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TECHNICAL REPORT

Mechanical structures for electrical and electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series
Part 3-1: Technological schemes and applications

IEC TR 60297-3-1:2023-02(en)

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colour inside

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Part 3-1: Technological schemes and applications

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MECHANICAL STRUCTURES FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – DIMENSIONS OF MECHANICAL STRUCTURES OF THE 482,6 mm (19 in) SERIES

Part 3-1: Technological schemes and applications

FOREWORD

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IEC TR 60297-3-1 has been prepared by subcommittee 48D: Mechanical structures for electrical and electronic equipment, of IEC technical committee 48: Electrical connectors and mechanical structures for electrical and electronic equipment. It is a Technical Report.

The text of this Technical Report is based on the following documents:

Draft	Report on voting
48D/756/DTR	48D/757/RVDTR

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this Technical Report is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts in the IEC 60297 series, published under the general title *Mechanical structures for electrical and electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series*, can be found on the IEC website.

Future documents in this series will carry the new general title as cited above. Titles of existing documents in this series will be updated at the time of the next edition.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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INTRODUCTION

The IEC 60297 series contains dimensional definitions of the entire mechanical structure layers from level 1 to level 4 for electrical and electronic equipment practices. Nowadays, the IEC 60917-1 generic standard defines all the elements and components in the mechanical structure layers from level 1 to level 4, and they are adopted for the IEC 60917-2 (metric) series. The original concept of the mechanical structure layers was established in DIN 41494 and introduced into the former IEC 297 series, later republished as the IEC 60297 series. Therefore, the second edition of IEC 60917-1:2019 (generic) categorizes the existing IEC 60297 series as a "conventional standard (legacy system)", which contains the detail dimensions of the structure levels from level 1 to level 4 as well as the structure levels of the IEC 60917-2 series (metric).

Applications of the IEC 60297 series are divided into two different perceptions by the users:

a) the traditional 19-inch racks and chassis configurations, and

b) the 19-inch subrack system.

The latter has been providing effective and rational solutions for the critical issues on interconnection and packaging for electronic equipment, which have been in a close relationship with the IEC connector standards of IEC SC 48B, in the microelectronics era since the 1960s.

In the 1980s, the 19-inch subrack system was adopted as the mechanical specifications for open computer bus standards in the IEEE and other manufacturers' associations or industrial consortia. In such fields, not only newly developed high-performance connectors have been applied, but also advanced mechanical features have been developed, based on the 19-inch subrack system. These new technologies have been standardized, and their efforts considered as development for extended specifications for the 19-inch subrack system in IEC SC 48D.

From these points of view, this Technical Report has been prepared to provide the following information, not only for users of the IEC 60297 series standards, but also for the engineers who will develop new architectures or hardware for advanced ICT equipment or systems for the current IoT or Industry 4.0 era:

– information on technological schemes of the IEC 60297 series standards, which have been in development for over 40 years in IEC TC 48/SC 48D. (In the market for industrial electronics and information and communication technology (ICT), there are active users who take the two different approaches regarding the application or adoption of the technologies from the IEC 60297 series standards);

– the technological background of the standards, and the principles or concepts, which had been adopted to cope with the technological evolutions through the development process of the IEC 60297 series standards in IEC SC 48D;

– in standardization for mechanical structures for electrical and electronic equipment in IEC SC 48D, IEC 60917-1 has been published as the generic standard for modular order for the development of mechanical structures for electrical and electronic equipment practices. The IEC 60297 series also considered that the dimensions of the mechanical structure are partly in accordance with IEC 60917-1. This document clarifies the relationship between the IEC 60917 series and the IEC 60297 series;

– to introduce the domain of each part of the IEC 60297 series for structures for electrical and electronic equipment.

Annex A introduces applicable connectors for the 19-inch subrack system, including newly developed high-performance connectors which are not (yet) published as IEC SC 48B standards.

Annex B introduces relationships and compatibilities between the 19-inch subrack system standards in IEC SC 48D, the IEEE standards for the 19-inch subrack and plug-in units, and other industrial standards for the mechanical specifications. It also shows outlines of the extended mechanical features adopted for the 19-inch subrack system. These features include the implementations of the mezzanine cards and the conduction cooled system, and they are not yet defined in IEC SC 48D standards.

Through the study of the additional information given in Annex A and Annex B, further prospects on applications of the 19-inch subrack system will be seen, and the directions of the next standards development in IEC TC 48/SC 48D will be provided.

MECHANICAL STRUCTURES FOR ELECTRICAL AND ELECTRONIC EQUIPMENT – DIMENSIONS OF MECHANICAL STRUCTURES OF THE 482,6 mm (19 in) SERIES

Part 3-1: Technological schemes and applications

1 Scope

This part of IEC 60297 provides information on the technological schemes of the IEC 60297 series, and shows how to apply the 19-inch series standards for the mechanical structure practices for electrical and electronic equipment.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60297-3-100:2008, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-100: Basic dimensions of front panels, subracks, chassis, racks and cabinets*

IEC 60297-3-101:2004, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-101: Subracks and associated plug-in units*

IEC 60297-3-102:2004, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-102: Injector/extractor handle*

IEC 60297-3-103:2004, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-103: Keying and alignment pin*

IEC 60297-3-104:2006, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-104: Connector dependent interface dimensions of subracks and plug-in units*

IEC 60297-3-105:2008, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-105: Dimensions and design aspects for 1U high chassis*

IEC 60297-3-106:2010, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-106: Adaptation dimensions for subracks and chassis applicable with metric cabinets or racks in accordance with IEC 60917-2-1*

IEC 60297-3-107:2012, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-107: Dimensions of subracks and plug-in units, small form factor*

IEC 60297-3-108:2014, *Mechanical structures for electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-108: Dimensions of R-type subracks and plug-in units*

IEC 60297-3-109:2015, *Mechanical structures for electrical and electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-109: Dimensions of chassis for embedded computing devices*

IEC 60297-3-110:2018, *Mechanical structures for electrical and electronic equipment – Dimensions of mechanical structures of the 482,6 mm (19 in) series – Part 3-110: Residential racks and cabinets for smart houses*

IEC 60603-2, *Connectors for frequencies below 3 MHz for use with printed boards – Part 2: Detail specification for two-part connectors with assessed quality, for printed boards, for basic grid of 2,54 mm (0,1 in) with common mounting features*

IEC 60917-1, *Modular order for the development of mechanical structures for electrical and electronic equipment practices – Part 1: Generic standard*

IEC 60917-2:1992, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2: Sectional specification – Interface co-ordination dimensions for the 25 mm equipment practice*

IEC 60917-2-1:1993, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2: Sectional specification – Interface co-ordination dimensions for the 25 mm equipment practice – Section 1: Detail specification – Dimensions for cabinets and racks*

IEC 60917-2-2:1994, *Modular order for the development of mechanical structures for electronic equipment practices – Part 2: Sectional specification – Interface co-ordination dimensions for the 25 mm equipment practice – Section 2: Detail specification – Dimensions for subracks, chassis, backplanes, front panels and plug-in units*

IEC 61076-4-100, *Connectors for electronic equipment – Part 4-100: Printed board connectors with assessed quality – Detail specification for two-part connector modules having a grid of 2,5 mm for printed boards and backplanes*

IEC 61076-4-101, *Connectors for electronic equipment – Part 4-101: Printed board connectors with assessed quality – Detail specification for two-part connector modules, having a basic grid of 2,0 mm for printed boards and backplanes in accordance with IEC 60917*

IEC 61076-4-113, *Connectors for electronic equipment – Printed board connectors – Part 4-113: Detail specification for two-part connectors having 5 rows with a grid of 2,54 mm for printed boards and backplanes in bus applications*

IEC 61076-4-116, *Connectors for electronic equipment – Product requirements – Part 4-116: Printed board connectors – Detail specification for a high-speed two-part connector with integrated shielding function*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

4 Technological scheme of the IEC 60297 series

4.1 Development history and technological background

4.1.1 General

This Subclause 4.1 introduces the history of the development and the applications of the IEC 60297-X series in IEC SC 48D.

The initial standards of the IEC 60297-X series[1] were published at the beginning of the 1980s. Before the publication of IEC standards, there was the EIA 19-inch rack standard (ANSI/EIA RS310-C 1971 *Rack, Panels and Associated Equipment*[2]), and the combination of 19-inch racks or cabinets and 19-inch chassis (modular chassis) in accordance with the EIA standard had been used broadly for telecommunication, instrumentation, and other electronic equipment in many countries. This model is still being applied to current IT equipment, servers, etc., which are mounted within the 19-inch racks/cabinets in datacentres. It is the traditional 19-inch rack and chassis configuration of the 482,6 mm (19 in) standard series.

IEC 60297-3[3] was published in 1984. This standard was developed by DIN and IEC SC 48D under the following circumstances.

4.1.2 Development of the 482,6 mm (19 in) subracks and associated plug-in units (19-inch subrack system)

In the middle of the 1960s, to cope with the expanding adoption of printed boards (PBs) in the fields of industrial electronics and telecommunication equipment, the development of a mechanical structure for housing PBs in a rack started in Germany. The dimensions of the rack and chassis were adopted from the 19-inch EIA standard, and the following development concept was established to mount the PBs into the 19-inch modular chassis as the structure of 482,6 mm (19 in) subracks and associated plug-in units.

Electronic equipment for telecommunication or industrial uses is required to obtain reliability, compatibility and interchangeability for easy maintenance. In such electronic equipment, in the case where one electronic system consists of multiple PCBs (functional units/sub-systems, they are interconnected in one chassis), its hardware should adopt the mechanical structure described above. And, the mechanical structure, 482,6 mm (19 in) subracks and associated plug-in units, shall be designed based on the following principles.

- The sizes of PBs of plug-in units are unified and based on the height and depth of the accommodated subracks.
- The adopted connectors on the PBs of plug-in units are unified and standardized to establish the interconnection between plug-in units (via a backplane or wire-wrap[4], which is a cable-connecting technology between tail pins of fixed connectors on the backside of a subrack).
- The plug-in units are placed vertically in the subracks to promote convective air flow for heat dissipation.

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1 The main parts of the IEC 60297-X series were published in the 1980s. IEC 60297-1:1986 and IEC 60297-2:1982 were merged into IEC 60297-3-100:2008.

2 The standard defines a flange width of 19 in (482,6 mm) and a height pitch of 1U = 1,75 in (44,45 mm) for mounting the chassis to the rack.

3 IEC 60297-3:1984 was replaced by IEC 60297-3-101:2004.

4 Wrapped connections are described in IEC 60352-1.

In accordance with these principles, the basic size of the PB for the 482,6 mm (19 in) subracks was defined as 100 mm × 100 mm and adopted for the 3U high subrack[5]. One connector in accordance with IEC 60603-2/DIN 41612 is placed on the 100 mm high PB. The extended sizes were also defined with regard to height as the double-size with two connectors for a 6U subrack and triple-size with three connectors placed on a 9U subrack, and with regard to depth in increments of 60 mm (see Figure 1 and Figure 2).

These modular structures and dimensions were adopted by DIN standards and proposed in IEC SC 48D. Consequently IEC 60297-3 was published in 1984.

The mechanical architecture of the 19-inch subrack system consists of plug-in units (connectors and PBs assembled with other mechanical parts) and subracks, in which the plug-in units are interconnected via the adoption of standard connectors on a backplane in a subrack. The configuration of the 19-inch subrack system has provided a rational hardware solution to microcomputing systems and microelectronics equipment for industrial and commercial uses.

In the industrial electronics and ICT market, the 19-inch subrack system in the 482,6 mm (19 in) standard series was accepted as an effective solution to the issue of packaging and interconnection for electronic equipment.

The 19-inch subrack system had been adding advanced extended features through the 1990s to the 2010s (see 4.2), and their applications had been expanding in the same market.

5 3U (133,35 mm) high subrack is defined to have the 100 mm high PBs vertically installed in accordance with the principles described, and such subracks are mounted into the 482,6 mm (19 in) cabinets or racks. See IEC 60297-3-101.

Dimensions in millimetres

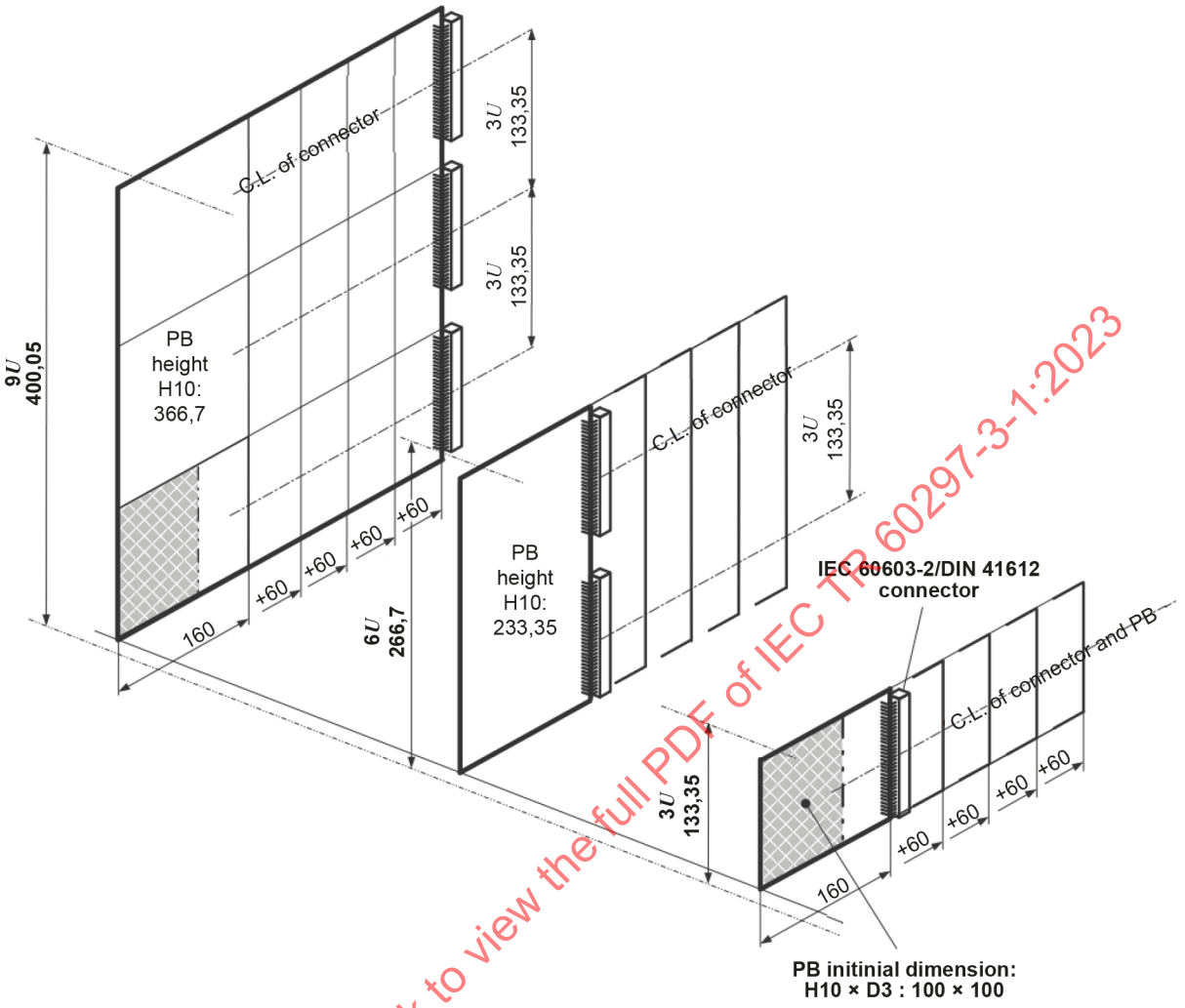


Figure 1 – Unified printed board size accommodated with height and depth of the subracks (recommended dimension matrix)

Dimensions in millimetres

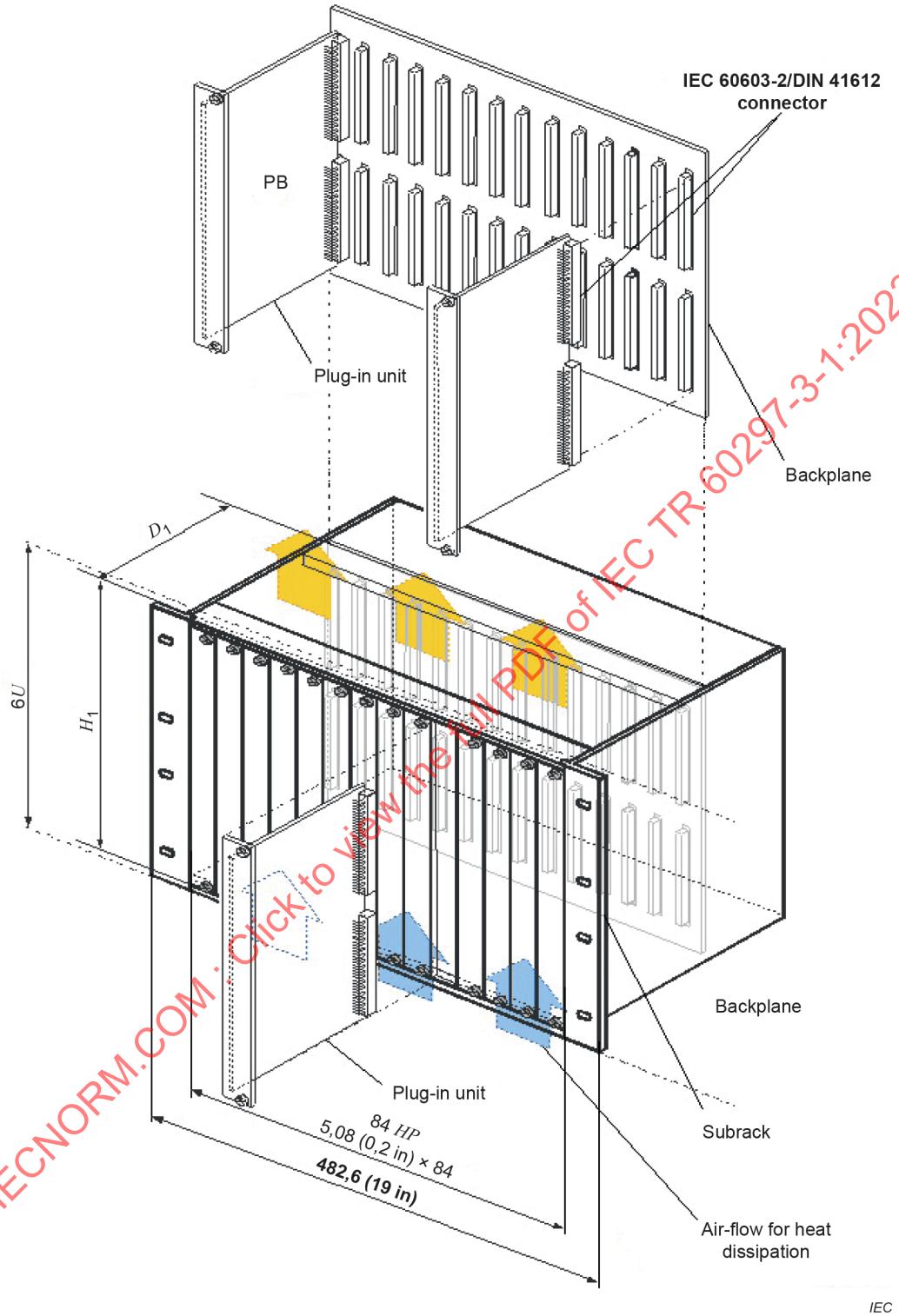


Figure 2 – Typical image of 19-inch subrack system (6U subrack with plug-in units, where the plug-in units are interconnected by a backplane fixed on the subrack frame)

4.1.3 Adoption of IEC 60603-2 connector in the 482,6 mm (19 in) subracks and associated plug-in units ("19-inch subrack system")

In the development of the 19-inch subrack system at DIN and IEC SC 48D, it was assumed that the DIN 41612 connectors would be adopted for interconnecting the plug-in units via backplanes in the subracks.

The DIN 41612 connector is a board-to-board connector and consists of a free board connector and a fixed board connector, which has a three-rows of a maximum of 32 contact pins on the 2,54 mm (0,1 in) grid (total 96 pin-count). The length of the connector is suited to the 100 mm high PB.

The major parts of the DIN 41612 series were released in the late 1970s. In the early 1980s, IEC 60603-2 was published by IEC SC 48B. (The 2,54 mm grid arrangement of the IEC 60603-2/DIN 41612 connector had been used as the grid for PBs in the electronics industry[6], and it also affected the dimensions of the subracks and associated plug-in units[7]).

In the early 1980s, the most important technological issue in the relationship between the IEC 60603-2 connector and the 19-inch subrack system was how to provide a solution to the problems of the physical interconnection between functional PB modules. The functional PB modules were data processing units, I/O units, memory storage, a system management module, etc., for digital telecommunication equipment and industrial computing systems in the coming evolutions in the microelectronics era. The IEC 60603-2 standard has been defined to ensure not only reliability of the interconnection and durability of the mechanical structure, but also compatibility for general industrial use[8], and actual products that had been widely accepted in the fields of industrial electronics and ICT equipment. The IEC 60297-X series 482,6 mm (19 in) standards for the subracks and associated plug-in units provided the physical environment to realize the performance and capability of the IEC 60603-2 connector fully by the modular structure based on design principles.

4.1.4 Modular structure of the 482,6 mm (19 in) series

The concept of modular structure[9] for the mechanical structure for electronic equipment was established through the development of the 482,6 mm (19 in) series in DIN and IEC SC 48D. The basic dimensions of the modular system consist of the inch modular pitch (1U = 1,75 in, 1 HP = 0,2 in and 0,1 grid on the print boards) and the metric pitch (the base dimension of the printed board which is 100 mm × 100 mm and the overall dimensions of the 19-inch cabinets). The metric dimensions are dealt with in accordance with the modular grid of IEC 60917-1.

Figure 3 shows the modular structure of the 482,6 mm (19 in) series. Figure 4 introduces the basic dimensions of the modular structure of the 482,6 mm (19 in) series.

6 The 0,1 in pitch of dual in-line packages (DIP) was developed as one of basic designs in microelectronics components in the middle of the 1960s. Through the 1970s, wiring and components layout on printed boards were designed based on the 2,54 mm (0,1 in) grid. IEC TC 52 published a standard on the 2,54 mm grid. In the 1980s, due to the evolution of printed board assembly technology by spread of the surface mounting technology, etc., the 2,54 mm grid on printed boards became no longer a major design method and the standard was withdrawn. IEC TC 52 was merged into IEC TC 91.

7 The increment of the horizontal pitch is defined as 1 HP = 5,08 mm (0,2 in) for the 482,6 mm (19 in) subracks and associated plug-in units. See IEC 60297-3-101.

8 Compatibility between products from different manufacturers has been established by the detailed definitions of performance requirements and test specifications.

9 The concept of the modular structure or modular system of the 482,6 mm (19 in) system for electronic equipment is defined in the DIN 41494 standard. But there are no descriptions of the modular structure consisting of the four modular levels (from Level 1 to Level 4) in the current IEC 60297-3-XXX series. Instead of the modular structure of the 482,6 mm (19 in) system, the IEC 60917-1:1989 generic standard defines "Structures for electronic equipment practices" and "Co-ordination dimensions" based on the metric modular grid. The concept of the structures of electronic equipment practices in IEC 60917-1 is accommodated with the idea of the mechanical structure layers from Level 1 to Level 4. It is the same as the modular system defined in DIN 41494. Therefore, the IEC 60297-3-XXX series is considered as one of several subsidized standard series complying with the concept of the IEC 60917 generic standard.

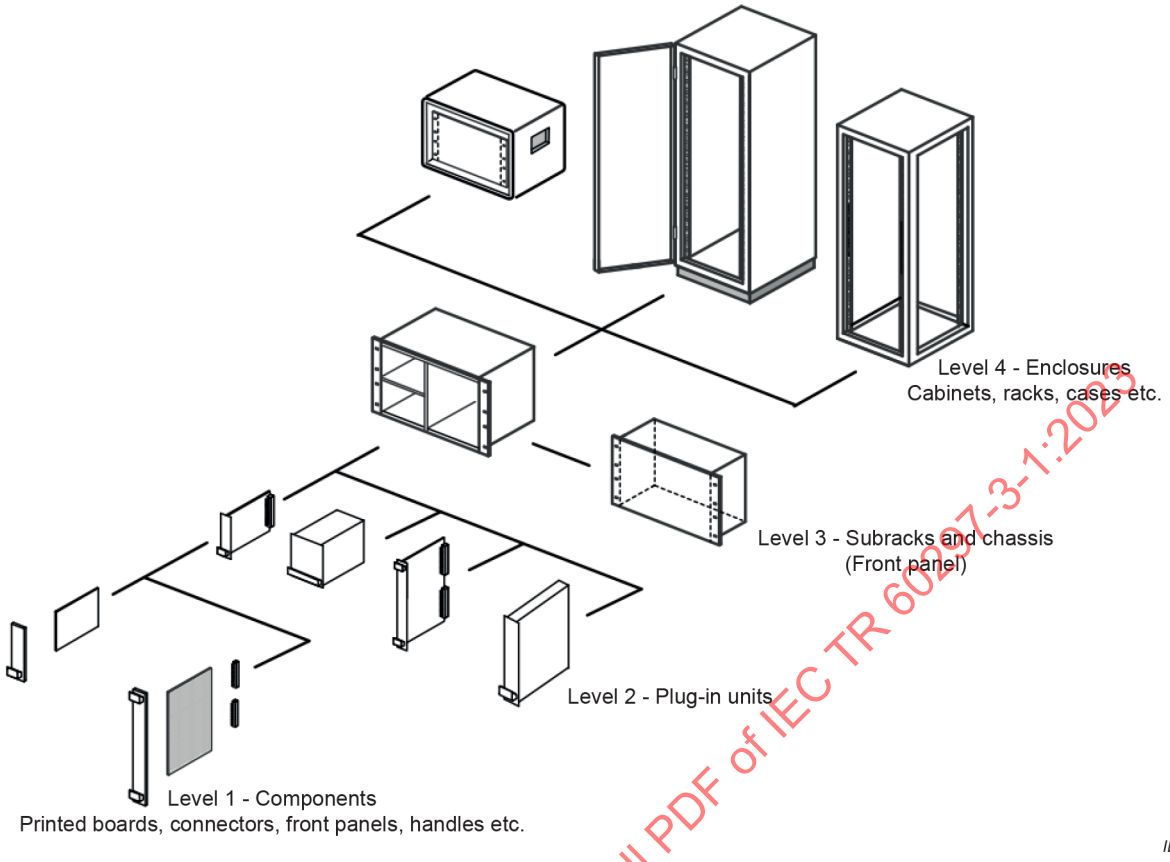
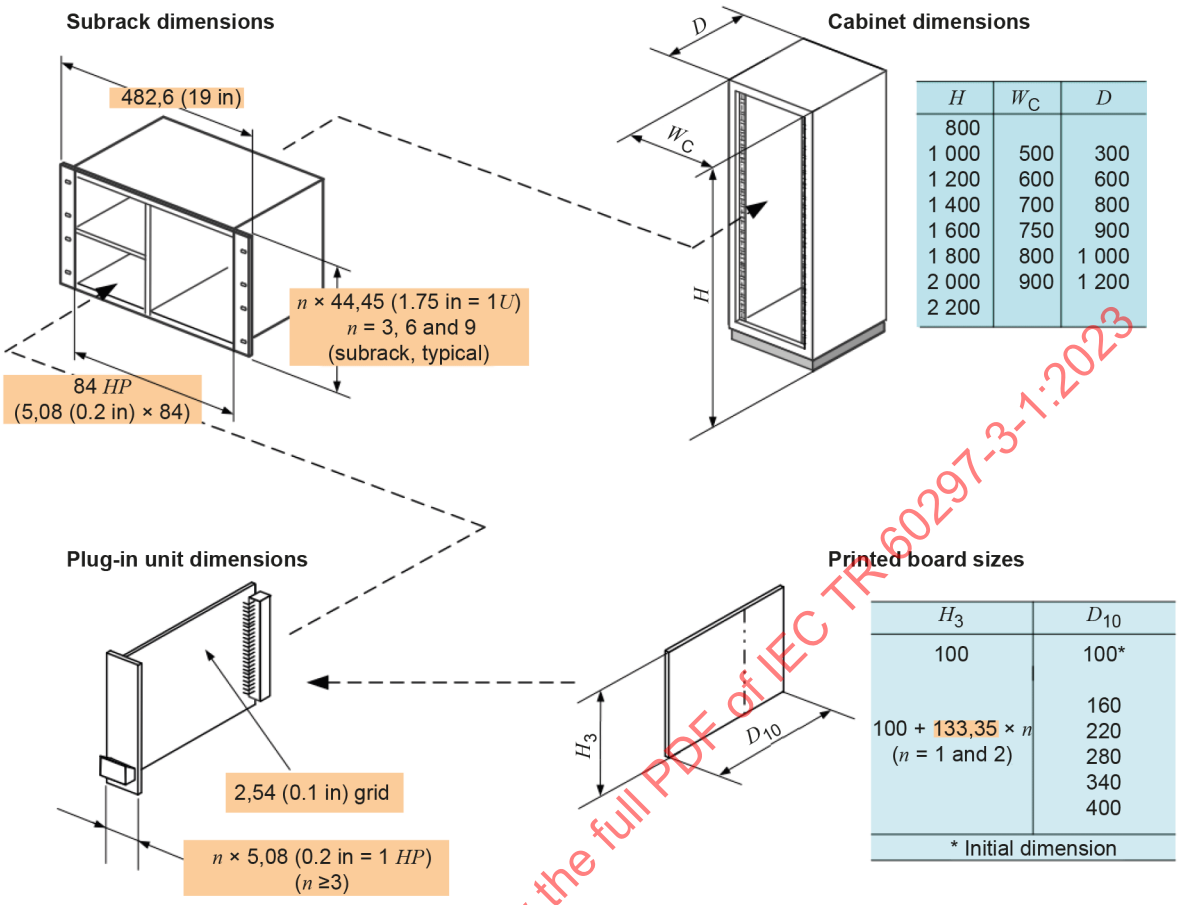


Figure 3 – Modular structure of the 482,6 mm (19 in) series

Dimensions in millimetres



H	W_C	D
800		
1 000	500	300
1 200	600	600
1 400	700	800
1 600	750	900
1 800	800	1 000
2 000	900	1 200
2 200		

H_3	D_{10}
100	100*
100 + 133,35 × n (n = 1 and 2)	160 220 280 340 400
* Initial dimension	

Key

Inch-based dimensions are highlighted in orange. Blue highlighted columns indicate metric dimensions (mm).

Figure 4 – Basic dimensions of the modular structure of the 482,6 mm (19 in) series

4.2 Extended specifications of the 486,2 mm (19 in) series

4.2.1 General

The current 482,6 mm (19 in) series, the IEC 60297-3-XXX series, were accomplished through two-step extensions in the 1990s and 2010s.

4.2.2 Extended specifications of 19-inch subrack system by the IEC 60917 series

Initially, the DIN/IEC standards, the 482,6 mm (19 in) subracks and associated plug-in units (19-inch subrack system) with IEC 60603-2 connectors, were intended for telecommunication equipment in Europe. In the early 1980s, the application had expanded into the field of the IEEE standardized open computer-bus system[10] using 16/32 bit MPU (microprocessor unit). Those open-bus architectures specified the 3U/6U 19-inch subrack system and IEC 60603-2 connectors as the packaging and interconnection for computer hardware. The IEEE Computer Society also released their own standards for the 19-inch subrack system[11]. The combination

[10] IEEE 1014-1987 (VME bus), IEEE 1296-1987 (MULTIBUS II), etc.

[11] IEEE 1101.1-1991, *IEEE Standard for Mechanical Core Specifications for Microcomputers Using IEC 603-2 Connectors*. Current edition: IEEE 1101.1-1998, *IEEE Standard for Mechanical Core Specifications for Microcomputers Using IEC 60603-2 Connectors*.

of the IEC 60297 mechanical structure system and IEC 60603-2 connectors became one of the major standard mechanical systems for the industrial computing systems and other electronic equipment except for military uses or space and aviation applications.

On the other hand, in the middle of the 1980s, DIN and IEC SC 48D started the new development of the mechanical structures for electronic equipment practices based on the metric modular order (adoption of metric modular grid for the entire mechanical structures). It was considered that such development would be an urgent and necessary project to cope with the next coming evolution of the microelectronics and computer technology. And, according to the following development concept, IEC 60917-1 "Generic standard" consisting of the modular order of 0,5 mm, 2,5 mm and 25 mm grids and the coordination dimensions, was published in 1988.

Design concepts for the new development of the mechanical structures for electronic equipment practices are:

a) Adopting a dimensional system premised on the use of CAD/CAE.

b) Support for interconnection and packaging of high-density printed board with SMD/SMT.

c) Support adoptions of high pin-count and high-speed connectors for the high-density interconnections that accompany the uses of high-density printed boards.

d) Support appropriate measures against EMC and heat problems that are caused by the higher density of printed boards and electronics components and higher signal speed devices.

Under the IEC 60917-1 generic standard, practical standards on the metric mechanical structure (metric cabinet/rack and subrack system based on the 25 mm equipment practice) were developed and published by DIN, IEC SC 48D and IEEE[12] in the early 1990s. In the connector industry, the high pin-count and high-speed metric connectors[13] based on the 0,5 mm, 2,5 mm, and 25 mm grid, were developed and published as IEC standards by IEC SC 48B in parallel with the standards on metric mechanical structures. At that time, it was considered that the packaging and interconnection solution by the combination of the IEC 60297 mechanical structures and the IEC 60603-2 connectors would be replaced by the metric system.

In the industry for the mechanical structures related with IEC SC 48D, after development of actual products in accordance with the practical standards on the metric subrack system, the new technologies for the metric subrack system were applied to the 482,6 mm (19 in) series. The 19-inch subrack system adopted the extended features which had been implemented in the metric subrack system in accordance with the development concept of the IEC 60917 series standards. Through the reconstruction of the IEC 60297 series in the 2000s, respective elements of such new technologies were published as follows:

– IEC 60297-3-101:2004 (where EMC provisions were added);
– IEC 60297-3-102:2004 (where new functions for plug-in unit handles were added);
– IEC 60297-3-103:2004 (function to distinguish the positions of the plug-in units in a subrack);
– IEC 60297-3-104:2006 (where the definition of how to adopt newly developed connectors was added).

Items b), c) and d) of the development concept of IEC 60917-1 have been covered by these standards, and the issue of item a) has been solved by rapid evolution of processing performance of CAD/CAE systems.

[12] Metric structure standards: DIN 43356 series (Withdrawn), IEC 60917-2:1992, IEC 60917-2-1:1994, IEC 60917-2-2:1994 , and IEEE 1301-1991 (Withdrawn).

[13] The metric modular connectors based on the 2 mm or 2,5 mm grid are IEC 61076-4-100, IEC 61076-4-101, IEC 61076-4-104, etc.

4.2.3 Enhanced 19-inch subrack system from the market applications

The next functional extension was brought by the explosive expansion of the internet technology and personal computer which started in the second half of the 1990s. The booming of the ICT (Information & Communication Technology) market affected the application of the 482,6 mm (19 in) series. To cope with requirements for more high-speed data transmission and data processing in systems or networks and computing or communication devices, high speed parallel or serial interface were developed and such functional elements became modules.

Conventional telecommunication equipment had been using proprietary architectures in their hardware, but it became real that the newly developed ICT market, in which the conventional telecommunication technology converged with the computer network/internet technology, made such hardware shift to the open architecture. AdvancedTCA (Advanced Telecommunications Computing Architecture) and MicroTCA (Micro Telecommunications Computing Architecture)[14], developed in PICMG and in which many international companies were involved, are typical examples of such open architectures.

Based on the chassis for AdvancedTCA and MicroTCA, which adopted the 19-inch subrack system in their basic dimensions, enhanced mechanical structure standards over the 482,6 mm subracks and associated plug-in units were published as follows:

– IEC 60297-3-107:2012 (based on MicroTCA mechanical form factor);
– IEC 60297-3-108:2014 (which reflects AdvancedTCA mechanical features).

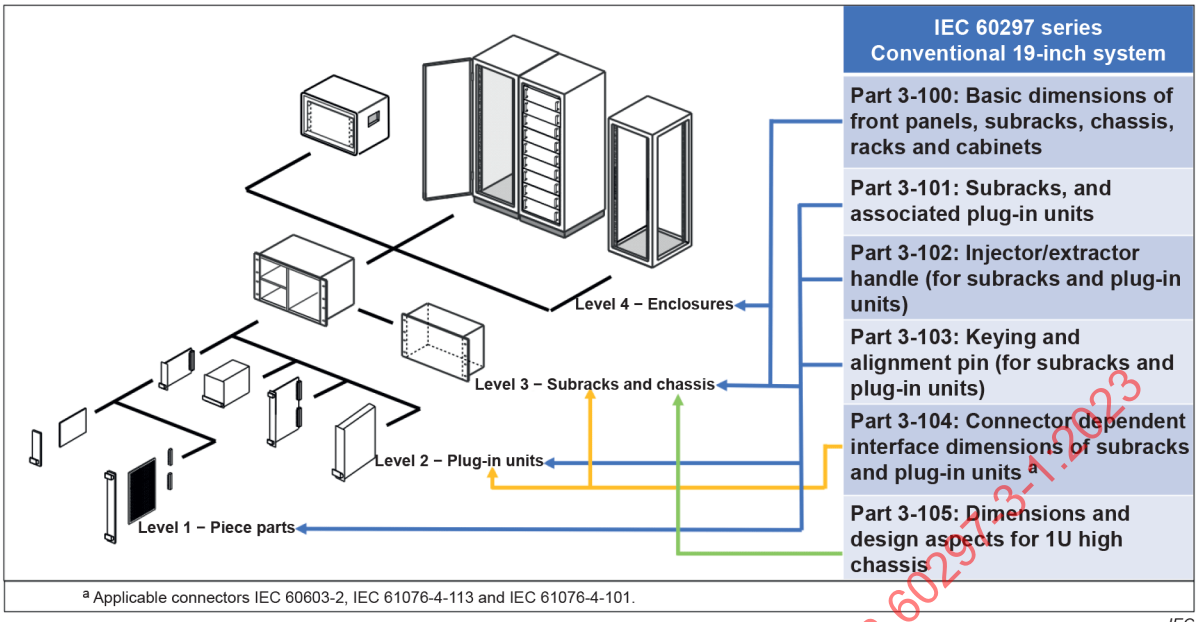
The differences of the applications between the IEC 60297-3-101 conventional 482,6 mm subracks and associated plug-in units, IEC 60297-3-107 and IEC 60297-3-108 are shown in Figure 5, Definition domain b).

5 Definition domains of the 482,6 mm (19 in) series standards

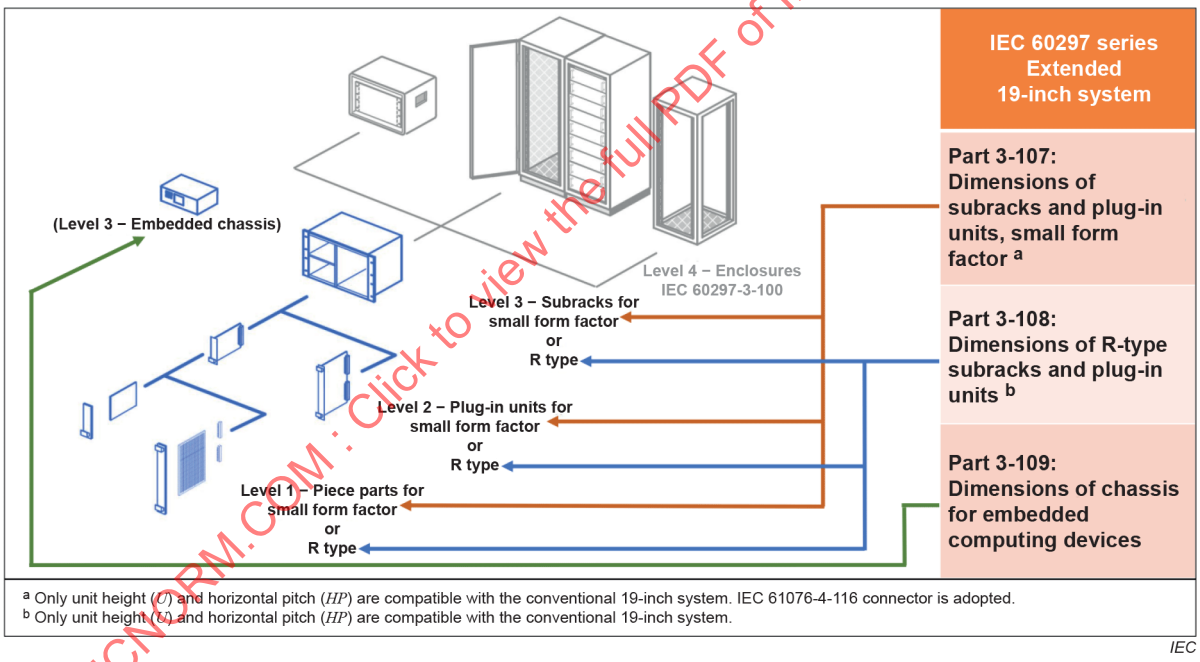
The current IEC 60297 series (IEC 60297-3-XXX series) consists of ten standards, which are not categorized for the users.

Figure 5 shows that these IEC 60297 series standards are divided into three categories, and, within each category, the definition domains of the ten standards referring to the layer levels of the mechanical structure are introduced.

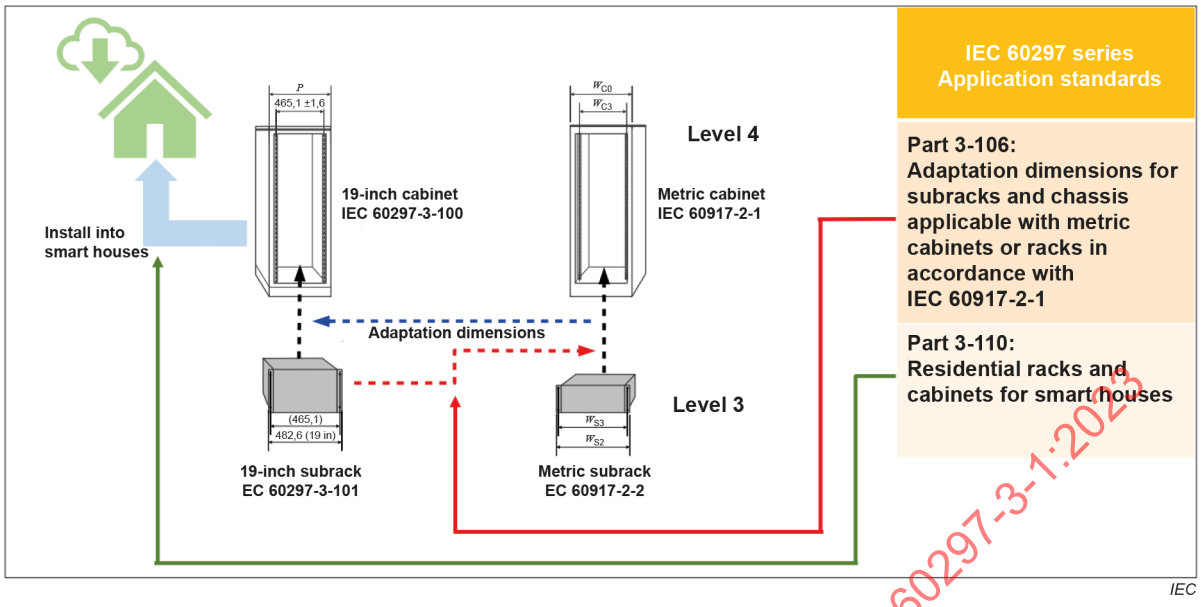
[14] Specifications of the chassis (subrack with cooling units) for AdvancedTCA (PICMG 3.0) and MicroTCA (PICMG MTCA.0) were developed based on the 19-inch subrack system by PICMG (PCI Industrial Computer Manufacturers Group, an international industrial consortium developing open standards for high performance telecommunications and industrial computing applications).



a) Conventional 19-inch system, including the extended specifications from the IEC 60917 series (See 4.2.2)



b) Extended 19-inch system, including the enhanced subrack system from the market applications (See 4.2.3)



c) 19-inch application related standards

Figure 5 – Definition domains of the 482,6 mm (19 in) series standards

6 Prospect for further applications and standards development of the 19-inch subrack system

Through this review of the technological scheme of the IEC 60297 series, it becomes clear that users in the industrial electronics and ICT market have recognized that the 19-inch series standards, especially the subrack system, have been providing useful and effective solutions for the mechanical structures with regard to their electronic equipment practices. They have also been adding new specifications and mechanical solutions onto the existing 19-inch subrack system.

Further possibilities on the applications are given in Annex A which introduces the newly developed connectors applicable on the 19-inch subrack system. In addition, apart from the IEC standards, Annex B mentions industrial standards developed for seeking enhanced functions on the 19-inch subrack system.

The contents of both annexes reflect the needs from the market and the users' requirements. Studying the information from Annex A and Annex B provides a prospect for further applications and standards development of the 19-inch subrack system.

Annex A
(informative)

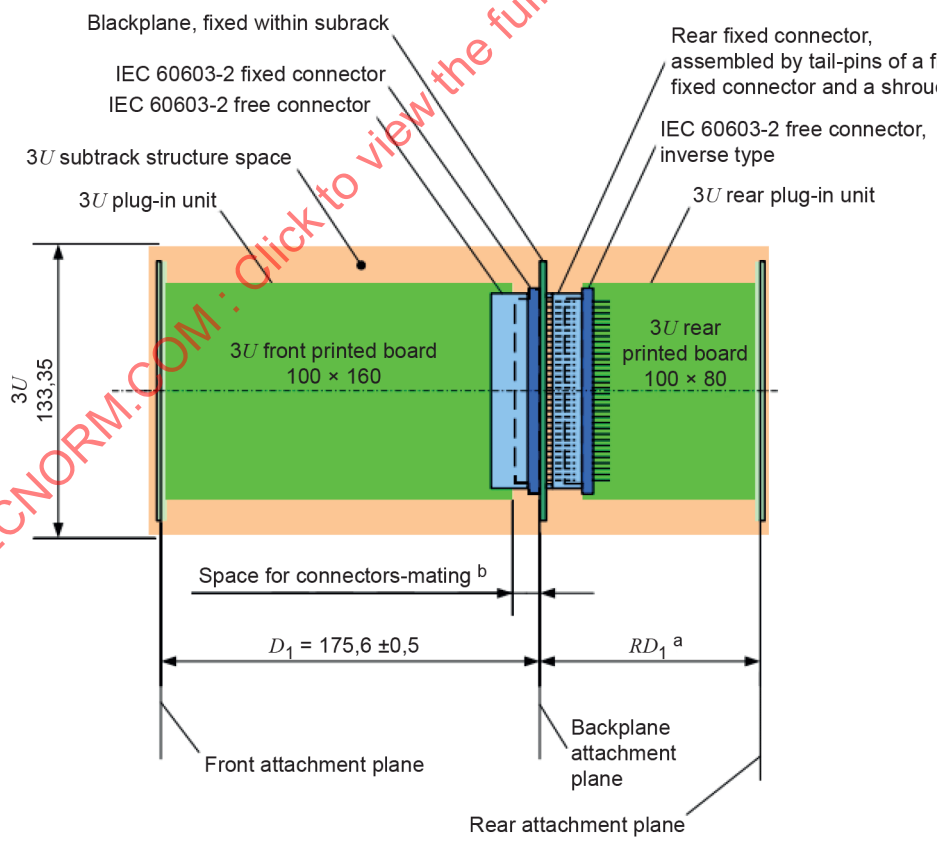
Applicable connectors to the 482,6 mm (19 in) subracks and associated plug-in units

A.1 General conditions of the applicable connectors

The subracks and associated plug-in units in accordance with IEC 60297-3-101 (conventional 19-inch system) are designed to be dedicated to the interconnection between plug-in units via a backplane in a subrack by using IEC 60603-2 connectors. This mechanical system became a major stream in industrial computer systems through the 1980s. After the 1990s, to cope with requirements on high performance interconnection and with the handling of high speed signals and high pin-counts, newly developed connectors and high-speed backplane design-methods were introduced into the market. Many of the enhanced connectors were designed to be applicable in the conventional 19-inch subrack system. Therefore, newly developed equipment adopting such connectors for the high-performance plug-in modules has the advantage of not only using the familiar mechanical construction, but also of working with the existing modules establishing backward compatibility.

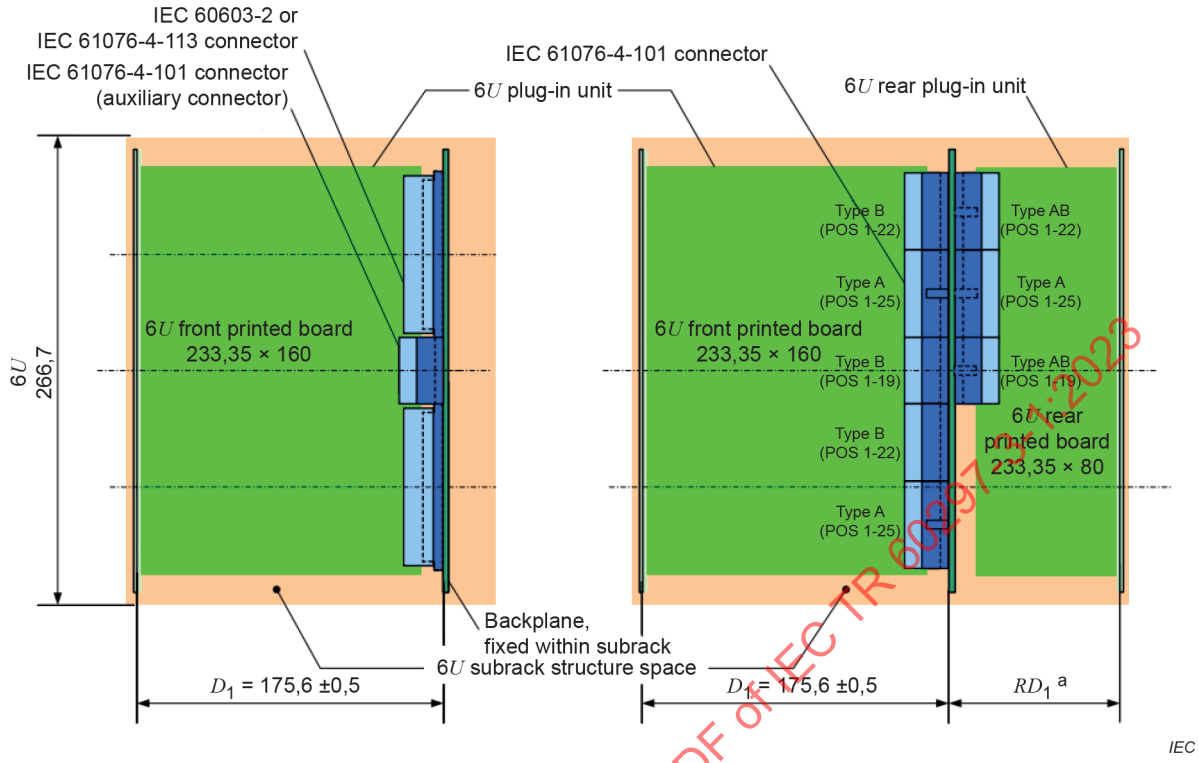
The dimensional relations of the connectors within mating condition in the subracks are shown in Figure A.1. Free connectors are mounted on the plug-in units and fixed connectors are located on the backplanes.

Dimensions in millimetres



a) Application of IEC 60603-2 connectors on a 3U subrack and associated plug-in units in accordance with IEC 60297-3-101

Dimensions in millimetres



b) Application examples of the enhanced connectors on 6U subracks and associated plug-in units in accordance with IEC 60297-3-101

[a] RD_1 dimensions depend on the dimensions of the rear plug-in unit, the backplane thickness and tail-pin length of the IEC 60603-2, IEC 61076-4-101, or IEC 61076-4-113 connector. See IEC 60297-3-101.

[b] Space for connectors-mating is within the mating zone reliable contact making defined in IEC SC 48B connector standards, IEC 60603-2, etc.

Figure A.1 – Dimensional relations of the connectors within mating condition, in the 482,6 mm (19 in) subracks and associated plug-in units

A.2 List of applicable connectors

Table A.1 shows the list of applicable connectors to the 482,6 mm (19 in) subracks and associated plug-in units.

Table A.1 – Applicable connectors to the 482,6 mm (19 in) subracks and associated plug-in units

IEC standard	Brand name	Subrack D1[a] dimension (Plug-in unit D4[a] dimension for PCB depth 160 mm)	Adoption with 19-inch subracks and associated plug-in units	Note
IEC 60603-2 Connectors for frequencies below 3 MHz for use with printed boards – Part 2: Detail specification for two-part connectors with assessed quality, for printed boards, for basic grid of 2,54 mm (0,1 in) with common mounting features **Types B, C and D**	**DIN 41612 connector**	D1: 175,60 ± 0,5 (D4: 169,93 ± 0,4)	Yes Conventional 19-inch system (IEC 60297-3-101) Plug-in unit width: ≥ 3*HP*	2,54 mm grid 3-row connector
IEC 60603-2 **Types F, G and H**		D1: 175,60 ± 0,5 (D4: 171,93 ± 0,4)		
IEC 61076-4-100 Connectors for electronic equipment – Part 4-100: Printed board connectors with assessed quality – Detail specification for two-part connector modules having a grid of 2,5 mm for printed boards and backplanes	Harpac connector	(D_{s1}: 175,5 + 1 / 0)[b]	Yes, but due to the connector module having a 25 mm length, the connector location is limited to 3 × 25 mm in a 3*U* plug-in unit.	Metric 2,5 mm grid 5-row connector
IEC 61076-4-101 Connectors for electronic equipment – Part 4-101: Printed board connectors with assessed quality – Detail specification for two-part connector modules, having a basic grid of 2,0 mm for printed boards and backplanes in accordance with IEC 60917	**HM 2mm connector**	D1: 175,60 ± 0,5 (D_{s1}: 175,5 + 1 / 0) (D4: 169,93 ± 0,4)	Yes Conventional 19-inch system (IEC 60297-3-101) Plug-in unit width: 4*HP* and more	D_{s1}: See Metric subrack standard IEC 60917-2-2 Ref. VITA 30-2000 (S2022), *2mm Connector Practice for Eurocard Systems*
IEC 61076-4-113 Connectors for electronic equipment – Printed board connectors – Part 4-113: Detail specification for two-part connectors having 5 rows with a grid of 2,54 mm for printed boards and backplanes in bus applications	5-row DIN connector **(VME 64X connector)**	D1: 175,60 ±0,5 (D4: 169,93 ± 0,4)	Yes Conventional 19-inch system (IEC 60297-3-101) Plug-in unit width: 4*HP* and more	
No IEC standard[c] ATCA Zone 1 Power backplane connector 34 pins	**ATCA power connector**	D1: 295,6 ± 0,5 as PCB depth 280 mm	Yes 19-inch system (IEC 60297-3-101 and IEC 60297-3-108), but basically applied within ATCA form factor, plug-in unit 6*HP* width and PCB sized as 280 mm deep × 8*U* 322,25 mm high.	8 power pins and 28 signal pins
No IEC standard[c] ATCA Zone 2 ZD signal connector	**ATCA signal connector** **HM ZD connector**			Dedicated pin-layout with shield/GND contacts for LVDS signal lines

IEC standard	Brand name	Subrack D1[a] dimension (Plug-in unit D4[a] dimension for PCB depth 160 mm)	Adoption with 19-inch subracks and associated plug-in units	Note
IEC 61076-4-116 Connectors for electronic equipment – Product requirements – Part 4-116: Printed board connectors: Detail specification for a high-speed two-part connector with integrated shielding function	**MTCA connector**	D1: 185,85 ± 0,3 (Plug-in unit depth dimension with IEC 61076-4-116, D5: 180,85 ± 0,4)	Yes, but only for 19-inch small form factor subracks and plug-in units, IEC 60297-3-107	Originally developed by PICMG for AMC (Advanced mezzanine card)
No IEC standard[d] MULTIGIG RT 2, or MULTIDID RT 2-R Ruggedized connectors (for VXS/VPX applications)	**MULTIGIG connector** (VPS/VPX connector)	D1: 175,60 ±0,5	Yes Conventional 19-inch system (IEC 60297-3-101) Plug-in unit width: 4*HP* and more	VPS and VPX

[a] See IEC 60297-3-101.

[b] See IEC 60917-2-2

[c] The connector is supported by multi-suppliers and dealt with as a de facto standard connector for ATCA (PICMG 3.0 AdvancedTCA Base Specification) applications in the related industry.

[d] The connector is supported by multi-suppliers and dealt with as a de facto standard connector for VPS/VPX (VITA 41.0 VPS: VMEbus Switched Serial Standard, and ANSI/VITA 46.0 VPX Base Standard) applications in the related industry.

Annex B
(informative)

IEEE and VITA standards[15] related with the 482,6 mm (19 in) series

B.1 Subracks and associated plug-in units

The mechanical system in accordance with IEC 60297-3-101 (conventional 19-inch subracks and plug-in units system) became a major stream in industrial computer systems through the 1980s. In the applications of 16/32 bit microprocessor units, almost all such industrial computing systems adopted IEEE standard bus architectures, which had been developed by the Microprocessor Standards Committee (MSC) or the Bus Architecture Standards Committee (BASC) of the IEEE Computer Society (C/MSC). They needed practical standards to apply the IEC conventional 19-inch subrack system for the mechanical structure in the open bus standards, and they developed IEEE 1101.1, IEEE 1101.11 (*Mechanical Rear Plug-in Units Specifications for Microcomputers Using IEEE 1101.1 and IEEE 1101.10 Equipment Practice*), IEEE 1101.2 (*Mechanical Core Specifications for Conduction-Cooled Eurocards*), etc. (See 4.2.2, Clause A.1 and Clause B.3 .)

These standards had been used as addenda to IEC 60297-3 and IEC 60297-4 (current IEC 60297-3-101, conventional 19-inch subracks and plug-in units system) to cope with various requirements from developments of the IEEE standard bus architectures. After the development body for the VMEbus related standards changed from IEEE to VITA, the IEEE 1101 series standards were withdrawn by C/MSC.

Nowadays, actual users of these IEEE standards have become members-companies of VITA and/or PICMG, and their necessary detail information related to the 19-inch subracks and plug-in units system also can be found in the mechanical specifications of VITA VME standards[16] or PICMG CPCI standards[17].

B.2 Mezzanine card standards

The Microprocessor Standards Committee of the IEEE Computer Society (C/MSC) developed IEEE Std 1301.4-1996[18]. The standard defines the dimensional outline of the mezzanine card based on a 25 mm modular order in accordance with IEC 60917-2:1992 (current IEC 60917-2) and IEEE Std 1301-1991 (withdrawn in 2007-01). See Figure B.1.

For actual applications for the mezzanine cards, IEEE 1386-2001 was published. It defines the detail specifications for mechanical structures and connectors on the mezzanine cards, which are applied on both host boards, plug-in units based on the IEC 60297-3-101 19-inch system and IEC 60917-2-2 metric system. The CMC single-sized card is applied as a 75 mm × 150 mm boundary envelope from IEEE 1301.4. See Figure B.2.

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15 VITA: VMEbus International Trade Association was established by VMEbus Manufacturers' Group in 1984, and shortened to VITA in 2005. VMEbus is known as IEEE 1014-1987 *IEEE Standard for A Versatile Backplane Bus: VMEbus*. It is based on the VMEbus specification, released by the VME Manufacturers' Group in August 1982. In June 1993, VITA was granted ANSI accreditation as ANSI Standards Body to facilitate the development of open-bus architecture standards. After this, efforts for the standard developments related with open-bus standards was shifted from IEEE to VITA.

16 Essential information on the 19-inch subracks and plug-in units system for VME bus is introduced in Chapter 7 Mechanical specifications of ANSI/VITA 1-1994 (R2002).

17 See 4 MECHANICAL REQUIREMENTS and 5 *CONNECTOR IMPLEMENTATION* in PICMG 2.0 R3.0 *CompactPCI Specification*.

18 IEEE Std 1301.4 defines the mezzanine card as "an electronic card assembly mounted parallel to, and with electrical and/or mechanical connections to, a host".

Dimensions in millimetres

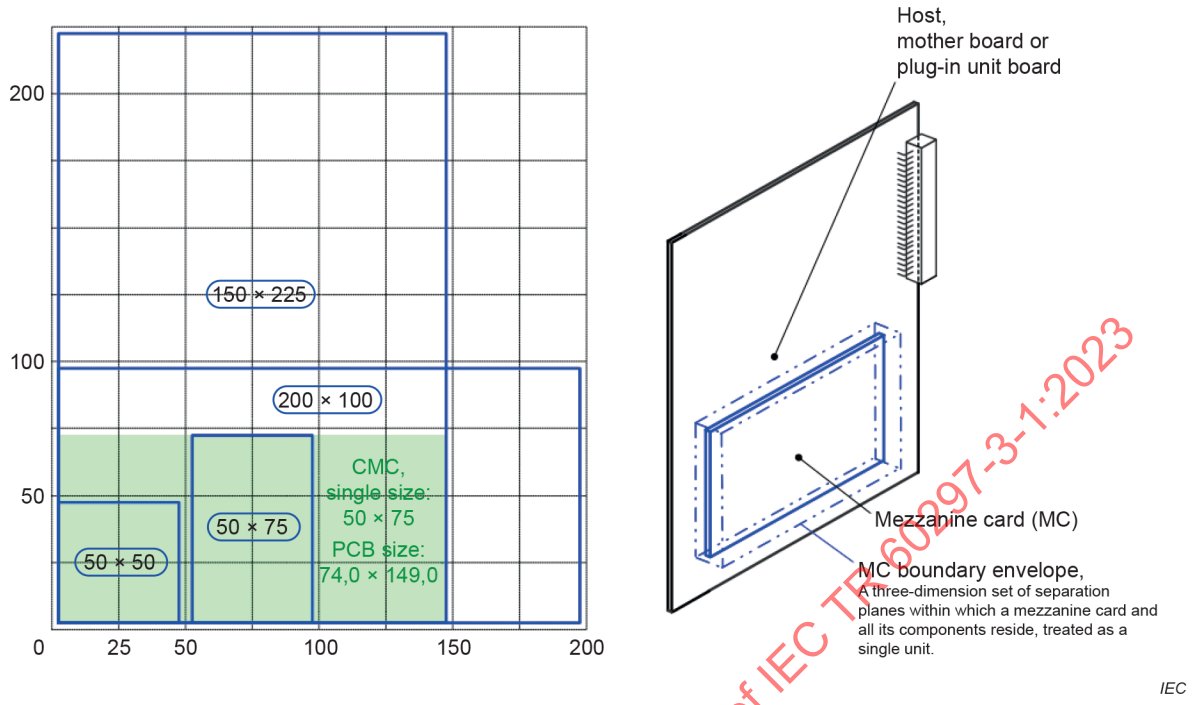

Figure B.1 – Examples of mezzanine card size (coordination dimensions as 25 mm grid) and mezzanine card boundary envelope in IEEE 1301.4

Dimensions in millimetres

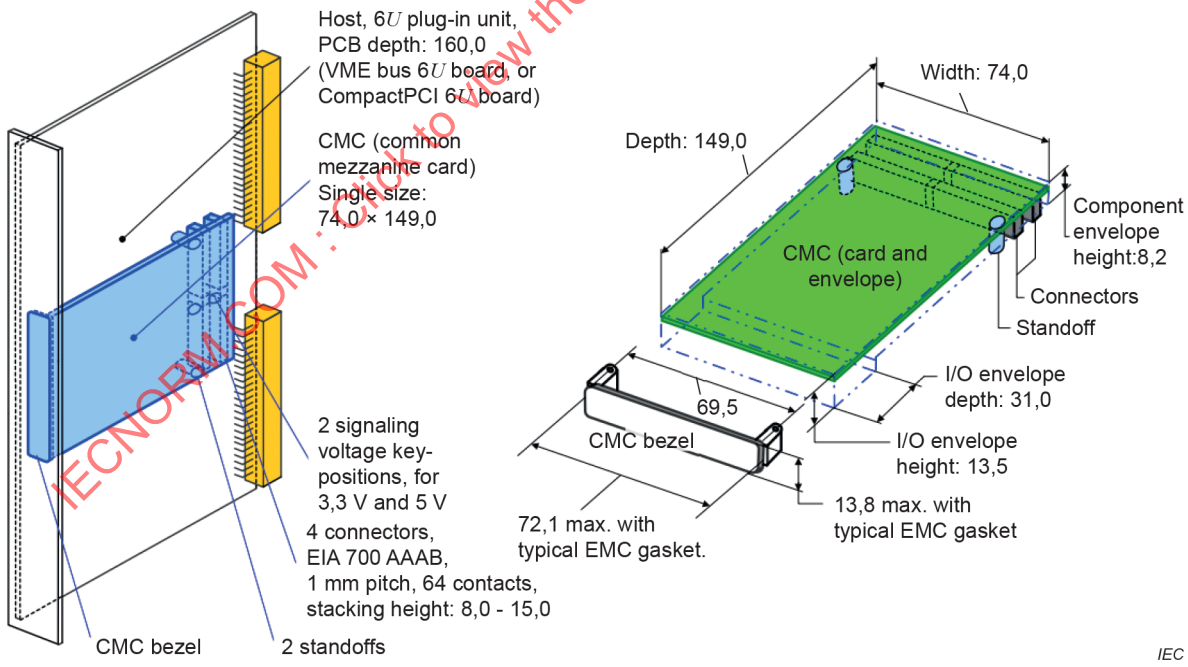

Figure B.2 – Example of adoption of CMC single size on 6U depth 160 mm plug-in unit, and outline of single size CMC (common mezzanine card) in IEEE 1386

Currently, the status of these IEEE standards related to mezzanine cards is inactive or withdrawn in the IEEE. In the market for industrial and military computer systems or embedded systems, there are many applications of PMC or XMC on the host boards based 3U/6U 160 mm depth plug-in units such as the VME/VPX module. The updated detail specifications have been

described in VITA standards. Table B.1 lists IEEE and VITA standards related with updated mezzanine card standards.

Table B.1 – IEEE and VITA standards for mezzanine cards applied on 19-inch subrack system

IEEE and VITA standards	Contents	Note
IEEE 1301.4-1996 *IEEE Standard for a Metric Equipment Practice for Microcomputers – Coordination Document for Mezzanine Cards.*	Establishes the metric modular order and coordination dimensions for mezzanine cards for use on host modules.	Status: Inactive-Reserved Withdrawn Date:2019-11-07
IEEE 1386-2001 *IEEE Standard for a Common Mezzanine Card Family: CMC*	Mezzanine cards can be used interchangeably on VME, VME64 and VME64x boards, CompactPCI boards, Multibus I and II boards, desktop computers, portable computers, servers, and other similar types of applications.	Status: Inactive-Withdrawn Withdrawn Date:2007-01-18
IEEE 1386.1-2001 *IEEE Standard Physical and Environmental Layers for PCI Mezzanine Cards: PMC*	Defines the physical and environmental layers of a PCI mezzanine card (PMC) family.	Status: Inactive-Withdrawn Withdrawn Date:2007-01-18
ANSI/VITA 20-2005 (S2021) *Conduction Cooled PMC*	This standard defines the methodology and implementation details to allow the creation of conduction cooled PMC modules to ensure electrical and physical compatibility with various host card modules onto which conduction cooled PMCs are mounted.	Status: ANSI Stabilized
ANSI/VITA 32-2003 (S2014) *Processor PMC*	The complete mechanical and the environmental requirements are accommodated with the IEEE 1386 CMC, except as noted in this document. If the information in this document contradicts IEEE 1386 or IEEE 1386.1, this document takes precedence. Processor PMC cards are used where modular attachment of a processor is required and may be used in conjunction with PMC I/O cards, traditional PCI cards.	Status: ANSI Stabilized
ANSI/VITA 35-2000 (S2021) *PMC-P4 Pin Out Mapping to VME P0 and VME64x P2*	This standard provides pin mapping assignments between a PCI mezzanine card (PMC) module's user IO connector (P4) and the VME host's user IO connector.	Status: ANSI Stabilized
ANSI/VITA 39-2003 (S2022) *PCI-X for PMC and Processor PMC*	PCI-X is defined in the PCI-X Addendum to the PCI Local Bus Specification and is the basis for the updates in this document.	Status: ANSI Stabilized
ANSI/VITA 42.0-2021 *XMC: Switched Mezzanine Card (XMC) Auxiliary Standard*	Including supports for: – A high-speed switched interconnect based on open, standardized switched fabrics. – Standard PMC form factors and stacking heights. – Compatibility with existing PMC specifications. – PMC, XMC, or dual-mode mezzanine cards and carriers on VME/VME64x, CompactPCI, Advanced TCA, and PCI Express modules. – Optional conduction cooling.	Status: ANSI Approved

IEEE and VITA standards	Contents	Note
ANSI/VITA 42.1-2006 (S2022)	XMC: Parallel RapidIO 8/16 LP-LVDS Protocol Layer	Status: VITA Stabilized
ANSI/VITA 42.2-2006 (S2018)	XMC: Serial RapidIO Protocol Layer	Status: ANSI Stabilized
ANSI/VITA 42.3-2020	XMC: PCI Express Protocol Layer	Status: ANSI Approved
ANSI/VITA 42.6-2009 (R2015)	XMC: 10 Gigabit Ethernet 4-Lane Protocol Layer	Status: ANSI Reaffirmed
ANSI/VITA 61.0-2022	XMC 2.0	Status: ANSI Approved

B.3 Conduction cooling

Owing to the expansion of military applications of VMEbus[19], there was a need for conduction-cooled circuit card assemblies (CCAs). The mechanical requirements for the CCAs accommodated with IEEE 1101.1 was defined as IEEE 1101.2-1992. See Clause B.1. An outline of the CCAs in IEEE 1101.2 is shown in Figure B.3.

[19] In the 1990s, military applications of the modules and systems based on VMEbus or other IEEE standard computer-buses increased under the movement towards the adoption of commercial off-the-shelf (COTS) hardware and software, with a view to reduce costs for the procurements. At present, recognizing its definite advantages over custom systems, the US government and the EU have used COTS as a formal term for commercial items, including services, available in the commercial marketplace, which can be bought and used under government contracts.