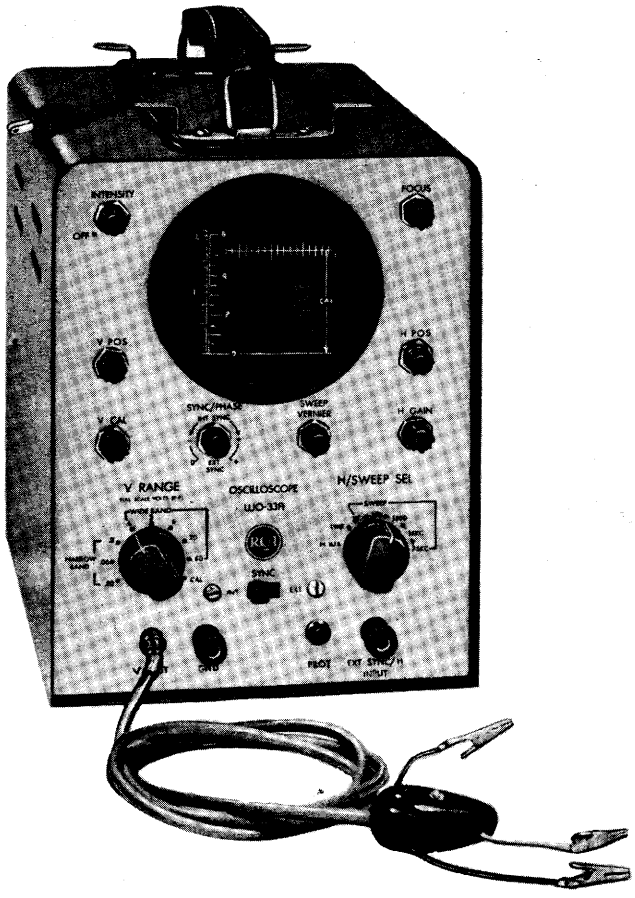
PRICE ONE DOLLAR

RCA CATHODE-RAY OSCILLOSCOPE

Type WO-33A



- Specifications
- Operation
- Applications
- Maintenance

RADIO CORPORATION of AMERICA

ELECTRONIC COMPONENTS AND DEVICES

ELECTRONIC INSTRUMENTS

HARRISON, N. J.

TP-WO-33A

Safety Precautions

The metal case of this instrument is connected to the ground of the internal circuit. For proper operation, the ground terminal of the instrument should always be connected to the ground of the equipment under test. The WG-349A Direct/Low-Capacitance Probe and Cable has a shield throughout its entire length which is connected to the instrument ground and case.

Care should be exercised to avoid striking the cathode-ray tube or subjecting it to more than moderate pressure in handling. Because the tube contains a high vacuum, implosion might result in injury from flying glass.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be especially careful to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

ITEMS

Supplied with WO-33A

Direct/Low-Capacitance Probe and Cable ..... Type No. WG-349A

Instruction Booklet

Available on Separate Order

WG-350A Demodulator Probe
for rf applications up to 250 Mc

WG-300B Direct/Low-Capacitance Switch Probe
(WG-271A Connector Adapter required)

Accessories for WG-300B Probe :

WG-302A RF Demodulator Probe

WG-354A Capacitance-Type Voltage Divider Probe
Permits high voltage measurements up to 5000 volts.

WO-33A1B(3) 6-62
Printed in U.S.A.

Cathode-Ray Oscilloscope

Type WO-33A

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Description

The RCA WO-33A is a 3-inch oscilloscope designed for "on-location" and service-shop use in servicing color and black-and-white television receivers, Hi-Fi equipment, PA and sound reenforcing systems, broadcast station and remote equipment, communications and industrial electronic equipment.

A novel feature of the WO-33A is the Vertical Input Attenuator which automatically switches the amplifier from Wide Band to Narrow Band when in the three highest gain positions.

Another important feature of the WO-33A is the exceptionally high gain in its vertical amplifier. There is enough sensitivity to provide a useful display of signals from low-level microphones, phono-pickups and other weak signals found in radio/TV receivers, audio amplifiers, etc.

A voltage-calibrated, frequency-compensated vertical-input attenuator, an internal calibrating-voltage source, and a graph screen scaled directly in volts make it possible to use the WO-33A as a visual voltmeter. The unique system of calibrating the graph screen provides for scaling voltages directly from the screen. The measurement procedure is very similar to that employed with a vacuum-tube voltmeter. A calibrating voltage is automatically applied to the vertical amplifier when the bandwidth control is set to the calibration position. This switch also disconnects internally the input and attenuator circuits, making it unnecessary to remove leads and probes from the external circuit under test. These unique facilities make voltage calibration and measurement a simple, almost automatic procedure.

The sweep-frequency control is continuously adjustable from 15 cps to 75 Kc. The sweep oscillator has excellent stability at high sweep rates, a fast retrace, and adequate linearity throughout its frequency range. The over-all frequency range of the oscillator is divided into four basic ranges; a vernier adjustment, which overlaps the basic sweep ranges, provides exact adjustment of the sweep frequency. The amount of sync signal fed to the sweep oscillator may be adjusted by means of a front-panel control. Sweep synchronization is exceptionally stable throughout the sweep range of the oscillator.

A phase control is provided for varying the phase of the internal sweep voltage when the "LINE" position of the H/SWEEP SEL control is used, enabling the WO-33A to be phased with an external line-frequency sweep oscillator.

To facilitate its use, the WO-33A is equipped with a specially designed single-unit probe and input cable. This accessory, the WG-349A Direct/Low-Capacitance Probe and Cable, is provided with a blue input lead and a yellow input lead. When the blue input is used, the test signal is fed directly to the vertical-input terminal. When the yellow input is used, a special high-impedance circuit in the probe is connected in series with the test point and the 'scope. This high-impedance circuit presents an over-all input resistance of 10 megohms and an input capacitance of approximately 10 $\mu\mu$f to the test circuit. This feature reduces circuit-loading effects and permits use in circuits which would not function properly if loaded down by a conventional oscilloscope.

The WO-33A can be used to trouble-shoot and signal trace all sections of both black-and-white and color-TV receivers. The voltage-calibrating facilities, wide band-pass, and high-impedance input characteristics make possible observations and measurements of color-burst signals and other critical, high-frequency waveshapes in circuits which are sensitive to loading effects.

The size and weight of the WO-33A make it an especially portable instrument, useful in such applications as industrial maintenance and trouble-shooting, general waveform analysis, adjustment of radio receivers and transmitters, square-wave and general testing of audio equipment, peak-to-peak voltage measurements, and observation of vacuum-tube characteristics. The WO-33A is a versatile and reliable instrument, well suited to applications which require a dependable oscilloscope.

Specifications

NOTE: Performance figures are for a line voltage of 117 volts, 60 cps.

Electrical

Frequency Response:

Vertical Amplifier:

Wide-Band Positions (5.5 cps to 5.5 Mc) ..... flat within −3 db

High-Sensitivity Positions:

20 cps to 150 Kc ..... flat within −3 db

3 cps to 1.5 Mc ..... flat within −6 db

Horizontal Amplifier (3.5 cps to 350 Kc) ..... flat within −6 db

Deflection Sensitivity:

Vertical Amplifier:

	(Wide-Band) Positions		(High-Sensitivity) Positions		
	rms	*p-p*	*rms*	*p-p*	
At V INPUT connector	0.10	0.3	.003	0.01	volt/in
With WG-349A Blue Lead	0.10	0.3	.003	0.01	volt/in
With WG-349A Yellow Lead	1.0	3.0	.03	0.1	volt/in

Horizontal Amplifier (at H INPUT terminal) ..... 0.9 rms volt/in

Rise Time (Vertical Amplifier):

5.5-Mc Positions ..... 0.1 μsec

Input Resistance and Capacitance:

Vertical Amplifier:

At V INPUT connector ..... 1 megohm shunted by approx. 50 μμf

With WG-349A Blue Lead ..... 1 megohm shunted by approx. 90 μμf

With WG-349A Yellow Lead ..... 10 megohms shunted by approx. 10 μμf

Horizontal Amplifier (at H INPUT terminal) ..... 10 megohms

EXT SYNC Input Terminal ..... 250 K to 55 K

Sweep Oscillator:

Frequency Range (continuously adjustable) ..... 15 cps to 75 Kc

Sync ..... External; ± Internal

Sync Range ..... To 4.5 Mc

Maximum AC Input Voltage (at Lo-Cap Probe):

(In presence of 400 volts dc) ..... 600 p-p volts

Phase-Control Range ..... 0 to 160 degrees

Power Requirements:

Voltage ..... 105-125 volts, 50-60 cps

Average Power Consumption ..... 50 watts

Tube Complement

1-6BR8A	2-12AT7	1-6C4
1-6BK7A	1-6X4	1-3AQP1

Mechanical

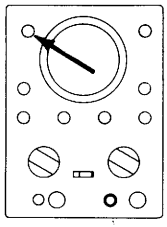
Height ..... 8¾"

Width ..... 6½"

Length ..... 10½"

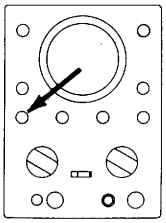
Weight ..... 14 lbs

Functions of Controls and Terminals

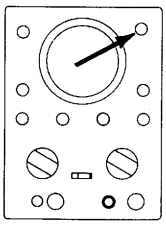


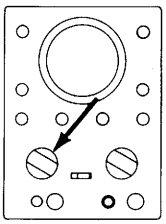
OFF-INTENSITY – Applies power to the instrument and increases intensity of the trace on the screen of the cathode-ray tube when control is turned clockwise from "OFF" position.

V-CAL – Adjusts sensitivity, or calibrates vertical amplifier to correspond with positions on V RANGE switch.

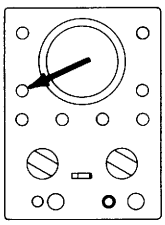


FOCUS – Adjusts the sharpness of the trace. Normally requires adjustment when setting of the INTENSITY control is changed.



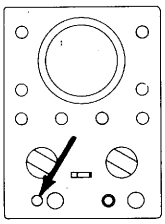


V RANGE – Adjusts overall sensitivity of vertical amplifier in "3-to-1" steps. Automatically changes bandwidth of vertical amplifier when going from ".2" to ".6" positions. In "CAL" position, disconnects vertical amplifier from input connector, and supplies a calibrating voltage which should be adjusted with "V-CAL" control to full-screen deflection.

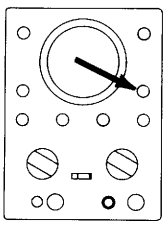


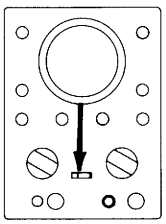
V POS – Adjusts vertical position of trace.

V INPUT – Feeds the input signal to the vertical amplifier through the attenuator circuits.

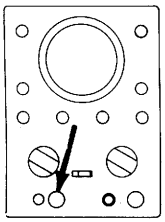


H POS – Adjusts horizontal position of trace.

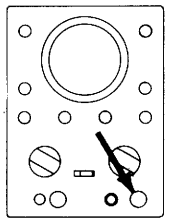




SYNC – Selects the source of the synchronizing signal.



GND – Connected directly to case and chassis.

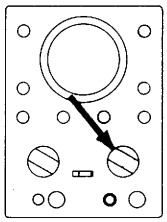


EXT SYNC/H INPUT – An external synchronizing signal for the sweep oscillator should be connected between this terminal and the ground terminal. The "SYNC" switch should be set to "EXT". An external signal for the horizontal amplifier should also be connected between this terminal and the ground terminal and the H/SWEEP SEL control set to "H IN". A positive-going signal will cause the spot to deflect to the right; a negative-going signal will cause the spot to deflect to the left.

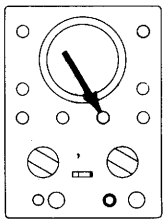
H/SWEEP SEL –
H IN – connect H IN terminal to horizontal amplifier. Permits external signal to be applied to horizontal amplifier.

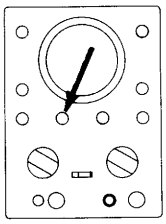
LINE – Provides 60 cps (power line frequency) sine wave sweep.

Four frequency ranges for sweep oscillator. Used in conjunction with SWEEP VERNIER to obtain the desired sweep frequency.

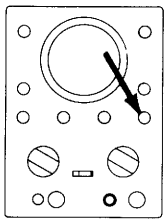


SWEEP VERNIER – Provides continuous control of the oscillator sweep frequency over the range selected by the SWEEP control. Also provides overlap of the SWEEP control positions.





SYNC/PHASE – Controls the amplitude of the synchronizing voltage applied to the grid of the sweep oscillator; should be adjusted to minimum setting necessary to lock pattern in a stationary position. Works zero-center for internal sync. Adjusts external sync by regular clockwise rotation. Also controls phase of the sinusoidal sweep voltage when the H/SWEEP SEL switch is in the "LINE" position.



H GAIN – Adjusts the gain of the horizontal amplifier and varies the width of the horizontal trace. Does not provide enough control to reduce trace length to zero.

Operation

To become familiar with the operation of the WO-33A Oscilloscope, it is recommended that the operator follow the procedure outlined below in the order given. The section "Function of Controls and Terminals" on pages 6 and 7 of the block diagram on page 20 will also be helpful.

Initial Procedure

1. Connect the power cord at the rear of the instrument to an ac outlet supplying 105-125 volts at 50-60 cps.

2. Turn the INTENSITY control clockwise from the "OFF" position and wait a few seconds for the instrument to warm up.

3. Rotate the INTENSITY control farther clockwise until either a spot or a horizontal line appears on the screen. The spot or line should increase in brilliance as the control is turned clockwise. NOTE: Do not allow a small spot of high brilliance to remain stationary on the screen for an appreciable length of time because discoloration or burning of the screen may result.

4. Adjust the FOCUS control for an image of maximum sharpness.

5. Turn the H/SWEEP SEL control to the "H-IN" position. In this position, without an external signal being applied to the H-INPUT terminals, no sweep voltage appears at the horizontal-deflecting electrodes of the cathode-ray tube and, therefore, only a spot will appear on the screen.

6. Position the spot in the center of the screen by adjusting the V POS and H POS controls.

Vertical-Amplifier Operation

1. Set the H/SWEEP SEL switch to the "15-150" range, and the V RANGE switch to "CAL". The screen should display a vertical trace, indicating that the internal calibrating signal has been applied to the input of the vertical amplifier.

2. Connect the WG-349A black ground lead to the ground side of the 6.3 volt 60 cps heater circuit in a radio or TV receiver. Connect the blue direct lead to the "hot" side of the 6.3 volt circuit. Turn the V RANGE switch to a position which provides a pattern height of about one inch. Note that by setting V RANGE and adjusting V CAL, which is a vernier attenuator, any desired height of pattern can be obtained.

Horizontal-Amplifier Operation

1. Apply an ac signal of from 1 to 3 volts to the EXT SYNC/H INPUT terminal. An audio-frequency generator or a 60-cps line signal may be used as the source. Set the H/SWEEP SEL to "H IN", set the V RANGE control to 60, and set the H GAIN control fully clockwise. A horizontal line will appear on the screen, indicating that an external signal has been applied to the horizontal-deflecting electrodes of the cathode-ray tube.

2. Disconnect the lead from the voltage source. The horizontal line will be replaced by a spot.

3. Turn the H/SWEEP SEL to the "LINE" position. A horizontal line should appear. NOTE: When the H/SWEEP SEL switch is set to the "LINE" position, part of the power-line signal is fed internally to the horizontal amplifier, providing a sinusoidal horizontal-deflection voltage of power-line frequency. The SYNC/PHASE control can be used to adjust the phase of the internal sinusoidal sweep.

4. Turn the H/SWEEP SEL control to any of the sweep positions. The sawtooth output from the sweep oscillator is applied internally to the horizontal amplifier and a linear horizontal trace appears on the screen.

Sweep-Oscillator Operation

1. Connect the blue direct lead and the black ground lead of the WG-349A probe to a 60 cps ac signal source such as an audio generator. Set the V RANGE switch and V CAL control to produce a trace about one inch high.

2. Set the SYNC slide switch to "INT", and the SYNC/PHASE control to the center of its range. Set the H/SWEEP SEL switch to 15-150, and adjust the SWEEP VERNIER control to produce a single cycle on the screen.

3. Rotate the SYNC/PHASE control in either direction just far enough to lock in a stationary pattern. Note: The SYNC/PHASE control should always be adjusted to the minimum position necessary to lock in a stationary pattern. The minimum amount

of internal sync occurs with the control in the center of its range.

4. Turn the SWEEP VERNIER slowly counterclockwise and note that the pattern will go out of sync. Continue turning the SWEEP VERNIER counterclockwise and note that the pattern will lock-in with two cycles, then with three cycles, etc. In this example, when the SWEEP VERNIER is set to produce two cycles the horizontal sweep rate is 60 (signal frequency) divided by 2 (number of cycles in trace), or 30 cycles.

5. If an audio frequency signal generator, such as the RCA WA-44C is available, it is interesting and instructive to use the generator as a source of external signal, repeating the experiment described above at various frequencies.

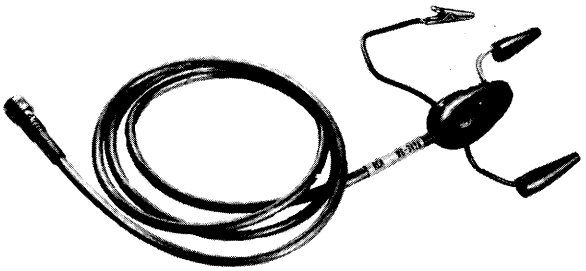


Figure 1. WG-349A direct/low-capacitance probe and cable supplied with WO-33A

Use of the WG-349A Direct/Low-Capacitance Probe

The WG-349A Direct/Low-Capacitance Probe and Cable is designed especially for use with the WO-33A Oscilloscope. This single-unit probe is equipped with two clips from the probe housing which permits using the probe for direct measurements or for connecting a built-in high-impedance network in series with the test point and the probe cable. When the yellow lead is used, the input capacitance of the cable and scope is reduced to 10 $\mu\mu$f and the input resistance is raised to 10 megohms. These high-impedance characteristics permit use of the WO-33A in high-impedance circuits, such as those found in TV sync-separator and video-amplifier stages, which would not operate properly if loaded down by a conventional scope probe and cable.

Whenever the probe is used in its low-capacitance position, however, the signal is attenuated by a factor of ten. Therefore, when voltage measurements

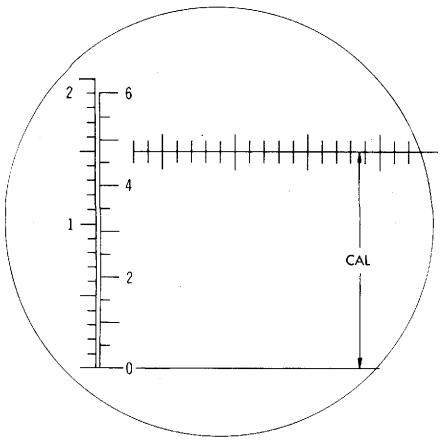


Figure 2. WO-33A graph screen with voltage scales

are made, the indicated voltage should be multiplied by 10.

Calibration and Voltage Measurement

The WO-33A Oscilloscope has been designed to permit simple and quick voltage calibration of the vertical amplifier and the cathode-ray screen. Once the instrument is calibrated, the graph screen scales can be used to measure the deflection amplitude of a displayed waveform directly in peak-to-peak volts.

When the V RANGE switch is set to "CAL", the probe, and input attenuator circuits of the scope are automatically disconnected from the vertical amplifier and an internal calibrating voltage is applied.

Calibration Procedure:

1. Set the V RANGE switch to "CAL", and the H/SWEEP SEL to "15-150".

2. Adjust the V POS and V CAL controls so that the vertical trace just fills the area on the graph screen between the two horizontal lines marked "CAL". The oscilloscope will remain calibrated on all ranges as long as the V CAL control is not readjusted.

Calibration will hold for both wide band and narrow band positions. After calibration, an input signal may be read directly in peak-to-peak volts by measuring the vertical deflection with the proper graph screen scale.

The graph screen has two vertical scales as shown in Figure 2. The scale to use depends upon the setting of the V RANGE switch. On the .02, .2, 2,

and 20 volt ranges, the 0-to-2 scale is used. On the .06, .6, 6, and 60 volt ranges, the 0-to-6 scale is used.

The procedure for measuring the peak-to-peak voltage of an input signal is provided below:

1. Calibration: Set the V RANGE switch to "CAL", and set the H/SWEEP SEL to "15-150". Adjust V POS so that the bottom of the trace rests on the base line, and adjust V CAL so that the vertical amplitude of the trace falls between the "CAL" lines on the graph screen. DO NOT RE-ADJUST V CAL IN THE FOLLOWING STEPS.

2. Connect the black ground lead and blue direct lead of the probe to the signal to be measured.

3. Set the V RANGE switch to a position that provides a trace with as much vertical amplitude as possible, but falling within the base line and the upper scale markings. Adjust V POS so that the bottom of the trace rests on the base line of the graph screen.

4. Lock in the waveform as described under "Sweep Oscillator Operation".

5. Using the appropriate scale, read the peak-to-peak voltage amplitude from the scale point opposite the top of the waveform.

For example, with the V RANGE switch set on the ".06" range, a trace extending vertically from the base line to the "4" mark on the 0-to-6 scale of the graph screen would be .04 volts peak-to-peak.

As another example, with the V RANGE switch set on the "20" range, a trace extending vertically from the base line to the "1" mark on the 0-to-2 scale would be 10 volts peak-to-peak.

NOTE: When observing waveforms and measuring amplitude of signals in high-impedance circuits, it is advisable to use the low-capacitance (yellow) lead of the probe. When using the low-capacitance lead, the signal is attenuated, or reduced, by a factor of 10 to 1. It is therefore necessary to multiply the indicated voltage readings by 10.

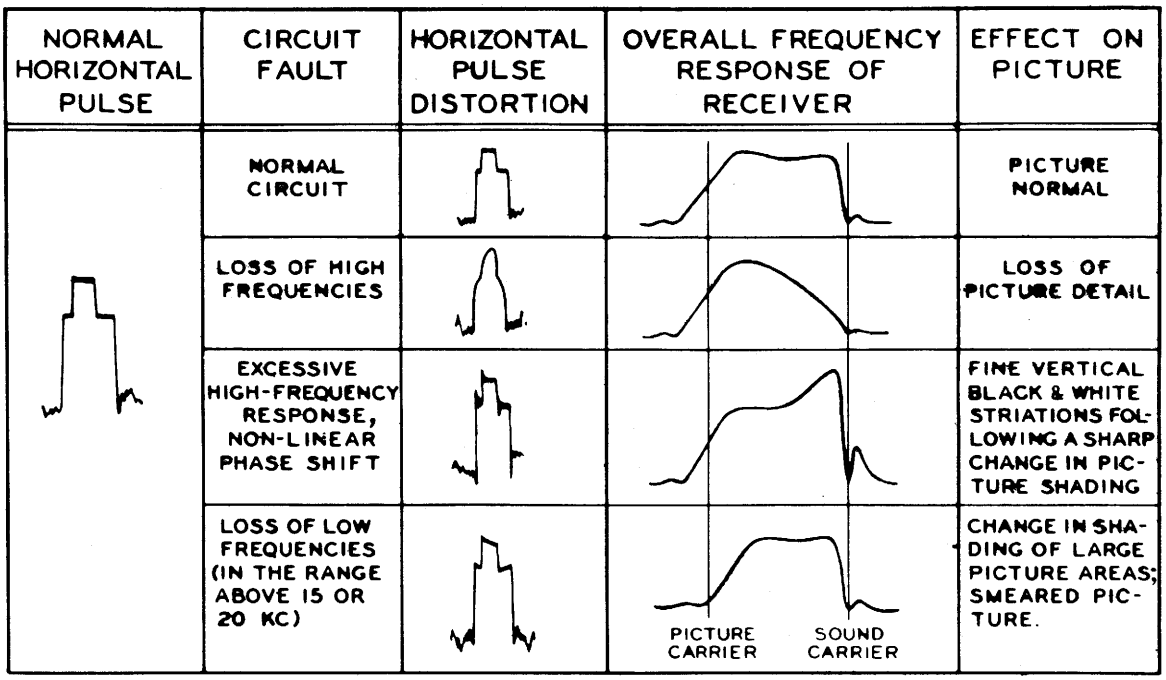


Figure 6. Sync-pulse distortion

(Continued from page 11)

1. Tune the television receiver to a television signal.

2. Rotate the INTENSITY control on the WO-33A clockwise. Set the SYNC control to "INT". Set the INTENSITY and FOCUS controls for the desired brightness and best focus.

3. Connect the WG-349A probe and cable connector to the V INPUT connector. Connect the ground lead to the receiver chassis. Connect the yellow probe clip to the grid terminal of the picture tube socket. It is not necessary that the picture tube be connected for this test.

4. Set the V RANGE switch and the V CAL control for a pattern of convenient height.

5. To obtain the horizontal-sync pulse on the WO-33A screen, set the H/SWEEP SEL control to the 1500 • 15 Kc position. Adjust the SYNC/PHASE control, if necessary, to obtain lock-in on the sync pulse, and adjust the SWEEP VERNIER control so that two complete waveforms appear on the screen. To obtain the vertical-sync pulse, set the H/SWEEP SEL to the 15 • 150 position. Readjust the SWEEP VERNIER for two complete waveforms. The pulses should resemble those shown in Figures 3 and 4.

Alignment

The process of television-receiver' alignment probably requires a greater amount of skill and understanding on the part of the service technician than does any other service function. Before undertaking alignment, it is important that the technician recognize the symptoms of a misaligned receiver.

The order in which various sections of the television receiver are aligned may differ between split-channel sound and intercarrier types. Different receivers of one system may also differ in the order of alignment. In all cases, however, the alignment order given by the manufacturer in his service notes should be followed.

For these reasons, it is not feasible to present a general alignment procedure applicable to all receivers. Some general precautions and suggestions for using the WO-33A Oscilloscope, however, are provided below to aid the television technician in servicing a receiver.

Applications

Successful servicing and maintenance of black-and-white and color-television receivers requires special techniques, not usually employed in the servicing of other electronic equipment. The general complexity and variety of circuits used in modern television receivers requires a great deal of knowledge on the part of the service technician and demands that test equipment be used properly.

The oscilloscope is of especial importance in the servicing of color receivers. A good television-service oscilloscope, such as the RCA WO-33A, may be used in signal tracing in every section of the receiver; the 'scope may also be used for making peak-to-peak voltage measurements in such important sections of the receiver as the sync and deflection circuits and in the video, chrominance, and luminance sections of color-TV receivers. In alignment work, where video, chrominance, and luminance circuit adjustments must be made to produce the desired waveshape, the oscilloscope is indispensable. The WO-33A may be used in all these applications.

Signal-tracing means tracing the television signal through various sections of the television receiver to determine how circuits are functioning in terms of the shape and voltage value of the waveform. As the signal passes from one stage to another in the receiver, the shape of the waveform may be altered, and the height, or voltage amplitude of the waveform may be changed. Whenever possible, the WG-349A probe should be used in the "LOW CAP" position for signal tracing the video amplifier and chrominance circuits because of the low input capacitance and consequent negligible loading of the circuit under test. When the WO-33A is calibrated as described under "Operation", it is possible to simultaneously read the voltage value and observe the shape of the waveform. The process of signal tracing is thus speeded up and it is possible to ascertain a circuit condition quickly.

NOTE: The applications described here apply both to color and to black-and-white receivers.

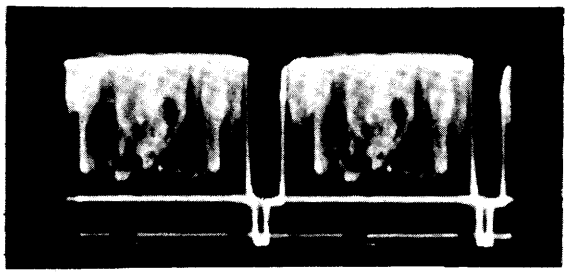


Figure 3. Horizontal-sync pulse in composite signal

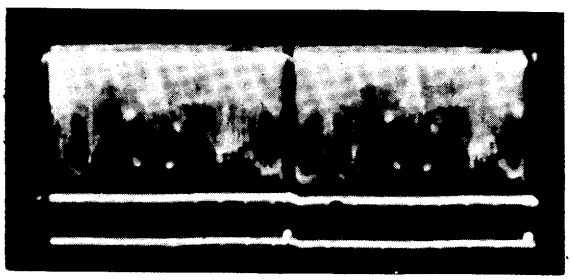


Figure 4. Vertical-sync pulse in composite signal

Analyzing Composite Television Waveforms

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. Photographs of the composite video signal are shown in Figures 3 and 4. The photographs are oscilloscope traces, and show what the composite video signal looks like as it proceeds through the video amplifier of a television receiver.

The television service technician 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-33A at various points in the video amplifier. Traces similar to those shown in Figures 3 and 4 may be obtained on the WO-33A as follows:

(Continued on page 14)

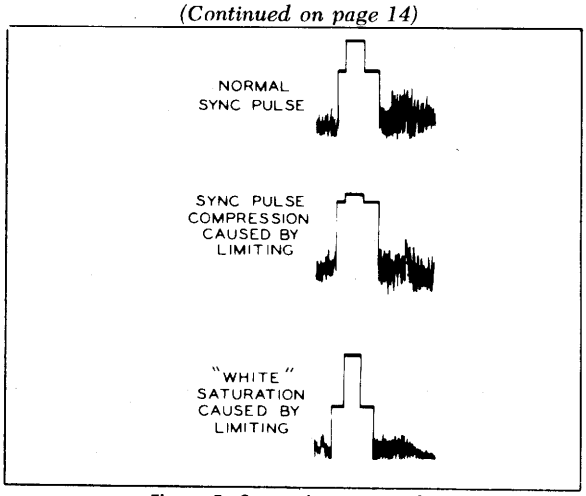
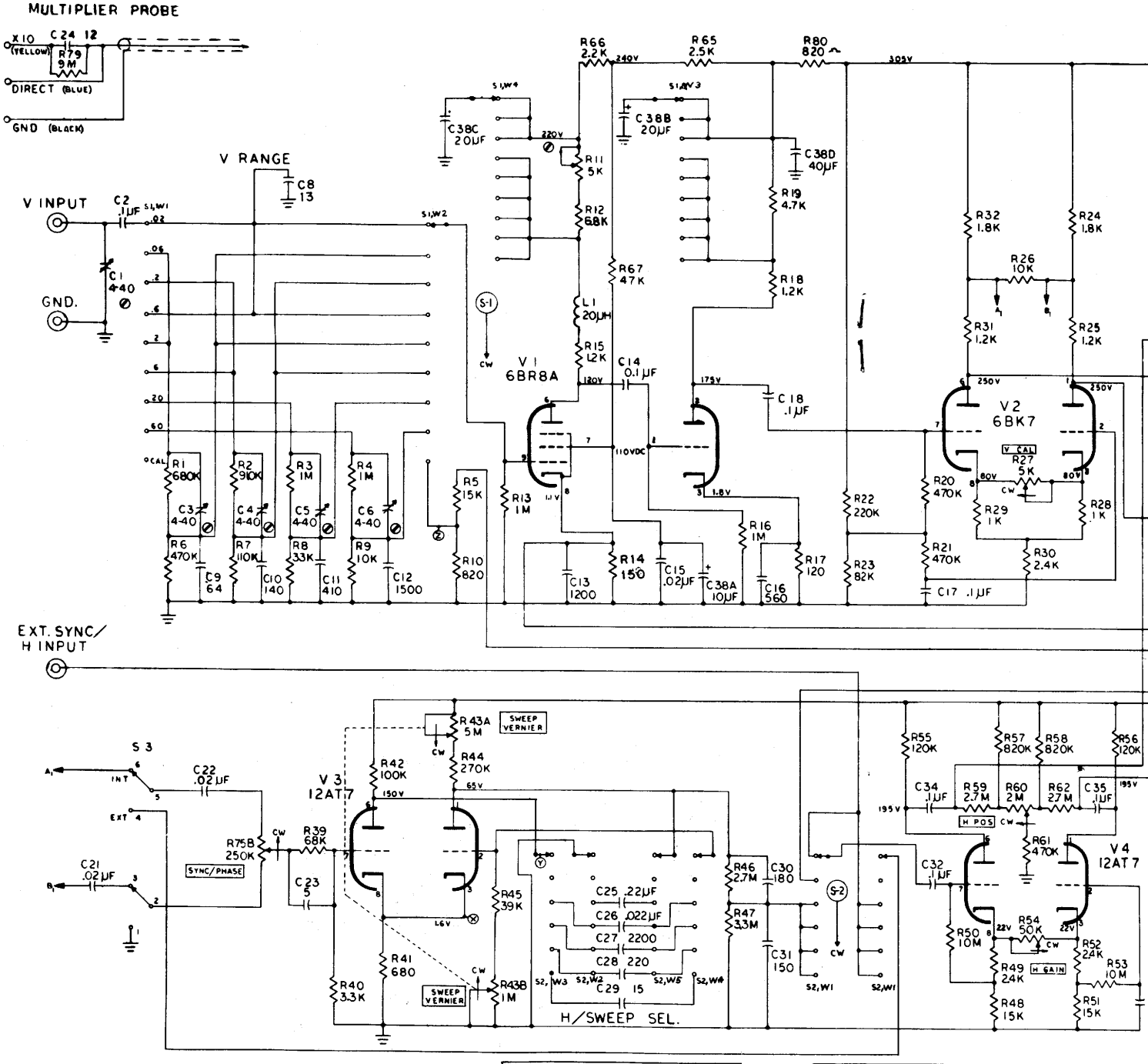


Figure 5. Sync-pulse compression



V RANGE FULL SCALE VOLTS (P-P) S-1

POSITION	RANGE	
1 (CCW MAX)	0.02	NARROW BAND
2	0.06	
3	0.2	
4	0.6	
5	2.0	WIDE BAND
6	6.0	
7	20.	
8	60	
9	CAL.	

H/SWEEP SEL. SW. S-2

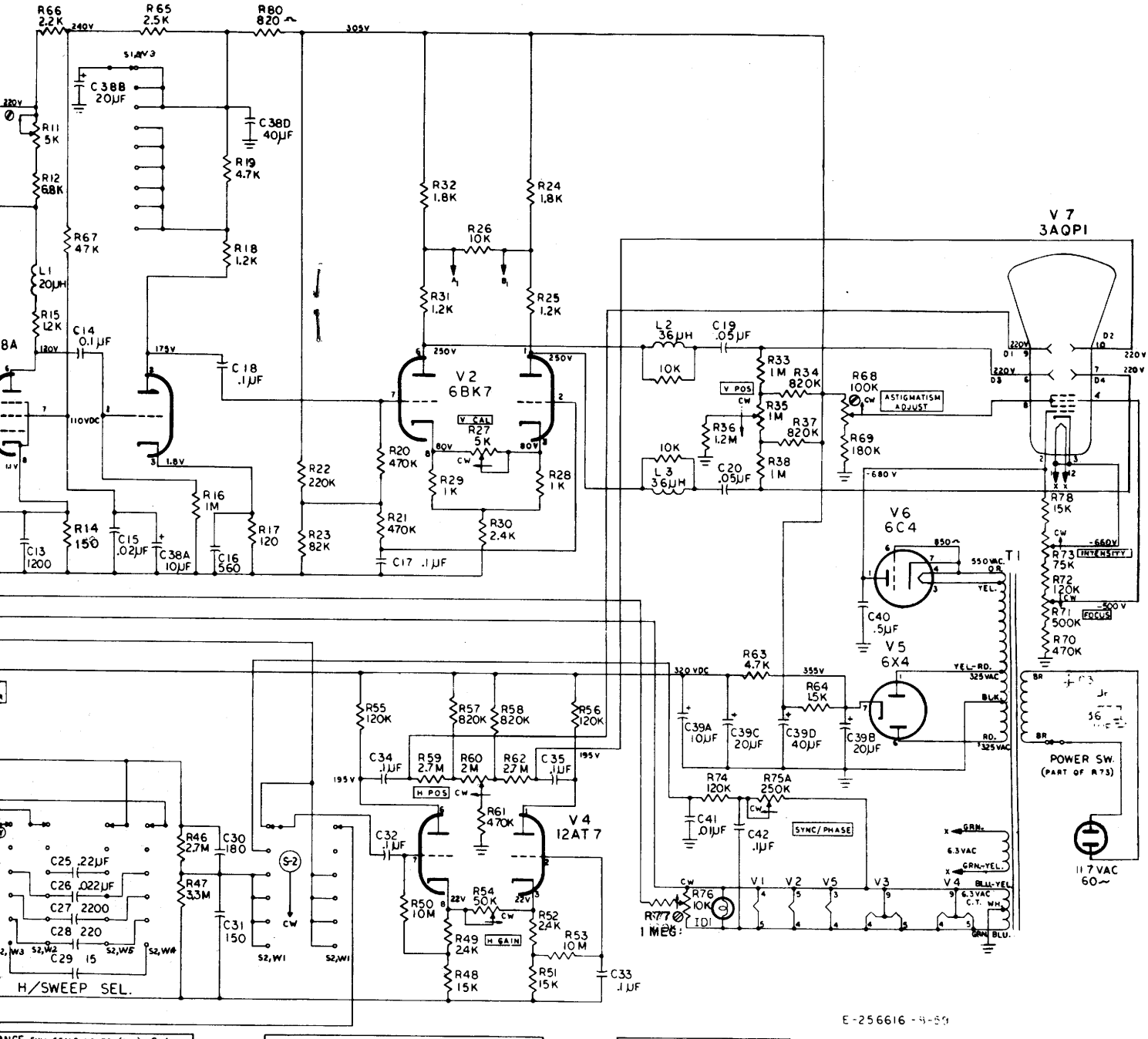
POSITION	RANGE	
1 (CCW MAX)	HOR. IN.	
2	LINE	
3	15 - 150	SWEEP
4	150 - 1500	
5	1500 - 15KC	
6	15KC - 75KC	

NOTES

ALL CAPACITORS IN μμF UNLESS OTHERWISE SPECIFIED.
ALL RESISTORS IN OHMS.
ALL VOLTAGES POSITIVE FROM GROUND, AND MEASURED WITH A VOLTOHMYST*
SWITCHES S-1 AND S-2 SHOWN IN MAXIMUM CCW POSITION
INSTRUMENTS WITH SERIAL NO.'S 1001 THRU 2300 HAVE TWO 0.01 μF DISC CAPACITORS BETWEEN THE AC LINE AND CASE GROUND

Schematic Diagram of WO-33A and WO-33A(K)

*TOHMYST" REG. U.S. PAT. OFF.



RANGE FULL SCALE VOLTS (P-P) S-1	
POSITION	RANGE
1 (CCW MAX)	0.02 (NARROW BAND)
	0.06
	0.2
	0.6
	2.0 (WIDE BAND)
	6.0
	20.
	60
	CAL.

H/SWEEP SEL. SW. S-2	
POSITION	RANGE
1 (CCW MAX)	HOR. IN.
2	LINE
3	15 - 150
4	150 - 1500
5	1500 - 15KC
6	15KC - 75KC

(SWEEP)

SYNC SW. S-3	
POSITION	RANGE
RIGHT	EXT
LEFT	INT.

Schematic Diagram of WO-33A and WO-33A(K)

Receiver alignment requires, in addition to the WO-33A, a sweep generator, a marker generator of crystal accuracy, and a vacuum-tube voltmeter. An RCA WR-59 or WR-69-series Sweep Generator, an RCA WR-39, WR-99 or WR-89 Calibrator, and an RCA VoltOhmyst*, such as the WV-77, WV-87, WV-97, or WV-98 are recommended.

Tuner Alignment – When preparing for tuner alignment, the manufacturer's recommendations should be followed closely. If the tuner has test points for connecting equipment, the test points should be used. The oscilloscope test point is usually connected internally to the mixer grid circuit where a demodulated signal is present.

The output cable of the sweep generator should be connected to the antenna input connectors. The ground lead of the WO-33A should be clipped directly to the tuner shield to minimize hum pickup on the sweep trace, and the WG-349A blue clip should be connected to the mixer grid circuit test point. If no test point is provided, the WG-349A may usually be connected to the grid circuit through a 5,000 to 10,000-ohm composition resistor.

It is important that the WG-349A be connected directly to the proper test point or, if a series resistor is used, that the lead length between the probe clip and the mixer grid circuit be kept as short as possible to prevent hum pickup and possible distortion of the tuner curve on the WO-33A. Hum pickup is evidenced by twisting of the base line when return-trace blanking is used on the sweep generator. This precaution is necessary because of the high-gain level at which the WO-33A is operated for tuner alignment.

The INTENSITY control should be turned clockwise to obtain a trace of suitable brilliance. The vertical gain controls should be set for maximum or near maximum gain. The output from the sweep generator and marker calibrator should be set at a low level to avoid over-loading the TV receiver, distortion of the sweep curve, and an erroneous picture of alignment on the oscilloscope screen.

When the WO-33A is used with a sweep generator, it is important that the two instruments be adjusted so that blanking is correct and the sweep of both instruments is in phase. If the phase adjustment is not properly set before starting alignment, the sweep

*Trade Mark "VoltOhmyst" Reg. U. S. Pat. Off.

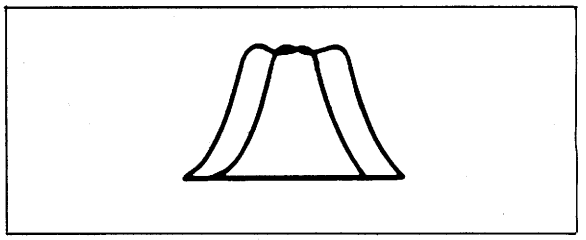


Figure 7. Double rf-response curve caused by improper setting of phasing control. No blanking used

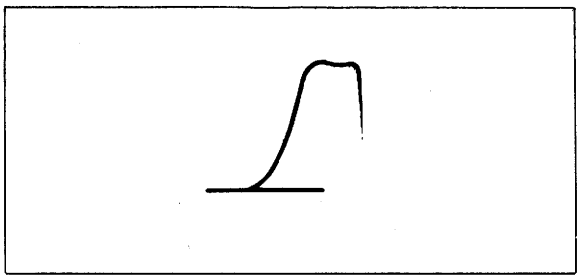


Figure 8. Sharp cutoff of response curve and misplaced base line with blanking indicate improper setting of phasing control

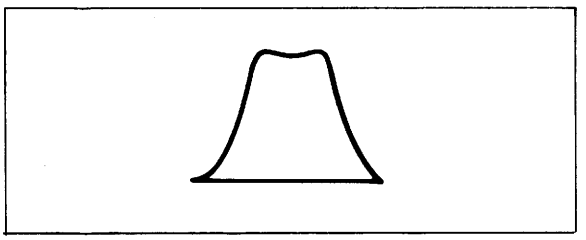


Figure 9. Typical rf-response curve

curve on the oscilloscope may be prematurely cut off or the curve may appear as a double or "mirror" image. These effects, shown in Figures 7 and 8, are sometimes misinterpreted as being caused by malfunctioning of test equipment although they may often be traced to improper tuner alignment.

The sweep generator may use either a sinusoidal or sawtooth sweep of line frequency. If a sinusoidal line-frequency sweep is used, the WO-33A may be driven internally by setting the H/SWEEP SEL control to "LINE". If a sawtooth sweep is used, the sweep generator deflection signal may be fed to the H INPUT terminal of the WO-33A. The H/SWEEP SEL should be set to "H IN". An internal sawtooth sweep may also be obtained by setting the H/SWEEP SEL to the 15 • 150 position.

If no blanking is used, the SYNC/PHASE control should be adjusted until the two response curves coincide on the oscilloscope screen. If blanking is used, the SYNC/PHASE control should be adjusted until the base line on the WO-33A screen extends the full width of the curve trace. An extremely sharp drop-off point on the response curve, which gives a "chopped-off" appearance to the trace short of the end of its sweep range, also indicates improper phasing. When a marker is superimposed on the response curve, improper phasing will cause two markers to appear on the curve. The SYNC/PHASE control should be adjusted to obtain the appearance of a single trace having only one marker. The setting of the SYNC/PHASE control is also important during sweep alignment of other sections of the receiver.

Serious misalignment of the tuner or considerable difficulty or failure in alignment may be caused by an unsuspected defective component. If proper alignment procedure fails to produce correct tuner curves, the technician should check individual components in the rf unit.

Picture-IF Alignment – To obtain an over-all picture-if response curve, the blue clip of the WG-349A probe should be connected across either the second detector load resistor or to the grid of the first video stage; test points which can provide a demodulated signal to the oscilloscope. The ground lead should be connected to the chassis. Because of the additional amplification in this section of the receiver, the oscilloscope gain should be considerably reduced, but not to the point where it is necessary to increase sweep-generator output.

Depending upon manufacturer's recommendations, it may be necessary to adjust the agc bias level, either through temporary wiring changes or by providing fixed battery bias. The service-notes should be followed closely because alignment procedure may involve considerable detail. Trap alignment is sometimes difficult because the marker disappears in the trap notch. This may often be overcome by magnifying the trap section of the trace with the V CAL and H GAIN controls.

Adjustment of the SYNC/PHASE control is also important when aligning the i-f sections of the receiver. The precautions and recommendations described under the section on tuner alignment, above, should be observed here. Controls on the WO-33A should be set the same as for tuner alignment except that less vertical gain will be required.

For observation of the response of individual stages in the picture-if amplifier, the WG-350A Demodulator Probe* should be used. This is a high-frequency rectifying-type probe. It is important that this probe be used properly and in accordance with service-note recommendations to prevent distortion of the response curve and an erroneous picture of alignment.

The WG-350A, which connects to the V INPUT of the WO-33A, is equipped with a short ground lead and clip. For alignment work, the ground clip of the probe should always be connected to ground near the test point being used for the WG-350A.

When the WG-350A is used to check individual stages, it should be connected on the output side of the stage being adjusted. For example, if the alignment of a coupling transformer is to be checked, the probe should be connected to the plate of the tube which has its grid coupled to the transformer. The tube thus acts as a buffer between the high-impedance grid circuit and the probe.

For general signal-tracing work, the probe may be moved from grid to grid throughout the i-f amplifier.

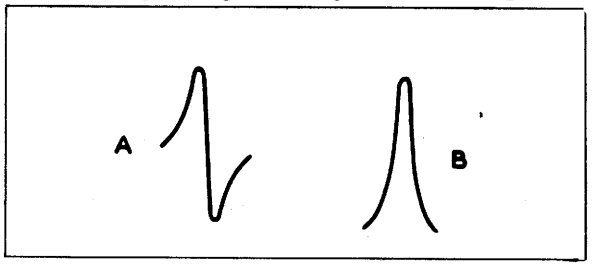


Figure 10. (A) Ratio-detector curve and (B) sound-if curve

Sound-IF and Detector Alignment – Most television receivers use either a discriminator or ratio detector. For either type, the WG-349A probe clip should be connected to the output of the sound detector. For detector alignment, the sweep and marker generators should be connected to the receiver as described in the service notes. An S-shaped curve, similar to that shown in Figure 10A, should be obtained on the oscilloscope screen. The setting of controls on the WO-33A should remain the same as before. A typical sound-if curve is shown in Figure

*Available on separate order.

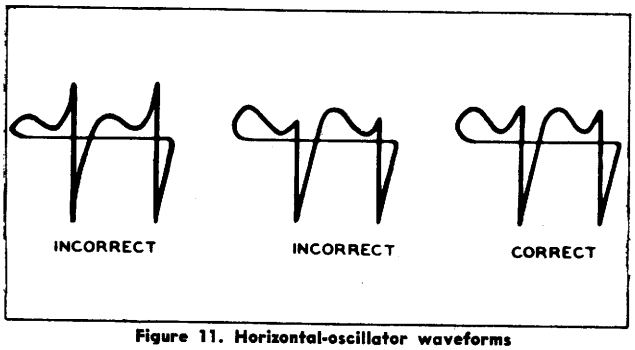


Figure 11. Horizontal-oscillator waveforms

10B. To obtain the sound-if response curve, the probe should be connected to either the grid-return of the limiter stage or to the grid-return of the last sound-if stage. The SYNC/PHASE control should be set no farther clockwise than necessary to lock in the waveshape.

Horizontal-Oscillator Adjustment — The WO-33A is well suited to adjustment of the horizontal oscillator and may be used as follows:

Set the H/SWEEP SEL control to the 1500 • 15 Kc position.

Adjust the SYNC/PHASE control to give stable lock-in of the waveshape, if necessary.

With the ground lead connected to the receiver chassis, connect the yellow clip of the WG-349A to the output of the horizontal oscillator, as described in the service notes. Connection to a typical horizontal-oscillator circuit is shown in Figure 12. Because the horizontal oscillator is a high-impedance circuit, the low-capacitance clip should always be used to reduce capacitance-resistance loading effects. Usually it is necessary to adjust the oscillator for suitable output waveshape. Typical horizontal-oscillator waveshapes which can be observed on the WO-33A are shown in Figure 13.

Sync-Separator Waveshape — To observe waveshapes in the sync-separator stage, the low-cap yellow clip should be used. Controls of the WO-33A should be set the same as for observation of the horizontal waveform. The probe clip should be connected to the plate of the sync separator or to the plate or grid of the sync amplifier.

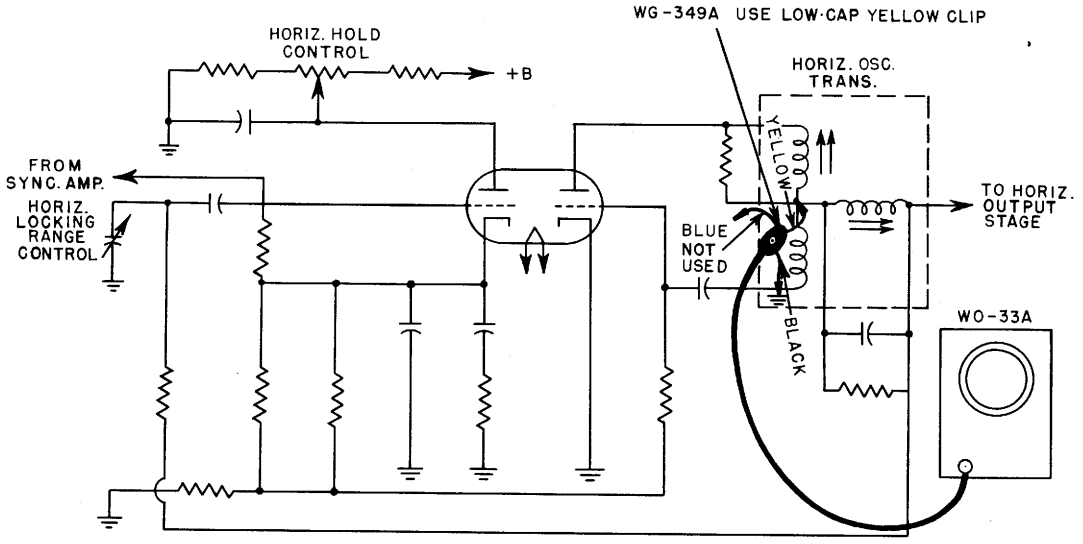


Figure 12. Adjustment of horizontal oscillator

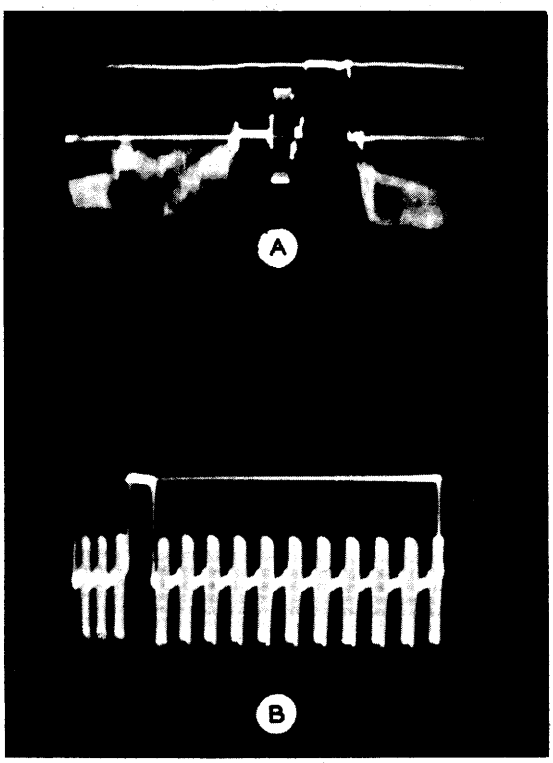


Figure 13. Color-TV signals as displayed by WO-33A. (A) Composite color-TV signal. Color-burst can be seen to left of sync pulse. (B) Output signal from RCA WR-61A Color-Bar Generator showing color-sync pulses and 10 color-bar pulses.

General Applications

Square-Wave Testing of Audio Amplifiers

The use of square waves for testing the characteristics of audio equipment has distinct advantages over other methods. A square-wave generator and the WO-33A Oscilloscope, when set up as shown in Figure 14, can provide a quick and accurate means of checking an amplifier and its adjustments. In this test setup, it is possible to check simultaneously the amplitude, phase, and frequency characteristics of the amplifier.

The value of the load resistance used depends upon the output impedance of the amplifier. It is important that the correct value be used. For an over-all check of amplifier response, the WO-33A should be connected directly across the load resistance, as shown.

It is desirable to employ square waves of at least two fundamental frequencies. The lowest fundamental frequency should be equal to approximately ten times the low-frequency limit of the amplifier being tested. A 100-cycle square wave should serve to check response from a few cycles to over 1000. If a square wave having a fundamental frequency of 2 Kc is used, the amplifier may be checked through the balance of the audible range.

The square-wave generator should be set to the proper frequency and connected to the regular input terminal of the amplifier. The WO-33A may be connected temporarily directly across the generator for a reference check of the waveform. The WO-33A may then be connected to various points in the amplifier to determine how each stage is functioning. The effect of various adjustments may be seen on the screen.

Care should be taken to prevent too large a signal from the square-wave generator from overloading the amplifier and causing distortion of the square wave.

Phase-Shift Measurements

To measure the phase shift of an audio network, apply a sine wave to the circuit under test and connect the direct probe to the output terminal of the network. This test signal should also be fed to the oscilloscope through the H INPUT and GND terminals. Set the H/SWEEP SEL control to the "H IN" position. If no phase shift exists, a sloping straight line will appear. Phase shift is indicated as an elliptical or circular trace. The method of calculating the degree of phase shift is shown graphically in Figure 16.

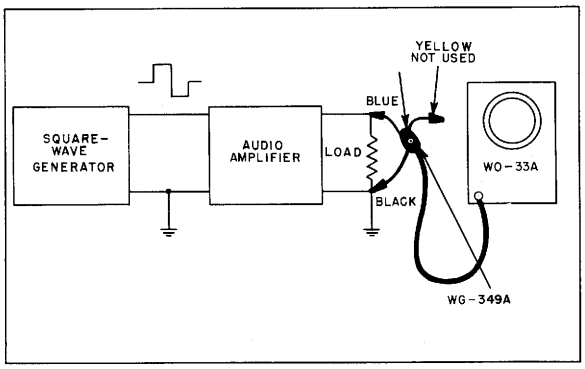


Figure 14. Audio amplifier test setup

Maintenance

CAUTION: Do not strike or subject the cathode-ray tube to more than moderate pressure as breakage of the tube may result in injury from flying glass. When the case of the instrument is removed, high voltages are exposed and the safety precautions outlined on Page 2 should be observed.

General

Performance of the WO-33A depends upon the quality of the components employed. If it should be necessary to replace any of the component parts, only RCA replacement parts or equivalents of those shown in the Replacement Parts List of this instruction booklet should be used.

The chassis may be removed from the case by removing two screws on each side of the case, and three screws from the bottom of the case. The panel and chassis assembly may then be pulled forward and out of the case.

If any alignment adjustments are made, the line voltage should be 117 volts at 50-60 cps. If trouble is encountered, voltage readings should be taken and compared with the operating voltages shown on the schematic diagram. Conventional trouble-shooting techniques should be used to locate trouble. Resistance and continuity checks can then be made to isolate the defective section or stage.

Astigmatism Adjustment

1. Turn on the WO-33A and allow at least 15 minutes warm-up time.

2. Set the H/SWEEP SEL to "LINE", the bandwidth control to "CAL", and adjust the PHASE, V CAL, and H GAIN control for a circular pattern approximately one inch in diameter.

3. With a screw driver, adjust potentiometer R-68 for best possible focus at all points on the circle. R-68 is located on top of the chassis.

Vertical Attenuator Alignment

Alignment of the frequency-compensated step-attenuator requires the use of a square-wave or clipped sine-wave signal of about 1000 cps in frequency.

1. Connect the blue clip of the WG-349A probe and cable to the square wave source.

2. Set the V RANGE switch to 60.

3. Adjust the scope controls so that two square waves, about an inch high and two inches wide are displayed on the screen.

4. Adjust C-6 so that the square waves are flat-topped, without overshoot spikes or drooping corners.

5. Reset the V RANGE control to 20, and reset the amplitude of the square wave generator. Adjust C-5 as in "4" above.

6. Repeat this process for V RANGE positions 6 and 2. The desired trimmer capacitor can be identified on the range switch by touching it with the finger and noting the appearance of a random noise signal on the CRT screen.

7. Now connect the square wave generator to the yellow clip of the WG-349A probe and cable. With the V RANGE control on position 2, adjust capacitor C-1 for a flat top trace without overshoot spikes or drooping corners.

Internal Calibrator Control Adjustment

1. Connect an audio oscillator or square wave generator to the blue clip of the WG-349A probe and cable. Set the V RANGE control to position 2. Adjust the signal source for full scale deflection on the CRT.

2. Transfer the signal source to the yellow clip lead of the WG-349A probe, and rotate the V RANGE control to position .2, and adjust potentiometer R-11 for full screen deflection.

RCA Repair Service

RCA maintains a complete repair service for the adjustment, calibration, and maintenance of RCA test equipment. If it becomes necessary to service this equipment, the report forms enclosed in this booklet should be filled out as described. It is important that:

1. Test equipment be packed carefully.

2. A full description of the trouble be included in the report.

Attention to these details will help prevent damage in transit and delay in repairs.

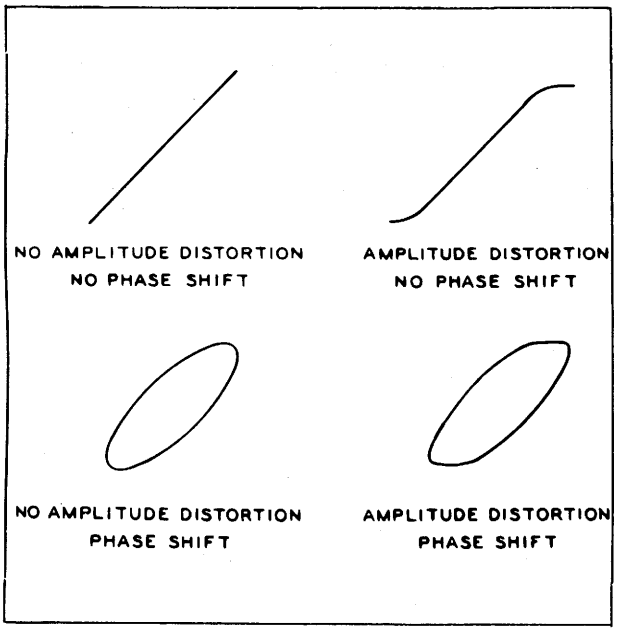


Figure 15. Distortion and phase shift in audio amplifier

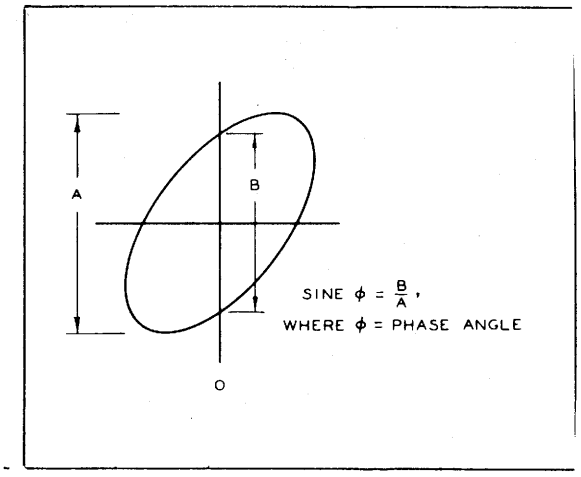


Figure 16. Measurement of phase shift

Frequency Measurements

Two methods may be used to determine frequency. In one method, a sine wave of known frequency is applied to the H INPUT terminal and the H/SWEEP SEL is set to "H IN". The unknown signal is fed to the V INPUT terminal. The resulting pattern, or Lissajous figure, indicates the ratio between the two frequencies. Typical Lissajous figures are shown in Figure 17.

In the other method of frequency measurement, the H/SWEEP SEL should be set at "LINE" to provide a sweep of line frequency. The signal of unknown frequency should be applied to the V INPUT terminal. If a stationary pattern is obtained on the oscilloscope screen, the frequency of the input signal must be equal to, a submultiple of, or a multiple of the line frequency.

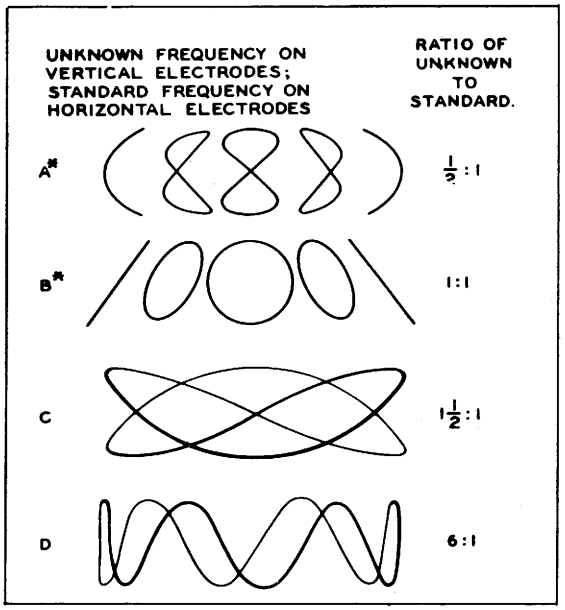


Figure 17. Lissajous figures

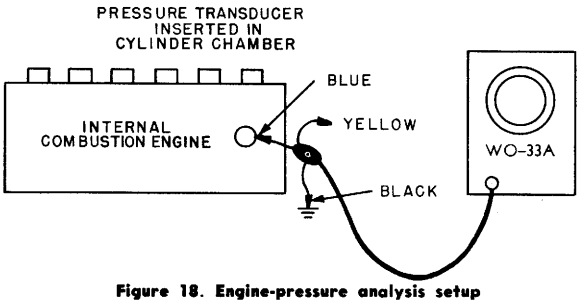


Figure 18. Engine-pressure analysis setup

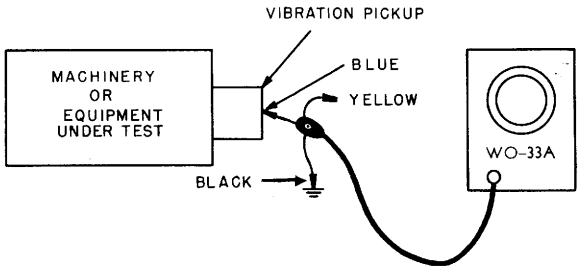


Figure 19. Vibration analysis setup

Industrial Applications

Use of the cathode-ray oscilloscope with a few auxiliary instruments has solved many perplexing problems both in the laboratory and in the service shop. The important applications of the oscilloscope are many. A few which serve to illustrate the wide range of possible applications are described below.

Engine-Pressure Analysis

When the WO-33A is used with auxiliary equipment such as is shown in Figure 18, variations in cylinder-head pressure developed in an internal-combustion engine or similar type machine can be shown on the oscilloscope screen. The oscilloscope has proven useful in the development of internal-combustion engines when used with engine pressure-measuring devices.

Vibration Measurements

The WO-33A can also be used with a piezo-electric transducer or with the RCA type 5734 mechano-electronic transducer for measuring vibration. Figure 19 shows a typical setup for observing vibration waveforms, indicating relative amplitudes and other characteristics of vibration on the oscilloscope screen.

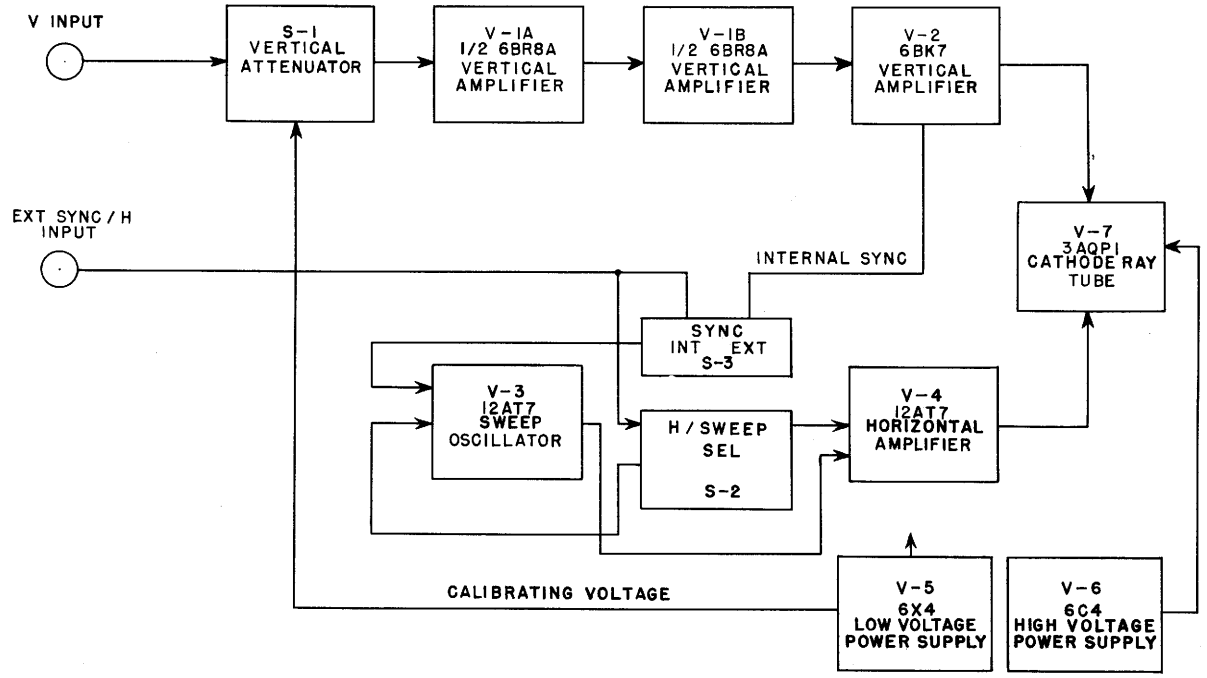


Figure 20. Block Diagram WO-33A

SYMBOL NO.	DESCRIPTION	STOCK NO.
	CAPACITORS	
C1, C3, C4, C5, C6	Trimmer, 4-40 $\mu\mu$f, Arco No. 422	
C2, C14, C17, C18, C32	Paper 0.1 μf, $\pm$20%, 400 V	
C8	Ceramic Disc, 22 $\mu\mu$f, $\pm$5%, 500 V	219215
C9	Ceramic Disc, 64 $\mu\mu$f, $\pm$5%, 500 V	219214
C10	Ceramic Disc, 140 $\mu\mu$f, $\pm$5%, 500 V	219205
C11	Ceramic Disc, 410 $\mu\mu$f, $\pm$10% 500 V	219206
C12	Ceramic Disc, 1500 $\mu\mu$f, $\pm$5%, 500 V	219207
C13	Ceramic Disc, 1200 $\mu\mu$f, $\pm$5%, 500 V	219216
C15, C21, C22	Ceramic Disc, 0.02 μf, 600 V	
C16	Ceramic Disc, 560 $\mu\mu$f, $\pm$5%, 500 V	219208
C19	Ceramic Disc, 0.05 μf, $\pm$20%, 200 V	219213
C20	Paper, 0.05 μf, $\pm$20%, 200 V	
C23	Ceramic Disc, 5 $\mu\mu$f, $\pm$20%, 150 V	104014
C24	Ceramic Tubular, 12 $\mu\mu$f, $\pm$5%, 500 V	
C25	Paper, 0.22 μf, $\pm$10%, 400 V	
C26	Paper, 0.022 μf, $\pm$10%, 400 V	
C27	Ceramic Disc, 2200 $\mu\mu$f, $\pm$5%, 400 V	219209
C28	Ceramic Disc, 220 $\mu\mu$f, $\pm$5%, 400 V	219210
C29	Ceramic Disc, 15 $\mu\mu$f, $\pm$5%, 500 V	219204
C30	Ceramic Disc, 180 $\mu\mu$f, $\pm$10%, 200 V	219211
C31	Ceramic Disc, 150 $\mu\mu$f, $\pm$10%, 200 V	219212
C33, C34, C35, C42	Paper, 0.1 μf, $\pm$20%, 200 V	
C38, C39	Electrolytic: 4 Sections	219127
C38A, C39A	10 μf, +100%, −15%, 450 V	
C38B, C39B	20 μf, +100%, −15%, 450 V	
C38C, C39C	20 μf, +100%, −15%, 450 V	
C38D, C39D	40 μf, +100%, −15%, 450 V	
C36, C37, C41	Ceramic Disc, 0.01 μf, 20%, 600 V	
C40	Paper, 0.5 μf, GMV, 1000 V	224112
	RESISTORS	
R1	Carbon Film, 680 K, 1/2 W, 5%	
R2	Carbon Film, 910 K, 1/2 W, 5%	
R3, R4, R13	Carbon Film, 1 M, 1/2 W, 5%	
R5, R48, R51	Carbon Film, 15 K, 1/2 W, 5%	
R6	Carbon Film, 470 K, 1/2 W, 5%	
R7	Carbon Film, 110 K, 1/2 W, 5%	
R8	Carbon Film, 33 K, 1/2 W, 5%	
R9, R26	Carbon Film, 10 K, 1/2 W, 5%	
R10	Carbon Film, 820, 1/2 W, 5%	
R11	Variable Wire Wound, 5 K, 2 W,	219121
R12	Composition, 6.8K, 1 W, 10%	
R14	Carbon Film, 100, 1/2 W, 5%	
R15, R18, R25, R31	Carbon Film, 1.2 K, 1/2 W, 5%	
R16, R33, R38	Composition, 1 M, 1/2 W, 10%	
R17	Carbon Film, 120, 1/2 W, 5%	
R19	Composition, 4.7 K, 1 W, 10%	
R20, R21, R61, R70	Composition, 470 K, 1/2 W, 10%	
R22	Carbon Film, 220 K, 1/2 W, 5%	
R23	Carbon Film, 82 K, 1/2 W, 5%	
R24, R32	Carbon Film, 1.8 K, 1 W, 5%	
R27	Variable, Carbon, 5 K, 1/2 W, 20%	219597
R28, R29	Carbon Film, 1 K, 1/2 W, 5%	
R30	Wire Wound, 2.4 K, 5 W, 5%	219125
R34, R37, R57, R58	Carbon Film, 820 K, 1/2 W, 5%	
R35	Variable, Carbon, 1 M, 1/2 W, 20%	219598
R36	Composition, 1.2 M, 1/2 W, 10%	
R39	Composition, 68 K, 1/2 W, 10%	
R40	Composition, 3.3 K, 1/2 W, 10%	
R41	Carbon Film, 680, 1/2 W, 5%	

SYMBOL NO.	DESCRIPTION	STOCK NO.
R42	Carbon Film, 100 K, 1 W, 5%	
R43	Variable, Dual Carbon, 1 M and 5 M, 1/2 W, 10%	219603
R44	Carbon Film, 270 K, 1/2 W, 5%	
R45	Carbon Film, 39 K, 1/2 W, 5%	
R46	Carbon Film, 2.7 M, 1/2 W, 5%	
R47	Carbon Film, 3.3 M, 1/2 W, 5%	
R49, R52	Carbon Film, 2.4 K, 1/2 W, 5%	
R50, R53	Composition, 10 M, 1/2 W, 10%	
R54	Variable, Carbon, 50 K, 1/2 W, 20%	219599
R55, R56	Carbon Film, 120 K, 1/2 W, 5%	
R59, R62	Composition, 2.7 M, 1/2 W, 10%	
R60	Variable, Carbon, 2 M, 1/2 W, 20%	219600
R63	Composition, 4.7 K, 1/2 W, 10%	
R64	Wire Wound, 1.5 K, 7 W, 10%,	219123
R65	Wire Wound, 2.5 K, 5 W, 10%,	219124
R66	Composition, 2.2 K, 1/2 W, 10%	
R67	Carbon Film, 47 K, 1/2 W, 5%	
R68	Variable, Carbon, 100 K, 1/4 W, 20%	219201
R69	Composition, 180 K, 1/2 W, 10%	
R71	Variable, Carbon, 500 K, 1/2 W, 20%	219601
R72, R74	Composition, 120 K, 1/2 W, 10%	
R73	Variable, Carbon, 75 K, 1/2 W, 20%, (Includes AC Switch)	219602
R75	Variable, Dual Carbon, 250 K and 250 K, 1/2 W, 20%	219604
R76	Variable, Carbon, 10 K, 1/4 W, 20%	219202
R77	Composition, 100 K, 1/2 W, 10%	
R78	Composition, 15 K, 1/2 W, 10%	
R79	Carbon Film, 9 M, 1/2 W, 1%	226414
R80	Composition, 820, 1 W, 10%	
	COILS	
L1	Coil, Peaking, 20 μH, 5%	219130
L2, L3	Coil, Peaking, 36 μH, 5% (On Comp. Res., 10 K, 1/2 W, 20%)	219129
	SWITCHES	
S1	Switch, Rotary (V Range) 9 Positions, 4 Sections	219199
S2	Switch, Rotary (H/Sweep Sel.) 6 Positions, 5 Sections	219200
S3	Switch, DPDT (Sync)	106478
	MISCELLANEOUS	
T1	Transformer, Power	219122
ID1	Lamp, Pilot, No. 47	
XID-1	Lampholder and Jewel, Pilot,	
	Socket, Tube, Min., 9 Pin, Wafer,	57761
	Socket, Tube, Min., 9 Pin, Molded,	
	Socket, Tube, Min. Bakelite, 7 Pin,	
	Socket, CRT, Wafer Type,	
	Panel, Front	219119
	Graph Screen	219258
	Bezel, Graph Screen	219128
	Board, Laminated Circuit	219203
	Binding Post	212151
	Clamp,	
	Connector, Miniature Microphone, Male,	
	Connector, Miniature Microphone, Female,	

SYMBOL NO.	DESCRIPTION	STOCK NO.
	Foot, Rubber,	
	Grommet, Rubber,	
	Cord, Power,	
	Knob, Blue Plastic	59543
	Knob, Black Rubber	94878

SYMBOL NO.	DESCRIPTION	STOCK NO.
	Clip, Minigator,	
	Insulator, Mini-Clip,	
	Shell, Probe (2 pieces)	219485
	Handle, Black,	219120


RCA