Motorcycle Audio Primer

By TubeAmpTech

The following statements are the opinions of the Author...and are only backed up by the laws of physics

There are quite a few companies selling audio for motorcycles these days...and a lot of them have some pretty outrageous claims about what their systems are capable of. This is intended to help you make sense of the ***important*** specifications, and help you figure out what questions to ask when shopping around for a system.

*****This is **NOT** intended by any means to be an all inclusive manifesto. I'm trying to keep it as simple as possible (there is some simple math involved) so the average person can make some sense of it all.

What kind of system do I need?

Well that's a question only you can answer. A lot of it will depend on your budget. Some of you will want a system that mounts permanently on your bike, some won't. Some of you have pipes so loud you couldn't hear the Space Shuttle taking off behind you and will opt for the loudest system you can find...and let's be honest here...some of you are just looking for an excuse to add more chrome...and you know who you are!

What you should consider is what you're playing your music from. If you have an Mp3 player it would be nice if your system could provide power to it so it wasn't just running off the battery. If you want to play from Flash Drives, CF Cards, SD Cards, etc., then your system needs to have the ability to do those things. The point is only you know what you need so the choice of what kind of system is up to you.

Understanding The Specifications:
Amps

So what do they mean, and which ones are important? Here are the most common specs with some simple definitions.

Wattage: Wattage (when it comes to an amplifier) is supposed to mean how much power is actually available to produce the music. This is the spec everyone seems to look at first. It is not only the most misunderstood spec by the consumer, it is also one that is most often inflated (or just outright lied about) by the manufacturer. There are also a few wattage specs usually given by a manufacturer. Such as:

Peak Output Power: This is theoretically how much wattage could be produced for a very short (usually milliseconds) time. This spec is virtually meaningless. However since it's also the biggest number they can give you they always like to include it. After all, you like big numbers don't you?

R.M.S. Power: This is the most meaningful spec when it comes to wattage. This is the average useful power that can (if their claim is actually true) be produced consistantly. The R.M.S. Power is usually (but not always) ½ of the peak output power.

Speaker Impedance or Load Impedance: This spec is important. This is the load the amp needs to operate safely. You will sometimes see a range of say 4-16 ohms. If your amplifier says it can produce 10 watts R.M.S. it is doing so at the lower impedance. Every time you double the speaker impedance you get half the available wattage to the speakers. So for our 10 watts R.M.S. example you get 10 watts @ 4 ohms, 5 watts @ 8 ohms, and 2 1/2 watts @ 16 ohms.

Frequency Response: This is the audible hearing range that can be produced by a piece of equipment. The human ear can hear between 20Hz and 20KHz. (much less as we grow older) If you were shopping for a home theater system, home stereo, or even car audio for that matter, this might be a useful spec to you. Since we are talking about motorcycles though it isn't very useful. You can safely assume that any amp you'd be interested in will easily produce a useful frequency range. (speakers are another matter but we'll get to that later)

Total Harmonic Distortion and Signal to Noise Ratio: Again, for a motorcycle sound system these are useless. Your bike is plenty loud enough that these specs don't matter in the slightest.

Supply Voltage and Current Rating: This turns out to be the **MOST USEFUL** spec when shopping around for a motorcycle sound system. How you ask? Good question! Bear with me:

Most people assume high wattage means high volume, but it isn't necessarily true. 1 watt is louder than most people realize. In order to be twice as loud (thru the same speakers...all things being equal) it would take 10 times the wattage. A 10 Watt amp would be twice as loud as a 1 watt amp. A 100 watt amp would be twice as loud as a 10 watt amp...see where this is going? For low wattages it makes more of a difference, but you quickly reach a point where increasing the wattage not only becomes impractical because of the supply current limitations on your motorcycle, it becomes pointless because it isn't buying you any more appreciable volume.

Doubling the wattage only produces a very slight increase in volume. 3dB to be exact. It's literally like turning up the volume knob on your stereo until you can *just* tell it got louder. Not much of a volume increase for that much extra load on your electrical system.

So why is the Supply Voltage and Current Rating the most useful spec when shopping for a sound system? Because from those two numbers you can figure out for yourself whether or not the manufacturer's claims are bogus or not!!!

Sorry folks...it's time for the math.

Don't panic. It's not as hard as you think. You will also be able to put this math to use in other areas of your bike...and away we go!

The supply voltage we will use for our calculations is 14.4 volts because that's what a typical motorcycle charging system runs at. You may see specs that say the amp will operate from say 8-15 volts or even higher. It makes no difference. What matters is what the bike supplies.

From what I've seen the typical fuse rating called for to supply these little amplifiers is 5 amps. We now have enough info to do some math.

14.4 volts and 5 amps of current are what we have to work with according to the manufacturers specs. (remember...their specs not mine) From these two numbers we can figure out the total Power (wattage) available to work with:

14.4 volts x 5 amps = 72 Watts!

That's it folks! That is all the power that a 5 amp circuit can produce safely and consistantly.

*To put that wattage in perspective the average motorcycle light bar uses two 35 watt bulbs which also adds up to 72 watts. (they are also supplied from a 10 amp circuit for other reasons) Would you be so quick to add a second light bar to your bikes charging system?

The next thing to understand is that you cannot possibly get more power out of an electrical device than goes into it. If all the power that's available is 72 watts feeding it then that's all that could ever possibly come out of it....except it isn't that easy because you don't get something for nothing. It takes power for an amp to do it's work.

Efficiency: This is how much of the total power being consumed is actually performing the work you want done. For these amps they are usually Class A/B amps for which the efficiency is .6. (The remaining .4 is lost as heat produced by the amp) We can now put that number to use in our calculations.

72 watts x .6 = 43.2 Watts

So in a perfect world if this amp is as efficient as it can be (running at it's absolute limit) and there weren't any other factors drawing power from it (like indicator lights, etc.) 43.2 watts would be all it could possibly produce...but we aren't done yet.

That 43.2 watts is Peak Power. We now have to cut it in half to get closer to the R.M.S. Power which is the useful spec we were talking about earlier.

43.2 / 2 = 21.6 Watts R.M.S.

Wait...there's more! Since it's a stereo amp it has two channels. That means we have to again cut that figure in half to get the R.M.S. Per Channel Wattage rating.

21.6 / 2 = 10.8 R.M.S. Watts Per Channel!

The math doesn't lie folks. 10 watts R.M.S. Per channel is about all you can realistically get from these little systems powered from a 5 amp circuit.

Remember that you aren't running your system at its' limits either. Typically you are drawing somewhere around 2 amps when operating your system so the wattage you're using is even lower.

I have seen the same little amplifiers sold from various places with specs that range from the spec we've arrived at through the math (about 10 watts R.M.S.) all the way up to 500 Watts!!! You've seen for yourself it isn't possible. Electricity is math...and the numbers don't lie.

Speakers

The specs for speakers are even more misunderstood than that of amps, but luckily there are only a few we have to be concerned with when it comes to motorcycles. They are:

Peak Power or Wattage Rating: This is how much power the speaker could theoretically survive for a *VERY* short time. We're talking about a few seconds here.

R.M.S . Power or Wattage Rating: This is how much **CLEAN CONSISTENT POWER** the speaker can handle safely without melting the voice coil when run in its' useable frequency range.

Notice I said **CLEAN POWER!** This is not easily understood by most people. To most folks if a speaker says it can handle 100 watts, and you are powering it from a 50 watt amplifier, well there should never be a problem, right? WRONG!

Speakers need **CLEAN POWER** to operate safely. What most people end up doing is buying the highest wattage speakers they can get because they think it means they're going to be tougher, or louder, or something. What matters most when buying speakers is how much CLEAN POWER can be supplied by your amplifier.

The problem here is you have no idea at what point your amplifier stops putting out **CLEAN POWER**. If the volume goes from 1 to 10 it could stop putting out **CLEAN POWER** as early as 3 or as late as 10...so how are you

supposed to know?

Well...you can't really without hooking it up to test equipment most folks don't have laying around. What you can do though is listen to it. As you turn it up you will get to the point the sound starts to change noticeably. It may either become more distorted, or the tone may start to change. This is most likely due to the onset of **CLIPPING!** (to really explain clipping is beyond the scope of our purpose here...take it from me it's bad...very bad!) Clipping produces a lot of heat and is the enemy of speakers, and is usually the cause of them failing. That change in sound would be as high as I would safely go because you are either reaching the amps' limit, or the speakers' limit. If you're buying speakers you can use the R.M.S. wattage rating of the amplifier to guess **CLEAN POWER.** You can run higher wattage amps into lower wattage speakers much more safely than you can lower wattage amps into higher wattage speakers. The higher wattage amps are much less likely to clip and fry the speakers.

I know...I can hear you now..."but TubeAmpTech...our amp only puts out 10 watts R.M.S. Everybody is selling little bullet speakers for our bikes that say 100...200...even 300 watts! Surely you must be mistaken!"

They know you love those big numbers...just like the bogus wattage ratings on the amps. Now I can't say with absolute certainty that those little bullet speakers won't handle their wattage claims because I've never tested them, but I've never seen a full range speaker that small ever take anywhere near those ratings...and as we've seen earlier speakers with ratings like that aren't buying you anything extra anyway.

*There are even companies out there (and I'm not mentioning any names...liability you know!) that are selling systems using the same amplifier but with different speaker options. They let you *assume* that you are buying higher wattage systems when what you are really buying are speakers with *supposedly* higher wattage ratings that are physically a tiny bit larger. As you will learn that doesn't necessarily translate into a louder system. It does separate you from more of your cash though.*

Speaker Impedance: This is the load the speaker puts on the amplifier. This is an important spec. If the amp says it needs a load of 4-16 ohms (and yes that means per channel) you can safely hook up a speaker to it as long as it falls into that range. Sometimes people run into trouble when they try and hook up more than one speaker to a channel. The most common way to hook up speakers is

parallel to each other, meaning you hook their positives together and negatives together. If you start out with two 8 ohm speakers and parallel them the result is the impedance is cut in half, and is now a 4 ohm load. For our amp example that has a range of 4-16 ohms this will work nicely. If you start out with two 4 ohm speakers and parallel them you would end up with a load of 2 ohms. This is too low for our amplifier to operate safely. You would most likely eventually fry the output transistors killing your amplifier.

Sometimes people end up with speakers that are mismatched, say for example one 4 ohm speaker and one 8 ohm speaker. They mistakingly hook these together thinking the resulting impedance will fall somewhere between 4 ohms and 8 ohms...***but it doesn't!*** Whenever you parallel two mismatched impedances (or two resistances for that matter) the result is always ***LOWER*** than the lowest impedance speaker. So hooking our 4 ohm and 8 ohm speakers together will result in an impedance ***LOWER*** than 4 ohms and would not be suitable for our 4-16 ohm amp example.

Frequency Range: This is how much of the 20Hz to 20KHz the speaker can reproduce safely at its' rated wattage. If you don't know what frequencies instruments are playing at what good does that spec do you? Well here's some info for you. This gets a bit technical but please stay with me for a moment.

The lowest note on a 5-string bass which is typically the lowest note heard in rock music is around 31Hz. (pianos and organs can go lower...don't get too anal on me!...LOL) That is what the fundamental frequency is. However musical notes are not only made up of fundamentals they are also made up of harmonics. The interesting part is you can strip out the fundamental and hardly notice it's missing.

Subwoofers produce those low notes along with their fundamental. You have no doubt been along side those cars with the bass pounding you. They have those big speakers with very high wattage amps and you can feel and hear the bass very clearly. Those speakers also have to move very far back and forth and move a lot of air to produce those low fundamentals.

You have also heard the same (ok...maybe not the same...lol!) music through little ear bud headphones. You can also hear the bass. Are those little speakers reproducing the same low frequencies the subwoofer did?

Not exactly. They are producing the higher harmonics of the note, but not the

fundamental. What's interesting is your brain fills in the blanks so to speak and it appears nothing has been lost.

Why is this important? Well if you look at a frequency range spec and it only goes down to say 80 or 100Hz it doesn't mean you won't "hear" the bass from that speaker. Only that you won't be getting the fundamental. Basically you won't be "feeling" it. On a Motorcycle you are not going to get sound like you would from a subwoofer. Just don't go there. Put it out of your mind.

Sensitivity or SPL: Now this is an important spec and is given in dB's. You will typically see specs around 88dB's. What's so important about it? If you recall earlier talking about amps I said doubling an amps power gave you a 3dB increase in sound and that it wasn't a good trade-off putting the extra strain on the electrical system. Well you can get that same 3dB increase by getting speakers that are 3dB higher in sensitivity without increasing the amps power! That's a much better way to go about it.

Speaker Size and Type: While size may not seem like a spec, with all things being equal a larger speaker moves more air and sounds *fuller*. It isn't necessarily *louder*. That is really a function of sensitivity.

Type of speaker is worth talking about. Some are single cone "full range" speakers, and others are "coaxial" speakers. The single cone is just that...one cone that reproduces all the frequencies. A coaxial speaker has the large cone that the full range one does, but in addition also has a little tweeter, or sometimes an additional midrange too. The tweeter helps in our situation because we are going to hear more high frequencies clearer. Tweeters also don't take as much power to produce high frequencies the way the full range speaker would. The result can be louder with less distortion. If you have a choice I would opt for the coaxial speaker...but with sound it's a very subjective matter. The right one is the one that sounds best to *your* ears.

So Now What?

So now you have some idea of what the ratings mean and how to apply them. You are not getting a 500 watt amp to operate from a 5 amp circuit no matter what the manufacturer says...and you now know the math to prove it.

We have so far been talking about those little box amplifiers that you get that you hook up your Mp3 players to, but what about the systems in fairings?

Well the fairing systems can either be the little box amps, or they can be like the in-dash radios in our cars. The math works out exactly the same though. If the in-dash radios are operating from a higher amped fuse you just plug in the numbers and recalculate. Lets say it's operating from a 10 amp circuit:

14.4 volts x 10 amps = 144 watts...Maximum power available from the circuit

Again we multiply that by .6 which is the efficiency for a class A/B amplifier.

144 x .6 = 86.4 watts Peak Power

Again we divide that in half to find the R.M.S. Power.

86.4 / 2 = 43.2 watts R.M.S.

...and once again we divide that in half to get the watts per channel R.M.S.

43.2 / 2 = 21.6 watts per channel R.M.S.

We can now compare the little box amp powered from the 5 amp circuit with the fairing in-dash unit powered from the 10 amp circuit. Since we doubled the current available in the in-dash example all we did was just double all the other numbers...so let's look at the R.M.S. Wattage results and really compare the overall result.

10.8 watts R.M.S. Per channel for the little box amp...21.6 watts per channel R.M.S. For the in-dash unit.

What did we learn before about doubling the wattage? We learned that doubling the wattage (with all other things being equal) means an increase of 3dB's which is only *ever so slightly* louder.

So why then are in-dash units (and even the little box units for that matter) so much louder in a fairing then? Well it's mostly because of the much larger speakers that can be used in a fairing. Those larger speakers are moving MUCH MORE AIR! More air means more sound. Time for some more math.

The largest handlebar mounted speakers I've seen regularly available are 3". (if there are larger ones so be it...I've seen 3" so that's what we're using as an

example) To figure out the area of the 3" speaker cone we use the formula for the area of a circle. Pi (3.14) times the radius (1.5") squared.

1.5 x 1.5 = 2.25 (radius squared) x 3.14 = 7.1325 square inches.

Fairings can have 6" speakers in them. Let's do the math:

3 x 3 = 9 x 3.14 = 28.26 square inches!

As you can see from the examples doubling the size of the speaker from 3" to 6" means you are increasing the area of the cone **4 TIMES!** This means you are moving 4 times the air with a 6" speaker as opposed to a 3' speaker. Now remember you also have two speakers so you need to double your findings.

Two 3" speakers is **14.265** square inches and two 6" speakers is **56.52** square inches!

So as you can see there is just no way the 3" speakers can compete with the 6" speakers. Some farings also have 4 speakers! Four 5" speakers would work out to 78.5 square inches! With a fairing you also have the advantage of blocking more wind and that makes it easier to hear it also.

So is there any danger to the electrical system using the in-dash system that draws twice the power? Probably not. In actual use it's probably drawing about 3-4 amps. 4 amps is still 4 amps though and you need to consider it when you add anything electrical to your motorcycle. There really is only so much power available.

You are now armed with enough information to make the vendors miserable. Ask them questions and gage their responses. If you're looking at a system and it seems to be missing certain specs it's usually on purpose. Take everything into consideration and make the best choice for you with your budget and space limitations.

This has been a *very* simplified explanation of a very complex subject. There is so much more that goes into these calculations, but for our basic needs I have tried to give you a good basis on which to make some choices. I hope it helps.

Ride Safe and Rock On!