Tech Focus: Rugged Box Systems Roundup

COTS JOURNAL

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The Journal of Military Electronics & Computing

Distributed Power Solutions SOAR TO NEW HEIGHTS

PLUS:

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Waveform Generators Smooth Radar Test Hurdles

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COTS JOURNAL
The Journal of Military Electronics & Computing

Features

November 2009 Volume 11 Number 11

Special Feature

Distributed Power in Military Systems

12 Power Conversion Solutions Toughen Up for Military Duty
Jeff Child

18 SSPC Advancements Enhance Vehicle Power System Designs
Steve Rood Goldman and Michael Glass, Data Device Corp.

26 Modular Approach Wins for VME Power Systems
Steve Butler, VPT

34 Meeting MIL-STD-810 for Batteries Presents Challenges
Jeffrey VanZwol, Micro Power Electronics

Tech Recon

Safety-Critical Standards

42 Data Distribution Service and MILS: A Powerful Combination
Joseph M. Schlesselman, Real-Time Innovations

48 DO-178B Provides Certification Safety Net
John Blevins, LynuxWorks

54 Growing Complexity Drives Need for Emerging DO-178C Standard
Bill St. Clair, LDRA Technology

System Development

Military Simulation & Test Trends

58 Signal Simulation Aids Testing of Advanced Radar Designs
John S. Hansen, Agilent Technologies

Technology Focus

Rugged Stand-Alone Box Systems

62 Rugged Box Systems Tighten Their Military Focus
Jeff Child

64 Rugged Stand-Alone Box Roundup

COTS (kots), *n.* **1.** Commercial off-the-shelf. Terminology popularized in 1994 within U.S. DoD by SECDEF Wm. Perry's "Perry Memo" that changed military industry purchasing and design guidelines, making Mil-Specs acceptable only by waiver. COTS is generally defined for technology, goods and services as: a) using commercial business practices and specifications, b) not developed under government funding, c) offered for sale to the general market, d) still must meet the program ORD. 2. Commercial business practices include the accepted practice of customer-paid minor modification to standard COTS products to meet the customer's unique requirements.

——**Ant.** When applied to the procurement of electronics for the U.S. Military, COTS is a procurement philosophy and does not imply commercial, office environment or any other durability grade. *E.g., rad-hard components designed and offered for sale to the general market are COTS if they were developed by the company and not under government funding.*

Departments

6 .....Publisher's Notebook
May I Have Another Bowl of Porridge, MILCOM?

8 .....The Inside Track

68 ....COTS Products

78.....Editorial
Five That Push the Computing Envelope

Coming in December...
...See Page 76

Cover Story ..... Page 12

The F-35 Lightening II, formerly called the Joint Strike Fighter, is packed with advanced electronics that require the latest distributed power supply technologies. The aircraft carries sensor-fused weapon systems, electro-optical targeting system, thermal imaging system, multi-function radar, electronic warfare suite and advanced digital radar.

Photo courtesy of Pratt & Whitney

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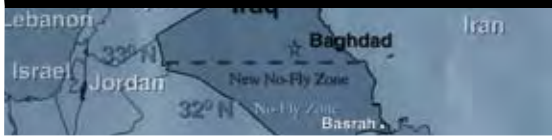

May I Have Another Bowl of Porridge, MILCOM?

Another great MILCOM…. I had severe misgivings about this year's MILCOM. Downtown Boston is not very enticing for locals to do day trips. The facility was small, leaving many potential exhibitors wait-listed until the last minute or settling for table top areas in the lobby and hallways. But aside from those handicaps, it was still a very good conference, especially for the military embedded market.

Jeff Child and I noted that more than a quarter of all the exhibitors were supplying some form of embedded computer electronics—from components to subsystems. This makes our market a major element in this conference. Maybe one day our contribution will be recognized by the MILCOM sponsors and governing board. In spite of the constraints imposed by the logistics, the number of exhibitors was only slightly lower than last year, and the number of attendees down by somewhere around 20 to 25 percent. All that said, as one exhibitor told me: "To go to a show in downtown Boston means you really want to go there; for us that means high-quality visitors and not too many tire kickers."

The exhibits are only one element of any conference like this. It's the actual programs offered that drive attendees to attend. Although this year's conference program was strong, last year's provided more meat than this year's. I'm guessing the change in administration and trying to adjust to any new administrative and congressional goals since last year's MILCOM makes it difficult to stand up and talk in detail about what will or should happen. I did get to spend some time with one of the keynotes this year, USAF Lt. Gen. Ted F. Bowlds. We had met before when he helped me out by being my keynote to a conference I was acting as program chair for a few years back. Since then he managed to get two stars and become the Commander of the Electronic Systems Center Hanscom AFB, Mass. I only managed to get older.

COTS Journal once again had its analyst breakfast. MILCOM brings in key research groups. We used the opportunity to bring the analysts, users and suppliers together for an informal "off the record" discussion about our marketplace. This year we added Embedded Market Forecasters to our normal cadre of analysts at the breakfast, which included Frost & Sullivan, Jane's and VDC. Unfortunately Larry White from Jane's was unable to attend. The exciting thing for us was that we had more suppliers and users than we could accommodate. Our desire to have new faces each year from different sized organizations forced us to disappoint some good friends of *COTS Journal*. We will do the breakfast again next year at MILCOM in San Jose and will continue it until we can figure out how to get the same end result with a larger number of attendees. The market insight, outlook and consensus that resulted from this meeting are invaluable to those of us that participated.

Figure 1

COTS Journal's annual breakfast gathering at MILCOM 2009. From left to right, Jeff Child, *COTS Journal*; Brad Curran, Frost & Sullivan; Jerry Krasner, Embedded Market Forecasters; Eric Gulliksen, VDC Research; Brent Salgat, Concurrent Technologies; Didier Thibaud, Mercury Computer Systems, and Mark Dupaul, SMART Modular Technologies. Also present, but not in photo: Nauman Arshad, Curtiss-Wright and Pete Yeatman, *COTS Journal*.

Embedded electronics is not only becoming a year-on-year bigger element in the military, it's also becoming that at MILCOM itself. Sooner or later MILCOM will have to accept embedded military electronics as its "Foster Child" and make it a full-blown element of its conference programs. All told, we number at over a quarter of their exhibitors and growing, and we're key to the DoD's future plans. Yet I still feel part of a Dicken's novel. See you in San Jose next year. ▮▮

Pete Yeatman, Publisher
COTS Journal

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The Inside Track

SMART Modular Tech's SDDs Selected for F/A-18 Upgrade Program

Harris has selected SMART Modular Technologies to provide solid-state drives (SSDs) for use in its Mass Storage Unit (MSU) program. The new MSU, which is part of a larger F/A-18 program (Figure 1), is the first of a new family of avionics file servers. According to Harris, the MSU enhances their ability to provide significant file storage for in-flight applications on the F/A-18 platform. The increased capacity and performance of today's SLC NAND flash drives enable them to support a broader range of applications with data consolidated from multiple sources.

Figure 1

Taking advantage of the capacity and performance of today's SLC NAND flash drives, the F/A-18 Mass Storage Unit (MSU) enables support of a broader range of applications with data consolidated from multiple sources.

Harris selected SMART's XceedSecure 2.5-inch SATA SSD for the in-flight file server application. XceedSecure high-performance SSDs range in capacity from 32 Gbytes to 256 Gbytes and include EraSure technology. EraSure technology complies with current military data elimination standards, providing multiple levels of secure erase techniques. EraSure Clear provides a fast data elimination function that enables erasing of data in seconds. EraSure Sanitize uses agency defined or unique customer defined sanitization procedures, allowing full media declassification. Additionally, EraSure complies with IRIG 106-07, chapter 10.8, addressing the specific needs of flash architectures and data structures and for bad block handling, write protection and for reviewing the secure erase results to verify that all classified data has been eliminated.

SMART Modular Technologies
Newark CA.
(510) 623-1231.
[www.smartm.com].

National Technical Systems Wins Weapons Test Contract

National Technical Systems has been awarded a five-year, Other Transaction Agreement (OTA) contract with maximum potential revenues of $10 million from the U.S. Department of Defense to test and help develop new weapons and ammunition technology. NTS expects to provide approximately $1.67 million of services by early in calendar year 2010 for the first phase of the contract and, pending further Department of Defense approvals, up to $8.33 million of additional services throughout the contract's five-year term.

The contract supports the military's Ordnance Technology Initiative titled "Assessment Support of Direct and Indirect Fire Munitions Product Improvements for Insensitive Munitions Performance." The first award is specifically for the U.S. Army but the technology being developed will benefit all the U.S. Armed Forces. The efforts are focused on five technical areas: high-performance rocket propulsion, minimum signature rocket propulsion, blast-fragmenting warheads, anti-armor warheads and large caliber gun propulsion.

National Technical Systems
Calabasas, CA.
(800) 270-2516.
[www.ntscorp.com].

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Quintron Systems Provides Comms Gear for Second Atlas V Launch

Quintron System's DICES mission voice switch was used to provide critical communications support for two Atlas V launches from Vandenberg Air Force Base, CA. Quintron supplied communications support during the March 18, 2008 launch of an Atlas V spacecraft for the National Reconnaissance Office, and most recently for the Defense Meteorological Satellite Program (DMSP) F-18 Block 5D-3 spacecraft, built under contract for the U.S. Air Force by Lockheed Martin.

Figure 2

The DMSP F-18 satellite provides strategic and tactical weather prediction, which aids the U.S. military in planning operations at sea, on land and in the air.

To assist preparations, Quintron technicians inspected, tested and updated the earlier DICES equipment as the first step. In addition, the DICES Subsystem Multiplexer (Sub-MUX) equipment was introduced for use in hazardous areas on and around the main launch complex tower. Use of the DICES Sub-MUX allowed moving much of the original DICES system equipment from SLC-3 itself into a larger Remote Launch Control Center (RLCC) approximately

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15 miles from the actual launch pad. The DMSP F-18 satellite (Figure 2) provides strategic and tactical weather prediction, which aids the U.S. military in planning operations at sea, on land and in the air.

Quintron Systems
Santa Maria, CA.
(805) 928-4343.
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GE Fanuc Receives Order for UH-1Y Huey Helicopter Avionics

GE Fanuc Intelligent Platforms has secured an order valued at approximately $1 million from Northrop Grumman. The order is the latest of several similar orders, and is for quantities of GE Fanuc QPMC-1553 1553 PMCs and CEI-830 ARINC

Figure 3

U.S. Marines aboard a new Bell UH-1Y helicopter fly toward the flight deck of the amphibious assault ship USS Boxer during an exercise in the Pacific Ocean.

boards that will be used by Northrop Grumman to upgrade its Integrated Avionics System (IAS) that is at the heart of the UH-1Y (Figure 3) and AH-1Z helicopters.

The GE Fanuc QPMC-1553 PMC and CEI-830 ARINC boards are used by the avionics data bus interface, both 1553 and ARINC 429, which is the communications link to the aircraft. According to GE Fanuc, they were selected because they are rugged and conduction-cooled, and capable of withstanding the rigors of deployment on a helicopter; and because GE Fanuc was able to commit to availability of an identical solution over an extended time period. The QPM-1553 offers a very high level of performance and flexibility for MIL-STD-1553A/B in the PMC form factor. The CEI-830 ARINC board provides complete, integrated databus functionality for up to 32 channels of ARINC 429, ARINC 575 and selected 2-wire, 32-bit protocols. It supports maximum data throughput on all 32 channels while providing onboard message scheduling, label filtering, multiple buffering options, time-tagging and error detection with support for either 33 MHz or 66 MHz PCI/PMC interfaces.

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[www.gefanucembedded.com].

OpenVPX Spec Completed and Turned Over for VITA Ratification

At a press event at MILCOM Boston last month, the OpenVPX Industry Working Group announced the completion of the OpenVPX specification and its release to the VITA 65 working group for quick ratification. The OpenVPX working group was formed in January 2009 to develop a system level specification that addresses interoperability improvements for the VITA 46 specification. The milestone stayed true to the group's goal of completing the spec by October 2009. The specification is designed to improve interoperability of

Figure 4

Curtiss-Wright's Nick Giannantonio shows *COTS Journal* Chief Editor Jeff Child a live demo of OpenVPX boards interoperating in Hybricon's SFF-4 Small Form Factor conduction-cooled chassis.

COTS 3U and 6U VPX boards achieved by implementation of predefined system topologies. This was needed, according to members, in order to lower the risk of adoption, expand the addressable market for VPX solutions, increase the market opportunities, and accelerate the deployment of VPX solutions into defense-related applications. The specification is now released to the VITA 65 working group, with the objective of the VITA Standards Organization's (VSO) ratification before year's end. Several OpenVPX member companies announced OpenVPX products compatible with the new spec at MILCOM (Figure 4).

The OpenVPX System Specification is nearly 400 pages, describing technical implementation details for 3U and 6U VPX payload and switch modules, backplane topologies and chassis products, which will provide clear guidance to the Defense primes and suppliers on how to build interoperable computing and communication platforms. The press event, attended by the key military embedded electronics publications, included a summary briefing and a panel discussion. The VPX standard was developed to define a new generation of computing systems that employ high-performance switch fabrics over a new high-speed connector, as well as operate in harsh environments.

Member companies who have joined the OpenVPX Industry Working Group and signed the OpenVPX operational MOU agreement include: Aitech, Agilent, BittWare, Boeing, Concurrent Technologies, CSPI, Curtiss-Wright, Diversified Technology, DRS Signal Solutions, Elma Electronic, Extreme Engineering, Foxconn Electronics, GE Fanuc, General Dynamics AIS, General Dynamics, Hybricon, Kontron, Lockheed Martin, Mercury Computer Systems, Molex, Northrop Grumman, Pentair/Schroff, Pentek, Pigeon Point Systems, SIE Computing Solutions, TEK Microsystems, Tracewell Systems and Tyco Electronics.

OpenVPX Industry Working Group
[www.openvpx.org].

VITA
[www.vita.com].

Boeing Taps Parvus for Display Systems on P-8A Poseidon

Boeing has contracted Parvus to supply the Flight Test Display (FTD) and the Instrumentation Crew station Control Panel (ICCP) for the P-8A Poseidon aircraft. Developed for the U.S. Navy, the P-8A is a long-range anti-submarine warfare, anti-surface warfare, intelligence, surveillance and reconnaissance aircraft capable of broad-area, maritime and littoral operations. The P-8A will begin flight test this fall and initial operational capability is slated for 2013.

Boeing selected the DuraVIS 4300 from Parvus to serve as the aircraft's ICCP. By combining the proven durability and power of Parvus' DuraCOR mission

Figure 5

A P-8A Poseidon displays its U.S. Navy paint scheme at the Boeing paint hangar in Renton, Washington.

computer with a COTS Multi-Function Display (MFD), the DuraVIS 4300 is an ideal solution for presenting flight, sensor, mapping, advisory and other information for the P-8A aircraft. Qualified to MIL-STD-810F, MIL-STD-704E and MIL-STD-461E standards, the DuraVIS 4300 offers exceptional low-temperature operation (-20°C) and resistance to shock and vibration profiles that will be experienced by the P-8A. In addition, Parvus' DuraVIS 3006 was chosen by Boeing to serve as the Flight Test Display for the P-8A.

Parvus
Salt Lake City, UT.
(801) 483-1533.
[www.parvus.com].

Event Calendar

December 8
Real-Time & Embedded Computing Conference
Copenhagen, Denmark
www.rtecc.com

December 10
Real-Time & Embedded Computing Conference
Gothenburg, Sweden
www.rtecc.com

November 30 - December 3
I/ITSEC
Orlando, FL
www.iitsec.org

January 26
Real-Time & Embedded Computing Conference
Santa Clara, CA
www.rtecc.com

February 2
AFCEA West 2010
San Diego, CA
www.afcea.org

February 9
Real-Time & Embedded Computing Conference
Huntsville, AL
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February 11
Real-Time & Embedded Computing Conference
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February 24-26
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Special Feature

Distributed Power in Military Systems

Power Conversion Solutions Toughen Up for Military Duty

Military power subsystems face all the burdens of any modern electronic system: multiple voltages and complex distributed system architectures. On top of that they require power conversion solutions built to work reliably in the harshest of environments.

Jeff Child
Editor-in-Chief

With more and more computing stuffed into smaller spaces, power has direct implications on the size, cooling and mobility of a system. Selecting power supplies and power conversion electronics rank as make or break technical choices in embedded military computer systems. Factor in the hurdles of multi-voltage electronics and the complexity of distributed system architectures, and it's clear to see why military system designers are hungry for solutions that untangle those challenges. Fortunately, military power conversion vendors are easing the burden with more efficient products, new partitioning strategies and increased ruggedization.

Taking aim at aircraft distributed power and similar applications, V•I Chip, a subsidiary of Vicor, offers a MIL-COTS BCM bus converter. This high-efficiency (more than 95 percent), Sine Amplitude Converter (SAC) operates from MIL-STD704E/F 270 VDC and delivers an isolated 30.0 to 41.3 VDC. This voltage is suitable as an input to the MIL-COTS PRM regulator and VTM current multiplier. The MIL-COTS BCM achieves a power density of 829W per cubic inch in a V•I Chip package compatible with standard pick-and-place and surface mount assembly processes. The package provides flexible thermal management through its low junction-to-case and junction-to-board thermal resistance. Owing to its high conversion efficiency and safe operating temperature range, the BCM may not require a discrete heat sink in typical applications. Low junction-to-case and junction-to-lead thermal impedances assure low junction temperatures and long life in the harshest environments.

Aircraft Distributed Power

Another bus converter solution targeting aircraft needs, the VPTHVM-270 Series (Figure 1) from VPT offers a bus converter module that offers wide input voltage ranges—a high priority in avionics systems. With up to 200W of output power, this regulated bus converter

module operates from a 270V bus to step down the power to create a regulated 28V bus for avionics power systems. A wide input voltage range accommodates MIL-STD-704 input power requirements for avionics and other applications. The high-efficiency design reduces input power requirements and eases thermal management, thereby increasing the overall system reliability.

With a footprint of just 2.35 inches (59.69 mm) by 1.550 inches (39.37 mm) and weighing in at 85 grams, the VPTHVM-270 Series saves valuable space and weight in a power system. Output power is up to 200W, with an efficiency up to 91 percent. Input voltage range is from 160 to 500 volts per MIL-STD-704. The unit is tested to JESD22, MIL-STD-810 and MIL-STD-883. A rugged six-sided all metal package improves performance reliability through the harsh environments of vibration, shock and temperature cycling.

Saving Board Space

Compact electronics are the norm these days, and high-power AC-DC conversion always comes down to a question of board space. With that in mind, TDK-Lambda has expanded its PFE series (Figure 2) of AC-DC power bricks with the introduction of the new PFE1000F modules. These modules provide a convenient AC-DC pcb-mounted solution with an output power of up to 1008W. Up to now, using bricks in an AC to DC conversion application required two modules. One module was needed to handle the AC input rectification and power factor correction (PFC), and a second for the DC-DC isolation and low voltage conversion. The PFE series combines these two functions into a single brick.

All PFE1000F models accept a wide AC input from 85V to 265V at 47-63 Hz, have active power factor correction (PFC), an input to output isolation of 3 kVAC, and an input to baseplate rating of 2.5 kVAC with application circuitry. In addition, over-voltage, over-current and over-temperature protections are included. The PFE1000F comes in a compact 3.94 x 0.53 x 6.3-inch package and can be conduction-cooled with a cold-plate or forced air-cooled with a heatsink.

Figure 1

The VPTHVM-270 Series of bus converter modules offers wide input voltage ranges and accommodates MIL-STD-704 input power requirement. With up to 200W of output power, the unit operates from a 270V bus to step down the power to create a regulated 28V bus for avionics power systems.

Figure 2

The PFE1000F modules provide an AC-DC pcb-mounted solution with an output power of up to 1008W. They accept a wide AC input from 85V to 265V at 47-63 Hz, have active power factor correction, an input to output isolation of 3 kVAC, and an input to baseplate rating of 2.5 kVAC with application circuitry. The PFE1000F comes in a compact 3.94 x 0.53 x 6.3-inch package and can be conduction cooled.

Reliable Power Factor Correction

Power factor correction is another piece of the power conversion puzzle where highly reliable commercial off-the-shelf solutions are vital to military and aerospace applications. Serving such needs, Martek Power provides an active power factor correction and harmonic attenuation module with 100W output power, extending the power range offered by the PFC family to 100 to 1000W. The PF100 (Figure 3) is intended for use with Martek Power's 100-watt 270 VDC input DC-DC converters; this front end rectifier provides a full 100W of output power from a universal single phase input from 85V to 265 VAC.

Packaged in a five-sided continuous aluminum case with dimensions of only 2.4 x 2.3 x 0.5 inch, the new unit meets CE101 and CE102 of MIL-STD-461 for conducted EMI without requiring any external filtering. Meeting MIL-STD-704E, ABD0100.1.8.1 and MIL-STD1399, it also delivers full performance over a wide, -40° to +100°C, operating temperature range, and boost efficiencies and power factor up to 93 percent and 0.99 respectively.

Getting the Heat Out

In harsh environment military applications, managing heat—in the form of dissipate power—is a tricky challenge. RECOM power attacks that problem with its PowerlinePlus Series of 20W to 50W power range DC-DC converters. These are the first modules to incorporate RECOM's innovative ICE Technology—a combination of techniques to minimize internal heat dissipation and maximize the heat transfer to ambient to create a new converter series, which offers high-end performance at a price that is significantly lower than conventional specialist converters.

PowerlinePlus converters boast a case temperature operating range of -45° to +120°C, built-in Class B EMC filters and fully protected outputs. PowerlinePlus converters combine a high-efficiency design with a revolutionary integrated

Figure 3

The PF100 provides an active power factor correction and harmonic attenuation module with 100W output power. Packaged in a five-sided continuous aluminum case with dimensions of only 2.4 x 2.3 x 0.5 inches, the new unit meets CE101 and CE102 of MIL-STD-461 for conducted EMI without requiring any external filtering.

heat sink case to deliver more power over a wider temperature range while requiring less space and cost than equivalent solutions previously offered for these demanding applications. The PowerlinePlus Converter Series consists of six module offerings. An example is the RPP20-S-D, which provides 20W of power with 2:1 input voltage range, single or dual output options, 2 kVDC isolation, built-in EMC filter and operates at efficiencies of up to 90% to offer an ambient operating temperature range from -45° up to +100°C without derating, in a case size of only 2 x 1.2 inches.

Board-Level Power Supplies

Not to be left out, rugged board-level power supplies provide system designers with a complete modular solution for slot-card military systems. An example is Aitech Defense Systems' P230 (Figure 4), a rugged, 3U, conduction-cooled, high-efficiency power supply that operates over a continuous input voltage range of 18 VDC to 36 VDC. The P230 provides four industry-standard isolated voltage levels of +3.3V, +5V, +12V and -12V at up to 10A, 20A, 9A and 1 A respectively, or a combined total power capacity output of up to 150W, with an efficiency of better than 85%. This makes the P230 suited for use in a number of small form factor, robust and rugged VME-, CompactPCI- and VPX-based subsystems for high-reliability, embedded computing applications.

The DC to DC converters are equipped with internal thermal shutdown circuitry to protect them from damage due to potential system overheating. Mechanical and thermal construction includes a protective aluminum housing for mechanical ruggedization, EMI/RFI shielding and thermal conduction of heat to the system enclosure. A chemical conversion coating provides maximum heat transfer and corrosion resistance on thermal interface surfaces. Wedge-locks hold the P230 in place and clamp it to the enclosure's thermal rails for optimum heat transfer, and extractors are included on the P230's top panel for easy removal. Military-rated

models operate at temperatures from -55° to +85°C (at the heat sink) when running at 85% of maximum rated power, and up to +75°C when operating at full rated power. ▮▮

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Figure 4

The P230 is a rugged, 3U, conduction-cooled, high- efficiency power supply that operates over a continuous input voltage range of 18 VDC to 36 VDC and total power capacity output of up to 150W. The unit is suited for use in rugged VME-, CompactPCI- and VPX-based subsystems.

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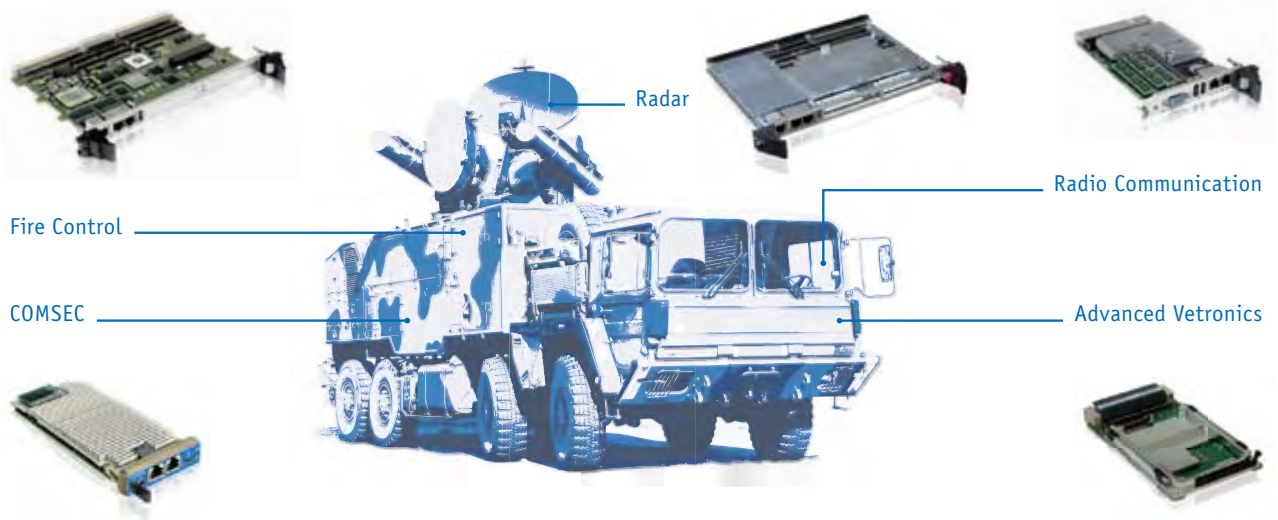

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Special Feature

Distributed Power in Military Systems

SSPC Advancements Enhance Vehicle Power System Designs

Vehicle and power system manufacturers are pressed to deliver huge increases in electric power. New SSPC technology reduces weight and power losses, and increases vehicle adaptability.

Steve Rood Goldman, Marketing Manager
Michael Glass, Principle Marketing Engineer
Data Device Corp.

Developers of electrical power management and distribution systems for current and future force ground vehicles face several challenges. As new applications increase the number and size of electrical loads, vehicle power demand is exceeding generation and storage capability. These limitations impact vehicle operating range and mission effectiveness. Additionally, an overburdened power distribution system results in faults and reduced reliability. Electrical architectures also require flexibility to accommodate system components that are unique to the vehicle.

These challenges are being addressed using smart power management and distribution methods enabled by the latest generation of solid-state power controllers (SSPCs). In addition to providing protection for cable harnesses and loads, smart SSPCs are capable of accurately monitoring power quality and load conditions, permitting the system controller to react to power fluctuations and faults automatically and in real time. SSPCs also provide wide programmability, which allows power management systems to adapt to system reconfiguration and future equipment insertion.

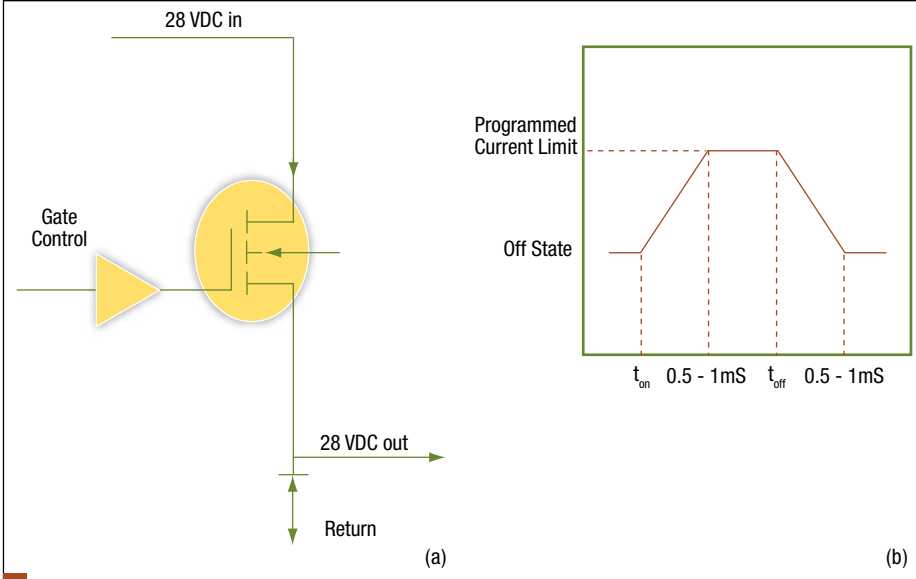

Figure 1

A MOSFET Gate Control is shown on the left (a). Controlled turn-on and turn-off time (b on the right) prevents surges and kickbacks, eliminating EMI and sympathetic tripping.

Migration to Solid-State

Driven by a combination of factors, electrical power distribution and control in ground vehicles has evolved rapidly in recent years. Further, it is anticipated that the need for power technology advancements will continue. The present and projected future needs for the U.S. Army and U.S. Marines are driving technology developments and deployments in applications, hardware (such as C4ISR), networking, computing, power electronics and power distribution technologies. Systems that once relied on traditional electromechanical power distribution architectures and equipment are migrating from purely discrete electrical, mechanical and man-

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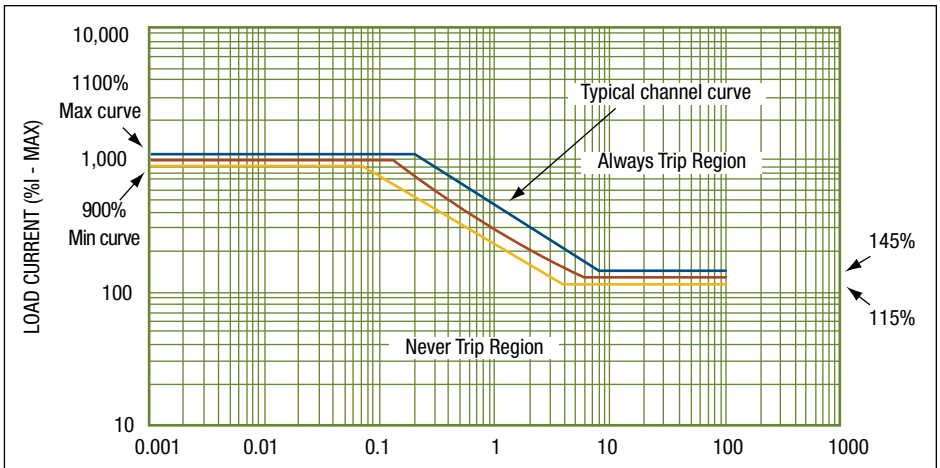

Figure 2

I²T curves mimic the Time-Current Curves of mechanical breakers. The curves are factory settable to application requirements.

ual control to network-based, solid-state power distribution and control systems.

Solid-state power controller (SSPC) designs use microprocessors to manage the operation of high-efficiency switching MOSFETs. Their basic operation is to perform on/off control of the load and to protect wiring harnesses and loads from short circuit and overload conditions. SSPCs eliminate the EMI associated with the rapid changes in currents during on/off transitions of mechanical breakers, switches and relays. As shown in Figure 1, MOSFET gate drives can be designed to control the rise and fall time of channel currents. In comparison to electromechanical switching and protection, SSPC short circuit and overload protection is precise (typically ± 5 percent) and reliable. Additional protection is provided by series flyback diodes on the load side of each MOSFET to prevent inductive voltage transients from damaging the SSPC when the MOSFET deactivates or there's an abrupt open-circuit fault in the wiring or load.

Figure 2 shows the I²T curve implemented by the SSPC to mimic the time-current behavior of a thermal mechanical breaker, including the high instant trip value needed to accommodate capacitive loads. A well-designed I²T circuit will deliver ten or more times the channel's maximum steady state current rating before the instant trip mechanism opens the MOSFET switch to protect the load and itself. The value of the maximum steady state operating current for a given SSPC channel is programmed by the user as a percentage of the maximum current allowed for the given channel. Further, this type of "electronic thermal memory" enables SSPCs to mimic the desirable characteristics of thermal mechanical breakers. If an overload or short circuit fault is followed by a subsequent event, the second trip will occur more quickly than the first, protecting against heat accumulation in the wiring.

More Reliable Operation

SSPCs eliminate the deleterious effects of unpredictable contact closure time and contact chatter characteristic of thermal, high-performance thermal (temperature compensating, in other words), magnetic, thermal magnetic, hydraulic magnetic and remote controlled circuit breakers. Opening and closing circuits electronically, whether for on/off control or for load and wire protection purposes, eliminates the need for moving parts such as solenoid cores, springs, latches, hinges, bi-metallic strips and contacts. This eliminates components whose normal operation includes compression, friction, heat and arcing.

Electromagnetic arcing is a fundamental characteristic of the circuit breaker contact make/break cycle. The greater the current level, the larger the arcs, resulting in

pit formations and carbon buildup. A common specification for mechanical breakers is the manufacturer's anticipated number of on/off cycles. Breaker "life" ("cycles" or "endurance") is adjusted according to percentages of the device's maximum rating or specified interrupt currents.

While there will always be uses for mechanical breakers, reliability is paramount for applications where lives and mission outcomes are directly at stake. Reliability predictions favor solid-state power controllers, especially those designed, qualified and tested in accordance with military standards. The inherent reliability advantage of SSPCs over mechanical devices becomes more pronounced in the harsh operating environment of military ground vehicles.

The Data Device Corporation EDGE Power Controller card, shown in Figure 3, is an example of a multichannel SSPC. The card, which was designed to efficiently support high load density power distribution systems, is network-enabled, and provides accurate load quality monitoring.

Network Control, Monitoring and Alarms

SSPCs provide network connectivity for programming, remote control of the loads, and monitoring of load status and power quality. Most vehicle power systems use SAE J1939-compatible CANbus as the network interface to the system controller. Interface communications over Ethernet, RS-232/422/485, or MIL-STD-1553 are other common choices. Traditional distribution systems using mechanical breakers and switches would use a manually operated control panel to control vehicle loads. Load shedding, to save electrical energy or extend mission radius, required intervention by the crew to control individual loads. With SSPC-enabled distribution systems, multiple channels or channel groups can be designated for autonomous control according to mission profiles and programmed into the system, thereby offloading work performed in real time by the crew.

Through their proximity to the system loads, SSPCs are able to monitor power quality parameters such as current, voltage and load temperature. These values can be continuously reported via network to the system controller or alternatively, the SSPC can generate an autonomous alarm to warn the system controller of out-of-bounds load parameters. The SSPC also continuously reports BIT results to the system controller indicating the proper operation of all channels.

SSPC load monitoring and network connectivity enable enhanced power system diagnostics and prognostics, which ensure mission readiness and timely maintenance, respectively. Since critical load parameters are monitored continuously, the system controller can diagnose the system state and respond to failure conditions in real time. The system controller can also log steady state and transition data to produce load signatures. This information is then made available at the depot to apply a condition-based maintenance (CbM) approach. When suitable algorithms to analyze logged load signatures are added to the mix, predictive maintenance (PdM) becomes realizable.

Mechanical, Power and Architectural Advantages

In vehicles using traditional distribution architectures, power is bussed from the electric generation and storage equipment to a main power distribution panel and, perhaps, sub-panels. When the panels are not readily accessible to the crew, switch loops, routed to the cabin, may be necessary for breaker resetting and on/off control. The switch loop conductors will be sized in accordance with the full load currents plus an overhead rating likely in the range of 30 to 50 percent. This architecture is functional but mechanically complex, heavy with wiring weight, and lacks sufficient flexibility for rapid changes and upgrades.

SSPCs are available in a variety of form factors ranging from Point of Load (PoL) modules to multichannel circuit cards, which may be open or enclosed, including ingress protection up to IP-67 or IP-68. System designers now have many options for location, mounting, environmental protection and cooling of power control devices. Multichannel SSPCs are typically used for high-density load centers, which may be centrally located

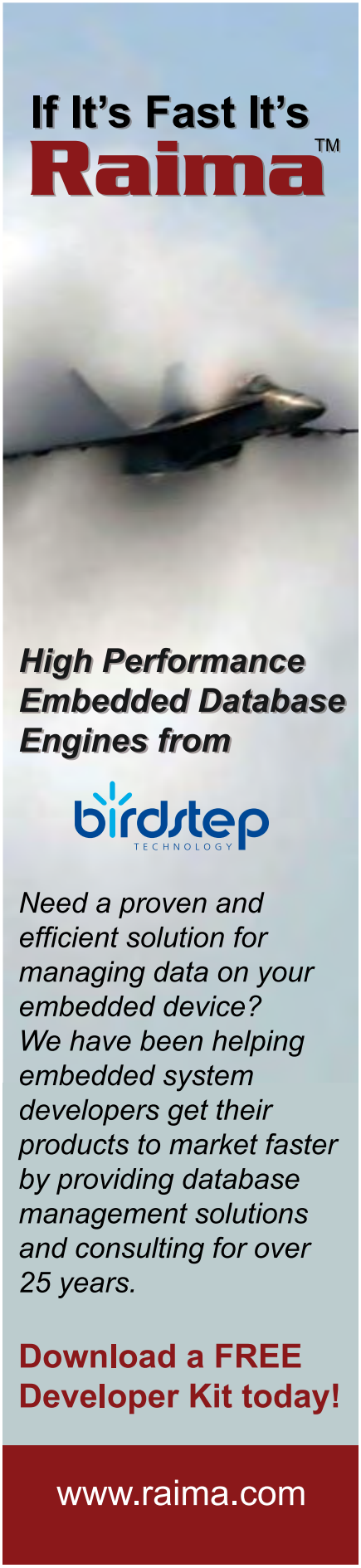

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Figure 3
EDGE Power Controllers deliver 16 programmable channels.

or distributed throughout the vehicle as multiple power distribution units (PDUs). As the name implies, PoL modules are located at the load and are useful for higher current requirements or when the load is in a remote location such as a turret. Newer power distribution architectures typically use a semi-distributed architecture, which employs a combination of modules and multichannel SSPCs.

Modern SSPC implementations, which use extremely low RDS-ON MOSFETs, can be 50 percent or more energy efficient than thermal circuit breakers. As an example, a fully loaded 16-channel SSPC board from Data Device Corporation will dissipate less than 2 watts per 25-amp channel and can operate within a conduction-cooled enclosure. As with weight and power savings, SSPC technology enables direct volumetric savings as the result of reduced component sizes, wiring and equipment for heat transfer. However, the greatest savings are afforded by the design options made available.

Innovation Continues

The military ground vehicle requirement for solid-state power controllers originated two decades ago. This was in response to the EMI, reliability, and remote control challenges of the time. The efficacy of the technology, along with its battle-proven use on the M1A2 Abrams and Bradley platforms, has ensured the adoption of SSPC technology for smart power management in equipment upgrades and for new vehicle programs.

Historically, there was a significant cost premium for SSPC technology and the perception of prohibitive cost still exists today. However, two significant factors have contributed to a sharp reduction in SSPC cost. First are incremental improvements in SSPC design and implementation, which have eliminated expensive components and reduced assembly cost. Next, and most significant, is the adoption of SSPC for tactical wheeled vehicle platforms. These high-volume applications have completely changed the game, leading to greater economies of scale, which have driven down the impact of SSPC on PDU cost to within 25 percent of mechanical implementations. ▮▮

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Steve Butler, Vice President of Engineering
VPT

Military electronics continue to push the performance envelope in all directions. With each new system design come the same challenges: more processing power, tighter specs and shorter development time. Continual advances in system performance often require similar advances in the power system. VME architecture is common in many military applications. It's also an architecture that is suited for mixing standard or custom circuit cards. Off-the-shelf VME power supplies are available, but often more customized solutions are required to get the right level of performance and to avoid compromises in features.

There is usually neither schedule or budget for a full blown custom power supply development effort. An optimized VME power supply solution can almost always be built from standard off-the-shelf high-reliability or COTS DC-DC converter modules. This type of solution can be rapidly developed at minimal cost since most of the design effort is internal to the modules. Most input power bus requirements such as MIL-STD-704 and MIL-STD-1275 can be met by combining standard DC-DC converter, EMI filter and transient protection modules, with custom interface and control circuitry. This modular approach can be made to fit almost any application, achieving the same end performance as a custom power supply with much lower risk.

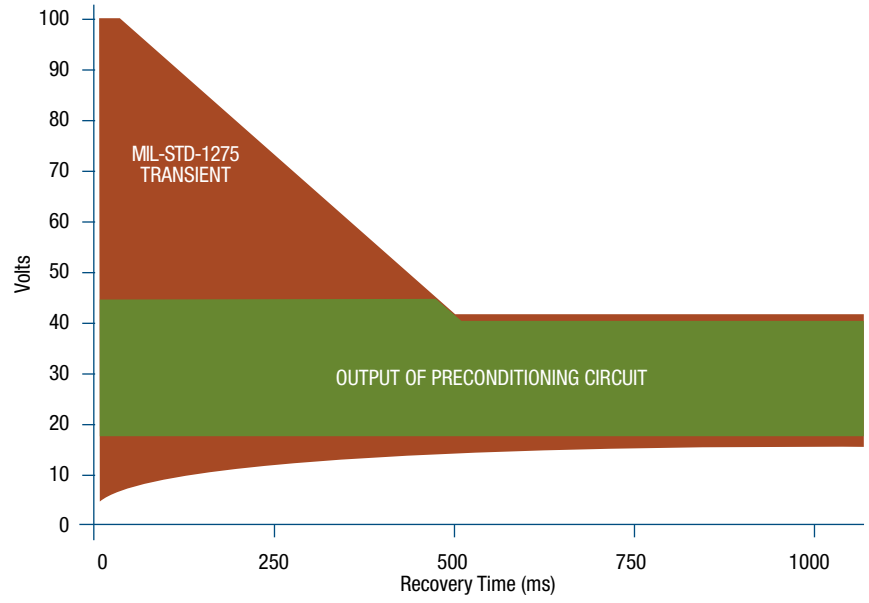

Figure 1

Shown here is a worst case envelope of the input voltage transients from MIL-STD-1275D along with the output envelope of a preconditioning circuit. Voltages above the range of the DC-DC converter are limited by the series pass MOSFET, while inputs below the input range are boosted.

For military, avionics and other high-reliability applications, it is best to choose DC-DC converters from a manufacturer who focuses on these applications. Look for high-quality standards such as J-STD-001 and IPC-

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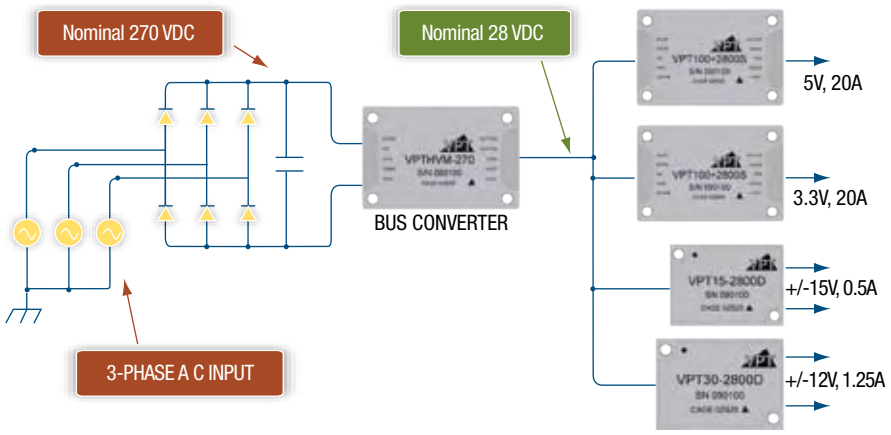

Figure 2

AC input power supply constructed with 28V input DC-DC converters.

A-610 class 3, or for the most critical applications, MIL-PRF-38534 class H or K. Products should have a wide temperature range, -55° to 100°C or more, a wide input voltage range and rugged mechanical construction. The environmental qualification should be to MIL-STD levels.

Meeting Output Voltage Requirements

The 28V DC power bus is common in military applications and there are several manufacturers who offer a wide variety of isolated DC-DC converters and accessory modules. The standard VME voltages such as 5V, 3.3V and ±12V are readily available, but also voltages down to 0.8V and up to 28V and everything in between, including single, dual and triple output configurations. Some models will have output voltage trim capability to achieve nonstandard voltages, and some can be paralleled for higher output power. Other common features include primary or secondary referenced inhibit (on/off) control as well as a frequency synchronization input.

Isolated converters can be configured in various ways to meet different output requirements. Outputs can be connected as positive or negative simply by reversing the output pins, or can be stacked to obtain higher output voltages. There are two options for low output voltages such as 3.3V and below. The first is an isolated converter that converts 28V directly to a low voltage output. The second is to use the isolated converter to provide 5V, then regulate the 5V down to a lower voltage with a non-isolated point-of load or POL converter. POL converters, recently available in high-reliability versions, are op-

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MIL-STD 28V Input Requirements

While there are many DC-DC converters available for the 28V DC power bus, a robust system design is often not as simple as it sounds. The actual power requirements for most VME applications is usually defined by a government standard such as MIL-STD-704 for aircraft or MIL-STD-1275 for military vehicles. The power bus can vary widely and will include voltage ripple, surges and transients. Some variation can be accommodated directly by the DC-DC converter, but some of it is quite severe and must be clamped or filtered externally to the DC-DC converter. There is usually also an EMI requirement such as MIL-STD-461 governing the conducted emissions and conducted susceptibility of the power supply. Proper selection of the DC-DC converter, EMI filter, and possibly input conditioning module or external circuitry will ensure compliance with the complete input requirements.

There are several versions of MIL-STD-704 still in use, governing airborne power systems. The main differences between MIL-STD-704A and later revisions is a steady state voltage of 15V during emergency battery only and engine start operating conditions, and a transient surge voltage of 80V. Compliance to MIL-STD-704A usually takes one of two forms. The first is a DC-DC converter with a 15V to 50V continuous input range and 80V transient capability. The transient rating should be at least 1 second to encompass the full decay of the transient. The second is a DC-DC converter with a 16V to 40V continuous input range preceded by transient protection circuitry or a dedicated preconditioning module. Compliance to later versions of MIL-STD-704 can usually be obtained with the DC-DC standalone, assuming it has the standard 16V to 40V continuous input range and 50V transient capability.

For military vehicles, MIL-STD-1275D is somewhat more difficult to meet. It includes a 6V engine starting disturbance, ±250V spikes and a 100V surge. Most DC-DC converters do not have that wide of an input voltage range. Instead, transient protection circuitry or a dedicated preconditioning module typically enables compliance. In either case, a wide input range on the DC-DC converter, such as 16V to 40V, simplifies the design.

Accommodating Higher Voltages

High voltage power buses, such as 270 VDC or 115 VAC, can be dealt with in several ways. At the card or box level, it can be advantageous to first do a bulk conversion to 28 VDC, then use individual DC-DC converters to regulate the individual low power outputs. This approach works with both DC and AC inputs and can often result in a simpler overall system design, not only by minimizing the amount of high voltage wiring that must be accommodated, but also by taking advantage of the wide variety of 28V input products available. There is a

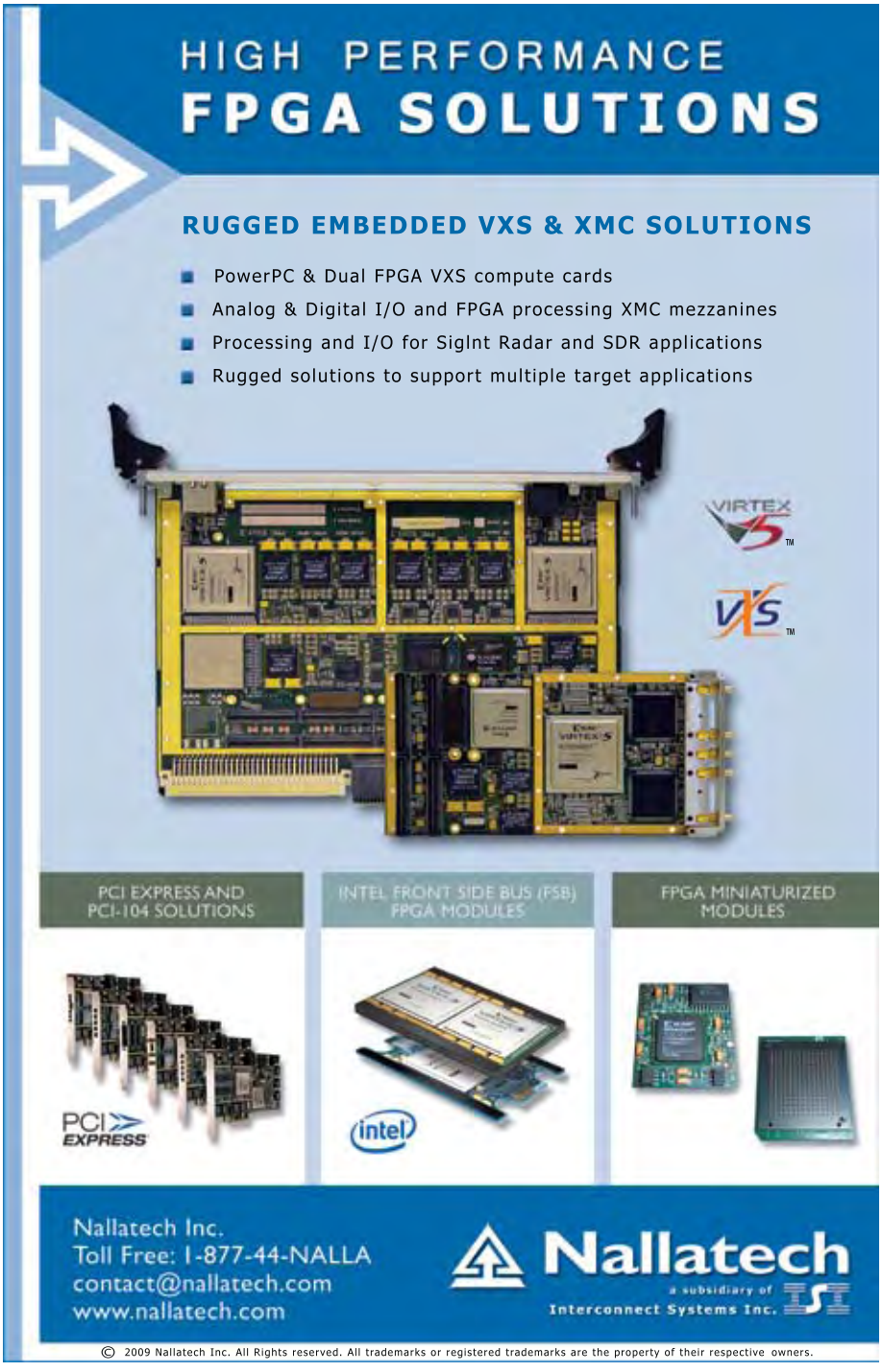

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Figure 3

VME power supply built from off-the-shelf DC-DC converter modules.

much wider range of off-the-shelf DC-DC converters for 28V input than for 270V input, including lower power levels, more output voltages, multiple output configurations such as dual and triple outputs, and higher reliability levels. There are also more manufacturers, and products with better performance and more extensive feature sets.

A typical aircraft power system design is shown in Figure 2. The input shown is a 3-phase wye-connected grounded-neutral system typical of MIL-STD-704 with a nominal voltage of 115VAC and a nominal frequency of 400 Hz. A 3-phase six-diode rectifier and bulk capacitor is used to convert the 3-phase AC to a nominal 270 VDC. A bus converter is used to convert the 270 VDC into a 28V power bus, which can then be converted to lower voltages with standard 28V input DC-DC converters. This bus converter can be implemented with a standard 270V input to 28V output DC-DC converter or it can use a dedicated bus converter module. The dedicated bus converter, newly available for 270V input high-reliability applications, takes advantage of the fact that it is powering downstream DC-DC converters. Its design is optimized with higher efficiency and higher power density than a typical DC-DC converter. The power system can maintain high overall efficiency, and by capitalizing on the flexibility of the 28V input converters, possibly smaller size.

With proper system design, standard 28V input DC-DC converters can satisfy a variety of input power bus requirements. The DC-DC converters, EMI filters and accessory modules are readily mounted to a PCB and packaged in a conduction- or convection-cooled housing. Power modules with a temperature rating of -55° to +100°C can easily meet a final power supply specification of -55° to +85°C rail temperature. Additional discrete circuitry can be added for enable signals, input and output monitoring, over temperature protection, status LEDs, and even output sequencing and timing. The VPTVME-28, shown in Figure 3, is a highly configurable VME power supply built from VPT Series COTS modules. It can accommodate various input and output requirements. The output voltages and power levels, as well as the number of outputs and I/O signals, can be configured for almost any application. ▮▮

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Meeting MIL-STD-810 for Batteries Presents Challenges

Designing battery systems to meet MIL-STD-810 specs is no easy task. Hurdles include meeting immersion, shock and vibration, high temperature performance and low temperature performance requirements.

Jeffrey VanZwol, Marketing Director
Micro Power Electronics

The military standard MIL-STD-810, "Department of Defense Test Method Standard for Environmental Engineering Considerations and Laboratory Tests" specifies the equipment's environmental design and test limits that it will experience throughout its service life, and establishes test methods used to measure the effects of the environment on the equipment. MIL-STD-810 testing addresses a broad range of environmental conditions that include: low pressure for altitude testing, exposure to high and low temperatures, temperature shock (both operating and storage), rain (including wind blown and freezing rain), humidity, fungus, salt fog for rust testing, sand and dust exposure, leakage, acceleration, shock and vibration.

MIL-STD-810 is typically specified for military products, but commercial products will commonly reference aspects of MIL-STD-810 as well. Custom batteries can be built to meet all the requirements, but the more challenging requirements for batteries include immersion, shock and vibration, high temperature performance and low temperature performance.

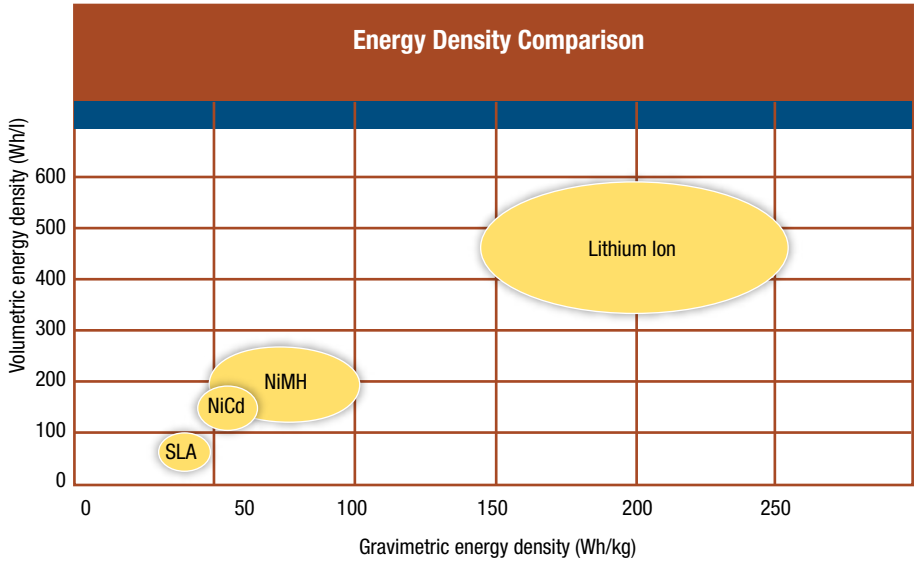

Figure 1

Li-ion provides the best volumetric and gravimetric energy performance.

Advances in battery technology have led to increased energy densities over the last few decades. More reactive materials have been employed in order to achieve these advances, and active safety circuits are now required to ensure that certain battery chemistries are kept in a stable condition. Common battery chemistries for military batteries, and their associated characteristics, are:

Rechargeable Sealed Lead Acid (SLA) – SLA Cells utilize concentrated sulfuric acid electrolyte and toxic heavy metal electrodes, and provide a nominal voltage of 1.5V. SLA Cells are cost-effective, but are bulky and heavy for most portable applications. SLA Cells have a wide operating temperature, ranging from -40° to +70°C. Note that SLA batteries have a liquid electrolyte,

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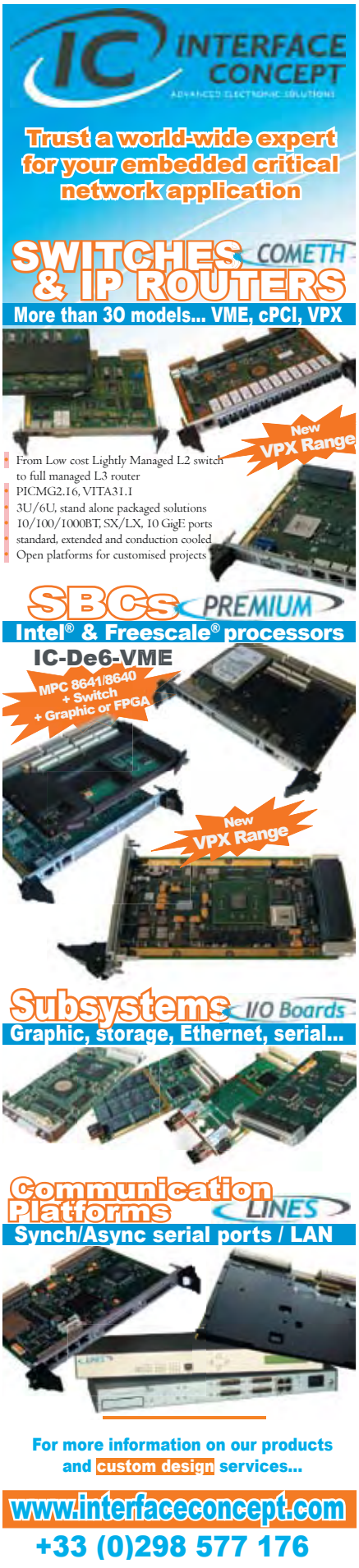

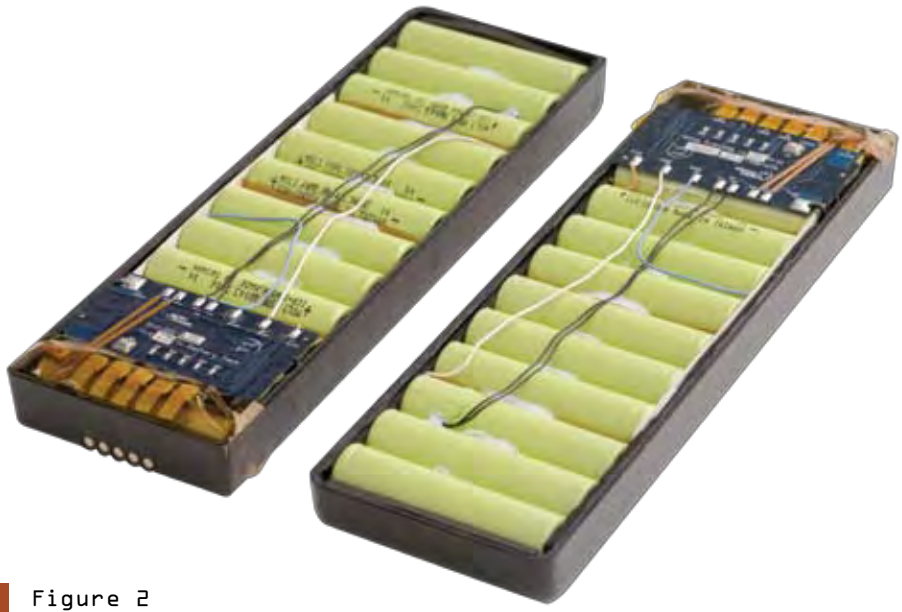

Figure 2

A battery pack consists of cells, printed circuit board, external contacts and enclosure.

so a cracked cell can leak toxic or dangerous fluids.

Rechargeable Nickel Metal Hydride (NiMH) – NiMH Cells include a nominal voltage of 1.25V, 500 duty cycles per lifetime, less than 0.5C optimal load current, an average energy density of 100 Wh/kg, less than four-hour charge time, typical discharge rate of approximately 30 percent per month when in storage, and a rigid form factor. NiMH Cells operate effectively between -20° and +60°C. NiMH has a solid solution electrolyte, so leakage due to shock is not an issue.

Rechargeable Lithium Ion (Li-ion) – Li-ion cell characteristics include a nominal voltage of 3.6V, 1000 duty cycles per lifetime, less than a 4C rate load current, an average energy density of 160 Wh/kg, a less-than-four-hour charge time, and a typical discharge rate of approximately 1-3 percent per month when in storage. Li-ion cells operate effectively between -20° and +60°C. Li-ion has a solid solution electrolyte, so leakage due to shock is not an issue. Several varieties of Li-ion are available: the older Cobalt Oxide and the newer mixed metal oxide (Nickel, Manganese and Cobalt), as well as the high rate varieties such as Lithium Iron Phosphate and Manganese Spinel.

Primary Lithium – Disposable lithium chemistries include Lithium Thionyl Chloride ($Li/SOCl_2$), Lithium Sulphur Dioxide (Li/SO_2) and Lithium Manganese Dioxide (Li/MnO_2). Primary Lithium cells provide a voltage of 3.6V, less than 5C optimal load current, an average energy density of 160 Wh/kg, and a negligible self-discharge rate supports years of storage. The operating temperature for Lithium primary cells ranges from -40° to +80°C.

Of all the chemistries listed above, Li-ion requires the greatest degree of protection and monitoring of the cell performance. However, as shown in Figure 1, Li-ion offers the highest gravimetric and volumetric performance for portable battery power. Many portable devices using the older chemistries have migrated to Li-ion in recent years.

Meanwhile, Figure 2 shows the main components of a typical Li-ion battery pack. They're comprised of the cells, the Printed Circuit Board Assembly (PCA) providing the intelligence of the system, a custom plastic enclosure, external contacts providing a physical electrical interface with the host device, and possibly insulation or internal frame/carrier used to absorb external shock.

Immersion and Shock

Most ruggedized equipment is specified to withstand 30 minutes of immer-

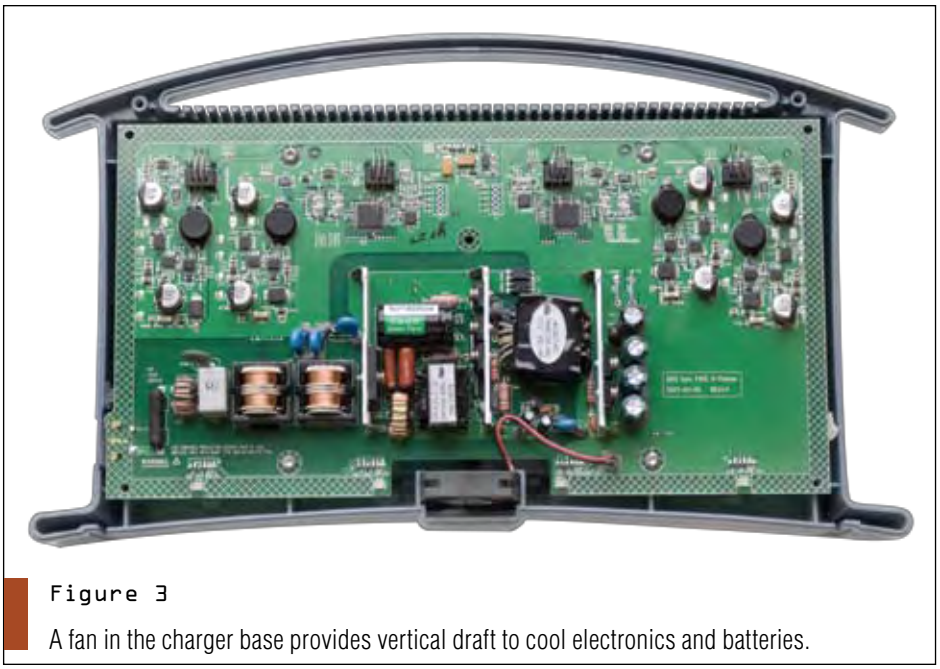

Figure 3

A fan in the charger base provides vertical draft to cool electronics and batteries.

sion in three meters of water. To ensure a watertight seal between the two halves of the plastic pack enclosure, ultrasonic welding is recommended to join plastic case surfaces. Unlike alternative methods of sealing enclosures such as snap-tight seals, watertight seals are possible. Ultrasonic welding ensures the enclosure is resistant to shock or impact, as the resultant joint strength can match the strength of the welded material. A material such as Polycarbonate-Siloxane copolymer offers good notched impact at lower temperatures, is flame retardant, and is ductile at lower temperatures for improved impact properties. This allows some of the impact energy to be absorbed by the enclosure and not transmitted to the cells and PCA within the enclosure.

If the battery enclosure design does not accommodate ultrasonic welding due to wall thickness or inability to create an acceptable weld joint, then adhesives can be used to seal the pack. Materials based on semi-crystalline polyamides (Nylon) with a 30-40% glass filler offer the following characteristics: non-conductive, impact resistant from shock and vibration, high levels of stiffness and strength, good dimensional stability, little warpage, low water absorption, minimal subsequent change in property values through any absorption of moisture, and good chemical resistance. Hence, a 30-40% glass-filled semi-crystalline co-polymer resin can be challenging to weld due to the high glass content. Given the challenges with ultrasonic welding this material, and the difficulty with creating a water tight and impact resistant weld joint, gluing is typically recommended.

High Temperature Performance

Upper temperature extremes provide challenges. Primary Lithium batteries can easily discharge in temperatures up to 80°C. Since they are not recharged, one does not have to worry about overheating during charge. Most Li-ion batteries can be charged and discharged up to 60°C, so thermal monitoring and heat dissipation within the battery pack is critical for high temperature operation. If a pack is to be used in high temperature environments, then specific design principles should be applied to that pack design.

When current is introduced (charged) or removed (discharged) from a battery, there is an associated temperature increase. The pack circuitry should use a thermal sensor to disconnect the cells at a specified temperature. This upper limit is programmable, so battery packs can be customized for hotter operating environments. This eliminates thermal runaway and overheating.

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Placement of circuitry within the pack is critical. The circuit board may have heat-generating components, such as a Field Effect Transistor (FET), and improper placement may result in the FET heating the cells. The application of heat to select cells within a pack erodes the longevity and safety of that pack.

Consideration is needed for the position of the pack in relation to any heat generating components, such as high-performance processors, operating within the host device. Uneven heating may cause the cells to behave differently from their companions in the pack, thus shortening the pack life and compromising safety.

Performance During Charge Cycle

The final consideration is managing pack performance during the charge cycle. Imagine a vehicle mount charger sitting in the transport bay of a Hummer in the desert. A battery could be dropped into the charging bay directly after use—already warm from discharge—and the charger starts applying charge current to the battery, which further heats the battery. Even the charger must be designed to accommodate these high temperature conditions. Variable current charging includes the active monitoring of the cell temperature during the charge cycle. Microcontrollers, embedded with the battery charger, allow the charger to monitor all electrical and environmental aspects of the cells in the pack. These microcontrollers can administer variable charge currents based on available power, cell temperature conditions, and maximum allowable charge current.

Cell temperature can be monitored in real time via the communication bus or thermistor pin, and charge current can be regulated until the battery approaches its high temperature limit. If the cells hit their high temperature limit, the charger can be designed to reduce or suspend the charge current. If further prevention of battery heating is required, a fan can be built into the base of the charger to evacuate heat generated by the charger electronics and batteries. Figure 3 shows a battery charger with a fan in the base that provides vertical draft to cool electronics and batteries. If needed, this vertical draft can be directed into the base of each of the battery charger cups.

Low Temperature Performance

Environmental requirements may specify extended operating temperatures down to -40°C. Rechargeable Li-ion comfortably operates at -20° to + 60°C. When challenged with this requirement, there are several design options to maximize electrical output at low temperatures. Li-ion comes in several varieties. The newer mixed metal oxide (Nickel, Manganese and Cobalt) and Lithium Iron Phosphate perform better than Cobalt Oxide at temperatures down to -30°C

Cell and chemistry selection is critical. If the battery is mounted in a vehicle and has access to vehicular power, a heater embedded with the pack can warms cells prior to use. The embedded heater can be powered from the main cells within the pack when the temperature drops below -20°C, or from an external source like vehicle power. Embedded heaters can heat cells, reduce electrolyte viscosity, and reduce voltage droop or delay prior to use.

The host device can be designed to pulse discharge cells prior to primary discharge; this self-warms the cells via the I^2R heating effect. This technique is applicable when the duty cycle is predictable and cyclical (periodic transmission of telemetry report), rather than a random or haphazard duty cycle (handheld radio transmission). Super-capacitors embedded within the pack can provide immediate energy to the host device while cells warm up to their optimal electrical performance.

Lastly, if these design techniques cannot extend operation of a rechargeable Li-ion pack down to the low temperature requirement, one should again consider utilizing Lithium primary cells to power the device. When assessing Lithium primary formulations, Li/MnO_2 provides less voltage droop than Li/SO_2 and $Li/SOCl_2$ in cold temperatures. ■■

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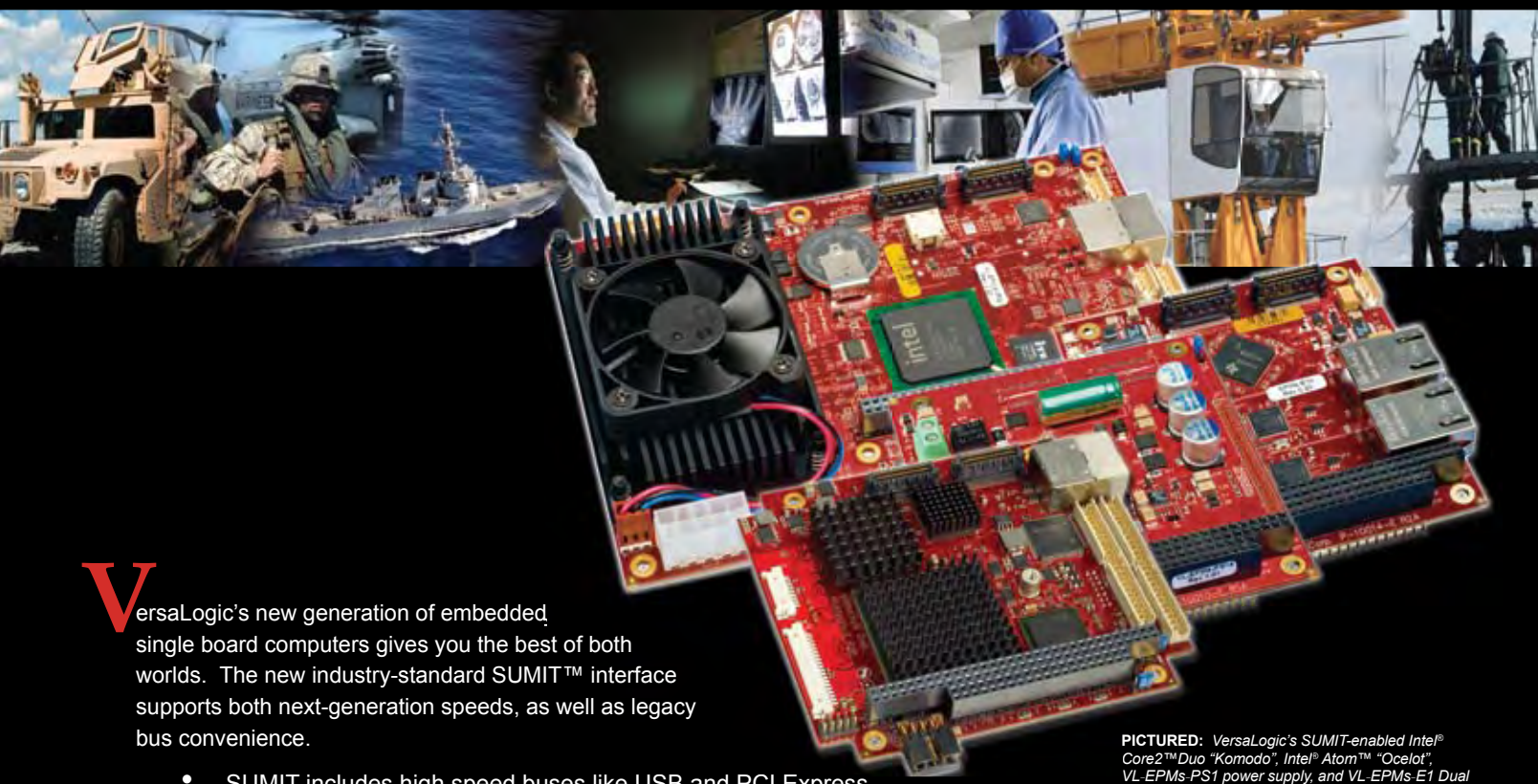

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Expansion Bus	PC/104 ISA Bus			✓						✓	✓	✓	✓	✓	✓
	PCI-104 PCI Bus	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		✓
	PCIe/104 Express Bus	✓	✓												
CPU and BIOS	CPU Max Clock Rate (MHz)	1860	1200	1400	1400	1400	1400	1400	1400	650	650	650	650	500	500
	Intel SpeedStep Technology	✓	✓	✓	✓	✓	✓	✓	✓						
	ACPI Power Management	3.0	3.0	2.0	2.0	2.0	2.0	2.0	2.0	1.0	1.0	1.0	1.0	2.0	2.0
	Max Onboard DRAM (MB)	2GB	2GB	512	1GB	512	1GB	1GB	1GB	256	256	256	256	256	256
	RTD Enhanced Flash BIOS	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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	Gigabit Ethernet	1	1												
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	Parallel Port				✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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SW	ROM-DOS Installed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
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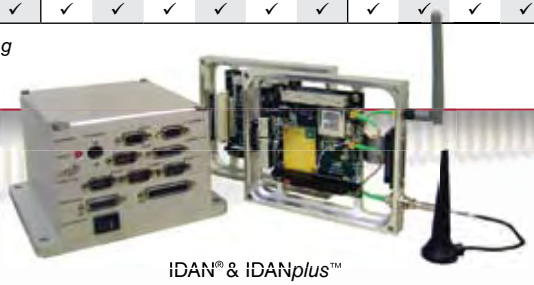

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	DMA or PCI Bus Master	✓	✓	✓	✓	✓	✓	✓	✓				✓	✓	✓	✓
	McBSP Serial Ports	✓	✓			✓	✓	✓	✓							
Analog Input	Single-Ended Inputs	16	16	16	16	16	16	16	16							
	Differential Inputs	8	8	8	8	8	8	8	8							
	Max Throughput (KHz)	1250	1250	500	100	1250	500	500	500							
	Resolution (bits)	12	12	12	16	12	16	16	16							
	Input Ranges/Gains	3/7	3/7	3/4	1/4	3/6	3/3	3/3	3/3							
	Autonomous Calibration	✓	✓													
	Data Marker Inputs	3	3	3		3										
Conversions	Channel-Gain Table	1K	1K	1K	1K	1K	1K	1K	1K							
	Scan/Burst/Multi-Burst	✓	✓	✓	✓	✓	✓	✓	✓							
	A/D FIFO Buffer	8K	8K	8K	8K	8K	8K	8K	8K							
	Sample Counter	✓	✓	✓	✓	✓	✓	✓	✓							
	SyncBus	✓	✓			✓	✓	✓	✓							
Digital I/O	Total Digital I/O	16	16	16	16	16	16	16	16	48	18/9	64	48	48	48	48
	Bit Programmable I/O	8	8	8	8	8	8	8	8	24	6/0		48	48	48	✓†
	Advanced Interrupts	2	2	2	2	2	2	2	2	2			2	2	2	✓†
	Input FIFO Buffer	8K	8K	8K	8K	8K	8K	8K	8K							
	Versatile Memory Buffer												4M	4M	4M	8MB
	Opto-Isolated Inputs											48				
	Opto-Isolated Outputs											16				
	User Timer/Counters	3	3	2	2	3	3	3	3	3	3		10	10	10	6
	External Trigger	✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓†
	Incr. Encoders/PWMs										3/9		4/8	4/8	4/8	✓†
Analog Out	Analog Outputs	2	2	2	2	2	2	2	2							
	Max Throughput (KHz)	200	200	200	100	200	100	100	100							
	Resolution (bits)	12	12	12	16	12	16	16	16							
	Output Ranges	4	4	3	1	4	5	5	5							
	D/A FIFO Buffer	8K	8K			8K	8K	8K	8K							

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Tech Recon

Safety-Critical Standards

Data Distribution Service and MILS: A Powerful Combination

By building on a foundation of DDS, engineers can more easily migrate to a MILS architecture with little effort. DDS provides a standards-based messaging middleware that serves as a "MILS API."

Joseph M. Schlesselman
Director of Market Development,
Aerospace and Defense, Real-Time Innovations

There are some unique benefits to using Data Distribution Service (DDS) publish-subscribe middleware within the Multiple Independent Levels of Security (MILS) architecture. Both MILS and DDS help achieve the goal of reducing the enormous time and cost associated with certification and accreditation (C&A) of safe and secure software. Although many parts of the Aerospace and Defense industry are already quite familiar with DDS for real-time messaging, the combination of MILS and DDS is relatively new.

MILS is a high-assurance security architecture. Its basic precept is that a modular approach to security will make software both more secure and also easier to certify. Briefly, the MILS architecture for safe and secure computing consists of several distinct components. The first component is a very small, trusted, high-assurance Separation Kernel. The Separation Kernel only has a few jobs, but it must do them without fail. It provides scheduling, enforces data separation, and controls information flow between partitions. Only this small Separation Kernel runs in a processor's unrestricted privileged mode. All other code runs in secure partitions that are controlled by the Separation Kernel.

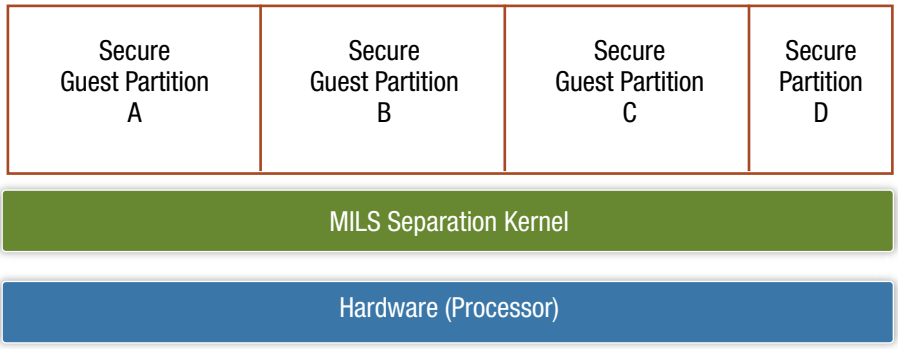

Figure 1

The MILS architecture consists of hardware, a separation kernel and secure partitions. Partitions can contain guest operating systems, middleware such as network stacks, file system, device drivers and running applications.

The key feature of a MILS Separation Kernel is that it provides provably secure partitions for middleware and applications. When implemented correctly, it completely isolates any failure or vulnerability to a single partition. MILS also guarantees that no covert communications channels are used between secure partitions. In the MILS sense, middleware consists of nearly everything other than the Separation Kernel that an operating system and application need to work—including things like the file system, device drivers and traditional network middleware, such as DDS.

DDS: Middleware for Distributed Apps

DDS is a standards-based data-distribution and messaging middleware for distributed, real-time applications. It is usually associated with high-performance, mission-critical networks such as military combat systems, air traffic management, power plant control systems, and financial securities trading. The DDS specification is managed by the Object Management Group (OMG), an industry

standards organization. DDS has been mandated for use by the U.S. DoD for several years.

DDS uses a publish-subscribe communications model. It allows distributed processes to share data without concern for the actual physical location, programming language, or architecture of their peers. In a MILS system, DDS peers can be other applications running in the same secure partition, across different partitions, on different processor cores, or even on different machines.

A fundamental benefit of DDS is simplifying otherwise complex distributed programming. The publish-subscribe model is used for sending and receiving data, events and commands among network nodes. Nodes that produce information (called publishers) create topics (flight plans, boiler temperatures, locations) and publish samples. DDS then delivers the sample to all authorized subscribers that declare an interest in that topic.

The job of DDS is to handle data transfer chores: message addressing, data marshaling and demarshalling (also called serialization and deserialization), delivery, flow control, retries, etc. Any application can be a publisher, subscriber, or both simultaneously. DDS provides many Quality of Service (QoS) policies specifically geared for real-time (deterministic) distributed systems. This is its most distinguishing characteristic and is what makes DDS unique among publish-subscribe middleware technologies.

DDS and MILS Combined

The reason publish-subscribe in general—and DDS in particular—became popular is that it allows loose coupling of software components. This loose coupling is in both the physical sense (publishers and subscribers can be located on the same device or span across multiple devices) and in the logical sense.

Tight coupling refers to making strong assumptions about the interface of interconnected components. Changes in one component's interface typically have a significant impact on the components that interact with it. Most existing methodologies and system software designs are rooted in principles of object-oriented (OO) design, which leads to tightly coupled interactions. However, when components live in different address spaces, the differences in communication latency and memory access among components become significant. OO methodologies that worked well for local or centralized processing begin to break down for distributed or decentralized systems. This is where DDS comes in.

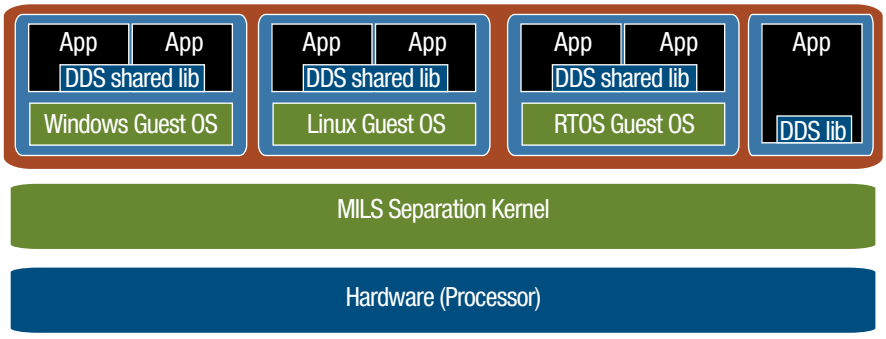

Figure 2

Real-Time DDS middleware enables applications within secure MILS partitions to write to a common standard messaging API.

Loosely coupled components provide the opportunity to lower certification and recertification costs. Traditional, tightly coupled components are inherently brittle. Brittleness here means that the inevitable changes to one software component—maybe just a single line of code—have a severe, cascading effect on the overall software development effort. Conversely, a loosely coupled, data-centric design tends to limit the effect of changes on the overall development effort and decreases brittleness.

This holds true both when starting from scratch on a new MILS software effort and when transitioning existing software into a MILS environment. As an illustration, consider that many new distributed system R&D efforts begin life as proof-of-concepts starting with Linux, Windows, or another non-MILS operating system. If the engineers start by using DDS, they can typically transition to a MILS architecture with minimum effort provided they have a general understanding of the distinction between a loosely coupled, "data-centric, data-oriented" mindset as opposed to a tightly coupled, "application-centric, object-oriented" mindset.

MILS and DDS for Hardware Consolidation

As a specific example, one goal of next-generation Integrated Modular Avionics (IMA) (Figure 3) is to take multiple software functions that used to be performed on separate processors and consolidate them all on a single processor. This includes the difficult requirement of simultaneously supporting software functions running at different ("mixed") criticality levels.

As faster common processor hardware becomes available, the engineer can either further consolidate even more software functions, or add new capabilities that were not possible due to hardware resource constraints.

Recall that the main goal is to contain certification costs. The computing hardware used in aerospace and defense applications (especially safety-critical applications) is often specialized and therefore quite expensive. Of course designers give some

consideration to minimizing hardware costs. However, certification and accreditation costs dwarf hardware costs by several orders of magnitude. As an example, consider that along with hardware Size, Weight and Power (SWAP) constraints, developing software for C&A accounts for the most important cost factor in safety-critical software design for Unmanned Vehicles.

Eventually, hardware becomes obsolete and unsupportable. Therefore, if the goal is to allow obsolete hardware to be upgraded and to minimize recertification costs, then a combined approach of MILS OS and a messaging middleware technology becomes essential.

Figure 3

An Integrated Modular Avionics (IMA) is an integrated architecture with application software portable across an assembly of common hardware modules. The IMA concept is used on fourth-generation jet fighters such as Lockheed Martin's F-35.

Integration of Software Components

There are a number of system complexity issues to consider when contemplating the use of DDS with a MILS architecture. Applications that are completely self-contained in a single process and work in absolute isolation have no need for DDS or any other middleware. However, anything beyond the simplest application usually needs to interact with other resources (at a minimum, device drivers, a file system and system services like getting the current time). The default inter-partition communication provided by the MILS Separation Kernel vendor may be adequate, especially if the configuration is essentially static—that is, no new applications or services will ever be added or removed, they will always run on the same processor, the system will always initialize in exactly the same order, and no significant patches, fixes or

Part Number	Total Channels	Common Voltage Channels	Kelvin Measurement*	Transorb ESD Protection	Address Busses	Enable Lines	Total Dose krads(Si)	SEU immune >MeV-cm²/mg	DSCC SMD Number
MANY-MUX									
MUX8500	64	32	32	■	2	4	300	120	5962-0050201KXC
MUX8501	64	64		■	2	4	300	120	5962-0050202KXC
MUX8502	48		48	■	1	3	300	120	5962-0323401KXC
MUX8503	48	48		■	1	3	300	120	5962-0323403KXC
MUX8506	48		48		1	3	300	120	5962-0323402KXC
MUX8508	32	32		■	2	2	300	120	5962-0822601KXC
MUX8510	64	32	32	■	2	4	150	90	5962-0920201KXC
MUX8511	64	64		■	2	4	150	90	5962-0920202KXC
MUX8512	48		48	■	1	3	150	90	5962-0920301KXC
MUX8513	48	48		■	1	3	150	90	5962-0920302KXC
MUX8518	32	32		■	2	2	150	90	5962-0920401KXC
MINI-MUX									
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MUX8521	16		16	■	1	1	300	120	5962-0922902KXC
MUX8522	32	32			2	2	300	120	5962-0923101KXC
MUX8523	32	32		■	2	2	300	120	5962-0923102KXC
MUX8530	16	16		■	1	1	150	90	5962-0923001KXC
MUX8531	16		16	■	1	1	150	90	5962-0923002KXC
MUX8532	32	32			2	2	150	90	5962-0923201KXC
MUX8533	32	32		■	2	2	150	90	5962-0923202KXC
COMING	2010 +5V ONLY								
MUX8561	16		16		1	1	150	90	Pending
MUX8562	32	32			2	2	150	90	Pending

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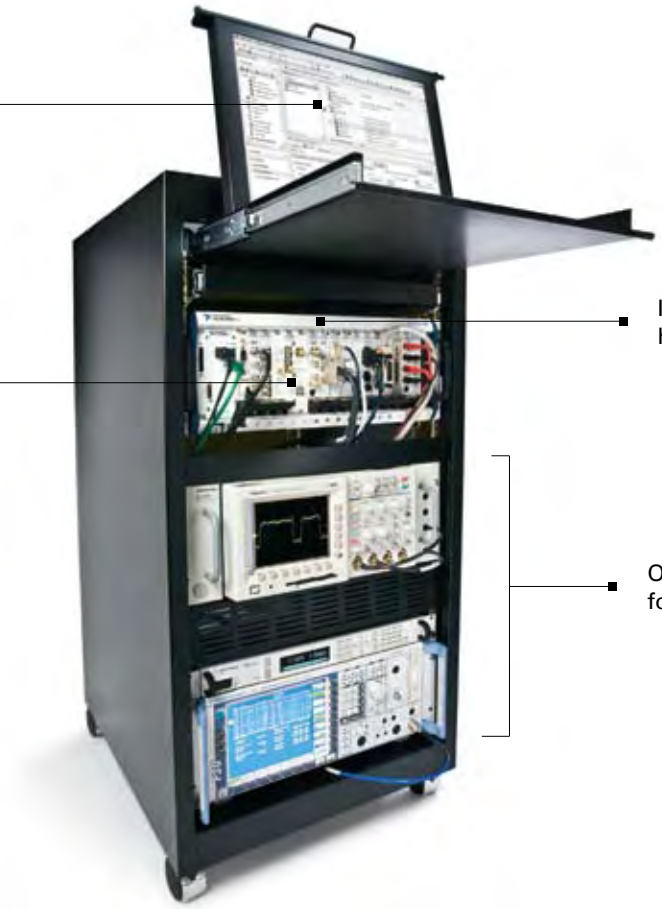

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upgrades will ever need to be applied over the system's lifecycle.

If software components and services need to interact with each other, or are likely to need modification at some point in the future (upgrades or bug fixes), or you anticipate that other software components will be added in the future, then having a messaging middleware capability like DDS quickly becomes important. In the most complex distributed systems, there are multiple processes running across multiple processors that are physically separated. In this case, you need a network layer and physical network transport (network interface cards, Ethernet, radio or satellite modems, encryptors/decryptors and so on). Having the QoS policies of DDS then becomes even more essential to guarantee that real-time requirements like bandwidth, throughput, latency, retries and so forth are met. MILS does not provide a standard for Inter Partition Communications (IPC). Each MILS Separation Kernel vendor provides its own proprietary IPC; there is no "MILS API." This makes a standards-based messaging middleware such as DDS even more important.

Future Proofing via DDS

For over 30 years, the embedded system industry has oscillated between favoring decentralization versus consolidated approaches to embedded computing. The current industry trend is toward hardware consolidation. An analog of this is the enterprise hardware trend toward server virtualization. 6U size Single Board Computer (SBC) servers of the early 1990s became 1U SBC servers in the late 1990s, and 1U servers became multi-SBCs stuffed into a 1U Server box. Then with the introduction of dual-core technology, servers began the march toward virtualization on many-core servers, which is where we are today.

For projects with high-assurance and mixed-criticality requirements, the combination of a Commercial off-the-Shelf (COTS) MILS OS and a COTS DDS middleware is compelling. This is because DDS has already been proven in hundreds of real-world Aerospace and Defense programs and is a well-supported industry standard. DDS provides a path for future-proofing a project against unconstrained recertification lifecycle costs as hardware and software are patched, upgraded and replaced. ▮▮

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Safety-Critical Standards

DO-178B Provides Certification Safety Net

Because aircraft avionics software includes safety-critical aspects, the military continues to embrace the DO-178B guidelines used for commercial aircraft systems.

John Blevins, Director, Software Tools Development
LynuxWorks

Safety-critical avionics software has been evolving for decades, providing increased functionality while becoming more complex. In response, regulatory authorities and commercial avionics manufacturers co-authored the RTCA/DO-178 guidelines for developing avionics software. Developers of commercial avionics software must demonstrate compliance with DO-178's guidelines to assure that their software can safely perform its intended function. More recently, the FAA has issued further guidance for so-called reusable software components (RSCs as defined in AC20-148). This guidance requires activities beyond those of DO-178, but the advantage is that certification evidence created under an RSC during one certification can be re-used on subsequent certifications, resulting in considerable cost and schedule savings.

Figure 1

While DO-178B was created to guide commercial avionics software development, developers of military avionics software have adopted it in recent years.

Complexity Drives the Need

The current version of these guidelines is known as DO-178B and is generally considered one of the strictest software standards in existence today. All commercial avionics software in the U.S. is required to comply with the DO-178B standard. The guidelines defined in DO-178B are intended to ascertain that avionics developers employ a degree of process rigor during software development and verification to ensure that the software will perform its intended function with an appropriate level of confidence in safety.

Note that while DO-178B was created to guide commercial avionics software development, developers of military avionics software have adopted it in recent years (Figure 1). However, nowadays military developers rarely adopt DO-178B in its entirety, often due to cost, effort and schedule, nor do they undergo the rigorous compliance audits conducted by the FAA or other certification authorities.

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It's All About Process

While DO-178B does not define a process per se, it does define guidelines that a compliant process must meet. DO-178B defines five major software life cycle processes:

Planning: During this process, the software plans for the following four life cycle processes are created. This planning must occur in the context of system/software considerations, especially those related to safety. More on this issue later.

Development: At this stage, software requirements, design and code are created and the resulting software is integrated with target hardware in preparation for testing.

Verification: Artifacts created in the development process are assessed to detect and report any errors (error removal is a development activity).

Software Configuration Management (SCM): This process spans both development and verification and ensures that adequate problem reporting, change control and configuration control are in force.

Software Quality Assurance (SQA): This last process spans development, verification and configuration management to ensure adequate quality controls are enforced.

The Software Planning Process

The primary objective of the planning process is the creation of plans for the other four life cycle processes. These plans define the processes to be used, procedures and standards to be followed, and tools/environments to be used (e.g., compilers/debuggers, testing tools, configuration management tools).

These plans must be created in the context of system/software considerations, especially those related to safety. DO-178B defines five levels of avionics "failure conditions" to which software might contribute (catastrophic, hazardous, major, minor and no effect) and five corresponding levels of software "design assurance" (levels A, B, C, D and E). For example, modern flight control software typically requires Level A design assurance, which imposes the most stringent process rigor, since a fault therein could be catastrophic (i.e., loss of aircraft and loss of life). Conversely, a maintenance function might require only Level D design assurance and very low process rigor, since a fault would have minimal effect on the safe operation of the aircraft. The five levels of software design assurance are directly mapped to the five "criticality" levels of avionics failure conditions. The key difference between Levels A and B is that Level A requires a more thorough degree of testing.

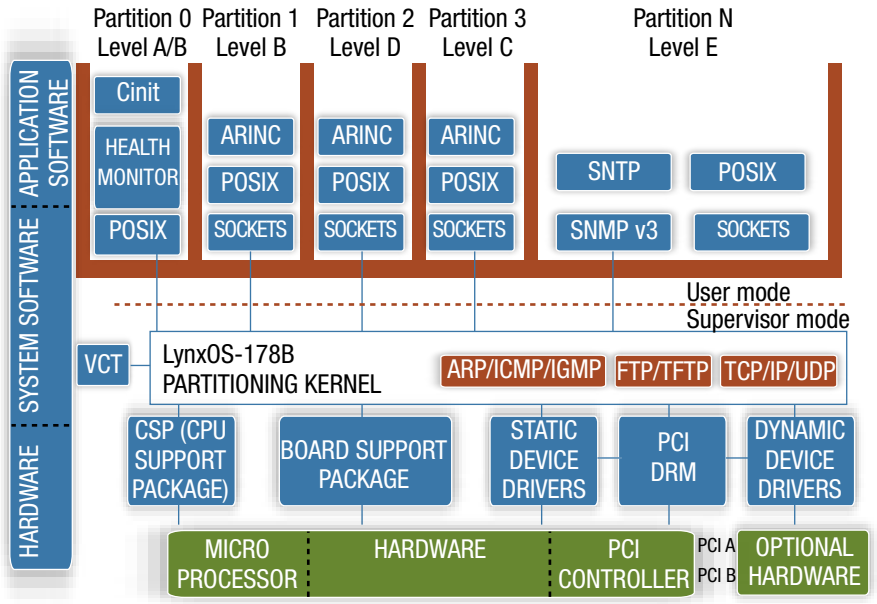

Figure 2

The LynxOS-178 RTOS is available with artifacts for all levels of FAA certification requirements, helping with the certification of the complete system including the RTOS.

The Software Development Process

The primary objective of the development process is creation of the software requirements, architecture, design and code in compliance with standards identified during the planning process. The development process also covers loading the resulting executable object code onto the target system for hardware/software integration and testing. Requirements are often written at two levels.

During the requirements phase, engineers develop high-level software requirements based on system requirements that have been allocated to software, safety requirements and system architecture. At the design phase, engineers develop low-level software requirements based on high-level requirements and develop software architecture (design constraints). Low-level requirements provide a level of detail such that code can be directly implemented from them with no further information.

Traceability Requirements

In general, high-level requirements must trace to the system-level constructs from which they were developed, and low-level requirements must trace to the high-level requirements from which they were developed. However, derived requirements may be identified that do not trace anywhere—such as command and control software might have a derived low-level requirement for a priority queue. That said, all derived high-level requirements must be fed back to the system safety assessment to ensure that they don't introduce safety issues. Similarly, all derived low-level requirements must be analyzed to ensure that they don't compromise any high-level requirements.

During the coding phase, engineers develop software that implements the low-level requirements in conformance with the software architecture. All code must trace to the low-level requirements from which it's developed. In general,

traceability for lower-level design assurance software (Levels C and D) can be relatively coarse-grained—an entire software module may trace to a handful of requirements. Conversely, traceability for higher-level design assurance software (Levels A and B) is generally expected to be much more finer-grained—a few lines of code may trace to one or more requirements. Under design assurance Levels A and B there can be no code that does not trace to the requirements.

During the integration phase, engineers create executable object code from the software developed during the coding phase. They then load the executable object code onto the target hardware in preparation for hardware/software integration and testing. The compilers used to create the executable object code must undergo a process called "object code analysis," which verifies that the generated code is correct for the constructs in the source code.

During this lifecycle process, the main objective is the detection and reporting of any errors in the artifacts created during development. All errors are fed back to the development phase to be corrected. Note: verification does not simply mean testing, it also includes review and analysis.

During the testing phase, engineers develop and execute test cases (test descriptions) and test procedures (executable test code) intended to demonstrate that the software satisfies its requirements, and to demonstrate, to a high degree of confidence, that all errors that could lead to unacceptable failure conditions have been removed. DO-178B emphasizes requirements-based testing (black box), wherein tests are developed from the software's high- and low-level requirements. In limited cases, unit level tests may be needed to drive hard to reach paths in a given piece of code (white box).

Tests should include: normal range cases—such as testing a tan( ) function with a value of zero—and robustness cases—testing a tan( ) function with a value of 90, hardware/software integration cases and software/software integration cases.

In general, tests should be run on the target hardware intended for use in the aircraft being developed. However, DO-178B allows that constraint to be relaxed under appropriate circumstances, especially in the case of low-level design assurance software. During the review phase, engineers assess the outputs of the development and verification processes for accuracy, completeness, consistency, verifiability, traceability and conformance to standards. Such reviews are typically guided by a checklist or similar aid to ensure a robust result.

During the analysis phase, engineers inspect three key outputs of the development and verification processes. First, test results are analyzed for correctness. The results of any failed tests are fed back to the development process for correction. Second, test cases and procedures are analyzed to ensure that every requirement traces to one or more tests and that every

test traces to one or more requirements. Third, the structural coverage generated during testing is analyzed to ensure an appropriate level of testing completeness.

Any code that is determined to be "dead code"—unreachable during execution—must be removed as part of the development process. The LynxOS-178 RTOS (Figure 2) is available with artifacts for all levels of FAA certification requirements, helping with the certification of the complete system including the RTOS.

The SCM Process and SQA Process

The SCM process is active throughout development and verification. Its major objectives include control configuration items (CIs) and establish controlled configurations of the software from which executable object code can be derived. A means must be established to reliably replicate executable object code. Any problems must be recorded and assessed, and any associated changes must be made in a controlled manner. And finally, formal procedures need to be established for approving/disapproving the inclusion of changes into a new baseline.

The SQA process also is active throughout development and verification. Its major objectives include ensuring that software development and verification activities comply with approved software plans and standards. Software life cycle transition criteria must also be satisfied. Before releasing the final executable object code, ensure that all software life cycle processes are complete, that the executable object code is controlled, and that it can be regenerated (if needed).

Using a RTOS that has been developed using the DO-178B process can be very beneficial to the integration and certification of that RTOS in the final system with the avionics application. At LynuxWorks, the DO-178B development process used for the LynxOS-178 operating system follows the strict SQA process used in developing avionics applications, making system integration and subsequent certification much easier for avionics developers.

Reusable Software Components (RSCs)

Driven by a desire to reduce cost and schedule, avionics manufacturers have begun to design and deploy reusable/portable hardware platforms and application software. This approach is especially attractive in markets such as commercial avionics, which require costly development, verification and certification activities. Clearly, if a manufacturer can incur the cost of developing and verifying a software component once, and if they can then reuse that software and the associated certification evidence at a drastically reduced cost, that manufacturer gains an advantage over any competitors that lack that capability.

Consequently, the FAA has developed guidelines for so-called RSCs. This guidance requires some activities beyond those of DO-178B, but the advantage is that all certification evidence created under the RSC during one certification can be reused, as is, on subsequent certifications. This reduces the time, effort and risk involved with a certification, and is particularly attractive if it is applied to embedded software, as this can be shared across many customers and systems. The LynxOS-178 operating system from LynuxWorks is the only RTOS to have been accepted as an RSC.

DO-178B has best been described as a set of overlapping safety nets intended to catch software errors and prevent them from finding their way onto aircrafts. It helps software developers achieve this goal within a flexible framework that allows for varying degrees of process rigor during software development and verification, thereby striking a practical balance between safety and cost/effort. ■■

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Tech Recon

Safety-Critical Standards

Growing Complexity Drives Need for Emerging DO-178C Standard

As avionics software grows in complexity, the new "C" version of DO-178 adds formal methods, models and OO technology to the mix.

Bill St. Clair, Technical Evangelist
LDRA Technology

The size and complexity of avionics software is projected to grow geometrically. Boeing and Airbus measure the current rate of software growth as 400 percent every two years (Figure 1). The challenges presented by this phenomenal growth are crystallized by the sobering realization that all this software has to be certified to the resource-intensive demands of the DO-178B development standard and its imminent successor, DO-178C. However, the expense of this software certification process is dwarfed by the staggering costs associated with correcting software defects once they're deployed on an airborne system—around 900 times more costly than corrections done at an early stage (design time).

In this context, the importance and potentially beneficial impact of a safety-critical development standard such as DO-178B can be understood, as well as the even greater influence of its successor, DO-178C. But the only way suppliers to this industry can meet these standards and produce the required zero-defect software is to take advantage of the advances in software technology and methodologies.

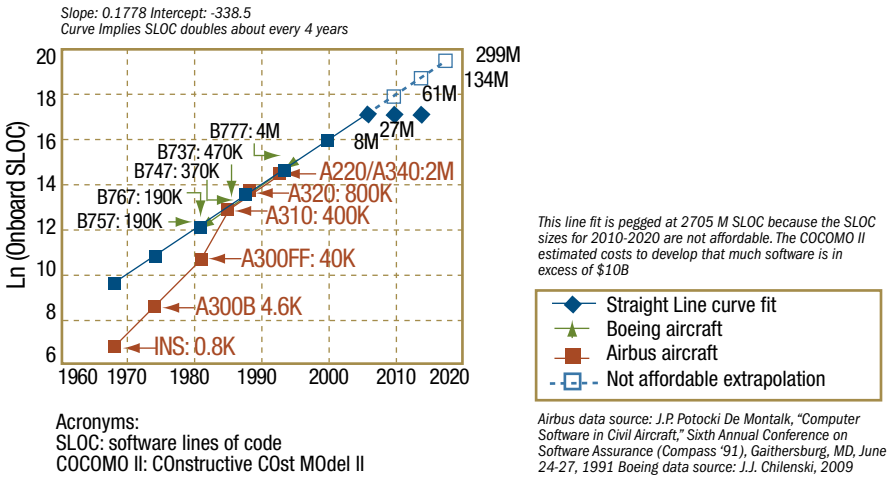

Figure 1

According to Boeing and Airbus, the size and complexity of avionics software is projected to grow geometrically—with the current rate of software growth as 400 percent every two years.

Building on DO-178B

Before discussing the new standard, it's helpful to take a critical look at the current one. DO-178B is a comprehensive, leveled set of software activities and objectives. "Leveled" refers to the four A, B, C and D Safety Integrity Levels (SILs) included in the standard with Level A being the most stringent. DO-178B offers comprehensive cross-referencing of these objectives for each of the levels to ensure its intent is clearly defined.

DO-178B assumes software development progresses linearly from requirements to design and code to integration and test. Its process model resembles a waterfall or V model in which validated requirements are a given (the current DO does not mention requirements validation), and there is a de facto partition-

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ing of the requirements engineering and software development processes. "Derived Requirements," a non-functional requirement derived from the design or implementation process, is the exception to this.

The given, "high-level" requirements are the predicates for the "low-level" requirements that specify the software design. However, separation of requirements from the software development process frequently results in a lack of differentiation between low-level requirements and design.

Top-Down Testing

Verification in the current DO comes primarily from top-down testing. This verification approach represents 60 to 80 percent of the project budget—a cost driven up by the fact that "Testing" is first performed on the integrated software system long after the requirements and design commitments have been made. In contrast, the new DO ensures that developers begin testing (or verifying) early in the process.

Current DO verification focuses on test coverage of functional requirements and software structures. These structures include code structures, measured as statement and decision coverage as well as data and program-control structures. The measurement of data and control coverage is typically performed as a manual, ad hoc analytical process—contributing to verification costs.

Finally, in the current DO, traceability—causal links between requirements at different levels and associated software development artifacts— must be established before the software system is considered certifiable. These causal links include both static links that must be established and maintained (mapping from low-level requirements to source code) and dynamic links (as determined by structural coverage analysis). Typically certification readiness includes a verification of traceability called "slice analysis," which follows one high-level software requirement to its low-level requirement(s) and associated test cases through design to source code and then to object code.

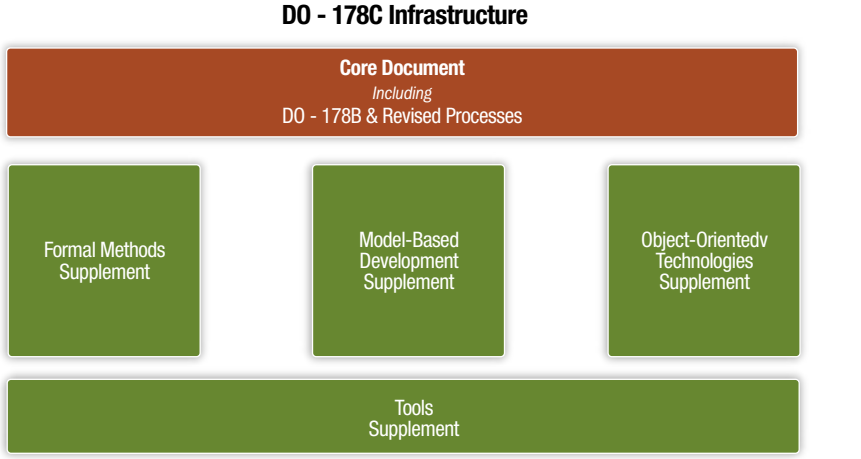

Figure 2

DO-178C adds three technology-specific legs under the "core document" or the current DO: Formal Methods, Model-based development and Object-oriented and related technologies.

Enter DO-178C

The new DO, depicted in Figure 2, adds three technology-specific legs under the "core document" of the current DO:

- Formal Methods
- Model-based development
- Object-oriented and related technologies

Each leg supplements the technology-agnostic core document. A supplement defines the steps (activities) related to the usage of the technology and any unique "objectives" or criteria for acceptance of the software produced. With two of three technologies primarily facilitated by third-party tools, a fourth supplement on tools becomes especially important as it addresses tool qualification

Formal Methods

The first draft of the Formal Methods supplement effectively supplanted software testing with mathematical proofs. Strong objections took the form that, however much Formal Methods might contribute, there must be a successful demonstration of the software running on the target system. Also, the ever-present possibility of a successful proof suffering from "vacuity"—a proof that gets the right results for the wrong reasons or coincidental correctness—was another powerful factor.

As a compromise, the Formal Methods supplement does not attempt to circumvent the necessity of testing while establishing itself as another viable means of verification. Also, the new DO section 6, Software Verification Process, was changed to use "verify" instead of "test" to allow functional verification of software using a means other than testing such as using Formal Methods.

Model-Based Development

To staunch the enormous growth of software, advanced research groups have advocated the use of model-based development (MBD). Research indicates that early stage prototyping of software requirements using an executable model effectively routes out "defects" at the requirements and design levels, a huge cost-saving step.

In preparation for the possible prominence of MBD, the new DO addresses the challenges of implementing this technology. The most common challenge to MBD is establishing and maintaining traceability from requirements, written in most cases in natural language, to a design represented in a modeling lan-

guage. In the new DO the models are the requirements, so traceability becomes self-evident.

However, other questions about traceability arise when the MBD process auto-generates source code: How do you map requirements to source code? How do you refine these mappings and the software behavior that they encapsulate? The answer to these questions depends on the characteristics of the modeling language and the mechanisms supported by the MBD tool auto-generating the code. MBD tools may also insert code that can be rationalized only in the context of the model's implementation, not the functional requirements.

Because the DO standard requires direct mapping between requirements and source code, unmapped code must be accounted for. In these circumstances, what should the applicant do—define "derived" requirements to justify the unmapped code? As a direct consequence of MBD limitations on implementing software behavior, including such things as hardware driver code or timing critical, multithreaded operations, MBD systems implemented using auto-code generation typically include some hand code. In addition to the different verification techniques that must be employed with hybrid systems, two distinct traceability techniques are required.

OO and Related Technologies

The third technology supplement for the new DO, Object Oriented and Related Technologies (OOT), focuses on OO languages in use today such as C++, Java and Ada 2005 along with guidance for technologies common to both OO languages and procedural languages—such as polymorphism with multiple inheritance and generics and function dispatch with dynamic and static dispatch.

Subtyping, the OOT ability to create new types or subtypes, increases the power of object-oriented languages, but it introduces the challenge of maintaining type consistency and verification of subtypes. Reacting to the potentially enormous number of feasibly executable methods, the FAA's OOTIA Handbook defaulted to an exhaustive, flattened-class approach, which significantly escalates OOT verification costs.

The OOT Supplement recommends a far more practical approach to establish type substitutability. Design Verification Testing (DVT), performed at the class level, proves that all the member functions conform to the class contract with respect to preconditions, post conditions, and invariants of the class state. As an alternative to DVT, developers can use formal methods in conformance with the Formal Methods Supplement.

Will the new DO-178C provide the guidance necessary to facilitate the acceptance of advanced technologies covered by its supplements? The answer is yes. But the real issue—the elephant in the room—lies in whether the use of these new development technologies will staunch the avalanche of avionics software in the coming years? That answer depends on the adoption of more agile and flexible development and verification processes that incorporate such objectives as continuous requirement engineering and lifecycle traceability. Easing the way will be a new generation of software verification tools to automate and replace manual and inefficient techniques. These steps will go a long way toward bringing about consistent, cost-effective development processes as software continues to grow in complexity and scope. ▮▮

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Signal Simulation Aids Testing of Advanced Radar Designs

Today's AWGs do the radar testing work that once required costly and complex custom systems. And unlike those systems, AWGs are capable of testing more than a single radar system.

John S. Hansen, Senior Applications Engineer
Agilent Technologies

When characterizing the performance metrics of modern military radar system designs, a variety of test signals are required to accurately simulate the operational environment. In the case of pulse-compression radars, the required signals may include FM chirps or coded signals that use Barker or polyphase bit sequences.

A suitable measurement solution must enable the creation of long, complex signal scenarios. This capability is found in some of today's advanced wideband arbitrary waveform generators (AWGs). These instruments can replace the costly and complex custom systems that are typically capable of testing only a single radar system. AWGs can also simplify the emulation of various operational scenarios, reducing the need for costly flight testing. They do this in part by producing a modulating or baseband signal—chirps or phase-modulated coding—that can be placed onto a high-frequency carrier.

Some advanced AWGs utilize two playback techniques that facilitate these long scenarios. One method is a sequencing capability that allows segments of the signal to be strung together dynamically—and in any order—as the waveform is played back. This lets the user change the waveform shape as needed during testing. This type of sequencing is sometimes called "memory multiplication." The other technique is a direct digital synthesis (DDS) capability that allows the user to separate the slowly changing attributes of a scenario—carrier frequency, phase and timing—from the rapidly changing signal modulation. This article provides an overview of both techniques as applied to the testing of building blocks within modern radar systems.

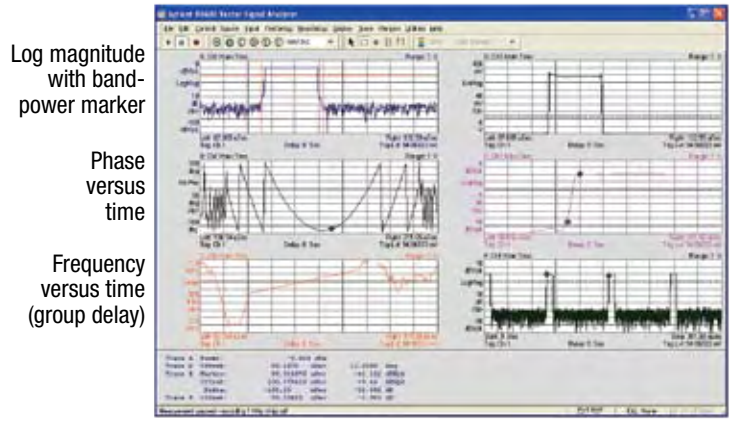

Figure 1
Coded pulses and the use of pulse-compression techniques enable long-range detection with excellent resolution.

Recent Trends in Radar Design

Ongoing changes in testing requirements are driven by emerging trends in radar missions and technologies. For example, one of the key goals in designing a modern radar system is reducing the probability of intercept (POI). This is essential to avoid electronic countermeasures (ECM) and is highly useful in low-observable aircraft used in direct combat or surveillance missions.

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tegrated phased-array antenna technology. In all cases, the underlying enabler is high-speed digital signal processing (DSP) technology. This has led to enhancements in both receivers and transmitters. For example, receivers equipped with high-speed DSP can perform techniques such as wider-bandwidth parallel-processing and "track-while-scan operation," which enables simultaneous scanning, acquisition and tracking of multiple targets. DSP-driven transmitters can generate software-defined multimode waveforms on a single platform and create the complex phase- or frequency-coded signals needed for wideband pulse-compression techniques.

To simplify the testing of these designs, many of the same high-speed DSP devices and techniques are used inside advanced AWGs. This is the key to implementing dynamic sequencing and direct digital synthesis of signals.

Generating Complex Signal Scenarios

In the real world, radar designers want long detection range and very fine range resolution simultaneously. Pulse-compression radars offer long detection range with excellent range resolution and, perhaps more important, reasonable peak transmitter power. Pulse-compression involves the transmission of coded pulses of sufficient width to provide the average power and peak power necessary to detect the target of interest at its specific range. The received echoes are then compressed by processing and decoding their modulation, which may be linear FM, nonlinear FM, Barker-coded or polyphase-coded, with or without frequency hopping.

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Dealing with Signals in Noise

In any operational scenario, signals exist in noise. Any form of noise can make detection more difficult by distorting or masking a return signal. The most common solution is to use a noise threshold to improve system performance. Of course, a threshold control has two potential problems: the possibility of missing signals that fall below the threshold and the likelihood of false alarms from unwanted signals that exceed the threshold.

Within a radar system, interaction between the intermediate frequency (IF) bandwidth and the threshold level will determine the alarm rate: the higher the threshold the lower the alarm rate. Optimizing the threshold/alarm rate is another application that can benefit from the testing capabilities built into advanced AWGs.

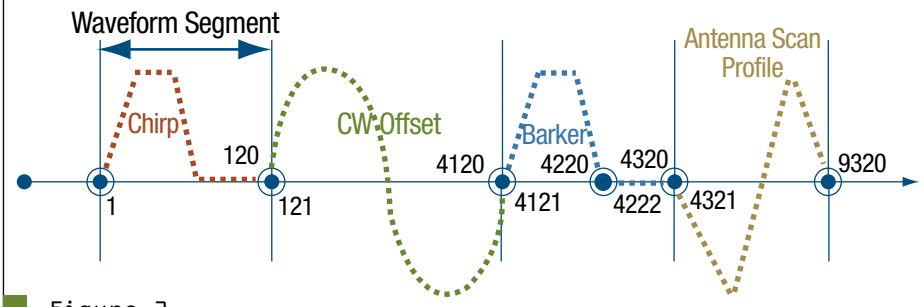

Figure 2

Four separate waveforms stored in just 9,320 samples can be used to create complex signal scenarios.

In addition to the modulation, these signals consist of complex combinations of on-time, off-time and repetitions. The complexity of these signals is illustrated in the FM chirp analysis shown in Figure 1. Clearly, the sophistication of the signals must be matched by that of the analysis tools, which, in this example, is vector signal analysis software.

For the simulation of such signals, the sequencing approach is the type of clever and elegant solution any engineer can appreciate. Implementing it in an AWG requires three key elements: waveform memory for storage of signal samples; a waveform playback capability that contains signal segments and sequences; and a waveform play table for creating signal scenarios.

The process begins by storing or creating a variety of waveforms in the AWG's memory. As shown in Figure 2, this could be a radar chirp, a continuous-wave (CW) signal, a Barker-coded waveform and an antenna-scan profile. This collection of waveforms occupies just 9,320 samples within the waveform memory.

Chaining Together Segments

Using only the four stored waveforms, the AWG can be programmed to chain together segments, loops and sequences that produce complex signal scenarios. An example sequence is shown in Figure 2. It consists of two independent segments followed by a segment loop that contains four distinct segments. The first segment (in red) is a 120-sample radar chirp that is repeated 100 times. In the second segment (blue), a 200-sample Barker-coded waveform is repeated 1000 times. The segment loop repeats the following sequence 1000 times: five cycles of the CW waveform; 65,536 iterations of the antenna-scan profile; 256 cycles of the CW waveform; and 10,000 Barker-coded pulses.

After the last segment loop is completed, the AWG can repeat the entire sequence continuously or change to a completely different sequence (Figure 3). This illustrates the power of the memory-multiplier effect: The four component signals occupy just 9,320 samples in waveform memory but the total length of the out-

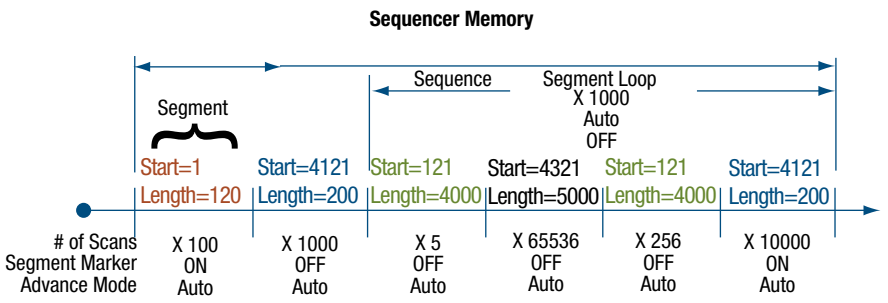

Figure 3

The use of segments, loops and sequences multiplies the effective amount of memory in an AWG.

put sequence is 330.7 Gsamples. A unique signal of that length would occupy approximately 2.65 Terabytes in memory if produced using eight-bit waveforms.

Simulating Dynamically Changing Waveforms

The inclusion of dynamic sequencing and DDS in an AWG provides independent control of waveform parameters such as carrier frequency, amplitude profiles, chirp frequencies and modulation characteristics (AM, FM and PM). In some AWGs, these waveforms are created outside of the waveform memory used for arbitrary waveforms, further extending the utility of the instrument.

The DDS approach can be used to simulate radar returns from an aircraft flying past an airport's surveillance radar. In such a case, each radar return varies in time, frequency and amplitude as the aircraft approaches the rotating antenna. An accurate simulation must replicate multiple effects: pulse-to-pulse amplitude variations; hopping of transmit and receive frequencies; and Doppler shifts caused by changes in aircraft speed.

Dynamic sequencing enables automated control of these parameters. For example, an AWG with this capability may offer a hardware interface that enables programmatic access to predefined waveforms stored in memory. The ability to point at specific waveforms can be used to simulate a frequency-hopping transmitter when testing radar receivers. This also makes it possible to simulate radar returns from a moving target by controlling the timing sequences of the output signal.

Relying on DSP Technology

The ability to achieve low POI depends on the presence of high-speed DSP technology in modern radar systems and in the AWGs used to test them. Because high-performance AWGs are capable of generating complex signal scenarios and simulating dynamically changing waveforms, they can replace costly, one-off customized test systems and reduce the need for expensive flight testing.

As specific examples, instruments such as the wideband, 1.25 Gsample/s Agilent N6030A AWG (PXI version) and N8241A AWG (LXI version) use DSP technology to implement the dynamic sequencing and DDS capabilities described here. Modulation onto high-frequency carriers up to 44 GHz can be accomplished with the wideband modulation inputs of the Agilent E8267D PSG vector signal generator. ▮▮

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Technology Focus

Rugged Stand-Alone Box Systems

Rugged Box Systems Tighten Their Military Focus

As stand-alone box systems move to their next generation of designs, the field of suppliers is shifting with a focus on improved ruggedness and mil-specific I/O features.

Jeff Child
Editor-in-Chief

Over the past couple of years, traditional embedded board vendors have been adding stand-alone rugged box-level systems to their military market offerings. These complete system boxes—which often support standard form factor boards inside them—provide a complete, tested and enclosed computing solution that eliminates complex integration chores for customers. The term "Stand-Alone Rugged Boxes," as coined by *COTS Journal*, applies to complete system boxes. Often the boards in the box are standards-based cards such as PC/104, PMC, 3U CompactPCI and VPX. But the enclosures by and large aren't in any industry standard footprint. There are a handful of companies—Octagon Systems, Parvus, Quantum 3D, Rave Computer, RTD Embedded Technologies—that were doing box-level products before the traditional board vendors joined it.

The concept of offering a more complete system solution is nothing new. In fact, the trend has been gaining momentum for almost a decade now—starting with solutions that were mainly "custom" offerings for specific customers. The term "custom" gets a lot of leeway here, because in the military embedded computing market, some degree of customization has always gone on—whether you're talking about boards or system boxes. More recently, however, the concept has really become a kind of staple in this market. In many ways it's moved to the center spot of the military embedded computing industry—the spot once held by SBCs. Now rugged box systems have become a second center of gravity alongside SBCs.

While rising significance of this product category shouldn't be underestimated, it's definitely evolving. As the product roundup on the following pages shows, there's a narrower set of vendors that have rolled out new box-level products in the past year—13 this year compared to 15 last year. Meanwhile, some I/O and Avionics specialists like Ballard Technology and Phillips Aerospace have entered the game too, bringing their expertise in 1553 to bear.

With the rugged box product category now well entrenched, a number of vendors are on their second and third generation of products. As this happens, products with more rigorous levels of ruggedization and environmental hardiness have emerged. An example is Crystal Group's SS11 Sealed Server. The server offers all aluminum construction with custom EMI gasketing to seal the server chassis. The SS11 Sealed Server offers immersion protection rated to IP68 (Figure 1). In tests, Crystal Group tested an extended shock and vibration configuration of their SS11 model for performance in harsh environments. Previous testing for the server had incorporated submersion in water for over 192 hours. Dynamic testing performed at the Nebraska Center for Excellence in Electronics included shock testing conducted in accordance with MIL-STD-810F. The test levels were 45G at 11 mS, 0.5 sine in each of the three axes. Vibration testing was also conducted in accordance with MIL-STD-810F. The test levels were 5.9g RMS, 5-500 Hz with a random-on-random profile, for a duration of 60 minutes per axis, in each of the three axes. ▮▮

Figure 1

Melissa Trace of the Crystal Group discusses their Crystal SS11 Sealed Server with *COTS Journal*'s Jeff Child. Shown here immersed in water, the SS11 offers immersion protection rated to IP68.

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Technology Focus:

Rugged Stand-Alone Box Roundup

Rugged System Features Military Connectors

The stand-alone rugged box trend has touched nearly every corner of the military embedded computer market. ADLINK Technology, for its part, has weighed deeper into that game with the MilSystem 800 Extreme Rugged COTS military computer. MilSystem 800 leverages the proven design of the RuffSystem 800 and uses MIL-STD-D38999 connectors instead of PC-style connectors to maximize the reliability of connections between the computer system and peripherals for the most extreme environmental conditions.

MilSystem 800 consists of the Ampro by ADLINK LittleBoard 800 single board computer (SBC) in a MIL-STD-810 tested RuffSystem enclosure. The system supports up to a 1.4 GHz Pentium M CPU and provides conductive cooling, requiring no fans or holes for ventilation. MilSystem 800 is dust-proof and splash-proof. MilSystem 800 comes in a 8- x 10- x 3-inch conductive-cooled enclosure that has been tested to MIL-STD-810 for shock and vibration, and tested over a wide temperature range of -40° to +75°C. The short height allows installation under seats and in other locations where cube-shaped and rackmount systems cannot fit. Built-in I/O includes Gbit Ethernet, 10/100 Ethernet, four USB 2.0 ports, four serial ports, video, audio and PS/2 keyboard-mouse all on two MIL-STD-D38999-style 55-pin connectors. A third connector is available for an additional 55 I/O signals. Samples of the MilSystem will be available in late Q1.

ADLINK Technology
San Jose, CA.
(408) 360-0200.
[www.adlinktech.com].

Box-Level System Is Based on ATOM Processor

The ATOM, Intel's low-power, PC-compatible processor, has found its way onto nearly every embedded form factor. And now Advantech is using it on a rugged box-level system. The ARK-6310-3M04E features an Intel ATOM processor and the Intel 945GSE chipset on an integrated Mini-ITX motherboard. This fanless design operates silently and works reliably in harsh environments. With all electronics well-protected in a rugged, cold-rolled steel housing only 232 x 65 x 232 mm in size, the ARK-6310-3M04E performs flawlessly in the harshest environments. The all-in-one embedded computer features rich I/O connections, including two Gigabit Ethernet ports, four USB 2.0 ports, three COM ports, VGA and PS/2.

The cushioned anti-vibration design secures one 2.5-inch SATA HDD/SSD with maximum reliability. Also, the user-friendly bottom cover makes it easy to access the CompactFlash socket on the back of the embedded motherboard. The Advantech ARK-6000 series provides a complete solution for space-limited industrial applications.

Advantech
Irvine, CA.
(949) 789-7178.
[www.advantech.com].

Rugged Box Marries 1553 and PowerPC

The trend toward complete box-level systems has broadened to include some offerings that target specific needs like avionics. Along those lines, Ballard Technology offers its Avionics BusBox 2000 (AB2000) systems—a family of over 30 small, lightweight, conduction-cooled, embedded computers for rugged environments. These systems have many built-in standard peripherals and interfaces for various avionics databuses, as well as PMC expansion capability. Typical applications for the AB2000 include data and protocol conversion, databus and network bridging, data servers, data recorders, communications, power controllers, federated controllers and multiple net-centric applications. The AB2000 is suited for helicopter, fixed wing and ground mobile platforms.

At the heart of the AB2000 is a user-programmable PowerPC processor that runs the software application and controls the various standard—serial, Ethernet, USB and discrete—and avionics databus—MIL-STD-1553, ARINC 429/708/717—interfaces. The high level of functionality implemented in the hardware interface circuitry ensures full use of the PowerPC processor for the software application. At power-on the embedded application boots from the flash memory and runs without host intervention. The tethered case is where a separate computer runs the application and controls the AB2000 over Ethernet.

Ballard Technology
Everett, WA.
(425) 339-0281.
[www.ballardtech.com].

Prequalified Rugged System Is 3U cPCI-based

One level of value that can be added to stand-alone rugged box systems is the benefit of pretesting and preconfiguration. Along just those lines, Curtiss-Wright earlier this year rolled out the first member of a new family of Packaged COTS (PCOTS) fully integrated rugged subsystems. The new PowerPC-based Multi-Platform Mission Computer-9350p (MPMC-9350p) and Intel-based MPMC-9350i PCOTS subsystems are flexibly configured five-slot 3U CompactPCI (cPCI) subsystems housed in a sealed, lightweight, compact chassis fully preconfigured with power supply, and a wide range of I/O.

The rugged MPMC-9350 family is designed to meet the harsh environments of many military and aerospace computing applications. To ensure the highest levels of performance, the MPMC-9350 has been designed to meet or surpass DO-160E Environmental Conditions for Airborne Equipment. The main processing power of the MPMC-9350p is provided by up to three Freescale 7448 PowerPC-based DCP-124 and DCP-124P SBCs. The DCP-124P peripheral-only processor is a variant of Curtiss-Wright's standard DCP-124 SBC and supports PMC I/O, dual Ethernet channels, and a USB 2.0, RS-232 and dual RS-422 ports. The MPMC-9350p and MPMC-9350i can be ordered with a modified front panel connector set, modified backplane wiring or a modified card set to fit a unique application's exact needs. Most configurations of the MPMC-9350p and MPMC-9350i are priced between $40,000 and $60,000.

Curtiss-Wright Controls Embedded Computing
Leesburg, VA.
(703) 737-3660.
[www.cwcembedded.com].

Half-ATR Conduction-Cooled System Targets Mobile Apps

VPX is the latest board form factor to ride this rugged box system trend. Extreme Engineering Solutions (X-ES) offers its XPand3200 system that supports both 3U VPX and cPCI backplanes. Measuring 4.88 x 5.62 in x 8.75 inches, the unit is a sub ½ ATR sized conduction-cooled, fully ruggedized system designed to meet the rigorous standards of MIL-STD-810F. The system is aimed at avionics, UAVs, AUVs and vetronics requirements.

Depending on processing requirements, the XPand3200 can be populated with 3U modules from X-ES based on the Intel Core2 Duo processor, the Freescale dual-core MPC8572E PowerQUICC III processor, or the Freescale dual-core MPC8640D processor. The XPand3200 can then be configured to meet I/O requirements. The XPand3200 supports Gigabit Ethernet, graphics, RS-232/RS-422/RS-485, MIL-STD-1553, MIL-STD-188-114A, ARINC 429, discrete I/O, as well as custom conduction-cooled PMC/XMC I/O through the back-panel D38999 circular connectors. An optional 32 Gbyte SATA SSD memory module provides the convenience of removable storage and the ruggedness of solid-state memory. An optional USB port provides system monitoring and maintenance capabilities.

Extreme Engineering Solutions
Middleton, WI.
(608) 833-1155.
[www.xes-inc.com].

Rugged 3U and 6U Chassis Family Is Customizable

Every military system design has its own little unique part that needs some level of custom work. Feeding that need, GE Fanuc offers a family of rugged systems and enclosures. The system chassis are all supplied with a backplane, power supply, I/O wiring and necessary connectors. They are available with VME or CompactPCI backplanes for 3U or 6U COTS boards. These ruggedized COTS chassis are designed to support GE Fanuc systems that will be deployed in harsh environments like submarine and naval applications, sonar and radar systems, land-based and avionic and aerospace systems in combat ground vehicles and UAVs. Because all of these systems chassis use standard backplane technology like CompactPCI and VME, customers can choose just the right embedded COTS boards for their customized designs and quickly field their applications.

These rugged systems chassis are ready for system customization and include the 3-slot 3U conduction-cooled RCBC03, 3-slot 3U conduction-cooled RCBC03 with fastening footpads, 3-slot 6U conduction-cooled RCCC03, 7-slot 6U conduction-cooled RCFC07, 8-slot conduction-cooled 6U RCFC08, 12-slot ATR conduction-cooled 6U RCFC12, and the 17-slot convection-cooled 6U RCFA17 chassis.

GE Fanuc Intelligent Platforms
Charlottesville, VA.
(800) 368-2738.
[www.gefanucembedded.com].

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Dual-Core Embedded Box PC Is Fanless

Military systems are adverse to components like fans that can be vulnerable points of failure. The Kontron Concept Box 751 is Kontron's new compact Embedded Box PC with a dual-core processor. It offers high computing performance, an extensive feature set in an extremely compact format, and it boasts fanless operation due to its high level of energy efficiency.

Thanks to the use of SSD or CF media, the box operates completely silently and is consequently the perfect choice for applications in noise-sensitive areas. There are numerous potential application scenarios for the Kontron Concept Box 751 (75 mm x 250 mm x 260 mm), thanks to the wide range of interfaces. On the front of the enclosure, it provides 3 x LAN 10/100/1000, 4 x USB 2.0, 1 x IEEE1394, 1 x RS232, VGA, HD audio, PS/2 mouse and PS/2 keyboard. Optionally, it can run DVI via an ADD2 extension card. The box has three further RS-232 and two USB interfaces at the back. At the heart of this fanless Box PC is a long-life Mini-ITX Kontron 986LCD-M/mITX (BGA) board with the choice of either an Intel Celeron 1.06 GHz or an Intel Core Duo LV 1.66 GHz processor and up to four Gbytes of DDR2-RAM. For data storage, there is a bay for 2.5-inch SATA hard disks and a CF socket on the board. In addition, this Embedded Box PC has a PCI Express extension slot. The maximum power consumption of the system, which is supplied via a 24 VDC external power supply, is 37W. The MTBF (Mean Time Between Failures) is 40,000 hours and reliable operation is guaranteed at environmental temperatures of 0° to 50°C.

Kontron America
Poway, CA.
(858) 677-0877.
[www.us.kontron.com].

Rugged Box System Provides Manpack-Sized Computing Platform

The stand-alone rugged box trend has pervaded all corners of the military embedded computing space. Many product lines have even moved on to second-generation, smaller spin-off versions. An example along those lines is Mercury Computer Systems' new, rugged, manpack-sized system. Enhancing the Ensemble 1000 Series family of computing systems, the 2-slot PowerBlock 15 has a convection-cooled or cold-plate mountable design, suitable for deployment on small platforms operating in harsh environments. Approximately the size of an external hard drive, the portable system can be configured with any of the processing, I/O, or storage modules currently used in the award-winning 6-slot PowerBlock 50 chassis.

Ensemble 1000 Series systems, using either the PowerBlock 15 or the PowerBlock 50 chassis, are scalable and optimized for real-time applications. A point-to-point PCI Express connection delivers high-throughput, non-blocking, serial connectivity between processing and I/O nodes. External I/O can be customized to accommodate virtually any type of digital or analog I/O. Processing options include the Intel EP80579 SoC (system-on-chip) device, Xilinx Virtex-4 and Virtex-5 FPGAs, the AMD M96 GPU (Graphics Processing Unit), and Freescale PowerQUICC processors, all supported by SATA hard-disk and solid-state storage drives.

Mercury Computer Systems
Chelmsford, MA.
(866) 627-6951.
[www.mc.com].

Rugged Box System Supports Wireless Connectivity

The stand-alone rugged box trend is perhaps the most significant new area of embedded military product development. Octagon's latest offering adds the twist of wireless connectivity. The RMB-C1 is a rugged mobile server designed for applications where severe environments and high performance meet. The unit tightly integrates the electrical, thermal and mechanical components into a complete system with no compromise to any one segment.

The RMB-C1 can be used as a central server, a stand-alone CPU, or a remote terminal. A full complement of I/O is provided: USB, CAN Bus, VGA, serial, video, audio, odometer and digital I/O ports. Additional functionality can be implemented via expansion cards in the PC/104 and Mini PCI formats. The RMB-C1's modularity enables custom functionality with COTS convenience without large up-front costs. The device supports 802.11 b/g Wi-Fi: FCC part 15.247 and is CE certified with Mini PCI interface. The unique thermal design allows for fanless operation over a -40° to 75°C range.

Octagon Systems
Westminster, CO.
(303) 430-1500.
[www.octagonsystems.com].

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Core2 Duo Box Is MIL-STD-810F Qualified

A key part of the rugged box system trend is the concept of vendors prequalifying their systems to meet a variety of harsh-environment specifications. Along just such lines, the DuraCOR 810-Duo from Parvus is a rugged multicore mission processor subsystem designed for high-reliability applications requiring MIL-STD-810F environmental compliance with extreme temperatures, shock/vibration and ingress. Based on a modular, open architecture COTS design with an Intel Core2 Duo CPU, solid-state disk, MIL-704/1275 power supply and conduction-cooled chassis, the DuraCOR 810-Duo is an ideal computing solution for harsh mobile military and homeland security C4ISR deployments.

To ensure high reliability, signal integrity and extended environment operation, this high-performance tactical computer comes equipped with sealed MIL-38999 connectors, integrated EMI/EMC filtering, MIL-qualified power supply, watertight conduction-cooled enclosure, aluminum railed card cage and near cable-less design. The unit is designed to meet and will be qualified to MIL-STD-810F and MIL-STD-461E for insertion into Size, Weight and Power (SWaP)-constrained aircraft, ground vehicle and maritime platform modernization programs. Locking MIL circular connectors bring out Gigabit and Fast Ethernet connections, 6 USB ports, 2 RS-232 ports, Dual Video Display (LCD/VGA), keyboard, mouse and audio signals, as well as an expansion connector for up to 79 signals from optional add-on cards. Up to six expansion slots are available to support PCI-104 or PC/104-Plus modules.

Parvus
Salt Lake City, UT.
(801) 483-1533.
[www.parvus.com].

PC/104-Based Box Systems Boast Sturdy Frames

Driven by the desire for a more complete system, stand-alone, ruggedized systems have become a go-to for military system developers who need solid, turnkey solutions. RTD Embedded Technologies makes box-level PC/104-based systems qualified for demanding applications like military vehicles. RTD's rugged HighRel line of systems is built using frames milled from solid aluminum blocks to exacting specifications ensuring that the solution is rugged and reliable. Frames for thermally sensitive components have internally milled heat sinks and embedded heat pipes to move heat to the outside walls of the enclosure, allowing operation from -40° to +85°C without the use of active cooling. Optional shock-mount bases withstand specific shock and vibration specifications.

RTD's IDAN box-level product consists of any RTD PC/104, PC/104-Plus, or PCI-104 boards mounted in its own frame and wired to the standard PC connectors on that frame, thus eliminating the need for module-to-module wiring inside the case. This solution maintains PC/104's modularity and lets system designers configure a system as rapidly as one would configure a stack of boards. The product line is also available in a watertight version, HiDANplus, with environmental sealing and EMI suppression O-rings coupled with MIL I/O connectors. HiDANplus does inter-module communications via a custom wiring harness that is enhanced by an internal 100-pin stackable signal raceway.

RTD Embedded Technologies
State College, PA.
(814) 234-8087.
[www.rtd.com].

Family of Rugged Enterprise Servers Boasts Quad-Core Xeons

1U and similar-sized servers are becoming a mainstay for compute-intensive military applications. Themis' rugged family of XR3 servers provides multicore processing, extensive I/O and storage options for high performance in compact, rackmountable 1U, 2U and 3U designs. Themis' new XR3 Rugged Enterprise Servers (RES) combine the latest Intel Quad-Core Intel Xeon processors with the ruggedized design features of the Themis RES server family. Designed to perform in environments where other systems fail, the new RES-12XR3, RES-22XR3 and RES-32XR3 servers blend the latest processor technologies with Themis' proprietary thermal and mechanical design to deliver outstanding performance and reliability.

Offered in compact, 1RU, 2RU and 3RU

in short, light (20-inch aluminum) chassis, these new servers feature more memory—up to 144 Gbytes—and up to eight lockable and removable drives, hot swappable fans and hard disk drives, single or redundant power supply options, and optional front panel filters for increased reliability in field deployments. These new systems combines the Quad-Core Intel Xeon 5500 series processors (Intel Nehalem Microarchitecture) with Themis' advanced thermal and mechanical design techniques to provide users industry-leading SWAP (Size, Weight and Power), RAS (Reliability, Availability and Service), storage and I/O configurability.

Themis Computer
Fremont, CA.
(510) 252-0870.
[www.themis.com].

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VME SBC Serves Up Low Power Core 2 Duo

The Core 2 Duo has become among the most prevalent CPUs in new embedded computer designs in the past couple of years. Its mix of performance and low power makes it much sought after. Themis Computer has announced its new LV1, a high-performance, VME SBC. The LV1 base configuration includes: Intel Core 2 Duo processor, four Gbytes of DDR II memory, three Gigabit Ethernet ports, three SATA II ports, four USB 2.0 ports and two XMC/PMC slots. An onboard ATI ES1000 video controller is provided with either front or rear panel VGA access. Storage can be provided through the use of an onboard CompactFlash or with an optional on-board SATA drive. The board includes optional VITA-41 dual-Gigabit Ethernet to support the modern highly networked environments.

Environmental features of the board in a temperature range of -5° to +55°C, humidity rating of 0 to 95 percent (non-condensing), shock rating of 30G at 40mS (operating) and vibration 10-2000 Hz, 0.90G (rms) (operating). The LV1 has extensive I/O. The base configuration includes three Gigabit Ethernet ports, three SATA II ports, and four USB 2.0 ports. The LV1 VMEbus SBCs will be available for evaluation in December.

Themis Computer, Fremont, CA. (510) 252-0870. [www.themis.com].

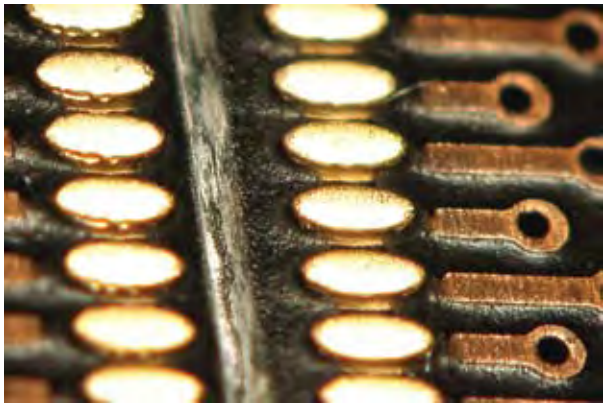
Multi-Channel Gbit Ethernet Data Recorder Boasts 500 Mbytes/s of Streaming

Applications like instrumentation recording, mission recording and SIGINT/ELINT recording depend on the integration of high-speed data recording and data logging capabilities. Curtiss-Wright Controls Electronic Systems has introduced the new Vortex SDRxE, a fixed-featured off-the-shelf multi-channel Gbit Ethernet streaming data recorder system for demanding sensor-to-processor streaming data applications. The Vortex SDRxE combines a uniquely equipped 3U controller with a reliable, scalable storage subsystem. This rack-mountable data recorder can record up to four channels of GbE data at 125 Mbyte/s per channel.

The newest member of Curtiss-Wright Controls' comprehensive Vortex family of data recorders, the Vortex SDRxE enables high-volume, continuous streaming recording of GbE data. Other Vortex SDR products support the recording of 10 Gbit Ethernet and Serial FPDP protocols at line rates, without interruption, from sensors such as radar, sonar, FLIR, RF tuners, MRI and cameras. For extreme applications requiring rugged storage, the Vortex SANbric system supports rotating FC disks. With sixteen 450 Gbyte FC disks, a single SBOD provides 7.2 Terabytes of storage. With four channels of 125 Gbyte/s GbE data, the Vortex SDRxE can support nearly 4 hours of recording time. To increase record time only requires the addition of another SBOD. Highly reliable enterprise class, FC disks are designed for 24/7 service with MTBF of greater than 1,600,000 hours. Availability is 3Q 2009.

Curtiss-Wright Controls Embedded Computing, Leesburg, VA. (703) 737-3660. [www.cwcembedded.com].

Adapters Support BGA ICs of Any Pitch to 0.40 mm Pitch Boards



It's a constant challenge to keep up with and mitigate the impact of component obsolescence in the military industry. ICs often move on to tighter packaging schemes forcing board designers to weigh the question of whether or not to redesign their boards to accommodate. Addressing just that sort of issue, Aries Electronics has expanded the line of Fine Pitch Bump Adapters to include adapters that accommodate boards with pitches down to 0.40 mm. As part of the Correct-A-Chip series, the new Fine Pitch Bump Adapters allow customers to use higher pitch devices on smaller pitch boards.

The adapter tops have landing pads that can be designed to accept any device on any pitch and easily settle into fine pitch footprints including Thin-Shrink Small Outline Packages (TSSOP) and Quad Flat Packages (QFP) with pitches down to 0.40 mm. In addition, the adapter bottom has raised connection pads up to 0.010 inch (0.25 mm) that provide easy mounting of the adapter to the target board. Pricing for the Fine Pitch Bump Adapters for a typical application starts at $15 per adapter in quantities of 100.

Aries Electronics, Bristol, PA. (215) 781-9956. [www.arieselec.com].

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3U Power Supply Marries Wide Input Range, Rugged Package

Board-level power supplies provide system designers with complete modular solutions for slot-card military systems. An example is Aitech Defense Systems' P230, a rugged, 3U, conduction-cooled, high efficiency power supply that operates over a continuous input voltage range of 18 VDC to 36 VDC. The P230 provides four industry-standard isolated voltage levels of +3.3V, +5V, +12V and -12V at up to 10A, 20A, 9A and 1A respectively, or a combined total power capacity output of up to 150W, with an efficiency of better than 85 percent. This makes the P230 suited for use in a number of small form factor, robust and rugged VME-, CompactPCI- and VPX-based subsystems for high-reliability, embedded computing applications.

The DC-to-DC converters are equipped with internal thermal shutdown circuitry to protect them from damage due to potential system overheating. Mechanical and thermal construction includes a protective aluminum housing for mechanical ruggedization, EMI/RFI shielding and thermal conduction of heat to the system enclosure. A chemical conversion coating provides maximum heat transfer and corrosion resistance on thermal interface surfaces. Wedge-locks hold the P230 in place and clamp it to the enclosure's thermal rails for optimum heat transfer, and extractors are included on the P230's top panel for easy removal. Military-rated models operate at temperatures from -55° to +85°C (at the heat sink) when running at 85 percent of maximum rated power, and up to +75°C when operating at full rated power.

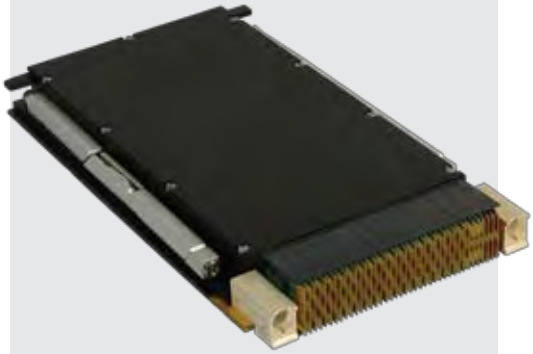
Aitech Defense Systems, Chatsworth, CA. (888) 248-3248. [www.rugged.com].

6U VPX Ethernet Switch Offers Full-Wire Speed Switching

The military has warmed completely to Ethernet, both as a network technology and as a fabric interconnect. Elma Electronic now offers a highly innovative 6U VPX 28-port Ethernet switch that provides full-wire speed switching of up to 125 Mbits/s, with 24 1 Gigabit Ethernet (GigE) ports and up to four 10 GigE ports. The new fully managed ComEth 4340a switch, available from Elma in North America, supports Layer 2 bridging and Layer 3 IPv4/v6 Unicast and Multicast routing with Layer 2 through Layer 4 advanced traffic classification, filtering and prioritization. It is ideal for applications requiring strict data prioritization and filtering, and advanced traffic classification traffic monitoring required by demanding network applications, as well as delay-sensitive and critical environments.

The ComEth 4340a offers flexible port options: four of the 24 GigE ports and two 10 GigE ports come out the front of the switch; 16 ports are accessible via the rear of the switch and are configurable in groups of four as 1000BT or 1000Kx ports. Accessible via a browser, CLI or SNMP, the new ComEth 4340a is easily managed, and a comprehensive built-in test suite provides simple maintenance and added security. Pricing for a ComEth 4340a Ethernet Switch starts at $8,500 in single quantities.

ELMA Electronic, Fremont, CA. (510) 656-3400. [www.bustronic.com].



AtomZ530 Rides OpenVPX 3U VPX-REDI Board

A lot of momentum has gathered around the newly completed OpenVPX specification. Concurrent Technologies has introduced a low-power 3U VPX-REDI SBC, the TR A40/30x RC, designed to comply with the OpenVPX VITA 65 standard. The TR A40/30x RC utilizes the 1.6 GHz Intel Atom processor Z530 and the highly integrated Intel System Controller Hub US15W both from the Intel embedded roadmap, ensuring long-term availability. The board supports up to 2 Gbytes DDR2-533 soldered SDRAM and a wide variety of I/O interfaces, including a CANbus interface, yet maintains a typical power requirement of less than 10W.

The RC-Series TR A40/30x RC is a VPX REDI Type 1 Two Level Maintenance conduction-cooled board with support for Built In Test (BIT). The TR A40/30x RC SBC provides a flexible PCI Express OpenVPX backplane fabric interface that can be configured for several OpenVPX slot profiles from 8 x1 PCIe ports through to 2 x4 PCIe ports. The VITA 46.0-compliant TR A40/30x is an air-cooled SBC designed for non-rugged environments operating over a temperature range of 0 to 55°C. The pin-compatible TR A40/30x RC is designed as a conduction-cooled SBC for rugged environments and operating over temperatures of -40° to +85°C and at altitudes from -1,000 to 50,000 feet.

Concurrent Technologies, Woburn, MA. (781) 933 5900. [www.gocct.com].

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PXI Digital I/O Card Sports 150 MHz FPGA

FPGAs have touched nearly every segment of military electronics, and the PXI instrumentation world is no exception. Expanding on its line of 3U PXI dynamic digital I/O cards, Geotest now offers a user-configurable FPGA 3U PXI card that features 160 digital I/O signals for specific application needs. The new GX3500 employs the Altera Cyclone III FPGA that supports clock rates up to 150 MHz and features over 55,000 logic elements.

The GX3500 is a user-configurable FPGA 3U PXI card that offers 160 digital I/O signals for specific application needs. The card employs the Altera Cyclone III FPGA, which can support clock rates up to 150 MHz and features over 55,000 logic elements and 2.34 Mb of memory. The GX3500's four banks of 40 digital I/O signals can be selectively isolated from the I/O connectors under software control. The signals are 5-volt tolerant and can be configured to support differential or single-ended operation. Logic families supported by the I/O interface include LVTTL and LVCMOS. The FPGA device supports up to four phase lock loops for clock synthesis, clock generation and for support of the I/ O interface. An onboard 80 MHz oscillator is available for use with the FGPA device or alternatively, the PXI 10 MHz clock can be used as a clock reference by the FPGA.

Geotest-Marvin Test Systems, Irvine, CA. (949) 263-2222. [www.geotestinc.com].

DC-DC Converter Features Parallel Capability

Creating a military power subsystem is a game of building blocks, where flexibility and scalability are top priorities. Along such lines, VPT has introduced a new DC-DC converter module: the VPT100+ 2800 Series. With up to 100W of output power per unit, this new commercial-off-the-shelf (COTS) converter offers parallel operation of up to five units to enable the fast, easy, affordable creation of high-power systems.

The device provides up to 100W output power per unit. Single outputs voltages are 3.3V, 5V, 7V, 12V, 15V and 28V and dual output versions offers +/-12V and +/-15V. Efficiency is very high—up to 91 percent—with very low output noise. A wide input voltage range accommodates MIL-STD-704 input power requirements for avionics and other high-reliability applications. Extremely efficient in a tiny, quarter brick size, the VPT100+ saves valuable space and weight in a power system. The device meets MIL-STD-461C/D/E conducted emissions requirements when used with a VPTF Series EMI filter. Units are priced at $183.79 each at OEM quantities.

VPT, Blacksburg, VA. (540) 552-5000. [www.vpt-inc.com].

PCIe Digital I/O Card Boasts State Change Detection

PCI Express is one of the fabric interconnect technologies that has made high-performance military data acquistion a desktop PC-driven application. ACCES I/O Products has made a new addition to its PCI Express family of products—Model PCIe-DIO-48S. The board is a 48-channel PCI Express (PCIe) card designed for use in a variety of digital I/O applications. The digital I/O is compatible with 8255 PPI (mode 0), making it easy to program and migrate from other ACCES PCI digital I/O cards. The card features a x1 lane PCI Express connector, which can be used in any x1 or higher PCI Express slot. The PCIe-DIO-48S is excellent for use in applications sensing inputs such as switch closures, TTL, LVTTL, CMOS logic and controlling external relays, driving indicator lights and more.

Connections to the card are made via two industry standard, 50-pin headers. Each header has three 8-bit I/O ports designated A, B and C. Each port can be programmed as inputs or outputs. Change of State (COS) detection and interrupt capabilities are designed to relieve software from polling routines that can consume valuable processing time. Each port can be programmed for detecting state changes on their lines. The PCIe-DIO-48S (48-Channel PCI Express digital I/O card) is priced at $379. The PCIe-DIO-24S (24-Channel PCI Express digital I/O card) is priced at $279.

ACCES I/O Products, San Diego, CA. (858) 550-9559. [www.accesio.com].

1U LCD Keyboard Drawers are Military Rugged

Because they're typically cast in mission-critical roles, military keyboards need a whole lot of reliability. Chassis Plan's CCX-17 and CCX-19 1U rackmount LCD keyboard drawers are military grade, providing rugged 5052-H32 aluminum construction and 17- or 19-inch 1280x1024 resolution. The units boast a bonded Anti-Reflective glass contrast enhancement filter and NEMA-4 / IP65 sealed keyboard. Three military-grade Genesis LCD controllers are available providing a mix of features with aRGB VGA, DVI-D, DVI-D and video inputs. Picture-In-Picture is supported in one of the controllers. The controllers are conformal coated for environmental and shock/vibration protection and support operating temperatures of -40° to +80°C.

The silicon rubber keyboard provides full travel with tactile feedback for ease of typing. The keyboard is sealed to NEMA-4 / IP65 standards and is spill proof, important where Coke and coffee are routinely spilled on these in use. A sealed pointing device is built into the keyboard. A wrist pad is provided to make typing more comfortable. The systems are designed to meet and are being tested to 901D and 810G. Native power is +12 VDC and a rack mount 110/220 VAC supply is provided. Options are available for a vehicular 12 VDC transient filter, MIL-STD-704/1275 28 VDC power and -48 VDC inputs. All components were selected for long availability for assured consistent delivery through multi-year programs.

Chassis Plans, San Diego, CA. (858) 571-4330. [www.chassis-plans.com].

SRAM MCM Family Provides Rad-Hard Operation

As memory chips are getting denser, the problem of radiation-based failures becomes more acute. Serving those needs, Aeroflex has rolled out six new members to its HiRel SRAM MCM (Multi-Chip Modules) memory family. With the completion of the 16M/20M Monolithic SRAM, Aeroflex will leverage this basic building block to create six new SRAM MCMs in a single universal 132 CQFP (ceramic quad flatpack) ranging from 32 Mbits to 160 Mbits.

The 132-lead package integrates up to eight 16M or 20M memory die using both cavities of the 132-lead ceramic flatpack package. This technique increases bit density, saving space and weight and provides high-speed (15ns) access. All products offer 100 krad(Si) total dose operational environment and are SEL immune to 111Mev-cm2/mg. The first product offerings, the UT8ER1M32 and UT8R1M39, will be offered in a 132-lead flatpack, Q and V qualified and will be available to a Standard Microcircuit Drawing. Prototypes are available now, with production in 4Q09. The UT8R1M39 is $5,013, QML Q, in lots of 100. The new 64 to 160 Mbit SRAM MCMs will be available as prototypes in 2Q10.

Aeroflex, Colorado Springs, CO. (719) 594-8000. [www.aeroflex.com].

1U Isolated Rugged UPS Has Hot Swap Batteries

Deployed military units are depending more and more on computing and networking, and often that calls for super reliable and rugged Uninterruptible Power Supply (UPS). IntelliPower has added new 1U Rack Mount 625VA and 800 VA models of its popular Global Input Isolated Double Conversion On Line High Temperature Rated Bright Uninterruptible Power Supply (UPS) family with Hot Swappable batteries.

The field-proven fully isolated 1U rugged model includes autoselect for inputs of 115 or 230 VAC, 50/60 Hz, with Power Factor Correction with an output of 115 VAC or 120 VAC. Output frequency can be 50/60 Hz as a frequency follower or fixed at 60 Hz. The output inverter can handle high surge loads of 40A plus without needing to use bypass and it is rated for -10° to +50°C. This model includes batteries to support a 500W load for 14 minutes and communications capabilities include SNMP or RS232. This very compact 1U UPS has been tested to meet MIL-STD-461E CE101, RS103, FCC Class A as well as MIL-STD-810F for shock and vibration mounted in a tactical transit case.

IntelliPower, Orange, CA. (714) 921-1580. [www.intellipower.com].

Mini-ITX and Pico-ITC Cards Serve Up High-Def Video

The military's migration to net-centric operations is boosting demand for advanced display nodes all across that network. The Via EPIA P720 Pico-ITX board and the Via Trinity-powered Via VB8003 Mini-ITX board from Via Technologies employ the latest HD H.264 and VC1 codecs that are quickly gaining traction. The Via EPIA P720 is a 10 cm x 7.2 cm Pico-ITX board that features the latest Via VX855 system media processor, designed specifically to deliver smooth playback of the latest high-res video formats through hardware acceleration, leaving the board's Via Eden ULV 1.0 GHz processor free to focus on other tasks.

Via EPIA P720 Specs include the Via Eden ULV 1.0 GHz combined with Via VX855 MSP chipset, 44-pin IDE header, 1 S-ATA connector, Gigabit LAN, VT1708B audio codec. Back panel I/O includes HDMI and VGA ports, RJ45 and two USB 2.0 ports. Pin headers provide additional four USB 2.0 ports, an LPC connector, SMBus, PS/2, single channel LVDS, Digital IO, UART, audio, S-ATA II and power connectors. The Via VB8003 Mini-ITX board features the Via Trinity Platform, and is targeted as a high-end multimedia platform. Combining a 64-bit Via Nano processor, the Via VX800 media system processor and a dedicated S3 Graphics processor, the Via Trinity platform brings high-definition video playback and a DX10.1 graphics engine to multiple displays. Powering true 1080p HD content playback across multiple displays, the Via VB8003 Mini-ITX board supports a variety of onboard display technologies in a range of flexible configurations including dual HDMI, LVDS, DVI and VGA.

Via Technologies, Fremont, CA. (510) 683-3300. [www.via.com.tw].

Atom-Based Edge Controller Offers Java Middleware Framework

The Atom processor has been a success in the military. It fits perfectly in with the defense industry's drive to reduce size, weight and power in mobile applications. A highly configurable edge controller platform from Eurotech offers data access and control on the edge of the cloud, to aggregate and deliver data from edge devices, pervasive sensors and distributed monitors to the network core for further analysis and action. The Helios platform from Eurotech offers new advances in flexibility with the ability to select an Intel Atom Series Z5xx processor-based configuration, at up to 1.6 GHz with memory and video display options.

Connectivity choices include wired or pre-certified wireless network services for devices for cellular, Bluetooth, Wi-Fi access within the secure and rugged USB bay area. The Eurotech Helios platform can be equipped with the Eurotech ESF middleware to offer an easily programmable edge controller system. With ESF, OEMs have a Java-based middleware framework as a starting point for their application coding, leading to faster time-to-market and ultimately, future-proofing and greater market success. Helios will be generally available in the first quarter of 2010.

Eurotech, Columbia, MD. (301) 490-4007. [www.eurotech.com].

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5-Slot 3U VPX REDI Backplane Features I/O Flexibility

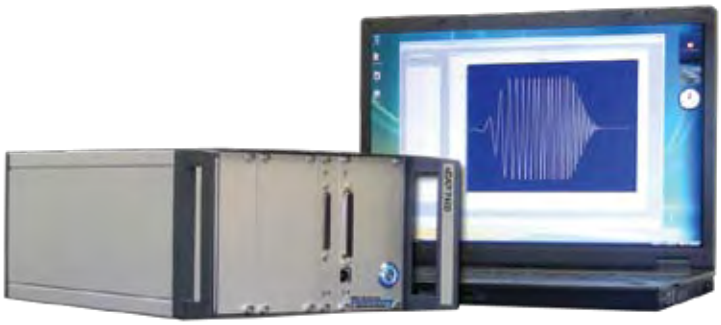
VPX is starting to catch hold, as the military looks for the next level of system performance. SIE Computing Solutions offers an enhanced 5-slot I/O Plus 3U VPX full mesh backplane that's suitable for a wide array of VPX applications. The highly configurable VPX REDI backplane offers high bandwidth in a compact size and provides greater I/O flexibility through I/O PLUS, which uses configurable I/O daughter cards to accommodate an array of VPX applications. I/O Plus brings two high-speed VPX connectors to the front edge of the board and utilizes two interchangeable daughter I/O cards, reducing the need for custom backplanes for each VPX application. The backplane design incorporates 10 fat pipes / high-speed differential channels on the J1 connector and 16 fat pipes as well as 20 single-ended signals on the J2 connector.

The backplane is capable of delivering over 200W of power per VPX slot. SIE Computing Solutions also offers standard and custom ATR rugged enclosures featuring convection, conduction, air-over conduction or liquid-cooling requirements to meet the demanding cooling requirements for a variety of thermal loads. The 5-slot 3U VPX REDI backplane is suitable for deployment in aerospace and vetronics military applications where high performance and the small 3U form factor are mandated.

SIE Computing Solutions, Brockton, MA. (800) 926-8722. [www.sie-computing.com].

USB Data Acq Processor Does Simultaneous Sampling

Military systems have become so complex that doing test and data acquistion on them requires as much automation as possible. A new semi-autonomous data acquisition system from Microstar Laboratories can—after programming—run independently from its host PC. PC software communicates with, configures and controls the system, but xDAP 7400 can be set up to run for long periods or indefinitely without any connection to a PC. With an application using a software trigger, data can be selected for processing automatically, and the host PC can be disconnected.



Each xDAP 7400 includes a 16-bit analog-to-digital converter running at 1 million samples per second on each of 8 channels simultaneously, for a throughput of 8 million samples per second. One gigabyte of local memory provides space for data buffers that let xDAP 7400 sustain this throughput indefinitely, transferring samples to the PC as required, with no loss of data. Recent tests have confirmed not only continuous transfer to a PC at the full 8 million samples per second, but also continuous disk-logging of the data. The new hardware costs $5,995 and is available now.

Microstar Laboratories, Bellevue, WA.
(425) 453-2345. [www.mstarlabs.com].

VME/VXS Signal Generator Boasts Eight 1.2 GSPS Channels

Applications such as beam-steering, simultaneous multi-signal generation for communications and radar systems have one thing in common: they're hungry from ever more high-performance multi-channel signal generation. A new FPGA-based multi-channel signal generator from Tek Microsystems offers eight 14-bit synchronized data streams at 1.2 Gsamples/s analog outputs from an FPGA-based board utilizing three Xilinx Virtex 5 FPGAs in a single 6U VME / VXS slot.

The Charon-V5 uses the 1.2 Gsample/s Analog Devices AD9736 14-bit DAC to generate multiple signals at bandwidths of up to 600 MHz. The eight 14-bit DAC digitizer channels are each combined with three Xilinx Virtex-5 FPGAs in a single VME/VXS payload slot. The front-end FPGAs are typically two SX95T devices generating eight channels of analog output data coupled with a back-end FPGA for multichannel processing and backplane communications. To meet application requirements, the back-end FPGA can be configured with any Xilinx Virtex-5 FPGA in the FF1738 package, including the SX240T with over 1,000 DSP48E slices for signal processing applications. In addition to the analog outputs, there are six high-speed serial fiber or copper I/O channels on the front panel as well as fabric and network connectivity via the optional P0 VXS backplane connector.

TEK Microsystems, Chelmsford, MA. (978) 244-9200.
[www.tekmicro.com].

2U Acceleration Platform Supports Eight PCIe I/O Cards

Graphics processing units (GPUs) combined with advanced switched fabric interconnects are emerging as an interesting technology option for processing massive sets of data in military systems. But they require a system architecture that serves those needs. One Stop Systems offers a 2UPCI Express acceleration platform that supports up to eight PCIe x16 Gen 2 I/O cards. There are three versions of acceleration platforms that include either one or two PCIe x16 Gen 2 interfaces, allowing more than one host computer to access cards. Host cable adapters and one-meter cables are included with the platform. The 2U platform supports both single-wide and double-wide boards. Dual 850W power supplies provide redundant power for GPUs or other high-speed I/O cards requiring high power output.

The 21-inch chassis allows all boards to be accessed through the rear, allowing cables to be connected to I/O ports. Removable trays allow easy installation of any full-length PCIe x16 add-in boards. The three versions of the 2U accelerator are the "4-1" which supports four double-wide cards with a single PCIe x16 interface, the "4-2" supporting four double-wide cards with two PCIe x16 interfaces, and the "8-2" supporting eight single-wide cards with two PCIe x16 interfaces. OEM volume pricing starts at $2,395.

One Stop Systems, Escondido, CA. (877) 438-2724. [www.onestopsystems.com].

100-150W Supplies Meet Energy Efficiency Standards

Power efficiency is becoming a huge concern in all industries, and the military is no exception as the DoD seeks to keep its own energy costs under control. TDK-Lambda offers a new range of AC-DC external power supplies with models rated from 100 to 150W to meet the latest Energy Star, EISA and CEC standards. The DT100-C and DT150-C series feature active PFC (meets EN61000-3-2) and operate from a universal AC input of 90 to 264 Vac (47-63Hz). Available output voltages include 12V, 16V, 19V, 24V, 36V and 48V.

These external power supplies are packaged in an insulated compact and lightweight enclosure measuring 3.35 inches wide by 6.7 inches long by only 1.73 inches high and are convection cooled (no fans needed). The operating temperature range is 0 to +40°C with no derating required. All models are fully isolated (3 kVac, input to output) and meet the Energy Star 1.1 and the California Energy Commission (CEC) level IV efficiency standards. Plus, models with outputs of 24V to 48V meet the Energy Star 2.0 version level V standards. The DT100-C and DT150-C series are available now and priced from $40.50 each in OEM quantities.

TDK-Lambda, San Diego CA. (619) 575-4400. [www.us.tdk-lambda.com].

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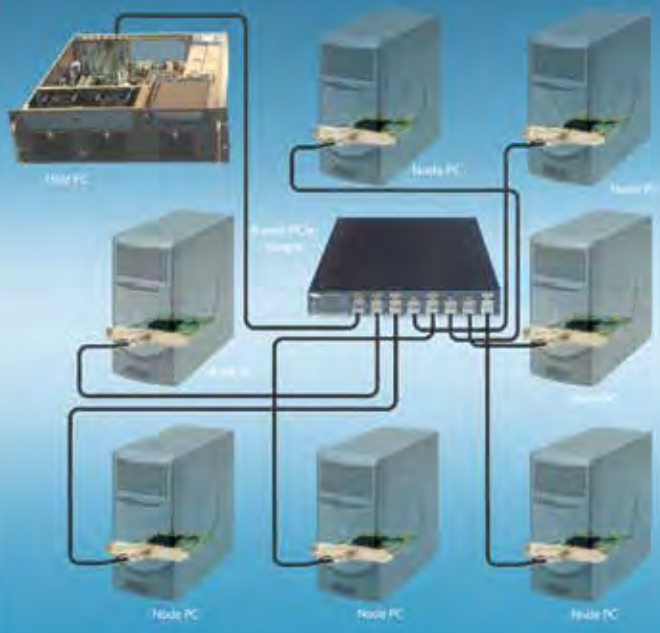

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USB Data Acquisition Module Delivers 800 kHz per channel

Gone are the days when military data acquisition systems required large racks of systems. The same functionality can now be done using USB-based modules. Data Translation has rolled out a multifunction, high-throughput, simultaneous USB data acquisition module that allows the user to sample six analog input channels independently at up to 800 kHz per channel. The DT9816-S from Data Translation is the latest addition to the ECONseries of USB data acquisition modules, providing a flexible yet economical series of multifunction data acquisition products. In addition to an extremely high throughput rate of up to 800 kHz per input channel, the DT9816-S offers a full set of features including eight digital input lines, eight digital output lines and a 16-bit counter/timer.

In addition to simultaneously sampling inputs at throughput rates up to 800 KHz per channel or 4.8 MHz total throughput across 6 channels, the DT9816-S provides a 16-bit resolution analog input subsystem with signal sampling ranges of +/-10V and +/-5V. Event counting is supported with one 16-bit counter/timer and eight digital input and eight digital output lines support monitoring and control. The unit runs off a standard USB connector and is housed in a shielded, rugged enclosure for noise immunity. The DT9816-S is priced at $595.

Data Translation, Marlboro, MA.
(508) 481-3700. [www.datatranslation.com].

VC1-250-SSD Conduction Cooled VME Solid State Disk

Phoenix International's VC1-250-SSD Conduction Cooled Serial ATA (SATA) based Solid State Disk VME blade delivers high capacity, high performance data storage for military, aerospace and industrial applications requiring rugged, extreme environmental and secure mass data storage.

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Calex	57	www.calex.com
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Curtiss-Wright Controls Embedded Computing	80	www.cwcembedded.com
Daitron Inc	73	www.daitron.com
Data Bus Products Inc	63	www.databusproducts.com
DRS Technologies	25	www.drs-ss.com
Extreme Engineering Solutions, Inc.	53	www.xes-inc.com
General Micro Systems, Inc.	9,20,21	www.gms4sbc.com
Innovative Integration	22	www.innovative-dsp.com
Interface Concept	36,61	www.interfaceconcept.com
Kontron America	17	www.kontron.com
Lauterbach Datentechnik Gmbh	15	www.lauterbach.com
Lind Electronics, Inc	73	www.lindelectronics.com
Mercury Computer Systems	29	www.mercury.com
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National Instruments	45	www.ni.com
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Ocean Server Technology	24	www.ocean-server.com
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Rave Computer	28	www.rave.com
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Special Feature: Control and Comms Trends for Small UAVs The flight control, mission control and communications gear aboard Small UAVs—like the Raven, Dragon Eye, Shadow and Killer Bee—face some of the most rigorous size, weight and power restrictions. Selecting the right small form factor board in those systems becomes a make or break decision. This section focuses on the electronics aboard UAVs under 1,320 pounds and range from Line-of-sight control UAVs up to those that fall under the "light sport aircraft" standards.

Tech Recon: Processor Boards: Pushing the Mips-per-mW Curve Compute-density has become the watchword in many segments of military system design. More and more programs are pushing for as much computer processing muscle as can possibility fit into a board-level solution. Feeding such needs, embedded computer vendors are focusing not just on raw performance but on "Mips-per-mW," seeking the right balance of processing and power consumption. The section examines the latest trends in high-performance SBCs in a variety of form factors, including VME, VPX, VXS, ATCA, Compact PCI, PrPMC and others.

System Development: HALT, HASS and ESS Analysis for Embedded Boards Relying on outdated Mil-Spec guidelines like MIL-STD-810F is no longer sufficient, and full environment stress screening (ESS) techniques like HASS and HALT have moved into the forefront. As these techniques gain acceptance, military programs have become eager to use the HALT/HASS methodologies for both cost and schedule reasons. Articles in this section delve into those areas and compare the solutions available.

Tech Focus: XMCs and Processor XMCs XMCs are becoming entrenched as the natural successor to PMC as the leading mezzanine form factor in military applications. Meanwhile, fabric-based Processor XMCs accommodate that trend nicely, enabling military system integrators to swap out just the computing core and leave the base board unchanged. This Tech Focus section updates readers on these trends and provides a product album of representative XMC and PrXMC products.

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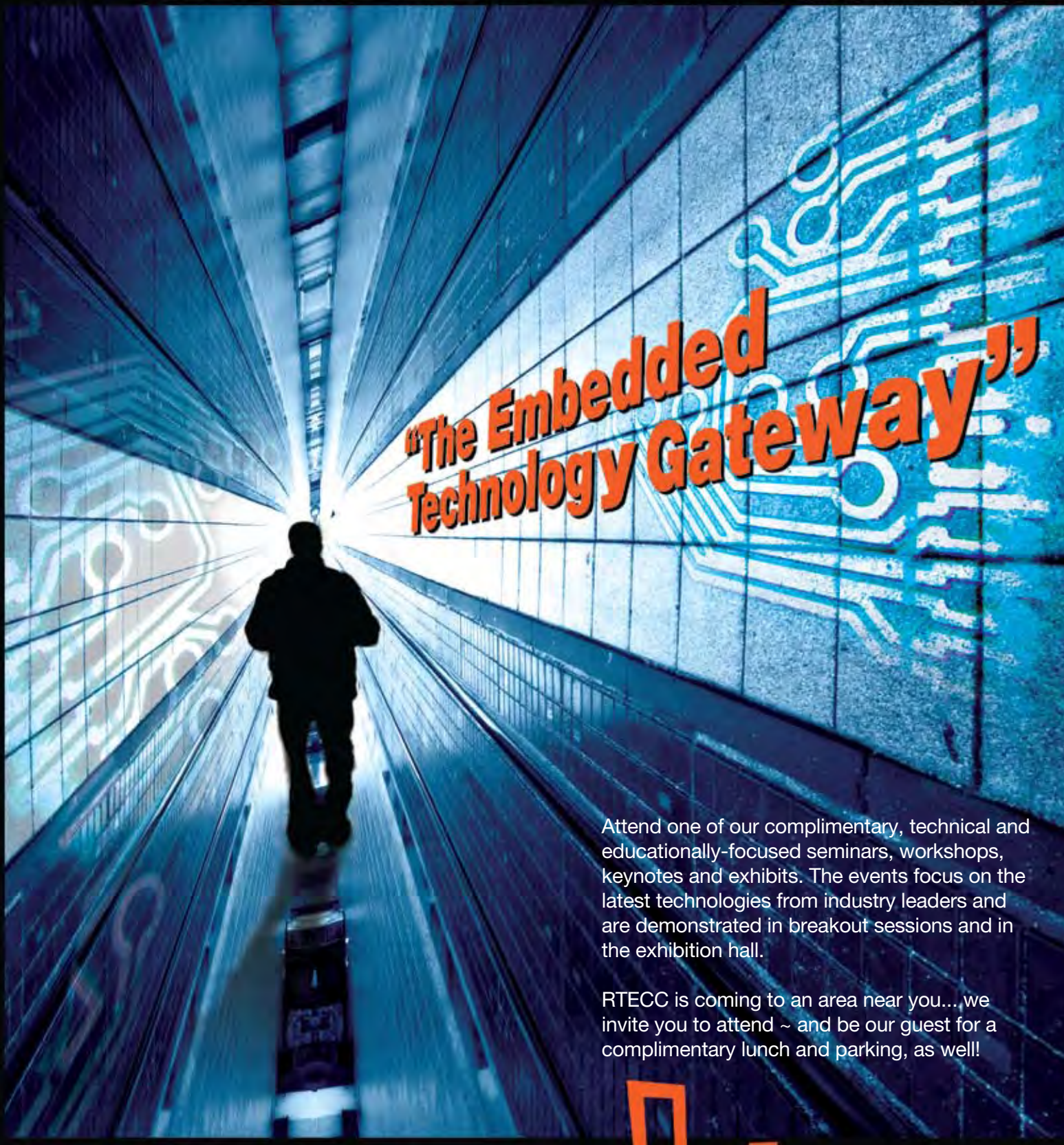

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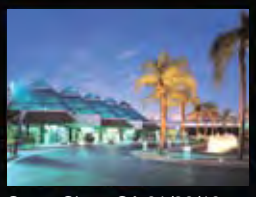
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Editorial

Jeff Child, Editor-in-Chief

Five That Push the Computing Envelope

Somehow every year I find it an absolute shock that the month of January falls immediately after December. You'd think my many years in the publishing industry would help me get wise to this disturbing truth. In the world of monthly magazines, just when the rest of the world seems ready to take a break, you've got a January issue on deck that not only needs attention, but special attention—it being the issue to kick off the year. Fortunately this time around I'm more fired up than usual to dive into the new year. This coming January we've even upped the ante a bit, doing our first in a series of 2010 Target Reports: special sections that explore highly relevant military technology themes that are key to our marketplace.

Our January Target Report theme is: Spotlight on the Five Most Compute-Intensive Defense Application Areas. The drive for ever more compute density has become the mantra for many of today's advanced military programs. More and more of system functionality is now implemented as software running on single board computers, replacing legacy systems based on hard-wired electronic assemblies. In this feature we pick out the five most compute-intensive military applications and explore how today's crop of embedded computer form factors and technologies is serving their needs.

As we work to prepare this special section, we're almost done weeding through the options in order to settle on which application areas will be "The Five." But it's already clear that the general desire for autonomous operations, along with real-time, or closer to real-time decision making are the driving factors. Automatic Target Recognition, for example, is in some ways a fairly established technology. But systems that can acquire and track targets completely autonomously, and do so when the target and shooter are moving, is a whole different level of computing task. Signal Intelligence (SIGINT) is another area where added computing muscle serves an endless appetite for security-critical data sifting.

In general, military UAVs and their payloads are by definition compute intensive, and will only become more so. Tasked to capture and download secure, encrypted surveillance data, today's advanced surveillance UAVs require a lot of communications overhead. At present, U.S. military recon UAVs relay almost all UAV captured data to the ground to process it for interpretation and decision making. The goal is to make use of onboard processing muscle to enable UAVs to instead relay the results of their data processing to the ground for decision making. The benefit is reduced reliance on data link rates in certain applications, particularly imagery collection. In today's UAVs, image formation is done in the air and then sent down. For payloads of the future, the trend is toward fusing data and sending down just the things that are different than the established data base—or some other way of compressing and fusing the information. All of this helps overcome the defining constraint for these systems: the limitations of data link bandwidth.

Meanwhile, waveform-intensive applications like radar and SIGINT seem to have no end to their appetite for signal processing power. Faster DSPs coupled with a broader range of IP cores and development tools for FPGAs are joining forces to form new DSP system architectures. Using those building blocks, board-level subsystems must quickly acquire and process massive amounts of data in real time. As FPGAs evolve to ever greater sophistication, complete systems can now be integrated into one or more FPGAs. That in turn means that the rack and backplane-based systems based on FPGAs offer the compute muscle of yesterday's supercomputers. Modern radar systems are operating over an ever increasing frequency range. Analog conversion technology—both A/D and D/A converters—are also feeding the radar needs of the military.

System developers can now build radar receiver systems with a higher instantaneous bandwidth thanks to the converters, and can handle the corresponding increase in compute power required to process the received data streams using FPGAs. The ASIC-based radar design approaches of the past can achieve the performance needed, but that path lacks the flexibility inherent in designs based on FPGA technology. A wealth of FPGA board-level products are available aimed specifically at this area.

This focus of computer-centric military applications is, we think, right in synch with the direction upcoming DoD budgets will shift to. It's too early to say for sure, but it's likely that the overall DoD budget will shrink in the coming year. But even as the political landscape changes, and forces within the government drive that budget down, the embedded computer component of the overall DoD budget is going to increase dramatically—a trend that's been occurring consistently now for several years.

If you have some thoughts on what you think should be among the top five military application areas, it's not too late to drop us a line. But do it quickly. I know it's hard to fathom, but January 2010 is indeed just around the corner.

With the September issue of COTS Journal *we mailed our special COTS Product Manufacturers Index. We neglected to include Mercury Computer Systems in the "Computing Product Suppliers" section of the list (although we did include them in the "Communications and I/O Product Suppliers section"). We apologize for the oversight. The mistake has been corrected in the online version of the Index at www.cotsjournalonline.com/pages/product_index*

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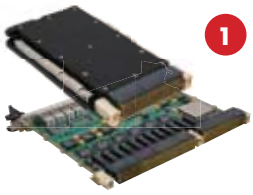
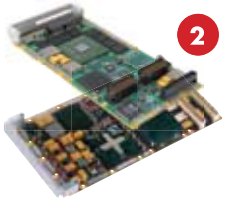
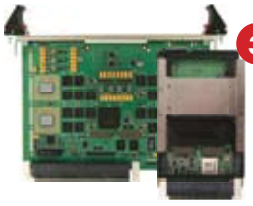


1 **Vehicle-wide Interconnects**
Network Switches & Security
VPX3-683 & VPX6-684 (VPX)



2 **Commander's Display Unit**
Video & Graphics
XMC-710 (XMC) & Modified COTS (PMC)



3 **Image Processing**
Digital Signal & FPGA Processors
CHAMP-AV6 & VPX3-450 (VPX)

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4 **System Control**
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5 **Image Control & Video Recording**
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6 **FLASH Storage**
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