TECHNICAL REPORT

IEC TR 62248

First edition
2002-12

Approaches to conformance and certification testing for design automation standards

Reference number
IEC/TR 62248:2002(E)

Publication numbering

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Commission Electrotechnique Internationale
International Electrotechnical Commission
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PRICE CODE L

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APPROACHES TO CONFORMANCE AND CERTIFICATION TESTING FOR DESIGN AUTOMATION STANDARDS

FOREWORD

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The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example “state of the art”.

IEC 62248, which is a technical report, has been prepared by IEC technical committee 93: Design automation.

This technical report focuses primarily on the work undertaken by IEC TC 93.

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

Enquiry draft	Report on voting
93/152/DTR	93/156/RVC

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

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

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

- transformed into an International standard;
- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

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

INTRODUCTION

The attention of the reader is drawn to the fact that this Technical Report provides an approach to conformance and certification methodology for TC 93 that takes into account the diversity of organizations contributing to the work of this committee.

APPROACHES TO CONFORMANCE AND CERTIFICATION TESTING FOR DESIGN AUTOMATION STANDARDS

1 Scope

This Technical Report provides guidelines for test suite specifications and benefits of conformance and certification testing.

2 Normative references

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

ISO 10303, *Industrial automation systems and integration – Product data representation and exchange*

IEEE 1003, *IEEE standard for information technology*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1 Application Program Interface (API)

program intended to provide a high level of interoperability between different supplier EDA platforms

3.2 Backus-Naur Format (BNF)

format used to describe computer actions through the use of keywords and attributes

3.3 certification

procedure by which a third party gives written assurance that a product, process, or service conforms to specific requirements

3.4 conformance

to be in accordance with some specified standard or specification

3.5 Core Model of the Electronics Domain (CMED)

includes the semantics definitions for various categories of information related to electronic circuit designs

3.6 Electronic Design Automation (EDA)

general term for automation standards related to electronic design

3.7 Electronic Design Interchange Format (EDIF)

format used to exchange design data between different CAD systems, and between CAD systems and printed circuit fabrication and assembly manufacturing facilities

3.8 I/O Buffer Information Specification (IBIS)

modeling data silicon template intended to specify a consistent format that can be parsed by software, allowing each simulation vendor to derive models compatible with their own product

3.9 POSIX

part of IEEE 1003 is part of the POSIX series of standards. It defines security interfaces to open systems for access control lists, audit, separation of privilege (capabilities), mandatory access control, and information label mechanisms. The standard is stated in terms of its C binding

3.10 Standard for Product Data Exchange (STEP)

group of standards that comply with ISO 10303 STEP consisting of a great variety of products that use EXPRESS information models

3.11 Very High Speed Integrated Circuit Hardware Description Language (VHDL)

programming language that has been designed and optimized for describing the behaviour of digital systems

3.12 VHDL - Language Reference Manual (VHDL-LRM)

manual that describes the foundation for most VHDL simulators and synthesis tools currently on the market

4 Diversity of feeder organizations

The approach to conformance and certification methodology for TC 93 must take into account the diversity of the international organizations that feed standards into TC 93. This diversity is a strength of TC 93 within the international Electronic Design Automation community; however it does add some complexity; such as with regard to conformance and certification methodologies. Due to the diversity of feeder organizations that input standards to TC 93 it would be very difficult to enforce a strict formal methodology, the goal of TC 93 should be to encourage the implementation of an effective methodology for conformance and certification that puts a minimal burden on the feeder organizations. Because of the diverse and international nature of TC 93,and the difficulty in identifying resources to apply to the task of standards development, including the related activity of conformance and certification, a generalized set of guidelines is needed. This report is intended as an initial definition of these guidelines. This report is also intended to identify the benefits of conformance and certification for TC 93 members and their constituents, in an effort to help them justify the necessary resources to support conformance and certification. This will be an ongoing and iterative process, whereby lessons learned are incorporated into the report. There are for example many concepts from the STEP approach that can be applied to the TC 93 domain.

The emphasis will be on test suite specifications, because TC 93 does not wish to become a developer or maintainer of the executable test suites. It is, however, intended that TC 93/WG 5: *Test validation, conformance and qualification technologies*, should provide guidelines (which will later become requirements) for development of test suite specifications which should be incorporated with or referenced by any standard submitted to TC 93.

5 Benefits of conformance and certification testing

One of the most critical aspects of a certification program is having it be accepted by the industry, and primarily the suppliers since they are most directly affected by the program. The suppliers (EDA vendors in this case) should be involved as early as possible in the definition of a certification program in order to ensure it's success.

It is reasonable to ask the question “what is the point of certification?” It is not just assurance of some level of *quality*. Usually certification conjures up notions of compatibility, inter-operability, and portability (see MALLIS in clause 12). In industry today, interoperability tests often refer to the testing, via pair wise matching, of specific applications. This is a very expensive proposition especially as the number of applications to be certified increases.

In some cases, the certification of the application program interfaces (APIs) themselves provides a high level of interoperability. POSIX is a case in point. There is no explicit interoperability certification involved in the POSIX certification. However, one of the results

of POSIX certification is the ability of different Unix implementations to interoperate at certain levels. This is due to the fact that the POSIX standard itself provides good coverage of the domain for which it is intended.

Interoperability or compatibility are loose terms that suggest some kind of cooperation or harmony among unlike components of a system. These terms have been applied to features ranging from “is written in the same language” to “can read ASCII” to “plug-and-play”. Portability is often mentioned when defining interoperability goals, and it usually means the ability to move a program or piece of data around among different environments and still be able to use it with a minimum of effort, even though the program may be very unlike other components in design or function. Conformance and certification programs can also stimulate the marketplace, because they give customers a level of assurance that the products they purchase will work with their existing infrastructure. If for example a company currently has installed tools from company “A” but is interested in acquiring a tool from company “B”, they would be less apprehensive about such a purchase if there were some formal mechanism in place by which they could gain assurance that the tools from these different companies would interoperate. Conformance and certification testing can provide such assurance if the program is well implemented. Another benefit to having conformance and certification programs in place (which assumes that test suites are available) is that the developers of conformant applications greatly benefit from the use of the test suites during their development process. Finding conformance problems early in the development process is another benefit. In addition, running the test suites often helps improve the overall quality of the product by identifying issues that might have been overlooked if the test suite had not been run against the application.

One of the key goals of WG 5's conformance and certification plan is to support the WG 1: *Electronical data harmonization (Approaches, methodologies and technologies)*, architecture for TC 93 which is based on the concept of a “core-model” (see Figure 1.) and also the requirement for overlapping standards to demonstrate an interoperability plan. The first step of any interoperability plan would be to demonstrate that a new standard has the minimum amount of information necessary to translate a portion of a design file into another standard format with which it shares some common information.

One question that remains to be answered is how will the many disparate models submitted to TC 93 be “mapped” to the CMED, and who will be responsible for this effort? In addition, the collection of information, and for lack of a better term will be referred to as “components”, must be defined, for example a connectivity component is currently defined by the CMED model.

It is obvious to most users of design automation tools that a single universal standard for any given data transfer scenario would greatly simplify their jobs, and save money and resources. However, in this very competitive industry we are all aware of the practical reality that in many cases there are multiple overlapping data formats which exist at various levels of standardization; it should be noted that the lack of formal standardization status does not necessarily mean that a given format won't be used by industry. Also, different constituencies have different reasons for wanting to use a given format, and changing their methodology to use a different format can be very unattractive if there is any cost of re-tooling and retraining... therefore the unfortunate reality is that conversion between formats (with varying degrees of overlapping information content) is often required. Again, this is where a structure based on a “core” model, and supported by a conformance and certification methodology could provide a significant benefit to the global design automation community; by improving the efficiency and the fidelity of such data transfer scenarios; that like it or not are a reality of the industry. In order to be a viable and relevant organization TC 93 must provide solutions that address real world problems and provide tangible benefits to the members, without dictating solutions which are unlikely to be adopted. A strong interoperability plan (within WG 1, based on CMED) which is supported by a strong conformance and certification program (from WG 5) could provide such benefits to the TC 93 members. Obviously this will not happen over night, but will take time to implement, and therefore a phased approach is described later in this report.

6 Benefits of test suite specifications

The existence of a test suite specification allows any organization to develop conformance tests for a given TC 93 standard. Due to the global nature of the internet and the opportunities for international commerce that it provides, more people are realizing the need for effective, accurate and user-friendly conformance testing tools. This means that there will be new business opportunities created by the availability of test suite specifications. For example a company could take a test suite specification and develop a test suite which they could then sell on the global market. The global nature of internet and the need to establish virtual enterprises, often across international borders, will drive more organizations to test their information technology tools (such as EDA software) for compliance to standards which provide interoperability within a given organization (or virtual enterprise). In many cases, a significant factor in the decision to purchasing new software tools is whether they are compliant with the necessary international standards. In the electronics industry, this trend is only increasing with the expanding use of virtual components (the success of which, will depend heavily on the ability to easily integrate virtual components from a variety of sources.)

TC 93 recognizes the benefits of information modelling as an important methodology for the development, study, and conformance testing of standards. As such WG 1 has recently been working towards a CMED model (Core Consensus Model for the Electronics Domain). If this model were adopted as the top level – highest level of abstraction – model in the TC 93 domain, then other application level models, for example EDIF's Express model, VHDL's LRM, Verilog and other application level models could be mapped to the CMED, for the particular components to which they apply. This would then allow commercial implementations (instances) of these standards to be tested for conformance to the application level models. The goal of this approach is to provide traceability from commercial implementations back to the application standard, and therefore to the CMED. The CMED would be expected to grow over time to include all views of electronic products, and possible activity models for some standards. This traceability could greatly enhance the interoperability between all standards recognized by TC 93.

7 Conformance and certification of TC 93 standards guidelines

It is recognized that initially not all groups submitting standards TC 93 will have the resources to develop a full-blown test suite specification. Therefore, it is recommended that a multi-phase approach be taken with respect to deploying a conformance and certification methodology for TC 93. This phased approach will allow for incremental increases in the amount of additional information that is required for standards submitted to TC 93. Table 1 shows each of the four phases and the information required from the submitters of a standard to TC 93, as well as the recommended items for standards submitted to TC 93, and also the support that WG 5 will provide to support this plan.

7.1 Definition of required and recommended elements

7.1.1 Definitions of levels of conformance and certification

Clear indication of which elements, entities, or components, within the referenced standard, must be complied with in order for a product to be certified at a specific level. Even if there is only one level of conformance, it should be named with both a numeric level and English name. Level 1 shall always be assigned to the highest level of certification, i.e. compliance with every element, entity or component defined within a standard. So that if a vendor indicates that they are level 1 compliant to standard X, you would have confidence that it implements the full standard. (Note that in the initial phase 1 of the TC 93 conformance and certification program this could provide some benefit to industry; and requiring very little resources, for example a standard submitted to TC 93 might include a simple definition for levels of conformance, such as: Level 1 conformance [“fully conformant”] requires that all entities in the specification be fully implemented, Level 2 conformance [“simulator conformant”] requires that only the entities defined in clauses 1 to 5 of the standard be implemented.)

7.1.2 Pre- and post- conditions

These would be supplied only where applicable, i.e. for standards which have some executable or dynamic aspects. This would describe the pre-/initial conditions (or inputs) and the post-conditions (or outputs) expected from a given entity specified within the standard. Again, this only applies to standards which exhibit dynamic behaviour, such as simulation languages.

7.1.3 Formal representation

This would provide a formal representation of any standard under consideration by TC 93, that lends itself to some level of parsing by software, and therefore potential for automated test generation and/or test suite specification, for example EXPRESS, BNF, or a structured programming language.

7.1.4 Commercial test suite plan

This will consist of either a letter of intent from a company planning to develop a conformance test suite and certification program, or a detailed specification describing how a test suite could be developed for the standard under question, including recommended methods for using the formal description of the standard to automatically generate a test suite.

7.1.5 Commercial test suite available

This requires that a commercially available test suite exists, or is under development and is planned for release within TBD months.

7.2 Definition of items provided by WG 5

7.2.1 Guidelines on conformance levels

This document would expand upon the definition of conformance levels given above, and would include examples using current standards.

7.2.2 Spec. (Specification) language recommended

This would provide guidance to standards developers as to some of the available languages for describing behaviour and sequence of events of pre- and post-condition testing, which might be applicable to their domain. Possible formats are EXPRESS, BNF, XML, etc. as examples.

7.2.3 Guidelines on accreditation

This would provide a list of accredited organizations, recognized by TC 93 for providing certification testing of products claiming conformance to TC 93 standards. In addition, it would describe the process of receiving accreditation and a relative timeline for the process.

7.2.4 List of certified products

WG 5 would maintain a list (available in both hard copy and the WWW) of the current products which have been certified by a TC 93 recognized testing laboratory.

Table 1 – Proposed phases of TC 93 conformance test suite specification plan

Phases	Required for any standard submitted to TC 93	Recommended (but not required) for any standard submitted to TC 93	Provided by WG 5
1	• Definition of conformance and certification levels	• Formal representation • Pre- and post- conditions	• Guidelines on conformance levels
2	• Definition of conformance and certification levels • Formal representation	• Formal representation • Pre- and post- conditions • Commercial test suite plan	• Guidelines on conformance levels • Spec. language recommended
3	• Definition of conformance and certification levels • Formal representation • Pre- and post-conditions	• Commercial test suite plan • Commercial test suite available	• Guidelines on conformance levels • Spec. language recommended • Guidelines on accreditation
4	• Definition of conformance and certification levels • Formal representation • Pre- and post- conditions • Commercial test suite plan	• Commercial test suite available	• Guidelines on conformance levels • Spec. language recommended • Guidelines on accreditation • List of certified products

8 Relationship to TC 93/WG 1

The following architecture describes the idea for an architecture in which a top level model (or family of models) is used to as the “core” model for a family of related (and in some cases partially overlapping standards) was discussed in relationship to a conformance test methodology. According to the diagram, the responsibility for verifying the mapping from the individual standards to the “core” model should be placed on TC 93 with a shared burden placed on the standards developers as defined in the current TC 93 policy on non-overlapping standards. It might be that TC 93 working groups take responsibility to ensure that this mapping is provided. (It is important to note that the “core” model, in this case the CMED model, would need to be expanded beyond it's current connectivity model in order to support all the lower level models as implied by this diagram.)

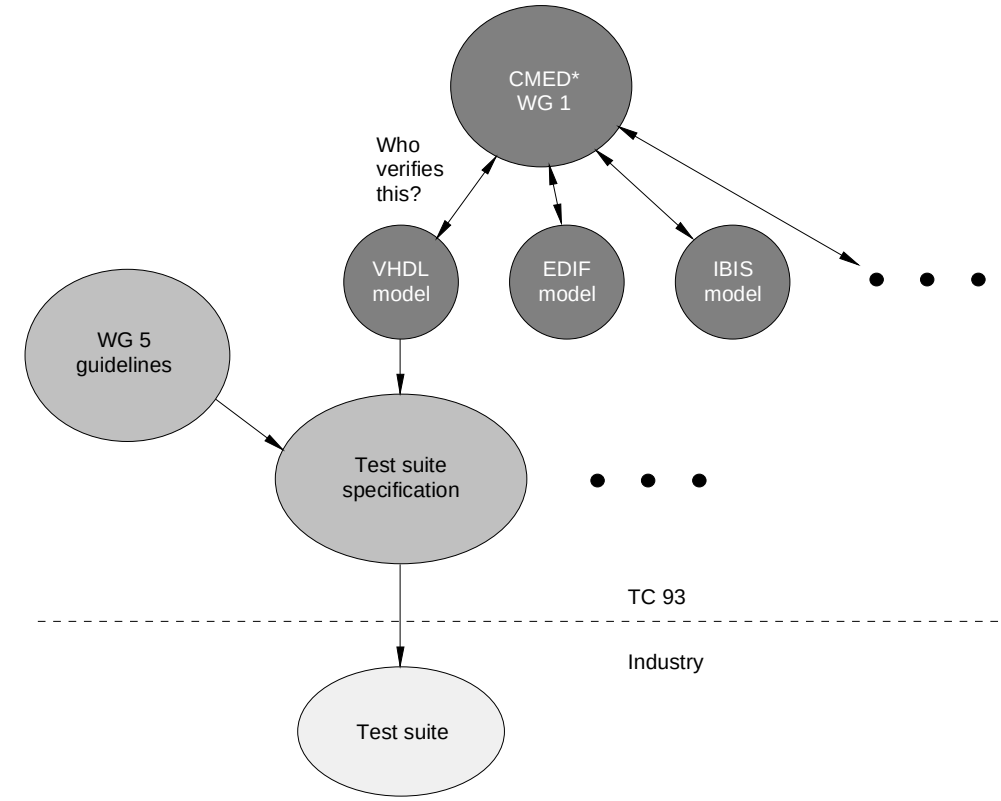

Figure 1 – WG 5 conformance testing traceability recommendation

The above figure shows that the availability of a test suite for a given standard, in conjunction with a verification or “mapping” of each standard to the “core” model would provide some level of assurance that a mapping does indeed exists between a given set of TC 93 standards, for example between VHDL and EDIF. As in the example of POSIX described above, this would not guarantee interoperability between TC 93 standards but it would certainly improve the current situation.

9 Potential future or related work, for example certification of virtual components and EDA rules

As electronic commerce continues to emerge, there are needs to measure the conformance of component information, models, and EDA design data against the standards which they are intended to implement (for example an MPEG decoder virtual component (aka, intellectual property core). This will provide an improved level of confidence in this type of new emerging virtual components, regardless of the provider, be it a large or small IP (virtual component) provider. These virtual components are expected to become a growing portion of the reusable component market.

Since most of the standards against which such virtual components must be tested are not in the domain of TC 93, liaisons will be required between TC 93 and the organizations which develop and control these other standards. For example the MPEG standard is not controlled by TC 93 and yet virtual components (both hard and soft versions) are available which implement this standard. This also ties into the need for automatic test suite specification generation from existing and future standards. This is not to say that TC 93 should provide virtual component certification or verification, rather TC 93 should work with industry and consortia such as the Virtual Socket Interface Alliance to facilitate the development of standards, and guidelines which support a framework for certification and exchange of virtual components.

10 Automatic test suite and specification generation

Guidelines for the development of automatic generation of a test suite specification (i.e., a document from which a test suite can be developed) should be pursued by this working group. Any automated methods or tools that could provide this type of capability would be very useful to the goals of WG 5. One result of the diversity of the standards bodies submitting standards to TC 93 is a wide diversity of how they are represented, i.e. information model languages, or lack thereof. In addition, automatic generation of the actual executable test suite is an area that this WG should investigate because of the significant cost savings it could provide. Note that TC 93 will not develop methods for automatic test generation, but rather, will recommend methods and investigate work being done in this area for possible standardization related to TC 93.

11 Certification and labelling

According to IEC guidelines, a table of recognized or accredited testing laboratories should be maintained by TC 93 and each of these laboratories should include a list of which products have been certified by them. This list should be updated monthly. Ideally, this would be provided publicly on the Internet so that users can identify products that are compliant to standards of interest. In addition, to third party certification by an accredited testing laboratory, self-certification should be recognized in accordance with ISO/IEC guidelines .

12 References

ISO/IEC Guide 22:1996, *General criteria for supplier's declaration of conformity*

ISO/IEC Guide 65:1996, *General requirements for bodies operating product certification systems*

MALLIS, D. Final Draft Report on Compliance and Certification, contractor report (unpublished) for contract 43ANB510468, National Institute of Standards and Technology, Gaithersburg MD 20899, 1995.

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Q1 Please report on **ONE STANDARD** and **ONE STANDARD ONLY**. Enter the exact number of the standard: *(e.g. 60601-1-1)*

.....

Q2 Please tell us in what capacity(ies) you bought the standard *(tick all that apply).* I am the/a:

purchasing agent ❑
librarian ❑
researcher ❑
design engineer ❑
safety engineer ❑
testing engineer ❑
marketing specialist ❑
other.....

Q3 I work for/in/as a: *(tick all that apply)*

manufacturing ❑
consultant ❑
government ❑
test/certification facility ❑
public utility ❑
education ❑
military ❑
other.....

Q4 This standard will be used for: *(tick all that apply)*

general reference ❑
product research ❑
product design/development ❑
specifications ❑
tenders ❑
quality assessment ❑
certification ❑
technical documentation ❑
thesis ❑
manufacturing ❑
other.....

Q5 This standard meets my needs: *(tick one)*

not at all ❑
nearly ❑
fairly well ❑
exactly ❑

Q6 If you ticked NOT AT ALL in Question 5 the reason is: *(tick all that apply)*

standard is out of date ❑
standard is incomplete ❑
standard is too academic ❑
standard is too superficial ❑
title is misleading ❑
I made the wrong choice ❑
other .....

Q7 Please assess the standard in the following categories, using the numbers:
(1) unacceptable,
(2) below average,
(3) average,
(4) above average,
(5) exceptional,
(6) not applicable

timeliness.....
quality of writing.....
technical contents.....
logic of arrangement of contents .....
tables, charts, graphs, figures.....
other .....

Q8 I read/use the: *(tick one)*

French text only ❑
English text only ❑
both English and French texts ❑

Q9 Please share any comment on any aspect of the IEC that you would like us to know:

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ISBN 2-8318-6763-0

ICS 25.040.01

Typeset and printed by the IEC Central Office
GENEVA, SWITZERLAND