

White Paper

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VITA 93 – QMC

Advancing Embedded Systems with VITA 93 (QMC):

A New Era in Modular I/O Solutions

A New Era in Modular I/O Solutions

Aerospace and defense system designers are demanding scalable and high-performance I/O solutions. While traditional mezzanine standards have proven reliable, they often fall short of meeting modern bandwidth, size, and flexibility requirements. This challenge is particularly evident in aerospace and defense applications where high-speed data processing must align with stringent size, weight, and power (SWaP) constraints.

Current mezzanine solutions also face significant limitations in scalability, thermal management, and I/O density. These constraints can lead to compromised system performance and limited upgrade paths in applications where adaptability is crucial. This white paper explores how the new VITA 93 (QMC) standard addresses these challenges through its innovative QMC architecture, enabling unprecedented modularity, flexibility, scalability, and rugged reliability while maintaining compatibility with existing and future systems. It also covers how VITA 93 (QMC) builds on lessons learned from previous standards, blending their best

features with new capabilities for the future.

In this white paper, system architects and design engineers will learn:

- How evolving embedded system requirements are driving the need for more flexible mezzanine solutions.
- The challenges of traditional mezzanine standards and their impact on system design.
- Practical advantages of VITA 93's (QMC's) modular architecture, including scalability from single- to quad-size implementations.
- Where VITA 93 (QMC) fits into the VITA ecosystem.
- The technical innovations of QMC, including advanced cooling options and high-speed interfaces.
- Benefits for single board computer (SBC) and carrier designers.
- How to leverage VITA 93 (QMC) for future embedded system designs.

What is SWaP?

For many years minimizing SWaP – size, weight, and power was imperative for system designers.

Today systems are not only evaluated on SWaP but also on other criteria like cost, cooling, and compliance.

Traditional Limitations

Mezzanine card standards like XMC were not designed to meet stringent SWaP requirements.

VITA 93 (QMC) builds on existing technology while addressing inherent challenges in current mezzanine card standards such as PMC and XMC. These issues include size, compatibility, thermal management, and limited expansion capabilities.

Modern systems demand compact solutions without compromising capabilities. Existing mezzanine cards, like XMC, were not designed to meet these stringent SWaP requirements, posing significant obstacles in aerospace, defense, industrial, medical and transportation sectors.

As Dean Holman, President and Executive Director of VITA, notes, "The circuit boards used in older PMC and XMC designs are simply too large for today's compact systems."

With current mezzanine card standards, system integration can sometimes become difficult: Air-cooled and conduction-cooled

XMC cards are based on different designs and provide multiple I/O options. These factors mean that designers must spend extra time and effort ensuring everything will work together and sometimes have fewer options than they'd like.

Getting the heat off the cards can also be problematic. As field programmable gate arrays (FPGAs) and application specific integrated circuits (ASICs) become more powerful, they generate substantial heat, which current mezzanine cards often struggle to dissipate efficiently.

Additionally, the increased complexity and requirements of today's systems leads to the need for system-health monitoring. Current mezzanine standards like XMC come only with a half-hearted approach to Intelligent Platform Management Interfaces (IPMI) and therefore require a higher integration effort.

Lastly, current mezzanine cards lack flexibility for growth as they come in fixed sizes – often too big – that cannot be easily changed, a situation akin to having a drawer that cannot be made bigger or



smaller based on what you need to store. Engineers often end up either buying more capability than they need or not having enough space for all their requirements.

These challenges call for a new approach – one that is more flexible, can scale with changing needs, and works efficiently across different platforms. This is where VITA 93 (QMC) steps in.

Advancing Mezzanine Design

The VITA 93 (QMC) standard revolutionizes mezzanine card technology, introducing a highly modular, flexible and scalable approach to I/O integration. Born from the VITA 90 working group's development of VNX+, this standard addresses the growing need for adaptable, high-density I/O solutions in modern embedded systems.

VITA 90 working group engineers realized they needed a new way to add I/O capabilities to their systems; they wanted something that was not just smaller, but also more flexible than existing solutions. While VITA 93 (QMC) was initially designed to work with VNX+, it was always the aim to develop a new standard that solves existing limitations and can be used in broad range of PCIe-based systems like VPX.



“With VITA 90, also known as VNX+, it became apparent we really needed small mezzanine cards – much smaller than the mezzanine cards nowadays used on VPX,” VITA’s president Dean Holman explains. “The primary driver was being able to get something small enough to fit one or two of them on these really small-form-factor VNX+ boards.”

This focus on size efficiency, combined with the need for more versatile I/O options, led to the development of the VITA 93 (QMC) specification – a design that is proving valuable across multiple industries and applications.

Driven by VITA 90 (VNX+)

Modular, Flexible and Scalable Design

Rugged and Reliable Mechanical Concept

Air – and Conduction – Cooled

Suitable for Front- and Rear-I/O-Systems

Smaller by Design

For certain applications where the primary use of this might be an I/O interface, I think you can't get much smaller than a single QMC. I would say this is pretty close to what we can expect at least for the next 10 years.

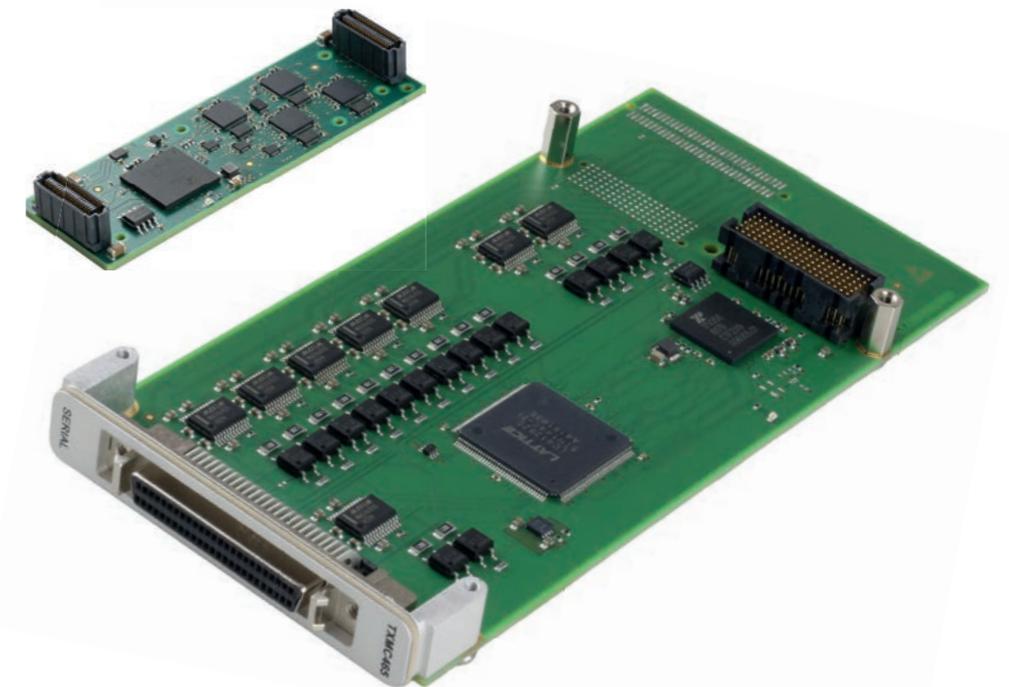
Dean Holman
President, VITA

A base single QMC measures just 26 mm by 78.25 mm, providing an optimal balance between component density and space efficiency. Compared to XMC modules (see drawing below), it is substantially smaller, making it ideal for I/O interfaces in reduced-SWaP applications.

VITA 93 (QMC) supports up to PCIe Gen 6, which offers significant bandwidth capabilities while maintaining backward compatibility in the small form factor.

It supports as many as x16 PCIe lanes in quad QMC configurations. The standard leverages the AccelerateHD Connector system by Samtec, ensuring reliable performance for high-speed applications.

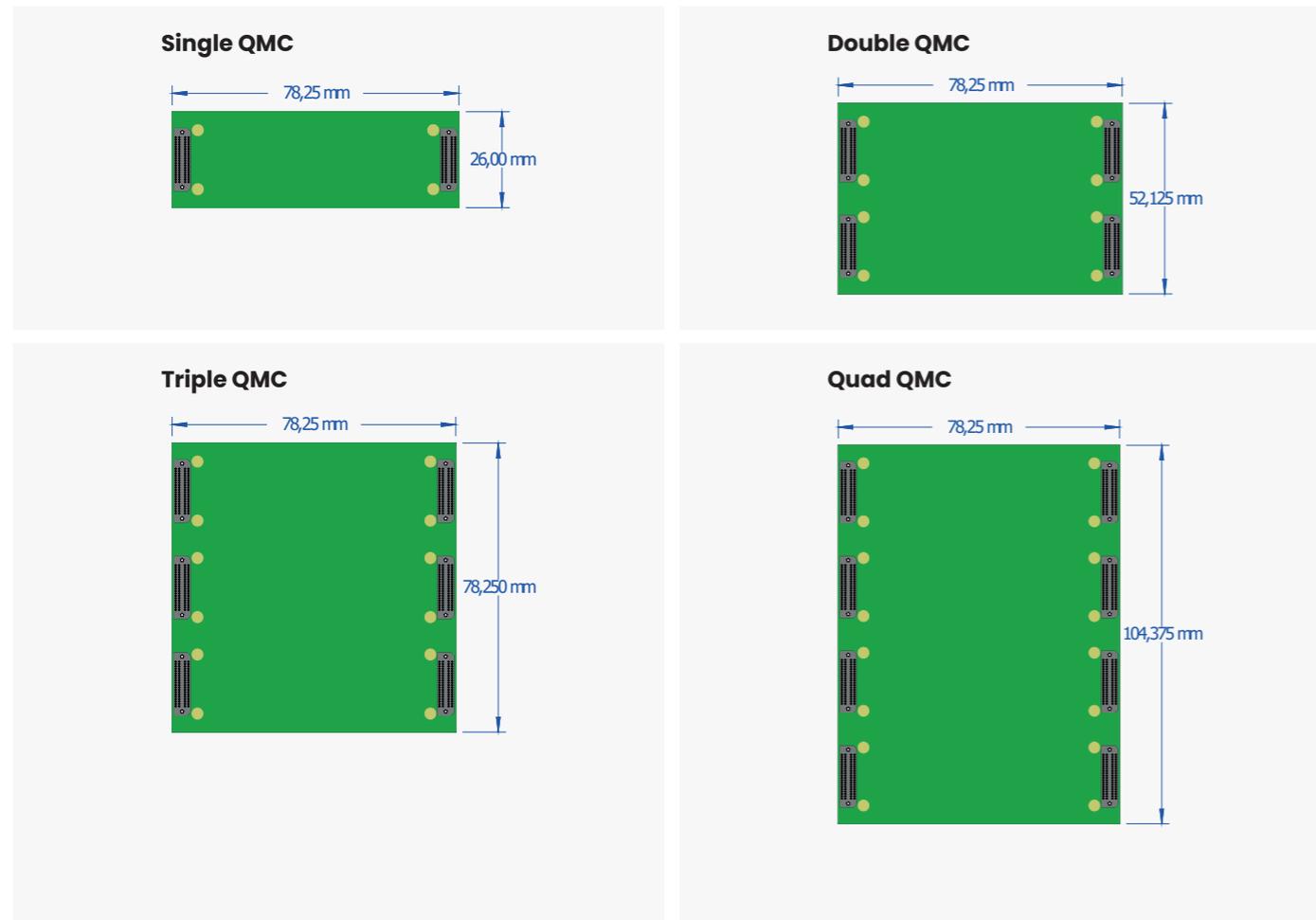
The total thermal design power per single QMC is almost 30 W. For a double, triple, or quad QMC, just multiply the thermal design power for a single QMC by two, three, or four.



Scalability

The VITA 93 QMC architecture offers unseen scalability as it defines four card sizes within the standard, enabling the design of QMC cards that can cover a whole range of applications, starting from simple I/O functionality on single QMCs up to the highest-complexity solutions with the need for high bandwidth and high I/O count.

Designs start with PCIe x4 and 40 I/Os on a single QMC and can go up to PCIe x16 and 160 I/Os on quad QMC.



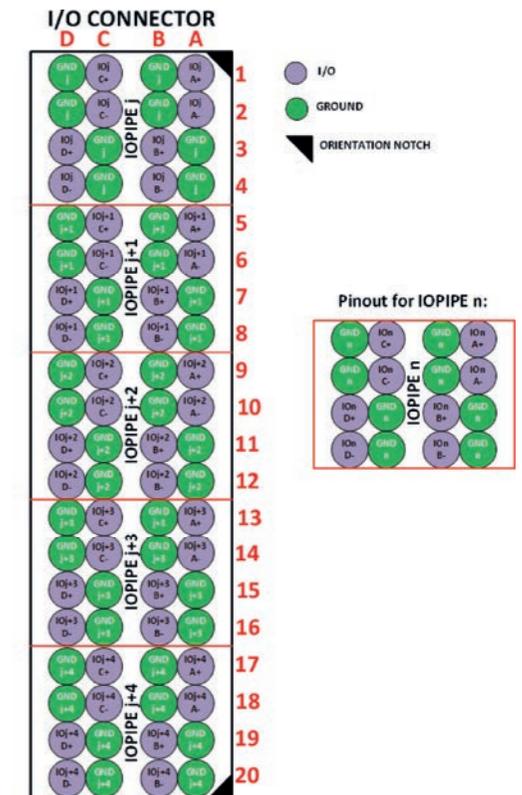
The standard scaling options of VITA 93 (QMC) include:

VITA 93 (QMC)	PCIe	I/Os
Single QMC	x4	40
Double QMC	x8	80
Triple QMC	x12	120
Quad QMC	x16	160

I/O Capabilities

The 40 I/Os of a single QMC are organized into five IOPIEs each offering eight single-ended or four differential I/Os.

Each IOPIPE comes with its individual ground supporting the integration of isolated interfaces.



Thermal Management

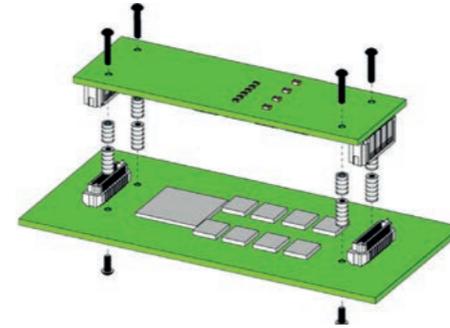
One of the key takeaways with VITA 93 (QMC) is that unlike previous standards like XMC or even PMC, the same card design can be used for either conduction or air cooled applications. In the past, that's always been somewhat difficult and users often ended up needing two different products, as these two cooling approaches didn't work together mechanically. That is not the case with VITA 93 (QMC).

Air cooled and conduction cooled QMCs are based on the same design. By adding a skyline heatsink to an air cooled QMC it is converted to a conduction cooled QMC. In addition, the conduction cooling approach of VITA 93 (QMC) provides much better heat transfer from the QMC to the carrier than the XMC's conduction cooling approach.

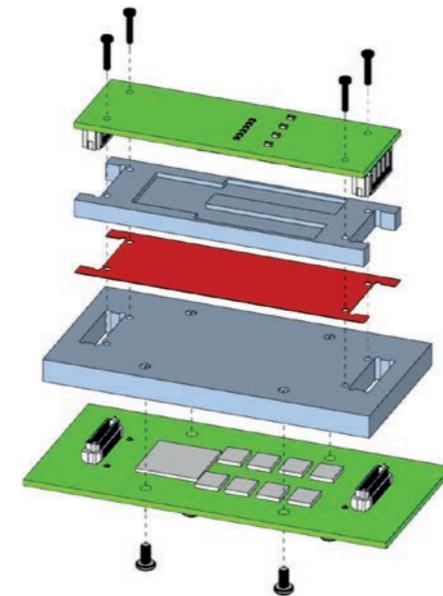
VITA 93 (QMC) ensures interoperability between vendors through a well-thought-out mechanical concept. All mechanical components required for the mounting of the QMC card have to be provided by the carrier manufacturer, which makes it possible to fit any QMC on any carrier, whether it's conduction cooled or air cooled, and independent of the QMC and carrier manufacturer.

With VITA 93 (QMC), system designers can optimize component placement and thermal management based on specific application requirements, as the standard defines variable stacking heights (9 mm, 11 mm, 14 mm, and 16 mm). The stacking height is solely defined by the carrier card, ensuring that all QMC cards will fit on the carrier card independent of the chosen stacking height and allows designers to most effectively use the PCB area underneath the QMCs.

Air Cooled



Conduction Cooled



Benefits for SBC and Carrier Designers

The VITA 93 (QMC) standard introduces several transformative advantages, marking a significant departure from traditional mezzanine card constraints.

Perhaps the most significant advancement is the ability to plug any QMC card into any QMC carrier without concerns about I/O routing, cooling method, or stacking-height compatibility. This universal approach eliminates the complex matching requirements for system designers with current mezzanine card standards, which dictate specific cards that must be carefully paired with their carriers.

SBC designers can now focus more intensively on their core competencies, as VITA 93 (QMC) enables simplified I/O mapping by eliminating the need for complex routing schemes. Other advantages include support for multiple I/O functions

on the same carrier and reduced design constraints that enable more specialized implementations.

Especially in SWaP applications where space is very limited, the variable stacking height concept with four defined heights (9 mm, 11 mm, 14 mm, and 16 mm, defined by the connector used on the carrier card) enables designers to integrate maximum functionality in limited space. For example, for VPX 1 inch or 1.2 inch carriers, an increased stacking height maximizes the component envelope available on the carrier.

The VITA 93 (QMC) standard supports multiple QMCs on a single carrier, offering advantages over XMC solutions that are typically limited to one or two functions per slot. This flexibility enables SBC designers to support diverse I/O requirements without compromising carrier design. Multiple functions can also

be implemented without additional carrier complexity, while scalability is done easily by adding or changing QMC configurations.

In the VITA 93 (QMC) group there were more than 40 different companies participating in the standard's development, many of them SBC vendors. "We expect more and more SBC vendors to offer QMC slots on their future SBC designs, benefiting from the advantages of this new standard," says VITA's Holman.

The highly modular, flexible, and scalable QMC architecture will bring the additional benefit of reduced development costs and minimal time-to-market for system designers, as highly diverse customer requirements can be met with integrated QMC cards.

Integration with VITA Ecosystem

VITA 93 (QMC) aligns seamlessly with other VITA standards like VPX and VNX+, offering a flexible, modular, and scalable I/O concept that enhances the entire ecosystem's flexibility.

"I think it fits in perfectly," Holman notes. "We specifically are structuring it so it supports VPX and other carrier-card standards, so everything that is being done now with 3U/6U OpenVPX can benefit from this."

Moreover, VITA 93 (QMC) fits into the ecosystems of

other standards, including those developed by PCISIG [Peripheral Component Interconnect Special Interest Group] and PICMG [PCI Industrial Computer Manufacturers Group] – for example, PCIe and CompactPCI-Serial – broadening its applicability.

Variable Stacking Heights

Variable stacking heights maximize the component envelope on a carrier (e.g. single board computer) resulting in additional available space on the carrier i.e. for VPX 1 inch or 1.2 inch carriers. Maximum Stacking height is limited by the form factor of the carrier.



Built to Evolve: VITA 93.1 QTM (QMC I/O Transition Modules)

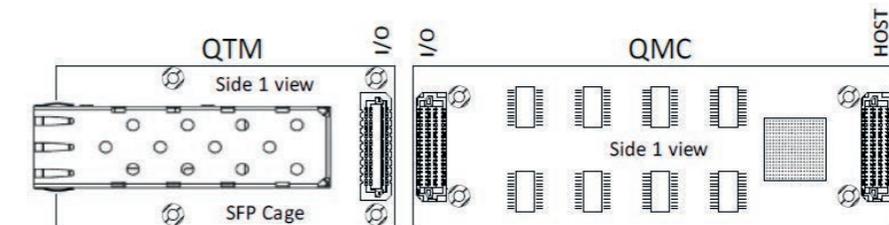
The VITA 93 working group has continued building on the initial success of the QMC standard to create the VITA 93.1 QTM (QMC I/O Transition Module) specification. QTM provides system integrators with a standardized, flexible method for bringing I/O to the front panel.

A QTM is a compact mezzanine card that mounts directly onto a QMC carrier card or rear transition module, routing I/O signals from the QMC's high-density I/O connector to industry-standard cable connectors at the front panel. Whether you require RJ45 for Ethernet, SFP for

fiber, D-Sub, OcuLink, or USB, the QTM supports all these options within a standardized mechanical envelope, ensuring interoperability across vendors and carrier platforms.

QTM's scalability reflects the modular philosophy of VITA 93, modules are available in single-, double-, triple-, and quad-width configurations, allowing engineers to meet I/O density requirements without redesigning the carrier. The same QTM carrier site supports modules from any compliant vendor, providing procurement flexibility and reducing long-term supply chain risk.

The QTM standard supports a wide range of carrier form factors, including VPX, CompactPCI, PCIe, MicroTCA, and VME. This enables system integrators to standardize on a single I/O transition approach across multiple program types, eliminating the need for separate solutions for each platform.



Architectural Resilience

System architects are caught in a continual dilemma: While platforms must remain operational for decades, the innovation cycles for the technologies they depend on are rapidly accelerating.

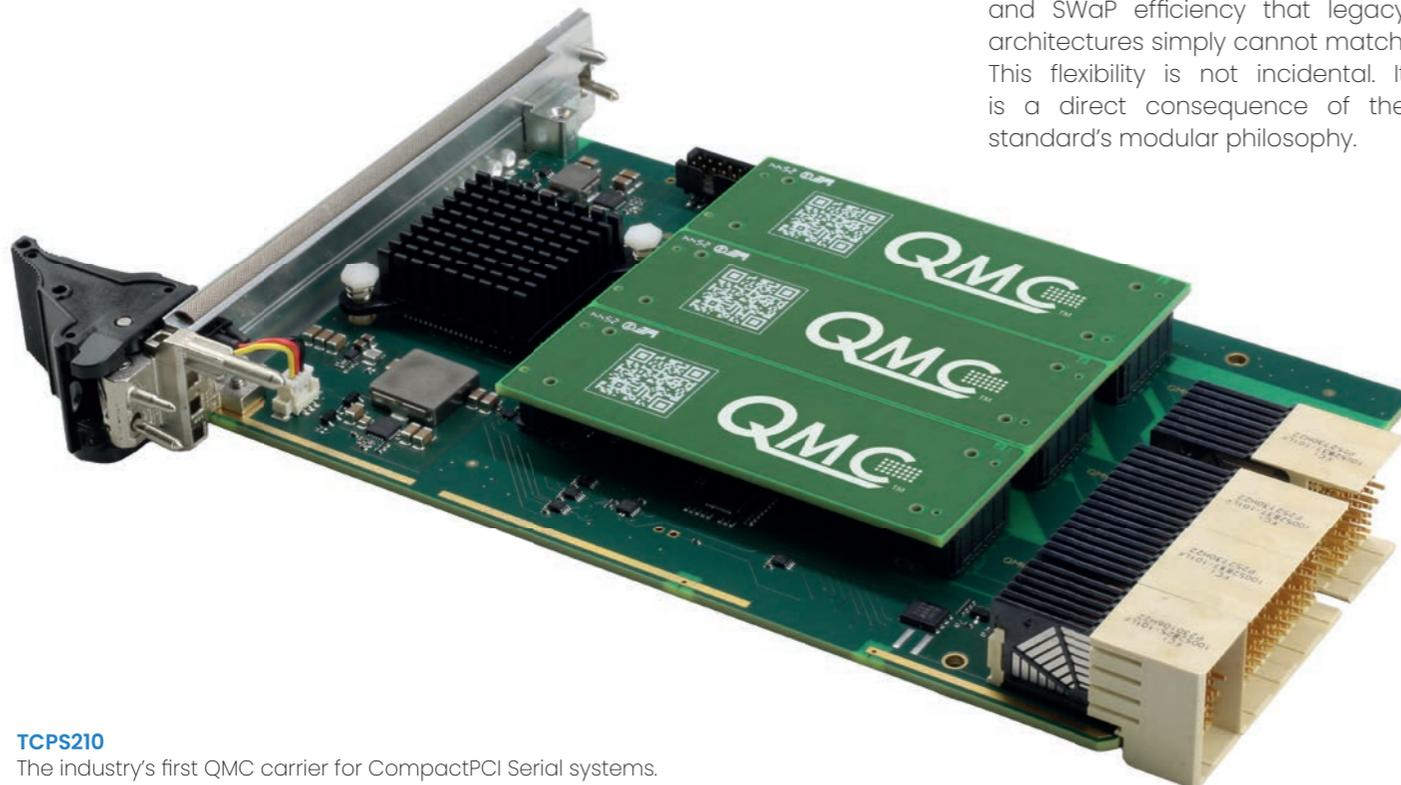
Component lifetimes are compressing, supply chains are becoming less predictable, and the capabilities that can define a mission-critical advantage are

constantly changing. The widening gap between system longevity and technology advancement is now a strategic risk that requires a better system architectural response.

The true power of the QMC architecture lies in its ability to address this gap by deliberately separating the innovation layer from the platform layer.

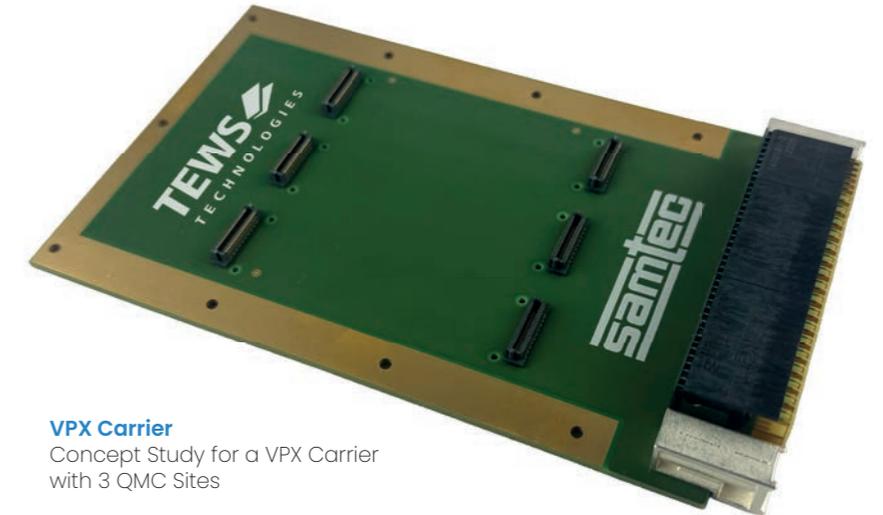
By consolidating computational and I/O functions into independently replaceable modules, QMC allows new technologies to be introduced incrementally without redesigning the platform. Equally significant is QMC's granular scalability. System architects can mix and match modules with varying functionality, enabling rapid response to changing mission requirements. The result is a functional density and SWaP efficiency that legacy architectures simply cannot match. This flexibility is not incidental. It is a direct consequence of the standard's modular philosophy.

The result is an unseen level of architectural resilience, enabling rapid, controlled innovation. Architects can design for an unpredictable future where the same architecture can be deployed across various platforms, clearly distinguishing between elements that require change and those that must remain stable. VITA 93 (QMC) accelerates time-to-market for new capabilities while safeguarding long-term platform investments and significantly reducing development costs. In an industry where obsolescence increases program risk and requalification costs, this layered modularity serves as a foundation rather than a feature.



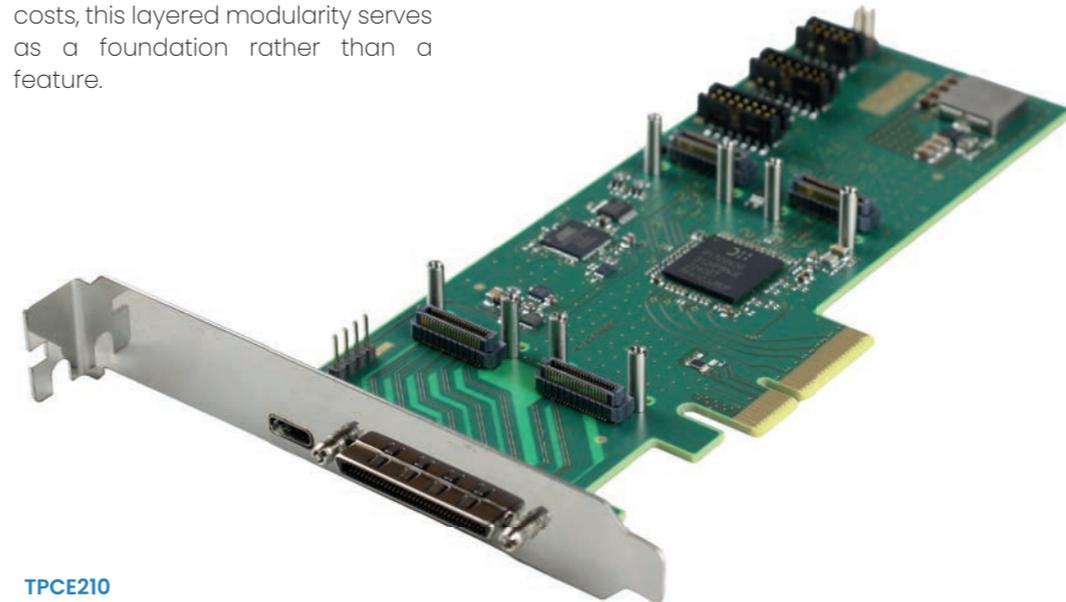
TCPS210

The industry's first QMC carrier for CompactPCI Serial systems.



VPX Carrier

Concept Study for a VPX Carrier with 3 QMC Sites



TPCE210

PCI Express x4, Gen 2, Dual QMC Carrier

VITA 90 VNX+ : Revolutionizing Rugged Embedded Systems

As embedded systems move to the extreme edge, the need for a compact, VPX-like architecture has driven the development of VITA 90 (VNX+). VITA 93 (QMC) delivers flexible mezzanine I/O, while VITA 90 (VNX+) acts as the rugged system-level standard, offering a MOSA-aligned solution for highly space-constrained environments.

VNX+ directly succeeds the VITA 74 (VNX) standard. It maintains the compact “deck of cards” footprint but delivers significantly higher performance. VITA 90 was designed to align with the SOSA® (Sensor Open Systems Architecture) Technical Standard, enabling small form factor systems to meet the interoperability and bandwidth requirements of traditional 3U and 6U OpenVPX systems.

VNX+ is designed to remove bottlenecks common in ultra-small systems. It uses advanced high-speed connectors and optimized pin assignments to support:

High-Speed Fabrics

Data rates exceeding 25 Gbps per lane, supporting PCIe Gen 4/5 and 100Gb Ethernet.

Massive I/O Density

Integration of high-density RF and optical interfaces through VITA 90.2 aperture blocks, supporting frequencies up to 110 GHz.

Enhanced Power & Cooling

Modernized power distribution (VITA 90.3) allows for module power densities up to 95W, supported by advanced conduction and liquid-cooling techniques.

For integrators working with UAVs, man-portable C5ISR systems, and autonomous ground vehicles, VITA 90 (VNX+) eliminates the need for proprietary small box designs. It of-

fers a standardized, COTS-based approach to deploy high-performance AI, signal processing, and sensor fusion in platforms where size and weight are critical.

Since a standard VNX+ module is too small for a traditional XMC mezzanine, VITA 93 QMC was created as the dedicated small form factor mezzanine for this ecosystem. Designers can now equip a VITA 90 carrier with modular I/O or processing blocks, enabling mix-and-match versatility not previously available in rugged SFF hardware.



TVNX210
Dual QMC Carrier for VNX+ Systems

TEWS Technologies: The Leader in VITA 93 QMC

TEWS Technologies, an active member of the VITA Standards Organization for more than 30 years, has been instrumental in shaping mezzanine card evolution from IndustryPack through PMC and XMC. Leveraging its expertise in PCIe-based solutions like XMC and mPCIe, TEWS Technologies is a leading contributor in the development of the VITA 90 (VNX+) and VITA 93 (QMC) standards.

TEWS Technologies is a driving force in the creation of the VITA 93 ecosystem, offering the industry's most comprehensive portfolio of QMC modules and carriers. Already introduced QMC modules cover applications such as serial interfaces, user-reconfigurable

FPGAs, Ethernet, ADCs, DACs, TTL, and CAN. Future planned product developments will include Video/Vision, Motion Control, Graphics, MIL-STD 1553, ARINC, RF/SDR, driven by customer demand and adoption of the QMC standard.

Carrier solutions cover commercial off-the-shelf (COTS) carriers for VPX, PCIe, CompactPCI Serial, and other form factors. TEWS is offering development of custom carriers, meeting customer-specific requirements, for such applications as rugged-box solutions.

TEWS Technologies' 50 years of experience and broad product portfolio allows rapid migration of existing functionalities to the

QMC form factor. As usual for TEWS products, device-driver support for various operating systems is provided and products will be offered with TEWS industry-leading warranty of five years. TEWS products support an industrial operating temperature range of -40 °C to +85 °C whenever possible.

When it comes to modified COTS and customer-specific developments TEWS partners and customers will benefit from its full product-life cycle management, starting from defining the target specification to prototyping and serial production with testing all the way to product obsolescence management.

VITA 93 (QMC) represents a groundbreaking advancement in mezzanine card technology, offering unmatched modularity, flexibility, scalability, and reliability. With its well-thought-out cooling concept, universal compatibility, and robust design, it sets a new standard for embedded systems across industries.

TEWS Technologies – well-known for its deep expertise and commitment to quality, support, and long-term availability – is ready to enable organizations to leverage the full potential of VITA 93 (QMC). Whether you need standard COTS solutions, modified designs, or custom developments, our team can provide the expertise and support to ensure successful implementation.

Conclusion

Contact Us

For more information about VITA 93 (QMC) solutions and how they can benefit your applications visit our website www.tews.com/vita-93-qmc or contact TEWS Technologies.



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