HEWLETT-PACKARD
JOURNAL
TECHNICAL INFORMATION FROM THE -hp- LABORATORIES
Vol. 13, No. 8
SHED BY THE HEWLETT-PACKARD COMPANY, 1501 PAGE MILL ROAD, PALO ALTO, CALIFORNIA
APRIL, 1962

A New 50 MC Oscilloscope Based on an Advanced CRT Design

FIG. 1 below shows a major new oscilloscope which has electrical and mechanical innovations that promise to make it a standard for high-frequency oscilloscope applications. The oscilloscope's electrical advances are fundamental in that they are made possible by a new cathode-ray tube which has been designed in the -hp- crt laboratory. The result is an oscilloscope that operates from dc to 50 megacycles and does so with a substantial decrease in circuit complexity. The oscilloscope is one that has a 50%-increased vertical deflection of 6 cm, has constancy of focus to the degree that no panel astigmatism control is necessary, and has the versatility that results from using plug-ins for both the vertical and horizontal systems.

CRT CONSTRUCTION

The new cathode-ray tube achieves its enlarged 6 cm vertical scan and high sensitivity together with other desirable features by means of a novel type of post-acceleration of the electron beam. As shown in Fig. 2, there is located between the deflection plates and the phosphor screen a thin spherical metal-gauze shield, a mesh, having extremely small apertures. The mesh is placed with its convex side toward the phosphor screen and serves to terminate the lines of force from the post-accelerator field in a controllable way. The resulting field configuration permits the electron beam to be accelerated by a large factor without the reduction in sensitivity or demagnification of deflection that limits the per-

Fig. 1. *-hp- Model 175A Oscilloscope uses new high-sensitivity -hp- cathode-ray tube to obtain dc–50 megacycle performance with simplified circuitry. New crt is also free of deflection defocusing so no astigmatism control is needed.*

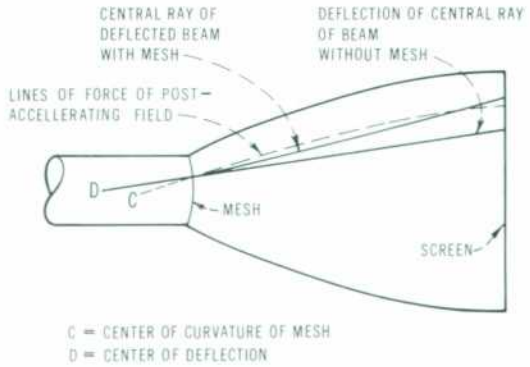


Fig. 2. *Diagram indicating how spherical shield or mesh in new crt terminates post-acceleration lines of force so as to magnify beam deflection angle.*

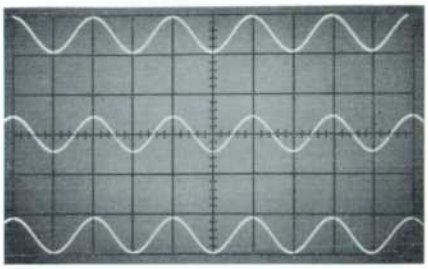


Fig. 3. *Oscillogram illustrating freedom of new -hp- crt from deflection defocusing of trace. Oscillogram is triple exposure with trace moved to new vertical position between exposures. This and other oscillograms herein also indicate how increased vertical scan of 6 cm is especially valuable when more than one trace is used.*

formance of tubes with open accelerating fields between deflection plates and screen. In fact, the curvature of the mesh makes possible a magnification of the angle of deflection of the beam that accounts for the increased sensitivity of this tube.

The magnification of deflection is accomplished by painting a spiral of resistive material on the tube wall between the mesh shield and the screen. The pitch of the spiral is controlled so that the potential near the shield varies inversely with the distance from the center of curvature C of the shield. This causes the lines of force to extend linearly from the shield along radii originating at C. If C lies between the center of deflection D and the shield, then the angle of deflection of the beam will be increased by the action of the radial accelerating field. In the region of the screen where the lines of force terminate, the lines are no longer radial, but the field is there weak and the beam velocity high so that the resulting demagnification is negligible. The overall result of the foregoing design approach is that the deflection sensitivity of the production crt is two to three times as high as that of otherwise-similar tubes.

In addition to achieving an increased amount of vertical scan, the new crt also has a markedly-reduced deflection defocusing and distortion. This occurs because of the reduced maximum angle of deflection at the deflection plates and because of the spherical symmetry of the post-accelerator field. As a consequence, no panel astigmatism control is required or provided in the new oscilloscope. In the new crt the mesh also repels toward the cathode secondary electrons produced in overscanning and thus reduces the background light at the screen as compared with tubes having open post-acceleration.

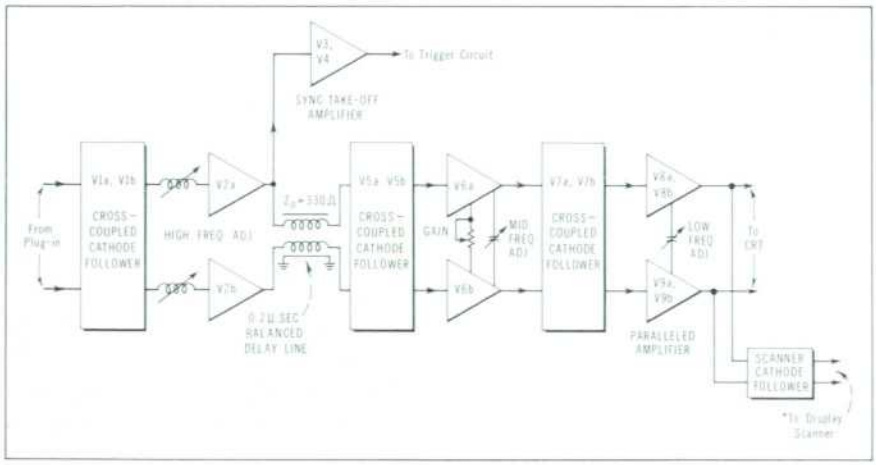


Fig. 4. *Block diagram of main vertical amplifier in new -hp- Model 175A Oscilloscope. Amplifier uses only 7 tubes, all of one type.*

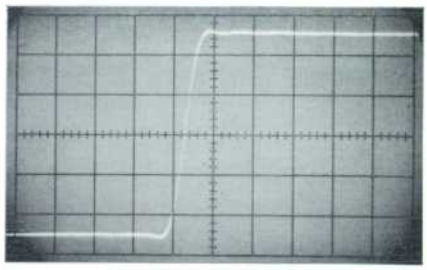


Fig. 5. *Oscillogram of step response of main vertical amplifier. Sweep time is 10 nanoseconds (10×10^{-9} sec)/cm. Rise time is less than 6 nanoseconds.*

VERTICAL AMPLIFIER CONSIDERATIONS

The high deflection sensitivity attained by the new cathode-ray tube leads to the advantageous result that the main vertical amplifier of the oscilloscope can achieve wide bandwidth and fast rise time without resort to complex circuitry. For example, the response of the main vertical system extends from dc to well beyond 60 megacycles with a rise time of less than 6 nanoseconds, as shown in Fig. 5. At the same time, though, the amplifier consists of but 3 amplifying stages separated by 3 impedance-reducing stages. Also, the delay element in the amplifier is merely a fixed delay cable. This simple system contrasts with the complicated distributed amplifiers and multi-adjustment delay networks that have previously been employed.

Simplicity of the vertical amplifier has been further enhanced by using only one tube type. This is the 6DJ8 triode, a frame-grid tube that has a respected performance record with regard to ruggedness and dependability. Also, in the amplifier as a whole, the number of calibration adjustments is confined merely to one gain control and 3 pulse-response adjustments (Fig. 4).

In addition to driving the crt deflection plates, the vertical amplifier provides two additional outputs. One of these is coupled from the deflection plates by a cathode follower and drives the Display Scanner, a horizontal plug-in used to

make X-Y recordings of the oscilloscope display. The second output is used for internal syncing of the oscilloscope. In this latter case a signal is coupled from the vertical amplifier ahead of the delay line and amplified by the sync stage before triggering the sweep.

The internal delay line is an -hp- development and has a simple and compact design. It consists of two helically-wound center conductors enclosed in one ground shield. Its electrical length is 0.2 microsecond and its characteristic impedance is 330 ohms. The losses inherent in a delay line are compensated by fixed components in the vertical amplifier so that variable compensation is not necessary. Balanced construction has permitted the line to be encased in a small container with only input and output connections necessary.

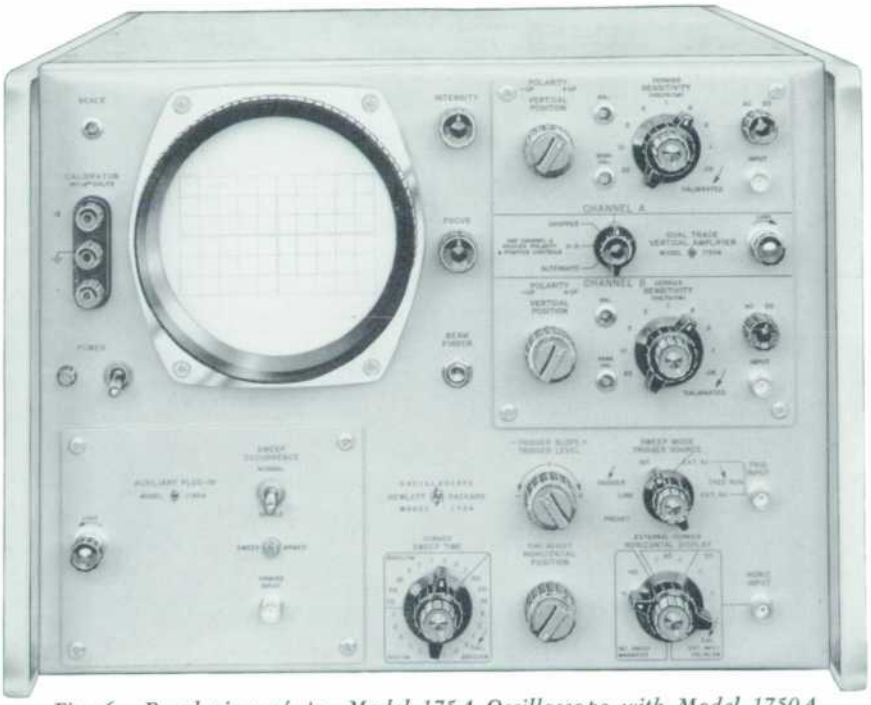


Fig. 6. *Panel view of -hp- Model 175A Oscilloscope with Model 1750A dual-trace vertical plug-in and Model 1780A Auxiliary horizontal plug-in. Simplicity of control layout is aided by lack of need for usual astigmatism control.*

VERTICAL/HORIZONTAL PLUG-INS

The Model 175A oscilloscope has been planned to achieve a high order of sophistication and flexibility, and in accordance with this philosophy the instrument has been designed so that both the horizontal and vertical axes employ plug-ins. A variety of such plug-ins has been designed. Thus, the range of applications to which the oscilloscope can be fitted is impressive. Additional plug-ins are currently under design. Further, the dual-plug-in plan stands as a safeguard of the oscilloscope's adaptability to possible new and unforeseen oscilloscope uses.

For the vertical axis three plug-ins have been designed. The dual-channel Model 1750A plug-in is a fast-rise unit with a 40-megacycle bandwidth when in the 175A main frame. Its basic sensitivity is 50 millivolts per centimeter ac or dc coupled, which is adjustable to 20 volts per centimeter with its range switch. The second plug-in, the Model 1753A, is a single-channel version of the dual-channel unit. Finally, for low signal levels, a higher-sensitivity unit is available. Its bandwidth is 18 megacycles with a sensitivity of 5 millivolts per centimeter when in the main frame.

At present there are four horizontal plug-ins available. The Sweep Delay Generator, Model 1781A, accurately measures time relationships on complex signals and pulse trains. It also provides for single sweep operation of the oscilloscope. The Model 1783A Time Mark Generator provides time markers to facilitate measuring rise times and other time intervals of interest. Thirdly, the Model 1780A Auxiliary plug-in is the basic horizontal plug-in and includes the single-sweep feature.

The fourth horizontal plug-in is the Model 1782A Display Scanner. This unit translates a repetitive display appearing on the crt into a low-frequency signal that will operate an X-Y recorder.

Additional information on the horizontal and vertical plug-ins is given elsewhere in this issue.

TRIGGER CIRCUITRY

The sweep employs a new triggering circuit based on a tunnel diode to achieve jitter-free syncing well beyond the frequency limit of the oscilloscope. The tunnel diode circuit generates very fast triggers to assure stable syncing and automatically counts down on high-frequency signals ahead of the sweep circuit to provide reliable high-frequency syncing.

The basic circuit arrangement of the trigger circuit is shown in Fig. 8.

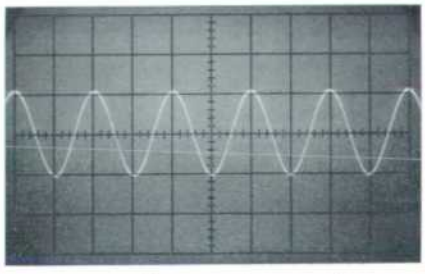


Fig. 7. *Oscillogram of internal syncing on 50-megacycle signal.*

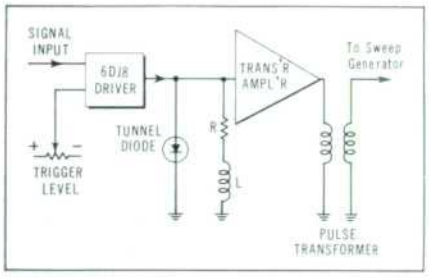


Fig. 8. *Basic trigger circuit used in -hp- 175A Oscilloscope.*

A signal from the vertical signal channel, the power line, or from an external trigger source is converted to a current signal by a 6DJ8 triode. This signal drives a tunnel diode which in turn drives a transistor amplifier. The level on the input signal at which the tunnel diode will be triggered is determined by the *Trigger Level* control. At the higher frequencies the range of the control varies the countdown frequency slightly to facilitate syncing. The pulse transformer load of the transistor amplifier differentiates the amplified tunnel diode pulse and couples it to the sweep generator. The tunnel diode load, R-L, has been adjusted such that the pulse rep rate of the tunnel diode is never higher than 2.5 mc, assuring very stable triggering of the sweep.

The accuracy of the sweep is typically within 2%. Sweep times are adjustable in 24 steps from 5 seconds per centimeter to 100 nano-

(Continued on page 6)

Fig. 9. *All tubes can be replaced from top or bottom of instrument. Top and bottom covers can be removed in seconds.*

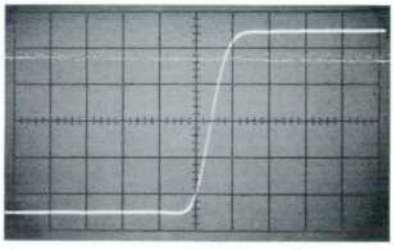
VERTICAL PLUG-INS

A series of three plug-ins has been designed for the vertical system of the Model 175A Oscilloscope These have been arranged to permit a wide variety of voltage measurements to be made. In contrast to general practice, the plug-ins can be installed or removed without turning off the oscilloscope.

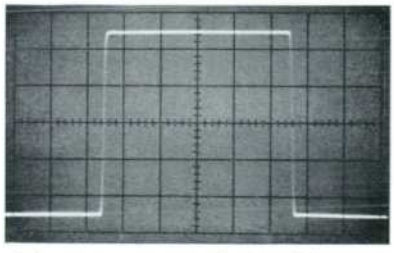
MODEL 1750A DUAL-TRACE FAST-RISE AMPLIFIER

The Model 1750A is a fast-rise, high-sensitivity, dual-channel input plug-in for the 175A. Its bandwidth in the 175A is 40 mc, ac or dc coupled, and its sensitivity is adjustable from 50 mv/cm to 20 v/cm. The sensitivity is continuously adjustable between steps by a vernier which also extends the lowest sensitivity to 50 v/cm.

The modes of operation include chopped, alternate, and differential. In the differential mode, the common-mode rejection at 1 mc is at least 40 db at maximum sensitivity and 30 db at other sensitivities. The chopping rate is approximately 200 kc with blanking provided during the switching interval.



Step response typical of Model 1750A dual-trace plug-in in Model 175A Oscilloscope. Sweep time is 10 nanoseconds/cm.



Pulse response typical of Model 1750A. Sweep time is 100 nanoseconds/cm.

The 1750A has a new, simplified attenuator which requires a minimum of adjustments. The amplifier utilizes the frame grid 6DJ8 dual-triode for high reliability. Regulated dc filaments minimize hum, increase tube life, and minimize drift.

MODEL 1752A HIGH-SENSITIVITY VERTICAL AMPLIFIER

The Model 1752A High-Sensitivity plug-in gives the oscilloscope a maximum sensitivity of 5 mv/cm, ac or dc coupled on all ranges. The plug-in has a differential input for the four most sensitive ranges with at least 40 db of common-mode rejection. Bandwidth is 18 mc at the higher sensitivity settings and 22 mc at the lesser.

MODEL 1753A SINGLE-CHANNEL FAST-RISE AMPLIFIER

The Model 1753A plug-in is a single-channel version of the Model 1750A dual-channel plug-in. It thus has a bandwidth of 40 mc, a maximum sensitivity of 50 mv/cm and is in other respects equal to one channel of the Model 1750A.

HORIZONTAL PLUG-INS

The horizontal plug-ins have been planned to give a high degree of flexibility to the sweep system in the oscilloscope. The basic sweep circuits are located in the main frame, and in general the plug-ins add special capabilities such as delayed sweeping to these basic circuits.

As with the vertical plug-ins, the oscilloscope does not have to be turned off to install or remove the horizontal plug-ins.

MODEL 1780A AUXILIARY PLUG-IN

The Auxiliary Plug-in is shown in place in the Model 175A Oscilloscope in Fig. 6. This plug-in is a basic, low-cost unit that supplements the normal oscilloscope sweep circuits by providing a single-sweep capability to the main sweep system of the oscilloscope.

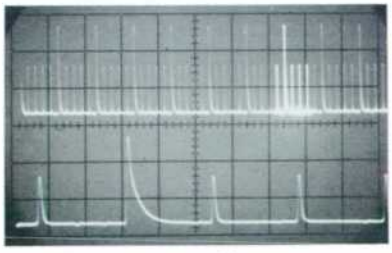
MODEL 1781A SWEEP DELAY GENERATOR

The Sweep Delay Generator gives a variety of sweep delay features to the oscilloscope and also provides for single-sweep operation. Through use of the plug-in, time relationships on complex signals or pulse trains can be conveniently and accurately measured.

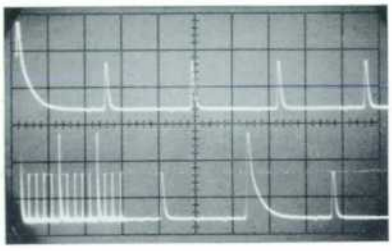
The basic operation of the 1781A involves generating a linear ramp which, in conjunction with a pick-off circuit, generates a trigger that can be used either to arm or to actually start the main sweep after a selected time interval.

The selector on the panel of the unit provides for four different types of operation. With the sweep selector in the *Main Sweep* position, the oscilloscope operates in the normal manner using the main sweep controls. In *Delaying Sweep* operation, trigger and sweep control are transferred to the Sweep Delay Generator, which then drives the trace across the crt in accordance with the setting of the delay control. When the ramp becomes equal to the value selected by the delay length pick-off control, the main sweep is triggered (or armed) and appears as an intensified segment of the trace.

The *Main Sweep Delayed* position differs from the previous position in that the delaying sweep is not fed to the horizontal crt plates, which instead are driven by the main sweep. Thus, the brightened section, which appeared in the *Delaying Sweep* position, is expanded to occupy the full 10 cm of the crt face.

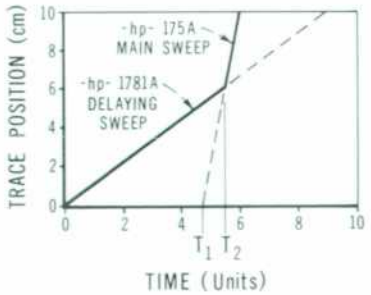


Double-exposure oscillogram comparing Delaying Sweep *(upper trace) and* Main Sweep Delayed *operation (lower trace) of Sweep Delay Generator. Intensified segment of* Delaying Sweep *is displayed by* Main Sweep Delayed *operation.*



Double-exposure oscillogram comparing Main Sweep *(upper trace) and* Mixed Sweep *(lower trace) operation of Sweep Delay Generator.*

In the special *Mixed Sweep* position, illustrated in the drawing, the delaying sweep drives the trace for the selected delay interval, at which time the main sweep is triggered (or armed). At some later time, determined by the amount of delay interval and the relative slopes of the two sweeps, the main sweep will overtake the delaying sweep and drive the beam for the remainder of the trace. The advantage of this mode of operation is that the operator can view the expanded portion of the trace while still retaining a presentation of earlier sections.



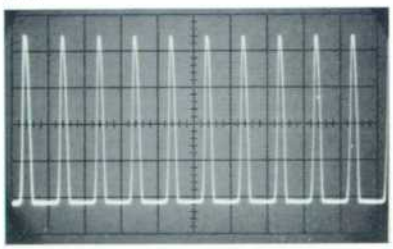
MODEL 1782A DISPLAY SCANNER

Although it is a horizontal plug-in, the operation of the Display Scanner is not limited to the horizontal system but ties to the vertical system as well. The function of the Display Scanner is to sample a repetitive trace displayed by the oscilloscope and translate it into low-frequency signals suited to driving an X-Y recorder. By this means permanent records can be made of the oscilloscope display.

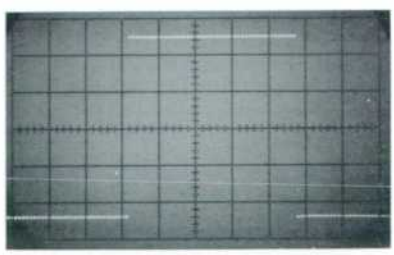
MODEL 1783A MARKER GENERATOR

To facilitate measurement of rise time and other important time intervals, the Marker Generator provides accurately calibrated intensity markers on the oscilloscope trace. Markers are available at 10, 1, and 0.1 microsecond intervals, accurate within ±0.5%, and synchronized to the signal being displayed.

In a second mode of operation, markers are available in a continuous train at a front panel jack for external use.



Typical 1-microsecond time markers provided by Model 1783A Marker Generator for internal or external use. Markers of 10 and 0.1 microseconds are also provided.



Use of 1-microsecond time markers as intensity-modulated markers to assist in time measurements.

Fig. 10. *Oscilloscope is provided with brackets that quickly convert the standard instrument into a rack-mountable unit.*

(Continued from page 4)

seconds per centimeter. A x10 calibrated magnifier expands all sweep times and increases the fastest sweep to 10 nanoseconds per centimeter. The sweep times are continuously adjustable between steps by use of the vernier which also slows the slowest sweep time to 15 seconds per centimeter.

The horizontal amplifier has an external calibrated sensitivity of 0.1 volt/cm and 1 volt/cm, ac or dc coupled. A vernier adjusts the horizontal sensitivity to 10 volts/cm.

A fast gate-rise time assures viewing of the initial portion of the trace with uniform trace intensity.

CRT OPERATION

In the oscilloscope the new high-sensitivity crt is operated with an accelerating potential of 12 kilovolts. This high value, combined with the aluminized phosphor in the tube, results in a bright trace and a high writing rate. The standard phosphor for the instrument is the type P31, which has a spectral output favorable to the eye. Other phosphors, namely the P2, 7, or 11, are optional.

The crt is constructed in the -hp- internal-graticule style in which the graticule is located inside the tube on the back of the front glass and thus in the same plane as the phosphor. This construction avoids parallax error and permits two or more observers to view the crt display with equal accuracy. A faceplate is bonded to the front of the crt and is constructed to reduce "mirroring" and glare to unnoticeable proportions. The non-glare faceplate is not structurally integral with the tube envelope and constitutes the safety plate for the crt.

As described previously, the tube is operated with no panel astigmatism control. An internal astigmatism control is provided to accommodate tube interchanges.

TRANSISTORIZED POWER SUPPLIES

The low-voltage power supply has been transistorized for high efficiency and long-term maintenance-free operation. Turn-on voltages are kept within safe values so that a time-delay relay is not required. In addition, the power supply is insensitive to loading, enabling it to handle wide variations in plug-in power requirements. This gives the oscilloscope the feature that plug-ins can be changed without turning off the instrument.

Virtually all of the tubes are operated from a regulated dc filament supply which minimizes hum, increases tube life and provides excellent stability.

1% CALIBRATOR

The internal square-wave calibrator is accurate within 1% over a temperature range of ±10°C from the temperature at which it was calibrated, and over the much wider range of from 0° to 55°C its accuracy is ±3%. The calibrator has a low output impedance and is provided with front panel outputs for use in probe compensation and gain calibration of the vertical and horizontal amplifiers.

ACCESSIBILITY AND SERVICEABILITY

Simplicity of design has been extended to all aspects of the instrument, and two important features, accessibility and serviceability, are apparent at first glance. By utilizing the new -hp- modular cabinet design, a clean, uncluttered mechanical layout has been obtained. Also, all internal adjustments and components are easy to get to, and all circuits are plated-through printed circuit boards with "edge-on" type lead connectors. These connectors, which are recognized for high reliability and ease of servicing in the computer industry, permit extremely easy removal of any printed circuit board in a minimum of time without unsoldering leads.

A minimum number of tube and transistor types are used in the Model 175A to simplify mainte-

Fig. 11. *Gun and deflection plate assembly used in new crt is discussed by William Kruger, tube designer and -hp- manager of crt development, and Floyd Siegel, project leader for Model 175A Oscilloscope.*

nance. The reliable 6DJ8 frame-grid triode is used extensively throughout the oscilloscope. All tubes are replaceable either from the top or the bottom of the unit. Components have been derated to increase dependability and all circuits have been proven through extensive environmental tests.

WIDE BANDWIDTH PROBE

A new 10:1 voltage divider probe has been designed to be compatible with the bandwidth of the Model 1750A 40-mc plug-in. The new probe has the same physical size and shape of the well-known present -hp- oscilloscope probe.

GENERAL

The oscilloscope includes the positive and simple -hp- beam finder control on the front panel to facilitate the immediate location of an off-screen trace. Sweep and gate outputs are available on the rear panel as an option. Both output levels are approximately 5 volts peak-to-peak, centered around ground. The external Z-axis modulation input is provided on the rear panel and is standard for all Model 175A's.

The oscilloscope is fan-cooled and has a maximum weight of approximately 70 pounds.

ACKNOWLEDGMENT

The design and development of the 175A Oscilloscope and its plug-ins represents the effort of a number of individuals in the -hp- Oscilloscope Research Division. Included were Al F. Augustine, Phillip G. Foster, William L. Grein, Wayne M. Grove, Tom D. McLaughlin, Don L. Palmer, John W. Riggen, Stuart C. Slade, Allen R. Smith, and James D. Williams, and the undersigned. William Kruger's design of the cathode-ray tube was a key contribution to the development of the oscilloscope. A number of valuable ideas and suggestions were contributed by Oscilloscope Research Manager Norman B. Schrock.

—Floyd G. Siegel

SPECIFICATIONS
HORIZONTAL PLUG-INS

-hp- MODEL 1781A SWEEP DELAY GENERATOR

(Installed in the -hp- Model 175A)

Delay Time: 1 μsec to 10 sec. Delay Time is the product of the DELAYING SWEEP setting in sec/cm, and the DELAY LENGTH setting in cm.

Delaying Sweep: 2 μsec/cm to 1 sec/cm. 18 calibrated ranges in a 1, 2, 5, 10 sequence.

Delay Length: (the physical location, in cm from the beginning of the trace, to the point at which the main sweep is triggered) 0 to 10 cm.

Accuracy: ±1% 2 μsec to 0.1 second ranges; ±3% 0.2, 0.5, 1 second ranges. ±0.2% linearity, all but 2, 5, and 10 μsec ranges. ±0.5% linearity, 2, 5, 10 μsec ranges. *Jitter:* Less than 0.01 μsec or ±0.005% of total delay.

Delay Functions: (a) Trigger main sweep. (b) Arm main sweep.

Triggering: Internal, ac-coupled; power line; external, ac or dc coupled. (2 mm or more vertical deflection. External, ½ volt peak-to-peak or more.)

Triggering Point: Controls allow selection of level and slope. Trigger level of external signal adjustable −30 to +30 volts.

Sweep Selector: (a) Main Sweep. (b) Delaying Sweep. Brightened segment of trace indicates time relationship between delaying sweep display and main sweep display. (c) Main Sweep Delayed. (d) Mixed Sweep.

Delayed Trigger Output: Approximately 20 volts positive.

Single Sweep: Manual or external arming.

Power: Supplied by Model 175A Oscilloscope.

Weight: Net 4½ lbs. Shipping 7 lbs.

Price: $375.00 f.o.b. factory.

-hp- MODEL 1780A AUXILIARY PLUG-IN

(Installed in the -hp- Model 175A)

Sweep Occurrence: NORMAL or SINGLE SWEEP.

Sweep Arming: Internal or by external pulse.

External Arming Pulse Required: 1 to 200 μsec, approximately +15 to +25 volts peak.

Input Connector: BNC.

Weight: Net 1 lb.

Price: $25.00 f.o.b. factory.

-hp- MODEL 1782A DISPLAY SCANNER

(Installed in the -hp- Model 175A)

Vertical Output: Approximately 200 mv/cm. Gain and dc level are independently adjustable.

Horizontal Output: 0 cm: approximately +50 volts; 10 cm: approximately −50 volts.

Bandwidth: Greater than 20 mc when installed in Model 175A.

Scanning: Manual, internal (with pen speed either stabilized or linear), or external.

Scanning Time: Internal, linear: approximately 1½ minutes. Internal, with pen speed stabilized: approximately 25 seconds when displaying time base only.

Oscilloscope Sweep Speed: From fastest sweep to 5 msec/cm; signal repetition rate greater than 20 cps.

Remote Pen Lift: Contact closure provided to facilitate pen lift on X-Y recorder when switching from RECORD to ARM RECORDER.

Power: Supplied by the Model 175A Oscilloscope.

Weight: Net 5 lbs.

-hp- MODEL 1783A TIME MARK GENERATOR

(Installed in the -hp- Model 175A)

INTENSITY MODULATION

Range: 10 μsec, 1 μsec, or 0.1 μsecond intervals.
Accuracy: ±0.5%.
Presentation: Trace-intensifying marks with duration a function of intensity, but always less than 40% of marker interval.
Synchronization: Triggered by sweep gate; synchronized to CRT presentation.

EXTERNAL OUTPUT MARKERS

Range: 10 μsec, 1 μsec, or 0.1 μsecond intervals.
Accuracy: ±0.5%.
Amplitude: 0 to 1 volt peak (positive) into open circuit, adjustable.
Waveform: Positive polarity clipped sine wave with duration a function of amplitude, but always less than 40% of marker interval.
Output Impedance: Approximately 75 ohms.

FUNCTIONS

Time Marker: Off—marker de-energized. Output—markers provided at BNC output jack. Display — markers provide synchronized intensity modulation of display (intensity modulation control set to INTERNAL).
Intensity Modulation: External: provide input for normal intensity modulation. Internal: allows intensity modulation of trace. (Time markers set to DISPLAY.)

GENERAL

Power: Supplied by -hp- Model 175A Oscilloscope.
Weight: Net 3½ lbs. Shipping 6 lbs.
Price: $130.00 f.o.b. factory.
Accessories Available:
AC-16B Cable (dual banana plug to male BNC, 45 inches long).
AC-16K Cable (male BNC to male BNC, 48 inches long).
AC-76A Adaptor (BNC to binding post).

Prices f.o.b. factory. Data subject to change without notice

SPECIFICATIONS
-hp-
MODEL 175A OSCILLOSCOPE

SWEEP GENERATOR
Sweep Range: 0.1 μsec/cm to 5 sec/cm in 1, 2, 5 sequence, 24 steps. Vernier provides continuous adjustment between ranges and extends slowest sweep to at least 12.5 sec/cm.
Sweep Magnification: X10.
Sweep Accuracy: ±3%, ±5% with X10 magnifier.
Triggering: Internal, ac coupled; power line; external, ac or dc coupled.
Triggering Sensitivity: Internal, approx. 2 mm vertical deflection at 1 mc, 2 cm at 50 mc. External, approx. .25 volts peak-to-peak at 1 mc, approx. .5 volts peak-to-peak at 50 mc.
Triggering Point: Controls allow selection of level and slope.

HORIZONTAL AMPLIFIER
Bandwidth: Dc coupled, DC to 500 kc; AC coupled, 2 cps to 500 kc.
Sensitivity: 2 ranges; 0.1 volt/cm and 1 volt/cm. Vernier provides continuous adjustment between the ranges and extends minimum sensitivity to 10 volts/cm.
Input Impedance: 1 megohm shunted by approx. 30 pf.

MAIN VERTICAL AMPLIFIER
Rise Time: Less than 7 nsec.

CALIBRATOR
Type: Approx. 1000 cycle square wave, approx. 3 μsec rise time.
Voltage: 2 ranges, 1 v and 10 v peak-to-peak ±1% at 15°C to 35°C ambient, ±3% at 0°C to 55°C ambient.

CATHODE RAY TUBE AND CONTROLS
Type: Post accelerator, 12 kv accelerating potential, -hp- Type G205. Type P31 aluminized phosphor standard, other phosphors (P2, P7, and P11) are available at no extra charge. Equipped with non-glare safety glass faceplate.
Writing Rate: A single 6 cm step function displaying 7 nsec main vertical amplifier rise time can be photographed with the -hp- 196B Oscilloscope Camera.
Graticule: Internal, parallax free 6 x 10 cm, marked in cm squares. 2 mm subdivisions on major horizontal and vertical axis. Front panel recessed SCALE control aligns trace with graticule.
Beam Finder: Depressing Beam Finder control brings trace on CRT screen regardless of setting of horizontal or vertical position controls or intensity control.
Intensity Modulation: Approximately +20 volt pulse will blank trace of normal intensity (BNC connector on rear panel).

GENERAL
Power Requirements: 115 or 230 vac ±10%, 50 to 60 cps. 425 watts max. (depends on plug-ins used).
Dimensions: 16¾ in. wide, 12¼ in. high, 24⅜ in. deep overall; hardware furnished for quick conversion to 12¼ in. x 19 in. rack mount, 22 in. deep behind panel.
Weight: Net approx. 70 lbs. max. (with heaviest plug-ins installed).
Price: $1,325.00 f.o.b. factory.
Plug-in Vertical Amplifiers: (in 175A)
-hp- Model 1750A Dual Trace Vertical Amplifier; dc to 40 mc (Rise Time 9 nsec) 50 mv/cm.
-hp- Model 1752A High Gain Vertical Amplifier; dc to 20 mc, 5 mv/cm.
-hp- Model 1753A Single Channel Vertical Amplifier; dc to 40 mc (Rise Time 9 nsec) 50 mv/cm.
Plug-in Horizontal Time Base Units:
-hp- Model 1780A Auxiliary Unit (provides single sweep operation).
-hp- Model 1781A Sweep Delay Unit.
-hp- Model 1782A Display Scanner (for making X-Y recordings).
-hp- Model 1783A Time Mark Generator.
Accessories Furnished: Two AC-21M Probes 10:1 voltage divider.
Accessories Available:
AC-83A Viewing Hood.
AC-21C Probe 50:1 voltage divider.
AC-21F Current Probe (conversion ratio: 1 mv/ma).
AC-67B Termination (for AC-21F Probe, bandwidth 2,500 cps to 30 mc).
AC-67C Termination (for AC-21F Probe, bandwidth 1,400 cps to 30 mc).
AC-76A BNC male to binding post adapter.
AC-115B Testmobile.
196B Oscilloscope Camera, includes UV source for illuminating the graticule and pre-sensitizing film.

OPTIONS
02 CRT with Internal Graticule and P2 phosphor installed.
04 Unblanking Gate (approx 4 v for duration of sweep) and Sweep Sawtooth (approx. −2.5 volts to +2.5 volts) outputs on rear panel.
07 CRT with Internal Graticule and P7 phosphor installed.
11 CRT with Internal Graticule and P11 phosphor installed.

Data subject to change without notice

SPECIFICATIONS
VERTICAL PLUG-INS

-hp-
MODEL 1750A
DUAL TRACE AMPLIFIER

(Installed in the -hp- Model 175A)

MODE OF OPERATION
1. Channel A alone.
2. Channel B alone.
3. Channels A and B displayed on alternate sweeps.
4. Channels A and B displayed by electronic switching at 200 kc rate, with blanking during switching.
5. Channel A minus Channel B (differential input).

EACH CHANNEL
Sensitivity Range: 0.05 v/cm to 20 v/cm. Nine calibrated ranges in 1, 2, 5, 10 sequence. Vernier extends minimum sensitivity to at least 50 v/cm and provides continuous adjustment between ranges. A sensitivity calibration adjustment for each channel is provided on the instrument front panel.
Attenuator Accuracy: ±3%.
Pass Band: DC coupled: dc to 40 mc. AC coupled: 2 cps to 40 mc.
Rise Time: Less than 9 nsec.
Dynamic Range: Input amplifiers may be overloaded by 18 cm signal without causing noticeable signal distortion.
Vertical Position Control Range: ±9 cm.
Input Impedance: 1 megohm (nominal) shunted by 27 pf.
Maximum Voltage of Input Capacitor: 600 vdc.
Polarity of Presentation: + up or − up, selectable for each channel.

DIFFERENTIAL INPUT
Both inputs, with their associated attenuators, may be switched to one channel to give differential input. The input attenuators may be set separately to allow mixing signals of different levels.
Common Mode Rejection: At least 40 db at maximum sensitivity up to 1 mc, or 30 db when using attenuators.

GENERAL
Weight: Net 5 lbs.
Power: Supplied by Model 175A Oscilloscope.
Price: $285.00 f.o.b. factory.
Accessories Available:
AC-21C Probe 50:1 voltage divider.
AC-21F Current Probe.
AC-21M Probe, 10:1 voltage divider (2 supplied with 175A).
AC-67B Feed-thru Termination (for AC-21F, 2.5 kc to 30 mc).
AC-67C Compensated Termination (for AC-21F, 1.4 kc to 30 mc).
AC-76A Adapter (terminal post to male BNC).

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-hp-
MODEL 1752A
HIGH GAIN VERTICAL AMPLIFIER

(Installed in the -hp- Model 175A)

Sensitivity: 5 mv/cm to 20 volts/cm in twelve calibrated ranges in a 1, 2, 5, 10 sequence. Vernier allows continuous adjustment between calibrated ranges, and extends minimum sensitivity to at least 50 volts/cm. Attenuator accuracy is ±3% and sensitivity calibration adjustment is provided on the front panel.
Dual Inputs: Two signal input jacks (BNC). AC or DC coupling of either input selectable with front panel switch. Isolation between inputs at least 80 db.
Differential Input: AC or DC differential input may be selected in the ranges of 5 mv/cm to 50 mv/cm. Common mode rejection at least 40 db. Common mode signal should not exceed 4 volts peak-to-peak.
Pass Band: DC Coupled—50 mv/cm and above: dc to 22 mc; 20 mv/cm to 5 mv/cm: dc to 18 mc. AC Coupled—2 cps to 22 mc; 2 cps to 18 mc.
Input Impedance: Approximately 1 megohm with less than 35 pf shunt capacitance.
Input Capacitor Rating: 600 vdc.
Weight: Net 5 lbs. Shipping 7 lbs.
Power: Supplied by Model 175A Oscilloscope.
Price: $225.00 f.o.b. factory.
Accessories Available: AC-16B Cable (dual banana plug to male BNC, 45 inches long). AC-16K Cable (male BNC to male BNC, 48 inches long).

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-hp-
MODEL 1753A
SINGLE CHANNEL
VERTICAL AMPLIFIER

(Installed in the -hp- Model 175A)

Pass Band: DC Coupled: DC to 40 mc, 9 nsec rise time. AC Coupled: 2 cps to 40 mc, 9 nsec rise time.
Sensitivity: Nine calibrated ranges in 1, 2, 5, 10 sequence from 0.05 v/cm to 20 v/cm. Vernier provides continuous adjustment between ranges and extends minimum sensitivity to at least 50 v/cm.
Attenuator Accuracy: ± 3%.
Input Impedance: 1 megohm (nominal) shunted by approximately 22 pf.
Input Capacitor Rating: 600 vdc.
Power: Supplied by -hp- Model 175A Oscilloscope.
Weight: Net 5 lbs. Shipping 7 lbs.
Price: $155.00 f.o.b. factory.
Accessories Available:
AC-16K Cable (male BNC to male BNC, 48 inches long).
AC-21F Current Probe (conversion ratio: 1 mv/ma).
AC-21M Probe; 10:1 Voltage Division (2 supplied with Model 175A Oscilloscope).
AC-21C Probe; 50:1 Voltage Division.
AC-67B Termination (for AC-21F Probe, bandwidth 2,500 cps to 30 mc).
AC-67C Termination (for AC-21F Probe, bandwidth 1,400 cps to 30 mc).
AC-76A Adaptor (terminal post to male BNC).

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