



IEEE

IEC 61523-4

Edition 2.0 2023-10

**INTERNATIONAL
STANDARD**

IEEE Std 1801™



**Delay and power calculation standards –
Part 4: Design and Verification of Low-Power, Energy-Aware Electronic Systems**

(<https://standards.iteh.ai>)

Document Preview

[IEC 61523-4:2023](https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>





THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2018 IEEE

All rights reserved. IEEE is a registered trademark in the U.S. Patent & Trademark Office, owned by the Institute of Electrical and Electronics Engineers, Inc. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from the IEC Central Office. Any questions about IEEE copyright should be addressed to the IEEE. Enquiries about obtaining additional rights to this publication and other information requests should be addressed to the IEC or your local IEC member National Committee.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland
Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue
New York, NY 10016-5997
United States of America
stds.info@ieee.org
www.ieee.org

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 300 terminological entries in English and French, with equivalent terms in 19 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

[IEC 61523-4:2023](https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>

INTERNATIONAL STANDARD

IEEE Std 1801™



**Delay and power calculation standards –
Part 4: Design and Verification of Low-Power, Energy-Aware Electronic Systems**

Document Preview

[IEC 61523-4:2023](https://standards.iteh.ai/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 25.040.01, 35.060

ISBN 978-2-8322-7540-5

Warning! Make sure that you obtained this publication from an authorized distributor.

Contents

1. Overview	13
1.1 Scope	13
1.2 Purpose	13
1.3 Key characteristics of the Unified Power Format	13
1.4 Contents of this standard	15
2. Normative references	16
3. Definitions, acronyms, and abbreviations	16
3.1 Definitions	16
3.2 Acronyms and abbreviations	22
4. Concepts	23
4.1 Introduction	23
4.2 Design structure	24
4.3 Design representation	24
4.4 Power architecture	28
4.5 Power distribution	31
4.6 Power management	39
4.7 Supply states and power states	44
4.8 Simstates	51
4.9 Power intent specification	52
5. Language basics	58
5.1 UPF is Tcl	58
5.2 Conventions used	59
5.3 Lexical elements	61
5.4 Boolean expressions	65
5.5 Object declaration	67
5.6 Attributes of objects	67
5.7 Precedence	72
5.8 Generic UPF command semantics	75
5.9 effective_element_list semantics	76
5.10 Command refinement	79
5.11 Error handling	80
5.12 Units	80
5.13 SystemC language basic	80
6. Power intent commands	81
6.1 Introduction	81
6.2 Categories	81
6.3 add_parameter	82
6.4 add_port_state (legacy)	83
6.5 add_power_state	84
6.6 add_pst_state (legacy)	91
6.7 add_state_transition	92
6.8 add_supply_state	94
6.9 apply_power_model	95
6.10 associate_supply_set	97
6.11 begin_power_model (legacy)	99
6.12 bind_checker	100

6.13 connect_logic_net.....	102
6.14 connect_supply_net.....	104
6.15 connect_supply_set.....	106
6.16 create_composite_domain.....	107
6.17 create_hdl2upf_vct.....	109
6.18 create_logic_net.....	110
6.19 create_logic_port.....	111
6.20 create_power_domain.....	112
6.21 create_power_state_group.....	119
6.22 create_power_switch.....	121
6.23 create_pst (legacy).....	128
6.24 create_supply_net.....	129
6.25 create_supply_port.....	133
6.26 create_supply_set.....	134
6.27 create_upf2hdl_vct.....	136
6.28 define_power_model.....	137
6.29 describe_state_transition (deprecated).....	139
6.30 end_power_model (legacy).....	139
6.31 find_objects.....	140
6.32 load_simstate_behavior.....	144
6.33 load_upf.....	145
6.34 load_upf_protected (deprecated).....	146
6.35 map_power_switch.....	146
6.36 map_repeater_cell.....	147
6.37 map_retention_cell.....	148
6.38 name_format.....	152
6.39 save_upf.....	153
6.40 set_correlated.....	154
6.41 set_design_attributes.....	155
6.42 set_design_top.....	156
6.43 set_domain_supply_net (legacy).....	157
6.44 set_equivalent.....	158
6.45 set_isolation.....	160
6.46 set_level_shifter.....	167
6.47 set_partial_on_translation.....	173
6.48 set_port_attributes.....	175
6.49 set_repeater.....	181
6.50 set_retention.....	185
6.51 set_retention_elements.....	189
6.52 set_scope.....	190
6.53 set_simstate_behavior.....	191
6.54 set_variation.....	194
6.55 sim_assertion_control.....	195
6.56 sim_corruption_control.....	197
6.57 sim_replay_control.....	200
6.58 upf_version.....	202
6.59 use_interface_cell.....	203
7. Power-management cell definition commands.....	205
7.1 Introduction.....	205
7.2 define_always_on_cell.....	206
7.3 define_diode_clamp.....	207
7.4 define_isolation_cell.....	208
7.5 define_level_shifter_cell.....	211
7.6 define_power_switch_cell.....	216
7.7 define_retention_cell.....	218

8. UPF processing.....	220
8.1 Overview	220
8.2 Data requirements.....	221
8.3 Processing phases	221
8.4 Error checking	225
9. Simulation semantics.....	225
9.1 Supply network creation.....	225
9.2 Supply network simulation.....	227
9.3 Power state simulation.....	228
9.4 Power state transition detection.....	231
9.5 Simstate simulation.....	232
9.6 Transitioning from one simstate state to another.....	234
9.7 Simulation of retention	235
9.8 Simulation of isolation.....	241
9.9 Simulation of level-shifting.....	242
9.10 Simulation of repeaters.....	242
10. UPF information model.....	242
10.1 Overview	242
10.2 Components of UPF information model.....	243
10.3 Identifiers in information model (IDs).....	244
10.4 Classification of objects.....	247
10.5 Example of design hierarchy	253
10.6 Object definitions.....	254
11. Information model application programmable interface (API).....	313
11.1 Tcl interface.....	313
11.2 HDL interface.....	323
Annex A (informative) Bibliography.....	387
Annex B (normative) Value conversion tables.....	388
B.1 Overview.....	388
B.2 VHDL_SL2UPF	388
B.3 UPF2VHDL_SL	388
B.4 VHDL_SL2UPF_GNDZERO.....	388
B.5 UPF_GNDZERO2VHDL_SL.....	389
B.6 SV_LOGIC2UPF.....	389
B.7 UPF2SV_LOGIC.....	389
B.8 SV_LOGIC2UPF_GNDZERO.....	389
B.9 UPF_GNDZERO2SV_LOGIC.....	389
B.10 VHDL_TIED_HI.....	390
B.11 SV_TIED_HI.....	390
B.12 VHDL_TIED_LO.....	390
B.13 SV_TIED_LO.....	390
Annex C (informative) UPF query examples.....	391
C.1 Overview.....	391
C.2 Utility procs	391
C.3 High-level procs.....	392
C.4 Superseded UPF queries	394
Annex D (informative) Replacing deprecated and legacy commands and options.....	396
D.1 Overview.....	396
D.2 Deprecated and legacy constructs.....	396

D.3 Recommendations for replacing deprecated and legacy constructs	398
Annex E (informative) Low-power design methodology	401
E.1 Overview	401
E.2 Simple System on Chip (SoC) example design	401
E.3 Design, verification, and implementation flow	404
E.4 Power intent of the example design	407
Annex F (informative) Power-management cell definitions in UPF and Liberty	428
F.1 Introduction	428
F.2 define_always_on_cell	428
F.3 define_diode_clamp	430
F.4 define_isolation_cell	431
F.5 define_level_shifter_cell	434
F.6 define_power_switch_cell	436
F.7 define_retention_cell	438
Annex G (informative) Power-management cell modeling examples	442
G.1 Overview	442
G.2 Modeling always-on cells	442
G.3 Modeling cells with internal diodes	448
G.4 Modeling isolation cells	450
G.5 Modeling level-shifters	467
G.6 Modeling power-switch cells	484
G.7 Modeling state retention cells	494
Annex H (informative) IP power modeling for system-level design	506
H.1 Introduction	506
H.2 Overview of system-level IP power models	506
H.3 Content of system-level IP power models	507
H.4 Power calculation using power functions	508
H.5 Power model structure	510
H.6 Power model instantiation—example approach	511
Annex I (normative) Switching Activity Interchange Format	513
I.1 Syntactic conventions	514
I.2 Lexical conventions	515
I.3 Backward SAIF file	518
I.4 Library forward SAIF file	534
I.5 RTL forward SAIF file	542
Annex J (informative) Participants	547

DELAY AND POWER CALCULATION STANDARDS –

Part 4: Design and Verification of Low-Power, Energy-Aware Electronic Systems

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC document(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation.

IEEE Standards documents are developed within IEEE Societies and Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board. IEEE develops its standards through a consensus development process, approved by the American National Standards Institute, which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of IEEE and serve without compensation. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information contained in its standards. Use of IEEE Standards documents is wholly voluntary. *IEEE documents are made available for use subject to important notices and legal disclaimers (see <https://standards.ieee.org/ipr/disclaimers.html> for more information).*

IEC collaborates closely with IEEE in accordance with conditions determined by agreement between the two organizations. This Dual Logo International Standard was jointly developed by the IEC and IEEE under the terms of that agreement.

- 2) The formal decisions of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees. The formal decisions of IEEE on technical matters, once consensus within IEEE Societies and Standards Coordinating Committees has been reached, is determined by a balanced ballot of materially interested parties who indicate interest in reviewing the proposed standard. Final approval of the IEEE standards document is given by the IEEE Standards Association (IEEE SA) Standards Board.
- 3) IEC/IEEE Publications have the form of recommendations for international use and are accepted by IEC National Committees/IEEE Societies in that sense. While all reasonable efforts are made to ensure that the technical content of IEC/IEEE Publications is accurate, IEC or IEEE cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications (including IEC/IEEE Publications) transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC/IEEE Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC and IEEE do not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC and IEEE are not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or IEEE or their directors, employees, servants or agents including individual experts and members of technical committees and IEC National Committees, or volunteers of IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (IEEE SA) Standards Board, for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC/IEEE Publication or any other IEC or IEEE Publications.
- 8) Attention is drawn to the normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that implementation of this IEC/IEEE Publication may require use of material covered by patent rights. By publication of this standard, no position is taken with respect to the existence or validity of any patent rights in connection therewith. IEC or IEEE shall not be held responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patent Claims or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility.

IEC 61523-4/IEEE Std 1801 was processed through IEC technical committee 91: Electronics assembly technology, under the IEC/IEEE Dual Logo Agreement. It is an International Standard.

The text of this International Standard is based on the following documents:

IEEE Std	FDIS	Report on voting
1801 (2018)	91/1870/FDIS	91/1884/RVD

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

The language used for the development of this International Standard is English.

The IEC Technical Committee and IEEE Technical Committee have decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

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

[IEC 61523-4:2023](https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>

IEEE Standard for Design and Verification of Low-Power, Energy-Aware Electronic Systems

Sponsor

Design Automation Standards Committee
of the
IEEE Computer Society

Approved 27 September 2018

IEEE-SA Standards Board

iteh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 61523-4:2023](https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>

Abstract: A method is provided for specifying power intent for an electronic design, for use in verification of the structure and behavior of the design in the context of a given power-management architecture, and for driving implementation of that power-management architecture. The method supports incremental refinement of power intent specifications required for IP-based design flows.

Keywords: corruption semantics, IEEE 1801™, interface specification, IP reuse, isolation, level-shifting, power-aware design, power domains, power intent, power modes, power states, progressive design refinement, retention, retention strategies

iTeh Standards
(<https://standards.iteh.ai>)
Document Preview

[IEC 61523-4:2023](https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>

Important Notices and Disclaimers Concerning IEEE Standards Documents

IEEE documents are made available for use subject to important notices and legal disclaimers. These notices and disclaimers, or a reference to this page, appear in all standards and may be found under the heading “Important Notice” or “Important Notices and Disclaimers Concerning IEEE Standards Documents.”

Notice and Disclaimer of Liability Concerning the Use of IEEE Standards Documents

IEEE Standards documents (standards, recommended practices, and guides), both full-use and trial-use, are developed within IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Association (“IEEE-SA”) Standards Board. IEEE (“the Institute”) develops its standards through a consensus development process, approved by the American National Standards Institute (“ANSI”), which brings together volunteers representing varied viewpoints and interests to achieve the final product. Volunteers are not necessarily members of the Institute and participate without compensation from IEEE. While IEEE administers the process and establishes rules to promote fairness in the consensus development process, IEEE does not independently evaluate, test, or verify the accuracy of any of the information or the soundness of any judgments contained in its standards.

IEEE does not warrant or represent the accuracy or content of the material contained in its standards, and expressly disclaims all warranties (express, implied and statutory) not included in this or any other document relating to the standard, including, but not limited to, the warranties of: merchantability; fitness for a particular purpose; non-infringement; and quality, accuracy, effectiveness, currency, or completeness of material. In addition, IEEE disclaims any and all conditions relating to: results; and workmanlike effort. IEEE standards documents are supplied “AS IS” and “WITH ALL FAULTS.”

Use of an IEEE standard is wholly voluntary. The existence of an IEEE standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard.

In publishing and making its standards available, IEEE is not suggesting or rendering professional or other services for, or on behalf of, any person or entity nor is IEEE undertaking to perform any duty owed by any other person or entity to another. Any person utilizing any IEEE Standards document, should rely upon his or her own independent judgment in the exercise of reasonable care in any given circumstances or, as appropriate, seek the advice of a competent professional in determining the appropriateness of a given IEEE standard.

IN NO EVENT SHALL IEEE BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE PUBLICATION, USE OF, OR RELIANCE UPON ANY STANDARD, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE AND REGARDLESS OF WHETHER SUCH DAMAGE WAS FORESEEABLE.

Translations

The IEEE consensus development process involves the review of documents in English only. In the event that an IEEE standard is translated, only the English version published by IEEE should be considered the approved IEEE standard.

Official statements

A statement, written or oral, that is not processed in accordance with the IEEE-SA Standards Board Operations Manual shall not be considered or inferred to be the official position of IEEE or any of its committees and shall not be considered to be, or be relied upon as, a formal position of IEEE. At lectures, symposia, seminars, or educational courses, an individual presenting information on IEEE standards shall make it clear that his or her views should be considered the personal views of that individual rather than the formal position of IEEE.

Comments on standards

Comments for revision of IEEE Standards documents are welcome from any interested party, regardless of membership affiliation with IEEE. However, IEEE does not provide consulting information or advice pertaining to IEEE Standards documents. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments. Since IEEE standards represent a consensus of concerned interests, it is important that any responses to comments and questions also receive the concurrence of a balance of interests. For this reason, IEEE and the members of its societies and Standards Coordinating Committees are not able to provide an instant response to comments or questions except in those cases where the matter has previously been addressed. For the same reason, IEEE does not respond to interpretation requests. Any person who would like to participate in revisions to an IEEE standard is welcome to join the relevant IEEE working group.

Comments on standards should be submitted to the following address:

Secretary, IEEE-SA Standards Board
445 Hoes Lane
Piscataway, NJ 08854 USA

Laws and regulations

[IEC 61523-4:2023](https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023)

<https://standards.iteh.ai/catalog/standards/sist/ec9ab384-e9a2-4942-986c-4c196493c0eb/iec-61523-4-2023>

Users of IEEE Standards documents should consult all applicable laws and regulations. Compliance with the provisions of any IEEE Standards document does not imply compliance to any applicable regulatory requirements. Implementers of the standard are responsible for observing or referring to the applicable regulatory requirements. IEEE does not, by the publication of its standards, intend to urge action that is not in compliance with applicable laws, and these documents may not be construed as doing so.

Copyrights

IEEE draft and approved standards are copyrighted by IEEE under U.S. and international copyright laws. They are made available by IEEE and are adopted for a wide variety of both public and private uses. These include both use, by reference, in laws and regulations, and use in private self-regulation, standardization, and the promotion of engineering practices and methods. By making these documents available for use and adoption by public authorities and private users, IEEE does not waive any rights in copyright to the documents.

Photocopies

Subject to payment of the appropriate fee, IEEE will grant users a limited, non-exclusive license to photocopy portions of any individual standard for company or organizational internal use or individual, non-commercial use only. To arrange for payment of licensing fees, please contact Copyright Clearance Center, Customer Service, 222 Rosewood Drive, Danvers, MA 01923 USA; +1 978 750 8400. Permission to photocopy portions of any individual standard for educational classroom use can also be obtained through the Copyright Clearance Center.

Updating of IEEE Standards documents

Users of IEEE Standards documents should be aware that these documents may be superseded at any time by the issuance of new editions or may be amended from time to time through the issuance of amendments, corrigenda, or errata. An official IEEE document at any point in time consists of the current edition of the document together with any amendments, corrigenda, or errata then in effect.

Every IEEE standard is subjected to review at least every ten years. When a document is more than ten years old and has not undergone a revision process, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE standard.

In order to determine whether a given document is the current edition and whether it has been amended through the issuance of amendments, corrigenda, or errata, visit the IEEE-SA Website at <http://ieeexplore.ieee.org/xpl/standards.jsp> or contact IEEE at the address listed previously. For more information about the IEEE-SA or IEEE's standards development process, visit the IEEE-SA Website at <http://standards.ieee.org>.

Errata

Errata, if any, for all IEEE standards can be accessed on the IEEE-SA Website at the following URL: <http://standards.ieee.org/findstds/errata/index.html>. Users are encouraged to check this URL for errata periodically.

Patents

Attention is called to the possibility that implementation of this standard may require use of subject matter covered by patent rights. By publication of this standard, no position is taken by the IEEE with respect to the existence or validity of any patent rights in connection therewith. If a patent holder or patent applicant has filed a statement of assurance via an Accepted Letter of Assurance, then the statement is listed on the IEEE-SA Website at <http://standards.ieee.org/about/sasb/patcom/patents.html>. Letters of Assurance may indicate whether the Submitter is willing or unwilling to grant licenses under patent rights without compensation or under reasonable rates, with reasonable terms and conditions that are demonstrably free of any unfair discrimination to applicants desiring to obtain such licenses.

Essential Patent Claims may exist for which a Letter of Assurance has not been received. The IEEE is not responsible for identifying Essential Patent Claims for which a license may be required, for conducting inquiries into the legal validity or scope of Patents Claims, or determining whether any licensing terms or conditions provided in connection with submission of a Letter of Assurance, if any, or in any licensing agreements are reasonable or non-discriminatory. Users of this standard are expressly advised that determination of the validity of any patent rights, and the risk of infringement of such rights, is entirely their own responsibility. Further information may be obtained from the IEEE Standards Association.