Psychoacoustic Enhancer

For months now he's been threatening us with this project and now it's arrived. Paul Williams **unleashes a feature packed Psychoacoustic Enhancer on an unsuspecting world to help transform good sounds into great ones.**

There's an awful lot of mystique surrounding devices of this type but we'll probably shatter a few illusions in this article when we describe fully and openly what magic creates this very attractive and popular sound.

When we tell you that this module can re-synthesise upper harmonics lost in the recording process, and help to enhance otherwise indistinct subtleties in the sound source, you may just shrug it off as being hyped-up sales talk; but it's all true!

To make sure that the user has the utmost flexibility at his disposal, the Enhancer described here boasts not only Drive and Mix controls, but also Frequency and Resonance so that a particular instrument or characteristic can be pinpointed for treatment. A Dry Defeat switch comes in handy when using the unit on an auxiliary send and return, and a three stage drive indicator monitors the effectiveness of the control settings.

Could it be that some readers still don't have a clue what we're talking about? An article on the subject – Getting Excited – by Paul White appeared in the June 85 issue of HSR, which will hopefully make things a little clearer.

Harmonics

Harmonics is what it is all about...or is it compression...or high frequency EQ? Well, to be honest, it is a complex mixture of HF boost, compression and harmonic generation which we have carefully balanced over many hours of listening tests to arrive at the 'magical' combination.

Within the unit, part of the input signal is tapped off and high-pass filtered with adjustable frequency and resonance, and passed to a harmonic generator, the output from which is compressed by a few dB and mixed back in with the input signal.

The harmonic generator produces upper harmonics, depending on the level of drive signal. Figure 1 demonstrates the typical spectra produced by the generator from a sine wave input at three different drive levels, with the tricolour drive indicator showing green, yellow and red respectively. Harmonics of higher order than the 5th are produced too, but since fundamental frequencies below 3KHz are not acted on to any great degree, higher order harmonics tend to be supersonic and are thus insignificant. The way in which the harmonic structure changes with signal amplitude is another important factor in the sonic succulence of the device, as this is the mechanism by which subtleties are enhanced.

Circuit

Figure 2 is where all the myths are shattered! No delay lines, no phase shift networks and no custom ICs.

The main route for the signal is via the input and output buffers IC1a and IC1b respectively. The remainder of the circuit is the sidechain. C5 and VR1 form a high-pass pre-filter and variable drive to the high-pass state-variable filter built around IC2a, IC2b and IC3b. This filter is fairly conventional in the way in which it provides variable cut-off frequency by means of VR2, and variable resonance by means of VR3. However, to overcome the problem of frequent adjustments to the drive control being necessary at different frequency settings due to the lesser signal content at higher frequencies, R12 forces the gain seen at pin 7 of IC2a to be higher at high frequency settings as a result of the loading effect of VR2.

The signal is at this point rectified by IC3a and D1, putting a charge on C9. This control voltage is buffered by IC4d and used to produce a control current via R36 for the compressor IC4b, half of an LM13600 Operational Transconductance Amplifier (OTA). The slope of the compressor varies with signal level, starting with a gentle slope at low levels, and increasing until it actually becomes negative at higher levels. This not only further enhances the effect, but is fortuitous in other ways as will become apparent. The other half of the OTA, IC4a is the harmonic generator itself! The signal enters this stage via R27 and R30 into pin 13. Some signal however is also injected into the diode bias input at pin 15. The combination of this, and the fact that R29 bleeds some assymetrical current from the junction of R27 and R30, causes the transconductance of IC4a to be assymetrical about 0v. The waveform of any signal presented to this stage is thus gently 'bent' to produce the required harmonics. We hesitate to mention the word distortion as it conjures up all sorts of convulsion-provoking thoughts; but this is of course exactly what is being produced. Fortunately, since only high frequencies are 'bent', the resulting harmonics are not smeared right across the spectrum, but are confined to the upper reaches, where it is not perceived as distortion; in fact the effect is quite the opposite and creates the illusion of clarity. So that the overall HF boost is not excessive, R34 has been included to cancel out some of the fundamental signal, allowing the generated harmonics to be more prominent.

The sidechain output is then mixed, by means of VR4, in with the input signal at the combined mixer/output buffer, IC1b. SW2 allows the direct dry signal to be removed so that only the sidechain signal is put on the output.

IC3c and d form the tricolour LED driver, which acts from the compressor control voltage at IC4c pin 8. At lowish signal levels, the small negative control voltage is amplified by IC3d via R20, to illuminate the green half of the LED, D2b in sympathy with the signal amplitude. IC3c drives the red half of the LED in a similar manner, but with lower gain such that the red half of the LED does not become effective until higher levels are reached. By this time the combination of the luminance from the green and red LEDs results in a yellow glow. At higher levels still, the output stage of IC3c becomes saturated, allowing its inverting input to go negative. This negative voltage is amplified by IC3d at pin 10, due to the effect of R19, causing the green half of the LED to extinguish, resulting in a red glow. TR1 keeps the LED current off our precious 0v rail by generating a synthetic 0v from the negative rail in the usual manner.

Construction

Building the Enhancer using the high quality kit should present no problems especially since, by exclusive use of PC mounting connectors, switches and potentiometers, there is no interwiring to do. The first step in construction is to insert,

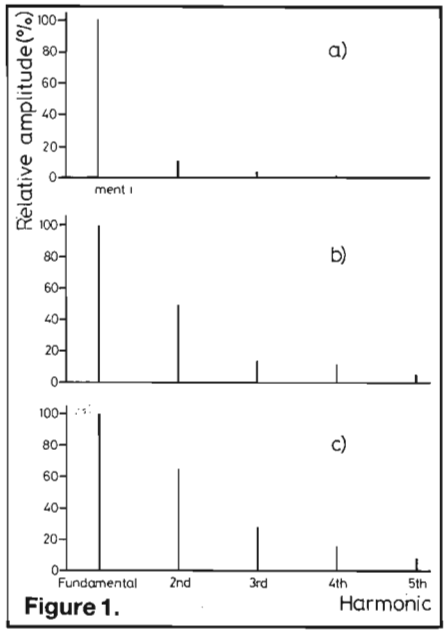


Figure 1.

solder and crop the resistor leads, populating the PCB according to the parts list, and the overlay printed on the PCB itself. Bending the leads outward at 45 degrees prior to soldering will hold the components in place without running the risk of shorting together a pair of pads. Solder the ten links in place using resistor lead off-cuts at the positions shown dotted on the overlay. Taking care with orientation, locate and solder the diode, D1 and transistor, TR1. The IC sockets come next, making sure that they are pressed down onto the PCB whilst soldering, but leaving the ICs themselves out until later. Now insert and solder the capacitors, taking care with the polarity of the electrolytic types. The buss connector and the two jack sockets can then be soldered whilst holding them firmly down onto the PCB. A piece of foam rubber laid on the bench comes in handy for holding connectors and the like in place on up-turned PCBs during soldering.

Trim each pot shaft to 8mm from the bush using a hacksaw, whilst holding the pot shaft in a vice, or just use a pair of cable cutters. Fit a PC bracket to each pot and locate into their respective PCB positions, but don't solder at this point. After determining the correct orientation of the LED, bend its leads down at right angles 4mm from its body and locate into the PCB without soldering. Screw one nut onto each toggle switch and locate into the PCB, again without soldering. Place shakeproof washers on the switches and pots, then offer the front panel up, feeding the pot and switch bushes and LED dome into the appropriate panel apertures. The panel is then fixed in place by means of the pot nuts which should be fully tightened. Only finger tighten the front switch nuts however, leaving the final securing to the rear nuts, which should be screwed up against the rear of the panel. The pots, brackets, switches and LED can now be soldered, after making sure that they are all fully home, and that the panel is square to the PCB.

Spend some time now checking over the assembly very carefully, especially on the track side where dry joints and solder splashes are all too common, even for the experienced constructor. When you are completely satisfied with the assembly, load the ICs into their sockets, being careful with orientation. Note that IC3 is fitted around the other way from all the other ICs. Finally, fit the knobs and caps so that the marker line of each covers the scale evenly, with equal 'dead-band' at each end, then push on the toggle switch lever covers.

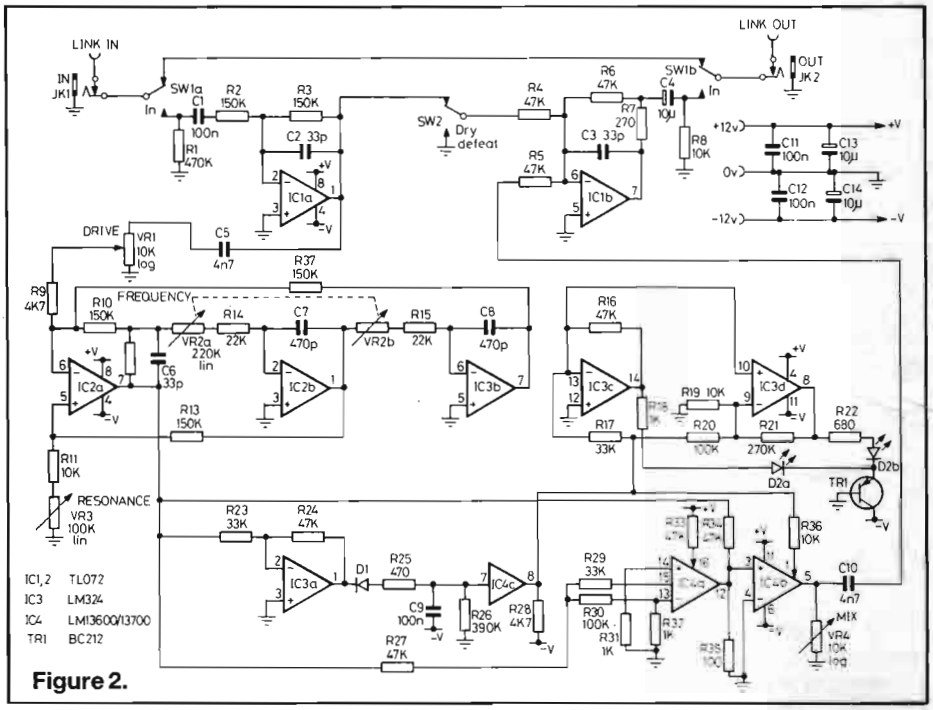


Figure 2.

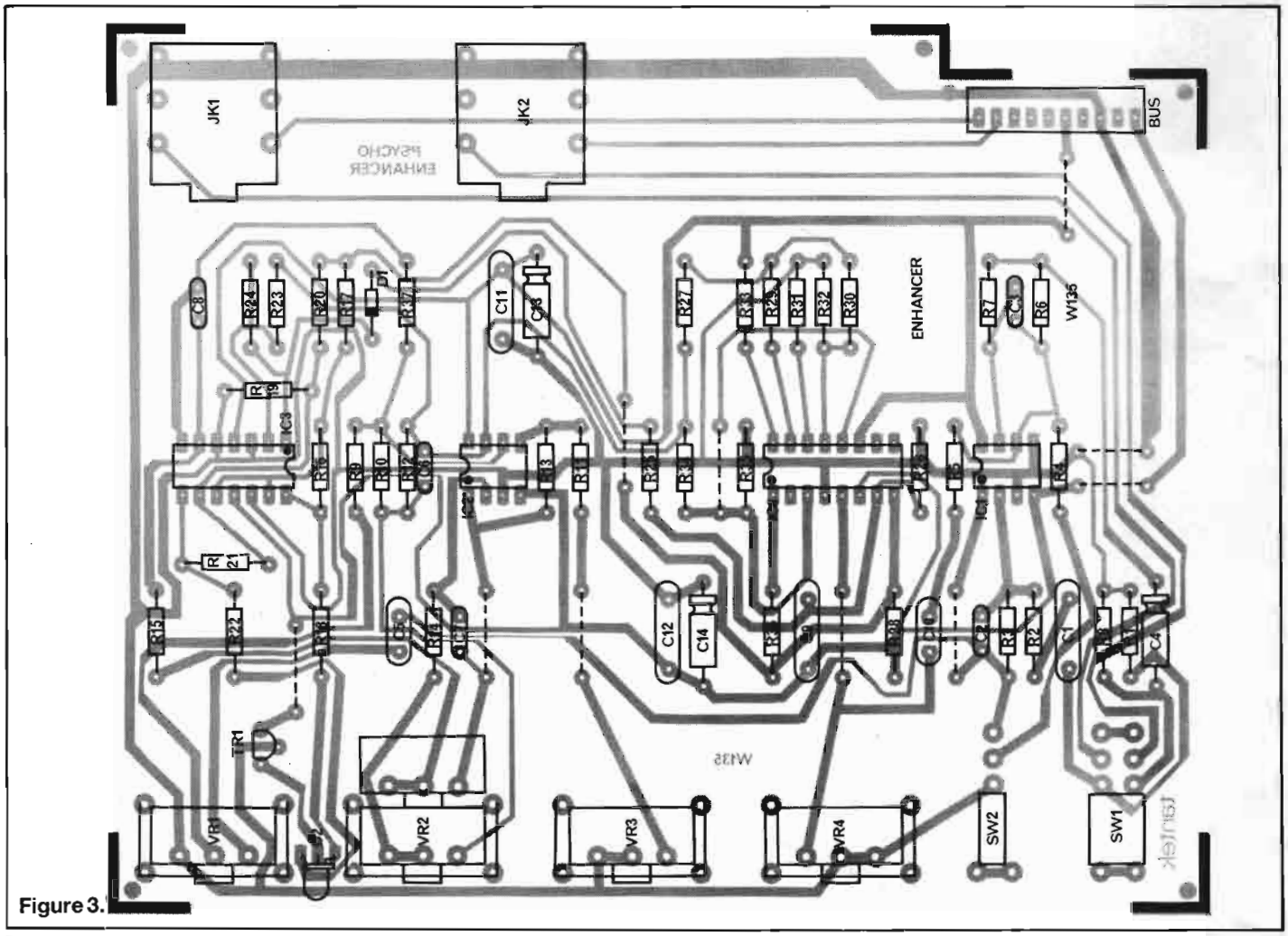


Figure 3.

In Use

Uses for the Enhancer are wide ranging, but the controls are used in a similar manner in all cases. The Drive control must be set correctly for the module to function in any useful way and would usually be set once for a particular track, although re-adjustment may be necessary if the frequency or resonance controls are subsequently altered. The aim is to get the indicator to show yellow for most of the time. It may be that quieter passages will result in a green indication, and vocal sibilants may cause the occasional red flash, but this is to be expected. Harmonic generation starts once green is indicated, but full, rich generation only gets under way during yellow indication. Nothing very dire happens in the red, since the negative slope of the compressor shuts down the output from the sidechain anyway. This can be particularly advantageous if you are mixing the effect over-the-top, where fuzzy vocal sibilants are sometimes encountered: just wind up the drive so that sibilants always indicate red, and they instantly become clean and clear. Alternatively, a de-esser could be used advantageously here.

The frequency control enables the user to select the area of interest, whether it be a particular instrument in a mix, or a characteristic of an instrument being treated. This facility is further extended by the resonance control which then allows very narrow pinpointing to be achieved. Only experimentation will reveal the best settings of these controls, but higher settings of the frequency control are often the most sonically gratifying, especially on vocals. Mid-range setting of the resonance control is the norm unless there is some particular characteristic you wish to emphasise. Very high resonance settings can be used for special effects, but the Mix control would usually need to be kept quite low to prevent any obtrusive ringing being too prominent.

The control which should be treated with the utmost care is Mix. This is the control which enables your sound source to be delicately tinted with enhancement. The biggest, and most tempting mistake is to wind the mix control fully clockwise in the belief that more must be better. In fact there is an optimum setting for any given situation, and only experience will teach you where this is. A/B comparisons should be made frequently by toggling the In switch, and since a top-heavy sound is very easy to get accustomed to, it pays to go and listen to a commercial album now and again as a reference.

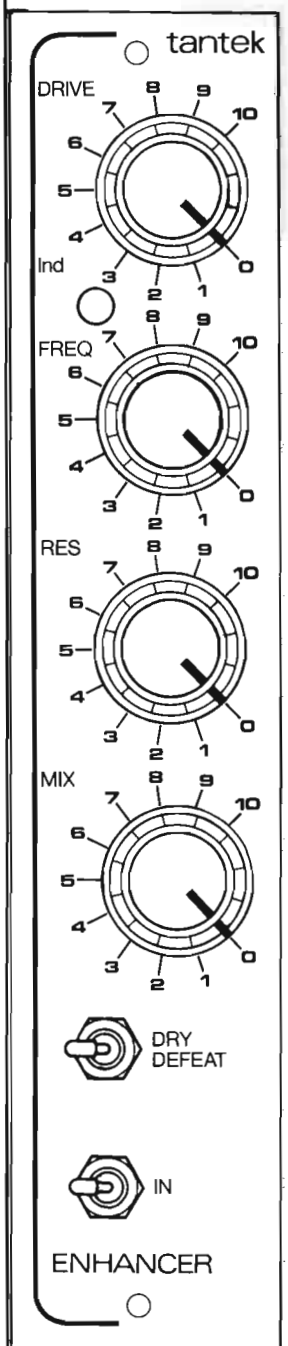
The Dry Defeat switch should be used only when linking the module into a mixer send and return system, where the Mix control on the Enhancer should be set fully clockwise. Be warned that on its own, the sidechain signal sounds absolutely abominable and should only be added back in very small doses!

Although it is commonplace to treat a final mixdown to improve the overall clarity and brilliance (where two units would be required for stereo operation), there are several advantages to applying the effect to instruments (including vocals) as they are being recorded by patching in enhancers at the desk insert points. The most obvious and perhaps most significant of these is the better noise performance but percussive sounds are dramatically enlivened in a way that no mere EQ circuit could achieve. Since HF boosting and compression are involved, any noise problem you have will be to some extent aggravated by the Enhancer; another good reason for keeping the Mix control down. However, two good examples of the need to come off-tape are the absolutely fantastic results obtained from enhancing double-tracked vocals (preferably not ADT), and when old tapes, including cassettes need to be brightened up by re-synthesising harmonics otherwise lost forever. Drum tracks also benefit from treatment, especially if they have been recorded with budget equipment and lost or muddy cymbals spring to life. If you do find you have a noise problem, a Dynamic Noise Filter module placed before the enhancer will usually solve it but the enhancer is a far less noisy solution to clarity problems than the less satisfactory alternative of turning up the HF EQ.

You will probably find your Enhancer so invaluable that you may be tempted to use it on every track you lay down in the future; but why not – hundreds of commercial studios do?

The Enhancer module is available from: Tantek, Enterprise House, Elder Way, Stevenage, Herts, SG1 1TL either in kit form for £39.95, or ready to use for £55.95. Prices include VAT and postage within the UK. Further information on the modular effects system can be obtained from the above address, or by phoning (0438) 726155.

Next month will see the addition of an infinite flanger to the effects rack.



Enhancer Parts List

Resistors –		
⅓W 5% carbon film R1	470K	
R2,3,10,12,13,37	150K	6 off
R4,5,6,16,24,27,33,34	47K	8 off
R7	270	
R8,11,19,36	10K	4 off
R9,28	4K7	2 off
R14,15	22K	2 off
R17,23,29	33K	3 off
R18,31,32	1K	3 off
R20,30	100K	2 off
R21	270K	
R22	680	
R25	470	
R26	390K	
R35	100	
VR1,4	10K log PC pot	2 off
VR2	220K lin dual PC pot	
VR3	100K lin PC pot	
Capacitors		
C1,9,11,12	100nF polyester	4 off
C2,3,6	33pF ceramic	3 off
C4,13,14	10uF 25v electrolytic	3 off
C5,10	4.7nF polyester	2 off
C7,8	470pF ceramic	2 off
Semiconductors		
D1	1N4148	
D2	Tricolour LED	
TR1	BC212	
IC1,2	TL072	2 off
IC3	LM324	
IC4	LM13600/13700	
Miscellaneous		
JK1,2	¼" PC jack socket	2 off
SW1	DPDT PC toggle switch	
SW2	SPDT PC toggle switch	
Toggle lever cover		2 off
Knob		4 off
Knob cap		4 off
Buss connector		
8 way DIL socket		2 off
14 way DIL socket		
16 way DIL socket		
PC pot bracket	4 off	
Panel (punched & printed)		
Black M2,5 screw		2 off
PCB (with printed overlay)		
Solder		