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MAKING SENSE OF AMPLIFIER AND RECEIVER SPECIFICATIONS

Whether you are selecting a surround sound system or experimenting with rendered sound, at some stage you will need amplifiers. '*Making sense of amplifiers and receivers'* is intended as a general guide to selection.

Most people know about electrical power from experiences with the mains power supply authority – power consumption costs money. The authority supplies you with 240 volts all (well most of) the time. These volts do the "pushing" – 240 volts can push a lot harder than say 12V as anyone who has received an electric shock will know. The current tells the amount that flows as a result of this electrical pushing and this depends on what you plug in – up to the point that the safety fuse blows, of course. If you turn off the switch and do not draw any current you do not use any power. In Australia, with a 240 Volt supply the maximum power available from a power point with a 10 Ampere fuse is 2400 Watt.

> The relationship is
> Power = voltage x current
> or
> P = V.I
> Ignoring phase angle

An amplifier is like a miniature power station that supplies electrical power to the loudspeaker. With amplifiers, the power supplied to the speakers is related to the current and voltage in the same way as the mains but the values are usually a lot lower and the power is in the form of an audio signal, hopefully without any mains hum.

Another key difference is that unlike the mains supply that maintains a constant voltage, the amplifier output voltage must continuously change in response to audio signals.

The power rating of the amplifier tells you the maximum power available for supply to the loudspeakers. The technical term used is the Root Mean Square (RMS) power measured in Watt. Figures of between 30 and 150 Watt RMS per channel are common for modern domestic systems.

Amplifier power ratings are a little more complicated than mains supplied power for four main reasons.

First, humans can hear quite low levels of distortion in audio signals and so can hear when the amplifier starts to overload. As a result, it is important to know the maximum power output at a given and low, ideally inaudible level of distortion.

For amplifiers, distortion figures of below 0.1% are easily achievable and this is generally inaudible for all but the most trained ears.

> **Amplifier load impedance**
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> The presence of separate current and voltage limiting behaviours in amplifiers implies that there is a "sweet spot" for the amplifier load – the loudspeaker. Some means of matching the amplifier and speaker is needed. This is called the load impedance. Each amplifier is designed to have maximum output power when working into a particular load or impedance that maximizes the current and the voltage simultaneously. This does not mean it is the only load that can be used, it just optimises the power from the amplifier. Any load can be used as long as the current and voltage capabilities of the amplifier are not exceeded. It is common to use a load impedance of 8 Ohm for tests of domestic equipment. Some manufacturers will also quote power available into other load impedances.

Second, humans can hear a wide range of frequencies – from below 20 Hz to over 20,000 Hz. The amplifier needs to state the range of frequencies for which full power is available. This is usually described as the power bandwidth.

Third, the amplifier power rating does not tell you the maximum output voltage or current capability, it just tells you the combination of the two. Distortion could occur because the amplifier is running out of output voltage. This type of distortion is usually referred to as clipping. The peaks of the signal become clipped. Alternately the amplifier may not be able to supply the current the speaker requires and so distorts. This is referred to as current limiting.

As a result, two amplifiers with the same power rating can be quite different. One could be designed to supply low output voltages but lots of current to make up the power whilst another could be designed to supply lots of voltage but be limited for available current. The power rating would be the same but the overload behaviour would be quite different.

Fourth, music is not a constant signal, it has wide ranging dynamics – a high peak to average power ratio. Some amplifiers may be able to provide higher levels of power for short durations and so better cater for the peaks before distorting. This should sound better on some program material with large short term peaks even though the long term average power is the same as for another unit. With the increasing use of dynamic range compression with all manner of media this is less of an issue but it is still valid.

There is also a wild card in the deck. Amplifier manufacturers want to present their products in the best possible light. As a result, some manufacturers develop proprietary tests favouring their products over others. Amplifiers with high values of low distortion RMS power are expensive to build. Budget design manufacturers often use short-term peak power ratings to provide impressive but somewhat unwarranted numbers for their products. For example, the use of “Peak Music Power Output (PMPO) ratings enable a nominally 10 Watt RMS rating amplifier to be advertised as a 200 Watt unit. With these approaches it is possible to have a multi-channel receiver with total audio power output ratings that well exceed the mains power available! This has been such a problem world-wide that most authorities have mandated standard test procedures and methods.

In Europe these are collectively referred to as the IEC standards and the measurements resulting as IEC (or in older equipment, DIN) power. Other traceable standards include AES (USA) and SMPTE (USA). Standards commonly used for domestic equipment include EIA(Japan) and IHF (USA). In each case the number given is meaningless unless some detail of the test procedure is given.

The following table compares typical RMS and peak power ratings for three amplifiers – a general purpose unit, a high performance professional unit and a budget unit. and gives some idea of the danger of comparing power output numbers alone.

	RMS power (Watt)	IEC rating (peak Watt)	Proprietary peak/dynamic rating (Watt typical)	PMPO (Watt typical)
Budget unit	10	12	20	200
Popular amplifier	50	55	100	Not common
Professional unit	100	110	Not used	Not used

What to look for

The specification should quote minimum RMS power for each channel over a power bandwidth at a maximum distortion level and for a load impedance.

For example: Minimum per-channel power 100W RMS into 8 Ohm over a power bandwidth of 20 Hz – 20 kHz with less than 0.04% Total Harmonic Distortion (THD).

This is the basic requirement. Additional specifications can be provided with the relevant test standards identified. For example IEC output power, Dynamic power (IHF). 8/4/2 Ohm 120W/180/250W" (in addition to the mandatory RMS power specification above). This additional specification shows that this particular amplifier is a quality unit capable of providing high currents into low impedance loads for short bursts and would suit lower impedance loudspeakers.

Other factors - dB scales and human hearing

Human hearing is extremely sensitive and varies over a very wide range of acoustic power. Rather than use a linear scale and have lots of zeros or decimal places, it is common to use a non-linear or logarithmic compressing scale. The table shows the approximate human hearing range in both formats.

	Power (acoustic Watt)	dB SPL (logarithmic)
Threshold of hearing	.000000000001 Watt/m^2 (1×10^{-12} Watt/m^2)	0 db
Maximum sound level before pain	10 Watt/m^2	120 dB

Note that this is sound power in the air, not amplifier power. The efficiency of the loudspeaker would need to be taken into account to determine the necessary amplifier power.

What is amplifier damping factor?

Damping factor is a measure of how well the amplifier can control any unwarranted loudspeaker output. Damping is active whenever the amplifier is switched on and is independent of any audio signal present. A high damping factor figure means that the amplifier will exert a high level of control over unwanted or undesirable loudspeaker behaviour. A figure of more than 100 is considered acceptable.

How much amplifier power sounds twice as loud?

Humans perceive relative rather than absolute sound levels. As a result a doubling of acoustic power (3 dB) is only just perceptible as louder. Up to ten times the power (10 dB) is needed to give a subjective doubling of perceived loudness. So to make an undistorted 50 Watt RMS system sound twice as loud you do not need 100 Watt, you need more than 500 Watt. - and you also need loudspeakers that can handle this power without distortion. In practice most systems run at far lower average power levels than their maximum ratings and thus have significant headroom before overload. It is easy to be tricked. Low power systems begin to sound very loud (and annoying) when they start to overload and distort. Also note that you cannot sneak up on the amplifier with a very large transient to beat the power limit. The amplifier will reward you with clipping of the peak and distortion.

What is headroom?

Headroom gives the amount of additional power available for short term peaks. It is another way of specifying dynamic power. Headroom is usually quoted in dB with figures of 1 – 2 dB (25 – 50%) being common.

Signal to noise ratio

It could be a great amplifier, but humans have very sensitive hearing. The amount of hum and noise from the amplifier without an input signal also needs to be considered. Reasonable quality amplifiers have signal to noise ratios greater than 100 dB. Higher power amplifiers should have greater ratios if you do not want them to be heard in the background. This is because the signal to noise figure is most commonly referred to the maximum output; larger output amplifiers will have more base level noise in the same specification as a result.

The weakest link

The loudspeaker is basically a mechanical device that does the tough job of converting the electrical signals from the amplifier into sound waves. It is common for distortion figures of 2% to be routinely introduced by the loudspeakers themselves when played at typical listening levels. Although all distortion detracts from the quality of reproduction, most amplifiers routinely produce less than 0.1% distortion. Their contribution pales into insignificance when compared to the loudspeaker contribution. Most manufacturers are happy to quote impressive amplifier distortion figures but rarely if ever quote loudspeaker distortion figures for this reason.

End to end assessment

A more meaningful way to assess any combination of the amplifier and loudspeaker is to measure how much overall distortion is added by the amplifier and loudspeakers from the source to the listener's ears.

A maximum sound level will be achieved for a given distortion and this will give a measure of relative performance, appropriate listening distance and an indication of the size of room suited to the equipment.

So how much power do I need?

There is no hard and fast rule as speaker power rating and efficiency, listening distance, desired loudness and even background noise levels all play a part. For typical domestic listening, amplifier power ratings between 50 and 100 w RMS per channel should be sufficient. You do not have to use all that power, you just need to have sufficient reserve to avoid distortion on peaks.

Amplifier ratings are a confusion of real and mis-information. This article tries to clarify the key issues and separate fact from manufacturer fiction when comparing amplifier specifications. But remember to thoroughly check out the loudspeakers you intend to use with the amplifier. They could turn out to be the weakest link.

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