TANDEMING EFFECTS IN NOISE REDUCTION SYSTEMS

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INTRODUCTION

There are now many kinds of noise reduction systems on the market which operate using a variety of techniques. Whether they are complementary compression/expansion systems or non-complementary dynamic noise filters they all have the objective of reducing the perception of undesired noise by the listener. It is also now no longer unusual for an audio signal to have passed through more than one type of noise reduction system on its passage from source to listener. This raises the possibility of what the telecommunications industry calls **"tandeming problems"**. These problems may affect both complementary and non-complementary noise reduction systems and are different from the well known problems of mistracking in incorrectly set up complementary noise reduction systems. The rest of the paper will first explain what tandeming is. It will then go on to examine the problems which could occur and then examine one particular tandem in some detail. The paper will finally conclude with methods of minimising the effect of tandeming problems in noise reduction systems.

TANDEMING

Tandeming occurs when two different systems are cascaded (see figure 1) so that the desired signal has to pass through both systems. For example, one may have two complementary noise reduction systems A and B (see figure 2) in tandem. Within the system shown in figure 2 there are two potential sources of degredation.

i) The encoder and decoder of either noise reduction system may be maladjusted. This results in 'mistracking'. However, this can be removed by correct adjustment of the system and is not a tandeming problem.

ii) The noise reduction systems may be correctly set up but system A may affect the signal in a way which impairs the effectiveness of system B. This is known as a tandeming problem and no amount of adjustment can remove it.

In what ways could one correctly adjusted noise reduction system affect the performance of another system? Problems are likely to occur under two circumstances.

i) The two noise reduction systems use very different forms of signal

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detection and treatment eg peak vs rms signal detection or broad band vs multiband compression. As an example a broadband noise reduction system followed by a multiband system may be less effective because the noise floor modulation caused by the broadband system is treated as signal by the multiband system.

ii) The second system (system B in figure 2) uses a signal detection and processing technique which is sensitive to particular aspects of the signal or channel and the first system (system A) affects the signal characteristics which the second system is sensitive to. For example, a sliding band system is sensitive to the signal and channel characteristics at the extreme ends of the frequency range thus if such a system followed one which affected the signal characteristics at the extreme ends of the frequency range then one could expect some problems to occur.

As a specific example, let us look at the tandeming of a Dolby C noise reduction system with a Dolby type noise reduction system. This example was chosen because:

a) It is quite common, many semi-professional machines use Dolby C and Dolby B is an accepted consumer format.

b) Both use a sliding band system but differ in some important respects and so could show tandeming effects.

DOLBY B AND C NOISE REDUCTION SYSTEMS

The details of these noise reduction systems may be found in References [1-3], however, to aid clarity, a brief description is given here. Both systems use a sliding band compression system which introduces high frequency boost dependent on signal amplitude and content on encode and a complementary high frequency cut on decode. However the 'C' system provides more compression than the 'B'. The 'C' system also has two other differences to the 'B' system. These are the introduction of spectral skewing and antisaturation networks. These were brought in to remove the known effects of the variability in high frequency performance of tapes and tape recorders [Reference 3]. The spectral skewing technique reduces the effect of high frequency irregularities by desensitising the system at high frequencies via the use of de-emphasis the input to the compressor and complementary pre-emphasis at the output of the expander [see figure 3]. The antisaturation network puts further de-emphasis/ pre-emphasis on to the signal at high levels in order to reduce tape saturation effects. The net result of this is that a Dolby C system has approximately 12db of boost at 20Khz relative to a signal at 1Khz in the expander section, unlike a Dolby 'B' system expander [see figure 4].

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THE EFFECT OF SPECTRAL SKEWING

Although the spectral skewing and antisaturation networks significantly improve the robustness of Dolby 'C' processing to imperfections in the high frequency performance of the system they can cause problems when the system is tandemed with a Dolby 'B' system. If one examines the expander frequency response for a Dolby 'C' system one can see that this has a 12db high frequency boost. Therefore the tape noise will be boosted as well [see figure 5]. However, the Dolby 'B' system has no spectral skewing and so it can interpret the high frequency peak of noise as a high frequency signal. This has the effect of preventing the Dolby 'B' system from achieving the maximum encoding effect and so the effeciency of the 'B' system is reduced. The sliding band does not go down as low in frequency because it is pinned by the high frequency noise, this results in noise being unmasked and thus audible.

THE MAGNITUDE OF THE PROBLEM

If the S/N ration of the first tape system is significantly better than the second, then there is unlikely to be a problem, however, if the S/N ratio of the first system is similar, then it is possible for problems to occur. Thus narrow track formats at low speeds are likely to cause problems as is a tape in which a lot of bouncing has occurred. In the second case the height of the noise peak is going to be a function of the number of bounces as shown in figure 6.

SOLUTIONS TO THE PROBLEM

The main solution is one of avoidance by ensuring that the tape speeds track widths, and production techniques result in a source with a S/N which is better than the second system. However, this is not always possible and in these situations a filter placed between the two systems (as shown in figure 7) may be the only solution. One of the proprietry single-ended noise reduction systems could be used as a filter but with one caveat, if the single ended system uses some form of frequency sensitive detection system it too may be affected by the high frequency noise peak.

CONCLUSIONS

It is possible to have a cascade of two correctly working and set up noise reduction systems in which the second systems performance is degraded by the first. By thinking about the likely effects of a tandemed system it is possible to avoid these effects and so preserve the quality of your audio signal.

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REFERENCES

[1] R M Dolby, *"An Audio Noise Reduction System"*, J Audio Eng Soc, Vol 15, pp 383-388 (1967 Oct).

[2] R Berkovitz and K J Gundry *"Dolby B-Type Noise Reduction System"*, Audio, pp 15-16, 33-36 (1973 Sept, Oct).

[3] R M Dolby "A *20 dB audio Noise Reduction System for Consumer Applications*" J Audio Eng Soc Vol 31, pp98-113 (1983 Mar).

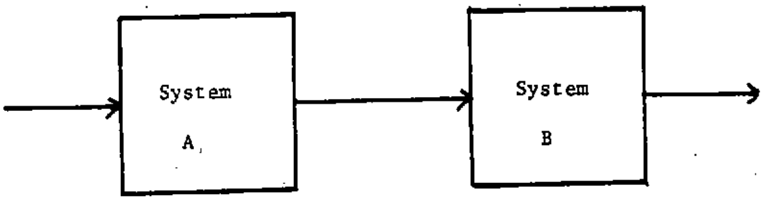

Figure 1 Two systems in tandem

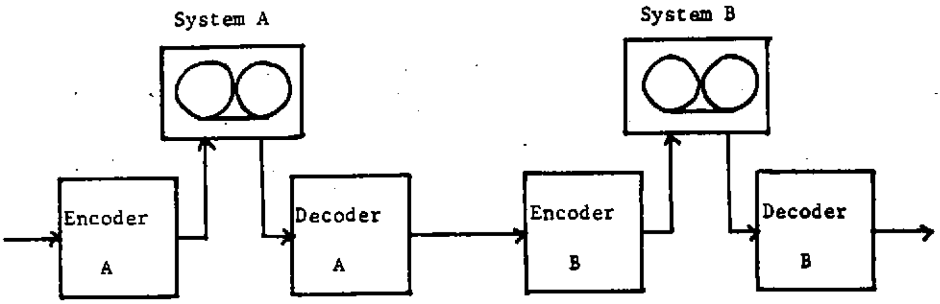

Figure 2 Two noise reduction systems in tandem

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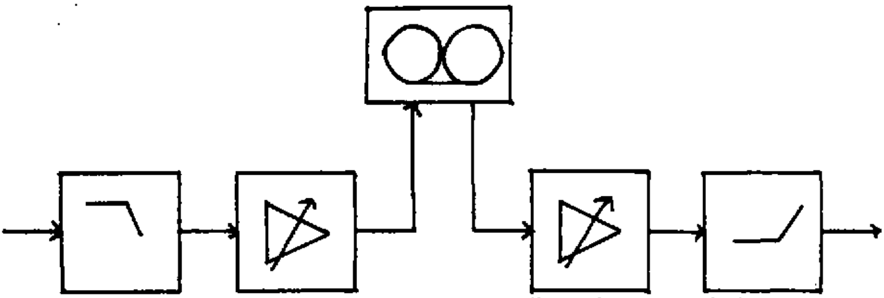

Figure 3 The "spectral skewing" technique

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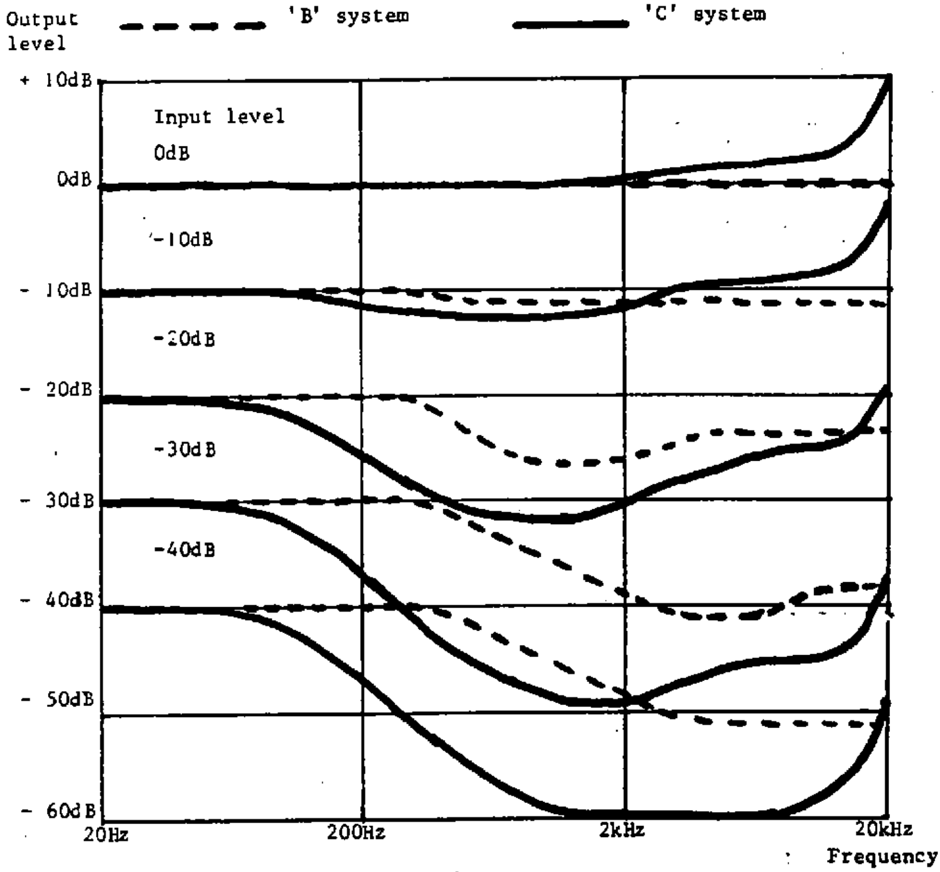

Figure 4 Dolby expander frequency responses

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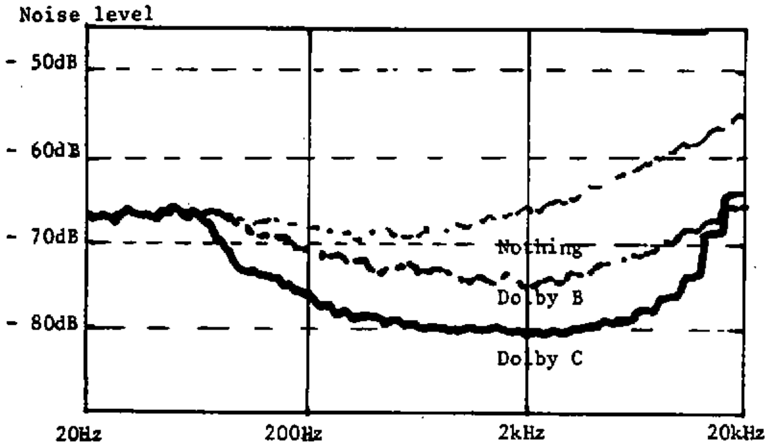

Figure 5 Tape noise spectrum

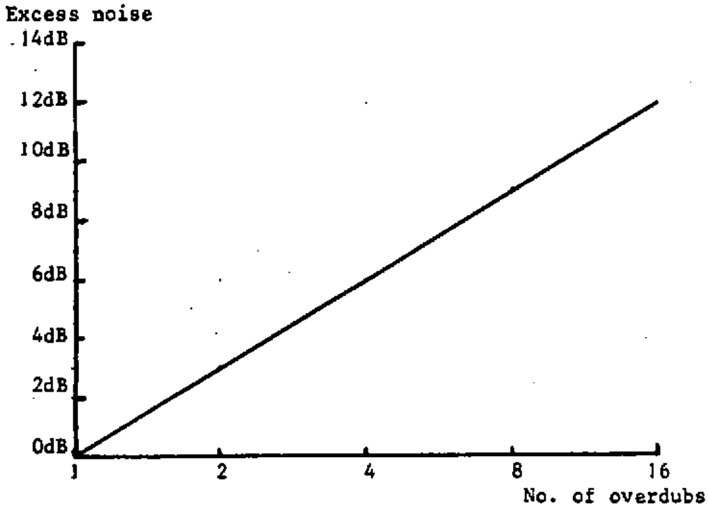

Figure 6 Build up of noise vs overdubs

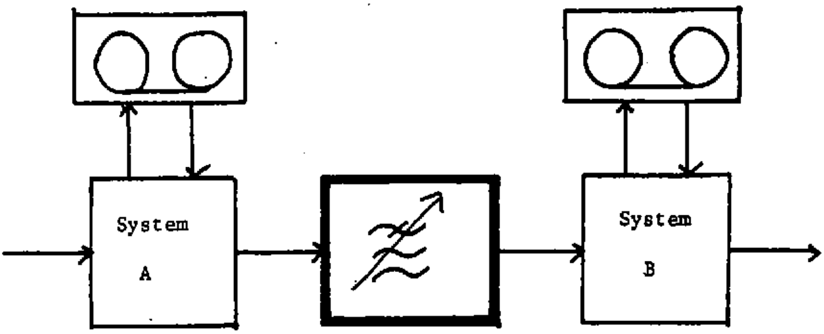

Figure 7 Reducing the tandeming effects