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**TEKTRONIX®**

**465 OSCILLOSCOPE**

SERVICE

INSTRUCTION MANUAL

Tektronix, Inc.  
P.O. Box 500  
Beaverton, Oregon 97005

Serial Number \_\_\_\_\_



# 465 SPECIFICATIONS

## Introduction

The 465 Oscilloscope is a wide-band, portable oscilloscope designed to operate in a wide range of environmental conditions. The instrument is light in weight and compact of design for ease of transportation, yet capable of performance necessary for accurate high-frequency measurements. The dual-channel, DC-to-100 megahertz vertical deflection system provides calibrated deflection factors from 5 millivolts to 5 volts/division. The bandwidth limiting switch reduces interference from signals above about 20 megahertz for viewing low-frequency, low-level signals.

The trigger circuits provide stable sweep triggering to beyond the bandwidth of the vertical deflection system. Separate controls are provided to select the desired mode of triggering for the A and B sweeps. The A sweep can be operated in one of three modes: automatic triggering, normal triggering, or single sweep. A variable trigger holdoff control provides the ability for A sweep to trigger stably on aperiodic signals or complex digital words. The horizontal deflection system has calibrated sweep rates from 0.5

second to 0.05 microsecond/division. A X10 magnifier increases each sweep rate by a factor of 10 to provide a maximum sweep rate of 5 nanoseconds/division in the 0.05  $\mu$ s position. The delayed and mixed sweep features allow the start of the B sweep to be delayed a selected amount from the start of A sweep to provide accurate relative-time measurements. Calibrated X-Y measurements can be made with Channel 2 providing the vertical deflection and Channel 1 providing the horizontal deflection (TIME/DIV switch fully counterclockwise and VERT MODE switch to CH 2). The regulated DC power supplies ensure that instrument performance is not affected by variations in line voltage and frequency. Maximum power consumption of the instrument is approximately 75 watts.

The following instrument specifications apply over an ambient temperature range of  $-15^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$  unless otherwise specified. Warm-up time for specified accuracies is 20 minutes. The calibration procedure given in section 5, if performed completely, will allow an instrument to meet the electrical characteristics listed below.

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## VERTICAL DEFLECTION SYSTEM

### Deflection Factor

Calibrated range is from 5 millivolts to 5 volts per division in 10 steps in a 1-2-5 sequence. Accuracy is within 3%. Uncalibrated VAR control provides deflection factors continuously variable between the calibrated settings, and extends deflection factor to at least 12.5 volts per division in the 5 volts/div position.

### Frequency Response

Bandwidth in both Channel 1 and Channel 2 is DC to at least 100 megahertz. Risetime is 3.5 nanoseconds or less. The AC-coupled lower  $-3$  dB point is 10 hertz or less (1 hertz or less when using a 10X probe). Vertical system bandwidth with the BW LIMIT pushbutton pulled is approximately 20 megahertz.

### Chopped Mode Repetition Rate

Approximately 250 kilohertz.

### Input Resistance And Capacitance

One megohm within 2% paralleled by approximately 20 picofarads.

### Maximum Input Voltage

DC coupled: 250 V (DC + Peak AC) or 500 V P-P AC at 1 kHz or less.

AC coupled: 500 V (DC + Peak AC) or 500 V P-P AC at 1 kHz or less.

### Cascaded Operation (CH 1 VERT SIGNAL OUT Connected to CH 2 OR Y)

Bandwidth is DC to at least 50 MHz with a sensitivity of at least 1 mV/division.

## TRIGGERING

### Sensitivity

DC Coupled: 0.3 division internal or 50 millivolts external from DC to 25 megahertz, increasing to 1.5 divisions internal or 150 millivolts external at 100 megahertz.

AC Coupled: 0.3 division internal or 50 millivolts external from 60 hertz to 25 megahertz, increasing to 1.5 divisions internal or 150 millivolts external at 100 megahertz. Attenuates all signals below about 60 hertz.

LF REJ Coupled: 0.5 division internal or 100 millivolts external from 50 kilohertz to 25 megahertz, increasing to 1.5 divisions internal or 300 millivolts external at 100 megahertz. Blocks DC and attenuates all signals below about 50 kilohertz.

HF REJ Coupled: 0.5 division internal or 100 millivolts external from 60 hertz to 50 kilohertz. Blocks DC and attenuates all signals below about 60 hertz and above about 50 kilohertz.

**Trigger Jitter**

0.5 nanosecond or less at 5 nanoseconds/division with 100 megahertz applied (X10 MAG on).

**External Trigger Input**

Maximum input voltage is 250 V DC + peak AC or 250 V P-P AC (1 kilohertz or less). Input resistance is 1 megohm within 10%.

**LEVEL Control Range**

EXT: At least + and - 2 volts, 4 volts peak to peak.

EXT ÷10: At least + and - 20 volts, 40 volts peak to peak.

**HORIZONTAL DEFLECTION SYSTEM**

**Calibrated Sweep Range**

A Sweep: from 0.5 second/division to 0.05 microsecond/division in 22 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 5 nanoseconds/division.

B Sweep: from 50 milliseconds/division to 0.05 microsecond/division in 19 steps in a 1-2-5 sequence. X10 MAG extends maximum sweep rate to 5 nanoseconds/division.

**Calibrated Sweep Accuracy**

Unmagnified sweep accuracy is ±2% from +20°C to +30°C (+68°F to +86°F) and ±3% from -15°C to +20°C and +30°C to +55°C (+5°F to +68°F and +86°F to +131°F). For the same temperature ranges, magnified sweep accuracy is ±3% and ±4% respectively. Exclude the first and last 50 ns of the 5 ns, 10 ns, and 20 ns magnified sweep rates. Accuracy specifications apply over full ten divisions unless otherwise specified.

Sweep accuracy, over any two or less division portion of the sweep, is ±5%. Exclude the first and last magnified divisions of the 5 ns and 10 ns/div magnified sweep rates. Also exclude the first and last 50 ns of the 5, 10, and 20 ns/div magnified sweep rates.

Mixed sweep accuracy is 2% plus the measured A sweep error when viewing the A sweep portion only. The B sweep portion retains its normal accuracy.

**A Time/Division Variable Range**

Provides continuously variable (uncalibrated) sweep rates between the calibrated settings of the A TIME/DIV switch. Extends the slowest A sweep rate to at least 1.25 seconds/division.

**A Trigger Holdoff**

Increases A sweep holdoff time by at least a factor of 10.

**Delay Time And Differential Time Measurement Accuracy**

	+15°C to +35°C (+60°F to +95°F)	-15°C to +55°C (+5°F to +131°F)
Over One Or More Major Dial Division	±1%	±2.5%
Over Less Than One Major Dial Division	±0.01 Major Dial Division	±0.03 Major Dial Division

**Delay Time Jitter**

Within 0.002% (less than one part in 50,000) of the maximum available delay time when operating on power line frequencies other than 50 Hz.

Within 0.005% (less than one part in 20,000) of the maximum available delay time when operating on 50 Hz power line frequency.

Maximum available delay time is ten times the setting of the A TIME/DIV switch.

**Calibrated Delay Time (A VAR set to calibrated position)**

Continuous from 5 seconds to 0.2 microsecond.

**X-Y OPERATION****Sensitivity**

Same as vertical deflection system.

X Axis deflection accuracy within 4%.

**Variable Range**

Same as vertical deflection system.

**X-Axis Bandwidth**

DC to at least 4 megahertz.

**Y-Axis Bandwidth**

Same as vertical deflection system.

**Input Resistance**

Same as vertical deflection system.

**Input Capacitance**

Same as vertical deflection system.

**Maximum Usable Input Voltage**

Same as vertical deflection system.

**CALIBRATOR****Output**

An approximate 1 kilohertz frequency 30 milliamperere ( $\pm 2\%$ ), 300 millivolt ( $\pm 1\%$ ) square-wave signal.

**Z AXIS INPUT****Sensitivity**

A 5-volt peak to peak signal causes noticeable modulation at normal intensity.

**Usable Frequency Range**

From DC to 50 megahertz.

**SIGNAL OUTPUTS****CH 1 VERT SIGNAL OUT**

Output voltage is at least 50 millivolts/division into a 1 megohm load (at least 25 millivolts/division into a 50 ohm load).

Bandwidth is from DC to at least 50 megahertz into a 50 ohm load.

Output DC level is approximately zero volts.

**A and B +GATE Outputs**

Output voltage is approximately 5.5 volts, positive-going.

**POWER SOURCE****Line Voltages**

110, 115, 120, 220, 230, or 240 VAC (all  $\pm 10\%$ ), depending on the settings of the Line Voltage Selector switch and the Regulating Range Selector assembly, with a line frequency of 48 to 440 hertz. Maximum power consumption is 75 watts at 115 VAC, 60 hertz.

**CATHODE-RAY TUBE****Graticule Area**

Eight by ten centimeters.

**Phosphor**

P31 is the standard phosphor with P11 offered as an option.

**SUPPLEMENTAL INFORMATION****General**

The supplemental information listed here represents limits that, when met, ensure optimum instrument operation. They are, however, not instrument specifications but are intended to be used only as maintenance or operational aids.

**VERTICAL DEFLECTION SYSTEM****Low-Frequency Linearity**

There should be no more than 0.1 division of compression or expansion of a two-division signal at center screen when the signal is positioned to the upper and lower extremes of the CRT graticule area.

**Bandwidth Limiter Bandwidth**

The  $-3$  dB point should be between 15 and 25 megahertz.

### Step Response Aberrations

There should be less than +3%, -3%, or a total of 3% peak to peak aberration on a positive-going step. Add 2% when checking a negative-going step. Position-effect should not cause total aberrations to be more than +5%, -5%, or a total of 5% peak to peak.

### Common-Mode Rejection Ratio

At least 10:1 at 20 megahertz for common mode signals of 6 divisions or less with vertical gain adjusted for best CMRR at 50 kilohertz.

### Step Attenuator Balance

Adjustable to 0.2 division or less of trace shift when switching between adjacent deflection factors.

### Trace Shift As Variable Is Rotated

Adjustable to one division or less.

### INVERT Trace Shift

Two divisions or less when switching from normal to inverted.

### Input Gate Current

0.5 nanoampere or less (0.1 division of deflection at 5 mV/div) from +20°C to +30°C. Four nanoamperes or less (0.8 division of deflection at 5 mV/div) from -15°C to +55°C.

### Channel Isolation

At least 100:1 at 25 megahertz.

### Position Control Range

Twelve divisions up and twelve divisions down from graticule center.

## TRIGGERING

### External Trigger Input Capacitance

Twenty picofarads within 30%.

## HORIZONTAL DEFLECTION SYSTEM

### A Sweep Length

10.5 to 11.5 divisions.

### Magnifier Registration

There should be 0.2 division or less difference at graticule center when switching from MAG on to MAG off.

### Position Control Range

Should be able to position the start of the sweep to the right of graticule center, and the end of the sweep to the left of graticule center.

### Phase Difference Between X And Y Axes Amplifiers

Typically 3° or less from DC to 50 kilohertz.

## CALIBRATOR

### Repetition Rate

Repetition rate accuracy is typically within 25%.

### Output Resistance

Approximately 9.4 ohms.

## EXTERNAL Z AXIS INPUT

### Maximum Input Voltage

Voltages applied to the EXT Z AXIS INPUT connector should be limited to less than 100 volts DC plus peak AC or 100 volts peak to peak AC at 1 kilohertz or less.

## OUTPUT SIGNALS

### Output Resistance

Output resistance of the CH 1 VERT SIG OUT connector is  $\approx 50 \Omega$ .

Output resistance of +A and +B GATE outputs is  $\approx 500 \Omega$ .

## CATHODE-RAY TUBE

### Resolution

Typically at least 15 lines per division horizontally and vertically.

### Geometry

0.1 division or less of tilt or bowing.

### Raster Distortion

0.1 division or less.

### Nominal Accelerating Potential

Approximately 18,500 volts.

# OPERATING INFORMATION

## Introduction

This section of the manual is intended to allow the operator to become familiar with the instrument power requirements, functions of controls and connectors, and how to obtain a few basic displays. For more complete operating information, refer to the 465 Operators Handbook.

## Instrument Repackaging

If this instrument is to be shipped for long distances by commercial means of transportation, it is recommended that it be repackaged in the original manner for maximum protection. The original shipping carton can be saved and used for this purpose. Fig. 5 in the Mechanical Parts List illustrates how to repackage the 465 and gives the part number for the packaging components. New shipping cartons can be obtained from Tektronix, Inc. Contact your local TEKTRONIX Field Office or representative.

## Operating Voltage

### 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.*

This instrument can be operated from either a 115-volt or 230-volt nominal line voltage source, 48 to 440 hertz. The Line Voltage Selector switch in the instrument converts the instrument from one nominal operating voltage to the other. The Regulating Range Selector assembly on the instrument rear panel selects one of three regulating ranges for each nominal line voltage; it also contains the line fuse for overload protection. To select the correct nominal line voltage and regulating range, proceed as follows:

1. Disconnect the instrument from the power source.
2. To convert from 115-volts nominal to 230-volts nominal line voltage, set the selector switch to the 230 volts position (toward the rear of the instrument). Change the line-cord plug to match the power source or use a 115-to-230 volt adapter.

## NOTE

*Color-coding of the cord conductors is as follows (in accordance with National Electrical Code):*

<i>Line</i>	<i>Black</i>
<i>Neutral</i>	<i>White</i>
<i>Safety earth (ground)</i>	<i>Green (or green with yellow tracer)</i>

3. To change regulating ranges, loosen the two captive screws which hold the cover onto the Regulating Range Selector assembly, then pull to remove the cover.

4. Pull out the range selector switch bar (see Fig. 2-1). Slide the bar to the desired position and plug it back in. Select a range which is centered about the average line voltage to which the instrument is to be connected (see Table 2-1).

TABLE 2-1

Regulating Ranges

Range Selector Switch Position	Regulating Range	
	115-Volts Nominal	230-Volts Nominal
Lo (switch bar in bottom holes)	99 to 121 volts	198 to 242 volts
M (switch bar in middle holes)	104 to 126 volts	208 to 252 volts
HI (switch bar in top holes)	108 to 132 volts	216 to 264 volts

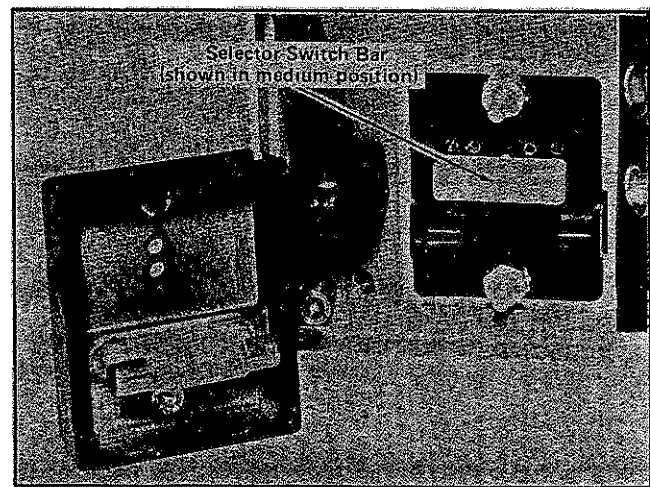


Fig. 2-1. Power supply regulating range selector.

## Operating Information—465

5. Re-install the cover and tighten the two captive screws.

6. Before applying power to the instrument, check that the line voltage selector switch and the indicating tab on the Regulating Range Selector assembly are in the correct position for the desired nominal line voltage and regulating range.



*This instrument may be damaged if operated with the line voltage selector switch or the Regulating Range Selector assembly set to incorrect positions for the line voltage applied.*

The 465 is designed to be used with a three-wire AC power system. If a 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.

The feet on the rear panel provide a convenient cord wrap to store the power cord when not in use.

## CONTROLS AND CONNECTORS

### General

The major controls and connectors for operation of the 465 are located on the front panel of the instrument. A few auxiliary functions are provided on the rear panel. Fig. 2-2 shows the front and rear panels of the 465. A brief description of each control and connector is given here. More detailed operating information is given in the 465 Oscilloscope Operators Handbook.

### Cathode-Ray Tube (CRT) and Display

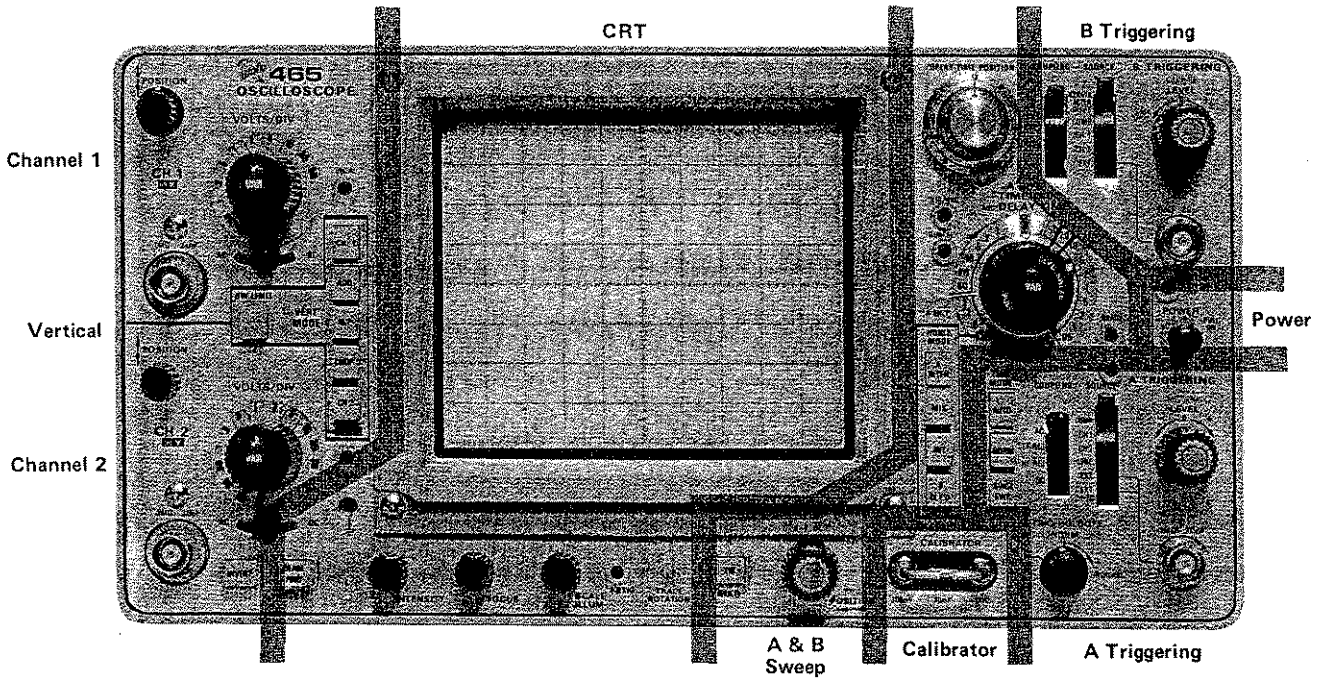
BEAM FIND	Compresses the display to within the graticule area, independently of display position or applied signals.
INTENSITY	Controls brightness of the display.
FOCUS	Provides adjustment for optimum display definition.
SCALE ILLUM	Controls graticule brightness.

ASTIG	Screwdriver adjustment used in conjunction with the FOCUS control to obtain a well-defined display. Does not require readjustment in normal use.
TRACE ROTATION	Screwdriver adjustment to align the trace with the horizontal graticule lines.

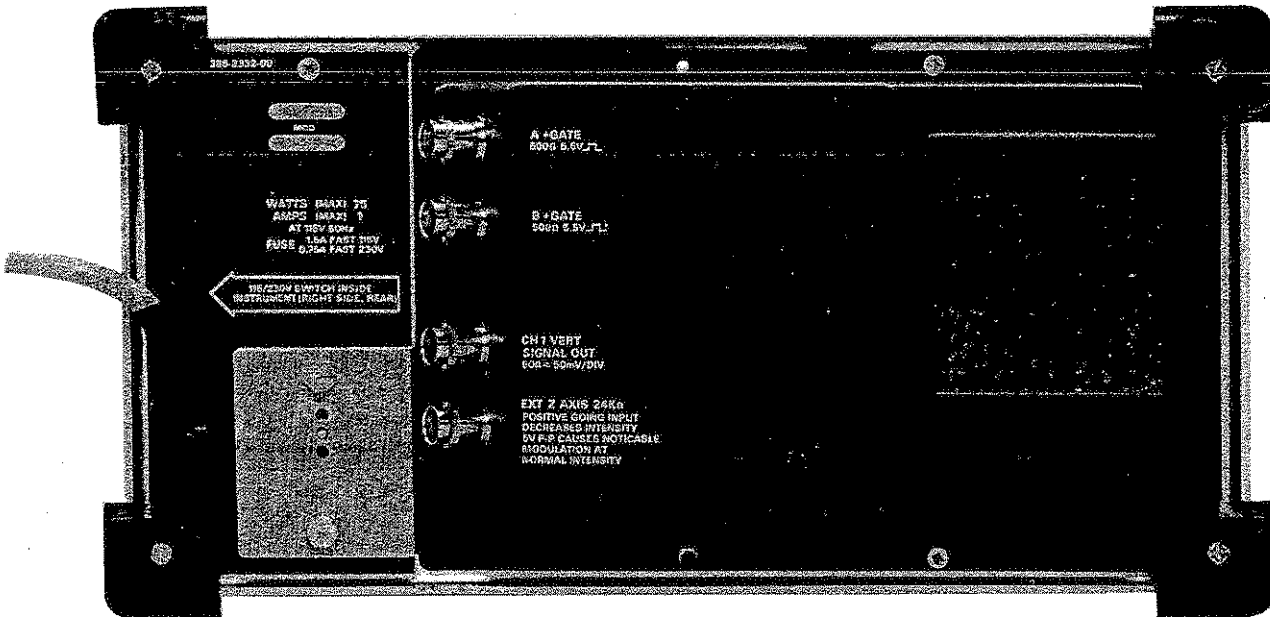
### Vertical Deflection System (Channel 1 & Channel 2)

POSITION	Controls the vertical position of the trace. In the X-Y mode of operation, the CH 2 control positions on the Y-axis (vertically) and the Horizontal POSITION control positions on the X-axis (horizontally).
CH 1 OR X	Input connector for Channel 1 deflection signals or X-axis deflection in the X-Y mode of operation.
CH 2 OR Y	Input connector for Channel 2 deflection signals or Y-axis deflection in the X-Y mode of operation.
GAIN (Side Panel)	Screwdriver adjustment to set the gain of the Vertical Preamp.
VOLTS/DIV	Selects vertical deflection factor in a 1-2-5 sequence (VAR control must be in the calibrated detent for the indicated deflection factor).
VAR	Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.
UNCAL	Light indicates that the VAR control is not in the calibrated position.
Input Coupling (AC-GND-DC)	Selects the method of coupling signal to the input of the Vertical Amplifier.  AC: Signal is capacitively coupled to the Vertical Amplifier. DC component of signal is blocked. Low-frequency limit (lower -3 dB point) is about 10 hertz.  GND: Input signal is removed and the input circuit is grounded. Does not ground the input signal.





A. Front panel.



B. Rear panel.

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

DC: All components of the input signal are passed to the Vertical Amplifier.

20 MHz BW/TRIG VIEW

Dual-purpose switch that, when pulled out, limits the bandwidth of the complete Vertical Deflection System to approximately 20 MHz, or when pressed causes signal present in A Trigger Generator circuit to be displayed on the CRT.

INVERT

Pushbutton switch that inverts the Channel 2 display.

VERT MODE

Selects the vertical mode of operation.

CH 1: Displays Channel 1 only.

ALT: Dual-trace display of signals on both channels. Display is switched between channels at the end of each sweep.

ADD: Signals applied to the CH 1 OR X and CH 2 OR Y connectors are algebraically added and the sum is displayed on the CRT. The INVERT switch in Channel 2 allows the display to be CH 1 + CH 2 or CH 1 - CH 2.

CHOP: Dual-trace display of signals on both channels. Display is switched between channels at an approximate repetition rate of 250 kHz.

CH 2 OR X-Y: Displays Channel 2 only. Must be pushed when operating in X-Y mode.

**A and B Triggering (both where applicable)**

COUPLING

Determines the method used to couple signal to input of trigger circuits.

AC: Rejects DC and attenuates signals below about 60 Hz. Accepts signals above about 60 Hz.

LF REJ: Rejects DC and attenuates signals below about 50 kHz. Accepts signals above about 50 kHz.

HF REJ: Accepts signals between 60 Hz and 50 kHz. Rejects DC and attenuates all signals outside the above range.

DC: Accepts all trigger signals from DC to 100 MHz or greater.

SOURCE

Selects source of trigger signal.

NORM: Internal trigger signal obtained from Vertical Deflection System. Actual source is signal(s) displayed on CRT.

CH 1: A sample of the signal connected to the CH 1 OR X input connector is used as a trigger signal.

CH 2: A sample of the signal connected to the CH 2 OR Y input connector is used as a trigger signal.

EXT: Trigger signal is obtained from signal connected to the External Trigger Input connector.

EXT ÷10 (A trigger circuit only): External trigger signal is attenuated by a factor of 10.

STARTS AFTER DELAY (B trigger circuit only): B sweep starts immediately after the delay time selected by the DELAY-TIME POSITION dial and the DELAY-TIME switch.

LINE (A trigger circuit only): Trigger signal is obtained from a sample of the line voltage applied to the instrument.

SLOPE

Selects the slope of the trigger signal which starts the sweep.

+: Sweep can be triggered from the positive-going portion of the trigger signal.

-: Sweep can be triggered from the negative-going portion of the trigger signal.

LEVEL

Selects the amplitude point on the trigger signal at which the sweep is triggered.

**A TRIG MODE**

Determines the operating mode for the A Trigger Circuit.

**AUTO:** With the proper trigger control settings, A Sweep can be initiated by signals that have repetition rates above about 20 hertz and are within the frequency range selected by the **COUPLING** switch. In the absence of an adequate trigger signal or when the trigger controls are misadjusted, the sweep free-runs to produce a reference trace.

**NORM:** With the proper trigger control settings, A Sweep can be initiated by signals that are within the frequency range selected by the **COUPLING** switch. In the absence of an adequate trigger signal or when the trigger controls are misadjusted, there is no trace.

**SING SWP:** After a sweep is displayed, further sweeps cannot be presented until the **SING SWP** pushbutton is pressed again. The display is triggered the same as for **NORM** operation using the A Triggering controls.

**A TRIG HOLDOFF**

Provides control of holdoff time between sweeps to obtain stable displays when triggering on aperiodic signals (such as complex digital words). Variable can increase holdoff time up to at least 10 times the holdoff time of the **NORM** position. In the **B ENDS A** position (fully clockwise), the A sweep is reset at the end of the B sweep to provide the fastest possible sweep repetition rate for delayed sweep presentations.

External Trigger Input (not labeled)

Input connectors for external trigger signals.

**A and B Sweep**

**DELAY-TIME POSITION**

Provides variable sweep delay between 0.20 and 10.20 times the delay time indicated by the **DELAY TIME** switch.

**A AND B TIME/DIV AND DELAY TIME**

A **TIME/DIV** switch (clear plastic outer flange) selects the sweep rate of the A sweep circuit and selects the basic delay time (to be multiplied by **DELAY-TIME POSITION** dial setting) for delayed-sweep operation. B **TIME/DIV** switch (inner dark knob) selects sweep rate of the B sweep circuit for delayed sweep operation only. **VAR** control must be in calibrated detent for calibrated A sweep rates.

**VAR**

Provides continuously variable A sweep rates between the calibrated settings of the A **TIME/DIV** switch. The A sweep rate is calibrated when the **VAR** control is fully clockwise into the calibrated detent.

**UNCAL**

Light that indicates when the **VAR TIME/DIV** control is out of the calibrated detent and the horizontal sweep rate is uncalibrated.

**X10 MAG Indicator**

Light that indicates when the **X10 MAG** is turned on.

**READY**

Light that indicates that A Sweep has been prepared to present a single sweep upon receipt of an adequate trigger signal.

**HORIZ DISPLAY**

Selects the horizontal mode of operation.

**A:** Horizontal deflection provided by A Sweep. B Sweep inoperative.

**MIX:** The first part of the horizontal sweep is displayed at a rate set by the A **TIME/DIV** switch and the latter part of the sweep at a rate set by the B **TIME/DIV** switch. Relative amounts of the display allocated to each of the two rates are determined by the setting of the **DELAY-TIME POSITION** dial.

**A INT:** Displayed sweep rate determined by the A **TIME/DIV** switch. An intensified portion appears on the display during the B sweep time. This switch position provides a check of the duration and position of the B sweep (delayed sweep) with respect to the delaying sweep (A).

B DLYD: Sweep rate determined by the B TIME/DIV switch with the delay time determined by the setting of the DELAY TIME (A TIME/DIV) switch and the DELAY-TIME POSITION dial.

Horizontal POSITION Positions the display horizontally.  
 X10 MAG Increases the displayed sweep rate by a factor of 10.

**Calibrator and Power**

CALIBRATOR A combination current loop and square-wave voltage output device. Provides a 30 mA square-wave current, 300 mV square-wave voltage signal with a repetition rate of approximately 1 kHz.

POWER Turns instrument power on and off.  
 LOW LINE Light that indicates the applied line voltage is below the lower limit of the regulating range selected by the Regulating Range Selector assembly.

**Rear Panel**

A +GATE Output connector providing a positive-going rectangular pulse coincident with the A sweep time.  
 B +GATE Output connector providing a positive-going rectangular pulse coincident with the B sweep time.  
 CH 1 VERT SIGNAL OUT Output connector providing a sample of the signal applied to the CH 1 input connector.  
 EXT Z AXIS INPUT Input connector for intensity modulation of the CRT display.  
 Regulating Range Selector Selects the regulating range of the internal power supplies (low, medium, high; determined by specific line voltage applied to instrument).

**OBTAINING BASIC DISPLAYS**

**Introduction**

The following instructions will allow the operator who is unfamiliar with the operation of the 465 to obtain the basic

displays commonly used. Before proceeding with these instructions, preset the instrument controls as follows:

**Vertical Controls**

VERT MODE Switch	CH 1
VOLTS/DIV Switches	Proper position determined by amplitude of signal to be applied.
VOLTS/DIV VAR Controls	Calibrated detent
Input Coupling Switches	AC
Vertical POSITION Controls	Midrange
20 MHz BW Switch	Not limited
INVERT Switch	Button out
INTENSITY Control	Fully counterclockwise
FOCUS Control	Midrange
SCALE ILLUM Control	Midrange

**Trigger Controls (both A and B if applicable)**

SLOPE Switch	+
LEVEL Control	0
SOURCE Switch	NORM
COUPLING Switch	AC
TRIG MODE Switch	AUTO
A TRIG HOLDOFF Control	NORM

**Horizontal Sweep Controls**

TIME/DIV Switches	Locked together at 1 ms
A TIME/DIV VAR	Calibrated detent
HORIZ DISPLAY Switch	A
X10 MAG Switch	Off (button out)
POSITION Control	Midrange

**Normal Sweep Display**

1. Set the POWER switch to on (button out). Allow several minutes for instrument warmup.

2. Connect the external signal to the CH 1 input connector.

3. Advance the INTENSITY control until the display is visible. If the display is not visible with the INTENSITY control at midrange, press the BEAM FIND pushbutton and adjust the CH 1 VOLTS/DIV switch until the display is reduced in size vertically. Then, center the compressed display with the vertical and horizontal POSITION controls, and release the BEAM FIND pushbutton. Adjust the FOCUS control for a well-defined display.

4. Set the CH 1 VOLTS/DIV switch and CH 1 POSITION control for a display which remains in the display area vertically.

5. Adjust the A Trigger LEVEL control for a stable display.

6. Set the A TIME/DIV switch and the horizontal POSITION control for a display which remains in the display area horizontally.

### Magnified Sweep Display

1. Preset the instrument controls and follow steps 1 through 6 for obtaining a Normal Sweep Display.

2. Adjust the horizontal POSITION control to move the area to be magnified to within the center graticule division of the CRT. If necessary, change the TIME/DIV switch setting so the complete area to be magnified is within the center division.

3. Set the X10 MAG switch to the on position (button in) and adjust the horizontal POSITION control for precise positioning of the magnified display.

### Delayed Sweep Displays

1. Preset the instrument controls and follow steps 1 through 6 for obtaining a Normal Sweep Display.

2. Set the HORIZ DISPLAY switch to A INT and the B Trigger SOURCE switch to STARTS AFTER DELAY.

3. Pull out the B TIME/DIV switch knob and turn clockwise so the intensified zone on the display is the desired length. Adjust the INTENSITY control to achieve the desired display brightness.

4. Adjust the DELAY-TIME POSITION dial to position the intensified zone to the portion of the display to be delayed.

5. Set the HORIZ DISPLAY switch to B DLYD. The intensified zone on the display noted in step 3 is now being displayed in delay form. The delayed sweep rate is indicated by the dot on the B TIME/DIV switch knob.

6. For a delayed sweep display that will exhibit less jitter, set the B Trigger SOURCE switch to the same position as the A Trigger SOURCE switch and adjust the B Trigger LEVEL control for a stable display. If the A Trigger SOURCE switch is in the LINE position, a sample of the line voltage will have to be supplied to the B Trigger circuit externally.

### Mixed Sweep Display

1. Preset the instrument controls and follow steps 1 through 6 for obtaining a Normal Sweep Display.

2. Pull out on the B TIME/DIV switch knob and turn clockwise to the desired sweep rate. Adjust the INTENSITY control to achieve the desired display brightness.

3. Set the HORIZ DISPLAY switch to MIX. The CRT display now contains more than one time factor on the horizontal axis. The first portion of the display is at the A Time Base sweep rate and the latter part is at the B Time Base sweep rate. The start of the B Time Base portion of the display can be changed by adjusting the DELAY-TIME POSITION control.

### X-Y Display

1. Preset the instrument controls and turn the instrument power on. Allow several minutes for instrument warm-up.

2. Set the TIME/DIV switch to X-Y and the VERT MODE to CH 2. Apply the vertical signal to the CH 2 or Y input connector and the horizontal signal to the CH 1 or X input connector. The CH 2 POSITION control will provide vertical positioning and the Horizontal POSITION control will provide horizontal positioning.

3. Advance the INTENSITY control until the display is visible. If the display is not visible with the INTENSITY control at midrange, press the BEAM FIND pushbutton and adjust the CH 1 and CH 2 VOLTS/DIV switches until the display is reduced in size both vertically and horizontally. Then, center the compressed display with the vertical POSITION controls, and release the BEAM FIND pushbutton. Adjust the FOCUS control for a well-defined display.

