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Edition 2.0 2015-08

TECHNICAL REPORT

colour inside

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

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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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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:

- 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- withdrawn,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.

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.

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

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 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:

```
<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.

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.

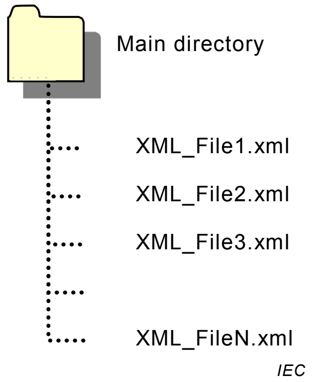


Figure 1 – Multiple XML files

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.

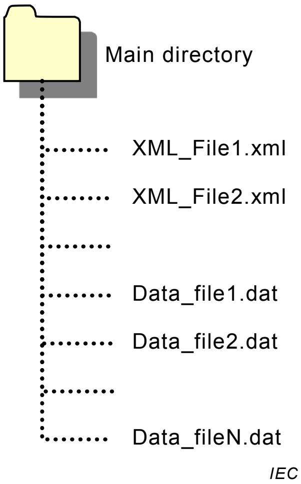


Figure 2a) – Data files in the same directory

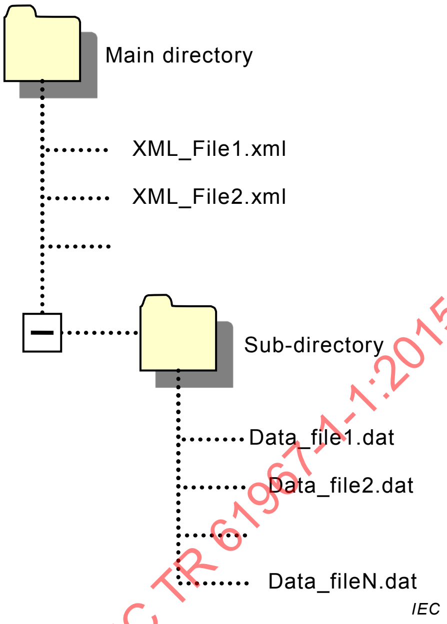


Figure 2b) – Data files in a sub-directory

Figure 2 – XML files with data files

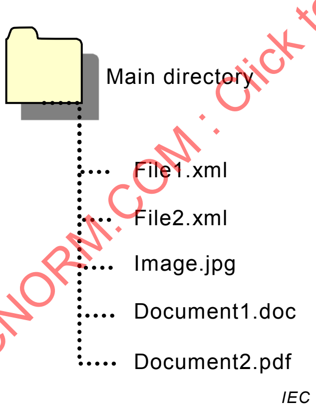


Figure 3a) – Additional files in the same directory

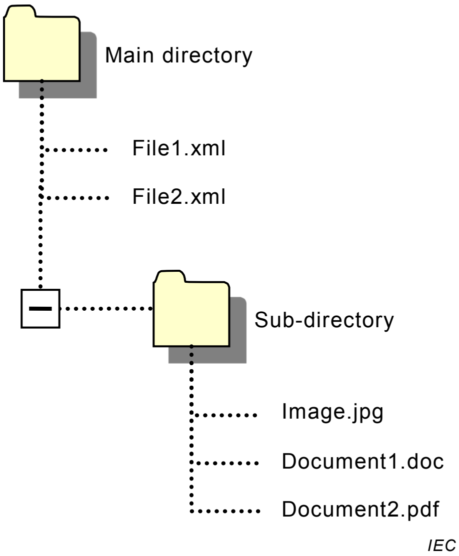


Figure 3b) – Additional files in a sub-directory

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”).

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.

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.

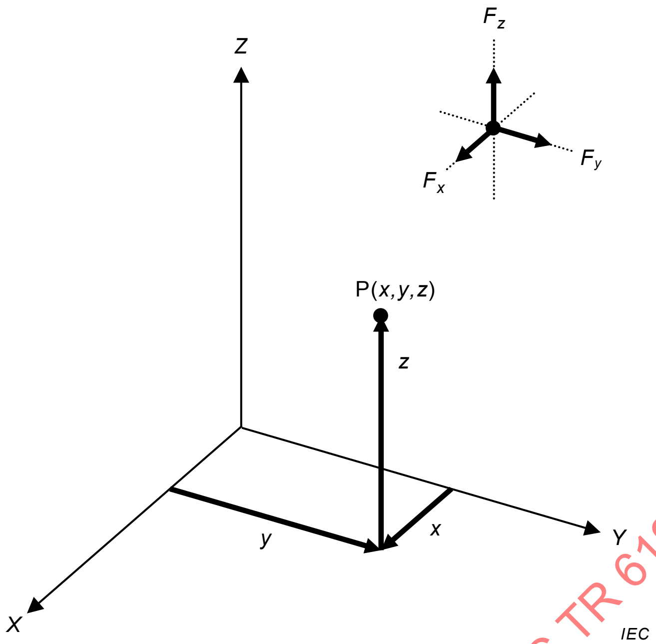


Figure 4 – Right-hand Cartesian coordinate system

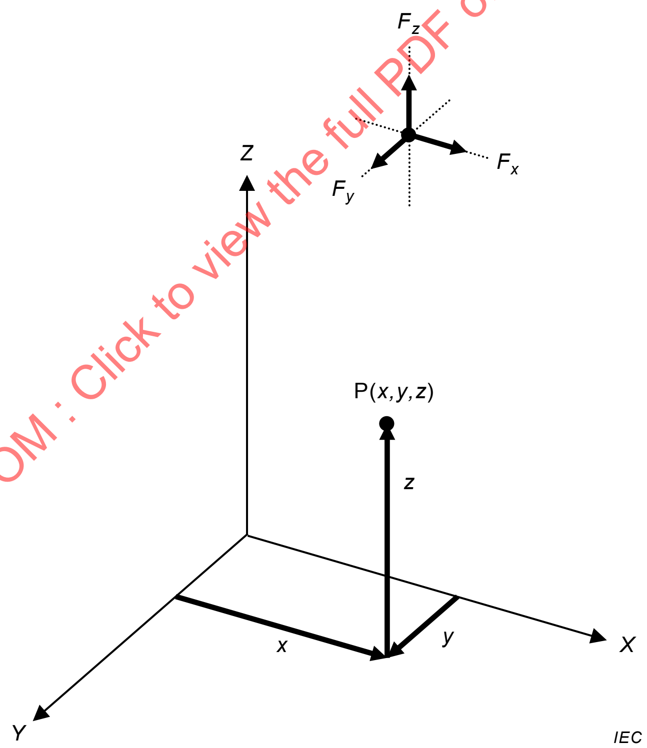


Figure 5 – Left-hand Cartesian coordinate system

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.

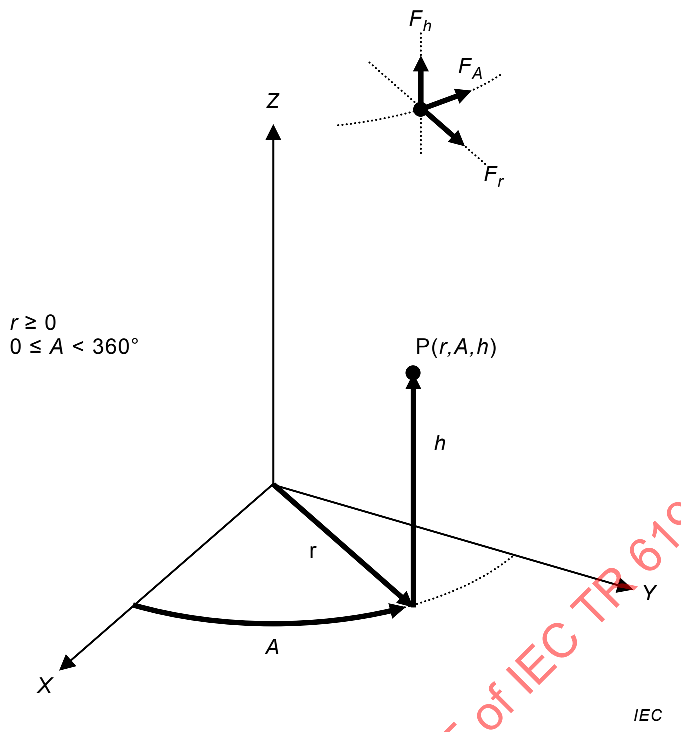


Figure 6 – Cylindrical coordinate system

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.

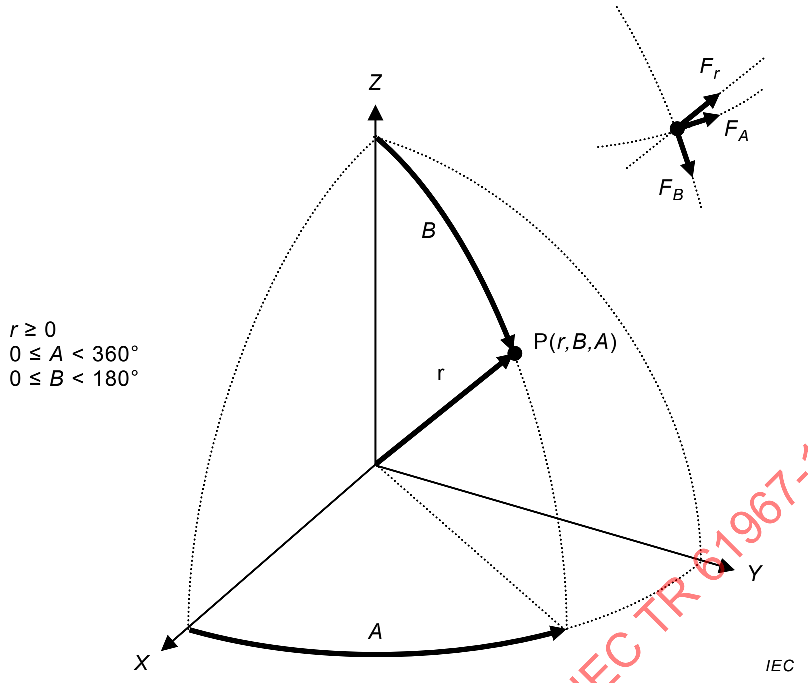


Figure 7 – Spherical coordinate system

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.

4.6.6 Image coordinates

The scan information can be overlaid with a picture of the component. The image dimensions are specified with the keywords: Xsize, Ysize, Zsize, Rsize, Hsize, Asize and Bsize. The origin of the image may be offset from the origin of the scan table; this offset is specified using the keywords: Xoffset, Yoffset, Zoffset, Roffset, Hoffset, Aoffset and Boffset. Figure 8 and Figure 9 show the offsets and dimensions of the image for right-hand and left-hand Cartesian coordinates respectively.

In the Cartesian coordinate system, the overlay of an image is usually in the *XY* plane, but it is also possible to overlay it in the *XZ* or *YZ* planes. This is specified by the pairs of keywords used for the size (e.g. Xsize and Ysize) and offset (e.g. Xoffset and Yoffset), etc.) of the image. When using spherical or cylindrical coordinates, the flat picture has no meaning. Nevertheless, a picture of the component, measurement setup, etc. may be included, even though it cannot be overlaid on the scan. In this case, no size and offset keywords shall be included in the document.

More details of how images shall be included in the project are given in 4.10.

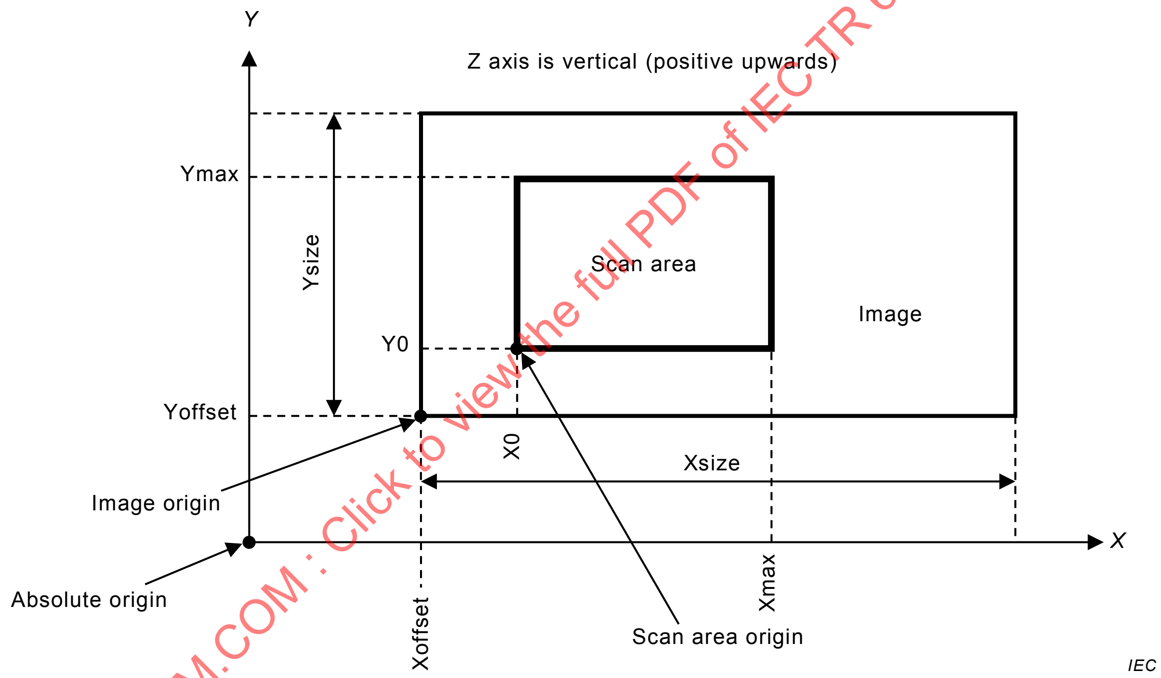


Figure 8 – Offsets and image positioning (right-hand Cartesian)

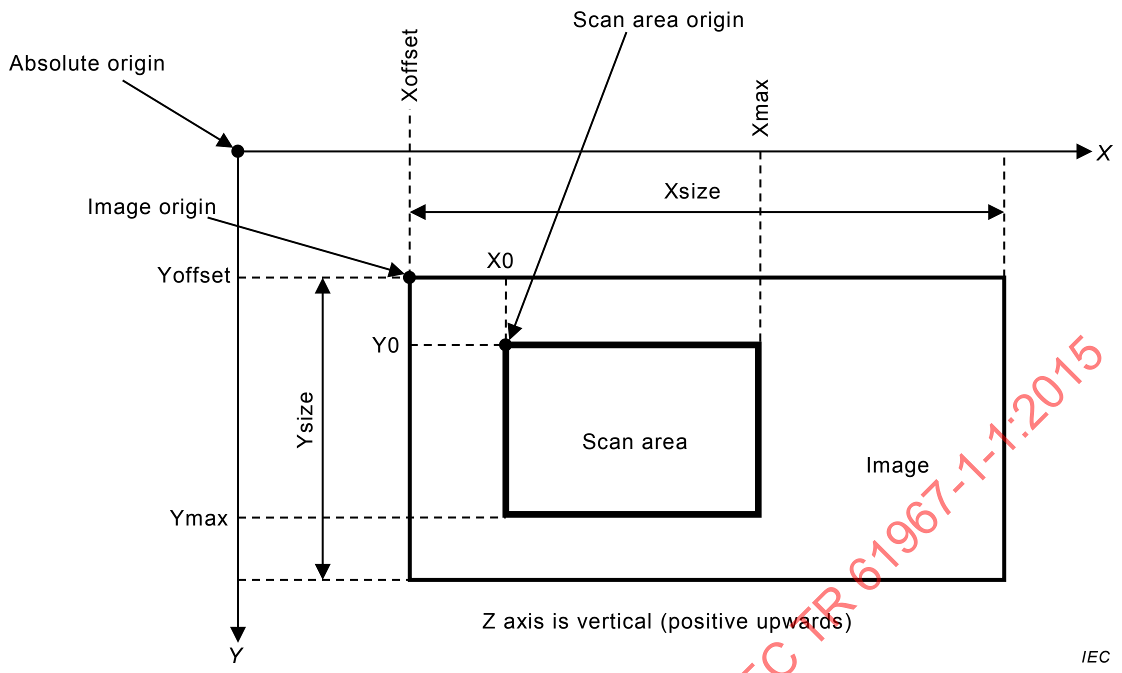


Figure 9 – Offsets and image positioning (left-hand Cartesian)

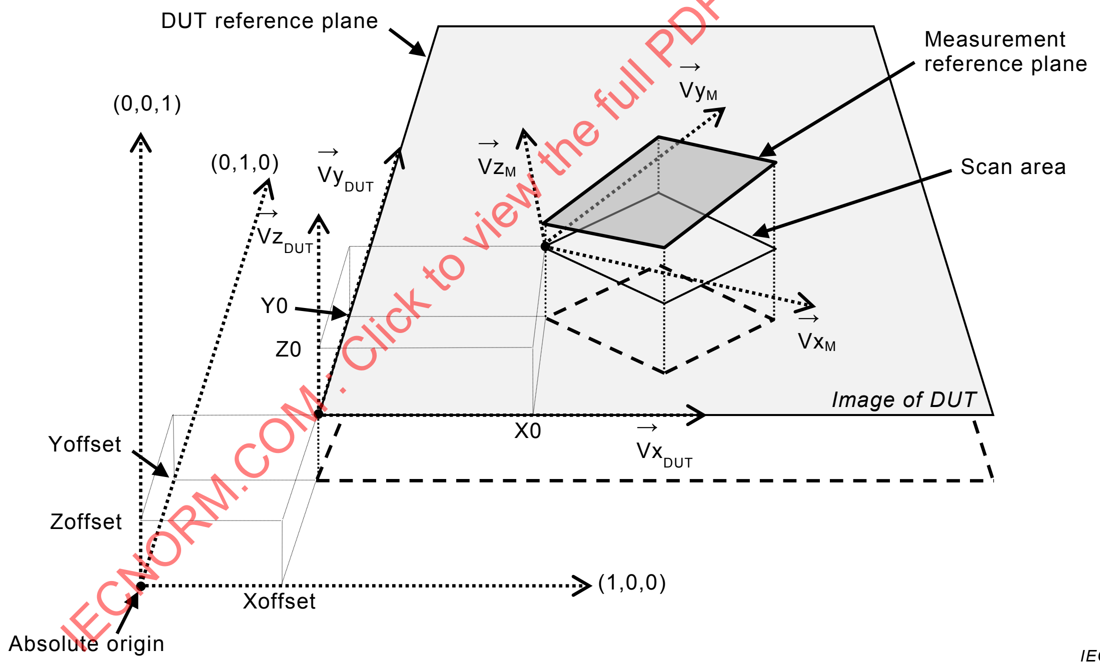


Figure 10 – Measurement and DUT planes – Right-hand Cartesian coordinate system

4.7 Field type and orientation

The field type is specified using the keyword: Field. Typically, the value will be "E" for the electrical field and "H" for the magnetic field. If the orientation of the field is not included in the data, the value can be enhanced by adding the field component, e.g.: Ex, Hz, Eh, Hr, etc.

Figure 11 to Figure 14 also show the field (F) directions corresponding to each coordinate system. The field may be magnetic (H) or electric (E). In all cases, the directions are parallel or tangential to the axes or angles of the coordinate system.

It is also possible to include the orientation of the field in the data (see 4.8). It is specified by the keyword: Coordinates, using an azimuth angle *C* and, optionally, a zenith angle *D*. If the zenith angle is omitted, its default value is 90°, which sets the two-dimensional orientation in the *XY*, *AH* or *BA* plane, depending on the coordinate system. Figure 11, Figure 12, Figure 13 and Figure 14 show the field orientations corresponding to each coordinate system.

The radiation diagram of a probe is generally symmetrical. The azimuth and zenith angles can therefore be limited to 180° and 90°.

Table 2 shows the relationship between the azimuth and zenith angles and the field component for each coordinate system.

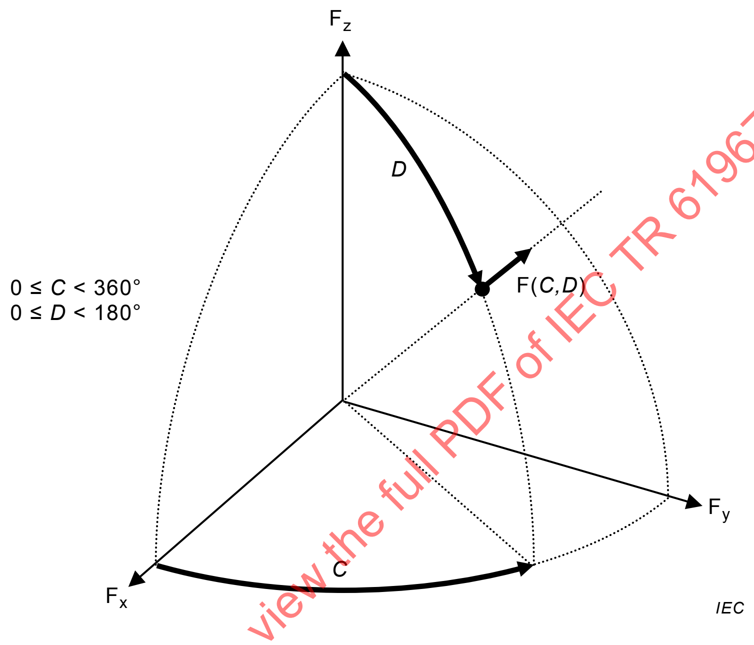


Figure 11 – Field orientation – Right-hand Cartesian coordinate system

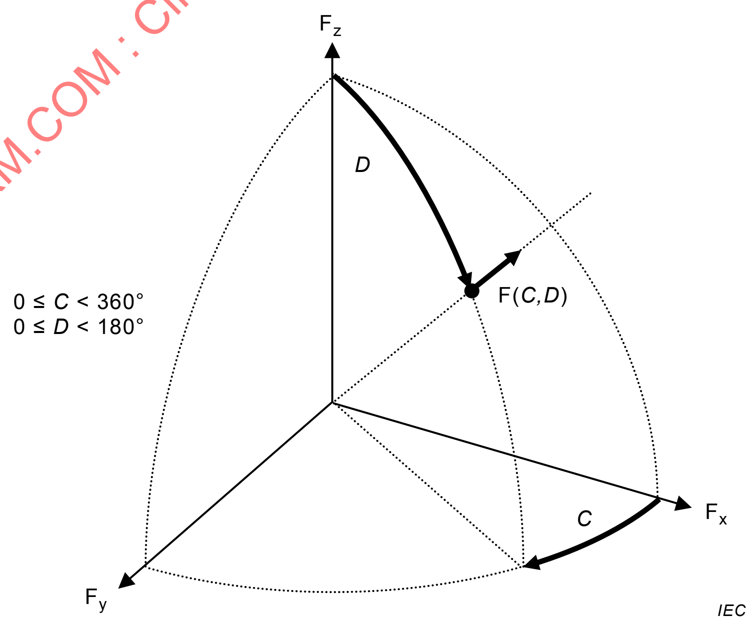


Figure 12 – Field orientation – Left-hand Cartesian coordinate system

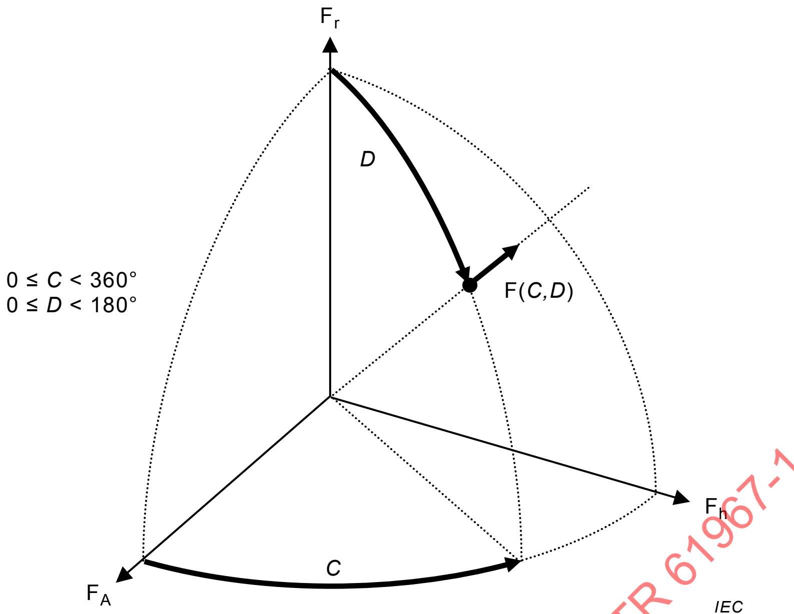


Figure 13 – Field orientation – Cylindrical coordinate system

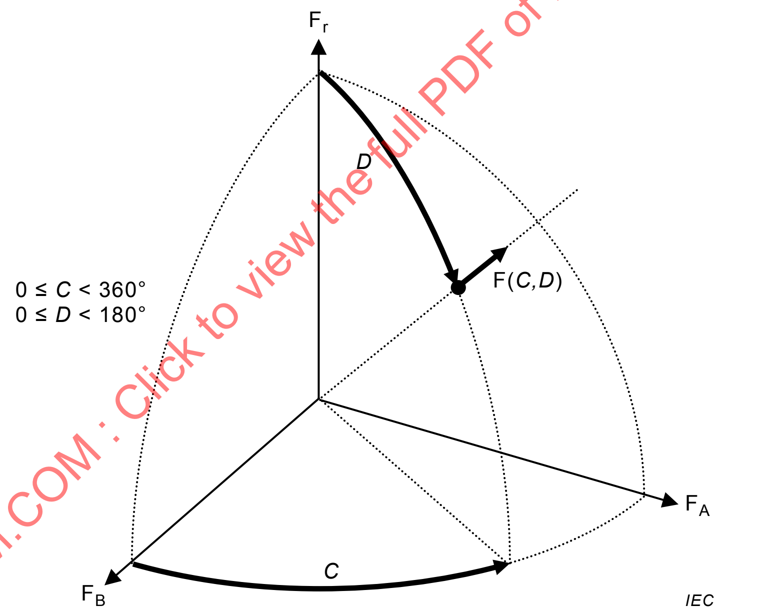


Figure 14 – Field orientation – Spherical coordinate system

Table 2 – Relationship between azimuth, zenith angles and field component

Coordinates	C °	D °	Field
Cartesian	–	0	z
	0	90	x
	90	90	y
Cylindrical	–	0	r
	0	90	a
	90	90	h
Spherical	–	0	r
	0	90	b
	90	90	a

4.8 Data syntax

4.8.1 General

The data may be organised with coordinate information (preferred and default) or without coordinate information. Either frequency domain data or time domain data may be included. Several formats are possible for data as described in 4.8.5. Moreover, two arrangements are possible for organising the data:

– Predefined list of frequencies or times.

– Piece-wise linear data in the form of a series of frequency-signal level or time-signal level pairs.

4.8.2 Data arrangement

4.8.2.1 Predefined list of frequencies or times

The keywords: Frequencies or Times specify whether frequency domain or time domain data is included. Only one of these keywords is permitted in the Data section. If neither keyword is present, it is assumed that the data is frequency domain magnitude only (see 4.8.5) and that the frequency of the measurement is unspecified. The keyword: List specifies the frequencies or times at which data is included and their order. The keyword: Units specifies the time or frequency units.

The data for each measurement point is a list of signal level values for each frequency or time separated by spaces " ". The format of these data values is described in 4.8.5.

4.8.2.2 Piece-wise linear data

The keywords: Frequencies or Times specify whether frequency domain or time domain data is included. Only one of these keywords is permitted in the Data section. If the keyword: List is not present in the Frequency or Time section it is assumed that the data in the measurement section is piece-wise linear in the form of a series of frequency-signal level or time-signal level pairs.

$ft_1\ v_1\ ft_2\ v_2\ ft_3\ v_3 \ldots\ldots\ldots ft_n\ v_n$

where ft is a frequency or time value and v is the corresponding signal level value.

The values for frequency or time shall be greater than the preceding value. The format of these data values is described in 4.8.5.

This arrangement is particularly useful for time domain data which usually describe a waveform, but can also be applied to frequency domain data. The use of piece-wise linear data allows optimisation of the number of signal level values and, therefore, the quantity of data to be exchanged.

4.8.3 Data with coordinate information

When coordinate information is included, data is organised with one line for each point. Each line contains the coordinates of the point (e.g. *x y z*) followed by data values separated by a space " ". Data may be according to 4.8.2.1 or 4.8.2.2. The order in which the lines are inserted in the document is not important.

Axis1 Axis2 Axis3 Data

The coordinate information contains at least the three coordinates of the coordinate system used, as described in 4.6, and may also include field orientation angles *C* and *D*, as described in 4.7.

Axis1 Axis2 Axis3 *C D* Data

The coordinate system used and the type of field orientation are specified using the keyword: Coordinates. In order to simplify the reading of the data, the order of the coordinates is fixed and only the values shown in Table 3 shall be used. The values are not case sensitive.

When the field orientation is frequency dependent (e.g. when the orientation of the field is optimised for the maximum field strength) "f" is added at the end of the value. In this case, the field orientation data (*C* or *C D*) precedes the data for each frequency.

Axis$_1$ Axis$_2$ Axis$_3$ C_1 D_1 data$_1$ C_2 D_2 data$_2$ …….. C_n D_n data$_n$

Frequency dependent field orientation data can only be used with frequency domain data according to 4.8.2.1.

Table 3 – Permitted values for the keyword: Coordinates

Coordinate system	Order of axes	Field orientation		
		None	Azimuth	Azimuth and zenith
Right-handed Cartesian	x, y, z	xyz	xyzc or xyzcf	xyzcd or xyzcdf
Left-handed Cartesian	x, y, z	−xyz	−xyzc or −xyzcf	−xyzcd or −xyzcdf
Cylindrical	R, A, h	rah	rahc or rahcf	rahcd or rahcdf
Spherical	r, B, A	rba	rbac or rbacf	rbacd or rbacdf

4.8.4 Data without coordinate information

When the coordinates are not included, the step between measurements in each direction shall be uniform. The keyword: Coordinates takes the value "none" (not case sensitive).

The minimum (or offset), maximum and step values for each axis shall be specified using the keywords: X0, Xmax, Xstep, etc., which also define the coordinate system used (see Figure 8 and Figure 9). The maximum value shall be greater than the minimum value and the step value shall be positive, except in the case of the left-hand Cartesian coordinate system, which is indicated by a negative Ystep value.

If an axis contains only one value (i.e. the scan is not three-dimensional), only the minimum value is required and the corresponding maximum and step values need not be included.

Field orientation data is not permitted.

The measurement data values are separated by a space or a line termination sequence (see 4.2.6). This allows the data to be organised in lines when it is given at several frequencies. The data shall be ordered as shown in Table 4.

An example of a simple XML file without coordinate information is given in Clause A.6.

4.8.5 Data format

Frequency domain data may include magnitude, magnitude and angle or real and imaginary data, as specified by the keyword: Format, which may take the following values:

- omitted: Magnitude data only (default)
- "ma": Magnitude and phase angle data
- "ri": Real and imaginary data

The frequencies at which the data is measured are specified in the frequencies section. An example XML file with magnitude and angle data is given in Clause A.2.

Time domain data shall not be complex and the keyword: Format shall not be included in the Times section.

In the case of immunity scans, the default criterion can be included in the file. The keyword Criterion allows the default criterion to be described. The data values then correspond to the level at which the default criterion is attained. If a single default criterion is required then the description shall be included within Criterion tags as shown in Clause A.9. The single data criterion is then valid for all data values.

In many cases, particularly when scanning complex devices, it is desirable to specify several default criteria and be able to associate each data value with a specific criterion. This can be achieved by inserting an Index keyword followed by a Description keyword for each criterion, as shown in Clause A.7. In order to associate a specific criterion with a data value, the index of the specific criterion is inserted in the data after the corresponding value for each point and each frequency. An index of "0" is reserved to indicate that no fault has been detected.

4.8.6 Data notation

When the values are stored in ASCII form, the number of digits and the type of notation has a direct and significant effect on the file size, especially when the file contains data for many points. Data and coordinates may be expressed in decimal notation (e.g. 123.45) or scientific notation (e.g. 1.2345e2). Units may also be defined for the coordinates and data.

It can be seen from the example above that, for the same number, the decimal notation requires fewer characters than the scientific notation. However, 0.0000012345 requires more characters than 1.2345e-6. If this value concerns for example a voltage, defining the units as uV allows the data to be written as 1.2345, which requires even fewer characters than the scientific notation.

Many instruments and simulators generate data with a large number of digits, all of which are not significant. For example, a spectrum analyser may output a value of power as 12.3456789 dBm (9 significant digits). Considering the accuracy of the instrument, a value of 12.34 dBm (4 significant digits) may be largely sufficient.

Data values should be expressed in the best suited units and with a number of characters compatible with the accuracy required.

Table 4 – Order of measurement points when coordinates are not included

Cartesian coordinates			Cylindrical coordinates			Spherical coordinates		
x0	y0	z0	r0	A0	h0	r0	B0	A0
x1	y0	z0	r1	A0	h0	r1	B0	A0
:	:	:	:	:	:	:	:	:
xmax	y0	z0	rmax	A0	h0	rmax	B0	A0
x0	y1	z0	r0	A1	h0	r0	B1	A0
x1	y1	z0	r1	A1	h0	r1	B1	A0
:	:	:	:	:	:	:	:	:
xmax	y1	z0	rmax	A1	h0	rmax	B1	A0
:	:	:	:	:	:	:	:	:
x0	ymax	z0	r0	Amax	h0	r0	Bmax	A0
x1	ymax	z0	r1	Amax	h0	r1	Bmax	A0
:	:	:	:	:	:	:	:	:
xmax	ymax	z0	rmax	Amax	h0	rmax	Bmax	A0
x0	y0	z1	r0	A0	h1	r0	B0	A1
x1	y0	z1	r1	A0	h1	r1	B0	A1
:	:	:	:	:	:	:	:	:
xmax	y0	z1	rmax	A0	h1	rmax	B0	A1
x0	y1	z1	r0	A1	h1	r0	B1	A1
x1	y1	z1	r1	A1	h1	r1	B1	A1
:	:	:	:	:	:	:	:	:
xmax	y1	z1	rmax	A1	h1	rmax	B1	A1
:	:	:	:	:	:	:	:	:
x0	ymax	z1	r0	Amax	h1	r0	Bmax	A1
x1	ymax	z1	r1	Amax	h1	r1	Bmax	A1
:	:	:	:	:	:	:	:	:
xmax	ymax	z1	rmax	Amax	h1	rmax	Bmax	A1
:	:	:	:	:	:	:	:	:
x0	y0	zmax	r0	A0	hmax	r0	B0	Amax
x1	y0	zmax	r1	A0	hmax	r1	B0	Amax
:	:	:	:	:	:	:	:	:
xmax	y0	zmax	rmax	A0	hmax	rmax	B0	Amax
x0	y1	zmax	r0	A1	hmax	r0	B1	Amax
x1	y1	zmax	r1	A1	hmax	r1	B1	Amax
:	:	:	:	:	:	:	:	:
xmax	y1	zmax	rmax	A1	hmax	rmax	B1	Amax
:	:	:	:	:	:	:	:	:
x0	ymax	zmax	r0	Amax	hmax	r0	Bmax	Amax
x1	ymax	zmax	r1	Amax	hmax	r1	Bmax	Amax
:	:	:	:	:	:	:	:	:
xmax	ymax	zmax	rmax	Amax	hmax	rmax	Bmax	Amax

4.9 Probe factor

The probe factor of the probe may be included in the Probe_factor section of the probe section.

The keyword Probe_factor replaces the keyword Perf_factor defined in IEC TR 61967-1-1:2010. All new XML files shall use the keyword Probe_factor. However, in order to ensure backward compatibility, parsers should cater for both keywords.

The probe factor of a probe relates the measured or applied value at its input or output connection (e.g. power in dBm, voltage or current) to the generated or applied field strength (e.g. H-field in A/m).

When voltage or current is measured at the input or applied to the output connection of the probe, the probe factor may be calculated according to one of the following formulas:

$$F_{PA} = \frac{M_F}{F} \qquad (1)$$

or $$F_{PB} = \frac{F}{M_F} \qquad (2)$$

Where:

F_{PA} and F_{PB}	are the probe factors;
M_F	is the signal level, in Volts or Amps;
F	is the field strength, in V/m or A/m;
F_{PA} and F_{PB}	are simply reciprocals of each other.

When the power is measured at the input or applied to the output connection of the probe, the equations for calculating the probe factor become:

$$F_{PC} = \frac{M_F}{F^2} \qquad (3)$$

or $$F_{PD} = \frac{F^2}{M_F} \qquad (4)$$

Where:

F_{PC} and F_{PD}	are the probe factors;
M_F	is the signal level, in Watts;
F	is the field strength, in V/m or A/m;
F_{PC} and F_{PD}	are simply reciprocals of each other.

The probe factor may also be expressed in dB.

The applicable relationship can be readily recognised by the units in which the probe factor is expressed. Table 5 and Table 6 show permitted combinations of units. In order to avoid confusion, scaling factors (k, m, μ, etc.) shall not be used. The use of parentheses in the units avoids confusion with other units (e.g. dBm for dB milliwatt and dB(m) for dB metre). By default, probe factor units are assumed to be dB(V.m). The units included in the XML file shall conform to the syntax shown in Table 1. Symbols such as "Ω" are not permitted.

If the units of the values in the Measurement section are field strength values (e.g. A/m, V/m, etc.), the probe factor is assumed to have been taken into account. In this case a Probe_factor section is not required.

Table 5 – Probe factor linear units

Probe factor		F_{PA} or F_{PC}		F_{PB} or F_{PD}	
Field strength units (F)		**A/m**	**V/m**	**A/m**	**V/m**
Signal units (M_F)	**V**	$\Omega \cdot m$ (1)	m (1)	S/m (2)	1/m (2)
	A	m (1)	$S \cdot m$ (1)	1/m (2)	Ω/m (2)
	W	$\Omega \cdot m^2$ (3)	$S \cdot m^2$ (3)	S/m^2 (4)	Ω/m^2 (4)
NOTE The number in brackets refers to the appropriate formula.					

Table 6 – Probe factor logarithmic units

Probe factor		F_{PA} or F_{PC}		F_{PB} or F_{PD}	
Field strength units (F)		**dBA/m**	**dBV/m**	**dBA/m**	**dBV/m**
Signal units (M_F)	**dBV**	dB($\Omega \cdot m$) (1)	dB(m) (1)	dB(S/m) (2)	dB(1/m) (2)
	dBA	dB(m) (1)	dB($S \cdot m$) (1)	dB(1/m) (2)	dB(Ω/m) (2)
	dBW	dB($\Omega \cdot m^2$) (3)	dB($S \cdot m^2$) (3)	dB(S/m^2) (4)	dB(Ω/m^2) (4)
NOTE The number in brackets refers to the appropriate formula.					

For an emission scan, the probe measures the field (electrical or magnetic) surrounding it. The distance from the source is of no significance. The probe factor is therefore defined as a function of frequency. The Frequencies section defines the frequencies at which the probe factor is specified and the probe factor values are given in the List section. Only one value shall be specified for each frequency. Care should be taken to include sufficient frequencies to describe the characteristic accurately. An example file for an emission scan is shown in Clause A.8.

For an immunity scan, the probe generates a field (electrical or magnetic) which decreases with increasing distance. It is therefore necessary to define the probe factor as a function of both distance (altitude) above the device being scanned and frequency. The Frequencies section defines the frequencies at which the probe factor is specified and the probe factor values are given in the List section. In this case, the List section shall contain lines consisting of an altitude followed by the probe factor values for each frequency. One line is required for each value of altitude. Units of the altitude value are specified by the keyword: Unit_a. Care should be taken to include sufficient frequencies to describe the characteristic accurately. An example file for an immunity scan is shown in Clause A.9.

4.10 Images

4.10.1 General

In order to facilitate interpretation of scan results, the scan information can be overlaid with a picture of the component. Keywords in the Component section allow an image file to be referenced and the image size and position to be specified. Details of the size and offset keywords are given in 4.6.6.

4.10.2 Image file types

Image files, typically containing a picture (photo) of the component, should be in JPEG format and use the extension .jpg or .jpeg. Other file types may be used, but viewers and processors may not be able to display the image correctly.

When using spherical or cylindrical coordinates, a flat picture has no meaning. Nevertheless, a picture of the component, measurement setup, etc., may be included, even though it cannot be overlaid on the scan. In this case, no size and offset keywords are included in the file (see 4.6.6).

4.10.3 Image file name and path

The path and filename of the image file is specified with the keyword: Path. The path shall conform to 4.4.2 and 4.4.3.

4.11 3D objects

4.11.1 General

Information describing three-dimensional images may be included in the Component section. Using suitable software a three-dimensional scan data may then be overlaid on a three-dimensional image of the object being scanned. An example is shown in Clause A.10.

4.11.2 3D object file types

The keywords included in the present document allow use of the Wavefront OBJ files with the extension .obj associated with map object file. The map object file should be in JPEG format and use the extension .jpg or .jpeg. Other file types may be used, but viewers and processors may not be able to display the image correctly.

4.11.3 3D object file name and path

The path and filename of the image file is specified with the keyword: Path. The path shall conform to 4.4.2 and 4.4.3.

4.11.4 3D map object file name and path

The path and filename of the 3D map object file is specified with the keyword: Mapobj. The path shall conform to 4.4.2 and 4.4.3.

Annex A
(informative)

Example files

A.1 Minimum default file

A.1.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>Minimum_NFS_file.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Measurement>
                  <List>
26e-3 29e-3 2e-3 -58.23
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```

A.1.2 Default value description

This example represents the minimum file required by the near-field scan XML file format. It contains the information for a near-field emission scan with one data point and at an unspecified frequency.

All values are default, as follows.

- The coordinate system is right-handed Cartesian.
- Coordinate information is present (x=26e-3, y=29e-3, z=2e-3).
- All offsets are zero.
- Measurements are in the frequency domain and the value is magnitude only expressed in dBm (-58.23 dBm).
- No probe information is given.
- Default values for units, etc., are assumed: dBm, m, etc. (for default values refer to Annex C).

For such a minimum file, it is strongly recommended to choose a file name describing clearly the measurement conditions (e.g. Devicename_xxxMHz.xml). Additional information can be added by including the appropriate keywords or a notes section.

A.2 File with magnitude and angle data

A.2.1 Example file


```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename> magnitude_angle_data.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 200 300 400</List>
            </Frequencies>
            <Measurement>
                  <Format>ma</Format>
                  <List>
26e-3 29e-3 2e-3 -58.23 22 -60.54 35 -59.96 42 -55.15 51
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```


A.2.2 Default value description

This example shows a file with data for one point at four frequencies with magnitude and angle data as follows.

- Data is in the frequency domain and the value is magnitude expressed in dBm and angle:

100 MHz	–58.23 dBm	22°
200 MHz	–60.54 dBm	35°
300 MHz	–59.96 dBm	42°
400 MHz	–55.15 dBm	51°

- All other values are defined in A.1.2.

A.3 File with field azimuth and zenith orientation

A.3.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
	<Nfs_ver>1.0</Nfs_ver>
	<Filename>Azimuth_zenith_field_orientation.xml</Filename>
	<File_ver>1</File_ver>
	<Probe>
		<Field>H</Field>
	</Probe>
	<Data>
		<Coordinates>xyzcd</Coordinates>
		<Frequencies>
			<Unit>MHz</Unit>
			<List>100 200 300 400</List>
		</Frequencies>
		<Measurement>
			<List>
26e-3 29e-3 2e-3 0 0 -58.23 -60.54 -59.96 -55.15
26e-3 29e-3 2e-3 0 90 -58.23 -60.54 -59.96 -55.15
26e-3 29e-3 2e-3 90 90 -58.23 -60.54 -59.96 -55.15
			</List>
		</Measurement>
	</Data>
</EmissionScan>
```

A.3.2 Default value description

This example shows a file with data for one point at four frequencies with three field orientation angles as follows.

- The probe measures the H-field and both azimuth and zenith angles are included in the coordinate information (Coordinates = xyzcd)
- The three lines of measurement data correspond to Hz (C=0°, D=0°), Hx (C=0°, D=90°) and Hy (C=90°, D=90°).
- Data is in the frequency domain and the value is magnitude only expressed in dBm.

  100 MHz –58.23 dBm

  200 MHz –60.54 dBm

  300 MHz –59.96 dBm

  400 MHz –55.15 dBm
- As no probe factor information is included, it is not possible to determine the magnetic field strength. An example with probe factor information is given in Clause A.8.
- All other values are defined in A.1.2.

A.4 File with optimised field azimuth orientation

A.4.1 Example file


```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>Azimuth_optimised_field_orientation.xml</Filename>
      <File_ver>1</File_ver>
      <Probe>
            <Field>H</Field>
      </Probe>
      <Data>
            <Coordinates>xyzcf</Coordinates>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 200 300 400</List>
            </Frequencies>
            <Measurement>
                  <List>
26e-3 29e-3 2e-3 5 -58.23 8 -60.54 4 -59.96 10 -55.15
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```


A.4.2 Default value description

This example shows a file with measurement data for one point at four frequencies with field azimuth orientation optimised for a maximum reading at each frequency as follows.

- The probe measures the H-field and the optimised azimuth angles are included in front of the magnitude data at each frequency:

  100 MHz: 5° –58.23 dBm

  200 MHz: 8° –60.54 dBm

  300 MHz: 4° –59.96 dBm

  400 MHz: 10° –55.15 dBm

- All other values are defined in A.3.2.

A.5 File with piece-wise linear time domain data in a separate binary file

A.5.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>2.0</Nfs_ver>
      <Filename> Time_binary_data.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Times>
                  <Unit>us</Unit>
            </Times>
            <Measurement>
                  <Datafileformat>bin32</Datafileformat >
                  <Data_files>
                        Time_binary_data.dat
                  </Data_files>
            </Measurement>
      </Data>
</EmissionScan>
```

A.5.2 Default value description

This example shows a file with piece-wise linear time domain data in a separate binary file as follows.

- Time domain data is in piece-wise linear form (No keyword: List in Times section)
- The data file format in 32-bit binary
- The data file name is Time_binary_data.dat
- All other values are defined in A.1.2.

A.6 File without coordinate information

A.6.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>0.5</Nfs_ver>
      <Filename>No_coordinates.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Coordinates>none</Coordinates>
            <X0>10mm</X0>
            <Xstep>1mm</Xstep>
            <Xmax>13mm</Xmax>
            <Y0>20mm</Y0>
            <Ystep>2mm</Ystep>
            <Ymax>24mm</Ymax>
            <Z0>2mm</Z0>
            <Measurement>
                  <List>
-58 -60 -61 -60
-59 -57 -58 -57
-60 -55 -57 -56
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```

A.6.2 Default value description

This example shows a file containing the information for a near-field scan with twelve measurement points and at an unspecified frequency as follows. See also Table A.1.

- Coordinate information is not included in the measurement data, indicated by the value of Coordinates "none".
- The coordinate system is right-handed Cartesian, indicated by the presence of X0, Y0, Z0, etc.
- The measurements are scanned in the *X* direction from 10 mm to 13 mm in 1 mm steps, in the *Y* direction from 20 mm to 24 mm in 2 mm steps and at a *Z* value of 2 mm (see 4.8.4).
- The measurement data is organised with one line for each *Y* value (see 4.8.4).
- Measurements are in the frequency domain and the value is magnitude only expressed in dBm.
- No probe information is given.
- All other values are defined in A.1.2.

Table A.1 – Data matrix

Y	***X***			
	10 mm	**11 mm**	**12 mm**	**13 mm**
20 mm	–58 dBm	–60 dBm	–61 dBm	–60 dBm
22 mm	–59 dBm	–57 dBm	–58 dBm	–57 dBm
24 mm	–60 dBm	–55 dBm	–57 dBm	–56 dBm

A.7 File for immunity scan with multiple criteria

A.7.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<ImmunityScan>
      <Nfs_ver>2.0</Nfs_ver>
      <Filename>Immunityscan_with_multiple_criteria.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 200 300 400</List>
            </Frequencies>
            <Criterion>
                  <Index>1</Index>
                  <Description>
                        PLL Frequency shift of 10kHz
                  </Description>
                  <Index>2</Index>
                  <Description>uP reset</Description>
                  <Index>3</Index>
                  <Description>VDC shifted by+/-0.2V</Description>
            </Criterion>
            <Measurement>
                  <Format>ma</Format>
                  <List>
26e-3 29e-3 2e-3 28.46 22 2 60.86 25 1 59.73 36 0 25.59 51 3
                  </List>
            </Measurement>
```

```
    </Data>
</ImmunityScan>
```


A.7.2 Default value description

This example shows a file with data for one point at four frequencies with magnitude and angle data and associated default criteria as follows.

- The coordinate system is right-handed Cartesian (default).
- Data is in the frequency domain and the value is magnitude expressed in dBm and angle.

100 MHz	28.46 dBm	22°
200 MHz	60.86 dBm	25°
300 MHz	59.73 dBm	36°
400 MHz	25.59 dBm	51°

- The default criteria are:

  1 `PLL Frequency shift of 10kHz`

  2 `uP reset`

  3 `VDC shifted by +/-0.2V`

- The default criteria are 2, 1, 0 and 3 at 100 MHz, 200 MHz, 300 MHz and 400 MHz respectively. At 300 MHz no fault was detected.
- All other values are default values (for default values refer to Annex C).

A.8 File for emission scan with probe factor

A.8.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>2.0</Nfs_ver>
      <Filename>Emissionscan_with_PF.xml</Filename>
      <File_ver>1</File_ver>
      <Probe>
            <Field>Hy</Field>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 1000</List>
            </Frequencies>
            <Probe_factor>
                  <Unit>dB(ohm.m2)</Unit>
                  <List>
                        -80.74 -60.37
                  </List>
            </ Probe_factor >
      </Probe>
      <Data>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 200 300 400</List>
            </Frequencies>
            <Measurement>
                  <List>
26e-3 29e-3 2e-3 -58.23 -60.54 -59.96 -55.15
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```

A.8.2 Default value description

This example shows a file with emission data for one point at four frequencies as follows.

- The coordinate system is right-handed Cartesian (default).
- Probe factor data is given in dB($\Omega \cdot m^2$) at 100 MHz and 1 000 MHz.
- Table A.2 shows the data in dBm converted to magnetic field strength (H) assuming a linear interpolation of the probe factor in dB with logarithmic frequency.
- All other values are defined in A.1.2.

Table A.2 – Magnetic field strength for emission

Frequency MHz	**100**	**200**	**300**	**400**
Measured power dBm	-58,23	-60,54	-59,96	-55,15
Probe factor dB($\Omega \cdot m^2$)	-80,74	-74,62	-70,59	-68,36
Magnetic field strength dBA/m	-7,49	-15,92	-19,37	-16,79

A.9 File for immunity scan with probe factor

A.9.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<ImmunityScan>
      <Nfs_ver>2.0</Nfs_ver>
      <Filename>Immunityscan_with_PF.xml</Filename>
      <File_ver>1</File_ver>
      <Probe>
            <Field>Hz</Field>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 1000</List>
            </Frequencies>
            <Probe_factor>
                  <Unit_a>mm</Unit_a>
                  <Unit>dB(ohm.m2)</Unit>
                  <List>
                        1 -34.0 -33.1
                        2 -22.0 -21.1
                  </List>
            </ Probe_factor >
      </Probe>
      <Data>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 200 300 400</List>
            </Frequencies>
            Criterion>Pin 5 goes high</Criterion>
            <Measurement>
                  <List>
26e-3 29e-3 1e-3 31 29 25 31
26e-3 29e-3 2e-3 43 41 37 43
                  </List>
            </Measurement>
      </Data>
</ImmunityScan>
```

A.9.2 Default value description

This example shows a file with immunity data for two points (same *X* and *Y*, but different *Z*) at four frequencies as follows.

- The coordinate system is right-handed Cartesian (default).
- Probe factor data is given in dB($\Omega \cdot m^2$) at 100 MHz and 1 000 MHz for two altitudes (1 mm and 2 mm).
- Only one default criterion is specified.
- Table A.3 shows the data in dBm converted to magnetic field strength (H) assuming a linear interpolation of the probe factor in dB with frequency.
- All other values are defined in A.1.2.

Table A.3 – Magnetic field strength for immunity

Altitude (mm)	100 MHz	200 MHz	300 MHz	400 MHz
1	35 dBA/m	32,7 dBA/m	28,6 dBA/m	34,5 dBA/m
2	35 dBA/m	32,7 dBA/m	28,6 dBA/m	34,5 dBA/m

A.10 File with image and 3D image

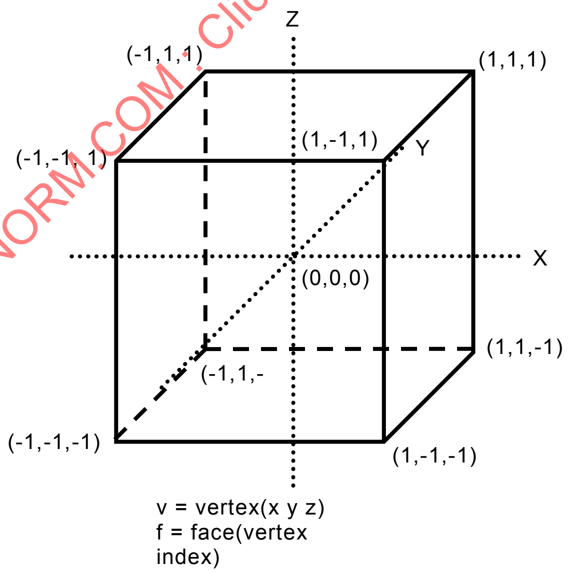
A.10.1 Example file

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>2.0</Nfs_ver>
      <Filename>Emissionscan_3D_image.xml</Filename>
      <File_ver>1</File_ver>
      <Component>
            <Object3d>
                  <Path>
                        cube.obj
                  </Path>
                  <Mapobj>
                        cube.jpg
                  </Mapobj>
            </Object3d>

            <Image>
                  <Path>
                        cube_image.jpg
                  </Path>
            </Image>
      </Component>

</EmissionScan>
```

A.10.2 Default value description

This example shows a file with an image file cube_image.jpg and a 3D-object described by cube.obj and cube.jpg. There is no other information in the file.

Figure A 1 shows an .obj file of a cube. There are 6 vertices and 6 faces.




```
# cube.obj

v 1 1 1
v 1 1 -1
v 1 -1 1
v 1 -1 -1
v -1 1 1
v -1 1 -1
v -1 -1 1
v -1 -1 -1

f 1 3 4 2
f 5 7 8 6
f 1 5 6 2
f 3 7 8 4
f 1 5 7 3
f 2 6 8 4
```

IEC

Figure A 1 – Example .obj file

A.11 File with plane rotation

The following file describes a measurement using coordinates in the DUT reference plane, as shown in Figure A.2.

```
<?xml version="1.0" encoding="utf-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>DUT_ref_plane.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100</List>
            </Frequencies>
            <Measurement>
                  <List>
2.00 7.00 0 -40
4.12 4.88 0 -50
6.12 7.00 0 -40
4.12 9.12 0 -50
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```

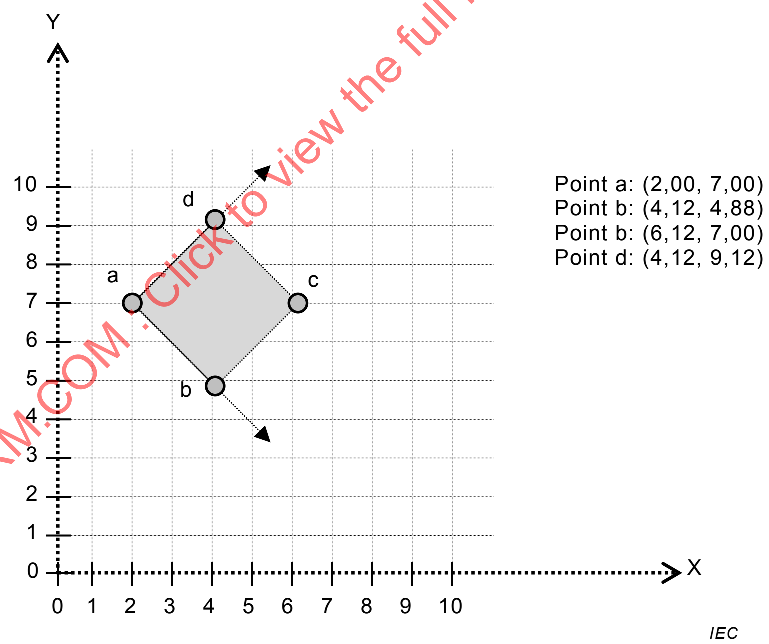


Figure A.2 – Coordinates in DUT reference plane

The following file describes the same points using coordinates in the measurement reference plane, as shown in Figure A.2.

```
<?xml version="1.0" encoding="utf-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>Measurement_ref_plane.xml</Filename>
      <File_ver>1</File_ver>
      <Component>
```

```
          <Image>
                ...
                <Xoffset>0</Xoffset>
                <Yoffset>0</Yoffset>
                <Zoffset>0</Zoffset>
          </Image>
     </Component>
     <Data>
          <X0>2 mm</X0>
          <Y0>7 mm</Y0>
          <Z0>0 mm</Z0>
          <Vx>0.5 -0.5 0</Vx>
          <Vy>0.5 0.5 0</Vy>
          <Vz>0 0 1</Vz>
          <Frequencies>
                <Unit>MHz</Unit>
                <List>100</List>
          </Frequencies>
          <Measurement>
                <List>
0 0 0 -40
3 0 0 -50
3 3 0 -40
0 3 0 -50
                </List>
          </Measurement>
     </Data>
</EmissionScan>
```

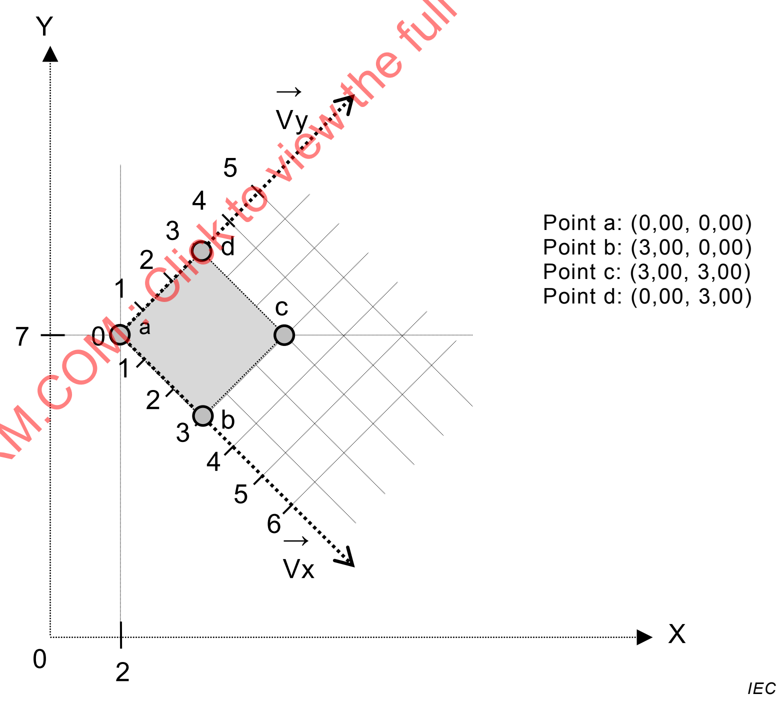


Figure A.3 – Coordinates in the measurement reference plane

A.12 Emission scan in several XML files

This example contains three XML files:

- File1.xml contains only probe information;
- File2.xml contains only component information;

- File3.xml contains only data information.

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>File1.xml</Filename>
      <File_ver>1</File_ver>
      <Probe>
            <Field>H</Field>
      </Probe>
</EmissionScan>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>File2.xml</Filename>
      <File_ver>1</File_ver>
      <Component>
            <Name>Board_1</Name>
            <Manufacturer>XYZ Corp</Manufacturer>
            <Status>
                  Software version 4.1
                  Device maskset A04A
                  Supply voltage 5.3V
            </Status>
      </Component>
</EmissionScan>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<EmissionScan>
      <Nfs_ver>1.0</Nfs_ver>
      <Filename>File3.xml</Filename>
      <File_ver>1</File_ver>
      <Data>
            <Coordinates>xyzcd</Coordinates>
            <Frequencies>
                  <Unit>MHz</Unit>
                  <List>100 200 300 400</List>
            </Frequencies>
            <Measurement>
                  <List>
26e-3 29e-3 2e-3 0 0 -58.23 -60.54 -59.96 -55.15
26e-3 29e-3 2e-3 0 90 -58.23 -60.54 -59.96 -55.15
26e-3 29e-3 2e-3 90 90 -58.23 -60.54 -59.96 -55.15
                  </List>
            </Measurement>
      </Data>
</EmissionScan>
```

Annex B
(normative)

Valid keywords

B.1 General

Annex B lists valid keywords with a brief description and an indication of whether the keyword is required, required in particular conditions or optional. More details concerning the usage of the keywords are given in Annex C.

B.2 File header keywords

The following keywords are placed at the beginning of the file after the root element start-tag:

Nfs_ver	Version of file format (2.0)	Required
Filename	Name of file	Required
File_ver	Version of file	Required
Data_source	Method of data acquisition	Required
Date	Creation or modification date	Optional
Source	Originator of the file	Optional
Disclaimer	Disclaimer information	Optional
Copyright	Copyright	Optional

B.3 Global keywords

The following keywords may be placed anywhere in the file, except within an XML element containing a value:

Notes	Notes to clarify the file	Optional
Documentation	Documentation to clarify the file	Optional

B.4 Component section keywords

The following keywords may be used in the Component section:

Component	Component section	Required if children
Name	Name of component	Optional
Manufacturer	Component manufacturer	Optional
Status	Status of component	Optional
Image	Contains elements concerning an image	Required if children
Path	Image file name and path	Optional
Unit	Units used for image size and offset	Optional
Xsize	Image size in the *X* direction	Optional
Ysize	Image size in the *Y* direction	Optional
Zsize	Image size in the *Z* direction	Optional
Rsize	Image size in the *R* direction	Optional
Hsize	Image size in the *H* direction	Optional
Asize	Image size in the *A* direction	Optional

Bsize	Image size in the *B* direction	Optional
Xoffset	Image offset in the *X* direction	Optional
Yoffset	Image offset in the *Y* direction	Optional
Zoffset	Image offset in the *Z* direction	Optional
Roffset	Image offset in the *R* direction	Optional
Hoffset	Image offset in the *H* direction	Optional
Aoffset	Image offset in the *A* direction	Optional
Boffset	Image offset in the *B* direction	Optional
Vx	Vector in the *X* direction	Optional
Vy	Vector in the *Y* direction	Optional
Vz	Vector in the *Z* direction	Optional
Object3d	Contains elements concerning a 3D object	Required if children
Path	3D object file name and path	Optional
Mapobj	3D image map file name and path	Optional

B.5 Setup section keywords

The following keywords may be used in the Setup section:

Setup	Setup section	Required if children
Config	Contains elements concerning the configuration	Required if children
Probe_signal	Describes the probe signal for an immunity scan	Optional
Att	Equipment attenuation setting	Optional
Average	Equipment averaging setting	Optional
Maxhold	Equipment "max hold" setting	Optional
Ref_level	Equipment reference level setting	Optional
Rbw	Equipment resolution bandwidth setting	Optional
Vbw	Equipment video bandwidth setting	Optional
Swp	Equipment sweep time setting	Optional
Tps	Equipment time per frequency step setting	Optional
Detector	Equipment detector type	Optional
Preamp	Equipment preamplifier setting	Optional
Preselector	Equipment preselector setting	Optional
Xdiv	Equipment horizontal scale per division	Optional
Ydiv	Equipment vertical scale per division	Optional
Bw	Equipment bandwidth setting	Optional
Coupling	Equipment coupling setting	Optional
Transducer	Transducer section	Required if children
Frequencies	Frequencies section	Required if List
Unit	Units used for the frequencies	Optional
List	List of frequencies at which the transducer gain is specified	Optional
Gain	Transducer gain values	Optional

Format	Format of the transducer gain data	Optional
Software	Description of any software used to obtain the data, control the scan equipment, etc.	Optional

B.6 Probe section keywords

The following keywords may be used in the Probe section:

Probe	Probe section	Required if children
Name	Name of probe	Optional
Field	Describes the field(s) of the probe	Optional
Frequencies	Frequencies section	Required if List
Unit	Units used for the frequencies	Optional
List	List of frequencies at which the probe factor is specified	Optional
Probe_factor	Probe factor section	Required if children
Format	Format of the probe factor data	Optional
Unit_a	Units used for the probe altitude	Optional
Unit	Units used for the probe factor of the probe	Required if List
List	List of probe factor values	Optional

B.7 Data section keywords

The following keywords may be used in the Data section:

Coordinates	Defines the coordinate system and probe orientation of the scan	Optional
X0	Start of scan (offset) in the *X* direction	Required if no coordinates with data
Y0	Start of scan (offset) in the *Y* direction	Required if no coordinates with data
Z0	Start of scan (offset) in the *Z* direction	Required if no coordinates with data
R0	Start of scan (offset) in the *R* direction	Required if no coordinates with data
H0	Start of scan (offset) in the *H* direction	Required if no coordinates with data
A0	Start of scan (offset) in the *A* direction	Required if no coordinates with data
B0	Start of scan (offset) in the *B* direction	Required if no coordinates with data
Xmax	Maximum scan value in the *X* direction	Required if no coordinates with data
Ymax	Maximum scan value in the *Y* direction	Required if no coordinates with data
Zmax	Maximum scan value in the *Z* direction	Required if no coordinates with data
Rmax	Maximum scan value in the *R* direction	Required if no coordinates with data

Hmax	Maximum scan value in the *H* direction	Required if no coordinates with data
Amax	Maximum scan value in the *A* direction	Required if no coordinates with data
Bmax	Maximum scan value of in the *B* direction	Required if no coordinates with data
Xstep	Step size of the scan in the *X* direction	Required if no coordinates with data
Ystep	Step size of the scan in the *Y* direction	Required if no coordinates with data
Zstep	Step size of the scan in the *Z* direction	Required if no coordinates with data
Rstep	Step size of the scan in the *R* direction	Required if no coordinates with data
Hstep	Step size of the scan in the *H* direction	Required if no coordinates with data
Astep	Step size of the scan in the *A* direction	Required if no coordinates with data
Bstep	Step size of the scan in the *B* direction	Required if no coordinates with data
Vx	Vector in the *X* direction	Optional
Vy	Vector in the *Y* direction	Optional
Vz	Vector in the *Z* direction	Optional
Frequencies	Frequencies section	Required if List
Unit	Units used for the frequencies	Optional
List	List of frequencies at which the measurement or simulation data is listed	Optional
Times	Times section	Required if List
Unit	Units used for the times	Optional
List	List of times at which the measurement or simulation data is listed	Optional
Criterion	Criterion section	Optional
Index	Criterion index for an immunity scan	Required if Description
Description	Criterion description for an immunity scan	Optional
Target	Target section	Optional
Frequencies	Frequencies section	Required if List
Unit	Units used for the frequencies	Optional
List	List of frequencies at which the measurement or simulation data is listed	Optional
Unit	Units used for the target data	Optional
Format	Format of the target data	Optional
List	List of target data	Optional
Measurement	Measurement section	Required
Unit	Units used for the measurement or simulation data	Optional
Unit_x	Units of the scan position in the *X* direction	Optional
Unit_y	Units of the scan position in the *Y* direction	Optional

Unit_z	Units of the scan position in the *Z* direction	Optional
Unit_r	Units of the scan position in the *R* direction	Optional
Unit_h	Units of the scan position in the *H* direction	Optional
Format	Format of the measurement or simulation data	Optional
Datafileformat	Format of data files containing measurement or simulation data	Optional
Data_files	List of data files containing measurement or simulation data	Required if not List
List	List of measurement or simulation data	Required if not Data_files

Annex C
(normative)

Keyword usage rules

The following Tables C.1 to C.6 give usage rules for keywords showing also the parent keyword and examples of values.

Table C.1 – File header keywords

Keyword	Parent	Usage rules	Default units or value	Examples
Nfs_ver	Root element	Specifies the version of file format (2.0). It shall follow the root element. Informs parsers of the version of XML exchange format used and allows them to know what keywords to expect.		<Nfs_ver>1.0</Nfs_ver>
Filename	Root element	Specifies the file name. Normally follows the keyword: Nfs_ver. The file name shall conform to 4.4.2. In addition, the file name shall use the extension ".xml". The file name shall include only the name of the file. Path information is not permitted.		<Filename> My_file.xml </Filename>
File_ver	Root element	Tracks the revision level of a particular .xml file. Revision level is set at the discretion of the originator of the file.		<File_ver>2.0</File_ver>
Data_source	Root element	Indicates the source of the data included in the file. The value shall be "measurement", "computation" or "simulation"		<Data_source> measurement </Data_source>
Date	Root element	The value can contain blanks, be of any format, but shall be limited to a maximum of 20 characters. The month shall be spelled out for clarity. The parser considers this information as a data string and does not interpret it.		<Date>March 12, 2008</Date>
Source	Root element	The value can contain blanks and be of any format. The parser considers this information as a data string and does not interpret it.		<Source> Prepared by A.B. Smith </Source>
Disclaimer	Root element	The value can contain blanks and be of any format. The parser considers this information as a data string and does not interpret it.		<Disclaimer> This file contains results of near-field scan. Other use is not guaranteed </Disclaimer>
Copyright	Root element	The value can contain blanks and be of any format. The parser considers this information as a data string and does not interpret it.		<Copyright> Copyright 2008, XYZ Corp., All Rights Reserved </Copyright>

Table C.2 – Global keywords

Keyword	Parent	Usage rules	Default units or value	Examples
Note	Any element except those containing a value.	Optionally adds information about the component, setup, probe, data, etc. The value can contain blanks, and be of any format. A notes section can be inserted anywhere in the file and the number of note sections in the file is not limited. The parser considers this information as a data string and it does not interpret it.		<Notes> Use this section for any special notes </Notes>
Document	Any element except those containing a value.	Optionally adds the paths to files containing documentation on the project. The path shall conform to 4.4.2 and 4.4.3.		<Documentation> Project doc.pdf Measurement_descr.doc </Documentation>

Table C.3 – Component section keywords

Keyword	Parent	Usage rules	Default units or value	Examples
Component	Root element	Contains information on the component being scanned. This section contains only elements relative to the component.		<Component> Component elements </Component>
Name	Component	Specifies the component Name. The parser considers this information as a data string and does not interpret it.		<Name>Board_1</Name>
Manufacturer	Component	Specifies the manufacturer of the component. The value can contain blanks and be of any format. The parser considers this information as a data string and does not interpret it.		<Manufacturer> XYZ Corp </Manufacturer>
Status	Component	Describes the present status of the equipment under test. Information such as operating conditions, hardware and software configuration may be included. The parser considers this information as a data string and does not interpret it.		<Status> Software version 4.1 Device maskset A04A Supply voltage 5.3V </Status>
Image	Component	Contains information on the image associated to the component being scanned. More details are given in 4.10. This section contains only elements relative to the image.		<Image> Image elements </Image>
Path	Image	Specifies the path name of the picture of the component under test. The file name, extension and path shall conform to 4.10.		<Path> ./images/mpcxxxx.jpg </Path> <Path>mpcxxxx.jpg</Path>
Unit	Image	Specifies the units of the size and offset of the image. The value shall conform to 4.5.5. If this keyword is omitted, the units are assumed to be "m". Angles are in degrees.	m	<Unit>mm</Unit>
Xsize Ysize Zsize Rsize Hsize Asize Bsize	Image	Specifies the size of the image in a direction in the specified units. The keywords shall conform to the coordinate system specified by the keyword: Coordinates. Data shall conform to 4.6.6. The value shall be numerical (see 4.5.2).	m	<Xsize>50</Xsize>
Xoffset Yoffset Zoffset Roffset Hoffset Aoffset Boffset	Image	Specifies the offset of the image in a direction in the specified units. The keywords shall conform to the coordinate system specified by the keyword: Coordinates. Data shall conform to 4.6.6. The value shall be numerical (see 4.5.2).	m	<Xoffset>2</Xoffset>
Vx Vy Vz	Image	Specifies the vectors of the DUT reference plane of (see 4.6.5). The Vx, Vy and Vz coordinates may be absolute or normalised and are separated by spaces. All three vectors shall be present. The three vectors shall	Vx:1 0 0 Vy:0 1 0 Vz:0 0 1	<Vx>1 0 0</Vx> <Vy>0 1 0</Vy> <Vz>0 0 1</Vz>

Keyword	Parent	Usage rules	Default units or value	Examples
		be orthogonal. If the keywords are omitted, the default values are assumed for the reference plane.		
Object3d	Component	Contains information on the 3D object associated to the component being scanned. More details are given in 4.11. This section contains only elements relative to the 3D image.		<Object3d> 3D object elements </Object3d>
Path	Object3d	Specifies the path name of the 3D object of the component under test. The file name, extension and path shall conform to 4.11.		<Path> ./3D_objects/mpcxxxx.obj </Path> <Path>mpcxxxx.obj</Path>
Mapobj	Object3d	Specifies the path name of the 3D map object of the component under test. The file name, extension and path shall conform to 4.11.		<Mapobj> ./images/mpx.jpg </Mapobj> <Mapobj>mpx.jpg</Mapobj>