FireWire: The Greenest Interface

Saving Energy Using the IEEE 1394 Standard

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FireWire is not merely the fastest network for connecting your external hard drive and other peripherals: it is also, potentially, the most environmentally friendly, the greenest. At a time when both individual consumers and companies are trying to reduce their carbon footprint, products equipped with the FireWire (IEEE 1394) standard, are an excellent choice. Plenty of power can be saved, and waste can be eliminated right now using FireWire, and there are additional opportunities to save even more if companies take full advantage of all of the standard's capabilities.

Power Over FireWire: Eliminating Energy Vampires

Both USB 2.0 and FireWire can provide power over their connection cables eliminating the need for external ac-dc power supplies (*wall warts*). The wall warts, also called energy vampires, provided with so many electronic devices, are often linear power supplies which are approximately 30% to 40% efficient. That means they waste up to 70% of the power being used by the device they are connected to. Unfortunately, when the appliance is turned off, it continues to consume power. I completed measurements of several that I own and found they use from 5.2 to 8.3 W (42 to 68 mA at 122 V) *with nothing connected to them.* Most users leave them plugged in all the time, which means they are using up to 73 kW per year per device, equivalent to 100 kg of CO_2 or driving your car 100 miles[1].

On the other hand, notebook, laptop and desktop computers use switching power supplies that achieve up to 85% efficiency. Also, switching power supplies use, essentially, zero power when the device is off. So by using power supplied by your laptop or desktop PC, you are saving a lot of energy.

But saving energy is a problem if you're using USB. Devices powered over USB are limited to 2.5 W (0.5 A at 5 V) per USB port. FireWire can provide up to 45 W[2], eighteen times as much power as USB. Why is this important? Take an external hard

[1] http://www.carbonify.com/carbon-calculator.htm

[2] Up to 1.5 A at up to 30 V

drive as an example. The capacity and speed of the hard drive you can power over the cable is limited by the amount of power it needs. A drive designed to operate off USB must limit the power it draws to 2.5 W, or it must include an ac adapter. Some USB devices use two USB ports to obtain up to 5 W. Unfortunately, if you don't have two spare ports, you need a USB hub, which on average draws 1.5 W when off and up to 3.5 W when on *and uses an external linear power supply*. More power means more devices that don't need an external power supply.

Apple computers provide 7 W over FireWire, and some network cards provide 18 W or more[3] allowing multiple FireWire devices to be powered off of a single port. Higher capacity drives also mean fewer drives are needed, providing more power savings. Also, many devices require voltages other than 5 V. For example, many drive spindle motors use 12 V. Since USB only provides 5 V, drives that require 12 V require an external supply. FireWire can provide up to 30 V, enabling many devices that require higher than 5 V to receive power over the cable. Furthermore, FireWire can be daisy chained. Multiple devices can share the same FireWire port on a computer. With USB, each device needs its own port, quickly using up the available ports and forcing the use of a USB hub, requiring more wall warts.

Perhaps more important is the cost and waste of producing and disposing of millions of those wall warts every year. While figures are not available for external disk drive power supplies, the following Table provides some guidance.

Worldwide Embedded Energy to Produce, Ship, Discard External Power Supplies

Product	PJ[4]	Metric Tons of CO_2	# 1000 MW power plant
Cell Phone	21	4,200,000	0.7
DECT Phone	5	1,000,000	0.2
Digital Camera	2	400,000	0.1
Set Top Box	5	1,000,000	0.2
Personal Care	1	200,000	0.0
Standard Battery Charger	3	600,000	0.1
Power Tool Charger	4	800,000	0.1
Printer	4	800,000	0.1
Laptop	2	400,000	0.1
Other	10	2,000,000	0.3

Table 1: Energy for Production, Distribution, End of Life CO_2 Generated by Coal

Obviously, eliminating the need to ship a wall wart with each product can eliminate a lot of waste. In 2008 alone, 3.2 billion external power supplies were manufactured worldwide, with 737 million external power supplies shipped to the US. Moreover, 434 million external power supplies will be retired in the US alone and only 12.6% of them

[3] Eg FWB-68300 PCI Express FireWire 800/400 Card
[4] 1 Petajoule (PJ) = 277.77 million kW

will be recycled, leaving 379 million external power supplies going into landfills.[5] These devices don't just go away either. According to the EPA "these power supplies are made with toxic materials and don't have a lot of salvageable components making them unattractive to recyclers."

Mobile Phone Chargers in a Georgia Landfill For Burial. Photo by Chris Jordan

FireWire's Speed Benefits

At 800 Mbit/s, FireWire is nearly 4x faster than USB 2.0 while reading and 2x while writing to disk[6]. Faster means less energy used. For example, a review of hard drives by iXBT Labs[7] shows that a typical 2.5-inch 5400 rpm hard drive might consume 0.8 W at idle, 3.75 W at start up, 2.5 W read, and 2.5 W write. Aside from the fact that the start up current exceeds what a USB port can provide, it is easy to see that faster read/write times equate to less power used. Using iXBT Lab's equations for power usage[8] modified to take into account the differences in speed for FireWire 800 and USB 2.0 it can be shown that USB consumes on average 40% more power for typical applications and 300% more for demanding tasks like backups and copying files.

The actual power savings can be far more pronounced if you have other USB devices connected. Due to its architecture, USB performance is affected far more than FireWire by having multiple connected devices. While specific test results on this are hard to find, since most tests are done with only one device on the port at a time, a reading of blogs and other anecdotal evidence shows a far greater difference in performance between FireWire and USB when multiple devices share the ports. Slower means, in effect, more power consumed and more of your valuable time is wasted waiting for tasks to complete.

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[5] Table 1 and data from Greenplug; http://www.greenplug.us/PressKit/Green_Plug_UCGEC_Whitepaper.pdf
[6] Digital Home Designline http://www.digitalhomedesignline.com/howto/209100415
[7] http://www.xbitlabs.com/articles/storage/display/25inch-hdd-250gb_11.html#sect0
[8] http://ixbtlabs.com/articles2/storage/hddpower-pro.html

CPU Cycles

The next area is the power used by the system processor. A typical PC CPU is very power hungry. A look at a number of sites provides a wide variation in test results but it is clear that USB 2.0 uses more CPU cycles than FireWire. Anecdotal evidence from blogs shows similar and even greater differences than the following:

Computer/Processor	Benchmark	USB 2.0	FireWire 400
Unknown[9]	HD Tune	6.6%	1.5%
Dell Dimension 8400[10]	Maxtor 6Y200P0 Benchmark	10.4%	1.4%
Athlon64 3000[11]	Maxtor 6Y200P0 Benchmark	23.8%	3.4%

Table 2: FireWire and USB 2.0 CPU Usage

Obviously fewer CPU cycles to service the port leaves more cycles for other applications. However, all else being equal, more cycles means more power and more heat: requiring the fan to operate harder to cool the CPU as well. While this is difficult to quantify, it is clear that for a processor that increases its power draw by 50 W or more from idle to maximum, CPU usage can be significant. But that is only part of the story. As the power used by the CPU goes up, the cooling fan works harder too. Thus, the total power increase is greater than simply the increase in CPU power. Again, there is little hard data to be found but it would appear the savings in power by reducing the load on the CPU and related system components is at least as great as that saved by the disk drive itself. Of course for battery operated notebooks and laptops, it also equates to more work getting done before the battery dies.

The Bottom Line: FireWire Saves Energy Now

It is clear that FireWire can save energy today. Unfortunately, most bus-powered FireWire devices include a USB port and therefore are limited to 2.5 W (5 W for a dual-port device) despite the availability of far more power over the FireWire port, forcing manufacturers to include an external power supply if they require more power.

Going forward, manufacturers of host devices such as desktop and laptop computers should include a powered 6-pin or 9-pin FireWire connector (the 4-pin connector does not supply power). Admirably, Apple provides 7 watts on nearly all of their computers and it is available to devices that need power as long as the computer is plugged in, even if it is turned off (don't worry, they use a switching power supply). However, the benefits are multiplied if more power is available. If manufacturers provided 20 or 30 watts, think of how many external energy vampires we could eliminate?

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[9] http://www.ocia.net/reviews/wdmybook320/page5.shtml
[10] http://forums.ilounge.com/archive/index.php/t-98746.html
[11] http://forums.ilounge.com/archive/index.php/t-98746.html

Further, device manufacturers, in particular external hard drive manufacturers, should offer consumers the choice of a FireWire only connection for their devices that require more than the extremely-limited 2.5 W of USB. Manufacturers benefit by eliminating the external power supplies and the additional costs from manufacture, packaging, and shipping while providing, for example, larger and faster hard drives. Consumers would benefit by reducing power consumption by hundreds of kW per year, and freeing up all those outlets that are blocked by the big bricks. Finally, society benefits by eliminating the need for millions of wall warts and the associated hundreds of thousands of tons of CO_2 generated by the manufacture, packaging, shipping, disposal, and use of these energy vampires, all due to the power of FireWire. Go green, go FireWire.

About The Author

Bill Rose is the president and founder of WJR Consulting advising companies on product and business development, market strategies, technology, and standards relating to consumer electronics and home entertainment networking. Prior to founding WJR Consulting, Bill was vice president of Electronic Engineering at Leviton; co-founder and VP of Engineering and Operations for InfraVision, a video datacasting startup; and Director of Advanced R&D for Coleco, creators of the Adam computer and ColecoVision.

Bill has been active in the consumer electronics industry for over 20 years serving in numerous positions of influence including HANA, 1394 Trade Association, CEA Home Networking Committee, IEEE 802.111; He has spoken at over thirty trade conferences.

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