Letters to the Editor

AUDIO AMPLIFIER LOAD SPECIFICATION

Like Mr Stuart, I go along with the principle of Mr Walker's proposal in the December issue but would like to reconsider the load values. Consider a simple case – that of a single-unit loudspeaker. This will have a rated impedance, R, stated by the manufacturer and subject to a manufacturing tolerance. Part of this will be due to variations in voice-coil resistance and part due to motional impedance effects which show up as a shallow minimum in the impedance curve, usually at around 400Hz. At low and high frequencies the reactive component will dominate and the impedance will be much higher than the rated value, falling to the d.c. resistance as zero frequency is approached.

The worst-case condition from the point of view in question, that of spurious operation of protection circuits, will be around that minimum of the impedance curve. Here Mr Stuart's $jXR / (R+jX)$ is a somewhat severe but fairly reasonable value.

The famous DIN 45500 gives a lower limit for the magnitude of the impedance of a domestic hi-fi loudspeaker of 0.8 times the rated value (although it is delightfully coy about the phase angle), and this applies to multi-way systems with dividing networks as well as to single units. It seems reasonable that monitor loudspeakers should be able to meet this standard (in the form 1.13 $jXR/(R+jX)$, that is) as well. After all, the BBC designs show very little impedance variation over the whole frequency range.

On examining typical loudspeaker impedance curves there seems to be little justification, however, for $R/2$, still less for Mr Stuart's $jXR/(R+jX)$ for *values of X between 0 and R*, and the demands made on heat sinks and power supply are considerably increased. An amplifier designed to drive the former load will, in fact, be capable of delivering twice its rated output power, which appears ultra-conservative. (For the latter case, no overload protection would seem possible.) Be sure that foreign competitors will not de-rate their products in that way – and it is likely to be economically better to improve the loudspeaker impedance curve anyway.

As to Mr Stuart's final query, the process is already under way. This subject is on the agenda to be discussed by Working Group 10 of IEC SC29B at Gaithersburg, USA, in March 1976. Opinions expressed through the columns of *WW* will be available to the members of WG10 by that time (or before, if they subscribe!). Furthermore, members of the Audio Engineering Society, British Section, will soon be advised of a new venture by which proposals like that of Mr Walker can reach, more quickly, a wide audience of informed opinion and progress to adoption as effective standards quite quickly.

J. M. Woodgate,
Hastings,
Sussex.

Peter Walker raises a very valid point in his reference to the reactive loading of amplifiers (December issue). We have tried to subject our amplifiers to such loads but have found difficulty in defining a "standard load". Our first attempt was to use an R50 crossover network (four section circuit) loaded by resistors. This load did not seem to be difficult enough. We then tried a Spendor BC3, perhaps the most difficult load currently on sale. The Spendor couldn't handle steady tones without (quite naturally) burning out. We were faced with designing an equivalent circuit of the BC3. We have not to date been successful.

To illustrate the problem we compared a P40 amplifier (well respected in its day) with a Classic Two amplifier. The amplifiers were alternatively loaded with an 8 ohm non-inductive load and an R50 loudspeaker. With the gains set for 10 watts into 8 ohms the results were:

	P40 8 ohms	R50
400Hz	0.035%	0.13%
1kHz	0.016%	0.062%
10kHz	0.022%	0.084%
20kHz	0.047%	0.15%
	Classic Two	
400Hz	0.0018%	0.0034%
1kHz	0.0027%	0.0073%
10kHz	0.0051%	0.015%
20kHz	0.018%	0.017%

The figures were measured on a Sound Technology 1700A analyser. The results achieved using the R50 as a load are as expected from its impedance curve. Equally with the Classic Two there was no disturbance on a 10kHz square wave of 12 volt peak-to-peak amplitude. Thus any measurable effects of the loading are probably only apparent at much higher levels, by which time the colourations of the speaker mask any amplifier colourations. Yet my ears tell me differently!

Stan Curtis,
Cambridge Audio,
Huntingdon.

I would like to add my voice to that of Mr Walker (December issue) in saying that a power amplifier must have a reasonable capability to drive reactive loads, if it is to truly called a high-fidelity amplifier.

His criteria seem reasonable to me (i.e. $R = \pm jX$), and indeed coincide with the often quoted load of $2\mu F$ // 8 ohms at 10 kHz. All too often one sees an oscillogram published in an amplifier review, of the square wave response of an amplifier at 10kHz, which shows very severe slew rate limitation with an 8ohm/$2\mu F$ load, but not without the capacitor.

I have recently been doing a good deal of work on class B amplifiers, and the requirement to deal with reactive loads has been well to the fore in my mind. The result of the work so far bears out Mr Walker's assertion that his criteria are no hardship to the designer.

I am frequently surprised at the relatively complex overload protection applied to amplifiers today, and especially that they often make no attempt to look at the mean rather than the instantaneous current. In my present class B design a simple fast-acting fuse is all that is used and this provides quite adequate protection from overload. I would add that the use of just a fuse means the use of transistors with a good safe operating area, and also the use of adequate heat sinks. To me, however, these two requirements are normal good design practice, which should be followed in any case.

Although the use of fast output transistors would seem to give a better output stage on paper, I have been able to get the necessary high performance I sought using 2N3055 (n-p-n) and 2N2955 (p-n-p) devices in the higher power versions of the amplifier, and owing to the use of a simple fuse the amplifier easily meets Mr Walker's requirements.

L. Nelson-Jones,
Bournemouth.