Plain Talk and Technical Tips

Mar.-Apr., 1972 • Volume 15/No. 3-4

Understanding AGC

Television AGC circuits and their service often confuse the service technician. The feeling of bewilderment results from the interdependent nature of the closed-loop circuit. The keyed AGC system used in modern television receivers has the prime function of assuring a constant-level video signal under widely varying signal-strength conditions. It accomplishes this function by comparing a video-signal sample against a reference voltage and generating a control bias which effects a change of gain in the RF and IF amplifiers. With this feedback arrangement, the video signal amplitude at the sampling point changes very little over a wide range of input signal levels.

The block diagram below (Figure-1) illustrates the basic configuration of a keyed AGC system. At low input signal levels (below about 500 μV) the RF amplifier operates at maximum gain and the IF amplifier gain is reduced to stabilize the video signal level. (The condition of IF gain reduction is shown in Figure-2.) The RF amplifier operates at maximum (about 8x) gain up to about 500 μV of signal to provide optimum signal for the mixer stage of the tuner—for best signal-to-noise ratio. (The maximum gain condition is provided by the RF delay network which will be discussed later in this article.) As the signal increases beyond 500 μV the RF amplifier gain is reduced by AGC to maintain a reasonably constant signal level at the mixer stage; thus, the IF AGC "rests" at a fairly constant gain until, at a signal input of about 100,000 μV, the RF amplifier reaches its cutoff point and has a gain of about .03x. At signal strengths beyond 100,000 μV the IF amplifier again assumes gain control.

Due to the nature of the video signal, the sync tip is the only reliable indicator of signal strength because it has a constant amplitude that represents

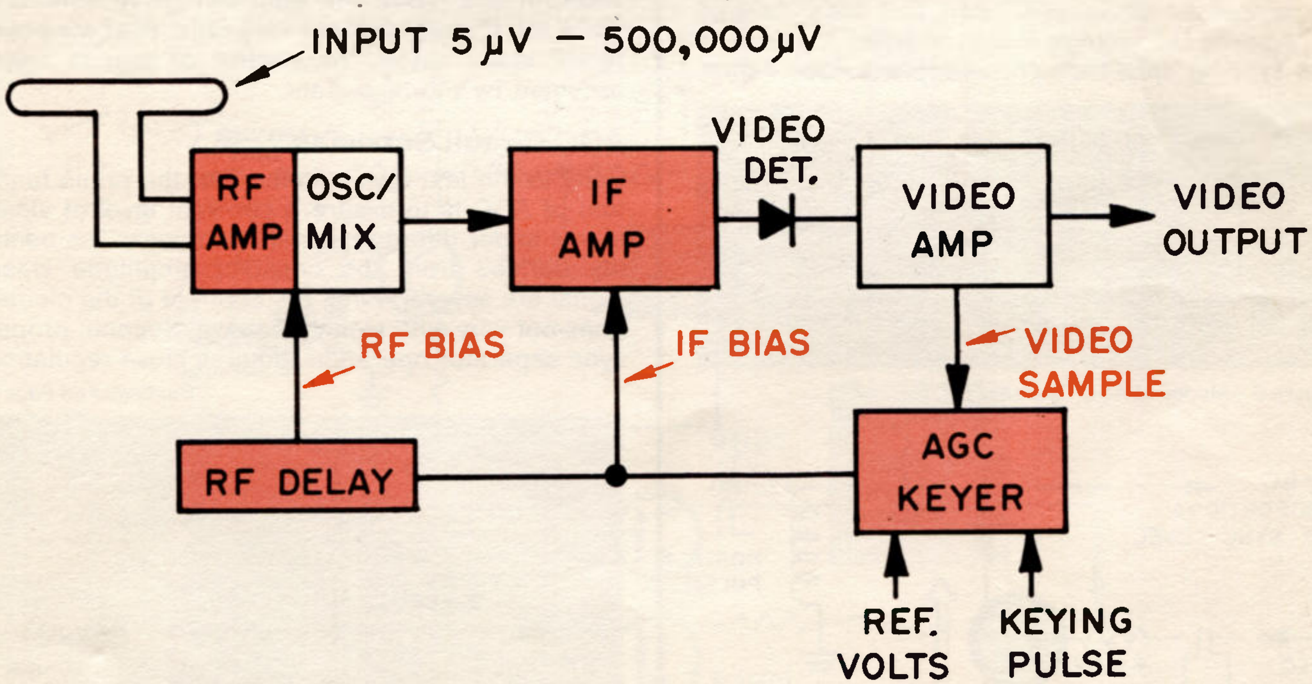

Figure 1—Television AGC Block Diagram

A publication for the service industry prepared by RCA Consumer Electronics

100% modulation of the transmitter and is easy to extract from the video signal. For this reason, the keyed AGC system is designed to compare the sync tip against the reference voltage. The AGC keyer depicted in Figure-3 is really quite simple in operation: Transistor Q1 operates as a common-emitter stage with its emitter returned to a 3.4-volt reference source rather than ground. This means that the input signal's sync tip must exceed 3.4 volts, plus a .6-volt barrier potential, before the base becomes forward biased. The sync tip of the video sample just touches the threshold of base conduction at the input signal level where AGC action is to begin. Obviously if the video signal increases, the base will receive more drive. Hence, the base current will be proportional to the sync-tip amplitude.

The collector of Q1 is driven by a positive pulse from the flyback transformer that is coincident in time with the horizontal sync pulse at the base. Thus, for Q1 to conduct and develop AGC it must have a video signal at the base whose sync tip exceeds 4 volts and a coincident horizontal keying pulse. In normal operation, the positive collector voltage pulse creates a flow of electrons (current) from the emitter to the collector which will be proportional to the base drive, and hence the amplitude of the video signal.

Conduction of keyer transistor Q1 allows electrons to accumulate on the left plate of C1. Thus during the large interval of time when the sync tip and pulse are not driving Q1, it is cut off and the right plate of capacitor C1 is grounded through the pulse winding. From this action, it should be obvious that the circuit of Q1 can, and does, develop a negative DC voltage that is a direct measure of the sync-tip amplitude of the applied video signal.

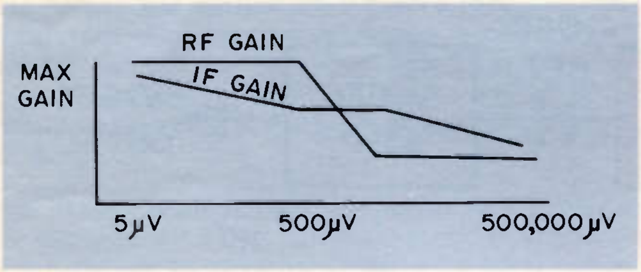

Figure 2—Modes of AGC Operation

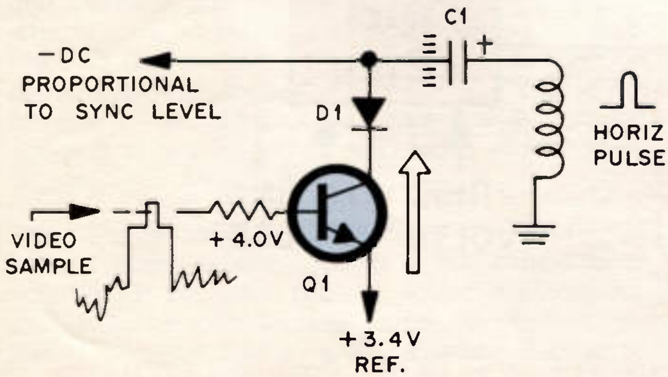

Figure 3—AGC Keyer Stage

If the circuit was connected "open-loop" so that the negative AGC voltage could be compared against the amplitude of the video sample, it would be evident that a **very** small change in video signal would cause an enormous change in the AGC voltage. Hence the circuit has high open-loop gain. When this negative AGC voltage is applied to the RF and IF amplifier stages, the increasing negative voltage causes a gain change so that the **RF, IF, Video** to AGC bias feedback path comprises an automatic-gain-control system in which the amplitude of the video signal is regulated to very close limits.

As shown in Figure-2, there are three distinct modes of AGC operation. At input signal levels lower than 500 μV, RF gain is at maximum and output level is controlled by reducing the gain of IF amplifier. With signal levels between 500 and about 100,000 μV, the RF amplifier assumes the task of gain reduction and the IF gain remains fairly constant. Past this point the RF stage is cut off and gain control reverts back to the IF amplifier.

The low-signal (maximum RF amplifier gain) condition is controlled by an RF AGC delay network which sets a specific positive voltage on the RF amplifier that drives it to maximum gain. As the input signal increases from minimum towards 500 μV, the AGC voltage becomes more negative and the positive voltage introduced by the AGC delay circuit is finally cancelled. At this time the loop-gain of the AGC system increases because gain control is now introduced a stage earlier. This means that the voltage change needed to effect the required gain change is now much smaller. Thus, in this mode, RF gain swings to minimum while the IF gain changes very little. Past the point of RF stage cutoff, the control of gain is again assumed by the IF system.

AGC Circuit Servicing

Early in the text it was stated that the prime function of AGC is to assure a constant level of video signal under differing signal conditions. The benefits derived from the constant amplitude video signal are several: First, the contrast of the picture does not vary with signal changes. Second, proper sync separator operation requires close regulation

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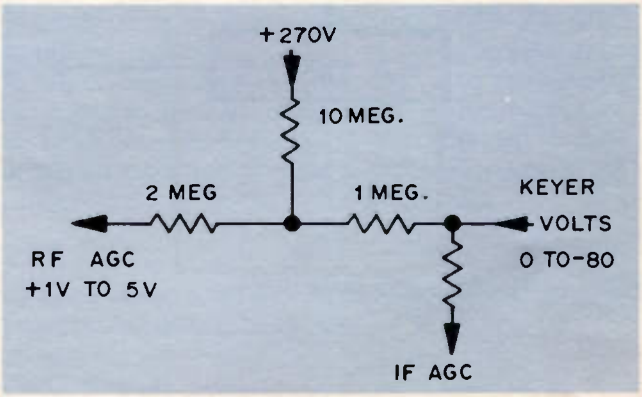

Figure 4—AGC Delay Network

CTC 54 Triac Power Switching

The RCA CTC 54 remote-control color chassis replaces the bi-stable relay used for AC power switching in previous remote-control color chassis with solid-state (triac) switching circuitry. The operation of the CTC 54 power switching circuit is easily understood. When transistor Q1113 is driven into conduction by operation of the remote or local "on/off" function, the input voltage to a schmitt trigger is momentarily reduced, causing it to trigger a bi-stable multivibrator (flip-flop.)

Figure-5 is a simplified schematic of the power-switching circuit. The flip-flop circuit (shown as a block) causes one of the driver stages (Q1105—TV driver, or Q1104) to always be saturated, and the other is always "off." The TV driver stage (Q1105) collector circuit contains the lamp of the PM100 lamp/photocell module. The lamp is illuminated when the flip-flop drives the TV driver transistor into conduction. Thus, when the user turns the set "on," the small lamp in the PM100 module illuminates a photo-conductive cell whose dark-resistance is very high, causing large decrease in resistance.

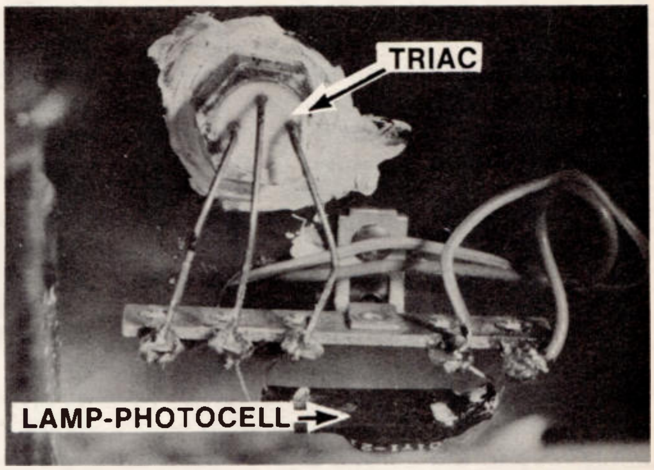

Figure 6—Lamp/Photocell and Triac

The photocell part of PM100 is connected between the main and gate terminals of a triac that is connected in series with the input power to the instrument. Hence when the lamp in PM100 is lit, the lower resistance of the photo-conductive cell permits gate bias to the triac. When the triac is gated "on," it acts as a closed switch and applies 120 volts AC to the input circuitry of the instrument.

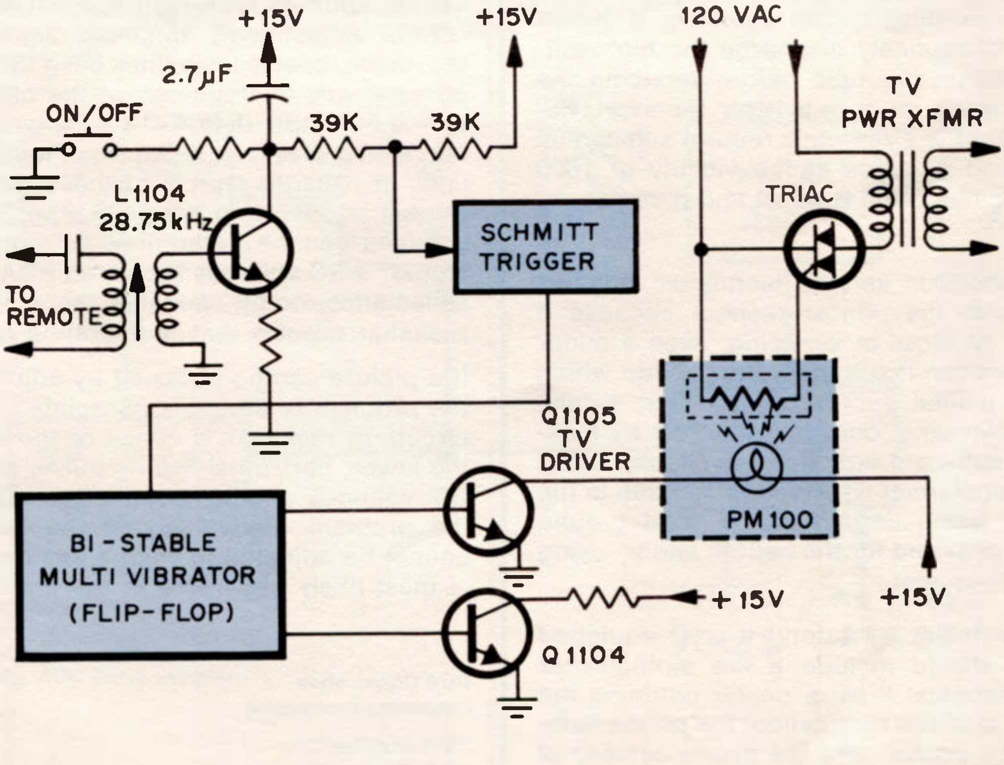

Figure 5—CTC 54 Triac Power Switching (Simplified)

Service Safety Practices

RCA Consumer Electronics exercises great care to design and manufacture products which are safe to operate and safe to service. You, the service technician, should certainly recognize that good service craftsmanship is important in maintaining the safety of the instrument.

The service technician need not expose himself to danger in order to effectively service an instrument. In fact if he follows the information regarding safety that is included in RCA Service Data, the hazards of servicing are minimized. Also, the television cabinet includes several precautionary notices. The service technician can become so familiar with the Service Data notices and cabinet labels that he may be inclined to disregard warnings and important service information. Thus through oversight, he jeopardizes his safety. Or, for some unknown reason, some service technicians feel that the notices posted in the TV cabinet apply only to the self-servicing customer and not to the technician.

One such notice deals with picture-tube replacement: When handling picture tubes, the technician should make use of safety goggles and gloves, and handle the tube in a cautious manner as prescribed on the notice attached to the picture tube.

When servicing the chassis, the technician should remember that high voltages are present and perform as much service as possible with the instrument power "off." Usually, resistance readings and thorough physical inspections can be used to good advantage in locating circuit troubles. It would also be wise to routinely discharge the high-voltage supply and picture tube before servicing the high voltage areas of a television receiver. Remember too that the TV circuits require substantial B+ voltage, and voltages in the vicinity of 1000 volts may be found in the B-boost and picture tube circuitry.

The safety-conscious service technician handles all voltages with the utmost respect because if one becomes careless in servicing, even a minor electrical shock can result in a reflex action which can cause a painful cut or bruise. Your safety, when bench servicing, can be enhanced by making sure that sufficient lighting is available; using an isolation transformer when recommended in the Service Data; being certain that a solid ground connection is provided for the bench; and by using an insulated floor mat.

From the standpoint of safety, a well equipped service shop should include a fire extinguisher suitable for electrical fires; a poster outlining the procedure for artificial respiration; the phone number of a nearby doctor; and the phone number of the fire department.

Finally, it is advisable to inspect your shop facilities periodically with a view toward eliminating any hazardous conditions. Remember that RCA has gone to great lengths to qualify its product for the UL seal which attests to a well-designed, safe instrument. Team this with safety consciousness on your part and you will prevent accidents before they can happen.

Understanding AGC

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of the sync-tip amplitude. Third, best strong-signal tuner operation results when the mixer stage is presented a fairly constant level, and protected from overload by the isolation and signal loss afforded by the cut off RF stage.

Obviously problems result when the video signal amplitude is abnormal or when the RF-stage AGC is incorrect. The problem of troubleshooting any closed-loop circuit stems from the difficulty in determining the area and nature of the failure. Symptoms associated with AGC problems include a weak, washed-out picture; signal overload (excessive contrast, picture tearing, loss of sync); low sensitivity; beats in the picture; etc. Of course, the above symptoms can be caused by problems other than AGC circuit malfunctions; but, because of the nature of the closed-loop system, they can produce erroneous AGC voltage which could send the technician off on a fruitless, time-consuming check of the AGC circuit.

When AGC problems are suspected, a good service technique is to first eliminate the obvious causes such as tube failure; module failure; AGC control adjustment; abnormal signal conditions; etc. Once these possibilities have been eliminated, an easy way to troubleshoot the closed-loop system is to simply defeat the AGC circuit by clamping, with a bias box or battery, the IF and RF AGC lines at voltages typical of those generated when the set is operating normally. The "normal" AGC voltages can be determined by noting the **"with signal"** AGC voltages shown on RCA Service Data schematics, or by checking the AGC voltages of a similar chassis that is operating normally.

If a picture can be obtained by adjusting the bias, the problem is probably associated with the AGC circuit. In this case a check of the video input to the keyer, horizontal keying pulse, and associated DC voltages should isolate the exact nature of the problem. Conversely, if the inserted biases cannot be adjusted to yield a picture, the problem is most likely elsewhere in the chassis.

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