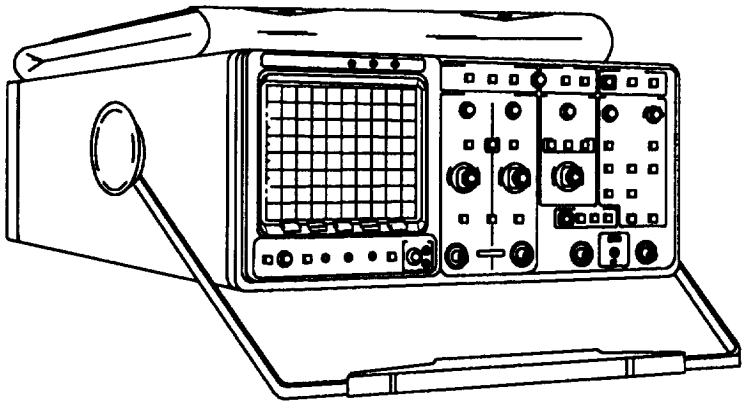
ARMY
MARINE CORPS

TM 11-6625-3241-12
TM 09045 B-12/1

TECHNICAL MANUAL

OPERATOR'S AND UNIT MAINTENANCE MANUAL



OSCILLOSCOPE OS-291/G (NSN 6625-01-258-0022)

DEPARTMENT OF THE ARMY
AND HEADQUARTERS, MARINE CORPS

01 MAR 1991

5 SAFETY STEPS TO FOLLOW IF SOMEONE IS THE VICTIM OF ELECTRICAL SHOCK

1 DO NOT TRY TO PULL OR GRAB THE INDIVIDUAL

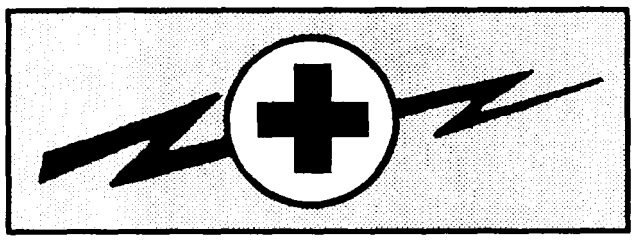
2 IF POSSIBLE, TURN OFF THE ELECTRICAL POWER

3 IF YOU CANNOT TURN OFF THE ELECTRICAL POWER, PULL, PUSH, OR LIFT THE PERSON TO SAFETY USING A DRY WOODEN POLE OR A DRY ROPE OR SOME OTHER INSULATING MATERIAL

4 SEND FOR HELP AS SOON AS POSSIBLE

5 AFTER THE INJURED PERSON IS FREE OF CONTACT WITH THE SOURCE OF ELECTRICAL SHOCK, MOVE THE PERSON A SHORT DISTANCE AWAY AND IMMEDIATELY START ARTIFICIAL RESUSCITATION

WARNING



HIGH VOLTAGE

is used in the operation of this equipment.

DEATH ON CONTACT

may result if personnel fail to observe safety precautions.

Never work on electronic equipment unless there is another person nearby who is familiar with the operation and hazards of the equipment and who is competent in administering first aid. When the technicians are aided by operators, they must be warned about dangerous areas.

A periodic review of safety precautions in TB 385-4, Safety Precautions for Maintenance of Electrical/Electronic Equipment, is recommended. When the equipment is operated with covers removed, DO NOT TOUCH exposed connections or components. MAKE CERTAIN you are not grounded when making connections or adjusting components inside the test instrument.

Be careful not to contact high-voltage connections or 115 volt AC input connections when installing or operating this equipment.

Whenever the nature of the operation permits, keep one hand away from the equipment to reduce the hazard of current flowing through the body.

WARNING

Do not be misled by the term “low voltage.”
Potentials as low as 50 volts may cause death under adverse conditions.

For Artificial Respiration, refer to FM 21-11.

TECHNICAL MANUAL
No. 11-6625-3241-12
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DEPARTMENT OF THE ARMY
AND HEADQUARTERS. MARINE CORPS
Washington, DC 01 March 1991

OPERATOR'S AND UNIT MAINTENANCE MANUAL FOR OSCILLOSCOPE OS-291/G (NSN 6625-01-258-0022)

REPORTING ERRORS AND RECOMMENDING IMPROVEMENTS

You can help improve this manual. If you find any mistakes or if you know of a way to improve the procedures, please let us know. Mail your letter, DA Form 2028 (Recommended Changes to Publications and Blank Forms), or DA Form 2028-2 located in the back of this manual direct to: Commander, U. S. Army Communication- Electronics Command, ATTN: AMSEL-LC-LM-LT, Fort Monmouth, New Jersey 07703-5000. Marine Corps Units, submit NAVMC 10772 (Recommended Changes to Technical Publications) to: Commanding General, Marine Corps Logistics Base (Code 850) Albany, Georgia 31704-5000. A reply will be furnished to you.

HOW TO USE THIS MANUAL

This manual tells about the Oscilloscope OS-291/G and contains instructions on how to use it while testing and maintaining other electronic equipment.

The technical manual for the other electronic equipment being maintained will give guidance in the correct method to make certain connections when testing and troubleshooting with this oscilloscope.

When first receiving this oscilloscope, start at the front of the manual and go all the way through to the back. Become familiar with every part of this manual and the OS-291/G.

This manual has an edge index which will help find specific information quickly. Simply spread the pages on the right edge of the manual until the printed blocks can be seen. Open the manual where the block on the edge of the page lines up with the selected topic printed on the front cover block.

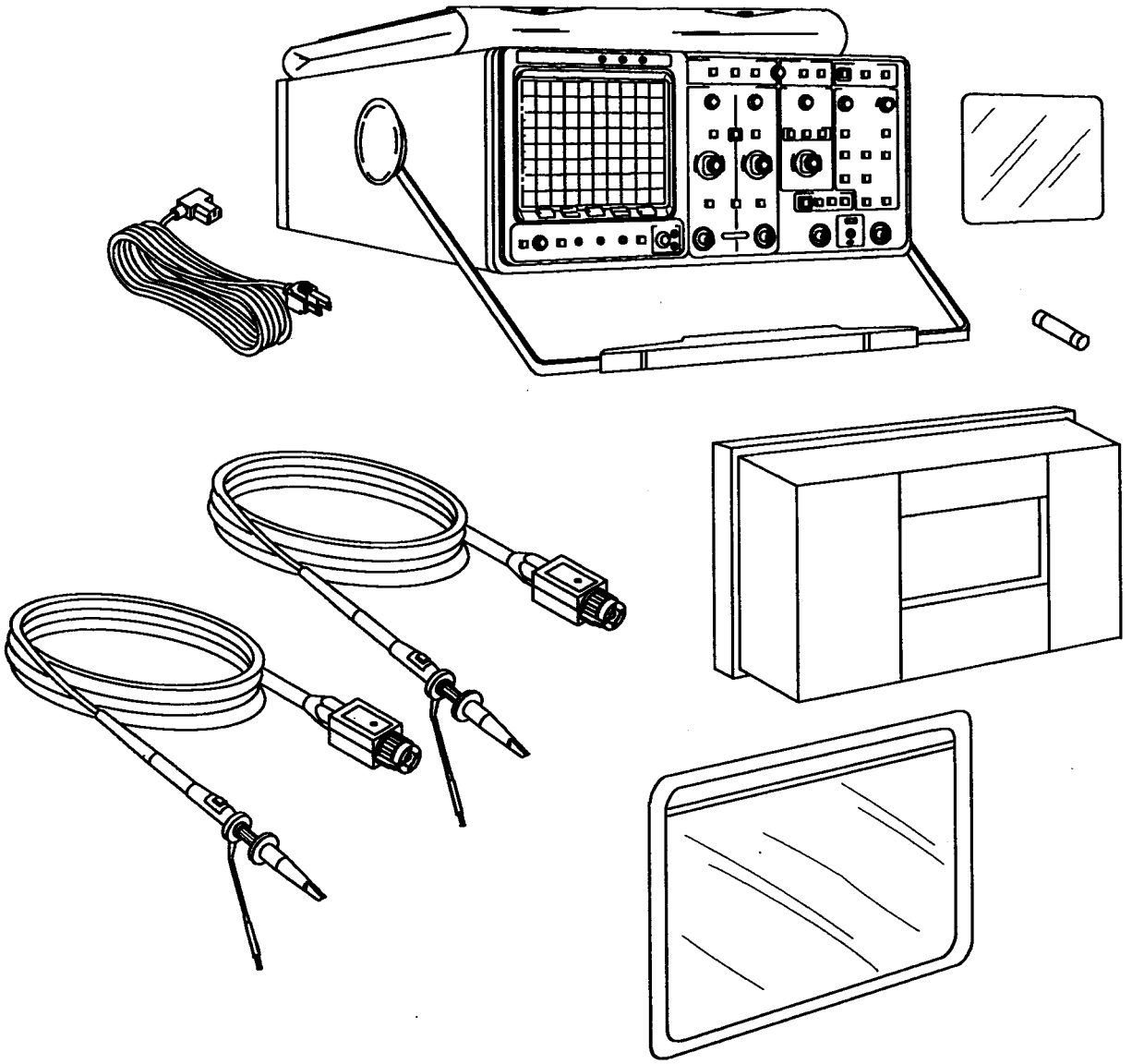


Figure 1-1. Oscilloscope OS-291/G.

CHAPTER 1
INTRODUCTION

Section I. GENERAL INFORMATION

1-1. SCOPE.

a. **Type of Manual.** Operator's and Unit Maintenance Manual.

b. **Equipment Name and Model Number:** Oscilloscope OS-291/G.

c. **Purpose of the Equipment:** The oscilloscope can acquire and digitize input signals, process the information, and display or store the results.

1-2. CONSOLIDATED INDEX OF ARMY PUBLICATIONS AND BLANK FORMS.

Refer to the latest issue of DA PAM 25-30 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. Marine Corps personnel refer to the latest issue of SL-1-2 to determine whether there are any new additions.

1-3. MAINTENANCE FORMS, RECORDS, AND REPORTS.

a. Reports of Maintenance and Unsatisfactory Equipment. Department of the Army forms and procedures used for equipment maintenance will be those prescribed by DA PAM 738-750, as contained in Maintenance Management Update. Marine Corps maintains forms and procedures as prescribed by TM 4700-15/1.

b. Report of Item and Packaging Deficiencies. Fill out and forward SF 364, Report of Discrepancy (ROD), as prescribed in AR 735-11-2/DLAR4140.55/NAVMATINST 4355.18/AFR400-54/MCO 4430.3J.

c. Transportation Discrepancy Report (TDR) (SF 361). Fill out and forward Transportation Discrepancy Report (TDR) (SF 361) as prescribed in AR 55-38/NAVSUPlNST 4610.33C/AFR 75-18/MCOP4610.19D/DLAR 4500.15.

1-4. ADMINISTRATIVE STORAGE.

Administrative storage of equipment issued to and used by Army activities will have preventive maintenance performed in accordance with the PMCS procedures before storing. When removing the equipment from administrative storage the PMCS should be performed to assure operational readiness.

1-5. DESTRUCTION OF ARMY ELECTRONICS MATERIEL TO PREVENT ENEMY USE.

Destruction of Army materiel to prevent enemy use is described in TM750-244-2.

1-6. REPORTING EQUIPMENT IMPROVEMENT RECOMMENDATIONS (EIR).

a. **Army.** If your Oscilloscope OS-291/G needs improvement, let us know. Send us an EIR. You, the user, are the only one who can tell us what you don't like about your equipment. Let us know why you don't like the design or performance. Put it on an SF 368 (Product Quality Deficiency Report). Mail it to us at: Commander, US Army Communications-Electronics Command and Fort Monmouth, ATTN: AMSEL-ED–PH, Fort Monmouth, New Jersey 07703-5000, We'll send you a reply.

b. **Marine Corps Users.** ODR shall be reported on SF 368 in accordance with MCO P4855.10, Product Quality Deficiency Report Manual. Submit to Commanding General, Marine Corps Logistics Base (Code 856), Albany, Georgia 31704-5000.

1-7. WARRANTY INFORMATION.

The Oscilloscope, OS-291/G is warranted by Tektronix for three years. Warranty starts on the date of shipment to the original buyer. Report all defects in material or workmanship to your supervisor who will take. appropriate action.

1-8. NOMENCLATURE CROSS-REFERENCE LIST.

Common names will be used when the Oscilloscope OS-291/G is mentioned in this manual.

N O T E

Official nomenclature must be used when filling out report forms or looking up technical manuals.

Common Name	Official Nomenclature
Instrument	Oscilloscope OS-291/G
Oscilloscope	Oscilloscope OS-291/G
OS-291	Oscilloscope OS-291 /G
OS-291 /G	Oscilloscope OS-291/G
Scope	Oscilloscope OS-291/G

1-9. LIST OF ABBREVIATIONS.

This list identifies abbreviations and descriptions that are used in this manual.

CCW	Counterclockwise
CMRR	Common Mode Rejection Ratio
FPP	Front Panel Processor
GPIB	General Purpose Interface Bus
HO	Hold Off
mP	Microprocessor
NVRAMS	Non-Volatile Random Access Memories
RAM	Random Access Memory
VSWR	Voltage Standing Wave Ratio
WP	Waveform Processor
P-P	Peak-to-Peak
DL	Digitization Level

Section II. EQUIPMENT DESCRIPTION

1-10. EQUIPMENT CHARACTERISTICS, CAPABILITIES, AND FEATURES.

a. **Characteristics.**

- Allows for:
  Frequency measurements.
  Period measurements.
  ADD mode measurements.
  Ratio measurements.
  Amplitude measurements.
  Delay by Events measurements.
  Mult mode measurements.
- Designed for benchtop use.

b. **Capabilities And Features**

- Auto Setup.
- Power-Up Self Test.
- Help messages for convenient operator assistance.
- Menu-driven for user-friendly operation.
- Soft push-button control allows for easy operation.
- LED indicators on front panel for constant equipment status.
- Extended-Diagnostic error tables define circuit failure.
- Programmed interface for remote operation.

1-11. EQUIPMENT DATA.

WEIGHT AND DIMENSIONS

Weight	28.1 lbs(12.8kg)
Length	18.86 in (479 mm)
Width	13.0 in (330 mm)
Height	6.3 in (160 mm)

POWER REQUIREMENTS

115VAC operation	90 to 132 VAC
230 VAC operation	180 to 250 VAC
Frequency	48 to 440Hz
Power	300 VA maximum
Fuse	5 amp, 250 V

ENVIRONMENTAL

operating temperature range	5° to 131 °F (-15° to+55°C)
Storage temperature range	-80 ° to 185 °F (-62° to + 85°C)
Relative humidity	
30°c to 55°c	95% maximum
Operating altitude	0 to 15,000 ft (4,500 meters)
Storage altitude	0 t0 50,000 ft (15,000 meters)
Vibration	4 g
Shock	50 g

TRIGGER

Minimum P-P Signal Amplitude for Stable Triggering from CH 1, CH 2, or ADD

A Trigger

DC Coupled . . . . . .0.35 division from DC to 50 MHz, increasing to 1.0 division at 150 MHz; 1.5 divisions at 150 MHz in ADD mode

NOISE REJ Coupled . . . . . 1.2 divisions or less from DC to 50 MHz, increasing to 3 division at 150 MHz; 4.5 divisions at 150 MHz in ADD mode

AC Coupled . . . . . 0.35 division from 60 Hz to 50 MHz; increasing to 1.0 division at 150 MHz, 1.5 divisions at 150 MHz in ADD mode. Attenuates signals below 60 Hz

HF REJ Coupled . . . . . .0.50 division from DC to 30 kHz. Attenuates signals above 30 kHz

LF REJ Coupled . . . . . .0.50 division from 80 kHz to 50 MHz; increasing to 1.0 division at 150 MHz; 1.5 divisions at 150 MHz in ADD mode. Attenuates signal below 80 kHz

B Trigger . . . . . Multiply all A Trigger specifications by two

A* B Selected . . . . . Multiply all A Trigger specifications by two

Minimum P-P Signal Amplitude for Stable Triggering from EXT TRIG 1 or EXT TRIG 2 Source

A Trigger

EXT Gain = 1

Decoupled . . . . . 17.5 mV from DC to 50 MHz, increasing to 50 mV at 150 MHz

NOISE REJ Coupled . . . . . 60 mV or less from DC to 50 MHz; increasing to 150 mV at 150 MHz

AC Coupled . . . . . 17.5 mV from 60 Hz to 50 MHz; increasing to 50 mV at 150 MHz. Attenuates signals below 60 Hz

HF REJ Coupled . . . . . 25 mV from DC to 30 kHz

LF REJ Coupled . . . . . 25 mV from 80 kHz to 50 MHz; increasing to 50 mV at 150 MHz

EXT Gain = ÷ 5 . . . . . Amplitudes are five times those specified for Ext Gain = 1

B Trigger . . . . . Multiply all A Trigger amplitude specifications by two

A* B Selected . . . . . Multiply all A Trigger amplitude specifications by two

Maximum P-P Signal Rejected by NOISE REJ Coupling Signals within the Vertical Bandwidth

CH 1or CH 2 Source . . . . . 0.4 division or greater for VOLTS/DIV settings of 10 mV and higher. Maximum noise rejected is reduced at 2 mV per division and 5 mV per division

EXT TRIG 1 or EXT TRIG 2 Source . . . . . 20 mV or greater when Ext Trig Gain = 1.100 mV or greater when Ext Trig Gain = ÷ 5

EXT TRIG 1 and EXT TRIG 2 Inputs

Resistance . . . . . 1 Megohm ± 1%

Capacitance . . . .15pF ±3pF

Maximum Input Voltage . . . . . 400 V (DC + peak AC); 800 V p-p AC at 10 kHz or less

LEVEL Control Range

CH 1or CH 2 Source . . . . . ±18 divisions times the VOLTS/DIV setting

EXT GAIN = 1 . . . . . ±0.9V

EXT GAIN = ÷ 5 . . . .±4.5V

LEVEL Readout Accuracy (for triggering signals with transition times greater than 20 ns)

CH 1 or CH 2 Source

DC Coupled

+15 °C to + 35°C . . . . . Within ± [3% of setting +3% of p-p signal + (0.2 division x VOLTS/DIV setting) +0.5 mV + (0.5 mV x probe attenuation factor)]

-15°C to+55°C . . . . . Add (1.5 mV x probe attenuation) to + 15°C to (excluding + 15°C to + 35°C) + 35°C specification

NOISE REJ Coupled . . . . . Add ± (0.6 division x VOLTS/DIV setting) to DC Coupled specifications

EXT TRIG 1 or EXT TRIG 2 Source

EXT GAIN = 1

DC Coupled . . . . Within ± [3% of setting + 4% of p-p signal +10 mV + (0.5 mV x probe attenuation factor)]

NOISE REJ Coupled . . . . . Add ± 30 mV to DC Coupled specifications

EXT GAIN = ÷ 5

De coupled . . . . . Within ± [3% of setting + 4% of p-p signal + 50 mV + (0.5 mV x probe attenuation factor)]

NOISE REJ Coupled . . . . . Add ± 150 mV to DC Coupled specifications

Variable A Trigger Hold off:

A SEC/DIV	Min. Holdoff	Max. Holdoff
5 ns 10 ns 20 ns 50 ns 100 ns 200 ns	2 – 4 µs	9 – 15 µs
500 ns	5 – 10 µs	
1 µs 2 µs 5 µs	10 – 20 µs 20 – 40 µs 50 – 100 µs	100 – 150 µs
10 µs 20 µs 50 µs	0.1 – 0.2 ms 0.2 – 0.4 ms 0.5 – 1.0 ms	1 – 1.5 ms
100 µs 200 µs 500 µs	1 – 2 ms 2 – 4 ms 5 – 10 ms	10 – 15 ms
1 ms 2 ms 5 ms	10 – 20 ms 20 – 40 ms 50 – 100 ms	90 – 150 ms
10 ms 20 ms 50 ms	0.1 – 0.2 s 0.2 – 0.4 s 0.5 – 1.0 s	0.9 – 1.5 s

A SEC/DIV	Min. Holdoff	Max. Holdoff
100 ms 200 ms	1 – 2 s 2 – 4 s	9 – 15 s
500 ms 1 s 2 s 5 s	5 – 10 s	

SLOPE Selection . . . . . Conforms to trigger-source waveform and AC-power-source waveform

Trigger Position Jitter (p-p)

SEC/DIV 0.5 µs per Division or Greater

A and B Triggered Sweeps . . . .0.04 times the SEC/DIV setting

B RUNS AFTER Delay . . . . 0.08 times the SEC/DIV setting

SEC/DIV 0.2 µs per Division or Less . . . . . (0.02 x SEC/DIV setting) + 300 ps

ACQUISITION SYSTEM - CH 1 AND CH 2

Resolution . . . .8 bits

Record Length . . . . . .1024 samples

Sample Rate . . . . . 10 samples per second to 100 mega samples per second (5 s per division to 500 ns per division)

Sensitivity

Range . . . . . 80 µV per Digitization Level to 0.2 V per Digitization Level in a 1-2-5 sequence of 11 steps (2mV per division to 5V per division)

Accuracy

Normal and Average Modes . . . . . Within ± (2% + 1 Digitization Level) at any VOLTS/DIV setting for a signa 1 kHz or less contained within ±75 Digitization Level (±3 divisions) of center when an Autocal has been performed within ±15°C of the operating temperature. Measured on a four-or five-division signal with VOLTS or V@T cursors; UNITS set to delta volts

Envelope Mode . . . . . Add 1% to Normal Mode specifications

Variable Range . . . . . Continuously variable between VOLTS/DIV settings. Extends sensitivity to 0.5 V per Digitization Level or greater, 12.5 V per division or greater

Bandwidth

Normal and Average Mode; Repeat off;
SEC/DIV at 0.5 µs or Faster . . . . DC to 40 MHz

Normal and Average Modes with Repeat On or Continuous Envelope Mode; SEC/DIV at 0.2 µs or Faster (-3dB Bandwidth) . . . . DC to150 MHz

AC Coupled Lower -3 dB Point

1X Probe . . . . . .10 Hz or less

10X Probe . . . . . .1 Hz or less

Step Response, Repeat and Average On:

Average Set to 16

Rise Time . . . .2.3 ns or less

Envelope Mode Pulse Response

Minimum Single Pulse Width for 50% or Greater Amplitude Capture at 85% or Greater Confidence . . . .2 ns

Minimum Single Pulse Width for Guaranteed 50% or Greater Amplitude Capture . . . .4 ns

Minimum Single Pulse Width for Guaranteed 80% or Greater Amplitude Capture . . . .8 ns

Channel Isolation . . . . . 100:1 or greater attenuation of the deselected channel at 100 MHz; 50:1 or greater attenuation at 150 MHz for a 10-division input signal from5 mV/div to 500 mV/div; 50:1 or greater attenuation @100 MHz for 2 mV/div with equal VOLTS/DIV settings on both channels

Acquired CH 2 Signal Delay with Respect to CH1 Signal at Full Bandwidth . . . . ±250 ps

Input R and C (1 Megohm)

Resistance . . . . . 1 Megohm ± 0.5%

Capacitance . . . .15pF ± 2pF

Input R (50 ohms)

Resistance . . . .50 ohms ± 1%

VSWR (DC to 150 MHz) . . . . . 1.3:1 o r better

NOTE

Changing Front Panel settings before the oscilloscope has recovered from a 50 ohm Overload condition may cause the oscilloscope to ''lockup.'' lf the oscilloscope locks up, remove the cause of the overload and press the POWER switch off and then on.

Maximum lnput Voltage A . . . . . 5V rms:0.5 W-sec for any one-second interval for instantaneous voltages from 5V to 50V

Maximum Input Voltages A

Input Coupling Set to DC, AC,or GND . . . . . 400V (DC+ peak AC); 800 Vp-p AC at 10 kHz or less

Common-Mode Rejection Ratio (CMRR); ADD Mode with either Channel inverted . . . . . At least 10:1 at 50 MHz for common-mode signals of 10 divisions or less with VARIABLE VOLTS/DIV adjusted for best CMRR at 50 kHz

POSITION

Range . . . . . ± (9.3 to 10.4) div., at 50mV per division with INVERT off, when Self Cal has been done with ± 5°C of the operating temperature

Gain Match Between NORMAL and SAVE . . . . . ± 3 Digization Levels for positions within ±5 divisions from center .

Low-Frequency Linearity

Normal or Average Mode . . . . . 3 Digitization Levels or less compression or expansion of a two-division, center-screen signal when positioned anywhere within the acquisition window

20 MHz Bandwidth Limiter

-3 dB Bandwidth . . . .13 MHz to 24 MHz

50 MHz Bandwidth Limiter
-3 dB Bandwidth . . . .40 MHz to 55 MHz
Rise Time . . . .6.3 ns to 8.7 ns

TIME BASE

Sample Rate Accuracy
Average Over 100 or More Samples . . . .± 0.0015%
External Clock
Repetition Rate
Minimum . . . .1 MHz
Maximum . . . . . .100 MHZ
Events Count . . . .1 to 65,536
Events Maximum Repetition Rate . . . .100 MHz
Signal Levels Required for EXT Clock or
EVENTS CH 1or CH 2 SOURCE
De coupled . . . . . 0.7 division from DC to 20 MHz; increasing to 2.0 divisions at 100 MHz;3.0 divisions at 100 MHz in ADD mode
NOISE REJ Coupled . . . . . 2.4 divisions or less from DC to 20 MHz; increasing to 6.0 divisions at 100 MHz;9.0 divisions at 100 MHz in ADD mode
AC Coupled . . . . . 0.7 division from 60 Hz to 20 MHz; increasing to 2.0 division: at 100 MHz;30 divisions at 100 MHz in ADD mode. Attenuates signals below 60 Hz
HF REJ Coupled . . . . . 1.0 division from DC to 30 kHz. Attenuates signals above 30 kHz
LF REJ Coupled . . . . . 1.0 division from 80 kHz to 20 MHz; increasing to 2.0 divisions at 100 MHz;3.0 divisions at 100 MHz in ADD mode. Attenuates signals below 80 kHz
EXT TRIG 1 o r EXT TRlG 2 Source
Ext Gain = 1
De coupled . . . . . 35 mV from DC to 20 MHz; increasing to 100 mV at 100 MHz
NOISE REJ Coupled . . . 120 mV or less from DC to 20 MHz; increasing to 300 mV at 100 MHz
AC Coupled . . . . . 35 mV from 60 Hz to 20 MHz; increasing to 100 mV at 100 MHz. Attenuates signals below 60 Hz
HF REJ Coupled . . . . 50 mV from DC to 30 kHz
LF REJ Coupled . . . . . 50 mV from 80 kHz to 20 MHz; increasing to 100 mV at 100 MHz
Ext Gain = ÷ 5 . . . . . Amplitudes are five times those specified fo rExt Gain = 1
Delay Time Range . . . . . (0.04 X B SEC/DIV) to (65,536 x 0.04 x B SEC/DIV)
Delay Time Accuracy . . . . . Same as the sample rate accuracy
Delay Time Resolution . . . . . The greater of (0.04 x B SEC/DIV) or 20 ns

NONVOLATILE MEMORY

Front-Panel Setting, Waveform Data,
Sequencer, and Calibration Data Retention Time . . . . . Greater than 3 years
Battery . . . . . Battery is an integral part of the memory

Proprietary Data Removal From Memory . . . . . Executing a TEKSECURE Erase Memory deletes all saved waveforms, settings, and sequences stored in memory. To further assure that no proprietary data remains stored, all RAM, except those locations storing calibration constants, status/results, and the clock, are cleared. The scope is left with the default front-panel setup that you get by doing an INIT front panel.

SIGNAL OUTPUTS

CALIBRATOR . . . . . CALIBRATOR output amplitudes at 5 MHz are at least 50% of output amplitudes at 1 ms SEC/DIV setting

Voltage (with A SEC/DIV switch set to 1 ms)

1Megohm Load . . . . . 0.4 V±1%

50 ohm Load . . . .0.2 V± 1.5%

Current (short circuit load with A SEC/DIV switch set to 1 ms) . . . . . 8 mA ± 1.5%

Repetition Period:

A SEC/DIV Setting	Calibrator Frequency	Calibrator Period	Div/ Cycle
5 ns	5 MHz	200 ns	40
10 ns	5 MHz	200 ns	20
20 ns	5 MHz	200 ns	10
50 ns	5 MHz	200 ns	4
100 ns	5 MHz	200 ns	2
200 ns	5 MHz	200 ns	1
500 ns	500 kHz	2 µs	4
1 µs	500 kHz	2 µs	2
5 µs	50 kHz	20 µs	4
10 µs	50 kHz	20 µs	2
20 µs	50 kHz	20 µs	1
50 µs	5 kHz	200 µs	4
100 µs	5 kHz	200 µs	2
200 µs	5 kHz	200 µs	1
500 µs	500 Hz	2 ms	4
1 ms	500 Hz	2 ms	2
2 ms	500 Hz	2 ms	1
5 ms	50 Hz	20 ms	4
10 ms	50 Hz	20 ms	2
20 ms	50 Hz	20 ms	1
50 ms	50 Hz	20 ms	0.4
100 ms	50 Hz	20 ms	0.2
200 ms	50 Hz	20 ms	0.1
500 ms	50 Hz	20 ms	0.04
1 s	50 Hz	20 ms	0.02
2 s	50 Hz	20 ms	0.01
5 s	50 Hz	20 ms	0.004

Accuracy . ... ±0.0015%

Symmetry . . . . . Duration of high portion of output cycle is 50% of output period ± (lesser of 500 ns or 25% of period)

CH 2 SIGNAL OUTPUT

Output Voltage . . . . . 20 mV per division ± 10% into 1 Megohm
10 mV per division ± 10% into 50 ohms

Offset . . . . . ± 10 mV into 50 ohms when DC balance has been performed within ±5°C of the operating temperature

-3 dB Bandwidth . . . . . DC to greater than 50 MHz

A TRIGGER, RECORD TRIGGER, and WORD RECOGNIZER Output

Logic Polarity . . . . . Negative true. Trigger occurrence indicated by a HI to LO transition

Output Voltage HI

Load of 400 µA or Less . . . .2.5 V to 3.5V

50 0hm Load to Ground . . . . . 0.45 V or greater

Output Voltage LO

Load of 4 mA or Less . . . . 0.5 V or less

50 0hm Load to Ground . . . . 0.15 V or less

SEQUENCE OUT, STEP COMPLETE Outputs

Logic Polarity . . . . . Negative true. HI to LO transition indicates the event occurred

Output Voltage Hl

Load of 400 µA or less . . . .2.5 V to 3.5 V

50 0hm Load to Ground . . . . . 0.45 V or greater

Output Voltage LO

Load of 4 mA or less . . . . . 0.5 V or less

50 0hm Load to Ground . . . . 0.15 V or less

SEQUENCE IN lnput

Logic Polarity . . . . . Negative true. HI to LO transition restarts a paused sequence

High-Level Input Current . . . . 20 µA maximum at Vin = 2.7V

Low-Level Input Current . . . . . .-0.4 mA maximum at Vin = 0.4 V

High-Level lrrput Voltage . . . .2.0 V minimum

Low-Level Input Voltage . . . .0.8 V maximum

Absolute Maximum Ratings

Vin max . . . . . +7. 0V

Vin min . . . .-0.5V

DISPLAY

Graticule . . . . . 80 mm times 100 mm (8x 10 divisions)

Phosphor P31

Nominal Accelerating Potential 16kV

Waveform and Cursor Display, Vertical

Resolution, Electrical . . . . . One part in 1024 (10 bit). Calibrated for 100 points per division

Gain Accuracy . . . . . Graticule indication of voltage cursor difference is within 1% of CRT cursor readout value, measured over center 6 divisions

Centering; Vectors OFF . . . . Within ± 0.1 division

Offset with Vectors ON . . . . Less than 0.05 division

Linearity . . . . . Less than 0.1 division difference between graticule indication and CRT cursor readout when active volts cursor is positioned anywhere on screen and inactive cursor is at center screen

Vector Response

NORMAL Mode

Step Aberration . . . . . +4%,-4%, 4% p-p

Fill . . . . . Edges of filled regions match reference lines within ±0.1 division

ENVELOPE Mode

Fill . . . . . Less than 1% change in p-p amplitude of a 6-division, filled ENVELOPE waveform when switching vectors ON and OFF

Waveform and Cursor Display, Horizontal

Resolution, Electrical . . . . . One part in 1024 (10 bit). Calibrated for 100 points per division

Gain Accuracy . . . . . Graticule indication at time cursor difference is within 1% of CRT cursor readout value, measured over center 6 divisions

Centering; Vectors OFF . . . . . Within ± 0.1 division

Offset with Vectors ON . . . . . Lessthan 0.05 division

Linearity . . . . . Less than 0.1 division difference between graticule indication and CRT cursor readout when active time cursor is positioned anywhere along center horizontal graticule line and inactive cursor is at center screen

Section III. TECHNICAL PRINCIPLES OF OPERATION

1-12. GENERAL FUNCTIONAL DESCRIPTION.

The OS-291/G is an oscilloscope with a maximum sample rate of 100 mega samples/second for a real-time bandwidth of 40 MHz. The equivalent-time bandwidth, for acquisition of repetitive signals, is 150 MHz. The OS-291/G can acquire and digitize input signals, process the information in a variety of ways, and display or store the results.

Input signal information, control and mode status, help menus measurement results and error tables are shown in the display. Various LED indicators provide additional instrument status.

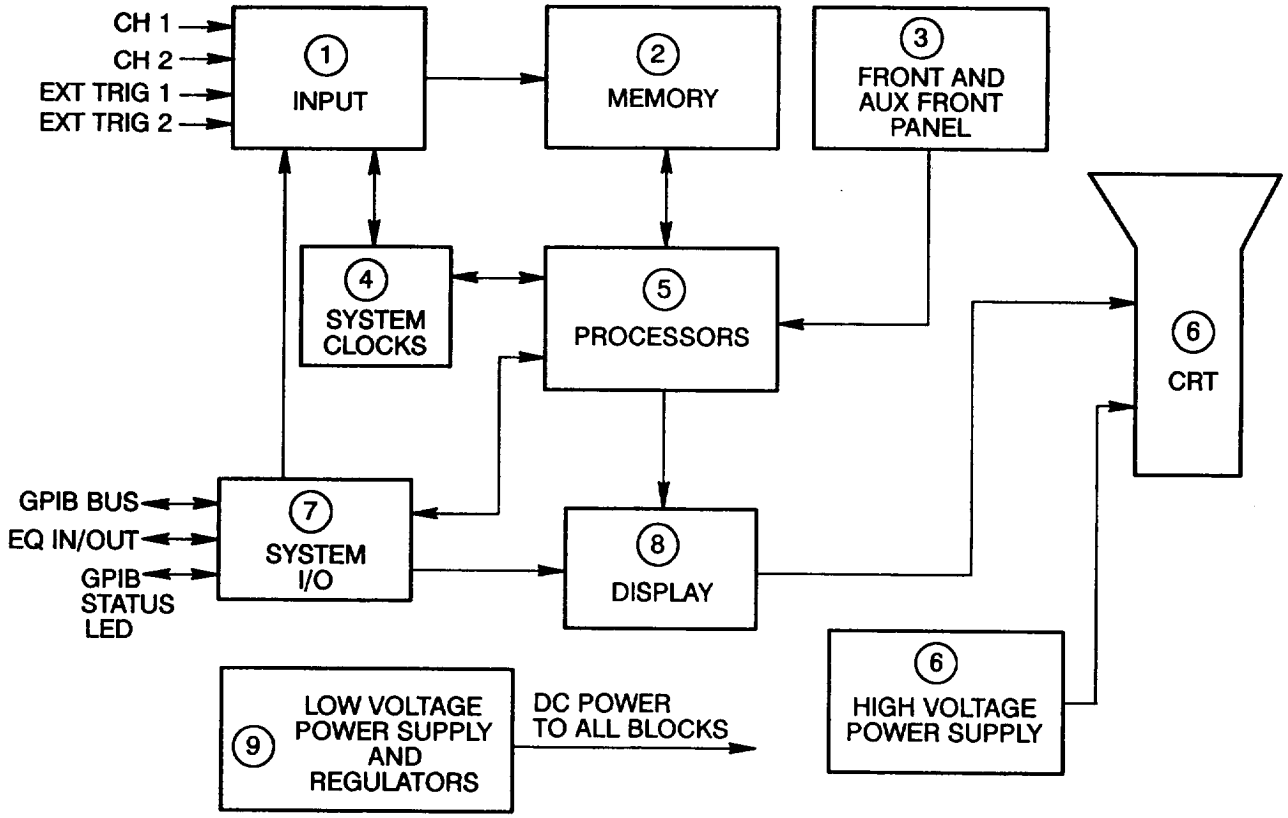


Figure 1-2. Oscilloscope OS-291/G Simplified Block Diagram.

The following is a description of the Simplified Block Diagram (fig. 1-2).

(1) The lNPUT section processes input signals connected to the front panel CH 1 or X, CH 2 or Y, EXTTRIG 1 and EXT TRIG 2 connectors. Analog shift registers can hold more than enough samples to fill the complete waveform record of 1024 samples per channel. The combined samples of analog signals are then converted to eight-bit data bytes and then transferred to the memory section.

(2) The MEMORY section temporarily stores data here before moving to the processor.

(3) The FRONT PANEL and AUXILIARY FRONT PANEL have all the buttons and knobs, and are “soft” controls which do not directly activate a circuit function. This fact allows the switch functions and menu labels to be changed (especially the menu buttons of the Auxiliary Front Panel, which are used to make menu selections) as necessary.

(4) The SYSTEM CLOCKS circuitry produces the fixed-frequency clock signals used throughout the OS-291. A 40 MHz crystal-controlled oscillator circuit produces the master clock signal that is divided down to provide the various system clocks that are needed.

(5) The SYSTEM PROCESSOR, under program direction, controls all the functions of the OS-291 and coordinates the functions of the other microprocessors (Front Panel Processor and Waveform Processor).

The Waveform Processor performs the high-speed data-handling operations required to produce and update the CRT displays.

The Front Panel Processor is a special-purpose device used to respond to switch and control changes. When a control changes, the Front Panel Processor informs the System Processor so that the operating state may be altered to match the requested change.

(6) The HIGH VOLTAGE POWER SUPPLY and CRT circuitry provide the auxiliary voltages needed by the CRT to produce a display. Focus, intensity, trace rotation, astigmatism, geometry, Y-Axis alignment, heater, and cathode-to-anode accelerating voltage are all provided by the various circuits included. These circuits are the High Voltage Oscillator, the High Voltage Regulator, the +61 V Supply, the Cathode Supply, the Anode Multiplier, the DC Restorer, the Focus and Z-Axis Amplifiers, the Auto Focus Buffer, and the various CRT adjustment potentiometers.

(7) The SYSTEM I/O circuits provide the interfaces between the scope and external devices that may be connected. Included in the interfaces is a standard general-purpose interface bus (GPIB) that permits two-way communication between the System Processor and a GPIB controller or other IEEE 488-1980 compatible GPIB devices. The GPIB interface permits waveforms, front-panel setups, and other commands or messages to be sent and viewed by the OS-291.

(8) The DISPLAY Control System controls the display of the waveforms and readouts. Data bytes stored in the Display Memory are read out and converted into analog vertical and horizontal current signals used to generate the waveform data and readout characters.

Horizontal and Vertical signal currents from the Display Controller are converted into the deflection voltage signals used to drive the CRT deflection plates by the Display Output circuitry.

(9) The LOW VOLTAGE POWER SUPPLY is a high-efficiency switching power supply which produces the majority of the Iow voltages required to power the OS-291. Input AC power of either 115 V or 230 V within the frequency range of 48 Hz to 400 Hz is rectified and used to drive a switching circuit at a frequency of approximately 50 kHz. The AC input has an interference filter, primary line fusing, and a thermal cutout that shuts down the power supply in the event of overheating.

CHAPTER 2
OPERATING INSTRUCTIONS

Section I. DESCRIPTION AND USE OF OPERATOR'S CONTROLS, INDICATORS AND CONNECTORS

2-1. INTRODUCTION.

This section describes all of the controls, indicators, and connectors for the OS-291/G. The Front Panel is shown in Figure 2-1. The figure is separated into seven different parts (Views A-G). The Rear Panel is shown in Figure 2-6.

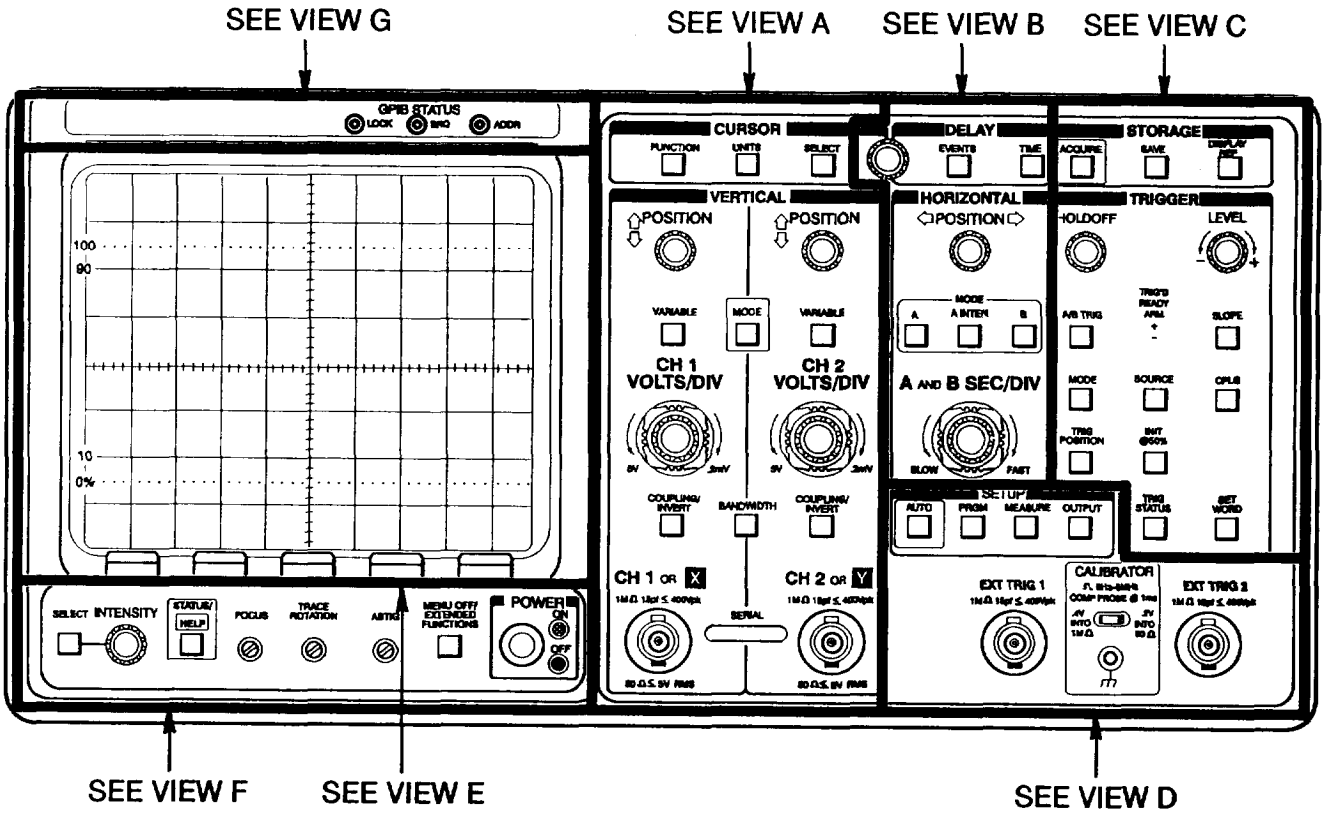
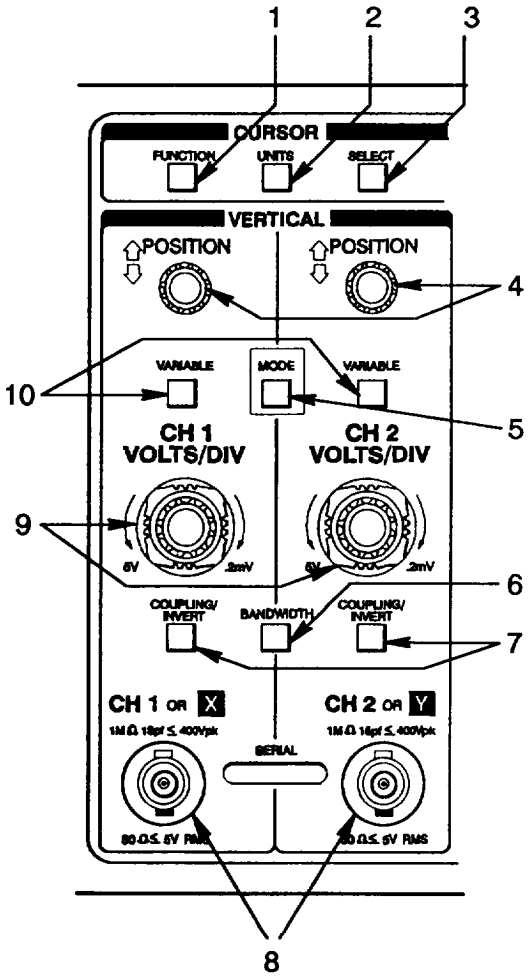


Figure 2-1. Operator's Controls, Indicators, and Connectors, Front View.



VIEW A

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
1	CURSOR FUNCTION Button	Calls up the CURSOR FUNCTION menu for selecting cursor type. The choices are **VOLTS, TIME, V@T, SLOPE,** and **1/TIME.** **VOLTS–Calls** up or cancels the volts cursor display (fig. 2-2). YT MODE: A VOLTS cursor is a horizontal line extending across the screen. The A cursor displays two VOLTS cursors. The active cursor is a dashed line; the fixed cursor is solid. The readout gives the voltage between the two cursors. The ABS (absolute) cursor mode displays only the active VOLTS cursor. The readout gives the voltage from the ground reference to the cursor. The readout is positive when the cursor is above ground, and negative when below.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
1	CURSOR FUNCTION Button (Cont)	XY MODE: A VOLTS cursor may be either a horizontal or a vertical line. The Δ mode displays two pair of VOLTS cursors. The active cursor is a dashed line. The readout gives the voltage between it and the parallel fixed cursor. The ABS Mode displays only the active cursors. The readout gives the voltage between the active cursor and ground. **TIME–Calls** up or cancels the TIME cursor display (fig. 2-2). YT MODE: A TIME cursor is a dotted vertical line across the center six divisions of the screen. The Δ cursor mode displays two TIME cursors. The active cursor has twice as many dots as the fixed cursor. The readout gives the time interval between the two cursors. The ABS cursor mode displays only the active cursor. The readout gives the time from the trigger (marked by a small T on the waveform) to the cursor. If the trigger mark or TIME cursor is at the edge of the graticule area, its actual position may be off screen. XY MODE: A TIME cursor is the vertical element of a small t attached to the waveform. The Δ cursor mode displays two TIME cursors. The readout gives the time interval between the cursors. The ABS cursor mode displays only one TIME cursor. The readout gives the time interval from the record trigger to the cursor. **V@T–** Calls up or cancels the V@T cursor display (fig. 2-2). YT MODE: A V@T cursor consists of a VOLTS cursor coupled to a TIME cursor. The VOLTS cursor meets the waveform at the point determined by the TIME cursor. The Δ cursor mode displays two V@T cursors. The active cursor is made up of the active VOLTS cursor and the active TIME cursor. The readout gives the voltage between the two VOLTS cursors. The ABS mode displays only the active V@T cursor. The readout gives the voltage from ground to the VOLTS cursor. XY MODE: A V@T cursor consists of a pair of coupled VOLTS cursors, one horizontal and one vertical. The horizontal or the vertical cursor can be active (shown by a dashed line). However, the two cursors track each other so that they always cross on the waveform. The Δ cursor mode displays two V@T cursors. The active cursor is a dashed line; the other three cursors are solid. The readout gives the voltage between the active cursor and the parallel fixed cursor. The ABS mode displays only one V@T cursor. The readout gives the voltage from the ground reference to the active cursor.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
	CURSOR FUNCTION Button (Cont)	**SLOPE–Calls** up or cancels the SLOPE cursor display (fig. 2-2). YT MODE: The SLOPE cursors consist of two coupled pairs made up of a VOLTS cursor and a TIME cursor. When a time cursor is at the edge of the graticule area, its actual position may be different. When its at the edge, the warning message EDGE? is displayed. XY MODE: The SLOPE cursors consist of two coupled pairs of VOLTS cursors. Each pair contains a horizontal cursor and a vertical cursor. The SLOPE gives the voltage between the horizontal cursors divided by the voltage between the vertical cursors $(\Delta Y \div \Delta X)$. **1/TIME–** Calls up or cancels the 1/TIME cursor display (fig. 2-2). The 1/TIME cursors are like the TIME cursors, except the readout has the units of hertz. When the cursors are at the start and end of a cycle, the readout gives the frequency. **ATTACH CURSORS TO Menu–** Appears when a cursor FUNCTION is chosen while more than one waveform is displayed. The source of each displayed waveform is displayed. The selected source waveform will be measured. Each press of FUNCTION toggles between the FUNCTION and the ATTACH CURSORS TO menus.

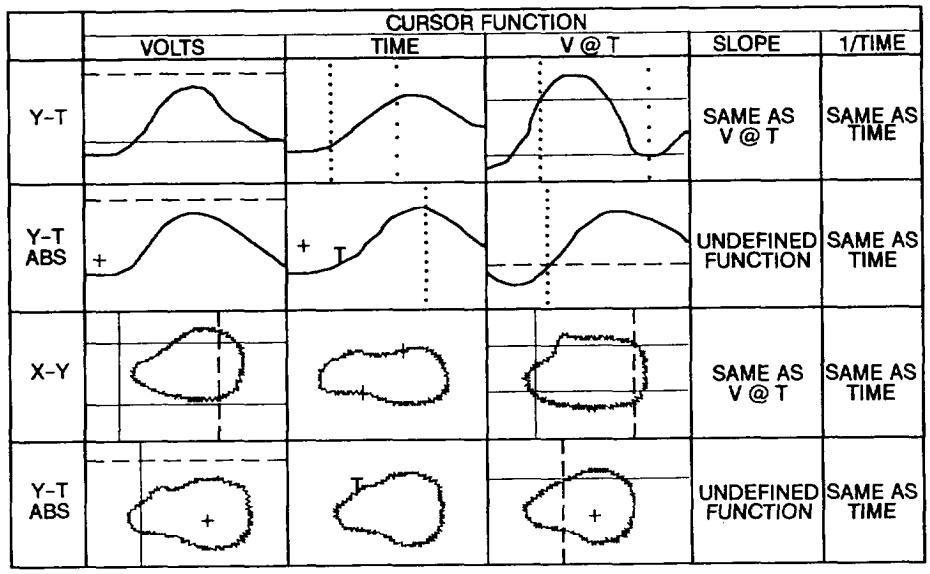
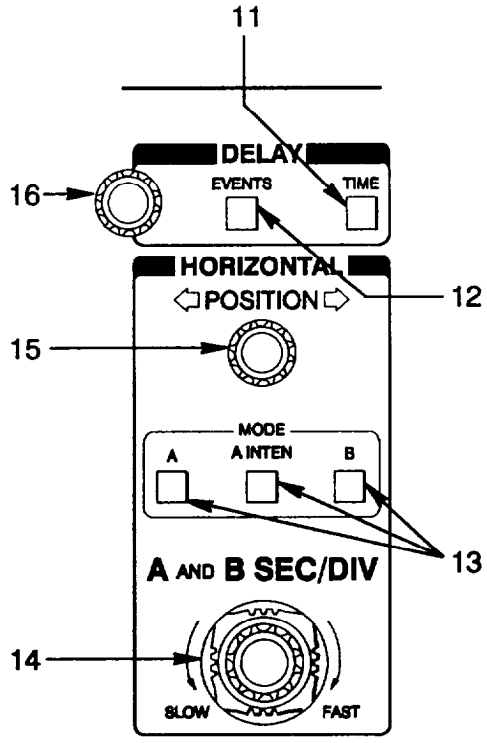


Figure 2-2. Typical Cursor Displays.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
2	CURSOR UNITS Button	Calls up the UNITS menu for the type of cursor selected in the FUNCTION menu. If no function is selected, it calls up the UNITS menu for VOLTS (or V@T) cursors. Each UNITS menu gives a choice of absolute units (VOLTS, SEC, SLOPE, or Hz) or ratiometric units (% and dB or DEGREES). All ratio measurements will need a reference. (To make a reference measurement, press NEW REF in the UNITS menu.) The ratio values for the reference are 100%, 0 dB, or 360°. The last selected cursor in delta mode is the active cursor in absolute mode. Δ|ABS– Toggles between delta and absolute cursor modes. This is not displayed in the UNITS menu for SLOPE cursors. In Δ cursor mode, measurements are made between the two cursors. In ABS cursor mode, VOLTS and V@T measurements are made between one cursor and the ground reference. Measurements of TIME and 1 /TIME are made between the cursor and the trigger point.
3	CURSOR SELECT Button	Selects the active A-mode cursor. In YT mode, the SELECT button toggles the two cursors between active and fixed. In XY mode, it sequentially activates the four VOLTS cursors and the four V@T or SLOPE cursors. In YT Mode, the cursor SELECT button toggles the two Δ cursors between active and fixed. In XY Mode, the SELECT button activates the cursors one at a time in sequence.
4	CH 1 and CH 2 VERTICAL POSITION Controls	Change the vertical position of the channels signal display. Clockwise rotation of the knob moves the trace up. Turning it counterclockwise moves the trace down. The CH 1 and CH 2 VERTICAL POSITION knobs are position-rate controls. The center area of the control produces linear positioning. Rotating a control into the spring-loaded region produces rate positioning of the display. The farther a knob is rotated toward the end-stop, the faster the positioning rate. Releasing the knob returns the control to its linear region.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
5	VERTICAL MODE Button	Calls up the VERTICAL MODE menu. ADD and MULT are mutually exclusive functions. Turning on one turns off the other. CH 1 –Toggles on and off the display of the signal in Channel 1. CH 2–Toggles on and off the display of the signal in Channel 2. ADD–Digitally adds the CH 1 and CH 2 waveform data. Waveforms add in terms of divisions, not scale factors. If a two-division signal in CH 1 and a three-division signal in CH 2 are in phase, the ADD waveform will be five divisions. This is true no matter what the VOLTS/DIV settings are for CH 1 and CH 2. MULT– Multiplies the CH 1 and CH 2 waveforms. This allows you to display a power waveform. It also allows you to make instantaneous power measurements. YT I XY– Switches between a Y-axis versus Time (YT Mode) or a Y-axis versus X-axis (XY mode) representation of the displayed signal. In XY mode, CH 1 supplies the horizontal and CH 2 supplies the vertical deflection. CH 1 vs CH 2 and REF1 vs REF2 can be displayed simultaneously for comparison.
6	BANDWIDTH Button	Calls up a menu that gives a choice of three system bandwidths: 20 MHz, 50 MHz, and Full.
7	CH 1 and CH 2 COUPLING/INVERT Button	Calls up a coupling menu. The menu includes the AC, DC, and GND choices for input coupling. The menu also includes 50 ohm ON | OFF for input termination, and INVERT ON | OFF for inversion of the signal. Each press of COUPLING/INVERT Cycles through the three input-coupling choices when the 50 ohm termination is OFF. It toggles between DC and GND when the 50 ohm termination is ON. AC– Capacitively couples the input signal to the vertical attenuator. It blocks its DC component. DC– Couples all frequency components of the input to the vertical attenuator. If 50 ohm is OFF, the input resistance is 1 Megohm to ground. GND– Grounds the input of the vertical amplifier. It also provides a zero (ground-reference) voltage display. 50 OHM–Terminates the input of the vertical attenuator with 50 ohms to ground. INVERT– Inverts the polarity of the signal being acquired by the channel. Both CH 1 and CH 2 may be inverted.

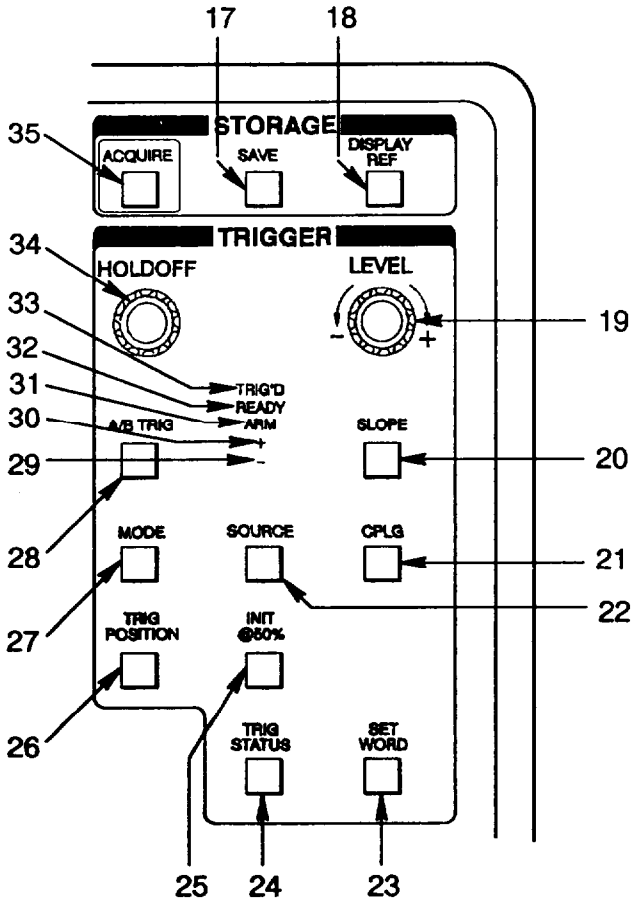
KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
8	CH 1 and CH 2 BNC Input	Inputs to the CH 1 and CH 2 attenuators.
9	CH 1 and CH 2 VOLTS/DIV Switches	Selects the vertical deflection settings. The controls are continuous-rotation switches. Both switches have no end stops. In SAVE mode, if the VOLTS/DIV control is turned to more sensitive settings, the waveform can expand vertically up to ten times. In AVERAGE mode, three more scale factors can be used.
10	CH 1 and CH 2 VARIABLE Buttons	Calls up the VARIABLE VOLTS/DIV menu for the channels. ↑/↓ **Buttons-** Vary the attenuation. A press of the ↓ menu button decreases the display amplitude. Each press of the ↑ menu button increases the display amplitude. **CAL–** Removes all of the variable attenuation that was added by the arrow buttons. Returns to the calibrated VOLTS/DIV range.



VIEW B

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
11	DELAY by TIME Button	Calls up both the menu and the DELAY TIME readout used to set up DELAY by TIME. While the menu is displayed, the CURSOR/DELAY knob can be used to set the delay time. **Δ TIME ON|OFF**—Selects a single (Δ TIME OFF) or a dual delay-time display. With Δ TIME ON, the main delay time is referenced to the A Trigger. Also, the delta delay is referenced to the main delay. When in B mode with Δ TIME ON, if a single channel is displayed, both delays occur on that channel.
12	DELAY by EVENTS Button	Calls up the menu and EVENTS COUNT readout used to set up DELAY by EVENTS. **EVENTS ON|OFF**—Toggles DELAY by EVENTS on and off. When EVENTS is ON, the A Trigger (the waveform acquisition) is delayed from the normal A Trigger event until after the specified number of B Triggers.
13	Horizontal MODE Buttons	Select the Horizontal mode. **A Button**—Selects the A Horizontal mode. Waveforms are acquired at the A SEC/DIV setting. **A INTEN Button**—Selects the Intensified Horizontal mode. **B Button**—Selects the B mode and changes the acquisition rate in accordance with the B SEC/DIV setting.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
14	A and B SEC/DIV Switch	Selects among 28 A and B SEC/DIV settings from 5s through 5 ns.
15	HORIZONTAL POSITION Control	Changes the horizontal position of signals displayed in YT mode. Clockwise rotation of the control moves the trace to the right. The Horizontal POSITION is a position-rate control. The center area of the control produces linear positioning. In its spring-loaded region it produces rate positioning of the display. The farther the control is rotated toward the end-stop, the faster the positioning rate. Releasing the control returns it to the linear region.
16	CURSOR/DELAY Control	The control is shared with DELAY by TIME, DELAY by EVENTS, and measure LEVEL. When one of the CURSOR functions (FUNCTION, UNITS, or SELECT) is selected, the control is directed to move the active cursor. The control is a position-rate potentiometer. It has a linear response in its center region and a fast response in its spring-loaded region. The farther the control is rotated towards its end-stop, the faster the rate of change. Releasing the control returns it to the linear region. In DELAY by TIME mode when Δ TIME is OFF, the CURSOR/DELAY control sets the main delay time. When Δ TIME is ON, the control sets either DELAY TIME or Δ DELAY TIME as selected in the menu. Each press of the DELAY by TIME button toggles control between the main delay and the delta delay.



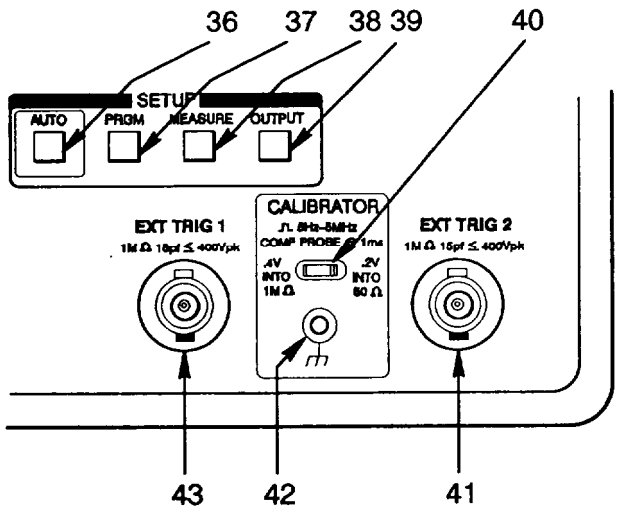
VIEW C

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
17	SAVE Button	Stops an acquisition and freezes the display. The SAVEREF SOURCE menu appears when the scope enters SAVE mode. This menu is used to select a waveform from the save display for storage in the REF memories. Saved waveforms can be measured using the cursor functions. The waveforms can be positioned using the POSITION controls. They can also be expanded using the SEC/DIV and the VOLTS/DIV controls. While in the SAVE mode, waveforms can be horizontally expanded up to 100% or 1000%. Vertical expansion is 10%. **SAVEREF SOURCE** –This menu contains all of the sources that are turned on. It is used to select a waveform for storage in a REF memory. **SAVEREF** DESTINATION–This menu is called up when a source is selected in the SAVEREF SOURCE menu. It is used to store the chosen waveform into a reference memory (REF1, REF2, REF3, or REF4).

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
18	DISPLAY REF Button	Calls up the menu for selecting stored waveforms (REF1, REF2, REF3, and/or REF4) for display. HORIZ POS REF calls up a menu that lets the Horizontal POSITION control move one of the reference waveforms. The display for a single reference is moved when REF HPOS is set to IND (independent) and the REF location is selected. Pressing the DISPLAY REF button returns the original DISPLAY REF menu. In XY mode, the DISPLAY REF menu offers only XYREF, for which REF1 is the horizontal component and REF2 is the vertical. The associated menu button turns the display on and off.
19	TRIGGER LEVEL Control	Sets the level on the trigger signal at which A or B acquisitions are triggered (as directed by the A/B TRIG switch). The Trigger Level readout is the voltage, relative to ground, at which triggering will occur.
20	SLOPE Button	Selects the Slope of the signal that triggers the A and/or B acquisition. An indicator (+ and –) shows the slope selected for triggering.
21	CPLG Button	Calls up the menu for coupling the trigger signal to the A and B Trigger circuits. The A/B TRIG switch selects the trigger affected. **DC–** Couples all of the frequencies to the trigger circuit. **AC–** Attenuates all of the frequencies below 60 Hz. It also blocks the DC component of the signal. **NOISE REJECT–** Couples all of the frequencies to the trigger circuit. However, it will also increase the peak-to-peak signal needed to cause a trigger. **HF REJECT–** Attenuates all of the frequencies above 50 kHz. **LF REJECT–** Attenuates all of the frequencies below 50 kHz. It also blocks the DC component of the signal.
22	SOURCE Button	Calls up one of the menus to select the trigger source for either the A- or the B-Trigger system. **VERT–** Selects the trigger source from the displayed waveforms. **CHAN 1 | 2** –Selects either the CH 1 or the CH 2 input signal as the trigger source. **EXT–** When in the A TRIGGER SOURCE menu, calls up the A EXT menu to select either the EXT TRIG 1 or the EXT TRIG 2 input signal as the trigger source. The menu also sets the gains of both external-trigger channels. When in the B TRIG SOURCE menu, EXT calls up the B EXT menu to select the external-trigger source for the B Trigger system.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
22	SOURCE Button (Cont)	**LINE–** Selects the AC power source as the trigger signal for A-Trigger system only. **A*B I WORD–** Selects either the logical AND of the A and the B Trigger or the 16-bit Optional Word Recognize Probe as the trigger source. **NOTE** The optional Word Recognize Probe is not issued with the OS-291/G.
23	SET WORD Button	Calls up the setup menu to set up the optional Word Recognize Probe to produce a trigger on a parallel TTL data word. **NOTE** The optional Word Recognize Probe is not issued with the OS-291/G.
24	TRIG STATUS Button	Displays a readout of the present A and B Trigger settings for MODE, SOURCE, CPLG, and TRIG POSITION.
25	INIT@ 50% Button	Forces the scope to do an AUTO LEVEL cycle. This sets the trigger level to 50'%. of the peak-to-peak Value of the trigger signal.
26	TRIG POSITION Button	Calls up the menu used to select the Trigger position in the waveform display. Choices Of 1/8, 1/4, 1/2, 3/4, and 7/8 determine the amount of pre-trigger data displayed prior to the Trigger in the next waveform.
27	TRIGGER MODE Button	Calls up either the A or the B TRIGGER MODE menu as directed by the A/B TRIG switch.
	A Trigger Modes	**AUTO LEVEL–** Adjusts the Trigger LEVEL to within the peak-to-peak limits of the trigger signal. **AUTO/ROLL–** Free runs the acquisition in the absence of a trigger by forcing an auto-trigger. AT SEC/DIV settings of 100 ms or slower, AUTO changes to ROLL. In ROLL mode, the display is updated a data point at a time, scrolling from right to left across the screen. **NORMAL–Permits** an acquisition when triggered or when the input coupling of the selected trigger channel is set to GND. **SINGLE SEQ–** Performs one complete storage sequence when triggered. It then enters SAVE mode.
	B Trigger Modes	**RUNS AFTER–** Forces the B Trigger to occur after the preset delay time. The delay time starts after the normal A Trigger event has elapsed. **TRIG AFTER–** Permits the B Trigger to occur only when triggered after the preset delay time has elapsed. **EXT CLK ON | OFF–** When ON, disables the internal time base and uses an external signal as the sample clock.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
28	A/B TRIG Button	Selects whether the A- or the B-Trigger system is targeted by the shared TRIGGER controls: MODE, SOURCE, CPLG, TRIG POSITION, SLOPE, and LEVEL.
29	(–) Indicator	Indicates negative slope is selected for triggering.
30	(+) Indicator	Indicates positive slope is selected for triggering.
31	ARM Indicator	Indicator lights up at the start of each acquisition while pre-trigger data is being acquired. Turns off at the end of pre-trigger holdoff.
32	READY Indicator	Indicator lights up at the end of the pre-trigger holdoff. When the Trigger occurs, the READY Indicator turns off.
33	TRIG'D Indicator	Shows the state of the OS-291 trigger system during an acquisition. Lights up at A Trigger, turns off when the acquisition is done.
34	HOLDOFF Control	Varies the amount of time from the A Trigger until the Trigger system will accept another A Trigger event.
35	ACQUIRE Button	Calls up the menu to select the acquisition mode. **NORMAL** – Produces a "live" display similar to that of a conventional scope. **ENVELOPE** – Causes the scope to use fast peak detection. **AVG (average)** – Causes the scope to average the set number of acquisitions. The display is updated each time. **REPET ON | OFF (Repetitive)** – Turns repetitive sampling on and off. With REPET OFF, the display locations of data points that are between digitized points are computed. **SAVE ON** Δ – Controls the Save-on-Delta mode. When ON, the scope compares each waveform to a stored envelope. The scope enters the SAVE mode if any part of the waveform is outside the limits set by the envelope. **SMOOTH ON | OFF** – Turns ON or OFF the SMOOTH function. When SMOOTH is ON, a 5-sample-point, moving-average is applied to every sample point. Each sample is averaged with the 4 previous sample before it is displayed. The result is a smoothing of the waveform. SMOOTH only operates in AVG and NORMAL.



VIEW D

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
36	AUTO Button	Calls up the AUTOSETUP menu and runs Auto Setup. Auto Setup sets the vertical and horizontal scales for the display based on the input signal, and the current selections. For Auto Setup to work, there must be a signal in the selected channel that can be triggered in AUTO LEVEL mode. To be triggerable, it must be at least 50 Hz and 0.3 division at the most sensitive vertical scale factor. Auto Setup turns off all delays and cursors except TIME cursors when WINDOW is ON. Auto Setup also sets the triggers to: DC coupling, AUTO mode, and VERT source. VIEW–Sets up the display for best overall viewing. PERIOD–Scales the waveform to optimize the display of one period. Use RES HI | LO to select 20 or 10 division scaling. PULSE– Scales the waveform to optimize the display of the minimum pulse width. Use RES HI I LO to select 20 or 10 division scaling. EDGE (Rising) –Scales the waveform to optimize the display of its rising edge. Use RES HI | LO to select 20 or 10 division scaling. EDGE (Falling)– Scales the waveform to optimize the display of its falling edge. Use RES HI I LO to select 20 or 10 division scaling. RES HI I LO– Selects the resolution that Auto Setup targets when scaling the waveform. in LO, the scaling is optimized for viewing over the ten divisions of the screen. in HI, the scaling is optimized for the MEASURE feature over the 20 divisions of record length.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
37	PRGM Button	Calls up the AUTOSTEP SEQUENCER menu. This menu is used to create, store, use, erase, or modify a list of steps. The steps can be front-panel setups, parametric measurements, output functions, etc. INIT PANEL sets the front panel to default values (See Appendix F.) **SAVE–** Calls up a second-level menu for naming the new sequence. The name of the sequence can contain up to six alphanumeric characters, including spaces. The two-digit number at the end of the first line is a default name that can be either used or replaced. The CURSOR menu button moves the underline cursor back and forth in the name field immediately to the right of "NAME:". The two menu buttons under ROLL-CHARS rotate the underlined character through 0-9 and A-Z. There is a space between the 9 and the A. Pressing the down-arrow button steps the characters forward. The up-arrow steps them in reverse. Press the EXIT button to stop and return to the first-level AUTOSTEP SEQUENCER menu. When the setup is complete and the parameter(s) specified, press the PRGM front-panel button to call up the SET STEP ACTIONS menu. The menu shows a list of all possible actions for each step of the sequence. The steps are arranged in the order they will occur when the sequence is run. With the exception of LOAD PANEL and MEASUREMENTS, the user can set each action on (Y) or off (N) for the current step. (BEGIN STEP and END STEP are not actions, but merely markers that show where the step starts and stops.) The arrow-buttons move the cursor among the actions. The Y I N button toggles the selected action on and off. NEXT STEP increments the step number. It also recalls the SETUP CONTROLS message for programming the next step of the sequence. SAVE SEQ stores the list of steps in non-volatile memory and recalls the AUTOSTEP SEQUENCER menu.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
37	PRGM Button (Cont)	**REPEAT–** Creates a loop by returning to the current step when the last step of the sequence is done (fig. 2-3). **SELF-CAL–** Runs a self calibration routine. After the self calibration, it loads the scope setup. If the scope fails to calibrate, the EXTENDED DIAGNOSTICS menu will appear. **SELF-TEST–** Runs self diagnostics prior to loading the scope setup. If the scope fails the routine, the EXTENDED DIAGNOSTICS menu will appear. **LOAD PANEL–** Sets up the the front-panel and the Continuous-Update parameters. It also sets the Auto Setup and Output modes. Settings used were set while SETUP CONTROLS was in effect. **AUTOSETUP–** Uses the mode set by LOAD PANEL to perform an Auto Setup. **PRINT/PLOT–** Sends out data and acquired waveforms for a step over the GPIB. **BELL–** Rings the bell to signal that a step is finished. **SRQ** –Transmits an Operation Complete signal over the GPIB at the end of each step and at the end of the sequence. **PAUSE–** Stops the sequence at the end of the current step and waits for a command to advance.

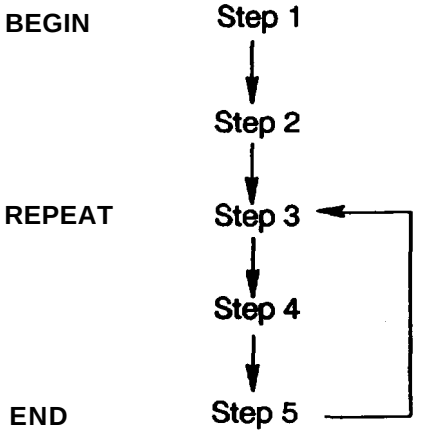


Figure 2-3. Event Order For Sequences.

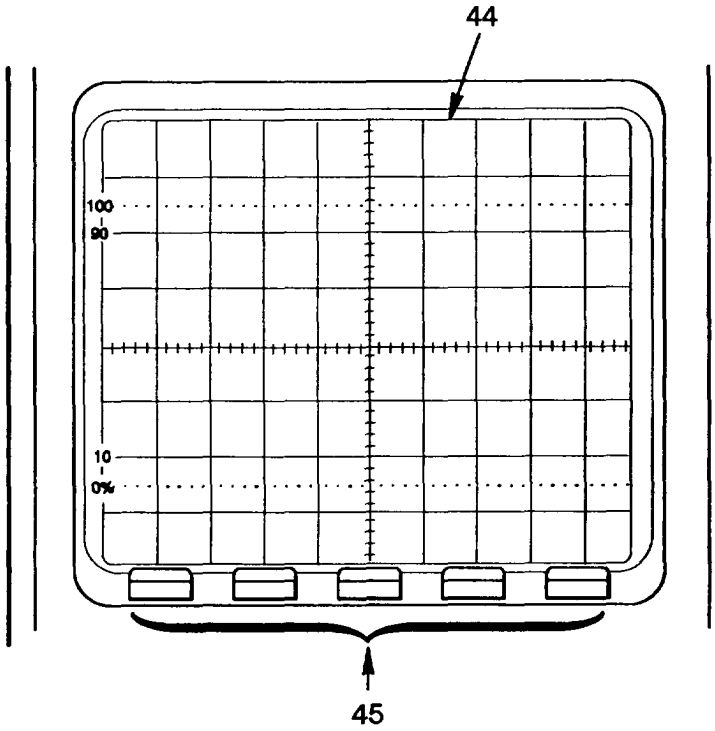
KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
37	PRGM Button (Cont)	**PROTECT–** Prevents the sequence from being deleted. **RECALL** –Calls up the menu to run a sequence. The names of all existing sequences, with the current selection underlined, are listed above the menu. The arrow-labeled menu buttons move the underline up and down through the list. To run the underlined sequence, press the RECALL menu button. Pressing EXIT returns to the first-level AUTOSTEP SEQUENCER menu without running the sequence. **DELETE–** Calls up the menu to delete a sequence. The arrow-labeled menu buttons move the underline up and down through the list. To delete the underlined sequence, press the DELETE menu button. Pressing EXIT recalls the first-level AUTOSTEP SEQUENCER menu. **EDIT–** Calls up the menu to modify a sequence. The arrow-labeled menu buttons move the underline up and down through the list. To modify the underlined sequence, press the EDIT menu button. To create a copy of the selected sequence under a different name, press the COPY menu button. Use the resulting menu to create the new name. To return to the first-level AUTOSTEP SEQUENCER menu, press the EXIT menu button. **EDIT–Calls** up a third-level menu for selecting the step(s) to be modified. The menu contains the same message that was called up by the SAVE button in the second-level SAVE menu when creating the sequence. The arrow-labeled menu buttons move through the steps of the sequence, and a message shows the number of the current step. If the down-arrow button is pressed on the last step of the sequence, the message **WARNING: NO MORE STEPS TO EDIT** will appear. To modify the current step, proceed as when creating the sequence. **DELETE TO BUF–** Deletes the current step from the sequence and stores it in a buffer. **ADD–** Calls up the menu for adding a step to the sequence being edited. Press LOAD BUFFER to replace the front-panel setup and actions with those in the step buffer. Otherwise, set up the front-panel and actions as described for creating or modifying a sequence. Press EXIT to return to the main AUTOSTEP SEQUENCER menu without adding a new step.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
38	MEASURE Button	Pressing this front panel button displays the measure menu. **SNAPSHOT–Takes** a SNAPSHOT of parameters from a waveform. If more than one signal source is selected in the **VERTICAL** MODE menu, the TARGET menu appears. From the TARGET menu the user can select the waveform from which the parameters are to be taken. The second-level TARGET menu lists all of the displayed signal sources (CH 1, CH 2, ADD or MULT, and REF). Selecting one of these signal sources gives a “snapshot” of the parameters for the corresponding waveform. See example below: **Snapshot** Readout: **SNAPSHOT OF CHX USING XXXXXXX METHOD:** DIS = 4.35 V TOP = 5.01 v WID = 20.3 µs MES = 2.12V BASE = 2.00mV DUTY = 50% PRX = -1.23 mV MEAN = 2.32 V FREQ = 24.6 kHz MAX = 5.15V OVRS == 2.0% PER = 40.6 m s MID = 2.47 V UNDS = 1.0% RISE = 28.4 ns MIN = -21.4 mV RMS = 2.65 V FALL = 18.3 ns P-P = 5.36 V AREA = 47.5 nVs DIST= 90.0 % MES = 50.0 % PROX= 10.0 % AGAIN Pressing AGAIN takes another snapshot. Pressing the up-arrow button returns the scope to the MEASURE menu. **MEAS TYPE–** Press MEAS TYPE to start a Continuous-Update parameter extraction. This calls up the parameter selection menu: DISTAL MESIAL PROX MAX MID MIN PK-PK TOP BASE MEAN OVRSHT UNDRSHT RMS AREA WIDTH DUTY FREQ PERIOD RISE FALL DELAY ← → ↓ ON OFF To select a parameter press the ON menu button when the name of the parameter is underlined. The arrow buttons move the underline around the matrix, “wrapping around” at the end of a row or column. The name of a selected parameter is bracketed with two asterisks. Pressing the OFF button when a selected parameter is underlined turns that parameter OFF.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
38	MEASURE Button (Cont)	**SETUP–** Press SETUP to display this second-level menu: --------METHOD -------- MARK MIN/MAX HIST CURSOR LEVEL ON | OFF **MIN/MAX–The** maximum (positive peak) of the target waveform is used as the TOP. The minimum (negative peak) of the target waveform is used as the BASE. **HIST–** A histogram of the vertical levels of the targeted waveform is used to determine the TOP and BASE. **CURSOR-** The level of the upper VOLTS Cursor (displayed or not) is used as the TOP and the level of the lower VOLTS Cursor is used as the BASE for the target waveform. **LEVEL–** Calls up a third-level menu for specifying the DISTAL, MESIAL, and PROXIMAL levels on the waveform and the units in which they are to be expressed. **DISTAL; MESIAL;PROXIMAL–** Directs CURSOR/ DELAY knob to adjust the level for the selected crossing type. **MESIAL2–** Directs the CURSOR/DELAY knob to adjust the level for the second mesial crossing. Set TOP ≥ DISTAL ≥ **MESIAL** ≥ PROXIMAL ≥ BASE or an error message is displayed. The error message is "?" marks, "LEVEL LIMIT?", or "LEVEL ORDER?". **% VOLT—** Sets the unit of measurement for each crossing level. **MARK ON | OFF–** Toggles "marks" ON and OFF for the target waveform. Marks are X's on the waveform that show the levels where time measurements are made in Continuous-Update mode. To display the marks, appropriate selections must be made in the MEAS TYPE menu. Set both DISPLAY ON in the MEASURE menu as well as MARK ON in the SETUP menu. **DISPLAY ON | OFF–** Toggles the readout ON and OFF for the measurements made in Continuous-Update mode. **WINDOW ON | OFF–** Toggles the WINDOW function ON and OFF. When WINDOW is on, the TIME cursors define an area on the waveform from which parameters are taken. Also, the scope searches between the TIME cursors to find data for the parameter.
39	OUTPUT Button	Calls up the OUTPUT menu containing STATUS, SETUP, DEBUG and either TRANSMIT, PLOT/PRINT, or SENDPRGM. **STATUS–** Displays GPIB parameter settings. **SETUP–Calls** up a second-level menu to define operation of the GPIB.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
39	OUTPUT Button (Cont)	**MODE–** Calls up a third-level menu: T/ONLY, L/ONLY, T/L, DEVICES, and OFF BUS. **T/ONLY–** Turns on the Talk-Only mode and presents a menu to specify the format of outgoing messages. ONLY– Only waveform data bytes are sent. **W/WFMPRE** – Preamble and waveform data bytes are sent. **SEND PRGM** – Sends a stored Auto Step sequence to other scopes on the bus. **L/ONLY–Turns** on the Listen-Only mode which the GPIB controller can issue front-panel setups to the scope. **T/L** –Turns on the Talk-Listen mode, which is the normal configuration for full two-way GPIB communication. **DEVICES–** Turns on a mode similar to T/ONLY for sending waveform data to a plotter or printer. **HPGL PLOTTER** – Sets up the GPIB to send waveform data to a plotter. **THINKJET** PRINTER– Sets up the GPIB to send waveform data to a Hewlett-Packard HP 2225A ThinkJet Printer. SETUP – Calls up a fifth-level menu used to select format parameters for the plotted or printed output. **SETTINGS ON | OFF** –Turns ON or OFF the top three lines of the screen where front-panel settings and menu choices are displayed. **TEXT ON I OFF–** Turns ON or OFF the middle ten lines of the screen where additional information is displayed. **GRAT ON | OFF** –Turns ON or OFF the graticule lines. When OFF, the graticule is not shown on the plot or print. **WFM ON | OFF** –Turns ON or OFF the waveform(s). **PGSIZE US I A4–** Selects the paper size. US is for 8.5" x 11" paper, and A4 is for the European standard paper. **OFF BUS–** Isolates the scope from the GPIB so they cannot communicate. It also removes the TRANSMIT entry from the OUTPUT menu. **TERM** –Calls up a third-level menu for specifying the message-termination characters. **ADDR–** Calls up a menu to set the address that must be sent to the scope to make it transmit or listen over the bus. The ↑ and ↓ buttons are used to increment and decrement the address between 0 and 30. Each press of an arrow button changes the address by 1. **ENCDG–** Calls up a third-level menu for specifying how waveform data is to be encoded. **DEBUG–** Calls up the menu used to control the debugging function of the GPIB.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
39	OUTPUT Button (Cont)	**DEBUG ON I OFF–** Turns DEBUG mode ON or OFF. **BUS I SCOPE–** Tells the scope whether to monitor all GPIB traffic or just its own messages. If set to BUS, all messages sent over the GPIB will be displayed on the screen. (The scope must be in Listen-Only mode before it can be set to BUS.) If set to SCOPE, only messages between the scope and the controller, along with error messages, will be displayed. **IN I OUT–** Specifies which messages the scope displays when SCOPE is selected. When set to IN, only incoming messages are displayed. When set to OUT, both incoming and outgoing messages are displayed. **SLOW–** Slows the character update rate on screen. An extra wait is observed on the message terminator. **PAUSE** – Halts the character update on screen. **TRANSMIT–** Sends an SRQ (service request) to the controller. **PLOT/PRINT–** Starts the output of a waveform to the plotter or printer. **ABORT–** Ends the transmission in progress.
40	CALIBRATOR Output Connector	Provides a 0.4 V peak-to-peak square-wave into a 1 Megohm load. Provides a 0.2-V peak-to-peak square-wave into a 50 ohm DC-coupled load. It will also provide an 8-mA peak-to-peak square-wave into a zero-ohm load for an A SEC/DIV of 1 ms. The signal can be used to verify the accuracy of the sweep, the delays, and the vertical deflection. It can also be used to check the accuracy of current probes. The signal can also be used to compensate voltage probes. The correct A SEC/DIV setting to use to compensate voltage probes is 1 ms. The frequency of this signal changes with the A SEC/DIV setting.
41	EXT TRIG 2 BNC	Input connector to the A and B Trigger system. This input makes it possible to use external signals for triggering. Coding-ring contacts on the BNC connector are used.
42	AUXILIARY GROUND Jack	A banana-plug jack that provides an auxiliary signal ground for use when connecting the equipment under test to the oscilloscope.
43	EXT TRIG 1 BNC	Input connector to the A and B Trigger system. This input makes it possible to use external signals for triggering. Coding-ring contacts on the BNC connector are used.



VIEW E

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
44	CRT	The CRT displays all of the visible waveforms and readouts. The CRT can display 16 lines of text (fig. 2-4). The readout locations are shown in the figure. The first readout line is for CH 1 and the A-Sweep. The second readout line is for CH 2 and the B-Sweep. The third readout line is for the Vertical mode and cursors. Lines 4, 5, 6, and 7 display measurement readouts. Line 15 gives the menu name and supplemental information. Line 16 shows the menu choices.
45	MENU Buttons	Five menu buttons on the CRT bezel are used to select one of the choices displayed. The bottom readout line on the CRT labels the buttons with the choices they select. The readout line above the bottom line usually contains the menu title. A choice is made by pressing the appropriate bezel button. A selected choice is indicated by an underscore of the menu label.

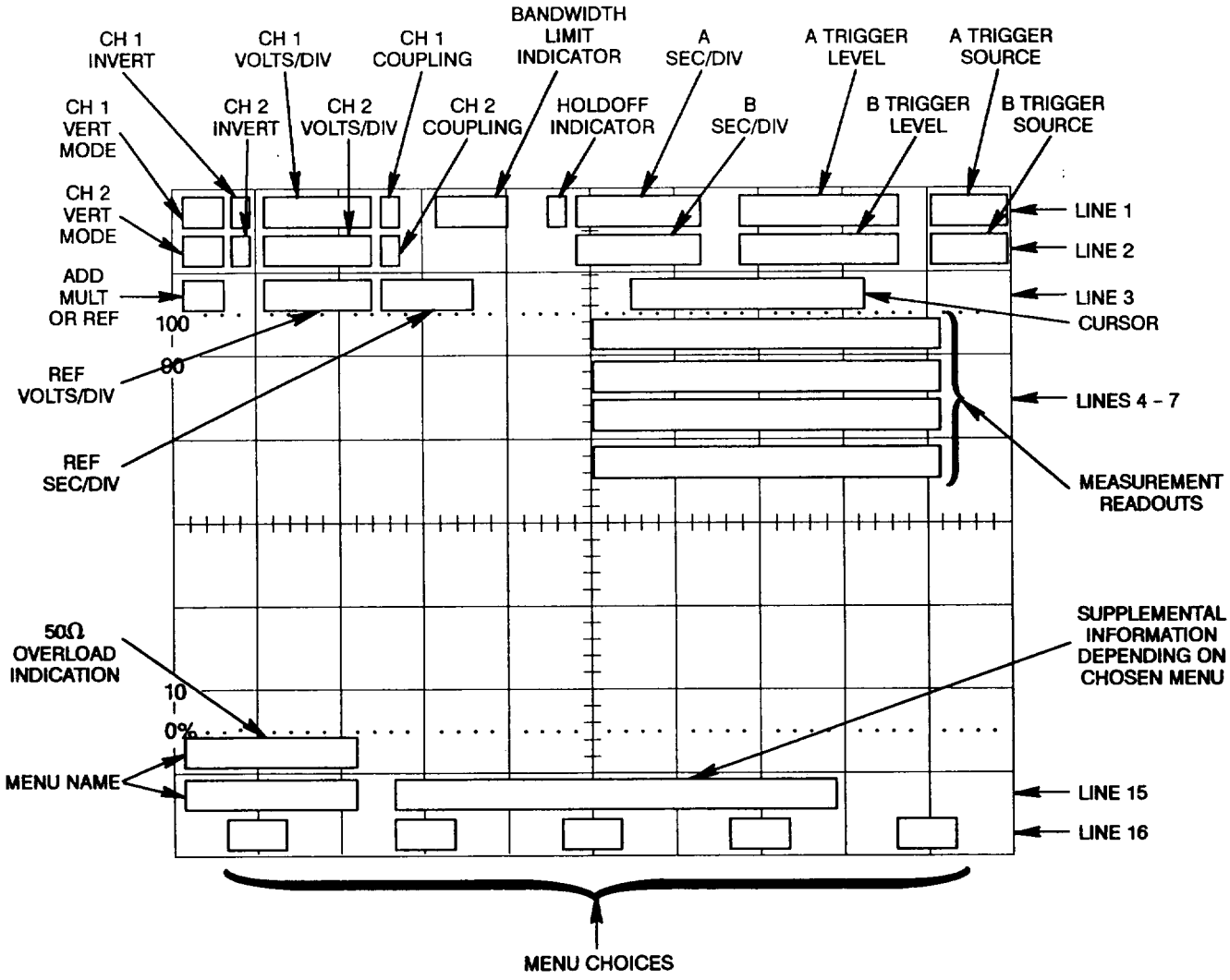
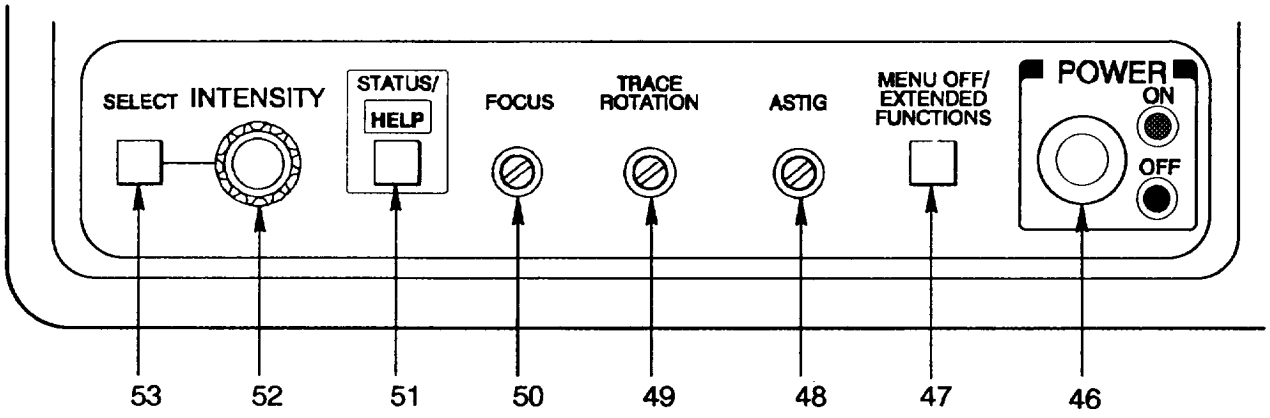


Figure 2-4. Readout Display Locations.



VIEW F

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
46	POWER ON/OFF Indicator	Turns scope power on and off. Press in for ON; press again for OFF. The indicator is green when the scope is on and black when it is off.
47	MENU OFF/EXTENDED FUNCTIONS Button	Turns off the displayed menu. If a menu is not displayed, turns on the EXTENDED FUNCTIONS Menu.
48	ASTIG Adjustment	Used with the FOCUS adjustment to optimize the focus over the entire CRT.
49	TRACE ROTATION Adjustment	Aligns the CRT trace with the horizontal graticule lines.
50	FOCUS Adjustment	Optimizes the focus of the display.
51	STATUS/HELP Button	Displays the status of the scope. All enabled functions are underlined (fig. 2-5). Use one of three methods to remove the status menu from the screen: • press MENU OFF to return to the normal waveform display with no menu. • press STATUS/HELP again to recall the menu that was displayed when it was first pressed. • press the suitable front-panel button to call up another menu. The STATUS/HELP menu will also access HELP text.
52	INTENSITY Control	Adjusts the brightness of display items. The SELECT menu directs control to either the readout, the waveform, the intensified zone, or the graticule.
53	SELECT Button	Displays the INTENSITY menu. The menu directs the INTENSITY control to either the READOUT, DISPLAY, intensified zone, or GRATicule. VECTORS ON: OFF toggles between vector (line) and dot waveform displays in YT (vertical vs time) mode. Only dot displays are possible in XY mode.

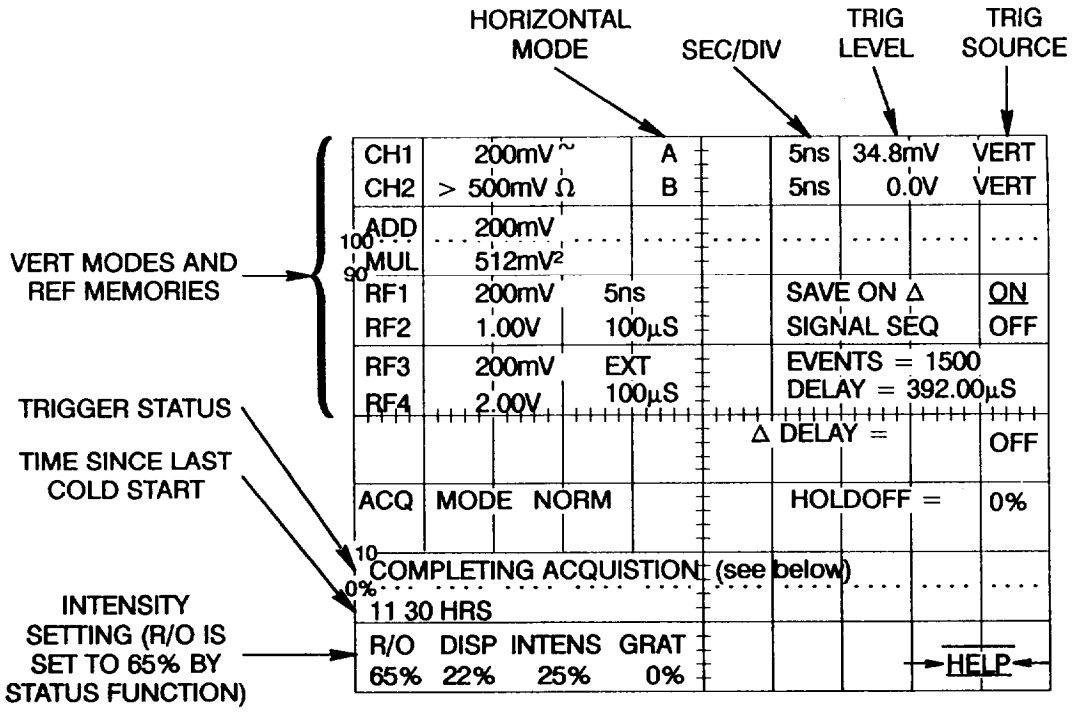
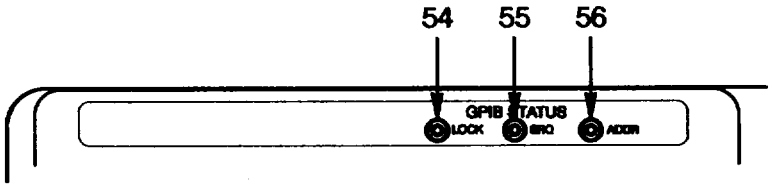


Figure 2-5. Status Readout Display.



VIEW G

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
54	LOCK Indicator	Turns on when the scope is in the local-lockout state. Changes to the front-panel settings are ignored.
55	SRQ Indicator	Turns on when the scope is requesting service from the controller.
56	ADDR Indicator	Turns on when the GPIB is in one of the addressed states: TACS (Talker-ACt ive State), LACS (Listener-ACtive State), TADS (Talker-ADdressed State), or LADS (Listener-ADdressed State). If the instrument is in either Talk-Only or Listen-Only mode, the ADDR LED is lit.

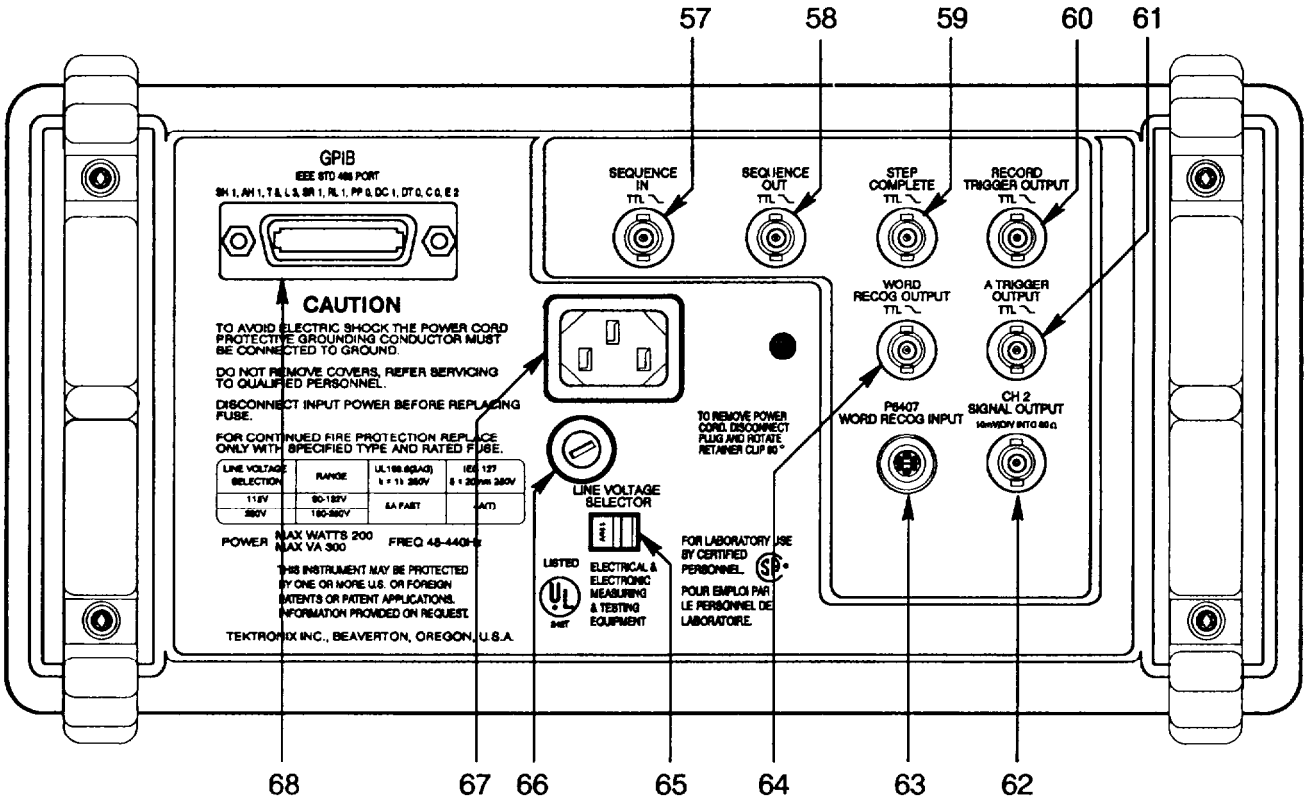


Figure 2-6. Operator's Controls, Indicators, and Connectors, Rear View.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
57	SEQUENCE IN BNC	A HI to LO transition at this input restarts the sequence after a pause. It is TTL compatible.
58	SEQUENCE OUT BNC	A HI to LO transition on this output signals the end of a sequence. While a sequence is in progress this output is high. It is TTL compatible.
59	STEP COMPLETE BNC	A HI to LO transition on this output signals the end of a step in a sequence. While a step is in progress this output is high. It is TTL compatible.
60	RECORD TRIGGER OUTPUT BNC	Provides a negative-true record trigger output signal for use as a trigger with external systems. It is TTL compatible.
61	A TRIGGER OUTPUT BNC	Provides a negative-true A-Trigger signal for application to external systems. It is TTL compatible.
62	CH 2 SIGNAL OUTPUT	Provides an output signal that is representative of the CH 2 input signal. The output into a 50-ohm load is about 10 mV per division of input signal.
63	P6407 WORD RECOG INPUT	Provides a port to obtain the word trigger output for use as the A and/or B trigger signal source.
64	WORD RECOG OUTPUT BNC	Provides a negative-true Word-Trigger signal for use with external test equipment. It is TTL compatible.

KEY	CONTROL, INDICATOR, OR CONNECTOR	FUNCTION
65	LINE VOLTAGE SELECTOR Switch	Selects the nominal input operating voltage for the scope.
66	Fuse Holder	Contains the primary fuse for the AC-power source.
67	Detachable Power Cord Receptacle	Provides contacts for connecting the scope to the AC voltage source via a detachable power cord.
68	GPIB Connector	Provides a port for the IEEE-488 data bus. The 24-pin connector conforms to the IEEE General Purpose Interface Bus Standard.

Section II. OPERATOR PREVENTIVE MAINTENANCE CHECKS AND SERVICES (PMCS)

2-2. GENERAL.

To be sure that the equipment is always ready for the mission, perform scheduled preventive maintenance checks and services (PMCS). When doing any PMCS or routine checks, keep in mind the WARNINGS and CAUTIONS about electrical shock and bodily harm.

2-3. PMCS PROCEDURES.

a. Tools, Materials, and Equipment Required for Preventive Maintenance. No tools or equipment are required for operator preventive maintenance. Cleaning materials required are listed in Appendix E.

b. PMCS for the OS-291/G is limited to routine checks such as shown below.

- cleaning
- dusting
- wiping
- checking for frayed cables
- storing items not in use
- covering unused receptacles
- checking for loose nuts, bolts, and screws

c. Perform these routine checks any time you see they must be done.

Section III. OPERATION UNDER USUAL CONDITIONS

2-4. PREPARATION FOR USE.

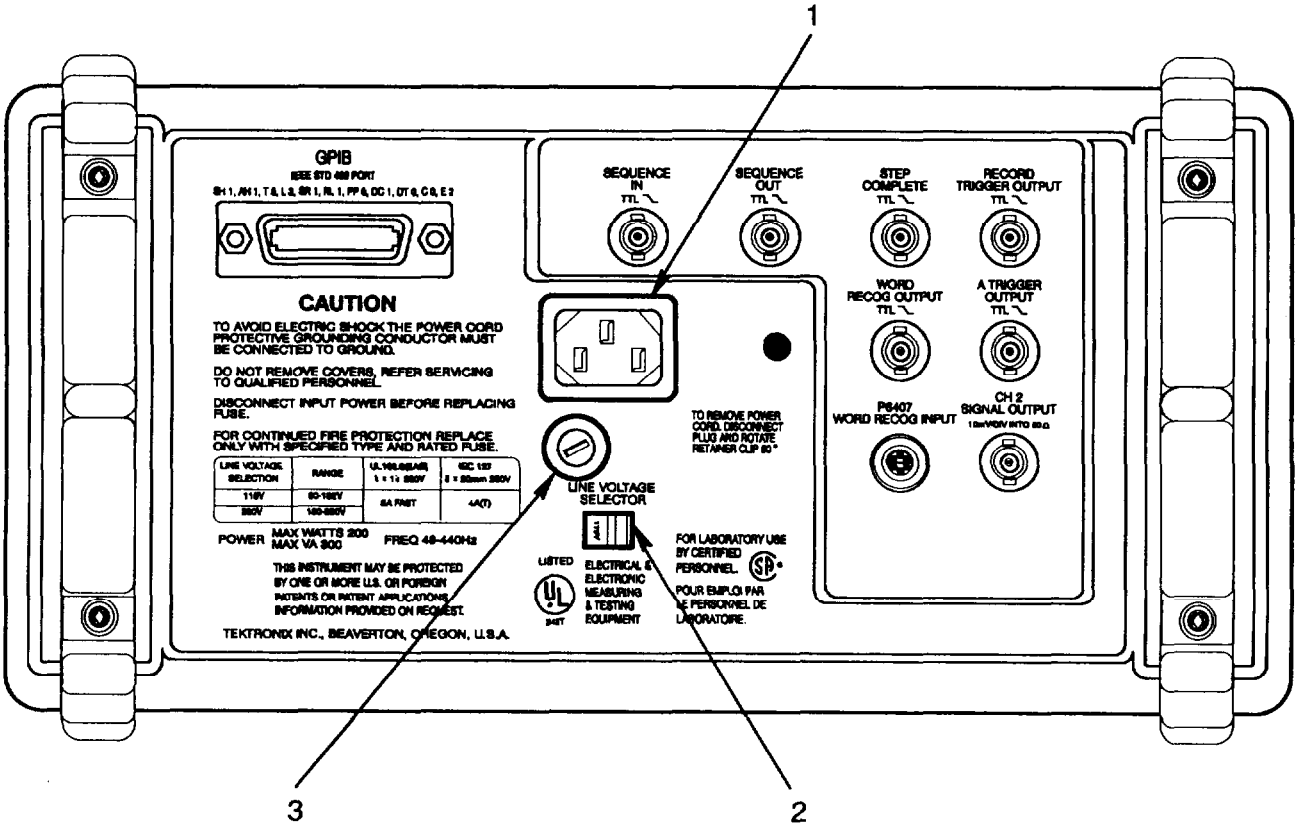
Follow these instructions before connecting the scope to a power source.

WARNING

The oscilloscope is equipped with a 3-wire power cable. When connected to an AC power receptacle, this cable grounds the oscilloscope chassis. Do not use extension cords or AC adapters without a ground connection.

CAUTION

The scope may be damaged if used with the LINE VOLTAGE SELECTOR switch set for the wrong applied AC input-source voltage. It may also be damaged if the wrong fuse is installed. Also, the scope is grounded through the grounding conductor of the power cord. It must be plugged into a proper receptacle. This is essential for safe operation.



1. Verify the LINE VOLTAGE SELECTOR switch (2) is set for the available AC power source.

2. Verify the Line Fuse (3) is the correct type and value as shown below.

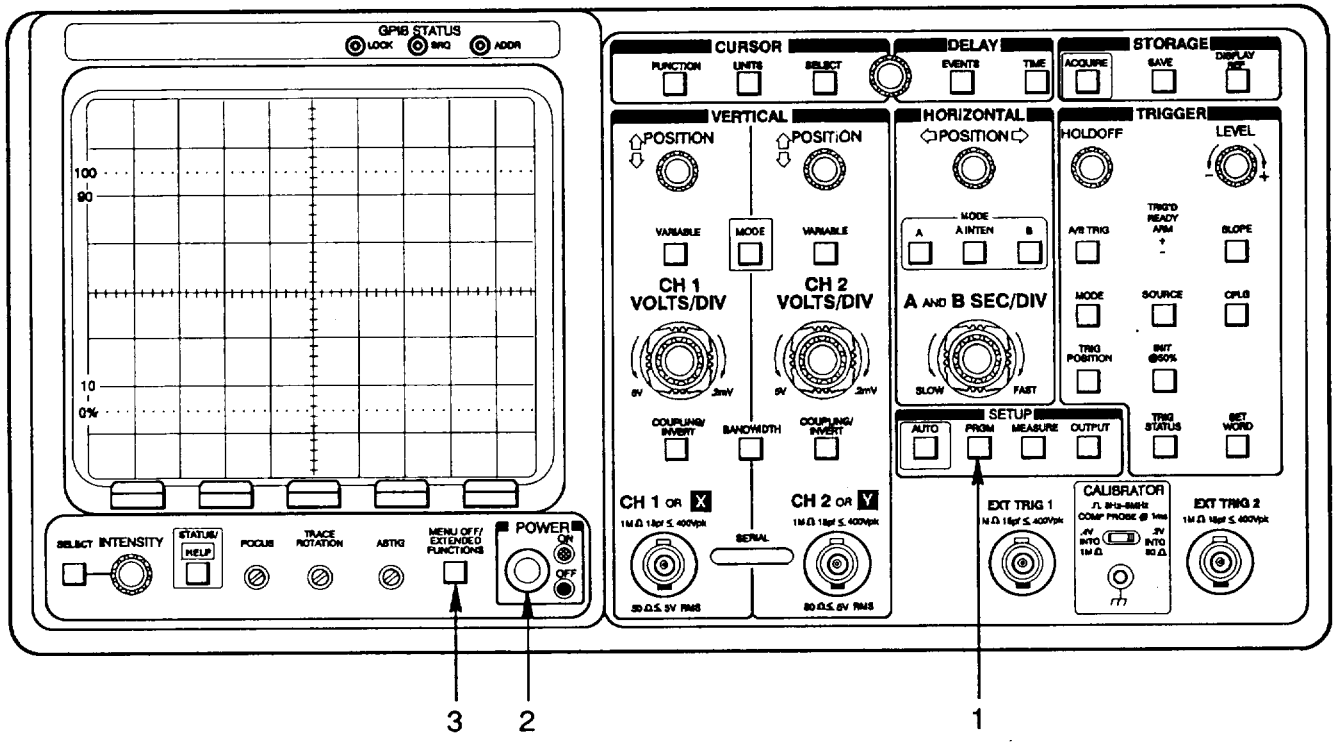
INPUT VOLTAGE	LINE VOLTAGE SELECTOR SWITCH POSITION	REAR PANEL FUSE
90 - 132 V	115 V	5 A fast
180 - 250 V	230 V	5 A fast

3. Verify the detachable power cord matches the power source.

4. Ensure the air holes on the bottom of the cabinet and the fan exhaust in the rear of the cabinet are free of any obstruction to air flow.

5. Connect the power cord to the scope receptacle (1).

2-5. TURN-ON PROCEDURE.



1. Verify that the POWER Switch/Indicator (2) is set to OFF. Working from the rear, connect the power cord to the AC power source.

2. Press the POWER Switch/Indicator (2) to the ON position. The scope will perform a set of power-up tests for several seconds. After the power-up tests, the scope typically is ready for operation with a baseline trace if no faults were encountered.

NOTE

The scope will enter the scope mode in either the ACQUIRE or SAVE mode depending on the mode in effect when it was powered off. If the OS-291 fails, an Extended Diagnostics menu will be displayed (fig. 2-7). If this occurs, notify next higher level of maintenance.

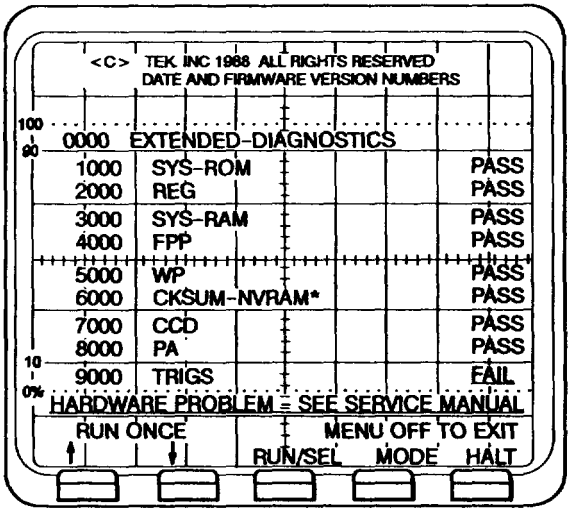


Figure 2-7. Extended Diagnostic Menu.

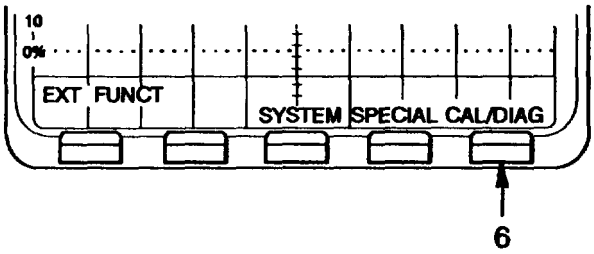
3. Allow for a 20-minute warm-up period.

NOTE

If the instrument was previously warmed-up and the power switch was momentarily turned off then on again, an additional 20-minute warm-up period is not necessary.

4. If a menu is not displayed, press the MENU OFF/EXTENDED FUNCTIONS button (3).

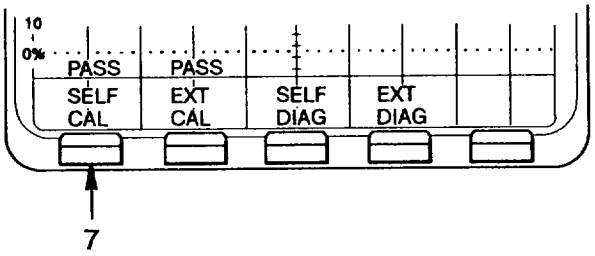
5. If a menu is displayed, press the MENU OFF/EXTENDED FUNCTIONS button (3) twice.



6. Press the CAL/DIAG menu button (6).

NOTE

For about ten minutes after power-on (whether the OS-291 is warm or not), the message NOT WARMED UP is displayed in the CAL/DIAG menu. This message is a warning that the temperature of the OS-291 may not be stabilized. SELF CAL maybe done at any time, but best results are obtained after the temperature is stable and the message is no longer displayed.



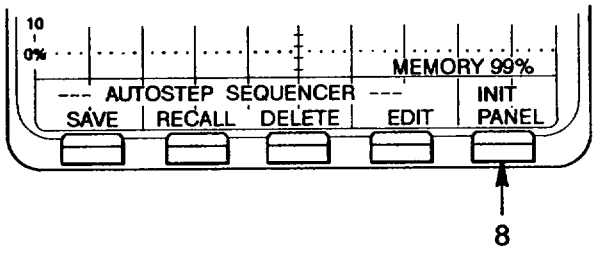
7. Press the SELF CAL menu button (7). The message RUNNING should appear in the menu display. After a few seconds, the RUNNING message will disappear and a PASS message should appear above the SELF CAL label.

NOTE

If the self calibration fails, the self-diagnostic mode is entered. If this happens push MENU OFF/EXTENDED FUNCTIONS button twice and repeat Step 3. If errors are still present notify next higher level of maintenance.

8. Press the MENU OFF/EXTENDED FUNCTIONS button (3).

9. Press the PRGM button (1).

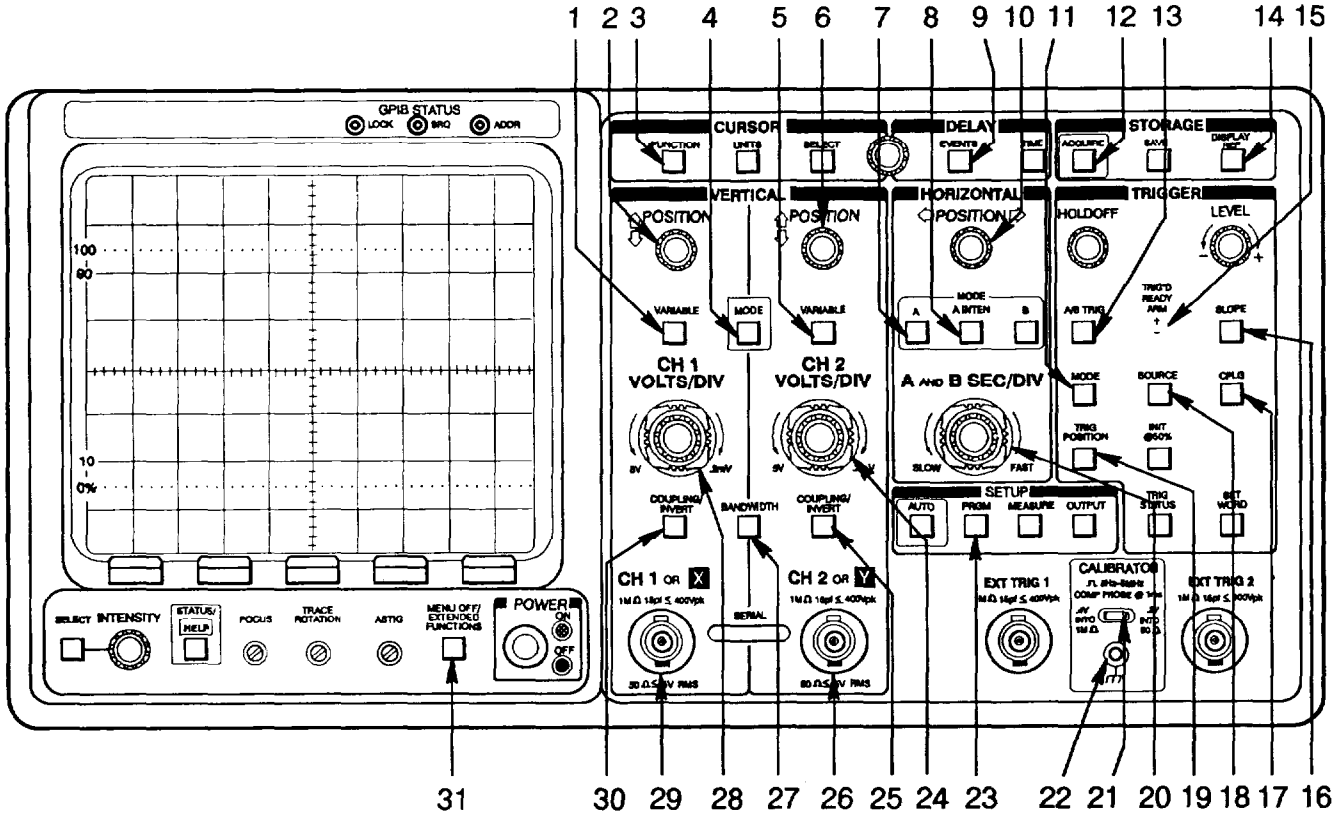


10. Select the INIT PANEL menu button (8).

2-6. CUSTOMIZE FRONT PANEL CONTROLS.

The following procedures tell how to setup front panel controls and make a basic front panel display. In addition, the procedures tell how to store, recall, and delete a front panel setup. While AUTO setup does many of the steps, this procedure lets you customize the front panel controls. The following procedures are not required and can be done at the operators discretion.

Storing a front panel setup is useful when a setup for a measurement is to be used often.



a. Setup the Front Panel Controls.

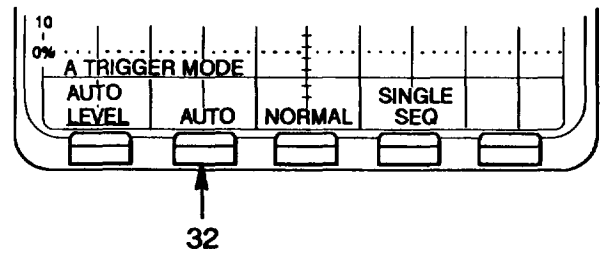
NOTE

- To select a function, underline the menu function by pressing the button beneath it. To deselect a selected function, remove the underline by pressing the button beneath it. To select between two functions (example, **ON|OFF, YT XY)** press the button beneath the menu functions to toggle between the two. Underline the needed function.

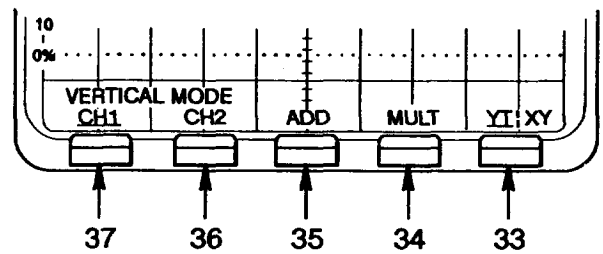
- Some steps may state to select or deselect a function that is already selected or deselected. If this is so, don't press the button beneath the menu function as it may deselect the selected function or vice versa.

NOTE

The following procedures are examples of the customized front panel controls. For all reference numbers 1 through 31 see the illustration located on page 2-35.



1. Press the TRIGGER MODE button (11). If not in A TRIGGER MODE, press the A/B TRIG button (13). Select AUTO using its menu button (32).



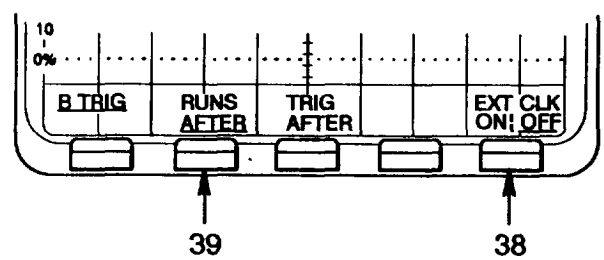
2. Press the VERTICAL MODE button (4). Select CH 1 (37), CH 2 (36), and YT (33) using their menu buttons. Deselect ADD (35) and MULT (34) using their menu buttons.

3. Press the HORIZONTAL MODE A button (7).

4. Adjust the A and B SEC/DIV control (20) for 50 µs.

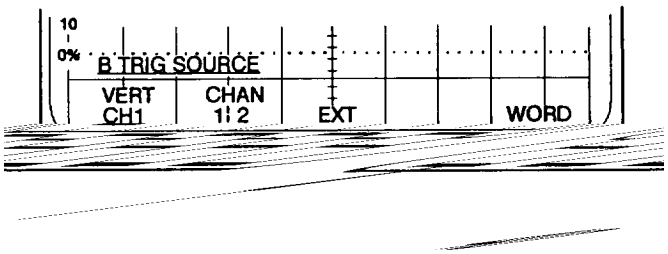
5. Press the A/B TRIG button (13).

6. Press the SLOPE button (16) if + (15) is not lit.



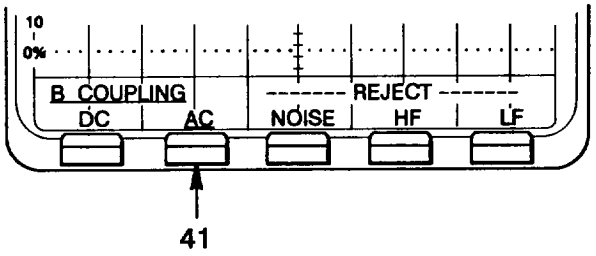
7. Press the TRIGGER MODE button (11). Select RUNS AFTER using its menu button (39). Select OFF for EXT CLK ON |OFF using its menu button (38).

8. Press the SOURCE button (18).



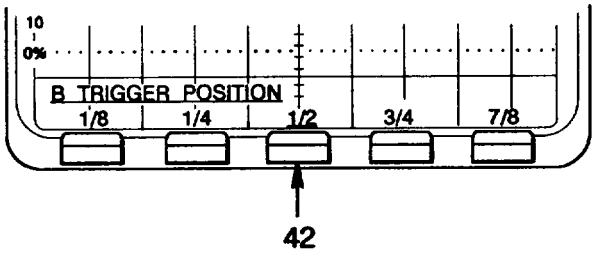
9. Select VERT CH 1 using its menu button (40).

10. Press the CPLG button (17).



11. Select B COUPLING AC using its menu button (41).

12. Press the TRIG POSITION button (19).

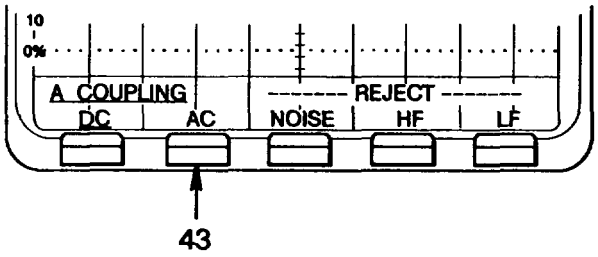


13. Select B TRIGGER POSITION 1/2 using its menu button (42).

14. Press the A/B TRIG button (13).

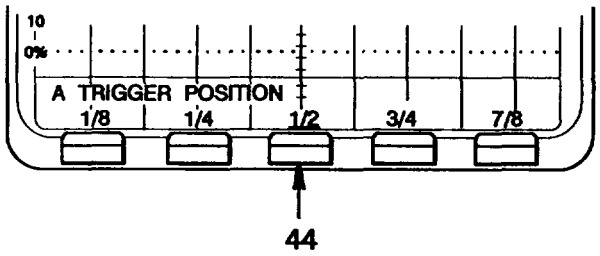
15. Press the SLOPE button (16) if + (15) is not lit.

16. Press the CPLG button (17).



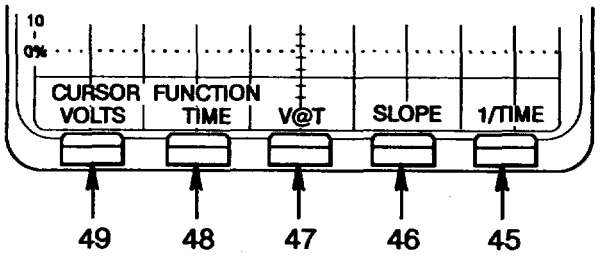
17. Select A COUPLING AC using its menu button (43).

18. Press the TRIG POSITION button (19).



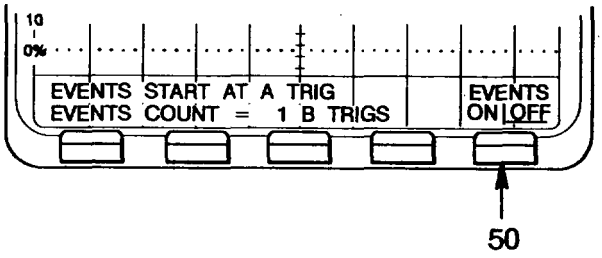
19. Select A TRIGGER POSITION 1/2 using its menu button (44).

20. Press the FUNCTION button (3).

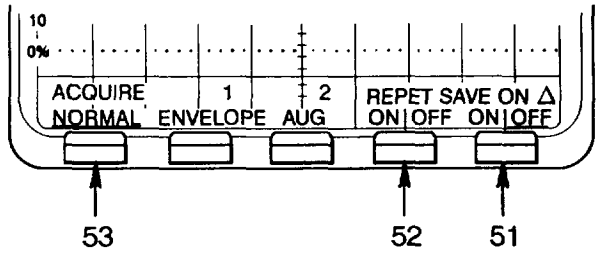


21. Deselect all CURSOR FUNCTIONS using their menu buttons (45 through 49).

22. Press the EVENTS button (9).

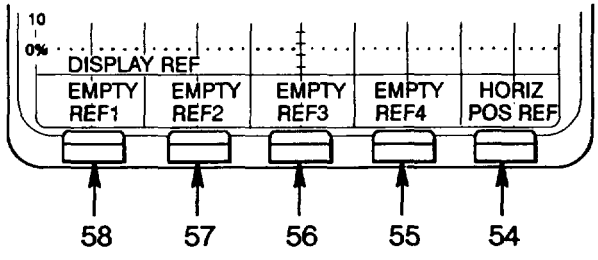


23. Select OFF for EVENTS ON/OFF using its menu button (50).



24. Press the ACQUIRE button (12). Select NORMAL using its menu button (53). Select OFF for REPET ON| OFF using its menu button (52) and select OFF for SAVE ON A ON|OFF using its menu button (51).

25. Press the DISPLAY REF button (14).

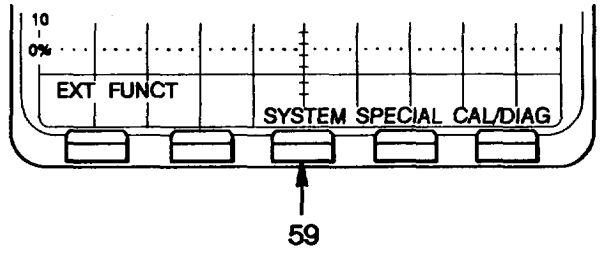


26. Deselect all REF selections using all five menu buttons (54 through 58).

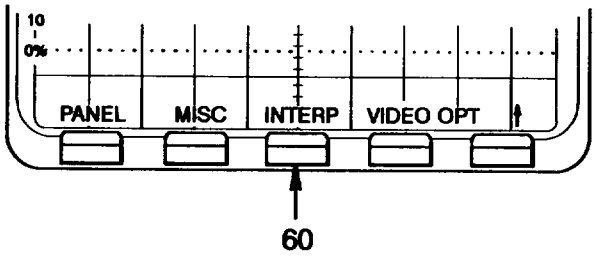
NOTE

The following steps will set up the SYSTEM menu.

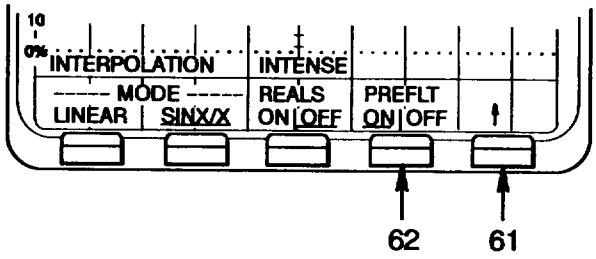
27. Press the MENU OFF/EXTENDED FUNCTIONS button (31) twice.



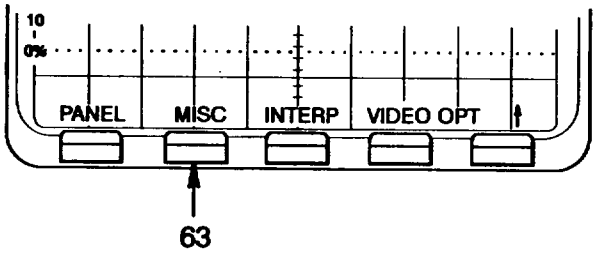
28. Select SYSTEM using menu button (59).



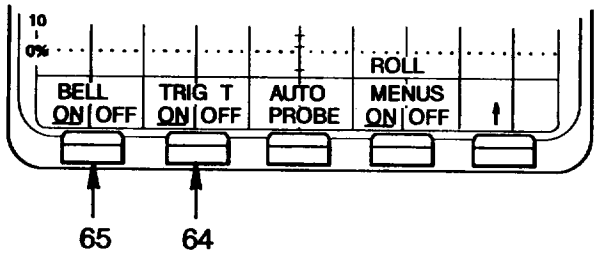
29. Select INTERP using its menu button (60).



30. Select ON for PREFLT ON| OFF using its menu button (62). Select ↑ using its menu button (61).



31. Select MISC using its menu button (63).



32. Select ON for BELL ON/ OFF using its menu button (65) and select ON for TRIG T ON/OFF using its menu button (64).

33. Press the MENU OFF/EXTENDED FUNCTIONS button (31).

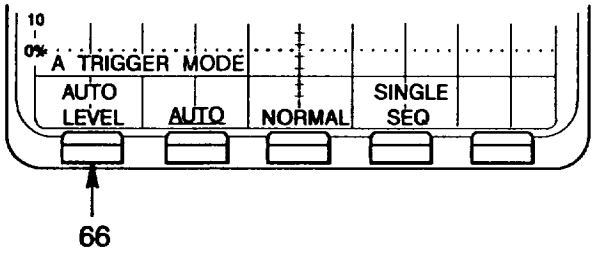
34. Adjust the Horizontal POSITION control (10) to center the Trigger Position Indicator (a T on the CH 1 and CH 2 traces) on the graticule.

35. Connect two 10X probes to the CH 1 or X (29) and CH 2 or Y (26) BNC connectors.

36. Connect the probe tips of both probes to the CALIBRATOR (21). Connect the ground leads to the scope ground (22).

37. Press the TRIGGER MODE button (11).

38. If necessary, press the A/B TRIG Button (13) to obtain the A TRIGGER MODE menu.



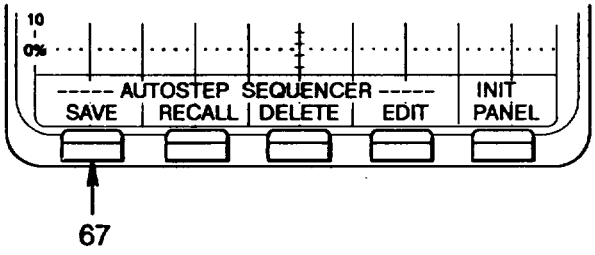
39. Select AUTO LEVEL using its menu button (66).

NOTE

This completes a basic front panel display setup for viewing signals applied to CH 1 and CH 2 inputs.

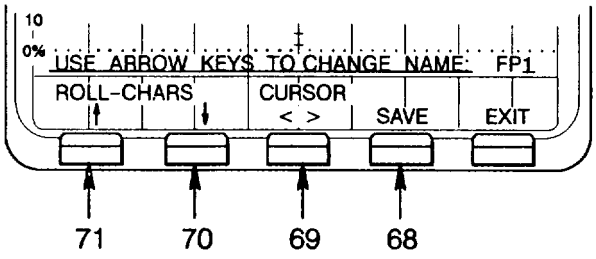
b. Storing Front Panel Setups.

1. Press the PRGM button (23).



2. Select SAVE using its menu button (67).

3. To create a label to store the front panel setup, use the example label FP1. Press the ↓ (70) or ↑ (71), using their menu buttons, to step through the alphabet and digits 0-9 to select the first character of the label (in this case, F).



4. When the letter or digit for the first character of the label is displayed, select CURSOR <> (69), using its menu button, to move to the next character. Repeat step 4 to select the letter or digit for the next character of the label.

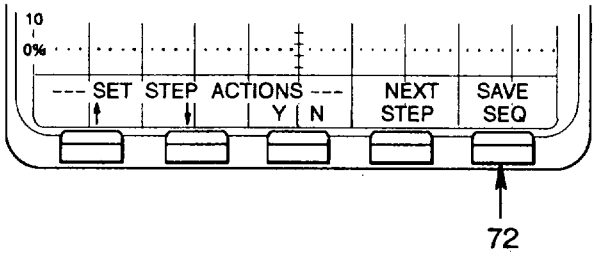
5. Repeat step 5 until the label FP1 is displayed.

6. Select SAVE, using its menu button (68), to assign the label to the current front panel settings.

NOTE

Labels can be as few as one character and can leave any character position (1-6) blank.

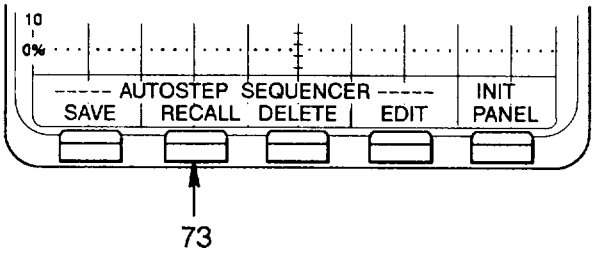
7. Press the PRGM button (23).



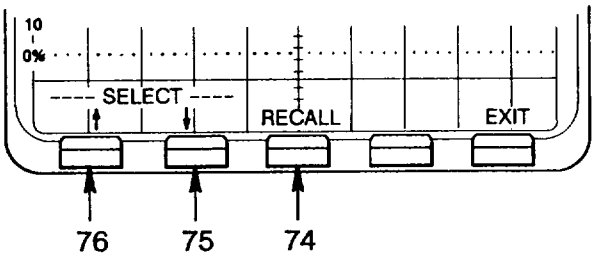
8. Select SAVE SEQ using its menu button (72).

c. Recall Front Panel Settings.

1. Press the PRGM button (23).



2. Select RECALL using its menu button (73).

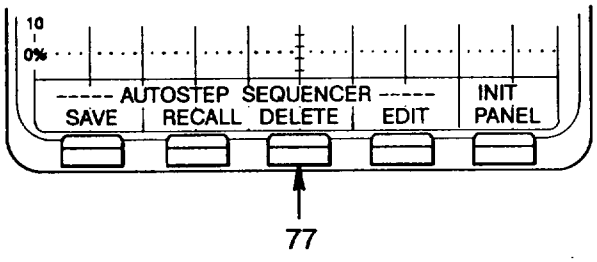


3. Select the front panel setup (FP1) by using the ↓(75) or ↑(76) arrows to underline it.

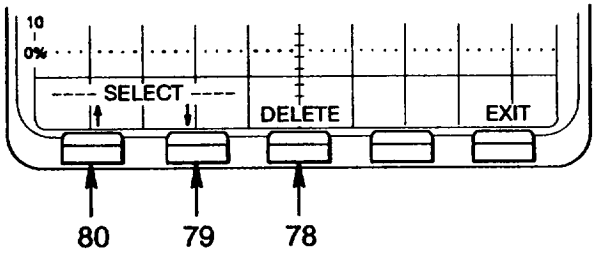
4. Select RECALL, using its menu button (74), to call up the selected setup.

d. Delete Front Panel Settings.

1. Press the PRGM button (23).



2. Select DELETE using its menu button (77).



3. Select the front panel setup (FP1) by using the ↓(79) or ↑(80) arrow to underline it.

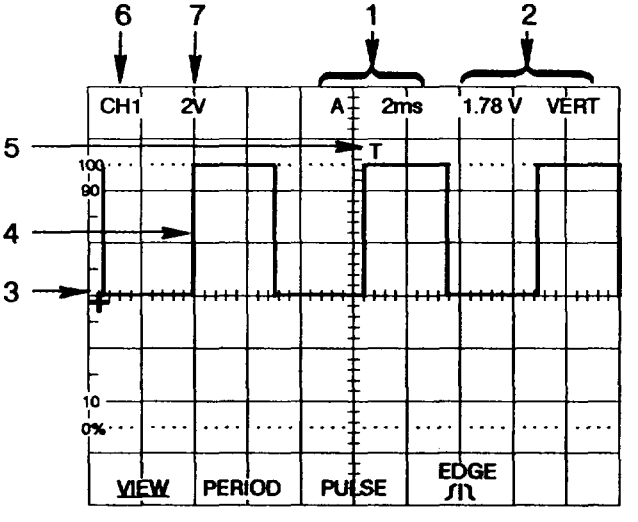
4. Select DELETE, using its menu button (78), to remove the selected setup.

2-7. OPERATING PROCEDURES.

Operation of the OS-291 is provided in paragraphs 2-8 through 2-34. Refer to paragraph 2-1 for a description of the controls and indicators.

Some of the procedures that follow may instruct the operator to press the AUTO SETUP button. The OS-291 will flash the message AUTO SETUP WORKING: PLEASE WAIT. In a few seconds, front-panel controls are changed that result in a display for CH 1. The CRT indicates:

- The applied signal (4)
- Ground" +" indicator (3)
- Trigger "T" indicator (5)
- CH 1 VERT MODE indicator (6)
- CH 1 VOLTS/DIV setting (7)
- SEC/DIV mode and setting (1)
- TRIGGER LEVEL and SOURCE (2)

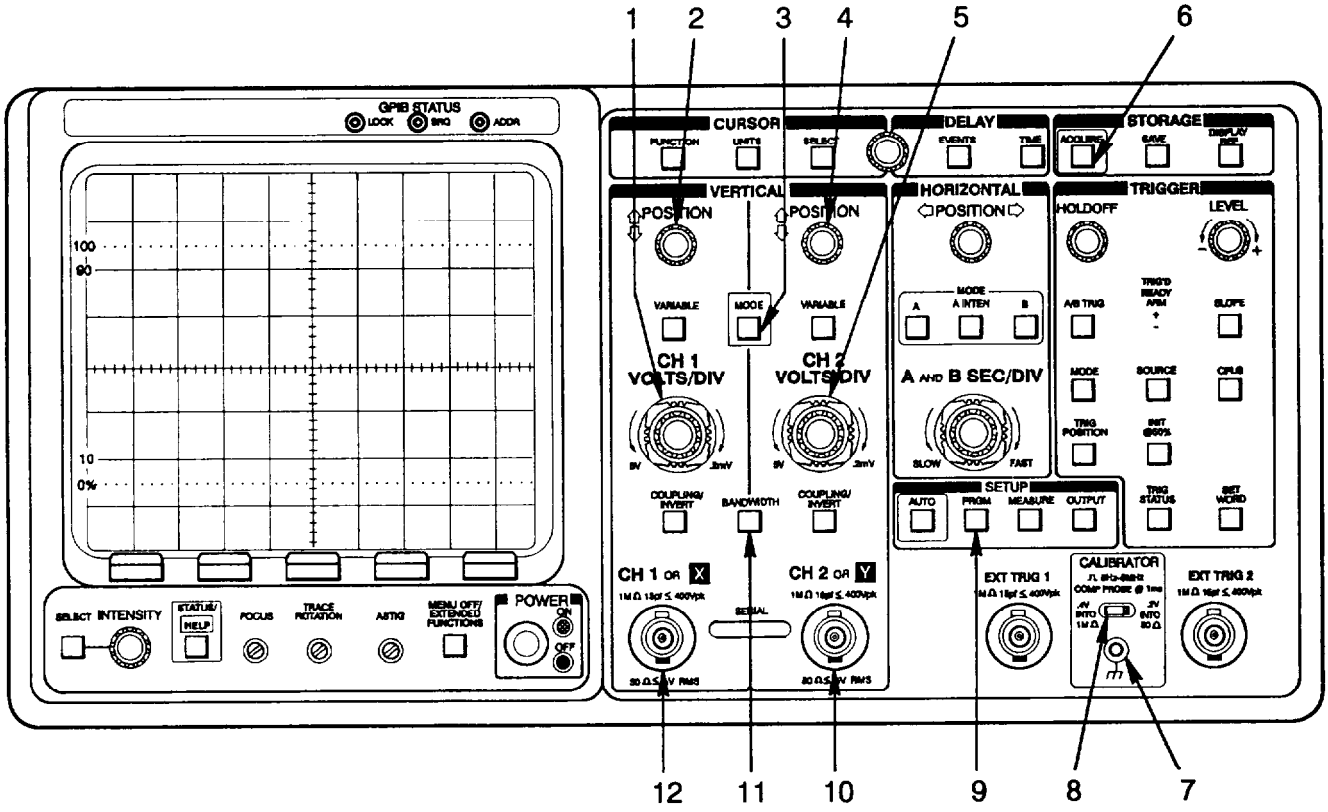


Auto Setup Display

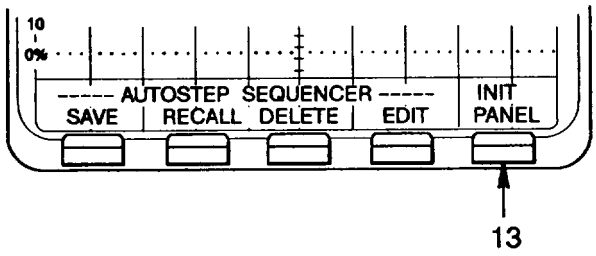
2-8. PROBE COMPENSATION.

NOTE

The misadjustment of probe compensation is a source of measurement error. For the best accuracy, check probe compensation before making measurements.



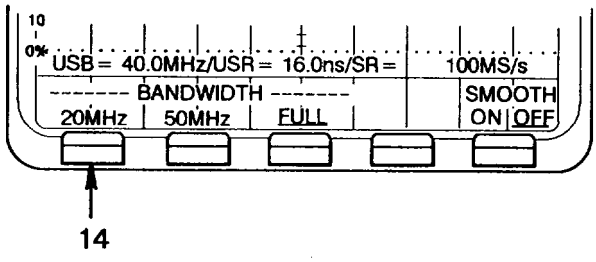
1. Press the PRGM button (9).



2. Select INIT PANEL using its menu button (13).

3. Connect the probes on the CH 1 input (12) and the CH 2 input (10) to the CALIBRATOR (8). Connect the ground leads to the scope ground (7).

4. Press the BANDWIDTH button (11).

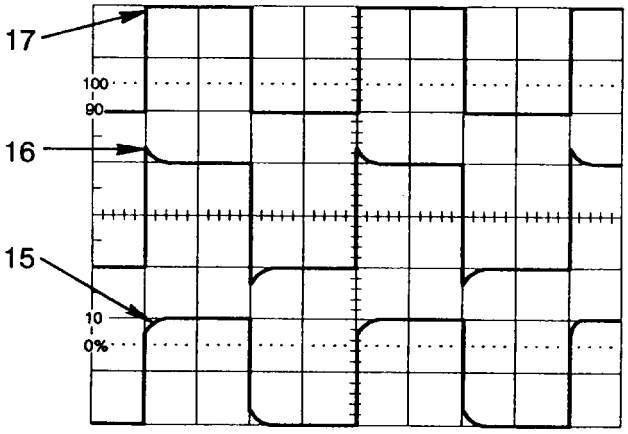


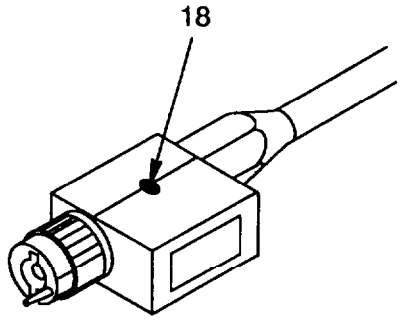
5. Select 20 MHz BANDWIDTH LIMIT using its menu button (14).

6. Adjust the CH 1 VOLTS/DIV control (1) to 100 mV.

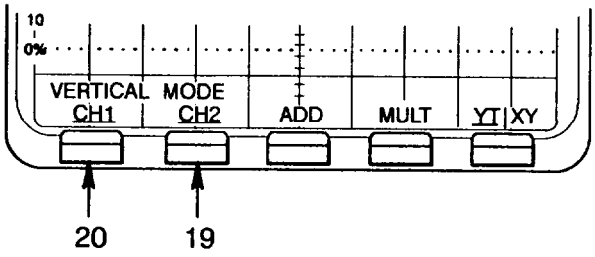
7. Press ACQUIRE (6) and adjust the CH 1 POSITION control (2) to center the four-division CALIBRATOR squarewave in the graticule area.

8. Check the squarewave signal for overshoot (16) or roll-off (15). If necessary, adjust the low frequency compensation (18) for a square front corner on the squarewave (17).





10X Probe



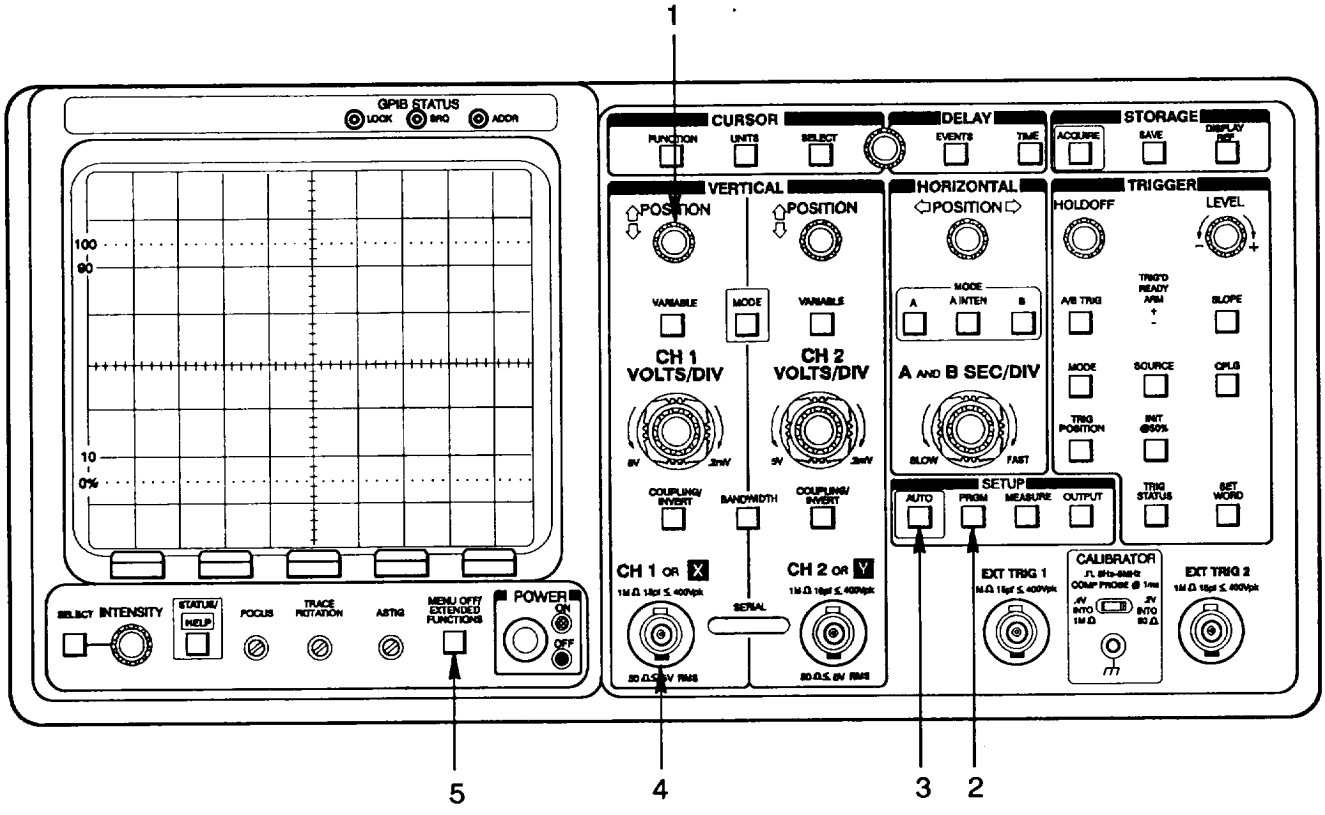
9. Press the VERTICAL MODE button (3). Select CH 2 using its menu button (19). Deselect CH 1 using its menu button (20).

10. Adjust the CH 2 VOLTS/DIV control (5) to 100 mV. Vertically center the waveform using the CH 2 POSITION control (4).

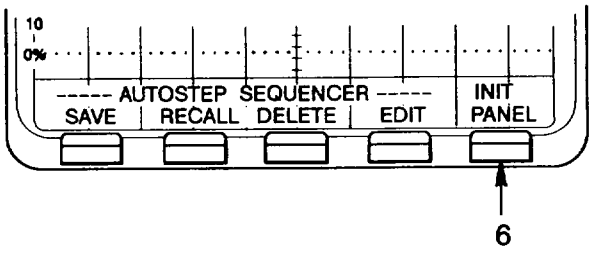
11. Press the CH 1 menu button (20). Adjust the CH 1 VOLTS/DIV control (1) to 100 mV.

12. The probes are now compensated.

2-9. PEAK-TO-PEAK VOLTAGE MEASUREMENTS.



1. Press the PRGM button (2).



2. Select INIT PANEL using its menu button (6).

3. Connect the CH 1 input (4) to the signal source (8).

4. Press the AUTO SETUP button (3). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (5) to turn off the menu.

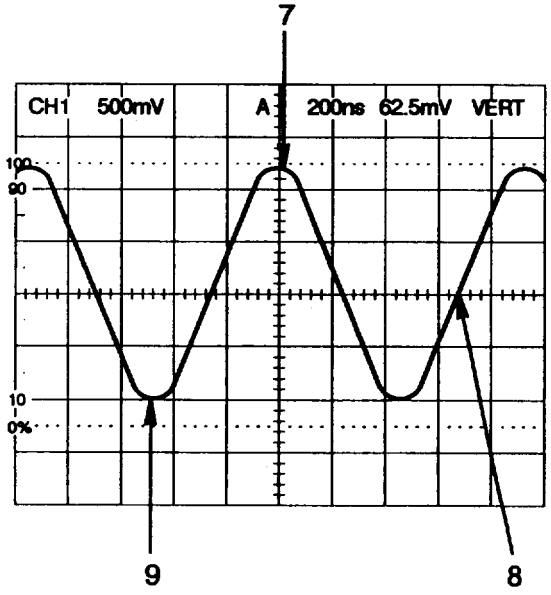
5. Adjust the CH 1 POSITION control (1) to position the trace so that the negative signal peaks are aligned with a horizontal graticule line (7).

6. Count the number of divisions from the negative peaks (9) to the positive peaks (7) of the trace.

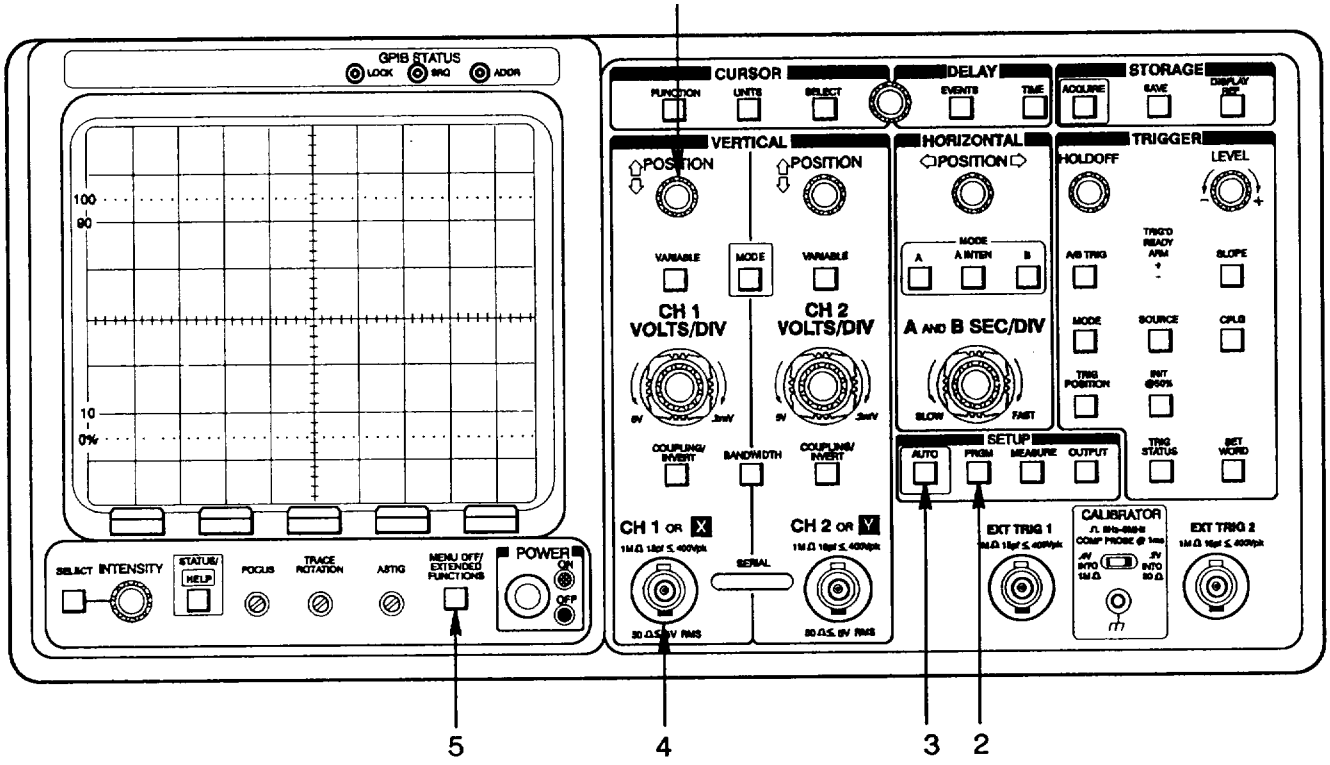
7. Calculate the voltage using: Volts (p-p) = Number of Divisions times the Volts per Division.

NOTE

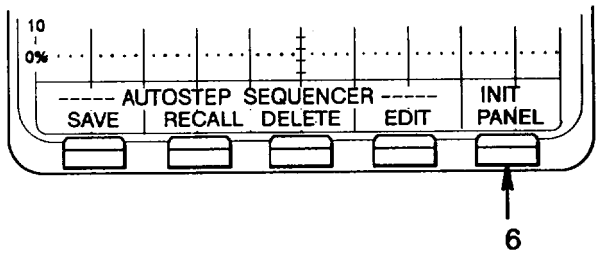
The probe attenuation factor does not need to be taken into account. The readout on the display reflects the probe attenuation factor and the VOLTS/DIV setting.



2-10. INSTANTANEOUS DC VOLTAGE LEVEL MEASUREMENTS.



1. Press the PRGM button (2)



2. Select INIT PANEL using its menu button (6).

3. Connect the CH 1 input (4) to the signal source (7).

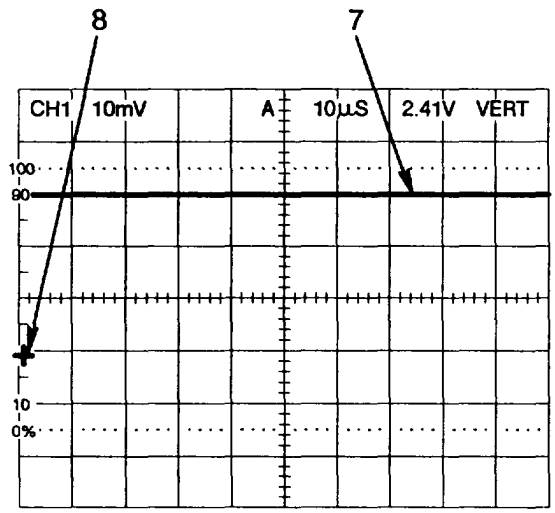
4. Press the AUTO SETUP button (3). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (5) to turn off the menu.

5. Adjust the CH 1 POSITION control (1) to move the ground reference "+" (8) to a horizontal graticule line. Keep the point to be measured (7) on the screen.

6. Count the number of divisions vertically between the ground reference (8) and the point to be measured (7).

7. To calculate the DC voltage level, use the formula: Volts (DC Level) = Number of Divisions times the Volts per Division.

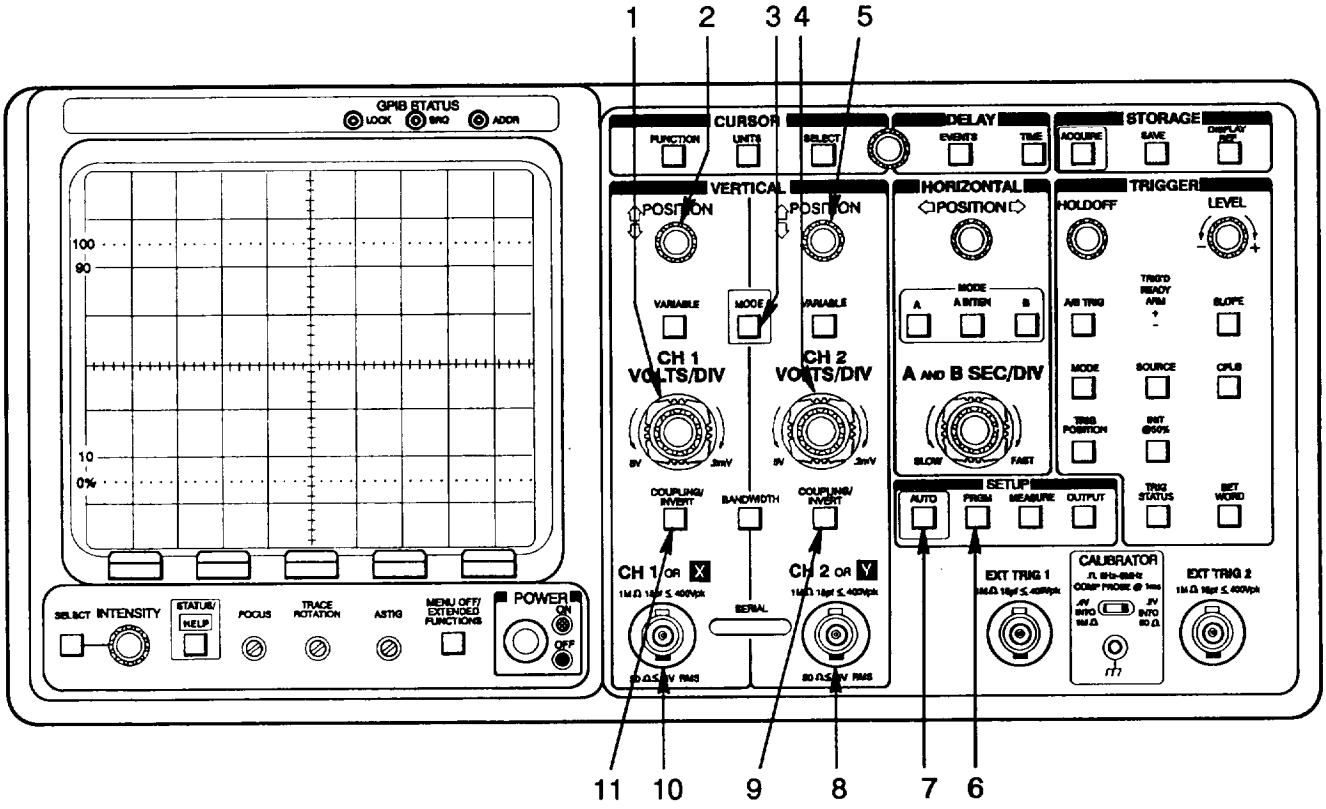
8. If the point to be measured is below the ground reference (8), and the channel isn't inverted, then multiply the result by -1. If the channel is inverted and the point to be measured is above the ground reference (8), multiply the results by -1.



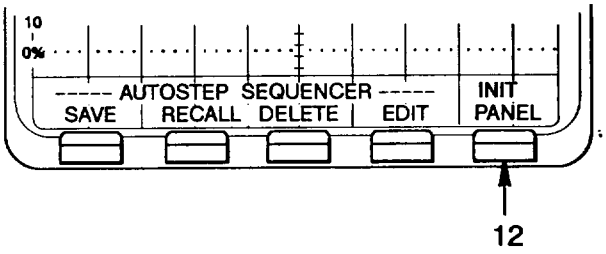
2-11. ADD MODE MEASUREMENTS.

NOTE

ADD Vertical Mode can be used to add or subtract two waveforms. With the two waveforms displayed, one on CH 1 and the other on CH 2, the ADD Mode waveform is the algebraic sum of the two.



1. Press the PRGM button (6).



2. Select INIT PANEL using its menu button (12).

3. Connect the CH 1 input (10) to the signal source (17).

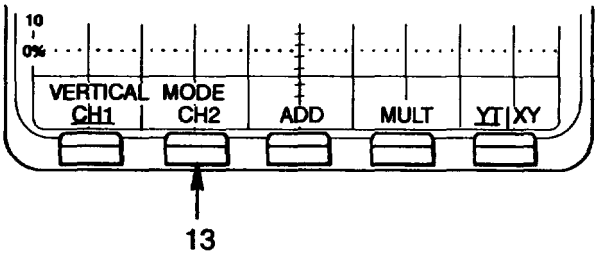
4. Connect the CH 2 input (8) to the other signal source (16).

5. Press the AUTO SETUP button (7) to display the CH 1 trace.

6. Adjust the CH 1 VOLTS/DiV control (1) so that the trace amplitude is no more than 3 divisions.

7. Adjust the CH 1 POSITION control (2) to position the trace (17) above the center horizontal graticule line.

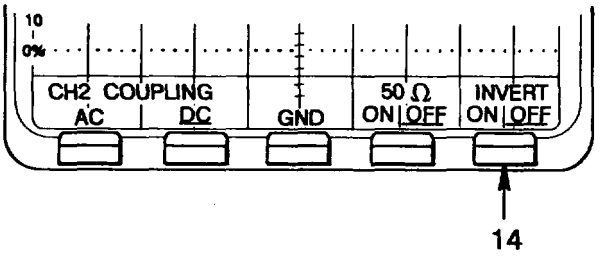
8. Press the VERTICAL MODE button (3) and the VERTICAL MODE menu will appear.



9. Select CH 2 using its menu button (13). The CH 2 trace (16) will be displayed.

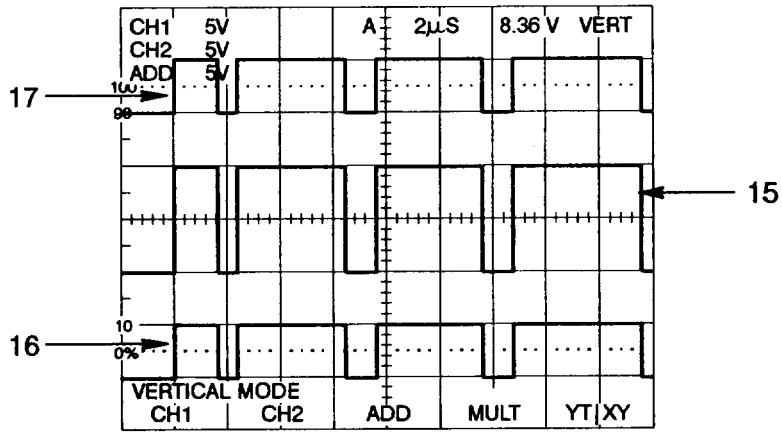
10 Adjust the CH 2 VOLTS/DIV control (4) to equal the CH 1 VOLTS/DIV setting. Both traces should be no greater in amplitude than 3 divisions. Adjust the VOLTS/DIV controls as required while keeping the settings equal.

11. Use the CH 2 POSITION control (5) to position the CH 2 trace (16) below the center horizontal graticule line.

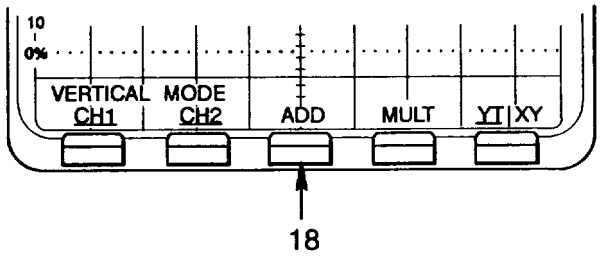


NOTE

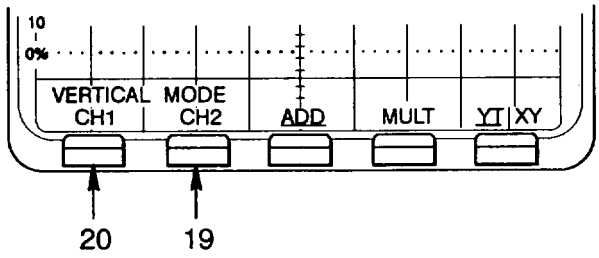
Press the CH 1 COUPLING/INVERT button (11), or the CH 2 COUPLING/INVERT button (9), and the INVERT ON/OFF menu Button (14) if one waveform is to be subtracted from the other.



12. If the VERTICAL MODE menu is not on the display (INVERT was previously selected), press the VERTICAL MODE button (3).



13. Select ADD using its menu button (18). The ADD signal (15) is now displayed, as are the CH 1 (17) and CH 2 (16) traces.



14 Deselect CH 1, using its menu button (20), and CH 2, using its menu button (19), to display only the ADD signal. The ADD trace (15) can now be measured.

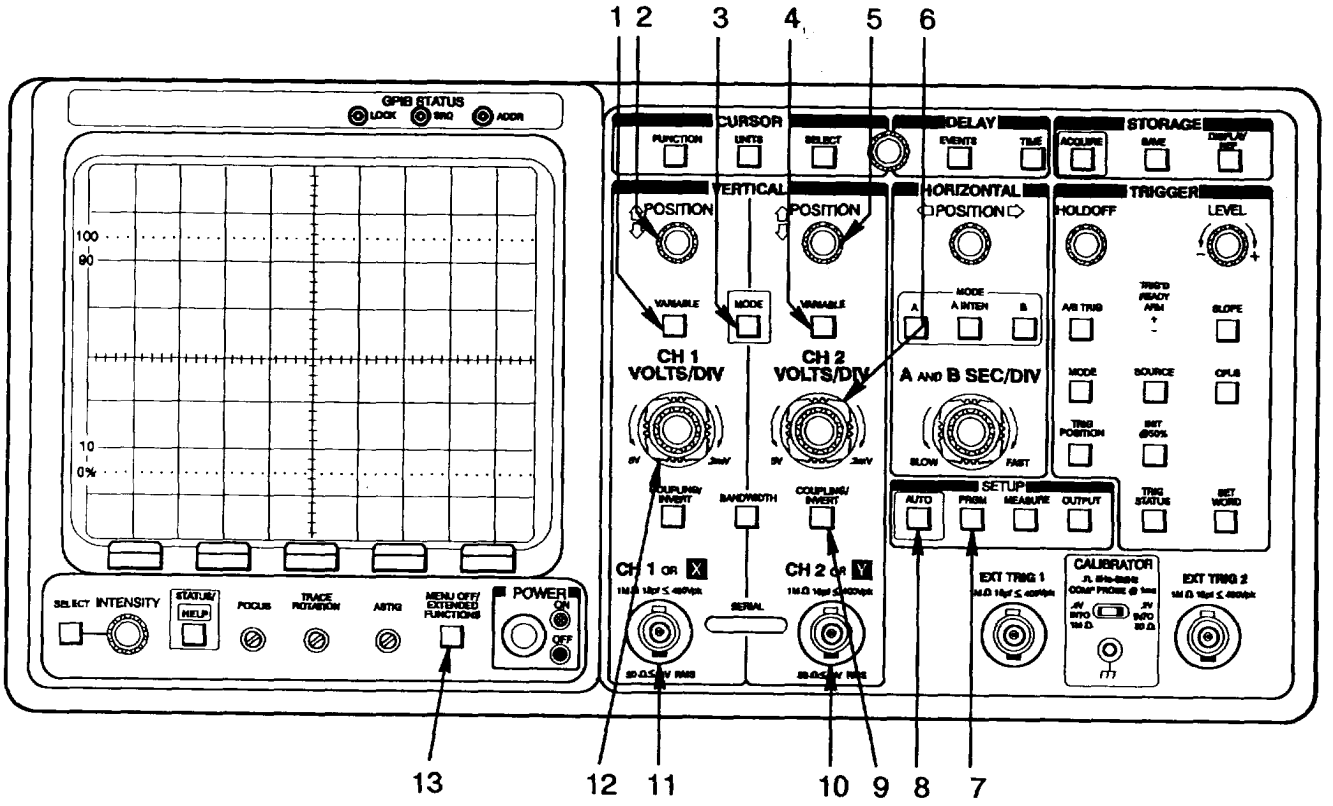
NOTE

The position of the ground reference for the ADD trace is based on the sum of the positions of the CH 1 and CH 2 ground references.

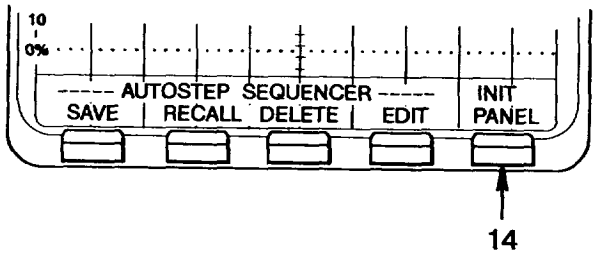
2-12. NOISE REDUCTION AND UNWANTED SIGNAL CANCELLATION.

NOTE

The ability to add or subtract waveforms allows you to cancel common mode noise on differential signals. It also allows you to cancel unwanted signals. To cancel common mode noise, do steps 1 through 15. To cancel unwanted signals, do steps 16 through 31.



1. Press the PRGM button (7').



2. Select INIT PANEL using its menu button (14).

3. Connect the CH 1 input (11) to the signal source (22).

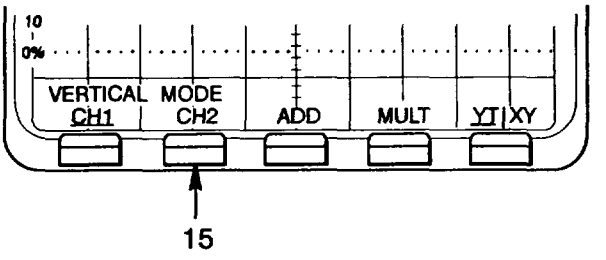
4. Connect the CH 2 input (10) to the other signal source (20).

5. Press the AUTO SETUP button (8) to display the CH 1 trace.

6. Adjust the CH 1 VOLTS/DIV control (12) so that the trace amplitude is no more than 3 divisions.

7. Adjust the CH 1 POSITION control (2) to position the trace (22) above the center horizontal graticule line.

8. Press the VERTICAL MODE button (3) and the VERTICAL MODE menu will appear.

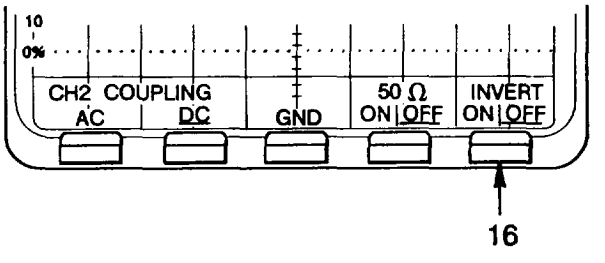


9. Select CH 2 using its menu button (15). The CH 2 trace (20) will be displayed.

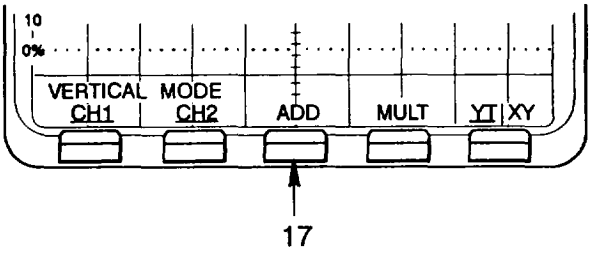
10. Adjust the CH 2 VOLTS/DIV control (6) to equal the CH 1 VOLTS/DIV setting. Both traces should be no greater in amplitude than 3 divisions. Adjust the VOLTS/DIV controls as required while keeping the settings equal.

11. Use the CH 2 POSITION control (5) to position the CH 2 trace (20) below the center horizontal graticule line.

12. Press the CH 2 COUPLING/INVERT button (9).



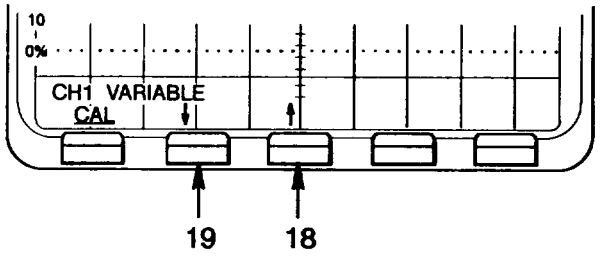
13. Select ON for INVERT ON | OFF using its menu button (16).



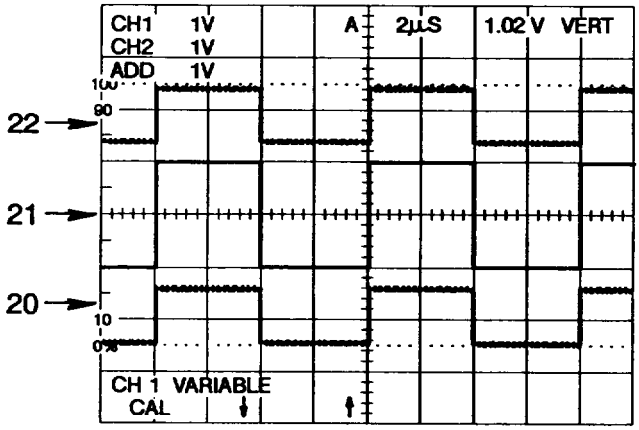
14. Press the VERTICAL MODE button. Select ADD using its menu button (17). The ADD trace (21) is now displayed and can be measured.

15. If the exact amplitude of the ADD waveform (21) is not critical, the VARIABLE gain control of one of the channels may be adjusted to further reduce noise. To adjust the VARIABLE gain, perform the following:

- Press one of the VARIABLE gain buttons (1 or 4).



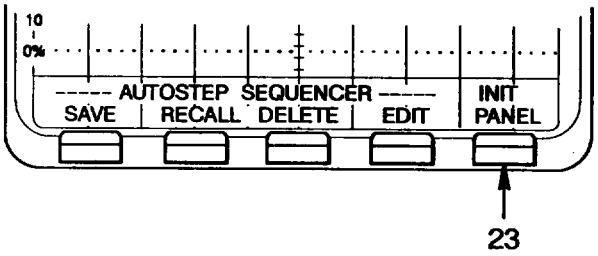
- Select ↑ (18) and ↓ (19), using their menu buttons, to vary the VERTICAL gain of the selected channel.



NOTE

Steps 16 through 31 cancel the unwanted part of the signal source (the AC portion). This is done by applying a signal to CH 2 that matches the unwanted part of the signal source. The CH 2 signal is then inverted and the two traces (17 and 18) are ADDed.

16. Press the PRGM button (7).

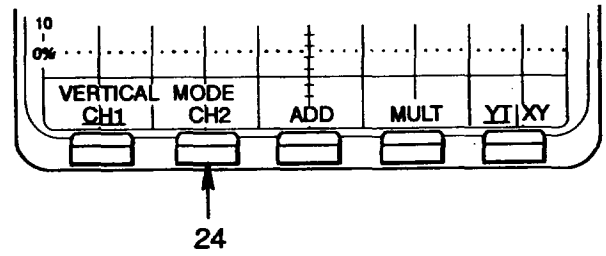


17. Select INIT PANEL using its menu button (23).

18. Connect the CH 1 input (11) to the composite signal source (26).

19. Press the AUTO SETUP button (8). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (13) to turn off the menu.

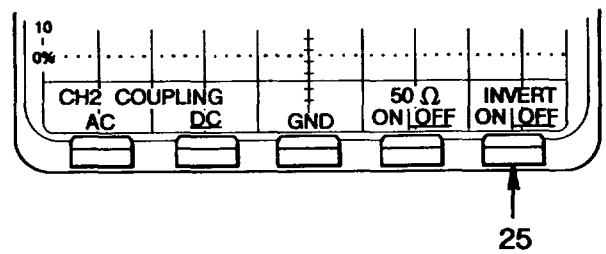
20. Press the VERTICAL MODE button (3) and the VERTICAL menu will appear.



21. Select CH 2 using its menu button (24). The CH 2 trace (27) will be displayed.

22. Connect the signal that matches the unwanted part of the signal source (27) to the CH 2 input (10).

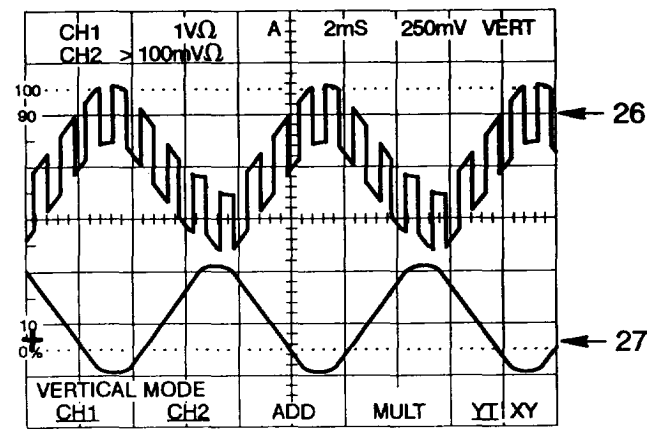
23. press the CH 2 COUPLING/INVERT button (9) to display the CH 2 COUPLING menu.



24. Select ON for INVERT ON/OFF using its menu button (25).

NOTE

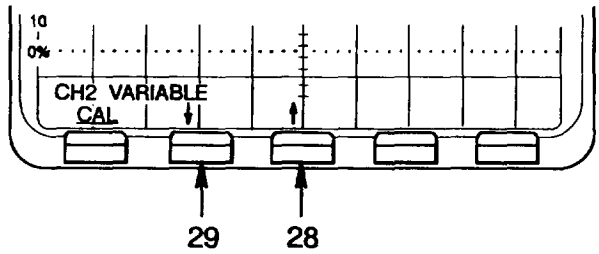
The phase of the CH 2 signal should match that of the unwanted part of the signal source in CH 1 for maximum cancellation to occur.



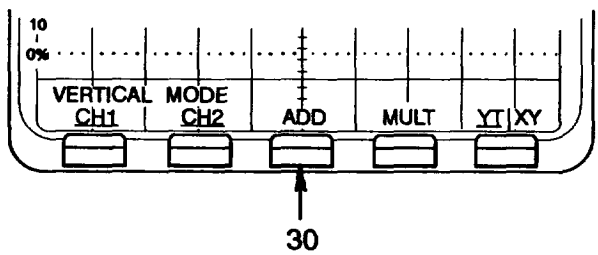
25. Adjust the CH 1 VOLTS/DIV control (12) to display about four divisions of signal (26).

26. Adjust the CH 2 VOLTS/DIV control (6) so the amplitude of the CH 2 signal is about equal to the unwanted part of the signal source (27) in the CH 1 display.

27. Press the CH 2 VARIABLE gain button (4) to display the CH 2 VARIABLE menu.



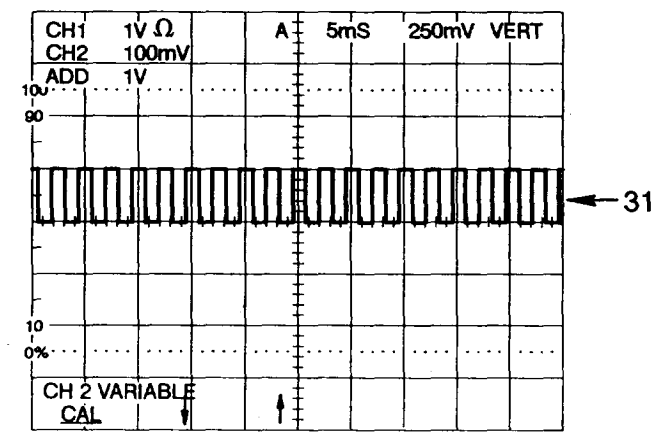
28. Using the ↑menu button (28) and the ↓ button (29), adjust the CH 2 signal (27) amplitude to match the unwanted component of the CH 1 signal (26).



29. Press the VERTICAL MODE button (3) and select ADD using its menu button (30). CH 1 and CH 2 maybe deselected if desired.

30. If required, repeat steps 27 and 28 above to further reduce the unwanted part of the signal source.

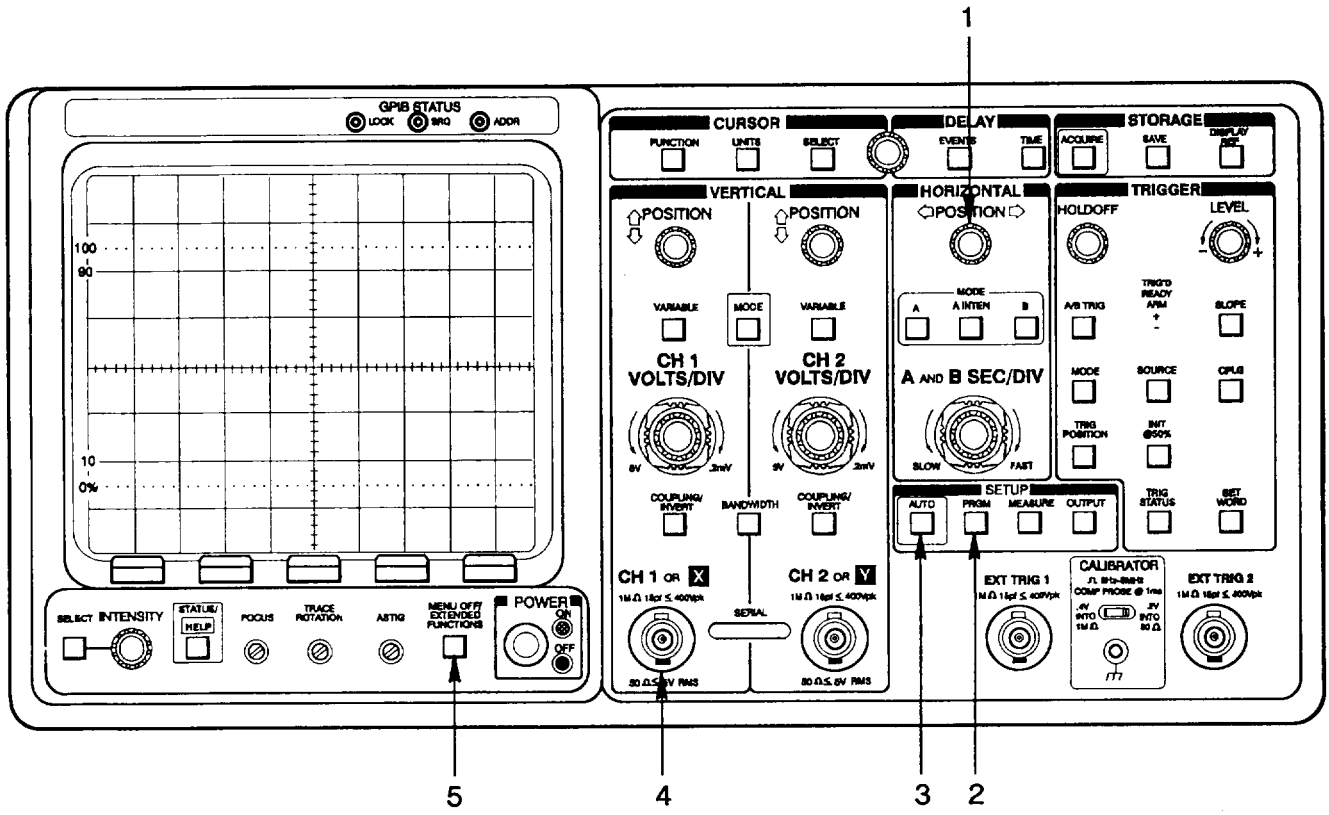
31. The wanted signal (31) is now ready to measure.



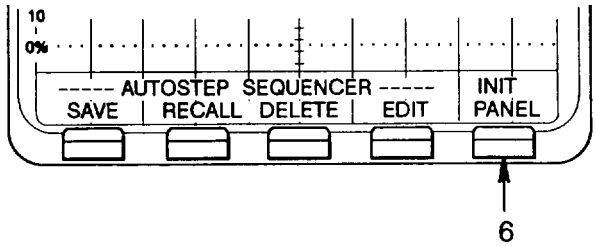
2-13. TIME AND FREQUENCY MEASUREMENTS–NON-DELAYED.

NOTE

To measure time duration between two points on a waveform while using the graticule, it is only necessary to display the points on screen, count the number of vertical divisions between the points, and apply a formula.



1. Press the PRGM button (2).



2. Select INIT PANEL using its menu button (6).

3. Connect the CH 1 input (4) to the signal source (7).

4. Press the AUTO SETUP button (3). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (5) to turn off the menu.

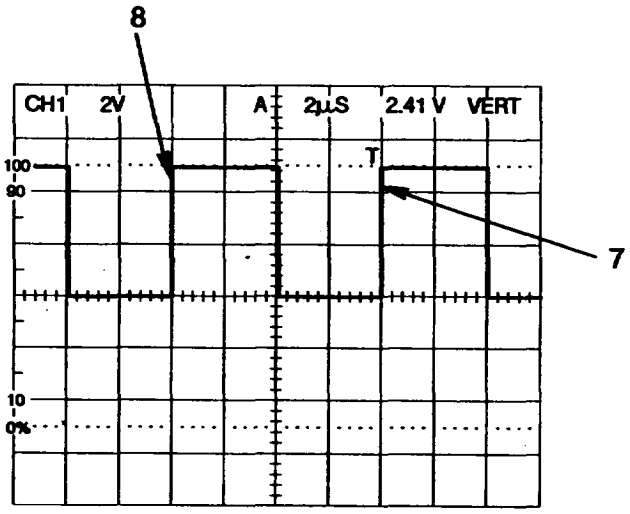
5. Adjust the HORIZONTAL POSITION control (1) so that the first point is aligned with a graticule line near the left side of the CRT (7).

6. Count the number of graticule lines between the first point (8) and the second point (7).

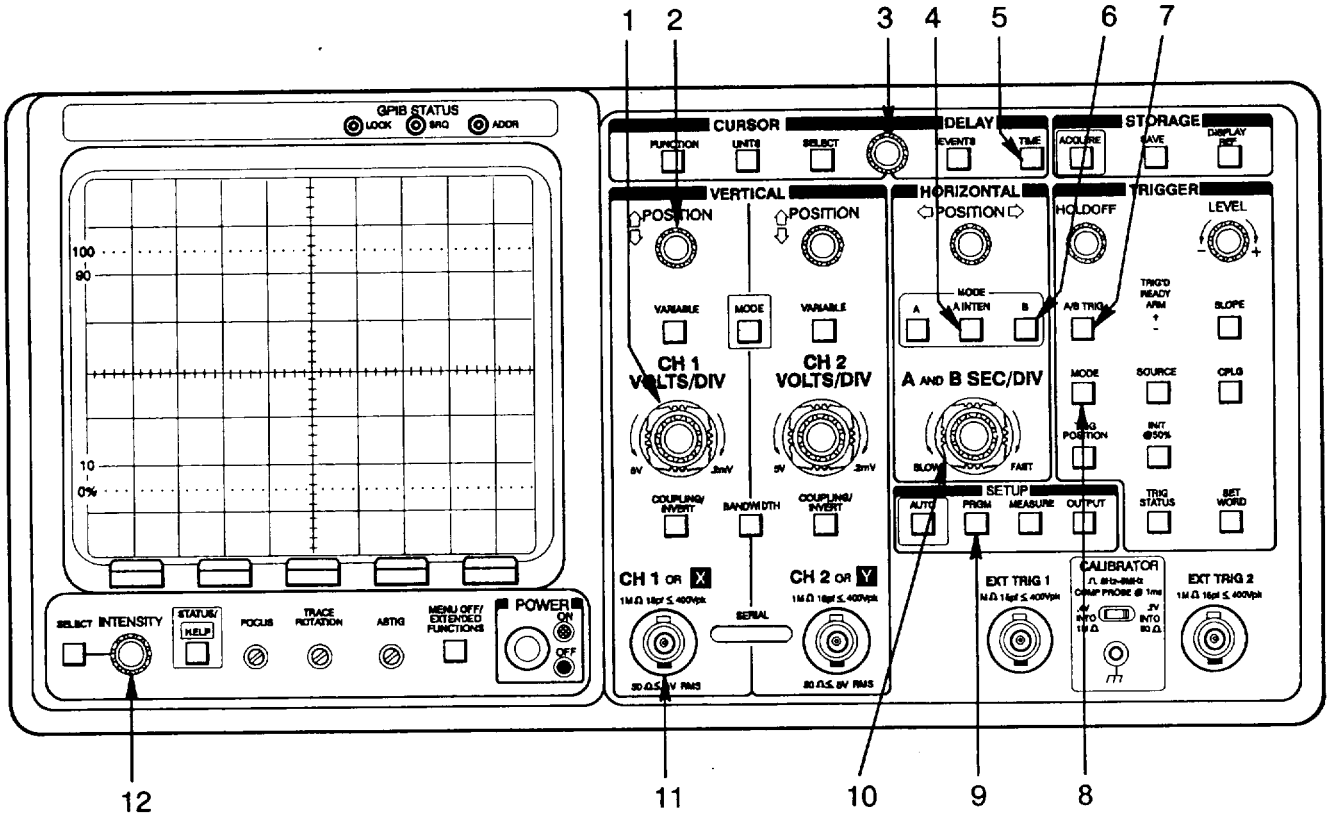
7. To find the time between the two points, use the formula: Time = Divisions times the SEC/DIV Setting

8. If the time is for a single cycle of a periodic waveform, the frequency can be determined by the formula:

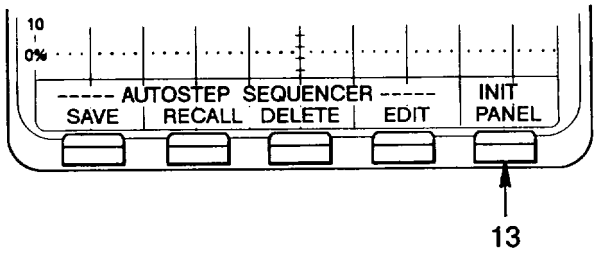
$$Frequency = \frac{1}{Time\ \ Duration}$$



2-14. DELAY TIME MODE AS A MAGNIFIER.



1. Press the PRGM button (9).



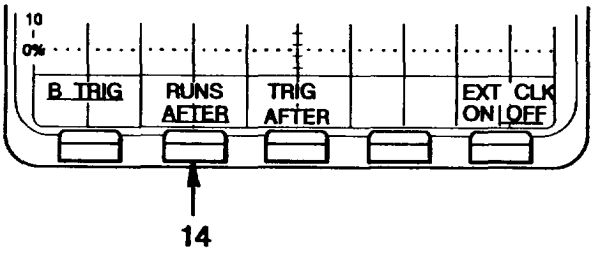
2. Select INIT PANEL using its menu button (13).

3. Connect the CH 1 input (11) to the signal source (16). Set the VOLTS/DIV control (1) for five vertical divisions of display. Adjust the VERTICAL POSITION control (2) to center the waveform.

4. Set the A SEC/DIV control (10) to display one or more waveform cycles.

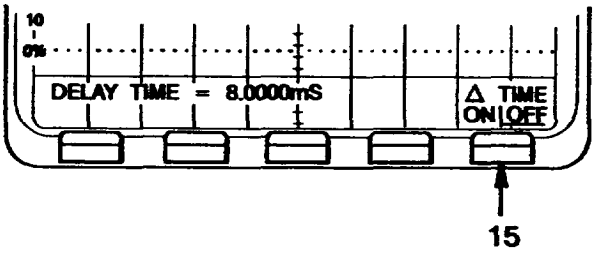
5. Press the A INTEN button (4).

6. Press the TRIGGER MODE button (8).



7. Press the A/B TRIG button (7) to display the B TRIG menu. Select RUNS AFTER using its menu button (14).

8. Adjust the B SEC/DIV control (10) to an acquisition rate 10 times faster than the A SEC/DIV (approximately 3 positions clockwise). Adjust the INTENSITY control (12) for adequate contrast between the two portions of the trace (16 and 17).

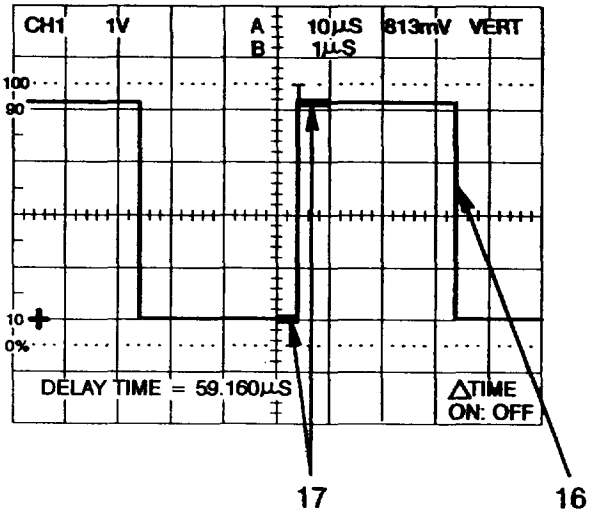


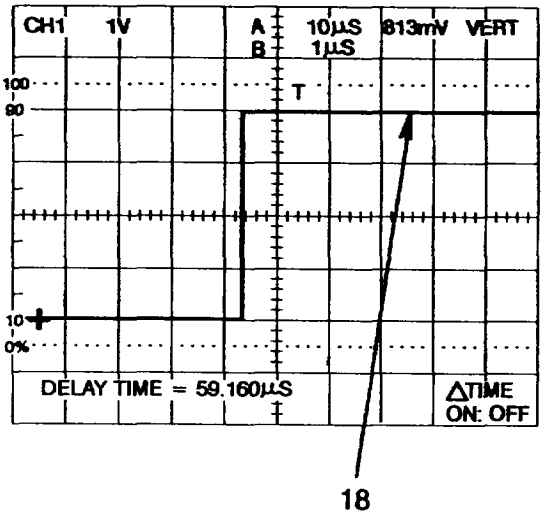
9. Press the DELAY TIME button (5) to display the menu. Select OFF for A TIME ON| OFF using its menu button (15).

10. Adjust the Cursor/Delay control (3) to position the intensified zone to the part of the display that is to be magnified (17).

11. Set the B SEC/DIV control (10) to a setting which completely intensifies the part of the display to be magnified.

12. Press the MODE B button (6). The intensified portion of the display (17) will appear at the SEC/DIV setting of the B time base (18).

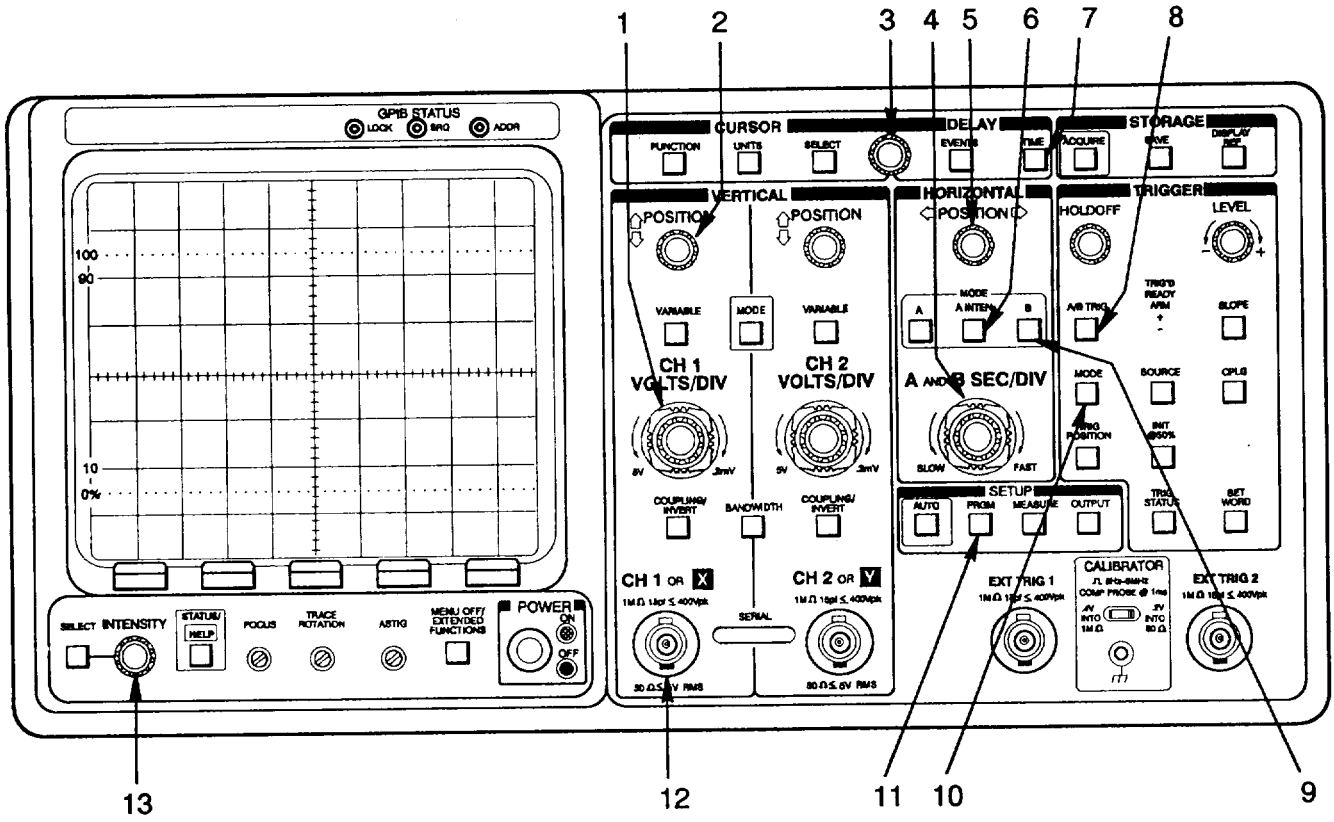




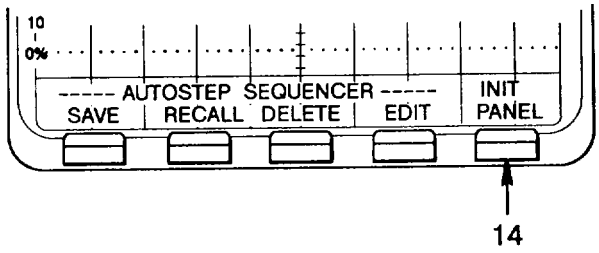
2-15. DELTA DELAY TIME AND FREQUENCY MEASUREMENTS.

NOTE

A DELAY TIME allows a second delay between the first B and a second B acquisition.



1. Press the PRGM button (11).



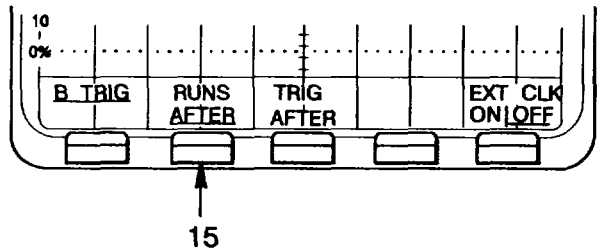
2. Select INIT PANEL using its menu button (14).

3. Connect the CH 1 input (12) to the signal source (18). Set the VOLTS/DIV control (1) for five divisions of display. Adjust the VERTICAL POSITION control (2) to center the waveform.

4. Set the A SEC/DIV control (4) so both points of interest (19 and 20) are displayed.

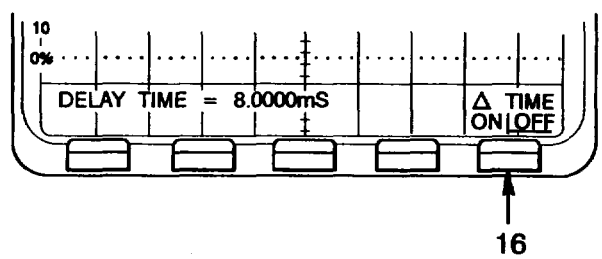
5. Press the A INTEN button (6).

6. Press the TRIGGER MODE button (10).



7. Press the A/B TRIG button (8) to display the B TRIG menu. Select RUNS AFTER using its menu button (15).

8. Adjust the B SEC/DIV control (4) to a rate 10 times faster than the A SEC/DIV (approx. 3 positions clockwise). Adiust the INTENSITY control (13) for adequate contrast between the two parts of the trace (17) (18)-



9. Press the DELAY TIME button (7) and select ON for A TIME ON | OFF using its menu button (16). Select A DELAY TIME by pressing the DELAY TIME button (7).

10. Turn the CURSOR/DELAY control (3) fully CCW to the end of the spring-loaded portion. Two overlapping zones, about two divisions long, should be displayed at the Record Trigger (20) on the waveform.

11. Press the DELAY TIME button (7). Adjust the CURSOR/DELAY control (3) to place both intensified zones to the first point of interest (20).

12. Press the DELAY TIME button (7). Position the A delay intensified zone, using the CURSOR/DELAY control (3), to the second point of interest (19).

13. Press the HORIZONTAL MODE B button (9). Adjust the INTENSITY control (13), if necessary, to intensify the waveform (22).

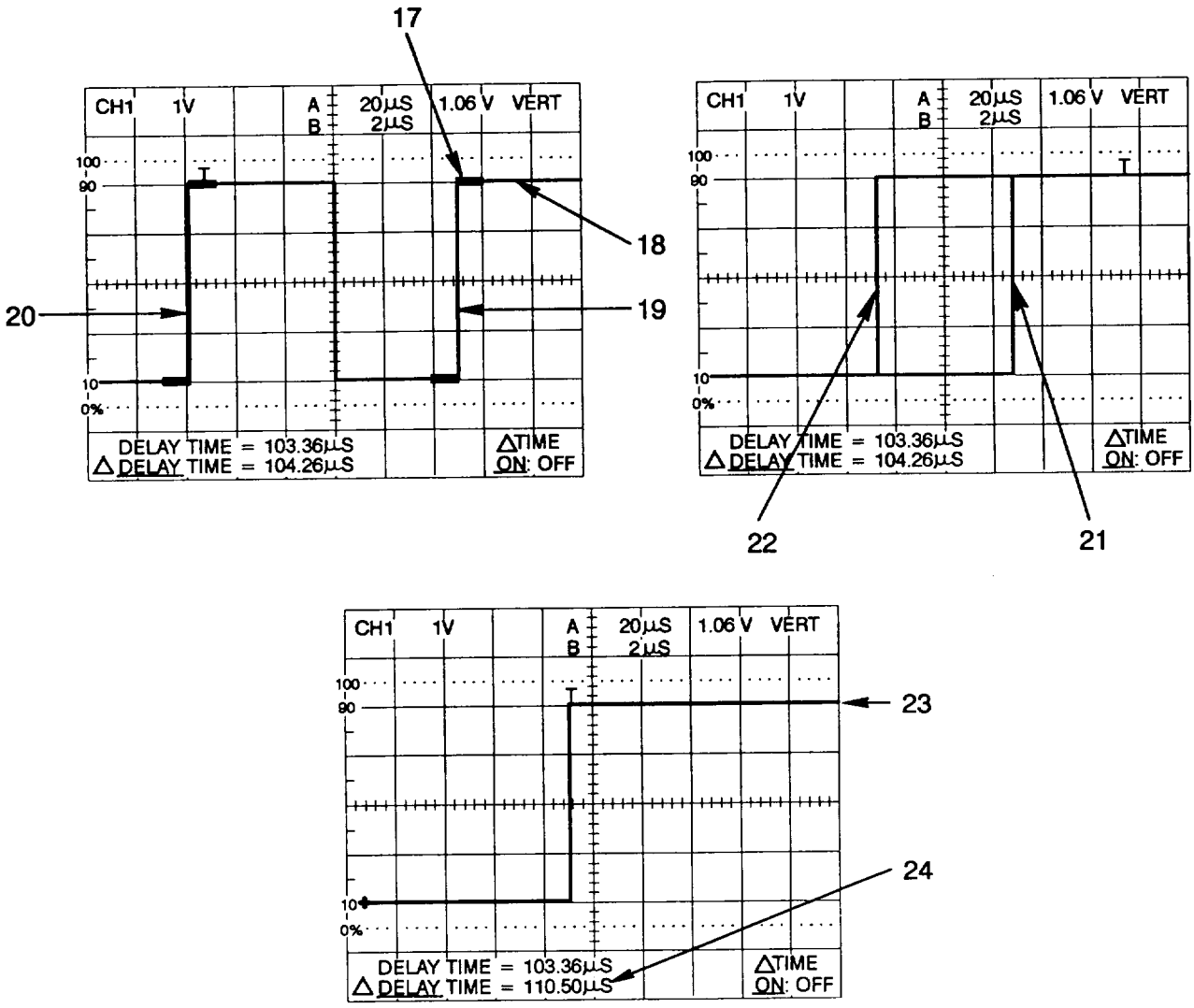
14. Adjust the CURSOR/DELAY control (3) to overlap the two points of interest (21 and 22). Adjust the HORIZONTAL POSITION control (5), if necessary, to view the displayed waveform (23).

NOTE

The A DELAY TIME readout (24) shows the time between the two points of interest when the two are superimposed.

15. The frequency can be determined by the formula:

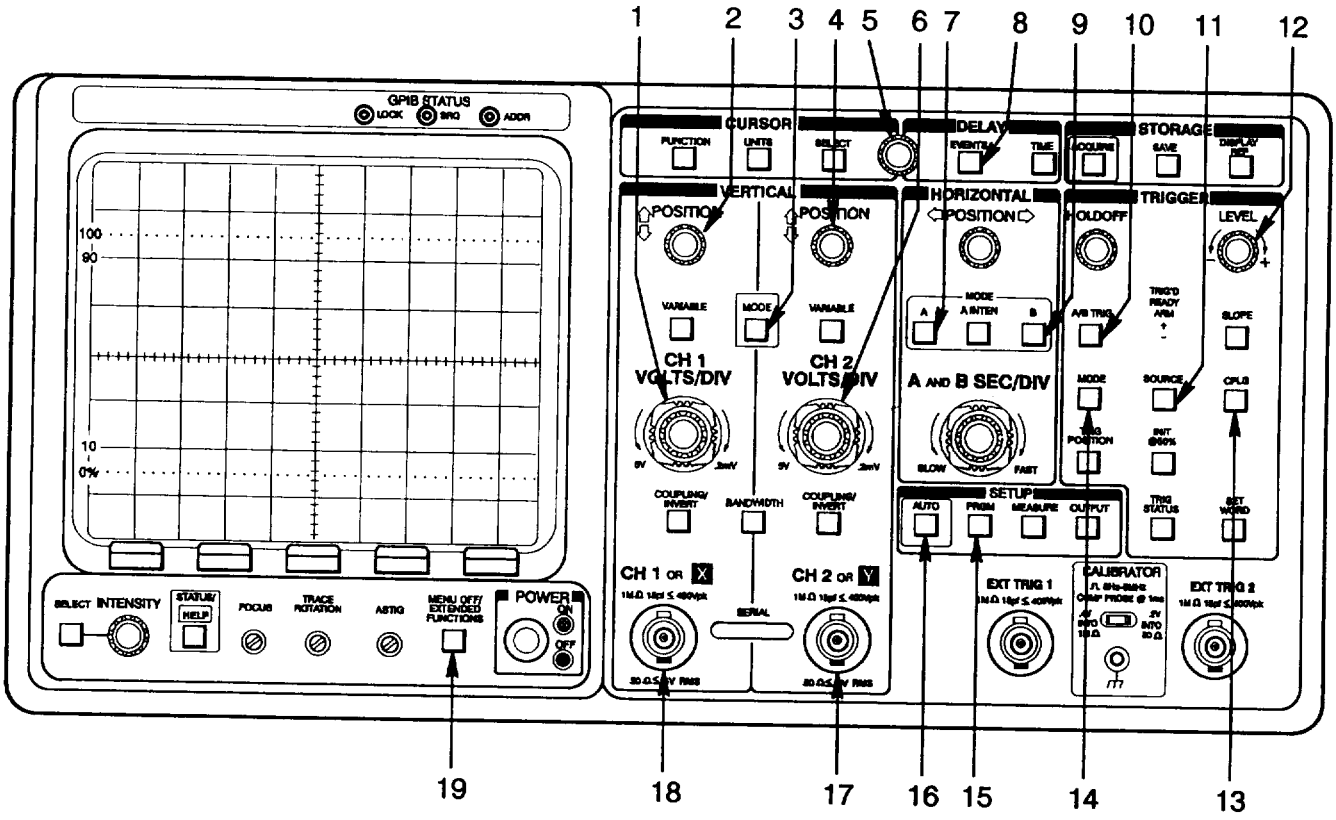
$$Frequency = \frac{1}{\Delta\ DELAY\ TIME} \quad (24)$$



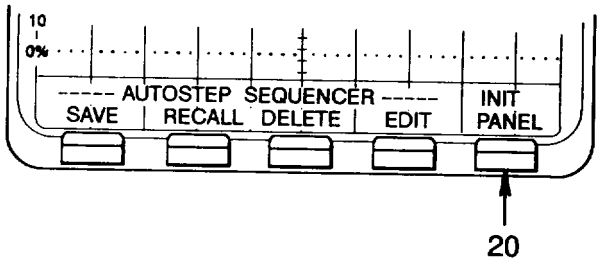
2-16. DELAY BY EVENTS MEASUREMENTS.

NOTE

DELAY by EVENTS allows you to create a delay between the normal A-Trigger and the A acquisition. The delay, which can be set by the operation, consists of a number of B-Trigger events. The count starts at the normal A Trigger. As soon as it has counted the number of B Triggers, it displays the A acquisition.



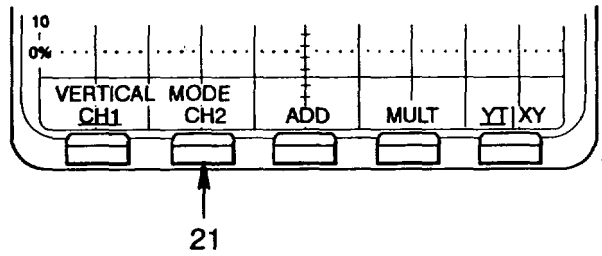
1. Press the PRGM button (15).



2. Select INIT PANEL using its menu button (20).

3. Connect the CH 1 input (18) to the signal (27) which will provide the trigger to start the events counting.

4. Connect the CH 2 input (16) to the signal (28) which will provide the triggers to be counted.

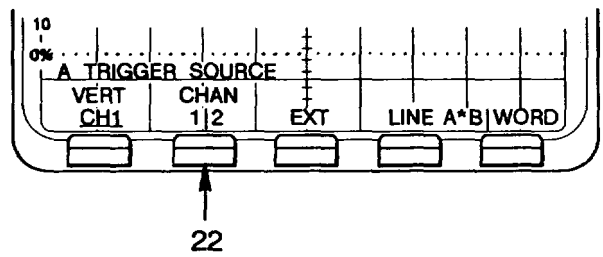


5. Press the VERTICAL MODE button (3). Select CH 2 using its menu button (21).

6. Press the AUTO SETUP button (16). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (19) to turn off the menu.

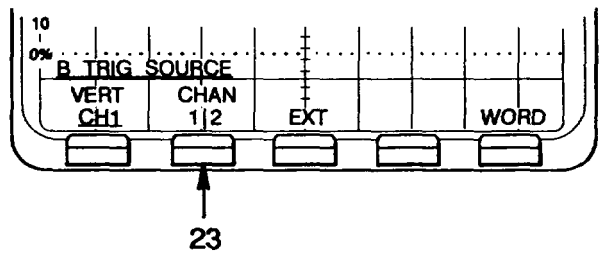
7. Adjust the CH 1 (2) and CH 2 (4) VERTICAL POSITION controls to separate the two waveforms.

8. Set the CH 1 (1) and CH 2 (6) VOLTS/DIV controls so that each waveform is less than three divisions in amplitude.



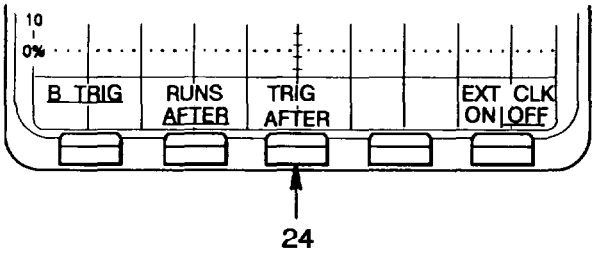
9. Press the TRIGGER SOURCE button (11). Select Channel 1 for A TRIGGER SOURCE CHAN 1/2 using its menu button (22).

10. Press the A/B TRIG button (10).



11. Select Channel 2 for B TRIG SOURCE CHAN 1/2 using its menu button (23).

12. Press the TRIGGER MODE button (14).

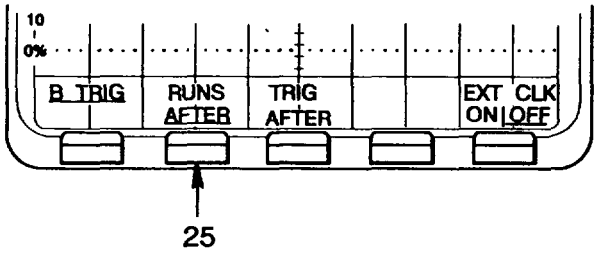


13. Select TRIG AFTER using its menu button (24).

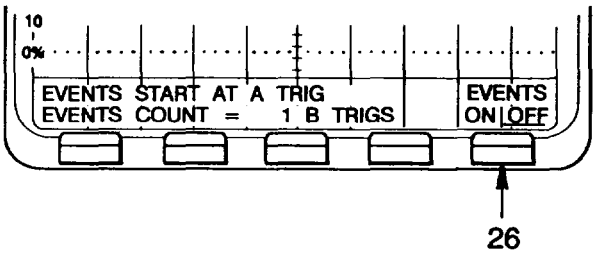
14. Press the HORIZONTAL MODE B button (9).

15. Press the TRIGGER CPLG button (13) and adjust the LEVEL control (12) for a triggered display.

16. Press the HORIZONTAL MODE A button (7).



17. Press the TRIGGER MODE button (14) and select RUNS AFTER using its menu button (25).

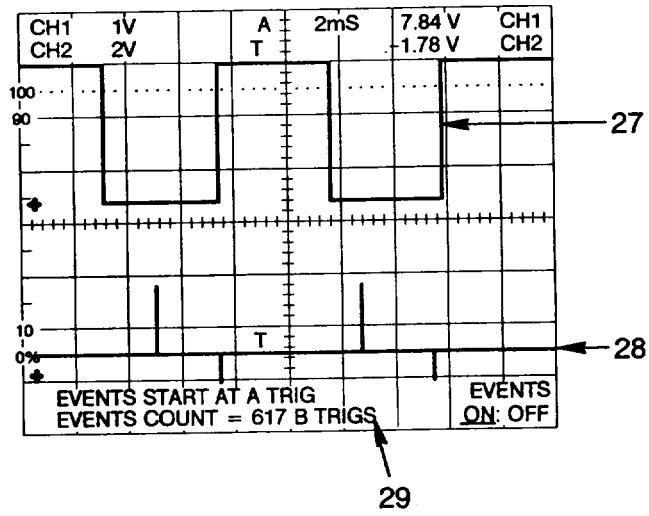


18. Press the DELAY by EVENTS button (8) and select ON for EVENTS ON| OFF using its menu button (26).

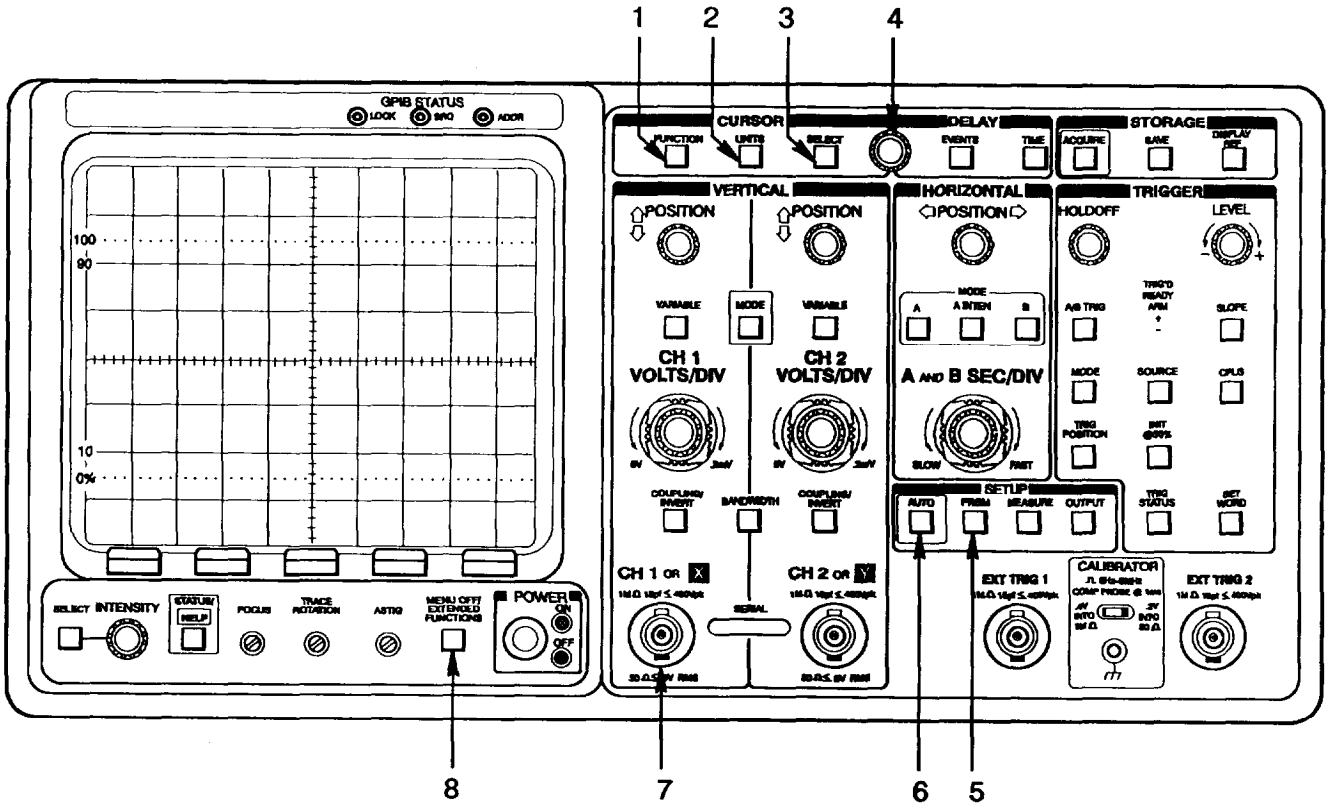
19. Adjust the CURSOR/DELAY control (5) and set the EVENTS COUNT (29) to the desired number of events. The resultant display will be delayed from the Normal A Trigger (event) by that number.

NOTE

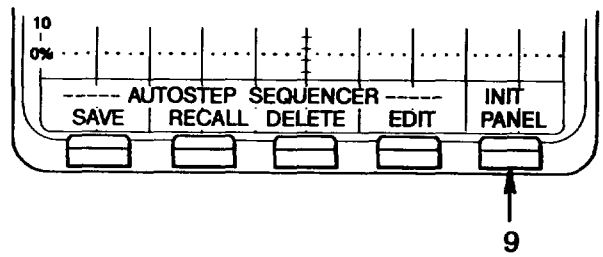
The A-Record Trigger (T) is the event around which the A acquisition is displayed. The A-Record Trigger is delayed from the A-Trigger event by the number of events specified in step 19.


CH1 1V
CH2 2V
A
T
2mS
7.84 V
1.78 V
CH1
CH2
100
90
10
0%
T
EVENTS START AT A TRIG
EVENTS COUNT = 617 B TRIGS
EVENTS
ON: OFF
27
28
29

2-17. DELTA VOLTAGE MEASUREMENTS.



1. Press the PRGM button (5).

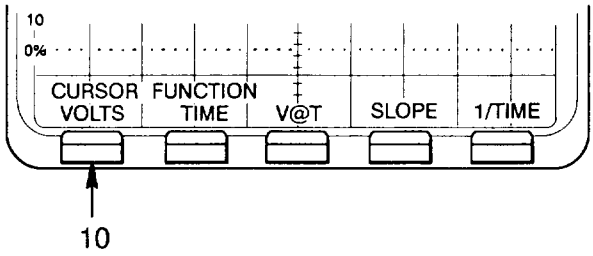


2. Select INIT PANEL using its menu button (9).

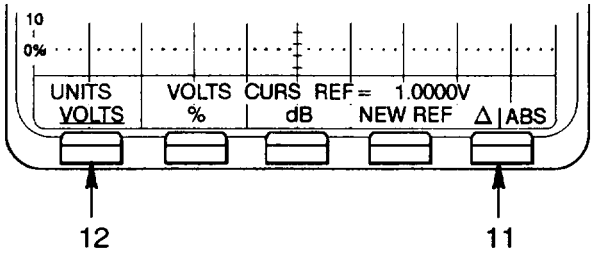
3. Connect the CH 1 input (7) to the signal source (13).

4. Press the AUTO SETUP button (6). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (8) to turn off the menu.

5. Press the CURSOR FUNCTION button (1) to display the CURSOR FUNCTION menu.



6. Select VOLTS using its menu button (10).

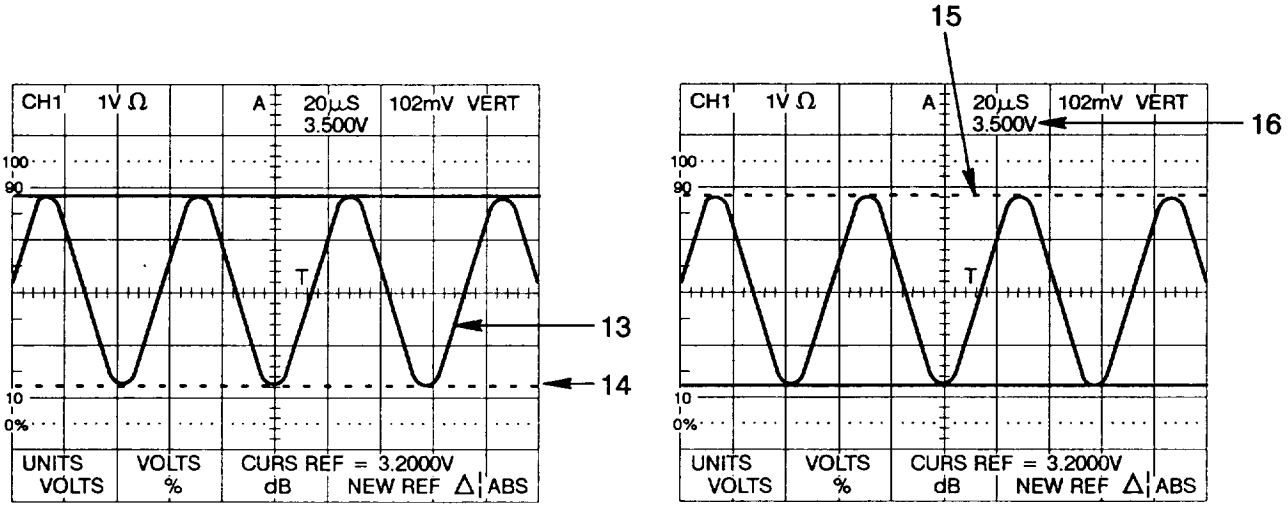


7. Press the CURSOR UNITS button (2). Select VOLTS using its menu button (12). Select Δ for Δ|ABS using its menu button (11).

8. Adjust the CURSOR/DELAY control (4) to position the dashed cursor (15) at the first voltage level on the displayed waveform.

9. Press the CURSOR SELECT button (3) to activate the other cursor (14) and position it at the second voltage level with the CURSOR/DELAY control (4).

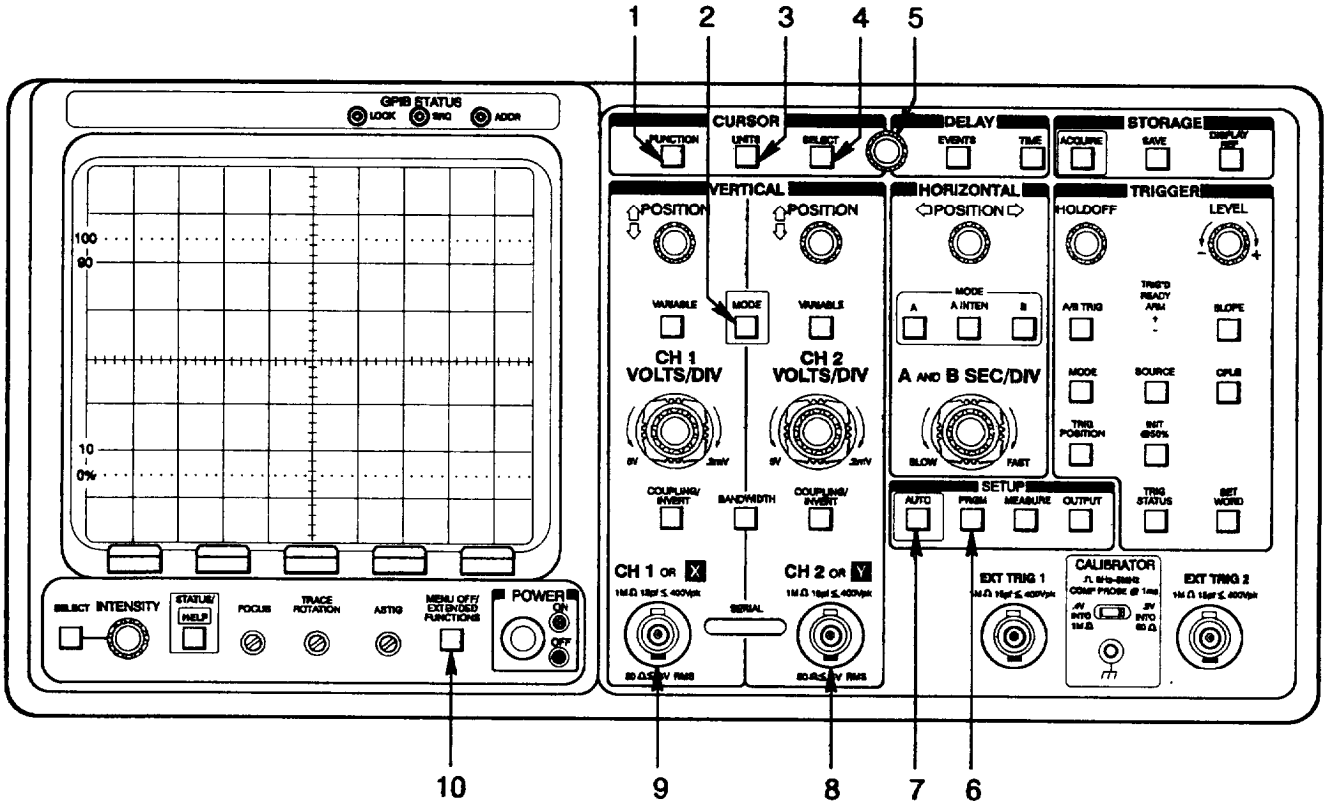
10. The cursor readout (16) gives the difference between the two levels in volts.



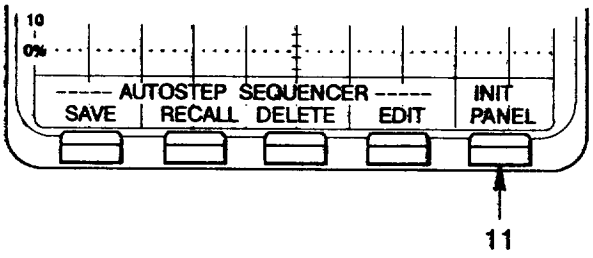
2-18. RATIO BETWEEN TWO VOLTAGES

NOTE

The special units (% and dB) allow the operator to make ratiometric measurements. When the measurement is made, its value is stored as a reference. Then, after a comparison measurement, the readout gives the ratio of the comparison to the reference in terms of percent or decibels.

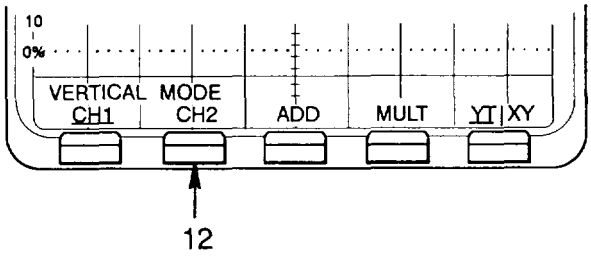


1. Press the PRGM button (6).



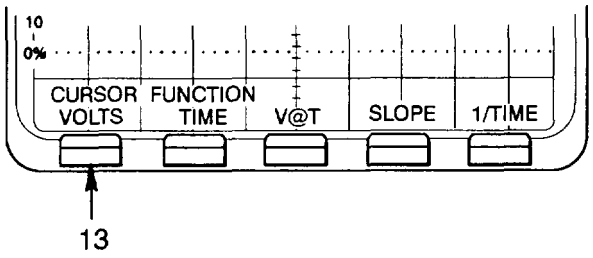
2. Select INIT PANEL using its menu button (11).

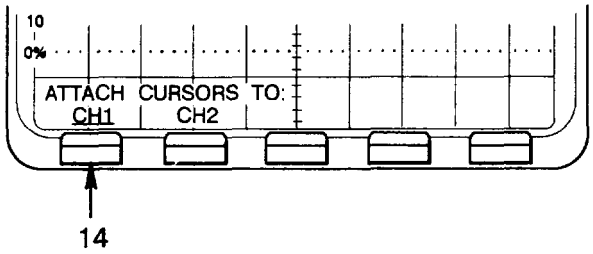
3. Connect the CH 1 input (9) to the reference signal (21) and the CH 2 input (8) to the comparison signal (22).



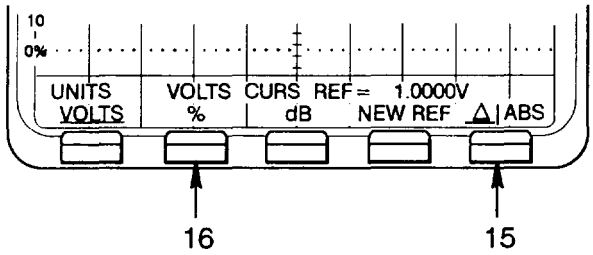
4. Press the VERTICAL MODE button (2) and select CH 2 using its menu button (12)

5. Press the AUTO SETUP button (7). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (10) to turn off the menu.





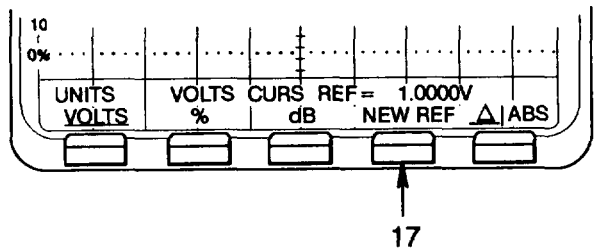
6. Press the CURSOR FUNCTION button (l). Select VOLTS, using its menu button (13), which will display the ATTACH CURSORS TO: menu. Select CH 1 using its menu button (14).



7. Press the CURSOR UNITS button (3). Select Δ for Δ | ABS, using its menu button (15), and %. using its menu button (16).

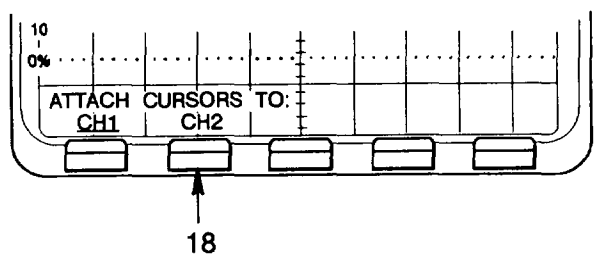
8. Using the CURSOR/DELAY control (5) align the active cursor (dashed) at the first voltage level of the reference signal (20).

9. Press the CURSOR SELECT button (4). Adjust the CURSOR/DELAY control (5) to the second voltage level of the reference signal (24).

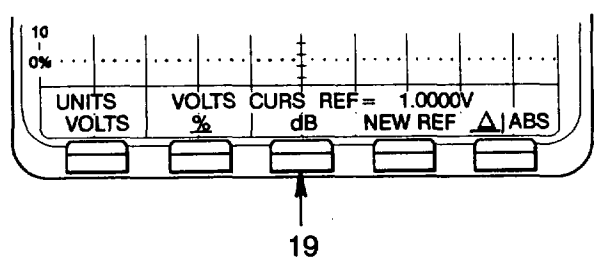


10. Select NEW REF using its menu button (17). Note that the cursor readout now shows 100% (23).

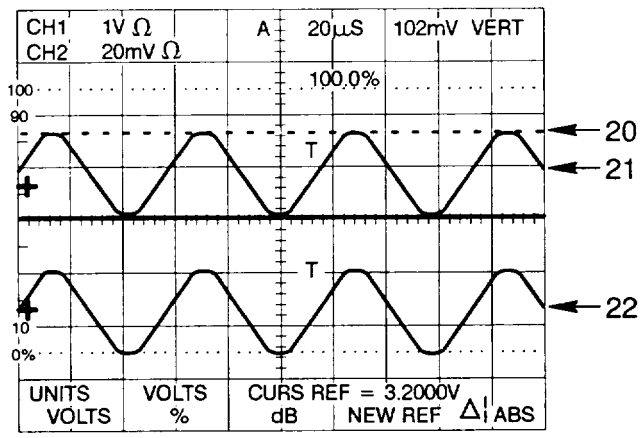
11 Repeat steps 7 and 8 for the comparison signal reference. If CH 1 and CH 2 have the same VOLTS/DIV setting, the readout now gives the peak-to-peak amplitude of the CH 2 signal as a percent of the peak-to-peak amplitude of the CH 1 signal.

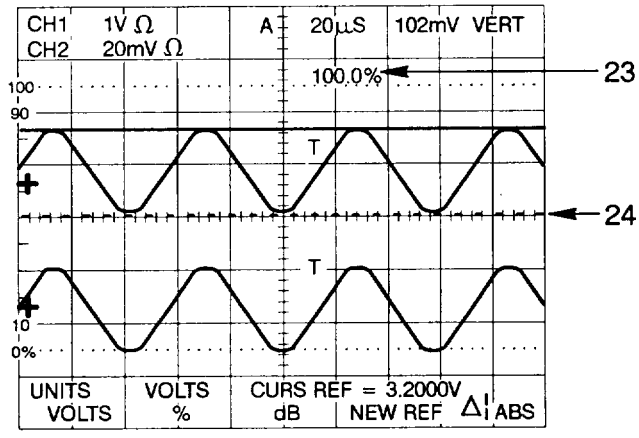


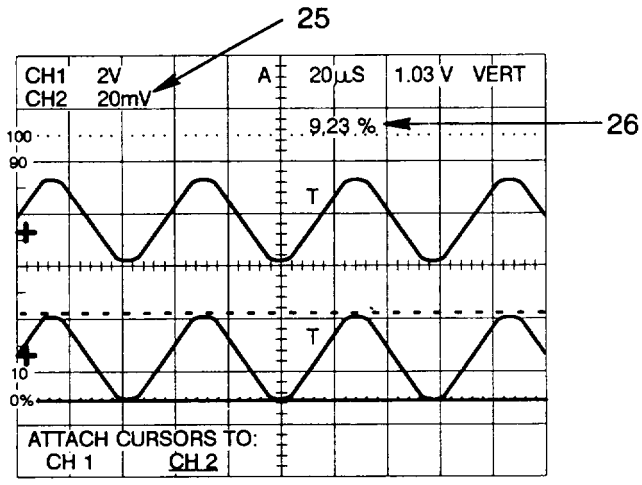
12. if CH 2 does not have the same VOLTS/DIV setting as CH 1 (25). Dress the CURSOR FUNCTION button (1) twice to display the ATTACH CURSORS TO: menu and select CH 2 using its menu button (18). The readout now gives the ratio between the comparison signal and the reference signal in percent (26).



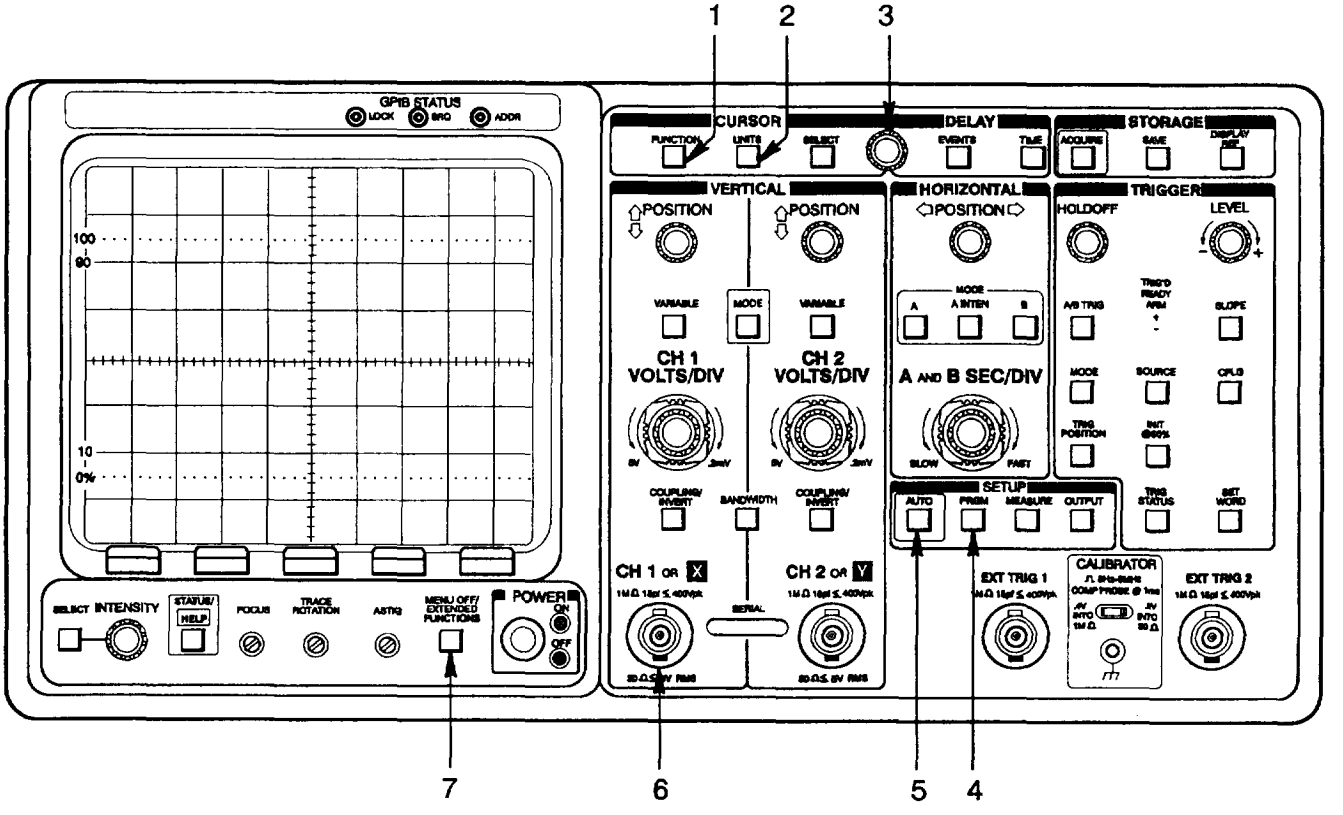
13. To display the results in dB (decibels) rather than %, press the CURSOR UNITS button (3) and select dB using its menu button (19).


CH1 1V Ω
CH2 20mV Ω
A 20µS 102mV VERT
100.0%
100
90
T
10
0%
UNITS VOLTS
VOLTS %
CURS REF = 3.2000V
dB NEW REF Δ ABS
20
21
22

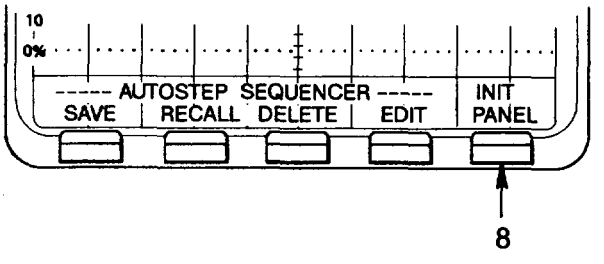

CH1 1V Ω
CH2 20mV Ω
A 20µS 102mV VERT
100.0%
100
90
T
10
0%
UNITS VOLTS
VOLTS %
CURS REF = 3.2000V
dB NEW REF Δ ABS
23
24


25
CH1 2V
CH2 20mV
A 20µS 1.03 V VERT
9.23 %
100
90
T
10
0%
ATTACH CURSORS TO:
CH 1 CH 2
26

2-19. ABSOLUTE VOLTAGE CURSOR MEASUREMENTS.



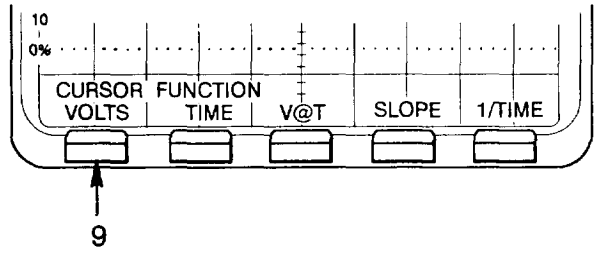
1. Press the PRGM button (4).



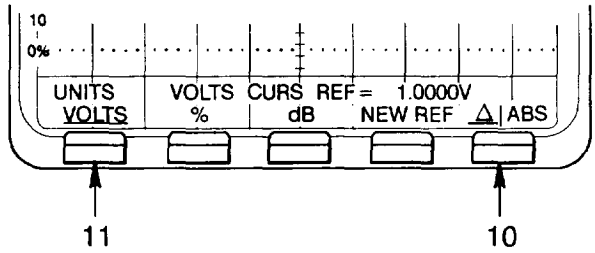
2. Select INIT PANEL using its menu button (8).

3. Connect the CH 1 input (6) to the signal source (13).

4. Press the AUTO SETUP button (5). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (7) to turn off the menu.



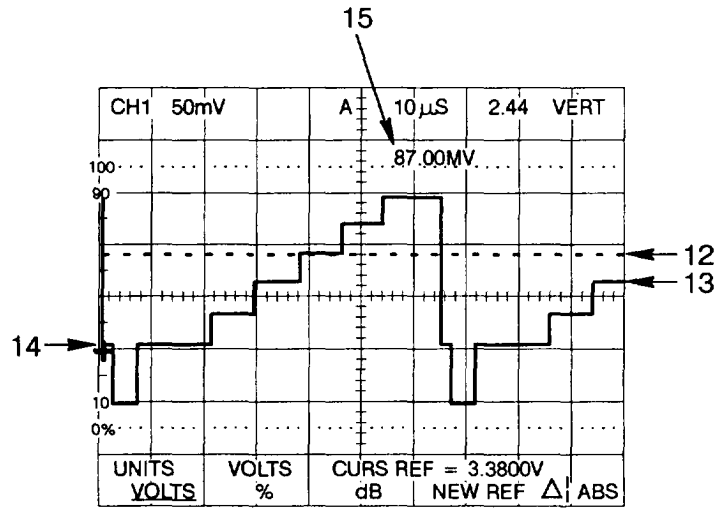
5. Press the CURSOR FUNCTION button (1). Select VOLTS using its menu button (9).



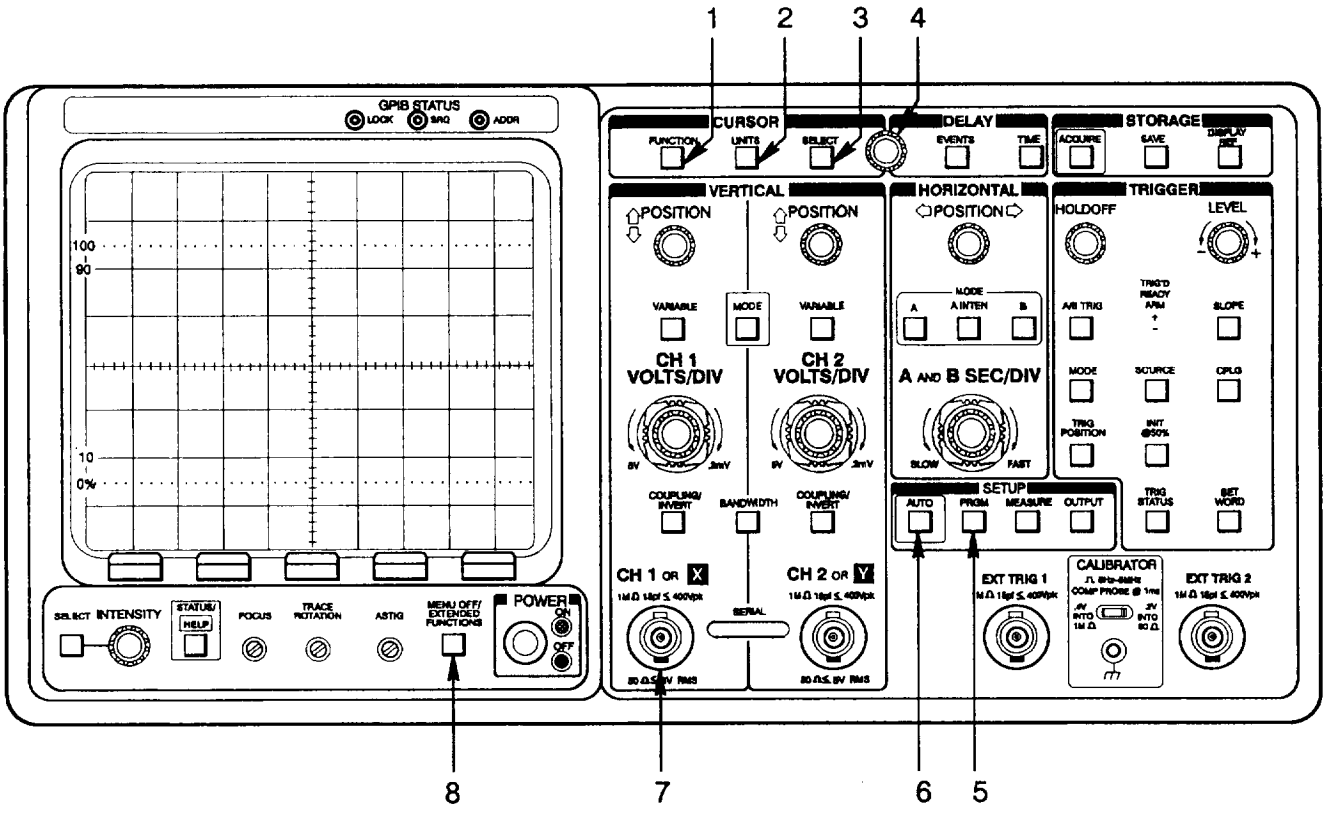
6. Press the CURSOR UNITS button (2). Select VOLTS using its menu button (11). Select ABS for Δ using its menu button (10).

7. Adjust the CURSOR/DELAY control (3) to align the cursor with the desired level in the displayed waveform (12).

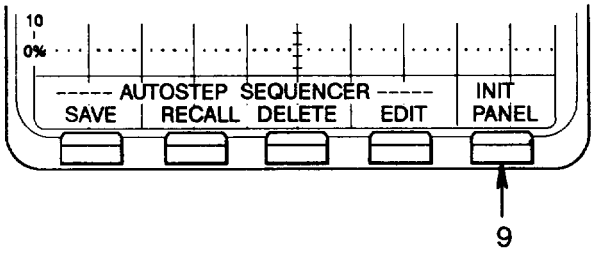
8. The cursor readout (15) gives the voltage level of the cursor with respect to ground (14).



2-20. DELTA TIME AND FREQUENCY CURSOR MEASUREMENTS.



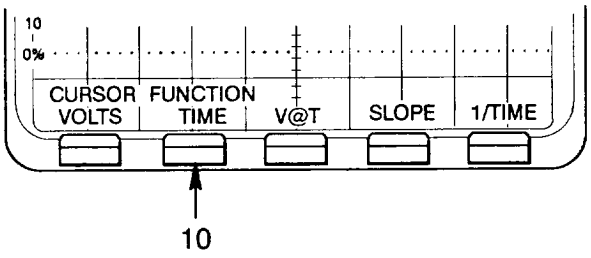
1. Press the PRGM button (5).

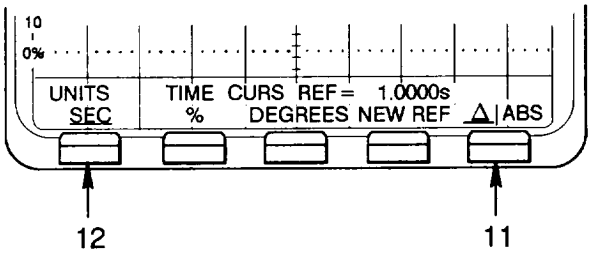


2. Select INIT PANEL using its menu button (9).

3. Connect the CH 1 input (7) to the signal source (16).

4. Press the AUTO SETUP button (6). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (8) to turn off the menu.



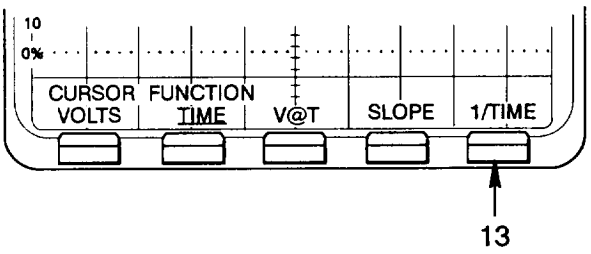


5. Press the CURSOR FUNCTION button (1). Select TIME using its menu button (10). Press the CURSOR UNITS button (2). Select SEC using its menu button (12) and select Δ for Δ | ABS using its menu button (11).

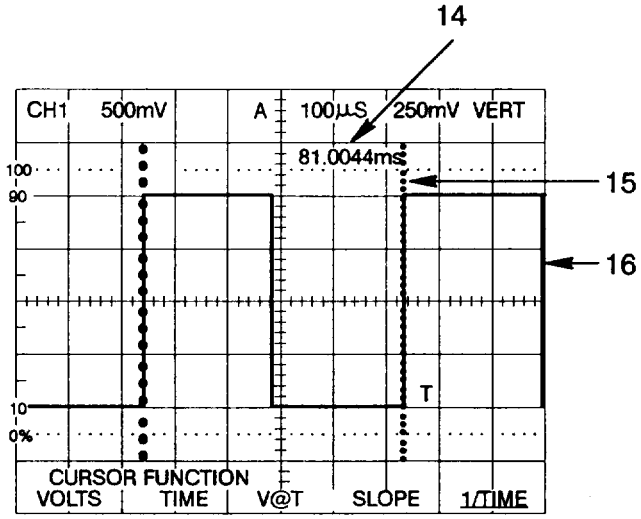
6. Adjust the CURSOR/DELAY control (4) to align the active cursor (the one with the most dots) to the first point (15).

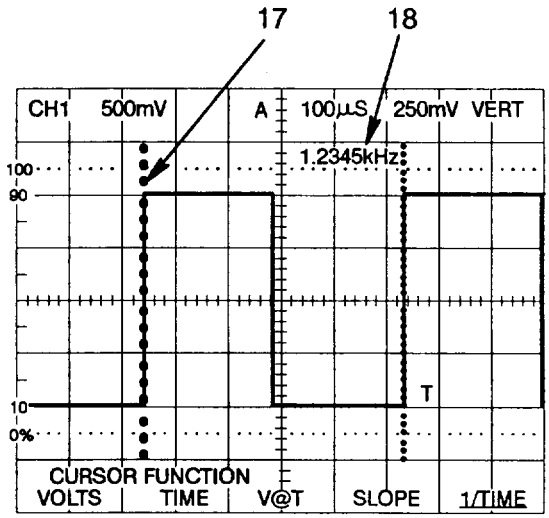
7. Press the CURSOR SELECT button (3) and align the active cursor to the second point (17) using the CURSOR DELAY control (4).

8. Read the time interval between the two points, in seconds (14).



9. Press the CURSOR FUNCTION button (1) and select 1/TIME using its menu button (13). If the two points selected in steps 6 and 7 bracket one cycle of a periodic waveform, the cursor readout now shows the frequency in Hz (18).

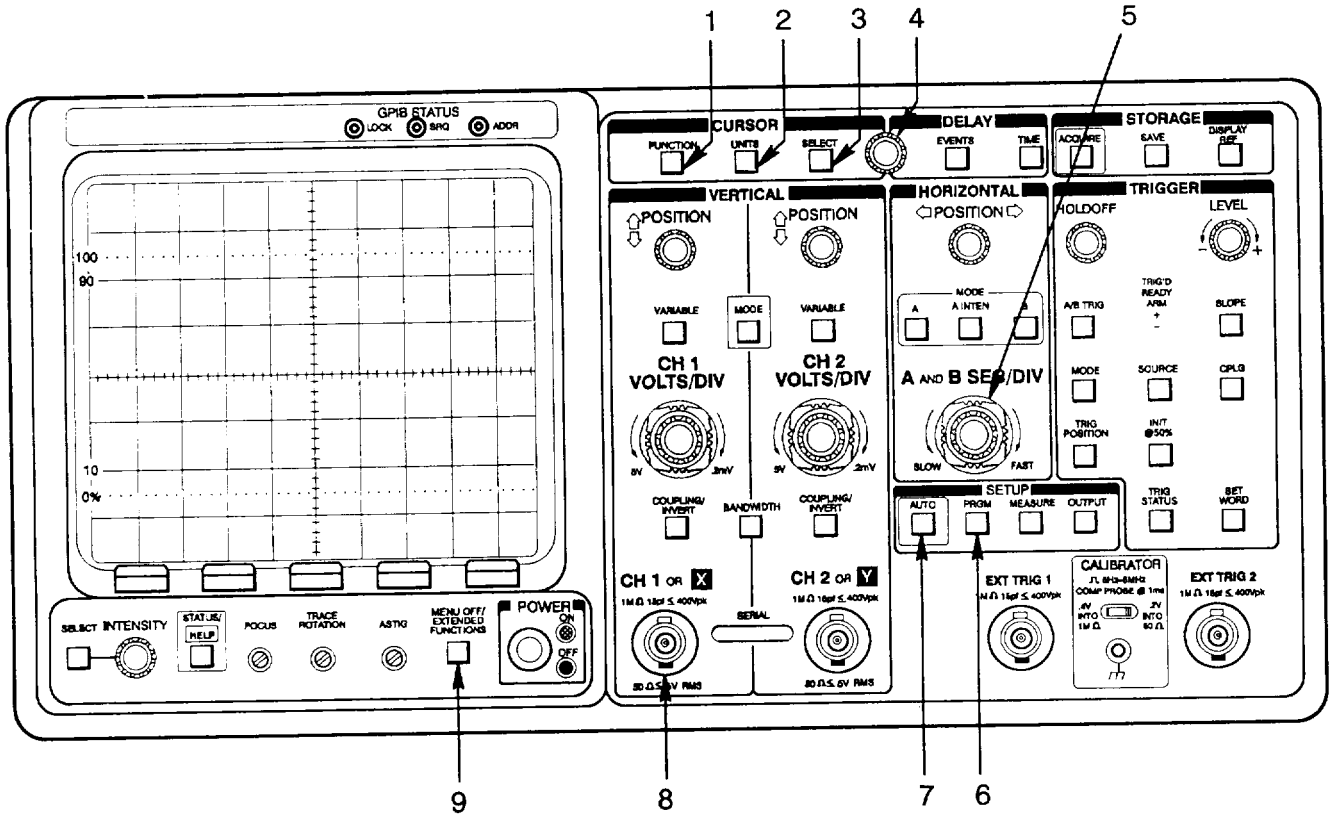

14
CH1 500mV
A 100µS 250mV VERT
81.0044ms
15
16
100
90
10
0%
T
CURSOR FUNCTION
VOLTS
TIME
V@T
SLOPE
1/TIME


17
18
CH1 500mV
A 100µS 250mV VERT
1.2345kHz
100
90
10
0%
T
CURSOR FUNCTION
VOLTS
TIME
V@T
SLOPE
1/TIME

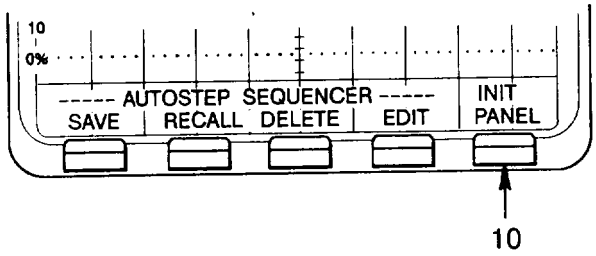
2-21. RATIO BETWEEN TWO TIME PERIODS.

NOTE

TIME (or 1/TIME) cursors can be used to measure ratios between two time periods. The units used can be either percent or degrees.



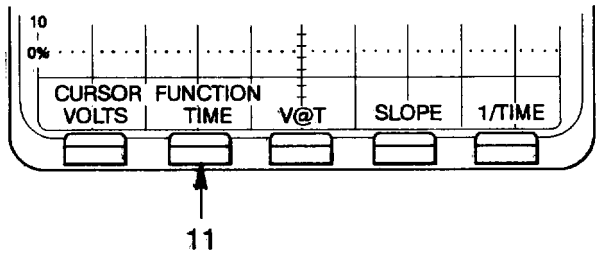
1. Press the PRGM button (6).



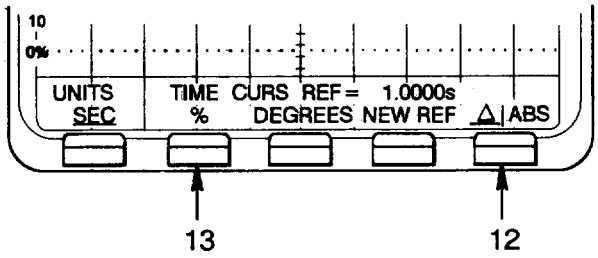
2. Select INIT PANEL using its menu button (10).

3. Connect the CH 1 input (8) to the signal source (15).

4. Press the AUTO SETUP button (7). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (9) to turn off the menu.

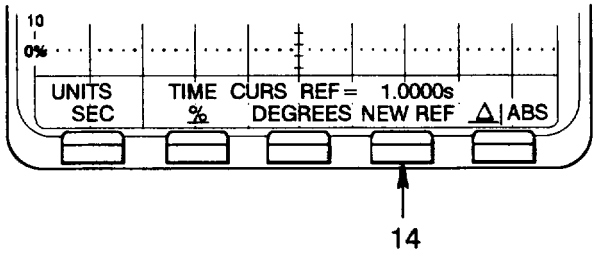


5. Adjust the SEC/DIV (5) to display one or two cycles of the waveform. Press the CURSOR FUNCTION button (1). Select TIME using its menu ‘button (11).



6. Press the CURSOR UNITS button (2). Select % using its menu button (13) and select Δ for Δ I ABS using its menu button (12).

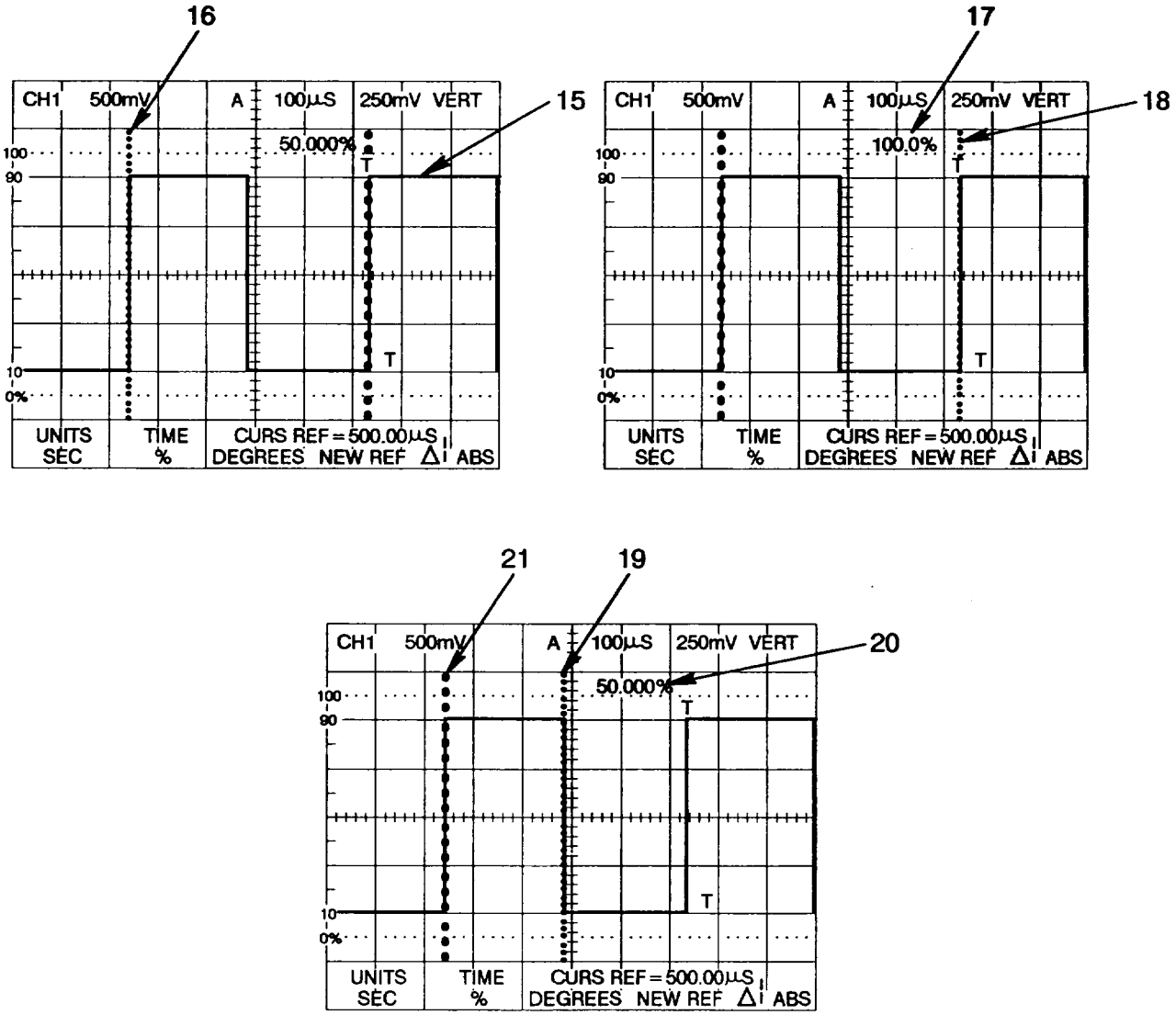
7. Adjust the CURSOR/DELAY control (4) to set the active cursor (the one with the most dots) to the first point of interest (16) on the waveform. Press the CURSOR SELECT button (3) and adjust the CURSOR/DELAY control (4) and set the active cursor (18) so as to bracket one cycle of the waveform.



8. Select NEW REF using its menu button (14). Note the cursor readout (17) now indicates 100%.

9. Use the CURSOR/DELAY control (4) to adjust one of the two cursors so that only the positive-going portion of the waveform is bracketed by the cursors(19 and 21).

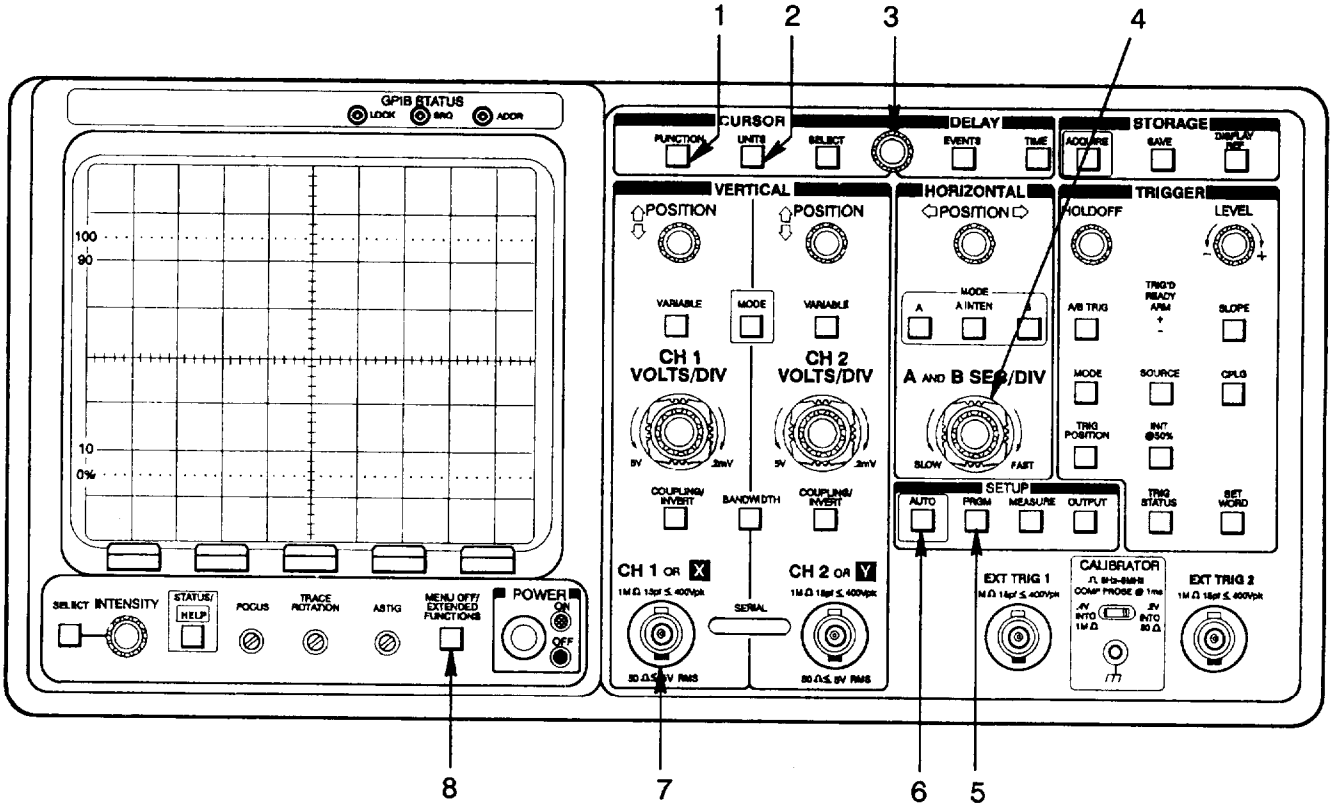
10. The cursor readout (20) shows the ratio of the presently bracketed time period to the time period used as a reference in step 7.


16
15
17
18
21
19
20
CH1 500mV
A 100µS 250mV VERT
50.000%
100.0%
100
90
10
0%
T
UNITS
SEC
TIME
%
CURS REF = 500.00µS
DEGREES NEW REF Δ ABS

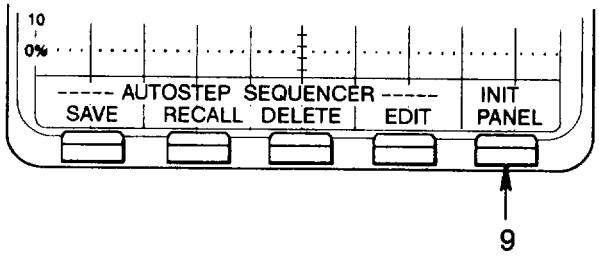
2-22. ABSOLUTE TIME CURSOR MEASUREMENTS.

NOTE

You can use Absolute mode for TIME cursor measurements. Only one cursor is displayed. The other cursor is at the Record Trigger position (shown by a T on the waveform).



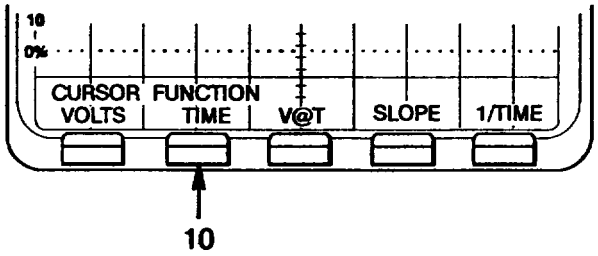
1. Press the PRGM button (5).



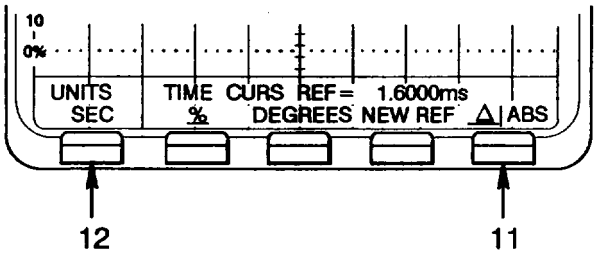
2. Select INIT PANEL using its menu button (9).

3. Connect the CH 1 input (7) to the signal source (15).

4. Press the AUTO SETUP button (6). When AUTO SETUP is done, press the MENU OFF/EXTENDED FUNCTIONS button (8) to turn off the menu.



5. Press the CURSOR FUNCTION button (1). Select TIME using its menu button (10).

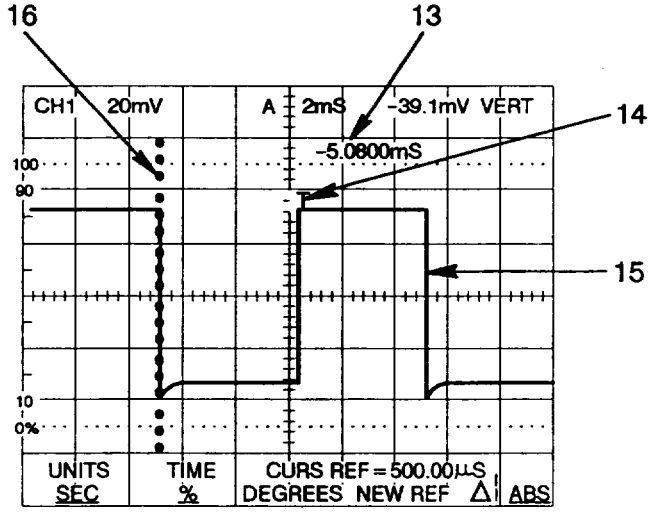


6. Press the CURSOR UNITS button (2). Select SEC using its menu button (11) and select ABS for A | ABS using its menu button (12).

7. Position the display to view both the record trigger (14) and the point of interest to be measured. Adjust the SEC/DIV control (4) as needed.

8. Use the CURSOR/DELAY control (3) to align the cursor (16) with the desired point.

9. Read the time interval between the cursor and the record trigger from the cursor readout (13).



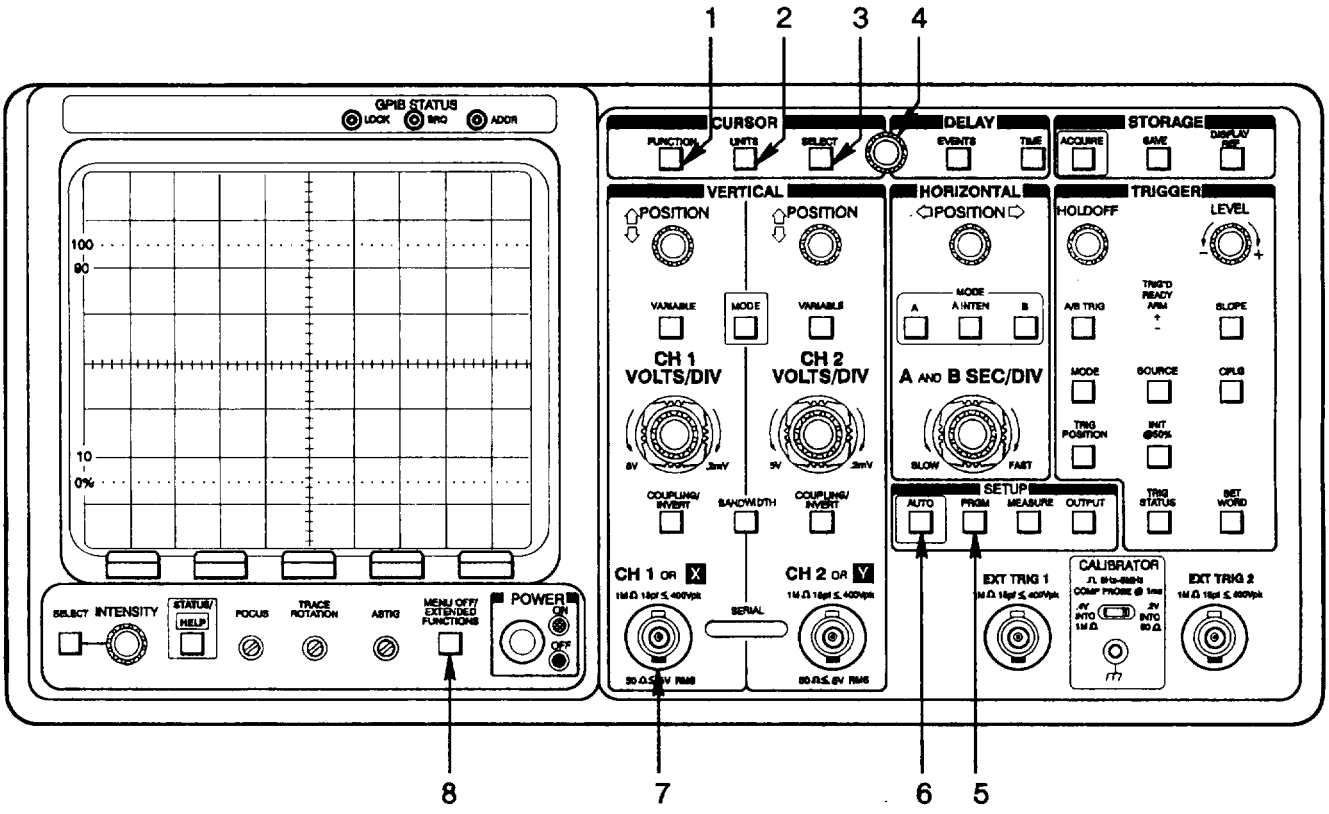
NOTE

When seconds are selected for the units, time can appear as a signed quantity. A minus sign (-) indicates the cursor (16) occurs before the record trigger (14) and no sign indicates the cursor (16) occurs after the record trigger (14).

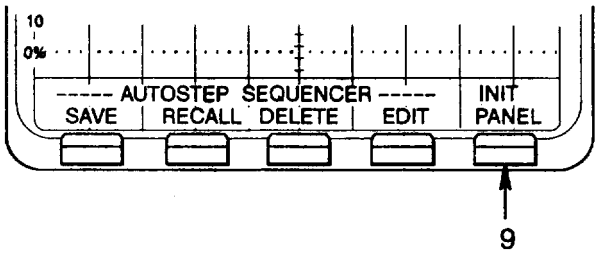
2-23. VOLTAGE COUPLED TO TIME CURSORS - V@T.

NOTE

For V@T (Volts at Time), the position of the VOLTS cursors depends on the placement of the TIME cursors. For V@T cursors, both Δ and ABS cursor modes are available. The readout shows the voltage between the two VOLTS cursors for Δ cursor mode. It shows the difference between the single, coupled VOLTS cursor and the ground reference for the ABS cursor mode.



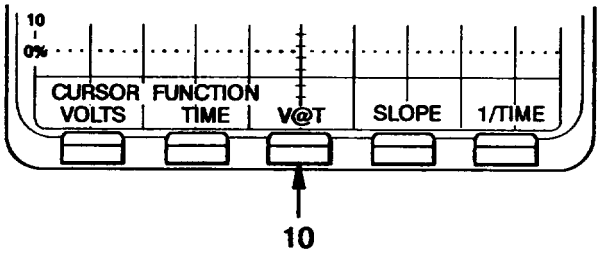
1. Press the PRGM button (5).



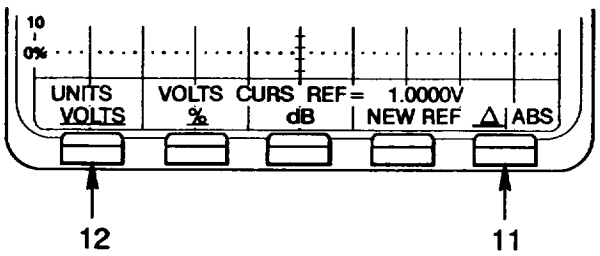
2. Select INIT PANEL using its menu button (9).

3. Connect the CH 1 input (7) to the signal source (15).

4. Press the AUTO SETUP button (6). When AUTO SETUP is complete. press the MENU OFF/EXTENDED FUNCTIONS button (8) to turn off the AUTO SETUP menu.



5. Press the CURSOR FUNCTION button (1). Select V@T using its menu button (10).



6. Press the CURSOR UNITS button (2). Select VOLTS using its menu button (12). Select the needed mode for Δ | ABS using its menu button (11).

NOTE

If Δ | ABS was set to ABS, do steps 6 and 7. If Δ | ABS was set to Δ, go to step 8.

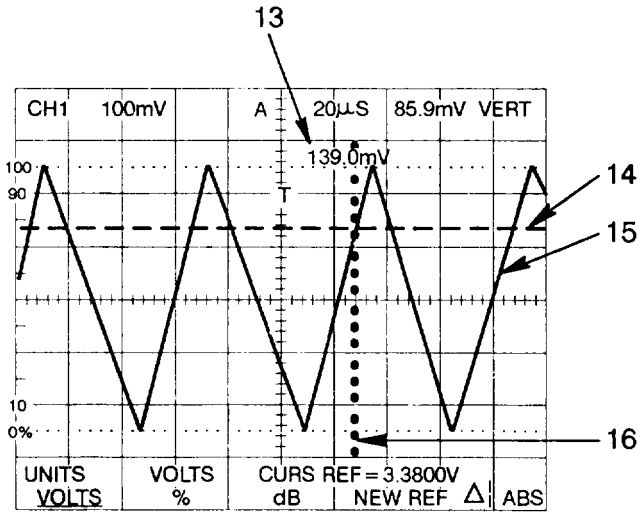
7. Adjust the CURSOR/DELAY control (4) to position the intersection of the VOLTS cursor (14) and the time cursor (16) to the point of interest on the waveform.

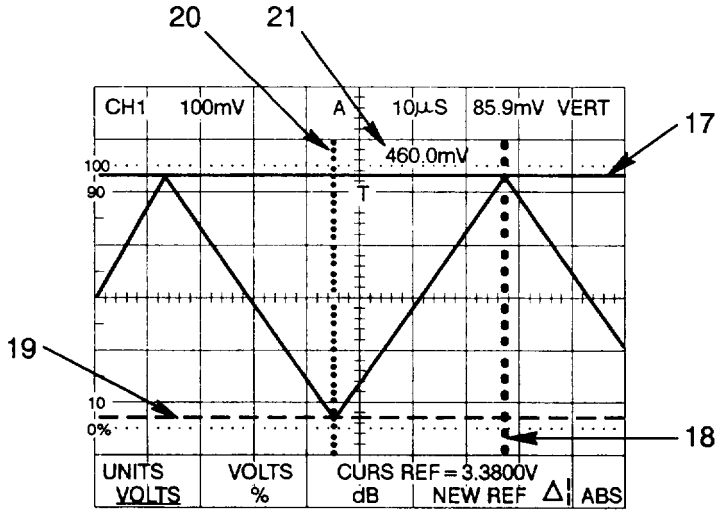
8. The readout (13) shows the voltage with respect to ground.

9. Adjust the CURSOR/DELAY control (4) to position the intersection of the VOLTS cursor (19) and the active time cursor (20) to the first point of interest on the waveform.

10. Press the CURSOR SELECT button (3). Adjust the intersection of the VOLTS CURSOR (17) and the new active time cursor (18) to the second point of interest on the waveform.

11. The readout (21) shows the voltage between the coupled cursors.

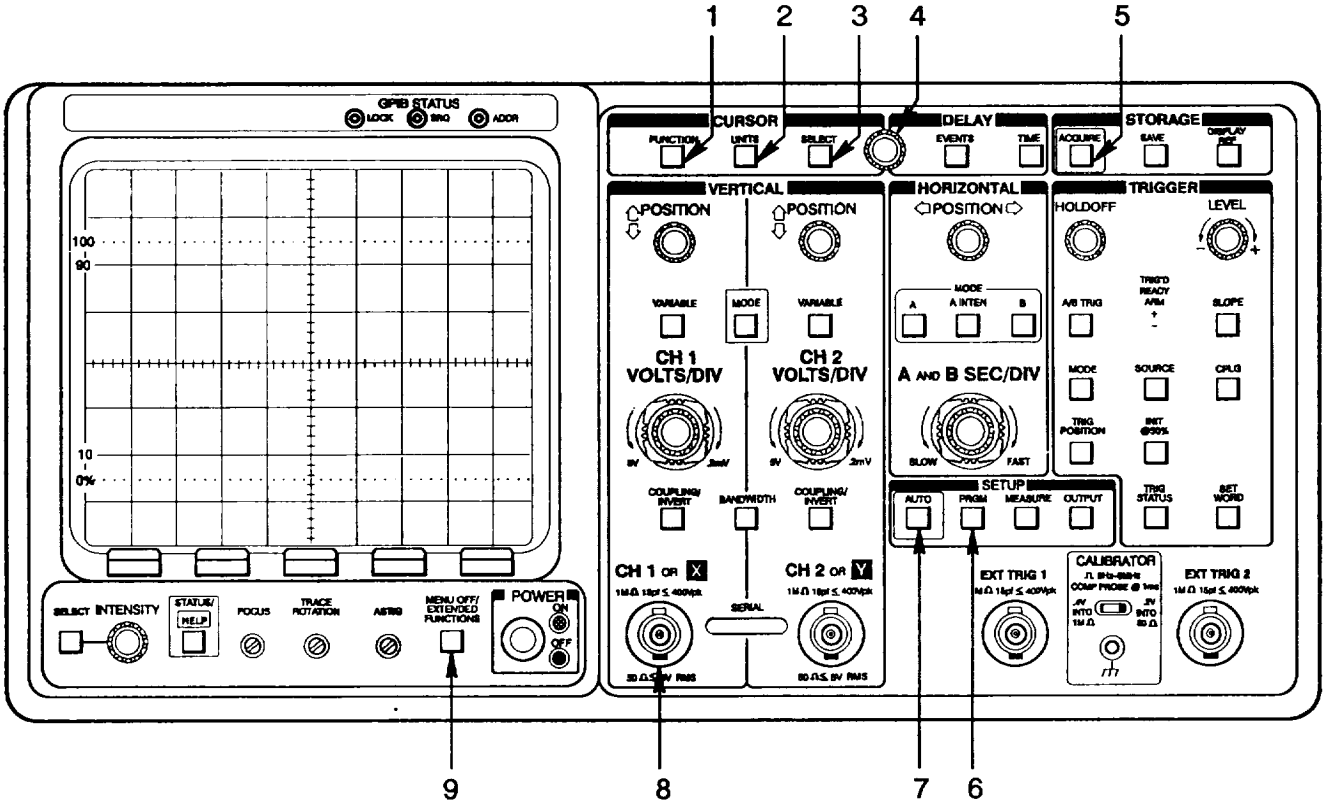

13
CH1 100mV
A 20µS 85.9mV VERT
139.0mV
100
90
T
14
15
10
0%
16
UNITS VOLTS
VOLTS %
CURS REF = 3.3800V
dB NEW REF Δ| ABS


20
21
CH1 100mV
A 10µS 85.9mV VERT
460.0mV
17
100
90
T
19
10
0%
18
UNITS VOLTS
VOLTS %
CURS REF = 3.3800V
dB NEW REF Δ| ABS

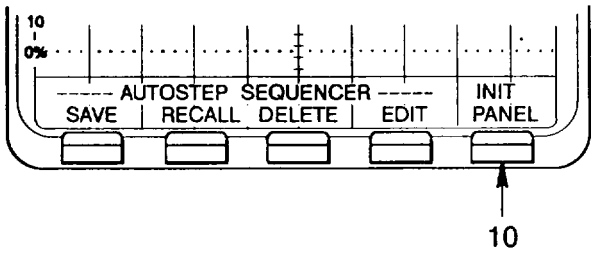
2-24. V@T TIME CURSOR PLACEMENT.

N O T E

The V@T cursors can be used to make accurate frequency or period measurements. The waveforms must be periodic. A main factor in their accuracy is cursor placement. Step 8 shows a method for precise placement of the cursors.



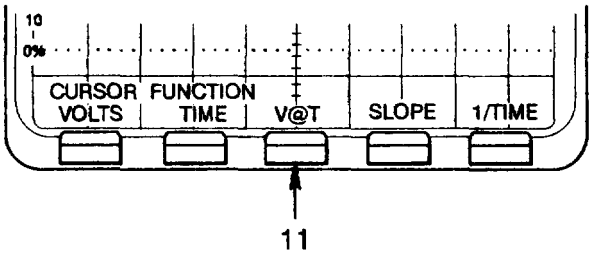
1. Press the PRGM button (6).



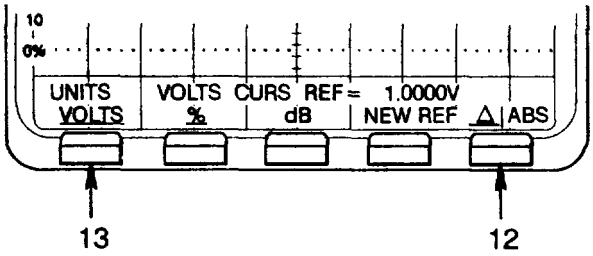
2. Select INIT PANEL using its menu button (10).

3. Connect the CH 1 input (8) to the signal source (18).

4. Press the AUTO SETUP button (7). When the AUTO SETUP procedure is complete, press the MENU OFF/EXTENDED FUNCTIONS button (9) to turn off the AUTO SETUP menu.



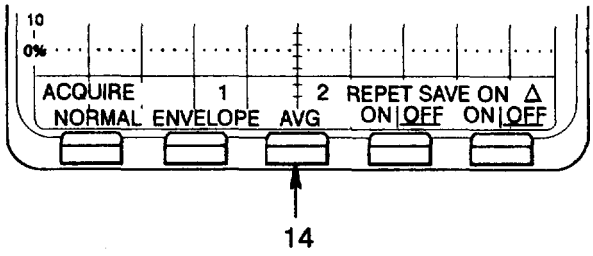
5. Press the CURSOR FUNCTION button (1). Select V@T using its menu button (11).



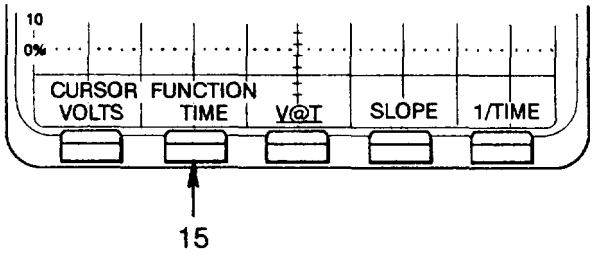
6. Press the CURSOR UNITS button (2). Select VOLTS using its menu button (13). Select Δ for Δ | ABS using its menu button (12).

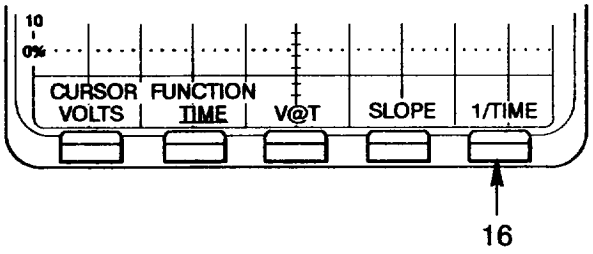
7. Adjust the CURSOR/DELAY control (4) and set cursors (17 and 19) to the first point of interest. Press CURSOR SELECT button (3).

8. Adjust the CURSOR/DELAY control (4) and set the second set of cursors (20 and 21) to bracket one cycle of the waveform.

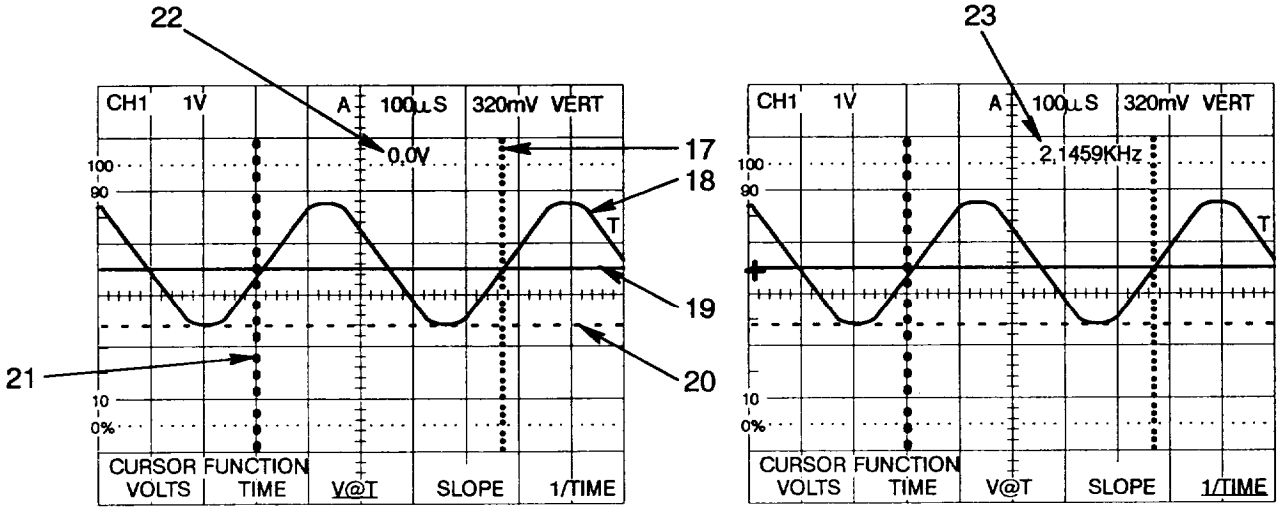


9. Fine-adjust the CURSOR/DELAY control (4) until the cursor readout (22) shows 0.0V (volts cursors are superimposed). If noise makes it hard to get a 0.0V reading, press the STORAGE ACQUIRE button (5) and then select AVG using its menu button (14).

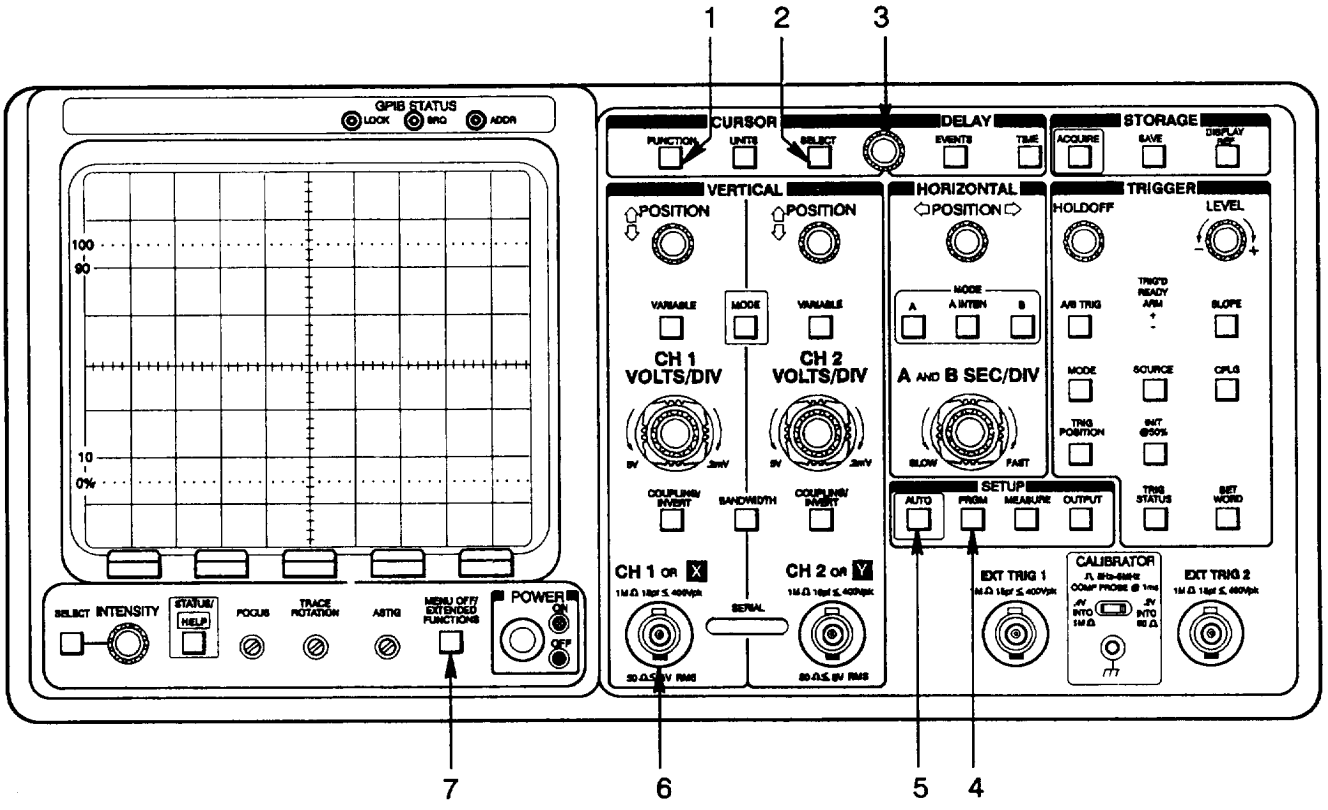




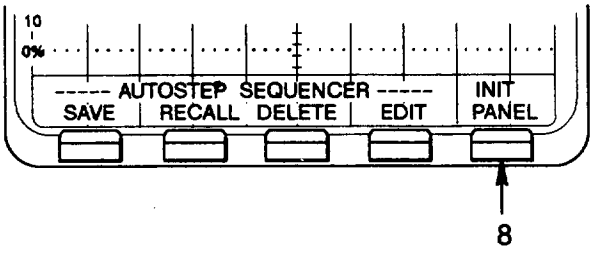
10. Press the CURSOR FUNCTION button (1) and select TIME using its menu button (15). The cursor readout now shows the time period for one cycle. Select l/TIME using its menu button (16). The readout (23) now shows the frequency in Hz.



2-25. SLOPE MEASUREMENTS.



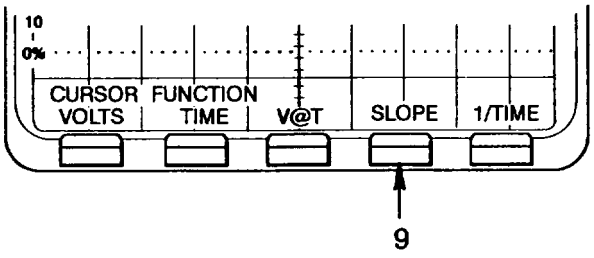
1. Press the PRGM button (4).



2. Select INIT PANEL using its menu button (8).

3. Connect the CH 1 input (6) to the signal source (12),

4. Press the AUTO SETUP button (5). When the AUTO SETUP procedure is complete, press the MENU OFF/EXTENDED FUNCTIONS button (7) to turn off the AUTO SETUP menu.

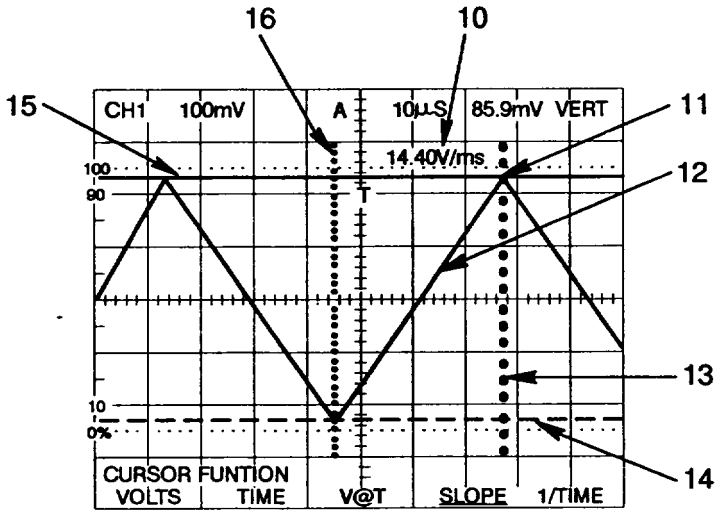


5. Press the CURSOR FUNCTION button (1). Select SLOPE using its menu button (9).

6. Adjust the CURSOR/DELAY control (3) to position the cursors (13 and 15) to the first point of interest (11).

7. Press the CURSOR SELECT button (2). Adjust the CURSOR/DELAY control (3) to Position the cursors (14 and 16) to bracket the slope to be measured (12).

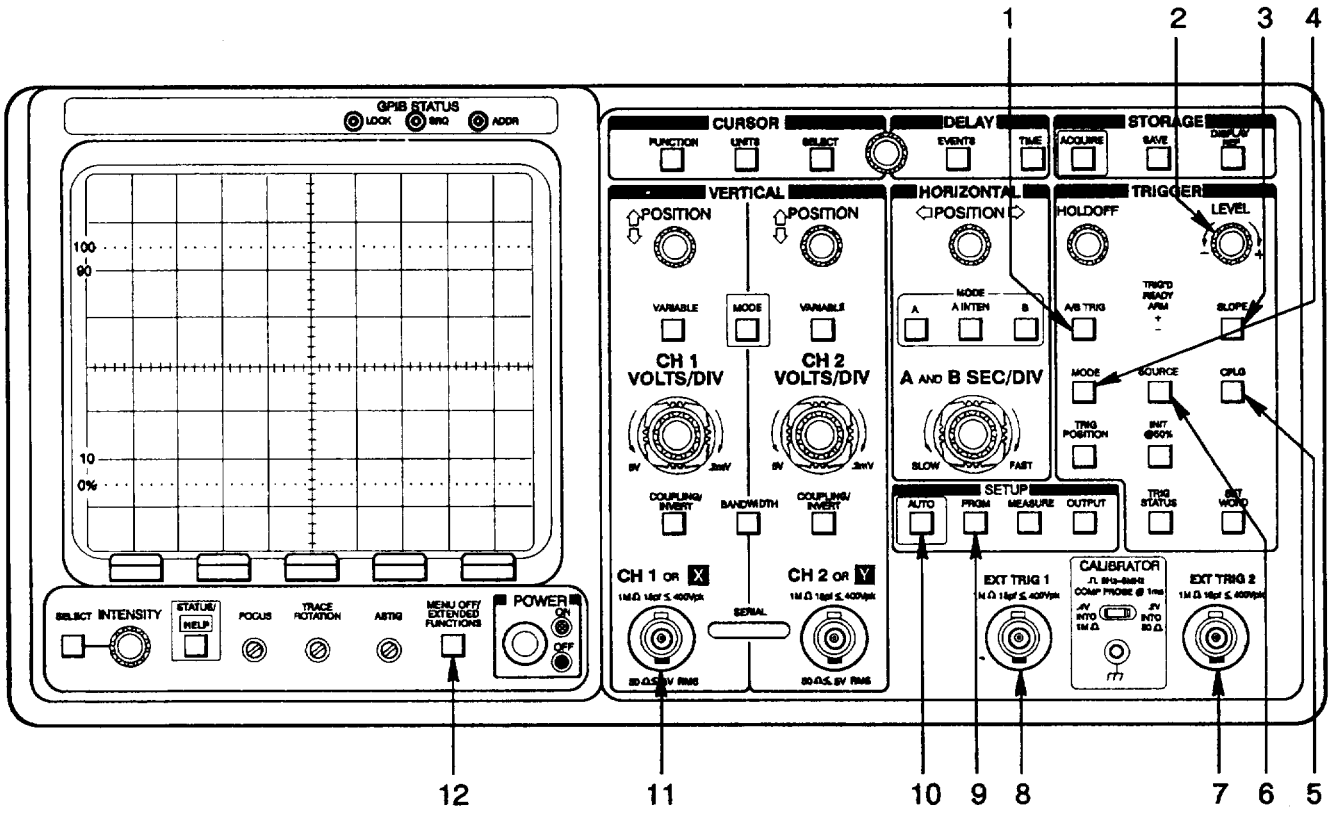
8. The cursor readout (10) shows the average slope in V/s between the two points.



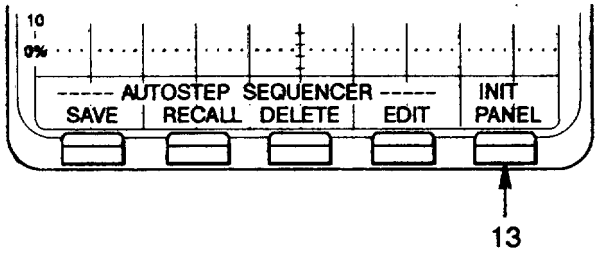
2-26. A*B TRIGGER SOURCE APPLICATION.

NOTE

The A*B trigger function logically ANDs the A- and the B-Trigger source to make the A-Record Trigger. An A acquisition can occur only when all of the conditions that have been set for both triggers are true at the same time. This is like the logical AND function.



1. Press the PRGM button (9),



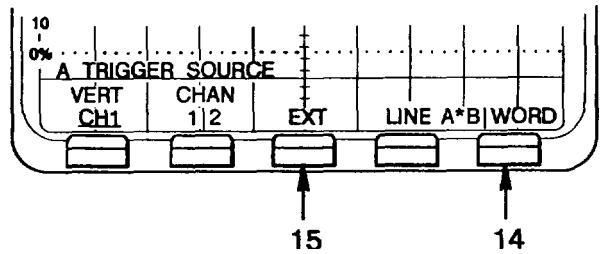
2. Select INIT PANEL using its menu button (13).

3. Connect the CH 1 input (11) to the signal source.

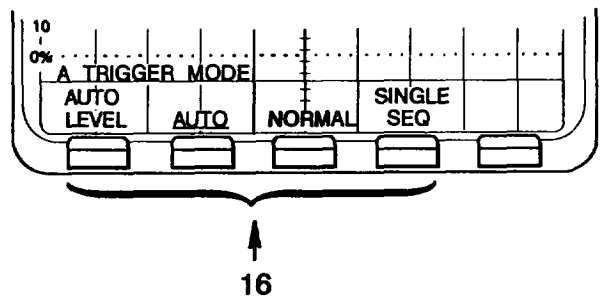
4. Press the AUTO SETUP button (10). When the AUTO SETUP procedure is complete, press the MENU OFF/EXTENDED FUNCTIONS button (12) to turn off the AUTO SETUP menu.

5. Connect the EXT TRIG 1 input (8) to one of the trigger-source signals.

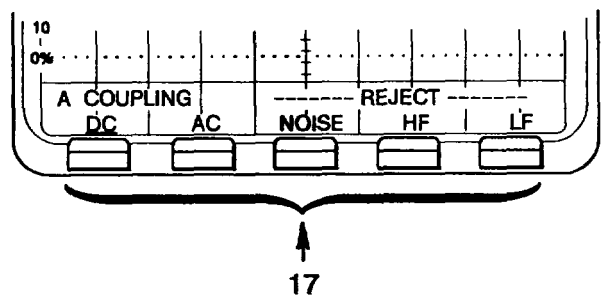
6. Connect the EXT TRIG 2 input (7) to the second trigger-source signal.



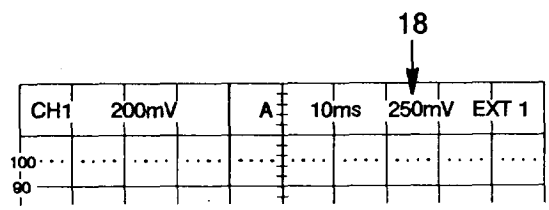
7. Press the TRIGGER SOURCE button (6). Select A*B for A*B I WORD using its menu button (14). Select EXT using its menu button (15).



8. Press TRIGGER MODE button (4). Select the desired mode using its menu button (16).



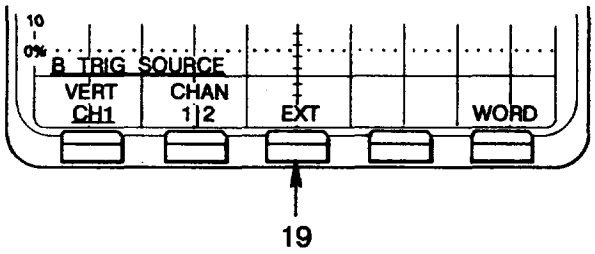
9. Press TRIGGER CPLG button (5). Select the desired mode using its menu button (17).



10. Adjust the TRIGGER LEVEL control (2) to set the required triggering level as displayed in the readout (18). Press the SLOPE button (3) to choose positive (+) or negative (-) slope.

11. Press A/B TRIG button (1).

12. Press the TRIGGER SOURCE button (6).

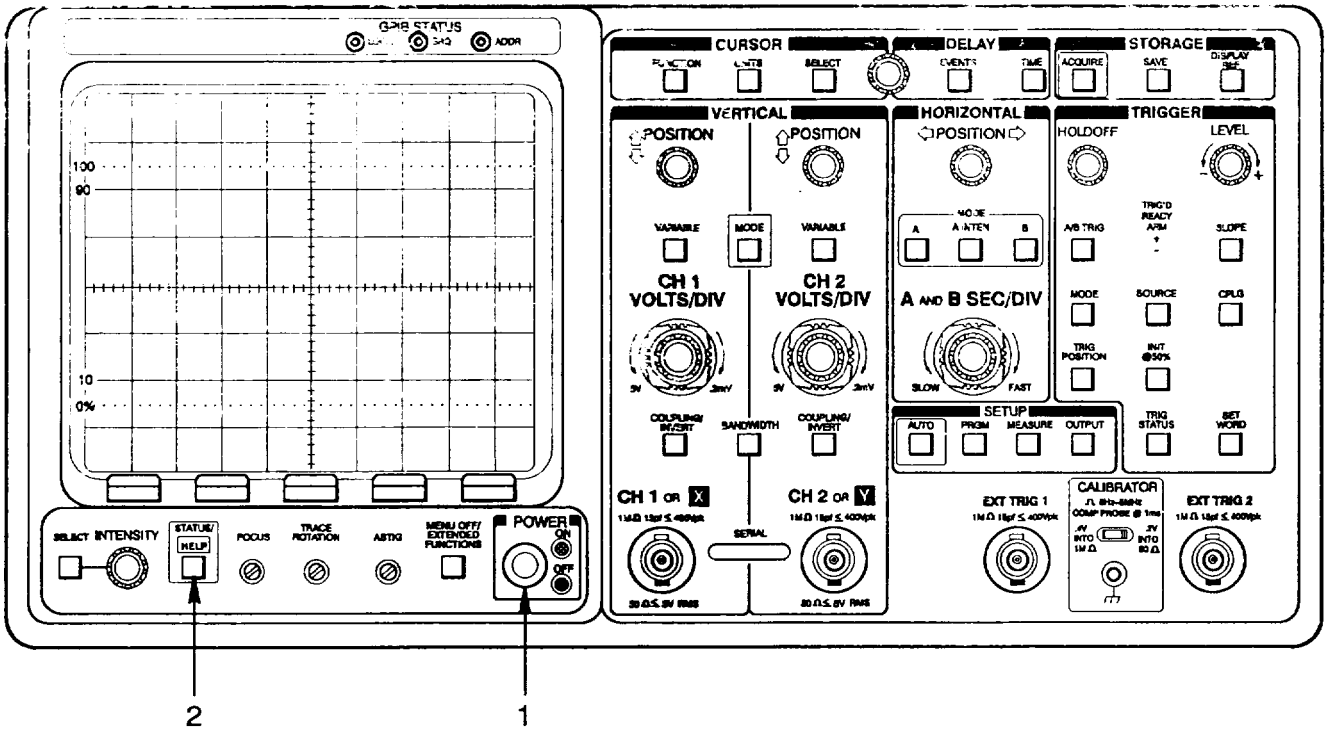


13. Repeat Steps 8 and 9 to select the Trigger Coupling, Level, and Slope for the B-Trigger source. Select EXT using its menu button (19).

The OS-291 is now set up to trigger on a composite of both sources, and it will acquire data if the proper triggering conditions are met for both the A- and B-Trigger source. Push the A/B TRIG button to switch between A- and B-Trigger systems as desired. Change the previously established triggering criteria as needed to develop the proper trigger conditions.

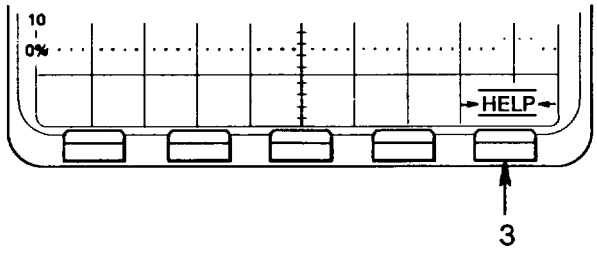
2-27. HELP PROCEDURE.

This procedure tells how to display information about the front panel controls. Information about each control can be obtained by pressing the desired control button. Each HELP screen displays the function/action of the control without activating (the selected control. If the controls function is call up a menu, a description of that menu will appear next.

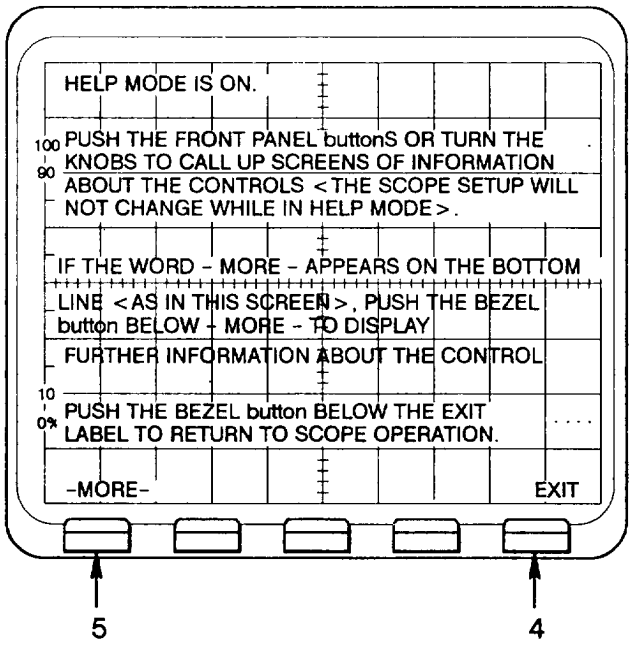


1. Set the Power Switch/Indicator to ON (1).

2. Press the STATUS/HELP button (2).



3. Select HELP using its menu button (3). The help screen is displayed.



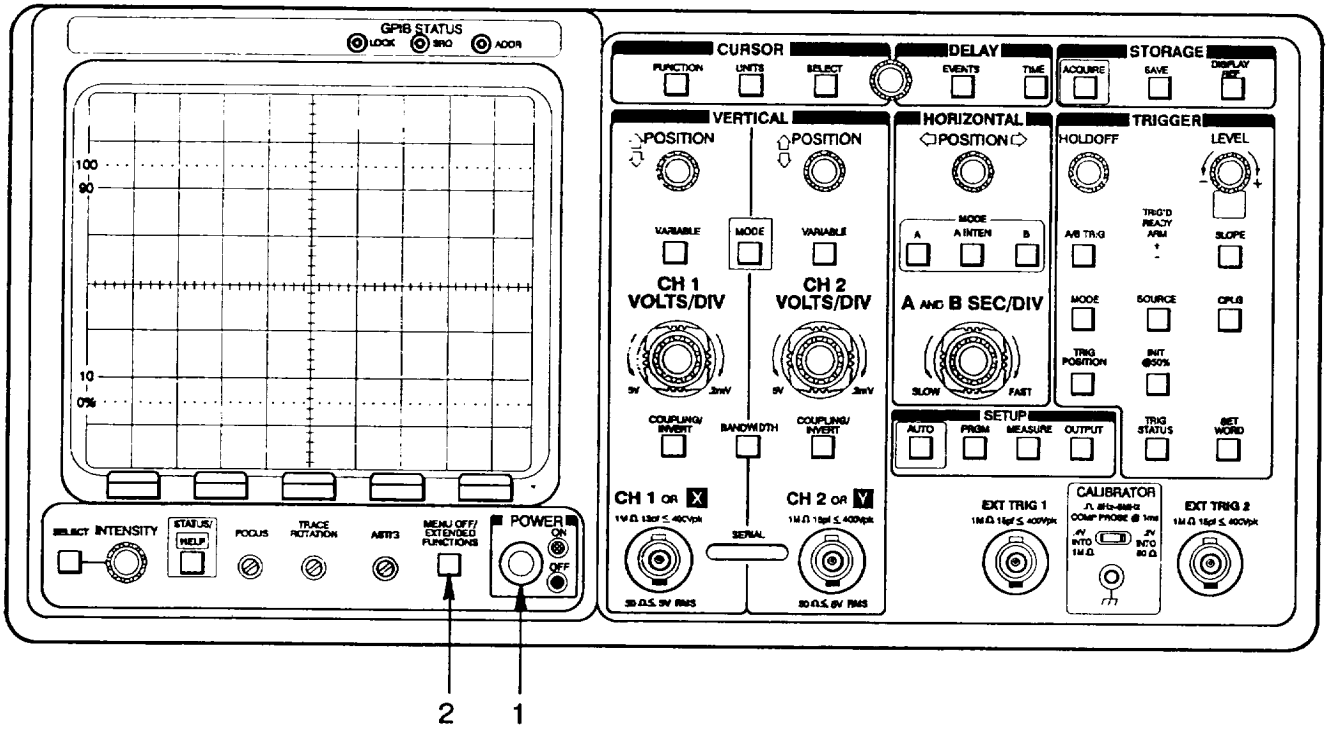
4. Select MORE using its menu button (5) to display the entire help screen description.

5. Select EXIT using its menu button (4) to exit the help screen and return to normal operation.

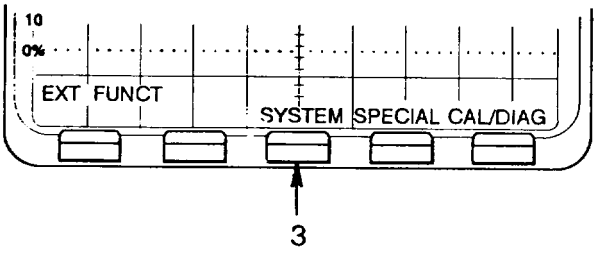
2-28. ERASE MEMORY.

NOTE

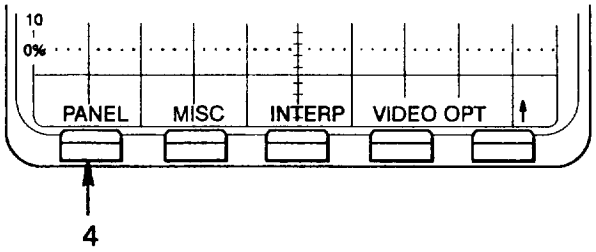
This scope can erase all waveforms, settings, and sequences stored in memory. To assure that no proprietary data remains stored, all RAM, except those locations storing calibration constants, status/results, and the clock, is cleared. The scope is left with the default front-panel setup that you get by selecting INIT PANEL.



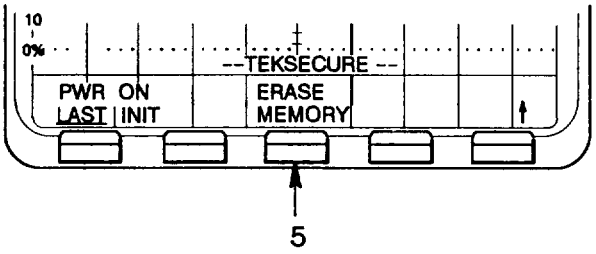
1. Set the Power Switch/Indicator to ON (1).
2. Press the MENU OFF/EXTENDED FUNCTIONS button (2).



3. Select SYSTEM using its menu button (3).



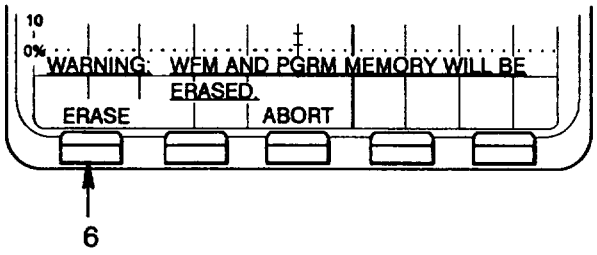
4. Select PANEL using its menu button (4).



5. Select TEKSECURE ERASE MEMORY using its menu button (5) to display the ERASE ABORT menu.

CAUTION

Waveform and Program memory will be erased.



6. Select ERASE using its menu button (6). The memory is now erased and its status displayed.

CHAPTER 3
UNIT MAINTENANCE INSTRUCTIONS

Section I. REPAIR PARTS; SPECIAL TOOLS; TEST, MEASUREMENT AND DIAGNOSTIC EQUIPMENT (TMDE); AND SUPPORT EQUIPMENT

3-1. COMMON TOOLS AND EQUIPMENT.

Common tools and equipment required for unit maintenance of Oscilloscope OS-291/G are listed in Appendix B (Maintenance Allocation Chart).

3-2. SPECIAL TOOLS, TMDE, AND SUPPORT EQUIPMENT.

No special tools, TMDE, or support equipment are required.

3-3. REPAIR PARTS.

Repair parts are listed and illustrated in the Repair Parts and Special Tools Lists (TM 11-6625-3241-24P).

Section II. SERVICE UPON RECEIPT

3-4. UNPACKING AND CHECKING UNPACKED EQUIPMENT.

a. Unpacking. The oscilloscope is shipped assembled in its original packing container. Unpack carefully and do not damage the container. Save the container for use in reshipment.

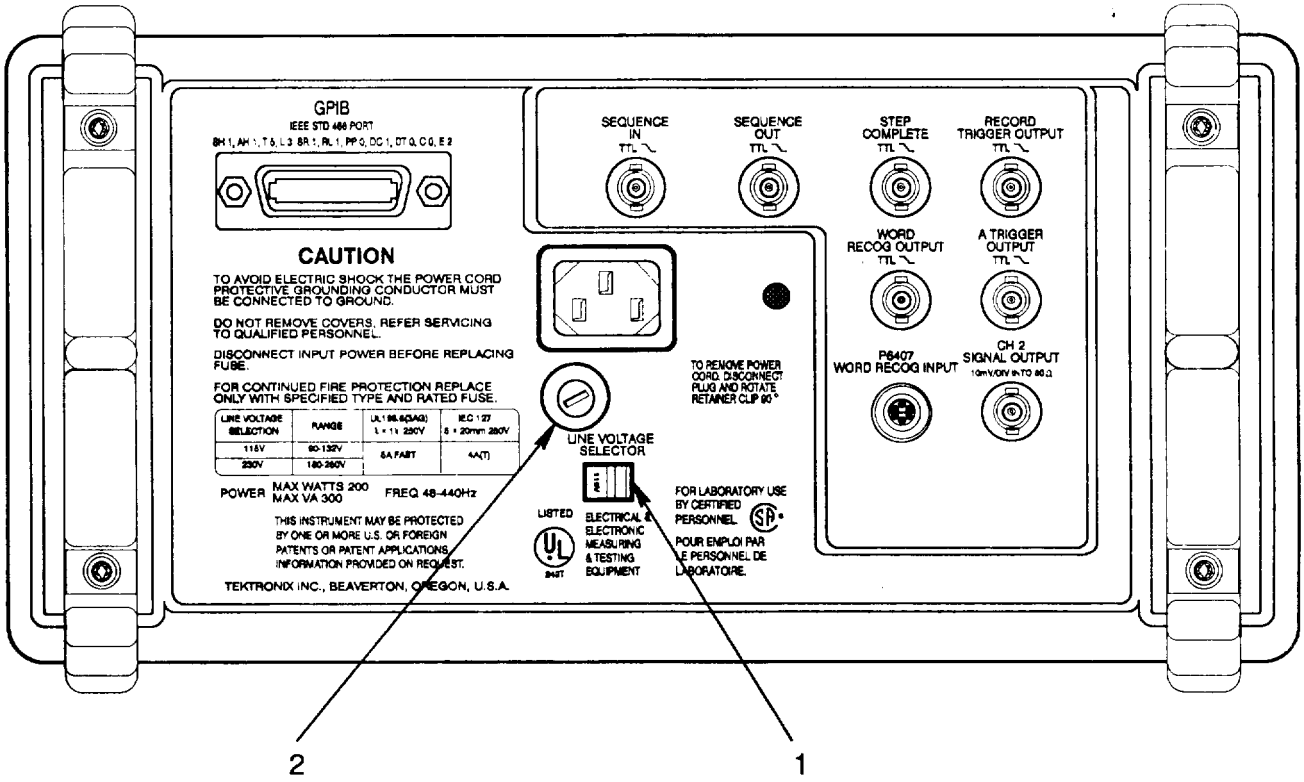
b. Checking Unpacked Equipment. Inspect the equipment for damage incurred during shipment, If the equipment has been damaged, report the damage on Form SF 364, Report of Discrepancy.

c. Check the equipment against the packing s!ip to see that the shipment is complete. Report all discrepancies in accordance with the instructions of DA PAM 738-750.

3-5. PRELIMINARY SERVICING AND ADJUSTMENT OF EQUIPMENT.

a. Verify voltage selection switch (1) is set to the line voltage available in your area. If not, adjust the Line Voltage Selector switch to the correct voltage by sliding it to the left or right.

b. Remove the rear panel fuse (2) (para 3-7). Check that the fuse is correct. Replace the fuse.



INPUT VOLTAGE	LINE VOLTAGE SELECTOR SWITCH POSITION	REAR PANEL FUSE
90 - 132 V	115 V	5 A fast
180 - 250 V	230 V	5 A fast

c. Perform turn-on procedures (para 2-6).

Section III. UNIT TROUBLESHOOTING

SYMPTOM INDEX

3-6. TROUBLESHOOTING.

NOTE

This manual cannot list all malfunctions that may occur, nor all tests or inspections and corrective actions. If a malfunction is not listed or is not corrected by listed corrective actions, notify next higher level of maintenance.

Table 3-1 Troubleshooting Table

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
1. OSCILLOSCOPE NOT OPERATING.
Step 1. Check the power cord.
• Connect power cord if disconnected.
• Replace, if power cord is defective.
Step 2. Check to see if fuse is blown or broken.
• Replace fuse, (para 3-7).
• If OS-291 fails to operate properly, notify the next higher level of maintenance.
Step 3. Allow OS-291 to cool and try again.
• If OS-291 operates normally, check for proper air flow around the bottom of the cabinet and fan exhaust holes in the rear panel.
• If OS-291 operates normally but then turns off during operation, notify next higher level of maintenance.
2. EXTENDED - DIAGNOSTICS INDICATES A FAILURE.
Refer to (para 2-6) to isolate error code.
• Notify next higher level of maintenance.

Table 3-1 Troubleshooting Table (cont)

MALFUNCTION TEST OR INSPECTION CORRECTIVE ACTION
3. CRT HAS NO BASELINE TRACE. Turn OS-291 off and then repower. ● Press the SETUP PRGM Button. ● Press Menu Button under INIT panel. ● If OS-291 fails to operate properly notify next higher level of maintenance.
4. CRT DOES NOT DISPLAY A WAVEFORM. Step 1. Press AUTO SETUP. Step 2. Swap CONNECTING DEVICES (i.e., probes, cables, attenuators). ● If display is present, replace bad connecting device. ● If OS-291 fails to operate properly notify next higher level of maintenance.

Section IV. UNIT MAINTENANCE PROCEDURES

3-7. LINE FUSE REPLACEMENT.

DESCRIPTION

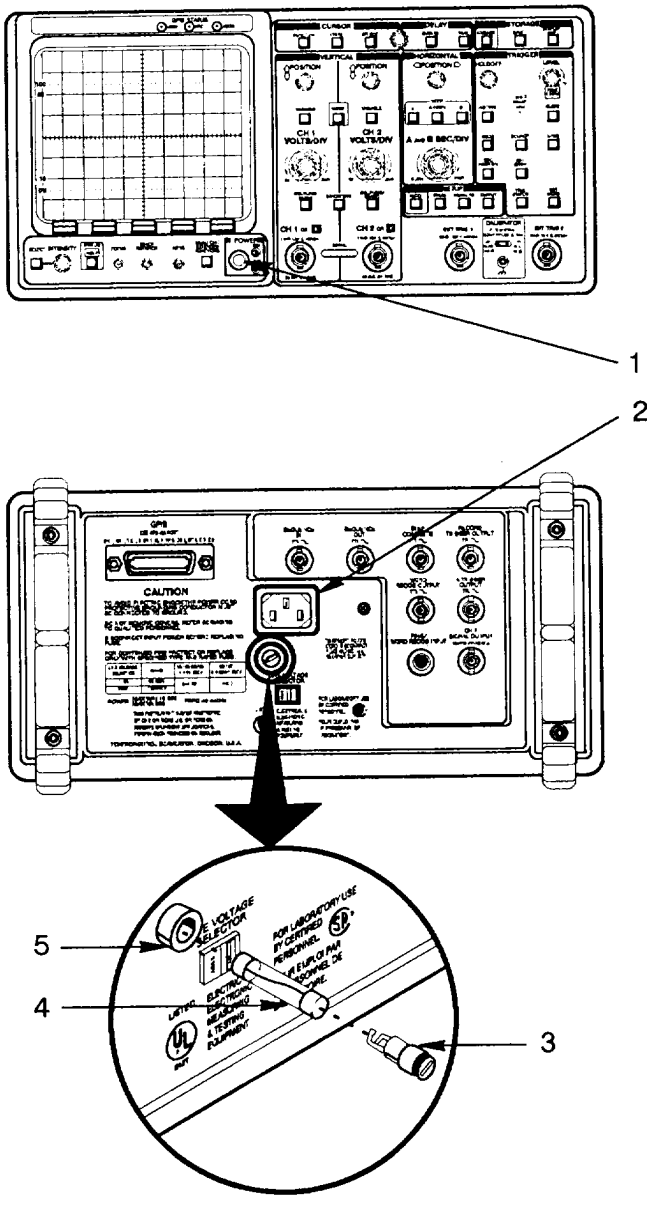
This procedure covers: Remove and install.

REMOVE

1. Working from the front panel, set Power On/Off (1) to Off.
2. Working from the rear panel, disconnect AC power cord (2) from AC source.
3. Remove fuseholder cap (3) by pressing in and rotating the fuseholder cap slightly in a counterclockwise direction to release it.
4. Withdraw fuseholder cap (3) with fuse (4) from fuseholder (5).
5. Remove fuse (4) from fuseholder cap (3).

INSTALL

1. Insert fuse F1 (4) and fuseholder cap (3) into fuseholder (5).
2. Connect AC power cord (2) to AC source.
3. Working from the front, set power On/Off (1) to On.



END OF TASK

3-8. KNOB REPLACEMENT (FRICTION).

DESCRIPTION

This procedure covers: Remove and install.

The following knobs are held on by friction:

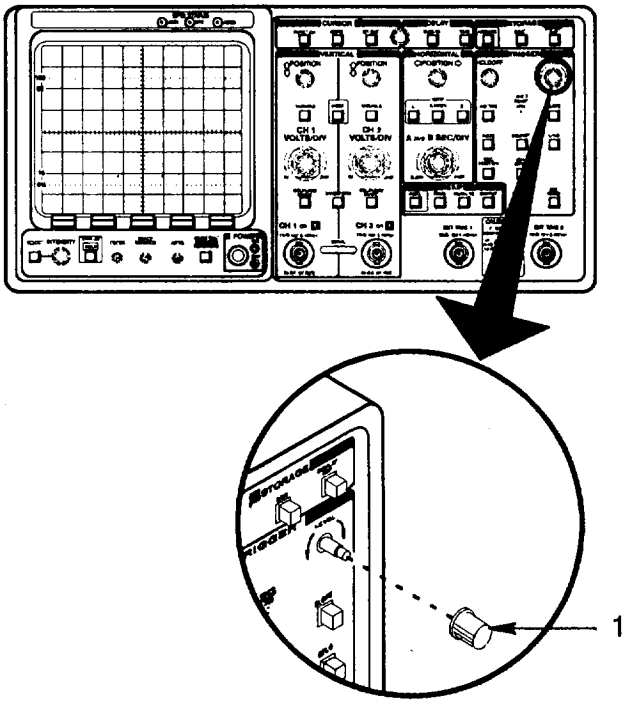
- VERTICAL POSITION CH 1, CH 2,
- CURSOR/DELAY
- INTENSITY
- HORIZONTAL POSITION
- TRIGGER HOLDOFF
- TRIGGER LEVEL

REMOVE

1. Working from the front panel, set Power On/Off (1) to Off.
2. Grasp knob (1) firmly.
3. Hold oscilloscope steady.
4. Pull straight out.

NOTE

This will expose the white potentiometer shaft. If the shaft is broken, contact next higher level of maintenance.



INSTALL

1. Lineup slot with potentiometer shaft.
2. Hold oscilloscope steady.
3. Press knob (1) on.

END OF TASK

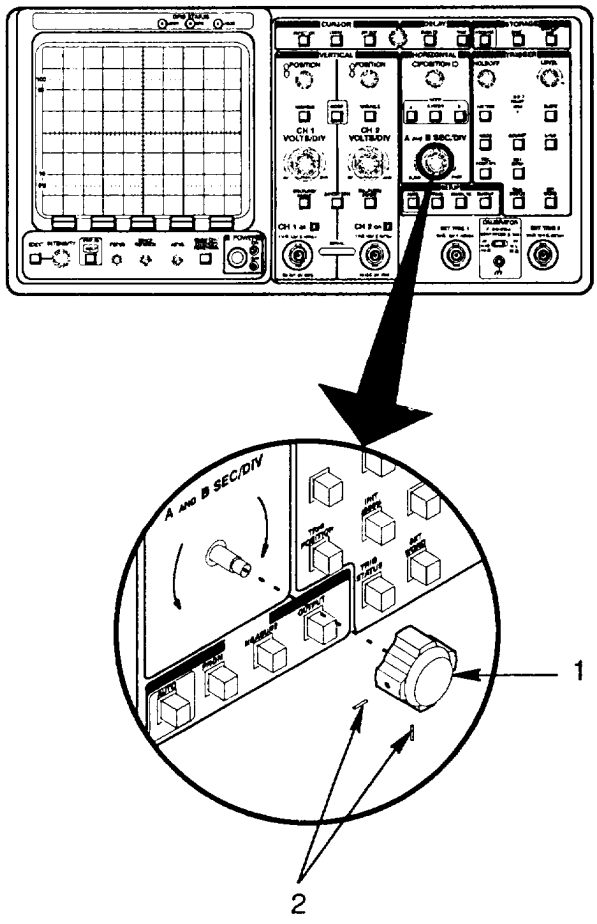
3-9. KNOB REPLACEMENT (SET SCREW).

DESCRIPTION

This procedure covers: Remove and install.

The following knobs are held on with set screws:

- VOLTS/DIVCH 1, CH 2
- A SEC/DIV
- B SEC/DIV



REMOVE

1. Working from the front panel, set Power On/Off (1) to Off.
2. Loosen set screws (2) and pull knob (1) off shaft.

INSTALL

1. Install knob (1) on shaft and tighten set screws (2).

NOTE

If the potentiometer shaft is broken, contact next higher level of maintenance.

END OF TASK

3-10. REPLACE LIGHT FILTER.

DESCRIPTION

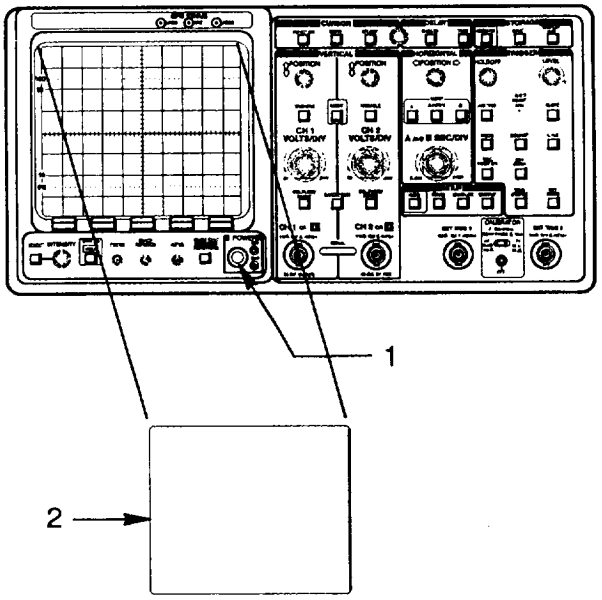
This procedure covers: Remove and install.

REMOVE

1. Working from front panel, set Power Switch/Indicator On/Off (1) to Off.
2. Gently press light filter (2) with both thumbs and slide up.
3. Lift bottom out and remove in a downward direction.

INSTALL

1. Place top of light filter (2) in place and slide up.
2. Push bottom of light filter (2) into place and let it slide down into position.



END OF TASK

3-11. CLEANING.

Loose dirt on the outside of the oscilloscope may be removed with a soft cloth. Dirt that remains can be removed with a soft cloth dampened in a mild detergent and water solution. The light filter can be easily removed, if necessary, for cleaning or replacement (para 3-10). Clean the light filter face with soft lint-free cloth dampened with either isopropyl alcohol or mild detergent and water solution.

Section V. PREPARATION FOR STORAGE OR SHIPMENT

3-12. PREPARATION FOR STORAGE OR SHIPMENT.

If original packing material was saved, pack the oscilloscope in the same manner as it was received. When using packing materials other than the original, use the following guidelines:

a. Wrap oscilloscope in polyethylene sheeting before placing in container.

b. Select corrugated cardboard container having inside dimensions at least 6 inches greater than oscilloscope dimensions and having a carton test strength of at least 275 pounds.

c. Use plenty of shock-absorbing material all around the oscilloscope to protect it against damage.

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

e. Mark container “FRAGILE-DELICATE INSTRUMENT” to insure proper handling.

3-13. TYPES OF STORAGE.

a. Short-term (administrative) = 1 to 45 days. All equipment in this type must be made ready within 24 hours for use on a mission. Make sure the next scheduled PMCS is done and all deficiencies corrected before placing in storage. The storage site should provide protection from extreme weather conditions and allow you to reach it for inspections or exercises, if needed.

b. Intermediate = 46 to 180 days.

c. Long-term = over 180 days.

3-14. ENVIRONMENT.

The OS-291 should be stored in a clean, dry environment. In high humidity environments, protect the oscilloscope from temperature variations that could cause internal condensation. The following environmental conditions apply to both shipping and storage.

Temperature	-79.6 °t0 185°F (-62° t0 85°C)
Relative Humidity	Less than 95%@30°t0 60°C
Altitude	Less than 50,000 ft. (15,000 m)
Shock	Less than 50g’s

APPENDIX A

REFERENCES

A-1. SCOPE.

This appendix lists all forms, field manuals, technical manuals, and miscellaneous publications referenced in this manual.

A-2. FORMS.

Equipment Inspection and Maintenance Worksheet . . . . . DA Form 2404

Product Quality Deficiency Report . . . . . Form SF368

Recommended Changes to Equipment Technical Manuals . . . . . DA Form 2028-2

Recommended Changes to Publications and Blank Forms . . . . . DA Form 2028

Report of Discrepancy (ROD) . . . . . Form SF364

Transportation Discrepancy Report . . . . . Form SF361

A-3. TECHNICAL MANUALS.

Procedures for Destruction of Electronics Materiel to Prevent Enemy Use (Electronics Command) . . . . . TM 750-244-2

Unit, Direct Support, and General Support Repair Parts and Special Tools List, for Oscilloscope OS-291/G . . . . . TM 11-6625-3241-24P

A-4. MISCELLANEOUS.

Abbreviations for Use on Drawings, Specifications Standards and in Technical Documents MIL-STD-12

Common Table of Allowances CTA50-970

Consolidated Index of Army Publications and Blank Forms . . . . . DA Pam 25-30

First Aid for Soldiers . . . . . FM 21-11

Safety Precautions for Maintenance of Electrical/Electronic Equipment . . . . . TB 385-4

The Army Maintenance Management System (TAMMS) . . . . . DA Pam 738-750

APPENDIX B

MAINTENANCE ALLOCATION CHART

Section I. INTRODUCTION

B-1. GENERAL.

a. This appendix provides a general explanation of all maintenance and repair functions authorized at various maintenance levels for the Oscilloscope OS-291/G.

b. The Maintenance Allocation Chart (MAC) in Section II designates overall authority and responsibility for the performance of maintenance functions on the identified end item or component. The application of the maintenance functions to the end item or component will be consistent with the capacities and capabilities of the designated maintenance levels.

c. Section Ill lists the tools and test equipment (both special tools and common tool sets) required for each maintenance function as referenced from Section Il.

d. Section IV contains supplemental instructions and explanatory notes for a particular maintenance function.

B-2. MAINTENANCE FUNCTIONS.

Maintenance functions will be limited to and defined as follows:

a. **Inspect.** To determine the serviceability of an item by comparing its physical, mechanical, and/or electrical characteristics with established standards through examination.

b. **Test.** To verify serviceability and to detect incipient failure by measuring the mechanical and electrical characteristics of an item and comparing those characteristics with prescribed standards.

c. **Service.** Operations required periodically to keep an item in proper operating condition; i.e., to clean (includes decontaminate, when required), preserve, drain, paint, or to replenish fuel, lubricants, chemical fluids, or gases.

d. **Adjust.** Maintain or regulate within prescribed limits, by bringing into proper or exact position, or by setting the operating characteristics to the specified parameters.

e. **Align.** To adjust specified variable elements of an item to bring about optimum or desired performance.

f. **Calibrate.** To determine the cause and corrections to be made or adjusted on instruments or test measuring and diagnostic equipment used in precision measurement. This consists of comparisons of two instruments, one of which is a certified standard of known accuracy, to detect and adjust any discrepancy in the accuracy of the instrument being compared.

g. **Remove/Install.** To remove and install the same item when required to perform service on other maintenance functions. install may be the act of emplacing, seating, or fixing into position an item, part, module (component or assembly) in a manner to allow the proper functioning of the equipment or system.

h. **Replace.** To remove an unserviceable item and install a serviceable counterpart in its place. Replace is authorized by the MAC and is shown as the 3rd position code of the **SMR** code.

i. **Repair.** The application of maintenance service, (inspect, test, service, adjust, align, calibrate, and/or replace) including fault location/troubleshooting, romoval/installation, and disassembly/assembly procedures, and maintenance actions (welding, grinding, riveting, straightening, facing, remachining, or

resurfacing) to identify troubles and restore serviceability to an item by correcting specific damage, fault, malfunction, or failure in a part, subassembly, module (component or assembly), end item or system.

j. **Overhaul.** That periodic maintenance effort (service/action) prescribed to restore an item to a completely serviceable/operational condition as required by maintenance standards in appropriate technical publications (i.e., DMWR). Overhaul is normally the highest degree of maintenance performed by the Army. Overhaul does not normally return an item to like-new condition.

k. **Rebuild.** Consists of those services/actions necessary for the restoration of unserviceable equipment to a like-newcondition in accordance with original manufacturing standards. Rebuild is the highest degree of material maintenance applied to Army equipment. The rebuild operation includes the act of returning to zero those age measurements (hours, miles, etc.) considered in classifying Army equipment/components.

B-3. EXPLANATION OF COLUMNS IN THE MAC, SECTION II.

a. **Column 1, Group Number.** Column 1 lists functional group code numbers, the purpose of which is to identify maintenance significant components, assemblies, subassemblies, and modules with the next higher assembly. End item group number shall be “00”.

b. **Column 2, Component/Assembly. Column** 2 contains the noun names of components, assemblies, subassemblies, and modules for which maintenance is authorized.

c. **Column 3, Maintenance Function.** Column 3 lists the functions to be performed on the item listed in Column 2.

d. **Column 4, Maintenance Level.** Column 4 specifies, by the listing of a work-time figure in the appropriate subcolumn(s), the level of maintenance authorized to perform the function listed in Column 3. This figure represents the active time required to perform that maintenance function at the indicated level of maintenance. if the number or complexity of the tasks within the listed maintenance function vary at different levels, appropriate work-time figures will be shown for each level. The work-time figure represents the average time required to restore an item (assembly, subassembly, component, module, end item, or system) to a serviceable condition under typical field operating conditions. This time includes preparation time (including any necessary disassembly/assembly time), troubleshooting/fauit location time and quality assurance/quality control time in addition to the time required to perform the specific tasks identified for the maintenance functions authorized in the Maintenance Allocation Chart. The symbol designations for the maintenance levels are as follows:

UNIT
C – Operator or Crew
O – Unit Maintenance

INTERMEDIATE
F – Direct Support Maintenance
H – General Support Maintenance

DEPOT
D – Depot Maintenance

e. **Column 5, Tools and Equipment.** Column 5 specifies by code those common tool sets (not individual tools) and special tools, TMDE, and support equipment required to perform the designated function.

f. **Column 6, Remarks.** This column shall, when applicable, contain a letter code, in alphabetic order, which shall be keyed to the remarks contained in Section IV.

B-4. EXPLANATION OF COLUMNS IN TOOL AND TEST EQUIPMENT REQUIREMENTS, SECTION III.

a. **Column 1, Reference Code.** The tool and test equipment code correlates with a code used in the MAC, Section 11, Column 5.

b. **Column 2, Maintenance Level.** The lowest level of maintenance authorized to use the tool or test equipment.

c. **Column 3, Nomenclature.** Name or identification of the tool or test equipment.

d. **Column 4, National Stock Number.** The National Stock Number (NSN) of the tool or test equipment.

e. **Column 5, Tool Number.** The manufacturer's part number.

B-5. EXPLANATION OF COLUMNS IN REMARKS, SECTION IV.

a. **Column 1, Reference Code.** The code recorded in Column 6, Section II.

b. **Column 2, Remarks.** This column lists information pertinent to the maintenance function being performed as indicated in the **MAC,** Section II.

Section II. MAINTENANCE ALLOCATION CHART FOR OSCILLOSCOPE OS-291/G

(1) Group Number	(2) Component/Assembly	(3) Maintenance Function	(4) Maintenance Level C	O	F	H	D	(5) Tools and Equipment	(6) Remarks
00	Digital Oscilloscope OS-291/G	Inspect		0.2					A
		Inspect				0.2			A
		Repair		0.2					B
01	Oscilloscope	Inspect		0.2					
		Inspect				0.2			C
		Test		0.1					D
		Calibrate				2.7		2	E
		Test				2.5			F
		Repair		0.1				1	G
		Repair				2.5		2-23	H
0101	Circuit Board Assembly: Main A10	Inspect				0.1			
		Test				1.5		2-23	
		Repair				10.0		2-23	J
0102	Circuit Board Assembly: Time Base A11	Inspect				0.1			
		Test				0.5		2-23	
		Repair				1.5		2-23	J
0103	Circuit Board Assembly: Processor A12	Inspect				0.1			
		Test				0.5		2-23	
		Repair				2.5		2-23	J
0104	Front Panel Assembly	Inspect				0.1			
		Repair				0.5		2	
010401	Circuit Board Assembly: Front Panel A14	Inspect				0.1			
		Test				0.2		2-23	
		Repair				0.5		2-23	J
0105	Circuit Card Assembly: LV Power Supply A16	Inspect				0.1			
		Test				0.2		2-23	
		Repair				1.0		2-23	J

Section III. TOOL AND TEST EQUIPMENT REQUIREMENTS FOR OSCILLOSCOPE OS-291/G

Tool or Test Equipment Ref Code	Maint Level	Nomenclature	National/NATO Stock Number	Tool Number
1	O	Tool Kit, Electronic Equipment	5180-00-064-5178	TK-101/G
2	H	Tool Kit, Electronic Equipment	4931-01-073-3845	JTK-17AL
3	H	Multimeter, Digital	6625-01-191-8755	Tek DM 501A
4	H	Generator, Function	6695-01-074-7956	Tek FG502
5	H	Calibrator, Oscilloscope	6695-01-057-2207	BAL 6126M
6	H	Power Supply	6695-01-076-8966	Tek PS503
7	H	Mainframe	6696-01-048-8920	Tek TM506
8	H	Oscillator, Test	6625-00-054-3483	HP 652A
9	H	Normalizer	6625-00-160-1325	7916146
10	H	Probe, 1X	6625-01-119-0155	Tek P6101A
11	H	Probe, 10X	6625-01-244-1831	Tek P6131
12	H	Alignment Tool	6625-01-083-6965	
13	H	Termination	5985-00-087-4954	
14	H	Attenuator, 10X	5985-00-572-7428	
15	H	Attenuator, 5X	5985-00-103-1877	
16	H	Attenuator, 2X	5985-00-540-6901	
17	H	Coaxial Cable	5995-00-498-4834	
18	H	Precision Coaxial Cable	5995-00-498-4834	
19	H	Dual-Input Coupler	6695-01-058-2187	
20	H	Adapter	6625-00-053-9454	
21	H	Fan		Rontron 119-0721-00
22	H	Controller/Display*	6625-01-206-5806	JF 1722A
23	H	GPIB Cable*	5995-01-058-2187	
		***OPTIONAL** – For Automatic Test Procedures Only		

Section IV. REMARKS
FOR DIGITAL OSCILLOSCOPE OS-291/G

Reference Code	Remarks
A	Inspect exterior of Oscilloscope and Accessories.
B	Repair by replacing probes, bag, cover, light filter and power cable.
C	Inspect exterior and interior of unit.
D	Power-up instrument. Record displayed self-test error messages.
E	Perform calibration as listed on TB 43-180.
F	Run performance verification tests.
G	Repair unit by replacing line fuse F1) and knobs.
H	Repair by replacing chassis mounted components and throwaway Side Panel CCA A13, HV Power Supply A17, and Scale Illumination A18.
J	Repair by replacing faulty components.

APPENDIX C

COMPONENTS OF END ITEM AND BASIC ISSUE ITEMS LISTS

Section I. INTRODUCTION

C-1. SCOPE.

This appendix lists components of end item and basic issue items for the OS-291/G to help you inventory items required for safe and efficient operation.

C-2. GENERAL.

The Components of End Item and Basic Issue Items Lists are divided into the following sections:

a. **Section II. Components of End Item.** This listing is for informational purposes only, and is not authority to requisition replacements. These items are part of the end item, but are removed and separately packaged for transportation or shipment. As part of the end item, these items must be with the end item whenever it is issued or transferred between property accounts. Illustrations are furnished to assist you in identifying the items.

b. **Section III. Basic issue items (BII).** These are the minimum essential items required to place the OS-291/G in operation, to operate it, and to perform emergency repairs. Although shipped separately packaged, BII must be with the OS-291/G during operation and whenever it is transferred between property accounts. The illustrations will assist you with hard-to-identify items. This manual is your authority to request/requisition replacement BII, based on TO E/MTOE authorization of the end item.

C-3. EXPLANATION OF COLUMNS.

The following is an explanation of columns found in the tabular listings:

a. **Column (1) - Illustration Number** (Illust. No.). This column indicates the number of the illustration in which the item is shown.

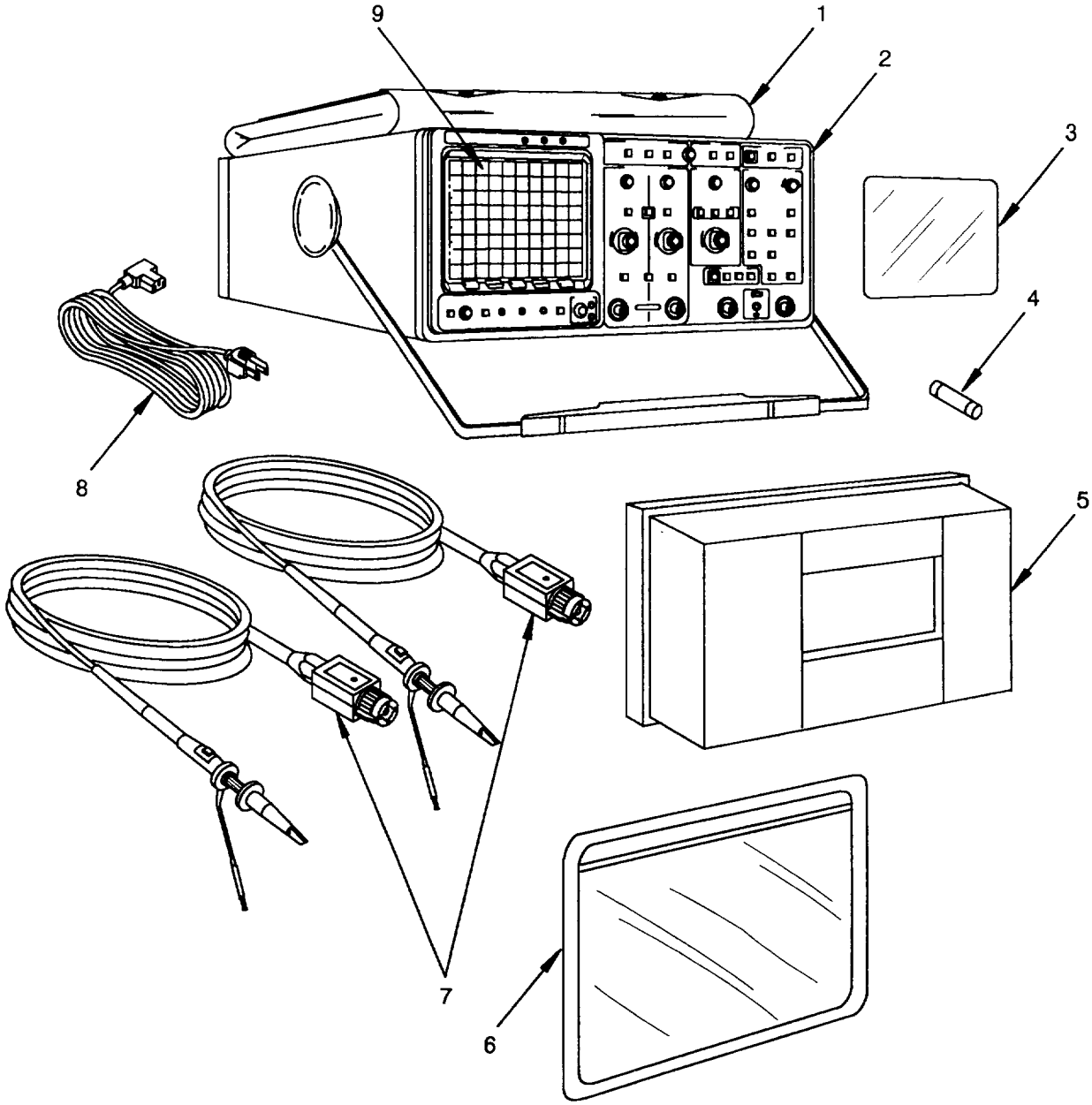
b. **Column (2) - National Stock Number.** Indicates the National Stock Number assigned to the item and will be used for requisitioning purposes.

c. **Column (3) - Description.** Indicates the Federal item name and, if required, a minimum description to identify and locate the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) (in parentheses) followed by the part number. if item needed differs for different models of this equipment, the model is shown under the Usable On heading in this column.

d. **Column (4) - Unit of Measure (U/M).** Indicates the measure used in performing the actual operational/maintenance function. This measure is expressed by two-character alphabetical abbreviation (e.g., ea, in, pr).

e. **Column (5) - Quantity Required (Qty Rqr).** Indicates the quantity of the item authorized to be used with the oscilloscope.

Section II. COMPONENTS OF END ITEM



(1) Ilust.No.	(2) National Stock Number	(3) Description FSCM and Part Number	(4) Qty U/M	(5) Rqr
1		Pouch Accessory, Snap (80009) 016-0692-00	ea	1
2		Oscilloscope, Storage, Digital (80009)2430A	ea	1
3		Filter, LT, CRT, Clear (80009)378-0208-00	ea	1
4		Fuse, Cartridge: 3AG, 5A, 250V, 0.8 SEC (71400) MTH-CW-5	ea	1
5		Cover, Front: ABS (TK 2165) 200-3199-01	ea	1
6		Pouch, Accessory: 6 in x 9 in w/zipper (05006)016-0537-00	ea	1
7		Probe, 10X, 1.3 meter w/accessories (80009) P6133 OPT 01	ea	2
8		Cable Assy, PWR: 3 Wire, 98.0 w/rtang corm (16428)761-0104-00	ea	1
9		Filter, LT, CRT, Blue (Installed) (TK1634) 378-0199-03	ea	1

APPENDIX D

ADDITIONAL AUTHORIZATION LIST

Section I. INTRODUCTION

D-1. SCOPE.

This appendix lists additional items you are authorized for the support of the OS-291/G.

D-2. GENERAL.

This list identifies items that do not have to accompany the OS-291/G and that do not have to be turned in with it, The items are all authorized to you by CTA, MTOE, TDA, or JTA.

D-3. EXPLANATION OF LISTING.

National stock numbers, descriptions, and quantities are provided to help you identify and request the additional items you require to support this equipment. The items are listed in alphabetical sequence by item name under the type document (i. e., CTA, MTOE, TD, or JTA) which authorized the item(s) to you.

Section II. ADDITIONAL AUTHORIZATION LIST

(1) National Stock Number	(2) Description FSCM and Part Number	Usable On Code	(3) U/M	(4) Qty Auth
	FUSE, 5A, 250 V, Cartridge, 3AG 0.8 SEC (71400) MTH-CW-5		ea	1

APPENDIX E

EXPENDABLE SUPPLIES AND MATERIALS LIST

Section I. INTRODUCTION

E-1. SCOPE.

This appendix lists expendable supplies and materials you will need to operate and maintain the Oscilloscope OS-291/G. These items are authorized to you by CTA 50-970, Expendable Items (except Medical, Class V, Repair Parts, and Heraldic Items).

E-2. EXPLANATION OF COLUMNS.

a. **Column (1)** - Item Number. This number is assigned to the entry in the listing and is referenced in the narrative instructions to identify the material (e. g., "Use cleaning compound, item 5, Appendix E").

b. **Column (2) - Level.** This column identifies the lowest level of maintenance that requires the listed item. Enter as applicable:

C - Operator/Crew
O - Unit Maintenance
F - Direct Support Maintenance
H - General Support Maintenance

c. **Column (3) - National Stock Number.** This is the National Stock Number assigned to the item; use it to request or requisition the item.

d. **Column (4) - Description.** Indicates the Federal item name and, if required, a description to identify the item. The last line for each item indicates the Federal Supply Code for Manufacturer (FSCM) (in parentheses) followed by the part number.

e. **Column (5) - Unit of Measure U/M).** Indicates the measure used in performing the actual maintenance function. This measure is expressed by a two-character alphabetical abbreviation (e. g., ea, in, pr). If the unit of measure differs from the unit of issue, requisition the lowest unit of issue that will satisfy your requirements.

Section II. EXPENDABLE SUPPLIES AND MATERIALS LIST

(1) Item No.	(2) Level	(3) National Stock Number	(4) Description	{5) U/M
1	0	8305-00-267-3015	Cloth, Cheesecloth, Cotton, Lintless, CCC-C-440, Type II, Class 2 (81349)	yd
2	C	6810-00-753-4993	Alcohol, Isopropyl, 8 Oz. Can, MIL-A-10428, Grade A (81349)	oz
3	C	7930-00-068-1669	Detergent, General Purpose	oz

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X

RECOMMENDED CHANGES TO EQUIPMENT TECHNICAL PUBLICATIONS

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Stateside, N.J. 07703-5007

DATE SENT
10 July 1975

PUBLICATION NUMBER	PUBLICATION DATE	PUBLICATION TITLE
TM 11-5840-340-12	23 Jan 74	Radar Set AN/PRC-76

BE EXACT PIN-POINT WHERE IT IS

PAGE NO	PARAGRAPH	FIGURE NO	TABLE NO
2-25	2-28		
3-10	3-3		3-1
5-6	5-8		
		F03	

IN THIS SPACE TELL WHAT IS WRONG AND WHAT SHOULD BE DONE ABOUT IT:

Recommend that the installation antenna alignment procedure be changed throughout to specify a 2^{o} IFF antenna lag rather than 1^{o}.

REASON: Experience has shown that with only a 1^{o} lag, the antenna servo system is too sensitive to wind gusting in excess of 25 knots, and has a tendency to rapidly accelerate and decelerate as it hunts, causing strain to the drive train. Hunting is minimized by adjusting the lag to 2^{o} without degradation of operation.

Item 5, Function column. Change "2 db" to "3db."

REASON: The adjustment procedure for the TRANS POWER FAULT indicator calls for a 3 db (500 watts) adjustment to light the TRANS POWER FAULT indicator.

Add new step f.1 to read, "Replace cover plate removed in step e.1, above."

REASON: To replace the cover plate.

Zone C 3. On J1-2, change "+24 VDC to "+5 VDC."

REASON: This is the output line of the 5 VDC power supply. +24 VDC is the input voltage.

PRINTED NAME GRADE OR TITLE AND TELEPHONE NUMBER
SSG I. M. DeSpiritof 999-1776

SIGN HERE
SSG I. M. DeSpiritof

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