Technical note

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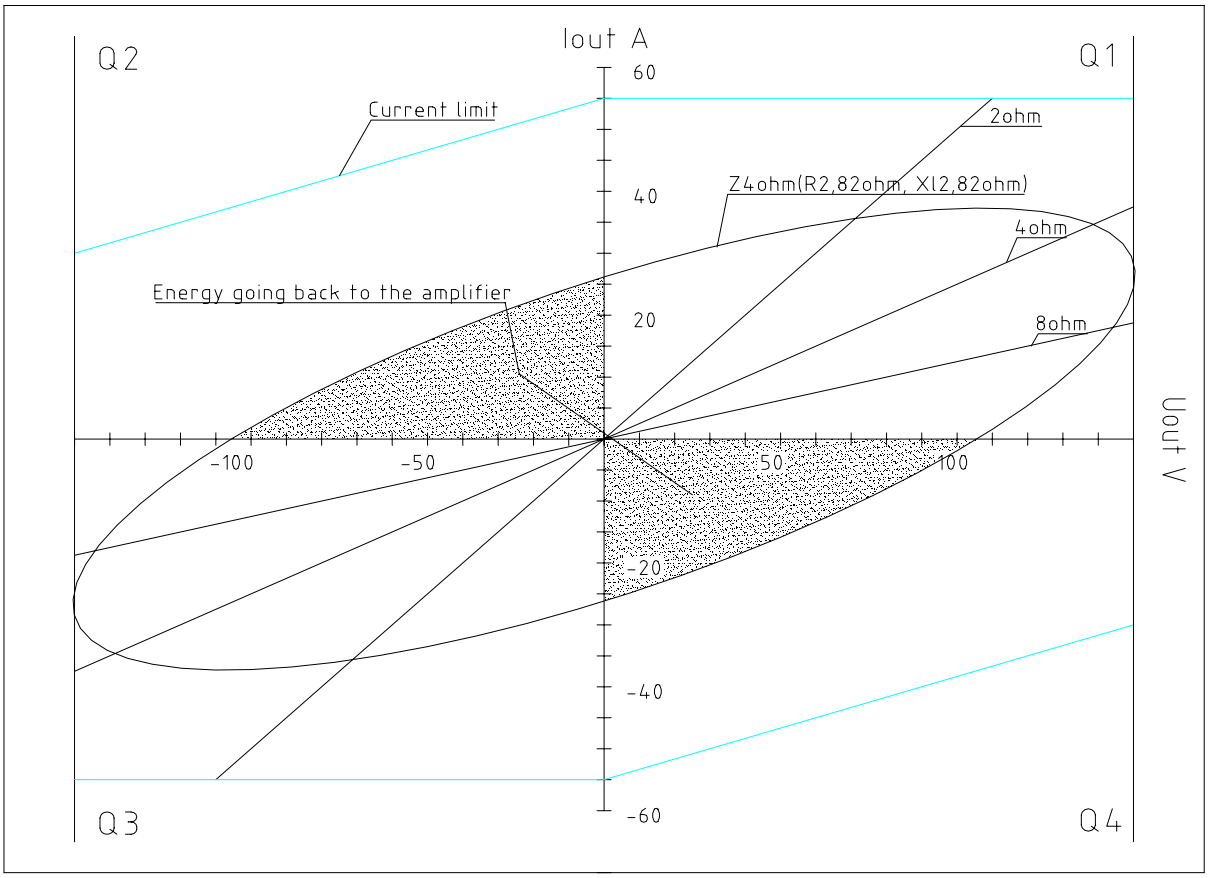
Important parameters for a professional audio power amplifier

1. The load



Different load lines, and limiting factors for a power amplifier

Different loads

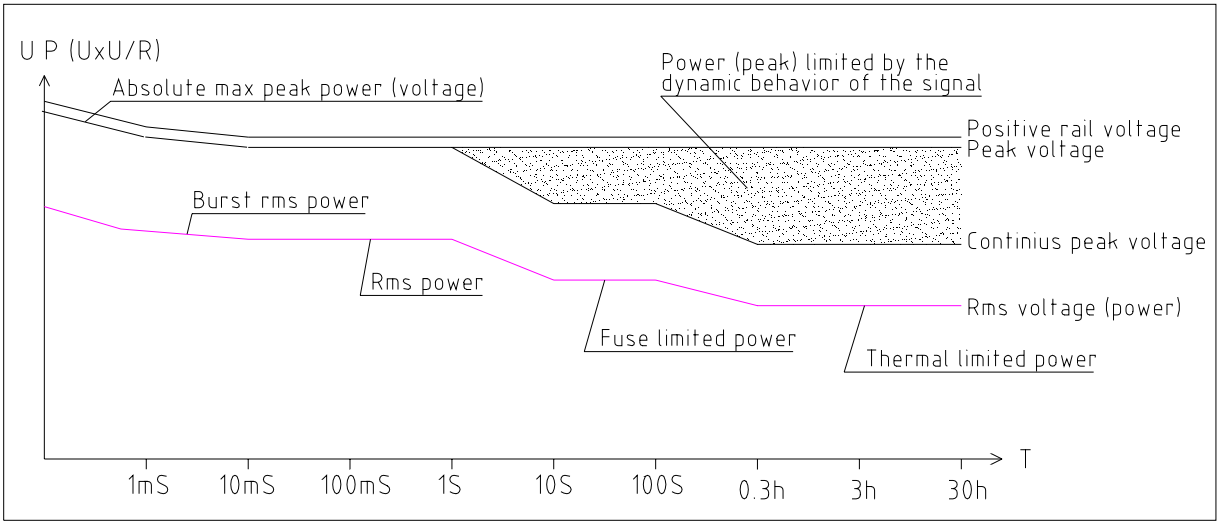
In practical use a professional power amplifier must be able to handle everything from open to shorted output. Normally the amplifier is tested with a resistive load of 8, 4, or 2 ohm. In practise this is never the case. A speaker cabinet is always a reactive load. A cabinet rated 4ohm can have impedance <3ohm, and >20ohm. If the impedance is low, and at the same time it has a big reactive part it put a lot of stress on the amplifier.
In the picture the load line for 4ohm impedance with equal resistive, and inductive (R=2,8ohm, Xl=2,8ohm) part are shown.
An important thing is that in quadrant 2, and 4 this load sends energy back to the amplifier.

Limitations

There are two basic limitations for the maximum power that can be delivered to the load.
Max output voltage.

Max output current. With a reactive load max current will not occur at max voltage. Depending on the limit-line and the load, current limit can occur at any voltage. Large currents in quadrant 2, and 4 can destroy the amplifier if the protection circuits are not designed properly.
The figure shows voltage limit for 8, and 4ohm resistive load. 2ohm resistive load is current limited. The reactive load is voltage limited, but if the input signal is increased the ellipse will grow, so that also the current limit can be reached.

2. Output power



Absolute max peak power.

The power at clip the first millisecond s at a transient. This is more or less the voltage at the power supply capacitors transferred to the load.

Burst RMS power.

Rms power measured with a 1kHz burst (10ms). This power is limited by both the sizes of the electrolytic's, and max current from the power supply.

RMS power

The power found after about 0,5s. The power is limited by the power supply. The power can be specified at 1kHz or for full bandwidth. (IEC 268-3 specifies that this power should be measured after 60s, but these will bee in conflict with fuse limited power.)

Fuse limited power.

Max continues power from the main outlet. Practical tests have show that a 16A slow blow fuse can carry >20A for 0,5min. Depending on the power supply this will limit the power some were around 2400W.

Thermal limited power.

Max rms power after 4h without thermal limitation. It is important that this is measured under realistic conditions with means that for a rack mounted amplifier there is no passive cooling on the top, bottom, or the sides of the amplifier. Practical experience have show that if the amplifier can handle 1/3 of the rms power continuously there will be no problem with thermal limitation.

3. Frequency response

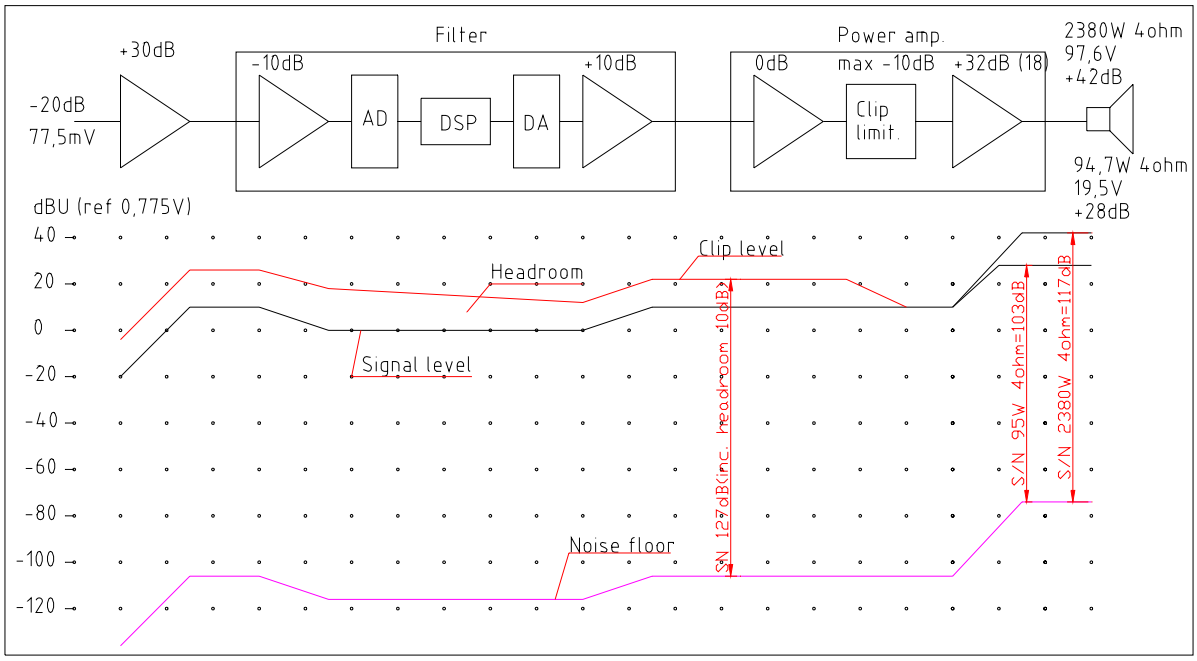
How small changes in amplitude can be heard?
Douglas Self is in his book, Audio power amplifier design handbook page 9, giving the figure 0,3dB as just detectable. This is a small change, so therefor frequency response must be handled carefully.

For class D amplifiers this can become a problem because the high output impedance, caused by output, and emc filter, will give a frequency response depending on the load impedance. In the worst case the filter can become in resonance with the load, causing many dB in amplitude change at high frequencies.

4. Distortion

How low distortion can be heard?
Douglas Self is in his book, Audio power amplifier design handbook page 9, giving some figures. 1% THD is just detectable. If it is cross over distortion even down to 0,3% can be heard. This figure can be reached by almost any amplifier topology.
In stead of distortion, many indications shows that the difference in sound between power amplifiers has more to do with frequency response, short circuit protection circuit design, and the behaviour of the amplifiers during overload and clip situations.
From the marketing point of view this figures are not acceptable because of the subjectivism in this field.
< 0,1% THD in a bench test is needed to not have the product rejected.

5. Noise



Method of measurement

All noise should be measured weighted according to the A curve (dBA). A steep low pass filter at 20kHz should limit the upper frequency. Frequency's above 20kHz are handled according to EMC regulations. (For a built in amplifier the bandwidth can be limited to the bandwidth of the driver.)

Noise level

Practical experience gives that a noise voltage of –75dBuA on the output of the amplifier are quiet together with most drivers. (Sometimes figures below this must be accepted). This means that an amplifier delivering 2000W in to 4ohm need a S/N of 117dBA. For an amplifier delivering 100W in to 4ohm a S/N of 103dBA is enough.

Headroom

If there is a clip limiter in the amplifier there should be min 10dB headroom before the limiter to make it possible for the limiter to reduce the gain 10dB. This gives that the equipment driving the amplifier should have a dynamic range of min 127dB. (Sometimes figures below this must be accepted).