Adding RF & Optical Capability Via VITA 65 and SOSA for Radar, Electronic Warfare, and Other Mission Critical Military Applications

ABSTRACT

The addition of apertures to the VITA 65 slot profiles has created a revolution in the types of available products, namely simplifying the configuration of the chassis and improving reliability. The flexible arrangements of contacts enabled by VITA 65 will help defense system integrators reduce size, weight, and power (SWaP) and improve interoperability. The strong ecosystem behind VITA 65 and the part it plays in the Sensor Open Systems Architecture (SOSA) environment will also make technology refreshes more efficient, helping lower long-term life cycle costs for warfighter systems such as radar and electronic warfare.

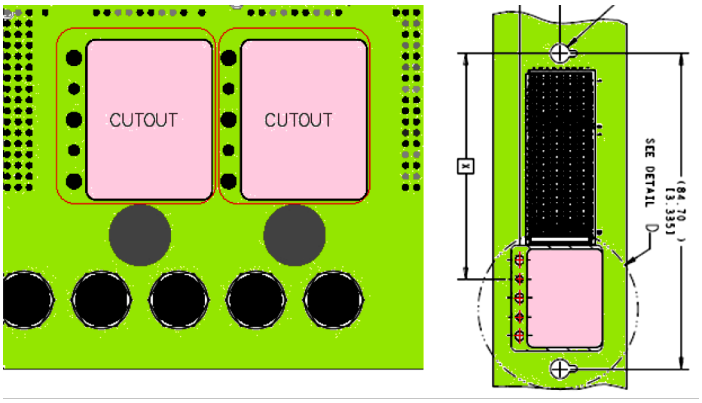
OpenVPX and Apertures – VITA 67

OpenVPX has become the mother ship under which other supporting VITA standards are developed. This is the case with backplane apertures, which are very important in terms of flexibility and interoperability of systems. In this vein, VITA 67.3 apertures represent a significant addition to the VITA 65.0 and VITA 65.1 standards. Additionally, the U.S. Navy's Hardware Open Systems Technologies (HOST) initiative and SOSA's work on VITA 46.11 chassis managers also enhance OpenVPX, as does TE Connectivity's announcement that its new 25 GB/sec backplane connector is backward-compatible to its current VPX connectors.

However, we believe that VITA 67.3 represents the most significant advance, as backplane apertures enable new configurations in coaxial and optical connections to pass signals through the OpenVPX backplane. This capability enables enhanced interoperability and flexibility in design that will absolutely benefit prime contractors designing systems for the warfighter.

What Are Apertures and How Are They Used?

Apertures are openings in VPX backplane slots enabling the use of blind-mate RF and optical connectors. These backplane apertures, the connector outline, mating interface, row and column nomenclature, and dimensional origins are defined in the VITA 66 and 67 standards. As RF and optical modules are defined, all the x-y locations, and type of contacts or ferrule are recorded in VITA 65.1. Module and slot profiles that utilize VITA 66 or 67 modules have their basic definitions in VITA 65.0 but the dash numbers representing specific modules are documented in VITA 65.1 as they are proposed and agreed to.



Apertures -- shown in their respective standard – are the cutout for the body of the connector as well as the location of the alignment pins and threaded fasteners that attach the assemblies to the backplane. The location of the mating connector and optical interface on the daughter cards is derived from the backplane positional information recorded for each module in VITA 65.1. New RF apertures intended backplanes with slots on a 1.0-inch pitch are defined within VITA 67.3. Connector modules incorporating optical or a combination of optical ferrules and RF contacts are defined in VITA 66.5 but utilize the apertures that are defined in VITA 67.3. These are designed to be removed and replaced from a backplane to support different configurations of coaxial connectors or optical module. Slots that have this feature are flexible, because it is possible for the end user to change the RF or optical module to accommodate different plug-in cards. (FIGURE 1)

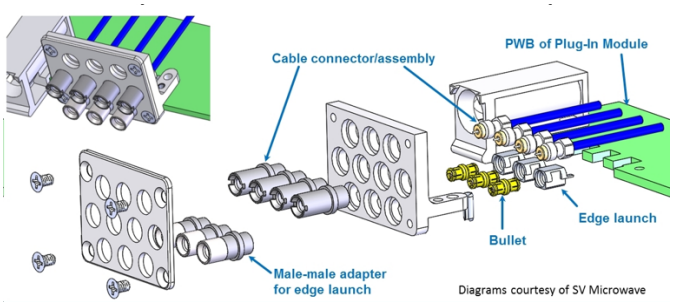
Flexibility for The End User

Flexibility for the end user is what drives most commonality initiatives within the defense electronics community and VITA 67.3 and VITA 66.5 are no different. The purpose of these two standards is to define how to document new RF and Optical module configurations. The importance of these backplane-connector modules lies first in the fact that they can be installed and replaced by the system integrator or the end user. And more important, VITA 67.3 backplane apertures can support modules with different arrangements of RF and optical contacts for each aperture size.

VITA 67.3 Supports RF FRMs With Direct Launch

VITA 66 and VITA 67 give the overall parameters for the outline of these modules which allows suppliers to create compatible connector modules. The type and location of contacts within a VITA 66 or VITA 67 connector module are defined in VITA 65.1. VITA 65.0 tells us the basic size (the most common aperture sizes are D, C, and E representing a half height module, full height module, and half+full module. Modules backward-compatible to early modules designed for 0.8 inch pitch apertures are also defined). There exists the flexibility to allow companies to design their own module configuration, per the general rules defined in the VITA 66 and VITA 67 documents. Developers must provide the contact's backplane x-y coordinates and type of

contact in each position for to list a RF, optical, or combined RF and optical module in VITA 65.1.



VITA 67.3 and 66.5 were developed to define modules with contacts that could be directly launched from the base card or from one or more mezzanines on a base card. This required that the contacts on the daughter card to be fixed and the mating contacts on the backplane to be sprung to allow contacts to align during engagement. Although a support bracket is shown in this diagram, it's not required; in most cases, there are simply holes in a rear plate through which the coaxial connectors protrude. Positioning and location would be determined by the spacing of the contacts within a row and by the spacing between the mezzanine cards and the base card and the location. All the permitted locations of a VITA 66 or 67 connector module within a slot is given defined within their respective standard. An example of a module incorporating both fixed launch and cable launch is shown above. (FIGURE 2)

Once again, we show how VITA 67.3 enables flexibility in the design. Figure 2 shows an example of two different types of contacts that can be used on 67.3 apertures. In the upper right-hand corner you can see four cable assemblies that can be snapped into the top row. Below that, you see edge launch contacts that might be used to launch directly from the mezzanine or baseboard. As stated earlier, the contact row spaces can be unique to a user's application.

The purpose of supporting these apertures was to move coaxial cables for RF signals from the front of systems to the rear of systems so that the cables don't have to be moved to access adjacent modules – in the past they were just draped across the front of plug-in modules. This also enables module wiring to leverage rigid and rigid-flex instead of just flexible cabling for higher speed and more demanding applications. This setup improves system reliability and allows more precise control of RF signals.

New connectors have now become available that fit as many as 16 RF contacts in a typical full-size VITA 67.3 module. The RF contacts that have thus far been specified or proposed include SMPM, SMPS, NanoRF™, and both 1 and 2 row MT/MPO optical ferrules. The SMPS and NanoRF™ contacts are much smaller to accommodate many more contacts per interface.

RF and Optical Signal Access

Apertures enable access to module RF and optical signals through the backplane. The backplanes require a matching connector module to populate apertures.

Plug-in cards can be populated with an assembled connector module with multiple contacts or can be configured to directly launch from individual contacts mounted on the base card and mezzanine(s).

How Are Apertures Located in a Slot?

VITA 67.3 apertures are located in relation to the center of the mounting hole for the upper guide pin. VITA 67.3 defines the required mounting holes for each size aperture, the location contact type, and all allowed locations within a slot.

C size apertures can be located in the J2 position for 3U backplanes or the J2, J3, J4, J5, or J6 position for 6U backplanes. The location of plug-in modules needs to be driven by design from the backplane location.

VITA 67.3 documents also show the locations for full, half, and full+half size modules. Similar location charts can be found for necessary aperture locations in VITA 67.1, 67.2, 66.1, and 66.4; VITA 66.5 modules utilize VITA 67.3 aperture dimensions and location charts, but have their own origin locations for the optical and guide features within each new VITA 67.3 and 66.5 module

The module designer determines location based on daughter card contact requirements, while thereafter, designers using 67.3 must drive their requirements. Once again, VITA 67.3 enables more flexibility for the end user. Currently defined 3U Slot Profiles have E modules starting in J1b (the bottom half of the J1 connector) and covering all of J2 as well as C modules that replace all of J2 and D modules in J2b which replace the bottom half of the J2 connector. There are 6U slot profiles with full size modules in J3, J5 and J6 as well as a slot profile with a half size module in J6b.

Upgrading to Leverage VITA 67.3

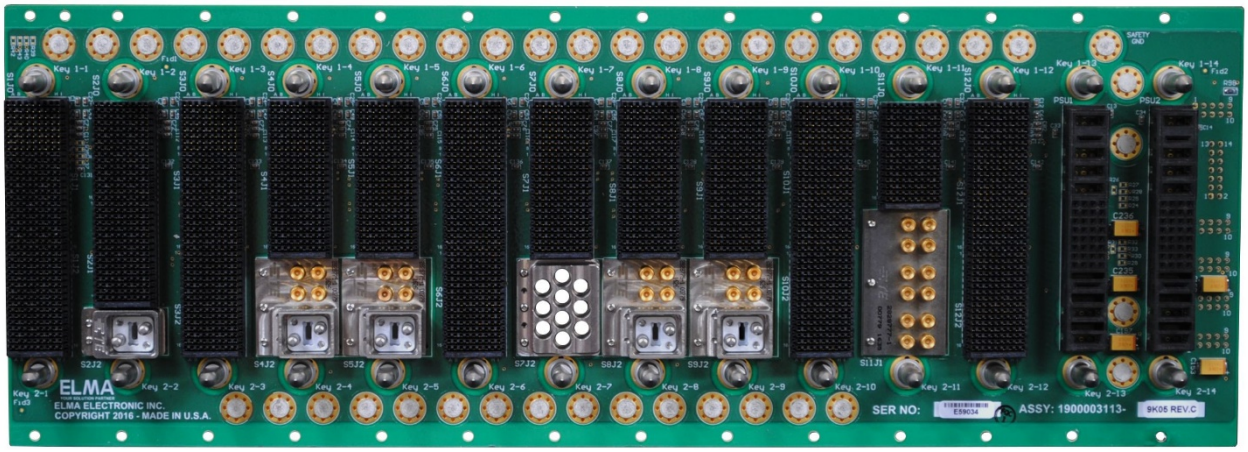
Any upgrade like the one to 67.3 requires new backplanes, but such a move is made easier by the availability of optical components by such suppliers as Reflex Photonics, which can incorporate optical technology while using very little board space.

With VITA 65 apertures, designers will be able make changes as new cards become available without requiring a change to the actual backplane PCB. Apertures solve a myriad of problems: Simply having all cables coming off the rear of the card solves human factor and reliability issues. VITA 67.3 and VITA 66.5 enable flexible arrangements of contacts to accommodate the board to mezzanine space.

Importance of Ecosystems

In addition to optical module suppliers Reflex Photonics and Samtec and coaxial contact suppliers such as TE, SVMicro, and Radial, we work with embedded VPX suppliers such as Interface Concept Kontron, Curtiss-Wright Defense Solutions, Abaco, and others in the OpenVPX ecosystem.

Currently, there are at least 44 different companies producing VPX modules for the open market and at least six connector companies that make various connector modules used in VPX products (Figure 3). There are also many larger suppliers building special VPX modules for their own customer programs.



OpenVPX is also extensively documented, with more than 47 ANSI-VITA standards supporting every aspect of the VPX architecture family. As capabilities increase, new guidance is added to support them. This sharing of information is important for users who want to define a specific module for possible use by other board designers who may wish to have more than one source.

SOSA

The VPX ecosystem is relatively small, however, when compared to what the SOSA initiative is targeting. All the companies previously mentioned are aiming products squarely at the SOSA market. The industry needs multiple cards to support these ecosystems; and SOSA is making that happen right now.

The June 2019 signing of a tri-service memo by every branch of the service was a very important milestone as it directs the defense agencies to consider open architectures and specifically the SOSA architecture. The impact of this accord was particularly important for the VITA 65 community, as there had been a small group working on actually composing the VITA 65 specification. Along came SOSA: Huge numbers of interested parties were brought into the

process – especially from the end-user side. Having the end user driving and requesting changes makes so many things possible that were not possible before.

This effort was driven by the defense acquisition community as it sought to reduce costs and development time by applying open-architecture principles in a practical and consensus-driven process.[i] The goal of these efforts is to select the best-of breed, use existing architectural frameworks, hew to relevant standards, and only create something where a gap exists.[i]

U.S. Defense organizations leading the SOSA effort include the Air Force Life Cycle Management Center (AFLCMC) at Wright-Patterson Air Force Base, Ohio, the U.S. Army's Combat Capabilities Development Command (CCDC, formerly CERDEC), and the U.S Navy's Naval Air Systems Command (NAVAIR) in Patuxent River, Maryland.

Benefiting the Warfighter

One of the primary goals with the addition of the VITA 65 apertures was to guarantee more interoperability, which is also the goal of SOSA. Previously, one of the biggest criticisms of VPX was cards with similar capabilities defined the location only of the data and control planes. All the other backplane signals were unique to each card supplier.

Now, however, by fully defining slot profiles, different cards with similar functions can populate the same slot profile and will be able to interoperate with cards in other slots, enabling easier upgrades. Eliminating the requirement for 3.3VDC and 5VDC rails for 3U cards and eliminating the 5VDC rails for 6U cards is another SOSA initiative which will make it easier to upgrade systems without changing to a different power supply. RF contacts bring so much more functionality and even more I/O. In other words, these new slot profiles will bring more plain old horsepower into the systems. This performance boost benefits not only the designers but the warfighters.

As VPX migrates to 25-gigabit channels, a great deal of engineering will be required to ensure that all daughter cards have command over the backplane. Now, thanks to VITA 67.3, designers can implement high-speed links with optics saving design time and reducing the demands on the PCBs

Making the system more reconfigurable via the common profiles means a system can be configured for one environment today, then reconfigured with new radar or electronic warfare features that may lend itself to a different warfighter environment the following year. In short, VITA 67.3 enables a more flexible system, supporting different types of sensors, for multiple theater environments.

That interoperability is also the goal of SOSA as Army, Air Force, and Navy officials realized that by working together under SOSA on standardization of hardware interfaces, they could reduce costs across the board.[i]

The ability to make changes quickly brings benefits all around: Systems are more agile to design and users can reconfigure environments more easily, which better prepares warfighters to face the complex threats from adversaries.

NOTES

[i] Hackert, Mike; Peddicord, Ben; Lipkin, Ilya, "Development of the next-generation OpenVPX embedded system standard: A tri-service convergence of approaches: Part 1 of 3," available at http://mil-embedded.com/articles/development-of-the-next-generation-openvpx-based-embedded-system-standard-a-tri-service-convergence-of-approaches-part-1-of-3/.