

# IEEE Standard for Space Applications Module, Extended Height Format E Form Factor

Sponsor  
**Bus Architecture Standards Committee  
of the  
IEEE Computer Society**

Approved March 16, 1995  
**IEEE Standards Board**

**Abstract:** The design requirements for a module designated for use in spacecraft, boosters, and other highly rugged, conductively cooled environments are established in this standard. The requirements herein serve to specify the mechanical design of the module. Dimensions and tolerances for racks, modules, printed wiring boards, backplanes, and other connector-related dimensions that are specific to the use of 300-pin and 396-pin connectors are given. These dimensions and tolerances are designed to ensure mechanical function and interoperability.

**Keywords:** mechanical interchangeability, module, SEM Format E extended height, space applications

---

The Institute of Electrical and Electronics Engineers, Inc.  
345 East 47th Street, New York, NY 10017-2394, USA

Copyright © 1995 by the Institute of Electrical and Electronics Engineers, Inc.  
All rights reserved. Published 1995. Printed in the United States of America.

ISBN 1-55937-527-2

*No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.*

**IEEE Standards** documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE that have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least every five years for revision or reaffirmation. When a document is more than five years old and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

**Interpretations:** Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

Secretary, IEEE Standards Board  
445 Hoes Lane  
P.O. Box 1331  
Piscataway, NJ 08855-1331  
USA

IEEE Standards documents may involve the use of patented technology. Their approval by the Institute of Electrical and Electronics Engineers does not mean that using such technology for the purpose of conforming to such standards is authorized by the patent owner. It is the obligation of the user of such technology to obtain all necessary permissions.

## Introduction

(This introduction is not a part of IEEE Std 1101.7-1995, IEEE Standard for Space Applications Module, Extended Height Format E Form Factor.)

The IEEE Computer Society Technical Committee on Microprocessors and Microcomputers found it appropriate to develop a separate IEEE standard for space and highly ruggedized applications based on a module with the same envelope as the Standard Hardware Acquisition and Reliability Program (SHARP) Standard Electronic Module (SEM) Format E. This standard provides dimensions and tolerances for modules, chassis, printed wiring boards (PWBs), backplanes, and other connector-related dimensions that are specific to the use of 300-pin and 396-pin connectors (as described in 5.9). These dimensions and tolerances are designed to ensure mechanical function and interoperability.

At the time this standard was approved, the members of the Space Application Mechanical Module Working Group were as follows:

**John W. McKinstry** , *Chair*  
**Jerry D. Keller** (*Editor*)

Darryl Adams  
Mitch Beaumont  
Steve Belvin  
Andy Brough  
Andrew Capobianco  
Tom Clark  
Bill Crnkovich  
Jerry Edwards  
Gary Gardner

Robert George  
Ken Heffner  
Thomas Hillyer  
Rod Hudson  
Dennis Kern  
David Kirk  
Dale Langston  
Cal Laurvick

Edward Marian  
Joe Marshall  
Richard Norman  
Elwood Parsons  
Dan Sherick  
Bill Schneider  
Keith Spence  
Dean Van De Walker  
David L. Wasler

The following persons were on the balloting committee:

Harry Andreas  
Keith D. Anthony  
Chris Bezirtzoglou  
Paul L. Borrill  
Charles Brill  
Andrew J. Brough  
Andrew Capobianco  
Jerald A. Edwards

Wayne Fischer  
Paul J. Fulton  
Gary Gardner  
Joseph D. George  
Julio Gonzalez Sanz  
Michael Lambrou  
John W. McKinstry  
Michael Munroe  
Granville Ott

Elwood Parsons  
L.M. Patnaik  
Frederick E. Sauer  
Robert Tripi  
Eike Waltz  
David L. Wright  
Yoshio Yamaguchi  
Janusz Zalewski

When the IEEE Standards Board approved this standard on March 16, 1995, it had the following membership:

**E. G. “Al” Kiener, *Chair***  
**Donald C. Loughry, *Vice Chair***  
**Andrew G. Salem, *Secretary***

Gilles A. Baril  
Clyde R. Camp  
Joseph A. Cannatelli  
Stephen L. Diamond  
Harold E. Epstein  
Donald C. Fleckenstein  
Jay Forster\*  
Donald N. Heirman

Richard J. Holleman  
Jim Isaak  
Ben C. Johnson  
Sonny Kasturi  
Lorraine C. Kevra  
Ivor N. Knight  
Joseph L. Koepfinger\*  
D. N. “Jim” Logothetis  
L. Bruce McClung

Marco W. Migliaro  
Mary Lou Padgett  
John W. Pope  
Arthur K. Reilly  
Gary S. Robinson  
Ingo Rusch  
Chee Kiow Tan  
Leonard L. Tripp

\*Member Emeritus

Also included are the following nonvoting IEEE Standards Board liaisons:

Satish K. Aggarwal

Richard B. Engelman  
Robert E. Hebner

Chester C. Taylor

Paula M. Kelty  
*IEEE Standards Project Editor*

| CLAUSE                                       | PAGE |
|----------------------------------------------|------|
| 1. Overview .....                            | 1    |
| 1.1 Scope.....                               | 1    |
| 1.2 Purpose.....                             | 1    |
| 1.3 Mechanical characteristics .....         | 1    |
| 1.4 Environmental requirements .....         | 1    |
| 2. References.....                           | 2    |
| 3. Definitions.....                          | 3    |
| 3.1 Special word usage.....                  | 3    |
| 3.2 Technical definitions.....               | 3    |
| 4. Module requirements .....                 | 3    |
| 4.1 Module description .....                 | 3    |
| 4.2 Module construction .....                | 4    |
| 4.3 Clearances .....                         | 4    |
| 4.4 Module identification .....              | 5    |
| 4.5 Thermal requirements .....               | 5    |
| 4.6 Reliability.....                         | 5    |
| 4.7 Module warp .....                        | 5    |
| 4.8 Mechanical bonding.....                  | 5    |
| 4.9 Personnel safety .....                   | 5    |
| 4.10 Test points .....                       | 5    |
| 4.11 EMI considerations .....                | 5    |
| 4.12 Printed circuit design .....            | 6    |
| 4.13 Materials.....                          | 6    |
| 4.14 Finishes and protective treatments..... | 7    |
| 5. Module interface requirements .....       | 7    |
| 5.1 Mechanical configuration .....           | 7    |
| 5.2 Module height .....                      | 7    |
| 5.3 Module span.....                         | 8    |
| 5.4 Module pitch .....                       | 8    |
| 5.5 Module profile.....                      | 8    |
| 5.6 Module frame.....                        | 8    |
| 5.7 Guide rib requirements.....              | 9    |
| 5.8 Module header.....                       | 11   |
| 5.9 Connector .....                          | 11   |
| 5.10 Module keying .....                     | 11   |
| 5.11 Module retainers .....                  | 12   |
| 5.12 Module insertion/extraction .....       | 13   |
| 5.13 Lateral displacement .....              | 14   |
| 5.14 Durability .....                        | 14   |
| 6. Engineering notes.....                    | 17   |
| 6.1 Backplane connectors .....               | 18   |
| 6.2 Chassis dimensions .....                 | 18   |

| CLAUSE                                  | PAGE |
|-----------------------------------------|------|
| 6.3 Weight.....                         | 18   |
| 6.4 Thermal considerations .....        | 18   |
| 6.5 Structural testing .....            | 19   |
| 6.6 Frame recommendations .....         | 21   |
| Annex A (informative) Bibliography..... | 23   |

# IEEE Standard for Space Applications Module, Extended Height Format E Form Factor

## 1. Overview

### 1.1 Scope

This standard establishes the design requirements for a module designated for use in spacecraft, boosters, and other highly rugged, conductively cooled environments. Conformance to IEEE Std 1101.4-1993<sup>1</sup> was maintained where applicable. The requirements herein serve to specify the mechanical design of the module. In the event of conflict between the text of this standard and the references cited herein, the text of this standard shall take precedence. Nothing in this standard, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

### 1.2 Purpose

The purpose of this standard is the specification of dimensions and tolerances that will ensure the mechanical intermateability of spaceborne modules within associated subracks. In addition, mechanical characteristics for spaceborne applications are included.

### 1.3 Mechanical characteristics

This standard provides dimensions and tolerances for modules, chassis, printed wiring boards (PWBs), backplanes, and other connector-related dimensions that are specific to the use of 300-pin and 396-pin connectors (as described in 5.9). These dimensions and tolerances are designed to ensure mechanical function and interoperability.

### 1.4 Environmental requirements

The module shall meet the environmental requirements of clause 6 of IEEE P896.10. The performance level shall be specified by the procurement activity. This standard is primarily intended for space applications using all performance levels specified, but does not exclude other applications using other performance levels.

---

<sup>1</sup>Information on references can be found in clause 2.

## 2. References

This standard shall be used in conjunction with the following publications. When the following standards are superseded by an approved revision, the revision shall apply:

ANSI Y14.5M-1982 (Reaff 1988), American National Standard for Dimensioning and Tolerancing.<sup>2</sup>

ANSI/IPC D-275-1991, Design Standard for Rigid Printed Boards and Rigid Printed Board Assemblies.<sup>3</sup>

ASTM E595-1984, Standard Test Method for Total Mass Loss and Collected Volatile Condensable Materials from Outgassing in a Vacuum Environment.<sup>4</sup>

EIA Proposed IS-22, Miniaturized Two-Part Blade-Tuning Fork Connector for Printed Wiring Boards and Backplanes.<sup>5</sup>

IEEE P896.10, IEEE Draft Standard for Futurebus+ Spaceborne Systems, Profile S (D3.6/Dec. 1994).<sup>6</sup>

IEEE Std 1101.4-1993, IEEE Standard for Military Module, Format E Form Factor (ANSI).<sup>7</sup>

IEEE Std 1156.1-1993, IEEE Standard for Microcomputer Environmental Specifications for Computer Modules (ANSI).

MIL-HDBK-217F, Reliability Prediction of Electronic Equipment.<sup>8</sup>

MIL-I-46058C, Electrical Insulating Compound (For Coating Printing Circuit Assemblies).

MIL-P-50884C, Flexible and Rigid-Flex Printed Wiring.

MIL-P-55110E, General Specification for Printed Wiring Boards.

MIL-STD-130G, Standard Identification Marking of United States Military Property.

MIL-STD-454N, Standard General Requirements for Electronic Equipment.

MIL-STD-889B, Standard for Dissimilar Metals.

MIL-STD-1543B, Standard Reliability Program Requirements for Space and Launch Vehicles.

MIL-STD-2118, Flexible and Rigid-Flex Printed Wiring for Electronic Equipment Design.

MIL-STD-1547B, Electronic Parts, Materials and Processes for Space and Launch Vehicles.

MIL-STD-2000A, Standard Requirements for Soldering Electrical and Electronic Assemblies.

<sup>2</sup>ANSI publications are available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

<sup>3</sup>IPC publications are available from the Institute for Interconnecting and Packaging Electronic Circuits (IPC), 7380 N. Lincoln Ave., Lincolnwood, IL 60646, USA.

<sup>4</sup>ASTM publications are available from the Customer Service Department, American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103, USA.

<sup>5</sup>EIA publications are available from Global Engineering, 1990 M Street, NW, Suite 400, Washington, DC, USA.

<sup>6</sup>This IEEE authorized standards project was not approved by the IEEE Standards Board at the time this went to press. For information about obtaining a copy of the draft, contact the IEEE.

<sup>7</sup>IEEE publications are available from the Institute of Electrical and Electronics Engineers, 445 Hoes Lane, P.O. Box 1331, Piscataway, NJ 08855-1331, USA.

<sup>8</sup>MIL publications are available from Customer Service, Defense Printing Service, 700 Robbins Avenue, Bldg. 4D, Philadelphia, PA 19111-5094, USA.

## 3. Definitions

### 3.1 Special word usage

**3.1.1 may:** A key word that indicates flexibility of choice with no implied preference.

**3.1.2 shall:** A key word indicating a mandatory requirement. Designers shall implement all such mandatory requirements to ensure interoperability with other IEEE 1101.7 conformant products.

**3.1.3 should:** A key word indicating flexibility of choice but with a strongly preferred implementation. The phrase *recommended* is used interchangeably with the key word *should*.

### 3.2 Technical definitions

**3.2.1 alpha end:** The end of the module nearest the lowest numbered contact.

**3.2.2 beta end:** The end of the module nearest the highest numbered contact.

**3.2.3 frame:** A component of the module that provides structural support and enhanced thermal performance

**3.2.4 g:** Acceleration due to gravity; approximately  $9.80 \text{ m/s}^2$  ( $32.2 \text{ ft/s}^2$ ).

**3.2.5 guide rib:** The alpha and beta ends of the module. These form the heat transfer paths and the mounting for the module retainers and provide for module alignment.

**3.2.6 insertion levers:** A device used to insert and extract the module.

**3.2.7 key code:** An alpha or alphanumeric designator used to identify the style and angular position of the keying pins.

**3.2.8 key pin:** A hardware implementation to prevent mating of incompatible modules.

**3.2.9 module header:** A structure attached to or integral to the top of a module's frame that is used for structural performance, marking, and optional component-mounting.

**3.2.10 module interference plane:** An assigned plane on the bottom surface of the connector from which the connector/s electrical pins protrude, forming the mating surface.

**3.2.11 module retainer (expansion element):** The device used to secure the module in the chassis and to hold module guide ribs against chassis webs to attain a good thermal interface.

**3.2.12 pitch:** The nominal spacing from the centerline of a module to the centerline of an adjacent module.

**3.2.13 profile:** The maximum thickness of the module.

**3.2.14 printed wiring board (PWB):** Any interconnection board.

**3.2.15 PWB:** Printed wiring board.

## 4. Module requirements

The module shall conform to the general requirements given in this clause.

### 4.1 Module description

A module consists of a PWB(s) with retainers mounted to guide rib on side B (side A has no retainers) and connector mounted at the bottom of the module. The recommended implementation of this module includes the above components and a frame with a PWB mounted on both sides. This standard does not preclude other implementations that meet the interface requirements specified herein. Headers, crossovers, covers, frames, test points, and insertion levers are options on modules. See figure 1 for module outline.