

# IEEE Standard for a Metric Equipment Practice for Microcomputers— Coordination Document

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**Microprocessor and Microcomputer Standards Subcommittee  
of the  
IEEE Computer Society**

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**Abstract:** The metric mechanical coordination of microcomputer components, including the cabinet, rack, subracks, printed boards, and common connector-dependent dimensions for connector pitches of 2.5, 2.0, 1.5, 1.0, and 0.5 mm is addressed. This generic standard may be applied in all fields of electronics where equipment and installations are required to conform to a metric modular order. This choice of coordination dimensions for the mechanical structure for heights, widths, and depths lies within a homogeneous, metric, modular, three-dimensional grid as specified in IEC 917. The intent is to provide a single metric equipment practice for worldwide use.

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## Foreword

(This Foreword is not a part of IEEE Std 1301-1991, IEEE Standard for a Metric Equipment Practice for Microcomputers—Coordination Document.)

The Metric Equipment Practice issues originated within IEEE due to a connector decision taken in the Futurebus+ (IEEE 896) Working Group in April 1989. At that time, the new 2.0 mm connector (EIA IS-64) was selected to solve the pin-count problem in the 32, 64, 128, and 256 bit wide backplane bus. The mounting of a Hard Metric Connector on a Soft Metric (inch dimensions converted to metric dimensions) Printed Board raised strong opposition from IEC since a roadmap for total metrication had been laid out. A study group within IEEE very quickly found out that a Hard Metric Standard, covering several connector families with pitches from 2.5 mm down to 0.5 mm in 0.5 mm steps, was of utmost importance. Due to the progress made, Futurebus+ and SCI (Scalable Coherent Interface) decided to use the new Metric Standard during Spring of 1990.

The Metric Equipment Practice Study Group, and later Working Group, were active between July of 1989 to September of 1990. The Sponsor Ballot Review Committee finished its work in May 1991.

During this time, the computer industry has shown a remarkable interest in the development of this specification, and the participation by many experts has enabled it to be developed in a very short time. Around 200 people have participated in the creation of this specification. Although it is not possible to acknowledge everyone who contributed, several individuals deserve special mention for the contributions they made toward the development of this document:

Dr. Paul Borrill of Sun Microsystems and Mike Humphrey of BICC-Vero for their support during the initial phases as well as during the whole activity.

Hans-Werner Kranz and Hans-Juergen Richter of Siemens and Helge Bodahl Johnsen of Ellemtel for numerous presentations and discussions concerning the importance of metrication.

Ernie Crocker of Digital Equipment Corp. for providing extensive support during the critical phases of the work.

In a very important meeting in January 1990, Greger Haraldsson of Ericsson Telecom, Hans-Werner Kranz of Siemens, and Paul Mazura of Schroff proposed a common document, based on an IEC document [IEC 48D(Secretariat)36], as the basis for the P1301.

Extensive technical input has been submitted by Charlie Barker and Rick Olson of Digital Equipment Corp., Gene Schramm, Roger Johnson, and Vid Chandraiah of AT&T Bell Laboratories, Peter Odell of BICC-Vero, Eike Waltz and Paul Mazura of Schroff, Hans-Werner Kranz and Hans-Juergen Richter of Siemens, David Brearley of DuPont Electronics, Greger Haraldsson, Kristian Martinsson, and Torbjörn Olsson of Ericsson Telecom, Helge Bodahl Johnsen of Ellemtel, Michael Thompson of Mupac, Paul Cook of Ameritech Services, and Joe Macura of Data General.

Extensive support for editing, copying, and mailing has been given by Rick Olson and Charlie Barker of Digital Equipment Corp., Joe Trainor of ITT Electro-Mechanical Components, Paul Cook of Ameritech Services, David Brearley of DuPont Electronics, Peter Odell of BICC-Vero, and Rich Carlson of Harting Elektronik.

The following is a list of those who were members of the Working Group on Metric Equipment Practices at the time this document was approved by the Working Group:

**Hans Karlsson, *Chair***

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The following persons were on the balloting committee that approved this document for submission to the IEEE Standards Board:

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# IEEE Standard for a Metric Equipment Practice for Microcomputers— Coordination Document

## 1. Introduction

This is a metric equipment practice specification in accordance with IEC 917 (1988) [13]<sup>1</sup> and IEC 917-0 (1989) [14], including cabinet, rack, subracks, printed boards, and common connector-dependent dimensions for connector pitches of 2.5, 2.0, 1.5, 1.0, and 0.5 mm.

Under this standard a number of detail standards can be developed. Standards for the application of different connector families with pitches of 2.5, 2.0, 1.5, 1.0, and 0.5 mm developed from this generic standard must all accept the backplane grid of 0.5 in order to intermix different connector families on the same backplane.

### 1.1 Scope and Field of Application

This generic standard may be applied in all fields of electronics where equipment and installations are required to conform to a metric modular order. The choice of coordination dimensions for the mechanical structure for heights, widths, and depths lies within a homogeneous, metric, modular, three-dimensional grid as specified in IEC 917 (1988) [13]. Optimum conditions are thereby created for the application of computer-assisted methods throughout design and manufacturing, such as, for instance, computer-assisted planning, development, manufacturing, testing, and installation.

### 1.2 Purpose

The purpose of this standard is to specify dimensions for a single metric equipment practice that will ensure mechanical interchangeability and promote worldwide use.

### 1.3 Dimensions

All dimensions in this document are in millimeters as per ISO 1000:1981 [18] and ISO 31-1:1978 [17] unless otherwise specified.

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<sup>1</sup> The numbers in brackets correspond to those of the references in Section 2.

First angle projection has been used throughout this document.

## 1.4 Coordination Dimensions

This standard defines the actual dimensions of a 25 mm metric equipment practice. These actual dimensions are derived from coordination dimensions using the principle of boundary and axis references illustrated in 4.1 and IEC 917 (1988) [13].

Overall dimensions and internal subdivisions are determined by using different increments or mounting pitches ( $mp_1 = 25$  mm,  $mp_2 = 5$  mm,  $mp_3 = 2.5$  mm, and  $mp_4 = 0.5$  mm). These mounting pitches have been used to derive the key dimensions given in this standard. They are also used when extending this standard with additional dimensions<sup>2</sup> (where such extensions are permitted) and when alternative positions of piece parts are described.<sup>3</sup> (In such cases, it is obvious that the relationships between involved dimensions shall be maintained.)

The subscript “C” has been used in this document to indicate coordination dimensions.

### 1.4.1 Dimensions of Cabinets and Racks

This standard covers a selection of coordination dimensions for a range of cabinets and racks conforming to proposed IEC standard 917-1 [15].

### 1.4.2 Dimensions of Subracks and Front Panels

This standard covers a selection of coordination dimensions for a range of subracks and front panels conforming to proposed IEC standard 917-1 [15] for mounting in cabinets and racks.

### 1.4.3 Dimensions of Backplanes

This standard covers a selection of coordination dimensions for backplanes conforming to proposed IEC standard 917-1 [15].

### 1.4.4 Dimensions of Plug-in Units and Printed Boards

This standard covers a selection of coordination dimensions for plug-in units and printed boards conforming to proposed IEC standard 917-1 [15] for mounting in subracks.

## 1.5 Connector-Related Parameters

This standard defines the basic connector-related parameters for the determination of product interfaces.

## 1.6 Environmental Requirements

See P1301.2 [16].

<sup>2</sup> For example, see Notes 2 and 3 of Table 6, and Note 1 of Table 7.

<sup>3</sup> See Note 1 of Fig 3.

## 1.7 Conformance

Conformance with this standard can be claimed provided that—

- The recommended values are used, or
- Allowed, but non-preferred, dimensions and options as indicated in this standard are implemented. The use of non-preferred dimensions shall be specified by other standard specifications or shall be agreed upon between supplier and user.

## 2. References

The following publications shall be used in conjunction with this standard:

[1] CFR (Code of Federal Regulations), Title 47: Telecommunications, Part 15J, published by Office of the Federal Register (FCC Rules and Regulations are contained within this document).<sup>4</sup>

[2] IEC 50, International Electrotechnical Vocabulary.<sup>5</sup>

[3] IEC 68-2-1 (1990), Environmental Testing, Part 2: Tests—Tests A: Cold.

[4] IEC 68-2-2 (1974), Environmental Testing, Part 2: Tests—Tests B: Dry Heat.

[5] IEC 68-2-6 (1982), Environmental Testing, Part 2: Tests—Tests Fc and Guidance: Vibration (sinusoidal).

[6] IEC 68-2-11 (1981), Environmental Testing, Part 2: Tests—Tests Ka: Salt mist.

[7] IEC 68-2-27 (1987), Environmental Testing, Part 2: Tests—Test Ea and Guidance: Shock.

[8] IEC 97 (1970), Grid system for printed circuits.

[9] IEC 249-2-1/2/3/4/5, Base materials for printed circuits, Part 2: Specifications.

- 1 (1985): Specification No. 1: Phenolic cellulose paper copper-clad laminated sheet, high electric quality.
- 2 (1985): Specification No. 2: Phenolic cellulose paper copper-clad laminated sheet, economic quality.
- 3 (1987): Specification No. 3: Epoxide cellulose paper copper-clad laminated sheet, of defined flammability (vertical burning test).
- 4 (1987): Specification No. 4: Epoxide woven glass fabric copper-clad laminated sheet, general purpose grade.
- 5 (1987): Specification No. 5: Epoxide woven glass fabric copper-clad laminated sheet, of defined flammability (vertical burning test).

[10] IEC 348 (1978), Safety requirements for electronic measuring apparatus.

[11] IEC 707 (1981), Methods of test for the determination of the flammability of solid electrical insulating materials when exposed to an igniting source.

[12] IEC 916 (1988), Mechanical structures for electronic equipment. Terminology.

[13] IEC 917 (1988), Modular order for the development of mechanical structures for electronic equipment practices.

<sup>4</sup>This document is available from the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

<sup>5</sup>IEC publications are available from IEC Sales Department, Case Postale 131, 3 rue de Varembe, CH-1211, Genve 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

[14] IEC 917-0 (1989), Modular order for the development of mechanical structures for electronic equipment practices, Part 0: Guide for the users of Publication 917.

[15] IEC 917-1 (to be published early 1992), Sectional standard on mechanical structures for electronic equipment, coordination dimensions for the 25 mm equipment practice.<sup>6</sup>

[16] P1301.2, Recommended Practices for the Implementation of a Metric Equipment Practice (IEEE Std 1301). D1.2, Sept 10, 1991.<sup>7</sup>

[17] ISO 31-1:1978, Quantities and units of space and time.<sup>8</sup>

[18] ISO 1000:1981, SI units and recommendations for the use of their multiples and of certain other units.

[19] ISO 1101:1983, Technical drawing—Geometric tolerancing—Tolerancing characteristics and symbols—Examples of indication and interpretation.

### 3. Special Word Usage, Definitions, and Abbreviations

#### 3.1 Special Word Usage

**may:** A key word indicating flexibility of choice with no implied preference. The phrase *is optional* is used interchangeably with the key word *may*.

**shall:** A key word indicating a mandatory requirement. Designers shall implement such mandatory requirements to ensure interchangeability and to claim conformance with the specification. The phrase *is required* is used interchangeably with the key word *shall*.

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

#### 3.2 Definitions

**aperture dimension:** The usable space between features.

**coordination dimension:** A reference dimension used to coordinate mechanical interfaces. This is not a manufacturing dimension with a tolerance.

**mounting pitch (mp):** The pitch used to arrange parts or assemblies in a given space.

**n:** Multiplier having integer values of 1, 2, 3,...

**reference plane:** A theoretical plane, not having thickness or tolerance, used to separate space. See 4.1.

**system unit (SU):** The equipment reference increment mounting pitch, 1 SU = 25.0 mm, for height, width, and depth.

<sup>6</sup> As this standard goes to press, IEC 917-1 is not yet published. Publication is anticipated in early 1992. Until that time, information about drafts can be obtained from the chair of IEC 48D Working group 2. Phone: +44 703 266 300. Fax: +44 703 268 610.

<sup>7</sup> This IEEE-authorized standards project is available from the Sales Dept., IEEE Service Center, 445 Hoes Lane, Piscataway, NJ 08855-1331.

<sup>8</sup> ISO publications are available from ISO, Case Postale 56, 1 rue de Varembe, CH-1211, Genve 20, Switzerland/Suisse. ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

### 3.3 Abbreviations

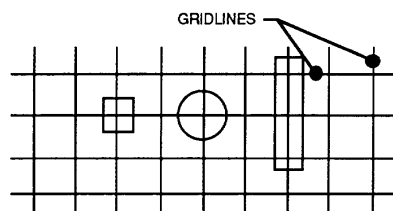
The following abbreviations are used in this document:

|     |                              |
|-----|------------------------------|
| alt | alternate                    |
| D   | depth nomenclature           |
| EMI | electromagnetic interference |
| Fig | figure                       |
| H   | height nomenclature          |
| I/O | input/output                 |
| mm  | millimeter                   |
| mp  | mounting pitch               |
| Nom | nomenclature                 |
| PB  | printed board                |
| SU  | system unit                  |
| W   | width nomenclature           |

## 4. Dimensional Nomenclature

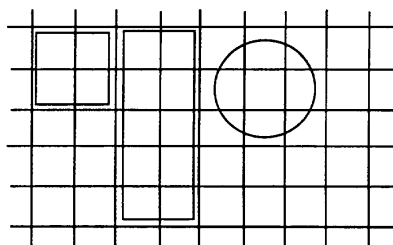
### 4.1 Axis and Boundary References

The following are examples of axis and boundary references to a two-dimensional grid. See IEC 917 [13].



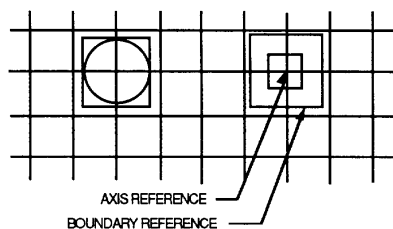
#### Axis reference

The axes of piece parts or assemblies are positioned with reference to the grid lines.



#### Boundary reference

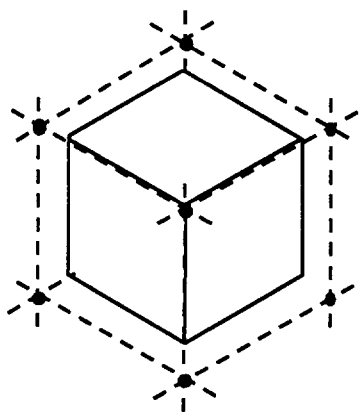
The boundaries of piece parts or assemblies are positioned with reference to the grid lines.



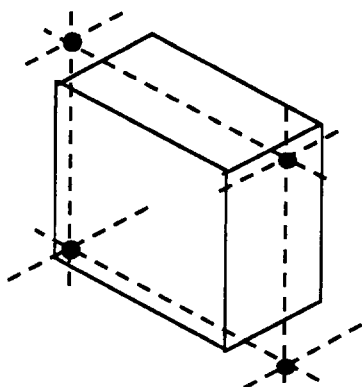
#### Combination reference

A combination of both positioning methods may be used.

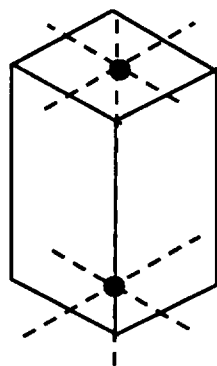
The following are examples of axis and boundary references to a three-dimensional grid. See IEC 917 [13].



(a) Boundary reference in all three directions



(b) Boundary reference in two directions and axis reference in one direction



(c) Boundary reference in one direction and axis reference in two directions.

## 4.2 Dimensional Location Nomenclature

The following location key is used to specify which document is responsible for assigning values to the defined dimensional parameters:

- 1) **IEEE Std 1301 Specified Dimensions.** This specification contains all the generic dimensions that are not connector-related.
- 2) **P1301.x Implementation Parameters.** These are connector-dependent dimensions for the defined printed board plug-in unit. They shall be defined in the appropriate P1301.x specification. If they are not specified in a P1301.x-type document, then they shall be considered application-specific parameters.
- 3) **Application-Specific Parameters.** Application-specific parameters are product-related and have not been assigned values by IEEE Std 1301 or P1301.x. In order to make products, these parameters should be specified according to P1301.2 [16].

## 4.3 Dimensional Nomenclature, Heights

Following is a list identifying abbreviations, the document location where they are assigned values, and a description of height dimensional nomenclature used in this document:

| Nom      | Location | Description                                                                                                         |
|----------|----------|---------------------------------------------------------------------------------------------------------------------|
| $H_C$    | ①        | Coordination height of rack and cabinet, $H_C = n \times SU$                                                        |
| $H_0$    | ①        | Rack and cabinet overall height                                                                                     |
| $H_1$    | ①        | Aperture height of rack and cabinet                                                                                 |
| $H_{2C}$ | ①        | Coordination height of subrack or rack and cabinet front panel, $H_C = n \times SU$                                 |
| $H_3$    | ①        | Height of subrack or of rack and cabinet front panel                                                                |
| $H_4$    | ①        | Aperture height of subrack                                                                                          |
| $H_5$    | ①        | Guidance height of subrack                                                                                          |
| $H_6$    | ①        | Usable space for connectors on plug-in unit front panels between PB mounting flanges                                |
| $H_7$    | ①        | Mounting center distance for plug-in units and backplanes                                                           |
| $H_8$    | ①        | Mounting center distance for plug-in unit front panel on printed board                                              |
| $H_9$    | ①        | Front and rear aperture for plug-in unit front panels or backplanes                                                 |
| $H_{10}$ | ①        | Backplane overall height                                                                                            |
| $H_{11}$ | ① ③      | Plug-in unit guidance height                                                                                        |
| $H_{12}$ | ①        | Mounting center distance for rack and cabinet front panels or subracks for mounting in racks or cabinets            |
| $H_{13}$ | ①        | Supplementary mounting center distance for rack and cabinet front panels or subracks mounting in racks or cabinets. |
| $H_{14}$ | ①        | Mounting center distance for rack and cabinet front panels of 1 SU size for mounting in racks or cabinets           |

| Nom                                   | Location | Description                                                         |
|---------------------------------------|----------|---------------------------------------------------------------------|
| H <sub>15</sub>                       | ②        | Connector-locating dimension                                        |
| H <sub>16</sub>                       | ①        | Printed board height and guidance height of box-type plug-in unit   |
| H <sub>17</sub>                       | ①        | Overall height of box-type plug-in unit                             |
| H <sub>18</sub>                       | ①        | Overall height of plug-in unit front panel                          |
| H <sub>19</sub>                       | ③        | Plug-in unit front panel—clear area for I/Os, indicator lamps, etc. |
| H <sub>20</sub>                       | ①        | Top panel height on cabinet                                         |
| H <sub>21</sub>                       | ② ③      | Backplane connector location                                        |
| 1 — IEEE Std 1301 Specified Dimension |          |                                                                     |
| 2 — P1301.x Implementation Parameter  |          |                                                                     |
| 3 — Application-Specific Parameter    |          |                                                                     |

#### 4.4 Dimensional Nomenclature, Widths

Following is a list identifying abbreviations, the document location where they are assigned values, and a description of width dimensional nomenclature used in this document:

| Nom                                   | Location | Description                                                                |
|---------------------------------------|----------|----------------------------------------------------------------------------|
| W <sub>C</sub>                        | ①        | Coordination width of rack and cabinet, $W_C = n \times SU$                |
| W <sub>0</sub>                        | ①        | Rack and cabinet overall width                                             |
| W <sub>1</sub>                        | ①        | Rack and cabinet aperture (mounting) width                                 |
| W <sub>2</sub>                        | ①        | Rack and cabinet front panel or subrack mounting width                     |
| W <sub>3</sub>                        | ①        | Rack and cabinet front panel or subrack mounting centers                   |
| W <sub>4C</sub>                       | ①        | Coordination width of subrack, $W_{4C} = n \times SU$                      |
| W <sub>5</sub>                        | ①        | Aperture width of subrack                                                  |
| W <sub>6</sub>                        | ①        | Overall width of subrack mounting flanges or rack and cabinet front panels |
| W <sub>7</sub>                        | ① ② ③    | Overall width of plug-in unit front panel                                  |
| W <sub>8</sub>                        | ① ② ③    | Overall width of box-type plug-in unit front panel                         |
| W <sub>9</sub>                        | ①        | Width of subrack                                                           |
| 1 — IEEE Std 1301 Specified Dimension |          |                                                                            |
| 2 — P1301.x Implementation Parameter  |          |                                                                            |
| 3 — Application-Specific Parameter    |          |                                                                            |

## 4.5 Dimensional Nomenclature, Depths

Following is a list identifying abbreviations, the document location where they are assigned values, and a description of depth dimensional nomenclature used in this document:

| Nom       | Location |   | Description                                                                                                      |
|-----------|----------|---|------------------------------------------------------------------------------------------------------------------|
| $D_C$     | ①        |   | Coordination depth of rack and cabinet, $D_C = n \times SU$                                                      |
| $D_0$     | ①        |   | Rack and cabinet overall depth                                                                                   |
| $D_1$     | ①        |   | Rack and cabinet aperture                                                                                        |
| $D_2$     | ①        |   | Actual depth of subrack between front and rear reference or mounting planes, including optional insulation strip |
| $D_3$     | ①        |   | Depth of subrack, excluding insulation strip                                                                     |
| $D_4$     | ②        | ③ | Depth of printed board (connector-dependent)                                                                     |
| $D_5$     | ②        | ③ | Plug-in unit depth (inspection dimension: connector-dependent)                                                   |
| $D_6$     | ②        | ③ | Frame- or box-type plug-in unit depth                                                                            |
| $D_7$     | ①        | 3 | Subrack depth extension—rear                                                                                     |
| $D_8$     | ①        | 3 | Subrack depth extension—front                                                                                    |
| $D_9$     | ①        |   | Rack and cabinet door or panel depth extension                                                                   |
| $D_{10C}$ | ①        | ② | Coordination depth of subrack, $D_{10C} = n \times SU$                                                           |
| $D_{11}$  | ②        |   | Connection depth location dimensions                                                                             |

1 — IEEE Std 1301 Specified Dimension

2 — P1301.x Implementation Parameter

3 — Application-Specific Parameter

## 4.6 Dimensional Nomenclature, Mounting Pitches

Following is a description of mounting pitch dimensional nomenclature used in this document:

| Nom    | Description                                                                |
|--------|----------------------------------------------------------------------------|
| $mp_1$ | Mounting pitch (25.0 mm) for example, outside coordination dimensions      |
| $mp_2$ | Horizontal mounting pitch (5.0 mm), for example, plug-in units in subracks |
| $mp_3$ | Coordination mounting pitch (2.5mm)                                        |
| $mp_4$ | Mounting pitch (0.5 mm) for connectors                                     |

## 5. Cabinets and Racks

Figures 1-15 illustrate and Tables 1-5 give specific dimensions for a range of cabinets, racks, and front panels.

Cabinets and racks need not conform with the examples illustrated in these figures; only the specific dimensions shall be applied. In the case of unspecified dimensions and tolerances, the manufacturers are free to choose according to their needs.

Cabinet Type A has both internal and external dimensions controlled, with all covers, panels, and doors contained within the overall dimensions. See Fig 12.

Cabinet Type B has both internal and external dimensions controlled, with side panels contained within the overall width. Front, rear, and top panels and doors may exceed the overall cabinet dimensions by defined values, i.e.,  $H_{20}$  and  $D_9$ . See Fig 13.

Cabinets Type C conform in all aspects to cabinet Types A and B but do not have panel mounting flanges; that is, only the internal aperture dimensions defined by  $H_1$  and  $W_2$  apply. External dimensions apply as defined by cabinet Types A and B; that is, cabinet Type AC is a cabinet Type A without mounting flanges; cabinet Type BC is a cabinet Type B without mounting flanges.

Cabinets Type D conform only to the internal dimension requirements of Fig 8. External dimensions are not specified and the manufacturers are free to choose according to their needs. Interchangeability of, for example, subracks is guaranteed in configurations as shown in Fig 6. However, slanted applications as shown in Fig 7 may have restricted height and depth dimensions. Cabinet Type DC is a cabinet Type D without mounting flanges and shall conform dimensionally to Fig 10.

The outside dimensions of racks shall comply with cabinet Type A. See Fig 12. It is permissible to use only the internal mounting flange dimensions. See Fig 4. In such solutions, compliance can be claimed to only Fig 4 of this specification.

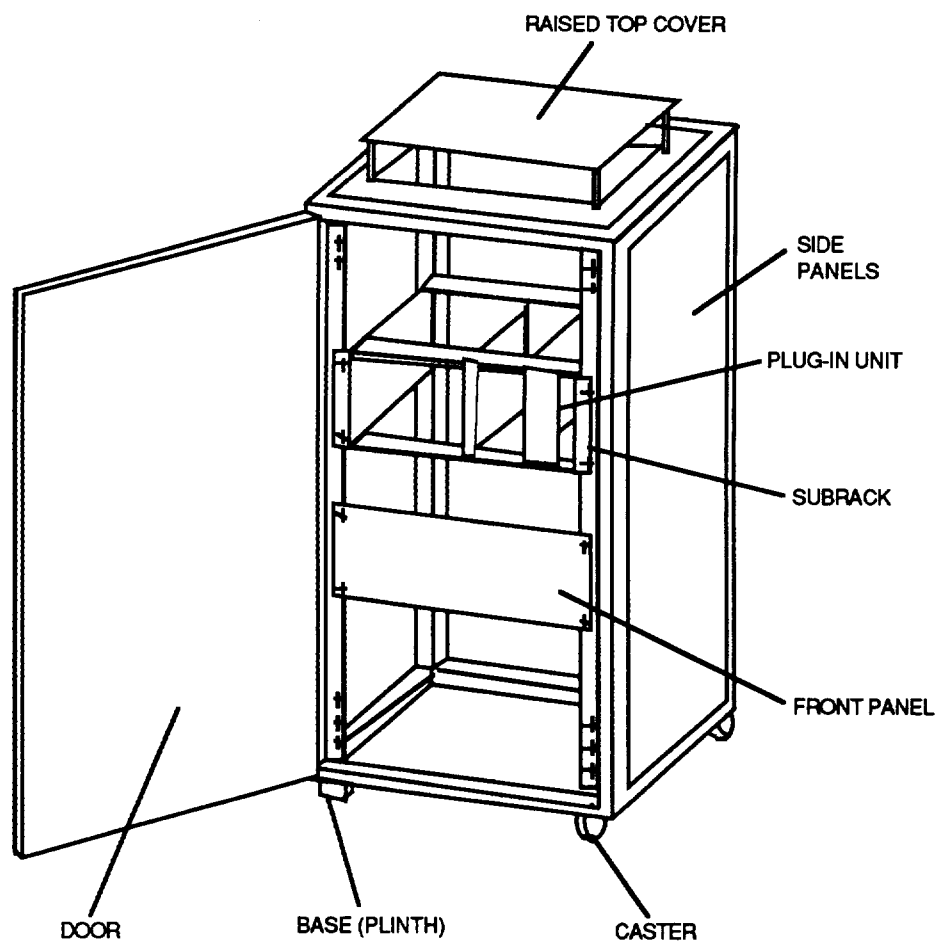


Figure 1— Example of a Cabinet with Subrack, Front Panel, and Attachments Installed