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White Paper: Power Issues in Edge Card Systems
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Introduction

The term "edge card" has a wide variety of meanings in embedded computing. In this article an edge card system is either a system using a combination of PCI-X, PCI or ISA edge cards or a system that features PCI Express, PCI-X or PCI edge cards. Industry standards are available that define among other things power specifications such as voltage levels, power pin placements, power requirements, etc. Specifically, PICMG 1.0/1.2 industry specifications define these power specifications for the parallel bus systems that contain PCI-X, PCI or ISA edge cards. A new standard called PICMG® 1.3 or SHB Express™ defines the power specifications for systems that use PCI Express® to communicate from the system host board to the backplane. These new PICMG 1.3 systems support PCI Express, PCI-X and PCI edge cards. Some SHB Express systems may even offer ISA edge card support. Our purpose here is to compare and contrast the power issues associated with the two classes of edge card systems: PICMG 1.0/1.2 parallel bus systems and PICMG 1.3 high-speed PCI Express serial systems.

PICMG 1.0 Power Delivery

The ISA connector slot for the SBC on a PICMG 1.0 backplane is capable of delivering 66W to the SBC. The SBC's PICMG connector is capable of delivering 100W in a 32-bit configuration and 161W with a 64-bit PCI extension. It's important to know if the PICMG 1.0 SBC being considered has a 64-bit PCI extension on the PICMG edge connector. The additional power deliver capability provided by the 64-bit PCI extension is frequently needed when using PICMG 1.0 single board computers with high-performance and/or dual processor configurations. The chart in figure 1 illustrates the total power deliver capability of two of the most common PICMG 1.0 single board computer edge card configurations. The total power delivery possible in each configuration is also broken down by the wattage possible for the +/-5V, +/-12V and the +3.3 supply voltages.

SBC Edge Connector Configuration	Total Wattage Delivery Possible	Comments
ISA edge connector + PICMG edge connector configured with 64-bit PCI extension	227W (5V = 140W, 12V = 48W, 3.3V = 39W)	Optimal maximum use of all available +V and ground pins in the ISA and 64-bit PCI connector must be made to achieve maximum power delivery.
ISA edge connector + PICMG edge connector configured with 32-bit PCI extension	166W (5V = 95W, 12V = 48W, 3.3V = 23W)	The number of ground pins available in the specification limits the maximum power delivery in the ISA + 32-bit PCI configuration.

Figure 1

The message here from a system design standpoint is to account for the total wattage delivery to the SBC as well as the wattage requirements of any option cards and system devices when choosing the system power supply. This is especially critical when using and SBC with high-performance dual processors

PICMG 1.3 Power Delivery

In PICMG 1.3 systems the ISA/PCI edge connectors for the single board computer or system host board (SHB) is replaced by a combination of x16 and x8 PCI Express connectors. These connectors provide more available power contacts and the PCI Express interface links from the SHB to the backplane require fewer communication lines as compared to the PICMG 1.0 systems. Therefore, PICMG 1.3 system host boards can have more available system power delivered to them via the edge connectors then is possible with PICMG 1.0 SBCs.

There are several SHB edge connector configurations supported in PICMG 1.3 or SHB Express industry standard. A common full-size PICMG 1.3 SHB configuration includes two x16 and one, x8 PCI Express connectors. A half-size PICMG 1.3 SHB configuration is also supported and uses one x16 and one x8 PCI Express connector. Figure 2 illustrates the wattage delivery possible with these two PICMG 1.3 SHB configurations

SHB Edge Connector Configuration	**Total Wattage Delivery Possible**	**Comments – PICMG 1.3 power numbers subject to change pending final specification approval.**
Full-size SHB, Connector A and C are x16 PCI Express connectors and connector B is a x8 PCI Express conn.	500.72W (5V = 44W, 12V = 369.6W, 3.3V = 87.12W)	An additional 7.26W and 11W of power can also be delivered to the SHB for 3.3VAUX and 5VAUX lines respectively.
Half-size SHB, Connector A and C are x16 PCI Express connectors	127.38W (5V =0W, 12V = 105.6W, 3.3V = 21.78W)	An additional 7.26W and 11W of power can also be delivered to the SHB for 3.3VAUX and 5VAUX lines respectively.

Figure 2

The total power delivery possible to a PICMG 1.3 SHB is roughly 100% greater than that which can be delivered to an equivalent full-size PICMG 1.0 SBC. This means that PICMG 1.3 SHBs have the additional power delivery capabilities demanded by high-performance system host boards. It also means that the system designer needs to be aware of the additional power capability of these new PICMG 1.3 system host boards when sizing the system power supply.

Power Budget

Several factors determine the total system power needs of an edge card system. Here's a listing of some of the most critical factors:

Processors – These can be the single largest consumer of power in an edge card system. It's a good idea to know the thermal design power rating of the processor used on the SHB under consideration. The ratings can vary wildly from a couple of watts to over 100 watts per processor. The SHB vendor frequently provides power rating and or current draw information for the voltages used on the board. Since other SHB components such as controllers are drawing increased power, the current draw and power rating figures are more useful since they take into account everything on the SHB These figures should be used when determining the size of the power supply needed for the system. Some vendors recommend power supplies with certain wattage levels for use with their boards.

Option Cards – The number and type of option cards supported by the edge card system backplane also plays a significant role in determining the size of the power supply needed in the system. Make sure to account for all possible board combinations when determining the power needs of the system. Ensure that adequate headroom is allowed as far as the power supply's power ratings are concerned in order to accommodate future option cards or upgrades to higher performance processors on the SHB.

Other System Components – Storage drives, special system devices, video displays, etc. all place some power demands on the system power supply. Don't forget these devices when determining the edge card system's total power budget and required system power supply.

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Power Sequencing

Power supply sequencing is a frequently overlooked aspect in edge card systems. When a system is powered up for the first time or is coming back on-line during an event such as Wake-On-LAN, all voltages may not come up to their rated levels at the desired time. Bring-up voltage delays and in-rush currents can cause significant operational problems. It's important to understand the power sequencing methodology of the specific power supply under consideration in order to ensure optimum edge card system performance. For example, if the system design supports multiple Wake-On-LAN or other types of system reset events then a power supply with adequate in-rush current handling capability and robust power sequencing must be specified. Inexpensive power supplies generally do a poor job of power sequencing and have minimal in-rush current ratings. However, if the system doesn't need to support frequent reset events then a cheaper power supply may be just fine.

Cable Issues

When high-performance processors first started appearing on system host boards a few years ago the need to provide additional +12V became an issue for many edge card systems. Later version ATX power supplies provide this additional voltage just fine, but edge card systems with early ATX or AT power supplies had problems supplying this needed voltage. Today this issue is largely moot, but care must be taken when upgrading the SBC of an older edge card system with an SBC with high performance processors. Make sure to check and see if the current system power supply can deliver enough +12V to adequately power the new SHB's processors.

On PICMG 1.0 SBCs this +12V level is frequently delivered to the SBC via an auxiliary connector located along the top edge of the board. Make sure that the cable connectors used can comfortably handle the current rating required by the +12V line on the SBC when the board is using the most extreme high performance processors, i.e. those processors with thermal design ratings well over 100W. Figure 3 shows an SBC with an auxiliary +12V power connector.

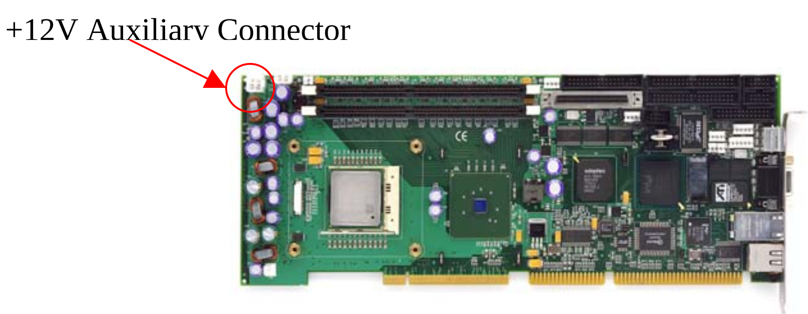

Figure 3

The new PICMG 1.3 specification eliminates this need to have a +12V AUX connection on the PICMG 1.3 System Host Board. This is due to the fact that the additional pins available in the SHB backplane slot allow the +12V AUX to be delivered to the SHB via the board's edge card connectors. This new PICMG 1.3 specification feature allows the +12V AUX line for the power supply to be connected to the +12V AUX connector located on the PICMG 1.3 backplane. This makes for a more robust cable harness design within the system.

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System Cooling and Airflow

The thermal design power ratings of the latest high-performance processors are exceeding 100W. As a result, the need for effective system cooling has become even more critical. Care must be taken to design effective system cooling solutions that remove the heat generated by these processors. Other edge card components like advanced video controllers and bridge chips are now generating more heat that also needs to be removed from the system enclosure.

In edge card systems the host board's heat sinks and fans need to be taken into consideration when choosing a backplane and placing option cards into the system. Adequate spacing between the SHB and option cards needs to be maintained in order to promote effective airflow. As an example some SHB vendors specify that the chassis' cooling system maintain 350LFM of airflow over the board in order to maintain the SHB's operating temperature specification.

Summary

As system host boards and option cards used in today's edge card systems continue to evolve the need to effectively manage system power resources becomes more of an issue. Today's power supply technology will continue to meet and exceed the increasing power demands of edge card systems. Hopefully the discussions of these specific system design challenges regarding the effective distribution of power in edge card systems will prove useful in future design projects.