



# TEKTRONIX

*Manufacturers of*

**CATHODE - RAY OSCILLOSCOPES  
AND VIDEO TEST INSTRUMENTS**

AUGUST 1951



## **O**UR CONTINUING CREED

*is that of serving Tektronix customers with products and policies that are unexcelled in the electronics industry and limited only by the current state of the art.*

# TEKTRONIX, INC.

*was organized and incorporated in January 1946 for the purpose of developing and manufacturing cathode ray oscilloscopes. The owners all had extensive wartime electronic experience, in either military or civilian capacities. All hold active supervisory or engineering positions in the organization.*

*In reviewing this backlog of experience, a large portion of which pertained to oscilloscopes, it was felt that a valuable contribution could be made in this field. This decision has been strengthened by the passage of time, and by the exceptional response of science and industry to the efforts that have been put forth.*

*The primary interest of Tektronix is the further development and improvement of the oscilloscope, not only as a "quality observation" device but, increasingly, as an accurate tool capable of precise quantitative measurements of time and amplitude. All present efforts are toward accomplishment of this goal, and all other Tektronix instruments have been developed for the purpose of supplementing and augmenting the operation of the oscilloscope.*



# CONTENTS

## Cathode Ray Oscilloscopes

---

Type 511AD  
Type 512  
Type 513D  
Type 514D  
Type 517

## Square Wave Generators

---

Type 104A  
Type 105

## Auxiliary Amplifiers

---

Type 112  
Type 121  
Type 122

## Miscellaneous Equipment

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Type 51 Camera Adapter  
Type 210 High Voltage Power Supply  
Type 420 High Voltage Power Supply  
Type 500 Scope Mobile

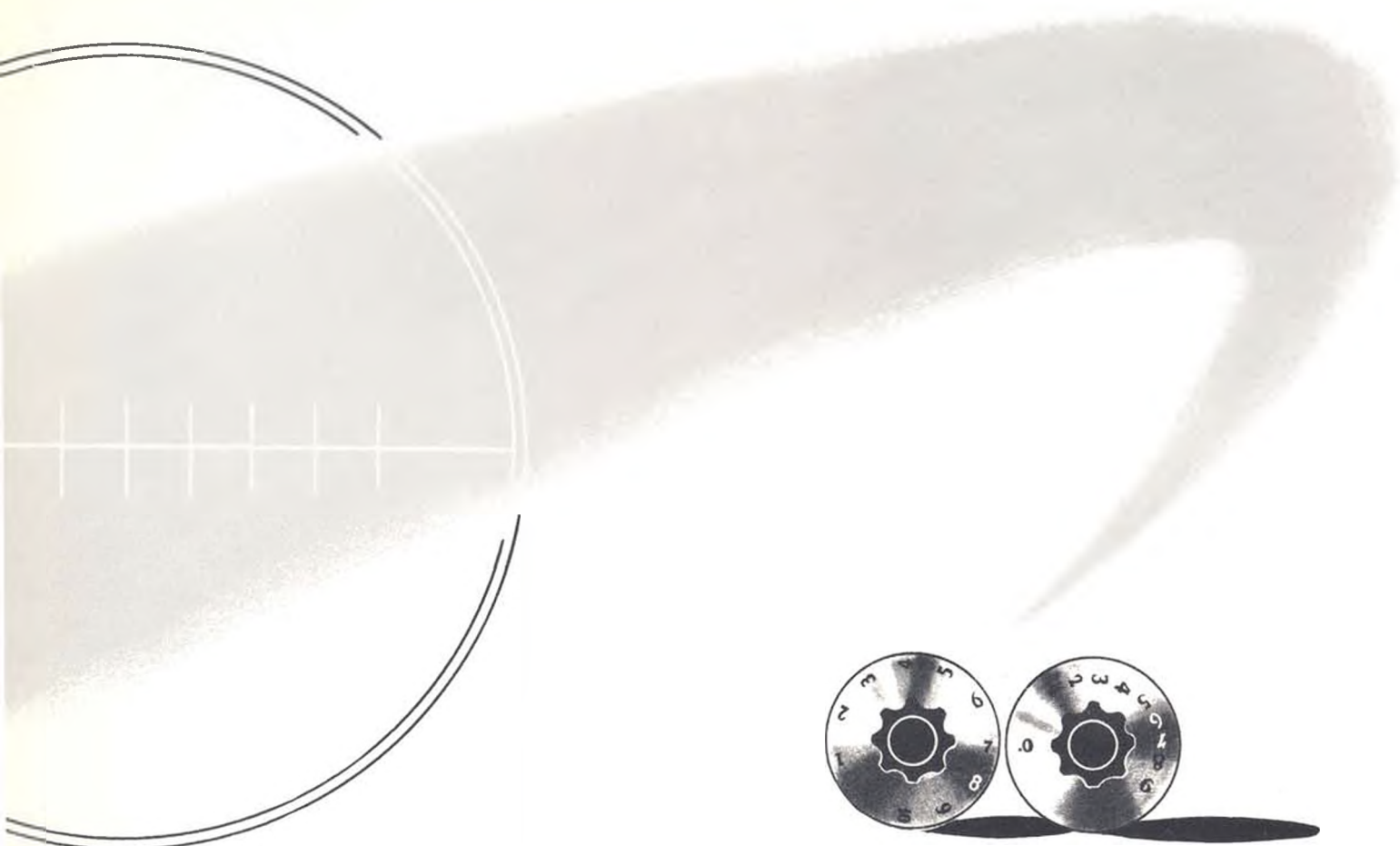
## Accessories

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Probes  
Terminations  
Attenuators  
Matched Cables  
Binding Post Adapters

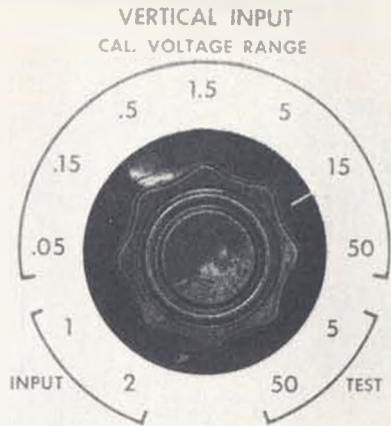






## CATHODE-RAY OSCILLOSCOPES

*Every Tektronix Oscilloscope is, from its inception, considered to be a specialized extension of the operator's senses. It is engineered not only to the highest standards of electronic circuit design, but arranged for maximum operator efficiency. Each instrument is built to conform to the distinctive Tektronix "look" as well as to strict standards of instrument design and layout.*

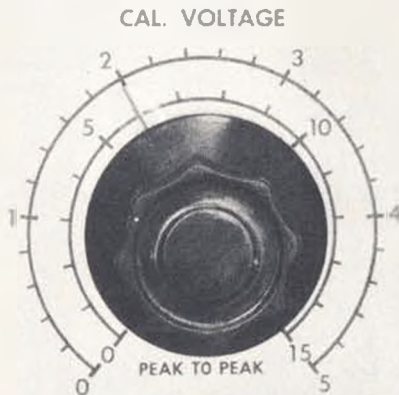


600 V MAX.

INPUT 1

GND.

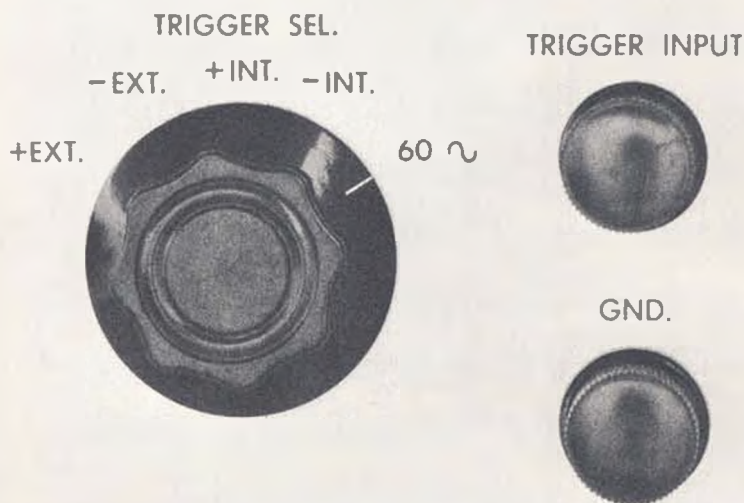
INPUT 2



VOLTAGE CALIBRATOR OF TYPE 514D OSCILLOSCOPE

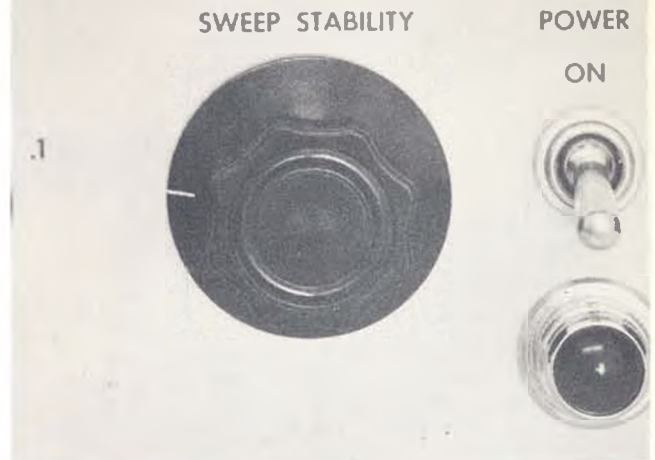
**AMPLITUDE CALIBRATION** — Every Tektronix Oscilloscope contains a built-in voltage calibrator which provides an amplitude measuring facility. According to the type of instrument, the calibrating waveform consists of a 60 cycle sine wave, 60 cycle square wave, or a 1 kc or 10 kc multivibrator controlled square wave.

**TRIGGER SELECTION** — A multi-position switch, mounted on the front panel of Tektronix Oscilloscopes, permits the instrument to be triggered from an observed signal or an external source of negative or positive polarity, or from the 60 cycle line voltage.



TRIGGER SELECTOR OF TYPE 511AD OSCILLOSCOPE

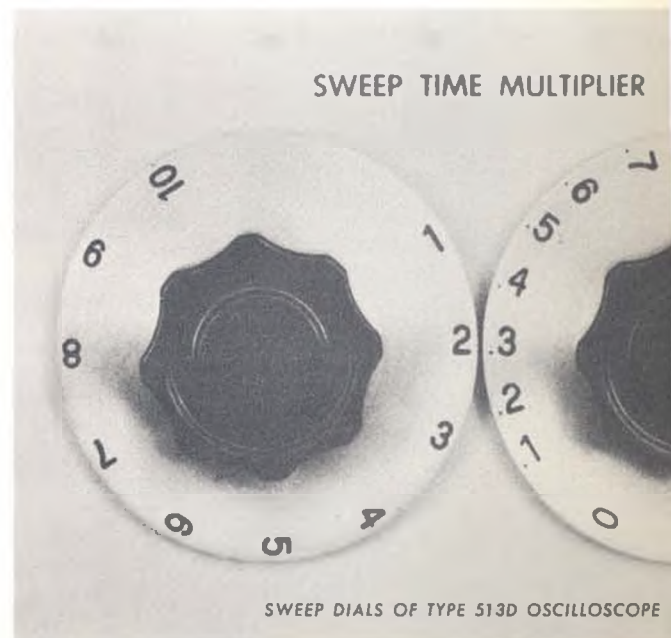
SWEEP STABILITY CONTROL OF TYPE 514D OSCILLOSCOPE



**SWEEP OPERATION** — A simple adjustment of a single control is sufficient to observe a phenomenon which occurs only once, takes place at irregular intervals or recurs with unerring precision. The setting of the sweep stability control determines whether the sweep generator is triggered into operation or is "free-running."

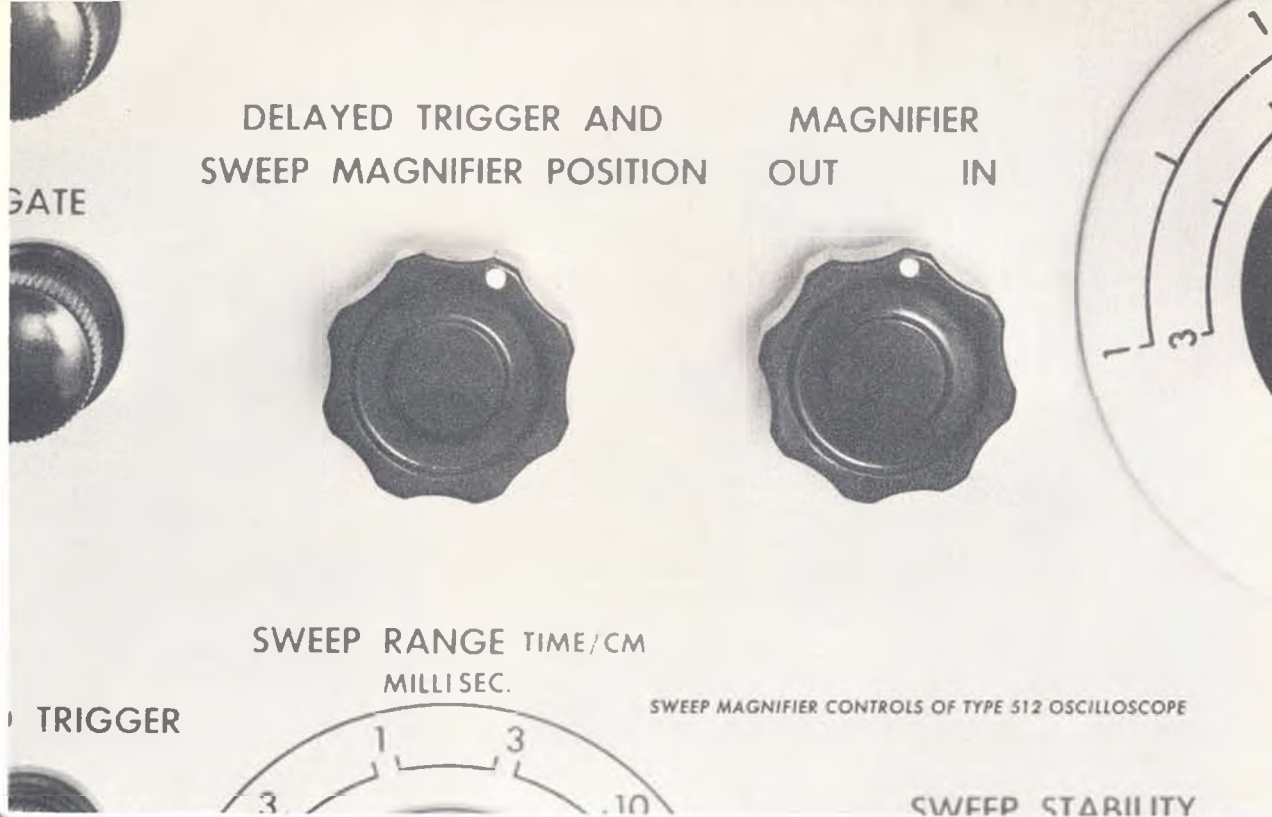
## FINGERTIP CONTROL

**DIRECT READING SWEEP DIALS** — Any "time of occurrence" data, required when measuring an observed waveform, is very simply obtained with Tektronix Oscilloscopes. The sweep indicator dials are calibrated directly in "time/unit distance," and one has only to refer to the illuminated graticule markings to measure the time intervals desired.



SWEEP DIALS OF TYPE 513D OSCILLOSCOPE

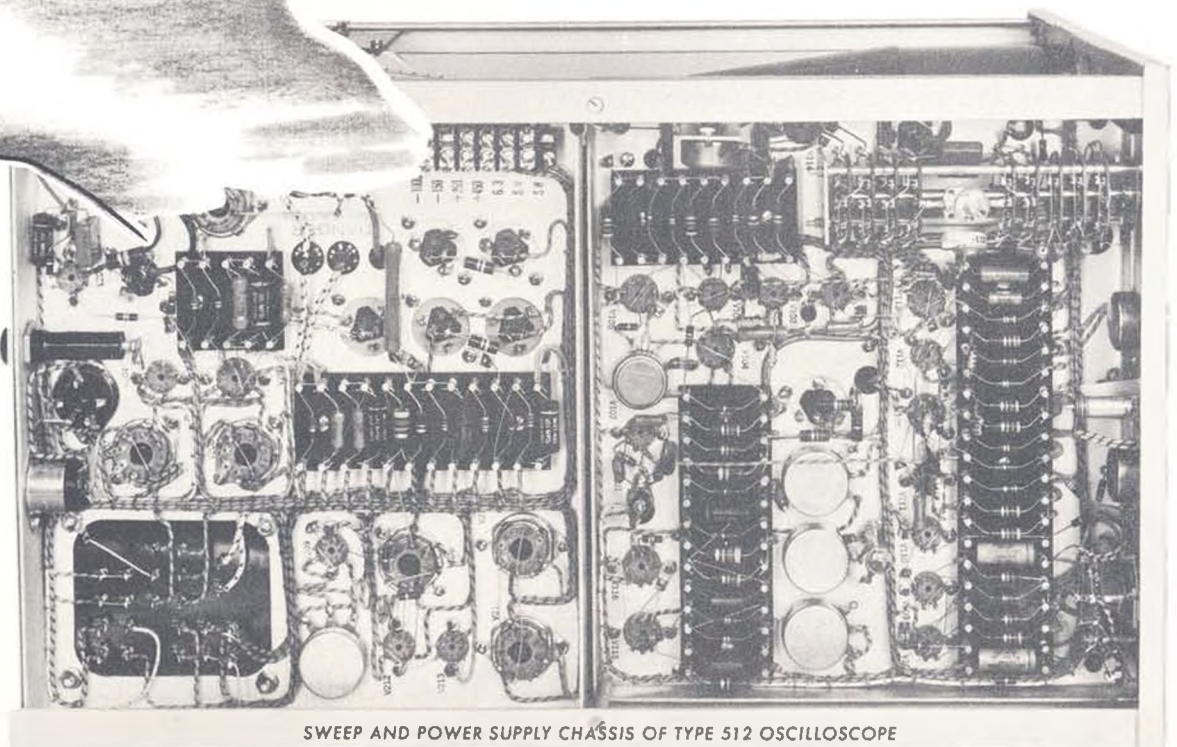




SWEEP MAGNIFIER CONTROLS OF TYPE 512 OSCILLOSCOPE

**SWEEP MAGNIFICATION** — To aid in determining the characteristics of a circuit, detailed scrutiny of certain portions of a waveform is sometimes necessary. Tektronix Oscilloscopes simplify this type of observation with a Sweep Magnifier Control, which enables any 20% of the sweep to be examined at a magnification of 5 times.

**MAINTENANCE** — Ease of maintenance is a prime consideration in the design and construction of a Tektronix Oscilloscope. Components are mounted on boards, leads are fully color-coded, all component parts and connections are exposed as much as possible and every effort is made to make the interior of the instruments accessible to the technician.



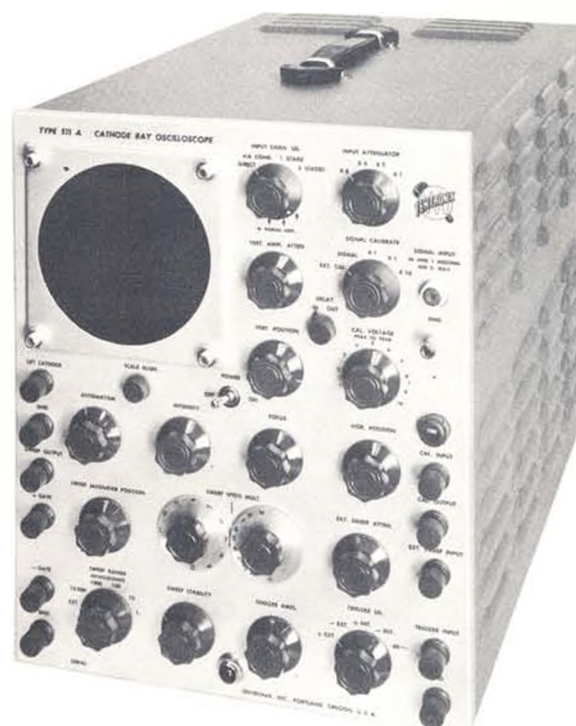
SWEEP AND POWER SUPPLY CHASSIS OF TYPE 512 OSCILLOSCOPE



# TEKTRONIX

## TYPE 511A TYPE 511AD

### CATHODE-RAY OSCILLOSCOPE



#### GENERAL DESCRIPTION

The Tektronix **Type 511A** Cathode Ray Oscilloscope is a moderately priced portable instrument utilizing a 5" tube. The **Type 511A** is similar to its predecessor, **Type 511** except that it now incorporates a regulated power supply and the weight is reduced to 50 pounds.

Its continuously variable triggered sweep circuit synchronizes readily with frequencies as high as 10 megacycles, thus extending oscillographic methods into the broadcast and medium frequency communication bands. The combination of a wide range of triggered sweeps and the excellent transient response of the vertical deflection system, makes possible the observation of a wide variety of pulses and other non-sinusoidal waveshapes.

Both time and amplitude calibrations are provided, permitting quantitative measurements.

#### VERTICAL DEFLECTION SYSTEM

The **Type 511A** is equipped with a very flexible vertical deflection system capable of amplifying or attenuating, as necessary, a wide range of waveshapes. Some of the more important features are:

**Input Channel Selector**—Since the best amplifiers have their limitations, it is desirable to use the minimum number of stages which will give the necessary gain. To make it convenient to do this a switching system is employed which connects the SIGNAL INPUT binding post to the deflection plates in four ways; directly, via a coupling condenser, or via a one or two stage amplifier. This gives the **Type 511A** three basic sensitivities: .25, 2.5 and 25 V per cm. The input impedance of all channels is maintained equal within 1%, making possible the use of the same RC compensated attenuator for any position of the INPUT CHANNEL SELECTOR.

**Input Attenuator**—An RC compensated attenuator with ratios of 1, 2, 4, and 8 provides sensitivities between those which are made available by the INPUT CHANNEL SELECTOR. Since the attenuator is usable on all positions of the INPUT CHANNEL SELECTOR, sensitivities ranging from .25 to 200 V per cm are available. The design of the attenuator is such that its input impedance is the same as that of the oscilloscope alone. Thus, the input impedance of the **Type 511A** is always the same regardless of the control settings.

**Wideband Amplifier**—The vertical amplifiers in the **Type 511A** are designed to provide optimum transient response consistent with reasonable gain and image size. Both high and low frequency compensation is employed.

The high frequency compensation of each oscilloscope is adjusted by observing a one megacycle square wave having a rise time of .02 microseconds. When the compensation is adjusted to provide the optimum rate of rise without overshoot a very smooth response curve is obtained, being only 3 db down at 10 megacycles with one stage, and 3 db down at 8 megacycles with two stages. (Fig. 1.)

The low frequency compensation of each stage is adjusted to produce the flattest top on a 60 cycle square wave. When properly adjusted, the tops are flat within  $\pm 3\%$ . (Fig. 2.)



Fig. 1. 1 megacycle square wave. Fig. 2. 60 cycle square wave.  
Response of 2 Stage Vertical Amplifier.





A cathode follower precedes the output stage to permit the use of a low impedance gain control, thus providing continuously variable attenuation between the steps of the input attenuator.

**Signal Delay Network**—If it is desired to observe the front of a pulse which is being used to trigger the sweep, a delay must be inserted in the signal channel. This may be accomplished by the use of the 24 section Tektronix **Type 1-AD-25** delay network. This delays the signals .25 microsecond without appreciably affecting the pulse shape. All necessary mounting holes are drilled in the **Type 511A** chassis so that incorporation of the network may be accomplished by the owner at any time. When the delay network is not needed, it may be removed by means of a panel switch. If the delay network is installed at the factory, the oscilloscope is designated **Type 511-AD**.

**Probe**—Since the input impedance of the **Type 511A** is the same for any position of the controls it is possible to decrease the loading on the circuit under observation by the use of an RC probe. The probe furnished with the instrument increases the input impedance from 1 megohm shunted by 40 mmf to 10 megohms shunted by 14 mmf, introducing an attenuation of ten.

## HORIZONTAL DEFLECTION SYSTEM

One of the most important features of the **Type 511A** is its very versatile sweep system. The sweep generator used employs a commercial adaptation of widely used radar circuits. A brief description of its more important points follows:

**Triggered Sweep**—A continuously variable, linear, triggered sweep, covering the range of .01 sec/cm to .1 microsec/cm, is available for the first time in a moderately priced oscilloscope. With this type sweep, the beam is cut off in its normal rest position at the left side of the screen until it is turned on and released by an external trigger signal or by the waveshape under observation. It then moves across the screen at a speed determined by the setting of the **SWEEP RANGE** and **SWEEP SPEED MULTIPLIER** controls. At the end of the sweep, the beam is cut off and rapidly returned to the left side of the screen to await another trigger. This type circuit enables the operator to vary the sweep speed without upsetting the synchronism as is inevitable with a conventional sawtooth or recurrent sweep.

The use of a wide band trigger amplifier permits the sweep to be readily synchronized with sine waves of frequencies as high as 10 megacycles or pulses as short as .05 microsecond. Fig. 3 illustrates the excellent linearity of even the fastest sweep and the ability to observe high frequency signals. When triggered by a sharp pulse, the sweep is started and the cathode ray tube is unblanked in less than .1 microsecond.

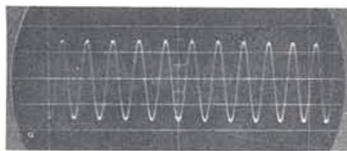


Fig. 3. 10 megacycle sine wave.

**Recurrent Sweep**—If it is desirable to have a sweep without the necessity of providing a trigger, a conventional sawtooth sweep may be obtained merely by readjusting the **SWEEP STABILITY** control.

**Single Trace Sweep**—The triggered sweep in the **Type 511A** inherently provides for single sweep operation. Single sweeps can be triggered either by pulses or by grounding the **TRIGGER INPUT** binding post with a mechanical switch.

**Trigger Selector**—The **TRIGGER SELECTOR** switch enables the sweep to be started by either positive or negative triggers from an external source, from the signal via the vertical amplifier, or from the 60 cycle line voltage.

**Calibrated Sweep Speeds**—The time in microseconds for the sweep to cross the ruled portion of the graticule can be determined with an error of less than 5% of full scale reading by multiplying the **SWEEP RANGE** setting by the readings on the **SWEEP SPEED MULTIPLIER** dials.

**Sweep Speed Magnifier**—A control on the panel allows any selected 20% of the sweep to be amplified five times and thus expanded to cover the entire trace. (Figs. 4, 5.) This is especially useful in examining widely spaced waveshapes such as television sync. pulses.



Fig. 4. Sweep magnifier off.



Fig. 5. Sweep magnifier on.  
20 Microsecond Pulse.

**External Sweep**—The **EXTERNAL SWEEP INPUT** binding post is connected to the horizontal deflection plates via the **EXTERNAL SWEEP ATTENUATOR** and a one stage push-pull amplifier. The entire system is DC coupled, permitting the use of very slow sweeps.

## OTHER FEATURES

**Deflection Polarity Switch**—To increase the undistorted deflection when observing pulses of a particular polarity, provision is made to move the operating point of the push-pull output amplifier from its normal position to one which allows almost the entire output swing to be utilized in either one direction or the other.

A three-position lever-type switch mounted at the rear of the **Type 511-A** and **511-AD** permits the operating bias on grid No.1 of V19 to be varied. With the switch set at the center (normal) position, the bias applied to V19 is equal to the bias of V18, resulting in balanced operation and equal upward and downward undistorted deflection of the trace.

If it is desired to observe pulses, the switch should be set in either the upward or downward position, corresponding to the deflection of the image on the cathode ray tube. In the upward position, the bias of V19 is increased, resulting in decreased output of V19 and increased output of V18, thus permitting greater undistorted upward deflection. These conditions are reversed when the deflection polarity switch is in the downward position.

**Regulated Power Supply**—All DC voltages including the accelerating potential for the CRT are obtained from an electronically regulated supply. Sweep speed, vertical deflection sensitivity and image brightness are unchanged by line voltage variations from 105 to 125 volts. The image stability thus obtained saves many hours of engineering time when quantitative measurements are being made.

**Voltage Calibration**—A 60 cycle sine wave calibrating voltage is provided to measure by comparison the amplitude



of the waveshapes under observation. This is continuously variable, by means of a calibrated potentiometer, from 100 millivolts to 100 volts peak to peak, in three ranges.

**Illuminated Graticule**—An illuminated graticule aids in the measurement of amplitude and duration of waveshapes being observed. By edge lighting the graticule, fine red lines are visible, which do not obscure the tube trace. A color filter is provided to increase the contrast of the trace when viewed in brightly lighted rooms.

**Deflection Plate Connections**—Although a signal can be supplied directly to the deflection plates from the front panel, a side panel is provided which allows the use of short leads to provide a low capacity direct connection to all plates.

**Output Waveshapes**—The sweep sawtooth, and positive and negative square wave gate pulses, having the same duration as the sweep, are available on the front panel.

**CRT Cathode Connection (Z Axis)**—A binding post is provided on the panel for the purpose of receiving blanking pulses or brightness time markers, etc.

## CONSTRUCTION

The **Type 511A** is constructed of the highest quality materials throughout. The three chassis, metal framework, case and front panel are all made of light, strong, electrically welded, aluminum alloys. As can be seen in Fig. 6 the various chassis are supported in a frame making possible a compact instrument with all components readily accessible.

Satin finished aluminum with photo etched lettering is used for the front panel. A light gray baked wrinkle finish is used on the cabinet.

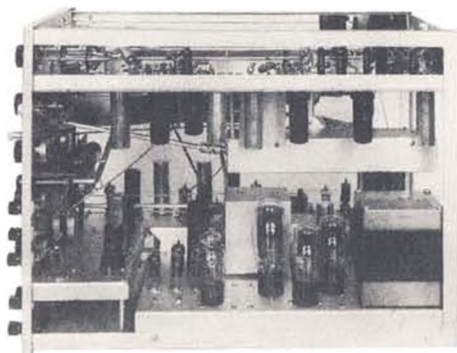


Fig. 6. Interior, compact and all parts readily accessible.

## CHARACTERISTICS

**Signals Observable**—Sine waves, 10 cycles to 10 mc. Pulses, .1 microsecond to 1/50 sec.

**Sweep Circuit**—Hard tube type, either triggered or recurrent as desired.

**Sweep Speeds**—Continuously variable, .1 sec to 1 microsecond for a sweep length of 10 cm.

**Trigger Requirements**—.5 to 50 V (peak) sine wave, or pulses as short as .05 microsecond.

**Sweep Lag**—.1 microsecond, max.

**Sweep Magnification**—5 times indicated sweep speed.

**External Sweep Input**—DC coupled via 100 K pot. and sweep amplifier. Maximum deflection sensitivity, 1.6 V per cm. DC or peak to peak AC.

**Input Attenuator Ratios**—2, 4 and 8. An additional 10 times available by use of PROBE.

**Vertical Deflection Sensitivity**—  
(peak to peak).

Without amplifier, 25 V per cm.

With 1 stage, 2.5 V per cm.

With 2 stages, .25 V per cm.

**Input Impedance**—1 meg. shunted by 40 mmf PROBE, 10 meg. shunted by 14 mmf.

**Vertical Amplifier Bandwidth**—

(3 db down from 1 mc response)

1 stage, 5 cps to 10 mc.

2 stages, 5 cps to 8 mc.

**Vertical Amplifier Transient Response**—

Rise time (10% to 90%):

1 stage, .04 microsecond;

2 stages, .05 microsecond.

**Calibrating Voltage**—Line frequency (50-60 cps). Three ranges, 0-1, 0-10 and 0-100 V peak to peak. Accuracy 5% of full scale.

**Waveforms Available**—Sweep sawtooth, positive and negative gates.

**CRT Cathode Connection**—Via .1 mfd condenser, RC=.012 sec.

**Cathode Ray Tube**—A Type 5CPA tube is used with accelerating potential of 3 kv. A P-1 screen is normally supplied, with P-7 or P-11 screens optional at no additional cost.

**Power Requirements**—105-125 / 210-250 volts, 50-60 cycles, 240 watts.

**Weight**—50 pounds.

**Dimensions**—15½" high, 12½" wide, 21½" deep.

## Vacum Tube Complement

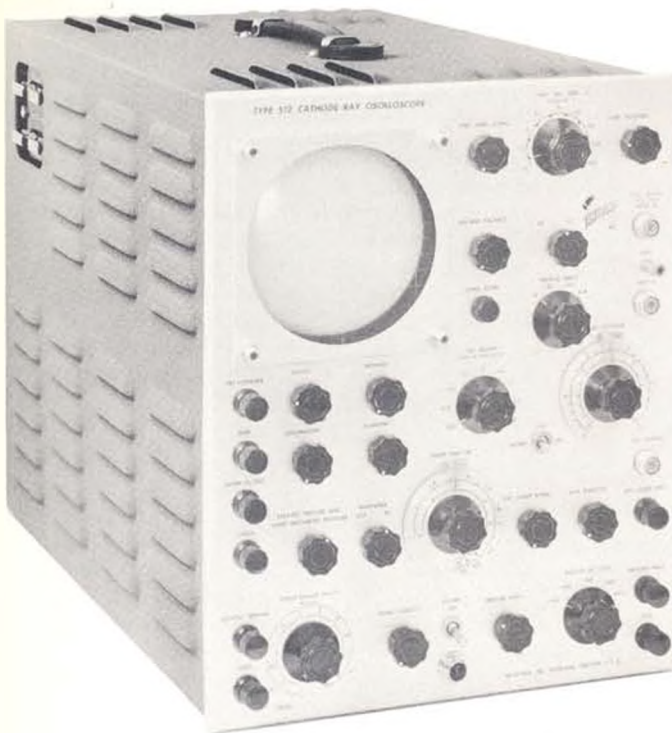
Trigger Phase Splitter	6AC7
Trigger Amplitude Control	6AG7
Trigger Coupling Diode	6AL5
Multivibrator	6AC7
Multivibrator	6AG7
Unblanking Limiter and sweepmagnifier DC restorer	6AL5
Unblanking Cathode Follower	6C4
Gate Output Phase Splitter	6C4
Sweep Generator	6AG7
Sweep Output Cathode Follower	6C4
Sweep Magnifier	6J6
Sweep DC Restorer	6AL5
Sweep Amplifier	2-6AU6
Sweep Voltage Regulator	6C4
Video Amplifier, 1st Stage	6AG7
Video Amplifier, 2nd Stage	2-6AG7
Video Amplifier, Gain Control Cathode Follower	6AG7
Low Voltage Rectifier	2-5V4G
Low Voltage Regulator	6AS7G
Low Voltage Regulator Amplifier	6AU6
Voltage Reference	5651
Sweep Supply Rectifier	6X4
Sweep Supply Regulator	6AQ5
Sweep Supply Regulator Amplifier	6AU6
High Voltage Supply Oscillator	6AQ5
High Voltage Supply Rectifier	2-1B3GT
Bias Rectifier	6X4
Bias Regulator	VR150
Cathode Ray Tube	5CPA

**Price Type 511A \$795.00** f.o.b. Portland, Oregon

**Price Type 511AD \$845.00** f.o.b. Portland, Oregon







# TEKTRONIX

## TYPE 512 CATHODE-RAY OSCILLOSCOPE

### GENERAL DESCRIPTION

The TEKTRONIX **Type 512** is a portable precision laboratory instrument incorporating direct coupled amplifiers throughout. Its sensitivity of 5 mv/cm DC and sweeps as slow as .3 sec/cm solve many problems confronting workers in the fields where comparatively slow phenomena must be observed. The vertical band width of 1 mc at maximum sensitivity (2 mc at lesser sensitivity) and sweeps as fast as 3 microsec./cm make it an excellent general purpose oscilloscope as well.

### VERTICAL DEFLECTION SYSTEM

**Direct Coupled Amplifier** — A high-gain direct-coupled wide-band vertical amplifier provides for observation of an extremely wide range of wave forms. The amplifier is divided into two sections, a pre-amplifier and an output amplifier, each having two push-pull stages. Both sections are used only in the three most sensitive positions of the vertical deflection sensitivity control, i.e. 5 to 150 mv/cm. In the first five positions, with only the output amplifier in use, a bandwidth of 2 mc is available. Because of the requirements of low drift, hum, grid current, etc., the bandwidth of the pre-amplifier is limited to 1 mc by the available tubes. As in all Tektronix instruments, primary emphasis is placed on obtaining excellent transient response rather than flat sine wave response. Each oscilloscope is adjusted for optimum transient response, with sine wave measurements made as an additional check. Since it is frequently desirable to observe only the AC components, a switch on the front panel permits optional insertion of coupling capacitors. To insure stability

when operating as a DC amplifier, the heaters of the 1st, 2nd, cathode follower and 3rd stages are supplied by direct current from an electronically regulated power supply.

**Balanced Differential Input** — Extreme versatility of input is provided by a differential amplifier which permits optional single ended or push-pull input. In the push-pull connection the differential feature minimizes effects of the in-phase components. At full gain of the amplifier, one volt of in-phase signal will produce less deflection than 5 mv applied between the inputs. The differential input also provides a ready means of mixing two signals without interaction or frequency discrimination.

The **Type 512** Oscilloscope permits full cycle observation of frequencies as low as 1/3 cps or of pulses as long as 3 sec. It can be synchronized with frequencies of at least 1 mc or higher, and pulses of as short as 1  $\mu$ sec will trigger the sweep.

**Sensitivity Control** — Two controls are provided to enable the **Type 512** to display a wide range of signal amplitudes. The vertical deflection sensitivity control inserts RC compensated attenuators and simultaneously removes or inserts the pre-amplifier as necessary to provide eight degrees of sensitivity in steps of approximately three times. The second control is a low impedance potentiometer in a cathode follower circuit giving continuous attenuation to fill in the steps. All attenuators are in balanced pairs on both sides of the push-pull amplifier.

**Direct Connection to Deflection Plates** — Since it is often desirable to make a low capacity, direct connection to the deflection plates, terminals are accessible ex-





ternally through a side panel in the case. The terminals are of the banana jack type, being inter-connected with jumper plugs.

**Probes** — The **Type 512** is supplied complete with 2 probes on 42-inch cables. The probes have an attenuation of ten and an input impedance of 10 megohms with a capacity of approximately 14 mmf.

## HORIZONTAL DEFLECTION SYSTEM

**Sweep Generator** — The **Type 512** employs a screen-coupled phantastron as the basic sweep generator. An adaptation of a circuit developed in England during World War II, it is similar to the well known "bootstrap" circuit used in the United States in radar applications. One of the important differences is that the output is taken from the plate, rather than from the cathode circuit, doing away with the necessity for a floating power supply between the grid and cathode.

The circuit is capable of excellent inherent linearity, which makes it ideal for precision sweep generation. It is additionally useful because the positive screen pulse is available for operating the blanking circuits.

**Sweep Amplifier** — The sweep amplifier, which is direct-coupled, provides the 350 v swing necessary to deflect the electron beam from one side of the CRT screen to the other. A constant average potential at the deflection plates is maintained — by the balanced output of the stages — to prevent defocusing the spot as it moves across the screen. The gain of the amplifier can be adjusted by an internal control to compensate for variations in cathode ray and sweep amplifier tubes.

**External Sweep Input** — A front panel binding post permits connection of external sweep generators to the **Type 512** via a continuously variable attenuator and the direct coupled push-pull sweep amplifier. The maximum sensitivity is 1.5 v/cm.

**Sweep Time Calibration** — To minimize the need for timing markers, the instrument is adjusted at the factory to provide an accuracy of sweep timing well within 5%. Two controls are provided, a ten position switch and a carefully calibrated potentiometer which provides approximately 9 inches of logarithmic scale per decade of sweep range. Convenient and accurate time determinations of observed phenomena are thus facilitated. This accuracy is made possible by the use of stable precision components and electronically regulating all DC voltages — including the CRT accelerating potentials—against line voltage variations.

**Sweep Magnification** — Frequently it is desirable to examine more closely a portion of a waveform which occurs at such a time on the trace that observation at a faster sweep rate is not feasible or possible. The sweep magnifier permits convenient 5X magnification of any desired 20% of the sweep. The accuracy and linearity of the main sweep is retained by the use of a separate sweep generator which consists of a modified "Miller rundown" circuit.

**Trigger Selector** — The trigger selector switch enables the sweep to be triggered from an external source or by the signal being observed. It thus permits the ob-

servation of a randomly occurring phenomenon or a single pulse. By a slight readjustment of the sweep stability control, a recurring sawtooth of extremely stable frequency characteristic is obtained. The sweep can also be synchronized with the power line frequency.

**Carrier Blanking** — Because of the slow sweeps and long waiting periods possible with the **Type 512**, conventional capacity coupled blanking of the CRT is unsatisfactory. To overcome this difficulty, the positive waveform from the screen of the sweep generator is used to control the operation of an RF carrier system which conveys the blanking voltage to the grid of the CRT during the flyback and waiting period of the sweep generator. Thus, when the CRT is unblanked, its grid bias is uniform regardless of the sweep time or repetition rate.

## ADDITIONAL FEATURES

**Amplitude Calibrator** — Amplitude calibration is accomplished by means of a comparison 1 kc square wave whose amplitude is continuously variable in nine ranges, from 5 millivolts full scale to 50 volts full scale. Two scales, 0-5 and 0-15 are provided on the dial of the output potentiometer. Accuracy of measurement exceeds  $\pm 5\%$  of full scale. When the **Type 512** is used direct coupled, the reference side of the square wave remains fixed as the amplitude is varied. A choice of upward or downward deflection is available. Besides performing its primary function of amplitude calibration for the oscilloscope, the 1 kc. square wave is available for checking the adjustment of the RC attenuators and probes incorporated in the video deflection system and for external use as a test signal for adjustment of other RC attenuators, measurement of amplifier gain, etc.

**Edge-Lighted Graticule** — The CR tube face is covered by a plastic edge-lighted graticule having scribed reference lines marked off in centimeters. These lines appear in a color complementary to that of the color filter which is used to improve the trace contrast under high ambient light conditions.

If the vertical amplifier is set to a known sensitivity, voltage readings of any portion of a waveform can be obtained directly from the illuminated reference lines. Time durations can be read in a like manner as the sweep time/cm is known from the setting of the sweep time dial.

**Delayed Trigger** — To provide a trigger for pulse generators, nerve stimulators, etc., whose effects are to be observed on the **Type 512**, a delayed trigger pulse can be made to occur at any point on the sweep. The position of the pulse on the sweep remains fixed as the sweep time is varied.

**Sweep Output** — To facilitate operation of external cathode ray or time delay equipment, the sweep waveform is made available at a front panel connection. The output is taken from a cathode follower circuit, in order that the sweep generator might be isolated from any effects caused by the external load.

**Positive Gate** — In the observation of certain phenomena which occur in a random manner, it frequently is desirable and necessary that auxiliary equipment operate only for the duration of the sweep. A positive gating



voltage, which is obtained from the screen of the phantastron, is available for the control of this type of operation. Isolation circuits prevent the external load from interfering with the operation of the sweep generator.

**Intensity Modulation** — Frequently a waveform is of such complexity that timing or marking pulses cannot easily be observed when superimposed on it. An RC coupling network provides for introducing blanking or brightening pulses to the cathode of the CRT, thus permitting intensity modulation of the trace.

**Cathode Ray Tube** — A Type 5CPA tube is used with accelerating potential of 3 kv. A P-7 screen is normally supplied, with P-1 or P-11 screens optional at no additional cost.

**Time Marker Input** — For those applications where timing markers are needed, an over-biased amplifier provides for their introduction, via a coaxial input, without interaction with the observed waveform.

## CHARACTERISTICS

**Sweep Circuit** — Phantastron followed by push-pull linear amplifier. Triggered, recurrent or single sweeps as desired.

**Sweeps** — Continuously variable from .3 sec/cm to 3 microseconds/cm in ten calibrated ranges. Calibration accuracy  $\pm 5\%$ .

**Magnification** — Any desired 20% of the sweep can be spread over the entire trace.

**External Sweep Input** — Via 100 K potentiometer and DC coupled amplifier. 1.5 v/cm maximum sensitivity.

**Trigger Requirements** — Triggers from signals being observed which produce deflection of 5 mm. or greater. External triggers of either polarity, pulses or sine waves. .5 v or larger.

**Vertical Deflection Sensitivity (peak to peak)** — Direct to plate — 5 v/cm. Via amplifier 5 mv. to 50 v/cm. Sensitivity reduced by a factor of 10 when probe is used.

**Input Impedance** — 1 meg. shunted by 45 mmf. With probe 10 meg. and 14 mmf.

**Vertical Amplifier Response** — For sensitivities of .15 v/cm or lower: Bandwidth DC to 2 mc. Rise time .2 microsec. For sensitivities between 5 mv and .15 v/cm: Bandwidth DC to 1 mc. Rise time .4 microsecond.

**Calibrating Voltage.** — 1 kc. square wave. Nine ranges 5 mv. to 50 v. full scale. Accuracy  $\pm 2\%$  of full scale.

**Waveforms Available Externally** — Sweep sawtooth, 100 volts peak. Delay trigger, 75 volts peak. Positive gate, 150 volts peak. 1 kc. square wave calibrating signal, 0-50 volts peak.

**Connection to CRT Cathode** — Via .1 mfd. capacitor. RC=.01 sec.

**Accelerating Voltage on Cathode Ray Tube** — 3 KV.

**Time Marker Input** — Via isolating stage to video amplifier. Minimum marker amplitude 8 v.

**Power Requirements** — 105-125 volts, or 210-250 volts, 50-60 cycles, 280 watts.

**Dimensions** — 15 1/2" high, 12 1/2" wide, 21 1/2" deep.

**Finish** — Panel, photo etched aluminum with black letters. Cabinet, gray wrinkle.

**Weight** — 53 pounds.

## Vacuum Tube Complement —

Trigger Amplifier .....	2	6AU6
Trigger Amplitude Control .....		6AU6
Trigger Limiter and Clamp Diode.....		6J6
Phantastron Sweep Generator.....		6BH6
Phantastron and Sweep Output Cathode Followers .....		12AU7
Sweep Amplifier .....		12AT7
Delayed Trigger and Magnifier Selector....		6J6
Delayed Trigger and Magnifier Shaper....		6AU6
Magnifier Sweep Generator.....		6AU6
Magnifier Sweep and Delayed Trigger Cathode Followers .....		12AU7
Magnifier Sweep Voltage Regulator and Clamp Diode .....		12AU7
+Gate Amplifier and Blanking Gate Inverter		12AU7
Blanking Oscillator .....		6AU6
Calibrator Multivibrator .....		12AU7
Calibrator Diode and Output Cathode Follower .....		12AU7
Blanking Bias Rectifier.....		6AL5
Vertical Pre-Amp. Inputs.....	2	6AK6
Vertical Pre-Amp. Outputs.....	2	12AU6
Vertical Gain Control Cathode Followers...	2	12AU6
Vertical Main Amplifier Inputs.....	2	12AU6
Vertical Main Amplifier Outputs.....	2	6AG7
Vertical Amplifier Voltage Regulators.....	2	12AU7
Marker Input Amplifier.....		6AU6
Low Voltage Rectifiers.....	4	6W4GT
High Voltage Rectifiers.....	2	1B3GT
High Voltage Supply Oscillator.....		6AQ5
Voltage Reference .....		5651
Voltage Regulator Amplifiers .....	2	6AU6
Voltage Regulator Series Tube.....		6AS7G
Sweep Power Supply Rectifier.....		6X4
Sweep Power Supply Regulator.....		12AU7
Cathode Ray Tube.....		5CPA

Price \$950.00 f.o.b. Portland, Oregon





# TEKTRONIX

## TYPE 513-D

# CATHODE - RAY OSCILLOSCOPE

### GENERAL DESCRIPTION

The TEKTRONIX **Type 513-D** is a portable, self-contained, precision instrument specifically designed for the study of short duration pulses. It features a 5XP type cathode ray tube with an accelerating potential of 12KV, making it particularly useful where a high writing rate is required, or when it is desired to photograph single high speed sweeps.

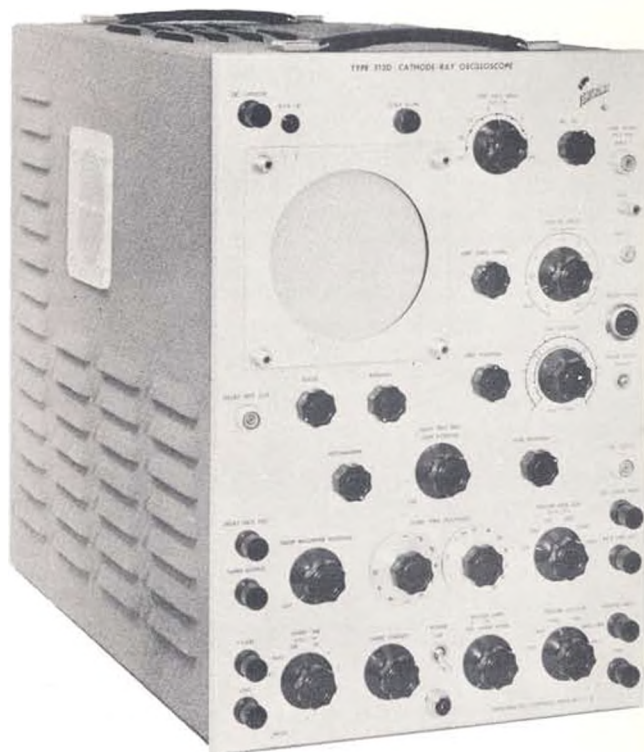
The direct coupled vertical amplifier, with its rise time of  $.025\mu\text{sec}$ , extends its usefulness beyond the limits of any previous cathode ray oscilloscope in general laboratory work.

Frequencies of 10 mc can be synchronized and clearly observed on this instrument. A pulse as short as  $.05\mu\text{sec}$  will serve to trigger the sweep generator, but pulses of .1 sec duration or full cycles of as low as 10 cps can be observed in their entirety.

### VERTICAL DEFLECTION SYSTEM

**Direct Coupled Amplifier** — A distributed type vertical amplifier is used which provides a sensitivity of .3 v/cm in the direct coupled position, or a maximum sensitivity of .03 v/cm when capacitively coupled. The vertical amplifier is adjusted for optimum transient response.

**Sensitivity Control** — Two controls are provided to enable the **Type 513-D** to display a wide range of signal amplitudes. The vertical deflection sensitivity control inserts RC compensated attenuators and also inserts the pre-amplifier stages in the two highest gain positions. It is variable in steps of approximately 3 to 1. The vertical amplifier attenuator is a low impedance potentiometer providing a continuously variable attenuation of 3 to 1



to fill in the steps of the vertical deflection sensitivity control. The overall sensitivity of the vertical amplifier is continuously variable from .03 volts/centimeter to 100 volts/centimeter, peak to peak.

**A. C. - D. C. Switch** — When the direct coupled feature of the amplifier is not needed, or when it is desirable to observe only the A.C. components of the signal, this switch may be thrown to the A.C. position, inserting a coupling capacitor and the necessary low frequency compensation.

**Input Selector** — The **513-D** is equipped with two signal input connections, either of which may be used, still retaining the full bandwidth. Selection is made by the vertical input selector switch. This feature offers a convenient method of making rapid comparison between two signals.

**Constant Input Impedance** — The input impedance of 1 megohm and  $35\mu\text{mf}$  is maintained at all sensitivity settings, permitting use of R-C input probes.

**Probe** — The **Type 513-D** is supplied complete with a high impedance probe on a 42" cable. The probe is R-C compensated and has an attenuation of 10X with an input impedance of 10 megohms and a capacity of approximately 12 mmf.

**Auxiliary Power** — A power supply socket is provided for a cathode follower probe or an auxiliary amplifier stage connected close to the circuit under observation. 6.3 volts A.C. at .5 amp and 20 to 200 volts regulated D.C. at 20 ma. is available. Also available from a front-panel connection is the voltage necessary to illuminate the data-board of the TEKTRONIX Type 51 Camera Adapter.





**Signal Delay Network** — A .25 microsecond delay network provides a means of observing the front of a pulse which is being used to trigger the sweep, by delaying the appearance of the signal until the cathode ray tube is unblanked and the sweep operating linearly.

**Amplitude Calibrator** — Amplitude calibration is accomplished by means of a comparison 1 kc square wave whose amplitude is continuously variable in 7 ranges from .05 volts full scale to 50 volts full scale. Accuracy of square wave amplitude exceeds  $\pm 2\%$  of full scale. The calibrator voltage is also brought out to a binding post so that it may be used for checking the adjustment of the probe or the R-C attenuators incorporated in the vertical amplifier, or used in conjunction with other equipment.

**Direct Connection to CRT Deflection Plates** — It is often desirable to make a low capacity-low inductance connection to the deflection plates to permit observation of extremely high speed transients which would be distorted by the amplifier. A hinged door in the side of the case permits convenient direct connection to the deflection plates.

## HORIZONTAL DEFLECTION SYSTEM

The sweep system employed in the **Type 513-D** is in most respects similar to that of the widely used TEKTRONIX Type 511-A Oscilloscope.

**Triggered Sweep** — A continuously variable, linear, triggered sweep is available covering the range of .01 sec/cm to .1 microsec/cm. A two dial sweep time multiplier is used which makes possible much more accurate readings than were possible with previous instruments. The sweep time is accurate to within 5% of the dial readings, permitting the **Type 513-D** to be used for many frequency and time measurements. The sweep may be readily synchronized with sine waves of frequencies as high as 10 mc. or with pulses as short as .05 microsecond. When triggered by a sharp pulse, the sweep is started, and the cathode ray tube is unblanked, in less than .1 microsecond.

**Trigger Selector** — The sweep may be triggered by an external signal of either positive or negative polarity. It may also be triggered by either the positive or negative portion of the signal under observation, or it may be synchronized with the power line frequency.

**Trigger Rate Generator** — A built-in, free running, blocking oscillator is used as a trigger rate generator. The frequency is variable in 5 steps from 200 to 5000 cycles per sec. A positive pulse of approximately 60 volts amplitude is available on a front panel binding post so that the trigger rate generator may be used to synchronize external equipment.

**Recurrent Sweep** — A conventional free running, sawtooth sweep may be obtained merely by readjusting the sweep stability control. This sweep may be readily synchronized with the waveform under observation.

**Sweep Magnifier** — A control on the panel allows any selected 20% of the sweep to be amplified five times and thus expanded to cover the entire trace.

**External Sweep** — An external sweep may be applied to the horizontal deflection plates via an attenuator and a two stage direct coupled amplifier. The maximum sensitivity is 1.6 volts (peak to peak) per cm. of deflection.

## OTHER FEATURES

**Delayed Gate** — A delayed positive gate of approximately 60 volts amplitude is available at a front panel binding post. The start of the gate may be positioned at any point on the sweep by means of a control on the front panel. The rise time of this delayed gate is approximately .75 microseconds.

**Delayed Trigger** — In cases where a trigger of short rise time is desired, a trigger of 50 volts amplitude, across 100 ohms, is available on a separate output connector. The rise time is .1 microsecond and its total duration is approximately .25 microsecond. This delayed trigger may be positioned to any point on the sweep, from within .2 microseconds of its start.

The delayed gate and the delayed trigger may be used simultaneously if it is desired. This feature greatly extends the usefulness of the **Type 513-D** in the fields of radar, medical research, etc.

**Edge Lighted Graticule** — As in all other TEKTRONIX Cathode Ray Oscilloscopes, a plastic, edge-lighted graticule is provided. The illumination on this graticule may be adjusted by a front panel control. Centimeter lines are scribed in both the horizontal and vertical directions to facilitate accurate measurement of amplitude and duration of the waveshapes being observed. A color filter is provided to increase the contrast when viewing in a brightly lighted room.

**Output Waveforms** — Binding posts are provided on the front panel, making available, in addition to the delayed gate and trigger, the sweep sawtooth and a positive gate starting simultaneously with the sweep and of the same duration. These waveforms are taken from the outputs of cathode followers, so that the termination will not affect the operation of the instrument.

**Regulated Power Supply** — All D.C. voltages are electronically regulated. Also, the **Type 513-D** features a regulated 12 kv. accelerating voltage supply. This prevents a change in acceleration potential as the intensity is changed. It makes possible the high accuracy of the calibration on the **Type 513-D** as there is very little change of image size with a change of brightness. The **Type 513-D** is not affected by line voltage variations over the range of 105 to 125 volts.

**Intensity Modulation (Z Axis)** — A binding post is provided on the panel for the purpose of receiving external blanking pulses, time markers, etc.

## CHARACTERISTICS

**Sweep Circuit** — Hard tube type, either triggered or recurrent as desired.

**Sweep Time** — Continuously variable, .01 sec. to .1 microsecond per centimeter of deflection. Calibration accuracy 5% or better.



**Trigger Requirements** — .5 to 50 volt (peak) sine wave, pulses as short as .05 microsecond, or signal under observation producing .5 cm. deflection or more.

**Sweep Lag** — .1 microsecond, maximum.

**Sweep Magnification** — Any 20% of sweep, magnified 5 times.

**External Sweep Input** — Coupled via 100K potentiometer and 2 stage direct coupled sweep amplifier. Maximum deflection sensitivity, 1.6 volts per cm. D.C. or peak to peak A.C.

**Vertical Amplifier** — 4 stage. 3rd and 4th stage direct coupled push-pull. Distributed output (4th) stage.

**A. C. Vertical Deflection Sensitivity** — Continuously variable from .03 volts/cm. to 100 volts/cm., peak to peak.

**D. C. Vertical Deflection Sensitivity** — Continuously variable from .3 volt/cm. to 100 volts/cm., peak to peak.

**Probe** — R-C frequency compensated. The sensitivity is reduced by a factor of 10 when the probe is used.

**Input Impedance** — 1 meg. shunted by 35 mmf. With probe, 10 meg. shunted by 12 mmf.

**Vertical Amplifier Transient Response** — Rise time (10%-90%) .025 microsecond.

**Vertical Amplifier Response** — D.C. to 20 mc. sensitivity of .3 volts/cm. or lower. 2 cycles to 18 mc. sensitivity .03 volts/cm. or lower.

**Signal Delay Network** — Provides .25 microsecond signal delay. Permits observation of wavefront which triggers sweep.

**Calibrating Voltage** — 1 kc square wave. Seven ranges .05 volt to 50 volts full scale. Accuracy  $\pm 2\%$  of full scale.

**Output Waveforms** — Sweep sawtooth, delayed trigger, delayed gate, gate, 1 kc calibrator square wave, trigger from internal rate generator.

**Internal Trigger Rate Generator** — 5 ranges from 200 to 5000 cycles per sec.

**Cathode Ray Tube** — A type 5XP tube is used with accelerating potential of 12 kv. P1, P2 or P11 screens are optional. **P-2 SUPPLIED UNLESS OTHERWISE SPECIFIED**

**Construction** — Completely self-contained, cabinet and chassis made of electrically welded aluminum alloy. Photo etched front panel.

**Dimensions** — 18 1/2" high, 12 1/2" wide, 21 1/2" deep.

**Weight** — 75 pounds.

**Power Requirements** — 105-125 or 210-250 volts, 50-60 cycles A.C., 475 watts.

## VACUUM TUBE COMPLEMENT

1st Stage Vertical Preamplifier	12AW6
2nd Stage Vertical Preamplifier	12AW6
Preamplifier Cathode Follower	12AT7
Internal Trigger Amplifier	6CB6
Attenuator Cathode Follower	2 19J6
Driver Phase Inverter	4 6AH6
Vertical Output Amplifier	14 6CB6
Driver Plate Voltage Cathode Follower	6AS5
Probe Power Cathode Follower	6J6
Square Wave Calibrator	2 12AU7
Trigger Rate Generator Blocking Oscillator	6J6
Trigger Rate Generator Cathode Follower	12AT7
Trigger Phase Splitter	6CB6
Trigger Amplifier	6AG7
Trigger Coupling Diode	1/2 6AL5
Trigger Amplifier DC Restorer	1/2 6AL5
Multivibrator: 1st Stage	6CB6
2nd Stage	6AG7
Unblanking Cathode Follower	1/2 12AU7
Positive Gate Cathode Follower	1/2 12AU7
Sweep Generator Clamp Tube	6AG7
Sweep Charging Potential Cathode Follower	6C4
Sweep Magnifier	6J6
Sweep DC Restorer	6AL5
Sweep Magnifier DC Restorer	1/2 12AU7
Sweep Output Cathode Follower	1/2 12AU7
Sweep Amplifier Phase Inverter	12AT7
Sweep Amplifier	2 6AQ5
Sweep DC Level Tubes	2 6CB6
Delayed Gate Amplifier	2 6CB6
Delayed Gate Output Cathode Follower	1/2 12AT7
Blocking Oscillator Trigger Tube	1/2 12AT7
Delayed Trigger Blocking Oscillator	12AT7
Delayed Trigger Output Cathode Follower	12AT7
Bias Rectifier	6X4
Bias Regulator	OA2
+225v Rectifier	Dry Selenium
+225v Series Regulator	1/2 6AS7
Low Voltage Reference	5651
+225v Voltage Comparator	12AX7
+225v Voltage Amplifier	6AU6
+275v Rectifier	Dry Selenium
+275v Series Regulator	1/2 6AS7
+275v Voltage Amplifier	6AU6
+800v Rectifier Doubler	2 6X4
+800v Series Regulator	6AS5
+800v Voltage Amplifier	6AU6
High Voltage Oscillator	6AU5
High Voltage Series Regulator	6AU5
High Voltage Comparator-Amplifier	12AU7
High Voltage Rectifiers	3 1X2A
Cathode Ray Tube	5XP

**Price** — \$1,650.00 f.o.b. Portland, Oregon.

## TYPE 513 CATHODE RAY OSCILLOSCOPE

The **Type 513** Cathode Ray Oscilloscope is identical to the Type 513-D, except that the .25 microsecond Signal Delay Network is omitted. Price **\$1,600.00** f.o.b. Portland, Oregon.



# TEKTRONIX

## TYPE 514-D

# CATHODE - RAY OSCILLOSCOPE

### GENERAL DESCRIPTION

The TEKTRONIX **Type 514-D** Cathode Ray Oscilloscope is a self-contained general purpose precision instrument, designed specifically to incorporate the advantages of direct coupling, excellent transient response and high gain into a medium priced oscilloscope. The successful realization of these qualities in an instrument has been combined with economy and portability by the use of distributed amplifier techniques.

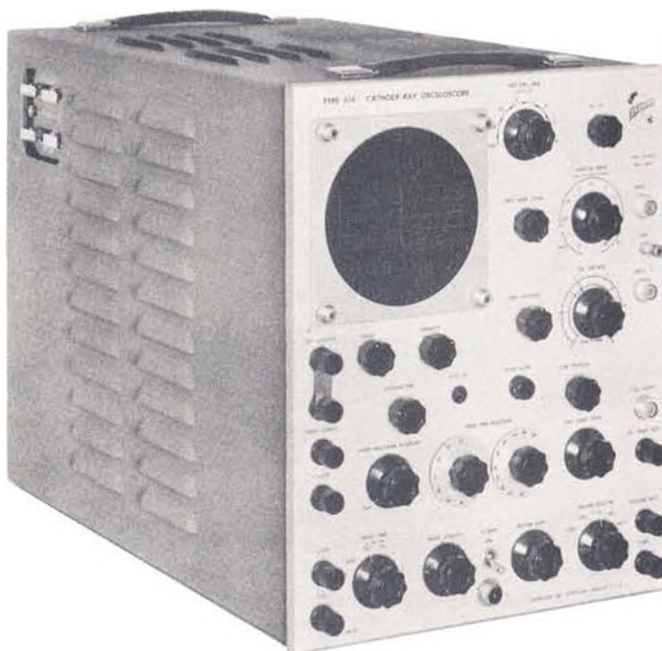
Accurate measurements of timing and amplitude are possible, with carefully calibrated controls reflecting the use of precision and matched components in fully compensated circuits.

### VERTICAL DEFLECTION SYSTEM

**10 mc Direct Coupled Amplifier** — The best overall criterion of amplifier response is the quality of the reproduction of a square wave. Therefore, the vertical amplifier of the TEKTRONIX **Type 514-D** Oscilloscope is adjusted for optimum transient response, as are all TEKTRONIX amplifiers. A sensitivity of  $.3\text{v/cm}$  is available in both direct and capacitively coupled positions. Additional sensitivity of  $.3\text{v/cm}$  to  $.03\text{v/cm}$  is provided with capacitive coupling only.

The desirable combination of 10 mc bandwidth, direct coupling, high sensitivity and 4 cm undistorted deflection is achieved efficiently by the use of a 3 section distributed amplifier in the push-pull output stage.

**Dual Inputs** — Provision is made for observing either one of two signal sources separately by the turn of a switch. This permits the change in wave shape between



the input and output of a circuit to be conveniently seen, comparisons of amplitude and time relationships to be made, or observation of other phenomena involving the relative forms of two different signals.

**Direct or Capacitive Coupling** — In the observation of ripple voltage, noise level, etc., it is sometimes unnecessary to display the DC component. Indeed, the sensitivity necessary to amplify the AC component sufficiently to be observed often will cause the DC component to exceed the range of the vertical position control. An AC-DC switch inserts coupling capacitors for the convenient analysis of this type of waveform.

**Deflection Sensitivity Controls** — The problem of attaining a large variation of amplifier gain, to permit displaying a wide range of signal amplitudes without distortion, is multiplied by the necessity of retaining stable amplifier characteristics over the full range of sensitivity. This requirement is solved in the **Type 514-D** by using a high gain amplifier and inserting precision, frequency compensated attenuator networks. These vary the over-all gain in steps of approximately 10 db, permitting a range in vertical deflection sensitivity of  $.03\text{ v/cm}$  to  $100\text{ v/cm}$ .

To obtain continuous variation between the 10 db steps, a potentiometer is employed in a cathode follower circuit. No appreciable change in amplifier stability or frequency response is encountered in adjusting the gain over this range.

**Direct Input to CRT** — For those occasions when a direct, low capacity connection to the deflection plates is desired, an access panel on the side of the instrument affords convenient plug-in facilities for this purpose.



## SWEEP CIRCUITS

The **Type 514-D** offers complete flexibility of operation within the limits of its design. A highly adaptable sweep system provides a fitting counterpart to the vertical amplifier previously described. The sweep generator, operating over a wide range of sweep rates, can be triggered from a versatile trigger selector system, offering convenient adaptation to the test conditions.

Offering a range of sweep rates from  $.1 \mu\text{sec}/\text{cm}$  to  $.01 \text{ sec}/\text{cm}$ , the sweep generator can be synchronized with frequencies as high as 10 mc, or triggered by pulses as short as  $.05 \mu\text{sec}$ . The CRT becomes unblanked, and the sweep is operating linearly, within  $.1 \mu\text{sec}$  after a sharp trigger impulse is received.

**Trigger Facilities** — The ability to synchronize with positive or negative pulses — from the signal being observed or from an external source — offers great flexibility of operation. Synchronization with the power line frequency is optional.

A wide-band phase splitter and trigger amplifier preserves the rise time of high speed transients, permitting the unusually short starting and unblanking time.

**Sweep Generator** — The sweep generator circuit of the **Type 514-D** is similar to that of the **Type 511-AD**. The versatility of operation which characterizes the **Type 511-AD** is shared by this instrument.

The sweep generating circuitry is such that a slight adjustment of the sweep stability control is sufficient to obtain either recurrent or triggered sweeps. Pulses occurring  $5 \mu\text{sec}$  apart will trigger individual sweeps, and the operating stability of the circuits is such that long periods can separate enabling pulses. In the free running condition, a sweep repetition rate of unusual stability is obtained.

**Sweep Amplifier** — The sweep amplifier is a direct coupled, wide band amplifier engineered to reproduce the sawtooth waveform faithfully and amplify it to the necessary voltage to deflect the electron beam across the cathode ray tube screen. An internal adjustment is provided should it become necessary to compensate for the changes caused by replacement of the sweep amplifier or cathode ray tubes.

For those occasions when it is necessary to use an external source as a sweep generator, the introduction of desired waveforms is simplified by a front panel connection. This input, which is connected to the amplifier by means of the sweep time selector switch, is provided with a separate variable attenuator, permitting a maximum sensitivity of 1.5 v/cm.

**Sweep Magnifier** — Closer inspection of certain portions of a waveform is sometimes necessary to properly analyze the operation of a circuit. Due to the time of occurrence of the portions in question, readjustment of the sweep controls to facilitate observation at a higher basic sweep rate may be difficult or impossible. The sweep magnifier permits the scrutiny of any 20% of the sweep at a 5X magnification without changing the settings of the main sweep controls.

## MEASUREMENT FEATURES

The accuracy of indication of the **Type 514-D** is insured by the consistent operation of the carefully designed amplifier, sweep and calibrator circuits.

**Amplitude Calibration** — To facilitate the amplitude measurement of any desired portion of a waveform, a 1 kc square wave generator is provided. Seven ranges from .05 volt to 50 volts are available on the input selector switch, permitting convenient selection of the proper range to be used in the comparison of the signal and the square wave. A carefully calibrated potentiometer allows amplitude measurements which are accurate to within 2% of full scale readings.

**Sweep Timing** — The five range sweep time selector offers a choice of sweeps ranging from  $.1 \mu\text{sec}/\text{cm}$  to  $.01 \text{ sec}/\text{cm}$ . The sweep time multiplier, consisting of a 10 section precision fixed resistance and a calibrated variable resistor, permits readings of sweep time accurate to within 5%, thus eliminating the need for timing markers in most measurement applications.

**Illuminated Graticule** — Accuracy of timing and amplitude measurements is enhanced by scribed graticule markings, which are illuminated in a color complementary to that of the filter. Direct voltage measurements of any portion of the signal can be made when the deflection sensitivity is pre-set with the aid of the calibrator. A glance at the settings of the sweep time controls likewise suffices for accurate measurements of duration, repetition rates, etc.

**Intensity Modulation** — Provision is made for brightening or blanking pulses to be introduced on the cathode of the CRT, via an RC coupling network. In cases where the observed waveform is extremely complex, and measurements must be made more accurately than is possible with the oscilloscope calibration alone, intensity modulation offers an easy method of introducing timing pulses.

## OUTPUT WAVESHAPES

In the measurement and observation of complex phenomena, it is frequently necessary that much auxiliary equipment, in addition to the oscilloscope, be operated in a strict time relationship to the phenomena. To eliminate the necessity of special external shaping and amplifying circuits, the **Type 514-D** offers a variety of output waveforms to control the operation of this accessory equipment.

**Sweep Output** — To use as a sweep on an external CRT, or to facilitate time delay operations, a sweep sawtooth of 20 volts amplitude is available at the front panel. Cathode follower output provides a relatively low impedance and prevents loading of the sweep generator circuit.

**Positive Gate** — Frequently, it is desirable that auxiliary equipment operate only for the period of the sweep. A square positive pulse of the same duration of the sweep, and of 40 volts amplitude, provides a convenient means of triggering and gating associated equipment.



**Negative Gate** — A similar pulse, of opposite polarity and —40 volts amplitude, appears simultaneously at another front panel binding post, offering like aid in operating auxiliary devices.

**Calibrator Output** — The 1 kc square wave calibrator output, available at the front panel, permits convenient checking and adjustment of the Type 514-D's compensating capacitors, and provides an accurately adjustable signal source for calibrating other equipment.

## ADDITIONAL FEATURES

**Probe** — Some observations require great care to prevent undue interference with the signal source. The shielded, frequency compensated probe supplied with the **Type 514-D** oscilloscope presents an input impedance of 10 megohms and 12  $\mu\text{f}$ , minimizing pickup of stray fields and providing reduced loading on the circuit under observation.

**Regulated Power Supplies** — To insure consistency in operation, all DC power supplies in the **Type 514-D** have been regulated against variations in load, and line voltage changes over the range of 105-125v. Changes in load, such as increasing the intensity of the trace, do not appreciably vary the deflection sensitivity of the instrument, thus maintaining accuracy of timing and amplitude calibration.

**Construction** — High quality, electrically welded aluminum alloy is used in the construction of the frame, chassis and case, providing a light, clean mechanical design that reflects the careful thought which enters into the development of all TEKTRONIX instruments. All chassis are mounted so that the wiring layouts and components are readily accessible, permitting easy maintenance and repair. The cabled wiring, terminal boards, mounting brackets and other details mirror the effort which is put forth to make the appearance of TEKTRONIX instruments consistent with their operation.

## TYPE 514-D CHARACTERISTICS

**Sweep Circuit** — Hard tube type, triggered or recurrent operation as desired.

**Sweeps** — Continuously variable, .01 sec/cm to .1  $\mu\text{sec/cm}$ . Calibration accuracy 5%.

**Trigger Requirements** — .5 to 50v (peak). Pulses as short as .05  $\mu\text{sec}$ . Signal under observation producing .5 cm deflection or more.

**Sweep Lag** — .1  $\mu\text{sec}$ , maximum.

**Sweep Magnification** — Any desired 20% of sweep, magnified 5 times.

**External Sweep Input** — Coupled via 100k potentiometer and 2 stage direct coupled sweep amplifier. Maximum deflection sensitivity, 1.5 v/cm D.C. or A.C. peak to peak.

**Vertical Amplifier** — 4 stage. 3rd and 4th stage direct coupled push-pull. Distributed output (4th) stage.

**A. C. Vertical Deflection Sensitivity** — Continuously variable from .03 v/cm to 100 v/cm, peak to peak.

**D. C. Vertical Deflection Sensitivity** — Continuously variable from .3 v/cm to 100 v/cm, peak to peak.

**Input Impedance** — 1 meg. shunted by 30  $\mu\text{f}$ . With probe, 10 meg. shunted by 12  $\mu\text{f}$ .

**Vertical Amplifier Response** — D.C. to 10 mc, sensitivity or .3 v/cm or lower; 2 cps to 10 mc, sensitivity of .03 v/cm or less.

**Vertical Amplifier Transient Response** — Rise time (10%-90%) .04  $\mu\text{sec}$ .

**Signal Delay Network** — Provides .25  $\mu\text{sec}$  signal delay. Permits observation of the waveform which triggers sweep.

**Calibrating Voltage** — 1 kc square wave. Seven ranges .05 to 50 v full scale. Accuracy  $\pm 2\%$  of full scale.

**Output Waveforms** — Sweep sawtooth, positive gate, negative gate, 1 kc square wave calibration signal.

**Cathode Ray Tube** — A type 5CPA is used with an accelerating potential of 3 kv (+1.5 & —1.5 kv). P1, P7 or P11 screens are optional. **P-1 SUPPLIED UNLESS OTHERWISE SPECIFIED**

**Construction** — Completely self-contained, cabinet and chassis made of electrically welded aluminum. Photo etched front panel.

**Dimensions** — 15 1/2" high, 12 1/2" wide, 21 1/2" deep.

**Weight** — 62 pounds.

**Power Requirements** — 105-125 or 210-250 volts, 50-60 cycles A.C. 375 watts.

## Vacuum Tube Complement —

Trigger Phase Splitter.....	6AC7
Trigger Amplifier .....	6AG7
Trigger Coupling Diode.....	6AL5
Multivibrator .....	6AC7
Multivibrator .....	6AG7
Unblanking Cathode Follower.....	1/2 12AU7
Unblanking Limiter .....	1/2 12AU7
Gate Output Phase Splitter.....	1/2 12AU7
Second Anode Cathode Follower.....	1/2 12AU7
Magnified Sweep DC Restorer.....	1/2 12AU7
Sweep Output Cathode Follower.....	1/2 12AU7
Sweep Generator .....	6AG7
Sweep Charging Potential Cathode Follower.	6C4
Sweep Magnifier .....	6J6
Sweep DC Restorer.....	6AL5
Sweep Amplifier .....	2 6AU6
Output Level Tubes.....	2 6CB6
+450V Rectifier .....	6X4
+450V Series Regulator.....	6AQ5
+450V Regulator Amplifier .....	6AU6
+225V Rectifier .....	3 5V4
+225V Voltage Reference.....	5651

+225V Regulator Comparator.....	12AX7
+225V Regulator Amplifier.....	6AU6
+225V Series Regulator.....	6AS7
-150V Rectifier .....	6X4
-150V Regulator .....	OD3
High Voltage Regulator Amplifier.....	6AS5
High Voltage Regulator Comparator.....	12AU7
High Voltage Oscillator.....	6AQ5
High Voltage Rectifier..... 2	1V2
1st Preamp Stage.....	12AW6
2nd Preamp Stage.....	12AW6
Trigger Amplifier .....	6CB6
Cathode Follower .....	2 19J6

C. F. Voltage Regulator.....	6AS5
Output Driver .....	4 6AH6
Push-Pull Output .....	6 6AG7
Cal. Multivibrator .....	12AU7
Cal. Limiter and Output Cathode Follower..	12AU7

**Price — \$950.00** f.o.b. Portland, Oregon.

### **TYPE 514 CATHODE RAY OSCILLOSCOPE**

The **Type 514** Cathode Ray Oscilloscope is identical to the **Type 514-D**, except that the .25  $\mu$ sec Signal Delay Network is omitted. **Price — \$900.00** f.o.b. Portland, Oregon.





# TEKTRONIX

## TYPE 517

# CATHODE - RAY OSCILLOSCOPE

### GENERAL DESCRIPTION

The TEKTRONIX Type 517 is a wide-band high-voltage cathode-ray oscilloscope designed primarily for the observation and photographic recording of very fast-rising waveforms having low duty cycle.


The use of 24 KV accelerating potential on a metallized cathode-ray tube permits photographic recording of single sweeps at the maximum writing-rate permitted by the vertical amplifier and sweep circuits. Distributed type vertical amplifiers provide a rise-time of 7 milli-microseconds with a maximum sensitivity of .1 V/cm. Both amplitude and time calibrations are provided. Sufficient time delay is incorporated in the vertical amplifier to permit viewing the leading edge of the waveform which triggers the sweep.

The Type 517 consists of two units, indicator and power supply, mounted on a Scope-Mobile, thus making a very convenient mobile unit. If desired, the units may be lifted off the Scope-Mobile for bench use.

### VERTICAL DEFLECTION SYSTEM

**Distributed Amplifier** — In order to provide sufficient vertical deflection voltage with a rise-time as short as 7 milli-microseconds for a cathode-ray tube using 24 KV accelerating potential, a distributed amplifier is employed. This amplifier consists of 5 distributed stages plus a phase inverter and a trigger tube. The first two stages use six 6AK5 tubes each, next a stage of seven 6CB6 tubes and a phase inverter of three 6CB6 tubes. The signal now goes to a push-pull driver stage having six 6CB6 tubes on a side; and finally to the output stage with twelve 6CB6 tubes on each side.



**Input** — The input to the vertical amplifier is directly to a 170 ohm grid line, through a  type coaxial connector mounted on the front panel. **UHF**

**Probe** — In order to provide higher input impedances, a cathode follower input probe, preceded by a capacitive attenuator, is used. By substituting various capacitive attenuators, a wide range of sensitivities and input capacitances can be obtained.

**Auxiliary Power** — A power supply socket is provided for a cathode follower probe or an auxiliary amplifier stage connected close to the circuit under observation. 6.3 V AC at 1 amp and 120 V regulated DC at 10 ma. is available.

**Sensitivity** — A front panel vertical amplifier attenuator control is provided which decreases the sensitivity of the vertical amplifier from .1 V/cm to .2 V/cm — a range of 2 to 1. Operation of this attenuator does not affect the characteristics of the vertical amplifier.

**Signal Delay** — Approximately 60 milli-microseconds of delay cable is incorporated in the signal channel. This delay, along with the inherent delay in the vertical amplifier, permits the sweep to start before the signal reaches the vertical deflection plates.



**Amplitude Calibrator** — A pulse-type amplitude calibrator is incorporated which provides continuously variable output voltages in six ranges, from .15 V full scale to 50 V full scale, with an accuracy better than 4% of full scale.

**Direct Connection to CRT Deflection Plates** — It is often desirable to make a low-capacity, low-inductance connection to the deflection plates to permit observation of extremely high speed transients which would be distorted by the amplifier. An aperture in the side of the case permits convenient direct connection to the deflection plates.

## HORIZONTAL DEFLECTION SYSTEM

Since many of the fast-rising pulses to be observed are either non-repetitive or non-uniformly spaced, it is essential to have a sweep which can be triggered by the observed pulse itself. The sweep circuit of the **Type 517** can be so triggered.

**Triggered Sweep** — A linear, triggered sweep is available with eleven fixed, accurately timed sweeps ranging from .01  $\mu\text{sec}/\text{cm}$  to 20  $\mu\text{sec}/\text{cm}$  at 24 KV accelerating potential and twice these rates for 12 KV. The basic sweep waveform is generated by a pentode clamp with a cathode follower boot-strap to maintain the charging current constant throughout the sweep. The waveform is inverted and fed to the opposite deflection plate for balanced deflection.

**Trigger Selector** — A front panel switch permits the choice of a trigger from an external source of either polarity, an observed signal of either polarity, or an internal trigger-rate generator.

**Trigger Amplifier** — To enable the **Type 517** to trigger from fast-rising signals of small amplitude, a wide-band, distributed type trigger amplifier is incorporated. Signals of .3 V amplitude, with a rise-time of 1 milli-micro-second, will easily trigger the sweep. When using the observed signal as trigger, any signal giving a deflection of 2 mm is adequate.

**Trigger-Rate Generator** — A continuously variable trigger-rate generator operating from 15 to 15,000 cps is incorporated. This consists of a calibrated phantatron oscillator controlling a blocking oscillator. Two cathode-follower outputs are provided so that a time delay may be inserted in one output if desired.

## POWER SUPPLY

Since the **Type 517** is a quantitative instrument, it is necessary that sweep rates and deflection sensitivities remain constant in spite of line voltage variations. To accomplish this, all critical voltages are electronically controlled. The DC supplies utilize series-regulator tubes controlled by high-gain amplifiers. All heaters in the indicator unit are regulated in RMS terms by a saturable-reactor regulator.

The accelerating potentials for the CRT are derived from an oil-filled oscillator-type supply with the CRT gun voltage regulated to compensate for both load and line changes. A panel switch on the indicator unit changes the accel-

erating voltage from approximately 24 KV to approximately 12 KV by changing the point of sampling in the regulator circuit.

Total power consumption for the **Type 517** is approximately 1250 watts at 105-125 or 210-250 V, 60 cycle, single-phase AC.

## OTHER FEATURES

**Calibrated Horizontal Shift** — In addition to the usual full scale horizontal positioning control, a vernier control calibrated in millimeters provides accurate measurements over a range of 1. cm for use in measuring rise-time, etc.

**Metallized Cathode Ray Tube** — The use of a metallized CRT screen provides two advantages: first, increased brightness; and second, removal of residual charge from previous sweeps. This is very important in single sweep operation, since any residual charge will cause the image to be displaced from its correct position.

**Forced Cooling** — Because of the high power consumption of the fast sweep and wide-band amplifier circuits, cooling fans are included in both units. The indicator unit has an efficient air filter to remove dust and foreign matter from the cooling air.

**Output Waveforms** — Coaxial connectors are provided on the front panel, making available two trigger-rate generator impedances, as well as the calibrator output voltage. A binding post makes available a positive gate waveform of 25 volts amplitude with a duration approximately equal to the sweep being generated, with a rise-time of .03  $\mu\text{sec}$  from a cathode follower source impedance of 200 ohms.

**Edge Lighted Graticule** — As in all other TEKTRONIX Cathode Ray Oscilloscopes, a specially-designed, edge-lighted, plastic graticule is provided. The illumination on this graticule may be adjusted by a front panel control. Centimeter lines are scribed in both the horizontal and vertical directions to facilitate accurate measurement of amplitude and duration of the waveshapes being observed.

## CHARACTERISTICS

**Vertical Amplifier** — 5 stages of distributed amplification; 4th and 5th stages are push-pull.

**Vertical Amplifier Transient Response** — Rise time (10% to 90%) is 7  $\mu\text{sec}$  (.007  $\mu\text{sec}$ ). Response is free of ringing and overshoot. See Fig. 1.



Fig. 1. The accompanying photograph shows the pulse response of the **Type 517** Vertical Amplifier. The sweep rate is 10.  $\mu\text{sec}/\text{cm}$ . Note rise-time and freedom from ringing and overshoot.





**Vertical Amplifier Sensitivity** — The maximum vertical amplifier sensitivity with a 5XP cathode-ray tube\* operated at 24 KV accelerating potential is .1 V/cm without a probe. With a cathode follower probe, the maximum sensitivity is .2 V/cm.

**Vertical Amplifier Attenuator** — A continuous control with a range of attenuation from 1X to 2X is provided in the vertical amplifier. Fixed plug-on attenuators are provided for use in conjunction with the cathode follower probe. An attenuator box with a characteristic impedance of 170 ohms is also provided.

**Vertical Amplifier Input Impedance** — Input impedance direct is 170 ohms resistive. Impedance looking into probe is 1 megohm and 5  $\mu$ fd. Higher impedance values can be had depending upon capacitive attenuator used ahead of probe.

**Signal Delay** — Delay line of RG63U coaxial cable contributes 60 m $\mu$ sec delay. This, plus the inherent delay of the distributed vertical amplifier stages, makes an approximate total signal delay of 120 m $\mu$ sec. This signal delay permits the sweep to be triggered and under way before the signal is applied to the vertical deflection plates.

**Vertical Amplitude Calibrator** — Pulse generator of 25 kc available on the front panel, with six ranges from .15 V to 50 V peak full scale. Accuracy is 4% of full scale.

**Vertical Amplifier Position Control** — With 24 KV accelerating potential, the vertical positioning control moves the trace  $\pm 2.5$  cm from the center line.

**Sweep Circuit** — Triggered, hard-tube bootstrap type sweep circuit with inverter to produce balanced deflection.

**Sweeps** — Eleven fixed ranges of 10, 20, 50, 100, 200, 500 m $\mu$ sec/cm and 1, 2, 5, 10, 20  $\mu$ sec/cm, with a maximum displacement error of 2% for 8 cm sweep length.

**Sweep Starting Time** — Approximately 70 m $\mu$ sec for the average instrument. A total signal delay of approximately 120 m $\mu$ sec permits the sweep to be triggered and underway before the signal is applied to the vertical deflection plates.

**Horizontal Position Control** — With 24 KV accelerating potential, the horizontal position control moves the trace approximately 5 cm.

**Horizontal Position Vernier** — In addition to the normal horizontal positioning control, a vernier control calibrated in millimeters provides accurate measurements over a range of 1 cm for use in measuring rise-time, etc.

**Duty Cycle** — The approximate limitations on sweep repetition rates for sweep ranges are:

Sweep Time	Maximum Repetition Rate
20 $\mu$ sec/cm.....	1.5 kc
10 $\mu$ sec/cm.....	3. kc
5 $\mu$ sec/cm.....	6. kc
2 $\mu$ sec/cm.....	12. kc
1 $\mu$ sec/cm.....	20. kc

\*With a nominal tube vertical deflection sensitivity of 30 V/cm.

Sweep Time	Maximum Repetition Rate
500 m $\mu$ sec/cm.....	50. kc
200 m $\mu$ sec/cm.....	50. kc
100 m $\mu$ sec/cm.....	50. kc
50 m $\mu$ sec/cm.....	50. kc
20 m $\mu$ sec/cm.....	60. kc
10 m $\mu$ sec/cm.....	80. kc

#### Trigger Requirements —

External trigger: .3 - 15 V peak amplitude.

Internal trigger (from signal): 2 mm deflection.

For optimum triggering, the rise time of the trigger source should be as short as possible.

#### Trigger Rate Generator —

Polarity.....Positive.

Length......4  $\mu$ sec.

Rise time.....0.15  $\mu$ sec.

Output level: 20 V with 50 ohms internal impedance;  
60 V with 200 ohms internal impedance.

Repetition rate: 15-15,000 cps variable in three ranges with an accuracy of 5% of full scale.

**Cathode Ray Tube** — A metallized type 5XP cathode-ray tube with P11 phosphor is furnished with the **Type 517** unless a P1 or P2 phosphor is specified as the optional choice.

**Construction** — Contained in two separate units of convenient size, normally mounted on a TEKTRONIX Type R-500 Scope-Mobile. Cabinets and chassis are made of electrically-welded aluminum alloy. Photo-etched front panels are employed.

**Power Requirements** — 1250 watts, 105-125 or 210-250 V, 60 cycle, single-phase AC. Three primary-circuit fuses are provided for protection against sustained over-load conditions.

#### Dimensions —

Indicator unit: 12 1/2" wide, 18 1/2" high, 25 1/2" deep.

Power unit: 16" wide, 10" high, 18" deep.

#### Weight —

Indicator unit: 76 lbs.

Power unit: 72 lbs.

R-500 Scope-Mobile: 42 lbs.

### TUBE COMPLEMENT

Circuit Use	Quantity	Type
<b>Vertical Amplifier</b>		
1st Distributed amplifier .....	6	6AK5*
2nd Distributed amplifier .....	6	6AK5*
3rd Distributed amplifier .....	7	6CB6*
Phase inverter stage .....	3	6CB6*
Push-pull distributed driver amplifier .....	12	6CB6*
Push-pull distributed output amplifier .....	24	6CB6*
Internal trigger coupling tube .....	1	6CB6*
<b>Sweep Generator Circuit</b>		
Trigger phase-splitter .....	1	6J6*
1st Distributed trigger amplifier .....	3	6AK5*

\*Selected



Circuit Use	Quantity	Type
2nd Distributed trigger amplifier . . . . .	3	6AK5*
Trigger limiter tube . . . . .	1	6AG7
Trigger switch tube . . . . .	1	6AG7
Trigger coupling diode . . . . .	1	6J6
Multivibrator . . . . .	2	6AG7
Paralleled sweep clamp tubes . . . . .	2	6AG7
Positive sweep out, cathode follower . . . . .	1	6J6*
Paralleled bootstrap cathode followers . . . . .	2	6J6*
Decoupling-diode, bootstrap circuit . . . . .	1	6X4
Sweep inverter . . . . .	1	6AG7
Bias, screen, CF voltage-regulator for sweep inverter tube . . . . .	1	12AU7
Sweep output DC restorer . . . . .	1	6AL5
Paralleled unblanking amplifier tubes . . . . .	2	6AG7
Screen CF voltage-regulator for unblanking amplifier tubes . . . . .	1	6AS5
Unblanking voltage CF output tube . . . . .	1	6J6
Plus gate output cathode follower . . . . .	1	6J6
CRT grid bias stabilizers . . . . .	4	NE2*

#### Calibrator Circuit

Multivibrator . . . . .	1	12AU7
Clipper . . . . .	1	6J6
Cathode follower calibrate voltage adj. . . . .	1	6J6
Calibrator range output, cathode follower . . . . .	1	6J6*

#### Trigger Rate Generator

Phantastron trigger-generator tube . . . . .	1	6BH6*
Recharging cathode follower . . . . .	1/2	12AU7
Trigger coupling triode . . . . .	1/2	12AU7
Plate catcher . . . . .	1	12AU7
Blocking oscillator . . . . .	1	12AU7
50 ohm output cathode follower . . . . .	1	12AU7
200 ohm output cathode follower . . . . .	1	12AU7

#### Astigmatism and Probe Voltage Supply

Astigmatism and probe voltage CF tube . . . . .	1	12AU7
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#### CRT High Voltage Supply

Quadrupler rectifiers, +20 KV supply . . . . .	4	1X2
Rectifier, —4 KV supply . . . . .	1	1X2
High voltage oscillator tube . . . . .	1	6AU5
Paralleled series-regulator tubes . . . . .	2	6AU5

\* Selected

Circuit Use	Quantity	Type
Comparator-amplifier . . . . .	1	12AU7
Oscillator plate voltage time-delay tube . . . . .	1	6C4
High-voltage rectifier-tube filament oscillator . . . . .	1	6AQ5

#### Power Supply, Low Voltages

+750 volt rectifier . . . . .	1	6X4
+750 volt supply series-regulator . . . . .	1	6AU5
Comparator-amplifier, +750 V supply . . . . .	1	6AU6
Rectifier, + 475 V supply . . . . .	1	5R4GY
Series-regulator, +475 V supply . . . . .	1	6AS7
Comparator-amplifier, +475 V supply . . . . .	1	6AU6
Full-wave rectifier, +365 V supply . . . . .	2	6X4
Paralleled series-regulator, +225 V supply . . . . .	2	6AS7
Comparator-amplifier, +225 V supply . . . . .	1	6AU6
Paralleled series-regulator, +150 " supply . . . . .	3	6AS7
Comparator-amplifier, +150 V supply, 2nd stage . . . . .	1	6AU6
Comparator-amplifier, +150 V supply, 1st stage . . . . .	1	12AX7
Rectifier, —250 V supply . . . . .	1	6X4
Series-regulator, —250 V supply . . . . .	1	6AU5
Comparator-amplifier, —250 V supply . . . . .	1	6AU6
Voltage reference source . . . . .	1	5651
Filament voltage regulator control diode . . . . .	1	2AS-15
Filament voltage regulator amplifier . . . . .	1	6AU5

#### Cathode-Ray Tube

Cathode-ray tube with optional phosphors of P1, P2, or P11, metallized . . . . .	1	5XP
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**Accessories Furnished.** The complete **Type 517** Oscilloscope consists of the following items:

Indicator unit with 5XP11 metallized cathode-ray tube, unless a P1 or P2 optional phosphor is specified

Power unit

Type R-500 TEKTRONIX Scope-Mobile

Inter-unit connecting cable

Viewing hood

Cathode follower probe

Attenuation box, 170 ohms characteristic impedance

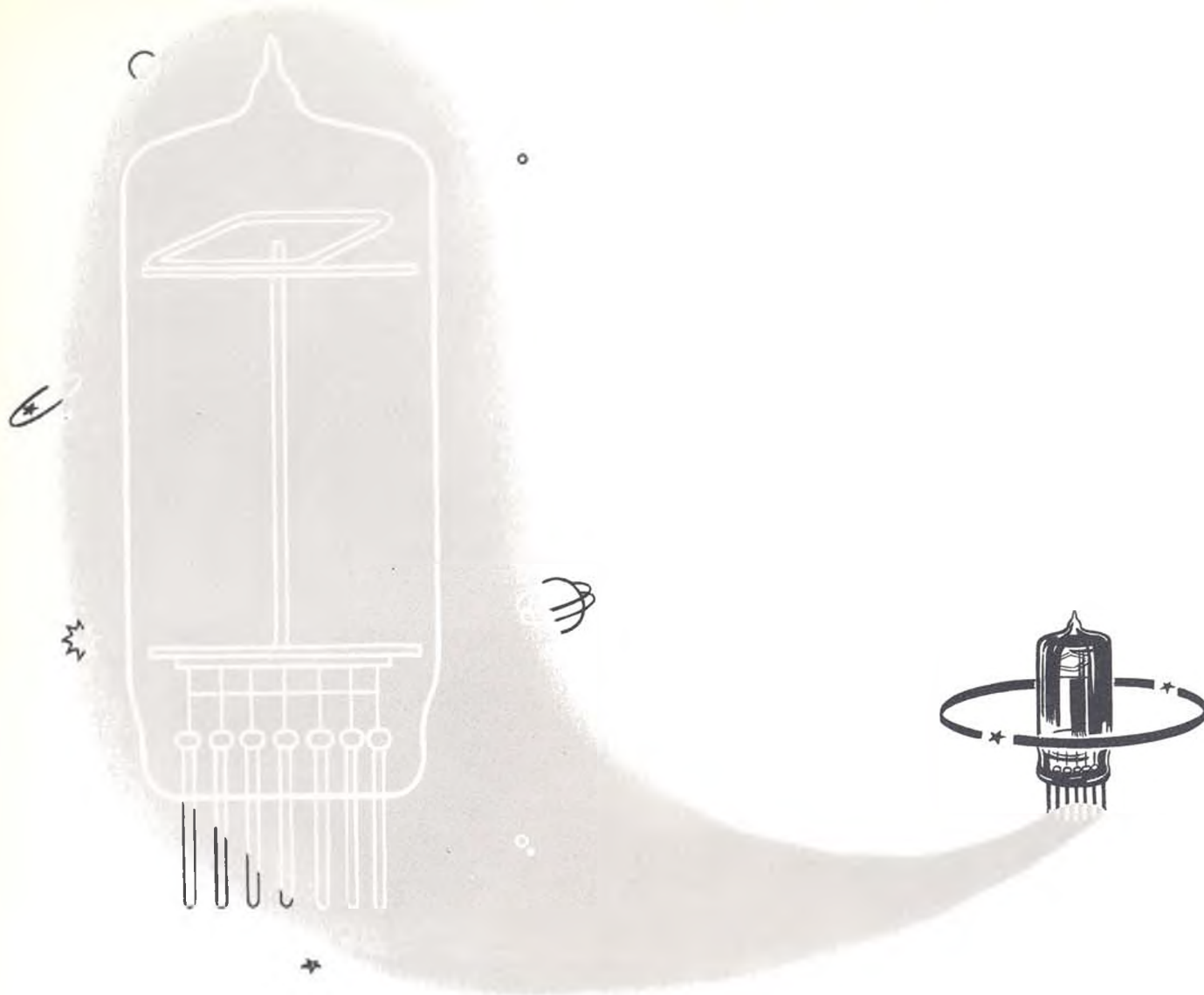
Instruction book

AC power cord

**PRICE \$3500.00** f.o.b. Portland, Oregon



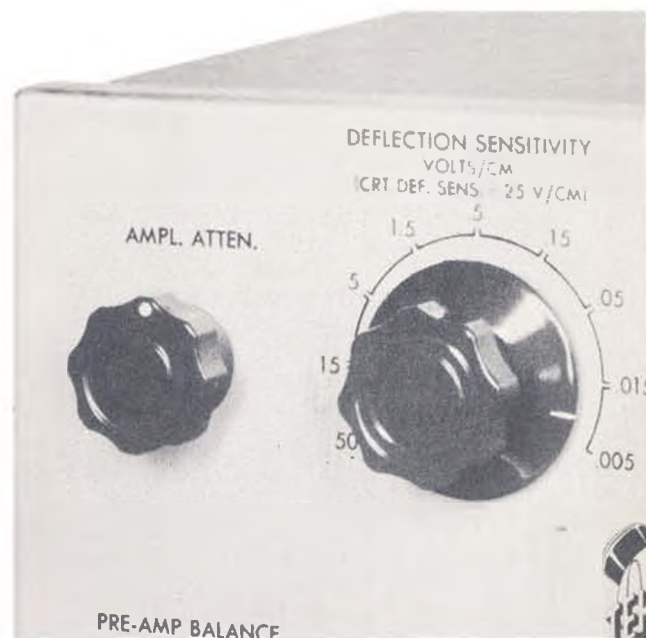




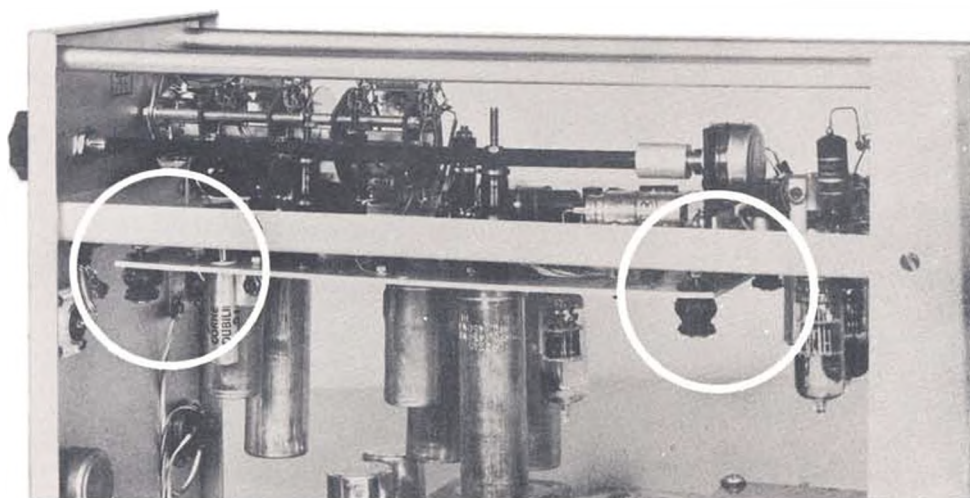
## AUXILIARY AMPLIFIERS

*are designed to expand the area of application of Tektronix oscilloscopes in certain specialized directions. Frequently it is desirable to increase the sensitivity of the oscilloscope amplifier into the  $\text{mv/cm}$  or  $\mu\text{v/cm}$  region. Other measurements may require that the horizontal deflection circuits may have the same order of bandwidth or sensitivity as the vertical circuits.*

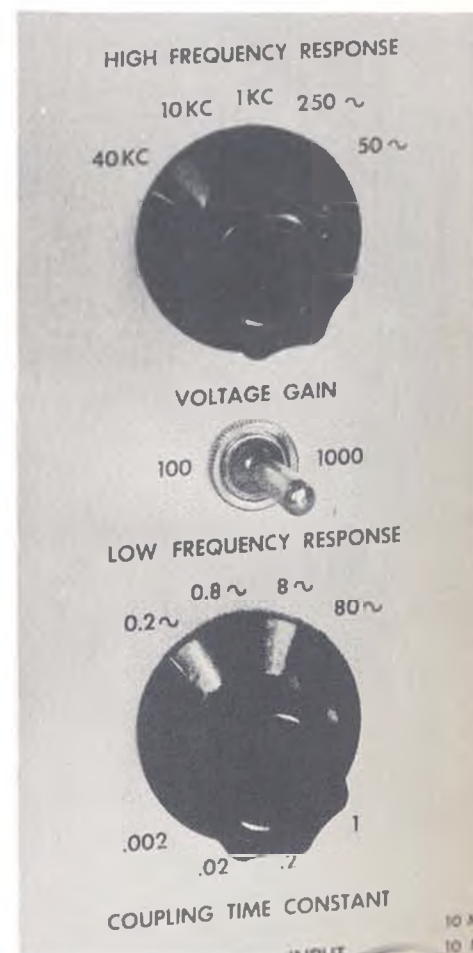
*As with other Tektronix instruments, the controls and connections are clearly and functionally marked, thus assisting in the accurate determination of timing and amplitude. Power supply regulation and efficient filtering provide maximum stability and signal to noise ratio. Low level signal circuits are shock mounted to prevent the introduction of spurious signals by physical jarring of the instrument.*



SENSITIVITY CONTROLS OF  
TYPE 112 AMPLIFIER



SHOCK MOUNTING OF  
TYPE 121 PRE-AMPLIFIER



BANDWIDTH CONTROLS OF  
TYPE 122 PRE-AMPLIFIER



**TEKTRONIX** TYPE 112  
**DIRECT COUPLED**  
**AMPLIFIER**

### Direct Coupled — Push Pull Throughout

### Band Pass DC-2mc

### Gain .5 to 5000, Continuously Variable

The **TEKTRONIX Type 112 Direct-Coupled Amplifier** is presented as a highly desirable auxiliary instrument primarily intended for use with the TEKTRONIX Type 511-A, 511-AD, 512 or other cathode ray oscilloscopes. It consists of the vertical amplifier of the Type 512 Oscilloscope complete with self-contained, fully-regulated power supply and 1 kc. square wave voltage calibrator.

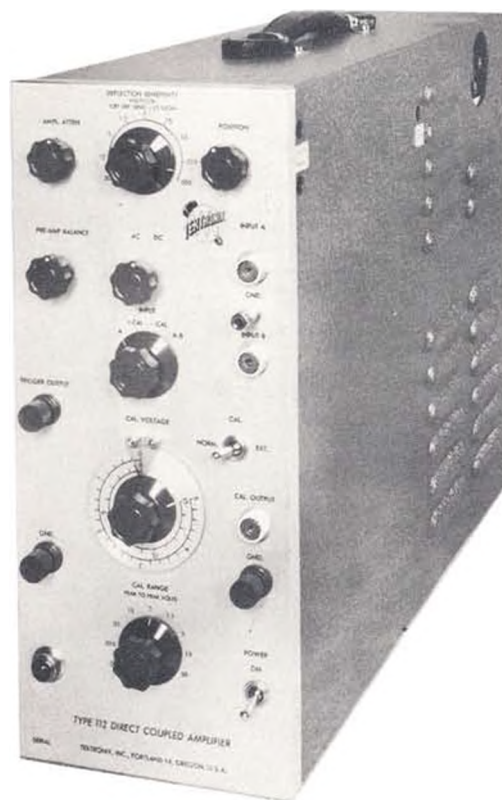
When used with a cathode ray oscilloscope, whose cathode ray tube has a basic deflection factor of 25 volts per centimeter, the deflection sensitivity (peak to peak) is 5 millivolts to 50 volts per centimeter. Expressed in terms of voltage gain, the range is .5 minimum to 5000 maximum, continuously variable by virtue of the range switch plus a fill-in potentiometer. The band pass is : DC — 2 mc. when voltage gain requirements are 166 or less; DC — 1 mc. when voltage gain requirements fall within the range of 166 to 5000.

The TEKTRONIX **Type 112** input impedance is approximately 1 megohm — 45 mmf. each side to ground for direct connection, but is approximately 10 megohms — 14 mmf. each side to ground when using the two RC probes which are supplied as a part of the instrument. Either single-ended or a differential input may be employed.

By virtue of the compensation employed to provide optimum transient characteristics, the amplitude response curves are approximately 3 db. down at the high frequency points mentioned above. The rate of fall of amplitude response, however, is quite gradual; with appreciable and useful amplification existing considerably above the quoted points.

Designed to work into a high impedance load (CRT plates), each output tube plate is connected to output terminals via 100 k. current limiting resistors and by-pass condensers. For other than design applications, short circuiting the limiting components will provide an output impedance of 8000 ohms plate to plate. A maximum output voltage of approximately 150 volts (peak to peak) is available when working into high impedance load.

Output connections are from a right hand side access panel by means of banana jacks and plugs. Mounted at the rear of the amplifier, a co-ax connector permits the injection of time markers at a balanced point just ahead of the output stage without deleterious effect to other video signals present. Also, at the rear of the cabinet are two controls which determine the voltage point with respect to ground at which the output circuits (CRT deflection plates when so used) function.



## SPECIFICATIONS

**Voltage gain . . . . .** .5 to 5000, continuously variable

Band pass.....DC — 2 mc., gain 166 or less  
DC — 1 mc., gain 166-5000

Input impedance.....1 meg. — 45 mmf. direct  
10 meg. — 14 mmf. with probes

Maximum signal input voltage . . . . . 600 v. (peak)

Voltage calibrator.....1 kc. square wave

Nine ranges, .5 mv. to 50 v. full scale. Accuracy  $\pm 5\%$

Output voltage . . . . . 150 v. high imp.; 75 v. 8000 ohms

Power requirement . . . 105-125/210-250 v., 50-60 cycles  
200 watts

Dimensions.....15 1/2" high, 6 1/2" wide, 21 1/2" deep

Weight.....32 pounds

## Vacuum Tube Complement

1st Stage .....	2	6AK6
2nd Stage .....	2	12AU6
Cathode Follower .....	2	12AU6
3rd Stage .....	2	12AU6
4th Stage .....	2	6AG7
Voltage regulators .....	2	12AU7
Marker input Ampl. ....	1	6AU6
Constant Current Control .....	2	6BH6
Calibrator Multivibrator .....	-	12AU7
Calibrator Diode & Output Cathode Follower .....		12AU7
Low Voltage Rectifiers .....	3	5V4G
Voltage Reference .....		5651
Voltage Regulator Amplifier .....	2	6AU6
Voltage Regulator Series Tube .....		6AS7G

**Price \$495.00 f.o.b. Portland, Oregon**



# TEKTRONIX

## TYPE 122

### LOW LEVEL PRE-AMPLIFIER



The TEKTRONIX **Type 122** Pre-amplifier was designed specifically to increase the sensitivity of the **Type 512** Oscilloscope to  $5\mu\text{v}/\text{cm}$ , over the band of  $1/6$  cycle to 40 kc. Thus a maximum voltage gain of 1000 is available, while a frequency compensated attenuator network permits the gain to be reduced to 100 to accommodate input signals of as much as .2 volts peak amplitude without distortion. The maximum bandwidth available is  $1/6$  cps to 40 kc, but front panel controls allow the high and low frequency responses to be varied separately in order to increase the signal-to-noise ratio.

The first two push-pull stages are designed to have a high degree of balance. The ratio of the gain of an out-of-phase signal to that of an in-phase signal, applied differentially to the grids, is between 90 and 100 db, when the differential balance control is carefully set. The input impedance from one grid to ground is 10 megohms and  $10\mu\text{f}$ , but from grid to grid it is 20 megohms and  $10\mu\text{f}$ .

A cathode-follower circuit provides a low impedance output of the order of 1000 ohms. An output level control permits operation at ground potential.

#### CHARACTERISTICS

**Frequency Response** —  $1/6$  cps-40 kc.

High Frequency Cutoff,

3 db points . . . . . 40 kc 10 kc 1 kc 250 cps 50 cps

Low Frequency Cutoff,

3 db points (frequencies-cps) .2 .8 8. 80.  
(time constants-sec) 1. 2. .02 .002

**Gain** — High Position 1000; Low Position 100. Rejection ratio for in-phase signals: 90-100 db (5 cps-40 kc).

**Maximum Output** — 20 v (peak-to-peak).

**Output Impedance** — 1000 ohms approximately (cathode follower).

**D. C. Output Level** — Adjustable to zero (for use with D.C. oscilloscopes).

**Maximum Input Signal** — .02v (peak-to-peak) in high gain position; .2v (peak-to-peak) in low gain position.

#### Input Impedance —

Single Ended . . . . . 10 meg. paralleled by  $10\mu\text{f}$  max.  
Differential . . . . . 20 meg. paralleled by  $10\mu\text{f}$  max.

**Noise Level** —  $1\mu\text{v}$  to  $4\mu\text{v}$  RMS depending on setting of frequency response controls.

**Power Requirements** — From batteries through a standard octal plug: -90 v at 4 ma.; +135 v at 5 ma.; 6.3 v at .9 amp.

**Vacuum Tube Complement** — 1 12AX7 (Specially selected for differential balance). 2 12AU7 (One specially selected for differential balance).

**Accessories Supplied** — Power Cable and Plugs; Input Plug; Output Cable.

**Dimensions** —  $10\frac{5}{8}$ " high;  $4\frac{1}{2}$ " wide; 6" deep.

**Finish** — Panel, photo etched aluminum with black lettering; cabinet, grey wrinkle.

**Price** — \$85.00 f.o.b. Portland, Oregon. Available for rack mounting, \$90.00.



# TEKTRONIX

## TYPE 121

### WIDE BAND PRE-AMPLIFIER

**Optimum Transient Response**

**Unusual Adaptability**

The TEKTRONIX **Type 121 Wide Band Pre-Amplifier** is a self-contained three-stage amplifier designed primarily to increase the sensitivity of the Type 511, 511-A, and 511-AD oscilloscopes. A maximum voltage gain of 100 is available, increasing the sensitivity of the oscilloscope to 2.5 mv. per cm. A combination of step and continuous attenuators on the TEKTRONIX **Type 121** provides a complete range of sensitivity from 2.5 mv./cm. to 25 v./cm. without the use of the attenuators on the oscilloscope. Connection between the TEKTRONIX **Type 121** and oscilloscope is via a matched 93-ohm co-axial cable so that the separation of the instruments may be 100 feet or more. As in all TEKTRONIX instruments, primary emphasis has been placed on transient response. A bandwidth in excess of 12 mc. preserves the excellent rise time of the oscilloscope.

Careful design results in a high input impedance of 1 meg. shunted by 20 mmf., maintained for all positions of the attenuators. When desired, conventional RC probes may be used to increase this impedance at the expense of a reduction of gain. DC plate and heater supplies are available on a front panel power supply socket so that when both high input impedance and high gain are necessary, a cathode follower probe or a special pre-amplifier stage mounted directly on the signal source may conveniently be used.

The self-contained power supply in the TEKTRONIX **Type 121** provides electronically regulated DC for the plates of the tubes and to minimize the hum level, rectified, filtered DC is supplied to the heaters of the first three tubes as well as the front panel power supply socket.



### SPECIFICATIONS

Voltage gain . . . . . 100  
Input impedance, direct . . . . . 1 meg. — 20 mmf.  
Max. peak output . . . . .  $\pm 1$  v. in 93-ohm cable  
Band pass . . . . . 5 CPS — 12 mc.  
Front panel power supply socket . . . . . 6.3 v. DC  
20 - 120 v. DC  
Dimensions . . . . . 5" wide, 10" high, 14" deep  
Self-contained — Total Weight, 18 lbs.

### Vacuum Tube Complement

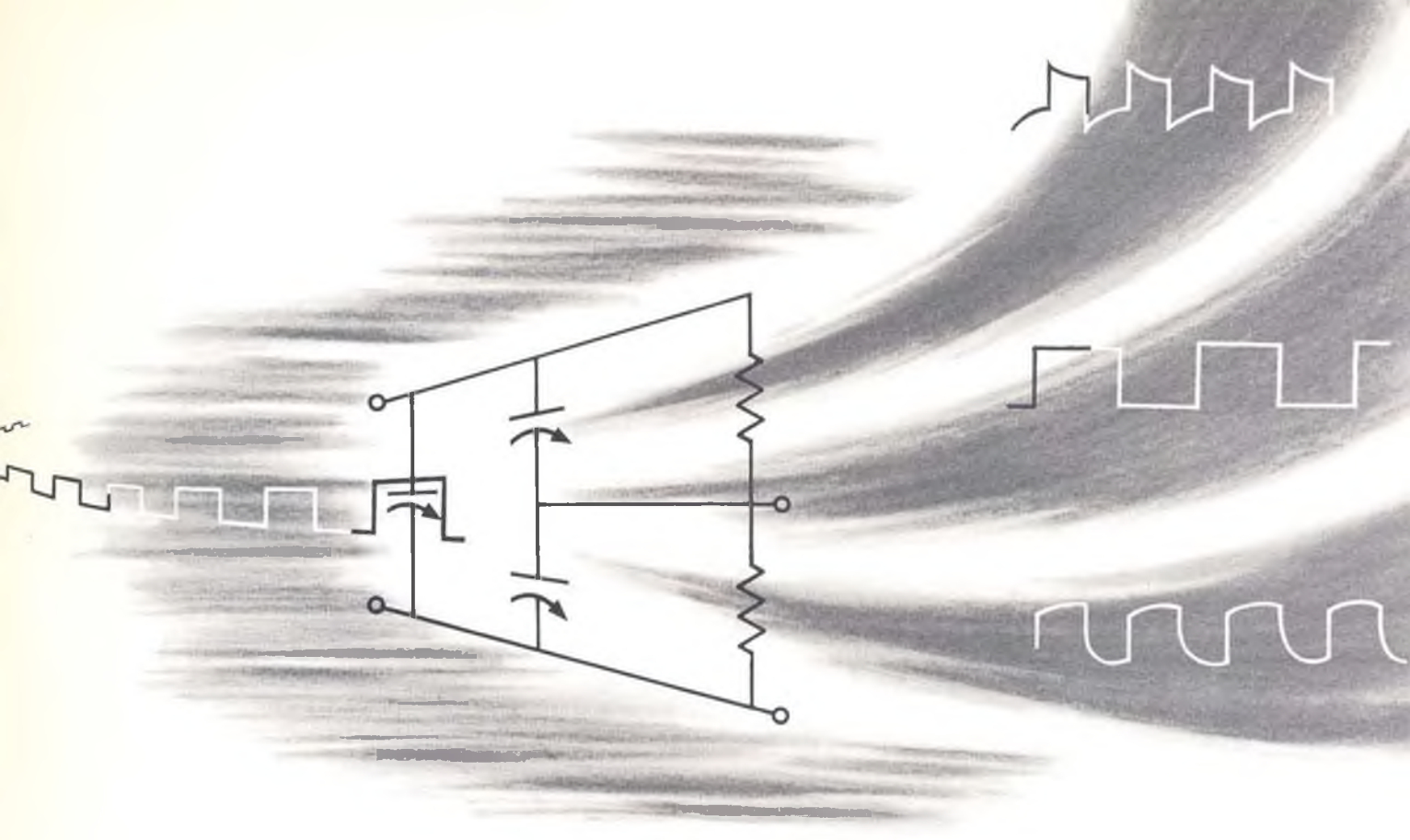
First stage . . . . .	6CB6
Second stage . . . . .	6CB6
C.F. Gain control . . . . .	6J6
Third stage . . . . .	6CB6
C.F. Output . . . . .	6J6
C.F. Voltage regulator . . . . .	6J6
Voltage regulator comparator . . . . .	12AX7
Plate rectifiers . . . . .	2 - 6X4
Series voltage regulator . . . . .	25L6
Regulator amplifier . . . . .	6AU6
Voltage reference . . . . .	5651

**Price \$265.00 f.o.b. Portland, Oregon**









## SQUARE WAVE GENERATORS

*Square wave testing techniques are recognized as providing one of the most efficient means of determining electronic circuit response. Precise adjustment of frequency compensated attenuator, amplifier and filter circuits is reduced to a simple procedure.*

*Tektronix Square Wave Generators provide precision square waves which contain useful frequency components ranging from the sub-audio to the vhf range. Thus, a wide variety of circuit types can be tested by square wave methods.*

*To insure stability of waveform, amplitude and indicated frequency, regulation circuits in the power supply compensate for adverse conditions of load, or for power line changes over the range of 105v to 125v.*





# TEKTRONIX TYPE 104A

## SQUARE WAVE GENERATOR AND VOLTAGE CALIBRATOR

### GENERAL DESCRIPTION

The Tektronix **Type 104-A Square Wave Generator** is an inexpensive generator of precision square waves in the frequency range most commonly used for amplifier response testing. The instrument is similar to its predecessor, the **Type 104**, except that it now includes an accurate voltage calibrator utilizing the two lower frequencies. Improved physical arrangement provides increased usefulness on the test bench. The **Type 104-A** is ordinarily furnished to supply square waves of 50 cps, 1 kc, 100 kc and 1 mc, giving good coverage of the audio and video ranges. By proper choice of these frequencies, the **Type 104-A** permits convenient adjustment of a wide range of amplifier types and accurate observation of their frequency and transient response.

### FEATURES

**Short Rise Time**—As a result of careful design, the two high frequency square waves have a rise time of not more than .02 microsecond without overshoot.

**High Frequency Output Available at Low Impedance**—The output of the two high frequencies is available through a matched cable terminated by a continuously variable attenuator and provides a maximum signal of 5 volts.

**Low Frequency Output Available as Calibrating Voltage**—Since the rise time is of less consequence at the two lower frequencies, a second multivibrator-limiter circuit provides these signals at a higher impedance, making it possible to obtain the low frequency output via a precision attenuator in 9 ranges of 5 mv to 50 v peak-to-peak. A calibrated wire wound potentiometer permits continuously variable amplitude adjustment for each range, accurate to within 2% of the full scale reading.

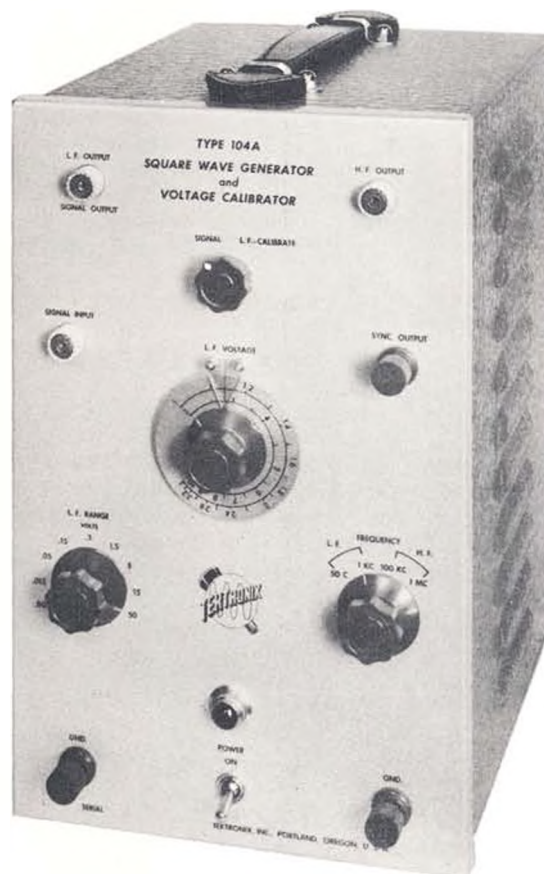
**Synchronizing Signal**—In order to synchronize the oscilloscope being used, a separate binding post supplies a synchronizing signal at a constant output of approximately 3 volts, regardless of attenuator or calibrator settings.

### APPLICATIONS

The 50 cycle square wave provides a quick test for the low frequency characteristics of amplifiers. The 1 kc square wave is a convenient signal for quickly and accurately adjusting capacity compensated attenuators. The 100 kc and 1 mc square waves permit convenient adjustment of high frequency compensating networks for video amplifiers.

Provision is made on the two low frequencies for inserting the instrument between a signal source and the oscilloscope. By the turn of a switch, either the signal or the calibrating voltage can be observed, permitting accurate measurement of amplitude of any portion of the signal waveform.

The small size and low cost of the **Type 104-A** extend the square wave testing technique into many fields of production testing.



### CHARACTERISTICS

**Frequencies**—Four fixed: 50 cps, 1 kc, 100 kc, 1 mc.

**Impedance**—Varies from 0 to 93 ohms for the high frequency output, depending on the attenuator setting. Varies from 0 to 10,000 ohms for the low frequency output, depending upon the calibrator control settings.

**Rise Time**—.02  $\mu$ sec for the high frequency outputs, and 3  $\mu$ sec for the low frequency outputs.

**Amplitude**—Continuously variable from 0 to 5 volts for the high frequency outputs. Continuously variable from 0 to 50 volts, in 9 calibrated ranges, for the low frequency outputs.

**Construction**—Chassis and cabinet are made of welded aluminum alloy. Front panel is photo etched, satin finished aluminum. Cabinet has baked gray wrinkle finish.

**Dimensions**—13 1/2" high; 9" wide; 10 1/2" deep.

**Weight**—21 pounds.

**Power Requirements**—105-125/210-250 volts, 50-60 cycles, approximately 115 watts.

#### Vacuum Tube Complement—

High Frequency Multivibrators . . . . .	2 6AG7
High Frequency Limiter . . . . .	1 6AG7
High Frequency Output Amplifier . . . . .	1 6AG7
Low Frequency Multivibrator . . . . .	1 12AU7
Low Frequency Limiter Diode and Cathode Follower . . . . .	1 12AU7
Trigger Output Cathode Follower . . . . .	1 6J8
Power Supply Rectifier . . . . .	1 5V4G
Series Regulator . . . . .	1 6AU5
Regulator Amplifier . . . . .	1 6AU6
Voltage Reference . . . . .	1 OC3/VR105

**Price** with listed frequencies **\$195.00** f.o.b. Portland, Ore.  
with selected frequencies **\$20.00** additional.



# TEKTRONIX

## TYPE 105

### SQUARE WAVE GENERATOR

**Continuously Variable, 25 CPS - 1 MC**

**Rise Time, .02 Microseconds**

**Direct Reading Frequency Meter**

Square wave testing techniques come into wider use as the need for good transient response in wide band amplifiers becomes increasingly important. In order to test the high frequency response it is necessary to have a signal which has a rise and fall at least equal to and preferably faster than the risetime of the amplifier being tested. In addition to a sharp rise and fall, the test signal should be free of over-shoots and other spurious responses. For examination of the low frequency response a square wave signal having flat horizontal portions is needed.

The TEKTRONIX Type 105 Square Wave Generator provides a suitable signal for both of these tests. Its frequency range extending continuously from 25 cycles to 1 mc., combined with its risetime of .02 microseconds, makes it possible to quickly and accurately test amplifiers, filters, etc., having pass bands from a few cycles to 20 mc.

For an excellent discussion on the connection between bandwidth and frequency response, composition of risetime and other details associated with square wave testing, see Vol. 18, Radiation Laboratory Series, "Vacuum Tube Amplifiers" (McGraw-Hill).

The TEKTRONIX Type 105 Square Wave Generator consists of a multivibrator frequency generator, having nine ranges in two steps per decade. The signal from the multivibrator is fed through two shaper stages to the output stage which consists of three 6AG7 tubes in parallel. The maximum square wave current available at the output terminals is approximately 160 ma. (peak to peak). This gives approximately 12 V. in 75-ohm cable or 15 V. in 93-ohm cable, the 93-ohm cable being supplied as a standard part. If higher output voltages are needed, correspondingly larger loads may be used with a deterioration of the risetime approximately proportional to the increased load. Maximum available output voltage is 100 V. A panel control permits setting the output amplitude from near zero to the previously mentioned maximums.

Because of the difficulties of maintaining frequency calibration on multivibrators using small plate loads, a direct reading frequency meter is incorporated. The ranges of the frequency meter are changed simultaneously with those of the multivibrator, thus providing two scales per decade.

Provision is made to furnish a synchronizing signal to an oscilloscope. The amplitude of this signal is independent of the output control setting. A sync. input binding post is also provided so that the square wave frequency may be synchronized with any desired standard.

All DC power supplies are electronically regulated so that uniform operation is obtained at line voltages of 105-125 V./210-250 V.



### SPECIFICATIONS

Frequency range . . . . .	25 cycles to 1 mc.
Risetime . . . . .	.02 microseconds for output load of 100 ohms or less.
Output Amplitude . . . . .	0-100 V. peak to peak across internal 600-ohm load 0-160 ma. available for external load.
Accuracy of frequency indication . . . . .	$\pm 3\%$ of full scale
Sync. Output . . . . .	5 Volts
Sync. Input . . . . .	3 Volts
Power requirements . . . . .	105-125, 210-250 V., 50-60 cycles, 250 watts
Dimensions . . . . .	10 1/2" wide, 16" high, 14 1/2" deep
Weight . . . . .	35 pounds

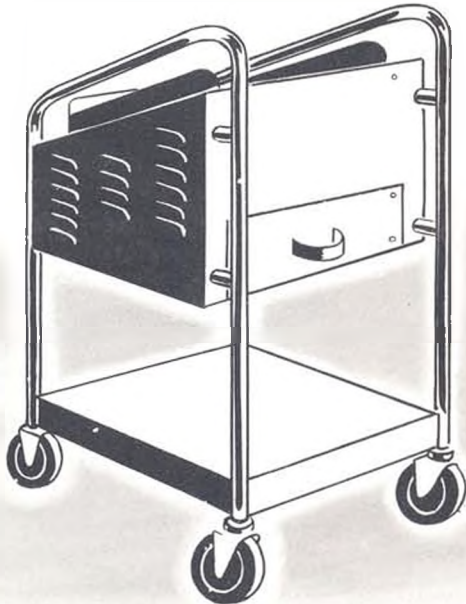
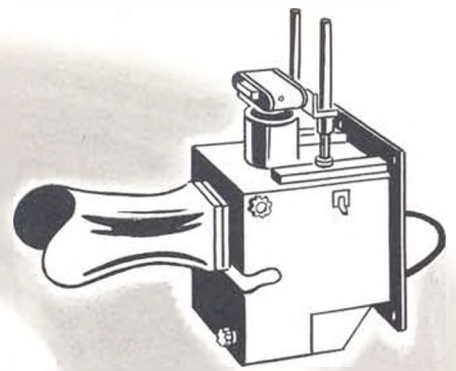
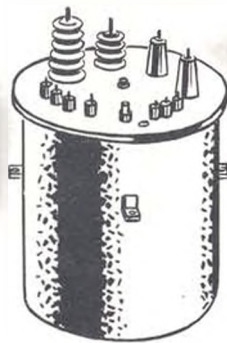
### Vacuum Tube Complement

Multivibrator . . . . .	2	6AK5
Amplifier . . . . .	1	6AG7
Shaper-amplifier . . . . .	2	6AG7
Output amplifier . . . . .	3	6AG7
Sync input amplifier . . . . .	1	6AG5
Sync coupling diode . . . . .	1	6AL5
Meter amplifier . . . . .	1	6AK5
Limiter & Catcher diode . . . . .	1	6AL5
Cathode Follower voltage regulator . . . . .	1	6J6
Meter diode . . . . .	1	6AL5
Sync output cathode follower . . . . .	1	6J6
Fixed power supply rectifiers . . . . .	2	5V4G
Series regulator tubes . . . . .	2	6Y6G
Regulator amplifier . . . . .	1	6AU6
Voltage reference tube . . . . .	1	5651
Variable power supply rectifiers . . . . .	2	5V4G
Series regulator tubes . . . . .	2	6Y6G
Regulator amplifier . . . . .	1	6AU6

**Price \$ 395.00 f. o. b. Portland, Oregon**







## MISCELLANEOUS EQUIPMENT

*These units are designed to expand the applicability of Tektronix Oscilloscopes in order that a greater benefit might accrue to the user.*



# TEKTRONIX

## TYPE 210 POWER SUPPLY



The Tektronix Type 210 High Voltage Power Supply is a compact, oscillator type supply, designed to furnish the potentials necessary to operate the recently developed high writing rate cathode ray tubes. It can also be used for other applications where this range of voltages — and negligible current — is required.

Empirically derived evidence indicates that proper operation of a cathode ray tube demands a post-deflection to pre-deflection accelerating potential ratio of 5:1, and this requirement has been observed during the development of this supply. To permit adaptation to the widest variation of needs, a versatile voltage doubler circuit, which requires an external oscillator and regulator, is the basis of the design. The plate B+ and grid taps of the oscillator transformer primary, project from the top of the case through ceramic insulators. Taps are provided for both positive and negative regulating potentials and for +10 kv, +6.6 kv, +3.3 kv and -2.1 kv.

The Type 210 is contained in a small cylindrical case, machined of cast aluminum, and filled with a transformer type mineral oil. An air filled neoprene bladder allows for expansion and contraction of the oil due to temperature variations.

### SPECIFICATIONS

Outputs . . . . . 10 kv — 300  $\mu$ a  
 — 2.1 kv — 700  $\mu$ a  
 6.6 kv  
 3.3 kv

Tube Types . . . . . +10 kv Rectifier    2    1X2A  
 — 2 kv Rectifier                    1X2A

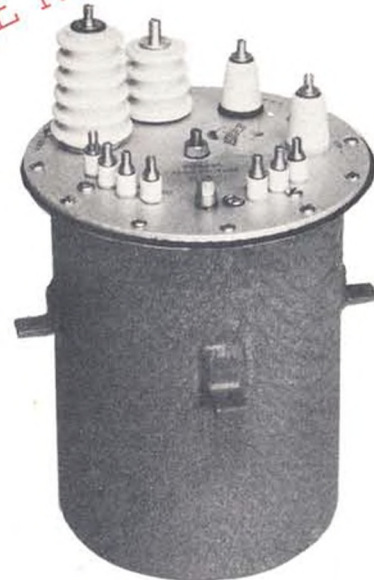
Finish . . . . . Baked gray crackle and etched aluminum

Dimensions . . . . . 5 1/2" diameter, 8" high  
 Weight 7 lbs. including oil

Price \$80.00 f.o.b. Portland, Oregon.

# TEKTRONIX

## TYPE 420 POWER SUPPLY



The Tektronix Type 420 High Voltage Power Supply is an oscillator type supply similar to the Type 210. It is designed to provide the potentials for the special high voltage cathode ray tubes which are used in the Tektronix Type 517 High Speed Oscilloscope.

The Type 420 uses a versatile voltage quadrupler type of circuit. Greater flexibility of operation is made possible by using separate transformers for both the filament and high voltage supplies. This permits varying the high voltage, without affecting the filament operation, by varying the excitation of the high voltage oscillator.

Design of the power supply in a self-contained package which requires external oscillator and regulator circuits, permits adaptation to a great variety of operation requirements.

### SPECIFICATIONS

Outputs . . . . . Maximum Voltages    20 kv. @ 200  $\mu$ a  
 — 4 kv @ 700  $\mu$ a  
 13.3 kv  
 6.6 kv

Operation at 10 kv    10 kv @ 400  $\mu$ a  
 — 2 kv @ 1.4 ma  
 6.6 kv  
 3.3 kv

Tube Types . . . . . +20 kv rectifier    4    1X2A  
 — 4 kv rectifier                    1X2A

Finish . . . . . Etched aluminum and baked gray crackle

Dimensions . . . . . 6 3/4" diameter, 10" high  
 Weight 11 lbs. with oil

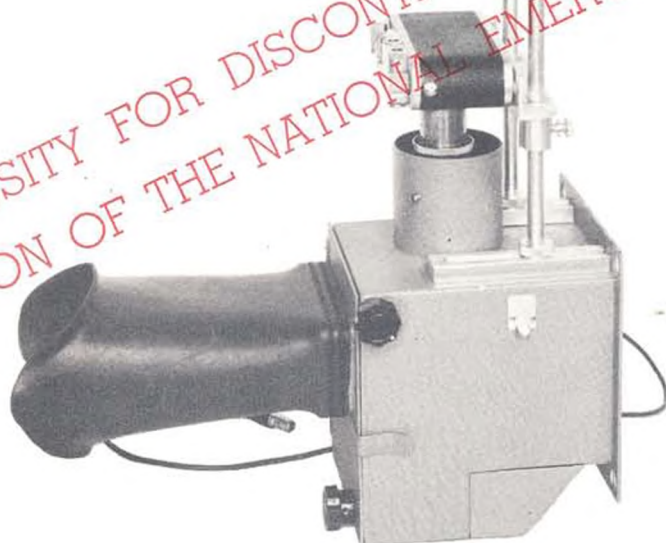
Price \$150.00 f.o.b. Portland, Oregon.



# TEKTRONIX

## TYPE 51

### CAMERA ADAPTER

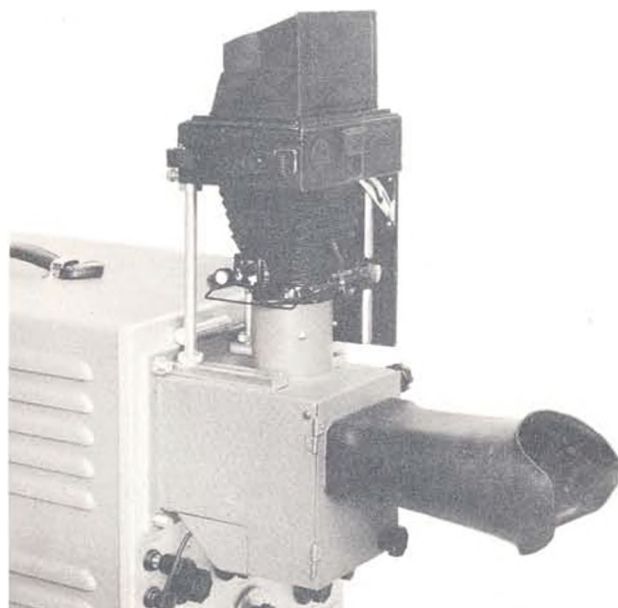


The TEKTRONIX **Type 51** Camera Adapter is designed to permit convenient recording of cathode tube ray traces and data pertaining to them. Throughout its development, the desirability of providing at all times an unobstructed view of the CRT face was kept in mind. The result is an extremely useful accessory for all of the TEKTRONIX oscilloscopes.

The **Type 51** has a versatile mounting system which adapts itself conveniently to a large number of camera types, ranging from 4"x5" filmpack to almost all 35mm types. Some movie cameras can also be used with it. The camera is mounted in a vertical plane, the CRT face being reflected by a partially metallized retractable mirror, transparent to the red portion of the spectrum. A lens of the proper focal length permits the camera focus to be left at infinity, thus simplifying the camera settings considerably. Crayoned data stands out in apparent bold relief on an edge-lighted piece of plastic which is visible through the mirror, enabling a permanent record to be kept of the circuit conditions at the time of the experiment.

A viewing hood mounted over the shutter opening in the front cover, permits the viewing of the entire CRT screen, while preventing an undue amount of extraneous light from entering. To provide access to the data board, the front cover swings open. It may be removed entirely, in the event that the camera is not in use and an unrestricted view of the CRT face is desired.

The weight of the **Type 51** is approximately 3 lbs. and the total dimensions, including camera mounting brackets and viewing hood, are 13 1/2" high, 6 1/4" wide and 13 1/2" deep.





# TEKTRONIX

## TYPE 500 SCOPE - MOBILE



The TEKTRONIX **Type 500 Scope-Mobile** has been especially designed to accommodate the Tektronix Cathode Ray Oscilloscopes. It provides a sturdy yet mobile and therefore highly useful support for the Oscilloscope. Convenient and easy observation of the CRT face is achieved by a 20° tilt back.

A blank panel, 11"x15", fronting a mounting space of approximately 1 1/2 cubic feet allows for auxiliary built-in equipment as an aid in meeting specialized requirements. This space is fully ventilated by means of louvers. A power input connector and three convenience outlets appear at the back.

A drawer is provided for the handy storage of cords, probes, instruction books, small tools, etc. For quietness and ease of operation the drawer, 15"x15"x3" in size, is felt lined and operates in roller bearing support runners. An open shelf, 17"x24" in size and topped with battle-ship linoleum, is located at the bottom of the unit.

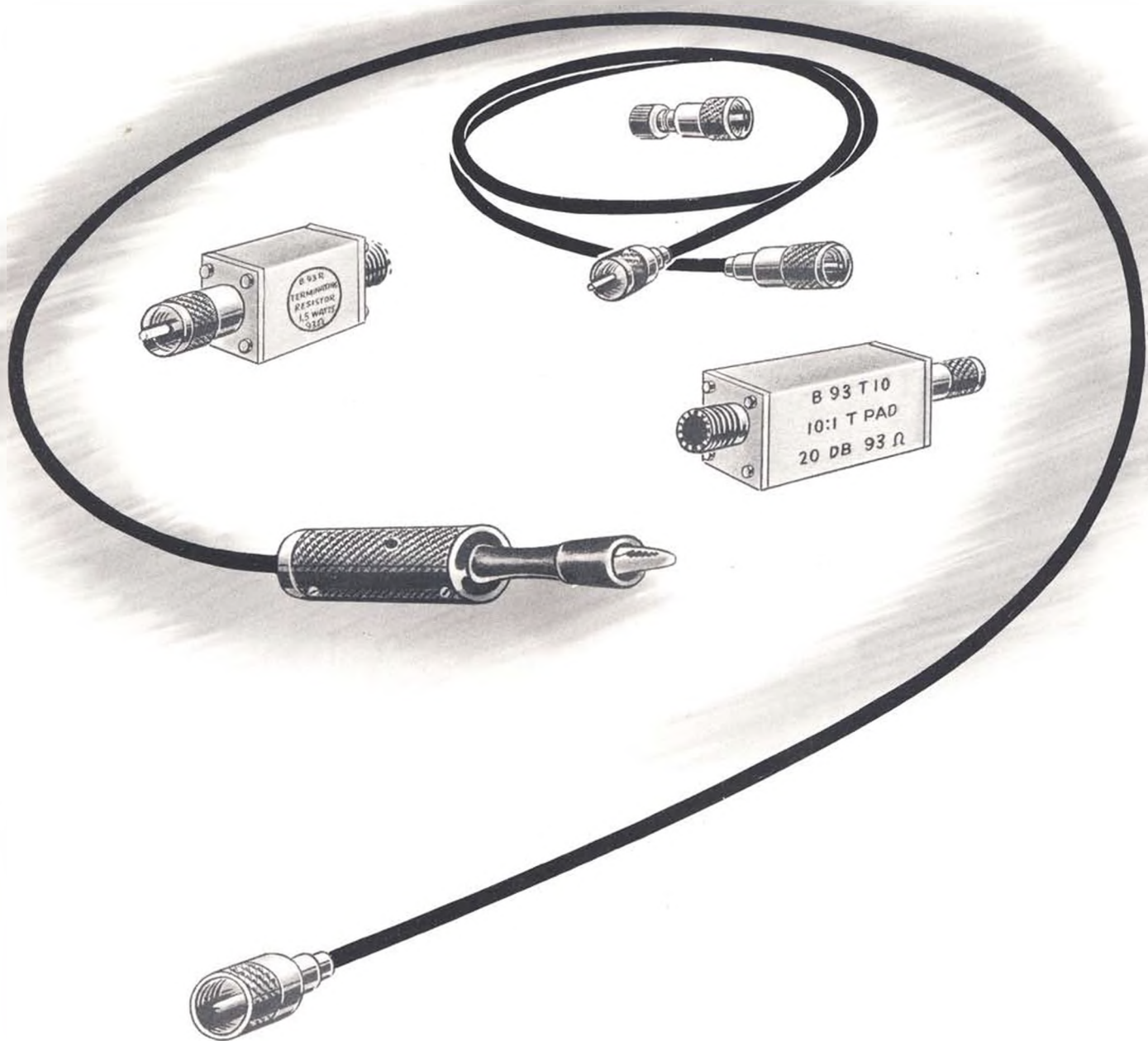
The unique and functional design of the Scope-Mobile assures ease of mobility through multi-handhold rails, 5" rubber tired castoring wheels and low weight. The entire unit is constructed of aluminum alloy materials, finished in bright buffed aluminum and baked grey crackle to match other Tektronix products.

Total "dry" weight of the Scope-Mobile is approximately 42 pounds and clearance dimensions are 18 1/2" wide, 39" high and 30" deep.

**Type 500 Scope-Mobile** price \$97.50, f.o.b. Portland, Oregon.

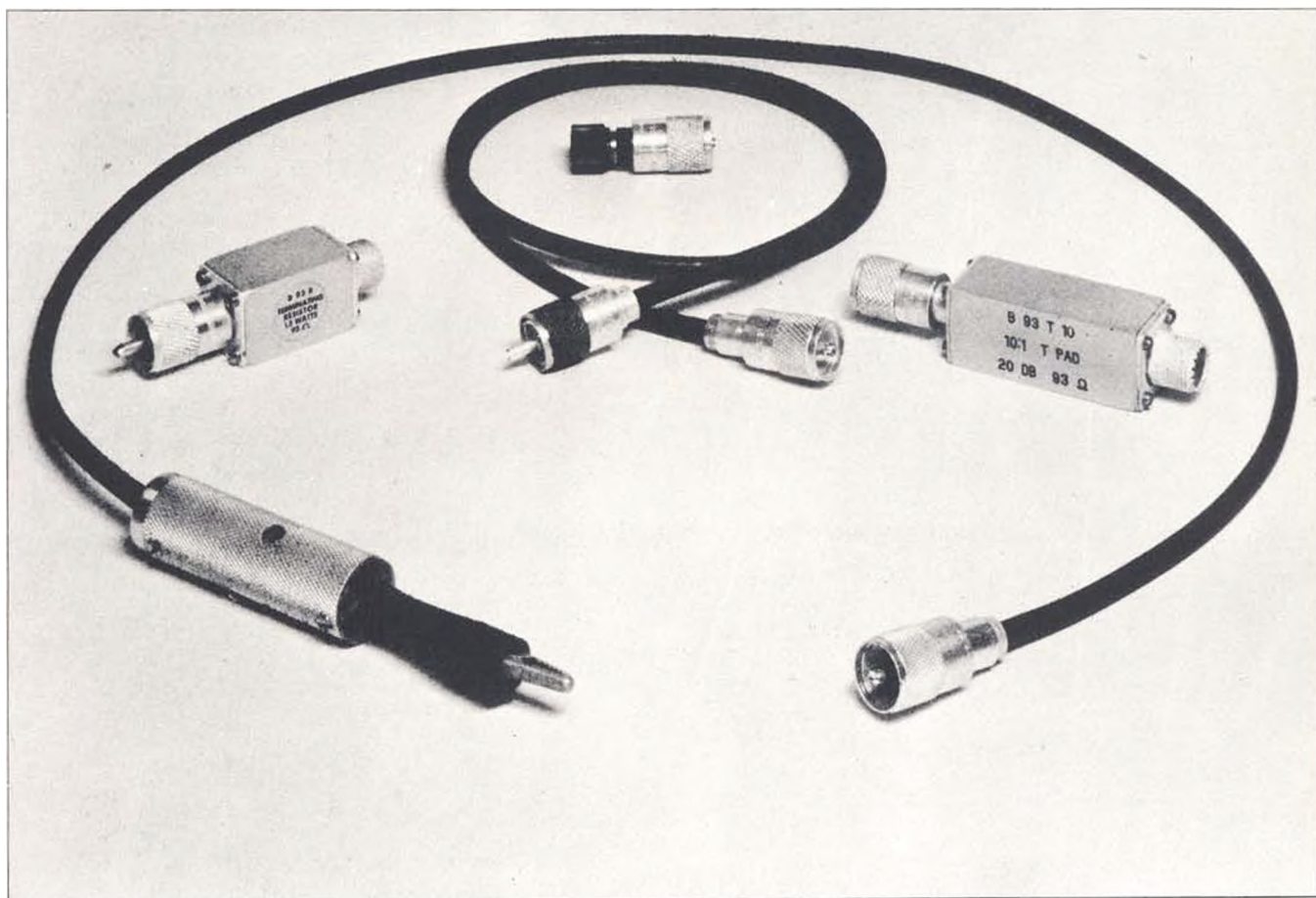






## ACCESSORIES

*These accessories are designed to expand the applicability of Tektronix Oscilloscopes in order that a greater benefit might accrue to the user.*



### PROBES

The Type P-510 Attenuator Probe permits low-level measurements to be taken with minimum interference with the observed circuit. It gives an attenuation of signal of 10X when used in conjunction with the oscilloscopes or amplifiers listed. It presents an input impedance of 10 megohms paralld by approximately 14  $\mu$ f. Type P-510 Attenuator Probe, Price \$9.25.

### MATCHED CABLES

Matched cables are a necessity, when working with high frequencies, in order to avoid reflections at the terminations. This is standard RG-62/U coaxial cable, terminated in a carefully selected 93 ohm resistor. Type C-121 Output Cable, Price \$5.00.

### TERMINATION ACCESSORIES

For those applications where a matched cable is not available, a terminating impedance will perform the same function. Terminations are available from stock to match 93 or 50 ohm cables, and upon receipt of special order other impedances are available. T and L pad attenuators can be had on regular order.

Type No.	Configuration	Impedance	Price
B50R	Termination resistor	50 ohms	\$ 8.50
B93R	Termination resistor	93 ohms	\$ 8.50
B50L5	5:1 L Pad	50 ohms	\$ 8.50
B50L10	10:1 L Pad	50 ohms	\$ 8.50
B93L5	5:1 L Pad	93 ohms	\$ 8.50
B93L10	10:1 L Pad	93 ohms	\$ 8.50
B93-50L	Minimum Loss L Pad	{ output 50 } { input 93 }	\$11.50
B50T10	10:1 Symmetrical T Pad	50 ohms	\$11.50
B93T10	10:1 Symmetrical L Pad	93 ohms	\$11.50

### ADAPTERS

Type A-100 Clip Lead Adapter — for connecting clip leads to coaxial cable. Price \$2.50.

Type A-510 Binding Post Adapter — a male coaxial input plug combined with a binding post. Price \$1.88.

### COAXIAL CABLES

Type P-50 Coaxial Cable, 42" long, 50 ohms impedance. Price \$4.00.

Type P-93 Coaxial Cable, 42" long, 93 ohms impedance. Price \$4.00.

Other lengths and impedances, prices on request.



**For Detailed Specifications Please Contact Nearest Representative or Tektronix, Inc.**

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Phone 5-8731

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Everett Associates  
6744 No. California Ave.  
Ambassador 2-3702

Jim Everett  
Rupert Noble  
Dave Pivan

CLEVELAND, OHIO  
The Satullo Co.  
1125 Fidelity Bldg.

Howard Heasley

DETROIT 14, MICHIGAN  
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7635 E. Jefferson

Anthony R. Satullo

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Fort Myers 5-6762

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# TEKTRONIX, INC.

**Manufacturers of Cathode-Ray and Video Test Instruments**

SUNSET HIGHWAY AND BARNES ROAD - P. O. BOX 831 - PORTLAND 7, OREGON, U. S. A.  
PHONE: ATwater 6357 CABLES: TEKTRONIX



All Tektronix instruments are fully guaranteed against defective materials and workmanship for one year. Should replacement parts be required, whether at no charge under warranty terms or at established net prices, they will be shipped from the factory, via air transportation upon request, prepaid to any point within the continental United States and Canada.

