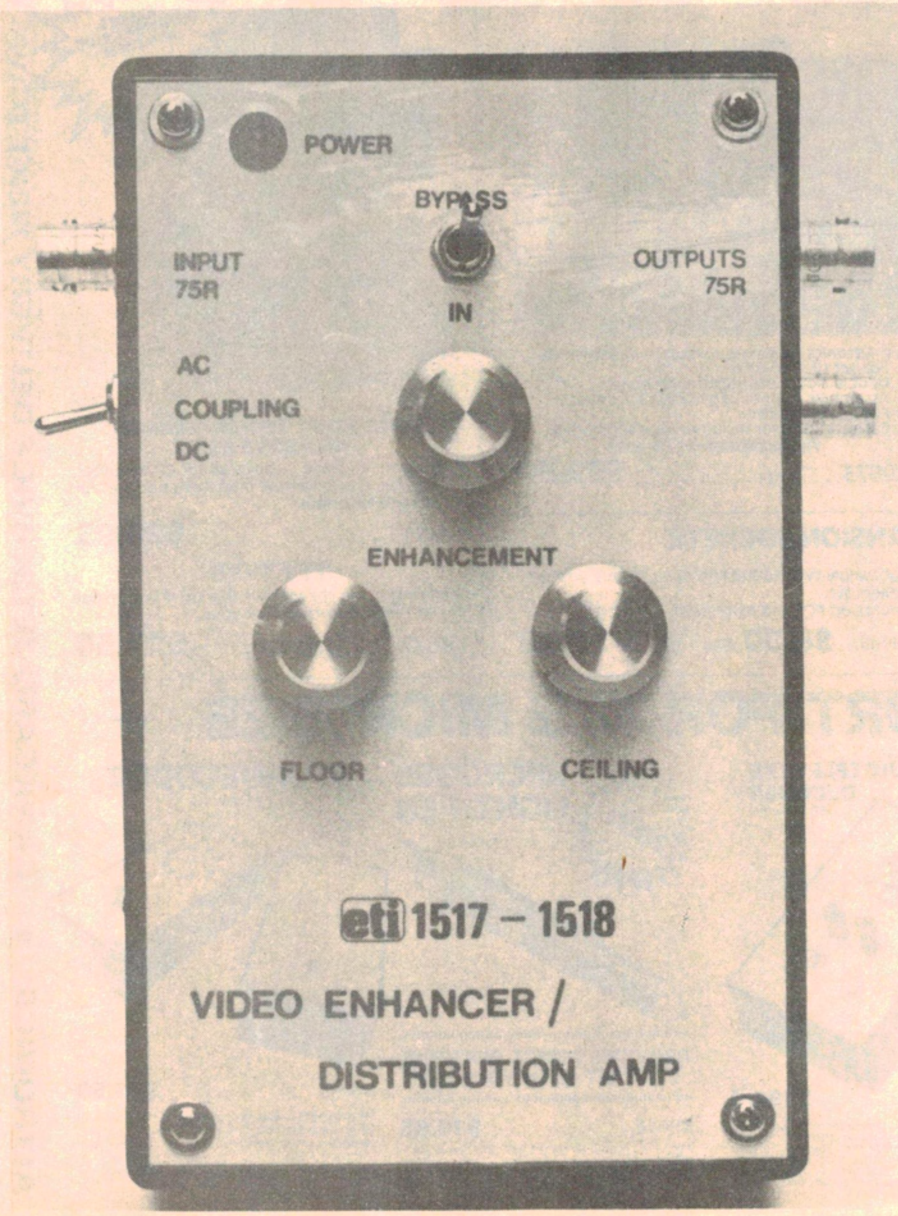
'Deluxe' video enhancer features three controls

This simple to build project features three controls for curing video 'image ills' — *floor* which cuts off the low-level noise that causes snow; *ceiling* — which ensures that high-level signals are not enhanced, causing ringing; and *enhancement*, which really 'crisps up' those soggy signals, providing up to 8 dB of boost.

John Power



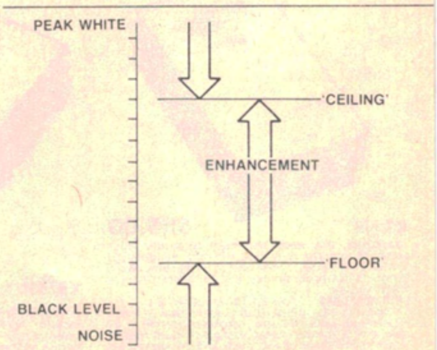
THIS PROJECT has been designed to team with the ETI-1517 Video Distribution Amplifier (September issue), but can be used 'stand alone' if you wish. It's easy to build, low in cost and effective in use.

The problems one meets with video signals, particularly when recording and replaying, have been explained by Jonathan Scott in '*The ins and outs of video enhancers*', in the October issue. This project has been designed to avoid the problems that can arise in trying to compensate for video bandwidth degradation. I have included a 'notch' at the 4.43 MHz colour subcarrier so that it will not be 'enhanced' — to the detriment of the picture! — and have provided controls that set the limits of enhancement so that noise at one extreme, and high-level signals at the other, are not boosted, which can also further degrade a picture.

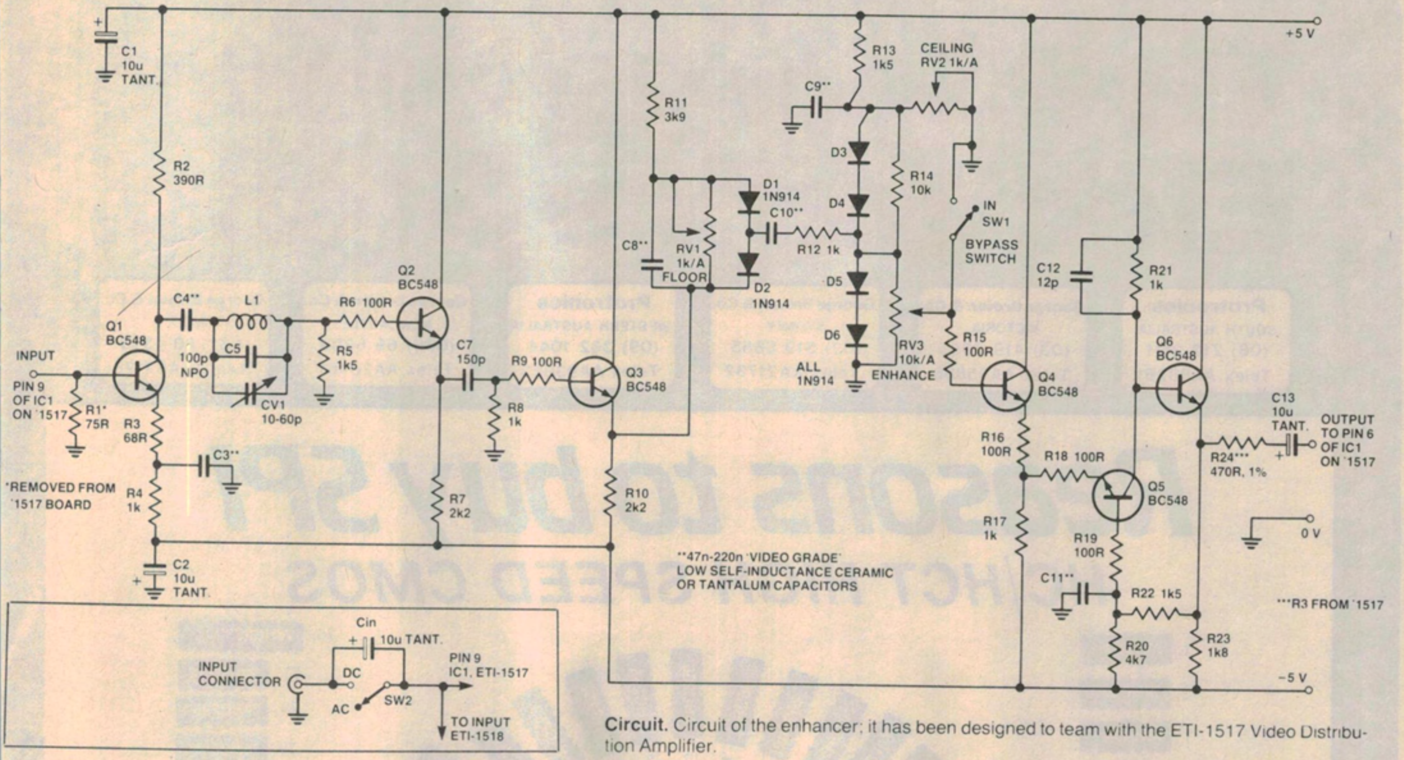
Many 'economy' video enhancers I've seen simply provide a single control, which sets the level of boost in the 2-5 MHz region. From experience, this is only effective on certain signals which have not suffered much degradation at all. Too many cases occur where you need to have some control of the signal level range over which the boost is applied. Thus, you see some commercial enhancers with a 'gamma' or 'core' control, which is there for just this purpose.

After some experimentation, I hit on a scheme that provided controls to adjust separately the minimum level from which boost is applied and the maximum level beyond which enhancement ceases. The minimum level I have dubbed *floor* and the maximum level control I have dubbed *ceiling*. Their function is obvious from the names. I prefer to work on the KISS theory ('Keep It Simple, Sam') and avoid jargon. Between the floor and ceiling, the amount of boost or enhancement can be varied from none to maximum with a control simply labelled *enhancement*. See? Simple, but 'deluxe'.

I notice that some VCRs have a direct-coupled output which sits at a mean dc level



Controls. The enhancement control works between the limits set by the floor and ceiling controls.



Circuit. Circuit of the enhancer; it has been designed to team with the ETI-1517 Video Distribution Amplifier.

HOW IT WORKS — ETI-1518

I will assume you are familiar with the operation of the ETI-1517 Video Distribution Amplifier. You will recall that it consisted of a differential amplifier with the signal applied to the non-inverting input and equal value resistors placed from output to inverting input and inverting input to ground, giving a gain of exactly two from input to output before termination loss, and a gain of exactly one after.

The enhancer section of this project takes the input signal, removes the low frequency part of it, inverts it, processes it according to the control settings, then adds it (out of phase) to the original signal by applying it to the inverting input of the differential pair in the '1517. By maintaining the output impedance of the final processing stage at the value of the lower leg of the feedback divider in the '1517 (470R) the original signal path gain remains unchanged.

The effective addition of the processed high frequency content of the signal to the unaltered original is equivalent to boosting that high frequency information, which is enhancing.

Referring now to the circuit of the enhancer section, Q1 is a buffer stage with a gain of −4 approximately. Here the inversion necessary to reverse the eventual inversion of the differential pair is introduced. Q1 is biased in such a manner as to clip off sync pulse tops without saturating. This prevents them being fully enhanced, which is desirable.

It may be necessary to remove dc from the incoming signal to ensure that no video is clipped as well. For this reason, provision to ac couple the whole system is included. Most VCR inputs are expecting only ac coupling, and most outputs are not dc offset, so maintenance of dc levels is not as crucial as it sometimes is in circuits not equipped to 'dc restore' off the sync waveform.

Coil L1 and surrounding components form a 'trap' which excludes from the circuit the colour subcarrier. This should not be enhanced, so a notch is introduced at 4.43 MHz. The subcarrier thus passes only through the distribution amp and remains unaltered.

Transistor Q2 is a common collector buffer stage, giving a low output impedance for C7/R8, which form a low cut filter which is 3 dB down at 1 MHz. This selects only the high frequencies for further processing. Q3 is another buffer stage to prevent different processing steps interacting. The base decoupling resistors prevent possible buffer instabilites in the face of reactive loading.

Potentiometer RV1 and surrounding components form the floor or gamma processing stage. The aim of this stage is to make it possible to selectively pass higher amplitude signals. The motivation for this is that noise, particularly 'snowy' effects, is predominantly present in the high frequency part of the signal, but needs to be minimally enhanced. The noise is also predominantly lower in amplitude than brightness transitions in the video signal, which it is desirable to enhance. Hence it is possible to apply more enhancement to higher-amplitude components without enhancing noise. This function is sometimes referred to as 'core'. However, I think the label 'floor', for its obvious connection, or 'gamma' (less obvious) are more descriptive of its function.

Potentiometer RV2, plus D3-6 and associated components, provide the reverse function, which I labelled 'ceiling'. This section basically permits the setting of a level above which enhancement is reduced, by smoothly limiting the signal. I am not entirely convinced of the utility of the function, but include it for purists on the theory that winding the control clockwise removes it anyway. The idea behind this process is that the problem when enhancing certain signals is that ringing on full amplitude transitions induces nasty shadow lines; thus there is something to be gained by limiting enhancements of the high end of the amplitude range.

Both floor and ceiling circuits work in a similar way. Diodes, two in the former case and two pairs in the latter, are subjected to varying forward dc bias conditions.

To proceed further down the signal path (to the right on the circuit diagram), the video signal must get through the diodes in the floor case, and not get shorted out through the diodes in the ceiling case. If the difference between the dc bias present on the diodes and that necessary to make them conduct is larger than the instantaneous signal amplitude, the signal will not pass without attenuation. Of course, the effect is not that sharp, as the levels are chosen to make use of the diodes' turn-on characteristics to produce no gross discontinuities in the waveform.

In the floor circuit, RV1 sets the bias on D1 and D2. Adjusted for maximum resistance, RV1 permits current to flow in the diodes turning them) on sufficiently to pass all the signal. At zero resistance only signals exceeding about half a volt pass, and then only their high-amplitude parts. These two extremes bound the useful region where mild selectivity of response is applied.

Signals not limited by the ceiling circuit are passed to RV3, which acts as a level control, setting the amount of signal passed back to the differential amplifier and hence the degree of enhancement. Transistors Q4-6 form a dc-coupled amplifier (in the form of a long-tailed pair and an emitter follower) which provides a gain of eight and a low output impedance. C13 and R24 pass the signal out and provide a precise 470 ohm impedance to ground for the feedback signal from distribution amplifiers.

The video amplifier output stage in the '1517 was designed to limit negative-going signals to an amplitude of about a volt. Thus, any gross overshoot on the partially limited sync pulses will be limited at that point. This occurs because the voltage gain is entirely vested in the differential pair, further stages providing only current gain. Q3 in the '1517's differential pair will saturate at a voltage corresponding to an output voltage of −2 V before matching loss.

of one to two volts or so. In a direct-coupled enhancer/distribution amp, this dc level can wreak havoc, clipping the video signal. Hence, I have provided the option of switching between ac and dc coupling. With ac coupling, some low frequency roll-off can be expected, but it's only slight.

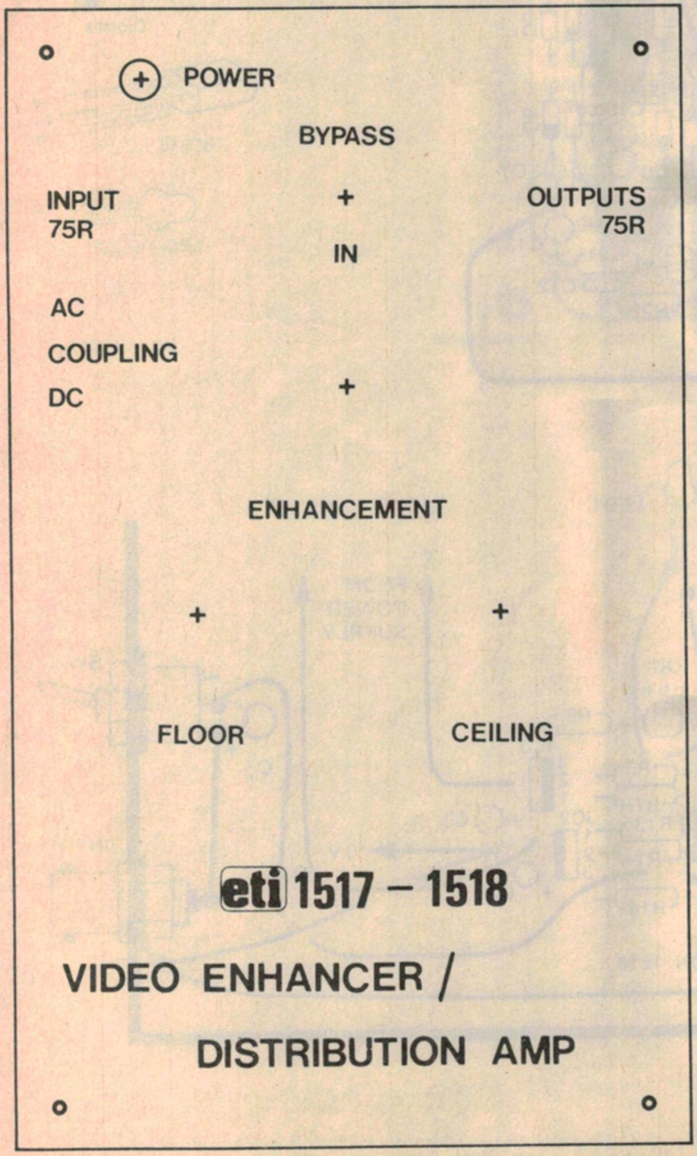
Construction

For the purposes of this discussion, I assume you have already built, or at least are prepared to build, the ETI-1517 Video Distribution Amplifier. The circuit presented here is designed to be used in conjunction with the previous circuit, as indicated in the article which accompanied that project.

The first thing to do is locate a suitable position within the box for the new pc board and the new switches and potentiometers. There are three pots and one switch directly related to the enhancing section, and one additional switch to be added to permit ac coupling of the incoming signal.

The dc/ac coupling selection switch is ideally located near the input connector. The other controls may be laid out as you see fit or according to the front panel design reproduced here. If you're using a different layout, the controls should be as close as practical to each other and the location of the Video Enhancer board. The new enhancer is best located adjacent to the distribution amp board, but a few centimetres of spacing can be tolerated if required.

Once the layout is decided and the appropriate holes drilled in the case and panel, the board may be assembled according to the overlay diagram. As I anticipate that a number of our constructors will be basically video enthusiasts, not electronics enthusiasts, I will take the liberty of stressing how vital it is not only that each component be inserted the correct way around, but that each solder connection be clean and neat. Only the resistors and ceramic capacitors may be put in either way around without impairing the operation of the circuit. It is best to put in only half a dozen items at a time, starting with the resistors and capacitors, and then solder these into place, cutting the component leads after soldering. Resistors R2 and R24 should be left out for now.



Front panel. Full-size reproduction of the front panel artwork.

Next, two modifications need to be made to the ETI-1517 board, or the whole must be constructed with these two variations taken into account. The first consists of removing the termination resistor from the input side of the ETI-1517 circuit. A termination resistor, nominally of 75 ohms and preferably a 2% type, is provided in the enhancer (R2), and hence the one in the distribution amp is unnecessary. It may be used as R2 in the enhancer circuit if you wish. A wire may then conveniently convey the input signal from the ETI-1517 to the ETI-1518, using the hole vacated by the resistor you have just removed or transferred.

The second modification also consists of transferring a resistor. This time it is R24 in the enhancer circuit. Resistor R3 in the ETI-1517 (nominally 470R), running to ground from pin 6 of IC1, should be moved to R24 on the enhancer board. Recall that this resistor was a 1% or 2% type, or at least a selected value resistor. This is why it is transferred; the precise gain of the distribution amp is not disturbed. A wire is again run, using a vacated hole, this time from pin 6 of IC1 on the ETI-1517 to the output of the ETI-1518 enhancer board.

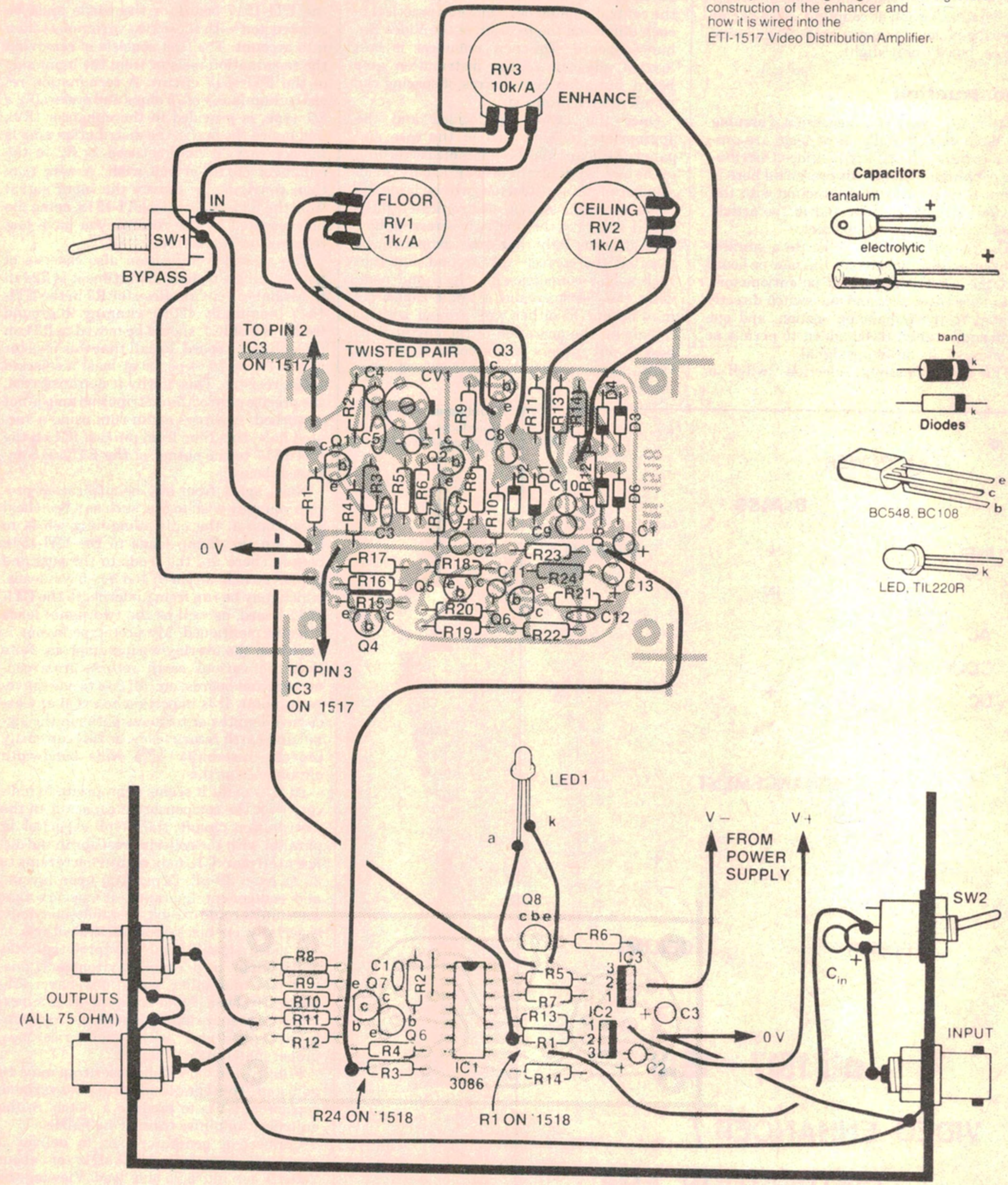
Now, apart from any beautification process you may wish to use, such as a Scotchcal panel fascia, the only remaining job is to hook up the flying leads to the ETI-1518 board. There are the leads to the pots and bypass switch, an earth and +/−5 volt leads, which may be run from underneath the ETI-1517 board, as well as the two signal leads already mentioned. My prototype layout is shown in the overlay/wiring diagram. Note that the various earth returns from connectors and boards, etc, all run to *one* convenient point. It is important to avoid any excessive lengths or tortuous paths in the signal and earth return leads, as this can easily provoke instability in a wide bandwidth circuit such as this.

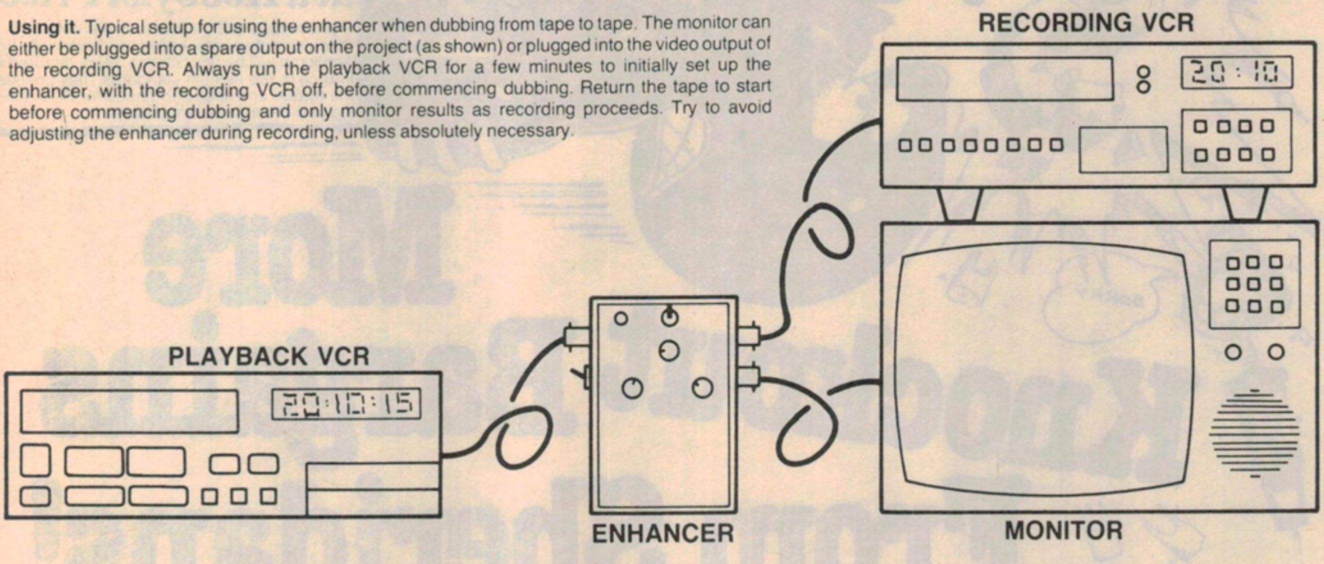
At this point it seems appropriate to indicate that the compensation capacitor in the distribution circuit, the 27 pF capacitor in parallel with the collector resistor in the differential pair (C1), may require increasing to 33 or even 39 pF. Depending upon layouts and component tolerance, it appears that some units could exhibit unstable behaviour, especially on black-to-white transitions in the video signal. While my prototype was quite happy in a 'clean' environment, mismatches and other variations have subsequently been found to upset it. If super-video frequency ringing is evident on squarewave transitions with short risetimes, proper matching will cure it.

Finally, the video subcarrier trap must be adjusted. This entails adjusting the variable capacitor (CV1) to produce a 'notch' in the enhancer amplifier train at 4.43 MHz.

Connect a generator, set to deliver a sinewave signal at 4.43 MHz of about 200 mV p-p into a 75 ohm load. Viewing the output with the bypass switch closed so as to pass unenhanced signal, verify that the output is the same as the input when terminated correctly. Switch in the enhancer part of the ▶

Overlay and wiring diagram. Showing overall construction of the enhancer and how it is wired into the ETI-1517 Video Distribution Amplifier.





Using it. Typical setup for using the enhancer when dubbing from tape to tape. The monitor can either be plugged into a spare output on the project (as shown) or plugged into the video output of the recording VCR. Always run the playback VCR for a few minutes to initially set up the enhancer, with the recording VCR off, before commencing dubbing. Return the tape to start before commencing dubbing and only monitor results as recording proceeds. Try to avoid adjusting the enhancer during recording, unless absolutely necessary.

PARTS LIST — ETI-1518

Resistors	all ¼ W,5% unless noted
R1	75R, 1%*
R2	390R
R3	68R
R4,8,12,17,21	1k
R5,13,22	1k5
R6,9,15,16,18,19	100R
R7,10	2k2
R11	3k9
R14	10k
R20	4k7
R23	1k8
R24	470R,1%*
RV1,RV2	1k/A pots.
RV3	10k/A pot.

*may be taken from ETI-1517 board

Capacitors	
C1,2,13	10u/35 V tant.
C3,4,8,9,10,11	47n-220n ceramic (low inductance)
C5	100p ceramic NPO
C7	150p ceramic
C12	12p ceramic
CV1 (C6)	10-60p trimmer
Cin	10u/35 V tant.
Semiconductors	
D1-D6	1N914
Q1-Q6	BC548,BC549 etc.
Miscellaneous	
L1	10 uH RF choke (Q of at least 50)
SW1,SW2	SPST or SPDT min. toggle switches

ETI-1518 pc board; power supply +/−5 V (can come from ETI-1517); ETI-1517 (if you wish); Scotchcal front panel.

Price estimate
$18-$24 (alone)
$45-$50 (with ETI-1517)

circuit, setting the floor low and the ceiling high (RV1 to maximum and RV2 to minimum resistance). Adjust RV3 to mid-position. Now adjust C6 for a minimum of output signal. This will be near, though not necessarily exactly at, the original output level before enhancement.

If you do not have access to the equipment needed to do this adjustment, you will not be able to set the enhancer trap correctly, but a setting satisfactory to your recorder should be obtainable simply by selecting that setting of CV1 which leaves the *colour* of the picture minimally disturbed throughout the travel of the enhancement control. If a range of settings fits this bill, leave the trimmer at the centre of the range.

Operation

Operation of the enhancer is quite straightforward, though some experience is necessary in optimising the control settings. The effects are subtle, but worthwhile if you do a lot of viewing and recording of video material.

Connect the enhancer between the video source you wish to enhance and the monitor or receiving VCR. If possible, choose some material with plenty of contrast and colour — commercials are good for this, if little else.

Initially, adjust the floor *down* and the ceiling *up*. Wind up the enhance knob. You will observe that the image first gets 'crisper', with fine print and signs, labels etc becoming more easily read. Eventually the snow and general noise gets significant, or perhaps the bright/dark transitions get shadowy, indicating too much boosting.

The noise problem can often be improved with judicious fiddling with the floor level. You will find that the floor and enhance functions are interactive to some extent. This is really a very fine point, because the amount of extra boost you can squeeze in with the use of the floor level control is usually minimal, but it is there.

Likewise, the transition overshoot problem, manifesting itself as rippled edges, can be improved with the ceiling function. This function may be rarely useful, but seeing the logic behind it, I included it for you to try out.

This control is also interactive, so the adjustment of all may be finnicky. I had better results by adjusting the enhance and floor controls until just too much enhancement was evident, then 'backing off' ceiling to just correct it.

A further check can be made by immediately playing back the copy. It is possible that over-enhancement to the immediate viewer can be just right when the signal has gone through another record-replay stage; sort of pre-enhancement.

About here is where the written advice is superseded by on-the-job fiddling with the knobs. I wish you all the best with your new project. ●

Board. Full-size pc board artwork.