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SOSA: Setting the Future Course of Embedded Military Electronics Systems

by Rodger Hosking
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IN THIS ISSUE

What is Open Systems Architecture (OSA)?

In 2013, the U.S. DoD issued a mandate to incorporate Open Systems Architecture principles within procurement requirements for defense hardware and software. OSA requires the use of existing open standards for well-defined, modular hardware and software components that can be sourced from multiple vendors. Once proven, hardware platforms should be reusable for quick reaction mission needs, feature upgrades, and new technology insertion. These advantages reduce development risks and help ensure significantly longer operational life-cycles.

How Did DoD Services Respond to the OSA mandate?

In response, each of the three primary U.S. services (Army, Navy, and Air Force), began developing standards that embraced OSA principles to meet future procurement needs of deployed systems for their respective services. The Army's CCDC (Combat Capabilities Development Command) in Aberdeen, MD developed CMOSS (C4ISR/EW Modular Open Suite of Standards), which is based on other open standards including OpenVPX, MORA, VICTORY, REDHAWK and SCA.

The Navy's NAVAIR (Naval Air Systems Command) in Patuxent River, MD created HOST (Hardware Open Systems Technology) for airborne and ground vehicle mission systems. It divides hardware into three tiers:

- the platform (airframe, vehicle, etc.)
- the system enclosure
- boards

with the latter two tiers being subsets of OpenVPX.

The Air Force's OMS (Open Mission Systems) initiative incorporates open standards including SOA, UCI, and FACE, all for standardizing messages, command, and control mission information for avionics systems.

What Led to SOSA?

While each service made significant progress in advancing OSA principles, they did so through different initiatives that often shared many common open standards like OpenVPX, and specific mandates tailored for service-specific platform requirements.

After recognizing this common ground, the DoD and each of the services perceived a strong need to promote a single, common initiative to define acquisition activities across all three armed services. In early 2017, the DoD issued an SBIR solicitation for Sensor Open System Architecture (SOSA) Architectural Research. This resulted in the formation of the SOSA Consortium managed by The Open Group, a large organization with strict and well-defined practices, policies, and procedures for standards development efforts.

What Are the Objectives of SOSA?

Major objectives include development and adoption of open systems architecture standards for C4ISR to provide a common, multi-purpose backbone for radar, EO/IR, SIGINT, EW and countermeasure systems. Additional objectives include platform affordability, rapid fielding, re-configurability, new technology insertion, extended lifecycles, and re-purposing of hardware, firmware, and software.

The major work product of the SOSA Technical Working Group is the SOSA Technical Standard that documents the SOSA Architecture. This is a modular system structure, with tight integration within modules for encapsulating functionality and behaviors, and yet well-defined interfaces. These modules must be based on open, published standards, with consensus-based influence stakeholders directing the evolution, and a strict conformance validation process.

SOSA™
Sensor Open Systems Architecture

The Technical Standard defines specifications for plug-in cards, backplanes, chassis, electrical components, and mechanical structures largely derived from VITA standards. The SOSA Conformance Policy defines processes for qualifying products against the Technical Standard. Until the award of certification, no product can claim to be SOSA conformant. The SOSA Business Working Group defines business and acquisition practices, and creates guidance for acquisition programs.

Who Participates in SOSA?

A primary mandate of the SOSA Consortium is broad participation, commitment, and contribution from the DoD, Army, Navy, and Air Force, as well as industry, academia, and other government organizations. As of this writing, SOSA membership is headed by nine Sponsor organizations including seven from the Army, Navy and Air Force, plus two prime contractors. The 14 Principal Members are all prime US defense contractors. The 81 Associate Members include well-known systems integrators, and major hardware and software suppliers to the defense community. Members of each of these organizations play critical roles in working groups to help develop the standards and practices.

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

Membership in SOSA is restricted to US citizens and organizations so that DoD-sensitive or classified requirements can be presented by representatives from the armed services to promote solution strategies within the SOSA Technical Standard. For this reason, technical details of on-going discussions in SOSA may not be disclosed to the public. However, once the standard is approved and released to the public, it will contain only specifications and rules, free from the underlying, sensitive use drivers. At that point, anyone can develop to the standard, including companies outside the US.

Is SOSA here to stay?

Technical Standard Snapshot 3 was released in July 2020 and the SOSA Technical Standard 1.0 should be released in the second quarter of 2021. After that release, vendors who collectively have already announced dozens of "SOSA-Aligned" products then may submit them for conformance certification. Interoperability demonstrations during 2020 of these early products were highly-successful and well attended by defense customers.

Ahead of the release of the Technical Standard, the DoD has already issued numerous requests for proposals and information clearly favoring respondents that offer OSA-based solutions. Active participation in SOSA by the DoD, all three armed services, embedded industry vendors, universities, and research facilities gives evidence of their substantial commitments of resources and personnel. These clear signals ensure that SOSA is well on its way to setting the future course for embedded military electronics systems. ☐

A SOSA Advantage: SOSA Aligned Systems Can Accelerate Aircraft Upgrades

by Rodger Hosking

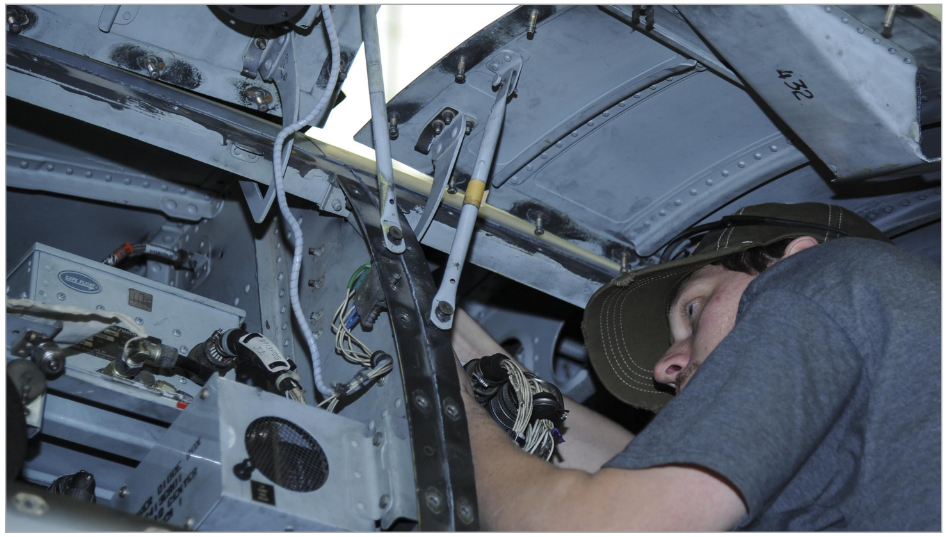


Photo credit: U.S. Air Force photo/Airman 1st Class Mya M. Crosby

How will SOSA Change the Process for Upgrading Military Aircraft?

Military aircraft avionics are traditionally a collection of subsystems, each dedicated to a particular fixed function. Each of them occupies an enclosure with well-defined dimensions, mounting points, and electrical interfaces for sensors, antennas, power supplies and control ports. Changing the function within any subsystem is often quite limited, so that an upgrade to improve performance or capabilities usually means replacing the entire subsystem with a new one. Design of the internal electronic hardware and software is invariably proprietary to the vendor.

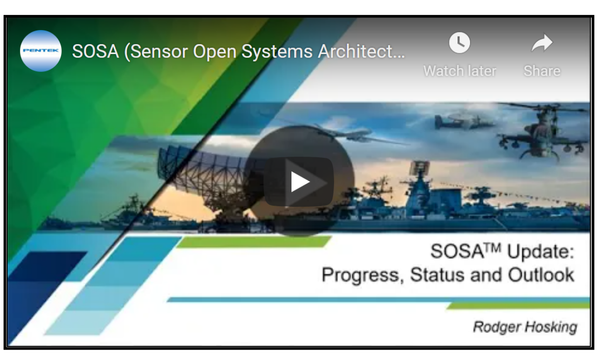
This causes several disadvantages. New technology takes a long time to find its way into the aircraft, thus hampering its warfighting effectiveness against enemy assets. The cost of upgrades is extremely high because the whole unit must be replaced. Often each subsystem is sourced from a single supplier with limited opportunities for meaningful competition.

SOSA offers significant solutions to this traditional methodology. First of all, the internal electronics, software and packaging must be based on open standard architectures, notably OpenVPX.

Upgrading a SOSA system can mean keeping the existing subsystem, but replacing one SOSA-compliant plug-in card with another to add new device technology, higher performance levels, faster computing power, and higher signal and data bandwidths. Secondly, SOSA limits the number of different plug-in card types to a very small subset of OpenVPX profiles, enhancing interchangeability across vendors and function. Finally, smaller companies can participate in the SOSA vendor community to offer competitive solutions shortly after new technology components become available.

SOSA Update: Progress, Status, and Outlook

Click the image to view an informative SOSA presentation by Rodger Hosking.



Example of Upgrading Aircraft with SOSA Components

One example might be a new EW radar countermeasure upgrade to a fighter jet that requires new algorithms and more powerful computing resources to defeat or disable enemy assets on the ground or in the air. The EW subsystem acquires signals from the enemy and then transmits countermeasure signals to confuse, disrupt, disable, destroy, or avoid detection.

As radar technology continuously advances in a leap-frog fashion to overcome the latest countermeasures, advanced signal processing techniques must keep pace to protect military aircraft. A critical factor in the effort is reducing the time required to make these upgrades, and replacing a SOSA board with one that adds the new required capabilities is a major benefit in this effort. This means the new technology is deployed years earlier than with the traditional scheme requiring replacement of the entire subsystem. □

Pentek Announces SOSA Aligned Development Platform that Speeds Integration Tasks

- Developed in alignment with the SOSA Technical Standard
- Eight 3U VPX slots for a variety of acquisition and processing modules
- Ready-to-run development platform for Pentek's Models 5550 and 5553 Eight-Channel A/D and D/A Zynq® UltraScale+™ RFSoC Processors
- Optional rear panel RF and optical connections

Pentek has announced a development platform, the Model 8256, that is aligned to the SOSA™ Technical Standard. The Model 8256 is a 3U VPX platform with IPMI and connectivity for RF and optical interfaces. The Model 8256 is ideal for application development with Pentek's Quartz® RFSoC data acquisition and processing boards. Pentek's SOSA aligned products facilitate interoperability, re-use, and rapid technology insertion, all consistent with the SOSA Consortium's approach and vision.

Several Pentek partners and key contributors to the emerging SOSA Technical Standard are involved in the development of this platform. Pentek teamed up with Elma Electronics for backplane and system management components, Interface Concept for backplane switch modules, Concurrent Technologies for single board computer modules, and Crossfield Technology for IPMI and chassis management support; all specifically designed to be in alignment with the SOSA Technical Standard.

"The efforts put into this platform demonstrate our commitment and the value of the alignment and interoperability goals driving the SOSA Consortium mission," said Bob Sgandurra, Pentek's Director of Product Management. *"Pentek has worked tirelessly with key suppliers in the open architecture community to put this platform together. With the Model 8256, customers can now immediately start integrating and building their application."*

Model 8256

Webinar: Understanding Conformance to the SOSA Standard

During this webinar, experts involved in the SOSA Consortium and the standard's development discuss the elements of conformance to the Technical Standard, how the upcoming 1.0 release will address it, and considerations for the certification process. Click **here** to view it.

The Open Group FACE™ and SOSA™ Consortia Technical Interchange Meeting (TIM)

This virtual event provided valuable information about What's Next and What's New in key Open Systems Standards. During the TIM, Tri-Service leaders and Open Standards experts presented on how open architectures and open systems can increase defense program efficiency and accelerate acquisition of the latest capabilities.

To view slides from these sessions, click **here**.

Model 8256 Advanced Features

The Open Group SOSA Consortium™ created a common framework, the emerging SOSA Technical Standard, for sensor systems based on key interfaces and open standards established by industry-government consensus. The forthcoming SOSA Technical Standard implements numerous VITA standards that are reflected in the Pentek Model 8256 configuration. The Model 8256 takes advantage of several advanced features including cooling, platform system management and RF/optical interface options.

- The Model 8256's built-in forced-air cooling is designed to support conduction-cooled boards in a standard 19-inch rackmount profile chassis. This provides the convenience of development on conduction-cooled boards in a desktop or laboratory environment.

- Pentek's SOSA aligned development chassis utilizes VITA 46.11 and HOST aligned Chassis Management Module (CMM). This CMM is software-upgradable to the forthcoming SOSA v1.0 standards. SOSA aligned systems will feature, and the CMM will enable, meaningful integration between the functional elements (SOSA Modules) and the System Manager, the CMM, and every Plug-In Card (PIC).

- The Model 8256 is designed for convenient access to RF and optical interfaces. Each RF payload slot can be optioned with 20 coaxial breakout connectors located on the back panel of the chassis, providing direct connections to the VITA 67.3C backplane connector. In addition, each RF payload slot can be optioned with two rear-panel MPO adapters to provide access to the VITA 67.3C dual optical interfaces.

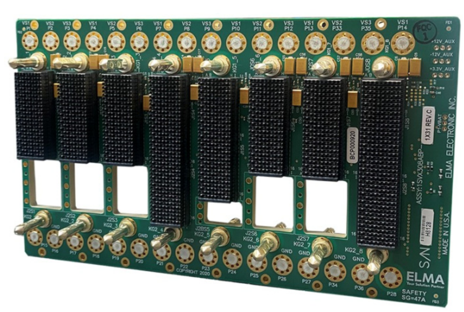
Partner Interoperability

Speeding development is the prime objective of the Model 8256. Customers can be up and running in short order because Pentek has taken many of the initial startup and configuration issues out of the equation. To reduce the development effort and risk, Pentek offers integration assistance to select and configure modules to meet overall system objectives.

Elma Electronic Backplane

"Users of high-performance data acquisition and signal processing boards and chassis often find themselves frustrated by the fact that when their new devices are delivered, they are unable to put them to immediate use," said Ken Grob, director of embedded computing, Elma Electronic Inc. *"This SOSA aligned development platform is delivered ready-to-use and tested, saving engineers much-needed development time. We are very pleased to be part of Pentek's 8256 development platform."* For more information, click **here**.

Elma Electronic Backplane



Concurrent Technologies SBC

"The Model 8256 is an ideal development platform for Pentek's Models 5550 and 5553 eight-channel A/D & D/A Zynq UltraScale+ RFSoC 3U VPX processors in conjunction with our compute-intensive TR H4X Single Board Computer," said Brent Salgat, president, Concurrent Technologies Inc. He added, *"These modules and this platform are well suited for many radar, electronic warfare, signals intelligence, electro-optical and communications applications."* For more information about the Concurrent Technologies TR H4X Single Board Computer, click **here**.

Concurrent Technologies TR H4X Single Board Computer

Crossfield Technology IPMI Software and Chassis Management Module

"The MOSA aligned goals of the emerging SOSA Technical Standard go beyond common OpenVPX hardware slot profiles. To be truly interoperable with each other, the system software must have common access and interfaces into system management functions," said Terry Hulett, products general manager, Crossfield Technology LLC. *"Pentek's Model 8256 development platform not only provides access to leading edge hardware, but does so with open-standards-based chassis management capabilities for just such common access."* For information about the Crossfield products, click **here**.

Interface Concept Switch Card

Click **here** for information about the 40 gigabit Ethernet switch from Interface Concept.

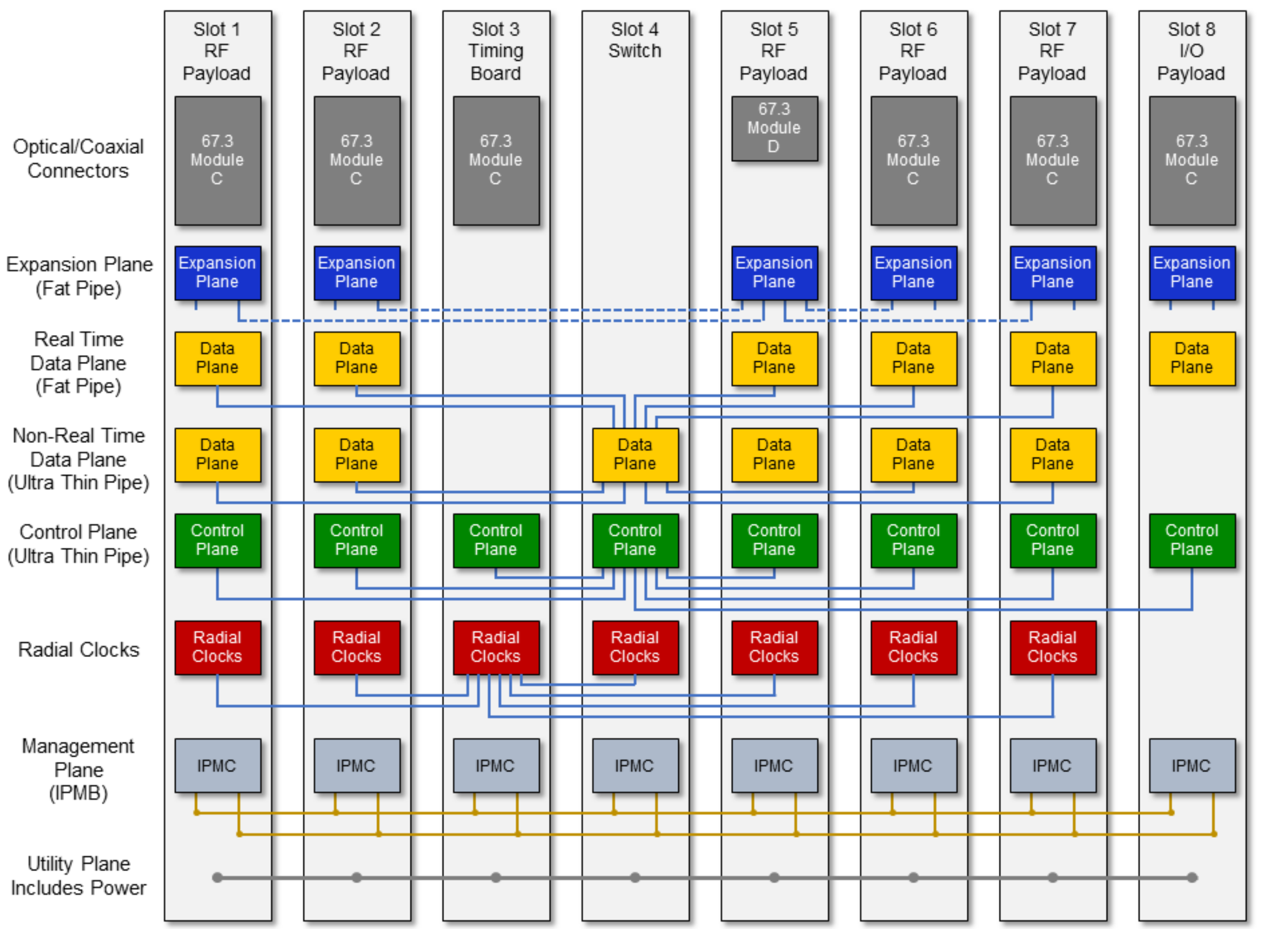
Development Platform Video

Click **here** to view a video overview of the Pentek Model 8256 development platform.

Product Options

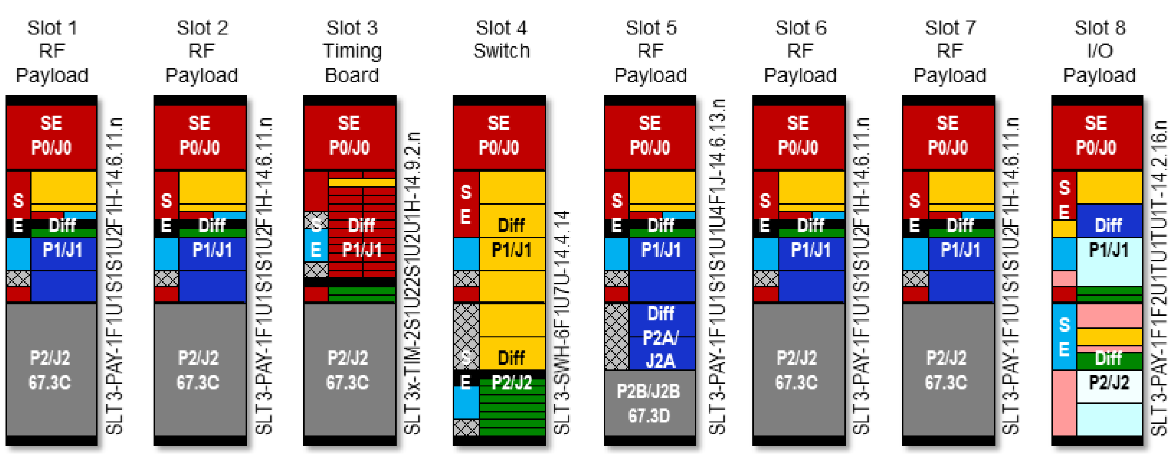
Several options for Pentek's Quartz® RFSoC data acquisition and processing boards, RF, and optical interconnections are available. To learn more, contact our sales department at sales@pentek.com, 201-818-5900 or contact your local representative.

Model 8256 Backplane



Note: Expansion Plane interfaces are not wired on backplane, but can be connected using the Meritec Cabling System

Model 8256 Backplane Profiles



Pentek's Quartz RFSoC Rugged Small Form Factor Subsystem is Ideal for Custom Integrations

- Pentek Quartz® Architecture with Xilinx Zynq UltraScale+ RFSoC FPGA
- Eight wideband RF/IF A/D and D/A converters
- Conduction-cooled and ideal for integration into custom enclosures
- Navigator® Design Suite for streamlined software and IP development

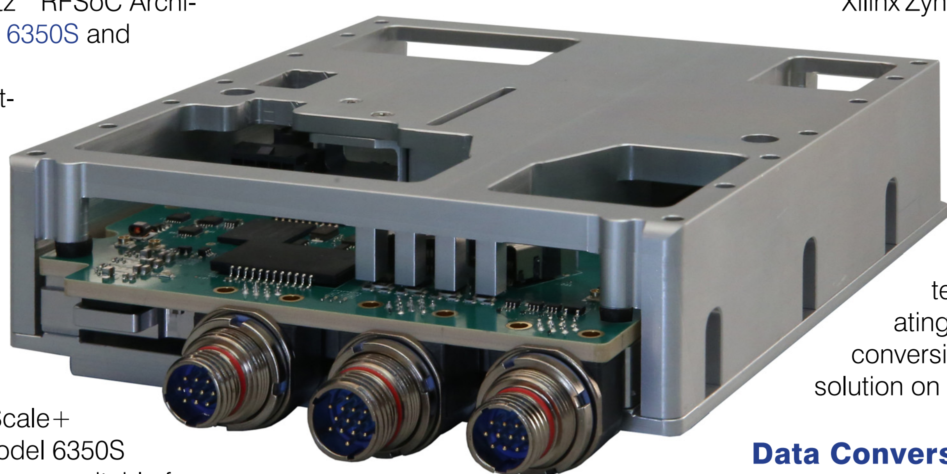
Pentek recently announced two new products in the Quartz® RFSoC Architecture family: Model 6350S and Model 6353S (Gen 3 RFSoC), eight-channel A/D and D/A converter subsystems in rugged small form factor package.

Based on Pentek's QuartzXM eXpress modules that utilize the Xilinx Zynq UltraScale+ RFSoC FPGA, the Model 6350S and Model 6353S are very suitable for SIGINT and COMINT, military communications, EW countermeasures, radar transceiver, test and measurement, SATCOM, LiDAR, 5G and LTE wireless applications.

"Our Quartz RFSoC customers continue to come up with requests for challenging packaging options for our QuartzXM eXpress modules. Pentek is now shipping the Model 6350S and Model 6353S to fill the gap between our module solutions and our fully enclosed system solutions," said Bob Sgandurra, Director of Product Management of Pentek. He added, *"The small size of these subsystems enables customers to install our Quartz RFSoC technology within their existing enclosures."*

Designed for Platform Integration

The Model 6350S and Model 6353S are complete self-contained RF converter and processing subsystems in a small mounting frame. Requiring only a single 12V power supply, the subsystems can be integrated as a component in a larger system with minimal design effort. All analog I/O and control and communication interfaces are easily accessible with industry standard connectors, simplifying connections to other system components. The bottom surface of the subsystem provides an efficient thermal interface enabling conduction cooling and allowing fan-less operation in most installations.



Optimized for SWaP (size, weight and power), the Model 6350S and Model 6353S are very small in size, measuring 1.5" H x 4.6" W x 6.7" D and weighing just under 30 oz. Intended for use in customer-provided enclosures, the subsystems are ideal for deployment in challenging and harsh environments.

The Quartz Architecture Difference

The Pentek Quartz architecture embodies a streamlined approach to FPGA products, simplifying the design for reduced power and cost, while still providing some of the highest performance FPGA resources available today. Supported by Pentek's Navigator Design Suite tools, Quartz products offer users an efficient path for developing and deploying software and FPGA IP for data and signal processing. The Xilinx Zynq UltraScale+ RFSoC Processor integrates eight RF-class A/D and D/A converters into the Zynq FPGA fabric along with quad ARM Cortex-A53 and dual ARM Cortex-R5 processors, creating a multichannel data conversion and processing solution on a single chip.

Data Conversion

The front end of the Model 6350S (Gen 1 RFSoC) accepts analog IF or RF inputs up to 4 GHz on eight coax connectors with transformer-coupling to eight 4 GSPS 12-bit A/D converters, delivering either real or complex DDC samples. Additional IP-based decimation filters provide overall DDC decimation from 2 to 128. Eight D/A converters accept baseband real or complex data streams from the FPGA's programmable logic. Each 6.4 GSPS 14-bit D/A includes a digital upconverter with independent tuning and interpolations of 1x, 2x, 4x and 8x. All A/Ds and D/As are transformer-coupled to wideband coax cable connectors.

The Model 6353S (Gen 3 RFSoC) boosts the input signal bandwidth to 6 GHz using a 5 GSPS 14-bit A/D with additional decimation settings. The D/A rate increases from 6.4 to 10 GSPS.

Fast Data Interface

The Model 6350S and Model 6353S support eight 28 Gb/sec full duplex lanes using RFSoC GTY gigabit serial ports. With the built-in 100 GigE UDP interface or installation of a user-provided serial protocol, this interface delivers a high-speed gigabit data streaming path between the Model 6350S or Model 6353S and other identical subsystems, optical transceivers, data storage, or other processing systems.

Factory-Installed IP Speeds Development

The Model 635xS subsystems are preloaded with a suite of Pentek IP modules to provide data capture, timing, interface, and processing solutions for many common applications. Modules include DMA engines, DDR4 memory controllers, test signal and metadata generators, data packing, and flow control.

Navigator Design Suite for Streamlined IP Development

Pentek's Navigator® Design Suite includes: the Navigator® FDK (FPGA Design Kit) for custom IP and the Navigator® BSP (Board Support Package) for creating host software applications.

The Navigator FDK includes the board's entire FPGA design as a block diagram that can be graphically edited in Xilinx's Vivado tool suite, with full source code and documentation. Developers can integrate their IP along with the factory-installed functions or use the Navigator kit to replace the IP with their own. The Navigator FDK Library is fully AXI-4 compliant, providing a well-defined interface for developing custom IP or integrating IP from other sources.

The Navigator BSP supports Xilinx's PetaLinux on the ARM processors. Users can work efficiently using high-level API functions, or gain full access to the underlying libraries including source code. Pentek provides numerous examples to assist in the development of new applications.

Pricing and Availability

For the latest pricing, delivery and available options, please fill out this form and your request will be delivered to the appropriate department.

To learn more about our products or to discuss your specific application please contact our sales department at sales@pentek.com, 201-818-5900 or contact your local representative. ☐

Two RFSoC Seminars from Pentek:

Seminar 1: **Finding the Best Path from RFSoC Hardware Design to Deployment** - To view the recorded webcast, click **here**.

Seminar 2, Leveraging Software and IP for Faster RFSoC Application Development - This webinar explores the software and IP environment for developing RFSoC applications. Learn effective strategies for leveraging existing IP and software to streamline development tasks. To register, click on the date and time you prefer.:

- **April 20, 2021** – **8:00 AM PST / 11:00 AM EST**
  or **9:00 PM PST / 12:00 Midnight EST**
- **Aprl 22, 2021** – **5:00 AM PST / 8:00 AM EST**
  or **2:00 PM PST / 5:00 PM EST**

Interview: Pentek's Quartz Xilinx Zynq UltraScale+ RFSoC Gen 3 Product Line

Since the successful introduction of the Quartz product line 3 years ago, Pentek continues to innovate with this proven technology. In December 2020, Pentek announced availability of the Gen 3 version of its Quartz products.

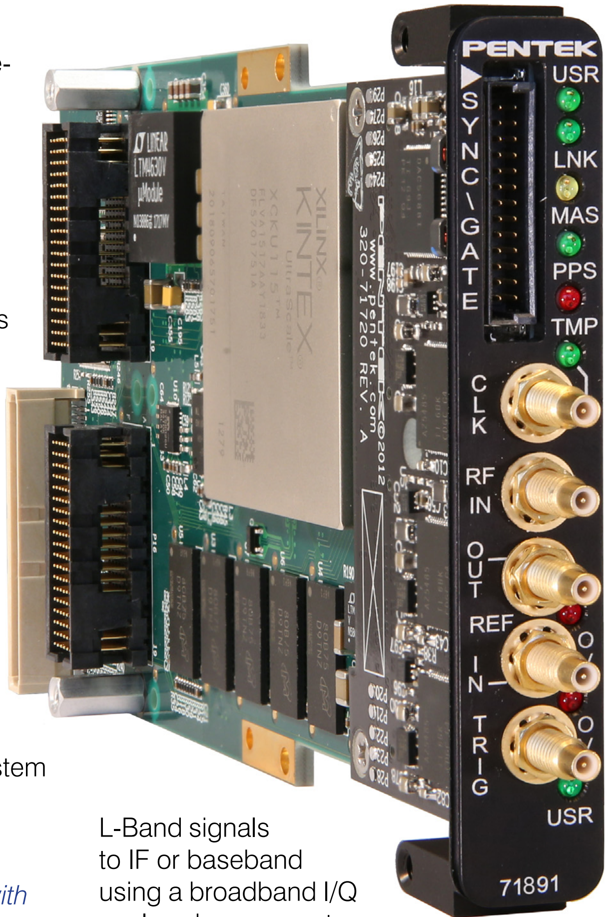
John Keller, the Editor-in-Chief, of **Military and Aerospace Electronics** recently interviewed **Bob Sgandurra, Pentek's Director of Product Management**, about Pentek's Gen 3 RFSoC products. To view the interview, click **here** or the image above.

Pentek's Latest L-Band RF Tuner XMC Module Enhances SATCOM and Communications Applications

- Maxim MAX2121 L-Band RF tuner boosts output bandwidth to 123 MHz
- Dual 400 MHz 14-bit A/Ds capture full signal bandwidth
- Improved signal quality with integrated digital downconverters
- Jade® Architecture with Xilinx Kintex UltraScale FPGA offers price, power and processing performance advantages
- Navigator® Design Suite speeds development and custom IP integration

Pentek has announced a new member of its highly popular Jade® family of high-performance XMC FPGA modules. The Jade Model 71891 XMC module is an L-Band RF tuner with two 400 MHz A/Ds based on the high-density Xilinx Kintex UltraScale FPGA. The Model 71891 is designed for connection directly to SATCOM or communications system L-band signals.

"Our customers benefit from this upgrade to the Jade Architecture with increased performance along with 20% lower power and 35% lower cost," said Bob Sgandurra, Director of Product Management for Pentek. **"***The Navigator Design Suite also provides them with a more robust toolset and extensive library of IP resources,"* he added.



RF Tuner Stage

A front panel SSMC connector accepts L-Band signals between 925 MHz and 2175 MHz, typically from an L-Band antenna or an LNB (low noise block). With its programmable LNA, the Maxim MAX2121 tuner directly converts these L-Band signals to IF or baseband using a broadband I/Q analog downconverter followed by 123 MHz low pass anti-aliasing filters. The two analog tuner outputs are digitized by two Texas Instruments ADS5474 400 MHz 14-bit A/D converters to capture the full 123 MHz bandwidth.

For best performance, the analog outputs of the MAX2121 can be used in the IF mode instead of the analog baseband I+Q mode. In this case, each A/D converter digitizes an IF signal and then delivers it to a DDC to produce perfectly balanced complex I+Q digital baseband samples for enhanced demodulation performance. An additional benefit of using the IF analog output mode is that two independent A/D and DDC channels are now available for digitizing and downconverting two signals with different center frequencies and bandwidths.

Factory-Installed IP Advances Development

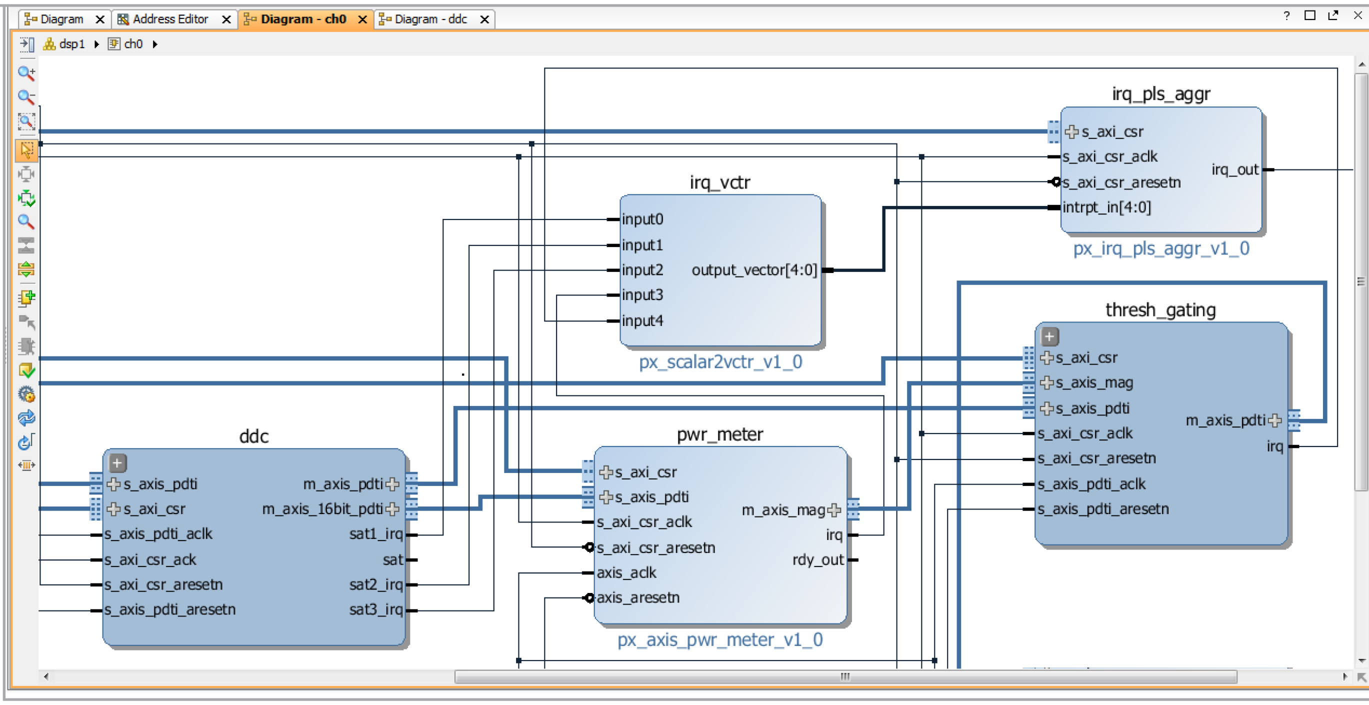
The Model 71891 features two Acquisition IP modules to easily capture and move data. Each module can receive data from either of the two A/Ds or a test signal generator. Each Acquisition IP module contains a powerful DDC IP core with decimation values from 2 to 64k, covering a wide range of signal bandwidths. Because of flexible input routing within the Acquisition IP modules, many different configurations can be achieved, including one A/D driving both DDCs or each of the two A/Ds driving its own DDC.

The Jade Architecture

The Pentek Jade architecture is based on the Xilinx Kintex UltraScale FPGA, which raises digital signal processing (DSP) performance by over 50% over the previous family, with equally impressive reductions in cost, power dissipation and weight. As the central feature of the Jade Architecture, the FPGA has access to all data and control paths, enabling factory-installed functions including data multiplexing, channel selection, data unpacking, gating, triggering and memory control.

Navigator Design Suite for Streamlined IP Development

Pentek's Navigator Design Suite includes: Navigator FDK (FPGA Design Kit) for custom IP and Navigator BSP (Board Support Package) for creating host software applications.

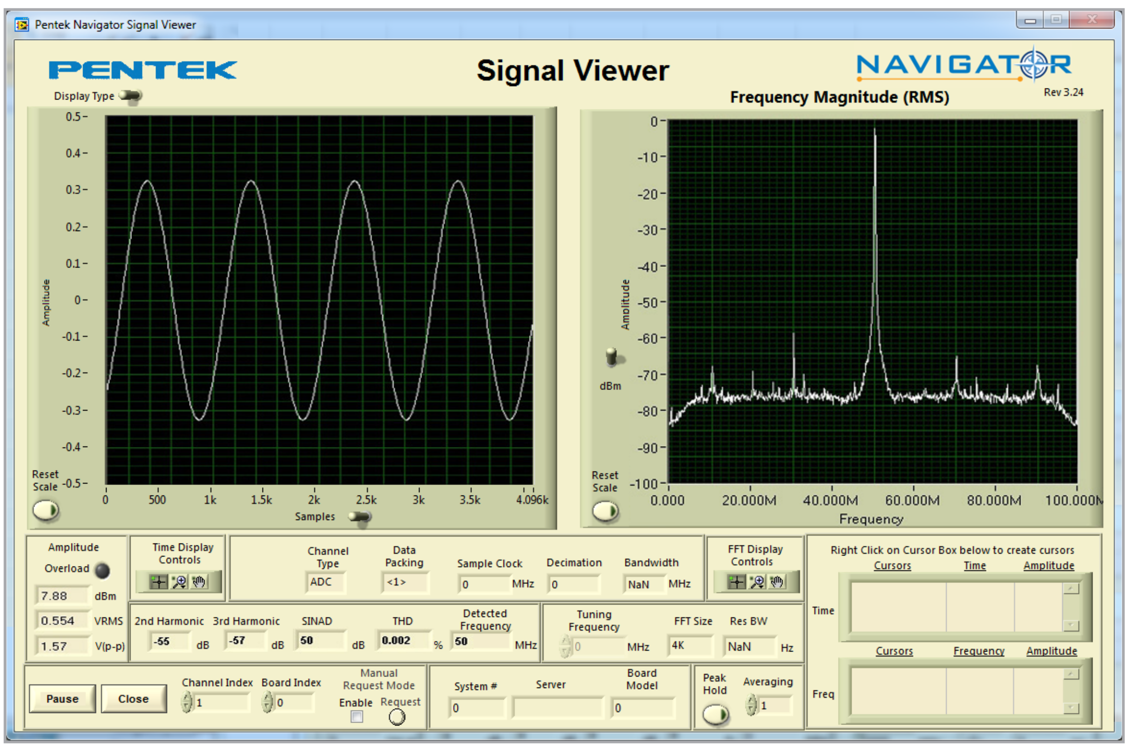


IP Integrator - Part of Xilinx's Vivado Tool Suite

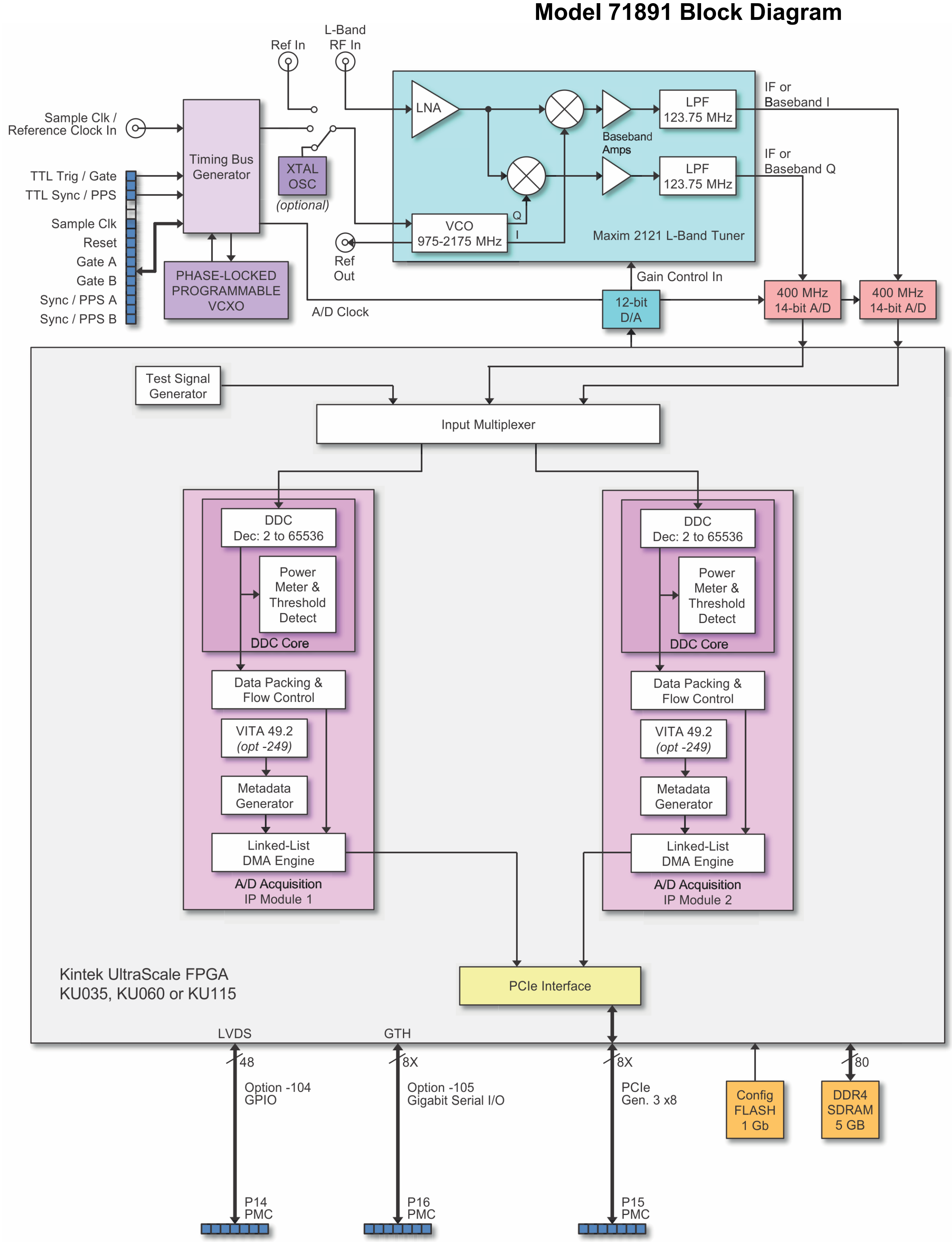
The Navigator FDK includes the board's entire FPGA design as a block diagram that can be graphically edited in Xilinx's Vivado tool suite, with full source code and documentation. Developers can integrate their IP along with the factory-installed functions or use the Navigator kit to replace the IP with their own. The Navigator FDK Library is fully AXI-4 compliant, providing a well-defined interface for developing IP or integrating IP from other sources.

Pentek's Navigator BSP provides a full suite of high-level C-callable libraries that support all features of the Model 71891 and demonstrate all of its functional modes with examples. The software package is provided with complete source code allowing the user to modify and integrate this functionality into the end application.

Navigator BSP also includes an extremely useful Signal Viewer utility that allows developers to view digitized signals from the output samples of any DDC in time and frequency domain.



Model 71891 Block Diagram



Pricing and Availability

For the latest pricing, delivery and available options, please fill out this form and your request will be delivered to the appropriate department. To learn more about Model 71891 or to discuss your specific application, contact our sales department at sales@pentek.com, 201-818-5900 or contact your local representative. ☐