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November 2012

## SMALL FORM FACTOR BOARDS

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# Tough choices

**George Los** explains some of the options for those looking to use small form factor boards in rugged applications

As technology progresses, the requirement for higher performance computational systems, that combine multiple functions in a smaller footprint, becomes a need rather than a desire. Also, as time goes on, there are new capabilities introduced that could save time and increase efficiency onboard many aircraft if effectively added.

All the while, new capabilities are constantly being added to platforms with the intent of decreasing the time it takes to perform a function or increasing the functionality and capability of an aircraft. Yet when new systems are proposed there is always a trade-off between the added weight of the system and a potential drop in carrying weight.

The two parameters that are constantly being focussed on are aircraft survivability and combat mission effectiveness. In many cases going to smaller and lighter electronics can increase the survivability and intelligence of a platform without any decrease in combat mission effectiveness. More than ever, this increases the need for even smaller systems onboard, or combining many functions in a smaller box. Additionally, upgrades take place on many platforms to reduce the size, weight and cost of legacy systems when obsolescence issues appear.

Many times it is possible to combine the functionality of multiple embedded systems into one small form factor footprint. This allows for increased space, fuel efficiency and carrying capacity, and typically is lower in cost.

Integrated electronic components and >

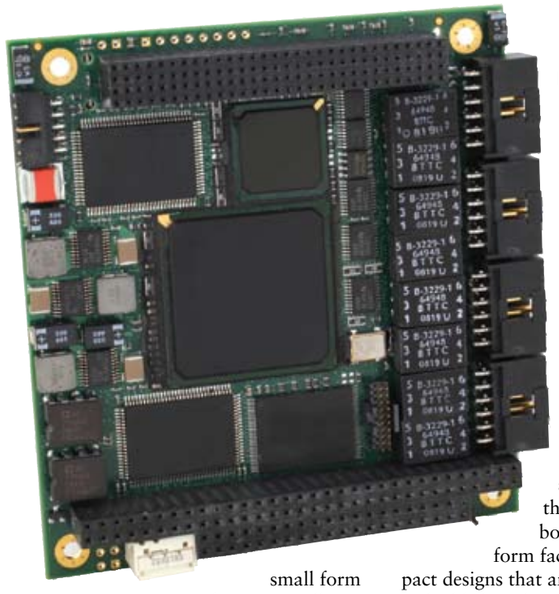

Fig. 1: MIL1553 PC/104-Plus card

small form factors are all new ways to decrease the footprint of electronics such that the overall systems become smaller. The concept of segmenting the processor board and IO portion of the system into two different board assemblies also makes a lot of sense to make things smaller and achieve a longer life cycle.

Many commercially available processor boards have end of life issues after just a few years in the market, while avionics IO such as MIL1553, Arinc-429, Arinc-717, AFDX and others have a longer service history. In many cases design cycles of 15 to 20 years or more are very common when the time to design the systems and platforms and production life cycles are taken into account.

This reality leads many system manufactures to have small mezzanine boards for the IO that plug into a main computer board. This allows one part of the system to be upgraded while keeping the IO on separate mezzanine boards to reduce redesign cost.

## PC/104-Plus

There are many types of small form factor boards on the market today with advances in technology allowing for even smaller footprints in the future. The first small form factor was the PC/104-Plus series of boards (see Fig. 1). These form factors are small and compact designs that are well suited for small embedded applications.

In the case of PC/104-Plus, the IO board is the same footprint as the processor card. The cards are small square boards that have an ecosystem of processors, power supplies, video cards and many different types of IO cards such as MIL1553 and Arinc-429 avionics data buses. The cards are stacked together to build a tower of boards that can go into a rugged, sealed fanless system.

There are also several standards groups working on reducing board size while increasing system functionality. The Vita standards organisation is an incorporated, non-profit organisation of vendors and users having a common market interest in real-time, rugged embedded computing systems. The community has realised that there is a driving need for electronic systems to get smaller and lighter.

There are three new competing standards: Vita-73, Vita-74 and Vita-75. These standards are targeted towards having small form factor boards for rugged systems. Vita-73 is based on the VPX (Vita 46/48) electrical standards in a much smaller footprint. This specification is about the same size as PC/104-Plus cards without all the individual interconnects required to get the IO out of the box since it is a slot based design with a small chassis. Vita-74 based boards are also very small in size, a bit smaller than PC/104-Plus and use a high speed PCIe back-end interface. They are specifically engineered for harsh, rugged conduction-cooled environments. All three provide a standard mechanical format for standardisation of switched serial interconnects for small form-factor applications, with specific concern taken to allow deployment in ruggedised environments.

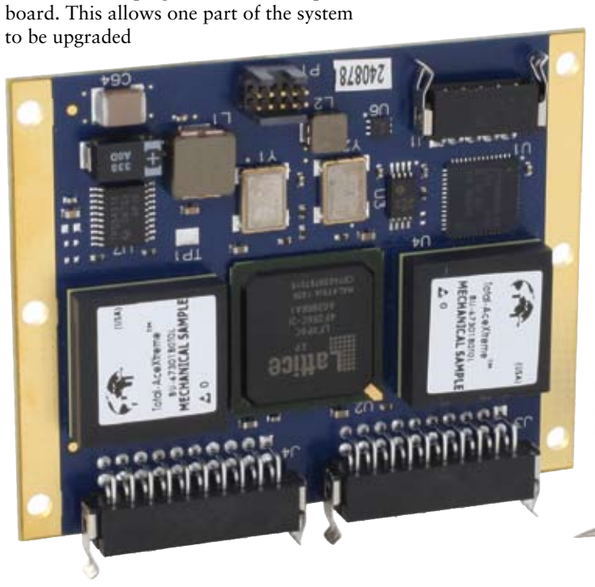

Fig. 2: MIL1553 small form factor USB board

## Q Seven

Another standard that has been released in the past two years is Q Seven. The Q Seven specification is hosted by the independent Q Seven Consortium. It is freely available at the consortium's web site. Q Seven is a computer-on-module small form factor board that can be used much like an integrated circuit component. It is smaller than other computer-on-module standards such as Com Express, ETX or XTX and is limited to very low power consuming CPUs. The idea here is that processor boards and IO boards would slide into a backplane via edge connectors. This is a smaller footprint than the traditional 3U cPCI.

## SFF-Sig

The Small Form Factor Special Interest Group (SFF-Sig) is another independent group that develops, promotes and supports small form factor circuit board, IO and storage specifications. The group embraces the latest technologies, but also has a philosophy of maintaining legacy compatibility and enabling smooth transitions to next-generation interfaces. SFF-Sig is focussed on trying various approaches to suit the miniaturisation of board-level electronics. The stackable USB camp, for its part, is focussed on using USB to replace ISA, PCI or PCIe as the board-to-board interconnects in rugged stacked systems. A new group has also formed around a new specification called Feature Pak, to address small modules.

## USB

USB is a popular approach in rugged embedded systems as well as laptops and tablets. The desire to use USB as a back-end interface exists simply because USB ports are everywhere. A small board with a USB interface allows the USB board to be mounted anywhere inside the system and does not require anything more than just a USB header on the computer board. An example of a small form factor MIL1553 board is shown in Fig. 2.

Following the USB trend, an independent consortium was started to promote stackable USB. Stackable USB combines >

the architecture of PC/104 Plus with a USB back-end interface instead of a PCI interface. This allows a group of even smaller boards to be stacked to build a rugged tower of boards.

## Mini-PCIe

The laptop and tablet industry has adopted Mini-PCIe form factors. Mini-PCIe (see Fig. 3) is a very small board that allows for a card edge connection to a main computer board with a PCIe interface. PCIe has become very popular because just about every modern processor has PCIe inside and it is a very high performance back-end interconnection.

The IO board sits parallel to the main computer board. In standard commercial use, this port is commonly used to add Wifi capability to many computers. For avionics systems, it can be used as a port to add MIL1553, Arinc-429 or other data communications networks.

Many PCIe/104 boards or larger systems are adding Mini-PCIe card slots for expansion due to the small amount of space taken up on the main board.

## Conclusion

There are many choices in the industry for building very rugged small form factor systems. The ones that will survive are going to be the ones with the easiest maintenance and a large backing of the user community to build processor and IO boards. Mini-PCIe and USB are established interfaces. Q Seven or perhaps some of the Vita small form factor standards may become more popular in years to come. One thing is clear, as technology advances, systems keep getting smaller with increasing capability. ■

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Fig. 3: MIL1553 Mini-PCIe card