AMPLIFIER HEAT OUTPUT AND CURRENT REQUIREMENTS

We are often asked by consultants and installers about heat output and mains requirements for our range of amplifiers. Since manufacturers do not actively publish these specifications in a concise way we decided to collate the figures and come up with a way to compute the results.

In order to understand what is involved, let’s first talk about heat output vs. power output.

Theoretically, at least, it should be possible to say that if a given amplifier is 100% efficient then all of the available power taken from the mains source is transferred to the load. (i.e. 100 Watts of power pulled from the wall socket is transferred directly to the loudspeaker without any losses at all).

In practice this is not the case. Amplifier designs today are typically between 25% and (claimed) 90% efficient with the remaining percentage of power being converted into heat. This heat is generated both inside the amplifier itself and in the connecting cables to the loudspeaker.

Heat generation in the cabling can be significantly reduced by using both short lengths and multi-strand large diameter conductors (just one of the reasons for using a good quality heavy gauge cable), although a certain percentage of power will always be lost through the hookup.

Whilst cable losses can be controlled to a certain extent, internal amplifier losses cannot, these being a characteristic of the particular design. Different design types or "classes" are directly responsible for the amount of heat produced together with imperfections in the design caused by the component restraints themselves. Hi-Fi buffs will tell you that "Class A" design amplifiers are by far the best sounding. In many cases, the excellent audio quality, "top of the range" Hi-Fi amplifiers are indeed Class A designs, but they are also the least efficient, producing more wasted heat than any other class.

Amplifier designs are progressing rapidly resulting in amplifiers that are becoming more efficient in terms of power wastage but preserving the excellent audio quality that is becoming widely sought after without resorting to operation entirely in Class A.

These internal losses (i.e. the wasted heat that is produced) can be of major consequence when many amplifiers are housed in multiple racks in a large installations in an enclosed (usually VERY small) equipment room (– the last thing the designer thought about!)

Air-conditioning is often necessary to keep ambient room temperature within acceptable limits for necessary equipment cooling.

To specify air conditioning requirements, it is necessary to know maximum heat output from devices in advance of installation – information that many manufacturers either cannot or will not supply.

In order to do this they would have to specify the efficiency of their designs, a fact that some would not like to disclose!

This can often be difficult to calculate as different models across the range are of totally different design. Cheaper amplifiers are built with different layouts and different circuitry mounted in different enclosures. The more expensive units are designed differently making it impossible to calculate heat outputs based on a general figure for their efficiency.
The only real way to find out is to measure the units yourself. Without proper test equipment this is not a five minute job.

Due to standardisation of layouts it’s easy to calculate what the predicted heat output is likely to be for each of the different models as most (standard technology) amps are around 65% efficient. This means that for every 100 Watts drawn from the mains supply 65 Watts is actually delivered to the load and the rest is generated as heat.

Although 65% sounds a little low this about on par with most of the rival manufacturers for this type of design. Also, another factor to add in, the standby power (when the amp is not doing anything). This, we have assumed to be 90W for all units.

Knowing these facts, an equation can be constructed to calculate the maximum heat output for the specific amplifier.

The calculation becomes:

\[
( ( ( (A*2)B*C)/E ) +Q)*D
\]

For A = Max. Amplifier output @ 4 ohms per channel

For B = 0.4 (The duty cycle of the input signal 40%)

For C = 0.35 (The inefficiency i.e. 100% - 65% = 35%)

For D = 3.415 (The conversion factor to convert watts to BTU/Hr)

For E = 0.65 (The amplifier efficiency 65%)

For Q = 90 (The quiescent (standby) power consumption)

As an example the MA600 (340W per side into 4 ohms) calculates up like this;-

\[
( ( ( ( 340 x 2 ) x 0.4 ) x 0.35 / 0.65 ) + 90 ) x 3.415 = 807.52 \text{ BTU/Hr}
\]

To calculate for other models, substitute the figure accordingly.

**CAVEATS**

Bear in mind that these figures are based on continuous maximum output power with both channels driven. In practice these heat output figures will rarely be obtained due to the intermittent nature of audio signals. The figures above are based on a duty cycle of 40% representing loud, compressed rock music played at the limit of the amplifier. For speech requirements the duty cycle is more like 10% and the figures can be amended accordingly (B = 0.1 instead of 0.4)

It follows that if you know what the efficiency is it’s quite possible to work out what the power requirements of the device in question are.
Taking an amplifier, with an output power of 820W per channel into 4 ohms, adding these up gives 1640W. Allowing for efficiency of 65% this means that you will need an additional 35% of power to deliver 1640W so if 1640W is 65% of the total power taken, 1% is 25.23W (1640/65).

Therefore 100% is 25.23*100=2523 Watts. Converting this to current draw using :

\[ I = \frac{P}{V} \]  
\( I = \frac{2523}{240} \), (of course, V is 240 volts) gives 10.51 Amps.

Finally the formula for this is:

\[ \frac{\left( \left( \frac{O/P \text{ Power at 4ohms} \times 2}{65} \times 100 \right) \right)}{240} \]

(Note: Strictly speaking the 240v should be multiplied by the power factor as there are other losses to take into account. If you wish to compute these figures then multiply the 240 by 0.83.)

Again, please remember that these calculations are for worst case outputs. In practice these limits will rarely be achieved. I’d suggest that in both cases, for the heat figures and the current figures, they be derated by about 15 – 20 % to give more reasonable workable figures in the "real world".

Power factor computation is not included in these figures. As a rough guide, absolute max. current draw should be no more than 30% higher than the above figures.

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