Versatile Power Supply with XMC Sites Enables 3U VPX Architectures

Read About

Versatile Power Supply

SWaP efficient 3U VPX

Dual XMC carrier

6-port PCIe NTB switch

Zero-slot VPX solutions

Introduction

Advanced technology is changing the face of modern embedded systems. Increased processing and functionality are bringing new capabilities and challenges to system design. The 6U VME open architecture systems of yesterday are migrating to VPX, with many of them transitioning to the reduced 3U VPX form factor. These same technology improvements have also made the capabilities and utility of the XMC mezzanines hosted on the VPX modules play an increasingly important function in these systems.

Customers are looking to architect systems using today's technology to improve size, weight, and power (SWaP). They have requirements to increase I/O count to match the processing performance in systems. They need to augment the PCI Express (PCIe) interface with increased number of interconnects and flexible data exchanges across domains. Spare slots are required to extend system lifecycles. The 28V PSU3-THOR VPX can provide all these capabilities in a rugged power supply product enabling SWaP-efficient 3U VPX system solutions.

Figure 1: Curtiss-Wright PSU3-THOR Power Supply

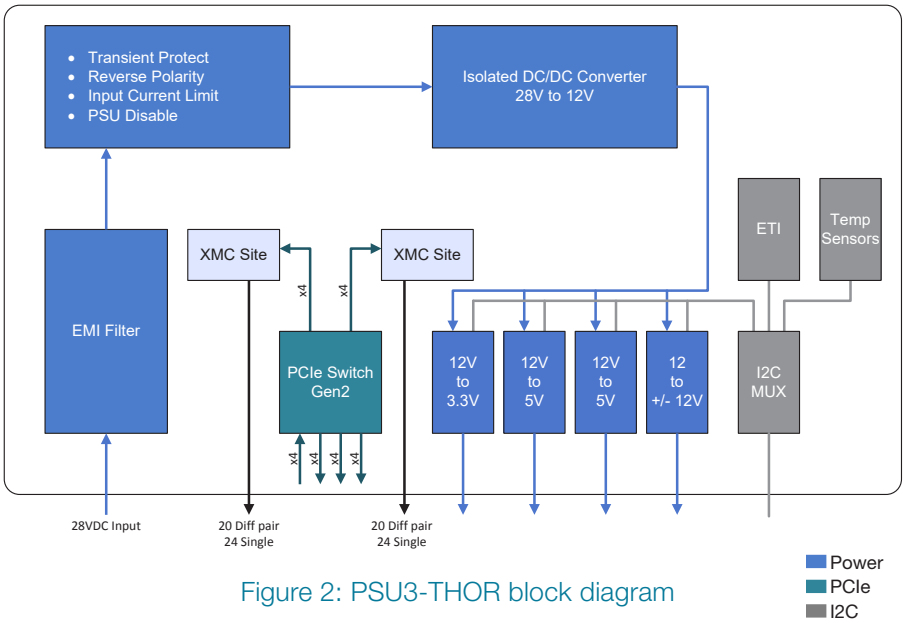

Figure 2: PSU3-THOR block diagram

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To meet the demanding SWaP and system requirements across a wide variety of 3U VPX systems, Curtiss-Wright engineers have developed a versatile power supply that provides the following capabilities:

- 250 to 500 watts of +5V, +3.3V, and ±12V inputs
- Transient protection, current limiting, and polarity protection safety features
- Dual embedded XMC sites to 15 watts each
- 6-port, four lane PCI Express Generation 2 switch
- Support for six non-transparent bridge (NTB) endpoints
- 50 milliseconds hold-up to 280 watts
- Voltage and temperature sensors with an elapsed time indicator

This white paper will explain the technology and applications advantages of the PSU3-THOR power supply shown in Figure 1. It will showcase a number of instances where the PCIe switched dual-embedded XMCs are an enabling technology for a variety of embedded applications.

3U and XMC Migration

Curtiss-Wright engineers have seen a trend of customers migrating to 3U VPX systems. This is occurring for both newly deployed systems and for conversion of legacy units, particularly 6U VME. One reason is the increasing capabilities per chip being delivered by Moore's Law. Unfortunately, the power dissipation requirements have not kept pace with the digital technology advancements. Modules for 6U VME and 6U VPX were once optimal for functionality per power requirements. But that sweet spot has now shifted to the 3U VPX architectures, whose size limits the amount of electronics on a card and improves heat-sinking efficiencies.

The standardization and efficiency of interfaces has also evolved to favor 3U architectures. The high pin count parallel buses of yesterday have been replaced with higher bandwidth serialized interfaces with reduced number of pins. So not only do the 3U interfaces transfer significantly more data, they do it with pin counts that allow them the communication bandwidth of the previous larger systems.

Another factor driving the trend to 3U systems is the equivalent functionality of applications has not necessarily increased correspondingly with the electronics technology. Applications such as mission computer or display controllers that were previously accomplished with 6U technology see equivalent, if not greater performance when moved to 3U. Our customers are then able to achieve size and weight reductions to enhance their mission applications.

The functionality and processing performance of XMCs has also been significantly augmented by the same advances in processing technology. COTS vendors now offer a multitude of XMC product with processors, communications, I/O, and other capabilities standardized to the VITA 42 specification. Today, system architects have a wide selection of available COTS XMCs that can solve an extensive list of application requirements.

Power Supply Features

Based on requirements and demand from its customers, Curtiss-Wright engineers determined that extending the functionality of the power supply would resolve limitations and enable solutions for a variety of SWaP-constrained applications. The PSU3-THOR power supply is a flexible design providing +5V, +3.3V, and ±12V power inputs. The power supply can be optimized to provide either 250 or 500 watts based on a modular design that incorporates a +5V plug-in to the standard power module.

The simplest and most extensible method to enhance power supply versatility is to engineer it to host XMC sites. The PSU3-THOR is engineered to host two XMC sites up to 15 watts each. The XMCs are tied to the VPX backplane through a six-port PCIe Express Generation 2 switch which provides a flexible, high bandwidth interconnect. The total bandwidth for the Gen 2 switch is 24 GBytes per second with PCIe Gen 3 technology slated to double that bandwidth for the next generation product.

The six-port switch extends PCIe functionality not only for the XMCs on the card, but also provides an additional four PCIe four-lane ports to the backplane. The switch supports six non-transparent bridge (NTB) endpoints each allowed to exchange data across PCIe domains. This capability allows true multi-host or multi-processor communications to the XMCs or to other backplane endpoints.

The Curtiss-Wright engineers designed the power supply to stand up to the harsh requirements of embedded applications. Power supply safety features provide transient protection, current limiting, and reversed polarity protection. It also has an optional 50 milliseconds hold-up to 280 watts for temporary power interrupts. For status monitoring it has voltage and temperature sensors as well as an elapsed time indicator which can be accessed over an I2C interface.

Power Supply Applications

There are a variety of applications that can exploit the capability of this power supply. Curtiss-Wright XMCs that can be hosted within the power limitations include the XMC-651 Ethernet switch, the XMC-120 single board computer, the XMC-XCLK1 for clock generation and distribution, the XMC-603 1553B I/O module, and other XMCs including many from third party COTS vendors.

PCIe switch additional ports

A primary benefit of the PSU3-THOR is its PCIe switch which can be used to provide a PCIe root with additional endpoints. In Figure 3, the system developer needs to interface three PCIe endpoints (modules 1, 2, 3) with the PCIe root (SBC #1).

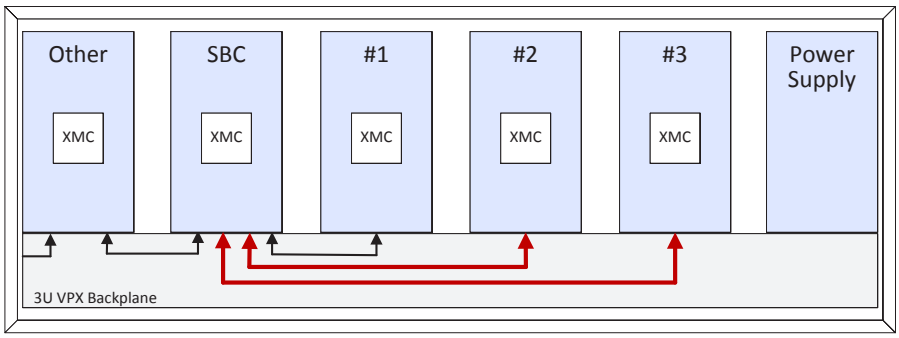

Figure 3: 3U VPX system lacking PCIe interfaces

The issue in Figure 3 is that the SBC has only two PCIe ports and requires four to connect to the system and the three modules. This could compromise the design impacting the module selection, requiring an additional slot for a PCIe switch card, or reducing bandwidth for the application. Figure 4 shows an alternative, incorporating the PSU3-THOR power supply. In this architecture, each of the endpoints now has a four-lane PCIe interconnect using the power supply switch. An added benefit is there are now two additional XMC slots available.

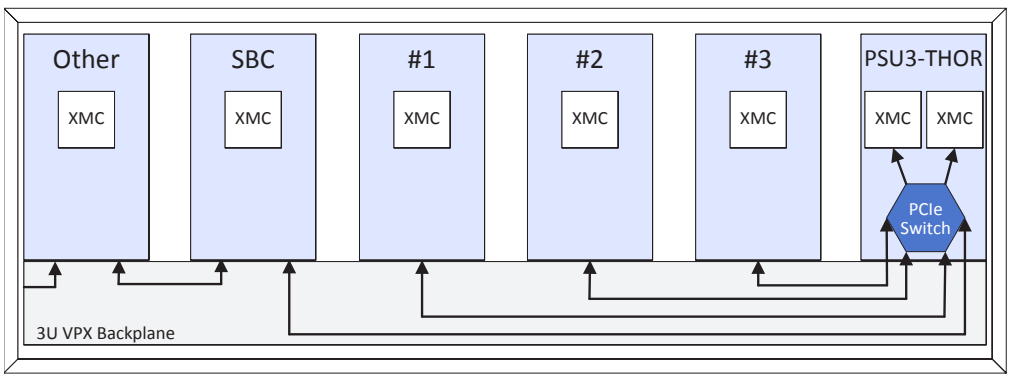

Figure 4: System interconnected with Power Supply switch

PCIe switch NTB utility

The non-transparent bridging feature of the power supply's PCIe switch is another useful feature for customer applications. Using its nontransparent bridge (NTB) capabilities, systems can be configured with separated PCIe domains and bandwidth. Figure 5 shows a system configured with dual system controllers such as the Curtiss-Wright single board computer XMC-120. Using the NTB functionality of the switch, each of the XMC SBCs has its own PCIe domain. This is a useful architecture for mission application with separate controller functionality, such as a combination system and display controller. The display controller of domain two might be controlling a graphics unit, while the system controller of domain one might be interfacing with signal processors, I/O modules, or other single board computers for mission control.

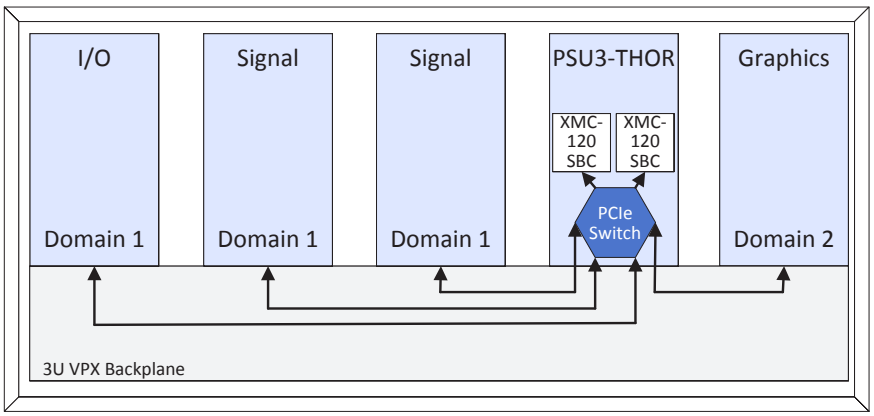

Figure 5: NTB enables XMCs hosting dual SBCs

Dual redundant units

Another customer application of interest is dual redundant electronics where the blue/black configurations are completely independent including backplane and power supply. Figure 6 shows a mission display computer with control, graphics, and I/O in a dual redundant configuration. In a standard configuration, this might be a 10-slot dual redundant configuration with a power supply slot for each redundant side. Using the XMCs on the PSU3-THOR as shown in Figure 6 requires only six slots for the dual redundant mission controller each power supply hosting custom I/O and Gigabit Ethernet switch XMCs, such as the Curtiss-Wright XMC-651. This reduction in the number of slots increases the probability of hosting the redundant systems in the same enclosure for a significant SWaP savings.

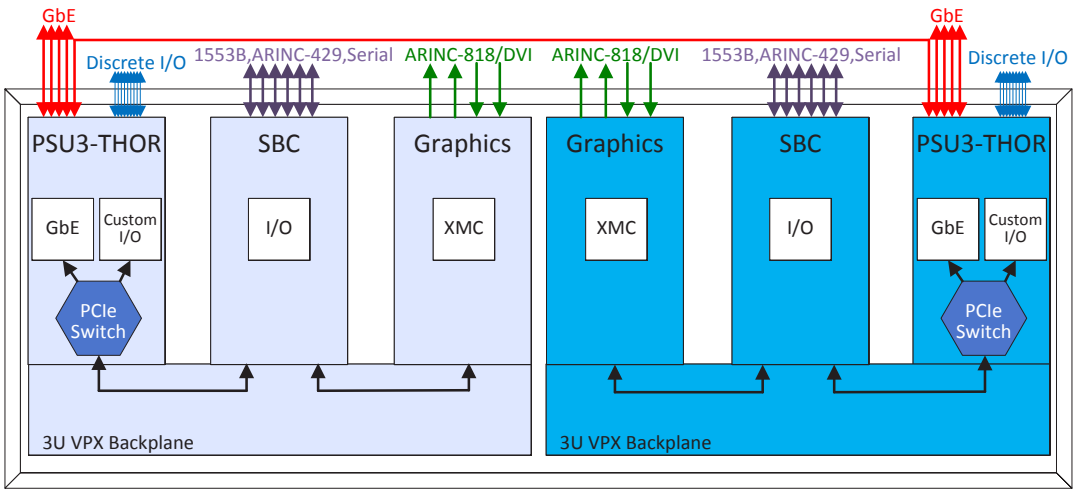

Figure 6: Dual redundant Mission Display Computer

Zero-slot systems – controller with I/O

The ultimate application of the PSU3-THOR power supply is the zero-slot system. This is a unit with a volume of 2.6” x 10.5” x 5.5” weighing less than three pounds which can combine any two available XMCs, generally one being a SBC controller. The reduced volume and modularity of this configuration makes it useful for many different applications. For example, a communications control system can be implemented combining a SBC and network switch XMCs as shown in Figure 7. Other configurations might include a data converter with an SBC and custom I/O XMCs.

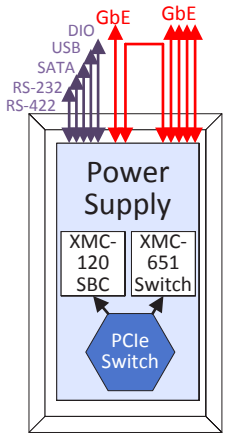

Figure 7: Zero-slot SBC with Gigabit Ethernet Switch

SDR Radio multi-channel synch

An SDR Radio is another application shown in Figure 8 benefited by the PSU3-THOR. The SDR multiple channels require phase--matched synchronized data capture. Curtiss-Wright’s XCLK1 XMC provides clock generation and synchronization, but the number of channels in the system requires three XCLKs. One XCLK1 located on the SBC is the master that generates the clock. The other two XCLKs located on the PSU3-THOR power supply distribute it to four VPX-530s using its multi-board synchronous trigger capabilities. Two PSU3-THOR power supplies are needed to provide the required 800 watts, the XCLK clock distribution, and the PCIe switching to the eight VPX3-530s. The power supply in this system is a variant of the standard with only a single XMC per PSU3-THOR to allow for five PCIe interfaces to the backplane per power supply switch.

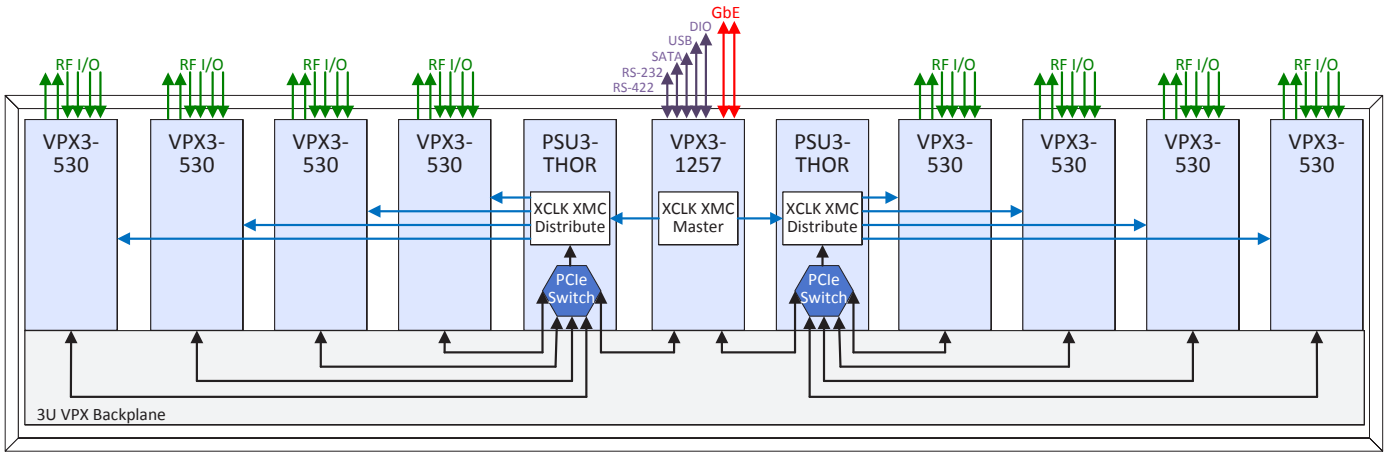

Figure 8: Multiple XCLKs hosted for SDR Radio

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Conclusions

We have provided a number of possible applications for the versatile PSU3-THOR power supply. There are a multitude of missions which may benefit by using this technology. Our customers have surprised us already with additional applications demonstrating its usefulness

Embedded architectures are increasingly migrating to 3U with XMC mezzanines. The PSU3-THOR 28 VDC power supply provides 250 to 500 watts and has safety features with hold-up capabilities to work in rugged environments. Its incorporation of a PCIe switch with dual XMC sites increases the flexibility of the PCIe backplane interconnect, bringing increased functionality with SWaP reductions. Its additional functionality is useful for 3U VPX mission applications enabling solutions from zero-slot to dual redundant systems.

Learn More

Products:

- PSU3-THOR Versatile Power Supply
- XMC-120 Intel Quad-Core Single Board Computer
- XMC-651 Ethernet Switch

White Papers:

- 6U to 3U Migration
- I/O Expansion for COTS-based Embedded Systems