

2.4.4 High power, the professional rationale p44

It was the demands of rock’n’roll sound reinforcement rental companies and guitar instrument amplifier makers that revolutionised the maximum SPL and hence dynamic range of the electro-dynamic drive-unit family: cone, compression and dome. Between 1965 and 1995, the ability of such drive units **to sustain power without frying**, and to give useful output in near proportion, has increased over 30 times, from barely 30w, to as much as 1kW. The techniques needed to cope better with sustained high power and excursions were pioneered as much in the UK (notably by Fane, ATC and Celestion) as in the USA (by JBL, Gauss and ElectroVoice). The development was co-spurred by power amplifier developments, as throughout Rock ‘n’ Roll’s history, the ratings of loudspeaker voice coils have lagged behind the power available to cook them. In the decade 1984–94, professional power amplifier makers competed at supplying a given power for less bucks, while also shrinking size and/or weight per watt. The exploration (making cheaper, smaller, lighter) amplifiers proved worthwhile, but while the amplifier makers’ backs were turned, some loudspeaker system developments crept up.

The majority of drive units built with modern materials can now handle music transients with instantaneous ‘power’ equivalent to at least 3 to 5 (and up to 10) times their AES (or EIA) power rating, depending on the music’s peak-to-mean ratio (PMR). To experience the full dynamic capabilities of such driver without risk of damaging them through clipping, amplifiers capable of delivering 1 to 10kW are required. Even for quite compressed music program with a 10dB PMR (averaged over a period), the long term heating (comparable to the AES rating) will be about 1/10th of the transient maximum (Figure 2.17), so a 600 watt rated driver (say) meeting this signal would be in no danger when driven by an amplifier rated for 2kW – assuming it has no excursion problems and is never driven into clip. Excursion capabilities have been extended in some high power drivers. The extra excursion may not be very linear but it is more linear than hitting the end stops or ripping the surround. In other designs, the pole pieces or other ‘end stops’ are made softer, so damage through over-excursion is lessened. Remaining excursion (X_{max} , $X_{destroy}$) limitations at the bottom-end of any driver’s range may be handled by suitable dynamic EQ processing [9]¹.

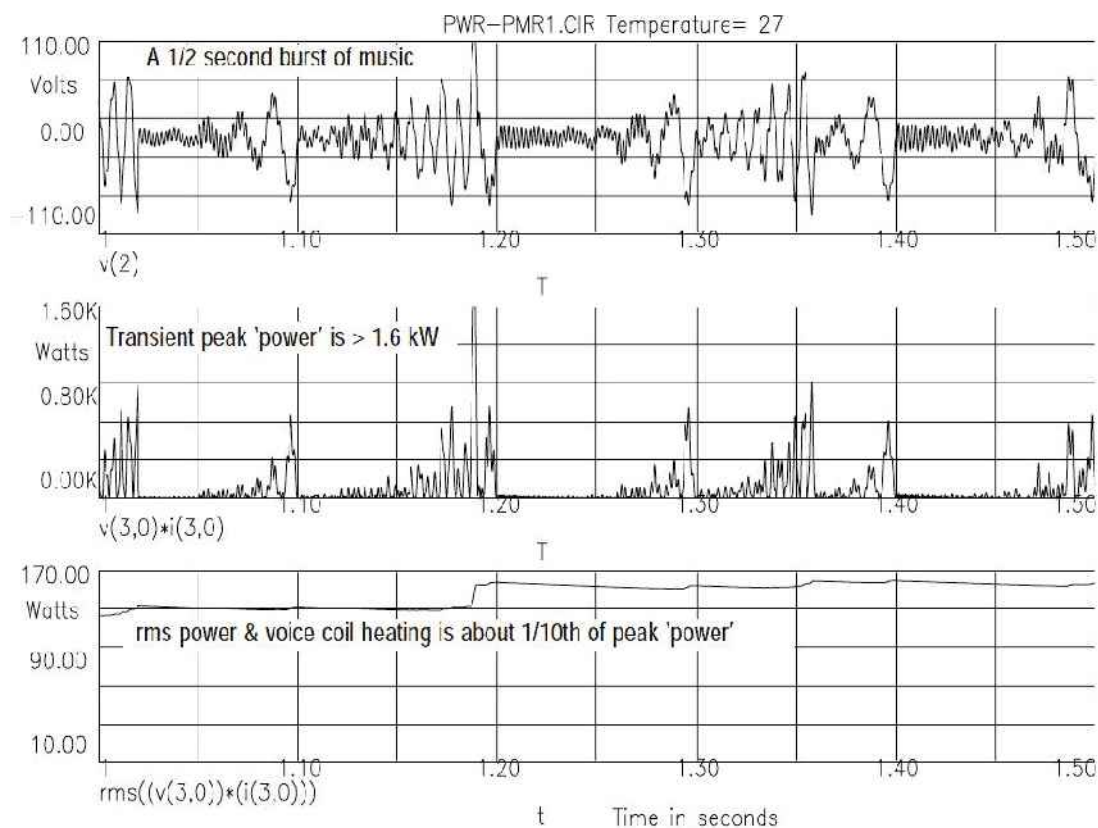
Why does anyone need all this power? In main studio monitoring, direct radiating and vented speakers with from 0.4% to at best 2.5% efficiency are the norm. This is better than some domestic designs, but no better than a quarter as efficient as the horn-loaded designs. Improvements in reproduction accuracy are usually at the expense of efficiency, so with continuing refinements, increasingly high power handling is necessary for the ideal single drive-unit per frequency band to continue to comfortably reproduce the highest SPLs in music, say 140dBc-wtdSPL. In medium to large-scale PA systems, for a given maximum SPL, higher power rated drive-units and amplification spells fewer drivers and cabinets. In turn, fewer speaker boxes (subject to having enough for full coverage) generate a more coherent soundfield – as well as lowering operating costs. In the UK, Turbosound have made breathtaking reductions in array size with their Flashlight and Floodlight speaker systems. Amplifier makers may in turn be challenged to put more power than ever before in a medium sized box, rather than offer existing power ranges in ever smaller, deeper boxes.

Figure 2.17 p45

*The upper graph shows a speaker-level music signal momentarily peaking at over 110V, and regularly peaking at over 55V. A 1kW/8 ohm amplifier would be required to handle this signal without clipping, but with just 1.5dB of headroom. The middle plot shows instantaneous power, which momentarily exceeds 1600 watts. This bothers the active devices inside the amplifier, **but not most drivers**. The lower plot shows the average power, the rms value that mirrors voice coil heating. Here, after 1.5 seconds it has levelled out at barely above 160 watts, or 1/10th of the peak instantaneous power. With adequate amplifier headroom, a 200 watt rated driver could be safely used in this situation, and with the*

1 [9] Duncan, Ben, & Mark Burgin, Dynamic loudness compensation, RP-3, Proc.IOA, 1987.

same music signal, a 600 watt rated driver would be safe with transient powers and voltages up to 3 times as large. However, an amplifier capable of about 220V rms (i.e. 3kW into 8 ohms) would be needed to realise this capability.



Tannoy's System 15 DMT-II is a major refinement and ruggedization of their renowned 15" Dual Concentric monitoring speaker. Standing just over 3'/1m high, it's been used by the author to test amplifiers of all sizes. It has handled over 1300 watts of bass-heavy house music and reggae as well as Baroque and choral music, without distress, although nominally rated at about a quarter of this. Increased power handling is equally about operating headroom and **the effortless sound it permits, most appreciated by those who can afford it, and about avoiding the amplifier clipping that's so harmful to drive units and human hearing alike.**

Reliance on limiters as the primary way to avoid output clipping creates a temptation to underspecify amplifier power, hence system headroom. This makes routine hard limiting more likely. The resulting compression may not be much kinder to ears and drivers than amplifier clipping. But with adequate amplifier headroom, limiters can be employed solely as safety nets, rarely to be heard.