IEC 61747-40-1

Edition 1.0 2013-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Liquid crystal display devices –
Part 40-1: Mechanical testing of display cover glass for mobile devices – Guidelines**

**Dispositifs d'affichage à cristaux liquides –
Partie 40-1: Essais mécaniques des verres protecteurs des affichages pour les dispositifs mobiles – Lignes directrices**

IEC 61747-40-1:2013

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.

Useful links:

IEC publications search - www.iec.ch/searchpub

The advanced search enables you 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It also gives information on projects, replaced and withdrawn publications.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 on-line 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 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) on-line.

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.

A propos de la CEI

La Commission Electrotechnique Internationale (CEI) 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 CEI

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

Liens utiles:

Recherche de publications CEI - www.iec.ch/searchpub

La recherche avancée vous permet de trouver des publications CEI 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.

Just Published CEI - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications de la CEI. 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 au monde 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 les langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (VEI) en ligne.

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 61747-40-1

Edition 1.0 2013-06

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Liquid crystal display devices –
Part 40-1: Mechanical testing of display cover glass for mobile devices – Guidelines**

**Dispositifs d'affichage à cristaux liquides –
Partie 40-1: Essais mécaniques des verres protecteurs des affichages pour les dispositifs mobiles – Lignes directrices**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

PRICE CODE
CODE PRIX **K**

ICS 31.120 ISBN 978-2-83220-862-5

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.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LIQUID CRYSTAL DISPLAY DEVICES –

Part 40-1: Mechanical testing of display cover glass for mobile devices – Guidelines

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.
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.
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.

International Standard IEC 61747-40-1 has been prepared by IEC technical committee 110: Electronic display devices.

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

FDIS	Report on voting
110/464/FDIS	110/476/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.

A list of all the parts in the IEC 61747 series, under the general title *Liquid crystal display devices*, can be found on the IEC website.

Future standards in this series will carry the new general title as cited above. Titles of existing standards in this series will be updated at the time of the next edition.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site 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.

INTRODUCTION

Mobile electronic devices have become increasingly sophisticated and often incorporate displays for the purposes of user interface and viewing. Such displays commonly incorporate a transparent cover glass which aids in protecting the display against the introduction of damage through routine device transport and use, as well as occasional or accidental misuse.

The purpose of this standard is to provide mechanical testing guidelines for cover glasses utilized in such applications. Such glasses may or may not be strengthened, for example via an ion-exchange process, which acts to increase mechanical strength through the introduction of a surface compressive layer.

It is assumed that all measurements – described in detail in individual test method standards – are performed by personnel skilled in the general art of mechanical property measurements. Furthermore, it should be assured that all equipment is suitably calibrated as is known to skilled personnel and that records of the calibration data and traceability are kept.

LIQUID CRYSTAL DISPLAY DEVICES –

Part 40-1: Mechanical testing of display cover glass for mobile devices – Guidelines

1 Scope

This part of IEC 61747 is a mechanical performance testing guideline for cover glass used in electronic flat panel displays in mobile devices. This document focuses on key mechanical testing performance parameters and covers mainly strength and damage resistance attributes. The test methods will focus on the cover glass level testing only.

NOTE The glass used for cover glasses for electronic mobile devices can be chemically strengthened by an ion-exchange process. This ion exchange process increases the mechanical strength of the glass.

2 Terms and definitions

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

2.1
abraded
subjected to a defined process which introduces mechanical abrasive damage to a portion of the specimen to be placed under tension during subsequent flexural strength testing, for example, biaxial flexure via ring-on-ring

2.2
as-received
representative of standard sample preparation and handling practices, and therefore free of intentional mechanical damage such as abrasion, scratching, or indentation

Note 1 to entry: The strength of glass is not an intrinsic material property, and like other brittle elastic materials, is highly dependent upon the surface flaw population. The term “as-received” is meant to represent the surface condition upon specimen receipt and should be distinguished from a condition where damage has been intentionally introduced prior to testing.

2.3
central tension
CT
tensile stress generated within the interior of a glass article which serves to counteract (i.e., force balance) compressive stress acting at or near the article surface

Note 1 to entry: This note applies to the French language only.

2.4
chemically strengthened
subjected to a molten salt bath containing alkali ions typically larger than those residing in the glass, resulting in the generation of residual compressive stress (2.5) and central tension (2.3)

2.5
compressive stress
CS
maximum residual stress in compression measured near the glass surface

Note 1 to entry: This note applies to the French language only.

2.6
cover glass
cover lens
glass that typically protects an optical component such as a display from damage

2.7
damage resistance
ability to resist certain potential damage-inducing events such as abrasion, indentation or scratching

2.8
depth of layer
DOL
distance from the surface of a strengthened glass to the depth of zero stress or the depth of transition from compressive to tensile stress

Note 1 to entry: The ability to approximate this depth is dependent upon the measurement methodology chosen.

Note 2 to entry: This note applies to the French language only.

2.9
edge strength
measured stress at failure in the case where failure is known to have originated from a specimen edge

2.10
mobile device
electronic device that includes a battery and is designed to be carried about by consumers

2.11
retained surface strength
abraded surface strength
measured stress at failure in the case where failure is known to have originated from a specimen surface which has experienced a prescribed abrasion or mechanical damage event

2.12
strength
stress at which a specimen fails for a given loading condition

2.13
thermally strengthened
subjected to fast cooling of the glass exterior relative to the glass interior, resulting in the generation of residual compressive stress (2.5) and central tension (2.3)

3 Mechanical performance testing guidelines

3.1 General

The appropriate attribute(s) and test method(s) shall be selected based on the detail specification or depending on the purpose of the evaluation.

The standard environment for testing shall be 23 °C ± 3 °C for temperature and 50 % ± 5 % for relative humidity, unless otherwise specified in the detail specification. These standard requirements are established to control fatigue effects when performing mechanical testing on glass. If environmental conditions differ from the standard environment, the conditions shall be reported with the test data.

3.2 Mechanical testing guidelines for display cover glass for mobile devices

The mechanical attributes and measurement methods are given in Table 1.

Table 1 – Mechanical attributes and measurement methods

Category	Attributes	Unit	Test method
Strength (as-received)	Edge strength	MPa	Uniaxial flexural strength (4-point bend)
Strength (as-received)	Surface strength	N	Biaxial flexural strength (ring-on-ring)
Impact resistance	Surface energy-to-failure	Joules	Biaxial flexural energy-to-failure (ball drop)
Surface damage resistance	Scratch performance	gF N	Scratch lateral crack visibility/retained strength
Surface damage resistance	Retained surface strength	N	Abraded biaxial flexural strength (ring-on-ring)
Surface damage resistance	Resistance to indentation cracking	gF N	Visual median radial crack resistance/retained strength

In case the samples to be tested are that of strengthened glass – for example, via chemical or thermal means – the results of mechanical testing will depend on the degree of strengthening. This degree of strengthening may be characterized by attributes such as compressive stress, depth of layer, or other. While these are to be stated with any test reports, the measurement methods for these parameters are outside the scope of this guideline document.

Strengthened glasses may result in non-linearities (such as in load to stress conversion) due to high deformations and the formation of membrane stresses, which shall be taken into consideration during data analysis and reporting.

4 Brief overview of mechanical test methods

a) Edge strength

Uniaxial flexural strength (4-point bend)

A uniaxial flexural test via a 4-point bend has been selected as the best representative test for edge strength. This is related to the observations of failures occurring from edge flaws rather than surface flaws in the specimen.

b) Surface strength

Biaxial flexural strength (ring-on-ring)

A biaxial flexural test via a ring-on-ring methodology is designed to test surface strength. A note of caution: when the specimen deflects more than 1/2 its thickness, the load-to-stress relationship is no longer linear, and non-linear effects shall be taken into account to properly convert load to stress.

c) Surface impact resistance (energy to failure)

Biaxial flexural energy-to-failure (ball drop)

A biaxial flexural test via a ball drop provides an indirect measurement of surface strength by applying a biaxial stress to the glass surface upon ball impact. Measurement of the impact energy is used to approximate equivalent performance for different ball sizes, weights and drop heights.

d) Scratch performance

Scratch lateral crack visibility/retained strength

Lateral cracks are cracks originating from the sub-surface of the glass (not from the surface) which initially extend nearly parallel to the surface. These cracks may ultimately propagate to intersect the surface of the glass resulting in visible chipping. The test is performed in a step-load manner utilizing sliding indentation with, for example, a Knoop or

Vickers diamond tip. Retained strength after sliding indentation may be measured via biaxial flexure (ring-on-ring) with the indentation site oriented in tension.

e) Retained surface strength

Abraded biaxial flexural strength (ring-on-ring)

An abraded biaxial flexural test (via ring-on-ring) can be an effective measure of the retained surface strength of a test specimen. Development of an abrasion method for standardization is currently under evaluation.

f) Resistance to indentation cracking

Visual median/radial crack resistance/retained strength

Median/radial cracks extend from the corners of the indent impression and are oriented perpendicular to the surface so that they have the greatest strength-limiting effect in bending. The test is performed in a step-load manner with, for example, a Vickers diamond tip until the cracks form. Retained strength after indentation may be measured via biaxial flexure (ring-on-ring) with the indentation site oriented in tension.