



F-1091

TEKTRONIX

NEELY ENTERPRISES
7432 MELROSE AVE.
HOLLYWOOD 46, CALIF.
Whitney 1147

Manufacturers of

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

TEKTRONIX

TYPE 104

SQUARE WAVE

GENERATOR



GENERAL DESCRIPTION

The **Type 104** is a low cost generator of precision square waves in the frequency range most commonly used for general purpose wide band oscilloscope and amplifier response testing. The instrument is supplied with four frequencies, two in the range of 25 cycles to 10 kc., and two in the range of 25 kc. to 1 mc. By proper choice of the four available frequencies, the **Type 104**, use in conjunction with a suitable wide band oscilloscope such as the Tektronix Type 511-A, Type 511-AD or Type 512, makes possible convenient adjustment of video amplifiers and observation of their transient response.

FEATURES

Short Rise Time—As a result of careful design, the two high frequencies square waves have a rise time of less than .015 microsecond without overshoot.

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

Low Frequency Output Available at High Amplitude—Since the rise time is of less consequence at the two lower frequencies, a second multivibrator provides these signals at a higher impedance, making it possible to obtain outputs up to 50 volts.

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

APPLICATIONS

The **Type 104** is normally supplied with the following frequencies: 50 cycles, 1 kc., 100 kc., and 1 mc. The 50 cycle square wave provides a quick test for the low frequency characteristic 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 video amplifier high frequency compensating networks.

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

CHARACTERISTICS

Frequency—Four fixed; 50 cycles, 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 20,000 ohms for the low frequency output, depending on the attenuator setting.

Rise Time—Less than .015 microsecond for the high frequency outputs. Less than 3 microseconds 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 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 grey wrinkle finish.

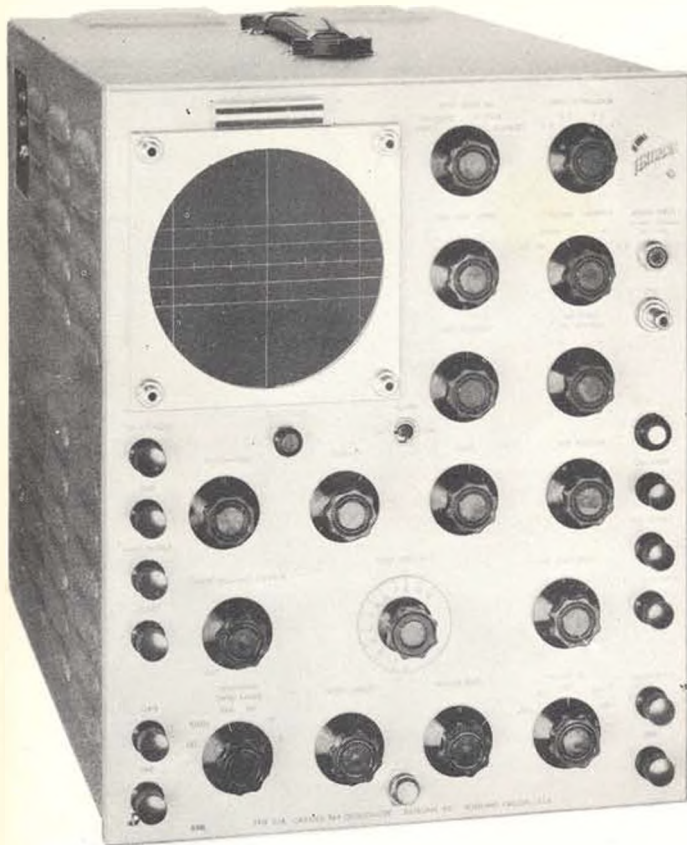
Dimensions—9" high, 13½" wide, 10" deep.

Weight—18 pounds.

Vacuum Tube Complement

High Frequency Multivibrators	2	6AG7
High Frequency Limiter	1	6AG7
High Frequency Output Amplifier	1	6AG7
Low Frequency Multivibrator	1	12AU7
Low Frequency Limiter Diode and Cathode Follower	1	12AU7
Trigger Output Cathode Follower	1	6J6
Power Supply Rectifier	1	5V4G
Series Regulator	1	6Y6
Regulator Amplifier	1	6AU6
Voltage Reference	1	VR-105

Price—\$195.00 f.o.b. Portland, Oregon.



TEKTRONIX

TYPE 511A

CATHODE-RAY

OSCILLOSCOPE

GENERAL DESCRIPTION

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

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

Both time and amplitude calibration is provided, permitting quantitative measurements.

VERTICAL DEFLECTION SYSTEM

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

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

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

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

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

The low frequency compensation of each stage is adjusted to produce the flattest top on a 50 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 11 mmf, introducing an attenuation of ten.

HORIZONTAL DEFLECTION SYSTEM

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

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

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

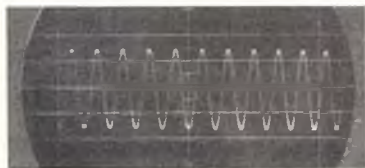


Fig. 3. 10 megacycle sine wave.

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

Single Trace Sweep—The triggered sweep in the **Type 511A** inherently provides for single sweep operation. Single sweeps can be triggered either by pulses or by a mechanical switch in series with a three-volt battery.

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 to within 10% by multiplying the SWEEP RANGE setting by the reading of the SWEEP SPEED MULTIPLIER dial.

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



Fig. 4. Sweep magnifier off.

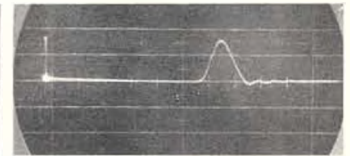


Fig. 5. Sweep magnifier on.
20 Microsecond Pulse.

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

OTHER FEATURES

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

Voltage Calibration—A 60 cycle sine wave calibrating voltage is provided to measure by comparison the amplitude of the waveshapes under observation. This is continuously variable, by means of a calibrated potentiometer, from 100 millivolts to 100 volts peak to peak, in three ranges.

Illuminated Graticule—An illuminated graticule aids in the measurement of amplitude and duration of waveshapes being observed. By edge lighting the graticule, fine red lines are visible, which do not obscure the tube trace. A green 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 in the cabinet which allows direct connection to all the plates with low capacity and short leads.

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

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

CONSTRUCTION

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

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

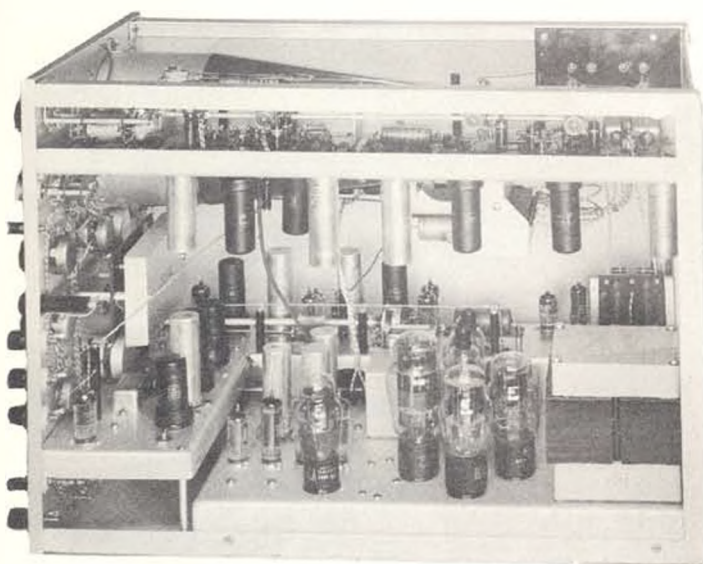


Fig. 6. Interior, compact and all parts readily accessible.

CHARACTERISTICS

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

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

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

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

Sweep Lag—.1 microsecond, max.

Sweep Magnification—5 times indicated sweep speed.

External Sweep Input—DC coupled via 100 K pot. and sweep amplifier. Maximum deflection sensitivity, 1.5 V. per cm. DC or peak to peak AC.

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

Vertical Deflection Sensitivity—

(peak to peak).

Without amplifier, 25 V. per cm.

With 1 stage, 2.5 V. per cm.

With 2 stages, .25 V. per cm.

Input Impedance—1 meg. shunted by 40 mmf PROBE, 10 meg. shunted by 11 mmf.

Vertical Amplifier Bandwidth—

(3 db down from 1 mc response)

1 stage, 5 cps to 10 mc.

2 stages, 5 cps to 8 mc.

Vertical Amplifier Transient Response—

Rise time (10% to 90%):

1 stage, .04 microsecond;

2 stages, .05 microsecond.

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

Waveforms Available—Sweep sawtooth, positive and negative gates.

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

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

Power Requirements—105-125/210-250 volts, 50-60 cycles, 220 watts.

Weight—50 pounds.

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

Vacuum Tube Complement

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

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

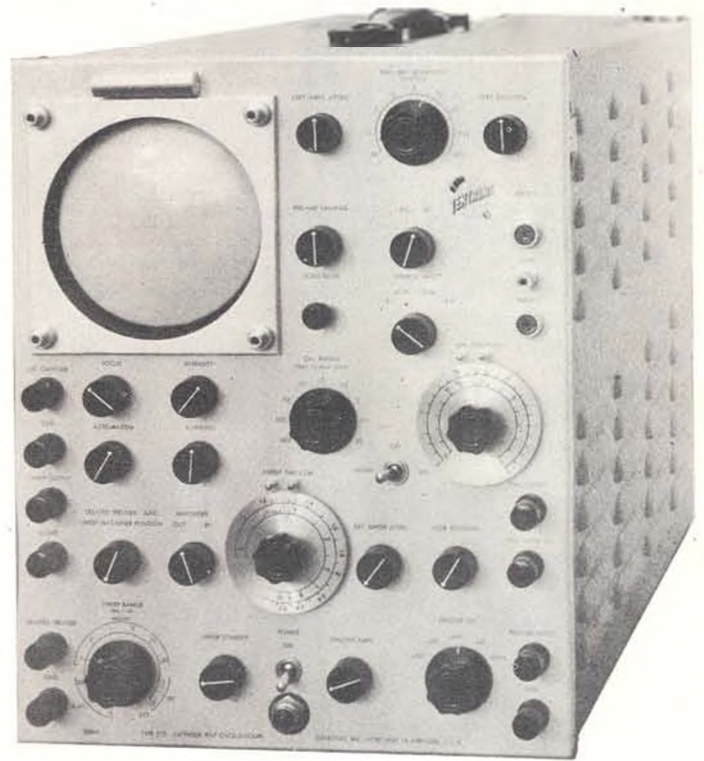
Price Type 511AD \$845.00 f.o.b. Portland, Oregon

TEKTRONIX

TYPE 512

CATHODE-RAY

OSCILLOSCOPE



GENERAL DESCRIPTION

The **Type 512** is a portable precision laboratory instrument incorporating DC coupled amplifiers throughout. Its sensitivity of 5mv/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

D. C. 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 VERT. DEF. SENSITIVITY control, i.e. 15 to 50 v/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 being made as an additional check. Since D. C. amplification is sometimes undesirable, a switch on the front panel permits the insertion of coupling condensers. The insure stability when operating as a D. C. amplifier, the heaters of the pre-amplifier 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.

Sensitivity Control—Two controls are provided to enable the **Type 512** to handle a wide range of signal amplitudes. The VERT. DEF. 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 approx. 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 13 mmf.

HORIZONTAL DEFLECTION SYSTEM

Linear Sweep—The **Type 512** employs a screen coupled phantastron linear sweep generator capable of producing single, triggered, or recurrent sweeps whose speed is continuously variable from 3 seconds to 30 microseconds for a 10 cm. deflection.

Sweep Time Calibration—To minimize the need for timing markers, the **Type 512** sweep time controls are carefully calibrated. Two controls are provided, a ten position switch and a calibrated potentiometer. A dial on the potentiometer having scales of 1-3 and 3-10 makes it possible to read the sweep time per cm to within 5%. This accuracy is made possible by the use of stable precision components and electronically regulating all D.C. voltages, including the accelerating potential, against line voltage variations.

Sweep Magnifier—A sweep magnifier circuit permits close inspection of portions of the trace. Any selected 20% of the sweep may be expanded 5 times, thus extending over the entire trace. The magnified sweep is obtained by a "Miller rundown" sweep generator assuring excellent linearity.

Carrier Blanking—Because of the slow sweeps available on the **Type 512**, conventional capacity-coupled blanking of the CRT is unsatisfactory. To overcome this difficulty, the blanking pulses are conveyed to the CRT grid by an RF carrier system. Thus, when the CRT is unblanked, its grid bias is uniform regardless of sweep time or repetition rate.

OTHER FEATURES

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

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

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 speed is varied.

Output Waveshapes—The sweep generator waveshape having an amplitude of 100 volts is available on a binding post. A positive square wave of the same duration as the sweep is also available at an amplitude of 50 volts.

Intensity Modulation—A binding post on the front panel provides connection to the CRT cathode for the purpose of receiving external blanking pulses, time markers, etc.

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

CHARACTERISTICS

Signals Observable—1. Sine waves from $\frac{1}{3}$ cps. to 500 kc. 2. Pulses of 1 microsecond to 3 seconds.

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

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

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

Trigger Requirements—Triggers from signals being observed which produce deflection of 5 mm. or greater.

External triggers of either polarity, pulses or sine waves. .5 v or larger.

Vertical Deflection Sensitivity—(peak to peak). Direct to plate 25 v/cm. Via amplifier 5 mv. to 50 v/cm.

Input Impedance—1 meg. shunted by 40 mmf. With probe 10 meg. and 13 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 microseconds.

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

Output Waveshapes—Sweep sawtooth. Delayed trigger. + Gate.

Construction—In order to keep the weight to a minimum, the cabinet and chassis are made of electrically welded aluminum alloy.

Weight—53 Pounds

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

Vacuum Tube Complement

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

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

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.

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