

CompactPCI power supplies – the power that drives the system

By Aaron Applebaum

System integrators by and large are focused on the applications of the redundant system. Whether it is communications, process control, medical, or other, the functionality of the end application is the subject of focus, as well it should be. However, it is sometimes forgotten that the reliable operation of the application is also a function of the infrastructure supporting its implementation – specifically the power supplies and the backplane.

The CompactPCI power supply requirements have been well defined in PICMG 2.11 R1.0. The purpose of this article is to review these requirements to focus in on those relevant product specifications that relate to overall system performance.

What is important in CompactPCI power supplies? The feature set can be broken down into four categories, as follows:

- Mechanical
- Electrical
- Reliability
- Cost

Mechanical

The mechanical size of CompactPCI power supplies is a function of the available space in the chassis and the power (watts) required.

Typically the supplies come in two form factors, 6U and 3U heights. Width is anywhere from one slot to four slots. Obviously, the more power output that can be obtained from a given size form factor, the better the supply. This is because the form factor of a CompactPCI chassis is fixed at 21 slots. The more slots that can be used for system functionality, the more cost efficient the system is as a whole. However, the size criteria becomes even more important when the (N+1) redundancy requirements of power in a CompactPCI system are taken into account.

A 3U x 1-slot, 350-watt power supply uses a quarter of the space of a 6U x 2-slot 350-

watt supply. In usable space the savings are 6U x 1 slot. However, in a minimum configuration of (1+1) supplies for a 350-watt system, the space savings grow to 6U x 3 slots, as opposed to current solutions that are 6U x 2 slots in size.

In another example, a 1050-watt (N=3 + 1) loaded system causes the space savings to grow to 6U x 6 slots. For a fully-loaded, 21-slot system, this accounts for 30 percent of the usable space.

Power supply vendors Jasper, Tracewell, and LV Power maximize overall chassis utilization by employing high-density CompactPCI power supplies.

Electrical

The electrical characteristics of a CompactPCI power supply include the following:

- Distribution of currents per rail
- Overall power supply efficiency
- Power supply derating characteristics
- Power quality, noise, regulation
- Output voltage sequencing
- Self-diagnostic capabilities

The specific output voltages defined in the CompactPCI specification are 5V, 3.3V, 12V, and -12V. However, what is not defined is the output current on each rail. In the past, the 12V was dominant for cooling and disk drive storage applications.

Today, the emphasis for high output current falls primarily on the 3.3V and 5V. What is important is to match the power needed per system application to the power supply capabilities. Sometimes a system designer can use a lower-power power supply if he receives the current needed on the specific rails. It is also worth checking whether the supply is rated at overall power output, in such a way as to allow more current consumption on any of the voltage rails (up to predefined limits) as long as the overall power output of the supply is not exceeded.



The overall power supply efficiency is perhaps one of the most important characteristics of merit for the supply. A high-efficiency supply saves electricity (money) for the overall operation of the system. However, more importantly, a low-efficiency power supply generates waste heat, which must then be removed from the system by use of strong, noisy fans that generate heat and consume power by themselves.

By way of example; if a loaded system of 1050 watts is using a supply that is 70 percent efficient, that means there is 30 percent of waste heat or 315 watts that needs to be removed. If the same system were using supplies that were 85 percent efficient, the waste heat generation would be reduced to 158 watts or half of the previous amount.

Finally, it is worth noting that those power supply manufacturers that produce the smallest supplies are almost by definition the most efficient manufacturers, simply because it is not possible to produce a small, high-power power supply that is not efficient.

Power supply derating characteristics allow manufacturers to “fudge” the real usable power output ratings of the power supply. The output power rating of a supply is meaningless if the operating conditions in which it was tested are not clearly stated. Specifically, the ambient temperature and the cooling requirements in LFM or CFM need to be stated.

Above 40° C some CompactPCI supplies start to derate heavily, between 0.5-3 watts per degree C. It is important to have the derating graph in order to make comparisons. The more airflow a supply has the more output power it can produce, so this is a very important parameter as well.

Typical power specifications are given at 400LFM (which is a lot of airflow). Some of the better manufacturers are now starting to specify power outputs at 300LFM or less. The manufacturer should have a graph of output power at several different airflows.

The CompactPCI chassis specifications are specified up to 55° C, so the best manufacturers will specify their supplies at full power rating with no derating up to an ambient of 55° C at a defined airflow.

The CompactPCI specifications define the minimum noise and ripple allowed at 50mvPP and the line load regulation at 3 and 5 percent. This is generally sufficient for digital applications, however, this may cause problems in some analog front-end capture systems. Check actual figures.

Noise and immunity specifications EN55022 and 47CFR,P15 SubB:01, ICES-003:97 are classified at Class A. Some manufacturers have improved on these specifications and are offering Class B noise and immunity as standard.

All things being equal, it is always much preferable to select a Class B certified product over Class A because of the lower level of interference caused by Class B certified products.

Output voltage sequencing simply means that when the supply is first turned on, a fixed predetermination on which voltage comes up first is set. CompactPCI supplies have an output signal "PWR Good" (pin 41 high from the I/O connector) that asserts itself after all the voltages have stabilized. However, not all CompactPCI implementations make use of this signal. If the supply voltages come up and turn on in a random manner, then expensive controller and controller implementation at the system level is needed to initialize.

A good turn-on sequence is for the 12V to come up first, to start operation of the slot hot-swap controller in the system and peripheral function cards. If in doubt, ask the manufacturer.

Self-diagnostic testing has become a popular subject, but is rarely, if ever, found in practice. The idea is that self diagnostics on the supply be implemented to the IPMI communication protocol via I_C communication from the supply to the system. This is indeed useful, but the PICMG committee has not yet defined the exact protocols for the power supply.

Generally speaking there are two types of communication to be defined:

- A) Information from the supply to the system about the internal workings of the supply
- B) Instructions from the system to the supply as to what actions need to be taken by the supply

The information the supply can provide to the system is a long list and is broken into three parts:

- A1) General information
- A2) Health of the supply
- A3) Preventive maintenance request

The general information the supply needs to tell the system is that it is alive, what its serial number is, and which slot it is plugged into. This information is used to control the specific supply and lets the system know how much power is at its disposal.

Health information is an ongoing measurement of all four voltages and currents being used.

Temperature of the power supply, power supply efficiency, and status of LED indicators is used to control the function cards in other slots, to turn some off if the supply is becoming overloaded, or if the internal temperature is rising above a preset level, and to tell maintenance to replace the supply the next time preventive maintenance is carried out on the system (if for example the supply efficiency is dropping as a preindicator to internal problems).

Preventive maintenance request gives a time log of the hours the supply has been in operation so that it can be replaced after a preset time in accordance with the MTBF of the supply.

- B) The information the system needs to provide the supply is a directive to shut itself down, or to turn itself on.

Reliability

The reliability of a CompactPCI supply is a function of several design factors among which some of the most important are:

- Current share accuracy
- Inrush Current suppression
- Overcurrent characteristics
- Efficiency

The current share function is meant to allow two or more supplies to work in parallel on the 5, 3.3, or 12V current rails.

The CompactPCI specifications state that the current share accuracy needs to be within a 10 percent full load range. The reason for this is that if one supply is taking most of the load and the other is running cool, the reliability of both suffers.

If the hot supply fails, then the jolt of the full load being transferred to the cool supply is likely to cause it to fail as well, which will lead to an overall system failure. The current share accuracy requirement of the CompactPCI specification is frequently violated, especially if the current sharing is implemented using the Droop method. Variances of 30-70 percent on load sharing are not uncommon.

A much better implementation is the active peak master slave method of current sharing, which allows current share accuracy of 1-2 percent between supplies, allowing an even load and uniform heating. Both Tracewell and LV Power are using this method.

High inrush current from a cold start is frequently a power supply killer. It is the highest stress point possible on the supply; therefore, good design dictates that the inrush current be controlled.

CompactPCI specifications have a minimum requirement for input inrush current suppression, commonly known as hot swap input control. Inrush current suppression should also be controlled by active means, and not rely on unreliable passive components such as NTC for one-time inrush current suppression.

In the case of a short circuit on the system bus, the supply needs to power down, and power up after the short circuit is removed. During the period of the short circuit, the power dissipation of the supply should be minimal, otherwise heating can occur that affects its reliability. A reliable supply will minimize the

self-heating effect during short circuit operation.

The enemy of power supply reliability is heat, it therefore goes without saying that the higher the efficiency of the supply the less heat it generates, and the more reliable the supply becomes.

Cost

The meltdown of the telecom industry has not left the CompactPCI industry untouched. A CompactPCI power supply is a specialized product catering to a niche market, which up to two years ago supported prices of \$2.5 to \$3 per watt. Today, this is no longer the case.

As system volumes have been reduced there is a relentless pressure on the sur-

vivors to reduce costs and increase functionality. Current prices for CompactPCI power supplies are hovering at about \$1.5 per watt for prototypes, and are below \$1 per watt in quantity. This is for those manufacturers that can provide the best feature sets as described above. The others are simply no longer in the game.



Aaron Applebaum
is the general manager of LV Power and a 22-year veteran in the electronics and power supply industry.

For more information, contact Aaron at:

LV Power

2 Granite St. Mitzpe Sapir Ind Area
P.O.B. 13183 Tzur Yigal 44862 Israel
Tel: 972-9-7498777 • Fax: 972-9-7498999
E-mail: sale@lvpower.net • Web site: www.lvpower.net

Power Supplies

Company/Model	Web site/Product	Plugin 3U 6U	Custom Design	Hot Swappable	Industrial Grade	Low EMI/RFI	Onboard DC to DC	N+1 Redundant	Mil-Spec	Thermal
Adlink Technology America	www.adlinktechnology.com									
cPCIS-3030	3U cPCI power supplies	x	x	x	x	x				
Advanced Power Solutions	www.advpower.com									
APS175ACP	AC/DC, 175W switching power supplies	x	x	x	x	x	x			
APS175DCP	DC/DC, 175W switching power supplies	x	x	x	x	x	x			
APS200ACP	AC/DC, 200W switching power supplies	x	x	x	x	x	x			
APS200DCP	DC/DC, 200W switching power supplies	x	x	x	x	x	x			
Advantech Network Computing	www.advantech.com									
MIC-3031	Redundant power supplies			x	x		x			
MIC-3032	AC, ATX power supplies			x	x		x			
MIC-3033	Redundant power supplies			x	x		x			
AEGIS Power Systems	www.aegispower.com									
N/A	Custom designs	x	x	x	x	x	x	x		x
American Power Conversion	www.apc.com									
PSX	PowerStruXure, modular, scalable architecture	x	x	x	x	x	x	x		x
SU420-SU5000	Smart-UPS Series w/line voltage monitoring	x	x	x	x	x				x
apra-norm Elektromechanik	www.apra.de									
PS 245	Power supplies	x		x	x					
APW Electronic Solutions	www.apw.com									
550cpci	550W cPCI power supply	x		x				x		x
PPS 300A	300W pluggable power supply, AC/DC or DC/DC	x		x				x		x
C&D Technologies	www.cdpowerelectronics.com									
cPCI350AC	350W, 6Ux8HP P47 power supply	x	x	x	x	x				
cPCI350DC	350W, 6Ux8HP P47 power supply	x	x	x	x	x				
cPCI420DC	420W, 6Ux8HP P47 power supply	x	x	x	x	x				
cPCI500DC-A	500W, 6Ux4HP P47 power supply	x	x	x	x	x	x			
cPCI500DC-B	500W, 6Ux4HP P47 power supply	x	x		x	x	x			
Cherokee International	www.mitrapowersystems.com									
CMP150	150W AC/DC power supply	x	x	x	x	x	x	x		x
CMP200	200W AC/DC power supply	x	x	x	x	x	x	x		x
CMP400	400W AC/DC power supply	x	x	x	x	x	x	x		x
DMP150	150W DC/DC power supply	x	x	x	x	x	x	x		x
DMP200	200W AC/DC power supply	x	x	x	x	x	x	x		x
DMP400	400W DC/DC power supply	x	x	x	x	x	x	x		x
Condor D.C. Power Supplies	www.condorpower.com									
CPCI-204-1203	200W 3U power supply	x	x	x	x	x				
CPCI-204-1203M	CPCI Series power supply	x	x	x	x				x	
CPCI-354-1203	CPCI Series power supply	x	x	x	x				x	
CPCI-354T-1203	CPCI Series power supply	x	x	x	x				x	
DPCI-204-1203	200W DC input power supply w/custom front panels	x	x	x	x	x				
DPCI-204-1203M	DPCI Series power supply	x	x	x	x		x		x	
DPCI-354-1203	DPCI Series power supply	x	x	x	x		x		x	
DPCI-354T-1203	DPCI Series power supply	x	x	x	x		x		x	
Continuous Computing	www.ccpu.com									
N/A	350W, dual feed DC telecom power supply	x		x	x	x	x			
N/A	150W, dual feed DC telecom power supply	x		x	x	x	x			
Dage Group	www.dage-group.com									
N/A	Custom designs	x	x	x	x	x	x		x	
Donghae Systems	www.donghaesystem.com									
CPCI Series	150/350W power supply w/quad output	x		x	x	x			x	
DPCI Series	150/350W power supply w/quad output and 48 VDC	x		x	x	x			x	
PCI Series	200/300W power supply w/power factor corrected	x		x	x	x			x	
Geotest	www.geotestinc.com									
GT7420-03	3.3V @ 10A fixed power supply									
GT7420-05	5V @ 10A fixed power supply									
GT7420-12	12V @ 8.4A fixed power supply									
GT7420-15	15V @ 7.6A fixed power supply									
GT7420-28	28V @ 3.6A fixed power supply									
GT7430	0-30VDC, 5A programmable power supply									
GT7460	0-60VDC, 2.5A programmable power supply									
GX7400	Plug-in programmable power supply	x	x							

continued on next page

Power Supplies

Company/Model	Web site/Product	Plugin 3U 6U	Custom Design	Hot Swappable	Industrial Grade	Low EMI/RFI	Onboard DC to DC	N+1 Redundant	Mil-Spec	Thermal
HiTek Power	www.hitekpower.com									
FM600	FM Series power supply, 1000/1600W		x	x	x	x		x	x	x
HF-10 & HF-16	HiFlex Series power supply, 1U/3U		x	x	x	x		x	x	x
Hybricon	www.hybricon.com									
233-5xx	Pluggable power supplies	x		x				x		
I-Bus/Phoenix	www.ibus.com									
IBP 1000, 1500 & 2000	Slimline rack UPS					x				
IBP 1250 & 2000	Rackmount UPS					x				
PSU-ACx	350W power supply			x						
PSU-DCx	350W input supply						x			
Inova Computers	www.inova-computers.com									
ICP-AC/DC-tvnp	AC/DC, 60W, stabilized, switched-mode PSU	x	x		x		x		x	
ICP-DC/DC-tvnp	24V DC/DC, switched-mode PSU w/M-connector	x	x		x		x		x	
ICP-PSU-120	120W modular power supply	x	x		x	x				
ICP-PSU-60	60W modular power supply	x	x		x	x				
ICP-UPS	Uninterruptable power supply	x	x		x				x	
Jasper Electronics	www.jasperelectronics.com									
2600	75W, 300W hot-swappable power supplies	x	x	x	x	x		x		x
PCI204/DPCI204 Series	250W, 3U, compact power supplies	x	x	x	x	x		x		x
PCI254/DPCI254 Series	350W, 6U, compact power supplies	x	x	x	x	x		x		x
Kaparel	www.kaparel.com									
PS1220 Series	3U power supplies	x	x	x	x	x	x			
PS3350-PS3353	6U power supplies	x		x	x	x	x			
PS3357-PS3358	6U, 350W power supplies, P-38/P-47 connectors	x	x	x	x	x	x			
Knurr USA	www.knurr.com									
Herakles Power Supply	Power supplies	x	x	x	x	x		x	x	x
Lambda Electronics	www.lambda.com									
CPCI175HP47	3U, 8HP hot-swap power supply w/P47 connector	x	x	x	x					
CPCI175MP47	3U, 8HP hot-swap power supply w/P47 connector	x	x	x	x					
CPCI175P47	3U, 8HP hot-swap power supply w/P47 connector	x	x	x	x					
CPCI400HP47	6U, 8HP hot-swap power supply w/P47 connector			x	x					
CPCI400P47	6U, 8HP hot-swap power supply w/P47 connector			x	x					
LV Power	www.lvpower.net									
LVDC350W3U1	3U, 1-slot, 350W DC/DC power supply	x		x	x	x	x			
LVDC350W6U1	6U, 1-slot, 350W DC/DC power supply	x		x	x					
Magnetek	www.magnetek.com									
HD8	500W rack-mount IPMI power supply, DC input		x	x	x					
HP8	500W rack-mount IPMI power supply, AC input		x	x	x					
PCI200-4CBDD	3U, 200W power supply, AC input, P47 connector	x		x						
PCI-3-4BCDD	6U, 350W power supply, AC input, DIN	x		x	x					
PCI-3-4BCDD-P1	6U, 350W power supply, AC input, 38-pin connector	x		x	x					
PCI-3P-4CBDD	6U, 350W power supply, AC input, P47 connector	x		x	x					
PDI200-4CBDD	3U, 200W power supply, DC input, P47 connector	x		x						
PDI-3-4BCDD	6U, 350W power supply, DC input, DIN	x		x	x					
PDI-3-4BCDD-P1	6U, 350W power supply, DC input, 38-pin connector	x		x	x					
PDI-3P-4CBDD	6U, 350W power supply, DC input, P47 connector	x		x	x					
PDI300-4CBDD	6U, 300W power supply, DC input, P47 connector	x		x						
MGV Stromversorgungen	www.mgv.de									
DG 4270	cPCI power supply	x	x		x	x				
DG 4270R	cPCI power supply	x	x	x	x	x	x			
DG4120	cPCI power supply	x	x		x	x				
DG4150	cPCI power supply	x	x		x	x				
P4180	cPCI power supply	x	x		x	x				
P4190	cPCI power supply	x	x		x	x				
P4270	cPCI power supply	x	x		x	x				
P4270R	cPCI power supply	x	x	x	x	x		x		
Miltron/Mektron Systems	www.mektron.co.uk									
N/A	Power supplies	x	x	x	x				x	
Pentair Electronic Packaging	www.pentair-ep.com									
10827-024	3U/6U pluggable power supply	x								
PEP Modular Computers	www.pep.com									
CP3-SVE-M120DC	19" 3U, 12HP power supply	x			x	x			x	
CP3-SVE-M150DC-R	19" 3U, 12HP power supply	x			x	x			x	
CP3-SVE-M180AC	19" 3U, 12HP power supply	x			x	x			x	

continued on page 78

Power Supplies

Company/Model	Web site/Product	Plugin 3U 6U	Custom Design	Hot Swappable	Industrial Grade	Low EMI/RFI	Onboard DC to DC	N+1 Redundant	Mil-Spec	Thermal
PEP Modular Computers cont.	www.pep.com									
CP3-SVE-P200AC	19" 3U, 8HP power supply, 85-264 VAC	x		x	x	x		x		
CP3-SVE-P200DC	19" 3U, 8HP power supply, 36-75 VDC	x		x	x	x		x		
Rittal Ripac	www.ripac.com									
Model PP	RiPower	x	x	x	x	x				
Schaefer	www.schaeferpower.com									
Autronic	Industrial power converter, 4W-200W DC/DC	x		x	x	x	x	x	x	x
Switching Power	www.switchpwr.com									
CPCI-210Q-DC-47	200W, rugged, 24/28 VDC input power supply	x	x	x	x	x			x	
CPCI-350Q-DC-47	400W, 48 VDC input power supply, 90A output	x	x	x	x	x			x	
CPCI-350Q-P-47	400W power supply, 90A output	x	x	x	x	x			x	
TDI Power	www.tdipower.com									
ZS500	Redundant, rack-mountable Zeus power supply	x	x	x	x	x				
MP600	Redundant, rack-mountable Apollo power supply	x	x	x	x	x				
Technology Dynamics	www.theallpower.com									
PCI 350-24	PCI 350 Series power supply	x		x		x	x			
TK Power	www.tkpower.com									
TK175B-CPCI	Cobalt Series 175W power supply	x	x	x	x	x	x			
Tri Source	www.trisourceinc.com									
PCI200-3A	cPCI power supply	x	x	x	x	x	x			
Unipower	www.unipowercorp.com									
TPCH Series	1U, 100W power cassette			x	x	x		x		x
VMIC	www.vmic.com									
VMICPCI-7458	Power backplane assembly w/power taps				x		x			
VMICPCI-PS351	Hot-swap power supply			x	x			x		
Westek	www.westekuk.com									
9U cPCI	Quad, octal hot-swap, high-power PSUs	x	x	x	x	x	x		x	
11U cPCI	Quad, hot-swap, high-power PSUs	x	x	x	x	x	x		x	