RCA
Plain Talk
and Technical Tips

Nov.-Dec., 1970 • Volume 13/No. 11-12

CTC 49 Field Training

RCA field representatives are embarking on a nationwide program to acquaint service personnel with the technical and service features of the new Trans Vista® CTC 49 chassis. In the weeks to come, RCA field representatives will contact thousands of service agencies, spending a few minutes in each to demonstrate the CTC 49. During the visit, the service technicians will be shown how the plug-in circuit-board modular construction of the CTC 49 chassis provides exceptional serviceability. With eleven modules containing nearly all of the chassis circuitry, it becomes a simple matter to trace a trouble to a particular module; as will be demonstrated by means of a number of simple service procedures which allow a substantial part of the chassis circuits to be checked for correct operation without the need for test equipment.

Each location visited by an RCA representative will receive a package containing service information on the CTC 49, a service aid for the CTC 44 chassis, a small book describing the KCS 185 black and white chassis, and several other important pieces of literature for each dealer location. The CTC 49 information includes RCA Television Service Data 1970 T-19 which contains complete service and parts information, and a wall-size CTC 49 schematic. To further familiarize the service technician with the CTC 49 chassis, the package contains a book entitled **"Trans Vista 100 Technical Manual—The CTC 49 Color Chassis."** This attractive volume features a detailed circuit description of the CTC 49 chassis along with two chapters devoted entirely to servicing. The modular KCS 185 chassis is described in the book entitled **"Portable AC/DC Trans Vista Television."** This useful book describes the circuit operation of the chassis, and, like the CTC 49 book, contains a section devoted to servicing.

These major publications and several other items of specific interest are contained in the literature package. The value of this information to you the service technician will be pointed out during the visit by the RCA field representative.

Figure 1—CTC 49 Technical Manual

Figure 2—KCS 185 Technical Manual

A monthly publication for the service industry prepared by RCA Sales Corporation

Color Television Servicing Aids

RCA provides service technicians with a variety of television servicing information. Your Service Data subscription, for example, includes "Plain Talk and Technical Tips." The Data subscription also includes the easily recognized blue and white "Service Tips," a publication specificially for the service industry, whose contents are schematic changes, parts list changes, and often a new or changed service procedure. So it would be wise for you to use this wealth of information advantageously by keeping it carefully filed, so that it may be quickly found when servicing a particular chassis.

For the past several years, RCA Technical Training has provided detailed training on each color television chassis as it is introduced. This is done in cooperation with the RCA Consumer Electronics Products Distributor in your area. Supporting information on each chassis are one or more publications which provide detailed circuit operation and service procedures that will simplify the servicing of these chassis.

Beginning some three years ago—with the Workshop on the CTC 38 chassis—training has been provided to great numbers of technicians. At the workshop training sessions, technicians have received valuable service information; many of you who have attended these workshops have this material close to your service bench. But how many of you actually use the material you have received advantageously? For the short period after the training session, while this material is still fresh in mind, the procedures are certainly used. But it is rather hard for anyone to fully remember information provided as long as three years ago. Thus, when you have a chassis to service with a specific problem, it is entirely possible that the servicing of the circuit involved was covered in detail in one of the service workshops you attended in the past.

In order to reacquaint you with the materials which have been provided for your assistance in servicing specific color chassis, the following page lists, by workshop number and chassis designation, the circuit areas covered in each of the individual training sessions.

SERVICING THE CTC 38 COLOR CHASSIS WORKSHOP—4

CTC 38—COLOR STAGES
CTC 38—CHROMA BANDPASS STAGES
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SERVICING THE CTC 40 SOLID-STATE COLOR CHASSIS WORKSHOP—5

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CTC 40—ISOLATING SYNC PROBLEMS
CTC 40—VIDEO AMP STAGES—SIGNAL TRACING
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CTC 40—ISOLATING COLOR PROBLEMS
CTC 40—CHROMA SIGNAL TRACING
CTC 40—CHROMA OSCILLATOR, ACC AND KILLER CHECKS
CTC 40—AFPC ADJUSTMENTS
CTC 40—TROUBLESHOOTING DEMODULATORS AND DIFFERENCE AMPLIFIERS
CTC 40—VERTICAL DEFLECTION STAGES—VISUAL ISOLATION
CTC 40—VERTICAL DEFLECTION—SIGNAL TRACING/SYNC CHECK
CTC 40—VERTICAL DEFLECTION—DC ISOLATION
CTC 40—HORIZ AFC—OSCILLATOR
CTC 40—HORIZONTAL WAVEFORMS
CTC 40—QUICK-CHECK HORIZONTAL TROUBLESHOOTING
CTC 40—TROUBLESHOOTING HORIZONTAL DEFLECTION
CTC 40—POWER SUPPLIES
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CTC 40—RF/IF RESPONSE CHECK
CTC 40—CHROMA ALIGNMENT CHECK

TEST EQUIPMENT and APPLICATIONS WORKSHOP—6

CURRENT MEASURING TECHNIQUES
IDENTIFYING TRANSISTOR ELEMENTS
METER PROBES
COLOR BAR/DOT/CROSSHATCH GENERATOR
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FUNCTIONAL DIAGRAM OF WO 91 SCOPE
VERTICAL SECTION OF WO 91 SCOPE
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COMPOSITE VIDEO WAVEFORMS
SCOPE TESTS OF VERTICAL SYNC
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COLOR TELEVISION ALIGNMENT TECHNIQUES WORKSHOP—7

THE SWEEP GENERATOR
THE MARKER GENERATOR
THE MARKER ADDER
THE WR 514 CHANALYST
EQUIPMENT CHECKOUT
RECEIVER PREPARATION
ALIGNMENT CHECK ANTENNA TO VIDEO DETECTOR
ALIGNMENT CHECK ANTENNA TO CHROMA DEMODS
INPUT TRAP TUNING
LINK RESPONSE CURVE
OVERALL IF RESPONSE
4.5 MHz TRAP ADJUSTMENT
VSM PREPARATION, CTC 40
VSM CHROMA ALIGNMENT

SERVICING THE CTC 44 COLOR CHASSIS

CTC 44—ALIGNMENT DETAILS
CTC 44—SERVICING DC TINT CONTROL CIRCUIT
CTC 44—ACCU-TINT OPERATION CHECK
CTC 44—TROUBLE SHOOTING ACCU-TINT
CTC 44—SERVICING DC COLOR CIRCUIT
CTC 44—HIGH VOLTAGE QUADRUPULER SERVICE CHECKS
CTC 44 REMOTE—VHF CHANNEL-CHANGE
CTC 44 REMOTE—UHF CHANNEL-CHANGE
CTC 44 REMOTE—VHF to UHF SWITCHING
CTC 44 REMOTE—COLOR, TINT, VOLUME MEMORY MODULE
CTC 44 REMOTE—DC VOLUME CONTROL

Transistors and Miller-Feedback

Part Two

Part one of this article, appearing on page 3 of the last issue, discussed the adverse effect of Miller-Feedback on the high-frequency gain of an amplifier. Sometimes it is indeed desirable for an amplifier's high-frequency response to be restricted. This is often accomplished by including R-C low-pass filter networks at the input or the output. Other times, the designer chooses to use Miller-Feedback to his advantage by connecting a capacitor or an R-C network from the collector to the base of a stage as shown in Figure-3.

High-Frequency Roll-off

Example A of Figure-3 is an audio stage that might find use where high-frequency roll-off is required. One application for this configuration might be matching the rising frequency characteristics of ceramic phonograph cartridges to achieve a flat output. Also this technique can be used to roll-off the gain of an audio amplifier above the maximum desired high-frequency response to prevent noise or high frequency instability. The advantages offered by the negative feedback of C1 are twofold: The frequency controlling effect of C1 is the same as would be obtained by connecting a capacitor whose value is equal to the stage voltage-gain multiplied by the value of C1. Often a 10-times reduction in the value of C is realized by using the feedback circuit instead of a base to ground capacitor. As a second advantage, the negative feedback acts to reduce distortion at high frequencies by an amount equal to the high-frequency gain reduction.

Low-Frequency Boost Circuit

Example B shows the amplifier response when an R-C network is used. At low frequencies, gain is maximum because little or no signal is fed back to the base. At a chosen frequency, the reactance of C1 is low enough that gain reduction begins, allowing the output signal to decrease. This action continues until a frequency is reached where the reactance of C1 equals the resistance of R1. Past this frequency, resistor R1 controls the feedback to set the amplifier gain, and output signal at a given level that is independent of frequency. This circuit might be used to furnish bass-boost in an audio preamplifier. A **BASS** control, of the low-frequency cut type, at the output will allow the user to set the desired bass response.

The Integrator

An amplifier with purposely limited high-frequency response may be used as an integrator in pulse circuits. The text book example of an integrator circuit is shown in Figure-4. The series R and shunt C arrangement rejects higher frequency signals just as example A of Figure-3. In more conventional terms, this circuit is called a low-pass R-C filter.

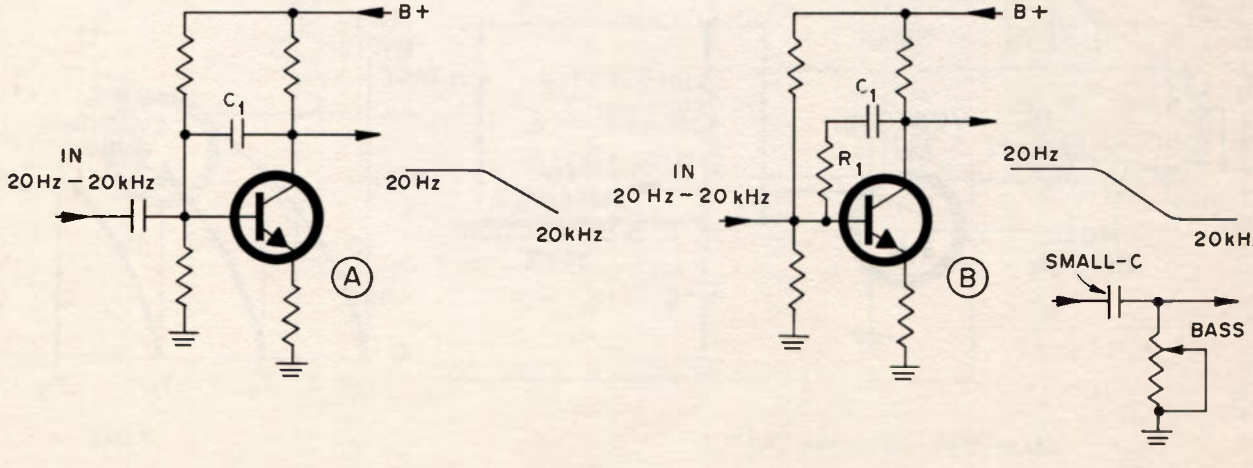

Figure 3—Miller-Feedback Amplifier Circuits

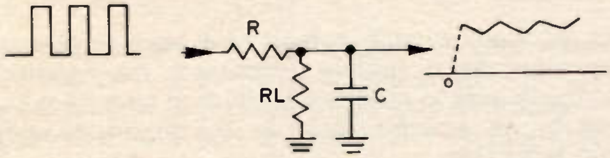

Figure 4—Simple Integrator

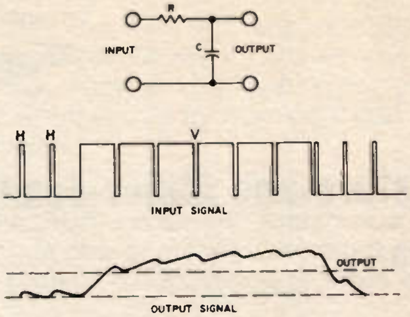

Figure 5—TV Vertical Integrator

This same R-C configuration is used in pulse circuits to integrate (a form of averaging) a series of pulses with respect to time. When the R-C time constant of the circuit is correctly chosen, the integrated output voltage will reflect the average amplitude and duration of the input pulses. So long as the input amplitude and pulse duration are constant, the integrated output will be a steady voltage with a ripple component at the pulse rate. If one or the other changes (duration or amplitude) the output voltage will change.

This simple integrator circuit is used to extract the vertical-sync pulse in most TV receivers. The output of the sync separator is a train of pulses at the horizontal line frequency. During the scan of a field, the pulse width is narrow and the pulses are of constant amplitude, as shown in Figure-5. The integrator output is a low and reasonably constant voltage during the scan interval. At the end of a field scan (beginning of vertical blanking) the pulse width increases (these wider pulses are known as vertical sync pulses) and the integrated output voltage increases as illustrated. This voltage increase is adequate to trigger the vertical oscillator; thus, vertical sync is provided to the oscillator. The same action could be obtained with a suitably designed low-pass amplifier, such as previously discussed, although there is no particular advantage to using the transistor circuit for this function, as the component values required to integrate sync pulses are easily and economically available.

An integrator is sometimes used to generate a sawtooth vertical deflection voltage. At 60 Hz (vertical field frequency) the capacitor required to produce a linear voltage change with respect to time becomes quite large. Figure-6 is a simplified schematic of a vertical sawtooth circuit used in some television chassis. This circuit is merely an R-C network with a transistor operating as a 60 Hz switch to discharge the capacitor during vertical retrace. When the time constant of the network ($T = R \times C$) equals .0168 seconds (1/60th of a second) the upper curve is produced. During

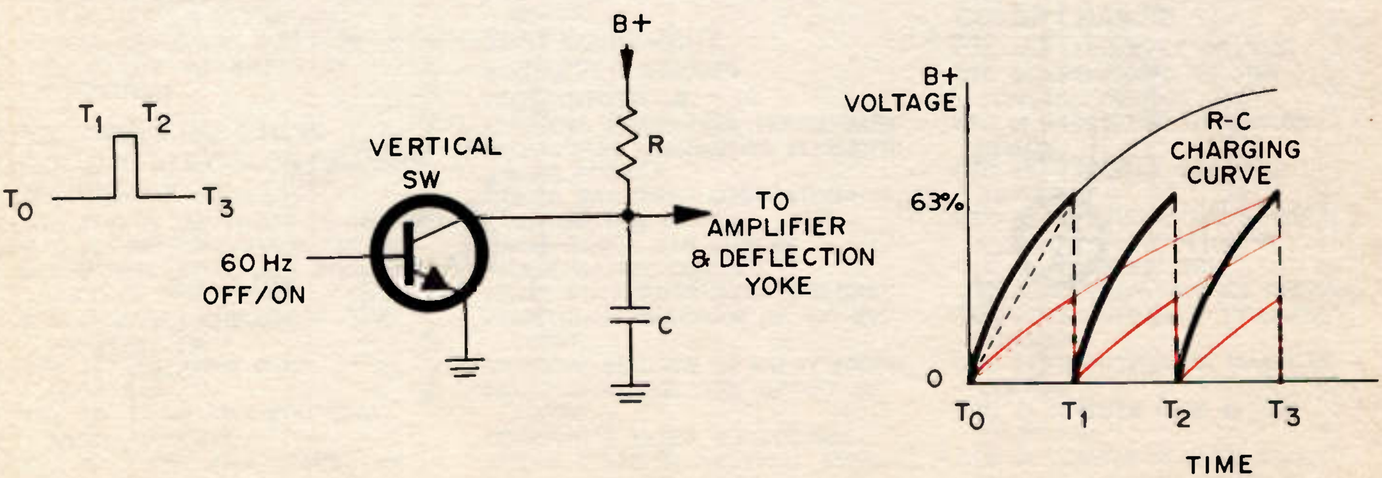

Figure 6—Simple Vertical Sawtooth Generator

the 1/60-second interval from T_0 to T_1, capacitor C charges to 63% of the B+ voltage. Notice that the voltage change from T_0 to T_1 approximates a a linear change, although the "bow" at the middle of the curve would certainly produce a poor (non-linear) picture. If the time constant of the R-C network is made longer, 3-times in +LC case of the bottom curve, the voltage change from T_0 to T_1 traverses a smaller portion of the R-C charging curve; consequently, the voltage change is more linear. Notice, however, that the actual peak-to-peak voltage is substantially reduced, making additional amplifier gain necessary. Close examination of the two R-C curves should make it evident that the longer the R-C time constant, the more linear the voltage change and the lower the voltage. Thus, a circuit of this type requires a large value of C and high amplifier gain.

High gain transistor amplifiers are quite practical; however, the low input impedance of a transistor amplifier requires a low impedance RC network to prevent excessive loading. Hence, a very large value is required for capacitor C in order to satisfy the linearity and loading requirements.

Remembering back, it was stated that a collector to base feedback capacitor would appear at the input of the amplifier as a capacitor from base to ground whose value is equal to the collector-base capacitor multiplied by the open-loop (no feedback) voltage-gain of the amplifier. In the case of single stages, a capacity multiplication of perhaps as high as 100 is practical.

Miller-Rundown Vertical Deflection

The same concept of Miller-Feedback can be extended to multi-stage amplifiers with astonishing results. The CTC 40 was the first RCA chassis to use a Miller-Feedback Amplifier as a vertical deflection circuit. Since then several other chassis have used this system. These include the CTC 44, CTC 47, CTC 49, and the KCS 185. The CTC 40, 44, 47 version of the Miller-Feedback Amplifier, or "Miller-Rundown Circuit" as it is sometimes known, uses a three-stage amplifier with an "open-loop gain of about one-million which is transformer coupled to the deflection yoke. Figure-7 illustrates the manner in which the negative feedback loop is connected from the output to the input of the amplifier.

For the sake of simplicity, two additional feedback loops, extending from the output of the amplifier to the base of the 60 Hz switch transistor, have been omitted. One of the loops is positive feedback which raises the overall gain of the transistor-switch/amplifier system to a point where self-sustaining oscillation will occur at a frequency somewhat higher than 60 Hz. The other feedback path is overall output to switch input negative feedback whose amplitude is adjustable by means of the **VERTICAL-HOLD** control. This controllable feedback allows the free-running frequency of oscillation to be adjusted to slightly less than 60 Hz. By so doing, the vertical-sync pulse, which is also applied to 60 Hz switch transistor, will trigger the vertical system, forcing it to run in step with the broadcast signal.

Assuming now that the circuit of Figure-7 will indeed oscillate at a locked 60 Hz, it is time to analyze the Miller-Feedback aspects of the circuit. The simple R-C circuit of Figure-6 was not practical because of the exceedingly large value capacitor needed for C. When Miller-Feedback is used in conjunction with a high-gain amplifier, as done in the CTC 40, a small value capacitor (.47 μF in the CTC 40) when multiplied by an open-

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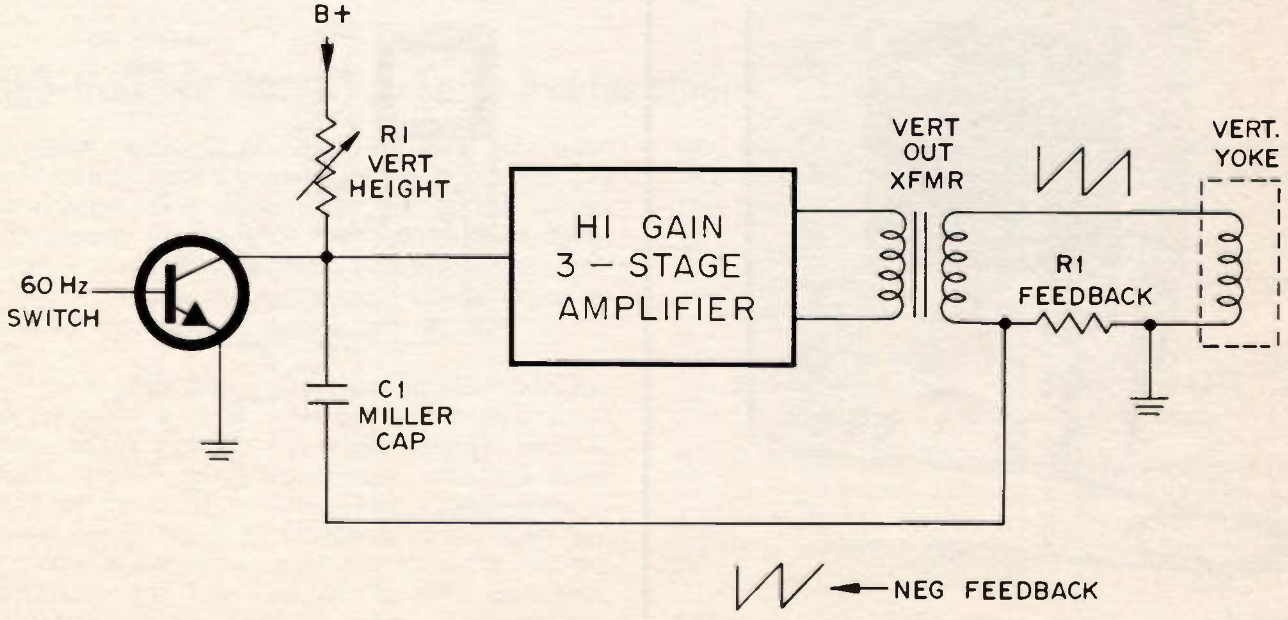


Figure 7—Simplified Block Diagram of Miller Run-Down Vertical Sweep Circuit

WO-505A Solid State Oscilloscope

RCA Electronic Components Division is now offering the new WO-505A solid-state 5-inch oscilloscope which has a number of outstanding features including retrace blanking, a laboratory type flat face cathode ray tube, an illuminated graph screen, and oscilloscope camera mounting studs. The last two features make the WO-505A useful for industrial, laboratory, and experimentor applications. This new instrument also includes all of the necessary features of a service type oscilloscope.

The vertical amplifier frequency response is flat within ± 1 dB from DC to 5 MHz, and features 15 millivolts peak-to-peak per inch sensitivity, making the WV-505 useful for measurement of low amplitude signals such as those experienced in the chroma circuits of many color receivers. To assist in the direct measurement of peak-to-peak voltages, the vertical input attenuator and graph screen of this new oscilloscope are calibrated directly in volts and an internal calibrated voltage source is provided to allow quick and convenient calibration of the vertical amplifier gain. As with other RCA oscilloscopes, the WO-505A provides external terminals on the back of the case to allow direct connection to the vertical deflection plates of the cathode ray tube, allowing observation of RF waveforms with frequencies higher than the bandpass of the vertical amplifier.

Six adjustable horizontal sweep frequency ranges are included, extending to 1 MHz. This high sweep frequency permits observation of signals of up to 10 MHz. Either positive or negative internal synchronization is provided in addition to the external and line sync positions. Horizontal and vertical rate television waveforms are easily observed with the WO-505A. Preset TV vertical and horizontal sweep rate positions insure automatic lock-in on vertical and horizontal sync pulses. To accommodate sweep alignment equipment, the WO-505A includes a line sweep position and phase control so that this new oscilloscope is compatible with the RCA WR-69 sweep generator as well as the new WR-514 Chanalyst television generator. Also, this new oscilloscope features internal voltage regulation to prevent trace bounce and amplifier gain changes such as caused by power-line voltage variations.

Deflection Component Testing (Ringing Check)

As an additional plus, the WO-505A may be used for deflection component ringing tests with no internal modifications. To make a ringing check it is only necessary to connect a small value capacitor of approximately 68 pF to the "Z" blanking terminal on the rear panel of the scope. A clip lead from the free end of the capacitor is connected to the winding of the component to be tested and the oscilloscope probe is also connected to the same point. Next, the scope horizontal frequency control is adjusted and the vertical amplitude is adjusted until a ringing pattern similar to those shown in Figure 10 is produced. Of course, the exact frequency, and the shape of the damped wavetrain is determined by the electrical characteristics of the inductor. For example,

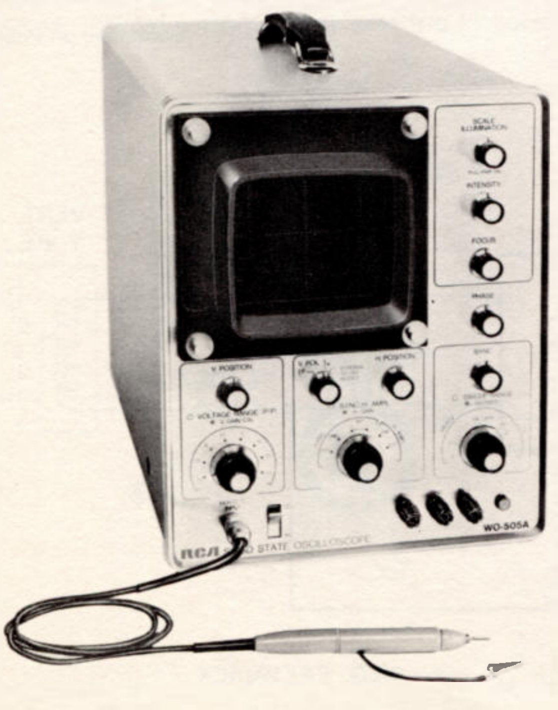


Figure 8—WO-505A Oscilloscope

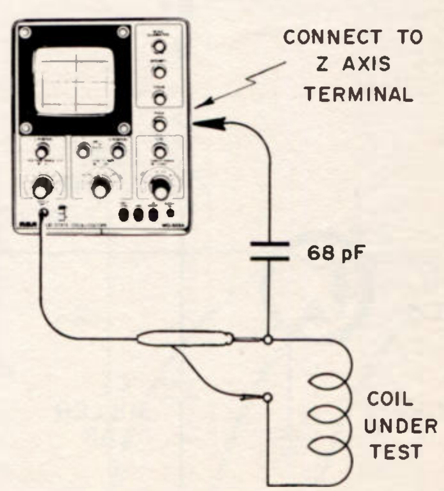
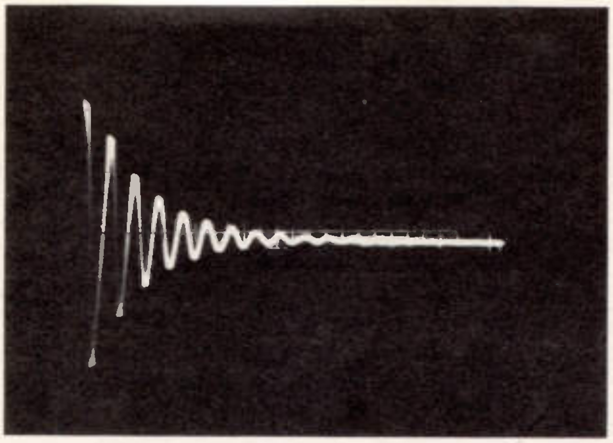
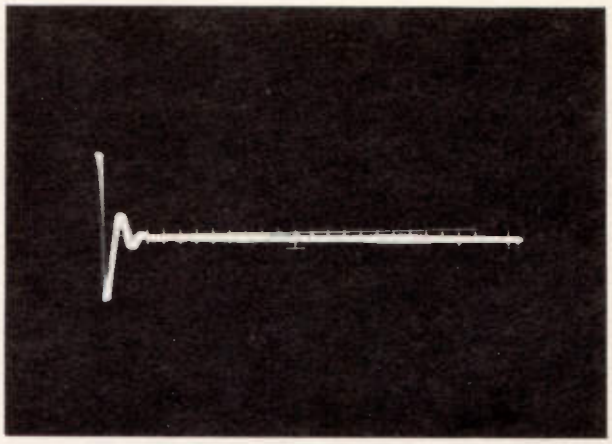


Figure 9—Ringing Test Set-up



A—Good Component



B—Component with shorted turns

Figure 10—Ringing Waveforms

a higher Q inductor will produce a longer wavetrain than would one of lower Q, as shown in Figure-10A. Shorted turns act to lower the Q of an inductor and consequently would produce a shorter wavetrain such as that of waveform B. Thus, this is the basis for the ringing check in that a deflection component having shorted turns will produce an abnormal ringing waveform.

This leaves the question of what is normal and what is abnormal. One way to determine what is a normal ringing waveform is to ring another component of the same type which is known to be good. Another way, and one which can be used if no replacement component is at hand, is to observe the pattern when ringing the component and then produce an artificial short by winding a turn of wire or solder around the inductor. Notice whether the wavetrain is shortened by this added shorted turn. Obviously, if the component already has shorted turns the addition of another shorted turn should have little or no effect. Hence, it might be concluded that a radical change in the amplitude and the length of the ringing waveform occurring when the external shorted turn is connected would indicate that the component is probably good.

There is one other consideration, however, and that is in components operating at high-voltage, the horizontal output transformer for example, the suspected problem might be caused by arcing between adjacent turns which might not be revealed with the low test voltages used in this scope ringing check. This leads to the conclusion that all good components will ring as will some bad ones. This does not imply however that this check cannot be used, for in most instances shorted turn failures will have low enough resistance to make visible indication in the ringing pattern.

High-Voltage Rectifier Tube Replacement

Excessive callbacks are the dirge of a television service shop. And too many of these wounds are self-inflicted. One example of this is the simple replacement of the high voltage rectifier tube. Simple— if a few elementary precautions are followed. If they are not, component failure (such as flyback transformer damage) can result.

RCA color television instruments produced in the last few years have an interlock-type high voltage compartment wherein the high voltage rectifier tube is automatically disconnected when the compartment cover is opened. The tube-to-flyback connection is made by insertion of the tube top cap into a specially-constructed cavity on the transformer tire. The tube top cap must be seated completely into the cavity to ensure a corona-free connection. Corona is suppressed by the plastic ring around the cavity and by the silicone grease in the cavity. To ensure proper seating of the top cap when replacing the tube:

1. Insert the tube pins completely into the tube socket then pull back out an eighth to one-quarter inch.
2. Position the cover so that the tube top cap is directly in line with the cavity. The tube position can be varied slightly in its socket.
3. Slide the cover toward its closed position maintaining correct alignment. After the tube cap contacts the cavity, press the cover firmly to its completely closed position. This ensures proper cap-to-cavity contact.

Other callback prevention measures to consider when changing the high voltage rectifier tube are:

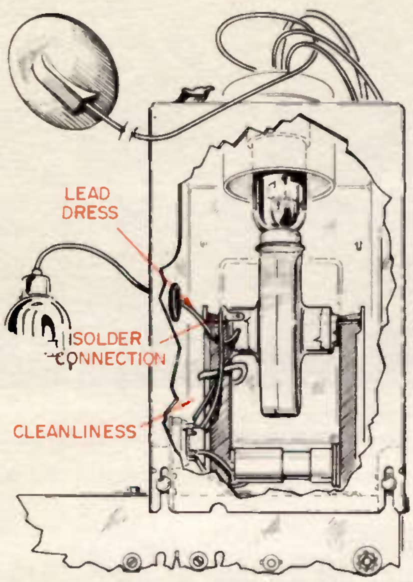


Figure 11—Things to Consider

Lead Dress

Dress all leads away from the transformer tire, tube and yoke socket terminals, and other connections. Check for discolored or missing insulation. Make certain the high voltage rectifier tube filament leads, picture tube second anode lead, and regulator tube leads are dressed properly.

Cleanliness

Dirt, metalic chips, and solder splashes are the enemies of high voltage circuits. Use a **clean dry** rag to wipe the interior of the high voltage compartment, the transformer, and the high voltage rectifier tube socket. **Caution:** Do not remove the silicone grease in the tube top cap cavity on the transformer tire, because this special grease aids in corona suppression.

Solder Connections

All solder connections must be rounded. Be certain that stranded wires have no loose conductors at solder joints.

CTC 44 Remote On/Off

Remote control-equipped CTC 44 chassis (CTP-19A Remote Control Chassis) use a bistable relay to switch the AC power "on" or "off". The bistable relay has a ratchet wheel arrangement that alternately closes and opens the relay contacts. In order for the ratchet wheel to step from position-to-position, the relay must be pulsed. The required pulse is provided when the "on/off" button of the CRK 16A remote hand-unit, or the manual touch-bar "on/off" switch is tapped (momentarily depressed). When the instrument is "off" and the touch-bar or remote "on/off" is tapped, a voltage pulse draws the relay armature down, allowing the ratchet wheel to step halfway to the "on" position. The release of the relay armature, occurring when the voltage pulse is removed from the relay coil, allows the ratchet wheel to rotate the remaining increment thereby closing the contacts to complete the AC power circuit. In the event the remote or manual "on/off" button is held down, the receiver will not come "on" because the bistable relay has not been allowed to completely "step" to the "on" position. When the instrument is turned "off', however, the ratchet action opens the relay contacts immediately when the relay receives the voltage pulse.

Transistors and Miller-Feedback

Continued from Page 5

loop voltage gain of perhaps one-million times acts as an extremely large capacitor from base to ground. For this reason, the R-C time constant of R1 and C1 is extremely long. This means that in the interval of time required to scan one field (1/60-second), the voltage at the amplifier input, which is produced by C1 charging to B+ through the **VERTICAL-HEIGHT** control, transverses only a minute segment of the R-C curve. The voltage change is so minute, in fact, that the total voltage swing is in-the-order of a few millivolts. Thus, the base voltage of this transistor, for all practical purposes, appears to be almost constant. This is due to the fact the feedback voltage derived from sampling the vertical deflection sawtooth current opposes the voltage change that would result if C1 were connected to ground, as in the circuit of Figure-6. Consequently, the amplifier input voltage is held nearly constant; the only change being the few millivolts difference between the voltage ramp produced by capacitor charging and the 180° out-of-phase voltage feedback from current sampling resistor R1. These voltages, counteracting one-another, furnish the base signal required to drive the amplifier.

In summary, the CTC 40 type Miller-Rundown vertical circuit offers a degree of sweep linearity hitherto unobtainable without sophisticated linearity correction circuitry that requires a vertical-linearity service adjustment. All of this is accomplished with a circuit little more complex than an audio amplifier, by making good use of the Miller-Effect —the same one cursed by RF circuit designers.

RCA Sales Corporation

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Product Performance—Technical Training

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