

required (or as far as the broadcast laws or equipment allows) and the only effect is to make the sound louder.

Consider the nature of the human voice and most musical instruments—they produce fundamental frequencies plus harmonic overtones. A signal comprised of fundamentals plus harmonics implies that we might expect waveform asymmetry; and this is the case. A good visual demonstration of this is to connect an oscilloscope across the output of a microphone, have someone say 'hello' into the mic and sustain the 'o' sound. The resultant trace will deflect much further in one direction than the other, indicating asymmetry. (Incidentally, a male voice is best for this test since, as a rule, they have much more asymmetry than female voices). Thus there exists asymmetry in voice and music, and negative modulation must be limited to 100%—but positive modulation is open to higher values. It would be useful if the incoming waveforms to the final limiter could be continuously monitored, and the proper phasing selected. This would allow the transmitter to always 'see' the higher value peaks as positive peaks, and the lower value peaks as negative.

This is what asymmetrical modulation is all about. No standard has ever been established for every component in every studio to be phased so that every voice recorded in every studio will always come out in the proper phase. The true asymmetrical limiter will continuously monitor the incoming line to determine whether normal or reverse phasing is necessary for max positive modulation.

Asymmetrical limiters are in wide use throughout the world. Problems arise where more than one microphone is used, and there is more than one strongly asymmetrical signal (such as two male voices) and the microphones are out of phase. As the first vocalist sings, the phase is switched to optimum. Then, the second vocalist sings and the phasing circuit must reverse the phase, and so on. *Don't Go Breaking My Heart*, by Elton John and Kiki Dee is an unusual record in many respects: firstly, Kiki Dee has an unusually asymmetrical voice for a female; and secondly, the microphones were reverse phased on the record. This caused the phase switching circuits in the limiters to be continuously searching for the proper phasing as the vocal bounced back and forth.

However, nothing is free and phase switchers are no exception—the price tag here is that of interrupting the signal as the phase is switched. Although the phase is switched in milliseconds, there is obviously a discontinuity in the waveform that can cause an audible 'click'. A properly designed limiter waits for a low passage or dead spot to switch in. On this record, however, Elton John's voice would start out phased properly; Kiki Dee would pick up and the limiter would recognise the reverse phase condition of her voice and would wait for a good place to switch. This occurred at the end of a verse, and the limiter would switch; but, then there would be Elton John's voice now reverse phased—back and forth throughout most of the song the peak limiter would be looking at the wrong phasing, and undermodulating the transmitter in the positive direction.

The only real answer to this problem was to either ignore it or to artificially make the vocal waveforms symmetrical so that the positive peaks could modulate near normal values. There are devices available that do this without excessive audio coloration, and that was my approach. The problem, however, is that advantage could never be taken of the naturally occurring asymmetry in the music.

It is obviously a great help to the broadcast engineer to have the recording studio check to ensure that all microphones are phased identically. This can be verified by an oscilloscope check of a male voice on each microphone. Obviously, this is not always possible, but it is good practice when recording in the studio, and should be done unless a desired effect requires otherwise. An example of how important asymmetrical modulation is to the broadcaster goes as follows: a 10 kW station puts out 40 kW peak power at 100% positive modulation; over 50 kW peak power at 125% positive modulation, and 62.5 kW at 150% positive modulation. Asymmetries where positive peaks are 1.5 times the amplitude of negative peaks are not uncommon in music. If advantage is taken of these asymmetries, the coverage and loudness can be increased in the same way as increasing the transmitter's power.

Asymmetry checks and spectral balance evaluation are two positive ways that can ensure the studio engineer is doing all he can to maximise the effective impact of his product on the listening audience. ■