



TEKTRONIX

Manufacturers of

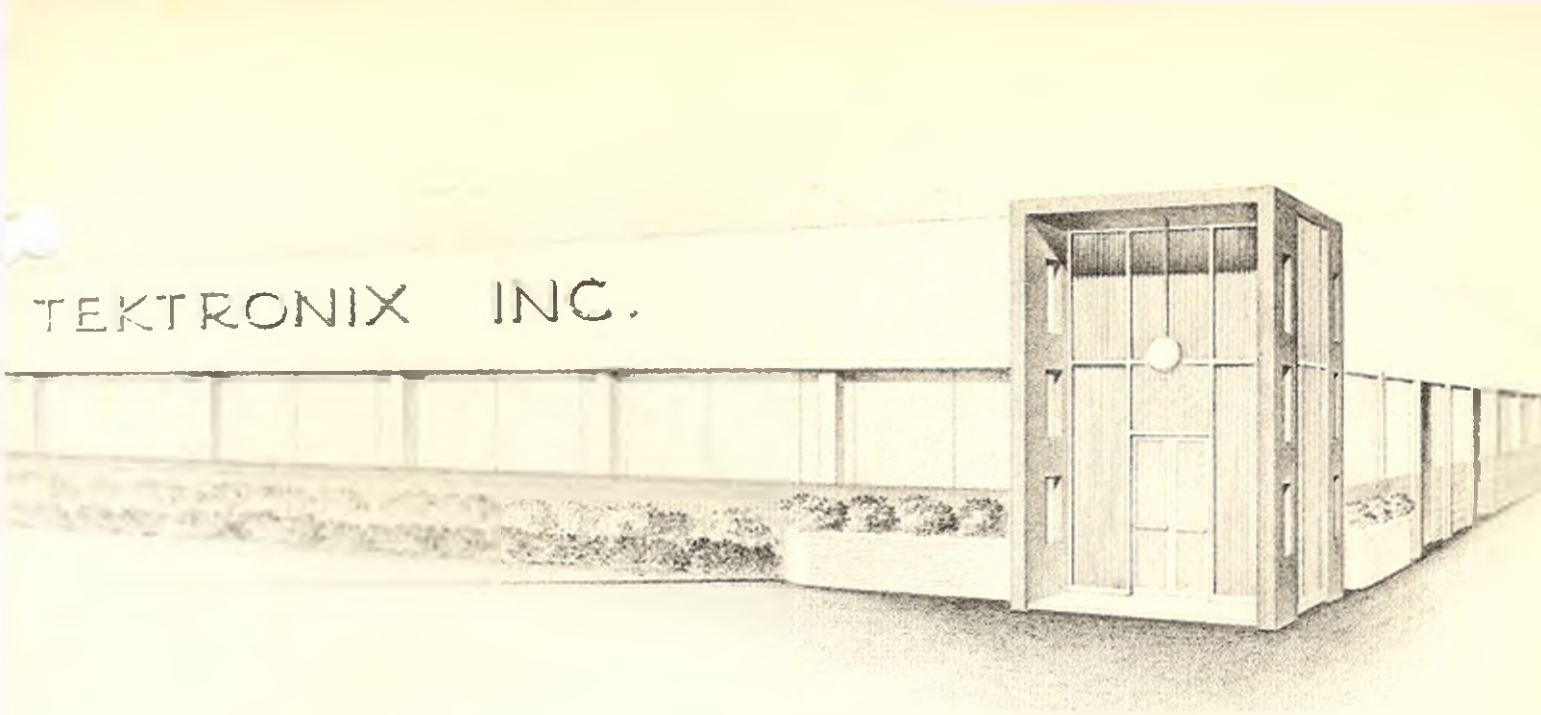
**CATHODE - RAY OSCILLOSCOPES
AND VIDEO TEST INSTRUMENTS**

MARCH 1953

HANK
CROMBIE
BOSTON

OUR 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.

TEKTRONIX, INC.

was organized as an Oregon Corporation 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.

TEKTRONIX, INC. • P. O. Box 831, Portland 7, Oregon, U.S.A.

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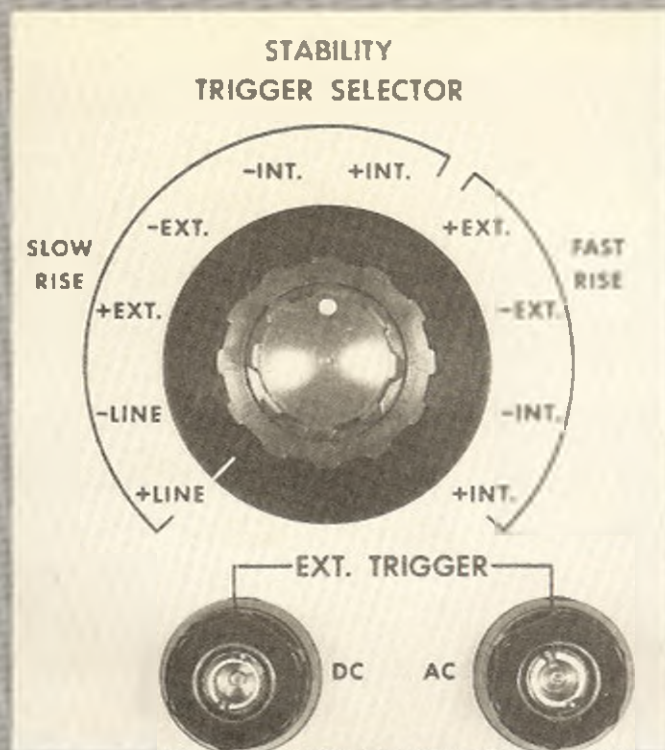
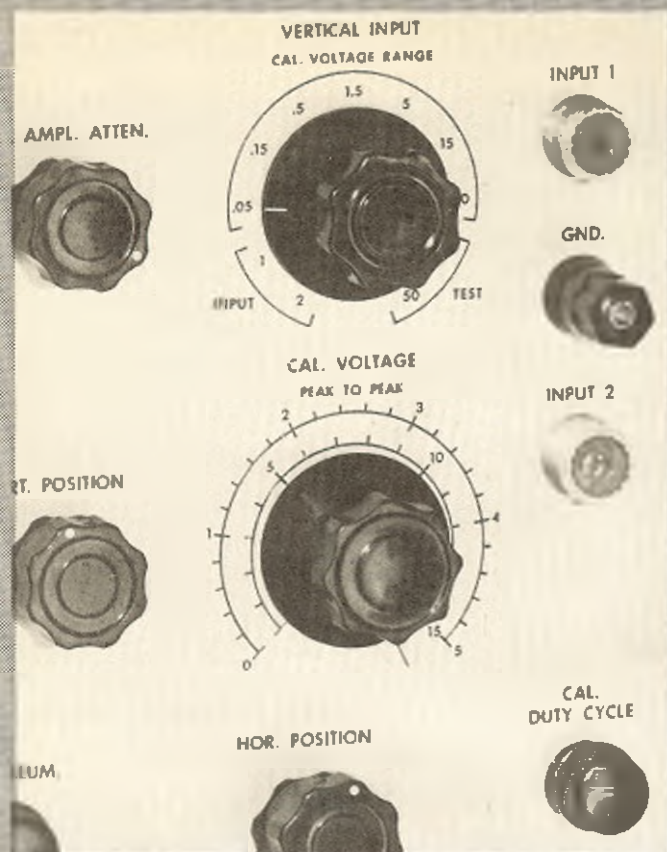
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CATHODE-RAY OSCILLOSCOPES

Every Tektronix Oscilloscope is, from its inception, considered to be a specialized extension of the operator's senses. It is engineered to the highest standards of electronic circuit design, and 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.



VOLTAGE CALIBRATOR OF THE TYPE 524-D OSCILLOSCOPE

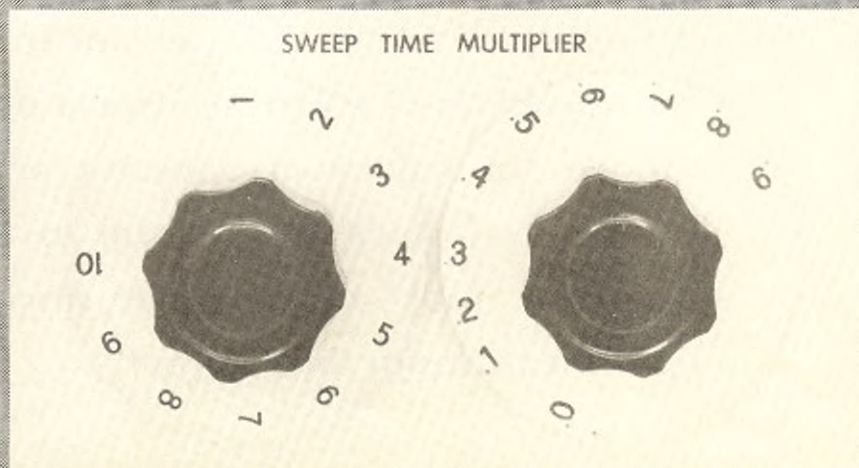
Every Tektronix Oscilloscope incorporates a built-in voltage calibrator providing an amplitude measuring facility. The duty cycle of the Type 524-D square wave calibrating voltage is variable from 1% to 99%. Depending on the instrument type, the calibrating voltage is a square wave of line frequency, a square wave of about 1 kc, or a pulse of about 25 kc.

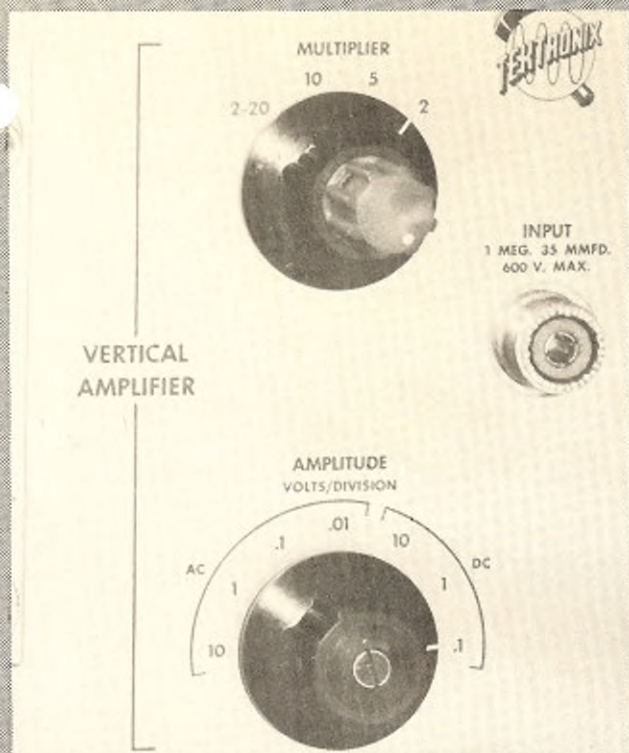
SWEEP AND TRIGGER CONTROLS OF THE TYPE 315-D

A multi-position switch permits triggering the sweep from an observed signal, from an external source of positive or negative polarity, or from the line voltage frequency. The setting of the STABILITY potentiometer determines whether the sweep generator is triggered into operation or is free-running. In the Type 315-D these two functions are combined in one coaxial control.

SWEEP DIALS OF THE TYPE 513-D OSCILLOSCOPE

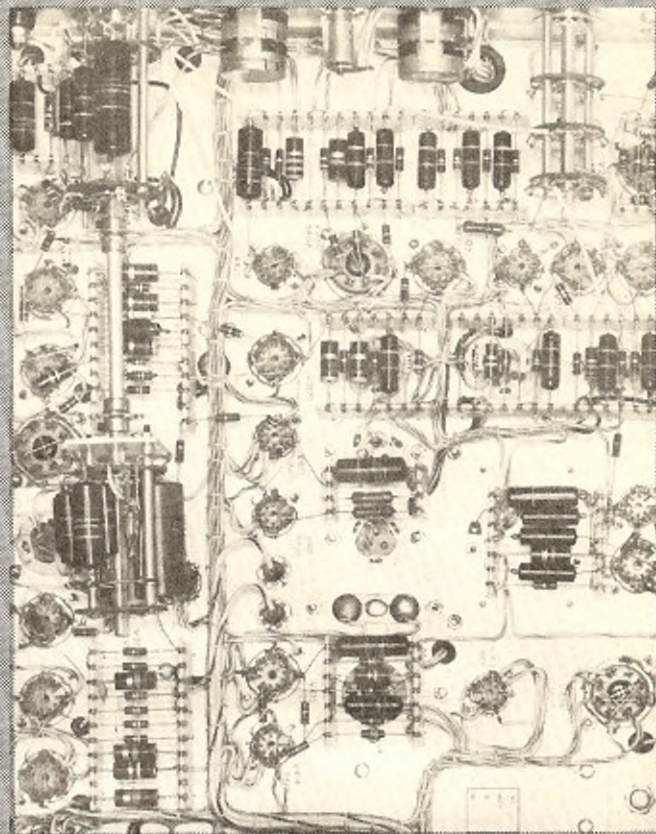
All Tektronix Oscilloscopes have direct-reading sweep dials. Sweep indicator dials are calibrated in "time/unit distance," and the "units of distance" are scribed on the graticule of the instrument. Time intervals are easily read from these illuminated graticule markers.





VERTICAL AMPLIFIER CONTROLS OF THE TYPE 315-D OSCILLOSCOPE

A combination of step attenuator and gain control potentiometer provides continuously variable vertical sensitivity over a wide range in all Tektronix Oscilloscopes. The calibrated range and multiplier switches of the Type 315-D permit making accurate voltage readings directly from the screen. Multiplier and fill-in potentiometer are combined in one coaxial control.

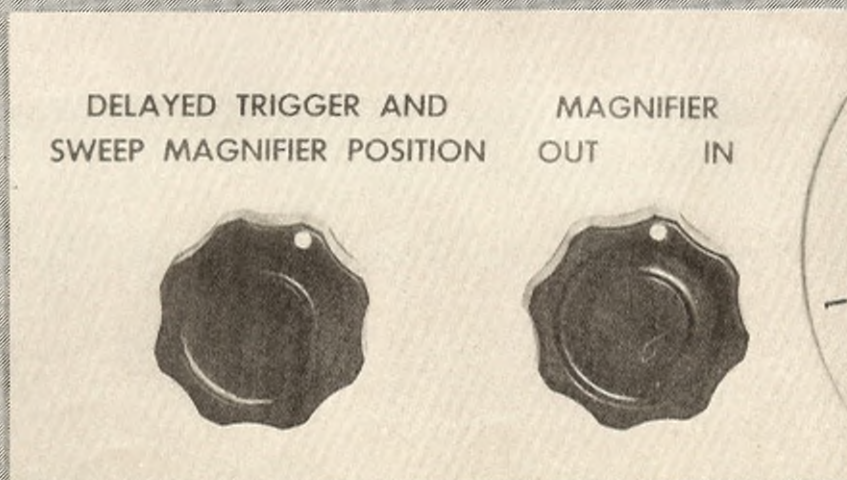


SWEEP SECTION OF THE TYPE 524-D OSCILLOSCOPE

Ease of maintenance is a prime consideration in the mechanical design and layout of all Tektronix instruments. All components and connections are exposed as much as possible, and all leads are color-coded. Ceramic mounting strips with silvered slots are used in the Type 524-D Oscilloscope.

SWEEP MAGNIFIER CONTROLS OF THE TYPE 512 OSCILLOSCOPE

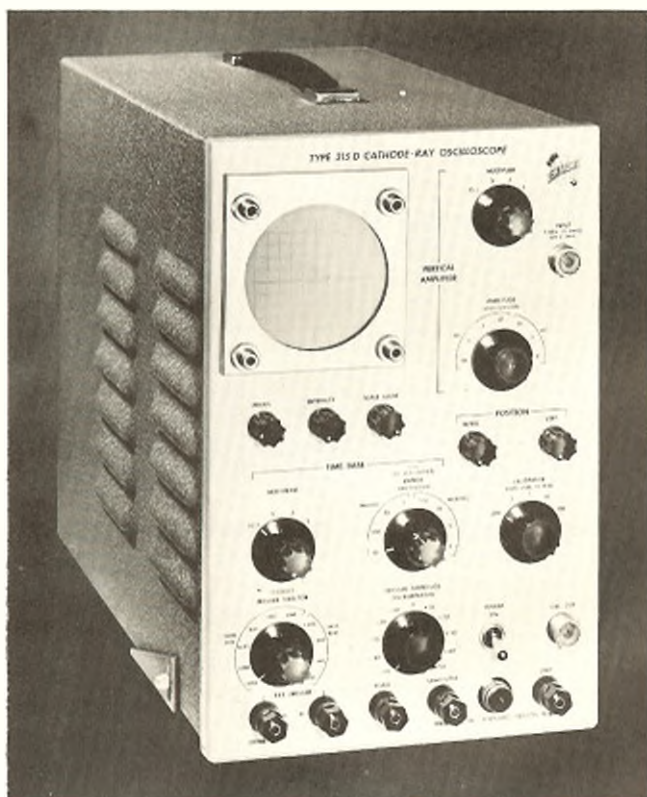
Detailed scrutiny of a waveform is sometimes necessary to aid in determining the characteristics of a circuit. Tektronix Oscilloscopes simplify this type of observation with a Sweep Magnifier control providing a predetermined amount of sweep expansion.



CATHODE-RAY OSCILLOSCOPE

N E W I N S T R U M E N T

TYPE 315-D



Time base range . . .
... 0.1 $\mu\text{sec/division}$ to 5 sec/division
Sensitivity . . 0.01 v/division ac—0.1 v/division dc
Vertical bandwidth dc to 5 mc
Risettime less than 0.07 μsec

GENERAL DESCRIPTION

The TEKTRONIX Type 315-D is a portable, self-contained precision oscilloscope using a three-inch flat-faced cathode-ray tube. Design features include engineering and constructional innovations, as well as small size and low weight.

The calibrated time base range of 0.1 $\mu\text{sec/division}$ to 5 sec/division is the widest offered in a commercial oscilloscope. Twelve calibrated vertical sensitivity positions cover the range of 0.01 v/division to 50 v/division. Vertical amplifier bandwidth is dc to 5 mc with the low frequency 3 db point at 5 cycles in the ac position. Risettime is less than 0.07 μsec .

Calibrated vertical sensitivity controls permit direct reading of amplitude levels from the screen. Calibrated time base controls permit direct reading of time intervals from the screen in the same manner. Where ratios rather than absolute values are to be determined, uncalibrated continuously variable vertical amplitude and time base controls add to the convenience and ease of operation of the Type 315-D.

A direct-coupled trigger amplitude discriminator permits trigger phasing on complex waveforms. Square wave voltage calibrator is built-in for convenient checking of vertical amplifier calibration. Direct coupled unblanking, new 5x sweep magnifier, and 0.25 μsec delay network are other features of the Type 315-D. All dc voltages are electronically regulated.

New mechanical design utilizes ceramic mounting strips and posts. This type construction makes possible a compact instrument that is not difficult to service. Forced ventilation is provided by a cooling fan mounted at the rear of the instrument. An efficient filter removes dust and foreign matter from the cooling air.

VERTICAL DEFLECTION SYSTEM

Twelve calibrated vertical sensitivity positions are available.

Vertical Sensitivity—The seven position vertical input switch covers the calibrated ranges 0.01, 0.1, 1, 10 v/division ac and 0.1, 1, 10 v/division dc. A four position switch is used to select the multiplier—1, 2, 5, or 10 to 1. In the 10 to 1 position the multiplier is continuously variable to approximately ten times but is not calibrated.

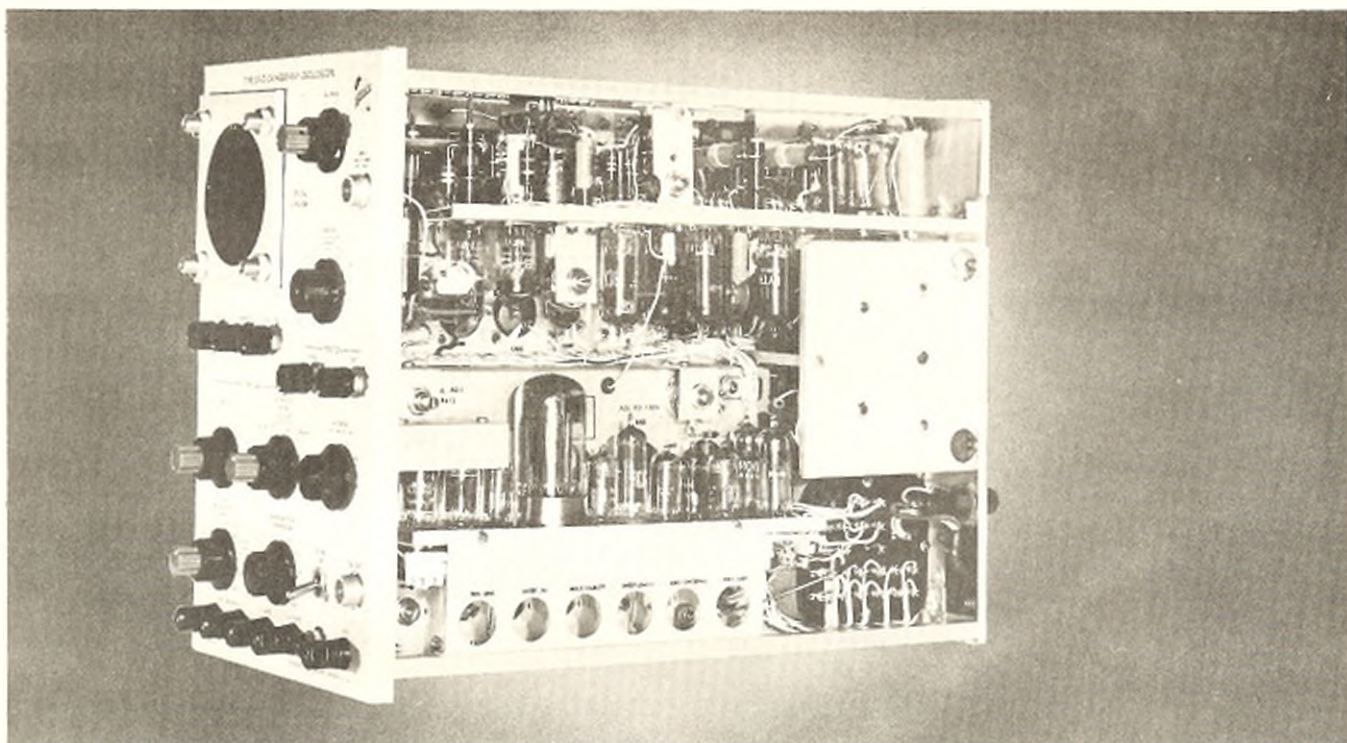
The calibrated vertical sensitivity is extended to 500 v/division by use of the small, insulated 10x probe furnished with the instrument. The probe presents an input impedance of ten megohms paralleled by approximately fourteen micro-microfarads.

The vertical amplifier presents an input impedance of one megohm paralleled by approximately thirty-five micro-microfarads.

Signal Delay—A 0.25 μsec signal delay is provided by a delay network between the first and second stages of the main amplifier. The second stage is a cathode-coupled parallel stage, providing a push-pull output. The pre-amplifier is capacitively coupled to the main amplifier in the 0.01 v/division range.

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HORIZONTAL DEFLECTION SYSTEM

An entirely new horizontal deflection system is used in the **Type 315-D**. The time base is generated in a Miller runup circuit. Sawtooth linearity is improved by a constant current charging source to the timing capacitor.

Wide Range—An 8-position range switch and a 1, 2, 5, and 10 to 1 multiplier switch provide 24 calibrated time bases, 3 per decade, from 0.1 $\mu\text{sec}/\text{division}$ to 5 sec/division. The 10 to 1 position of the multiplier switch provides a continuously variable uncalibrated time base from approximately 1 $\mu\text{sec}/\text{division}$ to 10 sec/division.

Sweep Magnifier—The 5x magnifier expands the time base to right and left of center. When the magnifier switch is turned on, a degenerative network in the output amplifier circuit is opened increasing the gain by a factor of five. The **HORIZONTAL POSITION** control precedes the magnifier circuits and therefore positions for both the magnified and the normal time bases. By means of a screw-driver adjustment the magnification can be accurately set to 5 times, except at sweep times of less than 0.1 $\mu\text{sec}/\text{division}$.

Direct Coupled Unblanking—Separate power supplies controlled by a common regulator are provided for the grid and cathode voltages of the cathode-ray tube. The cathode supply maintains a fixed potential. The grid supply is floating and has its positive end connected to the unblanking cathode followers. This provides a dc coupling for the unblanking waveform and assures that when the cathode-ray tube is unblanked its grid bias is uniform regardless of sweep time and repetition rate.

Direct Coupled Trigger Amplitude Discriminator

—The amplitude level on a waveform where triggering occurs may be selected by the **TRIGGER AMPLITUDE DISCRIMINATOR** control. This permits triggering the sweep at various levels on simple or complex waveforms. The degree of flexibility of this system is indicated by the fact that the sweep may be initiated at any point on the positive or negative portion of the negative going slope of a sine wave, as well as any point on the positive going slope.

Trigger Selector—A ten position switch permits selection of the positive or negative going portion of the waveform to trigger the sweep, either internally or by providing the trigger from an external source, and use of either a fast or slow risetime waveform for a trigger. Selection of either the positive or negative going portion of the line voltage waveform is also provided.

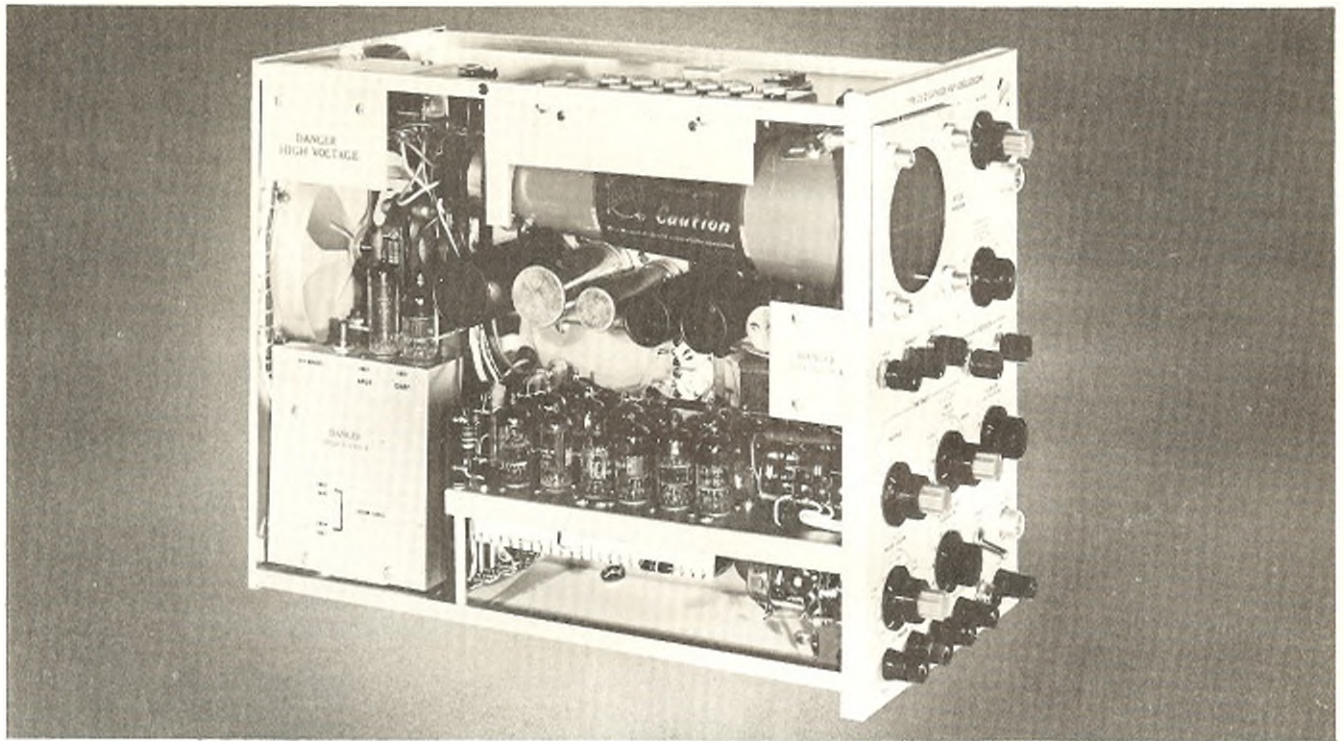
OTHER FEATURES

Voltage Calibrator—A square wave voltage is available at four accurate levels—0.1, 1, 10, and 100 volts, peak to peak. The calibrator operates at a frequency of about one kilocycle. This square wave is also useful for aligning the vertical amplifier, attenuator, and probe. It is a suitable signal for checking many types of amplifiers and other equipment.

Output Waveforms—A $\frac{1}{2}$ GATE voltage of the same duration as the sweep, and the sweep sawtooth waveform are available at the front panel via cathode followers.

Accelerating Potential—A flat-faced cathode-ray tube with 1.8 kv accelerating potential is used in the **Type 315-D**.

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Illuminated Graticule—An edge-lighted graticule marked in quarter inch divisions is provided. Illumination is controlled by a front panel knob. An appropriate color filter is provided to increase contrast when viewing in a brightly lighted room.

Regulated Power Supply—All dc voltages are electronically regulated to insure stable operation over the supply range of 105 v to 125 v. Selenium rectifiers are used throughout the main power supply.

CHARACTERISTICS

Time Base Circuit—Wide range Miller runup type, triggered or recurrent as desired.

Time Bases—24 calibrated: 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50, 100, 200, 500 microseconds/division, 1, 2, 5, 10, 20, 50, 100, 200, 500 milliseconds/division, 1, 2, 5 seconds/division. Calibration accuracy 3% or better except on 0.1, 0.2, 0.5 μ sec and 1, 2, 5 sec time bases where calibration accuracy is within 5%. Uncalibrated time base continuously variable from approximately 0.1 μ sec/division to 10 sec/division.

Sweep Magnification — 5x magnifier expands the sweep to right and left of center.

Vertical Amplifier—Three stage, push-pull output, response dc to 5 mc, 5 cycles to 5 mc when capacitively coupled. Rise time less than 0.07 μ sec.

Vertical Deflection Sensitivity—12 calibrated sensitivity ranges: 0.01, 0.02, 0.05, 0.1, 0.2, 0.5, 1, 2, 5, 10, 20, 50 volts/division. A front panel screwdriver adjust-

ment is provided for setting the vertical amplitude calibration. When set on any one range, all others will fall within 3% of this accuracy. The 0.01, 0.02, 0.05 volts/division ranges capacitively coupled only. Sensitivity continuously variable but uncalibrated from approximately 0.01v/division to 100 v/division.

Calibrating Voltage—Square wave, approximately 1 kc. Four fixed levels: 0.1, 1, 10, 100 volts peak to peak. Calibration accuracy 3% or better.

Construction—Self-contained, cabinet and chassis made of aluminum alloy, removable sub-chassis. Photo-etched front panel.

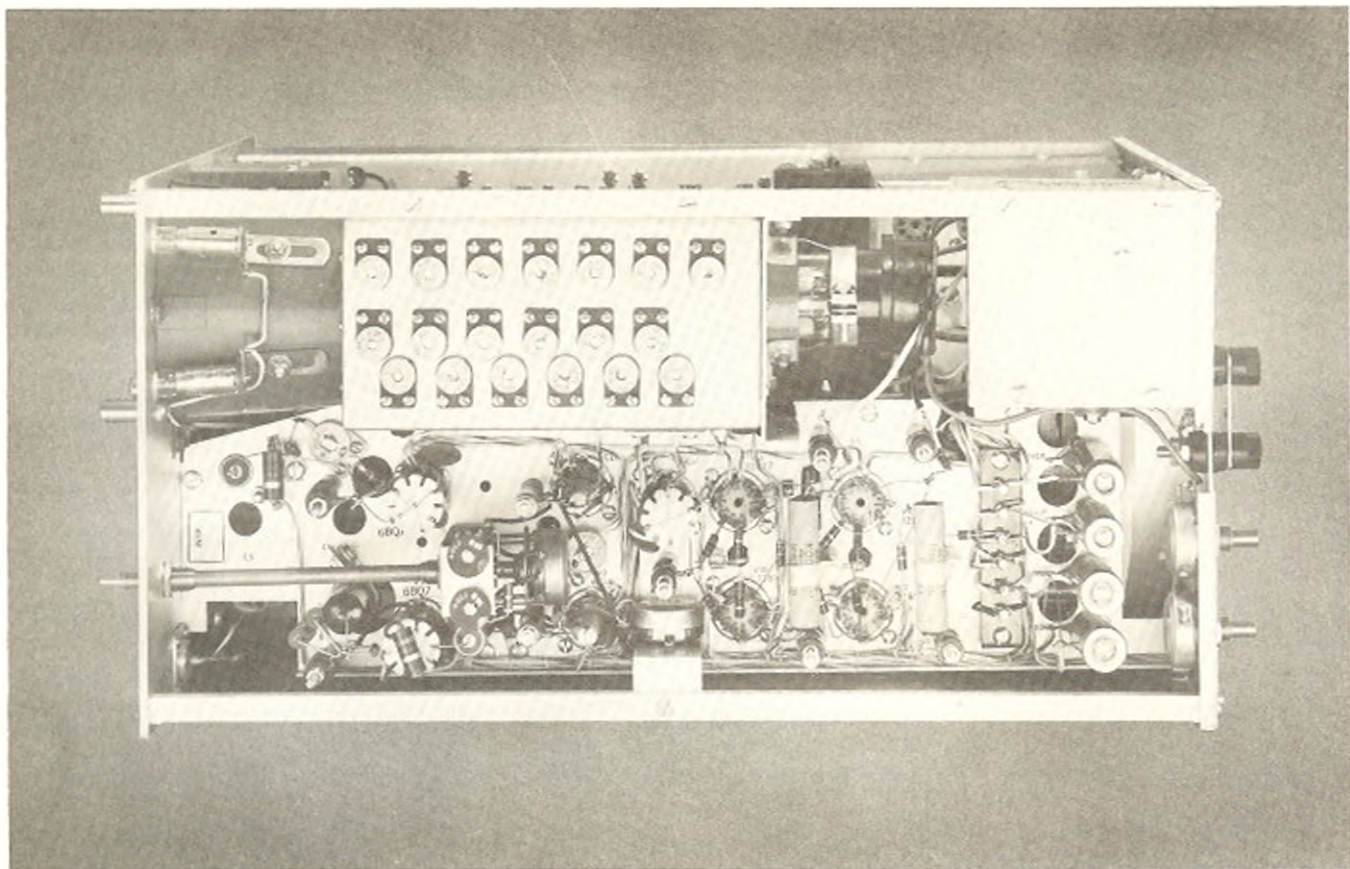
Dimensions—12 $\frac{3}{8}$ " high, 8 $\frac{3}{8}$ " wide, 15 $\frac{3}{8}$ " deep. Maximum depth including knobs and air filter, 18 $\frac{1}{4}$ ".

Weight — 36 pounds.

Power Requirements—105-125 or 210-250 volts, 50-60 cycles, 375 watts. The ability of the **Type 315-D** to use power line frequencies from 50 to 800 cycles is limited only by the type of ventilating fan used. Normally the **Type 315-D** is furnished with a shaded-pole ac ventilating fan motor, to be used on 50 to 60 cycle ac only. This fan motor has the advantages of being quieter and requiring very little maintenance. When the **Type 315-D** is ordered for use on power line frequencies from 50 to 800 cycles, it must be so designated on the order. When ordered for use on power line frequencies from 50 to 800 cycles the instrument is furnished with a dc ventilating fan motor and a selenium rectifier.

Accessories Included—Type P510A Attenuator Probe and two Type A510 Binding Post Adapters.

CATHODE-RAY OSCILLOSCOPE



VACUUM TUBE COMPLEMENT

Pre-amp input	68Q7
Pre-amp amplifier	1/2 68Q7
Pre-amp cathode follower	1/2 68Q7
Amplifier input	6CL6
Amplifier, delay line driver	6CL6
Vertical position cathode follower	1/2 68Q7
Driver cathode follower	1/2 68Q7
Vertical output amplifier	4 12BY7

DC reference tube	5651
-150 v regulator amplifier	6AU6
-150 v regulator series tube	2 12B4
+100 v regulator amplifier	6AU6
+100 v regulator series tube	6AS5
+225 v regulator amplifier	6AU6
+225 v regulator series tube	1/2 6080
+350 v regulator amplifier	6AU6
+350 v regulator series tube	1/2 6080

Cal. multivibrator	12AU7
Cal. clipper amplifier	1/2 12AT7
Cal. cathode follower	1/2 12AT7
High voltage oscillator	6AQ5
High voltage regulator	12AT7
High voltage rectifier	5642
Cathode-ray tube bias rectifier	5642
Cathode-ray tube	3WP
Trigger amplitude discriminator—phase inverter	12AT7
Trigger shaper multivibrator	6U8
Trigger amplifier	68Q7

Hold-off cathode follower	1/2 68Q7
Clamp diode	1/2 12AT7

Trigger cathode follower	1/2 68Q7
Hold-off clamp	1/2 12AT7
Unblanking cathode follower	1/2 68Q7
Buffer cathode follower	1/2 68Q7
+ Gate out cathode follower	1/2 6U8
Cascode multivibrator	2 68Q7
Multi reverting cathode follower	1/2 12AT7
Sawtooth out cathode follower	1/2 68Q7
Sweep out cathode follower	1/2 68Q7
DC feed back diode	1/2 6AL5
Sweep clamp cathode follower	1/2 6U8
Sweep clamp diode	1/2 6AL5
Constant current tube	1/2 12AT7
Miller sweep generator	6AK6
Sweep position cathode follower	1/2 68Q7
Driver cathode follower	1/2 68Q7
Sweep output amplifier (First side)	1/2 68Q7
Sweep output cathode follower (First side)	1/2 68Q7
Sweep output amplifier (Second side)	1/2 68Q7
Sweep output cathode follower (Second side)	1/2 68Q7

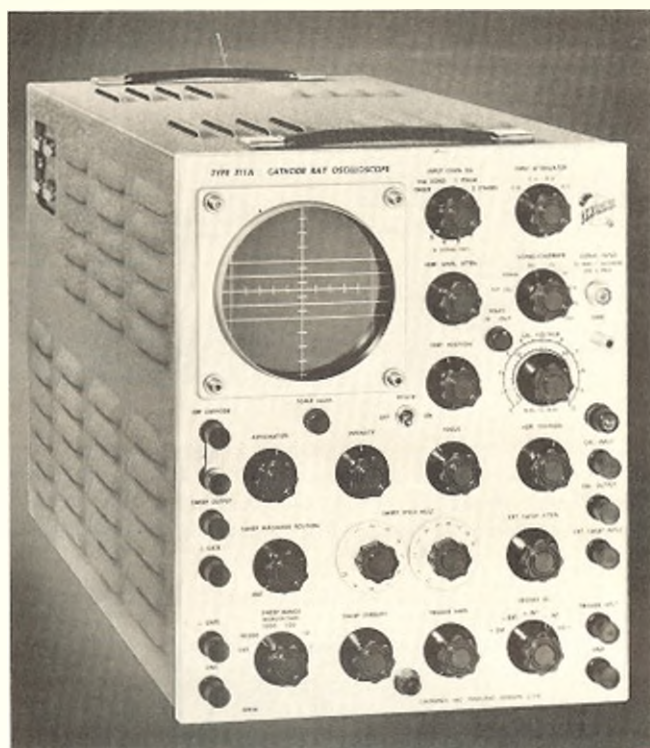
Type 315-D—For use on 105-125 or 210-250 v, 50-60 cycles only—Price \$770.

Type 315-D—For use on 105-125 or 210-250 v, 50-800 cycles—Price \$785. Be sure to specify for use on 50 to 800 cycle supply on your order.

MU15 Fan Motor Kit—For converting **Type 315-D** for use with various supply voltage frequencies (50-800 cycles). Contains bracket, selenium rectifier, dc ventilating fan motor, and fan blade. Price \$22.50.

MS15 Fan Motor Kit—For converting **Type 315-D** for use on fixed supply voltage frequency (50-60 cycles). Contains bracket, ac ventilating fan motor, and fan blade. Price \$7.50.

CATHODE-RAY OSCILLOSCOPE



TYPE 511A TYPE 511AD

GENERAL DESCRIPTION

The Tektronix **Type 511A** Cathode Ray Oscilloscope is a moderately priced portable instrument utilizing a 5" tube.

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: .125, 1.25, 12.5 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 .125 to 100 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.

CATHODE-RAY OSCILLOSCOPE

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.

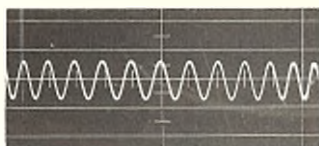


Fig. 3. 10 megacycle sine wave.

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, except on the 1 μ sec range, and thus expanded to cover the entire trace. (Figs. 4, 5) This is especially useful in examining widely spaced waveforms.



Fig. 4. Sweep magnifier off.

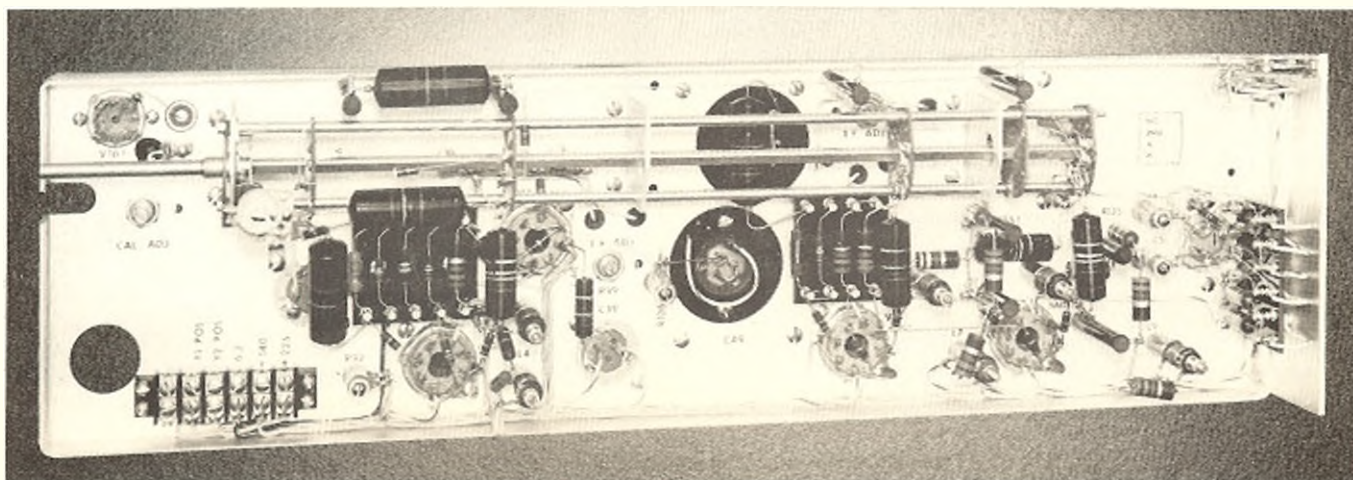


Fig. 5. Sweep magnifier on.

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



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utilized in either one direction or the other.

A three-position lever-type switch mounted at the rear of the instrument permits the operating bias of one of the push-pull output tubes to be varied. With the switch set at center the bias on both tubes is equal, resulting in balanced operation and equal upward and downward undistorted deflection of the trace.

When observing 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 on one of the output tubes is increased resulting in increased output of the other tube, 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 square 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 six 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.

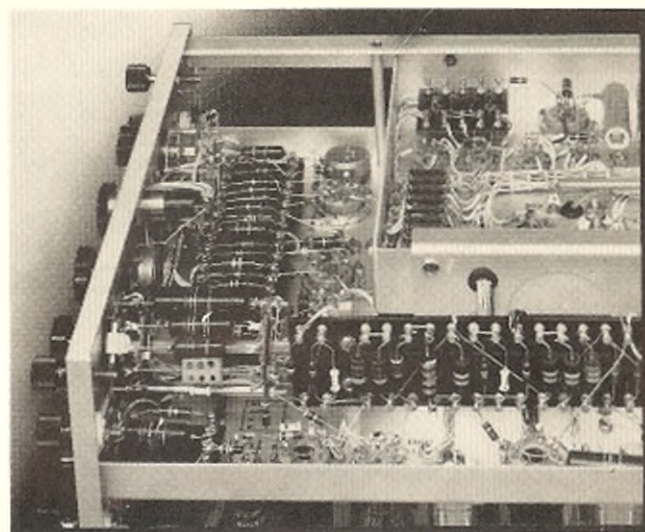
Output Waveshapes—The sweep sawtooth, and positive and negative square wave gate pulses, having the same duration as the sweep, are available on the front panel.

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. 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.



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—Sine waves 0.5 to 50 v peak. Pulses 0.15 to 15 v, as short as 0.05 μ sec. Signal under observation producing 0.5 cm or more deflection.

Sweep Lag—.1 microsecond, max.

Sweep Magnification—5 times indicated sweep speed, except on fastest range.

External Sweep Input—Direct coupled via 100 k potentiometer and sweep amplifier. Deflection sensitivity 1.5 v/cm.

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

Vertical Deflection Sensitivity—
(peak to peak).

Without amplifier, 12.5 V per cm.

With 1 stage, 1.25 V per cm.

With 2 stages, .125 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 square wave ranges, .3 V, 1 V, 3 V, 10 V, 30 V and 100 V peak to peak. Accuracy 3% of full scale.

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Waveforms Available — Sweep sawtooth, positive and negative gates.

CRT Cathode Connection — Via .1 mfd capacitor RC = .012 sec.

Cathode Ray Tube — A Type 5ABP tube is used with accelerating potential of 3 kv. The 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 — 55 pounds complete with accessories

Dimensions — 15 ¹⁵/₁₆" high, 12 ⁷/₈" wide, 21 ⁷/₈" deep.

Vacuum Tube Complement

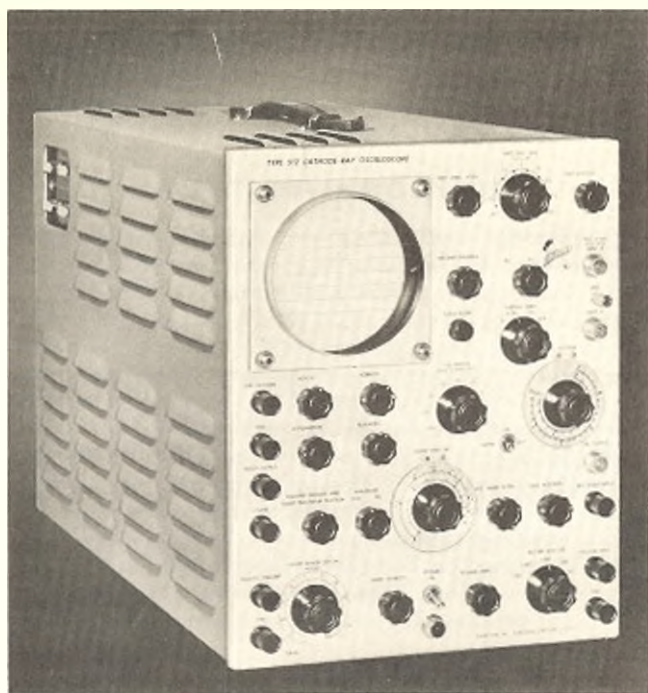
Trigger Phase Splitter	6AC7
Trigger Amplifier	6AG7
Trigger Coupling Diode	6AL5
Multivibrator	6AC7
Multivibrator	6AG7
Unblanking Amplifier and Cathode Follower	12AT7
Gate Output Phase Splitter	6C4
Sweep Generator	6AG7

Sweep Output Cathode Follower	6C4
Sweep Magnifier	6J6
Magnified Sweep DC Restorer	6AL5
Sweep DC Restorer	6AL5
Sweep Amplifier	2-6AU6
Sweep Voltage Regulator	6C4
Video Amplifier, 1st Stage	6AG7
Cal. Clipper and Cathode Follower	12AT7
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	2-1V2
Bias Rectifier	6X4
Bias Regulator	OD3
Cathode Ray Tube	5ABP

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

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

CATHODE-RAY OSCILLOSCOPE



TYPE 512

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 μ 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 externally 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 direct-coupled sweep amplifier provides the voltage 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 ad-

CATHODE-RAY OSCILLOSCOPE

justed 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 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 observation 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 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 $\pm 3\%$ 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 square wave is also 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.

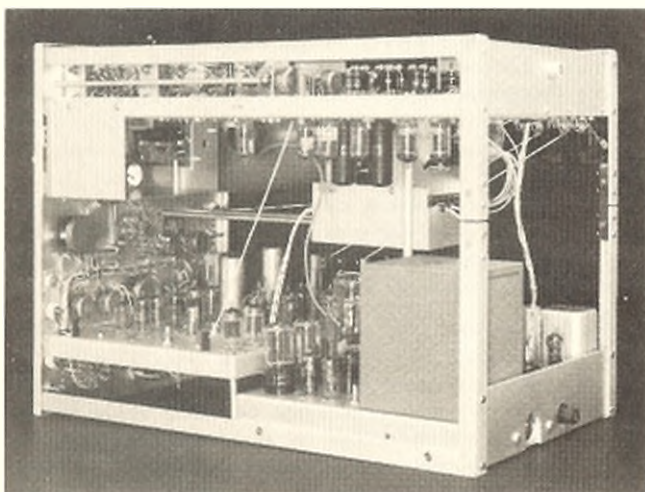
If the vertical amplifier is set to a known sensitivity, voltage readings of any portion of a waveform can be obtained directly from the illuminated reference lines. Time durations can be read in a like manner as the sweep time/cm is known from the setting of the sweep time dial.

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 phantastan, 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



TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

brightening pulses to the cathode of the CRT, thus permitting intensity modulation of the trace.

Cathode Ray Tube — A Type 5A8P 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 of $\pm 5\%$. 1 sec/cm and 3 sec/cm available on special order.

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 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. 10 mv. or larger.

Vertical Deflection Sensitivity (peak to peak) — Direct to plate—13 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 — Square wave, approximately 1 kc. Nine ranges, 5 mv to 50 v full scale. Continuously variable, accurate within 3% of full scale.

Waveforms Available Externally — Sweep sawtooth, 100 volts peak. Delay trigger, 75 volts peak. Positive gate, 150 volts peak. The 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.

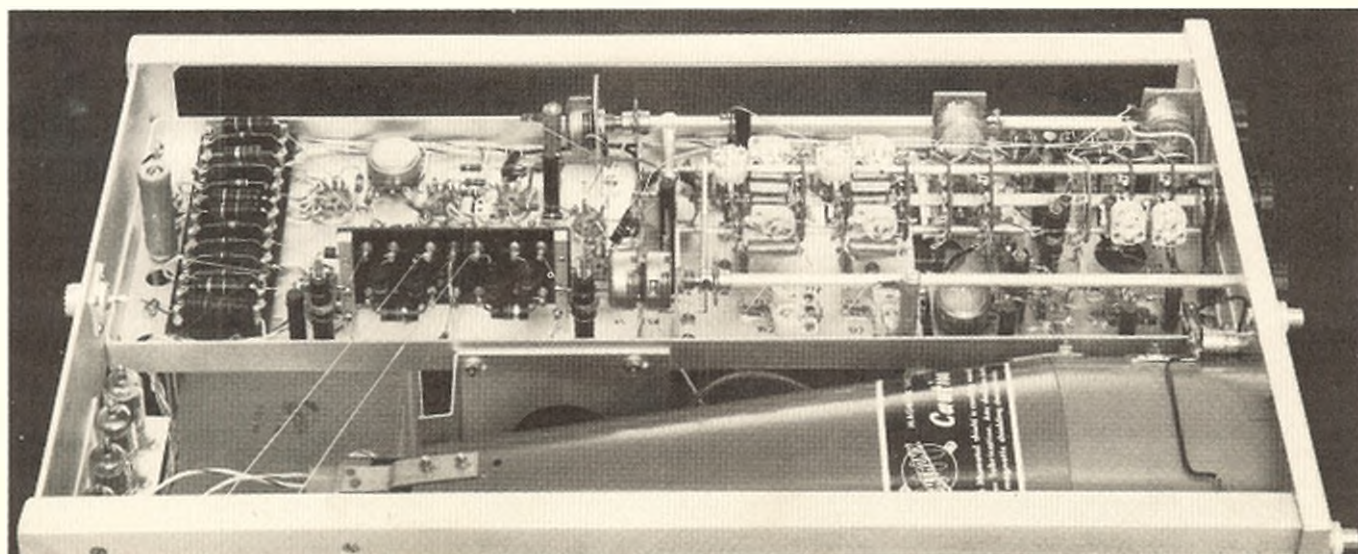
Dimensions — $15\frac{5}{16}$ " high, $12\frac{7}{8}$ " wide, $22\frac{7}{8}$ " deep.

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

Weight — 56 pounds, complete with accessories.

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



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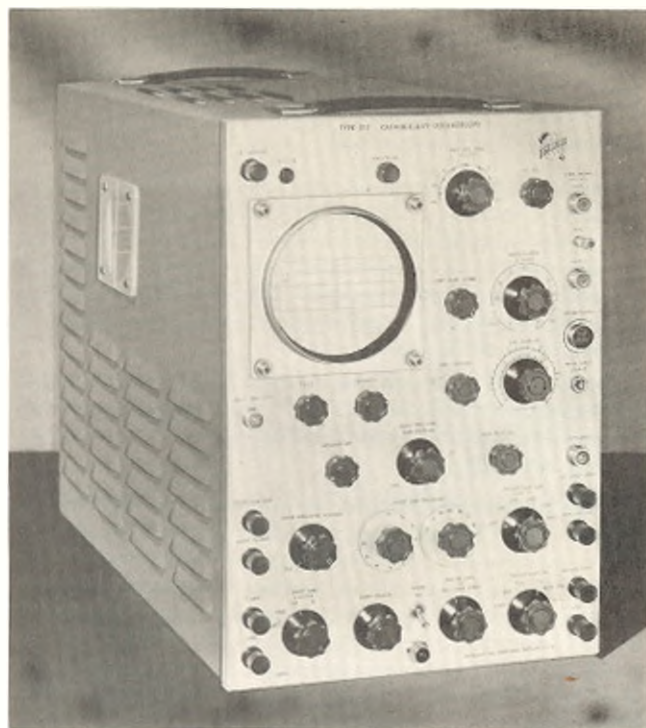
CATHODE-RAY OSCILLOSCOPE

Magnifier Sweep Generator.....	6AU6	Vertical Main Amplifier Outputs.....	2	6AG7
Magnifier Sweep and Delayed Trigger		Vertical Amplifier Voltage Regulators.....	2	12AU7
Cathode Followers.....	12AU7	Marker Input Amplifier.....		6AU6
Magnifier Sweep Voltage Regulator and		Low Voltage Rectifiers.....	4	6W4GT
Clamp Diode.....	12AU7	High Voltage Rectifiers.....	2	1V2
— Gate Amplifier and Blanking Gate Inverter	12AU7	High Voltage Supply Oscillator.....		6AQ5
Blanking Oscillator.....	6AU6	Voltage Reference.....		5651
Calibrator Multivibrator.....	12AU7	Voltage Regulator Amplifiers.....	2	6AU6
Calibrator Diode and Output Cathode		Voltage Regulator Series Tube.....		6AS7G
Follower.....	12AU7	Sweep Power Supply Rectifier.....		6X4
Blanking Bias Rectifier.....	6AL5	Sweep Power Supply Regulator.....		12AU7
Vertical Pre-Amp. Inputs.....	2	Cathode Ray Tube.....		5ABP
Vertical Pre-Amp. Outputs.....	2			
Vertical Gain Control Cathode Followers.....	2			
Vertical Main Amplifier Inputs.....	2			

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

CATHODE-RAY OSCILLOSCOPE

TYPE 513-D



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 12 kv, 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 $.3 \text{ v/cm}$ in the direct coupled position, or a maximum sensitivity of $.03 \text{ v/cm}$ 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 $.03 \text{ volts/centimeter}$ to $100 \text{ volts/centimeter}$, 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 ac components of the signal, this switch may be thrown to the ac position, inserting a coupling capacitor.

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 $40 \mu\text{mf}$ 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 14 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 ac at .5 amp and 15 to 150 volts regulated dc at 15 ma. is available. 6.3 volts ac is also available from a front panel pin jack.

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 square wave whose amplitude is continuously variable in 7 ranges from $.05 \text{ volts full scale}$ to $50 \text{ volts full scale}$. Accuracy of square wave amplitude exceeds $\pm 3\%$ of full scale. The calibrator voltage is also brought out to a uhf connector 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. An aperture 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.

CATHODE-RAY OSCILLOSCOPE

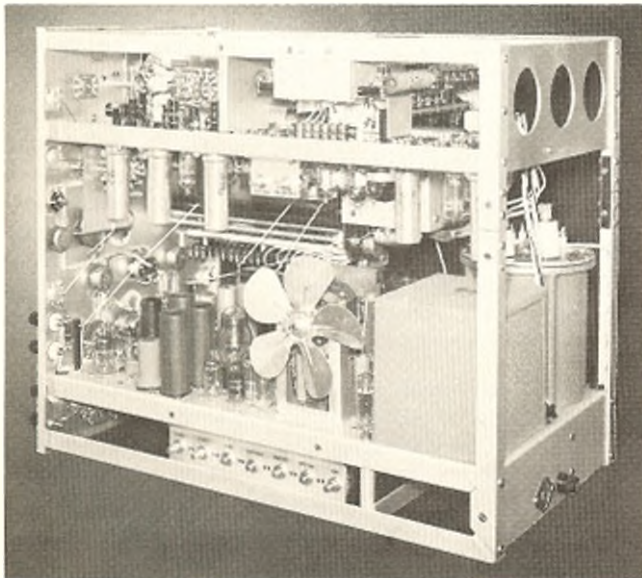
Triggered Sweep — A continuously variable, linear, triggered sweep is available covering the range of .01 sec/cm to .1 microsec/cm. A two dial sweep time multiplier is used which makes possible much more accurate readings than were possible with previous instruments. The sweep time is accurate to within 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 pulses 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, except on the 0.1 μ sec/cm range, 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 30 volts amplitude is available at a front panel binding post. The start of the gate may be positioned at any point on the sweep up to .3 microsecond from the start of 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 .4 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 dc 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 — Sine waves 0.5 to 50 v peak. Pulses 0.15 to 15 v, as short as 0.05 μ sec. Signal under observation producing 0.5 cm or more deflection.

Sweep Lag — .1 microsecond, maximum.

Sweep Magnification — 5 times indicated sweep speed, except on fastest range.

TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

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

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 40 mmf. With probe, 10 meg shunted by 14 mmf.

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

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

Calibrating Voltage — Square wave, approximately 1 kc. Seven ranges, 0.05v to 50v full scale. Continuously variable, accurate within 3% 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 metallized type 5XP cathode-ray tube with P2 phosphor is furnished with the **Type 513** unless a P1 or P11 phosphor is specified as the optional choice.

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

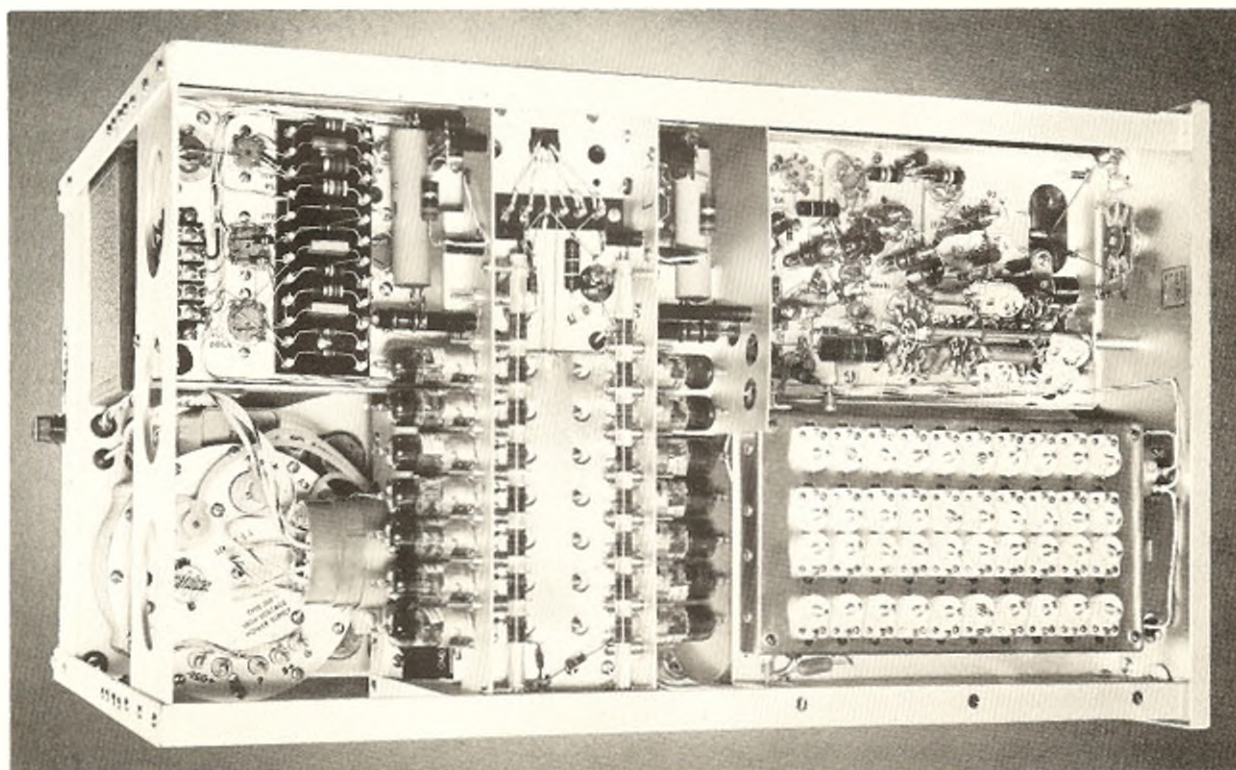
Dimensions — 18 1/8" high, 12 7/8" wide, 22 7/8" deep.

Weight — 79 pounds, complete with accessories.

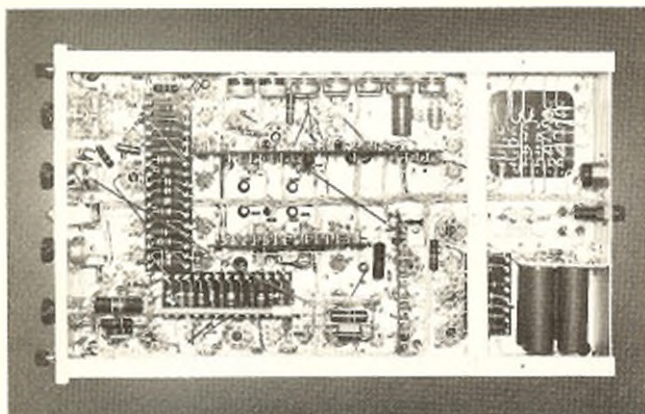
Power Requirements — 105-125 or 210-250 volts, 50-60 cycles ac, 475 watts.

VACUUM TUBE COMPLEMENT

Input Pre-Amplifier	12AW6
2nd Stage Pre-Amplifier	12AW6
Pre-Amplifier Cathode Follower	12AT7
Gain Control Cathode Follower	12AT7
Probe Power Cathode Follower	6J6
Internal Trigger Amplifier	12AW6
Delay Line Impedance Matching Cathode Follower	12AT7
Driver Cathode Follower	12AT7



CATHODE-RAY OSCILLOSCOPE



Driver	4	6AH6
Driver Voltage Cathode Follower		6AS5
Cal. Multivibrator		12AU7
Cal. Limiter and Output Cathode Follower ..		12AU7
Output Distributed Amplifier	14	6CB6
Trigger Inverter		6AH6
Trigger Amplifier dc Restorer	1/2	6AL5
Coupling Diode	1/2	6AL5
Trigger Amplifier		6AG7
Sweep Multivibrator		6AH6
Sweep Multivibrator		6AG7
Sweep Generator Clamp Tube		6AG7
Sweep Charging Potential Cathode Follower		6C4
Sweep dc Restorer		6AL5
Sweep Amplifier, Phase Inverter		12AU7
Sweep Amplifier	2	6AQ5
Sweep dc Level Control	2	6CB6
+ Gate Output Cathode Follower	1/2	12AU7
Astigmatism Potential Cathode Follower ...	1/2	12AU7
Unblanking Amplifier, Inverter		12AT7
Unblanking Cathode Follower		6C4

Sweep Length Multivibrator		12AT7
Sweep Output Cathode Follower		6C4
Sweep Magnifier dc Restorer		6AL5
Sweep Magnifier		6J6
Cathode Ray Tube		5XP
-800 v Rectifier, Doubler	2	6X4
+800 v Series Regulator		6AS5
+800 v Regulator Amplifier		6AU6
+275 v Series Regulator		6AU5
+275 v Regulator Amplifier		6AU6
+275 v Series Regulator		6AS7
+225 v Regulator Amplifier		6AU6
+225 v Regulator Comparator		12AX7
+225 v Voltage Reference		5651
-150 v Rectifier	2	6X4
-150 v Reference		OD3
High Voltage Oscillator Regulator		6AU5
High Voltage Oscillator		6AU5
High Voltage Regulator Comparator		12AU7
+10 kv Rectifier, Doubler	3	5642
-2000 v Rectifier		5642
Delayed Gate Multivibrator		12AT7
Delayed Gate Cathode Follower	1/2	12AT7
Blocking Oscillator Trigger Tube	1/2	12AT7
Delayed Trigger Blocking Oscillator		12AT7
Delayed Trigger Output Cathode Follower ..		12AT7
Trigger Rate Gen. Blocking Oscillator		6J6
Trigger Rate Gen. Cathode Follower		12AT7

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.

CATHODE-RAY OSCILLOSCOPE

N E W I N S T R U M E N T

TYPE 514-AD

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-AD Oscilloscope is adjusted for optimum transient response, as are all TEKTRONIX amplifiers. A sensitivity of 0.3 v/cm is available in both direct and capacitively coupled positions. Additional sensitivity of 0.3 v/cm to 0.03 v/cm is provided with capacitive coupling only.

The desirable combination of 10 mc bandwidth, direct coupling, high sensitivity and 6 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.

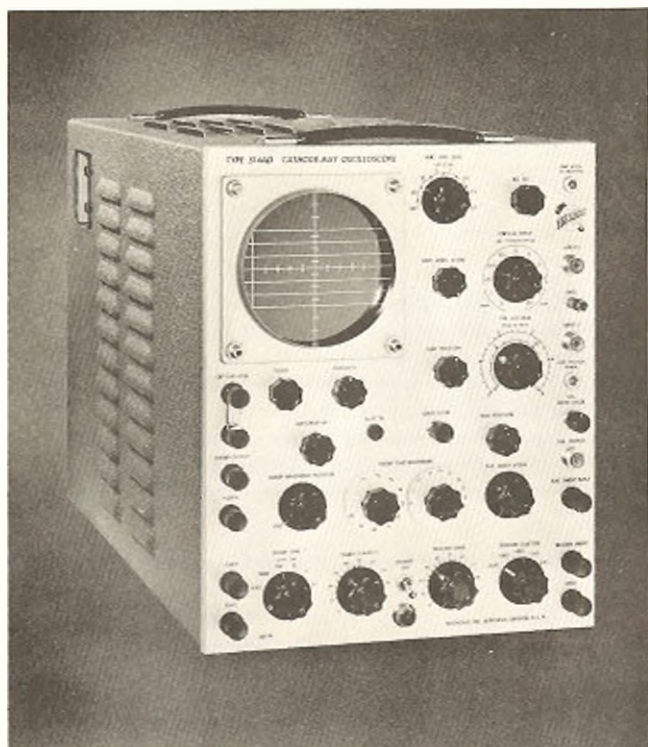
Deflection Sensitivity Controls — The problem of attaining a large variation of amplifier gain, to permit displaying a wide range of signal amplitudes without distortion, is multiplied by the necessity of retaining stable amplifier characteristics over the full range of sensitivity. This requirement is solved in the Type 514-AD 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 0.03 v/cm to 100 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-AD 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.



NEW VERTICAL AMPLIFIER

6cm undistorted deflection

Bandwidth—dc to 10 mc, 0.04 μ sec risetime

Sensitivity—dc to 10 mc, 0.3 v/cm to 100 v/cm
2 cps to 10 mc, 0.03 v/cm to 100 v/cm

NEW CATHODE-RAY TUBE

Flat-faced, 3 kv accelerating potential

TIME BASE RANGE

0.1 μ sec/cm to 0.01 sec/cm, accurate within 5%

DIRECT COUPLED UNBLANKING

Uniform crt grid bias regardless of sweep time and repetition rate

NEW CALIBRATOR

Variable duty cycle square wave

GENERAL DESCRIPTION

The TEKTRONIX Type 514-AD 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.

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Offering a range of sweep rates from 0.1 $\mu\text{sec}/\text{cm}$ to 0.01 sec/cm , the sweep generator can be synchronized with frequencies as high as 10 mc, or triggered by pulses as short as 0.05 μsec . The crt becomes unblanked, and the sweep is operating linearly, within 0.1 μsec 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 risetime of high speed transients, permitting the unusually short starting and unblanking time.

Sweep Generator — The sweep generator circuit of the Type 514-AD 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 μsec 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 — A control on the panel allows any selected 20% of the sweep to be amplified five times, except on the 0.1 $\mu\text{sec}/\text{cm}$ range, and thus expanded to cover the entire trace.

MEASUREMENT FEATURES

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

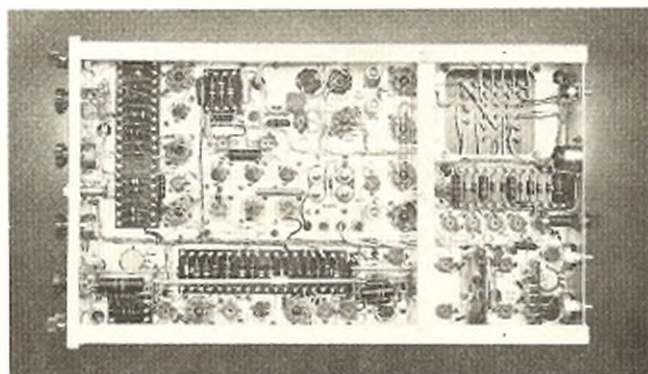
Amplitude Calibrator — A variable duty cycle square wave calibration voltage is provided. This voltage is continuously variable from zero to 50 volts in seven ranges, accurate within 3% of full scale. The duty cycle is variable from 2% to 98%. This permits the duty cycle of the calibrator to be matched with the duty cycle of the observed signal, thus minimizing error in amplitude calibration of an

ac coupled signal due to change in amplifier bias with the duty cycle of the signal.

Sweep Timing — The five range sweep time selector offers a choice of sweeps ranging from 0.1 $\mu\text{sec}/\text{cm}$ to 0.01 sec/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-AD 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 15 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.

CATHODE-RAY OSCILLOSCOPE

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.

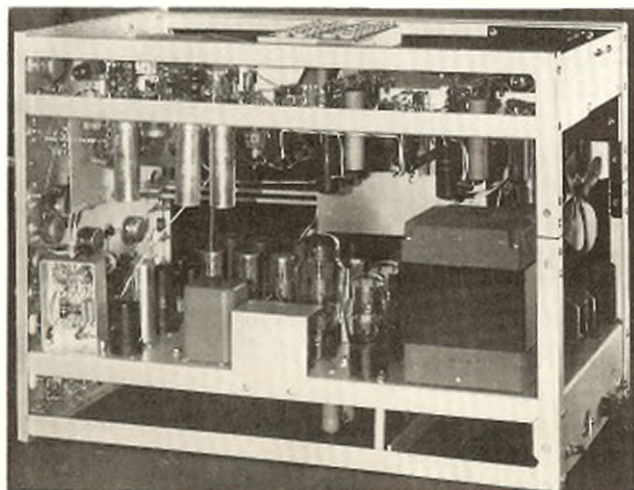
Calibrator Output—The square wave calibrator output, available at the front panel, permits convenient checking and adjustment of the Type 514 AD compensating capacitors, and provides an accurately adjustable signal source for calibrating other equipment.

ADDITIONAL FEATURES

Probe—Some observations require great care to prevent undue interference with the signal source. A small, insulated 10x probe is furnished with the instrument. The probe presents an input impedance of 10 megohms paralleled by approximately 14 μmf , minimizing stray pickup 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-AD 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-AD CHARACTERISTICS

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

Sweeps—Continuously variable, 0.01 sec/cm to 0.1 $\mu\text{sec/cm}$. Calibration accuracy 5%.

Trigger Requirements—Sine waves 0.5 to 50 v peak. Pulses 0.15 to 15 v, as short as 0.05 μsec . Signal under observation producing 0.5 cm or more deflection.

Sweep Lag—0.1 μsec , maximum.

Sweep Magnification—5 times indicated sweep speed, except on fastest range.

External Sweep Input—Direct coupled via 100 k potentiometer and sweep amplifier. Deflection sensitivity 1.5 v/cm.

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

A. C. Vertical Deflection Sensitivity—Continuously variable from 0.03 v/cm to 100 v/cm, peak to peak.

D. C. Vertical Deflection Sensitivity—Continuously variable from 0.3 v/cm to 100 v/cm, peak to peak.

Input Impedance—1 meg. shunted by 40 μmf . With probe, 10 meg. shunted by 14 μmf .

Vertical Amplifier Response—D.C. to 10 mc, sensitivity of 0.3 v/cm or lower; 2 cps to 10 mc, sensitivity of 0.03 v/cm or less.

Vertical Amplifier Transient Response—Risettime (10%-90%) 0.04 μsec .

Signal Delay Network—Provides 0.25 μsec signal delay. Permits observation of the waveform that triggers the sweep.

Calibrating Voltage—Variable duty cycle square wave. Seven ranges, 0.05v to 50v full scale, continuously variable, accurate within 3%. Duty cycle variable from 2% to 98%.

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

Cathode-Ray Tube—A 5ABP1 cathode-ray tube is furnished unless a P7 or P11 phosphor is specified as the optional choice. An accelerating potential of 3 kv is used (\pm 1.5 kv and — 1.5 kv).

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

Dimensions—15-15/16" high, 12 7/8" wide, 22 7/8" deep.

Weight—61 pounds complete with accessories.

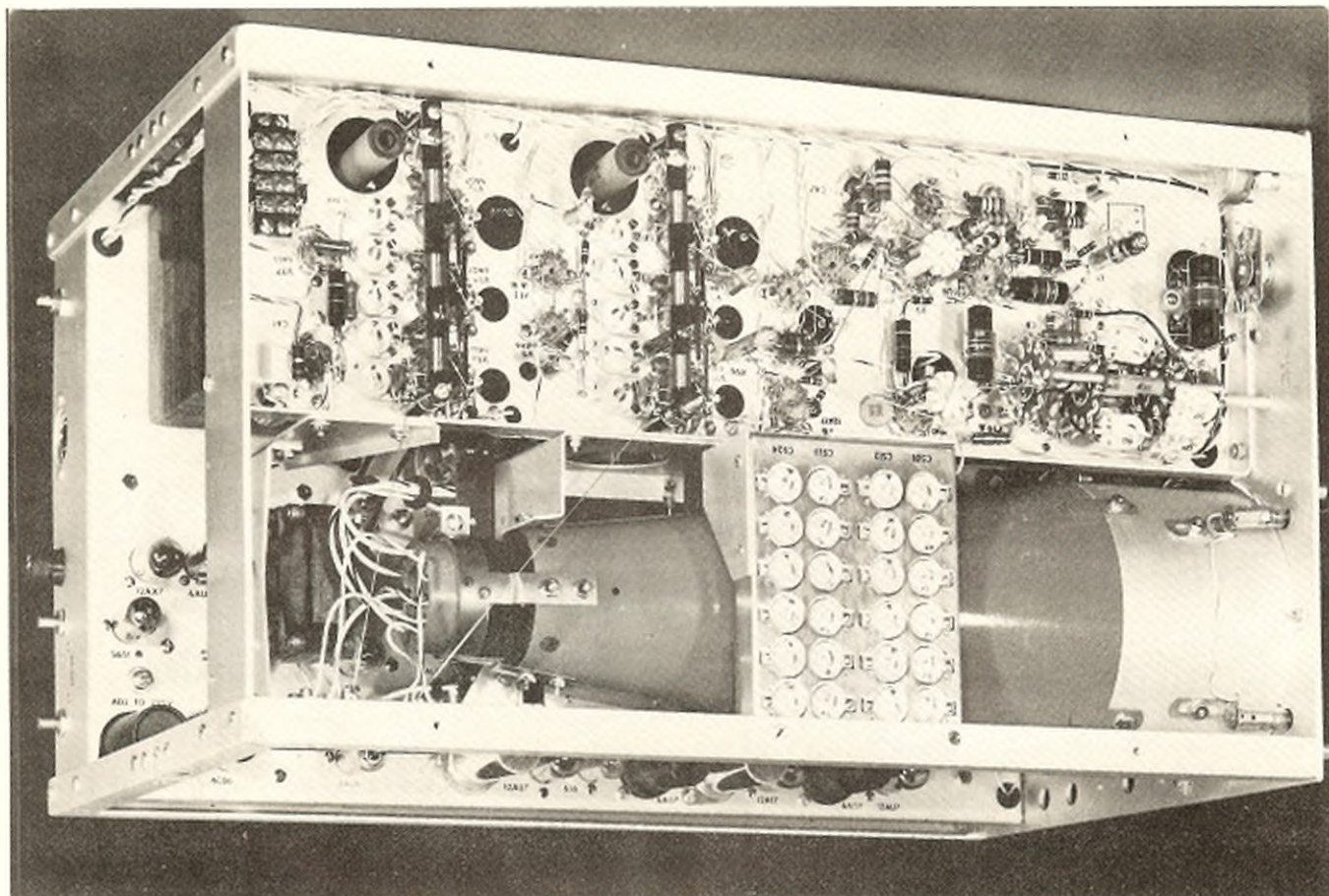
Power Requirements—105-125 or 210-250 volts, 50-60 cycles 375 watts.

Vacuum Tube Complement—

Trigger Phase Splitter..... 6AC7

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CATHODE-RAY OSCILLOSCOPE



Trigger Coupling Diode	6AL5	—150V Rectifier	6X4
Multivibrator	6AC7	—150V Regulator	OD3
Multivibrator	12AT7	High Voltage Regulator Amplifier	6AS5
Unblanking Cathode Follower	12AT7	High Voltage Regulator Comparator	12AU7
Unblanking Limiter	12AU7	High Voltage Oscillator	6AQ5
Gate Output Phase Splitter	12AU7	High Voltage Rectifier	3 5642
Second Anode Cathode Follower	12AU7	1st Preamp Stage	12AU6
Magnified Sweep CF Driver	12AT7	2nd Preamp Stage	6U8
Sweep Output Cathode Follower	12AT7	Trigger Amplifier	6U8
Sweep Generator	6AG7	Cathode Follower	2 12AT7
Sweep Charging Potential Cathode Follower	6C4	Phase Inverter Compensator	12AT7
Sweep Magnifier	6J6	C. F. Voltage Regulator	6AS5
Sweep DC Restorer	6AL5	Output Driver	4 6AU6
Sweep Amplifier	2 6AU6	Push-Pull Output	6 6AG7
Output Level Tubes	2 6CB6	Cal. Multivibrator and Output CF	12AU7
+ 450V Rectifier	6X4	Cal. Multivibrator and Limiter	6U8
+ 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		

Price — \$950 f.o.b. Portland, Oregon

TYPE 514-A CATHODE-RAY OSCILLOSCOPE

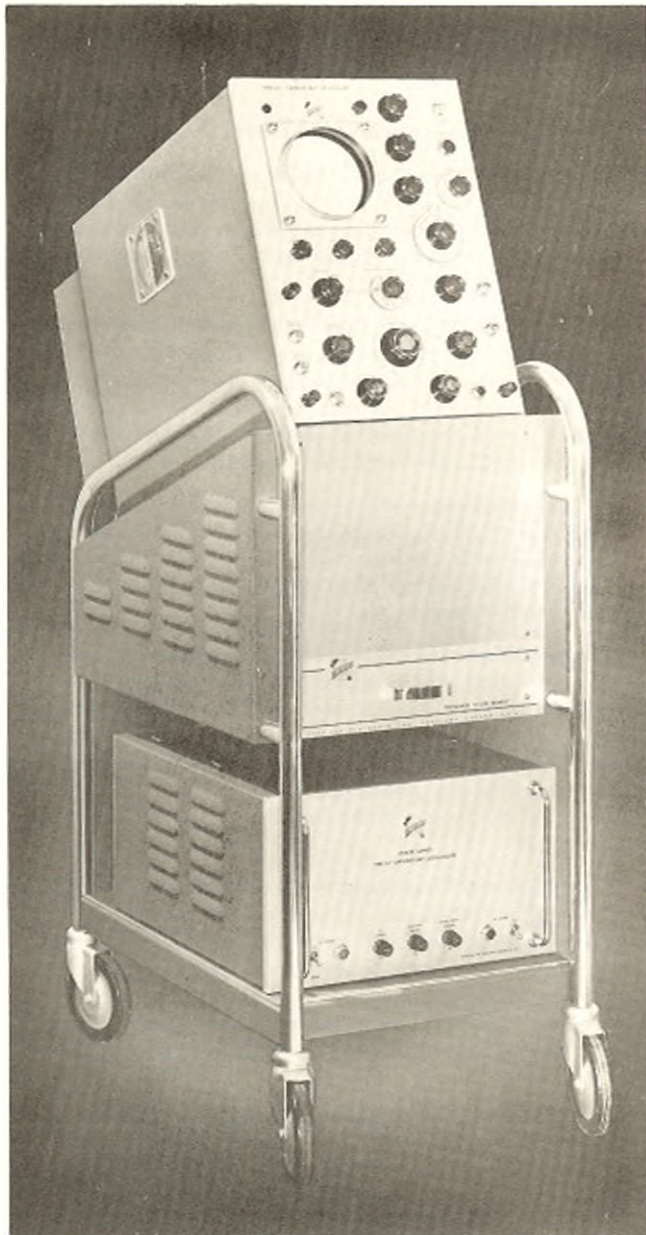
The Type 514-A Cathode-Ray Oscilloscope is identical to the Type 514-AD except that the 0.25 μ sec Signal Delay Network is omitted.

Price — \$900 f.o.b. Portland, Oregon

TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

TYPE 517



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 UHF type coaxial connector mounted on the front panel.

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 dc 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 appreciably 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

CATHODE-RAY OSCILLOSCOPE

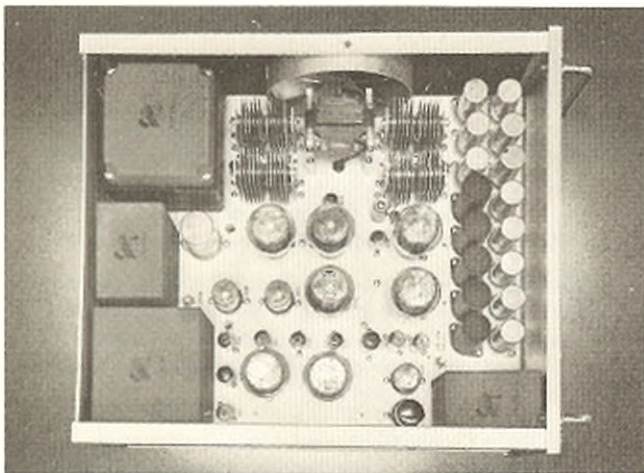
either non-repetitive or non-uniformly spaced, it is essential to have a sweep which can be triggered by the observed pulse itself. The sweep circuit of the **Type 517** can be so triggered.

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 half these times 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 phantastron 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.

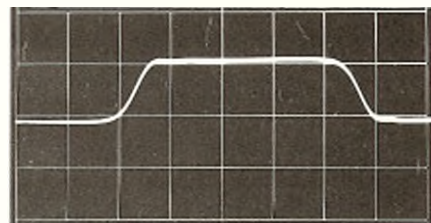
Output Waveforms — Coaxial connectors are provided on the front panel, making available two trigger-rate generator impedances, as well as the calibrator output voltage. A binding post makes available a positive gate waveform of 25 volts amplitude with a duration approximately equal to the sweep being generated, with a rise-time of .03 μsec 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 $\text{m}\mu\text{sec}$ (.007 μsec). Response is free of ringing and overshoot.



A 45 millimicrosecond pulse, initial risetime one millimicrosecond, displayed with a sweep time of 10 millimicroseconds per centimeter. Note amplifier risetime and freedom from ringing and overshoot.

CATHODE-RAY OSCILLOSCOPE

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 external step attenuator with a characteristic impedance of 170 ohms and a range of 1 to 64 db in 1 db steps is provided.

Vertical Amplifier Input Impedance — Input impedance direct is 170 ohms resistive. Impedance looking into probe is 12 megohm and $5\mu\text{fd}$. Higher impedance values can be had depending upon capacitive attenuator used ahead of probe.

Signal Delay — Delay line of RG63U coaxial cable contributes 64 nsec delay. This, plus the inherent delay of the distributed vertical amplifier stages, makes an approximate total signal delay of 120 nsec. 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 operating at about 25 kc available at front panel. Six ranges, 0.15 v to 50 v peak full scale. Continuously variable, accurate within 4% of full scale.

Vertical Amplifier Position Control — With 24 kv accelerating potential, the vertical positioning control moves the trace ± 2.0 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 nsec/cm and 1, 2, 5, 10, 20 $\mu\text{sec/cm}$, with a maximum displacement error of 2% for 8 cm sweep length.

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

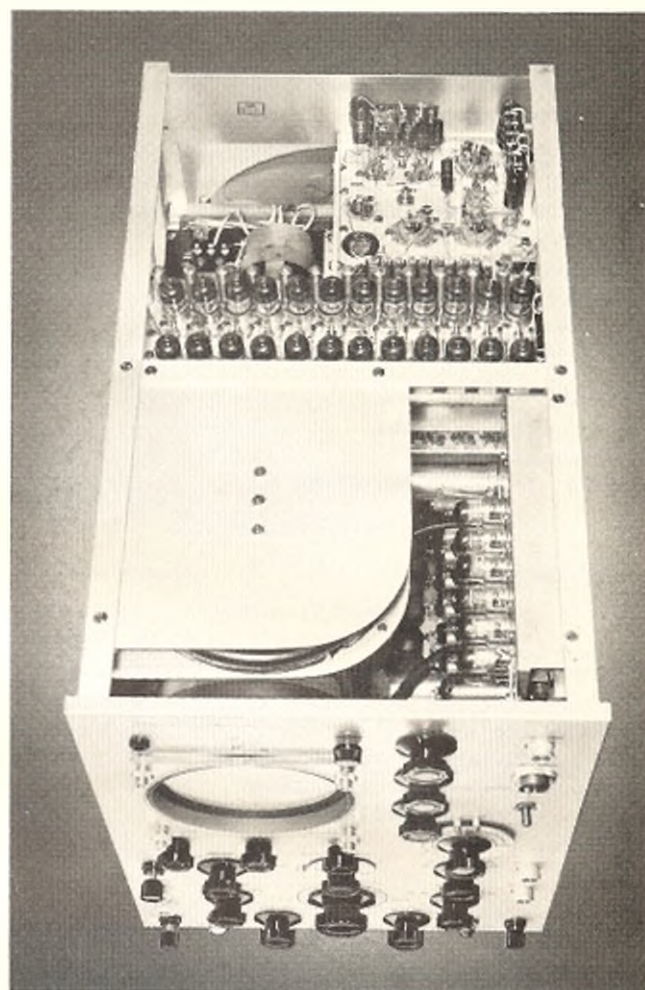
Horizontal Position Control — With 24 kv accelerating potential, the horizontal position control moves the trace approximately 5 cm.

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 $\mu\text{sec/cm}$	1.5 kc
10 $\mu\text{sec/cm}$	3. kc
5 $\mu\text{sec/cm}$	6. kc
2 $\mu\text{sec/cm}$	10. kc
1 $\mu\text{sec/cm}$	20. kc

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



Sweep Time	Maximum Repetition Rate
500 $\mu\text{sec/cm}$	50. kc
200 $\mu\text{sec/cm}$	50. kc
100 $\mu\text{sec/cm}$	50. kc
50 $\mu\text{sec/cm}$	50. kc
20 $\mu\text{sec/cm}$	50. kc
10 $\mu\text{sec/cm}$	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..... 0.4 μsec .

Rise time..... 0.15 μsec .

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.

CATHODE-RAY OSCILLOSCOPE

Construction — Contained in two separate units of convenient size, normally mounted on a TEKTRONIX Type 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: 12-15/16" wide, 18 3/8" high, 26-15/16" deep.

Power unit: 15-15/16" wide, 9 5/8" high, 19 3/4" deep.

Weight —

Indicator unit: 76 lbs.

Power unit: 72 lbs.

500 Scope-Mobile: 42 lbs.

TUBE COMPLEMENT

Circuit Use	Quantity	Type
Vertical Amplifier		
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*

*Selected

Circuit Use

Quantity Type

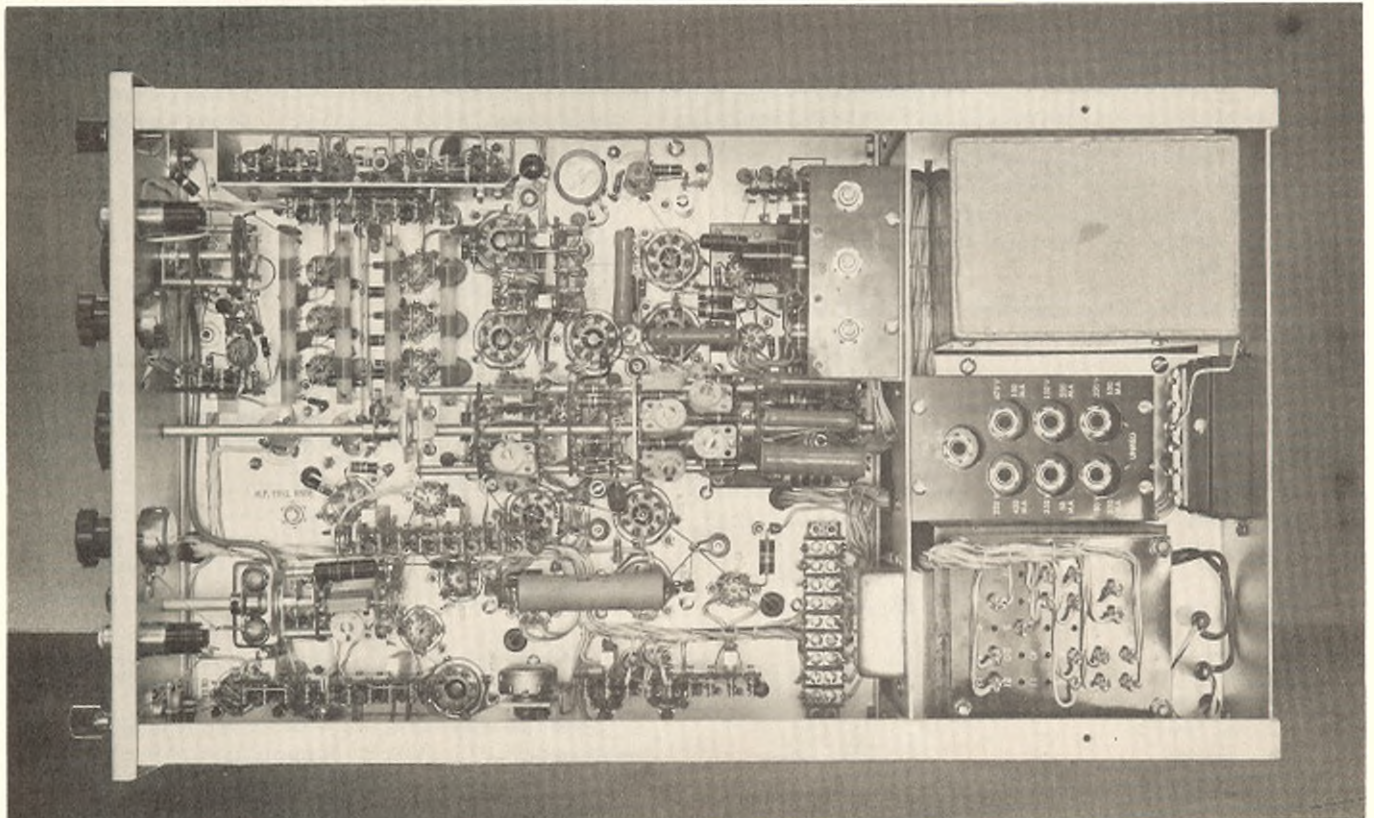
Sweep Generator Circuit

Trigger phase-splitter	1	6J6*
1st Distributed trigger amplifier	3	6AK5*
2nd Distributed trigger amplifier	3	6AK5*
Trigger limiter tube		6AG7
Trigger switch tube		6AG7
Trigger coupling diode		6J6
Multivibrator	2	6AG7
Paralleled sweep clamp tubes	2	6AG7
Positive sweep out, cathode follower		12BH7
Paralleled bootstrap cathode followers	2	12BH7
Decoupling-diode, bootstrap circuit		6X4
Sweep inverter		6AG7
Bias, screen, cathode follower voltage-regulator for sweep inverter tube		12AU7
Sweep output dc restorer		6AL5
Paralleled unblanking amplifier tubes	2	6AG7
Screen cathode follower voltage-regulator for unblanking amplifier tubes		6AS5
Unblanking voltage cathode follower output tube		6J6
Plus gate output cathode follower	1	6J6
CRT grid bias stabilizers	4	NE2*

Calibrator Circuit

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

*Selected



TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

Circuit Use	Quantity	Type
Trigger Rate Generator		
Phantastron trigger-generator tube		6BH6*
Recharging cathode follower	1/2	12AU7
Trigger coupling triode	1/2	12AU7
Plate catcher		12AU7
Blocking oscillator		12AU7
50 ohm output cathode follower		12AU7
200 ohm output cathode follower		12AU7

Astigmatism and Probe Voltage Supply

Astigmatism and probe voltage cathode follower tube	12AU7
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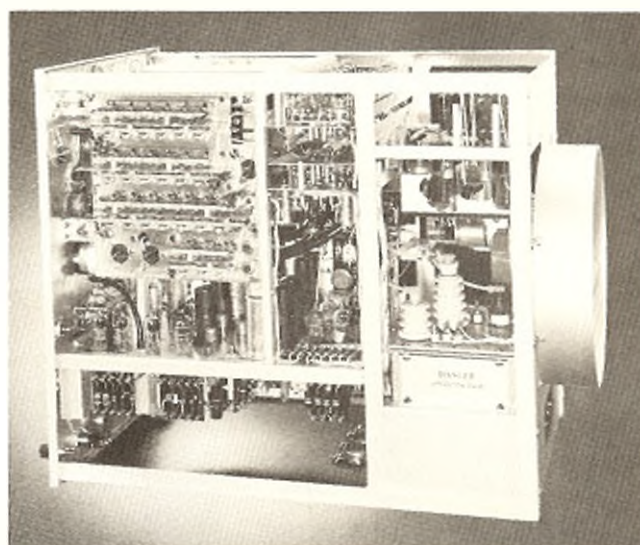
CRT High Voltage Supply

Quadrupler rectifiers, ± 20 kv supply	4	1X2
Rectifier, -4 kv supply		1X2
High voltage oscillator tube		6AU5
Paralleled series-regulator tubes	2	6AU5
Comparator-amplifier	12AU7	
Oscillator plate voltage time-delay tube		6C4
High-voltage rectifier-tube filament oscillator		6AQ5

Power Supply, Low Voltages

± 750 volt rectifier		6X4
± 750 volt supply series-regulator		6AU5
Comparator-amplifier, ± 750 v supply		6AU6
Rectifier, ± 475 v supply		5R4GY
Series-regulator, ± 475 v supply		6AS7
Comparator-amplifier, ± 475 v supply		6AU6
Full-wave rectifier, ± 365 v supply	2	6X4
Paralleled series-regulator, ± 225 v supply	2	6AS7
Comparator-amplifier, ± 225 v supply		6AU6
Paralleled series-regulator, ± 150 v supply	3	6AS7
Comparator-amplifier, ± 150 v supply, 2nd stage		6AU6
Comparator-amplifier, ± 150 v supply, 1st stage	12AX7	
Rectifier, -250 v supply		6X4
Series-regulator, -250 v supply		6AU5
Comparator-amplifier, -250 v supply		6AU6
Voltage reference source		5651

*Selected



Circuit Use	Quantity	Type
Heater voltage regulator control diode		2AS-15
Heater voltage regulator amplifier		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.

Scope-Mobile, Type 500

Inter-unit connecting cable, Type W517

Cathode follower probe, Type P170CF

Step attenuator, Type B170V

AC Power cable, Type COP16-8

Viewing hood, Type H510

170 ohm coaxial input cable.

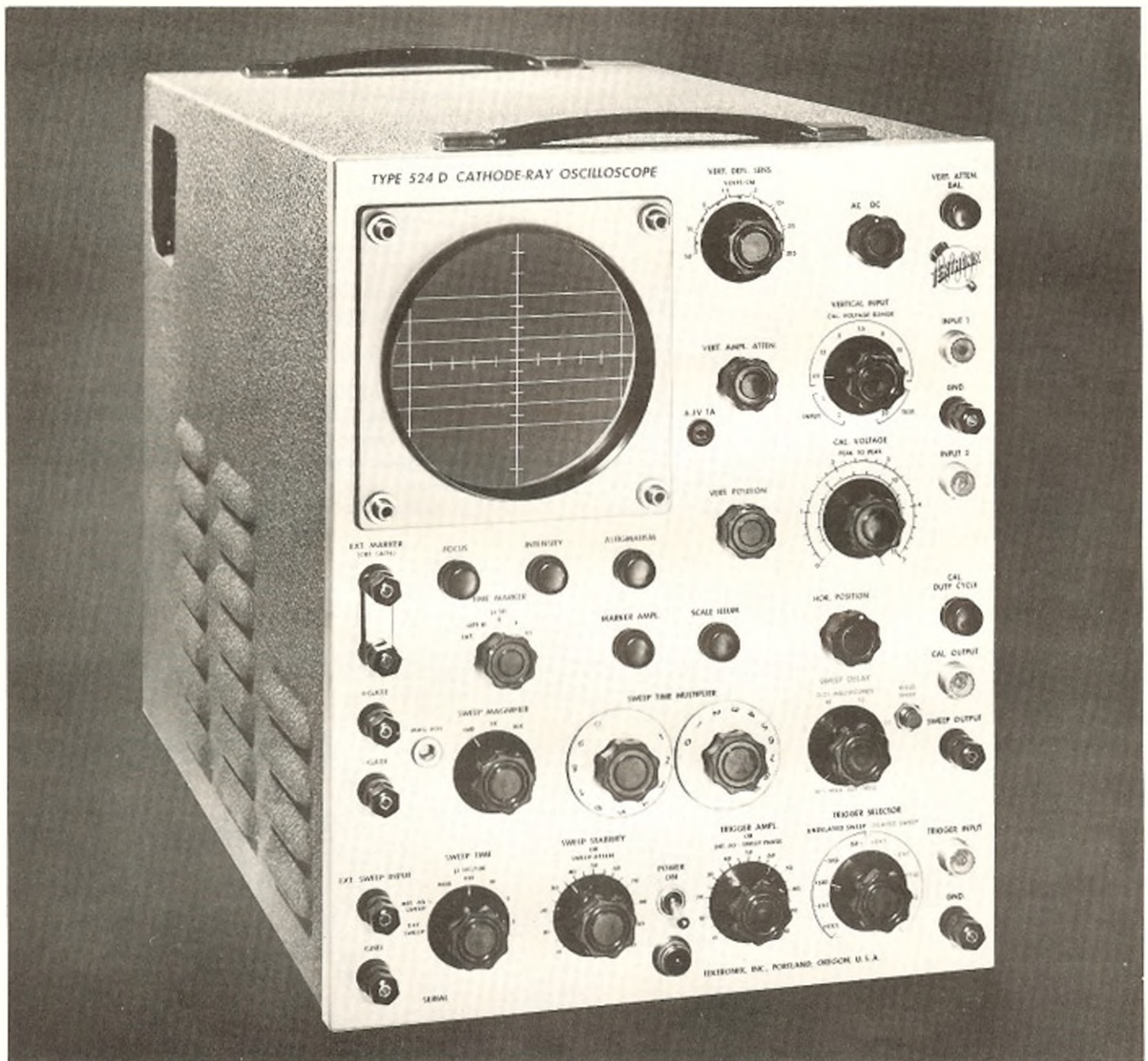
Instruction Manual, Type 517

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

TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

TYPE 524-D



GENERAL DESCRIPTION

The TEKTRONIX Type 524-D is a portable, self-contained cathode-ray oscilloscope specifically designed for maintenance and adjustment of television transmitter and studio equipment.

With this oscilloscope, any portion of the television picture may be observed—from complete frames to small portions of individual lines. Any one of the 525 lines in the picture may be located and observed in minute detail. Accurate time markers greatly facilitate sync pulse timing. The wide-band vertical amplifier is provided with a network that may be switched in to limit the high frequency response to that specified by the F.C.C. for standardized

level measurements.

VERTICAL DEFLECTION SYSTEM

Direct Coupled Amplifier—A 10 megacycle vertical amplifier with a maximum sensitivity of 0.15 v/cm direct coupled and 0.015 v/cm capacitively coupled provides an accurate presentation of the video signal. At sensitivities of 0.15 v/cm or lower the signal is fed into a cathode-coupled gain-control stage, then through the 0.25 μ sec delay network and into the push-pull driver stage. A cathode follower stage feeds the grid lines of the distributed output stage. For the sensitivity ranges 0.015-0.05 v/cm and 0.05-0.15 v/cm a capacitively coupled 2 stage pre-amplifier is switched in.

TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

Sensitivity Controls—A seven position control inserts frequency-compensated attenuators to cover the range of 0.015 v/cm to 50 v/cm. This same control inserts the capacitively coupled pre-amplifier in the 0.05 v/cm and 0.015 v/cm positions. The vertical amplifier attenuator is in the cathode circuit of the gain-control stage. These two controls make the vertical amplifier sensitivity continuously variable over its entire range.

Direct or Capacitive Coupling—When the direct coupled feature of the amplifier is not needed, or when it is desirable to observe only the ac components of the signal, the ac-dc switch may be placed in the ac position. In this position a coupling capacitor is inserted in the input circuit to block the dc component of the signal.

Dual Inputs—The 524-D is equipped with two uhf input connectors. Selection of either input is made by the vertical input selector. This feature offers a convenient method of making a rapid comparison of two separate signals.

Probe—The constant input impedance of the 524-D permits the use of rc input probes. A high impedance probe on a 42" cable is supplied with the instrument. The probe is frequency compensated and has an attenuation of ten times. The input impedance of the probe is 10 megohms paralleled by approximately 14 μ f.

Amplitude Calibrator—A variable duty cycle square wave calibration voltage is provided. This voltage is continuously variable from zero to 50 volts in seven ranges,

accurate within 3% of full scale. The duty cycle is variable from 1% to 99%. This permits the duty cycle of the calibrator to be matched with the duty cycle of the observed signal, thus minimizing error in amplitude calibration of an ac coupled signal due to change in amplifier bias with the duty cycle of the signal.

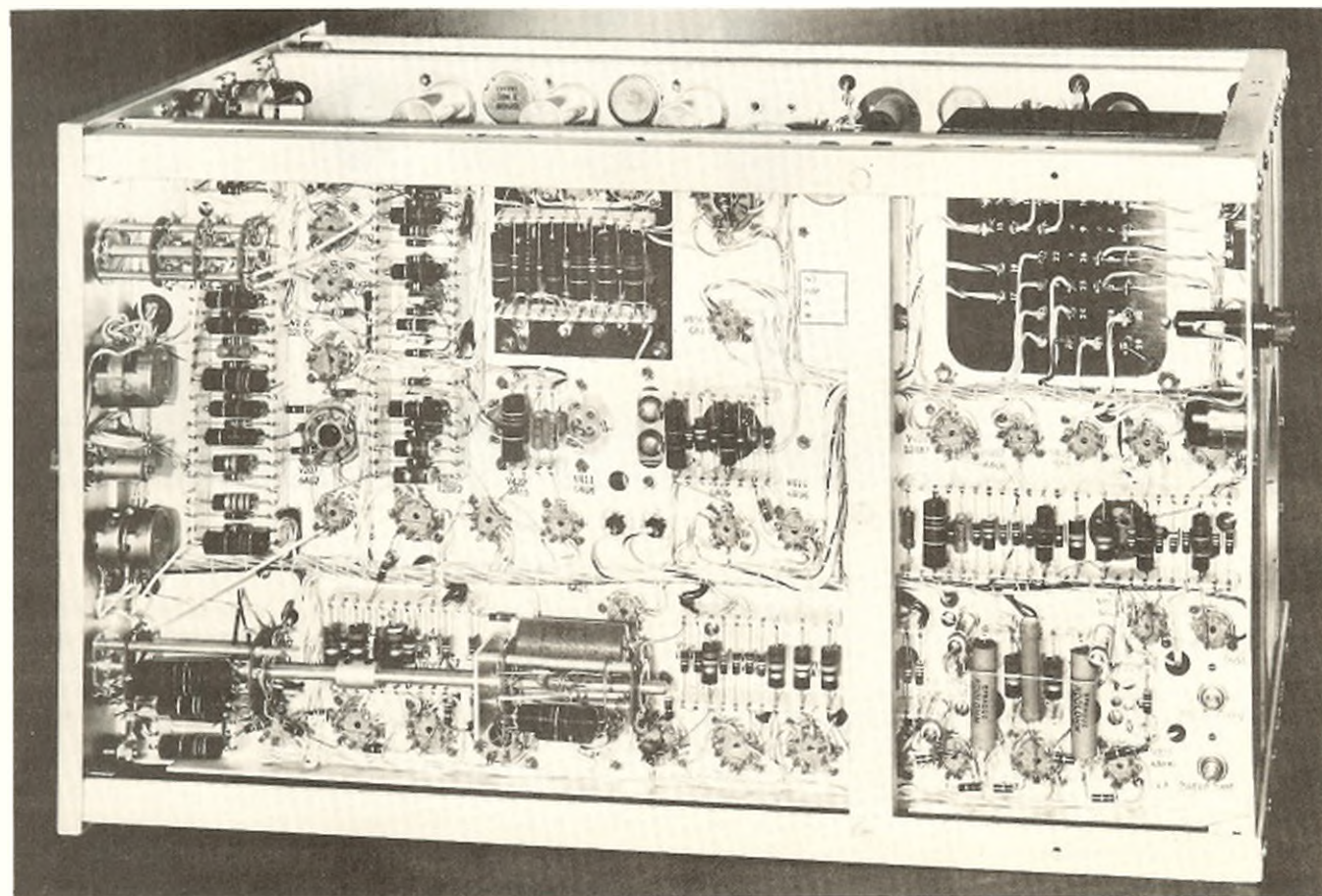
Access Panel—A panel on the side of the instrument provides a capacitively coupled connection to the vertical deflection plates and direct connection to the horizontal deflection plates, bypassing the vertical and horizontal amplifiers. The vertical position control remains operative.

Pass-band Limiting Switch—A switch located on the access panel controls the high-frequency response of the output circuit of the vertical amplifier, limiting the response to that specified by the F.C.C. for standardized television level measurements.

HORIZONTAL DEFLECTION SYSTEM

The **Type 524-D** has a continuously variable, linear, triggered time base covering the range of 0.01 sec/cm to 0.1 μ sec/cm. A seven position sweep time selector switch provides five sweep time positions, an internal 60 cycle sine wave sweep, and an external sweep position. Dual sweep time multiplier dials cover the range between steps. Calibration accuracy is within 5%.

Unblanking—The unblanking circuit used in the **Type 524-D** assures constant crt beam current at any sweep speed or duty cycle for a given intensity control setting.



TEKTRONIX, INC.

CATHODE-RAY OSCILLOSCOPE

Sweep Delay—To observe individual lines or sync pulses, the sweep must be fast enough to spread out the desired information. By delaying the start of the sweep until the picture has progressed to the desired portion and then triggering the sweep with one of the line sync pulses, any individual portion of the picture may be observed. The sweep delay introduced in the **524-D** is adjustable through about one and one-half fields, and operates at the frame rate of 30 cps so that only one interlaced line is observed at any time. A field shift button permits switching to the corresponding interlaced lines in the other field.

Sweep Magnifier—A magnifier principle has been incorporated in the **524-D** that gives either 3 or 10 times magnification of any detail that has been positioned to the center of the screen. With the magnifier on, the operator may explore the entire trace by slowly turning the 3-turn horizontal position control. The position of any detail with respect to the entire sweep may be determined by turning off the magnifier and observing which part of the trace is centered on the screen.

Trigger Selector—The **Type 524-D** has a ten-position trigger selector. Both normal and delayed sweeps may be triggered by an external signal of either polarity, by either the positive or negative portion of the signal under observation, or by the power line frequency.

Recurrent Sweep—A conventional free-running sawtooth sweep may be obtained by adjusting the sweep stability control. This sweep may be easily synchronized with the waveform under observation.

OTHER FEATURES

Time Mark Generator—Time markers are inserted as intensification pips in the crt beam at time intervals of 1 μ sec, 0.1 μ sec, 0.05 μ sec, or 200 pips per television line. These markers provide a means of accurately timing the sync pulses of a composite signal. Pips spaced 200 per television line (0.005 H, where H is 63.5 μ sec) are useful for adjusting both color and black and white equipment.

Output Waveforms—Positive and negative gate waveforms produced simultaneously with each sweep are provided so that intensification or blanking may be produced in a picture monitor to indicate the portion of the picture under observation. The sweep sawtooth waveform is also available on the front panel.

60-cycle Sweep—A 60-cycle internal sweep with phasing through approximately 150° and variable amplitude is provided to facilitate bandwidth measurements with a video sweep generator.

4kv Accelerating Potential—A flat-faced cathode-ray tube, type 5ABP1, is used in the **524-D**, with 4000 volts regulated accelerating potential.

Grouped Controls—The focus, intensity, and astigmatism controls are conveniently grouped below the crt screen.

Illuminated Graticule—An edge-lighted graticule marked in centimeters is provided. Illumination is controlled by a front panel knob. An appropriate color filter increases contrast when viewing in a brightly lighted room. Also included is a graticule marked for modulation measurement.

Regulated Power Supply—All dc voltages are electronically regulated to insure stable operation over the supply range of 105-125 volts, 50-60 cycles.

CHARACTERISTICS

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

Sweeps—Continuously variable, 0.01 sec/cm to 0.1 μ sec/cm. Calibration accuracy 5%.

Trigger Requirements—0.5 to 50v (peak). Pulses as short as 0.05 μ sec. Signal under observation producing 0.5 cm deflection or more. Composite television signal—1 v peak to peak external or 0.05 v to vert. amp.

Sweep Magnification—Magnifier expands the sweep to left and right of center. Either 3 times or 10 times magnification is available except on the 0.1 μ sec/cm sweep range.

External Sweep Input—Coupled via 100k potentiometer, sweep magnifier, and direct coupled sweep amplifier. Maximum deflection sensitivity, 0.25 v/cm dc or ac peak to peak.

Time Markers—Four markers: 1 μ sec, 0.1 μ sec, 0.05 μ sec, and 200 per television line. Accurate within 2%.

Vertical Amplifier—5 stage. 3rd, 4th, and 5th stage direct coupled push-pull. Distributed output (5th) stage.

AC Vertical Deflection Sensitivity—Continuously variable from 0.015 v/cm to 50 v/cm, peak to peak.

DC Vertical Deflection Sensitivity—Continuously variable from 0.15 v/cm to 50 v/cm, peak to peak.

Input Impedance—1 megohm shunted by 40 μ f. With probe, 10 megohms shunted by 14 μ f.

Vertical Amplifier Response—dc to 10 mc (3db down) sensitivity of 0.15 v/cm; 2 cps to 10 mc (3 db down) sensitivity of 0.015 v/cm. Undistorted deflection available — 6 cm.

Vertical Amplifier Transient Response—Rise time (10%-90%) 0.04 μ sec.

Signal Delay Network—Provides 0.25 μ sec signal delay. Permits observation of the waveform that triggers sweep.

Calibrating Voltage—Variable duty cycle square wave. Seven ranges, 0.05v to 50v full scale, continuously variable, accurate within 3%. Duty cycle variable from 1% to 99%.

Cathode Ray Tube—A 5ABP1 cathode-ray tube is furnished with the **Type 524-D** unless a P7 or P11 phosphor is specified as the optional choice. An accelerating potential of 4 kv is used (—2.5 and —1.5 kv).

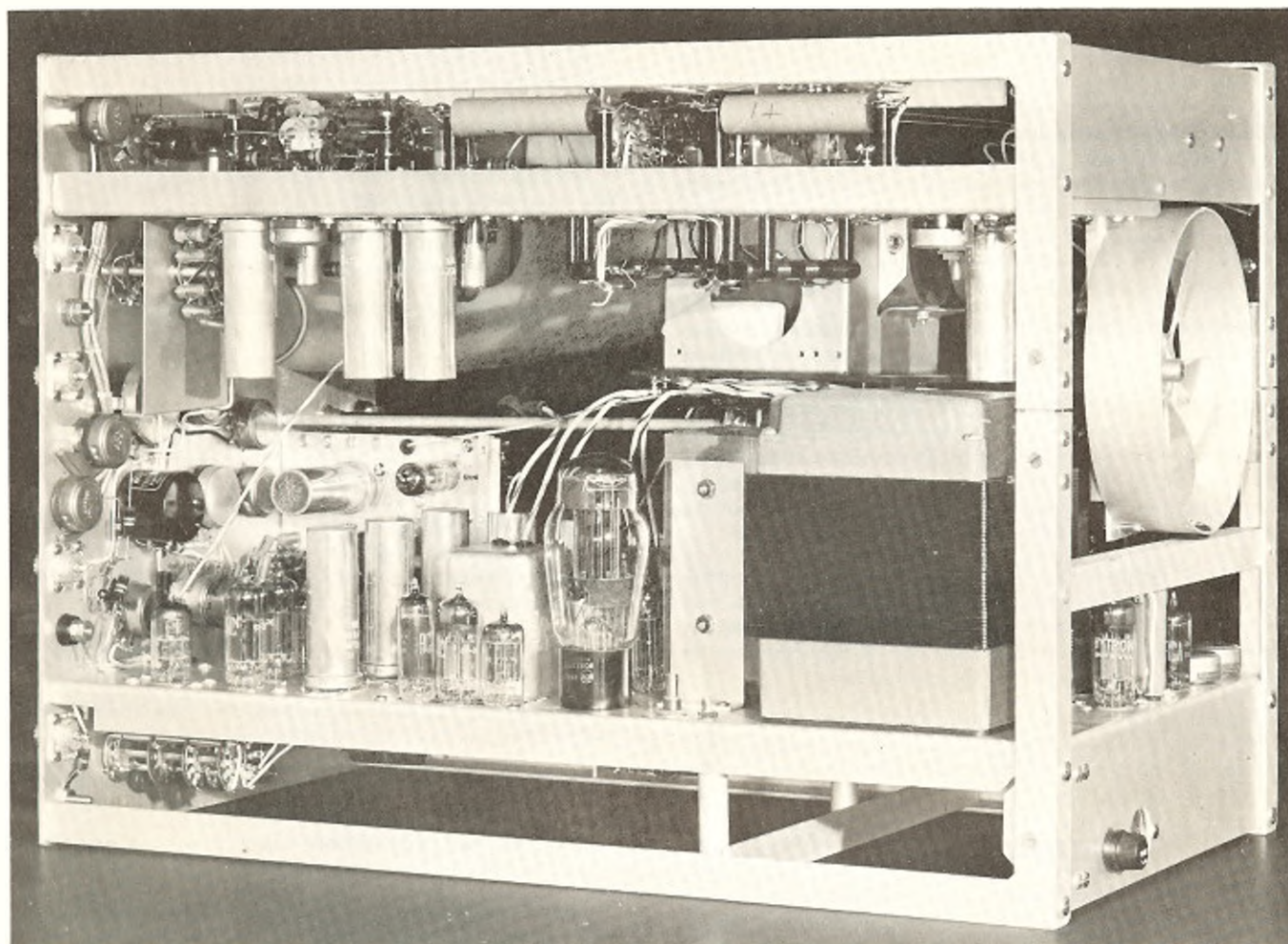
Construction—Completely self-contained, cabinet and chassis made of electrically welded aluminum. Photo etched front panel.

Dimensions—15 $\frac{15}{16}$ " high, 12 $\frac{3}{8}$ " wide, 22 $\frac{3}{8}$ " deep.

Weight—61 pounds.

Power Requirements—105-125 or 210-250 volts, 50-60 cycles, 500 watts.

CATHODE-RAY OSCILLOSCOPE



VACUUM TUBE COMPLEMENT

Preamplifier	2	6U8
Cathode-follower		6BQ7
Cathode-coupled amplifier	2	6CL6
Driver	2	6CL6
Cathode-follower, constant current triode	2	6BQ7
Output amplifier	6	6AG7
Cathode-follower		6AS5
Cal. multivibrator		12AU7
Cal. clipper amplifier	1/2	12AT7
Cal. cathode-follower	1/2	12AT7
Trigger inverter	1/2	6BQ7
Clamp diode	1/2	6BQ7
Sync amplifier		12BZ7
Sync separator	1/2	12BZ7
Coupling diode	1/2	12BZ7
Phantastron		6BH6
Voltage comparator		12BZ7
Trigger amplifier		6AG7
Coupling diode		6AL5
Negative multivibrator		12BY7
Positive multivibrator		12BY7
Gate amplifier	1/2	12AU7
Astigmatism cathode-follower	1/2	12AU7
Unblanking amplifier		12AT7
Clamp tube		6AG7

DC restorer		6AL5
Cathode-follower		12AT7
Decoupling diode	1/2	12AT7
Cathode follower	1/2	12AT7
Feedback amplifier		6U8
Clamp	1/2	12AT7
Output cathode-follower	1/2	12AT7
Sweep output amplifier	2	6AH6
Sweep output cathode-follower		6BQ7
Voltage reference		5651
Regulator amplifier	4	6AU6
Regulator series tube	2	12B4
Rectifier	3	6X4
Voltage comparator amplifier		12AX7
Regulator series tube		6AS7
Regulator series tube		6AS5
Regulator series tube		6AQ5
Time mark pulse shaper	1/2	6BQ7
Oscillator gate	1/2	6BQ7
Time mark oscillator		6AK5
Pulse amplifier		6AH6
Regulator amplifier		12AU7
High voltage oscillator		6AQ5
High voltage rectifier	3	5642
Cathode-ray tube		5ABP1

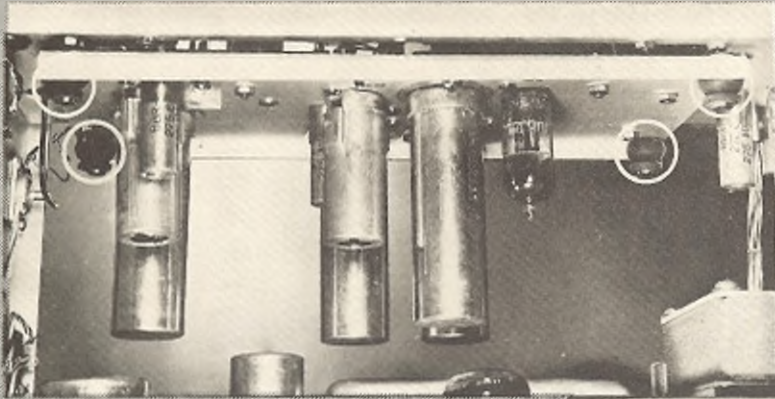
Price — \$1,180.00 f.o.b. Portland, Oregon.

TEKTRONIX, INC.

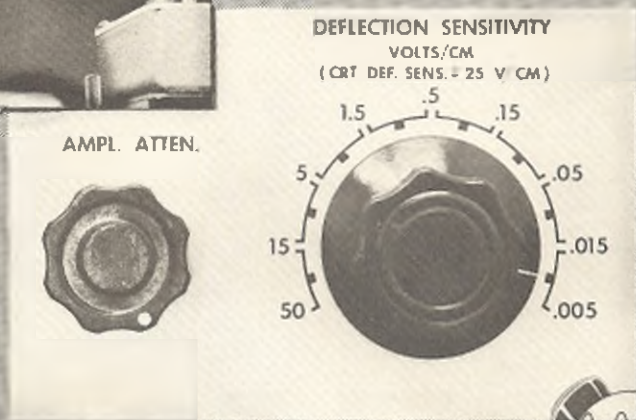


AUXILIARY AMPLIFIERS

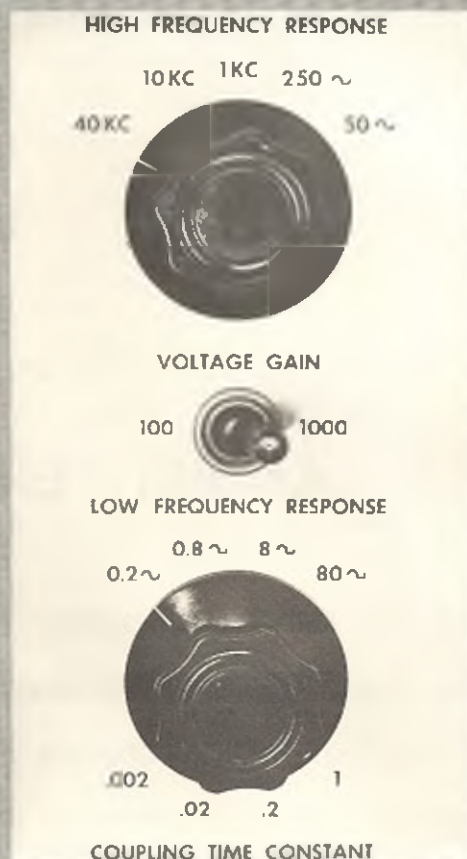
are designed to expand the area of application of Tektronix oscilloscopes in certain specialized directions. Frequently it is desirable to increase the sensitivity of the oscilloscope amplifier into the mv/cm or μ v/cm region. Other measurements may require that the horizontal deflection circuits have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



SHOCK MOUNTING OF
TYPE 121 PRE-AMPLIFIER



SENSITIVITY CONTROLS OF
TYPE 112 AMPLIFIER

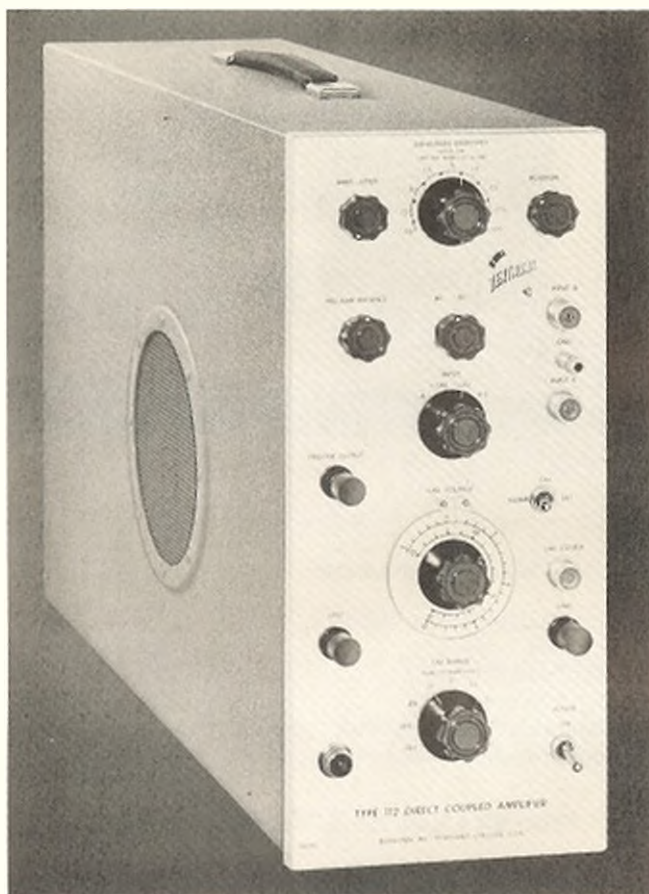


BANDWIDTH CONTROLS OF
TYPE 122 PRE-AMPLIFIER

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.

DIRECT COUPLED AMPLIFIER

TYPE 112



**Differential Input—Push-Pull Throughout
Band Pass DC — 2 mc
Gain .5 to 5000, Continuously Variable
Shock Mounted Pre-amplifier**

The TEKTRONIX Type 112 Direct-Coupled Amplifier is an 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 square

wave voltage calibrator. Forced air cooling is provided by a fan mounted on the power chassis.

When used with a cathode-ray oscilloscope in which the 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 means of the step attenuator and variable potentiometer. The pass band, when working into a 5CP type CRT and using short leads, is DC to 2 mc when voltage gain requirements are 166 or less, DC to 1 mc when voltage gain requirements fall within the range of 166 to 5000.

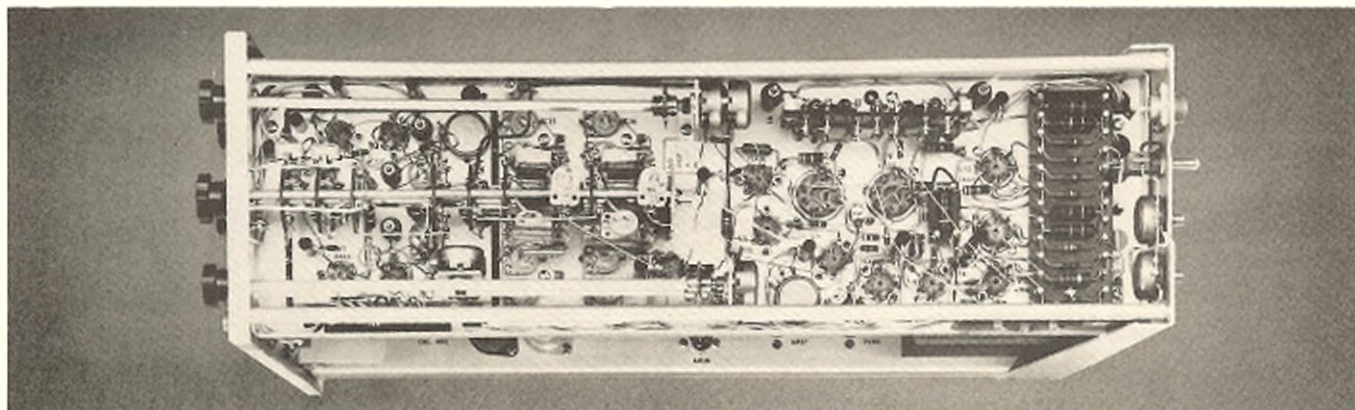
The TEKTRONIX Type 112 input impedance is approximately 1 megohm paralleled by 45 μf each side to ground for direct connection, and is approximately 10 megohms paralleled by 14 μf each side to ground when using the two RC probes which are supplied as standard accessories. The probes have an attenuation of ten. Either single-ended or a differential input may be employed.

When using the differential input, effects of the in-phase components are minimized. 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 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 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 capacitors. For other 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 a 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 coaxial connector permits the injection of time markers at a point just ahead of the output stage without interaction with other 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. The output level is adjustable between 0 and +150 v.



TEKTRONIX, INC.

DIRECT COUPLED AMPLIFIER

A rapid change between the adjusted output level and ± 150 v. is provided by a toggle switch.

SPECIFICATIONS

Deflection Sensitivity 5 mv/cm to 50 v/cm
(when used with oscilloscopes in which the crt has a basic deflection factor of 25 v/cm.)

Voltage Gain5 to 5000, continuously variable

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

Input Impedance 1 meg paralleled by 45 $\mu\mu\text{f}$ direct
10 meg paralleled by 14 $\mu\mu\text{f}$ with probes

Maximum Signal Input Voltage 600 v (peak)

Calibrating Voltage Square wave, approximately 1 kc. Nine ranges, 5 mv to 50 v full scale. Continuously variable, accurate within 3% of full scale.

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

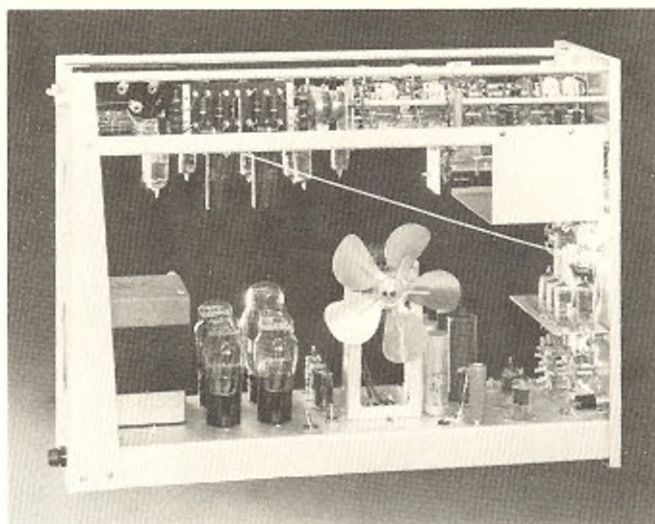
Power Requirement 105-125/210-250 v,
50-60 cycles, 200 watts

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

Weight 32 pounds, complete with accessories

Vacuum Tube Complement—

1st Stage	2	5879
2nd Stage	2	12AU6
Cathode Follower	2	12AU6
3rd Stage	2	12AU6
4th Stage	2	6AG7
Voltage Regulators	2	12AU7
Marker Input Ampl		6AU6
Constant Current Control	2	6BH6
Calibrator Multivibrator		12AU7



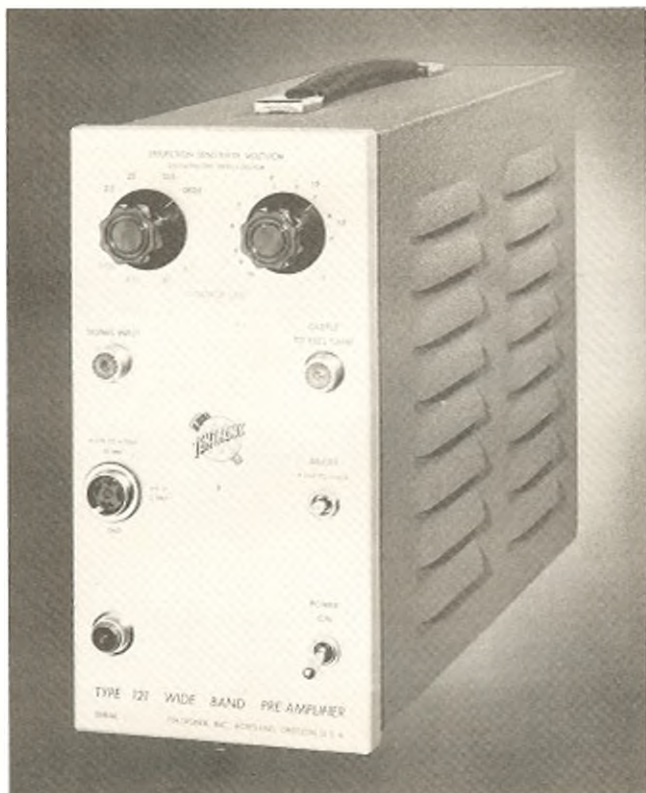
Vacuum Tube Complement—

Calibrator Diode and 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

WIDE BAND PRE-AMPLIFIER

TYPE 121



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. The first, second, and C.F. gain control stages are shock mounted.

SPECIFICATIONS

Voltage Gain 100

Input Impedance, Direct 1 meg paralld by 20 mmf

Max. Peak Output ± 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

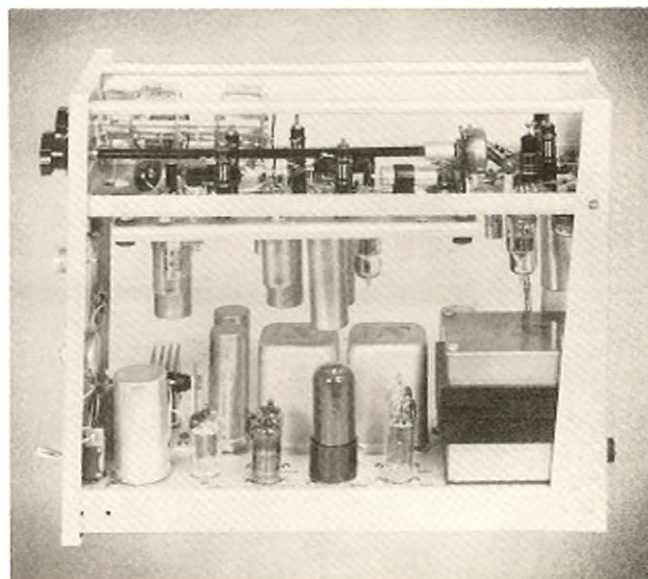
Power Requirements — 105-125/210-250 volts,
50-60 cycles, 80 watts.

Dimensions $5\frac{3}{4}$ " wide, $11\frac{1}{4}$ " high, 15" deep
Self-contained — Total Weight 18 $\frac{1}{2}$ lbs.

Vacuum Tube Complement

First Stage	6CB6
Second Stage	6CB6
C.F. Gain Control	6J6
Third Stage	6AH6
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

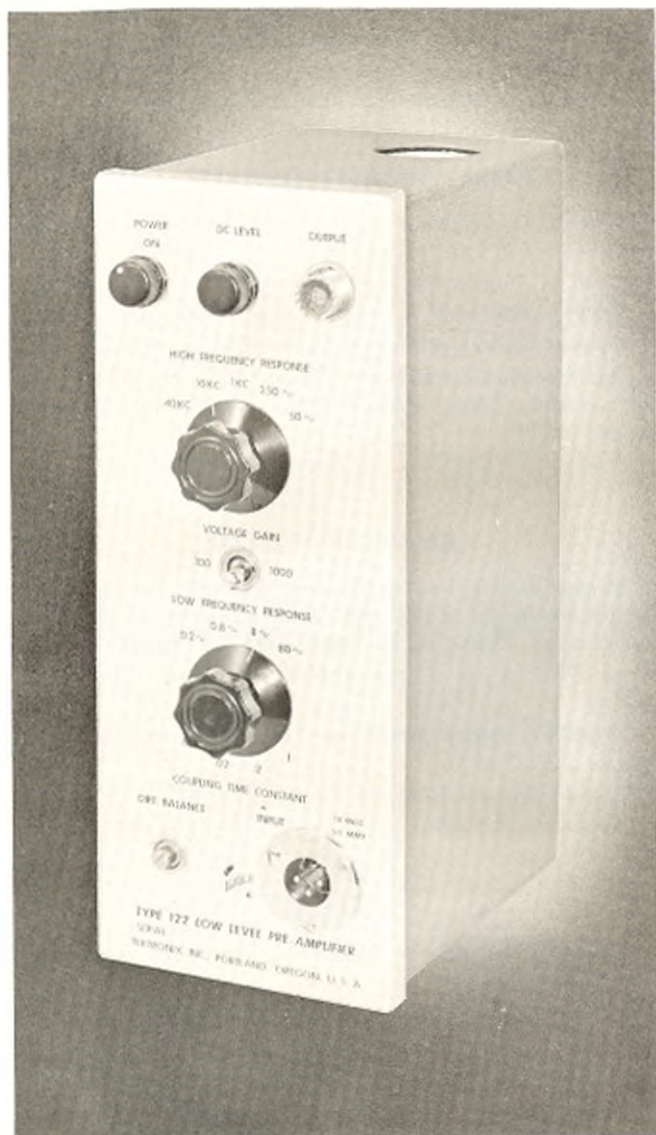
Price \$265.00 f.o.b. Portland, Oregon



TEKTRONIX, INC.

LOW LEVEL PRE-AMPLIFIER

TYPE 122



GENERAL DESCRIPTION

The TEKTRONIX Type 122 Pre-amplifier is a compact three-stage, battery operated amplifier designed primarily to extend the sensitivity of the TEKTRONIX Type 512 Oscilloscope into the microvolt region. The maximum voltage gain of 1000 times increases the sensitivity of the Type 512 Oscilloscope to 5 microvolts per centimeter. At maximum gain an input of 0.02 volts peak to peak is permissible.

At maximum bandwidth setting, frequency response is essentially flat between 0.16 cycles and 40 kc. Separate low-frequency and high-frequency controls permit the bandwidth to be reduced to improve the signal-to-noise ratio where reduced bandwidth is permissible.

The first two stages of the Type 122 Amplifier are operated push-pull and are designed especially to have a high degree of balance. With careful setting of the

front-panel differential-balance control, an 80- to 100-db rejection ratio can be realized between in-phase and out-of-phase signals applied to the input grids at frequencies above five cycles.

A frequency-compensated attenuator allows the voltage gain to be reduced by a factor of ten, to a gain of about 100 times. At this gain setting, a maximum input of 0.1 volts peak to peak is permissible.

A maximum output of 20 volts peak-to-peak is possible without appreciable deterioration of amplitude linearity at about 1000x gain, and an output of 10 volts at about 100x gain. Shockmounting, careful bypassing, and use of battery heater and plate supply reduce microphonics, noise, and hum to a low level.

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. 0.2 .02 .002

Gain—High position, approximately 1000; low position, approximately 100. Rejection ratio for in-phase signals—80 to 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 50 μ f max.
Differential 20 meg. paralleled by 50 μ f max.

Noise Level — 1 μ volt to 4 μ volts 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 Furnished — Type W122 battery cable with battery plugs, Type CON3P input plug, Type P93 output cable.

Dimensions — 10 5/8" high; 4 1/2" wide; 7" deep.

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

Price — \$85.00 f.o.b. Portland, Oregon.

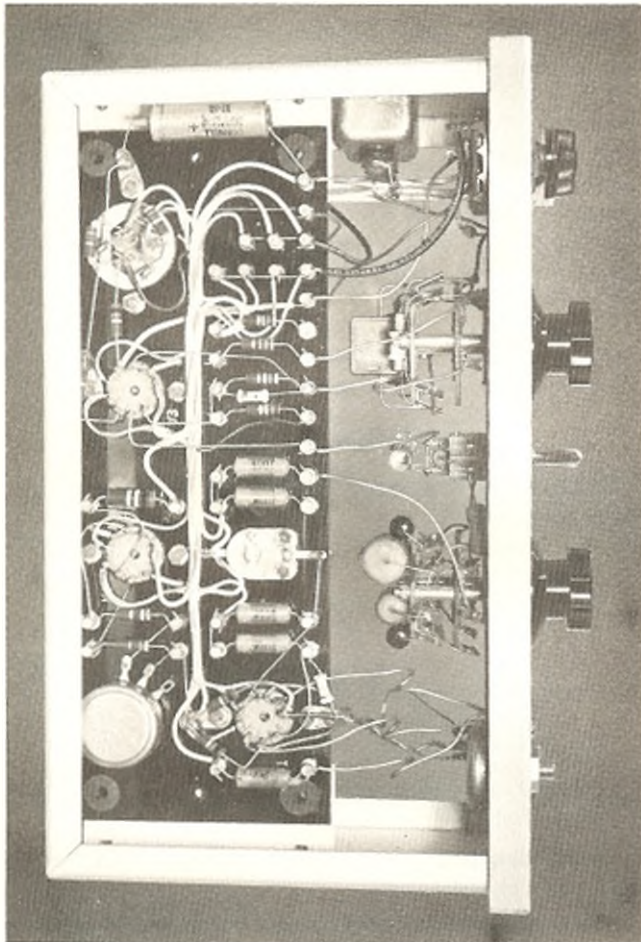
RACK MOUNTED TYPE 122

Mounting Method — The Type 122 is horizontally mounted in a 1/8" thick panel with the input jack at the left

LOW LEVEL PRE-AMPLIFIER

end of the panel.

Panel Size — 19" standard relay rack width, 5 1/4" height.



Power Input — Battery cable socket is on right end, to rear.

Accessories Furnished — Type W122 battery cable with battery plugs, Type CON3P input plug, Type P93 output cable.

Price — \$90.00 f.o.b. Portland, Oregon.

FRAME MOUNTED TYPE 122

Mounting Method — The Type 122 is designed for mounting in a special adapter frame, Type FA160; or it may be fastened to an existing support.

Panel Size — 4 1/8" wide, 12 1/4" high.

Power Input — Battery cable socket is on top, to rear.

Accessories Furnished — Type W122 battery cable with battery plugs, Type CON3P input plug, Type P93 output cable.

Price — \$90.00 f.o.b. Portland, Oregon.

ADAPTER FRAME

Type FA160 — Adapter frame mounts in a relay rack and is designed to hold four units made up of any combination of Type 122, Type 161, or Type 162. (A Type 160 power supply requires the panel space of two units.)

Outside Dimensions — 19" standard relay rack width, 12 1/4" high.

Inside Dimensions — 16 1/2" long, 10 3/8" high.

Price — \$5.00 f.o.b. Portland, Oregon.

SPECIALS

Battery Cables — Extra long, similar to Type W122 can be ordered as a special item.



SQUARE WAVE GENERATORS

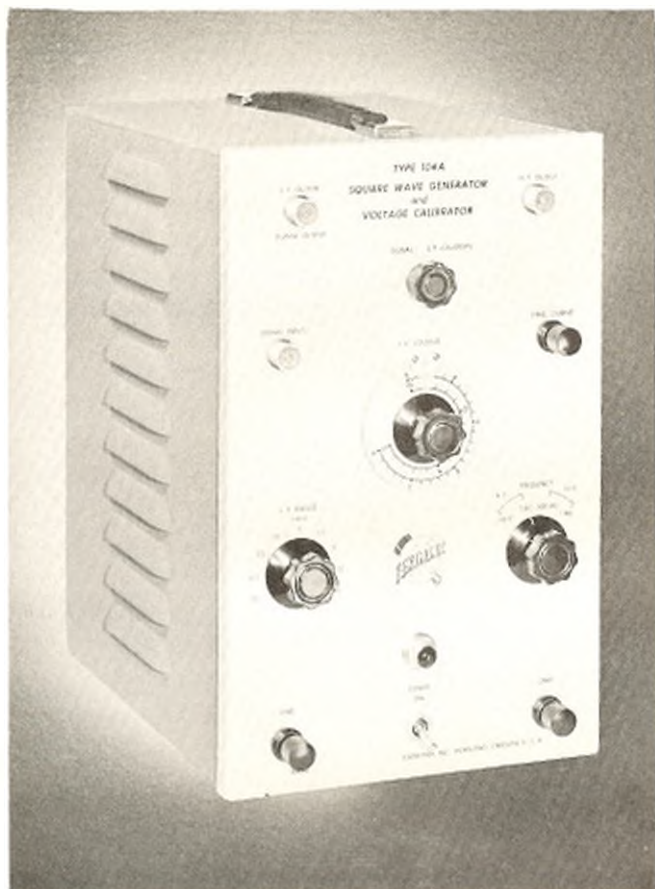
Square wave testing techniques are recognized as providing one of the most efficient means of determining electronic circuit response. Precise adjustment of frequency compensated attenuator, amplifier and filter circuits is reduced to a simple procedure.

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.

SQUARE WAVE GENERATOR & VOLTAGE CALIBRATOR

TYPE 104A



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 signal of at least 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 3% of the full scale reading.

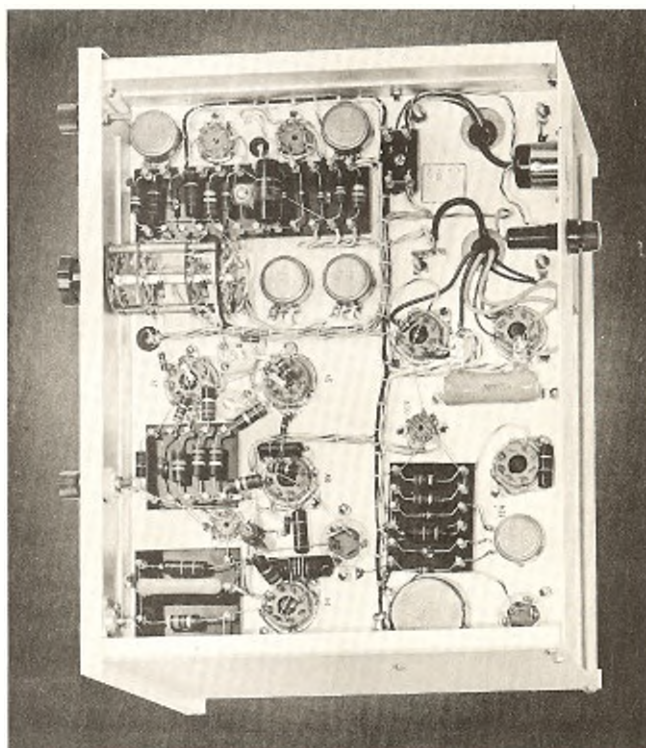
Synchronizing Signal—In order to synchronize the oscilloscope being used, a separate binding post supplies a synchronizing signal of at least 3 volts at all settings of attenuator or calibrator controls.

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 out-

TEKTRONIX, INC.

SQUARE WAVE GENERATOR & VOLTAGE CALIBRATOR

put, depending upon the calibrator control settings.

Rise Time—.02 μ sec for the high frequency outputs, and 3 μ 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; 11 1/2" deep.

Weight—22 pounds, complete with accessories.

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

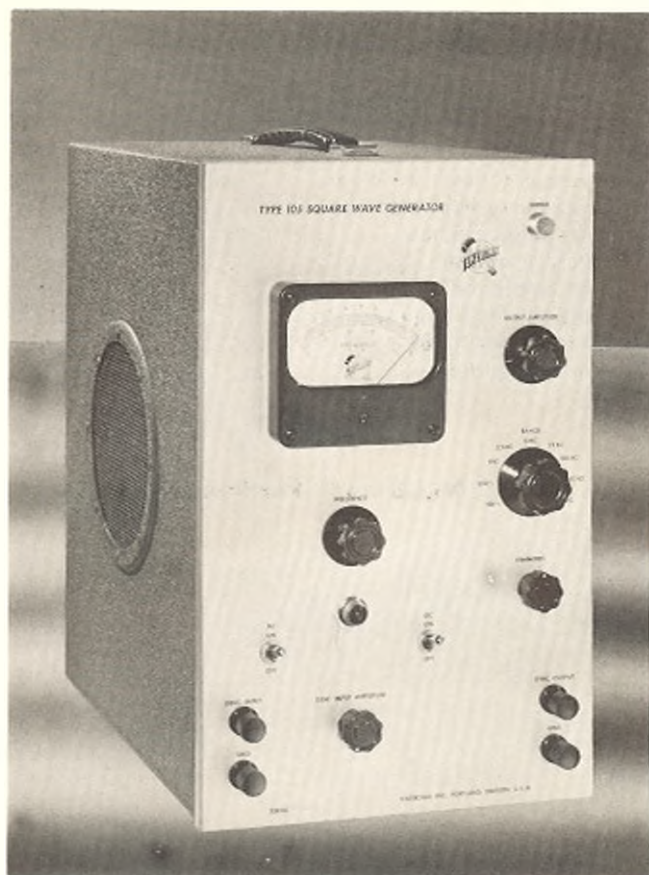
Vacuum Tube Complement—

High Frequency Multivibrators	2	6AG7
High Frequency Limiter		6AG7
High Frequency Output Amplifier		6AG7
Low Frequency Multivibrator		12AU7
Low Frequency Limiter Diode and Cathode Follower		12AU7
Trigger Output Cathode Follower		6J6
Power Supply Rectifier		5V4G
Series Regulator		6AU5
Regulator Amplifier		6AU6
Voltage Reference		OC3/VR105

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

SQUARE WAVE GENERATOR

TYPE 105



Continuously Variable, 25 CPS - 1 MC

Rise Time, .02 Microseconds

Direct Reading Frequency Meter

APPLICATIONS

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 rise-time and other details associated with square wave testing, see Vol. 18, Radiation Laboratory Series, "Vacuum Tube Amplifiers" (McGraw-Hill).

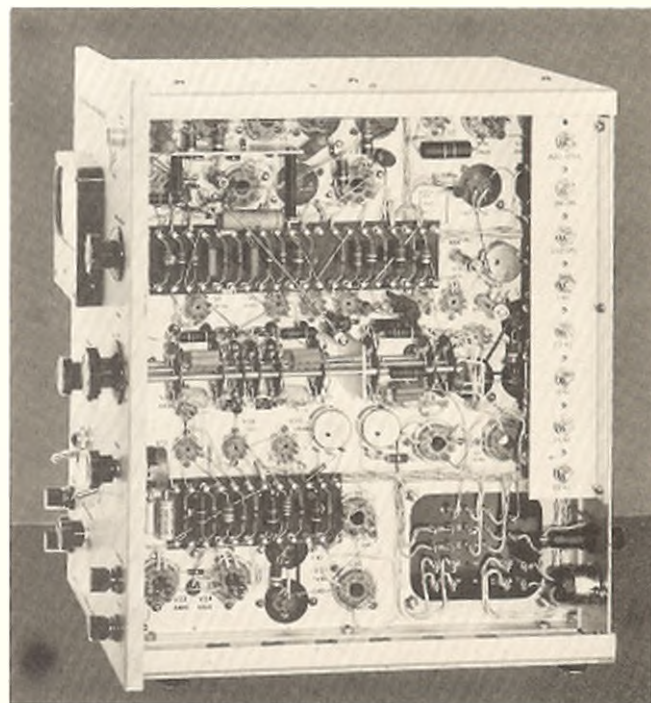
GENERAL DESCRIPTION

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. Type of output cable furnished with the instrument is optional. (52-ohm, 75-ohm or 93-ohm coaxial cable.) If higher output voltages are needed, correspondingly larger loads may be used with a deterioration of the rise-time 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.

For convenience a direct-reading frequency meter is incorporated in the instrument. The range of the frequency meter is changed simultaneously with the range of the multivibrator, providing two scales per decade. The frequency meter is accurate within 3% of full scale.

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 a frequency standard.

All DC power supplies are electronically regulated so



TEKTRONIX, INC.

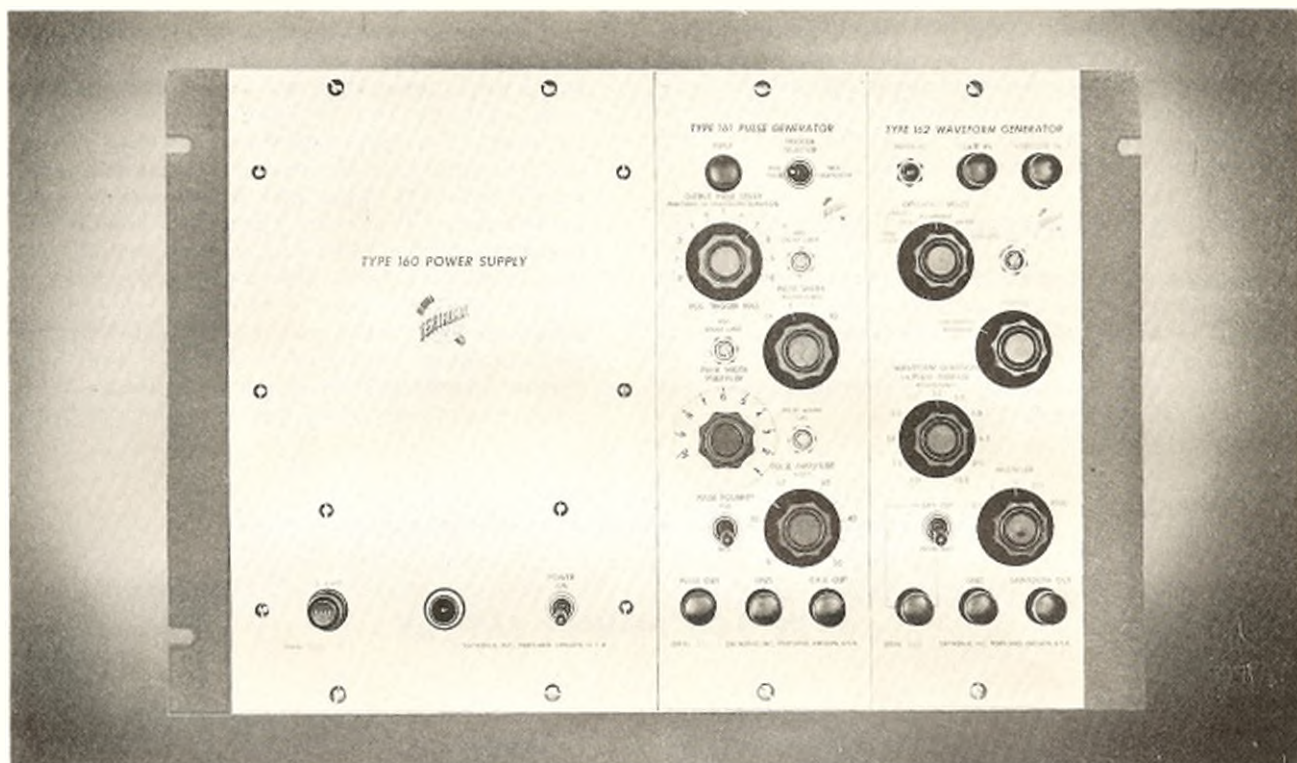


SPECIAL INSTRUMENTS

Work in some fields of research and development requires the use of special instruments in conjunction with the cathode-ray oscilloscope. Special instruments developed by TEKTRONIX are described in this section.

SPECIAL WAVEFORM GENERATORS

TYPE 160 SERIES



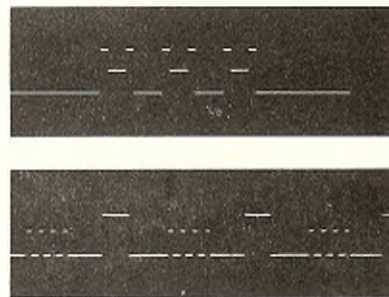
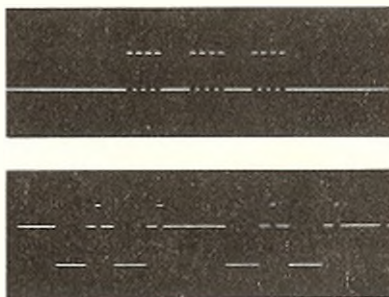
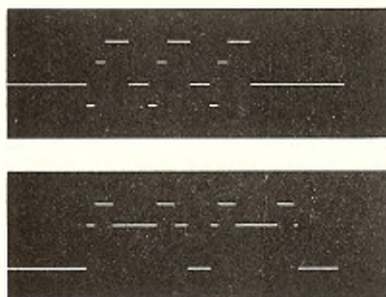
TYPE 160 POWER SUPPLY TYPE 161 PULSE GENERATOR TYPE 162 WAVEFORM GENERATOR

The TEKTRONIX 160 Series of instruments are designed to supply timed pulses of adjustable amplitude and duration. They have been used extensively for nerve stimulation, for example, in neurophysical experiments. In a typical use the response time and the nature of the response to an electrical stimulus generated by a Type 161 or Type 162 is measured on an oscilloscope. By using several instruments together a variety of pulse patterns can be obtained, such

as a simulation of a tetanus stimulus.

TYPE 160 POWER SUPPLY

The Type 160 Power Supply provides regulated DC voltages and AC filament supply for as many as six Type 161 or Type 162 instruments in any combination.



Some of the waveform combinations possible with Tektronix Type 160 Series Waveform Generators

TEKTRONIX, INC.

SPECIAL WAVEFORM GENERATORS

TYPE 161 PULSE GENERATOR

The **Type 161 Pulse Generator** can be controlled by means of either pulse or sawtooth outputs of the **Type 162**. The output pulse of the **Type 161** occurs simultaneously with the input pulse from the **Type 162**, or can be made to occur at any point on the input sawtooth from the **Type 162**. By selecting the desired portion of the sawtooth for the generation of the pulse, the **Type 161** can provide a delay of any fraction of the sawtooth duration.

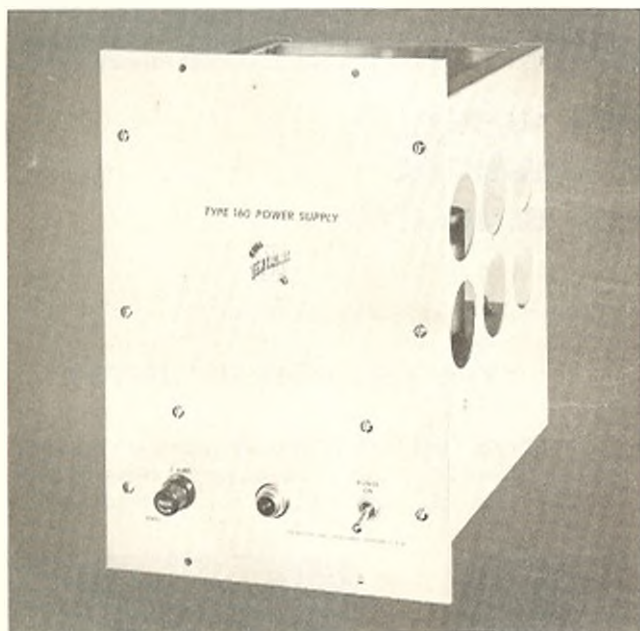
TYPE 162 WAVEFORM GENERATOR

The **Type 162 Waveform Generator** provides gating or enabling pulses and sawtooth waves which can be initiated by means of externally-derived signals such as might be provided by a push button and external battery, or which can be provided by a stable repetition rate generator built into the instrument itself.

USES OF COMBINATIONS OF TYPE 161 AND TYPE 162 GENERATORS

A convenient mounting frame is available which adapts these instruments to relay-rack mounting. One mounting frame will accommodate one **Type 160 Power Supply** and two **Type 161** or **Type 162** generators, or four generators. The **Type 160 Power Supply** will supply the required power for as many as six generator units in any combination. The **Type 161 Pulse Generator** can be used to gate one or more **Type 162 Waveform Generators**, and the **Type 162** can be used to trigger several **Type 161 Pulse Generators**. By using combinations of the generators, a variety of waveforms can be produced. One interunit octal power cable furnished with each generator and two furnished with each **Type 160 Power Supply** provide a convenient means of supplying power to a number of the instruments in combination.

TYPE 160 POWER SUPPLY



GENERAL DESCRIPTION

The **TEKTRONIX Type 160 Power Supply** is designed to provide the required voltages and current for as many as six **TEKTRONIX Type 161** or **Type 162 Generators** in any combination. Three regulated DC voltages are supplied. The output terminals consist of three octal sockets, each capable of supplying power for two of these generators.

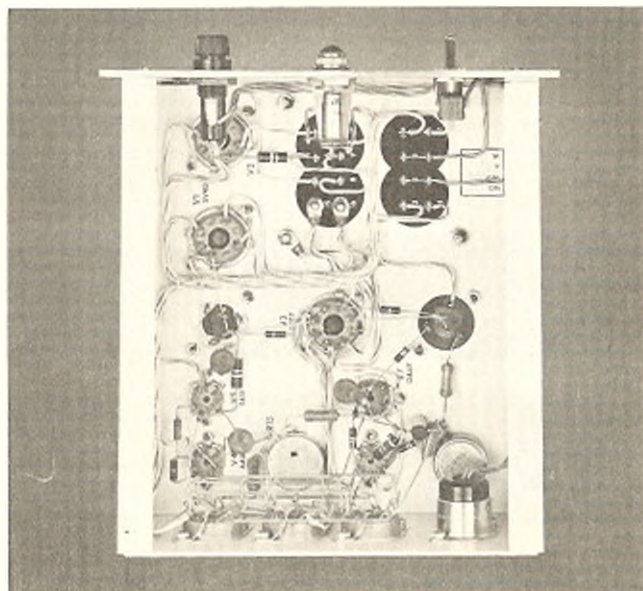
CHARACTERISTICS

Voltages —

- +300 volts DC, unregulated, at 170 milliamps.
- +225 volts DC, regulated, at 125 milliamps.
- +150 volts DC, regulated, at 5 milliamps.
- 170 volts DC, regulated, at 125 milliamps.
- 6.3 volts AC, unregulated, at 10 amps.

Type of Regulation — Electronic, with **Type 5651** gas diode reference element.

Output Connections — Three octal female sockets



TEKTRONIX, INC.

SPECIAL WAVEFORM GENERATORS

mounted on rear of chassis. Each socket is capable of supplying power to two generators. Two 17-inch octal interunit power cables are supplied.

Dimensions — 8 1/4" wide, 12 1/4" high, 10" deep.

Weight — 13.5 pounds.

Construction — Aluminum alloy.

Finish — Buffed photo-etched metal panel, etched metal chassis.

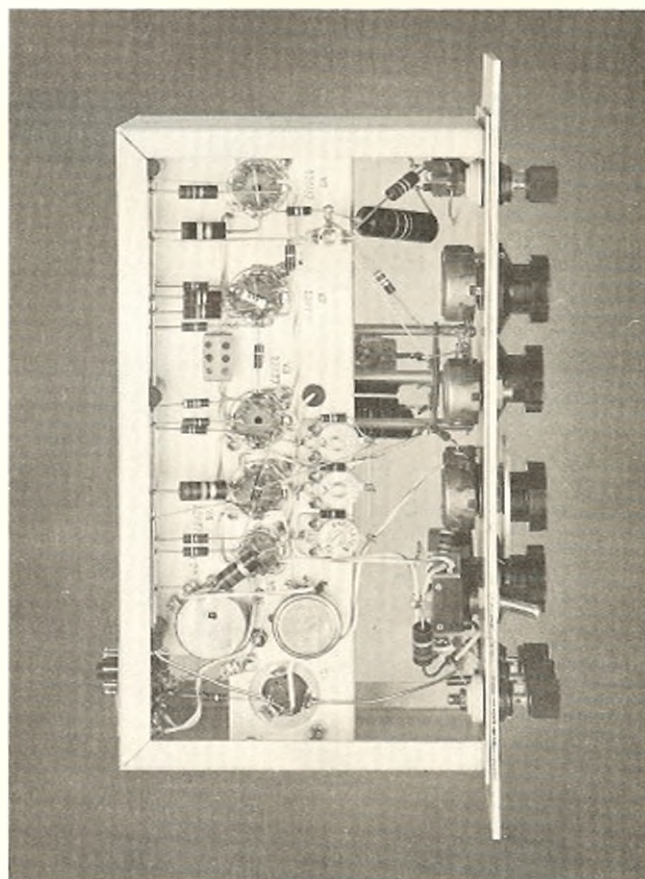
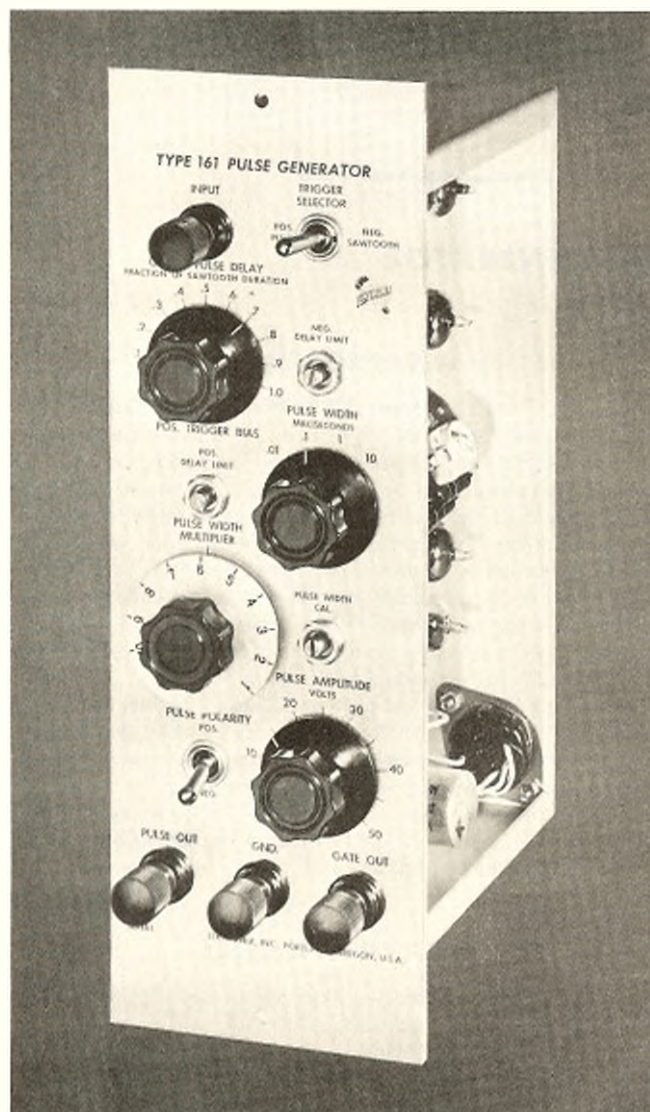
VACUUM TUBE COMPLEMENT

+300 v rectifier	5V4
—170 v rectifier	5V4
+225 v series regulator	1/2 6AS7
—170 v series regulator	1/2 6AS7
—170 v error voltage amplifier	6AU6
Gas diode voltage reference	5651
—225 v error voltage amplifier	6AU6
+150 v error voltage amplifier	1/2 12AU7
+150 v series regulator	1/2 12AU7

TYPE 161 PULSE GENERATOR

GENERAL DESCRIPTION

The TEKTRONIX Type 161 Pulse Generator is designed to supply calibrated rectangular output pulses of adjustable duration and amplitude and of either polarity when the required trigger voltage is received from an external source. Two types of trigger waveforms can be used to trigger the Type 161, a negative-going sawtooth or a



SPECIAL WAVEFORM GENERATORS

positive pulse. One output pulse is generated for each input pulse or each cycle of the sawtooth.

When a negative sawtooth waveform is used to trigger the generator a rectangular pulse of either polarity and a 50-volt positive gating pulse are generated. The time of occurrence of the pulse and of the gate can be adjusted to any point throughout the duration of the sawtooth. The duration of the generated pulse and the output gate are the same.

When a positive pulse is used to trigger the generator, the same output waveforms are available, but there is no delay available in the generation of the pulse.

CHARACTERISTICS

Output Waveform — Positive gate. Positive pulse. Negative pulse.

Positive Gate Characteristics — Amplitude, 50 volts positive from ground potential, not adjustable. Duration, 10 μ sec to 0.1 sec.

Positive Pulse Characteristics — Amplitude, 0 to 50 volts, continuously variable. Duration, 10 μ sec to 0.1 sec continuously variable. Risettime, 0.5 μ sec. Overshoot, less than 5%. Delay, 0 to 100% of duration of input sawtooth.

Negative Pulse Characteristics — Identical with

positive pulse, except polarity.

Output Impedance — Positive pulse, 1800 ohms maximum. Negative pulse, 5000 ohms maximum. Positive gate, 1000 ohms maximum.

Method of Triggering — Positive pulse, or negative-going positive sawtooth.

Trigger Sensitivity — Positive pulse, 2-volt peak minimum. Sawtooth, rate of change of input waveform, 15 volts/sec. Maximum repetition rate, 50 kc.

Construction — Aluminum alloy.

Finish — Buffed photo-etched metal panel, etched metal chassis.

Dimensions — 4 1/8" wide, 12 1/4" high, 7 1/2" deep.

Weight — 5 pounds.

Power Requirements — 225 volts DC positive at 22 ma. 170 volts DC negative at 17 ma. 6.3 volts AC at 1.1 amps.

VACUUM TUBE COMPLEMENT

Comparator	12AU7
Schmitt trigger	12AT7
Coupling diode and first half of one-kick multivibrator	12AT7
Second half multivibrator and positive pulse cathode follower	12AT7
Negative pulse amplifier	6J6

TYPE 162 WAVEFORM GENERATOR



GENERAL DESCRIPTION

The TEKTRONIX Type 162 Waveform Generator provides three types of waveforms of adjustable duration and repetition rate; pulse, gate, and sawtooth. Generation of the waveform can be initiated either by means of an externally derived electrical impulse, or by means of front-panel controls and switches. Pulse and gate waveforms have a minimum risetime of approximately one microsecond and an amplitude of 50 volts. The shortest pulse duration is approximately 10 microseconds. The sawtooth waveform is a positive voltage decreasing uniformly from positive 150 volts to positive 20 volts.

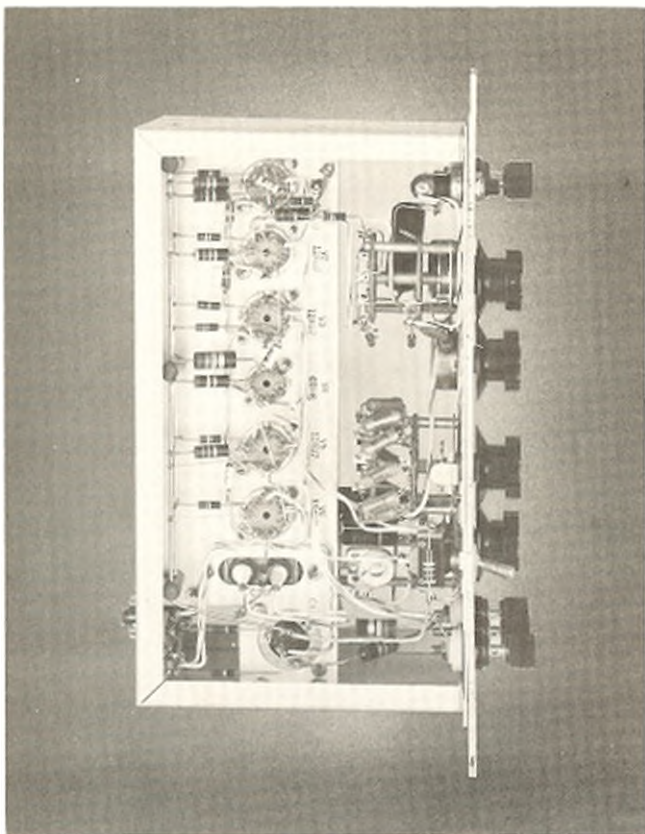
The Type 162 is useful for initiating chains of events electrically, and for controlling the duration of their occurrence and their repetition rate. When generating waveforms recurrently the instrument provides an unusually stable repetition rate. The Type 162 is specifically designed to operate in conjunction with TEKTRONIX Type 161 Pulse Generators.

CHARACTERISTICS

Output Waveform — Positive pulse. Positive gate. Negative-going sawtooth.

Pulse Characteristics — Amplitude, 50 volts positive from ground. Duration, 10 μ sec to 0.2 sec. Risettime, 1 μ sec, approximately, minimum. Repetition rate, 0.1 cps to 10 kc for recurrent operation.

SPECIAL WAVEFORM GENERATORS



Gate Characteristics — Amplitude, 50 volts positive from ground. Duration, 100 μ sec to 10 sec. Repetition rate, 0.1 cps to 10 kc for recurrent operation.

Sawtooth Characteristics — Amplitude decreases uniformly with time from positive 150 volts to positive 20 volts. Duration, 100 μ sec to 10 sec. Repetition rate, 0.1 cps to 10 kc for recurrent operation.

Output Impedance — Approximately 1000 ohms for all outputs.

Triggering Means — Externally derived electrical pulse or gate. Front-panel pushbutton or switch.

Triggering Input Impedance — High impedance, consisting of control grid with 1-megohm grid return resistor.

Trigger Sensitivity — Positive pulse, 3 volts peak or greater with risetime 5 milliseconds or less. Sine-wave, 2 volts rms, frequency between 5 cps and 50 kc. At frequencies below 5 cps, the product of rms voltage times frequency must exceed 10.

Gate Sensitivity — Three volts.

Construction — Aluminum alloy.

Finish — Buffed photo-etched metal panel, etched metal chassis.

Dimensions — 4 $\frac{1}{8}$ " wide, 12 $\frac{1}{4}$ " high, 7 $\frac{1}{2}$ " deep.

Weight — 5 pounds.

Power Requirements — 225 volts DC positive at 28 ma. 150 volts DC positive at 1 ma. 170 volts DC negative at 1.5 ma. 6.3 volts AC at 1.7 amps.

VACUUM TUBE COMPLEMENT

Schmitt trigger circuit	12AU7
Trigger amplifier (operating mode selection) $\frac{1}{2}$	12AU7
Multivibrator	$\frac{1}{2}$ 12AU7
Multivibrator	$\frac{1}{2}$ 12AU7
Pulse and gate shaping amplifier	$\frac{1}{2}$ 12AU7
Phantastron	6BH6
Pulse and gate amplifier	$\frac{1}{2}$ 12AU7
Phantastron plate coupling cathode follower, sawtooth out	$\frac{1}{2}$ 12AU7
Pulse and gate output cathode follower	$\frac{1}{2}$ 12AU7
Phantastron plate catching diode	$\frac{1}{2}$ 12AU7

Type 160 Power Supply — \$110

Type 161 Pulse Generator — \$95

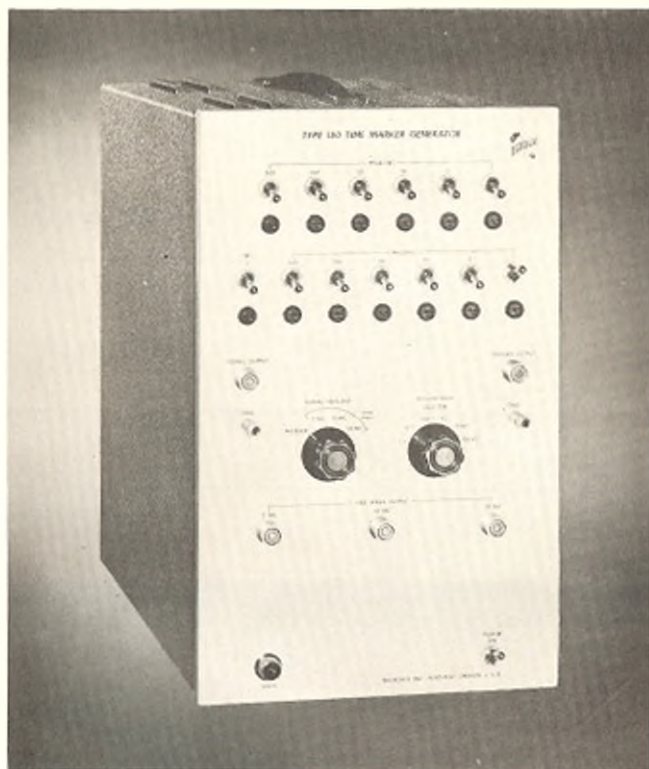
Type 162 Waveform Generator — \$95

MOUNTING FRAME adapts Type 160 Series to rack mounting. Holds four waveform generators — or two waveform generators and one power supply.

Type FA 160 Mounting Frame — \$5

TIME MARK GENERATOR

TYPE 180



GENERAL DESCRIPTION

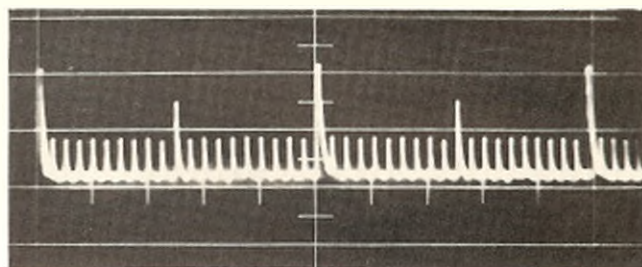
The TEKTRONIX Type 180 Time Mark Generator is a precision laboratory instrument of high quality design and construction. The Type 180 generates time markers of 1, 5, 10, 50, 100, 500 microseconds, — 1, 5, 10, 50, 100, 500 milliseconds, — 1 second; sine waves of 5 mc, 10 mc, 50 mc; trigger rates of 1, 10, 100 cycles, 1, 10, 100 kilocycles. A crystal controlled oscillator operating at one megacycle controls all outputs. The 1-mc frequency is factory adjusted within 0.005%, and may easily be standardized against Station WWV for greater accuracy.

The 1 μ sec markers are formed by a clipper, differentiating network, and biased cathode follower. 5 μ sec to 1 sec markers are generated in a chain of triggered multivibrator circuits and each is shaped in a differentiating network and biased cathode follower. Markers are mixed in a resistive circuit so that marker amplitudes are added together forming a distinctive timing comb. Markers selected by the trigger rate switch are fed to a shaper and cathode follower to form the trigger output. The sine wave outputs are formed by three frequency-multiplier circuits.

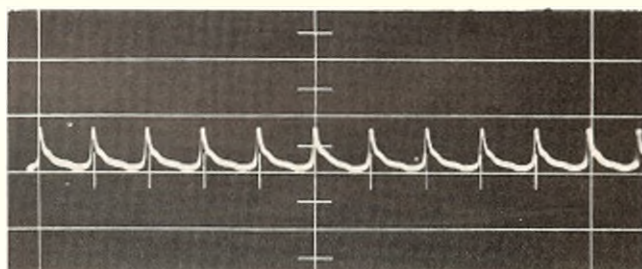
A four-position switch is used to select the signal output — markers, 5-mc sine wave, 10-mc sine wave, or 50-mc sine wave. Individual switches are used to form any combination of markers desired. The markers are also available separately and simultaneously through individual pin jacks, and each sine wave frequency is available at a separate

connector. A six-position switch is used to select the trigger repetition rate desired.

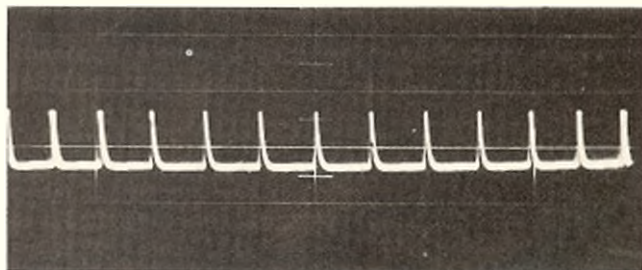
A Type 180 can be very helpful in the laboratory. You can use it to calibrate oscilloscope time bases; to calibrate audio, supersonic, and rf oscillators; to calibrate counters; as a time measuring instrument (calibrating points from 10 μ sec to 1 sec); as a repetition rate generator; as a secondary frequency standard.



Timing comb formed by a combination of 5 μ sec, 50 μ sec, and 100 μ sec markers displayed on a TEKTRONIX Type 524-D Oscilloscope with a 20 μ sec/cm time base setting.



1 microsecond marker displayed on a TEKTRONIX Type 524-D Oscilloscope with a 1 μ sec/cm time base setting.



1 kilocycle trigger output of the Type 180 displayed on a TEKTRONIX Type 513-D Oscilloscope.

TEKTRONIX, INC.

TIME MARK GENERATOR

CHARACTERISTICS

Nominal Voltage, Impedance, and Risetime Values

AT SIGNAL OUTPUT				AT PIN JACKS	
Marker	Amplitude	Impedance	Risetime	Amplitude	Impedance
1 μ sec	1 v	300 ohms	0.04 μ sec	20 v	400 ohms
5 μ sec to 10 μ sec	1 v	600 ohms	0.08 μ sec	25 v	400 ohms
50 μ sec	1.5 v				
100 μ sec to 1 sec	3 v		0.3 μ sec	50 v	600 ohms
Trigger Pulses 1, 10, 100 cycles					
1, 10, kc	9 v	200 ohms	0.2 μ sec		
100 kc	3 v	200 ohms	0.2 μ sec		
Sine Waves 5, 10, 50 mc	4 v (across 52 ohms)	30 ohms			

Regulation

All dc voltages electronically regulated.

Accuracy

Factory adjusted within 0.005%. (not temp. comp.)

Crystal Stability

Two parts per million per degree.

Construction

Aluminum alloy chassis and cabinet. Hinged sub-chassis. Photo-etched aluminum panel with anodized finish. Gray wrinkle finished cabinet.

Power Requirements

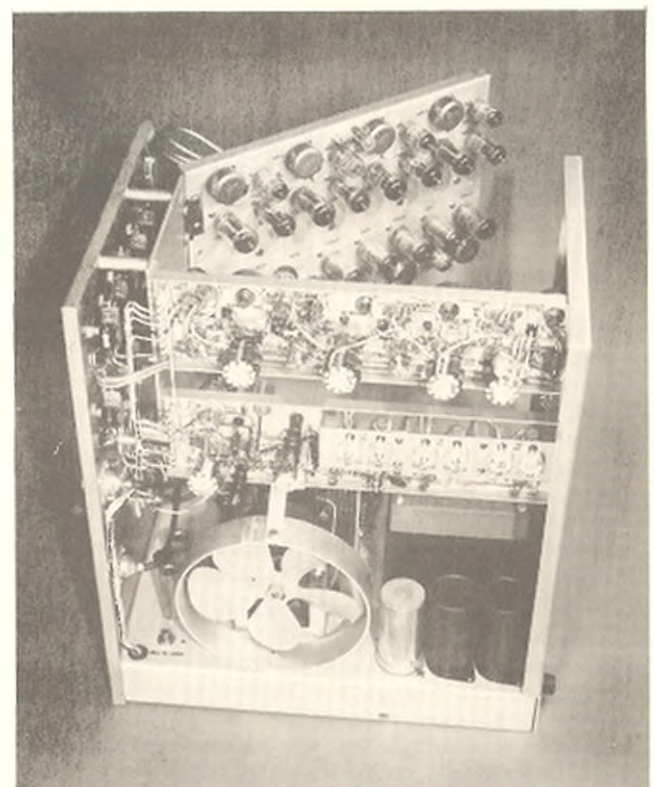
105-125 v or 210-250 v, 50-60 cycles — 330 watts.

Dimensions

10 $\frac{1}{8}$ " wide, 16 $\frac{1}{2}$ " high, 14 $\frac{7}{8}$ " deep.

Weight

37 lbs. complete with two P93 output cables, A100 clip lead adapter, and power cord.



VACUUM TUBE COMPLEMENT

Oscillator and buffer	1	6U8
Frequency Multiplier	3	6AH6
Cathode Follower		12AU7
Clamp and Clipper Diode		6AL5
Amplifier and Cathode Follower		12AT7
Divider Multivibrator	2	12AT7
Divider Multivibrator	10	12AU7
Coupling Diode and Clamp	12	6AL5
Marker Cathode Follower	3	12AU7
Marker Cathode Follower	10	6C4
Trigger Shaper and Cathode Follower		12AU7
Rectifier		6X4

Series Regulator	2	6AQ5
Series Regulator		6AS7
Regulator Amplifier	3	6AU6
Voltage Comparator		12AX7
Voltage Reference		5651

Price — \$575 f.o.b. Portland, Oregon

TEKTRONIX, INC.

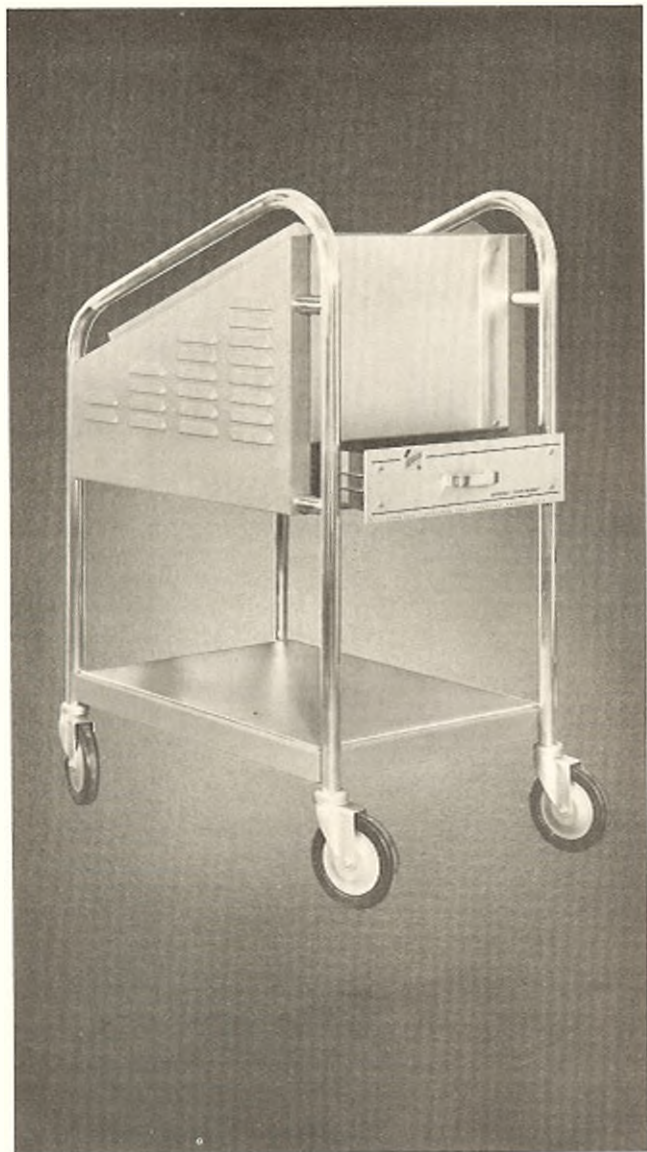


ACCESSORIES

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

SCOPE - MOBILE

TYPE 500



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.

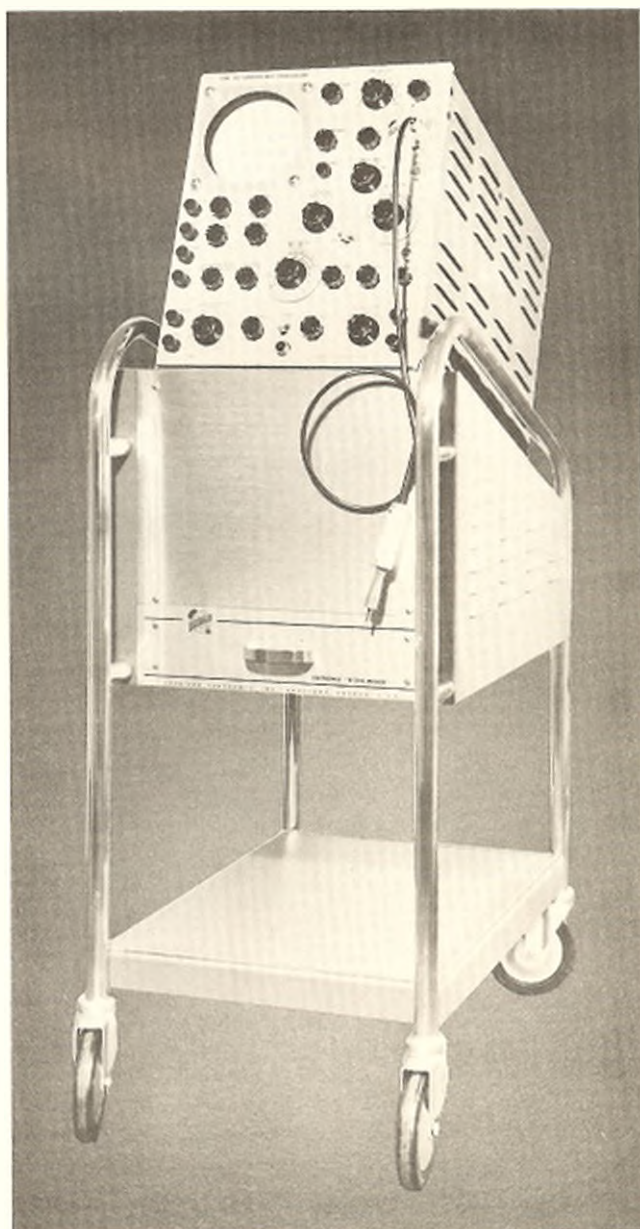
A blank panel, 11" x 15", fronting a mounting space of approximately 1 1/2 cubic feet allows for auxiliary built-in equipment as an aid in meeting specialized requirements. This space is fully ventilated by means of louvers. A power input connector and three convenience outlets appear at the back.

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" x 15" x 3" in size, is felt lined and operates in roller bearing support runners. An open shelf, 17" x 24" 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 wrinkle to match other Tektronix products.

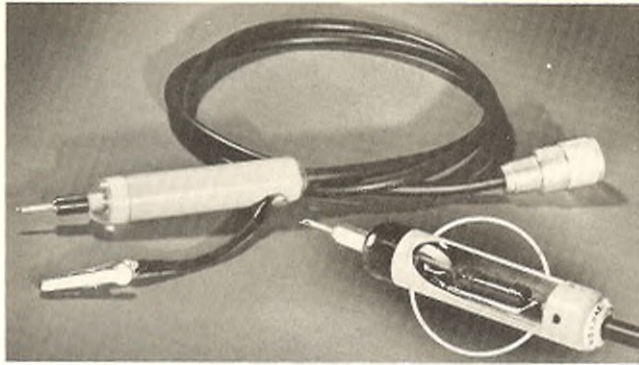
Total "dry" weight of the Scope-Mobile is approximately 42 pounds and clearance dimensions are 18 1/2" wide, 39" high and 30" deep.

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



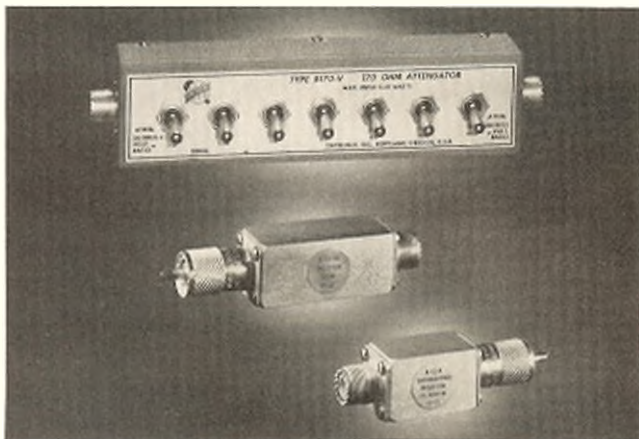
TEKTRONIX, INC.

ACCESSORIES



PROBES

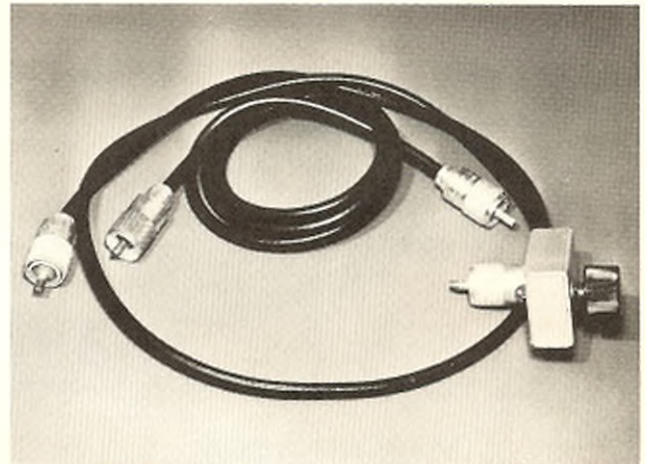
P510A Attenuator Probe (replaces the P510) — provides an attenuation of ten times when used with Tektronix oscilloscopes and amplifiers. The P510A is small and streamlined, and presents an input impedance of 10 megohms paralleled by 14 μ mf. The probe body is completely insulated—made of high impact strength Fiber Glass Reinforced Alkyd—and has an internal brass shield. Klipzon tip and attached ground clip increase its utility. The P510A has a 42" coaxial cable with uhf connector. \$8.50



TERMINATION ACCESSORIES

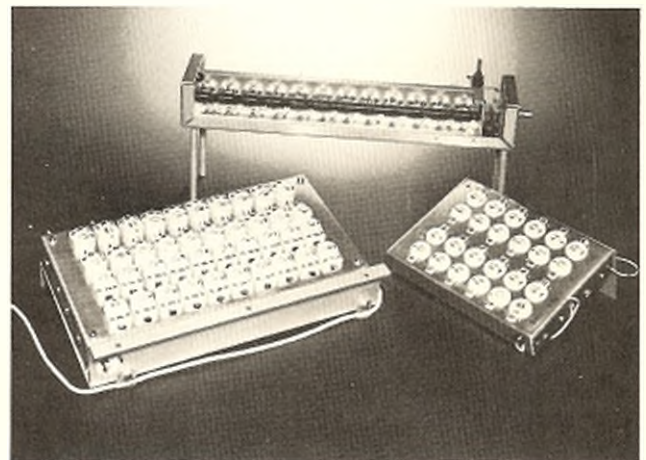
B52R Resistor, terminating, 52 ohms, 1.5 w. \$ 8.50
B93R Resistor, terminating, 93 ohms, 1.5 w. \$ 8.50
B52L5 Pad, "L" configuration, 52 ohms impedance, 5:1 voltage ratio, 1.5 w. \$ 8.50
B52L10 Pad, "L" configuration, 52 ohms impedance, 10:1 voltage ratio, 1.5 w. \$ 8.50
B93L5 Pad, "L" configuration, 93 ohms impedance, 5:1 voltage ratio, 1.5 w. \$ 8.50
B93L10 Pad, "L" configuration, 93 ohms impedance, 10:1 voltage ratio, 1.5 w. \$ 8.50
B52T10 Pad, "T" configuration, symmetrical, 52 ohms, 10:1 voltage ratio, 1.5 w. \$11.50
B93T10 Pad, "T" configuration, symmetrical, 93 ohms, 10:1 voltage ratio, 1 w. \$11.50
B93-52L Pad, "L" configuration, minimum loss, input 93 ohms, output 52 ohms, 1 w. \$11.50
B52-170L Pad, "L" configuration, minimum loss,

input 52 ohms, output 170 ohms, 0.5 w \$11.50
B170V Attenuator, step, 1-64 db in 1 db steps, 170 ohms impedance, 0.25 w. \$45.00



COAXIAL CABLES

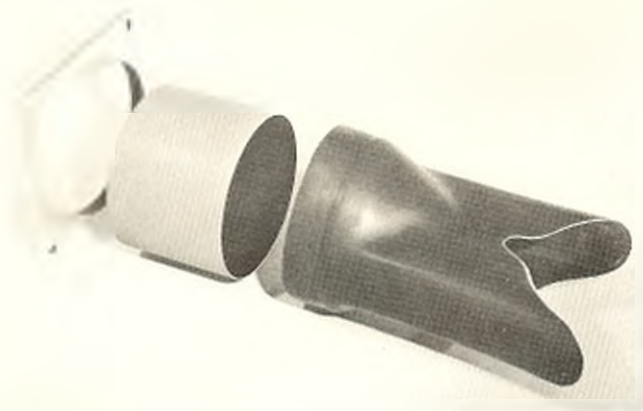
P50 Cable, coaxial, 50 ohms impedance, 42" long \$ 4.00
P93 Cable, coaxial, 93 ohms impedance, 42" long \$ 4.00
P93A Cable, coaxial, output, 93 ohms impedance, terminated one end with variable attenuator, 42" long \$13.50
P93B Cable, coaxial, output, 93 ohms impedance, terminated one end with $\frac{1}{2}$ watt, 93 ohm resistor, 42" long. \$ 5.00
P170 Cable, coaxial, 170 ohms impedance, 42" long \$ 9.50



DELAY NETWORKS

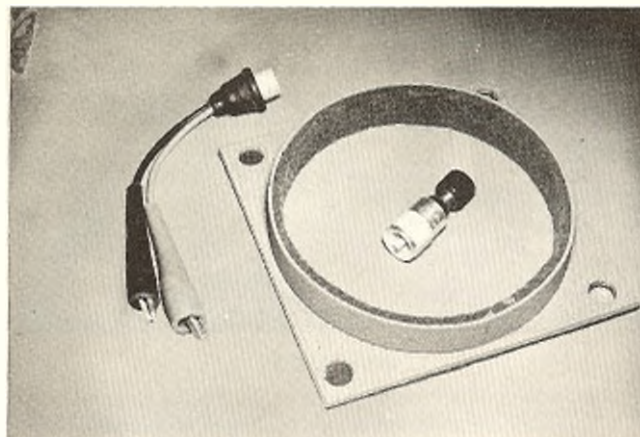
1-D-25 Delay network, .25 μ sec delay, for Type 511 \$50.00
1-AD-25 Delay network, .25 μ sec delay, for Type 511A \$50.00
3-D-25 Delay network, .25 μ sec delay, for Type 513 \$65.00
4-D-25 Delay network, .25 μ sec delay, for Type 514 \$50.00

ACCESSORIES



VIEWING HOOD

- H-510 Viewing Hood, for TEKTRONIX 5" Oscilloscopes. Two piece construction, rubber and aluminum, permits use of aluminum tube as deep light shield for less critical applications. Replacement graticule cover included. \$4.50



MISCELLANEOUS

- BE510 Bezel, for mounting camera on TEKTRONIX 5" Oscilloscopes. Dimensions — $5\frac{7}{8}$ " square, $\frac{1}{8}$ " thick; ring $\frac{7}{8}$ " deep, diameter $5\frac{5}{8}$ " outside, $5\frac{1}{8}$ " inside. Aluminum construction, gray wrinkle finish, felt lined . . . \$4.50
- A100 Adapter, clip lead . . . \$ 2.50
- A510 Adapter, binding post . . . \$ 1.88
- FA160 Frame, mounting, for Type 122 and Type 160 series units . . . \$ 5.00

GENERAL INFORMATION

Terms and Shipment

Our terms are 1% ten days, net thirty days on domestic orders; net thirty days on export orders. Shipping delay may be prevented by establishing credit at time of placing order. When desirable, C.O.D. shipments can be arranged.

For information relative to discounts on quantity purchases, please contact your nearest Tektronix representative, distributor, or branch office.

Although all quotations are for shipment f.o.b. Portland, Oregon, upon request transportation costs can be prepaid and the amount added to the invoice.

Normally, shipments are made by Railway Express or Motor Freight. If shipment by air is desired, please specify Air EXPRESS or Air FREIGHT. Experience has eliminated rail freight as a satisfactory method of surface transportation for electronic instruments.

Export Orders

All orders and inquiries from countries other than the United States should be addressed directly to: Tektronix, Inc., Export Department, P.O. Box 831, Portland 7, Oregon. Cable address: TEKTRONIX.

Delivery

Acceptance of purchase orders is indicated by our acknowledgment, and estimated delivery time is given from date of acknowledged acceptance. Every effort is made to meet the estimated delivery date, but it must be remembered that a manufacturer's ability to meet delivery schedules is contingent upon factors which tend to be uncertain during a time of national emergency.

Field Maintenance

Tektronix Field Maintenance is operated on a non-profit basis, as a service to our customers. Work is expedited whether or not the instrument is in warranty.

Requests for repairs or replacement parts should include type number and serial number and should be directed to our representative or branch office in your area. In an emergency, please wire or phone Field Maintenance, Tektronix, Inc., Portland, Oregon, in addition to notifying the local representative. This procedure will assure you the fastest possible service.

If an instrument must be returned to the factory for repairs, notify Field Maintenance directly or through the local representative, *indicating type number and serial number*, and you will be notified at once as to procedure to be followed. PLEASE DO NOT RETURN AN INSTRUMENT BEFORE RECEIVING DIRECTIONS.

It is standard practice for Tektronix to incorporate improvements into production instruments as they are developed in our laboratories. Owners of existing instruments are notified of modifications, and modification kits are made available, when practicable, to those who wish to modernize their own instruments.

For customers who have large quantities of Tektronix instruments and wish to equip their maintenance departments with factory-tested components, integrated kits of parts are available. Kits are designed to cover expected needs of a group of ten instruments of the same type.

Warranty

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 or at established net prices, they will be shipped from the factory, via air transportation on request, prepaid to any point within continental North America.

TEKTRONIX Transformers, manufactured in our own plant, carry an indefinite warranty. In the event of failure please be sure to contact the nearest TEKTRONIX Field Engineer, Field Sales Representative, or Headquarters.

APPROXIMATE SHIPPING WEIGHTS

INSTRUMENTS TYPE	NET WEIGHT IN POUNDS	DOMESTIC PACKED IN POUNDS	EXPORT PACKED IN POUNDS	EQUIVALENT DIMENSIONAL WEIGHTS IN	
				POUNDS	KILOGRAMS
315D	36	47	69	135	61.2
511A	53 ½	70 ½	92 ½	135	61.2
511AD	55	72	94	135	61.2
512	56	73	95	135	61.2
513	77	95	124	178	80.7
513D	79	97	126	178	80.7
514	60	77	99	135	61.2
514D	61	78	100	135	61.2
517					
Indicator Unit	76	103	127	178	80.7
Power Supply	72	86	105	105	47.7
Scopemobile	42	56	60	147	66.7
524D	62	80	114	178	80.7
104A	22	30	50	90	40.8
105	35 ½	47	66	90	40.8
112	32	49	76	135	61.2
121	18 ½	24	48	90	40.8
122	5 ½	9	19	35	15.9
160 Series	22	45	67	135	61.2
160	13 ¾	27			
161	3 ½	7			
162	3 ½	7			
FA 160	1 ¼				
180	37	48 ½	67 ½	90	40.8
500	42	56	60	147	66.7

CURRENTLY AVAILABLE EXTRAS

TYPE 104A SQUARE WAVE GENERATOR

Tropicalization*	Add	\$20
With selected frequencies		
2 in range 50 cps to 10 kc		
2 in range 50 kc to 1 mc	Add	\$20

TYPE 105 SQUARE WAVE GENERATOR

Tropicalization*	Add	\$20
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TYPE 112 DIRECT COUPLED AMPLIFIER

Tropicalization*	Add	\$25
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TYPE 121 WIDE BAND PRE-AMPLIFIER

Tropicalization*	Add	\$20
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TYPE 122 LOW LEVEL PRE-AMPLIFIER

Tropicalization*	Add	\$12
Cabinet mounting	Full Price	\$85
Rack mounting	Full Price	\$90
Frame mounting	Full Price	\$90
FA160 Frame for above		\$5

TYPE 160 POWER SUPPLY

Tropicalization*	Add	\$10
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TYPE 161 PULSE GENERATOR

Tropicalization*	Add	\$12
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TYPE 162 WAVEFORM GENERATOR

Tropicalization*	Add	\$15
FA160 Frame for 160 Series Instruments		\$5

TYPE 180 TIME MARK GENERATOR

Tropicalization*	Add	\$20
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TYPE 315-D CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$25
Rack mounting	Add	\$25
CRT Phosphors available:		
P1 Optional	No extra charge	
P2	NORMALLY FURNISHED	
P7 Optional	No extra charge	
P11 Optional	No extra charge	

*Tropicalization: TEKTRONIX instruments are tropicalized after assembly by spraying with a fungicidal varnish, Brooklyn Varnish Company #747S, which conforms with specifications of MIL-V-173A. While we attempt to do the best possible job, our method of application and extent of coverage does not necessarily conform with MIL-V-173A.

CURRENTLY AVAILABLE EXTRAS

TYPE 511A, 511-AD CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$25
Rack mounting	Add	\$25
Marker generator, 1 microsecond	Add	\$40
CRT Phosphors available:		
P1	NORMALLY FURNISHED	
P7	Optional	No extra charge
P11	Optional	No extra charge

TYPE 512 CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$25
Right-hand cathode-ray tube	Add	\$100
10 μ sec/cm to 1 sec/cm sweep time	Add	\$25
30 μ sec/cm to 3 sec/cm sweep time	Add	\$25
Rack mounting	Add	\$25
CRT Phosphors available:		
P1	Optional	No extra charge
P7	NORMALLY FURNISHED	
P11	Optional	No extra charge

TYPE 513, 513-D CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$50
CRT Phosphors available:		
P1	Metallized Optional	No extra charge
P2	Metallized	NORMALLY FURNISHED
P11	Metallized Optional	No extra charge

TYPE 514, 514-D CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$25
Rack mounting	Add	\$25
CRT Phosphors available:		
P1	NORMALLY FURNISHED	
P7	Optional	No extra charge
P11	Optional	No extra charge

TYPE 517 CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$75
CRT Phosphors available:		
P1	Metallized Optional	No extra charge
P2	Metallized Optional	No extra charge
P11	Metallized	NORMALLY FURNISHED

TYPE 524-D CATHODE-RAY OSCILLOSCOPE

Tropicalization*	Add	\$30
Rack mounting	Add	\$25
CRT Phosphors available:		
P1	NORMALLY FURNISHED	
P7	Optional	No extra charge
P11	Optional	No extra charge

*Tropicalization: TEKTRONIX instruments are tropicalized after assembly by spraying with a fungicidal varnish, Brooklyn Varnish Company #7475, which conforms with specifications of MIL-V-173A. While we attempt to do the best possible job, our method of application and extent of coverage does not necessarily conform with MIL-V-173A.

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WHitney 1147 John O'Halloran
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