Philips dynamic noise limiter for cassette tapes

by LEO SIMPSON

Much interest has been generated over the past few months in overseas journals in dynamic noise reduction systems such as the Dolby system. In this article we take a closer look at the Philips Dynamic Noise Limiter System. Fully compatible with present cassette machines, it is interposed between the cassette deck and stereo amplifier.

Last month in an article entitled "Hi-Fi Scene" we described the latest developments in cassette tapes and in particular, detailed the problems of compatibility between Dolbyised tapes and conventional cassette machines. The Philips noise reduction system was mentioned but not many details were given.

Recently, "Wireless World" published further details of the Philips system and this has enabled us to evaluate the circuit and its performance under typical conditions.

Basically, the Philips system is a dynamic treble-cut tone control circuit which operates on playback only. It does not involve any pre-conditioning of the recording, as does the Dolby system. It uses a steep top-cut filter which is inoperative when the program signal is loud and contains a substantial high frequency content. Under these conditions the noise is effectively masked by the program and noise reduction is not needed, anyway.

When the high frequency components of the program signal fall below a certain amplitude, the filter system becomes operative, heavily attenuating the noise and signal components above 4.5KHz. In this way the overall system exhibits flat response to high level signals but a rapid treble roll-off for signals of low level or having very little high frequency content.

Four transistors and six diodes form the basic noise reduction circuit. The first stage uses a silicon NPN transistor, Trl, as a phase-splitter. Signals out of phase with the input are fed directly to the output capacitor via the 4.7K preset resistor. Signals in phase with the input are fed from the emitter of Trl to an active high-pass filter consisting of the silicon NPN transistor Tr2 and associated components.

High frequency signals from the collector of Tr2 are further amplified by Tr3 and Tr4. Tr4 also functions as a phase-splitter. Signals from the collector of Tr4 are half-wave rectified by the silicon diodes D1 and D2 to develop a positive voltage across the .0047uF capacitor associated with D1 and a negative voltage across the .0047uF capacitor associated with D2. If the input signal is sufficient, the DC voltages so developed will forward bias diodes D3 and D4 into conduction so that high frequency signals fed from the emitter of Tr4 via the 22K resistor are shorted to ground.

If D3 and D4 are fully conducting, there is no treble attenuation of the output signal. If the voltages developed by D1 and D2 are not sufficient to bias D3 and D4 into conduction, the high frequency signals from the emitter of Tr4 are fed to the output via the 22K and 120K resistors so that they cancel the high frequency components of the output signal.

A signal voltage limiter formed by the two cross-connected diodes associated with the base of Tr3 prevents excessive voltages being fed to D1 and D2 and ensures a fast decay characteristic for the "compressor function" performed by D3 and D4.

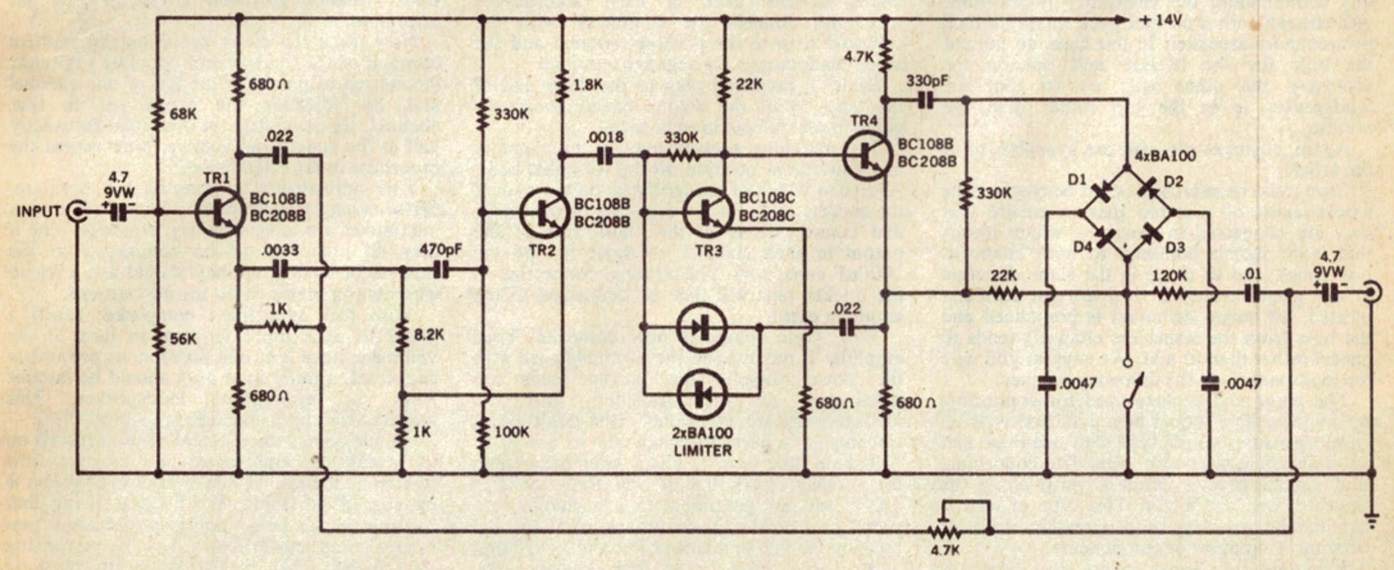
The noise cancelling function of the circuit is defeated by closing the SPST switch which shorts the junction of the 22K and 120K resistors to ground. This prevents high frequency signals from the emitter of Tr4 reaching the output and causing resultant HF attenuation of low-level signals.

Overall voltage gain of the circuit is approximately one, allowing the unit to be interposed between the cassette deck and the high level tape inputs of the stereo amplifier, with minimal change in the behaviour of the system.

As presented, the Philips noise-reduction circuit is not a great deal less complicated than the B-type Dolby circuit. However, an advantage claimed for the Philips system is that it benefits non Dolbyised tapes, i.e., the majority of pre-recorded tapes on the market today. Philips claim an effective improvement in signal-to-noise ratio of 10dB at 6KHz and 20dB at 10 KHz. In terms of figures, this is better than achieved by the B-type Dolby system although, of course, that is not the full story.

To verify the performance claims, we decided to mock-up the circuit and try it out in typical listening conditions. The semiconductors specified by Philips are not easily available in Australia but we used close equivalents and these are shown on the circuit diagram.

For optimum noise performance, the 4.7K preset resistor must be adjusted to give minimum hiss with a low level signal ap-



The Philips noise reduction circuit has a treble response which is dependent on signal level.

plied. The preset resistor does not affect the "threshold" at which the circuit comes into operation — this is set by other circuit components, the diodes D1 to D4, in particular. We found that, for signals above 5KHz and below 10mV RMS in amplitude, the circuit does give very heavy attenuation as claimed. For high level signals, the circuit has a flat response.

With signals above 5KHz and having an amplitude of 20 to 30mV RMS, some waveform clipping occurs. This is because the diodes in the output stage are only just biased into conduction on the peaks of the signal — this is the threshold level. In practice, the distortion caused by this clipping may not be directly apparent, because of the very high frequencies involved but other factors may intrude.

For best noise performance, the circuit must be driven with signals having an average level of about 300mV or more. If the signal level is too low, the treble attenuation function will operate almost continuously. If the signal level is too high the hiss component will not be cancelled effectively.

Our first listening tests were done with normal mono cassette machines with a price under the $100 mark. With these machines, the noise reduction circuit made little difference — the frequency response of the machines was such that hiss was not a problem anyway. In fact, with these machines the amplifier's tone controls can even be set for modest treble boost without hiss becoming a problem.

With more ambitious stereo cassette machines, costing around $200 or more, hiss can be a real problem and here the Philips circuit works well. On quiet passages it effects a dramatic reduction in hiss but some listeners would claim that this was noticeably at the expense of the treble response — even if only at low level. Most listeners, however, would regard the overall effect as an improvement.

On the debit side, we did notice that on programs with rapidly varying signal levels, the transients appeared distorted. Close listening seemed to suggest that the signal itself was not distorted but that it was modulating the hiss. At the beginning of a transient or loud, impulsive note, the treble attenuation function of the circuit is, or can be, fully operational. But as the signal rises to its maximum level, the diodes at the output conduct, cancelling the treble attenuation condition and allowing the hiss to "ride in" on top of the signal, ie, the rapidly varying signal switches the hiss on and off!

To some listeners, this effect could be unpleasant enough on some tapes to outweigh the overall advantages of the circuit. But, in general, it is merely an effect we noted and would not be unduly apparent to the average listener.

To sum up, if the reader has a high quality cassette machine and is bothered by the high hiss levels on many pre-recorded tapes, this circuit may be well worth a trial. For best effect, the machine should have a signal level output of about 300mV or more and preferably have a level control to adjust for different tapes. The circuit could also be used with conventional reel-to-reel machines but its effect will be noticeable only at the lower tape speeds. If the reader has a run-of-the-mill cassette machine, the circuit will have little or no effect.

While the circuit shows a supply rail of 14

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volts, it may be operated satisfactorily at up to 20 volts. This means that it can be operated from an 18-volt battery supply or from the mains supply using a 12.6 volt transformer, bridge rectifier and suitable filter capacitor. Current drain of the circuit is approximately 14 milliamps, or 28 milliamps for a two-channel version.

The transistors specified are selected beta types. The BC108B has a beta range of 240 to 500 while the BC108C has a beta range of 450 to 900 at a collector current of 2 milliamps. Two local manufacturers can supply such transistors. STC have the BC108B and BC108C, while Fairchild have the direct equivalents, BC208B and BC208C. Alternatively, normal BC108, BC148 or 2N3565 transistors may be selected for beta using a simple beta tester. The Transistor FET Checker featured in the August 1971 issue of Electronics Australia is ideal for this job.