How Big is Your Wall Wart?

by Pat Brown

In preparing for some upcoming international trips, I have had to evaluate the power requirements of the gear in my equipment rack.

In pursuing this it occured to me that the power requirements of my gear was not the issue - it was the *voltage* requirement that I had to be sure of. A wattage rating alone would not yield any information on whether my equipment would work properly or be damaged when plugged into an electrical outlet.

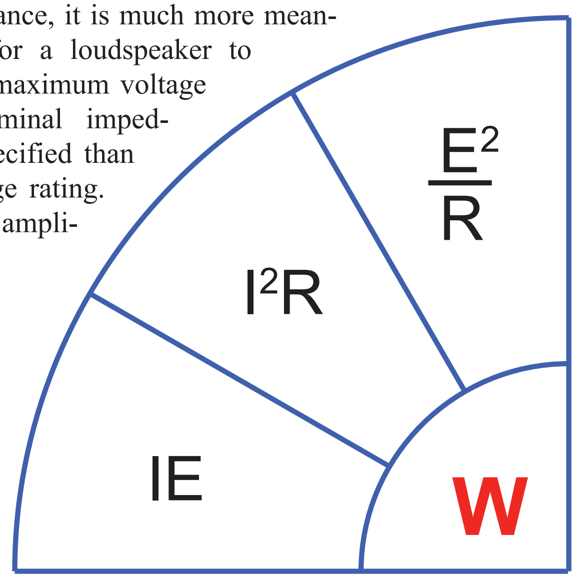
The situation is not unlike what we face in the audio world. Yes, our amplifiers are a source of electrical power to the loudspeakers, and the loudspeakers radiate acoustic power into the room. And yes, the traditional way to rate both amplifiers and loudspeakers is in watts. But power is not a very useful stand-alone metric for describing what is going on. The two parameters of interest are the RMS voltage and RMS current. The voltage is of interest because it determines the SPL that will be produced by the loudspeaker. The current is of interest because the current flow through the voice coil is what makes the loudspeaker move, and there needs to be sufficient current available from the amplifier.

As long as the demand for current is not excessive, it need not be initially considered when connecting loudspeakers to amplifiers. One way to assure this is to avoid loading the amplifier with too low an impedance, usually caused by paralleling too many loudspeakers onto a single amplifier.

Most household appliances are designed to plug into 110VAC electrical outlets. When the current draw is small (commonly the case) it is assumed that the 15 amps available from the outlet is sufficient, and current draw is not considered. If the voltage and current are multiplied, the approximate power drawn can be determined. The electrical power is being distributed using a constant voltage configuration. This means that the voltage does not sag or drop significantly when an appliance is connected to the circuit.

In similar fashion, the power drawn by a loudspeaker is a by product of the voltage placed across it and the impedance of the voice coil. As long as the impedance does not excessively load the amplifier (causing a voltage drop) it can be assumed that the available current is adequate. Just as with household appliances, the main consideration is the voltage. Current need only be considered when the load impedance becomes very low - a condition that can be avoided by proper system design.

The Ohm's Law/Power Equation wheel in Figure 1 tells the story. Watt ratings should be stated in terms of voltage, current, and/or impedance (any two of the three). For instance, it is much more meaningful for a loudspeaker to have a maximum voltage and nominal impedance specified than a wattage rating. And an ampli-



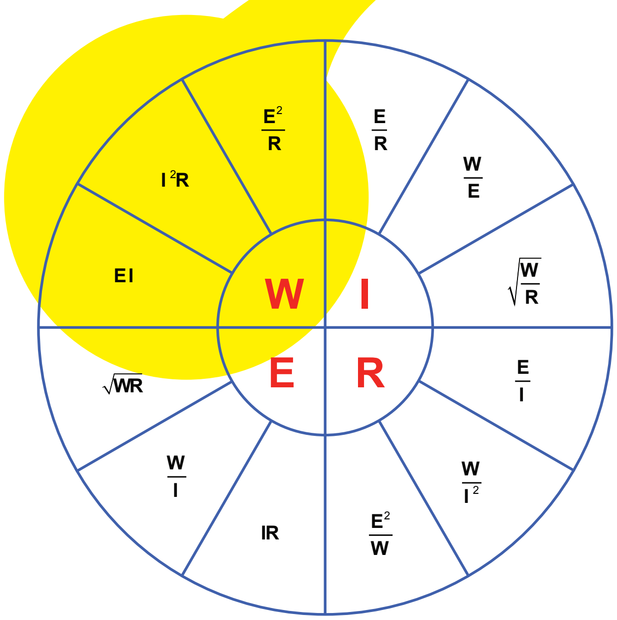


Figure 1 - The power equation allows watts to be calculated from a knowledge of two of three circuit parameters. For simplicity I have assumed a purely resistive load. Other than for considering thermal limitations, a stand-alone watts rating is not very useful. It is especially problematic when associated with performance criteria, such as sound level. Household appliances always have a voltage rating to assure that the device is powered correctly, as do the external "power supplies" provided for electronic products.

E = Volts_{RMS}

I = Amps_{RMS}

R = Resistance in ohms

W = Power in watts

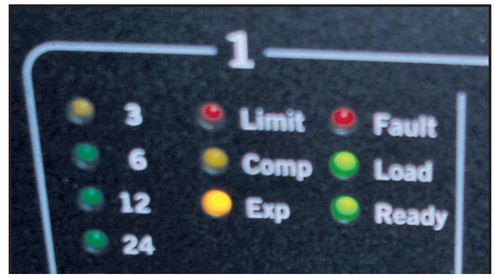
fier should specify the output voltage along with the lowest impedance at which this voltage can be maintained. It's fine if the manufacturer wants to do the math and express these in watts, but a watts rating is not a replacement for at least two of the individual parameters of voltage, current and/or impedance.

As an industry we need to re-think our specifications from time-to-time. The industry's preoccupation with power ratings has caused confusion, complicated the design process, and often causes sound system users to do exactly the *wrong* thing when interfacing devices.

As an example, the rated power of most amplifiers increases as the load impedance decreases (Figure 2). If "more watts" are what you are after (a common misconception), the incentive is to hook *more* loudspeakers to the amplifier, because the amplifier "puts out more" if more loudspeakers are connected to it. But in reality, the voltage across the loudspeaker is the same, whether one, two or even three loudspeakers are connected in parallel. The additional loudspeakers draw more current, but the sound level of each loudspeaker *does not increase* as more are connected. We can clearly see that it is best to hook *fewer* loudspeakers to the amplifier. The higher impedance load assures that ample current is available for the loudspeaker.

The Community M200 Compression Driver carries the following rating: Maximum Input Voltage: 24VRMS; Nominal Impedance: 8 ohms

Note that this information can be presented as a power rating of about 75 watts continuous, and it is. But when it comes time to make sure that the unit is being operated within its limits, the voltage rating is the meaningful number, since it is easily verified by measurement. And when it comes time to assure that the amplifier is not being overloaded, it is the impedance rating that is the meaningful number. At this point one could ask "Why is a power rating even necessary? I have what I need with the voltage and impedance ratings."



The Rane MA 4 Amplifier has a "Load" light that is "off" if the load exceeds 16 ohms, "on" if between 2 and 16 ohms, and "flashes" if the load is less than 2 ohms. This alerts the user that they are excessively loading the amplifier.

Summary

1. It is the voltage that is of primary interest when interfacing equipment.

2. If the current drawn by the equipment is small compared to that available from the source, it need not be considered.

3. Two of the three quantities must be known to find the third. A power rating alone is insufficient for assuring proper operation. *pb*

An Ideal Amplifier...

E_{sine}	I_{sine}	Z_{load}	CAW
28Vrms	1.75A	16	50W
28Vrms	3.5A	8	100W
28Vrms	7A	4	200W
28Vrms	14A	2	400W
28Vrms	28A	1	800W
28Vrms	56A	0.5	1600W
28Vrms	112A	0.25	3200W

A "wattage" mind set encourages the user to connect more loudspeakers to the amplifier! Note that for parallel connected loudspeakers, the sound level per loudspeaker does not increase as additional units are added. The amplifier simply works harder.

CAW = Continuous Average Watts

A Real-World Amplifier...

E_{sine}	I_{sine}	Z_{load}	CAW	
28Vrms	1.75A	16	50W	
28Vrms	3.5A	8	100W	
24Vrms	6A	4	150W	
20Vrms	10A	2	200W	Not Recommended
?	?	1	?	
?	?	0.5	?	
?	?	0.25	?	

A "voltage" mind set encourages the user to add additional amplifiers to drive the extra loudspeakers! This assures adequate current and cooler amplifier operation. It also ensures that the amplifier behaves as a constant voltage source.

Figure 2 - Ideal vs. real-world amplifier output.