Watts and Volt-Amps: Powerful Confusion

White Paper 15

Revision 1

by Neil Rasmussen

> Executive summary

This white paper helps explain the differences between watts and VA and explains how the terms are correctly and incorrectly used in specifying power protection equipment.

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DCSC@Schneider-Electric.com

Introduction

This note helps explain the differences between watts and VA and explains how the terms are correctly and incorrectly used in specifying power protection equipment. Many people are confused about the distinction between the watt (W) and volt-amp (VA) measures for UPS load sizing. Many manufacturers of UPS and load equipment add to this confusion by failing to distinguish between these measures.

Background

The power drawn by computing equipment is expressed in watts or volt-amps (VA). The power in watts is the real power drawn by the equipment. Volt-amps are called the "apparent power" and are the product of the voltage applied to the equipment times the current drawn by the equipment.

Both watt and VA ratings have a use and purpose. The watt rating determines the actual power purchased from the utility company and the heat loading generated by the equipment. The VA rating is used for sizing wiring and circuit breakers.

The VA and watt ratings for some types of electrical loads, like incandescent light bulbs, are identical. However, for computer equipment the watt and VA ratings can differ significantly, with the VA rating always being equal to or larger than the watt rating. The ratio of the watt to VA rating is called the "Power Factor" and is expressed either as a number (i.e., 0.7) or a percentage (i.e. 70%).

Watts may not equal VA

All information technology equipment including computers uses an electronic switching power supply. There are two basic types of computer switching power supplies, which are called 1) Power Factor Corrected (PFC) supplies or 2) capacitor input supplies. It is not possible to tell which kind of power supply is used by inspection of the equipment, and this information is not commonly provided in equipment specifications. PFC supplies were introduced in the mid 1990's and have the characteristic that the watt and VA ratings are equal (power factor of 0.99 to 1.0). Capacitor input supplies have the characteristic that the watt rating is in the range of .55 to .75 times the VA rating (power factor of 0.55 to 0.75).

All large computing equipment such as routers, switches, drive arrays, and servers made after about 1996 uses the PFC supply and consequently for this type of equipment the power factor is 1.

Personal computers, small hubs, and personal computer accessories typically have capacitor input supplies and consequently for this type of equipment the power factor is less than one, and is ordinarily in the range of 0.65. Larger computer equipment made prior to 1996 also typically used this type of power supply and exhibited a power factor less than one.

The power rating of the UPS

UPS have both maximum watt ratings and maximum VA ratings. Neither the watt nor the VA rating of a UPS may be exceeded.

It is a de-facto standard in the industry that the watt rating is approximately 60% of the VA rating for small UPS systems, this being the typical power factor of common personal computer loads. In some cases, UPS manufacturers only publish the VA rating of the UPS. For small UPS designed for computer loads, which have only a VA rating, it is appropriate to assume that the watt rating of the UPS is 60% of the published VA rating.

Related resource
White Paper 26
Hazards of Harmonics and Neutral Overloads

For larger UPS systems, it is becoming common to focus on the watt rating of the UPS, and to have equal watt and VA ratings for the UPS, because the watt and VA ratings of the typical loads are equal. For a further discussion of the issues of power factor of larger systems and data centers, see White Paper 26, *Hazards of Harmonics and Neutral Overloads*.

Examples where a sizing problem can occur

Example 1: Consider the case of a typical 1000 VA UPS. The user wants to power a 900 W heater with the UPS. The heater has a watt rating of 900 W and a VA rating of 900 VA with a power factor of 1. Although the VA rating of the load is 900 VA, which is within the VA rating of the UPS, the UPS will probably not power this load. That is because the 900 W rating of the load exceeds the watt rating of the UPS, which is most likely 60% of 1000 VA or around 600 W.

Example 2: Consider the case of a 1000 VA UPS. The user wants to power a 900 VA file server with the UPS. The file server has a PFC power supply, and so has a watt rating of 900 W and a VA rating of 900 VA. Although the VA rating of the load is 900 VA, which is within the VA rating of the UPS, the UPS will not power this load. That is because the 900 W rating of the load exceeds the watt rating of the UPS, which is 60% of 1000 VA or 600 W.

How to avoid sizing errors

Using the Schneider Electric UPS Selector can help avoid these problems, as the load power values are verified based on the equipment specified. Also, the selector ensures that neither the watt nor VA ratings are exceeded.

Equipment nameplate ratings are often in VA, which makes it difficult to know the watt ratings. If using equipment nameplate ratings for sizing, a user might configure a system, which appears to be correctly sized based on VA ratings but actually exceeds the UPS watt rating.

By sizing the VA rating of a load to be no greater than 60% of the VA rating of the UPS, it is impossible to exceed the watt rating of the UPS. Therefore, unless you have high certainty of the watt ratings of the loads, the safest approach is to keep the sum of the load nameplate ratings below 60% of the UPS VA rating.

Note that this conservative sizing approach will typically give rise to an oversized UPS and a larger run time than expected. If optimization of the system and an accurate run time are required, use the Schneider Electric UPS Selector.

Conclusion

Power consumption information on computer loads is often not specified in a way that allows simple sizing of a UPS. It is possible to configure systems that appear to be correctly sized but actually overload the UPS. By slightly over sizing the UPS compared with the nameplate ratings of the equipment, proper operation of the system is ensured. Over sizing also provides the side benefit of providing additional UPS backup time.

About the author

Neil Rasmussen is a Senior VP of Innovation for Schneider Electric. He establishes the technology direction for the world's largest R&D budget devoted to power, cooling, and rack infrastructure for critical networks.

Neil holds 19 patents related to high-efficiency and high-density data center power and cooling infrastructure, and has published over 50 white papers related to power and cooling systems, many published in more than 10 languages, most recently with a focus on the improvement of energy efficiency. He is an internationally recognized keynote speaker on the subject of high-efficiency data centers. Neil is currently working to advance the science of high-efficiency, high-density, scalable data center infrastructure solutions and is a principal architect of the APC InfraStruXure system.

Prior to founding APC in 1981, Neil received his bachelors and masters degrees from MIT in electrical engineering, where he did his thesis on the analysis of a 200MW power supply for a tokamak fusion reactor. From 1979 to 1981 he worked at MIT Lincoln Laboratories on flywheel energy storage systems and solar electric power systems.

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White Paper 26

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Related reading

For further reading on the subject of power factor as it relates to non-linear loads, consult the following:

- *IEEE Guide to Harmonic Control and Reactive Compensation of Static Power Converters* (IEEE Std 519-1981) The Institute of Electrical and Electronics Engineers, Inc., 345 E 47th Street, New York, NY 10017
- *Guideline on Electrical Power for ADP Installations* (FIPS PUB 94 September 21, 1983) U.S. Dept. of Commerce, National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161

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Data Center Science Center
DCSC@Schneider-Electric.com

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