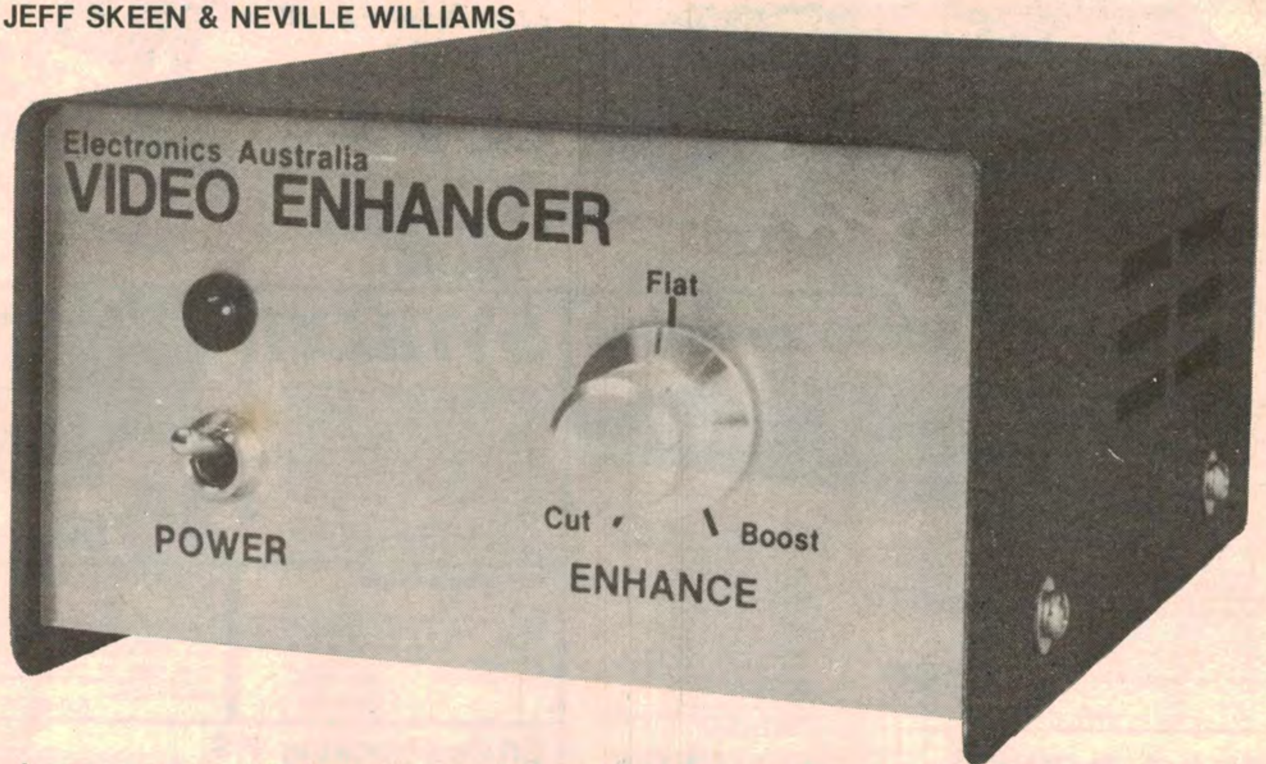
Video Enhancer

by JEFF SKEEN & NEVILLE WILLIAMS



Here's an opportunity for video enthusiasts to acquire a simple but effective build-it-yourself video enhancer for a fraction of what a commercial model might cost. But first: what are enhancers supposed to do and how do they work? Well, read on:

At the outset, we should put to rest the fiction that video enhancers are some kind of magic cure-all for a whole range of picture problems. They aren't! Like the tone controls in a hifi amplifier, they are meant simply to "touch up" the signal after things elsewhere in the system have been put right.

If the off-air pictures on your TV screen are consistently "noisy" or "grainy", or spoiled by "ghosting", you either live in a very poor area for TV reception, or you need a better antenna system. To install an enhancer, while ignoring the antenna, is very definitely putting the cart before the horse!

Again, if the pictures from your VCR frequently roll, or bend, or wobble, the chances are that your receiver needs to be modified internally to allow it to lock more effectively to the synchronising signals from a VCR. Either that, or the VCR may need attention for dirty or worn heads. Get those matters checked first.

The basic role of an enhancer is — where possible — to effect a further (and usually modest) improvement in the visual appeal of the on-screen picture. Most commonly, this means making the image more "crisp" by sharpening the outlines and, perhaps, slightly increasing contrast and colour content. Occasionally, it may mean "softening" the picture with the idea of reducing the "grain" or "noise".

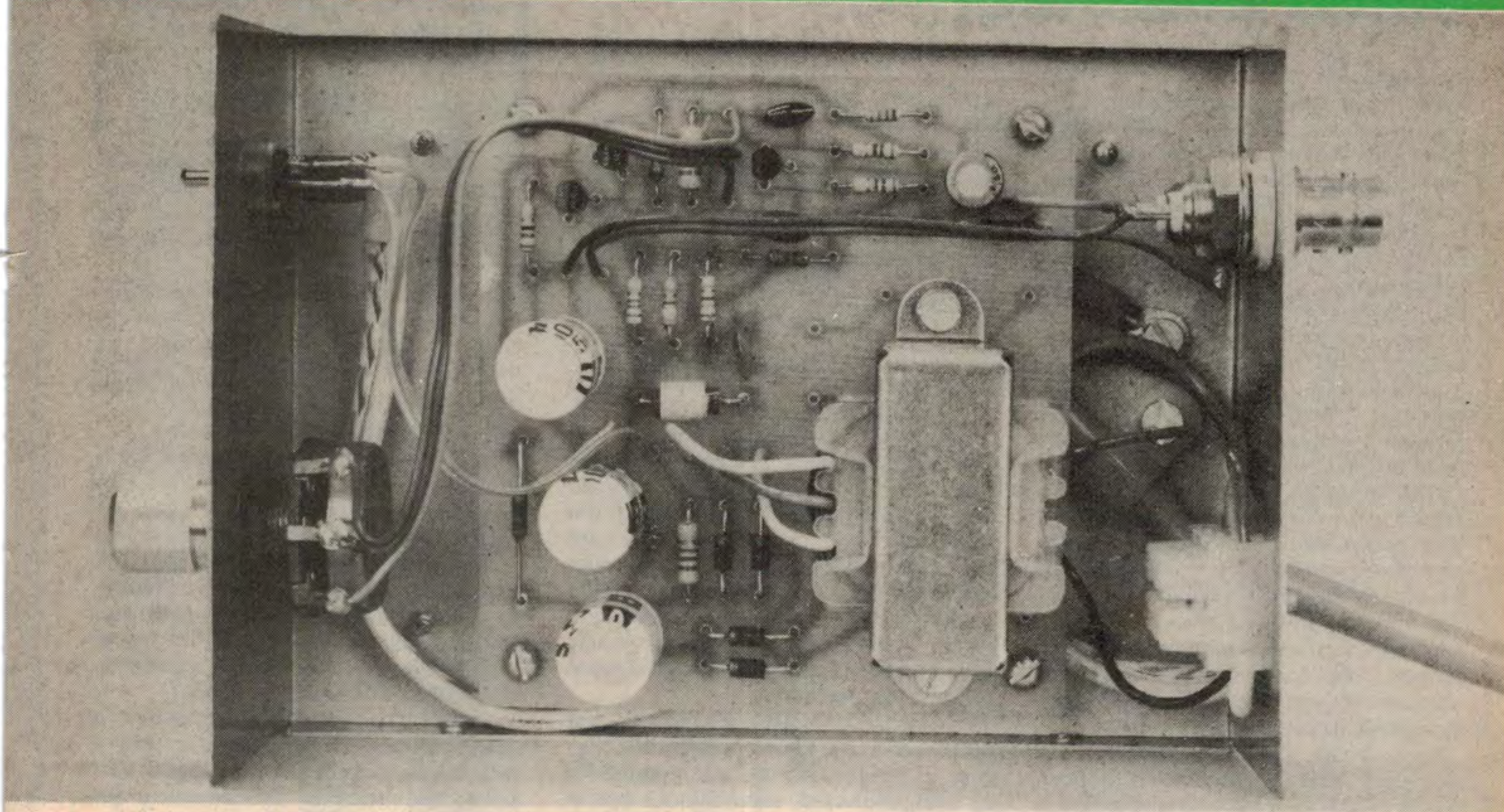
In principle, enhancers achieve the foregoing effects by modifying the frequency content of the video signals passing through them.

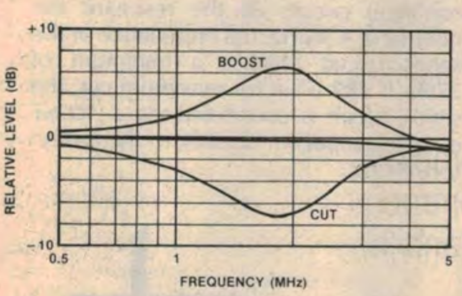
Selectively boosting frequencies within the range from about 1 to 4MHz tends to emphasise picture contrast and outline, usually with an attendant increase in noise content. Attenuating the same range of frequencies has the reverse effect. In between, it is usual to provide for a flat-response, unity-gain condition, where the enhancer is virtually passive, and where the picture can be seen "au naturel" for the sake of comparison.

In practice, the amount of high frequency boost which can be applied to a video signal is usually quite limited, especially where the signal has already been "peaked up" before transmission or

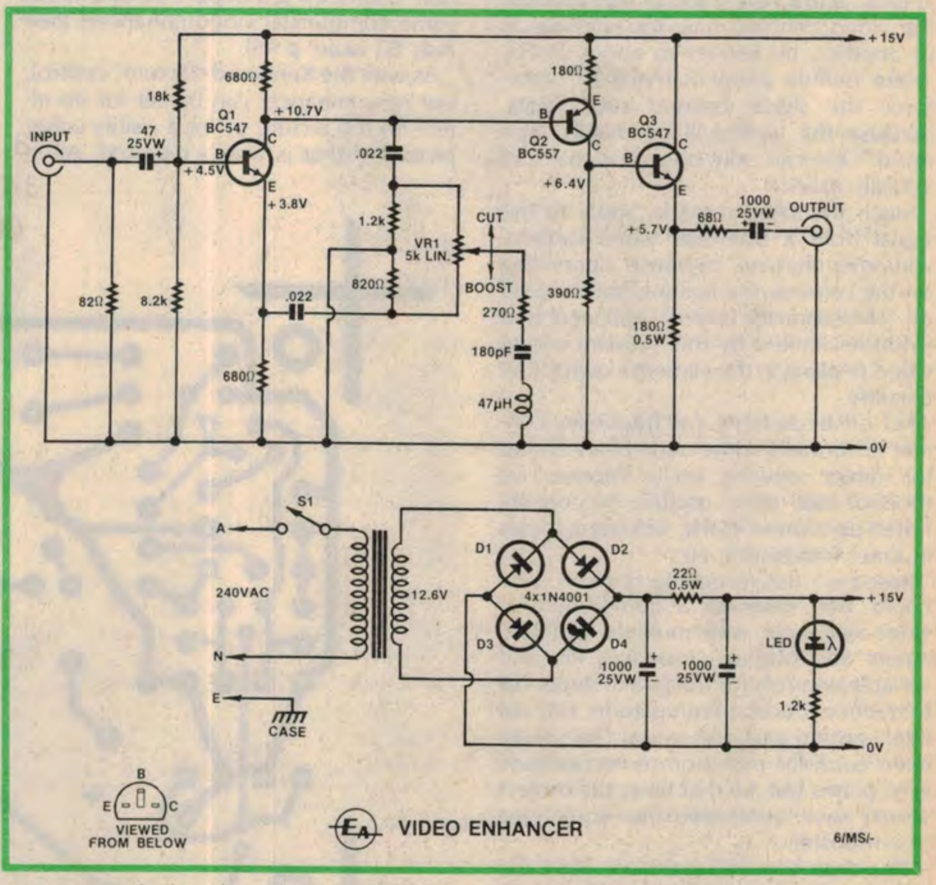
SPECIFICATIONS

Signal to noise ratio	−50dB ref 1Vp-p
Frequency response (flat setting)	1Hz to 6.5MHz −3dB
Boost and cut range	see graph
Gain	0dB
Input impedance	82Ω
Output impedance	68Ω





This graph shows the amount of boost and cut available with the enhancer.



before recording on tape. More than about 4 to 5dB of boost is likely to produce an unacceptable increase in noise, or to produce halo effects, with white edges around dark objects, and vice versa. In more technical terms, this would be described as video "overshoot" or "ringing".

Amongst video enthusiasts, enhancers are most commonly used in the following situations:

- Between a home video camera and a VCR. For this purpose, an enhancer needs to be easy to use, as light and compact as possible, and fitted with a socket and plug which allows it to be inserted straight into the camera cable link. Physically and electrically, this is a special case.
- In the video link between two domestic VCRs for purposes of editing or copying from an existing video cassette – legally or otherwise!
- Between a VCR and a TV receiver or monitor, with the idea of obtaining the sharpest looking pictures from video cassettes.
- Between a TV tuner, or a VCR used as a tuner, and a jumbo screen receiver or monitor, to sharpen all images, whether from cassette or off-air.

If domestic TV receivers had all been

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provided with sockets for direct video signal input, the design of enhancers would have been considerably simplified. They could simply have been provided with video input and output sockets (BNC or RCA) and coupled directly into any of the above situations, without further ado.

In fact, most TV receivers to date have had provision only for "RF" input via the antenna terminal. They therefore cannot be fed directly from an enhancer unless it incorporates – or is used in conjunction with – an RF modulator which will provide a composite video/audio signal in an unused TV channel.

Without such a modulator, a video enhancer can be used only between a VCR and monitor, between two VCRs, or between a camera and VCR (if it can be accommodated conveniently).

A further consideration is that video response of an enhancer needs to be optimised, not just in relation to the amount of boost or cut, but the frequency around which it is concentrated.

For example, the video signal from a domestic VCR is unlikely to contain much information beyond about 3MHz at best; with a visibly soft or fuzzy image, the video content may, for one reason or another, be limited to about 2MHz. There is little point in trying to brute-force the signal beyond such limits, because the yield will be mainly tape noise. One can only boost a signal that actually exists!

Much the same remarks apply to the signal from a domestic video camera, with the ultimate response depending on the camera, the lighting, the subject, etc. The scope for external enhancement is further limited by the frequent use of video peaking in the camera's own video circuitry.

For off-air pictures, the frequency content is normally wider and enhancement for direct viewing on a receiver or monitor may more usefully be concentrated up around 4MHz, offsetting losses in tuner bandwidth, etc.

Based on the foregoing remarks, one could well envisage a comprehensive video enhancer with multiple switched inputs and outputs, including RF, and variable controls for things like boost/cut frequency, boost/cut amplitude, top cut filter, system gain and so on. One might even consider provision to reconstitute sync pulses but, by that time, the project would have developed into something of a monster.

This time around, we have kept the design right down to basics, with no RF modulator and a single video and output circuit. The gain is unity when fed from and into 70-ohm circuits, and the response is substantially flat over the whole band when the control is in the physical centre position.

In practice, there are few modulator designs which do not cause a significant loss in video information at frequencies of 2MHz or more. So in a sense, feeding signals through an enhancer and then via a modulator is an excercise in frustration. Significantly those enhancers we have seen which did have an internal modulator were not very effective.

We envisage that the enhancer will be used mainly between two VCRs or between a VCR and a monitor and that its main task will be to sharpen-up images from cassettes which can obviously do with such treatment. That being the case, we have arranged the resonant boost/cut network to have its maximum effect around 2MHz, where there should always be some signal to work with. Above 2MHz, the response gradually reverts to normal, minimising the need for an additional filter.

The basic philosophy is similar to that employed in the Kenwood KVA-502 "Picture" control, which we commended for its straightforward, unambiguous operation – something that can't be said about some commercial video enhancers (See Aug '83 issue, p 46).

As with the Kenwood "Picture" control, our new enhancer can be set for no effect on the picture or for a visibly softer picture, if that is what's required. Alternatively, turning the control clockwise beyond centre position allows the outlines to be sharpened to just short of video over-shoot.

If you want to experiment, it is possible to shift the frequency of the resonant circuit by changing one component, as mentioned later. But let's now look at the project in detail:

We estimate that the current cost of parts for this project is approximately

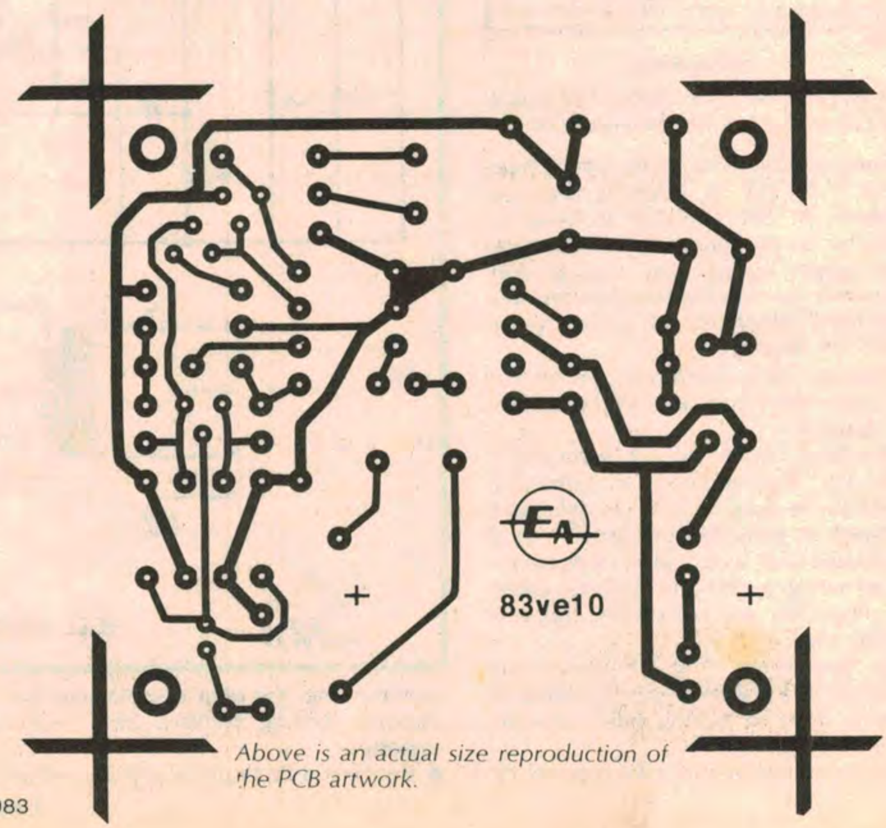
$35.00

This includes sales tax

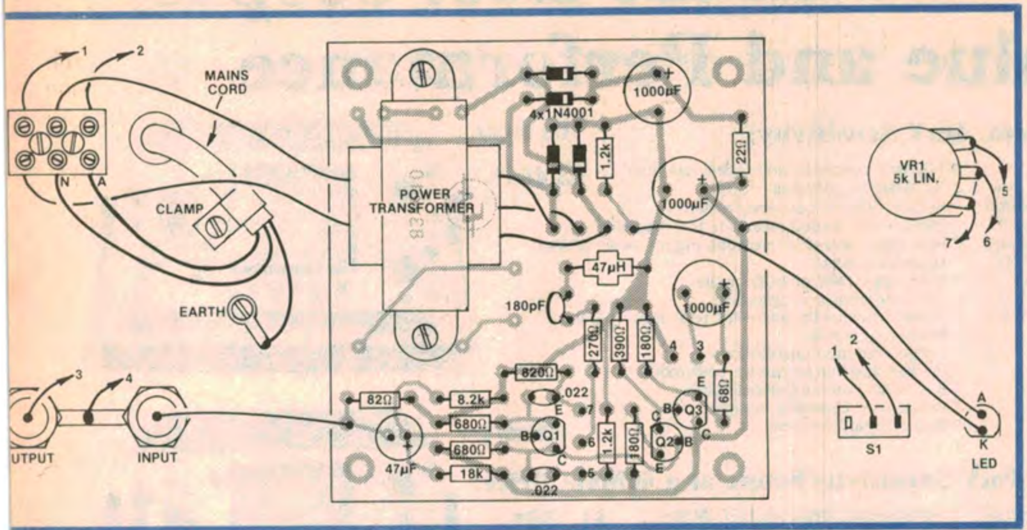
How the circuit works

Refer now to the circuit diagram. Q1 is connected as a common-emitter amplifier with a nominal gain of one set by the ratio of the collector impedance to the emitter impedance. The network associated with VR1 varies this collector-to-emitter impedance ratio and produces either boost or cut of the higher frequencies in the video waveform, depending on the setting of VR1.

A series resonant circuit composed of a 270Ω resistor, 180pF capacitor and a 47μH coil connected to the wiper of VR1 forms the heart of the boost-cut (or enhance) circuit. At the resonant frequency of 1.9MHz, the impedance of the series circuit reaches a minimum of 270Ω. If VR1 is set for maximum cut, the series circuit is connected via a .022μF coupling capacitor directly to the collector of Q1.



Above is an actual size reproduction of the PCB artwork.



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The AC load seen by the collector of Q1 is now reduced because of the low shunting impedance of the resonant circuit. Neglecting secondary effects, the impedance seen at Q1's collector is 270||680||1200=166Ω. The impedence at Q1's emitter is 680||820=166Ω. The ratio of these to impedances sets the gain of the stage at 166/372=0.446. This gives a maximum cut of −7dB.

When VR1 is set to maximum boost, the series resonant circuit is connected via a .022μF capacitor to the emitter of Q1. This sets the impedance seen by the emitter of Q1 at 680||820||270=156Ω. The corresponding impedance seen at the collector of Q1 is 680||1200=434Ω. This sets the gain of the stage to 434/156=2.78 and gives a maximum boost of 8.9dB.

Any amount of boost or cut between the above limits may be selected by an appropriate setting of VR1. Due to secondary effects such as collector capacitance, the load seen by Q1's collector is in practice lower than we have calculated. This reduces the maximum boost by about 2dB and increases the maximum cut by about 0.6dB.

The non-uniform loading on the collector and emitter of Q1 from secondary effects shifts the "flat" setting of VR1 away from the centre position of the potentiometer. The 1.2kΩ and 820Ω resistors connected between the ends of VR1 and ground compensate for the uneven loading and shift the "flat" position of VR1 back to the centre of the potentiometer.

Table 1. Peak frequency versus series resonant capacitor

Capacitor	Frequency
180pF	1.9MHz
100pF	2.2MHz
82pF	2.5MHz
56pF	2.9MHz

Since the impedance of the series resonant circuit rises as the signal frequency moves away from resonance, the amount of boost or cut will be decreased at frequencies away from resonance. The circuit response therefore shows a peak (or dip) which decays away slowly back to the 0dB level.

Following Q1 is a second common emitter amplifier consisting of Q2 and the 180Ω and 390Ω resistors. This stage provides an additional fixed gain of around two which is required for the following stage, as we shall see shortly.

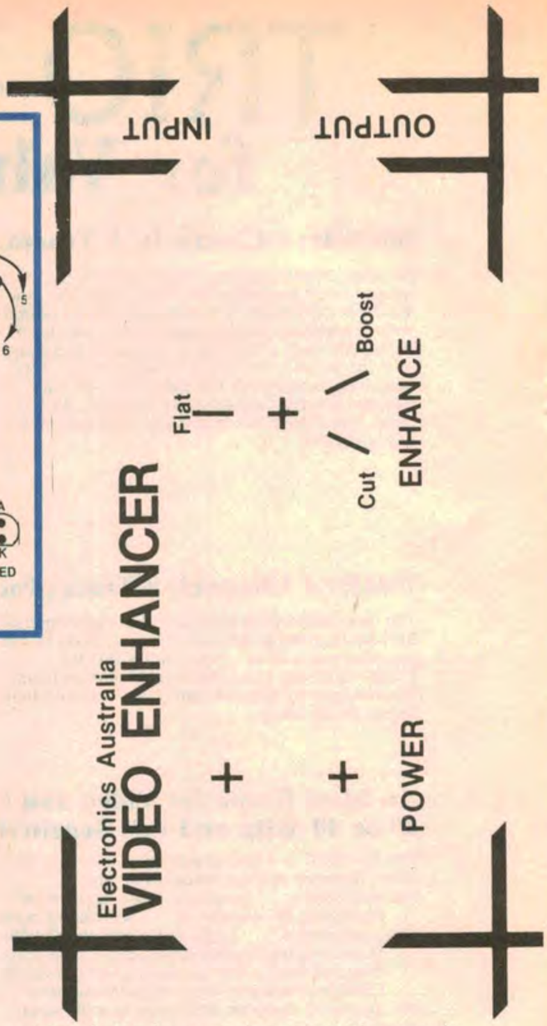
The output of the second stage is direct coupled into the third stage which is an emitter follower based around Q3. This stage acts as a buffer between the high impedance amplifying stages and the low impedance input of a VCR or television monitor.

The signal from the emitter follower is coupled via a 68Ω resistor and 1000μF capacitor to the output of the video enhancer. The capacitor AC-couples the signal so that DC bias conditions in the third stage will not be changed by the connection of a load impedance.

The 68Ω resistor in series with the output serves two purposes. First, it provides rough matching for the 75-ohm input impedance of most VCRs. Second, it protects the output stage against short-circuits.

As with any such matching arrangement, there is a signal loss of 50%. To compensate for this loss, Q2 provides a gain of two, as mentioned previously.

Note also that the input to the enhancer circuit is loaded with an 82Ω resistor and this gives rough matching to the output signal from a VCR or video camera.



Actual size front and rear panel artwork.

Power for the video enhancer is provided by a 12V centre-tapped transformer. The transformer output voltage is full wave rectified by diodes D1 to D4 and the resulting DC filtered by the first 1000μF capacitor. An RC filter network consisting of the 22Ω ½W resistor and the second 1000μF capacitor provides further supply filtering and results in a supply of 15VDC with about 15mV of ripple.

Power on-off indication is provided by the red light emitting diode (LED) connected to the enhancer power supply.

The frequency at which we have centred our boost and cut circuit gives the best result for enhancement of typical VCR playback signals. In some cases where the signal is of a higher quality (ie, greater bandwidth) the optimum frequency for enhancement will be higher. Table 1 shows the value of capacitance required in the series resonant circuit to achieve a particular centre frequency for boost and cut.

Note that changing the capacitance in the series resonant circuit will not change the amount of boost or cut available, only the frequency at which it occurs.

Construction

Construction is quite straightforward with most parts being mounted on a small printed circuit board (PCB) coded 83ve10 and measuring 90 x 85mm. Follow the layout diagram when mounting parts on the PCB and take particular care with polarised components. These include the transistors, diodes and electrolytic capacitors.

The PCB is mounted in a small metal instrument case measuring 150 x 103 x 61mm (L x W x H). Four 9mm tapped brass spacers are used to support the PCB and hold it clear of the case.

Holes for the BNC sockets, the terminal block and the mains cable entry point are now marked out and drilled in the back panel. Remember to fit the insulating washers to the BNC sockets and a grommet to the mains cable entry hole.

The mains cable is now inserted through the grommet and suitable locations marked out for the cable clamp and earth lug mounting holes. These holes should be drilled and then the Scotchcal label stuck to the front panel of the case. The Scotchcal label may now be used as a guide for locations of the front panel mounting holes.

Install the components on the front panel and then complete the wiring according to the wiring diagram. Note that 240VAC rated cable must be used for the wiring between the mains switch and the terminal block. If a PCB mounting transformer is used, 240VAC rated cable is also required between the terminal block and the transformer primary input on the PCB.

With construction completed, go over the unit and check for possible wiring errors. In particular, check that the mains wiring is correct and that the job is done in a workmanlike manner. The switch terminals should be sleeved with plastic tubing to prevent the possibility of electric shock.

Finally, some people may wish to run two VCRs or maybe one VCR and one television monitor from the output of the video enhancer. To do this just substitute a 39Ω resistor for the 68Ω output resistor and add a second BNC socket in parallel with the existing output socket.

PARTS LIST

1 Instrument case, 150 x 103 x 61mm (L x W x H)
1 PCB, code 83ve10, 90 x 85mm
1 Scotchcal front panel, 111 x 55mm
1 12V centre tapped transformer, AL7VA/12, PL/2/5VA or PF2851
1 SPST 240VAC rated toggle switch
1 mounting bezel to suit light emitting diode
2 insulated BNC panel mounting sockets
1 3-way mains terminal block
1 mains lead and plug
1 grommet to suit mains lead
1 cable clamp to suit mains lead
1 solder lug
4 9mm tapped PCB standoffs
½ metre 240VAC rated mains hookup wire
½ metre 3-way ribbon cable
1 front panel knob
10 sets of nuts and bolts for mounting hardware
1 47μH RF choke

SEMICONDUCTORS
4 1N4001 diodes
2 BC547 NPN transistors
1 BC557 PNP transistor
1 red light-emitting diode

CAPACITORS
3 1000μF 25VW PC mount electrolytics
1 47μF 25VW PC mount electrolytic
2 .022μF greencaps
1 180pF ceramic

RESISTORS (¼W, 5% unless stated)
1 x 18kΩ, 1 x 8.2kΩ, 2 x 1.2kΩ, 1 x 820Ω, 2 x 680Ω, 1 x 390Ω, 1 x 270Ω, 1 x 180Ω, 1 x 180Ω ½W, 1 x 82Ω, 1 x 68Ω, 1 x 22Ω ½W, 1 5kΩ linear potentiometer.