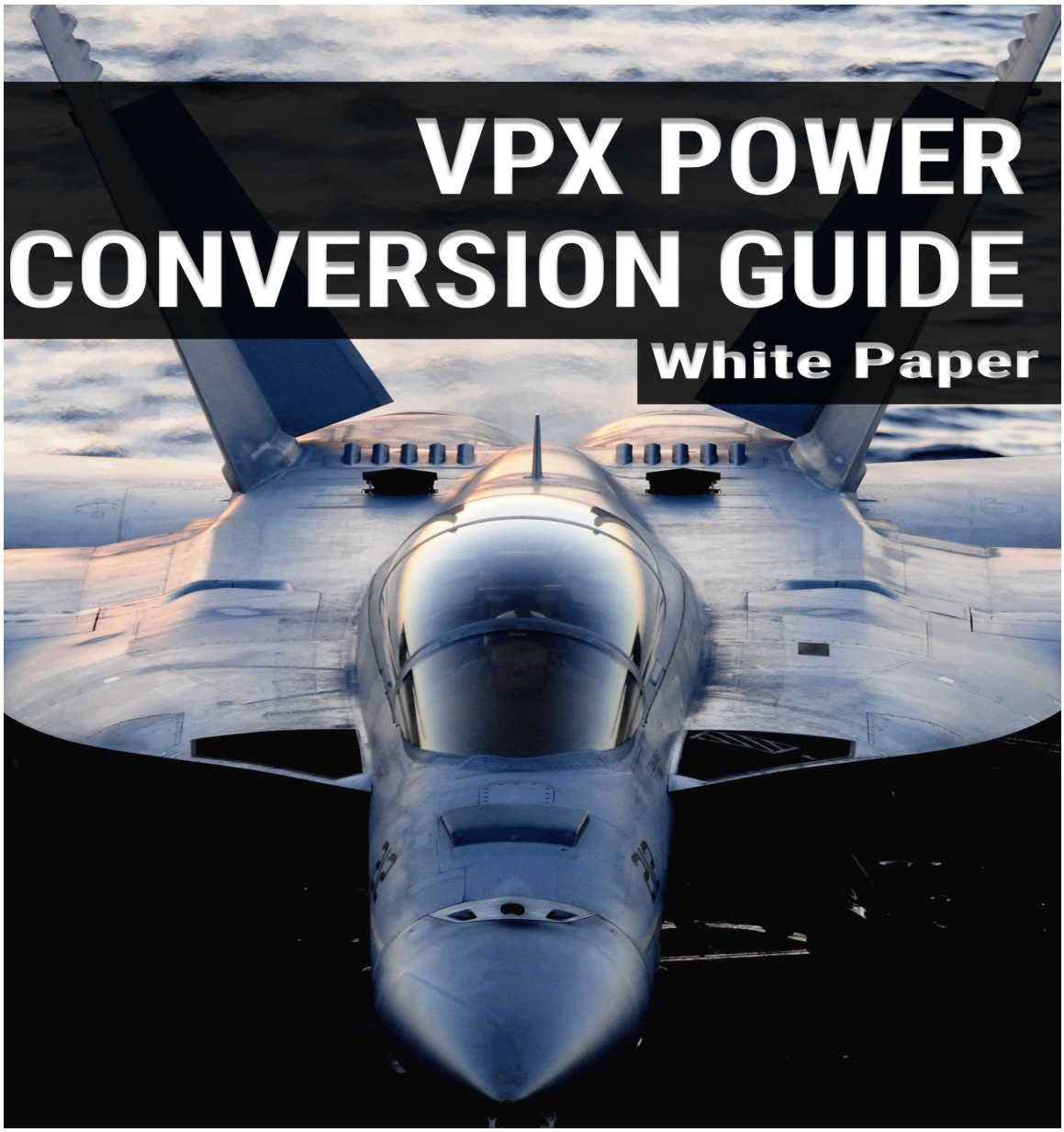

ABSTRACT

Rugged power supplies capable of addressing industry unique specifications have become a critical design element in today's military electronics. Are the performance specifications of VPX power supplies the solution?

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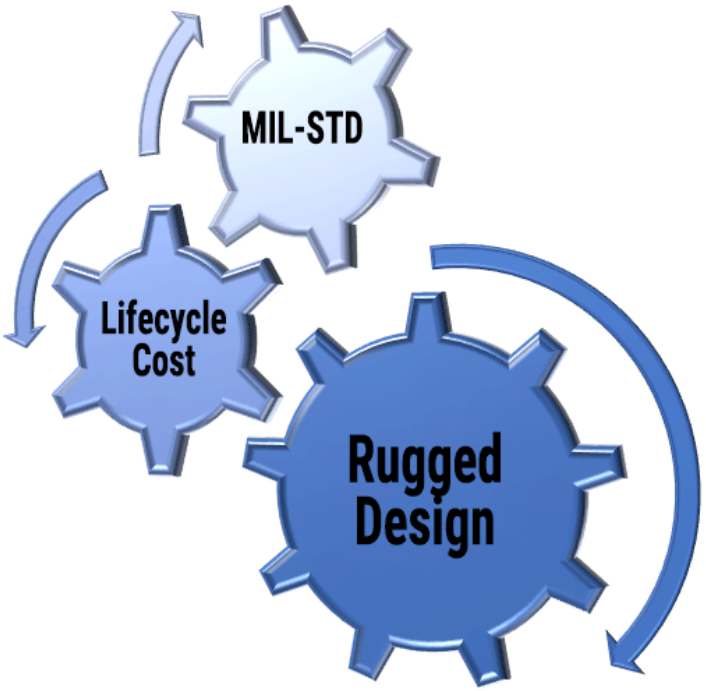
Introduction

Rugged power supplies capable of addressing industry unique specifications have become a critical design element in today's military electronics. Mature standards, such as MIL-STD-704 and MIL-STD-1275, defining electrical power characteristics, or MIL-STD-461 characterizing electro-magnetic interference (EMI) characteristics, have standardized design practices for engineers. Further, budget constraints have forced Program Managers to seek modular, open architecture solutions to address onerous challenges on behalf of our warfighters.

As such, the VPX form factor is quickly becoming a tool engineers may leverage to address many of the above standardization challenges, all while improving performance. To many, VPX power supplies are viewed as a "commodity" product, complying to the VITA working group's standard for support of switched fabrics over a unique high-speed connector, all encapsulated within a common form factor. Reality proves to be quite different; VPX VITA 62 compliant power supplies are not all equal; some offering significant advantages over others, especially for implementation in rugged and austere defense and homeland security applications.



The purpose of this white paper is to provide a list of considerations for power supply designers, systems engineers, procurement specialists, and program managers seeking to source a VPX power supply. This list is intended to assist those in ensuring the attributes and stated performance of a specific VPX power supply addresses the requirements of the application.

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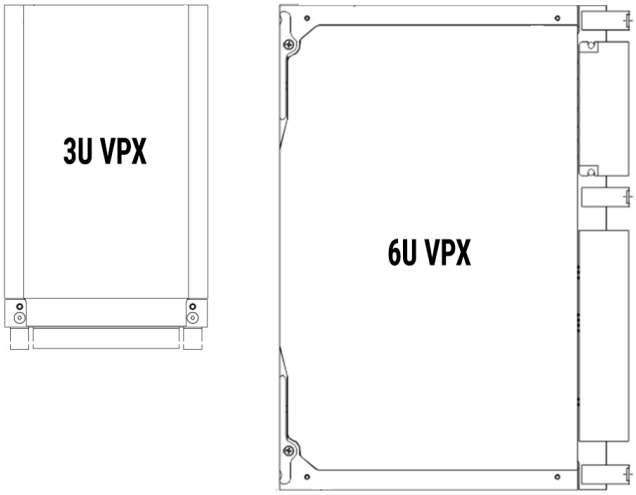
What is VPX?

VPX is a scalable, modular backplane technology designed by the VME International Trade Association (VITA) Working Group, designed for defense applications. It leverages the 3U and 6U form factors, offering switched fabric interconnects which are rapidly replacing parallel communications protocols, improving faster communications and processing capabilities.



VPX is quickly becoming a go-to form factor for the military embedded computing market, with a growing number of single board computer, I/O module, RF amplifier/modulator, and power supply products available in the market place.

What to Consider When Selecting a VPX Power Supply

The following questions are important considerations any engineer or program manager should ask themselves while evaluating VPX power supply products for incorporation into military applications. Not all VPX power supplies are designed equal, care should be taken when sourcing the correct and appropriate power supply to meet the demands of your application. For example, the Congressional Senate Armed Services Committee (SASC) recently questioned the DOD's use of commercial and industrial power supplies for military use in their FY18 budget report. The exemplifies the magnitude of the issue and the importance of understanding the capabilities of the VPX power supply.

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Does This VPX Card Rely on De-Rating to Improve Performance Specs?

De-rating is the designed operation of a device at less than its rated maximum capability. The VITA standard for 3U form factor has dramatically driven down the available volume to support improved power density, EMI filters, and other key features prominent in power supply design. Power supply designers are forced to make tradeoffs.

As such, there are an increasing number of VPX AC-DC and DC-DC power supplies on the market relying on de-rating to improve their primary power specifications. Similarly, some VPX power supplies are known to de-rate under loads approaching maximum voltage or under low line conditions. It is important to consider the de-rating at a load curve for a specific VPX power supply to ensure a consistent voltage. De-rating information may not be immediately obvious and is often times noted by an asterisk or fine print of a technical data sheet.

Virtually all power supplies have a temperature de-rating to account for ambient temperatures once integrated into a system. Many manufacturers begin the power supply's de-rating curve at a figure less than 85°C, commonly 60-70°C; well below the maximum operating temperature requirements for the vast majority of defense platforms. A low temperature de-rating may lead to untimely failure in the system. It is important to understand the de-rating curve when sourcing a VPX power supply.

These issues create a significant challenge when integrating a power supply, lacking confidence it may operate to spec; through a full range of ambient temperature and load conditions. Ensure the power supply you source offers a de-rating curve appropriate for your end application.

Is My VPX Card Appropriately Protected Against Reverse Polarity?

Reverse polarity is an all too common effect in any electrical design and an easy way to damage a power supply, if not properly protected. Any VPX power supply integrated to a military system should have proper reverse polarity protection, compliant to either MIL-STD-1275 or MIL-STD-704, up to -48VDC.

The vast majority of VPX power supplies, especially commercially available products, either do not incorporate reverse polarity protection, or offer insufficient protection that will result in premature failure. Reverse polarity protection is a relatively simple and low-cost circuit design which should be

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present in any rugged VPX power supply implemented to a military application, potentially saving significant money and time, and improving readiness.

How Is Heat Dissipated from the Power Supply?

Efficiency is not the only heat factor to consider when sourcing a VPX card. The increasingly tight constraints of military systems, especially in airborne applications, often limit the cooling options for the integrator. The heat sink design for VPX power supplies is critically important to understand during the selection process, as not all VPX power supplies are equal in their dissipation of heat. This originates due to a fundamental challenge in the selection and placement of components during board layout, which leads to unnecessary system level challenges inside the chassis for the integrator.

Understanding heat dissipation through a VPX power supply's wedge locks is an important design feature. Many VPX power supplies do not evenly dissipate heat through the wedgelocks of the card, this is true of both 3U and 6U designs. The challenge created for the integrator is how to efficiently and effectively cool a power supply that does not present even heat dissipation, especially within a small chassis, resulting in the need for redundant fans or increased water lines.

A properly designed VPX power supply offers even heat dissipation through both wedgelocks, providing a more efficient cooling design for the integrator and significantly reducing the challenge of cooling a VPX chassis.

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Does the VPX Power Supply Automatically Restart After Overcurrent or Overtemp Conditions?

When integrating a VPX power supply to an enclosed chassis, over temperature and over current conditions are likely to occur at some point during the product design lifecycle. An important, and often times overlooked, feature to consider in selecting a VPX power supply, is the product's ability to automatically restart after tripping an over current or over temperature fault. Once the power supply senses current or temperature levels within an acceptable range, the VPX power supply product should have logic designed in enabling an automatic restart, including built-in-test (BIT) cycle, quickly providing power to the chassis components, thereby ensuring mission continuation. Many power supply designs, especially commercially available products, have not considered the system level impact of over current or over temperature faults, causing mission failures and decreasing readiness. The power supply design engineer should consider not only whether the power supply will restart after these conditions, but can it continuously and fully function during voltage surges and spikes. Automatic restart is a critical feature that should be included in any VPX power supply for military applications.

Does the VPX Card Incorporate an EMI Filter?

Electro-magnetic interference (EMI) filters are critical components in any electrical design, especially in support of military systems requiring partial or complete qualification to MIL-STD-461. EMI filters are designed to reduce high frequency conducted and radiated electronic noise which may create interference with other electrical devices. Embedding EMI filters into the power supply, a potential signal source, is a key feature in any power supply design.

This holds true in the constrained volume of VPX 3U and 6U form factors. Some VPX power supply designs do NOT incorporate enough EMI filters, thereby potentially creating a litany of system-level EMI challenges for which the integrator would ultimately bear responsibility. One such challenge would be the need for a second card slot in a VPX chassis to host a stand-alone EMI filter. In many upgrade or retrofit programs, two card slots are not available to the integrator for a power supply and EMI filter, requiring migration to a larger chassis and space claim challenges. The integrator should be cautious to source a VPX power supply with an appropriately designed embedded EMI filter.

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Does My VPX Card Utilize Commercial Bricks?

Have you ever looked inside a VPX power supply to observe the board topology? Often, you will notice a "clean" and "simple" design consisting of a few bricks on a printed circuit board (PCB). In actuality, a board designed with such bricks presents considerable challenges for military applications.

First, these bricks are often commercially available components incorporating numerous standardized circuits. They are difficult to account for originating sources of electronic components, and are typically designed to commercial standards. Often, those commercial standards fall well short of design requirements appropriate for military applications. such as MIL-STD-810 for environmental conditions. The result is a product unable to qualify to program-defined specifications, which may lead to premature failure, impacting platform readiness.

The second challenge facing engineers when sourcing a VPX power supply implementing commercial bricks is the relatively short lifecycle of commercial products; which creates enormous risk for obsolescence.

The large-production environment common in commercial and industrial applications drive the business case for brick components, not the high mix, low volume production cycles typical of defense applications. Often, a commercially designed brick product will see end-of-life 5 years after introduction to the market, with the military platform not yet in service. As such, engineers designing for military applications must consider their decades-long life cycles and the ability to support sustainment of the platform for 20 or 30 years, sometimes more. Designing with commercial bricks in VPX power supplies can lead to significant obsolescence risk.

Finally, the use of commercially-designed bricks in VPX power supplies prevents an electrical engineer from implementing novel circuit topologies and enabling the incorporation of additional features, such as EMI filters, reverse polarity protection, automatic overtempt restart, etc. The result is a less functional and reliable VPX power supply. All VPX power supplies implemented to military applications should leverage discrete designs to reduce risk in component and system level qualification, eliminate obsolescence, improve reliability of the system.

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Congress Comments on Power Supplies

The Senate Armed Services Committee recently delivered a clear message to the defense community regarding the selection of power supply products for use in military systems. In "Commercial off-the-shelf power supplies" section, pg 199 of a markup of the National Defense Authorization Act For Fiscal Year 2018, the committee noted Commercial off-the-shelf power supplies (e.g. products not designed to MIL-Standards) introduce unnecessary risk and are a primary source of failures in military systems writing -

"Commercially available power supplies are not robustly designed to account for military environments, including the threats posed by electromagnetic interference, varying temperature and humidity conditions, or the shock and vibration loads commonly found on military platforms."

The committee went on to request program managers and acquisition professionals prioritize the design and qualification of the power supply products selected for use in military applications.

Conclusion

These six questions are critically important to address for any power supply designer, systems engineer, procurement specialist, and program manager seeking to source a VPX power supply. Failure to address one, or all, of the above questions may lead to a critical failure in the product design. System failure due to a poorly selected VPX power supply is a failure to our warfighters.

VPX power supply products which address all of the above considerations are available within the defense and homeland security industrial base today, and in many cases, are off-the-shelf (OTS) standardized products complying with the VITA standard. In many cases, these OTS VPX products can be tailored to meet unique and challenging requirements of the integrator, often with little or no non-recurring engineering (NRE) costs. Anyone sourcing a VPX power supply should consider answers to these questions while understanding not all VPX power supplies are equal in performance or design.

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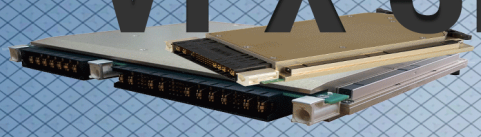
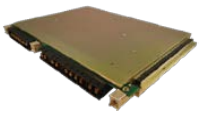


Milpower Source offers the MILVPX product family of VPX VITA 62 power supplies; designed for defense applications, and configurable to meet your unique requirements. The MILVPX product family includes both 3U and 6U form factors up to 1kW of total power and multiple outputs with embedded EMI filters. Available in off-the-shelf and custom configurations, the MILVPX product family is ready to deliver exactly the right VPX power solution for any application requirement.

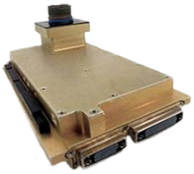
MILVPX™

Standard Features:

- ✓ VITA 62 Compliant
- ✓ 3U, 6U, and Custom
- ✓ Up to 1kW
- ✓ Embedded EMI Filter
- ✓ Remote Sense
- ✓ Designed to Meet: MIL-STD-461, MIL-STD-704, MIL-STD-810 and MIL-STD-1275

Form Factor	Power (W)	Input/Output	MILVPXe Lab Use Only	MILVPX VPX VITA 62 Compliant	MILVPX Pro Configurable Current Limits	Comments
3U 	250	DC-DC	VPX30250-E	VPX30205	VPX30250-#	
	350	DC-DC	VPX30350-E	VPX30350	VPX30350-#	
	350	DC-DC	VPX30351-E	VPX30351	VPX30351-#	With Hold-Up
	500	DC-DC	VPX30500-E	VPX30500	VPX30500-#	
	600	DC-DC	VPX30600-E	VPX30600	VPX30600-#	
	600	DC-DC	VPX30601-E	VPX30601	VPX30601-#	50µH Inductance
6U 	500	DC-DC	VPX60500-E	VPX60500	VPX60500-#	
	800	DC-DC	VPX60800-E	VPX60800	VPX60800-#	
	1000	DC-DC	VPX61000-E	VPX61000	VPX61000-#	
	1000	DC-DC	VPX61001-E	VPX61001	VPX61001-#	50µH Inductance
	1000	DC-DC	VPX61002-E	VPX61002	VPX61002-#	
	500	AC-DC	VPX60501-E	VPX60501	VPX60501-#	

Custom



All specifications are configurable. Customers are invited to work with a design engineer to define the specifications, from power, to input/output and even form factor, which best achieves their requirements.

MILVPXe - Available for lab use environments (0-70°C).
MILVPX - Off-the-shelf VPX VITA 62 compliant configurations models in stock.
MILVPX Pro - Configuration of current and voltage thresholds and protections V1, 2, 3 & AUX1, 2, 3 available.
MILVPX Custom - Full custom specifications available, speak with a design engineer to develop the right solution for your requirements.

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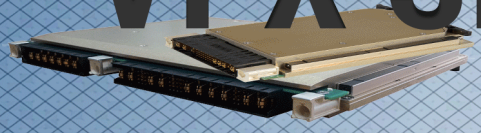

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About Milpower Source, Inc

Milpower Source is an industry leading manufacturer of rugged power conversion products for defense and aerospace applications. In addition to the MILVPX family of 3U, 6U and custom VPX VITA 62 power conversion products, Milpower Source offers a variety of off-the-shelf power conversion solutions to meet our customer's demanding specifications, including rapid modification of our large catalog of baseline power supply designs. Contact us today to challenge Milpower Source with your demanding power supply requirements.

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