


11301 and 11302 Programmable Oscilloscopes

INSTRUMENT SERIAL NUMBERS

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

B000000	Tektronix, Inc. Beaverton, Oregon, USA
100000	Tektronix Guernsey, Ltd., Channel Islands
200000	Tektronix United Kingdom, Ltd., London
300000	Sony/Tektronix, Japan
700000	Tektronix Holland, NV, Heerenveen, The Netherlands

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GPIB-PC is a trademark of National Instruments Corporation.
Centronics® is a registered trademark of Data Computer Corporation.

Key to Manuals

Operating Manuals

These manuals are provided with your instrument:

**INTRODUCING
the
11301 and 11302**

**11301
and
11302
USER'S
REFERENCE**

**11301
and
11302
INCOMING
INSPECTION**

**11301 and 11302
POCKET
REFERENCE**

Service Reference Manual

The service reference manual is an optional accessory. To order, use the service reference manual request card in the front of this manual.

**11301
SERVICE
REFERENCE**

**11302
SERVICE
REFERENCE**

Note:

For further information, refer to Instrument Documentation on the next page.

6106-001a

How to Use This Manual

The Table of Contents lists all headings to the third order head; that is, to the third level of importance. Each first order head is listed in order of use. The headings thereafter are listed alphabetically. This is done to facilitate finding material once you are in the midst of the text. For instance, if you were in Section 2, Operating Information, and in the "Waveform Acquisition" subsection reading Vertical Menu information, you would know that material relating to the Horizontal Menu is more towards the front of the manual. Horizontal comes alphabetically before Vertical.

To help you quickly retrieve information, bleed-tabs separate all information pertaining to a first order head. At the beginning of each new bleed-tab position is a brief contents of that subsection.

Some sections, like Section 4 where logical order of use isn't a primary concern, are alphabetized in their entirety. Section 3, "GPIB and RS-232-C Interfaces" has only the command set alphabetized.

Reference Aids

To quickly locate information, use the following reference aids:

- The Table of Contents at the beginning of this manual lists subjects covered in the six sections and two appendixes.
- The Table of Contents at the beginning of each section lists the subjects in more detail than covered in the main Table of Contents at the front of the manual.
- The Index is a quick way to find information when you don't know which section discusses it. All screen-displayed nomenclature can be identified by its medium or bold print.
- "Errors, Warnings, and Messages" explain meanings of various messages displayed on the screen and where to find more specific detail.
- Appendixes provide summaries of useful information, as follows:

Appendix A—Glossary

Appendix B—Accessory List

Instrument Documentation

Three documents provide operating information about the 11301 and the 11302 Programmable Oscilloscopes.

- The 11301 and 11302 Programmable Oscilloscopes Pocket Reference is designed to give you quick recall of operation and syntax of functions you already know.
- Introducing the 11301 and 11302 Programmable Oscilloscopes presents the concepts and methods of operating the instrument. As a training aid, this manual helps a new user easily learn the conventions and concepts of the oscilloscope and its operation.
- The 11301 and 11302 Programmable Oscilloscopes User's Reference manual is the reference document for the user-operator. This manual contains installation, a procedure for incoming inspection, measurement instructions, interface commands, instrument specifications, and a list of instrument options.

The service reference manual for your instrument is available as an optional accessory. Refer to Appendix B, Accessory List, for further information. To order, use the service reference manual request card in the front of this manual.

The Incoming Inspection Procedure provides a functional checkout of the instrument. For a Performance Verification procedure, see the service reference manual.

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11A32 Two Channel Amplifier
11A34 Four Channel Amplifier
11A52 Two Channel Amplifier
11A71 Amplifier

Appendix A—Glossary

Appendix B—Accessory List

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Operators Safety Summary

The following general safety information applies to all operators and service personnel.

Terms

In Manuals

CAUTION statements identify conditions or practices that could result in damage to the equipment or other property.

WARNING statements identify conditions or practices that could result in personal injury or loss of life.

As Marked 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.

Symbols

In Manuals

 Static-Sensitive Devices

As Marked On Equipment

 **DANGER**—High voltage.

 Protective ground (earth) terminal.

 **ATTENTION**—refer to manual.

Warnings

Power Source

This product is intended to operate from a power source that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection, by way of the grounding conductor in the power cord, is essential for safe operation.

Grounding the Instrument

The 11301 and 11302 are grounded through the grounding conductor of 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, before making connections to the input or output terminals of the instrument. A protective-ground connection, by way of the grounding conductor in the mainframe power cord, is essential for safe operation.

Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating), can render an electric shock.

Use the Proper Fuse

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

Do Not Operate In Explosive Atmospheres

To avoid explosion, do not operate the instrument in an atmosphere of explosive gasses.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the protective covers. Do not operate this instrument without the panels or covers properly installed.

Introduction

The 11301 Programmable Oscilloscope is a 400 MHz Analog real-time oscilloscope mainframe. The oscilloscope provides for up to three 11000-Series plug-in units and features two built-in analog time bases. Extensive microprocessor facilities increase measurement accuracy and improve human interpretation of the measurement results.

The 11302 is basically the same as the 11301 except that the 11302 has a micro-channel plate crt for increased writing rate and a bandwidth of 500 MHz. (See Table of Contents, "11302 Differences.")

The bench model oscilloscope can be converted into a rackmount model using a rackmount kit. See Appendix B.

This manual contains complete operating instructions for both the 11301 and the 11302 Programmable Oscilloscopes. However, this manual is not intended to be a procedural guide for a novice, but a guide for those already familiar with oscilloscope fundamentals. In this manual you'll find installation instructions, functional operating information, IEEE STD 488 (GPIB) and RS-232-C Interface instructions and examples, instrument specification, and options. The novice should refer to the "Introducing the 11301 and 11302 Programmable Oscilloscopes" manual.

Oscilloscope System Architecture

This description is intended to aid more knowledgeable users in their desire to get the most out of the instrument.

The block diagram (Fig. 1) represents the basic oscilloscope architecture and depicts primary analog paths within the instrument. Not shown are the digital control paths, the processor and its buses, the remote interfaces RS-232-C and IEEE-488, and the various self-calibration pick-offs and sensors.

Although the "brain" of the instrument is the main processor, the "heart" of the measurement capability is the Counter/Timer. The Counter/Timer has access to every signal input into the oscilloscope. It also has a path to the display system to allow you to view the same signals from which the Counter/Timer is performing measurements. In essence, these signals represent the Counter's "view" of what surrounds it. Hence, the name "Counter View" display as found in the WAVEFORM major menu.

Measured Signals

Signals to be measured can originate from the external inputs labeled A and B or from the plug-in compartments. Allowing the signal to be first applied to and amplified by a plug-in extends the usefulness of the Counter/Timer. For example, high impedance sources can be examined by using a very low loading probe. Also, signals of irregular and aperiodic ac components with large dc components can be centered within the triggering range by using a Differential comparator. Such a plug-in can compensate for dc components of 10,000 times the magnitude of the ac component. This is not available with any conventional Counter/Timer.

The amplified signal from the plug-in can take two different paths. It can be viewed on the display, examined by the triggers, or both. It is important to realize that the signal to the triggers need not be from the same source as the signal being displayed. For example, a displayed trace originating from the LEFT compartment can be triggered by a signal from the CENTER compartment. Also, within any plug-in, one channel can be viewed while another channel, not displayed, can be used for triggering.

To define trigger sources for the Main and Delayed time bases, use the major menu called TRIGGER SOURCE. Trigger sources from the LEFT and CENTER plug-in compartments can be combined for a composite algebraic expression. The trigger signal from the RIGHT plug-in compartment cannot be combined with the others. However, composite expressions can be created within each plug-in.

The A and B External inputs are routed to the triggers circuits and directly to the Counter/Timer. The External Inputs can be used for triggering sweeps when selected through the TRIGGER SOURCE major menu. However, if the sweeps are to be triggered from one of the other sources, the A and B inputs can still be used by the Counter/Timer because it is completely independent of the Main and Delayed triggers.

Remember, the Counter/Timer measures triggers, not displayed traces.

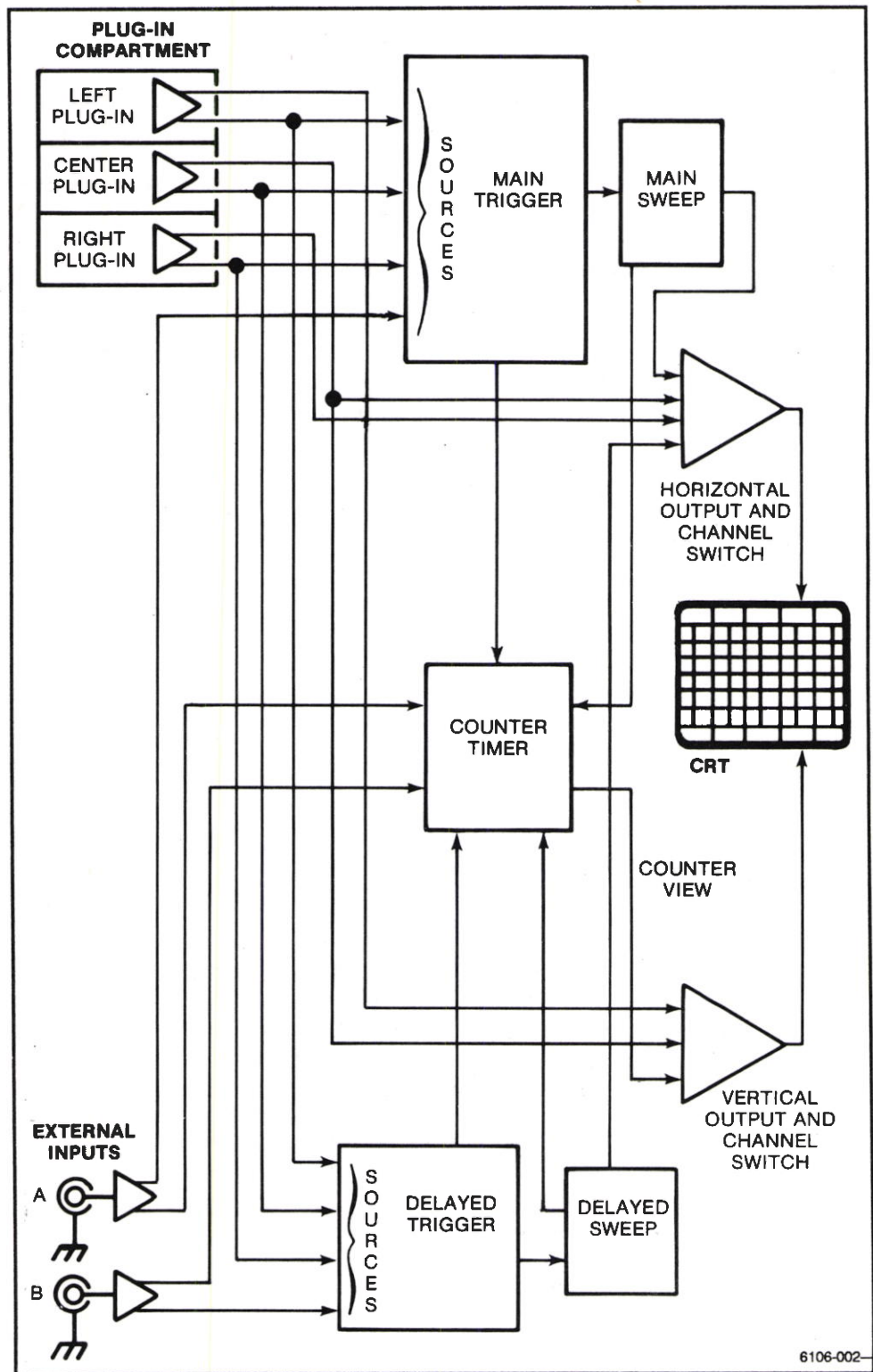


Figure 1. Simplified Block Diagram.

Triggering

In a conventional oscilloscope the triggering circuitry is used to provide a stable display of a desired signal. The triggers produce a processed signal which represents the detection of a signal transition having some prescribed level and direction (polarity). These, of course, are determined by the familiar controls of TRIGGER LEVEL and Slope. Beyond these, the oscilloscope offers three selections (high, medium, and low) of trigger Sensitivity to control the comparator. This greatly enhances the ability of the trigger to reject uncorrelated noise. Also, the trigger rate itself can be controlled through Holdoff.

The trigger circuit produces a series of high to low transitions. These are what the Counter/Timer is actually counting. Therefore, by adjusting the trigger level, sensitivity, and the slope, different characteristics of a signal can be measured.

Counter View Display

For the first time in a single instrument, a display of where and what the counter is actually counting can be obtained. Essentially a "counter's view" of the signal can be compared to the analog version of the signal to determine which features of the signal are being measured. This added display is indispensable as it allows you to adjust and control the measurement with greater precision and confidence.

Measurement Interval

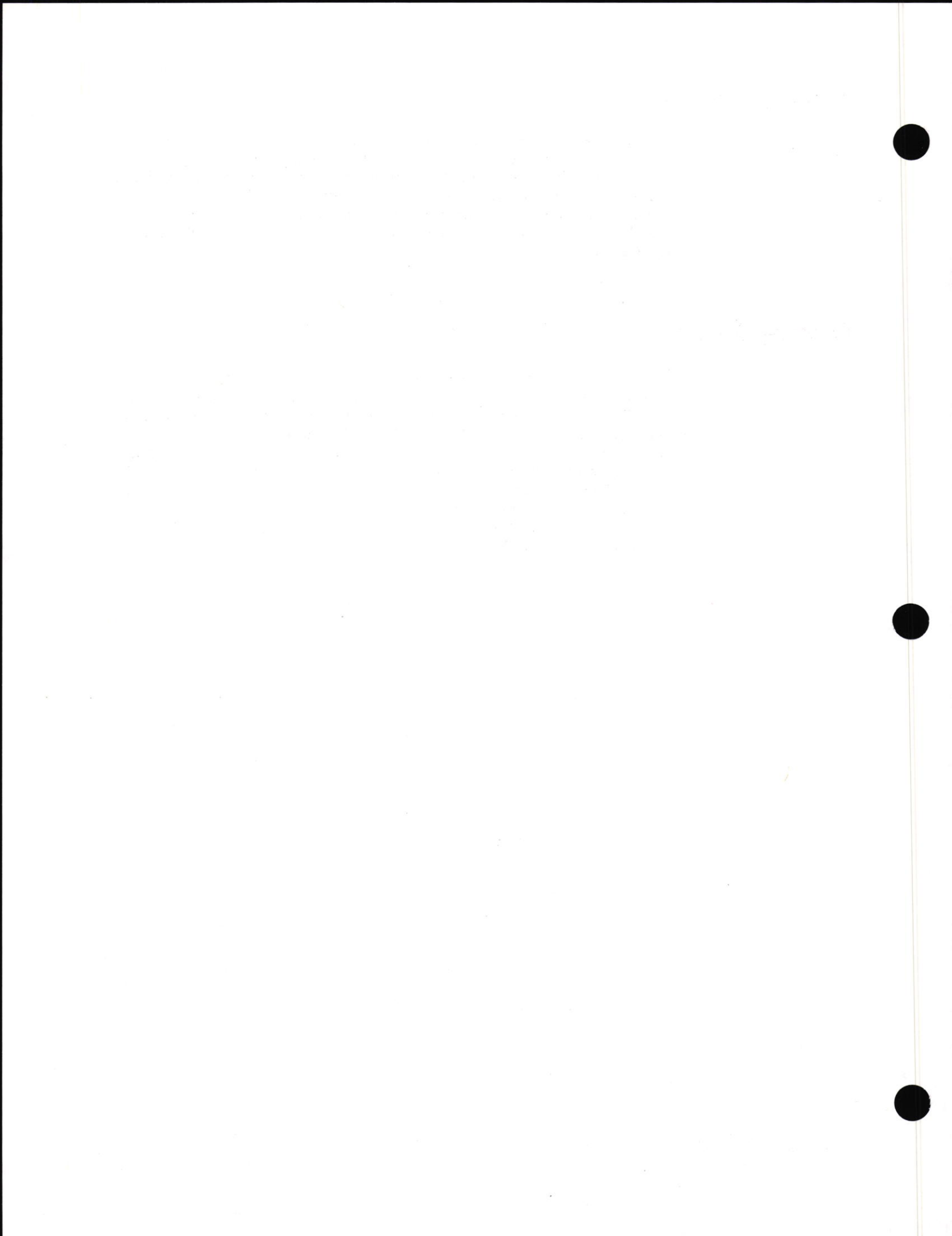
Triggering controls of LEVEL, Slope, and Sensitivity allow for discriminating in the vertical or amplitude dimension. In order to discriminate in the horizontal or time dimension, a signal from the Delayed Sweep generator can be used. This is referred to as Gating the Counter/Timer. By use of the Delay and Size controls, signal features can be excluded easily. Because the delayed sweep is time correlated to the triggers, it is especially convenient for gating. This means that the event which triggers the main sweep can be used to begin a delay period during which no measurements will be made. When the delay expires, measurements are allowed to commence. Measurements do not start immediately, however. They are permitted to start only if the trigger conditions are satisfied.

Of course, once permitted to start, the measurements must again be inhibited at the end of the gate interval. This length of time is determined by the delayed sweep time, approximately 10 times the Delayed Window Time/div setting.

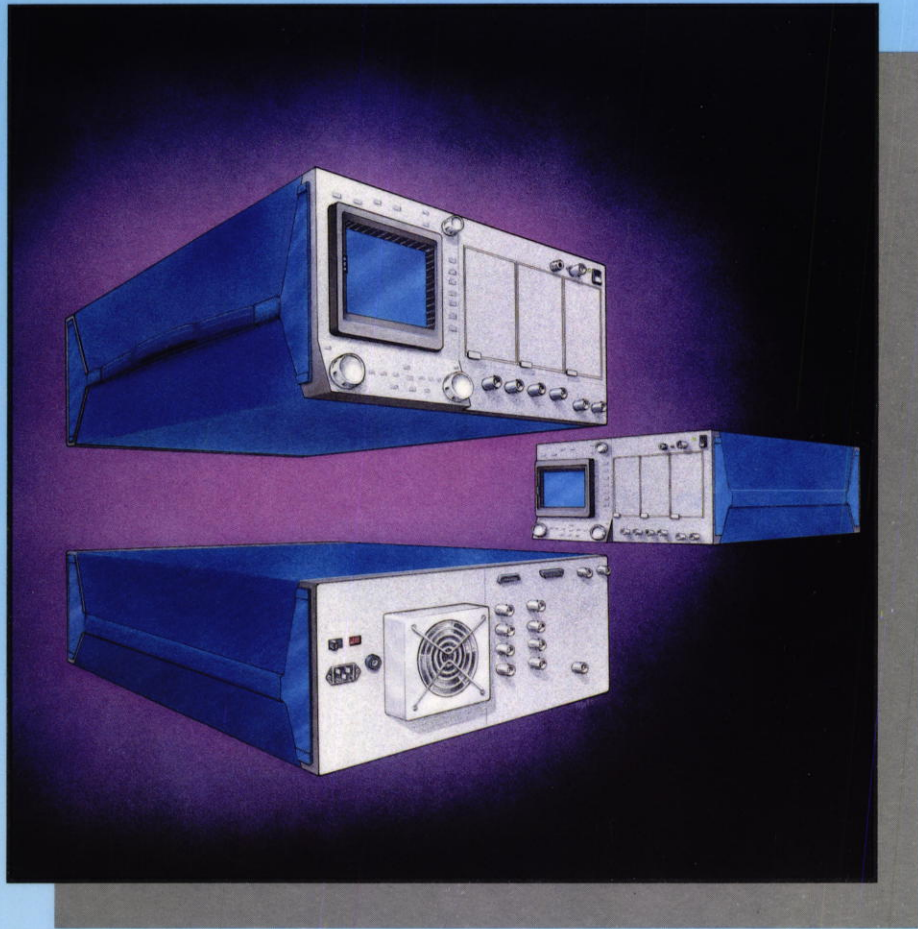
The External A and B inputs can also be used to gate a measurement. When both A and B inputs are used together to create a gate, the gate interval begins on the rising edge of the A input and the interval ends on the falling edge of the B input signal. The B input alone can be selected for gating. Here, the rising edge of B starts the interval and the falling edge of B stops the interval. Whenever both A and B inputs are used together to define the gate interval, these inputs cannot be used as measurement sources.

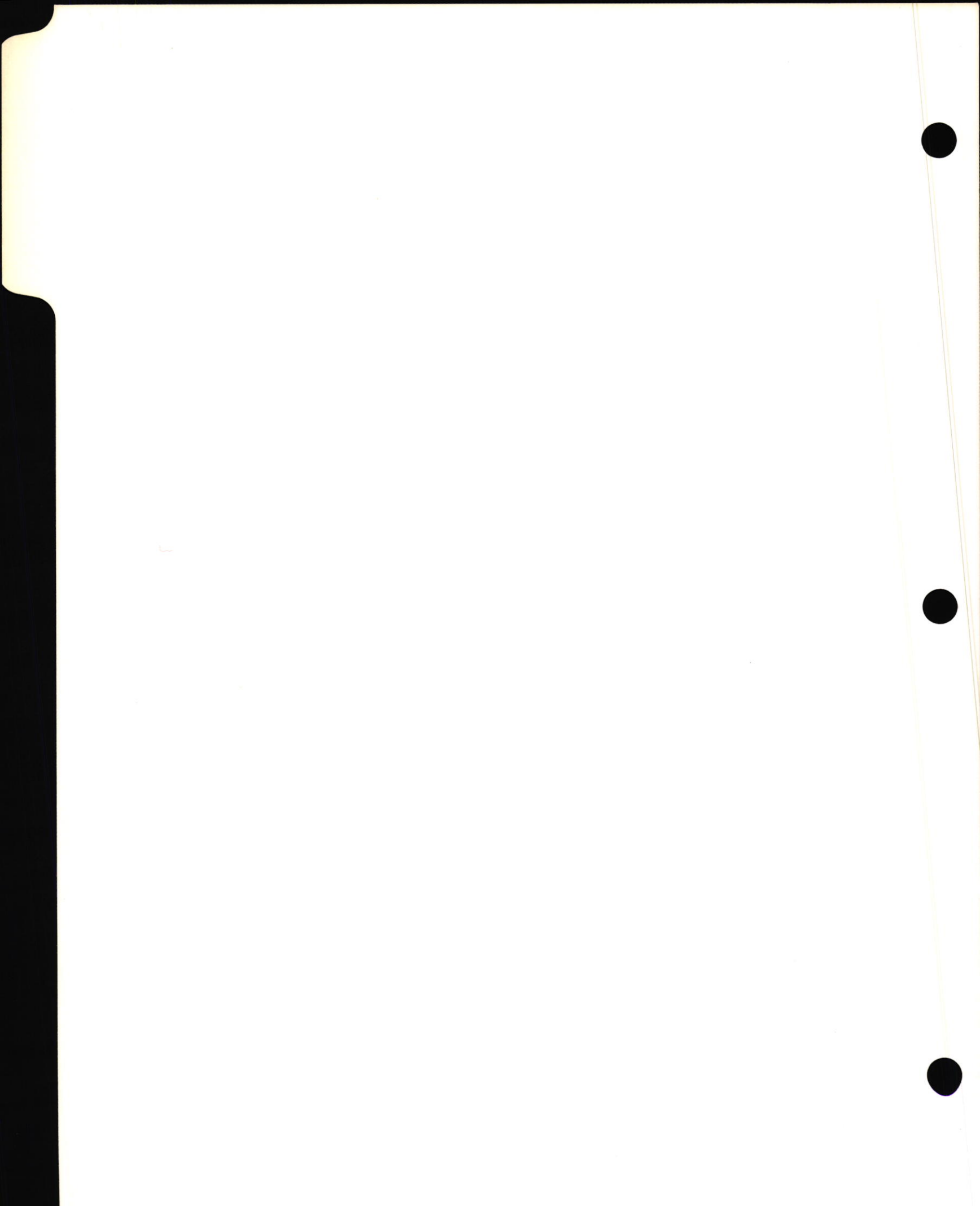
Display Paths

In addition to the already mentioned "Counter View" signals, the plug-in compartments provide the most common source of displayed signals. The LEFT and CENTER compartment paths have a vertical deflection bandwidth of up to the full bandwidth of the instrument. The LEFT compartment can be used only for vertical deflection in the display. The CENTER can be used for both vertical and horizontal deflection. This allows for simultaneous display of XY and YT traces. The RIGHT compartment can be used for horizontal deflection only when used for part of an XY trace. The horizontal bandwidth is a maximum of 3 MHz. The CENTER compartment is phase matched to within 1 degree at 1 MHz and approximately 3 degrees at 2 MHz.



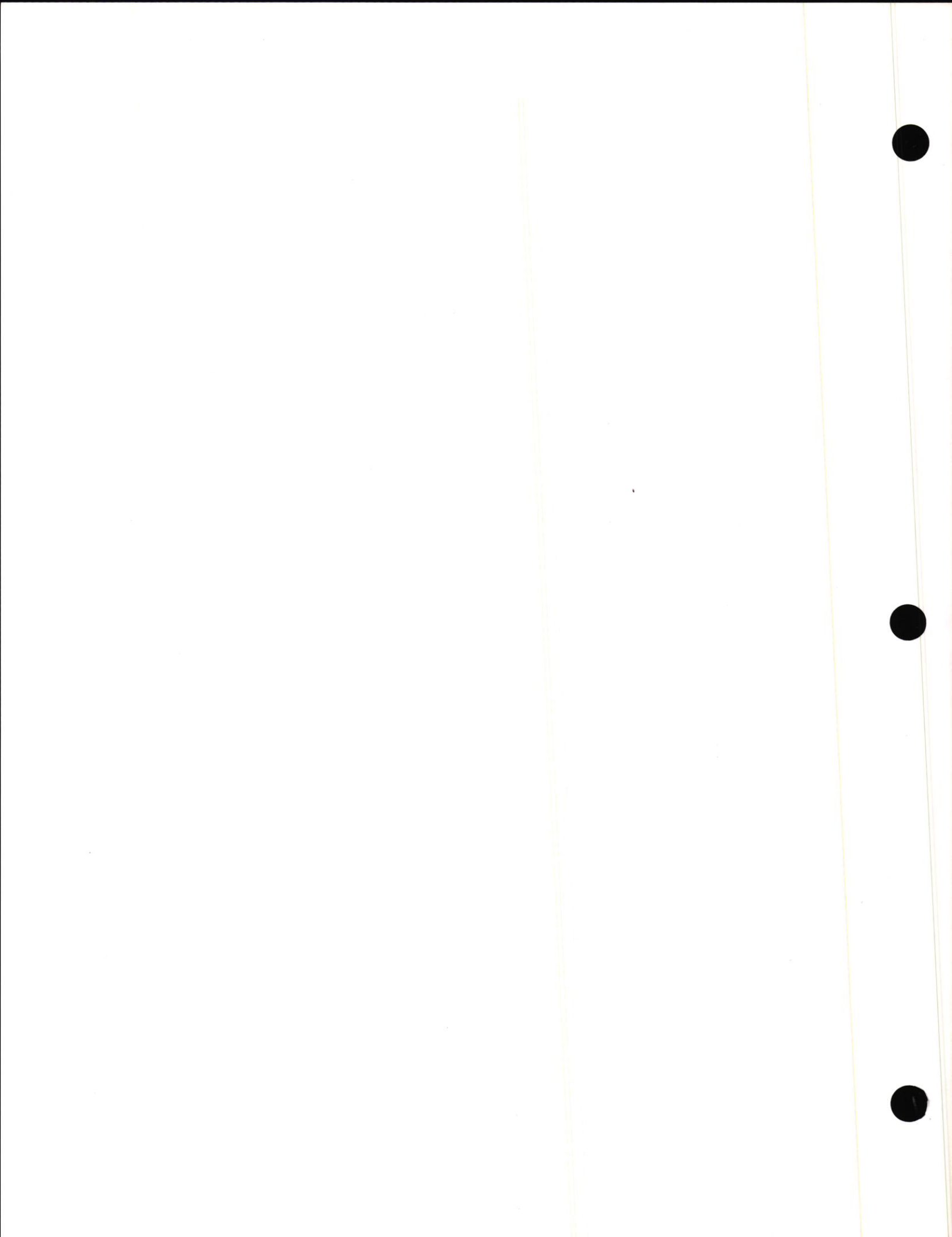
Section 1 Installation





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Installation

This section gives all the information needed to apply power and check to that the 11301 or 11302 Programmable Oscilloscope is operational.

Information on operating voltage and power cord needs as well as environmental conditions such as operating temperature and ventilation requirements is included here. Plug-in installation and compatibility to this 11000-Series mainframe is also explained.

Once the oscilloscope is turned on, this section also guides you through an Incoming Inspection Procedure to verify that you have indeed received a working instrument. If there is damage or deficiency, contact your local Tektronix Field Office or representative.

You'll also find information on how to interface the oscilloscope to instruments with GPIB (IEEE-488) and RS-232-C features. Information on how to convert a bench model into a rackmount model or vice versa is also found in this section.

Finally, there are instructions on how to package your oscilloscope if you ever need to return it for repair.

Operating Power Information

This instrument can be operated from either a 115-volt or 230-volt nominal line-voltage source, 48 to 440 hertz. The 6-ampere, 250-volt line fuse is used for both 115-volt and 230-volt operation.

WARNING

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

Before making connection to the power source, check that the oscilloscope LINE VOLTAGE SELECTOR on the rear of the instrument is set to match the voltage of the power source and has a suitable two-pole, three-terminal grounding-type plug. Refer any changes to qualified service personnel.

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

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

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

Memory Back-Up Power

This oscilloscope is equipped with a battery to save the most recent operating conditions between power on/off cycles. The self-test will display a message to indicate when the battery needs to be replaced.

The battery has a nominal shelf life of approximately five years. Partial or total loss of stored settings upon power-up may indicate that the battery needs to be replaced.

Operating Voltage

The LINE VOLTAGE SELECTOR (located on the rear panel) allows you to select 115-volt or 230-volt nominal line-voltage operation. The same line fuse is used for both 115-volt and 230-volt operation. Refer voltage conversion to qualified service personnel.

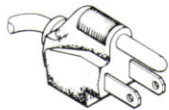
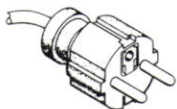

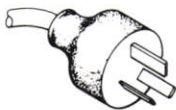
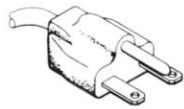
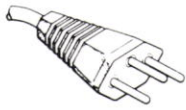
Power Cord Information

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

TABLE 1-1
Power-Cord Conductor Identification

Conductor	Color	Alternate Color
Ungrounded (line)	Brown	Black
Grounded (neutral)	Light Blue	White
Grounded (earthing)	Green/Yellow	Green

TABLE 1-2
Power-Cord and Plug Identification

Plug Configuration	Usage (Max Rating)	Reference Standards & Certification	Option #
	North American 125V/6A	¹ ANSI C73.11 ² NEMA 5-15-P ³ IEC 83 ¹⁰ UL ¹¹ CSA	Standard
	European 220V/6A	⁴ CEE (7), II,IV,VII ³ IEC 83 ⁸ VDE ⁹ SEMKO	A1
	United Kingdom 240V/6A	⁵ BSI 1363 ³ IEC 83	A2
	Australian 240 V/6A	⁶ AS C112 ¹² ETSA	A3
	North American 250V/10A	¹ ANSI C73.20 ² NEMA 6-15-P ³ IEC 83 ¹⁰ UL ¹¹ CSA	A4
	Switzerland 240V/6A	⁷ SEV	A5

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

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Operating Environment

The following environmental requirements are provided to ensure proper operation and long life of the instrument. To prevent damage to the 11301 or 11302 Programmable Oscilloscope certain environmental conditions must be met. See Section 4, "Specification," for a more complete list.

Operating Temperature

This instrument can be operated where the ambient air temperature is between 0° and +50° C. The Programmable Oscilloscope can be stored in ambient temperature between -40° and +75° C. After storage at a temperature beyond the operating limits, allow the chassis temperature to come within the operating limit before applying power.

Ventilation Requirements

To prevent damage to the Programmable Oscilloscope from overheated components, adequate internal airflow must be maintained at all times. Before turning on the power, check the air-intake holes for obstructions. Remove any obstructions to air flow and provide both the bench and the rack mount models with a minimum of two inches of clearance at the sides and rear.

A variable speed fan controls the air flow as temperature varies. To maintain adequate cooling, all plug-in compartments must have an 11000 series plug-in unit installed. If active plug-ins are not available, install blank plug-in units (Tektronix Part No. 016-0829-00). Failure to comply with these ventilation requirements violates conditions to which the advertised specifications (i.e., accuracy) apply.

CAUTION

The power supply of this instrument may temporarily shut down if air flow is restricted.

Plug-In Unit Operating Information

Section 6, "Plug-in Unit Information," contains an operating information supplement for each plug-in unit that was available when you received this mainframe.

Because the plug-in units are operated through the front panel and its touch screen, their operation is described in this manual.

Functions unique to a plug-in unit will be described in its plug-in supplement.

As new plug-in units are introduced, Tektronix will provide plug-in supplements. When you purchase a new plug-in unit, insert the new plug-in supplement in Section 6 of this manual.

Installing Plug-in Units

CAUTION

Before installing or removing plug-in units set the front-panel ON/STANDBY switch to STANDBY. Damage to the instrument may result if you install or remove a plug-in unit with the power ON. If the green indicator light (next to the ON/STANDBY switch) remains lighted, the ON/STANDBY switch has been internally disabled. Therefore, the power will remain ON regardless of the switch setting. Use the Principal Power switch (rear panel) to shut OFF the power before attempting to remove and/or replace plug-ins.

To once again enable the ON/STANDBY switch, refer the instrument to qualified service personnel.

To install a plug-in unit into the mainframe, align the grooves in the top and bottom of the plug-in with the respective guides in the plug-in compartment of the mainframe. Then push the plug-in unit in until its front panel is flush with the front-panel frame. See Figure 1-1.

To remove a plug-in, pull out the latch to disengage it from the mainframe plug-in compartment lock, then slide the plug-in out.

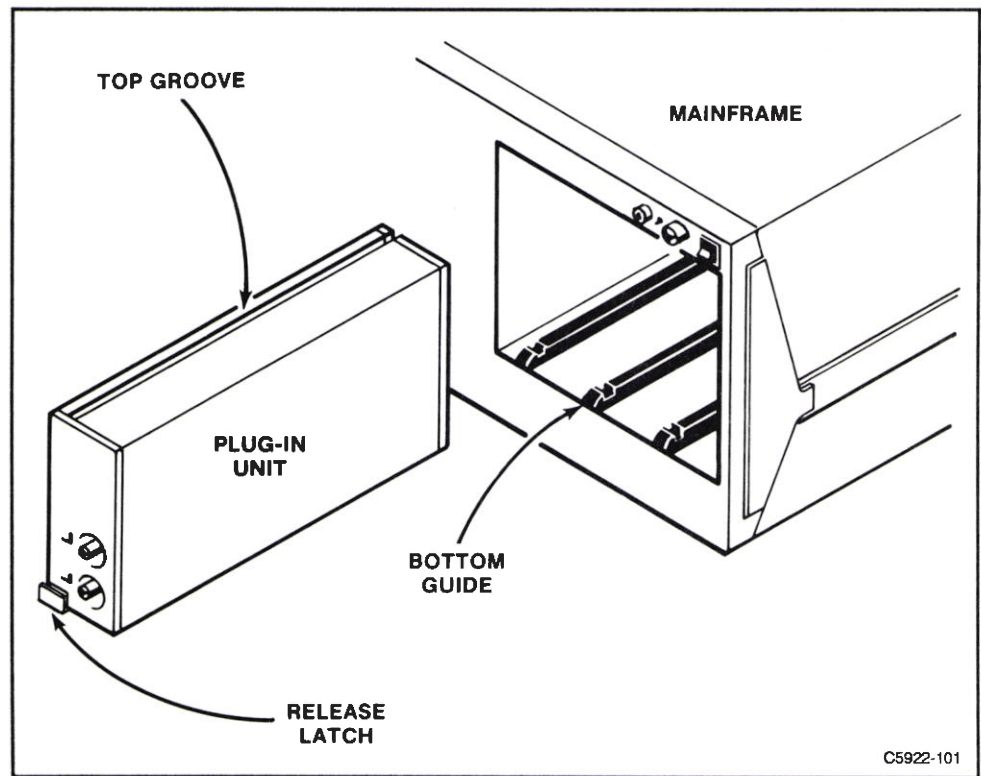


Figure 1-1. Installing a plug-in unit in the mainframe.

It is not necessary that all plug-in compartments be filled to operate the instrument. The only plug-ins needed are those required for the desired measurement.

Accuracy of the plug-in and mainframe combination is maintained by using the ENHANCED ACCURACY feature. This feature requires that the oscilloscope be powered on for at least 20 minutes. (See more on Enhanced Accuracy in Section 2 under "Instrument Verification").

Blank plug-in units must be inserted in unused compartments to maintain proper ventilation and compatibility with electromagnetic emissions, susceptibility and accuracy specifications. Refer to the Optional Accessories list in Appendix B at the rear of this manual for ordering information.

External Interface Connection

On the rear of the Programmable Oscilloscope are two connectors for remote operation: one 24 pin female connector for GPIB (IEEE-488) and one 25 pin female connector for RS-232-C. For further information, refer to Section 3, "GPIB and RS-232-C Interfaces."

Packaging for Shipment

The following information tells you what to do to ship the instrument or to return it for repair even if you do not have the original packaging material.

Shipping the Instrument

If the oscilloscope is to be shipped for long distances by commercial transportation, we recommend that you use the the original packaging material.

Shipping to Tektronix Service Center

If the oscilloscope is to be shipped to a Tektronix Service Center for service or repair, package it in the original shipping material and attach a tag showing the following information:

- a. Owner and address
- b. Name of person who can be contacted
- c. Complete instrument type and serial number
- d. Description of the service required

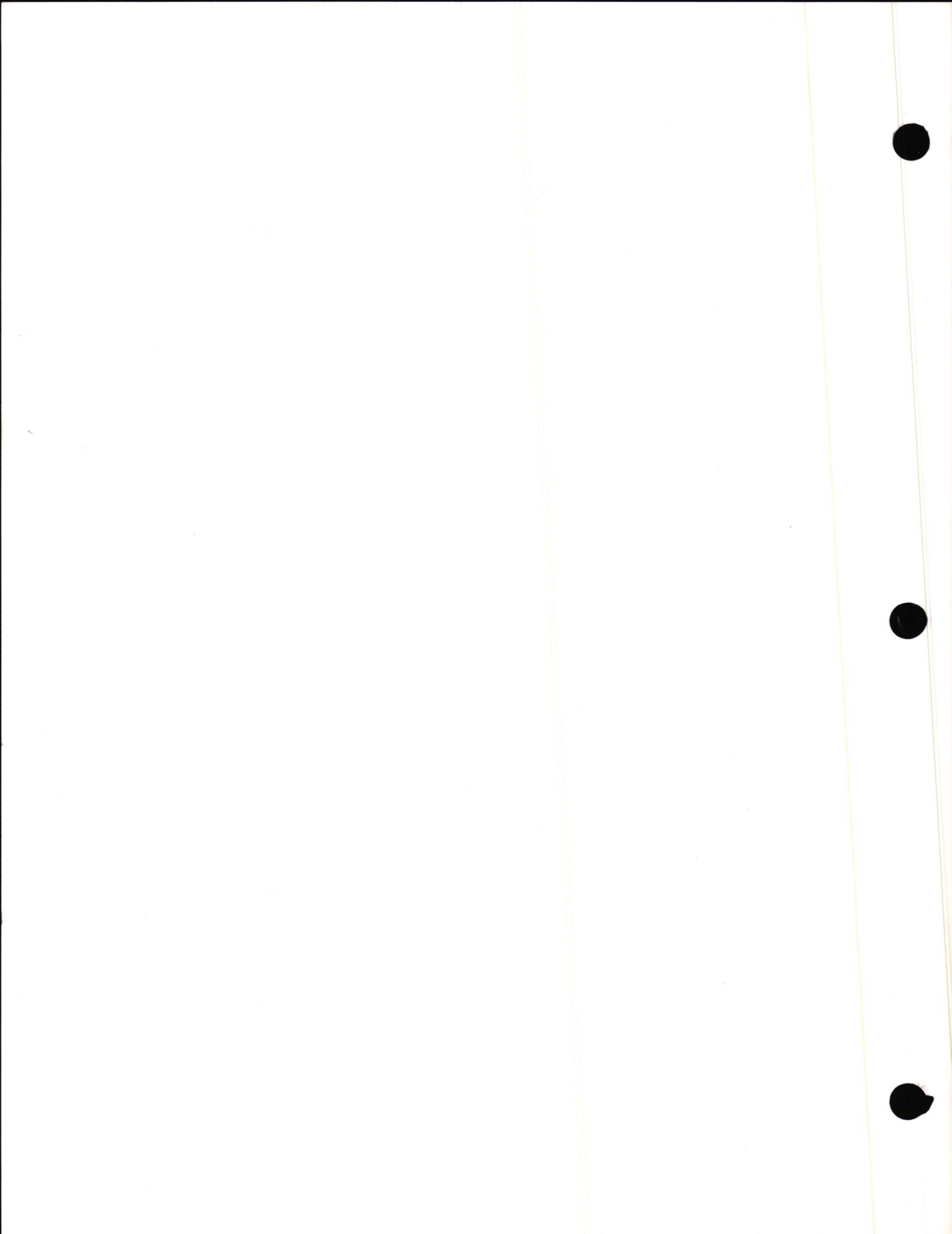
Substituting Original Packaging

If the original packaging is not reusable or not available, repackage the instrument as follows:

1. Obtain a corrugated cardboard shipping carton with a 275-pound test strength and inside dimensions at least six inches greater than the instrument dimensions (this allows for cushioning material).
2. Wrap the instrument with anti-static sheeting (or equivalent material) to protect the outside finish and prevent entry of packing materials into the instrument.
3. Allowing three inches on each side, cushion the instrument on all sides by tightly packing dunnage or urethane foam between the carton and the instrument.
4. Secure the carton with shipping tape or industrial staples.
5. Mark the address of the Tektronix Service Center and your return address on the carton in one or more prominent locations.

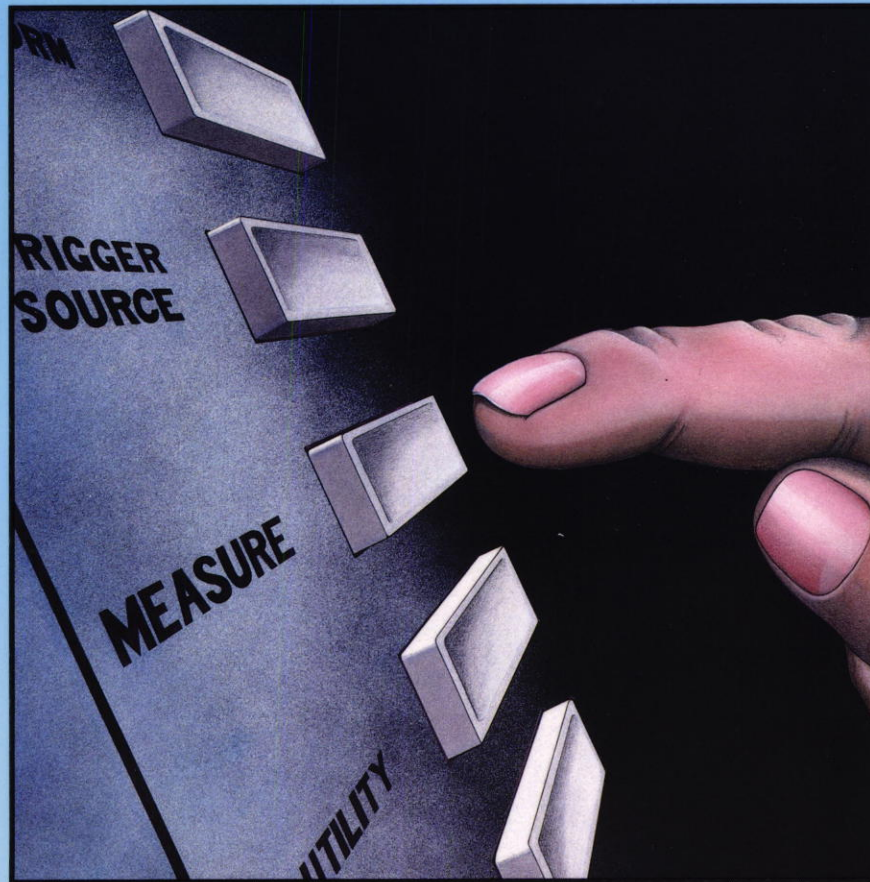
Rackmounting

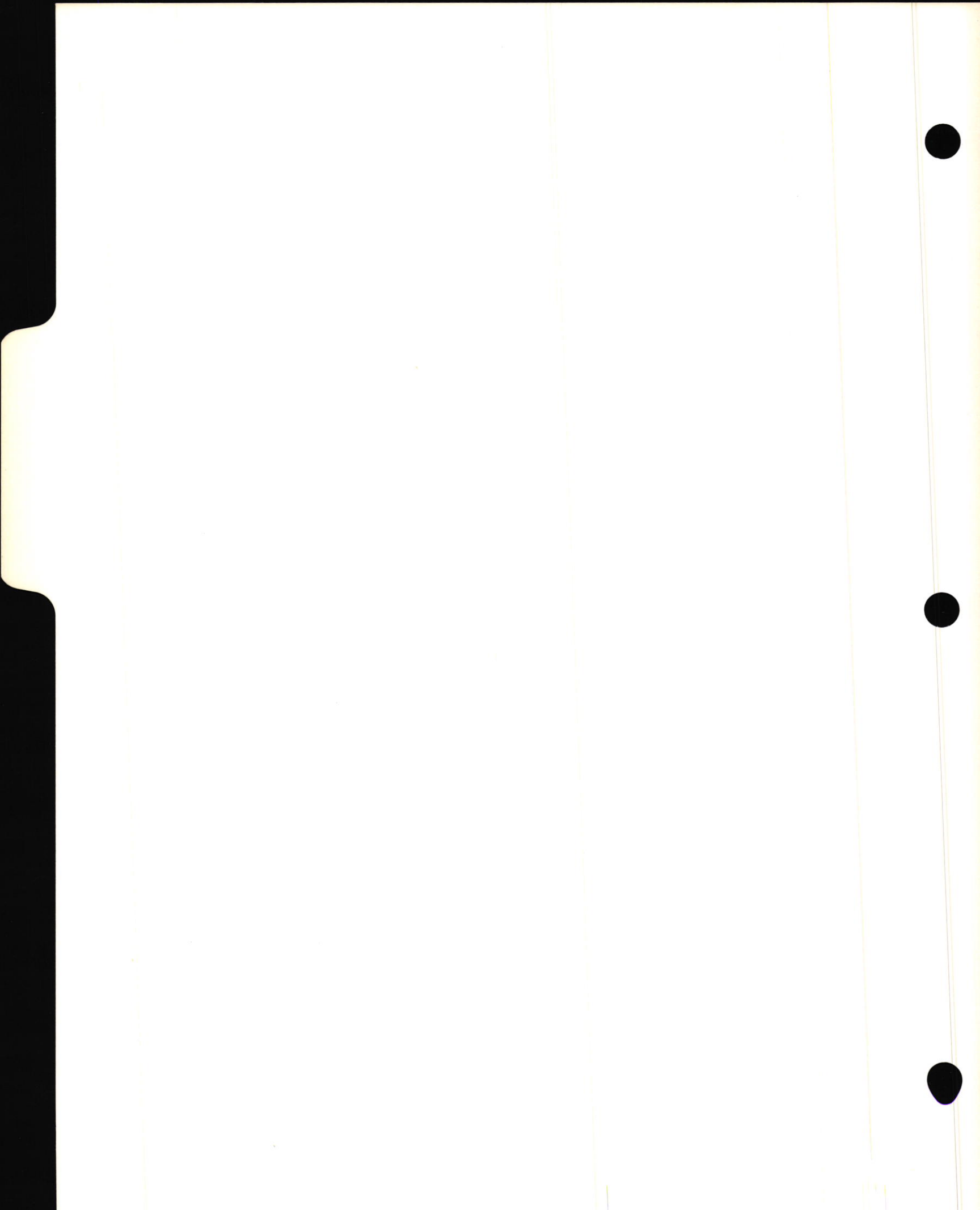
Option 1R is available to convert the standard benchtop 11301 or 11302 mainframe to a rackmount version. This option allows the oscilloscope to be mounted in a standard 19-inch rack with universal hole spacing. Refer to Section 5, "Instrument Options," for more detail and to Section 4, "Specification," for rackmounting physical dimensions.



Section 2

Operating Information





Operating Information

Oscilloscope Familiarization

Controls, knobs, and connectors are discussed in detail. Information on using the principal power switch and the ON/STANDBY switch is provided. Initialization conditions are listed.

Display Area

The general behavior of control menus and major menus are explained. The touch panel and the conventions of the display format are presented.

Waveform Acquisition

This subsection contains all the information needed to acquire a waveform and view it on screen. Acquiring a waveform via the probe ID button is also discussed.

Triggering

Triggering in its entirety is discussed here. This includes Trigger Holdoff, Trigger Level, and Trigger Source menus. Restrictions for trigger source and composite traces are listed.

Display Control

Focus, astigmatism, spot-shift, horizontal and vertical resolution, vector filter phase adjustments are discussed here as well as graticule, character, and sweep intensity levels.

Measurement

The measurement menus (Counter/Timer, Cursors, and Measure) are presented here. "Counter/Timer Concepts" discusses the principles of using the counter/timer.

Numeric Entry

Numeric entry is accomplished through the Numeric Entry major menu. This provides a means to directly enter a value instead of turning a knob or to compute simple algebraic expressions.

Store and Recall (Instrument Settings)

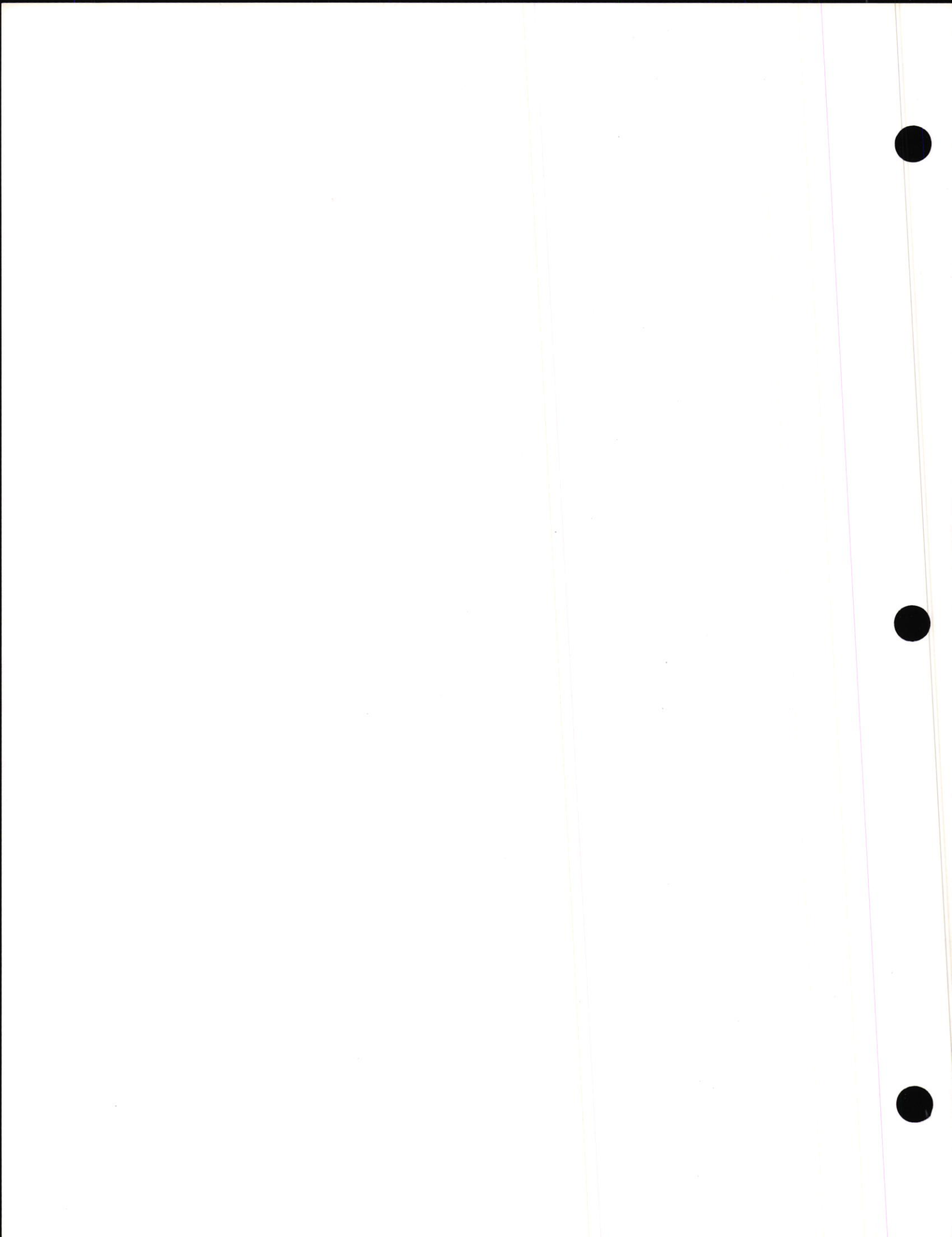
Store and recall discusses the menu operations required to store, recall, or erase settings in the Store and Recall major menu, and how to access randomly or sequentially stored information.

Utilities

Here is instruction for this collection of "utility" menus: Autoset, Beep, Cal, Cal Sig, Ext Text, GPIB, Init, I/O Bnc, Probe Cal, Probe ID, Probe Skew, RS232, Test, and Time and Date.

Measurement Concept Tutorial

This subsection is a step-by-step instruction on obtaining automatic measurements, measurements using cursors, and various Counter/Timer measurements.



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Operating Information

Section 2 contains all the information you need to operate either the 11301 or the 11302 Programmable Oscilloscope. The main headings of this section are broken into eleven functional parts listed in a logical order of use:

- Oscilloscope Familiarization
- Display Area
- Waveform Acquisition
- Triggering
- Display Control
- Measurement
- Numeric Entry
- Store and Recall
- Utilities
- Measurement Concept Tutorial

To facilitate quick access to information, a dictionary-like form is used. Notice in the contents of this section, each item listed below the main heading is in alphabetical order. The reason for this is that beyond the major heading each user's application may change the logical order of use.

To easily distinguish menu functions from menu function choices directly referred to within the text, menu functions will be printed in medium text and menu function choices will be printed in **bold** text.

Upper-case words refer to buttons, controls, connectors, or indicators marked on the front- and rear-panels of the oscilloscope. Initial upper-case words are unmarked controls (e.g., Control knobs, Probe ID button, and Camera Power connector).

Oscilloscope Familiarization

This section, "Oscilloscope Familiarization," is intended to familiarize you with the front and rear panels of the oscilloscope.

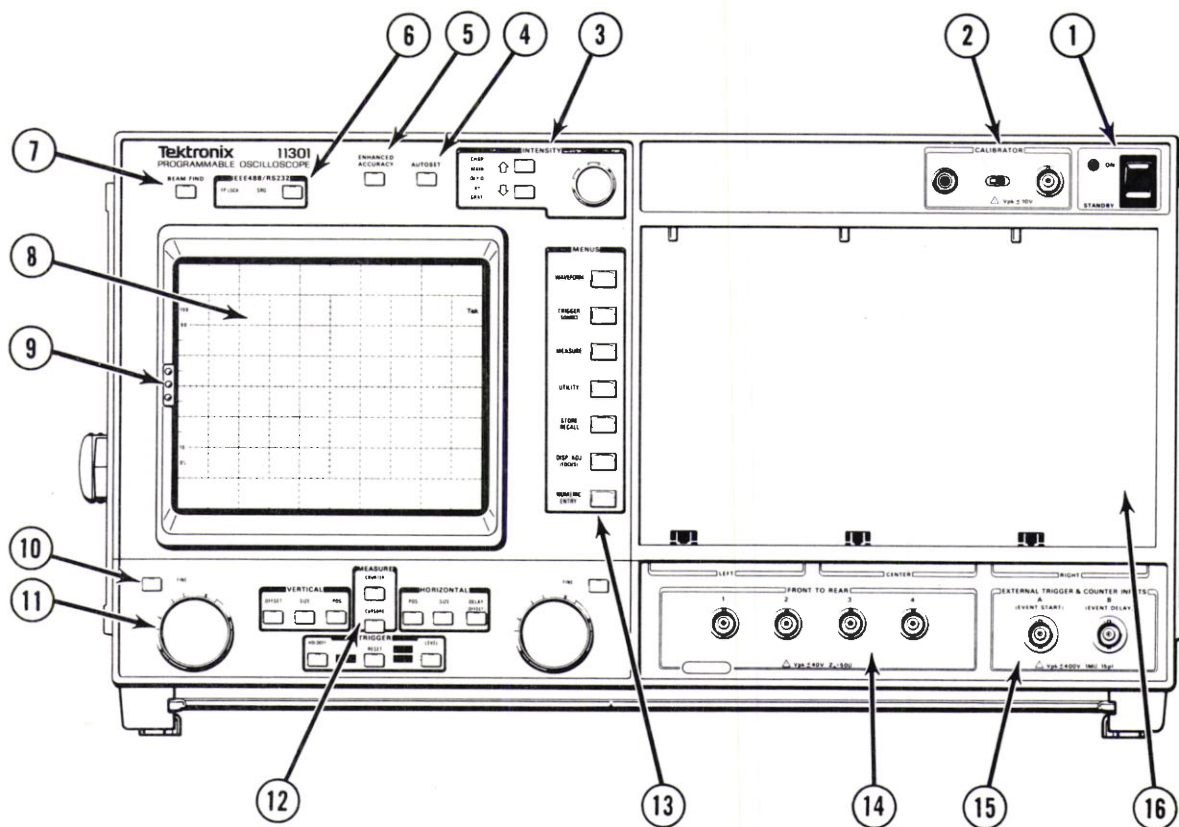


Figure 2-1. Front-panel controls, connectors, and indicators.

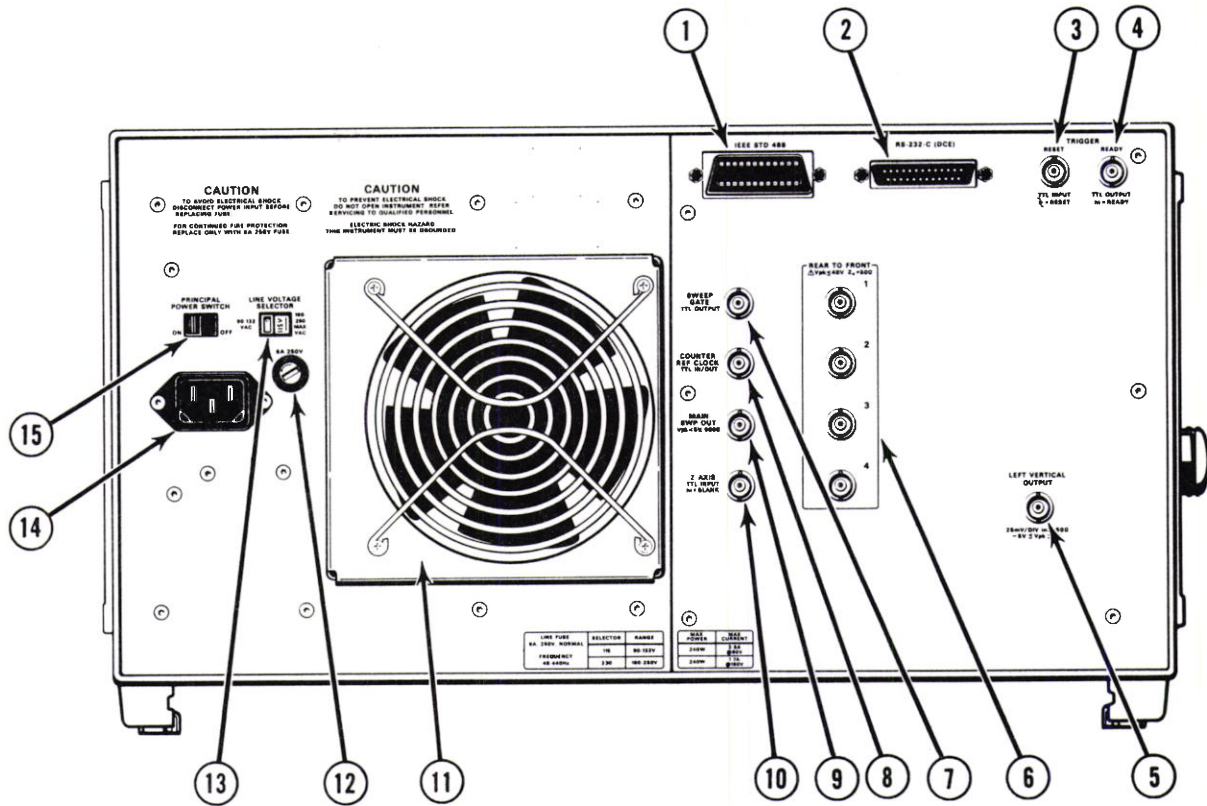
6106-201A

Front-Panel Descriptions

- ① **ON/STANDBY**—Applies dc power to entire oscilloscope.
- ② **CALIBRATOR Connector and Probe-tip Jack**—Provides a signal for calibrating probes and serves as a simple signal source.
- ③ **INTENSITY**—Controls brightness of selected trace, graticule, or characters.
- ④ **AUTOSET Button**—Gives a one time automatic scaling of vertical and horizontal deflection and triggering.
- ⑤ **ENHANCED ACCURACY Button**—Gives a one time self-calibration.
- ⑥ **IEEE488/RS232**—Pressing the SRQ button produces an interrupt. FP LOCKED, when backlighted, indicates a programmed nonoperating front panel.
- ⑦ **BEAM FIND Button**—When pressed, compresses the display within the graticule area.
- ⑧ **Crt with Touch Screen**—Display and touch selection area.
- ⑨ **Camera Power Connector (not labeled)**—Power for camera.
- ⑩ **FINE Button**—Gives "fine" increment adjustment for knobs.
- ⑪ **Knobs (not labeled)**—Performs selections chosen by pressing control-menu buttons.
- ⑫ **Control Menu Buttons**—When pressed, invoke respectively VERTICAL OFFSET, SIZE, and POSition; COUNTER; CURSORS; TRIGGER HOLDOFF; TRIGGER LEVEL; HORIZONTAL SIZE and POSition; and HORIZONTAL DELAY Knob menus. Also here is the TRIGGER RESET button and READY, D TRIG, and M TRIG indicators.
- ⑬ **Major Menu Buttons**—When pressed, these invoke respectively WAVEFORM, TRIGGER SOURCE, MEASURE, UTILITY, STORE/RECALL, DISP ADJ (FOCUS), and NUMERIC ENTRY major menus.
- ⑭ **FRONT TO REAR Connectors**—Allow input to the amplifiers through the instrument from the rear panel.
- ⑮ **A and B EXTERNAL COUNTER TRIGGER & INPUT Connectors**—Used for input to the Counter Timer and to the main and delayed triggers.
- ⑯ **Plug-in Compartments**—LEFT, CENTER, and RIGHT compartments for inserting plug-ins.

6106-201B

Figure 2-1 (cont). Front-panel controls, connectors, and indicators.



6106-202A

Figure 2-2. Rear-panel controls, connectors, and indicators.

Rear-Panel Descriptions

- ① **IEEE STD 488 Connector**—Interface connector for GPIB.
- ② **RS-232-C (DCE) Connector**—Interface connector for RS-232.
- ③ **TRIGGER RESET Connector**—Aborts and arms the Counter Timer measurements and the sweeps that are in progress.
- ④ **TRIGGER READY Connector**—Outputs a signal from the LEFT plug-in compartment.
- ⑤ **LEFT VERTICAL OUTPUT**—Outputs a signal from the LEFT plug-in compartment.
- ⑥ **REAR TO FRONT Connectors**—Allow input to the amplifiers through the instrument to the front panel.
- ⑦ **SWEEP GATE OUTPUT**—Signal derived from the Main or Delayed sweep gates as selected from the UTILITY menu (I/O BNC).
- ⑧ **COUNTER REF CLOCK**—Connects a cable for a reference into or out of the Counter as selected from the UTILITY menu (I/O BNC).
- ⑨ **MAIN SWEEP OUT**—Signal (sawtooth) derived from the Main time base.
- ⑩ **Z AXIS INPUT**—External control for intensity modulation of the display.
- ⑪ **Fan**—Variable speed, depending upon temperature, exhausting fan.
- ⑫ **Fuse Holder**—Contains the ac power source fuse.
- ⑬ **LINE VOLTAGE SELECTOR Switch**—Selects the nominal instrument operating voltage range.
- ⑭ **Receptacle for Detachable Power Cord**—Provides connection for the ac power source to the instrument.
- ⑮ **PRINCIPAL POWER SWITCH**—Ac power switch.

6106-202B

Figure 2-2 (cont). Rear-panel controls, connectors, and indicators.

Buttons, Controls, Connectors, and Indicators

The following description shows you the location and function of the controls, connectors, and indicators of the oscilloscope.

Buttons and Indicators Above The Display

Refer to Figure 2-1, *Front-panel controls, connectors, and indicators, and Figures 2-3 and 2-4.*

The BEAM FIND button, when held in, compresses the display to within the graticule area. Observing where the waveform appears gives you a clue to the direction the controls must be adjusted to bring the waveform on-screen.

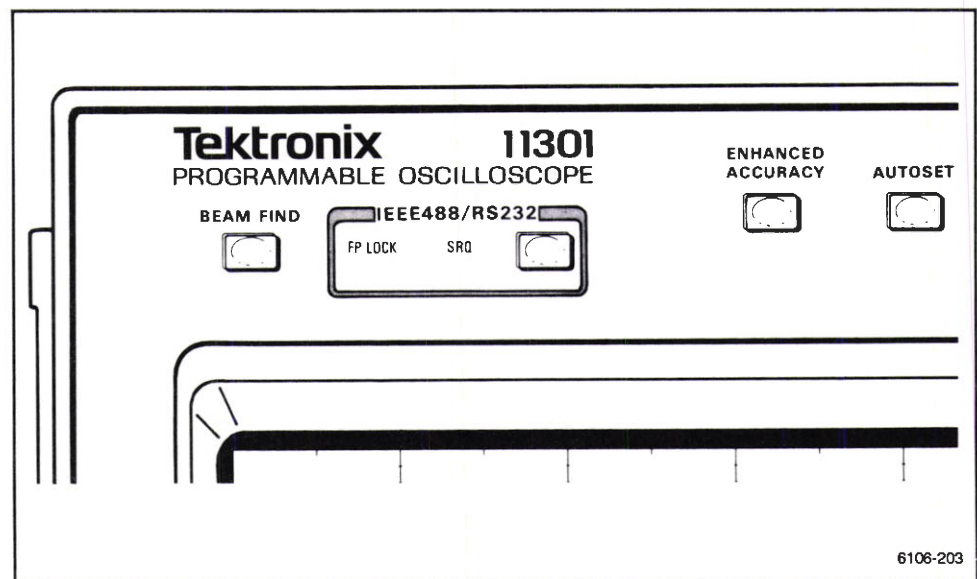


Figure 2-3. BEAM FIND, IEEE488/RS232, ENHANCED ACCURACY, and AUTOSET buttons.

This instrument is IEEE-488 (GPIB) and RS-232-C compatible. An interrupt can be generated, if programmed to do so, by pressing the SRQ button. SRQ will be backlighted while any interrupt is posted. It will be extinguished after the GPIB has serviced or cleared all SRQs.

FP LOCKED will be backlighted if the front panel has been programmed to be nonoperating. This means you cannot operate the front-panel controls, except the ON/STANDBY switch, when this light is illuminated.

There is a means to electrically lock the ON/STANDBY switch in the ON position. The instrument must be referred to a qualified service person for internal setting.

Pressing the ENHANCED ACCURACY button gives a one time self-calibration. The Enhanced Accuracy will remain until the temperature varies 5° C from the self-calibrated temperature, then lapse to the Not-Enhanced Accuracy state. (See "Power-Up Information" in this subsection for more information on Enhanced Accuracy.) Enhanced Accuracy can be used 20 minutes after power has been turned on. It is especially useful prior to making a critical precision measurement.

The AUTOSET button, when pressed, initiates a one time only automatic scaling of vertical and horizontal deflection and triggering of the selected trace.

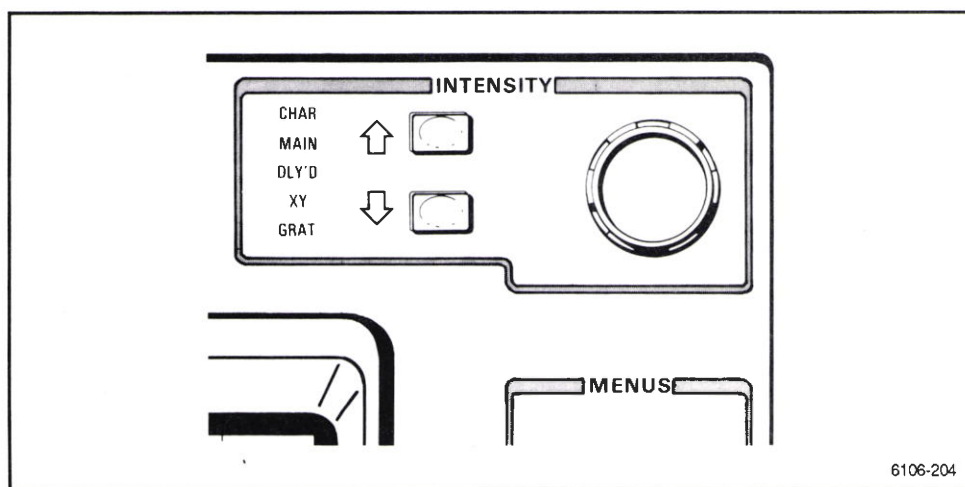


Figure 2-4. INTENSITY controls.

The INTENSITY controls include of two buttons and an adjacent knob. Pressing the upper button scrolls upward through the selections listed to the left of the buttons. The current selection is backlighted. Pressing the lower button scrolls through the list in the downward direction. Rotating the knob changes the intensity of the selected item.

Calibrator Connections

Refer to Figure 2-1, Front-panel illustration, and Figure 2-5.

The CALIBRATOR area provides three connectors: a ground connection, a probe-tip jack, and a bnc connector.

NOTE

All the instruments involved during testing (especially true on sensitive measurements) should be joined using heavy cable at this ground connector. Otherwise, any difference in the ground potential of these instruments results in current flowing in the probe shield. The signal displayed will be distorted. See "Coaxial Cables and Probes" under "Measurement Concept Tutorial."

The oscilloscope has both a bnc connector and a probe-tip jack that facilitates calibration of probes; each provides the same calibration signal. The signal type, amplitude output, and repetition rate are controlled using *Cal Sig* in the UTILITY menu.

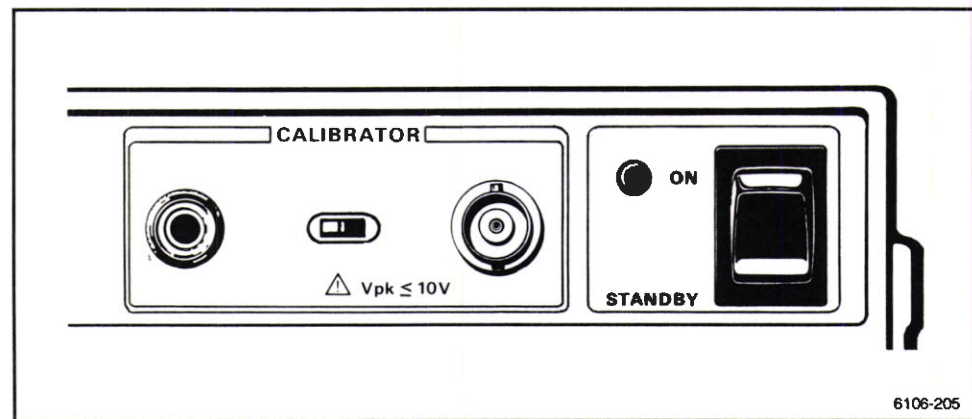


Figure 2-5. CALIBRATOR connections.

Crt Display Screen

Refer to Figure 2-1, Front-panel illustration, and Figure 2-6.

The crt is used in conjunction with a touch-screen; that is, selections can be made by touching the crt. Sometimes the crt may be referred to as "the screen" or as "the display."

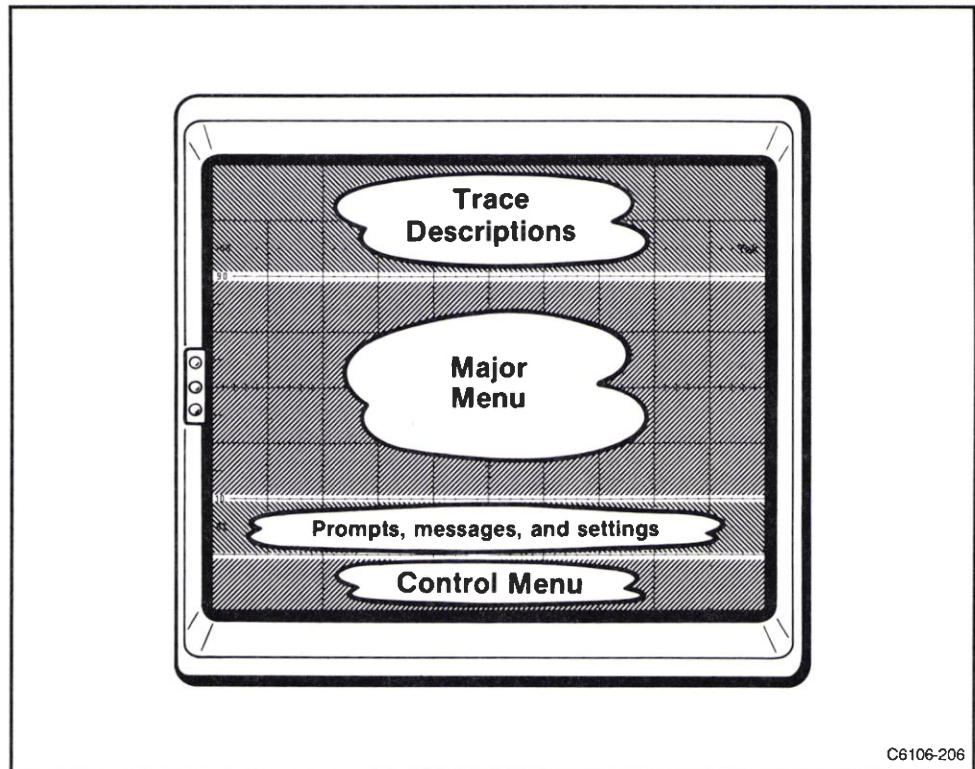


Figure 2-6. Display format.

Up to eight unique traces can be displayed. The names or descriptions of the traces occupy the area of the screen labeled "Trace Descriptions" as shown in Figure 2-6. Horizontal scaling information appears at the upper right corner. The *D Time/div* is displayed whenever the delayed time base is used. Both left and right knobs or knob controlled calculated values are displayed on the bottom third line. The oscilloscope functions that are known to interact or are believed to be convenient knob adjustments (control menus) are offered at the bottom.

The three-pin Camera Power connector (not labeled) on the left of the crt provides power for the camera and receives control signals from Tektronix automatic cameras to allow camera-controlled single-shot photography (see camera manual for complete instructions for obtaining waveform photographs).

Knobs and Control-Menu Buttons

Refer to Figure 2-1, Front-panel illustration, and Figure 2-7.

The functions that the knobs perform are selected with the control-menu buttons located below the crt.

Knobs

Below the crt are two large knobs that can be assigned to different functions by pressing one of the several adjacent buttons. A corresponding LED illuminates your choice.

Each knob can have coarse or fine increments. When the FINE button is pressed, FINE will be backlit offering small increments. When the button is pressed again, the light will no longer be illuminated and the increments will be coarse. Coarse and FINE settings are retained for different knob assignments.

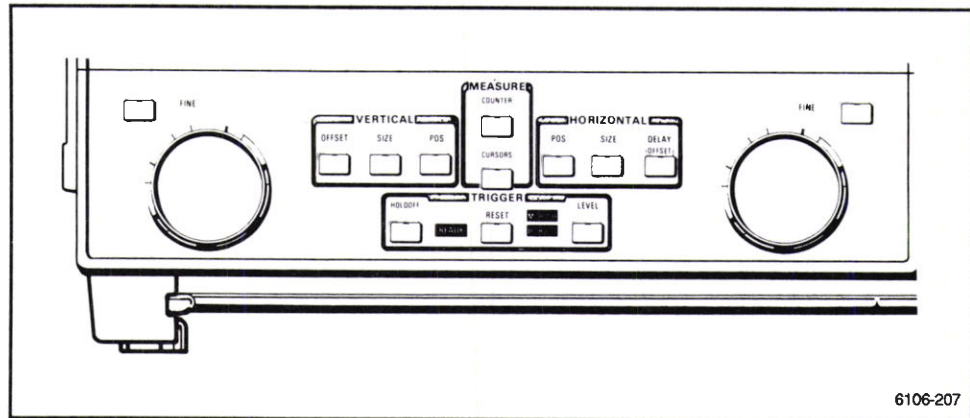


Figure 2-7. Knobs and control-menu buttons.

Refer to Figure 2-1, Front-Panel illustration, and Figure 2-8.

Control-Menu Buttons

The functions of the two knobs are selected by pressing the buttons located between them. These buttons, when pressed, invoke seven different types of control menus: VERTICAL SIZE, POS (position), or OFFSET buttons invoke the Vertical menu; HORIZONTAL POS or SIZE buttons invoke the Horizontal menu; the HORIZONTAL DELAY button invokes the Delay menu; TRIGGER HOLDOFF button invokes the Holdoff menu; the TRIGGER LEVEL button invokes the Trigger Level menu; the COUNTER button invokes the Counter/Timer menu; and CURSORS button invokes the Cursor menu.

Pressing a control-menu button once displays the corresponding menu and lets you change the selected parameter by turning a knob. (Notice that the left knob controls the Vertical selections and the right knob controls the Horizontal selections.) Pressing the control-menu button a second time removes the control menu from the screen. A third press returns the control menu to the original position on the display.

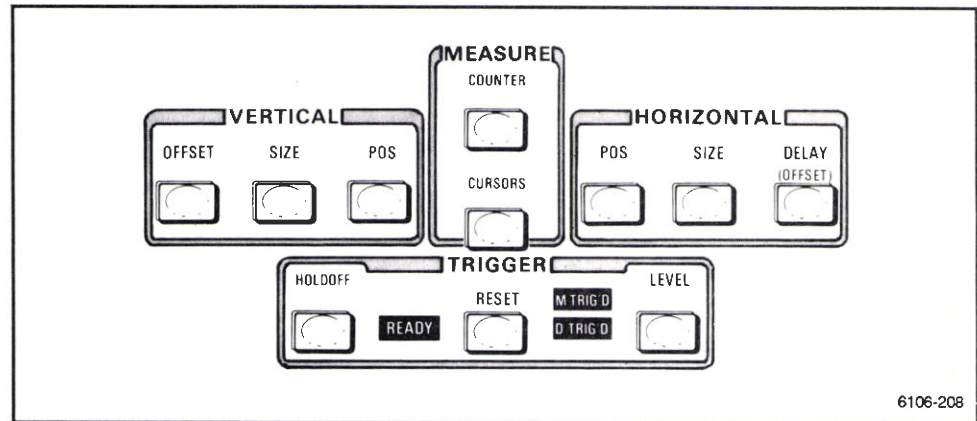


Figure 2-8. Control-menu buttons.

Pressing the VERTICAL OFFSET button assigns the left knob to controlling input offset within the amplifier. Other menu choices (e.g., *Coupling*, *Impedance*, etc.), dependent on the installed amplifier, are accessible.

Pressing the VERTICAL POSition button enables the left knob to move the trace upward or downward on the screen. Other menu choices (e.g., *Coupling*, *Impedance*, etc.), dependent on the installed amplifier, are accessible.

Pressing the VERTICAL SIZE button displays the vertical menu and assigns the left knob to vertical input sensitivity. Other menu choices (e.g., *Coupling*, *Impedance* etc.), dependent on the installed amplifier, are accessible.

Pressing the HORIZONTAL POSition button displays the Horizontal Control menu and enables the right knob to move the trace left or right on the screen.

Pressing the HORIZONTAL SIZE button displays the horizontal menu and assigns the right knob to control the time per division (*Time/div*) or horizontal sensitivity for XY traces. Turning the knob clockwise increases the sweep speed (lowers *Time/div*).

Pressing the HORIZONTAL DELAY button displays the Delay menu and assigns the knob to control the delay value of the delayed windows or the horizontal offset for an XY trace. Delay sweeps (windows) are created using this control menu.

Refer to Figure 2-1, Front-panel illustration, and Figure 2-9.

The MEASURE functions, COUNTER and CURSORS, display menus when their respective buttons are pressed. These menus are accessed similarly to the Vertical and Horizontal functions. Press either function and a corresponding control menu appears: one press displays the control menu, a second press removes the control menu from the screen, and a third press displays the menu again.

Pressing the COUNTER button displays the Counter menu while maintaining the previous knob assignments. No new functions are assigned to either knob. Counter selections are made on the touch screen.

The CURSORS button, when pressed, assigns both knobs to respective cursors. A Cursor menu is displayed allowing several cursor choices. Horizontal cursors are vertical lines marking a horizontal measurement. Vertical cursors are horizontal lines marking a vertical measurement.

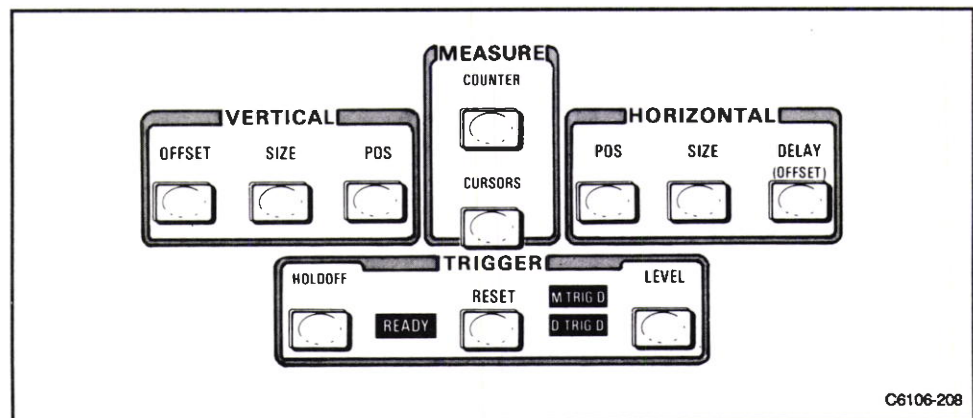


Figure 2-9. Control-menu buttons.

Pressing the TRIGGER HOLDOFF button allows you to use the left knob to vary the holdoff period (time between Main time-base triggers) to improve the triggering stability of repetitive complex waveforms. *Holdoff* can also be by **2ns Step, Countdown, or Events**.

Pressing the TRIGGER RESET button aborts the sweeps and Counter/Timer activity and then arms the trigger sweeps and Counter/Timer. When armed by the TRIGGER RESET button, the READY light will indicate an armed condition.

Pressing the TRIGGER LEVEL button displays the Trigger control menu and enables the right knob so that you may select a level on the trigger signal where triggering occurs.

Triggered indicators for Main (M Trig) and Delayed (D Trig) are illuminated when the respective trigger conditions (slope, level, etc.) detect a signal transition.

Major Menu Buttons

Refer to Figure 2-1, Front-panel illustration, and Figure 2-10.

Seven major menu buttons provide a direct path to major menus **independent** of previous selections. That is, any major menu can be accessed at random.

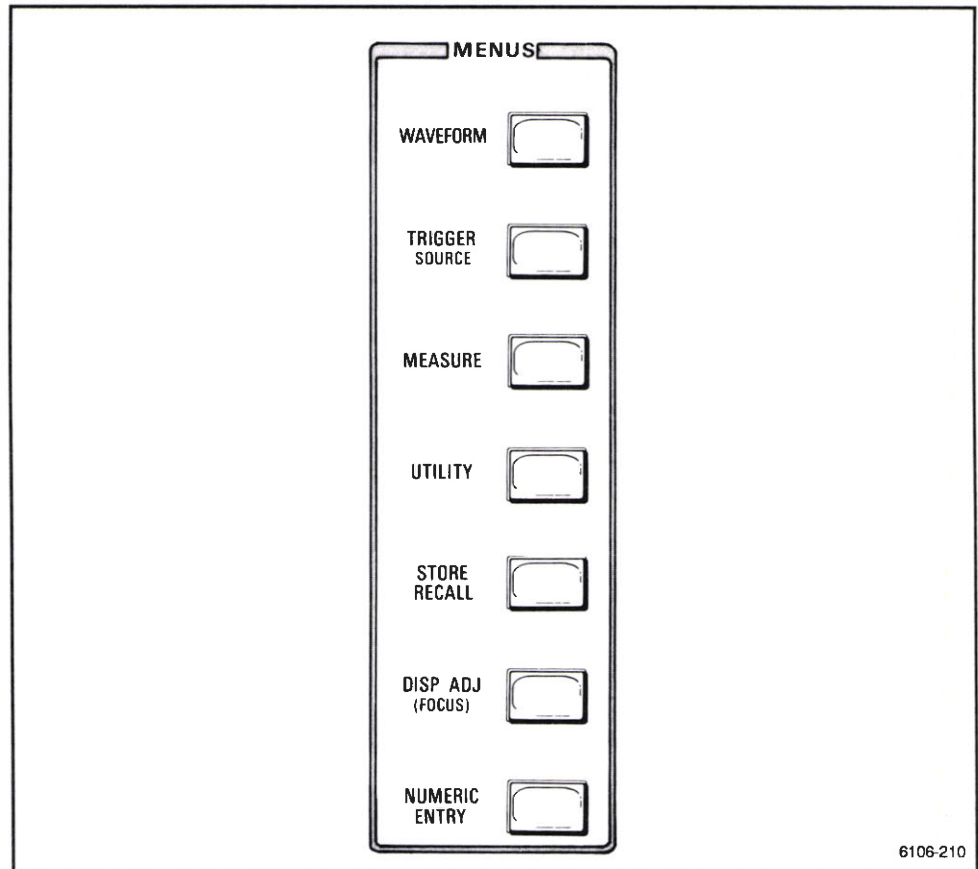


Figure 2-10. Major-menu buttons.

The **WAVEFORM** major menu is used to construct more complex waveforms using operators such as **+**, **-**, and **Vs** (versus). Counter/Timer signals (counter-views) can also be displayed. See the "Waveform Acquisition" subsection for detail.

The **TRIGGER SOURCE** major menu allows you to select the input signals that you wish to trigger on. Sources for the Main and Delayed (window) time bases are defined here. See the "Triggering" subsection for detail.

The **MEASURE** major menu is used to obtain a variety of waveform measurements. Automatic measurement of time and amplitude characteristics of a waveform can be made. See the "Measurement" subsection for detail.

Refer to Figure 2-1, Front-panel illustration, and Figure 2-11.

The UTILITY major menu gives access to these miscellaneous settings: Autoset, Beep (audio level), Calibration, Calibration Signal, Extended Testing, GPIB (IEEE-488) Interface, Initialize, defining Input/Output Bnc's, Probe Cal, Probe ID, Probe Skew, RS-232 Interface, Test (self-test), and setting the Time and Date. See the "Utilities" subsection for detail.

The STORE RECALL major menu allows the storing of instrument settings for recall at a later time. See the "Store and Recall" subsection for detail.

The DISP ADJ major menu accesses various special display patterns as well as controls for Focus, Astigmatism, and Trace Rotation. Contrast of the intensified zones and control of background shading of characters are controlled through selections of Δ Main and Δ Char respectively. Before other knob assignments can be made, this menu must be turned off. See the "Display Control" subsection for detail.

The NUMERIC ENTRY major menu allows you to change a setting in lieu of using a control menu, to specify a reference value for difference (Δ) measurements when using the Counter/Timer, and to compute simple algebraic expressions. See the "Numeric Entry" subsection for detail.

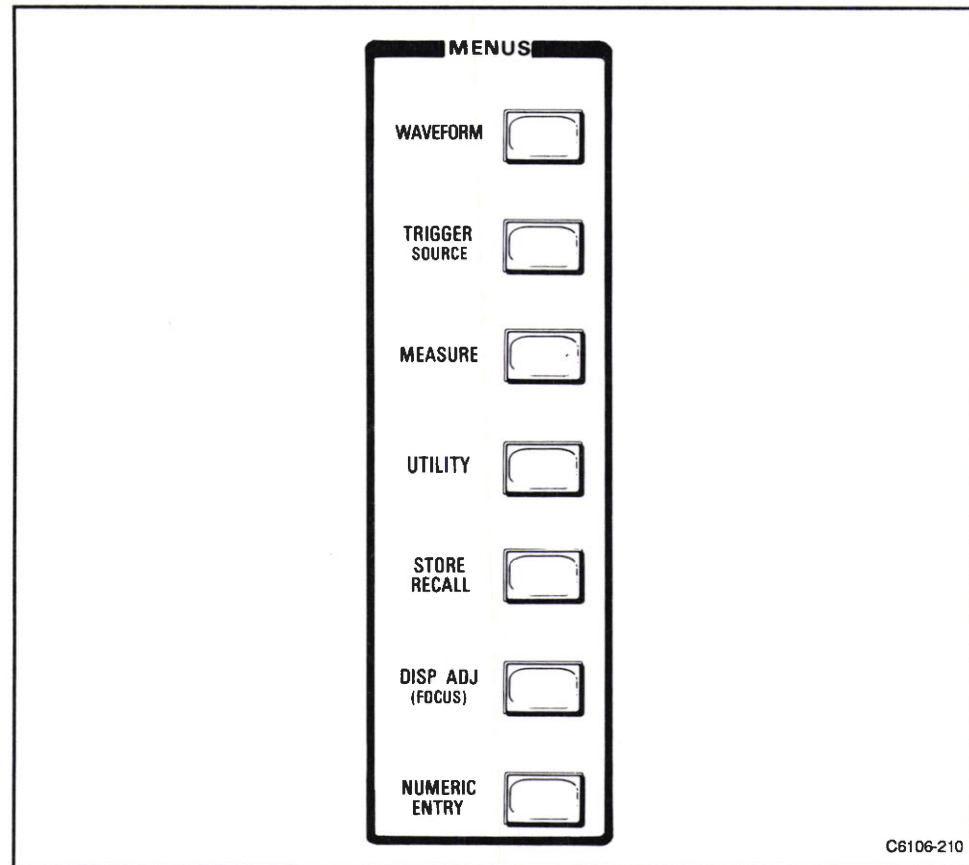


Figure 2-11. Major-menu buttons.

Plug-In Compartments

Refer to Figure 2-1, Front-panel illustration.

The three plug-in compartments are LEFT, CENTER, and RIGHT. The LEFT compartment can be used for vertical deflection only. The CENTER compartment can be used for either vertical or horizontal deflection. The RIGHT compartment can be used for horizontal deflection only. Any compartment can be used for a trigger source or other special purpose plug-in.

Rear- and Front-Panel External Connections

A number of external connections reside on the front and rear panel of the oscilloscope. The EXTERNAL A and B TRIGGER & COUNTER INPUT bnc connectors are on the lower right corner.

On the lower right front are four bnc FRONT TO REAR connectors. These connections are fed through the instrument to the matching set of REAR TO FRONT bnc connectors. (An optional set of eight connectors is available, see Section 5, "Instrument Options.")

On the rear of the instrument there is a IEEE-488 (GPIB) and a RS-232-C (DCE) connector as well as four other signal connectors (SWEEP GATE, COUNTER REF CLOCK, MAIN SWEEP OUTPUT, and Z-AXIS).

Front-Panel Connectors

Refer to Figure 2-1, Front-panel illustration, and Figure 2-12.

Beneath the plug-in compartments are several bnc type connectors. The first two, on the lower right, can be used for input to the Counter/Timer and to the main and delayed triggers.

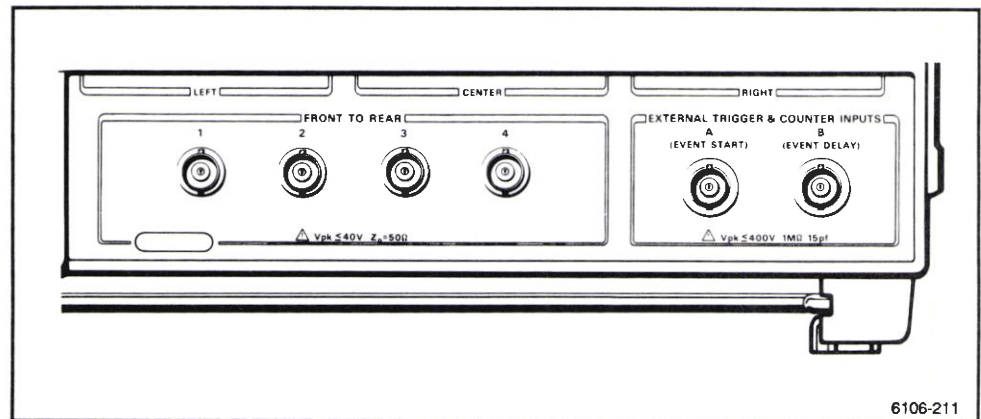


Figure 2-12. Front-panel external connectors.

The FRONT TO REAR bnc connectors allow input to the plug-in amplifiers through the instrument from the rear panel. These are 50Ω impedance coaxial cables.

Rear-Panel Connectors

Refer to Figure 2-2, Rear-panel illustration, and Figure 2-13.

The SWEEP GATE OUTPUT provides a signal derived from the Main or Delayed sweep gates as selected from *I/O Bnc* function choice in the UTILITY menu.

The COUNTER REF CLOCK allows a 10 MHz reference to be connected into or out of the Counter as selected from the *I/O Bnc* function choice in the UTILITY menu.

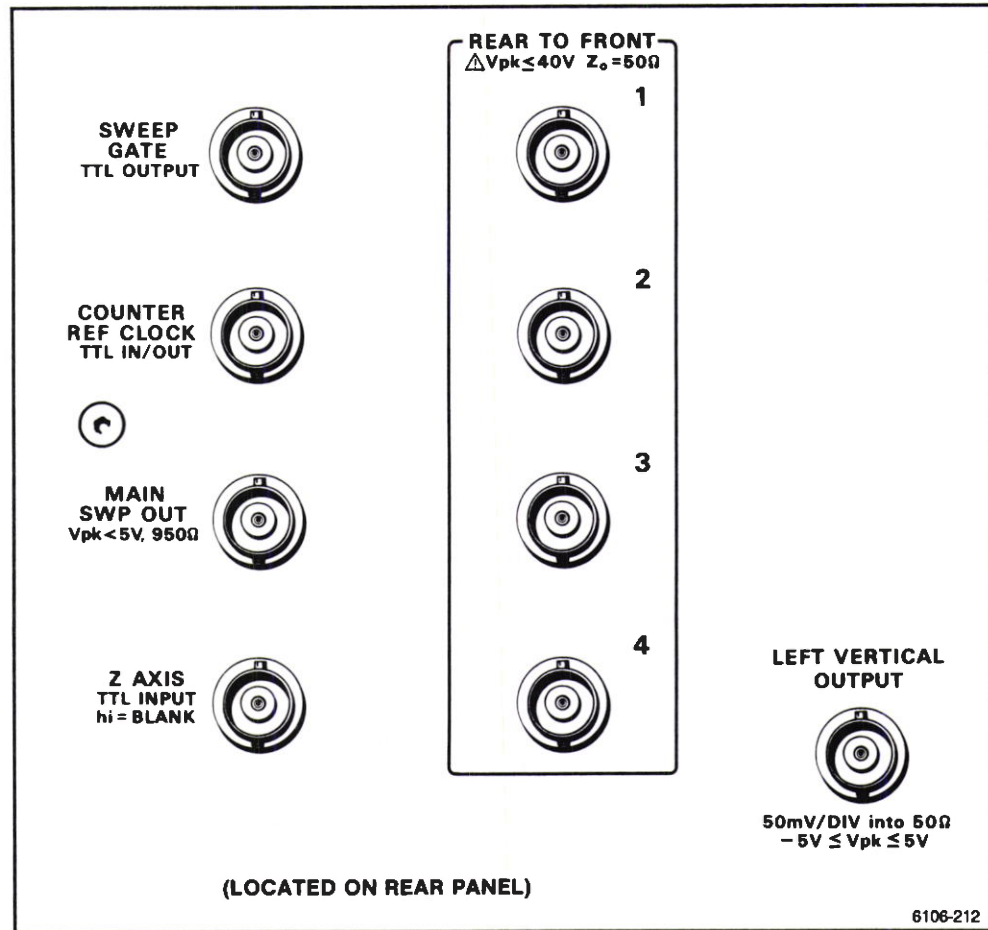


Figure 2-13. REAR TO FRONT and signal-controlling input/output connectors.

The COUNTER REF CLOCK allows a 10 MHz reference to be connected into or out of the Counter as selected from the *I/O Bnc* function choice in the UTILITY menu.

The MAIN SWEEP OUTPUT is a sawtooth signal derived from the Main time base.

The Z-AXIS INPUT is an external control for intensity modulation of the display.

The four (eight optional) bnc REAR TO FRONT connectors correspond to the four connectors on the front-panel. These are a direct feedthrough for convenience.

LEFT VERTICAL OUTPUT is an output signal from the LEFT compartment trigger signal.

Refer to Figure 2-2, Rear-panel illustration, and Figure 2-14.

The TRIGGER RESET input bnc connection allows you to abort and arm the Counter/Timer measurements and sweeps in progress on a high to low transition.

The TRIGGER READY output bnc connector signals when the Counter/Timer and sweeps have been armed by the TRIGGER RESET signal or front-panel button.

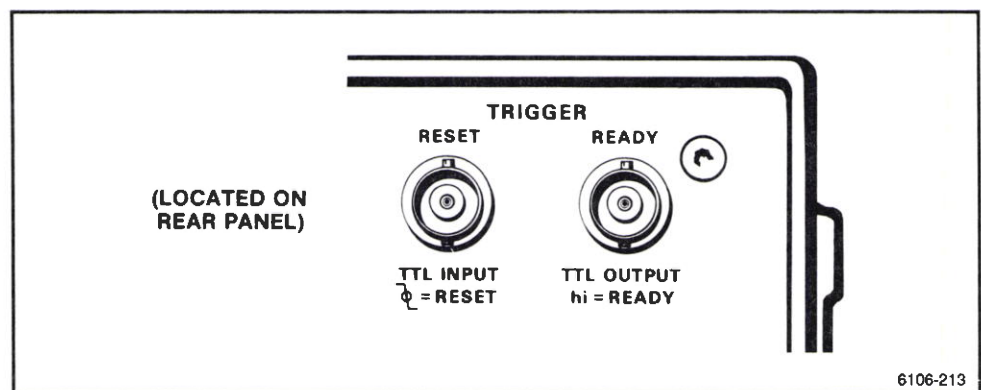


Figure 2-14. TRIGGER RESET and READY connectors.

Refer to Figure 2-2, Rear-panel illustration, and Figure 2-15.

The fan, the socket for the detachable line cord, the PRINCIPAL POWER SWITCH, the fuse, and the indicator that shows the selected line voltage are on the rear of the instrument.

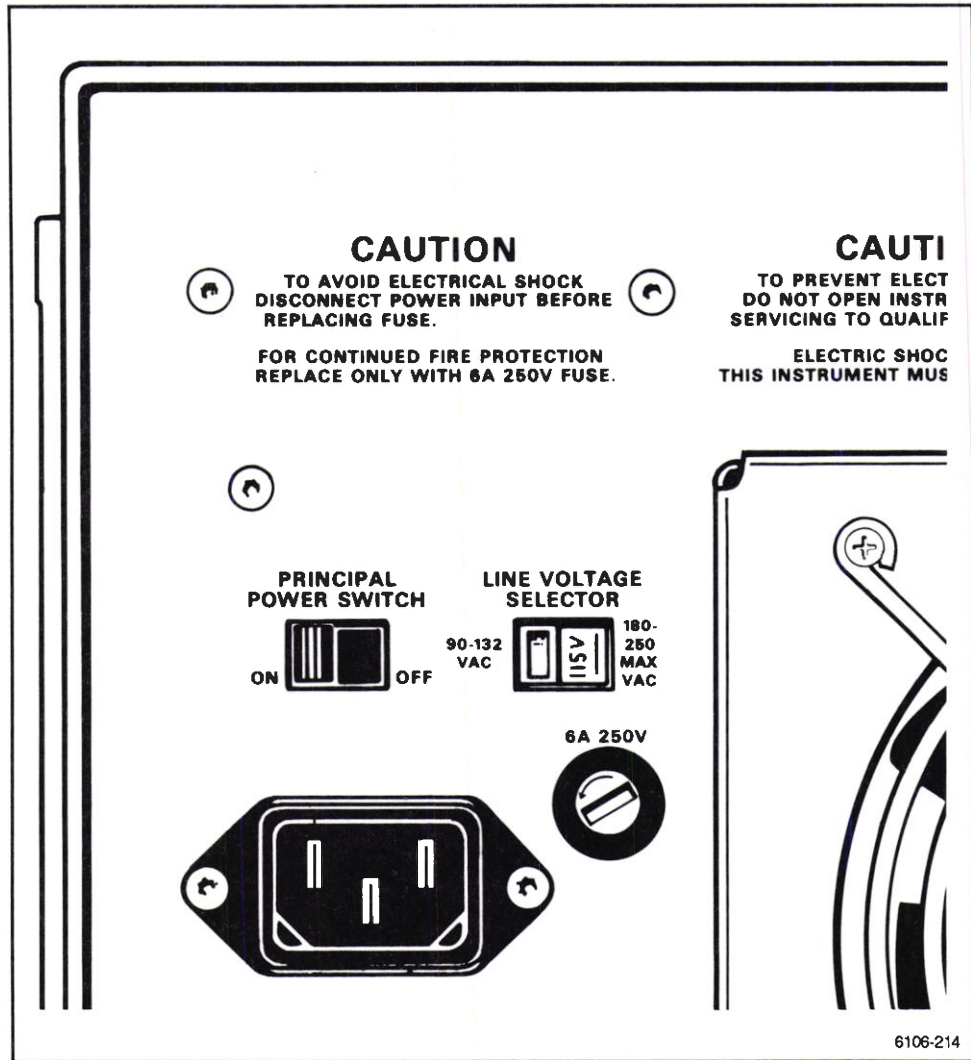


Figure 2-15 Fan, line cord socket, PRINCIPAL POWER SWITCH, fuse, and LINE VOLTAGE SELECTOR.

The fan is a variable speed, temperature-dependent, exhaust fan. The detachable power cord receptacle provides connection for the ac power source. The PRINCIPAL POWER SWITCH is the main ac power switch. The Fuse Holder contains the ac power source fuse, and the LINE VOLTAGE SELECTOR switch selects the nominal instrument operating voltage range.

RS232C and IEEE488 (GPIB) Interface Connectors

Refer to Figure 2-2, Rear-panel illustration, and Figure 2-16.

This oscilloscope interfaces with either GPIB (IEEE488) or RS-232-C instruments. These are respectively 24 pin female and 25 pin female connectors on the rear of the instrument. Please refer to "Utility" in this section for operating parameters, and refer to Section 3, "GPIB/RS-232-C Interfaces" in this manual for operation, programming, syntax, and command language.

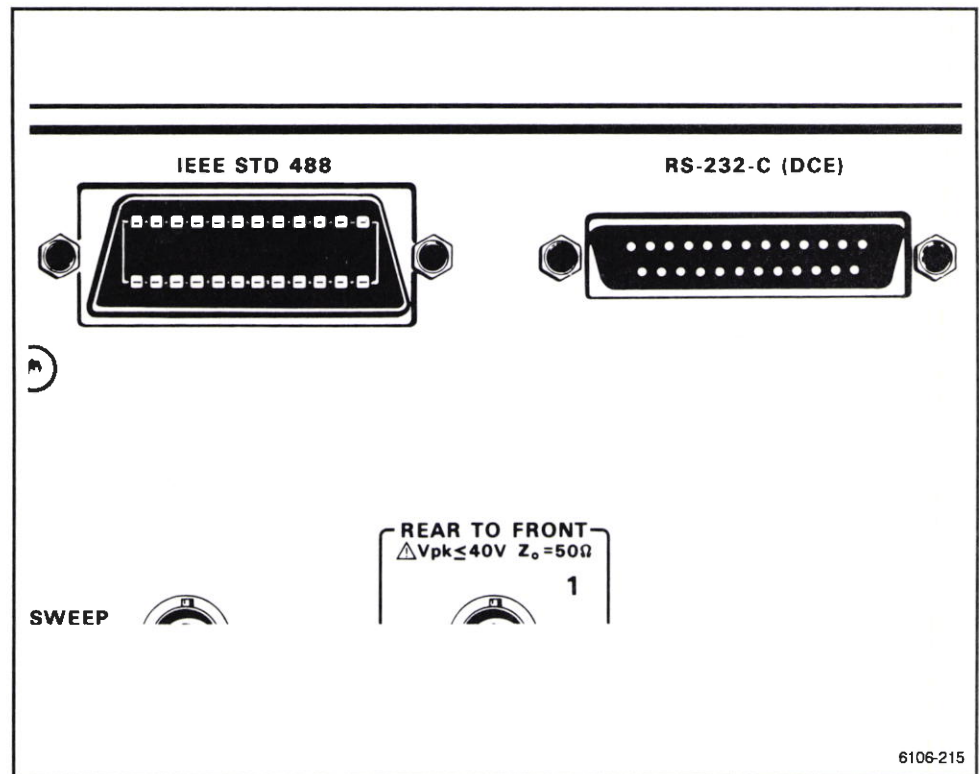


Figure 2-16. IEEE-488 (GPIB), and RS-232-C interface connectors.

Switches for Power (On/Standby and Principal Power Switch)

Refer to Figures 2-1 and 2-2, Front- and Rear-panel illustrations, and Figure 2-17.

The PRINCIPAL POWER SWITCH, which is located on the rear of the instrument, is the main power switch. The ON/STANDBY switch energizes the instrument. An indicator next to the ON/STANDBY switch illuminates when the rear power switch is in the ON position and the ON/STANDBY switch is in the ON position. (If Option 1T is installed, it will remain powered while in STANDBY).

As soon as both the PRINCIPAL POWER SWITCH and the front-panel ON/STANDBY switch are ON, a self test will verify the instrument functionality. This test can also be invoked from a menu (see "Test" under "Instrument Verification").

To electrically lock the ON/STANDBY switch in the ON position, refer the instrument to qualified service personnel.

CAUTION

Do not attempt to remove or reinstall plug-in units if the ON/STANDBY switch is disabled (locked-on). Damage to the plug-ins or the mainframe could result.

If the green light indicator remains lit after the ON/STANDBY switch is moved to STANDBY, the power has been internally locked on. To remove or replace plug-ins, use the PRINCIPAL POWER SWITCH (rear panel) to shut off the power.

To once again enable the ON/STANDBY switch, refer the instrument to qualified service personnel.

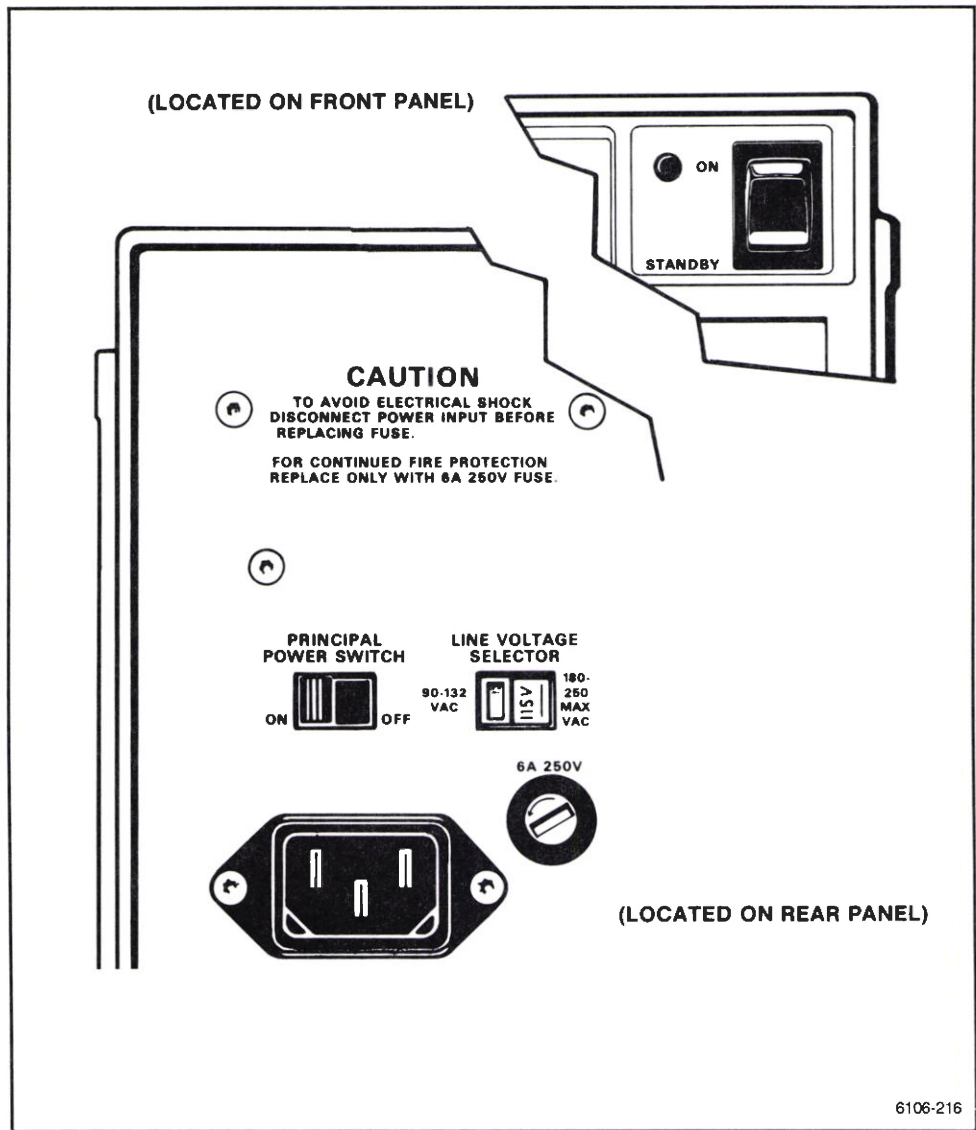


Figure 2-17. The PRINCIPAL POWER SWITCH (rear panel) and ON/STANDBY switch (front panel).

Power-Up Information

First attach the detachable power cord to the receptacle in the rear of the instrument. Once this is done, the oscilloscope must be plugged into the appropriate power source. See Section 1, "Operating Power Information." After this is accomplished, slide the PRINCIPAL POWER SWITCH located on the right side on the rear of the instrument to the ON position. The front-panel ON/STANDBY switch on the right, upper corner of the instrument applies power to the entire oscilloscope. Press this switch to ON. An indicator next to the ON/STANDBY switch illuminates when both the PRINCIPAL POWER SWITCH and the ON/STANDBY switch are in the ON position.

The PRINCIPAL POWER SWITCH is meant to remain ON; thereby, keeping the power supply and the optional Counter/Timer oven constantly in the "warmed up" condition. The ON/STANDBY switch must be in STANDBY when inserting or removing plug-ins. (See "Installing Plug-in Units" in Section 1 of this manual.

In computer controlled applications, it may be desirable to disable the front-panel ON/STANDBY switch. There is a means to secure it electrically in the ON setting; this procedure is to be performed only by qualified service personnel.

CAUTION

To prevent possible damage to plug-in units or the mainframe, do not attempt to remove or install plug-in units if the green power-on indicator is ON. Turn ON/STANDBY switch to STANDBY, then remove plug-in(s).

If the green indicator light remains ON when the STANDBY position of the ON/STANDBY switch is selected, the switch has been internally disabled.

To remove or reinstall plug-in units, use the Principal Power Switch (rear panel) to shut OFF the power. This will prevent damage to either the plug-in or the mainframe.

To once again enable the ON/STANDBY switch, refer the instrument to qualified service personnel.

As soon as both the PRINCIPAL POWER SWITCH and the front-panel ON/STANDBY switch are ON, a self-test verifies the instrument functionality. This test can also run from a menu (see "Test" under "Instrument Verification" in this subsection and "Test" under "Utilities" later in this section for detail).

The settings upon power-up will be the same as when previously powered-down. If these settings are not desired, you may initialize the instrument to a predefined known state. See the discussion of "Oscilloscope Initialization" in this subsection and also see "Initialize" in the "Utility" subsection.

Instrument Verification

The functionality and accuracy of the instrument is verified in several ways: calibration, diagnostics, and self-test.

Calibration

The 11301 and 11302 Programmable Oscilloscope has the ability to calibrate itself to achieve a state of enhanced accuracy. Enhanced Accuracy is typically twice Not-Enhanced Accuracy. All accuracy specifications pertain to Enhanced Accuracy with all plug-in compartments full to ensure proper ventilation.

To invoke the self-calibration process, press the EA button labeled ENHANCED ACCURACY near the top of the instrument. Since it is easy to inadvertently press the EA button, a second confirmation push of the EA button is necessary to actually cause calibration to begin. Any different second action that is not another EA button push will cancel the pending button push. The first time the EA button is pressed, the following message appears on the screen.

“Press EA again to confirm request”.

If calibration is successful, the following message will be displayed at the completion of the process.

“Self calibration completed successfully”.

There are actually four states of accuracy that can exist. They are warm-up, new configuration, not-enhanced, and enhanced. When the oscilloscope is first powered on, accuracy is in the warm-up state for the first 20 minutes. When the warm-up period expires, one of the other three states is entered depending on a number of factors. See the state diagram in Figure 2-18.

If there has been a change in plug-in units since the last time the oscilloscope was enhanced, the state of new configuration is entered; otherwise, the state of not-enhanced is entered. At either of these two points, if self-calibration is in Auto mode, the calibration process is started automatically and the enhanced accuracy state is entered at the completion of calibration.

Once in the enhanced state, the system (including plug-ins) will remain enhanced until the internal temperature changes by more than 5 degrees Celsius. If that happens, accuracy reverts to not-enhanced unless self-calibration is in Auto mode in which case the calibration process is started automatically.

Self-calibration can be either **Auto** or **Manual**. If **Auto MODE** has been selected in the Calibration menu and the warm-up period has expired, self-calibration will automatically begin anytime that the accuracy is not enhanced.

If **Manual MODE** has been selected in the Calibration menu and a new plug-in has been installed since the last calibration, the following message will appear when the 20 minute warm-up period expires.

“Warmup Complete. New config requires Cal. Press EA”

If the Calibration **MODE** is **Manual** and the accuracy is enhanced, then if the temperature changes by 5 degrees Celsius or more, accuracy becomes not-enhanced and the following message is displayed on the screen.

“Temp change since last Cal. Press EA to restore”

See “Calibration” in the “Utilities” subsection for information on how to change the self-calibration mode from Auto to Manual and vice versa.

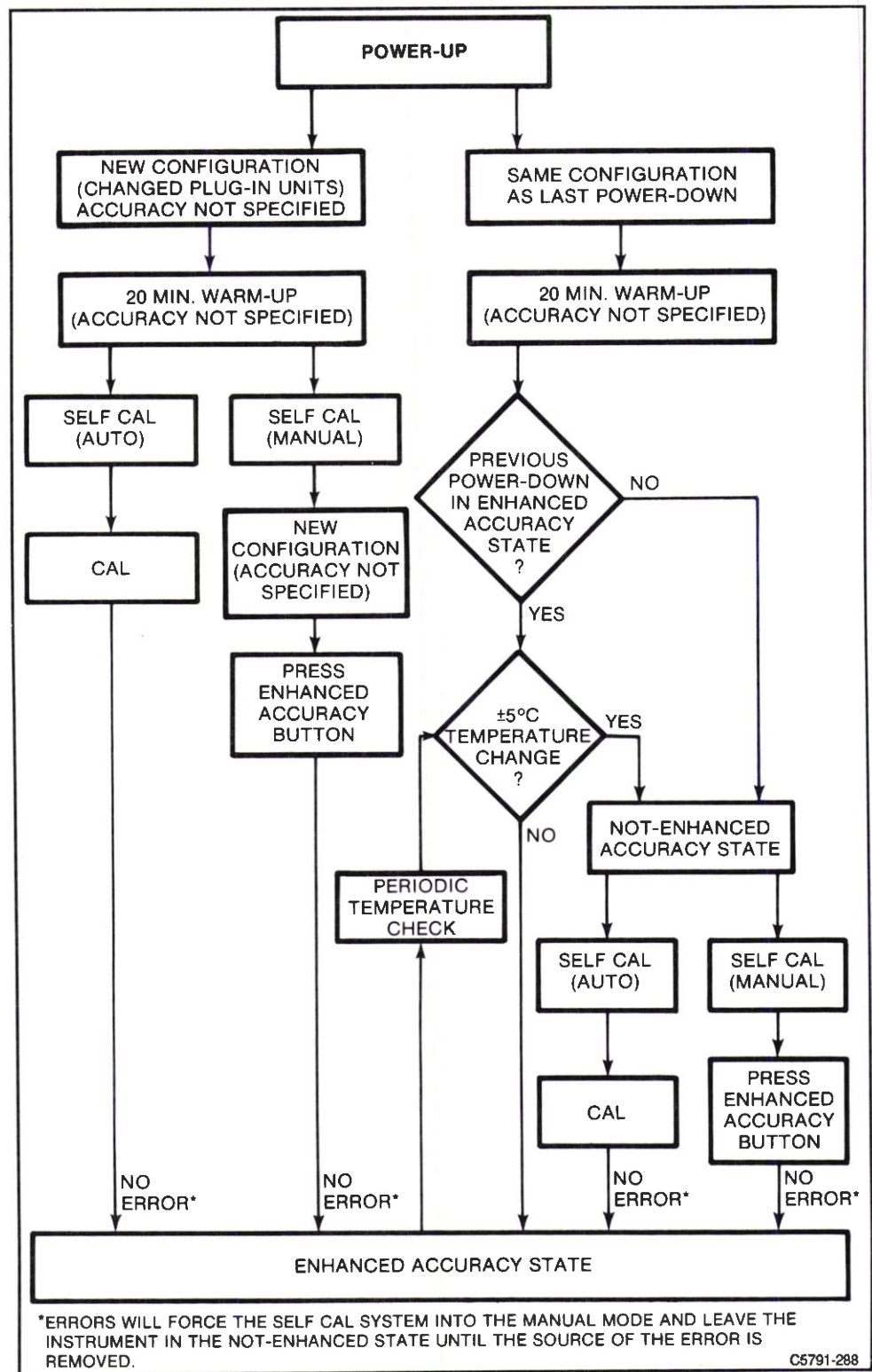


Figure 2-18. State diagram for Enhanced Accuracy.

If for some reason the instrument failed to calibrate, the instrument is left in the not-enhanced state, the self-calibration mode is automatically changed to Manual, and a message explaining the failure is displayed.

WARNING

It is inadvisable to change the configuration of the oscilloscope system while Enhanced Accuracy is being performed. For best results DO NOT attach or remove probes at the plug-ins and DO NOT remove or insert plug-ins during the Enhanced Accuracy process.

To indicate when the instrument is in Enhanced Accuracy, the symbol E_A will appear in the lower right hand corner of the screen at the end of the line that contains the value of the right knob. See Figure 2-19. When accuracy is anything but enhanced, this icon will not be displayed.

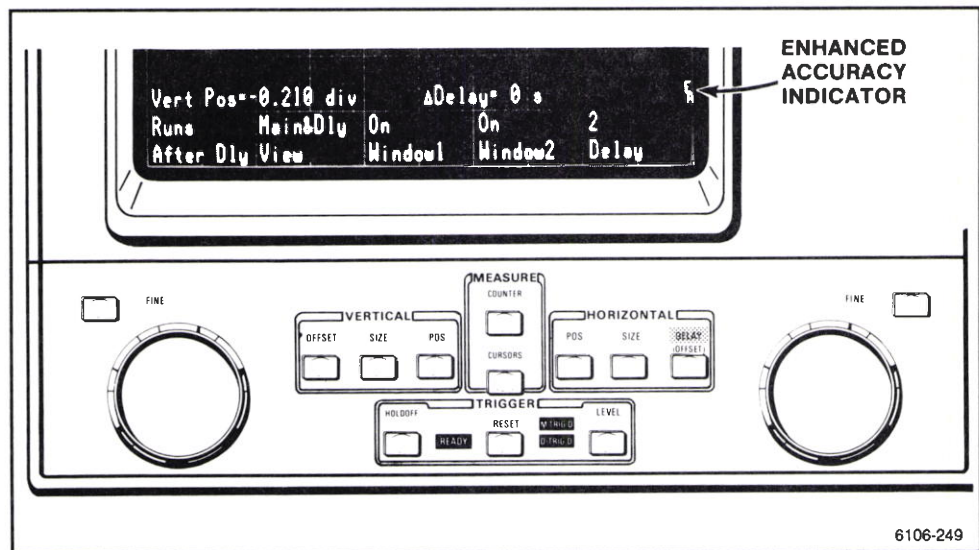


Figure 2-19. Enhanced Accuracy indicator on the lower right of screen.

Attempting to run calibration before warm-up period has expired results in the following message being displayed where N is the number of minutes remaining before the 20 minutes are up.

“Enhanced Accuracy avail after warmup in N minutes”

Diagnostics

These procedures check and adjust performance criteria. They should be used by qualified service personnel only.

Diagnostics, Cal, and Test contribute to overall functionality and performance accuracy of the instrument and should be considered as a whole and not in part.

Self-Test

Test (self-test) verifies the functionality of the instrument prior to or during normal operation. Test is intended to exercise a major portion of the instrument circuitry to determine if that circuitry is functioning properly.

Test runs automatically without operator intervention and is invoked as a single unit through GPIB and RS-232-C commands selected from the Test menu accessed through the UTILITY major menu, or by moving the ON/STANDBY switch to ON (assuming the PRINCIPAL POWER SWITCH is also ON).

The Test feature may be disabled from automatic calibration through *Cal* in the UTILITY menu.

GPIB and RS-232-C

Test will be invoked by sending the command TEST to the instrument. While Test is in progress, the busy bit is asserted. If RQS is ON and SRQMASK OPCMPL is ON, upon completion of Test the normal GPIB communication protocol of asserting SRQ with status byte will follow.

UTILITY Menu

Test may also be invoked from the UTILITY menu. See the "Utilities" subsection for more detail.

Power On

Test first tests the mainframe, then proceeds to test any installed 11A-series plug-ins. When Test is first invoked, it performs two sets of tests: kernel verification and instrument verification. Kernel verification turns all LEDs on the front panel on. When kernel verification completes with no failures, all the LEDs are turned off and Test automatically goes into instrument verification.

If no faults are encountered, the self-test completes in about two minutes, sending the POWERON event code to the RS-232-C and GPIB buses and returns the oscilloscope to normal operating mode. Any failure causes the SELFTEST FAILED event code to be sent to the external buses and the extended diagnostic block menu to be placed on the screen if possible. The Test halts at any failure; pressing any major menu button will continue the test.

If a fault is detected during kernel verification, a two-LED code will blink on the major menu LEDs indicating the device in question.

NOTE

Since failure codes refer to specific devices, they are not listed here. Devices should be replaced by qualified service personnel.

If a fault should occur once into instrument verification, the display then shows a block menu and the failed parameter is shaded.

In some cases, a noncatastrophic failure may occur and you may choose to continue to use the instrument. The instrument may still be operable, but Tektronix cannot guarantee its accuracy. The instrument should be referred to qualified service personnel immediately. Consult your service department, local Tektronix Service Center, or nearest Tektronix representative for additional assistance.

Self-test Not at Power On

When self-test is run other than at power on, either the "SELFTEST PASSED" event or the internal Error event "SELFTEST FAILED" message is sent to the source of the test invoked. Additional information on a test failure is possible by using the Ext Test entry in the UTILITY menu or TEST? on an external interface.

Oscilloscope Initialization

To set the Programmable Oscilloscope to a known starting state, press the UTILITY major menu button and touch the *Init* selection on the screen. This will bring the oscilloscope to the conditions shown in Table 2-1. Refer to "Initialize" in the "Utilities" subsection.

TABLE 2-1
Initial Oscilloscope Conditions

Selection	Subset	Function	Setting	Comments
Traces				All are deleted.
Autoset		Amplitude Timing	On On	
Knob Assignments		Right Knob Left Knob	Vertical POSition Horizontal POSition	No control menu displayed.
Vertical POSition		Position	0.0 div	
Plug-ins			Depends on plug-ins	
Horizontal SIZE and POSition		Display 10X Mag Main Time/div Dly'd Time/div Position	Auto Off 100 μ s 10 μ s 0.0 div	
Horizontal Delay		After Dly View Window 1 Window 2 Delay Delay 1 Delay 2	Runs Main&Dly Off Off 1 100 μ s 800 μ s	
Cursors	Horizontal	Solid Position Dotted Position Set Ref Tracking % Degree	3 divs left of center 3 divs right of center 5 divs Off Off	No Cursors displayed.
	Vertical	Solid Position Dotted Position Set Ref Tracking % dB	2 divs below center 2 divs above center 5 divs Off Off	
Intensity		Knob Selection CHAR MAIN DLY'D XY GRAT	CHAR (characters) Factory Preset Factory Preset Factory Preset Factory Preset 0%	

TABLE 2-1 (cont)
Initial Oscilloscope Conditions

Selection	Subset	Function	Setting	Comments
Counter	Measure=Off	None	None	
	Measure=Frequency	Averages Gating Update Source Reference	Auto Off Auto Main Trig 0.0	
	Measure=Period	Averages Gating Update Source Reference	Auto Off Auto Main Trig 0.0	
	Measure=Width	Averages Gating Update Source Reference	Auto Off Auto Main Trig 0.0	
	Measure=Ratio	Averages Gating Update Source Reference	Auto Off Auto M&D1 Trig 0.0	
	Measure=Total	Gating Update Source	Off Stopped M&D1 Trig	
	Measure= Time A→B	Averages Update Source Reference	Auto Auto Swp Start 0.0	
Trigger Holdoff	Holdoff=Time			Setting= minimum available at 100 μ s/div.
	Holdoff=Events	After HO One Start Count Start	Runs Off 2 ns Main Trig	
Trigger Level	Main	Level Mode Sensitivity Coupling Slope	0 div (midrange) P-P (Peak-to- Peak Auto) Medium Dc +	
	Dly1 and Dly2	Level Sensitivity Coupling Slope	0 div (midrange) Medium Dc +	
	CT Ext A and CT Ext B	Level Slope	0.0 +	

TABLE 2-1 (cont)
Initial Oscilloscope Conditions

Selection	Subset	Function	Setting	Comments
Trigger Source Major Menu		Main Dly1 Dly2		No triggers defined, in trigger pend- ing state.
Waveform Major Menu		Ref Wfm1 Ref Wfm2	All zeros All zeros	
Measure Major Menu		Meas List	No measurement selected.	
Store Recall Major Menu		No change		
Disp Adj Major Menu		Focus Astig Trace Rot Δ Main (contrast) Δ Char (contrast)	No change No change No change 50% 20%	
Utility Major Menu	Autoset	Amplitude Timing	On On	
	Beep	Buttons	Soft	
	Calibration	Mode	Man	
	Cal Signal	Type Amplitude Frequency	Sq Wave 5 V 1 kHz	
	Ext Test	No setting		
	GPIB	No Change	No Change	
	Input/Output Bnc	Gate Out Ref Clock	Main Int	
	Probe Cal	No selection		
	Probe ID	Autoset Sequence Measure	On Off Off	
	RS232	No Change	No Change	
	Test	No setting		
	Time and Date	Date Time	Off Off	

TABLE 2-1 (cont)
Initial Oscilloscope Conditions

Selection	Subset	Function	Setting	Comments
GPIB/RS-232-C		Display Text	Dots None	Text string cleared.
	Waveform Memory	Output Input Encoding XMULT XINCR XZERO XUNIT YMULT YZERO YUNIT	ST01 ST01 Ascii 100 1 0 "knot" 1 0 "slug"	
	Setting	Encoding	Ascii	
	Redirect	GPIB RS232 LONGFORM DEBUG FPANEL	OFF OFF ON OFF ON	
	SRQMASK	CMDERR EXERR INERR EXWARN INWARN OPCMPL USER IDROBE CALDUE	ON ON ON ON ON ON OFF OFF ON	
	Interrupts	RQS	ON	

Display Area

This subsection discusses the operation of the display.

In analyzing how novice users tend to learn the operation of the oscilloscope, we find they base their choices by observing the response in the display area while "experimenting" with the controls. Therefore, each selection is executed immediately to give you reinforcement and feedback needed to learn the operation of the instrument. Viewing all possible settings at one time is not necessary.

All operation, presentation, and definition apply to both the 9.8 cm x 12.2 cm 11301 crt display and the 8 cm x 10 cm 11302 crt display. Figure 2-20 shows the display format.

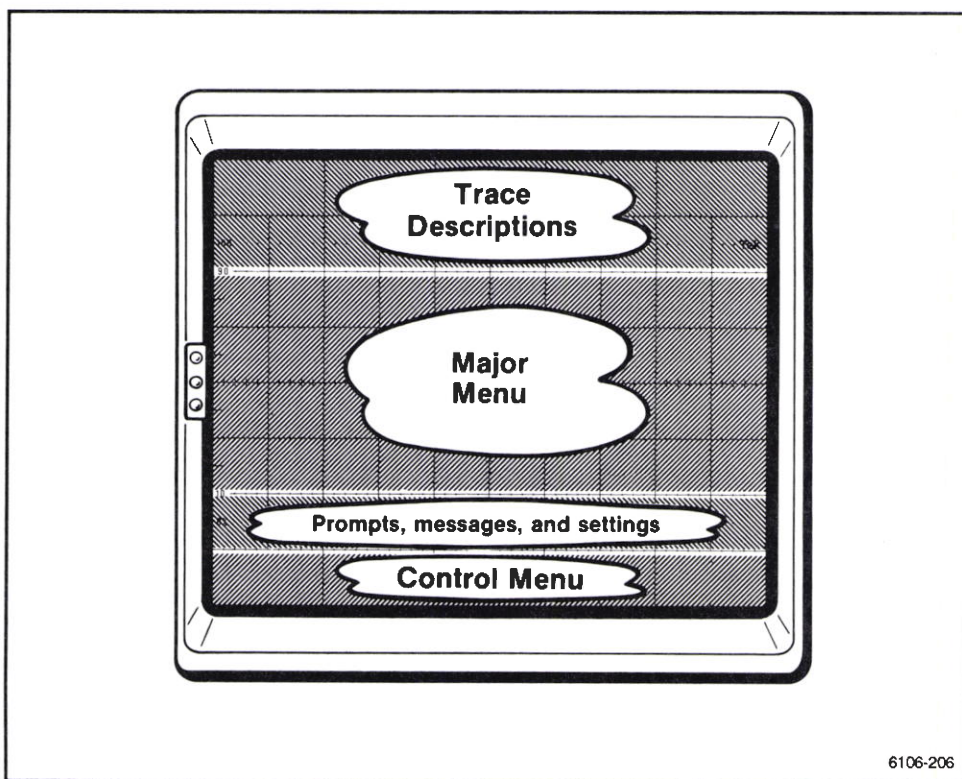


Figure 2-20. Display Format.

To display a menu you must first push either a major-menu button or a control-menu button. Each menu gives you choices that may be selected or changed by touching areas on the screen.

Control Menu

In this discussion, the general behavior of the control dependent menu is defined. The choices presented are those we anticipate to be especially convenient or that interact with a particular adjustment. Traditional front-panel controls (buttons) for modes, coupling, etc. are found in the control menu. This allows immediate access to other functions that interact with the present setting. These menus appear near the bottom of the display (see Fig 2-20).

Touching a menu function repeatedly causes its state to cycle through several choices. There is no need for a lengthy menu history (trail) as the control menu is the result of the most recent knob assignment.

Access to Control Menu

Pressing one of the buttons (except COUNTER and TRIGGER RESET) located between the two control knobs below the crt assigns one or both of the knobs. (CURSORS are assigned when either **Horiz** or **Vertical Cursors** is selected). Whenever a knob is assigned to a desired function, a menu appears at the bottom of the display just above the knobs. This menu appears only if there are some relevant or related choices to offer. For example, when using the 11A32, selecting the VERTICAL SIZE knob assignment displays a menu offering choices to control *Input Coupling*, *Input Impedance*, and *HF Limit*. Each choice and present status occupy a touch zone, touching that area changes the status. Repeated touching of the function cycles or scrolls through the available states. For example, touching *Coupling* when it's set for **Ac** changes it to **Dc**, touching again changes it from **Dc** to **Off**, and touching another time returns it to **Ac**. (See Figs. 2-21 and 2-22.)

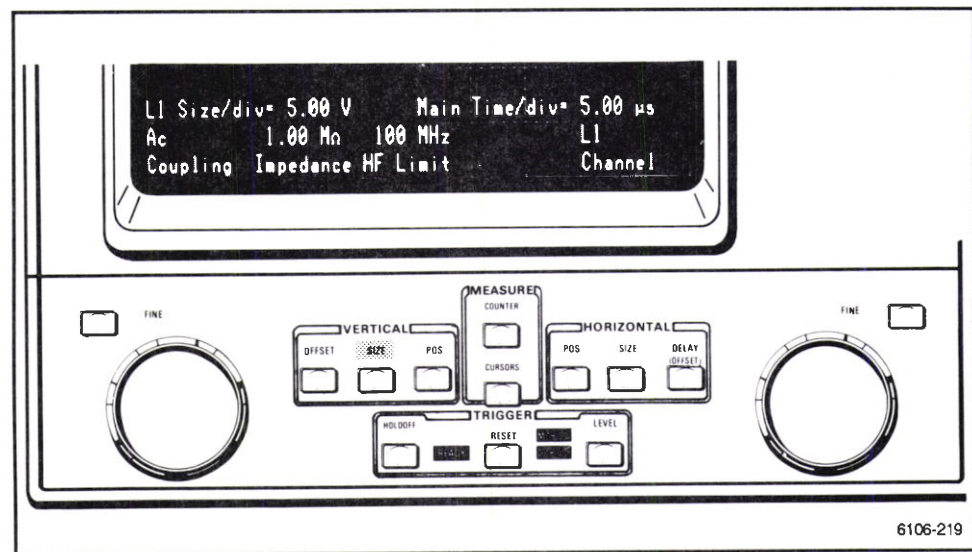


Figure 2-21. The Vertical menu with **AC Coupling** selected.

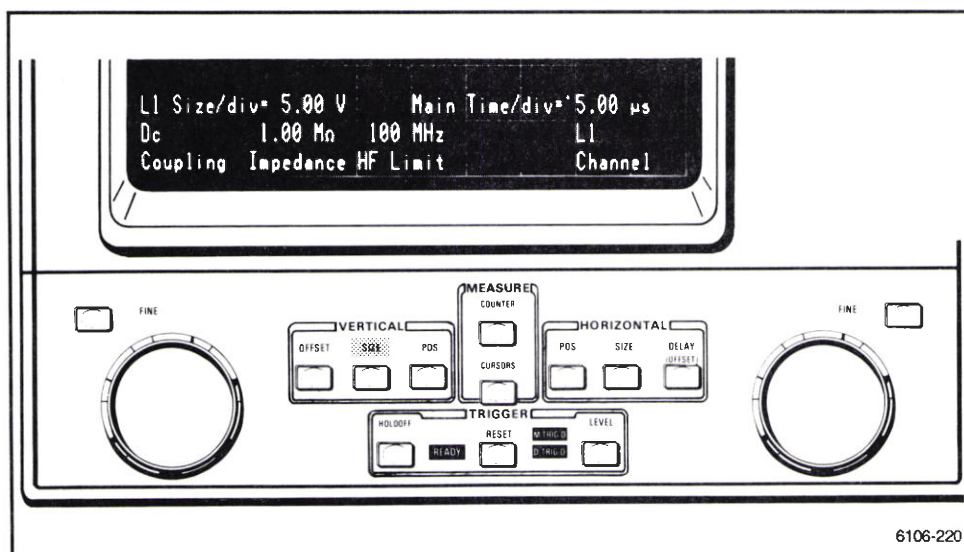


Figure 2-22. The Vertical menu with DC Coupling selected.

When another knob assignment is made, the associated menu has priority over the previous control menu and removes the old menu from the display. Although the state of the previous control menu is maintained, the menu itself can be accessed only by changing the knob assignment back to the previous one. Knob assignments for a given control are mutually exclusive, that is, choosing a new assignment cancels the previous one.

Alternate presses of any control button will remove and restore its menu. By such action, a menu can be turned on (see Fig. 2-23) for making selections or turned off (see Fig. 2-24) to make more area available for viewing traces. When turned off, the prompting message line and the knob setting line drop to the bottom two display lines.

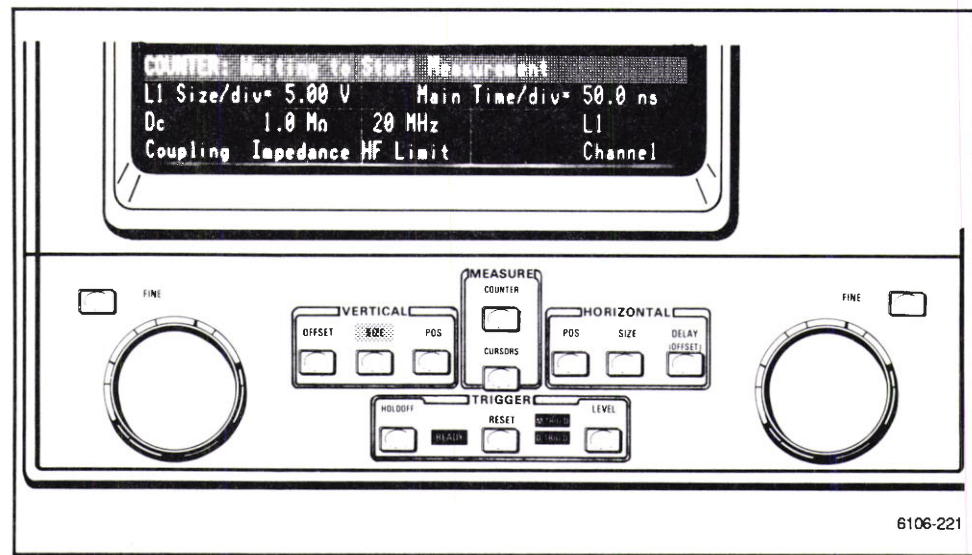


Figure 2-23. The prompt line, the knob setting line, and the two-line menu lines. This menu is On.

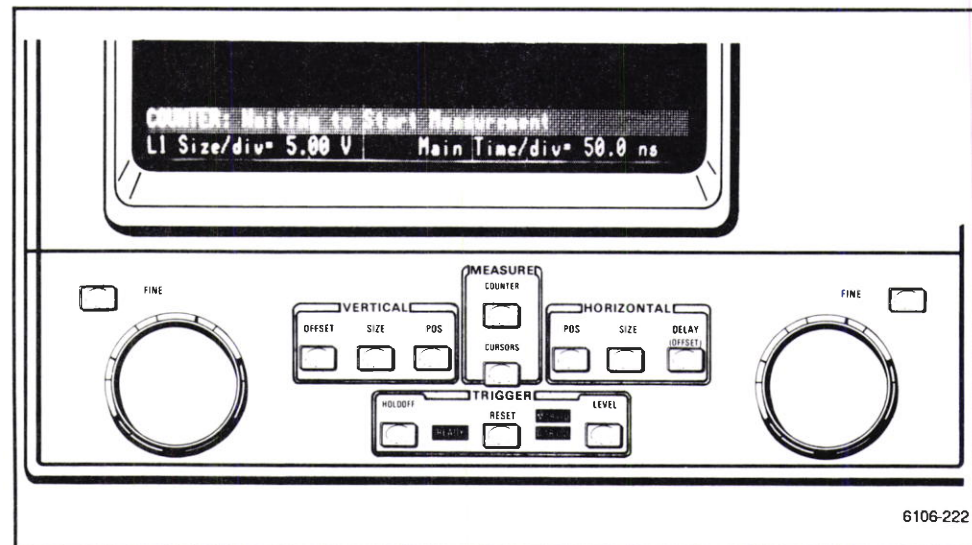


Figure 2-24. When the menu is Off, only the prompting and knob setting line appears.

Control menus can be operated as long as the associated control is still active even while major menus are active (except for the DISP ADJ major menu). To let you maintain control over the knob assignments, the knobs are not generally commandeered and reassigned by a major-menu action except for a few calibration adjustments.

For different knob assignments, the behavior of the knob may be different. For example, adjusting vertical offset is usually controlled in linear increments, whereas the time-base time/div is controlled in exponential increments (1-2-5-10...). In addition, the FINE button can change the time/div increments from coarse exponential to fine linear ones.

The buttons, located between the two knobs below the display, call seven different types of control menus when pressed: VERTICAL SIZE, POSition, or OFFSET buttons display the Vertical menu; HORIZONTAL SIZE and POSition display the Horizontal menu; HORIZONTAL DELAY displays the Delay menu; TRIGGER HOLDOFF displays the Holdoff menu; TRIGGER LEVEL buttons displays the Trigger Level menu; the COUNTER button displays the Counter/Timer menu; and the CURSORS button displays the Cursor menu.

Knobs

The two large knobs located below the display (crt) are assigned their functions by the adjacent buttons. (See Table 2-2.) To use these knobs see "Control Menu" and specific control menus: Horizontal, Vertical, Trigger, Counter, and Cursors.

TABLE 2-2
Knob Assignments

Menu	Left Knob	Right Knob
VERTICAL	OFFSET SIZE POSition	No change
COUNTER	No change	No change
CURSORS Horizontal Vertical	Solid cursor Solid cursor	Dashed cursor Dashed cursor
TRIGGER HOLDOFF	HOLDOFF	No change
TRIGGER LEVEL	No change	LEVEL
HORIZONTAL	No change	POSition SIZE
HORIZONTAL DELAY		DELAY
DISP ADJ	Focus	Astig Trace Rot Δ Main Δ Char

Major Menus

To the immediate right of the crt is a column of "major menu" buttons. These mutually exclusive buttons provide a direct path to major or complex menu structures independent of previous selections. When a selection is made, the previous menu is exited. If the previous operation was incomplete, it will be terminated and revert to the previous operation.

A history of the last menu state or condition is maintained, so when entered later, conditions are as they were when previously exited. Major menu buttons are alternate action (alternate presses of the same button displays or exits and removes the menu) and mutually exclusive of each other.

On major menus, a visual acknowledgement to a touch selection is displayed to indicate the interpretation of the selection by the oscilloscope. The oscilloscope shades the area around the menu entry it thinks you selected. In this way you get feedback, so your aim can be adjusted or you can change your mind if you erred.

Numeric Displays

Numeric displays of settings and computed results are formatted as a mantissa followed by a symbol serving as exponent (power of ten) followed by a dimension or unit. The mantissa is greater than or equal to one and less than 1,000. The exponents are integer multiples of three as represented by accepted SI (Système International d'Unités) notation (e.g., $10^3=k$, $10^{-6}=\mu$, etc.). Any exceptions are noted in this document.

Prompt and Message Areas

A prompt line appears near the bottom of the display. Helpful messages will be displayed prompting you to take corrective action after an error occurs or to clarify an operation. Any advisory message (prompts, errors, warnings, etc.) appears with background shading over the entire line (see Fig. 2-25).

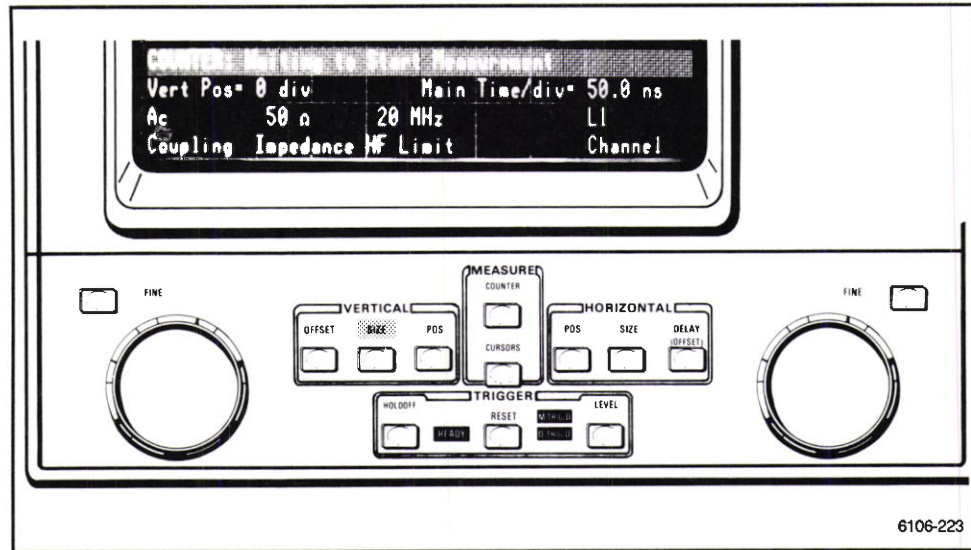


Figure 2-25. The Vertical menu with a helpful message.

Touch Panel

The Touch Panel allows you to make choices by touching the screen. A touch interrupts an infrared light beam that is transmitted across the crt (parallel to the screen surface) to sensors. Interrupting the light beam is interpreted into a viable function similar to pushing a button. After touching a selection, menus give visual acknowledgement by changing the parameter status presented on the screen or by shading a selected choice.

Waveform Display

Traces are defined and displayed three ways: one way uses the WAVEFORM major menu method; a second, simple method, is pressing the display on/off button of a plug-in channel; and finally, by pressing the probe ID button. See the "Waveform Acquisition" subsection for details.

When a trace is selected, its intensity is temporarily boosted (increased) for approximately one second to aid in identifying it from other traces.

If the trace uses only one input channel or uses two input channels having the same sensitivity or is an XY trace using only two input channels, the vertical scale factor is displayed as part of the trace description.

Up to eight unique waveforms can be displayed. An X-versus-Y trace is considered a single trace even though it can be created from two or more input signals.

Waveform Acquisition

This subsection discusses how to display a waveform. Its categories are in alphabetical order. You find your selection as you do in a dictionary.

Acquiring Waveforms

Traces may be acquired using two other methods besides the WAVEFORM major menu. These two ways are either by pressing the display on/off button on the plug-in or the ID button on the probe.

Acquiring a Trace using the Display On/Off Button

Each amplifier channel has an associated display on/off button. This is generally the only button per input channel on an amplifier. The on/off button is intended to serve as an obvious means to create and delete traces. When pressed, the input state of the channel will alternate between on and off. An illuminated LED indicates when an input is in use. The LED is off when the channel is not used.

When a channel display is turned off, all traces using the channel will be deleted! No history will be maintained to allow for recovery if the display is accidentally turned off. When the display of the channel is turned on again, only one trace is created: that channel versus the main time base.

Acquiring a Trace with the Probe ID Button

Pressing the probe ID button from the LEFT or CENTER compartment always (unless Front Panel Lockout is in effect) results in a defined trace without the need to access any menus if the channel isn't already in use and if there is space to create a new trace. This method is limited to designating a trace that is composed of an individual input channel versus the Main time base. It is most likely that this represents a common configuration used by the majority of oscilloscope users.

If an XY display or a multiple input-channel composite trace is desired, it must be constructed using the WAVEFORM major menu choices (see "Waveform Menu" at the end of this subsection). When invoked, this large menu appears offering the means to create a new trace. From this menu, all available input channels can be combined into a maximum of eight unique traces including delayed and XY traces.

If the WAVEFORM major menu is displayed, the probe ID buttons behave the same as when the menu is not displayed, that is, pressing the ID button creates and completes the trace. "ID Chan1" + "ID Chan2" is not permitted.

Autoset

The Autoset feature helps to create an acceptable oscilloscope display. This feature is intended to assist you so that only a few simple modifications are required to obtain the desired display. No attempt is made to judge or guess which of the previous oscilloscope settings should be left unmodified. For example, triggering will always be affected. The *Autoset* selection from the UTILITY menu allows you to disable the amplitude or time base scaling.

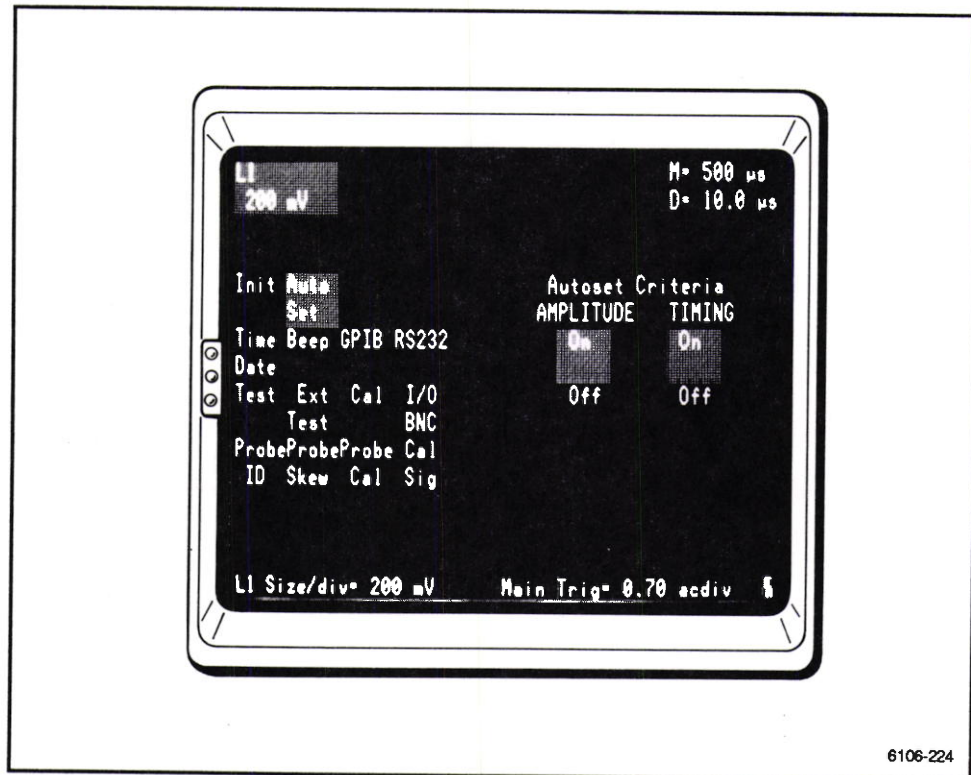


Figure 2-26. Autoset menu.

Autoset Operation

Assuming that *Autoset* and *Probe ID* are enabled, Autoset can be initiated by pressing one of two buttons: the ID button on the probe or the AUTOSSET button on the mainframe. Pressing either button initiates the process once. No action relating to Autoset is taken when the button is released.

NOTE

If Front Panel Lockout is in effect, Autoset cannot be initiated through the front-panel or probe ID button.

Autoset does not continually monitor the trace or input and make adjustments whenever it sees fit. Instead, you ask for it to take control momentarily. When the oscilloscope has either found and displayed the signal or given up, control is returned to you.

When setting a channel, the algorithm attempts to preserve dc coupling by offsetting the signal to make the trace appear on the display. If there is not enough offset available to view the ac component, dc coupling is abandoned and ac coupling is used with zero offset. The use of an active probe can eliminate the Ac Coupling choice. If this happens, performing AUTOSSET will produce a warning message declaring that Ac Coupling is not available.

To set the Time/div on the main time base, the signal must have a repetition rate between about 30 Hz and 500 MHz. The delayed time-base trigger level is modified to equal the main time-base trigger level. The trigger sources for the main and the delayed triggers are set equal to the vertical component of the selected trace.

AUTOSSET Button

The mainframe AUTOSSET button acts on the selected trace. If the trace is composed of more than one input, whether for vertical or horizontal deflection, all inputs comprising the trace will be scaled. Each input channel will be scaled individually. When all of the inputs are scaled, they are combined once again into the original expression.

Timing for the main and delayed time bases is based on the composite trace by creating a trigger expression to match the trace description. In the case of XY traces, only the vertical portion of the expression will be used for the triggering.

The **Main** time base will be scaled to view a few, two to five, cycles or events of the trace if the signal has a duty factor of near 50%. The oscilloscope will scale based upon the width of the signal. The Time/div will be near the measured width. An attempt to find a positive or negative width will be made, thereby, obtaining low duty factor signals and presenting the leading pulse. The **Dly'd** Time/div will be set to view a transition (about twenty times faster than the main) rather than a few cycles. An attempt will be made to place Window 1 on the first transition relative to the start of the main sweep (zero delay). Window 2 will be placed on the next transition (the width value). The **Dly'd** Time/div and *Delay* values are not modified if no windows exist. By placing the window on a transition and adjusting its Time/div, a trace having some two-dimensional interest may help maintain your orientation.

Whenever Autoset is performed on any trace, the main time base will be adjusted. If present, the windows will also adjust whenever any trace is automatically scaled.

Probe ID Button

The ID button of any probe attached to an 11A-Series amplifier can be used to perform Autoset on its channel and the time bases. This differs from the AUTOSET button on the mainframe in that the probe ID button will only initiate the scaling of the attached input. Autoset from the probe tip allows remote initiation of the scaling process without reaching for the mainframe. In such cases, a user is typically probing around a circuit hunting for signals, and it is highly unlikely that two channels have been combined to create a trace. Therefore, the probe ID initiation method is optimized for operating on a single channel per trace. The time bases are still adjusted as described for the AUTOSET button.

The way to enable or disable the initiation of the probe Autoset is found in the UTILITY menu as *Probe ID*. As this button can take on several meanings simultaneously, this menu shows the status of the ID initiated functions. See the "Probe ID" in this subsection for more detail.

Interactions with other Functions

When Autoset is completed, the control knobs are always set to these assignments:

Left Knob—VERTICAL POSition

Right Knob—HORIZONTAL SIZE (with **Main Time Base** selected.)

Intensity Knob (top)—MAIN sweep intensity

Along with these control knob assignments, the Vertical menu of one of the inputs that has been automatically scaled is active and displayed.

Oscilloscope Functions that can be Autoset:

Vertical Menu

- VERTICAL POSition (set to zero)
- Input OFFSET
- Input *Coupling* (dependent upon offset range and sensitivity)
- Input *Impedance* (set to 1 M Ω if selectable)
- Input Bandwidth (set to maximum)

Horizontal Menu

- HORIZONTAL POSition (set to zero)
- Main and delayed 10X *Mag* (set to **Off**)
- Main and Delayed Time/div

Holdoff Menu

- HOLDOFF (set to minimum)

Trigger Menu

- Main, Dly1, and Dly2 trigger *Level* (set the same as determined by **P-P Auto**)
- Main and Delayed 1 trigger *Coupling* (set to **Dc**)
- Main and Delayed trigger *Sensvty* (set to **Low**)
- Main trigger *Mode* (set to **P-P Auto**)
- Main and Delayed trigger *Slope*
- Main, Dly1, and Dly2 trigger sources set to the vertical component of the selected trace

Delay Menu

- Delayed time base (set for **Runs After Dly**)
- Delay reference values for *Dly1* and *Dly2* (*Dly1* set to 0.0, and *Dly2* set to width value)

Intensity Levels

- Main, Dly'd, and XY

Menu Selections

The Autoset UTILITY menu provides several ways for you to specify the behavior and criteria to control automatic scaling. See Table 2-3 for a list of menu choices.

Amplitude—constraints can be selected from **Off**, nothing disturbed or **On**, which allows the oscilloscope to set the vertical sensitivity for 2 to 5 divisions of amplitude.

Timing—criteria can be specified for automatic setting of the time base. **Off** prohibits Autosetting of the time base entirely. **On** allows the oscilloscope to set the timing and triggers.

TABLE 2-3
Function Choices of the Autoset Menu

Amplitude	Timing
On	On
Off	Off

The Autoset settings when the oscilloscope is initialized are *AMPLITUDE*, **On**; and *TIMING*, **On**.

The selections for Autoset criteria are found in the Autoset UTILITY menu. To access the menu as shown in Figure 2-26, press the UTILITY button and then touch *Autoset* in the menu, not the front-panel AUTOSSET button.

More Autoset Information

If the Autosetting process fails to scale properly (the oscilloscope can't meet the criteria), the previous settings of the oscilloscope will be restored. If the signal is not found, you may expect one of these messages:

"Horizontal signal not found"
 "Vertical signal not found"
 "Signal amplitude too large"
 "Signal amplitude too small"

The conditions to expect at initialization are *AMPLITUDE*=**On**, *TIMING*=**On**, and *Probe ID* enabled for Autosetting. These conditions may be different than those at power-up. See "Oscilloscope Initialization" in the "Oscilloscope Familiarization" subsection.

Beam Find

Many oscilloscopes have a beam finder feature to help you to find an off-screen signal. Although the signal can be found and displayed automatically, the 11301 and 11302 oscilloscopes also offer the familiar beam finder. There are some advantages in that it will not disturb any oscilloscope setting while lending some reassurance as to what is going on.

BEAM FIND will cause the vertical and horizontal gain to compress, force the time bases to free run (except when HOLDOFF is not set to TIME), disable the character readout, and boost all of the display intensities for as long as the button is pressed. When the button is released, the oscilloscope is restored to its prior state.

Delayed Windows ("Delayed Sweeps")

Windows (referred to also as Delayed Sweeps) can be specified by using the HORIZONTAL DELAY menu. Up to two windows can be placed on an individual main time-base trace. That's the same as the traditional "dual-delayed sweep" configuration. Windows are indicated on the main time-base trace as intensified zones. If the main trace is deleted, its associated windows are also deleted. If a window is deleted, the associated intensified zone disappears.

Creating Windows and Intensified Zones

Provisions for creating windows appear in a control menu associated with the HORIZONTAL DELAY button. When the button is pressed, the menu choices are available as shown in Table 2-4.

Table 2-4
Horizontal Delay Menu

After Dly	View	Window1	Window2	Delay
Runs	Main	On	On	1
Trig'd	Main&Dly Dly	Off	Off	2

Repeatedly touching a menu function on the screen cycles through all of the possible choices. (See "Horizontal Menu" for details on XY traces and DELAY button.)

Intensified zones on the Main trace locate the delayed windows relative to the trigger of the Main trace. Since there are only two different delay references, the delay of all windows created using *Delay 1* are changed when delay reference one is adjusted. The same thing occurs when delay reference two is changed.

Delay —is used to assign the DELAY control knob to modify either *Delay 1* or *Delay 2*.

Window1 —selections are **On** and **Off**. **On** and **Off** refer to the window and its respective intensified zone controlled by *Delay 1*.

Window2 —selections are **On** and **Off**. **On** and **Off** refer to the window and its respective intensified zone controlled by *Delay 2*.

View —allows for the choice of viewing only the Main traces, only the Delayed Window traces, or both Main and Delayed traces. None of these selections will affect the trace descriptions. Traces will be inhibited from view in some cases, but their trace descriptions will remain displayed.

As all of the trace descriptions are touchable at any time, selecting a trace that is inhibited will force the *View* status to **Main&Dly**. This will permit viewing of the newly selected trace.

After Dly—permits qualification of the delayed zones and sweeps. It can be set for **Runs After Dly** to immediately produce a window after the delay value expires. **Trig'd After Dly** has the added qualification of requiring a trigger from the delayed time base (e.g., the proper source, slope, and level).

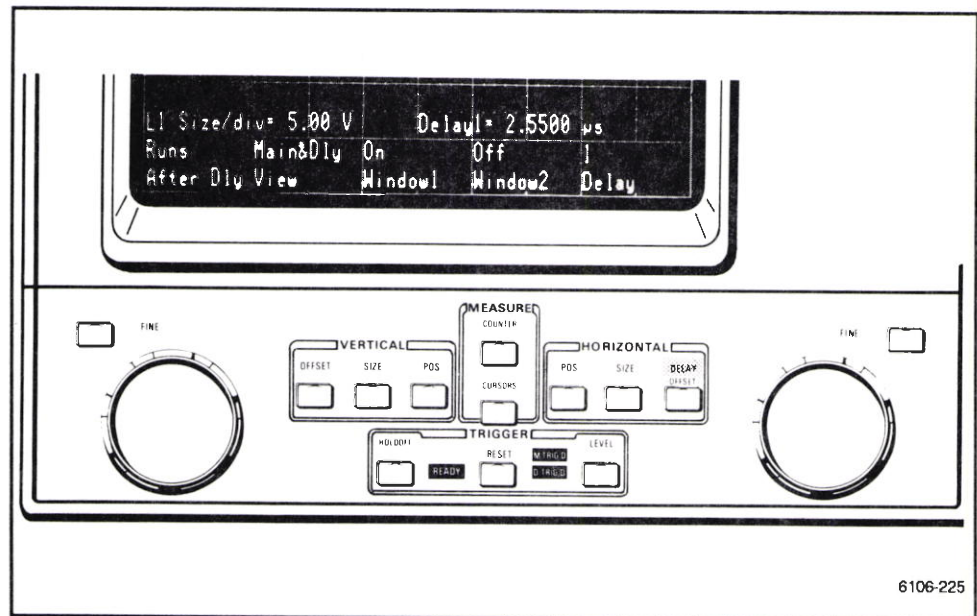


Figure 2-27. The HORIZONTAL DELAY menu for windows and YT traces.

Adjustments of the delay are made using the DELAY control knob and selecting *Delay 1* or *Delay 2* in the menu (see Fig. 2-27). There are no restrictions to inhibit the selection of either one or two.

Delay Readout

Whenever both delay references are in use (window one and two), the readout for the control knob when *Delay* is assigned is " Δ Delay." This is the difference of delay reference number two minus delay reference number one. If only one of the delayed zones or sweeps is displayed, the value reads *Delay* relative to the Main trigger.

If the Counter/Timer is engaged and measuring Time A→B, the result of the Counter may differ from the Delay reading. There are many contributing factors. The largest variation is due to manually adjusting the Delay (1 or 2) based on the intensified zones. As these are approximate indications of the start of the delayed windows, visual errors will increase with faster Time/div.

Delayed Window Restrictions

- The delay reference value cannot exceed the duration of the main sweep (10X Time/div).
- The sweep time (time span) of a window cannot exceed the sweep time of the Main time base. The Main time span must be equal to or longer than the Delayed time-base sweep time.
- No more than two windows can be created from a single Main time-base trace.
- Windows cannot be created from windows.
- Windows cannot be created from Reference waveforms. Any attempt to do so results in the following message being displayed on the prompt line.

"Cannot create a window from a reference trace"

- A window cannot be created if no Main traces exist. Any attempt to create a window when there are no traces defined results in the following message being displayed on the prompt line.

"Window trace requires a main (parent) trace"

- Windows created from XY traces can window only the vertical portion of the XY trace. The result is an intensified zone on the XY trace and a YT display of the windowed section.
- If any delayed windows are defined, the Main Time/div is restricted to sweep no faster than 10 ns/div (10X Mag=Off).
- The combined total number of delayed window traces and main traces cannot exceed eight. When no more traces can be created, touching *Window* does not change **Off** to **On** and this message is displayed:

"Too many traces. Use Waveform menu to clear one"

- If the Main Time/div is less than 10 ns (10X Mag=Off) or 1 ns (10X Mag=On) and no intensified zones are present, the Main Time/div is forced to 10 ns if 10X Mag=Off or 1 ns if 10X Mag=On when a window is created from it.

Selecting Traces

Because the traditional knobs and controls usually found on the plug-ins have been removed, there is no longer a one-to-one correspondence between individual controls and the input channels. On this oscilloscope there is only one set of controls to be shared among all of the displayed traces; therefore, they will operate only on the trace that has been "selected." Only one trace can be selected at a time.

The selected trace will be changed automatically in some cases. See "Trace Selection" in this subsection for more information.

Horizontal Menu

The following discusses the Horizontal control menu functions of POSition, SIZE, and DELAY for YT and XY traces.

Access to Control Menus

Access to control menus occurs whenever a control knob is assigned to a desired function. When another knob assignment is made, the associated menu has priority over the previous control menu and removes the old one from the display. Although the state of the previous selections are maintained, the menu itself can be accessed only by changing the knob assignment to the previous one. Knob assignments for a given control knob are mutually exclusive, that is, choosing a new assignment cancels the previous one.

NOTE

Whenever the Time/div is changed, the oscilloscope attempts to adjust the intensity (+ or -) to maintain reasonable brightness.

Horizontal Position and Size Menu and Delay (Offset) Menu

Whenever HORIZONTAL SIZE or POSition is pressed, the same menu appears (see the following examples). Table 2-5 shows the choices available in this menu.

TABLE 2-5
Horizontal Size and Position Menu Choices

10X Mag	Display	Time Base
On	Alt	Main
Off	Chop	Dly'd
	Auto	

Repeatedly touching a menu function on the screen cycles through all of the possible choices.

Delay Menu

When the DELAY button is pressed, the menu choices as shown in Table 2-6 appear (see Fig. 2-28). See "Creating Windows and Intensified Zones" under "Delayed Windows" for a complete discussion.

TABLE 2-6
Menu choices for DELAY

After Dly	View	Window1	Window2	Delay
Runs	Main	On	On	1
Trig'd	Main&Dly	Off	Off	2
	Dly			

Repeatedly touching a menu function on the screen cycles through all of the possible choices.

Intensified zones on the Main trace locate the delayed windows relative to the trigger of the Main trace. If no windows existed when powered-off, when powered-on a default choice for the delay type is **Runs After Dly**.

Since there are only two different delay references, the delay of all windows created using delay reference one are changed when delay reference one is adjusted. The same thing occurs when delay reference two is changed.

Delay—is used to assign the DELAY control knob to modify either *Delay 1* or *Delay 2*.

Window1—selections are **On** and **Off**. **On** and **Off** refer to the window and its respective intensified zone controlled by *Delay 1*.

Window2—selections are **On** and **Off**. **On** and **Off** refer to the window and its respective intensified zone controlled by *Delay 2*.

View—allows for the choice of viewing only the Main traces, only the Delayed window traces, or both Main and Delayed traces. None of these selections will affect the trace descriptions. Traces will be inhibited from view in some cases, but their trace descriptions will remain displayed.

As all of the trace descriptions are touchable at any time, selecting a trace that is inhibited will force the *View* status to **Main&Dly**. This will permit viewing of the newly selected trace.

After Dly—permits qualification of the delayed zones and sweeps. It can be set for **Runs After Dly** to immediately produce a window after the delay value expires. **Trig'd After Dly** has the added qualification of requiring a trigger from the delayed time base (e.g., the proper source, slope, and level).

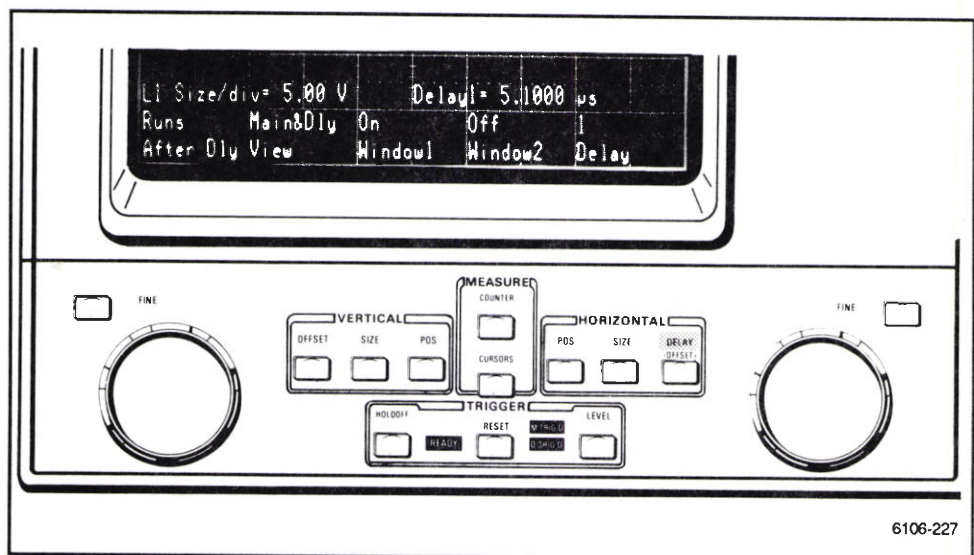


Figure 2-28. The HORIZONTAL DELAY menu for windows and YT traces.

Adjustments of the delay references are made using the DELAY control knob and selecting *Delay 1* or *Delay 2* in the menu. There are no restrictions to inhibit the selection of either one or two.

Time-Base Selection Besides the trace selection method, "Time Base Selection" is another way to designate which time base to adjust or modify in a more direct manner. The need will arise to directly specify a time base because accessing the time base indirectly through a trace description requires you to read through the list of trace descriptions to find a trace that is using the desired time base.

To select a time base you need only touch the *Time Base* choice in the Horizontal menu. When a time base is selected in this way, the oscilloscope simply alternates from the present time-base selection to the other. In addition, this direct selection implies that you prefer to bypass the selection of a trace. The selected trace remains selected.

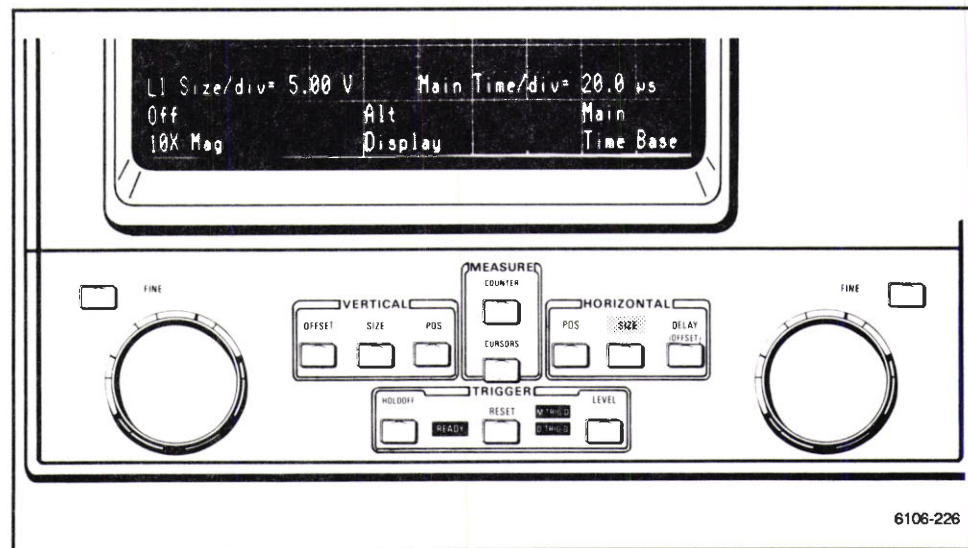


Figure 2-29. HORIZONTAL SIZE and POSition control menu for YT traces.

The menu in Figure 2-29 appears when either the HORIZONTAL SIZE or POSition button is pressed when dealing with a YT trace. In such a case, the choices for the time-base selection are **Main** or **Dly'd**. If working with an XY trace, the Horizontal menu resembles the Vertical menu and affords access to the amplifier plug-in that is driving the horizontal deflection. The components of the selected trace can be selected by touching *Chan/Time* in the menu. This selection is limited to the components of the selected trace.

When controlling an XY display, it is also necessary to select and adjust the Time/div and delay references of the time base. This requires a sharing of the horizontal controls between the time base and the horizontal deflection.

Touching *Chan/Time* will call the Time-Base menu to give control of the **Main** or **Dly'd** Time/div. The XY version of the Time-Base menu is the same as the YT version except the far right choice called *Time Base* is changed to *Chan/Time*. (See Fig. 2-30.)

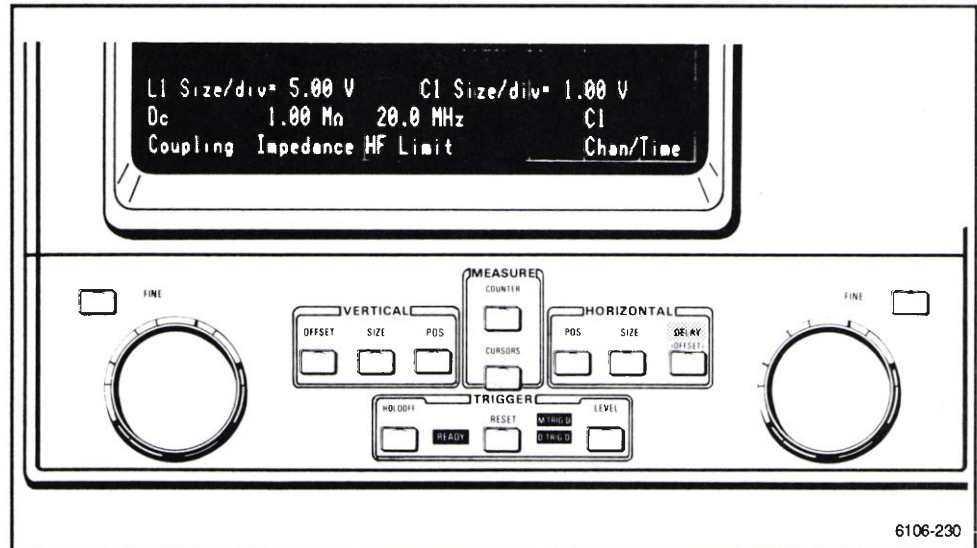


Figure 2-30. XY Horizontal Menu.

Once the time bases have been selected, the knob will remain in control of the time base function until a horizontal channel or any XY trace is selected.

Similarly, when an XY trace is selected and the DELAY button is pressed, one of the horizontal deflection channels is selected to control the offset of the amplifier. The means of accessing input offset and delay value is provided by the far right menu choice of *Chan/Dly*. The choices are the horizontal channels comprising horizontal deflection and delayed windows one and two. (See Fig. 2-31.)

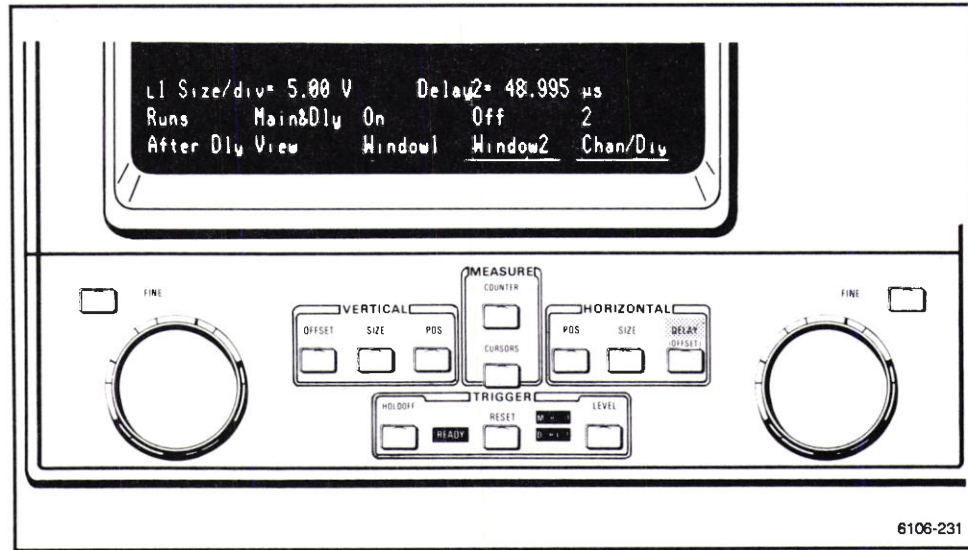


Figure 2-31. The DELAY (Offset) menu for an XY trace.

XY Traces

The menu for XY traces, shown in Figure 2-32, is similar to the vertical menu for the channel(s) providing the horizontal deflection, and it is dependent upon the type of plug-in used. It allows for selection of the two time bases as well as the input channels. See "Time-Base Selection" in this subsection.

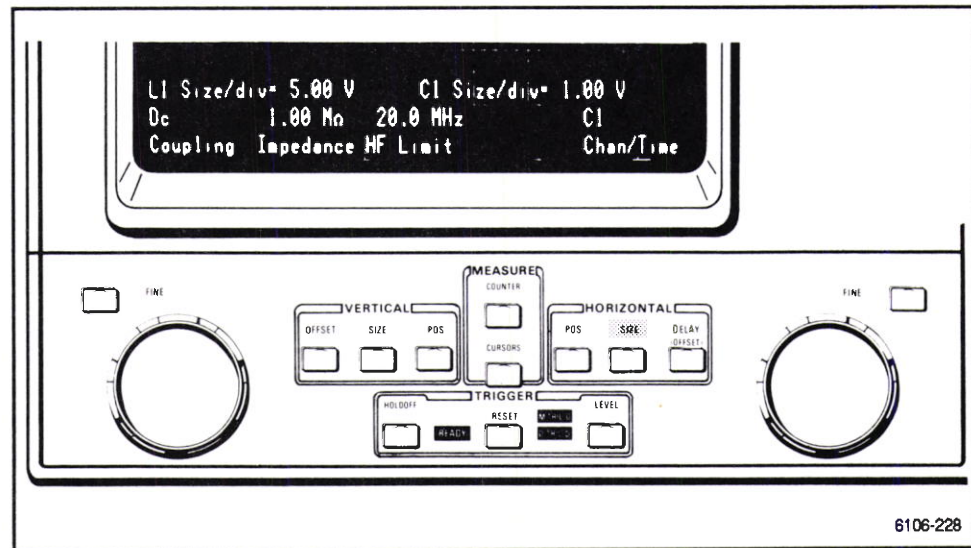


Figure 2-32. HORIZONTAL SIZE and POSition control menu for an XY trace.

YT Traces

The menu in Figure 2-33 is always displayed for YT traces using the internal time bases.

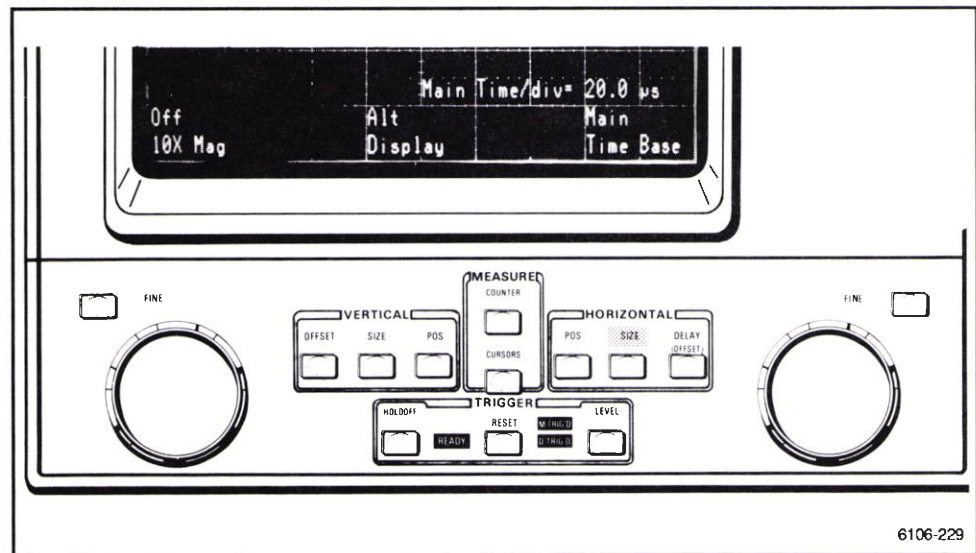


Figure 2-33. HORIZONTAL SIZE and POSition control menu for a YT trace.

Knob Behavior

Each control knob assignment has its own coarse/fine function status. The oscilloscope remembers and reinstates the coarse/fine condition for any given knob assignment. Selecting Coarse after making a FINE adjustment does not change the value of the setting. The value can be changed only by turning the knob. For any given knob assignment, the increment value of the control knob may be changed from coarse exponential to fine linear.

Delay and Offset

- Clockwise rotation increases the delay value.
- Valid coarse settings are linear increments of 0.1 division relative to the sweep speed of the Main time base. In other words, the delay time increment is one-tenth the Main time base time/division setting or 100 increments over the full sweep time of the Main time base.
- Valid fine settings are 20,000 linear increments over the 10 division range of the Main time base (2,000 increments per division).

Horizontal Position

- Clockwise rotation moves the trace to the right.
- Valid coarse (YT display, *10X Mag Off*) settings are linear increments of 0.2 divisions.
- Valid coarse (YT display, *10X Mag On*) settings are linear increments of 1 division. Remember that when using 10X Magnify, you really have 100 divisions of information, but can view only 10 at a time.
- Valid coarse (XY display) settings are linear 0.2 division increments throughout the entire range.
- Valid fine (YT display, *10X Mag Off*) settings are linear increments of 0.01 divisions.
- Valid fine (YT display, *10X Mag On*) settings are linear increments of 0.025 divisions.
- Valid fine (XY display) settings are linear 0.01 division increments.

Horizontal Size

- Clockwise rotation increases sweep speed (lowers Time/div) for YT and increases sensitivity (lowers Size/div) for XY.
- Valid coarse YT display settings are the traditional 1-2-5 sequence, exponential approximation.
- Valid coarse XY display settings are the traditional 1-2-5 sequence, exponential approximation.
- Valid fine YT display settings are linear increments of 1% of the faster coarse setting. For example, if $1 \mu\text{s} \leq \text{Time/div} < 2 \mu\text{s}$, then the increment is 10 ns (1% of 1 μs) resulting in 100 increments.
- Valid fine XY display settings depend upon the amplifier used for the horizontal deflection. Typically, they are linear increments of 1% of the lower coarse (1-2-5) step. For example, if $1 \leq \text{Size/div} < 2$, then the fine steps are 0.01(1% of 1) resulting in 100 increments.

X Offset for XY Traces (Range and resolution depend on the plug-in)

- Clockwise rotation decreases offset value.
- Valid coarse settings are determined by the plug-in.
- The fine increments are also determined by the plug-in.

Input Channel Selection (Using Probe ID)

The knob controls are assigned in two ways. The first way represents each channel input as a unique trace, thereby, allowing you to select the desired trace and manipulate it as described in "Trace Selection " in this subsection. The second way is to press the ID button on the probe for the desired channel. Assuming that the channel is being used, all occurrences of that channel are highlighted (brightened trace) in the display.

If the input is a component of the selected trace, then the trace remains selected. If the input channel is not used in the selected trace, the oscilloscope, searching left to right from the top left corner, chooses the first trace that uses the chosen input. Delayed or windowed traces are ignored in this search.

If the trace using the chosen input is an XY waveform and the input is part of the horizontal expression and Autoset is disabled, then the Horizontal controls operate upon that input channel.

If any input channel from the left or center is not in use, pressing its probe ID button creates a new trace—if there's room!—then selects it for manipulation. If there is no more room for another trace, the warning

"Channel is not displayed"

advises that this input is not or cannot be displayed, but you have control of the channel.

If the selected input is from the RIGHT compartment, VERTICAL SIZE is assigned to the knob, and the control menu of the input channel also appears. If Autoset is active, only the SIZE and OFFSET are scaled, and the time base will not be disturbed. However, as no trace is associated with the input, the trace selection is unchanged. The horizontal controls remain assigned to the selected time base. A warning advises that this input is not displayed.

Whenever a knob controls an input, the input name appears in the readout for that knob. See Figures 2-34 and 2-35.

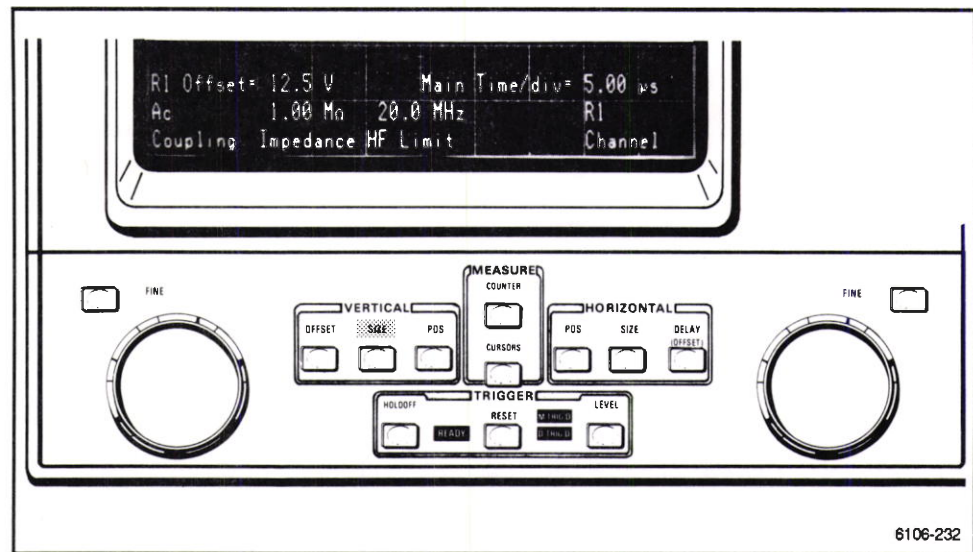


Figure 2-34. The left control knob is assigned for R1 input.

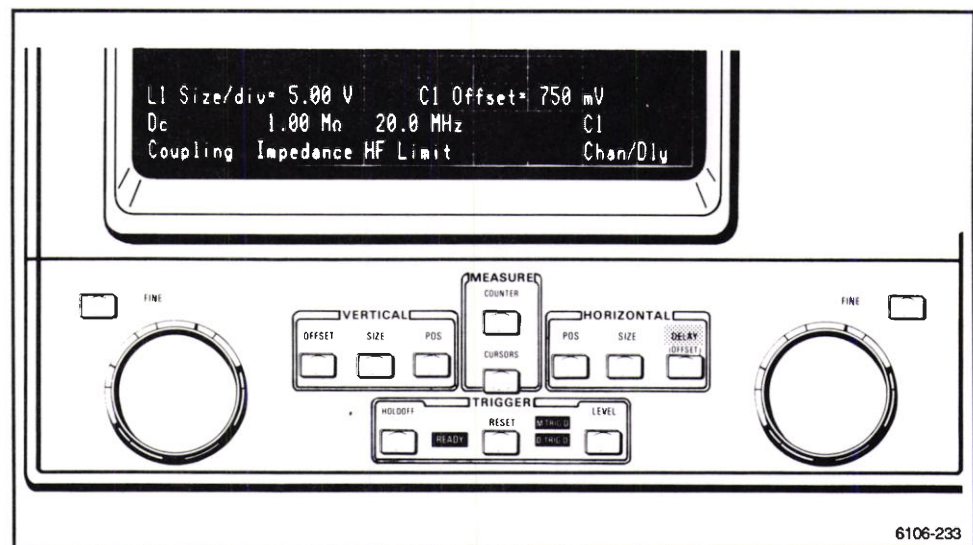


Figure 2-35. The right control knob is assigned to supply the offset for C1 even though it cannot be displayed vertically.

For an XY trace, the horizontal control knob can be assigned to an input at the same time the vertical control knob is assigned to another input.

When the probe ID button is pressed for an undisplayed left or center channel and there are eight traces already displayed, the following message is displayed:

"Channel is not displayed"

Whenever a knob controls an undisplayed input channel, the LED on the plug-in for that channel is illuminated to indicate that the channel is being controlled. If the display on/off button of an undisplayed channel is turned off, the knob reverts to controlling the last selected channel of the last selected trace.

Probe ID (Summary of Uses and Functions)

Probe ID (Identify) can be accessed through either the UTILITY menu selection *Probe ID* or by pressing the ID button on the probe body. The ID button can:

- Create New Traces
- Identify Channels in the Display
- Initiate AutoSet
- Initiate Automatic Measurements
- Manually Generate a Service Request Interrupt
- Select Traces
- Sequentially Recall Stored Settings

To assign different functions to the Probe ID button, selecting *Probe ID* in the UTILITY menu offers the necessary choices (see Fig. 2-36).

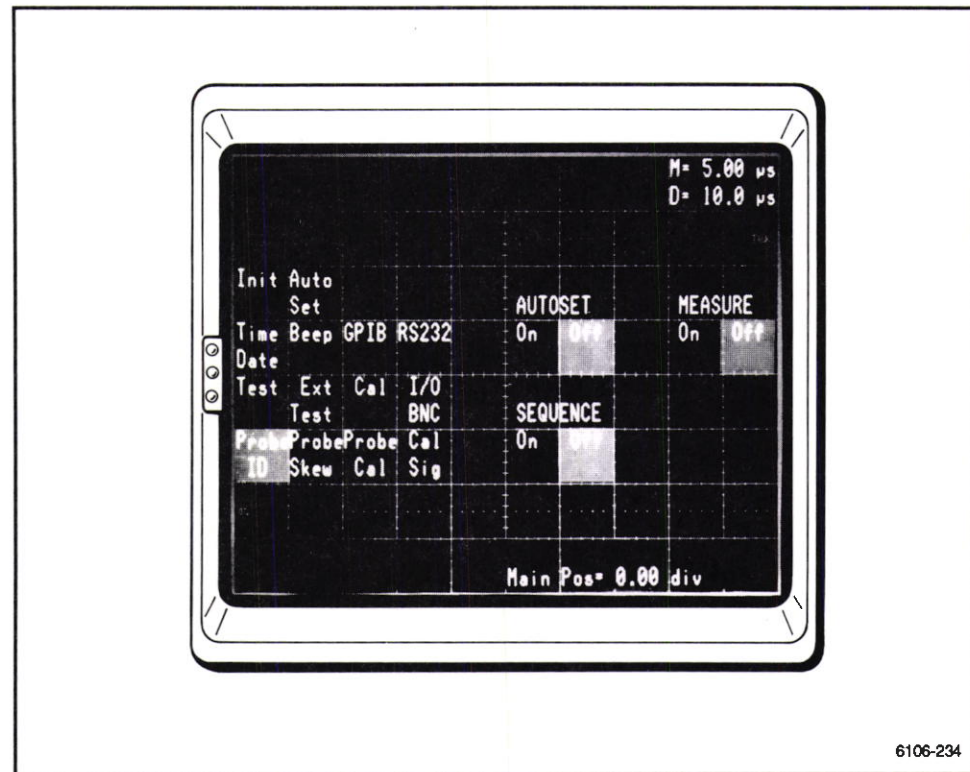


Figure 2-36. *Probe ID* selection from the Utility menu.

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Create New Traces

If an input channel is not already in use, pressing its Probe ID button causes a trace to appear versus the Main time base. The WAVEFORM major menu is not required if you choose to make traces this way. This function of the ID button can be inhibited only by locking out the front panel through the GPIB or the RS-232-C interface.

Function Compatibility

All of the previously listed ID functions are compatible with each other; none exclude any others. However, there is a priority (see Table 2-7) to the execution of each function.

TABLE 2-7
Execution Priority

Execution Order	Channel Not in Use	Channel already in Use
First	Create a trace	Select a trace or channel
↓	Select a trace or channel	Sequential Recall (if enabled)
↓	Sequential Recall (if enabled)	Autoset (if enabled)
↓	Autoset (if enabled)	Measure (if enabled)
↓	Measure (if enabled)	Generate SRQ (if enabled)
Last	Generate SRQ (if enabled)	

Identify Channels in the Display and Trace Selection

If a Probe ID button is pressed for a channel that is already used for display, trace selection is made and all traces using that channel brighten momentarily. See "Trace Selection" and "Input Channel Selection" in this subsection for more detail. This function can be inhibited only by locking out the front panel through the GPIB or the RS-232-C interface.

Initiate Autoset

Automatic scaling of an input channel can be initiated by the probe ID. This function can be inhibited by turning off the Autoset feature or by locking out the front panel through the GPIB or the RS-232-C interface. See "Autoset" in this subsection for more detail.

Initiate Measurements

Automatic measurements can be initiated by the Probe ID. This is selected using the UTILITY major menu. Front-panel lockout through the GPIB or the RS-232-C interface inhibits this function. See the "Measurement" subsection for more detail.

Manually Generate a Service Request

Service request (SRQ) interrupts to the GPIB and RS-232-C interfaces can also be generated by pressing the probe ID button. This function is **not** inhibited by front-panel lockout. The SRQ is inhibited only through using the interrupt mask call PROBEID. This can be set to on or off through the GPIB or the RS-232-C interface. See Section 3, "GPIB and RS-232-C Interfaces," for more detail.

Sequentially Recalled Stored Settings

The probe ID button functions similarly to touching **Next** followed by **Recall** while in the STORE/RECALL major menu. However, when sequencing from the ID button on the probe, only locations with stored settings will be used. Any location that has been erased is skipped. To enable sequencing by the probe, you must access *Probe ID* in the UTILITY menu. There the sequencing function can be set to **On**. From any probe, the next setting in sequence can be recalled by pressing the ID button on the probe. See the "Store and Recall" subsection for more information.

Trace Selection

This oscilloscope has only one set of controls to be shared among all of the displayed traces; therefore, they operate only on the trace that has been "selected." Only one trace can be selected at a time.

Traces are constructed (defined) through the WAVEFORM major menu, the plug-in Display On/Off button, and the probe ID button. Once defined, each trace description is displayed toward the top of the screen as an expression in a unique touchable location. Touching the screen where a trace description is displayed lets you designate (select) the trace to be manipulated. The most recently created trace becomes the selected trace.

When a trace is selected, the trace description is highlighted by background shading. The corresponding trace is also highlighted by momentarily (about one second) increasing its intensity. At this point, the selected trace and its components can be manipulated using the knobs, located below the crt, and their various assignments. If you select another trace before the one second expires, the previous selection and its one second timing is abandoned in favor of the new selection. The one second delay does not inhibit the use of any controls.

Although it is intended that the knobs operate on the selected trace, it is possible that changing one trace will disturb the other displayed traces. For example, traces L1 and L1+L2 are displayed. The HORIZONTAL SIZE actually adjusts all traces using the Main time base, thereby, changing both traces. Selecting L1 and changing VERTICAL SIZE also disturbs trace L1+L2.

When a composite trace is selected, the VERTICAL SIZE and OFFSET controls are assigned to one of the input channels comprising the trace. In addition, if the selected trace is an XY trace, the HORIZONTAL SIZE and OFFSET are assigned to an input channel.

There will always be a selected channel during trace construction. This will be the last channel in the expression. When a trace is selected, the input last selected for that trace will become the selected input. If you want to adjust a component other than the one the oscilloscope picked, you can simply press the channel selection offered in the Vertical control menu or press the probe ID button for that input. However, the probe ID will cause all traces using that channel to be brightened. See "Input Channel Selection," in this subsection, for detail.

The selected trace also affects other control menus. The Horizontal control menu for a YT trace allows you to select the Main or Delayed time base for control. However, as a consequence of selecting a trace, the oscilloscope also selects the appropriate time base as well. For example, if the Delayed time base is being controlled, the oscilloscope changes the selection to the Main time base when the selected trace is displayed using the Main time base. You can still change the time base selection; however, trace selection has priority. Similarly, Triggering controls track the trace selection, but you can still override what the oscilloscope chose.

If the selected trace gets deleted, the oscilloscope selects the first trace encountered in a search from the top left to the bottom right of the trace description list. The control knobs remain active and their values undisturbed. So long as there is one or more traces defined, there will always be a selected trace. The selected trace will be changed automatically in some cases.

A parent trace refers to the main trace from which a window is derived; this trace will always exist for any window trace. The selected trace will be determined by the following conditions.

1. If the selected trace is a main trace and:
 - a. If only one window is created from this parent, that window trace will become the selected trace.
 - b. If two windows are created, the last one created will become the selected trace.
2. If the selected trace is a window and:
 - a. Same as b above.
 - b. If the selected trace is turned off by the DELAY menu, the parent trace will once again become the selected trace.

The intent of all of this is to steer other control functions like VERTICAL POSition, TRIGGER LEVEL, and HORIZONTAL SIZE to affect the window being manipulated by the DELAY control knob.

Vertical Menu

The following is a discussion of the Vertical control menu function of SIZE, POSition, and OFFSET.

Access to Control Menus

Access to control menus occurs whenever a knob is assigned to a desired function. When another knob assignment is made, its associated menu has priority over the previous control menu and removes the old one from the display. Although the state of the previous selections are maintained, the menu itself can only be accessed by changing the knob assignment to the previous one. Knob assignments for a given knob are mutually exclusive, that is, choosing a new assignment cancels the previous one.

Vertical Size, Position, and Offset Menu

Whenever Vertical Size, Position, or Offset is pressed or the probe ID button is pressed, the control menu appears for the given channel. For details of channel selection see "Input Channel Selection" and "Trace Selection" in this subsection. The menu selection is dependent on the plug-in being used. See Table 2-8 and Figure 2-37 for the possible menu choices offered with a nondifferential amplifier.

TABLE 2-8
Possible Choices for a Nondifferential Amplifier

Coupling	Impedance	HF Limit	Channel
Ac	1 M Ω	20 MHz	(Indicates which input of the plug-in is being affected by this menu. Also allows choosing the components of the selected trace.)
Dc	50 Ω	100 MHz	
Off		300 MHz	

Repeatedly touching a menu function on the screen cycles through all of the possible choices.

Knob Behavior

Each knob assignment has its own coarse/fine function status. The oscilloscope remembers and reinstates the coarse/fine condition for any given knob assignment. Selecting Coarse after making a FINE adjustment does not change the value of the setting. The value can be changed only by turning the control knob. For any given knob assignment, the increment values of the knob may change from coarse exponential to fine linear ones.

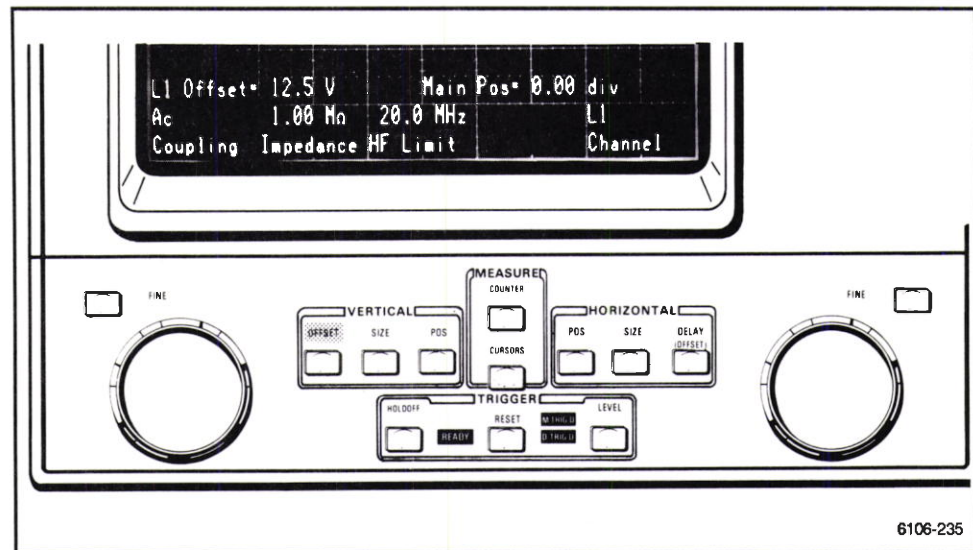


Figure 2-37. Control menu for a single-end amplifier. (See appropriate plug-in manual for exact function choices).

Vertical Offset
(Range and resolution depend on the plug-in)

- Clockwise rotation decreases offset value.
- Valid coarse settings are determined by the plug-in.
- The fine increments are also determined by the plug-in.

Vertical Position
(This is not a plug-in feature, but a main-frame display feature)

- Clockwise rotation moves the trace upward.
- Valid coarse settings are linear 0.2 division increments throughout the entire range.
- Valid fine settings are linear 0.01 division increments. An exception occurs when signals from left and center plug-ins are added. For this case, the increments are 0.02 division.

Vertical Size
(Range and resolution depend on the plug-in)

- Clockwise rotation increases sensitivity (less Volts/div).
- Valid coarse settings are the traditional 1-2-5 sequence, exponential approximation.
- Valid fine settings are linear increments of 1% of lower coarse (1-2-5) step. For example, if $1 \leq \text{Size/div} < 2$, then the fine steps are 0.01(1% of 1) resulting in 100 increments.

Waveform Menu

Traces are defined and displayed three ways. The simplest way is pressing the display on/off button of a plug-in channel, the second way is pressing the probe ID button, and the final way is choosing the WAVEFORM major menu.

Behavior of the Waveform Menu

The Waveform menu that represents the plug-in configuration presents the actual choices, not the potential possibilities. For example, if all three compartments are filled with two-channel amplifiers, the menu does not present any choices for channels 3 and 4.

As a trace is constructed, its expression appears toward the top of the display in the location determined by the oscilloscope. The oscilloscope chooses a location in one of these two ways:

1. If no traces exist, the expression of a new trace begins in the upper left corner and progresses to the right until the top locations are exhausted. After that, additional new trace descriptions appear at the left just below the first location and progress to the right. Each row has four locations.
2. If traces already exist, with descriptions occupying some of the first and second rows in the description list, and with vacancies scattered about, the oscilloscope tries to find a vacant location nearest to the top left of the display. This migration to the top of the display keeps the trace descriptions from interfering with the displayed waveforms.

Defining a New Trace with the WAVEFORM Menu

To construct a trace, press the major menu button labeled WAVEFORM. A menu like the one in Figure 2-38 appears offering several choices for trace construction.

The signals that can be displayed are categorized into three types: Counter View, Reference, and Scope (analog inputs). The organization of the menu can be explained as having a group of selections on the left side and the respective arguments and operations on the right side. In essence, there are three standard waveform menus that can be randomly selected. The presently selected one is highlighted by background shading.

Counter View

Touching *Count View* on the WAVEFORM major menu allows any or all of the Counter View signals originating from the Counter/Timer hardware to be viewed.

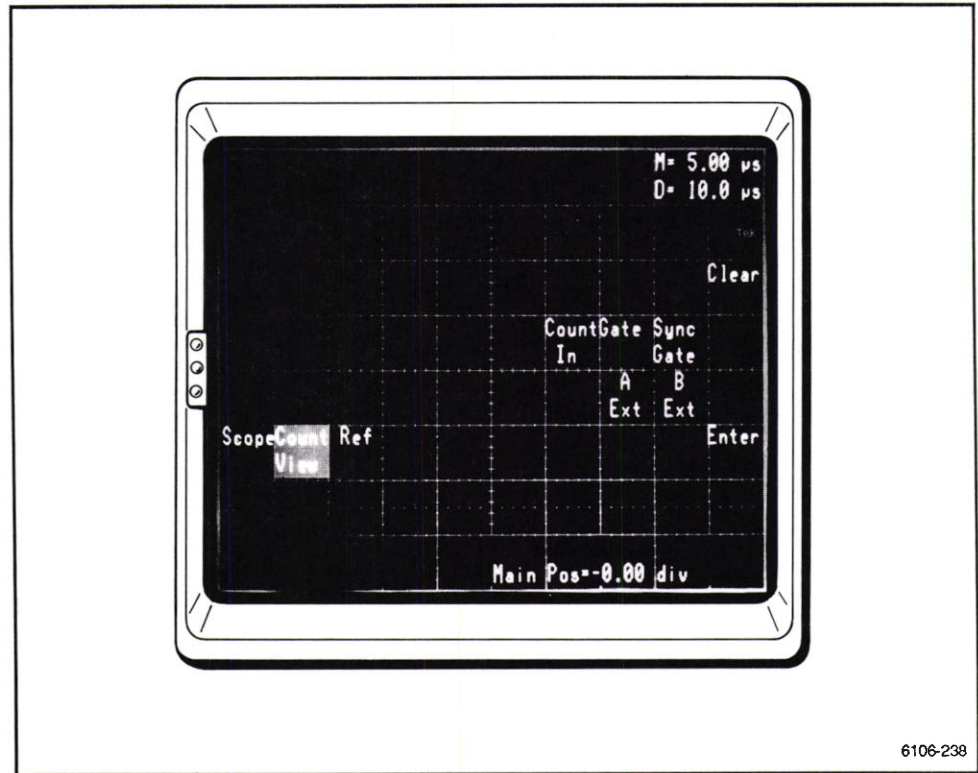


Figure 2-38. *Count View* selection in the WAVEFORM major menu.

These signals are useful in determining how the Counter/Timer is interpreting the signals it receives. There are no semantic constraints for these as they cannot interact with other signals. Any or all of the five signals can be displayed and windowed (see Fig. 2-38).

Reference

The *Ref* selection accesses waveforms that are useful for reference (see Fig 2-39). Previously stored "template" waveforms serve as references for visual comparisons. The reference waveforms can be defined by sending them into the oscilloscope from the GPIB or RS-232-C ports. The standard oscilloscope provides for two reference memories. (See "Data Transfers" in Section 3, "GPIB and RS-232-C Interfaces" for detail.)

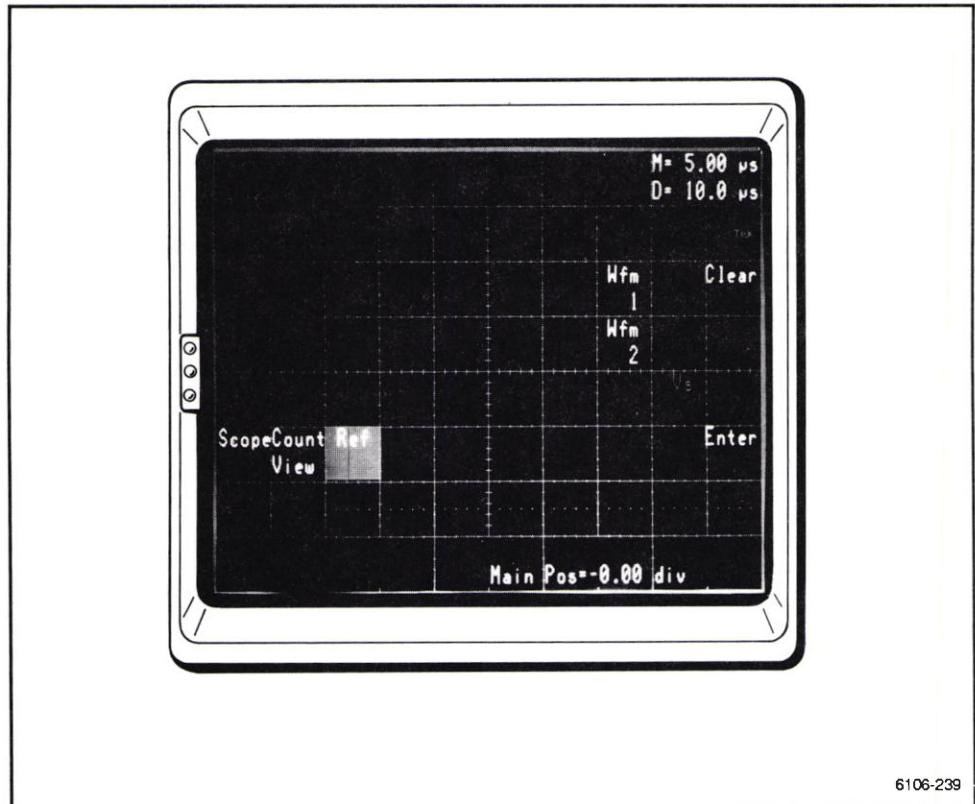


Figure 2-39. Reference selected in the WAVEFORM menu.

Scope

Selecting *Scope* permits the creation of the more traditional "analog" type oscilloscope traces. These signals use analog real-time display paths from the amplifier to the crt. Figure 2-40 represents three four-channel amplifiers installed.

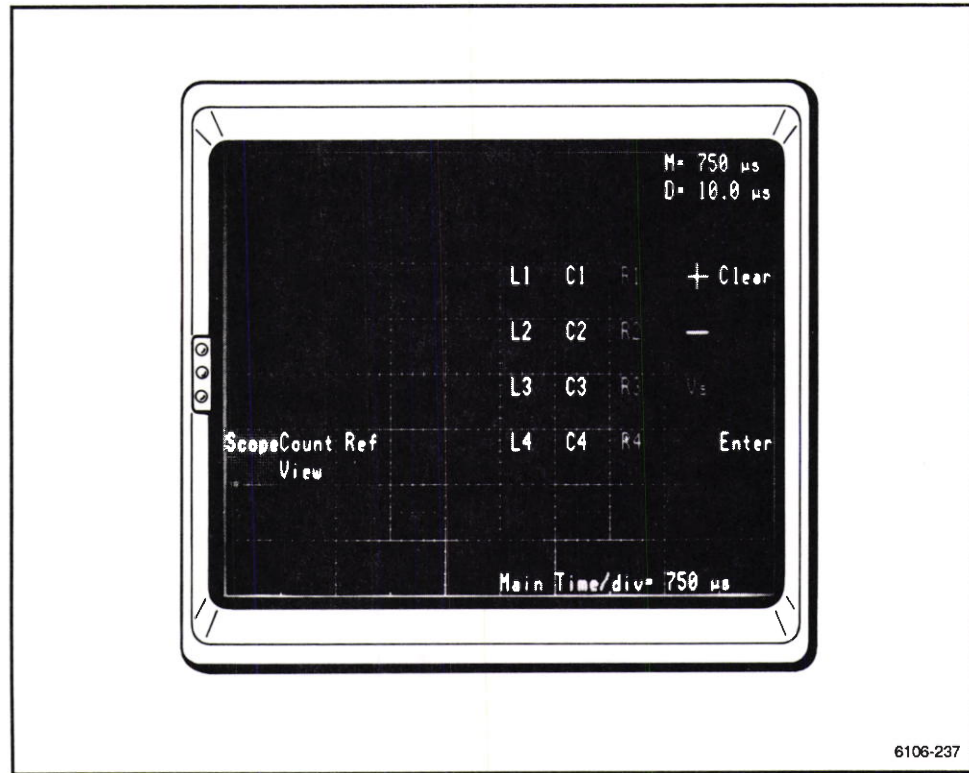


Figure 2-40. *Scope* selected in the WAVEFORM major menu.

General Trace Behavior

All trace expressions are displayed in the trace description list and any one trace can be selected by touching the desired expression. When a trace is being constructed, it is the selected trace and is highlighted by a shaded area behind the expression in the description list. At selection, the trace is momentarily brightened returning to a normal intensity after a short delay (about one second). Once selected, the trace can be controlled by the knobs and related control menu buttons.

When manipulating a composite trace (more than one channel), only one of the input channels specified in the trace is modified. See "Input Channel Selection" and "Trace Selection" in this subsection for more detail.

A blinking question-mark, used to attract your attention, indicates that the expression is under construction and the oscilloscope is waiting for more information. Upon termination, the question-mark disappears and the trace description shows the complete expression. See Figures 2-41 and 2-42.

A selected trace can be deleted (removed and no longer defined) by touching **Clear**. If the WAVEFORM major menu is exited or another waveform menu is selected without completing a trace definition, the oscilloscope accepts the most reasonable portion as a complete trace (e.g., L1+C2 Vs? would yield L1+C2 as a trace).

An individual input channel can be manipulated as if it were a separately defined trace by pressing its probe ID button. If the channel is not used in any trace descriptions, pressing the probe ID button produces a new trace. See "Input Channel Selection" in this subsection for more information.

The last item touched in a waveform menu is highlighted by a shaded background. Semantically, the item is no longer a valid choice. However, rather than dimming this choice, it is displayed with its shading. If it is touched again while it is shaded, the touch is ignored. The shading is important as it gives you feedback by showing what was touched.

When another item is touched it becomes the shaded one in the menu. Within the menu, only one argument or operator can be shaded at a time. Of course, invalid items will always be dimmed unless they are shaded. When the shading is removed from an invalid item it will then be dimmed. For example, within the *Scope* waveform menu while building the expression L1 Vs C2, the operators and operands behave as follows:

1. Touch **L1**. L1 becomes shaded and remains at normal intensity.
2. Touch **Vs**. L1 is no longer shaded and all left channel operands are dimmed. The Vs operator becomes shaded and remains at normal intensity.
3. Touch **C2**. Vs is no longer shaded and it is dimmed. C2 becomes shaded and remains at normal intensity.

If a dimmed invalid choice is touched, an error message is displayed on the prompt line. See "Errors, Warnings, and Messages" in the Appendixes for a list of messages.

Touching **Clear** when there are no traces defined results in the following message appearing on the prompt line:

"Trace does not exist"

Touching **Enter** when there is no trace being built does not cause anything to happen.

Display of Simple YT Traces (for all waveform types)

YT Displays of a single input source are the most common types and easiest to create.

One type of YT display is created simply by touching the label (trace name) for the desired source channel. The signal is immediately displayed using the main time base; this gives you feedback as the waveform shape is helpful to identify the signal.

The input label is added to a trace description list. Until **Enter** is touched (or the trace is completed as in item 4 that follows), you can touch any input source label. As each new input source is chosen, the previous one is cancelled along with its trace and description. When you are satisfied with the choice, then establish and "freeze" the trace and its trace description by touching **Enter**. The trace may also be completed by using any of the methods listed in item 4 of "Composite YT Traces" that follows.

Delayed Windows can also be created. For detail see "Delayed Windows" and "Creating Windows and Intensified Zones" in this subsection. In addition to the trace source and time base (Dly 1, Dly 2) being used, the scale factor of the input is displayed for this case of one input channel per trace.

Composite YT Traces

YT displays derived from multiple inputs require a more involved syntax. Input sources can be algebraically added or subtracted to produce a single trace. The symbols + (plus) and - (minus) are used in the expressions and shown in the trace description. To build an expression, you must use the following procedure:

1. After an input channel is designated, touching + or - begins the chain.
2. Alternately touching + and - (and vice versa) reverses the algebraic operator.
3. The input channel that is the last entry in the expression can be replaced by another input channel before the chain is completed.
4. The chain is completed by touching **Enter**, selecting a trace (including the trace being built), selecting another waveform menu, exiting the menu, creating a window from the HORIZONTAL DELAY menu, creating a trace using a plug-in display on/off button, pressing the probe ID button, or pressing the AUTOSET button.
5. Upon completion, the final item in the expression is the input channel that followed the last operator. As the expression is being constructed, it appears in the trace description list at the top of the display. The input channel added to the expression becomes the selected channel that can be manipulated by the oscilloscope controls. In other words, you can modify the latest item in the list.

The inclusion of the vertical scale factor in the trace description may exhaust the number of characters available within an individual description block. If the vertical scale factor can fit, it is displayed. Since it is possible to have a composite trace derived from inputs of different sensitivities, trace scaling becomes meaningless and will not be displayed. A vertical scale factor is displayed if the composite trace consists of two input channels that have the same sensitivity.

6. If a trace is under construction and no traces exist for a given channel when its ID or display on/off button is pressed, then the trace under construction will be completed and a new trace created and selected as derived from the button push.

Also, if a trace is under construction, a trace exists for a given channel that is not used in the constructed trace, and the display button is pressed to Off, then all the traces containing that channel will be deleted, but the current trace remains under construction.

To create the trace L1+C2 (LEFT1 + CENTER2) displayed using the Main time base, follow the procedure in Figure 2-41.

STEP NO.	TOUCH LABEL	TRACE DESCRIPTION
1.	L1	L1?
2.	+	L1+?
3.	C2	L1+C2?
4.	Enter	L1+C2

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Figure 2-41. Procedure for creating the trace "L1+C2."

Suppose you want to create "L1+C2", but you make a few mistakes along the way. Figure 2-40 proceeds the same as Figure 2-41, but shows how to handle accidental errors.

STEP NO	TOUCH LABEL	TRACE DESCRIPTION	COMMENTS
1.	L3	L3?	MISTAKE
2.	L2	L2?	MISTAKE
3.	L1	L1?	CORRECT
4.	-	L1-?	MISTAKE
5.	+	L1+?	CORRECT
6.	C3	L1+C3?	MISTAKE
7.	C2	L1+C2?	CORRECT
8.	Enter	L1+C2	COMPLETE

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Figure 2-42. Procedure for correcting mistakes while creating the trace "L1+C2".

Restrictions for Composite Traces (excluding XY)

- Input channels from the RIGHT compartment cannot be combined with any of the CENTER and LEFT inputs.
- The - (minus) operator cannot be used with an "empty" compartment designator for inversion or to combine two "empty" compartments (e.g., -L or L-C is not allowed).
- No more than two inputs can comprise an expression.
- Previously defined traces cannot be appended to create a new trace.
- An input appears only once in each trace description (e.g., L1-L1 is not allowed).
- An algebraic expression of two or more inputs cannot be formed by using the probe ID buttons or display on/off buttons. These buttons can create only one kind of trace: the one input versus the main time base. The trace is automatically completed.
- The RIGHT compartment cannot be used for vertical expressions.

XY Traces

XY displays are created using the **Vs** (versus) operator. Until something is specified for the horizontal displacement, the trace remains a YT trace.

If a trace is being constructed, touching **Vs** establishes it as the vertical part of the expression. Following this, the horizontal portion of the expression can be constructed under the same rules for creating composite trace expressions (this includes the prompting question mark). The pending **Vs** can be aborted while maintaining the vertical portion as a trace by touching **Enter**, selecting a trace (including the one being built), selecting another waveform menu, exiting the menu, creating a window from the HORIZONTAL DELAY menu, creating a trace using a plug-in display on/off button, pressing the probe ID button, or pressing the AUTOSET button.

The Main time base controls the duration of the XY display allowing you to examine arbitrary segments while blanking annoying bright spots common to most XY displays. This is referred to as "Triggered XY." If no trigger is detected, the XY trace will not be blanked. The Delayed time base can be used to generate intensified zones on the XY trace. This allows you to make delta-time measurements along the XY trace using the Counter/Timer. If the XY trace consists of a single input channel versus another single input channel, the vertical scale factor is displayed in its trace description block.

XY Trace Restrictions

- No input channel can be used for both vertical and horizontal displacement for the same trace.
- Vertical and horizontal sources cannot originate from the same compartment for the same trace.
- The horizontal portion of all XY traces must use channels of the same compartment. **L1 Vs R1** and **L1 Vs C1** cannot exist simultaneously.
- The RIGHT compartment can be used only for horizontal portions of trace descriptions.
- The LEFT compartment can be used only for vertical portions of the trace descriptions.
- The horizontal displacement cannot be an algebraic expression of inputs from more than one compartment.
- Previously defined traces cannot be appended to create a new trace.
- XY traces cannot be formed by using the display on/off or probe ID buttons. These buttons can create only one kind of trace: the one input versus the Main time base. The trace is automatically completed.

NOTE

Creating an XY trace that specifies the Right Compartment as the horizontal component will result in blanking (inhibiting view only) all traces if the Right Compartment is empty.

Inverting Channel Polarity

To create a trace that is the inverted polarity of one channel, the minus operator is touched followed by the desired channel. Touching **Enter**, selecting a trace (including the trace being built), selecting another waveform menu, exiting the menu, creating a window from the HORIZONTAL DELAY menu, creating a trace using a plug-in display on/off button, pressing the probe ID button, or pressing the AUTOSET button completes the trace. This requires that the - (minus) operator be used as the first symbol of a trace description. Once the minus is used the + (plus) operator must be used to cancel the minus.

Triggering

This subsection of the Operating Instructions deals with all aspects of triggering. This subsection is divided into three main parts: TRIGGER HOLDOFF control menu, TRIGGER LEVEL control menu, and TRIGGER SOURCE major menu. The main functions are described followed by the definition or behavior of the state that each function is allowed.

Trigger Holdoff Menu

Holdoff refers to the interval when the Main time base is inhibited. During this period, any detected trigger will not start the Main sweep. This interval has been traditionally defined as some time proportional to the Time/div setting. This oscilloscope has the capability to holdoff by a time value as well as an event count. Although technically this is a type of delay, the term *Holdoff* will denote the delay of the Main time base. This is done to distinguish this function from the *Delay* associated with the Delayed time base.

When trying to view one of several pulses each having a different width, it is possible to get a display where the traces seem superimposed. This is a situation where holdoff by events is especially useful. To isolate a single pulse, holdoff can be adjusted until the holdoff interval excludes the unwanted pulses from the trigger. When the signal repeats, the time base will be triggered on the same pulse.

When the holdoff by events is used, the knob value displayed will be "Holdoff=" with no dimensions. When **Time** is used, it will be expressed in % of range (0–100%).

Holdoff Menu Selections

When the HOLDOFF button is pressed, a menu offering the choices shown in Tables 2-9, 2-10, and 2-11 are displayed.

TABLE 2-9
Holdoff Menu

	Holdoff
	Time 2ns Step

Repeatedly touching a menu function on the screen cycles through all possible choices.

Holdoff—can be set for Time, 2ns Step, Countdown, or Events. **Time** is the conventional type derived as a percentage of the main sweep time. **2ns Step** is an event holdoff configuration that starts the holdoff with the main sweep and then counts in 1.8 ns increments. **Countdown** is another event holdoff that starts from the main sweeps and counts main triggers. **Events** offers more variety to the expert. The expert can choose which event to count, which event to start on, whether to Run or Trigger after the count, and whether to restart with each start event.

TABLE 2-10
Holdoff Previous and Next Menu

	Previous	Next	Holdoff
	Trig On	Trig On	Countdown

Repeatedly touching a menu function on the screen cycles through all possible choices.

Previous and Next—are available for Countdown. *Next* allows you to advance to the next trigger event to start the delay interval. *Previous* does the opposite. These two functions offer the convenience of stepping forward or backward within a stream of events without disturbing a critical holdoff setting.

Next and *Previous* do not have selections the control menu implies. There is no status to report as with the usual control menu selection (e.g., *Coupling= Ac, Dc, or Off*). *Next* and *Previous* always report **Trig On**; this means to trigger on the next (or previous) event. To perform a *Next* or *Previous*, the present Holdoff setting is temporarily incremented or decremented long enough to cause the trigger of the Main sweep to slip forward or backward one event. To preserve Holdoff synchronization with your signals, this temporary change exists for one sweep only; however, it also takes another sweep before the change is made. Therefore, two sweeps must pass before the beneficial effects can be observed. At slow sweep speeds and rep rates, such magic will appear sluggish.

TABLE 2-11
Holdoff Events Menu

Start	Count	One Start	After HO	Holdoff
Main Trig A Ext None	2ns Main Trig Dly Trig B Ext	On Off	Runs Trig'd	Events

Repeatedly touching a menu function on the screen cycles through all possible choices.

Start—choices determine which event will begin the holdoff interval. This signal must be less than 100 MHz.

Count—offers the choice of which event to count in order to include the Holdoff interval.

One Start—allows for restarting the holdoff count only with the recurrence of the start event (*One Start Off*) or to automatically restart the count at the termination of the count (*One Start On*). For *One Start On*, the start event need only occur once.

After HO—allows for the main sweep to run immediately after holdoff (**Runs After HO**) or to wait for a trigger after holdoff (**Trig'd After HO**).

To define each Holdoff choice in hardware combinations, Table 2-12 supplies a translation.

TABLE 2-12
Holdoff Operation

Holdoff	Description
Time	Time is proportional to Main Time/div. Duration of ≈ 1 to $20X$ Time/div ($2.5 \mu\text{s}$ minimum).
2ns Step	Main Sweep is held off by events where the Start Event=Main Sweep, the Counted Event=2 ns (1.8 increments), and the time base is triggered after the holdoff interval. The holdoff interval spans the Main sweep and sweep reset time.
Countdown	The Main Sweep is held off by events where the Start Event=Main Sweep, the Counted Event=Main Trigger, and the time base runs immediately after the holdoff interval. The holdoff interval spans the Main sweep and sweep reset time.
Events	<p>The caldron where a plethora of choices abound. Here is where the expert will find sanctuary, and the brave novice will be tested.</p> <p>The holdoff interval occurs at the completion of the Main sweep and the sweep reset time. The Start Event=Main Trigger or A Ext; the Counted Event=2 ns (1.8 ns increments), Main Trigger, Delay Trigger, or B External; and the Main sweep can Run After or wait to be Triggered After the holdoff interval. The holdoff interval can be automatically started when the count has expired (One Start=On) or it can wait for another Start event (One Start=Off).</p>

Knob Behavior when using Holdoff

Main Holdoff by Events and Countdown

- Valid coarse settings are linear increments of 100 within a total range of 2 to 2^{29} .
- Valid fine settings are linear increments of 1.

Main Holdoff by 2ns Step

- If Main sweep speed is <200 ns, then coarse increments are 1.8 ns. Otherwise, coarse increments are 1% of current coarse Main Time/div increment.
- Fine increments are 1.8 ns.

Main Holdoff by Time

- Valid coarse settings are 1%.
- Valid fine settings are 0.01%.

Restrictions for Holdoff

- When using *Holdoff=2ns Step* or *Holdoff=Countdown*, the minimum setting is dependent upon the Main Time/div setting. See Table 2-13.

If this restriction is violated, the time bases will no longer operate. To resume normal operation, either

- a. enter a valid holdoff setting from the NUMERIC ENTRY major menu, or
 - b. turn the holdoff knob to a valid setting and then press the TRIGGER RESET button.
- P-P mode and Auto trigger are not recommended for Holdoff by Events or Countdown. The following message appears:

"Use Norm trigger mode for best results"
 - When using *Holdoff=Countdown*, creation of holdoff time shorter than the minimum settings shown in Table 2-13 may cause the sweeps to stop. Changing the Main sweep speed or pressing RESET will restart the sweeps. For continued operation, the holdoff time must be set to meet or exceed the minimum time.

TABLE 2-13
Minimum Holdoff Time for 2ns Step and Countdown

Main Time/div	Minimum Holdoff
5 ns to 50 ns	3.50 μ s
>50 ns to 100 ns	4.30 μ s
>100 ns to 200 ns	5.50 μ s
>200 ns to 500 ns	9.80 μ s
>500 ns to 1 μ s	16.0 μ s
>1 μ s to 2 μ s	30.0 μ s
>2 μ s to 5 μ s	78.0 μ s
>5 μ s to 10 μ s	160 μ s
>10 μ s to 20 μ s	300 μ s
>20 μ s to 50 μ s	780 μ s
>50 μ s to 100 μ s	1.60 ms
>100 μ s to 200 μ s	3.00 ms
>200 μ s to 500 μ s	7.80 ms
>500 μ s to 1 ms	16.0 ms
>1 ms to 2 ms	30.0 ms
>2 ms to 5 ms	78.0 ms
>5 ms to 10 ms	160 ms
>10 ms to 20 ms	300 ms
>20 ms to 50 ms	780 ms
>50 ms to 100 ms	1.60 s ¹
>100 ms to 200 ms	3.00 s ¹
>200 ms to 500 ms	7.80 s ¹
>500 ms	20.0 s ¹

¹Applies only to Countdown.

Restrictions for Holdoff by Events

The following restrictions apply only when *Holdoff=Events*.

- *Start=None* and *One Start=On* are incompatible. To avoid this:
 1. If *Start=None* and *One Start* is selected to be **On**, then *Start* will be forced to **Main Trig** with the following crt/GPIB/RS-232-C warning.
 "Start is Main Trig—One Start needs a Start Event"
 2. If *One Start=On* and *Start* is selected to be **None**, then *One Start* will be forced to **Off** with the following crt/GPIB/RS-232-C warning.

"One Start forced to Off"

- *One Start=On* and *Count=2ns* are incompatible. To avoid this:
 1. If *One Start=On* and *Count* is selected to be **2ns**, then *One Start* will be forced to be **Off** with the following crt/GPIB/RS-232-C warning.

"One Start forced to Off"

2. If *Count=2ns* and *One Start* is selected to be **On**, then *Count* will be forced to **Main Trig** with the following crt/GPIB/RS-232-C warning.

Trigger Level Menu

The input signal of the oscilloscope may have a wide variety of shapes and amplitudes. The trigger controls allow you to select any voltage level on the rising or falling slope of the waveform and, in some instances, filter out selected frequencies of the input signal.

Menu Selections

The functions and function status occupy touch zones (see Fig. 2-43). Touching one of these zones selects a new state for the indicated function. For instance, if *Coupling* is touched, this state changes from **Ac** to **Dc**. If *Sensvtvy* (sensitivity), *Mode*, or *Slope* is touched, the selected function cycles through the possible states. Tables 2-14 through 2-16 list all possible states for each trigger function in the control menu.

TABLE 2-14
Trigger Level Menu Functions and States

Mode	Coupling	Sensvtvy	Slope	Trigger
P-P	Ac	High	+	Main
Auto	Ac Lf Rej	Medium	-	
Norm	Ac Hf Rej	Low		
Single	Dc			
	Dc Hf Rej			

Repeatedly touching a menu function on the screen cycles through all possible choices.

TABLE 2-15
Trigger Delay Choices

	Coupling	Sensvtvy	Slope	Trigger
	Ac	High	+	Dly1 Dly2
	Ac Lf Rej	Medium	-	
	Ac Hf Rej	Low		
	Dc			
	Dc Hf Rej			

Repeatedly touching a menu function on the screen cycles through all possible choices.

TABLE 2-16
External Trigger Choices

	Slope	Trigger
	+	CT EXT A
	-	CT EXT B

Repeatedly touching a menu function on the screen cycles through all possible choices.

Menu Selection Definitions

Triggering controls are accessed through the knob assignment button called TRIGGER LEVEL, located between the control knobs (see Fig 2-1, Front-panel illustration).

Source Coupling—selects the coupling, either **Ac** or **Dc**, for the selected source. If the input source is ac coupled, dc coupling probably won't mean a lot; however, it won't be excluded. Dc coupling with LF Reject is not allowed.

Ac—blocks the dc component of the trigger signal and reliably passes signals with frequency >50 Hz.

Dc—passes signals of 0.0 Hz to maximum system bandwidth.

Ac Low-Frequency Rejection—rejects dc and attenuates low-frequency trigger signals below about 80 kHz.

Ac High-Frequency Rejection—rejects dc and high-frequency signals above 30 kHz.

Dc High-Frequency Rejection—rejects high-frequency signals above 30 kHz, while retaining the dc component of the trigger signal.

Trigger Sensvty—selects low, medium, or high sensitivity for the trigger comparator.

Low—requires the greatest peak-to-peak swing of the trigger signal to produce a trigger. This is helpful in reducing the effects of noise on the trigger stability.

High—requires the smallest peak-to-peak swing to produce a trigger. This is most helpful in reducing hysteresis errors found in Width measurements.

Medium—is a compromise between Low and High.

Mode—selects P-P, Auto, Single, and Normal. The Dly1, Dly2, CT Ext A, and CT Ext B trigger have only **Normal** mode and do not offer this selection.

P-P—seeks and maintains a triggered trace by keeping the trigger level within the peak-to-peak amplitude of the trigger source signal. You have the freedom to modify the trigger level at will; the oscilloscope, however, will not let the level be set beyond the peak-to-peak range of the signal.

If the trigger signal changes such that triggering is lost, the oscilloscope attempts to reestablish a triggered trace by searching for a new trigger level. This continues indefinitely until a triggered display is restored. While searching, the trace "free-runs" until triggered.

If the signal is too small to trigger on, it's up to you to either boost the gain, select a different source, or invoke Autoset. P-P Auto does not invoke Autoset or modify the signal gain and offset. The time-out value to determine whether the trigger is present allows for trigger repetition rates of >30 Hz while waiting long enough to complete one full sweep if free-running. Do not use P-P for signals less than 30 Hz.

Auto—is the same as Normal except that when there's nothing to trigger on, the sweeps are forced to "free-run." Assuming a free-running sweep, the trigger time-out value allows for a repetition rate of >30 Hz while waiting long enough to complete a full sweep. Do not use Auto for signals less than 30 Hz.

Normal—is totally a manual process. You must set the level as desired. If the oscilloscope can't be triggered under the conditions imposed, you will not get a sweep.

Single sequence—is referenced in "Single (Sequence) and Trigger Reset" in this subsection.

Slope—selects the edge sensitivity of the trigger event. Either + or - is available.

Trigger Select—allows the trigger choice to be modified. The selectable triggers are Main, Dly1 (delayed window 1), and Dly2 (delayed window 2), CT Ext A, and CT Ext B. Each time a trace is selected, the oscilloscope matches the trigger to the corresponding time base. You have the option to manually override the choice of the oscilloscope.

Each function and its present status appears at the bottom of the display. Repeated touching of the label cycles through all possible states.

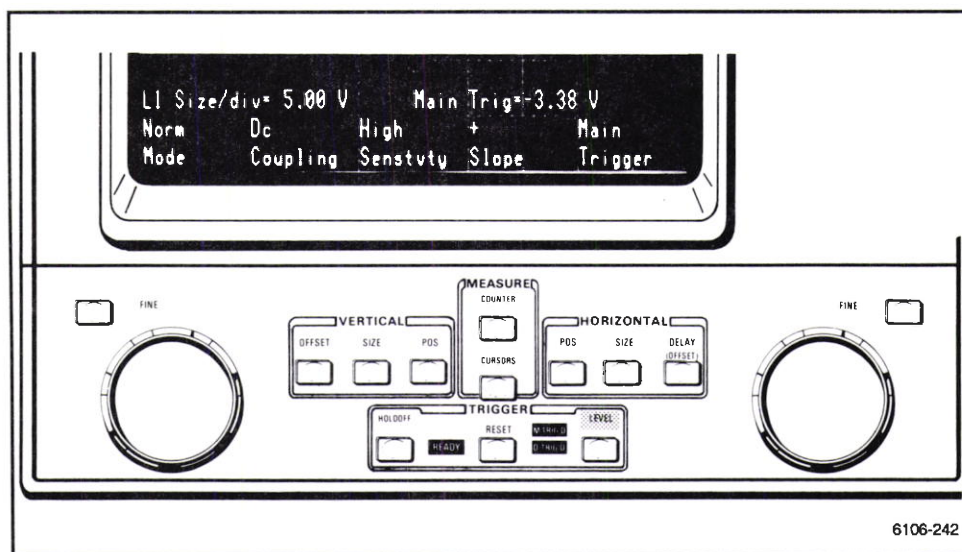


Figure 2-43. The TRIGGER LEVEL control menu and status.

Trigger Level Knob Behavior

- Clockwise rotation increases the level value.
- Valid coarse settings are 0.1 divisions.
- Valid fine settings are 0.01 divisions.

Trigger Scaling

The display value for the trigger level is scaled in divisions or in the dimensions given by the trigger source (e.g., Volts, Amp, etc.). See Figure 2-43. If the Trigger source is ac coupled anywhere along its path (either mainframe or plug-in), the trigger level dimension will have the prefix "ac". If the entire trigger path is dc coupled, then the level is scaled to the sensitivity and dimensions of the source.

If the path is dc coupled, each time the sensitivity or offset of the source changes the scaled trigger level will also change. The actual hardware setting of the trigger level will not be disturbed.

If the trigger source is a single inverted channel (e.g., -L1) or two inverted channels (e.g., -L1 -L2), then the polarity of the trigger level readout will be inverted. If the trigger expression is composed of multiple sources, then divisions are used to scale the trigger level. If using divisions for the Size/div scaling, 0.0 div Trigger Level will be located at center screen. If the trigger path is dc coupled, then the offset and sensitivity of the source will be used for scaling in the same way as the cursors. Trigger level range is ± 10 divisions.

The scaling for the CT Ext A and B levels is always in volts and doesn't have to deal with offset or Size/div; however, probe attenuation coding is included.

NOTE

***EXT+5** and **EXT** source selections interact with the trigger level scaling when dc coupled. **EXT+5** means the trigger sensitivity is reduced by a factor of 5. For example, if the Trigger Level=0.08 V with **EXT**, the Trigger Level=0.4 V with **EXT+5**.*

Trigger Source Major Menu

The TRIGGER SOURCE major menu allows you to specify the signals on which to trigger. This menu offers all the available sources for the Main, Dly1, and Dly2 triggers; the input sources from the vertical amplifiers; the A and B External input of the mainframe; and the ac line signal. Whenever a new source is desired, the old trigger can be replaced by touching any other valid source. (See Fig. 2-44.)

About Defining Trigger Sources

The triggers are defined on the left side of the display, and the available arguments are on the right side. (See Table 2-17.) Touching a trigger name Main, Dly1, or Dly2 presents the valid arguments for that trigger. As choices or expressions are made, they are implemented immediately to lend feedback. This is similar to making traces in that you may interact and respond to the current behavior of the instrument rather than wait until the expression is terminated. Each new selection cancels the previous one. The sources used are indicated by written description.

The trigger expression or definition is always displayed when the TRIGGER SOURCE major menu is displayed. Only one trigger definition can be designated for each time base. Alternate switching of the Main time-base trigger source is not available.

NOTE

As the hardware provides for only two independent time-base triggers, Main and Delayed, it is required that the delayed trigger be alternated to permit independent selection of trigger slope, source, and level for the two delayed windows. Therefore, the TRIGGER SOURCE major menu appears to present three independent trigger source definitions, one main and two delayed (Dly1 and Dly2). (See Fig. 2-45.) As a consequence, if no traces exist or only traces using the Main time base exist, the trigger source, level, and slope for Dly1 trigger will be active with the expression for Dly2 trigger unused. Dly2 trigger will only be implemented when delayed window number two (Window2=On) is in use. The trigger expression for Main will always be active.

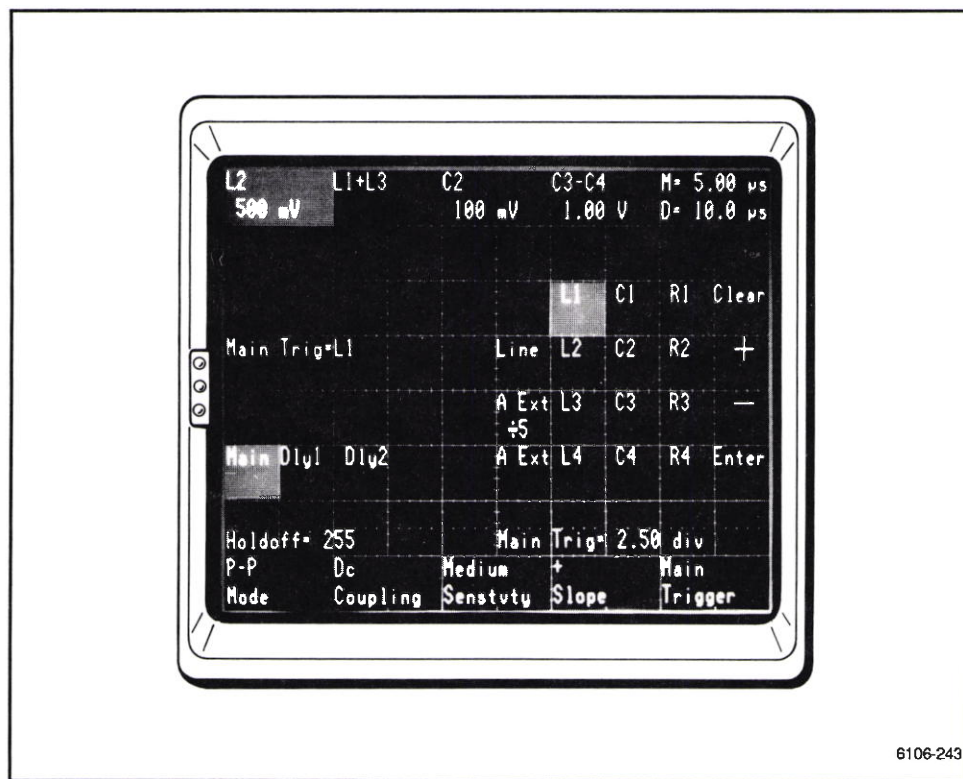


Figure 2-44. TRIGGER SOURCE major menu plus TRIGGER control menu.

TABLE 2-17
Trigger Source Selection and Choices

Trigger	Choices
Main	L, C, R, Line, A Ext+5, A Ext, +, -, Clear, Enter
Dly1	L, C, R, Line, B Ext+5, B Ext, +, -, Clear, Main Trig, Enter
Dly2	L, C, R, Line, B Ext+5, B Ext, +, -, Clear, Main Trig, Enter

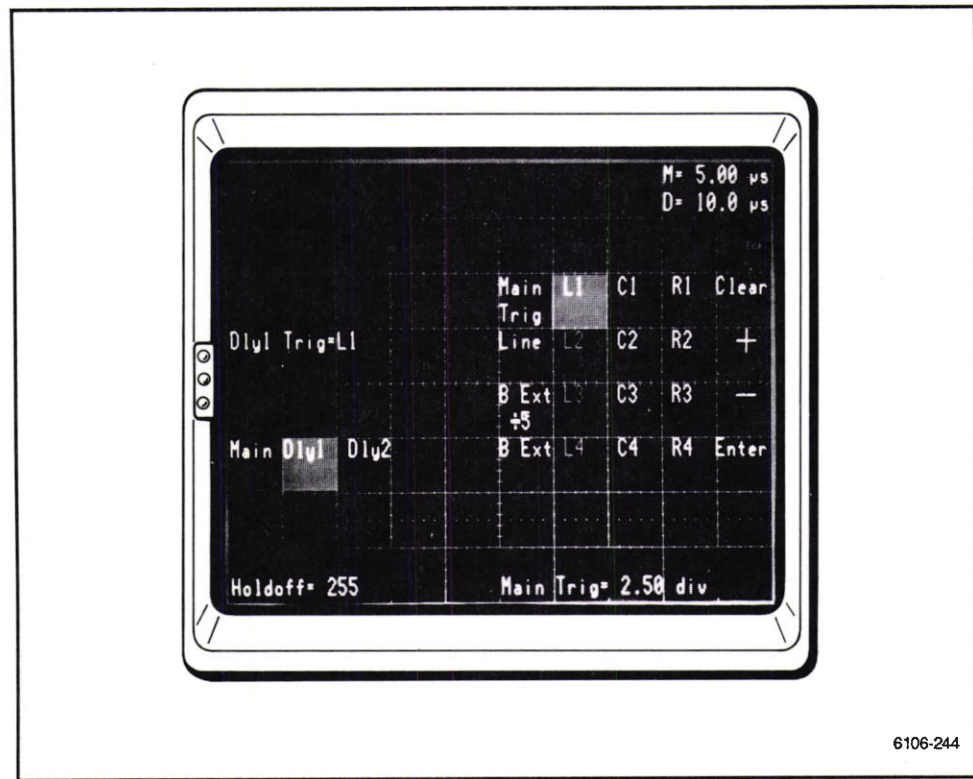


Figure 2-45. This example shows the selections (right half of menu) available for the *Dly1* trigger source. The *Dly2* trigger source menu offers the same selections.

Choices of Trigger Sources

Main Time-Base Sources

- Any combination of channels from the LEFT and CENTER compartments
- Any combination within the RIGHT compartment
- The ac-line signal of the mainframe
- The A External input of the mainframe
- The A External with 5X attenuation

Delayed (Dly1 and Dly2) Time Bases

- Any combination of channels from the LEFT and CENTER compartments
- Any combination within the RIGHT compartment

- The ac-line signal of the mainframe
- The B External input of the mainframe
- The B External with 5X attenuation
- The same as the Main Trigger expression (except Ext inputs)

NOTE

Dly1 and Dly2 have independent slope, level, and source expressions. Coupling and Sensitivity are not independent.

Creating Trigger Source Expressions for Main and Delayed Triggers

Menus that represent the plug-in configuration will present the actual available choices, not the potential possibilities. For example, if all three compartments are filled with two-channel amplifiers, none of the menus will present choices for channels 3 and 4.

Trigger Source Restrictions

The trigger sources derived from the plug-ins can be only one expression. This places a limitation on the available valid sources to the Main and Delayed triggers. As the delayed triggers are referenced to the occurrence of the main sweep, the source within the plug-in cannot be switched quickly enough to provide the delayed trigger with a reliable signal. Therefore, the choices for the delayed trigger sources depend upon the *Main* trigger source selection.

If the Main trigger source is an expression from one plug-in, this expression is the only valid one that both of the delayed sources can use from that plug-in. Any other sources that do not originate from the same plug-in used by the Main trigger are valid. Invalid choices are dimmed.

As a result of defining a new Main trigger source, a previously defined Delayed trigger source may now be invalid. When this occurs, the affected Delayed trigger source is automatically changed to match the new Main trigger source. One of the following three errors will be reported when this happens.

"Delayed trigger source #1 has been changed"

"Delayed trigger source #2 has been changed"

"Delayed trigger sources #1 and #2 have changed"

If an invalid choice that is dimmed is touched, an error message is displayed on the prompt line. See "Errors, Warnings, and Messages" in the Appendixes for a list of possible messages.

Expressions for Composite Triggers for Main and Delayed Triggers

Input sources can be algebraically added or subtracted to produce a trigger expression. The symbols + (plus) and – (minus) are used in the expressions. When building an expression, the following rules apply:

1. The last input channel chosen prior to touching + or – becomes the first element of the chain.
2. Alternately touching + and – (and vice versa) reverses the algebraic operator.
3. The input channel that is the last entry in the expression can be replaced by another input channel before the chain is completed.
4. The chain is completed by touching **Enter**, selecting another trigger source menu, exiting the menu, creating a window from the HORIZONTAL DELAY menu, running Autoset using probe ID or front-panel button, or creating a trace using the probe ID or plug-in display on/off button.
5. Upon completion, the final item in the expression is the input channel that followed the last operator. As the expression is being constructed, it appears above the menu selections on the left side of the screen.

A blinking question-mark, used to get your attention, indicates that the expression is under construction and the oscilloscope is waiting for more information. Upon termination, the question-mark disappears showing the complete expression.

6. Touching **Clear** will erase the current trigger source expression and cause the trigger source to be undefined.

Composite Trigger Restrictions

- Input channels from the RIGHT compartment cannot be combined with any of the CENTER and LEFT inputs.
- No more than two inputs can comprise an expression.
- Ac **Line**, **Ext**, and **Ext+5** cannot be used in a composite expression.
- Previously defined expressions cannot be appended to create a new one.
- An input appears only once in each trigger description (e.g., L1–L1 is not allowed).

Inverting Channel Polarity

To create a simple trigger expression that is the inverted polarity of one channel, the minus operator is touched followed by the desired channel. If exited before creating an expression (- or + does not abort the prior trigger expression), the old one is used and the following message is given in the prompt line.

"Incomplete Trigger expression aborted"

Pending Source Definition

A special case occurs when the oscilloscope attempts to create a trigger source when all traces have been deleted pending the definition of new ones. In such a case, it is possible that an old trigger source definition can be confusing because it may not be obvious why the newly created trace won't trigger! To avoid this possible trap, the oscilloscope chooses a source for you.

When all oscilloscope traces are deleted, the oscilloscope is in a "trigger source pending" state. Count View and Ref waveforms do not affect "trigger pending." If you then decide to define a Main or Delayed trigger from the TRIGGER SOURCE menu, "trigger pending" is cancelled and the oscilloscope does **not** attempt to automatically create a trigger source definition.

If, however, you do not directly create a trigger definition, the oscilloscope creates a trigger source and cancels the "trigger source pending." The source selected for the main and two delayed triggers is the same as the vertical component of the trace that you selected in the process of defining a trace.

Single (Sequence) and Trigger Reset

Single Sequence

When armed (ready) and properly triggered, Single sequence will provide one complete display of all analog "Scope" traces. If there is more than one "Scope" trace displayed and Holdoff is set for Time, multiple triggers are required to complete one display sequence. This is true regardless of CHOP, ALT, or AUTO display choices. One Main trigger is required for each trace using the Main time base. An additional Main trigger is required for each Window2 trace present. Also, if a Window traces exists with the Dly'd time base set for Trig'd After Dly and the Dly'd trigger event does not occur while the Main time base is sweeping, the delayed time base will not run. Hence, the Window trace(s) will not be displayed.

Once the number of Main trigger events is satisfied, Single sequence will complete successfully. Pressing the TRIGGER RESET button resets or reloads the Counter/Timer and Holdoff for a fresh count. The sweeps and triggers of the time bases are armed awaiting a trigger.

Use caution when using Events or Countdown Holdoff as these also require multiple trigger events.

Because Single sequence is nearly always used with long and indefinite photographic exposure times, the TRIGGER RESET button disables all readout text and graticule lights until the trigger events complete the sequence. Because the readout is disabled, all touch screen choices are disabled. The readout and the graticule are momentarily pulsed (approximately 100 ms) at the end of the sequence to record the text and graticule onto the film.

To restore the oscilloscope to its prior state, you may touch the screen or any button on the oscilloscope. If the screen or button is touched, the oscilloscope aborts the single sequence operation without executing any additional functions.

When not in the Single sequence mode, the TRIGGER RESET still functions, but it does not disable the display or impair any other oscilloscope functions.

Trigger RESET

Pushing the trigger RESET button on the front panel or a high-to-low transition at the rear panel TRIGGER RESET connector produce the same results. Upon Reset, the counter aborts and restarts its measurement and holdoff-by-event count. The sweeps will be interrupted and aborted and the triggers rearmed. For the interval from triggers rearming to the sweeps starting again, the READY light on the front panel will be illuminated. Whenever the READY light is on, the rear panel TRIGGER READY output will be set to a high state. When the READY light is off, the TRIGGER READY output will be set to a low state.

Triggered After Delay

Selection and control of the delay value and type of the delayed window are made through the Horizontal control menu. (See Fig. 2-46.) This appears whenever the HORIZONTAL DELAY button is pressed. See "Waveform Acquisition" and "Delayed Windows" for additional information.

If *Runs After Dly* is used, the delayed windows from the horizontal menu are forced to "run" immediately after a specified delay. If *Trig'd After Dly* is selected, the delayed windows will not appear until a trigger is detected after the delay has expired but before the end of the main sweep time.

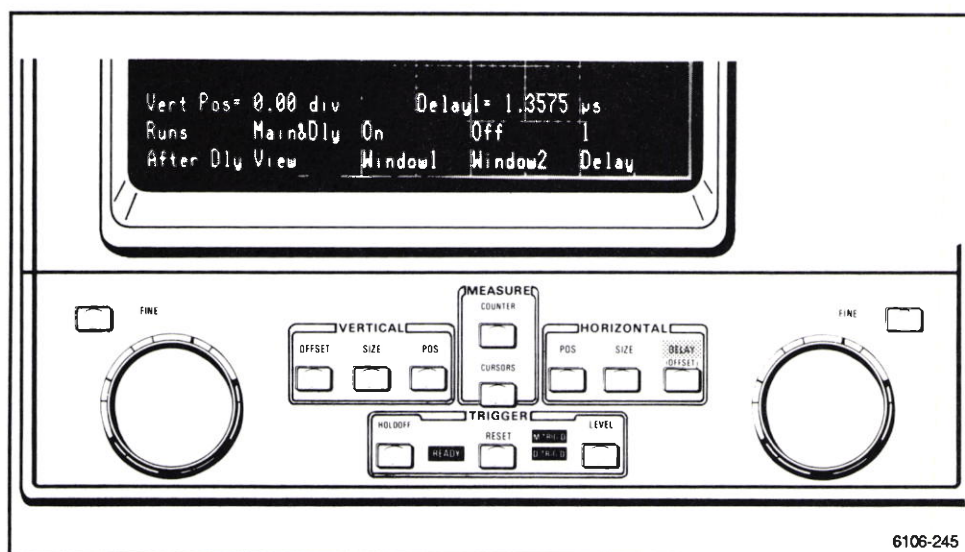


Figure 2-46. The DELAY control menu for YT traces.

Display Control

This section tells how to adjust the crt for astigmatism, trace contrast, character contrast, focus, and trace rotation. It also gives information on adjusting the intensity and graticule illumination.

Display Adjust Major Menu

The DISP ADJ major menu (as shown in Figure 2-47) presents the choices for various display adjustments. This major menu allows you to manually adjust focus, astigmatism, trace rotation, contrast between the Main sweep and its intensified zones, and contrast between the characters and the background shading. The status of the various selections is indicated by shading the choice within the menu.

When the DISP ADJ major menu button is pressed, Focus and Astigmatism are simultaneously assigned to the bottom control knobs. Focus is assigned to the left knob and Astigmatism to the right knob. The readout for the two knobs are labeled **Focus** and **Astigmatism**. Trace Rotation, when selected, is assigned to the right knob. The left knob is not assigned.

NOTE

This menu makes its own knob assignments and must be turned off before any control menu can assign the knobs.

To control the contrast between the intensified zone on the main traces, Δ Main can be used. Δ Char is used to control the difference of background shading to normal characters.

When Δ Main or Δ Char is selected, they are assigned to the right knob. The left knob is not assigned. When the menu is exited, the knobs return to the assignments prior to entering the DISP ADJ menu.

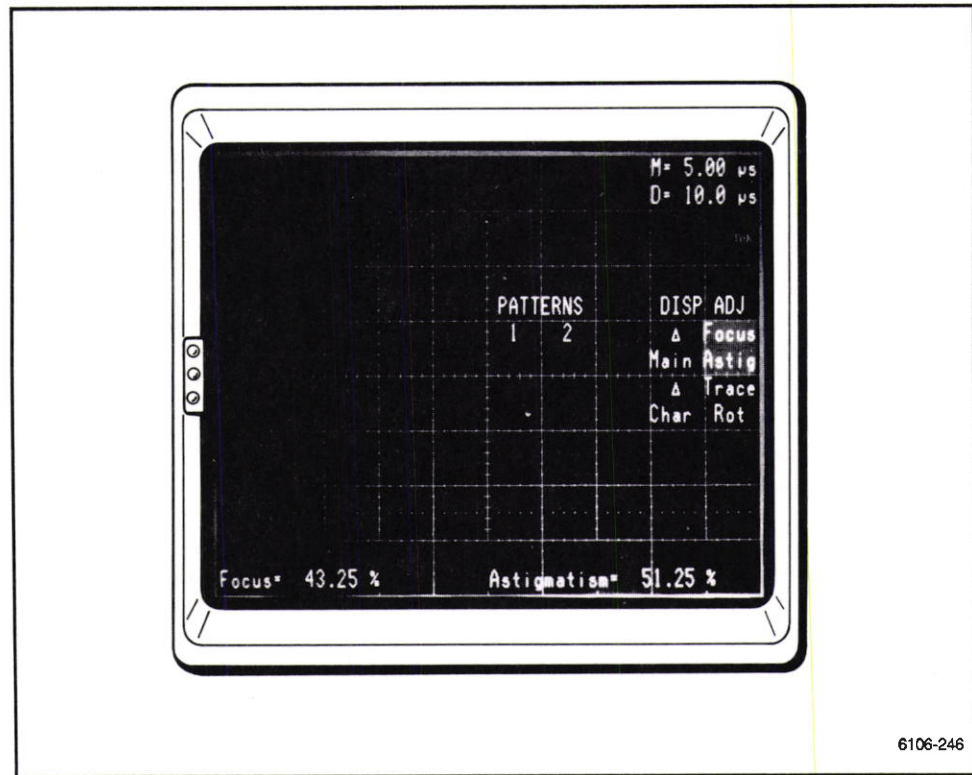


Figure 2-47. The DISP ADJ (Display Adjust) major menu.

In addition to the selections for adjustments, two special display patterns can be displayed. These are intended primarily for service personnel. Once a pattern has been selected, all readout characters are removed, and then any major menu button can be pressed to remove a pattern and return to normal operation. Upon reentry, text is displayed once again.

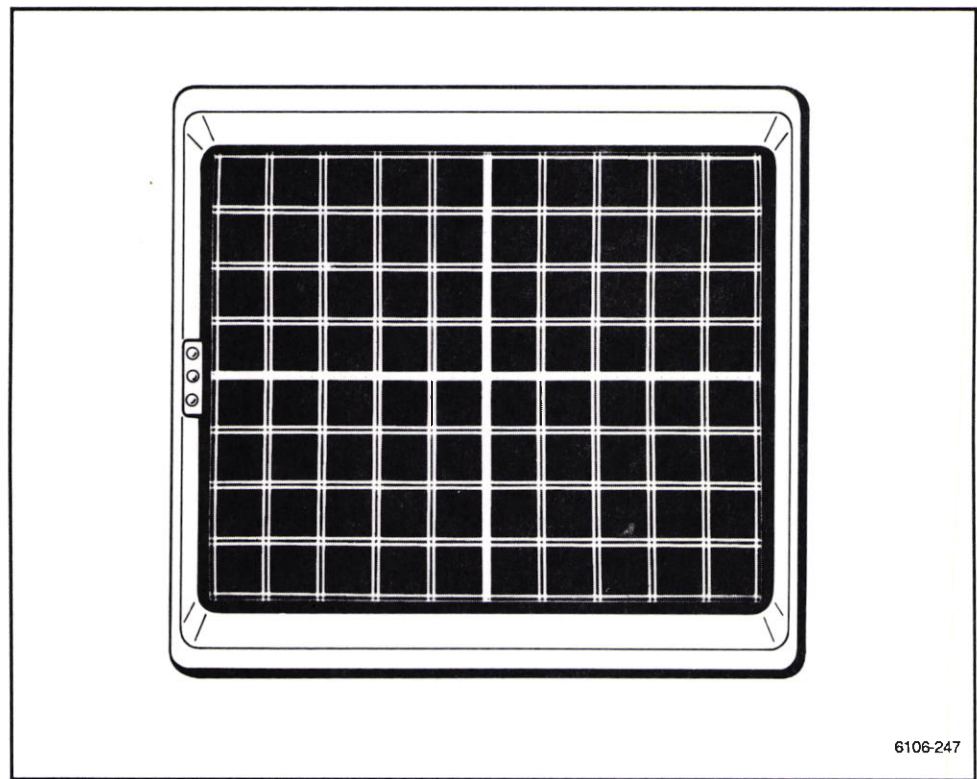


Figure 2-48. Crosshatch pattern 1 is useful for setting focus and astigmatism, and checking geometry and linearity.

Pattern 1 as shown in Figure 2-48 is used to set focus and astigmatism and check geometry and linearity. Geometry and linearity adjustments are accessible only to service personnel. This pattern is composed of dots spaced closely to form lines that fall on either side of the major graticule lines at a distance so as to have the graticule lines touch the display drawn lines if the geometry or linearity are not within specification. An additional vertical and horizontal line bisect the pattern and should fall on the center graticule lines if the display is properly aligned.

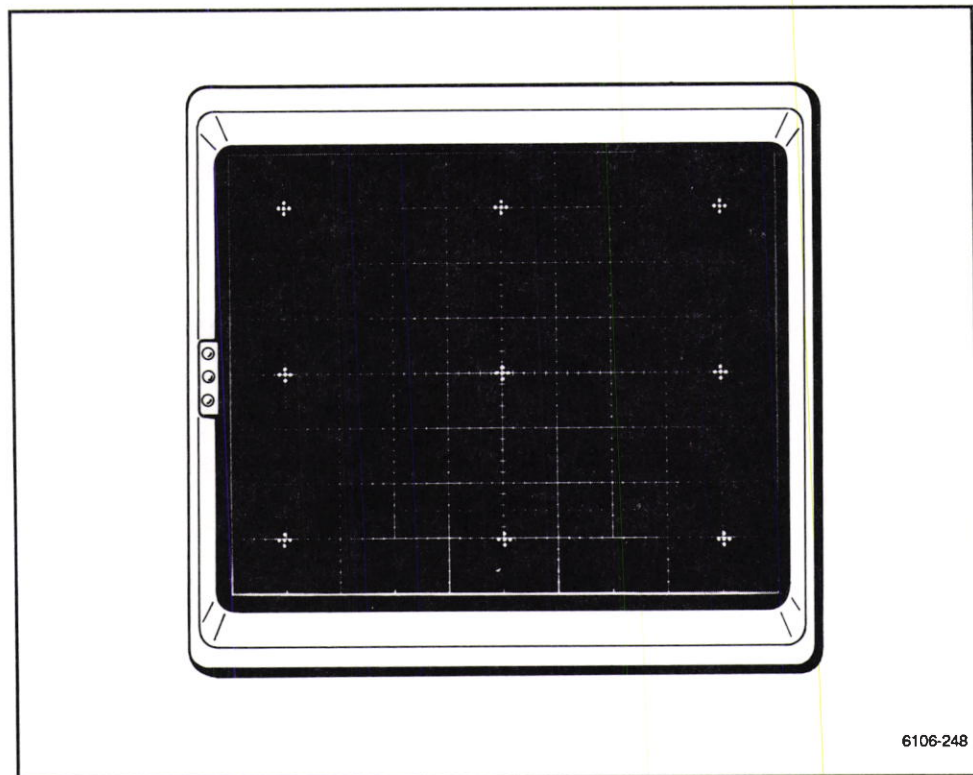


Figure 2-49. Pattern 2 is used during calibration to cancel "spot shift."

Pattern 2 (see Figure 2-49) is used in calibration to cancel the effect called "spot shift" present in the crt. "Spot Shift" is the small change in crt beam position as intensity varies. Each pattern has individually controllable intensity. These adjustments are for qualified service personnel only .

NOTE

Use of this pattern will result in Reference Waveforms 1 and 2 to be set to all zeros. Any data stored in Wfm1 and 2 will be lost upon display of pattern 2.

DISP ADJ Menu Knob Behavior

Whenever the knobs are assigned to a function found in the DISP ADJ menu, the LEDs on the front panel normally used for indicating knob function are turned off and the control menu is removed.

Whenever the knobs are assigned to Focus, Astigmatism, Trace Rotation, Δ Char Contrast, or Δ Main Contrast the control menu remains unchanged.

1. Focus and Astig
 - Fine increments are approximately 0.25% of full scale range.
 - Coarse increments are 2% of full scale range.
2. Δ Main and Δ Char Contrast
 - Coarse and Fine increments are 2% of full scale range.
3. Trace Rotation
 - Coarse and Fine increments are 0.1% of full scale.

Intensity

A single knob located above the crt controls the trace, character, and graticule intensities of the display. These five mutually exclusive assignments for the knob are:

- Character intensity
- Main Sweep intensity
- Delayed Sweep intensity
- XY intensity
- Graticule intensity

One of five LED indicators illuminates one choice in the list to show the present knob assignment. Pressing one of two buttons adjacent to the knob and LEDs selects the knob assignment. The buttons allow you to scan through the list in two directions (up and down). This selection will also "rollover." When the top of the column of choices is reached, pressing the "up arrow" button selects the item at the bottom of the column. Likewise, when the bottom of the column is reached, pressing the "down arrow" selects the item at the top of the column.

11302 Intensity Behavior

As a precaution in maintaining the micro-channel plate performance, a protection mechanism has been incorporated into the 11302. By monitoring the intensity of the display and the amount of user activity, the 11302 will determine if it is necessary to inhibit the display. This will protect the extremely sensitive crt and prolong its life.

There are two stages of inhibited display: complete shutdown and partial shutdown.

Complete Shutdown

If activity at the front panel, GPIB, or RS-232-C is not detected for a period of about five minutes, the entire display will be set to zero intensity. This includes all displayed characters and traces. This condition is indicated by blinking of the CHAR intensity LED. Pressing any button, turning a knob, or sending a command (not a query) through the GPIB or RS-232-C will restore the display for viewing.

Partial Shutdown

Whenever the trace display intensity, trigger rate, and Time/div combine to exceed a pre-determined limit, a warning message appears to advise you to reduce the display intensity. If this condition persists for up to 30 seconds, the trace intensity will be set to zero. Any front panel, GPIB, or RS-232-C activity will reactivate the intensity. However, it is important for you to adjust the intensity level to avoid this condition.

INTENSITY Knob Behavior

Counterclockwise rotation decreases intensity; clockwise rotation increases intensity.

The INTENSITY knob is always assigned to the last selected intensity. The physical range of adjustment is limited at the time of calibration to be between 0% and 100%, however the limit may be reached before encountering a setting of 100%. For example the maximum intensity may be restricted at a selection of 82%. Selecting a setting greater than 82% will exhibit no change in intensity. Also, all queries from GPIB or RS-232C will report the maximum limit if the attempted setting exceeds this limit.

When the character intensity is reduced to its minimum value, a software generated "click" indicates the characters are completely disabled. This allows waveforms to be displayed without holes caused by the momentary interruptions of writing the characters.

When the character intensity is disabled, one clockwise increment enables the characters and another "click" sounds.

NOTE

The term "characters" includes all display characters and graphics that are not analog real-time traces. This means the cursor lines, stored waveforms, and shading are controlled in this fashion.

The touch screen is completely disabled when the character intensity is off. However, the knobs and the knob assignment buttons will operate.

NOTE

Whenever the Time/div is changed, the oscilloscope attempts to adjust the intensity (+ or -) to maintain reasonable brightness.

Measurement

This section discusses the Counter/Timer, the Cursors, and the MEASURE major menu.

Counter/Timer

The Counter/Timer is treated as an integral part of the user interface of the instrument rather than a completely independent entity. This means that no one menu gives you the Counter/Timer functions, but that they are accessed through several menus: Trigger, Counter, Numeric Entry, and Waveform. See the simplified block diagram of the Counter/Timer in "Counter/Timer Concepts" in this subsection.

Counter/Timer Controls and Functions

The Counter/Timer has several parameters that specify its behavior and performance. While making a measurement, you may freely adjust these parameters. In most cases, changing a parameter will restart the measurement.

Averaging

Averaging selects the desired number of averages that determine the measurement resolution when measuring Frequency, Period, Width, Ratio, or Time. The choices for averaging are **1**, $\approx 10^2$, $\approx 10^4$, $\approx 10^6$, $\approx 10^8$, $\approx 10^{10}$, and **Auto**. Auto updates the measurement every 0.3 second or until one average is completed, whichever is greater. "Single-shot" measurements are made and displayed when Averages=1 (no averaging).

Count Ref

Count Reference (a NUMERIC ENTRY major menu feature) displays a number that is subtracted from all measurements. For example, a frequency result of 10 kHz can be established as the reference for all subsequent measurements. When set, the reading for frequency becomes the difference of the new value minus the reference yielding a delta frequency. The reference value is displayed on the same line as the measured values. The Count Reference feature is not available for **Total**. To use the present measurement result as the reference value, touch **Null** in the NUMERIC ENTRY menu.

Counter Source Selection

Source choices are the Main and Delayed internal triggers and the A External input for measuring **Frequency**, **Period**, and **Width**. The Main and Delayed sweep gates and trigger or the CT A and CT B External inputs are sources for **Time A→B**. For **Total** and **Ratio**, the choices are the CT A and B External triggers and the Main and Delayed Internal inputs. Also, Main trigger and CT B External may be used for **Ratio**.

Restrictions and Interactions

- If there is a conflict between the use of the CT External inputs as a measurement source or gating source, one of two messages appear.
 1. If source is already external and external gating is selected, the source is forced to M&D1 Trig and this message appears:

"Source is M&D1 Trig—Ext A&B can be Gate OR Source"
 2. If already in external gate and external source is selected, then gating is forced to off and this message appears:

"Gating is Off—Ext A&B can be Gate OR Source"
- If *Source* is selected to be **A&B Ext** when making **Total** or **Ratio** measurements or **A Ext** when making **Freq**, **Period**, or **Width** measurements, then gating cannot be **Ext A→B** or **B Ext**. If gating was set to one of these, then gating should be set to **Off**.
- If the source for **Total** or **Ratio** is already **A&B Ext** or **Freq**, **Period**, or **Width** is already **A Ext**, and the gating is selected to be **Ext A→B** or **B Ext**, then the source should be changed to **M&D1 Trig**.
- If Dly1 trigger is used as the measurement source and Window 2 is selected, this message is displayed:

"For accurate results remove Dly2 Window"

A similar conflicting situation occurs when Dly2 trigger is used as the measurement source and Window 1 is displayed. This message is displayed:

"For accurate results remove Dly1 Window"
- If while using Main or Delayed trigger as the measurement sources and the Time/div or Delay change, the Counter/Timer is reset and restarted.
- If the source is **Dly2**, gating by **Dly1 Swp** is not allowed and this message is displayed:

"Source is Main Trig – Cannot Gate Dly2 by Dly1"
- If the source is **Dly2** and *Window2* is **Off**, the measurement will use Dly1 Trigger as the source but indicate Dly2 in the menu.

Gating

Gating allows you to exclude the counting of events or features of a signal, and to have more control over the measurement. As an aid in measurement gating, counter view traces may be displayed along with the plug-in analog waveforms. (See "Counter View Traces" in this subsection for more information.) These are the choices allowed with gating:

Dly1 Swp—(Window 1 Delayed Sweep Gate) which is the approximate location of the Dly1 intensified zone on the main sweep trace.

B External input.

Ext A→B—Arm on A (start gate) and Disarm on B (stop gate) inputs, which are one of many uses for the EXTERNAL A and B INPUTS located on the lower-right, front corner of the instrument. The slope and level of the A and B inputs may be modified with the LEVEL control menu.

Off—means there is no gating, and the measurement is over a continuous interval.

Measure

Measurements has unique values for Averages, Gating, and Reference settings (e.g., Ratio can be set for a different number of averages than Frequency without interfering with it). A discussion follows of each of the *Measure* choices of **Frequency, Off, Period, Ratio, Time A→B, Total, and Width.**

Frequency

Table 2-18 shows the number of significant digits for Frequency, f , with averaging N times. The maximum number of significant digits equal 7 when the oven stabilized internal reference is not used. $f=1/\text{period}$ is then rounded to the number of digits given in the table. (Also see and Fig. 2-50 and Table 2-19.)

The number of significant digits displayed for Frequency **Auto** Averages will be dependent on the number of averages in the measurement interval (≥ 300 ms). Table 2-18 may be used to determine the number of digits displayed where N equals the number of periods in the Auto measurement interval.

The number of digits shown are limited to ensure that the actual frequency is within one count of the indicated frequency (assuming no time base or trigger jitter error).

TABLE 2-18
Significant Digits for Frequency (N = Number of Averages)

(f in Hz)	N=1	N=10 ²	N=10 ⁴	N=10 ⁶	N=10 ⁸	N=10 ¹⁰
f < 1 mHz	10	10	10	10	10	10
1 mHz ≤ f < 2.36 mHz	10	10	10	10	10	10
2.36 mHz ≤ f < 7.45 mHz	10	10	10	10	10	10
7.45 mHz ≤ f < 10 mHz	10	10	10	10	10	10
10 mHz ≤ f < 23.6 mHz	10	10	10	10	10	10
23.6 mHz ≤ f < 74.5 mHz	10	10	10	10	10	10
74.5 mHz ≤ f < 100 mHz	9	10	10	10	10	10
100 mHz ≤ f < 236 mHz	10	10	10	10	10	10
236 mHz ≤ f < 745 mHz	9	10	10	10	10	10
745 mHz ≤ f < 1 Hz	8	10	10	10	10	10
1 Hz ≤ f < 2.36 Hz	9	10	10	10	10	10
2.36 Hz ≤ f < 7.45 Hz	8	10	10	10	10	10
7.45 Hz ≤ f < 10 Hz	7	9	10	10	10	10
10 Hz ≤ f < 23.6 Hz	8	10	10	10	10	10
23.6 Hz ≤ f < 74.5 Hz	7	9	10	10	10	10
74.5 Hz ≤ f < 100 Hz	6	8	10	10	10	10
100 Hz ≤ f < 236 Hz	7	9	10	10	10	10
236 Hz ≤ f < 745 Hz	6	8	10	10	10	10
745 Hz ≤ f < 1 kHz	5	7	9	10	10	10
1 k Hz ≤ f < 2.36 kHz	6	8	10	10	10	10
2.36 kHz ≤ f < 7.45 kHz	5	7	9	10	10	10
7.45 kHz ≤ f < 10 kHz	4	6	8	10	10	10
10 k Hz ≤ f < 23.6 kHz	5	7	9	10	10	10
23.6 kHz ≤ f < 74.5 kHz	4	6	8	10	10	10
74.5 kHz ≤ f < 100 kHz	3	5	7	9	10	10
100 kHz ≤ f < 236 kHz	4	6	8	10	10	10
236 kHz ≤ f < 745 kHz	3	5	7	9	10	10
745 kHz ≤ f < 1 MHz	2	4	6	8	10	10
1 MHz ≤ f < 2.36 MHz	3	5	7	9	10	10
2.36 MHz ≤ f < 7.45 MHz	2	4	6	8	10	10
7.45 MHz ≤ f < 10 MHz	1	3	5	7	9	10
10 MHz ≤ f < 23.6 MHz	2	4	6	8	10	10
23.6 MHz ≤ f < 74.5 MHz	1	3	5	7	9	10
74.5 MHz ≤ f < 100 MHz	1	2	4	6	8	10
100 MHz ≤ f < 236 MHz	1	3	5	7	9	10
236 MHz ≤ f < 745 MHz	1	2	4	6	8	10
745 MHz ≤ f	1	1	3	5	7	9

NOTE

Although results can be presented for the frequencies above 500 MHz, their accuracy is not specified.

For the table above, f represents the internal representation for Frequency. The number of significant digits are determined using f, and then the Frequency value is formatted for display and finally rounded for display purposes. Therefore, it is possible to view a displayed result of 1.000 MHz (N=10²) shown with 4 digits even though the tables suggest 5 digits. The fact is that the Frequency is actually slightly less than 1.000 MHz. For example, the Measured frequency is 999.9998 kHz. When displayed with 4 digits of precision, it appears rounded to 1.000 MHz.

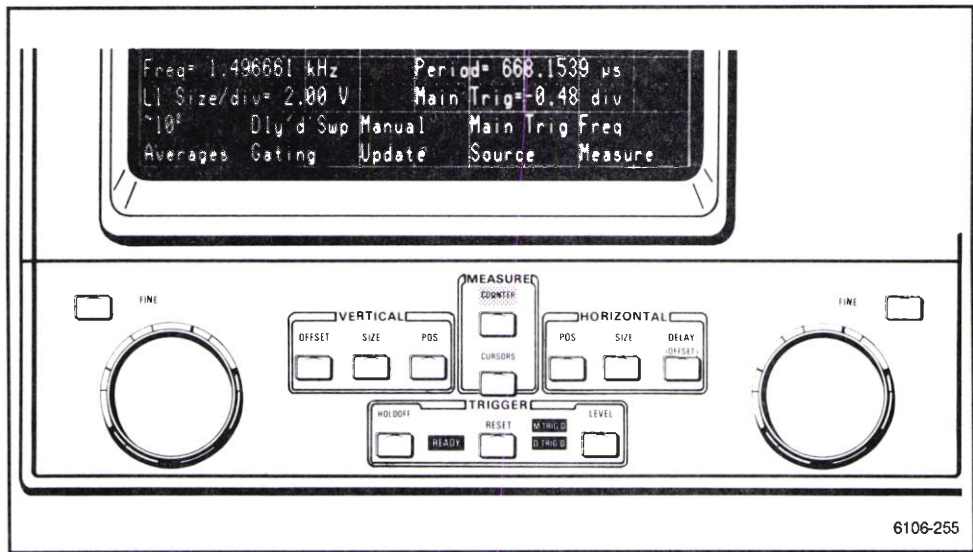


Figure 2-50. The COUNTER control menu showing the measured results for Frequency.

TABLE 2-19
Menu Choices for Frequency Measurements

Averages	Gating	Update	Source	Measure
1	Dly1 Swp	Manual	Main Trig	Freq
≈10 ²	B Ext	Auto	Dly1 Trig	
≈10 ⁴	Ext A→B		Dly2 Trig	
≈10 ⁶	Off		A Ext	
≈10 ⁸				
≈10 ¹⁰				
Auto				

Repeatedly touching a menu function on the screen cycles through all possible choices.

Off

Off erases the counter results from the display and shuts off the Counter/Timer to keep warning messages from interfering with other operations. Notice in Table 2-20 the absence of menu choices when **Off** is selected.

Period

Table 2-20 shows the number of significant digits for Period averaging N times. The maximum number of significant digits equals seven when the oven-stabilized internal reference is not used. Figure 2-51 shows an example of the MEASURE menu when **Period** has been selected and Table 2-21 shows the function choices available.

The number of significant digits displayed for Period **Auto** Averages will be dependent on the number of averages in the measurement interval (≥ 300 ms). Table 2-20 may be used to determine the number of digits displayed where N equals the number of periods in the Auto measurement interval.

TABLE 2-20
Significant Digits for Period (N = Number of Averages)

(t in Sec)	N=1	N=10 ²	N=10 ⁴	N=10 ⁶	N=10 ⁸	N=10 ¹⁰
1 s ≤ t	10	10	10	10	10	10
1 s > t ≥ 100 ms	9	10	10	10	10	10
100 ms > t ≥ 10 ms	8	10	10	10	10	10
10 ms > t ≥ 1 ms	7	9	10	10	10	10
1 ms > t ≥ 100 μs	6	8	10	10	10	10
100 μs > t ≥ 10 μs	5	7	9	10	10	10
10 μs > t ≥ 1 μs	4	6	8	10	10	10
1 μs > t ≥ 100 ns	3	5	7	9	10	10
100 ns > t ≥ 10 ns	2	4	6	8	10	10
10 ns > t ≥ 1 ns	1	3	5	7	9	10
1 ns > t	*	*	*	*	*	*

* indicates where the Counter/Timer results will be displayed as zeros.

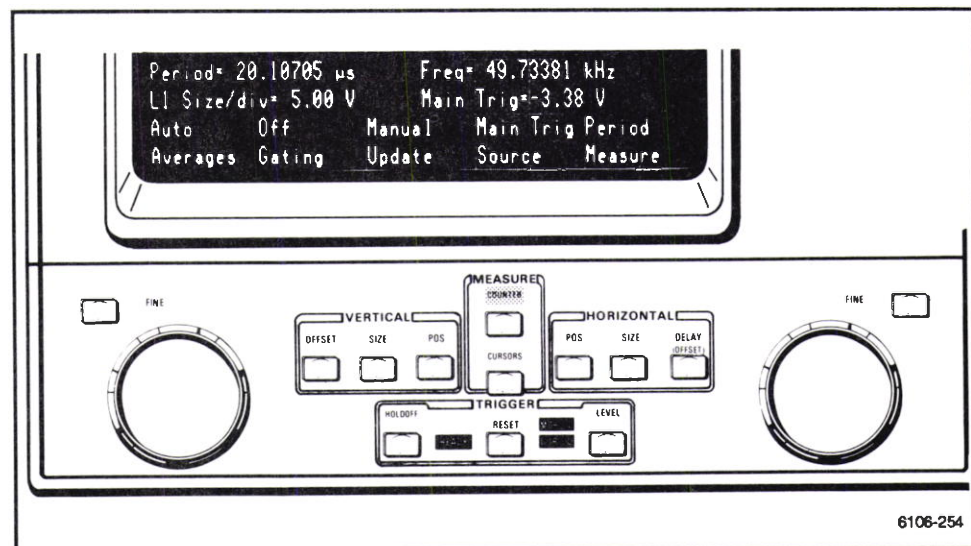


Figure 2-51. The Counter control menu showing the measured results for Period.

TABLE 2-21
Menu Choices for Period Measurements

Averages	Gating	Update	Source	Measure
1	Dly1 Swp	Manual	Main Trig	Period
$\approx 10^2$	B Ext	Auto	Dly1 Trig	
$\approx 10^4$	Ext A→B		Dly2 Trig	
$\approx 10^6$	Off		A Ext	
$\approx 10^8$				
$\approx 10^{10}$				
Auto				

Repeatedly touching a menu function on the screen cycles through all possible choices.

Ratio

In **Ratio** the counter measures the number of events on both channels for Main and Delay internal triggering, A & B External inputs, or Main and B External inputs during the time it takes to accumulate the selected number of Main or A External events (averaged by Main or A External events). See Table 2-22 and Figure 2-52 for menu choices when using Ratio. The total number of Delayed or B External events is then divided by the total number of Main or A External events, and the answer is displayed without units.

The ratio range is from 10^{-11} to 10^{11} . Applying the higher frequency to Delay or B External produces a ratio greater than one; applying the lower frequency to Delay or B External produces a ratio less than one. For better resolution with Averaging other than Auto, apply the higher frequency signal to Delay trigger or B External; Averaging will then be based on the lower frequency which will result in a longer measurement interval and more resolution.

TABLE 2-22
Menu Choices for Ratio Measurements

Averages	Gating	Update	Source	Measure
1	Dly1 Swp	Manual	M&D1 Trig	Ratio
$\approx 10^2$	B Ext	Auto	M&B Ext	
$\approx 10^4$	Ext A→B		A&B Ext	
$\approx 10^6$	Off			
$\approx 10^8$				
$\approx 10^{10}$				
Auto				

Repeatedly touching a menu function on the screen cycles through all possible choices.

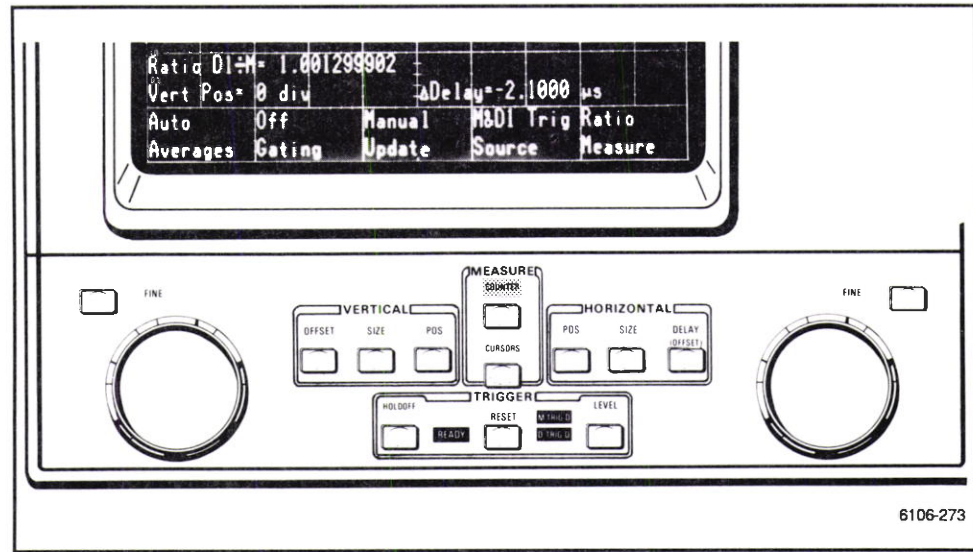


Figure 2-52. The COUNTER menu choices when using Ratio.

Time A→B

If the measurement source is set to **Swp Start** and only one window is displayed, the time between the main and the delayed sweep gate is displayed. If both delayed windows are displayed, then the time difference between the two windows is displayed as Time D1→D2. This is actually measured as the difference between the Main to Dly1 sweep start subtracted from the Main to Dly2 sweep start. If no delayed zones exist this message will prompt you that one is required:

"Delayed Window required for Time A→B."

A & B External Source

For the measurement type Time A→B with CT External A & B as the inputs, the time interval measured occurs between the edges of the A & B External inputs. This mode is equivalent to the Time A→B mode of conventional counter/timers and allows the user to free the trigger inputs of the oscilloscope for other uses. With a positive slope selected for both A & B External triggers, the time interval measured starts on the positive transition of A and ends on the positive transition of B. The slope selection allows you to invert the transition direction that begins and ends the time interval. The level can be set independently for the A & B External trigger. The **A Ext** and **B Ext** traces in the Counter View waveform menu may be used as an aid in setting the slope and level of these inputs. Using these inputs allows measurements to be independent of plug-in traces and other trigger sources. A minimum time interval of 2 ns is required.

Main and Delayed Trigger Source

For the measurement type Time A→B with Main and Delayed triggers as the inputs, the time interval measured occurs between the edges of the Main and Delayed trigger inputs. This mode offers the advantage of using the different capabilities of the plug-in amplifiers such as amplifier conditioning, increasing sensitivity, and displaying analog signals. With positive slope selected for both Main and Delayed triggers, the time interval measured starts on the positive transition of the Main trigger and ends on the positive transition of the Delayed trigger. The slope selection allows you to invert the transition direction that begins and ends the time interval. The level setting for these measurements from the Main and Delayed trigger source use the same slope and level settings as used in triggering the sweeps. A minimum time interval of 2 ns is required when using these inputs.

Table 2-23 shows the number of significant digits for Time A→B or Width averaging N times. The maximum number of significant digits equals 7 when the oven stabilized internal reference is not used. See Fig 2-54 and Table 2-25 for control menu choices.

The number of significant digits displayed for Time A→B **Auto** Averages will be dependent on the number of averages in the measurement interval (≥ 300 ms). See Table 2-23.

TABLE 2-23
Significant Digits for Time A→B (M→D Trig, CT Ext A & B)
and Width (N = Number of Averages)

(t in Sec)	N=1	N=10 ²	N=10 ⁴	N=10 ⁶	N=10 ⁸	N=10 ¹⁰
1 s	10	10	10	10	10	10
1 s > t ≥ 100 ms	9	9	10	10	10	10
100 ms > t ≥ 10 ms	8	8	9	10	10	10
10 ms > t ≥ 1 ms	7	7	8	9	10	10
1 ms > t ≥ 100 μs	6	6	7	8	9	10
100 μs > t ≥ 10 μs	5	5	6	7	8	9
10 μs > t ≥ 1 μs	4	4	5	6	7	8
1 μs > t ≥ 100 ns	3	3	4	5	6	7
100 ns > t ≥ 10 ns	2	2	3	4	5	6
10 ns > t ≥ 1 ns	1	1	2	3	4	5

Table 2-24 shows the number of significant digits for Time A→B averaging N times. The maximum number of significant digits equals 7 when the oven stabilized internal reference is not used. See Fig 2-54 and Table 2-25 for control menu choices.

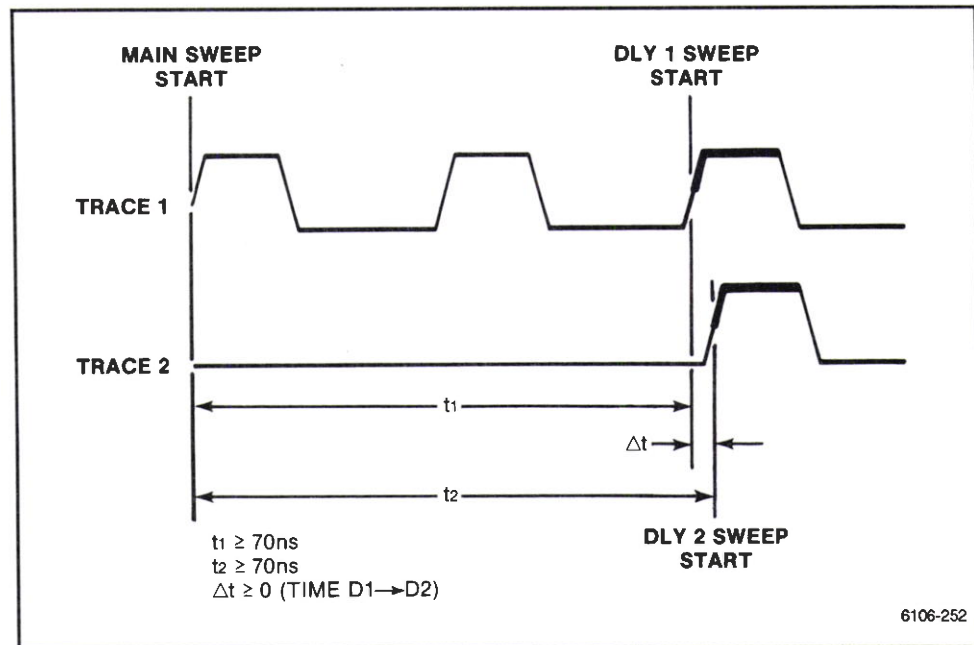


Figure 2-53. Precision timing between any two events is provided when using both window 1 and 2. The difference between Dly1 and Dly2 can equal zero.

Swp Start

Selecting **Swp Start** as the measurement source allows complex time interval measurements to be made with the aid of the Delayed sweep. Measurements begin at the start of the Main sweep and end at the start of the Delayed sweep. The versatility of this measurement comes about by the ability of the Main sweep to be synchronized to complex signals using Holdoff and the capability of the delayed sweep to be run after delay (for easy measurement setup) or triggered after delay for more precise measurement. The adjustable slope and level of the Delayed trigger allows the end of the measurement interval point on a waveform to be independently set with respect to the starting point.

The ability to define two windows on the Main sweep adds even more capability. The Counter/Timer will automatically subtract the time measured between the start of the Main sweep and Window 1 from the time measured between the start of the Main sweep and the start of Window 2. (There are limitations. When **Swp Start** is selected as the measurement source, the minimum time interval from Main to Dly1 or Dly2 sweep starts is 70 ns. However, the difference between Dly1 and Dly1 may be zero. See Figure 2-53.) Each window may have its delay time, source, level, and slope set independently for complete flexibility in setting the measurement interval. The intensified zones begin at approximately the same time as the Delayed sweep begins. By this means, the intensified zones can be used as markers to locate waveform features while the Counter/Timer measures the time between them. At faster Main sweep speeds, where the intensified zone is not as well defined, the Counter View may be used to aid in the selection of the measurement interval.

The number of significant digits displayed for Time A→B **Auto** Averages will be dependent on the number of averages in the measurement interval (≥ 300 ms). See Table 2-24.

TABLE 2-24
Significant Digits for Time A→B (Time D2→D1 and M→D1 Sweeps)
(N = Number of Averages)

(t in Sec) ¹	N=1	N=10 ²	N=10 ⁴	N=10 ⁶	N=10 ⁸	N=10 ¹⁰
1 s ≤ t	10	10	10	10	10	10
1 s > t ≥ 100 ms	9	9	10	10	10	10
100 ms > t ≥ 10 ms	8	8	9	10	10	10
10 ms > t ≥ 1 ms	7	7	8	9	10	10
1 ms > t ≥ 100 μs	6	6	7	8	9	10
100 μs > t ≥ 10 μs	5	5	6	7	8	9
10 μs > t ≥ 1 μs	4	4	5	6	7	8
1 μs > t ≥ 100 ns	3	3	4	5	6	7
100 ns > t ≥ 10 ns	2	2	3	4	5	6
10 ns > t ≥ 1 ns	1	1	2	3	4	5
1 ns > t ≥ 100 ps	*	*	1	2	3	4
100 ps > t ≥ 10 ps	*	*	*	1	2	3
10 ps > t ≥ 1 ps	*	*	*	*	1	2
1 ps > t ≥ 100 fs	*	*	*	*	*	1
100 fs > t	*	*	*	*	*	*

NOTE

Measurement results of less than 1 ns in this table apply only to measuring between two Delayed Windows (Time D1→D2).

** indicates where the Counter/Timer results will be displayed as zeros.*

¹For Time D2→D1, t represents the magnitude of the results.

TABLE 2-25
Menu Choices for Time A→B Measurements

Averages	Update	Source	Measure
1	Manual	Swp Start	Time A→B
≈10 ²	Auto	A&B Ext	
≈10 ⁴		M&D1 Trig	
≈10 ⁶			
≈10 ⁸			
≈10 ¹⁰			
Auto			

Repeatedly touching a menu function on the screen cycles through all possible choices.

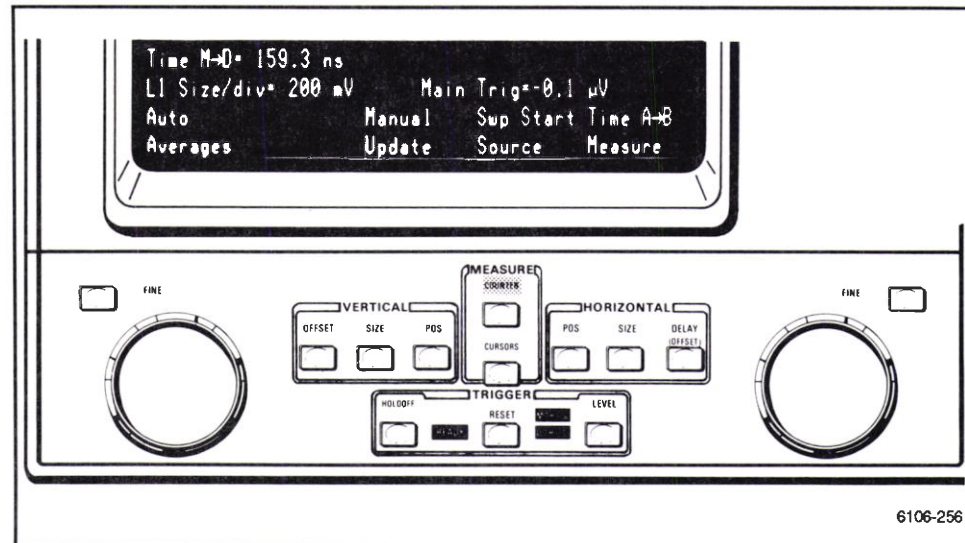


Figure 2-54. The COUNTER menu showing the difference between the Main and Dly1 sweep gates as Time M→D.

Total

Total is two sources measured simultaneously. (See Table 2-26 and Figure 2-55 for menu choices when using Total.) If the measurement is gated, then the totals are the counts within the gated interval. A Ext and M Trig sources display the total count and the time elapsed during which the total is accumulating. Ext A→B gating of Total is not available when the A Ext input is selected as the source. Selection of an invalid source/gating combination will default to valid settings. If Total has been stopped by other than the Update function (e.g., by pressing Enhanced Accuracy, Measure, or Autoset), the following message appears. "Counter/Timer TOTAL measurement has been stopped."

TABLE 2-26
Menu Choices for Total Measurements

Gating	Update	Source	Measure
Dly1 Swp B Ext Ext A→B Off	Running Stopped	M&D1 Trig A&B Ext A Ext M Trig	Total

Repeatedly touching a menu function on the screen cycles through all possible choices.

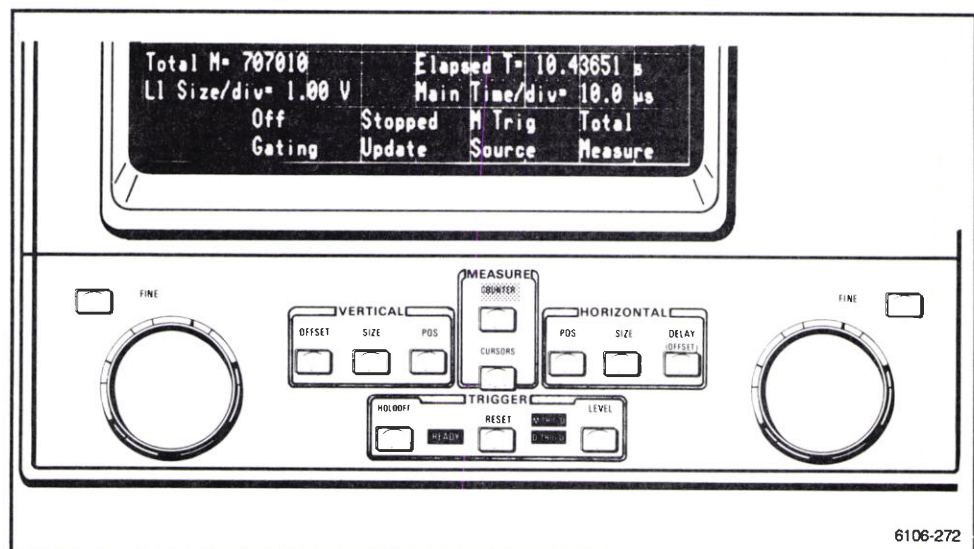


Figure 2-55. The COUNTER menu for Total.

Width

Width is the measured time between two adjacent transitions having opposite polarity. The width measurement begins on a transition that has its polarity set by the slope setting (+ equals a positive edge; - equals a negative edge) for the measurement source selected. See Table 2-27 and Figure 2-56 for menu choices when using Width.

TABLE 2-27
Menu Choices for Width Measurements

Averages	Gating	Update	Source	Measure
1	Dly1 Swp	Manual	Main Trig	Width
$\approx 10^2$	B Ext	Auto	Dly1 Trig	
$\approx 10^4$	Ext A→B		Dly2 Trig	
$\approx 10^6$	Off		A Ext	
$\approx 10^8$				
$\approx 10^{10}$				
Auto				

Repeatedly touching a menu function on the screen cycles through all possible choices.

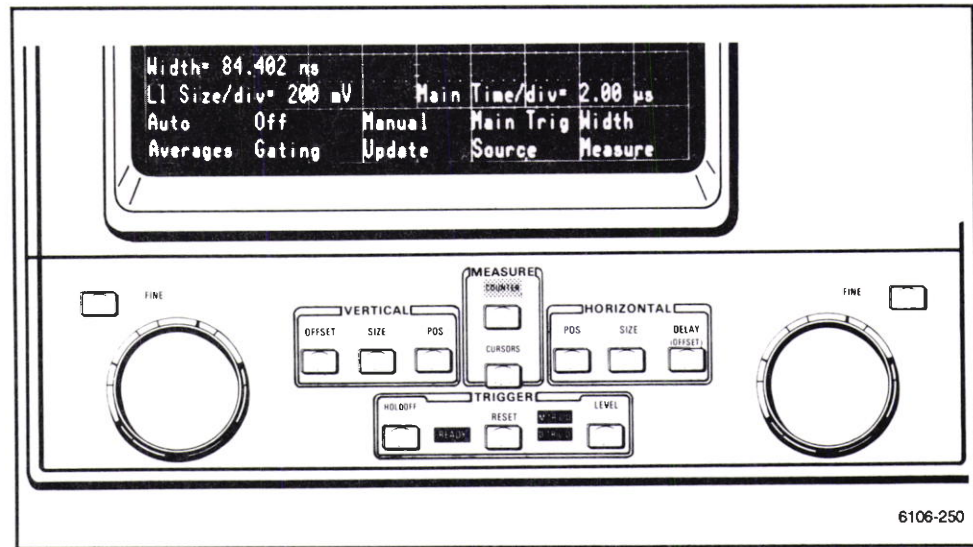


Figure 2-56. The COUNTER menu for Width.

Updating

Updating allows you to observe changes in the measurement result by constantly refreshing or, when completed, holding the results. For **Total**, the choices are **Running** and **Stopped**; for all other measurements, the choices are **Manual** or **Auto**. **Auto** updates the results every 300 ms or after the measurement average is complete. **Manual Update** will hold the current results until a new measurement is started by pressing **RESET**, choosing **Auto Update**, or initiating a GPIB measurement.

Because the results of the Counter/Timer use the prompting area in the display, there are times when the two conflict. Prompts, warning, and error messages have the same priority as a result. Therefore, a new message can replace an old result, and a new result can replace an old message.

When a message is cleared and the counter result hasn't been updated, it will be restored to the last legal state (e.g., $\text{Freq}=\text{xxxx}$ will reappear and not wait for a new result). Touching the screen restores the measurement results, providing the message has been dealt with.

If no signal has been detected after a period of 3 seconds for internal measurement sources or 5 seconds for external measurement sources, this message is displayed:

"COUNTER: Waiting to Start Measurement"

For measurements, in **Auto** or **1**, that take longer than 3 seconds for Main or Delayed internal sources or 5 seconds for external A and/or B sources and the number of averages reached is greater than 1, this message is displayed:

"COUNTER: Waiting to finish Measurement"

For measurements, in **Averages** equal to $\approx 10^2$, $\approx 10^4$, $\approx 10^6$, $\approx 10^8$, or $\approx 10^{10}$, that take longer than 3 seconds for Main and Delayed sources or 5 seconds for external sources and the number of averages reached (n) is greater than 1, this message is displayed:

"COUNTER: Still Measuring. Averages = n "

Any of the messages which overwrite the displayed results of the measurement may be removed by simply touching any area of the screen. Previously acquired results will be recalled and displayed until another timeout period elapses.

Counter/Timer Knob Assignments

The counter button is the exception to the operating conventions of the knob assignment buttons. Although the counter has its own menu, it does not have any unique knob functions. As the Counter/Timer is affected by virtually every control and mode of the oscilloscope (e.g., Trigger Level, Trigger Sensitivity, Vertical Size, Delayed Time/div, etc.), it is necessary to permit the use of all oscilloscope controls while viewing the the result of the counter.

To do this, the result of the Counter/Timer is displayed in the prompting line directly above the knob setting line in the display. In this way, adjustments can be made while observing their influence on the results.

Immediately after you press the COUNTER button, and before either control knob is moved, its menu is displayed while maintaining the previous knob assignments. Figure 2-57 shows the left knob controlling L1 Size/div and the right knob controlling the Main Trigger Level.

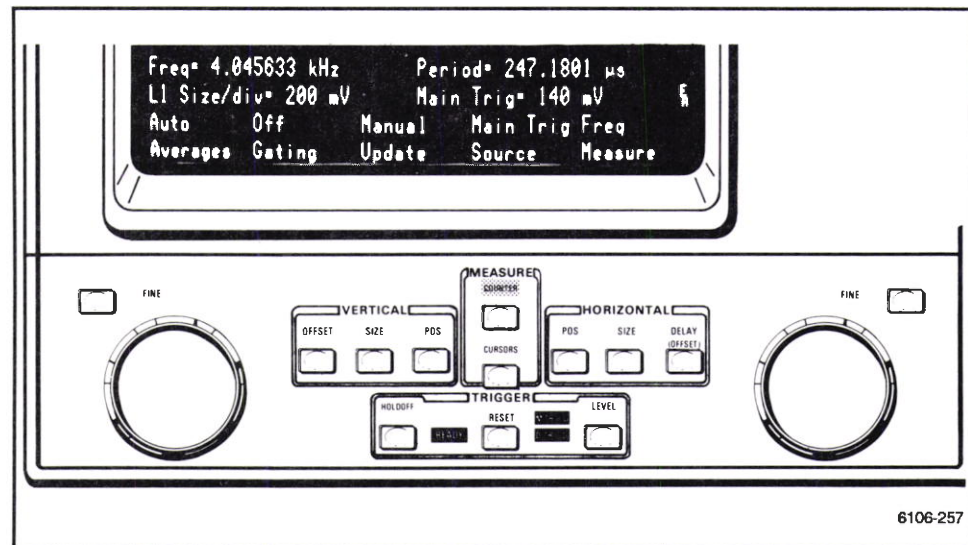


Figure 2-57. The COUNTER menu before either knob is moved (previous knob assignments displayed).

Fig. 2-58 shows that alternate presses of the COUNTER button (as with all menu buttons) remove its menu and preserve the knob setting and displayed results.

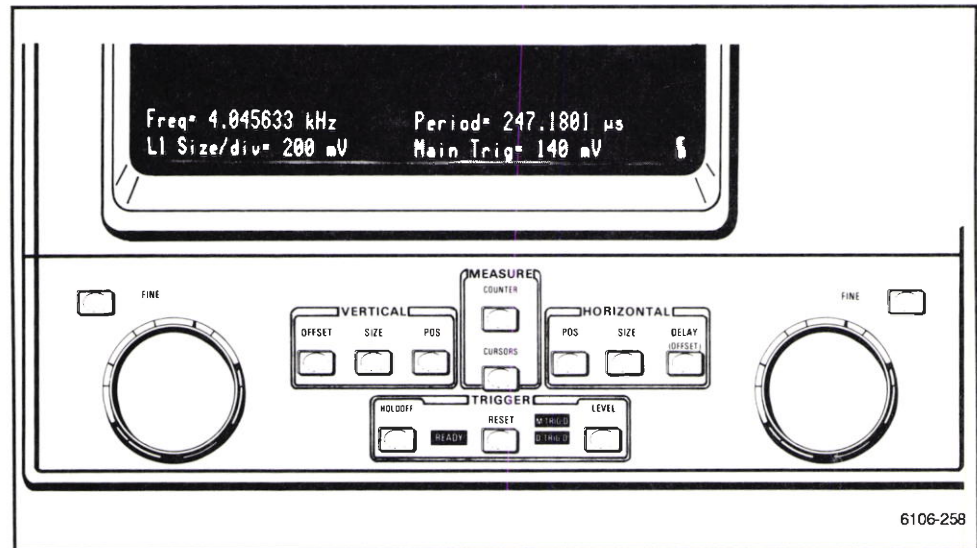


Figure 2-58. Alternate presses of the COUNTER button preserve the knob setting and results.

So long as the Measure setting of the counter is not **Off**, the results and labels of the Counter/Timer remain displayed even when another knob assignment is made. In Figure 2-59, the TRIGGER LEVEL button has been pressed, calling up its own menu while the results of the Counter/Timer are still displayed. The results and labels (e.g., Freq=) of the Counter/Timer can be removed from the display by setting *Measure* to **Off**.

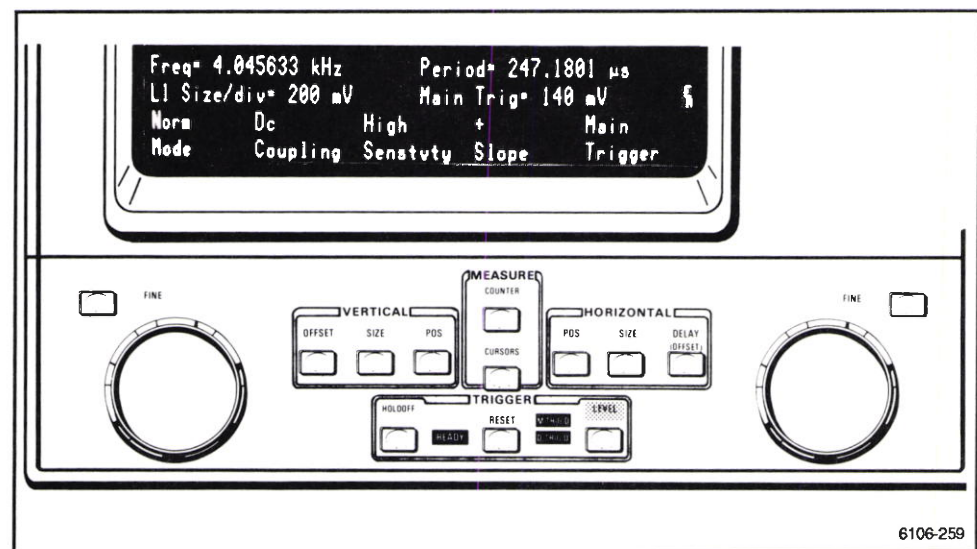


Figure 2-59. Here the TRIGGER LEVEL button has been pressed, calling up its own menu while the results of the Counter/Timer are still displayed.

Counter/Timer Operation

The Counter/Timer can operate even though its menu is not displayed. This allows you to manipulate other oscilloscope features that require the same menu space without disturbing a measurement in progress.

This is not to say you can't disturb it by some action. Whenever Enhanced Accuracy, Measure, or Autoset is executing, the measurement of the Counter/Timer is aborted. The measurement (except for **Total**) resumes when Enhanced Accuracy, Measure, or Autoset completes. When **Total** is interrupted, it does not resume, but clears and displays a message alerting you that the result has been disturbed.

Selections of *Gating*, *Averaging*, *Updating*, and *Source* are accessed through the COUNTER button, located between the two knobs and above the CURSOR button.

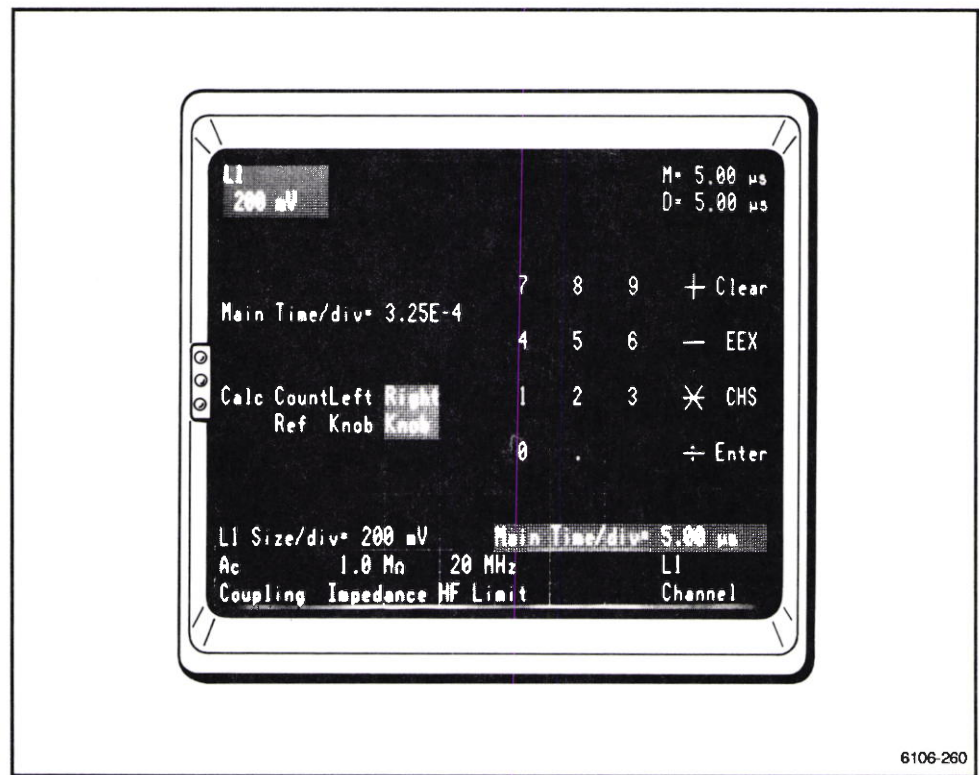
The currently measured signal source(s) is (are) derived from the time-base trigger or the EXTERNAL A and B INPUTS. This requires you to use the TRIGGER SOURCE major menu to specify the signals to be measured if the time-base triggers are used.

The Counter/Timer results can be viewed in a continuously updated fashion or held after one measurement is completed. If **Auto Update** is chosen, the display of the measured results updates each time a new result is computed or as soon as the display allows, whichever is slower. The fastest Auto update rate is limited to about 0.3 seconds.

If the result is held after the completion of a measurement (**Manual Update**), the result remains displayed until the RESET button is pressed, the rear panel RESET signal input transitions to a "high" state, or another measurement is selected. While **Totaling**, the update choices are **Running** and **Stopped**. When started after a stop, **Total** continues from its old value.

To freeze a result that would otherwise change too rapidly, selecting **Manual Update** (or **Stopped Update** when **Totaling**) holds the last measurement result indefinitely. Changing the update setting to **Manual** or **Stopped** never clears or removes results from the display. Touching *Update* again will resume updating.

To completely remove the Counter/Timer results and labels from the display, set *Measure* to **Off**.



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Figure 2-60. The NUMERIC ENTRY menu with a relative reference value set.

In addition to viewing the measured results, a reference value for relative comparisons can be set by using the NUMERIC ENTRY major menu. (See Fig. 2-60.) With the reference value set to zero, the actual measured result is displayed. Table 2-28 shows the format for zero reference values when the NUMERIC ENTRY menu is **Off**.

TABLE 2-28
Format for Zero Reference and NUMERIC ENTRY Off

Selected Measurement	Left Half	Display Right Half
Time A→B (if D1 & D2 sweeps are in use and source=Swp Start)	Time D1→D2=<measured>	
(if only one delayed sweep is in use or Ext A→B is selected)	Time M→D=<measured>	
(if Source=M&D Trigs)	Time M→D1=<measured>	
Frequency	Freq=<measured>	Period=<1/Freq>
Period	Period=<measured>	Freq=<1/Period>
Total (if selected source = A&B Ext)	Total A=<measured>	Total B=<measured>
Total (if selected source = A Ext)	Total A=<measured>	Elapsed=<measured>
Total (if selected source = M&D1)	Total M=<measured>	Total D1=<measured>
Total (if selected source = M Trig)	Total M=<measured>	Elapsed=<measured>
Ratio (if selected source = A&B Ext)	Ratio B+A=<measured>	
Ratio (if selected source = M&D1)	Ratio D1+M=<measured>	
Ratio (if selected source = M&B Ext)	Ratio B+M=<measured>	
Width	Width=<measured>	

When the reference is a nonzero value, it is shown on the left and the delta result is shown on the right of the display. A capital Greek delta (Δ) is displayed to the immediate left of the measurement name (e.g., Δ Freq) except for **Total** which has no ref value. Table 2-29 shows the format for nonzero reference values or when the NUMERIC ENTRY menu is on. This table also shows the displayed results of measurements and reference values.

When the NUMERIC ENTRY menu is displayed, it is treated as if the reference value is not zero. This offers you the choice to enter something for the reference. See the "NUMERIC ENTRY" subsection for target detail.

When **Null** on the Numeric keypad menu is touched, the present values for the measurement displayed are saved and subtracted (nulled) from all following measurements of that particular type. When **Clear** and **Enter** on the Numeric keypad menu are touched, the reference is set to zero and the measured results are displayed again as "absolutes." In addition, any valid number entered from the Numeric Keypad menu is interpreted as a new reference value and displayed in the readout.

TABLE 2-29
Format for Nonzero Reference or NUMERIC ENTRY On

Selected Measurement	Display	
	Left Half	Right Half
Time A→B (if D1 & D2 sweeps are in use and source=Swp Start)	Δ Time D1→D2=<measured-Ref>	Ref=<entered>
(if only one delayed sweep is in use or Ext A→B is selected)	Δ Time M→D=<measured-Ref>	Ref=<entered>
(if source=M&D Trigs)	Δ Time M→D=<measured-Ref>	Ref=<entered>
Frequency	Δ Freq=<measured-Ref>	Ref=<entered>
Period	Δ Period=<measured-Ref>	Ref=<entered>
Total (if selected source = A&B Ext)	Total A=<measured>	Total B=<measured>
Total (if selected source = A Ext)	Total A=<measured>	Elapsed=<measured>
Total (if selected source = M&D1)	Total M=<measured>	Total D1=<measured>
Total (if selected source = M Trig)	Total M=<measured>	Elapsed=<measured>

TABLE 2-29 (cont)
Format for Nonzero Reference or NUMERIC ENTRY On

Selected Measurement	Display	
	Left Half	Right Half
Ratio (if selected source = A&B Ext)	Δ Ratio B+A=<measured-Ref>	Ref=<entered>
Ratio (if selected source = M&D1)	Δ Ratio D1+M=<measured-Ref>	Ref=<entered>
Ratio (if selected source = M&B)	Δ Ratio B+M=<measured>	Ref=<entered>
Width	Δ Width=<measured-Ref>	Ref=<entered>

Whenever the measurement source is changed or Enhanced Accuracy, Measure, or Autoset is executed, the displayed results are cleared and the measurement in progress (except for **Total**) is aborted and restarted. The result for **Total** remains cleared with a message advising you to start again as the old result was disturbed. This tends to eliminate misleading and false measurement results when the source is changed.

Modifying any of the trigger controls or trigger source inputs for the selected measurement source (e.g., **Main** or **Dly1** trigger source menus) by selecting a new measurement source (e.g., **Main Trig**, **A Ext**, etc.) can disturb a measurement. Therefore, the measurement will be aborted and restarted.

Pressing RESET always clears the displayed results and reinitiates the measurement.

Additional Control and Status

Time A→B can measure the time difference from an event of one signal to an event of another signal. You should be aware of the dependency upon the Delayed trigger definitions when using **Time A→B** with *Source* equal to **Swp Start** and the delayed windows set to **Trig'd After Delay**. This means that the Delayed trigger sources are alternated to allow timing between two different signals. If **Runs After Dly** is used, the trigger sources are not important.

Another case is when Main and/or Delayed trigger sources are used for the **Ratio**, **Frequency**, **Period**, **Width**, or **Total** measurements. Here you are required to set, through the TRIGGER SOURCE menu, the trigger sources you wish to measure.

If either of the Delayed triggers is used as a measurement source, the **Trig'd After Dly** source must correspond to the measurement source.

Counter View Traces

Through the Counter/Timer, several different signals can be viewed to interpret measurement results. All counter-view signals are binary, that is, they have only two possible vertical states. Their significance is in the timing of the transitions.

Counter-view signals are displayed in the same manner as any new trace by using the WAVEFORM major menu. This means that they will occupy a touch zone in the trace description area. VERTICAL OFFSET and SIZE, and the trace construction operators +, -, and Vs cannot be used on Counter View traces. However, delayed windows can be created on Counter View traces and VERTICAL POSition can be used. The following entries in the WAVEFORM menu (as shown in Fig. 2-61) will help you in operating the Counter/Timer.

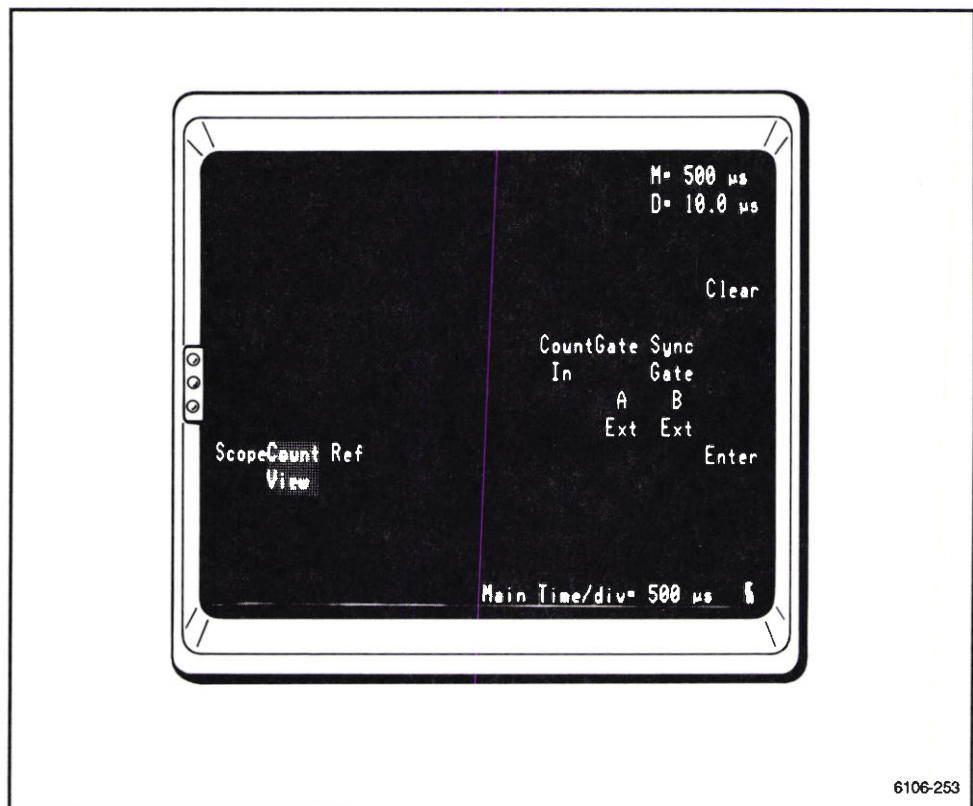


Figure 2-61. The WAVEFORM menu shows the additional entries from the counter-view signals of the Counter/Timer.

Count In—represents the signal counted as a binary signal (only two vertical states). When the counter is being gated, this trace shows the "gated input" to the counter. When not gated, this trace shows the same number of transitions as the detected input signal.

Sync Gate—views the interval actually being measured except for Time A→B. For Time A→B with the source set to M&D1 Trig, Sync Gate represents the measurement beginning at the Main trigger and ending at the Dly1 trigger.

All Counter/Timer measurements begin and end on transitions of the signal being measured. The gating signal may be unrelated to the measured signal resulting in the actual gated measurement beginning on the first edge of the signal after the start of the gate, and then ending on the next edge after the end of the gate. See Figure 2-62.

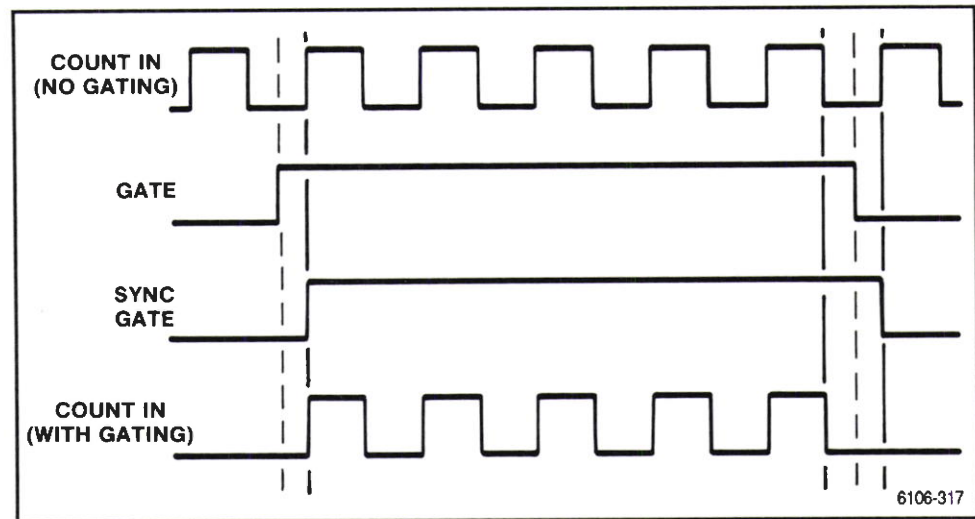


Figure 2-62. The relationship of Sync Gate to the gating signal and the measured signal.

Gate—views the applied gate that you can select as either the Delayed time-base sweep gate or the **B Ext** input.

To summarize the last three choices, **Count In** is what the counter counts, **Sync Gate** is the actual measurement interval, and **Gate** is the gating signal that, in conjunction with the input to the counter, defines the measurement interval. These three counter views are most useful for Frequency, Period, Width, Ratio, and Total. For Time A→B, these provide little insight into the measurement. All of these traces have only two vertical levels; therefore, they are binary representations of their respective signals.

A External Input—views the detected signal present at the **A External** input of the mainframe.

B External Input—views the detected signal present at the **B External** input of the mainframe. Counter View displays of A & B External are available at all times whether or not they are being used for measurements. The Counter View signals displayed as **Count In**, **Gate**, and **Sync Gate** depend on the measurement being made. See Table 2-30.

TABLE 2-30
Synopsis of Counter Views

MEASURE	COUNT IN Without Gating	COUNT IN With Gating	GATE	SYNC GATE
Freq/Period	Measurement Source	Gated Measurement Source	Gating Source	Synchronized Gate Source
Width	Measurement Source	Gated Measurement Source	Gating Source	Synchronized Gate Source
Ratio	Measurement Source	Gated Measurement Source	Gating Source	Synchronized Gate Source
Total	Measurement Source	Gated Measurement Source	Gating Source	Gating Source
Time A→B Internal M→D1	Measurement Clock*	—	M→D1 Time	Gating Source
Time A→B Internal M→D2	Measurement Clock*	—	Measurement Clock*	Measurement Clock*
Time A→B Internal D1→D2	None	—	None	None
Time A→B External	Measurement Clock*	—	Measurement Interval	Measurement Interval
Time A→B M&D1 Window1 on	Measurement Interval	—	Measurement Interval	Measurement Interval
Time A→B M&D2 Window2 on	Measurement Interval	—	Measurement Interval	Measurement Interval

* The measurement clock is the 555 MHz timing reference counted during the Main to Delay sweep time. It serves as an aid in positioning the Delayed windows at the fast main sweep speeds.

Presentation of Results

Frequency, Period, Ratio, Time, and Width

The measurement results for **Frequency, Period, Ratio, Time, and Width** are always scaled as a mantissa (M) with an exponent symbol (S) and dimension (D) using SI (Système International d'Unités) conventions where:

$$1 \leq M < 1000 \text{ and}$$

$$S = f, p, n, \mu, m, k, M, G, T, (\dots\text{etc.})$$

$$D = \text{Hz and s}$$

In some cases, there may not be enough resolution to accurately represent the measurement. For example, a single shot measurement of 120 MHz would produce either 111 or 138 MHz result from the counter. Under these or any other conditions where there are fewer significant digits than required to place the decimal point to the right, only the significant digits appear on the display with all digits to the right of the decimal point.

In the case of the example above, the result would be displayed as 0.1 GHz. In general, the result will be tested for enough significant digits to fit the general display format. If there are not enough digits to fill the format, then the following adjustment to the format will be made.

The mantissa, M, will be displayed as:

$$0.001 \leq M < 1$$

The exponent symbol, S, will represent a 1,000 times increase. In other words, divide the mantissa prescribed by the general form by 1,000 and multiply its associated exponent by 1,000.

Tables 2-17, 2-20, 2-23, and 2-24 list the number of digits available as a function of frequency and amount of averaging. These apply whether or not you are using *Gating*.

When averaging is increased the number of displayable significant digits usually increases. For example, 5.0 MHz would appear as:

old reading:	5.0 MHz (2 sig. digits with Averages set to 1)
new reading:	5.000 MHz (4 sig. digits with Averages set to 100)

It is also possible to have the number of displayable digits change due to a change in frequency. For example, a frequency change from 2.4 MHz to 2.30 MHz appears as:

old reading:	2.4 MHz (2 sig. digits with Averages set to 1)
new reading:	2.30 MHz (Averages still set to 1 but the lower frequency allows one more digit to be shown)

The maximum number of digits displayed for the **Frequency**, **Period** or **Width** time interval is reduced to seven when the oven-stabilized internal reference is not used. When **External** is selected for the clock source, the maximum number of significant digits is ten.

Total

The results for **Total** are presented as an integer of ten digits or less. If the value exceeds the ten digit display, exponent scaling (scientific notation) is applied. This, in effect, acts like a prescaler allowing you to continue to view the result without overflowing the display. The results are dimensionless.

Ratio

The results of **Ratio** are presented with ten digits. Leading zeros for results <1 are not counted as significant digits.

Counter/Timer Concepts

This is a discussion on the principles and capabilities of using the Counter/Timer features. Refer to "Counter/Timer" in this subsection for specific information on counter and timing operations by menu selection and external inputs. Refer to the "Measurement Concept Tutorial" subsection for more Counter/Timer examples.

Description

The 11301 and 11302 Programmable Oscilloscopes each contain a high performance Counter/Timer. By taking advantage of oscilloscope resources such as delayed sweeps, multiple trigger inputs, high sensitivity inputs, and a crt display, this becomes a true precision measurement instrument.

To appreciate the benefits that these resources provide when used with the Counter/Timer, a brief discussion of the oscilloscope architecture is helpful.

Figure 2-63 shows a simplified block diagram of the internal instrument architecture. The bold lines in this diagram represent the paths that relate directly to the Counter/Timer. Such paths include analog signal sources to be measured, processed and detected signals from the triggers, measurement delimiters, and a way to view not only the numeric results but to see how the signals actually appear from the point of view of the counter.

Counter View Display

The "Counter's View" of the signal can be used to determine which features of the signal are being measured. This added display allows you to adjust and control the measurement with greater precision.

Displaying Counter View Traces

Displaying the Counter View signal reveals what the counter is actually "seeing" and how it's being interpreted. The most valuable of these signals is the **Count In** signal, which represents the information the counter received from the selected trigger source. Other counter views include signals representing the applied **Gate**, which can be used to exclude and mask-out unwanted waveform features from the measurement; the **Sync Gate**, which indicates the interval within which the counter actually performs the measurement; and the **A Ext** and **B Ext** inputs as detected by the CT Ext trigger controls. **A Ext** and **B Ext** inputs are most easily viewed when they are time related and when the Main trigger has **A Ext** selected as its source.

In a conventional oscilloscope, the triggering circuitry is used to provide a stable display of a signal. The triggers produce a processed signal that represents the detection of a signal transition having some prescribed level and direction (polarity). These, of course, are determined by the familiar Trigger Level and Slope controls or by invoking Autoset for the Main and Delayed trigger sources.

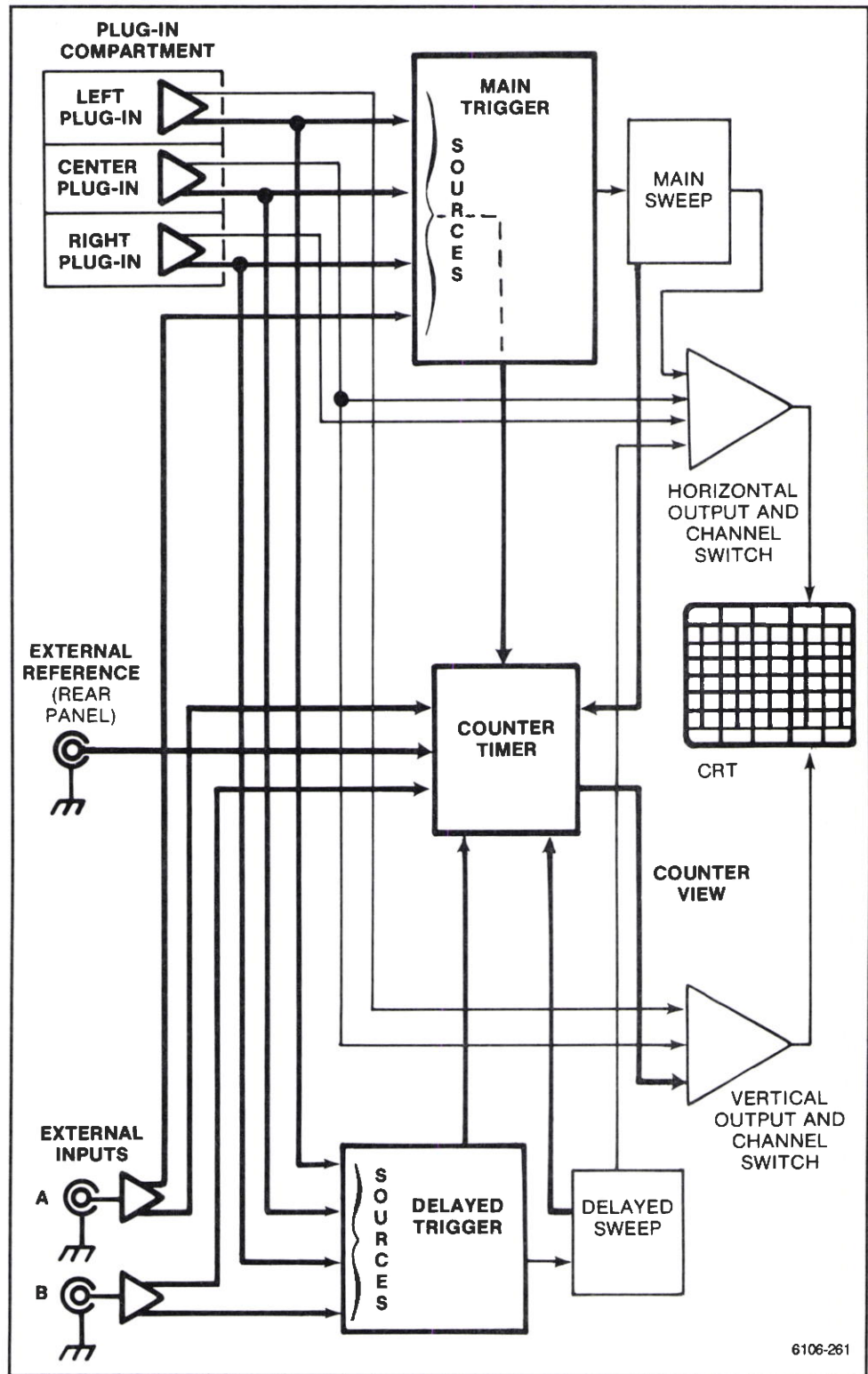


Figure 2-63. Simplified Block Diagram with highlighted Counter/Timer paths.

The trigger output signal is simply a series of high to low transitions. These are what most of the measurements of the Counter/Timer are based on. (The one exception is Time A→B with **Swp Start** as the *Source* and the delayed sweep set to **Runs After Dly**). Therefore, by adjusting the trigger level and the slope, different characteristics of a signal can be measured.

Viewing the **Count In** signal can lend more insight into a measurement even for seemingly simple waveshapes. For signals other than square wave signals, the placement of the trigger level can have a subtle effect upon the measurement. This will have a more profound effect when making a pulse-width measurement on a signal with appreciable rise and fall times.

A signal appearing to be symmetric about its middle level, such as a sine wave, may look quite different to the counter depending upon where the trigger level is set. For example, if the trigger level is set to 25% of peak-to-peak from the top of the signal, the detected signal as viewed by the counter will have a duty factor of about 33% (see Fig. 2-64). This means that the width of the signal appears to be two-thirds the value of what would be measured at the mid (50%) point of the signal. All of this may seem a bit unsettling for such a simple waveshape, but by displaying the **Count In** signal, such a situation can be easily observed.

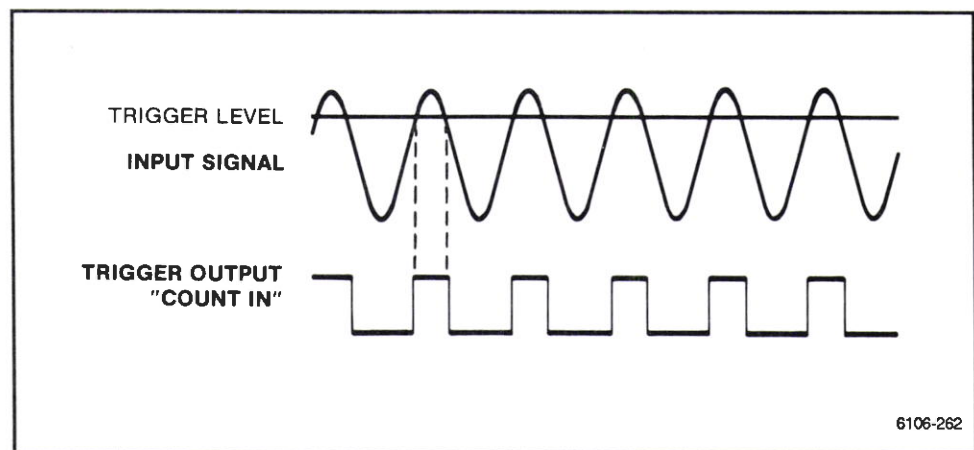


Figure 2-64. Counter View Traces.

Measured Signals

Signals to be measured can originate from the A and B External inputs or from the plug-in compartments. Allowing the signal to be first applied to and amplified by a plug-in unit extends the usefulness of the Counter/Timer. For example, high impedance sources can be examined by using a very low loading probe. Also, signals of irregular and aperiodic components with large dc components can be centered within the triggering range of the Counter/Timer by using a differential comparator amplifier. Such a plug-in can compensate for dc components of 10,000 times the magnitude of the ac component. This feature is not available with any conventional Counter/Timer.

The amplified signal from the plug-in has two different paths. It can be viewed on the display, examined by the trigger circuits, or both. It is important to realize that the signal to the trigger circuits does not have to be from the same source as the signal being displayed. For example, a displayed trace originating from the LEFT compartment can be triggered by a signal from the CENTER compartment. Also, within a given plug-in, one channel can be viewed while another undisplayed channel can be used for triggering.

To define trigger sources for the Main and Delayed time bases, the TRIGGER SOURCE major menu is used.

Measurement Intervals

The Counter/Timer offers several ways to control when measurements are made. In the human time frame, the *Update* setting controls when the measurements will be initiated by the processor within the instrument. Measurements may be started individually using RESET with **Manual Update** or allowed to repeat after completion with the processor limiting the update interval to 300 ms (for convenient visual monitoring of the result when using **Auto Update**).

When a more precise setting of the measurement interval is required, *Gating* may be used. Measurement gating is available for Frequency, Period, Width, Ratio and Total measurements. Time A→B measurements may not be gated. Gated measurements begin on the first transition following the start of the gate interval and end on the first transition after the gates end. The Counter View may be used as an aid in understanding where gating occurs, especially using the **Sync Gate** to show the realignment of the gate to the signal (**Count In**). Averaged measurements will continue until the end of the current gate interval after the number of averages has reached its selected value. Gating does affect the measurement results in that a one count error may occur for each gate that without gating would occur only once for each measurement. Gating sources provide three different ways to select the actual measurement interval.

Delayed sweep gating using the Dly1 window is, perhaps, the most convenient way to gate a measurement. Gating may use either **Runs** or **Trig'd After Delay**. It is often easier to position the gate using **Runs After Delay** then switch to **Trig'd After Delay** if it is still necessary. It is not necessary to turn on **Window1** unless you want to have the approximate gated area intensified on the Main sweep. Delay 1 may be set to position the gated measurement interval anywhere on the main sweep after about the first 100 ns of a visible main sweep on the screen. Allowing a typical setting of less than 150 ns, the gate interval will last the duration of the delayed sweep. At slower sweep speeds, it is approximately ten times the delayed Time/div setting.

The CT External A and B inputs may be used as a pair to determine the beginning and end of the gate interval. The A input starts the gate with the B input ending it. A positive transition will be the active edge with a + slope setting.

The CT External B input may be used by itself to develop a gate interval that occurs when the input is above the setting of the CT Ext B level with a + slope selected or when the input is below the setting of the CT Ext B level with a - slope selected.

Measurements do not start immediately, however. They are only permitted to start only after the trigger conditions are satisfied.

Once permitted to start, the measurements must again be inhibited at the end of the gate interval. This length of time is determined by the delayed sweep time, approximately ten times the Delayed Window Time/division setting.

The External A and B inputs can also be used to gate a measurement.

Frequency Measurements

For well-behaved and periodic signals, only a few special considerations are needed. For more complex signals and discriminating techniques, see "Gated Frequency Measurements" that follows.

First of all, it's important that the signal to be measured have sufficient amplitude and stability to produce accurate counter results. This does not mean that these are the only signals that can be measured. For this example, such a signal will serve as an effective vehicle. Second, the trigger source gets its signal from the counter not from the display directly.

The easiest way to ensure that the signal amplitude and triggering are correct is to use AUTOSET. Remember that AUTOSET, when fully enabled, adjusts the input sensitivity, input offset, input coupling, all of the triggering, and, most importantly, makes the trigger source the same signal as the one that gets automatically scaled. By using AUTOSET, all of the adjustments prior to making a frequency measurement on simple signals are made automatically.

After the trace and triggers are set, pressing the COUNTER button (located below the display) accesses the Counter/Timer menu. Here several different measurements can be selected. By repeatedly touching the menu item labeled *Measure* (located in the lower right corner of the display) the desired measurement and its associated parameters can be selected. In this case, keep touching *Measure* until **Frequency** is selected as the measurement.

To simplify the counter operation, several **Auto** selections are available for most of the measurement parameters. In the COUNTER menu, *Update* controls whether the results will be continually reported (*Update=Auto*) or reported only once and remain frozen in the display (*Update=Manual*). The measurements and the present results can be aborted (cleared) and restarted by pressing the trigger RESET button located below the crt. To control the resolution (number of significant digits), the number of measurement averages can be selected. When *Averages* is set for **Auto**, the number of averages will depend upon how many can be performed within about 0.3 seconds. This will permit the display to be updated several times each second when using **Auto Update**.

The *Gating* selection should be set to **Off** for simple signals. Its primary use is to discriminate and exclude events or waveform characteristics from the measurement. See "Gated Frequency Measurements" for more information.

The *Source* selection in the counter menu allows for choosing which trigger signals to use. These can be the detected output from the Main trigger (**Main Trig**), Delayed trigger number one (**Dly1 Trig**), Delayed trigger number two (**Dly2 Trig**), and the A External input to the counter (**A Ext**). As this is not altered by the Autoset feature, special care must be taken to make sure that it is set to the desired trigger source. Selecting **Main Trig** as the source when using Autoset is a simple way to minimize manual adjustments.

Gated Frequency Measurements

Measuring the frequency of complex signals such as bursts requires some special considerations. First, always display the counter view signal called **Count In**. This can be selected for display from the WAVEFORM major menu. As the trigger level is adjusted, the **Count In** signal shows the detected transitions. These transitions are what is measured.

In Figure 2-65, two bursts of different duration are detected by the trigger, which results in a series of pulses as shown by the trigger-view trace. As the counter averages these pulses over a fixed interval of time, it will measure a frequency lower than the frequency within the bursts. To get the proper frequency result, the time interval of the measurement must be confined to the burst of interest.

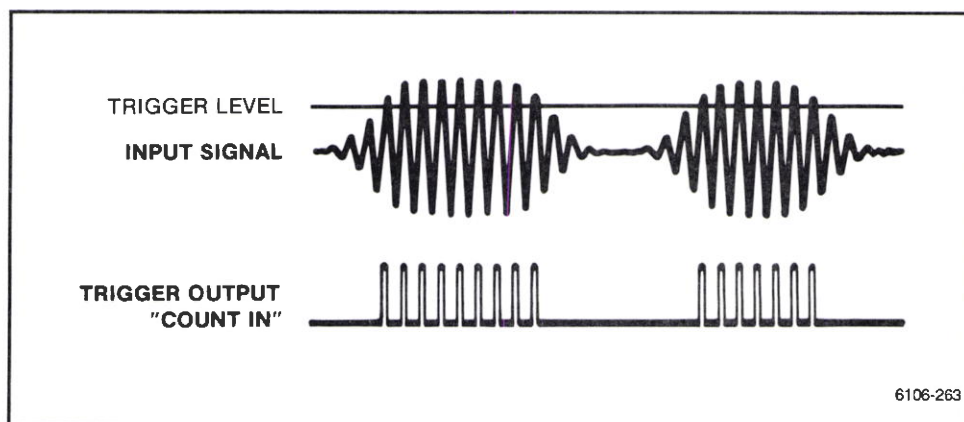


Figure 2-65. Trigger View trace shows pulses derived from two bursts of different durations.

The easiest way to do this is to select **Dly1 Swp** for gating in the COUNTER menu. This allows for control through adjusting the delayed time-base duration (Time/div) and delay reference number one. The best way to view this gate is to display the counter view signal called **Gate**.

Figure 2-66 shows the **Gate** and the **Count In**. When the gate is adjusted to align with the burst, the counter will "see" only the pulses shown as the Count In signal. The measurement interval, now confined to the burst, results in the proper frequency calculation.

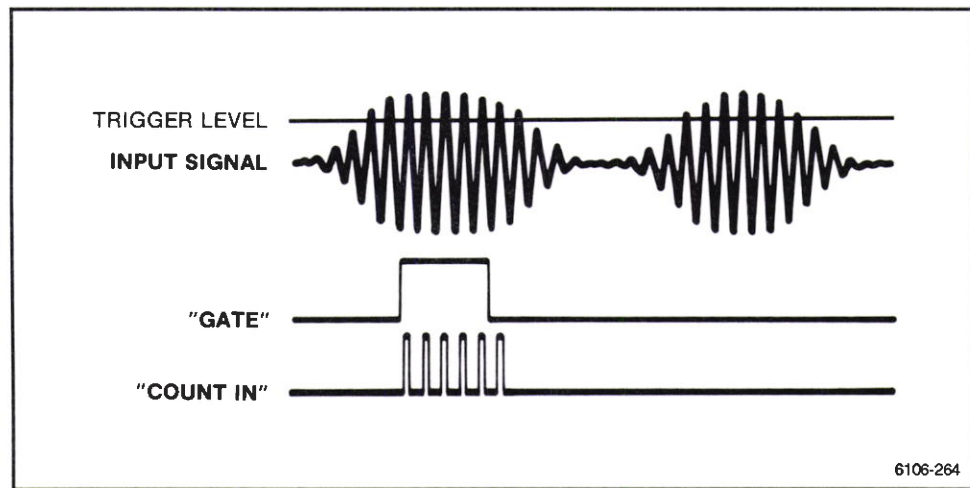


Figure 2-66. Gate and Count In pulses.

Input Coupling, Noise, and Attenuation

If using **AC Coupling** and the signal frequency or duty cycle changes, the triggering point may shift. This can produce measurement errors. You should use the **DC Coupling** for low frequency ac signals, signals with a low duty cycle, and during any Counter/Timer time interval measurements (Time A→B and Width).

Noise may be present at the input amplifiers along with the signal to be measured. Noise may originate from the operating environment, the signal source, or improper connections. If the noise is of sufficient amplitude, it can result in inaccurate measurements due to false triggering. See Figure 2-67.

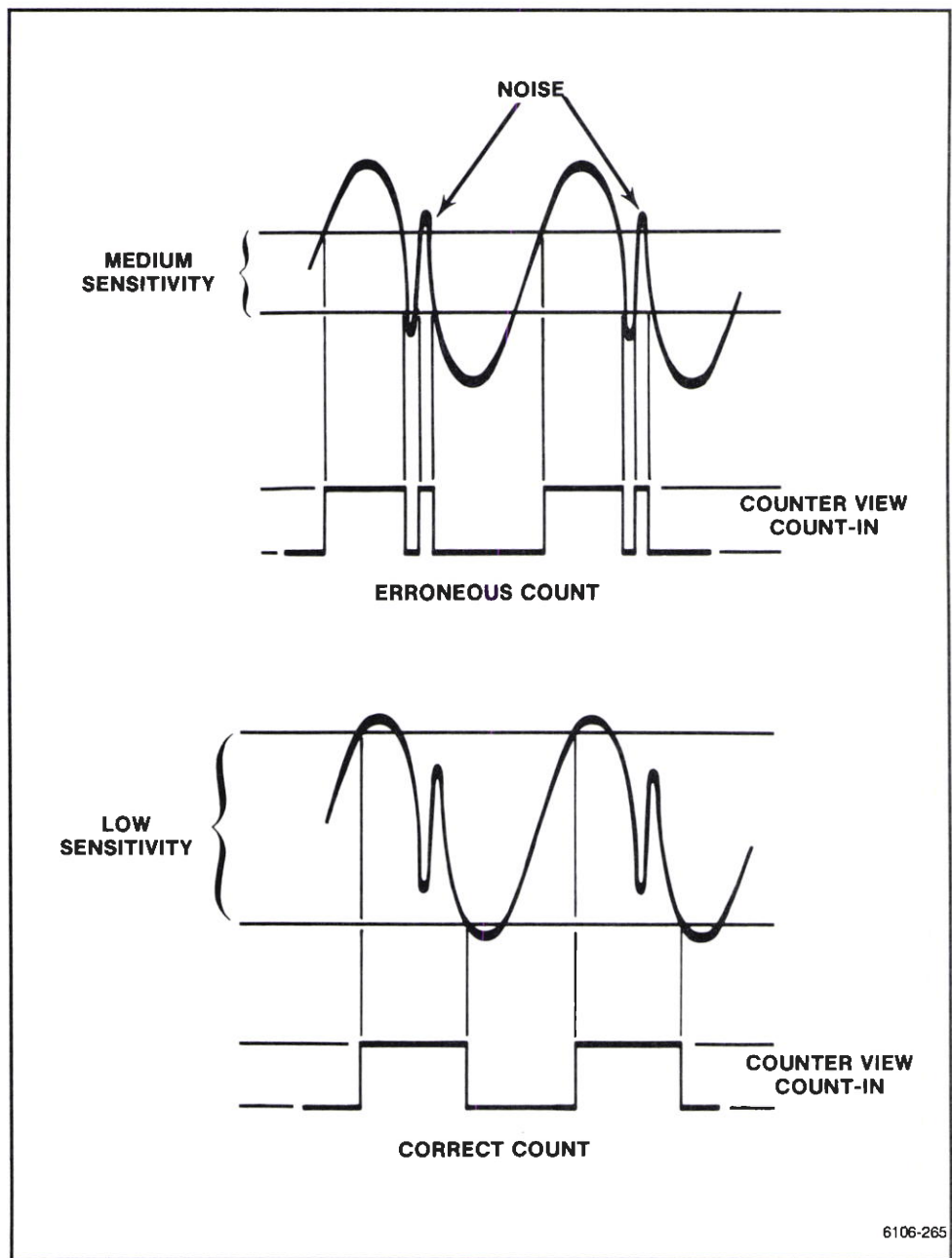


Figure 2-67. One advantage of selectable trigger sensitivity.

Nulling the Counter/Timer

Measurements are often compared to each other or to some previous result. This is a common practice when testing the stability of a particular electrical characteristic among several seemingly identical devices. To facilitate such comparisons, some Counter/Timers provide a feature called "nulling," which allows you to specify a reference to which all measurements will be compared.

The term nulling comes from the method used to establish the reference value. An actual measurement is made, then saved and subtracted from all measurements. The result is a measure of deviation. For example, if you wanted to know how a frequency varies over the course of an experiment, you can first make a reference measurement and save the result as a standard for comparison. Future frequency measurements will be presented as Δ Frequency showing either a + or - result.

The Counter/Timer of this instrument goes one step farther. With the NUMERIC ENTRY major menu, any arbitrary value can be quickly entered and established as a reference for comparison.

Nulling by establishing and using reference can be applied to all of the Counter/Timer measurements except the Total measurement. This feature of nulling allows relative results of Δ Frequency, Δ Period, Δ Width, and Δ Ratio. Nulling is especially useful for nulling the differences in electrical lengths of attached probes and cables when making time interval measurements between two different oscilloscope inputs.

Whenever a nonzero reference value is present, the measurement results will always present the nulled relative value as well as the reference value.

Reducing Measurement Errors

As an aid in reducing measurement errors, remember the following factors.

- Use a high impedance probe with a high impedance circuit. See "Coaxial Cables and Probes" in the "Measurement Concept Tutorial" subsection.
- Use the 50 Ω termination for low impedance, high frequency 50 Ω systems.
- Consider trigger errors caused by input signals with slow rise or fall times.
- Use **Auto Averages** if uncertain of the frequency of the signal being measured.
- If using Option 1T (high-stability oven oscillator), keep the PRINCIPAL POWER SWITCH on for at least two days to ensure maximum stability. The front panel ON/STANDBY switch does not affect stability.

Time Interval Measurements

Two types of time interval measurements may be made with the Counter/Timer. The source selected determines the type of Time A→B measurement to be made. Averaging and Update operate the same for both types of time interval measurements as it does for all other types of measurements. A 555 MHz clock is used as the time reference for 1.8 ns single measurement resolution. Averaging extends the resolution to beyond 10 ps.

The first type of time interval measurement is Time A→B with **Swp Start** selected as the *Source*. This measurement type allows complex time interval measurements to be made with the aid of the Delayed sweep. Measurements begin at the start of the Main sweep and end at the start of the Delayed sweep. Time A→B mode offers the unusual ability to synchronize the main sweep with complex signals. Such synchronizing ability results from the variable delay of the Delayed sweep and the variable trigger Holdoff time of the Main and Delayed sweeps. The adjustable slope and level of the Delayed sweep allows the end of the measurement interval point on a waveform to be independently set with respect to the starting point.

The ability to define two windows on the Main sweep adds even more capability. The Counter/Timer will automatically subtract the time measured between the start of the Main sweep and Window 1 from the time measured between the start of the Main sweep and the start of Window 2. (There are limitations. When **Swp Start** is selected as the measurement source, the minimum time interval from Main to Dly1 or Dly2 sweep starts is 70 ns. However, the difference between Dly1 and Dly1 may be zero. See Figure 2-68.) Each window may have its delay time, source, level, and slope set independently for complete flexibility in setting the measurement interval. The intensified zones begin at approximately the same time as the Delayed sweep begins. By this means, the intensified zones can be used as markers to locate waveform features while the Counter/Timer measures the time between them. At faster Main sweep speeds, where the intensified zone is less well defined, the Counter View may be used to aid in the selection of the measurement interval.

The other type of Time A→B measurement has the Main and Delayed triggers or the CT External A and B as its input pairs. The time interval measured occurs between edges of the selected pair of inputs. The slope selection allows you to invert the transition direction that begins and ends the time interval; + slope corresponds to positive transitions. The Level setting for these measurements from the Main and Delayed trigger sources use the same slope and level setting as used in triggering the sweeps. The slope and level settings for the CT Ext A and B inputs can be set independently. Using these inputs allows measurements to be independent of traces and other trigger sources. The **A Ext** and **B Ext** traces in the *Count View* waveform menu may be used as an aid in setting the slope and level of these inputs. A minimum time interval of 2 ns is required when using these inputs. The time between measurements may be less than 10 ns when using averaging as this increases resolution. Many averages may be made in a short time.

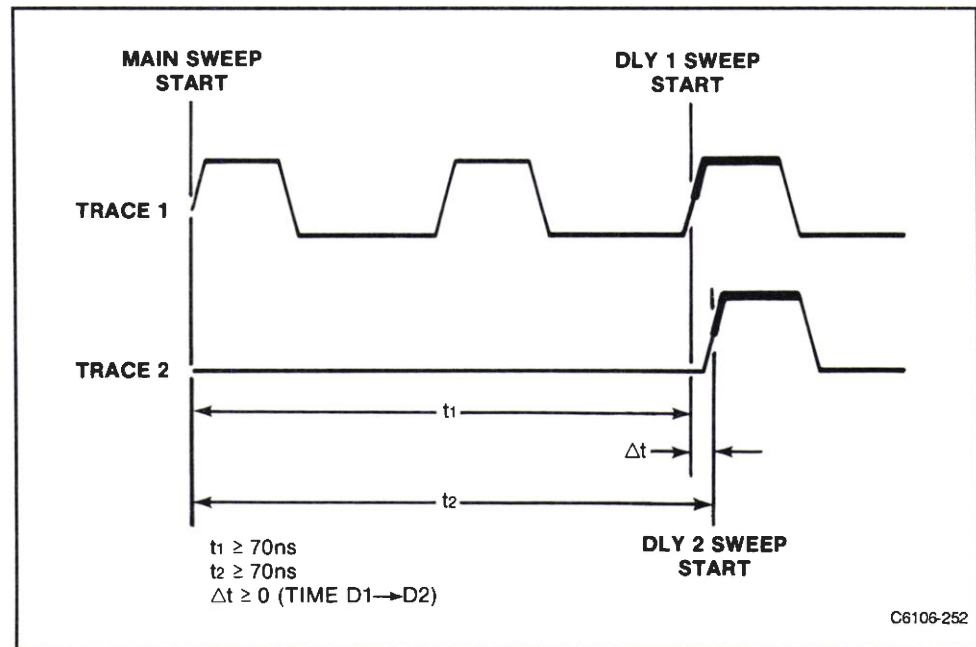


Figure 2-68. Precision timing between any two events is provided when using both Window 1 and 2. The difference between Dly1 to Dly2 equal to zero.

Also, the time from the Main trigger to the Dly1 trigger can be measured if **M&D1 Trig** is selected. This differs from **Swp Start** in that **Swp Start** can be used to make measurements between any two points on one or two waveforms. **M&D1 Trig** measures the time between adjacent Main and Dly1 trigger events. It is completely independent of the Main and Delayed sweeps. However, adjusting the Main and Dly1 trigger slope, level, coupling, and source may be required. When using **M&D1 Trig** as the Time A→B source, use the **Sync Gate** counter-view trace to view the measurement interval.

When **Swp Start** is selected as the Time A→B source, counter-view traces provide little additional information over the delayed windows and intensified zones. It is recommended that counter-views not be used when **Swp Start** is selected as the measurement source.

Cursors

Cursors are lines that serve as calipers. Cursors can be positioned arbitrarily on the crt. With cursors you can measure vertical or horizontal displacement and the oscilloscope does the calculations. Because the scale factors and dimensional units of the cursors depend on the source of the display, the oscilloscope extracts the needed information from the plug-ins.

When displayed, a solid line and a dashed line will appear. The solid line is always controlled by the left knob; the dashed line is controlled by the right knob.

Cursors Menu

The Cursor menu (see Fig. 2-69) is generated by pressing the CURSOR button on the front panel. Tables 2-31 through 2-34 show the Cursor menu choices.

Cursors Selected For Horizontal

The horizontal cursors (two vertical lines) display delta horizontal and $1/(\Delta\text{Horizontal})$ for a YT trace (see Fig. 2-69), but for an XY trace (see Fig. 2-70) they display delta horizontal and the difference between the solid cursor (cursor number one) and the horizontal zero reference. Because in a typical XY display both dimensions are derived from plug-in amplifiers, whatever is possible for the vertical reference is possible for the horizontal. Delta readings are always computed as the value of the solid cursor subtracted from the value of the dashed cursor. If dB scaling is selected for an XY trace, the Horizontal cursor readings are computed in the same manner as the Vertical cursor reading.

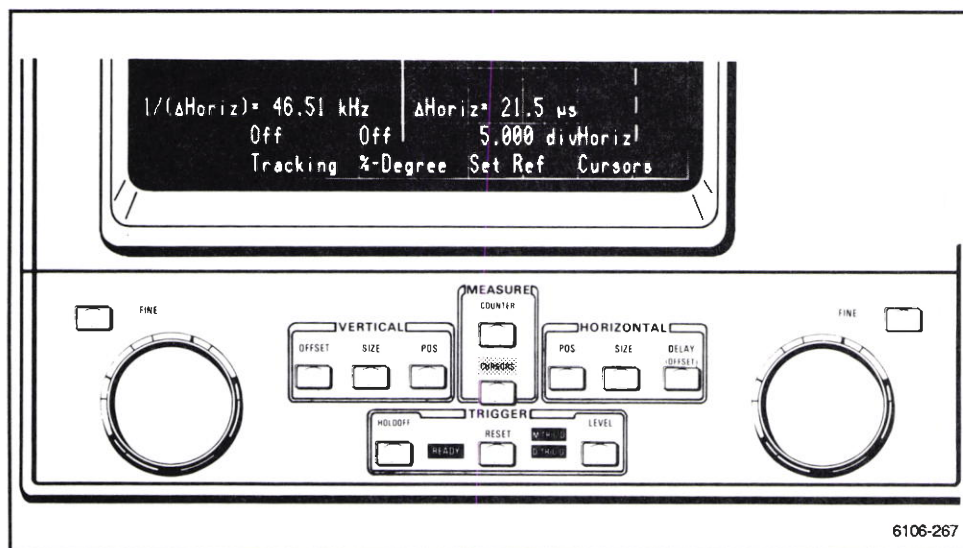


Figure 2-69. Horizontal CURSORS menu with a YT trace selected.

If % Degree is selected for a YT trace, the percent and degree are computed as follows:

$$\Delta\text{Horiz}(\text{percent}) = \frac{\text{ABS}(D_2 - D_1)}{\text{Ref Mag}} (100)\%$$

$$\Delta\text{Horiz}(\text{degree}) = \frac{\text{ABS}(D_2 - D_1)}{\text{Ref Mag}} (360)^\circ$$

Where:

Ref Mag = magnitude (in divs) established when *Set Ref* is touched.

$D_2 - D_1$ = displacement difference (in divs) between cursors.

ABS = Absolute value.

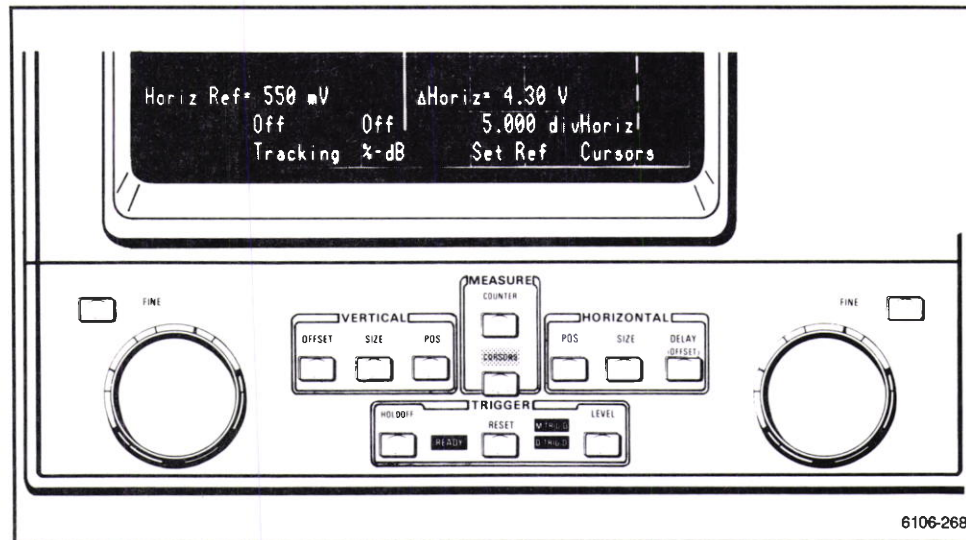


Figure 2-70. Horizontal CURSORS menu for an XY trace.

TABLE 2-31
Horizontal Cursor Measurements for YT Traces

Tracking	% Degree	Set Ref	Cursors
On	On	Value in divs	Horizontal
Off	Off	Value in divs	

Repeatedly touching a menu function on the screen cycles through all possible choices.

TABLE 2-32
Horizontal Cursor Measurements for XY Traces

Tracking	% dB	Set Ref	Cursors
On	On	Value in divs	Horizontal
Off	Off	Value in divs	

Repeatedly touching a menu function on the screen cycles through all possible choices.

Cursors Selected for Vertical

The vertical measurement cursors (two horizontal lines) display the delta vertical value (the difference between the two cursors). (See Fig. 2-71.) If the input is dc coupled, the difference from the solid cursor (cursor number one) and the vertical zero reference is displayed. If the input is ac coupled or if the vertical expression is a combination of inputs, input offset is ignored and assumed to be zero in the calculation that follows.

The vertical reference is derived from the known input offset and the known display position. This is given by the following formula:

$$\text{Vert Ref} = (\text{Vert Scale/div}) \times (D_1 - \text{Pos}) + \text{Offset}$$

Where:

D_1 = Displacement of the solid cursor from center screen in divisions (positive above center, negative below).

Offset = Input offset (scaled, not divs) applied to the signal.

Pos = Vertical Position value in divisions.

If the selected trace is an inverted channel (e.g., -L1), then the cursor scaling is also inverted. For example, moving the solid cursor downward will increase the reading as this is the direction of more positive signal.

If dB scaling is selected, the values of percent and dB are computed as follows:

$$\Delta\text{Vert}(\text{percent}) = \frac{\text{ABS}(D_2 - D_1)}{\text{Ref Mag}} (100)\%$$

$$\Delta\text{Vert}(\text{dB}) = 20 \log \left(\frac{\text{ABS}(D_2 - D_1)}{\text{Ref Mag}} \right) \text{ dB}$$

Where:

Ref Mag = magnitude (in divs) established when *Set Ref* is touched.

$D_2 - D_1$ = displacement difference (in divs) between cursors.

ABS = Absolute value.

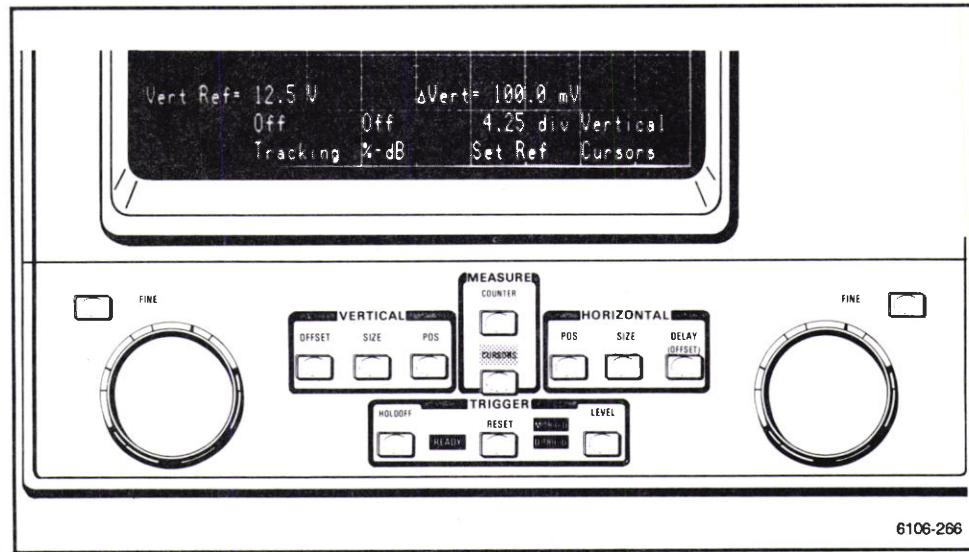


Figure 2-71. Vertical CURSORS menu.

TABLE 2-33
Vertical Cursor Measurements

Tracking	% dB	Set Ref	Cursors
On	On	Value in divs	Vertical
Off	Off	Value in divs	

Repeatedly touching a menu function on the screen cycles through all possible choices.

Cursors When Off

Cursors may be turned off. When Cursors are selected to be **Off**, then no menu choices are displayed.

Tracking and Nontracking Cursors

The Cursor Position *Tracking* can be either **On** or **Off**. When *Tracking* is **Off**, the left knob controls the solid cursor and the right knob controls the dashed cursor. When *Tracking* is **On**, the left knob controls the position of both cursors while maintaining a constant displacement between them. The right knob controls the displacement between them by moving the dashed cursor.

Set Ref

To establish a reference magnitude for the percent and dB or the percent and degree scaling, you adjust the cursor lines to the desired separation then touch *Set Ref*. The new reference magnitude is displayed, in divisions with resolution to 0.01 div, as the status over *Set Ref*.

Scaling

The results of the cursor calculations can be scaled in the dimensions (volts, amps, time, etc.) as derived from the selected trace, or scaled relative to your established reference magnitude. For the vertical cursors, the alternate scaling is in percent and dB (see Fig. 2-72). For the horizontal cursors on an XY trace the alternate scaling is also percent and dB.

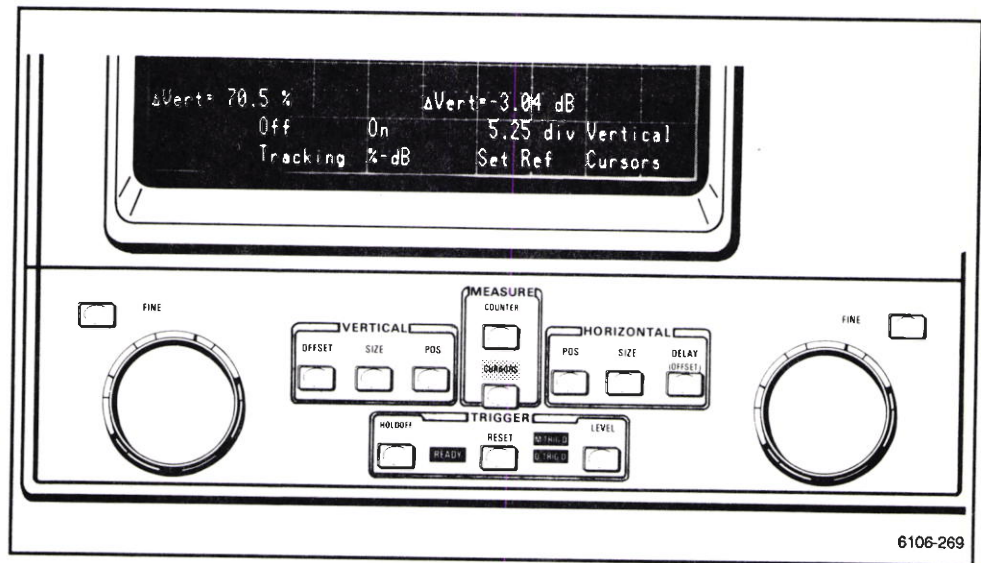


Figure 2-72. The Vertical CURSORS menu with % dB set to On yielding delta readings in percent and dB.

For the horizontal cursors on YT traces, the alternate scaling is percent and degrees (see Fig. 2-73). Delta readings of percent and degree are computed relative to the delta established when *Set Ref* is touched.

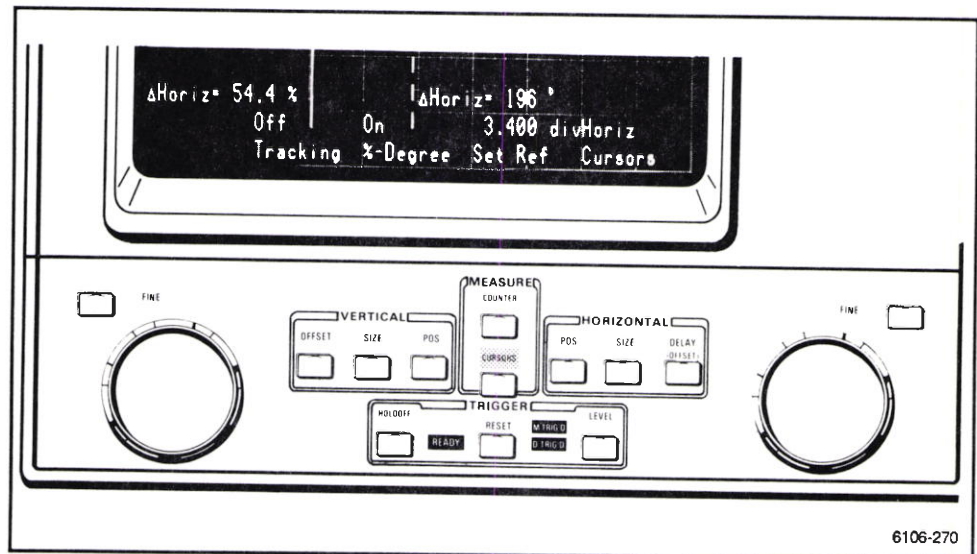


Figure 2-73. The Horizontal CURSORS menu for a YT trace with % Degree set to On.

Knob Behavior

When another knob assignment is made, the cursor readout is removed from the display, and the cursor lines remain.

Each knob assignment has its own coarse/fine function status. The oscilloscope remembers and reinstates the coarse/fine condition for any given knob assignment. Selecting coarse after making a fine adjustment does not change the value of the setting. The value can be changed only by turning the knob.

Horizontal Cursors

- Valid coarse settings are linear increments of 0.05 division.
- Valid fine settings are linear increments of 0.01 division.

Vertical Cursors

- Valid coarse settings are linear increments of 0.05 division.
- Valid fine settings are linear increments of 0.01 division.

Restrictions

- If a composite trace of conflicting sensitivities is selected, the cursors are scaled in divisions and the input offset is ignored in the cursor calculation.
- If no scaling information is available, the results are presented in divisions and the input offset is ignored.

Measure Menu

The MEASURE major menu allows you to set the oscilloscope to perform up to eight measurements. The standard measurement set consists of Frequency, Period, Width, and Duty factor plus Peak-to-Peak, Max, Mid, and Min amplitude measurements. (See Fig. 2-74.)

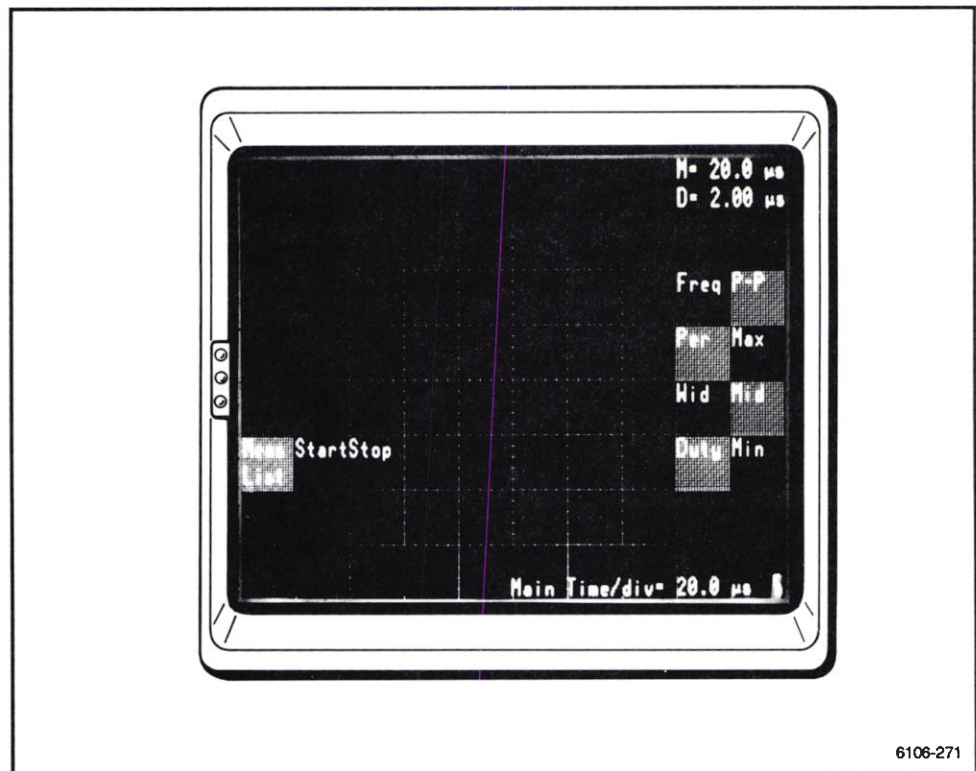


Figure 2-74. The measurement list with four choices (P-P, Per, Mid, Duty) selected.

Up to eight choices can be selected from the list. Selected measurements are shown by shading. The measurements are made once upon touching **Start**. The results will appear with time and date stamp. (See Fig. 2-75.)

The MEASURE menu has two pages: one is the list, and the other contains the results and the time and date stamp. Selecting **Meas List** displays the list showing the measurements and shading the choices you've selected. Measurement selections have alternate action. Repeatedly touching the same item once alternates it from selected to unselected.

When **Start** is touched, the select list is removed, and the measurements are made, and displayed as shown in Figure 2-75. Up to eight results can appear in the column on the right of the display. Measurements can be initiated by

touching **Start** or by pressing the probe ID button if **Probe ID** has been enabled through the UTILITY MENU. When measurements are completed, **Stop** will be shaded.

Measurements are always performed on the selected trace. If you are using the Probe ID to start the measurements, remember that the probe ID button also "selects" a trace. See the "Probe ID" in the "Waveform Acquisition" subsection for the priority of actions surrounding the ID button. If the trace consists of more than one channel for the vertical part of the trace expression, the measurements are made on the entire vertical portion. XY traces are treated similarly. Only the vertical part of the trace expression is measured.

To obtain the measurement results, the oscilloscope will have to alter many of the settings. When the measurements are completed, the oscilloscope settings are restored to their previous state.

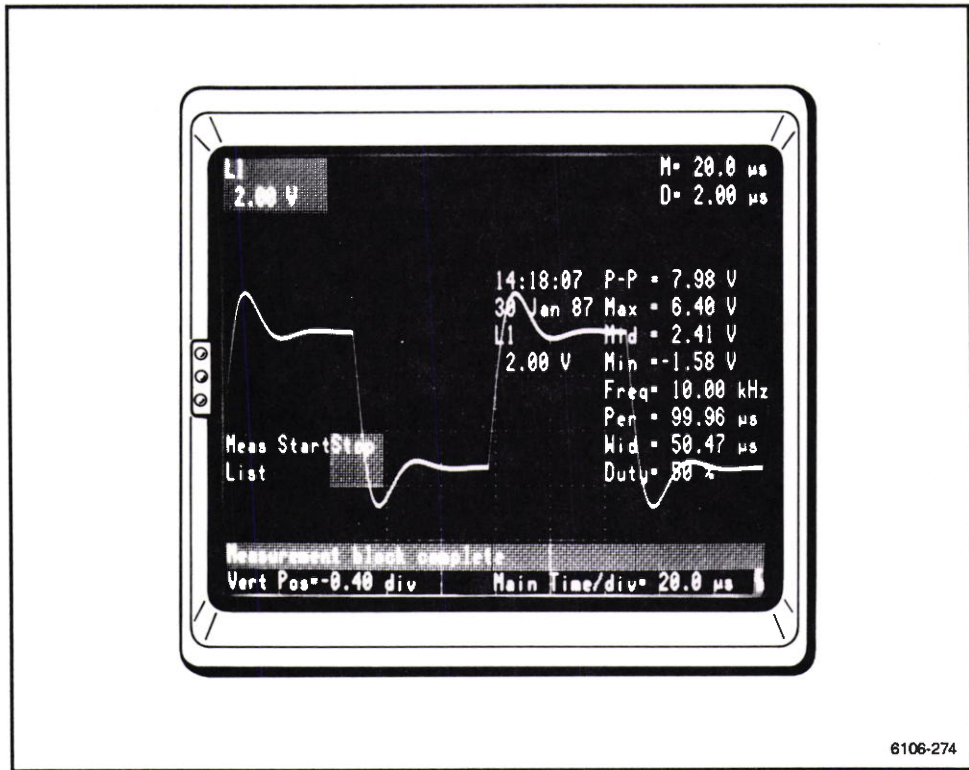


Figure 2-75. The results of eight measurements chosen from the measurement list as well as the trace measured and the time and date "stamp."

As the results displayed represent an instant in time rather than up-to-date conditions, a time and date "stamp" is displayed along with the results. The vertical expression of the trace being measured is also "stamped" and appears in the display.

There will be times, such as a loss of signal, when a measurement cannot be completed or found. If this should occur, the words "not found" appear where the numeric result usually goes. For example, if the p-p cannot be found the display shows:

"P-P = not found"

An appropriate and unique null value is available for query from the RS-232-C and GPIB interfaces. See Section 3, "GPIB and RS-232-C Interfaces."

Measurements can be aborted by touching **Stop**. If the measurements are stopped before completion, the results are treated as if they were "not found"; then **Stop** is also shaded. If **Stop** is touched when no measurements are being made, the last measured results are displayed and **Stop** is shaded.



Numeric Entry

The NUMERIC ENTRY menu provides the means to directly enter a value for:

- Changing a setting in lieu of using the knob
- Specifying a reference value for difference (delta) measurements when using the Counter/Timer
- Computing simple algebraic expressions as with a common calculator.

To engage in one of the above activities, the item of interest on the left side of the menu defines the target of the numeric operation.

In general, the name (e.g., Main Time/div) and status of the target is displayed in an area apart from the usual locations where status is shown. In this way, the actual status or setting can be viewed while constructing a new value to replace it.

New values or settings can be created in two distinctly different ways. One way is to modify the present setting using the +, -, *, and / operators. The other method is to begin with a new number or number followed by other operators. When a number is first touched, the present setting of the target is removed from the expression and replaced by the keyed-in value.

In other words, +, -, *, / can be used to modify and append a setting when touched first. Otherwise, a new expression is constructed.

For example, the target is L1 Size/div with a setting of 50 mV. To change this setting to be 1.5 times that value, two basic approaches can be taken. You can either modify or begin with a new number (see Figures 2-76 and 2-77).

STEP NO.	TOUCH	DISPLAY
1.		L1 Size/div= 50 E-3
2.	*	L1 Size/div= 50 E-3*
3.	1	L1 Size/div= 50 E-3*1
4.	.	L1 Size/div=50 E-3*1.
5.	5	L1 Size/div= 50 E-3*1.5
6.	Enter	L1 Size/div= 75 E-3

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Figure 2-76. The numeric entry modify approach.

STEP NO.	TOUCH	DISPLAY
1.		L1 Size/div= 50 mV
2.	7	L1 Size/div= 7
3.	5	L1 Size/div= 75
4.	EEX	L1 Size/div= 75E
5.	CHS	L1 Size/div= 75E-
6.	3	L1 Size/div= 75E-3
7.	Enter	L1 Size/div=75 mV

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Figure 2-77. The numeric entry new number approach.

Of course, an expression using +, -, *, and / can also be created to produce the desired value.

Entries can be completed and attempted as new settings only when **Enter** is touched. If the menu is exited before the entry is completed, the partial entry is abandoned.

All oscilloscope functions, except for major menus, do not interfere with the entry value. However, whether an entry is accepted depends on the present knob assignment.

All entries are assumed to be expressed in the same dimensions as indicated by the target. For example, an entry to change the Time/div is assumed to be in seconds. Cursor positioning is not accessible from the Numeric Entry menu. Trigger LEVEL for Main and Delayed triggers is always entered as division from the Numeric Entry menu.

In the case of the Counter/Timer, the entry can be used only to set a reference value. The entry cannot replace the measured result. There are two ways to specify the reference for the Counter/Timer. The precise number can be entered directly, as with a calculator, or the present measurement result can be used. The latter is referred to as "nulling." See "Count Reference" in this subsection.

A value between two valid settings is rounded to the nearest valid setting. For example, if 2.7231E-3 is attempted for Time/div, the oscilloscope sets the Time/div to 2.72 ms.

If the keyed-in value exceeds the maximum or minimum limits of the setting, an appropriate message is displayed in the prompt line. In general, all of the mainframe settings attempt to go to the nearest valid setting. Plug-ins may also do this but not in all cases. There will likely be cases where the setting will not be changed. This is evident by an error message.

Choices of Left or Right Knob

The left knob or the right knob allows an entry to be directed to change an instrument setting. Either of the present knob assignments can be affected by the entry.

Further indication of where the entry goes is given by shading the setting and its name. This is either the left half of the knob line or the right half of the knob setting line.

To complete an entry into the desired location, the location must be chosen before touching **Enter**. The number must be "keyed" in after the location is selected. The keyed-in numbers appear in the menu area. In this way, the actual setting is always visible in the knob line while you build and view the new setting. Figure 2-78 shows the Numeric Entry menu with an entry in progress and with its target shaded with the present setting. When the menu is exited, the shading of the target is removed.

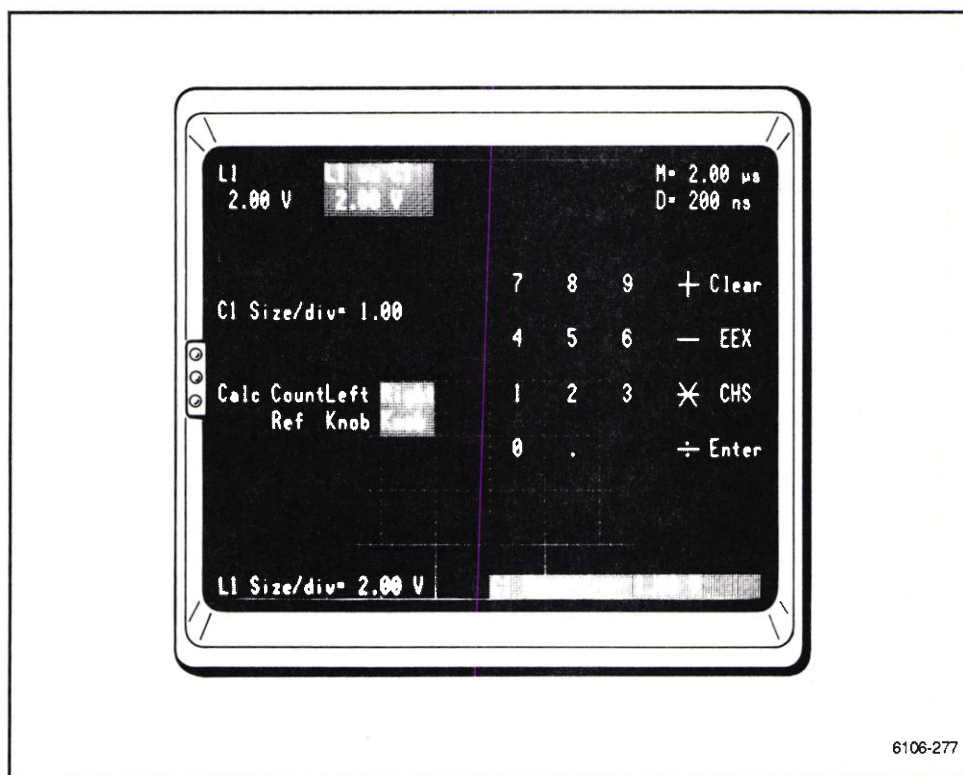


Figure 2-78. The NUMERIC ENTRY major menu.

Count Reference

Most of the measurements of the Counter/Timer can be displayed relative to something other than zero. For example, a frequency measurement can be displayed as the difference between the measured frequency and the reference. In this way, quick comparisons can be made as the display shows a deviation from the reference. When the Counter/Timer is off (not running), there is no measurement reference. When this occurs, a warning is displayed explaining that the Counter/Timer must be in use to specify a measurement reference.

When **Null** on the Numeric keypad is touched, the present values for the measurement displayed is saved and subtracted (nulled) from all following measurements of that particular type. When **Clear** and **ENTER** on the Numeric keypad menu are touched, the reference is zero and the results are displayed again as "absolutes." In addition, any valid number entered from the Numeric keypad menu is interpreted as a new reference value and displayed in the readout.

Functioning as a Calculator

As a calculator, this menu offers the convenience of performing simple operations. It does not affect any oscilloscope settings or displays other than the area displaying the calculations. Results are limited to exponents of $E \pm 308$.

Operation

When the menu is displayed, the present value of the prospective target is displayed above the four choices on the left. To change the value, the following operations apply:

- An expression can be constructed by appending to the present value. Touching **+**, **-**, *****, or **+** preserves the present value for use in a new expression. In this way, a setting could be changed by a multiple or offset by a constant. The **+**, **-**, *****, and **+** operators are interchangeable. For example, the **+** can be changed to a **-** or ***** so long as it is the latest addition to the expression.
- To eliminate the existing value from the expression, touch any number, the decimal point (**.**), or **Clear**. At this point, any expression can be constructed from the number pad and the **+**, **-**, *****, and **+** operators.
- Exponentiation (in powers of ten) of up to two digits is realized by touching **EEX**. When touched, the displayed expression will show "E+00." The two digits can be overwritten any number of times. For example, if E+76 for E+07 was mistakenly keyed-in, instead of clearing the entire expression, "0" then "7" may be touched. The new digits push out the old ones until another operator (**+**, **-**, *****, **+**) or **Enter** is touched, or the menu exited.

- **CHS** (CHange Sign) allows for sign reversal of + and -. CHS affects the first + or - found nearest to the right end of the expression. For example, when building the number "-25E-06," the leading minus can be changed before **EEX** is touched. Once touched, the expression grows from -25 to -25E+00. The sign of the exponent changes when **CHS** is touched as this is the farthest right - in the expression.

When satisfied with the new settings, the numeric entry pad can be removed by pressing the NUMERIC ENTRY Major Menu button again or by pressing any other major menu button. The shaded area, used to indicate target for the entry, also is removed.

Initial Conditions

The Keypad is assigned to the same function as it was prior to power Off.



Store and Recall (Instrument Settings)

Menu Behavior

The storing and recalling of instrument settings is intended to allow you to quickly set the instrument without the need to adjust knobs and make numerous menu selections. It is assumed that you set the oscilloscope to the desired settings and simply store the entire configuration for recalling later. Other major menus cannot be viewed while the Stored Settings menu is displayed.

One popular use permits different users, sharing the same instrument, to store setup conditions. Storing and recalling setups allows each user to have some variations without the burden of untangling settings left by someone else. In this case, the **Store** and **Recall** can serve to restore the instrument to a predefined state. However, remember if the oscilloscope is powered off, all settings, except the current one, will be lost.

The other more popular use is for a single user who wishes to cycle or sequence through many setups and repeat the sequence many times. This is an extremely valuable requirement when characterizing the behavior of a device or circuit over a wide range of conditions. In such a case, it is assumed again that the user is able to configure setups and store them in the required order. Rather than randomly recalling or deliberately choosing the next setup by its number in the sequence, the user only has to request the **Next** item in the sequence without consciously looking for the correct one. In short, the oscilloscope automatically selects the "next" setup as often as requested.

Two schemes have been devised to deal with sequential operations. The first relies upon using the **Next** operator. When **Next** is touched, the digits of the next location are retrieved as if they were keyed-in directly. The second method for sequentially accessing a setting location is through the probe ID button. From any probe, the next setting in sequence can be recalled by pressing the Identify (ID) button on the probe. The probe ID button functions identically to touching **Next**. When sequencing from the ID button on the probe, only locations with stored settings will be used. Any location that has been erased is skipped when recalling from the probe. When using the probe ID button, you can only recall settings. To enable sequencing by the probe, you must access the *Probe ID* in the Utility menu. There the sequencing function can be set to **On** or **Off**.

Operation

Pressing the STORE RECALL major menu button displays a menu offering random and sequential access for storing, recalling, and erasing complete instrument setups. (See Fig 2-79).

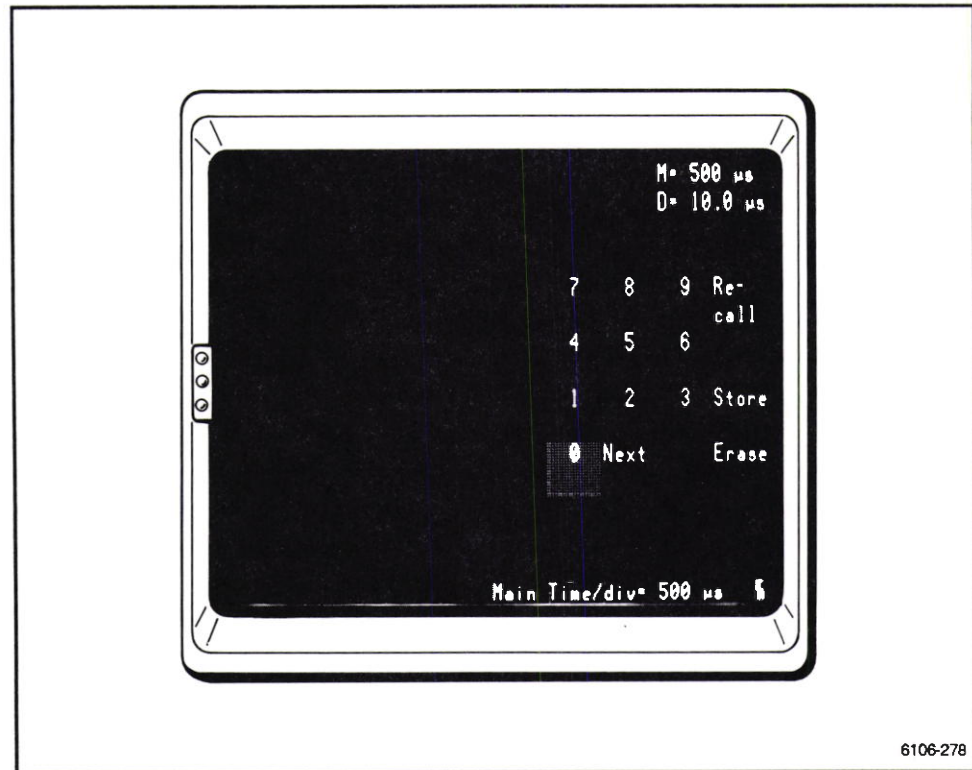


Figure 2-79. Stored settings menu selections.

To store, recall, or erase settings of a location, the desired location must be designated using the number pad followed by touching **Store**, **Recall**, or **Erase**.

As a number is entered from the menu, it is shaded to aid in identifying which location number was chosen. When you select **Store**, the Prompt/Message line displays "Storage in Buffer #X complete" (where X is a number from 0 to 9).

When you select **Recall** the message "Selected front panel setting #X recalled" (where X is a number from 0 to 9) is displayed in the Prompt/Message line (see Figure 2-80).

When **Erase** is touched, you get the message "Setting buffer erased".

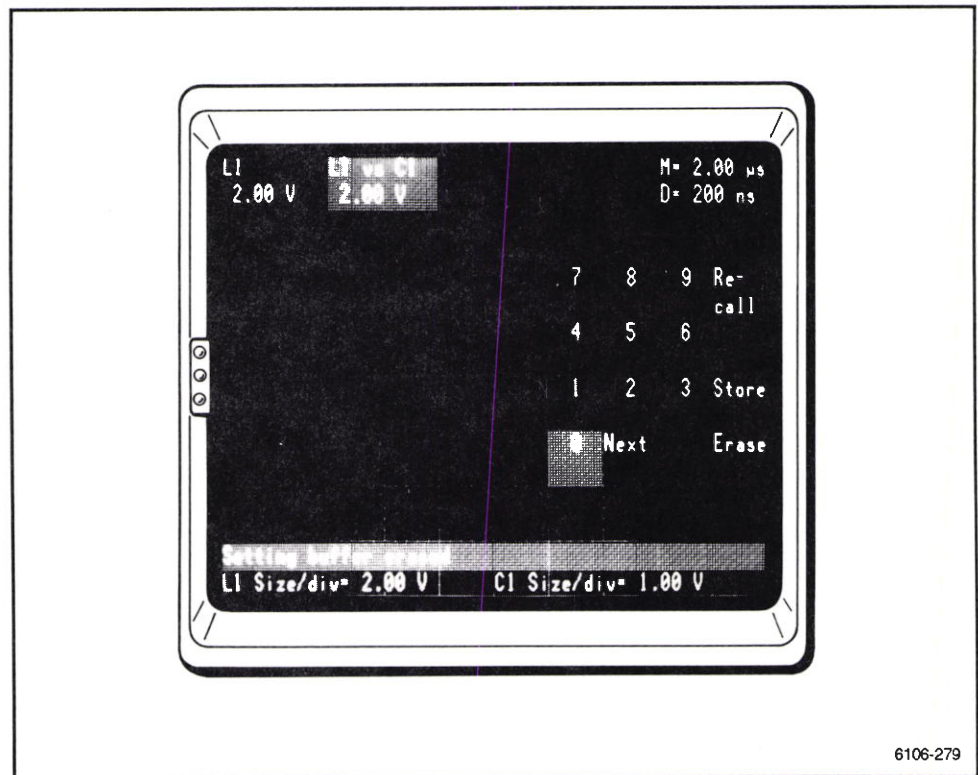


Figure 2-80. STORE/RECALL menu illustrating the Prompt/Message line.

If nothing has been stored in the location recalled, the configuration of the oscilloscope will not be modified and the message "Stored setting in buffer #X is empty" will be displayed. (X is a number from 0 to 9).

Operator's Procedure

1. Touch the desired location number.
2. Touch **Store** to record the present configuration, touch **Recall** to retrieve the desired configuration, or touch **Erase** to delete a previously stored configuration.

Utilities

The UTILITY major menu offers many selections for controlling useful but seldom accessed features. The display is divided into two sections showing all of the possible utilities on the left and specific choices for each utility, as they are selected, on the right. The selected utility is highlighted by background shading. As each utility name is touched, the functions, features, and status are displayed. The following utilities are available from this menu:

- **Autoset**—permits the selection of criteria used for searching and displaying Autoset signals.
- **Beep**—permits selection of two different loudness levels and off for the beeper.
- **Cal**—gives access to the conditions governing Enhanced Accuracy initiations.
- **Cal Sig**—allows you to specify front-panel calibrator signal characteristics.
- **Ext Test**—accesses the Extended Test menu. This is intended for qualified service personnel only.
- **GPIB**—permits selection of various parameters that control communication through the IEEE-488 computer interface.
- **Init**—configures the oscilloscope to a factory defined state.
- **I/O BNC**—permits definition of one (or more) general purpose input/output bnc connections.
- **Probe Cal**—permits correction of gain and offset errors from the probes.
- **Probe ID**—shows the status of all possible probe ID initiated functions. This also allows its assignments to be modified.
- **Probe Skew**—allows for aligning displayed traces to compensate for small variations in propagation delay.
- **RS232**—permits selection of various parameters that control communication through the RS-232-C computer interface.
- **Test**—allows access to diagnostic features.
- **Time and Date**—sets the clock and calendar of the oscilloscope display.

Autoset

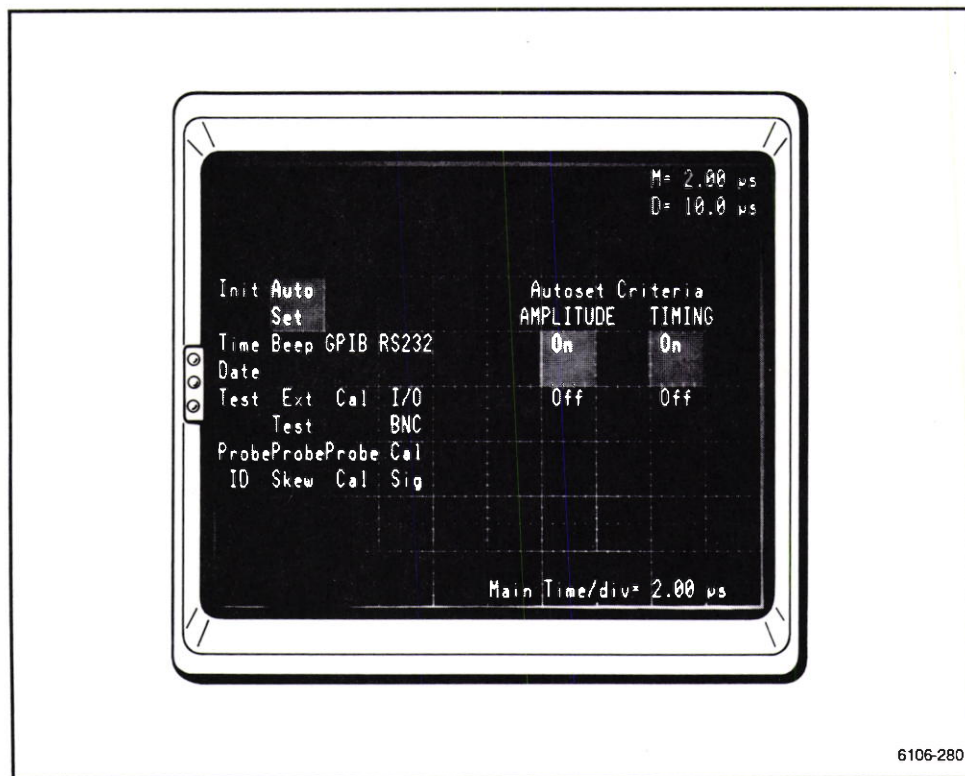


Figure 2-81. Autoset menu.

Autoset criteria can be selected for the main time base and the amplitude characteristics of the channels involved. (See Fig. 2-81.) When *TIMING* is set to **Off**, none of the time bases (main or delayed) will be adjusted. Likewise, when *AMPLITUDE* is set to **Off**, none of the input sensitivities, offset, coupling, etc. will be adjusted.

Beep

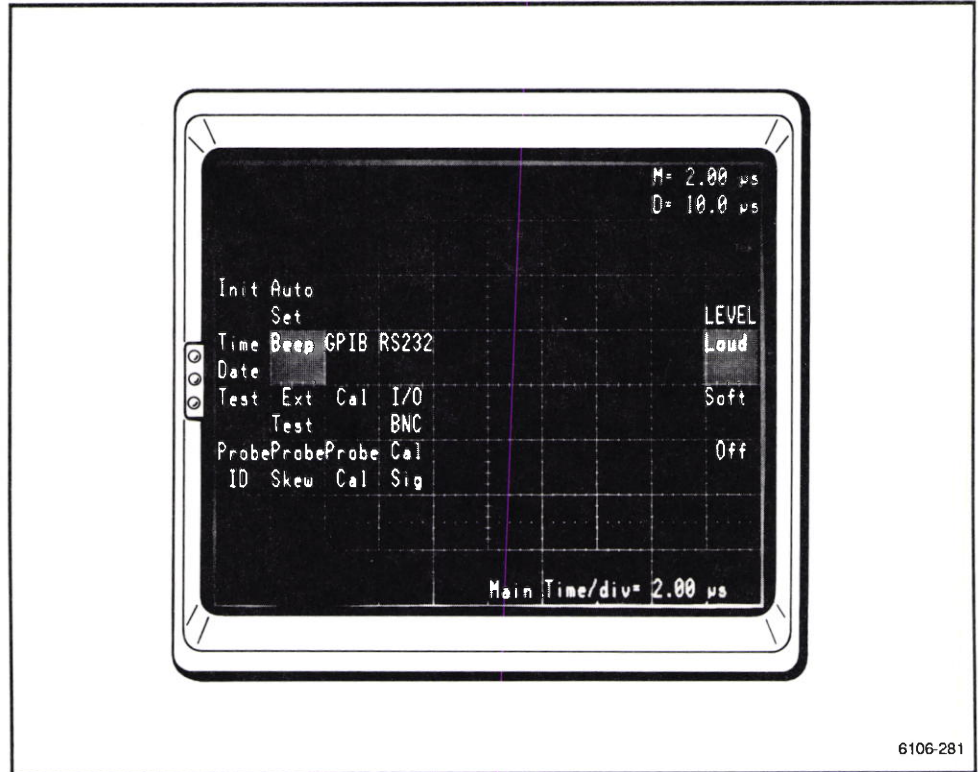


Figure 2-82. Beep menu.

The audible tone accompanying all touches and button presses can be set for **Loud**, **Soft**, or **Off**. (See Fig. 2-82.)

Calibration

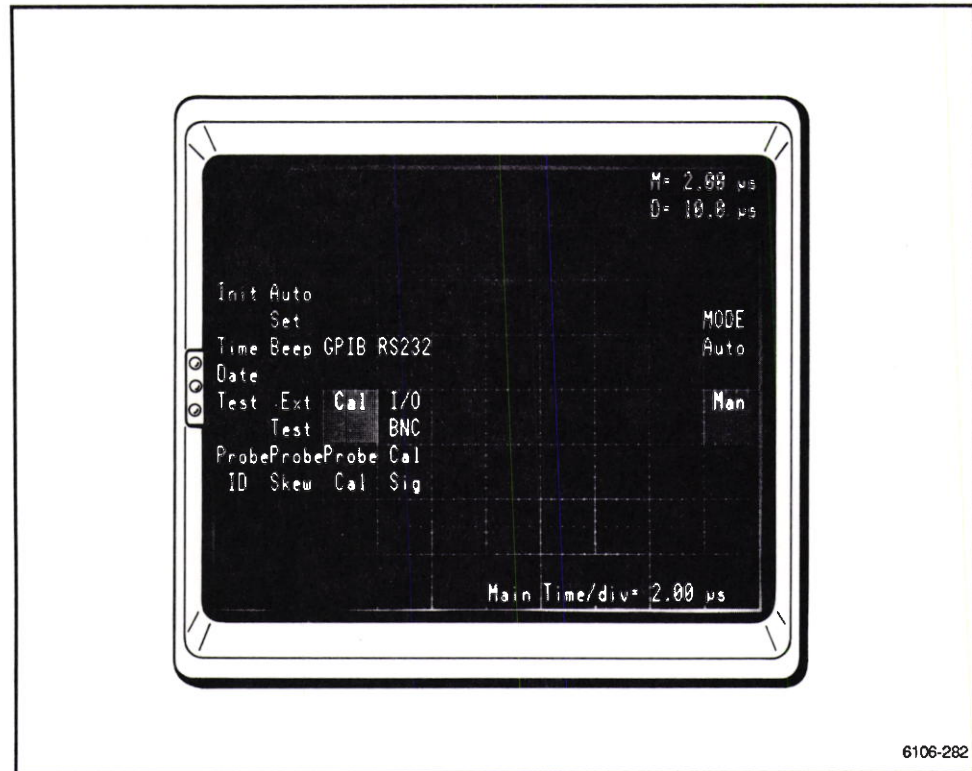


Figure 2-83. Cal menu.

The Calibration (Cal) Utility allows you to enable or disable the Enhanced Accuracy (automatic calibration) feature. The calibration feature of the oscilloscope can operate in one of two modes: Automatic or Manual (see Fig. 2-83). If **Auto** is selected, a complete self-calibration is performed when the factory preset temperature limit is exceeded. As this calibration process can disturb and interrupt the measurement process, a manual mode is provided to disable the automatic calibration.

If set for **Manual**, you must press the ENHANCED ACCURACY button, located above the crt, to initiate the process. When the temperature limit has been exceeded, a message is displayed alerting you that calibration is due.

When you manually invoke Enhanced Accuracy (EA) a message of "Self calibration completed successfully" or, if a failure occurs, a message explaining the failures goes to the originator of the command. (See also Section 3, "GPIB and RS-232-C Interfaces.")

Calibrator Signal (Front-Panel Output)

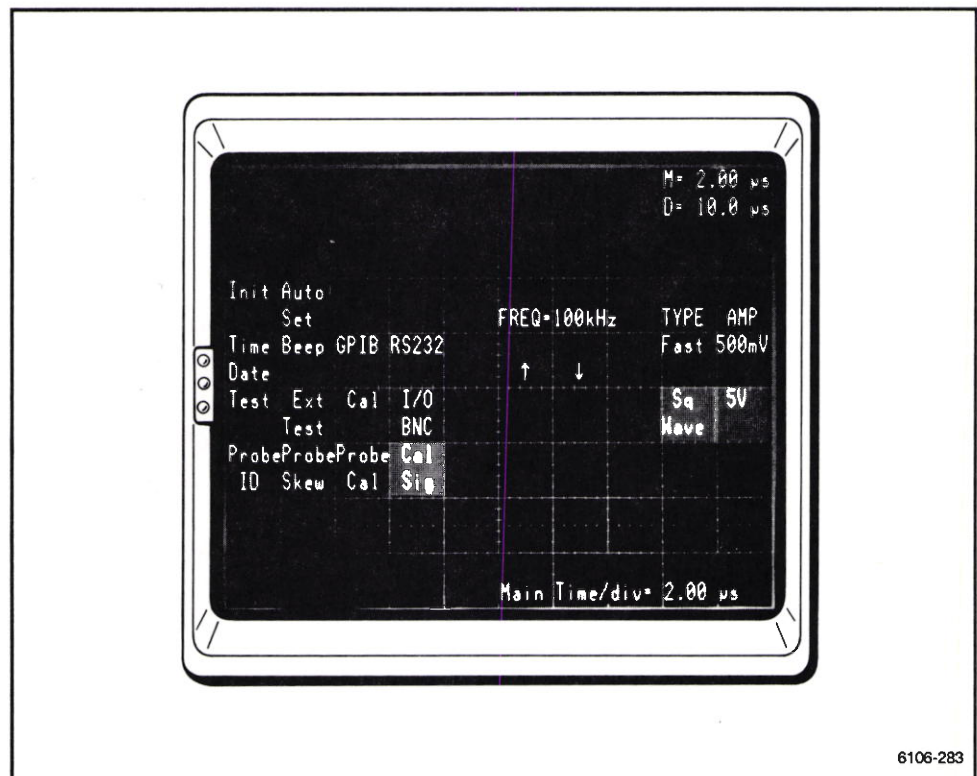


Figure 2-84. Calibrator Signal menu.

The calibration signal, which is available on the front panel of the oscilloscope, can have various amplitudes, repetition rates (frequency), and edge speeds (washes). (See Fig 2-84.) The choices available:

Signal Type: Fast or Square Wave
Amplitude: 5 V or 500 mV
Frequency (Rep Rate): 100 Hz, 1 kHz, 10 kHz, 100k Hz, or 1 MHz

If **Fast** is selected, the amplitude is forced to 500 mV and 5V cannot be selected; **5V** is dimmed. If **Sq Wave** is selected, the maximum frequency is 100 kHz.

Extended Test

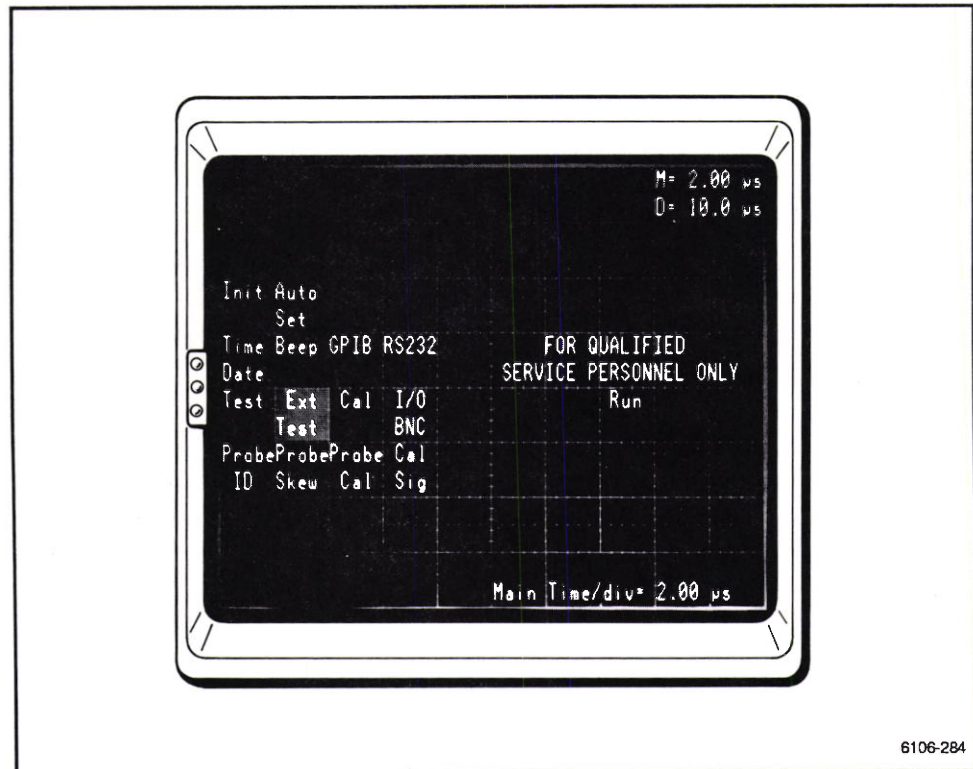


Figure 2-85. Extended Test menu.

Extended Test and diagnostics are intended for qualified service personnel only (see Fig. 2-85).

GPIB (IEEE-488)

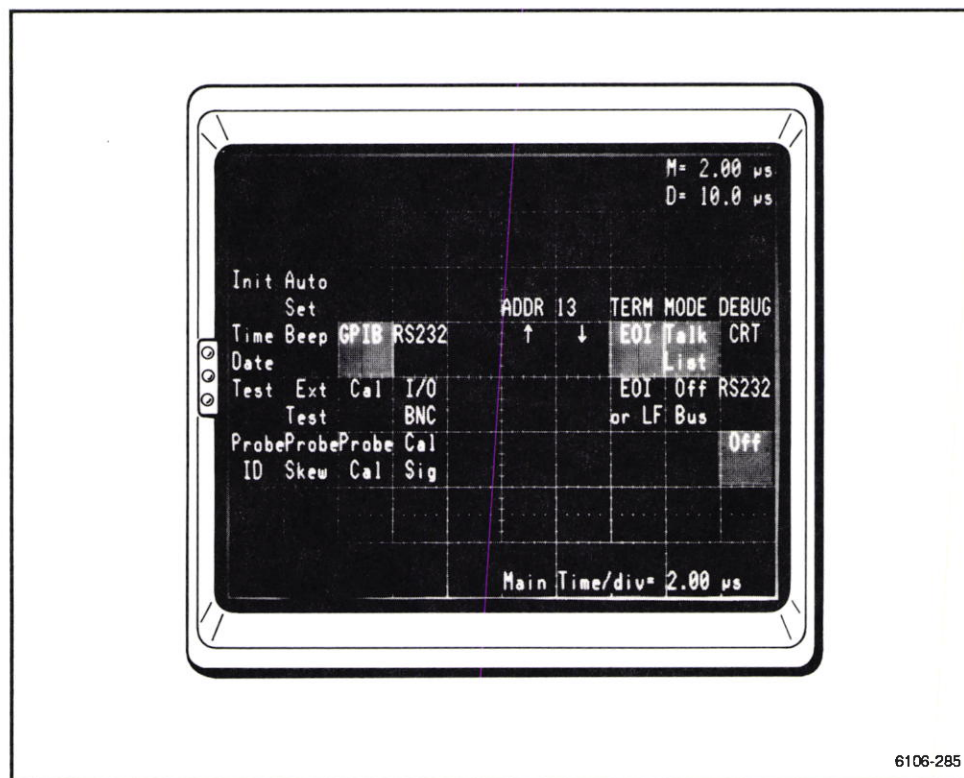


Figure 2-86. GPIB menu.

The GPIB Utility offers selection of Address (up/down), message terminator, Debug, and communication Mode. (See Fig. 2-86.)

GPIB configuration selections:

Address:	1 through 31
Message terminator:	EOI only, or EOI or LF (linefeed character)
Information destination of debugger:	Crt of oscilloscope, RS232, or Off
Mode of communication:	Talk/Listen and Off Bus

For more information see Section 3, "GPIB and RS-232-C Interfaces".

Address selection is made by touching either increment (\uparrow), or decrement (\downarrow). The value for the address can "rollover" when decremented below one or incremented above 31. These controls do not slew: only one incremental or decremental step is made at each touch.

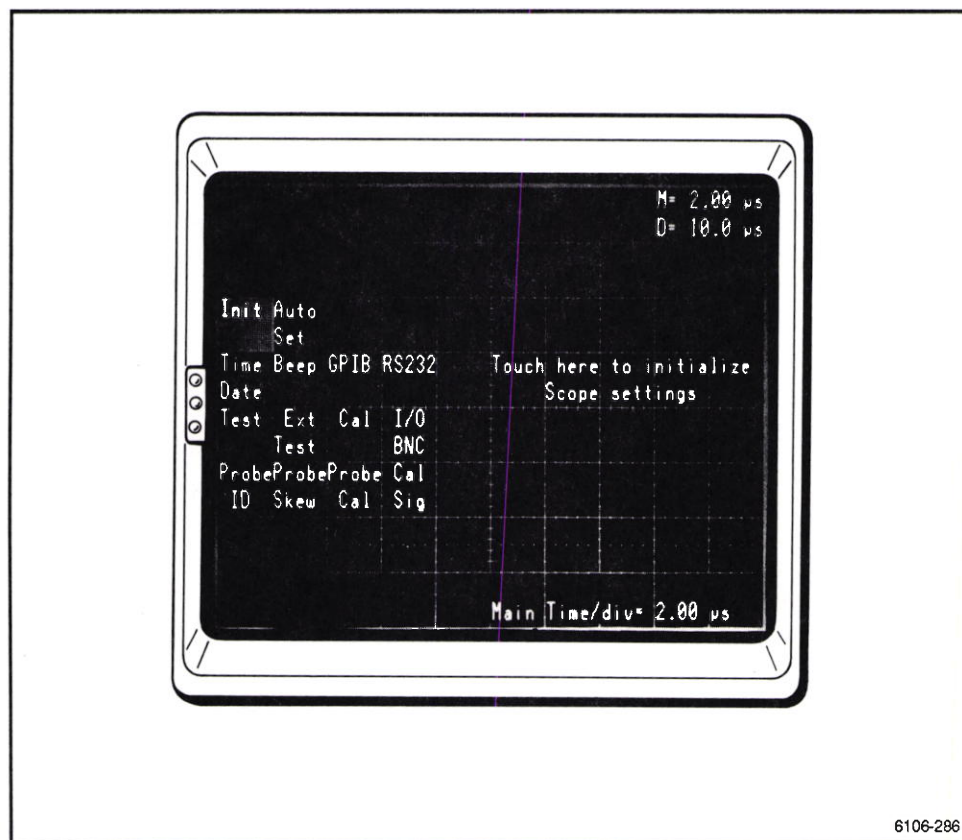
The message terminator is used to indicate the end of a transmitted message. It is required when a message is sent to or from the oscilloscope. The terminator, EOI, is a special control line defined by the IEEE-488 standard. However, to accommodate variations by the other manufacturers of computers and controllers, the choice of terminating on receipt of a LF (linefeed) character is also provided. When *TERM=EOI* or *LF*, either will be accepted. When *TERM=EOI*, only the EOI control line can terminate the message; LF alone will not.

As an added convenience in troubleshooting GPIB transactions, *DEBUG* allows you to monitor all messages received. When errors are detected, they are trapped and flagged to alert you. Either the crt of the oscilloscope or a terminal connected to the RS-232-C port can be used to view the *DEBUG* information. This information is simply a duplicate of the message received with errors noted of syntax, semantics, and illegal or unrecognizable commands. Errors are noted by an appropriate number code inserted into the message immediately following the source of error.

If the crt is chosen as the destination for viewing the message, the message appears in the space usually allotted for major menus, the center eight lines. If the message exceeds the 400 characters (8 lines x 50 characters), the display shows the latest information by vertically scrolling as each line of new characters are received. This information can be viewed only when no major menus are displayed. However, the message is still updated while another major menu is up. When the major menu is removed, the *DEBUG* message is complete and current.

The communication mode can be set for two-way transmissions by using **Talk List** (Talk and Listen) or **Off** by setting *MODE* to **Off Bus**.

Initialize

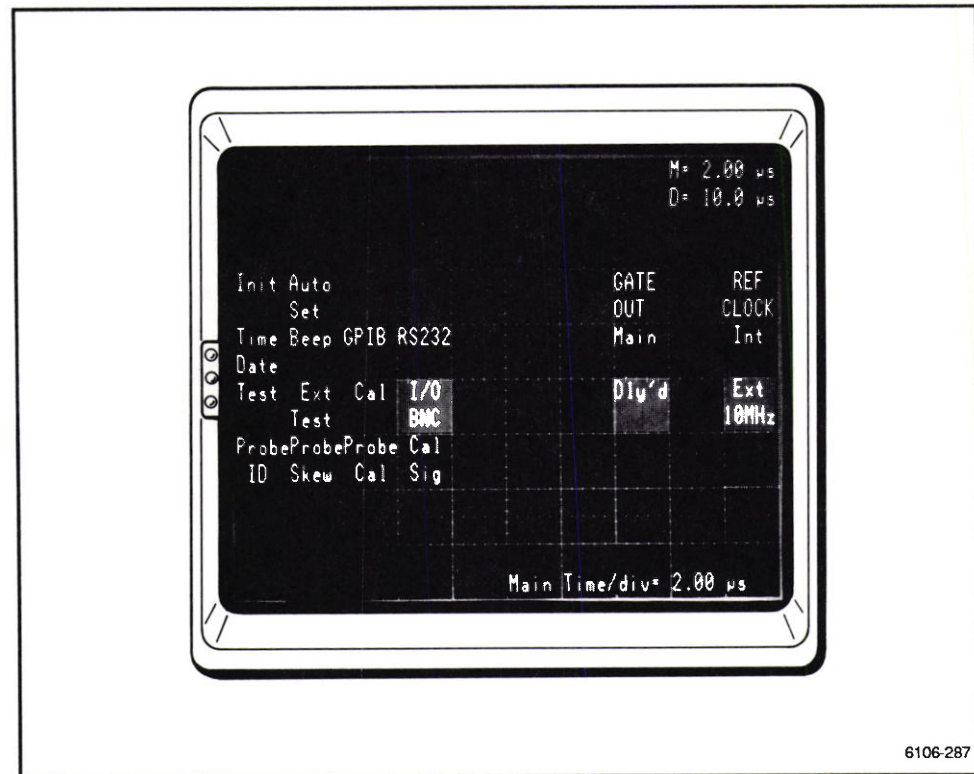


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Figure 2-87. Initialize menu.

Touching *Init* (see Fig 2-87) allows initialization of the oscilloscope to the conditions listed in "Oscilloscope Initialization" in the "Oscilloscope Familiarization" subsection.

Input and Output BNC Control



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Figure 2-88. I/O BNC menu.

On the rear of the oscilloscope, two bnc connectors share four possible input or output signals. One bnc is for the Main Sweep Gate or Delayed Sweep Gate output. The other bnc is for the reference clock into or out of the Counter/Timer. When *REFCLOCK=Ext 10 MHz*, the Counter time base reference is the External signal; when *REFCLOCK=Int*, the Counter uses the internal clock and outputs its 10 MHz reference. When selecting the *Int* (internal) clock, the optional high stability (oven) time base will supersede the standard clock if it is present. The mainframe figures out whether the oven is installed and operating. (See Fig. 2-88.)

Probe Cal

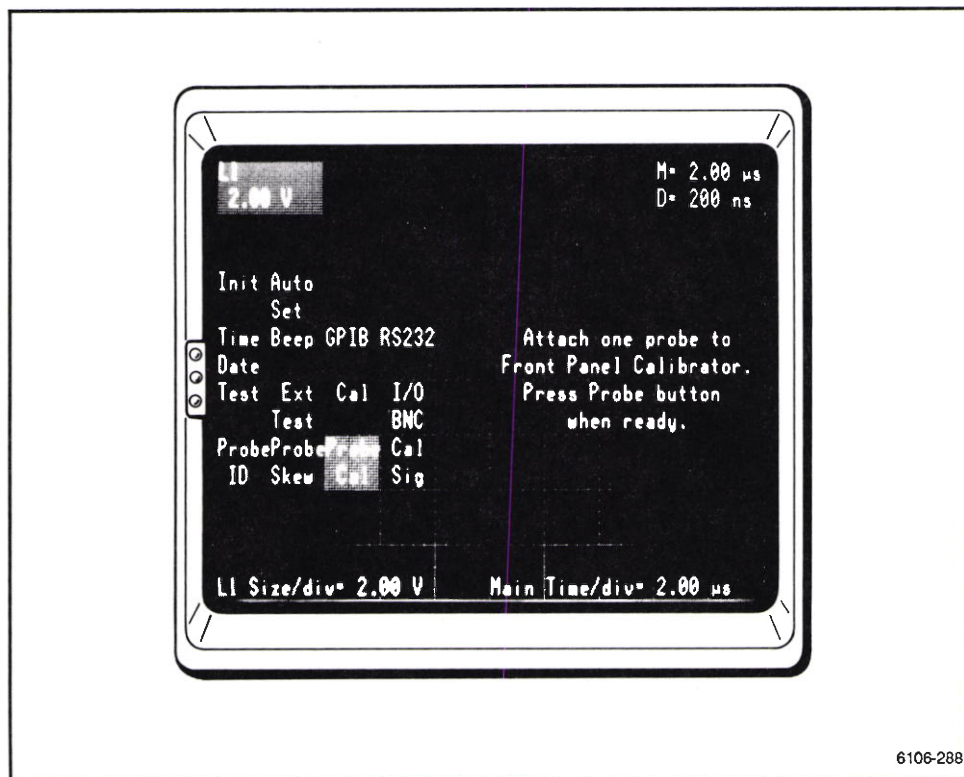


Figure 2-89. Probe Calibration menu.

When *Probe Cal* (see Fig. 2-89) is selected from the UTILITY menu, the right side of the screen displays the instructions for calibrating the dc gain and offset of the probe.

Probe ID

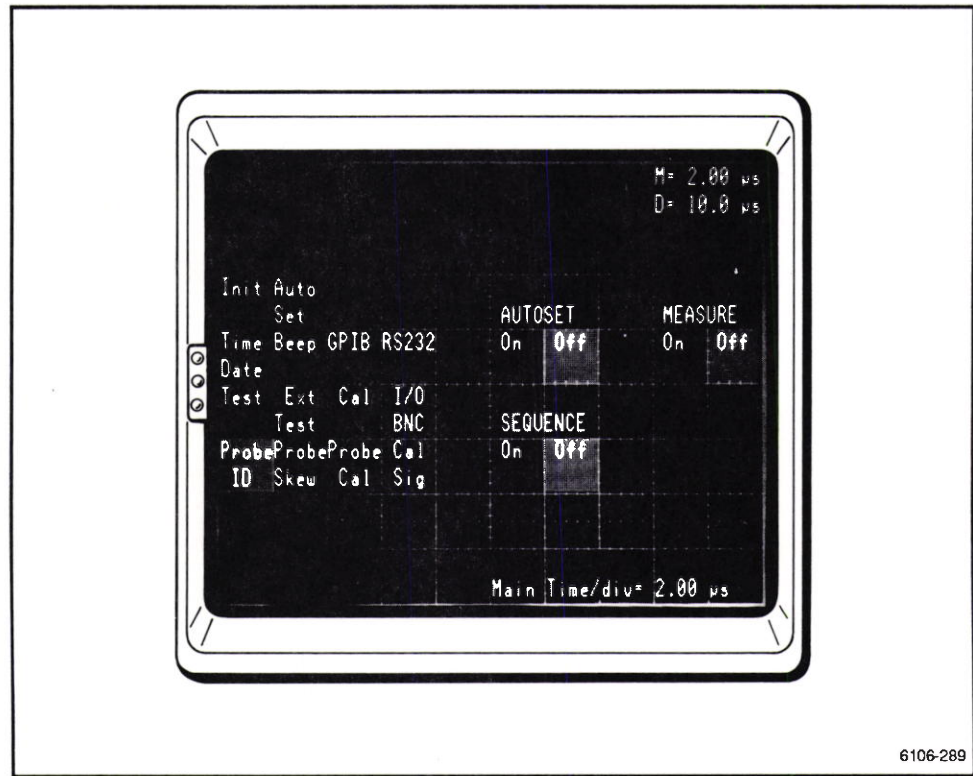


Figure 2-90. Probe ID selection.

The identify (ID) button on the probe body can be assigned to initiate several operations. These operations can be programmed through the **Probe ID** menu as shown in Fig. 2-90. The probe ID button can initiate Autoset, measurements, and the sequential recall of stored instrument settings.

Probe Skew

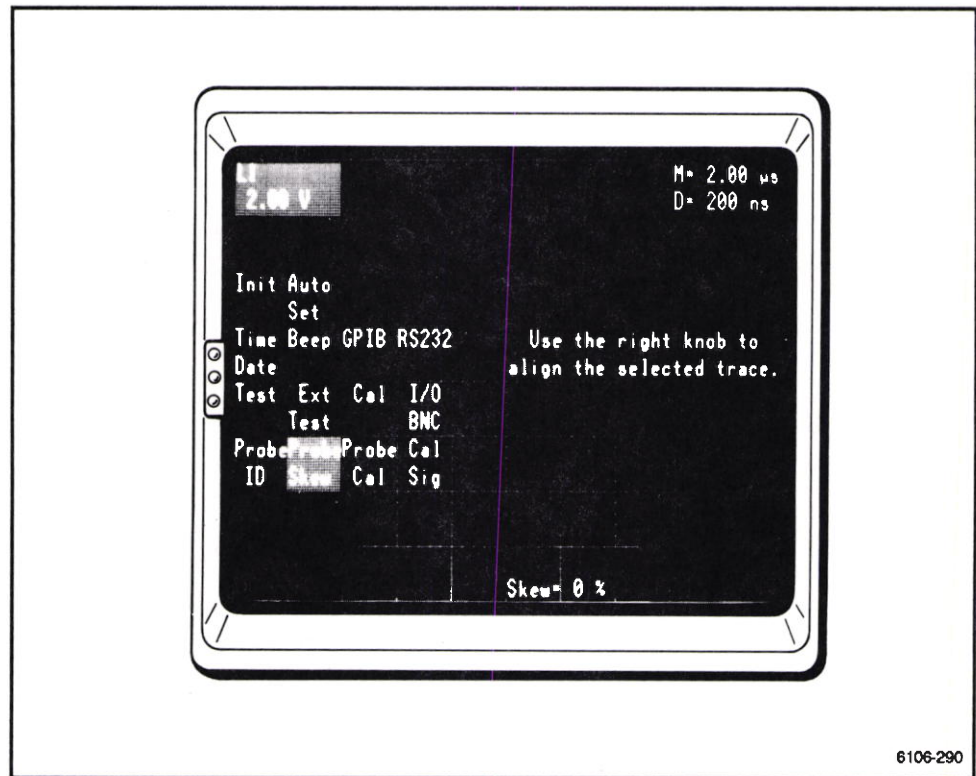


Figure 2-91. The Probe Skew menu.

When *Probe Skew* is pressed (see Fig. 2-91), you may align your probe with the selected trace to compensate for small variations in propagation delay. This adjustment allows for about 1 ns total range. This is intended for visual alignment of traces only. As this affects only the display, it has absolutely no effect on the Counter/Timer and Main and Delayed trigger functions. To compensate for timing differences in Counter/Timer measurements, see "Nulling the Counter/Timer" under "Counter/Timer Concepts" in this section.

RS-232-C Selections

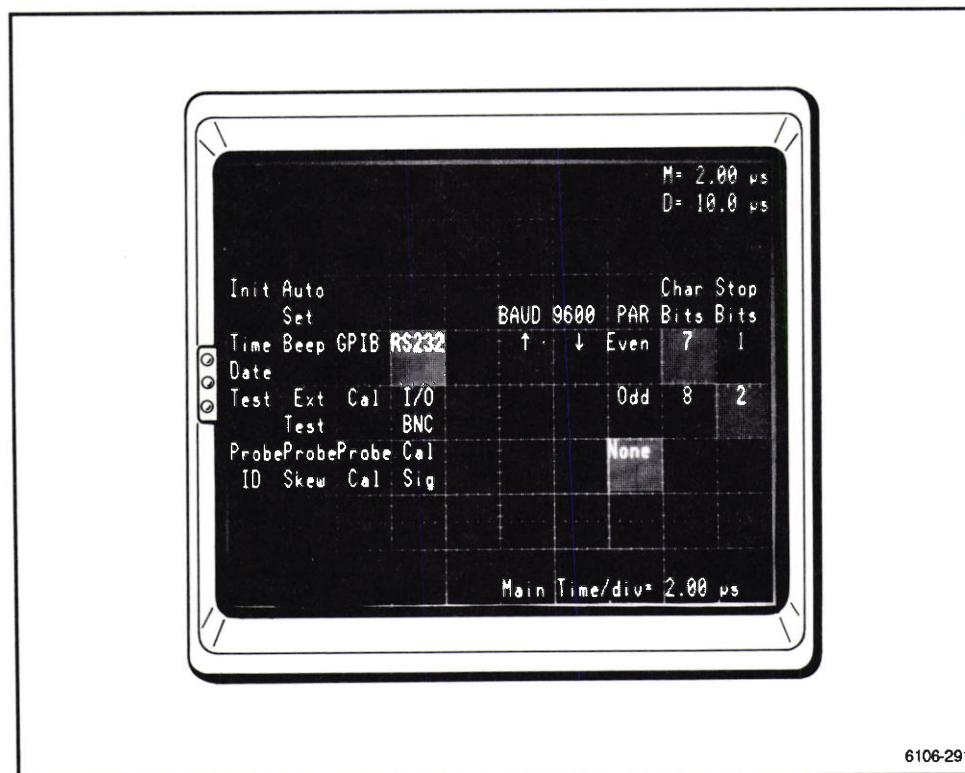


Figure 2-92. RS232 menu.

The RS232 Utility offers selections for Baud Rate (up/down), minimum Delay (up/down), Parity, and Flagging. (See Fig. 2-92.)

RS-232-C interface configuration selections:

BAUD: 110, 150, 300, 600, 1200, 2400, 4800, 9600
PARity: Odd, Even, or Off
Char Bits: 7 or 8
Stop Bits: 1 or 2

BAUD is selected by incrementing and decrementing controls. These values will "rollover." If decremented below the minimum value, the value will become the maximum. If incremented above the maximum value, the value will become the minimum.

For detail on Flagging, Parity, and Delay, see Section 3, "GPiB and RS-232-C Interfaces."

Test

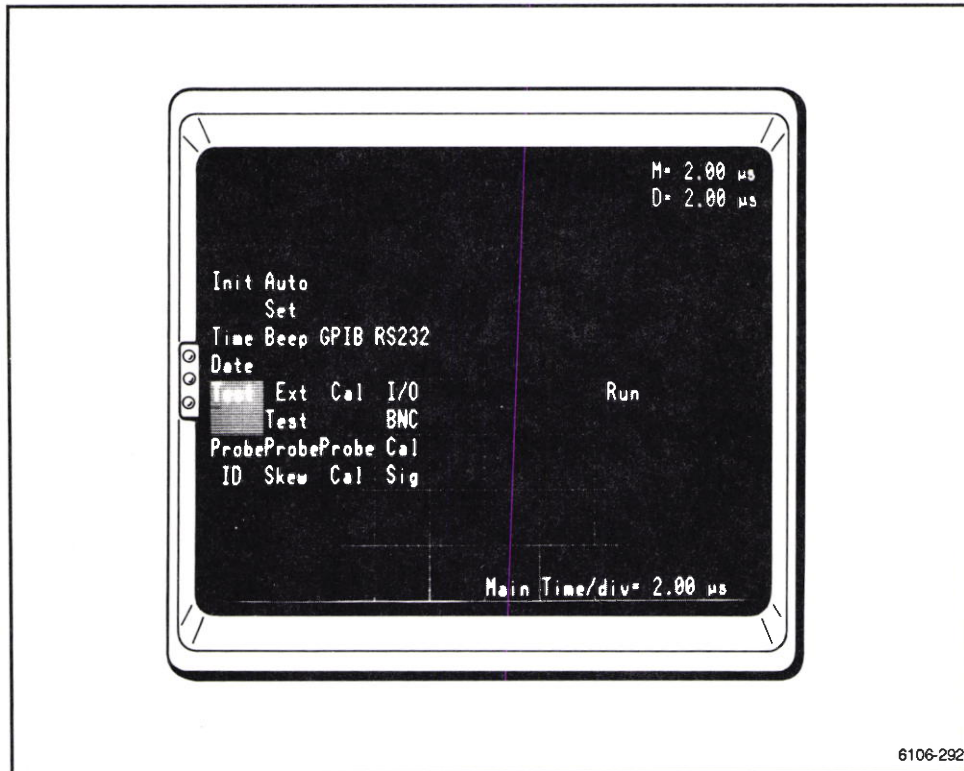


Figure 2-93. The Test menu.

To initiate self-test, the Test UTILITY menu must be selected followed by touching **Run**. (See Fig. 2-93.) This two step operation is intended to eliminate accidental activation of the self-test that may take up to 30 seconds. See more detail in "Self-Test" under "Power-Up Information" in the "Oscilloscope Familiarization" subsection.

Time and Date Selections

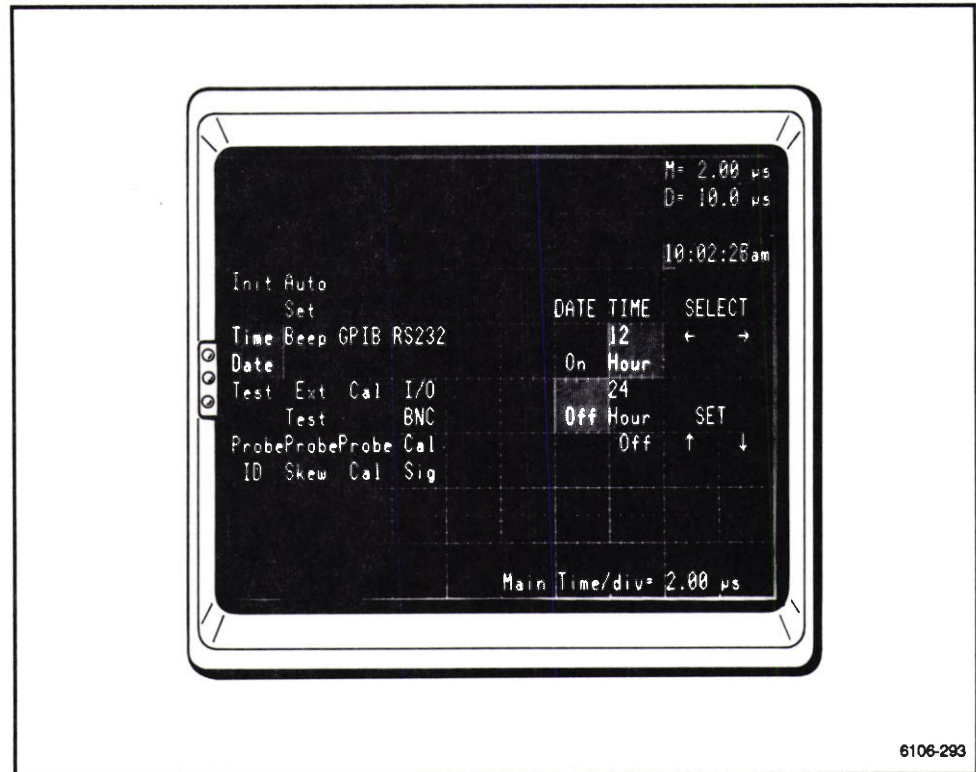


Figure 2-94. Time and Date selected from the UTILITY major menu.

In the Time and Date (calendar and clock) display, the time and date can be adjusted to the correct setting. Notice in Figure 2-94 that the time can be expressed in a 12-hour or a 24 hour format.

Upon entry into this menu, a shaded cursor, one character in width, appears over the far left digit in the *Time* display (if both Time and Date are displayed or if Time only is displayed). If Date only is displayed, then the cursor appears on the far left digit of the Date. To adjust the *TIME* or *DATE*, touch one of the *SELECT* arrows to position the cursor over the item to be modified, then use the *SET* arrows to increase or decrease the value. When satisfied, exiting the menu by touching another utility function removes the cursor from the display.

The date is expressed as **dd mmm yy** where **dd** is a two digit number for day, **mmm** a three character abbreviation for month, and **yy** a two digit number for the year (e.g., 12 Aug 88).

Measurement Concept Tutorial

The following discussion is intended to help the inexperienced user to know how, in general, to make certain kinds of typical measurements. This is not a detailed instruction; therefore, many of the steps will tell you what to do but not specifically why to do it.

Coaxial Cables and Probes

Coaxial Cables

Cables may be used to connect signals to the input connectors on the oscilloscope or plug-ins, but they may considerably effect the accuracy of a displayed waveform. To maintain the original frequency characteristics of an applied signal, use only high-quality, low-loss coaxial cables. Coaxial cables should be terminated at both ends in their characteristic impedance (e.g., 50 Ω cables should have the input impedance of the amplifier input set to 50 Ω). If this is not possible, use suitable impedance-matching devices. Coaxial connections on this instrument are bnc connectors.

Probes

Probes offer the most convenient means of connecting an input signal to the instrument. Shielded against electromagnetic interference, the standard X10 probes have a high input impedance that minimizes circuit loading. This allows the circuit under test to operate with a minimum of change from the normal, unloaded condition.

Both the probe and its accessories should be handled carefully to prevent damage. Avoid dropping the probe body. Replace the tip cover when not using the probe to protect the tip. Exercise care to prevent the cable from being crushed or kinked, and avoid pulling on the cable as this causes excess strain.

Inductance introduced by either a long signal or ground lead forms a series-resonant circuit. This circuit affects system bandwidth and causes ringing if driven by a signal containing significant frequency components at or near the resonant frequency of the series-resonant circuit. Oscillations (ringing) can appear on the oscilloscope display and distort the true signal waveform. Always keep both the ground lead and the probe signal-input connections as short as possible to maintain the best waveform fidelity.

Misadjustment of probe compensation is a common source of measurement error. Due to variations in oscilloscope input characteristics, probe compensation should be checked and adjusted, if necessary, whenever the probe is moved from one oscilloscope to another or between channels of the same oscilloscope. See "Probe Cal" in the "Utilities" subsection.

Measurement Examples

The following information describes the techniques for making basic measurements. You must remember that many, if not all, of the calculations are performed automatically by the oscilloscope and displayed in the readout. These applications are discussed to familiarize you with making a variety of measurements. Each application must be adapted to the requirements of the individual measurement. Contact your local Tektronix Field Office or representative for additional assistance.

Automatic Measurements

General waveform characteristics can be determined automatically with very little operator interaction. The MEASURE major menu allows you to perform such measurements as Peak-to-Peak (**P-P**), Maximum (**Max**), Middle (**Mid**), and Minimum (**Min**) amplitude, Frequency (**Freq**), Period (**Per**), Width (**Wid**), and Duty Factor (**Duty**). Any or all of these measurements can be chosen for display at one time.

Automatic measurements can be performed on the "Selected Trace." The procedure is the same for any measurement.

1. Press the MEASURE major menu button. (See Fig. 2-95.)

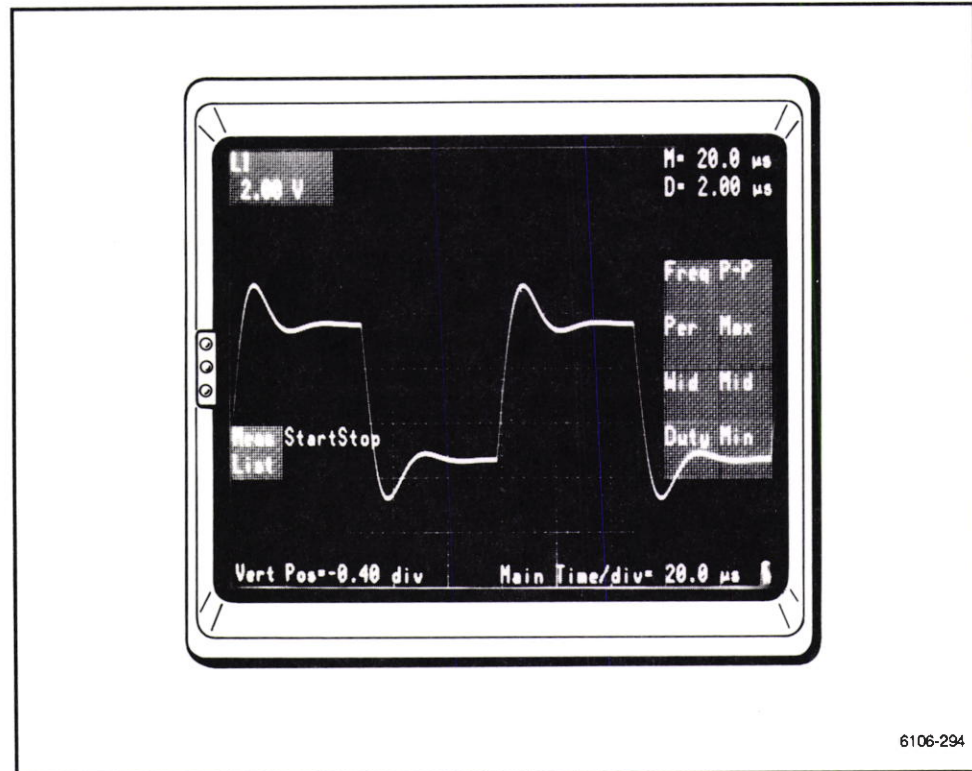


Figure 2-95. The MEASURE major menu.

2. On the screen, touch *Meas List* to display all the measurements that can be performed automatically.
3. Touch the desired measurement name (e.g., **P-P**, **Max**, **Freq**, etc.)

NOTE

At this point any or all the listed measurement items can be selected and performed simultaneously. To indicate that a measurement has been selected, it is highlighted. To eliminate a selected measurement that is highlighted, simply touch it again.

4. To begin the measuring process, touch **Start**. The results will appear on the right side of the display along with the time and date of the measurement. To get new results, touch start again. (See Fig 2-96.)

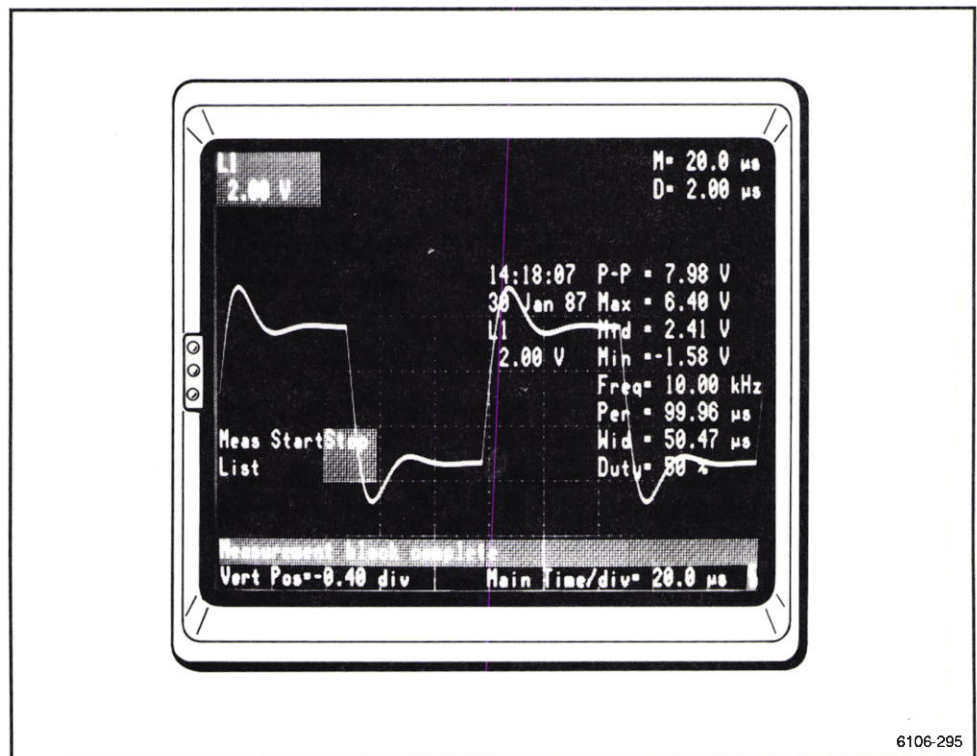


Figure 2-96. The MEASURE menu display after touching **Start**.

Measurements can be initiated three ways:

- By touching the **Start** label in the MEASURE menu.
- By touching a button at the tip of the probe. This must be enabled using the UTILITY menu called *Probe ID*.
- By the remote interfaces (GPIB and RS-232-C).

Cursors Measurements

The cursor feature provides you with caliper type (movable) marks on the crt screen, which you can align with any part of a waveform display to determine amplitude or time with respect to a reference point or with respect to each other.

Peak to Peak Measurements

The following procedure shows how to perform peak-to-peak amplitude measurements:

1. Connect the signal to a vertical amplifier.
2. Press the display on/off button to turn on the channel display.
3. Press the AUTOSET button to scale the vertical and horizontal and to set the triggering.
4. Press the CURSOR button and select **Vertical Cursors** from the menu. Make sure that % dB and Tracking are **Off**. (See Fig. 2-97.)

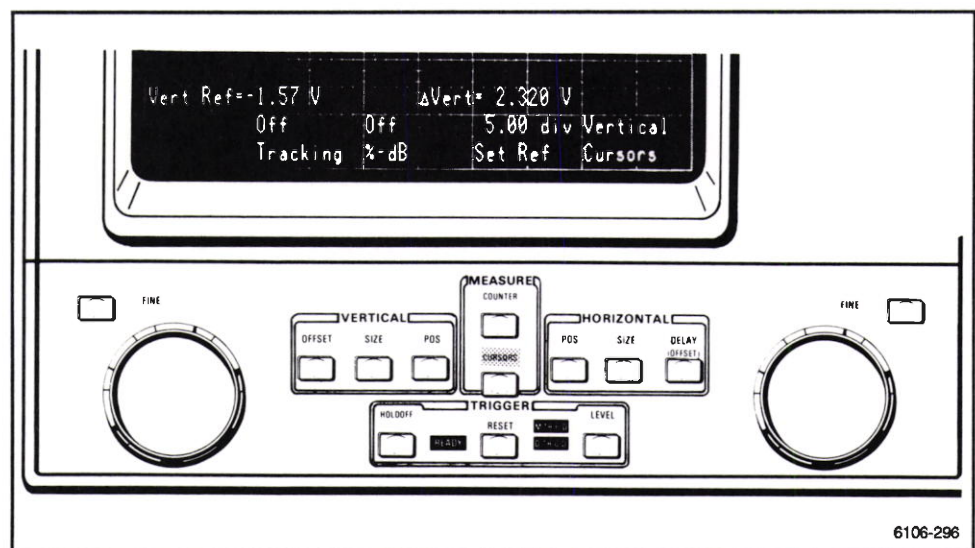


Figure 2-97. CURSORS menu after selecting vertical cursors.

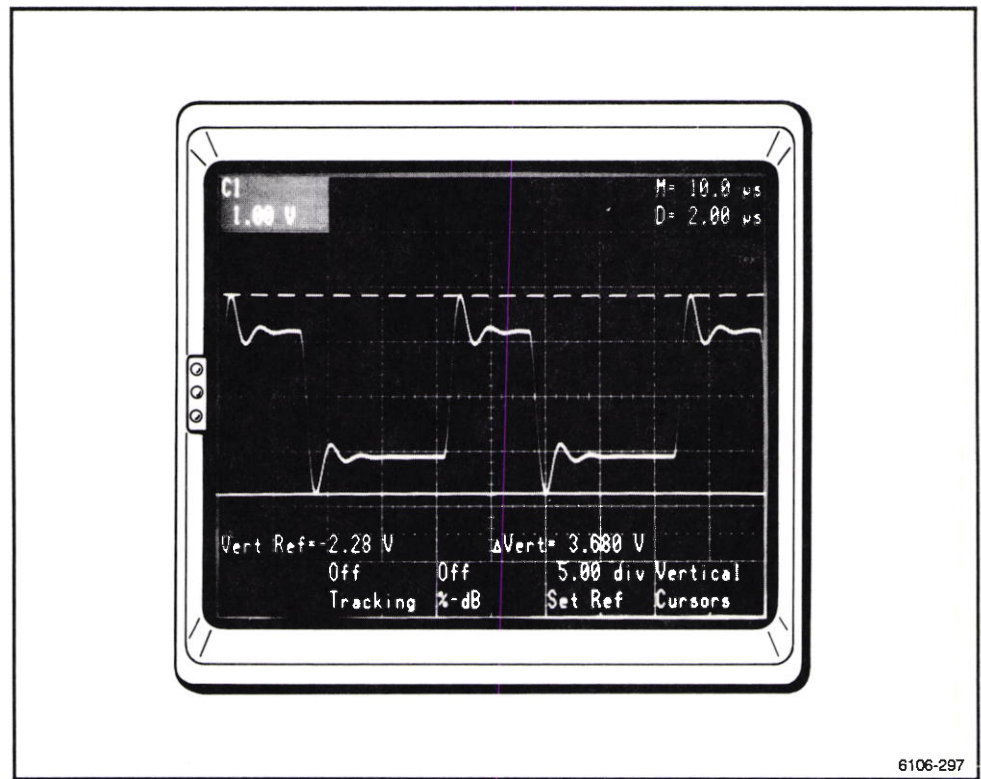


Figure 2-98. Cursors set to peaks of displayed waveform, and p-p voltage (ΔV).

5. Adjust the left knob to position one cursor at the bottom of the trace.
6. Adjust the right knob to position the other cursor line at the top of the trace.
7. The p-p voltage value will appear as ΔVert toward the lower right of the crt. (See Fig. 2-98.)

Phase Measurements

The phase angle between two or more time related signals can be accurately measured using Cursors. The following procedure shows you how to set the Cursor readout to get an answer in degrees.

1. Connect the lagging signal to an input channel and set the display on/off button to on. Press the AUTOSET button, then connect the leading signal and set the display on/off button to on. Press AUTOSET again to setup the second signal. (See Fig. 2-99.)

NOTE

Use coaxial cables or probes that have a similar time-delay characteristics with insignificant delay differences to connect the signals to the input channel connectors.

2. Press the HORIZONTAL SIZE button and adjust the right knob to display at least one cycle of both waveforms.
3. Press the VERTICAL POSITION button and use the left knob to move the waveforms so that a horizontal graticule line bisects each trace.
4. Press the CURSORS button, and then select **Horizontal Cursors** and **% Degree On**.

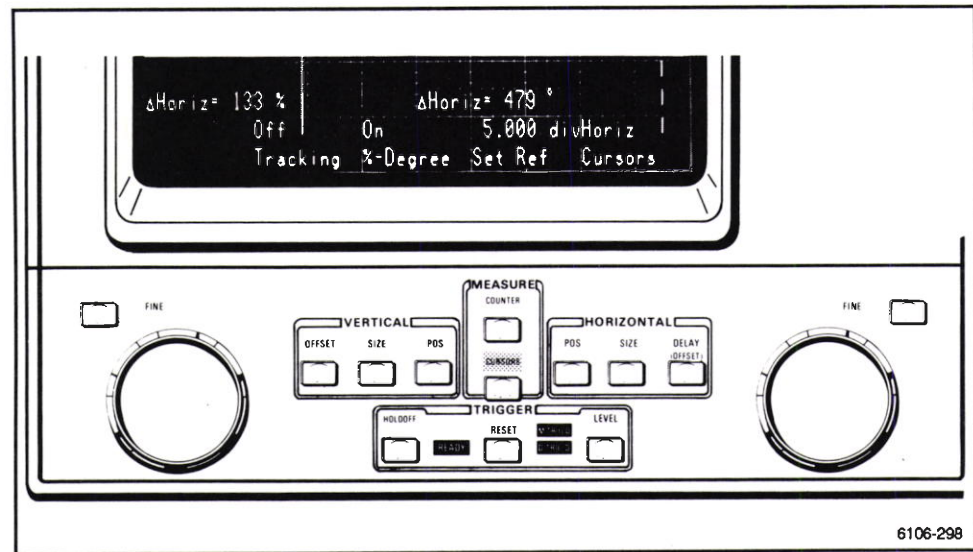


Figure 2-99. Cursor Menu with Horizontal cursors selected and % Degree set to On.

- Adjust both Cursors to span one cycle of the leading trace. Each cursor should intersect the trace and the horizontal graticule line which bisects the trace. (See Fig. 2-100.)
- Touch *Count Ref* in the cursor menu. This establishes the cursors displacement as 360° .

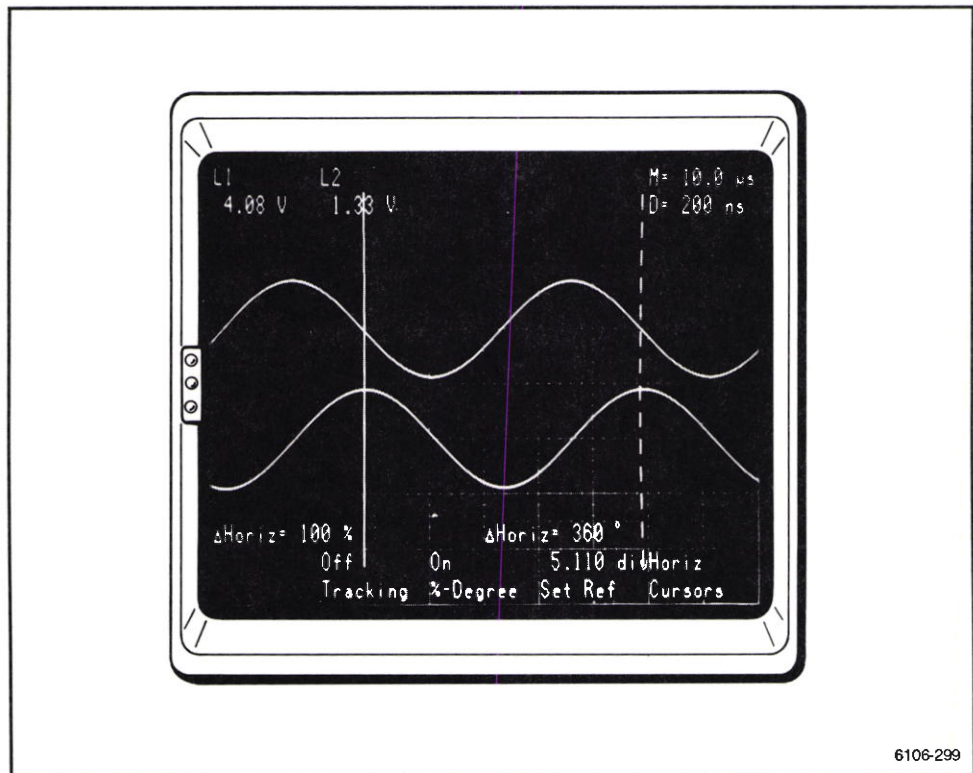


Figure 2-100. Selecting one cycle with the Horizontal Cursors.

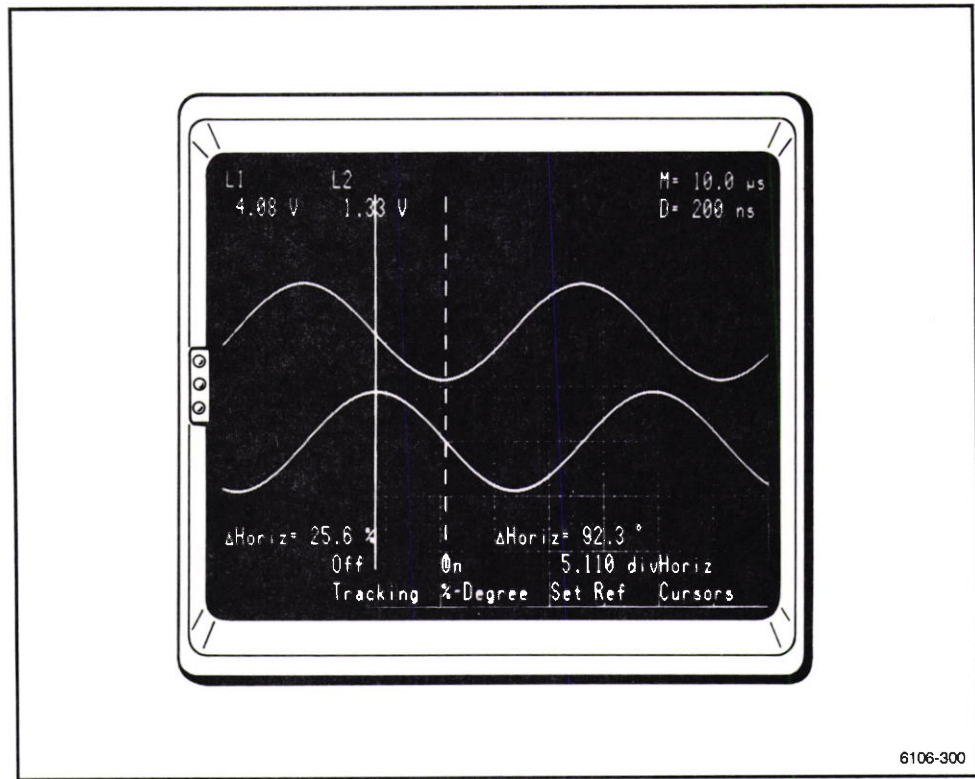


Figure 2-101 Phase angle result.

7. Position the right cursor to the first zero transition of the lagging trace that follows the position of the left cursor. (See Fig. 2-101.)
8. The phase angle answer is displayed as ΔHoriz near the lower right corner of the crt screen.

Rise Time Measurements

Rise time is the time the leading edge of a pulse takes to rise from 10% to 90% of its final value. The following procedure shows how to perform a rise time measurement using cursors.

1. Connect the signal to the input connector, set the display on/off button to on, and press the AUTOSET button. (See Fig. 2-102.)

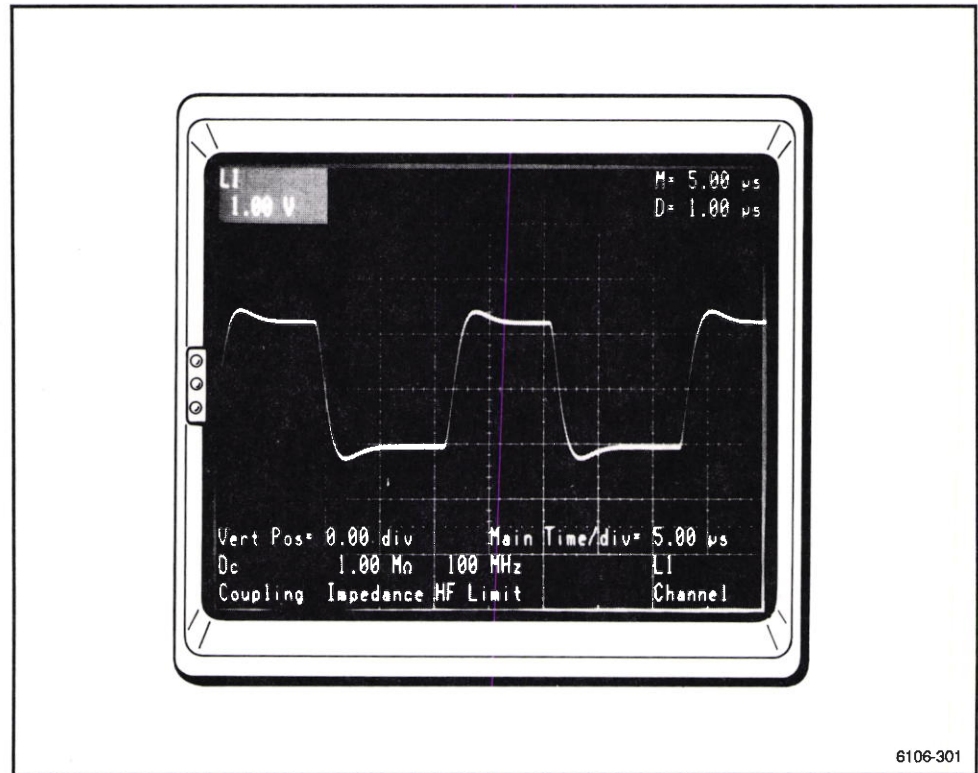


Figure 2-102. Input signal displayed.

2. Using the VERTICAL SIZE with the FINE control, adjust the trace such that the top (100% point or plateau) value and the bottom (0% point or baseline) value (not the Min or Max) are 5 divisions apart. (See Fig. 2-103.)
3. Using VERTICAL POSITION align the top and the bottom with the 0% and 100% markings on the crt screen.

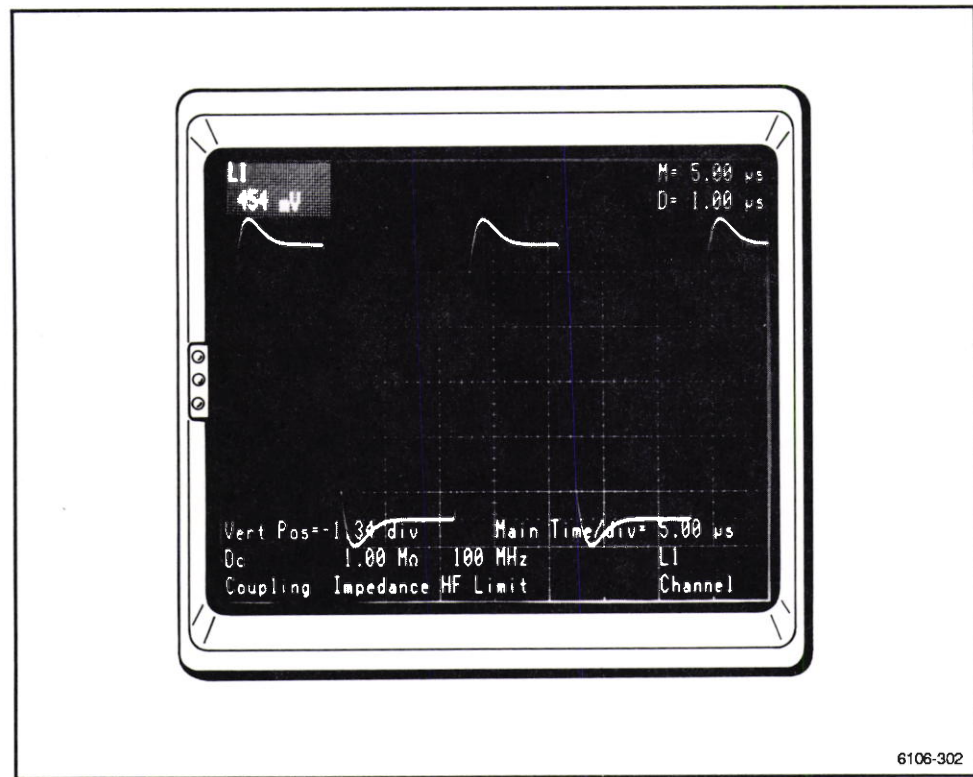


Figure 2-103. Setting VERTICAL SIZE and POSITION.

4. Press the HORIZONTAL POSITION button and align a rising edge of the signal with the center vertical graticule line. (See Fig. 2-104.)

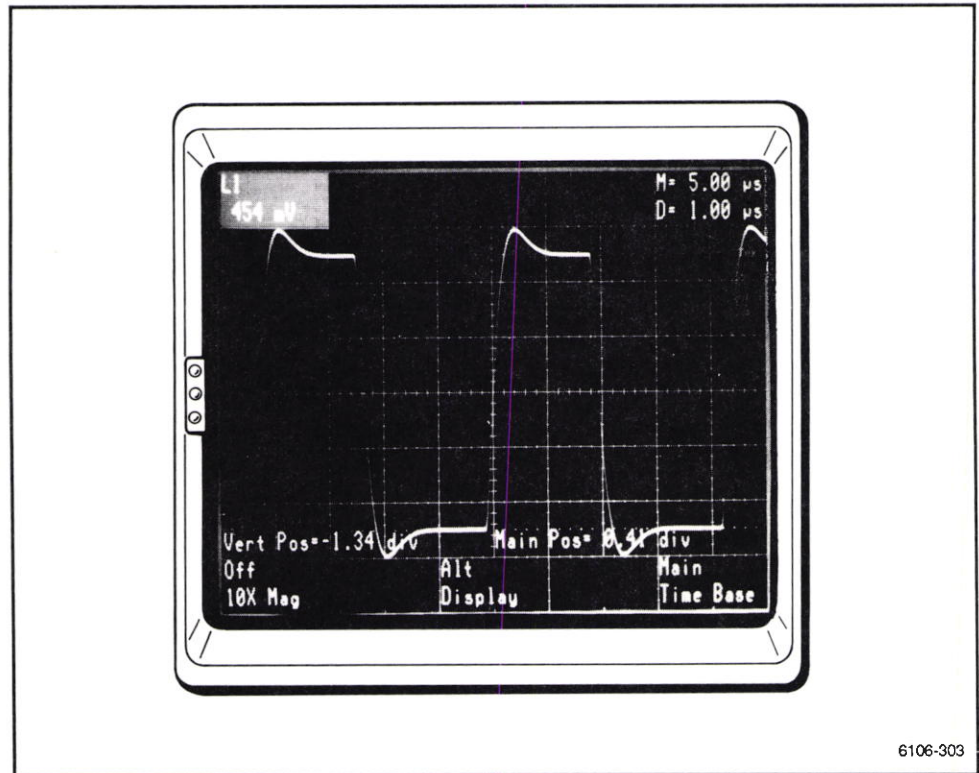


Figure 2-104. Aligning the rising edge using HORIZONTAL POSITION.

5. Touch *10X Mag* to read **On**. (See Fig. 2-105.)

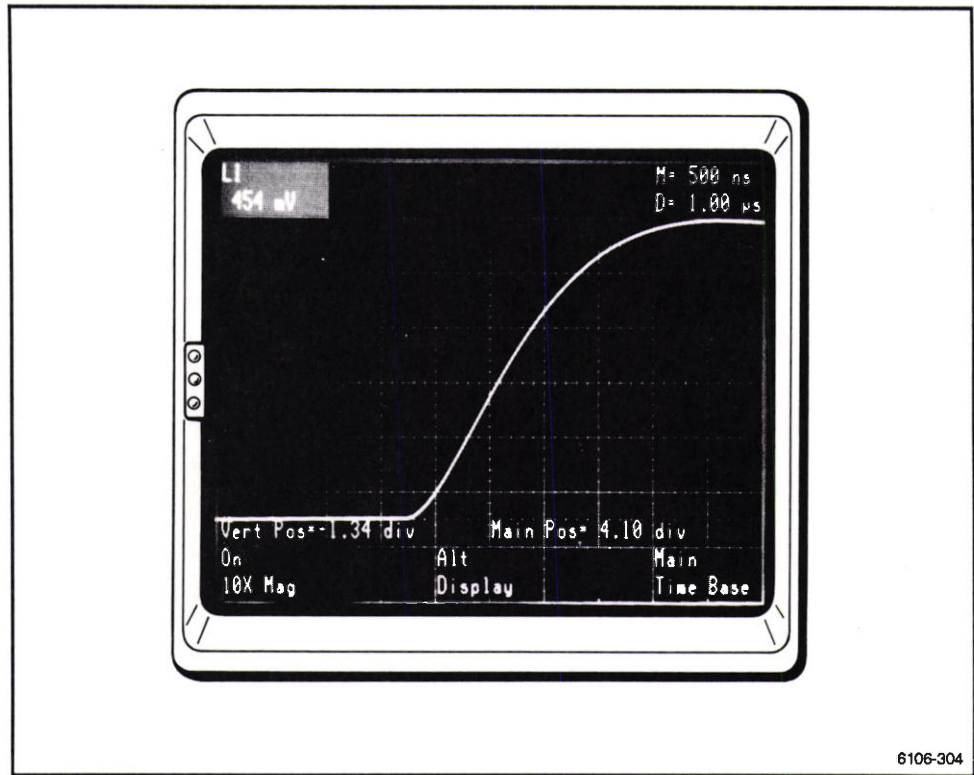


Figure 2-105. 10X Magnified signal.

6. Press the **CURSORS** button and select **Horizontal Cursors**. Be sure that **% Degree** is set to **Off**. Adjust the cursor lines until the left cursor intersects the trace at the 10% graticule line and the right cursor intersects the trace at the 90% graticule line. The rise time appears as ΔHoriz near the lower right corner of the crt screen. (See Fig. 2-106.)

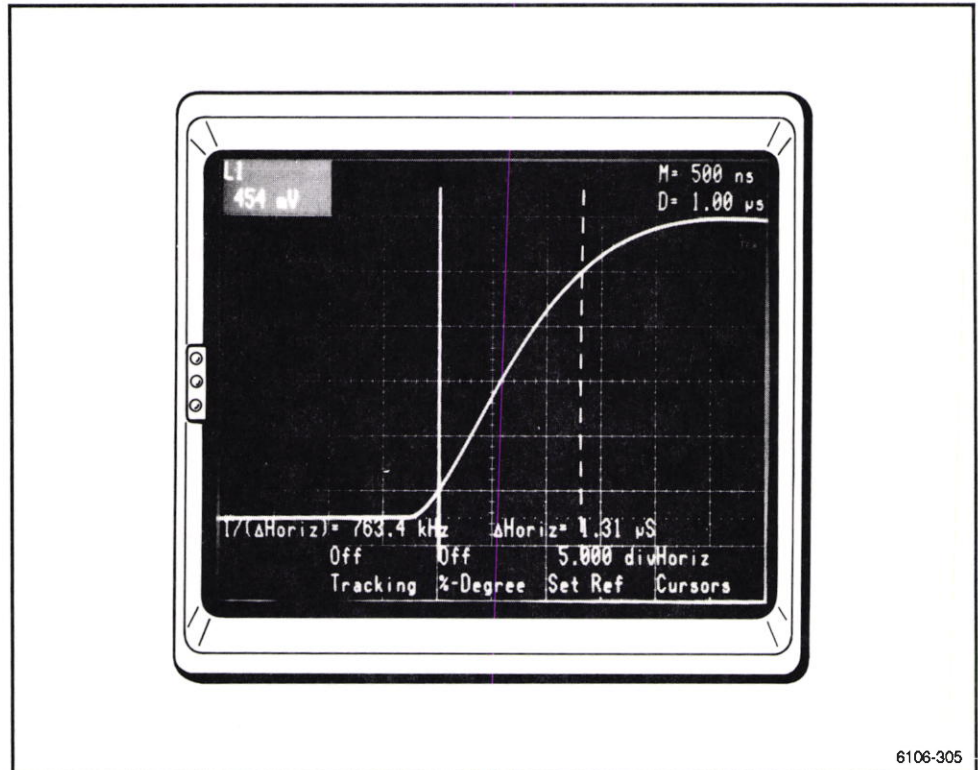


Figure 2-106. Setting the cursors to measure rise time.

Counter/Timer Measurements

The following shows step-by-step procedures on how to use various Counter/Timer features. For more information on these features see "Counter/Timer Concepts" in the "Measurement" subsection.

Basic Frequency Measurements

The following procedure shows an easy way to engage the counter to make frequency measurements. This same procedure can also be used for making *Width* and *Period* measurements.

1. Connect a cable or probe to the signal to be measured. For this example a sine or triangle wave with a frequency of 1 kHz or more will be best.
2. To display the signal, press the plug-in display on/off button, then press AUTOSET to scale the waveform and to set the triggering. As Autoset forces the trigger sources to be the same as the selected trace, there is no need to to examine the Trigger Source selections.

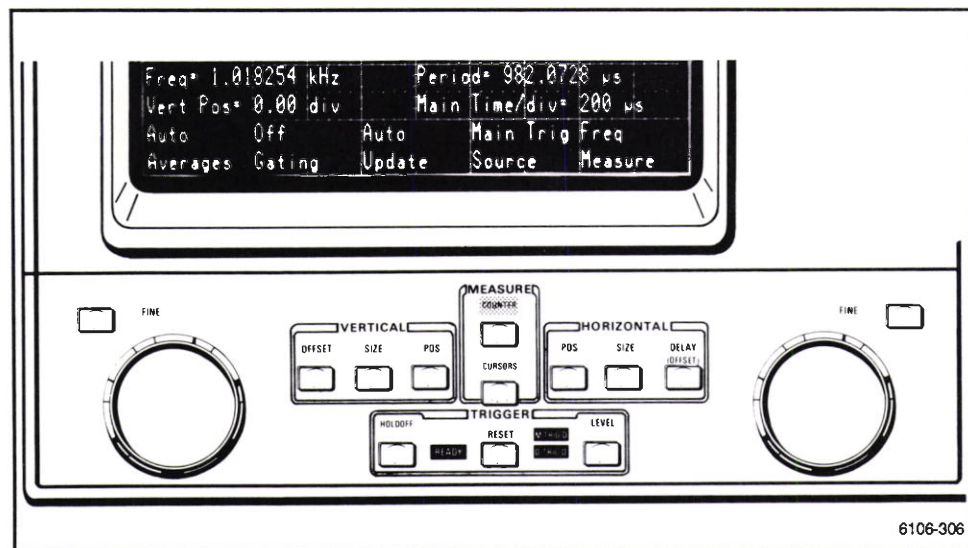


Figure 2-107. Counter/Timer menu.

3. Press the COUNTER button, located below the crt, to display the Counter/Timer menu. (See Fig. 2-107.)
4. Touch *Measure*, located at the right in the menu until **Freq** is selected.
5. Be sure that *Update* and *Averages* are set to **Auto**, *Gating* is set to **Off**, and that *Source* is set to **Main Trig**.
6. The result of the frequency measurement appears toward the lower left in the display.

Counter View Traces

The counter view display can be accessed in the following manner.

NOTE

*In this example, **Count In** will be used.*

1. Use the procedure for performing a Basic Frequency Measurement as described in the previous example.
2. Press the WAVEFORM major menu button and touch *Count View*, located toward the left of the screen. To display the counter input signal, touch the *Count In* menu entry. (See Fig. 2-108.)

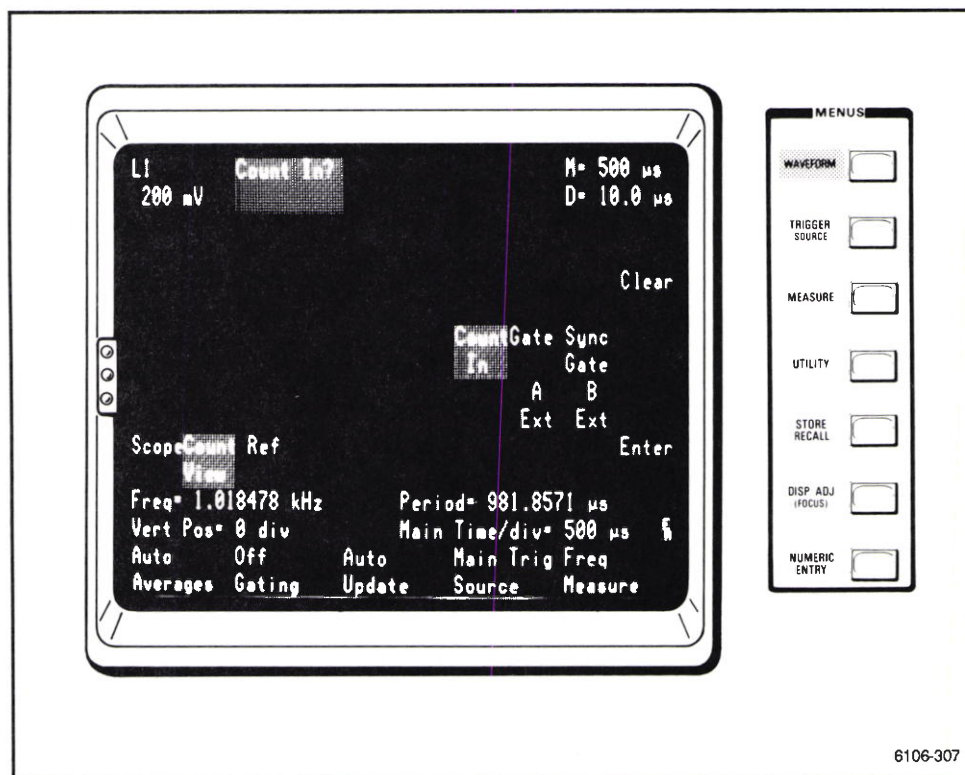


Figure 2-108. Setting the WAVEFORM menu for Counter View.

3. Turn off the menu by pressing the WAVEFORM major menu button again.
4. Use VERTICAL POS to vertically separate the two traces. (See Fig 2-109.)

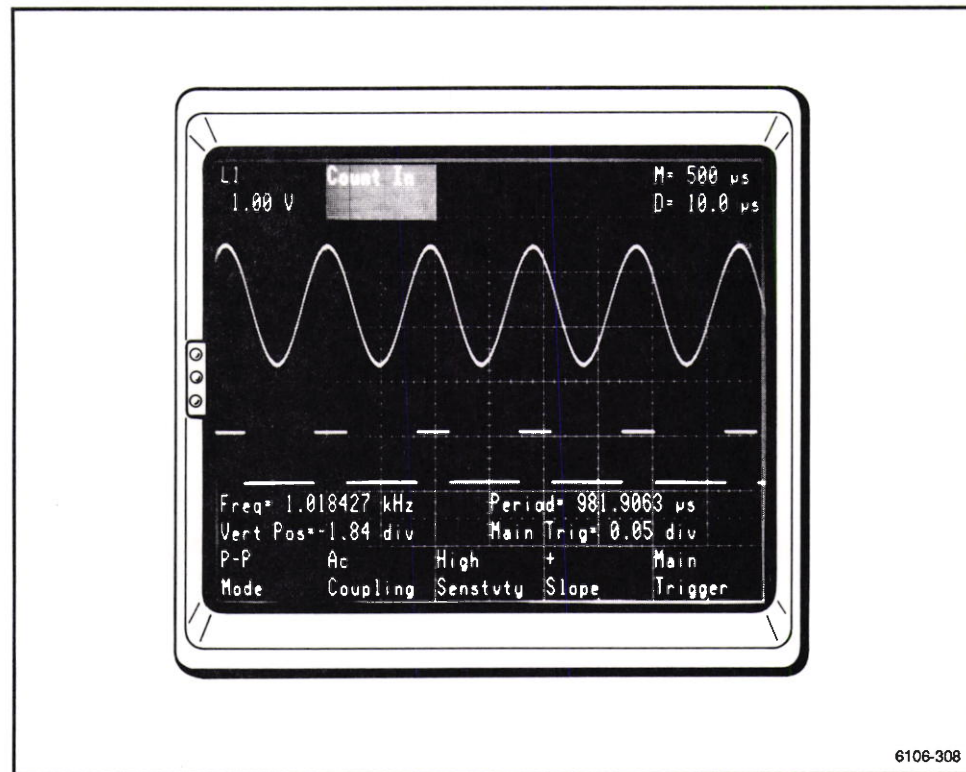


Figure 2-109. Two traces vertically separate.

5. To observe the effects of changing the triggering controls, press the TRIGGER LEVEL button and turn the right knob. Notice that the Count In trace shows a varying duty factor as the level is varied. (If the measured signal is a square wave, little or no change will be evident.)

Gated Frequency Measurements

This procedure shows how to use Gating to control the measurement interval of the counter.

1. Use the preceding procedure for a Basic Frequency Measurement.
2. Using the COUNTER menu, touch *Gating* to select **Dly1 Swp** as the gating type. (See Fig. 2-110.)

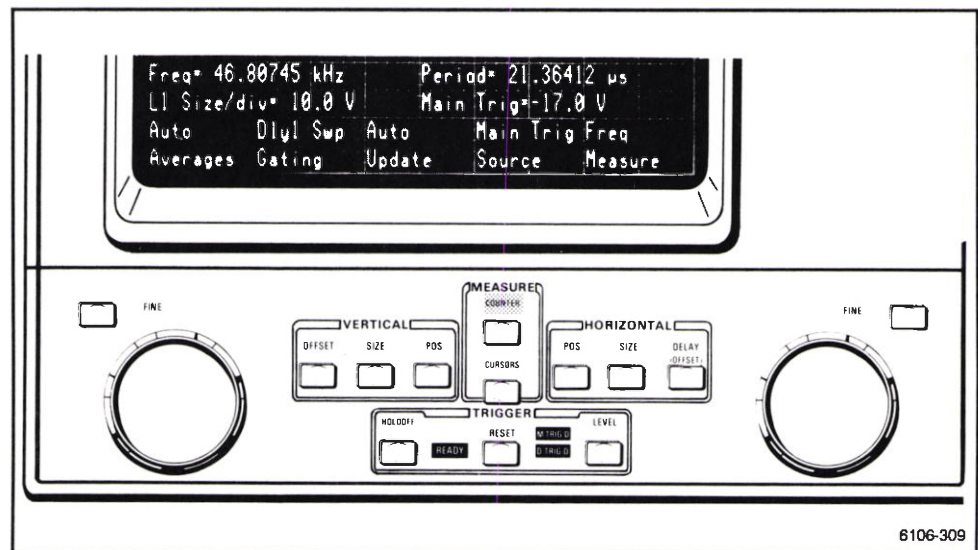


Figure 2-110. Counter/Timer menu with Dly1 Swp gating selected.

- From the WAVEFORM major menu, display the counter view signal called Gate by touching **Gate** in the *Count View* menu. Turn off the menu by pressing the WAVEFORM major menu button again. (See Fig. 2-111.)

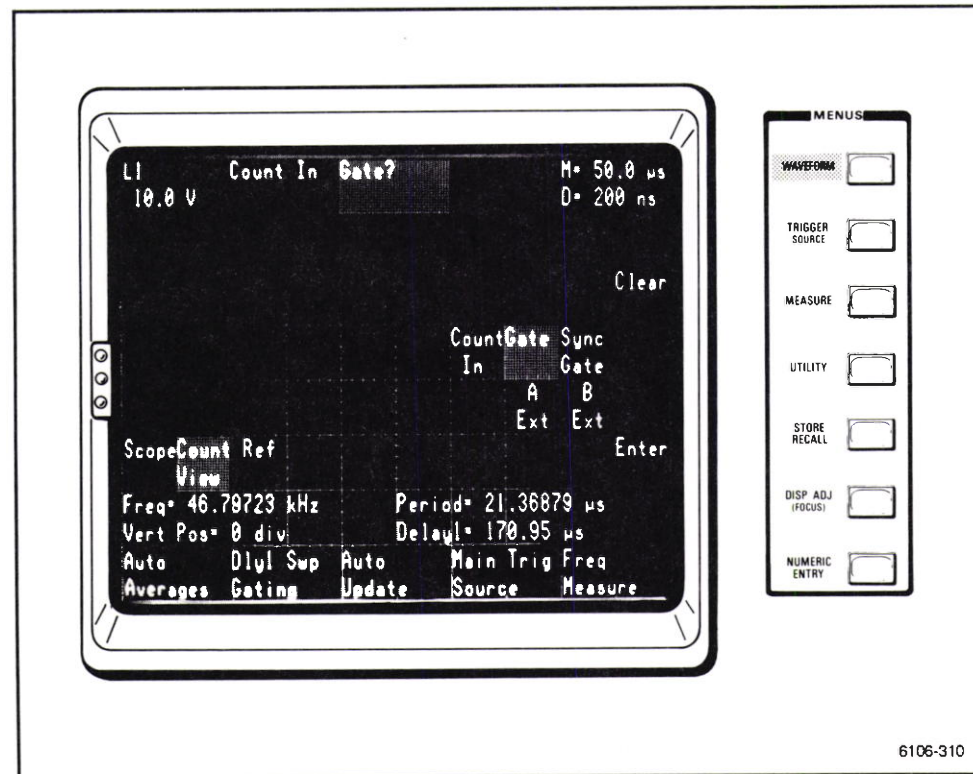


Figure 2-111. The WAVEFORM major menu with Count View selected, and the Count View menu with Gate selected.

- With the counter engaged, adjust the horizontal size of the delayed time base by pressing HORIZONTAL SIZE and touching the menu until it reads **Dly'd Time Base**. Turn the right knob until the Gate pulse width, which is displayed as Dly'd Time/div = nnn, falls within the desired measurement region. (See Fig. 2-112.)

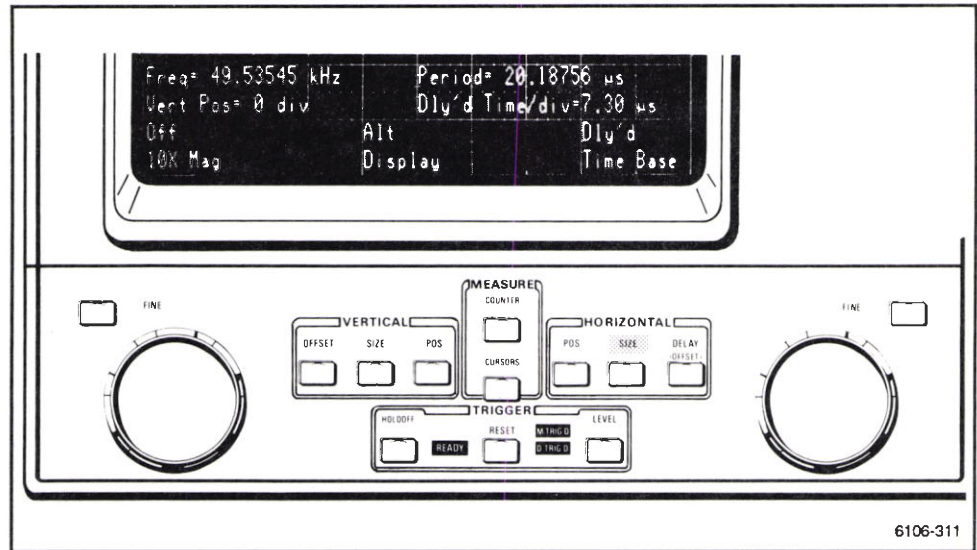


Figure 2-112. Adjusting Dly'd Time/div through HORIZONTAL SIZE menu.

- Press the HORIZONTAL DELAY button and set the *After Dly* selection to **Runs**. (**Trig'd** may be used with the proper setting of the Delayed Trigger Level, if desired). Next touch *Delay* to read 1, and turn the right knob to align the gate pulse within the desired measurement region. (See Fig. 2-113.)

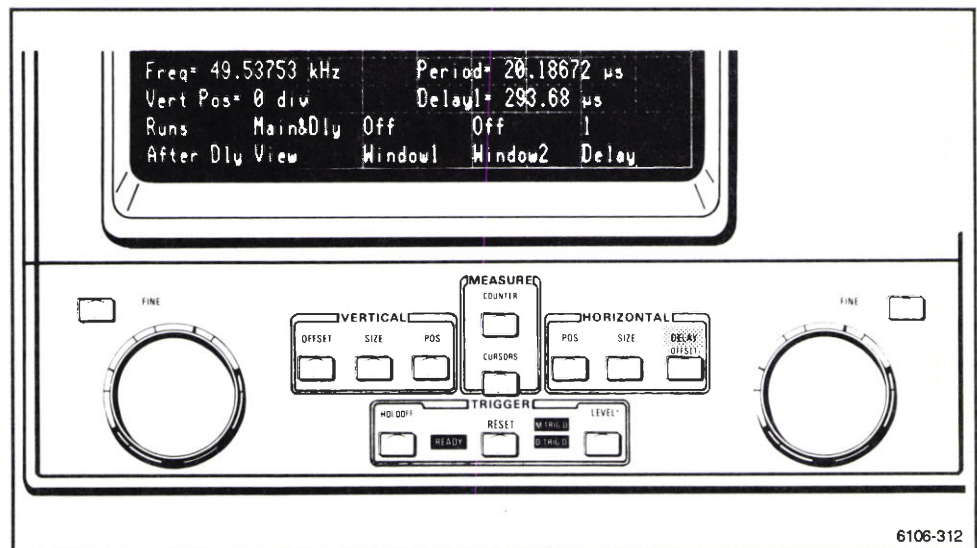


Figure 2-113. Adjusting the DELAY.

- 6. The gated frequency measurement will appear toward the lower left in the display. (See Fig. 2-114.)

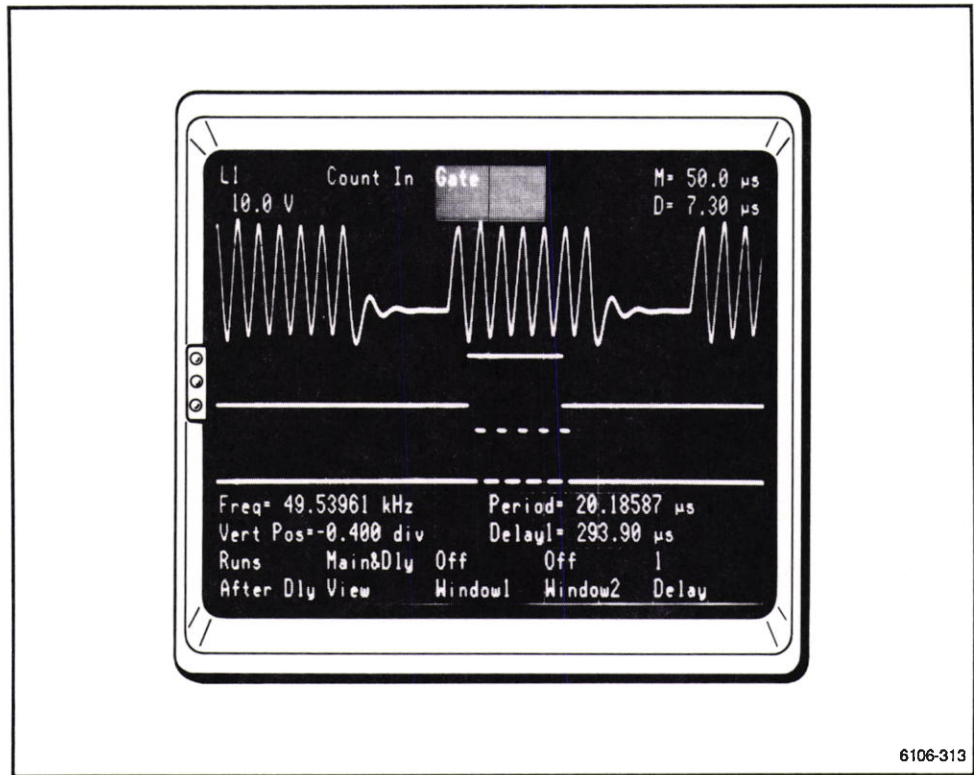


Figure 2-114. Gated frequency display.

Nulling the Counter/Timer

The procedure for nulling before a Time Interval Measurement is as follows:

1. Install amplifiers of the same model type in the LEFT and CENTER compartments.
2. Connect both probes or cables to the same signal. This can be either the signal of interest or the **Fast** rise signal from the front-panel Calibrator.
3. When the Counter/Timer has presented a measurement of the time-skew between the two signal paths, press the NUMERIC ENTRY button.
4. Touch *Count Ref*, which is to the left of the NUMERIC ENTRY menu.
5. Touch **Null** in the NUMERIC ENTRY menu. This will establish the latest Counter/Timer result as the reference for future time interval measurements (**Null** will appear in the NUMERIC ENTRY menu only if the Counter/Timer has a valid reference number. Touching **Clear** then **Enter** will return a zero reference and the results are again displayed as "absolutes."
6. Press the NUMERIC ENTRY button again to remove its menu.
7. Connect the probes or cables to the signals of interest and read the true time between them.

Nulling the other measurements is done the same way, except you need not change the connections to the signals being measured.

Time Interval Measurement of Propagation Delay

The following procedure depicts a way of measuring a time interval between events from two different input channels. In this case, the interval represents the propagation delay through an active circuit.

1. Install amplifiers of the same model type in the LEFT and CENTER compartments.
2. Connect channel L1 to the leading signal (input to the circuit under test) and press the display on/off button to display the signal.
3. Connect channel C1 to the lagging signal (output of the circuit under test) and press the display on/off button to display the signal.
4. Press the DELAY button and from its menu select *Window2* to be **On**. (See Fig. 2-115.)

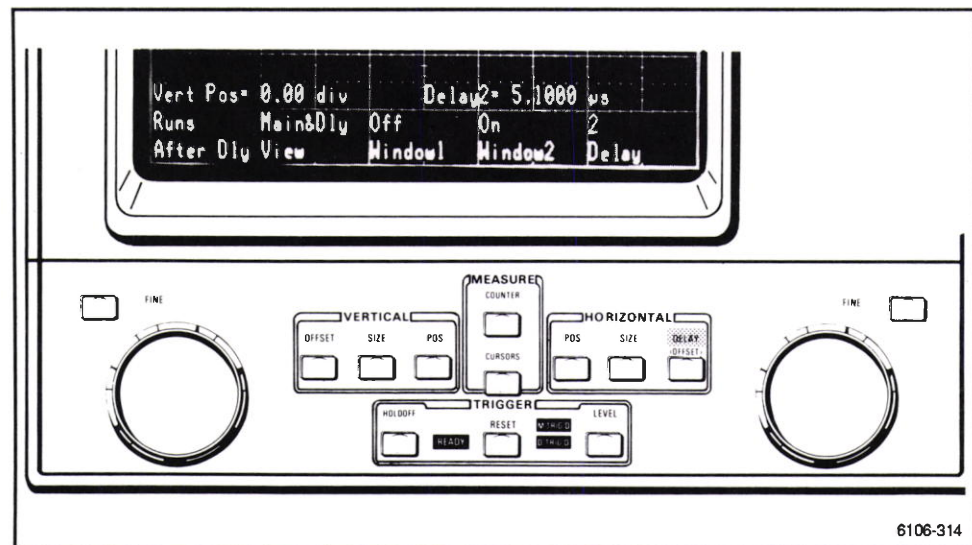


Figure 2-115. Delay menu with Window 2 set to On.

5. Press AUTOSET.
6. Select the leading trace (labeled "L1") by touching **L1**, which is located at the top left of the display.
7. From the DELAY menu, select *Window1* to be **On**.
8. Press AUTOSET. By now each main trace should have one intensified zone, each referenced to different delay adjustments. Use VERTICAL POSITION to separate traces if needed.

9. To simplify the appearance of the display, select *View* (from the DELAY menu) to be **Main**.

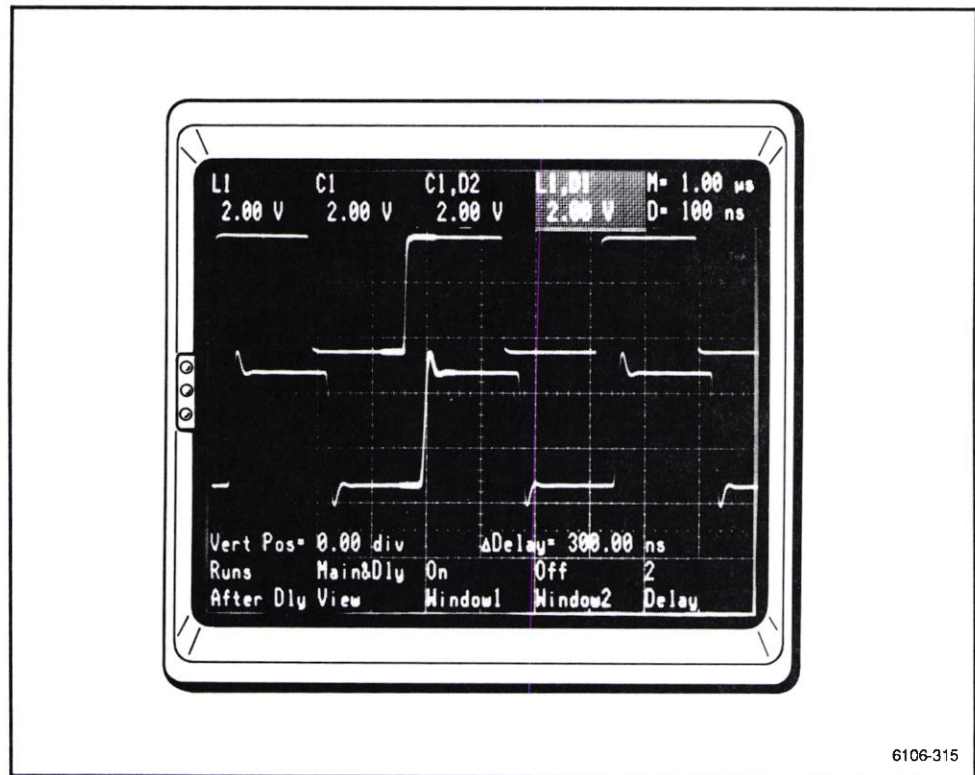


Figure 2-116. Setting delays for propagation delay measurement.

10. Use the Delay control to move the window zones to the desired event on each main trace. To do this, press the DELAY button, then turn the right knob. Touch *Delay* to alternate control from one zone to the other. (See Fig. 2-116.)
11. To measure the time between these events, press the COUNTER button and repeatedly touch *Measure* in the menu until it is set to **Time A→B**. Be certain that *Update* and *Averages* are set to **Auto** and that *Source* is set to **Swp Start**.

12. The measurement result, the time between the two events, appears at the lower left of the display as **Time D1→D2**. (See Fig. 2-117.)

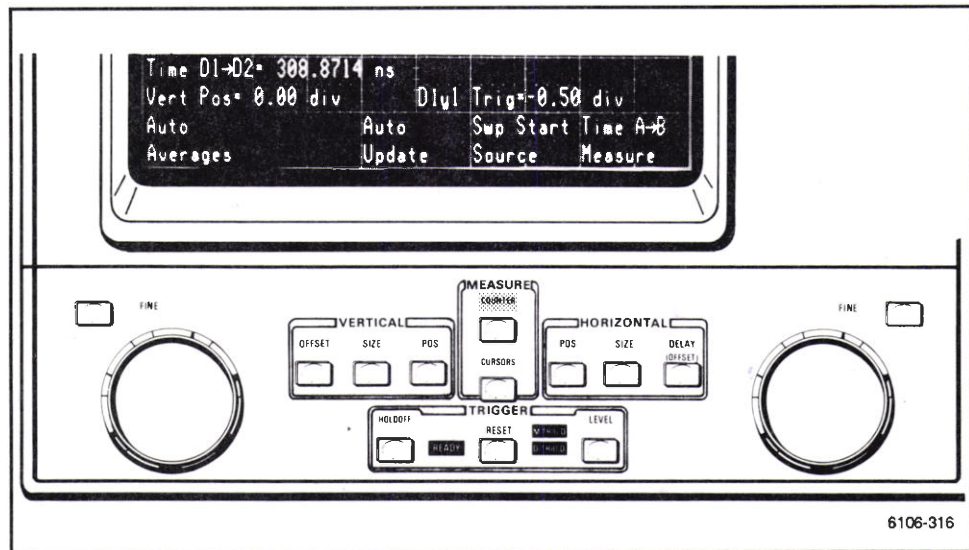
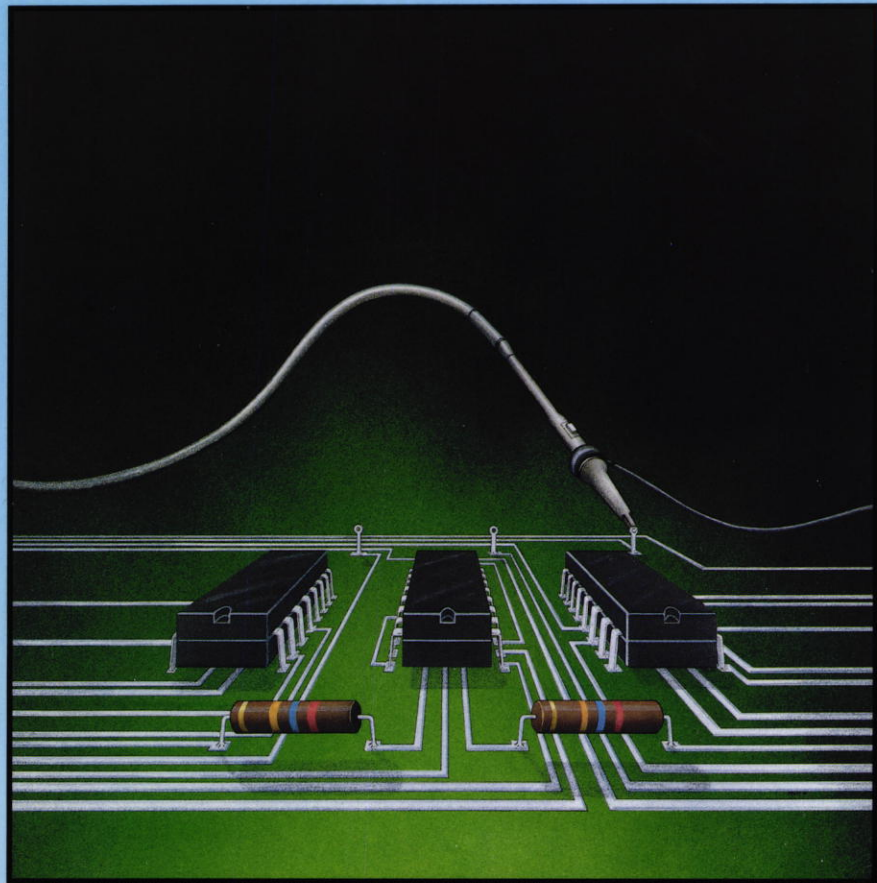


Figure 2-117. Time between events displayed as Time D1→D2 in message area.

13. At this point, the time between the two intensified zones is controlled only by the setting of the Delay control. To further qualify the measurement location, the delayed triggers can be used.
14. For Triggered Time A→B, press the TRIGGER SOURCE major menu button. Touch **Dly1**, located to the left in the menu. It should show that L1 (the leading signal) is its trigger source. Touch **Dly2** and select C1 (the lagging signal) as its trigger source. Press the TRIGGER SOURCE button again to remove its menu.
15. In the DELAY menu, set the windows to be triggered after the delay by touching *After Dly* to select **Trig'd**. At this point, the intensified zones should begin on the transitions of interest. If they do not, then adjust the **Dly1** and **Dly2** trigger levels by pressing the TRIGGER LEVEL button and touching Trigger until Dly1 or Dly2 appears at the lower far right of the display.

Section 4 Specification





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Specification

The specifications that follow apply when:

- The instrument has been calibrated at an ambient temperature between +18° C and +23° C by a qualified service technician.
- All plug-in compartments are full. Unused compartments can be filled with blank units (Tektronix Part No. 016-0829-00).
- The instrument has reached thermal equilibrium, which requires a 20-minute warm-up period.
- The instrument is in the Enhanced Accuracy condition. Enhanced Accuracy is indicated on the CRT display and remains in effect as long as the internal mainframe temperature does not change 5° C (or more) from the temperature at which the Enhanced Accuracy condition was entered.

If the internal mainframe temperature changes 5° C or more, the accuracy condition of the instrument becomes Not Enhanced.

When operating in the Not Enhanced Accuracy condition or with one or more empty plug-in compartments, those Characteristics that are temperature sensitive may not remain within the limits of these specifications.

Electrical Characteristics

TABLE 4-1
Electrical Specification

Characteristics	Performance Requirements
11301 Cathode-Ray Tube	
Display	8 x 10 divisions; 1.22 cm/div.
Graticule	8 x 10 divisions with 5 divisions rise-time markings (0%, 10%, 90%, and 100%).
Phosphor	Standard P31.
Acceleration Voltage	22 kV.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
11302 Cathode-Ray Tube with Micro Channel Plate (MCP)	
Display	8 x 10 divisions; 1.00 cm/div.
Graticule	8 x 10 divisions with 5 divisions rise-time graticule markings (0%, 10%, 90%, and 100%).
Phosphor	Standard P31.
Visual Writing Speed	≥6 cm/ns at 20 fc (footcandle ambient illumination).
Ac Power Source	
Source Voltage	
Nominal Ranges	
115 V	90 V to 132 V.
230 V	180 V to 250 V.
Source Frequency	48 Hz to 440 Hz.
Fuse Rating	6 A, 250 V, Normal blow.
Power Consumption	
Maximum	240 watts. Fully optioned instrument including plug-ins.
Maximum Line Current	3.6 A rms at 50 Hz, 90 V with 5% clipping of voltage peak.
Primary Circuit Dielectric Voltage Withstand Test	1500 V rms, 60 Hz for 10 seconds without breakdown.
Primary Grounding	Routine test to check grounding continuity between chassis ground and protective earth ground.

Table 4-1 (cont)
Electrical Specification

Characteristic	Performance Requirement
Battery Backup Memory	
Battery Backup Memory	
Backup Time	5 years.
Cell Type	Lithium.
Character Display	
Number of Characters per line	50 per line. 10 per div in top and bottom divs, 5 per div in center 6 divisions.
Number of lines	16 lines. 2 per division.
Counter/Timer	
General	
Display	
Auto Update	With Auto Update selected, N is greater of one period or the number of periods that occur in a 300 ms interval.
Averaging	Resolution may be improved by averaging. The number of measurements made will be sufficient to guarantee the higher resolution and may be greater than the minimum number of measurements necessary to attain the displayed resolution. The amount of averaging is selectable in two decade steps (1, $\approx 10^2$, $\approx 10^4$, etc.) up to $\approx 10^{10}$ for Frequency, Period, Width, Ratio, and A→B measurements except for Total, which may not be averaged.
Display Update Rate	Auto updating occurs at the maximum rate of three times per second. Manual updating occurs upon pressing the Trigger RESET button, selecting another measurement, or a low to high transition of the rear-panel TRIGGER RESET INPUT.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Counter/Timer (cont)	
General (cont)	
Number of Digits	Up to 7 digits (10 digits using the external reference or optional high-stability reference) may be displayed. Engineering notation is used for positioning of the decimal point except for totaling events measurements.
Gating	
Minimum Arm/Disarm Time Between CT External A & B Inputs	25 ns.
Minimum CT External B Width	25 ns.
Sensitivity	
Main & Dly'd Triggers CT External A & B Inputs	2 x Sweep Trigger Sensitivity. 3 times the Sweep Trigger Sensitivity for Frequency >50 MHz, Averages $\geq 10^8$ for FREQ, PERIOD, RATIO, and TOTALIZE. See External Connector Section.
Measurement Functions	
Frequency	
Internal Main and Dly'd Triggers and CT External A Source	
Range	1 mHz to 500 MHz.
Least Significant Digit (LSD)	$10 \exp \{ \text{Int}(\log((1.8\text{ns})F^2 / (N \pm F(1.8 \text{ ns}))) + 1) \}$.
Ungated Resolution (in Hz)	Greater of $\text{LSD} \pm 1.4(\text{TJE})F^2/N$ or 1 count.
Gated Resolution	$\pm 1.8 \text{ ns } (F^2)/n$ $\pm 1.4(\text{TJE})F^2/n$
Accuracy (in Hz)	Resolution $\pm F(\text{TBE})$.

Table 4-1 (cont)
Electrical Specification

Characteristic	Performance Requirement
Counter/Timer (cont)	
Measurement Functions (cont)	
Period	
Internal Main and Dly'd Trigger Sources	
Range	2 ns to 1000 s.
Least Significant Digit (LSD)	1.8 ns/N.
Ungated resolution (in s)	LSD \pm 1.4(TJE)/N.
Gated Resolution	2 ns/n \pm 1.4(TJE)/n.
Accuracy (in Hz)	Resolution \pm TBE(P).
CT External A Source	
Range	2 ns to 1000 s.
Least Significant Digit (LSD)	1.8 ns/N.
Ungated Resolution	LSD \pm 1.4(TJE)/N.
Gated Resolution	2 ns/n \pm 1.4(TJE)/n.
Accuracy (in Hz)	Resolution \pm TBE(P).

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Counter/Timer (cont)	
Measurement Functions (cont)	
Ratio	
Internal Main and Dly'd Trigger Sources	
Range	10 ⁻¹¹ to 10 ¹¹ .
Frequency Range	1 MHz to 400 MHz.
Least Significant Digit (LSD)	Ratio/10 ¹⁰ .
Ungated Resolution	LSD ±1.4(TJED/ND) ± 1.4(TJEM/NM) ±FM ² /(FD ² ±FMFD) where N refers to Main trigger events.
Accuracy	Same as resolution.
CT External A and B Sources	
Range	10 ⁻¹¹ to 10 ¹¹ .
Frequency Range	1 MHz to 400 MHz.
Least Significant Digit (LSD)	Ratio/10 ¹⁰ .
Ungated Resolution	LSD ±1.4(TJEB/NB) ±1.4(TJEA/NA) ±FA ² /(FB ² ±FAFB) where N refers to CT External A events.
Accuracy	Same as resolution.

Table 4-1 (cont)
Electrical Specification

Characteristic	Performance Requirement
Counter/Timer (cont)	
Measurement Functions (cont)	
Total	
Internal Main and Dly'd Triggers and CT External A & B Sources	
Range	0 to 10^{15} counts (engineering notation used above $10^{11}-1$ with 10 digit resolution).
Repetition Rate	>0 Hz to 500 MHz.
Least Significant Digit (LSD), Resolution and Accuracy	1 up to $10^{11}-1$.
Elapsed Time Range	25 ns to 1250 hrs.
Width	
Internal Main and Dly'd Triggers and CT External A & B Sources	
Range	2 ns to 1000 s.
Maximum Repetition Rate	200 MHz (100 MHz for CT Ext A & B sources).
Least Significant Digit (LSD)	2ns (for N=1); $10\text{ns}/\sqrt{N}$ (for N>1).
Resolution	$\text{LSD} \pm 1.4((TJ_{E_L}) \pm 1.4(TJ_{E_T}))/\sqrt{N} \pm 2 \text{ ps.}$ (For $1 \leq N \leq 10^6$).
Accuracy (gated and nongated)	Resolution $\pm \text{Width}(TBE)$ $\pm \text{Hysteresis error}$ $\pm TLE / (\text{Slew}_E - \text{Slew}_S) \pm 1\text{ns.}$ NOTE <i>Slew rate may be limited by the plug-in amplifier used as the signal source.</i>

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Counter/Timer (cont)	
Measurement Functions (cont)	
Time Interval	
Main to Dly'd Sweep (only one Dly'd Window)	
Delay Time	
Runs After	
Range	0 to 10 times the Main Time/div setting.
Least Significant Digit (LSD)	2 ns (for N=1); 10 ns / \sqrt{N} (for N>1).
Resolution	$\pm \text{LSD} \pm (\text{DJ} / \sqrt{N})$ $\pm 1.4 \text{TJEM} / \sqrt{N}$ (for $1 \leq 10^6$). $\pm 3 \times 10^{-4}$ (Main Time/div).
Accuracy	$\pm \text{Resolution}$ $\pm \text{TBE (Result)} \pm 50 \text{ ns}$.
Triggered After	
Range	75 ns to 10 times the Main Time/div setting.
Least Significant Digit (LSD)	2 ns (for N=1); 10 ns / \sqrt{N} (for N>1).
Resolution	$\pm \text{LSD} \pm 1.4 \text{TJEM} / \sqrt{N}$ $\pm 1.4 \text{TJED} / \sqrt{N}$ (for $1 \leq N \leq 10^6$).
Accuracy	
15° C to 35° C	$\pm \text{TLEM} / \text{SlewM} \pm \text{TLED} / \text{SlewD}$ $\pm \text{Resolution}$ $\pm \text{TBE (Result)} \pm 500 \text{ ps}$.
0° C \leq T < 15° C or 35° C < T \leq 50° C	Add $\pm 700 \text{ ps}$ to 15° C to 35° C tolerance.

Table 4-1 (cont)
Electrical Specification

Characteristic	Performance Requirement
Counter/Timer (cont)	
Measurement Functions (cont)	
Time Interval (cont)	
Delta Delay Time (both Dly'd Windows)	
Runs After	
Range	0 to ± 10 times the Main Time/div setting.
Least Significant Digit (LSD)	2 ns (for N=1); 10 ns/ \sqrt{N} (for N>1).
Resolution	$\pm \text{LSD} \pm 1.4 \text{ DJ} / \sqrt{N}$ $\pm 2(\text{TJE}_M) / \sqrt{N}$ (for $1 \leq N \leq 10^6$). $\pm 3 \times 10^{-4}$ (Main Time/div).
Accuracy	\pm Resolution \pm TBE(Result) ± 500 ps
Triggered After	
Range	0 to $\pm(10$ times the Main Time/div setting -75 ns).
Least Significant Digit (LSD)	2 ns (for N=1); 10 ns/ \sqrt{N} (for N>1).
Resolution	$\pm \text{LSD} \pm 2 \text{ TJE}_M / \sqrt{N}$ $\pm 1.4 \text{ TJE}_{D1} / \sqrt{N}$ $\pm 1.4 \text{ TJE}_{D2} / \sqrt{N}$ (for $1 \leq N \leq 10^6$).
Accuracy	\pm Channel-to-channel mismatch (plug-in dependent) if different channels are used \pm Resolution $+ \text{TLE}_{D2} / \text{Slew} - \text{TLE}_{D1} / \text{Slew}$ $\pm \text{TBE (Result)} \pm 200$ ps.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Counter/Timer (cont)	
Measurement Functions (cont)	
Time Interval (cont)	
Main & Delay Trigger Sources	
Range	2 ns to 1250 hrs.
Least Significant Digit (LSD)	2 ns (for N=1); 10 ns/ \sqrt{N} (for N>1).
Resolution	$\pm\text{LSD} \pm(1.4(\text{TJE}_A + \text{TJE}_B))/\sqrt{N} + 2 \text{ ps.}$
Accuracy	$\pm(\text{TBE})(\text{Time Interval}) \pm \text{Resolution}$ $\pm\text{Plug-In Delay Mismatch}$ $+\text{TLE}_M/\text{Slew}$ $-\text{TLE}_D/\text{Slew}$ $\pm\text{M to D Offset } 200 \text{ ps}$
Max Rep Rate	200 MHz.
M to D Offset	Nominally 400 ps provided (without null).
CT External A to B Sources	
Range	2 ns to 1250 hrs.
Least Significant Digit (LSD)	2 ns (for N=1); 10 ns/ \sqrt{N} (for N>1).
Resolution	$\pm\text{LSD}$ (for N=1); $\pm(1.4(\text{TJE}_A + \text{TJE}_B))/\sqrt{N} \pm 2 \text{ ps}$ (for N>1).
Accuracy	$\pm(\text{TBE})(\text{Time Interval}) \pm \text{Resolution}$ $\pm\text{Channel Delay Mismatch}$ $+\text{EBLE}/\text{Slew}$ $-\text{EALE}/\text{Slew}$ $\pm 500 \text{ ps.}$
Max Rep Rate	200 MHz.
Channel Delay Mismatch	Not more than $\pm 500 \text{ ps}$ (without null).

Table 4-1 (cont)
Electrical Specification

Characteristic	Performance Requirement
Counter/Timer (cont)	
Time Base	
Standard Internal Time Base	
Frequency	10 MHz, ± 50 Hz
Temperature Stability	± 50 Hz, $5 (10^{-6})$ 0 to 50° C (5 ppm).
Aging	<10 Hz/year (1 ppm/yr).
Adjustment Resolution	0.5 Hz.
Optional Internal Time Base (Option 1T)	
Frequency	10 MHz, (at calibration), ± 0.2 Hz (0.02 ppm).
Temperature Stability	± 2 Hz 0 to 50° C (0.2 ppm).
Warm-up time	10 minutes at 25° C to within 0.4 ppm of final frequency. 24 hours at 25° C to within 0.2 ppm of final frequency.
Aging	$1(10^{-8})$ per day at time of shipping. $4 (10^{-8})$ per week after 30 days continuous operation. $<1(10^{-6})$ per /year after 60 days continuous operation.
Short Term Stability	$\leq 1(10^{-9})$ rms based on 60 consecutive 1 second measurements.
Adjustment Resolution	0.2 Hz.
Adjustment Range	Sufficient for 8 years of aging.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Counter/Timer (cont)	
Counter-View	
Amplitude	1 div p-p within 20%. (10 MHz).
Rise Time	2 ns or less.
Aberrations	25% p-p.
Sources	Dly'd Gate Synchronized Gate Counter Input A External Input B External Input

Definitions of Terms for the Counter/Timer

DJ = Delay Jitter.

EALE = CT External A Input Level Error.

EBLE = CT External B Input Level Error.

en1 = input signal rms noise voltage.

en2 = rms noise voltage contributed by the plug-in.

en3 = rms noise voltage contributed by the mainframe trigger (see trigger and external input specs).

F = frequency of the signal being measured. (F=1/P)

F_A = F of the CT External A Trigger Source.

F_B = F of the CT EXternal B Trigger Source.

F_D = F of the Dly'd Trigger Source.

F_M = F of the Main trigger source.

Hysteresis Error (in seconds) = (Sensitivity/Slew) for negative going transitions

Table 4-1 (cont)
Electrical Specification

Characteristic	Performance Requirement
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Counter/Timer (cont)

Definitions of Terms for the Counter/Timer (cont)

with + slope or positive going transitions with – slope selected.

LSD = Least Significant Digit.

N = number of events in a measurement interval; selectable as 1, $\approx 10^2$, $\approx 10^4$, $\approx 10^6$, $\approx 10^8$, $\approx 10^{10}$, and Auto. For Auto Averaging, N is the greater of one or the number of events in a 300 ms interval.

n = number of events within the gate interval for gated measurements.

P = the period of the signal being measured ($P=1/F$).

Resolution = the amount an input signal must change to assure a change on the display.

Result = The measurement result.

Sensitivity = Trigger sensitivity, see TRIGGER specifications.

Slew = The absolute value of the Signal Slew rate (amplitude/second) at the trigger point.

Slew_D = Slew for Delay Trigger.

Slew_E = Slew at the Ending edge of a measurement.

Slew_M = Slew for Main Trigger.

Slew_S = Slew at the Starting edge of a measurement.

TBE = time-base error (see CT time-base spec).

TJE = Trigger Jitter Error (in seconds rms), which is $(en^2 + en^2 + en^3)^{0.5}/\text{Slew}$.

TJE_A = CT External A Input Trigger Jitter Error.

TJE_B = CT External B Input Trigger Jitter Error.

TJE_D = Delayed Trigger Jitter Error (see TJE).

TJE_L = Trigger Jitter Error of the Leading edge.

TJE_M = Main Trigger Jitter Error (see TJE).

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
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Counter/Timer (cont)

Definitions of Terms for the Counter/Timer (cont)

TJ_{E_T} = Trigger Jitter Error of the Trailing edge.

TLE = Trigger Level Error; error resulting from the actual trigger point being different from the set trigger point.

TLE_M = Trigger Level Error of the Main Trigger.

TLE_D = Trigger Level Error of the Delayed Trigger.

Math Terms used in the preceding expressions

$\exp()$ = exponentiates to the power given by the expression within the brackets.

$\text{Int}()$ = converts the expression within the parenthesis to the nearest integer of lesser or equal value (e.g., $\text{Int}(1.7)=1$ and $\text{Int}(-1.7)=-2$).

$\log()$ = computes the base 10 (common) logarithm of the expression within the parenthesis.

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
External Connectors	
Camera Power	
Connector Type	3-contact connector compatible with Tektronix C-50 series cameras.
Top Pin	+15 Volts.
Center Pin	Single Sequence Reset.
Bottom Pin	Ground.
CALIBRATOR	
Output Connector	Bnc and probe hook; also has adjacent grounding post.
Square Wave Mode	
Output Voltage and Current	5.0 V, or 500 mV $\pm 1\%$ into a 1 M Ω load; 500 mV or 50 mV $\pm 1.9\%$ into a 50 $\pm 0.5\%$ Ω load.
Polarity	Positive-going with baseline at 0 V.
Output Resistance	450 $\Omega \pm 0.5\%$.
Repetition Frequency	100 Hz, 1 kHz, 10 kHz, 100 kHz.
Accuracy	$\pm 0.2\%$.
Rise Time	≤ 200 ns into ≤ 20 pf.
Aberrations	$\pm 1\%$ into ≤ 20 pf > 500 ns after square-wave transitions.
Symmetry	Duration of high portion of output cycle is 50% $\pm 0.5\%$ of output period.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
External Connectors (cont)	
CALIBRATOR (cont)	
Fast Rise Mode	
Output Voltage Swing	≥0.5 V into open circuit with baseline at 0 V ±0.1 V.
Output Resistance	50 Ω ±5%.
Transition Time (+Slope)	≤2 ns into 50 Ω.
P-P Aberrations	≤20% into 50 Ω.
Frequencies	100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz; ±0.2%.
Counter/Timer Signal Inputs	
COUNTER REF CLOCK In/Out	
Connector Type	Female bnc. Serves as both Clock In and Clock Out.
Clock In	A center frequency of 10 MHz. 0 dBm (0.63 V p-p) signal may be applied to the bnc when an external source is used, such as the Counter/Timer reference.
Clock Out	A 10 MHz TTL compatible signal is available when the internal time base is used as the time reference for the Counter. The TTL output level is in series with 50 ohms.

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
External Connectors (cont)	
Counter/Timer Signal Inputs (cont) EXTERNAL COUNTER INPUTS A & B Connectors	The Counter/Timer A and B external inputs share the front-panel bnc's with the External Trigger Inputs. A buffer amplifier splits the signal for connection to the A and B trigger generators and the Counter/Timer. The Counter/Timer outputs are connected to Schmitt trigger inputs of the Counter/Timer for conversion to logic signals.
Sensitivity	+1, +5 selection applies to the External source for the Main and Dly'd trigger generators and the Counter/Timer.
Divide by 1	100 mV p-p (dc to 100 MHz) increasing to 500 mV at 500 MHz.
Divide by 5	Multiply above voltages by 5.
Counter/Timer A & B Input Noise	<5 mV rms.
Counter/Timer External Trigger Level Readout Range	
Divide by 1	±0.5 Volt.
Divide by 5	±2.5 Volts.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements	
External Connectors (cont)		
Counter/Timer Signal Inputs (cont)		
Counter/Timer External Level Accuracy	For signals with transition times of ≥ 10 ns.	
Divide by 1 (Signal Amplitude within ± 1 V)	Within $\pm 3\%$ of setting +4% of p-p signal + 10 mV + (0.5 mV times passive probe attenuation factor)].	
Divide by 5 (Signal Amplitude within ± 5 V)	Within $\pm 3\%$ of setting +4% of p-p signal + 50 mV + (0.5 mV times passive probe attenuation factor)].	
Counter/Timer External Slope Selection	Conforms to the input signal waveform.	
RS-232-C (DCE)		
Connector Type	25 pin "D" type female connector configured as DCE (Data Communications Equipment).	
Connector Pin Assignments	Pin	Name
	1	Protective Ground (PGNO)
	2	Transmitted Data (TxD)
	3	Received Data (RxD)
	4	Request to Send (RTS)
	5	Clear to Send (CTS)
	6	Data Set Ready (DSR)
	7	Signal Ground (SGND)
	8	Data Carrier Detect (DCD)
	20	Data Terminal Ready (DTR)
	Configured as DCE.	
	Name	Direction
	PGNO	N/A
	TxD	to DCE
	RxD	from DCE
	RTS	to DCE
	CTS	from DCE
	DSR	from DCE
	SGND	N/A
	DCD	from DCE
	DTR	to DCE

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
External Connectors (cont)	
IEEE-488 (GPIB)	
Connector Type	24 pin female connector for connecting instrument to GPIB. Meets specification IEEE-488-1978.
TRIGGER READY OUTPUT	Single sequence armed indication.
Connector Type	Female bnc.
Low Level	Output between 0 V and +0.5 V. Maximum current sink is 8 mA.
High Level	Output between +2.4 V and +5.0 V. Maximum current sourcing is 0.4 mA.
TRIGGER RESET INPUT	Measurements or sweeps in progress are aborted, then restarted on a high to low transition. (If in Single sequence, the sequence is also armed.)
Connector Type	Female bnc.
Input	TTL compatible.
Minimum Pulse Width	10 μ s at 50% amplitude points.
Input Voltage	0 V to +5 V (dc plus peak ac).
SWEEP GATE Output	
Connector Type	Female bnc.
Output Voltage	2.4 V to 5 V positive-going pulse, starting at 0 V to 0.5 V.
Output Drive	Will supply 400 μ A during high state; will sink 2 mA during low state.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
External Connectors (cont)	
MAIN SWEEP Output	
Connector Type	Female bnc.
Source	A horizontal sweep.
Polarity	Positive-going ramp with baseline at 0V ± 0.5 V into 1 M Ω load.
Rate of rise	
Into 50 Ω Load	25 mV/unit of time, set by the time base Time/div control, within 15%; 100 ns/div maximum.
Into 1 M Ω Load	0.5 V/unit of time, set by the time base Time/div control, within 10%; 1 μ s/div maximum.
Output Resistance	950 Ω \pm 10%.
Z-AXIS Input	
Connector Type	Female bnc.
Sensitivity	Positive voltage decreases intensity. +3 V blanks a maximum intensity trace. +3 V, dc to 15 MHz, modulates a normal intensity trace.
Input Resistance	6 k Ω \pm 10%.
Maximum Input Voltage	± 25 V peak. 25 V p-p ac at ≤ 10 kHz.
Propagation Delay	From input transition to On/Off ≤ 50 ns.

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
External Connectors (cont)	
LEFT VERTICAL OUT	
Connector Type	Female bnc.
Source	Display channel of left plug-in unit.
Output Voltage	100 mV/div $\pm 10\%$ into 1 M Ω . 50 mV/div $\pm 10\%$ into 50 Ω .
Offset	± 150 mV into 1 M Ω with no input at plug-in interface.
Bandwidth (Mainframe Only)	Dc to 100 MHz.
Output Impedance	50 $\Omega \pm 10\%$.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Horizontal Deflection System	
Main Sweep Time-Base Range	1.5 s/div to 5 ns/div. 10X Mag extends maximum sweep rate to 0.5 ns/div.
Dly'd Sweep Time-Base Range	0.6 s/div to 5 ns/div. 10X Mag extends maximum sweep rate to 0.5 ns/div.
Main and Dly'd Sweep Accuracy	Measured centered vertically on the graticule. Time/div in any coarse or fine setting.
Unmagnified	
+15° C to +35° C	
1.5 s/div to 10 ns/div or 5 ns/div	±(0.7% of time interval plus 0.6% of full scale).
9.95 ns/div to 5.05 ns/div (fine settings)	±(2.4% of time interval plus 0.6% of full scale).
0° C ≤ T ≤ 15° C or 35° C < T ≤ 50° C	
1.5 s/div to 5 ns/div	Add 0.5% of time interval to 15° C to 35° C tolerance.
Magnified	
+15° C to +35° C	
150 ms/div to 2 ns/div	±(1.2% of time interval plus 0.6% of full scale).
1 ns/div or 500 ps/div	±(1.7% of time interval plus 0.6% of full scale).
1.99 ns/div to 505 ps/div (fine settings)	±(3.8% of time interval plus 0.7% of full scale).

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Horizontal Deflection System (cont)	
Main and Dly'd Sweep Accuracy (cont)	
Magnified (cont)	
$0^{\circ} \text{ C} \leq T < 15^{\circ} \text{ C}$ or $35^{\circ} \text{ C} < T \leq 50^{\circ} \text{ C}$	
150 ms/div to 2 ns/div	Add 0.5% of time interval to 15° C to 35° C tolerance.
1.99 ns/div to 500 ps/div	Add 0.75% of time interval to 15° C to 35° C tolerance.
Time/div in FINE Position	Continuously variable and calibrated between Time/div settings. Extends slowest Main sweep speed to 1.5 s/div, slowest Dly'd sweep speed to 0.6 s/div. Fine increments are 1% of next faster coarse setting. For example, a setting between 2 and 5 μs would be in 20 μs increments from 5 μs to 2 μs .
10X Mag Registration	Within 0.4 div from graticule center at 1 ms Time/div setting (10X Mag On to 10X Mag Off).
HORIZONTAL POSition Range	Start of 1 ms/div sweep can be positioned from right of graticule center to at least 10 div left of graticule center. Some portion of the 1 ms/div sweep is always visible with 10X Mag Off.
Sweep Length	10 divisions minimum.
Match of Δ Horiz Cursor readout to crt graticule with cursors set to +4 div and -4 div at center horizontal graticule line.	± 0.05 div.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Horizontal Deflection System (cont)	
Numeric Range of Δ Horiz Cursors	± 10 times the Time/div setting.
Delta-Time Measurement Using Cursors	
Unmagnified	
+15° C to +35° C	
1.5 s/div to 10 ns/div or 5 ns/div	$\pm(0.5\%$ of time interval plus 0.3% of full scale).
9.95 ns/div to 5.05 ns/div (fine settings)	$\pm(2.2\%$ of time interval plus 0.5% of full scale).
0° C \leq T \leq 15° C or 35° C < T \leq 50° C	
1.5 s/div to 5 ns/div	Add 0.5% of time interval to 15° C to 35° C tolerance.
Magnified	
+15° C to +35° C	Exclude first and last four divisions of sweep.
150 ms/div to 2 ns/div	$\pm(1.0\%$ of time interval plus 0.3% of full scale).
1 ns/div or 500 ps/div	$\pm(1.4\%$ of time interval plus 0.5% of full scale).
1.99 ns/div to 505 ps/div (fine settings)	$\pm(3.6\%$ of time interval plus 0.6% of full scale).
0° C \leq T < 15° C or 35° C < T \leq 50° C	
150 ms/div to 2 ns/div	Add 0.5% of time interval to 15° C to 35° C tolerance.
1.99 ns/div to 500 ps/div	Add 0.75% of time interval to 15° C to 35° C tolerance.

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Horizontal Deflection System (cont)	
Delta-Time Delay Using Delayed Sweep with both Delays set $\geq 2\%$ of Full Scale from Minimum Delay	
Accuracy	
Main Time/div ≤ 0.1 sec	
+15° C to +35° C	$\pm(0.3\%$ of time interval plus 0.1% of full scale).
0° C \leq T < 15° or 35° C < T \leq 50° C	$\pm(0.5\%$ of time interval plus 0.1% of full scale).
Main Time/div 0.5 sec and 0.2 sec	
+15° C to +35° C	$\pm(0.8\%$ of time interval plus 0.1% of full scale).
0° C \leq T < 15° or 35° C < T \leq 50° C	$\pm(1.3\%$ of time interval plus 0.1% of full scale).
Resolution	0.005% of full scale.
Range	± 10 times the Main Time/div setting.
Delay Accuracy of two different delay settings $\geq 1\%$ of full scale using one delayed sweep	$\pm(0.3\%$ of delay setting plus 0.6% of full scale).
Delay Jitter	Within 0.005% (one part or less in 20,000) of full scale plus 100 ps.
Delay-Time Range	0 to 10.0 times the Main Time/div setting. The main sweep triggering event is observable on the delayed sweep when delay is set to zero in Runs After Delay mode.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Horizontal Deflection System (cont)	
XY Operation Mainframe Only	
Numeric Position Range	± 4.0 times Size/div setting.
Visual Position Range	At least ± 3.9 div.
X-Axis Deflection Accuracy for Mainframe Only, CENTER and RIGHT Compartments	Compatible with 11000-Series Plug-in units.
X-Axis Low Frequency Linearity for CENTER & RIGHT Compartments	0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned within the display area.
X-Axis Bandwidth for CENTER and RIGHT Compartments	Dc to 3 MHz. Checked using a standard plug-in with a bandwidth of dc to >100 MHz.
CENTER Compartment Phase Difference between X and Y Axes	$\leq 1^\circ$ from dc to 1 MHz; $\leq 3^\circ$ from 1 MHz to 2 MHz. Checked using a standard plug-in with a bandwidth of dc to >100 MHz.
CENTER Compartment Horiz Accuracy Using Cursors (XY Operation)	Refer to System Specification Section (page 4-42) under the category "Horizontal Deflection Accuracy (XY) of Center Plug-In".

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Holdoff	
Time Range	
Minimum	Main Time/div multiple of 1 or 2; greater of 1.25 x Time/div or 3.5 μ s. Main Time/div multiple of 5; greater of 2.5 x Time/div or 3.5 μ s.
Maximum	At least 20 x minimum.
2 ns Step	
Minimum Range	See "Minimum Holdoff for 2 ns Step, Countdown, and Events" that follows.
Maximum Range	>0.99 sec.
Resolution	1.8 ns.
Countdown	
Minimum Range	See "Minimum Holdoff for 2 ns Step, Countdown, and Events" that follows.
Maximum Event Frequency	100 MHz.
Main Swp Start Jitter	400 ps.
Holdoff by Events	
Minimum Number of Events	2.
Maximum Number of Events	>500,000.
Maximum Count Frequency	
One Start Off	500 MHz.
One Start On	100 MHz.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Holdoff (cont)	
Holdoff by Events (cont)	
Start Event to Count Event	
Main Trig to Dly Trig	
Setup Time	1 ns.
Hold Time	-1 ns.
Main Trig to CT B Ext	
Setup Time	6.5 ns.
Hold Time	-4.5 ns.
CT A Ext to Main Trig	
Setup Time	-1.5 ns.
Hold Time	3.5 ns.
A Ext to Dly1 Trig	
Setup Time	-1.5 ns.
Hold Time	3.5 ns.
CT A Ext to CT B Ext	
Setup Time	1 ns.
Hold Time	-1 ns.
Setup Time, Last Count to Main Trig	26 ns.
Main Sweep Start Jitter	
One Start On	400 ps.
One Start Off	4 ns.

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements	
Holdoff (cont)		
Minimum Holdoff Time for 2ns Step and Countdown	Main Time/div	Minimum Holdoff
	5 ns to 50 ns	3.50 μ s
	>50 ns to 100 ns	3.50 μ s
	>100 ns to 200 ns	3.50 μ s
	>200 ns to 500 ns	9.80 μ s
	>500 ns to 1 μ s	16.0 μ s
	>1 μ s to 2 μ s	30.0 μ s
	>2 μ s to 5 μ s	78.0 μ s
	>5 μ s to 10 μ s	160 μ s
	>10 μ s to 20 μ s	300 μ s
	>20 μ s to 50 μ s	780 μ s
	>50 μ s to 100 μ s	1.60 ms
	>100 μ s to 200 μ s	3.00 ms
	>200 μ s to 500 μ s	7.80 ms
	>500 μ s to 1 ms	16.0 ms
	>1 ms to 2 ms	30.0 ms
	>2 ms to 5 ms	78.0 ms
	>5 ms to 10 ms	160 ms
	>10 ms to 20 ms	300 ms
	>20 ms to 50 ms	780 ms
	>50 ms to 100 ms	1.60 s ¹
	>100 ms to 200 ms	3.00 s ¹
	>200 ms to 500 ms	7.80 s ¹
	>500 ms	20.0 s ¹

¹Applies only to Countdown .

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Triggering, Main and Dly'd	
Minimum P-P Signal Amplitude for Stable Sweep Triggering	Upper frequency limitation depends on plug-in unit. The upper frequency limits listed below apply when using an 11A71 amplifier.
High Sensitivity	
Dc Coupled	0.35 div from dc to ≤ 50 MHz; increasing to 1.0 div from >50 MHz to 500 MHz.
Ac Coupled	0.35 div from 50 Hz to ≤ 50 MHz; increasing to 1.0 div from >50 MHz to 500 MHz. Attenuates signals below 50 Hz.
HF Reject Coupled	0.50 div to 30 kHz.
LF Reject Coupled	0.50 div from 80 kHz to ≤ 50 MHz; increasing to 1.0 div from >50 MHz to 500 MHz.
Medium Sensitivity	Multiply high sensitivity requirements by 2.
Low Sensitivity	Multiply high sensitivity requirements by 3.
Minimum P-P Signal Amplitude for Stable Sweep Triggering from Composite or Multiple Channel Source	Add 1.0 div to above specifications.

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Triggering, Main and Dly'd (cont)	
Minimum P-P Signal Amplitude Required for Stable Sweep Triggering from A or B External Inputs	
High Sensitivity	
Divide by 1 Input Sensitivity	
Dc Coupled	≤ 20 mV from dc to ≤ 50 MHz; increasing to ≤ 60 mV from >50 MHz to 300 MHz; and ≤ 150 mV from >300 MHz to 500 MHz.
Ac Coupled	≤ 20 mV from 50 Hz to ≤ 50 MHz; increasing to ≤ 60 mV from >50 MHz to 300 MHz; and ≤ 150 mV from >300 MHz to 500 MHz. Attenuates signal below 50 Hz.
HF Reject Coupled	≤ 28 mV from dc to 30 kHz.
LF Reject Coupled	≤ 28 mV from 80 kHz to ≤ 50 MHz; increasing to ≤ 60 mV from >50 MHz to 300 MHz; and ≤ 150 mV from >300 MHz to 500 MHz.
Divide by 5 Input Sensitivity	Multiply above voltages by 5.
Medium Sensitivity	Multiply figures for high sensitivity by 2.
Low Sensitivity	Multiply figures for high sensitivity by 3.
Jitter	<600 ps Total (peak to peak) with 5 divisions of amplitude at 300 MHz with Time/div set to 5 ns and 10X Mag On.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Triggering, Main and Dly'd (cont)	
Triggering LEVEL Control Range	
LEFT or CENTER Plug-In	±10 times Size/div setting.
A, B External Inputs	
Divide by 1 Sensitivity	±500 mV.
Divide by 5 Sensitivity	±2.5 V.
Trigger LEVEL Readout Accuracy	
LEFT or CENTER Plug-in	Depends on plug-in unit and probe being used. See "System Accuracy Specification."
Single Plug-In Channel Signal Source	See "System Specification."
A or B External Input	For triggering signals with 10 to 90% transition times greater than 10 ns.
Divide by 1 Max Signal ±1 V	Within ±[3.0% of setting plus 4% of p-p signal plus 10 mV plus (0.5 mV times probe attenuation factor)].
Divide by 5 Max Signal ±5 V	Within ±[3.0% of setting plus 4% of p-p signal plus 50 mV plus (0.5 mV times probe attenuation factor)].
Slope Selection	Conforms to trigger-source waveform at input connector or ac power-source waveform.
P-P and Auto Mode Triggering Signal Period	≤50 ms.
Line Trigger Level Range	Sufficient to trigger at positive and negative peaks of ac power source waveform.
Trigger Noise (Mainframe only)	0.05 div rms.
Measurement Accuracy	See "System Specification."

Table 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Vertical Deflection System	
Deflection Factor	Compatible with 11A-series plug-in units.
Accuracy, with 11000-Series Plug-ins	See System Accuracy Specification tables.
Match of ΔV Cursor readout to crt graticule with Cursors set to +3 div and -3 div at center vertical graticule line.	± 0.05 div.
Numeric Range of ΔV Cursors	± 8 times the Size/div setting.
DC Accuracy Using Cursors	See System Accuracy in Specification tables.
Channel Isolation (between LEFT and CENTER plug-ins)	$\geq 100:1$ attenuation of unselected channel at ≤ 100 Mhz; $\geq 50:1$ at ≤ 300 MHz, for an 8 div input signal.
Delay Between Channels (display only)	1.0 ns range of adjustment.
Low-Frequency Linearity	0.1 div or less compression or expansion of a 2 div, center-screen signal when positioned anywhere within the graticule area.
Vertical Signal Delay	
≥ 10 ns/div unmagnified or ≥ 1 ns/div magnified	At least 30 ns of the sweep is displayable before the triggering event is displayed.
5 ns/div to 9.95 ns/div unmagnified or 500 ps/div to 995 ps/div magnified	At least 15 ns of the sweep is displayable before the triggering event is displayed. Test plug-in must have ± 100 ps match between vertical and trigger signal outputs.

TABLE 4-1 (cont)
Electrical Specification

Characteristics	Performance Requirements
Vertical Deflection System (cont)	
Chopped Mode Switching Rate	<p>Vertical display switches sequentially through the selected channels at the chop switching rate. The chop switching rate is 1 MHz \pm10.0% (dual channel switching rate is 500 kHz \pm10.0%).</p> <p>The chop switching rate is asynchronous to the sweep frequency, to minimize waveform breaks when viewing repetitive signals.</p>
Vertical Trace Visual Positioning Range	<p>At least \pm3.9 divisions.</p> <p>Plug-in signal is applied to exactly center trace when position readout is equal to zero.</p>
Vertical Trace Positioning Numeric Range	\pm 4.0 divisions.

Environmental Characteristics

TABLE 4-2
Environmental Characteristics

The test result is highly dependent on procedure. For customer verification of environmental performance, refer to the listed government/industry document for test methods. Tektronix internal verification procedures are in some cases more stringent than contained in the listed standards. Tektronix standards may be proved to customers on request.

Under MIL-T-28800, the instrument is classified as Type III, Class 5, Style E. Only those requirements from MIL-T-28800 that are listed apply.

"Nonoperating" means the PRINCIPAL POWER SWITCH on the rear panel of the instrument is set to OFF, or the power cord is disconnected.

Characteristics	Information
Temperature	
Operating	0° C to +50° C.
Storage	-40° C to +75° C.
Humidity	
Operating and Storage	5 days, per MIL-T-28800C, Type III, Class 5.
Altitude	
Operating	To 4.57 km (15,000 feet).
Storage	To 15.18 km (50,000 feet).
Vibration	
Operating and Nonoperating	Tested to MIL-T-28800C, SECT. 4.5.5.3.1, Type III, Class 5.
Shock	
Nonoperating	Tested to MIL-T-28800C, SECT. 4.5.5.4.1, Type III, Class 5.
Bench Handling	
Operating	Tested to MIL-T-28800C, SECT. 4.5.5.4.3, Type III, Class 5.

**TABLE 4-2 (cont)
Environmental Characteristics**

Characteristics	Information
Transportation	
Vibration and Bounce of packaged product	Meets ASTM D999-75, Method A, Paragraph 3.1, (NSTA Project 1A-B-1).
Drop of Packaged Product	Meets ASTM D775-61, Method 1, Paragraph 5. (NSTA, Project 1A-B-2).
Electromagnetic Immunity	
Operating	0-15 kV with no performance degradation. 0-20 kV with no instrument damage.
Electromagnetic Compatibility	
United States	Tested to MIL-T-28800C; MIL-STD-461B; FCC Part 15, Subpart J, Class B; VDE 0871, Class B; CE-01, Part 4 (with exceptions); CE-03, Part 4, Curve 1; CE-03, Part 4, Curve 4, Navy, NB, BB (with exceptions); CS-01, Part 7; CS-02, Part 4 (with exceptions); CS-06, Part 5; RE-01, Part 4 (with exceptions); RE-02, Part 4; RS-01, Part 4; RS-03, Part 7, (limited to 1 GHz).
United States FCC	Part 15, Subpart J, Class A.
Germany	Tested to VDE 0871/6.78, Class B.

Physical Characteristics

TABLE 4-3
Physical Characteristics

Characteristics	Information
Weight	
11301	198 nt (44 lbs) without plug-ins.
11302	196 nt (44 lbs) without plug-ins.
Mass	
11301	20.24 kg (1.39 slug) without plug-ins.
11302	19.96 kg (1.37 slug) without plug-ins.
Shipping Weight/Mass	
Domestic	266 nt (59.8 lbs). 27.13 kg (1.87 slug).
Cooling	Forced-air circulation using a variable speed (based on temperature) exhaust fan. All plug-in compartments must be filled. For unused compartments, install a blank plug-in unit (Tektronix Part No. 016-0829-00).
Finish	Blue painted aluminum cabinet.
Construction	Aluminum-alloy chassis (sheet metal). Die-cast aluminum front and rear subpanel. Glass-laminate circuit boards.

Dimensional Drawings

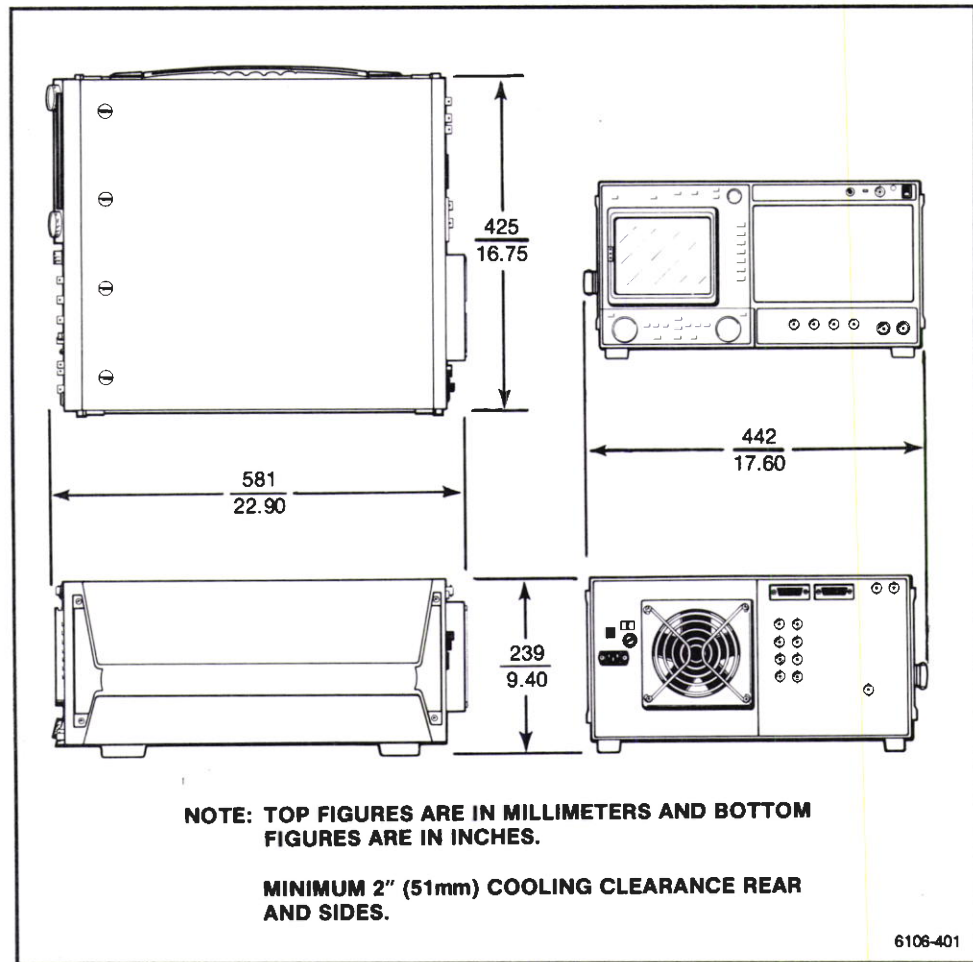


Figure 4-1. Bench Model.

The same outside dimensions apply to the 11302 Oscilloscope.

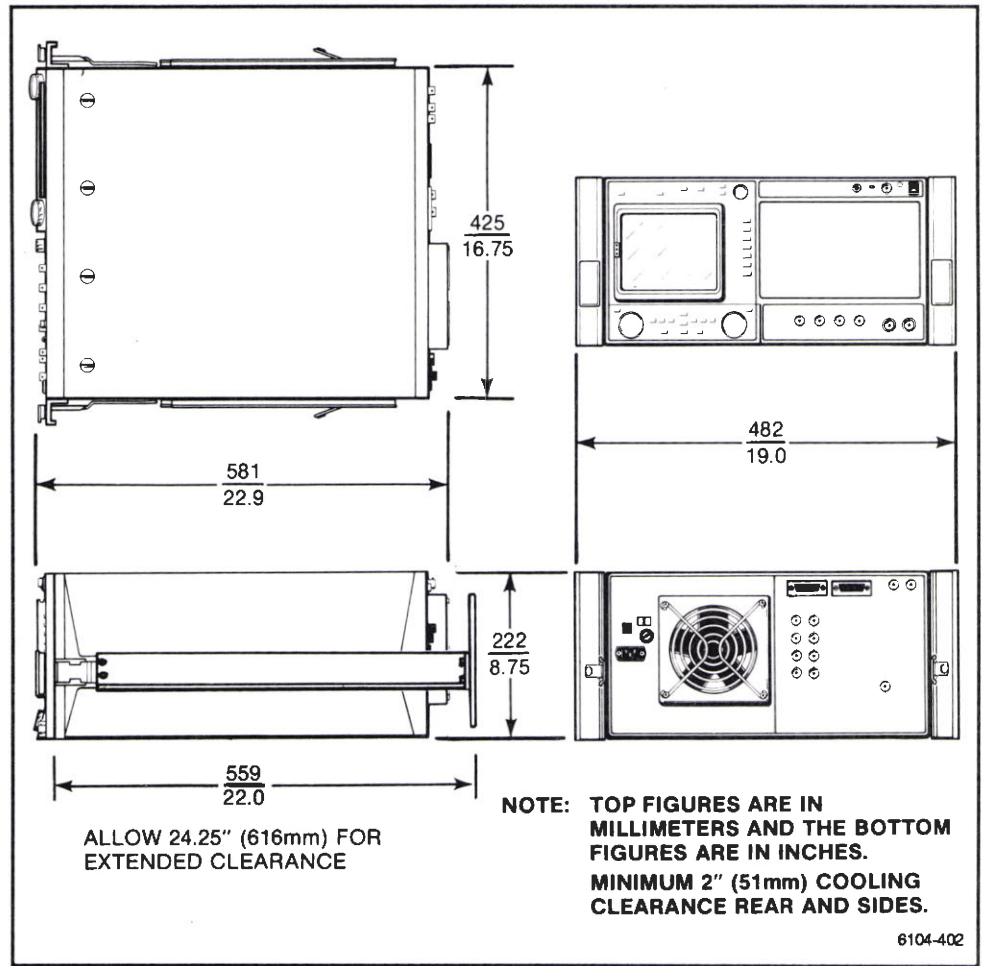


Figure 4-2. Rackmount Model.

The same outside dimensions apply to the 11302 Oscilloscope.

System Specification

The plug-in bandwidth may be restricted depending upon which 11000-Series mainframe it is installed in. Check Table 4-8 find the system bandwidth for the plug-in and mainframe combination you wish to use.

Vertical Bandwidth

TABLE 4-4
System Bandwidth and Rise Time

Specified System Bandwidth (0 to 35° C)
Rise Time Cal, 0.35/BW

Plug-in	Deflection Factor	11301	11302
11A71	all V/div	400 MHz 0.9 ns	500 MHz 0.7 ns
11A52	≥10 mV/div	350 MHz 1.0 ns	400 Mhz 0.9 ns
	5 mV to 9.95 mV/div	300 Mhz 1.2 ns	350 MHz 1.0 ns
	2 mV to 4.98 mV/div	250 MHz 1.4 ns	250 Mhz 1.4 ns
	1 mV to 1.99 mV/div	200 Mhz 1.8 ns	200 MHz 1.8 ns
11A32	≥10 mV/div	300 MHz 1.2 ns	350 MHz 1.0 ns
	5 mV to 9.95 mV/div	250 MHz 1.4 ns	250 MHz 1.4 ns
	2 mV to 4.98 mV/div	200 MHz 1.8 ns	200 MHz 1.8 ns
	1 mV to 1.99 mV/div	200 MHz 1.8 ns	200 MHz 1.8 ns
11A34	≥10 mV/div	250 MHz 1.4 ns	250 MHz 1.4 ns
	5 mV to 9.95 mV/div	200 MHz 1.8 ns	250 MHz 1.4 ns
	2 mV to 4.98 mV/div	200 MHz 1.8 ns	200 MHz 1.8 ns
	1 mV to 1.99 mV/div	150 MHz 2.3 ns	150 MHz 2.3 ns

Dc Vertical Accuracy Using Cursors

TABLE 4-5
Accuracy with 11A71 Amplifier

11A71 with the 11301/11302 Mainframes.
Accuracy of On Screen Cursor Readings with position set to 0.00

Enhanced Accuracies Without Probes

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
10 mV/div to 1 V/div	$\pm(0.9\% + 0.05 \text{ div})$	$\pm 0.2 \text{ div}$	$\pm(0.4\% + 0.01 \text{ div})$

Enhanced Accuracies With P6231 450- Ω Bias/Offset 10X Active Probe

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
100 mV/div to 1 V/div	$\pm(1.6\% + 0.05 \text{ div})$	$\pm 0.2 \text{ div}$	$\pm(0.15\% + 3.8 \text{ mV})$
Probe Tip TC terms	100 ppm/DegC		

TABLE 4-6
Accuracy with 11A52 Two Channel Amplifier

11A52 with the 11301/11302 Mainframes (with on screen cursors).

Enhanced Accuracies Without Probes

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
1 mV/div to 99.5 mV/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(0.2 \text{ mV} + 0.13 \text{ div})$	$\pm 0.15\% + 0.75 \text{ mV}$
100 mV/div to 995 mV/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(2 \text{ mV} + 0.13 \text{ div})$	$\pm(0.20\% + 7.5 \text{ mV})$
1 V/div to 10V/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(20 \text{ mV} + 0.13 \text{ div})$	$\pm(0.20\% + 75 \text{ mV})$

Enhanced Accuracies With P6231 450- Ω Bias/Offset 10X Active Probe

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
10 mV/div to 995 mV/div	$\pm(1.1\% + 0.04 \text{ div})$	$\pm(2 \text{ mV} + 0.13 \text{ div})$	$\pm(0.15\% + 3.8 \text{ mV})$
$\geq 1 \text{ V/div}$	$\pm(1.7\% + 0.04 \text{ div})$	$\pm(20 \text{ mV} + 0.13 \text{ div})$	$\pm(0.15\% + 3.8 \text{ mV})$
Probe Tip TC terms -	100 ppm/Deg C		

TABLE 4-7
Accuracy with 11A32 Two Channel Amplifier
and 11A34 Four Channel Amplifier

11A32/11A34 Plug Ins with the 11301/11302 Mainframes (with on screen cursors).

Enhanced Accuracies Without Probes

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
1 mV/div to 99.5 mV/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(1.0 \text{ mV} + 0.13 \text{ div})$	$\pm 0.2\% + 0.8 \text{ mV}$
100 mV/div to 995 mV/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(10 \text{ mV} + 0.13 \text{ div})$	$\pm 0.25\% + 8 \text{ mV}$
1 V/div to 10 V/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(100 \text{ mV} + 0.13 \text{ div})$	$\pm 0.25\% + 80 \text{ mV}$

Enhanced Accuracies with P6134 10-M Ω Passive 10X Probe

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
10 mV/div to 995 mV/div	$\pm(1.0\% + 0.04 \text{ div})$	$\pm(12 \text{ mV} + 0.13 \text{ div})$	$\pm(0.25\% + 8 \text{ mV})$
1 V/div to 9.95 V/div	$\pm(1.5\% + 0.04 \text{ div})$	$\pm(120 \text{ mV} + 0.13 \text{ div})$	$\pm(0.75\% + 80 \text{ mV})$
10 V/div to 100V/div	$\pm(1.5\% + 0.04 \text{ div})$	$\pm(1.2 \text{ V} + 0.13 \text{ div})$	$\pm(0.75\% + 0.8 \text{ V})$
Probe Tip TC terms	100 ppm/Deg C		

Enhanced Accuracies With P6231 450- Ω Bias/Offset 10X Active Probe

Deflection Factor	Delta-V DC Accuracy	DC Balance	DC Offset Accuracy
10 mV/div to 995 mV/div	$\pm(1.1\% + 0.04 \text{ div})$	$\pm(10 \text{ mV} + 0.13 \text{ div})$	$\pm(0.2\% + 3.8 \text{ mV})$
$\geq 1 \text{ V/div}$	$\pm(1.1\% + 0.04 \text{ div})$	$\pm(100 \text{ mV} + 0.13 \text{ div})$	$\pm(0.2\% + 3.8 \text{ mV})$
Probe Tip TC terms	100 ppm/DegC		

**Horizontal
Deflection
Accuracy (XY) of
Center Plug-in**

Horizontal deflection dc accuracy using cursors from the center plug-in depends on the plug-in and probe in use. For a single plug-in channel signal source with Dc coupling, calculate the allowed tolerance using the terms for the vertical system with the following modifications: add 0.5% to the "Delta-V DC Accuracy" term and add 0.1 div to the "DC Balance" term.

Measurement Accuracy

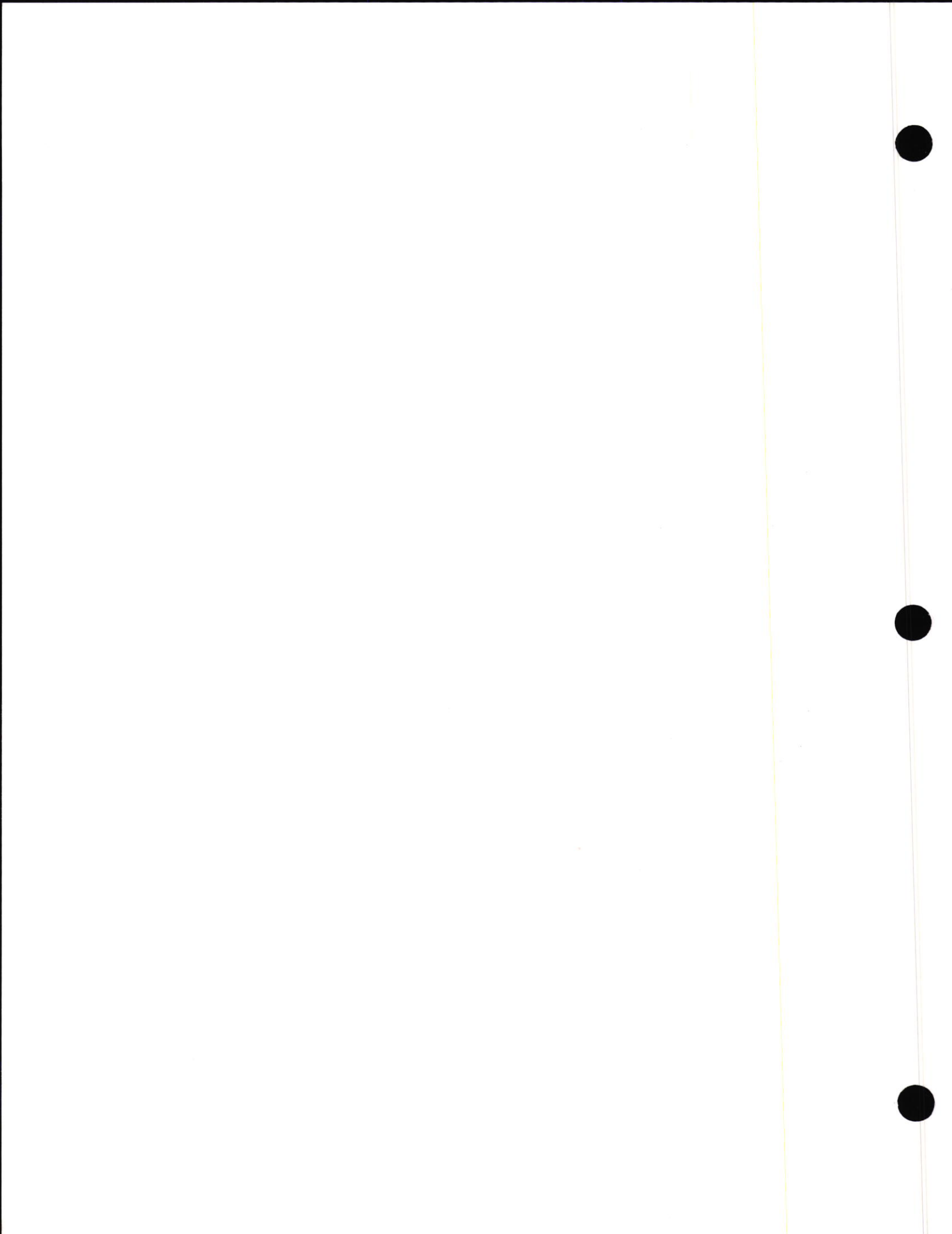
Measurement accuracy depends on plug-in and probe use, using a single plug-in channel and signals with amplitudes of $\leq \pm 8$ divisions of relative to the plug-in offset and with a rise time of >10 times the system rise time, and dc input coupling.

For the MIN or MAX measurement, calculate the ground-referenced accuracy of the Vertical system; add 3% and 0.1 div to the Delta-V DC term, where delta-V is the MIN or MAX value minus the amplifier offset; add 0.4 div to the DC Balance term; and add peak noise in divs.

For the P-P measurement, calculate the differential accuracy of the vertical system; add 3% and 0.4 div to the Delta-V DC term, where delta-V is the p-p voltage; and add p-p noise in divs.

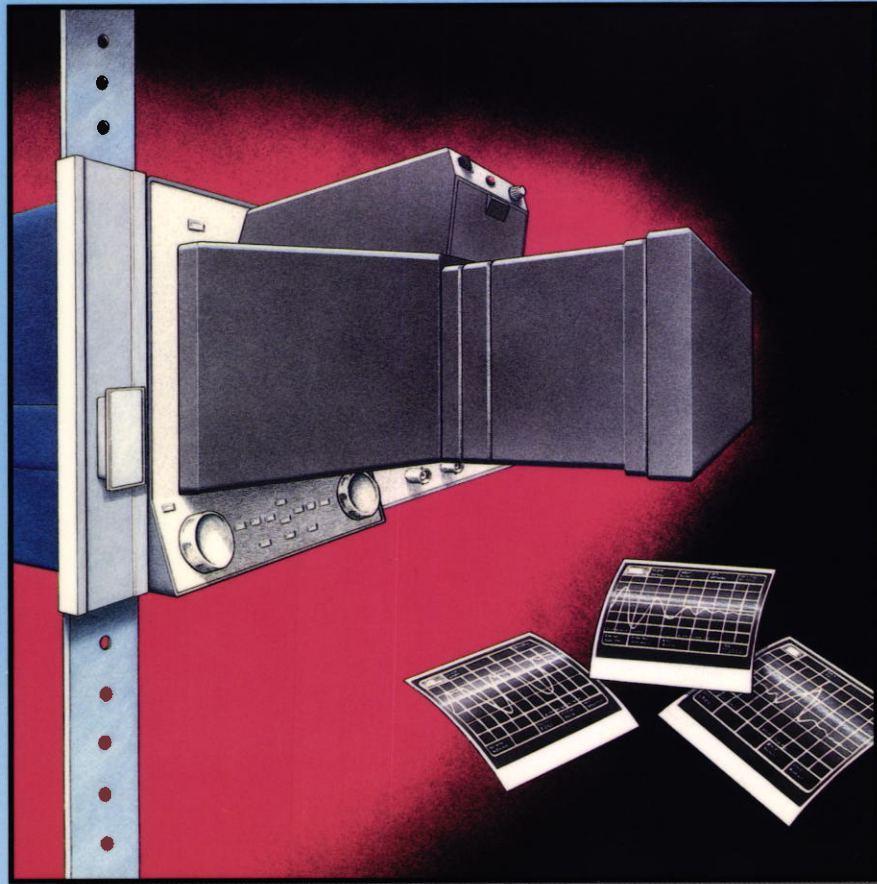
Trigger Level Readout Accuracy

Trigger level readout dc accuracy depends on the plug-in and probe in use. For a single plug-in channel signal source with Dc coupling, calculate the ground-referenced accuracy using the terms for the vertical system with the following modifications: add 2% to the "Delta-V DC Accuracy" term, where delta-V is the (Level readout – Amplifier offset) divided by Volts/div; add 0.3 div to the "DC Balance" term; add peak noise in divs.



Section 5

Instrument Options





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Instrument Options

Your instrument may be equipped with one or more instrument options. A brief description of each available option is given in the following discussion. Option information is incorporated into the appropriate sections of the manual. Refer to Table 5-1 and the Table of Contents for location of option information. For further information on instrument options, see your Tektronix Products catalog or contact your Tektronix Field Office.

WARNING

To avoid electric shock hazard, operating personnel must not remove the protective instrument covers. Component replacement and internal adjustments must be made by qualified service personnel only.

Instrument Option Identification

- | | |
|------------------|---|
| Option 1C | Option 1C adds 8 bnc connectors to the front- and rear-panels so that signals may be internally routed directly between the two panels. This is especially useful for rackmounted applications. This option can be added at any time. |
| Option 1R | Option 1R adds side rails and rackmounting hardware to convert the benchtop instrument to a standard 19-inch rackmount version. This option can be added at any time. |
| Option 1T | Option 1T provides a high-stability time base for the Counter Timer. This option can be added at any time. |
| Option A1 | The standard power cord is replaced with the Universal European 220-volt type power cord. |
| Option A2 | The standard power cord is replaced with the United Kingdom 240-volt type power cord. |
| Option A3 | The standard power cord is replaced with the Australian 240-volt type power cord. |
| Option A4 | The standard power cord is replaced with the North American 250-volt type power cord. |
| Option A5 | The standard power cord is replaced with the Switzerland 240-volt type power cord. |

TABLE 5-1
Option Information Locator

Option	Location in Manual		Information
	Section	Heading	
Option 1C (Provides front to rear bnc connectors)	5 Instrument Options	Option 1C	Gives a brief description of Option 1C
Option 1R (Provides rack-mount hardware)	5 Instrument Options	Option 1R	Gives a brief description of Option 1R.
Option 1T (Provides high-stability time base)	5 Instrument Options	Option 1T	Gives a brief description of Option 1T.
A1 Option (Provides Universal European power cord)	1 Installation	Power-Cord and Plug Identification Table 1-2	Lists details of Option A1.
	5 Instrument Options	Option A1	Gives a brief description of Option A1.
A2 Option (Provides United Kingdom power cord)	1 Installation	Power-Cord and Plug Identification Table 1-2	Lists details of Option A2.
	5 Instrument Options	Option A2	Gives a brief description of Option A2.
A3 Option (Provides Australian power cord)	1 Installation	Power Cord and Plug Identification Table 1-2	Lists details of Option A3.
	5 Instrument Options	Option A3	Gives a brief description of Option A3.

TABLE 5-1 (cont)
Option Information Locator

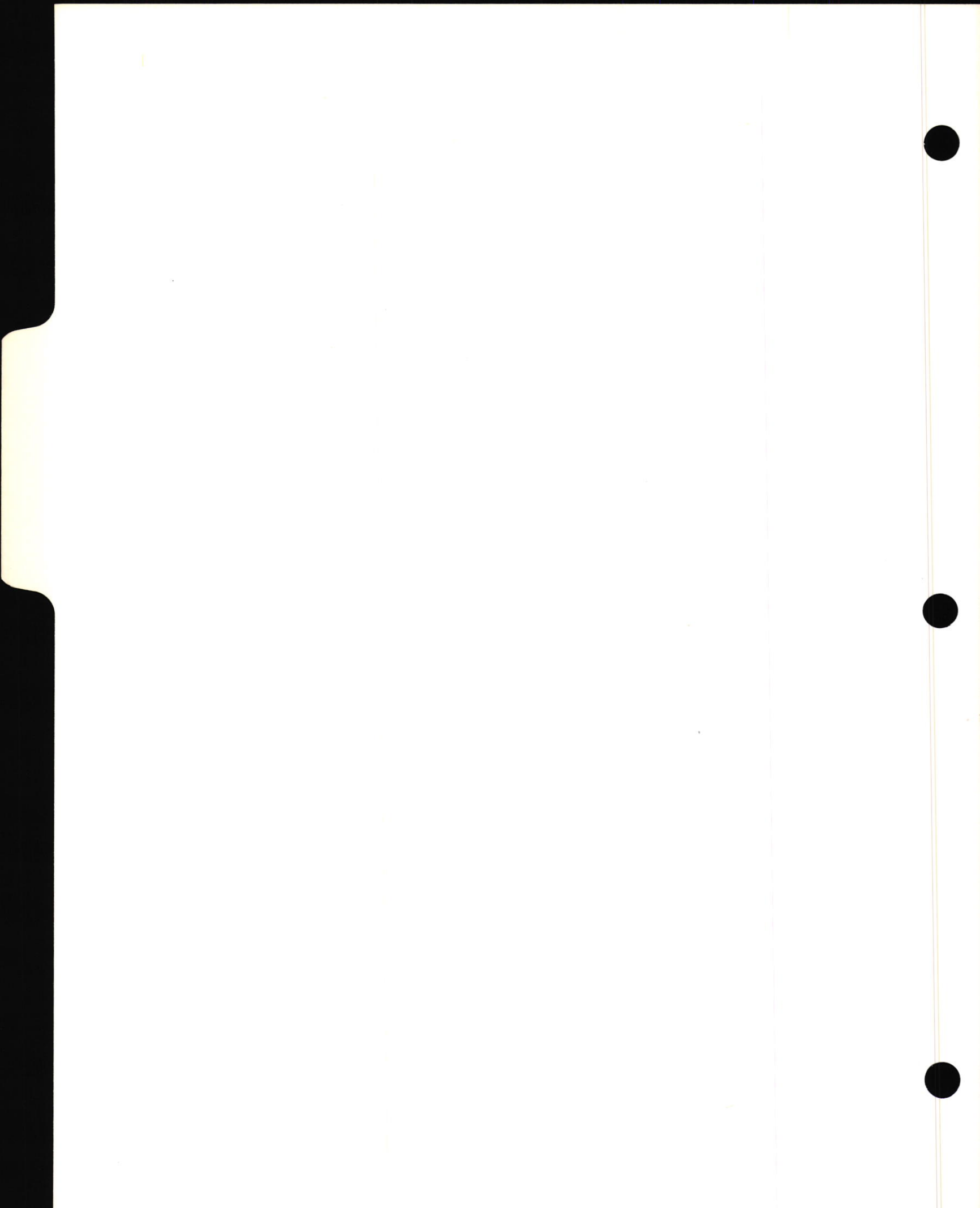
Option	Location in Manual		Information
	Section	Heading	
A4 Option (Provides North American power cord)	1 Installation	Power-Cord and Plug Identification Table 1-2	Lists details of Option A4.
	5 Instrument Options	Option A4	Gives a brief description of Option A4.



Section 6

Plug-In Unit Information





Plug-In Unit Information

Insert your Plug-in User's Reference Supplement(s) here.

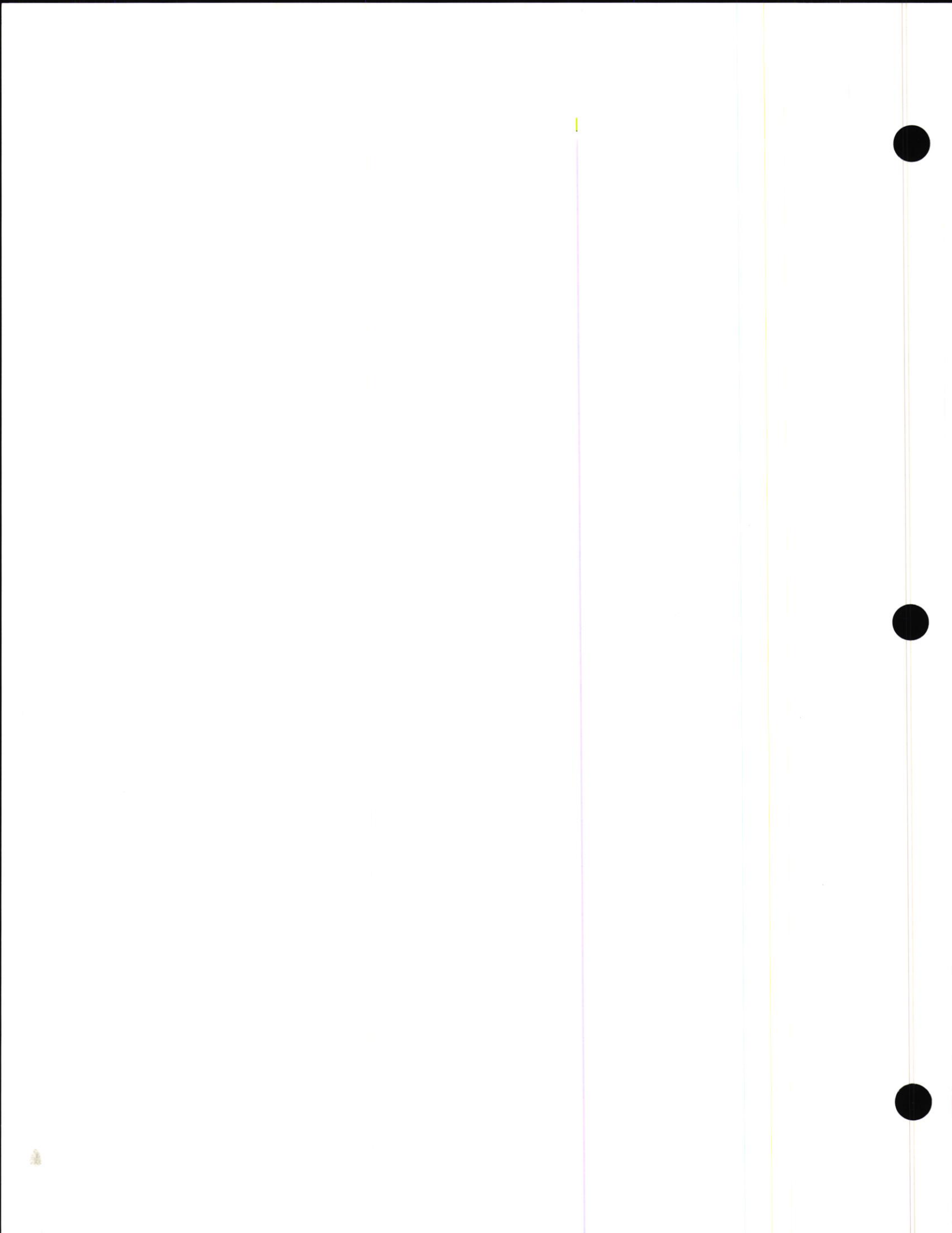


Appendices



Appendix A—Glossary

D1 (or 2)	An alternate abbreviation for Dly1 (or 2) used in the trace descriptions.
Deflection factor	The ratio of input signal to response in the 11000-Series system. The reciprocal of sensitivity.
Display on/off button	The front-panel plug-in button that designates a channel for display, or removes a channel from the display.
Dly1 (or 2)	Indicates the delay reference number one (or two) and window number one (or two).
Duty	The duty factor of the signal is a percent of its period; $Duty = 100 (Wid/Per)$.
Freq	The fundamental frequency of the signal as measured by its crossing the reference level.
Main	An abbreviation for Main time base.
Mainframe	Any 11000-Series oscilloscope.
Max	The most positive amplitude value; its maximum.
Mid	The middle value; halfway between the maximum and the minimum value of the signal. That is, the time between the first positive slope and first following negative slope of the signal; pulse width.
Min	The most negative amplitude value; its minimum.
Offset	A control that allows the you to subtract a precision voltage from the input signal to vary the position of the displayed signal.
ON/STANDBY	The front-panel power control on 11000-series mainframes. When set to ON, applies operating power to all circuits. When set to STANDBY, the mainframe dc power supply furnishes power to the counter/timer crystal oven (Option 1T).
P-P	Peak-to-peak amplitude as given by the difference from the minimum value of the signal to its maximum value.
Parent Trace	The main trace from which a window is derived.
Per	The inverse of frequency: $Per (period) = 1/Freq$.
Sensitivity	The ratio of response to input signal in the 11000-Series system. In the 11A32, 11A34, 11A52, and 11A71, division/volts. Also called size, vertical size, and deflection factor in this manual.
Size	See Sensitivity.
Wid	The time between the first positive slope and the first following negative slope of the signal; pulse width.



Appendix B—Accessory List

Standard Accessories

The following standard accessories are included in each instrument package. To obtain replacements, refer to a Tektronix Products catalog or contact your local Tektronix Field Representative.

- Introducing the 11301 and 11302 Programmable Oscilloscopes
- 11301 and 11302 Programmable Oscilloscopes Pocket Reference manual
- 11301 and 11302 Programmable Oscilloscopes User's Reference manual
- Power Cord (North American 125 V)

Optional Accessories

These optional accessories have been selected from our catalog specifically for your instrument. They are listed as a convenience to help you meet your measurement needs. For detailed information and prices, refer to a Tektronix Products catalog or contact your local Tektronix Field Representative.

- 11301 Service Manuals:
 - Service Volume 1—Maintenance
 - Service Volume 2—Diagnostics & Troubleshooting
 - Service Volume 3—Schematics & Parts List
- 11302 Service Manuals:
 - Service Volume 1—Maintenance
 - Service Volume 2—Diagnostics & Troubleshooting
 - Service Volume 3—Schematics & Parts List
- Blank Plug-in Unit (for empty plug-in compartment)
- 2 meter GPIB cable
- 10 foot RS-232-C cable

Recommended Accessories

The accessories listed here are additions you may wish to use with your oscilloscope. For detailed information and prices, refer to a Tektronix Products catalog or contact your local Tektronix Field Representative.

- **Cameras**—C-4, C-5C, C-7, C-51¹, C-53¹, C-59¹
- **Viewing Hoods**—Nonfolding and Folding
- **Scope Cart**—Model 205
- **Probes**—P6134, P6135, P6231, P6204

NOTE: Also refer to Section 5, "Instrument Options."

¹Require Option 11 adapter lens.



Errors, Warnings, and Messages



Error and Warning Messages

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
108	no	Checksum error in binary block transfer
109	no	Incorrect byte count value on a binary block transfer
151	no	Symbol or number too long
152	no	Invalid or out-of-range input character
153	no	Invalid escape sequence
154	no	Invalid number input
155	no	Invalid string input
156	no	Unknown symbol
157	no	Syntax error An unexpected symbol or character was detected in an input statement, usually caused by missing delimiter or misspelled command.
160	no	Expression too complex
161	no	Too many binary points
162	no	Too many ASCII points
165	no	Numerical overflow A number was received which was too large to express in IEEE double-precision format.
166	no	Numerical underflow A number was received which was too small to express in IEEE double-precision format.
167	no	Function not available to External Port
168	yes	Incomplete trigger expression, aborted
203	no	I/O buffers full, output flushed Input and output are deadlocked.
205	no	Argument is not executable A value was received which could not be used for the requested setting. Rather than choosing the nearest setting, the oscilloscope ignored it.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
206	yes	Signal amplitude too small The Autoset process could not find sufficient amplifier sensitivity to display the signal properly.
207	yes	Signal amplitude too large The Autoset process could not decrease the amplifier sensitivity to display the signal properly.
208	yes	Vertical signal not found The Autoset process could not find any triggerable signal.
209	yes	Horizontal signal not found The Autoset process could not measure the timing characteristics of the signal.
210	yes	Cannot autoset, trace not available Autoset was requested for a trace which does not exist.
211	yes	Cannot autoset this type of trace An attempt was made to autoset a trace which cannot be manipulated, such as a stored waveform or a counter view trace.
212	yes	Cannot autoset with empty slots Autoset was requested on a trace which represents an empty compartment or a plug-in which is not an 11000-series unit.
213	no	Cannot autoset, channel not available Autoset was requested for a channel which does not exist, such as channel 4 of a two-channel amplifier.
214	yes	Autoset is disabled An attempt to autoset was made while the Autoset parameters found in the UTILITY menu were turned off.
224	no	Function not available in selected plugin range The command just requested cannot be executed due to the current plug-in settings. Most commonly this is due to attempting probe calibration with the 11A33 set at 1 G Ω impedance.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
225	yes	Delayed trigger source #1 has been changed A new Main Trigger source was selected which conflicted with the present Dly1 Trigger source. The Dly1 source was changed to be the same as the Main trigger source to resolve the conflict.
226	yes	Channel is not displayed A channel which cannot be displayed was selected for control by pressing its probe ID or display on/off button.
231	yes	DLY1 or DLY2 required to view intensified zones No intensified zones (delayed windows) were present while adjusting Δ Main, which controls the contrast between the main trace and its intensified zone(s).
232	no	Invalid trigger source description An attempt was made to create a semantically illegal trigger description.
233	no	Invalid trace description An attempt was made to create a semantically illegal trace description.
234	yes	Cannot measure counter view or reference traces An attempt was made to measure a counter view or stored waveform trace using the AUTOMEASURE START command or the MEASURE major menu.
235	yes	Measurement list is empty An attempt was made to measure without any measurements selected.
236	yes	Enhanced Accuracy available after warmup in %a min An attempt to execute self-calibration was made before the oscilloscope reached thermal stability. The typical warmup time is 20 minutes.
243	no	Function disabled by hardware strap
250	no	No trace currently defined An attempt was made to perform measurements without a trace present by using the AUTOMEASURE START command or the MEASURE major menu.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
259	no	Illegal number of points designator An illegal byte-count in a binary waveform transmission was received.
263	no	Illegal channel specified An attempt was made, using the ABSTOUCH command, to access an amplifier channel which did not exist.
265	no	Illegal date/time argument The string sent to represent the date or time setting was incorrect.
267	no	Query response too long, truncated
272	no	Function not supported by plugin An attempt was made to access a plug-in function which did not exist, such as MINUSCOUPLING for a single-ended channel.
277	yes	Maximum number of traces already defined An attempt to create more than eight traces was made.
278	no	Main and window trace numbers cannot be the same An attempt was made to define a Window trace of the same trace number as a Main trace.
279	yes	Window trace requires a main (parent) trace An attempt was made to define a window without first defining the main trace from which it could be made.
280	no	Cannot create a window from a window trace An attempt was made to define a window trace made from another window trace.
281	yes	Cannot create a window from a reference trace An attempt to define a window from a stored waveform was made.
282	no	Cannot select an undefined trace The requested trace did not exist as specified in the SELECT TRACE command or no traces existed when the SELECT TRNEXT command was received.
283	yes	Trace does not exist An attempt was made to CLEAR an undefined trace.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
284	yes	Requested coupling not available on %b%a An attempt was made to change a plug-in coupling to an invalid selection.
285	yes	Requested impedance not available on %b%a An attempt was made to change a plug-in impedance to an invalid selection.
286	yes	Delayed trigger source #2 has been changed A new Main Trigger source selection was made, which conflicted with the present Dly2 Trigger source. The Dly2 source was changed to be the same as the Main to resolve the conflict.
287	yes	Delayed trigger sources #1 and #2 have been changed A new Main Trigger source selection was made, which conflicted with the present Dly1 and Dly2 Trigger sources. The Dly sources were changed to be the same as the Main trigger to resolve the conflict.
288	yes	Stored setting buffer %%a is empty An attempt was made to Recall setting from a location which had nothing stored in it.
290	yes	0 is not a legal value for set reference An attempt was made to use zero as a cursor 100%, 0 dB, or 360 degree reference value.
291	yes	Delayed window required for Time A→B When using the counter timer to make timing measurements between sweeps, one or two delayed windows are needed.
292	yes	Start is Main Trig – One Start needs a Start Event When Holdoff by Events was used and the Start Event was set to None and One Start was changed to On, the Start Event could not remain set to None. To resolve this, the oscilloscope changed the Start Event to Main Trig.
293	yes	Count event forced to Main Trig When Holdoff by Events was used and the Count event was 2 ns and One Start was changed to On, the Count event could not remain set to 2 ns. To resolve this, the oscilloscope changed the Count event to Main Trig.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
294	yes	One Start forced to OFF When Holdoff by Events was used and One Start was set to On, and the Start Event was changed to None, One Start could not remain set to On. To resolve this, the oscilloscope changed One Start to Off.
295	no	Command cannot be executed while GPIB in RWLS
296	no	Undefined cell, ABSTOUCH not executed An attempt was made to address an undefined button with the ABSTOUCH command.
308	yes	Level 2 probe checksum error on channel %b%a An internal plug-in/probe communication failure occurred.
309	yes	%B Plugin Communication Failure There has been a breakdown in communication between the oscilloscope and plug-in. Repeated attempts have exceeded the timeout limit.
351	yes	Counter timer phaselock loop not locked A hardware failure occurred with the Counter/Timer internal oscillator and phase-lock loop control.
352	yes	Counter Timer PLL unlocked – check ext ref input A hardware failure occurred with the Counter/Timer external oscillator and phaselock loop control. This is usually caused by a missing external oscillator reference.
394	yes	Self-test failure
397	yes	Internal DAC overflow on channel %a of %B plugin A hardware failure occurred in the plug-in.
400	no	No status to report
401	no	Power on initialization complete
403	no	User requested SRQ, front panel button The front panel button label SRQ was pressed.
457	no	Probe %a ID button pressed on %B plugin A probe ID button was pressed.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
459	no	SRQ pending, cannot query event without serial poll An SRQ occurred which must be polled before the oscilloscope cannot send the accompanying Event query response.
460	no	Self test completed successfully
461	yes	Self calibration completed successfully All portions of self-calibration passed and the oscilloscope entered the Enhanced Accuracy state.
462	yes	Default initialization of scope complete
463	yes	Measurement block complete The measurements performed using the AUTOMEASURE START command or the MEASURE major menu were completed.
464	yes	Autoset complete The autoset process completed successfully.
465	no	Self calibration due A temperature change of more than 5° C occurred since the last self-calibration. The oscilloscope is not in the Enhanced Accuracy state.
466	yes	Selected front panel setting #%a recalled The requested oscilloscope settings were successfully recalled from memory.
467	no	Counter timer measurement aborted
468	no	Counter timer measurement completed A new Counter/Timer measurement result was available.
469	yes	Extended diagnostics complete Diagnostics have finished and the instrument has finished restoring its settings.
470	yes	Storage in buffer #%a complete The requested oscilloscope settings were successfully stored in memory.
471	no	20 minute warmup complete Self-calibration can be performed. The oscilloscope has reached thermal stability.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
472	no	Automatic Self Calibration occurring When the self-cal mode was set to Automatic and a 5° C change was detected, self-calibration was initiated.
473	no	Warmup complete. New config requires Cal. Press EA After warmup and a new plug-in configuration was detected, self-calibration was needed.
476	yes	Mainframe amplifier calibration failed
477	yes	Left plugin calibration failed
478	yes	Center plugin calibration failed
479	yes	Right plugin calibration failed
480	yes	Trace separation calibration failed
481	yes	Trigger calibration failed
482	yes	Sweep calibration failed
483	yes	Sweep position calibration failed
484	yes	Enhanced Accuracy requires 11000 series plugins This occurs if Enhanced Accuracy is attempted without 11000-series plug-ins installed.
485	yes	Counter Timer measurement error. Pulse too short The event detected had a pulse width too short to count accurately. A narrow spike, less than 1 ns, will cause this error. Care should be taken to band limit the signal by using the amplifier's HF limit feature or the trigger's HF Reject feature.
486	yes	Savefactory completed Writing calibration constants to the EEROM has completed.
487	yes	Graticule Detection Complete
550	no	%A argument is out of range
551	no	Invalid setting – fp calibrator not changed
553	no	Measurement not selected – no result to query

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
554	no	Trigger mode not single sequence – reset ignored
555	yes	<p>Source M&D1 Trig – Ext A&B can be Gate OR Source When a Counter/Timer measurement Source was External A or B, and Gating was changed to Ext A→B, or A or B Ext, the Source could not remain at that setting. To resolve the conflict the oscilloscope changed the Source to M&D1 Trig.</p>
556	yes	<p>Source is Main Trig – Cannot Gate Dly2 by Dly1 When a Counter/Timer measurement Source was Dly2 Trig, and Gating was changed to Dly1 Swp, the Source could not remain as Dly2 Trig. The oscilloscope changed the Source to Main Trig to resolve the conflict.</p>
557	yes	<p>Gating is off – Ext A&B can be Gate OR Source When a Counter/Timer measurement Gating choice was Ext A→B, or A Ext and the Source was changed to A&B Ext or B Ext, the Gating choice became incompatible. The oscilloscope changed the Gating to Off to resolve the conflict.</p>
558	no	<p>No probe on + channel %b%a The setting for probe offset was received without an offset probe attached to the + input of a differential amplifier. The value was accepted.</p>
559	no	<p>No probe on – channel %b%a The setting for probe offset was received without an offset probe attached to the – input of a differential amplifier. The value was accepted.</p>
560	yes	<p>Source Dly2, for best result remove Dly1 window When a Frequency, Period, or Width measurement used Dly2 Trig as the Source while Dly1 window was present, an erroneous measurement was made. To ensure a valid result, Dly1 window should not be present.</p>

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
561	yes	Source Dly1, for best result remove Dly2 window When a Frequency, Period, or Width measurement used Dly1 Trig as the Source while Dly2 window was present, an erroneous measurement was made. To ensure a valid result, Dly2 window should not be present.
562	yes	All front panel storage buffers are empty A settings recall was attempted with nothing stored in memory.
563	yes	Holdoff set below minimum for current Time/div Holdoff was 2ns Step and the Time/div was changed such that the holdoff setting was less than the minimum allowed for that Time/div.
564	yes	Use Norm trigger mode for best results Holdoff was not set to Time and the trigger mode was P-P or Auto.
565	yes	Holdoff by 2ns step invalid slower than 50 ms/div Holdoff by 2ns Step is not valid when the Main Time/div is slower than 50 ms.
566	no	Undersized number, display zero
567	no	Large negative number, display -infinity
568	no	Large positive number, display +infinity
569	no	Illegal number (NaN)
570	yes	Gating is Off - Cannot Gate Dly2 by Dly1 When a Counter/Timer measurement Gating was Dly1 Swp and Source was changed to Dly2 Trig, the Gating could not remain as Dly1 Swp. The oscilloscope changed the Gating to Off to resolve the conflict.
571	yes	Source M&D1, for best results remove Dly2 window When a Time A→B, Total, or Ratio measurement used M&D1 Trig as the Source while Dly2 window was present, an erroneous measurement was made. To ensure a valid result, Dly2 window should not be present.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
572	yes	Counter timer TOTAL measurement has been stopped An automatic process such as Autoset, Automeasure, or Self-calibration interrupted the Counter/Timer totaling function and the totaling was stopped.
651	yes	Input channel %a overload on %B plug-in
652	yes	Input channel %a overdrive on %B plug-in
653	no	RS232 input parity error
654	no	RS232 input framing error
655	no	RS232 input buffer overrun
656	yes	Delayed sweep missing
657	yes	Last setup lost. Factory defaults have been used. The oscilloscope was unable to restore the last settings upon power-on. Battery backed-up memory contents have been lost or corrupted.
658	yes	Five minute timeout, all intensities shutdown The instrument has seen no activity for five minutes and has reduced all intensities to zero to prolong the crt life. Any front panel touches or commands over the GPIB or RS-232-C bus will restore intensities at the completion of the first command. Queries over the GPIB or RS-232-C bus will not restore intensities.
659	yes	MAIN intensity is too bright, shutdown pending The main trace intensity has exceeded the long term safe level. The instrument will send this warning every 3 seconds, or after any GPIB or RS-232-C command, until 30 seconds or 10 commands have been received and will then reduce the intensity to protect the crt.
660	yes	DELAY intensity is too bright, shutdown pending The delay trace intensity has exceeded the long term safe level. The instrument will send this warning every 3 seconds, or after any GPIB or RS-232-C command, until 30 seconds or 10 commands have been received and will then reduce the intensity to protect the crt.

Remote Interfaces (event code)	Displayed on Screen	Message and Probable Cause
661	yes	XY intensity is too bright, shutdown pending The XY trace intensity has exceeded the long term safe level. The instrument will send this warning every 3 seconds, or after any GPIB or RS-232-C command, until 30 seconds or 10 commands have been received and will then reduce the intensity to protect the crt.
662	yes	MAIN intensity shutdown The instrument has reduced the intensity to zero to protect the crt. Any front panel touches or commands over the GPIB or RS-232-C bus will restore intensities at the completion of the first command. Queries over the GPIB or RS-232-C bus will not restore intensities.
663	yes	DELAY intensity shutdown The instrument has reduced the intensity to zero to protect the crt. Any front panel touches or commands over the GPIB or RS-232-C bus will restore intensities at the completion of the first command. Queries over the GPIB or RS-232-C bus will not restore intensities.
664	yes	XY intensity shutdown The instrument has reduced the intensity to zero to protect the crt. Any front panel touches or commands over the GPIB or RS-232-C bus will restore intensities at the completion of the first command. Queries over the GPIB or RS-232-C bus will not restore intensities.

Note: In the above table, the character % represents several possibilities:

%a represents an integer number.

%b represents the short form for the L, C, or R plug-in compartment.

%A represents the argument name.

%B represents the long form for the LEFT, CENTER, or RIGHT plug-in compartment.

Messages Displayed only on the Screen and not available to the external interfaces:

Temp change since last Cal. Press EA to restore

Self-cal mode was set to Manual, and a 5° C change was detected. Pressing the Enhanced Accuracy button or SELFCAL FORCE command was required to restore the oscilloscope to the Enhanced Accuracy state.

Press EA again to confirm request

The front panel Enhanced Accuracy button was pressed. Two presses are required to begin self-calibration.

Probe cal completed

Probe calibration for the Right plug-in was successfully completed.

Probe cal completed: check LF compensation

Dc probe calibration for the Left or Center plug-in was successfully completed. Manual adjustment of the low-frequency response of the probe can be made.

No cal signal detected: Attach probe to hook

Probe calibration was attempted but no signal found for that probe.

Probe cal failed

The plug-in was unable to properly adjust for the attached probe.

COUNTER: Waiting to Finish Measurement

The counter timer started a measurement but either the measured signal or applied gate was lost.

COUNTER: Still measuring. Averages = xxxxx

The selected number of averages in combination with the signal repetition rate caused the measurement to take a long time to complete. Nothing was wrong. This message appears to indicate activity.

COUNTER: Waiting to Start Measurement

The counter timer was waiting to begin a measurement. Either the signal was not triggered or the gating source was not present.

Select a measurement before pressing start

Start was touched in the Measure major menu with no measurements selected from the Meas List.

Probe Skew does not apply to this type of trace

An attempt was made to adjust an XY trace or a stored waveform.

Setting buffer erased

Erase was touched in the Store Recall major menu.

Use Time Holdoff for best results

Holdoff was set to Countdown, 2nsStep, or Events and the trigger mode was changed to P-P or Auto.

Select Auto or 1 Average when using Single Seq.

To ensure a complete measurement when using Single Sequence, the counter timer average selection should be set to Auto or 1.

**Messages Displayed
only on the Screen
and not available
to the external
interfaces: (cont)**

Use left or center channel for vertical component

Right channel was touched while vertical portion of trace was being defined.

Remaining channels may not be inverted

Minus operator was touched but all the remaining channels are non 11000-series, non-invertable 11000-series or external (in trigger source menu).

Must define vertical component of trace first

Vs was touched before a vertical channel was entered.

Trace is already an XY trace

Vs was touched while defining horizontal component of trace.

Cannot use same channel twice in expression

A channel that is already part of trace description was touched.

Cannot use left channel for horizontal component

Left channel was touched while horizontal portion of trace was being defined.

Touch a right channel, center channel already used

Center channel was touched while defining horizontal portion of trace.

Vertical component contains a center channel.

Use center channel for horizontal component

Right channel was touched while defining horizontal component but center channel is already part of the horizontal component of some trace description, not necessarily part of the current trace.

Use right channel for horizontal component

Center channel was touched while defining horizontal component but right channel is already part of the horizontal component of some trace description, not necessarily part of the current trace.

Channel must use same operator as it used in Main

An illegal channel was touched. The most recently selected operator would cause this channel to have a polarity that is opposite to the polarity that this channel uses in the main trigger source menu. This occurs while in either of the delayed trigger source menus.

Both delayed sources must use same external signal

Ext was touched in a delayed trigger source menu while the other delayed trigger source is using Ext/5 and vice versa.

Only 11K plugin channels may be inverted

External channel was touched after selecting MINUS as the operator. A non 11000-series channel was touched after selecting the MINUS operator.

No more channels available, touch "Enter"

PLUS or MINUS was touched but there are no more channels to combine.

**Messages Displayed
only on the Screen
and not available
to the external
interfaces: (cont)**

Cannot create XY trace, no channels available

Vs was touched while it was dim. It is dimmed because there is no valid way to make an XY trace at this time. Usually this happens when the vertical component of the current trace has a center channel and some other trace has a horizontal component with a center channel. It can also happen if either or both the left and center compartments contain smart plugins.

Already using two channels, touch "vs" or "Enter"

PLUS or MINUS was touched after the limit of 2 channels per trace component was reached.

Already using two channels, touch "Enter"

PLUS or MINUS was touched after the second horizontal component was defined.

Too many traces. Touch "Clear" to delete one

A channel or operator in the waveform menu was touched when there are already 8 traces defined.

This plugin does not support channel inversion

A non-invertable 11000-series plug-in channel was touched after selecting the MINUS operator.

Remaining channels must use "+" operator

MINUS was touched in a delayed trigger source menu at a point when the remaining channels must have a positive polarity. The channel's polarity must be positive because that's the way it was used in the main trigger source.

Remaining channels must use "-" operator

PLUS was touched in a delayed trigger source menu at a point when the remaining channels must have a negative polarity. The channel's polarity must be negative because that's the way it was used in the main trigger source.

Delayed trigger source cannot use A external input

Main Trig was touched while the main trigger source is an external channel.

External inputs may not be combined

PLUS or MINUS was touched after selecting an external as a trigger source.

Touch "Main Trig" to use right channels

Right channel was touched while the main trigger source consisted of a composite source from the right compartment.

Trigger expression is already using two channels

PLUS or MINUS was touched after defining second channel in trigger source.

Touch "Main Trig" to use center channels

Center channel was touched while the main trigger source consisted of a composite source from the center compartment.

Messages Displayed only on the Screen and not available to the external interfaces: (cont)

Touch another plugin channel or touch "Enter"
External channel was touched after selecting an operator for the second channel for one of the trigger sources.

Please choose a right compartment channel
A left or center channel was touched but the first channel of the trigger source is from the right compartment.

Please choose a left or center compartment channel
A right channel was touched but the first channel in the trigger source is a left or center channel.

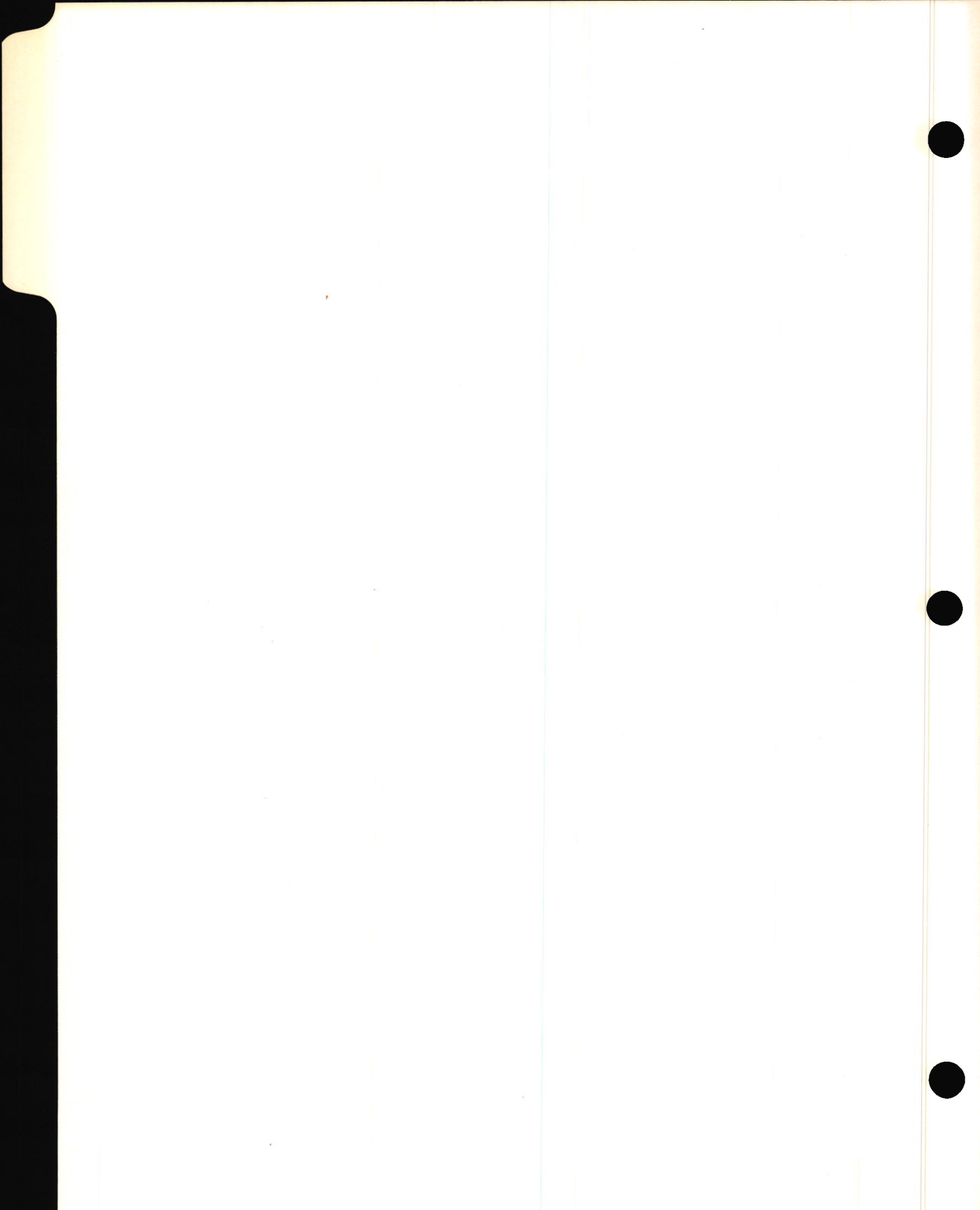
Touch "Main Trig" to use left channels
Left channel was touched while the main trigger source consists of a composite source from the left compartment.

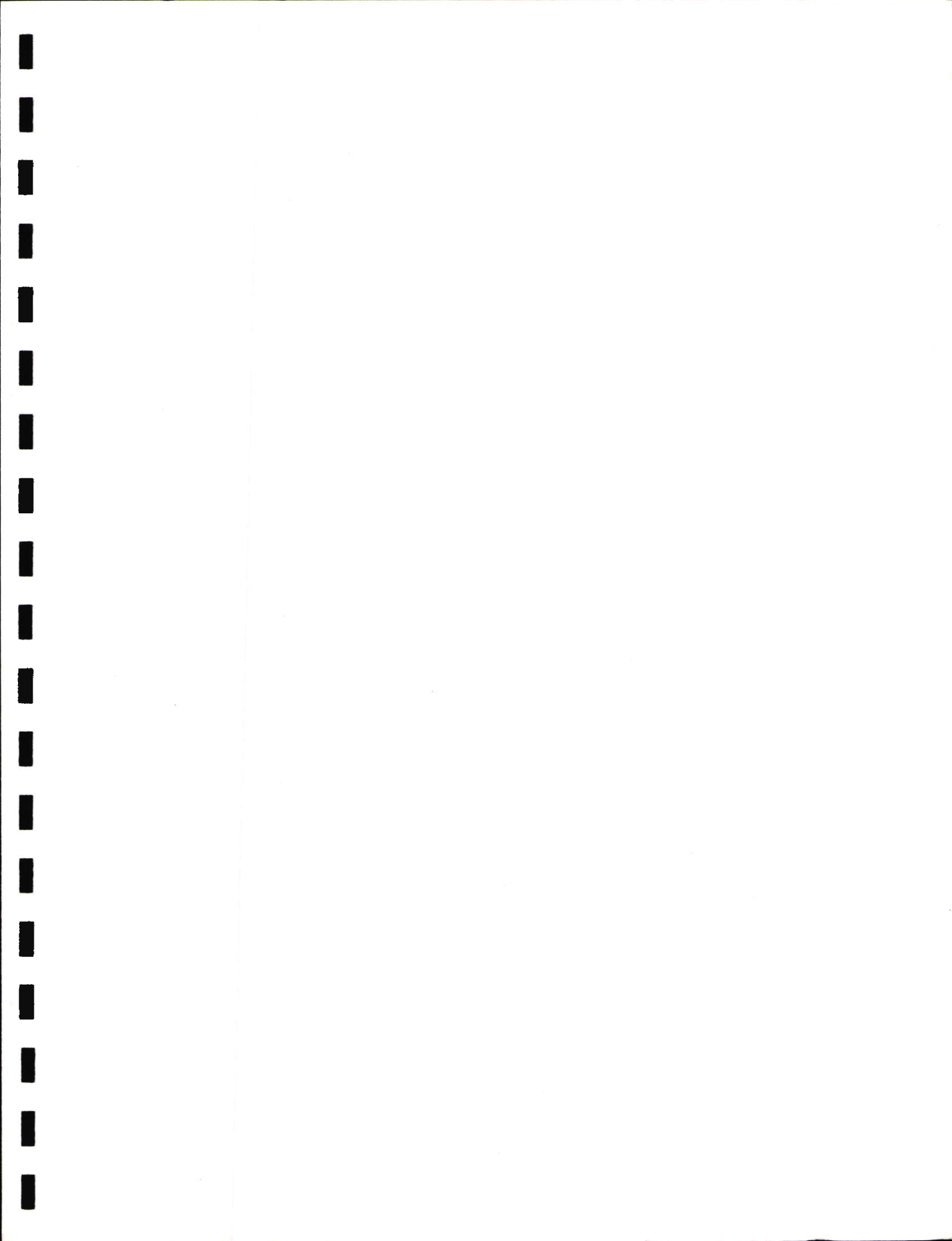
Numeric entry not available
For the knob selection, numeric entry was not allowed. This occurs if Cursors are selected or if nothing is selected for the knob.

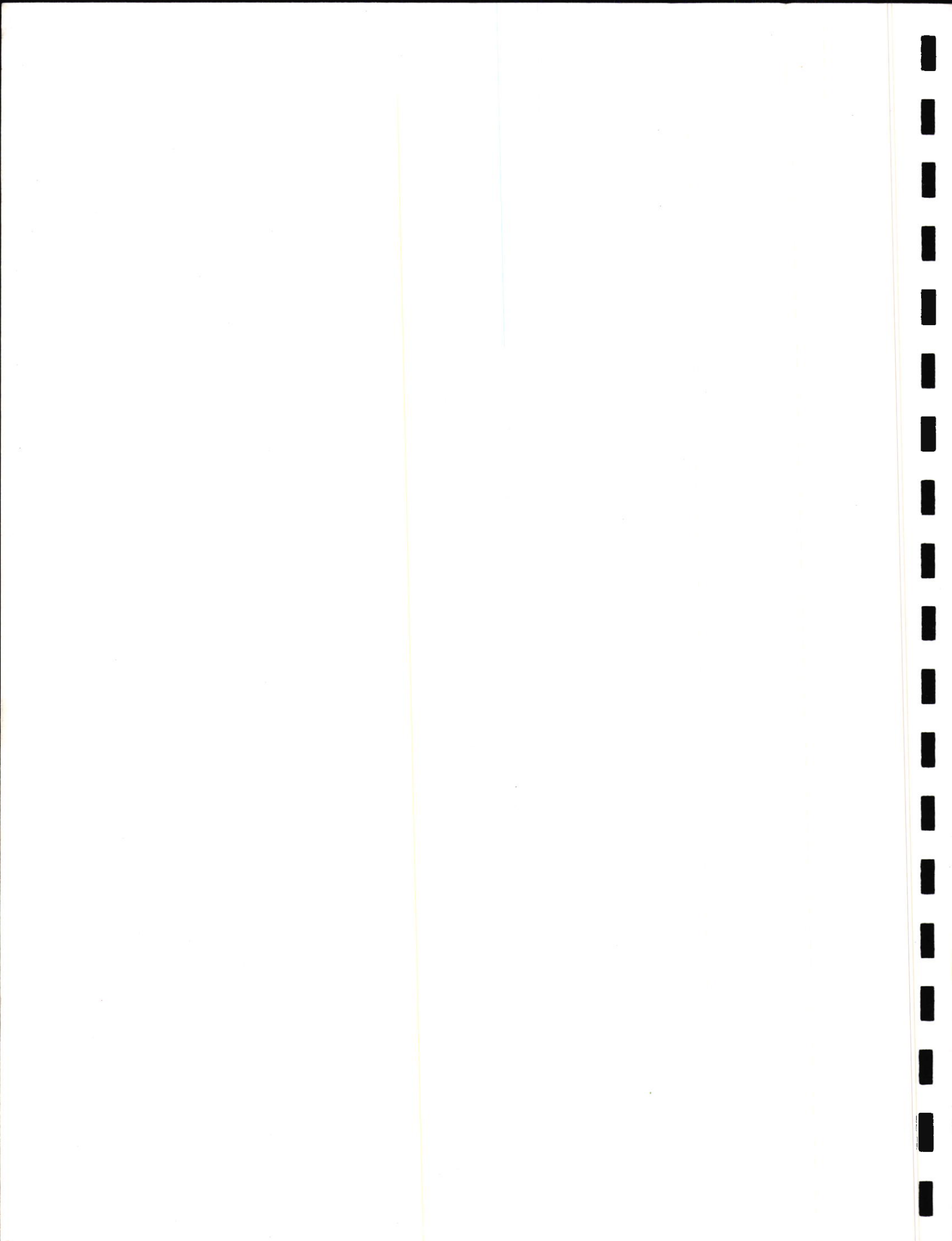
Fatal Errors

The firmware in the 11301 Series Oscilloscopes has a large number of built-in error checks. In the (hopefully rare) circumstance where an inconsistency is discovered, the instrument will attempt to display "FATAL ERROR = nnnnnH," where nnnnn is a 5 digit hexadecimal number. This message will show up in the lower left corner of the crt and then the instrument will halt all operation. If this occurs, recording and reporting that 5 digit number along with the instrument configuration, firmware version number and any details of what led to the error, etc., will give the best opportunity of finding and fixing the problem. That 5 digit number pinpoints exactly where the problem was discovered. In many cases the tests which lead to fatal errors are extremely specific and can narrow the problem to a handful of possibilities.

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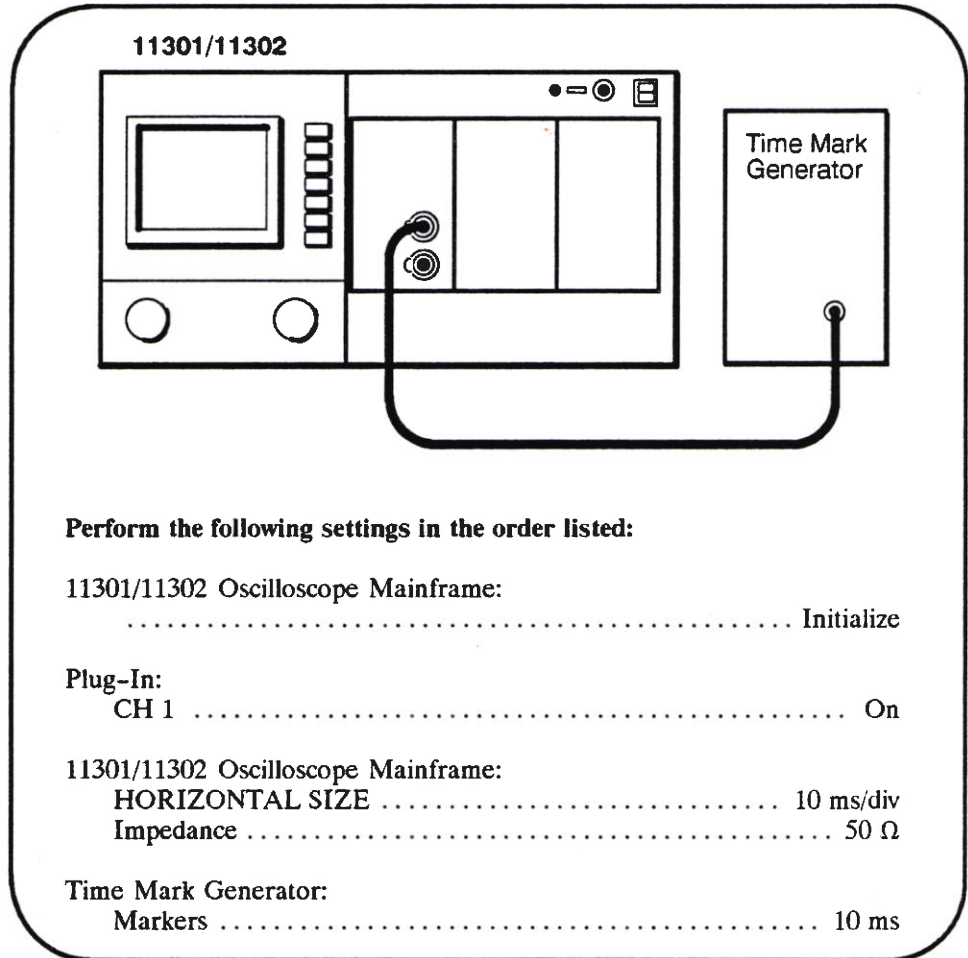






Part 7: Horizontal Timing with Cursors

Setup



Procedure

- Adjust the vertical size of the displayed waveform to be from 3 to 6 divisions high. Center the display vertically.
- Turn on the horizontal cursors.
- CHECK**—the accuracy of the **Main Time/div** entries noted in Table 4 on the next page. For each check, set the Time Mark Generator, **X10 Mag**, and **Main Time/div** to the noted settings. Then position the horizontal cursors the noted number of waveform cycles apart, by placing each cursor at a point where the waveform crosses the centerline of the graticule. Use the rising edges of the waveform markers to set the cursors.

Finally, **CHECK**—that the Δ **Horiz** cursor readout is within the range noted; you may need to press the **CURSOR** button to see this readout. Some of the higher speed tests may require adjustment to the vertical size or centering.

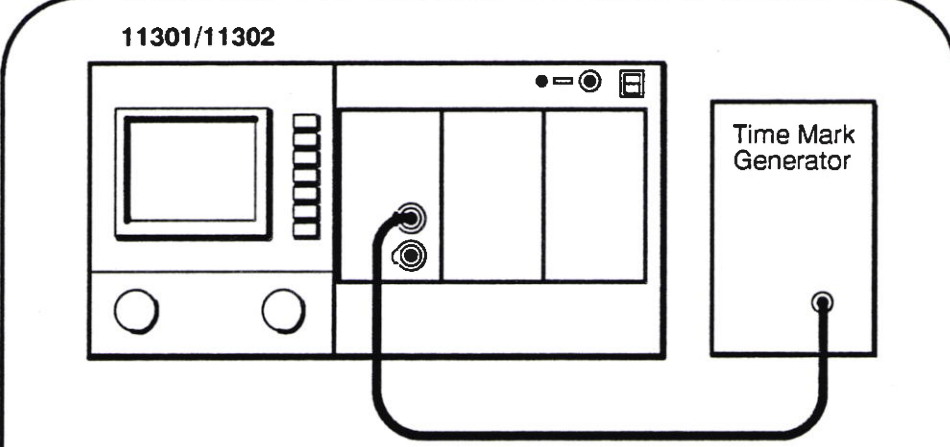
Table 4 – Timing Accuracy

Time Mark Generator	X10 Mag	Main Time/div	Number of Waveform Cycles	Range of Δ Horiz
10 ms	Off	10 ms/div	8	79.3–80.7 ms
1 ms	Off	1 ms/div	8	7.93–8.07 ms
0.1 ms	On	100 μ s/div	8	789–811 μ s
10 μ s	Off	10 μ s/div	8	79.3–80.7 μ s
5 ns	On	1 ns/div	1	4.88–5.12 ns

- d. Bring up window 1, which is available under the HORIZONTAL DELAY (OFFSET) button below the screen. Set the delay 1 time to 0 s.
- e. **CHECK**—the same tolerances using the delayed time base. Use the **Main Time/div** notation in Table 4 for the **Dly'd Time/div** settings. Make sure that **Main Time/div** and **Dly'd Time/div** are set the same, or else the repetition rate of the sweeps may render the trace too difficult to see.

Part 8: Delta Delay Accuracy

Setup



11301/11302

Time Mark Generator

Perform the following settings in the order listed:

11301/11302 Oscilloscope Mainframe: Initialize

Plug-In:
CH 1 On

11301/11302 Oscilloscope Mainframe:
Impedance 50 Ω

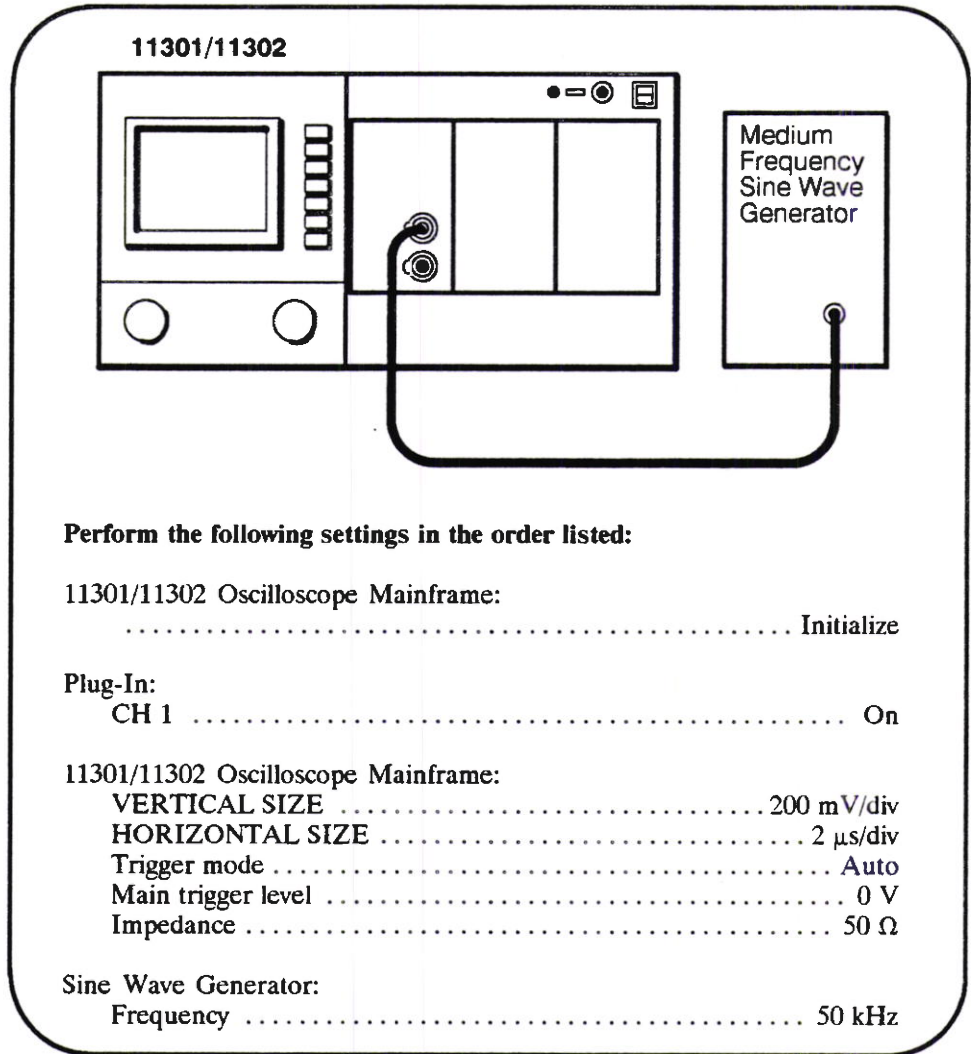
Time Mark Generator:
Markers 0.1 ms

Procedure

- Adjust the vertical size of the waveform to be from 3 to 6 divisions high, and position the baseline of the waveform about one division above the centerline of the graticule.
- Use the HORIZONTAL DELAY (OFFSET) button to turn on window 1, and set **Main&Dly View** to **Dly View**.
- Adjust the delayed sweep size to 1 $\mu\text{s}/\text{div}$. You may need to adjust the delayed intensity to see the trace.
- Adjust the horizontal position of the delay 1 sweep to align the rising edge of the time mark with a vertical graticule line.
- Turn on window 2. Adjust the HORIZONTAL DELAY (OFFSET) to precisely overlay the two window waveforms.
- CHECK**—that the ΔDelay readout is between 696.90 and 703.10 ms.

Part 9: Trigger Filters

Setup



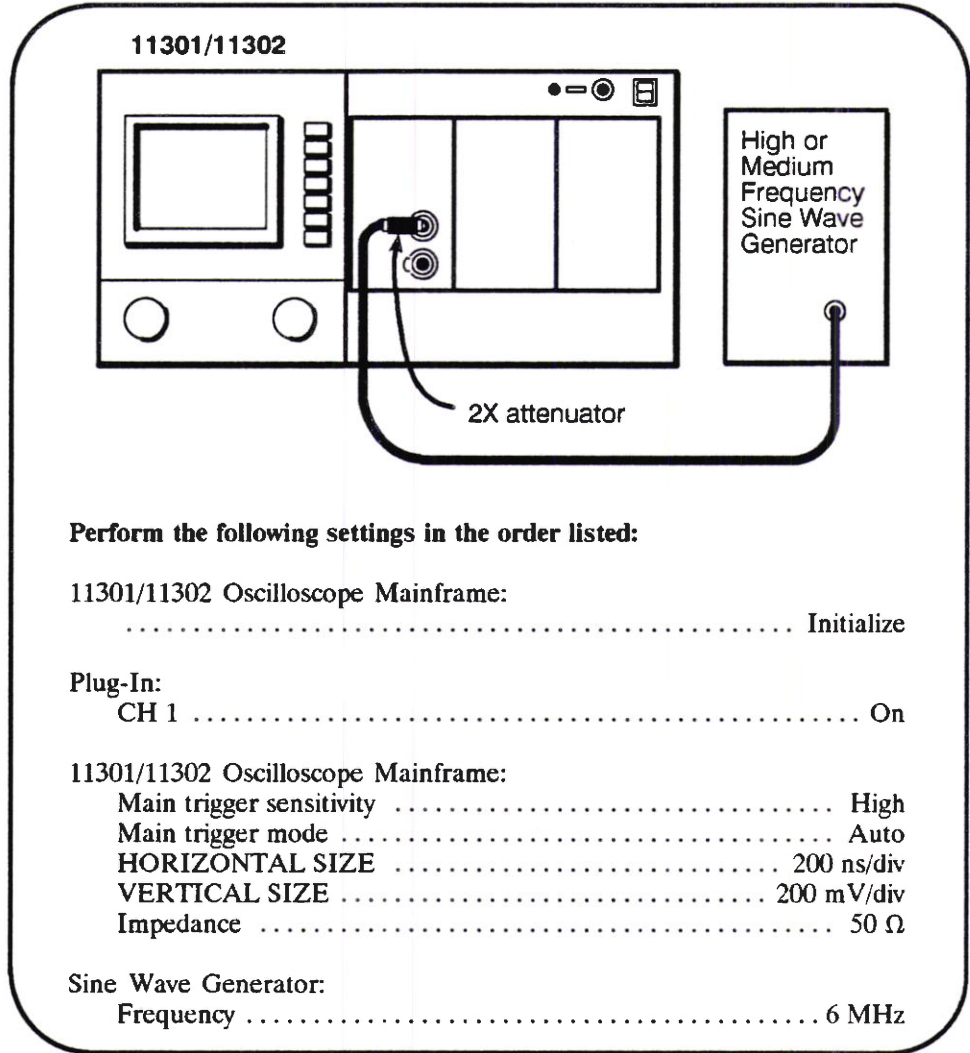
Procedure

- Adjust the Sine Wave Generator Amplitude to produce a waveform about 6 divisions in height.
- Change the VERTICAL OFFSET, and as you are turning the knob, **CHECK**—that the signal moves up and down on the screen while the triggering point (the leftmost edge of the sweep) stays at a fixed point on the screen. When done, return the offset to zero.
- Select **AC** coupling for the main trigger.

- d. Change the VERTICAL OFFSET, and as you are turning the knob, *CHECK*—that the signal moves up and down on the screen while the triggering point (the leftmost edge of the sweep) also moves up and down. The triggering point should maintain its relationship to the rest of the waveform. When done, return the offset to zero.
- e. Set trigger coupling to **Dc**. Align the falling edge of the sine wave to cross at the center of the screen by adjusting the horizontal position.
- f. Set trigger coupling to **DcHf Rej**. *CHECK*—that the falling edge of the sine wave now crosses the horizontal centerline at a point left of the vertical centerline. The distance to the left should be between 0.6 and 1.8 divisions.
- g. Set trigger coupling to **AcLf Rej**. *CHECK*—that the falling edge of the sine wave has moved right between 0.6 and 1.8 divisions.
- h. Set trigger coupling to **AcHf Rej**. *CHECK*—that the falling edge of the sine wave has moved between 0.6 and 1.8 divisions to the left of center.
- i. Set the **Main Time/div** to 5 μ s, and return coupling to **Dc**. Verify that the **Main Trig** and **L1 Offset** are zero.
- j. Set window 1 on, **Trig'd After Dly**, and **Dly View**. Set the **Dly'd Time/div** to 2 μ s, and ensure that the **Dly1 Trig** level is zero.
- k. Change the VERTICAL OFFSET, and as you are turning the knob, *CHECK*—that the signal moves up and down on the screen while the triggering point stays at a fixed point on the screen. When done, return the offset to zero.
- l. Select AC coupling for the delayed trigger.
- m. Change the VERTICAL OFFSET, and as you are turning the knob, *CHECK*—that the signal moves up and down on the screen while the triggering point also moves up and down. The triggering point should maintain its relationship to the rest of the waveform. When done, return the offset to zero.
- n. Set trigger coupling to **Dc**. Align the falling edge of the sine wave to cross at the center of the screen by adjusting the horizontal position.
- o. Set trigger coupling to **DcHf Rej**. *CHECK*—that the falling edge of the sine wave now crosses the horizontal centerline at a point left of the vertical centerline. The distance to the left should be between 0.6 and 1.8 divisions.
- p. Set trigger coupling to **AcLf Rej**. *CHECK*—that the falling edge of the sine wave has moved right between 0.6 and 1.8 divisions.
- q. Set trigger coupling to **AcHf Rej**. *CHECK*—that the falling edge of the sine wave has moved between 0.6 and 1.8 divisions to the left of center.

Part 10: Trigger Sensitivity

Setup



Procedure

- a. Use the same Sine Wave Generator used in Part 6; one capable of producing a sine wave of a frequency equal to the **HF Limit**. Adjust the Sine Wave Generator Amplitude for a waveform height of 1.75 divisions, or 350 mV.

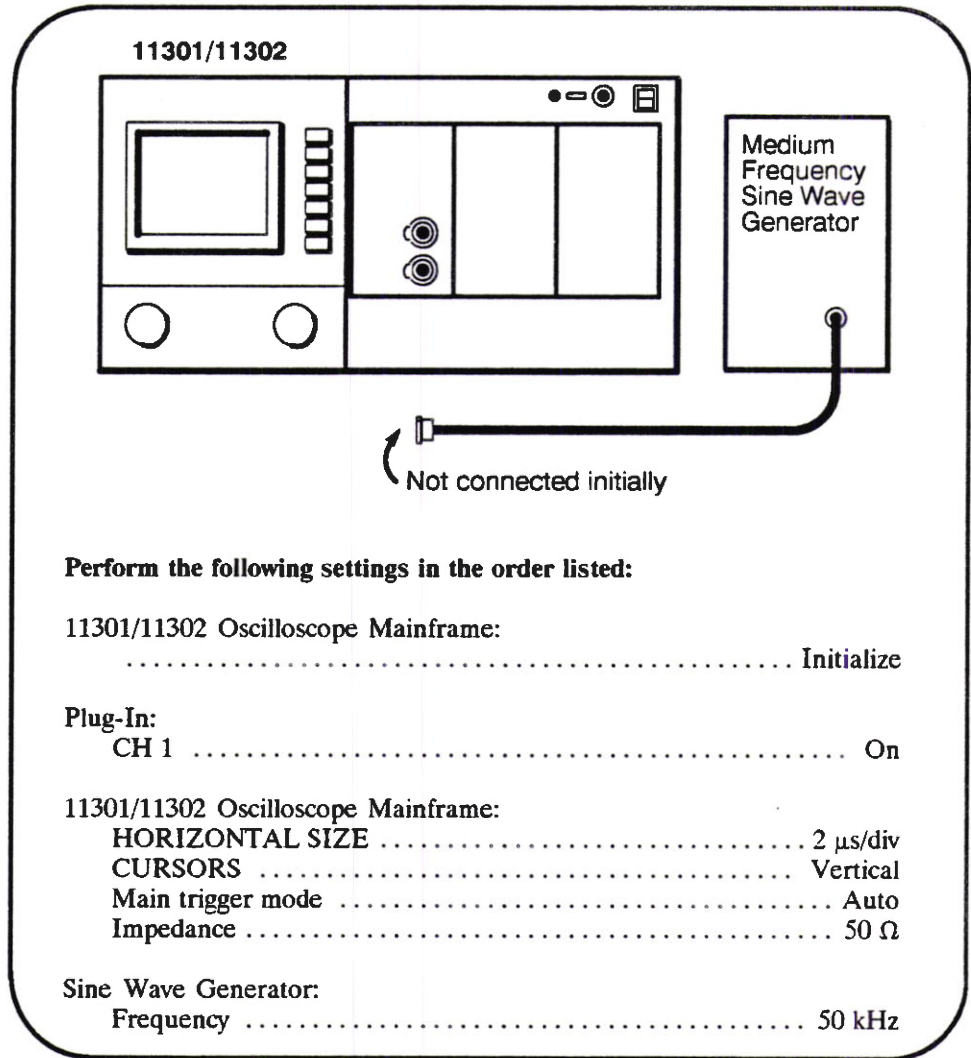
Throughout this test, be precise in establishing waveform heights as nearly as possible to the specification. One way this can be accomplished is by using the vertical cursor controls. Set **On Tracking**, and adjust the Δ VERT readout to the voltage specification of the adjustment. Then, by simultaneously using the VERTICAL POS control and adjusting the Amplitude of the Sine Wave Generator, the waveform can be matched to the cursor size.

- b. Set window 1 on, and adjust delay 1 to 0 s.

- c. Using the VERTICAL POS control, position the main trace in the top half of the screen and the window trace in the bottom half.
- d. For the DELAY 1 TRIGGER, select **Trig'd After Dly** and **High Sensvty**.
- e. Install a 5X attenuator in series with the 2X attenuator at the plug-in input.
- f. Adjust the TRIGGER LEVEL of both the main and delay 1 triggers.
CHECK—to verify that stable traces can be established on the screen. You will need to use the Fine knob settings.
- g. Remove the 5X attenuator, leaving the 2X attenuator in the signal path.
- h. Adjust the Sine Wave Generator for a vertical Amplitude of 3.5 divisions, or 700 mV, for each waveform.
- i. Reinstall the 5X attenuator in the signal path.
- j. Change the trigger sensitivity of both the main and delay 1 triggers to **Medium Sensvty**.
- k. Adjust the TRIGGER LEVEL of both the main and delay 1 triggers.
CHECK—to verify that stable traces can be established on the screen.
- l. Remove the 5X attenuator, leaving the 2X attenuator in the signal path.
- m. Adjust the Sine Wave Generator for a vertical Amplitude of 5.25 divisions, or 1.05 V.
- n. Reinstall the 5X attenuator in the signal path.
- o. Change the trigger sensitivity of both the main and delay 1 triggers to **Low Sensvty**.
- p. Adjust the TRIGGER LEVEL of both the main and delay 1 triggers.
CHECK—to verify that stable traces can be established on the screen. You may need to increase the intensity of the main and delayed traces to see the waveforms. Also, the M TRIG'D and D TRIG'D lights next to the TRIGGER LEVEL button show whether the main and delay triggers are active.
- q. Change the trigger sensitivity of both the main and delay 1 triggers to **High Sensvty**.
- r. Adjust the **Main Time/div** to 10 ns. This will force the **Dly'd Time/div** to match.
- s. Remove the 5X attenuator, leaving the 2X attenuator in the signal path.
- t. Press the VERTICAL POS button below the screen to bring up the vertical menu. Observe the system bandwidth in the **HF Limit** readout at the bottom of the screen, and adjust the Sine Wave Generator Frequency to match.
- u. Adjust the Sine Wave Generator for a vertical Amplitude of 5.00 divisions, or 1.00 V.
- v. Reinstall the 5X attenuator in the signal path.
- w. Adjust the TRIGGER LEVEL of both the main and delay 1 triggers.
CHECK—to verify that stable traces can be established on the screen.

Part 11: Trigger Accuracy

Setup



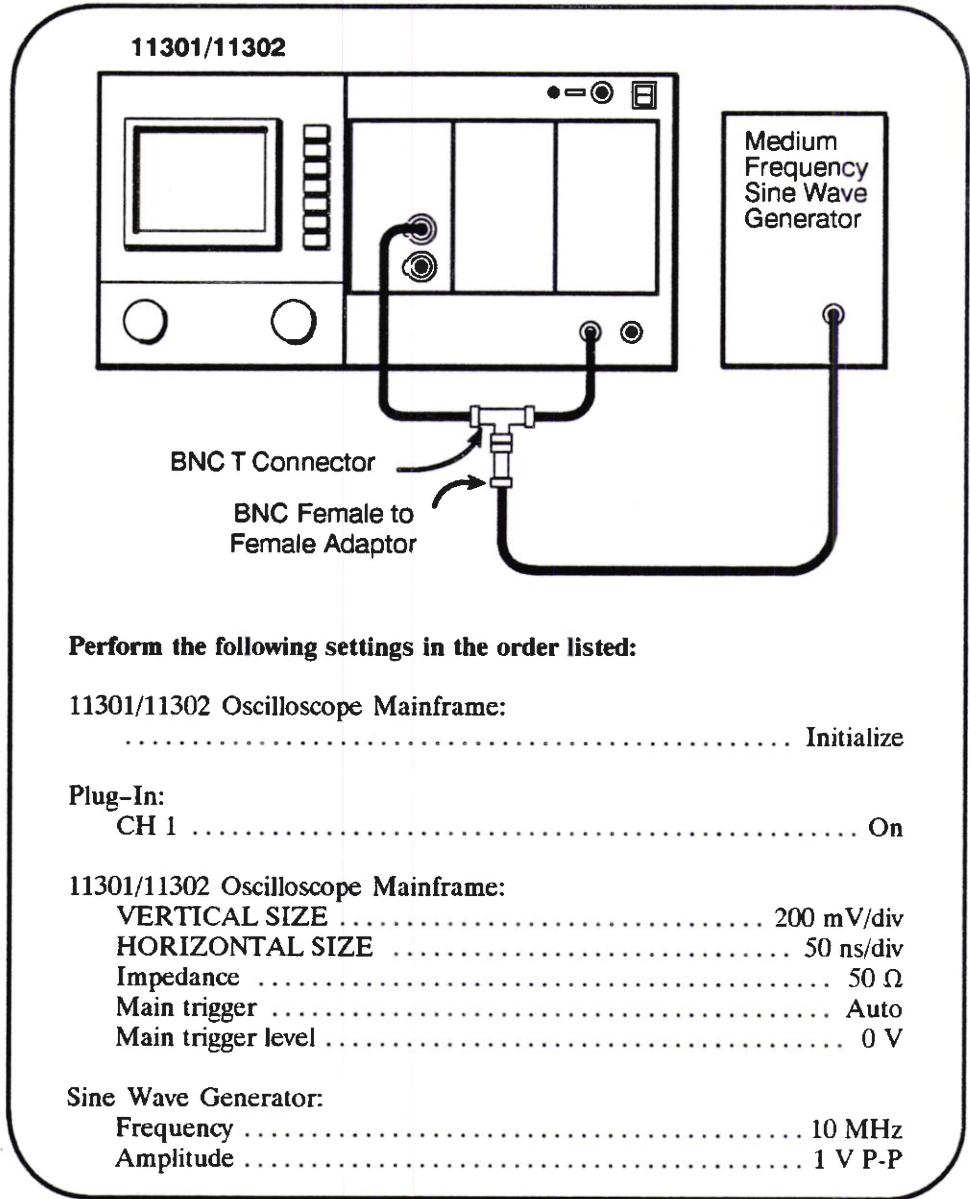
Procedure

- Adjust the reference cursor (left knob) to the center of the trace. Note the **Vert Ref** cursor readout voltage.
- Connect the Sine Wave Generator cable to the plug-in Channel 1 input. Adjust its Amplitude to produce a waveform height of approximately 4 divisions. Do not change the VERTICAL POSITION, which should remain at zero.
- Set the **Main Trig** level to 0 V.
- Move the trace slightly to the right using HORIZONTAL POSITION, so that its leading end is visible on the screen.

- e. Adjust the reference cursor (left knob) so that the cursor touches the leading end of the waveform.
- f. **CHECK**—that the **Vert Ref** cursor readout is within ± 0.3 V of the value noted in Step a., before the generator was connected.
- g. Bring up window 1, and select **Dly View** and **Trig'd After Dly**. Set the **Main Time/div** to $5 \mu\text{s}$ and the **Dly'd Time/div** to $2 \mu\text{s}$.
- h. Verify that the **Dly1** Trig level is 0 V.
- i. Move the delayed trace slightly to the right using **HORIZONTAL POSITION**, so that its leading end is visible on the screen.
- j. Adjust the reference cursor (left knob) so that the cursor touches the leading end of the waveform.
- k. **CHECK**—that the **Vert Ref** cursor readout is within ± 0.3 V of the value noted in step a., before the generator was connected.

Part 12: A and B External Inputs

Setup



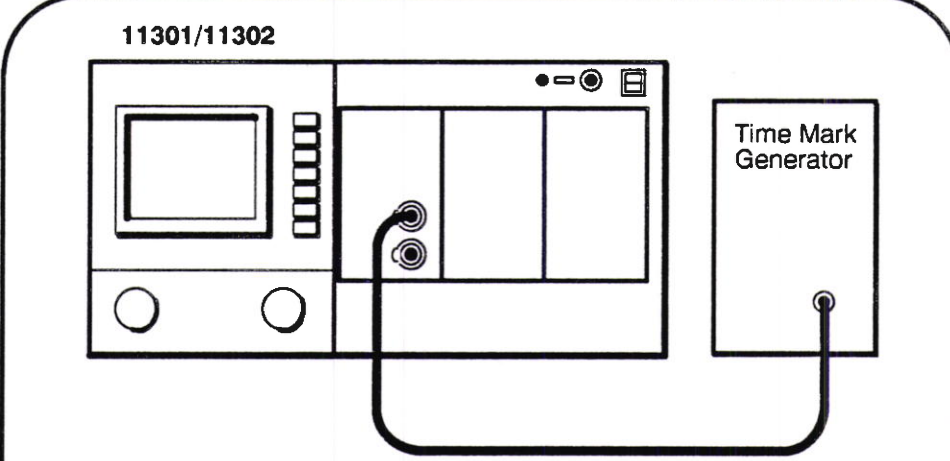
Procedure

- a. From the TRIGGER SOURCE menu, select the main trigger source to be **A Ext→5** and the delay 1 trigger source to be **B Ext→5**.
- b. Adjust the following trigger levels to be 0 V: **Main, Dly1, CT Ext A, and CT Ext B**.
- c. Press the COUNTER button, and select **Ratio Measure**.

- d. Place a $50\ \Omega$ terminator on the B EXTERNAL INPUT. Remove the cable from the plug-in CH 1 and connect it to the terminator.
- e. *CHECK*—that the **Ratio $D1 \div M$** is between 999.9990000m and 1.000001000.
- f. Select **A & B Ext Source** from the COUNTER menu.
- g. *CHECK*—that the **Ratio $B \div A$** is between 999.9990000m and 1.000001000.
- h. From the TRIGGER SOURCE menu set the main trigger source to **A Ext** and the delay 1 trigger source to **B Ext**.
- i. Install a 5X attenuator between the coaxial cable from the Sine Wave Generator and the BNC T Connector.
- j. *CHECK*—that the **Ratio $B \div A$** is between 999.9990000m and 1.000001000.
- k. From the COUNTER menu, select **M & D1 Trig Source**.
- l. *CHECK*—that the **Ratio $D1 \div M$** is between 999.9990000m and 1.000001000.
- m. From the WAVEFORM menu, touch **Count View** and create two new waveforms on the screen representing the **A Ext** and **B Ext** counter view signals. Use the VERTICAL POS controls to separate the two traces.
- n. *CHECK*—that both the new waveforms appear on the screen as square or rectangular waves with both high and low portions, and are not simply horizontal lines.

Part 13: Counter Timer

Setup



11301/11302

Time Mark Generator

Perform the following settings in the order listed:

11301/11302 Oscilloscope Mainframe:
..... Initialize

Plug-In:
CH 1 On

11301/11302 Oscilloscope Mainframe:
HORIZONTAL SIZE 100 ns/div
Vertical coupling Dc
Impedance 50 Ω

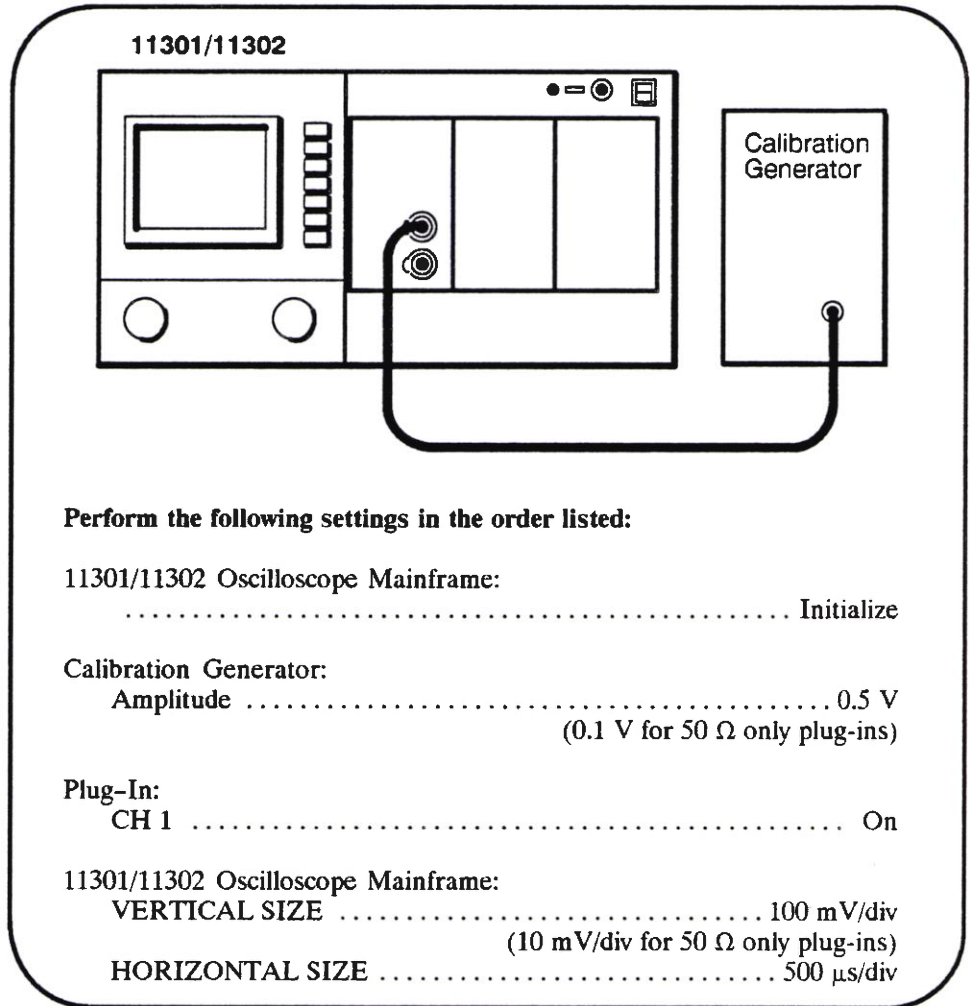
Time Mark Generator:
Markers 0.1 μs

Procedure

- Adjust VERTICAL SIZE and VERTICAL POS for a waveform display from 3 to 6 divisions high. If necessary, adjust the main trigger for a stable display.
- Turn on window 1 and adjust the Delay1 readout to 400 ns.
- Turn on window 2 and adjust ΔDelay to 0 s.
- Use the COUNTER menu to select Time A→B Measure.
- CHECK—that the TimeD1→D2 readout is within the range 0 ns ± 1.5 ns.

Part 14: Front Panel Calibrator

Setup



Procedure

- Use the VERTICAL POS button to center the trace vertically on the screen.
- If possible, set the bandwidth limit to **20.0 MHz HF Limit**. Not all plug-ins support this setting.

Note

To minimize noise interference of the calibration signal, set any nearby sine wave generators to their reference (lowest) frequencies.

- Use the vertical cursors to measure the amplitude of the waveform. Use the fine knob settings, and set the reference cursor to split the waveform bottom and the measuring cursor to split the waveform top.

- d. Touch the **Set Ref** area, and the **% - dB** screen area to set it on.
- e. Move the cable from the Calibration Generator output to the 11301/11302 CALIBRATOR output.
- f. Use the UTILITY menu and the **Cal Sig** selector to set calibrator output to a **500 mV Sq Wave** of 1 kHz.
- g. Adjust the cursors to measure the calibrator signal. **CHECK**—that the Δ Vert readout is between 98.8% and 101.2%. For 50 Ω plug-ins, use 98% and 102% as acceptable limits.

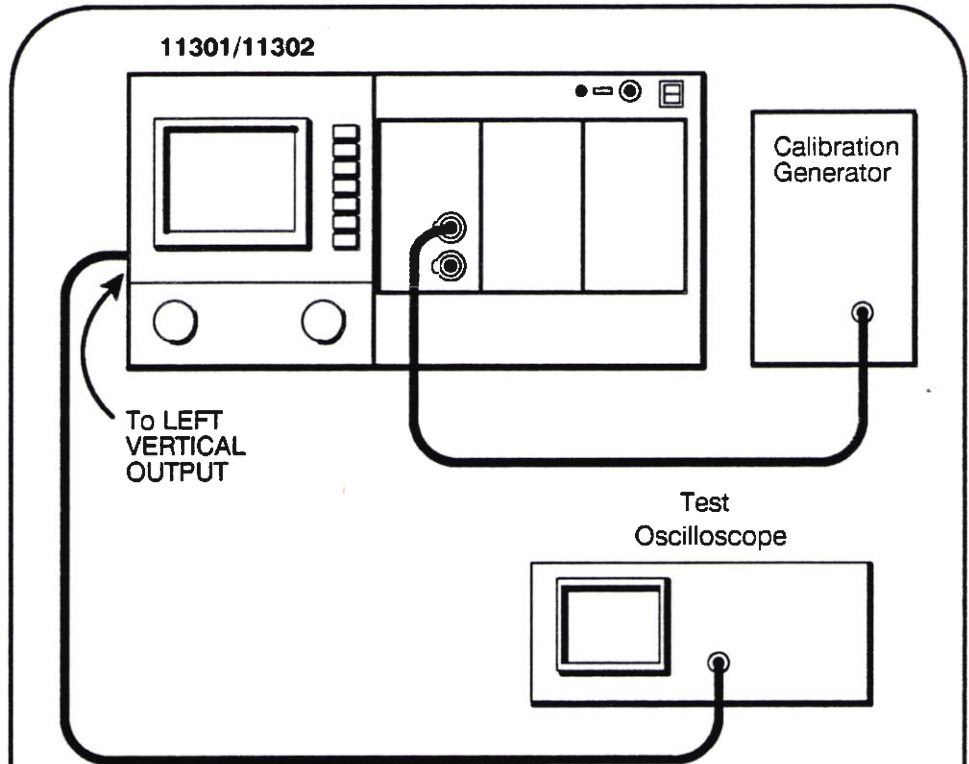
NOTE

The 11301/11302 CALIBRATOR has an output impedance of 450 ohms, while the output impedance of the Calibration Generator you use will probably be different. The Tektronix PG506 Calibration Generator has an output impedance of 50 ohms. The tolerance of the plug-in input varies with the impedance matching of the signal source and the input impedance of the plug-in, and this is why the different specification with 50 Ω only plug-ins.

- h. On 50 Ω only plug-ins, set the vertical sensitivity to 50 mV/div.
- i. Adjust the calibrator with the UTILITY menu to **Fast**.
- j. Adjust the cursors to measure the calibrator signal. **CHECK**—that the Δ Vert readout is 100% or greater for all plug-ins.
- k. Set VERTICAL SIZE to 1 V/div (100 mV/div for 50 Ω only plug-ins).
- l. Move the cable from the 11301/11302 CALIBRATOR output back to the Calibration Generator output. Set the Calibration Generator output to 5 V (1 V for 50 Ω only plug-ins).
- m. Adjust the cursors to measure the new signal, and touch **Set Ref**.
- n. Move the cable from the Calibration Generator output to the 11301/11302 CALIBRATOR output.
- o. Use the UTILITY menu and the **Cal Sig** selector to set calibrator output to a **5 V Sq Wave** of 1 kHz.
- p. Adjust the cursors to measure the calibrator signal. **CHECK**—that the Δ Vert readout is between 98.8% and 101.2%. For 50 Ω plug-ins, use 98% and 102% as acceptable limits.
- q. Press the MEASURE COUNTER button beneath the screen (not the MEASURE button to the right of the screen), and select **Freq Measure**.
- r. **CHECK**—that the **Freq** readout is between 998.0000 Hz and 1.002000 kHz.
- s. **CHECK**—that the number of displayed digits in the **Freq** readout display is 7, or, for 11301/11302 Option 1T, 9 digits.

Part 15: Rear Panel Input/Output Signals

Setup



Perform the following settings in the order listed:

11301/11302 Oscilloscope Mainframe: Initialize

Plug-In:
CH 1 On

11301/11302 Oscilloscope Mainframe:
VERTICAL SIZE 500 mV/div
HORIZONTAL SIZE 500 μ s/div
Impedance 50 Ω

Calibration Generator:
Amplitude 5 V

Test Oscilloscope:
Horizontal 500 μ s/div
Vertical 100 mV/div
Triggering Auto

Procedure

- a. Use the 11301/11302 VERTICAL POS control to center the waveform vertically.
- b. **CHECK**—that the signal displayed on the Test Oscilloscope shows a waveform baseline within the range of ± 175 mV.
- c. **CHECK**—that the peak-to-peak amplitude of the signal on the Test Oscilloscope is in the range 450 mV – 550 mV.
- d. Disconnect the cable from LEFT VERTICAL OUTPUT. Using a BNC T Adaptor, connect the Calibration Generator signal to the back-panel Z AXIS connector in addition to the plug-in.
- e. **CHECK**—that the positive peaks of the signal are blanked on the screen.
- f. Set the HORIZONTAL SIZE to 1 ms/div.
- g. Remove all cables from the plug-in and the Z AXIS. Connect a cable from the back-panel MAIN SWP OUT to the Test Oscilloscope. Set the Test Oscilloscope to 1 V/div vertical, 2 ms/div horizontal, 1 M Ω impedance, auto triggering, and - slope trigger.
- h. **CHECK**—that the waveform baseline on the Test Oscilloscope is within the range ± 0.5 V. **CHECK**—that the slew rate is 0.5 V/ms $\pm 10\%$. Over a sweep distance of 4 divisions, the waveform should rise vertically 4 divisions ± 0.4 divisions.
- i. Remove the cable from the MAIN SWP OUT, and connect it to the back-panel SWEEP GATE. Adjust the Test Oscilloscope to normal (not auto) triggering, dc coupling for vertical and trigger signals, and negative trigger slope. Adjust the Test Oscilloscope trigger level near the middle of the range in which triggering occurs.

NOTE

This setup of the Test Oscilloscope will be used in an upcoming step, in which the trigger level adjustment is somewhat difficult. Leave the settings on the Test Oscilloscope as they are through the end of this Part.

- j. **CHECK**—that the low level of the signal is in the range of 0 – 0.5 V, and the high level of the signal is in the range of 2.4 – 5 V.
- k. On the 11301/11302, set the trigger to Auto, and set the main trigger level to its maximum value (5 V). Select the **2 ns Step Holdoff** and rotate the left knob one click. Observe that the **Holdoff** readout indicates in the range of 15.999999 – 16.000001 ms.
- l. Select the MEASURE COUNTER mode of **Period Measure, A Ext Source**. Remove the cable from the Test Oscilloscope and use it to connect the SWEEP GATE to the A EXT INPUT.
- m. From the TRIGGER SOURCE menu, select **A Ext $\div 5$** as the main trigger source, to set the A EXT INPUT sensitivity. Then select **L1** as the main trigger source.
- n. Adjust the **CT Ext A** trigger level to 1.500 V.

- o. **CHECK**—that the measured period is in the range of 15.99999 – 16.00001 ms. For Option 1T additional digits will be displayed.
- p. Select **Time TRIGGER HOLDOFF**, and select **Off Measure** on the counter. Remove the cable from between the SWEEP GATE and the A EXT INPUT.
- q. Set the **HORIZONTAL SIZE** to 10 ms/div.
- r. Move the BNC cable connected to the Calibration Generator from the plug-in input to the rear-panel **TRIGGER RESET** connector. Set the Calibration Generator for an Amplitude of 5 V.
- s. **CHECK**—that the 11301/11302 sweep does not traverse the full width of the screen, and that the beeper sounds continually.
- t. Connect the rear-panel **TRIGGER READY** output to the Test Oscilloscope.
- u. Set the **HORIZONTAL SIZE** to 1 ms/div. Use the **TRIGGER LEVEL** menu to establish **Single Mode**.

NOTE

*When in **Single Mode** the knobs and buttons will not respond in a normal manner, and the 11301/11302 may appear to be “locked up.” Normal operation may be reestablished by removing the **TRIGGER RESET** signal and touching any button.*

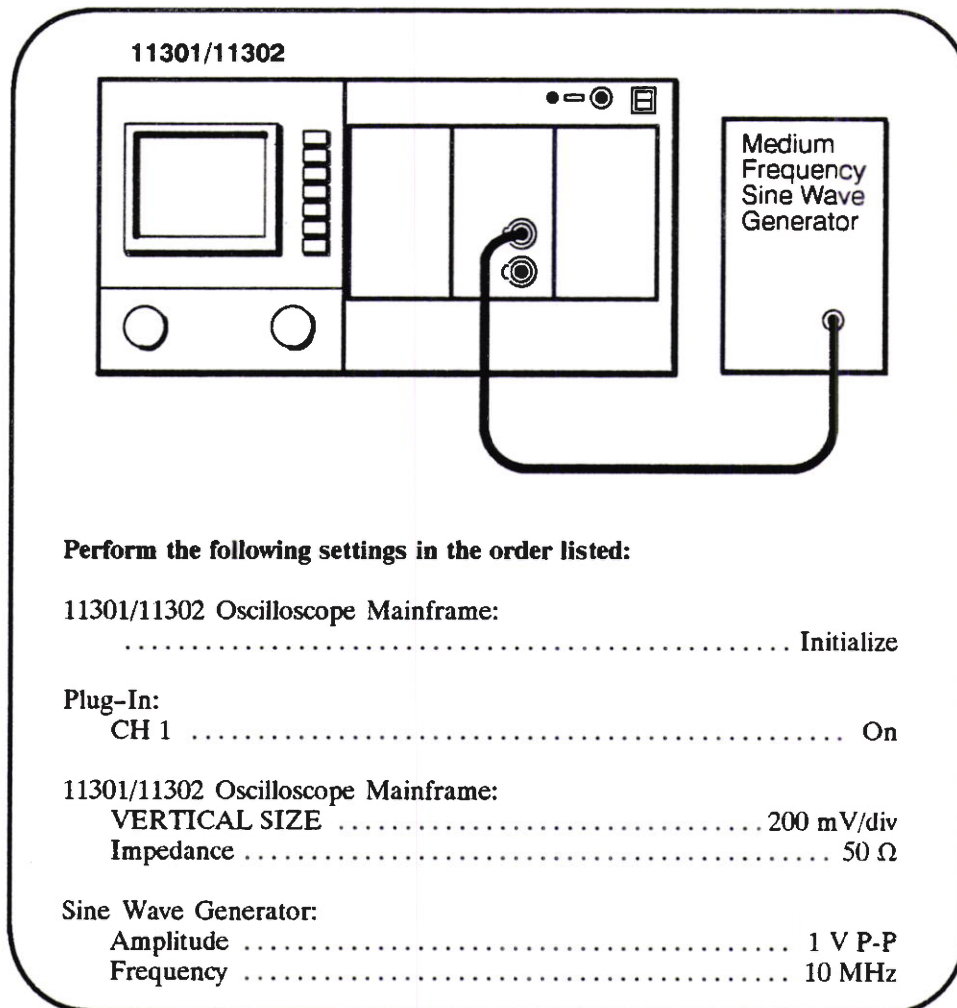
- v. **CHECK**—that the low level of the signal on the Test Oscilloscope is in the range of 0 – 0.5 V, and the high level of the signal is in the range of 2.4 – 5 V.

NOTE

*If you are performing an Incoming Inspection Procedure upon the plug-in installed in the **LEFT** compartment, detour and perform that procedure before continuing on to Part 16.*

Part 16: Clock In/Out

Setup



Procedure

NOTE

The CENTER plug-in compartment is being tested in the next few Parts. If you do not have a plug-in in the CENTER compartment, power down the oscilloscope and move the plug-in from the LEFT compartment to CENTER. You may proceed with this Part and with Part 17 without waiting for the 20-minute warm-up period to permit ENHANCED ACCURACY.

- a. Use the MEASURE COUNTER button to bring up **Freq Measure**, and refine the Sine Wave Generator frequency to a range from 9.99 – 10.1 MHz.

- b. Use the **UTILITY** menu's **I/O BNC** selector to set the clock to **Ext 10 MHz**.
- c. **CHECK**—for the message **Counter Timer PLL unlocked** being on the screen.
- d. Use a BNC T Adaptor to connect the incoming signal to the rear-panel **COUNTER REF CLOCK** connector, as well as the plug-in input.
- e. **CHECK**—that the **Freq** readout is from 9.999993 – 10.000007 MHz.
- f. Disconnect the **COUNTER REF CLOCK** cable and BNC T Adaptor from the plug-in, leaving only the Sine Wave Generator attached to the plug-in input. Cable from the **COUNTER REF CLOCK** through a 50 Ω terminator to the input of a Digital Counter. (You should have one cable from the Sine Wave Generator to the plug-in input, and a second cable from the **COUNTER REF CLOCK** connector to a 50 Ω terminator on the Digital Counter input.) Return the clock reference back to internal (**UTILITY MENU I/O BNC** selector).

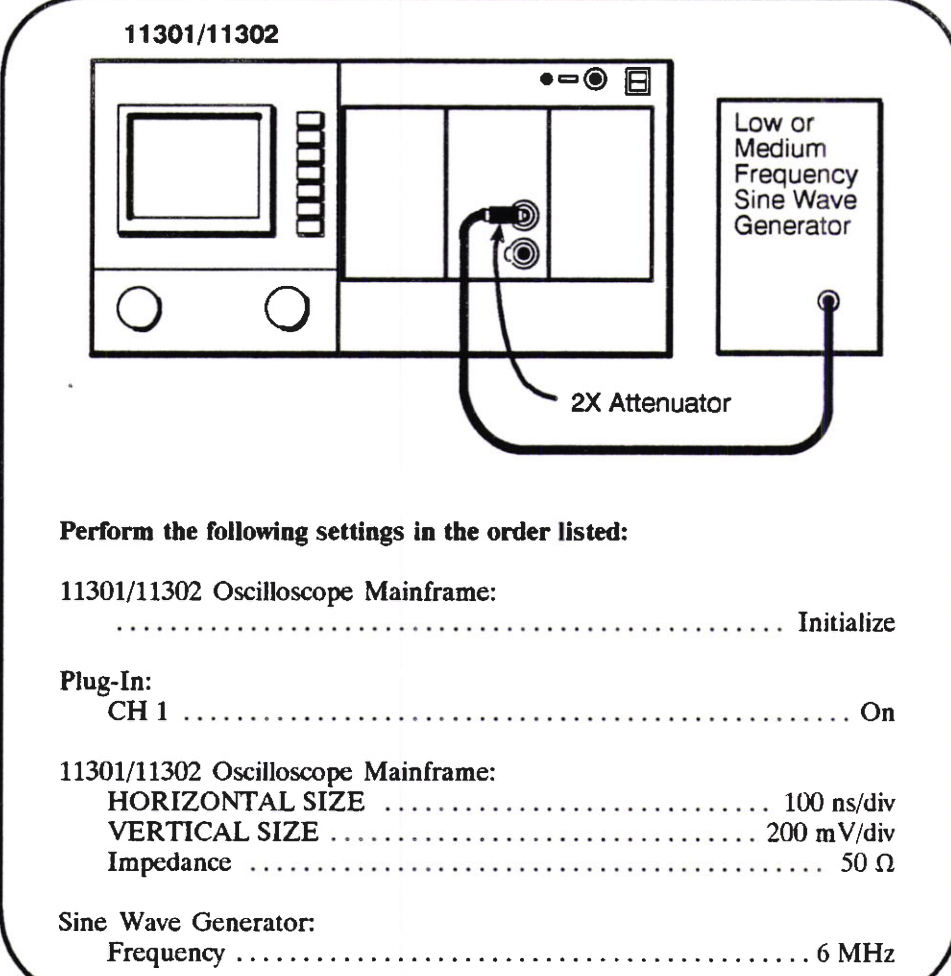
NOTE

In the next steps, the Digital Counter being used must be thoroughly warmed up. Ideally, it should have been turned on at the beginning of this entire Incoming Inspection Procedure.

- g. On the Digital Counter, select a frequency measuring mode with a short gating period. Adjust the trigger level near the middle of the range in which triggering occurs. Select a gating period that resolves to 1 Hz on a 10 MHz measurement.
- h. **CHECK**—that the frequency measured on the Digital Counter is within the range 9.999950 – 10.000050 MHz, or for Option 1T, 9.999988 – 10.000012 MHz.

Part 17: Vertical Bandwidth

Setup



11301/11302

Low or Medium Frequency Sine Wave Generator

2X Attenuator

Perform the following settings in the order listed:

11301/11302 Oscilloscope Mainframe: Initialize

Plug-In:
CH 1 On

11301/11302 Oscilloscope Mainframe:
HORIZONTAL SIZE 100 ns/div
VERTICAL SIZE 200 mV/div
Impedance 50 Ω

Sine Wave Generator:
Frequency 6 MHz

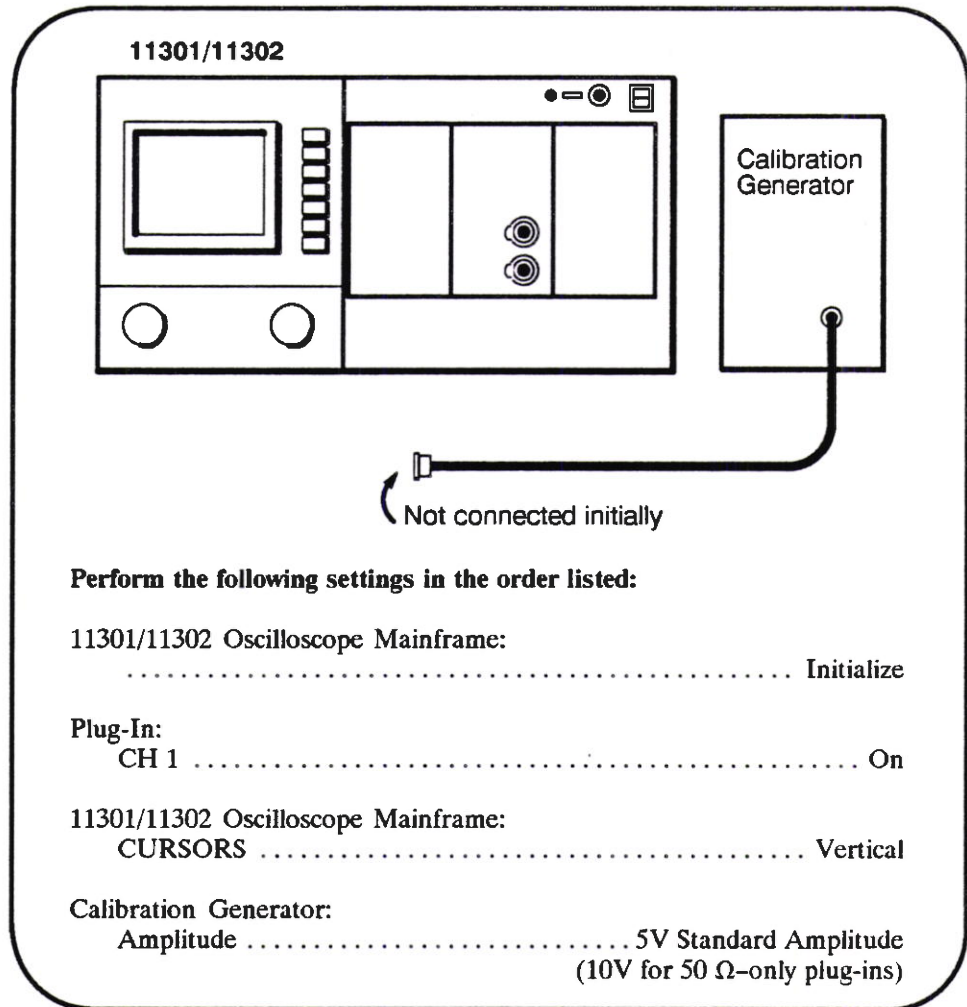
Procedure

- a. Press the VERTICAL SIZE button below the screen. **CHECK**—to ensure that Sine Wave Generator you are using is capable of producing the frequency listed on the screen as the **HF Limit**.
- b. Adjust the amplitude of the Sine Wave Generator to produce a 6-division high displayed waveform. Use VERTICAL POS to vertically center the waveform if necessary.
- c. Display the vertical cursors, and adjust them to the top and bottom of the waveform.
- d. Touch the **Set Ref** region of the screen.
- e. Touch the **%-dB** region of the screen to select it on.

- f. *CHECK*—that the readout indicates $\Delta\text{Vert} = 100\%$ and $\Delta\text{Vert} = 0$ dB, and that the reference amplitude (immediately above **Set Ref**) is between 5.90 and 6.10 divisions.
- g. Set the Sine Wave Generator to the frequency indicated as the **HF Limit**. If necessary, you can display this limit by pressing the **VERTICAL SIZE** button. Do not change the amplitude of the Sine Wave Generator.
- h. Adjust the **INTENSITY** and **HORIZONTAL SIZE** as required to achieve a viewable waveform on the display.
- i. Realign the vertical cursors to the new top and bottom of the waveform.
- j. *CHECK*—that the ΔVERT cursor readout indicates a value of 70.7% or greater.

Part 18: Vertical Cursor Accuracy

Setup



Procedure

NOTE

This Part requires that the 11301/11302 be in Enhanced Accuracy mode. If you powered off the oscilloscope to move the plug-in just before Part 16, be sure to press ENHANCED ACCURACY now to calibrate the oscilloscope. If it has been less than 20 minutes since that power down, you will need to wait for the complete warm-up timeout before being able to perform the Enhanced Accuracy calibration.

- a. Adjust the reference cursor (LEFT KNOB) to the vertical center of the trace. Bisect the trace as exactly as possible, using the FINE setting of the knob.

- b. *CHECK*—that the **Vert Ref** readout is within specifications of Table 5 on the next page.
- c. Connect the Calibration Generator output to the Plug-In CH 1 input.
- d. Center the trace vertically on the screen.
- e. Set the main horizontal size to 500 $\mu\text{s}/\text{div}$.
- f. Align the cursors to the waveform base and top. Place the reference cursor at the waveform base, and the other cursor at the top.
- g. *CHECK*—that the ΔVert readout is within the specifications of Table 5.

Table 5 - Vertical Cursor Tolerances

Plug-In Type	DC Balance (Step b.)	ΔVert Accuracy (Step g.)
11A32	$\pm 230 \text{ mV}$	4.910 – 5.090 V
11A33	$\pm 180 \text{ mV}$	4.890 – 5.110 V
11A34	$\pm 230 \text{ mV}$	4.910 – 5.090 V
11A52	$\pm 150 \text{ mV}$	4.910 – 5.090 V
11A71	$\pm 200 \text{ mV}$	4.905 – 5.095 V

Part 19: Measurement Accuracy

Setup

As left from previous test.

Procedure

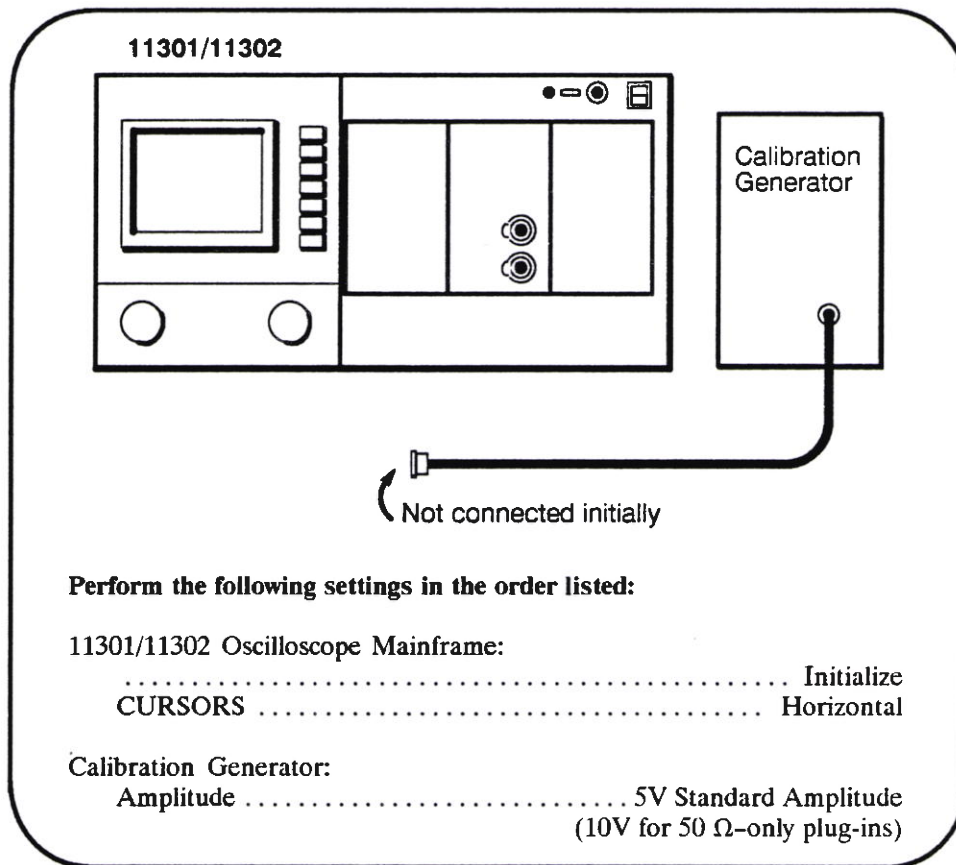
- a. Press the **MEASURE** menu button, and select **Min**, **Max**, and **P-P** measurements. Touch **START**.
- b. **CHECK**—that the measurement values that appear on the screen fall within the following ranges:

Table 6 - Measurement Tolerances

Plug-In Type	P-P	Max	Min
11A32	4.360 – 5.640 V	4.370 – 5.630 V	± 630 mV
11A33	4.340 – 5.660 V	4.420 – 5.580 V	± 580 mV
11A34	4.360 – 5.640 V	4.370 – 5.630 V	± 630 mV
11A52	4.360 – 5.640 V	4.450 – 5.550 V	± 550 mV
11A71	4.355 – 5.645 V	4.400 – 5.600 V	± 600 mV

Part 20: X-Axis Cursor Accuracy

Setup



Procedure

- Use the WAVEFORM button to define an XY trace representing **L vs C1**.
- Adjust XY INTENSITY to dim the resultant dot waveform to a level low enough to prevent possible crt damage.
- Adjust the reference cursor (LEFT KNOB) to the center of the dot. Use the FINE knob adjustment.
- CHECK**—that the Horiz Ref readout is within specifications of Table 7 on the next page.
- Connect the Calibration Generator output to the Plug-In CH1 input.
- Use HORIZONTAL POS to center the two dots on the screen.
- Readjust the reference cursor (LEFT KNOB) to the center of the left dot, and use the RIGHT KNOB to adjust the other cursor to the center of the right dot.

- h. CHECK—that the Δ Horiz readout is within the specifications of Table 7.

Table 7 - Horizontal Cursor Tolerances

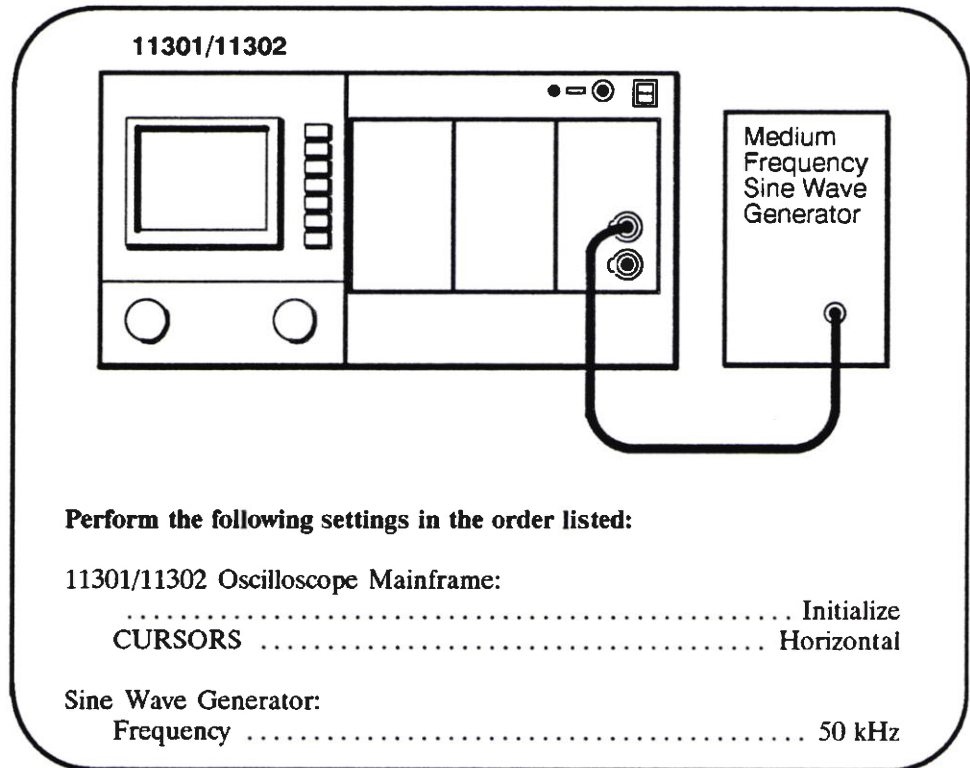
Plug-In Type	DC Balance (Step d.)	Δ Horiz Accuracy (Step h.)
11A32	± 330 mV	4.885 – 5.115 V
11A33	± 280 mV	4.865 – 5.135 V
11A34	± 330 mV	4.885 – 5.115 V
11A52	± 250 mV	4.885 – 5.115 V
11A71	± 300 mV	4.880 – 5.120 V

NOTE

If you are performing an Incoming Inspection Procedure upon the plug-in installed in the CENTER compartment, detour and perform that procedure before continuing on to Part 21. If the plug-in you are using in the CENTER compartment has already been so inspected in the LEFT compartment, there is no need to repeat that procedure in the CENTER compartment.

Part 21: Right Plug-In Compartment

Setup



Procedure

NOTE

The RIGHT plug-in compartment is being tested in this Part. If you do not have a plug-in in the RIGHT compartment, power down the oscilloscope and move the plug-in from the CENTER compartment to RIGHT. You may proceed with this Part without waiting for the 20-minute warm-up period to permit ENHANCED ACCURACY.

- Use the WAVEFORM button to define an XY trace representing L vs R1.
- Adjust XY INTENSITY to dim the resultant dot waveform to a level low enough to prevent possible crt damage.
- Use the TRIGGER SOURCE button to select R1 as the main trigger source. Use the TRIGGER LEVEL button to select **Auto Mode** and adjust the main trigger level to 0V, in that order.
- Use HORIZONTAL SIZE to set R1 to 100 mV/div.
- Adjust the Sine Wave Generator Amplitude for a 7-division horizontal deflection.

- f. Adjust the cursors to the ends of the waveform and verify that the Δ Horiz readout indicates a range from 690 – 710 mV.
- g. Touch %–dB to turn it on and touch Set Ref. Verify that the Δ Horiz readouts indicate 100% and 0 dB. (On some early versions of firmware, the %–dB area is mislabeled %–Degree.)
- h. Change the Frequency of the Sine Wave Generator to 3 MHz, without changing its Amplitude.
- i. Adjust the cursors to the ends of the waveform.
- j. **CHECK**—that the Δ Horiz readout indicates a value of 70.7% or larger.
- k. Change the HORIZONTAL SIZE to set R1 to 1 V/div.
- l. **CHECK**—that the main trigger level can be adjusted so that the M TRIG'D light is illuminated. Use the FINE knob setting if necessary.
- m. Use the WAVEFORM button to select an additional trace of L or L1. Select window 1 on and Trig'd After Dly. Use the TRIGGER SOURCE button to set R1 as the trigger source for the delay 1 trigger.
- n. **CHECK**—that the delay 1 trigger level can be adjusted so that the D TRIG'D light is illuminated. Use the FINE knob setting if necessary.

NOTE

If you wish to perform an Incoming Inspection Procedure upon the plug-in installed in the RIGHT compartment, you will need to reconfigure the system so that this plug-in is installed in either the LEFT or CENTER compartments. The capabilities of the RIGHT compartment are limited, and this compartment cannot be used for a plug-in Incoming Inspection Procedure. If the plug-in you are using in the RIGHT compartment has already been inspected in either the LEFT or CENTER compartments, there is no need to repeat the Incoming Inspection Procedure.

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

