PD IEC/TR 61967-1-1:2015

BSI Standards Publication

Integrated circuits — Measurement of electromagnetic emissions

Part 1-1: General conditions and definitions — Near-field scan data exchange format

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

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TECHNICAL REPORT

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Integrated circuits – Measurement of electromagnetic emissions – Part 1-1: General conditions and definitions – Near-field scan data exchange format

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

Part 1-1: General conditions and definitions – Near-field scan data exchange format

FOREWORD

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IEC TR 61967-1-1, which is a technical report, has been prepared by subcommittee 47A: Integrated circuits, of IEC technical committee 47: Semiconductor devices.

This second edition cancels and replaces the first edition published in 2010. This edition constitutes a technical revision.

This edition includes the following significant changes with respect to the previous edition:

- Addition of:

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  - 4.11 3D objects;
  - Binary data files;
  - Piece-wise linear time domain and frequency domain data;
  - Vectors permitting rotation and offset of measurement and DUT reference planes;
  - Transducer gain and probe factor can be complex;
  - New keywords: Object3d, Mapobj, Maxhold, Datafileformat, Vx, Vy, Vz, Target, Software, Data_source.
- Updating of:
  - 4.9 Probe factor and corresponding keywords.
- Modification of:
  - Keywords: Average.

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
47A/953/DTR	47A/962/RVC

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts of the IEC 61967 series, under the general title *Integrated circuits – Measurement of electromagnetic emissions,* can be found on the IEC website.

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

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

A bilingual version of this publication may be issued at a later date.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

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INTRODUCTION

Near-field scan measurements, as described for example in IEC TS 61967-3 [1] [1] or IEC TS 62132-9 [2], and simulations generate a large amount of data. Many different formats are used for storing the data, thereby rendering its exchange extremely difficult.

The proposed format is intended to facilitate exchange of near-field scan data between industrials, academics, EDA tool vendors and end customers. It is based on the well-known XML format, which is both machine and human readable. Its structure allows the files to be generated and processed on any operating system. In order to limit the file size, it is possible to store the information and data in a single file or multiple files. Moreover, the ASCII-based XML format allows the files to be compressed to a very high level with readily available compression software.

The three conventional coordinate systems (Cartesian, cylindrical and spherical) are supported by the proposed exchange format. Information on the device under test, the test set-up, the probe, etc., is also included in the files. Notes and links to external documents allow complex test environments to be well described.

The version of the exchange format described in this technical report is 2.0. Future revisions will add items, such as new keywords and rules, considered to be "enhancements" to Version 1.0. Consequently, all future revisions will be considered supersets of Version 2.0, allowing backward compatibility.

[1] Figures in square brackets refer to the Bibliography.

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INTEGRATED CIRCUITS – MEASUREMENT OF ELECTROMAGNETIC EMISSIONS –

Part 1-1: General conditions and definitions – Near-field scan data exchange format

1 Scope

This part of IEC 61967 provides guidance for exchanging data generated by near-field scan measurements.

The described exchange format could also be used for near-field scan data generated by simulation or computation software. It should be noted that, although it has been developed for near-field scan, its use is not restricted to this application. The exchange format can be applied to emission and immunity near-field scan data in the frequency and time domains.

The scope of this technical report includes neither the methods used for the measurements or simulations, nor the software and algorithms used for generating the exchange file or for processing or viewing the data contained therein.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary* (available at <http://www.electropedia.org>)

IEC 61967-1, *Integrated circuits – Measurement of electromagnetic emissions, 150 kHz to 1 GHz – Part 1: General conditions and definitions*

ISO 8879, *Information processing – Text and office systems – Standard Generalized Markup Language (SGML)*

ANSI INCITS 4:1986, *Information Systems – Coded Character Sets – 7-Bit American National Standard Code for Information Interchange (7-Bit ASCII)*

IEEE Std 754™-2008: *IEEE Standard for Floating-Point Arithmetic*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 61967-1, IEC 60050-131 [3] and IEC 60050-161 [4], as well as the following, apply.

3.1.1
section
XML element placed one level below the root element or within another section, and that contains one or more XML elements, but no value

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3.1.2
parent
keyword, one level above another keyword (child)

3.1.3
child
keyword, one level below another keyword (parent)

3.1.4
probe factor
ratio of electric or magnetic field strength at a specified location in near-field evaluation to the signal level measured at the output connection or applied to the input connection of a probe

[SOURCE: IEC 61967-3:2014, 3.1.2]

3.2 Abbreviations

EDA Electronic Design Automation

NFS Near-Field Scan

XML eXtensible Markup Language

SGML Standard Generalized Markup Language

4 General syntax rules and guidelines

4.1 General

The following rules and guidelines ensure that files intended for exchange will be correctly recognised and processed by viewers and processors. Examples of XML files conforming to the present exchange format are given in Annex A.

4.2 XML requirements

4.2.1 General

This exchange format uses XML 1.0 fourth edition to structure the information. XML shall conform to the standard generalized markup language (SGML) (ISO 8879).

The rules below ensure that the NFS files can be parsed correctly by an NFS parser.

4.2.2 XML declaration

Although the XML declaration is optional in an XML file, the NFS file should include an XML declaration, dedicated to basic XML parsers. An NFS file parser does not interpret this header.

A file header example is given below:

```
<?xml version="1.0" encoding="UTF-8"?>
```

The XML declaration shall be the first line of the file.

4.2.3 XML elements

All information is saved in the form of XML elements. Each element starts with a start-tag and ends with an end-tag. The start-tag consists of a keyword enclosed in triangular brackets, “<Keyword>”. The end-tag consists of the same keyword prefixed by the character “/” and

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enclosed in brackets, “</Keyword>”. Content in the form of text is enclosed by a start-tag and an end-tag.

An example of an element is given below:

```
<Keyword>        <!-- start-tag -->
      text       <!-- content -->
</Keyword>       <!-- end-tag -->
```

It is also allowed to write an element on the same line, for example, to include short content.

```
<Keyword>text</Keyword>
```

The contents of an element may consist of one or more other elements or a value (numerical, or alphanumerical). For clarity, tab characters may be used for indenting. Except when used for surrounding keywords, triangular brackets "<" and ">" shall not be part of content.

An empty element may be included to indicate that a particular keyword exists, but has no content:

```
<empty_element/>
```

4.2.4 Root element

The XML file shall contain one, and only one, root element. It encloses all the other elements and is therefore the sole parent element to all the other elements. The start-tag of the root element is placed at the beginning of the file or after the XML declaration when present. The end-tag of the root element is at the last entry of the file.

4.2.5 Comments

Comments may be inserted into the file between “<!--” and “-->”. An example is given below:

```
<!-- this line is a comment -->
```

Comments can be inserted anywhere in the file, except inside start- and end-tags, and written on a single line or on several lines. All text enclosed by comment brackets is considered as a comment and may be ignored.

4.2.6 Line terminations

In order to facilitate readability, it is usual to organise the file into lines. The line termination sequence shall be either a linefeed character or a carriage return character followed by a linefeed character.

4.2.7 Element hierarchy

The order of the elements is not important, but their hierarchy shall be respected.

example layout:

```
<Keyword1> ... </Keyword1>
<Keyword2>
      <Keyword21> ... </Keyword21>
      <Keyword22> ... </Keyword22>
</Keyword2>
<Keyword3> ... </Keyword3>
```

An acceptable equivalent layout of the example:

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```
<Keyword3> ... </Keyword3>
<Keyword1> ... </Keyword1>
<Keyword2>
      <Keyword22> ... </Keyword22>
      <Keyword21> ... </Keyword21>
</Keyword2>
```

In this layout the order is changed, but the hierarchy is respected.

An unacceptable layout of the example:

```
<Keyword2> ... </Keyword2>
<Keyword22> ... </Keyword22>
<Keyword21> ... </Keyword21>
<Keyword3>
      <Keyword1> ... </Keyword1>
</Keyword3>
```

In this layout the hierarchy is not respected.

4.3 Keyword requirements

4.3.1 General

Keywords, placed in start- and end-tags, are used to introduce descriptions, values and sections that are specific to NFS measurements and simulations. A list of keywords is given in Annex B and a more detailed description of each keyword is given in Annex C.

Keywords for sections with the Root element as parent, such as Component, Setup and Probe, shall only appear once in an XML file or a group of XML files (see 4.4.5). However, an XML file or a group of XML files (see 4.4.5) may contain several data sections. This allows the measurements on a component using, for example different lists of frequencies or coordinate offsets, to be included in the same XML file or group of XML files.

Some keywords, such as Frequencies, Unit, List, etc., may be present in several sections.

A parent keyword is required when a child keyword is present.

The rules below ensure that the file can be correctly parsed by an NFS parser.

4.3.2 Keyword characters

Only ASCII characters, as defined in ANSI INCITS 4:1986, shall be used in the files. The use of characters with codes greater than hexadecimal 07E is not allowed. Also, ASCII control characters (those numerically less than hexadecimal 20) are not allowed, except for tabs or in a line termination sequence. For example, the "°" character (ASCII 176) is not permitted. Only alphabetical or numerical characters can be used to write keywords. Spaces are not permitted. If needed, the underscore "_" character can separate the parts of a multi-word keyword.

4.3.3 Keyword syntax

The content of the files is case sensitive. All keywords shall be written in lower case starting with an upper case letter.

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4.3.4 Root element keywords

As described in 4.2.4, all elements of the file shall be enclosed within the root element. The following keywords are reserved for root elements and shall not be used for any other purposes in the file:

EmissionScan

ImmunityScan

If the proposed XML file format is used for other applications, other keywords may be used in the root element, but NFS parsers may not be able to parse the file.

4.4 File structure

4.4.1 General

The information to be exchanged may be stored in a single XML file or in several XML and data files. The following rules and guidelines ensure that the files can be correctly located by an NFS parser.

4.4.2 File names

To facilitate portability between operating systems, file names should have a base name of no more than forty characters followed by a period ".", followed by a filename extension of no more than three characters. The file name and extension shall use characters from the set (space, " ", 0x20 is not included):

```
a b c d e f g h i j k l m n o p q r s t u v w x y z
0 1 2 3 4 5 6 7 8 9 _ ^ $ ~ ! # % & - { } ) ( @ ' `
```

4.4.3 File paths

In order to ensure portability and compressibility, only relative paths can be used to define a path name. An absolute path is not exportable and is not permitted. The relative path shall start with "./" to indicate that the path name of the picture file will be appended to the path of the current XML file. It is not permitted to browse to a higher level from the current XML path (e.g. by using "../"). A file name without "./" is assumed to be located in the same directory as the current XML file.

4.4.4 Single XML file

When the information is contained in a single XML file, it shall conform to the rules and guidelines applicable to XML files, as described in 4.2.

Data is included in the Data section of the file within the XML element using the keyword: List and shall be stored in ASCII form. When binary data is to be stored, it shall be included in separate data files as described in 4.4.6.

4.4.5 Multiple XML files

The XML document is divided into several sections having the root element as parent. Such a section contains information on a particular part of the NFS environment and is defined by keywords such as Component, Setup, Probe and Data. Each XML file may contain one or more sections and shall conform to the rules and guidelines applicable to XML files as described in 4.2 and 4.3.1. An example of multiple XML files is given in Clause A.12.

In order to ensure portability and compressibility, all the XML files shall be placed in the same directory, as shown in Figure 1. The NFS parser shall parse all the XML files that are in the main directory.

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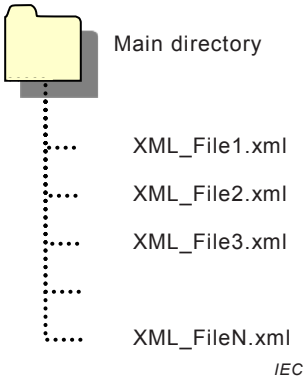

Figure 1 – Multiple XML files

4.4.6 Separate data files

Information may be contained in a single file or multiple XML files and the data contained in one or more additional data files. XML files shall conform to the rules and guidelines applicable to XML files, as described above and in 4.2. Data files shall contain only lines of data as described in 4.8. The names and paths of the data files are defined by the keyword: Data_files and shall conform to 4.4.2 and 4.4.3.

The information contained in the data file(s) may be stored in ASCII form for human readability or in binary form. Binary data shall conform to the binary32 interchange floating-point format described in IEEE Std 754™-2008. This 32-bit format includes 1 sign bit, an 8 bit biased exponent and a 23 bit trailing significant field. The format of the data files is specified by the keyword: Datafileformat. If the keyword: Datafileformat is empty or absent, it is assumed that the data is stored in ASCII form. All data files shall use the same data format.

In order to ensure portability and compressibility, the data files shall be placed either in the same directory as the XML files or in a sub-directory located at the same level or a lower level as the XML files, as shown in Figure 2. It is not permitted to locate the additional files at a higher level than the XML files.

4.4.7 Additional files

An XML file may contain references to other files such as image files (Keyword: Image) and document files (Keyword: Documentation). In order to ensure portability and compressibility, these additional files shall be placed either in the same directory as the single XML file or in a sub-directory located at the same level or a lower level as the XML files, as shown in Figure 3. It is not permitted to locate the additional files at a higher level than the XML files.

4.4.8 File compression

When compressing the file system, care shall be taken to include the paths of the various XML and data files in the compressed file. This ensures that, when decompressed, the file structure is conserved. The paths are not required when all files are stored in the same directory.

NOTE The most common compression used is the .ZIP File Format [5]. When the various XML and data files are compressed using the .ZIP File Format, the extension may be .nfs.

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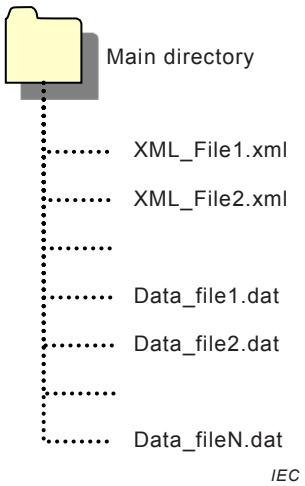

Figure 2a) – Data files in the same directory

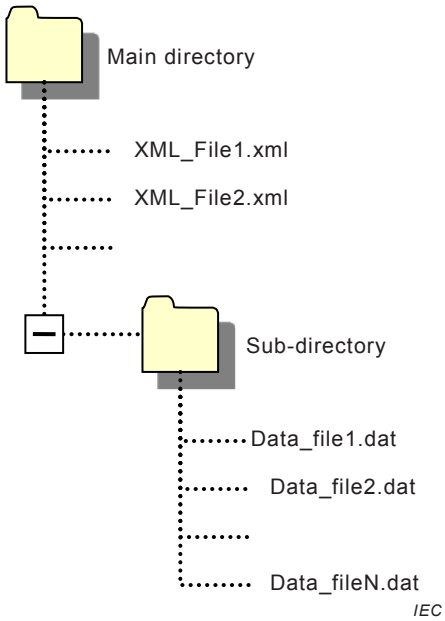

Figure 2b) – Data files in a sub-directory

Figure 2 – XML files with data files

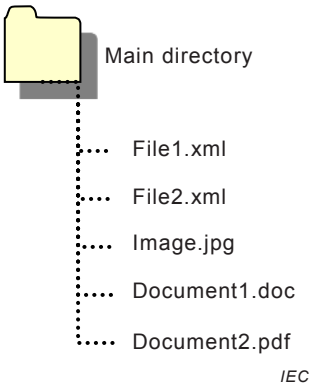

Figure 3a) – Additional files in the same directory

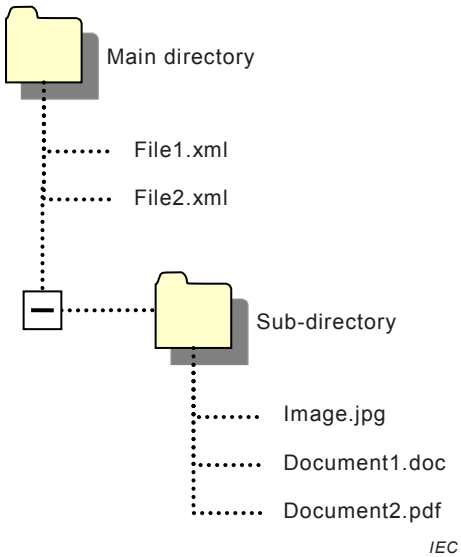

Figure 3b) – Additional files in a sub-directory

Figure 3 – Additional files

4.5 Values

4.5.1 General

When an element contains a value, this may be a numerical value (e.g. “123.45”), a numerical value with units (e.g. “123.45MHz”) or a text string (e.g. “This is text string number 2”).

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4.5.2 Numerical value syntax

Numerical values may be expressed in decimal form with the period as the decimal separator (e.g. “123.45”) or in scientific form (e.g. 1.2345e2). Spaces " " and commas "," which are often used as thousand separators, and other characters, are not allowed.

In cases where several numerical values are required, they shall be separated by spaces " " or tab characters.

4.5.3 Numerical value with units syntax

The numerical value (see 4.5.2) is followed by valid units, as described in 4.5.5 (e.g. 123.45MHz). Spaces are not allowed between the numerical value and the units.

4.5.4 Text string

A text string may represent a word recognised by the NFS parser or it may be a file name, a description, etc. A text string may contain any of the alphanumerical characters given in 4.3.2.

4.5.5 Valid units

Units may be expressed as simple linear units or as logarithmic units (dB).

Although not strictly a near-field parameter, power flux density has also been included in the list of valid units for completeness.

Valid units are:

V for volt	A for ampere	W for watt	ohm for ohm
Hz for Hertz	m for metre	s for second	

Inverse units are also valid:

S for siemens =1/ohm

Combined units are permitted, such as:

V/m	for	volt per metre
A.m	for	ampere metre
/V.m	for	per volt metre

Valid scaling factors are:

T = tera:	1e12	k = kilo:	1e3	n = nano:	1e-9
G = giga:	1e9	m = milli:	1e-3	p = pico:	1e-12
M = mega:	1e6	u = micro:	1e-6	f = femto:	1e-15

When no scaling factors are specified, the appropriate base units are assumed. These are volts, amperes, watts, ohms, siemens, hertz, metres and seconds. Abbreviations for the units (e.g., pV, nA, ms, MHz) shall be used, except ohm, which shall be written in full.

All temperatures shall be represented in degrees Celsius. Symbol "°C" is not required.

Angles shall be expressed in degrees. The symbol "°" is not required.

Units are case sensitive.

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Table 1 shows a list of valid logarithmic units. The logarithmic units for probe factor contain brackets in order to avoid confusion with other units (e.g. dBm for dB milliwatt and dB(m) for dB metre).

Table 1 – Valid logarithmic units

Usage	Symbol	Unit	Reference
Ratio	dB	decibel	1
Power	dBW	dB watt	1 W
Power	dBm	dB milliwatt	1 mW
Voltage	dBV	dB volt	1 V
Voltage	dBuV	dB microvolt	1 uV
Current	dBA	dB ampere	1 A
Current	dBuA	dB microampere	1 uA
Electric field strength	dBV/m	dB volt per metre	1 V/m
Electric field strength	dBuV/m	dB microvolt per metre	1 uV/m
Magnetic field strength	dBA/m	dB ampere per metre	1 A/m
Magnetic field strength	dBuA/m	dB microampere per metre	1 uA/m
Power flux density	dBW/m^2	dB watt per square metre	1 W/m^2
Power flux density	dBm/m^2	dB milliwatt per square metre	1 mW/m^2
Probe factor[a]	dB(ohm.m)	dB ohm metre	1 Ω.m
Probe factor[a]	dB(ohm/m)	dB ohm per metre	1 Ω/m
Probe factor[a]	dB(S.m)	dB siemens metre	1 S.m
Probe factor[a]	dB(S/m)	dB siemens per metre	1 S/m
Probe factor[a]	dB(m)	dB metre	1 m
Probe factor[a]	dB(/m)	dB per metre	1/m
Probe factor[a]	dB(ohm.m^2)	dB ohm square metre	1 Ω.m^2
Probe factor[a]	dB(ohm/m^2)	dB ohm per square metre	1 Ω/m^2
Probe factor[a]	dB(S.m^2)	dB siemens square metre	1 S.m^2
Probe factor[a]	dB(S/m^2)	dB siemens per square metre	1 S/m^2
The corresponding linear units are also permitted.			
[a] Details of the probe factor are given in 4.9.			

4.6 Coordinate systems

4.6.1 General

The near-field scan data may be based on Cartesian, cylindrical or spherical coordinate systems. The keyword: Coordinates defines the coordinate system used in the technical report. The right-hand Cartesian coordinate system is used by default.

4.6.2 Cartesian coordinate system

In order to accommodate different scan table coordinate systems and existing documents, Cartesian coordinates may be either right-hand (see Figure 4) or left-hand (see Figure 5). However, the right-hand Cartesian coordinate system is preferred and shall be used whenever possible.

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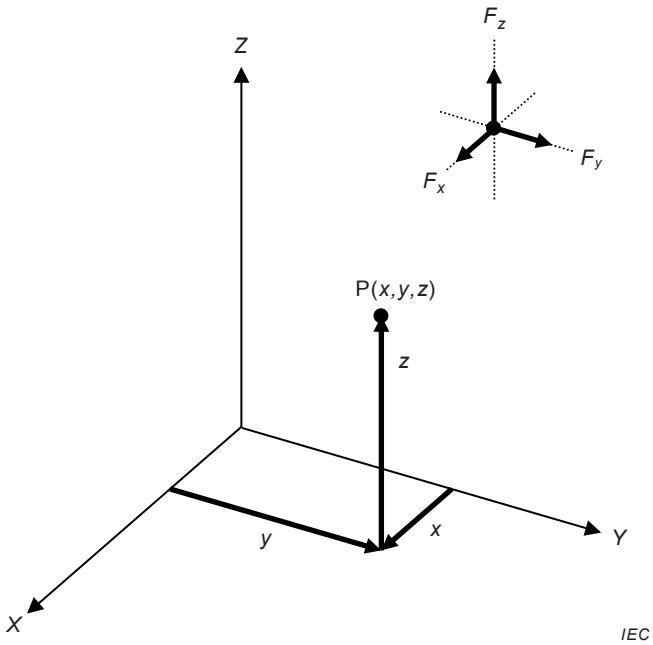

Figure 4 – Right-hand Cartesian coordinate system

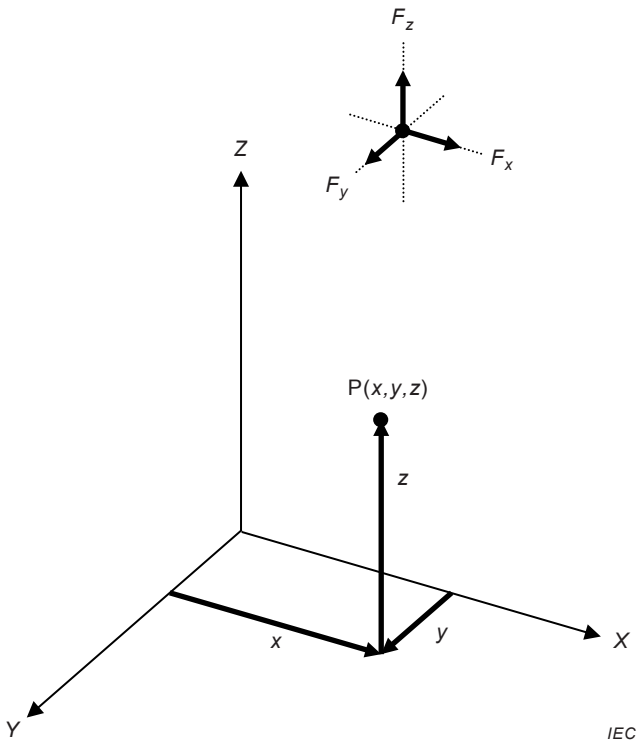

Figure 5 – Left-hand Cartesian coordinate system

4.6.3 Cylindrical coordinate system

Although the scan equipment may be orientated differently, the cylindrical coordinate system assumes that the polar plane (*r*, *A*) lies in the *XY* plane of a Cartesian coordinate system and that the linear axis (*h*) lies in the *z*-direction of a Cartesian coordinate system, as shown in Figure 6.

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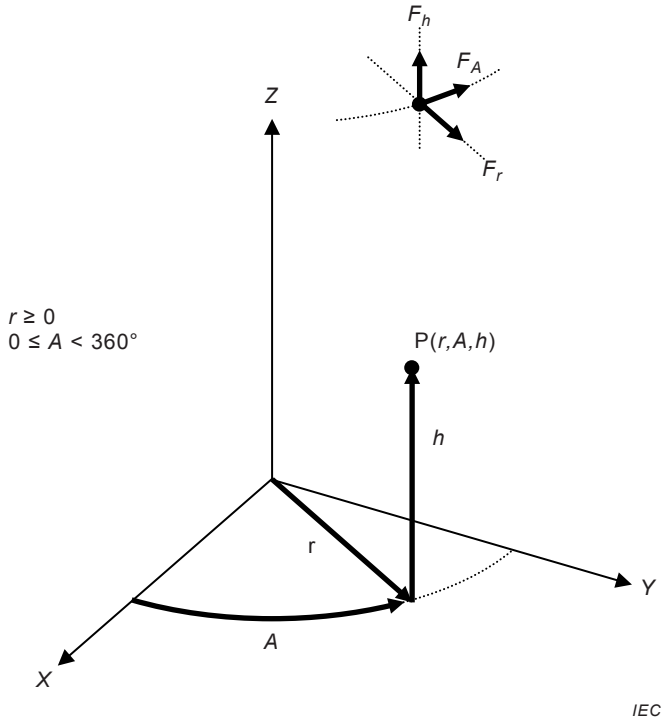

Figure 6 – Cylindrical coordinate system

4.6.4 Spherical coordinate system

Similarly, the spherical coordinate system assumes that the azimuth angle (*A*) lies in the *XY* plane of a Cartesian coordinate system and that the zenith angle (*B*) lies between the *Z*-axis of a Cartesian coordinate system and the vector *r*, as shown in Figure 7. In order to avoid the use of negative angle values, the zenith angle shall be used in preference to the elevation angle (angle between the *XY*-plane and the vector *r*), which is used for antenna radiation diagrams, for example.

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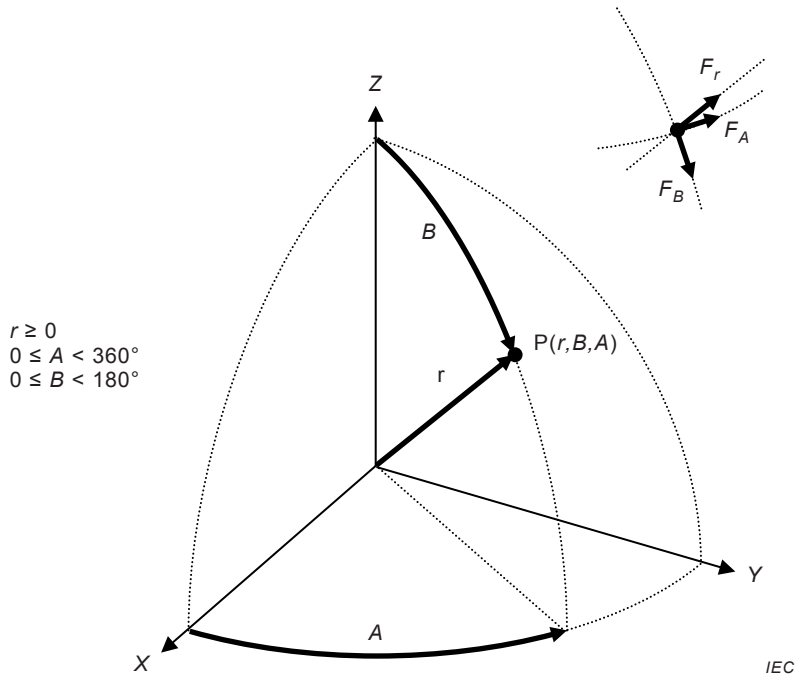

Figure 7 – Spherical coordinate system

4.6.5 Coordinate offsets

Provision is provided for the origin of the scan area to be offset from the origin of the scan table, for example. The offset is specified using the keywords: X0, Y0, Z0, R0, H0, A0 and B0. Figure 8 and Figure 9 show the offsets for right-hand and left-hand Cartesian coordinates respectively. Offsets in the cylindrical and spherical coordinate systems are used in a similar way.

Sets of three vectors may also be included to indicate the reference planes in the Cartesian coordinate system of the DUT and measurement as shown in Figure 10.

All measurement points are defined in the measurement reference plane by Vx_M, Vy_M and Vz_M (see Figure 10). Vx_M, Vy_M and Vz_M are specified by the keywords: Vx, Vy and Vz in the Data section. If they are absent, the measurement reference plane is assumed to be defined by Vx = (a,0,0), Vy = (0,a,0) and Vz = (0,0,a), where here "a" is any number.

The measurement reference plane is defined in DUT reference plane by Vx_{DUT}, Vy_{DUT} and Vz_{DUT} (see Figure 10). Vx_{DUT}, Vy_{DUT} and Vz_{DUT} are specified by the keywords: Vx, Vy and Vz in the Image section. If they are absent, the DUT reference plane is defined by Vx = (a,0,0), Vy = (0,a,0) and Vz = (0,0,a), where here "a" is any number.

The information provided by the vectors is particularly useful when the measured fields from several objects are to be combined, for example, to define several faces of the DUT or to define two objects to combine both measurement results in the same 3D space.

The vectors are specified by the keywords: Vx, Vy and Vz. Each vector is described by values in the X-axis, Y-axis and Z-axis. The three vectors shall be orthogonal and referenced to the plane of the object scanned. If the three vectors are not present, it is assumed that the measurement coordinates are parallel to the plane of the object scanned. The two planes are parallel when Vx = (a,0,0), Vy = (0,a,0) and Vz = (0,0,a). "a" is any number. Figure 10 shows two planes and the three corresponding vectors. Example files are shown in Clause A.11.

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