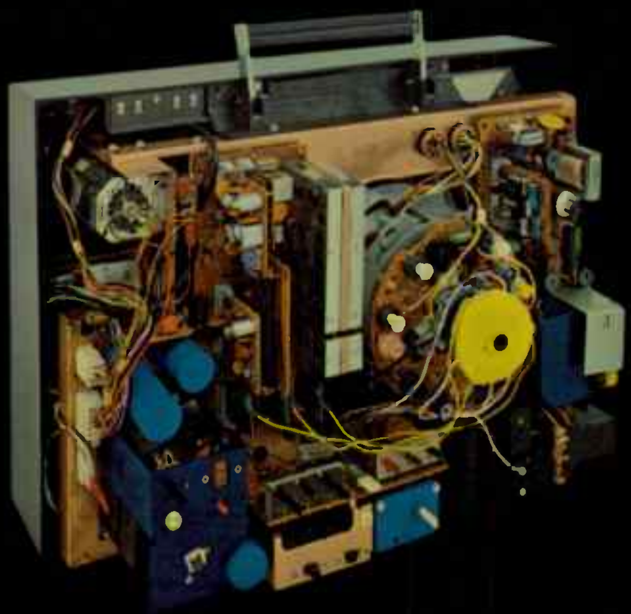
RCA



Trans Vista 100 Technical Manual

The CTC 49 Color Chassis

Trans Vista 100

Technical Manual

The CTC 49 Color Chassis

Prepared By

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A Subsidiary of RCA Corporation

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Indianapolis, Indiana 46201

Price $4.50

First Edition 7032
Printed in U.S.A.

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FOREWORD

The CTC 49 chassis represents the first of a "new breed" of RCA all-solid-state color television receivers. This is particularly true from the standpoint of servicing. The extensive use of plug-in circuit modules, eleven in all, a tuner which may be exchanged without the need for realignment of the coupling circuit to the IF amplifier, a solid-state high-voltage quadrupler, which essentially is another module, and the use of plug-in transistors makes it possible to correct most failures with very little servicing effort.

In the preparation of this manual less than the usual space was devoted to circuit description for three reasons. First, some of the circuitry bears a close resemblance to earlier RCA chassis. This is true of the tuner, AFT, and horizontal deflection system, which are similar to their counterparts in either the CTC 40 or CTC 47 chassis; and the sound module which is almost identical to the one used in the CTC 41, 42, and 43 chassis. Second, integrated circuits are used in the IF and chroma circuits, and a stage-by-stage analysis of these systems has little value to the service technician, since many active devices are packaged in a single unit. Third, since most repairs can be accomplished most readily by module replacement, rather than by replacement of a single component, an intimate knowledge of the function of each part in a module is not essential to the technician.

Complete schematic diagrams of the various circuits were used instead of partial or simplified diagrams. This will allow the technician to identify all components of a particular circuit without tracing the interconnecting lines used in the complete instrument schematic which is bound in the back of this manual. Whenever possible the location of components in the diagrams located in the text is indicated; however, the complete instrument schematic should be consulted to verify component locations and intermodule connections.

Servicing information contained in this manual is divided into two chapters. The first of these discusses techniques and procedures for rapid servicing either in the home or the shop. The final chapter goes into greater detail and considers those areas of servicing which require the facilities and equipment normally found only in the service shop.

1

GENERAL DESCRIPTION

The RCA CTC 49 chassis is a fourth-generation solid-state color receiver, employing, for the first time, plug-in modules for most of the essential functions. The CTC 40 chassis, introduced in 1968, is the first of the RCA solid-state color receivers; however, a vacuum-tube high-voltage rectifier was used in that instrument. Next in order of introduction was the RCA CTC 47 chassis (the G-2000), which was released in 1969. This instrument retained most of the circuits used in the CTC 40, but several significant changes were incorporated in its design. The electronically tuned VHF tuner and signal-seeking UHF tuner of the CTC 47 are important advances in the state of the electronic art, and because of their spectacular performance they tend to overshadow two other important advances. These are solid-state high-voltage rectification, using a voltage quadrupler, and motorless remote control, of volume, tint, and color.

The RCA CTC 44 chassis represents the third generation of solid-state color receivers and comprises many of the basic circuit configurations of the CTC 40, upgraded in many respects, plus the high-voltage quadrupler and motorless remote control of volume, tint, and color, from the CTC 47.

The CTC 49 is a natural outgrowth of these predecessors; however a number of radical changes have been made. Two of these are perhaps equally significant. These are modular construction, and the extensive use of integrated circuits. Other advances include active side-pincushion correction, transformerless vertical output, matrixing of the color-difference and luminance signals before they are fed to the kinescope, significant changes in the convergence circuits, and a 110° color kinescope. These will be described in this book, but before proceeding to circuit descriptions, an overall examination of the chassis is in order.

Figure 1-1 is a block diagram of the RCA CTC 49 chassis. A total of eleven plug-in modules is used; a brief description of each module follows:

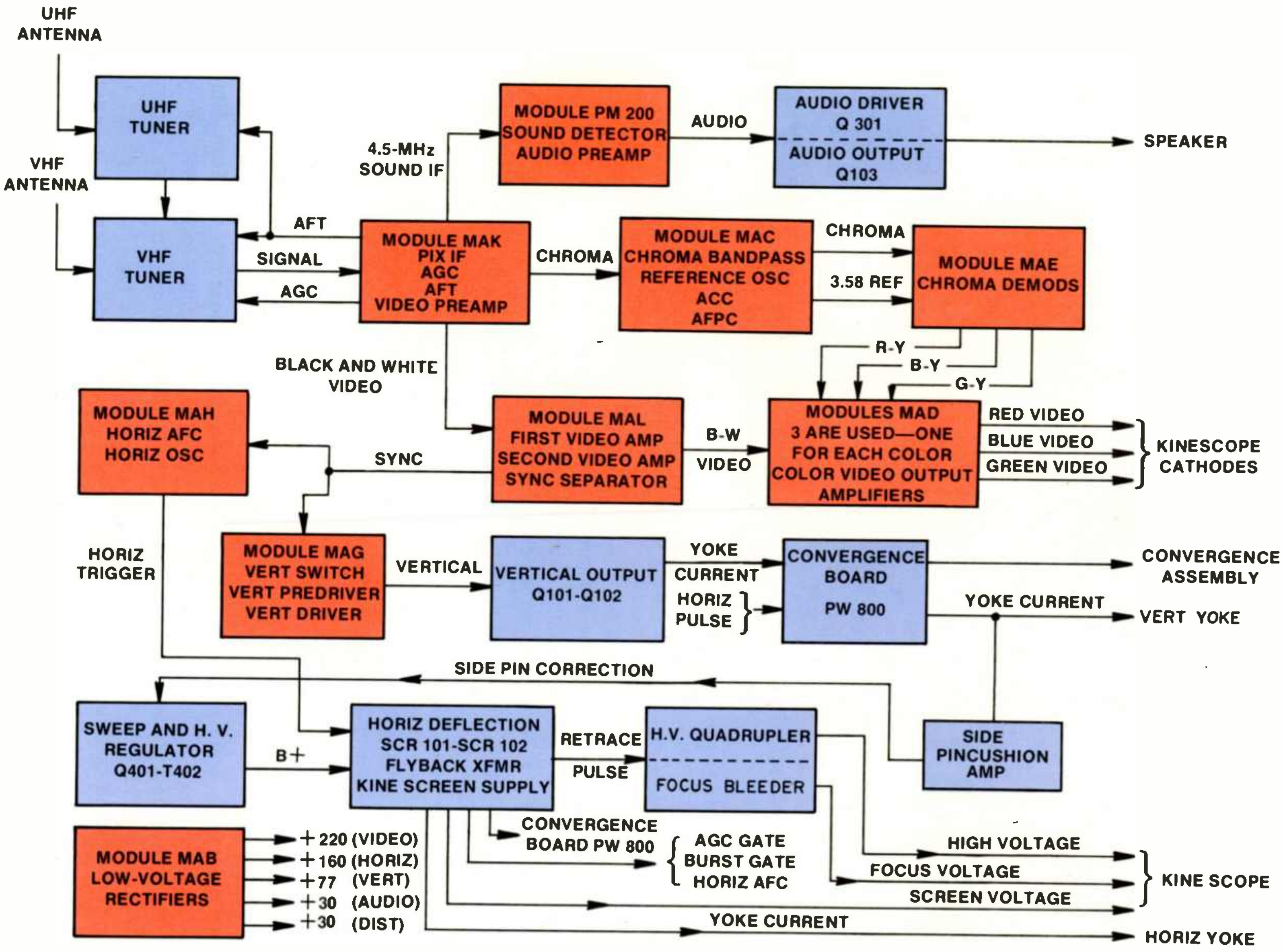
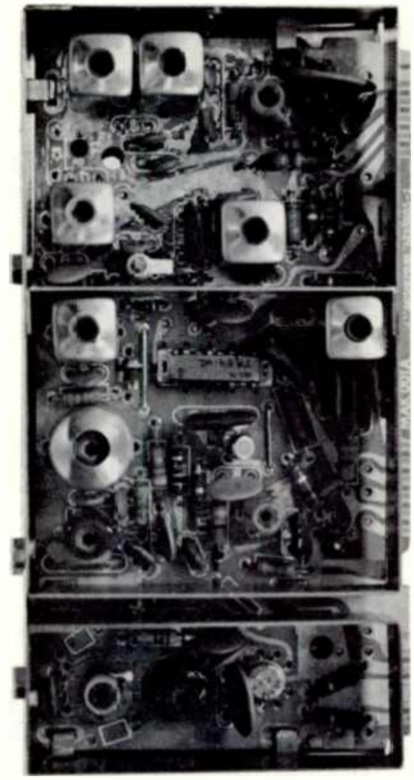


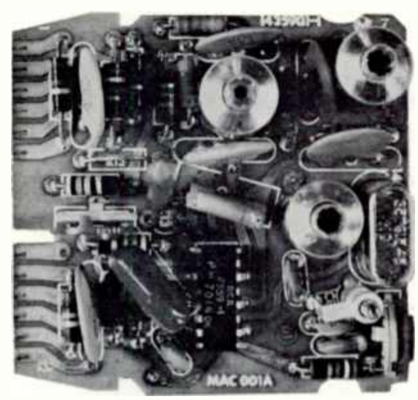
Figure 1-1 Functional Diagram of the RCA CTC 49

Module MAK



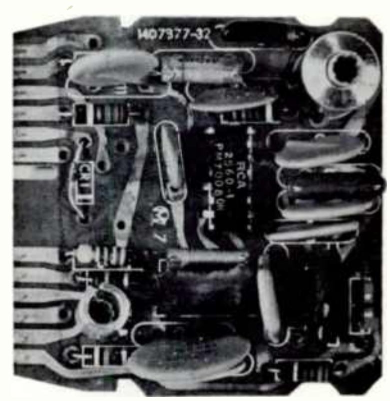
The active devices in this module are two transistors and two IC's. IC 1 contains all the IF amplifiers and the keyed-AGC circuit. IC 2 is used for AFT. Q1 is the voltage regulator transistor for IC 1. Q2 is the video preamplifier, an emitter follower which couples the video detector and amplifier contained in IC 1 to modules MAC and MAL.

Module MAC



The single active device in this module is IC 1, which performs all the functions of the chroma-bandpass amplifiers, color killer, ACC, AFPC, and 3.58-MHz reference oscillator found in earlier receivers. In addition, a DC reference voltage developed in this IC is used as control voltage for the voltage regulator of Module MAE. In turn, regulated voltage, +11.2 volts, is supplied to this module from Module MAE.

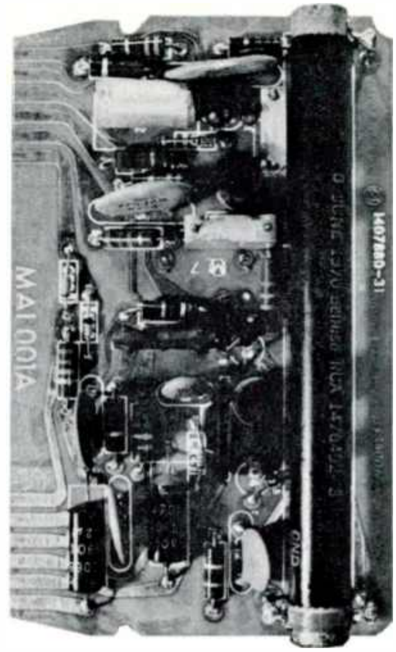
Module MAE



This module performs functions similar to the discrete-component chroma demodulators and color-difference amplifiers of the CTC 40 and CTC 47. All this is performed in IC 1. The single transistor in this module, Q1, provides regulated 11.2 volts for Modules MAC and MAE.

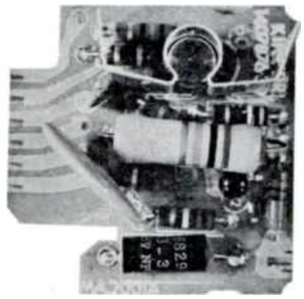
Module MAL

Two video amplifiers and the sync separator are located in this module. The brightness limiter, brightness control, peaking control, and contrast control (located on PW 300) are connected into this module.



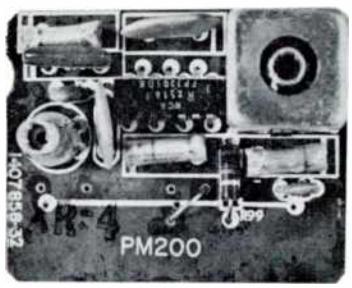
Module MAD

Three of these modules are used, one for each color of video. Black-and-white video from MAL is fed to all three of the MAD modules; the appropriate color-difference signal from MAE is applied to each of them. The outputs of the three MAD modules are fed to the cathodes of the kinescope. Two transistors are used in each MAD module.



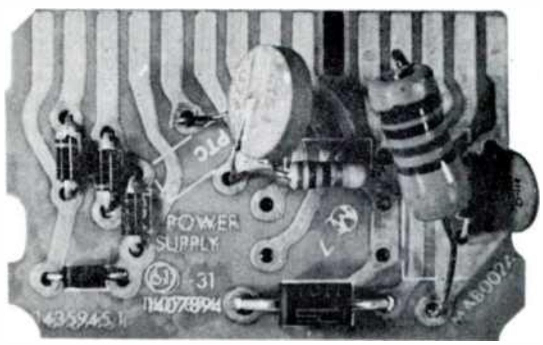
Module PM 200

The sound detector, which recovers audio from the 4.5-MHz sound signal, and the low-level audio amplifier are combined in a single integrated circuit which is mounted with several passive components in this plug-in module.



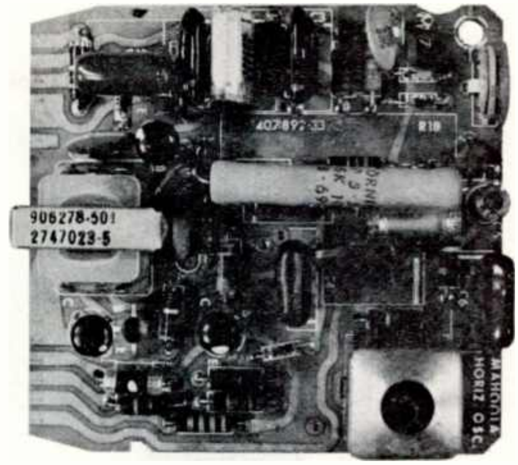
Module MAB

Six diodes, used as power-supply rectifiers, part of the degaussing circuit and several minor components are located on Module MAB. The power transformer and filter capacitors are located on the main chassis.



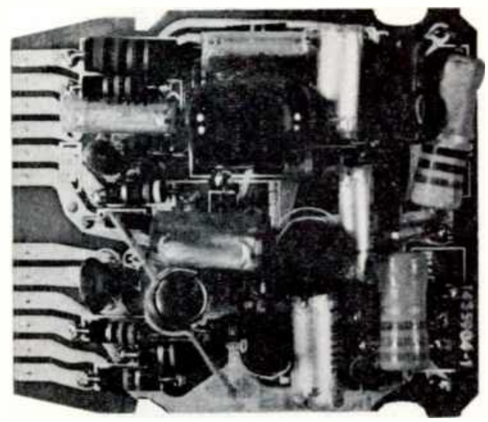
Module MAH

The circuit of Module MAH is similar to the horizontal AFC and oscillator circuit of the CTC 40 chassis. Q1 is the sync phase splitter and Q2 is the blocking-oscillator transistor. One additional active device, Q3, is used in the AFC system.

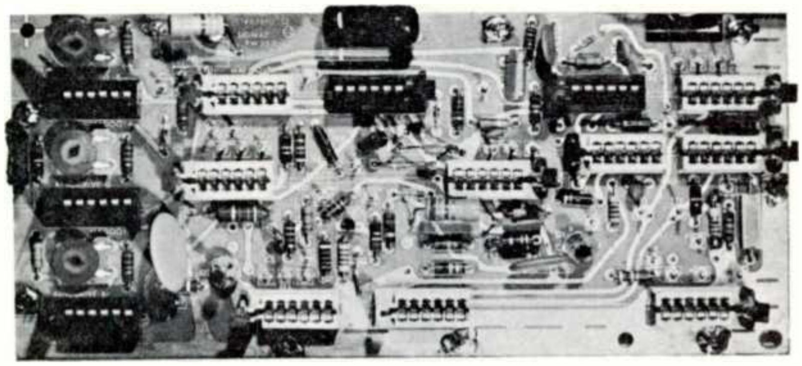


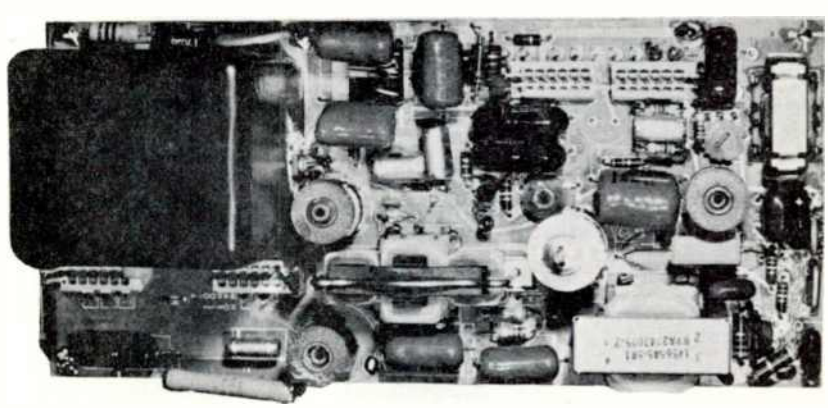
Module MAG

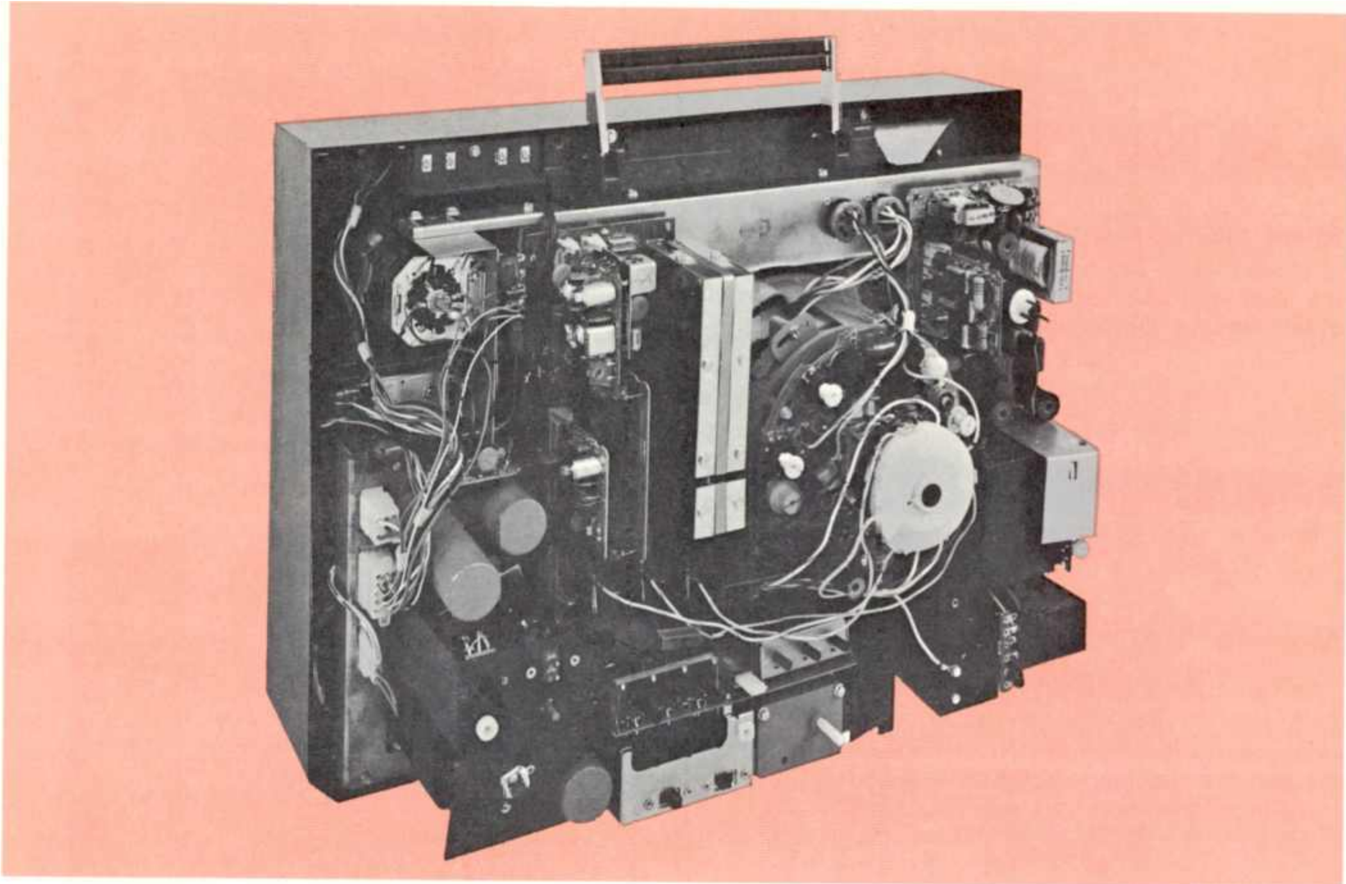
The vertical-deflection system uses the Miller circuit, familiar from its use in several earier solid-state receivers. The switch, predriver, and driver stages are in this module. The vertical-output transistors are mounted on the main chassis.



Four major boards are used. PW 200 mounts various controls—contrast, noise, the three screen controls, kine bias, height, vertical hold, and the three-position service switch. PW 300 serves as the parent board for all modules except MAB, MAH, and MAG. The audio-driver and brightness-limiter transistors, Q301 and Q302, the three kine drive controls, plus various passive components also are mounted on PW 300. Modules MAH and MAG are mounted on PW 400, as are most of the components of the horizontal deflection and high voltage systems, the high-voltage regulator, and the side-pincushion amplifier and control potentiometer.







The main chassis mounts the power transformer, power-supply filters, the audio-output transistor, two vertical-output transistors, high-voltage quadrupler and focus bleeder, and the SCR's and diodes of the horizontal-deflection system. The power supply utilizes a transformer; however, one side of the AC line is connected to the chassis. The DC outputs and their principal uses are as follows:

1. The 220-volt source powers the kine drivers, Modules MAD. A half-wave rectifier and an RC pi filter is used.
2. Four diodes in a bridge configuration provide two outputs. One of these provides about 77 volts to the vertical-output transistors. Capacitive filtering is used. The second output is divided into separate supplies—one for the low-level transistors throughout the instrument; the other for the audio system. Both are nominally 30-volt sources and both use RC pi filters.
3. A half-wave rectifier with an LC pi filter supplies 160 volts to the horizontal deflection system.

As illustrated in the schematic diagram, Figure 1-2, the degaussing circuit is rather unusual. T101 is the power transformer (for simplicity several windings are deleted from this schematic) and S102 is the Normal/High line switch. At turn-on the resistance of RT 1 is low and the degaussing current is high. As RT 1 warms, its resistance increases until the degaussing current approaches zero. After warm-up the voltage drops across R4 and RT 1 are equal to the voltages across the upper and lower transformer windings, respectively, making the voltage across the degaussing coil zero. The current which still flows through R4 and RT 1 keeps the latter warm, to maintain its high resistance.

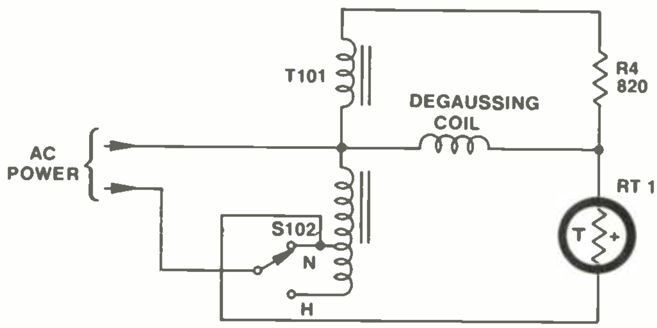


Figure 1-2 Simplified Degaussing Circuit

2

RF and IF SYSTEM

Except for a minor change in the biasing of the RF amplifier and revamping of the mixer output to lower its impedance, the KRK 165 VHF tuner used in the CTC 49 is the same as the KRK 142 of the CTC 40 chassis. Both are four-tuned-circuit, wafer-switch tuners using a MOSFET RF amplifier, a cascode type mixer, and AFT controlled local oscillator.

In the KRK 165, AGC bias is applied to only one gate of the MOSFET, instead of both gates as in the KRK 142. This circuit change is shown in Figure 2-1.

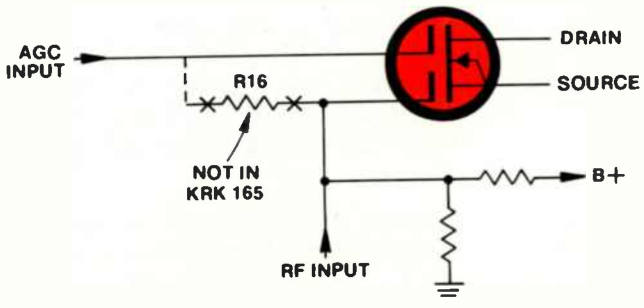


Figure 2-1 Simplified RF Amplifier

The familiar "link circuit" which has been used with minor variations for several years has been replaced by a terminated coaxial line which interconnects the tuner and the IF amplifier. This coupling method makes the tuning of the mixer and the IF-amplifier input independent of each other; also, the length of the interconnecting cable no longer is critical.

The mixer-output circuits of the KRK 142 and KRK 165 are shown in Figure 2-2. Operation of the "Low C" output circuit of the KRK 142 was amply explained in SOLID STATE COLOR TELEVISION, to which the reader may refer. In the KRK 165, the 82-pF capacitor has been removed and a 47-ohm resistor has been inserted in series with the output.

As it will be explained later, the input impedance of the IF amplifier is nominally 50 ohms. Therefore, it is desirable that the output impedance of the mixer, as seen "looking back" from the IF amplifier, also be nominally 50 ohms. As seen from the output, the combination of L1 and C1 is a series resonant circuit which has a very low impedance to ground, and this impedance is in series with the 47-ohm resistor. Thus the link cable itself, type RG 58A/U, is terminated by its characteristic impedance, and its length is not critical.

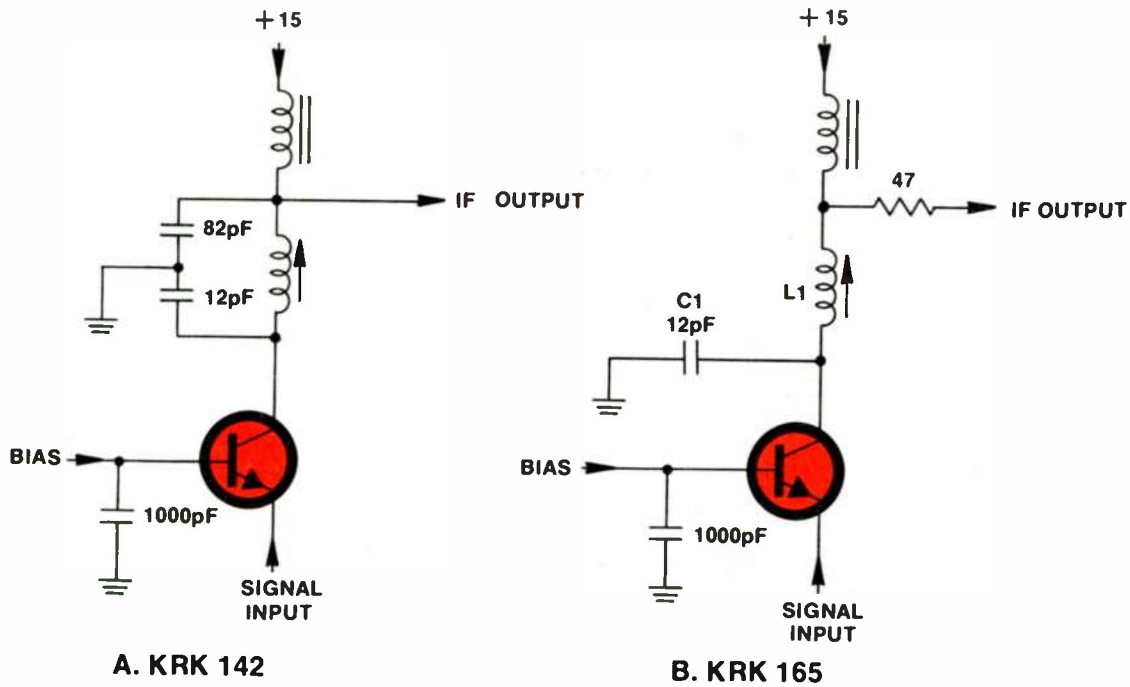


Figure 2-2 Mixer Output Circuit of the KRK 142 and KRK 165 Tuners

IF INTEGRATED CIRCUIT

As stated in Chapter 1, all IF amplification and the generation of AGC voltage is accomplished in a single integrated circuit, IC 1, mounted in the IF module, MAK 001A. While the actual circuitry of the IC may be of academic interest, a rigorous discussion is beyond the scope of this book. For the present purposes, an examination of the functional block diagram of the IC and an explanation of the surrounding discrete-component circuits will suffice.

Referring to Figure 2-3, the IF signal from the tuner ultimately is developed across L4 and injected, along with AGC voltage, to input terminal 6 of the IC. The first IF amplifier actually consists of two emitter followers and a common-emitter amplifier. The second IF is essentially a common-base circuit. As signal passes through these circuits, the AGC voltage is stripped off, modified by the external noise control, and fed back to the signal shunt to control the gain. The output of the second IF stage appears at terminal 9 of the IC.

The interstage coupling circuit is a capacitively coupled, double tuned system, from which are derived two outputs. One of these is fed to terminal 12, where it is amplified and detected. The 4.5-MHz intercarrier signal generated in this detector is amplified and conducted from terminal 2 of the IC to the sound module, PM 200.

The second output from the interstage coupling circuit reenters the IC at terminal 13 and drives an emitter follower which has two outputs. One of these outputs leaves the IC at terminal 14; the other passes through the third IF amplifier to the video detector. The video detector has three outputs, one to the noise-immunity circuit, a second to the AGC keyer, and a third to output terminal 19. At this point, the video white level is about +7 volts and sync-tip level is about +.7 volt.

The precise manner in which keyed AGC voltage is developed and made immune to sync-tip noise spikes is rather unconventional; but since these functions take place entirely within the IC, they are of no particular interest from the standpoint of servicing. The output of the AGC amplifier passes from terminal 4, through a filter circuit, and then back into the IC at terminal 6, along with the IF signal.

The block connected to terminal 18 is passive, containing the equivalent of two zeners and a diode connected in series. A +12-volt drop is provided for the base of the voltage regulator used to supply power to several devices in the integrated circuit.

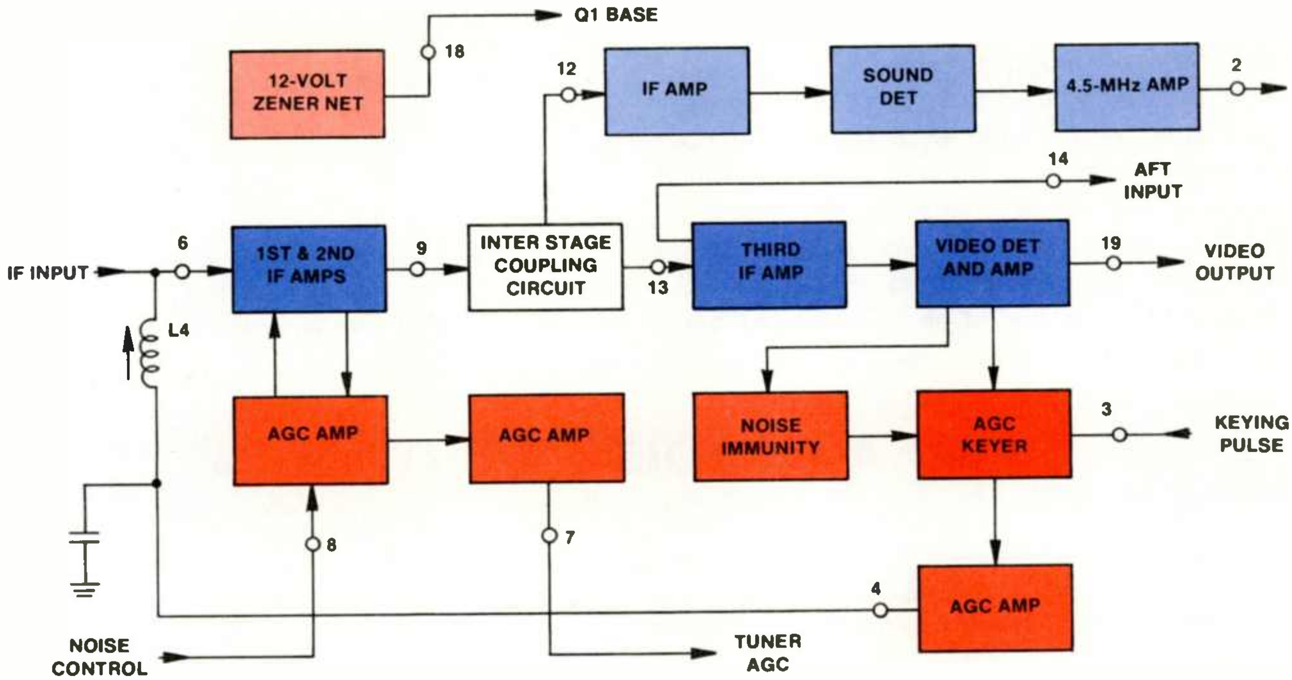


Figure 2-3 Functional Diagram of the IF/AGC Integrated Circuit

TUNER-IF LINK CIRCUIT

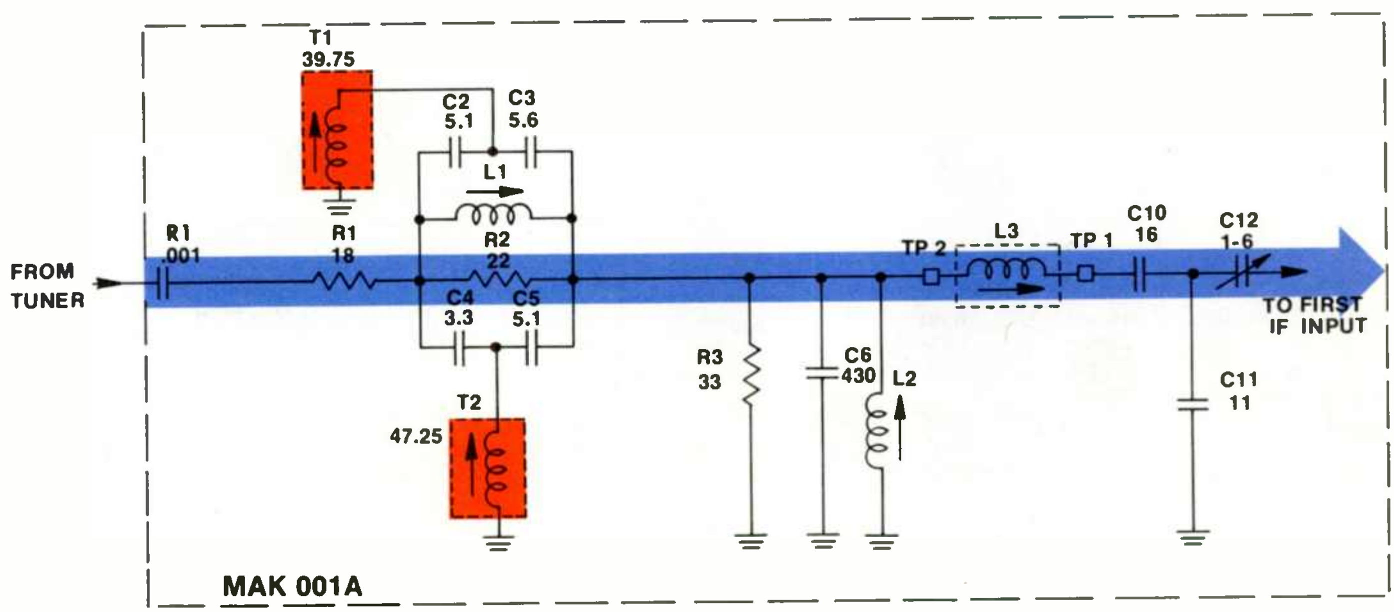


Figure 2-4 Traps and IF Input Tuned Circuits

Signal from the mixer in the VHF tuner is conducted through 50-ohm coaxial cable to PW 300, and thence to the MAK module. Passing through C1 and R1 (Figure 2-4), it next encounters the parallel paths offered by C2 and C3, L1, C4 and C5, and R2. Traps tuned to 39.75 MHz, adjacent-channel video carrier, and 47.25 MHz, adjacent-channel sound carrier, are connected as shown. L1 is a low-Q tuned circuit adjusted for best nulling of the 47.25-MHz trap. From the parallel paths named above, paralleled paths to ground (having an equivalent resistance of about 18 ohms) are provided by R3, the parallel resonant circuit of L2 and C6, and the series resonant circuit formed by L3 with C10, C11, and C12. Therefore, the input impedance seen at C1 is nominally 50 ohms, matching the impedance of the link cable.

The coupling network consisting of L3, C10, and C12 (Figure 2-4), and L4 (Figure 2-5) tunes the input of the first IF amplifier, located inside IC 1A. The adjustment of these components is similar to the alignment of the link circuit of many earlier receivers, L3 is tuned to the center frequency of the IF passband (about 44 MHz), L4 principally controls the tilt of the response curve, and C12 establishes the bandwidth.

AGC AND NOISE CONTROL

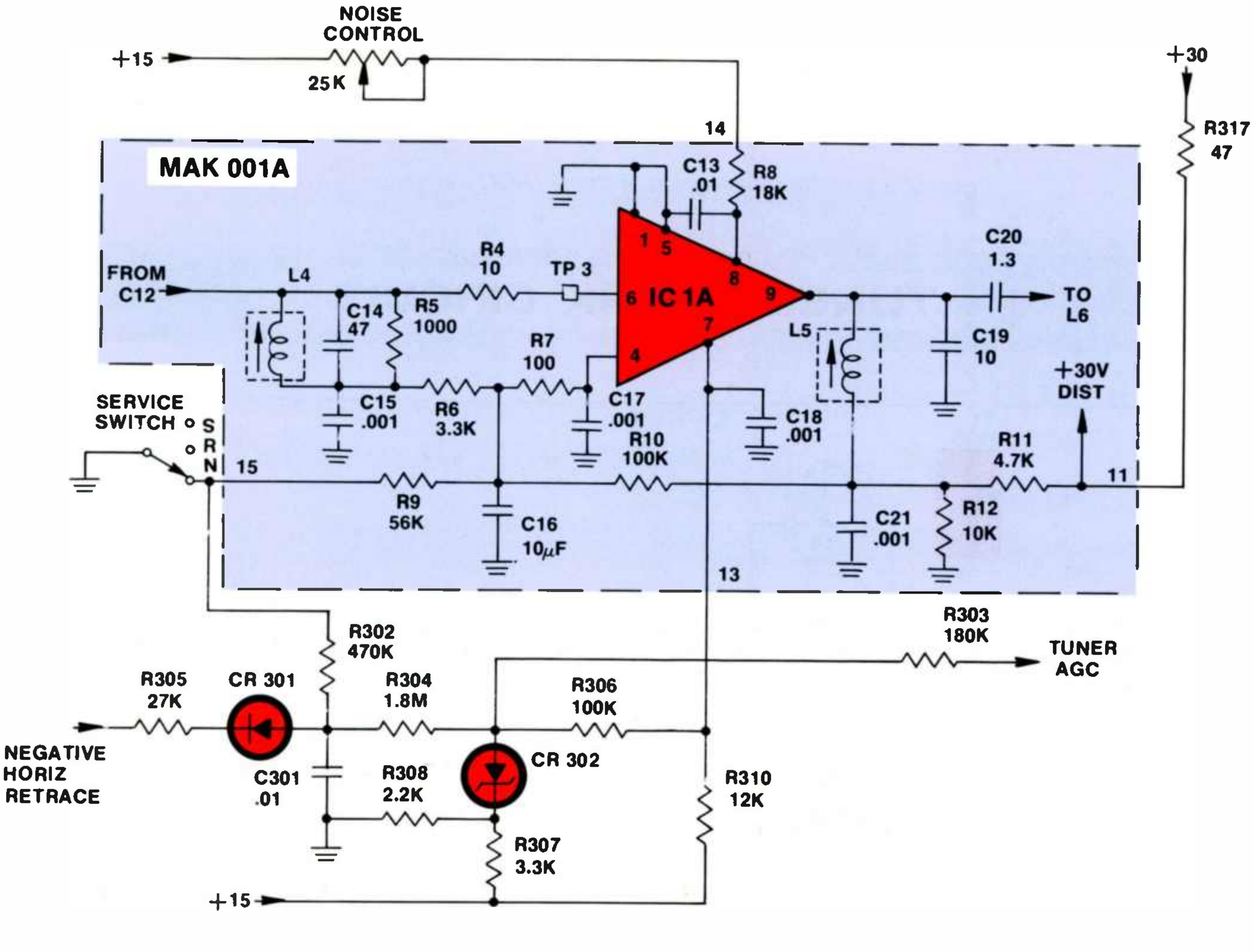


Figure 2-5 First and Second IF Amplifiers and AGC Circuits

R10 is the collector load resistor of the AGC-amplifier transistor located inside the IC and connected to terminal 4. Depending on the level of input signal to the receiver, the voltage at terminal 4 will vary slightly, above and below to about +2.7 volts. As it becomes more positive, the IF gain is increased. This voltage is aoolied to the bottom of L4, and thence to terminal 6 of the IC along with the IF signal.

Notice that when the service switch is in the normal position one end of R9 is grounded. In either the raster or service position of the switch, the ground is removed and R9 is connected via R302 to the anode of CR 301, which has a potential of about —100 volts. The portion of this voltage which is applied to terminals 4 and 6 of the IC cuts off the IF amplifier for servicing.

Before discussing the operation of the noise control and tuner AGC circuits of Figure 2-5, it is appropriate to review the fundamentals of AGC operation. Since the output level from the video detector must be held constant, it is obvious that the receiver gain to this point must be made inversely proportional to the signal strength. This, of course, is the purpose of AGC. Since the range of signal strengths which a receiver must process may vary from perhaps 15 microvolts to 150 millivolts, the ratio of receiver gain from maximum to minimum is in the order of 10,000:1. To design a single stage having this much dynamic range is difficult; but two amplifiers each having a dynamic range of 100:1 will fulfill the same requirement and are more easily constructed. For this reason, the gains of both the tuner RF amplifier and the first IF amplifier (and sometimes the second IF amplifier) are controlled.

The ability of a receiver to produce a useful picture from a very weak signal depends upon the amount of noise generated within the receiver itself. Since most of this harmful noise is generated in the tuner, it is desirable to amplify the signal as much as possible in the RF amplifier, to maintain the ratio of signal to noise as great as possible. For this reason it appears that it always would be desirable to operate the RF amplifier at maximum gain; however, this could cause the mixer to overload and produce beats during reception of strong signals. The solution to this problem is to design the AGC system so that the RF amplifier operates at maximum gain on all signals weaker than some predetermined level, perhaps 1000 microvolts; above this level, tuner noise no longer is detrimental, and the gain of the RF amplifier is reduced progressively by the AGC as stronger signals are received. This is called AGC delay.

In the CTC 49 chassis, the AGC voltage from terminal 7 of IC 1 (Figure 2-5) is more positive than +6.7 volts under no-signal conditions, but the diode action of the zener, CR 302, clamps the tuner AGC voltage to +6.7 volts. As signal strength is increased, the terminal-7 output drops, and falls below 6.7 volts at about 1000 microvolts; however, until this point is reached, the gain of the RF tuner is maximum and receiver gain is controlled by the IF AGC.

Further increasing the signal beyond 1000 microvolts (nominal) causes the tuner AGC voltage to swing downwards from +6.7 volts toward a negative maximum. When it reaches −5 volts, CR 302 conducts in the zener mode, preventing a further negative swing. This is the minimum-gain operating point of the RF amplifier. Beyond the point where the tuner begins operating at minimum gain, the gain-controlled IF amplifier again controls overall gain.

To summarize AGC action, there are three distinct modes of operation, depending on signal strength:

1. No signal to about 1000 microvolts—RF gain is maximum to provide best possible signal-to-noise ratio of the receiver. IF AGC maintains constant video output from the detector.

2. About 1000 microvolts to perhaps 100 millivolts—RF gain is decreased by the AGC voltage to maintain constant output from the video detector. IF gain is substantially constant.

3. Above about 100 millivolts—RF gain is held at minimum to prevent overload of the mixer, and IF gain is decreased by AGC to maintain constant video-detector output.

The function of the noise control is to allow the service technician to predetermine the amount of signal strength at which AGC operation shifts from the first to the second mode and, of course, from the second mode to the third. For example, in a suburban or rural area where all signals are relatively weak, the noise control may be set to allow maximum RF gain (and minimum noise); in a strong-signal area, the noise control may be set to minimize RF gain and the possibility of mixer crosstalk.

IF, VIDEO PREAMP, AND AFT

The schematic diagram in Figure 2-6 shows the remaining section of IC 1 and those external circuit components which connect to it. Notice that L5, C19, and C20 are shown on both Figures 2-5 and 2-6. Signal from the second amplifier appears at terminal 9 of the IC and is coupled to the third IF amplifier input, terminal 13.

The collector of the second IF is tuned to about the center of the IF passband (44 MHz) by L5 and C19. Energy is coupled via C20 to L6, which is tuned to remove tilt from the response curve. 41.25-MHz sound-carrier energy is removed from the IF signal before it reenters the IC at terminal 13, but this energy still is present at the take-off point to the IF amplifier whose input is at terminal 12. As stated earlier, the circuits in the IC between terminals 12 and 2 amplify the IF, produce the 4.5-MHz intercarrier sound signal, and amplify it for injection into the sound module, PM200.

The IF signal fed into terminal 13 is amplified, detected, and amplified; the resulting video signal appears at terminal 19. The video signal at this point has a peak-to-peak amplitude of about 6.3 volts with negative-going sync; sync-tip level is about + .7 volt. Passing through the 4.5-MHz trap and the preamplifier, Q2, the video is fed from the IF module to the video module, MAL. A second output from the preamplifier is developed across the chroma peaking coil L7, and fed to the first chroma module, MAC.

QI is a regulator transistor which supplies voltage to a number of devices in the integrated circuit. Base voltage for QI is established by a 12-volt

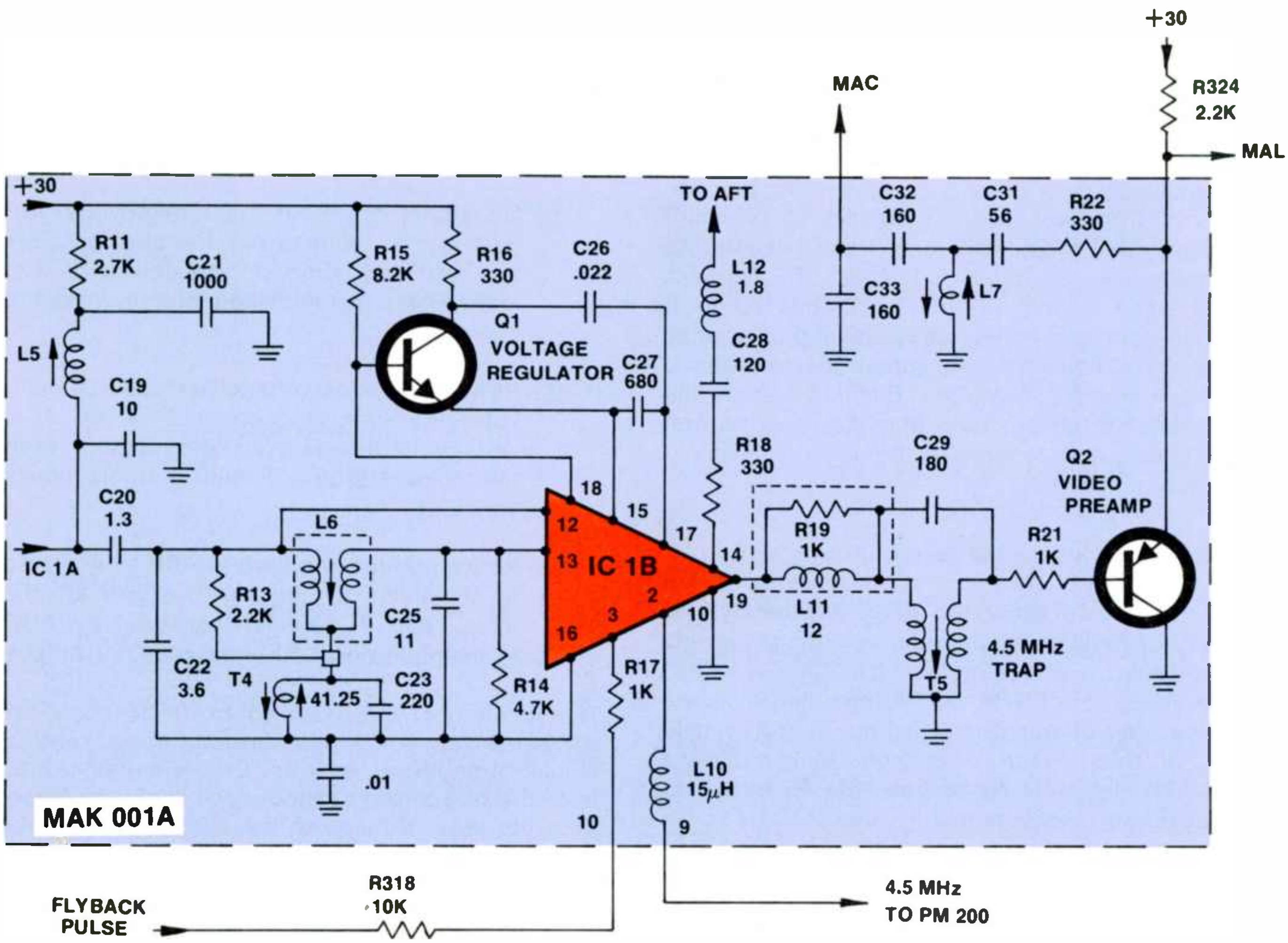


Figure 2-6 IF Output and Video Preamplifier

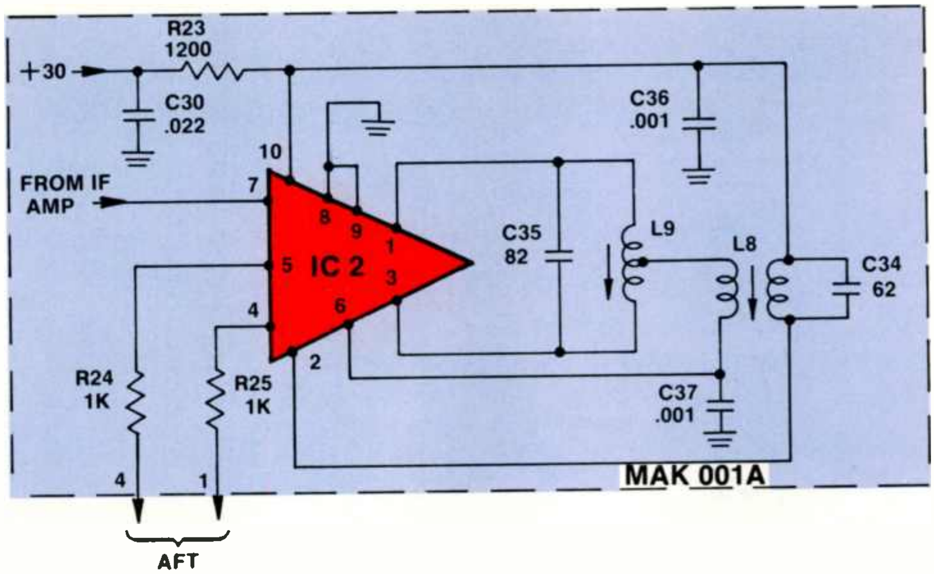


Figure 2-7 AFT Integrated Circuit and Discrete Components

zener regulator in the IC, making the regulated voltage at terminal 15 nearly 11.3 volts. In some modules, a diode may be found connected between IC terminal 18 and the base of Q1. This raises the base and emitter voltages of Q1 to 12.7 and 12 volts, respectively. The increase in supply voltage is necessary for some IC's to provide sufficient video output.

The AFT circuit, shown in Figure 2-7, is similar to the one used in the CTC 42 chassis. Only two adjustments are necessary; L8 is adjusted for symmetrical response around 45.75 MHz, and L9 sets the crossover point to this precise frequency. The AFT output at terminals 1 and 4 "rides" on a DC level of about 6.7 volts.

3

THE VIDEO SYSTEM

In the past, the majority of texts describing color television receivers have treated the monochrome video circuits separately from the chroma video circuits. In this book, several reasons prompted the departure from this precedent; the most important being the fact that both the chrominance and luminance signals are processed in many of the same circuits. Figure 3-1 shows the general configuration of the complete video-processing system.

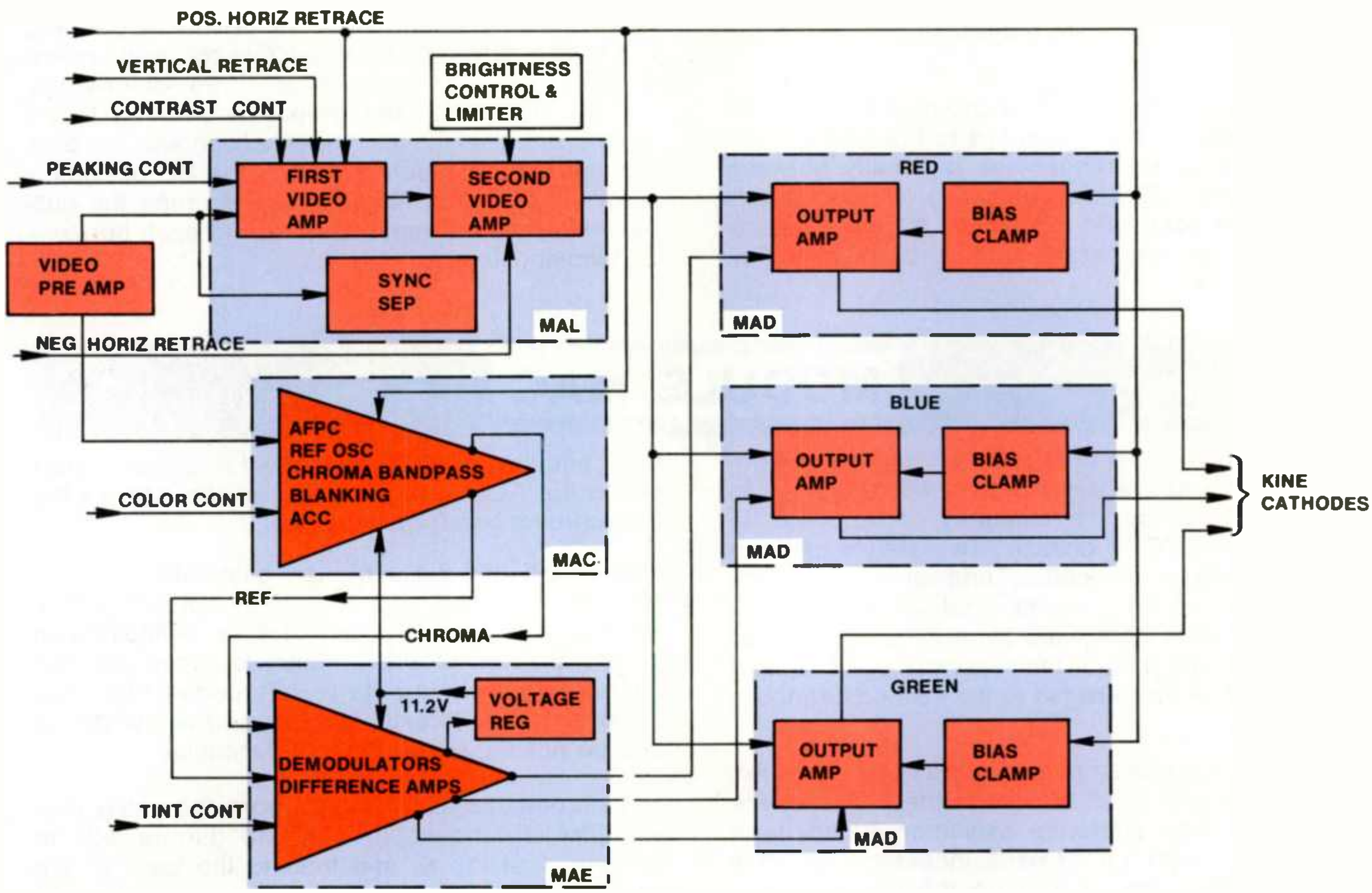


Figure 3-1 Functional Diagram of the Video System

From the video preamplifier situated in Module MAK, video is fed to the video/sync module MAL, which contains the first and second video amplifiers as well as the sync separator. The positive sync pulses from the sync separator have a peak amplitude of 30 volts and are routed from the module without processing.

The functions of luminance delay, vertical and horizontal retrace blanking, control of contrast, and control of video peaking are performed in the first video amplifier. Depending on the setting of the contrast control, the stage gain varies from about .3 to unity or slightly more. Since the video output is taken from the collector, video polarity is inverted in the stage and the output is positive-going towards black level. A shunt filter between the first and second video amplifiers attenuates 3.58-MHz video.

The second video amplifier is an emitter-follower stage which provides an impedance match between the first video amplifier and the three parallel-driven kine-drive modules, MAD. Bias for the base of the second video amplifier is controlled by the brightness control and the brightness limiter. A negative-going horizontal-retrace pulse is fed to the emitter to enhance operation in the vicinity of black level. Since this is an emitter-follower stage, the polarity of the output is the same as the input.

A peaking coil in the video preamplifier restricts the bandpass of the signal fed to the first chroma module, MAC, to frequencies nominally between 3.08 Mz and 4.08 MHz. All active devices in this module are contained in a single IC which serves as a chroma-bandpass amplifier, burst amplifier, and reference oscillator. AFPC, ACC, color-level control, and burst blanking also are accomplished in this module.

The 3.58-MHz reference signal and the chroma signal are conducted from MAC to the second chroma module, MAE, which is the chroma demodulator and color-difference-amplifier module. The three color-difference signals, R-Y, B-Y, and G-Y, are conducted from MAE to the three kine driver modules. An 11.2-volt regulator which provides voltage for MAE and MAC is located in the MAE module; as is the tint control input circuit.

While those portions of the video system discussed thus far bear at least a similarity to the ones found in many earlier chassis, the matrixing of luminance and chrominance video outside the kinescope has not been done in an RCA color receiver since the CTC 2 chassis was discontinued. Although several advantages are realized, the most significant is that the load offered by the three kinescope cathodes may be divided equally among three moderately rated drivers instead of one relatively high-power device, and, of course, the three kine-control-grid drivers are eliminated.

Three identical modules, MAD, are used to drive the three kine cathodes. Insofar as the luminance signal is concerned, they are driven in parallel, but each is driven by its respective color-difference signal. Thus the outputs are true color-video signals, red, blue, and green. In addition to an output amplifier, each module contains a bias regulator stage which stabilizes the DC operating point of the output amplifier by returning the output voltage to the same point during each horizontal-blanking interval.

MODULE MAC

The functions of the integrated circuit, which contains all the active devices in MAC, is shown in Figure 3-2. Notice the similarity of functions to those in the CTC 38 chassis. Two stages of chroma-bandpass amplification and an emitter follower make up the chroma amplifier. Gain of the first amplifier is controlled by ACC and the color control sets the gain of the second. Burst blanking and killer bias also are fed to the second bandpass amplifier.

Burst is gated and amplified in the burst amplifier, after which it is used to control the phase of the injection-locked reference oscillator. When burst is present, oscillator drive is increased and this operates the killer to turn on the second chroma-bandpass amplifier. Similarly, changes in burst amplitude (which also affect oscillator drive) cause the ACC system to control the gain of the first chroma-bandpass amplifier.

Figures 3-3 and 3-4 show the complete circuit of Module MAC and also those components which are not in the module, but directly connected to it. The division of the circuitry between the two figures is purely arbitrary; interconnections between the circuits exist but they are within the IC and do not appear in these schematics.

The chroma-bandpass signal from the video preamplifier is coupled through C10 (Figure 3-3) to terminal 1 of the IC and then to the base of the input transistor of a cascode type amplifier. R8 and R10 fix the base bias of this device. The tank

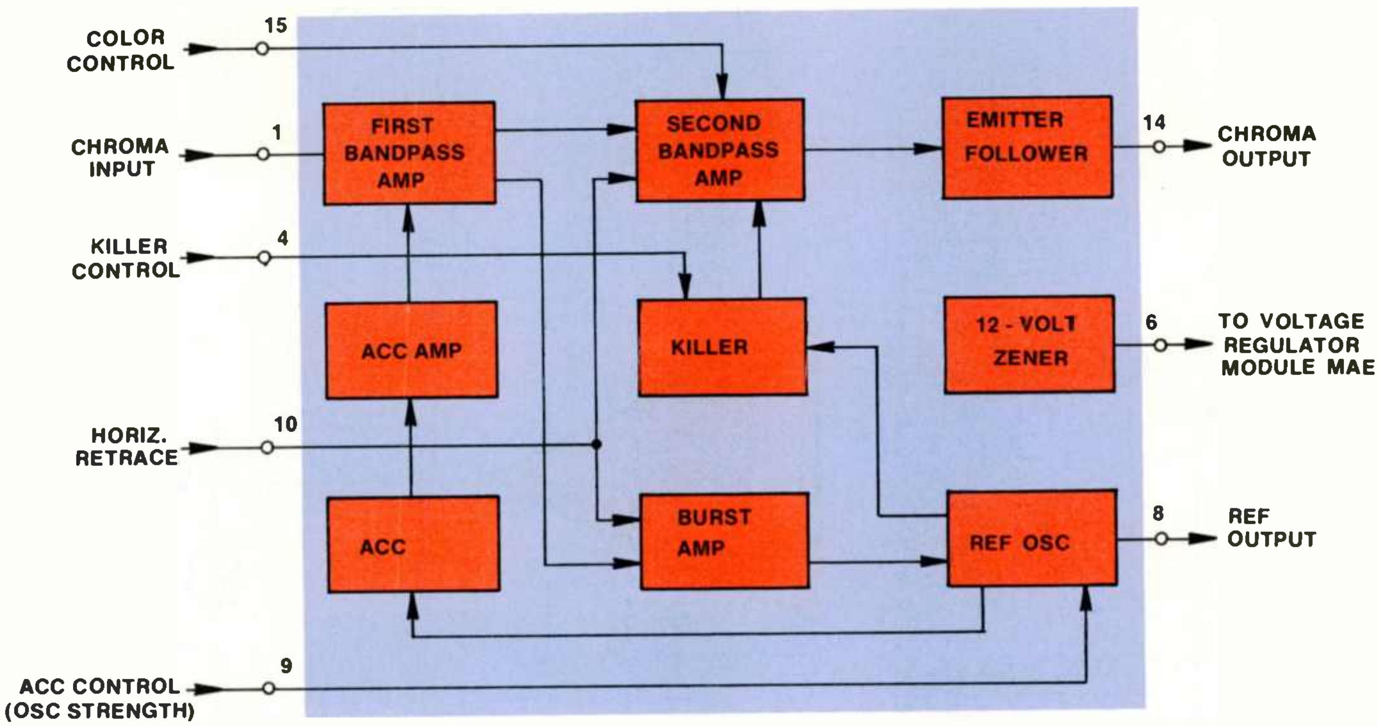


Figure 3-2 Functional Diagram of First Chroma IC

circuit connected to terminal 16 tunes the output of this amplifier to about 4.0 MHz, near the upper limit of the chroma passband.

Inside the IC, signal is coupled from terminal 16 to the second chroma-bandpass amplifier, whose output is tuned by the tank circuit connected to terminal 13. This tank is tuned near the lower limit of the chroma passband, about 3.0 MHz. An emitter follower in the IC couples the signal developed across this tank circuit to the chroma-output terminal of the IC, terminal 14. R13 is the emitter load resistor for this emitter follower. Signal level at terminal 14 can be as high as 1.5 volt at maximum chroma gain, and the DC level is about +4.5 volts.

A voltage-operated gain control system is incorporated in the IC. The actual gain control voltage appears at terminal 15, and is developed from two sources. One of these is a voltage divider external to the chip, consisting of R9, R15, R4013, and the color control. Adjusting the control to increase the positive voltage at terminal 15 increases the color intensity, and the voltage at terminal 15 may be varied from about 8.8 volts to approximately 9.4 volts during color reception.

The second gain-controlling voltage at terminal 15 is derived from the color killer, which is inside the IC. During monochrome reception or no-signal conditions, the killer drives terminal 15 to a nominal +4.5 volts, a level which cuts off the second chroma-bandpass amplifier.

Burst blanking of the second chroma-bandpass amplifier is accomplished by the 30-volt positive horizontal-retrace pulse which is divided and timed by the network connected to the IC at terminal 10.

The tank circuit connected to terminal 13 may be excited by the leading and trailing edges of the blanking pulse, producing a spurious ringing. For this reason, secondary blanking at the chroma output has been incorporated in the design. The positive retrace pulse is coupled through R327 and CR 305 to the emitter of the chroma-output NPN transistor. This positive pulse cuts the transistor off; betwen pulses, CR 305 isolates the retrace-pulse input circuit from the chroma output circuit.

The circuits having to do with reference-signal generation, ACC, and the color killer are shown in Figure 3-4. The chroma signal from the first bandpass amplifier of the IC is conducted to a burst-amplifier transistor which is gated on during horizontal retrace time. In order to minimize variations in the burst gating waveform which occur as the kinescope beam current is changed, the positive 30-volt horizontal retrace pulse is clamped to +11.2 volts by CR 306 (Figure 3-3). The resulting pulse is then integrated by R325 and C308 in order to provide correct timing for burst gating. The collector of the burst amplifier is connected to the burst transformer at terminal 11. The reference oscillator is injection locked, similar to the system

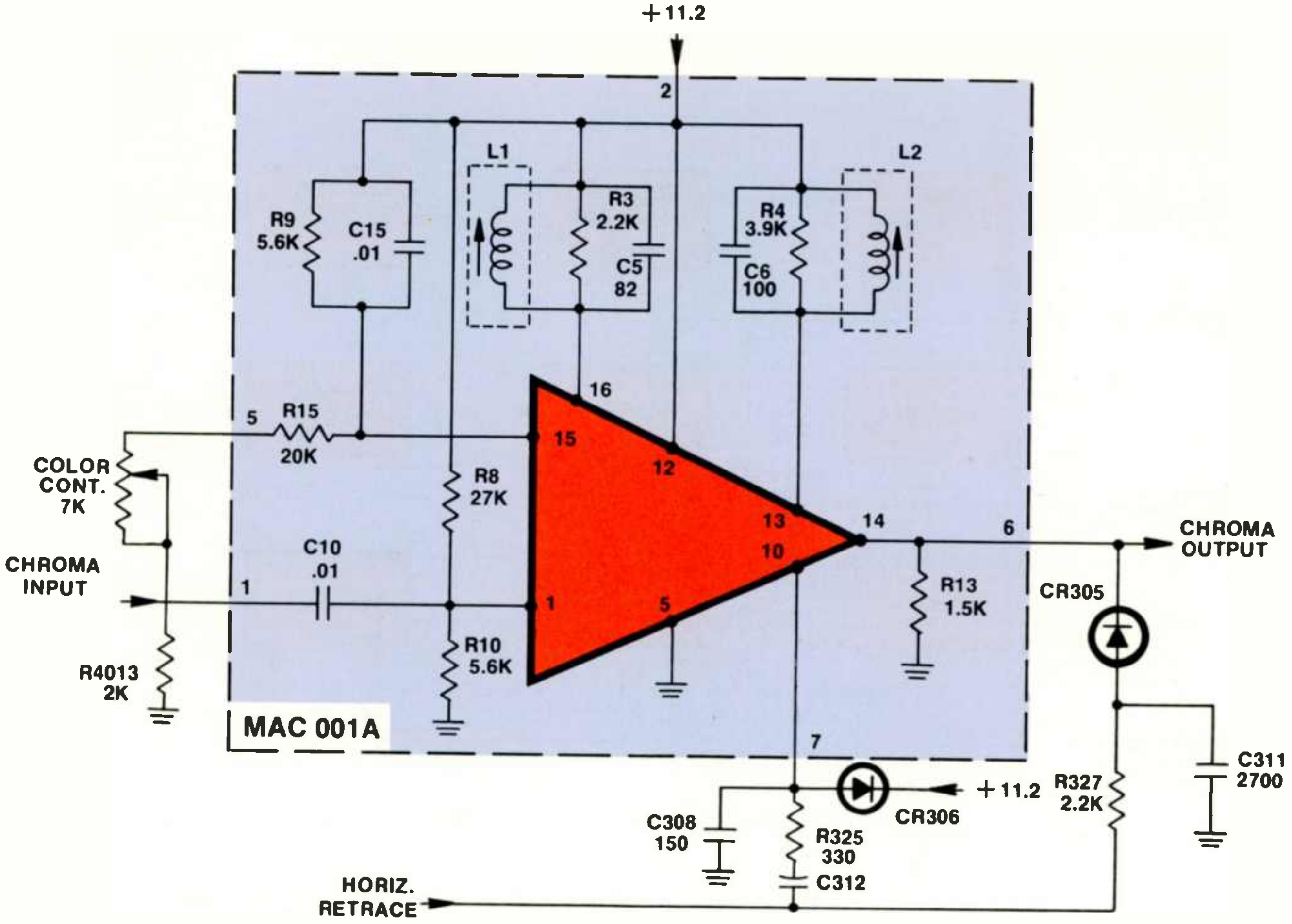


Figure 3-3 Bandpass Amplifier Section of Module MAC

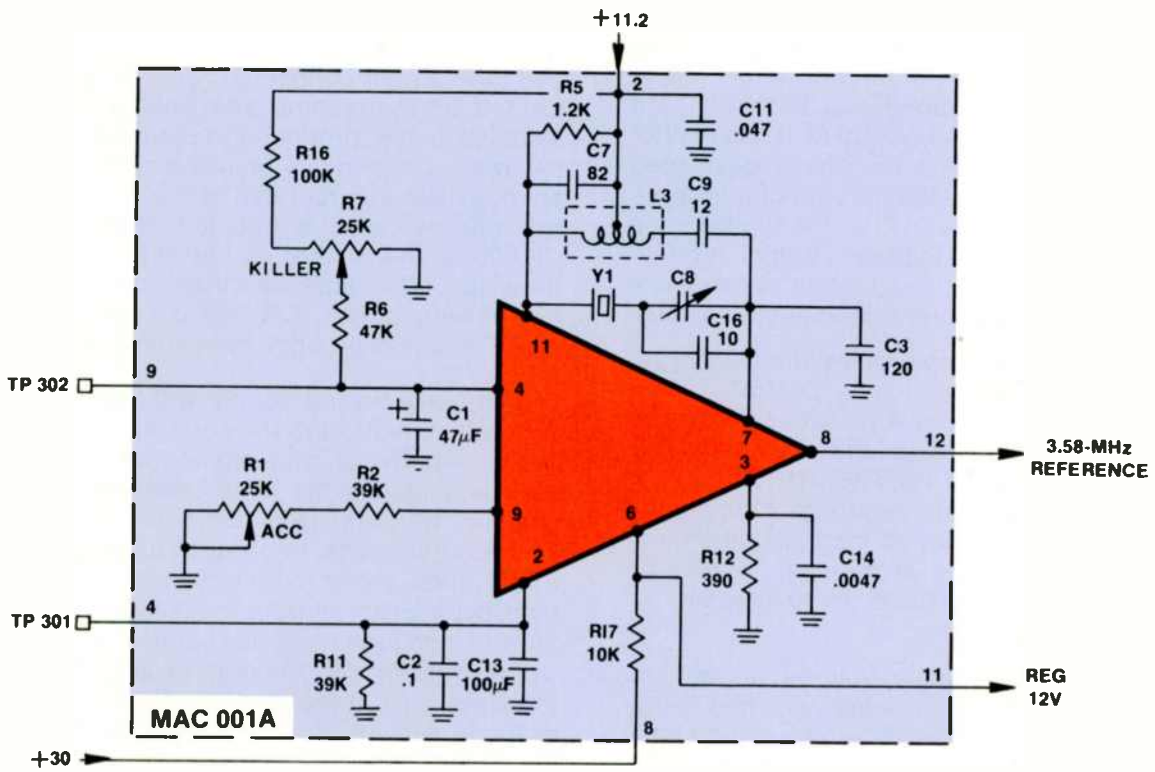


Figure 3-4 Reference Oscillator, Killer, and ACC Section of Module MAC

of the RCA CTC 38 chassis. Oscillator output is obtained at terminal 8. With no signal input, the signal level at this point is about 1.2 volt, p-p, rising to about 2.5 volts, p-p, during color reception.

R1, labelled ACC adjust, has the same function as the oscillator strength adjustment in the RCA CTC 38 chassis. Under no-signal conditions it is set to produce +650 millivolts at TP 301, the ACC bias-voltage observation point. During color reception this voltage will rise to approximately 900 mv. As mentioned before, ACC bias ultimately is fed to the first chroma-bandpass amplifier.

The killer threshold control, R7, sets bias on a switching transistor so that when burst is received the second chroma-bandpass amplifier is turned on. With no burst being received, the killer control is set to produce 1.25 volt at TP 302. This voltage rises to about 1.5 volt during color reception.

Terminal 3 of the IC provides the grounding point for a pair of transistors used in the burst-amplifier and second-chroma-amplifier circuits. Emitter bias is provided by R3, which is bypassed by C14. Typically, the voltage at this point is 2.7 volts.

The internal zener voltage regulator connected to terminal 6 of the IC has no connections to any other part of the integrated circuit. The 12-volt supply from this regulator is used as a control voltage for the 11.2-volt regulator in Module MAE.

MODULE MAE

With the exception of the voltage regulator, Q1, all active components in Module MAE are within the IC. The functions of these active devices are illustrated in Figure 3-5. Bear in mind, however, that this block diagram is extremely simplified, and a single block may contain several transistors.

The 3.58-MHz reference signal enters the IC at terminal 10 and is split into two signals having different phase angles. These two signals are recombined after being amplified separately. By controlling the relative gains of the separate amplifying circuits, the phase angle of their combined outputs may be caused to vary, thus providing tint control.

In the process of controlling the phase angle of the reference signal, an amplitude variation results. To restore constant amplitude, a limiting amplifier is used; and the signal voltage is restored to a sinusoid by the tank circuit which is part of the external phase-shift network driven from terminal 1 of the IC.

Two outputs, approximately in quadrature, from the phase-shift network reenter the IC at terminals 6 and 12, are amplified, and then drive the demodulators; chroma signal is applied to the demodulators directly from terminal 14. After demodulation and amplification (the demodulators themselves have about 10× gain), the R-Y and

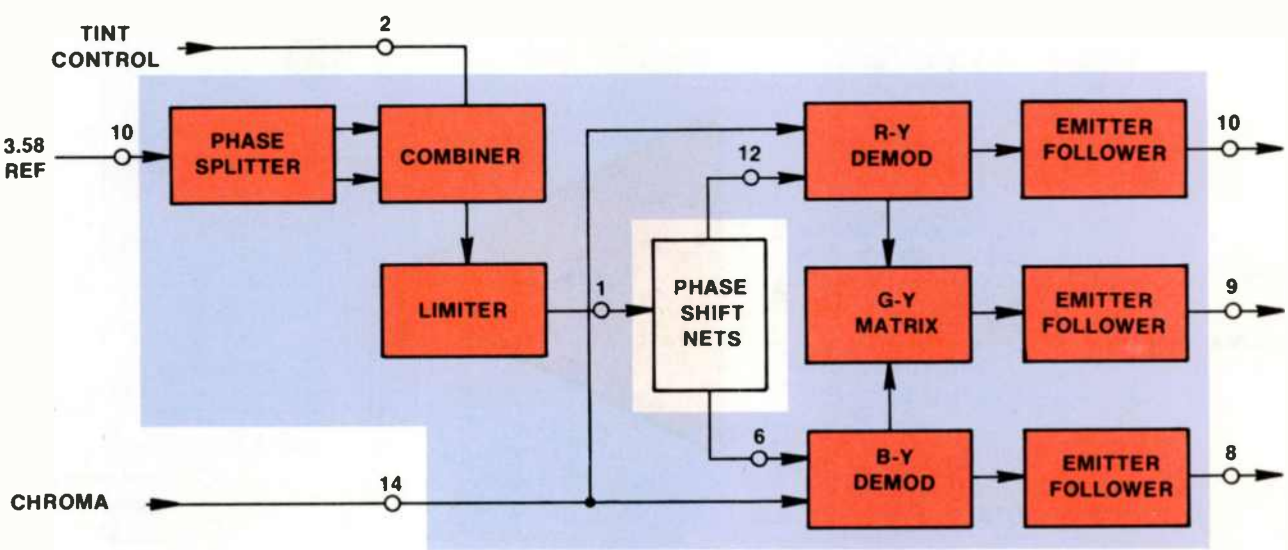


Figure 3-5 Functional Diagram of Chroma-Demodulator IC

B-Y signals pass through emitter followers to their respective output terminals. G-Y signal is derived from the R-Y and B-Y signals in a matrix and this signal passes to its output terminal via an emitter follower.

The circuitry which surrounds the integrated circuit of Module MAE is diagrammed in Figure 3-6. The chroma signal, having an amplitude of the order of 200 millivolts, passes through R12 and C7 to the IC demodulators. C7 and L2 form a low-Q filter (by virtue of R12) which rolls off below about 2 MHz. This removes residue from the blanking pulse which was discussed in the explanation of Module MAC.

The 3.58-MHz refrence signal at terminal 10 of the module has an amplitude of about 2.5 to 3 volts but this is reduced to approximately 30 mv by the input network consisting of R1, C1, and C2. R1 matches the impedance of the line to the IC, C1 is a blocking capacitor, and C2 shifts the reference phase to center the tint-control range.

After it is phase controlled by the tint control, amplified, and limited, the reference signal appears at terminal 1 of the IC with a peak-to-peak amplitude of about 800 mv. L1 is tuned for maximum signal at TP 303, roughly 60 mv. Phase is shifted between terminals 6 and 12 by coil L1, and resistors R4 and R5. Voltage dividers, C8, C9, R4, and R5, provide the correct voltage levels at terminals 6 and 12. The inputs to terminals 6 and 12 are approximately in quadrature and have nominal amplitudes of 8 millivolts.

Capacitors C4, and C6 (connected to IC terminals 7 and 11, respectively) are emitter bypass capacitors for the common emitter amplifiers driven from terminals 6 and 12 respectively of the IC. Since CR 2 is forward biased, the junction of C4, CR2, L4, and C13 is effectively placed at signal ground, making it seem that L4 and C13 are super-

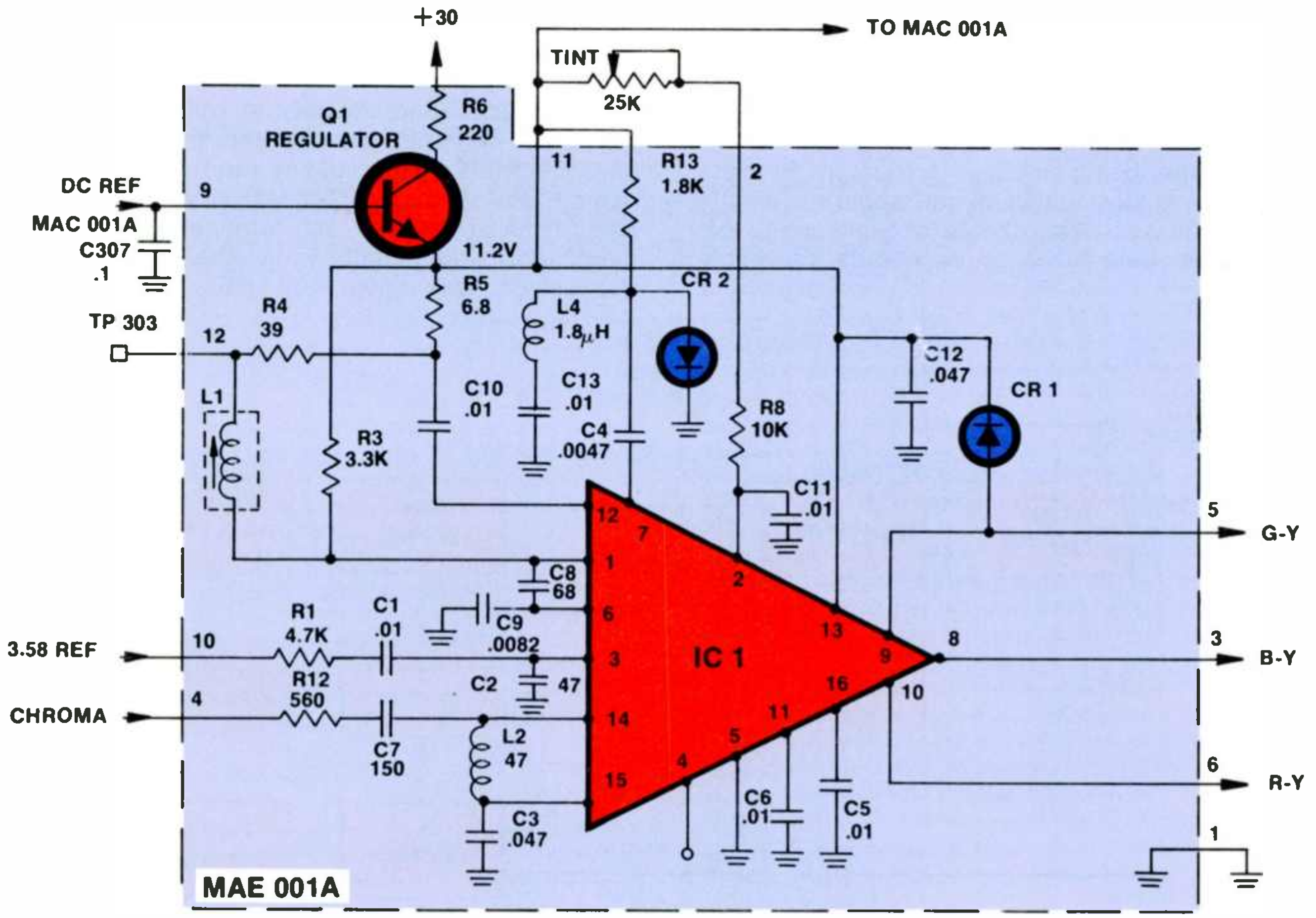


Figure 3-6 Chroma Module MAE

fluous. However, these components are included to make the module directly interchangeable with the module to be used in another television chassis. C3 and C5 (IC terminals 15 and 16) are base-bypass capacitors for differential amplifiers in the demodulators and the reference-signal limiting amplifier, respectively. These two capacitors are external to the IC since it is impractical to construct an integrated-circuit capacitance larger than perhaps 50 pf.

C12 is a bypass capacitor for the regulated 11.2-volt supply and CR 1 provides kine-arc protection for the color-difference outputs. Terminal 4 of the IC is unused; internally there is a zener connected from this point to ground. It has no connections to any other circuits in the IC.

The operating levels of the three color-difference output leads is 5 volts, which may vary ± about 10% from one module to another; however the DC levels of the three outputs from any single module will be almost equal. Obviously, the output signal amplitude will depend on picture content and the setting of the color control. Typically, the signal amplitude will be of the order of 1.5 to 2 volts, but a maximum undistorted output in excess of 3 volts is possible. These outputs are conducted to the respective kine driver modules, MAD, which will be discussed later in the text.

MODULE MAL

A two-stage video amplifier and the sync separator are located in the MAL module, which also is mounted on the PW-300 parent board. As shown in Figure 3-7, the emitter load resistor, R324 located on PW 300, develops the video signal voltage. The signal which appears at terminal 1 of MAL has a nominal peak-to-peak amplitude of 6.7 volts with negative-going sync pulses. This signal is distributed within the module to the sync separator and the first video amplifier.

The sync separator (Figure 3-7) is very similar to the one used in the CTC 40 chassis and is amply explained in "Solid State Color Television" RCA Sales Corporation, 1968, p. 22. Output sync is positive and has a peak amplitude of about 30 volts.

The first video amplifier (Figure 3-8) provides impedance matching for the delay line, signal inversion, horizontal and vertical retrace blanking, and provision for the contrast and peaking controls. Components of this amplifier are located variously in the module, on the parent board, PW 300, and on the controls board, PW 200.

The video signal is matched to the delay line by R4 and L4, and in turn, the delay line output is matched to the base of Q3 by R5, L3, and R6. Base bias is established by the R5-R6 voltage divider.

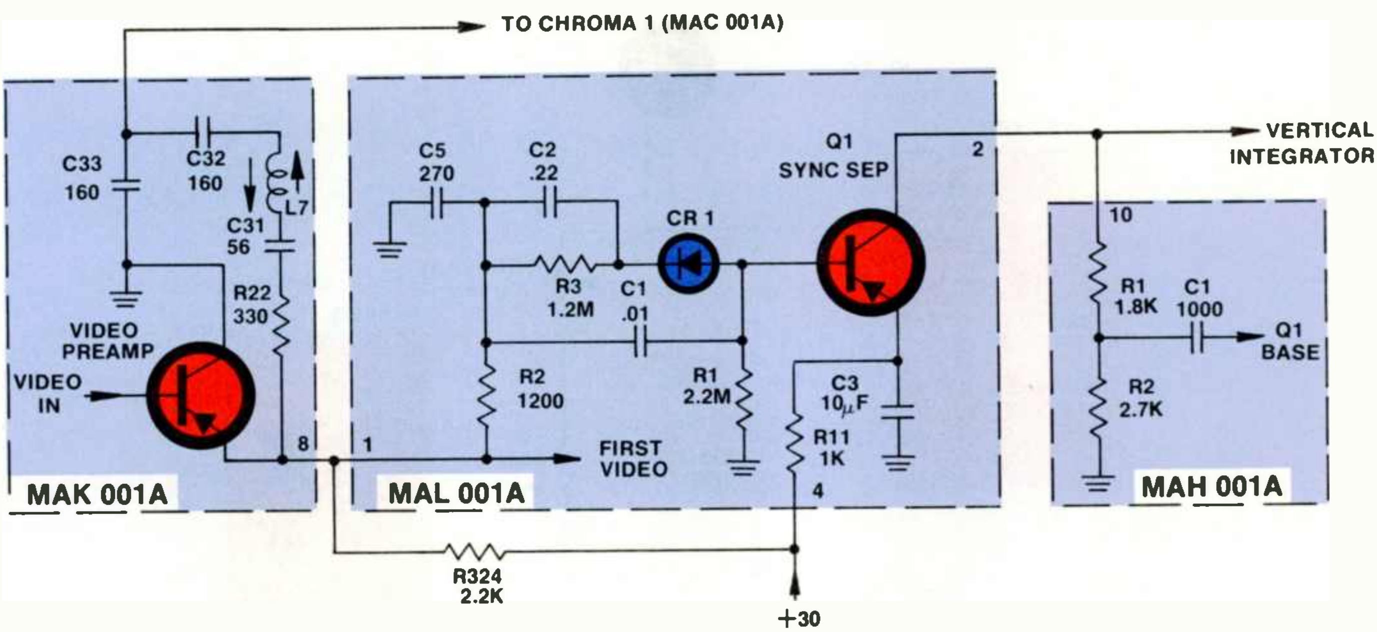


Figure 3-7 Sync Separator and Sync Distribution

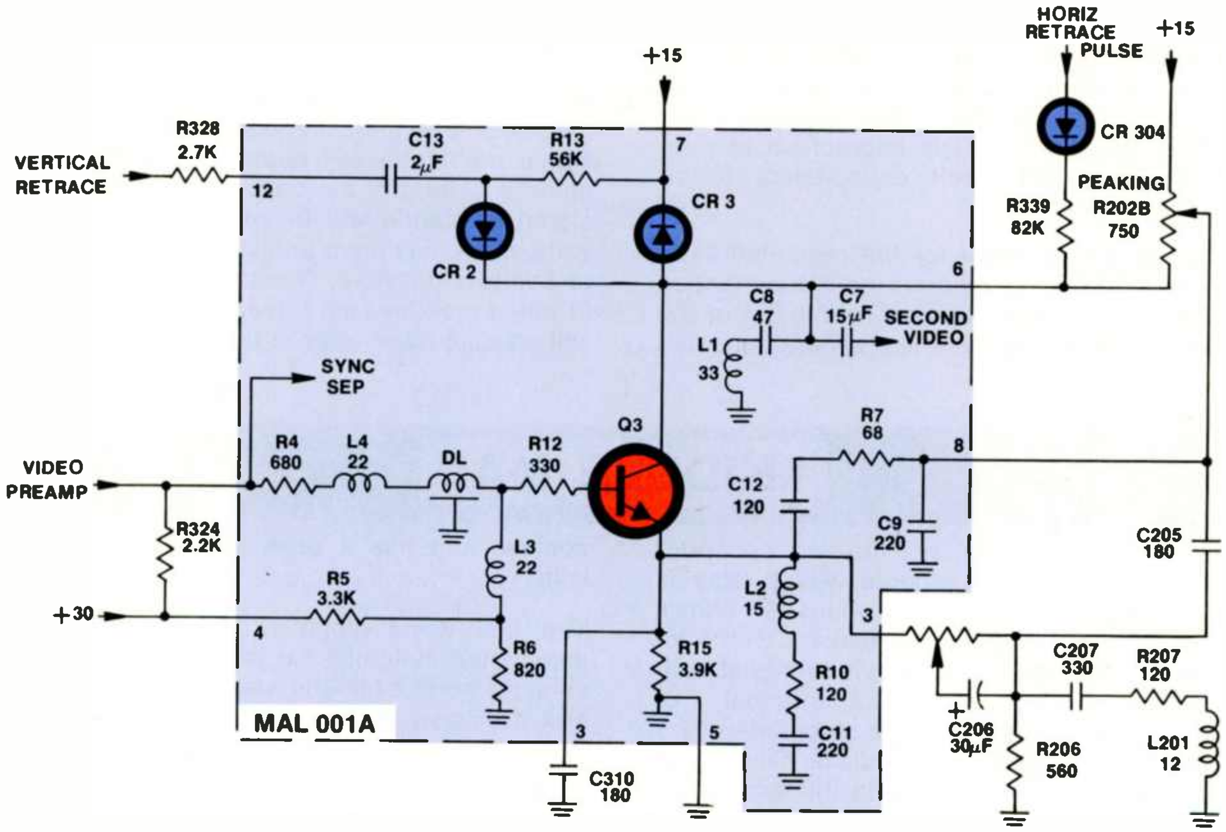


Figure 3-8 First Video Amplifier

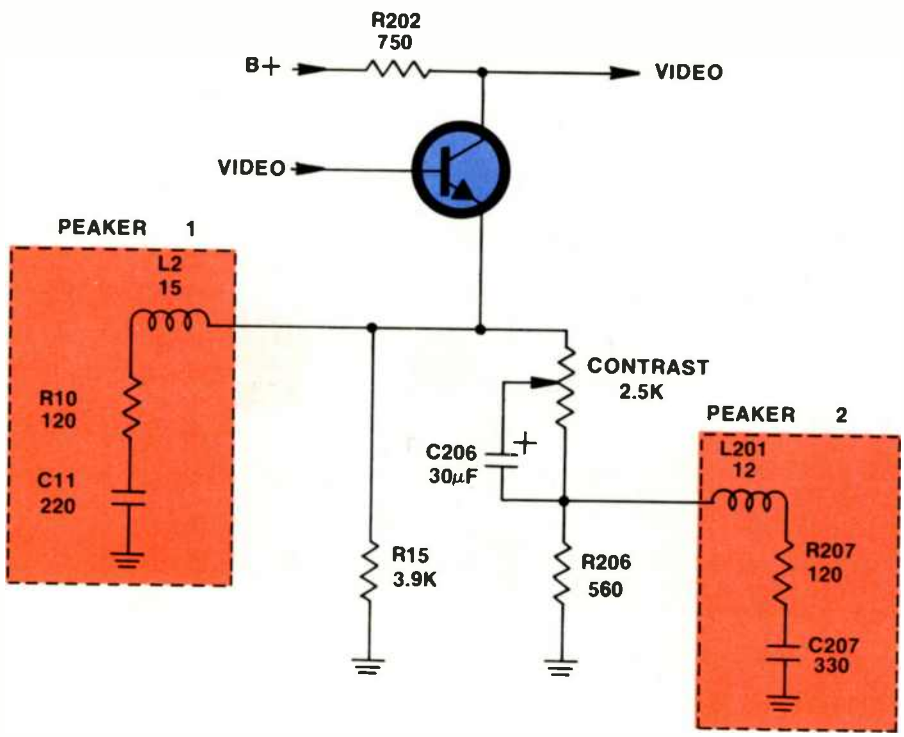


Figure 3-9 Simplified Peaking Circuits

To facilitate the explanation of the contrast and peaking circuits, these are simplified in Figure 3-9. In an amplifier of this type, the gain is roughly proportional to the ratio of collector and emitter impedances. If it is assumed that both peaker circuits are disconnected, the maximum gain is approximately 750:490 or 1.5. At minimum gain, the ratio is 750:1700 and the gain is about .44. Since the emitter and collector impedances are both resistive (the reactance of C206 is neligible at video frequencies) the gain of the amplifier is about the same at all frequencies of interest.

Now assume that peaker 1 has been reconnected and that the contrast control is set for minimum gain (none of the resistance bypassed by C206). At a low frequency, 100 KHz for example, the amplifier gain remains 750:1700 (.44), but at the series resonant frequency of the peaker the emitter impedance drops to about 110 ohms and gain rises to about 750:110 or 6.82. This indicates that the higher frequencies would be amplified more than 15 times as much as the lower frequencies; however, in practice the peaking factor is much less than this. Since the Q of the peaker circuit is very low, about 0.4, the peaking occurs over a very broad range of frequencies.

From the paragraph above, it may be deduced that the ratio of gains at two frequencies is equal to the ratio of emitter impedances at these same two frequencies. At minimum gain this ratio was shown to be about 15:1; but at maximum gain the ratio is reduced to only 490:93, or a peaking factor of 5.4. It is evident, therefore, that the efficacy of peaker 1 is dependent on the setting of the contrast control, with greatest peaking at minimum contrast.

Peaker 2 is connected to the low end of the contrast control, and it may be shown that its effect is greatest at maximum contrast and least at minimum contrast—the exact opposite of peaker 1. The net effect of both peakers is to maintain approximately the same amount of peaking at all settings of the contrast control.

To allow the observer to choose the amount of peaking which is most pleasing, the high sides of the peaker circuits are returned to the wiper of the peaking control, which also is the collector load of Q3, (R202B of Figure 3-8). If the control is positioned with the wiper at the B+ end, the peaking action is greatest, but as the wiper is repositioned towards the collector of Q3, the signal fed back to the peakers progressively increases, finally reducing the peaking to zero.

Output is taken from the collector of Q3 and coupled to the second video amplifier via C7. At this point black level is positive-going. C8 and L1 form a 3.58-MHz series-resonant trap which shunts to ground any residue of the chrominance signal which may be present.

Except during the blanking intervals, CR 3 and CR 304 are back biased and nonconducting, and the current through CR 2 is insignificant because of R13. During the horizontal retrace interval a positive pulse from the flyback transformer is coupled through CR 304 and R339, tending to drive the collector of Q3 to some high positive potential; however, CR 3 clamps the collector to 15 volts. This is several volts above normal black level, and so the kine is blanked. Vertical-retrace blanking is accomplished in much the same manner; the blanking pulse input is by way of R328, C13, and CR 2.

The second video amplifier and its associated circuits are shown in Figure 3-10. Video from the first video amplifier is coupled through C7 to the base of Q4; the output is taken from the emitter. Since this emitter follower drives the **emitters** of the three kine drivers, the output impedance of Q4 is very low, and R330 is a very small part of the total output load. Thus, although the **voltage** gain of Q4 is less than unity, the **power** gain is quite large.

The base bias of Q4 is derived from the brightness control; driving the base further positive decreases brightness of the kine. One end of the brightness control is connected to a voltage divider between the regulated 15-volt supply and the unregulated 30-volt supply. The values of these two resistors have been chosen to maintain constant brightness with changes in line voltage.

The opposite end of the brightness control returns to ground through R321 and Q302, which is saturated so long as its base current is significant. Observe that the base voltage of Q302 cannot exceed .7 volt since the emitter is directly connected to ground. Therefore, the current through R319 must be 1.43 ma in order to drop 14.3 volts. This current may flow either in the emitter-to-base circuit of Q302 or through the kine, high-voltage quadrupler, R115, R320, and then through R319. Normally, some of this total current flows in each circuit, Q302 remains saturated, and the collector voltage is near zero. But if the kine current becomes excessive, the drop across R319 increases to more than 14.3 volts, and Q302 cuts off. This allows the collector voltage to rise, ultimately reducing kine current.

For optimum performance of the receiver, it is desirable to limit only the long-term average kine current, not the current peaks required to repro-

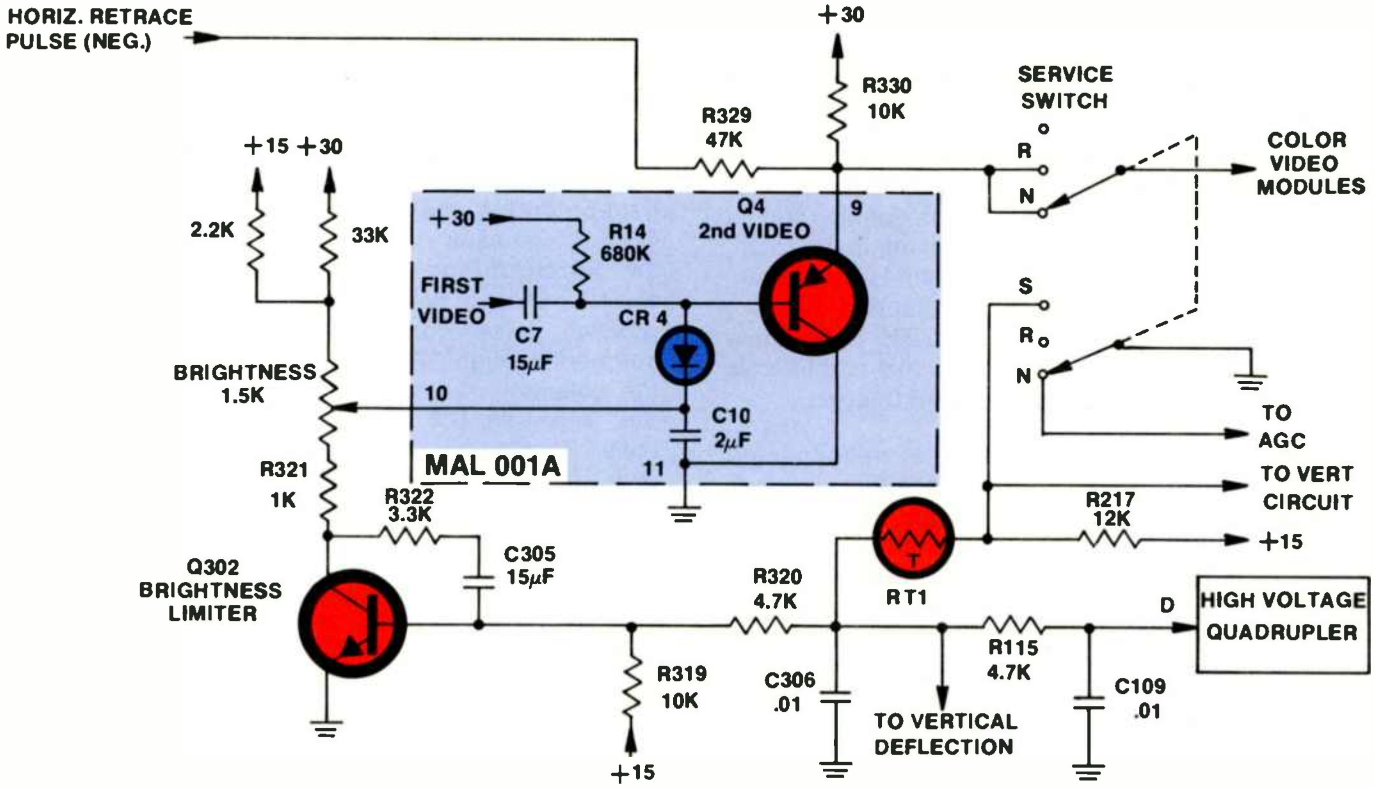


Figure 3-10 Second Video Amplifier and Brightness Limiter

duce highlights in the televised scene. C305 and R322 provide an integrating feedback loop which allows the limiter to respond only to prolonged intervals of high kine current.

Also shown in Figure 3-10 are the functions of the service switch. In the normal position, video passes through one section of the switch and cut-off bias voltage to the AGC system is grounded. In the raster position, the AGC voltage is allowed to cut off the receiver, but video (actually only the white-level voltage) still passes to the kine drivers. In the service position, the vertical-deflection system is disabled by removing voltage from the switch transistor, and the white-level voltage from the second video amplifier is disconnected from the kine drivers.

MODULE MAD

Three identical kine-drive modules, MAD, are used, one for each color of video. In each module the luminance video is combined with one color of the chrominance video (color-difference signal); the two are amplified and finally fed to the appropriate kine cathode. Figure 3-11 shows the circuit.

First consider the signal paths. Luminance video passes from the service switch to the emitter of Q1, via three parallel paths. These are R7, called the primary path for convenience; R6 and C2, which provide high-end video peaking; and R335 and R336, which allow control of amplifier gain for gray-scale setup. The color-difference video, R-Y for example, drives the base of Q1, and thus R-Y is added to Y to produce R, or red. The color-video output is conducted directly from the module to the kine socket without passing through the edge connector; the spark gap and 3.3K-ohm resistor are in the kine socket.

DC stability of the kine cathodes is provided by the positive horizontal retrace pulse injected at C309 and conducted to the bias transistor, Q2. Considering only the circuitry within the module, observe that a feedback loop exists from the collector of Q1, through R2, CR 1, R9, Q2, and R5, back to the emitter of Q1. Assuming that there are no input signals, it functions as follows: A rise in the voltage at the collector of Q1 increases emitter-to-base current in Q2; this increases the collector current of Q2, which passes through Q1. The increase in collector current of Q1 increases the drop across R3 and drives the collector voltage of Q1 back to its former value. Conversely, a drop in collector voltage at Q1 decreases the forward bias of Q2, reducing the drop across R3 and returning the collector of Q1 to its former potential. Since the loop gain is fairly high (greater than 20) the collector voltage of Q1 is held within very close limits.

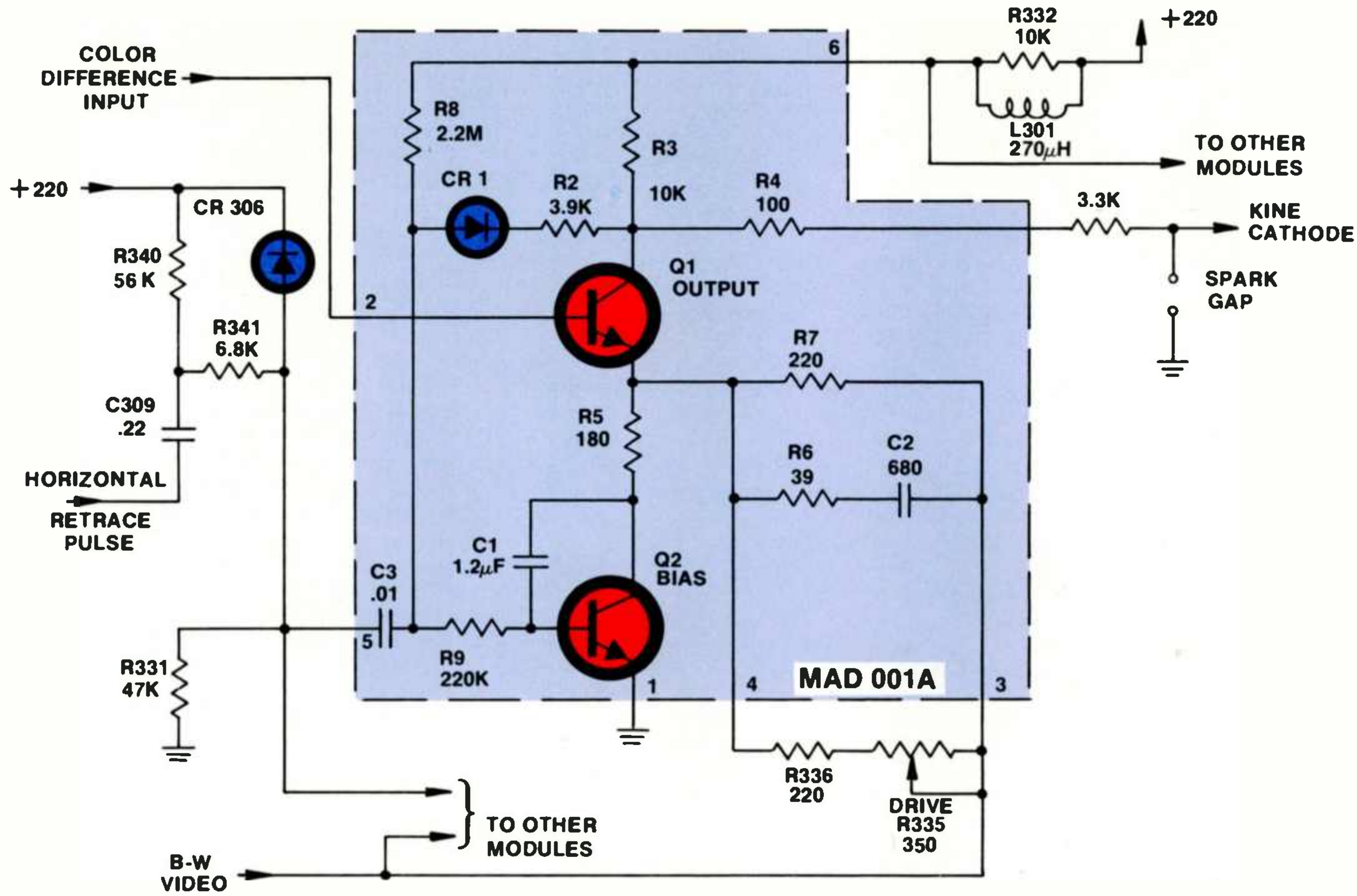


Figure 3-11 Module MAD Kine Driver

This explanation is oversimplified, because it ignores two important facts. Signals are present, so the collector voltage of Q1 must vary; and no reference voltage has been provided to establish the voltage at which the collector of Q1 is stabilized. There is, however, a period when no signals are present—the horizontal-retrace blanking period. If the bias current through Q1 is set to produce kine cutoff during blanking time and sufficient integration is provided, this amount of bias can be maintained until the next blanking interval. This integration is provided by C1.

The characteristics of the kine dictate that its cathodes, and the collector of all Q1's, be driven to +160 volts for blanking. A reference voltage, keyed on only during blanking, is conveniently derived from the horizontal retrace pulse. This pulse enters the circuit via C309 and is limited to a peak value of 220 volts by CR 306. This limited pulse is fed through C3 to the stabilizing loop. In any pulse circuit the DC level is equal to the pulse voltage times the duty cycle. (Duty cycle is defined as the product of the pulse width in seconds and the number of pulses per second; e.g., a horizontal-retrace pulse having a width of 5 microseconds has a duty cycle of .0787.) The circuit constants in these modules were selected so that the average DC voltage at the junction of R1, CR1, R8 and C3 is 160 volts less positive than the peak voltage at that point.

Under ideal conditions, the voltage at the collector of Q1 always would return to +160 volts during retrace blanking. The 220-volt retrace pulse at the anode of CR 306, coupled through C3 would be clamped at the Q1 collector voltage by CR1, and a constant DC bias voltage at the base of Q2 would be developed. In practice the blanking-level voltage at the collector of Q1 may tend either to increase or decrease. If it should tend to increase, the retrace pulse is clamped to a higher potential, the bias at the base of Q2 increases conduction of this device, and the collector voltage of Q1 is driven back to 160 volts. Conversely, a tendency toward a drop in the collector voltage of Q1 decreases the bias current of Q2, boosting the Q1 collector voltage back to 160 volts.

The process just described fulfills the requirements for voltage stabilization. Sampling of kine cathode voltage occurs during blanking time when no signal voltage is present, and the bias current established is maintained constant throughout the scanning interval by virtue of the integration in the base-collector circuit of Q2.

4

HORIZONTAL DEFLECTION

The horizontal deflection and high-voltage system of the CTC 49 chassis is similar to the one employed in the CTC 47 chassis, which in turn, was derived from the circuits of the CTC 40 chassis. It is recommended that those unfamiliar with SCR deflection read the appropriate sections of the technical manuals pertaining to each of these instruments.

The horizontal AFC and oscillator circuits of the CTC 49 are contained in Module MAH. The AFC circuit is shown in Figure 4-1. Differentiation of the

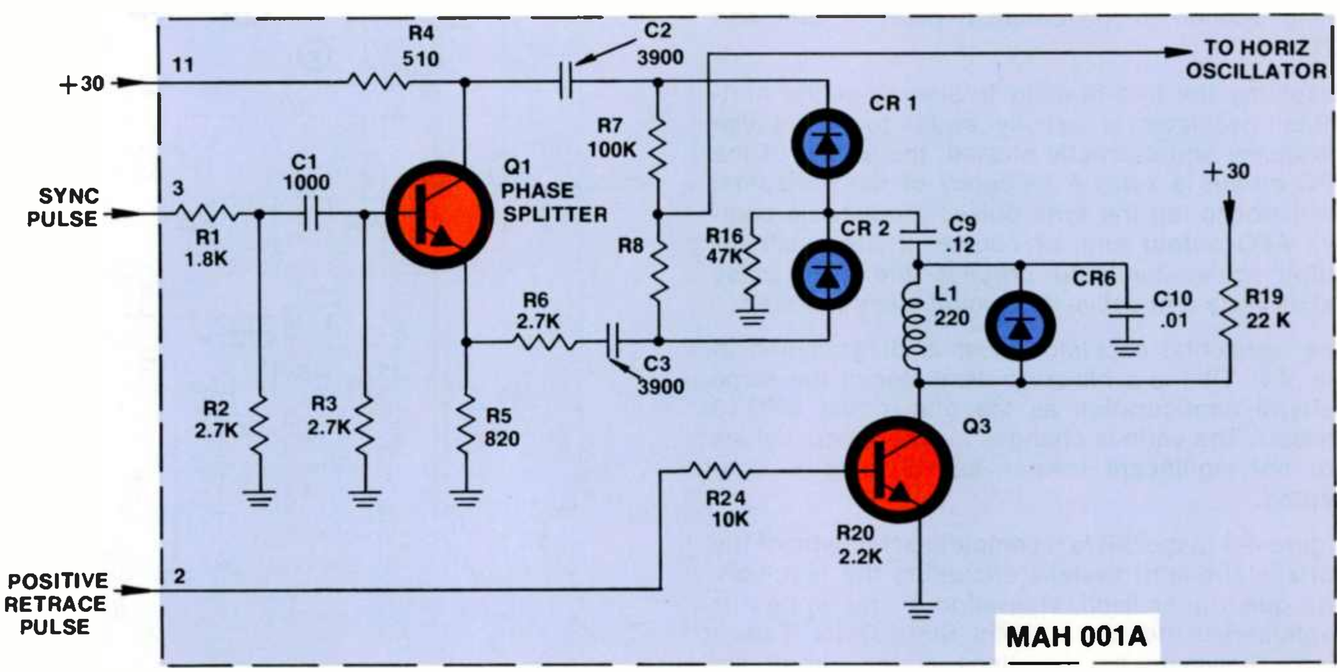


Figure 4-1 Horizontal AFC Circuit

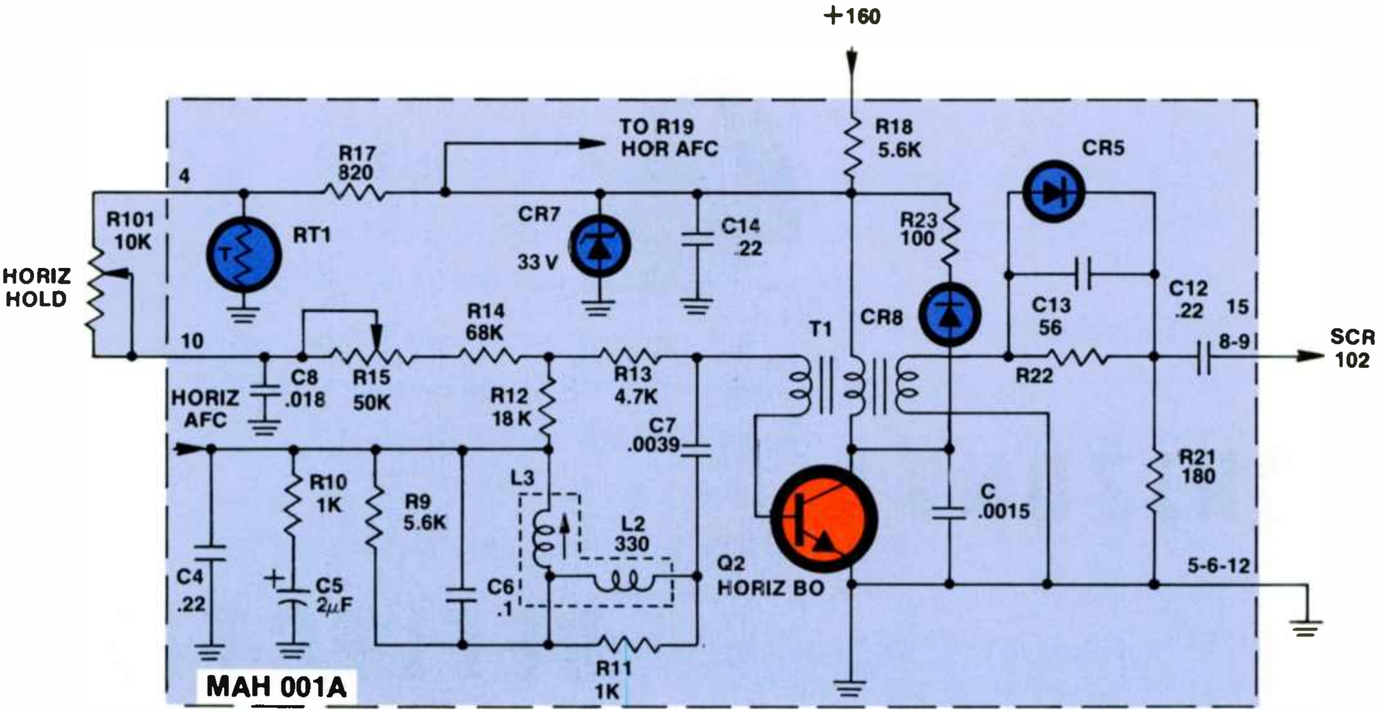


Figure 4-2 The Horizontal Oscillator

combined vertical and horizontal sync pulses by C1 and R3 eliminates the former; the horizontal sync pulses are split in phase and supplied to the two inputs to the phase detector, C2 and C3. Positive retrace pulses from the flyback transformer are shaped in the collector circuit of Q3 before being applied to the common point of CR1 and CR2.

Assuming the free-running frequency of the horizontal oscillator is exactly equal to sync-pulse frequency and correctly phased, the output of the AFC circuit is zero. A tendency of the horizontal oscillator to lag the sync pulses produces a positive AFC output and, of course, if the oscillator output pulse tends to precede the sync pulse excessively a negative AFC voltage is generated.

The horizontal oscillator itself is diagrammed in Fig. 4-2. This is a blocking oscillator of the same general configuration as the one in the CTC 40 chassis. The various changes in component values are not significant insofar as servicing is concerned.

Figure 4-3 (page 30) is a complete schematic of the horizontal-output system, excluding the high-voltage quadrupler itself. Operation of this system is explained in detail in "Solid State Color Television"; however, the functions of the circuit are summarized here for the convenience of the reader.

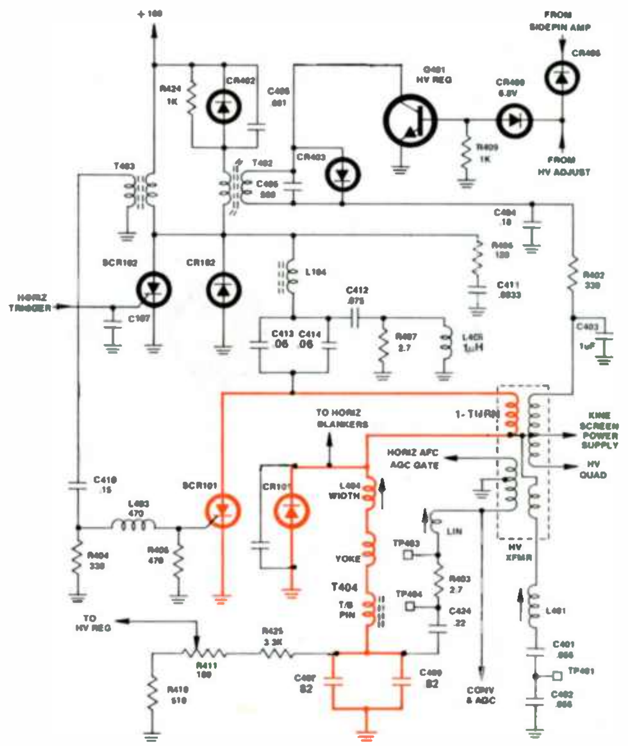


Figure 4-3A Trace Resonant Circuit

There are three resonant circuits to be considered in the operation of the yoke circuit. These are:

1. The trace resonant circuit consisting primarily of C408 and C409 in parallel, T404, the yoke, L404, and either CR 101 or SCR 101, whichever is conducting. The yoke inductance is by far the greatest inductance, comprising roughly 90% of the total. The resonant frequency of this circuit is **roughly** 10 KHz; therefore the period of one-half cycle is approximately equal to the duration of one scanning interval. Refer to Figure 4-3A.
2. The retrace resonant circuit made up of C408 and C409 in parallel, T404, the yoke, L404, C413 and C414 in parallel, L104, and either CR 102 or SCR 102, whichever is conducting. The resonant frequency of this circuit is such that its half-cycle period is equal to retrace time. Refer to Figure 4-3B.

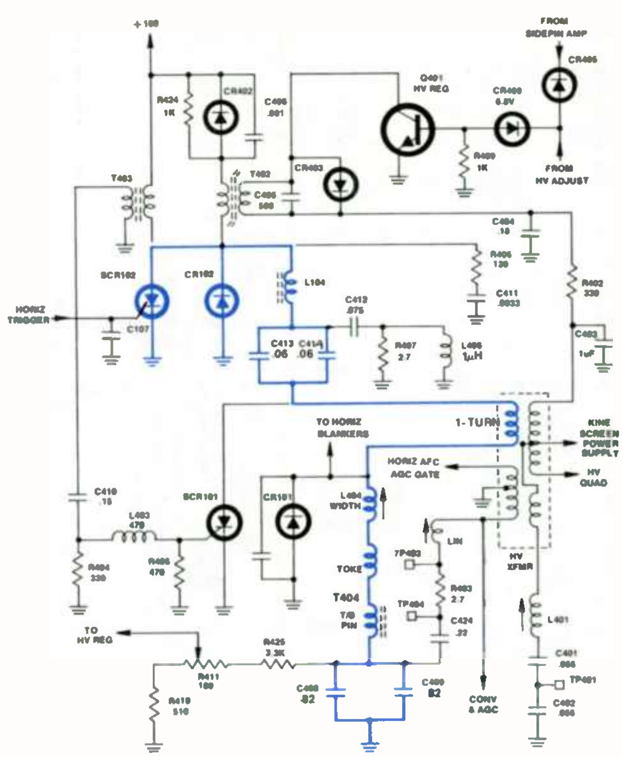


Figure 4-3B Retrace Resonant Circuit

3. The power-input resonant circuit consisting of R424 and T402 in parallel with T403, L104, and two parallel paths to ground. One of these is C412 and R407 paralleled by L406; the other is C413 and C414 in series with either SCR 101 or CR 101, whichever is conducting. The resonant frequency of this circuit allows the voltage at the junction of T403 and L104 to rise to its positive peak and begin to decay during each scanning interval. The precise frequency is varied by the voltage regulator, to be explained. Current flowing through T403 generates a positive gate voltage for SCR 101 during most of the scanning interval. Refer to Figure 4-3C.

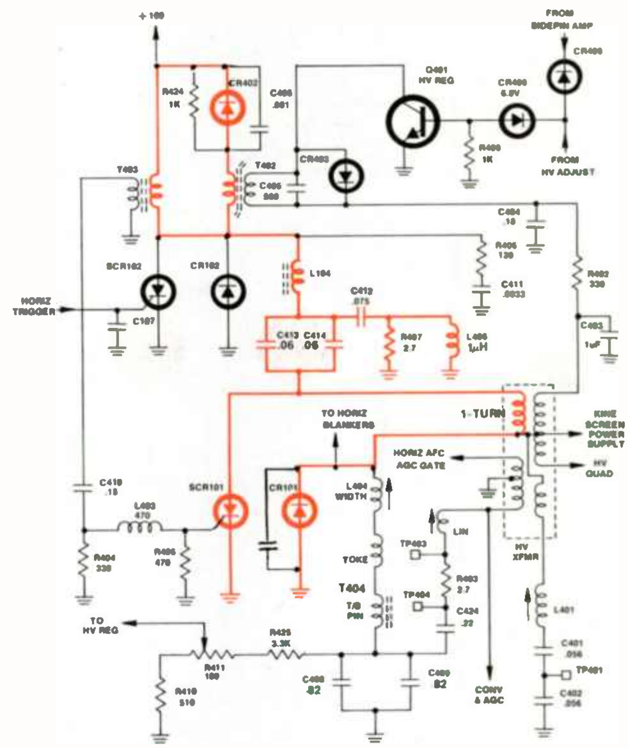


Figure 4-3C Power-Input Resonant Circuit

Considering a point in time just after retrace is completed, time 0 in Figure 4-4, a large current is flowing in the trace circuit and conduction is through CR 101. This current decays to zero at midscan and reverses, flowing through SCR 101 and rising from zero to maximum at the right end of scan. Near the end of the scanning interval, gate voltage is removed from SCR 101, but it continues conducting.

Throughout the scan interval, the lower ends of C413 and C414 effectively are grounded. Electron current flows from ground through C413, C414, C412 and the rest of the power-input circuit to B+. L104 is small compared to T403 and T402, so the voltages at its opposite ends are about the same. The voltage at the anode of SCR 102 and CR 102 reaches maximum slightly before the end of trace

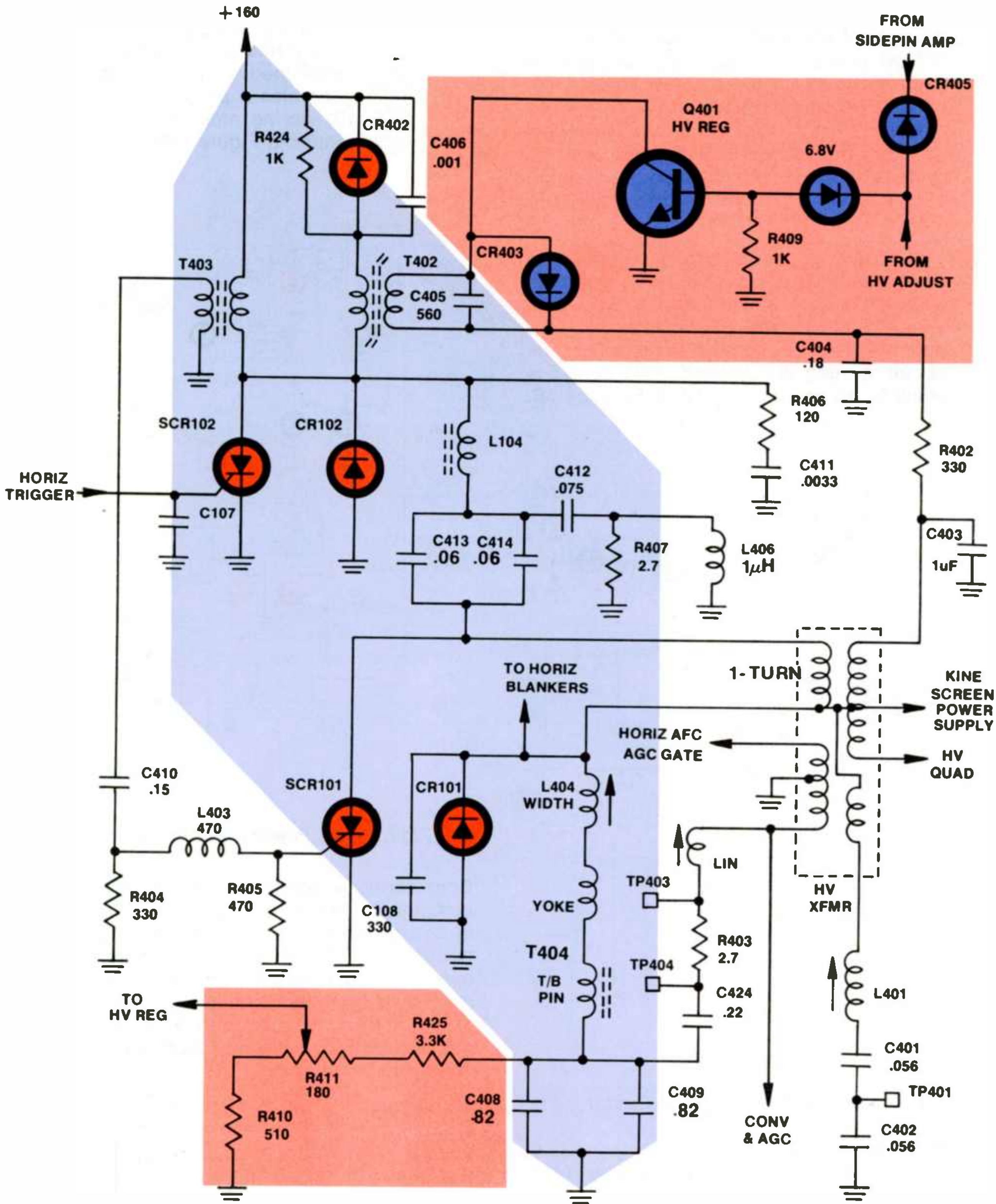


Figure 4-3 Horizontal Deflection and High-Voltage Regulation Circuits

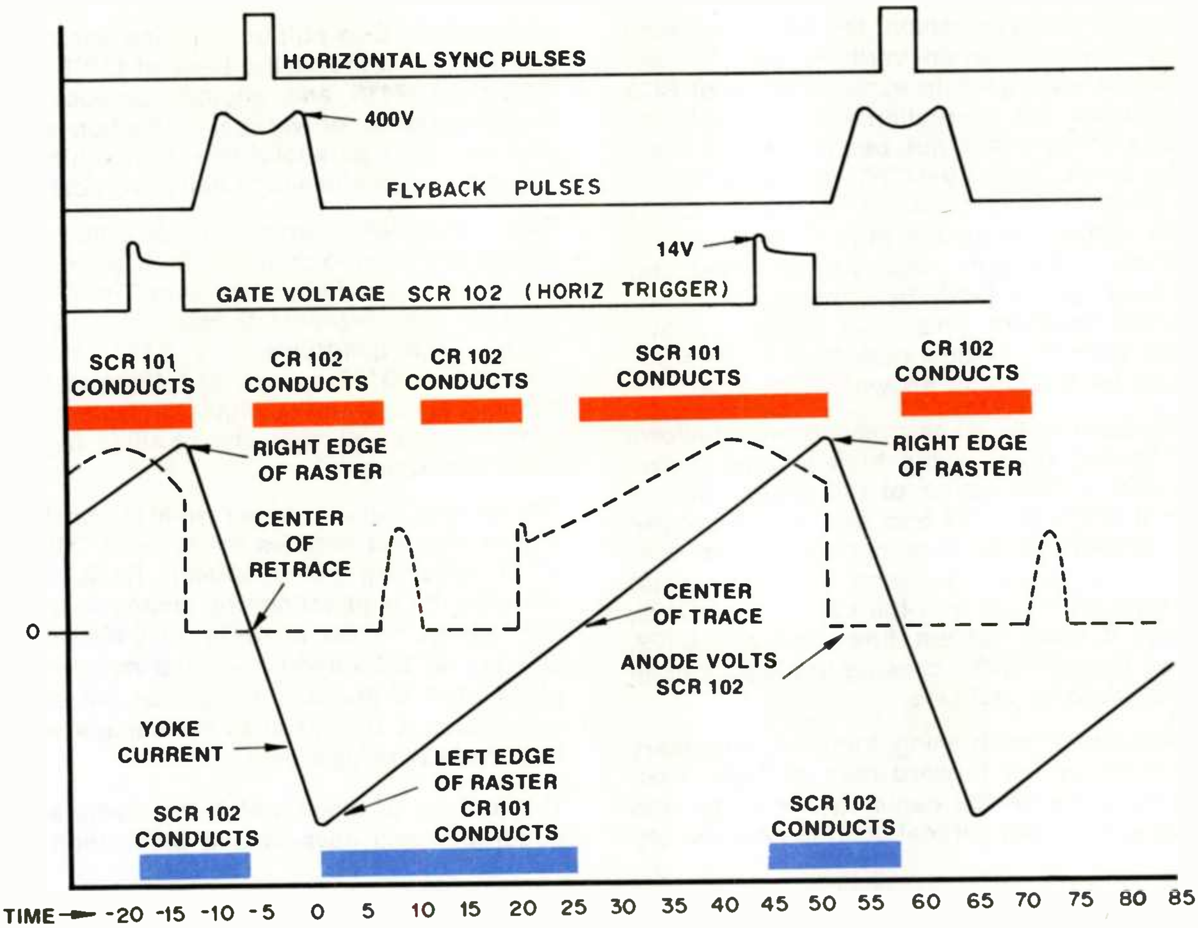


Figure 4-4 Timing Diagram of Horizontal Deflection System

and begins to decay, since the power-input circuit is resonant. Regulation of input power is accomplished by changing the resonant frequency; this is the function of the saturable reactor, T402.

When SCR 102 is triggered, the retrace resonant circuit is completed and the energy stored in C412, C413, and C414 causes electron flow to continue downward through the yoke, rapidly cutting off SCR 101.

Resonance causes the yoke current to decay to zero and reverse, cutting off SCR 102 and turning on CR 102. At this instant, scan is at the center of retrace. Current increases until it reaches a maximum, driving the scan to the left side of the kine, but it cannot reverse again because gate voltage no longer is present on SCR 102. The large current flowing in the yoke at the end of retrace takes the only path available, through CR101. This, of course, was the condition assumed at the beginning of this summary.

The high-voltage transformer is connected parallel to the yoke circuit. During scan time either SCR 101 or CR 101 is conducting, thus shorting the primary so that very little energy can enter. However, during retrace the flyback voltage pulse drives the transformer primary, and the transformer converts this voltage to a higher voltage, which is used to drive the quadrupler and kine screen power supply. Energy transfer is optimized by tuning the transformer to the third harmonic of the retrace pulse. This is the function of L401.

Scan width and high-voltage level are sensed by sampling the voltage developed across C408 and C409 during scan time. An increase in scan width and high voltage increases the collector current of Q401. This further saturates T402, decreasing its inductance and increasing the resonant frequency of the **power input** resonant circuit. Since this causes the voltage at the anode of SCR 102 to crest sooner, and decay further before the next retrace begins, there is less energy available for scan and high voltage during the subsequent retrace and trace cycle. If scan width and high voltage tend to decrease, they are stabilized in the same way, except, of course, all processes are reversed.

To overcome side pincushion, the horizontal scan must be increased when vertical scan is near the center of the raster. In earlier models of RCA color receivers, this correction was accomplished by passive components; but, because of the wider deflection angle used in the CTC 49, a more sophisticated means of correction is necessary. Since the high voltage regulator of this chassis also controls the scan width, side pincushioning may be corrected conveniently by providing a second input to the regulator. This input to the regulator is derived from the vertical deflection circuits and processed by the circuit shown in Figure 4-5.

Q402 may be considered as a resistor which allows current flowing towards the high-voltage control (Figure 4-3) to take either of two paths. One of these is through CR 408 and the emitter-to-base junction of Q401, which is the normal voltage-regulating current previously described. The second path is through CR405 and the collector of Q402. Obviously, if more current flows through Q402, less flows through Q401, causing the high voltage and scan width to increase.

To correct side pincushioning, then, it is necessary only to increase the forward bias of Q402 when vertical scan is near the center of the raster and decrease it when the vertical scan is near the top and bottom. One output from the vertical deflection system is fed to the base of Q402 by way of R416 and R415 and another arrives via R417. These samples of vertical deflection signal are shaped into a parabolic waveform which reaches its maximum positive potential at vertical mid-scan.

Two inputs taken from the horizontal deflection system are used to optimize the high voltage regulation and pincushion correction. The first of these is taken from terminal D (see Figure 4-6) of the high-voltage quadrupler, via R115, and reaches the base of Q402 by way of R426 and R419. The purpose is to allow the regulator system to "measure" the beam current and regulate high voltage more accurately.

The second input is taken from terminal C of the quadrupler and reaches the base of Q402 by way of an adjusting potentiometer, R428. This input samples the high voltage by means of the capacitive voltage divider made up of C426 and the capacitors in the quadrupler, and compensates for phase shift of the side pincushion correction voltage, which is the result of the capacitance of the kinescope ultor connection.

The amount of effect which this sample from the quadrupler will have on the pincushion amplifier

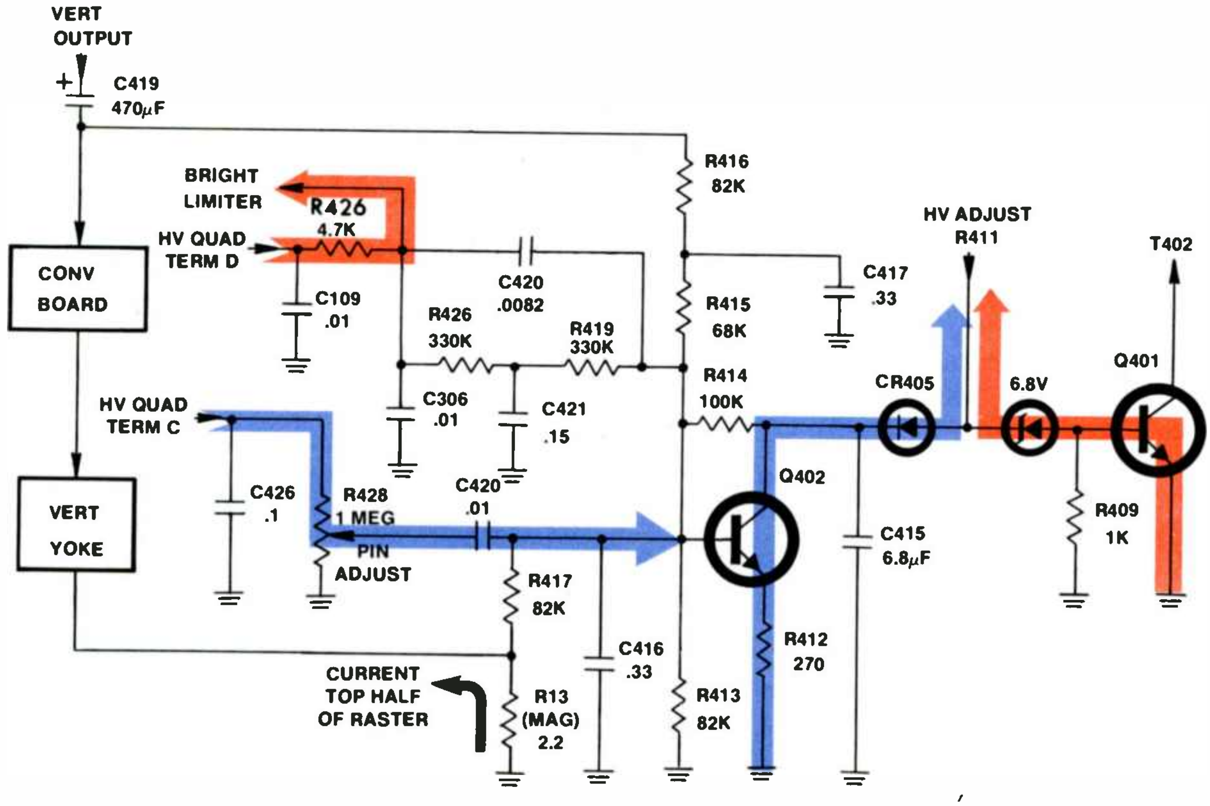


Figure 4-5 Side Pincushion Amplifier

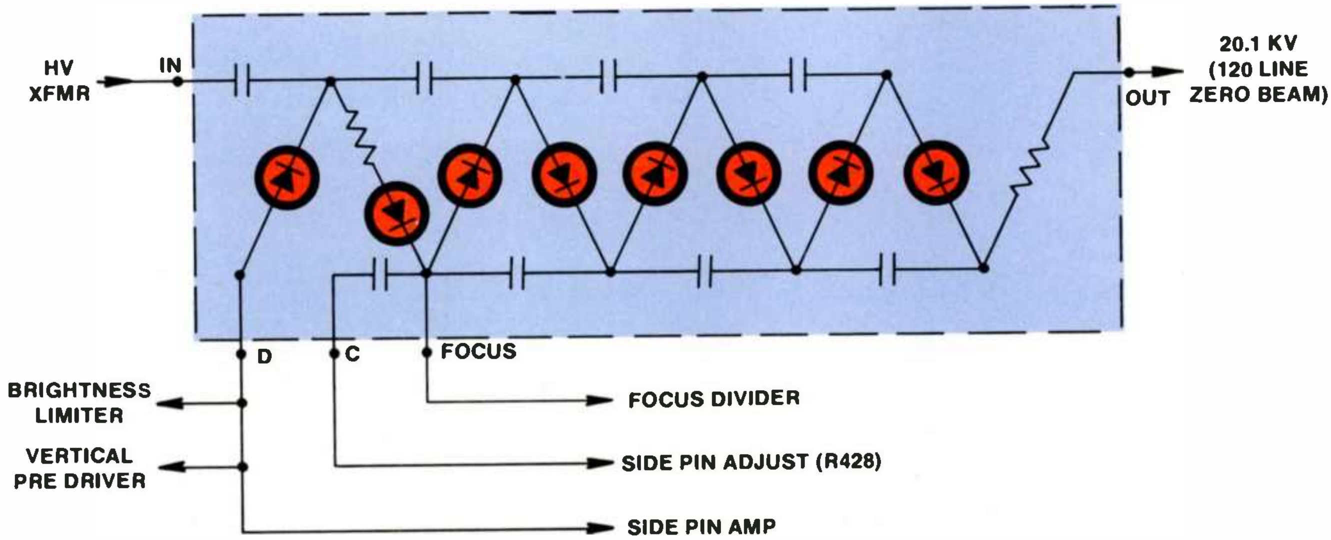


FIGURE 4-6 HIGH VOLTAGE QUADRUPLER

Figure 4-6 High-Voltage Quadrupler

may be adjusted with R428. The amplifier has been designed so that when brightness is set for a barely visible raster and R428 is set to minimum (CCW) there will be no pincushion. Then R428 is adjusted to correct the pincushioning which will appear when the brightness is increased to maximum.

Unlike conventional high-voltage power supplies which rectify a positive pulse from the flyback transformer with a half-wave rectifier, the CTC 49 uses a solid-state quadrupler to produce high voltage. This reduces the required pulse amplitude from about 23KV to nominally 6KV. The quadrupler itself is hermetically sealed and is not repairable; however, its schematic is shown in Figure 4-6 as a means of identifying its external connections.

5

VERTICAL DEFLECTION

Prior to discussing the details of the vertical deflection system of the CTC 49 chassis, it is appropriate to discuss solid-state vertical deflection in more general terms. Figure 5-1 is the schematic of an oversimplified deflection circuit which might produce some semblance of a vertical field.

Assume that the time of observation is very shortly after a positive base bias has driven Q1 into saturation. This has driven the junction of R2 and C1 essentially to ground, also grounding the base of Q2. Accordingly, Q2 and Q3 are cut off, the base of Q4 is at its maximum positive voltage, and current flowing through the primary of T1 is rising towards its maximum value.

Current in the yoke soon reaches its maximum value, in the direction shown, and this produces maximum upward deflection on the kine. However, this is an unstable condition, because the voltage drop across R6 is fed back to the base of Q1, cutting that transistor off. The sequence of events just described is, of course, the one which takes place during vertical retrace.

When Q1 returns to cutoff, the voltage across C1 begins to rise exponentially. Until the voltage at the junction of C1, R2, and R3 rises above the barrier potentials of Q2 and Q3, these two transistors remain cut off, a serious problem because it leads to non-linearity at the top of the raster. The method of overcoming this problem will be discussed later.

When Q2 and Q3 finally begin conducting, the base current of Q4 begins to decrease. This leads to a reduction of current in the primary of T1 and also in the yoke, and the vertical deflection moves towards the center of the raster. As the current through C1 continues decreasing, the base currents of Q2 and Q3 continue increasing until finally the emitter current of Q4 becomes very small. Meanwhile, the direction of current flow in the secondary of T1 and in the yoke has dropped to zero and begun to increase in the opposite direction. At zero yoke current, vertical deflection is at the center of the raster, moving downwards.

Yoke current which produces the bottom half of the raster also produces a positive voltage drop across R6, and at some critical value of this increasingly positive potential, Q1 once more is biased into conduction. When Q1 conducts, Q2 and Q3 are driven quickly to cutoff, and forward bias for Q4 goes to maximum. Current increases from minimum to maximum in the primary of T1, and in the secondary it swings from maximum in one direction to maximum in the other. Once more the voltage fed from R6 to the base of Q1 cuts off that transistor, and another vertical scan begins.

A number of things determine the period of the vertical-deflection cycle; however those components of immediate interest are R1, R6, and R7. If R1 is set to maximum resistance, the fixed base

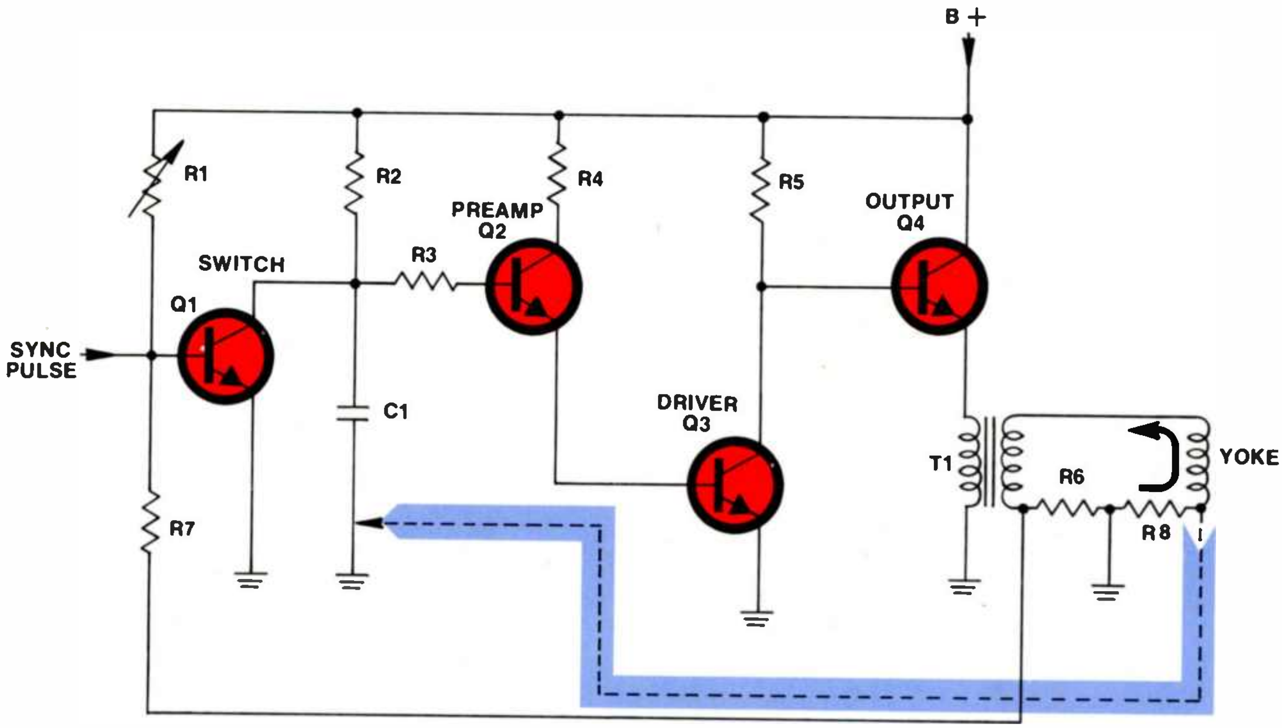


Figure 5-1 Simplified Vertical Deflection Circuit

bias of Q1 is minimum, say +.2 volt. Therefore when the yoke current has increased sufficiently to produce an additional +.5 volt across R6, Q1 conducts and retrace begins. On the other hand, if the fixed bias were increased to .3 volt, retrace would occur sooner, when the drop across R6 reached only an additional .4 volt.

To synchronize the vertical deflection to broadcast sync pulses, it is necessary that the natural frequency of the deflection system is slightly less than sync-pulse frequency. Otherwise, spontaneous retrace will precede the arrival of the sync pulse, making synchronization impossible.

In the preceding explanation the problems of obtaining linearity of the sweep current were not discussed. One non-linearity results from the fact that the voltage rise across C1 is not linear. The result is that the base currents of Q2 and Q3 also do not increase linearly. A solution would be to make the capacitance of C1 very large, in the order of millifarads, but this solution has practical limitations. A better solution is to place C1 in a negative feedback loop from the output circuit to the base of the preamplifier. In Figure 5-1, this could be done by connecting a small resistance, R8, in the secondary of T1 and returning C1 to its junction with the yoke instead of to ground.

In this new configuration, the end of C1 which formerly was grounded reaches its maximum positive potential during retrace. Then, during the vertical scanning interval, this voltage decreases to zero and finally reaches its maximum negative value when scan reaches the bottom of the raster. This negative-going voltage opposes the positive-going voltage being generated by the current flowing through R2 to B+ so that the voltage at the base of the preamplifier can rise only very slightly during the scanning interval. This, of course, decreases the effective gain by a factor of several thousand, but sufficient output still is possible by making Q2, Q3, and Q4 high-gain amplifiers. The advantage to be derived is that any non-linearity is decreased by the same amount as the overall gain of the circuit has been decreased.

The feedback circuit just described, known as a "Miller run-down circuit," was known, but seldom used, before the advent of transistors, because of the requirements for high gain. Solid-state design has made it feasible to obtain the necessary gain with relatively very little cost, and so the use of the Miller circuit has become widespread. To summarize, the Miller run-down circuit effectively multiplies the charging capacitance by a factor equal to the gain of the amplifier without feedback. This causes the output to be extremely linear. Further, many of the variations in supply voltage, amplifier gain, etc. which would drastically change the output of a conventional vertical-deflection circuit have but slight ill effects in the Miller circuit, because of the large degenerative feedback.

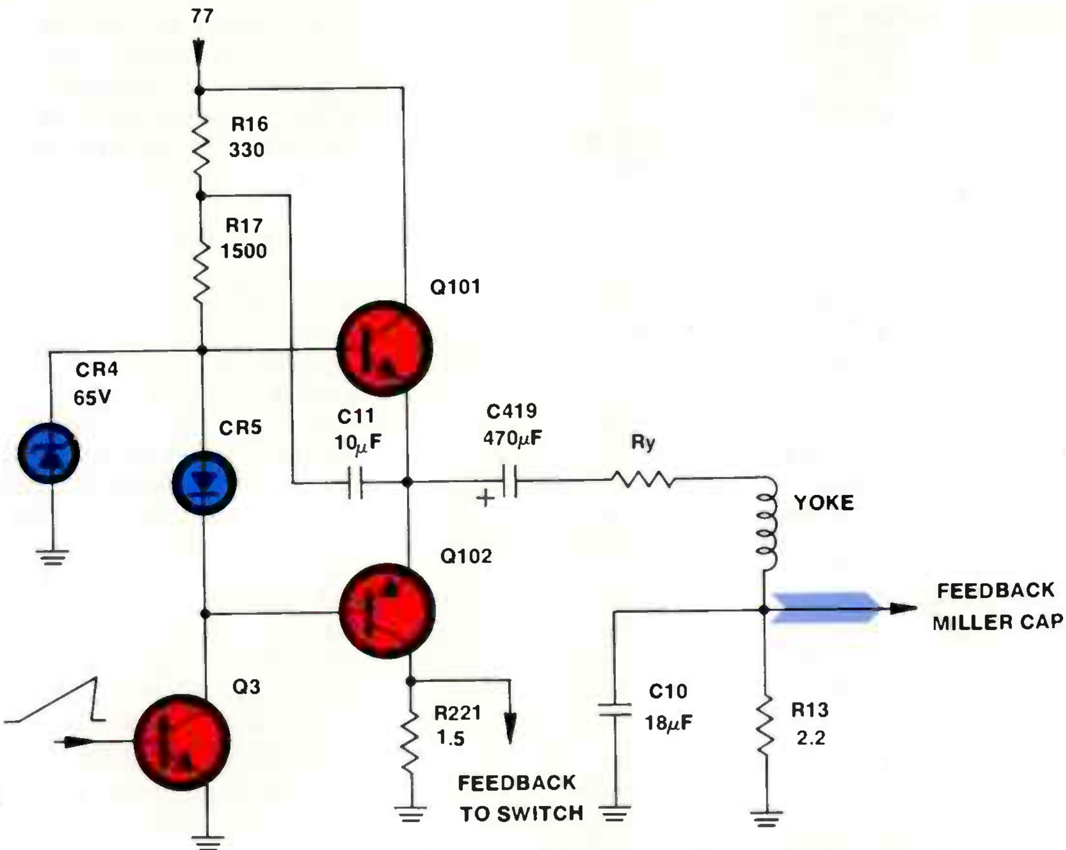


Figure 5-2 Vertical Driver, Output, and Simplified Yoke Circuit

A second linearity problem of the open-loop deflection circuit was mentioned before—the fact that a delay exists between the time when Q1 is cut off at the end of retrace and the time when C1 becomes sufficiently charged to forward bias Q2 and Q3 into conduction. This may be overcome by returning the lower end of C1 to a modest positive voltage, instead of ground. In the closed-loop configuration, indicated by the dotted-line connection of Figure 5-1, a positive voltage will exist at the lower end of C1 during the latter part of the retrace interval. As a result, when Q1 cuts off, its collector voltage immediately will rise enough to turn on Q2 and Q3.

A schematic of the RCA CTC 49 vertical-output stage with the yoke circuit simplified appears in Figure 5-2. Notice that the circuit configuration is similar to a high-quality audio amplifier. The yoke itself is analogous to the speaker voice coil, C419 is the coupling capacitor, and R_Y is the equivalent of the total resistance of the yoke and convergence circuits. The value of C419 has been chosen to provide maximum energy transfer at the vertical scanning frequency. Feedback to the Miller capacitor is developed across R13 and C10 is a filter.

During retrace, Q3 is cut off, allowing its collector to rise towards B+; however, the 65-volt zener, CR 4, limits the maximum base bias of Q101, serving to limit yoke retrace current. During scanning time, the bases of Q101 and Q102 are driven progressively less positive at a linear rate. Conduction is through Q101 during most of the retrace time and as scan passes from the top of the raster to center. The voltage across C419 at vertical scan center has reached maximum (90° out of phase with current) and during the lower half of scan, C419 discharges back through the yoke and Q102. This current increases at a linear rate, since forward bias on the base of Q102 is increasing at a linear rate.

The diode connected between the bases of Q101 and Q102 improves the switching characteristics of the transistors at mid-scan. Q102 has zero bias so long as Q101 is conducting. Therefore only slight voltage swings are necessary to cut off Q101 and turn on Q102 at the center of the raster. If the diode were shorted or bypassed, reverse bias would exist between base and emitter of Q102 while Q101 was conducting, and consequently there would be appreciably more disturbance in the circuit during transition time. This probably would be sufficient to produce a white horizontal line at the center of the raster.

The equivalent circuit of the yoke was shown in

Figure 5-2; Figure 5-3 shows the yoke circuit in its entirety. From Q101 and Q102 the positive retrace pulse is coupled to the first video amplifier (Figure 3-8) for blanking. Yoke current passes through C419 and **through** the convergence circuits (Figures 5-6 and 5-7) to the yoke itself. A voltage take-off between C419 and the convergence assembly drives the side pincushion amplifier.

Connected between the two vertical yoke windings is the top-and-bottom pincushion circuit, which is similar to the ones used in many other RCA color receivers. Horizontal yoke current passing through the primary of the Top/Bottom pincushion transformer, T404, excites a tuned circuit, consisting of the pincushion phase coil and C418, which is in series with the vertical yoke. Depending on its phase, this 15.73-kHz voltage may either buck or boost the vertical deflection. The core in the pincushion coil is adjusted so that vertical-yoke current is decreased at the edges of the raster and increased at the vertical centerline. R418 controls the amount of buck and boost of yoke current, so that the inherent pincushioning is exactly cancelled.

Passing through the second yoke winding, terminals 8 to 6, the yoke circuit reaches ground through R13. The voltage at the junction of R13 and the yoke is positive during the top half of scan and negative during the bottom half. This voltage is fed to the vertical amplifier via the Miller feedback loop and also to the side pincushion amplifier, where it is used for wave shaping.

Figure 5-4 illustrates the complete circuit of the vertical predriver circuit, Q2. Q102 is the same vertical-output transistor that was shown in Figure 5-2; it appears at the left in Figure 5-4 so that the feedback loop may be conveniently identified. The components of the predriver stage are physically located in a number of places in the instrument; locations may be determined in Figure 5-4 by the symbol numbers. Component symbols of one or two digits (C9 and R11, for instance) are in Module MAG. 200-, 300-, and 400-series symbols indicate locations on boards PW 200, PW 300, and PW 400, respectively.

To relate the circuit of Figure 5-4 to the simplified circuit in Figure 5-1, Q1 and Q2 have the same functions in each diagram, and C1 of Figure 5-1 (when connected to R8) is analogous to C7 of Figure 5-4. R2 of Figure 5-1 is replaced by R8, but a number of other components also are included in the resistance between the base of Q2 and B+.

In understanding the functions of these additional components, remember that anything which in-

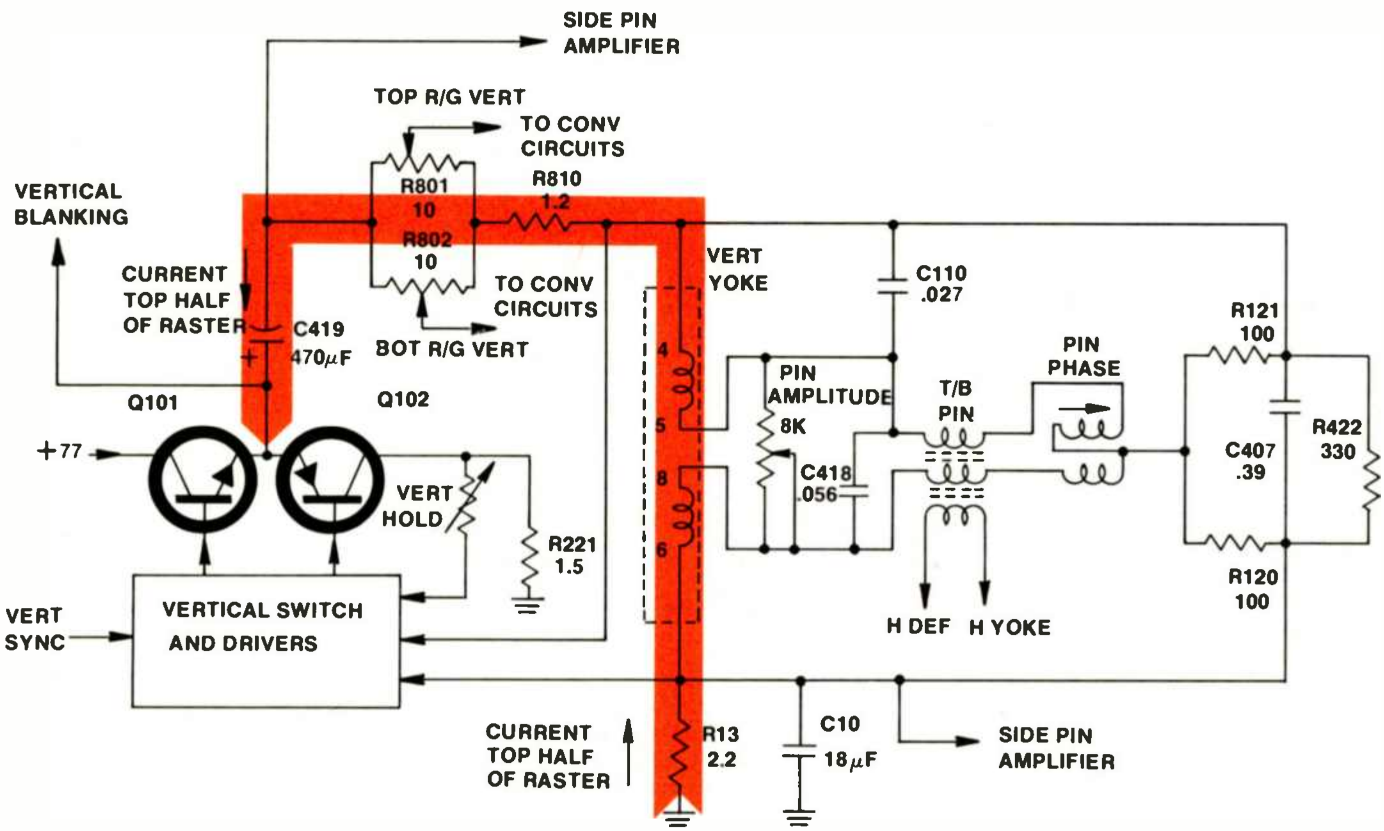


Figure 5-3 Yoke Circuit of the RCA CTC 49

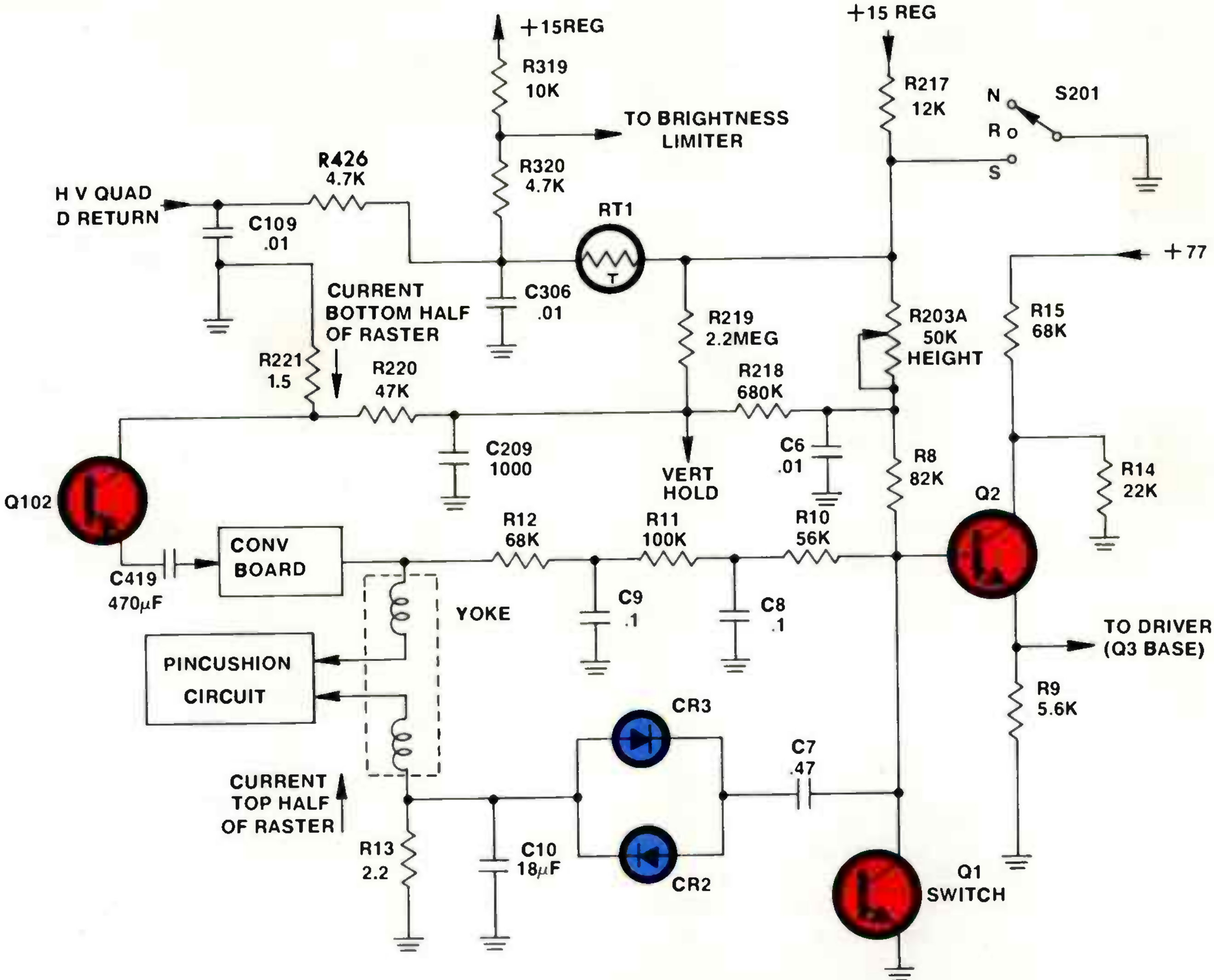


Figure 5-4 The Vertical Predriver With Its Inputs

creases the positive voltage at the junction of R8 and R203A will increase the raster height. Consider first the major voltage source to R8, consisting of R203A and R217. As the resistance of R203A is decreased, height will increase. If S201, the setup switch, is closed to the service position, the supply to R8 is diminished practically to zero, collapsing the raster.

Because Q102 is cut off while the top half of the raster is scanned, the voltage at its collector is zero until vertical scan reaches the center. During the bottom half of scan, the collector current of Q102 increases linearly, so the voltage fed back to R8 tends to "stretch" the lower part of the raster, to overcome some tendency towards bottom compression. Feedback to the vertical-switch transistor also is derived from R221.

The remaining input to R8 comes from the horizontal system. As high voltage return current from the quadrupler to the brightness limiter increases or decreases (see description of the brightness limiter in Chapter 3), the voltage at the junction of R426 and R320 also varies. Thus, an increase in kine current reduces slightly the voltage to the height control, causing a slight decrease in vertical deflection. This causes scanning height to track scanning width.

The most important feedback signal in the system is fed to C7 from the junction of R13 and the yoke. Ignoring the effect of C10, the voltage at this point reaches its maximum positive value at the beginning of scan, passes through zero, and reaches maximum negative just before vertical retrace. Therefore, the feedback to Q2 is degenerative, since voltage at the base of Q2 tends to rise throughout the scanning interval. C10 is used to filter out any horizontal-deflection voltage which may be present.

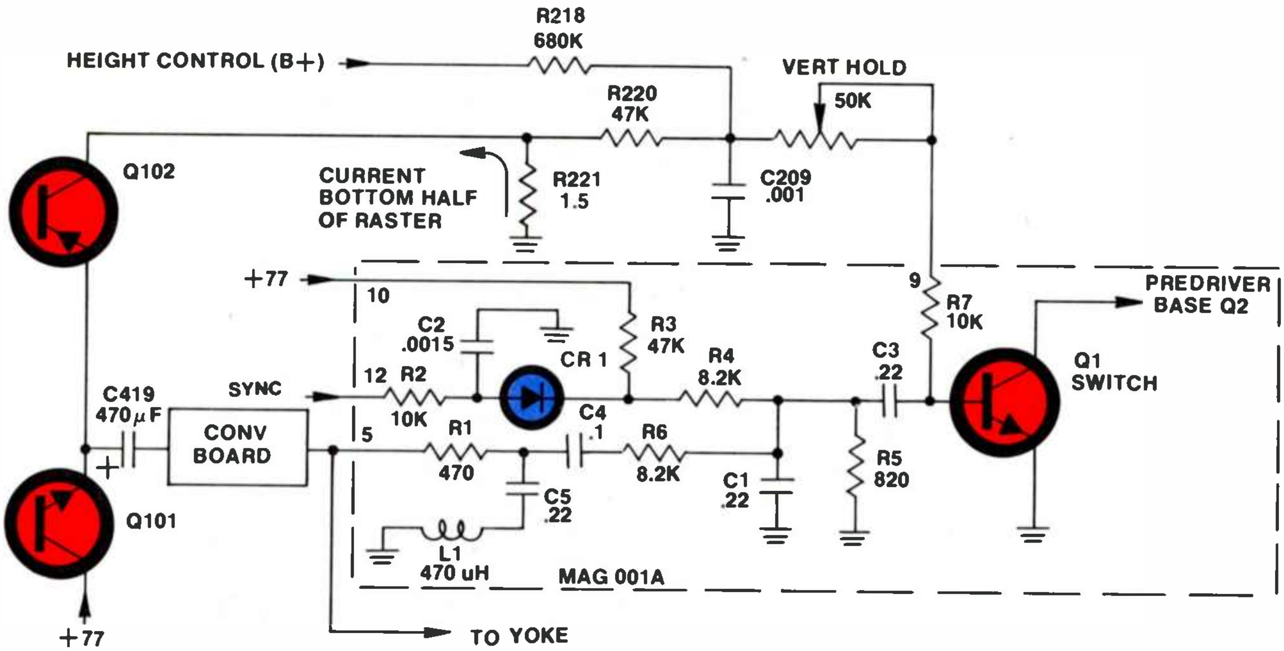


Figure 5-5 Vertical Switch Circuit

The switch transistor and its circuit (Figure 5-5) performs three functions: It controls the free-running frequency of the vertical deflection system, allows synchronization with the received signal, and determines the duration of vertical retrace. Taking these functions in order, first consider the vertical system as a free-running oscillator. The base of Q1 is returned to B+ via R7, the hold control, R218, and then the height control and R217 (see Figure 5-4 for these last two components). Assuming no sync pulses are present, at the moment after the end of retrace, C209 begins charging, allowing the base of Q1 to begin swinging positive. When Q1 begins conducting, (about 17 milliseconds later) Q2 and Q3 (Figures 5-4 and 5-2, respectively) conduct less, and Q101, which was cut off during the lower half of vertical scan, resumes conduction. Since the voltage across the yoke inductance leads the current through it, a sharp positive pulse appears at the input to R1, and this pulse, coupled to the base of Q1, drives Q1 into saturation. This transistion of Q1 from cutoff to saturation is very rapid.

C5 and L1, connected from the junction of R1 and C4 to ground, are series resonant at the horizontal-scan frequency, and shunt to ground any 15.734-kHz energy which may be present. The presence of horizontal ripple at the vertical switch will tend to synchronize the vertical scan with the horizontal, degrading interlace. R6 and C1 shape the feedback pulse so that the transition of Q1 from cutoff to saturation is as rapid as possible.

When Q1 saturates, Q101 reaches maximum conduction (as already explained), and the yoke current rises to maximum in the direction which produces maximum upward deflection. During retrace, the base current of Q1 charges C3 negatively. The duration of the scanning is determined by the length of time required for the base of Q1 to become forward biased once more.

A second feedback circuit improves the frequency stability of the oscillator circuit. During the top half of scan, Q102 is cut off and the voltage at the junction of R221 and R220 is essentially zero. Therefore, the voltage rise at the base of Q1 is exponential. But, as scan nears the bottom of the raster, Q102 conducts, causing a positive voltage to be developed across R221. This sharpens the voltage rise at the base of Q1, so that its transition from cutoff to saturation is more rapid. Likewise, the sharp drop in voltage across R221 (from maximum to zero during the first half of retrace) enhances the cutoff characteristics of the Q1 circuit.

Composite sync from Module MAL is introduced to the vertical system at terminal 12 of Module MAG. R2 and C2 integrate the input so that the horizontal sync pulses are reduced in amplitude to about 8 volts and the vertical pulses have about twice this amplitude. Since CR 1 has about 12 volts of positive bias on its cathode, only vertical sync can pass to the switch transistor. Assuming that the free-running frequency of the vertical system is slightly less than the vertical-sync rate, Q1 will be at the threshold of conduction when each sync pulse arrives, enabling it to "lock-up" with incoming sync.

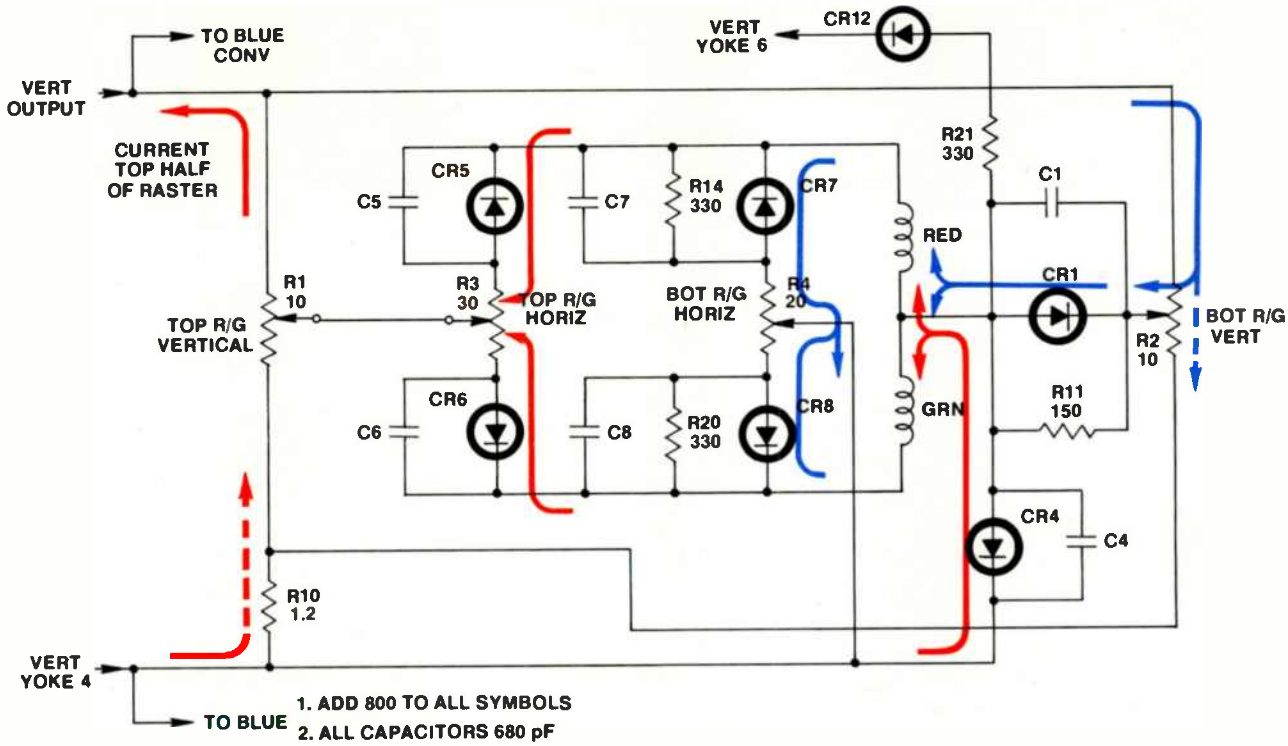


Figure 5-6 Top and Bottom Red-Green Convergence

The fact that the vertical-yoke current passes through the top-and-bottom convergence circuits is rather novel, and while a thorough explanation of these convergence circuits is hardly necessary, a brief description is in order.

The red/green convergence circuits (Figure 5-6) are parallel with the blue convergence circuit (Figure 5-7), and the entire circuit is located electrically between the vertical-output coupling capacitor, C419, and the yoke. The equivalent series resistance of the convergence circuit is about 6 ohms.

The principal current paths during the top and bottom halves of scan are shown in Figure 5-6. During the top half of scan, R1 determines how much of total deflection current is bypassed **around** the red-green convergence coils and how much passes **through** one or the other of them. R3 determines how this latter current is divided between the red and green coils. R2 and R4, respectively, perform these same functions during the lower half of scan.

As illustrated in Figure 5-7, the blue coil is, in effect, connected across the arms of a bridge. If both R5 and R6 are centered, the bridge is balanced and there is no current flow through the coil. If R5 is adjusted from center, current will flow in the coil during the top half of scan in whichever direction is dictated by the position of the control. R6 performs the same function as R5, but during the lower half of vertical scan.

The 680-pF capacitors connected across the diodes in Figures 5-6 and 5-7 suppress diode radiation. They have no significant effect on the actual convergence currents.

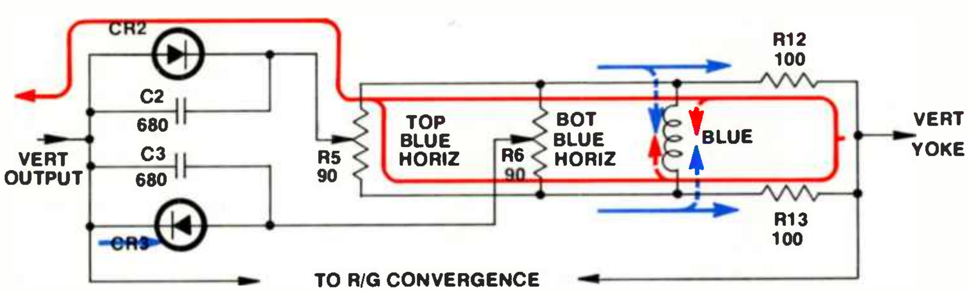


Figure 5-7 Top and Bottom Blue Convergence

6

FIRST-LEVEL MAINTENANCE

The modular construction of the RCA CTC 49 chassis practically revolutionizes the procedures for servicing color television. Before the use of solid-state devices in television receivers became widespread, the bulk of the failures could be corrected in the home by replacing one or more tubes. It has been estimated by various authorities that 75% to 90% of all failures were corrected in the home. This was changed drastically by transistors for at least two reasons: First, the incidence of transistor failures is much less than the incidence of tube failures, making the **percentage** of "other" failures several times greater. Second, with the exception of high-power, socket-mounted devices, the replacement of solid-state components in the home has been generally unpopular with the servicing industry.

The use of circuit modules once again makes it feasible to correct the majority of malfunctions in the home. The bulk of the circuitry of the receiver is contained in 11 modules, three of which are identical; only 9 items of service-call inventory will allow most of the instrument to be checked and repaired by substitution. In addition to these modules, replacements for the 5 plug-in transistors, two plug-in SCR's, and the two diodes of the horizontal-deflection circuit should be carried on service calls. Immediate availability of these 18 items will make it possible to repair most instruments in the home in a matter of minutes.

This chapter attempts to describe the symptoms produced by failures of the different modules; however, different modes of failure may cause different types of symptoms. Nevertheless, the modules are so easy to replace that it is not advantageous to ascertain beyond doubt that a certain module is at fault before substituting it. Of course, a close visual inspection of a suspected module often will verify that a fault exists in it.

In those instances when the failure of an active device has been caused by (or is the cause of) the failure of some other component, replacement of the entire module will replace automatically the other damaged or off-tolerance components. Thus the problem of locating multiple-fault troubles is simplified, and the possibility of call-backs resulting from failures of components related to the original fault are reduced.

It is possible that failure of a parent-board-mounted component could cause symptoms similar to those resulting from a module failure. (For example, the emitter load resistor for the video preamplifier is not in the module.) To help in isolating problems of this type, module socket voltages were recorded and these are recorded in this chapter.

In servicing any equipment using plug-in elements, it should be remembered that high contact resistance is a potential trouble source. This is particularly likely to develop in atmospheres which contain corrosive substances such as salt and various sulphur compounds. The edge connectors of the modules used in the CTC 49 may be cleaned easily by use of an ordinary pencil eraser; contact cleaner may be used on the sockets.

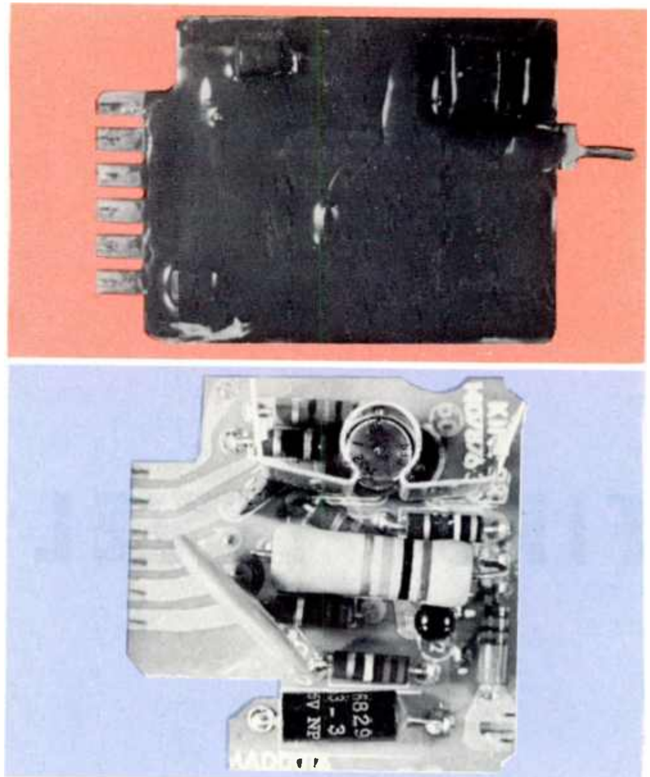
Because it is highly desirable, from the viewpoints of both the technician and the owner of the receiver, to repair the instrument in the home whenever possible, it is assumed that any repair which consists of the substitution of any of the 18 aforementioned items will be done in the home. Setup and test procedures which do not require test instruments other than a meter and a color-bar generator also are considered to be first-level maintenance.

Video Output Modules MAD

Three of these modules are used, one for each primary color. Failure of one of these modules will cause degradation of the corresponding color; for example, failure of the "red" module will result in abnormalities in the red video component of the picture. The specific failure may cause the kine cathode for that color to go to B+; in which case that color will be lost from the video. Conversely, a failure which causes the kine cathode voltage to drop below its average value (80 to 150 volts depending on the brightness-control setting) will shift the raster color towards the color of the defective module. A quick check to locate a leaking output transistor is to remove the chroma module, MAE, and turn the set on. If the raster is not dark when the receiver is tuned to a vacant channel, one MAD module has a leaking output transistor. A red raster indicates a defective red module, etc.

The simplest way of finding a defective MAD module is to replace the one which is suspected with a new module and observe the results. The drive controls will have to be readjusted, of course.) If a new module is not available, try each module in one socket with the other two sockets vacant. It should not be difficult to determine which module is faulty. Caution: **Do not remove or insert any module when the receiver is turned on.**

As an aid to isolating problems to a MAD module, typical voltages at each socket contact are tabulated below. When these measurements were made, line voltage was set to 120 volts, the receiver was tuned to a keyed-rainbow, color-bar generator (RCA WR 64B), and all receiver controls were set for normal reception. Voltages were recorded with the module in place and also with the module removed. When the module was removed, the other two modules were in place. Terminal 1 is the top-most terminal of the socket.



Two different types of MAD modules may be used in the RCA CTC 49 chassis. The ceramic module (top) and the module using discrete components (bottom) are interchangeable, requiring only readjustment of the kine drive control for tracking.

	Module Inserted		Module Removed
1	—0—		—0—
2	5		5.3
3	4.2		4.0
4	4.5		4.0
5	30		71
6	220		230
Output	100	(depends on brightness)	132

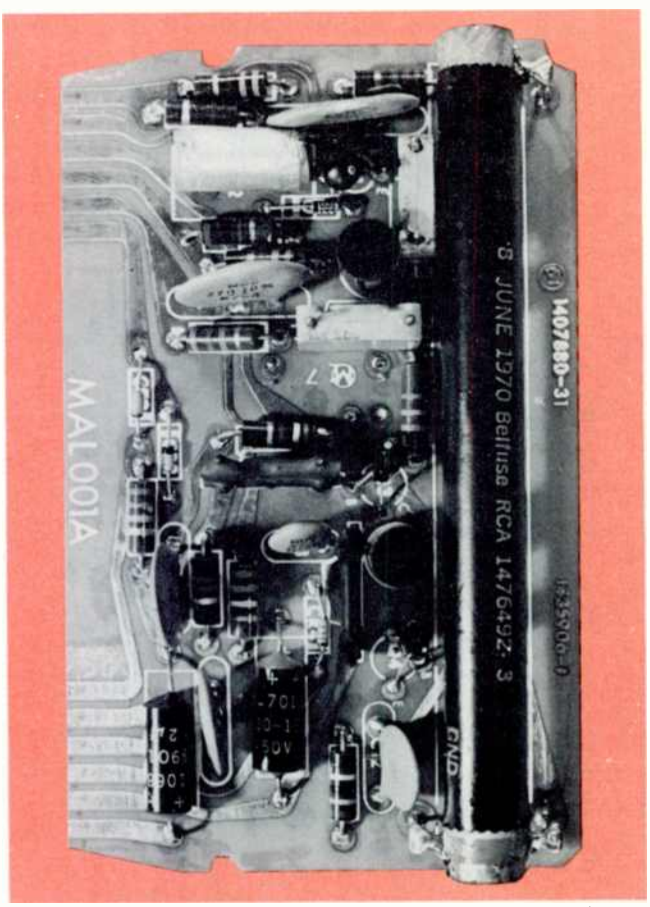
Video Module MAL

The first and second stages of luminance-video amplification and the sync separator are contained in the MAL module, and so it should be suspected if there is a loss of sync or black-and-white video. The brightness limiter, brightness control, video peaking control, and contrast control connect to this module and failure of any of these controls to operate normally also can be the result of a failure in MAL.

Module MAL uses discrete components throughout. This makes it possible to detect some faults by careful visual inspection, and in some instances, a repair may be made in the home. Of course, a trouble may be isolated to this module most readily by substitution with a new module.

As a further aid in determining the quality of the MAL module, observation of the raster with this module removed may be useful. With all controls set to their normal positions, the receiver tuned to a color-bar generator (RCA WR-64B), and the module removed, operation of the receiver is as follows:

1. Raster is dark except that color bars "float" across it. By careful manipulation of the vertical and horizontal hold controls, these bars can be held almost stationary for short intervals.
2. The brightness control has no effect.
3. The color control will change the intensity of the color bars, but the spaces between bars will remain dark.
4. The tint control functions normally, although this is somewhat difficult to determine since the bars are floating.



Module MAL contains the sync separator and two video-amplifier stages. Failure of this module is likely to cause loss of sync, incorrect brightness, or loss of black-and-white (but not color) video.

With the color-bar generator still connected, brightness and color controls set to maximum, tint control set to midrange, and all other controls set for normal operation, the voltages at the socket terminals of MAL were measured, first with the module inserted and then with it removed. These voltages are tabulated below. Terminal 1 is the top-most terminal.

	Module Inserted	**Module Removed**
1	3.4	3.1
2	4.5	-0-
3	4.0	-0-
4	29.5	30
5	-0-	-0-
6	12.5	16.1
7	15.5	15.6
8	13.5-15.4 (depends on peaker)	15.6-16.2
9	4.2	4.8
10	7.2-9.3 (depends on brightness)	3.6-9.3
11	-0-	-0-
12	29	29

Chroma Modules MAE and MAC

These two modules taken together perform all the functions necessary to process the burst and chrominance signals obtained from the video preamplifier into color-difference signals which are fed to the kine-driver modules, MAD. The specific functions of each module are summarized here, but remember that some malfunctions in one of these modules can produce the same symptoms as malfunctions in the other module.

The following functions are performed in the MAC module:

1. Amplification of the chroma sideband signals to a maximum amplitude of about 200 millivolts, depending on the color control. The DC level is about 4.5 volts.
2. Recovery of color burst and amplication of it to a level suitable for injection into the reference oscillator.
3. Generation of a 3.58-MHz chroma reference signal.
4. Generation of ACC voltage, which is used within the module.
5. Generation of a color-killer voltage, also used within the module.
6. Establishment of a nominal 11.6-volt reference for the voltage regulator in module MAE.

Module MAC has three controls located in it, killer threshold, oscillator trimmer, and ACC level; and the color control is connected to this module.

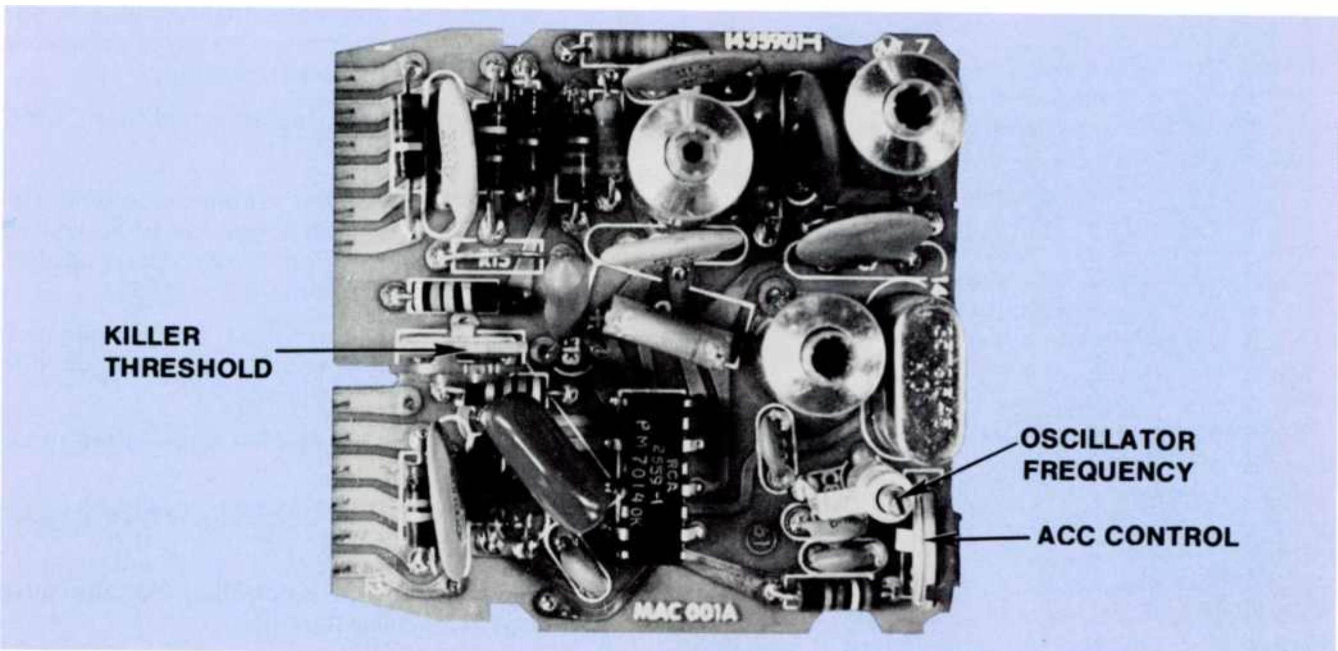
Module MAE performs the following functions:

1. It amplifies the 3.5-MHz reference signal and shifts its phase as dictated by the tint control.
2. It splits the phase of the reference signal to allow chroma demodulation on the two desired axes.
3. It demodulates the chrominance sidebands on two axes, developing R-Y and B-Y video.
4. It derives G-Y video by matrixing portions of the R-Y and B-Y voltages.
5. It amplifies the color-difference signals to about 1.5 to 2 volts, peak-to-peak, each riding on a DC level of about 5 volts.
6. It provides regulated power, nominally 11 volts, to itself and Module MAC, using the receiver 30-volt supply as a power source and a nominal 11.6-volt reference from Module MAC.

Since forward bias for the video-output transistor of each MAD module is supplied from MAE, removal of MAE from its socket will cause complete loss of raster; however sound still is normal. Further, reference voltage for the 11-volt regulator in module MAE is obtained from MAC, and removing this latter module disables the power source to both modules, also resulting in a black raster. Obviously, a failure of the regulated supply also would cause a black raster, as would loss of high voltage to the picture tube.

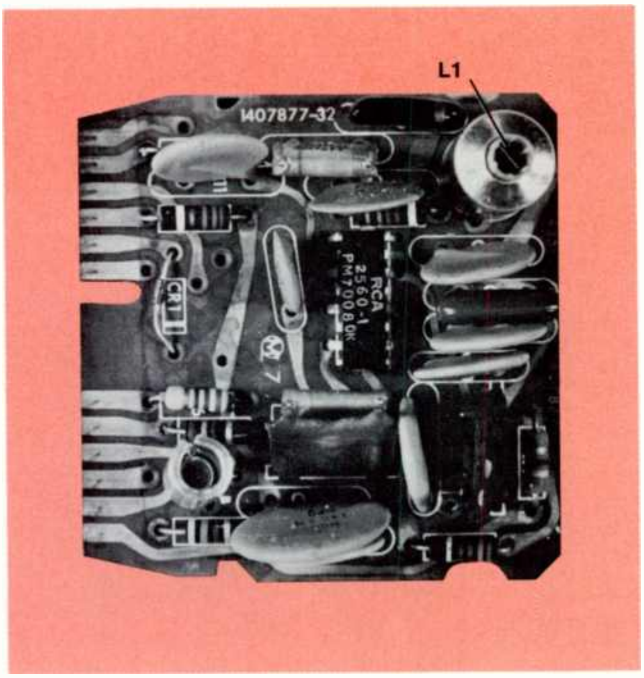
A keyed-rainbow generator and a VTVM capable of measuring accurately .65 volt will be required to perform the AFPC adjustments to Module MAC.

1. Connect the keyed-rainbow generator to the receiver and adjust for best reception.
2. Turn receiver off and ground module terminal 7 or TP 305.
3. Connect module terminal 9 (or TP 302) to stake PW 300AF, using a resistor of any value from 50K ohms to 100K ohms.
4. Turn the receiver on and adjust C8 (adjacent to the 3.58-MHz crystal) until the color bars remain stationary on the raster.
5. Disconnect the jumper from TP302 to PW 300AF and the color-bar generator; turn receiver on.
6. Adjust the ACC control, near the rear of the module, for .65 volt at TP 301. This is critical.
7. Adjust the killer threshold control for 1.25 volt at TP 302.
8. Remove the grounding lead and tune to a colorcast. Check that color is present and the voltage at TP 301 rises to .9 volt.



Module MAC (Chroma-I module) functions as a bandpass amplifier and 3.58-MHz reference oscillator. It also has the ACC and color-killer circuits.

There is one adjustment to be performed on module MAE, and while it may be set more accurately on the service bench, field adjustment of L1 is possible. With the receiver tuned to a keyed-rainbow generator and all controls set for normal reception, rotate the tint control from one extreme to the other. If the most red portion of the raster moves from the second to the fourth bar, with the third bar maximum red when the control is mechanically centered, L1 does not require adjustment. If the above criteria cannot be attained, turn the core of L1 slightly in whichever direction is necessary.



Module MAE (Chroma-2 module) contains the chroma demodulators and color-difference amplifier, and accommodates the tint control. L1 may be adjusted in the field to center tint-control range.

Since demodulation takes place in module MAE, loss of a single color in the picture is likely to be caused by a fault in MAE (assuming, of course, that the MAD modules are all right). Incorrect color may be caused by a number of specific faults, such as improper adjustment of the reference oscillator circuit (AFPC), failure of the phase shifting circuit in the integrated circuit of MAE, failure of the reference-signal phase splitter, etc.

It may be difficult or impossible to determine which of the two chroma modules is the cause of a problem except by substituting new modules. If these are not available, measurement of socket voltages may be helpful. Typical voltages for each module are listed below. All controls were set for normal operation and the receiver was tuned to a keyed-rainbow generator. The terminals are numbered from top to bottom.

Module MAC

	Inserted	Removed
1	-0-	-0-
2	11	-0-
3	-0-	-0-
4	.8 (.65 no signal)	-0-
5	8.5 (depends on color control)	-0-
6	4.6	16.3
7	−6.2	26.6
8	29.5	31.6
9	1.5 (1.25 no signal)	-0-
10	-0-	-0-
11	11.7	.3
12	2.2	.9

Module MAE

	Inserted	Removed
1	-0-	-0-
2	3.4 (depends on tint)	1.4
3	5.1	1.3
4	4.6	.5
5	5.1	1.6
6	5.2	1.7
7	29.7	31.7
8	11.1	1.4
9	11.7	11.7
10	2.2	.7
11	11.1	1.4
12	11.1	1.6

IF Module MAK

Failure in this module may be expected to cause one or more of the following symptoms:

1. Loss of video, both chrominance and luminance
2. Reduction in the levels of both chrominance and luminance
3. An increase in noise level (snowy picture)
4. Improper operation of AFT
5. Improper AGC operation, such as receiver overload on strong signals
6. Loss of sound, or noisy sound.

It should be kept in mind that any of the first four of the above symptoms also can be caused by tuner problems. Symptoms involving sound may originate in the MAK module, since the intercarrier sound signal is detected and amplified here, but aural problems also may be the result of failures in PM200 (the sound module) or in the audio amplifier.

The IF amplifier is designed so that it may be aligned independently of the tuner and the chroma-bandpass amplifiers. This makes it possible to substitute MAK in the home, and therefore the simplest means of isolating a suspected fault to this module is to substitute a new one. If this does not restore operation, the facilities of the shop probably will be required for repairs. There are, however, a few procedures which may be performed in the home.

If there is a complete loss of video, it is possible that the setup switch is at fault. If the switch is operating normally, terminal 15 of the module is grounded when the switch is in the normal position. With the switch in "service" or "raster," the voltage at terminal 15 of the module is about —15 volts; if this voltage is present when the setup switch is in the normal position, the IF amplifiers will be cut off. In some instances, nearly normal audio may be present with the service switch in the raster position, or even with MAK removed. This is normal.

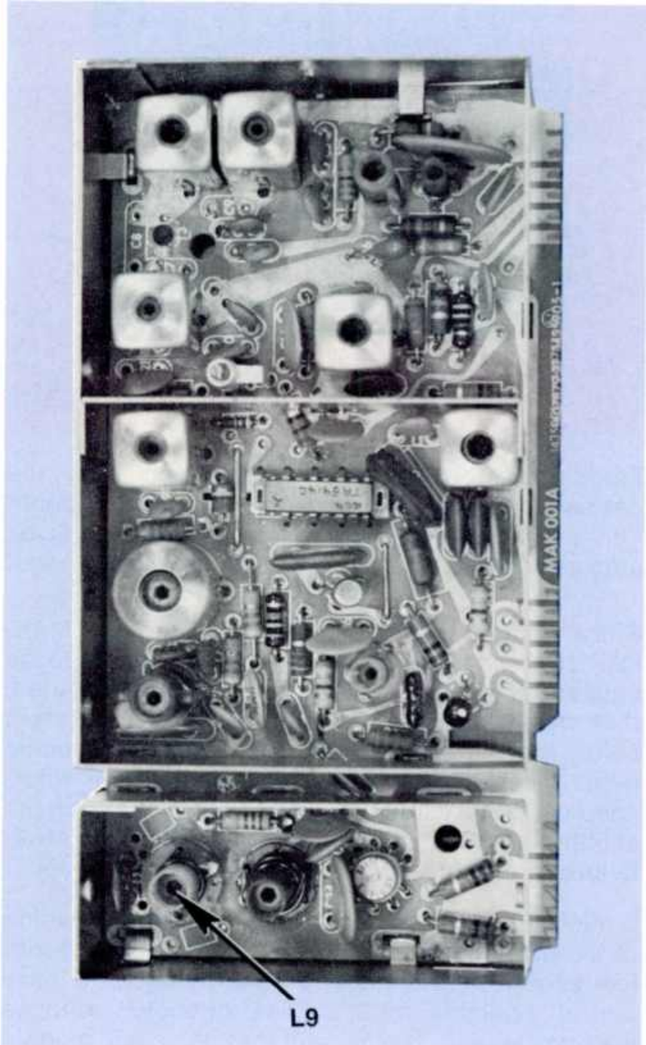
In some areas it may happen that best reception will occur when the AFT is disabled and fine tuning is adjusted manually. This may indicate either that the received signal is non-standard (as may happen in MATV or CATV systems) or the AFT discriminator crossover is not correct. If this symptom should appear, a superficial check of AFT operation should be made and discriminator crossover may be adjusted if appropriate.

To check the AFT operation, connect a VTVM across the AFT inputs of the VHF tuner. These are located behind the antenna terminal board, which must be removed. Fine tune for best reception, release the fine-tuning knob and observe the AFT voltage, which should be 0 ± .5 volt. Detune the fine tuning in each direction to verify that the AFT voltage becomes greater as mistuning is increased and that the polarity reverses at or very near the point of correct tuning.

To adjust discriminator crossover, fine tune the receiver for best reception, then with AFT on, rotate the core of L9 (to the rear of the AFT section of the module) until the AFT voltage falls to zero. Make sure that rotating the core in either direction slightly will cause the AFT voltage to increase. Of course, the polarity will reverse as the voltage passes through zero. **Caution: It is unlikely that the core will require more than ½ turn; also, when adjusting the core, note the amount and direction it is turned so that it may be reset to its original position if desired.** After L9 is retuned, check all channels to be certain that reception of some of them has not been degraded.

The table of voltages which follows may be helpful in ascertaining whether a trouble is in the module or the surrounding circuitry.

	Module Inserted	Module Removed
1	6.7 (AFT off)	1.2 (AFT off)
2	-0-	-0-
3	-0-	-0-
4	6.7 (AFT off)	1.2 (AFT off)
5	-0-	-0-
6	-0-	-0-
7	-0-	-0-
8	7.1	15.4
9	6.6	-0-
10	1	-0-
11	28.1	31.4
12	-0-	-0-
13	14.5	14.5
14	15.3 (Noise control)	15.4
15	-0-	-0-
16	15.2	15.2
17	-0-	-0-
18	-0-	101



Module MAK (IF/AFT module) with the top shield off. L9 is also accessible from the opposite side.

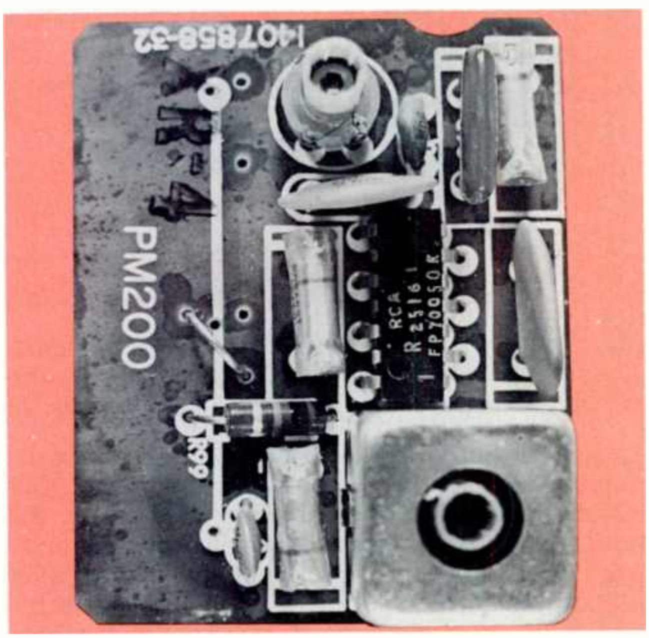
Module PM 200

Loss of sound can take place in the IF amplifier (module MAK), PM 200, the audio driver circuit (Q301), or the chassis-mounted audio-output stage (Q103). Substitution of PM 200 with a module known to be good is the best way to eliminate or confirm it as the source of trouble.

Without an oscilloscope, it is unlikely that signal observation at TP 304 will be meaningful, although absence of the normal 7-volt DC level at this point indicates loss of output from the IF module, MAK. On the other hand, a meter is useful to determine if there is an audio output from PM 200 at its terminal 7. Depending on the setting of the volume control and the program content, audio signal voltage at this point may be as high as 2.5 RMS volts on modulation peaks. At normal listening levels, the voltage is so low as to be barely perceptible on a 1.5-volt-full-scale meter. The DC level is about 4.6 volts.

The volume control is DC operated and there is no signal present at terminal 10 of PM 200. At maximum volume setting, the DC level at this point is about 1.8 volt; at zero volume, it rises to about 4.3 volts.

Alignment of the module may be performed in the home without the use of test equipment. With the channel selector set to an active channel, defeat AFT and fine tune away from sound until noise is present in the audio. Alternately adjust the discriminator coil (unshielded) and the input transformer for best audio and minimum noise.



Sound module PM 200. The edge connections are on the rear. The input transformer is at the top.

Typical socket voltages are tabulated below:

	Module Inserted	Module Removed
1	-0-	-0-
2	-0-	-0-
3	6.6	6.7
4	14.7	38.1
5	5.0	-0-
6	1.6	-0-
7	4.6	-5.3
8	5.7	-0-
9	5.7	-0-
10	1.8-4.3 (Depends on volume)	-0-
11	-0-	-0-
12	-0-	-0-

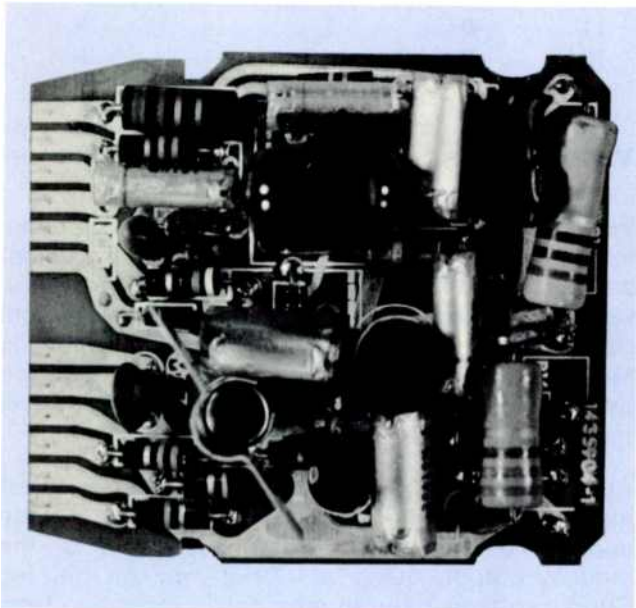
Vertical Oscillator Module MAG

Vertical deflection troubles involving loss of sync, loss of interlace, non-linearity, and insufficient size are likely to be caused by some failure in the vertical module, MAG. Complete loss of vertical deflection also may result from malfunction in MAG; however, this type of failure may be caused by other components in the receiver, particularly the vertical-output transistors.

Again, substitution of modules is the simplest method of isolating faults. If this is not feasible, an analysis of symptoms and measurement of the module output, using a VTVM, may be helpful. Supply voltage is fed to terminal 10 (counting from top to bottom) of the module and should be near 77 volts. Drive for the vertical-output transistors appears at terminals 4 and 6 of the module. Typically, a peak-reading AC VTVM will indicate about 55 volts, peak-to-peak, and a DC level of about 25 volts at each of there terminals is normal. Terminal 6 should be approximately 0.6 volt positive with respect to terminal 4. If the voltages stated above are not present, a fault probably exists in the module; however, a shorted output transistor could change these voltages drastically. With both vertical-output transistors removed from their sockets, the peak-to-peak voltage at terminals 4 and 6 of MAG rises to about 67 volts.

The tabulated voltages (next page) are typical for a properly operating receiver; however, there may be considerable variations in these voltages among a group of receivers. This is particularly true of the voltages observed when the module is removed. **Caution: When operating the receiver with this module removed, keep the brightness control set to minimum to preclude damaging the kinescope.**

	Module Inserted	Module Removed
1	-0-	1.3
2	—.1	1.2
3	-0-	-0-
4	28.9	2.7
5	-0- ±1	1
6	29.5	—2.6
7	10	14.3
8	31	.6
9	—.6	1.2
10	75.5	83.6
11	-0-	-0-
12	4.5	5.1



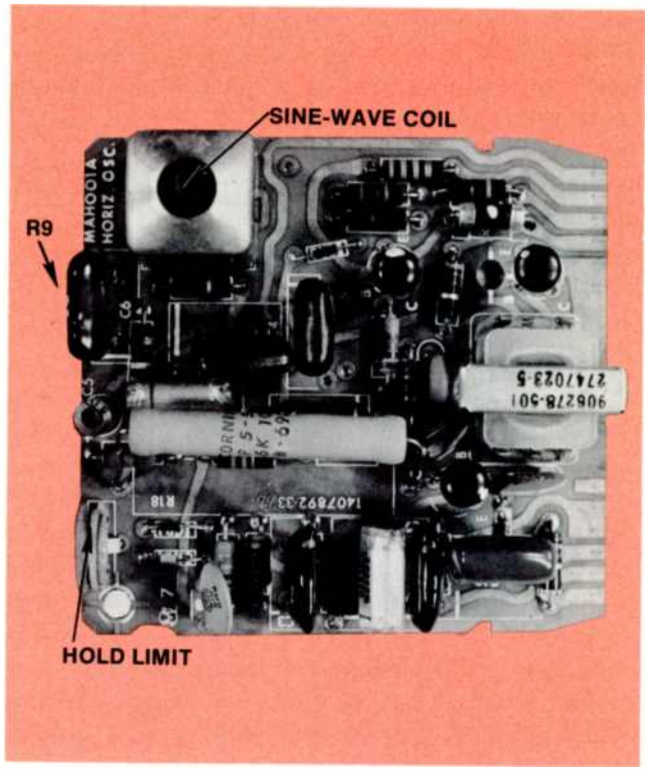
Module MAG. The vertical switching transistor is located near the lower edge below the predriver and the vertical driver is identified by its heat sink.

Horizontal Oscillator Module MAH

Loss of horizontal sync causes instability of vertical sync, since normal AGC is disrupted. Because of this, it is difficult to decide whether a sync trouble is being caused by the horizontal AFC and oscillator circuits or by the sync separator. In general, however, if careful manipulation of the vertical hold control will restore vertical sinc, the sync separator is operating normally. If this is the case, replacement of the horizontal oscillator module will solve horizontal sync failures.

If the horizontal oscillator operates slightly off frequency, it may be possible to correct it by setup of the hold-limit control and sine-wave coil. To make these adjustments proceed as follows:

1. Turn the receiver off and disable the horizontal sync by connecting a jumper between terminals A and F of PW 400.
2. Disable the sine-wave coil by connecting a jumper across R9, a 5.6K-ohm resistor located near the edge of the module adjacent to the shielded sine-wave coil.
3. Turn the receiver on and tune to a broadcast signal; set the horizontal-hold control to mechanical center.
4. Adjust the hold limit potentiometer for best possible raster.
5. Remove the jumper from R9 and adjust the sine-wave coil for best raster.
6. Remover the jumper from A to F of PW 400 and check that the raster falls out of sync at both extremes of the horizontal-hold control when signal is interrupted. If it falls out at one extreme of the hold control, but not the other, readjust the hold-limit control.



MAH is the horizontal oscillator and AFC module. The hold-limit and sine-wave coil adjustments are indicated, R9 parallels C6 and is located behind it.

Failure of the horizontal oscillator to produce an output will result in loss of high voltage and horizontal deflection; however, loss of drive to the horizontal-output circuits normally will not damage these latter circuits. Complete absence of output from MAH will not result in tripping of the circuit breaker, although it may trip at the time of failure. Spurious outputs from MAH may cause circuit-breaker tripping.

When it is operating normally, the output at terminals 4 and 5 of the module (numbered from bottom to top) will indicate 10 to 12 volts when measured with an AC, peak-to-peak VTVM, A DC voltage of approximately —0.8 volt is normal. If these voltages are incorrect it may be caused by improper operation of MAH, a retrace SCR having a shorted input (in which case the power supply will be shorted), or an open in the trace diode (CR 101), which causes the hold-down circuit to function. The presence of these voltages does not necessarily prove that the module is operating normally. The module may be checked most readily by substitution; however, the module terminal voltages are tabulated below.

	Module Inserted	Module Removed
1	-0-	-0-
2	29.7	30.8
3	30.7 (Depends on horiz. hold)	-0-
4	−1	-0-
5	−1	-0-
6	.1	-0-
7	-0-	-0-
8	-0-	-0-
9	30.7	-0-
10	4.5	16.2
11	-0-	-0-
12	155	172

Power Supply Module MAB

Since the power-supply module is relatively simple, complete isolation of failures to components in it is possible using only an ohmmeter.

While spontaneous failure of rectifiers is possible, it also is true that shorted loads often are the cause. For this reason, it is recommended that resistance checks of the various power-supply loads be made before a new or repaired module is inserted in the socket. The resistances tabulated below were measured with MAB removed, both the master and front-panel switches turned off, and the line cord disconnected. All resistances are to chassis ground. The socket terminals are numbered from right to left. To discharge all capacitors, momentarily short all terminals to ground before measuring resistance.

The voltages measured are the power supply output voltages. The ripple voltages at terminals 3, 7, and 14 were measured using an AC VTVM. The ripple at terminal 14 comes from two sources, power line and vertical output. This voltage varies from about .6 volt to 1.2 volt, depending on the relative phase of these two components of ripple at the time of observation.

	Resistance to Ground (Module Removed)	Voltage to Ground (Module Inserted)
1	18	
2	infinite	
3	60K	218 DC/.15 RMS ripple
4	4	120 AC
5	.5	
6	(socket key)	
7	50K	160 DC/3 RMS ripple
8	NC	
9	NC	
10	26	
11	4	
12	-0-	
13	570 ohms	37 DC/26 AC
14	30K	77 DC/1.2 RMS ripple
15	same as 13	37 DC/26 AC

PW 300

There are two plug-in transistors mounted on PW 300, the brightness limiter (Q302) and the audio driver (Q301). Failure of Q302 will cause loss of brightness if the collector is open, or blooming at high brightness levels if it is grounded. Failure of Q301 will result in loss of sound. These transistors may be checked with an ohmmeter.

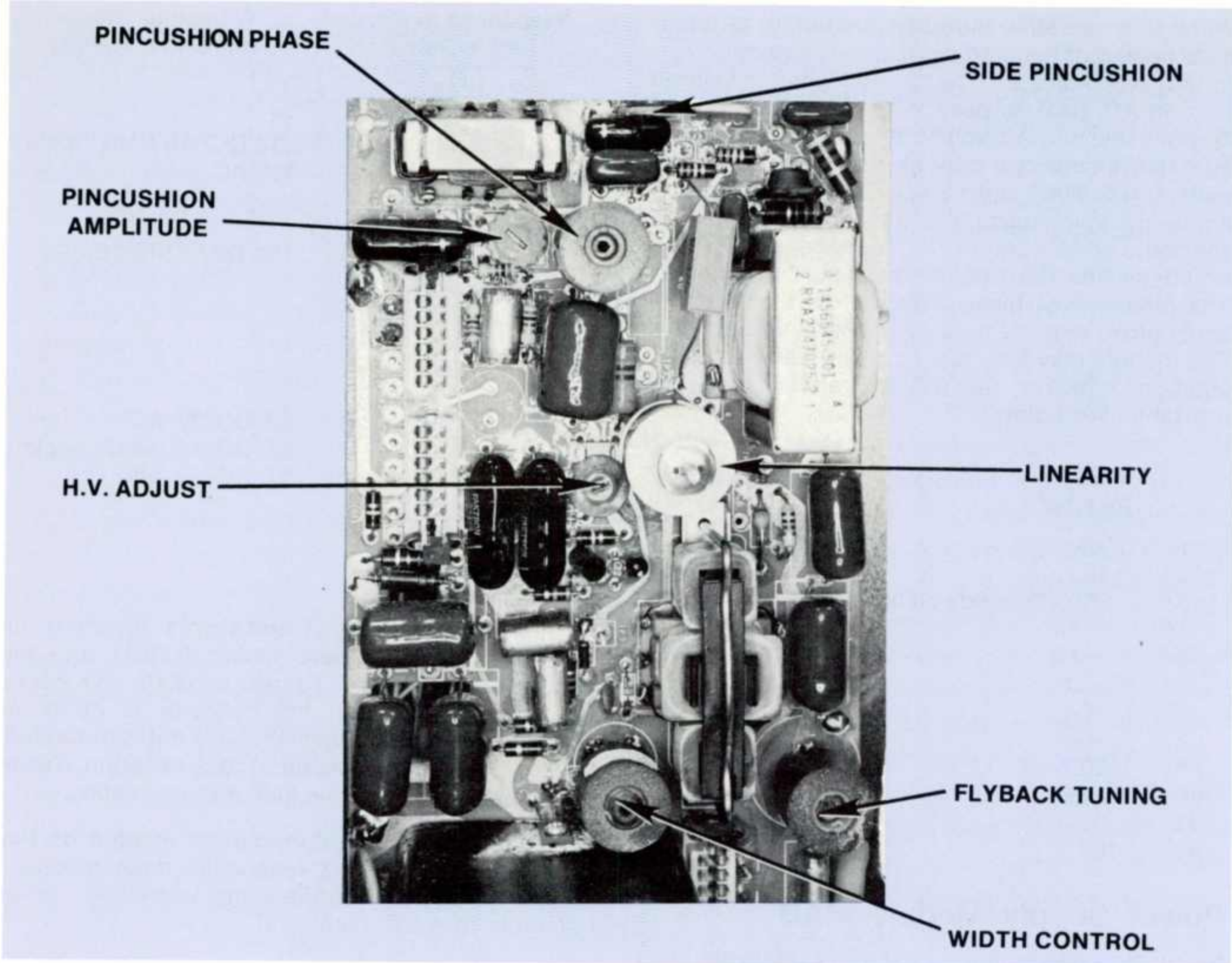
The three kine drive controls are located on PW 300, adjacent to their respective drive modules. These are adjusted in the same manner as similar controls in other receivers.

PW 400

With the exception of the MAH and MAG modules, there are no components which plug into the PW-400 board. Hence, first-level service is restricted to the modules themselves and to the adjustments described here.

The top-and-bottom pincushion phase and amplitude controls are situated near the top of the board. To adjust these controls, either connect a cross-hatch generator to the receiver or place the setup switch in raster position and reduce height sufficiently to make the top scanning line visible on the raster. Set the pincushion amplitude potentiometer fully counterclockwise and adjust the core of the phase coil until the center of scan bows upwards; then adjust the amplitude control to straighten the scan.

The amount of side pincushion correction is adjusted by R428, located near the top edge of PW 400. This control may be adjusted while observing a crosshatch or vertical bar pattern, or while view-



The linearity, pincushion, high voltage, and width adjustments are located in this view of PW 400.

ing a scene containing any straight vertical line near the edge of the raster. At minimum brightness and with R428 set fully CCW, there should be no side pincushioning. To set R428, advance the brightness to maximum and set the control to minimize the pincushioning.

The width control is an unshielded inductor located near the vertical centerline of PW 400 just above the high-voltage compartment. The core should be adjusted to produce the desired raster width. It is a good practice to allow some overscanning, perhaps ½ inch at each side; however, the deflection system in this receiver is much less prone to losing width due to aging, reduced line voltage, etc., than systems using vacuum tubes.

The linearity coil, L402, may be adjusted in the home. Connect a VTVM between TP 403 and TP 404, which are located slightly to the right side of PW 400 and above the horizontal centerline. Turn the core of L402 to produce 16 volts, p-p between these two test points.

The adjustment of the third harmonic tuning inductor requires the use of an oscilloscope and normally is not done in the home. The procedure is described in the next chapter.

Chassis-Mounted Components

There are seven power-output devices in the CTC 49, all of which are mounted on the chassis. Since these devices are readily accessible, faults isolated to them may be corrected in the home. The symptoms which may develop when each of these devices fails are discussed in later paragraphs. Since these devices control significant amounts of power, a short is likely to cause the circuit breaker to trip. To preclude further damage to the receiver by repeatedly resetting the breaker and allowing it to trip, an attempt should be made to locate the short circuit with the power turned off. A simple field technique is to remove the rectifier module, MAB, and check the resistance to ground of the four B+ socket terminals.

Terminals 13 and 15 connect to the 30-volt distribution through a secondary of the power transformer. If the resistance is less than about 500 ohms, a short circuit is indicated. One possible fault is a defective audio-output transistor, Q103. If the restance measured above increases significantly when Q103 is removed from its socket, this transistor, or the insulation between its collector and the chassis, probably is at fault.

Q103 is an NPN transistor; therefore, if the negative lead of an ohmmeter is connected to its base, the resistance measured to either its emitter or collector should be very high. If the meter leads are reversed, these resistances should be low. Resistance from the collector to the emitter of any transistor should be high. Accordingly, the base lead of a good transistor may be identified by first determining those two leads which have high resistance between them regardless of ohmmeter polarity; the lead which remains is the base connection. This technique will not work with certain diffused-junction transistors; however none of these is used in the CTC 49.

Supply voltage for the vertical module and the vertical-output transistors is routed from terminal 14 of the rectifier module, MAB. With module MAB removed, the resistance from terminal 14 to ground is normally about 40K ohms; a radical decrease should be investigated. If the vertical module is removed and the resistance of the B+ line still is low, it is likely that either the filters or the vertical-output transistors are at fault.

If either of the vertical-output devices should short, there is a definite possibility that the other one also will become shorted, and it is likely that this will cause R221, a 1.5-ohm, 2 watt resistor located near the front edge of PW 200, to open. Thus, the original short may have cleared by the time the instrument is serviced. The transistors may be checked individually by removing them from their sockets. Q101 is an NPN device and the ohmmeter checks are the same as for the audio output transistor. Q102 is a PNP transistor; therefore high resistance should be measured from emitter to base and collector to base when the positive meter lead is connected to the base.

The horizontal oscillator and deflection system is powered from the 160-volt line feeding from terminal 7 of the power-supply module. If the resistance from this terminal of the socket to ground is low it is likely that either the commutating (retrace) SCR or diode (SCR 102 and CR 102, respectively) is shorted. These may be checked individually by removing them and measuring their cathode-to-anode resistance. The resistance of the SCR should be very high (10 megohms or more), regardless of meter polarity; and the back resistance of the diode also should be very high. The diode forward resistance (positive ohmmeter lead to the anode) is a few ohms.

Unlike the retrace (commutating) SCR and diode, the trace devices (SCR 101 and CR 101) will not overload the power supply if they are shorted. It is likely that a momentary overload will occur at the instant of failure, but once the circuit breaker is reset it will not trip again. Of course, there will be no raster. These two devices may be checked with an ohmmeter and have about the same resistance characteristics as the retrace devices.

The table which follows lists common symptoms with their possible causes, and suggests the corrective action required. It is recognized that many other causes can produce the same symptoms and that symptoms may develop which are not listed here. In compiling this table, failures which normally would not be corrected in the home were ignored, as were corrective actions of a very general nature; e.g., checking for faulty socket connections, making routine setup adjustments, etc.

Symptom	Possible Causes	In-Home Repairs
RECEIVER DEAD	1. Not plugged in	
	2. Wall outlet dead	RESTORE POWER.
	3. Receiver switch disconnected from chassis	CHECK CABLE AND PLUG.
	4. Power supply module has open rectifiers	REPLACE MODULE MAB.

CIRCUIT BREAKER TRIPS	1. Short on 220-V bus (terminal 3 of MAB socket)	REMOVE ALL MAD MODULES. IF SHORT CLEARS, REPLACE DEFECTIVE MODULE.
	2. Short on 160-V bus (terminal 7 of MAB socket)	CHECK RETRACE SCR AND DIODE (SCR 102 AND CR 102); REPLACE AS NECESSARY.
	3. Short on 77-V bus (terminal 14 of MAB socket)	CHECK VERTICAL-OUTPUT TRANSISTORS Q101 AND Q102 FOR SHORTS. REPLACE AS NECESSARY AND CHECK MAG FOR FAULTS.
	4. Short on 30-V bus (terminal 15 of MAB socket)	CHECK AUDIO OUTPUT TRANSISTOR, Q103, AND REPLACE IF NECESSARY.
	5. Shorted rectifier diodes	REPLACE MODULE MAB, BUT FIRST CHECK FOR SHORTS IN LOADS.
NO RASTER AND NO HIGH VOLTAGE	1. No trigger from horizontal oscillator	REPLACE MODULE MAH.
	2. Shorted trace diode, CR 101	CHECK WITH OHMMETER AND REPLACE AS NECESSARY.
	3. Shorted trace SCR, SCR 101	CHECK BY SUBSTITUTION.
	4. Open retrace diode, CR 102	CHECK WITH OHMMETER AND REPLACE AS NECESSARY.
	5. Open retrace SCR, SCR 102	CHECK BY SUBSTITUTION.
NO RASTER OR DIM RASTER (HIGH VOLTAGE NORMAL)	1. Loss of forward bias from chroma module to kine-driver modules	SUBSTITUTE MODULES MAC AND MAE. IF TROUBLE CLEARS REPLACE WHICHEVER MODULE IS AT FAULT.
	2. Brightness limiter transistor, Q302, open	CHECK WITH OHMMETER AND REPLACE AS NECESSARY.
	3. Incorrect output level from video module MAL	SUBSTITUTE MODULE MAL.
RASTER BLOOMS	1. Brightness limiter transistor, Q302 shorted	CHECK WITH OHMMETER AND REPLACE AS NECESSARY.
	2. Insufficient high voltage	ADJUST HIGH VOLTAGE FOR 20.1 KV AT MINIMUM BRIGHTNESS AND 120V LINE.
LOSS OF VERT SYNC LOSS OF INTERLACE VERT NON-LINEARITY	Fault in vertical oscillator module, MAG	CHECK MODULE BY SUBSTITUTION.

INSUFFICIENT HEIGHT OR NO VERT DEFLECTION	1. Open or shorted vertical output transistor	CHECK TRANSISTORS BY SUBSTITUTION, REPLACE AS NECESSARY.
	2. Fault in vertical oscillator module, MAG	CHECK MODULE BY SUBSTITUTION.
	3. 77 V supply voltage low (terminal 14 of MAB)	CHECK POWER SUPPLY MODULE MAD.
LOSS OF HORZ SYNC; PICTURE TEARS OR BENDS	1. Horizontal oscillator module, MAH, out of adjustment	ADJUST HOLD LIMIT AND SINE-WAVE COIL.
	2. Fault in horizontal oscillator module, MAH	CHECK BY SUBSTITUTION.
	3. Fault in sync separator	CHECK VIDEO MODULE, MAL, BY SUBSTITUTION.
	4. Fault in AGC circuits	CHECK IF MODULE, MAK BY SUBSTITUTION.
RECEIVER CANNOT BE ADJUSTED FOR GRAY SCALE	1. Fault in kine-driver module, MAD	SUBSTITUTE GOOD MODULE FOR SUSPECTED ONE, REPLACE AS NECESSARY.
	2. Fault in chroma module, MAE	CHECK MODULE BY SUBSTITUTION.
LOSS OF ONE COLOR BUT GRAY SCALE IS NORMAL	Fault in chroma module, MAE	CHECK MODULE BY SUBSTITUTION.
LOSS OF COLOR, LOSS OF COLOR SYNC, REDUCED COLOR, EXCESS COLOR, WRONG HUE	1. Inproper adjustment of chroma modules, MAC and MAE	ADJUST KILLER CONTROL, ACC CONTROL, AND OSCILLATOR FREQUENCY ON MODULE MAC. ADJUST L1 ON MODULE MAE.
	2. Fault in either chroma module, MAC or MAE	CHECK MODULES BY SUBSTITUTION.
	3. Chorma take-off (peaker) coil in IF module, MAK, misadjusted or faulty	CHECK MODULE MAK BY SUBSTITUTION.
INSUFFICIENT CONTRAST, VIDEO RINGING, OR VIDEO SMEARING	1. Fault in video module MAL	CHECK MODULE MAL BY SUBSTITUTION.
	2. Fault in IF module, MAK	CHECK MODULE MAK BY SUBSTITUTION.
BLANK RASTER AND NO SOUND	1. Setup switch in "RASTER" position or open switch contact	GROUND STAKE RY ON PW 300 TO CHECK SWITCH OPERATION.
	2. Defective IF module MAK	CHECK MODULE MAK BY SUBSTITUTION.

LOSS OF SOUND, NO AUDIO VOLTAGE AT TERMINAL 7 OF PM 200	1. Defect in sound module, PM 200	CHECK MODULE PM 200 BY SUBSTITUTION.
	2. Defect in IF module MAK	CHECK TRANSISTOR BY SUBSTITUTION.
LOSS OF SOUND, BUT AUDIO VOLTAGE PRESENT AT TERMINAL 7 OF PM 200	1. Defective audio driver transistor, Q301	CHECK TRANSISTOR BY SUBSTITUTION.
	2. Defective audio output transistor, Q103	CHECK MODULE MAK BY SUBSTITUTION.
	3. Leads disconnected from speaker	CHECK CONNECTIONS AND SECURE IF NECESSARY.
DISTORTED OR NOISY SOUND	1. PM 200 out of alignment	ADJUST TUNED CIRCUITS, USING BROADCAST SIGNAL.
	2. Defective module PM 200 or MAK	CHECK BY SUBSTITUTION.
	3. Defective audio transistor	CHECK Q 301 and Q 103 BY SUBSTITUTION.

7

SHOP-LEVEL MAINTENANCE

The preceding chapter discussed primarily those procedures and techniques which could be used to repair the receiver in the home. Obviously, these same techniques can, and should be used in the service shop prior to attempting more difficult troubleshooting routines. Experience has proven that many simple problems in troubleshooting become very difficult if the obvious symptoms are ignored or overlooked.

The purpose of this chapter is to present approaches to making repairs which cannot normally be accomplished in the home. These repairs fall naturally into two categories: repairing the individual module after the fault has been isolated to it, and servicing the circuitry of the parent boards and the main chassis.

It is not the intent of this book to dictate that any of the various modules of the RCA CTC 49 chassis must not be repaired when they became unserviceable, because it is recognized that under some circumstances shop repair of a module may be desirable, or perhaps even necessary. However, the technician should consider carefully the merits of repairing a module vis-a-vis replacing it.

If replacement modules are not carried by the service technician when he is making service calls, or if they are not available in the shop when an instrument is carried in for service, it is likely that diagnostic time will be increased considerably. Often this may make it necessary to remove the receiver from the home to the shop, or, if the receiver is carried into the shop by the owner, the in-shop time may be seriously increased. In either case, service will be more time consuming for the technician and more costly for the owner. Therefore, in the interests of efficient operation and best customer relations, it appears that a supply of replacement modules is essential.

Repair of a module will involve locating the specific component which is at fault, replacing it, realigning the module in some instances, and checking the module for correct operation, preferably by installing it in a receiver. Any one of these first three steps conceivably can require more time than is justified by the cost of the module. On the other hand, a failure caused by a standard item, in a circuit which requires little or no readjustment after the repair is made, sometimes can be corrected at a lesser cost than a new module.

In spite of the disadvantages of attempting to correct all faults which may occur in a module, there may be circumstances which make this necessary. For this reason, the troubleshooting information concerning modules which follows has been included.

It is assumed that, before attempting repairs to a module, it has been definitely ascertained that the fault is within the module. This may be done most easily by substituting another module; otherwise, observation of input and output waveforms and measurement of the socket terminal voltages will be helpful. Pertinent waveforms are included in this chapter; voltages were tabulated in the preceding chapter.

Experience has shown that failures of semiconductor devices account for many of the faults which arise in solid-state circuitry, and it is reasonable to assume that this will be the case in the CTC 49. Therefore, the technician will find it expedient to check the transistors and diodes in a module before making more sophisticated tests. An ohmmeter check usually will be adequate.

If a diode or transistor is to be checked with an ohmmeter while it is in the circuit, the possibility of sneak circuits cannot be ignored. Figure 7-1 (part of Module MAH, Figure 4-1, page 27) illustrates the point. If Q1 is normal and the emitter to base junction is checked out of the circuit with an ohmmeter, the resistance between emitter and base will be very high when the negative ohmmeter lead is connected to the base and the positive lead is connected to the emitter. If the meter leads are reversed, the resistance will be only a few ohms.

If Q1 is connected in its circuit, however, the resistance measured when the negative ohmmeter lead is connected to the base will be only 3500 ohms, the series resistance of R3 and R5. Also, if the negative meter lead is connected to the emitter and the positive lead is connected to the collector, the resistance will be very high, as it should be. However, if the meter heads are reversed, the resistance measurement will drop to several thousand ohms. The reason, of course, is that the meter "sees" the forward biased collector-to-base junction in series with R3 and R5. If the module were inserted during these measurements, resistance might be still lower because of the various current paths from the collector, through the power supply to ground, and back to the emitter via R5.

Along these same lines, resistance readings of CR 1 and CR 2 could also be misleading. For example, an ohmmeter connected across CR 1 will read a low resistance if connected one way, but if connected oppositely, it will measure the series resistance of R7, R8, and CR 2.

Just as the passive components of a circuit affect the apparent resistance of the solid-state devices, the devices also may affect the resistance measured through passive components. Still referring to Figure 7-1, the resistance of R3 will be indicated erroneously if the meter is connected so that the emitter-to-base junction of Q1 is forward biased.

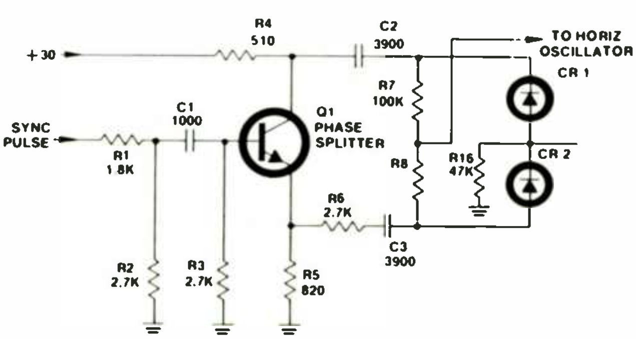


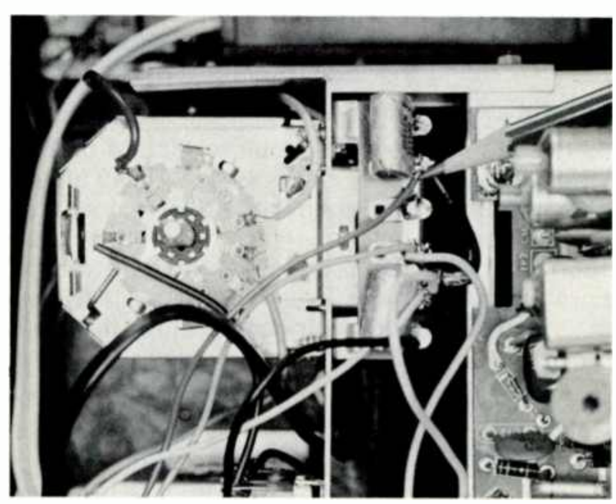
Figure 7-1 Horizontal AFC Circuit

Tuner, If and AGC

In addition to substituting Module MAK, several other procedures may be used to determine if it is malfunctioning. In many instances it is possible that a tuner fault will produce symptoms similar to those produced by a fault in the IF amplifier, so a logical starting point is to determine which of these actually requires service.

Connecting a small capacitor, about 120 pf, between PW 300-A and TP 4 will allow sound to be received even if the IF module, MAK, is removed. This can be a useful aid in determining whether a fault is in the tuner or the IF amplifier. Simply remove the latter and determine if broadcast aural signals can be received. If they can, it is probable that the tuner is operating normally. If sound is not present under these conditions it is likely, but not necessarily conclusive, that the tuner is malfunctioning.

Under no-signal conditions, the tuner AGC voltage should be near +6.7 volts. A malfunction in the module or in the off-module circuitry shown in Figure 7 - 2 could cause this voltage to change. A negative tuner AGC voltage would cause low tuner gain, making the sound check described above inconclusive. Contrariwise, AGC voltage more positive than 6.7 volts, or failure of the tuner AGC volt-



Rear view of the KRK 165C tuner. The test point for tuner AGC voltage is indicated by the pencil.

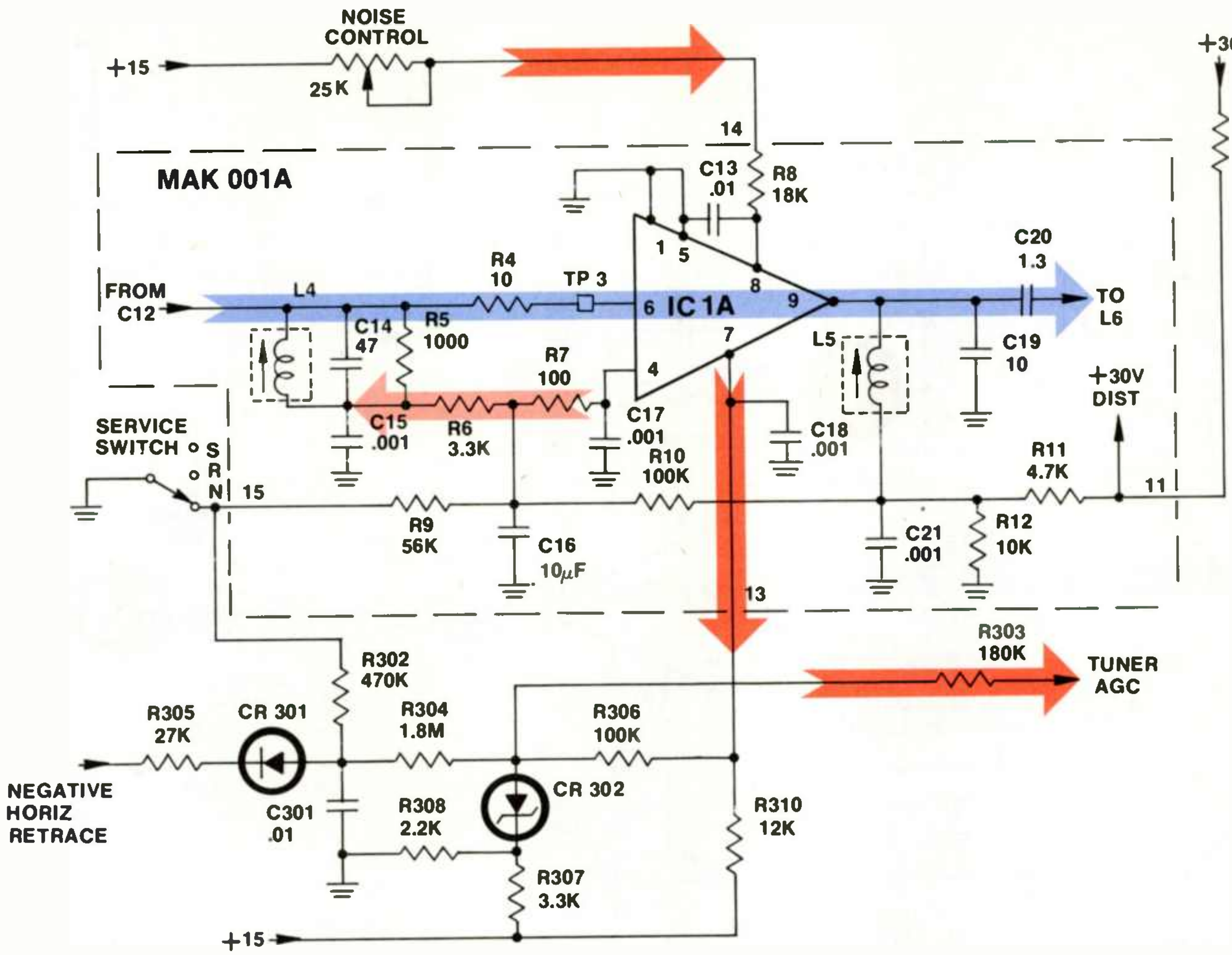
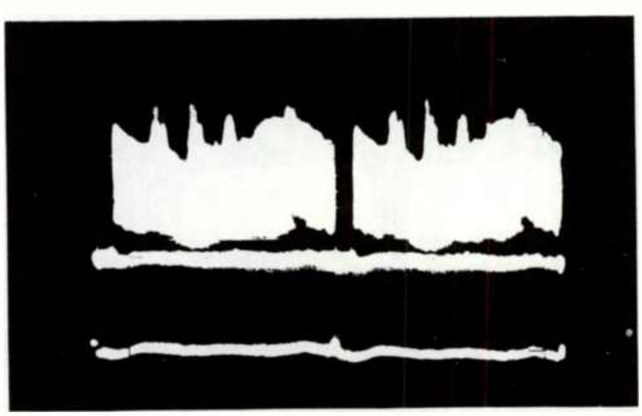


Figure 7-2 First and Second IF Amplifiers and AGC Circuit

age to decrease with strong signals (above about 1000 microvolts) can cause sound buzz, loss of sync, cross modulation, etc.

Tuner AGC voltage may be measured at the second terminal from the top of the terminal strip mounted to the rear of the TMA. This point is the junction of a green wire from the connecting plug, a .27-mfd capacitor to ground, and a 10K-ohm resistor to the tuner. With MAK removed, the voltage should be +6.7 volts; with it inserted and no signal it should remain the same. During normal reception, this voltage will depend on signal strength and the noise-control setting, swinging towards −5 volts (maximum negative) with increases in signal strength and swinging towards +6.7 volts as the noise control is turned clockwise.



Composite Video at Tuner Output—Vertical Rate

During reception of moderate to strong signals the tuner AGC voltage will normally be near zero volts. By grounding the AGC line to the tuner, there should be some signal present on the kinescope. Further, with a strong signal present, composite video may be observed having a level of 10 to 200 millivolts if a detector probe such as RCA WR 415 is connected to the tuner output and the tuner AGC is set to maximum positive by turning the noise control fully clockwise.

Assuming that the input to MAK is normal, composite video should be present at the output, stake VO on PW 300. If it is not, check that the emitter load resistor (R324) for the video preamplifier is

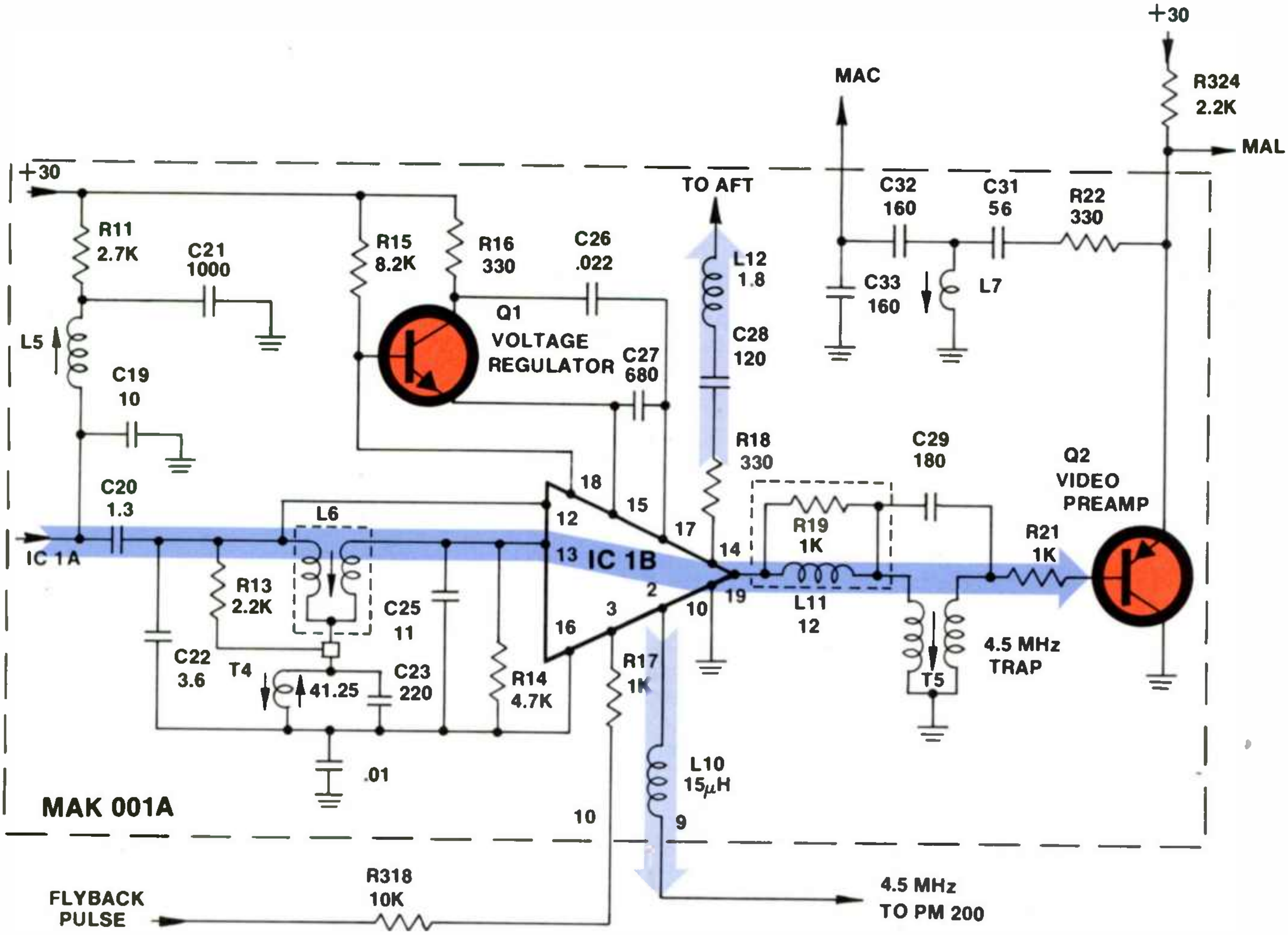
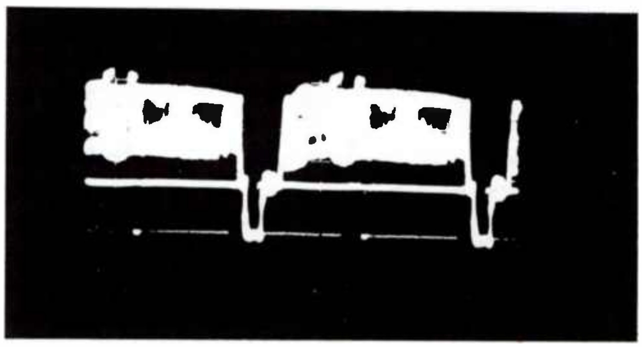


Figure 7-3 Final IF Amplifier, Video Preamplifier, and Voltage Regulator

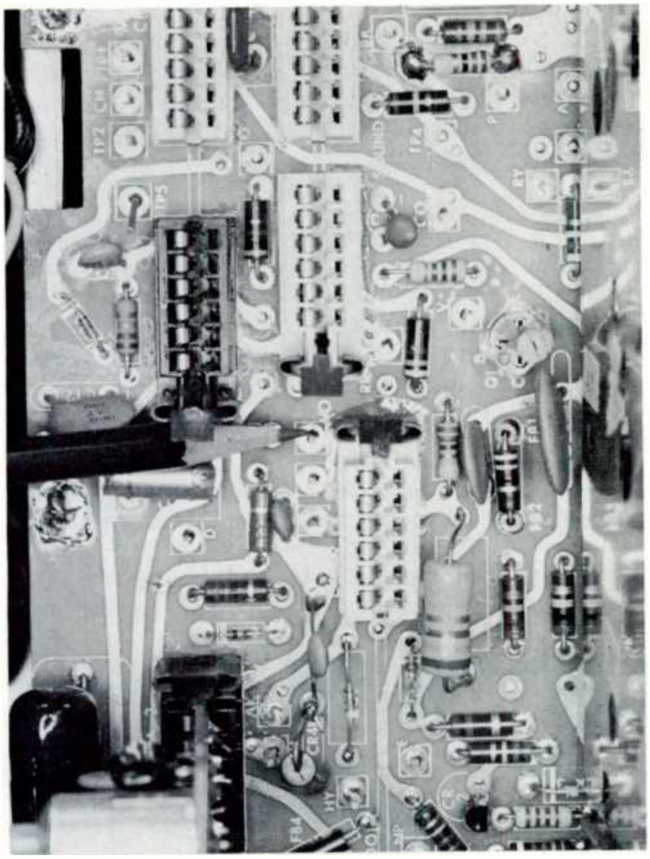
intact and if it is, trace back to the emitter of the preamplifier, Q2 of MAK. Signal tracing may be continued backwards to the base of Q2 and ultimately to terminal 19 of the integrated circuit. These components are shown schematically in Figure 7-3.

Since all IF amplification as well as the generation of AGC voltage takes place within a single IC, there is little to be gained in attempting to signal trace through these circuits. If input signal from the tuner, keying pulses from the flyback transformer, and B+ are present, there is little point in determining which particular part of the IC is at fault. Positive 30 volts is fed to the module at terminal 11. If this voltage is less than normal, the power supply and the decoupling resistor, R317, should be investigated. Within the module, the 30 volt supply is distributed to the AFT circuit via a decoupling circuit, to the output circuit of the second IF amplifier via its tuned circuit, and to the collector and base of the regulator transistor by way of R16 and R15, respectively.

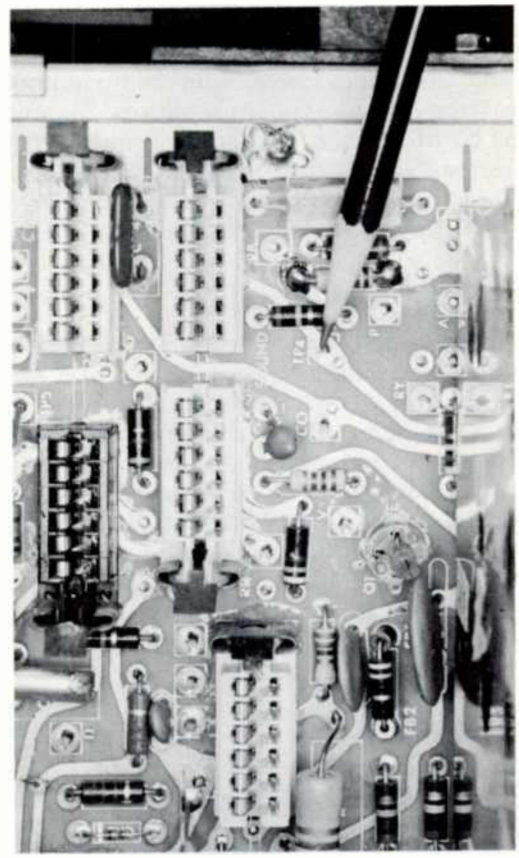
Failure of the regulator transistor, Q1, is a possibility if there is no video output from MAK. The emitter voltage of this device is approximately 11.3 volts, except that in modules using IC drawing number 2554-1, a diode connected between the base of Q1 and terminal 18 of the IC, raises the emitter voltage to about 12 volts. In an emergency, an external zener could be connected to provide reference voltage for the base of the regulator transistor.



Composite Video at Stake VO—Horizontal Rate



The luminance video output from Module MAK appears at stake VO of PW 300. When they are inserted, Module MAL is to the right of this test point and the sound Module, PM 200, is above it.



The location of TP 304 is between Module MAK and PM 200. The DC level and the 4.5-MHz aural output from Module MAK may be checked here.

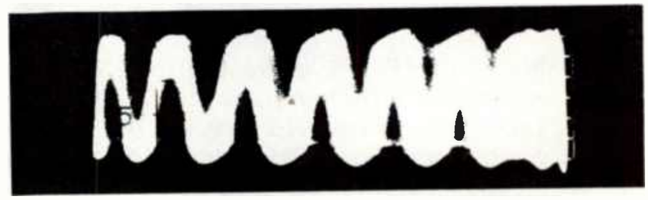
Alignment data for Module MAK is contained in the service data, 1970 T19, which is being published concurrently with this manual. The economic feasibility of aligning MAK is questionable; however, the alignment procedure can be very useful in troubleshooting the module. It also should be noted that this alignment is more simple than alignment of earlier models of color television chassis. Since the tuner output is terminated in the characteristic impedance of the link cable, there is no "link alignment," and since the chroma take-off coil, or peaker coil, is broadly tuned, there is no requirement for VSM alignment of the chroma circuitry.

Aural Circuits

Unlike most color receivers, wherein the aural take-off point is at the output of the last video IF amplifier, aural signal is taken from a point near the center of the video IF chain. (Refer to Figures 2-3 and 2-6, pages 9 and 12.) The aural output of MAK is the 4.5-MHz, frequency-modulated intercarrier signal which may be observed at TP 4 of PW 300. A wideband scope is required, the signal amplitude is typically .75 to 1.5 volts, p-p.

As stated in Chapter 6, low-level audio should be present at terminal 7 of the sound module, PM 200. If signal is present at TP 4 (the input to PM 200), the control voltage at module terminal 10 (stake RR) is about 3 volts, and supply voltage (about 15 volts at terminal 4) is present, but there is no output at terminal 7, the module should be replaced.

Because of the difficulty of testing the various components of PM 200, it is unlikely that this would ever be done. As a matter of interest, this



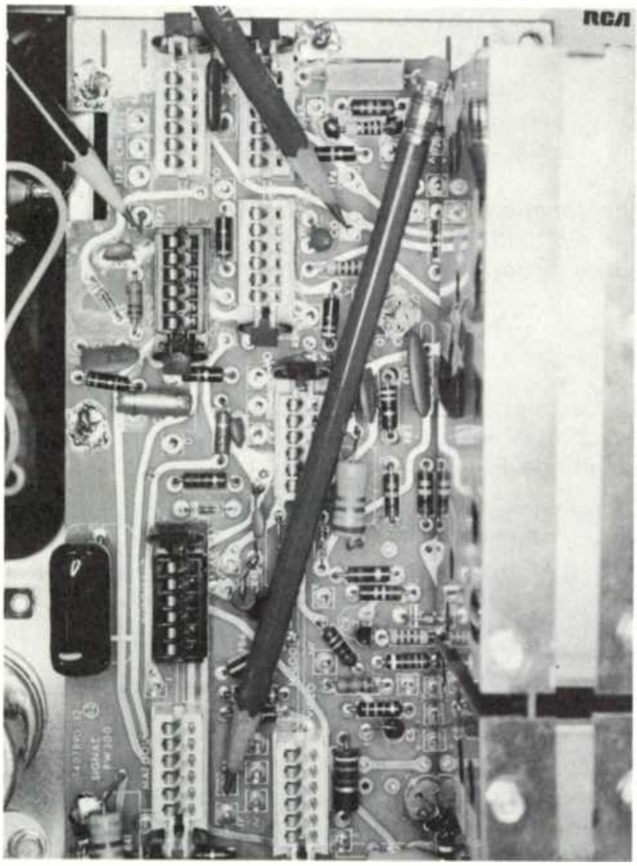
4.5-MHz Intercarrier Signal at TP 4

module is interchangeable with the sound module of the CTC 42R chassis.

Servicing the audio driver and audio output circuits follows conventional procedures. Supply voltage for both of these stages is normally 30 volts; however, as the supply voltage is distributed in the CTC 49, it is possible for voltage to one stage to be interrupted and still be present at the other.

Chrominance Circuits

The circuits which process the chrominance video are situated in Modules MAK, MAC, and MAE. It is unlikely that a fault will occur in MAK which would cause loss of chrominance without also causing loss of monochrome video; nevertheless, the chroma output of MAK may be observed, if desired, at stake CO of PW 300. This waveform is shown in the complete schematic in the rear of this manual. Stake CO is located directly below TP 4, as shown in the photograph.

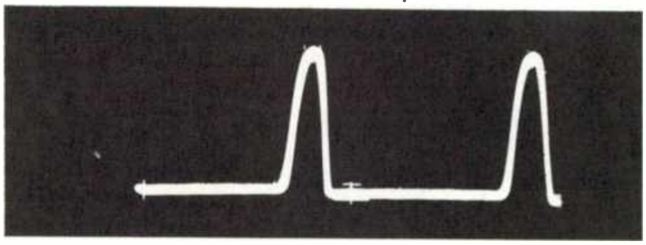


The locations of TP 305, stake CO (top, left and right), and stake AF (bottom) are indicated by the three pencils. CO is used to monitor the chrominance-video output from the Module MAK. TP 5 is the observation point for the burst-blanking pulse, and stake AF is the regulated 11-volt test point.

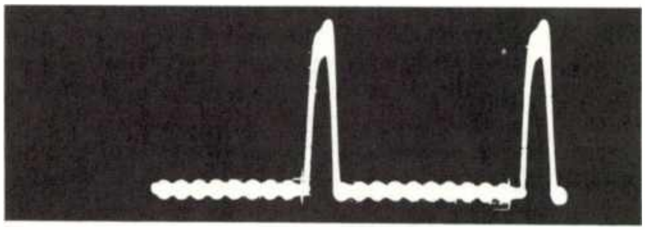
The inputs necessary for the operation of Module MAC are chrominance video from MAK, regulated 11.2 volts from MAE, and the burst gate pulse from the flyback transformer. These inputs may be observed at stake CO, stake AF, and TP 5, respectively, of PW 300.

As explained in Chapter 3, a single voltage regulator located in Module MAE provides power for both chroma modules; however, base reference voltage for the regulator is obtained from the IC in MAC, appearing at IC terminal 6. Loss of supply voltage could be the fault of the regulator transistor, the reference zener in the IC of MAC, or one of the resistors associated with these devices.

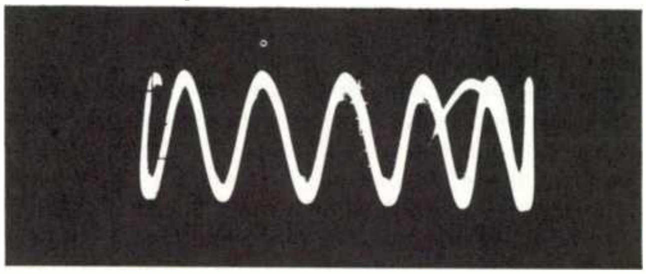
The two outputs of MAC are amplified chrominance video at terminal 6, and 3.58-MHz reference at terminal 12. Waveforms of these two signals are shown on this page. An RCA WR 64B was used as a source of keyed-rainbow signal, and all controls were set for normal reception.



15-Volt Burst Gate at TP 5



5-Volt Blanking Pulse and .3-Volt Chroma at MAC-6



2.4-Volt, 3.58-MHz Reference at MAC-12

An RCA WO 505 scope was used to observe the waveforms. Many other models of oscilloscopes do not have time-base circuits adequate to sync the 3.58-MHz reference signal; however, its presence can be determined with any wideband scope. Under no-signal conditions reference-signal amplitude is about 1.5 volt; with the bar generator connected it rises to about 2.4 volts.

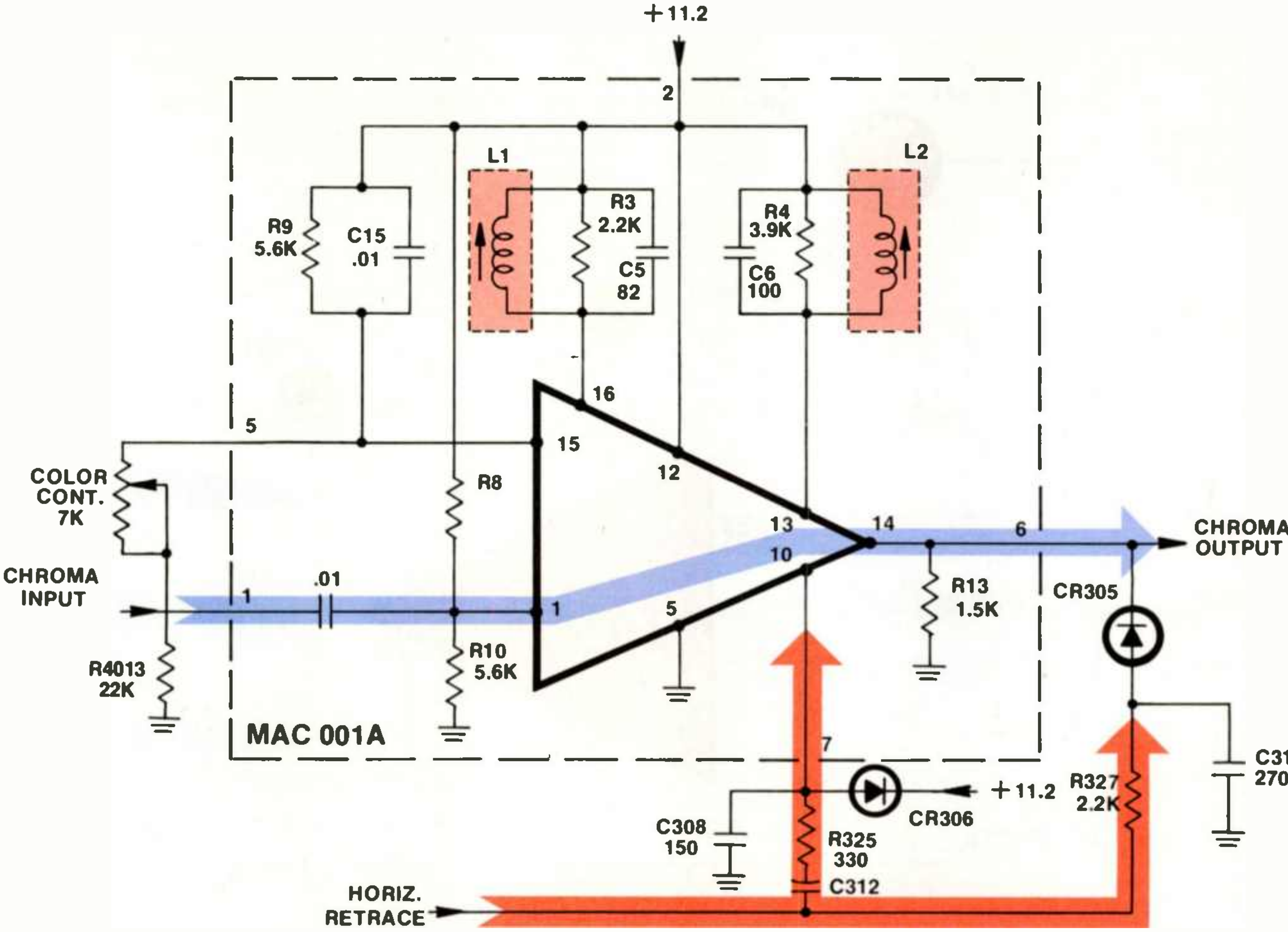


Figure 7-4 Bandpass Amplifier Circuits of Module MAC

The chroma output varies in amplitude from 0 to about .4 volt, depending on the setting of the receiver color control. Varying the chroma-level control of the WR 64B from 50% to 150% has but slight effect on chroma amplitude. This indicates that the ACC circuit is functioning.

Loss of reference-oscillator signal can be caused by a number of faults, including the oscillator crystal. (Failure of the oscillator will cause loss of color, of course.) There is no adjustable core in the coil (L3) connected to the crystal. The alignment procedure for the bandpass amplifiers in MAC is specified in the service data, 1970 T19. The setup procedure for oscillator tuning, ACC adjustment, and killer threshold is given in Chapter 6, page 46.

If there is no chrominance signal coming from MAC (see Figure 7-4) it is likely that the integrated circuit is at fault, assuming, of course, that the supply voltage is present. Other possibilities are an open tuned circuit, L1 or L2, or a short to ground in the interconnections between IC terminal 15 and the color control. (A very recent circuit change has resulted in a direct connection from IC terminal 15 to the color control and the increase of R4013 from 2K to 22K. Figure 3-3, page 18, does not show this change.) It also is possible that the forward bias to IC terminal 1 is insufficient; this should be about 1.9 volt. Another possible cause of loss of color, particularly in fringe areas, is a misadjusted killer control.

CR 305 couples blanking pulses to the output of MAC as explained in Chapter 3. If this diode becomes open, it is possible that faint vertical bars of color will be seen near each edge of the kinescope. If CR 305 shorts, the chroma signal will be shunted to ground via C311.

Excluding the voltage regulator, all active devices in Module MAE (Figure 7-5) are inside the integrated circuit, leaving very few servicing possibilities except to change the IC. Two diodes are located in the module; CR 1 is a kine-arc protector and CR 2 functions to ground C4 and L4 as explained in Chapter 3.

If CR 1 should open there would be no noticeable symptoms, but, of course, arc protection for the IC would be lost. If the IC ever is changed, CR 1 should be checked before the module is returned

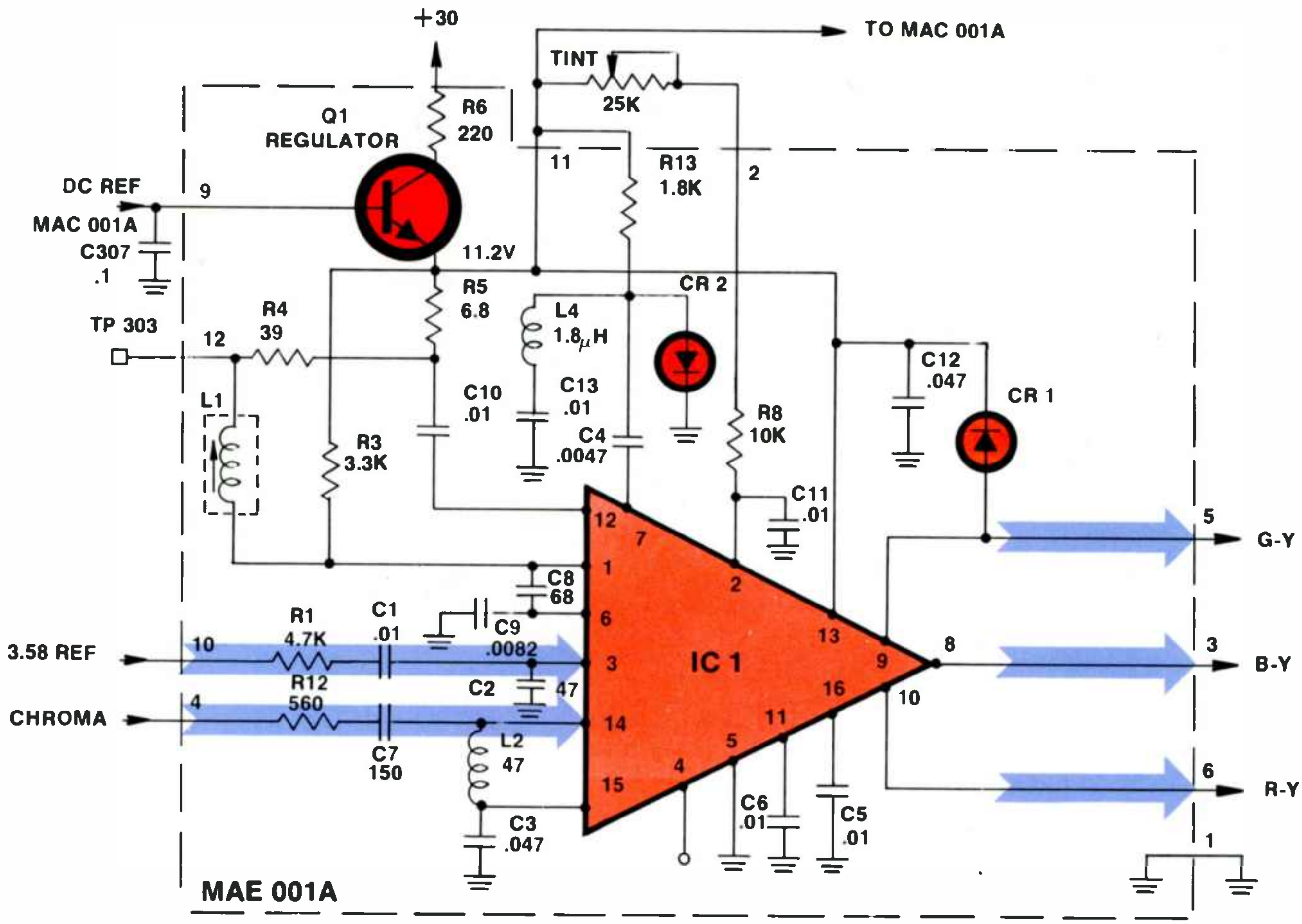


Figure 7-5 Module MAE—the Chroma-2 Board

to service. On the other hand, shorting CR 1 applies 11 volts to the base of the kine-driver transistor in the green MAD module, producing a very bright green screen which washes out all video. Failure of CR 2 produces practically no symptoms. Since it always conducts, a short has no effect on circuit operation; opening it shifts tint, but not beyond the range of the tint control.

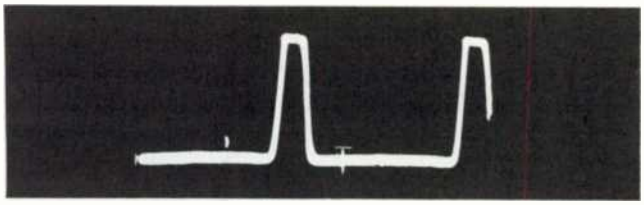
L1, the reference signal phase-splitter coil, may be adjusted in the field as explained in Chapter 6, page 47. The shop setup given here includes performance checks and may be useful in troubleshooting. Inability of the module to meet the tint-range requirements could be caused by tolerance shift of R4, R5, R8, C2, C8, or C9.

1. Connect a wide-band sensitive oscilloscope to TP 303; a direct probe may be used.
2. Turn the receiver on and adjust for normal reception of color bars.
3. Adjust L1 for maximum 3.58-MHz output, about 60 millivolts. The signal amplitudes at IC terminals 6 and 12 should be about 8 millivolts.
4. Connect scope to module terminal 3 (B-Y) and adjust tint control for nulls at the third and ninth bars.
5. Connect scope to module terminal 6 (R-Y) and check that the null falls between the fifth and sixth bars (5½ ±½). Check that the tint control will shift the null at least one bar in each direction.
6. Adjust the color control for a 2-volt p-p R-Y signal and check for a B-Y amplitude of 2.4 volts ±20% and a G-Y amplitude (module terminal 5) of .72 volts ±6%.

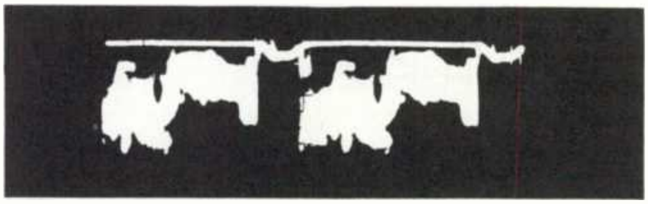
Luminance Circuits

Two types of MAD modules will be used in the RCA CTC 49 chassis. One has discrete components; the other uses a ceramic substrate and is totally non-repairable. It is recommended that a like type of module be used for replacement; however, they may be "mixed" if this becomes necessary.

Discrete-component modules may be repaired if desired. In view of the small number of components in these modules, it probably is simpler to troubleshoot with an ohmmeter than it is to signal trace. If signal tracing techniques are used, one of the operating modules may be used to determine correct waveforms and voltages.

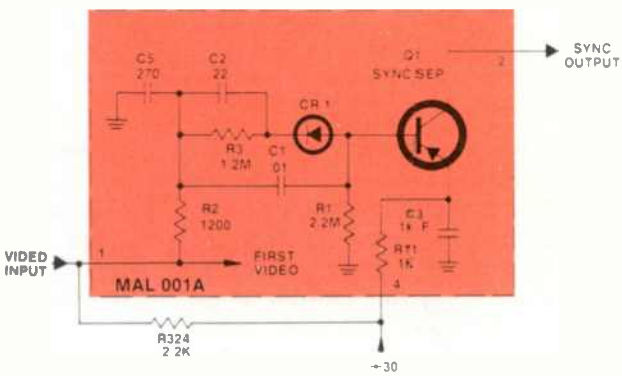


Waveform at MAD-5—220 Volts P-P



Waveform at MAD-3—About 2 Volts, P-P

Components external to the modules are the drive controls and the retrace-pulse clamping diode, CR 306 (see Figure 3-11, page 25). The integrity of the drive control and its series resistor, R335 and R336, may be determined by measuring the resistance between module socket terminals 3 and 4. If CR 306 shorts, the kine will go to very high brightness, washing out the video; if it opens, there will be only a slight decrease in brightness and contrast.



Since the video module, MAL, uses discrete components throughout, normal servicing techniques may be used. Two distinct circuit areas are contained in this module; their functions are sync separation and video amplification.

Both circuits have input from Module MAK by way of test stake VO. At this stake, the composite video has a peak-to-peak amplitude of 6.3 volts with negative-going sync pulses. The sync output is positive-going with 30 volts amplitude, and the video output reaches a maximum output of about 3 volts with black-level positive.

Figure 7-6 diagrams the sync separator and shows the normal waveforms at the base and collector of Q1. Failure of Q1, short or open, will cause complete loss of sync, both horizontal and vertical. If CR 1 shorts, the setting of the vertical-hold control will be very critical. Shorting CR 1 may produce only slight symptoms; probably all that will be noticed is a tendency towards instability of horizontal sync.

Signal tracing is probably the easiest method of troubleshooting the video amplifiers. The composite video has a peak-to-peak amplitude of about 3.2 volts at the base of the first video amplifier, Q3 of Figure 7-7. Depending on the setting of the contrast control, the **signal** at the collector of Q3 will range in amplitude from about 1.5 to 3 volts. Horizontal and vertical blanking pulses are inserted in the collector circuit and the peak amplitude of these is about 7 volts.

It is impossible to predict the results of a failure

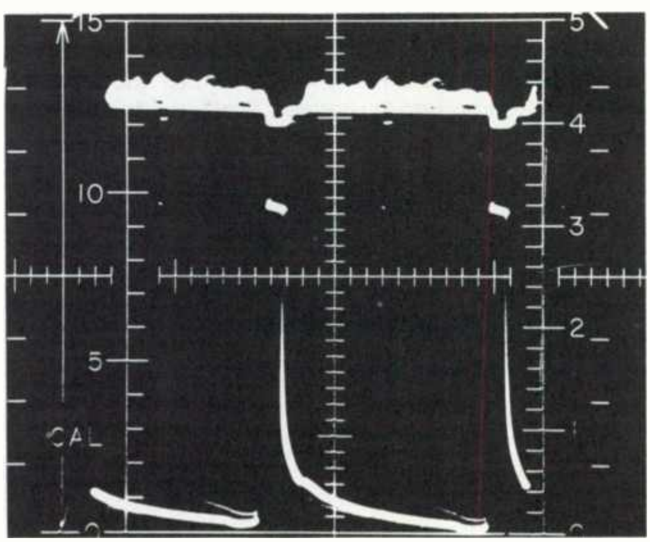
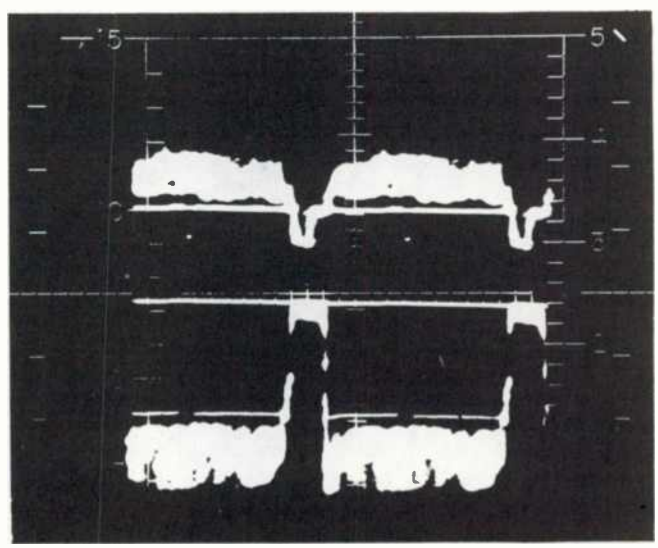


Figure 7-6 Sync Separator With Waveforms at Base (Top) and Collector. Horizontal Rate, Double Exposure, Scope Gain Constant for Both Waveforms



Base (Top) and Collector Waveforms of First Video Amplifier. Same Photo Conditions As in Figure 7-6

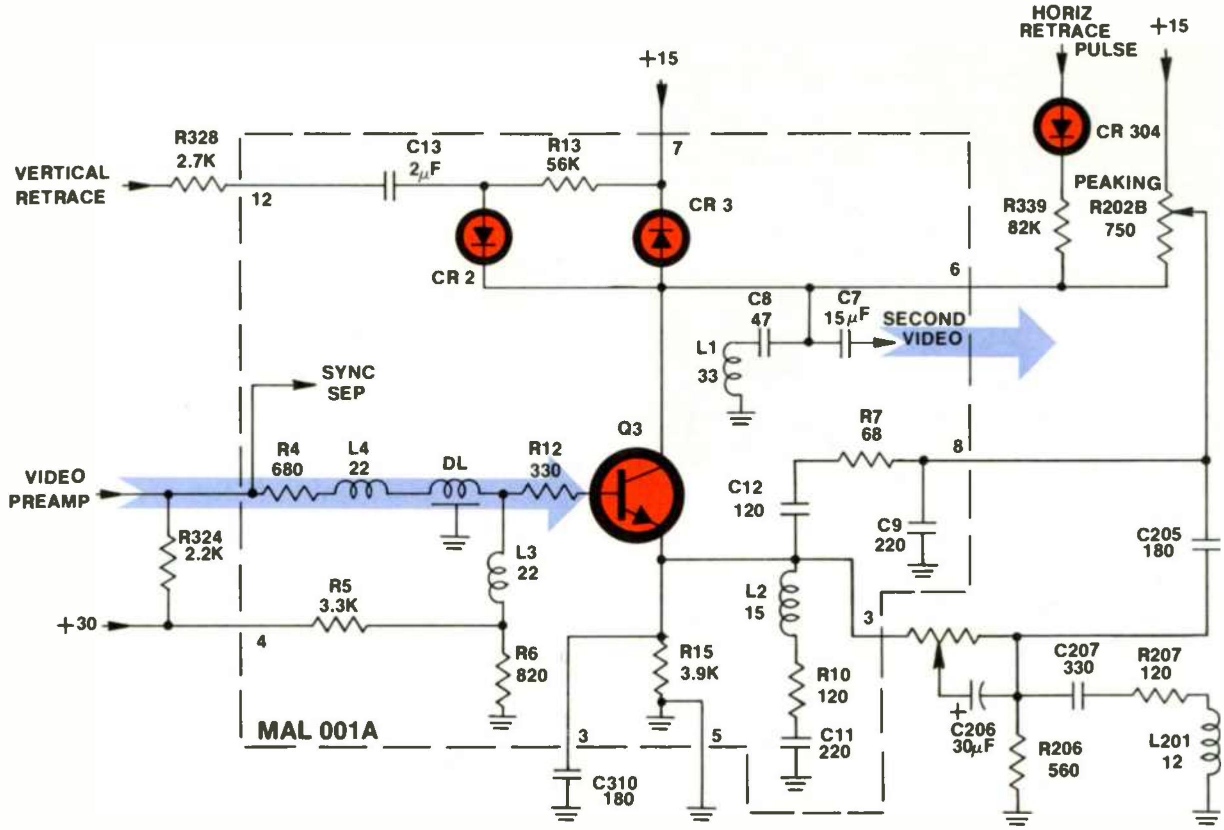
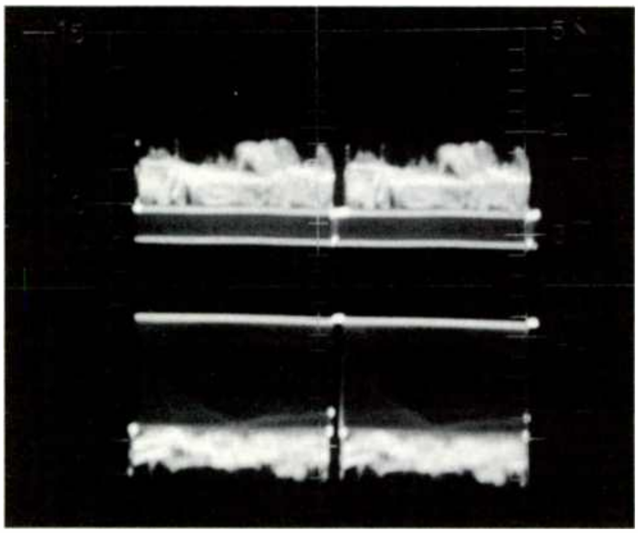


Figure 7-7 First Video Amplifier

of each component in the circuit, but the following hints may be helpful in troubleshooting:

1. The output of the first video amplifier is capacitively coupled to the second video amplifier and therefore failures in the first stage should not affect brightness.
2. Check the signal level at the base of Q3 to split the circuit into two problem areas.
3. Loss of horizontal or vertical blanking probably would be caused by the respective coupling diodes, CR 304 and CR 2.
4. The collector load resistor is the peaking control; shorting CR 3 will bypass the load resistance and kill the output.
5. Increasing the emitter impedance will decrease gain, and vice versa.



Base (Top) and Collector Waveforms of First Video Amplifier at Vertical Rate and Constant Scope Gain

There are no blocking capacitors between the second video amplifier (Figure 7-8), and the kine cathodes, so any change in DC levels from the base of Q4 onward will change brightness. Black is produced by positive-going video at the base of Q4, so anything which causes the base to become abnormally positive will darken the raster.

Barring failure of Q4, the voltage at its emitter always will be .7 volt positive with respect to the base. The base voltage is determined by the setting of the brightness control and ranges between about 4 and 6.5 volts. With the service switch placed in the raster position, the voltage will drop about .5 volt.

Abnormally high voltage at the base of Q4 could be caused by CR 4 being open or by the collector of Q302 being open. A short in CR 4 allows C10 to shunt the video signal to ground and the result is a "color-only" picture. If the collector of Q302 is shorted to ground, the brightness limiter is inoperative and blooming will occur if the brightness control is advanced towards maximum.

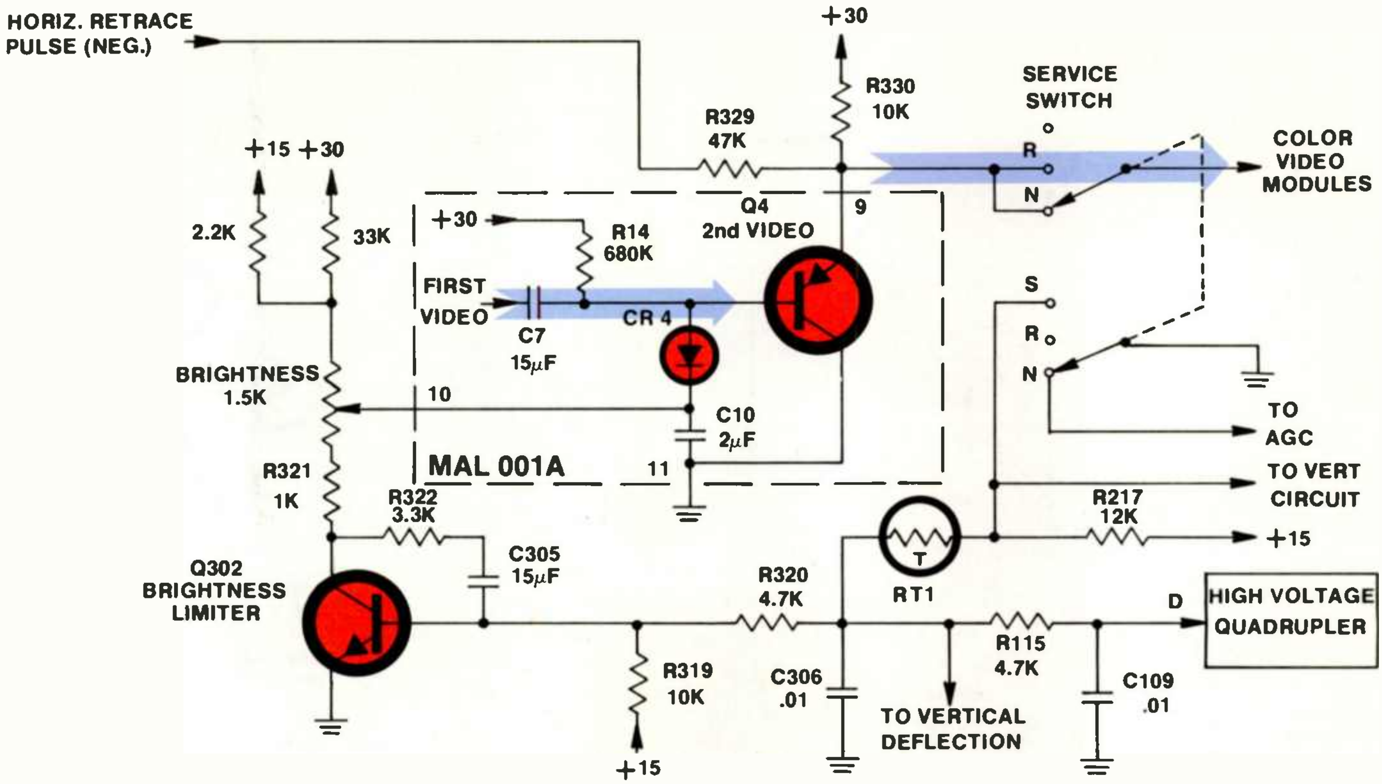


Figure 7-8 Second Video Amplifier

Horizontal Deflection

Servicing the horizontal deflection system of the CTC 49 is very similar to servicing the horizontal deflection systems of the RCA CTC 40, 44, and 47 chassis. The high-voltage system is very similar to the CTC 44 and 47. Because of this, many of the service tips contained herein may be used with all of these earlier chassis, and vice versa.

The horizontal AFC circuit (Figure 7-9) differs somewhat from the circuit used in the earlier chassis. Sync input at the base of Q1 is designed to be of somewhat less amplitude than it was in earlier chassis, allowing the limit diodes on the AFC output to be eliminated. Also, a third transistor, Q3 has been added to couple the flyback pulse to the AFC diodes.

If a problem should arise in maintaining correct horizontal frequency, it first should be determined whether the fault is in the AFC circuit or in the oscillator itself. This may be done by disconnecting the common ends of R7 and R8 from the board, thus removing the AFC input to the oscillator. If the oscillator will run at the correct frequency with the AFC input disconnected, the fault lies in the AFC system. Off-frequency operation of the oscillator which clears when AFC is disconnected could be caused by a change in value of R7 or R8, which are a matched pair, or by failure of either CR 1 or CR 2. Loss of sync would be the result of failure of either Q1 or Q2.

Three general types of trouble may occur in the horizontal oscillator (Figure 7-10). Either there will be no output, the output frequency will be wrong, or the output waveshape can be incorrect. Loss of output could be caused by a number of component failures, including Q2, an open CR 5, loss of supply

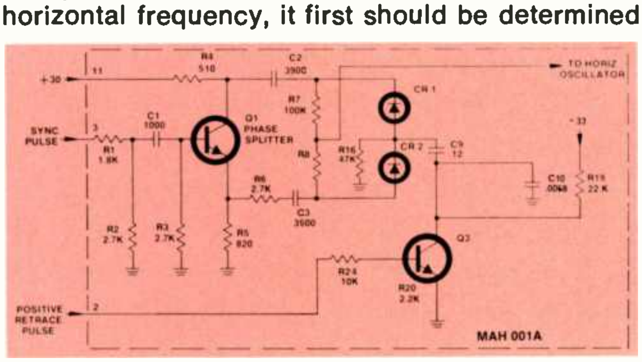


Figure 7-9 Horizontal AFC Circuit

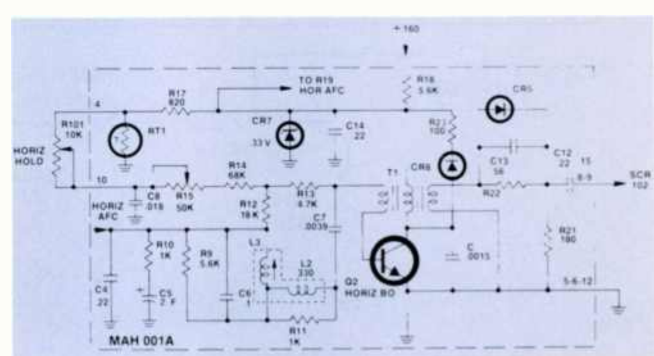


Figure 7-10 Horizontal Blocking Oscillator

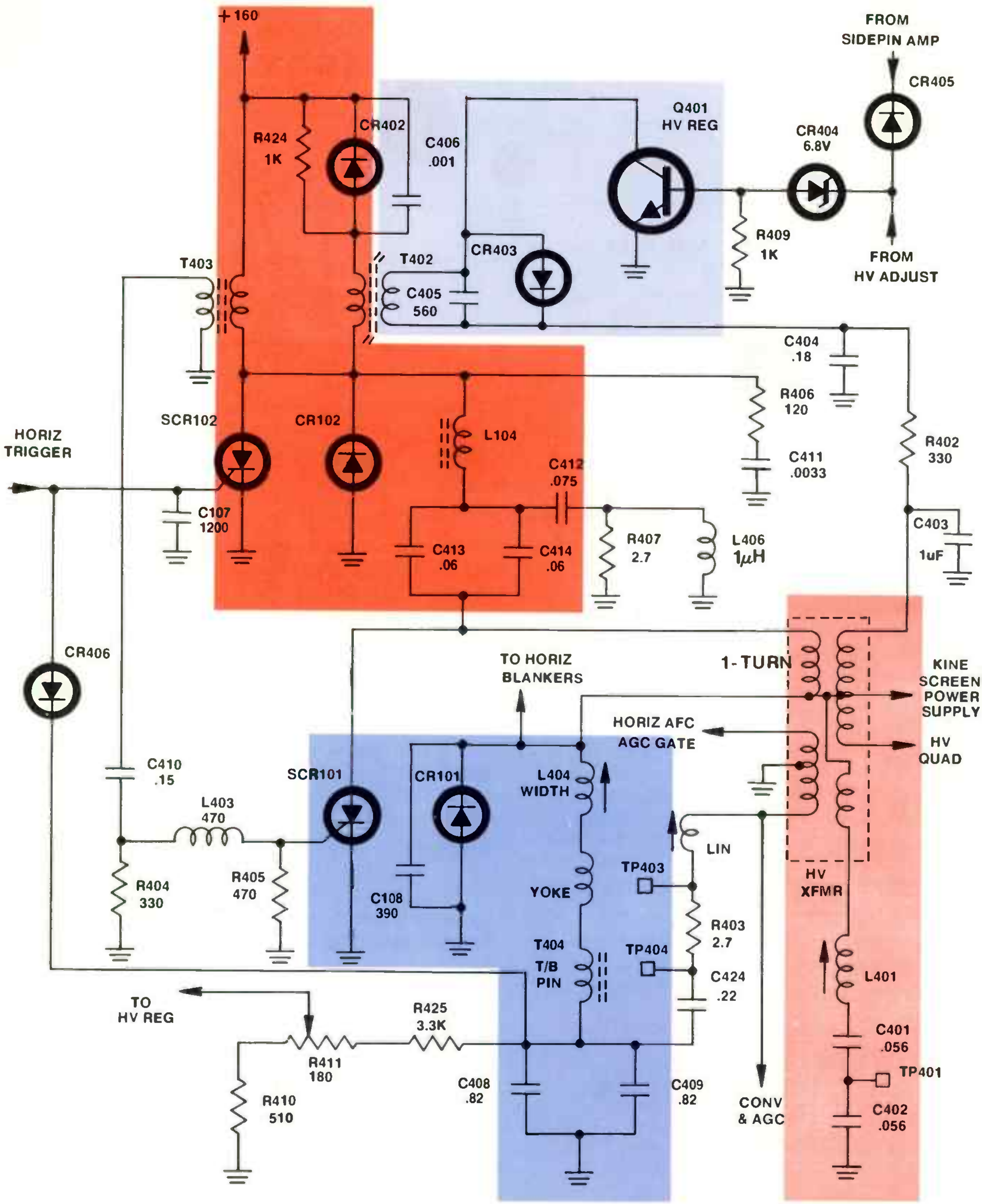
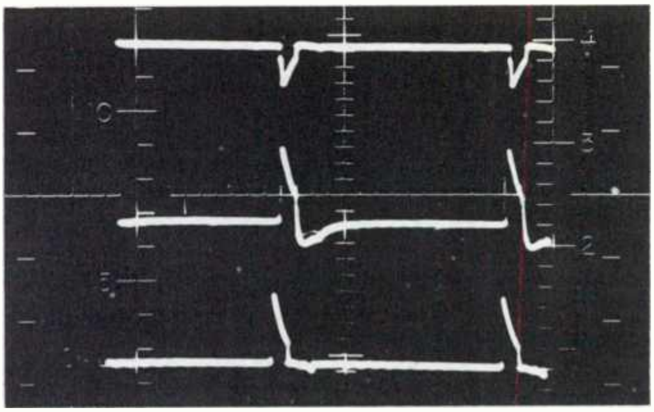
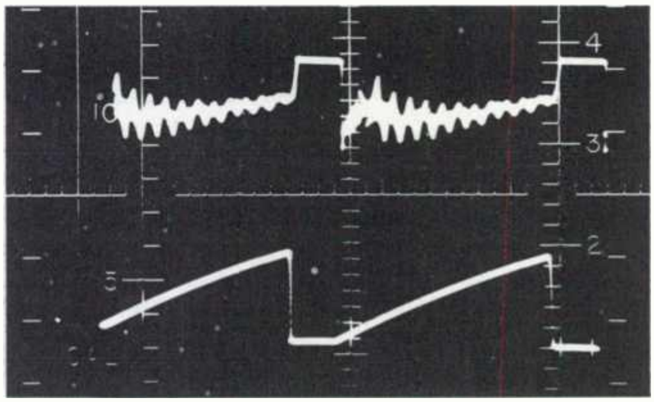


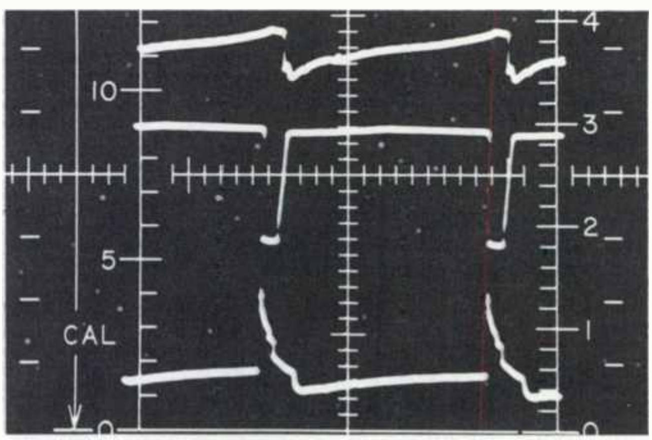
Figure 7-11 Horizontal Deflection Circuit and High-Voltage Regulator



Waveforms of MAH-Q1—Collector, Base Emitter (Top to Bottom). Base Voltage Is 1.8 Volt, P-P.



Waveforms of MAH-Q3—Base (Top) and Collector. Horizontal Time Base, Base Signal Is .9 Volt P-P.

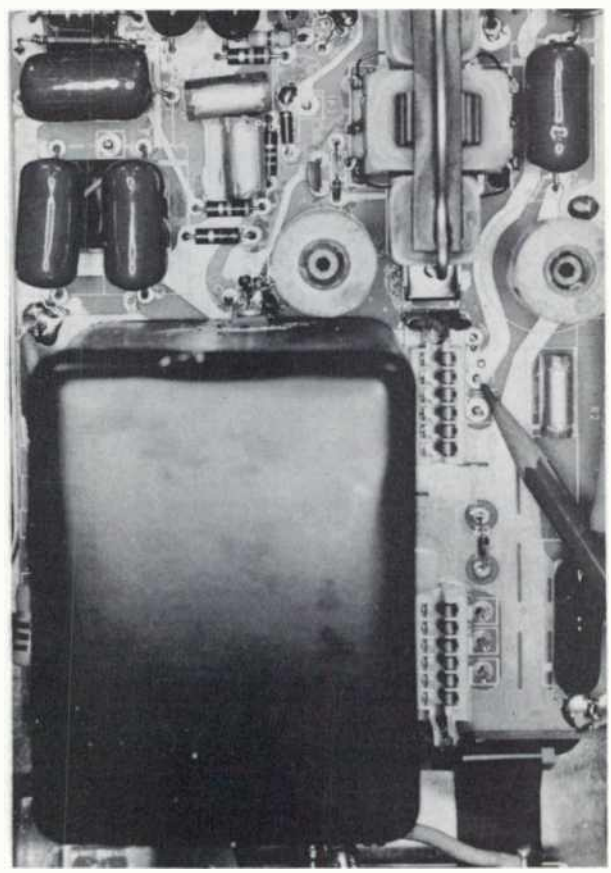


Waveforms of MAH-Q2 Base (Top), Collector, and MAH-5. P-P Volts Are 5, 30, and 9, Respectively

(shorted CR 7), etc. The frequency of operation is determined by the time constant of the base circuit of Q2 and the AFC voltage, which may be disconnected for troubleshooting as described above. A change in value of nearly any component in the base circuit of Q2 could shift the oscillator frequency beyond the limits which can be corrected by the AFC voltage. Change of output waveshape could be caused by a shift in value of a component in the oscillator collector circuit. Perhaps the most likely would be an open in CR 8. Opening this diode causes the circuit breaker to trip since the trigger waveshape swings positive at about the midpoint of scan, triggering the retrace SCR at the wrong time.

It should be noted that the only bleeder circuit for the 160-volt supply is through R18 of Module MAH. If the receiver is turned on while the module is removed and then the module is re-inserted, even with the receiver turned off or disconnected, the energy stored in the 160-volt power supply filter will cause the horizontal oscillator to start and high voltage may be generated. To prevent damage to test equipment which may have been left attached and to avoid the possibility of electrical shock, discharge the 160-volt power-supply filters after the receiver has been operated with MAH removed. This may be done by grounding stake X of PW 400.

Failures in the horizontal-deflection and high-voltage system generally will lead to loss of high voltage, possibly accompanied by tripping of the circuit breaker. Whether or not the circuit breaker



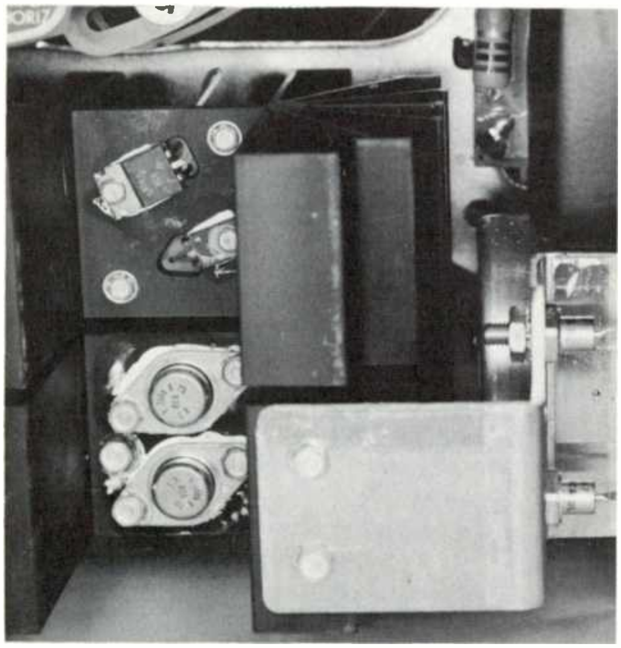
If the receiver is operated with Module MAH removed, there will be no bleeder for the 160-volt power supply. To discharge this supply after the receiver is turned off, ground stake X of PW 400.

trips is a good indicator to use as a first isolation of the fault.

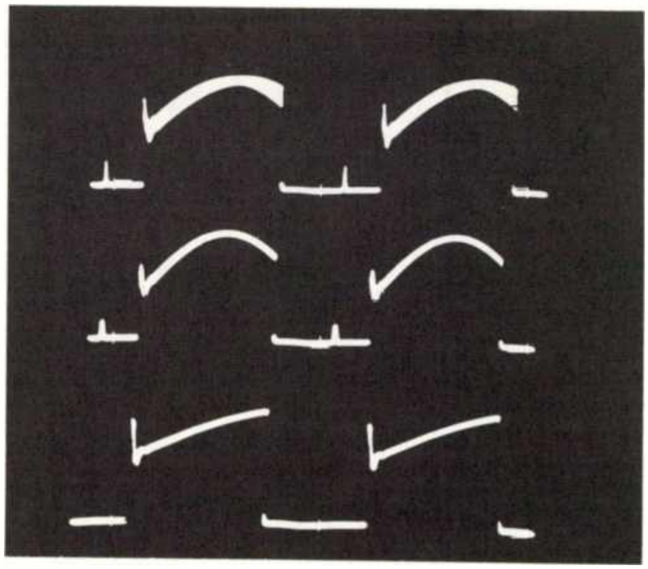
If there is no high voltage and the circuit breaker does not trip (or having tripped once at the onset of the trouble, does not trip after it is reset), it is likely that either SCR 101 or CR 101 (Figure 7-11) is shorted. This may be verified with an ohmmeter as outlined in Chapter 6, page 53. Of course, any short-circuit path paralleling these devices would have the same effect. With the positive ohmmeter lead attached to the cathode of CR 101, the normal in-circuit resistance reading is about 4000 ohms to ground.

If either of the retrace (commutating) devices shorts, the 160-volt supply will be shorted and the circuit breaker will trip. If both these devices are removed and the short circuit persists, check the various capacitors which parallel these devices and also C 413 and C 414.

Late in the design of the CTC 49, a diode (CR 406) was added between the gate of SCR 102 and the junction of C408, C409, C424, and R425. The purpose of this diode is to prevent the generation of excessive high voltage in the event that CR 101 opens. If CR 406 shorts, it will cause the circuit breaker to trip; however, opening CR 406 will produce no symptoms if there are no other circuit faults. Opening CR 101 will produce a narrow, unsynchronized raster, and an audible squeal will be heard.



This photo of the rear of the chassis shows the location of the deflection output devices. At the left from top to bottom are Q101, and Q102 (vertical output), then SCR 102 and SCR 101 (horizontal output). To the right are CR 102 (top) and CR 101 (bottom), the horizontal retrace and trace diodes.



Waveform At Anode of CR 102. Top Is Normal, 320 Volts P-P. Center Caused by Shorted Q401 or Open Q402; Bottom by Open Q401 or Shorted Q402.

Failure of the regulator circuit may cause either an increase or decrease in high voltage, but the most noticeable symptom is the appearance of side pincushioning. If Q401 opens, high voltage will increase, reducing height and width; if it shorts, high voltage will decrease, which causes an increase in vertical and horizontal scan. If Q402, the side-pincushion amplifier, shorts, high voltage increases; if it opens, high voltage is reduced.

The flyback transformer is tuned by L401, C401, and C402. The procedure is given in the service data, 1970 T19. Unless a component is replaced it is not likely that tuning will be required; but if it is, the specified procedure must be followed carefully.

The high-voltage quadrupler is not serviceable and must be replaced as a unit if it fails. Previous experience has indicated that the quadrupler has often been changed needlessly, and to prevent this, the following check-out procedure should be followed before deciding to replace the quadrupler. This procedure is similar to one published for the RCA CTC 47 chassis.

1. Remove the picture-tube neck socket; turn the receiver on and measure high voltage. If high voltage is present, a kine short or a video-amplifier problem is indicated.
2. Disconnect the high-voltage bleeder resistor and check high voltage. If it has returned, the bleeder is defective.

3. Remove the focus lead from the quadrupler and check to see if high voltage is restored. If it is, check the focus circuit for shorts.
4. Check the low side of the high-voltage system by measuring the resistance from terminal D of the quadrupler to the base of Q302, the brightness limiter. The resistance should be 9400 ohms. Terminal D is identified by the two black wires connected to it.
5. Observe the pulse at PW 400 AB (See waveform 18 on the complete schematic.) If this waveform is normal with the lead between the flyback transformer and the quadrupler disconnected, but is drastically changed when the connection is restored, either the quadrupler or its output is shorted.

Vertical Deflection

Since the vertical deflection circuits form a closed-loop system, a fault occurring at nearly any point will produce abnormalities in the waveforms and voltages at many other points in the loop. Because of this, it often will be simpler to isolate component failures by using an ohmmeter than to attempt to analyze waveforms.

A reasonable starting point in troubleshooting a loss of vertical scan is to check the output transistors and the 1.5-ohm resistor (R221) between the collector of Q102 and ground. The transistors are shown in the photograph on page 70; Q101 is above Q102. The transistors are easily removed and may be checked with an ohmmeter. While they are removed, R221 may be checked by measuring the resistance from the collector terminal of the Q102 socket to ground.

The continuity of the vertical yoke and the convergence circuits may be checked by removing Module MAG and measuring the resistance between terminals 1 and 2 of its socket. This resistance is about 14 ohms and should measure the same, regardless of meter polarity.

If it differs from this, the major resistances in the yoke circuit may be measured individually by following the procedure below. Module MAG should be left out of its socket.

1. MAG socket terminal 2 to yoke socket terminal 2 should measure 6 ohms. This checks the convergence circuits.
2. Yoke plug terminal 2 to yoke plug terminal 8, and yoke plug terminal 1 to yoke plug terminal 7 should measure about 3.7 ohms each. These are the yoke winding resistances.
3. Yoke socket terminal 7 to yoke socket terminal 8 should measure about 1 ohm, the resistance of the pincushion transformer and phase coil.

C419, the coupling capacitor between the output transistors and the yoke may be checked for a short circuit by measuring resistance between module socket terminals 2 and 8. The location of this capacitor has been changed from PW 400 to the chassis; however, early production PW 400 boards will include it in the road mapping.

In most cases, Module MAG also may be serviced by use of an ohmmeter. This will be especially effective in locating defective transistors and diodes. Failure of any of the three transistors in the module will cause loss of deflection, so the ohmmeter approach is obviously the best; however, the symptoms produced by diode failures may be helpful in troubleshooting.

If either CR 2 or CR 3 shorts, there will be a slight reduction in height and the picture may roll, both symptoms may be corrected by the appropriate controls. Opening either CR 2 or CR 3 causes very rapid scanning from the top to near the center of the kine. Horizontal scan lines are about ⅜ inch apart in this area. The remainder of the frame is compressed into about 2 inches of deflection and the lower part of the raster is black.

Opening CR 1 causes complete loss of vertical sync, as would be expected. Shorting this diode may cause a slight loss of interlace. The remaining diode, CR 4, is a 65-volt zoner regulator connected from the driver collector to ground. If this device shorts, excessive current through the collector load resistors will cause them to overheat, and, of course, there will be no vertical deflection. Opening CR 4 may produce no noticeable symptoms; however, the increased vertical ouput current which may result could cause premature failure of the vertical-output transistors. If these latter devices are replaced at any time, CR 4 should be checked before restoring the receiver to service.

SPECIAL NOTICE

To allow this manual to be published as soon as possible after production of the RCA CTC 49 was begun, it was necessary to write most of it before all designs were finalized. Insofar as possible, this manual was continually updated; however, the following circuit changes were incorporated into the receiver as this manual was in the final stages of preparation and could not be included elsewhere.

1. R4009 and R4008 in the brightness-limiter circuit have new values of 22K ohms and 8200 ohms, respectively.

2. A diode has been added between stakes BL and AB of PW 300. The diode anode connects to stake AB.

3. A 1000-ohm resistor has been added between stake PW 300-BL and terminal 3 of the brightness control, R4002.

4. A 6800-ohm resistor has been connected in parallel with the peaking control, R4010.

5. C419, the vertical-output coupling capacitor has been relocated from PW 400 to the main chassis. Its voltage rating has been increased from 50 volts to 75.

6. This manual refers to two separate diodes as CR 306. The correct designation for the diode which clamps the reset pulse for the MAD modules is CR 307. CR 306 designates the diode which limits the blanking pulse applied to Module MAC-7 via R325. These diodes are identified correctly in the complete schematic.

7. R339 has been changed to 56K ohms and relocated between the anode of CR 304 and terminal HY of PW 300. A 10-μf capacitor has been connected between ground and the junction of CR 304 and R339.

8. A 10K-ohm resistor has been connected between the tint control, R4003, and PW 300-AH.

9. C406, formerly connected across CR 402 and R424 of the horizontal-deflection power-input system, has been deleted.

10. C410, in the trigger circuit from the secondary of input reactor T403 to the gate of SCR 101, has been changed from .15 to .18μf.

11. The ferrite bead, FB 103 shown on the cathode lead of CR 101 in the main schematic, has been deleted.

12. R314, the emitter resistor for the audio output transistor, Q103, is now 15 ohms instead of 10.

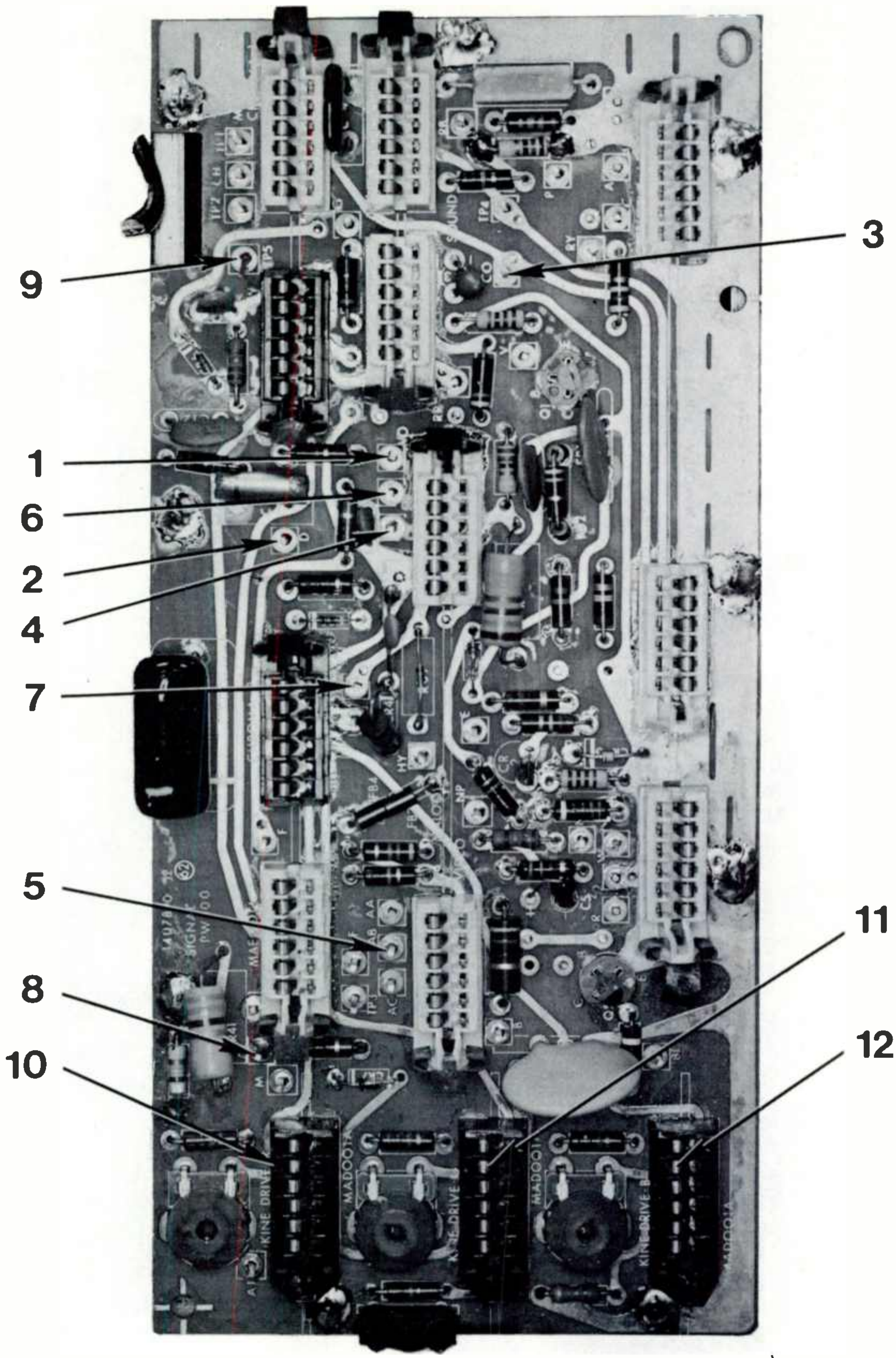
13. L301, in the B+ line which feeds the MAD modules, has been changed to 180 μh.

14. CR 5 of Module MAG has been removed from the module and relocated at the sockets of Q101 and Q102.

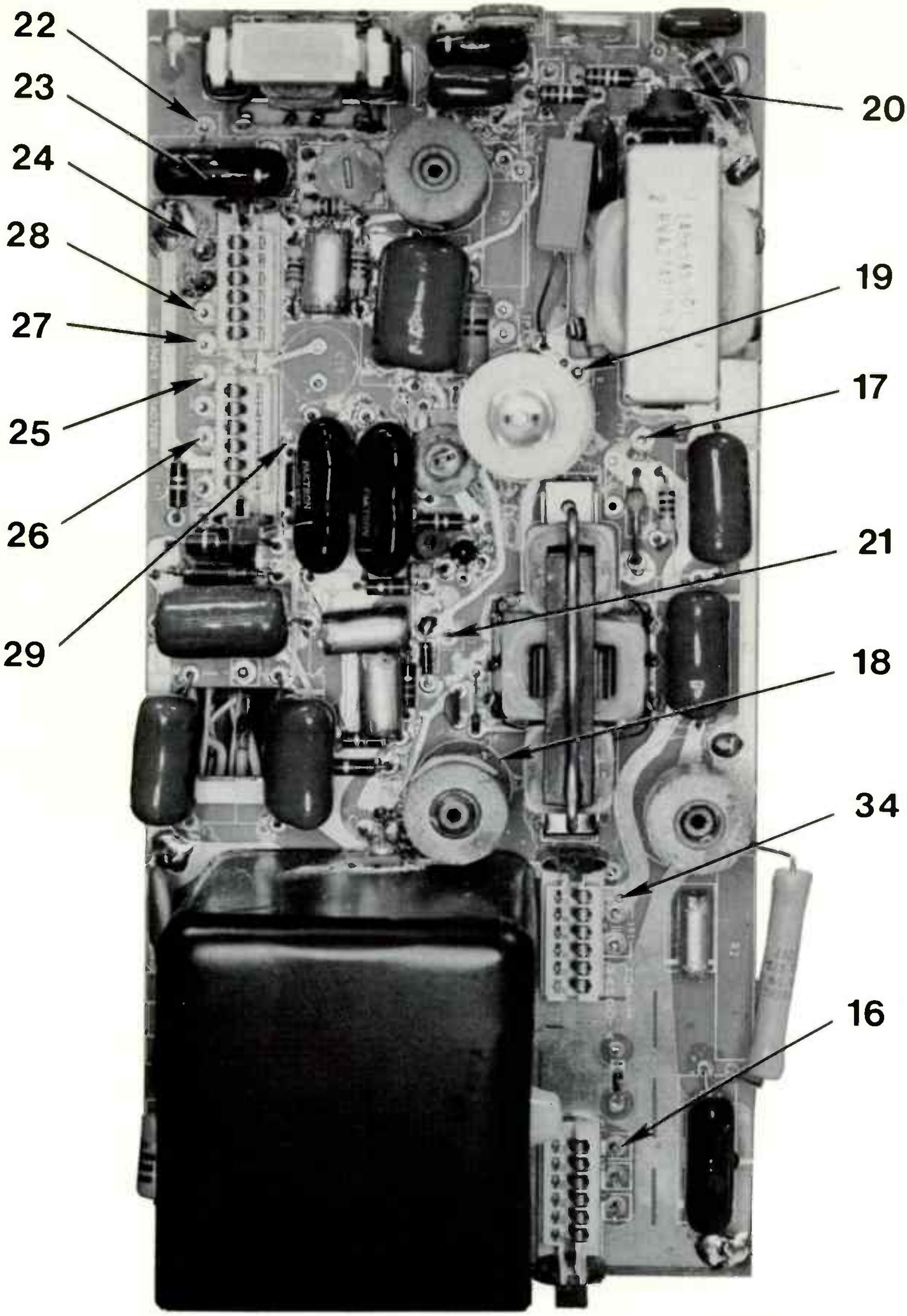
15. In Module MAH, R17 has been increased to 1500 ohms.

16. In Module MAK, R10 has been changed from 100K ohms to 120K ohms.

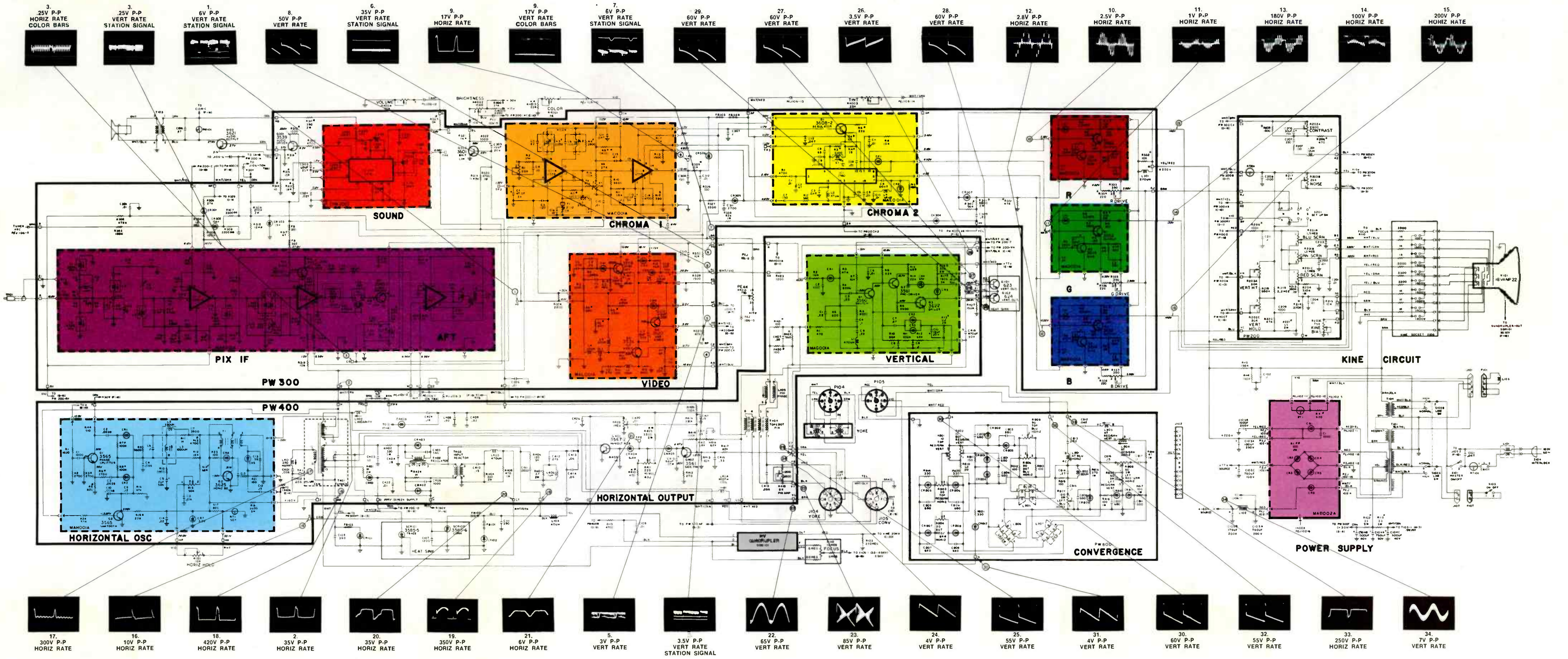
17. C10 of Module MAL has been changed from 2 μf to .01 μf.



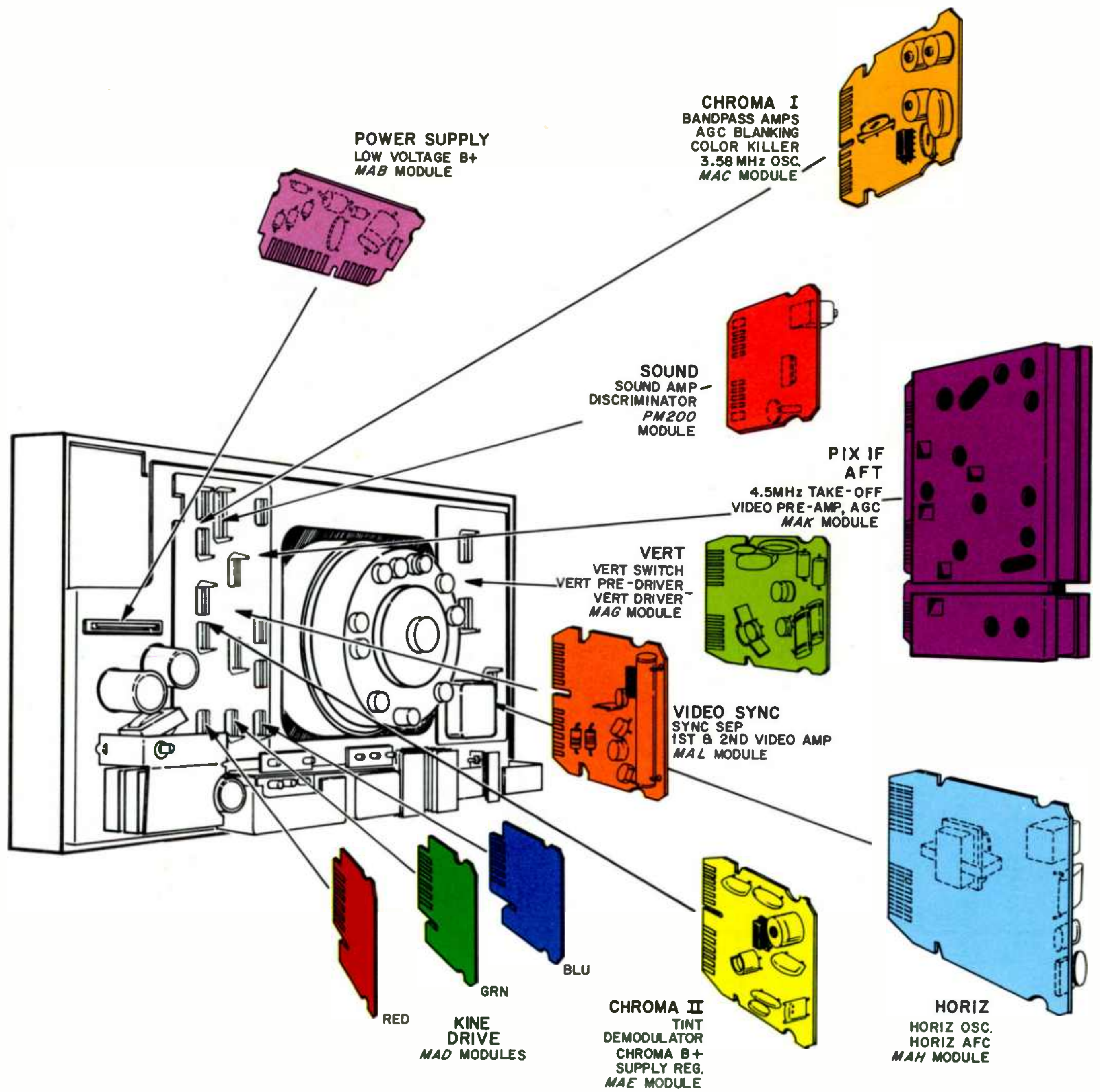
Test-Point Location for Schematic Diagram, PW 300.



Test-Point Location for Schamtic Diagram, PW 400



CTC 49 (PRELIMINARY)



POWER SUPPLY
LOW VOLTAGE B+
MAB MODULE
CHROMA I
BANDPASS AMPS
AGC BLANKING
COLOR KILLER
3.58 MHz OSC.
MAC MODULE
SOUND
SOUND AMP
DISCRIMINATOR
PM200
MODULE
PIX IF
AFT
4.5MHz TAKE-OFF
VIDEO PRE-AMP, AGC
MAK MODULE
VERT
VERT SWITCH
VERT PRE-DRIVER
VERT DRIVER
MAG MODULE
VIDEO SYNC
SYNC SEP
1ST & 2ND VIDEO AMP
MAL MODULE
RED
GRN
BLU
KINE
DRIVE
MAD MODULES
CHROMA II
TINT
DEMODULATOR
CHROMA B+
SUPPLY REG.
MAE MODULE
HORIZ
HORIZ OSC.
HORIZ AFC
MAH MODULE

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