

SECTION 4 : FREQUENCY DISTORTION

(i) *Frequency range* (ii) *Tonal balance* (iii) *Minimum audible change in frequency range* (iv) *Sharp peaks*.

(i) Frequency range

Frequency distortion in an amplifier is the variation of amplification with the frequency of the input signal. A high fidelity a-f amplifier should have nearly constant amplification over the whole range audible to the most critical listener—from say 30 to 20 000 c/s (see Sect. 7). There is no serious difficulty in designing such an amplifier, but it can only be usefully applied when it is fed from a wide-range source and excites a wide-range loudspeaker system.

In practice there are limitations imposed by both the source and the loudspeaker, but it is good practice to design the amplifier for full-power-handling capacity with negligible non-linear distortion over a wider frequency range than it will normally be required to handle. The limitation in frequency range (if not inherent in the source) should preferably be applied either by a filter between the source and the input terminals, or in an early stage in the amplifier—see Chapter 15 Sect. 1(iii).

The full frequency range is only audible at very high levels as is demonstrated in Sect. 7. If a particular equipment is to be operated always at comparatively low levels (e.g. dinner music) or in noisy locations, reduction of the frequency range is quite correct and may even be beneficial.

Amplifiers for other than wide-range high-fidelity are usually designed to meet the requirements of the average listener, with a frequency range (at maximum orchestral level) of about 45 to 15 000 c/s, which may be still further reduced to about 70-13 000 c/s at typical levels for home listening—see Sect. 7(ii).

In commercial quantity-produced equipment the frequency range is often restricted to the extreme. By this means non-linear distortion and hum are reduced to a bearable level without expense. Unfortunately, frequency range can only be extended, while remaining free from obvious distortion, at a cost which rises at a rapidly increasing rate—largely due to the loudspeaker. It is important to reduce the distortion before widening the frequency range—see Sect. 12(ii).

(ii) Tonal balance

It has been found that good **tonal balance** between high and low frequencies is obtained when the product of the limiting frequencies is about 500 000* (Refs. A8, A17, A38, C1, C10).

For example :

1. 25-20 000 c/s. Very wide frequency range,
2. 33-15 000 c/s. Wide frequency range,
3. 50-10 000 c/s. Fairly wide frequency range,
4. 60- 8 000 c/s. Medium frequency range,
5. 100- 5 000 c/s. Restricted frequency range,
6. 150- 3 300 c/s. Very restricted frequency range,

but these should not be taken as more than a general guide. (5) is typical of a medium quality console, and (6) a mantel model receiver with "mellow" tone. These frequency ranges should include both amplifier and loudspeaker. Wide frequency range is only comfortable to the listener so long as other forms of distortion are imperceptible.

(iii) Minimum audible change in frequency range

Just as with sound level there is a minimum audible change in level, so there is also a minimum audible change in frequency range. The limen has been proposed (Ref. A25) as being the minimum difference in band width that is detectable by half the observers. Tests were made on a limited number of observers resulting in the following list of frequencies in steps of 1 limen : 15 000, 11 060, 8000, 6400, 5300,

*Various authorities place this figure from 400 000 to 640 000.