

What's RMS Power or RMS Watts?

by Paul Quillen, 1993

This is an interesting subject. Both RMS Power and RMS Watts are a fiction created by the Federal Trade Commission.

In the mid-1970's the FTC decided that they would create a standard for power ratings for power amplifiers. Their motivation was furniture store stereo consoles rated at 800 Watts that actually put out a few Watts...blatantly false advertising. Of course, everyone knew that the furniture store power ratings were a joke, but the FTC saw it as an opportunity to regulate (control).

Amplifier power is typically measured across a precision resistor, typically a Dale 8 Ohm power resistor. These are precision high-power resistors that can dissipate lots of power.

A sinusoidal waveform is applied to the amplifier input at various frequencies and the output waveform is watched on an oscilloscope. When the output waveform starts to distort, the input level is backed down until the measured distortion falls below a certain percentage. Then the Voltage is measured across the 8 Ohm load resistor.

The formula for power is:

$$\text{Power} = \frac{V^2}{8}$$

Now here's where the FTC goofed. The Voltage measured here is RMS Voltage. (RMS is the DC heating equivalent Voltage. It's .707 X the peak voltage of a sine wave. RMS means Root Mean Square, which means the Square Root of the Mean of the Squares of the sum of all the voltages in the waveform.) So far so good.

The FTC then incorrectly assumed that if you were measuring RMS Voltage, the result from the above formula would be RMS power.

The problem is that it's not. It's average power. This is clear in all electrical engineering textbooks. There is no such thing as RMS power.

The FTC also incorrectly assumed that the measurement of the power in Watts would be RMS Watts. It's not. It's Watts. There's no such thing as RMS Watts.

In summary, RMS Voltage is correct, but there's no such thing as RMS Power or RMS Watts.

Or stated differently, the Voltage that's measured is RMS Voltage, but the resulting power is Average Power and it's measured in Watts.

So the question is, what power rating do you use when you look at a spec sheet?

Use the one that is incorrectly labeled RMS, as that's the one that's measured correctly, but misnamed.

Flash: After 25 years, in 2000, the FTC finally got the RMS issue right, but added pre-conditioning which is simply cooking the power amp with a sine wave before testing its power (not too bright, and no relationship to music):

[Code of Federal Regulations]

[Title 16, Volume 1, Parts 0 to 999]

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TITLE 16--COMMERCIAL PRACTICES

CHAPTER I--FEDERAL TRADE COMMISSION

PART 432--POWER OUTPUT CLAIMS FOR AMPLIFIERS UTILIZED IN HOME ENTERTAINMENT PRODUCTS--Table of Contents

Sec. 432.1 Scope.

(a) Except as provided in paragraph (b) of this section, this part shall apply whenever any power output (in watts or otherwise), power band or power frequency response, or distortion capability or characteristic is represented, either expressly or by implication, in connection with the advertising, sale, or offering for sale, in commerce as ``commerce" is defined in the Federal Trade Commission Act, of sound power amplification equipment manufactured or sold for home entertainment purposes, such as for example, radios, record and tape players, radio-phonograph and/or tape combinations, component audio amplifiers, self-powered speakers for computers, multimedia systems and sound systems, and the like.

(b) Representations shall be exempt from this part if all representations of performance characteristics referred to in paragraph (a) of this section clearly and conspicuously disclose a manufacturer's rated power output and that rated output does not exceed two (2) watts (per channel or total).

(c) It is an unfair method of competition and an unfair or deceptive act or practice within the meaning of section 5(a)(1) of the Federal Trade Commission Act (15 U.S.C. 45(a)(1)) to violate any applicable provision of this part.

[39 FR 15387, May 3, 1974, as amended at 63 FR 37235, July 9, 1998]

Sec. 432.2 Required disclosures.

Whenever any direct or indirect representation is made of the power output, power band or power frequency response, or distortion characteristics of sound power amplification equipment, the following disclosures shall be made clearly, conspicuously, and more prominently than any other representations or disclosures permitted under this part:

(a) The manufacturer's rated minimum sine wave **continuous average power output, in watts, per channel** (if the equipment is designed to amplify two or more channels simultaneously)--

(1) For each load impedance required to be disclosed in paragraph (b) of this section, when measured with resistive load or loads equal to such (nominal) load impedance or impedances, and

(2) Measured with all associated channels fully driven to rated per channel power;

(b) The load impedance or impedances, in Ohms, for which the manufacturer designs the equipment to be used by the consumer;

(c) The manufacturer's rated power band or power frequency response, in Hertz (Hz), for each rated power output required to be disclosed in paragraph (a)(1) of this section; and

(d) The manufacturer's rated percentage of maximum total harmonic distortion at any power level from 250 mW to the rated power output, for each such rated power output and its corresponding rated power band or power frequency response.

Sec. 432.3 Standard test conditions.

For purposes of performing the tests necessary to make the disclosures required under Sec. 432.2 of this part:

(a) The power line voltage shall be 120 volts AC (230 volts when the equipment is made for foreign sale or use, unless a different nameplate rating is permanently affixed to the product by the manufacturer in which event the latter figure would control), RMS, using a sinusoidal wave containing less than 2 percent total harmonic content. In the case of equipment designed for battery operation only, tests shall be made with the battery power supply for which the particular equipment is designed and such test voltage must be disclosed under the required disclosures of Sec. 432.2 of this part. If capable of both AC and DC battery operation, testing shall be with AC line operation;

(b) The AC power line frequency for domestic equipment shall be 60 Hz and 50 Hz for

equipment made for foreign sale or use;

(c) The amplifier shall be preconditioned by simultaneously operating all channels at one-third of rated power output for one hour using a sinusoidal wave at a frequency of 1,000 Hz;

(d) The preconditioning and testing shall be in still air and an ambient temperature of at least 77 deg.F (25 deg.C);

(e) Rated power shall be obtainable at all frequencies within the rated power band without exceeding the rated maximum percentage of total harmonic distortion after input signals at said frequencies have been continuously applied at full rated power for not less than five (5) minutes at the amplifier's auxiliary input, or if not provided, at the phono input.

(f) At all times during warm-up and testing, tone loudness-contour and other controls shall be preset for the flattest response.

Sec. 432.5 Prohibited disclosures.

No performance characteristics to which this part applies shall be represented or disclosed if they are not obtainable as represented or disclosed when the equipment is operated by the consumer in the usual and normal manner without the use of extraneous aids.

Sec. 432.6 Liability for violation.

If the manufacturer or, in the case of foreign made products, the importer or domestic sales representative of a foreign manufacturer, of any product covered by this part furnishes the information required or permitted under this part, then any other seller of the product shall not be deemed to be in violation of Sec. 432.5 of this part due to his reliance upon or transmittal of the written representations of the manufacturer or importer if such seller has been furnished by the manufacturer, importer, or sales representative a written certification attesting to the accuracy of the representations to which this part applies: And provided further, That such seller is without actual knowledge of the violation contained in said written certification.