IEC 61182-2-2

Edition 1.0 2012-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Printed board assembly products – Manufacturing description data and transfer methodology – Part 2-2: Sectional requirements for implementation of printed board fabrication data description

Produits pour cartes imprimées équipées – Données descriptives de fabrication et méthodologie de transfert – Partie 2-2: Exigences intermédiaires pour la mise en œuvre de cartes imprimées – Description des données de fabrication

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The text of this standard is based on the following documents:

FDIS	Report on voting
91/1025/FDIS	91/1038/RVD

Full information on the voting for the approval of this standard 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.

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PRINTED BOARD ASSEMBLY PRODUCTS – MANUFACTURING DESCRIPTION DATA AND TRANSFER METHODOLOGY –

Part 2-2: Sectional requirements for implementation of printed board fabrication data description

1 Scope

This part of IEC 61182 provides the information on the manufacturing requirements used for fabricating printed boards. This standard determines the XML schema details, defined in the generic standard IEC 61182-2 and some of the sectional standards that are required to accomplish the focused tasks. When other standards are invoked, their requirements become a mandatory part of the fabrication details as defined in the IEC 61182-2.

The IEC 61182-2 contains all the requirements necessary to build an electronic product. The cardinality indicated in the IEC 61182-2 may be superseded by a restriction of an attribute (enumerated string ID) or indication of a requirement that is noted as being optional in the generic standard. However, this standard renders the requirement mandatory based on the supply chain communication need.

In order to assist the users of this standard, all the applicable XML schema elements that apply to the board fabrication function are listed in Annex A. The list is grouped by topics and shows the absolute path for the elements that pertain to the focus of this standard. If the parent element is not present no children are considered in the implementation either. However, all attributes identified for a particular element follow the cardinality of the IEC 61182-2, unless a restriction is stated in this standard.

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 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 61182-2, *Printed board assembly products – Manufacturing description data and transfer methodology – Part 2: Generic requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions of IEC 60194 as well as the following apply.

3.1
data
intelligent information that may be used directly by machine in order to accomplish a particular manufacturing event

3.2
drawings
hard copy or un-intelligent documentation (e.g. PDF) to which all formatting criteria apply

3.3
printed circuit board
PCB
composite of organic and inorganic material with external and internal wiring allowing electronic components to be mechanically supported and electrically connected

3.4
supplier
organization or company responsible for providing the goods and/or services required to produce an electronic product which includes physical items as well as intellectual/software characteristics and is documented as either user procurement, supplier data or contractual agreements

3.5
user
individual, organization, company or agency responsible for the procurement of electrical/electronic hardware, and having the authority to define the class of equipment and any variation or restrictions (i.e., the originator/custodian of the contract detailing these requirements)

3.6
via
opening in the dielectric layer(s) through which a conductor passes upwards or downwards to subsequent chip or package conductive layers for electrical interconnections or for heat transfer

4 General principles

4.1 Requirements

The requirements of IEC 61182-2 are a mandatory part of this standard. The generic details specifically provide data related to design, printed board manufacturing, assembly and test.

The XML schema of the IEC 61182-2 consists of four major functions each of which have several children who then become new parent elements. Several of these major elements and their associated new parents are defined in other sectional specifications, thus the requirements of those standards are also a mandatory part of the board fabrication standard to the extent of their description and any restrictions contained in this standard.

Each of the standards and the elements defined therein has a specific function or task respectively, and although they may at times be used independently, they become an important addition to the requirements of the board fabrication descriptions. As such the following paragraphs provide the total requirements for the three types of board fabrication files that are supported by the principles of the IEC 61182-2.

Accordingly, the information interchange for the specific purpose of printed board fabrication is only possible if all the XML instances have been properly prepared for such a purpose.

4.2 Interpretation

"Shall", the emphatic form of the verb, is used throughout this standard whenever a requirement is intended to express a provision that is mandatory. Deviation from a "shall" requirement is not permitted, and compliance testing is required in order to demonstrate that the XML instances are correct according to the W3C directives and this standard. The XML

schema shall be the method to check syntax and semantics. Any appropriate software tool that prompts the user, to correct the ambiguity or to insert missing information, may be used for this purpose.

The words "should" and "may" are used whenever it is necessary to express non-mandatory provisions.

"Will" is used to express a declaration of purpose.

4.3 Categories and content

Table 1 provides the major functions that shall be addressed by this standard. The descriptions relate to the appropriate printed board fabrication processes. There are fifteen (15) unique functions that can be defined by the use of the XML elements and the resulting XML instances.

Table 1 indicates the relationships of the requirements for various elements and topics within the descriptions for a particular process.

Table 1 – Function relationship of an IEC 61182-2-2 fabrication file

Name	Fabrication			Comment and standard reference
	1	2	3	
File content descriptions	M	M	M	Elements indicated in IEC 61182-2 according to their cardinality and restrictions of this standard.
Logistic descriptions	M	M	M	
File history descriptions	O	M	M	
BOM	M	M	M	Elements indicated in IEC 61182-2 according to their cardinality and restrictions of this standard.
AVL	–	M	M	
Miscellaneous image layers	–	O	O	Elements indicated in IEC 61182-2 according to their cardinality and restrictions of this standard.
Documentation layers	O	M	M	
Design for excellence (Dfx) analysis	O	O	O	
Component packages [a]	–	–	O	Elements indicated in this sectional standard, according to cardinality of IEC 61182-2 and any restrictions contained in the following paragraphs of this standard.
Land patterns [a]	–	–	O	
Soldermask, legend layers	M	M	M	
Drilling and Routing (tooling) layers	M	M	M	
Net list (soft tooling) [a]	O	M	M	
Outer conductive layers	M	M	M	
Inner conductive layers	M	M	M	
Board construction	M	M	M	

Abbreviations:
BOM Board fabrication materials
AVL Board material suppliers
Dfx Design for eXcellence

Key:
M Mandadory
O Optional (may or may not be pertinent to the particular file or data interchange)
– Extraneous section (not necessary)

Although software tools used to parse the file will permit the extraneous data, it is recommended that only the requirements identified as mandatory or optional are included in the file in order to reduce file size transfer.

[a] Component packages and land patterns will be further defined in future IEC 61182-2-3[1], and net lists in future IEC 61182-2-4[1], their XML schemas are repeated in this standard.

[1] Under consideration

It should be understood that without a net list it is difficult to verify that the produced board meets the design intent.

The correlation between the various descriptions identified in this standard is indicated in Figure 1. It shows the relationship of test coupons, individual board, phototools, etc. The illustration identifies those characteristics that are available in the CAD tools and are usually transferable to the CAM station. The left hand side illustrates combinations of the design intent including assembly characteristics and embedded components. Some of these concepts are important for IEC 61182-2-2 FAB1, FAB2 or FAB3 file and are illustrated for the board manufacturing processes shown on the right hand side of the illustration.

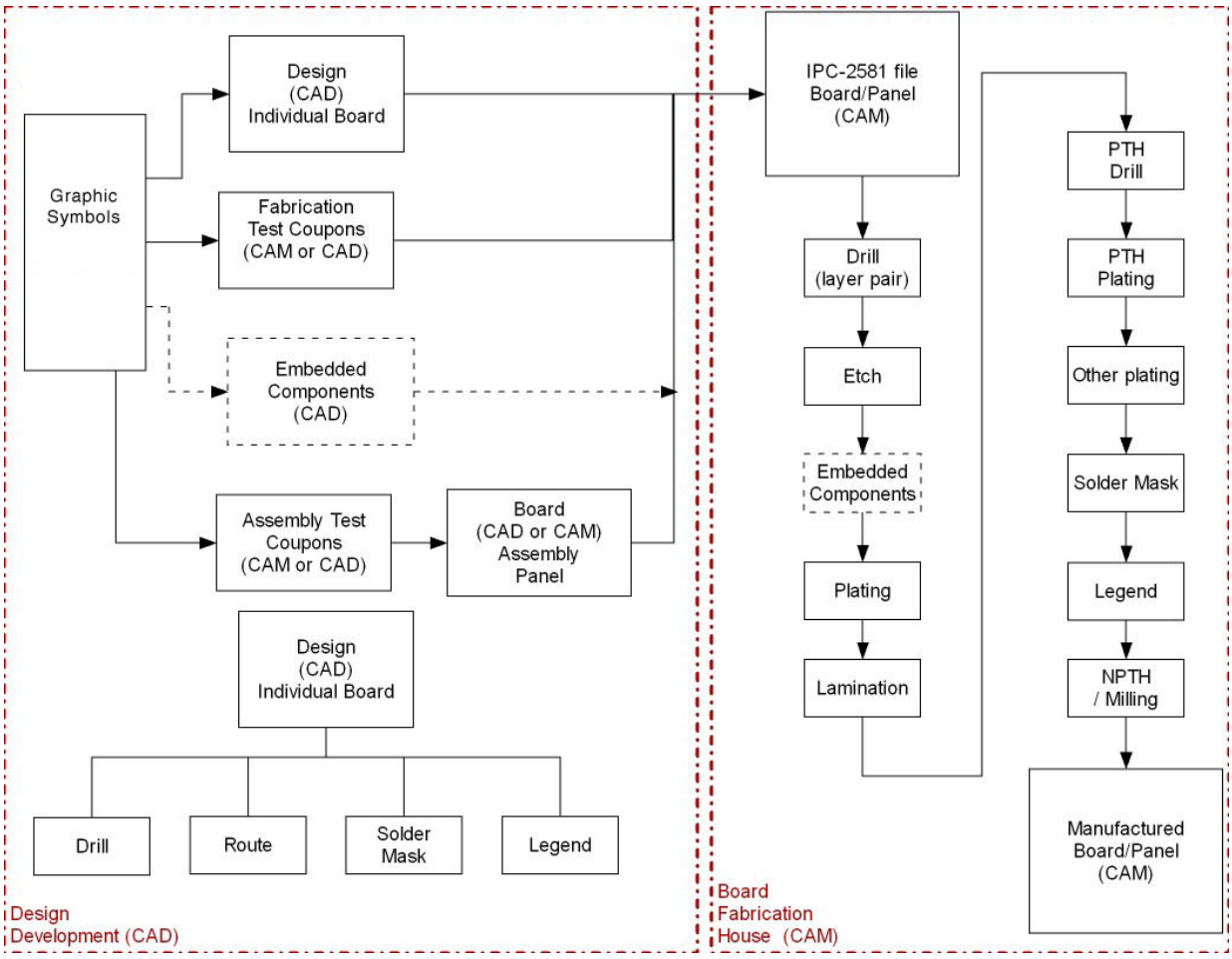

Figure 1 – Board fabrication data relationship

5 General rules

5.1 Overview

The following details reflect the rules used in describing the printed board characteristics in order to meet the requirements for board fabrication. These rules are intended to meet the needs of the manufacturer to understand the customer requirements. Wherever necessary, additional requirements have been detailed to reflect precision.

The attributes and rules described in IEC 61182-2 are required. Wherever necessary, detailed descriptions or definitions of the entities, attributes or characteristics are reproduced as defined in IEC 61182-2 in an attempt to clearly define the mandatory descriptions.

5.2 File content descriptions

The file content descriptions shall be in accordance with IEC 61182-2. This is a mandatory requirement for all FAB layers, FAB1, FAB2, and FAB3.

The only restriction in `Content` is that a `BomRef` is mandatory (1-1). A `Bom` for board material description will appear in the future IEC 61182-2-1[2] file.

IEC 61182-2/Content/BomNameRef=1

5.3 Logistic descriptions

All requirements for the logistic descriptions shall be in accordance with IEC 61182-2. The only restriction being if the file will be used as a transfer of information outside the domain that creates the file. In this case, the `RoleRef` attribute of `Person` shall exist and is no longer optional.

IEC 61182-2/LogisticHeader/Person@RoleRef=1

It is required that the `Role` name be one of the 9 enumerated strings listed in IEC 61182-2 with a recommendation that if no other obvious name exists, the name SENDER should be used.

IEC 61182-2/LogisticHeader/Role@name=SENDER

It should be understood that the sender of the file may not actually have electronic means to add data or modify the existing XML schema instance. If a dialog occurs between the sender and receiver of the data, verification should be made to establish file hierarchy and modification capability at either end.

5.4 File history descriptions

5.4.1 General

All requirements for the history descriptions are in accordance with IEC 61182-2. The restrictions are slightly different for the various fabrication levels and pertain to:

FAB1 has no restrictions and meets all requirements of IEC 61182-2.

FAB2 takes the `changeRecord` and makes it a mandatory requirement (1-*n* instead of 0-*n*).

FAB3 requires that `changeRecord` and the `Approval` element are a mandatory part of the instance file.

IEC 61182-2/HistoryRecord/ChangeRec=1-n
IEC 61182-2/HistoryRecord/ChangeRec/Approval=1-n

Figure 2 provides a case study of the HistoryRecord. Figure 2 and subsequent subclauses show the trend in communication between design at the OEM level and manufacturing.

---

2 Under consideration.

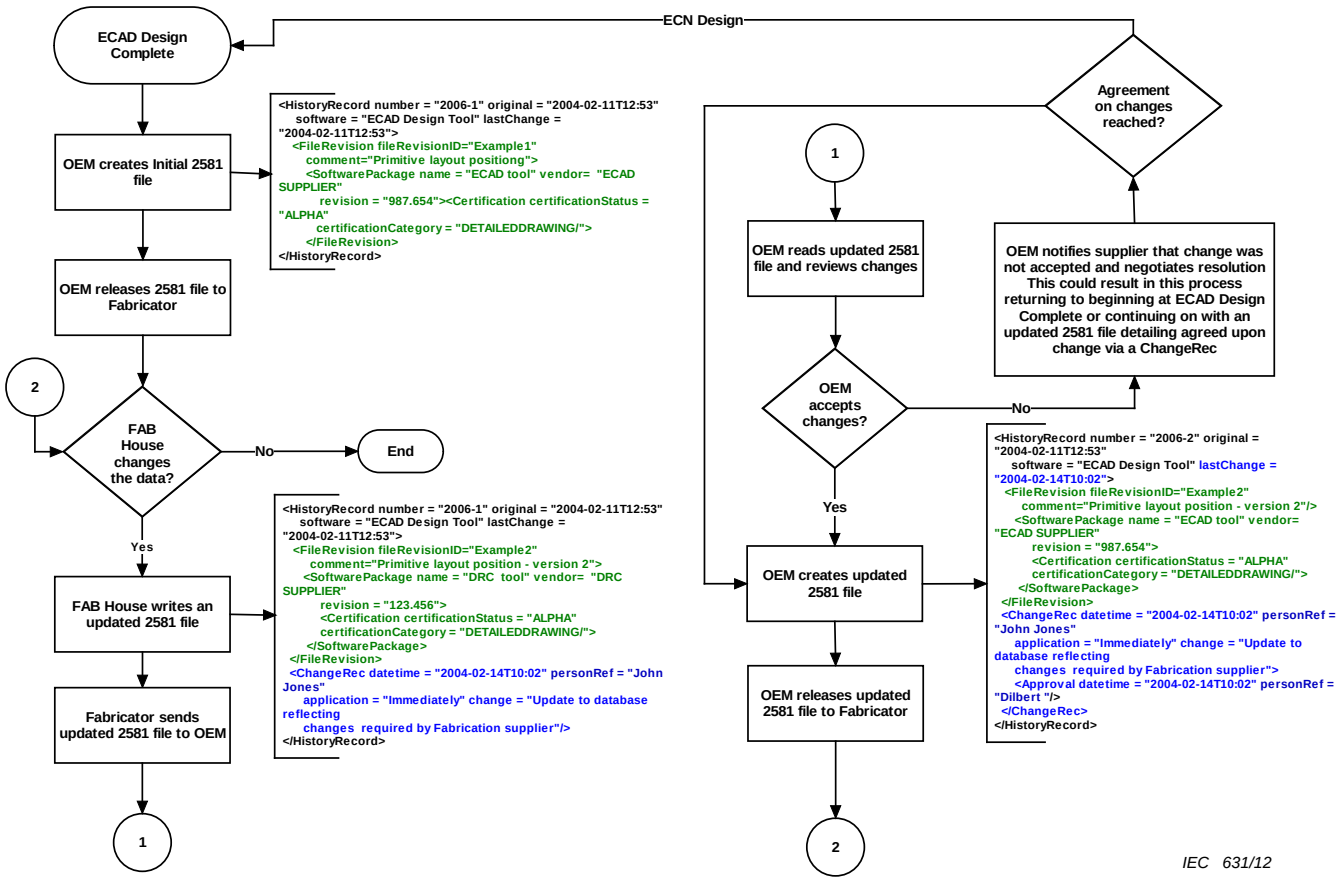

Figure 2 – HistoryRecord use case

5.4.2 HistoryRecord use case – Initial design release

5.4.2.1 General

The EDA design tool creates the initial IEC 61182-2 file is with the LogisticHeader, HistoryRecord and the HistoryRecord child FileRevision elements.

5.4.2.2 LogisticHeader

The LogisticHeader contains the contact information for the OEM personnel who have defined roles for the design project. There are many methods for getting contact information into the EDA tool for export to an IEC 61182-2 file. These methods will range from manual manipulation such as using a dynamic dialog box to automatically importing from a contacts.xml file or corporate database.

The `Role` name and `Person` name shall be unique names. The `Person` name may be an actual name, such as John Smith; title, such as senior designer, or department name, such as purchasing department.

Ideally, the ability to import all preferred supplier information from external sources will be available in order to include preferred suppliers in the `LogisticHeader` element. Below is a sample of the minimum data necessary for a complete `LogisticHeader` element with optional fields populated.

```
<LogisticHeader>
```

```
        <Role name = "OEM Account Manager" description = "OWNER"
              publicKey = "x3d8rf7ko90mKMC07" authority = "OEM
              purchasing agent"/>

        <Enterprise id = "OEM" name = "Design House" code="34567"
              codeType = "DUNS" address1 = "123 Avenue Street " city =
              "Bigcity" stateProvince = "PV" country = "US" postalCode
              = "99999-1111" phone = "888-555-1212" fax = "888-555-
              1212" email="purchasing@oem.com" url =
              "http://www.oem.com" />

        <Person name="Purchasing Manager" enterpriseRef ="OEM" title =
              "Senior Purchasing Manager" email =
              "purchasing.manager@oem.com" phone = "888-555-1212ext123"
              fax = "888-555-1212" roleRef = "OEM Account Manager "/>

    <Logistic Header>
```

5.4.2.3 HistoryRecord

The `HistoryRecord` is the location of log type information for maintaining revision control of the IEC 61182-2 file for a design's life cycle. This does not mean that the entire history is present in any IEC 61182-2 file. It gives the OWNER a data record, which could be exported to a corporate database.

The EDA tool shall create a `HistoryRecord` for each IEC 61182-2 file by providing a means to enter the `HistoryRecord` number and the `FileRevision fileRevisionID`. This data could be entered by manual manipulation such as using a dynamic dialog box.

```
    <HistoryRecord number = "2006-1" original = "2004-02-11T12:53"
          software = "ECAD Design Tool" lastChange = "2004-02-11T12:53">

        <FileRevision fileRevisionID="12345ENG-0"
              comment="Primitive layout position">

              <SoftwarePackage name = "ECAD tool" vendor= "ECAD
                    SUPPLIER"
                    revision = "987.654">

                    <Certification certificationStatus = "ALPHA"
                          certificationCategory = "DETAILEDDRAWING/">

              </SoftwarePackage>

         </FileRevision>

    </HistoryRecord>
```

5.4.3 Supply chain modifications

5.4.3.1 General

A modification is added to the initial IEC 61182-2 file by a member of the supply chain. This modification can be as simple as adding a test coupon or panelizing the board to finding problems with the design and requiring design modification in order to produce a finish board.

5.4.3.2 LogisticHeader update

In order to add the `ChangeRec` to the `HistoryRecord`, the supply chain may need to update the `LogisticHeader` with additional information to provide the `Role`, `Enterprise` and `Person` data for the supply chain.

The supplier shall not modify the information associated with any enterprise id other than their own. Updating the LogisticHeader shall create a ChangeRec even if no other data was modified. This will provide the means for the OEM to update their contacts information.

There are many methods for getting this information into the file that range from manual manipulation to importing a contacts.xml. Below is a sample of a contacts.xml file.

```
<LogisticHeader>
      <Enterprise id = "OEM" name = "Design House" code="34567"
            codeType = "DUNS" address1 = "123 Avenue Street " city =
            "Bigcity" stateProvince = "PV" country = "US" postalCode
            = "99999-1111" phone = "888-555-1212" fax = "888-555-
            1212" email="purchasing@oem.com" url =
            "http://www.oem.com" />
      <Role name = "OEM Account Manager" description = "OWNER"
            publicKey = "x3d8rf7ko90mKMC07" authority = "OEM
            purchasing agent"/>
      <Person name="Purchasing Manager" enterpriseRef ="OEM" title =
            "Senior Purchasing Manager" email =
            "purchasing.manager@oem.com" phone = "888-555-1212ext123"
            fax = "888-555-1212" roleRef = "OEM Account Manager "/>
      <Enterprise id = "Fab" name = "Board Shop" code="23456"
            codeType = "DUNS" address1 = "123 Street Avenue" city =
            "Mytown" stateProvince = "ST" country = "US" postalCode =
            "00000-1111" phone = "800-555-1212" fax = "800-555-1212"
            email="support@boardshop.com" url =
            "http://www.boardshop.com" />
      <Role name = "Supply Chain Customer Account Manager"
            description = "CUSTOMERSERVICE" publicKey =
            "x6d8rf7xd90mJHR13" authority = "Feed back to OEM"/>
      <Role name = "FAB Project Lead Engineer" description =
            "ENGINEER" publicKey = "x444rf7xd90mJHR13" authority =
            "FAB Lead Engineer"/>
      <Person name="Account Manager" enterpriseRef ="Fab" title =
            "Senior Global Account Manager" email =
            "customer.service@boardshop.com" phone = "800-555-
            1212ext123" fax = "800-555-1212" roleRef = "Supply Chain
            Customer Account Manager "/>
      <Person name="Project Engineer" enterpriseRef ="Fab" title =
            "Manager, Fabrication" email =
            "project.engineer@boardshop.com" phone = "800-555-
            1212ext456" fax = "800-555-1212" roleRef = " FAB Project
            Lead Engineer "/>
<Logistic Header>
```

5.4.3.3 HistoryRecord update

The HistoryRecord parent shall remain unchanged by the supply chain's software. It is identified in the example by the use of underlined text. The supply chain's software uses the FileRevision to identify the software used to create the updated IEC 61182-2 file.

```
<HistoryRecord number = "2006-1" original = "2004-02-11T12:53"
      software = "ECAD Design Tool" lastChange = "2004-02-11T12:53">
```

```
        <FileRevision fileRevisionID="12345ENG-0mod"
              comment="Primitive layout position – updated with
              manufacturing requirements">
              <SoftwarePackage name = "DRC tool" vendor= "DRC SUPPLIER"
                    revision = "123.456">
                    <Certification certificationStatus = "ALPHA"
                          certificationCategory = "DETAILEDDRAWING/">
              </SoftwarePackage>
        </FileRevision>
        <ChangeRec datetime = "2004-02-14T10:02" personRef = "Supply
              Chain Engineer"
              application = "Immediately" change = "Update to database
              reflecting
              changes required by fabrication process."/>
  </HistoryRecord>
```

5.4.4 OEM reviews modifications – HistoryRecord update

The OEM and their supply chain can use the `fileRevisionID` to match IEC 61182-2 files to their predecessors. Maintaining consistency in the `fileRevisionID` field will facilitate the ability to reuse items during the design's lifecycle.

```
  <HistoryRecord number = "2006-2" original = "2004-02-11T12:53"
        software = "ECAD Design Tool" lastChange = "2004-02-14T10:02">
        <FileRevision fileRevisionID="12345ENG-1
              comment="Primitive layout position - version 2"/>
              <SoftwarePackage name = "ECAD tool" vendor= "ECAD
                    SUPPLIER"
                    revision = "987.654">
                    <Certification certificationStatus = "ALPHA"
                          certificationCategory = "DETAILEDDRAWING/">
              </SoftwarePackage>
        </FileRevision>
        <ChangeRec datetime = "2004-02-14T10:02" personRef = "John
              Jones"
              application = "Immediately" change = "Update to database
              reflecting
              changes required by Fabrication supplier">
              <Approval datetime = "2004-02-14T10:02" personRef =
                    "Dilbert "/>
        </ChangeRec>
  </HistoryRecord>
```

5.5 BOM (board fabrication materials)

The BOM layer requirements shall be in accordance with IEC 61182-2. The following restrictions apply:

Bom/BomItem@category=MATERIAL

This is a mandatory requirement for FAB1, FAB2, and FAB3. Table 2 shows the `Bom` restrictions for board fabrication.

Table 2 – Bom restrictions

Content/FunctionMode	FunctionModeType	@mode= FABRICATION @level=1	@mode= FABRICATION @level=2	@mode= FABRICATION @level=3
Bom/BomItem	BomItemType	@category=MATERIAL	@category=MATERIAL	@category=MATERIAL
Bom/BomItem/RefDes.	RefDesType	Per Table 3	Per Table 3	Per Table 3
Bom/BomItem/RefDes/ Tuning	TuningType	0	0	0
Bom/BomItem/RefDes/ Firmware	FirmwareType	0	0	0
Bom/BomItem/RefDes/ Firmware/File	FileType	0	0	0
Bom/BomItem/RefDes/ Firmware/CachedFirmware	CachedFirmware Type	0	0	0
Bom/BomItem/RefDes/ Firmware/FirmwareRef	FirmwareRefType	0	0	0
Bom/BomItem/ Characteristics	CharacteristicsType	@category=MATERIAL	@category=MATERIAL	@category=MATERIAL
Bom/BomItem/ Characteristics/ Measured	MeasuredType	IEC 61182-2	1-*n*	1-*n*
Bom/BomItem/Characteristics/ Ranged	RangedType	IEC 61182-2	IEC 61182-2	1-*n*

When reference designators are required, as indicated for `BomItem`, the `RefDes` shall be in accordance with Table 3. Since the `RefDes` element is normally restricted to electronic components, this table has been constructed as a recommended methodology for defining different materials within the `Bom`. `RefDes` has a 1-*n* cardinality requirement. This is still appropriate for FAB1, FAB2, and FAB3. When the `RefDes` element is instanced, the attribute name shall be in accordance with Table 3.

IEC 61182-2/Bom/BomItem/RefDes@name=Table 3

Table 3 – Recommended reference designators for printed board material

Material type	Reference designator	Comments
Legend ink	LEG	
Soldermask	SDM	
Conductor	CND	
Dielectric base material	DBM	
Dielectric core	DIC	
Dielectric prepreg	DPP	
Dielectric adhesive	DIA	
Solder bump	SBM	
Hole fill material	HFM	
Resistive material	ERM	
Capacitive material	ECM	
Other	OTH	

Additional restrictions for `BomItem` are that the `Category` attribute shall be listed as MATERIAL.

IEC 61182-2/Bom/BomItem@category=MATERIAL

The `Characteristic` element also has some restrictions that pertain to FAB2 and FAB3. These relate to the occurrence of the `Measured` and `Ranged` elements which become mandatory in certain applications.

IEC 61182-2/Bom/BomItem/Characteristic@category=MATERIAL (same as BomItem)
IEC 61182-2/Bom/BomItem/Characteristic/Measured=1 (for FAB2 and FAB3)
IEC 61182-2/Bom/BomItem/Characteristic/Ranged=1 (for FAB3)

5.6 AVL (board material suppliers)

The AVL requirements shall be in accordance with IEC 61182-2. The following restrictions apply and are detailed in Table 4:

Avl/AvlHeader@modRef=FABRICATION

This is an optional requirement for FAB2 and FAB3.

Table 4 – Avl restrictions

Avl/AvlHeader	**AvlHeaderType**	**@modRef= FABRICATION**	**@modRef= FABRICATION**	**@modRef= FABRICATION**
Avl/AvlItem	AvlItemType	1-1	1-1	1-1
Avl/AvlItem/AvlVmpn	AvlVmpnType	@qualified=FALSE @chosen=FALSE	@qualified=FALSEor TRUE @chosen=FALSE or TRUE	@qualified=FALSE or TRUE @chosen=FALSE or TRUE
Avl/AvlItem/AvlVmpn/AvlMpn	AvlMpnType	0-1	0-1	0-1
Avl/AvlItem/AvlVmpn/AvlVendor	AvlVendorType	0-1	0-1	0-1

5.7 Documentation layers

5.7.1 General

The documentation layer requirements shall be in accordance with IEC 61182-2. The following restrictions apply:

Ecad/CadData/Layer@LayerFunction=DOCUMENTATION

Ecad/CadData/Layer@name=unique layer name recommended consistent with Step name

This is a mandatory requirement for FAB1, FAB2 and FAB3.

5.7.2 Documentation layer restrictions

The following functions shown in Table 5 are applicable when a documentation layer is identified.

Table 5 – Documentation layer restrictions

Content/Function Mode	**FunctionMode Type**	**@mode=FABRICATION @level=1**	**@mode=FABRICATION @level=2**	**@mode=FABRICATION @level=3**
Ecad/CadData/ Layer	LayerType	*@layerFunction=COURTYARD*	*@layerFunction=COURTYARD*	*@layerFunction=COURTYARD*
		@layerFunction=GRAPHIC	*@layerFunction=GRAPHIC*	*@layerFunction=GRAPHIC*
		@layerFunction=DRAWING	@layerFunction=*DRAWING*	@layerFunction=DRAWING
		@layerFunction=LANDPATTERN	*@layerFunction=LANDPATTERN*	*@layerFunction=LANDPATTERN*
		@layerFunction=COMPONENT_TOP	@layerFunction=*COMPONENT_TOP*	@layerFunction=*COMPONENT_TOP*
		@layerFunction=COMPONENT_BOTTOM	@layerFunction=*COMPONENT_BOTTOM*	@layerFunction=*COMPONENT_BOTTOM*
		@layerFunction=OTHER	*@layerFunction=OTHER*	*@layerFunction=OTHER*
Key: *italics* = optional				

To facilitate the interpretation, Table 6 provides a reference illustration table of those restrictions shown in their XML path description in Table 5.

Table 6 – General descriptions of documentation layer functions

@layerFunction	**FAB1**	**FAB2**	**FAB3**	**Remarks**
COURTYARD	O	O	O	
GRAPHIC	O	O	O	
DRAWING	O	M	M	Used mostly for any form of documentation
LANDPATTERN	O	O	O	
COMPONENT_TOP	O	M	M	Only applies to assembly documentation
COMPONENT_BOTTOM	O	M	M	Only applies to assembly documentation
OTHER	O	O	O	

5.7.3 Reference to documentation

The information in Table 7 highlights the documentation functions for the IEC 61182-2 standard. This information shall be consistent throughout the data file.

Figure 3 provides an illustration indicating an approximate variation in the degree of mixture between electronic and hard copy documentation. Electronic documentation is considered non-intelligent (ready for printing a hard copy), while data is considered intelligent (ready for machine usage).

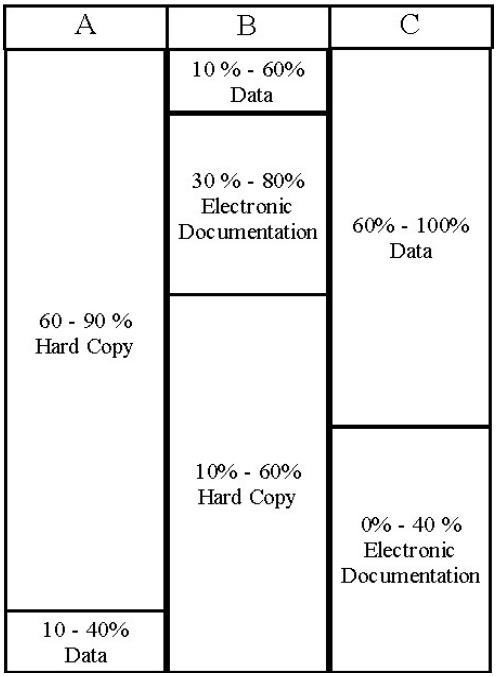

Figure 3 – Documentation package grade requirements

Since the documentation requirment has three grades (A, B, C), plus three levels of complexity in each grade (1, 2, 3), a correlation should be established between the particular grade levels and the data documentation in an IEC 61182-2-2 file, see Table 7.

Table 7 – Relationship to documentation standard

Complexity/Grade	A	B	C
1	N/A	FAB1, FAB2	FAB1, FAB2
2	N/A	FAB1, FAB2, FAB3	FAB1, FAB2, FAB3
3	N/A	FAB2, FAB3	FAB2, FAB3

Grade B will fail the automated use case validation and needs to be manually validated. The goal is to strive for Grade C documentation when using the IEC 61182-2 to accommodate a 60 % to 100 % data transfer.

5.7.4 Step usage

5.7.4.1 Step element

The `Step` element is used several times when `Layer` is used for documentation. Each `Step` has a `Step name`. It is recommended that the `Step name` assigned to the `Step` be unique and be similar to the `name` attribute assigned for `layer`. The `LayerFunction` shall be DOCUMENTATION types, see Table 5.

5.7.4.2 Step

There may be one to many "`Step`"s in any IEC 61182-2-2 file. Each `Step` has a unique name, which may be anything but is recommended to be an identifiable subset of the `Step`, and should be in accordance with the attribute `Step/name`.

It should be noted that some "`Step`"s for documentation take advantage of previously defined "`Step`"s (i.e. taking a board `step` and an assembly `step` to make an assembly

drawing. This would use the StepRepeat element to combine previously defined "Step"s by placing the graphical images on a drawing format.

Each Step requires a mandatory definition for Datum and Profile. All graphical information shall be provided as a LayerFeature.

When LayerFeature defines the graphical information using the various “Set”s, it shall be associated with the specific layer as identified by the layer name. This is accomplished through the mandatory layerRef associated with the LayerFeature of any Step within any IEC 61182-2-2 file.

Step/LayerFeature@layerRef=Layer@name (unique user assigned)

5.7.5 Set

All documentation requirements shown in Table 1 shall be pre-defined in the user dictionary section of the file and will be instanced through the path:

Ecad/CadData/Step/LayerFeature/Set/Features

When documentation features are instanced at the time the feature is described, the lineDescGroup associated with the specific feature (Line, Arc, Polyline, and Outline) shall take precedence and the lineDescGroup of Set shall be 0.

5.8 Design for excellence (Dfx) analysis

5.8.1 General

All characteristics for DfxMeasurement shall be in accordance with IEC 61182-2. When Dfx analysis is required as defined in Table 1, the DfxMeasurementList shall restrict the category to BOARDFAB.

Ecad/CadData/Step/DfxMeasurementList@category=BOARDFAB

This is a mandatory requirement for FAB2 and FAB3.

5.8.2 DfxMeasurement

When DfxMeasurement characteristics are instanced at the time the feature is described, the lineDescGroup associated with the specific feature (Line, Arc, Polyline, and Outline) shall take precedence and the lineDescGroup of Set shall be 0.

5.9 Miscellaneous image layers

5.9.1 General

Miscellaneous image layers are used primarily to capture and transfer graphical descriptions that do not necessarily belong in any of the specific categories of the CadData descriptions.

This layer’s requirements shall be in accordance with IEC 61182-2. The following restrictions apply:

Ecad/CadData//Layer@layerFunction=OTHER

This is an optional requirement for FAB2 and FAB3.

5.9.2 Step usage

5.9.2.1 Step element

The Step element is used several times when Layer is used for miscellaneous layers. Each Step has a Step name. It is recommeded that the Step name assigned to the Step be unique and the name be similar to the layerFunction attribute assigned for layer. The LayerFunction shall be OTHER.

It is also recommended that the information be included in the dictionary as graphical images, defined in the user or standard dictionary and called out as needed.

5.9.2.2 Step

There may be one to many "Step"s in any IEC 61182-2-2 file. Each Step has a unique name, which may be anything but is recommended to be an identifiable subset of the Step and should be in accordance with the attribute Step name.

Each Step requires a mandatory definition for Datum and Profile. See Table 8 for miscellaneous layer restrictions. All graphical information shall be provided as a LayerFeature.

Table 8 – Miscellaneous layer restrictions

Content/FunctionMode	@mode=FABRICATION @level=1	@mode=FABRICATION @level=2	@mode=FABRICATION @level=3
Ecad/CadData/Layer	*@LayerFunction OTHER*	*@LayerFunction OTHER*	*@LayerFunction OTHER*
Key: *italics* = optional			

5.10 Packages and land patterns

5.10.1 General

When packages are required to define component dimensions, which is optional for level FAB3, the characteristics for Step shall define the instances of the package descriptions. When this occurs, the Layer PROCESS shall indicate ASSEMBLY.

Ecad/CadData/Layer@layerFunction=ASSEMBLY

This is an optional requirement only for FAB3.

Most packages are described in accordance with the Step Package function. The appropriate name of the Package type shall be in accordance with the IEC 61182-2 and future IEC 61182-2-3 e.g., BARE_DIE, FLIECHIP, CHIP, OTHER, etc.

The name convention for Package type should be in accordance with Annex A of IEC 61182-2.

Ecad/CadData/Step/Package@name=per Annex A of IEC 61182-2
Ecad/CadData/Step/Package@type=per Package TypeType IEC 61182-2

5.10.2 Step usage for component packages and land patterns

5.10.2.1 Step element

The Step element is used several times when Layer is used for Package layer descriptions. Each Step has a Step name. The recommendation is that the Step name is unique and is

similar to the name and LayerFunction attribute assigned for Layer i.e., recommended step details coincide with LayerFunction = ASSEMBLY.

5.10.2.2 Step

There may be one to many "Step"s in any IEC 61182-2 file. Each Step has a unique name, which may be anything but is recommended to be a similar subset of the Step name used for component package descriptions and should be in accordance with the attribute step name.

Each Step requires a mandatory definition for Datum and Profile. All graphical information shall be provided as a LayerFeature.

5.10.3 Land pattern details

LandPattern is an optional (0-1) child element of Package. As such, it inherits all of the restrictions of Package as stated in the previous subclauses and defines the appropriate Pad(s) and Target(s) needed to correlate the board surface copper to the characteristics of the Package being described. Three additional restrictions are required and those are the characteristics of the Pin(s) defined as a part of the Package. These attributes deal with electricalType and mountType and are enumerated strings. In their use in this application, the appropriate name shall be assigned as well as the pinType.

These requirements are in accordance with IEC 61182-2.

Ecad/CadData/Step/Package/Pin@type=THRU | SURFACE
Ecad/CadData/Step/Package/Pin@electricalType=ELECTRICAL | MECHANICAL | UNDEFINED
Ecad/CadData/Step/Package/Pin@mountType=per future IEC 61182-2-3.

CAD systems should either use through hole or surface mounting techniques for component attachment.

5.11 Solder mask and legend layers

5.11.1 General

Any descriptions for solder mask and legend shall be in accordance with IEC 61182-2 with the restrictions shown in the following subclauses.

5.11.2 Solder mask details

The Layer descriptions for solder mask shall restrict the layerFunction to the enumerated string SOLDERMASK. This is an attribute of the Layer element and includes a restriction to the side where the solder mask is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding CadData/Step shall be used to define board, board panel, or coupon characteristics.

Ecad/CadData/Layer@layerFunction=SOLDERMASK
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

5.11.3 Legend details

The Layer descriptions for legend shall restrict the layerFunction to the enumerated string LEGEND. This is an attribute of the Layer element and includes a restriction to the side where the legend is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding CadData/Step shall be used to define board, board panel, or coupon characteristics.

Ecad/CadData/Layer@layerFunction=LEGEND
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

The source for legend information is mostly derived from the `Silkscreen` element of `Package` for the components that are placed on the appropriate board side. Other legend Information, such as logos, UL status, etc., may be added to the final image defined under the Step/LayerFeature/Set/Features hierarchy.

In FABRICATION or ASSEMBLY modes the IEC 61182-2 elements shall present an explicit and unambiguous image of the layers to be produced. Therefore the FABRICATION or ASSEMBLY elements take precedence, when they exist. The legend layer image considered for production will be the single Step/LayerFeature/Set/Features for the appropriate legend.

All legend descriptions contained in the final Step/LayerFeature/Set/Features elements from the `Silkscreen` element of `Package`, or from other sources, shall be consolidated before the IEC 61182-2 file is generated.

5.11.4 Step usage for solder mask and legend layers

All layers representing data that ends up forming part of the Board shall be part of the step whose `purpose` is defined using the enumerated string BOARD. Since legend and solder mask are inseparable from the board after fabrication then the legend and solder mask layers for the top and bottom sides (and inner layers, if defined, for special applications) of the board shall be included in the BOARD step.

Additional solder mask and legend layers may be included in a step used to define BOARDPANEL, ASSEMBLYPALLET, or COUPON if these entities require special legend markings or solder mask descriptions or clearances.

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example, if the layer name for the top legend layer is Legend_Top then the step whose use is assigned as BOARD shall have a Step/LayerFeature element who's LayerRef is set to the qualified name "Legend_Top".

5.12 Drilling and routing (tooling) layers

5.12.1 General

Any descriptions for drilling and routing information shall be in accordance with IEC 61182-2 with the restrictions shown in the following subclauses.

5.12.2 Drilling details

The `Layer` descriptions for drilling shall restrict the `layerFunction` to the enumerated string DRILL. This is an attribute of the `Layer` element and includes a restriction to the side where the drilling is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding `CadData/Step` shall be used to define board, board panel, or coupon characteristics.

Ecad/CadData/Layer@layerFunction=DRILL
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL | ALL

5.12.3 Routing details

The `Layer` descriptions for routing shall restrict the `layerFunction` to the enumerated string ROUTE. This is an attribute of the `Layer` element and includes a restriction to the side where the routing is applied. These restrictions are mandatory for FAB1, FAB2, and FAB3. The corresponding `CadData/Step` shall define the "Step" `purpose` using the enumerated string BOARD.

Ecad/CadData/Layer@layerFunction=ROUTE
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL | ALL
Ecad/CadData/Step@purpose=BOARD

5.12.4 Step usage for drilling and routing

5.12.4.1 General

All layers representing data that ends up forming part of the board shall be part of the step that is used to define BOARD characteristics. Both plated and un-plated holes shall be part of the step used to define the board, board panel or coupon since they are a part of the delivered product. This includes the drilling information of the plain hole plus the thickness of the plating within the hole-barrel for plated-through holes. Similarly the routing forms the outline of the final delivered BOARD, and therefore all board route layers (usually a single one) shall belong to the step used for these descriptions.

Additional drilling and routing layers may be included in the assembly pallet, coupon or panel steps if these entities require special mounting or tooling holes and for the routing layers forming the outline of these steps.

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example, if the layer name for the through hole layer is Drill then the single step whose step purpose is assigned as BOARD shall have a Step/LayerFeature element whose LayerRef is set to the qualified name “Drill”.

5.12.4.2 Additional step restrictions

Within a LayerFeature/Set information describing specific characteristics of drilling or routing aspects, the Pad element may be instanced (0-*n*). When Pad is instanced, the padUsage attribute of Set shall be restricted to either TOE | VIA | TOOLING_HOLE | NONE.

Ecad/CadData/Step/LayerFeature/Set@padUsage= TOE | VIA | TOOLING_HOLE | NONE

An IEC 61182-2 file may also contain step elements used to define TOOLING characteristics. This condition may occur where the step is a possible container for additional fixture information, such as electrical test fixtures. However, drilled holes or routing information forming part of the CAD data shall always be included in LayerFeature/Set/Features belonging to the BOARD descriptions for any specific board. If a need is identified to describe use cases for fixtures that information should be contained in a TOOLING step.

5.13 Net list

5.13.1 General

When electrical connectivity information is required, which is optional for level FAB2 and mandatory for FAB3, the characteristics for the `Step` shall define the `PhysNetGroup` instances of the electrical descriptions. All requirements of future IEC 61182-2-4 (IEC 61182-2) will prevail. When this occurs, the physical net list represents all required information and does not require the component and package descriptions. The information thus defines the interconnectivity of the conductive pattern without reference to component pin or reference designation.

The conductor layers that will be used for calculating connectivity shall be those fitting the restrictions written below:

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

When the information required in the IEC 61182-2-2 file necessitates that description of electrical testing include the references to component pins the file shall include `LogicalNet` descriptions that define the components their pin numbers and the component reference designators (`refDes`). In order to maintain a cohesive file a step used to define TOOLING should be used in order to coordinate the physical to logical descriptions.

Ecad/CadData/Layer@layerFunction=PROBE
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

5.13.2 Step usage for net list

In most cases the BOARD step is used to describe the physical interconnectivity of the conductor layers (CONDFOIL | CONDFILM) (and the drill layers). In multilayer fabrication it is sometimes important to perform the electrical evaluations prior to the final lamination step. This is especially important when an internal double sided core contains vias that will be buried in the final lamination step. The `layer` element includes a methodology that permits identification of these sequential fabrication functions under the `CadData` element `Stackup`.

It is important to maintain consistency in the naming and cross-referencing of the physical net information in conjunction with the board construction information. The `StackupGroup` element provides this feature that permits combining several layers under the element StackupLayer and provides an appropriate name that can be referenced in the final multilayer board product. These features are especially useful for producing HDI boards which fabricate a core of several layers and then sequentially add micro via layers on the top and bottom of the stackup.

The use of multiple steps can manage the data consistency through the combination of physical and electrical descriptions related to the fabrication of sequential multilayer board construction.

Ecad/CadData/Stackup/StackupGroup@name=unique identifier
Ecad/CadData/Stackup/StackupGroup/StackupLayer/@layerOrGroupRef=unique identifier
Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM|

Ecad/CadData/Layer@layerFunction=PROBE
Ecad/CadData/Layer@side=TOP | BOTTOM

5.14 Outer conductive layers

5.14.1 General

Any descriptions for the outer conductive layers shall be in accordance with IEC 61182-2 with the restrictions shown in the following subclauses.

5.14.2 Outer conductive layer details

All layers representing data that ends up forming part of the Board shall be part of the step used to define the BOARD. The outer conductive characteristics are a mandatory requirement of FAB1, FAB2, and FAB3.

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM

5.14.3 Step usage for outer conductive layers

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example, if the layer name for the single top conductive layer is “Top” then the step

used to define the BOARD shall have a Step/LayerFeature element whose LayerRef is set to the qualified name “Top”.

Additional outer conductive layers may also, in many cases, be included in the assembly pallet, coupon or board panel steps as these entities require conductive elements such as thieving features, venting feature or fiducials to appear.

5.15 Inner conductive layers

5.15.1 Requirement

Any descriptions for the inner conductive layers shall be in accordance with IEC 61182-2 with the restrictions shown in the following subclauses.

5.15.2 Inner conductive layer details

All layers representing data that ends up forming part of the Board shall be part of the step used to define the BOARD. The inner conductive layer characteristics are a mandatory requirement of FAB1, FAB2, and FAB3.

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=INTERNAL

5.15.3 Step usage for inner conductive layers

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. As an example, if the layer name for the top most inner conductive layer is Layer2 then the step whose step is used to define BOARD shall have a Step/LayerFeature element whose `LayerRef` is set to the qualified name “Layer2”.

Additional inner conductive layers may also in many cases be included in the assembly pallet, coupon or board panel steps as these entities require conductive elements such as thieving features, venting feature or fiducials to appear.

Another example intended to clarify step usage would be the description of a ten (10) layer board. The board has eight (8) inner layers. Under the assumption that all layers are functional then in the step used to define the BOARD there will be eight distinct `LayerFeature` elements pointing to the named eight layers of this boards’ `Layer` element. Namely, if the first inner layer from the top is called “signal2” and the second is called “ground3n” then there will be eight `LayerFeature` elements with the first two being:

StepList/Step/LayerFeature@layerNameRef = “signal2” ; and
StepList/Step/LayerFeature@layerNameRef = “ground3n”

respectively, and so forth, until all eight inner layers are covered. In FAB and ASSEMBLY modes (also TEST when TEST mode is covered) there shall be a step that is used to define the BOARD, and the layer images to be manufactured are solely represented by the respective `Step/LayerFeature` elements for which the `Step/LayerFeature@` layerNameRef elements point at those layers.

5.16 Board construction

5.16.1 Requirement

Any descriptions for the board construction layers shall be in accordance with IEC 61182-2 with the restrictions shown in the following subclauses.

5.16.2 Board construction details

All layers representing data that ends up forming part of the board shall be part of the step(s) that have a purpose which defines the characteristics of a printed board, board panel, or coupon. The board construction characteristics are a mandatory requirement of FAB1, FAB2, and FAB3. The construction includes the stackup of the layers for the board and defines the order in which the conductive and non-conductive materials are to be combined. The relationship of the naming conditions and the order in which the layers are identified is significant. Material properties are defined by the `layerFunction` attribute. Some examples are:

Ecad/CadData/Layer@layerFunction=CONDFOIL
Ecad/CadData/Layer@layerFunction=DIELPREG
Ecad/CadData/Layer@layerFunction=DIELCORE
Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM

Ecad/CadData/Layer@side=TOP
Ecad/CadData/Layer@side=INTERNAL
Ecad/CadData/Layer@side=BOTTOM

5.16.3 Step usage for board construction

5.16.3.1 General

Layers that pertain to the BOARD step shall define the Step/LayerFeature hierarchy and contain the LayerFeature elements whose LayerRef definition points to the appropriate layer. When there are no features in the step the `layerFunction` defines the characteristics of the material (thickness, finish, etc.). As an example, if the layer for the first dielectric layer in the board construction is prepreg the `layerFunction` shall be DIELPREG and the name would be “Dielectric One”. If the delectric had cutouts in it to accommodate resin flow the cutouts would be defined in the BOARD step and have a Step/LayerFeature element whose `LayerRef` is set to the qualified name “Dielectric One”.

Additional construction layers may also, in some cases, be included in the assembly pallet, coupon or board panel steps as these entities may require additional features that can be described in the element structure. The concepts become relatively important for special cutouts, or manufacturing features that help to describe panels for boards such as rigid-flex combinations or assembly pallets that have configurations in the borders for equipment usage or testing.

5.16.3.2 Stackup restrictions

When defining construction of a multilayer board, the `Stackup` element describes the overall thickness and where the material is measured. The restriction under board construction would be the `whereMeasured` attribute of `Stackup` and shall identify across which characteristic the overall thickness is measured.

Ecad/CadData/Stackup@whereMeasured=LAMINATE | METAL | MASK

6 Modeling

6.1 General

The data files of the IEC 61182-2-2 may be mapped to the information models. Information models are developed to ensure that complete mapping is capable between the information provided within the IEC 61182-2 characteristics.

All data activities are based on activity models. The activity models covered by CAD and CAM include the engineering, design, administrative, and fabrication and assembly characteristics.

Each of these sections is intended to be detailed at various levels of activity, much like layers of information needed to perform a particular manufacturing process.

Figure 4 shows the activity needed to develop board fabrication data.

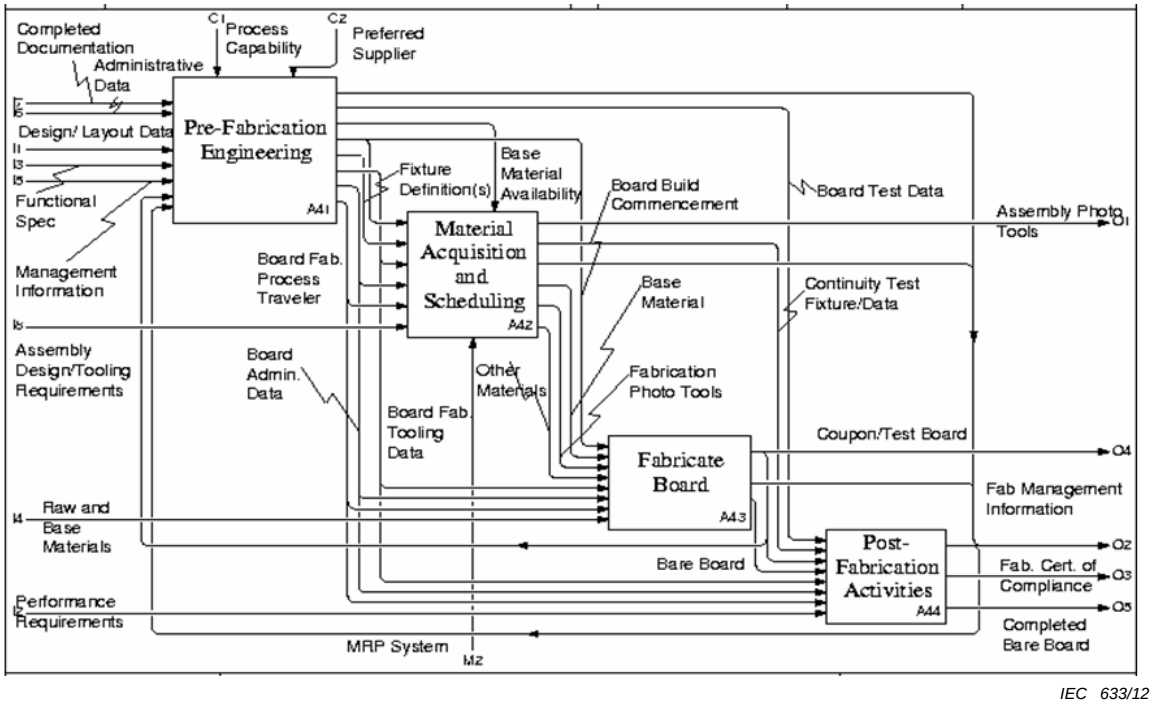

Figure 4 – Fabrication steps data model example

6.2 Information models

Information models are also helpful in understanding the requirements of the board fabrication section. Attribute information is correlated to the parameters of the IEC 61182-2-2 as well as to the activity or analysis models used to describe board fabrication data.

UML (Universal Modeling Language) is used to develop the data design model as well as the analysis model, see Figure 5.

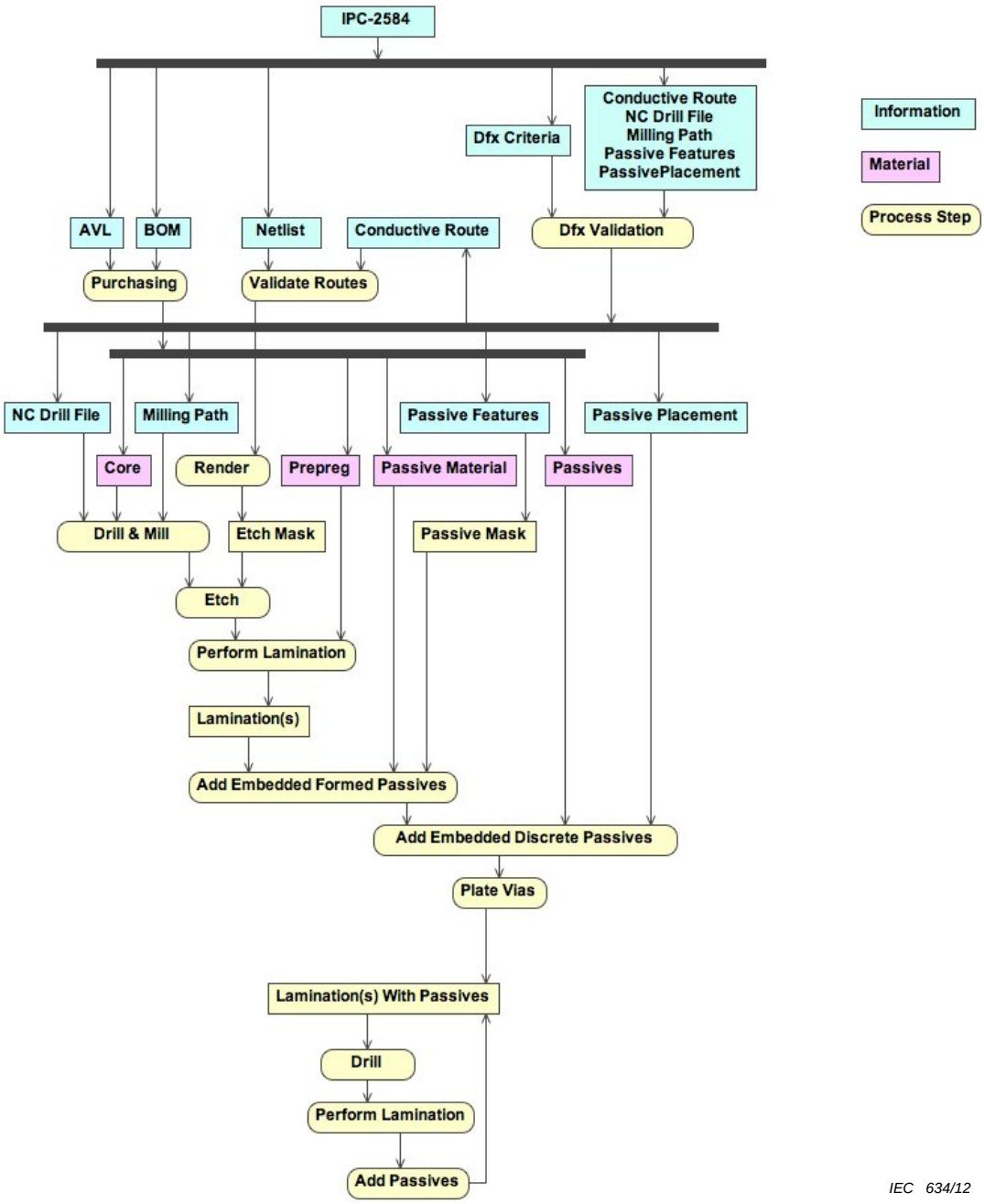

Figure 5 – IPC-2584 UML data model

7 Report generators

7.1 IEC 61182-2-2 format

Each of the sections of the IEC 61182-2-2 format has various report generators that industry uses to provide the user with a hard copy of the IEC 61182-2-2 data file. Some of them are preferred, based on industry preferences, others are mainly examples. The detailed report generators will be described in each of the four standards: IEC 61182-2-1 through IEC 61182-2-4.

7.2 Hole usage report

HOLE SIZE USAGE
Hole size hole, count type usage tooling
0.157 4 NPTH Tooling
0.020 40 PTH Electrical
0.035 65 PTH Electrical
0.041 120 PTH Electrical
0.125 8 NPTH Mechanical
Total 237

7.3 Pad usage report

PAD USAGE
X Y count pad
0.040 0.040 40 Fiducial
0.055 0.055 65 Component1
0.030 0.076 20 SOIC1

7.4 Conductor usage report

CONDUCTOR
USAGE
0.006
0.008
0.025
0.125

8 Glossary

Name or acronym	Description	Reference name
IEC 61182-2	Top level data structure	ODB++(X) / IEC 61182-2
Avl	Approved Vendor List	ODX_AVL
Bom	Bill Of Materials	ODX_BOM
Ecad	Computer-Aided Design information	ODX_CAD
Content	Information about contents of the file	ODX_CONTENTS
HistoryRef	Information about order and supply data	ODX_HISTORY_REC
LogisticHeader	File change information	ODX_LOGISTICS_HEADER
VpLComponent	CAD parts library	CAD_VPL_COMPONENTS
VplComponentList	EDA component after assembly merge	CAD_VPL_COMPONENTS LIST
CadVmpnList	CAD manufacturer part number list	CAD_VMPN_LIST
CadVmpn	CAD manufacturer part number list	CAD_VMPN
CadVplVendor	CAD component vendor	CAD VPL VENDOR
Header	Header	ODX_HEADER
AblVmpnList	Manufacturer part number list	AVL_VMPN_LIST
AvlVmpn	Manufacturer part number	AVL_VMPN
AvlVendor	Vendor	AVL_VENDOR

Annex A
(normative)

Printed board fabrication schema

IEC 61182-2-2
Content Elements in Accordance with IEC 61182-2
Logistic Header Elements in Accordance with IEC 61182-2
History Record Elements in Accordance with IEC 61182-2
BOM (Board Fabrication Materials) Elements in Accordance with IEC 61182-2
AVL (Board Material Suppliers) Elements in Accordance with IEC 61182-2
Miscellaneous Image Layers Elements in Accordance with IEC 61182-2
Documentation Layers Elements in Accordance with IEC 61182-2
Design for eXcellence (Dfx) Analysis Elements in Accordance with IEC 61182-2

IEC 61182-2/Ecad
IEC 61182-2/Ecad/CadHeader
IEC 61182-2/Ecad/CadHeader/Spec
IEC 61182-2/Ecad/CadHeader/Spec/Xform
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IEC 61182-2/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Donut
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IPC-2588, *Sectional Requirements for Implementation of Part List Product Data Description*

IPC-2614, *Sectional Requirements for Board Fabrication Documentation*

IPC-2615, *Printed Board Dimensions and Tolerances*

IPC-7351, *Generic Requirements for Surface Mount Design and Land Pattern Standard*

ANSI X3/TR-1-77, *American National Dictionary for Information Processing*

ANSI X3.12, *Subroutine Record Format Standardization*

ANSI Y14.5, *Dimensioning and Tolerancing for Engineering Drawing*

ANSI Y32.1, *Logic Diagram Standards*

ANSI Y32.16, *Electrical and Electrical Reference Designators*

ANSI Z210.1, *Metric Practice Guide (ASTM 380-72)*

DoD-STD-100, *Engineering Drawings*

EDIF 4 0 0, *Electronic Data Interchange Format*

ISO 10303-210, *Industrial automation systems and integration – Product data representation and exchange – Part 210: Application protocol: Electronic assembly, interconnect, and packaging design*

ISO 10303-212, *Industrial automation systems and integration – Product data representation and exchange – Part 212: Electrotechnical design and installation*

AP220, *Process Planning, Manufacturing, and Assembly of Layered Electronic Products*

AP221, *Process Plant Functional Data & Schematic Representation*

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SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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PRODUITS POUR CARTES IMPRIMÉES ÉQUIPÉES – DONNÉES DESCRIPTIVES DE FABRICATION ET MÉTHODOLOGIE DE TRANSFERT –

Partie 2-2: Exigences intermédiaires pour la mise en œuvre de cartes imprimées – Description des données de fabrication

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La Norme internationale CEI 61182-2-2 a été établie par le comité d'études 91 de la CEI: Techniques d'assemblage des composants électroniques.

Le texte de cette norme est issu des documents suivants:

FDIS	Rapport de vote
91/1025/FDIS	91/1038/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à l'approbation de cette norme.

Cette publication a été rédigée selon les Directives ISO/CEI, Partie 2.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de la CEI sous "http://webstore.iec.ch" dans les données relatives à la publication recherchée. A cette date, la publication sera

- reconduite,
- supprimée,
- remplacée par une édition révisée, ou
- amendée.

IMPORTANT – Le logo «colour inside» qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

PRODUITS POUR CARTES IMPRIMÉES ÉQUIPÉES – DONNÉES DESCRIPTIVES DE FABRICATION ET MÉTHODOLOGIE DE TRANSFERT –

Partie 2-2: Exigences intermédiaires pour la mise en œuvre de cartes imprimées – Description des données de fabrication

1 Domaine d'application

La présente partie de la CEI 61182 fournit les informations relatives aux exigences de construction utilisées pour fabriquer des cartes imprimées. La présente norme détermine les détails du schéma XML, défini dans la norme générique CEI 61182-2 et certaines des normes intermédiaires qui sont requises pour réaliser les tâches concernées. Lorsque d'autres normes sont associées, leurs exigences deviennent une partie obligatoire des détails de fabrication comme défini dans la CEI 61182-2.

La CEI 61182-2 contient toutes les exigences nécessaires pour construire un produit électronique. La cardinalité indiquée dans la CEI 61182-2 peut être remplacée par une restriction d'un attribut (identificateur de chaîne énumérée) ou l'indication d'une exigence notée comme étant facultative dans la norme générique. La présente norme rend toutefois l'exigence obligatoire en se fondant sur la communication de la chaîne d'approvisionnement nécessaire.

Afin d'aider les utilisateurs de la présente norme, tous les éléments du schéma XML applicables s'appliquant à la fonction de fabrication de carte sont énumérés à l'Annexe A. La liste est regroupée par sujets et montre le chemin absolu pour les éléments concernés par l'objet de la présente norme. Si l'élément parent n'est pas présent, aucun enfant n'est envisagé dans la mise en œuvre non plus. Toutefois, tous les attributs identifiés pour un élément particulier suivent la cardinalité de la CEI 61182-2 sauf restriction mentionnée dans la présente norme.

2 Références normatives

Les documents suivants sont cités en référence de manière normative, en intégralité ou en partie, dans le présent document et sont indispensables pour son application. Pour les références datées, seule l'édition citée s'applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

CEI 60194, *Printed board design, manufacture and assembly – Terms and definitions* (disponible en anglais seulement)

CEI 61182-2, *Printed board assembly products – Manufacturing description data and transfer methodology – Part 2: Generic requirements* (disponible en anglais seulement)

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

3.1
données
informations intelligentes pouvant être directement utilisées par une machine pour exécuter un événement de fabrication particulier

3.2
dessins
copie fidèle ou documentation "non intelligente" (par exemple PDF) à laquelle s'appliquent tous les critères de formatage

3.3
carte de circuit imprimé
PCB
composition de matière organique et inorganique avec un câblage extérieur et intérieur permettant de maintenir mécaniquement des composants électroniques et de les connecter électriquement

3.4
fournisseur
organisme ou société responsable de la fourniture des biens et/ou services nécessaires pour fabriquer un produit électronique incluant des éléments physiques ainsi que des caractéristiques intellectuelles/logicielles et qui est documenté en tant qu'approvisionnement de l'utilisateur, données du fournisseur ou accords contractuels

3.5
utilisateur
personne, organisme, société ou administration responsable de l'approvisionnement de circuits électriques/électroniques et disposant de l'autorité lui permettant de définir la classe de matériel et toute variante ou restriction (c'est-à-dire, l'initiateur/dépositaire du contrat détaillant ces exigences)

3.6
trou d'interconnexion
ouverture dans la ou les couches diélectriques traversée vers le haut ou vers le bas par un conducteur vers une puce ou des couches conductrices d'un boîtier qui suivent en vue d'interconnexions électriques ou pour le transfert de chaleur

4 Principes généraux

4.1 Exigences

Les exigences de la CEI 61182-2 sont une partie obligatoire de la présente norme. Les détails génériques fournissent de façon spécifique des données concernant la conception, la fabrication, l'assemblage et l'essai des cartes imprimées.

Le schéma XML de la CEI 61182-2 consiste en quatre fonctions principales dont chacune a plusieurs enfants qui deviennent ensuite de nouveaux éléments parents. Plusieurs de ces éléments principaux et leurs nouveaux parents associés sont définis dans d'autres normes intermédiaires, ainsi les exigences de ces normes sont également une partie obligatoire de la norme de fabrication des cartes dans la limite de leur description et de toutes restrictions contenues dans la présente norme.

Chacune des normes et les éléments définis dans celles-ci ont respectivement une fonction ou une tâche spécifique et bien qu'elles puissent parfois être utilisées indépendamment, elles deviennent un complément important aux exigences des descriptions de fabrication des cartes. Ainsi, les alinéas suivants fournissent les exigences complètes pour les trois types de fichiers de fabrication de cartes qui sont pris en charge par les principes de la CEI 61182-2.

En conséquence, l'échange d'informations dans le but spécifique de la fabrication de cartes imprimées n'est possible que si toutes les instances XML ont été convenablement élaborées dans ce but.

4.2 Interprétation

«Devoir», forme emphatique du verbe, est utilisé dans l'ensemble de la présente norme à chaque fois qu'une exigence est destinée à exprimer une disposition obligatoire. Aucun écart n'est permis par rapport à une exigence "devoir" et un essai de conformité est requis afin de démontrer que les instances XML sont correctes selon les directives W3C et la présente norme. Le schéma XML doit être la méthode de vérification de la syntaxe et de la sémantique. Tout outil logiciel approprié qui invite l'utilisateur à corriger l'ambiguïté ou à insérer une information manquante peut être utilisé dans ce but.

Les termes «convient» et «peut» sont utilisés à chaque fois qu'il est nécessaire d'exprimer des dispositions non obligatoires.

«Sera» est utilisé pour exprimer une déclaration d'intention.

4.3 Catégories et contenu

Le Tableau 1 indique les principales fonctions que la présente norme doit traiter. Les descriptions concernent les processus de fabrication appropriés des cartes imprimées. Quinze (15) fonctions spécifiques existent pouvant être définies en utilisant les éléments XML et les instances XML résultantes.

Le Tableau 1 indique les relations des exigences pour divers éléments et sujets au sein des descriptions pour un processus particulier.

Tableau 1 – Relation des fonctions d'un fichier de fabrication 61182-2-2

Nom	Fabrication			Commentaire et références normatives
	1	2	3	
Descriptions du contenu des fichiers	M	M	M	Éléments indiqués dans la CEI 61182-2 en fonction de leur cardinalité et des restrictions de la présente norme.
Descriptions logistiques	M	M	M	
Descriptions de l'historique des fichiers	O	M	M	
BOM (Matériaux de fabrication de carte)	M	M	M	Éléments indiqués dans la CEI 61182-2 en fonction de leur cardinalité et des restrictions de la présente norme.
AVL (Fournisseurs de matériau de carte)	-	M	M	
Couches d'image diverses	-	O	O	Éléments indiqués dans la CEI 61182-2 en fonction de leur cardinalité et des restrictions de la présente norme.
Couches de documentation	O	M	M	
Analyse de conception d'eXcellence (Dfx)	O	O	O	
Boîtiers de composants [a]	-	-	O	Éléments indiqués dans la présente norme intermédiaire en fonction de leur cardinalité selon la CEI 61182-2 et toutes restrictions contenues dans les alinéas suivants de la présente norme.
Zones de report [a]	-	-	O	
Masque de brasage, Couches de marquage	M	M	M	
Couches de perçage et de routage (Outillage)	M	M	M	
Liste d'interconnexions (Outillage logiciel) [a]	O	M	M	
Couches conductrices extérieures	M	M	M	
Couches conductrices intérieures	M	M	M	
Construction de la carte	M	M	M	

Abréviations:
BOM Matériaux de fabrication de carte
AVL Fournisseurs de matériau de carte
Dfx Analyse de conception d'eXcellence

Légende:
M Obligatoire
O Facultative
– Partie étrangère (inutile)

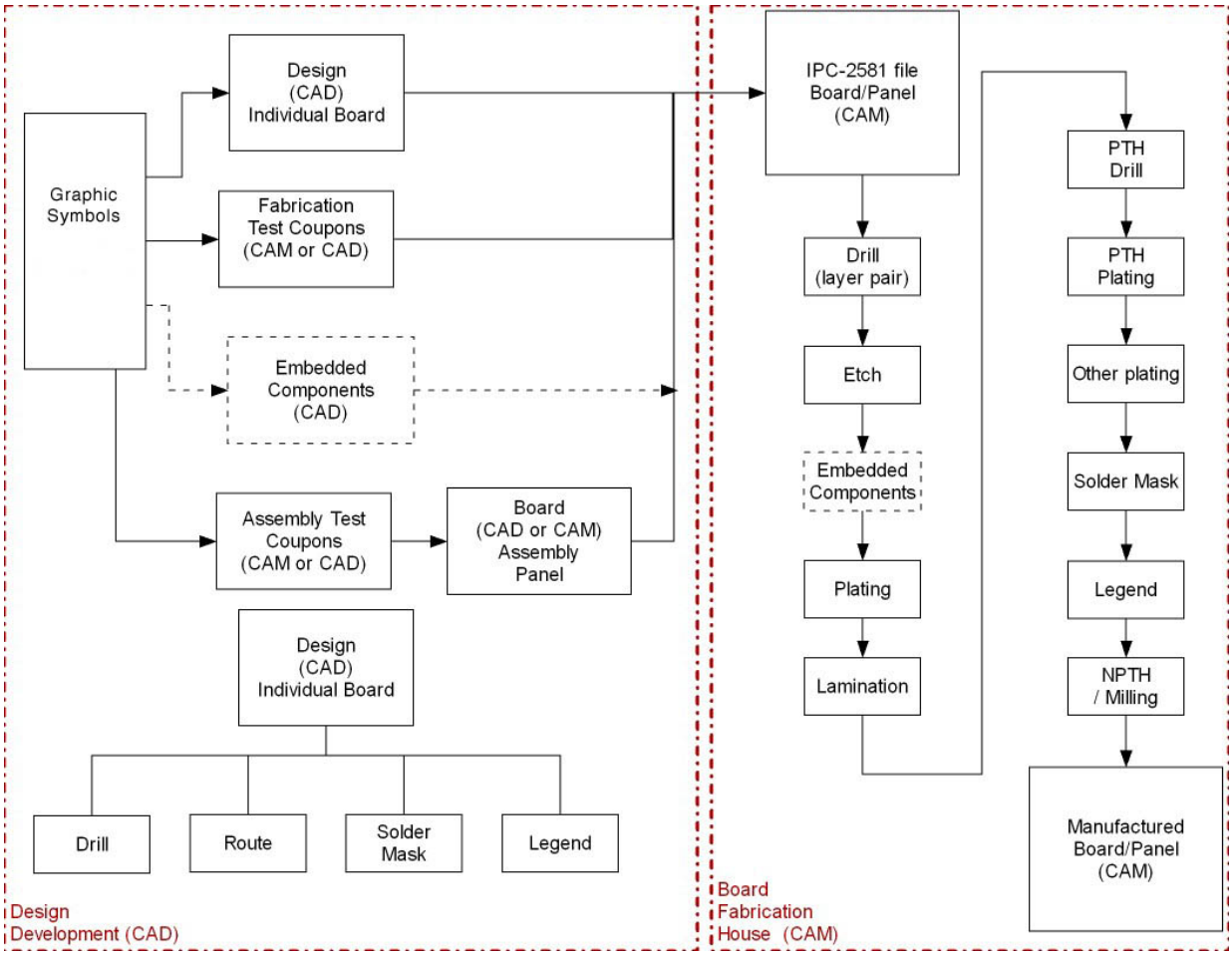
Bien que les outils logiciels utilisés pour analyser le fichier autorisent les données étrangères, il est recommandé que seules les exigences identifiées comme obligatoires ou facultatives soient incluses dans le fichier afin de diminuer la taille du transfert de fichiers.

[a] Bien que les boîtiers de composants et les zones de report seront définis plus spécifiquement dans la future CEI 61182-2-3[1], et les listes d'interconnexions dans la future CEI 61182-2-4[1], leurs schémas XML sont répétés dans la présente norme.

Il convient de comprendre que sans liste d'interconnexions il est difficile de vérifier que la carte fabriquée satisfait le but de conception.

La corrélation entre les diverses descriptions identifiées dans la présente norme est indiquée à la Figure 1. Celle-ci montre la relation des éprouvettes, de la carte elle-même, des masques photographiques, etc. L'illustration identifie les caractéristiques qui sont disponibles dans les outils de CAO (conception assistée par ordinateur) et qui sont habituellement transférables à la station de FAO (fabrication assistée par ordinateur). La partie de gauche illustre les combinaisons du but de conception incluant les caractéristiques de montage et les composants incorporés. Certains de ces concepts sont importants pour un fichier FAB1, FAB2 ou FAB3 de la CEI 61182-2-2 et sont illustrés pour les processus de fabrication de cartes représentés dans la partie de droite de l'illustration.

1 A l'étude.



IEC 630/12

Légende

Anglais	Français
Graphic symbols	Symboles graphiques
Design (CAD) individual board	Conception (CAO) carte individuelle
Fabrication test coupons (CAM or CAD)	Fabrication des éprouvettes (FAO ou CAO)
Embedded components (CAD)	Composants incorporés (CAO)
Assembly test coupons (CAM or CAD)	Assemblage des éprouvettes (FAO ou CAO)
Board (CAM or CAD) assembly panel	Panneau d'assemblage de carte (FAO ou CAO)
Design (CAD) individual board	Conception (CAO) carte individuelle
Drill	Perçage
Route	Route
Solder mask	Masque de brasage
Legend	Légende
Design development (CAD)	Elaboration de la conception (CAO)
IPC-2581 file board/panel (CAM)	Fichier carte/panneau IPC-2581
PTH drill	Perçage PTH
Drill (layer pair)	Perçage (paire de couches)
PTH plating	Métallisation PTH
Etch	Gravure
Other plating	Autre métallisation
Embedded components	Composants incorporés

Anglais	Français
Solder mask	Masque de brasage
Plating	Métallisation
Legend	Légende
Lamination	Stratification
NPTH/milling	NPTH/fraisage
Manufactured board/panel (CAM)	Carte/panneau fabriqué (FAO)
Board fabrication house (CAM)	Société de fabrication des cartes (FAO)

Figure 1 – Lien entre les données de fabrication de cartes

5 Règles générales

5.1 Vue d'ensemble

Les détails suivants représentent les règles utilisées pour décrire les caractéristiques des cartes imprimées afin de satisfaire aux exigences de fabrication des cartes. Ces règles sont destinées à satisfaire aux besoins du fabricant afin de comprendre les exigences du client. Si nécessaire, des exigences supplémentaires ont été détaillées afin de représenter la précision.

Les attributs et les règles décrits dans la CEI 61182-2 sont requis. Si nécessaire, des descriptions détaillées ou des définitions des entités, attributs ou caractéristiques sont reproduites comme défini dans la CEI 61182-2 afin de définir clairement les descriptions obligatoires.

5.2 Descriptions du contenu des fichiers

Les descriptions du contenu du fichier doivent être conformes à la CEI 61182-2. Ceci constitue une exigence obligatoire pour toutes les couches FAB, FAB1, FAB2 et FAB3.

La seule restriction de `Content` est qu'un `BomRef` est obligatoire (1-1). Un `Bom` pour la description de matériau de carte apparaîtra dans le future fichier CEI 61182-2-1[2].

CEI 61182-2/Content/BomNameRef=1

5.3 Descriptions logistiques

Toutes les exigences pour les descriptions logistiques doivent être conformes à la CEI 61182-2. La seule restriction étant lorsque le fichier est utilisé comme transfert d'informations à l'extérieur du domaine qui crée le fichier. Dans cette instance, l'attribut `RoleRef` de `Person` doit exister et il n'est plus facultatif.

CEI 61182-2/LogisticHeader/Person@RoleRef=1

Il est exigé que le nom `Role` soit l'une des 9 chaînes énumérées dans la CEI 61182-2 avec la recommandation selon laquelle, si aucun autre nom évident n'existe, il convient d'utiliser le nom SENDER (expéditeur).

CEI 61182-2/LogisticHeader/Role@name=SENDER

Il convient de comprendre que l'expéditeur du fichier peut ne pas avoir réellement de moyens électroniques pour ajouter des données ou modifier l'instance de schéma XML existante. Si un dialogue a lieu entre l'expéditeur et le récepteur des données, il convient d'effectuer une

2 A l'étude.

vérification pour déterminer la hiérarchie des fichiers et la capacité de modification à l'une ou l'autre extrémité.

5.4 Descriptions de l'historique des fichiers

5.4.1 Généralités

Toutes les exigences pour les descriptions historiques doivent être conformes à la CEI 61182-2. Les restrictions sont légèrement différentes pour les différents niveaux de fabrication et sont:

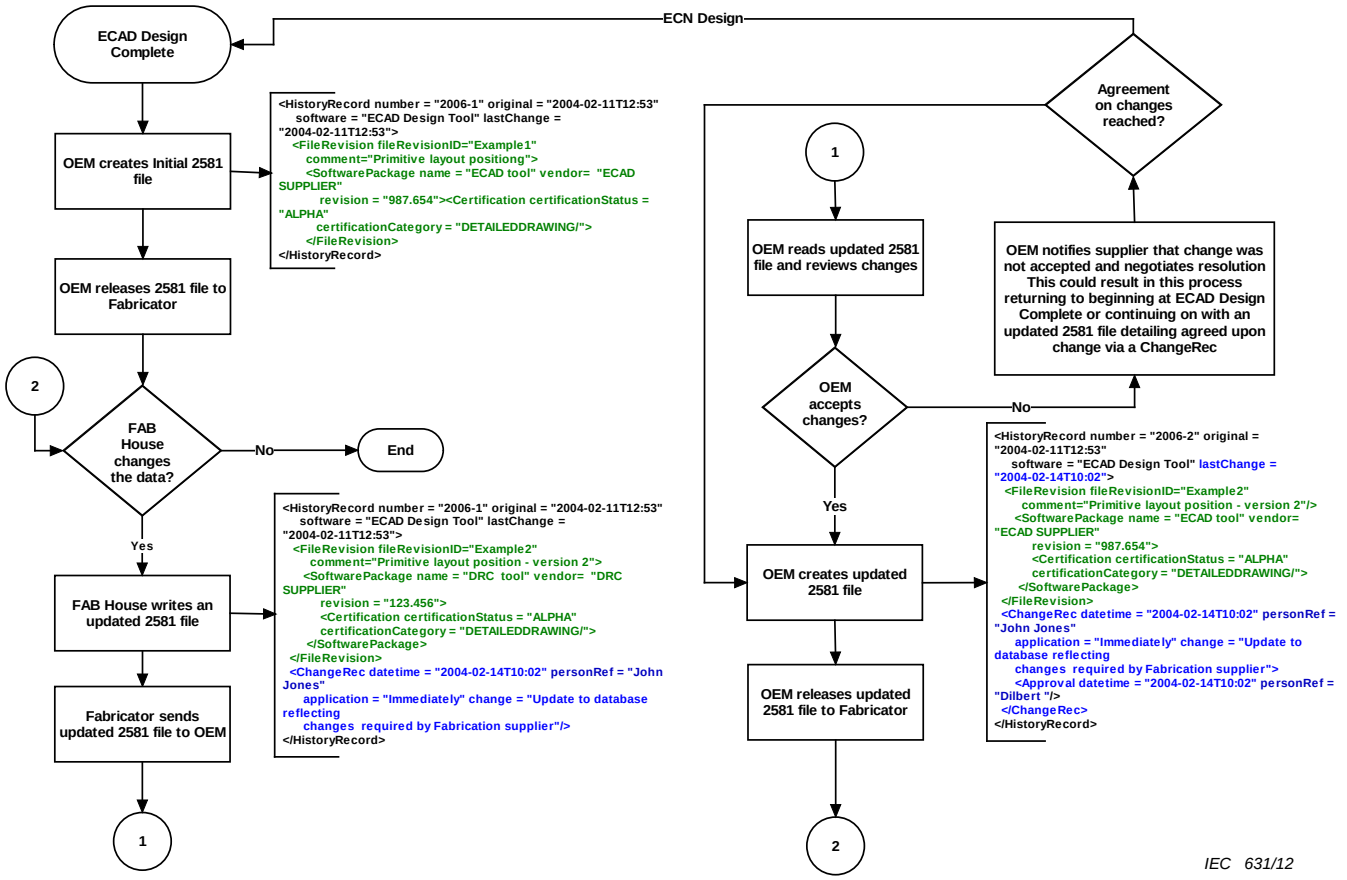
FAB1 n'a aucune restriction et satisfait à toutes les exigences de la CEI 61182-2.

FAB2 prend le `changeRecord` et en fait une exigence obligatoire (1-n au lieu de 0-n).

FAB3 exige que `changeRecord` et l'élément `Approval` soient une partie obligatoire du fichier d'instances.

CEI 61182-2/HistoryRecord/ChangeRec=1-n
CEI 61182-2/HistoryRecord/ChangeRec/Approval=1-n

La Figure 2 fournit une étude de cas de HistoryRecord. La Figure 2 et les paragraphes qui suivent montrent la tendance de la communication entre la conception au niveau constructeur de matériel et la fabrication.



Légende

Anglais	Français
ECAD design complete	Conception ECAD terminée
ECN design	Conception ECAD
OEM creates initial 2581 file	Le constructeur de matériel crée le fichier 2581 initial

Anglais	Français
OEM releases 2581 file to fabricator	Le constructeur de matériel livre le fichier 2581 au fabricant
FAB house changes the data?	La société de fabrication modifie les données?
Yes	Oui
No	Non
End	Fin
FAB house writes an updated 2581 file	La société de fabrication écrit un fichier 2581 mis à jour
Fabricator sends updated 2581 file to OEM	Le fabricant envoie le fichier 2581 modifié au constructeur de matériel
Agreement on changes reached?	Accord conclu sur les modifications?
OEM reads updated 2581 file and reviews changes	Le constructeur de matériel lit le fichier 2581 modifié et examine les modifications
OEM notifies supplier that change was not accepted and negociates resolution This could result in this process returning to beginning at ECAD design Complete or continuing on with an updated 2581 file detailing agreed upon change via a ChangeRec	Le constructeur de matériel avertit le fournisseur que la modification n'a pas été acceptée et négocie une résolution Ceci peut conduire ce processus à recommencer au début de la conception ECAD Fin ou poursuite avec un fichier 2581 mis à jour dont les détails de modifications ont été acceptés par l'intermédiaire d'un ChangeRec
OEM accept changes?	Le constructeur de matériel accepte les modifications?
Yes	Oui
No	Non
OEM creates updated 2581 file	Le constructeur de matériel crée un fichier 2581 mis à jour
OEM releases updated 2581 file to fabricator	Le constructeur de matériel livre le fichier 2581 modifié au fabricant

Figure 2 – Cas d'utilisation de HistoryRecord

5.4.2 Cas d'utilisation de HistoryRecord Use – Abandon de la conception initiale

5.4.2.1 Généralités

L'outil de conception EDA crée le fichier initial CEI 61182-2 avec LogisticHeader, HistoryRecord et les éléments de FileRevision de l'enfant de HistoryRecord.

5.4.2.2 LogisticHeader

LogisticHeader contient les informations de contact pour le constructeur de matériel ayant défini les rôles pour le projet de conception. Il existe un grand nombre de méthodes pour obtenir les informations de contact dans l'outil EDA pour l'exportation vers un fichier CEI 61182-2. Ces méthodes vont d'une manipulation manuelle, par exemple l'utilisation d'une boîte de dialogue dynamique, à l'importation automatique à partir d'un fichier contacts.xml ou d'une base de données d'entreprise.

Le nom `Role` et le nom `Person` doivent être des noms uniques. Le nom `Person` peut être un nom réel, tel que John Smith; un poste tel que Concepteur principal ou un nom de service, tel que Service achats.

De façon idéale, l'aptitude à importer toutes les informations préférées du fournisseur depuis des sources externes sera disponible afin d'inclure les fournisseurs préférés dans l'élément `LogisticHeader`. Un exemple est indiqué ci-dessous des données minimales nécessaires pour un élément complet `LogisticHeader` avec les champs facultatifs remplis.

```
<LogisticHeader>
      <Role name = "OEM Account Manager" description = "OWNER"
            publicKey = "x3d8rf7ko90mKMC07" authority = "OEM
            purchasing agent"/>
      <Enterprise id = "OEM" name = "Design House" code="34567"
            codeType = "DUNS" address1 = "123 Avenue Street " city =
            "Bigcity" stateProvince = "PV" country = "US" postalCode
            = "99999-1111" phone = "888-555-1212" fax = "888-555-
            1212" email="purchasing@oem.com" url =
            "http://www.oem.com" />
      <Person name="Purchasing Manager" enterpriseRef ="OEM" title =
            "Senior Purchasing Manager" email =
            "purchasing.manager@oem.com" phone = "888-555-1212ext123"
            fax = "888-555-1212" roleRef = "OEM Account Manager "/>
<Logistic Header>
```

5.4.2.3 HistoryRecord

`HistoryRecord` est l'emplacement des informations du fichier journal pour maintenir le contrôle de révision du fichier CEI 61182-2 pendant un cycle de vie de la conception. Ceci ne signifie pas que la totalité de l'historique est présente dans n'importe quel fichier CEI 61182-2. Ceci fournit à OWNER (le propriétaire) un enregistrement de données qui peut être exporté vers une base de données d'entreprise.

L'outil EDA doit créer un `HistoryRecord` pour chaque fichier CEI 61182-2 en fournissant un moyen pour entrer le nombre `HistoryRecord` et le `FileRevision fileRevisionID`. Les données peuvent être entrées par manipulation manuelle, par exemple en utilisant une boîte de dialogue dynamique.

```
<HistoryRecord number = "2006-1" original = "2004-02-11T12:53"
       software = "ECAD Design Tool" lastChange = "2004-02-11T12:53">
      <FileRevision fileRevisionID="12345ENG-0"
            comment="Primitive layout position">
            <SoftwarePackage name = "ECAD tool" vendor= "ECAD
                  SUPPLIER"
                  revision = "987.654">
                  <Certification certificationStatus = "ALPHA"
                        certificationCategory = "DETAILEDDRAWING/">
            </SoftwarePackage>
       </FileRevision>
</HistoryRecord>
```

5.4.3 Modifications de la Chaîne d'approvisionnement

5.4.3.1 Généralités

Une modification est ajoutée au fichier CEI 61182-2 initial par un membre de la chaîne d'approvisionnement. La modification peut être aussi simple que l'ajout d'une éprouvette ou la division en panneaux de la carte pour rechercher des problèmes de conception et la demande de modification de conception afin de produire une carte finie.

5.4.3.2 Mise à jour de LogisticHeader

Pour ajouter le ChangeRec au HistoryRecord, la chaîne d'approvisionnement peut avoir besoin de mettre à jour le LogisticHeader avec des informations supplémentaires pour fournir les données Role, Enterprise et Person pour la chaîne d'approvisionnement.

Le fournisseur ne doit pas modifier les informations associées à un quelconque identificateur d'entreprise différente de la sienne. La mise à jour de LogisticHeader doit créer un ChangeRec même si aucune autre donnée n'a été modifiée. Ceci donne le moyen au constructeur de matériel de mettre à jour ses informations de contacts.

Il existe un grand nombre de méthodes pour obtenir ces informations dans le fichier, allant d'une manipulation manuelle à l'importation d'un contacts.xml. Un exemple du fichier contacts.xml est indiqué ci-dessous.

```
<LogisticHeader>
      <Enterprise id = "OEM" name = "Design House" code="34567"
            codeType = "DUNS" address1 = "123 Avenue Street " city =
            "Bigcity" stateProvince = "PV" country = "US" postalCode
            = "99999-1111" phone = "888-555-1212" fax = "888-555-
            1212" email="purchasing@oem.com" url =
            "http://www.oem.com" />
      <Role name = "OEM Account Manager" description = "OWNER"
            publicKey = "x3d8rf7ko90mKMC07" authority = "OEM
            purchasing agent"/>
      <Person name="Purchasing Manager" enterpriseRef ="OEM" title =
            "Senior Purchasing Manager" email =
            "purchasing.manager@oem.com" phone = "888-555-1212ext123"
            fax = "888-555-1212" roleRef = "OEM Account Manager "/>
      <Enterprise id = "Fab" name = "Board Shop" code="23456"
            codeType = "DUNS" address1 = "123 Street Avenue" city =
            "Mytown" stateProvince = "ST" country = "US" postalCode =
            "00000-1111" phone = "800-555-1212" fax = "800-555-1212"
            email="support@boardshop.com" url =
            "http://www.boardshop.com" />
      <Role name = "Supply Chain Customer Account Manager"
            description = "CUSTOMERSERVICE" publicKey =
            "x6d8rf7xd90mJHR13" authority = "Feed back to OEM"/>
      <Role name = "FAB Project Lead Engineer" description =
            "ENGINEER" publicKey = "x444rf7xd90mJHR13" authority =
            "FAB Lead Engineer"/>
      <Person name="Account Manager" enterpriseRef ="Fab" title =
            "Senior Global Account Manager" email =
            "customer.service@boardshop.com" phone = "800-555-
            1212ext123" fax = "800-555-1212" roleRef = "Supply Chain
            Customer Account Manager "/>
      <Person name="Project Engineer" enterpriseRef ="Fab" title =
            "Manager, Fabrication" email =
            "project.engineer@boardshop.com" phone = "800-555-
            1212ext456" fax = "800-555-1212" roleRef = " FAB Project
            Lead Engineer "/>
<Logistic Header>
```

5.4.3.3 Mise à jour de HistoryRecord

Le parent de HistoryRecord doit rester inchangé par le logiciel de la Chaîne d'approvisionnement. Il est identifié dans l'exemple par l'utilisation de texte souligné. Le logiciel de la chaîne d'approvisionnement utilise FileRevision pour identifier le logiciel utilisé pour créer le fichier CEI 61182-2 mis à jour.

```
<HistoryRecord number = "2006-1" original = "2004-02-11T12:53"
      software = "ECAD Design Tool" lastChange = "2004-02-11T12:53">
      <FileRevision fileRevisionID="12345ENG-0mod"
            comment="Primitive layout position – updated with
            manufacturing requirements">
            <SoftwarePackage name = "DRC tool" vendor= "DRC SUPPLIER"
                  revision = "123.456">
                  <Certification certificationStatus = "ALPHA"
                        certificationCategory = "DETAILEDDRAWING/">
            </SoftwarePackage>
      </FileRevision>
      <ChangeRec datetime = "2004-02-14T10:02" personRef = "Supply
            Chain Engineer"
            application = "Immediately" change = "Update to database
            reflecting
            changes required by fabrication process."/>
</HistoryRecord>
```

5.4.4 Modifications des révisions du constructeur de matériel – Mise à jour de HistoryRecord

Les constructeurs de matériel et leur chaîne d'approvisionnement peuvent utiliser fileRevisionID pour adapter les fichiers CEI 61182-2 à leurs prédécesseurs. Le maintien de la cohérence dans le champ fileRevisionID facilitera l'aptitude à réutiliser des éléments durant le cycle de vie de la conception.

```
<HistoryRecord number = "2006-2" original = "2004-02-11T12:53"
      software = "ECAD Design Tool" lastChange = "2004-02-14T10:02">
      <FileRevision fileRevisionID="12345ENG-1
            comment="Primitive layout position - version 2"/>
            <SoftwarePackage name = "ECAD tool" vendor= "ECAD
                  SUPPLIER"
                  revision = "987.654">
                  <Certification certificationStatus = "ALPHA"
                        certificationCategory = "DETAILEDDRAWING/">
            </SoftwarePackage>
      </FileRevision>
      <ChangeRec datetime = "2004-02-14T10:02" personRef = "John
            Jones"
            application = "Immediately" change = "Update to database
            reflecting
            changes required by Fabrication supplier">
            <Approval datetime = "2004-02-14T10:02" personRef =
                  "Dilbert "/>
      </ChangeRec>
</HistoryRecord>
```

5.5 BOM (matériaux de fabrication de carte)

Les exigences de la couche BOM doivent être conformes à la CEI 61182-2. Les restrictions suivantes s'appliquent:

Bom/BomItem@category=MATERIAL

Ceci constitue une exigence obligatoire pour FAB1, FAB2 et FAB3. Le Tableau 2 indique les restrictions de `Bom` pour la fabrication de la carte.

Tableau 2 – Restrictions de Bom

Content/FunctionMode	Type FunctionMode	@mode= FABRICATION @level=1	@mode= FABRICATION @level=2	@mode= FABRICATION @level=3
Bom/BomItem	BomItemType	@category=MATERIAL	@category=MATERIAL	@category=MATERIAL
Bom/BomItem/RefDes.	RefDesType	Selon Tableau 3	Selon Tableau 3	Selon Tableau 3
Bom/BomItem/RefDes/Tuning	TuningType	0	0	0
Bom/BomItem/RefDes/ Firmware	FirmwareType	0	0	0
Bom/BomItem/RefDes/ Firmware/File	FileType	0	0	0
Bom/BomItem/RefDes/ Firmware/CachedFirmware	CachedFirmwareType	0	0	0
Bom/BomItem/RefDes/ Firmware/FirmwareRef	FirmwareRefType	0	0	0
Bom/BomItem/Characteristics	CharacteristicsType	@category=MATERIAL	@category=MATERIAL	@category=MATERIAL
Bom/BomItem/Characteristics/ Measured	MeasuredType	CEI 61182-2	1-n	1-n
Bom/BomItem/Characteristics/ Ranged	RangedType	CEI 61182-2	CEI 61182-2	1-n

Lorsque des désignateurs de référence sont requis, comme indiqué pour `BomItem`, `RefDes` doit être conforme au Tableau 3. Puisque l'élément `RefDes` est normalement limité à des composants électroniques, ce tableau a été construit en tant que méthodologie recommandée pour définir différents matériaux au sein du `Bom`. `RefDes` a une exigence de cardinalité de 1-*n*. Ceci est toujours approprié pour FAB1, FAB2 et FAB3. Lorsque l'élément `RefDes` est instancié, ne nom d'attribut doit être conforme au Tableau 3.

CEI 61182-2/Bom/BomItem/RefDes@name=Table 3

Tableau 3 – Indicateurs de référence recommandés pour le matériau des cartes imprimées

Type de matériau	Désignateur de référence	Commentaires
Encre de la légende	LEG	
Masque de brasage	SDM	
Conducteur	CND	
Matériau diélectrique de base	DBM	
Cœur du diélectrique	DIC	
Préimprégné du diélectrique	DPP	
Adhésif du diélectrique	DIA	
Plot de soudure	SBM	
Matériau de remplissage des trous	HFM	
Matériau résistif	ERM	
Matériau capacitif	ECM	
Autre	OTH	

Les restrictions supplémentaires pour `BomItem` sont que l'attribut `Category` doit être énuméré en tant que MATERIAL (matériau).

CEI 61182-2/Bom/BomItem@category=MATERIAL

L'élément `Characteristic` possède également certaines restrictions concernant FAB2 et FAB3. Celles-ci concernent l'occurrence des éléments `Measured` et `Ranged` qui deviennent obligatoires dans certaines applications.

CEI 61182-2/Bom/BomItem/Characteristic@category=MATERIAL (comme BomItem)
CEI 61182-2/Bom/BomItem/Characteristic/Measured=1 (pour FAB2 et FAB3)
CEI 61182-2/Bom/BomItem/Characteristic/Ranged=1 (pour FAB3)

5.6 AVL (fournisseurs de matériau de carte)

Les exigences concernant AVL doivent être conformes à la CEI 61182-2. Les restrictions suivantes s'appliquent et sont détaillées au Tableau 4.

Avl/AvlHeader@modRef=FABRICATION

Ceci constitue une exigence facultative pour FAB2 et FAB3.

Tableau 4 – Restrictions d'Avl

Avl/AvlHeader	**AvlHeaderType**	**@modRef= FABRICATION**	**@modRef= FABRICATION**	**@modRef= FABRICATION**
Avl/AvlItem	AvlItemType	1-1	1-1	1-1
Avl/AvlItem/AvlVmpn	AvlVmpnType	@qualified=FALSE @chosen=FALSE	@qualified=FALSEor TRUE @chosen=FALSE or TRUE	@qualified=FALSE or TRUE @chosen=FALSE or TRUE
Avl/AvlItem/AvlVmpn/AvlMpn	AvlMpnType	0-1	0-1	0-1
Avl/AvlItem/AvlVmpn/AvlVendor	AvlVendorType	0-1	0-1	0-1

5.7 Couches de documentation

5.7.1 Généralités

Les exigences de la couche de documentation doivent être conformes à la CEI 61182-2. Les restrictions suivantes s'appliquent:

Ecad/CadData/Layer@LayerFunction=DOCUMENTATION

Ecad/CadData/Layer@name=nom de couche unique recommandé, cohérent avec le nom Step

Ceci constitue une exigence obligatoire pour FAB1, FAB2 et FAB3.

5.7.2 Restrictions de la couche de documentation

Les fonctions suivantes, représentées au Tableau 5, sont applicables lorsqu'une couche de documentation est identifiée.

Tableau 5 – Restrictions de la couche de documentation

Mode Content/Function	**Type FunctionMode**	**@mode=FABRICATION @level=1**	**@mode=FABRICATION @level=2**	**@mode=FABRICATION @level=3**
Ecad/CadData/ Layer	LayerType	*@layerFunction=COURTYARD*	*@layerFunction=COURTYARD*	*@layerFunction=COURTYARD*
		@layerFunction=GRAPHIC	*@layerFunction=GRAPHIC*	*@layerFunction=GRAPHIC*
		@layerFunction=DRAWING	@layerFunction=DRAWING	@layerFunction=DRAWING
		@layerFunction=LANDPATTERN	*@layerFunction=LANDPATTERN*	*@layerFunction=LANDPATTERN*
		@layerFunction=COMPONENT_TOP	@layerFunction=COMPONENT_TOP	@layerFunction=COMPONENT_TOP
		@layerFunction=COMPONENT_BOTTOM	@layerFunction=COMPONENT_BOTTOM	@layerFunction=COMPONENT_ BOTTOM
		@layerFunction=OTHER	*@layerFunction=OTHER*	*@layerFunction=OTHER*
Légende: *en italique* = facultatif				

Pour faciliter l'interprétation, le Tableau 6 est un tableau d'illustrations de référence des restrictions qui sont représentées dans leur description de chemin XML au Tableau 5.

Tableau 6 – Descriptions générales des fonctions de la couche de documentation

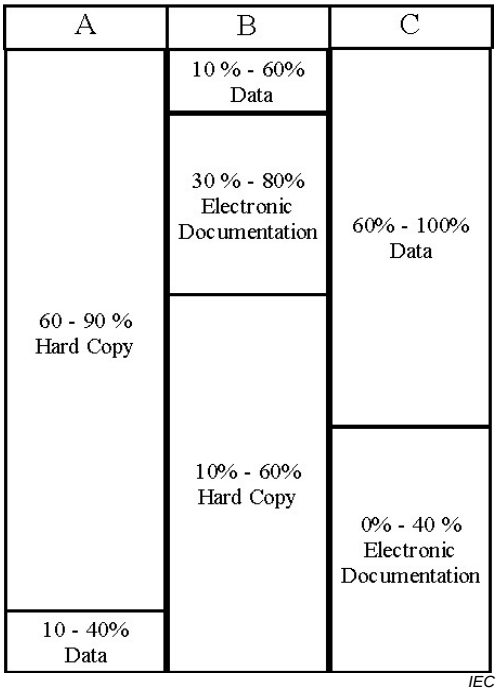
@LayerFunction	**FAB1**	**FAB2**	**FAB3**	**Remarques**
COURTYARD	O	O	O	
GRAPHIC	O	O	O	
DRAWING	O	M	M	Utilisé principalement pour toute forme de documentation
LANDPATTERN	O	O	O	
COMPONENT_TOP	O	M	M	Ne s'applique qu'à la documentation d'assemblage
COMPONENT_BOTTOM	O	M	M	Ne s'applique qu'à la documentation d'assemblage
OTHER	O	O	O	

5.7.3 Référence à la documentation

Les informations présentées au Tableau 7 soulignent les fonctions de la documentation pour la norme CEI 61182-2. Ces informations doivent être cohérentes dans l'ensemble du fichier de données.

La Figure 3 est une illustration indiquant une variation approximative du degré de mélange entre la documentation électronique et par copie fidèle. La documentation électronique est

considérée comme non intelligente (prête pour imprimer une copie fidèle), tandis que les données sont considérées comme intelligentes (prêtes à être utilisées par une machine).



Légende

Anglais	Français
10 % to 60 % data	10 % à 60 % données
30 % to 80 % electronic documentation	30 % à 80 % documentation électronique
60 % to 90 % hard copy	60 % à 90 % copie fidèle
60% to 100 % data	60 % à 100 % données
10 % to 60 % hard copy	10 % à 60 % copie fidèle
10 % to 40 % data	10 % à 40 % données
0 % to 40 % electronic documentation	0 % à 40 % documentation électronique

Figure 3 – Exigences des catégories de la documentation

Puisque les exigences concernant la documentation comportent trois catégories (A, B, C) plus trois niveaux de complexité dans chaque catégorie (1, 2, 3), il convient de déterminer une corrélation entre les niveaux de catégories particuliers et la documentation des données dans un fichier CEI 61182-2-2. (Voir Tableau 7.)

Tableau 7 – Relation avec la norme de documentation

Complexité/Catégorie	A	B	C
1	N/A	FAB1, FAB2	FAB1, FAB2
2	N/A	FAB1, FAB2, FAB3	FAB1, FAB2, FAB3
3	N/A	FAB2, FAB3	FAB2, FAB3

La catégorie B fait échouer la validation du cas d'utilisation automatique et nécessite d'être validée manuellement. Le but est de s'efforcer que la documentation de Catégorie C utilisant la CEI 61182-2 admette un transfert de données de 60 % à 100 %.

5.7.4 Utilisation de Step

5.7.4.1 L'élément Step

L'élément Step est utilisé plusieurs fois lorsque Layer est utilisé pour la documentation. Chaque Step possède un Step name. Il est recommandé que le Step name assigné au Step soit unique et soit similaire à l'attribut name assigné à layer. LayerFunction doit être de type DOCUMENTATION, voir Tableau 5.

5.7.4.2 Step

Il peut y avoir de un à un grand nombre de «Step» dans tout fichier CEI 61182-2-2. Chaque Step a un nom unique qui peut être quelconque mais il est recommandé qu'il soit un sous-ensemble identifiable de Step et il convient qu'il soit conforme à l'attribut Step/name.

Il convient de noter que certains «Step» pour la documentation tirent avantage des «Step» précédemment définis (c'est-à-dire, utilisation d'un step de carte et d'un step d'assemblage pour réaliser un dessin d'assemblage. Ceci utilise l'élément StepRepeat pour combiner les «Step» précédemment définis en plaçant les images graphiques sur un format de dessin.

Chaque Step nécessite une définition obligatoire de Datum et Profile. Toutes les informations graphiques doivent être fournies sous la forme d'un LayerFeature.

Lorsque LayerFeature définit les informations graphiques en utilisant les divers «Set», il doit être associé à la couche spécifique comme identifié par le nom de couche. Ceci est réalisé par l'intermédiaire du layerRef obligatoire associé au LayerFeature de tout Step dans n'importe quel fichier CEI 61182-2.

Step/LayerFeature@layerRef=Layer@name (utilisateur unique assigné)

5.7.5 Set

Toutes les exigences de documentation représentées au Tableau 1 doivent être prédéfinies dans la section dictionnaire d'utilisateur du fichier et sont instanciées par l'intermédiaire du chemin.

Ecad/CadData/Step/LayerFeature/Set/Features

Lorsque les propriétés de documentation sont instanciées au moment où la propriété est décrite, le lineDescGroup associé à la propriété spécifique (Line, Arc, Polyline, et Outline) doit avoir priorité et le lineDescGroup de Set doit être à 0.

5.8 Analyse de conception d'excellence (Dfx)

5.8.1 Généralités

Toutes les caractéristiques de DfxMeasurement doivent être conformes à la CEI 61182-2. Lorsqu'une analyse Dfx est requise comme spécifiée au Tableau 1, DfxMeasurementList doit restreindre la catégorie à BOARDFAB.

Ecad/CadData/Step/DfxMeasurementList@category=BOARDFAB

Ceci constitue une exigence obligatoire pour FAB2 et FAB3.

5.8.2 DfxMeasurement

Lorsque les propriétés de DfxMeasurement sont instanciées au moment où la propriété est décrite, le lineDescGroup associé à la propriété spécifique (Line, Arc, Polyline et Outline) doit avoir priorité et le lineDescGroup de Set doit être à 0.

5.9 Couches d'image diverses

5.9.1 Généralités

Les couches d'images diverses sont principalement utilisées pour saisir et transférer des descriptions graphiques qui n'appartiennent pas nécessairement à l'une des catégories spécifiques des descriptions de CadData.

Les exigences de cette couche doivent être conformes à la CEI 61182-2. Les restrictions suivantes s'appliquent:

Ecad/CadData//Layer@layerFunction=OTHER

Ceci constitue une exigence facultative pour FAB2 et FAB3.

5.9.2 Utilisation de Step

5.9.2.1 L'élément Step

L'élément Step est utilisé plusieurs fois lorsque Layer est utilisé pour des couches diverses. Chaque Step possède un Step name. Il est recommandé que le nom de Step assigné au Step soit unique et soit similaire à l'attribut layerFunction assigné à layer. LayerFunction doit être OTHER.

Il est également recommandé que les informations soient incluses dans le dictionnaire sous forme d'images graphiques, définies dans le dictionnaire utilisateur ou standard et appelées comme nécessaire.

5.9.2.2 Step

Il peut y avoir de un à un grand nombre de «Step» dans n'importe quel fichier CEI 61182-2-2. Chaque Step a un nom unique qui peut être quelconque mais il convient qu'il soit un sous-ensemble identifiable du Step et il convient qu'il soit conforme à l'attribut Step name.

Chaque Step nécessite une définition obligatoire de Datum et Profile. Voir Tableau 8 pour les restrictions de couches diverses. Toutes les informations graphiques doivent être fournies sous la forme d'un LayerFeature.

Tableau 8 – Restrictions de couches diverses

Content/FunctionMode	@mode=FABRICATION @level=1	@mode=FABRICATION @level=2	@mode=FABRICATION @level=3
Ecad/CadData/Layer	*@LayerFunction OTHER*	*@LayerFunction OTHER*	*@LayerFunction OTHER*
Key: *en italique = facultatif*			

5.10 Boîtiers et zones de report

5.10.1 Généralités

Lorsque des boîtiers sont requis pour définir les dimensions des composants, ce qui est facultatif pour le niveau FAB3, les caractéristiques de Step doivent définir les instances des descriptions de boîtiers. Lorsque tel est le cas, le PROCESS Layer doit indiquer ASSEMBLY.

Ecad/CadData/Layer@layerFunction=ASSEMBLY

Ceci constitue une exigence facultative seulement pour FAB3.

La plupart des boîtiers sont décrits conformément à la fonction Step Package. Le nom approprié du type Package doit être conforme à la CEI 61182-2 et la future CEI 61182-2-3, par exemple, BARE_DIE, FLIECHIP, CHIP, OTHER, etc.

Il convient que la convention de nom du type Package soit conforme à l'Annexe A de la CEI 61182-2.

Ecad/CadData/Step/Package@name=selon l'Annexe A de la CEI 61182-2
Ecad/CadData/Step/Package@type=selon le type Package Type de la CEI 61182-2

5.10.2 Utilisation de Step pour les boîtiers de composants et les zones de report

5.10.2.1 L'élément Step

L'élément Step est utilisé plusieurs fois lorsque Layer est utilisé pour les descriptions de couches Package. Chaque Step possède un Step name. La recommandation est que le Step name soit unique et similaire au name et à l'attribut LayerFunction assigné pour Layer c'est-à-dire que les détails de step recommandés coïncident avec LayerFunction = ASSEMBLY.

5.10.2.2 Step

Il peut y avoir de un à un grand nombre de «Step» dans tout fichier CEI 61182-2. Chaque Step a un nom unique qui peut être quelconque mais il convient qu'il soit un sous-ensemble similaire du nom Step utilisé pour les descriptions de boîtiers de composants et il convient qu'il soit conforme à l'attribut step name.

Chaque Step nécessite une définition obligatoire de Datum et Profile. Toutes les informations graphiques doivent être fournies sous la forme d'un LayerFeature.

5.10.3 Détails de la zone de report

LandPattern est un élément enfant facultatif (0-1) de Package. Ainsi, il hérite des restrictions de Package comme mentionné dans les paragraphes précédents et définit le ou les Pad(s) et Target(s) appropriés nécessaires pour effectuer la corrélation du cuivre de surface de la carte avec les caractéristiques du Package décrit. Ces restrictions supplémentaires sont requises et ce sont les caractéristiques des Pin(s) définies en tant que partie du Package. Ces attributs traitent electricalType et mountType et sont des chaînes énumérées. Dans leur utilisation dans la présente application, le nom approprié doit être assigné ainsi que le pinType.

Ces exigences sont conformes à la CEI 61182-2.

Ecad/CadData/Step/Package/Pin@type=THRU | SURFACE
Ecad/CadData/Step/Package/Pin@electricalType=ELECTRICAL | MECHANICAL | UNDEFINED
Ecad/CadData/Step/Package/Pin@mountType=selon la future CEI 61182-2-3.

Il convient que les systèmes de CAO (Conception assistée par ordinateur) utilisent des techniques de trous traversants ou de montage en surface pour la fixation des composants.

5.11 Masque de brasage et couches de légende

5.11.1 Généralités

Toutes les descriptions concernant le masque de brasage et la légende doivent être conformes à la CEI 61182-2 avec les restrictions indiquées dans les paragraphes suivants.

5.11.2 Détails du masque de brasage

Les descriptions de Layer pour le masque de brasage doivent limiter layerFunction à la chaîne énumérée SOLDERMASK. Ceci est un attribut de l'élément Layer et inclut une restriction du côté où est appliqué le masque de brasage. Ces restrictions sont obligatoires

pour FAB1, FAB2, et FAB3. Le CadData/Step correspondant doit être utilisé pour définir la carte, le panneau de carte ou les caractéristiques de l'éprouvette.

Ecad/CadData/Layer@layerFunction=SOLDERMASK
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

5.11.3 Détails de la légende

Les descriptions de Layer pour la légende doivent limiter layerFunction à la chaîne énumérée LEGEND. Ceci est un attribut de l'élément Layer et inclut une restriction du côté où est appliquée la légende. Ces restrictions sont obligatoires pour FAB1, FAB2, et FAB3. Le CadData/Step correspondant doit être utilisé pour définir la carte, le panneau de carte ou les caractéristiques de l'éprouvette.

Ecad/CadData/Layer@layerFunction=LEGEND
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

La source pour les informations de légende est principalement déterminée à partir de l'élément Silkscreen de Package pour les composants qui sont disposés du côté approprié de la carte. Les autres informations de légende tels que les logos, l'état UL, etc., peuvent être ajoutés à l'image finale définie sous la hiérarchie Step/LayerFeature/Set/Features.

Dans les modes FABRICATION ou ASSEMBLY, les éléments CEI 61182-2 doivent présenter une image explicite et non ambiguë des couches à fabriquer. Les éléments FABRICATION ou ASSEMBLY ont donc priorité lorsqu'ils existent. L'image de la couche de légende envisagée pour la fabrication sera la simple Step/LayerFeature/Set/Features pour la légende appropriée.

Toutes les descriptions de légende contenues dans les éléments finaux Step/LayerFeature/Set/Features de l'élément Silkscreen de Package ou d'autres sources, doivent être consolidées avant de générer le fichier CEI 61182-2.

5.11.4 Utilisation de Step pour le masque de brasage et les couches de légende

Toutes les couches représentant des données qui se terminent en faisant partie de la carte doivent faire partie du Step dont purpose est défini en utilisant la chaîne énumérée BOARD. Puisque la légende et le masque de brasage sont inséparables de la carte après fabrication, alors les couches de légende et de masque de brasage pour les faces supérieure et inférieure (et les couches intérieures, si elles sont définies, pour des applications particulières), de la carte doivent être incluses dans le step BOARD.

Des couches supplémentaires de masque de brasage et de légende peuvent être incluses dans un Step utilisé pour définir BOARDPANEL, ASSEMBLYPALLET, ou COUPON si ces entités nécessitent des marquages de légende spéciaux ou des descriptions de masque de brasage ou des espaces.

Les couches qui concernent le step BOARD doivent définir la hiérarchie Step/LayerFeature et contiennent les éléments LayerFeature dont la définition LayerRef pointe sur la couche appropriée. Par exemple, si nom de couche pour la couche de légende supérieure est Legend_Top alors le step dont l'utilisation est assignée comme BOARD doit avoir un élément Step/LayerFeature dont LayerRef est fixé au nom qualifié «Legend_Top».

5.12 Couches de perçage et de routage (outillage)

5.12.1 Généralités

Toutes les descriptions concernant les informations de perçage et de routage doivent être conformes à la CEI 61182-2 avec les restrictions indiquées dans les paragraphes suivants.

5.12.2 Détails de perçage

Les descriptions de `Layer` pour le perçage doivent limiter `layerFunction` à la chaîne énumérée DRILL. Ceci est un attribut de l'élément `Layer` et inclut une restriction du côté où est appliqué le perçage. Ces restrictions sont obligatoires pour FAB1, FAB2, et FAB3. Le `CadData/Step` correspondant doit être utilisé pour définir la carte, le panneau de carte ou les caractéristiques de l'éprouvette.

Ecad/CadData/Layer@layerFunction=DRILL
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL | ALL

5.12.3 Détails du routage

Les descriptions de `Layer` pour le routage doivent limiter `layerFunction` à la chaîne énumérée ROUTE. Ceci est un attribut de l'élément `Layer` et inclut une restriction du côté où est appliqué le routage. Ces restrictions sont obligatoires pour FAB1, FAB2, et FAB3. Le `CadData/Step` correspondant doit définir le `purpose` de «Step» en utilisant la chaîne énumérée BOARD.

Ecad/CadData/Layer@layerFunction=ROUTE
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL | ALL
Ecad/CadData/Step@purpose=BOARD

5.12.4 Utilisation de Step pour le perçage et le routage

5.12.4.1 Généralités

Toutes les couches représentant des données qui se terminent en faisant partie de la carte doivent faire partie du Step qui est utilisé pour définir les caractéristiques BOARD. Il convient que les trous métallisés comme les trous non métallisés fassent partie du step utilisé pour définir la carte, le panneau de carte ou l'éprouvette puisque ces trous font partie du produit fini. Ceci inclut les informations de perçage du trou simple plus l'épaisseur de métal à l'intérieur de la colonne pour les trous métallisés. De façon similaire, le routage forme le contour de la BOARD (carte) finalement fournie et en conséquence, toutes les couches de routage de la carte (habituellement une seule) doivent appartenir au step utilisé pour ces descriptions.

Des couches de perçage et de routage supplémentaire peuvent être incluses dans les steps palette d'assemblage, éprouvette ou panneau de carte, si ces entités nécessitent un montage spécial ou des trous métallisés et pour les couches de routage formant le contour de ces steps.

Les couches qui concernent le step BOARD doivent définir la hiérarchie Step/LayerFeature et contiennent les éléments LayerFeature dont la définition LayerRef pointe sur la couche appropriée. Par exemple – si le Nom de couche pour la couche de trou traversant est Drill alors le Step unique dont l'utilisation de Step est assignée comme BOARD (carte) doit avoir un élément Step/LayerFeature dont LayerRef est fixé au nom qualifié «Drill».

5.12.4.2 Restrictions supplémentaires de Step

Dans une information LayerFeature/Set décrivant des caractéristiques spécifiques des aspects de perçage ou de routage, l'élément Pad peut être instancié (0-*n*). Lorsque Pad est instancié, l'attribut padUsage de Set doit être limité à TOE | VIA | TOOLING_HOLE | NONE.

Ecad/CadData/Step/LayerFeature/Set@padUsage= TOE | VIA | TOOLING_HOLE | NONE

Un fichier CEI 61182-2 peut également contenir des éléments Step utilisé pour définir des caractéristiques TOOLING (outillage). Cette condition peut se produire lorsque step est un récipient possible pour des informations de montage supplémentaires par exemple des montages d'essai électrique. Toutefois, les informations de trous percés ou de routage faisant

partie des données de CAO (Conception assistée par ordinateur) doivent toujours être incluses dans LayerFeature/Set/Features appartenant aux descriptions BOARD (carte) pour toute carte spécifique. Si un besoin est identifié pour décrire des cas d'utilisation pour des montages, il convient que ces informations soient contenues dans un step TOOLING (outillage).

5.13 Liste d'interconnexions

5.13.1 Généralités

Lorsque des informations de connectivité électrique sont requises, qui sont facultatives pour le niveau FAB2 et obligatoires pour FAB3, les caractéristiques de `Step` doivent définir les instances `PhysNetGroup` des descriptions électriques. Toutes les exigences de la future CEI 61182-2-4 (CEI 61182-2) prédominent. Lorsque ceci se produit, la liste d'interconnexions physiques représente toutes les informations requises et ne nécessite pas de descriptions du composant et du boîtier. Les informations définissent ainsi l'interconnectivité du motif conducteur sans référence aux broches de composants ou à la désignation de référence.

Les couches de conducteur qui seront utilisées pour calculer la connectivité doivent être celles qui s'adaptent aux restrictions mentionnées ci-dessous:

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

Lorsque les informations requises dans le fichier CEI 61182-2-2 nécessitent que la description de l'essai électrique comporte les références aux broches des composants, le fichier doit inclure des descriptions `LogicalNet` qui définissent les composants, les numéros de leurs broches et les désignations de référence des composants (`refDes`). Pour maintenir un fichier cohérent, il convient qu'un step utilisé pour définir TOOLING (outillage) soit utilisé pour coordonner les descriptions physiques aux descriptions logiques.

Ecad/CadData/Layer@layerFunction=PROBE
Ecad/CadData/Layer@side=TOP | BOTTOM | INTERNAL

5.13.2 Utilisation de Step pour la liste d'interconnexions

Dans la plupart des cas, le step BOARD (carte) est utilisé pour décrire l'interconnectivité physique des couches conductrices (CONDFOIL | CONDFILM) (et des couches de perçage). Dans la fabrication multicouche il est parfois important d'effectuer l'évaluation électrique avant le step de stratification finale. Ceci est particulièrement important lorsqu'un noyau interne double face contient des trous d'interconnexion qui seront enfouis à le step de stratification finale. L'élément `layer` inclut une méthodologie permettant l'identification de ces fonctions de fabrication en séquence sous le `Stackup` de l'élément `CadData`.

Il est important de maintenir la cohérence dans la dénomination et le référencement croisé des informations d'interconnexions physiques en même temps que les informations de construction de la carte. L'élément `StackupGroup` fournit cette caractéristique permettant de combiner plusieurs couches sous l'élément StackupLayer et fournit un nom approprié pouvant être référencé dont le produit de carte multicouche final. Ces caractéristiques sont particulièrement utiles pour produire des cartes HDI fabriquant un noyau de plusieurs couches puis ajoutant en séquence des couches de petits trous d'interconnexion au-dessus et au-dessous de l'empilement.

L'utilisation de plusieurs steps permet de gérer les données de façon cohérente dans la combinaison de descriptions physiques et électriques associées à la fabrication de la construction d'une carte multicouche en séquence.

Ecad/CadData/Stackup/StackupGroup@name=identificateur unique
Ecad/CadData/Stackup/StackupGroup/StackupLayer/@layerOrGroupRef=identificateur unique
Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM|

Ecad/CadData/Layer@layerFunction=PROBE
Ecad/CadData/Layer@side=TOP | BOTTOM

5.14 Couches conductrices extérieures

5.14.1 Généralités

Toutes les descriptions concernant les couches conductrices extérieures doivent être conformes à la CEI 61182-2 avec les restrictions indiquées dans les paragraphes suivants.

5.14.2 Détails des couches conductrices extérieures

Toutes les couches représentant des données qui se terminent en faisant partie de la carte doivent faire partie du Step utilisé pour définir BOARD (carte). Les caractéristiques conductrices extérieures sont une exigence obligatoire de FAB1, FAB2 et FAB3.

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=TOP | BOTTOM

5.14.3 Utilisation de Step pour les couches conductrices extérieures

Les couches qui concernent le step BOARD doivent définir la hiérarchie Step/LayerFeature et contiennent les éléments LayerFeature dont la définition LayerRef pointe sur la couche appropriée. Par exemple, si le nom de couche pour la couche conductrice supérieure unique est «Top» alors le Step utilisé pour définir BOARD doit avoir un élément Step/LayerFeature dont LayerRef est fixé au nom qualifié «Top».

Dans un grand nombre de cas, des couches conductrices extérieures supplémentaires peuvent être incluses dans les Steps palette d'assemblage, éprouvette ou panneaux de carte car ces entités nécessitent des éléments conducteurs tels que l'apparition de caractéristiques de prise d'échantillon, d'évacuation à l'air libre ou de calibrage.

5.15 Couches conductrices intérieures

5.15.1 Exigence

Toutes les descriptions concernant les couches conductrices intérieures doivent être conformes à la CEI 61182-2 avec les restrictions indiquées dans les paragraphes suivants.

5.15.2 Détails des couches conductrices intérieures

Toutes les couches représentant des données qui se terminent en faisant partie de la carte doivent faire partie du Step utilisé pour définir BOARD (carte). Les caractéristiques des couches conductrices intérieures sont une exigence obligatoire de FAB1, FAB2 et FAB3.

Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM
Ecad/CadData/Layer@side=INTERNAL

5.15.3 Utilisation de Step pour les couches conductrices intérieures

Les couches qui concernent le step BOARD doivent définir la hiérarchie Step/LayerFeature et contiennent les éléments LayerFeature dont la définition LayerRef pointe sur la couche appropriée. Par exemple, si le nom de couche pour la couche conductrice supérieure la plus intérieure est Layer2 alors le Step dont le Step est utilisé pour définir BOARD doit avoir un élément Step/LayerFeature dont `LayerRef` est fixé au nom qualifié «Layer_2».

Dans un grand nombre de cas, des couches conductrices intérieures supplémentaires peuvent être incluses dans les Steps de palette d'assemblage, éprouvette ou panneaux de

carte car ces entités nécessitent des éléments conducteurs tels que l'apparition de caractéristiques de prise d'échantillon, d'évacuation à l'air libre ou de calibrage.

Un autre exemple destiné à clarifier l'utilisation de step serait la description d'une carte à dix (10) couches. La carte comporte huit (8) couches intérieures. En faisant l'hypothèse que toutes les couches sont fonctionnelles, alors dans le step utilisée pour définir BOARD huit éléments `LayerFeature` distincts pointent sur les huit couches nommées de cet élément `Layer` des cartes. C'est-à-dire que si la première couche intérieure à partir du haut est appelée «signal2» et que la deuxième est appelée «ground3n», alors il y a huit éléments `LayerFeature` les deux premiers étant:

StepList/Step/LayerFeature@layerNameRef = "signal2"; et
StepList/Step/LayerFeature@layerNameRef = "ground3n"

respectivement, et ainsi de suite jusqu'à ce que l'ensemble des huit couches intérieures soit couvert. Dans les modes FAB et ASSEMBLY (ainsi que TEST lorsque le mode TEST est couvert) un Step doit être utilisé pour définir BOARD et les images de couches à fabriquer sont uniquement représentées par les éléments respectifs `Step/LayerFeature` pour lesquels les éléments `Step/LayerFeature`@layerNameRef pointent sur ces couches.

5.16 Construction de la carte

5.16.1 Exigence

Toutes les descriptions concernant la construction de la carte doivent être conformes à la CEI 61182-2 avec les restrictions indiquées dans les paragraphes suivants.

5.16.2 Détails de construction de la carte

Toutes les couches représentant des données qui se terminent en faisant partie de la carte doivent faire partie de la ou des Steps ayant un but définissant les caractéristiques d'une carte imprimée, d'un panneau de carte ou d'une éprouvette. Les caractéristiques de construction de la carte sont une exigence obligatoire de FAB1, FAB2 et FAB3. La construction comporte l'empilement des couches pour la carte et définit l'ordre dans lequel les matériaux conducteurs et non conducteurs doivent être combinés. La relation des conditions de dénomination et l'ordre dans lequel les couches sont identifiées sont significatifs. Les propriétés des matériaux sont définies par l'attribut `layerFunction`. Certains exemples sont:

Ecad/CadData/Layer@layerFunction=CONDFOIL
Ecad/CadData/Layer@layerFunction=DIELPREG
Ecad/CadData/Layer@layerFunction=DIELCORE
Ecad/CadData/Layer@layerFunction=CONDFOIL | CONDFILM

Ecad/CadData/Layer@side=TOP
Ecad/CadData/Layer@side=INTERNAL
Ecad/CadData/Layer@side=BOTTOM

5.16.3 Utilisation de Step pour la construction de la carte

5.16.3.1 Généralités

Les couches qui concernent le step BOARD doivent définir la hiérarchie Step/LayerFeature et contiennent les éléments LayerFeature dont la définition LayerRef pointe sur la couche appropriée. Lorsqu'il n'y a aucune caractéristique dans le step, `layerFunction` definit les caractéristiques du matériau (épaisseur, fini, etc.). Par exemple, si la couche pour la première couche de la construction de la carte est préimprégnée, `layerFunction` doit être DIELPREG et le nom est "Dielectric One". Si le diélectrique comporte des découpes destinées à recevoir le flux de résine, les résines sont définies dans le step BOARD et ont un élément Step/LayerFeature dont `LayerRef` est fixé au nom qualifié "Dielectric One".

Des couches de construction supplémentaires peuvent également, dans certains cas, être incluses dans les Speps de la palette d'assemblage, éprouvette ou panneaux de carte de l'assemblage, car ces entités peuvent nécessiter des caractéristiques supplémentaires qui peuvent être décrites dans la structure de l'élément. Les concepts deviennent relativement importants pour des découpes spéciales ou des caractéristiques de fabrication facilitant la description des panneaux pour des cartes telles que des combinaisons rigides-souples ou des palettes d'assemblage ayant des configurations aux limites pour l'utilisation ou l'essai de l'équipement.

5.16.3.2 Restrictions de l'empilement

Lors de la définition de la construction d'une carte multicouches, l'élément `Stackup` décrit l'épaisseur totale et l'emplacement où le matériau est mesuré. La restriction de construction de la carte est l'attribut `whereMeasured` de `Stackup` et doit identifier par rapport à quelle caractéristique l'épaisseur totale est mesurée.

Ecad/CadData/Stackup@whereMeasured=LAMINATE | METAL | MASK

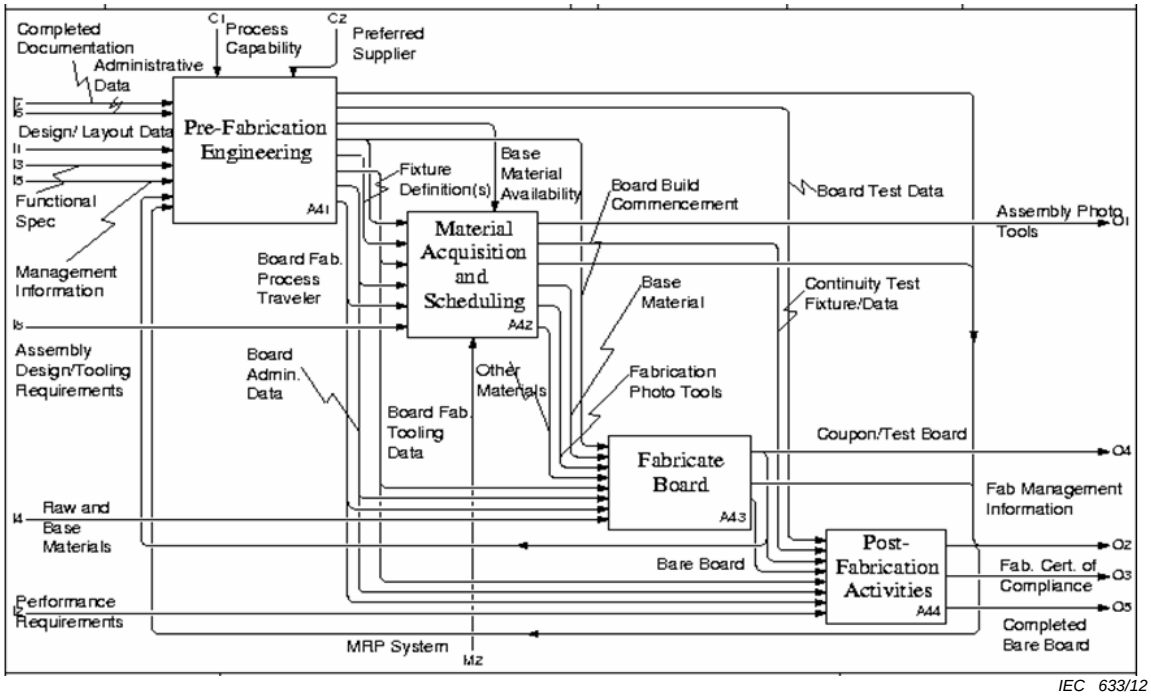
6 Modélisation

6.1 Généralités

Les fichiers de données de la CEI 61182-2-2 peuvent être mis en correspondance sur les modèles d'informations. Les modèles d'informations sont élaborés pour garantir qu'une mise en correspondance complète est possible entre les informations fournies dans les caractéristiques de la CEI 61182-2.

Toutes les activités des données sont basées sur des modèles d'activité. Les modèles d'activité couverts par la CAO (conception assistée par ordinateur) et la FAO (fabrication assistée par ordinateur) comportent les caractéristiques d'ingénierie, de conceptions, administratives et d'assemblage. Chacune de ces sections est destinée à être détaillée à divers niveaux d'activité tout comme les couches d'informations nécessaires pour exécuter un processus de fabrication particulier.

La Figure 4 présente l'activité nécessaire pour élaborer des données de fabrication de carte.



IEC 633/12

Légende

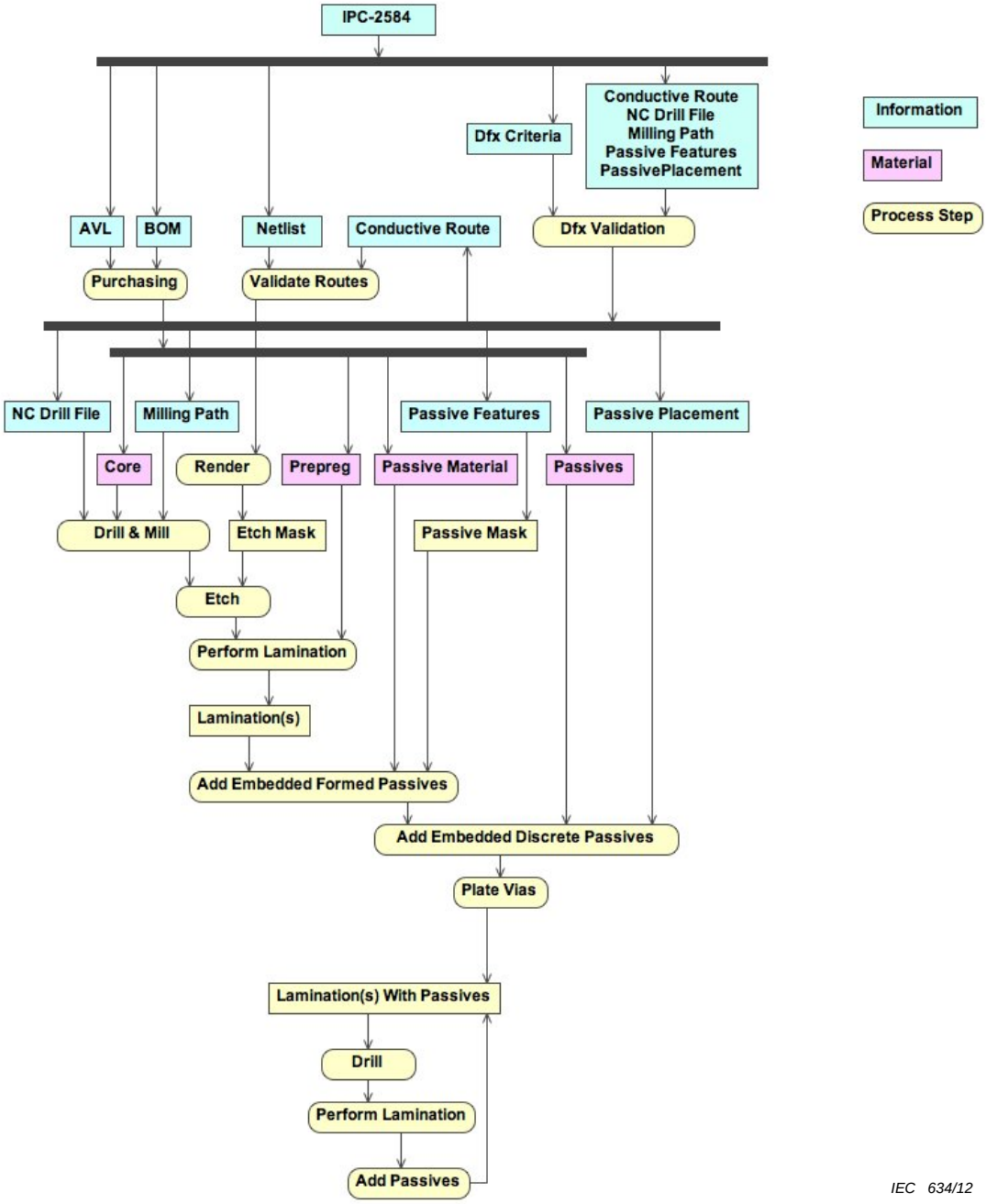
Anglais	Français
Completed documentation	Documentation terminée
Administrative data	Données administratives
Process capability	Capacité du processus
Preferred supplier	Fournisseur préféré
Design layout data	Conception des données d'implantation
Functional spec	Spécifications fonctionnelles
Pre-fabrication engineering	Ingénierie de préfabrication
Fixture definition(s)	Définition(s) des montages
Base material availability	Disponibilité des matériaux de base
Board build commencement	Début de construction de carte
Board test data	Données d'essai carte
Assembly photo tools	Assemblage masques photo
Management information	Informations de gestion
Assembly design/tooling requirements	Exigences conception d'assemblage/outillage
Board fab. process traveler	Fiche suiveuse de processus de fabrication de carte
Board admin. data	Données administratives de carte
Board fab tooling data	Données d'outillage de fabrication de carte
Material acquisition and scheduling	Acquisition des matériaux et ordonnancement
Other materials	Autres matériaux
Base materials	Matériaux de base
Fabrication photo tools	Masques photo de fabrication
Fabricate board	Fabrication carte
Continuity test fixture/data	Essai de continuité montage/données
Coupon/test board	Éprouvette/carte d'essai
Fab management information	Informations de gestion de fabrication
Raw and base material	Matériau brut et de base
Performance requirements	Exigences de performance
Bare board	Carte vierge
Post-fabrication activities	Activités post-fabrication
Fab. cert. of compliance	Certificat de conformité de fabrication
Completed bare board	Carte vierge terminée
MRP system	Système MRP

Figure 4 – Exemple de modèle de données des steps de fabrication

6.2 Modèles d'informations

Les modèles d'informations sont également utiles pour comprendre les exigences de la section de fabrication de carte. Les informations d'attribut sont corrélées avec les paramètres de la CEI 61182-2-2 ainsi qu'avec les modèles d'activité ou d'analyse utilisés pour décrire les données de fabrication de la carte.

Un UML (langage de modélisation universel) est utilisé pour élaborer le modèle de conception des données ainsi que le modèle d'analyse, voir Figure 5.



Légende

Anglais	Français
Dfx criteria	Critères Dfx
Conductive route	Route conductrice
Nc drill file	Fichier perçage NC
Milling path	Chemin fraisage
Passive features	Propriétés composants passifs
Passive placement	Placement composants passifs
Information	Informations
Material	Matériau
Process step	Step de processus
Purchasing	Achat

Anglais	Français
Netlist	Liste d'interconnexions
Conductive route	Route conductrice
Validate route	Validation route
Dfx validation	Validation Dfx
NC drilling file	Fichier perçage NC
Milling path	Chemin fraisage
Passive features	Propriétés composants passifs
Passive placement	Placement composants passifs
Core	Cœur
Render	Restitution
Prepeg	Préimprégné
Passive material	Matériau passif
Passives	Composants passifs
Drill and mill	Perçage et fraisage
Etch mask	Masque de gravure
Passive mask	Masque composants passifs
Etch	Gravure
Perform lamination	Exécution stratification
Lamination(s)	Stratification(s)
Add embedded formed passives	Ajout de composants passifs moulés
Add embedded discrete passives	Ajout de composants passifs discrets incorporés
Plate vias	Trous d'interconnexion de plaques
Lamination(s) with passives	Stratification(s) avec composants passifs
Drill	Perçage
Perform lamination	Exécution stratification
Add passives	Ajout composants passifs

Figure 5 – Modèle de données UML IPC-2584

7 Générateurs de rapports

7.1 Format CEI 61182-2-2

Chacune des sections du format CEI 61182-2-2 comporte divers générateurs de rapports utilisés par l'industrie pour doter l'utilisateur d'une copie fidèle du fichier de données CEI 61182-2-2. Certains d'entre eux sont préférés, basés sur les préférences de l'industrie, d'autres sont principalement des exemples. Les générateurs de rapport détaillés seront décrits dans chacun des quatre normes CEI 61182-2-1 à CEI 61182-2-4.

7.2 Rapport d'utilisation des trous

UTILISATION DE LA TAILLE DES TROUS
Taille des trous, compte de trous utilisation de type outillage

```
0.157 4 NPTH Tooling
0.020 40 PTH Electrical
0.035 65 PTH Electrical
0.041 120 PTH Electrical
0.125 8 NPTH Mechanical
Total 237
```

7.3 Rapport d'utilisation des plots

UTILISATION DES PLOTS
Plot comptage X Y
0.040 0.040 40 Fiducial
0.055 0.055 65 Component1
0.030 0.076 20 SOIC1

7.4 Rapport d'utilisation des conducteurs

CONDUCTEUR
UTILISATION
0.006
0.008
0.025
0.125

8 Glossaire

Nom ou acronyme	Description	Nom de référence
CEI 61182-2	Structure de données de niveau supérieur	ODB++(X) / CEI 61182-2
Avl	Liste de fournisseurs agréés	ODX_AVL
Bom	Nomenclature	ODX_BOM
Ecad	Informations de conception assistée par ordinateur	ODX_CAD
Contents	Informations concernant le contenu du fichier	ODX_CONTENTS
HistoryRef	Informations concernant les données de commande et de fourniture	ODX_HISTORY_REC
LogisticHeader	Informations de modification de fichier	ODX_LOGISTICS_HEADER
VpLComponent	Bibliothèques d'éléments de CAO	CAD_VPL_COMPONENTS
VplComponentList	Composant EDA après fusion d'assemblage	CAD_VPL_COMPONENTS LIST
CadVmpnList	Liste des numéros d'éléments du fabricant de CAO	CAD_VMPN_LIST
CadVmpn	Liste des numéros d'éléments du fabricant de CAO	CAD_VMPN
CadVplVendor	Fournisseur de composants de CAO	CAD VPL VENDOR
En-tête	En-tête	ODX_HEADER
AblVmpnList	Liste des numéros d'éléments du fabricant	AVL_VMPN_LIST
AvlVmpn	Numéro d'élément du fabricant	AVL_VMPN
AvlVendor	Fournisseur	AVL_VENDOR

Annexe A
(normative)

Schéma de fabrication des cartes imprimées

CEI 61182-2-2
Eléments de contenu selon CEI 61182-2
Eléments d'en-tête logistique selon CEI 61182-2
Eléments d'enregistrement d'historique selon CEI 61182-2
Eléments de BOM (Matériaux de fabrication de carte) selon CEI 61182-2
Eléments d'AVL (Fournisseurs de matériau de carte) selon CEI 61182-2
Eléments des couches d'image diverses selon CEI 61182-2
Eléments de la couche documentation selon CEI 61182-2
Eléments d'analyse de conception d'excellence (Dfx) selon CEI 61182-2

IEC 61182-2/Ecad
IEC 61182-2/Ecad/CadHeader
IEC 61182-2/Ecad/CadHeader/Spec
IEC 61182-2/Ecad/CadHeader/Spec/Xform
IEC 61182-2/Ecad/CadHeader/Spec/Location
IEC 61182-2/Ecad/CadHeader/Spec/Outline
IEC 61182-2/Ecad/CadHeader/Spec/Outline/Polygon
IEC 61182-2/Ecad/CadHeader/Spec/Outline/Polygon/PolyBegin
IEC 61182-2/Ecad/CadHeader/Spec/Outline/Polygon/PolyStepCurve
IEC 61182-2/Ecad/CadHeader/Spec/Outline/Polygon/PolyStepSegment
IEC 61182-2/Ecad/CadHeader/Spec/Outline/LineDesc
IEC 61182-2/Ecad/CadHeader/Spec/Outline/LineDescRef
IEC 61182-2/Ecad/CadHeader/Spec/Modification
IEC 61182-2/Ecad/CadHeader/SurfaceFinish
IEC 61182-2/Ecad/CadHeader/SurfaceFinish/FinishType
IEC 61182-2/Ecad/CadHeader/SurfaceFinish/FinishType/Color
IEC 61182-2/Ecad/CadHeader/SurfaceFinish/FinishType/ColorRef
IEC 61182-2/Ecad/CadHeader/ChangeRec
IEC 61182-2/Ecad/CadHeader/ChangeRec/Approval
IEC 61182-2/Ecad/CadData
IEC 61182-2/Ecad/CadData/Layer
IEC 61182-2/Ecad/CadData/Layer/Span
IEC 61182-2/Ecad/CadData/Layer/DrillTool
IEC 61182-2/Ecad/CadData/Stackup
IEC 61182-2/Ecad/CadData/Stackup/StackupGroup
IEC 61182-2/Ecad/CadData/Stackup/StackupGroup/StackupLayer
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Xform
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Location
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Polyline
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Polyline/PolyBegin
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Polyline/PolyStepCurve
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Polyline/PolyStepSegment
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Polyline/LineDesc
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Polyline/LineDescRef
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon/PolyBegin
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon/PolyStepCurve
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Polygon/PolyStepSegment
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout/PolyBegin
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout/PolyStepCurve
IEC 61182-2/Ecad/CadData/Stackup/StackupImpedance/Contour/Cutout/PolyStepSegment
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IEC 61182-2/Ecad/CadData/Step
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IEC 61182-2/Ecad/CadData/Step/OptionAttribute

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IEC 61182-2/Ecad/CadData/Step/PadStack/LayerHole/Span
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad
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IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Location
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Butterfly
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Circle
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Contour
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IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Contour/Polygon/PolyStepSegment
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IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Contour/Cutout/PolyStepSegment
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IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Donut
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Ellipse
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Hexagon
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Moire
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Octagon
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Oval
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/RectCenter
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/RectCham
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/RectCorner
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/RectRound
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Thermal
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/Triangle
IEC 61182-2/Ecad/CadData/Step/PadStack/LayerPad/StandardPrimitiveRef
IEC 61182-2/Ecad/CadData/Step/Route
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/IntegerAttribute
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/TextAttribute
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Xform
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Location
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Butterfly
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Circle
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Contour
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Contour/Cutout/PolyStepCurve
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Oval
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/RectCham
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/RectCorner
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/RectRound
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Thermal
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Pad/Triangle
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/BadBoardMark/StandardPrimitiveRef
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial
IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/GlobalFiducial/Xform
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Ellipse
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/Xform
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IEC 61182-2/Ecad/CadData/Step/Route/LayerFeature/Set/Features/Text/FontRef
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IEC 61182-2/Ecad/CadData/Step/Profile/Polygon/PolyStepCurve
IEC 61182-2/Ecad/CadData/Step/Profile/Polygon/PolyStepSegment
IEC 61182-2/Ecad/CadData/Step/Profile/Cutout
IEC 61182-2/Ecad/CadData/Step/Profile/Cutout/PolyBegin
IEC 61182-2/Ecad/CadData/Step/Profile/Cutout/PolyStepCurve
IEC 61182-2/Ecad/CadData/Step/Profile/Cutout/PolyStepSegment
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IEC 61182-2/Ecad/CadData/Step/Package/Outline/Polygon/PolyStepCurve
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IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Circle
IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Contour
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IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Contour/Polygon/PolyStepCurve
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IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Donut
IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Ellipse
IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Hexagon
IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/Moire
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IEC 61182-2/Ecad/CadData/Step/Package/LandPattern/Pad/RectCham
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IEC 61182-2/Ecad/CadData/Step/Package/SilkScreen/Target/Contour/Cutout/PolyStepCurve
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IEC 61182-2/Ecad/CadData/Step/Package/SilkScreen/Target/RectCham
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IEC 61182-2/Ecad/CadData/Step/PhyNetGroup/PhyNet/PhyNetPoint/Donut
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IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/Pad/Oval
IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/Pad/RectCenter
IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/Pad/RectCham
IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/Pad/RectCorner
IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/Pad/RectRound
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IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark
IEC 61182-2/Ecad/CadData/Step/LayerFeature/Set/BadBoardMark/Xform
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