

# Calculating power requirements for HP ProLiant rack-mounted systems

technology brief



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# Abstract

With power requirements of computing equipment continuing to increase and the cost of energy forever rising, IT organizations need to obtain accurate estimates of power and cooling requirements when designing and expanding data centers. The use of equipment nameplate ratings can yield inflated numbers that can result in overspending for power infrastructure components and a less efficient data center design. HP developed the Power Calculator utility to enable IT planners to better estimate the power needs of HP ProLiant systems. This paper identifies factors affecting power needs, explains how the Power Calculator works, and provides an example of how it is used.

## Introduction

As integration technology evolves and system density increases, the amount of power once required for several racks of computing equipment is now consumed by systems housed in a single rack. A key benefit of high-density systems is the efficient use of valuable floor space. Advances in processor architectures and speeds have resulted in performance-per-watt gains with a reduction in cost-per-transaction. Table 1 indicates an approximate 3x performance-per-watt increase over a four-year period.

**Table 1.** Cost per tpm comparison

HP ProLiant System	Date of system availability	TPC-C [1]	Cabinet Power	\$ price/tpm [2]
DL580 6/900 4S Intel Xeon	10/15/01	39.1K	5.8 kW	\$7.95
DL585 G1 DC AMD Opteron	11/28/05	236.034 K	10.8 kW	\$2.02

NOTES:

[1] Transaction Processing Performance Council benchmark of online transaction processing (OLTP)

[2] tpm = transactions per minute

Nevertheless, new applications and virtualization techniques require more processing and I/O capacity, and power consumption per rack will continue to increase. Effective sizing of a computing infrastructure while managing IT costs requires realistic estimates of current and future power and cooling requirements. Determining the power consumption of individual racks can yield an estimate for the total consumption for a data center. It can also provide a starting point for determining power distribution requirements and cooling needs at the rack level.

To determine power distribution, power redundancy, and battery backup requirements, the major active components within a rack must be analyzed for their needs based on operating parameters. Considerations such as system serviceability and scalability should also be taken into account during planning.

## Key parameters

Determining total power needs for a data center requires consideration of the key parameters described in the following paragraphs.

### Input line voltage

Input voltage may be low-line or high-line voltage, and it is determined by what is available at the data facility. Low-line voltage [100 – 120 volts alternating current (VAC)] is commonly delivered to standard AC wall outlets in North America, while high-line voltage (200 – 240 VAC) is commonly used in other parts of the world but is also increasingly common in data centers in North America. Most HP server equipment is designed to operate in the 100- to 240-VAC range.

Electrical equipment requiring high power consumption usually operates more efficiently at 200 – 240 VAC. Using a higher voltage lowers current drain and creates less heat, thus reducing the

demand (kilowatt hours) on cooling systems while increasing equipment reliability. Some systems that can use either low-line or high-line power actually require high-line voltage to meet maximum performance specifications. Facilities may also distribute AC power as single- or three-phase. Three-phase high-line power (such as 3-phase 208 VAC in the U.S.) is more efficient and recommended for systems requiring 3 kilowatts or greater.

### **Device VA rating**

The total amount of power a device requires from the facility AC feed is known as apparent power and is measured in volt-amperes (VA). Knowing the total amount of VA for all active components in a system helps IT designers determine the type and quantities of power distribution unit (PDU) and uninterruptible power supply (UPS) needed for a given rack configuration.

### **Device input power**

The amount of power a device turns into work and dissipates as heat is known as real (or true) power and is measured in watts (W). Since any heat created by electrical equipment must be extracted, knowing the total amount of watts created by systems in a data center helps determine the cooling capacity needed by the facility.

### **BTUs required for cooling**

The British Thermal Unit (BTU) is the standard for measuring the capacity of cooling systems. The amount of power (watts) consumed by equipment determines the number of BTUs/hr required for component cooling, based on this formula:

$$\text{BTUs/hr} = \text{watts} \times 3.41.$$

For example:

$$399 \text{ watts} \times 3.41 = 1360 \text{ BTUs/hr.}$$

Air conditioning equipment is typically rated in terms of tons of cooling, an old measurement based on the cooling ability of tons of ice (1 ton of cooling = 12000 BTUs/hr).

### **Input/inrush current**

Input current is the amount of amperes a system draws during normal operation. However, when AC voltage is first applied (power cord plugged in and/or a circuit breaker is switched on), power supplies of electrical components can momentarily draw several times more current than they will draw while operating. This inrush current is cumulative across devices within a common power circuit, and it must be considered when building a rack. Power supplies in HP servers include circuitry that minimizes inrush current. Staggering activation of segmented circuits can further reduce the effects of inrush current.

### **Leakage current**

Leakage current (typically measured in milliamps) is residual current that originates in power supply filters and flows from chassis ground to the phase and neutral power conductors. Leakage current is cumulative across components within a power distribution circuit and can become a hazard if proper grounding procedures are not used.

## **Determining power needs**

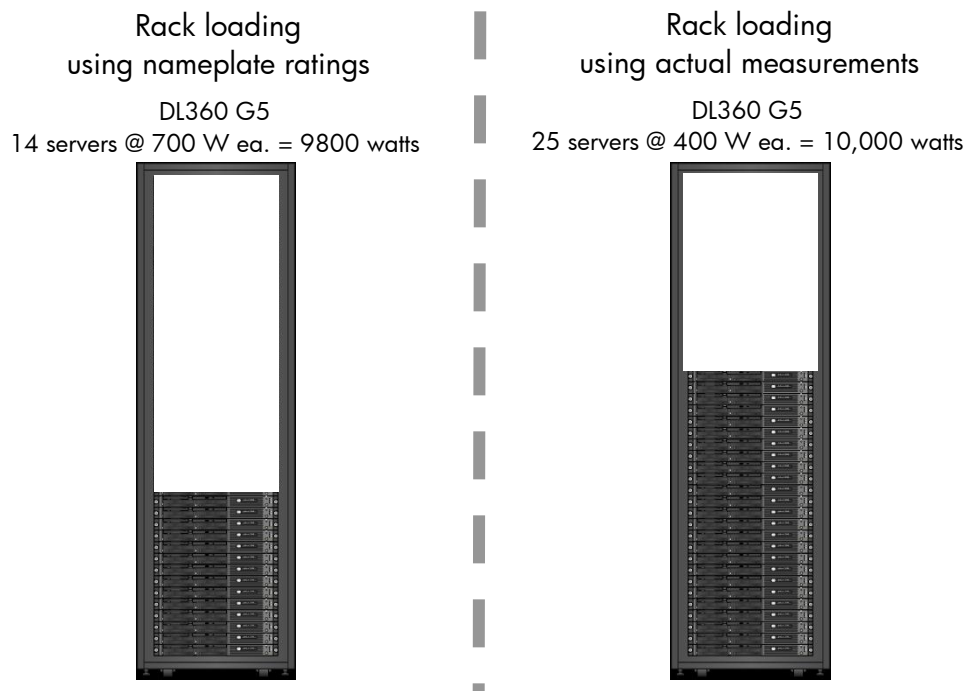
Equipment power needs have commonly been determined in one of two ways:

- Nameplate ratings
- Actual power measurements

Nameplate ratings on power supplies typically represent the maximum amount of output power the supplies are capable of providing. Name plate ratings are typically based on the power needs of fully loaded servers configured for maximum processing and storage capability and running at 100 percent utilization. Since servers rarely are configured to their maximum and run at 100 percent utilization, estimating rack requirements using nameplate ratings would likely result in inflated power requirement numbers.

Figure 1 illustrates how the use of nameplate ratings can distort rack installation planning. Using the power supply nameplate rating of 700 watts as a guide, only 14 DL360 G5 servers could be installed in a rack designed to handle 10 kW of power. Significant rack space would be unused. However, depending on processor and peripheral configuration and system utilization, DL360 G5 servers may use substantially less power. A DL360 G5 using the latest low-wattage Intel processors and utilized at 75 percent may require only 400 watts, so more servers can be installed in the same 10 kW rack.

**Figure 1.** Loading of a 10 kW rack



The most accurate power consumption predictions are those obtained by pre-configuring and measuring actual systems under load. This method of obtaining data is usually impractical for customers in a planning mode since it would require purchasing, setting up, configuring, and running of each component to acquire the measurements. HP has taken the initiative of performing a number of tests on server products under various configurations to determine actual power requirements.

# HP Power Calculators

The HP Power Calculator utility reduces the research and guess-work for determining power requirements of systems based on ProLiant servers. Each calculator provides precise data that planners can use to accurately predict power and cooling requirements for single systems and, consequently, for racks of systems.

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## **NOTE:**

HP Power Calculator is intended to be a conservative estimator of power. No two software programs will consume exactly the same amount of power. Even programs that report the same CPU utilization will have different power consumption characteristics, based on the exact mix and sequence of instructions being executed. The programs used as the measurement reference for the HP Power Calculator were intended to consume as much or more power than actual user applications.

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## Developing the calculators

HP develops a unique Power Calculator for a specific ProLiant server using data collected from server tests. Each test starts with a system fully-configured with the maximum number of processors, memory, hard drives, expansion cards, and power supplies. Proprietary software is used to exercise the processors and all peripherals while voltage and current measurements are taken. Tests are repeated for all levels of processor support at all speeds, with different memory amounts and hard drive sizes. Revised or updated servers are retested during development cycles to ensure calculator integrity.

## Using the calculators

Online HP Power Calculators for HP ProLiant DL, ML, and PL servers are available at this URL:  
<http://h30099.www3.hp.com/configurator/powercalcs.asp>

Online Power Sizer utilities for HP ProLiant BladeSystem (BL) p-Class and c-Class servers are available at this URL: [HP BladeSystem Power Sizer](#)

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## **NOTE:**

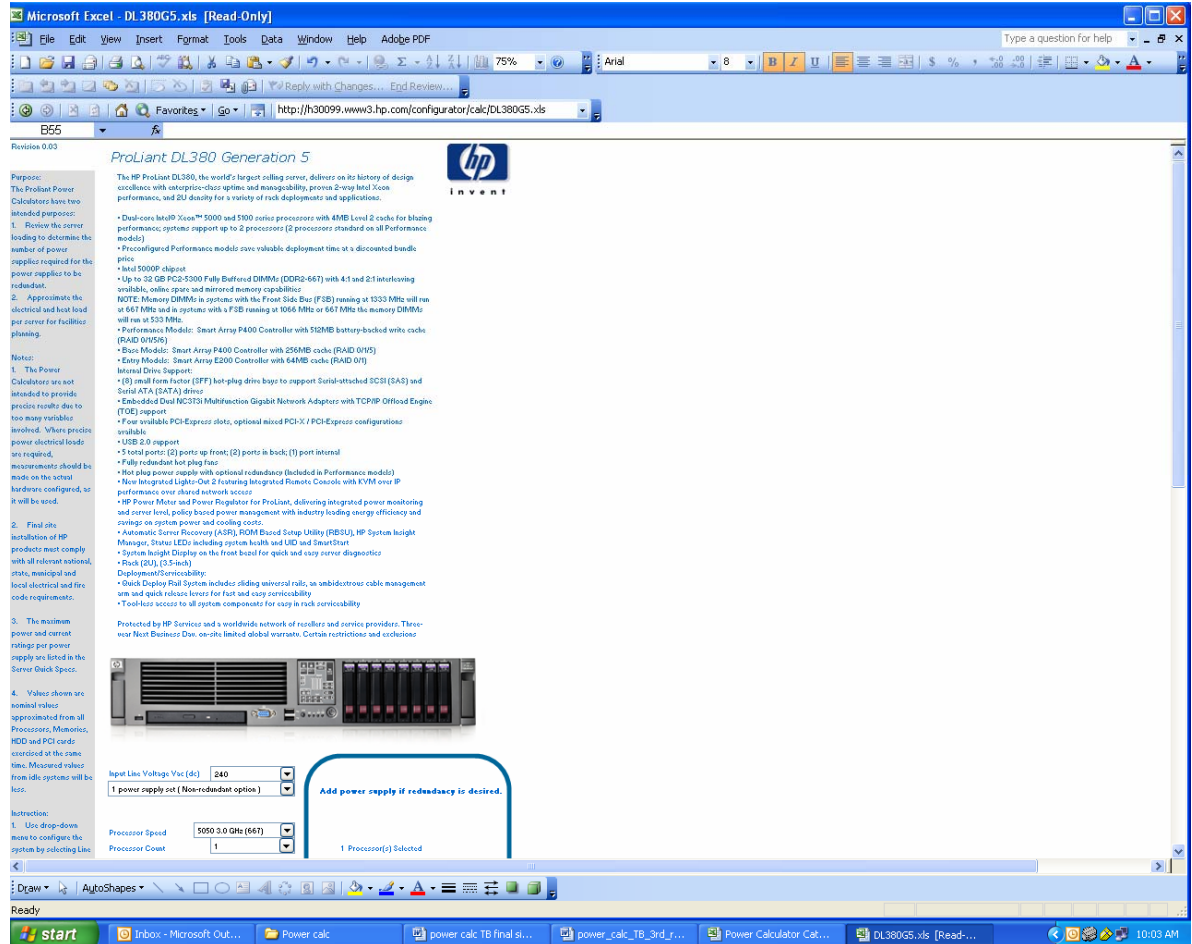
For planning hybrid installations involving varied and dissimilar equipment, the HP Site Preparation Utility is also available at this URL:  
<http://h30099.www3.hp.com/configurator/calc/Site%20Preparation%20Utility.XLS>.

The time required to download the program will depend on the Internet connection.

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Figure 2 shows a partial screen of the Power Calculator for the HP ProLiant DL360 G5. The upper half of the screen provides an overview of the server model. The lower half of the screen provides the data fields for configuring the server as desired. Users can configure such parameters as level of input voltage; number, type, and speed of processors; amount of memory; number and size of hard drives; and types of expansion boards, all of which affect power consumption. The resulting operating parameters of that configuration will be displayed in real time.

**Figure 2.** HP Power Calculator for HP ProLiant DL380 G5 (partial screen shown)



Each Power Calculator also provides a slider control allowing users to set the utilization level for the server from 0 (minimum or idle) to 100 percent (maximum usage). Resulting power consumption data is updated in real time.

**NOTE:**

The slider control does not replicate CPU usage as measured by the operating system. Instead, it approximates overall system utilization, which is a more meaningful figure.

# Example rack calculation

The HP Power Calculator utility provides accurate operating parameters that planners can use to predetermine the worst-case power requirements of a populated rack. In the following example, the HP ProLiant DL380 G5 server is the key component type to be installed in a standard 42U rack. The HP ProLiant DL380 G5 server supports one or two Intel® Xeon® 5000, 5100, or 5300 series processors, up to 32 gigabytes (GB) of memory, up to eight hot-plug hard drives, four PCI expansion cards, and one (plus one for redundancy) power supply.

For this calculation, each server in the rack will be configured with two Intel Xeon 5150 processors, 2 GB of memory, one PCI Express (PCI-e) card, four 72-GB hard drives, and 1 + 1 power supplies for redundancy (Figure 3).

**Figure 3.** Power calculation for single HP DL380 G5 server

The screenshot shows the HP Power Calculator utility interface. The configuration is as follows:

- Input Line Voltage Vac (dc): 208
- power supply set (1+1 Redundant Option)
- Processor Speed: 5150 2.66 GHz (1333)
- Processor Count: 2
- 512 MB: 0
- 1 GB: 2
- 2 GB: 0
- 4 GB: 0
- PCI-E Card(s): 1
- SAS Controller Card
- HDD, 36 GB SAS: 0
- HDD, 72 GB SAS: 4
- HDD, 146 GB SAS: 0
- HDD, 60 GB SATA: 0

The system is configured as Power Redundant. The selected components are:

- 2 Processor(s) Selected
- 0 512 MB Memory Card(s) Selected
- 2 1 GB Memory Card(s) Selected
- 0 2 GB Memory Card(s) Selected
- 0 4 GB Memory Card(s) Selected
- Total of 2 GB(s) in 2 slots selected.
- 1 PCI-E Card(s) Selected
- 1 SAS Controller Card (PCI-E)
- 4 HDD(s) Selected

The System Utilization slider is set to 75%. The resulting power requirements are:

System Utilization:	Min	Max
Total System Input power requirement (W)	372	372
Total System Input current requirement (A)	1.9	1.9
Total System BTU/Hr	1268	1268
Total System VA Rating	399	399
Total System Leakage Current (mA)	1.80	1.80
Total System Peak Inrush Current (A) 3mS	52	52

With the system utilization slider control set at 75 percent, the system input requirement for operating at 208 VAC will be 372 watts. The apparent power (VA) required will be 399 VA, and the system will draw approximately 1.9 amperes of current.

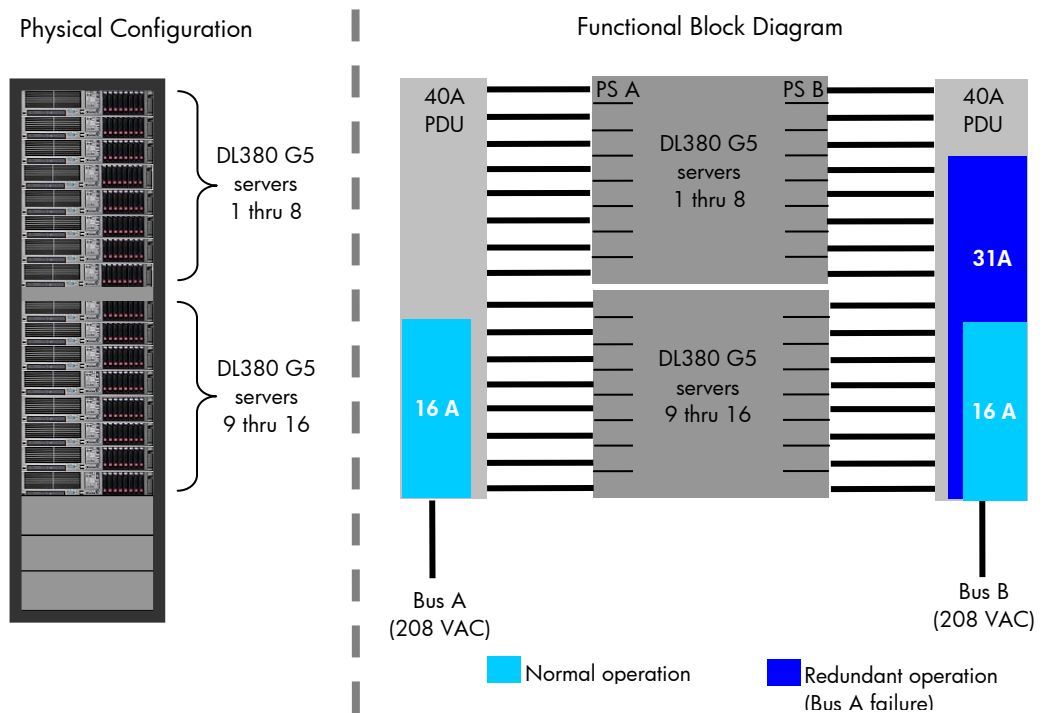
While a standard 42U rack can physically accommodate 21 ProLiant DL380 G5 servers, it is advisable to allow space for server expansion, power distribution components such as PDUs and UPSs, keyboard/video/mouse (KVM) equipment, or networking components. Figure 4 shows a rack configuration of 16 servers with redundant power. Based on individual unit needs determined using the Power Calculator, the rack configuration would require the following:

- 6384 VA total apparent power ( $16 \times 399$  VA) that the power distribution components must handle
- 30.4 amperes total current ( $16 \times 1.9$  A) drawn by the 16 servers

In a system with redundant power (Figure 4), the power supplies (PS A and PS B) of each server are typically connected through PDUs to separate power buses. With both power buses active, each power supply will evenly share the server load. Should one power bus fail, the power supplies on the active bus will handle 100 percent of the server load. The associated PDU will need to distribute the full 30.4 amps ( $16 \times 1.9$  A) required by all the servers.

It is a common but unwise practice to plug additional components into a PDU that has available outlets—even if measurements made under normal conditions indicate that the PDU loading is well under the rated capacity. To ensure full redundancy, a PDU should never handle more than 50 percent of its rated capacity in normal operation. For redundant PDUs with segmented circuits, circuit loading for each segment should be held at less than 50 percent of the circuit breaker rating. In the configuration shown in Figure 4, the 40-amp PDUs provide some headroom for additional equipment to be installed.

**Figure 4.** 42U rack configuration of HP ProLiant DL380 G5 servers with redundant power



The cooling requirement for the rack configuration shown in Figure 4 would be 19776 BTUs/hr ( $1236 \times 16$ ). Actual cooling requirements can be affected by additional factors including air flow within the rack and rack placement within the data center. If the configuration in Figure 4 were to require battery backup support due to a power failure, the UPSs would need to provide 6384 VA for the servers. The HP UPS and PDU sizing tool provides UPS and PDU model suggestions based on user input. The sizing tool is available at the following URL: <http://www.upssizer.com/>



## Conclusion

The HP Power Calculator is a valuable utility for planning systems based on HP ProLiant products. The calculator provides meaningful estimates of power for use in sizing an infrastructure. It is important to note, however, that actual power consumption of an installed system running certain applications may vary. To use the Power Calculator effectively, IT organizations must observe the following caveats:

**Do use the calculator for:**

- Estimating requirements only for HP systems
- Determining maximum equipment power and cooling needs at the unit (chassis) and rack levels

**Do not use the calculator for:**

- Estimating requirements of systems from other vendors
- Direct comparisons with other vendors' products
- Precise predictions of the power consumption of a single instance of a server running a particular application. Actual power consumption can be less than the power and cooling needs indicated by the Power Calculator.
- Estimating power consumption of individual components (memory, hard drives, cards, etc.)

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### NOTICE

The HP Power Calculator is provided "as is" without any warranty of any kind. The entire risk arising out of the use of the Power Calculator remains with the customer. In no event shall HP be liable for any direct, consequential, incidental, special, punitive, or other damages whatsoever (including without limitation, damages for loss of business profits, business interruption or loss of business information) even if HP has been advised of the possibility of such damages. Refer to the HP Power Calculator program license terms for more information.

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## For more information

For additional information, refer to the resources listed below.

Resource	Hyperlink
HP Power Calculator Catalog	<a href="http://h30099.www3.hp.com/configurator/powercalcs.asp">http://h30099.www3.hp.com/configurator/powercalcs.asp</a> or <a href="http://www.hp.com/go/bladesystem/powercalculator">www.hp.com/go/bladesystem/powercalculator</a>
HP UPS and PDU Sizer	<a href="http://www.upssizer.com/">http://www.upssizer.com/</a>
HP rack and power products	<a href="http://h18004.www1.hp.com/products/servers/platforms/rackandpower.html">http://h18004.www1.hp.com/products/servers/platforms/rackandpower.html</a>
HP Site Preparation Utility	<a href="http://h30099.www3.hp.com/configurator/calc/Site%20Preparation%20Utility.XLS">http://h30099.www3.hp.com/configurator/calc/Site%20Preparation%20Utility.XLS</a>

## Call to action

Send comments about this paper to [TechCom@HP.com](mailto:TechCom@HP.com).

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TC070301TB, March 2007

