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About Power Ratings Power Amp Design

Synopsis: A brief discussion of the meaning of power ratings as they relate to power operational amplifiers.

When we want to purchase a home stereo amplifier we might consider the power rating of the amplifier, say a 100 watt amplifier model vs. a 200 watt model. What does the power rating mean? Does the power rating mean something different for a power op amp?

In the audio amplifier market there are many definitions for the power ratings of an amplifier but they all relate to the power that can be delivered to the load (speakers) and the rating always relates to sine wave signals to the load. DC to the load is not considered (we can't hear DC) and even avoided in the amplifier design since DC to a speaker can damage the speaker voice coil.

With home audio amplifiers there is also no discussion, or rating, of the power dissipation capability of the amplifier or often even a rating for the temperature extremes over which the amplifier can operate safely. It is assumed that the amplifier is going to operate in the home and that the ambient temperature is not going to vary much. And since the amplifier is purchased as a whole unit the user does not need to consider the power dissipation capability of the amplifier — that was the job of the amplifier designer.

But with applications in the industrial world we do need to consider ambient temperature, DC operation and other factors safely ignored in home amplifiers. Although the power operational amplifier (power op amp) can be used as an audio amplifier the language for power ratings of industrial power op amps is quite different. For one thing, the hyperbole of consumer marketing advertisements for home stereo amplifiers is usually avoided since engineers are probably going to see through the hype and are looking for solid technical information that insures their application circuit is going to be reliable.

A power op amp is considered a component since the op amp needs power supplies, other components and a printed circuit board to connect all the pieces together to produce a finished amplifier. As such, the designer of the application circuit using a power op amp must consider the ambient environment, both the DC and AC power dissipation capability of the power op amp, and the required power needed to drive the load.

Integrated circuit or hybrid component power op amps are usually rated, not for their power output capability, but for their DC power dissipation capability, with the amplifier case (the area connected to the heat sink) at 25°C and the junction of the power transistors in the output stage of the amplifier at their maximum rated junction temperature (usually 150°C or 175°C). This is just a reference point so that various products can be compared in that regard and doesn't reflect an operating condition that is usually achievable in a real-world application.

To calculate the actual power dissipation capability of a power op amp the application designer needs to know the thermal resistance of the amplifier itself (junction to case), the power dissipation expected in the application, the thermal resistance of the interface material between the amplifier and the heat sink (thermal grease), the thermal resistance of the heat sink and the ambient temperature expected for the application.

Consequently, a component power op amp rated for 125W might, in a real-world application, only be capable of 50W of power dissipation or even less. This is a common result with commercially available heat sinks, even with those heat sinks made available by the manufacturer for their products.

Power Amp Design power op amp products are rated differently since our amplifiers are supplied with integral heat sinks and fan cooling. Our amplifiers are still component power op amps but most of the derating factors have been eliminated for the user. When we rate an amplifier for 100W we mean the amplifier can dissipate 100W DC with 30°C air at the fan inlet. And since there are no other factors to derate the amplifier dissipation capability, the 100W dissipation capability is readily achievable. In short, our dissipation rating of 100W means 100W DC in real-world applications and the designer doesn't need to apply any derating factors other than the ambient air temperature expected.

Dissipation capability for AC signals is usually significantly higher than for DC signals. For AC signals the output transistors (usually two, an N type and a P type) are able to share the load and thus the apparent thermal resistance of the amplifier is lower. But Power Amp Design doesn't use AC thermal resistance to rate a power dissipation rating capability. We use the AC thermal resistance to rate output power capability with AC signals. *By output power capability we mean the maximum continuous RMS power delivered into a resistive load when the output signal swings to its maximum peak to peak value with the maximum power supply voltages applied.* This is a somewhat ideal condition but one that can do useful work in a real-world application. Some manufacturers refer to the power delivered to the load with the amplifier locked up to one supply rail. This condition does deliver the maximum power to the load, but this is not a useful condition in most real-world applications.

The real measure of a power op amp is not the power it can deliver to the load but the power dissipation the amplifier must withstand while delivering that power. It's usually not easy to calculate the maximum power dissipation an amplifier must tolerate in an application circuit, especially with reactive loads. To solve this problem Power Amp Design has developed a custom Excel based design spreadsheet called **PAD Power**[™] that can easily calculate power dissipation, junction temperatures and heat sink temperatures given all the circuit parameters for load, signal and power supply voltages for each of the power op amp models available. PAD Power is available free and can be downloaded from the website. [_](#)