The ins and outs of video enhancers

Jonathan Scott

Just as an equaliser and noise reduction system is used to restore lost quality and fidelity with audio tape recording, a 'video enhancer' is used to improve picture quality from video tapes. But video is quite different to audio, and video enhancers will be unfamiliar to many readers. This article will put you 'in the picture'.

VIDEO CASSETTE recorders have become a popular consumer item, in the category of 'every home should have one'. However, they are a relatively recent arrival on the domestic market and people are just getting used to the idea of owning one.

Many of the tricks of the trade haven't filtered through to the owners of VCRs and the accessories and additional gadgetry are not yet fully appreciated. An analogy to this situation is the appearance of dynamic expansion units and conductive fibre dust bugs long after the release of other hi-fi components.

This article explains the functions of a video enhancer and the differences between units.

To put it simply, a video enhancer is a tone control for the eye. The analogy here would be with a graphic equaliser, which is a tone control for the ear.

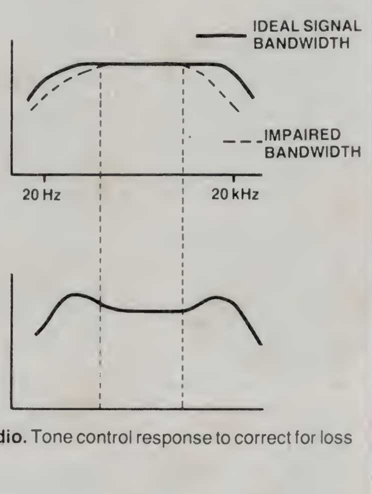
The bandwidth (frequency range) of a complete video signal is 5 MHz. However, VCRs have bandwidths of less than 5 MHz due to the way the video signal is rearranged for recording. Typically, the signal would be 3 dB down around 3 MHz.

Consequently, after one recording/playback of the programme material there is some degrading of the sharpness. After two or more recording stages there is a severe loss of the high frequency components. This affects the picture by blurring the sharp edges where there is a change of luminance, or contrast.

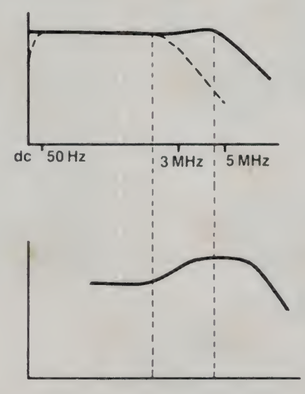
The eye is very tolerant of luminance nonlinearities, or distortions, but is very sensitive to the loss of the high frequency content and so the 3 dB drop at 3 MHz looks bad.

If there is a 3 dB drop in the high frequency component of music you will only detect a certain retirement of the cymbals and other high-pitched instruments. However, a 3 dB drop at the high frequency end of a video signal causes a smudging or smearing of the image and the fine print becomes illegible.

Figure 1. This shows the ideal effect of the tone control response. The original response shape is recovered when the degraded signal is fed through the filter. This is the basic idea behind video enhancing.



1(a) Audio. Tone control response to correct for loss



1(b) Video. Low end response, down to dc, is recovered (if lost by ac coupling) by a dc restorer circuit.

To make matters worse, this effect is only in the horizontal component and not the vertical direction of the video signal. When you're looking at the picture it would be hard to pick this up, but it does impart a strange, abnormal look to the picture which is difficult to define. The vertical resolution, or effective bandwidth, is largely unaffected because of the horizontal scanning pattern of the TV image.

A video enhancer aims to restore some of the lost frequency components, in the same way as you might try to bring back the cymbals to a piece of music by winding up the treble knob. See Figure 1.

There are some video enhancers around which are only capable of this basic function, however four problems stand in the way of such a system and limit its success.

Colour subcarrier signal

The colour subcarrier signal gives the trace the information about the colour it should be writing in. This signal is added to the video information before transmission and is removed before viewing. This technique is used as it effectively leaves a colour signal B & W compatible.

While it is desirable to boost the contrast past of the video information it is necessary to hold the subcarrier amplitude fairly constant. Most VCRs have some tolerance or degree of latitude for the amplitude of this part of the signal, but it is often not above 3 dB. A better video enhancer is designed with a 'unity gain notch' at a frequency of 4.43 MHz. See Figure 2.

Some VCRs don't have this problem as they have a built-in enhancer which intercepts the path of the signal before it contains the subcarrier. However, these circuits are generally not accessible and are not able to be adjusted for varying external effects, such as the state of the video signal. These enhancers are usually set to give only a small improvement in signal.

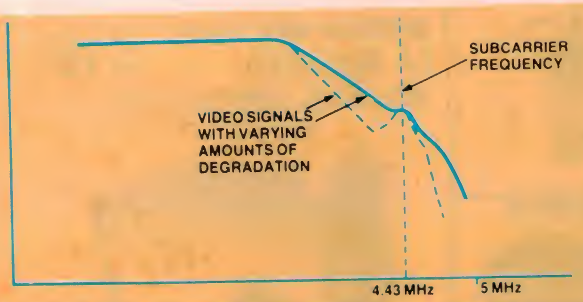


Figure 2(a). The first complication to pure high frequency boost is the presence of a subcarrier at 4.43 MHz. This signal must not be seriously tampered with.

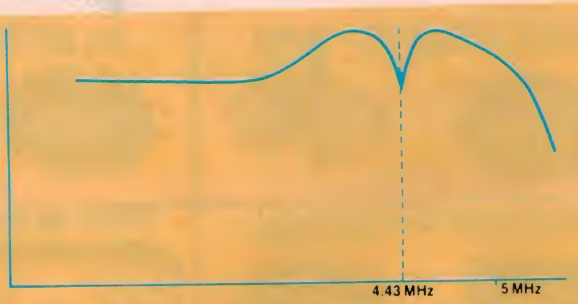


Figure 2(b) The typical enhancer is careful not to touch the subcarrier frequency.

Synchronising pulses

Synchronisation pulses in with the video signal are susceptible to over-enhancement. Some video enhancers are designed to leave the synchronising part of the waveform alone. This is sometimes achieved by reducing the enhancement of negative-going edges.

Generally the pulses will tolerate a considerable amount of over-enhancement before the hold of the picture is upset and usually some other problem arises before this happens.

Noise

When the signal is enhanced so is the noise. This is annoying as it manifests itself as 'snow' or random crud scattered over the picture. However, this is not necessarily a limiting factor as it is possible to tell the difference between the noise in the signal and those parts in the signal which it is important to enhance.

The edges between different levels of luminance in a picture are the parts of the waveform which cause the most annoying effects when the signal is degraded. And the more contrast there is in a picture, the more it will suffer.

Noise, however, is concentrated around the 'black' end of the video signal. Therefore, a level-sensitive amount of boost in the enhancement circuit will produce more enhancement around the 'white' end of the range. This allows a greater amount of boost to be applied overall before the physical limits of recovery are reached. See Figure 3.

Enhancers with this facility are easily identified as the degree of black boost to white boost is generally varied by a knob on the front panel. This knob may be labelled as 'GAMMA', from the technical description of the non-linearity response, 'CORE' or similar video jargon words.

In practice, boosting the sharpness of the picture and subduing the noise is optimised by adjusting the 'ENHANCE' and 'GAMMA' controls. These controls are, to some extent, interactive and it takes practice to achieve a good setting. However, these functions cannot eliminate existing noise, nor can they stop all of it.

The fact that the small-signal response of an enhancer is level sensitive makes it rather tricky to list the specifications. To quote a frequency response curve or specify the amount of boost at some peak frequency is to miss the point of why the circuit was designed.

The GAMMA control should have a sufficient range to be able, at one end of travel, to effectively disarm itself and pass all signal levels equally to the enhancer. At the other extreme of its travel this control should be able to refuse all signals to the enhancing circuitry, implying that no signal level was sufficient to warrant enhancement.

The effective range between these two extremes should be a smooth transition from no enhancement to normal enhancement. Any radical transitions would cause the rate of change of luminance in the ramp signal to alter sharply.

Overshoot

The main limiting factor in enhancement is overshoot. It is a fundamental property of filters that increasing the high frequency response causes overshoot on the sharp transitions passing through the system.

Overshoot on video signals manifests itself as small shadow lines which can be seen immediately to the right of any vertical line separating light and dark areas in the picture. This is, of course, not desirable and it doesn't look very natural.

Therefore, the effective limit of recovery of sharpness is determined by the amount of overshoot which is tolerable. Beyond some point of degradation, response restoration will be impossible without the annoying shadow lines. The situation is worse on transitions going from dark to light, and from left to right.

Some degree of latitude in this respect can be achieved by another signal level dependant function. The basic idea is that video signals are a standard level, or amplitude, from black to white. Overshoot on large signals would normally exceed the standard level and are more capable of producing the unpleasant visual effects.

A 'clipping' function, which prevents the boosting of signals exceeding the standard level, will attenuate the offending overshoot on the full dynamic range transitions. See Figure 4.

This function will also help to clean up synchronisation signals, if they are enhanced along with the video signals. There is not usually an adjustment control provided for setting the clipping level as the levels involved are fixed in normal systems.

Conclusion

After studying all the complexities involved in a video enhancer, it was decided that some video enhancers are better than others. There are full signal processing units around which actually separate out the coded components of the signal and process them separately.

The signal can be modified by these units with the flexibility of a graphic equaliser. However, they are not yet suitable for the domestic market when you consider their cost and the functions they offer.

The simple video enhancers have a limited number of functions but they are very cheap. A unit in the middle price range would be adequate for the amateur who only wants to do the occasional editing and avoid the signal degradation imposed when using a 'domestic' video recorder. ●

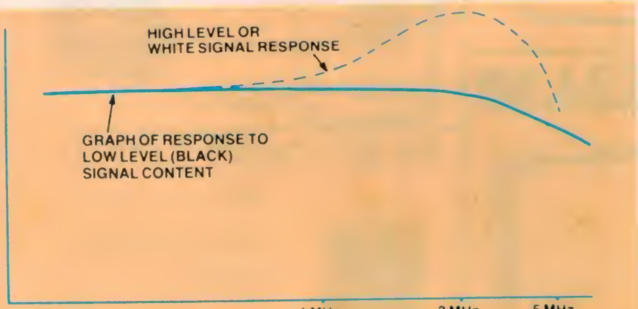


Figure 3. Amplifying all the high frequency components may enhance the noise. However, as noise is usually most visible when attached to low level signals, these may be selectively ignored.

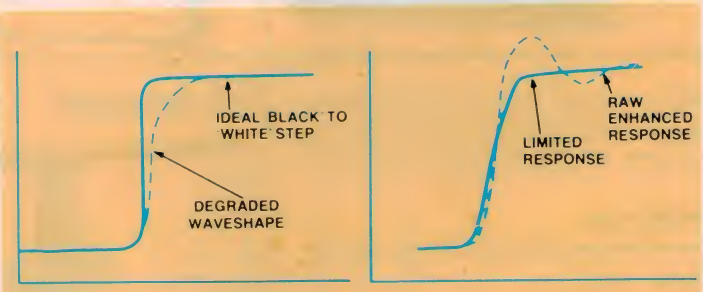


Figure 4. Enhancement of high frequency sinewave components causes overshoot and ringing. This is excessive on large steps in the video signal. Circuits to limit this are sometimes included.