitivity Test Setup (Two)

16. Press the **SET LEVEL TO 50%** button and confirm a stable display.
17. Press the **TRIGGER MENU** button and set **SLOPE** to **Falling**.
18. Press the **SET LEVEL TO 50%** button and confirm a stable display.
19. Press the **HORIZONTAL MENU** button and set **DELAY** to **On**.
20. Select **TRCSEP** and position the delayed sweep below the main sweep using the General Purpose Knob.
21. Press the **TRIGGER MENU** button and set **MODE** to **Trig After**.
22. Press the **SET LEVEL TO 50%** button and confirm a stable delayed sweep display.
23. Set **SLOPE** to **Falling**.
24. Press the **SET LEVEL TO 50%** button and confirm a stable delayed sweep display.
25. Press the **HORIZONTAL MENU** button and set **DELAY** to **Off**.
26. Set the volts/div scale to 10 mV.
27. Set the sine wave generator to 50 kHz.
28. Set the sec/div scale to 50 μ s.
29. Adjust the sine wave generator amplitude for a 3.5 division display.
30. Set the sine wave generator frequency to 25 MHz.
31. Set the main sec/div scale to 100 ns.
32. Press the **TRIGGER MENU** button and set **SRC** to **EXT <1>**.
33. Press the **SET LEVEL TO 50%** button and confirm a stable display.

High Frequency — The following steps check trigger sensitivity at 100 MHz (TAS 455) or 150 MHz (TAS 465).

1. Remove the 10X attenuator from the test setup. Reconnect as shown in Figure 6-14.

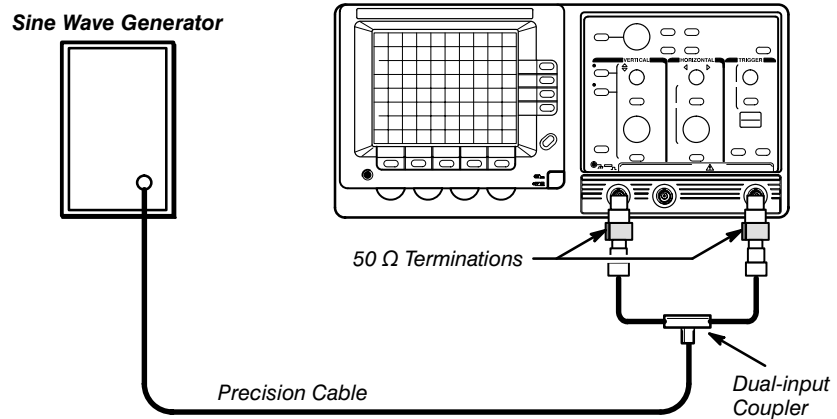


Figure 6-14: Trigger Sensitivity Test Setup (Three)

2. Set the volts/div scale to 1 V.
3. Adjust the sine wave generator amplitude for a one division display at 25 MHz.
4. Set the sine wave generator frequency as follows:
 - TAS 455 — 100 MHz
 - TAS 465 — 150 MHz
5. Press the **MAG** button.
6. Set **SRC** to **EXT <10>**.
7. Press the **SET LEVEL TO 50%** button and confirm a stable display.
8. Add a 10X attenuator to the test setup as shown in Figure 6-15.

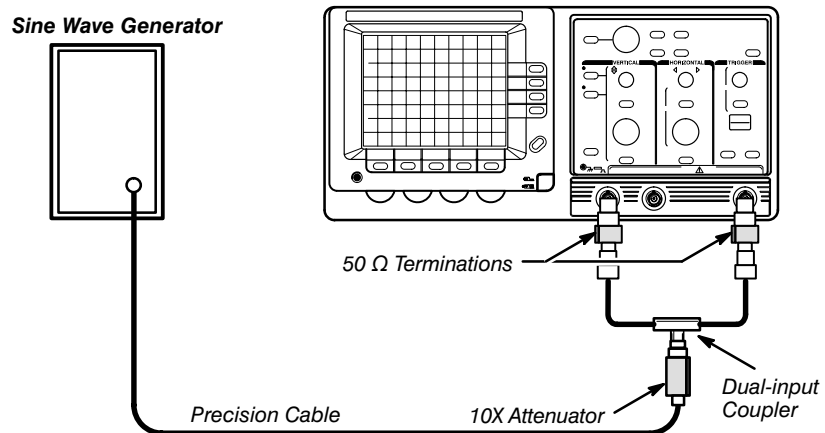


Figure 6-15: Trigger Sensitivity Test Setup (Four)

9. Set the volts/div scale to 50 mV.
10. Adjust the sine wave generator amplitude for a one division display.
11. Set **SRC** to **Ch1**.
12. Press the **SET LEVEL TO 50%** button and confirm a stable display.
13. Set **SLOPE** to **Rising**.
14. Press the **SET LEVEL TO 50%** button and confirm a stable display.
15. Press the **MAIN/DELAY SELECT** button (selecting delay).
16. Press the **SET LEVEL TO 50%** button and confirm a stable delayed sweep display (see the following note).

NOTE

*A slight adjustment of the delay time may be necessary to obtain a stable delayed sweep display. Press the **Horizontal Menu** button and adjust the delay time using the General Purpose Knob. Press the **Trigger Menu** button after confirming a stable display.*

17. Set **SLOPE** to **Rising**.
18. Press the **SET LEVEL TO 50%** button and confirm a stable delayed sweep display.

NOTE

*A slight adjustment of the delay time may be necessary to obtain a stable delayed sweep display. Press the **Horizontal Menu** button and adjust the delay time using the General Purpose Knob.*

19. Press the **HORIZONTAL MENU** button and set **DELAY** to **Off**.
20. Disconnect the test setup from the oscilloscope.

Video Trigger — The following steps check the video trigger sensitivity.

Equipment Required: One NTSC Television signal generator (item 13), one 75 Ω termination (item 4), and one 75 Ω coaxial cable (item 6).

1. Display channel 1, turning all others off.
2. Connect the composite sync output of the television signal generator to the **CH 1** input as shown in Figure 6-16.

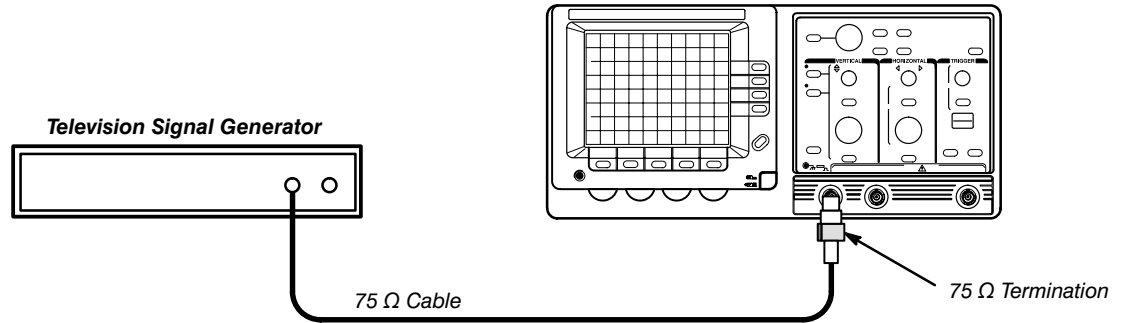


Figure 6-16: Video Trigger Test Setup

3. Press the **AUTOSET** button.
4. Set the volts/div scale to 200 mV.
5. Set the sec/div scale to 100 μ s.
6. Press the **UTILITY** button and select **CONFIG**.
7. Select **MORE** until you can select **Video Sync Negative** from the sub menu.
8. Press the **TRIGGER MENU** button and make the following selections:
 - Set **MODE** to **Video Field <odd>**
 - Set **SLOPE** to **Falling**
9. Confirm a stable display of the video field.
10. Set **MODE** to **Video Field <even>**.
11. Confirm a stable display of the video field.
12. Disconnect the test setup from the oscilloscope.

Adjustment

Adjustment Procedures

This section contains information needed to adjust the TAS 455 and TAS 465 Analog Oscilloscopes.

Description — The *Adjustment Procedures* are divided into two parts:

- General information about adjusting the oscilloscope
- Written procedures for oscilloscope calibration

Purpose — Use this procedure to return the oscilloscope to conformance with its *Warranted Characteristics* as listed in Section 4, *Specifications*. It also optimizes the performance of the oscilloscope.

This procedure is *not* required to verify the oscilloscope conforms with its warranted characteristics. Performance verification procedures are found in Section 6, *Performance Verification*.

Adjustment Interval — As a general rule, perform these adjustments after every 2,000 hours of operation or once a year if used infrequently.

Requirements for Performance

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

Personnel

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

Access to Adjustments

The cabinet must be removed to perform the adjustment procedure. Refer to the *Maintenance* section for procedures to remove the cabinet. The adjustment procedures make references to adjustments located on internal circuit boards. Figure 7-1 shows the location of each board with adjustments. The end of this section contains figures that show the location of each adjustment for each circuit board.

Warm-Up Period

This oscilloscope requires a 20 minute warm-up period in a 20° C to 30° C environment before performing this adjustment procedure. Adjustments performed before the operating temperature has stabilized may cause errors in performance.

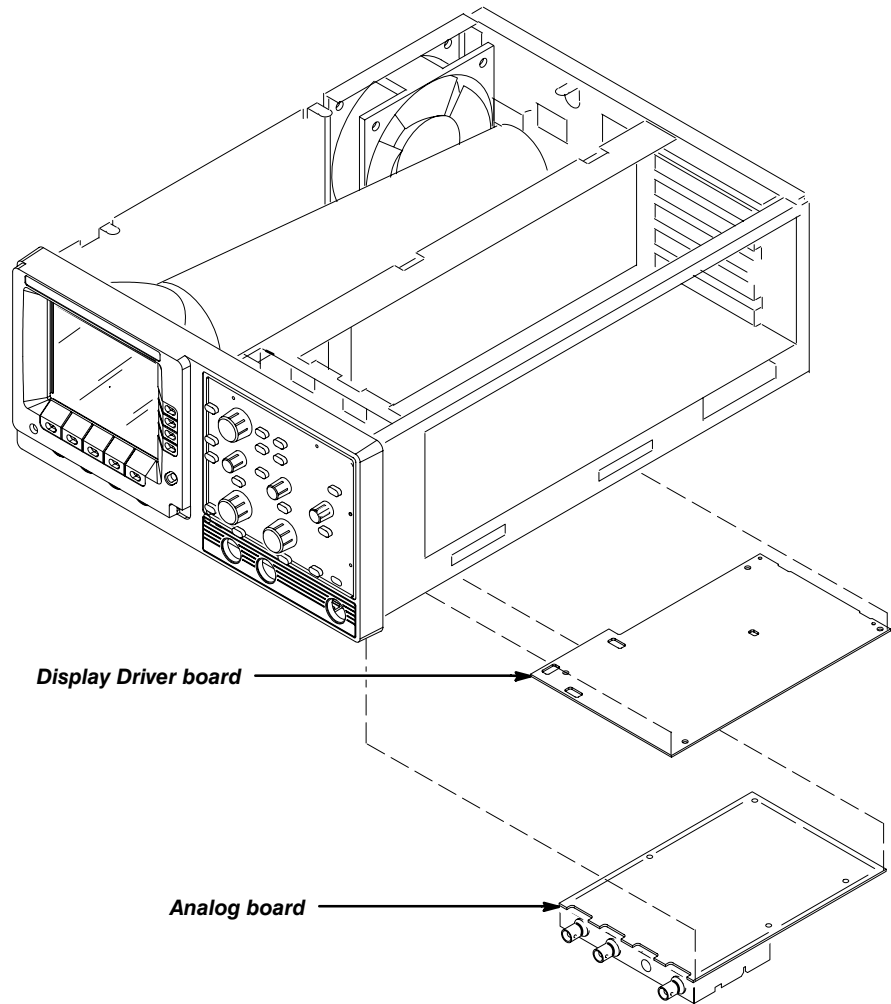


Figure 7-1: Location of Boards for Adjustments

Equipment Required

These procedures use external, traceable signal sources to calibrate the TAS 455 and TAS 465 Oscilloscopes. Table 6-1 on page 6-14 lists all the test equipment required for these procedures.

Performing the Adjustment Procedures

The following topics cover what is required to adjust the oscilloscope. Also, the performance of individual adjustments is discussed.

The **Factory Horizontal Cal** and **Factory Vertical Cal** calibration routines are selected from the Utility menu of the oscilloscope. These routines use both front-panel controls and external standards you provide in response to instructions displayed on the CRT readout.

Complete Adjustment

A complete adjustment consists of a sequence of individual calibration steps performed in the order shown:

1. Power Supply Adjustment (Serial Number B020100 and Above)
2. CRT Adjustment
3. Low Frequency Output Compensation
4. Factory Horizontal Cal
5. Factory Vertical Cal
6. High Frequency Step Response Adjustment
7. Attenuator Compensation
8. Vertical Gain Adjustment

Partial Adjustment

The Adjustment Procedures allow you to make individual adjustments of the steps outlined above; however, usually all adjustment steps are made. Read the information under *Adjustment Dependencies* that follows before performing an individual adjustment.

Adjustment Dependencies

Some adjustments depend on the successful prior completion of other adjustments. Generally, the procedures should be performed in the order shown under *Complete Adjustment*. Some adjustments do not depend on completion of other adjustments. Table 7-1 lists the adjustments and their dependencies.

Table 7-1: Adjustments and Dependencies

Adjustment	Prior Completion Requirements
Power Supply (B020100 and above)	None
CRT Adjustment	Power Supply (B020100 and above)
Low Frequency Output Compensation	Power Supply (B020100 and above)
Factory Horizontal Cal	CRT Adjustment
Factory Vertical Cal	Low Frequency Output Compensation and Factory Horizontal Cal
High Frequency Step Response	Factory Vertical Cal
Attenuator Compensation	Low Frequency Output Compensation

Table 7-1: Adjustments and Dependencies (Cont.)

Adjustment	Prior Completion Requirements
Vertical Gain Adjustment	Low Frequency Output Compensation, Factory Vertical Cal, and Attenuator Compensation

Adjustment Instructions

The following instructions will guide you through each of the adjustments outlined in *Complete Adjustments*. Each adjustment section lists all necessary equipment required to perform the adjustments.

Power Supply Adjustment (Serial Number B020100 and Above)

Equipment Required: One digital multimeter (item 14) and one adjustment tool (item 15).

Adjustment Locations: This procedure requires adjustment to the Power Supply board. See Figure 7-16 on page 7-21 for the location of the adjustment.

1. Connect the digital voltmeter low lead to chassis ground and connect the volts lead to the -8.6 V supply (W55-2) on the CPU board.
2. Measure the -8.6 V supply. If the supply measures from -8.56 V to -8.64 V, the supply is adjusted properly and you may disconnect the voltmeter.
3. If the power supply is not within the limits specified in step 2, adjust the -8.6 V ADJ potentiometer (R43) for a voltmeter reading of -8.60 V.
4. Disconnect the voltmeter from the instrument.

CRT Adjustments

Equipment Required: One time marker generator (item 9), one precision coaxial cable (item 5), and one $50\ \Omega$ termination (item 3).

Adjustment Locations: This procedure requires adjustments to the Display Driver board. See Figure 7-14 on page 7-19 for the location of the adjustments.

1. Disconnect all signal inputs from the oscilloscope.
2. Display channel 1, turning all others off.
3. Press the **AUTOSET** button.
4. Set the volts/div scale to 50 mV.
5. Set the sec/div scale to 2 μ s.

6. Press the **VERTICAL MENU** button and make the following selections from the menu:
 - Set **CPLG** to **GND**
 - Set **BW** to **20 MHz**
7. Position the channel 1 trace to the center horizontal graticule line and adjust the **FOCUS** control for a well-defined display.
8. Adjust the **TRACE ROTATION** control (screw-driver adjustment) to align the trace with the center horizontal graticule line.
9. Press the **HORIZONTAL MENU** button and set **XY** to **On**.
10. Set the **INTENSITY** control fully counterclockwise (off).
11. Adjust R321 on the Display Driver board until the dot is visible, then re-adjust R321 until the dot just extinguishes.
12. Set **XY** to **Off**.
13. Connect the output of the time mark generator to the **CH 1** input as shown in Figure 7-2.

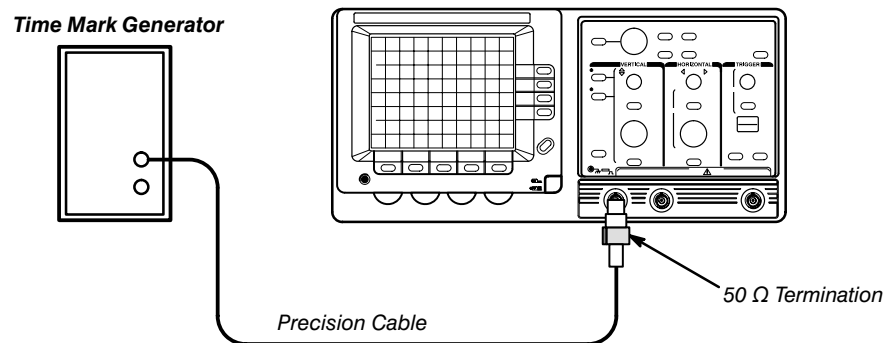


Figure 7-2: CRT Adjustments Calibration Setup

14. Set the time mark generator for 1 μ s markers.
15. Set the **INTENSITY** control to view the display.
16. Press the **VERTICAL MENU** button and set **CPLG** to **DC**
17. Press the **SET LEVEL TO 50%** button.
18. Adjust the **FOCUS** and R322 on the Display Driver board for the best focus of the time mark display and readout display.
19. Set the vertical **POSITION** control counterclockwise, moving the base-line of the time mark display down off the graticule area.
20. Set the **READOUT INTENSITY** control fully counterclockwise (off).
21. Adjust R323 on the Display Driver for the best geometry (minimum bowing) of the time mark display across the entire graticule area.

22. Set the **READOUT INTENSITY** control to view the readout.
23. Disconnect the calibration setup from the oscilloscope.

Low Frequency Output Compensation

Equipment Required: One pulse generator (item 10), one precision coaxial cable (item 5), one 50 Ω termination (item 3), and one dual-input coupler (item 7).

Adjustment Locations: This procedure requires adjustments to the Display Driver board. See Figure 7-14 on page 7-19 for the location of the adjustments.

1. Display channel 1, turning all others off.
2. Press the **AUTOSET** button.
3. Set the volts/div scale to 50 mV.
4. Set the sec/div scale to 1 ms.
5. Press the **ALT/CHOP, ADD** button and set **DISP** to **Alt**.
6. Press the **VERTICAL MENU** button and set **CPLG** to **AC**.
7. Connect the positive fast rise pulse output of the pulse generator to the **CH 1** and **CH 2** input connectors as shown in Figure 7-3.

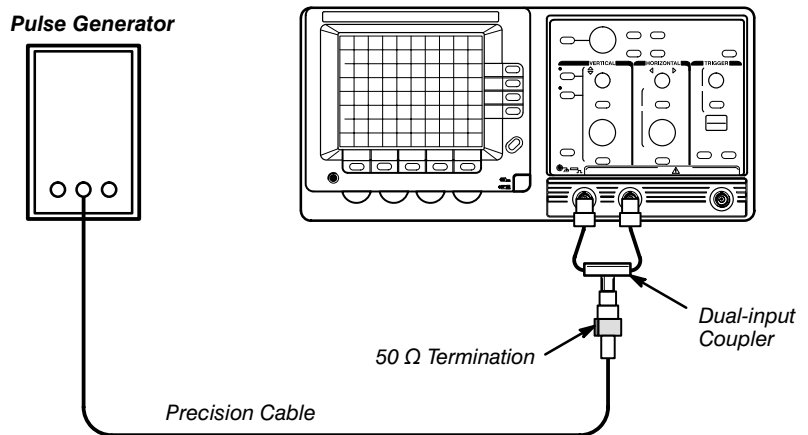


Figure 7-3: Low Frequency Output Compensation Calibration Setup

8. Set the pulse generator for fast rise period of 1 ms and a 4 division display.
9. Press the **SET LEVEL TO 50%** button.
10. Press the **CURSOR** button and set **Δ VOLT** to **On**.
11. Set the cursors 5 divisions apart using the General Purpose Knob and the **TOGGLE** button.

12. Set the volts/div scale to 20 mV.
13. Press the **CH 2** button.
14. Set the channel 2 volts/div scale to 20 mV.
15. Press the **VERTICAL MENU** button and make the following selections from the menu (channel 2):
 - Set **CPLG** to **GND**
 - Set **VAR** to **Off**
 - Set **INV** to **Off**
 - Set **BW** to **Full**
16. Position the channel 2 trace to the center vertical graticule line.
17. Set **CPLG** to **AC**.
18. Adjust R111 located on the Display Driver board for minimum vertical movement of the readout (over the entire graticule area).
19. Disconnect the test setup from the oscilloscope.

Factory Horizontal Cal

Equipment Required: One time mark generator (item 9), one precision coaxial cable (item 5), and one 50 Ω termination (item 3).

Prerequisites: CRT adjustment procedure.

NOTE

To enable factory calibration on oscilloscopes with firmware version 2.10 or above, remove jumper J205 (CAL–DIS) on the CPU board. (See Figure 7-17 on page 7-22 for the location of J205.) If you do not remove this jumper, the message “See manual to enable Factory Cal” appears when you select the factory calibration routine.

Firmware versions below 2.10 do not have the calibration lockout feature and the factory calibration routine can still execute with J205 installed.

1. Disconnect all signal inputs from the oscilloscope.
2. Press the **UTILITY** button to display the Utility menu.



To avoid replacing the calibration constants with erroneous values, be sure to complete all steps of this procedure after initiating the calibration routine.

3. Select **CAL** from the main menu.
4. Select **Factory Horizontal Cal** to initiate the calibration routine.

This routine takes about 20 seconds to complete its initial calibrations. Once complete, 2 dots are displayed and the message “**Toggle to set 8div about center**” appears. The displayed dots are used for the next horizontal calibration steps.

NOTE

The following steps use both the General Purpose Knob and the **TOGGLE** button to make adjustments. The General Purpose Knob performs two functions: to adjust horizontal gain and centering. The **TOGGLE** button selects the function of the General Purpose Knob.

5. Use a combination of the **TOGGLE** button and the General Purpose Knob to position the dots 8 divisions apart, centered horizontally (see Figure 7-4).
6. Select **Done** when you have the appropriate display.

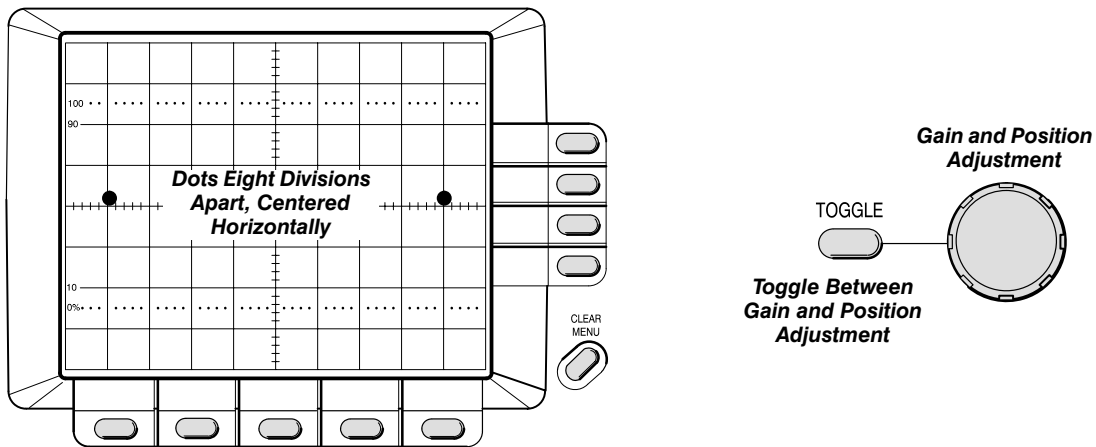


Figure 7-4: Horizontal Adjustments (One)

7. Again, use a combination of the **TOGGLE** button and the General Purpose Knob to position the dots 8 divisions apart, centered horizontally (see Figure 7-4).

8. Select **Done** when you have the appropriate display.
9. One dot is displayed.
10. Use a combination of the **TOGGLE** button and the General Purpose Knob to center the single dot at the center of the screen (see Figure 7-5).

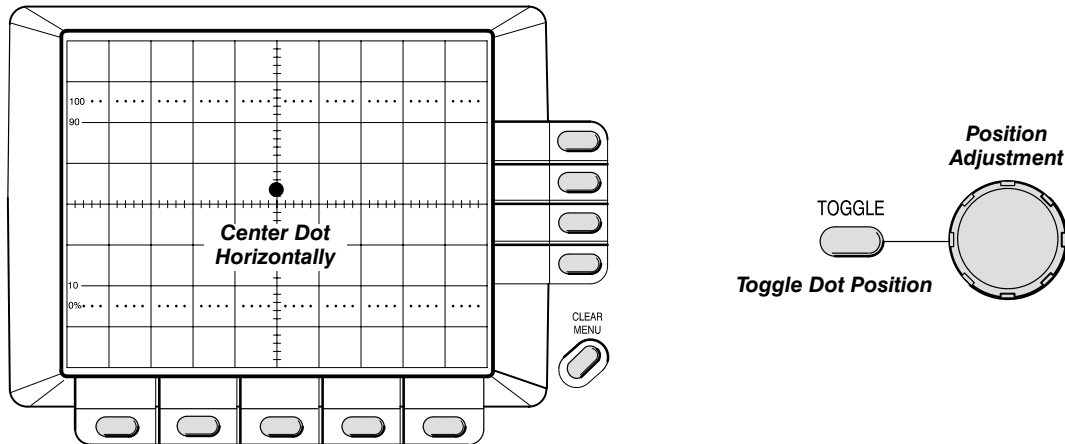


Figure 7-5: Horizontal Adjustments (Two)

11. Continue to press the **TOGGLE** button and adjusting the dot to center screen with the General Purpose Knob until the dot stays centered while pressing the **TOGGLE** button.
12. Select **Done** when you have the appropriate display.
13. Two vertical cursor lines are displayed.
14. Use a combination of the **TOGGLE** button and the General Purpose Knob to position the vertical lines 8 divisions apart, centered horizontally (see Figure 7-6).

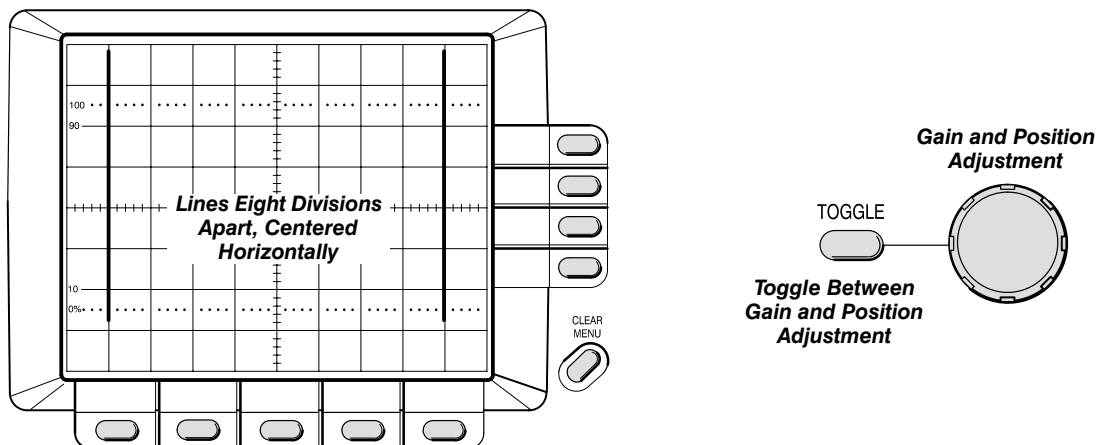


Figure 7-6: Horizontal Adjustments (Three)

15. Select **Done** with the menu button when you have the appropriate display.

NOTE

*At this time, the calibration routine can be terminated by selecting **Abort** instead of **Done**. The abort option appears through the remainder of this Factory Horizontal Cal routine.*

16. Select **Done** to continue or **Abort** to terminate the calibration routine.
17. Connect the output of the time mark generator to the **CH 1** input as shown in Figure 7-7.

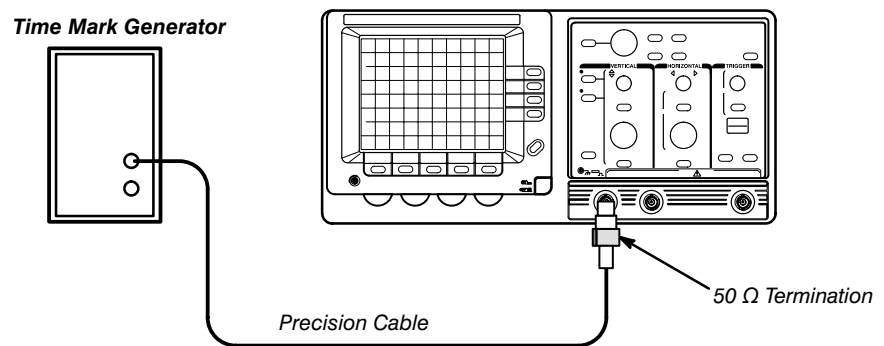


Figure 7-7: Horizontal Output Calibration Setup

18. Set the time mark generator for 5 ns markers.
19. Select **Done** when completed.
20. Adjust the 5 ns main sweep accuracy by performing these substeps.
 - a. Using the General Purpose Knob, adjust the display for 1 time marker per division over the center 8 divisions.
 - b. Select **Done** when adjusted.
21. Adjust the 5 ns delay sweep accuracy by performing these substeps.
 - a. Using the General Purpose Knob, adjust the display for 1 time marker per division over the center 8 divisions.
 - b. Select **Done** when adjusted.
22. Adjust the 2 ns main sweep accuracy by performing these substeps.
 - a. Using the General Purpose Knob, adjust the display for 2 time markers per 5 divisions over the center 8 divisions.
 - b. Select **Done** when adjusted.
23. Adjust the 2 ns delay sweep accuracy by performing these substeps.

- a. Using the General Purpose Knob, adjust the display for 2 time markers per 5 divisions over the center 8 divisions.
 - b. Select **Done** when adjusted; a **Cal Passed** message appears.
24. Select **Done** to exit the routine.
 25. Disconnect the test setup from the oscilloscope.
 26. If you do not intend to proceed with Factory Vertical CAL, replace J205 (CAL–DIS) to lock out the calibration routine. (This jumper only works with firmware version 2.10 and above.)



To prevent accidental loss of calibration, be sure the calibration lockout jumper (J205) is in place. If J205 is not in place, erroneous calibration constants can result if the calibration routine is accidentally invoked and not properly completed.

Factory Vertical Cal

Equipment Required: One DC calibration generator (item 11), one precision coaxial cable (item 5), and one dual-input coupler (item 7).

Prerequisites: Low Frequency Output Compensation adjustment and Self Cal Horizontal adjustment procedures.

NOTE

To enable factory calibration on oscilloscopes with firmware version 2.10 or above, remove jumper J205 (CAL–DIS) on the CPU board. (See Figure 7-17 on page 7-22 for the location of J205.) If you do not remove this jumper, the message “See manual to enable Factory Cal” appears when you select the factory calibration routine.

Firmware versions below 2.10 do not have the calibration lockout feature and the factory calibration routine can still execute with J205 installed.

1. Press the **UTILITY** button.



To avoid replacing the calibration constants with erroneous values, be sure to complete all steps of this procedure after initiating the calibration routine.

2. Select **CAL** from the main menu.
3. Select **Factory Vertical Cal** to initiate the calibration routine.

The calibration routine displays user prompts on-screen throughout this procedure.

NOTE

*At this time, the calibration routine can be terminated by selecting **Abort**. The abort option appears through the remainder of this Factory Vertical Cal routine.*

4. Set the DC calibration generator for 10 VDC output and connect to the **CH 1** and **CH 2** inputs as shown in Figure 7-8.

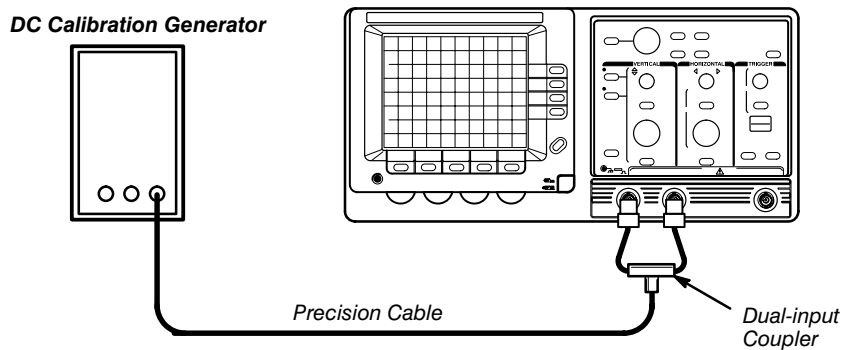


Figure 7-8: Factory Vertical Calibration Setup

5. Select **Done** when completed.
6. Set the DC calibration generator for 1 VDC output.
7. Select **Done** when completed.
8. Set the DC calibration generator for 100 mVDC output.
9. Select **Done** when completed.
10. Disconnect the test setup.
11. Select **Done** when completed.

This portion of the routine takes about one minute to complete.

12. Connect the DC calibration generator to the **EXT TRIG** input as shown in Figure 7-9.

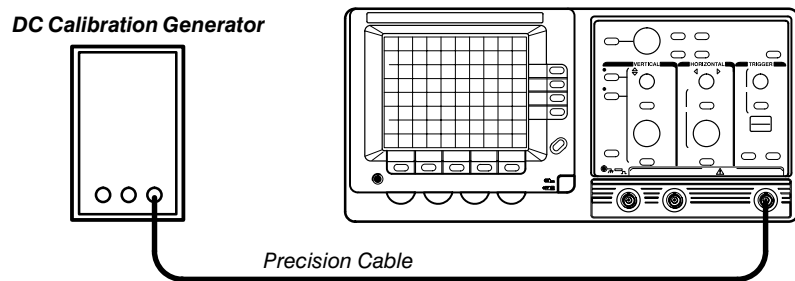


Figure 7-9: External Trigger Calibration Setup

13. Set the DC calibration generator for 500 mVDC output.
14. Select **Done** when completed.
15. Set the DC calibration generator for 5 VDC output.
16. Select **Done** when completed.

NOTE

*The following steps use both the General Purpose Knob and the **TOGGLE** button to make adjustments. The General Purpose Knob performs two functions: adjust horizontal gain and centering. The **TOGGLE** button selects the function of the General Purpose Knob.*

17. Use a combination of the **TOGGLE** button and the General Purpose Knob to position the dots 6 divisions apart, centered horizontally (see Figure 7-10).

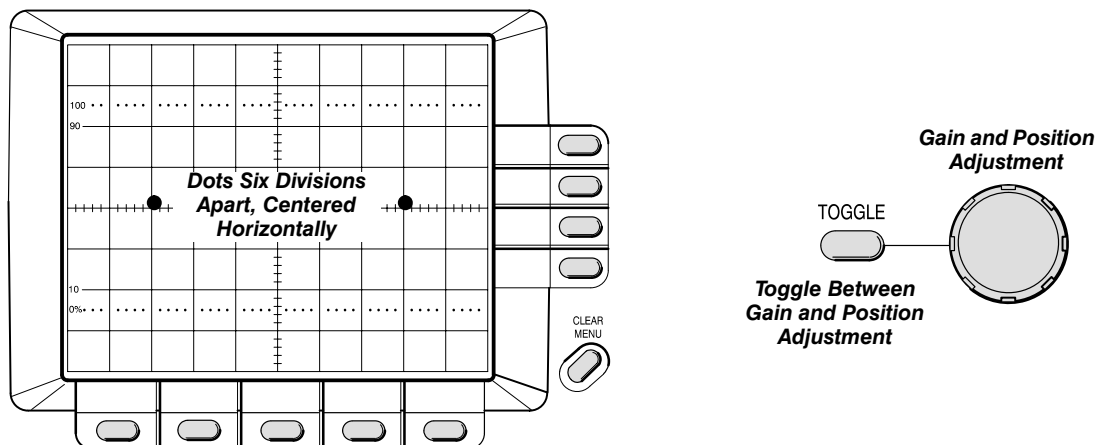


Figure 7-10: Vertical Adjustments

18. Select **Done** when you have the appropriate display.
19. Adjust R112 (vertical gain) and R154 (vertical centering) on the Display Driver board, setting the horizontal cursors 6 divisions apart, centered vertically (see Figure 7-11).

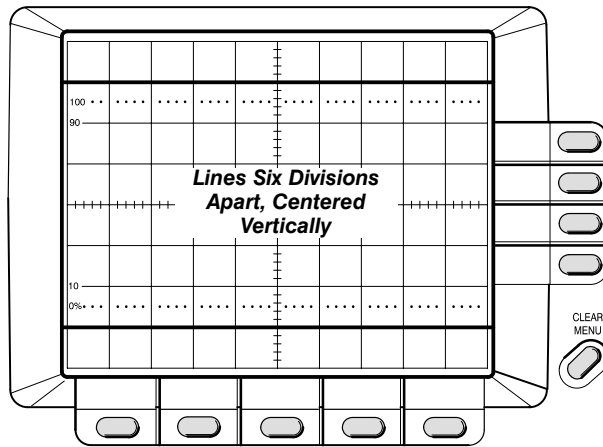


Figure 7-11: Adjusting Vertical Gain and Centering

20. Select **Done** when you have completed the adjustments.
21. Select **Done** again to exit the routine.
22. Replace J205 (CAL-DIS) to lock out the calibration routine. (This jumper only works with firmware version 2.10 and above.)



To prevent accidental loss of calibration, be sure the calibration lockout jumper (J205) is in place. If J205 is not in place, erroneous calibration constants can result if the calibration routine is accidentally invoked and not properly completed.

High Frequency Step Response

Equipment Required: One pulse generator (item 10), one precision coaxial cable (item 5), one 5X attenuator (item 1), and one 50 Ω termination (item 3).

Adjustment Locations: This procedure requires adjustments to the Display Driver board. See Figure 7-14 on page 7-19 for the location of the adjustments.

Prerequisites: Factory Vertical Cal adjustment procedure.

1. Display channel 1, turning all others off.

2. Connect the positive fast rise pulse output of the pulse generator to the **CH 1** input as shown in Figure 7-12.

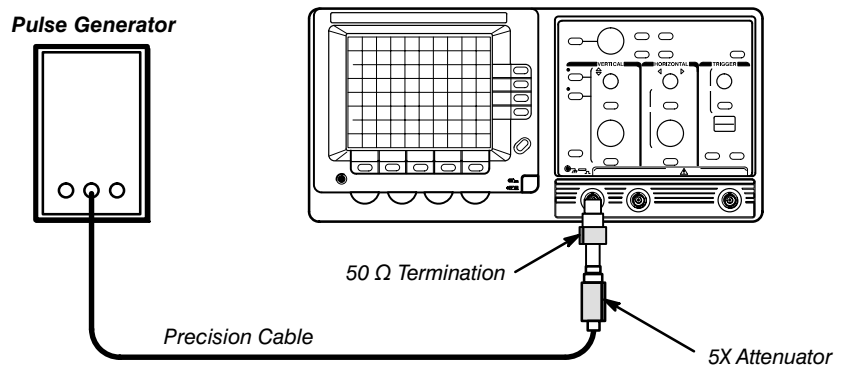


Figure 7-12: High Frequency Step Response Test Setup

3. Set the pulse generator fast rise period to 1 μs and pulse amplitude to mid-range.
4. Press the **AUTOSET** button.
5. Set the volts/div scale to 10 mV.
6. Set the sec/div scale to 200 ns.
7. Press the **VERTICAL MENU** button and set **CPLG** to **DC**.
8. Adjust the vertical **POSITION** control and the generator pulse amplitude to obtain a 5 division, vertically centered, display.
9. **TAS 465 Only** — Adjust R141 and C122 on the Display Driver board for flattest long term response of the pulse front corner.
10. Set the sec/div scale to 20 ns.
11. Adjust R140 and C121 on the Display Driver board for minimum signal aberrations of the pulse front corner.

NOTE

Some interaction of the adjustments made in steps 9 and 11 may occur. For optimum oscilloscope performance, these steps should be rechecked after making adjustments.

12. Disconnect the calibration setup from the oscilloscope.

Attenuator Compensation

Equipment Required: One pulse generator (item 10), one precision coaxial cable (item 5), one 50 Ω termination (item 3), and one dual-input coupler (item 7).

Adjustment Locations: This procedure requires adjustments to the Analog board. See Figure 7-15 on page 7-20 for the location of the adjustments.

Prerequisites: Low Frequency Output Compensation adjustment procedure.

1. Display channel 1, turning all others off.
2. Connect the high amplitude output of the pulse generator to the **CH 1** and **CH 2** inputs as shown in the following test setup diagram.

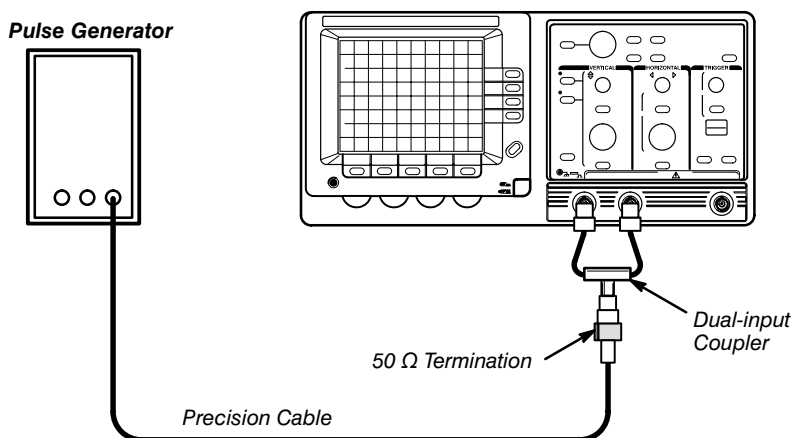


Figure 7-13: Attenuator Compensation Test Setup

3. Set the pulse generator high amplitude period to 1 ms.
4. Press the **AUTOSET** button.
5. Press the **VERTICAL MENU** button and set **CPLG** to **DC**.
6. Set the volts/div scale to 200 mV.
7. Set the sec/div scale to 200 μ s.
8. Using the vertical **POSITION** control and the generator pulse amplitude, obtain a 5 division, vertically centered display of channel 1.
9. Set the volts/div scale to 100 mV.
10. Press the **CH 2** button.
11. Press the **VERTICAL MENU** button and make the following selections from the menu:
 - Set **CPLG** to **DC**
 - Set **VAR** to **Off**

- Set **INV** to **Off**
 - Set **BW** to **Full**
 - Set the volts/div scale to 100 mV
 - Position the channel 2 display approximately 0.5 divisions below the channel 1 display
12. Press the **CH 1** button.
 13. Adjust Ch 1 10X on the Analog board for the flattest response of the most positive portion of the channel 1 waveform.
 14. Set the channel 1 volts/div scale to 1 V.
 15. Press the **CH 2** button.
 16. Adjust Ch 2 10X adjustment on the Analog board for the flattest response of the most positive portion of the channel 2 waveform.
 17. Set the channel 2 volts/div scale to 1 V.
 18. Set the pulse generator amplitude to maximum.
 19. Adjust Ch 2 100X on the Analog board for the flattest response of the channel 2 waveform.
 20. Adjust Ch 1 100X on the Analog board for the flattest response of the channel 1 waveform.
 21. Disconnect the test setup from the oscilloscope.

Vertical Gain Adjust (Cabinet On)

Equipment Required: None.

Adjustment Locations: This procedure requires adjustments to the Display Driver board. See Figure 7-14 on page 7-19 for the location of the adjustments.

Prerequisites: Low Frequency Output Compensation, Factory Vertical Cal, and Attenuator Compensation adjustment procedures.

1. Slide the cabinet on the instrument and allow a 20-minute warm-up.
2. Press the **CURSOR** button and set **ΔVOLT** to **On**.
3. Set the volts/div scale to 1 V.
4. Position the cursors 6 divisions apart, centered vertically and check that the ΔVolts readout is between 5.96 V and 6.04 V.

NOTE

If the readout in step 4 is within the limits given, stop here. The calibration is complete.

If the readout is outside the limits, continue with this procedure.

Adjustment Procedures

5. Adjust the cursors until the Δ Volts readout is 6 V.
6. Note the cursor display error (are the cursors more or less than six divisions apart).
7. Slide the cabinet off the instrument and adjust R112 on the Display Driver board to compensate for the display error noted in step 6.

For example, if you noted in step 6 that the with the Δ Volts readout at 6 V, the cursor display equaled 6.2 divisions. Compensate by adjusting the cursor display to 5.8 divisions with R112.

8. Slide the cabinet on the instrument and repeat this procedure until the cursor display matches the Δ Volts readout.

Adjustment Complete

The adjustment procedure is complete. Install the cabinet and rear cover.

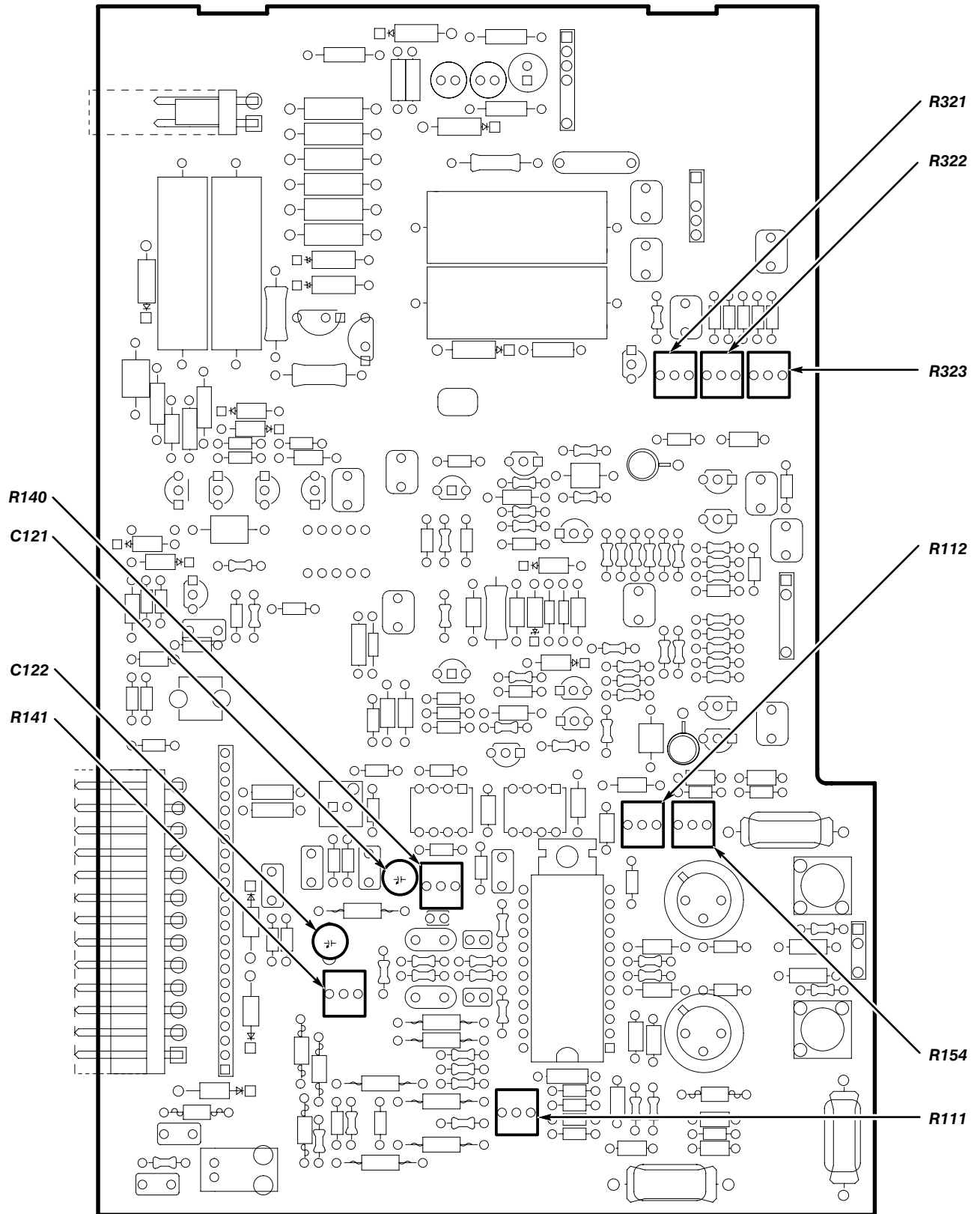


Figure 7-14: Display Driver Board Adjustment Locations

Adjustment Procedures

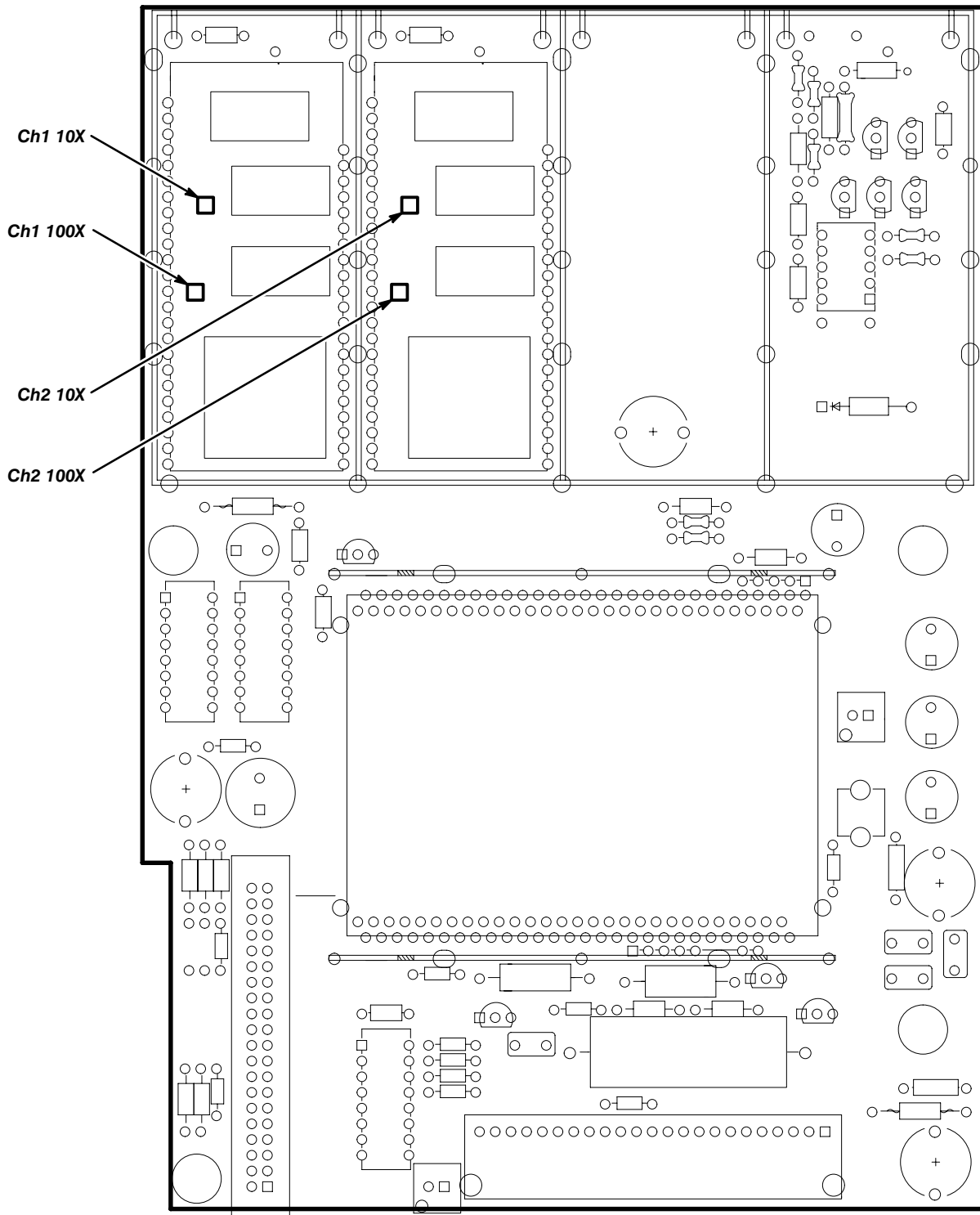


Figure 7-15: Analog Board Adjustment Locations

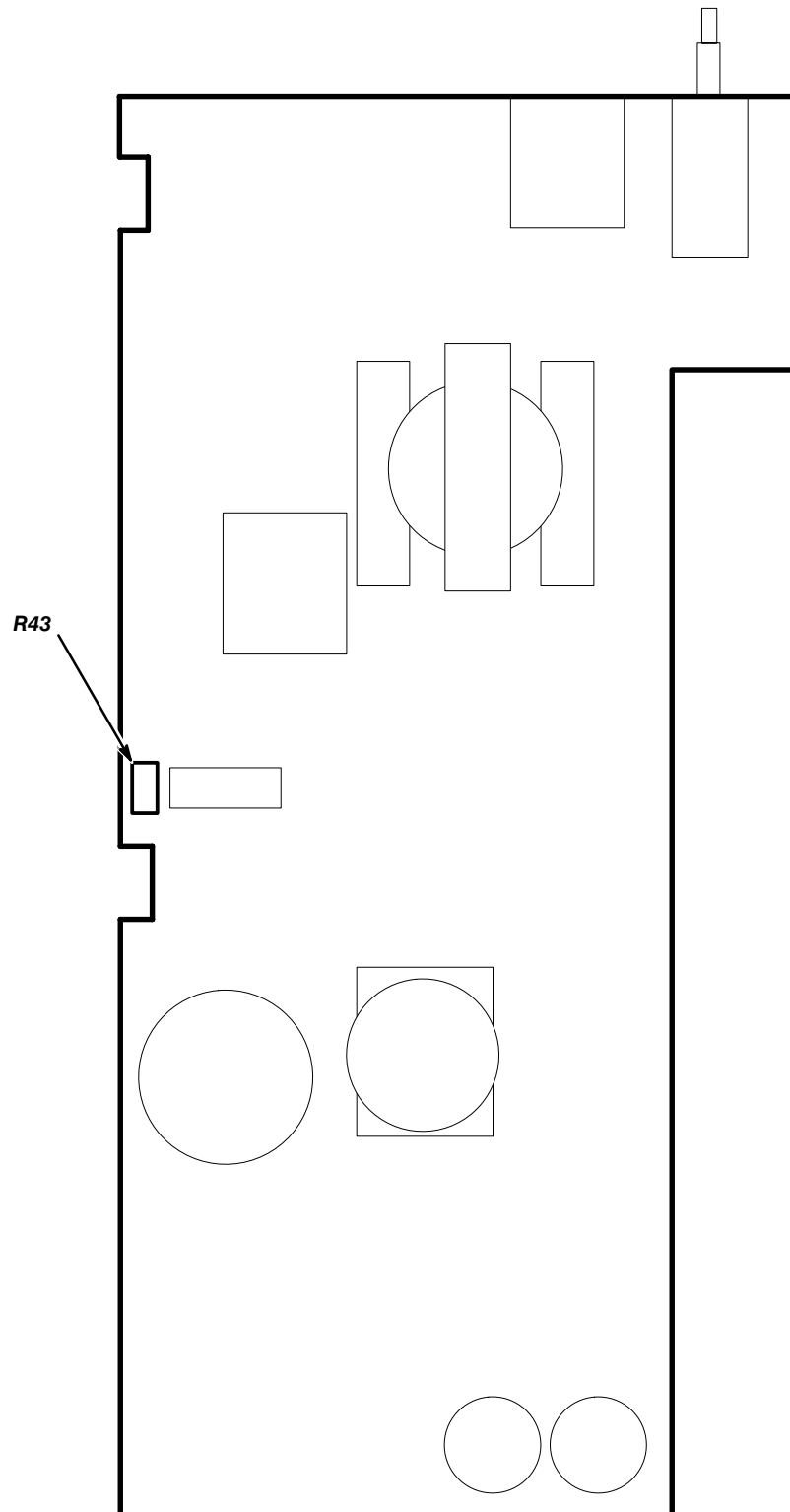


Figure 7-16: Power Supply Adjustment Location (B020100 and Above)

J205 (CAL-DIS)

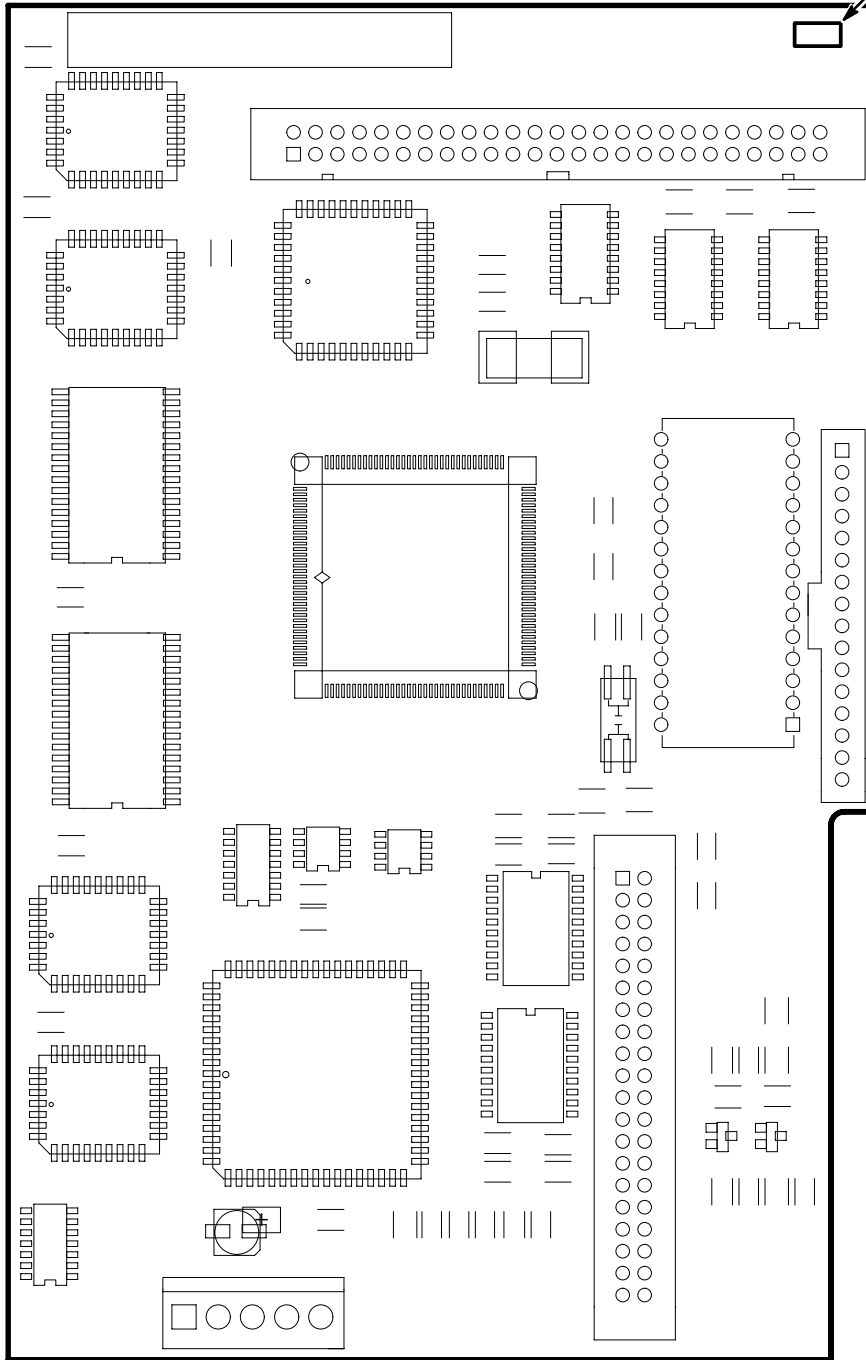


Figure 7-17: Location of J205 (CAL-DIS) on the CPU Board

Maintenance

Maintenance Information

This section contains the information needed to do periodic maintenance and make basic repairs to the TAS 455 and TAS 465 Analog Oscilloscopes.

- **Maintenance Information** — This subsection. It includes this introduction, servicing information, 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 removing and installing the modules, circuit boards, and mechanical parts.
- **Troubleshooting Aids** — Procedures that help isolate problems to a module.

Before Servicing

This manual is for servicing of the TAS 455 and TAS 465 Analog 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.

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

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 TAS 455 and TAS 465 Analog Oscilloscopes. Tektronix technicians are apprised of the latest information on improvements to the product as well as the latest new options.

Warranty 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

Tektronix offers several types of service contracts that you may purchase to tailor repair and/or calibration of your TAS 455 and TAS 465 Analog Oscilloscopes to fit your requirements.

Self Service

This manual contains all the information needed for periodic maintenance and repair of the TAS 455 and TAS 465 Analog Oscilloscopes.

For periodic maintenance, use these sections:

- Performance verification procedures
- Calibration procedures

For instrument repair, use these sections:

- Troubleshooting aids to help isolate problems to a module
- Disassembly procedures
- Parts lists

Replace failed modules with fully tested modules obtained from the factory.

For information, contact your local Tektronix service center or sales engineer on any repair services.

Preventing ESD

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).



Static discharge can damage any semiconductor component in this oscilloscope.

1. Minimize handling of static-sensitive modules.
2. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. All service must be done at a static-free work station.
3. Do not remove the oscilloscope cabinet unless you have met precaution number 2, above. Consider all internal modules static-sensitive.
4. Remove anything capable of generating or holding a static charge from the work station surface.

5. Do not slide the modules over any surface.
6. Do not use high-velocity compressed air when cleaning dust from modules.

Susceptibility to ESD

Table 8-1 lists the relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Table 8-1: Relative Susceptibility to Static-Discharge Damage

Semiconductor Classes	Relative Susceptibility Levels¹
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

¹Voltage 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 and clean the TAS 455 and TAS 465 Analog Oscilloscopes. Inspection and cleaning are 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 you use the oscilloscope. A proper time to perform preventive maintenance is just before oscilloscope adjustment.

General Care

The cabinet helps keep dust out of the oscilloscope and it is a major component of its cooling system. It should normally be in place when operating the oscilloscope. The oscilloscope front cover protects the front panel and display from dust and damage. Install it when storing or transporting the oscilloscope.

Inspection and Cleaning Procedures

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



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

Avoid the use of high pressure compressed air when cleaning dust from the interior of this instrument. (High pressure air can cause ESD.) Instead, use low pressure compressed air (about 9 psi).

Inspection — Exterior

Inspect the outside of the oscilloscope for damage, wear, and missing parts. Use Table 8-2 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 8-2: 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 and cabinet feet	Correct operation.	Repair or replace defective module.
Accessories	Missing items or parts of items, bent pins, broken or frayed cables, and damaged connectors.	Replace damaged or missing items.

Cleaning Procedure — Exterior

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.



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

3. Clean the CRT screen with a lint-free cloth dampened with either a 75% isopropyl alcohol solution or, preferably, a gentle, general purpose detergent-and-water solution.

NOTE

If the CRT Implosion Shield needs further cleansing, refer to the procedure on page 8-7.

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 solution and wait 60 seconds for the majority of the alcohol to evaporate.
6. Use hot (+50° C to +60° C) 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 (+50° C to +60° C) circulating air.

Cleaning the CRT Implosion Shield



This procedure describes how to clean both sides of the CRT Implosion Shield, thus requiring its removal. Perform this procedure only if cleaning the backside of the Implosion Shield is necessary.

1. Remove the Implosion Shield as described in *Removal and Replacement* beginning on page 8-26.
2. Clean the shield with a lint free cloth dampened in a general purpose detergent-and-water solution. Do not use abrasive cleaners.
3. Remove any static charge that may have accumulated by holding the shield in a deionized air flow.
4. Install the shield as described in *Removal and Replacement* beginning on page 8-26.

Removal and Installation Procedures

This subsection contains procedures for removal and installation of all replaceable mechanical and electrical modules. Replaceable mechanical and electrical modules are listed in the *Replaceable Parts* section of this manual.

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 oscilloscope components, read Safety Summary in the front matter, and Preventing ESD in this section.

This subsection contains the following:

- This preparatory information that you need to properly do the procedures that follow.
- A list of equipment required to remove and disassemble all modules.
- Procedures for removal and reinstallation of the electrical and mechanical modules.
- Three module locator diagrams for finding all the modules in this oscilloscope. (See Figures 8-2, 8-3, and 8-4.)

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.

Cable Removal

Cables are partially or completely removed in the course of removing a board or module they plug into.

General Instructions



READ THESE GENERAL INSTRUCTIONS BEFORE REMOVING A MODULE.

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

Procedures refer to the “front,” “rear,” “top,” etc. of the oscilloscope. Figure 8-1 illustrates these references.

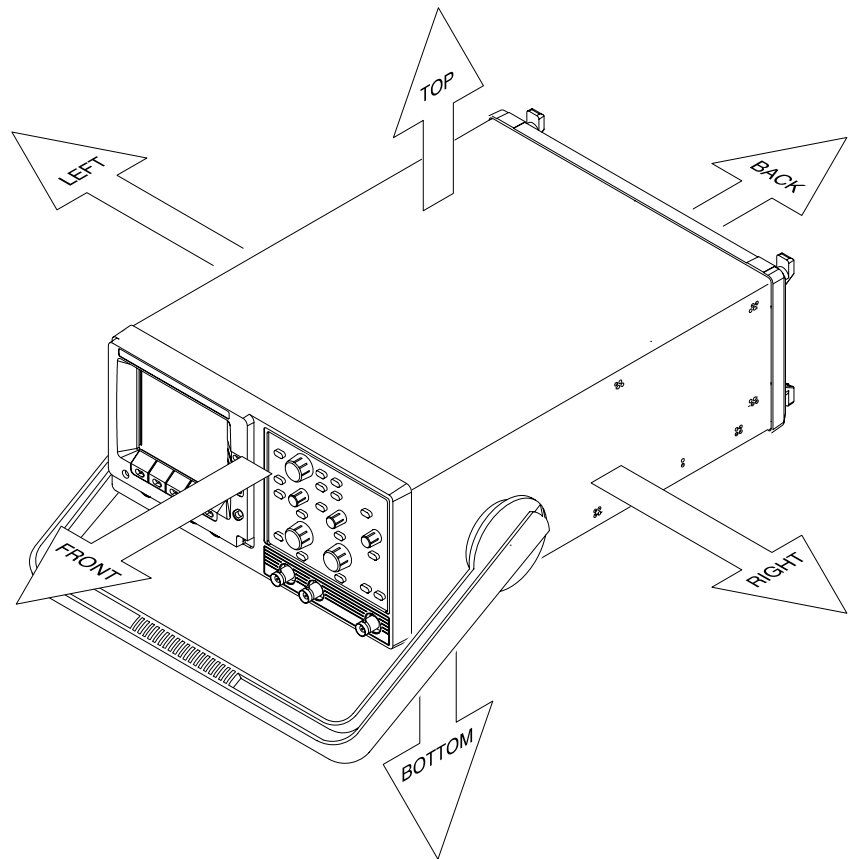


Figure 8-1: Oscilloscope Orientation

Summary of Procedures

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

Equipment Required — Table 8-3 lists the tools required to completely disassemble the oscilloscope into its modules.

All the tools are standard tools readily available from tool suppliers.

Table 8-3: Tools Required for Module Removal

Item No.	Name	Description
1	Screwdriver handle	Accepts Torx®-driver bits.
2	T-15 Torx tip	Torx®-driver bit for T-15 size screw heads.
3	T-20 Torx tip	Torx®-driver bit for T-20 size screw heads. Used only for removal of the cabinet handle.
4	Nut driver, 5/16 inch	Used for removing the CRT earth ground cable.
5	Angle-tip tweezers	Used for knob and shaft removal.
6	Flat-bladed spudger	A non-metallic probe-like tool with a flat bladed tip. Used to remove the front-panel trim and front module.
7	Slip-Jaw Pliers	Used for removing the front feet from the cabinet.

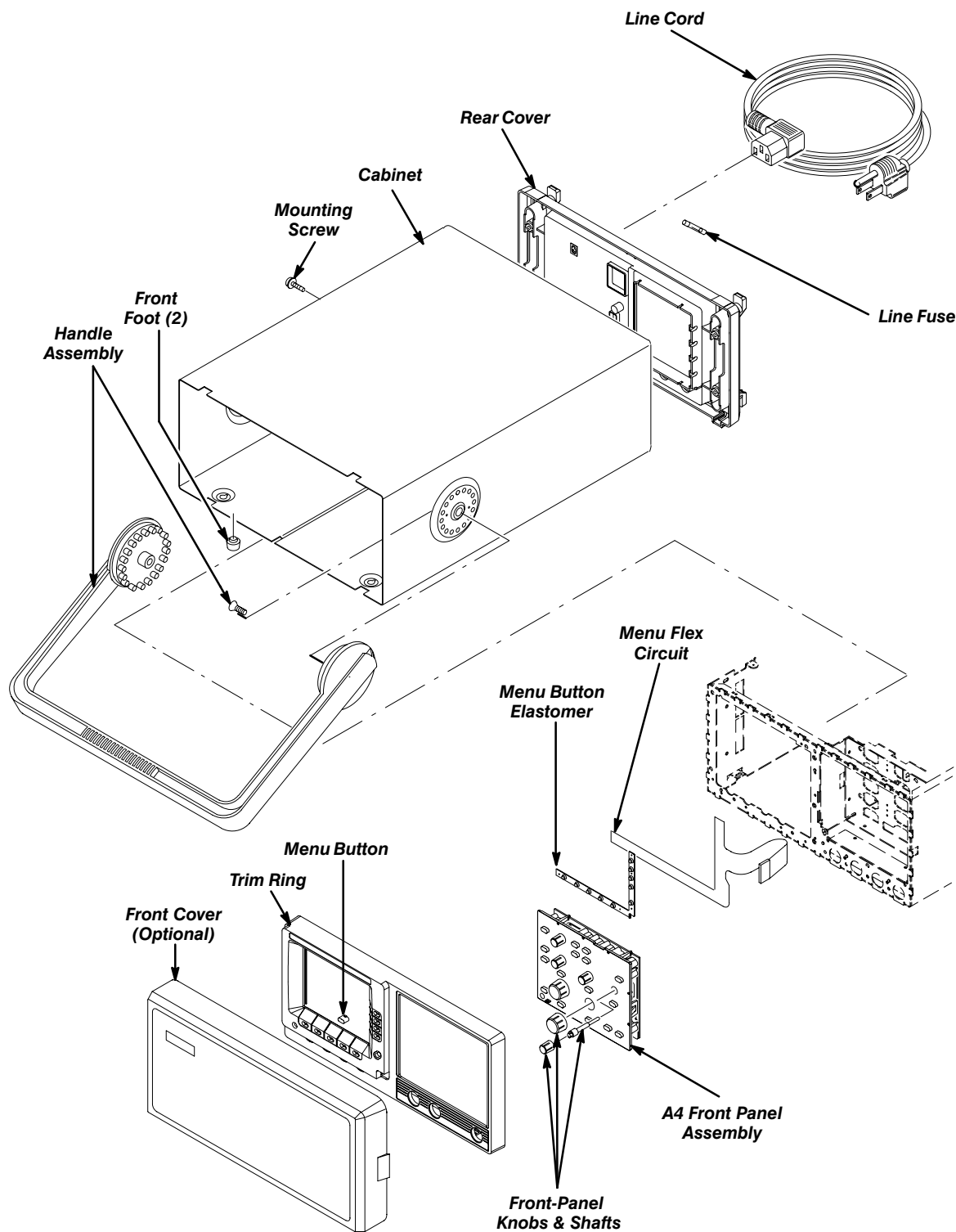


Figure 8-2: Cabinet and Front-Panel Mounted Modules

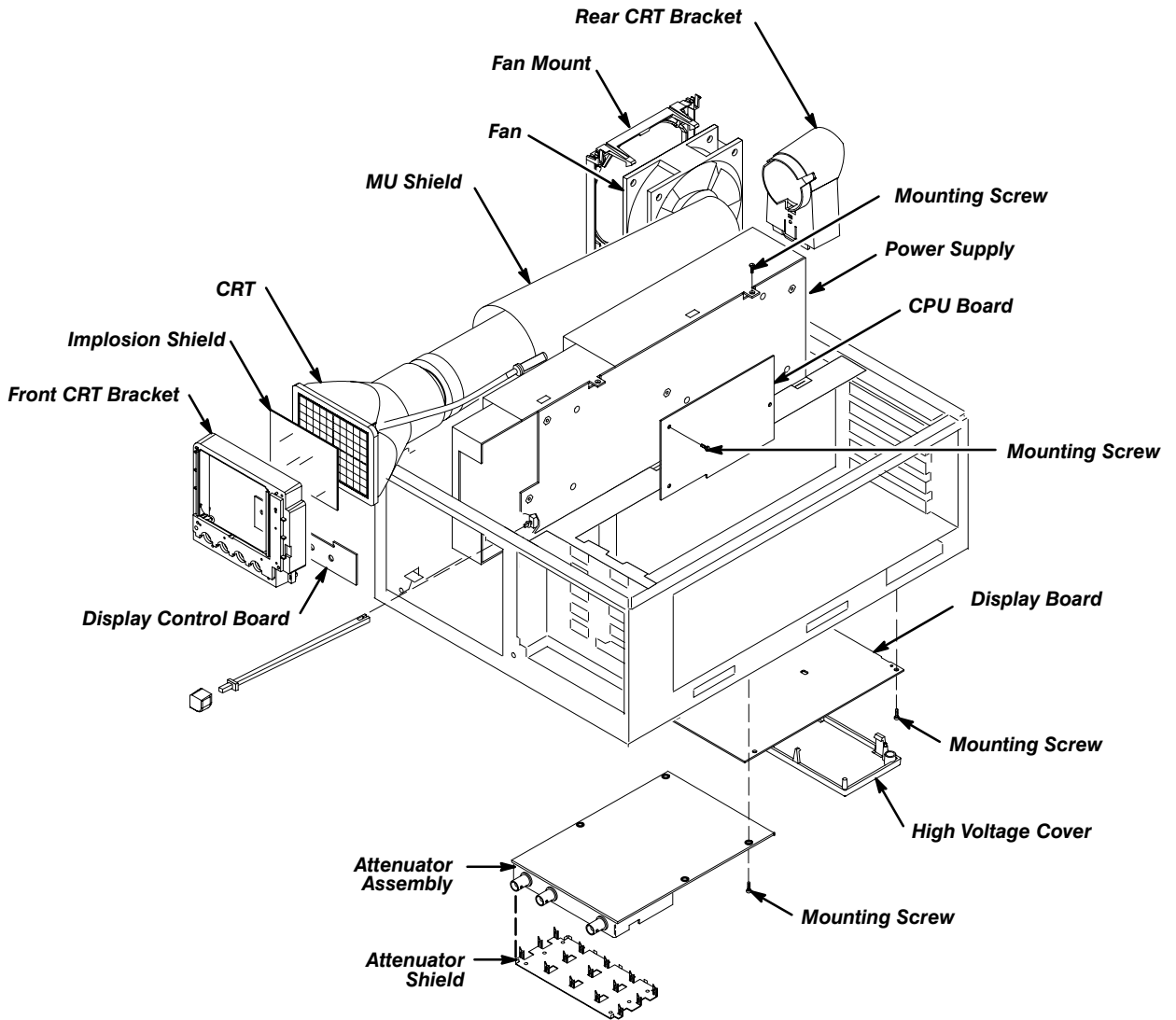


Figure 8-3: Internal Modules

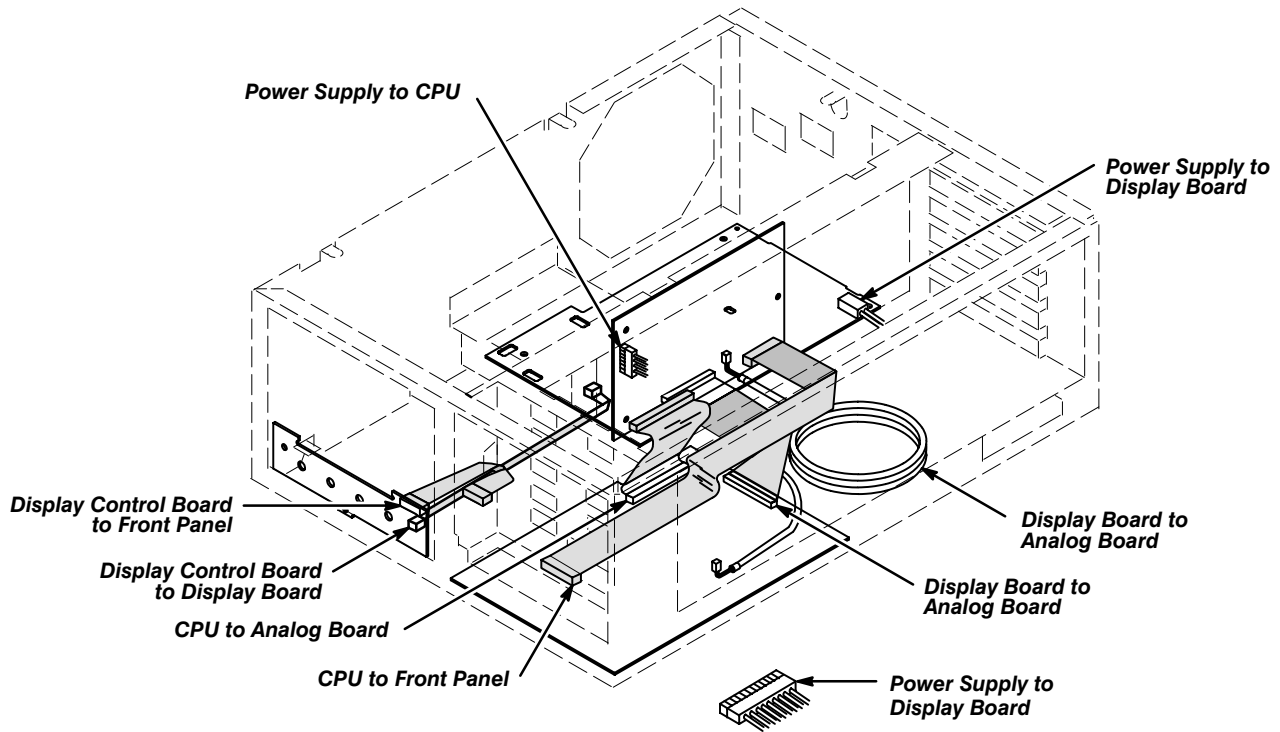


Figure 8-4: Cables and Cable Routing

Line Cord and Line Fuse

The following procedures describe how to remove and install the line cord and line fuse located on the back side of the oscilloscope.

WARNING

Unplug the line cord from the line voltage power source before continuing. Failure to do so can cause injury or death.

Prepare the oscilloscope by positioning the bottom side down on the work surface and facing the back side toward you. Refer to Figure 8-5.

Line Cord

1. Unplug the line cord from the power source.
2. Unplug the other end of the line cord from the back of the oscilloscope.
3. Grasp the end of the line cord and retaining clamp and rotate them 90 degrees counterclockwise (Figure 8-5).
4. Pull the line cord and clamp away from the back of the oscilloscope.

5. Perform this procedure in reverse order to install the power cord on the oscilloscope.

Line Fuse

1. Unplug the line cord from the power source.
2. Pull out the fuse holder drawer and remove the fuse (Figure 8-5).
3. Perform this procedure in reverse order to install the fuse.

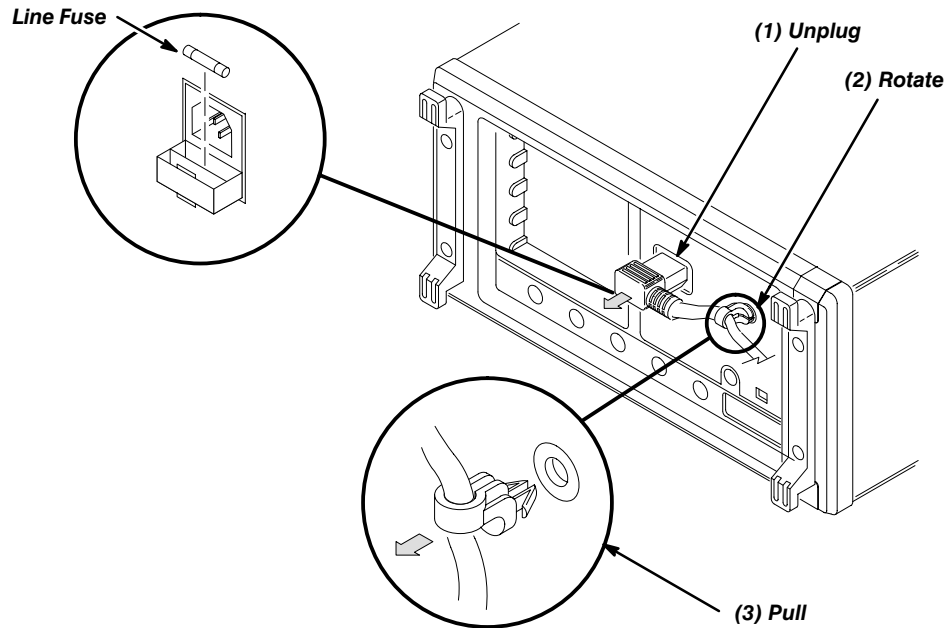


Figure 8-5: Line Fuse and Line Cord Removal

Front-Panel Knobs and Shafts

Use the following procedures to remove and install front-panel knobs and shafts.

Prepare the oscilloscope by setting it bottom side down on the work surface and facing the front side toward you.

Removing Front-Panel Knobs and Shafts

1. Remove any knob by pulling it straight out from the front panel slightly. This will create some clearance between the base of the knob and the front panel to create some clearance between the base of the knob and the front panel.
2. Insert the tweezers between the knob and front panel and use them to remove the knob and attaching shaft (see Figure 8-6).

3. Pull the shaft out of the knob to separate the two pieces.

Installing Front-Panel Knobs and Shafts

1. Align the inside of the knob to the end of the shaft and push it in until it snaps.
2. Insert the shaft of the assembly into the proper hole on the front panel and push it in until it stops.
3. Lightly push in the knob and rotate it until the shaft slips into place.
4. Push the knob all the way in to seat the assembly.

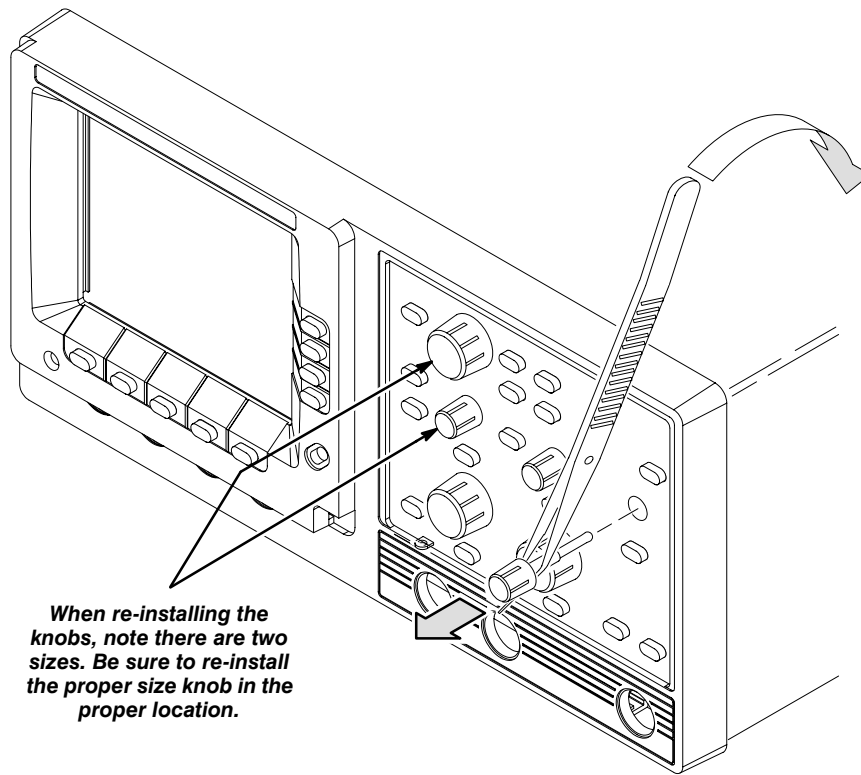


Figure 8-6: Knob and Shaft Removal

Feet, Rear Cover, and Cabinet

Before removing the rear cover or cabinet, install the optional front cover on the front panel of the oscilloscope (if available) and then position the oscilloscope as indicated in Figure 8-7.

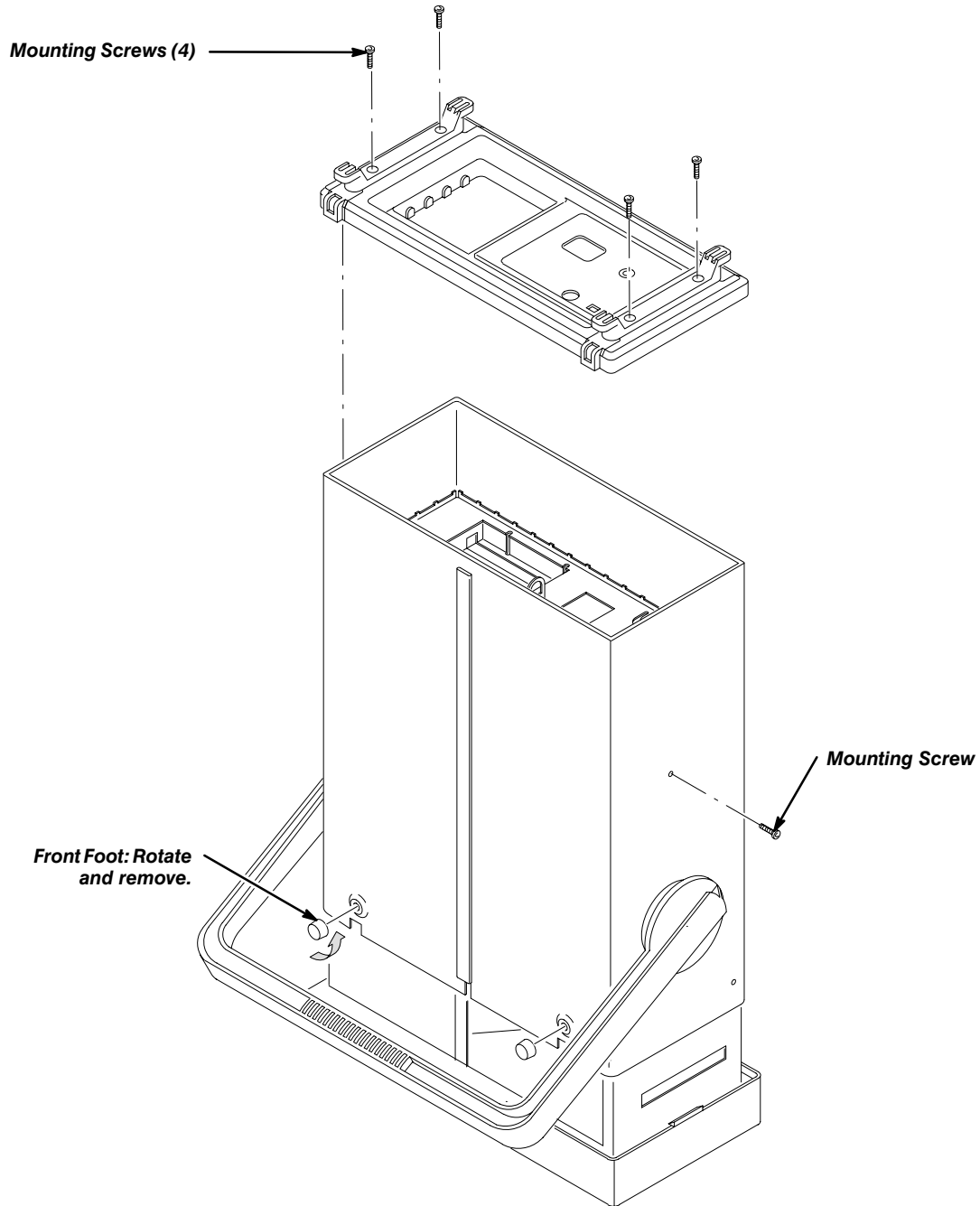


Figure 8-7: Rear Cover, Cabinet, and Feet Removal

Rear Cover

1. Position the oscilloscope as indicated in Figure 8-7.
2. Use the screwdriver to remove the four T-15 Torx screws that secure the rear cover to the oscilloscope.
3. Lift off the rear cover. Do these steps in reverse order to install the rear cover.

Cabinet

1. Remove the rear cover.
2. Remove the single T-15 Torx screw on the left side of the oscilloscope.
3. Grasp the two handle hubs and pull them outward as if to rotate the handle.
4. While holding the handle hubs out, lift the cabinet up and slide it off the oscilloscope. Take care not to bind or snag the cabinet on the internal cabling as you remove it.

Replacing the Front Feet

If you are replacing a front foot, use a pair of slip-jaw pliers to firmly grip the foot, then pull with a turning motion to remove. Do this step in reverse order to replace the foot.

Front-Panel Trim, Menu and Power Buttons, EMI Gasket

Use the following procedures to remove and install front-panel trim, buttons, and EMI gaskets.

Additional procedures required — These procedures require that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal

Removing the Front Trim

1. Slide a flat-bladed spudger between the chassis and the plastic front trim, near one of the four flex locks. See Figure 8-8.
2. Gently pry the front trim up and slightly forward to disengage the flex lock. Do this until all four flex locks are disengaged.
3. Pull the front trim forward and off the instrument.

Menu Buttons and Elastomer

1. Lay the front trim on a flat surface.
2. Gently remove menu button elastomer. Avoid touching the electrical contacts.
3. Remove the menu button(s).
4. Install menu buttons by placing a menu button in each menu button location.
5. Place the menu button elastomer over the menu buttons, ensuring that all standoffs protrude through the elastomer. Avoid touching the electrical contacts.

Power Button Replacement

1. With the front trim removed, grasp the power button and pull straight out from the chassis.
2. Install the power button by pushing the button onto the power button shaft until it locks into place.

Installing the Front Trim

1. If the menu buttons were removed, insert each button to its hole in the trim ring and install the menu button elastomer.
2. Align the front trim to the front of the instrument, without engaging any of the four flex locks.
3. Position the power button in line with the front-panel power button opening.
4. Slide the front trim onto the instrument, ensuring that all four flex locks engage.
5. If installing a new front trim, apply the appropriate front trim label.

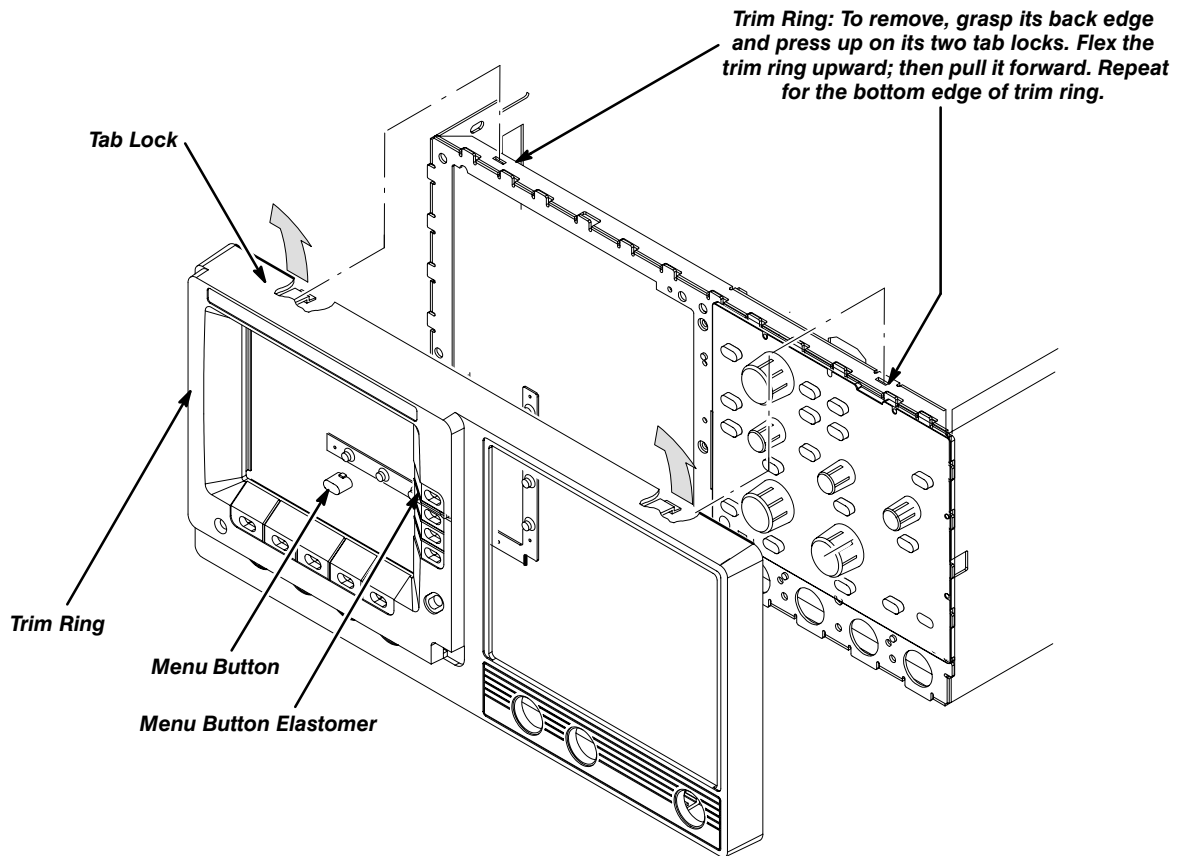


Figure 8-8: Trim Ring and Menu Buttons Removal

Installing the EMI Gaskets

The EMI gaskets were added to improve the performance of the oscilloscope. You may add them to your oscilloscope if they were not installed originally.

1. If you are servicing the front EMI gaskets, discard the old ones.
2. Without installing the EMI gaskets, align the trim ring to the front of the chassis and push it on to seat. Be sure that both pairs of flex locks, one pair each at the inside top and bottom of the trim ring, snap over the edge of the chassis.
3. Lay the oscilloscope so its front cover is on the work surface.
4. Align an EMI gasket so it lies between any pair of adjacent flex locks along the groove between the cabinet and the trim ring.
5. Using a flat-bladed spudger, push the EMI gasket until it is firmly seated at the bottom of the groove (see Figure 8-9). It should not overlap either flex lock.
6. Repeat the process just described to install the remaining three gaskets.

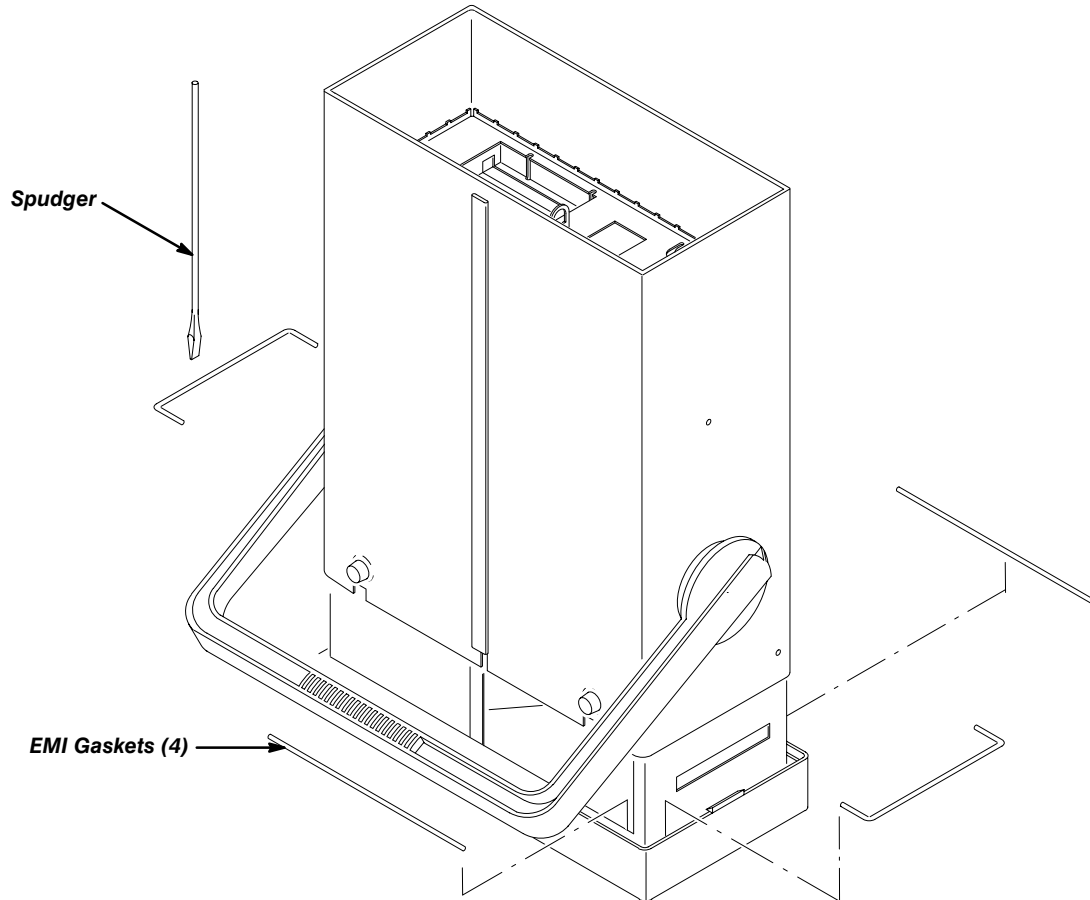


Figure 8-9: EMI Gasket Installation

A62 Front Panel Module Removal

The following procedure describes how to remove the A62 Front Panel module.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
 - Cabinet Removal
 - Front-Panel Trim Ring
1. Set the oscilloscope so its bottom is down on the work surface and its front is facing you.
 2. Insert a flat-bladed screwdriver into the slot at the front-right of the chassis. Push inwards to release the snap lock at the right side. (See Figure 8-10.)

Removal and Installation Procedures

3. Pull the Front Panel module slightly away from the front of the chassis until you can reach the interconnect cables at the rear of the module.
4. Unplug the following cables from their jacks on the Front Panel module:
 - The Display Control-to-front-panel cable at J84
 - The menu flex circuit-to-front panel at J40
 - The CPU-to-front-panel cable at J30
5. Lift the Front Panel module out from the chassis.

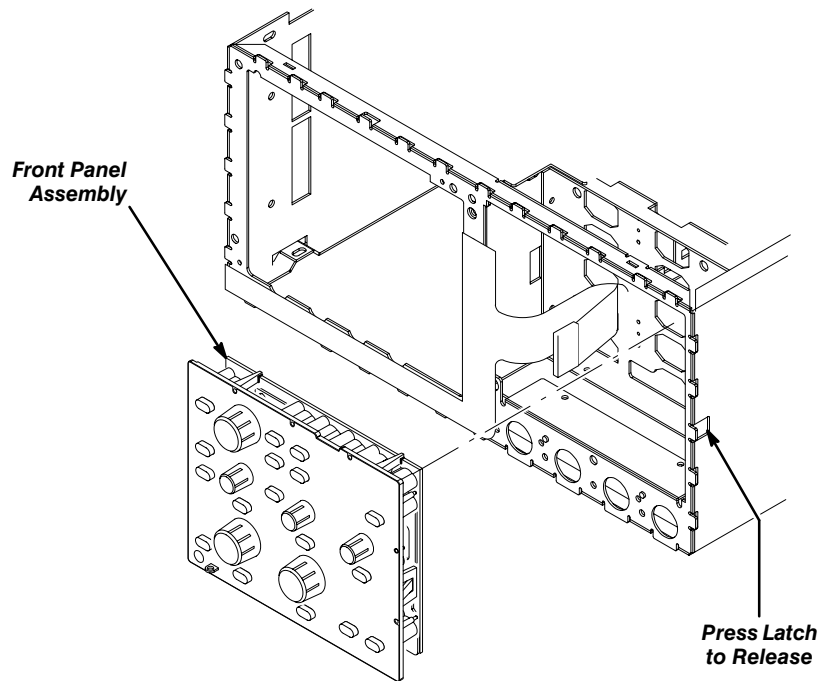


Figure 8-10: A62 Front Panel Module Removal

Menu Flex Circuit Replacement



Perform this procedure only if replacing a failed or damaged menu flex circuit with a fresh unit from the factory. (Removal of the circuit is likely to destroy it.)

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal
- Front Trim Removal
- A62 Front Panel Module Removal

1. Pull the flex circuit away from the front of the main chassis. (It is held on by its sticky backing.) See Figure 8-11.
2. Wipe the front of the chassis using isopropyl alcohol and a clean, lint-free cloth. Let dry. (Some adhesive from the flex circuit you removed will be left on the front of the chassis. This is normal.)

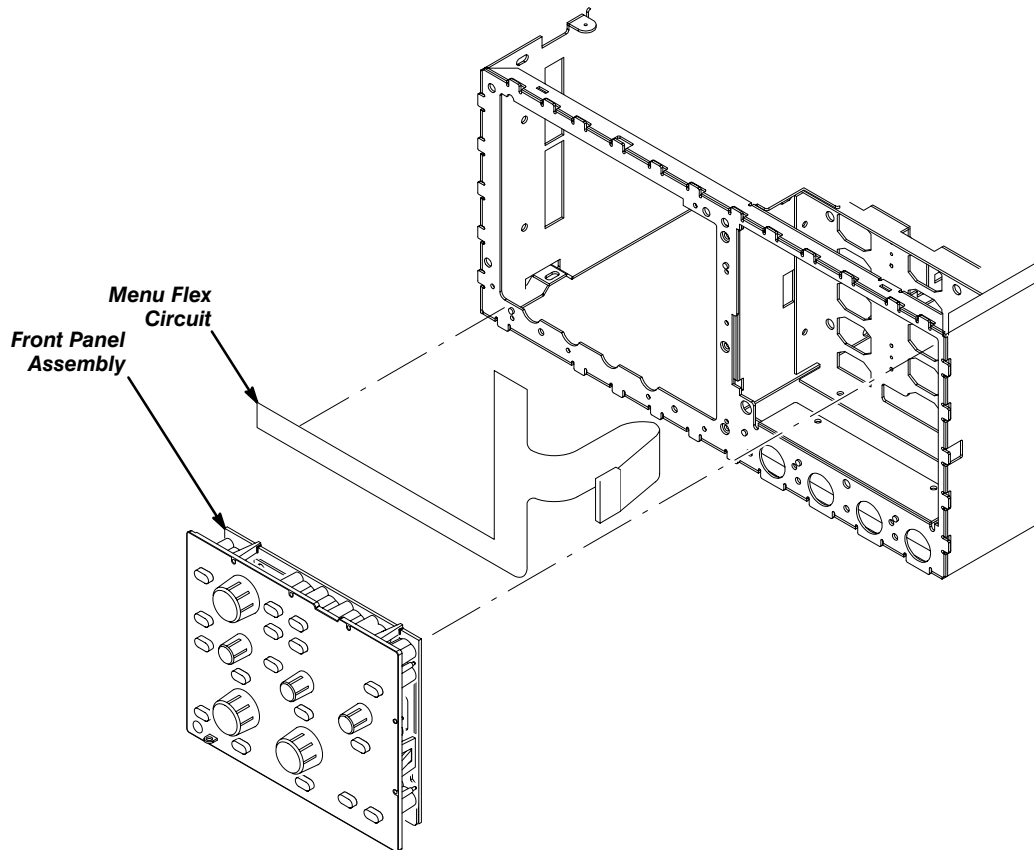


Figure 8-11: Menu Flex Circuit Board Removal

3. Find the score line in the adhesive backing and peel the backing off of the menu flex circuit.

NOTE

DO NOT touch the contacts on the menu flex circuit with your bare fingers. You should wear clean cloth gloves that are free of lint when installing the menu flex circuit on the front chassis.

4. Carefully align the three holes on the menu flex circuit to the locator studs on the front of the main chassis. When the alignment is correct, press the flex circuit against the chassis so it adheres to the chassis.

5. Clean the surface of the menu flex circuit just installed using isopropyl alcohol and a clean, lint-free cloth.
6. Repeat all procedures performed in reverse order to reassemble the instrument.

A1 Analog Board

The following procedure describes how to remove the A1 Analog board.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
 - Cabinet Removal
 - Front Trim Removal
1. Set the oscilloscope so its top side is down on the work surface and its front is facing you.
 2. Disconnect the delay line from its holder and at connector J68 on the Analog board.
 3. Disconnect the cables at connectors J50 and J67 on the Analog board.
 4. Disconnect the cable to the rear panel Z-axis connector.
 5. Using Figure 8-12 as a guide, remove the four T-15 Torx® screws securing the attenuator assembly to the front of the chassis. Next remove the four T-15 Torx® screws securing the attenuator board to the chassis.
 6. Lift the attenuator assembly away from the oscilloscope to complete its removal.

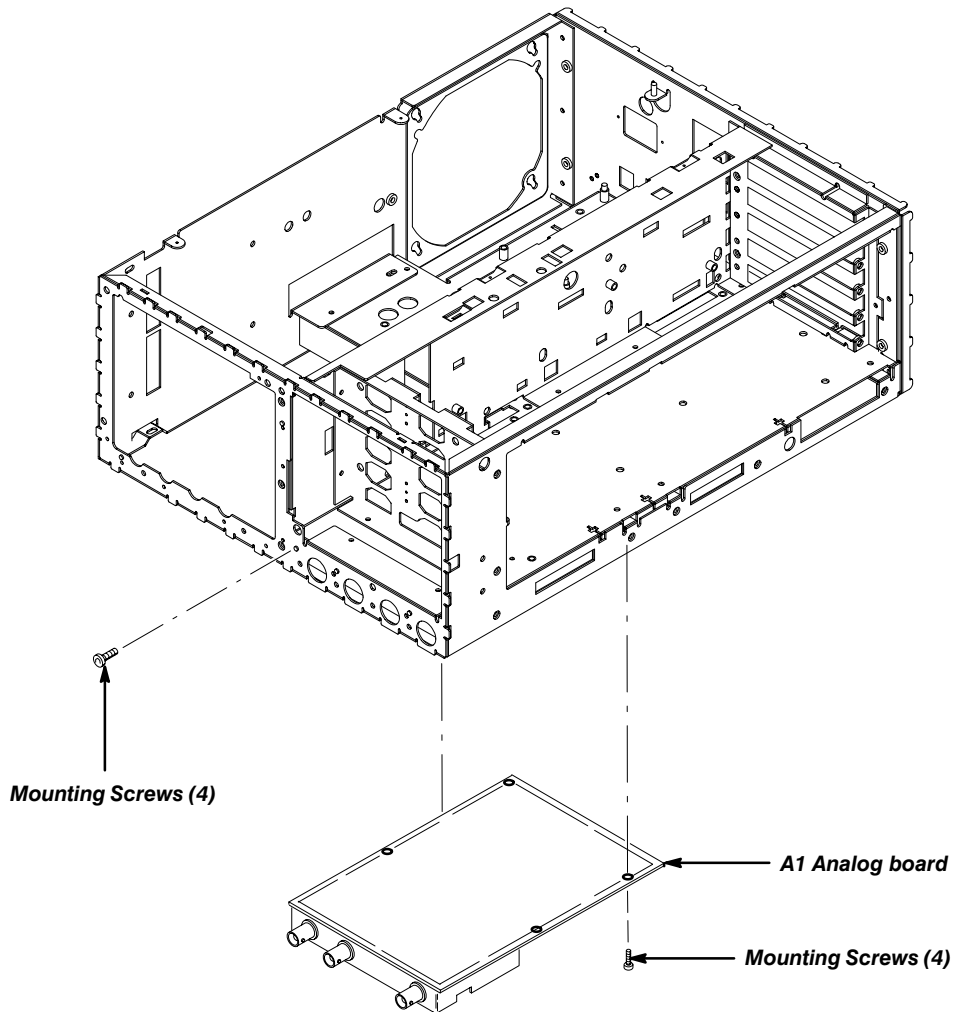


Figure 8-12: A1 Analog Board Removal

Display Driver Board (A3)

Remove and replace the Display Driver board as follows:

1. Remove the plastic high voltage cover from the rear of the Display Driver board (A3). Refer to Figure 8-13.
2. Disconnect the delay line from its holder and at connector J69 on the Display Driver board.
3. Disconnect the cables from J70, J71, J72, J73, J74, J75, and J80 on the Display Driver board.
4. Disconnect J67 from the Analog Board (A1).
5. Remove the four T-15 Torx screws used to attach the Display Driver board to the chassis.

Removal and Installation Procedures

6. Remove the Display Driver board from the chassis, but leave the clear plastic sheet in place.
7. Replace the Display Driver board by performing the reverse of the procedure described in steps 1 through 5.

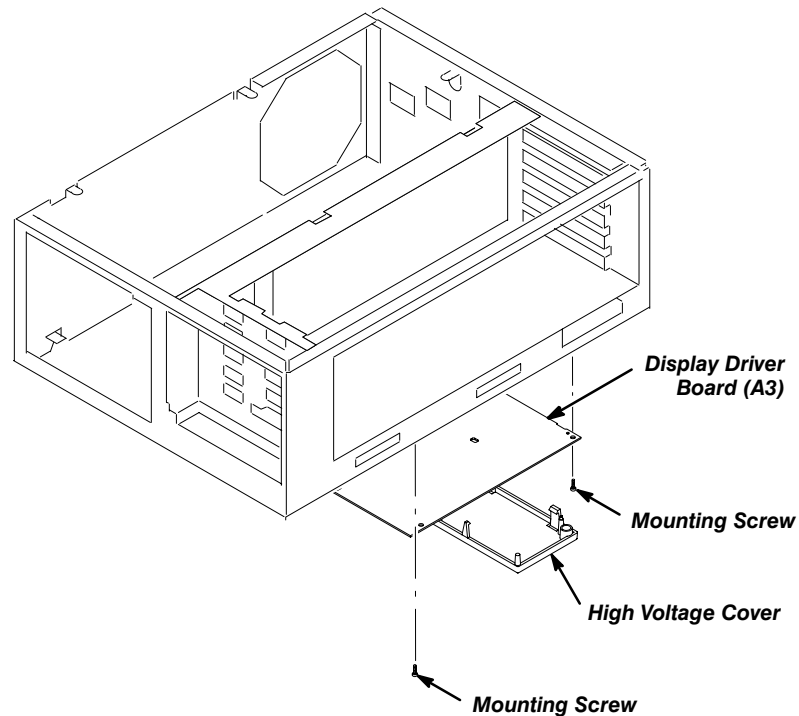


Figure 8-13: Location of Display Driver Board

CRT Implosion Shield

The procedures that follow describe how to remove and install the CRT Implosion Shield. The method to accomplish this is different depending on the serial number of your instrument. Choose the correct procedure for your instrument by comparing your instrument serial number to those listed.

Current Method—The following procedures describe the removal of the CRT Implosion Shield for the instrument models described in the following note.

NOTE

TAS 455 — SN: B011876 and Above
TAS 465 — SN: B011640 and Above

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
 - Cabinet Removal
 - Front Trim Removal
1. From the front of the Implosion Shield, slip the spudger into the slot provided on the side of the CRT Front Bracket. See Figure 8-14.
 2. Carefully pry the Implosion Shield up and out of the CRT Front Bracket guides.
 3. Re-install the Implosion Shield by placing the left side of the shield into the CRT Front Bracket guides. If installing a new Implosion Shield, remove the clear protective covers.
 4. Snap the right side of the Implosion shield into the CRT Front Bracket snaps.
 5. Install all previously removed components.

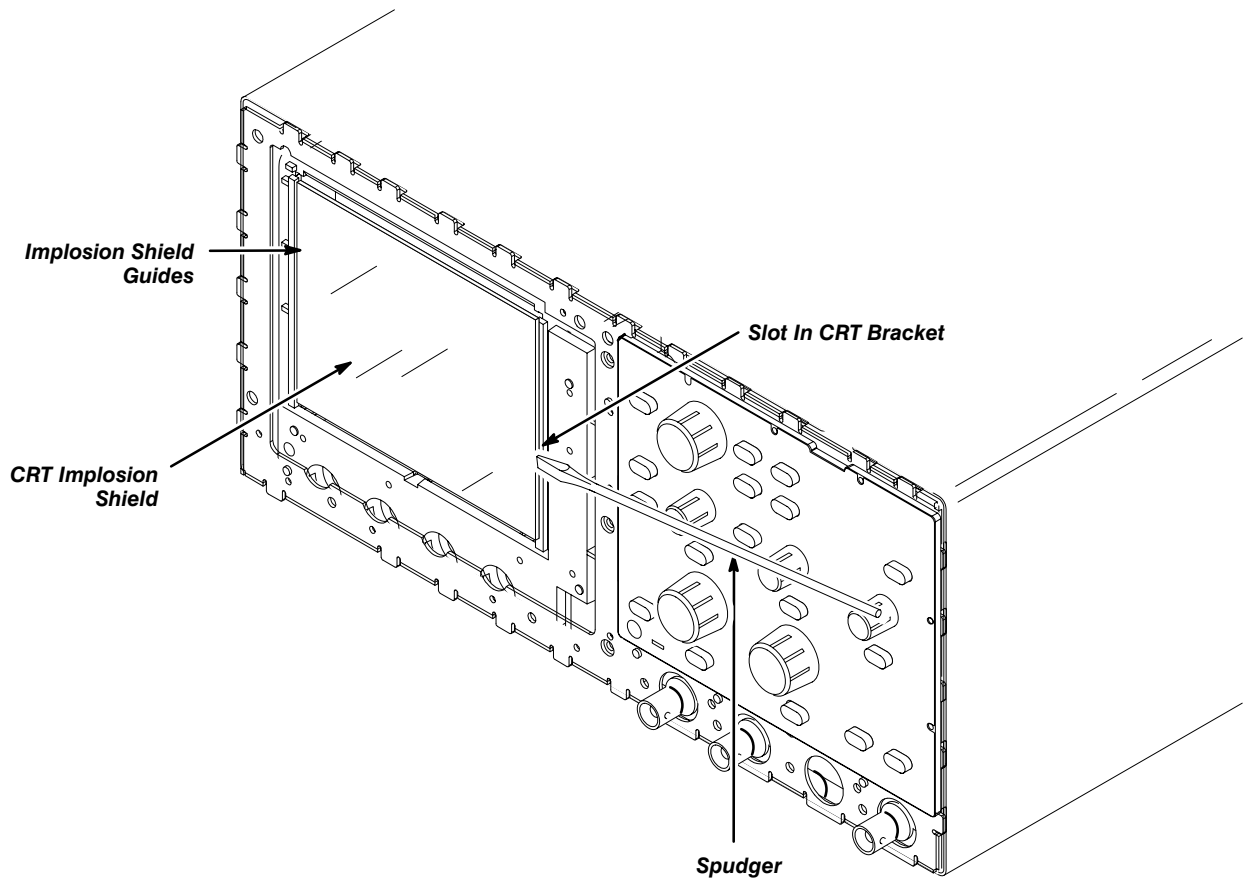


Figure 8-14: CRT Implosion Shield Removal

Early Method—The following procedures describe the removal of the CRT Implosion Shield for the instrument models described in the following note.

NOTE

TAS 455 — SN: B011875 and Below

TAS 465 — SN: B011639 and Below

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
 - Cabinet Removal
 - Front Trim Removal
 - A3 Display Driver Board
 - CRT
1. From the front of the Implosion Shield, push the top of the shield until it pops out of the back side of the CRT Front Bracket.
 2. Re-install the CRT Implosion shield by snapping the shield into the rear of the CRT Front Bracket. If installing a new Implosion Shield, remove the clear protective covers.
 3. Install all previously removed components.

CRT

The procedures that follow describe how to remove and install the CRT. Refer to Figure 8-16 for this procedure.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal
- Front Trim Removal
- A3 Display Driver Board

CRT Removal

1. Set the oscilloscope so its bottom is down on the work surface, with its front facing you.

WARNING

Breaking a CRT causes it to implode, scattering glass fragments with high velocity and possibly injuring you. Wear protective clothing and safety glasses (preferably a full-face shield). Avoiding striking the CRT with or against any object.

Store the CRT with its display face down in a protected location, placing it on a soft, nonabrasive surface to prevent scratching the face plate.

2. Unplug the the 2-wide red/black cable from the A2 Display Control board.

WARNING

High voltage is present on the anode lead. Do not touch the end of the anode lead until it has been fully discharged to ground.

3. Disconnect the red CRT anode lead from the A63 Power Supply module and immediately discharge to chassis ground.
4. Using a $\frac{5}{16}$ inch nut driver, remove the nut securing the ground wire at the rear of the CRT.
5. From the bottom of the chassis, unsnap the Rear CRT Bracket from the chassis. See Figure 8-15.

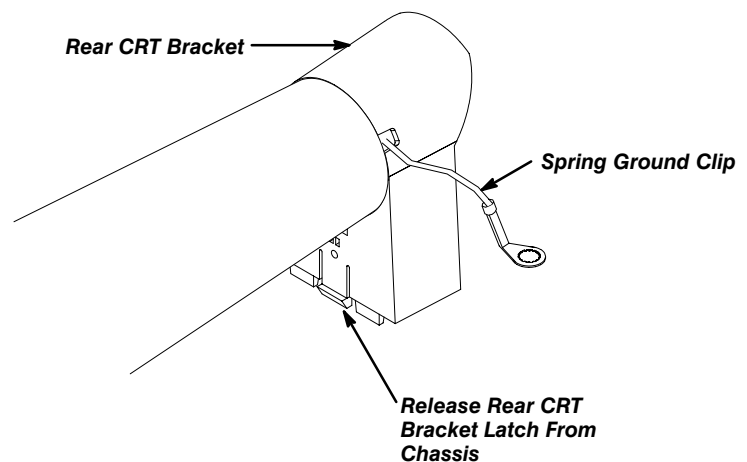


Figure 8-15: CRT Rear Bracket and Ground Clip

6. Lift the rear of the CRT until it is above the chassis. Then pull the CRT away from the CRT Front Bracket.



Stop here if you are removing the CRT assembly to gain access to other portions of the instrument. If you are installing a new CRT or hardware attached to the CRT, continue with this procedure.

7. Slide the Rear CRT Bracket from the CRT. The Spring Ground Clip will slide out also.
8. Remove the CRT Socket with its cover from the rear pin connector of the CRT.
9. Disconnect the vertical and horizontal control wires from the side of the CRT. Note the proper location of both sets of wires for reinstallation.
10. Slide the CRT shield and its front support off the CRT.
11. Store the CRT in a safe location.

CRT Installation

1. Slide the CRT shield and its front support onto the CRT as far forward as possible.
2. Align the holes in the shield so that the vertical and horizontal control pins on the side of the CRT are accessible.
3. Align the slot in the CRT Socket to the key on the CRT pin connector and slide the Socket onto the pins.
4. Slip the CRT socket wires through the Rear CRT Bracket and slide the bracket onto the rear of the CRT.
5. Ensure that the Rear CRT Bracket is properly aligned with the slots provided in the CRT Shield.
6. Slide the Spring Ground Clip into the slot provided in the Rear CRT Bracket.
7. Connect the vertical and horizontal control wires to the side CRT pins.
8. Guide the front of the CRT into the CRT Front Bracket. Ensure that the four CRT Cushions are in their proper place in each corner of the Bracket.
9. Lower the rear of the CRT into the chassis and press down on the CRT Rear Bracket until it snaps into the chassis.
10. Route the vertical and horizontal control cables to the bottom of the chassis.
11. Connect the read anode lead to its connector from the A63 Power Supply module.
12. Plug the the two-wide red/black cable to the A2 Display Control board.
13. Install all previously removed components.

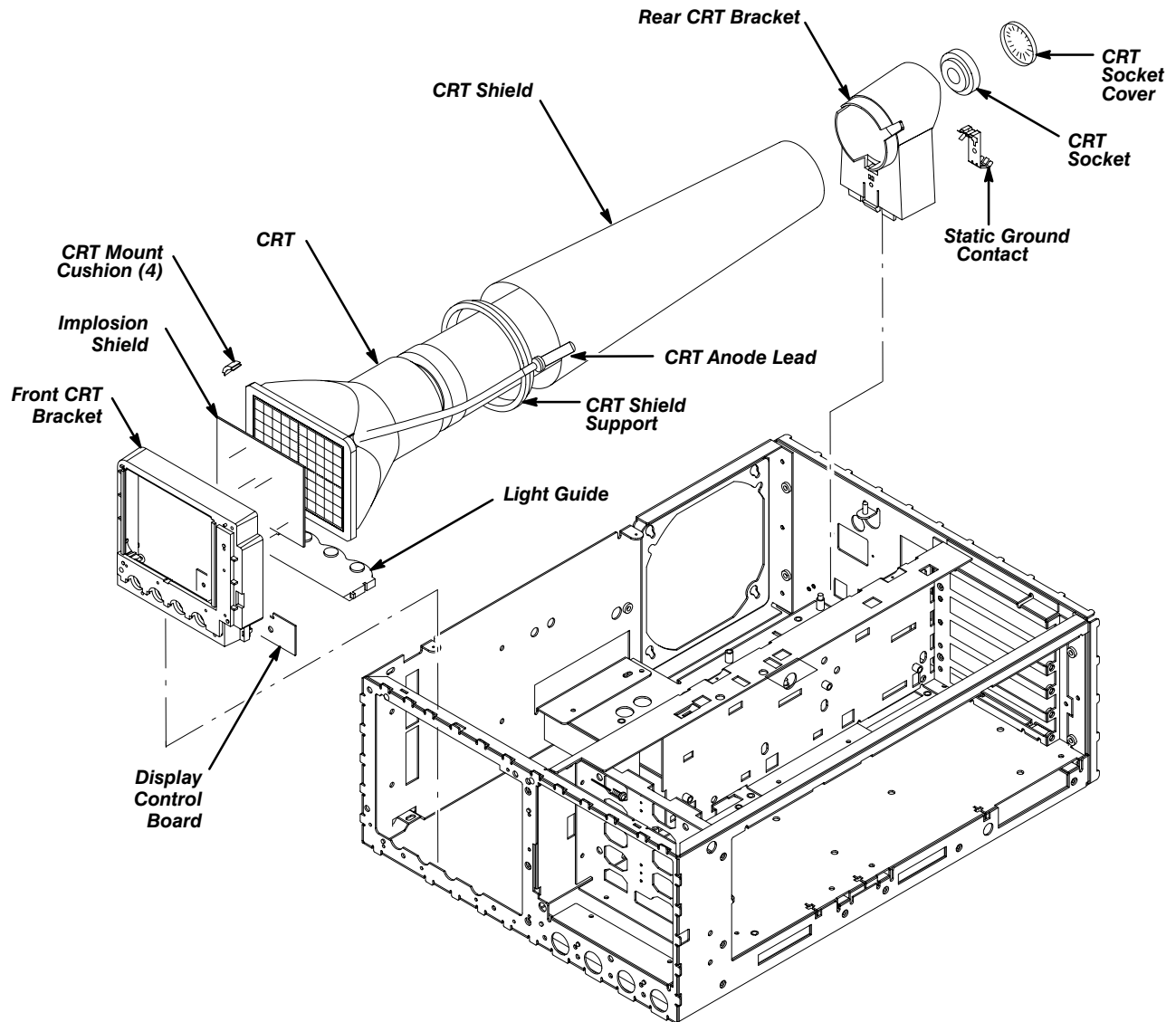


Figure 8-16: CRT Removal

CRT Light Guide

The procedures that follow describe how to remove and install the CRT Light Guide. Refer to Figure 8-16 for this procedure.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal
- Front Trim Removal

Removal and Installation Procedures

- A3 Display Driver Board
 - CRT
1. Lift the light guide off the light bulbs on the A2 Display Control board.
 2. Re-install the light guide by sliding the guide over the light bulbs on the A2 Display Control board.

NOTE

To properly guide the light to the CRT, the beveled edge of the light guide must be facing up, toward the CRT.

3. Install all previously removed components.

CRT Front Bracket

The procedures that follow describe how to remove and install the CRT Front Bracket. Refer to Figure 8-16 for this procedure.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
 - Cabinet Removal
 - Front Trim Removal
 - A3 Display Driver Board
 - CRT
1. Remove the four screws securing the CRT front bracket to the chassis.
 2. Lift the CRT front bracket out from inside the chassis.
 3. Re-install the CRT front bracket by sliding the bracket into the chassis and secure it with the four mounting screws.
 4. Install all previously removed components.

A2 Display Control Board

The procedures that follow describe how to remove and install the CRT Front Bracket.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal

- Front Trim Removal
 - A3 Display Driver Board
 - CRT
1. Unplug the cables from connectors J80, J82, and J84 on the A2 Display Control board.
 2. Lift the A2 Display Control board up toward the top of the chassis, sliding the board out of the board retainers.
 3. Re-install the A2 Display Control board by sliding the board into the board retainers.
 4. Re-install all cables at connectors J80, J82, and J84.
 5. Install all previously removed components.

A63 Power Supply Module

The procedures that follow describe how to remove and install the Power Supply module.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal

Power Supply Removal

1. Set the oscilloscope so its top is down on the work surface.
2. Disconnect the power button shaft from the power switch on the Power Supply module. See Figure 8-17.

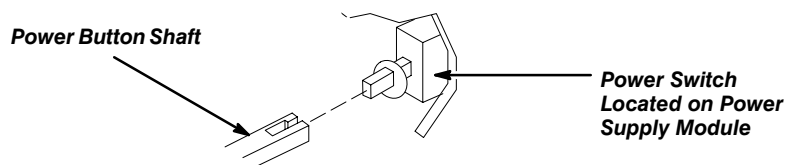


Figure 8-17: Power Button Shaft Disconnect

3. Unplug the cables going to the A3 Display Driver board at J70 and J71.
4. Set the oscilloscope so its bottom down on the work surface.
5. Unplug the cable going to the A5 CPU board at J55.
6. Unplug the two-wide cable from the fan.

Removal and Installation Procedures

7. Unplug the red CRT anode lead from the power supply connector.
8. Remove the two screws securing the Power Supply module to the chassis.
9. Lift the Power Supply module out of the chassis to complete its removal.
10. Slide the Power Supply module into the chassis, noting that the tab at the bottom of the Power Supply module slides into the slot at the bottom of the chassis.

Power Supply Installation

1. Reconnect all cables and wires disconnected during the removal procedure.
2. Re-install all components removed.

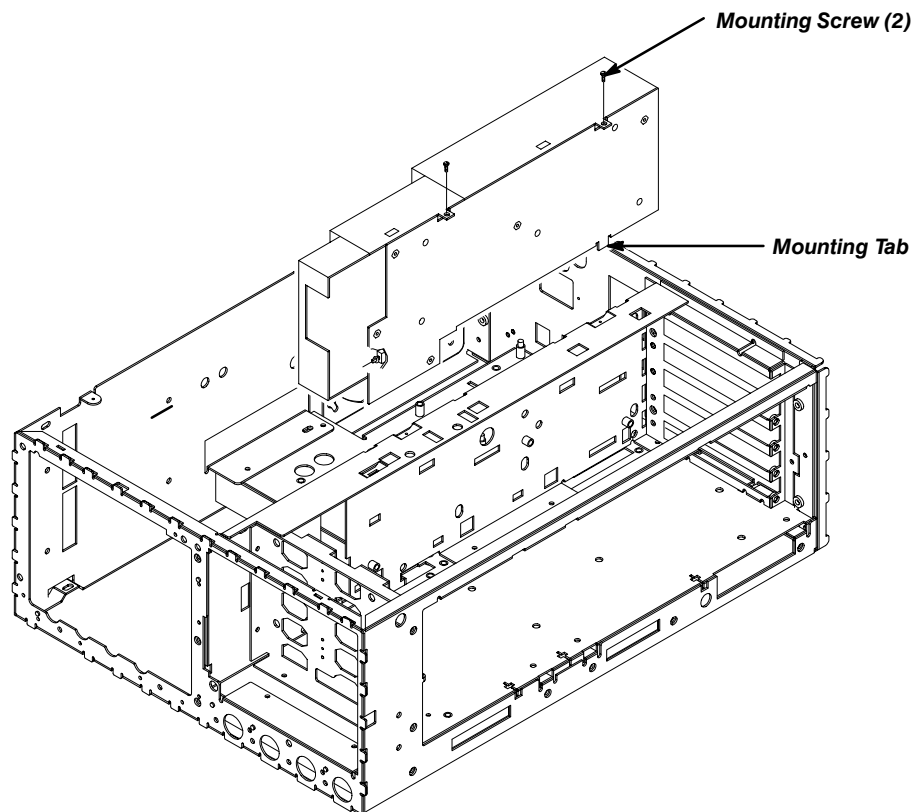


Figure 8-18: Power Supply Removal

Fan and Fan Mount

The procedures that follow describe how to remove and install the Fan and Fan Mount.

Additional procedures required — This procedure requires that the following procedures be performed first:

- Rear Cover Removal
- Cabinet Removal

Fan and Fan Mount Removal

1. Set the oscilloscope so its bottom is down.
2. Unplug the fan power cable from the A63 Power Supply module.
3. Rotate the oscilloscope so the side that houses the fan mount is facing upwards.
4. Depress the two flex locks to release them (see Figure 8-19).
5. While holding the flex locks released, slide the fan mount so its four retainer lugs slide from their small retainer holes in the chassis into their large release holes.
6. Move the fan mount inward so its retainer lugs are out of the large retainer holes and lift the fan mount and fan out of the chassis.

Removal and Installation Procedures

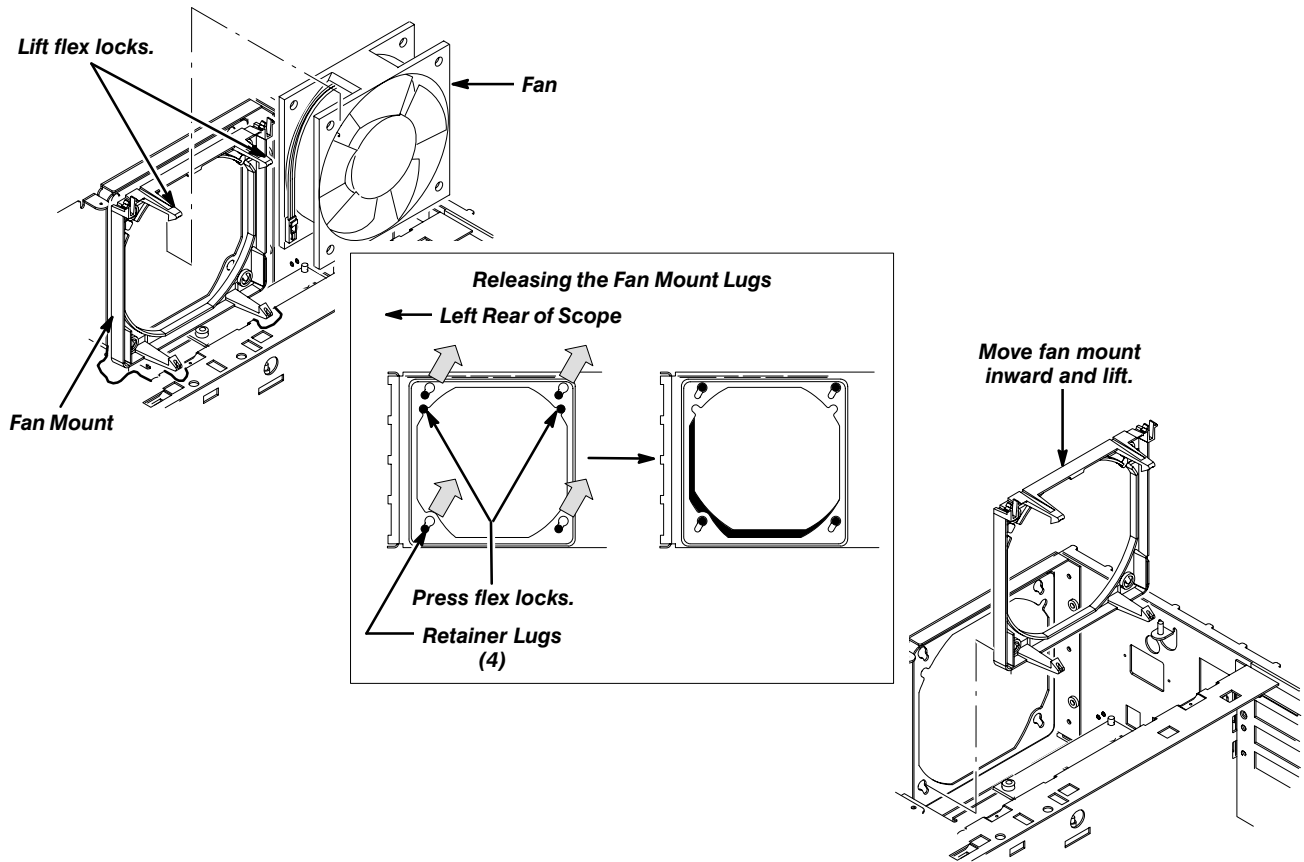


Figure 8-19: Fan and Fan Mount Removal



DO NOT remove the fan from the fan mount unless servicing a broken fan or fan mount or removing the mount for cleaning.

7. Release the two flex locks securing the top of the fan to the fan mount, and then lift the fan out from the mount.

Fan and Fan Mount Installation

1. If the fan was removed from the fan mount, press the fan into the fan mount until the four retainer clips snap into place, securing the fan.
2. Install the fan assembly so that the retainer lugs on the mount are positioned in the large holes of the chassis; then, slide the fan assembly until the lugs slip into the small holes and the two flex locks snap into place.
3. Reconnect the fan's power cable.
4. Re-install all removed components.

Troubleshooting

This subsection contains information and procedures designed to help you isolate problems to a faulty module in the oscilloscope. If a module needs to be removed for repair or replacement, follow the *Removal and Installation Procedures* located in this section.

Troubleshooting Procedure

If the oscilloscope does not perform correctly, note each symptom or failure. Next, refer to the Symptom Matrix Table (Table 8-5). Locate the symptoms that most closely resemble the symptoms you noted. If there are multiple symptoms, use a process of elimination to reduce the number of possible faulty modules. Identify possible faulty modules, then perform the troubleshooting procedure/s indicated.

The cabinet must be removed to gain access to the modules for measuring signals and voltages. Refer to the *Removal and Installation Procedures* beginning on page 8-9 for instructions to remove the cabinet.

Equipment

Table 8-4 list the equipment is required to perform the troubleshooting procedures.

Table 8-4: Equipment Required for Troubleshooting

Equipment	Example
Test Oscilloscope	Tektronix TAS 465
Digital Multimeter (DMM)	Tektronix DM250
High Voltage Probe	Fluke Model 80K-40



High voltages are present when the cabinet is removed. Do not remove the high voltage shield from the A3 Display Driver board unless it is necessary to measure the high voltage. Do not perform this procedure without the presence of another person who is capable of providing aid.

Symptom Matrix

The Symptom Matrix (Table 8-5) is an aid in determining which modules to troubleshoot. There is no separate troubleshooting procedure for the power supply, since each module troubleshooting procedure includes checks of the power supply. The CRT is checked in the display control and display driver troubleshooting procedures.

The ● indicates the troubleshooting procedure most likely to locate the failed module. The ○ indicates additional troubleshooting procedures that may help locate the failed module.

Table 8-5: Symptom Matrix

Symptom	Processor	Analog	Display Driver	Front Panel	Display Control
Display Problems					
No display at all	○	○	○	○	●
Traces or readout, but not both	○	●		○	○
Abnormal readout	●	○			
Abnormal traces	○	●			
Abnormal traces and readout	○	○	●		
Power-on diagnostics indicates a failure	●	●		○	
Self-calibration does not pass	○	●			
Volts/Div and Sec/Div controls					
One control works but not both	○	●		○	
Neither control works	○	○		●	
No control of Volts/Div or vertical position of a single channel	○	●			
No control of Volts/Div or vertical position of any channels	○	○		●	
Intensity Control Problems					
No control of readout and trace intensity	○	○		●	
Control of readout or trace intensity but not both		●		○	
Focus Problems					
No control of focus			○		●
Unable to focus properly			●		○
No control of trace rotation					●
No control of scale illumination					●

Table 8-5: Symptom Matrix (Cont.)

Symptom	Processor	Analog	Display Driver	Front Panel	Display Control
Trigger level, vertical position, and horizontal position					
The trace position controls nor the Trigger Level control works	○	○		●	
Some of these controls work but not all	○	●		○	
Probe Scale (X10) Problems					
Volts/Div readout does not change with a X10 probe on any channel				●	
Front Panel Control Problems					
Front panel controls do not work but readout display works	○			●	
Front panel controls do not work and the readout display is abnormal	●			○	
CRT Bezel buttons do not work but other buttons and knobs work				●	
Front panel LED Problems					
No LED's momentarily light at power-on but readout is okay	○			●	
No LED's momentarily light at power-on and abnormal readout	●			○	
Some LED's momentarily light at power-on, but not all do				●	
No trigger on line source	○	●	○		

Troubleshooting

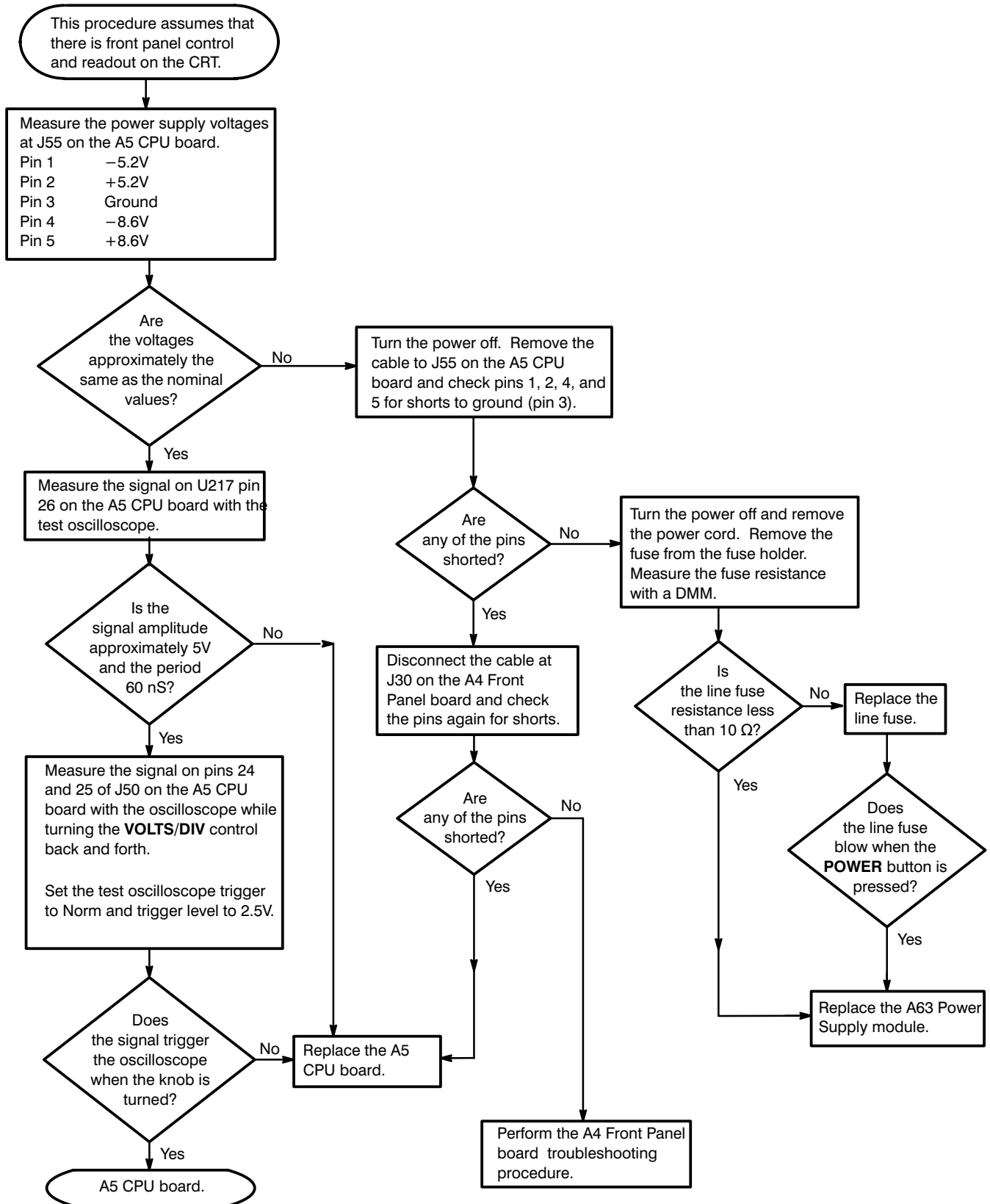


Figure 8-20: A5 CPU Board Troubleshooting Procedure

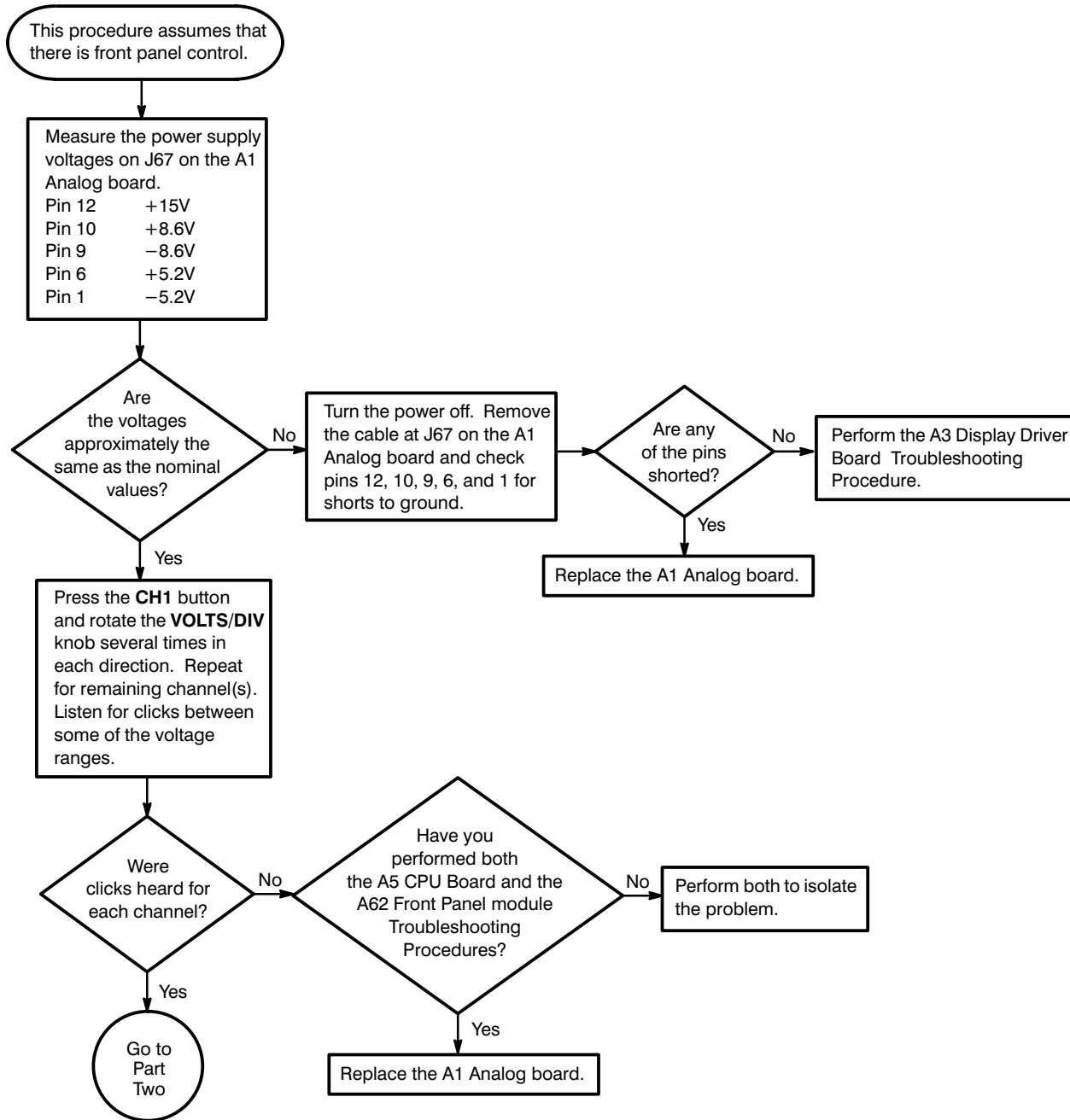


Figure 8-21: A1 Analog Board Troubleshooting Procedure

Troubleshooting

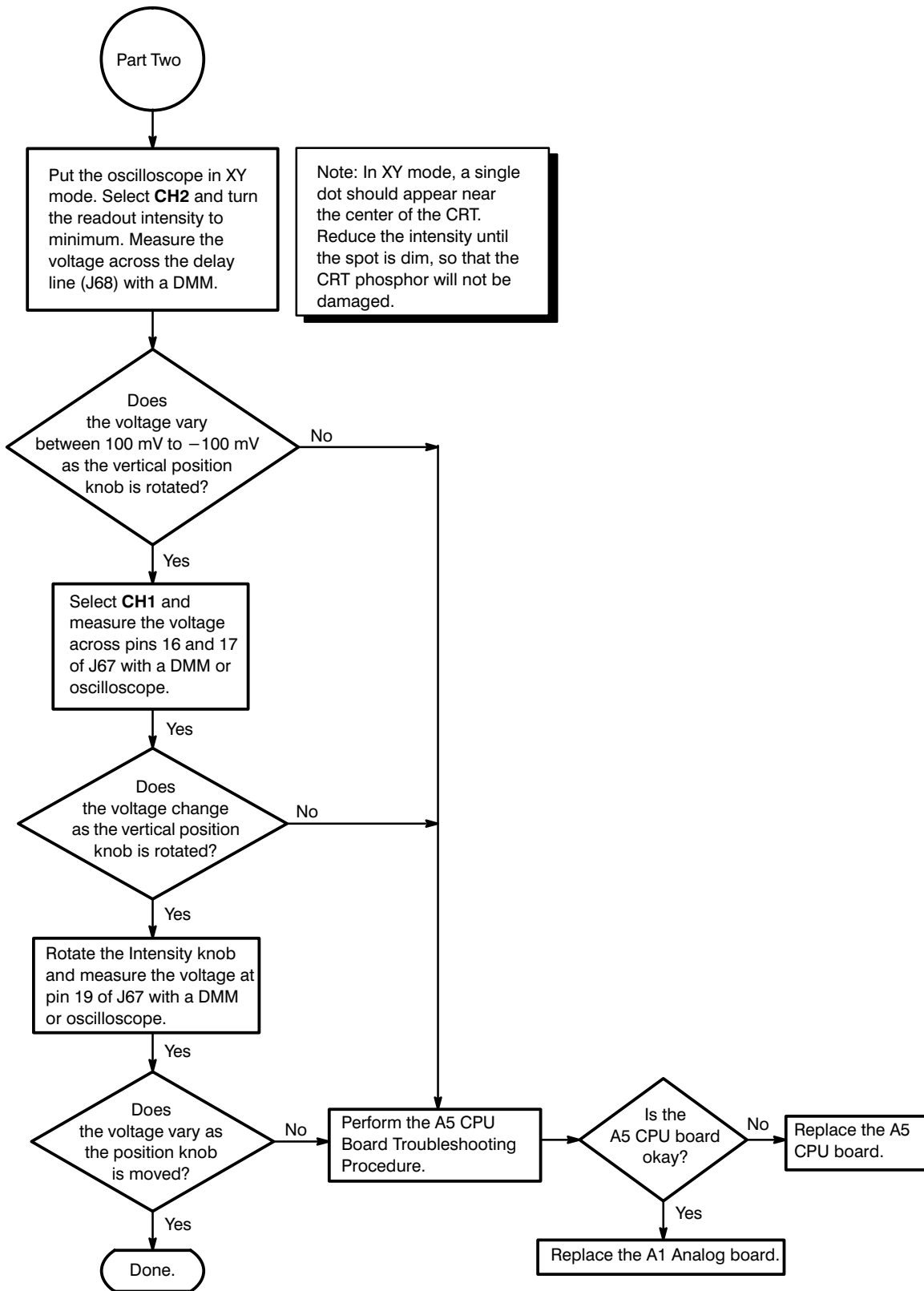


Figure 8-21: A1 Analog Board Troubleshooting Procedure (Cont.)

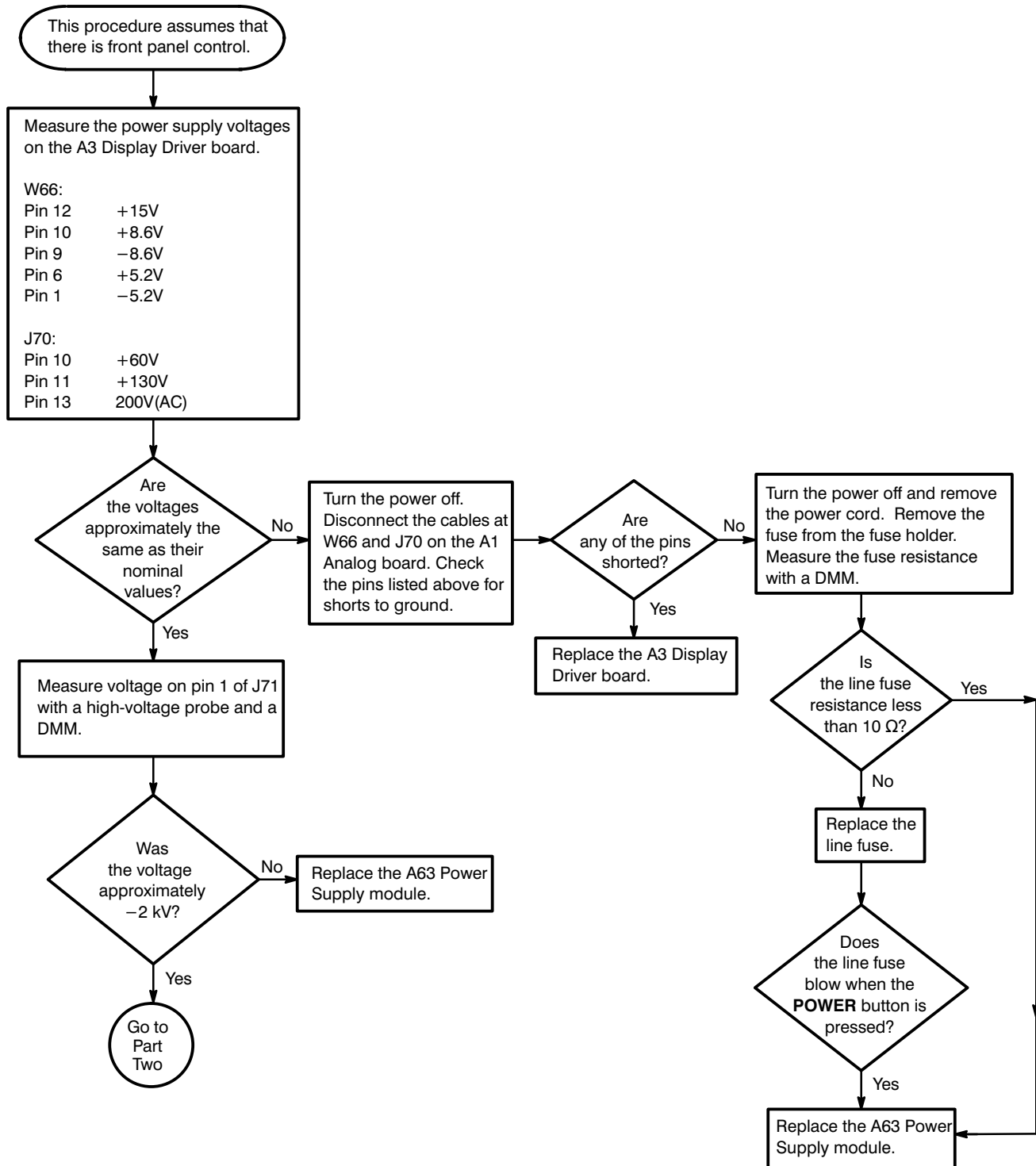


Figure 8-22: A3 Display Driver Board Troubleshooting Procedure

Troubleshooting

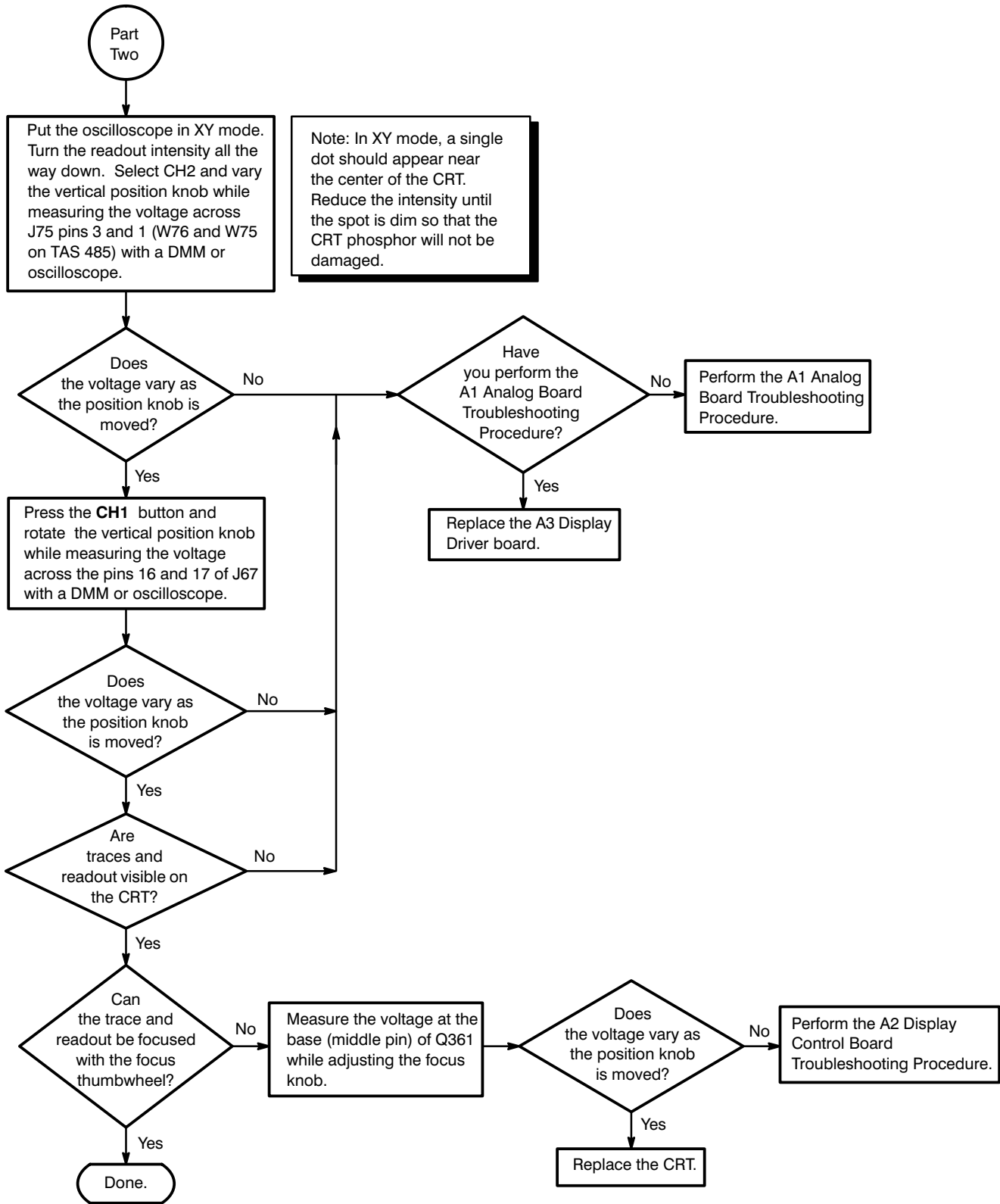


Figure 8-22: A3 Display Driver Board Troubleshooting Procedure (Cont.)

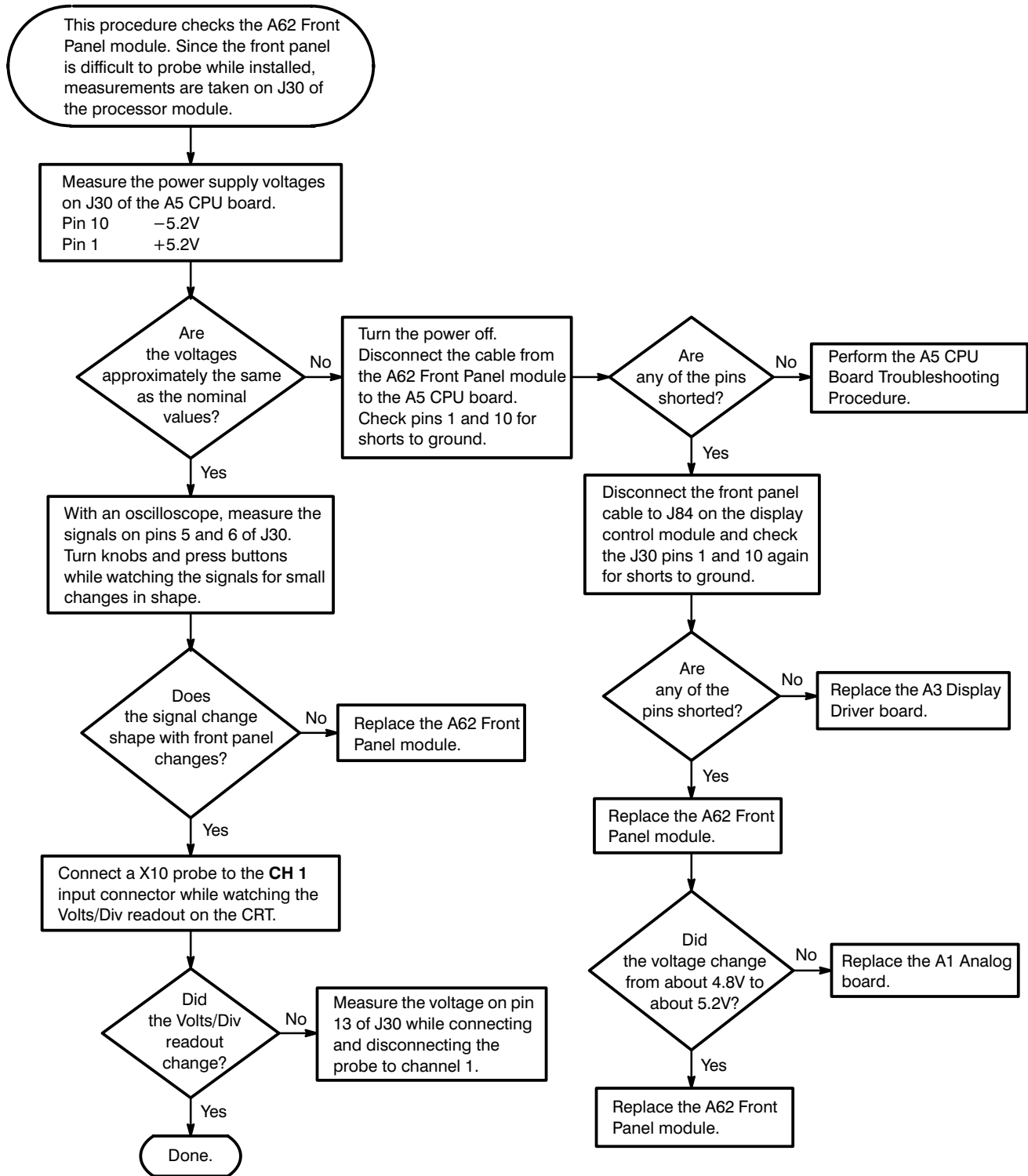


Figure 8-23: A62 Front Panel module Troubleshooting Procedure

Troubleshooting

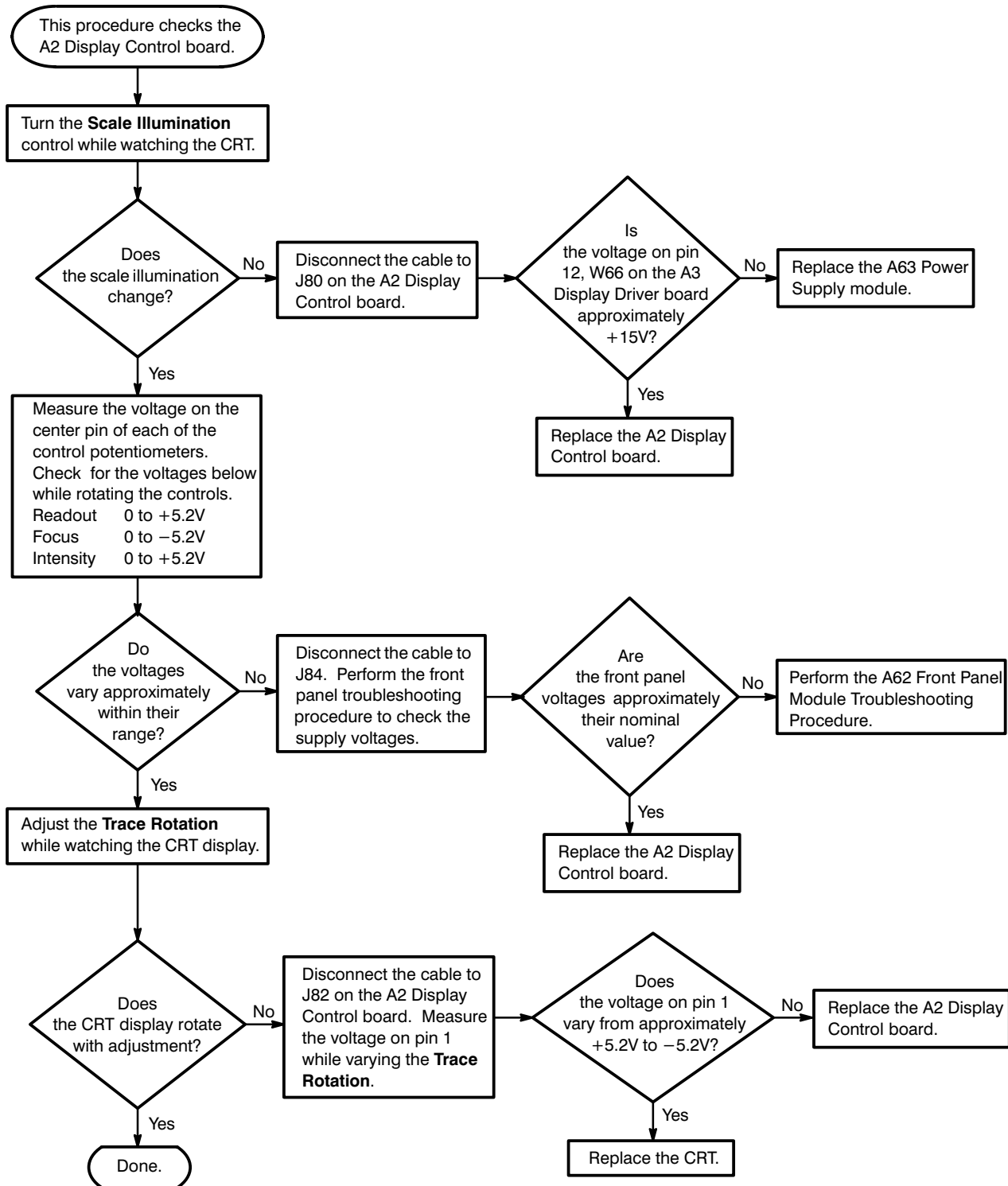


Figure 8-24: A2 Display Control Board Troubleshooting Procedure

Repackaging Information

If you ship the TAS 455 or TAS 465, pack it in the original shipping carton and packing material. If the original packing material is not available, package the instrument as follows:

1. Obtain a corrugated cardboard shipping carton with inside dimensions at least 15 cm (6 in) taller, wider, and deeper than the TAS 455 or TAS 465. The shipping carton must be constructed of cardboard with 170 kg (375 pound) test strength.
2. If you are shipping the TAS 455 or TAS 465 to a Tektronix field office for repair, attach a tag to the oscilloscope showing the instrument owner and address, the name of the person to contact about the instrument, the instrument type, and the serial number.
3. Wrap the oscilloscope with polyethylene sheeting or equivalent material to protect the finish.
4. Cushion the oscilloscope in the shipping carton by tightly packing dunnage or urethane foam on all sides between the carton and the oscilloscope. Allow 7.5 cm (3 in) on all sides, top, and bottom.
5. Seal the shipping carton with shipping tape or an industrial stapler.

Repackaging Information

Replaceable Parts

Replaceable Parts

This section contains a module level list of the replaceable parts for the TAS 455 and TAS 465 Oscilloscopes. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available from or through your local Tektronix, Inc. service center or representative.

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

- part number
- instrument type or model number
- instrument serial number
- instrument modification number, if applicable

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

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

Instrument Repair

If your TAS 455 and TAS 465 Oscilloscopes appears to have an electrical failure during or after the warranty period, contact your local Tektronix service center or representative or call 1-800-TEKWIDE, extension 6630.

A Service manual is also available for the TAS 455 and TAS 465 Analog Oscilloscopes, part number 070-8524-XX. The service manual contains a complete electrical and mechanical parts list for the TAS 455 and TAS 465 Oscilloscopes.

Using the Replaceable Parts List

The tabular information in the Replaceable Parts List is arranged for quick retrieval. Understanding the structure and features of the list will help you find the all the information you need for ordering replacement parts.

Item Names

In the Replaceable Parts List, an Item Name is separated from the description by a colon (:). Because of space limitations, an Item Name may sometimes appear as incomplete. For further Item Name identification, U.S. Federal Cataloging Handbook H6-1 can be used where possible.

Indentation System

This parts list is indented to show the relationship between items. The following example is of the indentation system used in the Description column:

1	2	3	4	5	Name & Description
					<i>Assembly and/or Component</i>
					<i>Attaching parts for Assembly and/or Component</i> <i>(END ATTACHING PARTS)</i>
					<i>Detail Part of Assembly and/or Component</i>
					<i>Attaching parts for Detail Part</i> <i>(END ATTACHING PARTS)</i>
					<i>Parts of Detail Part</i>
					<i>Attaching parts for Parts of Detail Part</i> <i>(END ATTACHING PARTS)</i>

Attaching parts always appear at the same indentation as the item it mounts, while the detail parts are indented to the right. Indented items are part of, and included with, the next higher indentation. Attaching parts must be purchased separately, unless otherwise specified.

Abbreviations

Abbreviations conform to American National Standards Institute (ANSI) standard Y1.1

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

Mfr. Code	Manufacturer	Address	City, State, Zip Code
S3109	FELLER	72 VERONICA AVE UNIT 4	SUMMERSET NJ 08873
S4246	JAPAN SERVO CO LTD	7 KANDA MITOSHIRO-CHO CHIYODA-KU	TOKYO JAPAN
TK0860	LABEL GRAPHICS	6700 SW BRADBURY CT	PORTLAND OR 97224
TK1149	ALMAN INC	97 THORNWOOD RD	STAMFORD CT 06903-2617
TK1159	IMPROVED PRODUCTS	3400 OLYMPIC STREET	SPRINGFIELD OR 97477
TK1163	POLYCAST INC	9898 SW TIGARD ST	TIGARD OR 97223
TK1326	NORTHWEST FOURSIDE INC	18224 SW 100TH CT	TUALATIN OR 97062
TK1908	PLASTIC MOLDED PRODUCTS	4336 SO ADAMS	TACOMA WA 98409
TK1918	SHIN-ETSU POLYMER AMERICA INC	1181 NORTH 4TH ST	SAN JOSE CA 95112
TK1935	ACCRA-FAB INC	11007 NE 37TH CIRCLE	VANCOUVER WA 98682
TK2045	ITW CHRONOMATIC	4126 N NASHVILLE AVE	CHIGAGO IL 60634
TK2280	ESCORT INSTRUMENTS CORP	2-FL NO 37 POA HSIN RD PO BOX 3-20 MUCHA	TAIPEI TAIWAN ROC 00080
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
TK6056	ASTEK USA	2880 SAN TOMES EXPRESSWAY SUITE 200	SANTA CLARA CA 95051
OJR05	TRIQUEST CORP	3000 LEWIS AND CLARK HWY	VANCOUVER WA 98661-2999
OJ7N9	MCX INC	30608 SAN ANTONIO ST	HAYWARD CA 94544
OJ9P9	GEROME MFG CO INC	PO BOX 737	NEWBERG OR 97132
OKBZ5	MORELLIS Q & D PLASTICS	1812 16TH AVE	FOREST GROVE OR 97116
OKB00	SCHRAMM PLASTIC FABRICATIORS	7885 SW HUNZIKER	TIGARD OR 97223
OKB01	STAUFFER SUPPLY	810 SE SHERMAN	PORTLAND OR 97214
05469	BEARINGS INC	3634 EUCLID P O BOX 6925	CLEVELAND OH 44101
07416	NELSON NAME PLATE CO	3191 CASITAS	LOS ANGELES CA 90039-2410
13103	THERMALLOY CO INC	2021 W VALLEY VIEW LN PO BOX 810839	DALLAS TX 75381
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
52152	MINNESOTA MINING AND MFG CO INDUSTRIAL SPECIALTIES DIV	3M CENTER	ST PAUL MN 55144-0001
55335	JKL COMPONENTS CORP	13343 PAXTON STREET	PACOIMA CA 91331
70903	COOPER BELDEN ELECTRONICS WIRE AND CABLE SUB OF COOPER INDUSTRIES INC		
73743	FISCHER SPECIAL MFG CO	111 INDUSTRIAL RD	COLD SPRING KY 41076-9749
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

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No.		Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont				
9-1-1	390-1106-01			1	CABINET,OSC:ALUMINUM	TK1935	ORDER BY DESC
-2	367-0356-01			1	HANDLE,CARRYING:13.855,SST,	0JR05	ORDER BY DESC
-3	212-0144-00			2	SCREW,TPG,TF:8-16 X 0.562 L,PLASTI,SPCL HD	0KB01	ORDER BY DESC
-4	348-0659-00			2	FOOT,CABINET:BLACK POLYURETHANE	0JR05	ORDER BY DESC
-5	-----			1	CABINET,OSC:ALUMINUM (NOT REPL, ORDER 390-1106-XX)		
-6	211-0730-00			1	SCR,ASSEM WSHR:6-32 X 0.375,PNH,STL CD PL	0KB01	ORDER BY DESC
-7	334-8203-00	B010100	B020099	1	MARKER,IDENT:MKD REAR COVER SUPPLY INFO	80009	334820300
	334-8836-00	B020100		1	MARKER,IDENT:MKD REAR COVER SUPPLY INFO	80009	334883600
-8	159-0277-00	B010100	B020099	1	FUSE,CARTRIDGE:5 X 20MM,3A,250V,5 SEC (STANDARD)	75915	235003
	159-0311-00	B010100	B020099	1	FUSE,CARTRIDGE:METRIC,1.5A,250V,FAST (OPTIONS A1,A2,A3,A4,A5)	TK2280	62-25608-1U
	159-0277-00	B020100		1	FUSE,CARTRIDGE:5 X 20MM,3A,250V,5 SEC (STANDARD)	75915	235003
	-----	B020100		1	FUSE,CARTRIDGE:METRIC,3.1A,250V,FAST (OPTIONS A1,A2,A3,A4,A5)		
-9	211-0691-00			4	SCREW,MACHINE:6-32 X 0.625,PNH,STL	0KB01	ORDER BY DESC
-10	334-8494-00			1	MARKER,IDENT:MKD	80009	334849400
-11	200-3971-01			1	COVER,REAR:W/FEET AND LABELS	TK1163	200-3971-01
-12	161-0230-01			1	CABLE ASSY,PWR,:3,18 AWG,92 L,SVT,TAN (STANDARD ACCESSORY)	TK2432	ORDER BY DESC
-13	343-1213-00			1	CLAMP,PWR CORD:POLYIMIDE (STANDARD ACCESSORY)	TK1163	ORDER BY DESC

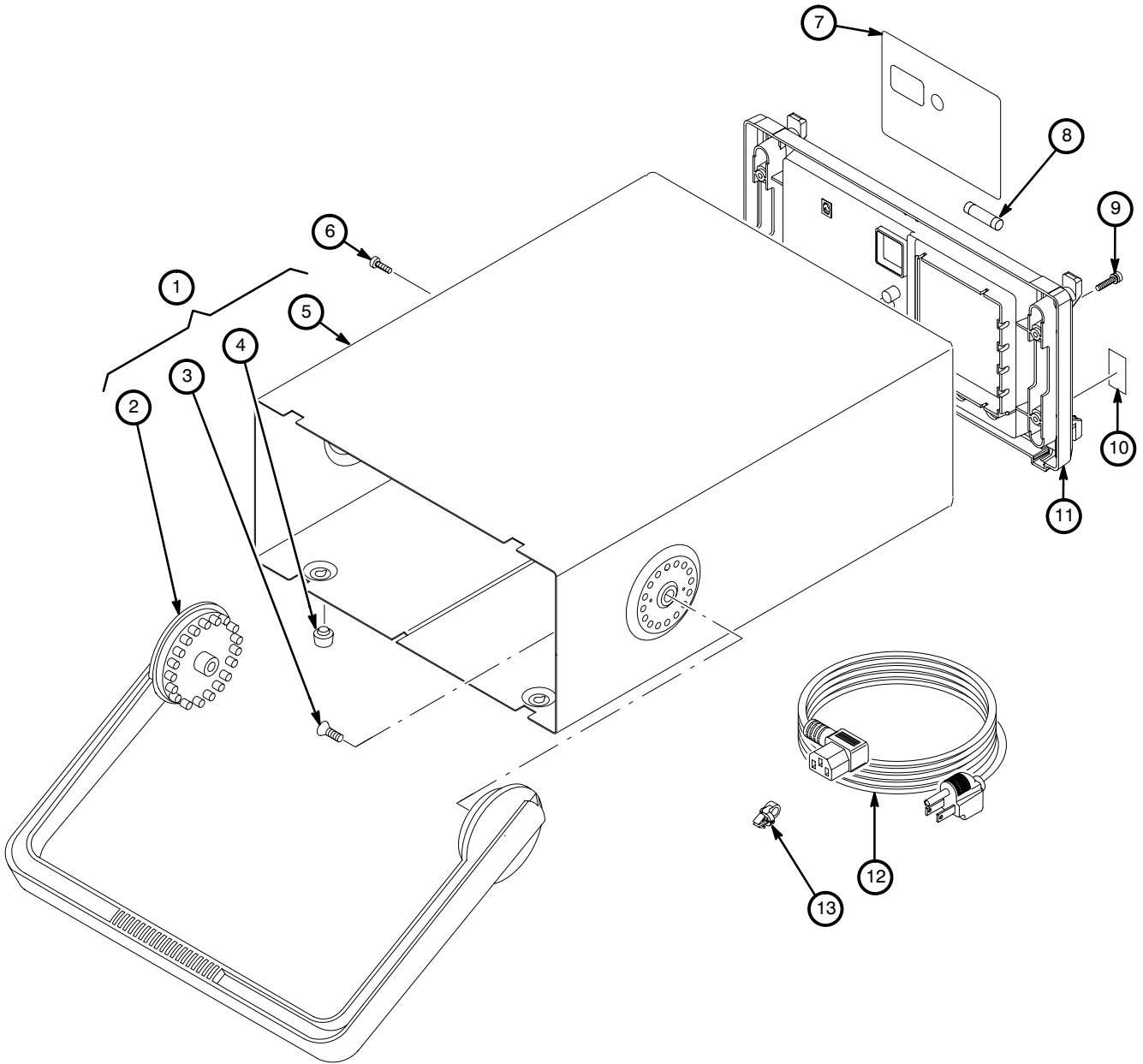


Figure 9-1: Cabinet and Rear

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No.		Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont				
9-2-1	200-3232-00	B010100	B010799	1	COVER,FRONT:ABS (TAS455 ONLY)	TK1908	ORDER BY DESC
	200-3232-01	B010800		1	COVER,FRONT:ASB (TAS455 ONLY)	TK1908	ORDER BY DESC
	200-3232-00	B010100	B010674	1	COVER,FRONT:ABS (TAS465 ONLY)	TK1908	ORDER BY DESC
	200-3232-01	B010675		1	COVER,FRONT:ASB (TAS465 ONLY)	TK1908	ORDER BY DESC
-2	334-8420-00			1	MARKER,IDENT:MKD INST NOMENCLATURE (TAS 455 ONLY)	80009	334842000
	334-8204-00			1	MARKER,IDENT:MKD INST NOMENCLATURE (TAS 465 ONLY)	80009	334820400
-3	101-0135-00			1	TRIM.DECORATIVE:	80009	101013500
-4	378-0199-03			1	FILTER,LT,CRT:BLUE,3.415 X 4.105 X 0.030THK	0KB00	378019903
-5	260-2561-00			1	SWITCH,PB:BEZEL	80009	260256100
-6	-----			1	FLEX CIRCUIT:BEZEL (SEE A9 REPL)		
-7	-----			1	CIRCUIT BD ASSY:FRONT PANEL MODULE (SEE A62 REPL)	80009	672136200
-8	384-1689-01			6	SHAFT EXTENDER:ACETAL	80009	384168901
-9	366-2111-00			3	KNOB:SMALL,FLUTED	TK1163	ORDER BY DESC
-10	131-5142-00			1	CONTACT,ELEC:PROBE ADJUST	TK1935	ORDER BY DESC
-11	366-2113-00			3	KNOB:MEDIUM,DETENTED	TK1163	ORDER BY DESC
-12	366-2164-00			10	PUSH BUTTON:SMOKE TAN	80009	366216400
-13	348-1258-00			4	SHLD, GASKET, ELE2 LAYER	80009	348125800

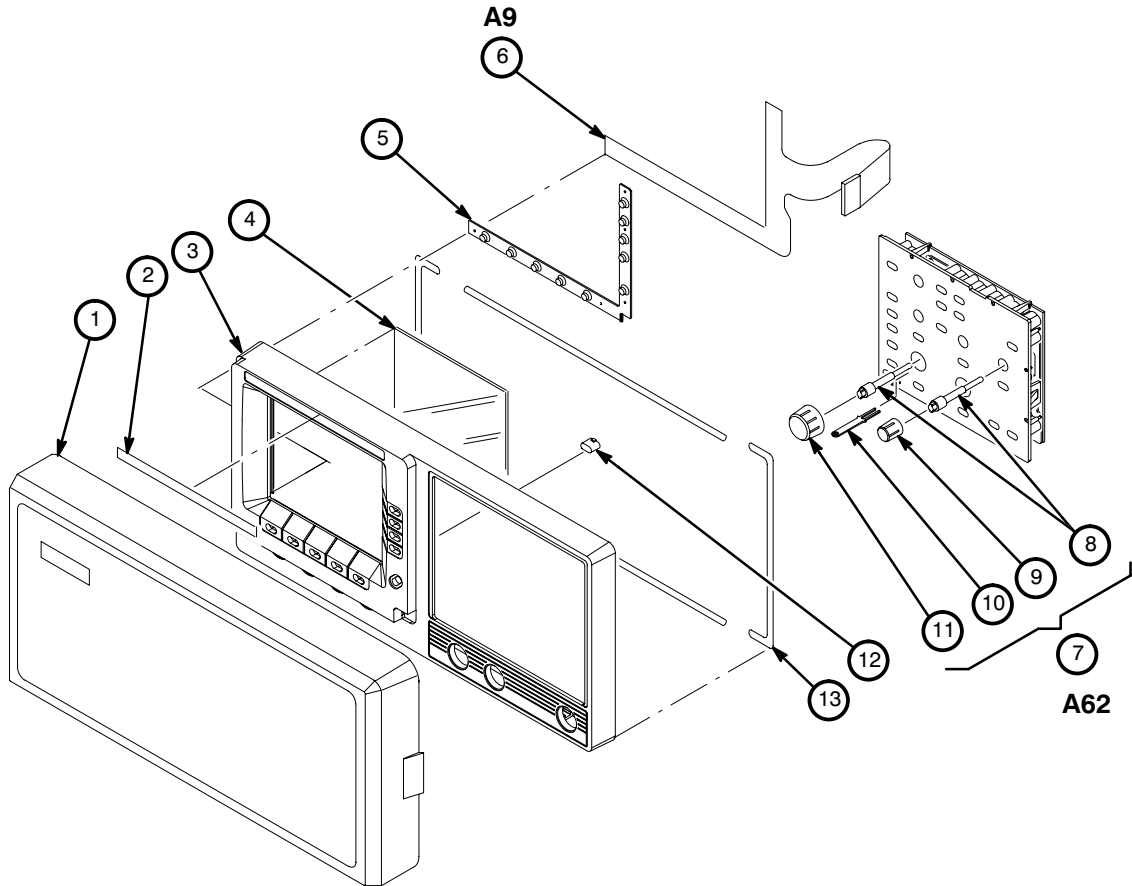


Figure 9-2: Front Panel Assembly

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No.		Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont				
10-3-1	337-2926-03			1	SHLD,IMPLOSION:4.44 X 3.67 X 0.06,CLEAR	TK1159	ORDER BY DESC
-2	407-4130-00	B010100	B011875	1	BRACKET,CRT:FRONT (TAS455 ONLY)	80009	407413000
	407-4130-01	B011876		1	BRACKET,CRT:FRONT (TAS455 ONLY)	80009	407413001
	407-4130-00	B010100	B011639	1	BRACKET,CRT:FRONT (TAS465 ONLY)	80009	407413000
	407-4130-01	B011640		1	BRACKET,CRT:FRONT (TAS465 ONLY)	80009	407413001
-3	348-1474-00	B031000		1	GASKET; DUST SEAL (TAS465 ONLY)	80009	348147400
-4	348-0660-00			4	CUSHION,CRT:POLYURETHANE	80009	348066000
-5	-----			1	ELECTRON TUBE:CRT (SEE A64 REPL)		
-6	344-0347-00			1	CLIP,ELECTRICAL:ANODE,0.72OD,NYLON	80009	344034700
-7	386-4443-00			1	SUPPORT,SHIELD:CRT,FRONT,PLASTIC	80009	386444300
-8	-----			1	LEAD,ELECTRICAL:DESCRETE,SDI/IDC,2,22 AWG (SEE P75 REPL)		
-9	-----			1	LEAD,ELECTRICAL:DESCRETE,SDI/IDC,2,22 AWG (SEE P74 REPL)		
-10	334-1951-00			1	MARKER,IDENT:MKD WARNING,CRT VOLTAGES	TK0860	ORDER BY DESC
-11	334-1379-00			1	MARKER,IDENT:MKD HI VACUUM	07416	ORDER BY DESC
-12	337-3487-00			1	SHIELD,ELEC:CRT,STL	0J9P9	337348700
-13	426-2426-00			1	FRAME,FAN MTG:POLYCARBONATE	TK1163	426-2426-00
-14	-----			1	FAN,TUBEAXIAL:12V,1.72W,42 CFM (SEE B90 REPL)		
-15	200-0616-00	B010100	B010363	1	COVER,CRT SKT:1.78 DIA X 0.2 D,WHITEPOLY (TAS455 ONLY)	80009	200061600
	200-0616-02	B010364		1	COVER,CRT SKT:1.78 DIA X 0.2 D,WHITEPOLY (TAS455 ONLY)	80009	200061602
	200-0616-00	B010100	B010349	1	COVER,CRT SKT:1.78 DIA X 0.2 D,WHITEPOLY (TAS465 ONLY)	80009	200061600
	200-0616-02	B010350		1	COVER,CRT SKT:1.78 DIA X 0.2 D,WHITEPOLY (TAS465 ONLY)	80009	200061602
-16	-----			1	CA ASSY,SP:DESCETE,SDI,9,26 AWG,7.4L (SEE P76 REPL)		
-17	131-5546-00			1	CONN,CONTACT:STATIC	80009	131554600
-18	407-4129-00			1	BRACKET,REAR:REAR OUT	80009	407412900
-19	213-0882-00			17	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	0KB01	ORDER BY DESC
-20	-----			1	POWER SUPPLY:LOW POWER VERSION (SEE A63 REPL)		
-21	343-0549-00	B010903		1	STRAP,TIEDOWN,E:0.098W X 4.0L (TAS455 ONLY)	TK1499	HW-047
	343-0549-00	B010773		1	STRAP,TIEDOWN,E:0.098W X 4.0L (TAS465 ONLY)	TK1499	HW-047
-22	-----			1	CA ASSY RF:DESCRETE,;SDI/RFD,22 AWG,8.625 L (SEE J21 REPL)		
-23	407-4196-00			1	BRACKET,STD:ALUMINUM	80009	407419600
-24	441-1982-00			1	CHASSIS ASSY:ALUMINUM	80009	441198200
-25	348-0150-00			1	GROMMET,PLASTIC:DK GRAY,U-SHAPE,0.66 ID	0KBZ5	ORDER BY DESC

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
-26	348-1334-00	B010100		1	SHLD,GSKT ELEK:CLIP ON EMI,0.46 L (TAS455 ONLY)	30817	97-605-09-005W
-26	348-1334-00	B010100	B021145	1	SHLD,GSKT ELEK:CLIP ON EMI,0.46 L (TAS465 ONLY)	30817	97-605-09-005W
-27	384-1370-00			1	EXTENSION SHAFT:4.68 L,MOLDED PLASTIC	OJR05	ORDER BY DESC
-28	366-2168-00			1	PUSH BUTTON:ON/OFF	80009	366216800
-29	351-0914-00			1	GUIDE,LIGHT:GRATICULE	80009	351091400
-30	384-1689-01			4	SHAFT EXTENDER:ACETAL	80009	384168901
-31	366-2169-00			4	KNOB:THUMBWHEEL	80009	366216900

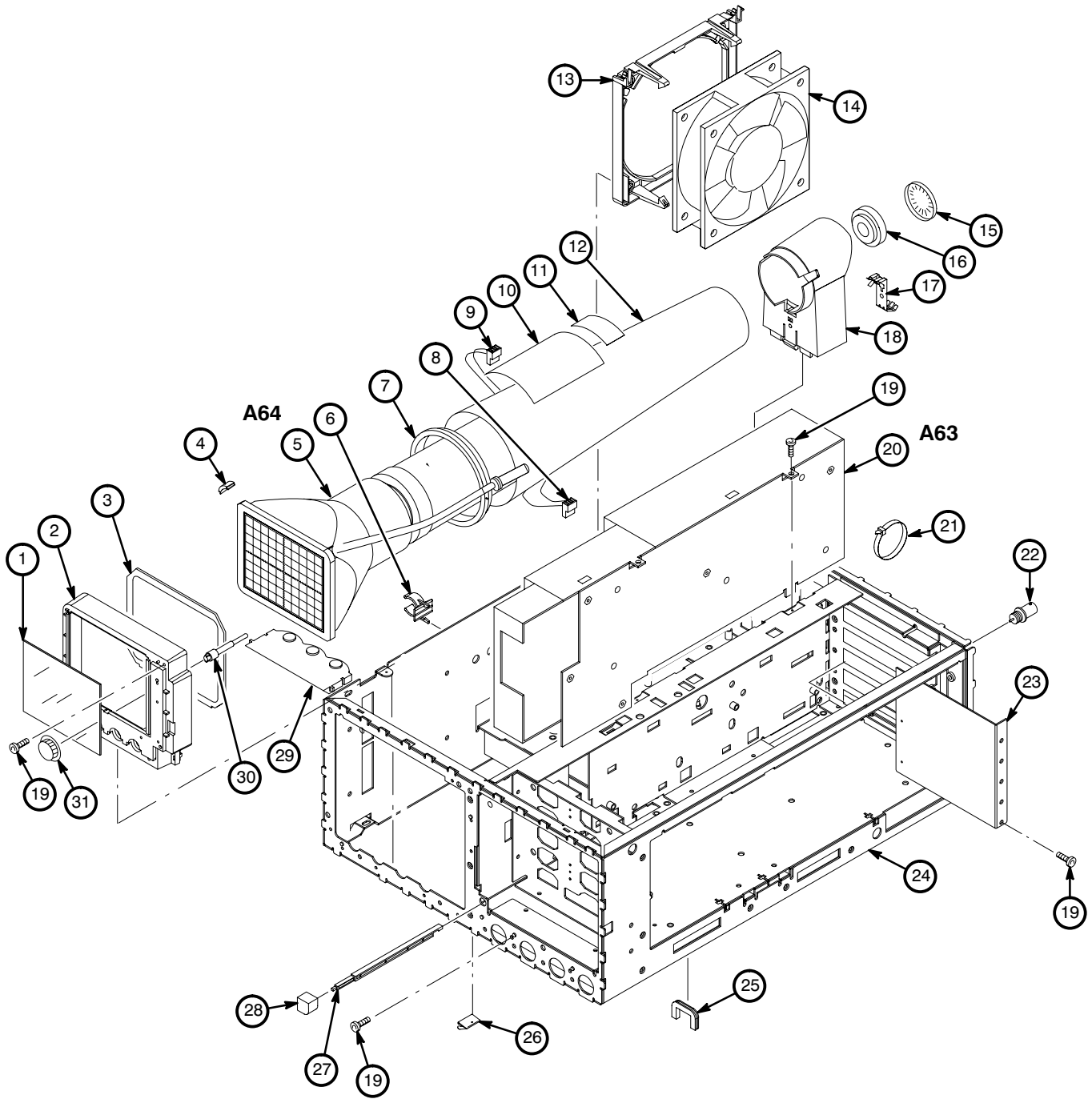


Figure 9-3: Chassis

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
9-4-1	-----			2	LAMP,INCAND:14V,0.08A,WEDGE BASE,T1.75 (SEE A2DS1,DS2 REPL)		
-2	196-3405-00			1	LEAD,ELECTRICAL:4.0L,W/AMPRING TERMINAL	80009	196340500
-3	210-0457-00			1	NUT,PL,ASSEM WA:6.32 X 0.312,STL CD PL	OKB01	ORDER BY DESC
-4	334-8543-00			1	MARKER,IDENT:0.500 IN DIA BLANK MYLAR	80009	334854300
-5	213-0882-00			7	SCREW,TPG,TR:6-32 X 0.437 TAPTITE,PNH,STL	OKB01	ORDER BY DESC
-6	-----			1	CIRCUIT BD ASSY:CPU (SEE A5 REPL ON PAGE 9-15)		
-7	-----			1	DELAY LINE,ELEC:VERTICAL (SEE DL68 REPL ON PAGE 9-17)		
-8	-----			1	CA ASSY,SP:FLAT FLEX,FLX,23,26 AWG,6.5L (SEE A3W66 REPL ON PAGE 9-17)		
-9	342-0960-00			1	INSULATOR,SHEET:POLYCARBONATE	80009	342096000
-10	337-3880-00			1	SHIELD,ELEC:PLASTIC,HIGH VOLTAGE	80009	337388000
-11	-----			1	CIRCUIT BD ASSY:DISPLAY DRIVER (SEE A3 REPL ON PAGE 9-15)		
-12	-----			1	CIRCUIT BD ASSY:ANALOG (SEE A1 REPL ON PAGE 9-15)		
-13	343-0775-00	B012359		1	CABLE,CLAMP:RIBBON,1.0 X 1.0,GRAY POLY (TAS455 ONLY)	52152	3484-1000
	343-0775-00	B011891		1	CABLE,CLAMP:RIBBON,1.0 X 1.0,GRAY POLY (TAS465 ONLY)	52152	3484-1000
-14	-----			1	CA ASSY,SP:FLAT FLEX,;FLX,16,26 AWG,13.7 L (SEE P30 REPL ON PAGE 9-17)		
-15	-----			1	CA ASSY,SP:RIBBON,;IDC,40,28 AWG,3.5 L,2X2 (SEE P50 REPL ON PAGE 9-17)		
-16	-----			1	CA ASSY,SP:FLAT FLEX,;FLX,2,26 AWG,7.65 L (SEE P80 REPL ON PAGE 9-17)		
-17	-----			1	CA ASSY,SP:FLAT FLEX,;FLX,5,26 AWG,8.7 L (SEE P84 REPL ON PAGE 9-17)		
-18	-----			1	CIRCUIT BD ASSY:DISPLAY CONTROL (SEE A2 REPL ON PAGE 9-15)		

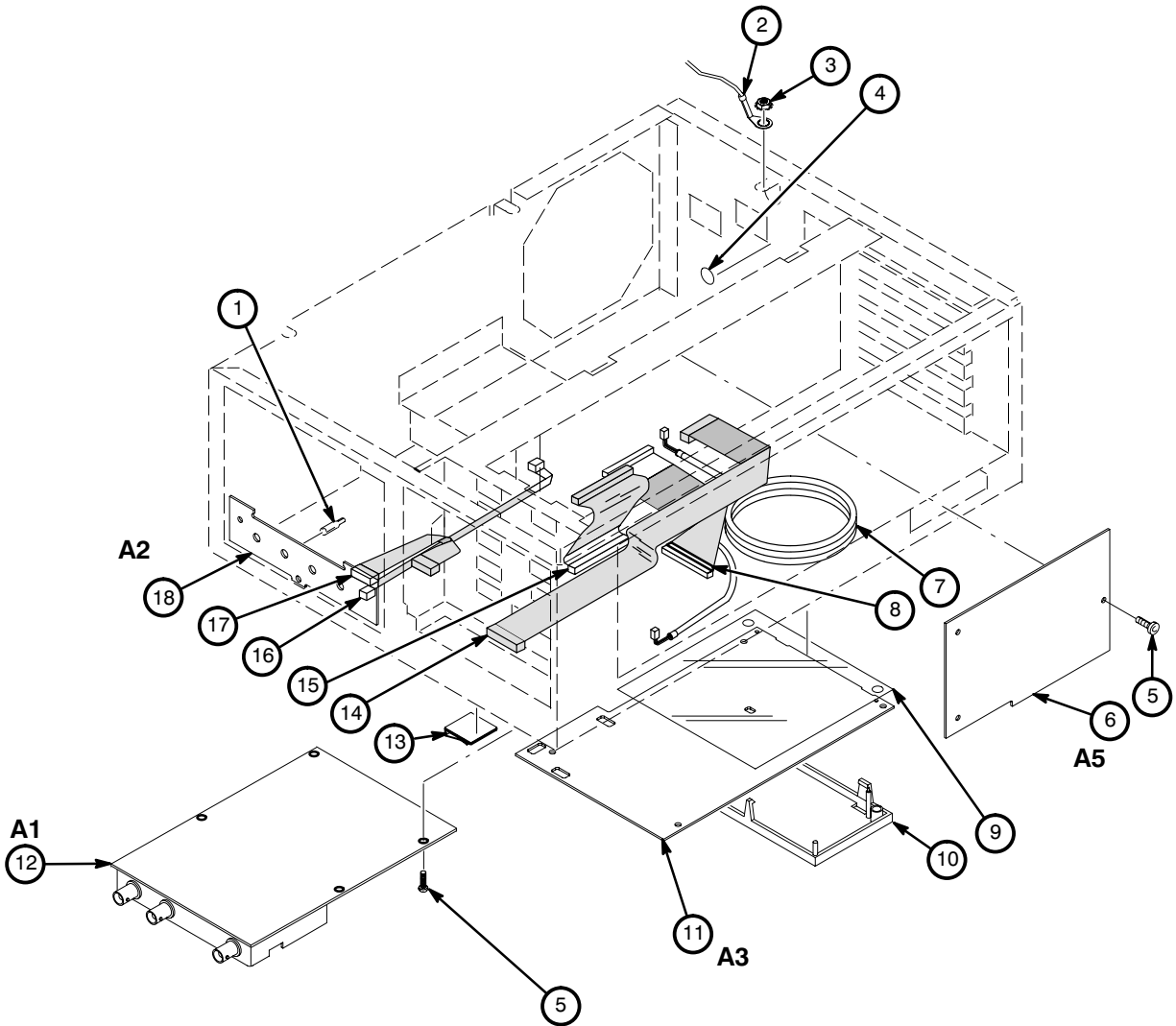


Figure 9-4: Circuit Boards

Replaceable Parts

Fig. & Index No.	Tektronix Part No.	Serial No. Effective	Dscont	Qty	12345 Name & Description	Mfr. Code	Mfr. Part No.
STANDARD ACCESSORIES							
10-5-1	161-0104-05			1	CABLE ASSY,PWR,,:3,18 AWG,240V,98.0 L (OPTION A3-AUSTRALIAN)	S3109	SAA/3-OD3CCFC3X
5-2	161-0104-06			1	CABLE ASSY,PWR,,:3 X 0.75MM SQ,220V,98.0 L (OPTION A1-EUROPEAN)	S3109	VIIGSOPO-HO5VVF
5-3	161-0104-07			1	CABLE ASSY,PWR,,:3,1.0MM SQ,240 VOLT,2.5 M (OPTION A2-UNITED KINGDOM)	S3109	ORDER BY DESC
5-4	161-0104-08			1	CABLE ASSY,PWR,,:3,18 AWG,98 L,SVT,GREY/BLK (OPTION A4-NORTH AMERICAN)	70903	ORDER BY DESC
5-5	161-0167-00			1	CABLE ASSY,PWR,,:3.0 X 0.75,6A,240V,2.5M L (OPTION A5-SWITZERLAND)	S3109	ORDER BY DESC
-----				1	CABLE ASSY,PWR,,:3,18 AWG,92 L,SVT,TAN (STANDARD, SEE FIGURE 9-1-13)		
-----				1	ACCESSORY PKG:(2)P6109B 2M PROBES W/ACC		
070-8522-XX				1	MANUAL,TECH:TAS455,TAS465 REF	80009	0708522XX
070-8523-XX				1	MANUAL,TECH:INSTRUCTION	80009	0708523XX
070-8690-XX				1	MANUAL,TECH:USER,XYZS OF OSCILLOSCOPE	80009	0708690XX
-----				1	FUSE,CARTRIDGE:5 X 20MM,3A,250V,5 SEC (SEE FIGURE 9-1-8)		
-----				1	CLAMP,PWR CORD:POLYIMIDE (SEE FIGURE 9-1-15)		
OPTIONAL ACCESSORIES							
003-1472-00				1	HAND TOOL:CLAMP,DETENT SPRING	80009	003147200
003-1473-00				1	HAND TOOL:SPRING INSERTION	80009	003147300
070-8524-XX	B010100	B020099		1	MANUAL,TECH:SERVICE,COMPONENT LEVEL B020099 AND BELOW	80009	0708524XX
070-9403-XX	B020100			1	MANUAL,TECH:SERVICE,COMPONENT LEVEL B020100 AND ABOVE	80009	0709403XX
016-1154-00				1	HOOD ASSEMBLY:2KDSO	80009	016115400
016-1166-00				1	RACK MOUNT KIT:TAS SERIES	80009	016116600

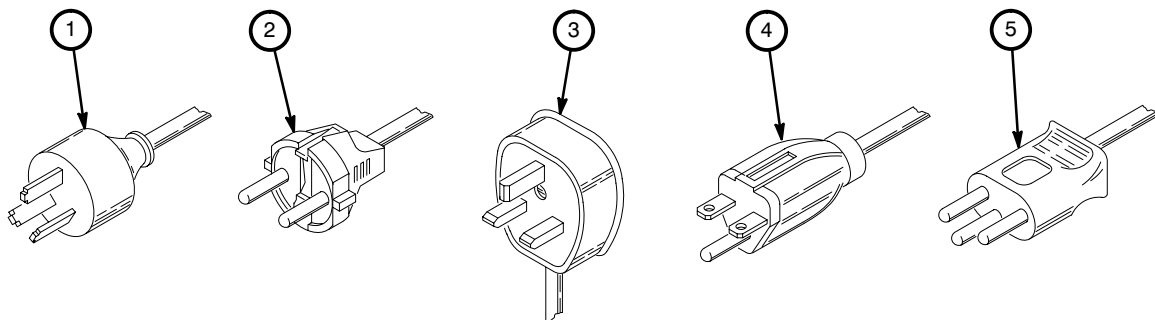


Figure 9-5: Accessories

Replaceable Parts

Component Number	Tektronix Part No.	Serial No.		Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont			
A1	671-2219-02	B010100	B010362	CIRCUIT BD ASSY:ANALOG (TAS455 ONLY)	80009	671221902
A1	671-2219-03	B010363	B010363	CIRCUIT BD ASSY:ANALOG (TAS455 ONLY)	80009	671221903
A1	671-2219-04	B010364	B011312	CIRCUIT BD ASSY:ANALOG (TAS455 ONLY)	80009	671221904
A1	671-2219-05	B011313	B011920	CIRCUIT BD ASSY:ANALOG (TAS455 ONLY)	80009	671221905
A1	671-2219-06	B011921	B012452	CIRCUIT BD ASSY:ANALOG (TAS455 ONLY)	80009	671221906
A1	671-2219-07	B012453		CIRCUIT BD ASSY:ANALOG (TAS455 ONLY)	80009	671221907
A1	671-2219-02	B010100	B010348	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221902
A1	671-2219-03	B010349	B010349	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221903
A1	671-2219-04	B010350	B011151	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221904
A1	671-2219-05	B011152	B011803	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221905
A1	671-2219-06	B011804	B011959	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221906
A1	671-2219-07	B011960	B012541	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221907
A1	671-2219-08	B012542	B013596	CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221908
A1	671-2219-09	B013597		CIRCUIT BD ASSY:ANALOG (TAS465 ONLY)	80009	671221909
A2	671-2222-00	B010100	B010540	CIRCUIT BD ASSY:DISPLAY CONTROL (TAS455 ONLY)	80009	671222200
A2	671-2222-01	B010541		CIRCUIT BD ASSY:DISPLAY CONTROL (TAS455 ONLY)	80009	671222201
A2	671-2222-00	B010100	B010515	CIRCUIT BD ASSY:DISPLAY CONTROL (TAS465 ONLY)	80009	671222200
A2	671-2222-01	B010516		CIRCUIT BD ASSY:DISPLAY CONTROL (TAS465 ONLY)	80009	671222201

Replaceable Parts

Component Number	Tektronix Part No.	Serial No.		Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont			
A3	671-2540-01	B010100	B010274	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS455 ONLY)	80009	671254001
A3	671-2540-02	B010275	B011567	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS455 ONLY)	80009	671254002
A3	671-2540-03	B011568	B011920	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS455 ONLY)	80009	671254003
A3	671-2540-04	B011921		CIRCUIT BD ASSY:DISPLAY DRIVER (TAS455 ONLY)	80009	671254004
A3	671-2540-05			CIRCUIT BD ASSY:DISPLAY DRIVER (TAS455 ONLY)	80009	671254005
A3	671-2223-01	B010100	B010260	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS465 ONLY)	80009	671222301
A3	671-2223-02	B010261	B011393	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS465 ONLY)	80009	671222302
A3	671-2223-03	B011394	B011803	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS465 ONLY)	80009	671222303
A3	671-2904-01	B011804	B012561	CIRCUIT BD ASSY:DISPLAY DRIVER (TAS465 ONLY)	80009	671290401
A3	671-2904-02	B012562		CIRCUIT BD ASSY:DISPLAY DRIVER (TAS465 ONLY)	80009	671290402
A5	671-2221-00	B010100	B010687	CIRCUIT BD ASSY:CPU (TAS455 ONLY)	80009	671222100
A5	671-2221-01	B010688	B011482	CIRCUIT BD ASSY:CPU (TAS455 ONLY)	80009	671222101
A5	671-2221-02	B011483	B011862	CIRCUIT BD ASSY:CPU (TAS455 ONLY)	80009	671222102
A5	671-2221-03	B011863		CIRCUIT BD ASSY:CPU (TAS455 ONLY)	80009	671222103
A5	671-2221-00	B010100	B010588	CIRCUIT BD ASSY:CPU (TAS465 ONLY)	80009	671222100
A5	671-2221-01	B010589	B011336	CIRCUIT BD ASSY:CPU (TAS465 ONLY)	80009	671222101
A5	671-2221-02	B011337	B011621	CIRCUIT BD ASSY:CPU (TAS465 ONLY)	80009	671222102
A5	671-2221-03	B011622	B013240	CIRCUIT BD ASSY:CPU (TAS465 ONLY)	80009	671222103
A5	671-2221-04	B013241		CIRCUIT BD ASSY:CPU (TAS465 ONLY)	80009	671222104
A9	259-0091-00			FLEX CIRCUIT:BEZEL	80009	259009100
A62	672-1362-00			CIRCUIT BD ASSY:FRONT PANEL MODULE (TAS455 ONLY)	80009	672136200
A62	672-1362-00	B010100	B012835	CIRCUIT BD ASSY:FRONT PANEL MODULE	80009	672136200
A62	672-1362-01	B012836		(TAS465 ONLY)	80009	672136201

Replaceable Parts

Component Number	Tektronix Part No.	Serial No.		Name & Description	Mfr. Code	Mfr. Part No.
		Effective	Dscont			
A63	119-5024-00	B010100	B020099	POWER SUPPLY:LOW POWER VERSION (TAS455 & TAS465)	TK6056	119-5024-00
A63	119-5033-00	B020100	B020966	POWER SUPPLY:HIGH POWER VERSION (TAS465 ONLY)	80009	119503300
A63	119-5033-01	B020967		POWER SUPPLY:HIGH POWER VERSION (TAS465 ONLY)	80009	119503301
A64	154-0905-01			ELECTRON TUBE:CRT	80009	154090501
CHASSIS PARTS						
A3W66	174-2602-00			CA ASSY,SP:FLAT FLEX,;FLX,23,26 AWG,6.5 L	TK2469	174-2602-00
B90	119-1770-04			FAN,DC:TUBEAXIAL;12V,1.72W,35CFM,W/CONN	S4246	CUDC12D4
DL68	119-5023-00			DELAY LINE,ELEC:VERTICAL	TK2469	119-5023-00
J21	174-3005-00			CA ASSY RF:DISCRETE,;SDI/RFD,22 AWG,8.625 L (WITH P66)	0J7N9	ORDER BY DESC
P30	174-2598-00			CA ASSY,SP:FLAT FLEX,;FLX,16,26 AWG,13.7 L (FRONT PANEL/CPU)	80009	174259800
P50	174-2600-00			CA ASSY,SP:RIBBON,;IDC,40,28 AWG,3.5 L,2X20 (CPU/ANALOG)	80009	174260000
P74	196-3374-00			LEAD,ELECTRICAL:DISCRETE,;SDI/IDC,2,22 AWG (VERTICAL, QTY 2) TAS455 ONLY	0J7N9	196-3374-00
P74	196-3374-00	B010100	B013240	LEAD,ELECTRICAL:DISCRETE,;SDI/IDC,2,22 AWG (VERTICAL, QTY 2) TAS465 ONLY	0J7N9	196-3374-00
P74	196-3374-01	B013241			0J7N9	196-3374-01
P75	196-3375-00			LEAD,ELECTRICAL:DISCRETE,;SDI/IDC,2,22 AWG (HORIZ DEFL LEAD, QTY 2)TAS455 ONLY	0J7N9	196-3375-00
P75	196-3375-00	B010100	B011992	LEAD,ELECTRICAL:DISCRETE,;SDI/IDC,2,22 AWG (HORIZ DEFL LEAD, QTY 2) TAS465 ONLY	0J7N9	196-3375-00
P75	196-3375-01	B011993			0J7N9	196-3375-01
P76	198-5790-01			CA ASSY,SP:DISCRETE,;SDI,9,24 AWG,6.5 L	0J7N9	198-5790-01
P80	174-2601-00			CA ASSY,SP:FLAT FLEX,;FLX,2,26 AWG,7.65 L (DC/DD)	80009	174260100
P84	174-2284-00			CA ASSY,SP:FLAT FLEX,;FLX,5,26 AWG,8.7 L (DC/FP)	80009	174228400

Appendices

Appendix A: Detailed Menu Descriptions

This section contains detailed information of the TAS 455 and TAS 465 Oscilloscopes menu functions.

Vertical System Menus

The **VERTICAL MENU** button displays the menu items for either channel 1 or channel 2 vertical operating system. The menu displayed is dependent on the channel select buttons. Each menu and its choices are discussed here.

- **CPLG** — Selects the method to couple input signals to the attenuators of the selected input channel.
 - **DC** — DC coupling passes all components of the signal to the input channel. The D_C indicator appears to the right of the associated volts/div readout.
 - **AC** — AC coupling blocks the DC component of the input signal. The A_C indicator appears to the right of the associated volts/div readout.
 - **GND** — Disconnects the input signal and grounds the input of the associated vertical attenuator to provide a zero (ground) reference voltage display; it does not ground the front panel input connector. The \downarrow indicator appears to the right of the associated volts/div readout.

- **VAR** — When on, the **VOLTS/DIV** control operates in an uncalibrated or variable mode and the > symbol appears to the left of the readout.

Variable gain increases the vertical deflection of the selected channel by a factor of at least 2.5 times. Use the General Purpose Knob to change the gain by a factor of up to 2.5 times the current volts/div scale.

- **INV** — When on, the instrument inverts the channel input signal and the \downarrow indicator appears to the right of the channel indicator.
- **BW** — Provides a selection to enable the full bandwidth of the vertical and trigger systems or limit them.
 - **20 MHz** — Selecting **20 MHz** limits the bandwidth of the vertical deflection system and trigger system to 20 MHz. The B_W indicator appears in the readout when the bandwidth limit is in effect.
 - **Full** — Selecting **Full** enables the entire bandwidth of the oscilloscope.

ALT/CHOP, ADD — Pressing the **ALT/CHOP ADD** button displays the menu choices for display modes and math operations.

- **ADD** — When on, the instrument displays a third signal that is the sum of the channel 1 and channel 2 input signals. The + indicator appears when add mode is on.
- **DISP** — The display selection allows you to choose how to display multiple channels.
 - **Alt** — When in alternate mode, the instrument displays the selected channels in sequence (alternating at the end of each sweep).
 - **Chop** — When in chop mode, the display chops between selected input channels at a rate of about 550 kHz.

Horizontal System Menus

The **HORIZONTAL MENU** button displays the following menu choices for the horizontal operating system.

- **MAIN** — Selects the main sweep horizontal deflection mode. The **SEC/DIV** control determines the sweep speed scale, which appears on the CRT readout. The main sweep can be displayed exclusively or with delay.
- **DELAY** — Selects the delayed sweep horizontal deflection mode. The **SEC/DIV** control determines the delayed sweep speed scale, which appears on the CRT readout. The delayed sweep can be displayed exclusively or with main.

In **Runs After** mode, the start of the delayed sweep (or the arming of the delayed trigger in any trigger mode) is delayed by the time you set with the General Purpose Knob. The delayed sec/div scale and the delay time position setting appear in the CRT readout. The > indicator appears in front of the delay time position readout if the delayed trigger mode is not **Runs After**.

- **XY** — Selects XY mode. The **CH 1** input signal produces the horizontal (X-axis) deflection. The **CH 2** or the added channel are sources for providing the vertical (Y-axis) deflection.

Use the channel 1 **POSITION** control to horizontally position an XY display. Use the channel 2 **POSITION** control for vertical positioning.

- **VAR** — When on, the **SEC/DIV** control is uncalibrated and provides variable, uncalibrated sweep speeds to at least 2.5 times slower than the calibrated sec/div scales. Use the General Purpose Knob to change the variable sweep speeds.

The > indicator appears to the left of the sec/div readout to show that the horizontal scale is uncalibrated.

- **TRCSEP** — Trace separation assigns the General Purpose Knob to adjust the vertical separation between the main and delayed sweeps.

Trigger System Menus

The **TRIGGER MENU** button displays menu choices for the trigger operating system. This section discusses each menu and its choices. Menus for either the main or delayed sweeps are dependent on the selection of the **MAIN/DELAY SELECT** button.

Main Trigger Menu

- **MODE** — Selects the type of trigger used to initiate a sweep.
 - **Auto** — The main sweep will trigger when you set the trigger level within the peak-to-peak limits of an adequate trigger signal. The main sweep will free-run if the trigger is lost, such as if the signal amplitude is too low or the frequency is less than 10 Hz.
 - **Auto Level** — Automatically sets the trigger level to midtrace.

If the instrument loses the trigger, it will reset the auto-level range. The main sweep will free-run if the trigger is lost, such as if the signal amplitude is too low or the frequency is less than 10 Hz.
 - **Normal** — The main sweep will trigger when you set the trigger level within the peak-to-peak limits of an adequate trigger signal. The main sweep will not run if there is no adequate trigger signal.
 - **Single Sequence** — Single sequence sets the main sweep to complete one sweep when the instrument receives an adequate trigger. Once triggered, the **MAIN SWP TRIG'D** indicator lights and remains lit until the instrument completes all displays. Pressing the **RESET S SEQ** button arms the main sweep, lights the **READY** indicator, and the trigger circuit waits for the next trigger signal.

You can set the readout and cursors to turn on briefly at the start of the sequence (useful when using a camera), or remain on by changing the instrument configuration from the **UTILITY** menu (see page A-7).
 - **Video Line** — The main sweep triggers at the beginning of each horizontal sync pulse (every line) of a composite video signal. The **SLOPE** polarity must match the **Video Sync Polarity** (see page A-7) to obtain video line triggering. Inverted video uses positive trigger slope. Normal video uses negative trigger slope.

- **Video Field** — The main sweep triggers at the beginning of each vertical sync pulse (every field) of a composite video signal. The **SLOPE** polarity must match the **Video Sync Polarity** (see page A-7) to obtain video field triggering.
 - **odd** — The main sweep triggers at the beginning of the vertical sync pulse of field one in a standard interlaced video signal.
 - **even** — The main sweep triggers at the beginning of the vertical sync pulse of field two in a standard interlaced video signal.
 - **both** — The main sweep triggers at the beginning of the vertical sync pulse of either field one or field two in a standard interlaced video signal.
- **SRC** — Selects the source of the trigger signal to initiate the main sweep.
 - **Priority Vert** — The instrument obtains the trigger signal from the highest priority active channel. See Table A-1 to determine the trigger source.
 - **Ch1** — The signal applied to the **CH 1** input connector is the source of the trigger signal.
 - **Ch2** — The signal applied to the **CH 2** input connector is the source of the trigger signal.
 - **Add** — The instrument obtains the trigger signal from the signal created when adding input channels together.
 - **Line** — The instrument obtains the triggering signal from the AC power source.
 - **Ext 1 10** — The instrument obtains the trigger signal the signal applied to the **EXT TRIG** input connector. Selecting **10** attenuates the signal by a factor of 10. Selecting **1** provides no signal attenuation.

Table A-1: Selected Trigger Source When in Priority Vert

Channel Conditions			Selected Trigger Source
CH 1	CH 2	Add	
On	On	Off	Channel 1
On	Off	Off	Channel 1
Off	On	Off	Channel 2
On	On	On	Channel 1
Off	On	On	Channel 2
Off	Off	On	Add

- **CPLG** — Coupling selects the components of the trigger signal applied to the trigger circuitry.
 - **DC** — Couples DC and all frequency components of a triggering signal to the trigger circuitry.
 - **Noise Reject** — Noise reject couples all frequency components of the trigger signal to the trigger circuitry but increases the peak-to-peak signal amplitude required to trigger the sweep.
 - **HF Reject** — High frequency reject attenuates the frequency components of the trigger signal that are above 50 kHz, reducing high-frequency interference.
 - **AC** — Blocks the DC component of the trigger signal and attenuates trigger signal frequency components below 160 Hz.
 - **LF Reject** — Low frequency reject blocks the DC component of the trigger signal and attenuates the frequency components of the trigger signal that are below 50 kHz, reducing low-frequency interference.
- **SLOPE** — Selects the slope of the trigger source signal that triggers the sweep.
 - **Rising** — The rising edge (positive going) of the input signal triggers the sweep.
 - **Falling** — The falling edge (negative going) of the input signal triggers the sweep.
- **HOLDOFF** — When on, holdoff adds additional time between the end of the sweep and the arming of the trigger circuit. The holdoff time is adjustable from a preset minimum value to 10 times the minimum value. The General Purpose Knob adjusts the holdoff time.

Delayed Trigger Menu

- **MODE** — Selects the operating mode of the delayed trigger system.
 - **Runs After** — Starts the delayed sweep immediately after the delay time requirement is satisfied, selected by the General Purpose Knob.
 - **Trig After** — The delayed sweep triggers when the instrument receives an adequate trigger signal after the delay time condition has been met. When there is no trigger signal, there is no delayed sweep trace.
 - **Video Line (from main trigger)** — Starts the delayed sweep at the beginning of a video signal line received after the delay time condition has been met.

Slope polarity defaults to the main trigger slope. The slope polarity must match the **Video Sync Polarity** (see page A-7) to obtain correct triggering on the horizontal sync pulse.

- **SRC** — Selects the source of the trigger signal to initiate the delayed sweep.
 - **Ch1** — The signal applied to the **CH 1** input connector is the source of the trigger signal.
 - **Ch2** — The signal applied to the **CH 2** input connector is the source of the trigger signal.
 - **Add** — The trigger signal is the signal created when adding input channels together.
 - **Line** — The triggering signal is the AC power source.
- **CPLG** — Coupling selects the components of the trigger signal applied to the trigger circuitry.
 - **DC** — Couples DC and all frequency components of a triggering signal to the trigger circuitry.
 - **Noise Reject** — Noise reject couples all frequency components of the trigger signal to the trigger circuitry but increases the peak-to-peak signal amplitude required to trigger the sweep.
 - **HF Reject** — High frequency reject attenuates the high-frequency components of the trigger signal that are above 50 kHz, reducing high-frequency interference.
 - **AC** — Blocks the DC component of the trigger signal and attenuates trigger signal frequency components below 160 Hz.
 - **LF Reject** — Low frequency reject blocks the DC component of the trigger signal and attenuates the low-frequency components of the trigger signal that are below 50 kHz, reducing low-frequency interference.
- **SLOPE** — Selects the slope of the trigger source signal that triggers the sweep.
 - **Rising** — The sweep triggers on the rising (positive going) edge of the input signal.
 - **Falling** — The sweep triggers on the falling (negative going) edge of the input signal.

Cursor Menus

The **CURSOR** button displays the cursors on the waveform. Use the General Purpose Knob to move the cursors. The **TOGGLE** button switches cursor control from active cursor to inactive.

- **ΔVOLTS** — Displays the delta voltage (difference) between the two horizontal cursors.
- **ABS V** — Displays the absolute voltage level of the horizontal cursor (referenced to ground).

- **Δ TIME** — Displays the delta time (measured in seconds) between the two vertical cursors.
- **$1/\Delta T$** — Displays the frequency (measured in Hertz) between the two vertical cursors.

Save and Recall Menus

The **SAVE/RECALL SETUP** button displays menus that allow you to store four complete front-panel setups for later recall. You can select save and recall functions by pressing the menu-item select buttons. Setup locations are underlined on the CRT if they contain a stored setup.

- **RECALL** — Pressing the **RECALL** menu button recalls the front-panel settings previously saved in one of the four memory locations.
 - **1 through 4** — These are the memory locations to retrieve a front-panel setting.
- **SAVE** — Pressing the **SAVE** menu button will save the front-panel setup to one of four memory locations.
 - **1 through 4** — These are the memory locations to save a front-panel setting.
- **ERASE** — Pressing the **ERASE** menu button will erase the memory of one of the four memory locations.
 - **1 through 4** — These are the memory locations that can be erased.

Utility Menus

The **UTILITY** button displays menus used to configure certain aspects of the oscilloscope operating system and perform calibration routines.

- **CONFIG** — Use the configuration menu to define operating conditions seldom changed once set.
 - **Intensity Delay = Main** — Both the main and the delayed sweeps have the same intensity level.
 - **Intensity Delay > Main** — The intensity of the delayed sweep is greater than that of the main sweep.
 - **Intensity Delay >> Main** — The intensity of the delayed sweep is much greater than that of the main sweep.
 - **Video Sync Positive** — When using a video trigger mode, the trigger system triggers on the positive slope of the video signal (horizontal sync pulses on the top of the video signal).
 - **Video Sync Negative** — When using a video trigger mode, the trigger system triggers on the negative slope of the video signal (horizontal sync pulses on the bottom of the video signal).
 - **Video Sync = Main Trigger Slope** — Sets the slope of the trigger source for video signals to match the main trigger slope selection.

- **Dual Delay Disabled** — Provides one intensified delayed event.
- **Dual Delay Enabled** — Provides two intensified delayed events when time measurement cursors are on and both the main and delayed sweeps are on.
- **SSeq Readout Continuous** — The readout remains on when the trigger mode is set to single sequence.
- **SSeq Readout Flash** — The readout is flashed on at the end of the display sequence when the trigger mode is set to single sequence.
- **CAL** — This selection displays calibration routines.
 - **Horizontal Sweep Path** — Initiates the temperature compensation calibration procedure for the horizontal system.
 - **Vertical Signal Path** — Initiates the temperature compensation calibration procedure for the vertical system.
 - **Factory Horizontal Cal** — Initiates the horizontal calibration procedure.
 - **Factory Vertical Cal** — Initiates the vertical calibration procedure.
- **ID** — Displays the software version on-screen.

Appendix B: Autoset Control Settings

Using the Autoset Feature

The **AUTOSET** feature of the TAS 455 and TAS 465 Oscilloscopes automatically sets most of the front panel controls. Table A-2 lists the instrument control settings obtained when using **AUTOSET**.

Table A-2: Control Setup Action During Autoset

Front Panel Control		AUTOSET Action
Horizontal	Magnification	X1.
	Position	Midrange.
	Main Sweep	On.
	Delay Sweep	Off.
	XY	Off.
	Main Sec/Div Scale ¹	At least one complete cycle of the signal is displayed (no slower than 20 ms/div).
	Variable	Off.
Trigger	Main Mode	Auto Level.
	Main Source	Priority Vert.
	Main Coupling	Noise Reject if the volts/div scale is set to 2 mV or 5 mV, otherwise DC.
	Main Level	Midway between the peaks of the signal.
	Holdoff	Off (min).
Vertical	Bandwidth	Full.
	Add	Off.
	Display Mode	Chop if the main sec/div scale is 0.1 ms/div or slower; alternate if 50 μ s/div or faster.
	Invert	Off.
	Position (both channels displayed) ²	
	CH 1	If selected, the ground level is aligned with third graticule line (± 0.2 div) from the top; otherwise no action.
CH 2	If selected, the ground level is aligned with seventh graticule line (± 0.2 div) from the top; otherwise no action.	

Table A-2: Control Setup Action During Autosegment (Cont.)

Front Panel Control	AUTOSET Action	
Position (single channel displayed) ²	CH 1 or CH 2	The ground level is aligned with the center horizontal graticule line.
	Volts/Div Scale (displayed channels)	The lowest value for which all waveform values are within approximately ± 2 divisions of ground.
Coupling (displayed channels)	DC, if coupling set to GND or DC; otherwise AC.	
Variable Mode	Off.	
Other	Menu Selection	Menus are turned off.
	Intensity	40% of maximum intensity if current intensity is less than 28% from the counter clockwise stop; otherwise as adjusted by user.

¹ Uncertain settings may occur when using AUTOSET on signals with periods of less than 20 ms (50Hz).

² Uncertain settings may occur when using AUTOSET on signals with large DC offsets relative to the pk-to-pk voltage when vertical coupling is set to DC.

Glossary

Glossary

AC coupling

A type of signal transmission that blocks the DC component of a signal but uses the dynamic (AC) component. Useful for observing an AC signal that is normally riding on a DC signal.

Accuracy

The closeness of the indicated value to the true value.

Active cursor

The cursor that moves when you turn the General Purpose Knob. It is represented in the display by a solid line.

Amplitude

The high waveform value less the low waveform value.

Area

Measurement of the waveform area taken over the entire waveform or the gated region. Expressed in volt-seconds. Area above ground is positive; area below ground is negative.

Attenuation

The degree the amplitude of a signal is reduced when it passes through an attenuating device such as a probe or attenuator. That is, the ratio of the input measure to the output measure. For example, a 10X probe will attenuate, or reduce, the input voltage of a signal by a factor of 10.

Automatic trigger mode

A trigger mode that causes the oscilloscope to automatically display a sweep if triggerable events are not detected within a specified time period.

Autoset

A function of the oscilloscope that automatically produces a stable waveform of usable size. Autoset sets up front-panel controls based on the characteristics of the active waveform.

Bandwidth

The highest frequency signal the oscilloscope can accurately display with no more than -3 dB ($\times .707$) attenuation of the original (reference) signal.

Channel

An input used for coupling signals to oscilloscope.

Coupling

The association of two or more circuits or systems in such a way that power or information can be transferred from one to the other. You can couple the input signal to the trigger and vertical systems several different ways.

Cursors

Paired markers that you can use to make measurements between two waveform locations. The oscilloscope displays the values (expressed in volts or time) of the position of the active cursor and the distance between the two cursors.

Cycle area

A measurement of waveform area taken over one cycle. Expressed in volt-seconds. Area above ground is positive; area below ground is negative.

Cycle RMS

The true root mean square voltage over one cycle.

DC coupling

A mode that passes both AC and DC signal components to the circuit. Available for both the trigger system and the vertical system.

Delay measurement

A measurement of the time between the middle reference crossings of two different waveforms.

Delay time

The time between the trigger event and the display of data.

Display system

The part of the oscilloscope that shows waveforms, measurements, menu items, status, and other parameters.

Edge Trigger

Triggering occurs when the oscilloscope detects the source passing through a specified voltage level in a specified direction (the trigger slope).

Fall time

A measurement of the time it takes for trailing edge of a pulse to fall from a high-ref value (typically 90%) to a low-ref value (typically 10%) of its amplitude.

Frequency

A timing measurement that is the reciprocal of the period. Measured in Hertz (Hz) where 1 Hz = 1 cycle per second.

General purpose knob

A front-panel knob used for multiple tasks such as cursor placement or changing the value of the assigned parameter.

Graticule

A grid on the display screen that creates the horizontal and vertical axes. You can use it to visually measure waveform parameters.

Ground (GND) coupling

Coupling option that disconnects the input signal from the vertical system.

Holdoff, trigger

A specified amount of time after a trigger signal that elapses before the trigger circuit will accept another trigger signal to help ensure a stable display.

Horizontal bar cursors

The two horizontal bars that you position to measure the voltage parameters of a waveform. The oscilloscope displays the value of the active (moveable) cursor with respect to ground and the voltage value between the bars.

Intensity

Display brightness.

Main menu

A group of related controls for a major oscilloscope function that the oscilloscope displays across the bottom of the screen.

Main menu buttons

Bezel buttons under the main menu display. They allow you to select items in the main menu.

Maximum

Amplitude (voltage) measurement of the maximum amplitude. Typically the most positive peak voltage.

Mean

Amplitude (voltage) measurement of the arithmetic mean over the entire waveform.

Minimum

Amplitude (voltage) measurement of the minimum amplitude. Typically the most negative peak voltage.

Negative duty cycle

A timing measurement representing the ratio of the negative pulse width to the signal period, expressed as a percentage.

Normal trigger mode

A mode on which the oscilloscope does not display a waveform unless a valid trigger event occurs.

Oscilloscope

An instrument for making a graph of two factors. These are typically voltage versus time.

Peak-to-Peak

Amplitude (voltage) measurement of the absolute difference between the maximum and minimum amplitude.

Period

A timing measurement of the time covered by one complete signal cycle. It is the reciprocal of frequency and is measured in seconds.

Phase

A timing measurement between two waveforms of the amount one leads or lags the other in time. Phase is expressed in degrees, where 360° comprise one complete cycle of one of the waveforms. Waveforms measured should be of the same frequency or one waveform should be a harmonic of the other.

Positive duty cycle

A timing measurement of the ratio of the positive pulse width to the signal period, expressed as a percentage.

Positive width

A timing measurement of the distance (time) between two amplitude points — rising-edge and falling-edge on a positive pulse.

Probe

An oscilloscope input device.

Probe compensation

Adjustment that improves low-frequency response of a probe.

Reference memory

Memory in an oscilloscope used to store settings. The data is saved even when the oscilloscope is turned off or unplugged.

Rise time

The time it takes for a leading edge of a pulse to rise from the minimum value (typically 10%) to the maximum value (typically 90%) of its amplitude.

RMS

Amplitude (voltage) measurement of the true root mean square voltage.

Selected waveform

The waveform on which all measurements are performed, and which is affected by vertical position and scale adjustments. The light next to one of the channel selector buttons indicates the current selected waveform.

Side menu

Menu that appears to the right of the display. These selections expand on main menu selections.

Side menu buttons

Bezel buttons to the right of the side menu display. They allow you to select items in the side menu.

Slope

The direction at a point on a waveform. You can calculate the direction by computing the sign of the ratio of change in the vertical quantity (Y) to the change in the horizontal quantity. The two values are rising and falling.

Sweep speed

See time base.

Time base

The parameters that let you define the timing of the sweep, expressed as seconds per division.

Toggle button

A button that changes which of two displayed cursors is active.

Trigger

An event that marks time zero in the waveform record. It results in acquisition and display of the waveform.

Trigger level

The vertical level the trigger signal must cross to generate a trigger.

Vertical bar cursors

The two vertical bars you position to measure the time parameter of a waveform record. The oscilloscope displays the value of the active (moveable) cursor with respect to trigger and the time value between the bars.

Waveform

The shape or form (visible representation) of a signal.

XY format

A display format that compares the voltage level of two waveforms. It is useful for studying phase relationships between two waveforms.

YT format

The conventional oscilloscope display format. It shows the voltage of a waveform (on the vertical axis) as it varies over time (on the horizontal axis).

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