An introduction to VPX:
VPX extends VME in NextGen mil systems

By Stewart Dewar

Based upon serial fabrics, VPX and the VPX-REDI ruggedization format represent the single most important advance in open standard COTS computing for defense and aerospace applications.

The new VPX (VITA 46) standard and its complement, VPX-REDI (VITA 48), bring several performance and ruggedization improvements to the open standard 6U and 3U board and system ecosystem long made popular by the earlier VMEbus architectures. VPX, which defines the base electrical and mechanical standard, and VPX-REDI, which defines enhanced mechanical ruggedization formats, together represent the single most important advance in open standard COTS computing for defense and aerospace applications since VME was first introduced 25 years ago.

Interfaces abound; pins do not

Driving these new standards is the rapidly growing trend of serial fabrics replacing parallel buses for local communications. These fabrics include PCI Express, Advanced Switching Interconnect (ASI), Serial RapidIO (SRIO), InfiniBand Architecture (IBA), and 10 Gigabit Ethernet (10 GbE). Meanwhile, standard I/O interfaces are also moving to high-speed signals. These new high-speed video interfaces include digital video standards such as DVI, HDMI, and SMPTE 292M (HDTV). Storage I/O interfaces are also becoming faster with the increased popularity of Fibre Channel, Serial ATA, and Serial Attached SCSI.

One also finds this move toward high-speed I/O in the sensor arena, where interfaces such as Serial FPDP and Xilinx RocketIO are pushing bandwidths ever higher. In addition to the push toward serial switched fabrics and higher speed I/O interfaces, there is also a need for a significant increase in the number of I/O pins available to the user compared to what is currently available with VME64x. As chip-level densities increase, they are driving requirements for more I/O pins at the board level. In fact, many of today's existing products already exceed VME's 205-pin capacity for user I/O pins. The good news is that VPX addresses all of these requirements and goes much further with major improvements in ruggedization, ESD protection, and cooling.

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Even better, VPX and VPX-REDI provide an evolutionary roadmap for legacy VME users. By providing support for a full VME64x electrical interface, VPX and VPX-REDI enable users to leverage the broad spectrum of high-speed interconnect technologies. Their investments are protected thanks to the new standards' compatibility with VMEbus electrical, software, and selected mechanics. And the use of the familiar 3U and 6U form factors simplifies technology insertion and integration of new systems into existing platforms.

VITA 46/48 is aimed at application areas typified by defense and aerospace that are space-constrained, need to operate in harsh environments including conduction-cooled environments, and where a high value is placed on backplane I/O. In addition, VPX and VPX-REDI together provide a standardized approach for addressing two important and growing issues faced by military and aerospace system designers:

- Handling ever-increasing power dissipation
- Providing the means to use the module in a Line-Replaceable Module (LRM) to support direct remove and replace operations of the module at the platform level

VPX basics – 6U

The 6U version of VPX provides for both an air-cooled IEEE 1101.1/10 form factor version and an IEEE-1101.2 conduction-cooled compliant Outline and Installation (O&I) envelope, both compatible with existing enclosures. A major difference between VPX/VPX-REDI and VME64x is the use of a new connector type, the Tyco MultiGig 7-row RT2 connector (Figure 1). The RT2 connector provides excellent electrical properties, being nominally rated for signals of up to 6.25 Gbaud. In addition, this connector is mechanically robust with blade-style pinless design, eliminating the problem of broken backplane pins sometimes experienced with VME, and redundant contacts for each signal, reducing the likelihood of failure under mechanical stress.

Figure 1

To support PMC and XMC mezzanines, the dimensions of the 7-row RT2 connector were specifically tailored to allow standard length PMCs and XMCs to fit. All in all, the VPX formats represent a more robust module design than their predecessor. It incorporates *alignment and keying modules* that ensure proper alignment between the card and the backplane to eliminate wear and tear on the connectors during insertions and extractions. They also provide an integral card-keying mechanism. To combat damage from exposure to Electrostatic Discharge (ESD), the MultiGig 7-row RT2 connector provides a built-in ESD safety protection feature. The 6U version of VPX uses seven MultiGig connectors, configured as six 16-column 7-row RT2 connectors and one 8-column 7-row RT2.

VPX basics – 3U

The 3U version of VPX preserves the PICMG 2.0 Rev 3 air-cooled compliant O&I envelope (Figure 2), making it compatible in this sense to the multitude of existing enclosures designed by COTS vendors and end users. For conduction-cooled designs, 3U VPX follows the VITA 30.1 conduction-cooled standard, providing similar benefits of mechanical compatibility.

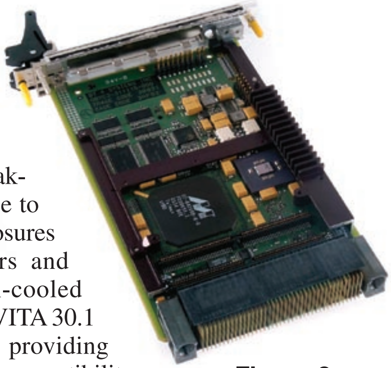

Figure 2

Akin to its 6U big brother, the 3U version also uses the Tyco MultiGig 7-row RT2 connectors and hence receives all the same benefits, including the ability to host standard-length PMCs and XMCs. The connectors on the 3U form factor version of VPX are configured as two 16-column 7-row RT2 connectors and one 8-column 7-row RT2, supported with two alignment and keying modules.

VPX – The benefits

VPX boasts numerous significant benefits over preceding 6U and 3U form factor board standards. Its greatly increased total I/O complement provides – in the 6U case – a total of 707 nonpower electrical contacts. Of its 464 nonpower, nonground signal contacts, 64 signals are implemented as 32 high-speed differential pairs for core fabric; 104 signals are used for a full VME64 implementation; 268 are used for general purpose user I/O, including 128 high-speed differential pairs; and 28 signals are defined for system utilities (reset, JTAG, geographical addressing, and so on) and spares.

The new standard's I/O is also able to handle much greater I/O bandwidth than VME64x. VPX's 160 high-speed differential pairs are each nominally rated for up to 6.25 Gbaud performance. VPX also greatly increases power provisioning compared to VME64x, with support for up to 115 W of 5 V power, up to 384 W of 12 V power, or up to 768 W of 48 V power.

VPX-REDI basics

VPX-REDI is a complementary mechanical standard to VPX, and defines alternate mechanical formats that go beyond the traditional IEEE 1101.1 and 1101.2 formats to provide new enhanced capabilities. These new capabilities include an increase in useable PWB area and improved thermal management (air-cooled, conduction-cooled, liquid flow-through cooling), enabling increased functional density and providing support for use as an LRM.

The conduction-cooled module version of VPX-REDI (Figure 3) can be on either a .85" or 1.00" pitch. The .85" pitch version allows for the top and bottom covers that provide protection for the LRM mode of use and provide improved cooling for components mounted on the rear side of the module. The 1.00" pitch versions allow for top and bottom covers and also provide for increased component height allowance.

Figure 3

Specifically, the 1.00" pitch version provides 0.150" on the secondary side for increased PWB thickness and higher components, and 0.08" on its primary side for increased component height and/or improved thermal management via a thicker mid-plane thermal shunt. A major benefit of the increased component height allowance on the topside of the card is that PMC and XMC modules sit 0.08" higher above the basecard PWB, thus allowing components to be placed in what is the PMC I/O keepout area on standard pitch cards. For cards that support two XMC/PMC sites, this results in a total 5-6 square inches of additional PWB area.

All things considered, the increased pitch width of the VPX-REDI conduction-cooled format delivers approximately a 41 percent increase in allowable power dissipation on a conduction-cooled module and a net increase of about 13 percent in functional density over the 0.8" pitch width of legacy VME64x. The standard also defines the use of top and bottom metal covers that provide thermal management benefits and protection for components against ESD and handling.

Current VPX status

At the same time as the VPX standard is being finalized within the VITA 46 working group of the VITA Standards Organization (VSO), product development and announcements from the vendor community are continuing. Recent months have seen announcements of a suite of 3U VPX modules by Radstone Technologies, a Liquid Flow-Through (LFT) cooled chassis from Parker Hannafin, and a laboratory development/test chassis by Hybricon (see Figure 4, photo courtesy of Hybricon). These product announcements follow previous announcements made by Micro Memory, Elma Bustronic, and Curtiss-Wright Controls Embedded Computing. Ω

Figure 4

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