IEC TR 62878-2-2

Edition 1.0 2015-12

TECHNICAL REPORT

RAPPORT TECHNIQUE

Device embedded substrate –
Part 2-2: Guidelines – Electrical testing

iTeh STANDARD PREVIEW
(standards.iteh.ai)

Substrat avec appareil(s) intégré(s) –
Partie 2-2: Directives – Essai électrique

IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

IEC TR 62878-2-2:2015-12(en-fr)

THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2015 IEC, Geneva, Switzerland

All rights reserved. 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 either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
Fax: +41 22 919 03 00
info@iec.ch
www.iec.ch

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 corrigenda or an amendment might have been published.

IEC Catalogue - webstore.iec.ch/catalogue
The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

IEC publications search - www.iec.ch/searchpub
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 also once a month by email.

Electropedia - www.electropedia.org
The world's leading online dictionary of electronic and electrical terms containing more than 30 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary
More than 60 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

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: csc@iec.ch.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbd9a474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

A propos de l'IEC
La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC
Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Catalogue IEC - webstore.iec.ch/catalogue
Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

Recherche de publications IEC - www.iec.ch/searchpub
La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,…). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished
Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

Electropedia - www.electropedia.org
Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient plus de 30 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary
Plus de 60 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

Service Clients - webstore.iec.ch/csc
Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

IEC TR 62878-2-2

Edition 1.0 2015-12

TECHNICAL REPORT

RAPPORT TECHNIQUE

Device embedded substrate –
Part 2-2: Guidelines – Electrical testing

Substrat avec appareil(s) intégré(s) –
Partie 2-2: Directives – Essai électrique

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.180; 31.190

ISBN 978-2-8322-3032-9

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

® Registered trademark of the International Electrotechnical Commission
Marque déposée de la Commission Electrotechnique Internationale

CONTENTS

FOREWORD 3
INTRODUCTION 5
1 Scope 6
2 Electrical tests 6
2.1 Test level 1A for device embedded substrate 6
2.2 Test level 1B for component embedded substrate 7
2.3 Test level 2A for component embedded substrate 7
2.4 Test level 2B for passive device embedded substrate 9
2.5 Test level 3 for device embedded substrate 10
3 Electrical test procedure for device embedded substrate 12
Bibliography 15

Figure 1 – Interconnection open/short test 5
Figure 2 – Test level 1A 7
Figure 3 – Test level 1B 7
Figure 4 – Test level 2A 8
Figure 5 – Test level 2B 9
Figure 6 – Device embedded substrate with two or more passive devices 10
Figure 7 – Test level 3 for functional test 11
Figure 8 – Circuit model and simulation result 12
Figure 9 – Preparation for the test setup 13
Figure 10 – Test procedure flow 14

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

INTERNATIONAL ELECTROTECHNICAL COMMISSION

____

DEVICE EMBEDDED SUBSTRATE –

Part 2-2: Guidelines – Electrical testing

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 Publication(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. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements 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.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
iTeh STANDARD PREVIEW
(standards.iteh.ai)
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/b0dfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is 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 its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees 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 Publication or any other IEC 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 some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

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 TR 62878-2-2, which is a Technical Report, has been prepared by IEC technical committee 91: Electronics assembly technology.

The text of this Technical Report is based on the following documents:

Enquiry draft	Report on voting
91/1220/DTR	91/1245/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.

The French version of this Technical Report has not been voted upon.

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

A list of all parts in the IEC 62878 series, published under the general title *Device embedded substrate*, can be found on the IEC website.

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

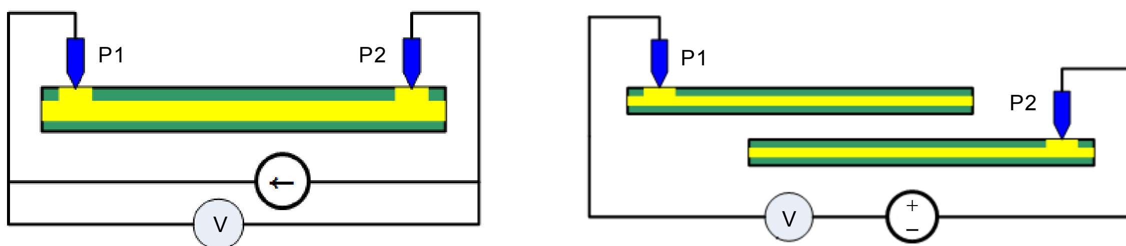
- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

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

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

INTRODUCTION

Current electrical package designs are becoming more complex, more functionally integrated, more reliable and more miniaturized than ever. Hence, electrical tests should be classified into levels in order to ensure the performance and quality of device embedded substrates since the substrate contains active/passive devices within it. While the interconnection open/short test is enough for general substrates, functional tests should be done when active/passive devices are embedded inside the substrate. However, the main problem is that we need to understand which devices are embedded and how they are connected functionally to each other. This is the main reason that there should be standardized test methods for device embedded substrate. Figure 1 shows the existing substrate test method: the interconnection open/short test.



a) Open test b) Short test

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

Figure 1 – Interconnection open/short test

DEVICE EMBEDDED SUBSTRATE –

Part 2-2: Guidelines – Electrical testing

1 Scope

This part of IEC 62878, which is a Technical Report, describes the necessary information on electrical testing for device embedded substrate. This includes the interconnection open- and short-circuit tests as well as the device functional test. It also provides guidelines by demonstrating the electrical test for device embedded substrate.

This part of IEC 62878 is applicable to device embedded substrates fabricated by use of organic base material, which include for example active or passive devices, discrete components formed in the fabrication process of electronic wiring board, and sheet formed components.

The IEC 62878 series does not apply to the re-distribution layer (RDL) nor to the electronic modules defined as an M-type business model in IEC 62421.

2 Electrical tests

iTeh STANDARD PREVIEW
(standards.iteh.ai)

2.1 Test level 1A for device embedded substrate

IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

Test level 1A for device embedded substrate is to check the continuity and isolation of interconnections which are not connected to any embedded components. This is shown in Figure 2. Test point 1 and test point 2 are on different networks. After measuring the resistance between net 1 and net 2, it can be found that net 1 and net 2 are short if the measured resistances are below a certain resistance. Test point 3 and test point 4 are on the same net, which is net 3. They are open if the measured resistance between the two test points is over a certain resistance. It means that they are not electrically connected.

Multi-testers which can measure voltage and current are commercially available. The source meter can measure the resistance directly since it has its own power supply. In terms of reliability, a high-current or low-level voltage test can be done to check the micro-open which causes the latent defects in the printed-circuit board and to check the micro-short which causes noise in the RF system.

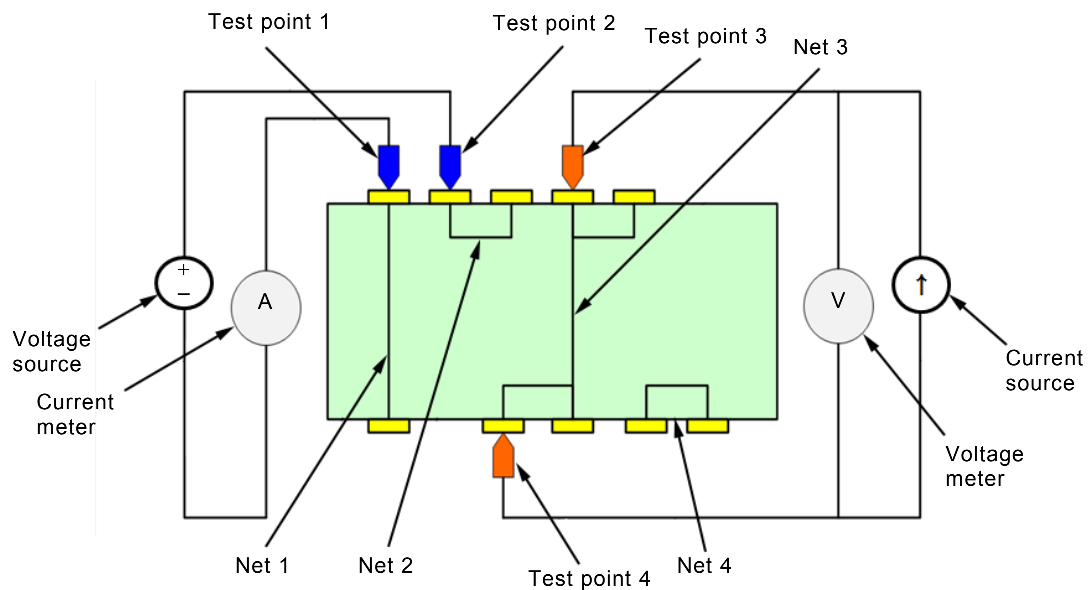


Figure 2 – Test level 1A

2.2 Test level 1B for component embedded substrate

Test level 1B is for testing electrical interconnection between wiring nets and component nets. This is shown in Figure 3. The test method of this level is the same as that of test level 1A because test level 1B is to check the isolation interconnection. Electrical interconnections are short if the measured resistance between wiring nets and component nets is below a certain resistance. It means that they are electrically connected.

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

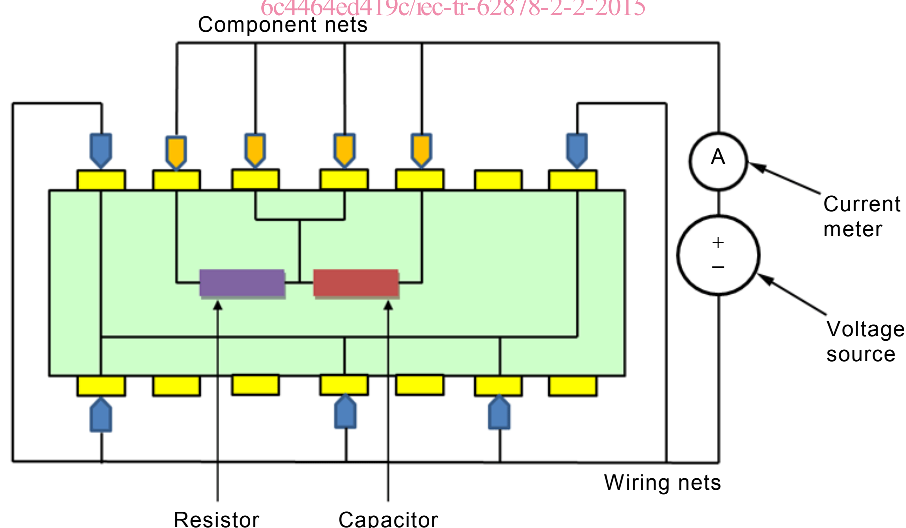


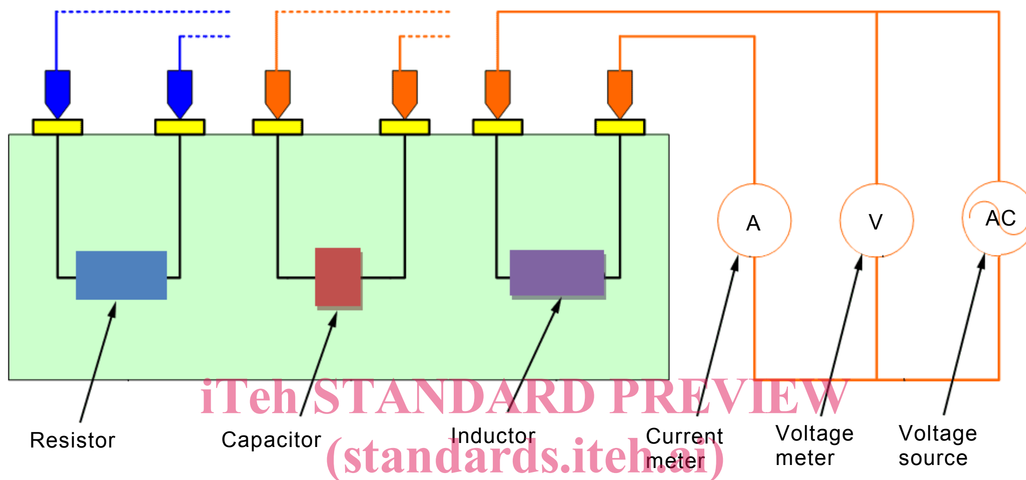
Figure 3 – Test level 1B

2.3 Test level 2A for component embedded substrate

Test level 2A is for testing a single component embedded substrate. Figure 4 a) shows the passive component scheme. Through this test, the electrical performance of the passive component and the continuity of the net can be measured. However, only the electrical performance test is suitable because the performance of the passive component will be affected if there is a problem with the continuity. In order to measure the performance of the passive component, the test method and the test signal need to be changed along with the

type of passive component. In the case of resistors, resistance can be measured by detecting the current/voltage ratio using constant voltage and constant current as in test levels 1A and 1B. However, in the case of capacitors and inductors, capacitance and inductance need to use an AC source to get the values. LCR meters and impedance analyzers are commercially available to measure resistance, capacitance, inductance and impedance. The equipment should be selected based on the frequency range to be measured.

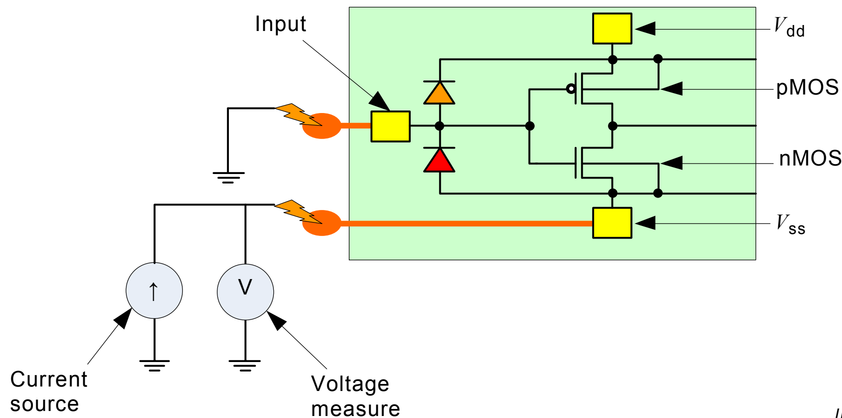
Figure 4 b) shows the active component circuit diagram, the method and the design of the electrostatic discharge (ESD) protection diode. Test level 2A is achieved by applying positive/negative bias to the circuit.



iTeh STANDARD PREVIEW
(standards.iteh.ai)

a) Passive component scheme

IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015



b) Active component circuit diagram and the method

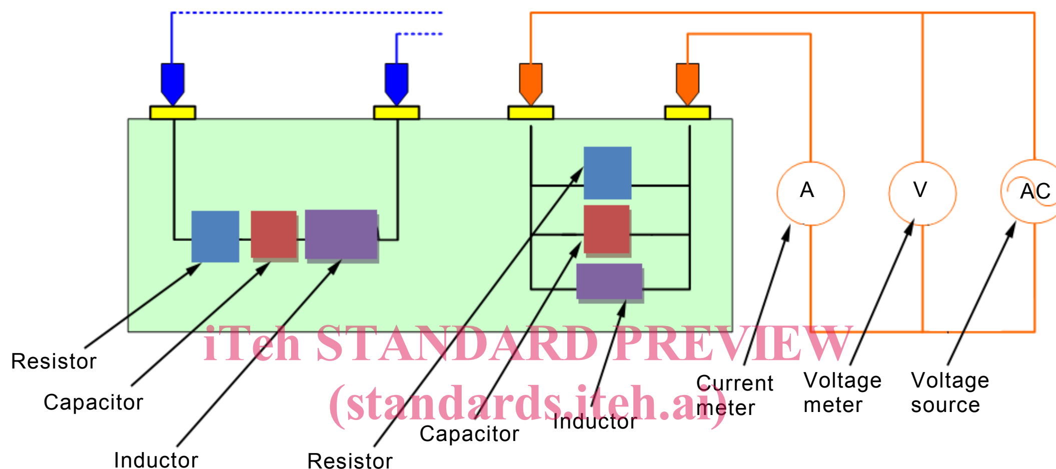
Key

V_{dd}	drain voltage
V_{ss}	source voltage
pMOS	p-channel metal oxide semiconductor
nMOS	n-channel metal oxide semiconductor

Figure 4 – Test level 2A

2.4 Test level 2B for passive device embedded substrate

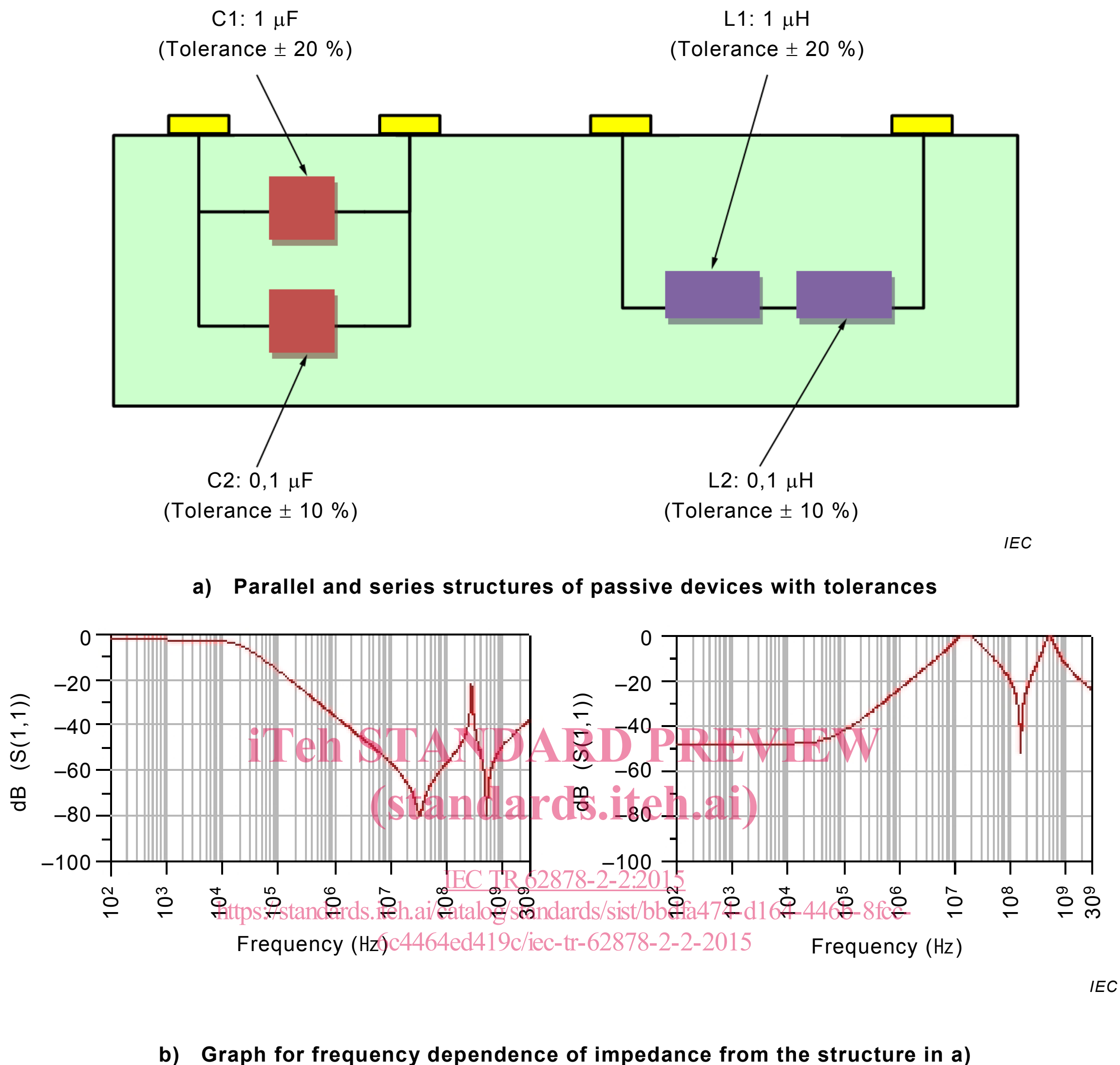
Test level 2B is for a simple passive structure which consists of a few passive components. These components are connected either in parallel or in series (Figure 5). This test will measure the electrical performance of the structure and the continuity of the transmission lines. For this case, only the electrical performance test is suitable because the performance of the passive components will be affected if there is a problem with the continuity, as for test level 2A. To be able to test passive components, test level 2B uses an AC source like test level 2A. However, it cannot measure the performance of individual passive components because the measured impedance will be the combination of impedances of all passive components. Moreover, tolerance values are introduced when the passive components are measured.



iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-446b-8fcc-6c4464ed419c/iec-tr-62878-2-2-2015

Figure 5 – Test level 2B

For example, as shown in Figure 6 a), if the capacitance of C1 is 1 μF with a tolerance of ± 20 %, the capacitance of C2 is 0,1 μF with a tolerance of ± 10 % and they are good components, then the total capacitance will be 0,89 μF ≤ (C1 + C2) ≤ 1,31 μF because of their tolerances. Thus, the passive component is good if the measured capacitance is between 0,89 μF and 1,31 μF. However, if C1 is good and C2 (< 0,09 μF) is bad, or C1 is good and C2 (> 0,11 μF) is bad, then the results are 0,8 μF ≤ (C1 + C2) ≤ 1,29 μF and (C1 + C2) > 0,91 μF, respectively. In these cases, we cannot judge if the passive components are good or bad because the results of both experiments are good even though one component is bad. However, if the frequency dependence of impedance is measured as in Figure 6 b), then the performances of each individual capacitor can be seen. Hence we can decide if C1 and/or C2 are good or bad depending on the frequency difference of resonance frequency. The inductance case between L1 and L2 of Figure 6 a) is similar to the capacitance case of Figure 6 a).



a) Parallel and series structures of passive devices with tolerances

iTeh STANDARD PREVIEW
(standards.iteh.ai)
IEC TR 62878-2-2:2015
https://standards.iteh.ai/catalog/standards/sist/bbdfa474-d164-4468-8fce-
0c4464ed419c/iec-tr-62878-2-2-2015

b) Graph for frequency dependence of impedance from the structure in a)

Figure 6 – Device embedded substrate with two or more passive devices

Therefore, it is necessary to judge whether each series or parallel passive component is good or bad at more than two specific frequency points by measuring total impedance and phase difference as test level 2B. The frequency points will be selected from simulation results or calculation. For more detailed analysis, continuous changes of impedance or phase difference need to be measured along with the frequency.

There is commercially available measurement equipment such as impedance analyzer and network analyzer. If the equipment has a wider measurable frequency range, the measurement result from the equipment will be more accurate. When a very high frequency measurement is required, the equipment setting such as probe tips and transmission lines to the equipment should be changed for a very high frequency measurement. One tip for easier measurement at high frequency is to design external test pads well so as not to use a high-cost probe card for high frequency measurement but to use RF probe tips which are commercially available.

2.5 Test level 3 for device embedded substrate

Figure 7 shows the functional test method of device embedded substrate which acts like a signal filter. The passive components in the substrate are connected to each other either in parallel or in series. In case of such a structure, the test result will not be the performance of individual passive components, but the performance of the filter. Typical open/short tests are