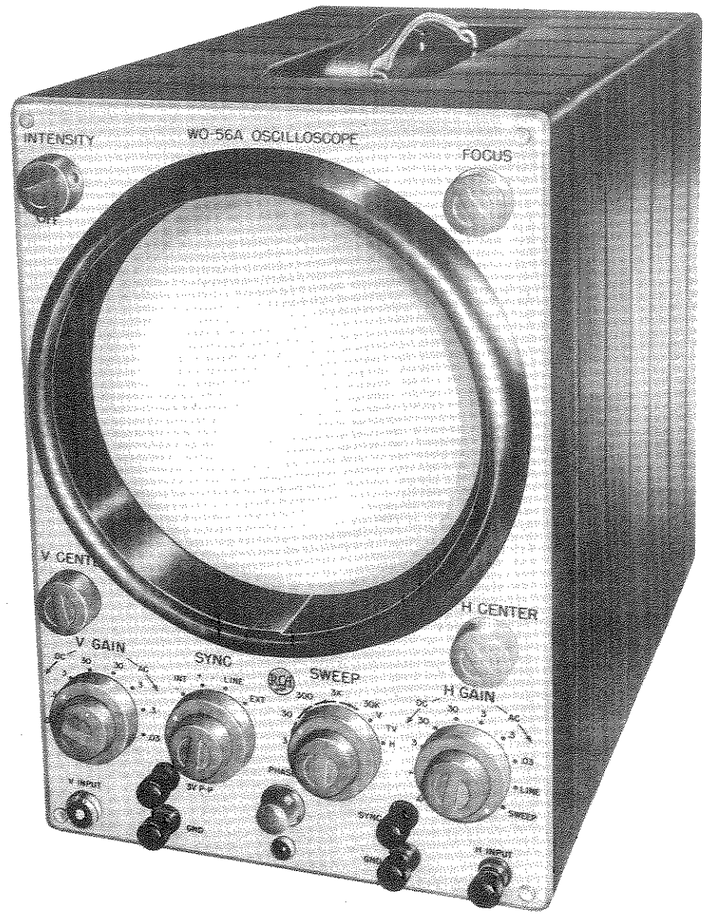
H.W. Berry

RCA CATHODE-RAY OSCILLOSCOPE

TYPE WO-56A



- Specifications
- Operation
- Applications
- Maintenance

RADIO CORPORATION of AMERICA
TEST AND MEASURING EQUIPMENT
HARRISON, N. J.

Safety Precautions

High-Voltages are dangerous! Always observe the following precautions:

1. Do not work alone. Another person should be present to remove power and apply resuscitation in case of accident.

2. Avoid close proximity to high-voltage points. If you are unfamiliar with the equipment, find out where the high-voltage points are located. Remember that high voltage may appear at unexpected points in defective equipment.

3. Power should be removed from high-voltage points, if possible, before the test leads are connected.

4. If it is impractical to turn power off, make sure that the ground clip of the test equipment is securely attached. Keep fingers far back from probe tip. Avoid contact between any part of the body and ground. Obtain dry insulating material to stand on, if floor is not insulated. Do not lean against equipment racks, metal bulkheads, or any object which can provide a ground.

5. Short-circuit all filter capacitors, if possible, before attaching test leads.

6. Never use leads with broken insulation.

7. Always disconnect test leads immediately after measurement is completed.

8. Do not connect ground lead of the WO-56A to a high-voltage point! The ground lead of the instrument is connected internally to the case.

Items Supplied with the WO-56A

Tubes Supplied: 4 RCA-6BH6, 5 RCA-12AU7, 1 RCA-6X4, 1 RCA-1V2, 1 RCA-7JP1.
WG-218 Direct Probe and Cable
WG-216A Low-Capacitance Probe
Ground Cable
Alligator Clip
Green Graph Screen
Warranty Certificate
Instruction Booklet

TEST AND MEASURING EQUIPMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

INSTR.-WO-56A-(1)
Photolithographed in U.S.A.

CATHODE-RAY OSCILLOSCOPE

Type WO-56A

Contents

(Continued)

List of Illustrations

General Description

The RCA WO-56A Cathode-Ray Oscilloscope features a frequency range, a square wave response, and a sensitivity which provide waveshape reproductions of unusual accuracy and clarity on its seven-inch screen. Designed with a view toward practical applications in television servicing, the WO-56A provides facilities which allow the rapid, accurate, and efficient trouble-shooting of television receivers. This instrument has a sensitivity of 10.6 rms millivolts per inch. The frequency response of both the vertical and horizontal amplifiers from 0 to 500 kc is within 2 db down from maximum response; the frequency response from 0 to 1 Mc is within 6 db down from maximum response.

The vertical and horizontal amplifiers of the WO-56A are electrically identical. Each amplifier consists of three push-pull stages of amplification, a feature which provides high deflection sensitivity with good stability. The trace can be expanded to approximately three times the diameter of the screen and centered on any portion for examination of waveshape details. The use of push-pull stages also reduces astigmatic distortion, thus producing a uniformly sharp trace over the entire useful area of the screen.

Both the vertical and horizontal amplifiers are designed to provide low-frequency response flat down to dc, a feature which not only allows amplification of the ac component of a signal but of its dc component as well. Low-frequency square-wave response, essential to correct sweep alignment, is assured. High-frequency square-wave response up to at least 100 kc insures faithful reproduction of blanking and pulse waveshapes. A square-wave response with negligible tilt and overshoot provides a reliable display of sync-pulse, vertical- and horizontal-deflection, video-amplifier, and composite-television waveshapes. Frequency-compensated step and vernier attenuators maintain response independent of changes in gain.

Both peak-to-peak and dc voltage measurements can be made directly from the screen of the WO-56A. A voltage for calibrating either the vertical or horizontal amplifier is available at a panel terminal.

The sweep, or time-base, oscillator produces a linear sawtooth voltage with an extremely fast retrace, further insuring faithful waveshape reproduction. This oscillator is of the Potter type, with a range of 3 to 30,000 cycles per second. Two preset sweep frequencies of 30 cps and 7875 cps speed up signal tracing and trouble shooting in television rf, deflection, and video circuits.

The sweep oscillator can be synchronized by an internally supplied voltage of power-line frequency, by an externally supplied sync voltage, or by a voltage which is either positive or negative in direction and which is internally selected from the vertical amplifier. This feature insures a steady pattern on the oscilloscope screen. When the sweep oscillator is synchronized with the line voltage, the phase control can be used to center any portion of the waveshape on the oscilloscope screen.

A phase-controlled sinusoidal sweep of power-line frequency, essential in sweep-alignment applications, is available internally; its phase can be adjusted by the phase control. This arrangement eliminates the need for an external phase-controlled line-voltage source.

The seven-inch cathode-ray tube gives a large, clear display for accuracy in alignment applications. The metal shield which surrounds this tube greatly minimizes hum pickup, thereby eliminating the necessity of carefully arranging sets and equipment on the service bench to avoid hum deflection. A retractable light shield and a green calibrating screen reduce ambient-light reflections on the face of the cathode-ray tube.

Although designed primarily for television servicing, the WO-56A can be used in industrial applications as well as in the usual oscilloscope applications, such as waveshape analysis, adjustment of radio receivers and transmitters, determination of peak-to-peak and instantaneous voltages, and tracing of vacuum-tube characteristics. For information on the application of the WO-56A to unusual industrial processes, you are invited to send the details of your application to Commercial Engineering, Radio Corporation of America, Harrison, New Jersey.

Specifications

Electrical

Frequency Response:

Vertical and Horizontal Amplifiers:

From 0 to 500 kc
within 2 db down from maximum response

From 0 to 1 Mc
within 6 db down from maximum response

Input Resistance and Capacitance:

Vertical Amplifier:

Without cable and probes.....1 megohm shunted by 30 $\mu\mu$f
With Direct Probe & Cable WG-218
1 megohm shunted by 75 $\mu\mu$f
With Low-Capacitance Probe WG-216A
1 megohm shunted by 9.5 $\mu\mu$f

Horizontal Amplifier:

Without cable and probes..... 1 megohm shunted by 35 $\mu\mu$f

Sync Input:

Without cable and probes..... 1 megohm shunted by 35 $\mu\mu$f

Deflection Sensitivity:

Vertical Amplifier:

	millivolts per inch	
	rms	*p-p*
With Direct Probe & Cable WG-218.....	10.6	30.0
With Low-Capacitance Probe WG-216A....	106	300
Horizontal Amplifier:		
Without cable and probes.....	21.2	60.0

Sweep-Circuit Frequency:

Variable..... 3 cps to 30,000 cps
Preset..... "TV/V" position..... 30 cps
"TV/H" position..... 7875 cps

Maximum Input Voltage:

With no ac present..... 700 volts dc
With 400 volts dc present..... 600 volts rms

Power Supply:

Voltage Rating ..... 105-125 volts
Frequency Rating ..... 50-60 cps
Power Consumption ..... 65 watts

Tube Complement:

4 RCA-6BH6, 5 RCA-12AU7, 1 RCA-6X4, 1 RCA-1V2, 1 RCA-7JP1

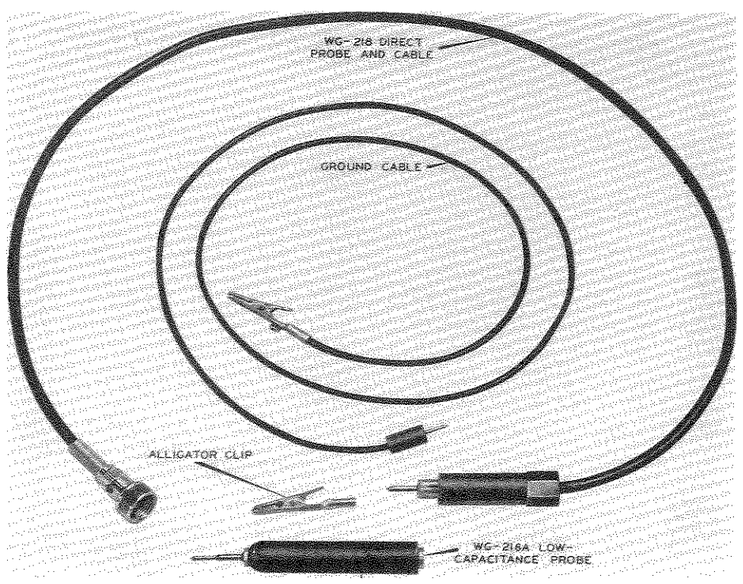
Mechanical

Dimensions:

Height ..... 13⅝ inches
Width ..... 9 inches
Depth ..... 16⅝ inches

Weight.....(approx.) 31 pounds

Finish..... blue-gray hammeroid case, anodized satin aluminum panels



Cables and Probes Supplied with the WO-56A

Installation

To install the WO-56A Cathode Ray Oscilloscope for operation, the following procedure should be followed:

1. Remove the three screws from the back of the case.

2. Remove the chassis from the case by pushing on the rear chassis apron through the hole provided for the power cord at the rear of the case.

3. Fasten the cathode-ray tube in place by tightening the clamp around the tube base.

4. Connect the power cord to an ac outlet supplying 105-125 volts at 50-60 cycles.

5. Set controls and selectors as follows:
INTENSITY control fully clockwise
V GAIN selector at position "30" on the AC range
V GAIN vernier for minimum gain
H GAIN selector at "LINE" position
H GAIN vernier for minimum gain.

6. Short the interlock switch S-6, located on the rear apron of the chassis.
CAUTION: See "Safety Precautions".

7. Allow at least 15 minutes for the instrument to warm up.

8. Center the line by means of the V CENTER and H CENTER controls. (Refer to section on Function of Controls and Terminals.)

9. Focus the spot with the FOCUS control.

10. Loosen the clamp around the tube base. Orient the tube so that the trace is in a horizontal plane.

11. Retighten tube base clamp.

12. Place the shield of the cathode-ray tube in forward position, and fasten in place with wing nut.

13. With pressure applied only on the corners of the front panel, install the chassis in its case. Replace the three screws at the back of the case.

14. Place the green graph screen in place. It fits in the rubber ring around the face of the cathode-ray tube.

Operation

General

To install the WO-56A for initial operation, follow the procedure outlined in the "Installation" section. For subsequent operation, connect the power cord at the rear of the instrument to an ac outlet supplying 105-125 volts at 50-60 cycles; set the H GAIN selector to "SWEEP" position; and adjust the H GAIN vernier to its center position, approximately. Turn the INTENSITY control clockwise from "OFF" position, and allow 15 minutes for the instrument to warm up.

In order to derive the most profitable use from the WO-56A Cathode-Ray Oscilloscope, the operator should refer to the section on "Functions of Controls, and Terminals" and work the various controls until he is thoroughly familiar with the location and function of each control and terminal.

Calibration of Vertical Amplifier

When the instrument is to be used as a voltmeter, the vertical amplifier should be calibrated according to the following procedure:

1. Connect the WG-218 Direct Probe and Cable to the V INPUT terminal and the Ground Cable to a GND terminal.

2. Connect the probe of the WG-218 to the 3V P-P terminal.

3. Set the V GAIN selector on either "3" AC or "3" DC and adjust the V GAIN vernier until one inch of vertical deflection is obtained on the oscilloscope screen.

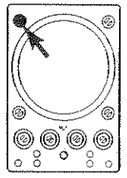
4. Disconnect the cable from the 3V P-P terminal. NOTE: Do not touch the V GAIN vernier while voltage measurements are being made. Otherwise the vertical amplifier will have to be recalibrated.

5. Connect the Direct Probe and Cable and the Ground Cable across the voltage to be measured and set the V GAIN selector for a convenient vertical deflection.

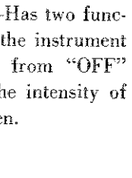
The peak-to-peak voltage at the probe tip is the V GAIN-selector setting multiplied by the number of inches of vertical deflection. When a sine-wave voltage is being measured, the above value can be multiplied by .354 to give the rms voltage.

The WG-216A Low-Capacitance Probe may also be used for voltage measurements. The procedure is the same, except that the results obtained above are multiplied by 10, in order to compensate for the greater signal attenuation of the WG-216A.

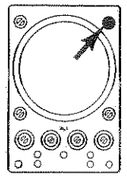
Functions of Controls and Terminals



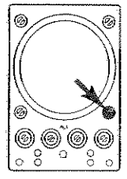
INTENSITY control—Has two functions; applies power to the instrument when turned clockwise from "OFF" position, and controls the intensity of the spot on the CRT screen.



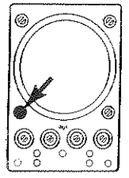
V GAIN vernier—Permits continuous adjustment of vertical-amplifier gain. Use with V GAIN selector to adjust trace height to desired value. See "Operation" section for calibration procedure.



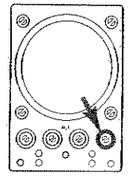
FOCUS control — Adjusts sharpness of pattern on CRT screen. Normally requires adjustment when setting of INTENSITY control has been changed.



H CENTERING control — Adjusts horizontal position of trace.



H CENTERING control — Adjusts horizontal position of trace.



H GAIN selector—Has three functions, as indicated below:

(1) Controls degree of attenuation of input voltage to horizontal amplifier. This control is marked for both ac and dc voltages. Attenuation is as indicated below for each selector position.

Position ".03" — Zero attenuation. Signal voltage attenuated 1 to 1.

Position ".3" — Signal voltage attenuated 10 to 1.

Position "3" — Signal voltage attenuated 100 to 1.

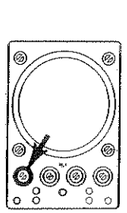
Position "30".— Signal voltage attenuated 1000 to 1.

(2) When an internal linear sweep is desired, set this control to "SWEEP" position.

Position "SWEEP" — Applies plate voltage to sweep oscillator tube, and couples output of sweep oscillator to input of horizontal amplifier.

(3) When sinusoidal sweep of power-line frequency is desired, set this control to "LINE" position.

Position "LINE"—Applies sinusoidal voltage at power-line frequency to horizontal-amplifier input.



V GAIN selector—Controls degree of attenuation of input voltage to vertical amplifier. This control is marked for both ac and dc voltages. To determine amplitude of signal voltage when vertical amplifier has been calibrated, multiply V GAIN selector setting by total deflection in inches. When Direct Probe and Cable WG-218 is used, attenuation is as indicated below for each selector position. When Low-Capacitance Probe WG-216A is used, attenuation is ten times as great as indicated below.

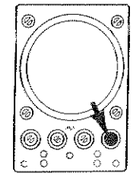
Position ".03" — Zero attenuation. Signal voltage attenuated 1 to 1.

Position ".3" — Signal voltage attenuated 10 to 1.

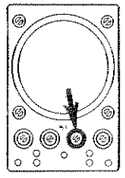
Position "3" — Signal voltage attenuated 100 to 1.

Position "30" — Signal voltage attenuated 1000 to 1.

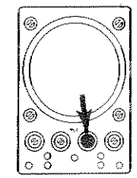
NOTE: The outer knob of each of the four dual controls is the selector control; the inner knob is the vernier control.



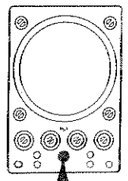
H GAIN vernier—Permits continuous adjustment of horizontal-amplifier gain. Use with H GAIN selector to adjust horizontal trace to desired width.



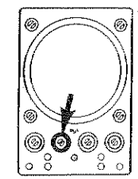
SWEEP selector—Selects frequency band of sweep oscillator. Positions "TV/V" and "TV/H" give preset sweep frequencies of 30 cps and 7875 cps, respectively, for viewing vertical- and horizontal-deflection-circuit waveshapes, sync-separator waveshapes, and composite television signals.



SWEEP vernier—Provides continuous control of sweep frequency over bands selected by SWEEP selector.



PHASE control—Controls the phase of the sinusoidal sweep voltage fed to the horizontal amplifier when the H GAIN selector is set at "LINE" position, and controls the phase of the line-frequency voltage used to synchronize the sweep oscillator when the SYNC selector is at "LINE" position and the H GAIN selector is at "SWEEP" position.



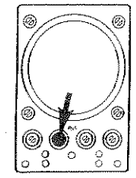
SYNC selector—Selects sync voltages for sweep oscillator.

Position "INT—"—Selects synchronizing voltage from vertical amplifier. Sweep-trace flyback starts during negative-going excursion of voltage applied to vertical amplifier.

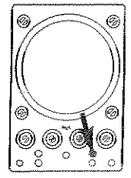
Position "INT+"—Selects synchronizing voltage from vertical amplifier. Trace flyback starts during positive-going excursion of voltage applied to vertical amplifier.

Position "LINE"—Selects synchronizing voltage from power supply. Sweep oscillator synchronized with power-line frequency. When the SYNC selector is in "LINE" position and the H GAIN selector in "SWEEP" position, the PHASE control can be used to adjust the phase of the sweep voltage with respect to the input voltage.

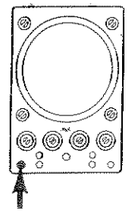
Position "EXT" — Feeds external sync voltage applied at SYNC terminal to sweep oscillator.



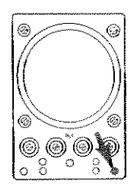
SYNC vernier—Controls amplitude of synchronizing voltage applied to grid of sweep oscillator. Adjust to minimum setting necessary to lock pattern in a stationary position on the CRT screen.



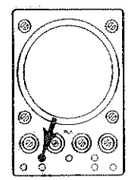
SYNC terminal — An external synchronizing voltage can be applied at this terminal.



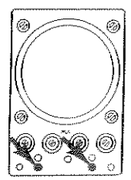
V INPUT terminal—The voltage to be applied to the vertical amplifier is introduced at this terminal through the Direct Probe and Cable WG-218. When the V GAIN selector is on its ac positions, the signal is applied to the vertical amplifier through a blocking capacitor; when the V GAIN selector is on its dc positions, the signal is applied directly to the vertical amplifier.



H INPUT terminal—The voltage to be applied to the horizontal amplifier is introduced at this terminal.



3V P-P terminal—Internal calibrating voltage is available at this terminal. See "Operation" section for calibration procedure.



GND terminals — Are directly connected to the chassis of the oscilloscope; serve as a common ground for the WO-56A and the chassis of the equipment under test or associated test instruments.

Applications

Applications in Television

Analyzing Composite Television Waveforms

The successful servicing and maintenance of modern television receivers requires techniques not usually employed in the servicing of the less intricate circuits found in broadcast and short-wave receivers. Foremost in these new techniques is the analysis of television waveforms, such as sync pulses, deflection waveforms, composite video waveforms, etc., and from that analysis, the step-by-step tracing of a waveform fault to the defective component producing it. Probably the most important waveform encountered in television service work is the composite video waveform consisting of the video signal, the blanking pedestals, and the sync pulses. Two photographs of the composite video signal are shown in Figure 1. These photographs

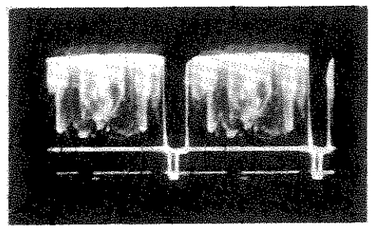


Figure 1A. Horizontal Sync Pulse

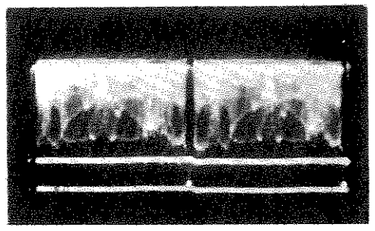


Figure 1B. Vertical Sync Pulse

are actual oscilloscope traces of what the composite video signal looks like as it proceeds through the video amplifier of a television receiver.

The television serviceman should devote some time to the study of such waveforms by setting up a television receiver known to be in good operating condition, and noting the waveforms on the WO-56A Oscilloscope at various points in the video amplifier. The traces shown in Figure 1 are obtained on the WO-56A Oscilloscope as follows:

1. Tune the television receiver to a television signal.

2. Rotate the INTENSITY control on the oscilloscope clockwise to turn the instrument on, set the H GAIN selector to "SWEEP" position, and adjust the H GAIN vernier for a horizontal line of convenient length. Set the INTENSITY and FOCUS controls for the desired brightness and best focus.

3. Connect the WG-218 Direct Probe and Cable supplied with the instrument to the V INPUT terminal and attach the WG-216A Low-Capacitance Probe to the probe end. Connect the ground cable to the television-receiver chassis, and the WG-216A to the signal-grid terminal on the socket of the picture tube. (The picture tube in the receiver need not be in its socket for this test.)

4. Set the V GAIN selector on an AC position and adjust the V GAIN vernier control for a pattern of convenient height. Set the SYNC selector on "INT+" or "INT−".

5. In order to obtain the horizontal sync pulse on the oscilloscope screen, proceed as follows:
   a. Set the SWEEP selector at "TV/H" position.
   b. Carefully rotate the SYNC vernier control until the pattern shown in Figure 1A is obtained on the oscilloscope screen. NOTE: To avoid distortion of the pattern, always use the minimum setting of the SYNC vernier necessary to hold the pattern still.

6. In order to obtain the vertical sync pulse on the oscilloscope, the procedure to be followed is the same as that in paragraph 5 above, except that the preset "TV/V" position of the SWEEP selector is used instead of the "TV/H" position. The pattern will resemble that in Figure 1B.

To afford practice in tracing and observing the video signal, place the WG-216A Low-Capacitance Probe at various points in the video-amplifier circuit. The oscilloscope controls should be manipulated until the operation of the instrument is completely understood, for in the hands of an experienced operator, the WO-56A Oscilloscope is a valuable television service tool.

A chart showing the effects of different circuit faults on the horizontal sync pulse is shown in Figure 2. The chart also shows the effects of these faults on the overall frequency response of the receiver, and upon

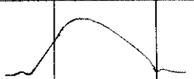
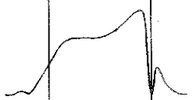
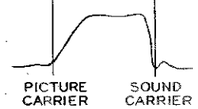
NORMAL HORIZONTAL PULSE	CIRCUIT FAULT	HORIZONTAL PULSE DISTORTION	OVERALL FREQUENCY RESPONSE OF RECEIVER	EFFECT ON PICTURE
	NORMAL CIRCUIT			PICTURE NORMAL
	LOSS OF HIGH FREQUENCIES			LOSS OF PICTURE DETAIL
	EXCESSIVE HIGH-FREQUENCY RESPONSE, NON-LINEAR PHASE SHIFT			FINE VERTICAL BLACK & WHITE STRIATIONS FOLLOWING A SHARP CHANGE IN PICTURE SHADING
	LOSS OF LOW FREQUENCIES (IN THE RANGE ABOVE 15 OR 20 KC)			CHANGE IN SHADING OF LARGE PICTURE AREAS; SMEARED PICTURE.

Figure 2. Sync-Pulse Distortion

the picture observed on the picture tube. As experience with the oscilloscope is acquired, the television serviceman will be able rapidly to analyze circuit faults from the characteristics of the composite signal noted on the oscilloscope.

Signal Tracing in Video Amplifiers

The method of tracing a signal through the video amplifier of a television receiver is analogous to the method used in tracing an audio signal through the audio amplifier of a broadcast receiver. However, because of the wider band of frequencies handled by video amplifiers, greater care must be used to avoid changing the response characteristics when the oscilloscope probe is applied to the circuit under test.

A schematic diagram of a typical video amplifier, together with the oscilloscope probe connections used in signal tracing, is shown in Figure 3. The receiver

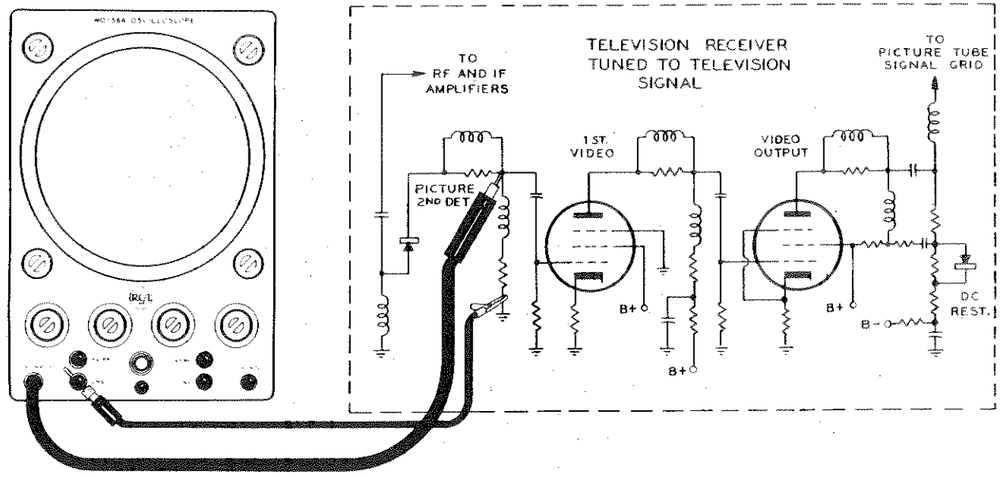


Figure 3. Video-Amplifier Test Setup

and the oscilloscope should be set up and operated as explained in the foregoing section on composite signal waveform analysis. The V GAIN selector should be set on an AC position.

The composite signal first appears across the picture-detector load; in Figure 3, the oscilloscope cables are shown connected at this point. If the waveform does not look like the waveform of Figure 1, or if the signal is absent, then the fault is ahead of the detector load. If the signal is present and normal in waveform, then the probe can be moved forward stage by stage, toward the picture tube. In going from grid to plate of each tube, the signal should appear amplified and inverted, although the waveshape remains otherwise unchanged. When the signal deviates from normal, then the fault is isolated to a stage where the deviation occurs, and a simple voltage and resistance check or tube check is usually enough to locate the defective component. Peaking-coil faults are usually evidenced by a change in the shape of a horizontal sync pulse; limiting in a stage is evidenced by compression of the sync pulse, or the "whites" of the signal, or both. (See Figure 4.)

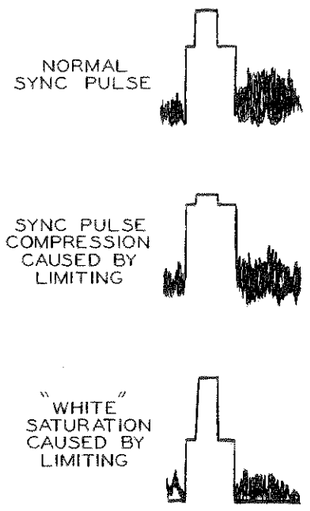


Figure 4. Sync-Pulse Compression

Whenever possible, the WG-216A Low-Capacitance Probe should be used for video-amplifier signal tracing because of the low input capacitance and consequent negligible loading of this probe. However, this probe attenuates the signal by a factor of ten, so that the direct probe may prove to be more useful in low-level stages. The capacitance of the direct probe loads the circuit to which it is attached, thus decreasing slightly the high-frequency input to the oscilloscope. The effect on the waveform observed on the oscilloscope is a slight rounding of the horizontal sync-pulse leading edge. After a little experience, the television serviceman will be able to differentiate between distortion of the horizontal sync pulse due to a faulty circuit, and the slight rounding of the pulse caused by the direct probe. If the probe is placed at the cathode of one of the video-amplifier tubes and the cathode resistor is unbypassed, the circuit response will be unaffected, and the sync pulse may be observed as it appears in the circuit.

Signal Tracing in Sync and Deflection Circuits

Loss of picture synchronization is quickly and easily traced to its source with the WO-56A Oscilloscope by viewing the waveforms found in the TV sync and deflection circuits. A block diagram of a typical television-receiver sync and deflection circuit is shown in Figure 5. The various waveforms appearing on the diagram illustrate the waveforms which should be seen as the probe is moved from the input of the sync separator to the points indicated in the horizontal and vertical oscillators. These waveforms will differ in receivers of different make, but the signal-tracing procedure will remain the same. Some manufacturers include, in their television service notes, photographs or diagrams of the waveforms to be expected at various points in the circuit. In this case, the signal tracing procedure is simple; merely compare the diagrams with the waveforms actually seen on the oscilloscope to determine the location of the fault.

Faults in deflection are traced in the same manner as are faults in synchronization. The probe is placed first at the horizontal or vertical oscillator to determine whether or not it is operating, and, if so, the signal is traced through the discharge tube to the deflection output stage and finally the deflection plates (or coils, if electromagnetic deflection is used). Here, as in the tracing of sync signals, the serviceman must understand the functions of the circuits under test in order to interpret properly the waveforms observed on the oscilloscope.

CAUTION: In modern television receivers, very high pulse voltages, often several thousand volts, exist in deflection circuits. See "Maximum Input Voltages" under Specifications above.

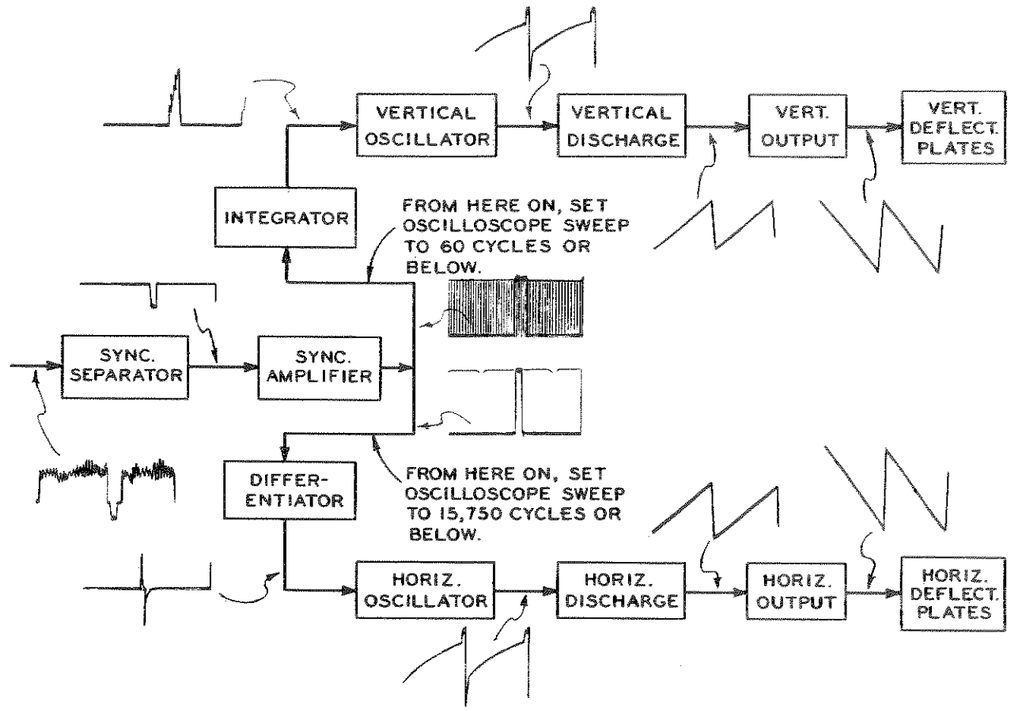


Figure 5. Signal Tracing in Sync and Deflection Circuits

Measuring Peak-to-Peak Voltages

Often, in signal tracing, it is necessary to know the peak-to-peak voltage of the waveform observed on the oscilloscope. This may be necessary to determine whether or not a video stage is operating with sufficient gain, for example, or to determine whether or not sufficient sync signal exists at the deflection oscillators. The procedure for making voltage measurements is given under "Calibration of Vertical Amplifier".

Aligning Picture-IF Circuits

Because of the unusual shape of the picture-if amplifier response curve, visual alignment is required. In addition to the WO-56A Oscilloscope, a sweep generator, such as the RCA WR-59B Television Sweep Generator, and a marker oscillator, such as the RCA WR-39B Television Calibrator, are needed. The setup is as shown in Figure 6. The manufacturer's service notes should be consulted for alignment instructions, but a general alignment procedure is as follows:

1. Set up the equipment as shown in Figure 6. Tune the sweep generator to sweep the picture-if frequency.

2. If the sweep generator uses a sinusoidal sweep of line frequency, set the H GAIN selector on "LINE", and adjust the PHASE control to give a single pattern on the oscilloscope screen. If the sweep generator uses a sawtooth sweep, feed the sweep-voltage output of the generator to the horizontal-input terminals on the oscilloscope and set the H GAIN selector to a position which will give a horizontal deflection of convenient length.

3. Adjust the tuning adjustments in the if amplifier to give a curve like that shown in Figure 7. With the WR-39B Television Calibrator, check the

(Continued on Page 18)