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 edge cards with either ISA or PCI Express 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 SHB Express or PICMG 1.3 defines the power specifications for systems that use PCI Express to communicate from the system host board to the backplane. These new SHB Express systems can support PCI Express, PCI-X and PCI edge cards. Some SHB Express systems may even offer limited 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 SHB Express high-speed 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. Edge card systems with an ATX or BTX power supply use a +12V cable to provide additional power to the PICMG 1.0/1.2 SBC’s +12V auxiliary connector. The additional power deliver capability provided by the 64-bit PCI extension and the +12V auxiliary connector is frequently needed when using PICMG 1.0/1.2 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 +3.3V supply voltages. In edge card systems featuring newer ATX/BTX power supplies, additional +12V power is cabled over to the SBC’s +12V auxiliary connector. The +12V auxiliary connector is discussed in the cables issues section of this paper.

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 an SBC with high-performance dual processors.

PICMG 1.3 Power Delivery

In upcoming PICMG 1.3 systems the ISA/PCI edge connectors for the single board computer or system host board (SHB) have been replaced by a combination of x16 and x8 PCI Express connectors. These connectors provide more available contacts and PCI Express serial interface links use fewer communication lines as compared to the parallel busses of PICMG 1.0/1.2 systems. Therefore, PICMG 1.3 system host boards have more edge contacts available to deliver system power.

Several potential SHB edge connector configurations are supported in the upcoming PICMG 1.3 or SHB Express industry standard. A common full-size PICMG 1.3 SHB configuration will include one x8 and two x16 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 1.0/1.2 SBC. This 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. A good rule of thumb regarding processors to consider is: Higher Frequency = Greater Power Consumption. SHB designers are concerned about the thermal design power rating of the processors when designing the system host board. 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. These board ratings take into account the power consumption of all components on the board and should be used by system designers when specifying the system power supply. Some SHB vendors take this a step further and 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.

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.

Power Sequencing

Power supply sequencing is a frequently overlooked aspect in edge card systems. ATX and BTX power supplies generally have very good power sequencing and voltage ramp rate specifications, but other types of power supplies may not. 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 longer ramp rates with 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 SBC's processors.

On PICMG 1.0/1.2 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 using the most extreme high performance processors, i.e. those processors with thermal design ratings well over 100W. Some SBC s may have +12V auxiliary connectors with only 2-pins and these may not provide enough current carrying capability. Figure 3 shows an SHB with an auxiliary +12V power connector with a 4-pin connector.

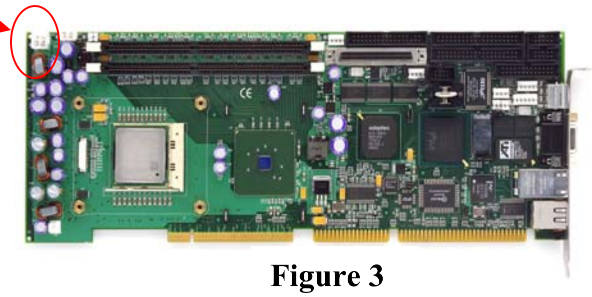

Figure 3

(Note: The new PICMG 1.3 specification defines additional +12V pins on the PCI Express edge connectors. These additional power pins are intended to eliminate the need for +12V auxiliary connectors on SHB Express boards.)

System Cooling and Airflow

With the thermal design power ratings of the latest high-performance processors exceeding 100W, 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. Figure 4 illustrates how an SHB with two high-performance processors maintains airflow and provides efficient processor cooling while accommodating optimum option card placements.

Figure 4

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.