TEKTRONIX®

7613/R7613 STORAGE OSCILLOSCOPE

OPERATORS

INSTRUCTION MANUAL

Tektronix, Inc.
070-1365-00

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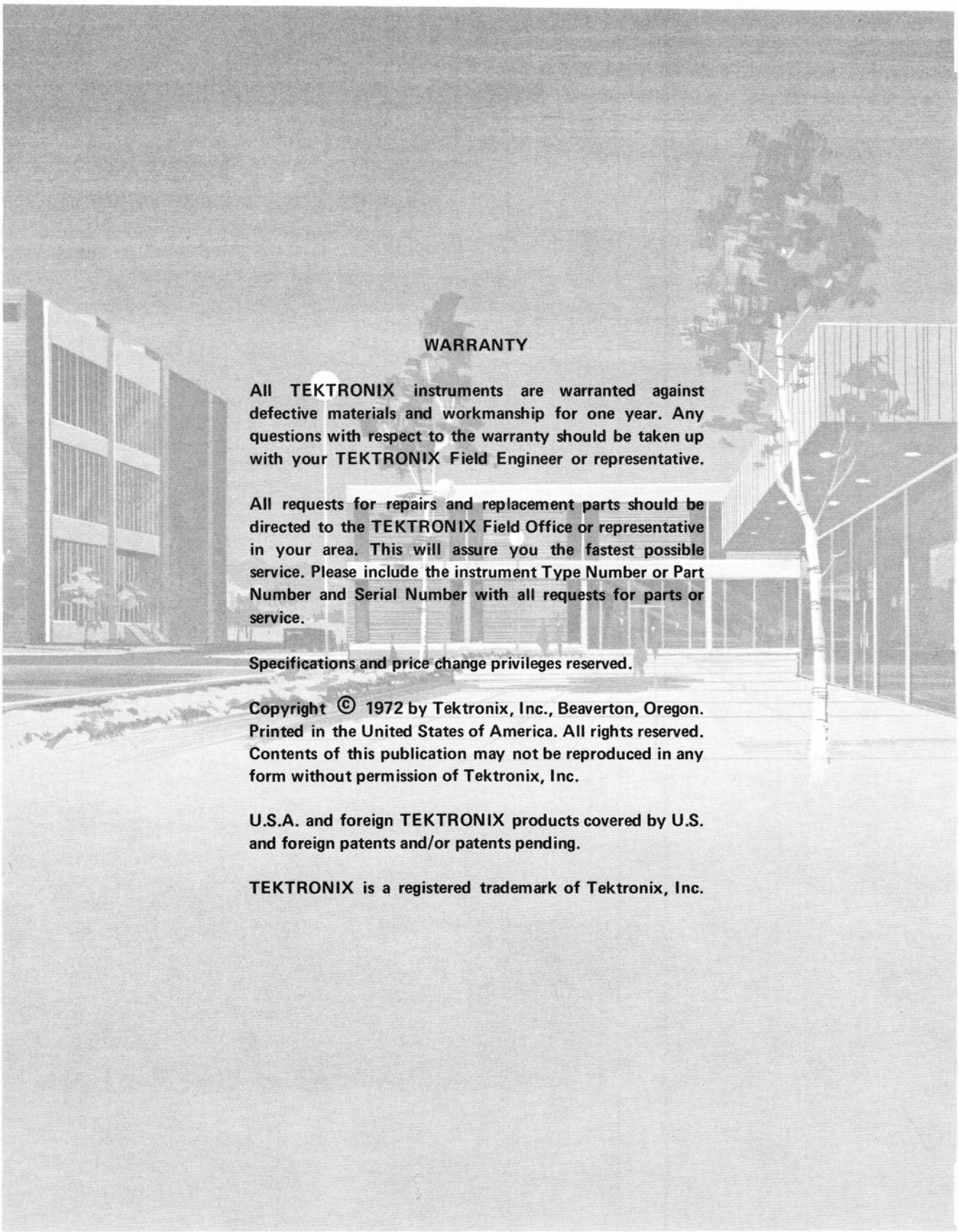

WARRANTY

All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

All requests for repairs and replacement parts should be directed to the TEKTRONIX Field Office or representative in your area. This will assure you the fastest possible service. Please include the instrument Type Number or Part Number and Serial Number with all requests for parts or service.

Specifications and price change privileges reserved.

U.S.A. and foreign TEKTRONIX products covered by U.S. and foreign patents and/or patents pending.

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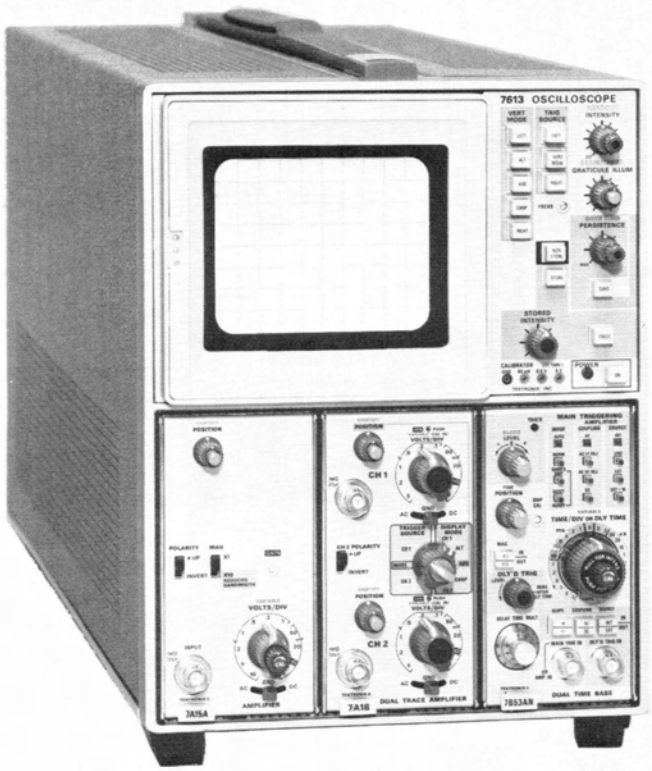
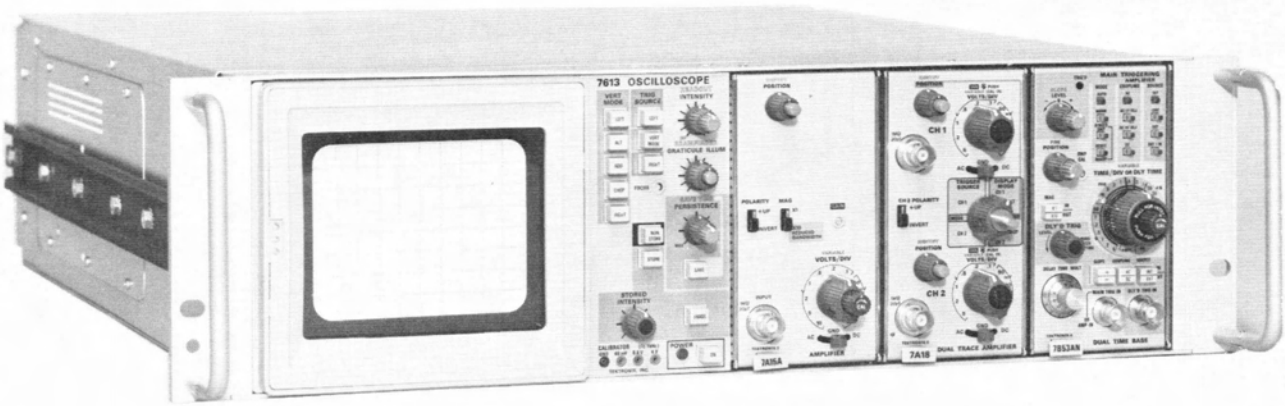


The TEKTRONIX 7613 Storage Oscilloscope is a solid-state, light-weight instrument designed for general purpose applications. This instrument has three plug-in compartments that accept TEKTRONIX 7000-Series plug-in units to form a complete measurement system. The two plug-in compartments on the left are for vertical preamplifiers. The right plug-in compartment is connected to the horizontal deflection system. Electronic switching is used to connect either vertical plug-in to the vertical deflection system. It is possible to alternately display the vertical signals (multi-trace display). The flexibility of this plug-in feature and variety of plug-in units available allow this system to be used for many measurement applications.

This instrument features a large screen, 8 X 10 division display; each division equals 0.9 centimeter. The Cathode ray tube (CRT) provides small spot size and a fast storage writing speed. Storage operation uses a variable Persistence mode and a Save mode. The variable Persistence mode electrically controls the retention of the CRT. The Save mode provides longer retention of the stored display, and a lockout function to prevent accidental erasure of the stored display.



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OPERATING INSTRUCTIONS

PRELIMINARY INFORMATION

Safety Information

This instrument has been designed and tested according to International Electrotechnical Commission (IEC) Publication 348 "Safety Requirements for Electronic Measuring Apparatus", and has been supplied in safe condition. This instruction manual contains some informative and warning texts which the user must follow to ensure safe operation and to retain this instrument in safe condition.

This instrument meets the requirements of Safety Class I apparatus.

AC Power Sources. This instrument is intended to be operated from a single-phase earth-referenced power source having one current-carrying conductor (the Neutral Conductor) near earth potential. Operation from power sources where both current-carrying conductors are live with respect to earth (such as phase- to-phase on a three-wire system) is not recommended, since only the Line Conductor has over-current (fuse) protection within the instrument.

AC Power Cord. This instrument has a three-wire power cord with a three-terminal polarized plug for connection to the power source and safety-earth. The safety-earth terminal of the plug is directly connected to the instrument frame. For electric-shock protection, insert this plug only in a mating outlet with a safety-earth contact or otherwise connect the frame to a safety-earth system. The color-coding of the cord conductors is in accordance with recognized standards.

Power Cord Conductor Identification

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

The 7613 can be operated from either a 110-volt or a 220-volt nominal line-voltage source. In addition, three operating ranges can be selected within each nominal line voltage source. The voltage-selector jumper on the Rectifier board (see Fig. 1-1) allows selection of the operating voltage. To convert the instrument from one regulating range to another, first disconnect the instrument from the power source. Then, slide out the power unit as described in the Maintenance section of the Service manual. Remove the voltage-selector jumper and re-install it on the set of pins which represent the desired regulating range. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 1-1).

TABLE 1-1

Regulating Range and Fuse Data

Pins Selected	Regulating Range	
	110-volts nominal	220-volts nominal
LOW	90 to 110 volts	180 to 220 volts
MED	99 to 121 volts	198 to 242 volts
HI	108 to 132 volts	218 to 262 volts
Line Fuse	3.1 A slow-blow	1.6 A slow-blow

To convert from 110-volts to 220-volts nominal line voltage, or vice versa, remove the voltage-selector jumper and replace it with the spare jumper (stored on pins adjacent to voltage selector area). The jumpers are color-coded to indicate the nominal voltage for which they are intended; brown for 110-volt nominal operation and red for 220-volt nominal operation. Change the line fuse to provide protection for the selected nominal line voltage. Use the fuse located in the ALT FUSE holder on the Rectifier board (see Fig. 1-1) or see Table 1-1 for value. Also, change the line-cord plug to match the power-source receptacle or use a suitable adapter.

Operating Temperature

The 7613 can be operated where the ambient air temperature is between 0°C and +50°C. This instrument can be stored in ambient temperatures between –55°C and +75°C. After storage at temperatures beyond the operating limits, allow the chassis temperature to come within the operating limits before power is applied.

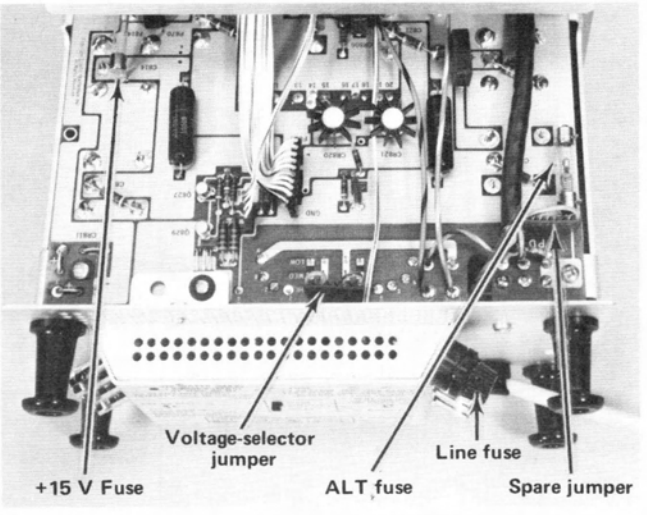


Fig. 1-1. Location of Voltage-selector jumper, spare jumper, and 230 V fuse in power-unit (shown removed).

The 7613 is cooled by air drawn through the instrument. Components which require the most cooling are mounted externally on a heat radiator at the rear. Adequate clearance must be provided on all sides to allow heat to be dissipated from the instrument. Do not block or restrict the air flow through the holes in the cabinet or the heat radiator on the rear. Maintain the clearance provided by the feet on the bottom and allow about two inches clearance on the top, sides, and rear (more if possible).

The R7613 is cooled by air drawn in through the air filter on the rear panel and blown out through the holes on the right side. Adequate clearance must be provided at these locations. Allow at least one and one-half inches clearance behind the air filter and at least one inch on the right side.

A thermal cutout in this instrument provides thermal protection and interrupts the power to the instrument if the internal temperature exceeds a safe operating level. Power is automatically restored when the temperature returns to a safe level. Operation in confined areas or in close proximity to heat-producing instruments may cause the thermal cutout to open more frequently.

Operating Position

A bail-type stand is mounted on the bottom of this instrument. This stand permits the 7613 to be tilted up about 10° for more convenient viewing.

Rackmounting

Instructions and dimensional drawings for rackmounting the R7613 are located in Section 3 of the Operators manual.

DISPLAY DEFINITIONS

General

The following definitions describe the types of displays which can be obtained with a 7613 Oscilloscope system with real-time amplifiers, time-base units, or combinations of these. Use of special purpose plug-in units may result in different types of displays, which are defined in the instruction manuals for these special units. The following terminology will be used throughout this manual.

Alternate Mode

A time-sharing method of displaying two or more signals with a single cathode-ray tube beam. Channel switching is sequential and occurs at the end of each sweep.

Chopped Mode

A time-sharing method of displaying two or more signals with a single cathode-ray tube beam. Channel switching is sequential and occurs at a rate determined by an internal clock generator (chopping rate).

Stored Displays

A display that is retained by the target surface (phosphor particles).

Variable-persistence

A system where the retention of the storage CRT can be changed electronically.

NOTE

See Simplified Operating Instructions in this section for set-up information to obtain each of the following displays.

Single Trace

A display of a single plot produced by one vertical signal and one sweep.

Dual Trace

A display of two plots produced by two vertical signals and one sweep.

Delayed Sweep — Single Trace

A display of a single plot produced by one vertical signal and a delayed sweep. Two sweeps are used to produce this display; the sweeps are operating with a delaying/delayed relationship where one sweep (identified as the delaying sweep) delays the start of the second sweep (identified as the delayed sweep).

Delayed Sweep — Dual Trace

A display of two plots produced by combining two vertical signals and a delayed sweep. Two sweeps are used to produce this display; the sweeps are operating with a delaying/delayed relationship. Each vertical signal is displayed against the delayed sweep.

X-Y

A plot of two variables, neither of which represents time. X refers to the horizontal axis and Y refers to the vertical axis.

PLUG-IN UNITS

General

The 7613 is designed to accept up to three TEKTRONIX 7-series plug-in units. This plug-in feature allows a variety of display combinations and also allows selection of bandwidth, sensitivity, display mode, etc. to meet the measurement requirements. In addition, it allows the oscilloscope system to be expanded to meet future measurement requirements. The overall capabilities of the resultant system are in large part determined by the characteristics of the plug-in selected. For complete information on plug-ins available for use with this instrument, see the current Tektronix, Inc., catalog.

Plug-In Installation

To install a plug-in unit into one of the plug-in compartments, align the slots in the top and bottom of the plug-in with the associated guide rails in the plug-in compartment. Push the plug-in unit firmly into the plug-in compartment until it locks into place. To remove a plug-in, pull the release latch on the plug-in unit to disengage it and pull the unit out of the plug-in compartment. Plug-in units can be removed or installed without turning off the instrument power.

It is not necessary that all of the plug-in compartments be filled to operate the instrument; the only plug-in units needed are those required for the measurement to be made. At environmental extremes, excess radiation may be radiated into or out of this instrument through the open plug-in compartments. To reduce such interference, or to meet EMI specifications for Option 3 modified instruments, blank plug-in panels are available from Tektronix, Inc., to cover the unused compartment; order TEKTRONIX Part No. 016-0155-00.

When the 7613 is calibrated in accordance with the calibration procedure given in the Service manual, the vertical and horizontal gain are standardized. This allows calibrated plug-in units to be changed from one plug-in compartment to another without recalibration. However, the basic calibration of the individual plug-in units should be checked when they are installed in this system to verify their measurement accuracy. See the operating instructions section of the plug-in unit instruction manual for verification procedure.

Special purpose plug-in units may have specific restrictions regarding the plug-in compartments in which they can be installed. This information will be given in the instruction manual for these plug-in units.

NOTE

Later production of rackmount oscilloscopes are provided with support posts between the individual plug-in compartments. A post or posts must be removed if a multi-width plug-in is to be installed. To remove a post, unfasten the screws that secure it at the top and bottom of the plug-in housing.

CONTROLS AND CONNECTORS

The major controls for operation of the 7613 are located on the front panel of the instrument. Figs. 1-2 and 1-3 provide a brief description of each control and connector. More detailed operating information is given under General Operating Information.

OPERATING CHECKOUT

General

The following Operating Checkout provides a means of verifying instrument operation and basic calibration without removing the covers or making internal adjustments. Since it demonstrates the use of all controls and connectors, it can also be used to provide basic training on the operation of this instrument. If re-calibration of the 7613 appears to be necessary, see the Calibration procedure in Section 5 of the Service manual. If re-calibration of a plug-in unit is indicated, see the Instruction manual for the appropriate plug-in unit.

Set-Up Information

1. Set the front-panel controls as follows:

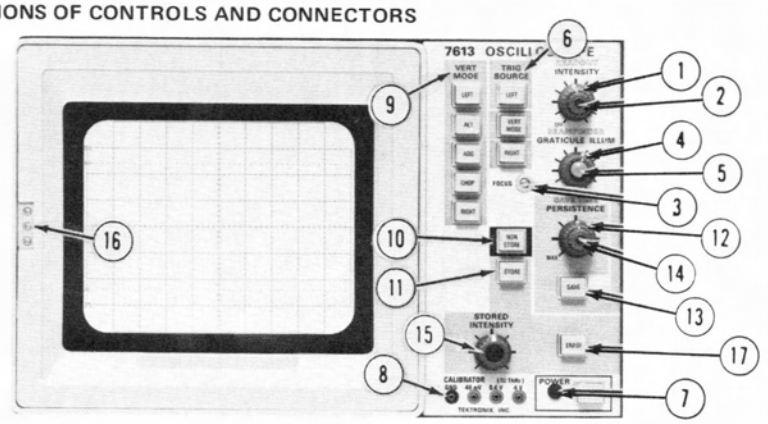
INTENSITY	Counterclockwise
FOCUS	Midrange
GRATICULE ILLUM	As desired
VERT MODE	LEFT
TRIG SOURCE	VERT MODE
POWER	ON
NON-STORE	Pushed In
STORE	Out
SAVE	Out
STORED INTENSITY	Counterclockwise
PERSISTENCE	Counterclockwise
SAVE TIME	Clockwise

2. Connect the 7613 to a power source which meets the voltage and frequency requirements of this instrument. The applied voltage should be near the center of the voltage range marked on the rear panel (see Operating Voltage in this section for information on converting this instrument from one operating voltage to another).

3. Install TEKTRONIX 7A-series amplifier units into both the left and right vertical plug-in compartments. Install a 7B-series time-base unit into the horizontal compartment.

4. Press the POWER switch to turn the instrument on. Allow several minutes warmup before proceeding.

FUNCTIONS OF CONTROLS AND CONNECTORS



1. INTENSITY—Controls brightness of the display. Control is inoperative when horizontal compartment is vacant.

2. READOUT—Turns on the readout display and controls the readout intensity.

3. FOCUS—Provides adjustment for optimum display definition.

4. GRATICULE ILLUM—Controls graticule illumination.

5. BEAM FINDER—When pressed, the display is limited within the graticule area.

6. TRIG SOURCE—Selects source of internal trigger signal for the time base plug-in in the horizontal compartment.

   LEFT: The trigger signal is obtained from the plug-in unit in the left vertical compartment only.

   VERT MODE: Trigger signal automatically follows the vertical display except in CHOP and ADD; then the trigger signal is the algebraic sum of the signals from the left and right vertical compartments.

   RIGHT: The trigger signal is obtained from the plug-in unit in the right vertical compartment only.

7. POWER—Switch controls the power to the instrument. Light indicates that the power switch is on and that the instrument is connected to a line voltage source.

8. CALIBRATOR—Calibrator output pin jacks (4 V, 0.4 V, 40 mV, and ground). Positive-going pulse or DC voltage selected by changing internal jumper.

9. VERT MODE—Selects vertical mode of operation.

   LEFT: Signals from plug-in unit in left vertical compartment are displayed.

   ALT: Signals from both plug-in units in both the left and right vertical compartments are displayed (dual trace). Display switches between vertical plug-in units after each sweep.

   ADD: Signals from plug-in units in both the left and right vertical compartments are algebraically added and the sum is displayed on the CRT.

   CHOP: Signals from plug-in units in both the left and right vertical compartments are displayed (dual trace). The display is switched between vertical plug-in units at approximately a one megahertz rate.

   RIGHT: Signals from plug-in unit in right vertical compartment is displayed.

10. NON-STORE—Selects non-store operation.

11. STORE—Selects storage operation.

12. PERSISTENCE—Controls the retention of the stored display.

13. SAVE—Prevents accidental erasure, and additional storage of information.

14. SAVE TIME—Used with the SAVE mode for extending retention. When in the MAX detent there is no visible stored display in all storage modes.

15. STORED INTENSITY—Select writing speed and view time combination controls (brightness of stored display).

16. Camera Power (Not Labeled)—Three-pin connector on CRT bezel provides power output (+15 V). Receives remote single sweep reset signal from compatible camera systems, and a ground pin connection.

17. ERASE—Erases stored display.

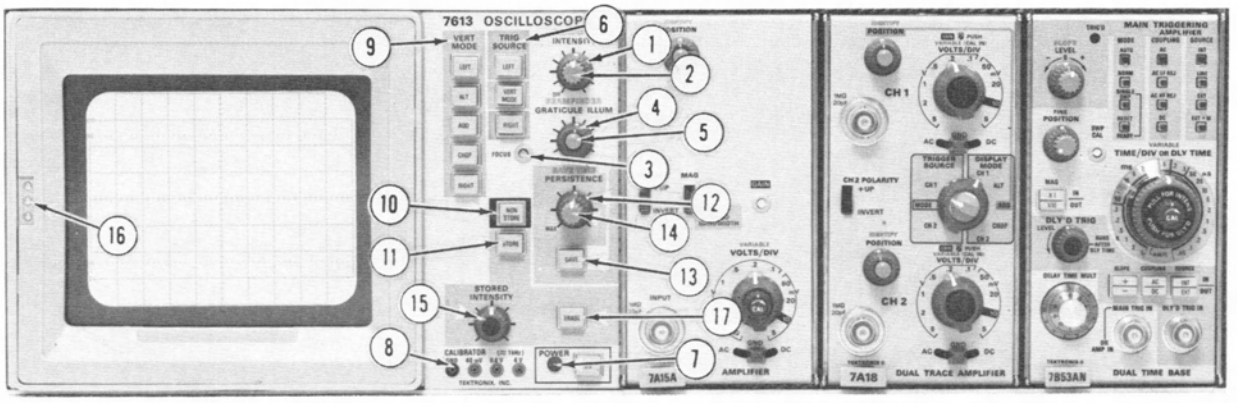


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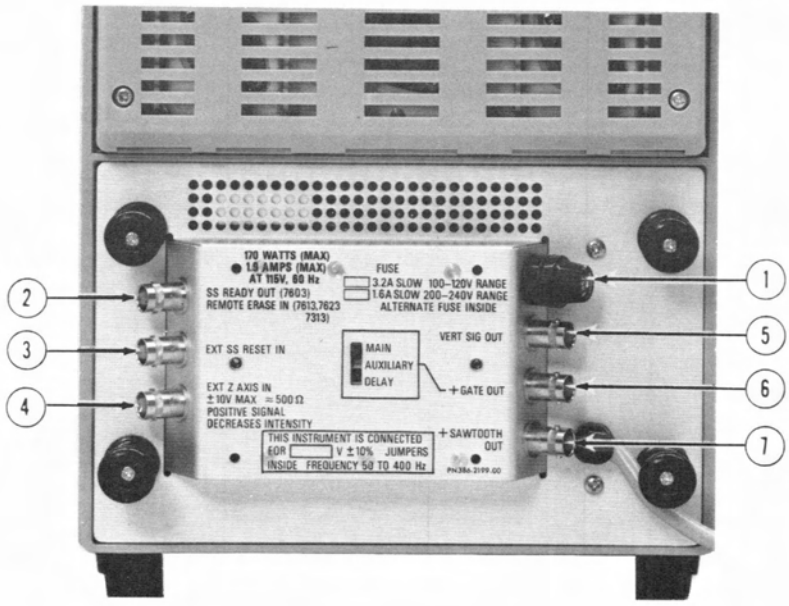
Fig. 1-2. Front-panel controls and connectors.



1. FUSE—Line voltage fuse.

2. REMOTE ERASE IN—Provides external connection for remote erase.

3. EXT S S RESET IN—Remote single sweep reset.

4. EXT Z AXIS IN—Input for intensity modulation of the CRT display.

5. VERT SIG OUT—Vertical signal selected by TRIG SOURCE switch (LEFT, RIGHT, ALT and ADD).

6. +GATE OUT—Gate signal selected by gate selector switch (Main, Auxiliary, and Delay).

7. +SAWTOOTH OUT—Positive-going sawtooth from time-base unit.

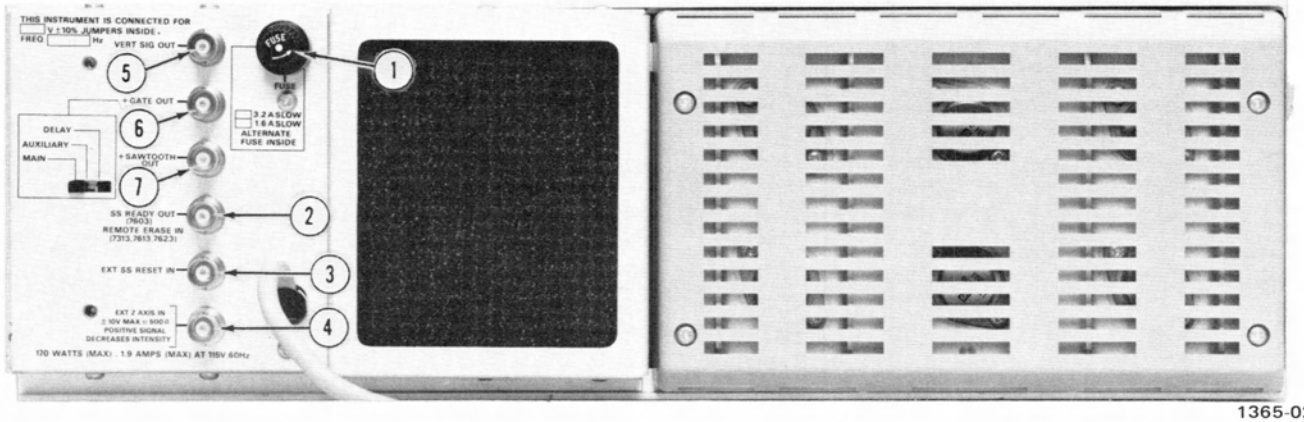


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Fig. 1-3. Rear-panel controls and connectors.

5. Set both vertical units for a deflection factor of two volts/division and center the vertical position controls. Set both vertical units for AC input coupling.

6. Set the time-base unit for a sweep rate of one millisecond/division in the auto, internal trigger mode.

7. Advance the INTENSITY control until the trace is at the desired viewing level (near midrange). Advance the READOUT until the readout display is at the desired viewing level.

8. Connect the 4 V calibrator pin-jack to the input of the left vertical unit with a BNC to pin-jack cable (supplied accessory).

Display Focus

9. Adjust the FOCUS adjustment for a sharp, well-defined display over the entire trace length. If a properly focused display cannot be obtained with the FOCUS adjustment, the internal Astigmatism adjustment must be reset; see the Calibration section of the Service manual.

Trace Alignment

10. Disconnect the input signal and position the trace with the left vertical unit position control so it coincides with the center horizontal line of the graticule. If the trace is not parallel to the center horizontal line of the graticule, see Trace Rotation adjustment procedure in Calibration section.

Graticule Illumination

11. Rotate the GRATICULE ILLUM control throughout its range and notice that the illumination of the graticule lines increases as the control is turned clockwise (most obvious with tinted filter installed). Set the control so the graticule lines are illuminated as desired.

Vertical Deflection System

12. Connect the 4 V calibrator signal to the input connector of the left vertical unit with the BNC to pin-jack cable. Set both vertical units for a deflection factor of one volt/division. The display amplitude should be four divisions. Note the exact display amplitude for step 15.

13. Notice that the position control of only the left vertical unit has an effect on the position of the display. Position the display to the upper half of the graticule.

14. Press the RIGHT button of the VERT MODE switch. Remove the calibrator signal from the left vertical and connect it to the right vertical. The display amplitude should be four divisions within 0.12 division. Note the exact display amplitude for the next step.

15. A correct display in both steps 12 and 14 indicates that the 7613 Vertical Deflection System and the vertical plug-in units are calibrated. If the displays noted previously are both outside the given tolerance in the same direction (i.e., high or low), the Vertical Gain or 4 Volts calibrator adjustment probably needs re-adjustment. Otherwise, check the calibration of the vertical plug-in units.

16. Notice that the position control of only the right vertical unit has an effect on the position of the display. Position the display to the lower half of the graticule. Set both vertical units for a deflection factor of two volts/division. Connect the calibrator signal to both vertical units by using a dual input coupler.

17. Press the ALT button of the VERT MODE switch. Notice that two traces are displayed on the CRT. The top trace is produced by the left vertical unit and the bottom trace is produced by the right vertical unit. Set the sweep rate to 50 milliseconds/division. Notice that the display alternates between the left and right vertical units after each sweep. Turn the sweep rate switch throughout its range. Notice that the display alternates between vertical units at all sweep rates.

18. Press the CHOP button of the VERT MODE switch. Turn the sweep rate throughout its range. Notice that a dual-trace display is presented at all sweep rates, but unlike ALT both vertical units are displayed on each sweep in a time-sharing manner. Return the sweep rate to 0.5 millisecond/division.

19. Press the ADD button of the VERT MODE switch. The display should be the algebraic sum of both signals. Notice that the position control of either vertical unit moves the display. Return the VERT MODE switch to LEFT.

Triggering

20. Center the display on the CRT with the left vertical unit position control. Disconnect the input signal from the right vertical unit input connector. Sequentially press all of the VERT MODE switch buttons. Notice that a stable display is obtained in all positions of the VERT MODE switch (straight line in RIGHT position).

21. Press the LEFT button of the TRIG SOURCE switch. Again, sequentially press all of the VERT MODE buttons. Notice that the display is again stable in all positions, as in the previous step.

22. Press the RIGHT button of the TRIG SOURCE switch. Sequentially press all of the VERT MODE buttons and notice that a stable display cannot be obtained in any position. This is because there is no input signal connected to the right vertical unit. Return the TRIG SOURCE switch to VERT MODE. Remove calibrator signal from left vertical unit and connect it to right vertical unit. Repeat steps 20 to 22. The trigger signal will come from right vertical, and if the LEFT button is pressed of the TRIG SOURCE switch the display is not stable because there is no input signal connected to the left vertical. Return the TRIG SOURCE switch to VERT MODE.

Horizontal Deflection System

23. Position the start of the sweep to the left graticule line with the time-base unit position control. Disconnect the input signals.

24. Connect a 10X probe to the input of the right vertical unit. Set the right vertical unit for a deflection factor of 10 volts/division and set the VERT MODE switch to RIGHT. Set the time-base unit for a sweep rate of five milliseconds/division.

25. Connect the probe tip to a line-voltage source. The display should show three complete cycles over the 10 divisions within 0.3 division. A correct display indicates that the 7613 Horizontal Deflection System and the time-base plug-in unit are correctly calibrated. If the display is outside the given tolerance, either the 7613 or the time-base unit needs to be recalibrated. Refer to the Calibration section of the Service manual, and to the time-base unit manual for adjustment procedure.

NOTE

This step is based on an accurate 60-hertz line frequency. For other line frequencies, this procedure will need to be changed accordingly.

26. Disconnect the probe from the line-voltage source and the right vertical unit. Set the VERT MODE switch to LEFT and set the time-base unit for a sweep rate of 0.5 millisecond/division. Disconnect all cables.

Storage Operation (Variable-persistence)

27. Connect the 4 V Calibrator signal to the input connector of the left vertical unit, and set the deflection factor for one volt/division. Set the horizontal plug-in unit for single sweep operation at 0.5 millisecond/division. Be sure that the horizontal unit is triggered.

28. Press the STORE button (the NON-STORE switch button should release). The CRT screen will be flooded positive. Turn the PERSISTENCE control to approximately midrange.

29. Press the Reset button on the horizontal plug-in unit. One sweep will be generated, and a display should be visible, but will fade out within a few seconds. Increase the PERSISTENCE control setting (counterclockwise) if a display of longer retention is required. Increase the STORED INTENSITY setting if a brighter display is required. If there is no display visible increase the INTENSITY control setting, and press the Reset button.

30. Press the ERASE button, the CRT should turn positive and erase. Press the Reset button on the horizontal plug-in unit and a stored display will appear on the CRT screen. Press the SAVE button, the display is stored and no other sweep or change in position will affect the display. The SAVE switch will lock out all functions except the STORED INTENSITY control and the SAVE TIME control. When the SAVE TIME is turned counterclockwise (into the switch detent) the display is stored at the Maximum time. Turning the SAVE TIME control clockwise will decrease the time a stored display is retained on the CRT. When the display is not being used turn the SAVE TIME control counterclockwise, (the display will not be visible on the screen), the information has not been lost or destroyed. Turn the SAVE TIME control clockwise until a display is visible when needed. When the instrument is in the SAVE mode and the SAVE TIME control is counterclockwise and into the detent, the instrument can be turned off without losing any stored information. Turn the instrument on again and turn the SAVE TIME control clockwise until display appears. In the MAX detent the stored display can not be viewed.

Beam Finder

31. Set the deflection factor of the left vertical unit to 0.1 volt/division. Notice that a square-wave display is not visible, since the deflection exceeds the scan area of the CRT.

32. Press and hold the BEAM FINDER switch. Notice that the display is returned to the viewing area in compressed form. Increase the vertical and horizontal deflection factors until the display is reduced to about two divisions vertically and horizontally (when the horizontal unit is operated in the time-base mode, change only the deflection factor of the vertical unit). Adjust the position controls of the displayed vertical unit and the time-base unit to center the compressed display about the center lines of the graticule. Release the BEAM FINDER switch. Notice that the display remains within the viewing area.

Z-Axis Input

33. If an external signal is available (two volts peak-to-peak minimum at two megahertz or less), the function of the EXT Z AXIS input can be demonstrated. Connect the external signal to both the input of the right vertical unit and the EXT Z AXIS connector with two BNC cables and a BNC T connector. Set the VERT MODE switch to RIGHT and set the vertical unit for a deflection factor of one volt/division. Set the time-base unit for a sweep rate which displays several cycles of the signal. Adjust the amplitude of the signal generator until intensity modulation is visible on the display. The positive peaks of the waveform should be blanked out and the negative peaks intensified. Notice that the setting of the INTENSITY control determines the amount of intensity modulation that is visible.

34. Disconnect the signal from the EXT Z AXIS connector, but leave it connected to the right vertical unit input. Check that peak-to-peak amplitude of the displayed signal is four divisions maximum.

35. This completes the Operating Checkout procedure for the 7613. Instrument operations not explained here, or operations which need further explanation are discussed under General Operating Information.

SIMPLIFIED OPERATING INSTRUCTIONS

The following information is provided to aid in quickly obtaining the correct setting for the 7613 controls to present a display. The operator should be familiar with the complete function and operation of this instrument as described elsewhere in this section before using this procedure. For detailed operating information for the plug-in units, see the instruction manuals for the applicable units.

Single-Trace Display

The following procedure will provide a display of a single-trace vertical unit against one time-base unit. For simplicity of explanation, the vertical unit is installed in the left vertical compartment. The right vertical compartment can be used if the procedure is changed accordingly.

1. Install a 7A-series vertical unit in the left vertical compartment.

2. Press the LEFT button of the VERT MODE switch.

3. Install a 7B-series time-base unit in the horizontal compartment.

4. Press the VERT MODE button of the TRIG SOURCE switch.

5. Connect the signal to the input connector of the vertical unit.

6. Set the vertical unit for AC input coupling and calibrated deflection factor.

7. Set the time-base unit for auto mode, internal triggering at a calibrated sweep rate of one millisecond/division.

8. Advance the INTENSITY control until a display is visible. (If no display is visible with INTENSITY at about midrange, press and hold the BEAM FINDER switch and adjust the vertical deflection factor until the display is reduced in size vertically; then center the compressed display with vertical and horizontal position controls; release the BEAM FINDER.) Adjust the FOCUS adjustment for a well-defined display. Adjust Readout INTENSITY for the desired viewing level.

9. Set the vertical deflection factor and vertical position control for a display which remains within the graticule area vertically.

10. If necessary, set the time-base triggering controls for a stable display.

11. Adjust the time-base position control so the display begins at the left edge of the graticule. Set the time-base sweep rate to display the desired number of cycles.

Stored Display

1. Repeat steps 1-11 under Single-Trace Display (if necessary) to obtain a display.

2. Press the STORE button.

3. Adjust the PERSISTENCE control for the desired background level and retention. If blooming occurs decrease the STORED INTENSITY control or the INTENSITY control for the desired viewing level. This is the Variable-Persistence mode.

4. Press the SAVE button, and adjust the SAVE TIME control for the desired intensity and the time that the stored display is retained. When the SAVE TIME is fully counterclockwise and in the switch detent the stored display is at the maximum retention. This is the Save mode, and the display can not be accidentally erased. In the MAX detent the stored display is not visible.

5. Press and release the SAVE button and turn the SAVE TIME control out of detent.

6. Press and release the ERASE button if new information is to be stored.

7. Press the NON-STORE button for normal operation.

Dual-Trace Display

The following procedure will provide a display of two single-trace vertical units against one time-base unit.

1. Install 7A-series vertical units in both vertical plug-in compartments.

2. Press the LEFT button of the VERT MODE switch.

3. Install a 7B-series time-base unit in the horizontal compartment.

4. Press the VERT MODE button of the TRIG SOURCE switch.

5. Connect the signal to the input connectors of the vertical units.

6. Set the vertical units for AC input coupling and calibrated deflection factors.

7. Set the time-base unit for auto mode, internal triggering at a sweep rate of one millisecond/division.

8. Advance the INTENSITY control until a display is visible. (If no display is visible with INTENSITY at midrange, press and hold BEAM FINDER switch and adjust vertical deflection factor until display is reduced in size vertically; then center compressed display with vertical and horizontal position controls; release the BEAM FINDER switch.) Set the FOCUS adjustment for a well-defined display.

9. Set the left vertical unit deflection factor for a display about four divisions in amplitude. Adjust the left vertical position control to move this display to the top of the graticule area.

10. Press the RIGHT button of the VERT MODE switch.

11. Set the RIGHT vertical unit deflection factor for a display about four divisions in amplitude (if display cannot be located, use BEAM FINDER switch). Position this display to the bottom of the graticule area with the right vertical unit position control.

12. Press the ALT or CHOP button of the VERT MODE switch. A dual-trace display of the signal from the left vertical and right vertical plug-in units should be presented on the CRT. (For more information on choice of dual-trace mode, see Vertical Mode in this section.)

13. If necessary, adjust the time-base triggering controls for a stable display.

14. Adjust the time-base position control so the display begins at the left edge of the graticule. Set the time-base sweep rate for the desired horizontal display.

Dual Trace Stored Display

1. Repeat steps 1-14 under Dual Trace Display (if necessary) to obtain a display.

2. Press the STORE button.

3. Adjust the PERSISTENCE control for the desired background level and retention. If blooming occurs decrease the STORED INTENSITY LEVEL control or the INTENSITY control for the desired viewing level. This is the variable Persistence mode.

4. Press the SAVE button, and adjust the SAVE TIME control for the desired intensity and the time that the stored display is retained. When the SAVE TIME control is fully counterclockwise and in the switch detent, the stored display is at maximum retention. This is the SAVE mode and the display can not be accidentally erased. In the MAX detent the stored display is not visible.

5. Press and release the SAVE button and turn the SAVE TIME control clockwise out of the detent.

6. Press and release the ERASE button if new information is to be stored.

7. Press the SAVE button if the display is to be stored or press the NON-STORED button for normal operation.

Delayed Sweep — Single Trace

The following procedure will provide a delayed sweep display of a single-trace vertical unit.

1. Follow the complete procedures given under Single-Trace Display and Stored Display.

2. Be sure the time-base unit installed in the horizontal compartment is a dual time-base with delaying/delayed capabilities.

3. Follow the procedure given in the instruction manual for the dual time-base unit to obtain a delayed-sweep display.

Delayed Sweep — Dual Trace

The following procedure will provide a delayed-sweep display of two single-trace vertical units.

1. Follow the complete procedures given under Dual-Trace Display and Stored Display.

2. Be sure the time-base unit installed in the horizontal compartment is a dual time-base unit with delaying/delayed capabilities.

3. Follow the procedure given in the instruction manual for the dual time-base unit to obtain a delayed-sweep display.

X-Y Display

The following procedure will provide an X-Y display (one signal versus another rather than against time).

NOTE

Some 7B-series time-base units have provisions for amplifier operation in the X-Y mode; see X-Y operation in this section for details of operation in this manner.

1. Install 7A-series amplifier units in both the left vertical and the horizontal compartments.

2. Press the LEFT button of the VERT MODE switch.

3. Connect the X-signal to the amplifier unit in the horizontal compartment.

4. Connect the Y-signal to the amplifier unit in the left vertical compartment.

5. Set both amplifier units for AC input coupling and calibrated deflection factors.

6. Advance the INTENSITY control until a display is visible. (If no display is visible, press and hold BEAM FINDER switch and adjust the deflection factors of both amplifier units until display is reduced in size both vertically and horizontally; then center compressed display with the position controls; release the BEAM FINDER switch.) Adjust the FOCUS adjustment for a well-defined display.

GENERAL OPERATING INFORMATION

Intensity Control

The setting of the INTENSITY control may affect the correct focus of the display. Slight re-adjustment of the FOCUS adjustment may be necessary, when the intensity level is changed. To protect the CRT phosphor; do not turn the INTENSITY control higher than necessary to provide a satisfactory display. The light filters reduce the observed light output from the CRT. When using these filters, avoid advancing the INTENSITY control to a setting that may burn the phosphor. When the highest intensity display is desired, remove the filters and use only the clear faceplate protector (permanently installed behind bezel). Apparent trace intensity can also be improved in such cases by reducing the ambient light level or using a viewing hood. Also, be careful that the INTENSITY control is not set too

high when changing the time-base unit sweep rate from a fast to a slow sweep rate, or when changing to the X-Y mode of operation. The instrument incorporates protection circuitry which automatically reduces the display intensity to a lower level when the time-base unit is set to a slow sweep rate. This reduces the danger of damaging the CRT phosphor at these slower sweep rates.

Display Focus

The FOCUS adjustment allows control for best definition of the CRT display. The Readout intensity should be turned on when adjusting the Focus adjustment. Slight re-adjustment of this control may be necessary as the display conditions change. If a properly focused display cannot be obtained with the FOCUS adjustment, the internal Astigmatism adjustment must be re-set; see the Calibration section of the Service manual.

Graticule

The graticule of the 7613 is marked on the inside of the faceplate of the CRT, providing accurate, non-parallax measurements. The graticule is divided into eight vertical and ten horizontal divisions. Each division is 0.9 centimeters square. In addition, each major division is divided into five minor divisions. The vertical gain and horizontal timing of the plug-in units are calibrated to the graticule so accurate measurements can be made from the CRT. The illumination of the graticule lines can be varied with the GRATICULE ILLUM control.

Fig. 1-4 shows the graticule of the 7613 and defines the various measurement lines. The terminology defined here will be used in all discussions involving graticule measurements. Notice the 0%, 10%, 90%, and 100% markings on the left side of the graticule. These markings are provided to facilitate risetime measurements.

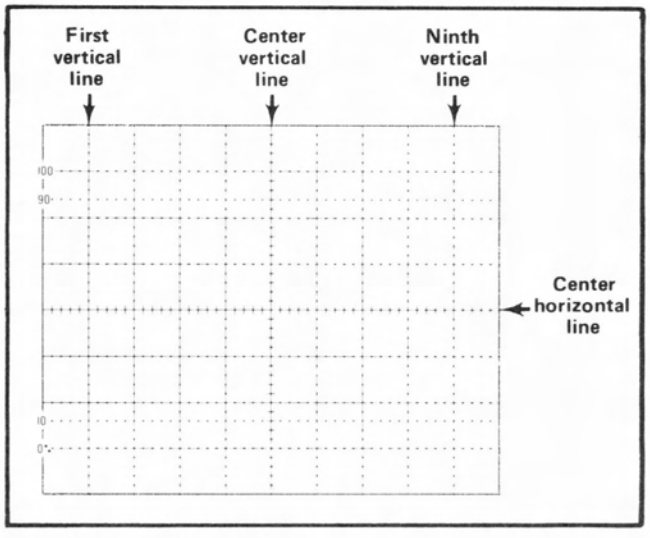

Fig. 1-4. Definition of Measurement lines on graticule.

NOTE

Two types of crt graticules have been used in some Tektronix oscilloscopes. One graticule has 0% and 100% risetime reference points that are separated by 6 vertical graticule divisions. The other graticule has the 0% and 100% risetime reference points separated by 5 vertical divisions. In your manual, illustrations of the crt face or risetime measurement instructions may not correspond with the graticule markings on your oscilloscope.

Light Filter

The tinted filter provided with the 7613 minimizes light reflections from the face of the CRT to improve contrast when viewing the display under high ambient light conditions. This filter should be removed for waveform photographs or when viewing high writing rate displays. To remove the filter, loosen the two screws on the right side of the bezel and remove the bezel. Remove the tinted filter; leave the clear plastic faceplate protector installed and replace the bezel. The faceplate protector should be left in place at all times to protect the CRT faceplate from scratches.

An optional mesh filter is available for use with the 7613. This filter provides shielding against radiated EMI (electro-magnetic interference) from the face of the CRT. It also serves as a light filter to make the trace more visible under high ambient light conditions. The mesh filter fits in place of the plastic CRT mask and the tinted filter. The filter can be ordered by TEKTRONIX Part No. 378-0603-00.

Beam Finder

The BEAM FINDER switch provides a means of locating a display which overscans the viewing area either vertically or horizontally. When the BEAM FINDER switch is pressed and held, the display is compressed within the graticule area. Release the BEAM FINDER switch to return to a normal display. To locate and reposition an overscanned display, use the following procedure:

1. Press and hold the BEAM FINDER switch.

2. Increase the vertical and horizontal deflection factors until the vertical deflection is reduced to about two divisions and the horizontal deflection is reduced to about four divisions (the horizontal deflection needs to be reduced only when in the X-Y mode of operation).

3. Adjust the vertical and horizontal position controls to center the display about the vertical and horizontal center lines of the graticule.

4. Release the BEAM FINDER switch; the display should remain within the viewing area.

Readout Modes

The characters of the readout display are written by the CRT beam on a time-share basis with signal waveforms. The Readout System operates in a free-running mode to randomly interrupt the waveform display to present the readout characters. The Readout System can also operate in a GATE TRIG'D mode; no readout signal is produced until after the sweep has occurred. In this mode the sweep must run to have a readout display. Switch 2110 located on the Readout board changes the Readout modes.

Display Photography

A permanent record of the CRT display can be obtained with an oscilloscope camera system. The instruction manuals for the TEKTRONIX Oscilloscope Cameras include complete instructions for obtaining waveform photographs. The following specific information applies to the 7613.

The CRT bezel of the 7613 provides integral mounting for a TEKTRONIX Oscilloscope Camera. The three pins located on the left side of the CRT bezel connect power to compatible camera systems. It also receives control signals from TEKTRONIX automatic cameras to allow camera-controlled single-shot photography (see camera manual for further information).

Storage

The storage feature greatly increases the versatility of the 7613 Oscilloscope. The storage cathode-ray tube allows a display to be retained for a longer period of time. When the NON-STORE button is pressed in, the instrument operates as a conventional oscilloscope.

When the STORE button is pressed in, the instrument operates in a storage mode. Two modes of storage are available. They are Variable Persistence, where the persistence of the CRT is electrically controlled by the PERSISTENCE control; and a SAVE mode, that allows longer retention of the displayed information. When the SAVE button is pressed in, a lockout function prevents accidental erasure of the stored display.

Erase

When the ERASE switch is pressed in, the CRT screen is erased. In the SAVE mode, the Erase function is disabled.

Care of Storage Screen

The following precautions will prolong the useful storage life of the CRT screen used in this instrument.

1. Use the minimum beam intensity required to produce a clear, well-defined display. A too-high beam intensity may permanently damage the CRT screen, particularly if a bright spot is allowed to remain stationary on the display area.

2. Avoid repeated use of the same area of the screen. If a particular display is being stored repeatedly, change the vertical position occasionally to use other portions of the display area.

3. Do not leave a stored display on the screen when it is no longer needed.

4. Operate the instrument in the non-store mode unless storage is required.

Vertical Mode

Left and Right Mode. When the LEFT or RIGHT button of the VERT MODE switch is pressed, only the signal from the plug-in unit in the selected compartment is displayed.

Alternate Mode. The ALT position of the VERT MODE switch produces a display which alternates between the plug-in units in the left vertical and right vertical compartments with each sweep of the CRT. Although the ALT mode can be used at all sweep rates, the CHOP mode provides a more satisfactory display at sweep rates below about 20 milliseconds/division. At these slower sweep rates, alternate-mode switching becomes visually perceptible.

NOTE

This instrument will not operate in the ALT mode if the horizontal plug-in unit is not operated in the time-base mode.

The TRIG SOURCE switch allows selection of the triggering for an alternate display. When this switch is set to the VERT MODE position, each sweep is triggered by the signal being displayed on the CRT. This provides a stable display of two unrelated signals, but does not indicate the time relationship between the signals. In either the LEFT or RIGHT positions of the TRIG SOURCE switch, the two signals are displayed showing true time relationship. However, if the signals are not time-related, the display from the plug-in unit which is not providing a trigger signal will appear unstable on the CRT.

Chopped Mode. The CHOP position of the VERT MODE switch produces a display which is electronically switched between channels at a one-megahertz rate. In general, the CHOP mode provides the best display at sweep rates lower than about 20 milliseconds/division, or whenever dual-trace single-shot phenomena are to be displayed. At faster sweep rates, the chopped switching becomes apparent and may interfere with the display.

Correct internal triggering for the CHOP mode can be obtained in any of the three positions of the TRIG SOURCE switch. When the TRIG SOURCE switch is set to VERT MODE, the internal trigger signals from the vertical plug-in units are algebraically added and the time-base unit is triggered from the resultant signal. Use of the LEFT or RIGHT trigger-source positions triggers the time-base unit on the internal trigger signal from the selected vertical unit only. This allows two time-related signals to be displayed showing true time relationship. However, if the signals are not time-related, the display from the channel which is not providing the trigger signal will appear unstable. The CHOP mode can be used to compare two single-shot, transient, or random signals which occur within the time interval determined by the time-base unit (ten times selected sweep rate). To provide correct triggering, the display which provides the trigger signal must precede the second display in time. Since the signals show true time relationship, time-difference measurements can be made from the display.

Algebraic Addition. The ADD position of the VERT MODE switch can be used to display the sum or difference of two signals, for common-mode rejection to remove an undersired signal, or for DC offset (applying a DC voltage to one channel to offset the DC component of a signal on the other channel). The common-mode rejection ratio between the vertical plug-in compartments of the 7613 is greater than 20:1 at 50 megahertz. The rejection ratio increases to 100:1 at DC.

The overall deflection factor on the CRT in the ADD mode is the resultant of the algebraic addition of the signals from the two vertical plug-in units. It is difficult to determine the voltage amplitude of the resultant display unless the amplitude of the signal applied to one of the plug-in units is known. This is particularly true when the vertical units are set to different deflection factors, since it is not obvious which portion of the display is a result of the signal applied to either plug-in unit. Also, the polarity and repetition rate of the applied signals enters into the calculation.

The following general precautions should be observed to provide the best display when using the ADD mode:

1. Do not exceed the input voltage rating of the plug-in units.

2. Do not apply large signals to the plug-in inputs. A good rule to follow is not to apply a signal which exceeds an equivalent of about eight times the vertical deflection factors. For example, with a vertical deflection factor of 0.5 volt/division, the voltage applied to that plug-in unit should not exceed 4 volts. Larger voltages may result in a distorted display.

3. To ensure the greatest dynamic range in the ADD mode, set the position controls of the plug-in units to a setting which would result in a mid-screen display if viewed in the LEFT or RIGHT positions of the VERT MODE switch.

4. For similar response from each channel, set the plug-in units for the same input coupling.

Trigger Source

The TRIG SOURCE switch allows selection of the internal trigger signal for the time-base unit. For most applications, this switch can be set to the VERT MODE position. This position is the most convenient, since the internal trigger signal is automatically switched as the VERT MODE switch is changed, or as the display is electronically switched between the left vertical and right vertical plug-in units in the ALT position of the VERT MODE switch. It also provides a usable trigger signal in the ADD or CHOP positions of the VERT MODE switch, since the internal trigger signal in these modes is the algebraic sum of the signals applied to the vertical plug-in units. Therefore, the VERT MODE position ensures that the time-base unit receives a trigger signal regardless of the VERT MODE switch setting, without the need to change the trigger source selection.

If correct triggering for the desired display is not obtained in the VERT MODE position, the LEFT or RIGHT positions can be used to obtain the trigger signal from either the left vertical or right vertical plug-in unit. The internal trigger signal is obtained from the selected vertical compartment, whether the plug-in unit in that compartment is selected for display on the CRT or not. If the internal trigger signal is obtained from one of the vertical units, but the other vertical unit is selected for display, the internal trigger signal must be time-related to the displayed signal in order to obtain a triggered (stable) display.

X-Y Operation

For some applications, it is desirable to display one signal versus another (X-Y) rather than against time (internal sweep). The flexibility of the plug-in units available for use with the 7613 provides a means for applying an external signal to the horizontal deflection system for this type of display. Some of the 7B-series time-base units can be operated as amplifiers in addition to their normal use as time-base generators. This feature allows an external signal to provide the horizontal deflection on the CRT. For most of the time-base units with the amplifier function, the X (horizontal) signal can be connected either to an external input connector on the time-base unit or it can be routed to the time-base unit through the internal triggering system (see time-base instruction manual for details). If the latter method is used, the TRIG SOURCE switch must be set so that the X (horizontal) signal is obtained from one of the vertical units and the Y (vertical) signal is obtained from the other vertical unit. The advantages of using the internal trigger system to provide the X signal are that the attenuator switch of the amplifier unit providing the horizontal signal determines the horizontal deflection factor to allow full-range operation. The plug-in units do not have to be moved between compartments when X-Y operation is desired.

Another method of obtaining an X-Y display is to install an amplifier plug-in unit in one of the horizontal plug-in compartments (check amplifier unit gain as given in the plug-in instruction manual to obtain calibrated horizontal deflection factors). This method provides the best X-Y display, particularly if two identical amplifier units are used, since both the X and Y input systems will have the same delay time, gain characteristics, input coupling, etc. For further information on obtaining X-Y displays, see the plug-in unit manuals. Also, the reference books listed under Applications provide information on X-Y measurements and interpreting the resultant lissajous displays.

Intensity Modulation

Intensity (Z-axis) modulation can be used to relate a third item of electrical phenomena to the vertical (Y-axis) and the horizontal (X-axis) coordinates without affecting the waveshape of the displayed signal. The Z-axis modulating signal applied to the CRT circuit changes the intensity of the displayed waveform to provide this type of display. "Gray scale" intensity modulation can be obtained by applying signals which do not completely blank the display. Large amplitude signals of the correct polarity will completely blank the display; the sharpest display is provided by signals with a fast rise and fall. The voltage amplitude required for visible trace modulation depends upon the setting of the INTENSITY control. A two-volt peak-to-peak signal will completely blank the display even at maximum intensity levels. Lower amplitude signals can be used to only change the trace brightness rather than completely blank the display. Negative-going modulating signals increase the display intensity and positive-going modulating signals decrease the display intensity. Useful input frequency range is DC to 10 megahertz (input voltage derating necessary above two megahertz). The maximum input voltage should be limited to 10 volts (DC plus peak AC).

Time markers applied to the EXT Z AXIS input connector provide a direct time reference on the display. With uncalibrated horizontal sweep or external horizontal mode operation, the time markers provide a means of reading time directly from the display. However, if the markers are not time-related to the displayed waveform, a single-sweep display should be used (for internal sweep only) to provide a stable display.

Raster Display

A raster-type display can be used to effectively increase the apparent sweep length. For this type of display, the trace is deflected both vertically and horizontally by sawtooth signals. This is accomplished in the 7613 by installing a 7B-series time-base unit in one of the vertical plug-in compartments. Normally, the time-base unit in the vertical compartment should be set to a slower sweep rate than the time-base unit in the horizontal compartment; the number of horizontal traces in the raster depends upon the ratio between the two sweep rates. Information can be displayed on the raster using several different methods. In the ADD position of the VERT MODE switch, the signal from an amplifier unit can be algebraically added to the vertical deflection. With this method, the vertical signal amplitude on the CRT should not exceed the distance between the horizontal lines of the raster. Another method of displaying information on the raster is to use the EXT Z AXIS input to provide intensity modulation of the display. This type of raster display could be used to provide a television-type display. Complete information on operation using the Z-axis feature is given under Intensity Modulation.

To provide a stable raster display, both time-base units must be correctly triggered. Internal triggering is not provided for the time-base units when they are in the vertical compartments; external triggering must be used. Also, blanking is not provided from the time-base units when they are installed in a vertical compartment. To blank out the retrace portion from the time-base unit in the vertical compartment, special connections must be made from this time-base unit to the blanking network of the 7613. If this mode of operation is desirable, contact your local TEKTRONIX Field Office or representative for specific information on obtaining blanking with the specific time-base unit being used in the vertical compartment.

Calibrator

General. The internal calibrator of the 7613 provides a convenient signal source for checking basic vertical gain and for adjusting probe compensation as described in the probe instruction manual. In addition, the calibrator can be used as a convenient signal source for application to external equipment.

Voltage. The calibrator provides accurate output voltages of 40 millivolts, 0.4 volt, and 4 volts at the three front-panel pin-jack connectors into high-impedance loads. Output resistance is approximately 50 ohms at the 40 mV and 0.4 V pin jacks and approximately 450 ohms at the 4 V pin jack.

Current. A 40-milliampere, one-kilohertz output current is provided when the optional current-loop accessory (TEKTRONIX Part No. 012-0259-00) is connected between the 4 V pin jack and ground. This output can be used to check and calibrate current-measuring probe systems.

Waveshape. The square-wave output signal of the calibrator can be used as a reference waveshape when checking or adjusting the compensation of passive, high-resistance probes. Since the square-wave output from the calibrator has a flat top, any distortion in the displayed waveform is due to the probe compensation. DC voltage output is also available by changing a jumper on the calibrator board; see Fig. 1-5.

Signals Out

Vertical Signal. The VERT SIG OUT connector provides a sample of the vertical deflection signal. The source of the output signal is determined by the TRIG SOURCE switch.

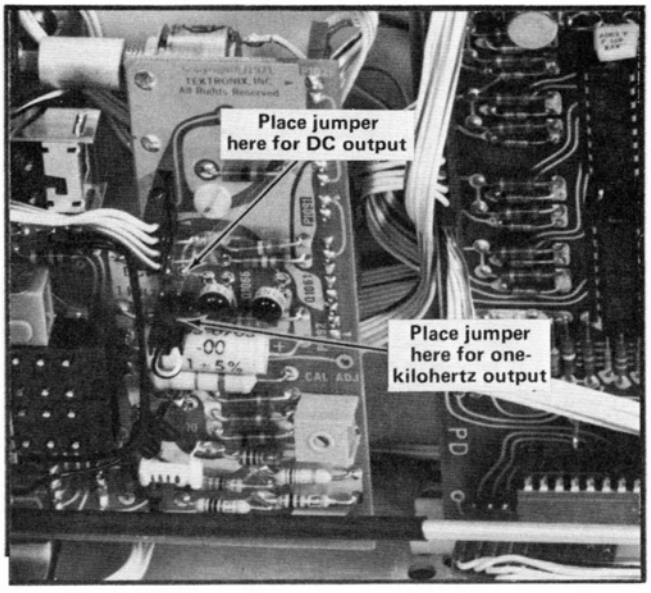

Fig. 1-5. Locations of adjustment and jumper on Calibrator circuit board.

The source will follow the setting of the TRIG SOURCE switch. When the TRIG SOURCE is in the VERT MODE the output will follow the VERTICAL MODE switch. In the CHOP mode the signals are added. The output signals are LEFT, ALT, ADD, and RIGHT. The output signal into 50 ohms is about 25 millivolts/division of the vertical signal displayed on systems CRT. The output signal into 1 megohm is about 0.5 volts/division of the vertical signal displayed on the systems CRT.

+ Gate. The + GATE connector provides a sweep gate signal that is generated by the time base plug-in unit. The gate selector switch provides three gates MAIN, AUXILIARY, and DELAY. The duration of the gate pulse is determined by the respective sweep. Auxiliary and Delay gates can only be produced by dual sweep time-base plug-in units. The amplitude of the gate signal is about 50 millivolts into 50 ohms or 10 volts into 1 megohm.

+ Sawtooth. The SAWTOOTH connector provides a positive going sample of the sawtooth from the time base unit in the horizontal compartment. The rate of rise of the sawtooth signal is about 50 millivolts/unit of time into 50 ohms or 1 volt/unit of time into 1 megohm. Unit of time is determined by the time/division switch of the horizontal plug-in unit.

Applications

The 7613 Oscilloscope and its associated plug-in units provide a very flexible measurement system. The capabilities of the overall system depend mainly upon the plug-in units that are chosen for use with this instrument. Specific applications for the individual plug-in units are described in the plug-in manuals. The overall system can also be used for many applications which are not described in detail either in this manual or in the manuals for the individual plug-in units. Contact your local TEKTRONIX Field Office or representative for assistance in making specific measurements with this instrument.

The following books describe oscilloscope measurement techniques which can be adapted for use with this instrument.

John D. Lenk, "Handbook of Oscilloscopes, Theory, and Application", Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1968.

J. Czech, "Oscilloscope Measuring Techniques", Springer-Verlag, New York, 1965.

J. F. Golding, "Measuring Oscilloscopes", Transatlantic Arts, Inc., 1971.

Charles H. Roth Jr., "Use of the Oscilloscope", A Programmed Text, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1970.

SPECIFICATIONS

Information given in this manual applies to the R7613 Oscilloscope also, unless otherwise indicated. The R7613 is electrically identical to the 7613, but is adapted for mounting in a standard 19-inch rack. Rackmounting instructions and a dimensional drawing for the R7613 are given in Section 3.

This instrument will meet the following electrical specifications after complete calibration as given in Section 3 of the Service manual. The Operating Checkout procedure which is given in Section 1 provides a convenient method of checking instrument performance without making internal checks or adjustments. The following electrical characteristics apply over an ambient temperature range of 0°C to +50°C, except as otherwise indicated. Warmup time for given accuracy is 20 minutes.

NOTE

Many of the measurement capabilities of this instrument are determined by the choice of plug-in units. The following characteristics apply to the 7613 Oscilloscope only. See the System Specification at the end of this section for specifications of the complete system.

TABLE 2-1

VERTICAL DEFLECTION SYSTEM

Characteristic	Performance Requirements	Supplemental Information
Deflection Factor	Compatible with all 7000-series plug-in units.	
Between Compartments	Within 1%.	
Low Frequency Linearity	0.1 division or less compression or expansion of a center-screen 2 division signal when positioned anywhere vertically within the graticule area.	
Bandwidth	See System Specifications for 7600-series instruments.	
Step Response Risetime	See System Specifications for 7600-series instruments.	
Isolation Between Vertical Compartments	At least 100:1 from DC to 100 MHz.	
Delay Line		Permits viewing leading edge of trigger signal.
Chopped Mode		
Repetition Rate	1 MHz within 20%.	
Time Segment From Each Compartment	0.4 to 0.6 μs.	
Difference In Delay Between Vertical Compartments		0.5 ns or less.

TABLE 2-1 (cont)

TRIGGERING

Characteristic	Performance Requirements	Supplemental Information
Vertical Display Modes	LEFT: Left vertical unit only. ALT: Dual trace, alternate between vertical units. ADD: Added algebraically. CHOP: Dual trace, chopped between vertical units. RIGHT: Right vertical unit only.	Selected by VERT MODE switch.
Trigger Source	LEFT VERT: From left vertical only. VERT MODE: Determined by vertical mode switch. RIGHT VERT: From right vertical only.	Selected by TRIGGER SOURCE switch.

HORIZONTAL DEFLECTION SYSTEM

Characteristic	Performance Requirements	Supplemental Information
Fastest Calibrated Sweep Rate	5 ns/division.	
Deflection Factor	Compatible with all 7000-series plug-in units.	
Low Frequency Linearity	0.1 division or less compression or expansion of a center-screen 2 division signal when positioned anywhere horizontally within the graticule area.	
Phase Shift Between The Vertical and Horizontal Amplifiers	Less than 2° from DC to 35 kHz.	
Frequency Response Bandwidth (8 division Reference)	At least 2 MHz.	

CALIBRATOR

Characteristic	Performance Requirements	Supplemental Information
Waveshape	Positive-going squarewave or DC (DC voltage selected by internal jumper).	
Voltage Output Range	40 mV, 0.4 V, and 4 V.	Into 1 MΩ load.
Voltage Output Accuracy		
+15°C to +35°C	Within 1%.	
0°C to +50°C	Within 2%.	
Current Output	40 mA.	
Current Output Accuracy		With optional current loop accessory (012-0259-00) connected between 4 V pin jack and ground pin jack.
+15°C to +35°C	Within 2%.	
0°C to +50°C	Within 3%.	

TABLE 2-1 (cont)

CALIBRATOR (cont)

Characteristic	Performance Requirements	Supplemental Information
Repetition Rate		Approximately 1 kHz.
Output Resistance		
40 mV and 0.4 V		Approximately 50 Ω.
4 V		Approximately 450 Ω.

EXTERNAL Z AXIS INPUT

Characteristic	Performance Requirements	Supplemental Information
Sensitivity	2 V peak to peak provides useful intensity modulation over full intensity range.	
Useful Input Voltage Versus Frequency	2 V peak to peak, DC to 2 MHz; reducing to 0.4 V peak to peak at 10 MHz.	
Polarity of Operation	Positive-going signal decreases intensity.	
Maximum Input Voltage		10 V (DC to peak AC).
Input Resistance		Approximately 500 Ω.

OUTPUTS

Characteristic	Performance Requirements	Supplemental Information
Camera Power (P1041 at CRT Bezel)		
Pin 1 – +15 V		
Pin 3 – single sweep reset		
Pin 5 – ground		

CHARACTER GENERATOR

Characteristic	Performance Requirements	Supplemental Information
Character Size	Adjustable	
Modes of Operation	Free-run independent of sweep	Selected by internal Readout mode switch.
	Triggered after sweep	

DISPLAY (CRT) and OPTIONS

Characteristic	Performance Requirements	Supplemental Information
Cathode Ray Tube Type	T 7420	
Graticule		
Type	Internal and illuminated.	
Area	8 X 10 division.	
Standard Division Size	1 division equals 0.9 cm.	

TABLE 2-1 (cont)

DISPLAY (CRT) and OPTIONS

Characteristic	Performance Requirements	Supplemental Information
Phosphor		
Standard	P31	
Beam Finder		Limits display to within graticule area when BEAM FINDER switch is actuated.
Stored Writing Speed (with 15 sec view time)	At least 5 Div/μs	
Storage View Time Versus Stored Writing Speed		It is necessary to use the STORED INTENSITY (Storage voltage level) control to trade-off Writing Speed and View Time.
(Using MAX PERSISTENCE) with display stored at:		The SAVE mode and increased SAVE TIME settings (reduce view intensity) extend these view times.
5 Div/μs	At least 15 sec	
1 Div/μs	At least 60 sec	

POWER SOURCE

Characteristic	Performance Requirements	Supplemental Information
Line Voltage Ranges		
110 V nominal	100 V ±10%.	
	110 V ±10%.	
	120 V ±10%.	
220 V nominal	200 V ±10%.	
	220 V ±10%.	
	240 V ±10%.	
Line Frequency		50 to 60 Hz.
Maximum Power Consumption (115 V AC; 60 Hz)		7613 170 W, 1.9 A. R7613 180 W, 2 A.
Fuse Data		
110 V line (F1000)		3.2 A slow blow.
220 V line (F1000)		1.6 A slow blow.
+130 V Supply (F855)		0.15 A fast blow.

TABLE 2-1 (cont)

SIGNALS OUT

Characteristic	Performance Requirements	Supplemental Information
VERT SIG OUT	See Systems Specifications for 7600-series instruments.	
Vertical Signals	LEFT, RIGHT, and VERT MODE	Selected by TRIG SOURCE switch.
Gain		
Into 50 Ω		25 mV/division
Into 1 MΩ		0.5 V/division ±20% system CRT to VERT SIG OUT.
Risetime (Into 50 Ω)		5 ns or less.
Aberrations		
Centering		±1 division system CRT to VERT SIG OUT. (1.5 V into 1 MΩ or 75 mV into 50 Ω.)
Output Resistance		950 Ω within 2%.
+GATE OUT		
Gate Signals	MAIN, AUXILIARY, and DELAY.	Selected by Gate Selector switch.
Output		
Into 50 Ω		0.5 V within 10%.
Into 1 MΩ		10 V within 10%.
Risetime (Into 50 Ω)		20 ns or less.
Output Resistance		950 Ω within 2%.
+SAWTOOTH OUT		
Output		
Into 50 Ω		50 mV/unit time[1] within 15%.
Into 1 MΩ		1 V/unit time[1] within 10%.
Output Resistance		950 Ω within 2%.

[1] **Referenced to Time/Div setting.**

TABLE 2-2

ENVIRONMENTAL

Characteristic	Information
NOTE *This instrument will meet the electrical characteristics given in the Performance Requirement column of the Specifications over the following environmental limits.*	
Temperature Range	
Operating	0°C to +50°C.
Non-operating	−55°C to +75°C.
Altitude	
Operating	15,000 ft.
Non-operating	Test limit 50,000 ft.
Electro-magnetic Interference (EMI) as tested in MIL-I-6181D (when equipped with option 3 only)	
Radiated interference	Interference radiated from the instrument under test within the given limits from 150 kilohertz to 1000 megahertz.
Conducted interference	Interference conducted out of the instrument under test through the power cord within the given limits from 150 kilohertz to 25 megahertz.
Transportation (packaged instrument, without plug-ins)	Qualifies under National Safe Transit Committee test procedure 1A, Category II.

TABLE 2-3

PHYSICAL

Characteristic	Information
Ventilation	Safe operating temperature maintained by Forced Air cooling. Automatic resetting thermal cutout protects instrument from overheating.
Finish	Anodized aluminum front panel. Painted cabinet.
7613 Overall Dimensions (measured at maximum points)	
Height	12.0 in (30.4 cm).
Width	8.7 in (23.0 cm).
Length	23.7 in (60.2 cm).
Net Weight (instrument only)	30 lb (13.6 kg).
R7613 Overall Dimensions (measured at maximum points)	
Height	5.25 in (13.4 cm).
Width	19.0 in (48.5 cm).
Length	21.5 in (62.0 cm).
Net Weight (instrument only)	30 lb (13.6 kg).

STANDARD ACCESSORIES

Standard accessories supplied with the 7613 are given in the Mechanical Parts List, in the Service manual. For optional accessories available for use with this instrument, see the Tektronix, Inc., catalog.

TABLE 2-4

7600-SERIES SYSTEM SPECIFICATIONS

Amplifier Plug-In Unit	Vertical System							
				Accuracy			SIG OUT	
	Probe	BW	T_r	EXT CAL 0 to 50°C	INT CAL 15 to 35°C	INT CAL 0 to 50°C	BW	T_r
7A11	Integral	100 MHz	3.5 ns	2%	3%	4%	60 MHz	5.9 ns
7A12	None	85 MHz	4.2 ns	2%	3%	4%	55 MHz	6.4 ns
	P6053			3%	4%	5%	55 MHz	6.4 ns
7A13	None	80 MHz	4.4 ns	1.5%	2.5%	3.5%	55 MHz	6.4 ns
	P6055			1.5%	2.5%	3.5%	45 MHz	7.8 ns
7A14	P6021	50 MHz	7.0 ns	2%	3%	4%	40 MHz	8.8 ns
	P6022	85 MHz	4.2 ns	2%	3%	4%	50 MHz	7.0 ns
7A15A	None	65 MHz	5.4 ns	3%	4%	5%	50 MHz	7.0 ns
	P6053			3%	4%	5%	50 MHz	7.0 ns
7A16	None	100 MHz	3.5 ns	2%	3%	4%	60 MHz	5.9 ns
	P6053			3%	4%	5%	60 MHz	5.9 ns
7A17	None	100 MHz	3.5 ns				15 MHz	24 ns
7A18	None	70 MHz	5.0 ns	2%	3%	4%	50 MHz	7.0 ns
	P6053			3%	4%	5%	50 MHz	7.0 ns
7A19	None or P6051	100 MHz	3.2 ns	2%	3%	4%	65 MHz	5.4 ns
	P6056/ P6057			3%	4%	5%	65 MHz	5.4 ns
7A22	None or Any	1.0 MHz ±10%	350 ns ±9%	2%	3%	4%	1.0 MHz ±10%	350 ns ±9%

Bandwidth and Risetime measured from 0° to +50°C. The bandwidth of a vertical plug-in used in the horizontal compartment is 2 MHz except for the 7A22 which has a bandwidth of 850 kHz. The X-Y phase shift between 2 similar units is 2° at 35 kHz.

TABLE 2-5

TIME BASE PLUG-INS

Time Base	Performance Feature	Max Sweep Rate	Triggering Freq Range
7B50	Delayed Sweep & Ext Amplifier	5 ns/div	DC to 100 MHz
7B51	Delaying Sweep	5 ns/div	DC to 100 MHz
7B52	Delayed & Mixed Sweeps	5 ns/div	DC to 100 MHz
7B53N	Delayed & Mixed Sweeps	5 ns/div	DC to 100 MHz
7B70	Delayed Sweeps & Ext Amplifier	5 ns/div	DC to 200 MHz
7B71	Delaying Sweep	5 ns/div	DC to 200 MHz
7B92	Display Switching	5 ns/div	DC to 250 MHz

TABLE 2-6

SPECIAL PURPOSE and SAMPLING PLUG-INS

Plug-In	Performance Feature
7CT1N	Low Power Semiconductor Curve Tracer
7D13	Measures: Temperature, Voltage, Current, and Resistance
7D14	Directly Gated Counter to 525 MHz
7L12	1 MHz to 1.8 GHz Spectrum Analyzer
7M11	High Quality Dual Delay Line
7S11	Accepts Plug-In Sampling Heads
7S12	TDR and Sampling Applications
7T11	Random or Sequential; Equivalent or Real-Time Sampling

For more complete specifications on plug-in units for the 7600-Series Oscilloscope System, refer to the TEKTRONIX Catalog.

RACKMOUNTING INSTRUCTIONS

Introduction

The 7613 Oscilloscope is designed to be installed in a standard 19-inch wide rack. It can be mounted in racks with Universal, EIA, RETMA, or Western Electric mounting-hole spacing. The following information provides complete rackmounting instructions for this instrument.

Instrument Dimensions

A dimensional drawing showing the major dimensions of the R7613 is shown in Fig. 3-6.

Rack Dimensions

Height. At least 5 1/4 inches of vertical space is required to mount this instrument in a rack. This allows sufficient clearance for adjacent instruments or panels. Additional height may be necessary if an oscilloscope camera system is to be used with this instrument.

Width. Minimum dimension between the front rails of the rack is 17 5/8 inches. This allows room on each side of the instrument for the slide-out tracks to operate freely, permitting the instrument to move in and out of the rack.

Depth. Total depth necessary to mount this instrument in an enclosed cabinet rack is 24 inches. This allows sufficient room for air circulation, power cord and signal connections, and for the necessary mounting hardware.

NOTE

If this instrument is mounted in a shallow rack where the rear mounting brackets must extend behind the instrument, a maximum of 26 inches clearance behind the front rails is required.

The rear mounting brackets supplied allow mounting this instrument in racks which have rear rails spaced between 14 5/8 and 28 1/2 inches from the front rail. Do not mount the R7613 in an installation where it is not correctly supported at the rear, as the instrument may be damaged.

Slide-Out Tracks

The slide-out tracks provided with this instrument permit it to be extended out of the rack for maintenance and calibration without removing it from the rack. To operate this instrument in the extended position, be sure the power cord and any signal cables are long enough for this purpose.

The slide-out tracks consist of two assemblies; one for the left side of the instrument and one for the right side. Fig. 3-1 shows the complete slide-out track assemblies. The stationary section of each assembly attaches to the front and rear rails of the track, and the chassis section is attached to the instrument. The intermediate section slides between the stationary and chassis sections to allow the instrument to be extended out of the rack.

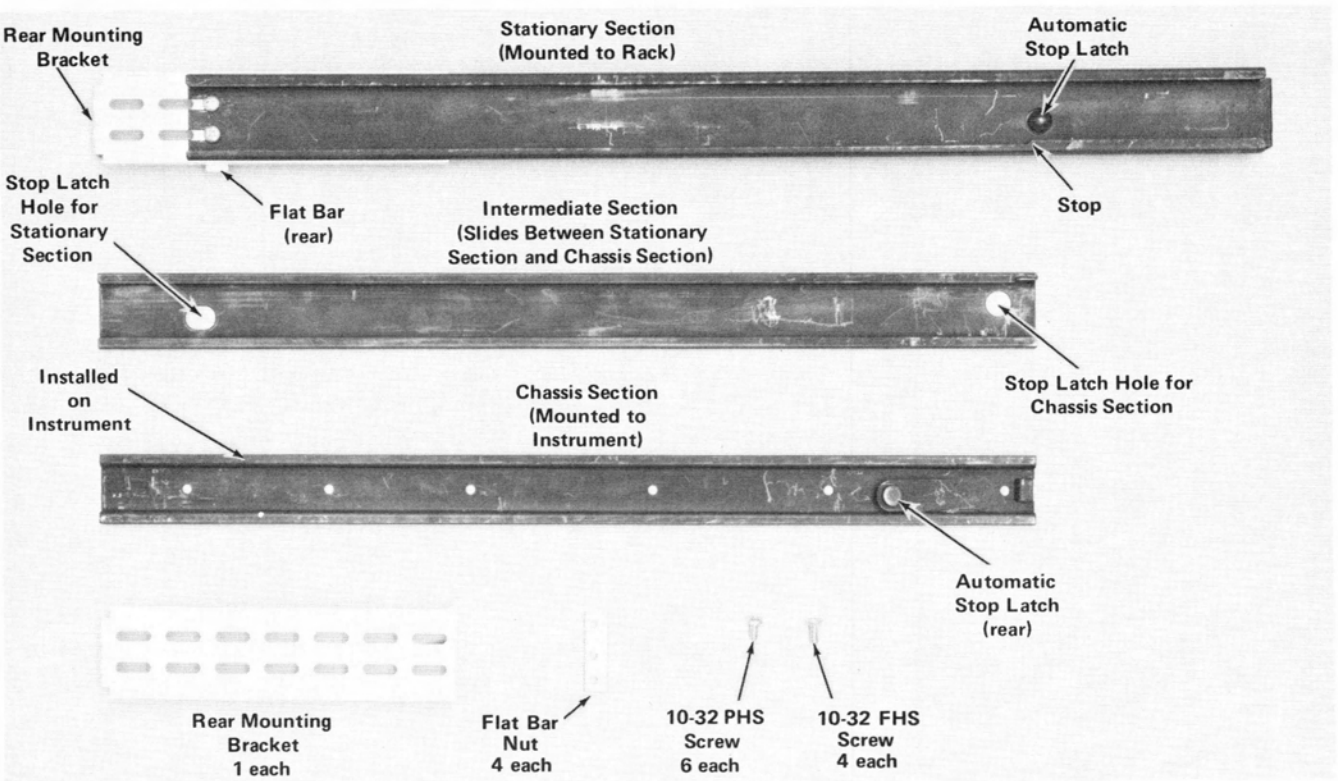

Fig. 3-1. Left side slideout track assemblies, and small hardware components for mounting the stationary sections to the rack rails.

The hardware needed to mount the slide-out tracks to the rack is shown in Fig. 3-1. Since the hardware supplied is intended to make the tracks compatible with a variety of cabinet racks and installation methods, not all of it will be needed for this installation. Use only the hardware that is required for the mounting method used.

Mounting Procedure

Use the following procedure to install this instrument in a rack:

1. Select the proper front-rail mounting holes for the stationary sections using the measurements shown in Fig. 3-2.

2. Mount the front-flanges of the stationary sections to the front rails of the rack with a bar nut and two pan-head screws (see Fig. 3-3A).

NOTE

If the rails of the rack are tapped, drill out these three holes with a 0.196-inch drill.

3. Mount the rear of the stationary sections to the rear rails using the method shown in either Fig. 3-3B or 3-3C. Be sure the tracks are mounted level.

4. Refer to Fig. 3-4 to install the instrument into the rack.

5. Follow the procedure given in Fig. 3-5 to adjust the alignment of the stationary sections.

6. After the tracks operate smoothly, connect the power cord to the power source and connect any necessary cables to the rear panel connectors.

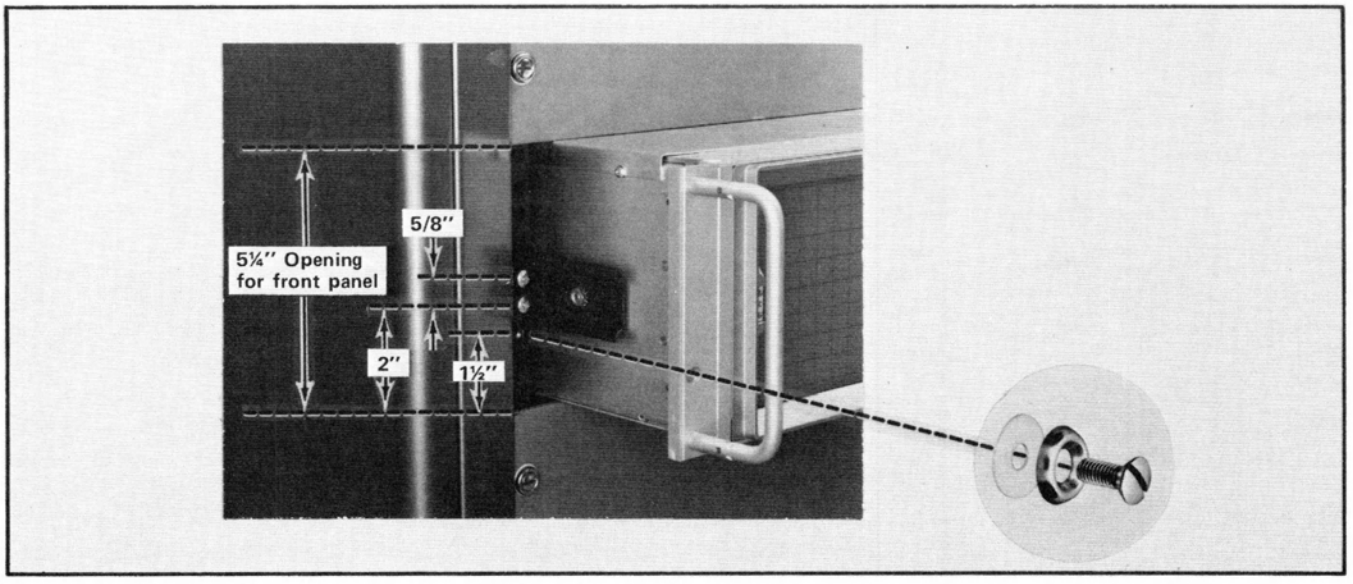

Fig. 3-2. Vertical mounting position of the left stationary section and location of the thumb screw securing hole. These same dimensions apply to the right front rail.

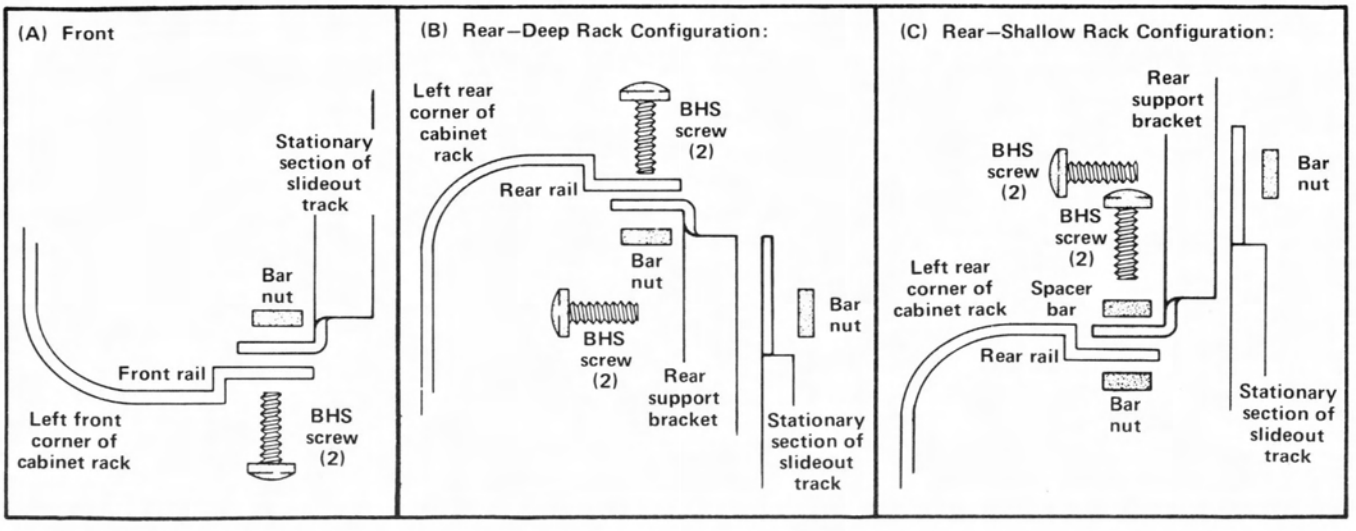

Fig. 3-3. Details for mounting stationary sections.

7. Push the instrument all the way into the rack and secure it to the front-rail of the rack with the securing screws and washers shown in Fig. 3-2. If the securing hole is not tapped, use a "speed-nut" or similar item to install the securing screws.

Removing or Installing the Instrument

After initial installation and adjustment of the slide-out tracks, the instrument can be removed or installed by following the instructions given in Fig. 3-4. No further adjustments are required under normal conditions.

Slide-Out Track Lubrication

The special finish on the sliding surfaces of the slide-out tracks provides permanent lubrication. However, if the tracks do not slide smoothly even after proper adjustment, a thin coating of paraffin can be rubbed onto the sliding surfaces for additional lubrication.

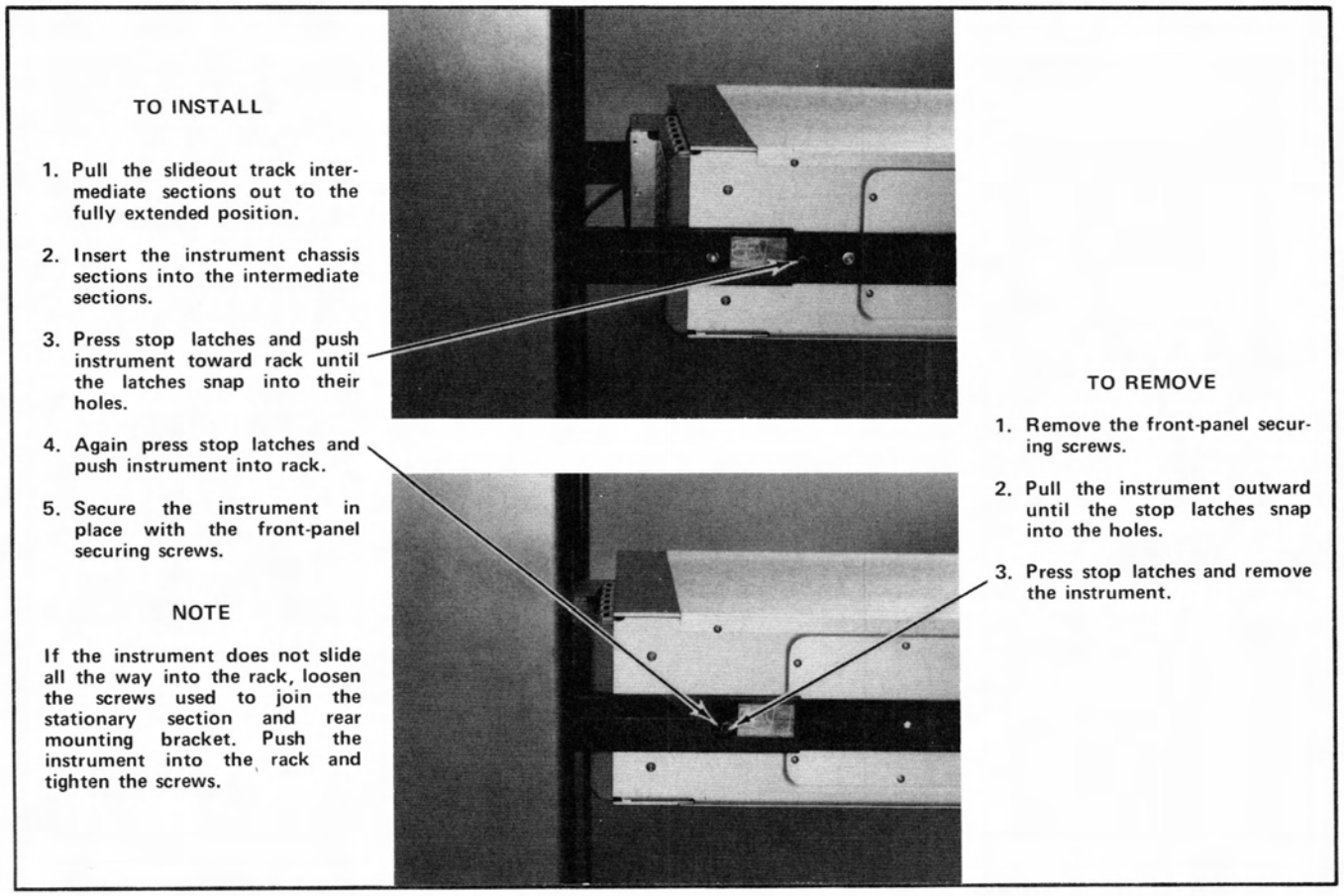

Fig. 3-4. Installing and removing the instrument.

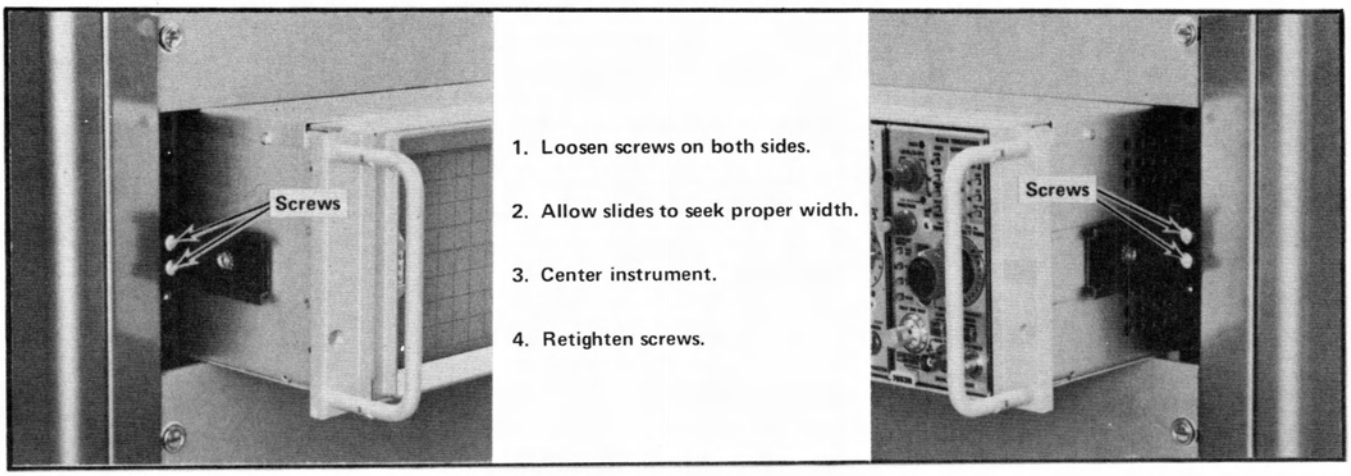

Fig. 3-5. Adjusting the slide-out tracks for smooth sliding action.

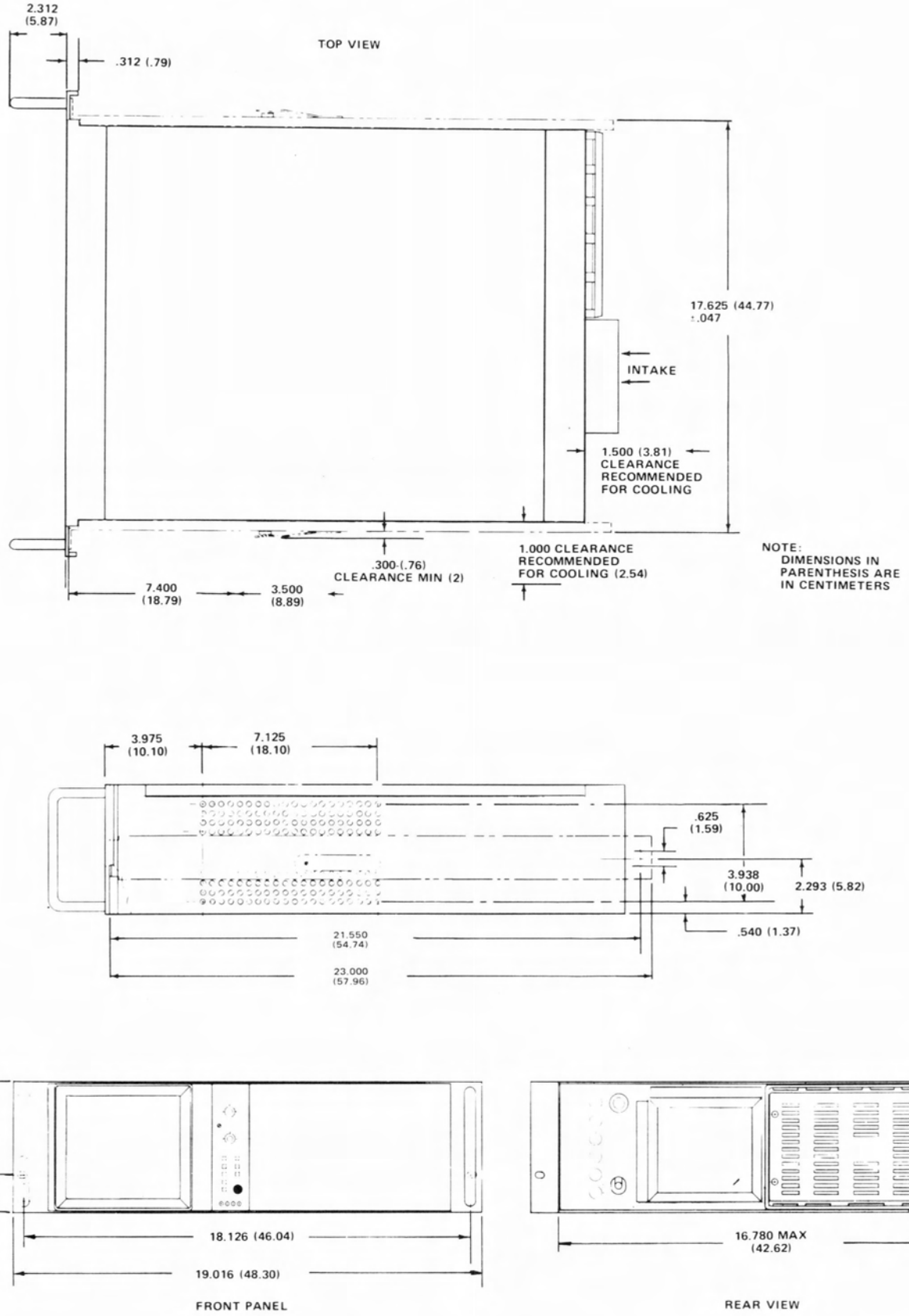

Fig. 3-6. Dimensional drawing.

MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Since the change information sheets are carried in the manual until all changes are permanently entered, some duplication may occur. If no such change pages appear following this page, your manual is correct as printed.

SERVICE NOTE

Because of the universal parts procurement problem, some electrical parts in your instrument may be different from those described in the Replaceable Electrical Parts List. The parts used will in no way alter or compromise the performance or reliability of this instrument. They are installed when necessary to ensure prompt delivery to the customer. Order replacement parts from the Replaceable Electrical Parts List.

CALIBRATION TEST EQUIPMENT REPLACEMENT

Calibration Test Equipment Chart

This chart compares TM 500 product performance to that of older Tektronix equipment. Only those characteristics where significant specification differences occur, are listed. In some cases the new instrument may not be a total functional replacement. Additional support instrumentation may be needed or a change in calibration procedure may be necessary.

Comparison of Main Characteristics

DM 501 replaces 7D13		
PG 501 replaces 107	PG 501 - Risetime less than 3.5 ns into 50 Ω.	107 - Risetime less than 3.0 ns into 50 Ω.
108	PG 501 - 5 V output pulse; 3.5 ns Risetime.	108 - 10 V output pulse; 1 ns Risetime.
111	PG 501 - Risetime less than 3.5 ns; 8 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger Pulse delay.
114	PG 501 - ±5 V output.	114 - ±10 V output. Short proof output.
115	PG 501 - Does not have Paired, Burst, Gated, or Delayed pulse mode; ±5 V dc Offset. Has ±5 V output.	115 - Paired, Burst, Gated, and Delayed pulse mode; ±10 V output. Short-proof output.
PG 502 replaces 107		
108	PG 502 - 5 V output	108 - 10 V output.
111	PG 502 - Risetime less than 1 ns; 10 ns Pretrigger pulse delay.	111 - Risetime 0.5 ns; 30 to 250 ns Pretrigger pulse delay.
114	PG 502 - ±5 V output	114 - ±10 V output. Short proof output.
115	PG 502 - Does not have Paired, Burst, Gated, Delayed & Undelayed pulse mode; Has ±5 V output.	115 - Paired, Burst, Gated, Delayed & Undelayed pulse mode; ±10 V output. Short-proof output.
2101	PG 502 - Does not have Paired or Delayed pulse. Has ±5 V output.	2101 - Paired and Delayed pulse; 10 V output.
PG 506 replaces 106	PG 506 - Positive-going trigger output signal at least 1 V; High Amplitude output, 60 V.	106 - Positive and Negative-going trigger output signal, 50 ns and 1 V; High Amplitude output, 100 V.
067-0502-01	PG 506 - Does not have chopped feature.	0502-01 - Comparator output can be alternately chopped to a reference voltage.
SG 503 replaces 190, 190A, 190B	SG 503 - Amplitude range 5 mV to 5.5 V p-p.	190B - Amplitude range 40 mV to 10 V p-p.
191	SG 503 - Frequency range 250 kHz to 250 MHz.	191 - Frequency range 350 kHz to 100 MHz.
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
TG 501 replaces 180, 180A	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Marker outputs, 5 sec to 1 μs. Sinewave available at 20, 10, and 2 ns. Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns.	181 - Marker outputs, 1, 10, 100, 1000, and 10,000 μs, plus 10 ns sinewave.
184	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Marker outputs, 5 sec to 2 ns. Sinewave available at 50, 20, 10, 5, and 2 ns. Separate trigger pulses of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs. Marker amplifier provides positive or negative time marks of 25 V min. Marker intervals of 1 and .1 sec; 10, 1, and .1 ms; 10 and 1 μs.
2901	TG 501 - Marker outputs, 5 sec to 1 ns. Sinewave available at 5, 2, and 1 ns. Trigger output - slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - Marker outputs, 5 sec to 0.1 μs. Sinewave available to 50, 10, and 5 ns. Separate trigger pulses, from 5 sec to 0.1 μs. Multiple time-marks can be generated simultaneously.

NOTE: All TM 500 generator outputs are short-proof. All TM 500 plug-in instruments require TM 500-Series Power Module.

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