RECOMMENDATION ITU-R BS.642-1*

Limiters for high-quality sound-programme signals

(1986-1990)

The ITU Radiocommunication Assembly,

considering

a) that over-modulation of FM transmitters can cause distorsion of the programme material and interference to other transmissions;

b) that the level of some sound-signal components (most commonly those at the higher audio frequencies) may be raised by the application of pre-emphasis to the modulating signal;

c) that techniques exist to design low-distortion limiters without overshoot (for example, by the use of delay lines);

d) it is generally undesirable to subject sound signals to more than one limiting process,

recommends

1 that low-distortion limiters should be employed to protect transmitters against over-modulation, and enable more efficient use to be made of the available dynamic range;

2 that if pre-emphasis is applied, the limiter should take account of this. An example of a limiter which does this is described in Annexes 1 and 2;

3 that the limiter be situated at the interfaces between studios and sound-programme distribution circuits, so that each limiter may serve a relatively large number of transmitters and that in principle there may be no need to employ any subsequent limiting. Limiters so positioned may also provide a useful degree of protection against overload for the sound-programme circuits which follow.

ANNEX 1

Variable-emphasis limiters

Limiters are commonly employed at the programme inputs of frequency modulated sound-programme transmitters in order that the carrier deviation, and hence the signal-to-noise ratio at the receiver, may be kept as high as is practicable, whilst avoiding over-deviation and the consequent risk of audible distortion or of causing interference. Similarly, limiters may be used at the sending

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ends of point-to-point sound-programme transmission circuits, analogue or digital, so that the signal-to-noise ratios at the receiving ends are optimized, by permitting the signal levels on the circuits to be kept high without risk of distortion caused by over-loading.

In the above cases, the sound signals are commonly subjected to high-frequency pre-emphasis. However, programme levels are normally controlled using a meter at a point in the circuit which is not subject to pre-emphasis. In consequence high-level, high-frequency, components are likely to cause overmodulation – even on properly controlled programmes – unless a limiter is employed to prevent this.

In a conventional limiter, gain variations affect all sound signals equally, and limiter action brought about by high-amplitude high-frequency components may cause obvious and objectionable level fluctuations of low- and medium-frequency components in the reproduced programme. This effect, commonly known as "gain ducking" or "limiter-cut-back", may be reduced by allowing a wide margin between the nominal maximum programme peaks and the limiting level. Such a practice is considered to be undesirable, as the listening signal-to-noise ratio would then be less than it otherwise could be. Tests have shown that the need for this wide margin may be avoided by the employment of a frequency-selective form of limiter.

ANNEX 2

Description of a variable-emphasis limiter for high-quality sound-programme signals

A block diagram illustrating one form of a variable-emphasis limiter which has been found to be suitable for use on 50 μs pre-emphasized signals (a different value of pre-emphasis time constant may be used if appropriate) is shown in Fig. 1.

In the first stage, the incoming audio signal is limited by a "flat-spectrum" limiter using delay-line and gain change-rate control techniques to prevent transient overshoot.

In the second stage it is limited by a variable pre-emphasis circuit. This imposes 50 μs pre-emphasis so long as the resulting output signal does not exceed the prescribed maximum value, but momentarily reduces the amount of pre-emphasis as necessary to ensure that the prescribed maximum output level is not exceeded when high-level high-frequency programme signal components are present.

Subjective tests show a definite preference for a variable-emphasis limiter rather than a flat limiter. Further tests have indicated that if a peak clipper, set about 0.75 dB above the limiting level, is employed at the output of the limiter as shown in Fig. 1, it is not necessary for the variable emphasis stage to include a delay line.

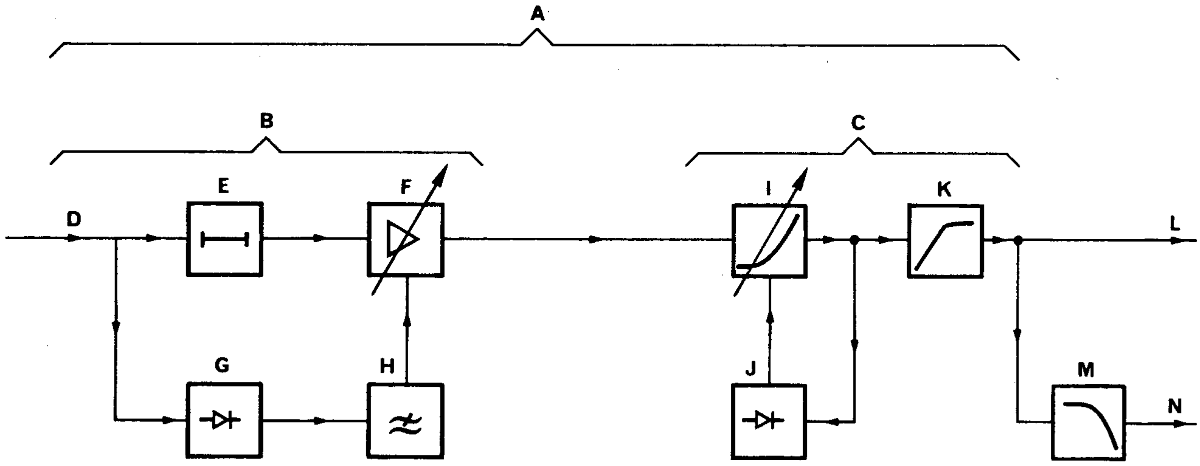

FIGURE 1 – *Block diagram illustrating one possible variable-emphasis limiter arrangement*

A: variable-emphasis limiter (complete)
B: 1st limiter stage (flat-spectrum, delay-line design)
C: 2nd limiter stage (variable-emphasis design)
D: audio input
E: delay line
F: variable-gain amplifier, with law appropriate for control provided by G
G: control signal rectifier, smoothing and time-constant circuits
H: shaping network (low-pass filter)
I: variable-pre-emphasis circuit, 50 μs quiescent
J: control-signal rectifier, smoothing and time constant circuits
K: peak clipper
L: audio output, 50 μs pre-emphasis protected
M: 50 μs de-emphasis network (optional)
N: audio output, 50 μs pre-emphasis protected signal with 50 μs de-emphasis applied, if required (i.e. for monitoring)

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