TEKTRONIX®

7704A
OSCILLOSCOPE SYSTEM

OPERATORS

INSTRUCTION MANUAL

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7704A
OSCILLOSCOPE SYSTEM

OPERATORS

Serial Number _____

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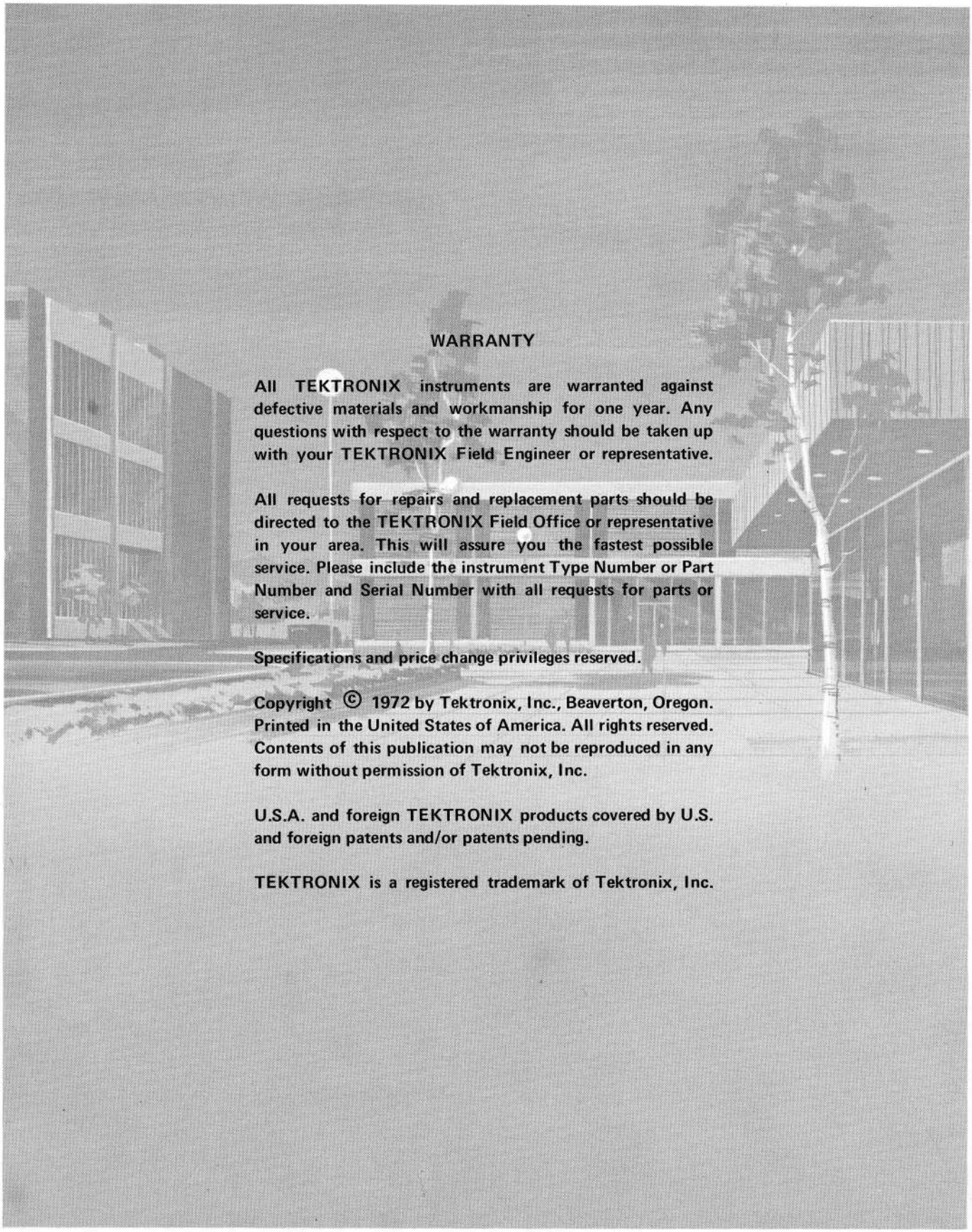

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All TEKTRONIX instruments are warranted against defective materials and workmanship for one year. Any questions with respect to the warranty should be taken up with your TEKTRONIX Field Engineer or representative.

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.

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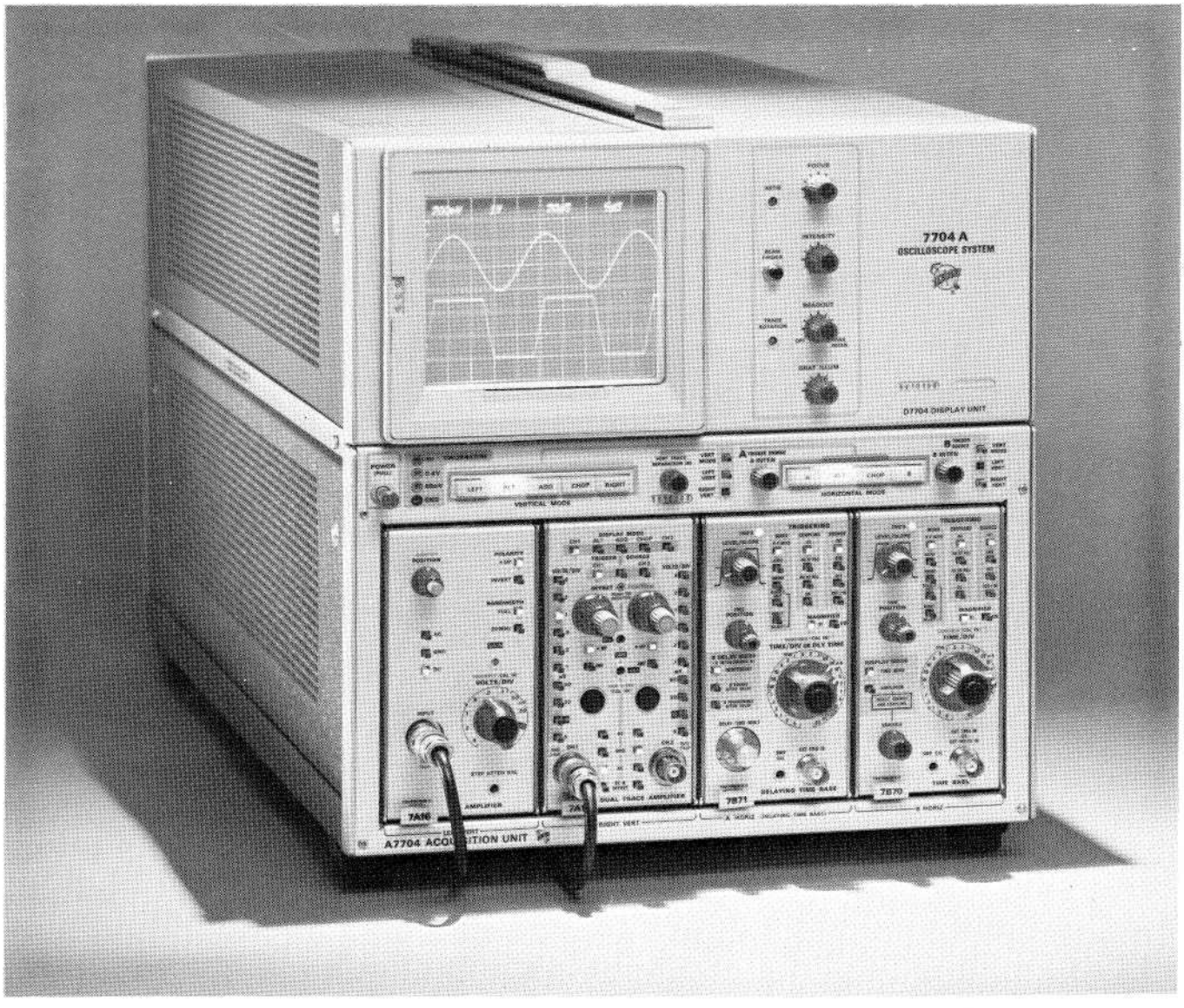


7704A Oscilloscope System.

INTRODUCTION

The TEKTRONIX 7704A Oscilloscope System is a solid-state, high performance instrument designed for general applications. (For rise time and bandwidth specifications of oscilloscope systems using the 7704A, see page 2-5.) The system is composed of two individual units, the A7704 Acquisition Unit and the D7704 Display Unit.

The A7704 Acquisition Unit has four plug-in compartments. The left pair of plug-in units is connected to the vertical system; the right pair is connected to the horizontal system. Electronic switching between the plug-ins connected to each system allows a dual-trace vertical display and/or a dual-sweep horizontal display.

The D7704 Display Unit features a CRT with small spot size and high writing rate. In addition to the waveform, the CRT can also display alpha-numeric information from the plug-in units, such as deflection factor, sweep rate and other encoded parameters. Standard graticule size is 8 X 10 cm.

DC supplies in the Acquisition Unit supply power for the entire instrument. These supplies are regulated to assure that performance is not affected by variations in line voltage and frequency, or by changes in load due to the varying power requirements of the plug-in units.

OPERATING INSTRUCTIONS

General

To effectively use this instrument, the operation and capabilities of the instrument must be known. This section describes the operation of the front- and rear-panel controls and connectors and gives general operating information.

PRELIMINARY INFORMATION

Operating Voltage

The 7704A can be operated from either a 115-volt or a 230-volt nominal line voltage source. The Line Selector assembly on the rear panel converts this instrument from one operating voltage to the other. This assembly also includes line fuses. Use the following procedure to obtain correct instrument operation from the line voltage available.

CAUTION

This instrument is designed for operation from a power source with its neutral at or near earth (ground) potential with a separate safety-earth conductor. It is not intended for operation from two phases of a multi-phase system, or across the legs of a single-phase, three-wire system.

1. Disconnect the instrument from the power source.

2. Loosen the two captive screws which hold the cover onto the selector assembly; then pull to remove the cover.

3. To convert from 115-volts to 230-volts nominal line voltage, or vice versa, pull out the Selector switch bar (see Fig. 1-1) and plug it back into the remaining hole. Change the line-cord power plug to match the power-source receptacle or use a 115- to 230-volt adapter.

Power Cord Conductor Identification

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

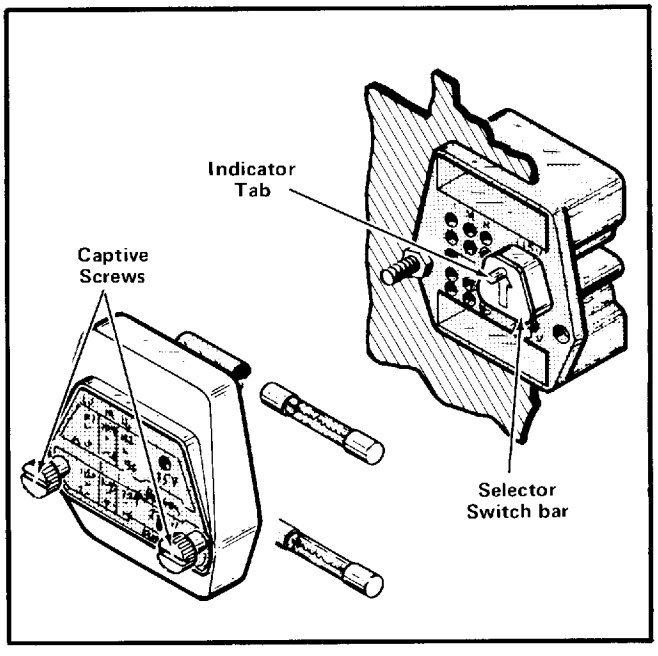


Fig. 1-1. Line Selector assembly on rear panel (shown with cover and fuses removed).

4. Re-install the cover and tighten the captive screws.

5. Before applying power to the instrument, check that the indicator tab on the switch bar is protruding through the correct hole for the desired line voltage range.

CAUTION

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

The 7704A is designed to be used with a three-wire AC power system. If the three- to two-wire adapter is used to connect this instrument to a two-wire AC power system, be sure to connect the ground lead of the adapter to earth (ground). Failure to complete the ground system may allow the chassis of this instrument to be elevated above ground potential and pose a shock hazard.

Operating Temperature

The 7704A 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.

The 7704A is cooled by convection air flow through the instrument. Adequate clearance must be provided on all sides to allow heat to dissipate. Do not block or restrict the air flow through the holes in the cabinet. Maintain the clearance provided by the feet and allow about two inches clearance on the top, sides and rear (more if possible).

Operating Position

A bail-type stand mounted on the bottom of the instrument permits the 7704A to be tilted up about 10° for convenient viewing.

PLUG-IN UNITS

General

The 7704A accepts up to four 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 system are determined by the characteristics of the plug-ins selected. Some typical combinations are given under "Applications" on page 1-18. along with simplified instructions for setting them up. For information on other plug-ins, see the current Tektronix, Inc. catalog.

Installation of Plug-In Units

CAUTION

Plug-in units should not be installed or removed without first turning the instrument power off, to prevent instrument damage.

To install a plug-in unit into a plug-in compartment, 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 to pull the unit out of the compartment.

All the plug-in compartments do not need 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 the instrument through the open plug-in compartments. Blank plug-in panels are available from Tektronix, Inc. to cover the unused compartments; order TEKTRONIX Part No. 016-0155-00.

Interchanging Plug-ins

When the instrument is calibrated as directed in the Service Manual's Calibration procedure, the vertical and horizontal gains are normalized, allowing calibrated plug-in units to be interchanged from one 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 manuals for verification procedure.

CONTROLS AND CONNECTORS

The major controls and connectors are located on the front panel of the instrument. Several auxiliary functions are provided on the rear panel. Figure 1-2 shows the front and rear panels and provides brief descriptions of each control and connector. More detailed operating information is given under 'Detailed Operating Information' starting on page 1-9.

Front-Panel Color Coding

Portions of the front-panel of the 7704A and its plug-in units are color-coded as follows to aid in operating the instrument:

RED

Identifies the nomenclature and controls that will uncalibrate the instrument.

BLUE

Identifies the controls affecting the CRT display mode.

GREEN

Identifies all trigger controls.

Other colors such as gray, orange, yellow, etc. have no functional assignments, but are used as needed to indicate the relationship between the appropriate controls and connectors.

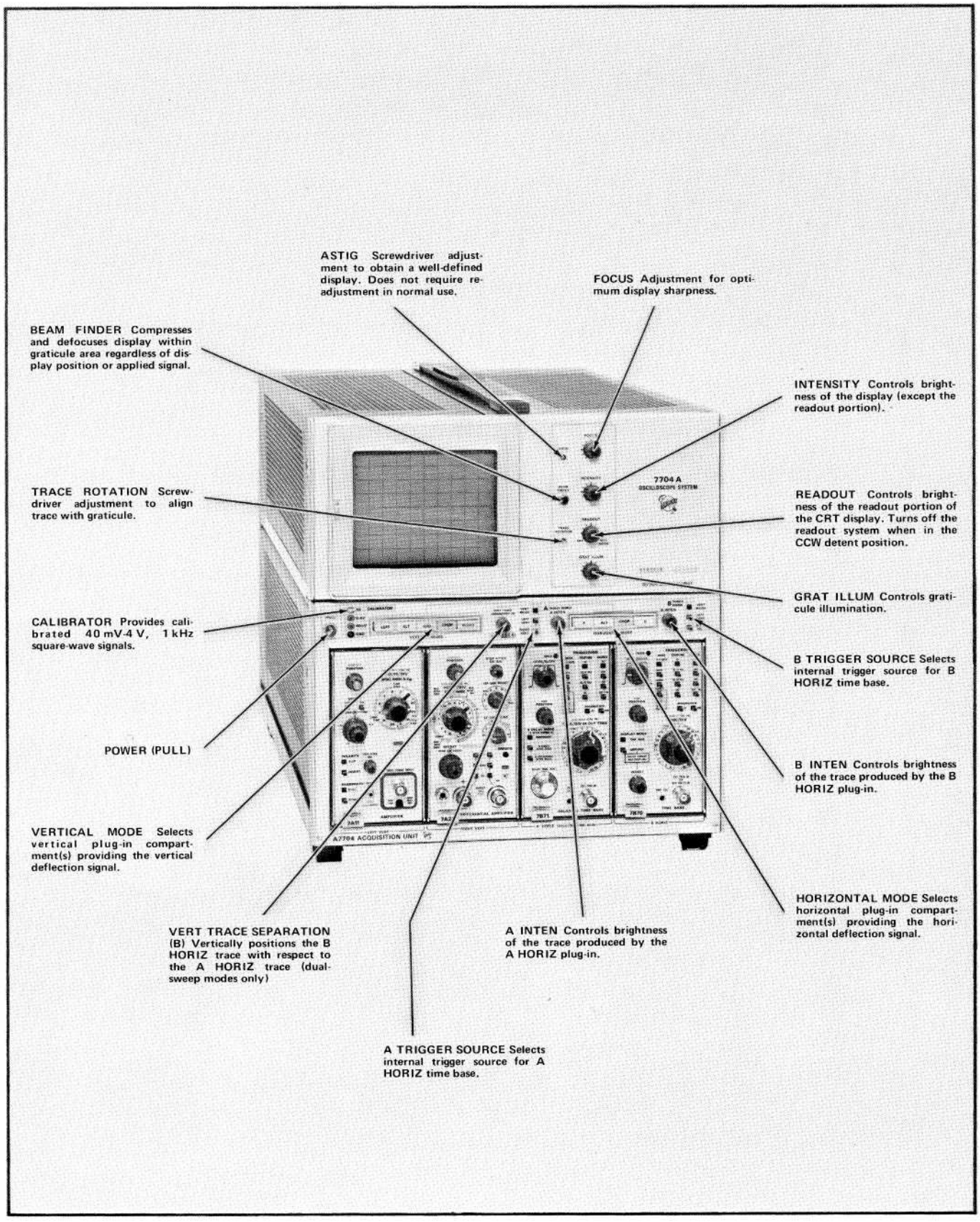
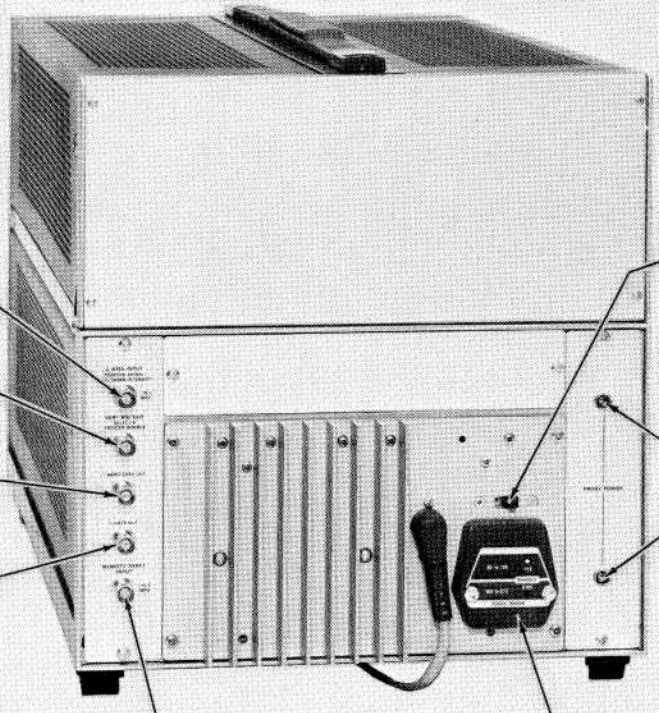


Fig. 1-2A. Front-panel controls and connectors.



Z AXIS INPUT Input for Z-Axis circuit providing intensity modulation of the CRT.

VERT SIG Sample of vertical signal as selected by B TRIGGER SOURCE switch.

+ SAW TOOTH Sample of A Sawtooth or B Sawtooth as selected by an internal switch.

+ GATE Square-wave signal as selected by an internal switch: A Gate; B Gate; or A Dely'd Gate.

CONTROL ILLUM Controls illumination of push-button switches.

PROBE POWER Connectors supplying power to one or two active probes.

REMOTE RESET INPUT Provides remote single-sweep reset when Time base is in Single Sweep Mode.

Line Selector Assembly Selects the nominal line voltage (115 or 230 VAC).

Fig. 1-2B. Rear-panel controls and connectors.

OPERATING CHECKOUT

The following procedure checks the basic operation of the instrument. It may also be used for familiarization with the instrument or as an incoming inspection.

Preliminary

1. Set the front-panel controls as follows:

INTENSITY	Counterclockwise
A INTEN	Midrange
FOCUS	Midrange
B INTEN	Midrange
READOUT	OFF
GRAT ILLUM	Counterclockwise
VERTICAL MODE	LEFT
A TRIGGER SOURCE	VERT MODE
HORIZONTAL MODE	A
VERT TRACE SEPARATION (B)	Midrange
B TRIGGER SOURCE	VERT MODE

2. Connect the instrument to a power source that meets the voltage and frequency requirements of this instrument. If the available line voltage is outside the limits of the Line Selector switch (on rear panel), see "Operating Voltage" in this section.

3. Insert 7A-series amplifier units into both vertical compartments. Insert 7B-series time-base units into both horizontal compartments.

4. Pull the POWER switch to ON. Allow several minutes warmup so the instrument can reach a normal operating temperature before proceeding.

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

6. Set both time-base units for a sweep rate of 0.5 millisecond/division in the auto, internal trigger mode.

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

8. Connect the 4 V CALIBRATOR signal to the input connector of the LEFT VERT unit with the special patch cord (supplied accessory).

9. Adjust the FOCUS control for a well-defined display over the entire trace length. (If focused display cannot be obtained, see "Display Focus" in this section.)

10. Disconnect the input signal and position the trace (with the LEFT VERT unit position control) on the center horizontal line of the graticule. If the trace is not parallel with the center horizontal line, re-adjust the TRACE ROTATION control.

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

Vertical and Horizontal Gain Check

12. Connect the 4 V CALIBRATOR pin-jack to the input connector of either vertical unit using the BNC to pin-jack cable (supplied accessory) and BNC T connector. Connect the output of the BNC T connector to the input of the other vertical unit with a BNC cable.

The display should be two divisions in amplitude with five complete cycles shown horizontally. An incorrect display indicates that the plug-ins need to be recalibrated. See the instruction manual of the applicable plug-in unit for adjustment information.

Vertical and Horizontal Modes

13. Notice that the POSITION controls of only the LEFT VERT unit and the A HORIZ time-base unit have any effect on the displayed trace. Position the start of the trace to the left edge of the graticule with the A HORIZ time-base unit POSITION control. Move the trace to the upper half of the graticule with the LEFT VERT unit POSITION control.

14. Press the RIGHT button of the VERTICAL MODE switch. Also press the B button of the HORIZONTAL MODE switch. Notice that the position controls of only the RIGHT VERT unit and the B HORIZ time-base unit have any effect on the displayed trace.

15. Position the start of the trace to the left edge of the graticule with the B HORIZ time-base POSITION control and move the display to the bottom half of the graticule with the RIGHT VERT unit POSITION control.

16. CHOP VERTICAL MODE. Press the CHOP button of the VERTICAL MODE switch. Turn the B HORIZ time-base unit TIME/DIV switch throughout its range. Notice that a dual-trace display is present at all sweep rates with both vertical units being displayed on each sweep on a time-sharing basis.

17. ALT VERTICAL MODE. Press the ALT button of the VERTICAL MODE switch. Note that two traces are displayed on the CRT. The top trace is produced by the LEFT VERT unit, the bottom trace is produced by the RIGHT VERT unit, and the sweep for both traces is produced by the B HORIZ time-base unit.

Reduce the sweep rate of the B HORIZ time-base unit to 50 milliseconds/division. Notice that the display alternates between the left and right vertical plug-ins after each sweep. Turn the B HORIZ TIME/DIV switch throughout its range. Notice that the display alternates between vertical units at all sweep rates. Return the B HORIZ time-base unit TIME/DIV switch to 0.5 millisecond/division.

18. ADD VERTICAL MODE. Press the ADD button of the VERTICAL MODE switch. The display should be four divisions in amplitude. Notice that the position control of either vertical unit moves the display. Press the LEFT button of the VERTICAL MODE switch.

19. CHOP HORIZ MODE. Press the CHOP button of the HORIZONTAL MODE switch. Turn the TIME/DIV switches of both time-base units throughout their range. Notice that two traces are displayed on the CRT at all sweep rates. Also notice that when both time-base units are set to a slow sweep rate (50 milliseconds/division or slower), both traces are visible on the CRT at the same time.

20. ALT HORIZ MODE. Press the ALT button of the HORIZONTAL MODE switch. Two traces should be present on the CRT. Adjust the VERT TRACE SEPARATION (B) control to move the B trace to the bottom of the graticule area.

NOTE

Both horizontal plug-ins must run individually if the 7704A is to operate in ALT Horiz. Mode.

Turn the TIME/DIV switches of both time-base units throughout their range. Notice that each time-base unit controls one of the traces independent of the other time-base unit. Also notice that when one of the time-base units is set to a slow sweep rate (below about 50 milliseconds/division), sweep alternation is evident, with only one of the traces present on the CRT at a time.

Return the sweep rates of both time-base units to 0.5 millisecond/division. Adjust the A INTENSITY control. Notice that it changes the intensity of the trace produced by the A HORIZ time-base unit only. Likewise, the B INTENSITY control changes the intensity of the trace produced by the B HORIZ time-base unit only. Return both intensity controls to the desired level.

21. CHOP HORIZ-CHOP VERT MODE. Change the input signal from the CALIBRATOR to 0.4 V. Press the CHOP buttons of the VERTICAL MODE and HORIZONTAL MODE switches. Four traces should be displayed on the CRT. If not, adjust the POSITION controls of the vertical units and the VERT TRACE SEPARATION (B) control to position the four traces onto the viewing area. Adjust the POSITION controls of the plug-in units to identify which traces are produced from each of the plug-in units (if vertical units have the identify feature, it can be used to identify the traces). Also, set one of the time-base units to a sweep rate of one millisecond/division. Notice that the vertical deflection produced by the LEFT VERT unit is displayed at the sweep rate of both the A HORIZ and B HORIZ time-base units. The vertical deflection produced by the RIGHT VERT plug-in unit is also displayed at the sweep rate of both the A HORIZ and B HORIZ time-base units.

22. ALT HORIZ-CHOP VERT MODE. Press the ALT button of the HORIZONTAL MODE switch. Notice that the display is very similar to the display obtained in the previous step. The main difference in this display is that the sweeps are produced alternately by the time-base units (noticeable only at slow sweep rates).

23. INDEPENDENT-PAIRS. Press the ALT button of the VERTICAL MODE switch. Connect the BNC to pin-jack cable to the 0.4 V calibrator output. Notice that only two traces are displayed on the CRT. Also notice that one of the traces is produced by the left vertical unit at the sweep rate of the B HORIZ time-base unit and the other by the right vertical unit at the sweep rate of the A HORIZ time-base unit. This feature is called independent-pairs operation, and is obtained only when the VERTICAL MODE switch is in the ALT position and the HORIZONTAL MODE switch is in either the ALT or the CHOP position.

Triggering

24. Press the LEFT button of the VERTICAL MODE switch and the A button of the HORIZONTAL MODE switch. Center the display on the CRT with the LEFT VERT unit POSITION control. Disconnect the input signal from the right vertical unit input connector. Sequentially press all of the VERTICAL MODE switch buttons. Notice that a stable display is obtained in all positions of the VERTICAL MODE switch (straight line in RIGHT position).

25. Press the LEFT VERT button of the A TRIGGER SOURCE switch. Again, sequentially press all of the VERTICAL MODE buttons. Notice that the display is again stable in all positions.

26. Press the RIGHT VERT button of the A TRIGGER SOURCE switch. Sequentially press all the VERTICAL MODE switch 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 A TRIGGER SOURCE switch to VERT MODE.

27. Check that the B TRIGGER SOURCE switch operates in a similar manner to the A TRIGGER SOURCE switch when the B HORIZ time-base unit is selected for display.

Control Illumination

28. Operate the CONTROL ILLUM switch on the rear panel to see that it controls the illumination of the front-panel pushbuttons.

Readout (Deleted by Option 1)

The following three steps apply only to instruments equipped with a Readout System.

29. Turn the READOUT control clockwise until an alpha-numeric display is visible within the top or bottom division of the CRT (reset the FOCUS control if necessary for best definition of the readout). Change the deflection factor of the 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 providing the sweep. Notice that the readout display for the time-base unit changes also as the sweep rate is changed.

30. Set the time-base unit for magnified operation. Notice that the readout display changes to indicate the correct magnified sweep rate. If a readout-coded 10X probe is available for use with the vertical unit, install it on the input connector of the vertical plug-in. 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 probe.

31. Sequentially press all of the VERTICAL MODE HORIZONTAL MODE buttons. Notice that the readout from a particular plug-in occupies a specific location on the display area. If either of the vertical plug-in units is a dual-trace unit, notice that the readout for channel 2 appears within the lower division of the CRT.

Beam Finder

32. Set the vertical deflection factor of the vertical plug-in which is displayed to 0.1 volt/division. Notice that a squarewave display is not visible since the deflection exceeds the scan area of the CRT.

33. Press the BEAM FINDER button. Notice that the display is returned to the viewing area in compressed form. Release the BEAM FINDER switch and notice that the display again disappears from the viewing area.

34. With the BEAM FINDER button pressed in, change the vertical and horizontal deflection factor until the display is reduced to about two divisions vertically and horizontally (when the time-base unit is in the time-base mode, change only the deflection factor of the vertical unit). Adjust the position controls of the displayed vertical and horizontal units to center the compressed display on the graticule. Release the BEAM FINDER switch. Notice that the display remains within the viewing area.

Calibrator

35. Operation of the 0.4 V and 4 V CALIBRATOR outputs has been verified during the above procedure. To check the 40 mV output, connect a lead between it and the left vertical input. Set the vertical deflection factor to 10 mV/division and notice that a four-division squarewave signal is displayed.

Z-Axis Input (Deleted by Option 7)

36. Connect a signal (five volts peak-to-peak minimum) to both the input connector of the displayed vertical unit and the Z-AXIS INPUT connector. Set the sweep rate of the displayed time base to display about five cycles of the waveform. Adjust the amplitude of the signal generator until intensity modulation is visible on the display (change the vertical deflection factor as necessary to produce an on-screen display). The positive peaks of the waveform should be blanked out and the negative peaks intensified. Notice that the setting of the intensity controls determines the amount of intensity modulation that is visible.

37. This completes the basic operating procedure. Instrument operations not explained here, or operations which need further explanation, are discussed under "Detailed Operating Information" on pages 1-9 through 1-17.

SIMPLIFIED OPERATING INSTRUCTIONS

General

The following information will aid in quickly obtaining the correct setting for the 7704A controls to present the various types of displays. The operator should be familiar with the basic function and operation of this instrument before using this simplified procedure. For more detailed operating information on the plug-in units, see their individual instruction manuals.

For simplicity of explanation, these directions recommend using the LEFT VERT and A HORIZ compartments for single-signal and/or single-sweep-rate displays. The other two compartments can be used instead if the procedure is changed accordingly.

Single-Trace Display of One Signal

The following procedure will provide a display of a single signal on one time-base:

1. Connect the signal to the input connector of a vertical plug-in unit installed in the LEFT VERT compartment; install a time-base plug-in unit in the B HORIZ compartment.

2. Set the 7704A front-panel switches as follows:

VERTICAL MODE	LEFT
HORIZONTAL MODE	B
B TRIGGER SOURCE	VERT MODE or LEFT VERT

3. Adjust the plug-in controls for the desired display.

Dual-Sweep-Rate Display of One Signal

The following procedure will display the signal from one vertical plug-in unit on two separate traces at two independent sweep rates:

1. Connect the signal to the input connector of a vertical plug-in unit installed in the LEFT VERT compartment and install time-base plug-ins in both HORIZ compartments.

2. Set the 7704A front-panel switches as follows:

VERTICAL MODE	LEFT
A TRIGGER SOURCE	LEFT VERT
HORIZONTAL MODE	ALT or CHOP
B TRIGGER SOURCE	LEFT VERT

3. Adjust the plug-in controls as needed for the desired display. For more information on choice of dual-sweep modes, see 'Dual-Sweep Displays' on page 0-00.

4. Adjust the VERT TRACE SEPARATION (B) control to position the B Trace somewhat below the A Trace (to avoid confusion when adjusting A INTENSITY and B INTENSITY).

Dual-Trace Single-Sweep-Rate Display of Two Signals

The following procedure will provide a display of two signals on two separate traces at a single sweep-rate:

1. Connect one signal to a vertical plug-in installed in the LEFT VERT compartment, connect the other signal to a vertical plug-in installed in the RIGHT VERT compartment, and install a time-base plug-in in the B HORIZ compartment.

2. Set the 7704A front-panel switches as follows:

VERTICAL MODE	ALT or CHOP
HORIZONTAL MODE	B
B TRIGGER SOURCE	VERT MODE

3. Adjust the plug-in controls as needed for the desired display. For more information on choice of dual-trace mode, see "Alternate Mode" and "Chopped Mode" on page 0-00.

Dual-Trace Dual-Sweep-Rate Display of Two Signals (Independent Pairs)

The following procedure will provide a display having the signal applied to the LEFT VERTICAL unit displayed on one trace at the sweep rate of the B HORIZ time-base unit and the signal applied to the RIGHT VERTICAL unit displayed on another trace at the sweep rate of the A HORIZ time-base unit:

1. Connect one signal to a vertical plug-in installed in the LEFT VERT compartment, connect the other signal to a vertical plug-in installed in the RIGHT VERT compartment, and install time-base plug-ins in the A HORIZ and B HORIZ compartments.

2. Set the 7704A controls as follows:

VERTICAL MODE	ALT
A TRIGGER SOURCE	RIGHT VERT
HORIZONTAL MODE	ALT or CHOP
B TRIGGER SOURCE	LEFT VERT
VERT TRACE SEP (B)	As needed

3. Adjust the plug-in controls as needed for the desired display. For more information, see 'Vertical Alternate Mode' on page 1-13 and 'Horizontal Alternate Mode' on page 1-14.

Delayed-Sweep Display

1. Connect the signal to a vertical plug-in unit installed in the LEFT VERT compartment, install a delaying time-base unit in the A HORIZ (DELAYING TIME BASE) compartment and any 7B-series time-base unit in the B HORIZ compartment.

2. Set the 7704A front-panel controls as follows:

VERTICAL MODE	LEFT
A TRIGGER SOURCE	LEFT VERT
HORIZONTAL MODE	A

3. Follow the procedure given in the delaying sweep time-base unit's Instruction Manual to obtain a stable delayed-sweep display.

4. Set HORIZONTAL MODE to 'A' to obtain an 'A Intensified by B' display; set HORIZONTAL MODE to 'B' to obtain a delayed-sweep display; or use 'ALT' or 'CHOP' HORIZONTAL MODE to display the intensified and delayed displays at the same time.

NOTE

When operating in the delayed-sweep mode, there is no special display relationship between the vertical and horizontal plug-ins (as for independent pairs operation) regardless of the vertical mode selected.

X-Y Display

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

1. Install 7A-series amplifier units in both the LEFT VERT and B HORIZ compartments. (Note: Time-base units may be used in either or both compartments if they provide for amplifier-mode operation.)

2. Connect the Y-signal to the LEFT VERT amplifier input and connect the X-signal to the B HORIZ amplifier input.

3. Press the LEFT VERT button of the VERTICAL MODE switch and the B button of the HORIZONTAL MODE switch.

4. Advance the B INTENSITY control until a display is visible. (If display is not visible, press BEAM FINDER switch and adjust the deflection factors of both amplifier units until display is reduced in size both vertically and horizontally; center the compressed display with the position controls and release the BEAM FINDER.) The amplifier in the A HORIZ compartment controls the horizontal deflection and the unit in the LEFT VERT compartment controls the vertical deflection.

DETAILED OPERATING INFORMATION

Intensity Controls

The 7704A has four separate intensity controls. The A INTEN control determines the brightness of the display produced by the plug-in in the A HORIZ compartment; the B INTEN control determines the brightness of the display produced by the plug-in in the B HORIZ compartment. The INTENSITY control on the display unit affects both A and B traces. The READOUT intensity control affects the brightness of only the readout portion of the CRT display.

NOTE

When using a delaying time-base unit in the A HORIZ compartment in conjunction with a delayed time-base unit in the B HORIZ compartment, the contrast between the intensified and non-intensified portions of the A sweep is dependent upon the setting of the A INTEN control. The higher (further cw) the A INTEN setting the smaller the contrast between the intensified and non-intensified portions of the trace.

To protect the CRT phosphor, do not turn the intensity controls higher than necessary to provide a satisfactory display. (Remember that the light filter reduces the apparent light output from the CRT. When using these filters, avoid advancing the intensity too high.)

If the beam-intensity controls are advanced to a point where the CRT beam current exceeds a potentially damaging level for more than about ten milliseconds, protection circuitry automatically limits the beam current to a safe level. The current is limited to an even lower level when operating in an X-Y mode, or if either time-base unit is set to a slow-sweep rate (even if the time-base unit with slow sweep rate is not selected for display by the HORIZONTAL MODE switch). This reduces the danger of damaging the CRT phosphor with a stationary or slowly moving spot. Since beam-current limiting does not take effect until after about ten milliseconds, the full display intensity is available for most single-shot uses.

Display Focus

This instrument contains an automatic-focusing circuit which maintains optimum focus for all intensity settings after correct setting of the FOCUS control is established. The easiest way to obtain correct setting of the FOCUS control is to set the READOUT intensity control so the readout portion of the display is clearly visible. Then adjust the FOCUS control for best definition of the readout display. If this instrument does not contain the Readout System (Option 1), set the FOCUS control for best definition of a CRT display at low intensity settings.

Astigmatism-Focus Adjustments

If a well-defined display cannot be obtained with the FOCUS control, adjust the ASTIG adjustment as follows:

NOTE

To check for proper setting of the ASTIG adjustment slowly turn the FOCUS control through the optimum setting. If the ASTIG adjustment is correctly set, the vertical and horizontal portions of the display will come into sharpest focus at the same position of the FOCUS control. This setting of the ASTIG adjustment should be correct for any display.

1. Use the special jumper lead to connect one of the CALIBRATOR pin jacks to the input of the vertical unit. Adjust the vertical deflection factor to produce a two- or three-division display.

2. Set the time-base unit for a sweep rate of 0.2 millisecond/division. Set the INTENSITY control so the display is at normal intensity (about midrange).

3. Turn the FOCUS control fully counterclockwise and set the ASTIG adjustment to midrange.

4. Adjust the FOCUS control so the top and bottom of the displayed squarewave are as thin as possible but not elongated.

5. Set the ASTIG adjustment so the top and bottom of the displayed squarewave are as thin as possible.

6. Repeat steps 4 and 5 for the best overall focus.

Beam Finder

The BEAM FINDER switch helps locate a display which overscans the viewing area vertically or horizontally. When the BEAM FINDER switch is pressed, the display is compressed and defocused within the graticule area. To locate and reposition an overscanned display, use the following procedure:

1. Press the BEAM FINDER switch. While the display is compressed, change the vertical and horizontal deflection factors until the vertical deflection is about two divisions high and the horizontal deflection is about four divisions wide (the horizontal deflection needs to be reduced only when in the X-Y mode of operation).
2. Adjust the vertical and horizontal position controls to center the display on the graticule.

3. Release the BEAM FINDER switch; the display should remain within the graticule.

Control Illumination Switch

The CONTROL ILLUM switch on the rear panel determines whether or not the pushbutton switches on the 7704A and the associated plug-in units are illuminated.

Trace Alignment Adjustment

If a free-running trace is not parallel with the horizontal graticule lines, set the TRACE ROTATION adjustment as follows:

Position the trace to the center horizontal line and adjust the TRACE ROTATION adjustment so the trace is parallel with the horizontal graticule lines.

Graticule

The CRT graticule is internally marked on the CRT faceplate to provide accurate, no-parallax measurements. The graticule is divided into eight vertical and ten horizontal divisions. Each division is one centimeter square (except for Option 4, which uses a 0.5 centimeter division). In addition, each major division is divided into five minor divisions at the center vertical and horizontal lines. The vertical gain and horizontal timing of the plug-ins 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 control.

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.

Fig. 1-3 shows the graticule and defines the various measurement lines. The terminology defined here will be used in all discussions involving graticule measurements.

Light Filters

The tinted filter provided with the standard instrument 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, pull outward on the bottom of the plastic CRT mask and remove it from the CRT. Remove the tinted filter (leave the metal light shield in place) and snap the plastic CRT mask back into place. A clear plastic faceplate protector is mounted between the CRT faceplate and the bezel. This faceplate protector should be left in place at all times to protect the CRT faceplate from scratches.

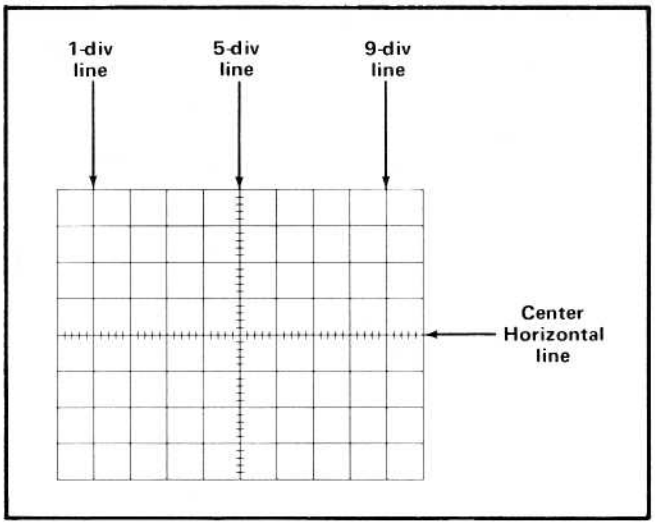


Fig. 1-3. Graticule measurement lines.

An optional mesh filter is available at extra cost (included with Option 3). 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.

Readout

NOTE

If the Readout System is not installed in this instrument (Option 1), disregard the following information.

The Readout System provides an 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 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 behind the right side panel of the Acquisition Unit, see Fig. 1-4) determines the operating mode of the Readout System. When this switch is in the "FR" (Free Run) position, the Readout System operates in a free-running mode to randomly interrupt the waveform display to display characters. The waveform display is interrupted for only about 20 microseconds for each character that is displayed.

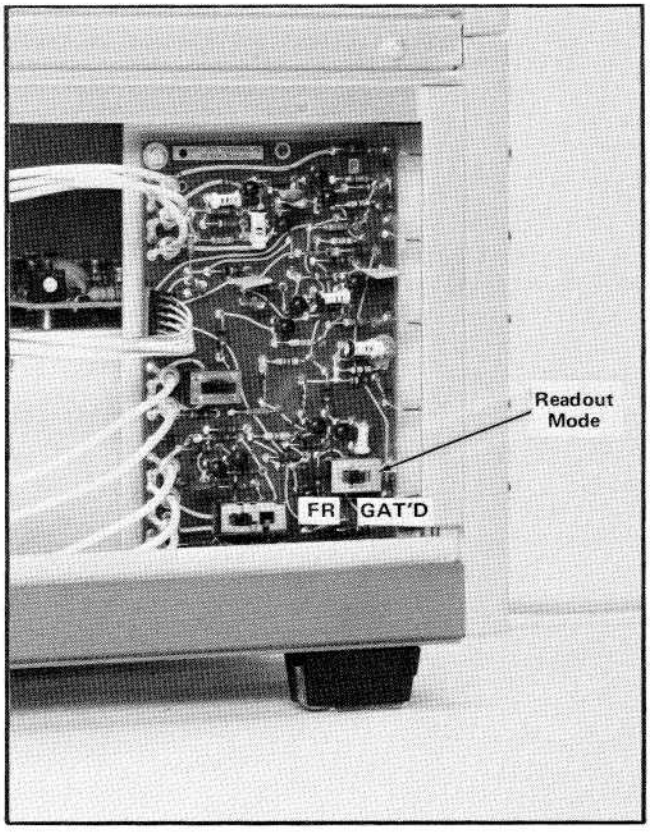


Fig. 1-4. Location of Readout Mode switch (behind right side panel).

In the "Gated" 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. The trigger for the Readout System in the Gate Trig'd position is produced from the sweep gate selected by the Gate switch (located on same board as Readout Mode switch) and is the same as the gate signal connected to the rear panel + GATE connector. A time-base unit must be installed in the selected horizontal compartment.

The readout information from each plug-in is called a word. Up to eight words of readout information can be displayed on the CRT (two channels from each of the four 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. Fig. 1-5 shows the area of the graticule where the readout from each plug-in unit and/or channel is displayed. Notice that the readout from channel 1 of each plug-in unit is displayed in the top division of the graticule and the readout from channel 2 is displayed directly below in the bottom division of the graticule. Only the readout from plug-ins and/or

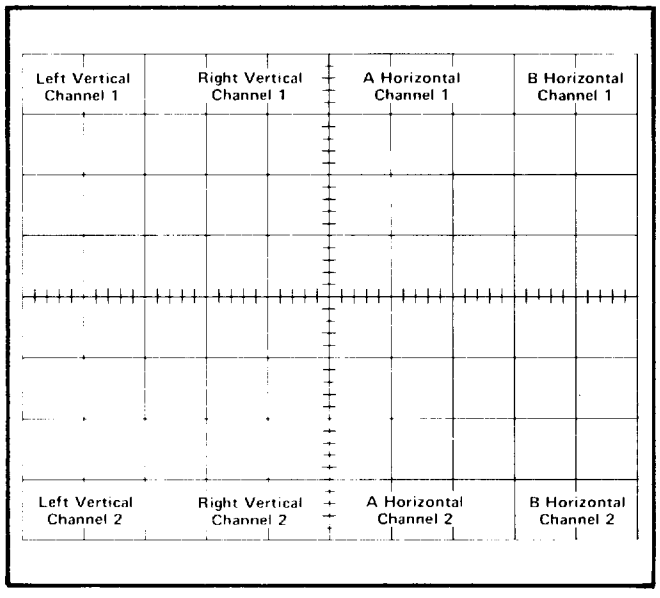


Fig. 1-5. Location of readout on the CRT identifying the originating plug-in and channel.

channels which are selected for display by the MODE switches, appear in the readout display. (Some special purpose plug-in units may over-ride 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 originating 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 which produces a noticeable change in the analog waveform display to identify the associated trace when the "Identify" button is pressed (see the plug-in instruction manuals for details).

The READOUT control determines the intensity of only the readout portion of the display, independent of the other traces. The Readout System is inoperative in the fully counterclockwise OFF position. This may be desirable when the top and bottom divisions of the graticule are to be used for waveform display, or when the trace interruptions necessary to display characters interfer with the waveform display.

NOTE

If the instrument is to be operated with the Readout System board removed, the center conductor of J2004 (on Main Interface Board) must be grounded. Failure to make this wiring change will result in timing error, particularly at fast sweep rates.

Vertical and Horizontal Mode Switch Logic

There are 20 possible combinations of VERTICAL MODE and HORIZONTAL MODE switch settings. The total possible number of display combinations is further multiplied by the variety of plug-in units available for use with this instrument, the interchangeability of plug-ins (i.e., an amplifier or time-base unit can be installed in either of the vertical or horizontal compartments), and by the capabilities of the plug-in units which are used in the instrument (e.g., a dual-trace vertical unit can be used in either of the two single-channel modes, in either dual-trace mode or added algebraically; a delaying time base may be used either for a normal sweep or for delayed sweep). Therefore, it is difficult to list all of the display combinations which can occur using the 7704A and its plug-in units. Table 1-1 lists the combination of VERTICAL MODE and HORIZONTAL MODE switch positions available and the type of display provided with each combination. For further information on operation in each position of the VERTICAL MODE and HORIZONTAL MODE switch positions, see the following sections on Vertical Mode and Horizontal Mode.

TABLE 1-1

Display Combinations[1]

VERTICAL MODE	HORIZONTAL MODE	Comments
LEFT	A B	One trace. Vertical deflection from single units; horizontal deflection from single unit.
	ALT CHOP	Two traces. Vertical deflection from single unit; horizontal deflection from both units.
ALT	A B	Two traces. Vertical deflection from both units; horizontal deflection from single unit.
	ALT CHOP	Two traces. Vertical deflection from both units; horizontal deflection from both units. Provides independent-pairs operation between the LEFT VERT and B HORIZ plug-ins and the RIGHT VERT and A HORIZ plug-ins.

[1] **Combinations given for single-channel vertical and horizontal units only.**

TABLE 1-1 (cont)

VERTICAL MODE	HORIZONTAL MODE	Comments
ADD	A B	One trace. Vertical deflection is algebraic summation of both units; horizontal deflection from single unit.
	ALT CHOP	Two traces. Vertical deflection is algebraic summation of both units; horizontal deflection from both units.
CHOP	A B	Two traces. Vertical deflection from both units; horizontal deflection from single unit.
	ALT CHOP	Four traces. Vertical deflection from both units; horizontal deflection from both units.
RIGHT	A B	One trace. Vertical deflection from single unit; horizontal deflection from single unit.
	ALT CHOP	Two traces. Vertical deflection from single unit; horizontal deflection from both units.

Vertical Modes

Left or Right Modes. When the LEFT or RIGHT button of the VERTICAL 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 VERTICAL MODE switch produces a display which alternates between the LEFT VERT and RIGHT VERT 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 perceptible.

Alternate Mode displays have three types of triggering available. When the A and B TRIGGER SOURCE switches are set to the VERT MODE positions, 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 VERT or the RIGHT VERT positions of the TRIGGER SOURCE switches, the two signals are displayed showing true time relationship. However, if the signals are not time related, the display from the plug-in which is not providing a trigger signal will be unstable on the CRT.

When the ALT vertical mode is selected and either the ALT or CHOP buttons of the HORIZONTAL MODE switch are pressed, the instrument operates in the independent-pairs mode. Under this condition, the LEFT VERT unit is always displayed at the sweep rate of the B HORIZ time-base unit, and the RIGHT VERT unit is displayed at the sweep rate of the A HORIZ time-base unit (non-delayed sweep only). This results in two displays that have completely independent vertical deflection and sweep rate. This display is equivalent to the display obtainable with a dual-beam oscilloscope for most repetitive display combinations.

If delayed-sweep operation is used with this Mode, a different sequence is displayed. First, the LEFT VERT unit is displayed at the sweep rate of the A HORIZ time-base unit (delaying sweep) and then at the sweep rate of the B HORIZ time-base unit (delayed sweep). The vertical display then shifts to the RIGHT VERT unit and its signal is displayed consecutively at the delaying and delayed sweep rate.

Chopped Mode (Vertical). The CHOP position of the VERTICAL 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 slower 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 interfer with the display.

NOTE

An internal Chop. Freq. switch (mounted on the lower-left corner of the Main Interface board) can be set to provide a vertical chop rate of either 100 kHz or 1 MHz. The 100 kHz rate is provided for other systems using the A7704 Acquisition Unit (the bottom half of the 7704A). For normal operation of the 7704A, this switch should be left in the '2 MHz' position.

When the A or B TRIGGER SOURCE switches are set to VERT MODE, internal trigger signals from the vertical plug-ins are algebraically added and the time-base units are triggered from the resultant signal. The LEFT VERT or RIGHT VERT trigger source positions trigger the time-base units on the internal trigger signal from the selected vertical unit only. This allows two time-related signals to be displayed showing true time relationship. (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 VERTICAL MODE switch can be used (1) to display the sum or difference of two signals, (2) for common-mode rejection to remove an undesired signal, or (3) 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 is at least 10:1 at 150 megahertz. The rejection ratio increases to 100:1 at 20 megahertz.

The overall deflection 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-ins 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. The polarity and repetition rate of the applied signals also affect the ADD display.

The following precautions should be observed 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 more than about eight times the vertical deflection factor. For example, with a vertical deflection factor of 0.5 volt/division, the voltage applied to that plug-in should not exceed four 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 VERTICAL MODE switch.

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

Horizontal Modes

A and B. When either the A or B button of the HORIZONTAL MODE switch is pressed, the signal is displayed at the sweep rate of the selected time-base unit. Set the applicable intensity control and trigger source switch for the desired display.

Alternate Mode. The ALT position of the HORIZONTAL MODE switch produces a display which alternates between time-base units after each sweep on the CRT. Although the ALT horizontal mode can be used at all sweep rates, the CHOP horizontal mode provides a more satisfactory display at sweep rates below about 20 milliseconds/division. At slower sweep rates, the switching between the alternate-mode traces becomes apparent and may interfere with correct analysis of the display.

NOTE

This instrument will not operate in the ALT position of the HORIZONTAL MODE switch if either horizontal plug-in compartment is left vacant.

The A and B INTENSITY controls allow individual adjustment of the traces produced by the time-base units in the A HORIZ and B HORIZ compartments. Correct triggering of both time-base units is essential to obtaining the correct display in the ALT horizontal mode. If either of the time-base units does not receive a correct trigger, and therefore, does not produce a sweep, the other unit cannot produce a sweep either. This means that one time-base unit cannot begin its sweep until the previous unit has completed its entire display. This can be avoided if the time-base units are set for auto-mode triggering (sweep free runs if not correctly triggered). See 'Trigger Source' for operation of the A and B TRIGGER SOURCE switches. Also, see 'Vertical Trace Separation' for information on positioning the B HORIZ display when in the ALT dual-sweep mode.

Chopped Mode (Horizontal). When the CHOP button of the HORIZONTAL MODE switch is pressed, the display is electronically switched between the two time-base units at a 2 megahertz rate. In general, the CHOP horizontal mode provides the best display when either of the time-base units is set to a sweep rate slower than about 20 milliseconds/division. It also provides the best display when the two time-base units are set to widely varying sweep rates. In the CHOP horizontal mode, equal time segments are displayed from each of the time-base units. This provides a display which does not change greatly in intensity as the sweep rate of one of the time-base units is reduced (in contrast to ALT horizontal mode operation where the slowest trace tends to be the brightest).

NOTE

An internal Chop. Freq. switch (mounted on the lower-left corner of the Main Interface board) can be set to provide a horizontal chop rate of either 200 kHz or 2 MHz. The 200 kHz rate is provided for other systems using the A7704 Acquisition Unit (the bottom half of the 7704A). For normal operation of the 7704A, this switch should be left in the '2 MHz' position.

The A and B INTENSITY controls allow individual adjustment of the intensity of the traces produced by the time-base units in the A HORIZ and B HORIZ compartments. Triggering is not as critical in the CHOP horizontal mode as in ALT since only the trace from the un-triggered time-base unit is missing from the display if one of the units is not triggered properly. The other trace will be presented in the normal manner. See 'Trigger Source'. Also, see 'Vertical Trace Separation' for information on positioning the trace produced by the B HORIZ unit in relation to the trace from the A HORIZ unit.

Vertical Trace Separation

When one of the dual-sweep horizontal modes is selected, the VERT TRACE SEPARATION (B) control allows the trace produced by the B HORIZ sweep to be positioned above or below the trace produced by the A HORIZ sweep. To use the control, first position the trace produced by the A HORIZ plug-in unit. Then adjust the VERT TRACE SEPARATION (B) control to move the trace produced by the B HORIZ plug-in unit away from the A HORIZ display. If both waveforms are larger than four divisions in amplitude, the displays can only be positioned so they do not directly overlap since each waveform cannot be positioned to a unique area of the CRT.

Trigger Source

The A and B TRIGGER SOURCE switches select the internal trigger signals for the A HORIZ and B HORIZ time-base units. For most applications, these switches can be left in the VERT MODE position. This position is the most convenient since the internal trigger signal is automatically switched as the VERTICAL MODE switch is changed or as the display is electronically switched between the LEFT VERT and RIGHT VERT plug-ins in the ALT position of the VERTICAL MODE switch. It also provides a usable trigger signal in the ADD or CHOP positions of the VERTICAL 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 units receive a trigger signal regardless of the VERTICAL 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 trigger source for either the A HORIZ or B HORIZ time-base unit can be changed to obtain the trigger signal from either the LEFT VERT or RIGHT VERT plug-in. The internal trigger signal is obtained from the selected vertical compartment whether the plug-in 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.

Intensity Modulation

NOTE

The rear-panel Z-AXIS INPUT connector and cable are part of the Signal Buffer Assembly, so are not available if this assembly has been deleted by Option 2.

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. This is accomplished by changing the intensity of the displayed waveform to provide a "gray scale" display.

The voltage amplitude required for visible trace modulation depends on the setting of the INTENSITY controls. Lower amplitude signals can be used to only change the trace brightness. Negative-going signals increase the display intensity and positive-going signals decrease the display intensity.

The sharpest display is provided by signals with a fast rise and fall; bandwidth for this mode of intensity modulation is DC to 10 megahertz, with input voltage derating necessary above two megahertz. The maximum input voltage in this mode should be limited to 15 volts (DC plus peak AC).

Time markers applied to the Z-AXIS INPUT provide a direct time reference on the display. With uncalibrated horizontal sweep or X-Y mode operation, the time markers provide a means of reading time directly from the display. If the markers are not time-related to the displayed waveform, use a single-sweep display.

Calibrator Output

The internal calibrator provides a convenient signal for checking basic vertical gain and sweep timing. The cali-

brator signal is also very useful 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 at the CAL connectors from forty millivolts to four volts in decade steps into high impedance loads. In addition, it provides from 20 millivolts to 0.4 volt into a 50-ohm load.

Current. The optional current loop, when plugged into the 4 V and GND connectors, provides a 40-milliampere output current which can be used to check and calibrate current-measuring probe systems. The current signal is obtained by clipping the probe around the current loop.

Repetition Rate. The repetition rate of the calibrator is one kilohertz. The calibrator circuit uses frequency-stable components to maintain accurate frequency and constant duty cycle. Thus the calibrator can be used for checking the basic sweep timing of time-base units (one-kilohertz rate only).

Wave Shape. The squarewave output signal of the calibrator can be used as a reference wave shape when checking or adjusting the compensation of passive, high-resistance probes. The squarewave output from the calibrator has a flat top so any distortion in the displayed waveform is due to the probe compensation.

Signal Outputs

NOTE

If the 7704A is ordered with Option 7, the Signal Buffer assembly will not be installed in the instrument and the + SAWTOOTH, + GATE, and VERT SIG output signals described below will not be available, along with the Z-AXIS INPUT and REMOTE RESET INPUT features described in the Operating Instructions.

+ Sawtooth. The + SAWTOOTH connector provides a positive-going sample of the sawtooth signal from the time-base units in the horizontal plug-in compartments. The internal Sweep switch (located behind right side panel; see Fig. 1-6) allows the output sawtooth to be selected from the time-base unit in either the A HORIZ or B HORIZ compartments. Rate of rise of the sawtooth output signal is about 50 millivolts/unit of time into a 50-ohm load or about one volt/unit of time into a one-megohm load. Unit of time is determined by the time-base time/division switch (e.g., if 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). The peak output voltage is greater than 500 millivolts into a 50-ohm load or greater than 10 volts into a one-megohm load.

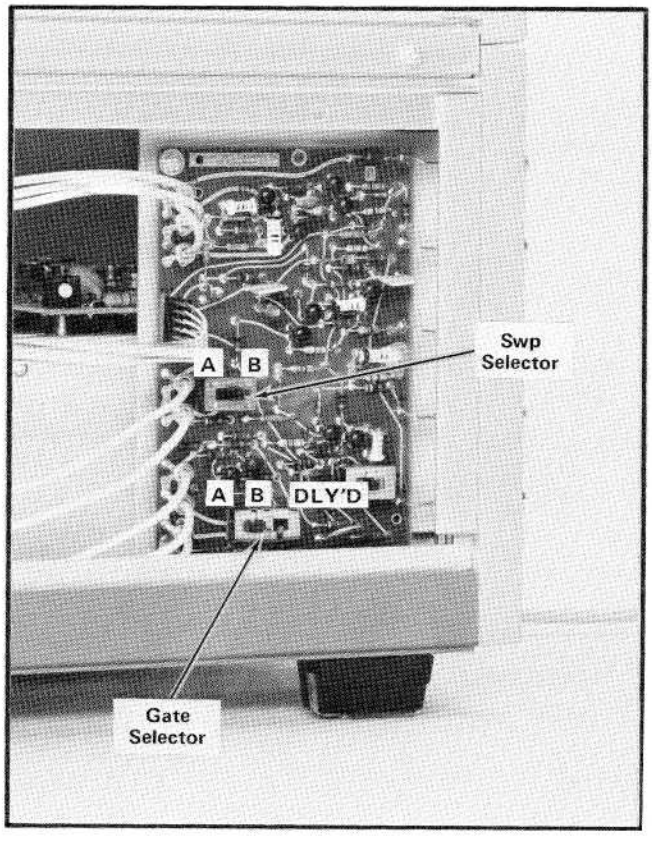


Fig. 1-6. Location of Sweep and Gate switches (behind right side panel).

+ Gate. The + GATE output connector provides a positive-going rectangular output pulse from the time-base units in the horizontal plug-in compartments. The Gate switch (located behind the right side panel; see Fig. 1-6) allows the output signal to be selected from the time-base unit in the A HORIZ compartment, B HORIZ compartment, or the delayed gate from a delaying time-base unit in the A HORIZ compartment. Duration of the gate output signal is the same as the duration of the respective sweep or, in the case of the delayed gate, it starts at the end of the delay period and lasts until the end of the sweep from the delaying time-base unit. Amplitude of the output signal at the + GATE connector is about 0.5 volt into 50 ohms or about 10 volts into one megohm.

Vertical Signal. The VERT SIG OUT connector provides a sample of the vertical deflection signal. The source of the output signal at this connector is determined by the B

TRIGGER SOURCE switch. In the VERT MODE position of the B TRIGGER SOURCE switch, the output signal is determined by the setting of the VERTICAL MODE switch. The output signal in the LEFT and RIGHT positions of the VERTICAL MODE switch is obtained only from the selected vertical unit. In the ALT position of the VERTICAL MODE switch, the output signal at the SIG OUT connector switches between vertical units along with the CRT display. However, the vertical output signal in the CHOP position is a composite signal and is the same as obtained in the ADD position due to the requirements of the triggering system. The LEFT VERT and RIGHT VERT positions of the B TRIGGER SOURCE switch provide the vertical output signal only from the selected vertical unit even when it is not selected for display.

The output voltage into a 50 ohm load is about 25 millivolts/division of CRT display and about 0.5 volt/division of display into a one-megohm load. The bandwidth of the output signal is determined by the vertical plug-in unit which is used (see Systems Specification given in Section 2).

Probe Power

NOTE

The Probe Power circuit is mounted on the Character Readout assembly, so it is not available if the Readout System is not installed (Option 1).

The two PROBE POWER connectors on the rear panel of this instrument provide operating power for active probe systems. It is not recommended that these connectors be used as a power source for applications other than the compatible probes or other accessories which are specifically designed for use with this system.

Remote Single-Sweep Reset (Deleted by Option 7)

Remote single-sweep reset operation can be provided to 7B-series time-base units with compatible features through rear-panel connector J3320. The remote single-sweep reset actuation can be obtained from either an active system (pulse generator, logic circuit, etc.) or a passive system (switch or relay). Requirements for remote single-sweep reset operation are:

Signal required:	Closure to ground (within −5 to +0.5 volt) from a positive level.
Maximum current required:	10 milliamperes.
Minimum pulse width:	10 microseconds at 50% amplitude points.
Maximum input voltage:	15 volts (DC + peak AC).

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 CRT bezel 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).

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 readout portion of the CRT display. The auto-focus feature in this instrument will maintain the traces at optimum focus.

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 Gate Trig'd position (see Readout 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.

APPLICATIONS

The 7704A Oscilloscope and its associated plug-in units make up a very flexible measurement system with capabilities dependent mainly on the plug-ins; typical combinations are described below. See page 0-00 for simplified instructions for setting up some of the basic displays.

More specific applications are described in the Instruction Manual of the individual plug-ins; or see your current Tektronix, Inc. catalog for other plug-ins which might become available after this manual was printed. Contact your local TEKTRONIX Field Office or representative for assistance in making measurements not covered otherwise.

Vertical Amplifier Plug-Ins

The switching logic circuits in the 7704A and its plug-ins allow up to four individual signals to be displayed on the CRT at one time. Several combinations of vertical plug-ins providing such displays are listed below; horizontal sweep units for the displays are described later.

Single-Trace. Any single-channel amplifier can display a single signal, with the sweep provided by any 7B-series time base plug-in. This combination leaves two unused compartments available for other units (e.g., 7D13 Digital Multimeter or a 7D14 Digital Counter). Blank plug-in panels are available to cover any unfilled plug-in compartments.

Dual-Trace. A single Dual-Trace Amplifier (7A12 or 7A18, for example) in either vertical compartment can produce a display of two separate signals with the other vertical compartment free for other uses. The same display can also be generated by two single-channel amplifiers, using both vertical compartments. The two units can be the same type, or can be mixed to offer different input and display configurations.

Three-Trace. A Dual-Trace 7A12 or 7A18 can be used with any single-channel amplifier to provide a plot of three separate signals. If two sweep plug-ins are used in the horizontal compartments, two signals can be displayed at one sweep rate while the other signal is displayed at the other sweep rate.

Four-Trace. Two dual-channel 7A12's or 7A18's can be used to provide a display of four separate signals. If one sweep plug-in provides the sweep signal for the displays, all four signals will be displayed at the same sweep rate.

If two sweep plug-ins are used, the LEFT VERT signals can be displayed at the B HORIZ sweep rate and the RIGHT VERT signals displayed at the A HORIZ sweep rate.

Time-Base Plug-Ins

Although any 7B-series plug-in unit can be used in the 7704A to provide sweep signals for the display, the sweep rates and triggering range of the 7B70 Time Base and the 7B71 Delay Time plug-in units make them especially suitable for most 7704A time-base requirements.

To provide delayed-sweep displays using two time-base units, a 'Delaying Time Base' or 'Dual Time Base' unit must be inserted in the A HORIZ compartment, and any 7B-series can be used in the B HORIZ compartment. A delayed-sweep display can also be provided by only one horizontal plug-in in either horizontal compartment if a Dual Time Base plug-in (such as the 7B92) is used. This leaves the other horizontal compartment available for other plug-ins as suggested later in this section.

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 7704A 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 A and B TRIGGER SOURCE switches 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 and 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. For further information on obtaining X-Y displays see the plug-in unit manuals.

Raster Displays

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 7704A 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 VERTICAL 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 Z-AXIS INPUTS to provide intensity modulation for 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 7704A.

Sampling Displays

The sampling-system plug-ins for the 7000-series oscilloscopes provide displays of fast-changing signals that cannot be examined in any other way. For example, sampling systems available for the 7704A can resolve repetitive signals having less than 10 millivolts of peak amplitude and occuring in less than 1 nanosecond.

The technique used for sampling is very similar in principle to the use of stroboscopic light to study fast motion. Samples of successive waveforms are taken, amplified by relatively low-bandwidth amplifier, and finally shown on the cathode-ray tube to plot a graph that is a replica of the sampled waveform.

Two sampling systems are available at this time for the 7704A: (1) the 7S12, which provides time-domain-reflectometer displays and/or general-purpose measurements; and (2) the 7S11/7T11 systems described below. See your current TEKTRONIX catalog to determine the characteristics of the individual units mentioned below, and of additional units made available after this manual was written.

Single-Trace Sampling. A single-trace sampling display requires either a double-width 7S12 (which includes a time-base), or the 7S11 (vertical) Sampling Unit and the 7T11 Sampling Time Base. Direct interconnections between the 7S11 and the 7T11 require these units to be adjacent, with the 7S11 in the RIGHT VERT compartment and the 7T11 in the A HORIZ compartment. When the 7S12 is used, it must be located in the same two middle compartments to make the proper connections to the 7704A.

Dual-Trace Sampling. Two 7S11's can be used with a single sampling-time-base unit for time-related displays of two signals. Direct interconnections from the LEFT VERT 7S11 pass through the RIGHT VERT 7S11 to reach the A HORIZ time-base unit.

Dual-trace sampling displays can also be made by a 7S12 in the two middle compartments, with a 7S11 in the LEFT VERT compartment. In this application the 7S12 supplies the time-base for both traces.

X-Y Sampling. Two 7S11's mounted in the RIGHT VERT compartment and the adjacent A HORIZ compartment automatically share a 50 kHz free-running strobe condition for X-Y displays.

Single-Trace Sampling with Single-Trace Real Time. A pair of real-time plug-ins can be used with a 7S12 or a pair of sampling plug-ins for convenience in applications requiring frequent use of both types of displays. (This capability is unique to the four-plug-in oscilloscope system.)

Special Purpose Plug-ins

Digital Counter and Multimeter Plug-Ins. The 7D13 Digital Multimeter plug-in measures DC current and voltage, temperature, and resistance; the 7D14 Digital Counter plug-in measures frequency from DC to above 500 MHz. Both plug-ins use the readout system of the oscilloscope to display the measurement information on the CRT, independently of any graphic display on the CRT. They can function in any compartment in combination with each other or with any other plug-ins available for the 7000-series oscilloscopes, provided that the CRT provides a readout display (Option 1 not specified).

The ability of these digital plug-ins to operate with other plug-ins makes it possible to process and monitor the signal at the same time the digital measurement is being made.

For example, by locating the counter in one of the vertical compartments and a vertical amplifier in the other, the CRT can show the 7D14 trigger waveform superimposed on the incoming signal, to indicate the actual triggering point. For another example, if the counter is placed in a horizontal compartment, a low-amplitude signal can be applied to a vertical amplifier and amplified before it is internally routed by the trigger source switches to the 7D14 trigger circuit. This allows the 7D14 to be used on signals too small to trigger other counters.

Transistor-Curve-Trace Plug-In. The 7CT1N Curve Tracer checks small-signal transistors and diodes by producing a display showing the basic characteristic curves for the device being tested. Stepped sweep signals from an internal power supply are applied to the device; the resulting output signals are, in turn, applied to the horizontal and vertical deflection systems of the oscilloscope to plot a family of characteristic curves. This plot can be used to check for damaged transistors and diodes, to select for special or matched characteristics, and to calculate gain, leakage, breakdown voltage, g_m, etc.

Spectrum Analyzer Plug-In. The 7L12 Spectrum Analyzer displays the applied signal's amplitude dispersed over a 300 Hz to 3 MHz portion of the RF spectrum extending from 1 MHz to 1.8 GHz. Absolute signal energy is plotted on the vertical axis against frequency on the horizontal axis. Applications include waveform and distortion analysis, EMI and random noise measurement, filter design, spectrum surveillance, etc.

SPECIFICATION

Many of the measurement capabilities of this instrument are determined by the choice of plug-in units. The characteristics apply to the 7704A Oscilloscope only. See the system specifications in Table 2-2 for characteristics of the complete system.

ELECTRICAL PERFORMANCE REQUIREMENTS

This instrument will meet the electrical characteristics listed following complete calibration as given in the Service Manual. These electrical characteristics apply over an ambient temperature range of 0°C to +50°C, except as otherwise indicated. Warm-up time for given accuracy is 20 minutes.

VERTICAL DEFLECTION SYSTEM

Deflection Factor—Compatible with all 7-series plug-in units

Difference between vertical compartments: 1% or less

Linearity, Low Frequency: 0.1 division or less compression or expansion of center-screen two-division signal when positioned anywhere within the graticule area

Bandwidth—Varies with vertical plug-in; see System Specifications in Table 2-2.

Step Response (Risetime)—Varies with vertical plug-in; see System Specifications

Vertical Display Modes—Selected by front-panel VERTICAL MODE switch:

LEFT: Left plug-in compartment only

ALT: Dual-trace; alternating between vertical plug-in compartments

ADD: Both vertical plug-in compartments added algebraically

CHOP: Dual-trace; chopped between vertical plug-in compartments

RIGHT: Right plug-in compartment only

Isolation Between Vertical Compartments:

DC to 100 MHz: At least 100:1

200 MHz: At least 50:1

Trace Separation Range (Dual-trace displays): B trace can be positioned above and below A trace

TRIGGERING

Trigger Source—Selected by front-panel A TRIGGER SOURCE and B TRIGGER SOURCE switches:

VERT MODE: Signal being displayed as determined by VERTICAL MODE switch; trigger signals are added algebraically when VERTICAL MODE is in CHOP or ADD

LEFT VERT: Left vertical plug-in compartment only

RIGHT VERT: Right vertical plug-in compartment only

HORIZONTAL DEFLECTION SYSTEM

Deflection Factor—Compatible with all 7-series plug-in units

Difference between A HORIZ and B HORIZ compartments: 1% or less

Fastest Calibrated Sweep Rate: 2 ns/div with 7B70; see Table 2-3 for sweep rates with other time-base plug-ins

Display Modes—Selected by front-panel HORIZONTAL MODE switch:

A: A HORIZ plug-in compartment only

ALT: Dual-sweep, alternating between horizontal compartments

CHOP: Dual-sweep, chopped between horizontal compartments

B: B HORIZ plug-in compartment only

Phase Shift when using identical plug-ins: $\leqslant 2^{\circ}$ at 50 kHz

CALIBRATOR

Waveshape: Positive-going squarewave with baseline at zero volts

Voltage Output—

Into 1 Megohm: 40 mV, 0.4 V, and 4 V at front-panel pin jacks; 4 mV and 40 V available to front panel via internal connections

Into 50 Ohms: 20 mV, 0.2 V, and 0.4 V at front-panel pin-jacks; 2 mV available to front-panel via internal connection

Current Output: 40 mA available with current loop accessory 012-0259-00 connected between 4 V pin-jack and ground

Accuracy (Voltage and Current Amplitude):

+15°C to +35°C: Within 1% of specified value

0°C to +50°C: Within 2% of specified value

Repetition Rate—

+15°C to +35°C: 1 kHz, ±0.25%

0°C to +50°C: 1 kHz, ±0.5%

CHARACTER READOUT
(Deleted by Option 1; see page 2-4)

Characters Available: Any character encoded by 7-series plug-in units

Readout Display Triggering—

With Signal Buffer (triggering determined by internal Read-Out Mode switch):

Gated: Triggered at end of selected sweep gate

FR: Free-running (independent of sweep)

Without Signal Buffer, as deleted by Option 7:

Free-running only (independent of sweep)

SIGNAL BUFFER
(Deleted in Option 7; see page 2-5)

VERTICAL SIGNAL OUTPUT
(Deleted in Option 7)

Source of Signal—As determined by B TRIGGER SOURCE switch:

VERT MODE: Signal being displayed (except in VERT CHOP mode)

LEFT VERT: Vertical signal output of LEFT VERT plug-in compartment

RIGHT VERT: Vertical signal output of RIGHT VERT plug-in compartment

Voltage Output—

Into 50 Ohm Load: 25 mV/division of display, ±10%

Into 1 Megohm Load: 0.5 V/division of display, ±10%

Output Resistance, Nominal: 950 ohms

Z-AXIS INPUT
(Deleted in Option 7)

Sensitivity: 2 volts P-P signal provides trace modulation over full intensity range

Minimum Pulse Width: 30 nanoseconds at 2 volts provides usable intensity modulation

Input Voltage—

Maximum: ±15 volts (DC + peak AC)

Polarity: Positive-going signal reduces trace intensity

DC Input Resistance: 500 ohms, ±10%

+ SAWTOOTH OUT
(Deleted in Option 7)

Source—Selected by internal Sweep Selector switch—

A: From A HORIZ plug-in compartment

B: From B HORIZ plug-in compartment

Output Signal—

Amplitude:

50 Ohm Load: ≥0.5 volt P-P

1 Megohm Load: ≥10 volts P-P

Polarity (Into 1 Megohm Load): Positive-going with base line at zero volts ±1 volt

Rate of Rise

50 Ohm Load: 50 millivolts/unit of time[1], ±15%

1 Megohm Load: 1 volt/unit of time[1], ±10%

Output Resistance, Nominal: 950 ohms

+ GATE OUT
(Deleted in Option 7)

Source—Selected by internal Gate Selector switch:

A: From A HORIZ plug-in compartment

B: From B HORIZ plug-in compartment

Dly'd: From delayed sweep of a dual or delaying time-base plug-in in A HORIZ plug-in compartment

Output Voltage—

50 Ohm Load: 0.5 volts, ±10%

1 Megohm Load: 10 volts, ±10%

Output Resistance, Nominal: 950 ohms

Risetime: ≤20 nanoseconds (into 50-ohm load)

[1] **Unit of time selected by time base TIME/DIV switch.**

REMOTE RESET INPUT (Single Sweep)
(Deleted in Option 7)

Reset A & B Sweeps: Requires closure to ground within −5 volts to +0.5 volts from positive level; must sink 10 milliamperes

Minimum Pulse Width: 10 microseconds at 50% amplitude level

Maximum Applied Voltage: 15 volts (DC + Peak AC)

CATHODE-RAY TUBE (CRT)

Accelerating Potential: 24 kilovolts total

Phosphor: P31 (P11 optional at no extra charge)

Graticule: Internal; edge-illuminated with variable-intensity lighting

Size:

With Standard CRT: 8 x 10 cm

With Maximum-Brightness CRT (Option 4): 4 x 5 cm (Size reduced to provide higher writing speed and to increase visibility of low-rep-rate high-speed signals)

TABLE 2-1

Photographic Writing Speed in cm/ns—using Polaroid[2] Type 410 roll film (10,000 A.S.A. rating)

CRT	Camera	P31 Phosphor		P11 Phosphor	
		Without Fogging	Fogged[3]	Without Fogging	Fogged[3]
Standard (8 x 10 cm)	C-27-R with *f*/1.3 1:0.5 lens	≥2.5	≥5.0	≥5.0	≥10.0
	C-51-R with *f*/1.2 1:0.5 lens	≥3.5	≥7.0	≥7.0	≥14.0
	C-52-R with *f*/1.4 1:1 lens	≥1.4	≥2.8	≥2.8	≥5.6
Option 4 (4 x 5 cm)	C-27-R with *f*/1.3 1:0.5 lens	≥3.7	≥7.4	≥7.4	≥14.8
	C-51-R with *f*/1.2 1:0.5 lens	≥5.2	≥10.4	≥10.4	≥20.8
	C-52-R with *f*/1.4 1:1 lens	≥2.1	≥4.2	≥4.2	≥8.4

[2] **Registered trademark of Polaroid Corp.**

[3] **With TEKTRONIX Writing Speed Enhancer.**

POWER SUPPLY

Line Voltage Range—Selected by rear-panel Line Selector switch—

115 Volts Nominal: 90 to 132 volts RMS

230 Volts Nominal: 180 to 264 volts RMS

Line Frequency Range: 48 to 440 hertz

Power Consumption (Maximum) from 60-hertz 115-volt line: 180 watts, 2.5 amperes

Short Circuit Protection: Fold-back current limiting for all supplies except Control Illumination

Probe Power (Deleted if 7704A is ordered with Option 1):

Maximum Power available to each probe connector:

100 milliamperes from each supply (−15 volts, +5 volts, +15 volts)

ENVIRONMENTAL CHARACTERISTICS

Temperature Range—

Operating: 0°C to +50°C

Non-operating: −55°C to +75°C

Warm-up Time for Rated Accuracy: 20 minutes

Maximum Altitude—

Operating: 15,000 feet

Non-Operating: 50,000 feet

Electro-magnetic Interference (EMI)—When equipped with Option 3, meets interference requirements of MIL-1-6181D as follows:

Radiated Interference: Within MIL-1-6181D limits from 150 kilohertz to 1000 megahertz

Conducted Interference: Within MIL-1-6181D limits from 150 kilohertz to 25 megahertz

PHYSICAL CHARACTERISTICS

Ventilation—Safe operating temperature maintained by convection cooling

Finish—Anodized front panel; blue vinyl-painted aluminum cabinet

Overall Dimensions (measured at maximum points)—

Height: 13.6 inches (34.5 cm)

Width: 12.0 inches (30.5 cm)

Length: 22.7 inches (57.7 cm)

Net Weight (instrument without plug-ins)—30 pounds

INSTRUMENT OPTIONS

Option 1

Deletes Readout System and Probe Power circuit. Operation of the instrument is unchanged except that there is no alphanumeric display on the CRT and active probes must use an accessory power supply.

The Readout System and Probe Power functions can be added at any time by ordering the Readout Conversion Kit 040-0613-00.

Option 3

Provides Electro-Magnetic Interference (EMI) shielding to meet MIL-1-6181D limits for radiated interference from 150 kilohertz to 1000 megahertz, and for conducted interference from 150 kilohertz to 25 megahertz.

Any unused plug-in compartments must also be covered with an EMI shielded blank plug-in panel in order to meet the EMI interference specifications. Order or use Tektronix Part No. 016-0155-00 only. One is required for each unused compartment. This applies whether the mainframe was ordered as an Option 3 or modified with the appropriate EMI Conversion Kit.

Option 3 can be added at any time by ordering the EMI Modification Kit 040-0612-00.

Option 4

Replaces the standard CRT with a one-half scan CRT (four by five centimeter graticule area) to provide maximum trace brightness and optimum photographic writing speed.

Option 7

Deletes the Signal Buffer sub-assembly. Operation of the instrument is unchanged except that Vertical Signal Out, + Sawtooth Out, + Gate Out, Z-Axis Input, and Remote Reset Input circuits are no longer provided. In addition, the Readout display cannot be triggered at the end of the sweep but will free-run instead. The circuits deleted by Option 7 can be added at any time by ordering the Inputs/Outputs Kit 040-0619-00.

Option 9

Adjusts vertical circuit performance to extend sine-wave response to 250 MHz (upper −3 dB) when 7A19 is used; +15°C to +35°C.

STANDARD ACCESSORIES

1	Pin-to-BNC Cable	175-1178-00
1	Operators Manual	070-1402-00
1	Service Manual	070-1260-00

SYSTEM ELECTRICAL CHARACTERISTICS

System Environmental Specifications. Operating temperature range is from 0°C to +50°C. Operating altitude to 15,000 feet. Nonoperating to 50,000 feet.

TABLE 2-2

Plug-In Amplifier	Performance Feature	Min Defl Factor	Bandwidth	Risetime	VERT SIG OUT Bandwidth	Accuracy[4] Without Probe	Accuracy[4] With Probe
7A11	Low Capacitance Built-In FET Probe Amplifier	5 mV/div	170 MHz 180 MHz[5]	2.1 ns 2.0 ns[5]	70 MHz		2% (Integral)
7A12	Dual-Channel Amplifier with DC Offset	5 mV/div	105 MHz	3.4 ns	60 MHz	2%	3% (P6053)
7A13	Differential DC Offset, High-Freq CMRR Amplifier	1 mV/div	100 MHz 65 MHz	3.5 ns 5.4 ns	60 MHz 50 MHz	1.5% 1.5%	1.5% (P6053) 1.5% (P6055)
7A14	AC Current Probe Amplifier (2 Current Probes)	1 mA/div	50 MHz 105 MHz	7.0 ns 3.4 ns	40 MHz 55 MHz		2.0% (P6021) 2.0% (P6022)
7A15A, 7A15AN	Low-Cost Conventional Input Amplifier with X10 Gain	5 mV/div (0.5 mV/div)[6]	75 MHz	4.7 ns	55 MHz	2%	3% (P6053) 3% (P6054) 3% (P6061)
7A16	Wide-Bandwidth Conventional Input Amplifier	5 mV/div	160 MHz 170 MHz[5]	2.2 ns 2.1 ns[5]	70 MHz	2%	3% (P6053)
7A17	Low-Cost, Easy to Customize 50 Ω Input Amplifier	50 mV/div	150 MHz	2.4 ns	15 MHz	Adjustable	
7A18, 7A18N	Dual-Channel Amplifier	5 mV/div	80 MHz	4.4 ns	55 MHz	2%	3% (P6053) 3% (P6054) 3% (P6061)
7A19	Wide-Bandwidth 50-ohm Input Amplifier	10 mV/div 20 mV/div	200 MHz 250 MHz[5]	1.8 ns	80 MHz	2%	3% (P6056) 3% (P6056)
7A22	DC-Coupled, High-Gain Differential Amplifier	10 μV/div	1 MHz ±10%	350 ns ±9%	1 MHz ±10%	2%	2% (Any)

[4] Accuracy percentages apply to all deflection factors. Plug-in gain must be set at the deflection factor designated on each plug-in. When a probe is used, the gain must be set with the calibration signal applied to the probe tip. The calibration signal is supplied by an external calibrator whose accuracy is within 0.25%

[5] Obtained with 7704A Option 9 (+20°C to +30°C).

[6] Obtained with X10 gain at reduced bandwidth of 10 MHz.

TABLE 2-3

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 Sweep & Ext Amplifier	2 ns/div	DC to 200 MHz
7B71	Delaying Sweep	2 ns/div	DC to 200 MHz
7B92	Display Switching	2 ns/div	DC to 250 MHz

TABLE 2-4

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

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.