Tech Recon

Power Issues in Board and Box Systems

VPX Systems Face New Power Challenges

Along with the much welcome processing and bandwidth benefits of VPX comes a slew of new complexities to managing power and power-related issues.

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There are many decisions a system architect needs to make during the design and development of an ATR system. One crucial component that is sometimes not given the attention it needs is the power delivery within the system. While this issue has always been a concern for ATR box design, it is especially true for VPX-based systems where increased processing and communication bandwidth, as well as improvements in thermal transfer capabilities, have lead to ever-increasing performance advancements and power input requirements for payload modules.

Even though the VPX payload module's P0 power (utility) connector allows for significant increases in power consumption over the older cPCI and VME connectors (Figure 1), thermal limitations will continue to limit the achievable power consumption per VPX payload slot. Since the processing requirements of today's ATR systems have already surpassed the power input capabilities of VME and CompactPCI (cPCI) connectors, continuing advancements of the thermal transfer capabilities within the system will continue to push power consumption per slot, and system architects will need to find a way to deliver power to these higher performance VPX modules.

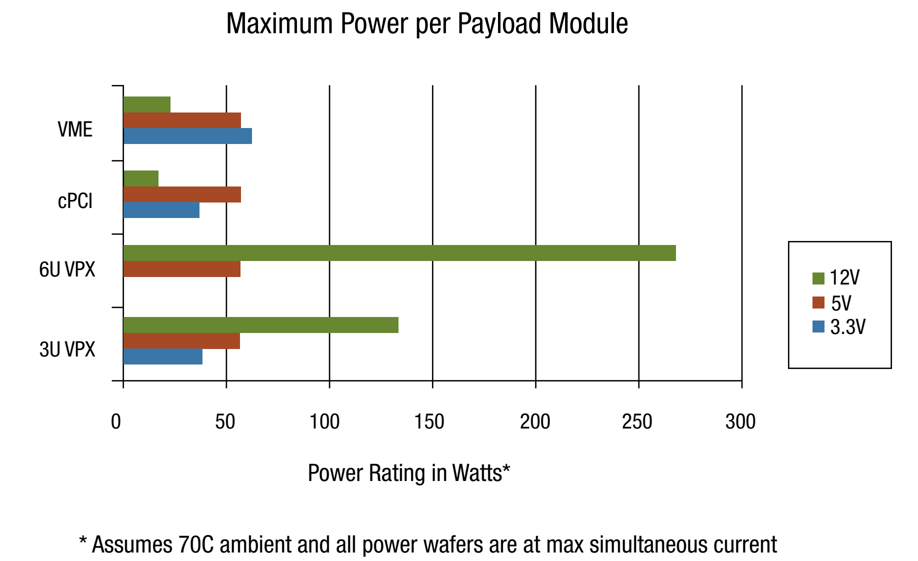

Figure 1

The maximum amount of power, in watts, that VME, cPCI and VPX payload modules can bring in from the 3.3V, 5V and 12V backplane rails.

Limitations of VME and cPCI

In traditional rugged ATR designs based on the VME or cPCI standards, MIL-STD-704 power supply designs and the power distribution of the system were constrained by the limitations of VME and cPCI. However, for system designs that are based on the newer VPX standard, system architects have the ability to improve power supply designs and power distribution while at the same time reducing size and weight.

There are two major developments driving the system architect's ability to

Figure 2

The VITA 62 specification defines a COTS plug-in power supply module for 3U and 6U VPX systems. Shown here is a 3D rendering of the XPm2120, a VITA 62 3U VPX power supply that will be available in 2011.

improve power supply design and power distribution for VPX-based ATR systems while at the same time reducing overall Size, Weight and Power (SWaP): allocating 12V as the primary distribution rail across the backplane and using a COTS VITA 62 power supply within the chassis.

VITA 62 for VPX Power

VITA 62 provides a standards-based plug-in power supply module (Figure 2) designed to support the needs of high-performance conduction-cooled VPX-based systems by resolving problems associated with older power supply standards. For instance, cPCI (PICMG 2.11) and VME (DIN 41612 Type M) power supply modules have three major limiting factors: no support for user-defined pins, no support for VITA 46.11 system management, and a limited amount of output power available for the 12V power rail.

The inclusion of user-defined pins to the VITA 62 power supply standard encourages innovation within the industry by providing the ability for power supply designers to add additional features to their standards-based COTS power supplies as customer requirements and technological capabilities of power supplies evolve. VITA 46.11 System Management is also supported by the VITA 62 standard, providing the system's management controller with access to features such as system power consumption and voltage levels at each power rail, as well as access to temperature sensors within the power supply module.

Another significant issue with the cPCI and VME power connectors is that their output power pins are positioned on the opposite side of the backplane as a 3U VPX payload module's P0 power connector. VITA 62 solves this problem and positions its 3U connector's output power pins in line with the power pins on the VPX module's power connector. This simplifies the power routing on the already space-constrained 3U VPX backplane and has the added benefit of reducing cost by removing unnecessary layers from the backplane.

Connector Issue Resolved

The VITA 62 connector has resolved an additional problem specifically attributed to using the cPCI power supply connector in VPX-based conduction-cooled systems. In order for the cPCI power connector to fit within the standard conduction-cooled slot, either the sides of the connector have to be shaved down or the guide rails for the power supply slot within the chassis have to be modified. Alternatively, a VITA 62-compliant power supply fits within a standard conduction-cooled 0.8- or 1.0-inch pitch VPX slot without modifications and also includes the standard VITA 46 key guides for commonality to other VPX cards within the system.

VITA 62 recognizes the value of integrating some of the system design requirements that were formerly left up to the system architect. Two of these integrated features include hold-up and EMI filtering. By integrating these into the standard COTS power supply, the overall system design complexity and size can be greatly reduced. For instance, a power supply can be designed to boost the input voltage to a higher level internally in order to reduce the total bulk capacitance needed to maintain the required hold-up time of the system. This enables a power supply to potentially fulfill the entire hold-up time without the use of external capacitors, greatly reducing total system size, weight and complexity without having a noticeable impact on efficiency.

EMI filtering can also be integrated into the power supply to address many of the EMI requirements needed for systems to comply with MIL-STD-461 and DO-160. Integrating EMI filtering into the power supply removes a great deal of the burden off the system designer, who would otherwise have to significantly overdesign their filtering circuitry or delay the design of their tailored filtering solution until the emissions profiles and susceptibility of the power supply were known and documented. As the result of VITA 62, conduction-cooled power supplies can now be implemented as true off-the-shelf products for VPX systems. This mitigates design, development and production risk because VPX-based ATR boxes designed with VITA 62 power supply slots will support compatible power supplies from multiple vendors to be integrated into these systems.

12V Power Distribution Rail

VPX, along with XMC, are unique within the industrial and military markets in that 12V has now become an option for the main power distribution rail across the backplane. For 6U VPX designs, 12V, 5V, or 48V can be used as the primary power path from the backplane. However, due to the many technical difficulties involved with generating and using a voltage as high as 48V within a VPX-based system, 48V is rarely used. For 6U VPX designs, 3.3V is not available from the backplane and must be generated locally on each payload module. For 3U VPX designs, the backplane can provide 12V, 5V and 3.3V to the payload modules; however, there are many technical advantages for using 12V as the primary power rail within 3U as well as 6U VPX designs.

In legacy products such as cPCI, VME and PMC, a very limited number of pins are available for 12V power input and 3.3V is often heavily loaded from on-card devices. As a result the main distribution rail used to source power supplies on the payload modules is 5V. This leads to the power output of legacy power supply modules focusing on 5V and 3.3V and providing a limited amount of power available on 12V. These limitations on 12V output power from legacy power supplies has the unfortunate impact of either reducing the capability and performance enhancements of a VPX-based system or forcing the system architect to use a custom designed power delivery solution.

Since lower voltage distribution sources, such as 5V, are heavily loaded and also tied directly to devices within the payload modules, this distribution method increases system susceptibility to on-card current transients (di/dt), causing a significant enough drop in voltage that could lead to component malfunctions and even module resets. Alternatively, when using 12V as the distribution power rail, susceptibility to current transients is greatly reduced because there is much less current draw when using this higher distribution voltage (P = IV), and 12V can dip much further than 5V before being out of tolerance. Also, there are very few, if any, devices besides the on-card power supplies that use 12V directly, so if the 12V rail does dip, it will not lead to component failure.

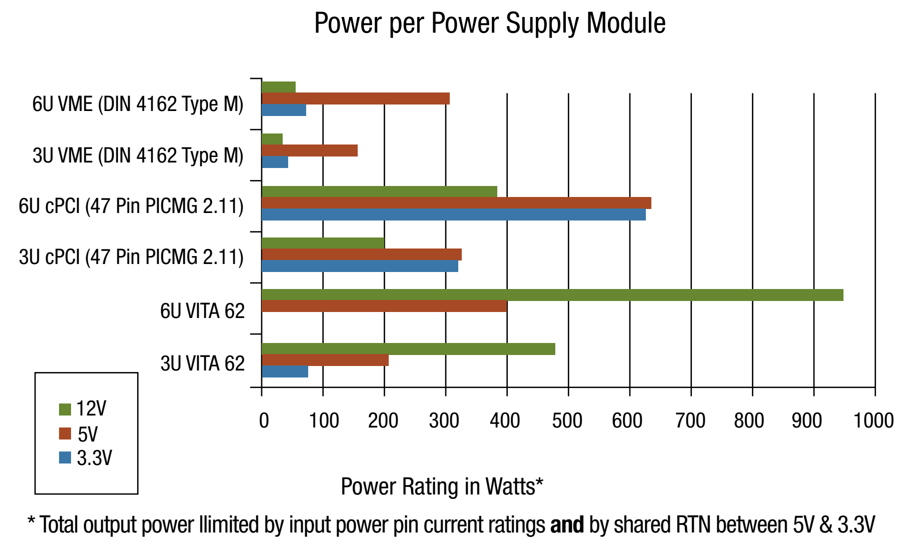

Figure 3

The amount of power, in watts, that power supply modules can supply to the 3.3V, 5V and 12V backplane rails.

Lower Voltage Sources

Lower voltage distribution sources, such as 5V, require larger copper power planes within the backplane and modules in order to counter higher steady state currents and resulting increased distribution losses (V = IR). These larger copper power planes are also needed to counter the increased susceptibility to voltage drops from on-card current transients that result from using 5V as opposed to 12V as the primary distribution voltage. Higher voltage distribution sources, such as 12V, allow for the use of smaller copper power planes, which decreases board layer count, complexity and cost. Additionally, with higher voltage distribution sources, less point of load capacitance is required to suppress localized current transients, saving valuable real estate on payload modules.

In most VPX- and XMC-based systems, 5V is not heavily used by on-card devices within payload modules and even though many devices on payload cards use 3.3V directly, the load requirement is usually relatively small. Therefore, in the chassis power supply module the amount of circuitry dedicated to providing 5V and 3.3V for the backplane can be reduced with the focus put on maximizing the 12V output for the backplane, thereby increasing the total amount of power available on this primary power rail (Figure 3).

Legacy System Upgrades

When upgrading a legacy system, many managers want to limit the scope of the risk to the project cost and schedule by reusing as much of the legacy system as possible. When upgrading a cPCI or VME system to use VPX modules, since the physical size, pitch (0.8”) and input voltage levels between VPX and legacy cPCI and VME modules are nearly identical, there may be a desire to reuse the power supply and chassis. However, attempting to reuse a legacy power supply within a VPX-based system limits the performance benefits that a system architect could achieve with VPX and could also create other unintended consequences.

The inherent nature of new high-performance VPX modules bring with them additional system-level issues that may have been less of a concern in legacy system designs. For example, many legacy power supplies are incapable of handling increased power load from upgrading to a VPX-based system. Also, because many VPX modules are designed using the latest power saving technology that will turn off or disable many higher power consuming features until they are needed by the application, the power distribution scheme within VPX systems needs to account for the significant di/dt that can result. Since legacy power supplies are usually incapable of supporting a 12V distribution rail, these transients can severely impact the capabilities of the system.

Problem with Custom Solutions

Due to the limitations of older power supply module specifications, many legacy ATR systems used custom-designed power supplies to meet the needs of the system. Without VITA 62, many system architects currently defining their VPX-based design would be forced to go down the same painful path. A custom-designed power supply can be tailored to meet the power distribution requirements of the system today; however, if future system upgrades are needed, system component choices would have to be based on whether they are compatible with the custom power supply's capabilities.

Designing a VPX-based system around a VITA 62 off-the-shelf power supply module and a 12V primary distribution rail not only allows the system architect to choose a power supply and distribution method that meets the needs of the latest available VPX technology both today and in the future, but also reduces the overall system SWaP. There is no doubt that VITA 62 does allow you to get the most out of your VPX system. ▮

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