TEKTRONIX®

7313/R7313 OSCILLOSCOPE

WITH OPTIONS

OPERATORS

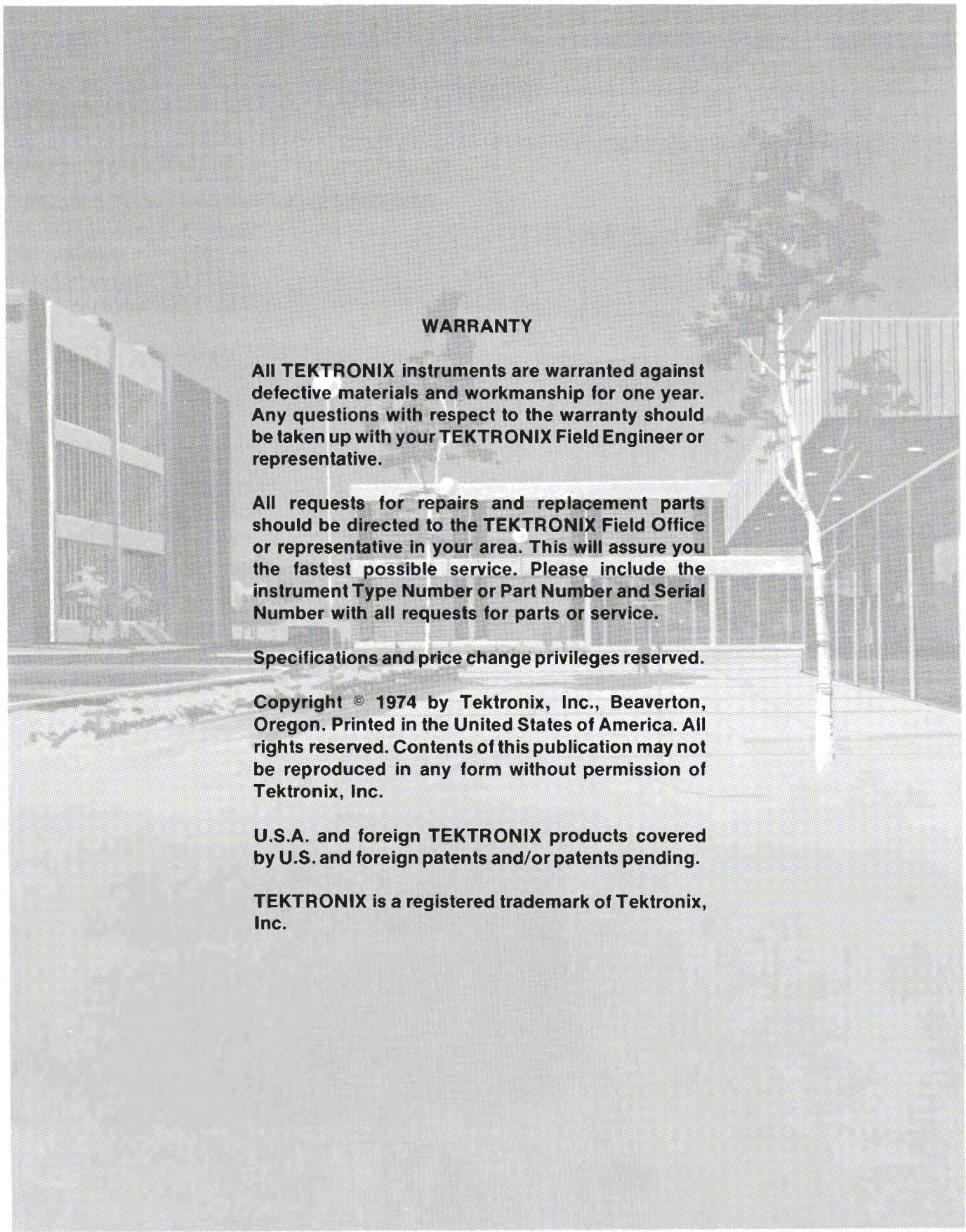
INSTRUCTION MANUAL

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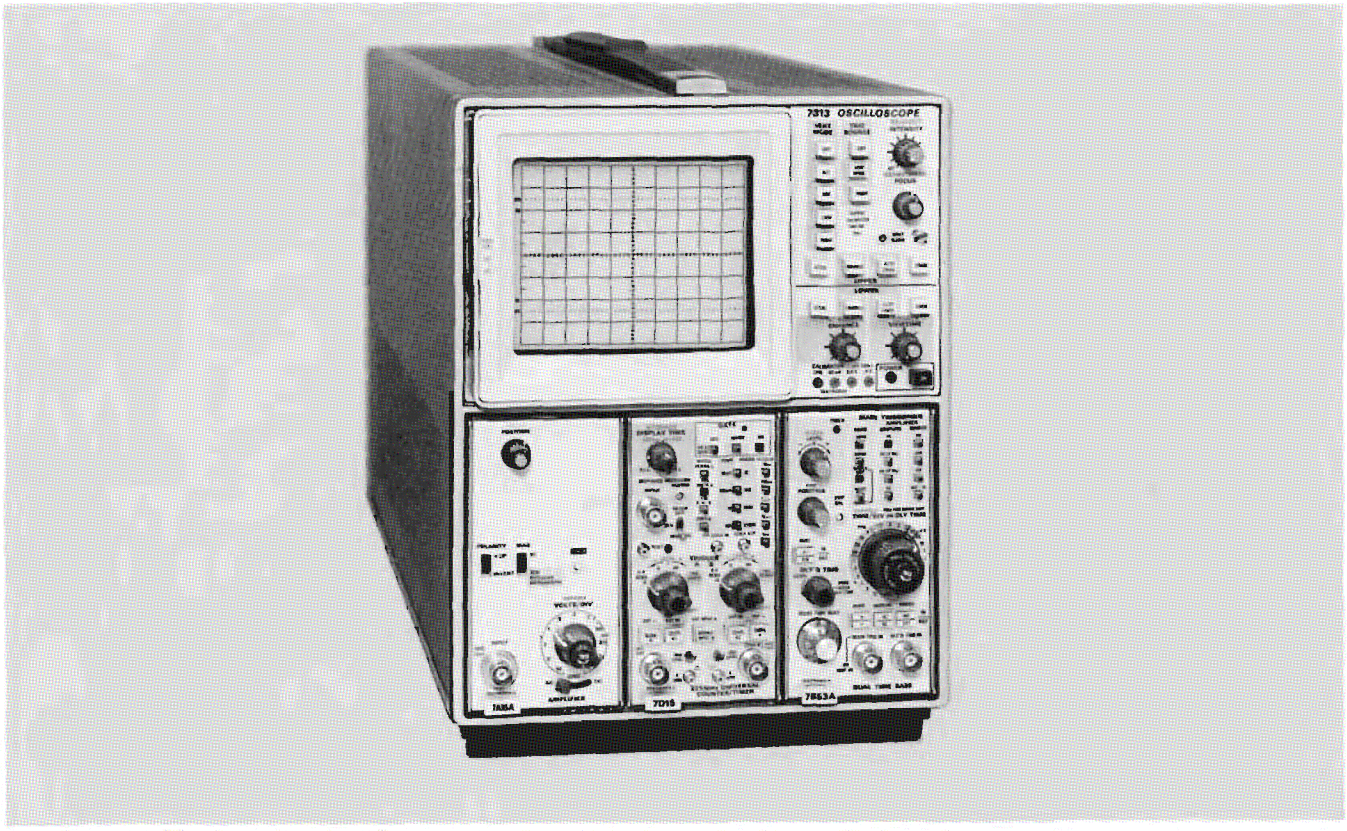
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NOTE

Refer to the 7313/R7313 Service manual for circuit description, maintenance, calibration, diagrams, and parts replacement information.



7313/R7313 FEATURES

The Tektronix 7313/R7313 Oscilloscope is a solid-state instrument designed for general-purpose application where display storage is desired along with high performance conventional (non-store) operation. This instrument has three plug-in compartments that accept Tektronix 7-Series plug-in units to form a complete measurement system. The two plug-in compartments on the left are connected to the vertical deflection system. The right plug-in compartment is connected to the horizontal deflection system. Electronic switching between the vertical plug-in compartments allow a multi-trace vertical display. The flexibility of this plug-in feature and the variety of plug-in units available allow this system to be used for many applications.

The cathode ray tube is a direct view, bi-stable storage tube having an 8 x 10 division display area divided into two 4 x 10 division storage screens. The storage screens are independently controlled for split screen applications. A non-storing area to the left of the storage screens permits beam location without disturbing a stored display. Regulated dc power supplies assure that performance is not affected by variations in line voltage and frequency, or by changes in load due to varying power requirements of the plug-in units. The 7313/R7313 operates from a 115 volt or a 230 volt nominal line voltage source.



OPERATING INSTRUCTIONS

To effectively use the 7313/R7313 Oscilloscope, the operation and capabilities of the instrument must be known. This section describes the operation of controls and connectors and gives basic and general operating information.

PRELIMINARY OPERATION

SAFETY INFORMATION

This instruction manual contains informative and warning text which the user must follow to ensure safe operation and to retain the instrument in safe condition.

AC POWER SOURCES. This instrument is intended to be operated from a single-phase earth-reference 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 as shown in Table 1-1.

Power Cord Conductor Identification

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

OPERATING VOLTAGE

The 7313/R7313 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. Use the following procedure to obtain correct instrument operation from the line voltage available:

1. Disconnect the instrument from the power source.

2. To gain access to the voltage selector jumper, perform the applicable procedure which follows:

7313. Remove three screws from each side of the power unit. Slide the power unit out of the rear of the chassis (see Fig. 1-1).

R7313. Remove the top cover and remove the power unit from the rear of the instrument. See Power Unit Removal in the Maintenance section.

CAUTION

This instrument may be damaged if operated with the Line Selector set to the incorrect positions for the line voltage applied.

3. 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 the pins adjacent to voltage selector area (see Fig. 1-1). 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 rear-panel 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 for location and Table 1-2 for fuse type). Also change the line-cord plug to match the power-source receptacle or use a suitable adapter.

4. To convert the instrument from one regulating range to another, remove the voltage selector jumper and reinstall it on the set of pins that represents the desired regulating range. Select a range that is centered about the average line voltage to which the instrument is to be connected (see Table 1-2).

TABLE 1-2

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	3.2 A slow-blow	1.6 A slow-blow

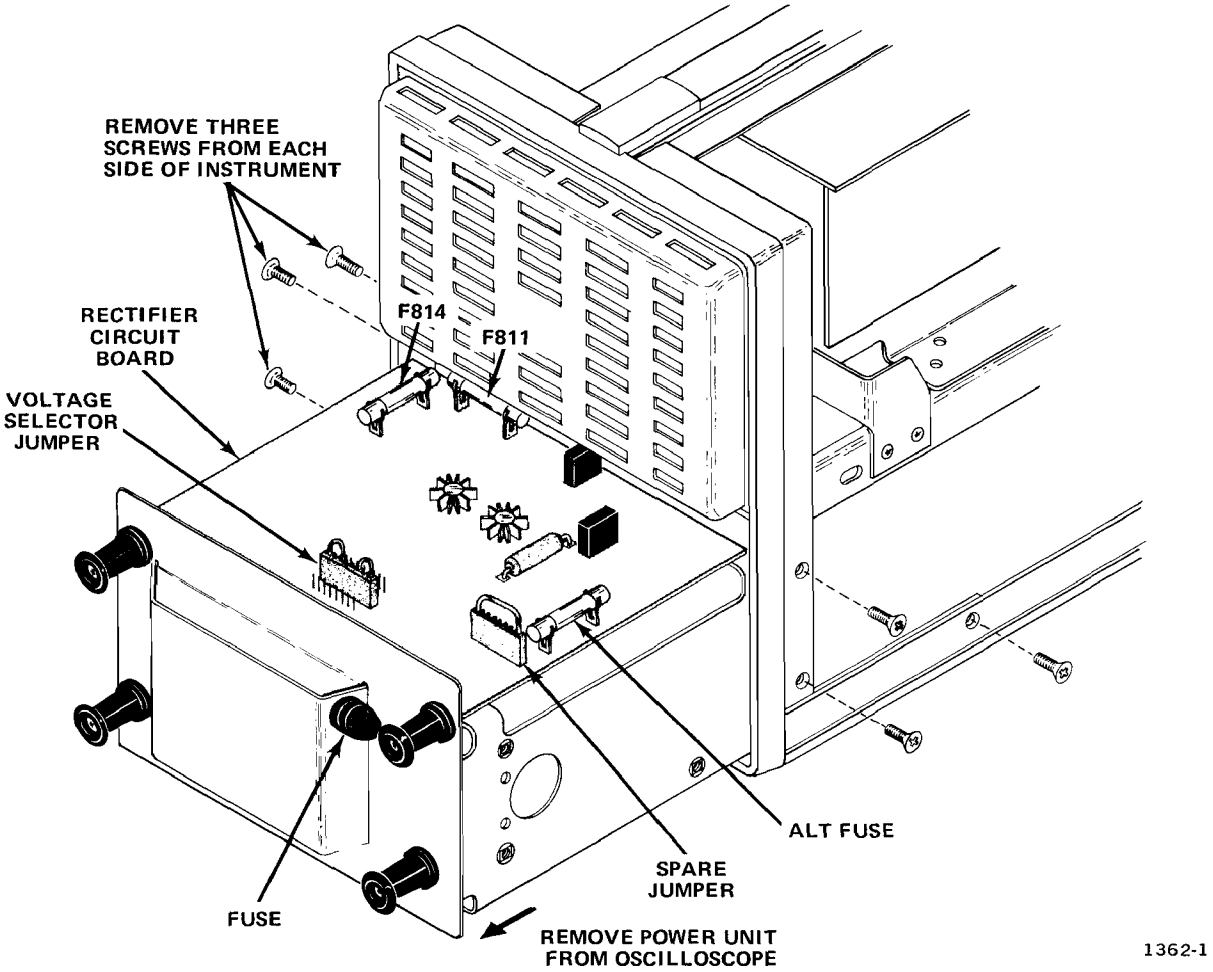


Fig. 1-1. Locations of voltage selector, spare jumper, and alternate fuse in power unit (7313 shown).

PLUG-IN UNITS

The 7313/R7313 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 polarity, sensitivity, display mode, etc. to meet the measurement requirements. In addition, it allows the oscilloscope system to be expaned 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. Refer to the Tektronix Products catalog for specifications of plug-in units currently available.

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.

All of the plug-in compartments do not have to be filled to operate the instrument; the only plug-ins needed are those required for the measurement to be made. At environmental extremes, excess interference may be radiated into or out of the instrument through the plug-in compartments. To reduce such interference, or to meet EMI specifications on factory equipped Option 3 or field EMI modified instruments, all unused plug-in compartments must be covered with an EMI shielded blank plug-in panel. Order or use only Tektronix Part No. 016-0155-00. One is required for each unused compartment.

When the 7313/R7313 is calibrated in accordance with the calibration procedure given in the service manual, the vertical and horizontal gains are normalized. 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.

The plug-in versatility of the 7313/R7313 allows a variety of display modes with many different plug-in units. The following information is provided to aid in plug-in unit selection.

To produce a single-trace display, install a single-channel vertical unit (or dual-channel unit set for single-channel operation) in either of the vertical compartments; for dual-trace displays, either install a dual-channel vertical unit in one of the vertical compartments or install a single-channel vertical unit in each vertical compartment. A combination of a single-channel and dual-channel vertical unit allows a three-trace display; likewise, a combination of two dual-channel vertical units allows a four-trace display.

Non-delayed single-trace displays can be obtained with a single-trace time-base unit. A dual-trace time-base unit must be used for delayed-sweep displays.

X-Y displays can be obtained in two ways with the 7313/R7313 system. If a 7B-series time-base unit is available that has an amplifier feature, the X signal can either be routed through one of the vertical units via the internal-trigger pickoff circuitry to the horizontal system, or connected to the external horizontal input connector of the time-base unit. Then, the vertical signal (Y) is connected to the remaining vertical unit. Also, a 7A-series amplifier plug-in can be installed in one of the horizontal compartments for X-Y operation.

Special purpose plug-ins may have specific restrictions regarding the plug-in compartments in which they can be installed. This information will be given in the instruction manuals for these plug-ins. Refer to the Tektronix Products catalog for additional information on plug-in unit selection.

NOTE

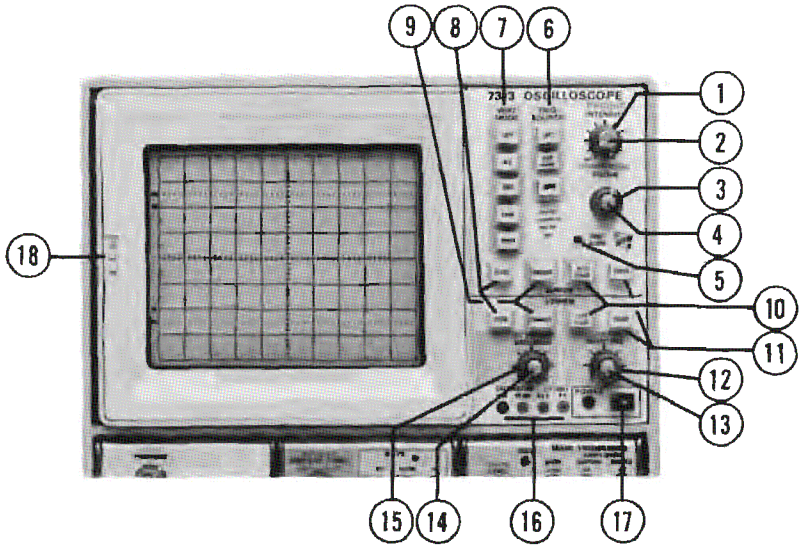
Later production of rackmount ocilloscopes are provided with support posts between the individual plug-in compartments. A post or posts must be removed if a multi-width plug-in is to be installed. To remove a post, unfasten the screws that secure it at the top and bottom of the plug-in housing.

CONTROLS AND CONNECTORS

EXTERNAL

The major controls and connectors for operation of the 7313/R7313 are located on the front panel of the instrument and several auxiliary functions are provided on the rear panel. Fig. 1-2 provides a brief description of the front-panel controls and connectors and Fig. 1-3 provides a brief description of the rear-panel controls and connectors. More detailed information is given under General Operating Information.

1362-2



(1) INTENSITY. Varies brightness of crt display.

(2) READOUT. Varies brightness of readout portion of crt display.

(3) FOCUS. Provides optimum display definition.

(4) BEAMFINDER. Returns crt display by compressing vertical and horizontal deflection within graticule area.

(5) GRAT ILLUM. Varies graticule illumination.

(6) TRIG SOURCE. Selects source of trigger signal for time-base unit.

(7) VERT MODE. Selects vertical plug-in compartment that provides vertical deflection signal.

(8) STORE (UPPER and LOWER). Selects storage operation.

(9) ENHANCE (UPPER and LOWER). Increases writing rate for storage of single sweep displays.

(10) AUTO ERASE (UPPER and LOWER). Stores the crt display at the end of each sweep and inhibits further sweeps for a time selected by the VIEW TIME control.

(11) ERASE (UPPER and LOWER). Manually erases stored display.

(12) VIEW TIME. Determines variable viewing interval of stored display.

(13) LOCATE. Pushbutton switch unblanks the crt to provide an indication of the sweep starting point.

(14) INTEGRATE. Permits storage of very fast repetitive signals.

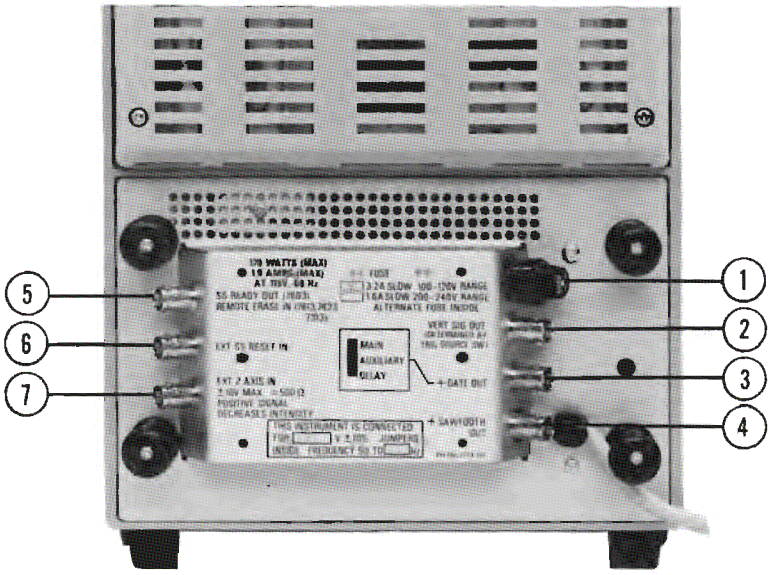
(15) ENHANCE Level (Level not labeled). Provides a selectable increase in writing speed for single sweep displays.

(16) CALIBRATOR. Pin jacks provide 4 V, 0.4 V, and 40 mV outputs at a one kilohertz repetition rate. Dc output can be selected by an internal selector.

(17) POWER. POWER switch controls power to the instrument; POWER light indicates that the power switch is on and the instrument is connected to the power source.

(18) Camera Power (not labeled). Provides power output and receives remote single sweep reset for compatible camera systems.

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



(1) FUSE. Line voltage fuse for instrument.

(2) VERT SIG OUT (Delete with Option 7). Vertical signal selected by TRIG SOURCE and VERT MODE switches (Left, Right, Alt, and Add).

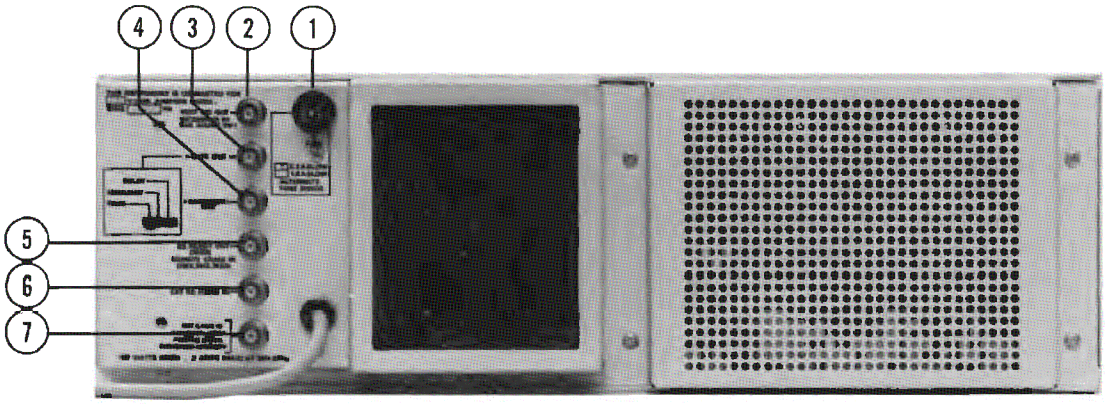
(3) +GATE OUT (Delete with Option 7). Gate signal selected by rear-panel gate selector switch (MAIN, AUXILIARY, and DELAY).

(4) + SAWTOOTH OUT (Delete with Option 7). Positive-going sawtooth signal from time-base unit.

(5) REMOTE ERASE IN (Delete with Option 7). Provides input for an external signal to erase the stored display.

(6) EXT SS RESET IN (Delete with Option 7). Provides input for an external signal to reset the sweep (Time-base unit operating in Single Sweep mode).

(7) EXT Z AXIS IN. Input for intensity modulation of crt display.



1362-3

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

INTERNAL

Several switch functions are located on circuit boards within the instrument. A brief description of each internal switch is given in the following discussion.

REMOTE ERASE SELECTOR. Internal multi-pin connector (located on Storage Switch circuit board) to determine whether the external signal, applied to the REMOTE ERASE IN connector, erases the upper storage screen, lower storage screen, or both storage screens. See Fig. 1-4 for further information.

CALIBRATOR SELECTOR. Internal multi-pin connector (located on the Calibrator circuit board) to determine whether the CALIBRATOR output is a one-kilohertz square-wave signal or a dc voltage level. See Fig. 1-4 for further information.

READOUT MODE SWITCH. Two-position switch (located on the Readout circuit board) to determine whether the readout display is present independent of a sweep (free runs) or is triggered at the end of each sweep. See Fig. 1-4 for further information.

VOLTAGE SELECTOR. Multi-pin connector selects Low, Medium, or High voltage regulating range. The multi-pin connector can be exchanged to select 110-volt or 220-volt nominal line voltage source. See Fig. 1-1 and Preliminary Operation, in this section, for further information.

FAMILIARIZATION PROCEDURE

The following procedure may be used for familiarization with the 7313/R7313 or as a check of basic instrument operation. If performance of the Familiarization Procedure reveals improper calibration or instrument malfunction, first check the operation of the associated plug-in units; then refer to the Calibration and Maintenance sections of the 7313/R7313 Service Manual.

A Set-Up Status summary, preceding each major section of the Familiarization Procedure, provides the settings of controls and lists the signals connected at that point in the procedure.

SET-UP INFORMATION

1. Set the front-panel controls as follows:

INTENSITY	Midrange
FOCUS	Midrange
READOUT	OFF (counterclockwise into switch detent)
GRAT ILLUM (screwdriver adjustment)	Counterclockwise
VERT MODE	LEFT
TRIG SOURCE	VERT MODE
STORE (UPPER and LOWER)	Off (push button out)
ENHANCE (UPPER and LOWER)	Off (push button out)
AUTO ERASE (UPPER and LOWER)	Off (push button out)

2. Connect the 7313/R7313 to a power source that meets the voltage and frequency requirements of the instrument. If the available line voltage is outside the limits of the Voltage Selector, see Operating Voltage discussion in this section.

3. Insert Tektronix 7A-series amplifier units into both the Left Vertical and Right Vertical compartments. Insert a 7B-series dual time-base unit into the Horizontal compartment.

4. Turn the POWER switch ON. Allow several minutes warm-up so that the instrument reaches a normal operating temperature before proceeding.

5. Connect a BNC-to-pin-jack cable from the 4 V CALIBRATOR output to the amplifier unit installed in the Left Vertical compartment.

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

7. Set the time-base unit in the Horizontal compartment for a sweep rate of one millisecond/division. Set the triggering for the auto mode, internal source, ac coupling, and adjust for a stable display. Position the display as necessary.

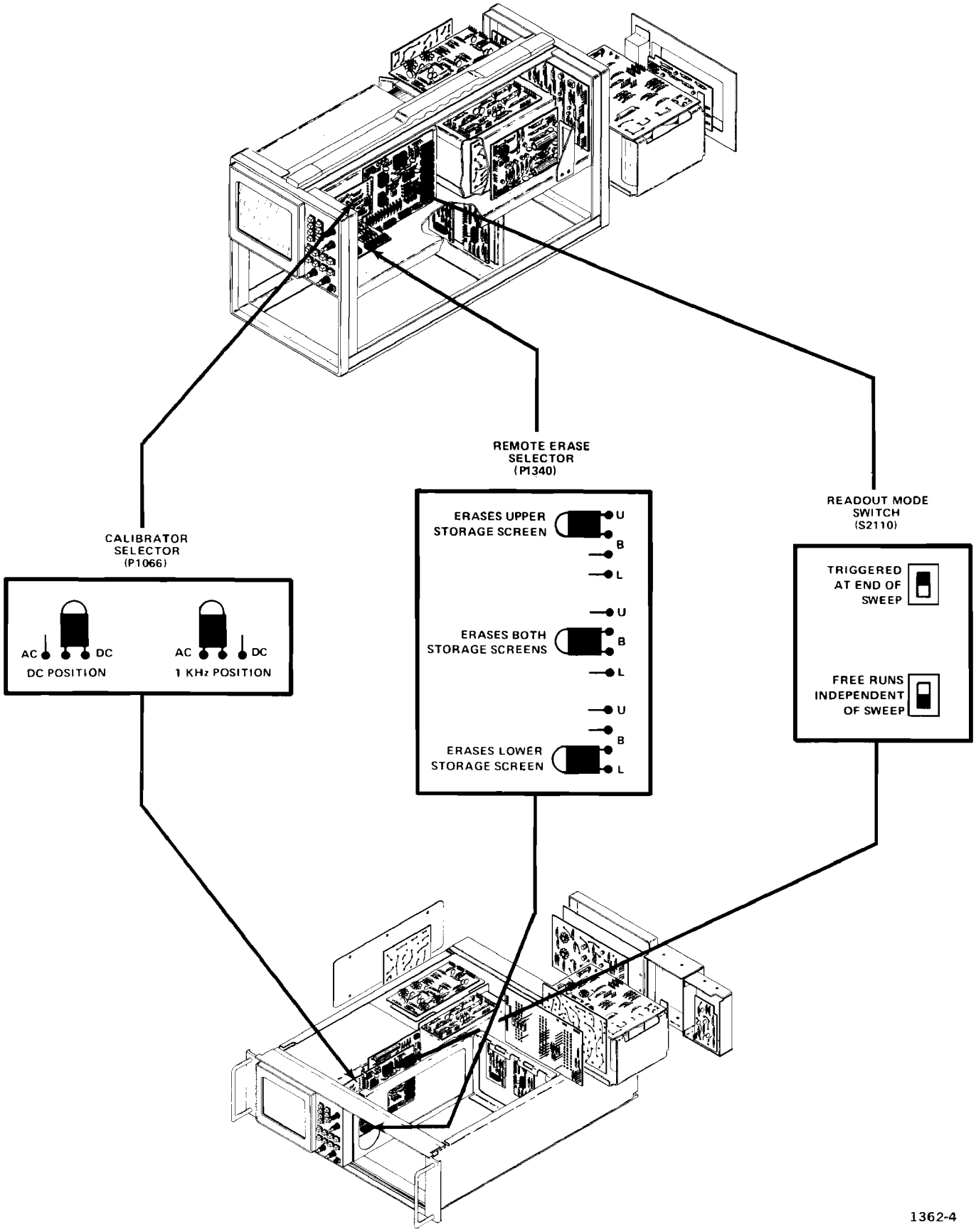


Fig. 1-4. Location and function of internal selectors.

DISPLAY CONTROLS

8. Adjust the INTENSITY control throughout its range; then adjust so that the trace is at the desired viewing level.

9. Adjust the FOCUS control so the top and bottom of the displayed square wave are as thin as possible but not elongated.

NOTE

The oscilloscope system contains circuitry to automatically protect the crt against damage due to excessive crt beam current. If the intensity control is set to a point where crt phosphor damage could occur, these circuits limit the beam current to a safe level. The circuit action will also cause the trace to defocus (widen), which indicates that the INTENSITY should be reduced. Therefore, if the FOCUS adjustment cannot be made satisfactorily, reduce the INTENSITY and repeat step 9.

10. Rotate the GRAT ILLUM screwdriver control throughout its range and notice that the graticule lines are illuminated as the control is turned clockwise. Set the control so that the graticule lines are illuminated as desired.

11. Set the deflection factor of the Left Vertical plug-in unit to 0.1 volt/division. Notice that a square-wave display is not visible, since the deflection exceeds the scan area of crt.

12. Press the BEAMFINDER. Notice that the display is returned to the viewing area in a compressed form. Release the BEAMFINDER switch and notice that the display again disappears from the viewing area.

13. With the BEAMFINDER switch pressed in, increase the deflection factor of the Left Vertical unit until the display is reduced to about two divisions vertically. Adjust the Left Vertical unit position control to center the compressed display about the center of the graticule. Release the BEAMFINDER and notice that the display remains within the viewing area.

NOTE

Readout operation steps apply only when the 7313/R7313 and the plug-in units installed in the 7313/R7313 are equipped with a Readout System. 7313/R7313 Oscilloscopes with Option 1 do not contain a Readout System.

14. Turn the READOUT control clockwise (out of switch detent) until an alphanumeric display is visible within the top or bottom division of the crt. Change the deflection factor of vertical unit that is selected for display. Notice that the readout portion of the display changes as the deflection factor is changed. Likewise, change the sweep rate of the time-base unit and notice that the readout display for the time-base unit changes as the sweep rate is changed.

15. Sequentially select all of the VERT MODE push buttons. Notice that the readout from a particular plug-in unit occupies a specific location on the display area. If either of the plug-in units is a dual unit, notice that the readout for channel 2 appears within the lower division of the crt. Return the VERT MODE switch to LEFT.

16. Set the time-base unit for magnified operation. Notice that the readout display changes to indicate the correct magnified sweep rate. If a readout-encoded 10X probe is available for use with the vertical unit, install it on the input connector of the Right Vertical plug-in unit and set the VERT MODE switch to RIGHT. Notice that the deflection factor indicated by the readout is increased by 10 times when the probe is added. Return the time-base unit to normal sweep operation and disconnect the 10X probe.

17. Switch the vertical and horizontal unit deflection switches (Volts/Div, Time/Div) to the uncalibrated position. Notice the > symbol that precedes the readout display. Return the vertical and horizontal unit deflection switches to the calibrated position.

VERTICAL AND HORIZONTAL SYSTEM CONTROLS

Set the 7313/R7313 controls as follows:

INTENSITY	As desired
FOCUS	As desired
READOUT	As desired
GRAT ILLUM (screwdriver adjustment)	As desired
VERT MODE	ALT
TRIG SOURCE	VERT MODE
STORE (UPPER and LOWER)	Off (push button out)
ENHANCE (UPPER and LOWER)	Off (push button out)
AUTO ERASE (UPPER and LOWER)	Off (push button out)
CALIBRATOR	4 V output connected to the Left Vertical and Right Vertical units with a BNC-to-pin-jack cable and a BNC-to-BNC jumper lead.

Set the associated equipment as follows:

Left Vertical unit	Deflection factor, 2 V/Div; position, centered in the top half of the graticule; input coupling ac.
Right Vertical unit	Deflection factor, 2 V/Div; position, centered in the bottom half of the graticule; input coupling, ac.
Horizontal unit	Deflection factor, 1 ms; triggering, auto mode, ac coupling, internal source, level adjusted for stable display.

18. Set the VERT MODE switch to LEFT. Rotate the position controls of the Left and Right Vertical units and notice that the position control of only the Left Vertical unit has any affect on the vertical position of the displayed trace.

19. Select the RIGHT VERT MODE. Notice that only the position control of the Right Vertical unit has any affect on the vertical position of the displayed trace.

20. Select the ALT VERT MODE. Notice that two traces are displayed on the crt. The upper trace is produced by the Left Vertical unit and the lower trace is produced by the Right Vertical unit. Change the sweep rate of the time-base unit to 50 millisecond/division. Notice that the display alternates between the Left Vertical and Right Vertical plug-in units after each sweep. Return the sweep rate to one millisecond/division.

21. Select the CHOP VERT MODE. Notice that two traces are displayed on the crt. Both vertical units are displayed on each sweep on a time-sharing basis.

22. Select the ADD VERT MODE. Check for an added display approximately four divisions in amplitude. Notice that the position control of either vertical unit will vertically position the added display. Return the VERT MODE switch to LEFT.

CALIBRATOR AND TRIGGERING CONTROLS

Set the 7313/R7313 controls as follows:

INTENSITY	As desired
FOCUS	As desired
READOUT	As desired
GRAT ILLUM (screwdriver adjusment)	As desired
VERT MODE	ALT
TRIG SOURCE	VERT MODE
STORE (UPPER and LOWER)	Off (push button out)
ENHANCE (UPPER and LOWER)	Off (push button out)
AUTO ERASE (UPPER and LOWER)	Off (push button out)
CALIBRATOR	4 V output connected to the Left and Right Vertical units with a BNC-to-pin-jack cable and a BNC-to BNC jumper lead.

Set the associated equipment as follows:

Left Vertical unit	Deflection factor, 2 V/Div; position, Left Vertical unit display centered in the top half of the graticule; input coupling, ac.
Right Vertical unit	Deflection factor, 2 V/Div; position, Right Vertical unit display centered in the bottom half of the graticule; input coupling, ac.
Horizontal unit	Deflection factor, 1 ms; triggering, auto mode, ac coupling, internal source, level adjusted for a stable display.

23. Set the VERT MODE switch to LEFT. Change the CALIBRATOR pin-jacks and notice that 4 V, 0.4 V, and 40 mV outputs can be obtained (change the amplifier unit defection as necessary). The CALIBRATOR output must be terminated in a one-megohm load for stated output. Set The CALIBRATOR pin-jacks for 4 V output and set the amplifier deflection factor to two volts/division.

24. Adjust the time-base unit triggering controls for a stable display. Disconnect the CALIBRATOR signal from the Right Vertical unit. Sequentially select all VERT MODE switch settings. Notice that a stable display is obtained in all positions of the VERT MODE switch (as reference trace is provided in the RIGHT VERT MODE position). Adjust the time-base unit triggering level control as necessary.

25. Set the TRIG SOURCE switch to LEFT. Sequentially select all VERT MODE switching settings. Notice that a stable display is obtained in all positions of the VERT MODE switch (a reference trace is provided in the RIGHT VERT MODE position). Adjust the time-base unit triggering level control as necessary.

26. Set the TRIG SOURCE switch to RIGHT. Sequentially select all VERT MODE switch settings 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.

27. Disconnect the 4 V CALIBRATOR signal from the Left Vertical unit and connect it to the Right Vertical unit. Sequentially select all VERT MODE switch settings. Notice that a stable display is obtained in all VERT MODE switch settings (a reference trace is provided in the LEFT VERT MODE position). Adjust the time-base unit triggering level control as necessary.

28. Set the TRIG SOURCE switch to VERT MODE. Sequentially select all VERT MODE switch settings. Notice that a stable display is obtained in all VERT MODE switch settings (a reference trace is provided in the LEFT VERT MODE position). Adjust the time-base unit triggering level control as necessary.

29. Set the TRIG SOURCE switch to LEFT. Sequentially select all VERT MODE switch settings and notice that a stable display cannot be obtained in any position. This is because there is no signal connected to the Left Vertical unit.

30. Connect the 4 V CALIBRATOR signal to both vertical units. Set the TRIG SOURCE switch to VERT MODE and the VERT MODE switch to ALT. Check that both traces of the alternate display are stable.

31. Set the VERT MODE switch to CHOP and the TRIG SOURCE switch to LEFT and then to RIGHT. Notice that the chopped display can be triggered from either vertical compartment.

STORAGE CONTROLS

Set the 7313/R7313 controls as follows:

INTENSITY	As desired
FOCUS	As desired
READOUT	As desired
GRAT ILLUM (screwdriver adjustment)	As desired
VERT MODE	CHOP
TRIG SOURCE	LEFT
STORE (UPPER and LOWER)	Off (push button out)
ENHANCE (UPPER and LOWER)	Off (push button out)
AUTO ERASE (UPPER and LOWER)	Off (push button out)
CALIBRATOR	4 V output connected to the Left and Right Vertical units with a BNC-to-pin-jack cable to a BNC-to-BNC jumper lead.

Set the associated equipment as follows:

Left Vertical unit	Deflection factor, 2 V/Div; position, Left Vertical unit display centered in the top half of the graticule; input coupling, ac.
Right Vertical unit	Deflection factor, 2 V/Div; position, Right Vertical unit display centered in the bottom half of the graticule; input coupling, ac.
Horizontal unit	Deflection factor, 1 ms; triggering, auto mode, ac coupling, internal source, level adjusted for a stable display.

32. Turn the INTENSITY control fully counterclockwise. Press in both STORE push buttons. Notice the normal storage mode background light level present on the storage screens. Advance the INTENSITY control slowly clockwise to produce a waveform display of normal intensity; then return the INTENSITY control to minimum intensity (fully counterclockwise). Notice a stored waveform of moderate brightness. Press the UPPER ERASE push button and then the LOWER ERASE push button. Notice that each half of the crt display can be erased or stored independently.

33. Set both STORE push buttons to their non-store position (push buttons out). Set the 7313/R7313 and the associated plug-in units for a stable display of normal intensity. Set the time-base unit for single sweep operation and engage both 7313/R7313 STORE push buttons. Apply a single sweep trace by pressing the time-base unit reset push button. Notice a stored display on the UPPER and LOWER storage areas. If the display is not stored, increase the INTENSITY and repeat the demonstration.

34. Press both ERASE push buttons. Press the LOCATE push button and notice dots slightly to the left of the sweep starting point. The LOCATE function is useful to locate and position the trace while the sweep is held off (single sweep operation). Return the time-base unit to a normal triggering mode (non-single sweep), and adjust for a stable display.

35. Engage both AUTO ERASE push buttons. Notice that one sweep is displayed on the crt and further sweeps are locked out until the stored display is erased. Rotate the VIEW TIME control throughout its range and note that this control varies the amount of time that the display remains stored before it is erased.

36. Rotate the VIEW TIME control fully clockwise. As soon as the display is automatically erased and another trace is stored, press both ERASE push buttons. Notice that the crt is erased and other sweeps are locked out during the period selected by the VIEW TIME control. Disengage both AUTO ERASE push buttons and both STORE push buttons (push buttons out).

37. Set the time-base unit time/division switch to 0.2 microseconds/division. Adjust the INTENSITY control fully clockwise. Position the rising portion of the waveform within the graticule area. Adjust the INTENSITY control so that the trace is just visible. Press both STORE push buttons. Notice the normal storage mode background light on the crt. Press the INTEGRATE push button momentarily (a fraction of a second to several seconds is reasonable). Notice a normal fully-stored display. If the trace does not fully store on the first attempt, repeat the integration for a longer period or with higher intensity. Disengage both STORE push buttons and press both ERASE push buttons. Remove the CALIBRATOR signal from both vertical units.

38. Apply a sine-wave signal of approximatley 300 kilohertz to the Left Vertical unit. Set the TRIG SOURCE and VERT MODE switches to LEFT. Adjust the amplifier unit for three divisions of display, centered on the graticule. Adjust the oscilloscope INTENSITY for a moderately bright trace. Set the time-base unit for single sweep operation and engage both 7313/R7313 STORE push buttons. Press the time-base unit reset push button to obtain a single sweep trace. Notice that a complete stored display cannot be obtained at any setting of the INTENSITY control.

39. Press both ERASE push buttons; then press both ENHANCE push buttons. Apply a single sweep trace by pressing the reset push button. While repeatedly erasing and applying a single-sweep signal, adjust the ENHANCE Level control sufficiently clockwise to completely store the display without fading the target positive (it may be necessary to vary the oscilloscope intensity).

GENERAL OPERATING INFORMATION

INTENSITY CONTROLS

The 7313/R7313 has separate intensity controls for display and display readout. The INTENSITY control determines the brightness of only the signal display; the READOUT control determines the brightness of only the readout portion of the crt display.

The setting of the INTENSITY control may affect the correct focus of the display. Slight re-adjustment of the FOCUS control may be necessary when the intensity level is changed. Do not turn the intensity control higher than is necessary to provide a stable display.

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 oscilloscope system 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 slower sweep rates.

CRT 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 crt phosphor.

DISPLAY FOCUS

The FOCUS control allows adjustment for best definition of the crt display. 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 control, the internal Astigmatism adjustment must be re-set; see the Calibration section in the 7313/R7313 Service Manual.

GRATICULE

The graticule of the 7313/R7313 is marked on the inside of the faceplate of the crt, providing accurate, no-parallax measurements. The graticule is divided into eight vertical and ten horizontal divisions. Each division is 0.975 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 GRAT ILLUM screwdriver adjustment.

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.

Figure 1-5 shows the graticule of the 7313/R7313 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.

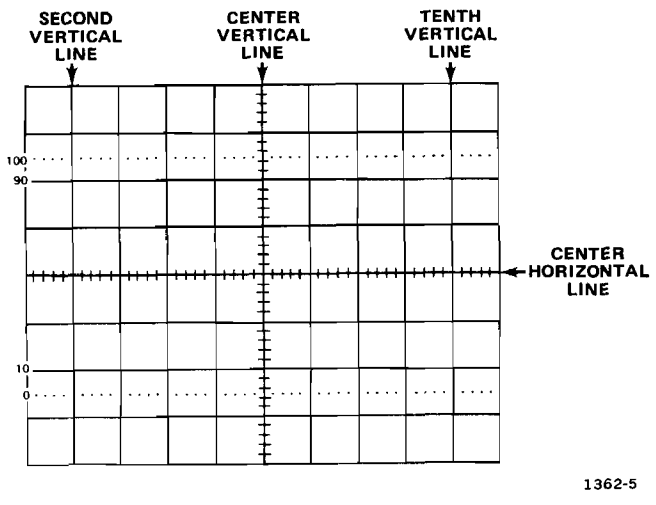


Fig. 1-5. Definition of measurement lines on the 7313/R7313 graticule.

LIGHT FILTER

The tinted filters provided with the 7313/R7313 reduce light reflections from the face of the crt to improve contrast when viewing the display under high ambient light conditions. The light blue filter is recommended primarily for non-storage operation and the light green filter is recommended primarily for storage operation. These filters should be removed for waveform photographs or when viewing high writing-rate displays. To gain access to the light filter, remove the plastic frame mask.

BEAMFINDER

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

1. Press in the BEAMFINDER switch.

2. While the display is compressed, 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 operating in the X-Y mode).

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 BEAMFINDER switch; the display should remain within the viewing area.

VERTICAL MODE

LEFT AND RIGHT MODE. When the LEFT or RIGHT push 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 that 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.

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 the RIGHT positions, 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 that 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 TRIG 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 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 undesired 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 7313/R7313 is 100:1 from dc to 25 megahertz.

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 ratings 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 that 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 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. However, if correct triggering for the desired display is not obtained in the VERT MODE position, the trigger source can be changed to obtain the trigger signal from the plug-in unit in either the Left Vertical or Right Vertical compartment. 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.

READOUT (Deleted by Option 1)

The Readout System of the 7313/R7313 allows alphanumeric display of information on the crt along with the analog waveform displays. The information displayed by the Readout System is obtained from the plug-in units which are installed in the plug-in compartments. The characters of the readout display are written by the crt beam on a time-shared basis with the signal waveforms.

The Readout Mode switch, (located on the Readout circuit board) determines the operating mode of the Readout System (see Fig. 1-4). When this switch, S2110, is set to the Free-Run position, the Readout System randomly interrupts the waveform display to display readout characters. The waveform display is interrupted for only about 20 microseconds for each character that is displayed.

In the Triggered position the Readout System is locked out so no characters are displayed during the sweep. At the end of the sweep, the Readout System is triggered and a complete frame of all applicable readout words is displayed. This mode of operation can be used when the trace interruptions necessary to display characters would not otherwise allow a satisfactory waveform display to be obtained. Also, when performing single-sweep photography or during single-sweep storage operation, the Triggered readout mode avoids blurring of the readout characters due to continuous display. The trigger for the Readout System in the Gate Triggered position is produced from the sweep gate selected by the rear-panel Gate Selector switch (a time-base unit must be installed in the Horizontal compartment.).

The readout information from each plug-in channel is called a word. Up to six words of readout information can be displayed on the 7313/R7313 crt (two channels for each of three plug-in compartments). The location at which each readout word is presented is fixed and is directly related to the plug-in unit and channel from which it originated.

Figure 1-6 shows the area of the graticule where the readout from each plug-in unit and channel is displayed. Notice that the readout from channel 1 of each plug-in unit is displayed within the top division of the graticule, and the readout from channel 2 is displayed directly below within the bottom division of the graticule. Only the readout from plug-in units or channels that are selected for display by the VERT MODE switch or by the mode switches of dual channel plug-in units, appear in the readout display. Some special-purpose plug-in units may override the mode switches to display readout, even though the compartment is not selected for waveform display.

An "identify" feature is provided by the Readout System to link the readout word with the orginating plug-in unit and channel (amplifier units only). When the "Identify" button of an amplifier unit is pressed, the word IDENTIFY appears in the readout location allocated to that plug-in and channel. Other readout words in the display remain unchanged. When the "identify" button is released, the readout display from this plug-in channel is again displayed. Circuitry may also be provided in the amplifier unit that produces a noticeable change in the analog waveform display to also identify the associated trace when the "Identify" button is pressed; see the plug-in instruction manuals for details.

An "uncalibrated" feature is encoded into the readout display. When the plug-in unit deflection factor switches (Time/Div, Volts/Div) are in the uncalibrated position, the > symbol is displayed preceding the readout display.

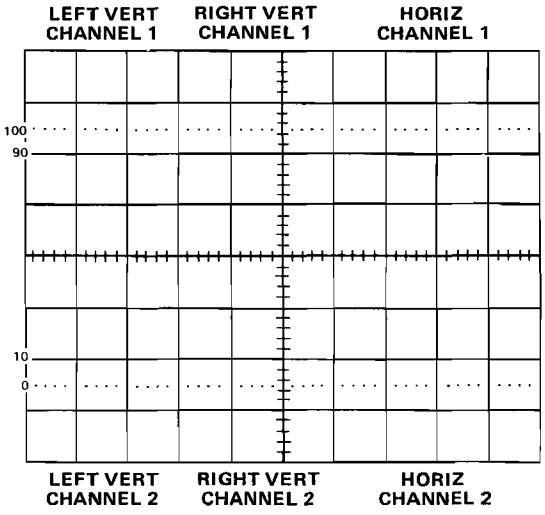


Fig. 1-6. Location of the readout on the crt identifying the originating plug-in compartment and channel.

STORAGE OPERATION

The storage feature of the 7313/R7313 increases the versatility of this instrument. The crt display area is divided into two 4 x 10 division storage screens that are independently controlled for split screen applications. Separate STORE, ENHANCE, ERASE, and AUTO ERASE switches allow independent control of these functions for the UPPER and LOWER storage screens.

STORAGE MODE. The UPPER and LOWER STORE push buttons determine the operating mode of the associated display area. When the STORE push button is out, the associated screen operates in the conventional non-store manner. The remaining storage switches have no effect on the operation of the instrument even though they may be engaged. When the STORE push button is pressed in, the assocated screen operates in the storage mode and the associated storage functions are activated.

MANUAL ERASE. When the UPPER or LOWER ERASE push button is pressed, the associated storage screen is erased. The ERASE switch overrides any of the other storage switches, so the display can be manually erased in any storage mode.

AUTOMATIC ERASE. When the UPPER or LOWER AUTO ERASE push button is pressed in, the stored display is automatically erased after the viewing interval selected by the VIEW TIME control. The VIEW TIME control provides continuously variable viewing intervals from less than 0.5 second (counterclockwise) to greater than 10 seconds (clockwise). The view time begins at the end of sweep. This is apparent at slow sweep rates.

REMOTE ERASE INPUT. A ground closure (from a positive level) applied to the rear-panel REMOTE ERASE IN connector erases the stored display. The remote actuation can be obtained from either an active system (pulse generator, logic circuit, etc.) or a passive system (switch or relay). Refer to the Specification section for Remote Erase signal requirements.

A Remote Erase Selector (located on the Storage circuit board) determines whether the external signal, applied to the REMOTE ERASE IN connector, erases the upper storage screen, lower stage screen or both storage screens. See Fig. 1-4 for further information.

SINGLE SWEEP ENHANCEMENT AND LOCATION. The ENHANCE mode (UPPER and LOWER) provides a method of storing single-sweep or low repetition-rate displays that exceed the normal writing speed of the cathode-ray tube. This mode is not normally used for repetitive sweeps.

NOTE

After sustained use (6 hours or more) of the 7313/R7313 in the non-store mode or in the STORE mode with nothing written, the writing speed may be improved by leaving the crt target fully stored for five to fifteen minutes. This procedure may be repeated every few hours to refresh the storage target in applications requiring maximum stored writing rate.

To use this feature, first obtain the best possible display of the signal in the normal storage mode. Then press the ENHANCE push buttons (UPPER or LOWER) and set the ENHANCE Level control to about midrange. Apply a single-sweep display. If the ENHANCE Level control is properly set, the display will be stored with minimum background luminance.

If the ENHANCE Level control is set too high, the background luminance may obscure the desired display; if the ENHANCE Level is too low, the display may not be adequately stored. Therefore, experimentation is necessary for an optimum enhanced display.

During single-sweep operation, the LOCATE push button can be used to locate the trace or display while the sweep is held off. Pressing the LOCATE push button unblanks the crt and allows the display to be positioned before storing. The start of the sweep will be approximately 0.2 division to the right of the bright locate spot.

CARE OF STORAGE CRT. To prolong the useful life of the storage screens, the following precautions should be observed when operating the 7313/R7313.

1. Use minimum beam intensity required to produce a clear, well-defined display. Care must be observed in the degree of writing-beam intensity that is used, particularly when using slow sweep rates and sampling displays.

2. Turn the INTENSITY control to minimum when changing plug-in units. An undeflected spot on the crt screen can burn the storage target.

3. Do not increase beam intensity to store fast-changing portions of a waveform. See instructions given earlier in this section for storing fast-rise waveforms.

4. Avoid repeated use of the same area of the screen.

5. Do not leave a display on the crt screen (either written or stored) when the display is not needed.

6. Do not leave STORE switches pushed in when the storage mode is not needed.

INTEGRATED FAST-RISE WAVEFORMS. The INTEGRATE push button permits storage of waveforms at relatively fast sweep speeds with relatively low repetition rates. Waveforms that would be difficult to see because of the low duty cycle of the sweep, or have poor resolution due to the required high setting of the INTENSITY control, can often be stored, using the Integrate method, to produce higher brightness or better resolution.

CAUTION

Do not attempt to store extremely fast-rising or fast-falling portions of waveforms viewed at relatively slow sweep rates. The high trace intensity required (due to the intensity difference between the horizontal and the vertical segments) could cause storage target damage.

To use the INTEGRATE function, first obtain a triggered well-defined display. Then, press the INTEGRATE push button (a fraction of a second to several seconds is reasonable). If all portions of the display are not properly stored, repeat the integration for a longer period with higher trace intensity.

Lower trace intensity and longer integration periods produce optimum resolution of jitter-free signals. If integration is used too long, the stored image will broaden and obscure the desired display. Use of the INTEGRATE function in the AUTO ERASE mode is not recommended.

CALIBRATOR

The calibrator of the 7313/R7313 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 voltage 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 CALIBRATOR output can be switched for a dc level or one-kilohertz square-wave signal via an internal selector (P1066) on the Calibrator board. See Fig. 1-4, in this section, for further information.

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.

In the DC position; 40 mV, 0.4 V, and 4 V levels are provided at the CALIBRATOR pin-jacks. When the 40 milliampere current loop is connected between the 4 V output and GND, 40 milliamperes of dc current is provided through the current loop.

SIGNAL OUTPUTS

NOTE

If the 7313/R7313 is ordered with Option 7, the signal buffer assembly will not be installed in the instrument. The VERT SIG OUT, +GATE OUT, +SAWTOOTH OUT, and the REMOTE ERASE IN and EXT SS RESET IN rear-panel connectors are deleted.

+SAWTOOTH. The rear-panel +SAWTOOTH OUT connector provides a positive-going sample of the sawtooth signal from the time-base unit in the Horizontal compartment. The unit of time is determined by the time-base unit time/division switch (e.g., if the time/division switch is set to one millisecond/division, a unit of time is one millisecond; at five milliseconds/division, a unit of time is five milliseconds). Refer to the Specification section for +SAWTOOTH OUT parameters.

+GATE OUT. The +GATE OUT connector provides a positve-going rectangular output signal from the time-base unit installed in the Horizontal compartment. The source of the gate signal (MAIN AUXILIARY, or DELAY) is determined by the rear-panel Gate Selector switch. The duration of the gate pulse is determined by the respective sweep. AUXILIARY and DELAY GATE pulses can be produced only by a compatible dual time-base unit. Refer to the Specification section for +GATE OUT parameters.

VERTICAL SIGNAL. The VERT SIG OUT connector provides a sample of the vertical deflection signal. The source of this output signal is determined by the TRIG SOURCE switch. In the VERT MODE position of the TRIG SOURCE switch the output signal is determined by the setting of the VERT MODE switch. The output signal, in the LEFT and RIGHT positions of the VERT MODE switch, is obtained from the selected vertical compartment. In the ALT position of the VERT MODE switch, the signal at the VERT SIG OUT connector, switches between vertical compartments along with the crt display. In the CHOP and ADD positions of the VERT MODE switch, the output is a composite signal. The composite signal is the resultant of the algebraic addition of the vertical signals from the Left Vertical and Right Vertical compartments.

The bandwidth of the VERT SIG OUT is determined by the Amplifier plug-in unit used (see Systems specification in the Specification section). Refer to the Specification section for the parameters of the VERT SIG OUT signal.

REMOTE SINGLE SWEEP RESET (Delete with Option 7)

An external single sweep reset signal can be applied to the time-base unit in the Horizontal compartment through the rear-panel EXT SS RESET IN connector. The remote single-sweep reset actuation can by obtained from either an active system (pulse generator, logic circuit, etc.) or a passive system (switch or relay). Requirements for the EXT SS RESET IN signal are given in the Specification section.

DISPLAY PHOTOGRAHY

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 7313/R7313.

The crt bezel of the 7313/R7313 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. Control signals are also received from Tektronix automatic cameras to allow camera controlled single-shot photography (see camera manual for further information).

When this instrument is operated in the storage mode, a photograph may be easily composed by erasing unwanted displays as many times as necessary before the desired display is obtained. This ability to compose a photograph in advance prevents wasted film due to incorrect displays.

If the readout portion of the display is to be included on waveform photographs, the following suggestions will aid in obtaining good photographs.

1. Focus the oscilloscope display and the camera on the center of the crt display.

2. Set the READOUT intensity control for a minimum setting that allows the characters to be written. This normally occurs at a slightly lower intensity level than is necessary for complete writing of the waveform display. Some experimentation may be necessary to establish the correct level. Too high a setting of the READOUT intensity control will result in a broad, poorly defined photograph of the readout display.

3. If single-shot photography is used, set the Readout Mode switch to the Triggered position (see the Readout discussion in this section for complete operating information). Then, the readout is displayed in a single-shot manner after the trace is complete (be sure the camera shutter remains open at least 0.5 second after the sweep is completed to photograph the entire readout). Also, set the GRAT ILLUM control counterclockwise while the trace is being photographed. Then, the graticule can be photographed later to produce a double-exposure picture showing complete information.

X-Y OPERATION

In 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 7313/R7313 provides a means of 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: (1) The plug-in units do not have to be moved between compartments for X-Y operation. (2) The attenuator switch, of the amplifier unit providing the horizontal signal, determines the horizontal deflection factor for full range operation.

Another method of obtaining 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 that 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). When the EXT Z AXIS IN is not in use, replace the BNC cap.

Time markers applied to the EXT Z AXIS IN 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 display waveform, a single-sweep display should be used (for internal sweep only) to provide a stable display.

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.

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 7313/R7313 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 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 IN 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 7313/R7313.

For further information, see the instruction manual for the applicable time-base unit.

APPLICATIONS

The 7313/R7313 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. 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 manaul 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.

SPECIFICATION

Information given in this section of the manual applies to both the 7313 and R7313 Oscilloscopes, except as otherwise indicated. The R7313 is electrically identical to the 7313, but it is adapted for mounting in a standard 19-inch rack. Rackmounting Instructions and a dimensional drawing for the R7313 are given in Section 3.

This instrument will meet the electrical characteristics listed in the Performance Requirement column of Table 2-1 following complete calibration as given in the Service manual. 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 7313/R7313 Oscilloscope only. See the System Specification at the end of this section for specifications of the complete system.

TABLE 2-1

Electrical

Characteristic	Performance Requirement	Supplemental Information
VERTICAL SYSTEM		
Deflection Factor (Each Channel)	Compatible with all 7000-Series plug-in units	
Accuracy Between Compartments	Less than 1% difference	
Low Frequency Linearity	0.1 division or less compression or expansion of a two-division (at center-screen) signal when vertically positioned within the graticule area	
Bandwidth	Dependent upon amplifier plug-in selected. See system specifications	
Isolation Between Vertical Compartments	At least 100:1 from dc to 25 MHz	
Vertical Display Modes		
LEFT	Display from left vertical unit only	
ALT	Dual-trace display, alternate between vertical units	Selected by VERT MODE switch
ADD	Single-trace display added algebraically from both vertical units	See Controls and Connectors discussion for more detail
CHOP	Dual-trace display, chopped between vertical units	
Repetition Rate		Approximately 1 MHz
Time Segment From Each Compartment		0.4 μs to 0.6 μs

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	VERTICAL SYSTEM (cont)	
RIGHT	Display from right vertical unit only	
	TRIGGERING	
Trigger Source		Selected by TRIG SOURCE switch. (See Controls and Connectors discussion for more detail)
LEFT VERT	Trigger signal from left vertical unit only	
VERT MODE	Source of trigger signal determined by vertical mode	
RIGHT VERT	Trigger signal from right vertical unit only	
	HORIZONTAL SYSTEM	
Fastest Calibrated Sweep Rate	20 ns/div	Exclude the first 50 ns of sweep
Deflection Factor	Compatible with all 7000-Series plug-in units	
DC Linearity	0.1 div or less compression or expansion of a two-division (at center-screen) signal when horziontally positioned within the graticule area	
Phase Shift Between Vertical and Horizontal Systems	Less than 2° from dc to 35 kHz	
Bandwidth (Eight-Divison Reference)	At least 500 kHz	
	CALIBRATOR	
Wave shape	Square wave or dc voltage (dc voltage available only when selected by internal jumper)	
Polarity	Positive-going, reference to baseline at zero volts	
Voltage Output		Into 1 MΩ load
Range	40 mV, 0.4 V, 4 V	
Accuracy		
+15°C to +35°C	Within 1%	
0°C to +50°C	Within 2%	
Repetion Rate		Approximately 1 kHz

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	CALIBRATOR (cont)	
Output Resistance		
40 mV and 0.4 V		Approximately 50 Ω
4 V		Approximately 450 Ω
Current Output	Approximately 40 mA	40 mA available only when current loop accessory 012-0259-00 is connected between 4 V and GND pin jacks
	OUTPUTS	
VERT SIG OUT (Rear Panel) (Deleted by Option 7)	See System Specifications for 7300-Series instruments	
Vertical Signals	LEFT, RIGHT, ALT and ADD	Selected by TRIG SOURCE switch
Gain		
Into 50 Ω		25 mV/div
Into 1 MΩ		0.5 V/div
Risetime (Into 50 Ω)		5 ns or less
Centering		±1 graticule div from crt display to VERT SIG OUT
Output Resistance		950 Ω within 2%
+GATE OUT (Rear Panel) (Deleted by Option 7)		
Gate Signals	MAIN, AUXILIARY and DELAY	Selected by Gate selector (rear panel) Auxiliary gate from dual-sweep time-base unit
Polarity	Postive-going with baseline at 0 V within 0.1 V	
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%

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	OUTPUTS (cont)	
+SAWTOOTH OUT (Rear Panel) (Deleted by Option 7)		
Output Voltage		
Into 50 Ω	Greater than 500 mV p-p with non-magnified sweep	
Into 1 MΩ	Greater than 10 V p-p with non-magnified sweep	
Polarity	Positive-going with baseline at zero volts	
Rate of Rise		
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%
Camera Power (P1041 at CRT Bezel)		
Pin 1 (Top)	+15 V	
Pin 3	Single Sweep Reset	
Signal Required	Closure to ground within −5 V to +0.5 V	Sinking 10 mA
Minimum Pulse Width		10 ms at 50% amplitude points
Maximum Safe Input	+15 V (dc + peak ac)	
Pin 5 (Bottom)	Ground	
	SIGNAL INPUTS	
REMOTE ERASE IN (Rear Panel) (Deleted by Option 7)		
Voltage Level	Closure to ground (within 0.4 V) from a positive level	Holding input level at ground locks out automatic erase operation, but sweep lockout still occurs for the interval selected by VIEW TIME control
Rate of Change		1 V/μs
Maximum Current		10 mA
Maximum Open Circuit Voltage		+5 V
Maximum Safe Input Voltage	+10 V (dc + peak ac)	

[1] **Unit of time selected by time-base unit time/division switch.**

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	SIGNAL INPUTS (cont)	
EXT SS RESET IN (Deleted by Option 7)		
Voltage Level	Closure to ground (within −5 V to +0.5 V) from a positive level	
Minimum Pulse Width		10 μs at 50% amplitude points
Maximum Safe Input Voltage	15 V (dc + peak ac)	
Max Current		5 mA
EXT Z AXIS IN		
Sensitivity	2 volts p-p provides trace modulation over full intensity range	
Useful Input Voltage versus Frequency	2 volts p-p, dc to 2 MHz; reducing to 0.4 V p-p at 10 MHz	
Polarity of Operation	Positive-going signal decreases trace intensity; negative-going signal increases trace intensity	
Maximum Safe Input Voltage		10 V (dc + peak ac)
Input Resistance at DC		Approximately 500 Ω
	DISPLAY	
Graticule		
Type	Black internal graticule	
Area	8 X 10 div (1 div=0.975 cm)	
Phosphor	P1	
Vertical and Horizontal Resolution		
Non-Store		15 lines/division
Storage		8 lines/division
Spot Centering (No Signal Applied)		Within 0.5 division radius of graticule center
Beamfinder		Limits display to within graticule area when BEAMFINDER is actuated

TABLE 2-1 (cont)

Characteristic	Performance Requirement	Supplemental Information
	DISPLAY (cont)	
Stored Display		
Storage Type	Bi-stable, split screen	
Storage Modes	Normal and Enhance	
Stored Writing Speed	500 div/ms minimum (5000 div/ms enhanced)	
Maximum Recommended Storage Time	4 hours	
Erase Time		400 ms or less
View Time in Auto Erase	Less than 0.5 sec to greater than 10 sec	
Enhance Pulse		
Amplitude		Adjustable with front-panel ENHANCE Level Control
	CHARACTER GENERATOR	
Mode	Free-run independent of sweep	Selected by internal readout mode switch
	Triggered at end of sweep	
Character Height		Adjustable by internal control
Word Location		See Fig. 1-6
	POWER SOURCE	
Line Voltage Range (AC, RMS)		
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		
7313		50 to 440 Hz
R7313		50 to 60 Hz
R7313 Option 5		50 to 440 Hz
Maximum Power Consumption		170 watts, 2.0 amps at 60 Hz, 115 V Line

TABLE 2-2

Environmental

Characteristic	Performance
	NOTE *This instrument will meet the electrical characteristics given in the Performance Requirement column of Table 2-1 over the following environmental limits, except as otherwise indicated.*
Temperature Range	
Operating	0° C to +50° C
Non-operating	−55° C to +75° C
Altitude	
Operating	15,000 feet
Non-operating	Test limit 50,000 feet
Electro-Magnetic Interference (EMI) in accordance with MIL-STD-461A as tested in MIL-STD-462 (when equipped with Option 3)	*NOTE* *Any unused plug-in compartments must be covered with a blank plug-in panel (EMI shielded) in order to meet EMI specifications. See Options section for additional information.*
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 Committe test procedure 1A, Category II

TABLE 2-3

Physical

Characteristic	Information
Ventilation	Safe operating temperature maintained by convection cooling (7313) or forced air cooling (R7313). Automatic resetting thermal cutout protects instrument from overheating
Finish	Anodized aluminum front panel, painted cabinet
7313 Overall Dimensions (measured at maximum points)	
Height	12.0 inches (30.4 cm)
Width	8.7 inches (22.0 cm)
Length	22.7 inches (57.6 cm)
Net Weight (instrument only)	30 pounds (13.6 kg)
R7313 Overall Dimensions (measured at maximum points)	
Height	5.25 inches (13.4 cm)
Width	19.0 inches (48.5 cm)
Length	21.5 inches (62.0 cm)
Net Weight (instrument only)	30 pounds (13.6 kg)

STANDARD ACCESSORIES

Standard accessories supplied with the 7313/R7313 are given in the Mechanical Parts List illustrations in the Service manual. For optional accessories available for use with this instrument, see the Tektronix, Inc. catalog.

SYSTEM SPECIFICATIONS

Your Tektronix 7313/R7313 oscilloscope system provides exceptional flexibility in operation with a wide choice of general and special purpose plug-in units. The type number of a particular plug-in identifies its usage as follows:

The first digit (7) denotes the oscilloscope system for which the plug-in unit is designed (7000-Series).

The second letter describes the purpose of the plug-in unit:

A—Amplifier unit

B—"Real time" time-base unit

D—Digital unit

L—Spectrum analyzer

M—Miscellaneous

S—Sampling Unit

T—Sampling time-base unit

The third and fourth digits of the plug-in type number are sequence numbers and do not carry any special connotation.

An "N" suffix letter added to the normal four digit type number identifies a unit not equipped with the circuitry necessary to encode data for the 7000-Series readout system.

TABLE 2-4

7313/R7313 OSCILLOSCOPE

SYSTEM VERTICAL SPECIFICATIONS

Table 2-4 lists the vertical specifications that are system dependent. For more complete specifications on plug-in units for the 7000-Series Oscilloscope System, refer to the Tektronix, Inc. catalog.

Amplifier Plug-in Unit	Probe	BW	Tr	Vertical System Deflection Factor Accuracy[2]			SIG OUT	
				EXT CAL 0° to 50° C	INT CAL 15° to 35° C	INT CAL 0° to 50° C	BW	Tr
7A11	Integral	25 MHz	14 ns	2%	3%	4%	60 MHz	5.9 ns
7A12	None	25 MHz	14 ns	2%	3%	4%	55 MHz	6.4 ns
	P6053A, 54	25 MHz	14 ns	3%	4%	5%	55 MHz	6.4 ns
7A13	None	25 MHz	14 ns	1.5%	2.5%	3.5%	55 MHz	6.4 ns
	P6053A, 54	25 MHz	14 ns	1.5%	2.5%	3.5%	55 MHz	6.4 ns
	P6055	24 MHz	15 ns	1.5%	2.5%	3.5%	45 MHz	7.8 ns
7A14	P6021	24 MHz	15 ns	2%	3%	4%	40 MHz	8.8 ns
	P6022	25 MHz	14 ns	2%	3%	4%	50 MHz	7.0 ns
7A15A	None	25 MHz	14 ns	2%	3%	4%	50 MHz	7.0 ns
	P6053A, 54, 61	25 MHz	14 ns	3%	4%	5%	50 MHz	7.0 ns
7A16A	None	25 MHz	14 ns	2%	3%	4%	60 MHz	5.9 ns
	P6053A, 54	25 MHz	14 ns	3%	4%	5%	60 MHz	5.9 ns
7A17	None	25 MHz	14 ns	—	—	—	15 MHz	24 ns
7A18	None	25 MHz	14 ns	2%	3%	4%	50 MHz	7.0 ns
	P6053A, 54, 61	25 MHz	14 ns	3%	4%	5%	50 MHz	7.0 ns
7A19	None	25 MHz	14 ns	3%	4%	5%	65 MHz	5.4 ns
	P6056, P6057	25 MHz	14 ns	4%	5%	6%	65 MHz	5.4 ns
7A22	None or any	1.0 MHz ±10%	350 ns ±9%	2%	3%	4%	1 MHz ±10%	350 ns ±10%
7A24	None	25 MHz	14 ns	2%	3%	4%	60 MHz	5.9 ns
	P6056, P6057			3%	4%	5%		
7A26	None	25 MHz	14 ns	2%	3%	4%	60 MHz	5.9 ns
	P6065			3%	4%	5%		

[2] **Deflection factor accuracy is checked as follows:**

EXT CAL 0° C to 50° C—Plug-in gain set at a temperature within 10° C of operating temperature, using an external calibrator whose accuracy is within 0.25%.

INT CAL 15° C to 35° C—Plug-in gain set while operating within a temperature range of +15° C to +35° C, using the oscilloscope calibrator.

INT CAL 0° C to 50° C—Plug-in gain set using the oscilloscope calibrator (within 10° C of the operating temperature) in a temperature range between 0° C and +50° C.

RACKMOUNTING INSTRUCTIONS

The R7313 is designed to be installed in a standard 19-inch rack with Universal hole spacing. If a rack with other than Universal hole spacing is used, additional mounting holes may need to be drilled.

INSTRUMENT DIMENSIONS

A drawing showing the major dimensions of the R7313 is shown in Fig. 3-6.

RACK DIMENSIONS

HEIGHT. At least 5.2 inches of vertical space is required to mount this instrument in a rack. This gives enough clearance for adjacent instruments and panels. Additional height may be required if an oscilloscope camera is to be used with this instrument.

WIDTH. Minimum space between the front rails of the rack is 17 5/6 inches. This space allows the slide-out tracks to operate freely, permitting the R7313 to move in and out of the rack.

DEPTH. Total depth required to mount this instrument in an enclosed-cabinet rack is 23.9 inches. This allows enough space for air circulation, signal connections, and the power cord.

The rear mounting brackets allow this instrument to be mounted in racks with 14 5/8 to 28 1/2 inches between the front and rear rails. The R7313 must be properly supported at the rear. Improper support may result in instrument damage.

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. Be sure the power cord and signal cables are long enough to allow operation in the extended position.

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 slide-out track assembly. The stationary section of each assembly attaches to the front and rear rails of the rack. The chassis sections allow the instrument to be extended out of the rack.

The hardware needed to mount the tracks to the rack is shown in Fig. 3-1. Since enough hardware is supplied to make the tracks compatible with a variety of racks and installation methods, some of it may not be needed.

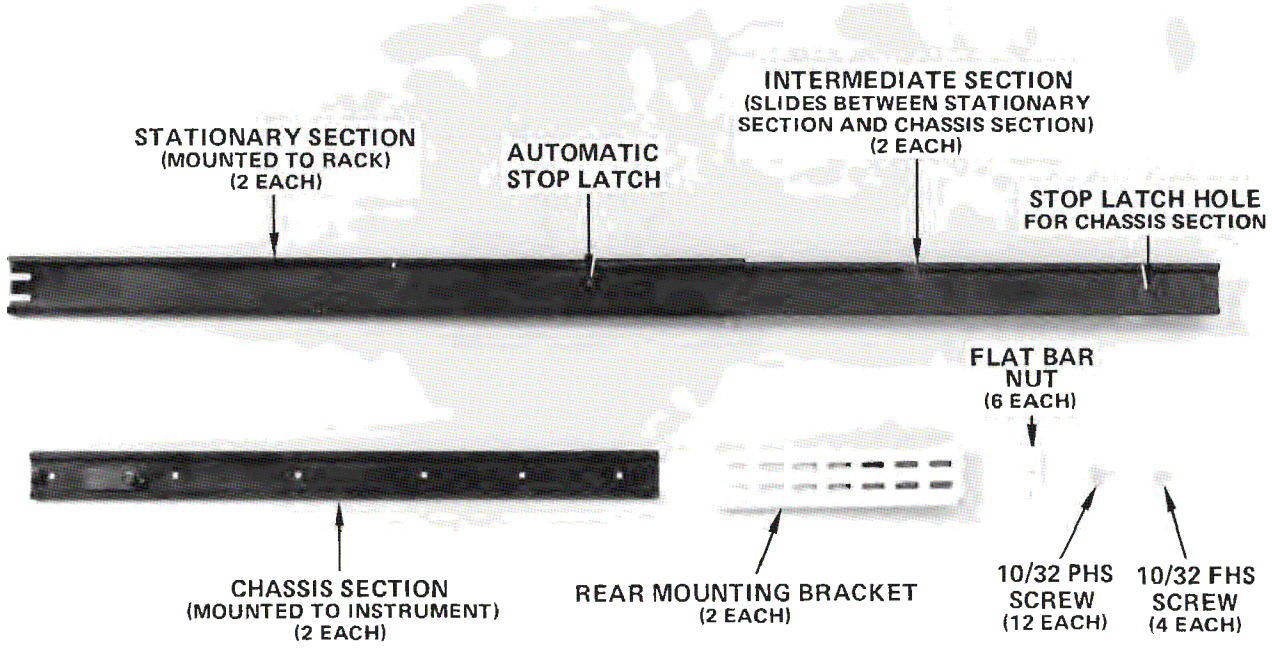


Fig. 3-1. Slide-out track assembly.

MOUNTING PROCEDURE

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

NOTE

If the rails of the rack are tapped, either drill out the holes with a 0.196 inch drill, or mount the front flanges in front of the rails.

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).

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

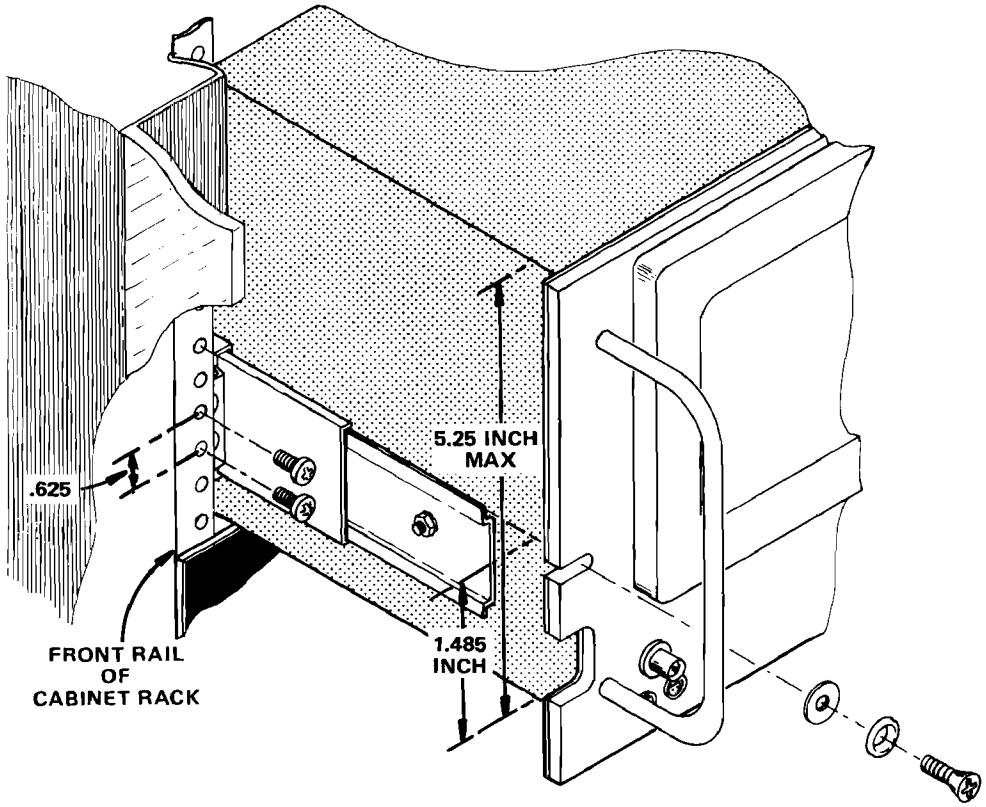


Fig. 3-2. Vertical mounting position of the left stationary section and location of the thumb screw securing hole. These dimensions also apply to the right front rail.

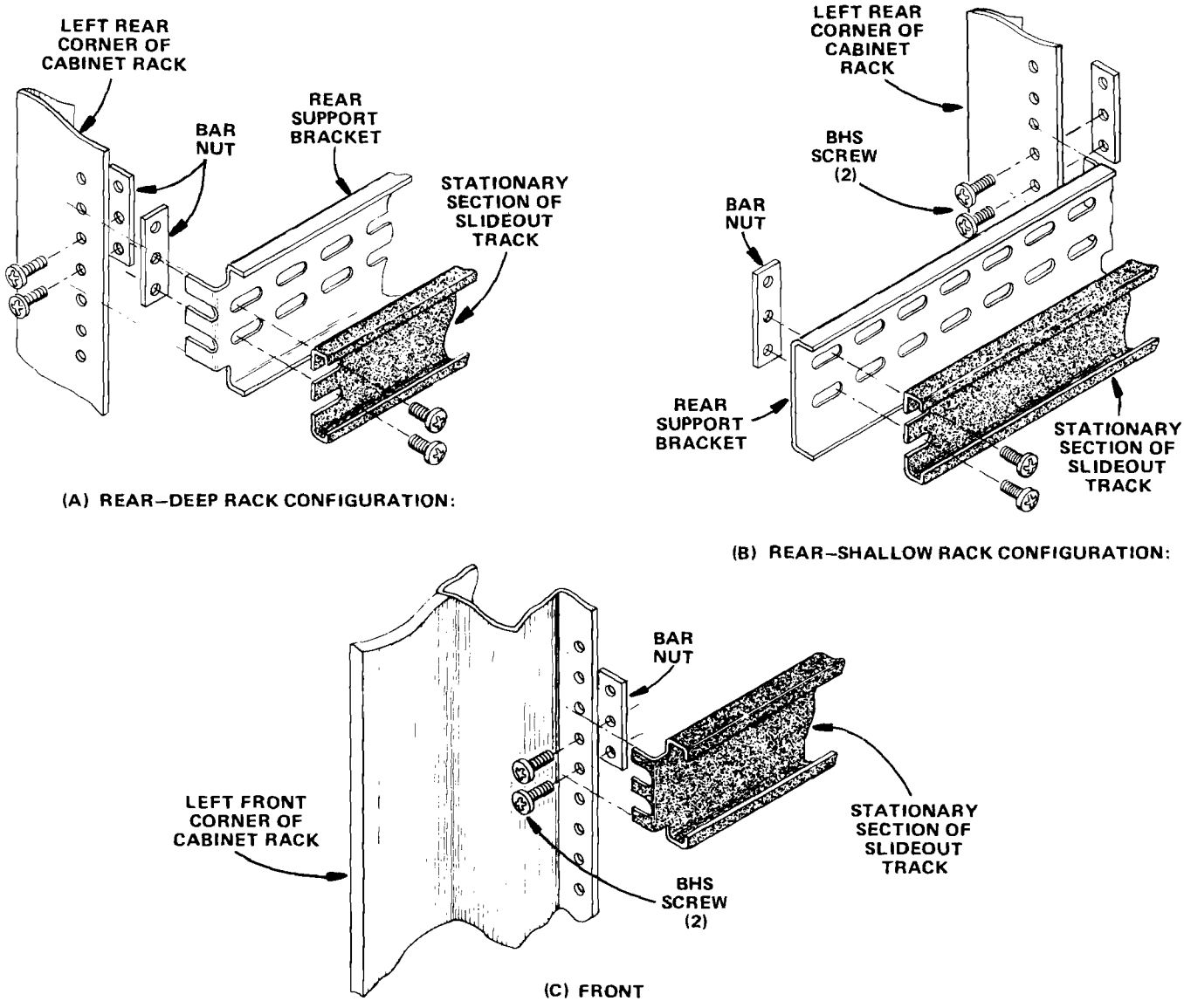


Fig. 3-3. Details for mounting stationary sections.

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

5. See Fig. 3-5 to adjust the alignment of the stationary sections.

6. After the tracks operate smoothly, connect the power cord and all necessary cables to the rear-panel connectors. 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 holes are 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 tracks provides permanent lubrication. However, if the tracks require additional lubrication, a thin coat of paraffin can be rubbed onto the sliding surfaces.

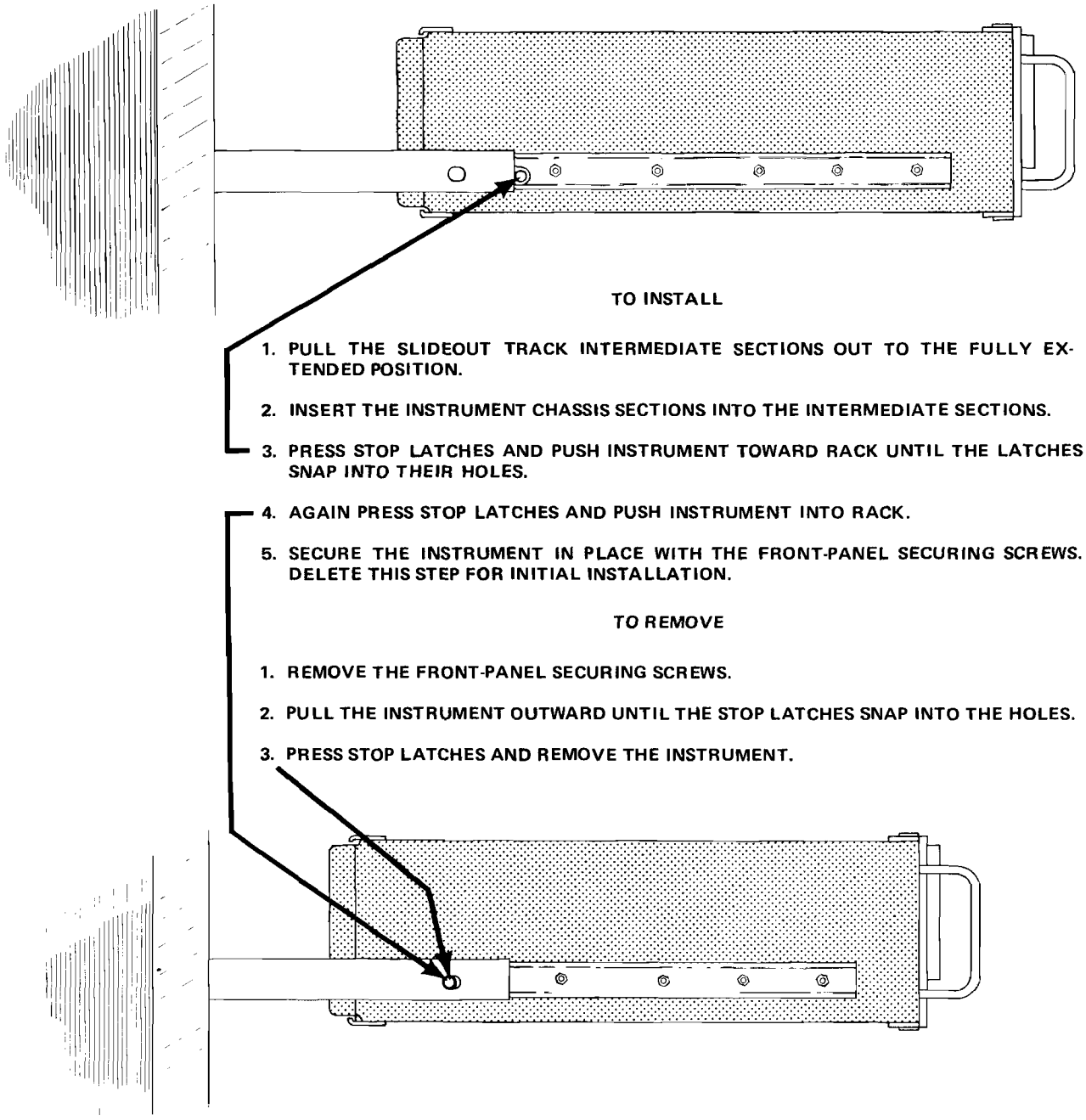
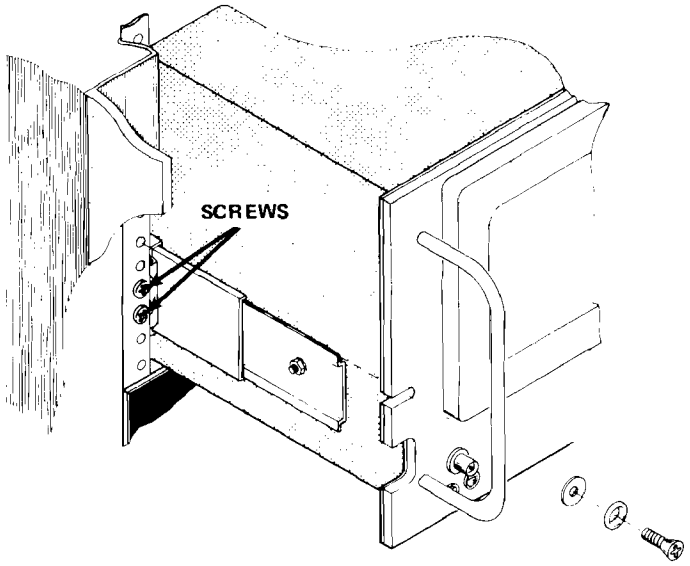


Fig. 3-4. Installing and removing the instrument.



1. LOOSEN SCREWS ON BOTH SIDES (LEFT SIDE SHOWN).
2. ALLOW SLIDES TO SEEK PROPER WIDTH.
3. CENTER INSTRUMENT.
4. RETIGHTEN SCREWS.
5. PUSH THE INSTRUMENT ALL THE WAY INTO THE RACK. IF TRACKS DO NOT SLIDE SMOOTHLY, CHECK FOR CORRECT SPACING BETWEEN THE REAR SUPPORTS.

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

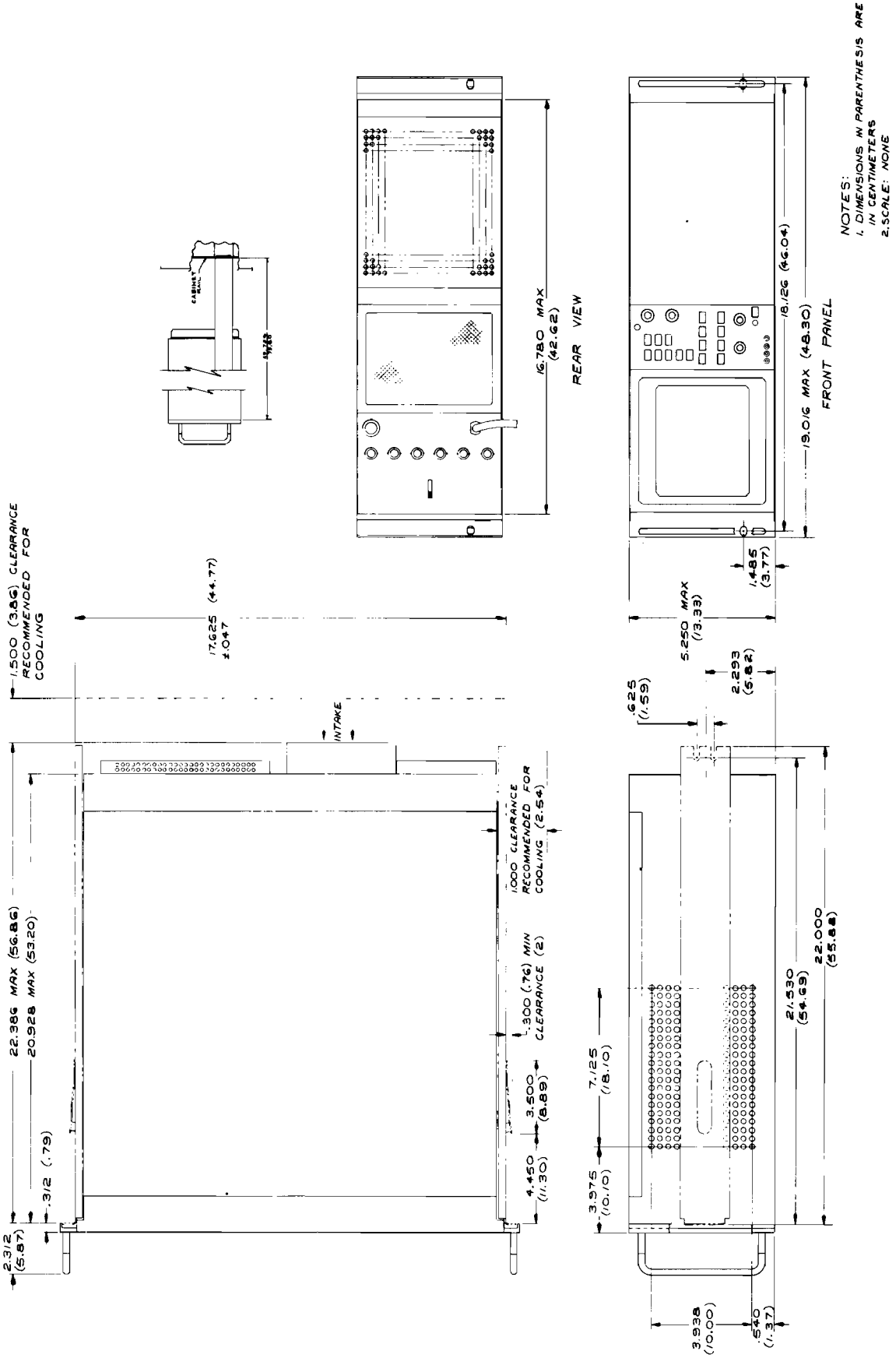


Fig. 3-6. R7313 dimensional drawing.

INSTRUMENT OPTIONS

The following factory-installed options are available for the 7313/R7313. Conversion kits, for most options, are available and can be installed at a later time. A description of each option is given in the following discussion. Complete option information is incorporated into the appropriate sections of the manual. See Table 4-1 and the Table of Contents for the location of option information.

For further information on instrument options, see your Tektronix, Inc. catalog or contact your Tektronix Field Office.

OPTION 1

This option deletes the Readout System. Operation of the instrument is unchanged except that there is no alpha-numeric display on the cathode-ray tube.

OPTION 3

This option provides electro-magnetic shielding so that the instrument will meet the electro-magnetic interference parameters given in the Specification section. To meet the specifications of Option 3, all unused plug-in compartments must be covered with an EMI-shielded blank plug-in panel (Tektronix part number 016-0155-00). One blank panel is required for each unused plug-in compartment.

OPTION 5 (Rackmount instruments only)

Option 5 provides a special fan circuit to allow operation of the R7313 from a power source with from 50 Hertz to 440 Hertz line frequency.

OPTION 7

Option 7 deletes the +SAWTOOTH OUT, +GATE OUT, VERT SIG OUT, EXT SS RESET IN, and REMOTE ERASE IN connectors from the rear-panel of the 7313/R7313.

TABLE 4-1

Option Information Locator

Instrument Option	Manual Section	Location of Information
Option 1 (Deletes Readout System)	1 Operating Instructions	Controls and Connectors Delete READOUT Intensity information. Delete the Readout Mode Switch information. Delete Readout portion of Familiarization Procedure.
	2 Specification	Electrical Delete Character Generator specifications.
Option 3 (Provides EMI shielding)	1 Operating Instructions	Plug-In Units Includes EMI operating information.
	2 Specification	Environmental Includes Electro-Magnetic Interference characteristics.
Option 5 (50 Hertz to 440 Hertz fan on R7313 only)	2 Specification	Electrical Includes option 5 parameters in Line Voltage specifications.

Table 4-1 (cont)

Option Information Locator

Instrument Option	Manual Section	Location of Information
Option 7 (Deletes rear panel inputs and outputs)	1 Operating Instructions	Controls and Connectors Delete the Vert Sig Out, +Gate Out, +Sawtooth Out, Remote Erase In, and Ext SS Reset In information. Operating Information Delete the Remote Erase Input information from the Storage Operation discussion. Delete the Signal Output discussion. Delete the Remote Single Sweep discussion.
	2 Specification	Electrical Delete Outputs specifications. Delete Remote Erase In and Ext SS Reset In parameters from Signal Inputs specifications.

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
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
PG 508 replaces 114	Performance of replacement equipment is the same or better than equipment being replaced.	
115		
2101		
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		
067-0532-01	SG 503 - Frequency range 250 kHz to 250 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
SG 504 replaces 067-0532-01	SG 504 - Frequency range 245 MHz to 1050 MHz.	0532-01 - Frequency range 65 MHz to 500 MHz.
067-0650-00		
TG 501 replaces 180, 180A	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	180A - Trigger pulses 1, 10, 100 Hz; 1, 10, and 100 kHz. Multiple time-marks can be generated simultaneously.
181		181 - Multiple time-marks
184	TG 501 - Trigger output-slaved to market output from 5 sec through 100 ns. One time-mark can be generated at a time.	184 - Separate trigger pulses of 1 and 0.1 sec; 10, 1, and 0.1 ms; 10 and 1 μs.
2901	TG 501 - Trigger output-slaved to marker output from 5 sec through 100 ns. One time-mark can be generated at a time.	2901 - 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.

REV B, JUN 1978