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 one 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 an RF 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 capacities can be obtained.

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

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

Signal Delay — Approximately 60 milli-microseconds of delay cable is incorporated in the signal channel. This delay, along with the inherent delay in the vertical amplifier, permits the sweep to start before the signal reaches the vertical deflection plates.
Amplitude Calibrator — A pulse-type amplitude calibrator is incorporated which provides continuously variable output voltages in six ranges, from .15 V full scale to 50 V full scale, with an accuracy better than .4% of full scale.

Direction Control to CRT Deflection Plates — It is often desirable to make a low-capacity output-induction 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 common direct connection to the deflection plates.

**HORIZONTAL DEFLECTION SYSTEM**

Since many of the fast-rising pulses to be observed are either non-symmetric 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 sec/cm to 200 sec/cm at 24 KHz accelerating potential and twice these rates for 12 KHz. The basic sweep waveform is generated by a pentode clamp with a cathode follower output stage 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 for small-amplitude, a wide-band, distributed type trigger amplifier is incorporated. Signals of .3 V amplitude, with a rise-time of 1 milli-microsecond, will extinguish the sweep. When using the observed signal as trigger, any signal giving a deflection of 2 mm on a 2 cm tube in approximately 12 KHz by changing the point of sampling in the circuit.

Total power consumption for the Type 517 is approximately 1250 watts at 105-125 or 210-230 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.

Metalized Cathode Ray Tube — The use of a metalized 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 the charge on the screen 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 amplification 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 impulses as well as the calibrator output voltage. A binding post 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 usc 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 to be just visible at the prevailing control settings. Centimeter lines are ruled in both the horizontal and vertical directions at 5 mm intervals. Measurements of amplitude and duration of the waveforms are observed.

**CHARACTERISTICS**

**Vertical Amplifier** — 5 stages of distributed amplification; 4th and 5th stages have flat frequency response. For optimum triggering, the rise time of the amplifier is approximately 12 KHz by changing the point of sampling in the circuit.

**Vertical Amplifier Sensitivity** — The maximum vertical amplifier sensitivity with a 5X cathode-ray tube is approximately 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 100 dB attenuation from 1X to 10X is provided in the vertical amplifier. Fixed plug-in attenuators are provided for use in conjunction with the cathode follower probe. An attenuator box with a characteristic impedance of 170 ohms is also provided.

**Vertical Amplifier Input Impedance** — Input impedance direct is 170 ohms relative. Impedance looking into probe is 16megohm and 90 joules. Higher impedance values can be had depending upon capacitive attenuator used ahead of probe.

**Signal Delay** — Delay line of RG63U coaxial cable contributes 60 microsec delay. This, in addition to the delay of the amplifier, makes an approximate total signal delay of 120 microsec. This signal delay permits the waveform to be accurately centered under way before the signal is applied to the vertical deflection plates.

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

**Vertical Amplifier Position Control** — With 24 KV accelerating potential, the vertical position control moves the trace 1.25 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, 1000, 2000, 5000, and 1, 2, 5, 10, 20 usec/cm, with maximum displacement error of 2% for 8 cm sweep length.

**Sweep Starting Time** — Approximately 70 microsec for the average instrument. A signal delay of approximately 0.5 microsec to the sweep is required to allow the signal to be triggered prior to the sweep being generated, with a rise-time of .03 microsec from a cathode follower source impedance of 200 ohms.

**Horizontal Position Control** — With 24 KV accelerating potential, the horizontal position control moves the trace approximately 3 cm.

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

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

**PROCEDURE FOR VERTICAL SCALES AND TRIGGERS**

1. Adjust the VERTICAL SCALES and TRIGGERS to the desired setting.
2. Set the Vertical Amplifier Sensitivity to the desired value.
3. Adjust the Vertical Amplifier Attenuator to the desired value.
4. Adjust the Vertical Amplifier Input Impedance to the desired value.
5. Adjust the Signal Delay to the desired value.
6. Adjust the Vertical Amplifier Calibrator to the desired value.
7. Adjust the Vertical Amplifier Position Control to the desired value.
8. Adjust the Sweep Circuit to the desired value.
9. Adjust the Sweep Starting Time to the desired value.
10. Adjust the Horizontal Position Control to the desired value.
11. Adjust the Horizontal Position Varistor to the desired value.
12. Adjust the Duty Cycle to the desired value.

**TUBE COMPLEMENT**

Circuit Use

<table>
<thead>
<tr>
<th>Circuit Use</th>
<th>Quantity</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Amplifier</td>
<td>1st Distributed amplifier</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>2nd Distributed amplifier</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>3rd Distributed amplifier</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Phase Inverter stage</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Push-pull distributed driver amplifier</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Push-pull distributed output amplifier</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Internal trigger coupling tube</td>
<td>1</td>
</tr>
</tbody>
</table>

**Sweep Generator Circuit**

Trigger phase-splitter

1st Distributed trigger amplifier | 3 | 6A6*5 |

**Selected**

**Trigger Requirements**

External trigger — .3 to 15 V peak amplitude, internal (from signal), 2 mA deflection.
Amplitude Calibrator—A pulse-type amplitude calibrator is incorporated which provides continuously variable output voltages in six ranges, from .15 V full scale to 30 V full scale, with an accuracy better than 4% of full scale.

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

HORIZONTAL DEFLECTION SYSTEM

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

Triggered Sweep—A linear, triggered sweep is available with eleven fixed, accurately timed sweeps ranging from 0.1 sec/cm to 20 sec/cm at 24 KV accelerating potential and twice these rates for 12 KV. The basic sweep waveform is generated by a pentode clamp with a cathode follower bootstrap to modulate 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 at small amplitudes, a wide-band, distributed type trigger amplifier is incorporated. Signals of .3 V amplitude, with a rise-time of 1 milli-microsecond, will readily trigger the sweep when using the observed signal as trigger, any signal giving a deflection of 2 mm in accordance with the trigger-rate generator.

Trigger-Rate Generator—A continuously variable trigger-rate generator operating from 1.5 to 15,000 cps is incorporated. This consists of a calibrated phonolamp 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 accelerating 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 210-230 V, 60 cycle, single-phase AC.

OTHER FEATURES

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

Metalized Cathode Ray Tube—The use of a metalized 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 to avoid streaking which 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 sec from a cathode follower source impedance of 200 ohms.

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

CHARACTERISTICS

Vertical Amplifier—5 stages of distributed amplification; 4th and 5th stages as well as the calibrator output voltage. For optimum triggering, the rise time of the output is .03 sec/cm and free of ringing and overshoot. See Fig. 1.

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

Vertical Amplifier Attenuator—A continuous control for use in the calibration of the cathode follower probe. Fixed plug-in attenuators are provided for use in the calibration with the cathode follower probe. An attenuator box with a characteristic impedance of 170 ohms is also provided.

Vertical Amplifier Input Impedance—Input impedance is approximately 170 ohms for AC. Reaction to input is approximately 200 ohms in the deflection system. Deflection into probe is not significant. Higher impedance values can be had depending upon capacitive attenuator used ahead of probe.

Signal Delay—Delay line of RG53U coaxial cable contributes 60 usec delay. This, plus the inherent delay of the deflection amplifier, since the signal is not a voltage but a current, makes an approximate total signal delay of 120 usec. This signal delay pertains to the sweep and current amplifier and under normal conditions the signal is applied to the vertical deflection plates.

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

Vertical Amplifier Position Control—With 24 KV accelerating potential, the vertical positioning control moves the trace 12.5 cm from the center line.

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

Sweeps—Eleven fixed ranges of 10, 20, 50, 100, 200, 500, 1000, and 1, 2, 5, 10, 20 usec/cm, with maximum displacement error of 2% for 8 cm sweep length.

Sweep Starting Time—Approximately 70 usec for the average instrument. A signal delay of approximately 40 usec is necessary from the sweep to be triggered to the sweep circuit. The sweep circuit is not operated (with the switch in the off position) until 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 3 cm.

Horizontal Position Varialor—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 shown on the chart.

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

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 should be as short as possible.

Trigger Rate Generator—Polarity—Positive. Length—1 to 5 sec. Rise time—0.15 usec. Output level—50 or 200 ohms Internal impedance. 60 V with 200 ohms Internal impedance. Repetition rate: 15-15,000 cps variable in three ranges with a maximum of 5% of full scale.

Cathode Ray Tube—A metalized type 5X cathode-ray tube with P1 phosphor is furnished with the Type 517 unless a P2 or P3 phosphor is specified as the optional choice.

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

Power Requirements—1250 watts, 105-125 or 210-230 V, 60 cycle, single-phase AC. Three primary-circuit fuses are provided for protection against sustained overload conditions.

Dimensions—Indicator unit: 12 ½" wide, 18 ½" high, 25 ½" deep. Weight: 30 lbs. Scope-Mobile: 16" wide, 10" high, 18" deep.


TUBE COMPLEMENT

Circuit Use Quantity Type

Power Amplifier—1st Distributed amplifier......6 6AK5*

2nd Distributed amplifier......6 6AK5*

3rd Distributed amplifier......6 6CB8*

Phase inverter stage......3 6CB8*

Push-pull driven output amplifier......12 6CB8*

Push-pull driven output amplifier......24 6CB8*

Internal trigger coupling tube......1 6CB8*

Sweep Generator Circuit—Trigger phase-splitter......1 6J6*

1st Distributed trigger amplifier......3 6AK5*

*Selected

Fig. 1. The accompanying photograph shows the pulse response of the Type 517 Vertical Amplifier. The sweep rate is .03 sec/cm. Probe rise-time and freedom from ringing and overshoot.
**Circuit Use** | **Quantity** | **Type**
--- | --- | ---
2nd Distributed trigger amplifier | 3 | 6AK5*
Trigger limiter tube | 1 | 6AG7
Trigger switch tube | 1 | 6AG7
Trigger coupling diode | 1 | 6J6
Multivibrator | 2 | 6AG7
Paralleled sweep clamp tubes | 2 | 6AG7
Positive sweep out, cathode follower | 1 | 6J6*
Paralleled bootstrap cathode followers | 2 | 6J6*
Decoupling-diode, bootstrap circuit | 1 | 6X4
Sweep inverter | 1 | 6AG7
Bias, screen, CF voltage-regulator for sweep inverter tube | 1 | 12AU7
Sweep output DC restorer | 1 | 6AL5
Paralleled unblanking amplifier tubes | 2 | 6AG7
Screen CF voltage-regulator for unblanking amplifier tubes | 1 | 6AS5
Unblanking voltage CF output tube | 1 | 6J6
Plus gate output cathode follower | 1 | 6J6
CRT grid bias stabilizers | 4 | NE2*

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

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

**Astigmatism and Probe Voltage Supply**
- Astigmatism and probe voltage CF tube | 1 | 12AU7

**CRT High Voltage Supply**
- Quadrupler rectifiers, —20 KV supply | 4 | 1X2
- Rectifier, —4 KV supply | 1 | 1X2
- High voltage oscillator tube | 1 | 6AU5
- Paralleled series-regulator tubes | 2 | 6AU5

*Selected

---

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

**Power Supply, Low Voltages**
- +750 volt rectifier | 1 | 6X4
- +750 volt supply series-regulator | 1 | 6AU5
- Comparator-amplifier, +750 V supply | 1 | 6AU6
- Rectifier, +475 V supply | 1 | 5R4GY
- Series-regulator, +475 V supply | 1 | 6AS7
- Comparator-amplifier, +475 V supply | 1 | 6AU6
- Full-wave rectifier, +365 V supply | 2 | 6X4
- Paralleled series-regulator, —225 V supply | 2 | 6AS7
- Comparator-amplifier, —225 V supply | 1 | 6AU6
- Paralleled series-regulator, —150 V supply | 3 | 6AS7
- Comparator-amplifier, +150 V supply, 2nd stage | 1 | 6AU6
- Comparator-amplifier, —150 V supply, 1st stage | 1 | 12AX7
- Rectifier, —250 V supply | 1 | 6X4
- Series-regulator, —250 V supply | 1 | 6AU5
- Comparator-amplifier, —250 V supply | 1 | 6AU6
- Voltage reference source | 1 | 56S1
- Filament voltage regulator control diode | 1 | 2AS-15
- Filament voltage regulator amplifier | 1 | 6AU5

**Cathode-Ray Tube**
- Cathode-ray tube with optional phosphors of P1, P2, or P11, metallized | 1 | 5XP

**Accessories Furnished.** The complete Type 517 Oscilloscope consists of the following items:

- Indicator unit with 5XP11 metallized cathode-ray tube, unless a P1 or P2 optional phosphor is specified
- Power unit
- Type R-500 TEKTRONIX Scope-Mobile
- Inter-unit connecting cable
- Viewing hood
- Cathode follower probe
- Attenuation box, 170 ohms characteristic impedance
- Instruction book
- AC power cord

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