



Power-On

PCIe Graphics and Power

PCI Express (PCIe) Graphics cards have raised the PC video experience to a new levels of performance. Unfortunately, in many cases, these same cards require more power that what is commonly available. PCIe Graphics power implications are often misunderstood or overlooked, creating the potential for an unsatisfactory end user experience. This article seeks to clarify PCIe graphics power requirements, calculations, and solutions.

PCIe builds upon the PCI (Peripheral Component Standard) standard. Under the hood, there are significant differences between PCIe and PCI, namely PCIe uses a serial protocol versus PCI's parallel bus. PCIe can be thought to operate in a more "network" fashion as opposed to PCI parallel operation. Because of this, PCIe devices can form point to point connections without disturbing other parts of the PC system. Importantly, PCIe is also much faster than PCI or AGP (Accelerated Graphics Port), a predecessor graphics point to point protocol.

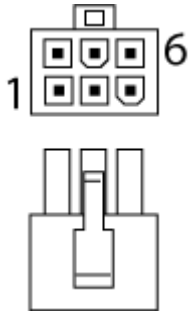
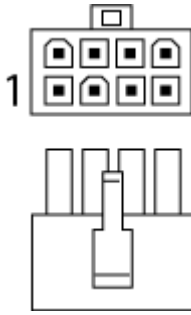
Market leaders AMD ATI and NVIDIA have aggressively moved to the PCIe X16 interface, producing cards and GPUs (Graphics Processing Units) that can be extremely power intensive.

Manufacturer	Model	TDP
AMD ATI	Radeon HD 5870 X2	376W
AMD ATI	Radeon HD 5970	294W
NVIDIA	GeForce GTX 295	289W
AMD ATI	Radeon HD 4870 X2	286W
AMD ATI	Radeon HD 6970	250W
NVIDIA	GeForce GTX 480	250W
AMD ATI	Radeon HD 4850 X2	250W
NVIDIA	GeForce GTX 580	244W
NVIDIA	GeForce GTX 280	236W
AMD ATI	Radeon HD 5870	228W
AMD ATI	FireStream 9370	225W
AMD ATI	FirePro 3D V9800	225W
AMD ATI	FireStream 9270	220W
NVIDIA	GeForce GTX 275	219W
NVIDIA	GeForce GTX 570	219W

Power intensity is measure by TDP (Thermal Design Power). Simply stated, TDP can be thought of as the maximum power predicted while running approved operations.

NVIDIA® SLI™ and AMD® CrossFire™ Multi GPU platforms use PCIe to combine individual graphics cards into a single graphics solution. Both SLI™ and CrossFire™ use a bridge connector to link the individual cards together. Alternatively, a SLI™ or CrossFire™ graphics card may be used by itself.

Given the PCIe X16 maximum power draw is 75W, alternatives means are required to supply power above the PCIe maximum. This is accomplished by a direct power supply connection via PCIe 6-pin and 8-pin connectors. The PCIe 8-pin connector is not to be confused with 8-pin CPU power connector. Although both deliver +12V, they are keyed differently with different pinouts.

PCIe 6-pin	PIN	Voltage	PCIe 8-pin	PIN	Voltage
	1	+12V		1	+12V
	2	+12V		2	+12V
	3	+12V		3	+12V
	4	GND		4	GND
	5	GND		5	GND
	6	GND		6	GND
				7	GND
				8	GND

It's important to take note of graphics power composition. The PCIe X16 slot supplies 75W as previously mentioned. 10W comes from the +3.3V output (3.0A) and 65W from +12V output. As observed from the PCIe power connectors pinout, the supplemental power draw is entirely from the +12V output.

Many high wattage power supplies have developed the concept of +12V rails. A rail is an isolated +12V output, theoretically independent from the other +12V outputs. A common design is four +12V rails, labelled +12V1, +12V2, +12V3, +12V4. Each rail supports a maximum current. For example, if a rail maximum current is 15A, then the output is rated at 180W (12V x 15A).

Power Calculations

Graphics power calculation can be categorized into three cases:

- 1) Single graphics card which does not require supplemental +12V power. This is the most common case where the known maximum graphics power is less than 75W PCIe restriction. These cards do not have PCIe 6-pin or 8-pin supplemental power connectors. It is usually not necessary to upgrade the power supply considering power gained by removal of old card and standard overhead power budget. The exception being systems with a pre-existing under-power condition such as a budget slim line computer.
- 2) Single graphics card which does require supplemental +12V power via PCIe 6-pin and/or 8-pin connectors. Exact requirement dictated by the specific card. The minimum power supply requirement will be 400W with a PCIe 6-pin connector. Standard issue PC systems will need a power upgrade. Except for a potential maximum 10W from the PCIe +3.3V slot, all remaining power consumption will be on a +12V output.


- 3) SLI™ or CrossFire™ Multi GPU platform. From a power perspective, Multi GPU installations are a multiple of the number of individual cards used in the platform. Because Multi GPU systems share the video processing load, the utilization is lessened on each GPU for normal operation. This means power consumption is less than the sum of individual cards. At this time, 0.65 is used as multiplier constant.

As an example, let's calculate maximum power for a pair of GeForce GTX 460's in SLI mode.

$$\text{Multi GPU Power} = 0.65(2 \times 160\text{W per GeForce GTX 460}) = 208\text{W}$$

Typical Power Solutions

Without all system variables, only a general power supply solution can be offered in the aftermarket. The general solution takes the form of a single high wattage (600W and up) power supply. The theory being that a large enough power supply will handle any graphics scenario. These power supplies will have a 120mm top mounted fan, 24 pin mainboard connector and various PCIe 6-pin / 8-pin connector combinations. From a graphics card perspective the "large power supply" solution is usually fine. Unfortunately, there can be many problems integrating an off the shelf "large power supply" with the rest of the system. These problems include form factor, attach points & fan orientation and power connectors. Always verify form, fit, and function before upgrading.

Form, Fit, and Function		
Power supply ATX standard form factor: 140L x 150W x 86H mm (5.5" x 5.9" x 3.4") is required.		
Power supply attach points must be per ATX standard and oriented so 120mm Fan exhausts correctly.		
Power supply connectors must support existing motherboard and peripheral requirements.		

Alternative Solutions

Power-On.com offers the [large power supply](#) for graphic card upgrades and system builds. We also have alternatives which provide flexibility and a more informed approach.

One such alternative is a Graphics Booster Power. Our [450W Graphics Booster](#) is especially designed for Multi-GPU graphics supplemental +12V power. The booster easily slides into any open drive bay and is the ideal solution for system owners unable to do a full power supply upgrade due to form factors, proprietary connectors, or fan orientation. It also provides an answer for those happy with their existing power supply but need supplemental +12V graphics power.

Finally, we suggest anyone curious about their hardware or considering a graphics upgrade to run [Auto Check](#). Auto Check describes a process which automatically inspects a computer's hardware profile and reports results in your browser. The resulting report is similar to Windows Device Manager with additional information and a more intuitive layout. System power analysis, memory summary, and graphics upgrade scenarios/solutions are provided. Auto Check takes less than 30 seconds to complete with privacy and security assured.