About The Author
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Alex first picked up a bass when studying engineering at university, and his quest for sonic perfection led him to found Barefaced Audio, while also leading The Reluctant, an alt-ska/funk outfit.

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This column is brought to you in association with Barefaced Ltd who manufacture high-output speaker cabs for the gigging bassist. Barefaced have recently launched their new Big Baby and Big Twin cabs, the most accurate and extended range bass cabs ever made. An archive of previous articles plus a glossary of terms can be found at **www.barefacedbass.com**

Our First email To bgm@barefacedbass.com Was An Interesting One!

Bob writes: "A couple of years ago, I treated myself to a 600W 1x15" combo which, according to the manufacturer's imaginative specification had a power rating of 600 watts RMS. In use, I was very disappointed with the performance which did not live up to what I would have expected from a unit of this power. With some interest, I noticed that the label by the mains socket on the back stated that power consumption was 220 watts so, even taking into account the class D output stage and the switched mode power supply, would have realistically resulted in about 180 watts RMS at best. I emailed the manufacturer in the USA and was given some fairy story about European specifications; I also took this up with the Advertising Standards Authority but they were unable to do anything because the manufacturer's specification was prepared and issued in the USA. I'm not sure how they get away with it, but perhaps an article about the differences between RMS, peak power, music power etc would be interesting? Incidentally, I have now sold it and replaced it with a 350W 2x10" combo, which performs exactly how I expected a combo of this rating to behave... ...[previously] I had a 410 combo from about 1985. Good, combo but soooooo heavy!"

So has this bassist been hoodwinked?

In short, yes and no. Or vice versa. In long, it's complicated! Let's look at the first point: How can the output power of an amplifier be greater than the power consumption from the mains supply? The fundamental issue is that music is musical – it has quiet bits and loud bits. Consequently modern class D amplifiers are no longer designed to be able to sustain their full power output for an extended period of time. The most common power modules found in class D bass amps are B&O IcePower modules and here are the specs for the 500W @ 4 ohm model: (see Fig1)

Why the huge differences?

The manufacturer's ratings are for short bursts of full power (probably 200ms) like you'd find in real music (bass drum hits, big downbeats with everyone landing on The One, etc). The FTC rating requires 'pre-conditioning' the amp by running it at 1/8 power for an hour (basically getting it warm) and then running at full power for 5 minutes. It has to meet the manufacturer's specified % THD at this full power rating, and the amplifier has to run without thermal or current related shut downs or limiting throughout the 65 minute duration of the full test. FTC stands for Federal Trade Commission and is so called because they introduced a ruling in 1974 that all home-audio amplifiers sold in the USA must state their power rating following this more exacting test (in response to the RMS/MPO/PMPO silliness that had begun to proliferate). The long-term thermal rating is for the module without additional heat-sinking or fan cooling, at 25 degrees Celsius ambient temperature.

80% efficiency and 220W input equals 176W

A typical class D amp with SMPS (switch mode power supply) is a very efficient beast so Bob's calculation is correct. But to provide some perspective let's look at a proper power amplifier, a 3000W monster which we at Barefaced own, rather than a bass amp: (see Fig2)

As this amplifier runs on 230V mains (probably closer to 240V

The suspicious mains input

in the UK) through a 13A socket there's 'only' 3000W available from the wall, hence the numbers in bold aren't actually attainable. (You may have also noted that this class H amp with SMPS is only 50% efficient – still much more efficient than a class AB amp with conventional 50Hz transformer). But as we said, the use of power is hugely variable, quiet notes need very little power, loud notes need lots. Think of it like your daily water requirement – when you run a bath or have a shower you're using far more water than is available to the square footage you live in from the precipitation at that moment. But when you're not washing, cooking or making cups of tea you need no water. The mains water system uses reservoirs to collect the relatively low rate but high time period of rainfall and this buffers the high demand on water when so many people are getting up and having simultaneous showers. Likewise the power supply in your amplifier contains large capacitors which act as reservoirs for electrical power,

Fig 1

Type of power rating	Power	Total Harmonic Distortion	Frequency
Manufacturer's	550W	1%	1kHz
Manufacturer's	550W	0.05%	1kHz
FTC	200W	0.05%	0-3kHz
Long-term thermal	90W	0.05%	Unspecified

Fig 2

Power Consumption	Typical (1/8 power with pink noise)	Full (1/3 power with pink noise)	Max (continuous sine wave @ 1%)
8 ohm	720W	1320W	2400W
4 ohm	1140W	2040W	3960W
2 ohm	1680W	3240W	6000W

holding large amounts of charge (current x time – analogous to litres of water) at high voltage (analogous to high head, i.e. up a water tower). When you're rocking out these capacitors can supply the power you need to get the full 600W (in our original case) from your amp for the peaks of the loudest notes, and in the quieter moments in between (remember, even the sustain and decay of a loud note is pretty low power in comparison to the peak on attack, and the muted moments between notes require zero power) the capacitors get to recharge from the wall.

PMPO, MPO and all that rubbish...

Music Power Output tends to be just RMS power output doubled and Peak Music Power Output is MPO doubled. Both these terms mean almost nothing – the peak power output is simply the peak voltage multiplied by the peak current and the former is fixed by the amplifier voltage rails and no amount of wishful marketing thinking will change that. Yes, amplifiers can often manage bursts of much greater output than their continuous output (as shown above) but as RMS ratings are often based on bursts you can't then quadruple that figure to make a spec of any use (or with a modicum of honesty!)

So why does this 600W combo sound so much quieter than expected?

We've already discussed that the amplifier section probably produces the claimed power (or close to it within the rather loose specification tolerances found amongst bass amps), despite the seemingly magical ability to produce more power than it takes from the wall. But we don't hear electrical watts, we hear acoustic ones. This means that the lone 15" driver in this combo has to be able to handle all that power and turn it efficiently into loud sound and this is by far the weakest link in the chain! (see Fig3)

Bob's previous combo was a mid '80s 150W 4x10" of green-ish aspect and this combo had two advantages over the modern one: The greater cone area and enclosure size both increase the low frequency sensitivity so it produces more decibels per watt, meanwhile the larger cone area more than makes up for the inferior cone excursion of the older speakers, hence the volume displacement (ability to move air) is higher. All three combos have enough power to drive their speakers to full volume displacement (because the amp power output is greater than the mechanical power handling) so the maximum low frequency output (which is the key with bass) is determined by the volume displacement. So we've shown that an old 150W combo can more air and thus produce louder fatter lows than a new 600W combo. However, if both combo's were named or described by their volume displacement then no-one would have been disappointed – the old combo was a 440cc one, the new combo a 380cc one. Should we not be naming combos and cabs by how much air they can move? Most of know that's what matters because it's what we FEEL when we use them!

Shouldn't a 600W combo use a 600W loudspeaker?

Well that would be nice. But here's the problem – once you figure in the retailer, distributor and manufacturer margins, all the shipping costs, marketing cost, and the manufacturing cost (often one of the smaller components) there's rarely much money left for a really good loudspeaker. And a single 15" loudspeaker which can handle 600W happily and do something useful with it is not going to be cheap. You can make an inexpensive yet sensitive (i.e. LOUD) woofer by using a short voice coil and pushing a good amount of magnetic flux across that coil. Or you can make an inexpensive woofer that'll handle lots of power and moves lots of air by using a long voice coil and having a relatively weak magnetic field across the coil but it'll take lots of watts to play loud and it'll sound very woolly and lack midrange punch and treble attack (and it'll be called a car subwoofer!) To make a woofer sensitive and able to move lots of air you need a big magnet to give you a strong magnetic field across a long voice coil. Big magnets are expensive (and heavy if they're not neodymium) and require expensive cast baskets to support them and keep the motor well aligned. Keith Bontrager is often quoted in the world of cycling as saying, 'strong, light, cheap, pick any two'. With loudspeakers 'loud, light, cheap, pick any two' tends to be applicable.

The barky bitey punchy side of things

There are a few other issues we also need to consider in why this new combo didn't sound as loud expected. The old 4x10" and the new 2x10" combo both use loudspeakers with short (and thus low inductance) voice coils. Inductance in a loudspeaker acts as a first order low pass filter. The other first order low pass filter you'll all be familiar with is the tone knob on a passive bass (or guitar). Increase the inductance in the woofer and you have a similar sonic result to turning the tone knob down – less brightness in the treble. Less brightness equals less loud and less clear. Many people would assume that the reason for the reduced brightness is because it's 10"s vs 15"s but it's actually the voice coil inductance that dominates the treble difference.

Another consideration is the thermal power handling of the loudspeakers vs the output of the amplifier – greater relative thermal power handling equals less power compression which equals more output and a more dynamic sound and feel at very high SPL. Once again ye olde 4x10" wins out.

Finally, the less fancy speakers in the old premium combo and the new budget combo will exhibit greater distortion – and as you'll have noticed with guitars, add distortion and it makes things sound louder. In fact, a really good loudspeaker will often sound surprisingly quiet when cranked up, as we've all become conditioned to associate loudness with high distortion (we're talking about the sort of distortion that isn't very obvious at all, it just sounds like LOUD music), and it's only when you try to talk to someone over this loud but clean loudspeaker do you realise how loud it really is.

To conclude...

High power amplifiers are pretty cheap nowadays. High 'power' speakers aren't. The output of a combo or cab would be better described by its volume displacement in cubic centimetres than its amplifier power output (with a combo) or thermal power handling (with a cab). When shopping for a combo you need to consider how much air it can move – and if the cone area is smaller than what you're currently using then you need to find out if has the cone excursion to make up the difference. Don't be fooled by all the wattage marketing speak, watts alone will not make you loud!

Fig 3

Type of bass Rig	Amplifier section maximum power output	Loudspeaker section thermol power handling	Loudspeaker section mechanical power handling	Loudspeaker section low frequency handling	Volume displacemnet	Maximum low frequency acoustic output
Modern 'premium 600W 1 x 15" combo	600W	300W	210W	98db	380cc	121db
Mid '80s 'premium' 1500W 4 x 10" combo	150W	600W	150W	100db	440cc	122db
Modern 'budget' 'premium' 350W 2 x 10" combo	250W	250W	100W	97db	285cc	117db