An Enhancer for Cleaner Video Duplicating

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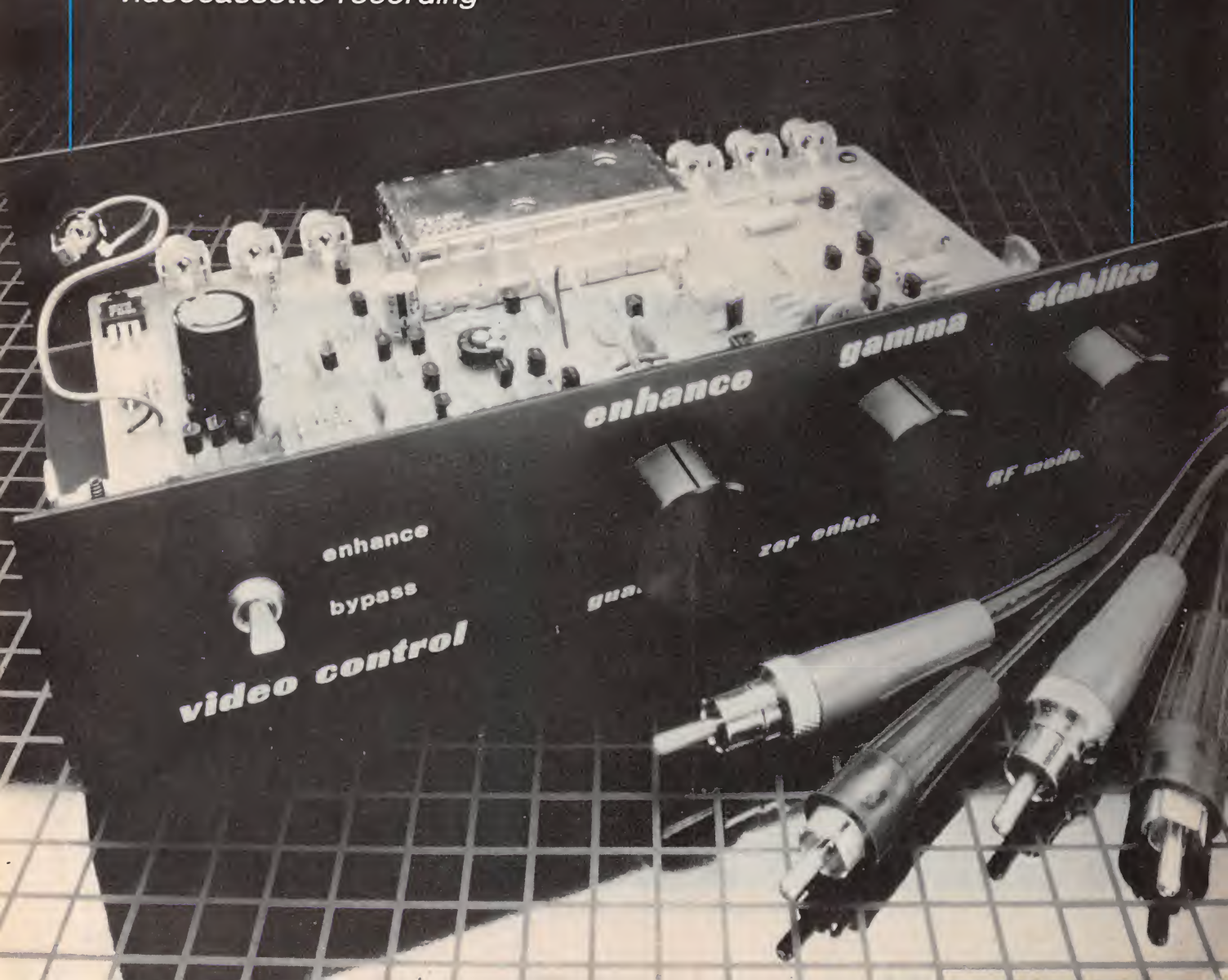
BUILD THIS

VIDEO ENHANCER WITH COPY GUARD STABILIZER

BY ROGER COTA

Inexpensive video control unit eliminates troublesome copy guard and recovers picture detail lost through videocassette recording



Owners of videocassette tape machines soon realize that there are some problems to overcome. One is the expense of video tape, which motivates the user to record at a slower speed. This, however, degrades picture quality. Another consideration is that many prerecorded movies, concerts, and special programs available for sale or rent are "copy guarded." Accordingly, some television receivers will not play these tapes well because the guard signal makes the picture roll, jitter, or disappear altogether.

To overcome these challenges, here is a low-cost professional unit that will allow you to record video at slower speeds or copy any tape with improved picture quality. The unit also provides a distribution power amplifier for driving more than one tape machine and permits use of an r-f modulator for real-time enhancement while viewing.

Copy Guarding. Video is made up of two components: sync pulses and picture information. Sync pulses are as important as picture information because they format the picture on the screen. Television is made up of fields of pictures traced on the screen of a picture tube by an electron beam. A vertical oscillator controls the picture tracing from top to bottom of the screen. Every 1/60 second, vertical sync pulses in the video signal reset the oscillator, which starts the trace at the top of the screen again. If the vertical sync pulses were missing, the picture would appear to roll uncontrollably.

Tracing action of the beam for one field is illustrated in Fig. 1. Normal vertical sync pulses in the video signal are illustrated in Fig. 2. These pulses are stripped out of the video signal by circuitry in the VCR or TV receiver and then integrated to create a ramping voltage. When this voltage reaches a set threshold, the vertical oscillator driving the picture tube is reset, starting the beam at the upper left of the picture tube screen.

The path of the vertical sync pulses is shown in Fig. 3. Most TV receivers have the designation "vertical hold" for the threshold control, accessible as either a front- or rear-panel control. Some TV receivers and especially videocassette recorders have automatic or fixed thresholds.

When vertical sync pulses are altered, the picture will roll and, therefore, be unviewable. Most manufacturers of prerecorded video tapes, especially of motion pictures, are processing the vertical sync pulses to prevent buyers and renters from copying the tapes. The guard process, however, alters the width of the vertical sync pulses, making them narrower than normal, as shown in Fig. 2B. When integrated, these sync pulses will not produce enough voltage to reach the fixed threshold of the vertical timing circuit in VCRs, "confusing" the VCR's circuitry and preventing recording. The original tape can be viewed normally on TV receivers equipped with vertical-hold controls because vertical hold can be adjusted to compensate for the guard. A problem occurs, though, when a tape is viewed on a TV receiver that has no vertical-hold control. For these receivers, this outboard guard-defeating circuit is needed.

Picture Enhancing. The picture portion of the video signal carries the visual scenes that are actually viewed. The picture is made up of a luminance signal (the black-and-white portion) and a chrominance signal (the color portion). Picture clarity and detail or sharpness is carried by the luminance signal, while color and tone are added by the chrominance signal. As in audio, the luminance signal has a frequency range, though a much wider one. As shown in Fig. 4, the standard luminance signal's bandwidth ranges from dc to approximately 4 MHz, whereas audio ranges from dc to 20 kHz. The highest frequencies of 2 to 4 MHz correspond to the smallest details in the picture. Without these high frequencies, the picture appears fuzzy-soft and fine detail is lost.

High frequencies are lost due to the

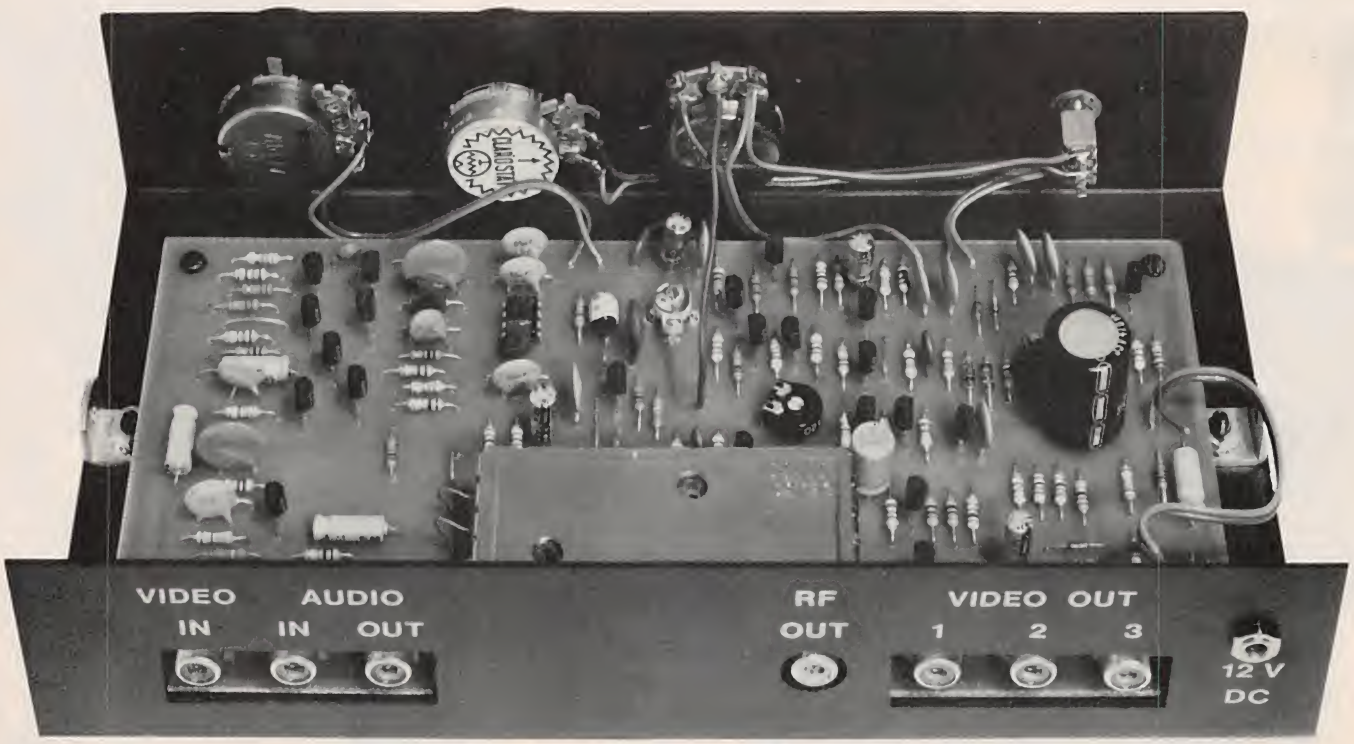


Photo shows interior construction details of the Video Enhancer.

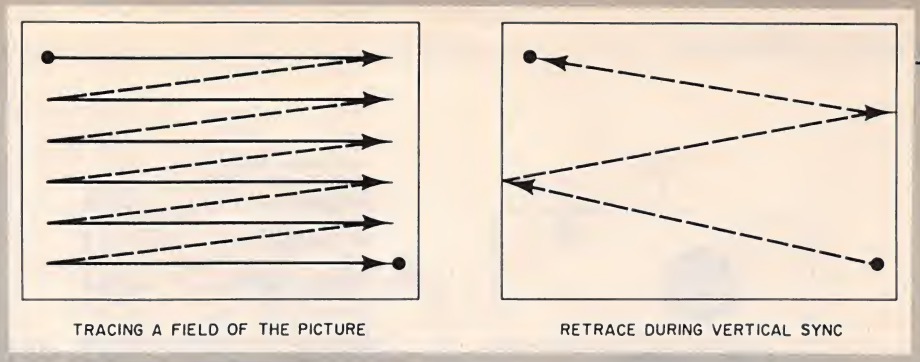


Fig. 1. Shown here is the tracing action of the electron beam on the face of the picture tube during field and retrace.

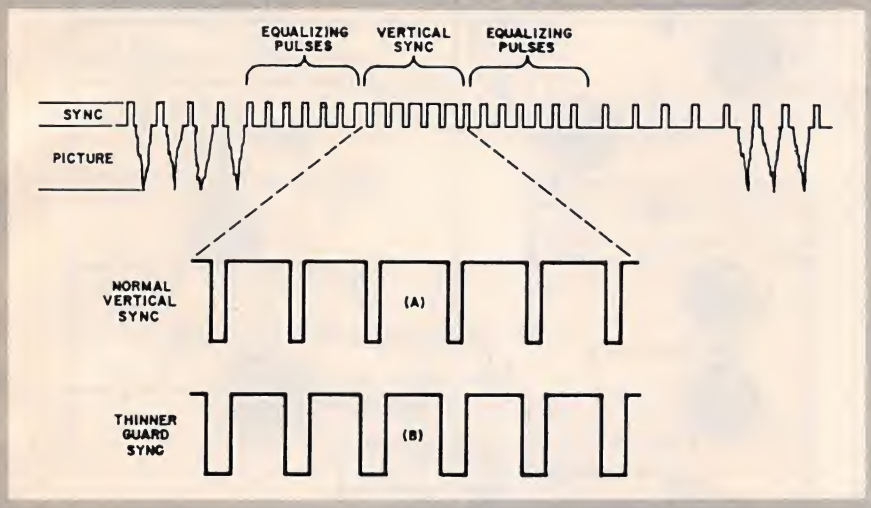


Fig. 2. Top trace shows standard sync pulses and picture signals. Contrast between normal vertical sync and thinner guard sync are illustrated in (A) and (B).

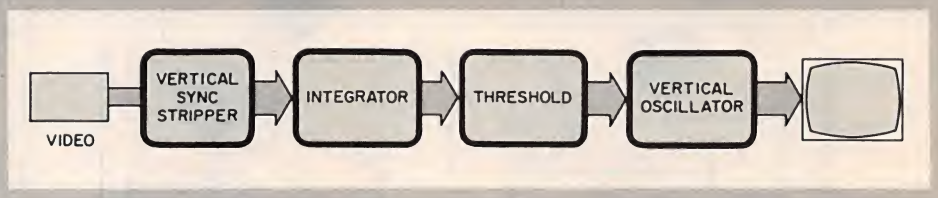


Fig. 3. Path of vertical sync pulses is illustrated in this block diagram.

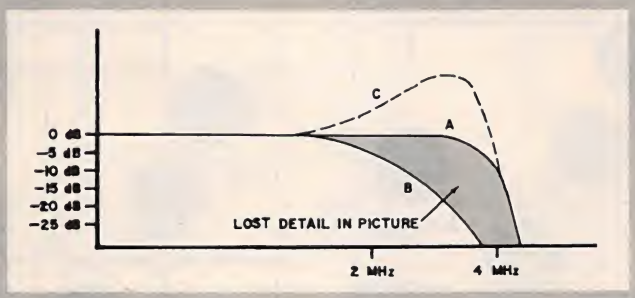
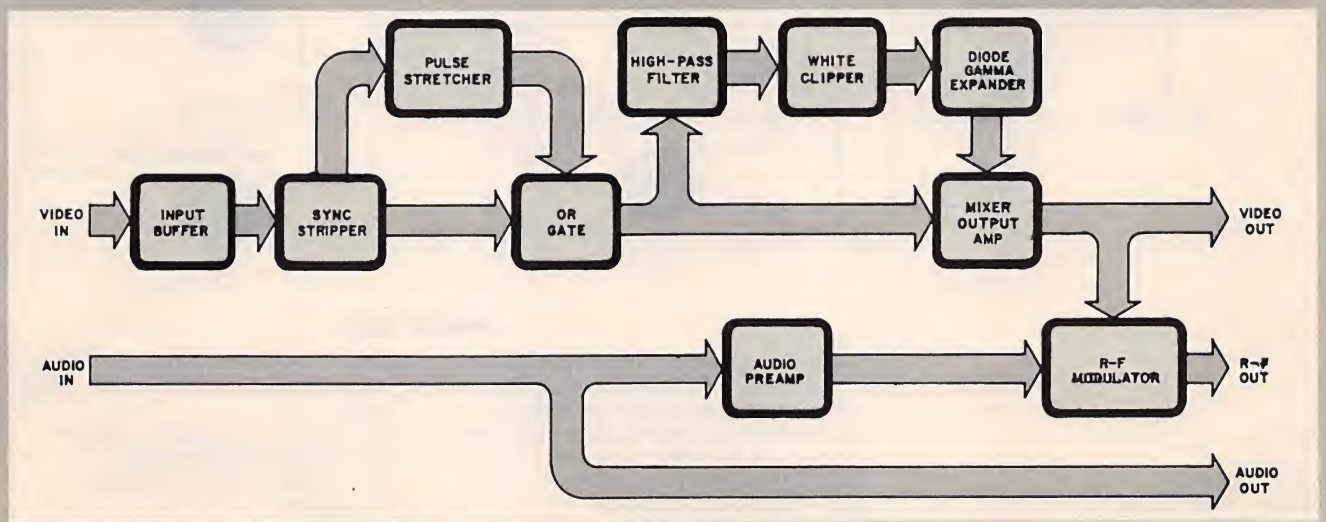


Fig. 4. Plots show (A) frequency bandwidth of standard luminance, (B) bandwidth after recording on tape, and (C) boost in frequency by enhancer.

Fig. 5. This is the block diagram of the enhancer/stabilizer project.



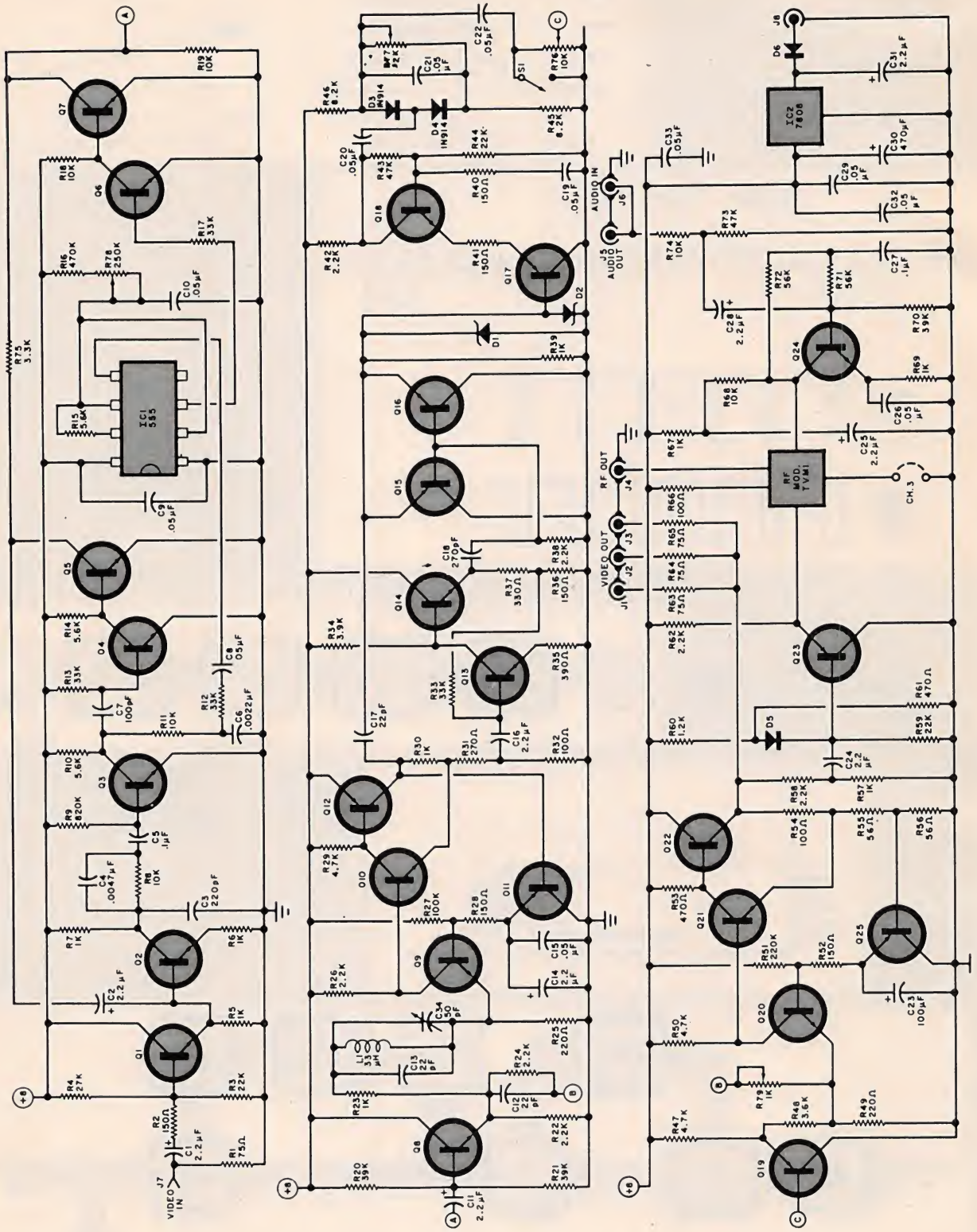


Fig. 6. Schematic diagram of Video Enhancer.

PARTS LIST

C1,C2,C11,C14,C16,C24,C25,C28,C31—2.2-µF, 50-volt electrolytic capacitor
C3—220-pF, 50-volt disc capacitor
C4—0.0047-µF, 100-volt Mylar capacitor
C5,C27—0.1-µF, disc capacitor
C6—0.0022-µF Mylar capacitor
C7—100-pF disc capacitor
C8,C9,C10,C15,C19,C20,C21,C22,C26,C29,C32,C33—0.05-µF disc capacitor
C12,C13,C17—22-pF disc capacitor
C18—270-pF disc capacitor
C23—100-µF, 10-volt electrolytic capacitor

C30—470-μF, 35-volt electrolytic capacitor
C34—5-55-pF trimmer capacitor
D1,D2—1N270 zener diode
D3,D4,D5—1N914 diode
D6—1N4001 rectifier diode
IC1—555 timer IC
IC2—7808 8-volt regulator IC
J1 thru J7—Phono jack
J8—Miniature phone jack
L1—33-uH high-Q inductor coil
Q1 thru Q10,Q13,Q14,Q16,Q18,-Q20,Q21,Q24—Sylvania ECG287 npn transistor
Q11,Q12,Q15,Q17,Q19,Q22,Q23,Q25—Sylvania ECG288 pnp transistor
All resistors 1/4 watt, 5% tolerance:
R1,R63,R64,R65—75 ohms
R2,R28,R36,R40,R41,R52—150 ohms
R3,R44,R59—22,000 ohms
R4—27,000 ohms
R5,R6,R7,R23,R30,R39,R57,R67,R69—1000 ohms
R8,R11,R18,R19,R68,R74—10,000 ohms
R9—820,000 ohms
R10,R14,R15—5600 ohms
R12,R13,R17,R33—33,000 ohms
R16—470,000 ohms
R20,R21,R70—38,000 ohms
R22,R24,R26,R38,R42,R58,R62—2200 ohms
R25,R49—220 ohms
R27—100,000 ohms
R29—4700 ohms
R31—270 ohms
R32,R54,R66—100 ohms
R34—3900 ohms
R35—390 ohms
R37—330 ohms
R43,R73—47,000 ohms
R45,R46—8200 ohms
R47,R50—4700 ohms
R48—3600 ohms
R51—220,000 ohms
R53,R61—470 ohms
R55,R56—56 ohms
R60—1200 ohms
R71,R72—56,000 ohms
R75—3300 ohms
The following are linear-taper potentiometers:
R76—10,000 ohms
R77—2000 ohms
R78—250,000 ohms
R79—1000-ohm trimmer potentiometer
S1—Spdt switch
TVM1—TV r-f modulator and antenna switch (Radio Shack kit Cat. No. 277-122)
Misc.—117-volt ac to 12-volt dc, 300 mA power adaptor; printed-circuit board; control knobs; line cord; aluminum or steel cabinet; machine hardware; hook-up wire; solder; etc.

Note: The following are available from Video Control, 3314 H Street, Vancouver, WA 98663 (tel. 1-206-693-3834): Complete kit containing pc board, power adapter, case, and all parts but excluding r-f modulator/antenna switch for $110; etched and drilled pc board for $15; power adapter for $10. Please add $3.50 for postage and handling.

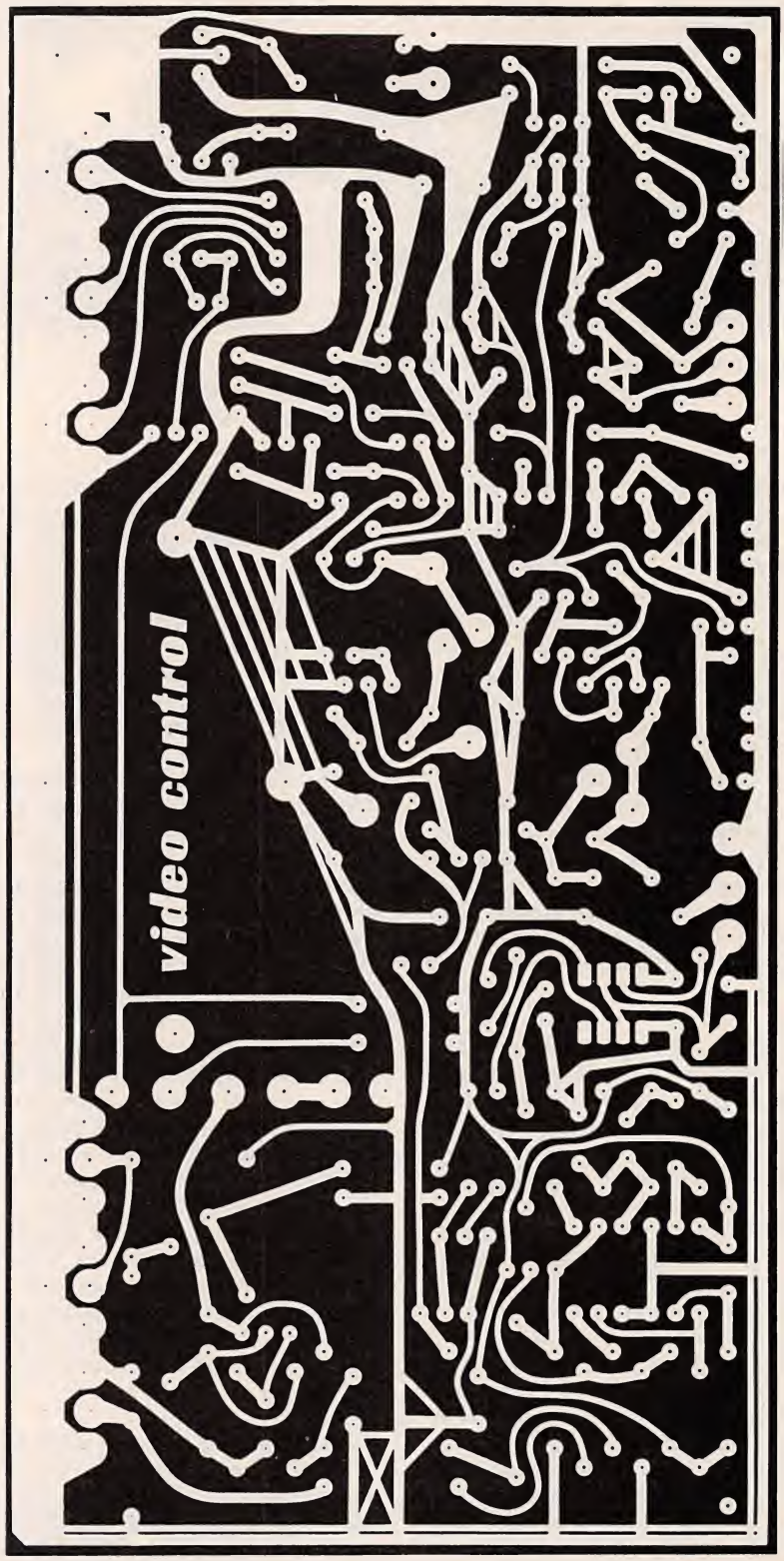


Fig. 7A. Actual-size etching and drilling guide for enhancer project.

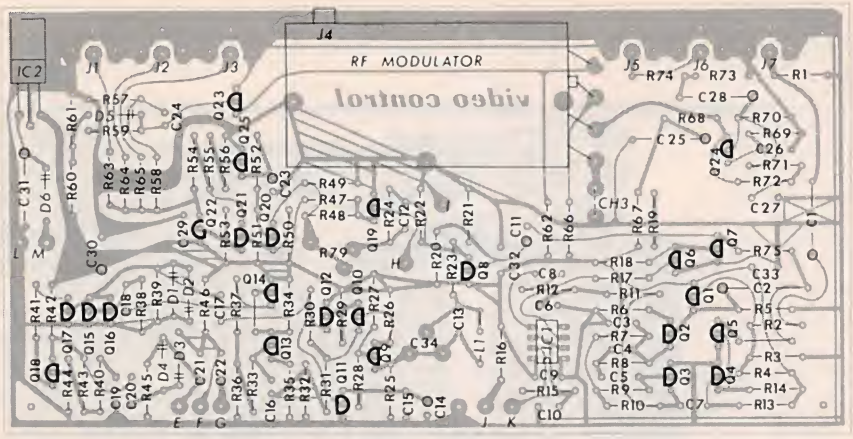


Fig. 7B. Components-placement guide for enhancer project.

Notes: R77 CONNECTS BETWEEN HOLES *E* AND *F*
R76 CONNECTS BETWEEN HOLES *G* AND *I*, WIPER TO HOLE *H*
S1 CONNECTS ACROSS R76 (HOLE *G* TO HOLE *I*)

recording process and limitations of the recording tape (Fig. 4). Every recording (generation) from the original causes more loss in detail. The picture-enhancing portion of this project re-equalizes the luminance bandwidth by boosting the high frequencies. When this is done prior to recording, the loss caused by the tape and machine can be canceled out, giving a copy that has as much detail as the original.

Enhancing high-frequency components of the video signal may increase noise, appearing as snow in the picture. This noise is reduced by a logarithmic gamma circuit that acts like an amplitude expander. When properly adjusted, low-level noise is eliminated by the logarithmic gamma circuit.

About The Circuit. This project has three controls. Adjustment of the ENHANCE control increases detail and edge sharpness. Proper adjustment of the GAMMA control complements the enhance adjustment by reducing snow and other low-level luminance noise. The STABILIZE control locks in the picture and cancels the copy-guard signal. (A block diagram of the enhancer stabilizer circuit is shown in Fig. 5.)

As shown in Fig. 6, *Q1* acts as a buffer for video inputs. Transistors *Q2* and *Q3*, capacitors *C3*, *C4*, and *C5*, and resistor *R8* separate sync pulses from the video. Sensing of vertical sync and triggering of *IC1* is accomplished with *C6* and *R11*, while *Q4* and *Q5* clamp the video to ground. The width of the sync pulse is set by *C10*, *R16* and *R78*.

The output of *IC1* drives *Q6* and *Q7*, which mix the new vertical sync pulses in with the video. At this point, any guard signal is eliminated. Buffer *Q8* drives a chroma filter madeves up of *R23*, *C13*, *C34*, and *L1*, which reduces any color shift that may occur as a result of over-enhancing. High-pass filter *C17/R39* is driven by *Q9*, *Q10*, *Q11*, and *Q12*. Clamping transistors *Q15* and *Q16* are driven by inverter *Q13/Q14*. Diodes *D1* and *D2* clamp any signal overshoot, while transistors *Q17* and *Q18* make up a cascode amplifier that drives gamma circuit *D3/D4*. The diodes operate as a nonlinear signal expander whose threshold is controlled by the setting of *R77*.

The gamma circuit reduces any noise introduced by enhancing action, by an amount set by *R76*. Switch *S1* inserts and defeats enhancement. Buffer *Q19* delivers the signal to the output mixer, while *R79* mixes in the original video. The output mixer amplifier is made up of *Q20*, *Q21*, *Q22*, and *Q25*. The video is prepared for r-f modulator *TVM1* by *R60*, *R61*, *D5*, and *Q23*. A modulator designed for reception on a standard TV receiver on Channel 2 or 3 must be used. A typical example of such a modulator is Radio Shack's Catalog No. 277-122, which includes an antenna isolation switch for attachment at the TV receiver's antenna terminals.

Audio preamplifier *Q24* preemphasizes high frequencies for the r-f modulator. System power is regulated at 8 volts by *IC2*, while input power requirements are 12 volts dc at 300 mA, obtained from a standard battery eliminator/charger.

Construction. A printed circuit board is imperative for this project, due to the high-frequency requirements of low stray capacitance. An actual-size etching and drilling guide and a components-placement diagram are shown in Fig. 7.

Proper orientation of parts during assembly is very important. So, take careful note of the directions of transistors, diodes, and electrolytic capacitors. The plus (+) lead holes for the electrolytic capacitors are identified by circles on the board. Since high frequencies are involved, it is a good idea to keep all component leads as short as possible. And, when soldering in the r-f modulator, make certain that the ground pins are fully coated with solder and firmly attached to the copper traces.

Once the project is assembled, install jumper *CH3* if you plan to use the device on TV Channel 3; otherwise, the modulator will transmit on Channel 4. Also, after soldering components to the board traces, clean away the flux residue with alcohol and follow up with a careful inspection to make sure that there are no solder bridges between closely spaced traces.

The project is designed to fit into a custom aluminum case to insure low r-f radiation. Before placing the top on the case, however, connect the project to the VIDEO OUT jack of a VCR and the device's r-f modulator output to a TV receiver's antenna isolation switch. With the enhancer defeated, play a tape and adjust *R79* so that the picture on the screen is as bright as a regular TV program's. Engage the enhancer at full enhancement and adjust *C34* so that the picture is enhanced without altering the color. This done, assemble the case.

Summing Up. The enhancer/stabilizer is an excellent tool for making copies as good as the original and for viewing older video tapes. Furthermore, it will save money spent on tapes by giving comparable viewing quality of the 2-hour mode when recording in the 6-hour mode.

This project is not intended to be used for illegal copying, of course. It is intended solely to correct problems arising when a copy-guarded tape is played on a TV receiver that has a limited-range vertical-hold control. ◇