MicroTCA Application Guide

A Modular Open Systems Approach for Computer Architecture

Version 1.1

August 1, 2012

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Revision History

Version	Date	Comments
V1.0	August 11, 2010	Initial release by MTCA.3 committee. Includes: • Information on MTCA.0, MTCA.1, MTCA.3 specifications • Preliminary information on MTCA.2 and MTCA.4
V1.1	August 1, 2012	Update by the MTCA.2 committee. Includes: • Additional information on MTCA.2 and MTCA.4 • Expanded and clarified specification comparisons

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Scope

This guide is intended for system architects who are responsible for evaluating and selecting the architecture and form factor for specific project requirements. As such, the goal of this document is to help those architects to narrow down their search space when considering the MicroTCA family of specifications.

This document gives a high level overview of the types of applications and requirements that would drive a project toward one MicroTCA specification or another. This document does not explicitly compare MicroTCA against other form factors. Instead, it is designed for the architect who wants to leverage the advantages of MicroTCA but is unsure of which variation or designation of a MicroTCA product class to use.

Please note that this guide is derived from information in the PICMG® MTCA.0, MTCA.1, MTCA.2, MTCA.3, and MTCA.4 specifications and working group documents. For guidelines on the design of MicroTCA™ compliant modules and systems, refer to the full specifications and/or working group documents.

Modular Open Systems Approach (MOSA)

What is MOSA - A Modular Open System Approach to computer architecture design is based on open architecture and open source constructs that ensure reduced development expense, design cycle time and manufacturing cost at a time when product complexity and reliability demands are increasing. Open architecture and open source are hardware or software architectures based on specifications:

- Available to the public and generated, approved and controlled by various standards and trade associations (e.g., PICMG®), or
- Uniquely generated, provided they are made public by its owners (e.g., Peripheral Component Interconnect, or PCI).

Open architecture system specifications must be controlled by an objective third party industry organization to ensure that no single developer or vendor has control over their use.

MOSA fosters - A truly open architecture that has multiple vendors producing products to its standard. This creates competition in industry, thereby forcing recurring costs to trend downward. By embracing MOSA, both system developers and procurement communities:

- Promote efficiency by cutting acquisition/development cycle time, enhancing supportability and reducing life-cycle costs
- Produce better-performing systems that offer both the flexibility to adapt to evolving requirements, and improved interoperability
- Enhance access to cutting-edge technologies and products from multiple suppliers, thereby increasing competition
- Exploit technology transparency for rapid upgrades
- Enhance commonality and reuse of components among systems
- Promote closer cooperation between commercial and military electronics industries

The family of ATCA, AdvancedMC® and MicroTCA specifications, which are controlled by PICMG®, a third-party industry consortium supported by many companies - truly embraces the MOSA doctrine.

Related Specifications

MicroTCA has its foundations in the Advanced Telecommunications Computing Architecture (ATCA), in which Advanced Mezzanine Cards (AdvancedMCs) are used for removable I/O modules. Essentially, the MicroTCA base specification defines a system where AdvancedMCs can be used outside of an ATCA carrier. This enables the potential to create a system with many of ATCA's advantages in a smaller and more energy-efficient package.

A number of more rugged and more specialized MicroTCA implementations have also been defined. With each of these derivative specifications, the goal is to reuse the exact same AMC printed circuit boards and as much of the MicroTCA base specification infrastructure as possible.

Table 1 provides a current list of MicroTCA-related specifications. Figure 1 illustrates the relationship of these specifications.

PICMG Specification	Name	Description
PICMG 3.0	AdvancedTCA Base Specification	The PICMG 3.0 "core" specification specifies board, backplane and shelf mechanicals; power distribution and the connectivity required for system management.
AMC.0	AdvancedMC Mezzanine Module	Defines a mezzanine building block approach for the addition of crucial functionality to a PICMG 3.0 carrier card available from a number of third-party suppliers.
MTCA.0	MicroTCA	Defines a system architecture that uses AdvancedMC Mezzanine Modules plugged directly into a backplane without modifications.
MTCA.1	Air Cooled Rugged MicroTCA	Defines hardened version of MicroTCA for exterior and mobile communications applications.
MTCA.2	Hardened Hybrid Air/Conduction Cooled MicroTCA	Defines hardened version of MicroTCA for rugged industrial and military applications with forced air flow over wedge-locked modules.
MTCA.3	Hardened Conduction Cooled MicroTCA	Defines ruggedized version of MicroTCA for rugged industrial and military applications with no air flow over the modules.
MTCA.4	MicroTCA Enhancements for Rear I/O and Precision Timing	Develops additional features and options for MicroTCA for use in particle physics research including data collection and accelerator control systems.

Table 1. *The MicroTCA family of specifications includes five MTCA.x specifications and two supporting specifications.*

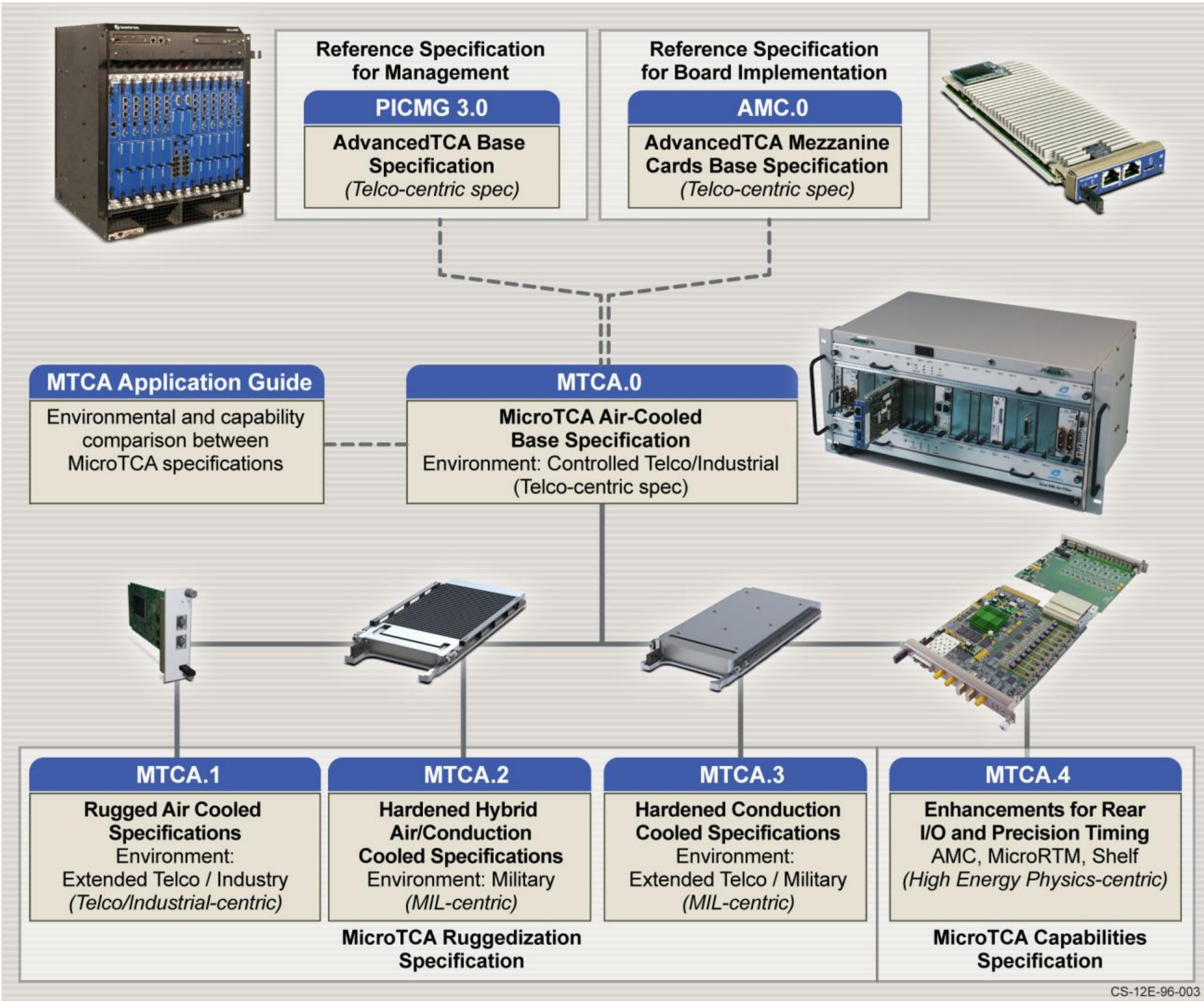

Figure 1. *The MicroTCA family of specifications maximizes reuse from its ATCA and AMC parent specifications.*

MicroTCA Specifications Overview

All of the MicroTCA specifications are based on the MicroTCA base specification, MTCA.0.

Specifications MTCA.1, MTCA.2, and MTCA.3 enhance the base specification by allowing MicroTCA to be deployed in increasingly rugged environments. These can be thought of as “Ruggedization Specifications.”

Specification MTCA.4 extends the capabilities of MicroTCA to allow additional functionality including more rear I/O pins, a powered Rear Transition Module, and high precision timing. These enhancements were originally intended for implementation in high speed physics applications, such as particle accelerators. MTCA.4 can be thought of as a "Capabilities Specification."

The distinction between ruggedization and capabilities specifications is subtle, but important. All MicroTCA modules and systems will be targeting one ruggedization specification. Optionally, the base ruggedization specification can be extended by the capabilities specification, MTCA.4.

Grammatically, a MicroTCA module or system would be specified as compliant to:

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(MTCA.0, MTCA.1, MTCA.2, MTCA.3), [MTCA.4]
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That is, the base or one of the ruggedization specifications is required, and then the capabilities specification (e.g., MTCA.4) is optional.

The following sections detail the differences between the different MicroTCA specifications, so that the engineer can quickly determine the MicroTCA specification that best applies for a specific program.

Capabilities Specifications

Capabilities specifications add additional functionality to the MicroTCA family of specifications. In theory, Capabilities Specifications are orthogonal to the Ruggedization Specifications, so they could be implemented in a module of any level of ruggedization.

Currently, the only Capabilities Specification is MTCA.4. The main capabilities that are added by MTCA.4 are:

- More details about Rear I/O implementations in Zone 3
- Powered Rear Transition Modules
- Provisions for high-precision timing signals

Ruggedization Specifications

MTCA.0 defines the base level of ruggedization, mainly intended for central office controlled environments. MTCA.1, MTCA.2, and MTCA.3 define additional enhancements to allow MicroTCA to be deployed in more rugged environments.

Table 2 gives an overview of the shock and vibration tolerances of the various specifications, while Figure 2 shows operating temperature range and cooling mechanisms.

Requirement	**Maximum Operating Shock**	15g	25g	40g
	Maximum Operating Vibration	1g sinusoidal	8g random	12g random
Implementation	**Required Retention Mechanism**	Hot swap handle	Enhanced retention screw	Wedge locks
	MicroTCA Ruggedization Specification	**MTCA.0**	**MTCA.1**	**MTCA.2 or MTCA.3**

Table 2. *Higher levels of shock and vibration require the use of enhanced technologies from the Ruggedization Specifications*

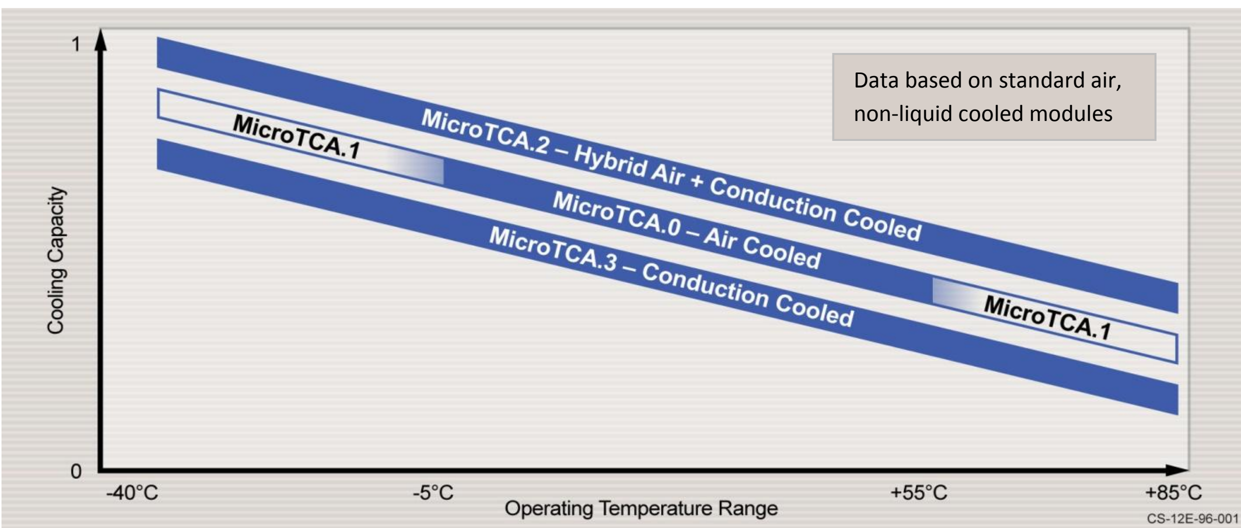

Figure 2. *Relative performance of cooling mechanisms across the operating temperature range.*

As shown in Figure 2, all ruggedization specifications allow for operation over an extended temperature range. However, the amount of power that can effectively be thermally dissipated relies on the underlying cooling mechanism. As a rule of thumb, air-cooled boards can dissipate more heat than conduction-cooled boards. MTCA.2's hybrid air and conduction cooling allows the greatest amount of heat to be dissipated.

Each of the Ruggedization Specifications contains a number of environmental classes which can be thought of as sub-specifications. Table 3 is a more detailed look at the Ruggedization Specifications, including a detailed overview of the environmental classes defined in each.

Note that MTCA.4 is not included in this table because it is a Capabilities Specification. Instead, the ruggedization of a MTCA.4 module or system depends on the Ruggedization Specification (MTCA.0, MTCA.1, MTCA.2, or MTCA.3) to which it also complies.

Environmental Category and Range		MTCA.0 (Air cooled)	MTCA.1 (Air cooled)	MTCA.2 (Hybrid air / conduction cooled	MTCA.3 (Conduction cooled)
Operating Temperature	-5C to +55C	BASE	BASE	MIL-FC1	TEL-1
	-40C to +55C		XT1-L	MIL-FC2	MIL-CC2
	-40C to +70C			MIL-FC3	MIL-CC3
	-40C to +85C		XT1	MIL-FC4	TEL-2 MIL-CC4
Non-Operating Temperature	-40C to +70C	BASE	(all classes)		TEL-1
	-40C to +85C			MIL-FC1 MIL-FC2	MIL-CC2
	-45C to +85C				TEL-2
	-50C to +100C			MIL-FC3	MIL-CC3
	-55C to +105C			MIL-FC4	MIL-CC4
Operating Vibration	1g (sine)	BASE			TEL-1
	3g (sine)		XR1		
	8g (random)		XR2		TEL-2
	12g (random)			(all classes)	MIL-CC2 MIL-CC3 MIL-CC4
Operating Shock	15g	BASE			TEL-1
	25g		XR1		TEL-2
	20g / 11ms		XR2		
	40g / 11ms			(all classes)	MIL-CC2 MIL-CC3 MIL-CC4
Altitude	-60m to 4000m	BASE	(all classes)		
	-460m to 18300m			(all classes)	(all classes)

Table 3. *The ruggedization level is defined by the Ruggedization Specification and an environmental class defined within the specification.*