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INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Flexible display devices – Part 6-1: Mechanical stress test methods

Dispositifs d'affichage flexibles – Partie 6-1: Méthodes d'essais de contraintes mécaniques

IEC 62715-6-1:2014-02(EN-FR)

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FOREWORD

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

CDV	Report on voting
110/452/CDV	110/513/RVC

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 62715 series, under the general title *Flexible display devices*, 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 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- withdrawn,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.

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FLEXIBLE DISPLAY DEVICES –

Part 6-1: Mechanical stress test methods

1 Scope

The object of this part of IEC 62715 is to define the standard test methods to evaluate the mechanical stability of flexible display modules which include displays such as LCD, e-paper, and OLED. It takes into account, wherever possible, the mechanical test methods outlined under mechanical stress.

2 Normative references

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

IEC 62341-5:2009, *Organic light emitting diode (OLED) displays – Part 5: Environmental testing methods*

3 Standard atmospheric conditions

The standard atmospheric conditions in IEC 62341-5:2009, 5.3, shall apply unless otherwise specifically agreed between customer and supplier. The standard atmospheric conditions shall be a temperature of 25 °C ± 5 °C, relative humidity between 45 % and 75 %, and atmospheric pressure between 86 kPa and 106 kPa. When all the kinds of tests are carried out, the temperature condition shall be commented because the temperature is critical for the bending and rolling stability regarding image quality on the panel.

4 Evaluations – Visual evaluation of panel image quality

The specimen shall be the display module since the final evaluation has to be made based on panel image quality such as luminance, chromaticity, uniformity, line defect, and point defect. The bending stress may cause the deterioration of image quality on a panel, [1] to [9][1]. The allowable critical bending radius of a panel depends on the application of the flexible display. Therefore, the required critical bending radius will be changed case by case.

5 Mechanical stress test methods

5.1 General

Flexible displays have a diversity of shape in comparison with non-flexible displays. Therefore, a wide variety of mechanical stress test methods is available, such as a cyclic bending (folding) or dynamic bending test, a static bending test, a rolling test, a combined mechanical test and more. The selection of the appropriate test methods shall be based on the requirement of the application. For each mechanical stress test, the relevant test method specification shall be stated along with the explanation of the purpose of each unique test.

[1] Numbers in square brackets refer to the Bibliography.

5.2 Cyclic bending test

5.2.1 General

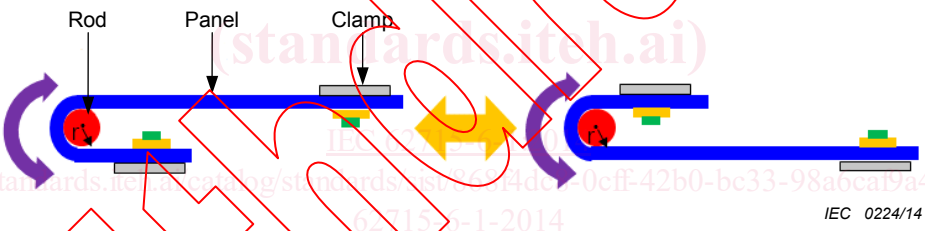
This procedure is for conditioning the sample under mechanical stress by repeated bending.

5.2.2 Purpose

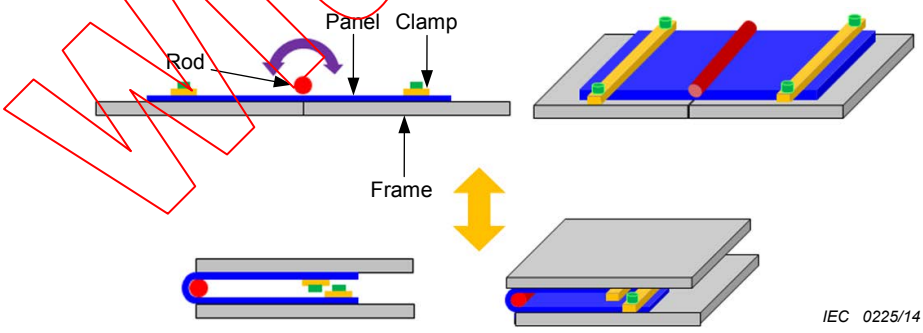
The purpose of this test is to provide a standard procedure for evaluating the robustness of a flexible display against a cyclic bending stress which might typically happen in application. The bending properties might cover several typical parameters of the characteristics of display panel image quality. The typical parameters of display panel image quality might cover the luminance, chromaticity, uniformity, line defect, and point defect.

5.2.3 Test apparatus

The cyclic bending test equipment includes the clamp to hold a bending test sample, the moving part to shuttle, and the control system which regulates the number of cyclic bending, the moving distance, and the moving speed while testing. The specimen shall be securely clamped with a gripping part during the test. Several cyclic bending test equipments are available and shown in Figure 1, [4],[7],[10]. It is not necessary that a certain type of bending test equipment be preferred but the constant bending radius (r), equal to the radius of the rod, should be kept during the bending test. The specimen experiences bending stress when the specimen is shuttled back and forth (Figure 1a)) or while the specimen is folded and unfolded (Figure 1b)).



a)



b)

Figure 1 – Apparatus for diverse cyclic bending test

5.2.4 Test procedure

The cyclic bending test shall be performed using repeated motion to move regularly between two points or two states (folded state and unfolded state). For each test, the moving speed, the bending radius and the number of cyclic bending should be mentioned, because the characteristics of the image quality displayed on the module might depend on these elements. The direction in which the specimen faces shall be stated, such as face-up or face-down. For example, the conditions shall be selected as below:

r (bending radius): 20 mm, 10 mm, 5 mm, 3 mm, 2 mm, 1 mm, 0,5 mm, 0,2 mm, 0,1 mm

t (time for one bend and interval): 0,5 s, 1 s, 2 s, 3 s, 5 s, 10 s

All the conditions shall be reported if the test uses the conditions other than the conditions given above.

5.3 Static bending test

5.3.1 General

This test is especially applicable for evaluating the bending properties of a flexible display device by measuring its performance after it remains bent for a certain period of time. Each specimen is bent at a fixed bending radius for any length of time.

5.3.2 Purpose

This test is to provide a standard procedure for evaluating the bending properties of a flexible display device under constant stress for a certain period of time. Each specimen is bent at a fixed bending radius for a controlled length of time.

5.3.3 Test apparatus

The body of the display panel shall firmly adhere to the surface of the test equipment during the test, where the test equipment should have a round shape with a certain radius as in Figure 2. The specimen shall be bent at a fixed bending radius for a period of time. During the test, the FPC (flexible printed circuit) and the driver should be carefully handled in order not to cause bending damage on them. The COF (chip on film) method is preferable in order to avoid the occurrence of bending damage on the driver IC during the bending test.

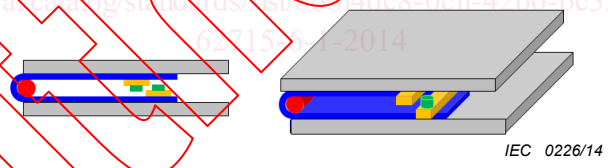


Figure 2 – Apparatus for static bending test

5.3.4 Test procedure

The static time bending test shall be carried out with a fixed bending radius for a certain period of time. For each test, the bending radius and the period of time shall be mentioned because the static bending properties of the characteristics of the display panel image quality might depend on the bending radius and the period of time.

5.4 Combined bending test

5.4.1 General

This test is especially applicable for evaluating two kinds of combined bending properties (cyclic bending properties and static bending properties (see Figure 3)) of the flexible display device, after the flexible display remains in the curved shape for a certain period of time and goes through the cyclic bending condition for a certain period of time in real usage environment.

5.4.2 Purpose

The objective of this test is to provide a standard procedure for evaluating the combined bending properties of cyclic bending and duration time bending. This test aims to take the real product usage environment into consideration where the real product keeps the panel in a curved, folded, or rolled shape for a long time when it is used or before it is rolled out.

5.4.3 Test apparatus

The combined bending test utilizes the same apparatus as the cyclic bending test as shown in Figure 3. The instrument controller shall be capable of stopping the mechanism while the sample is in a bent state during each iteration of the cycle.

5.4.4 Test procedure

The cyclic bending test procedure is modified to include a pause of adjustable duration between each iteration of the cycle where the specimen remains in a fully bent state [4]. The entire test sequence and all of the test conditions of the cyclic bending test part and the static bending test part shall be reported to ensure reproducibility.

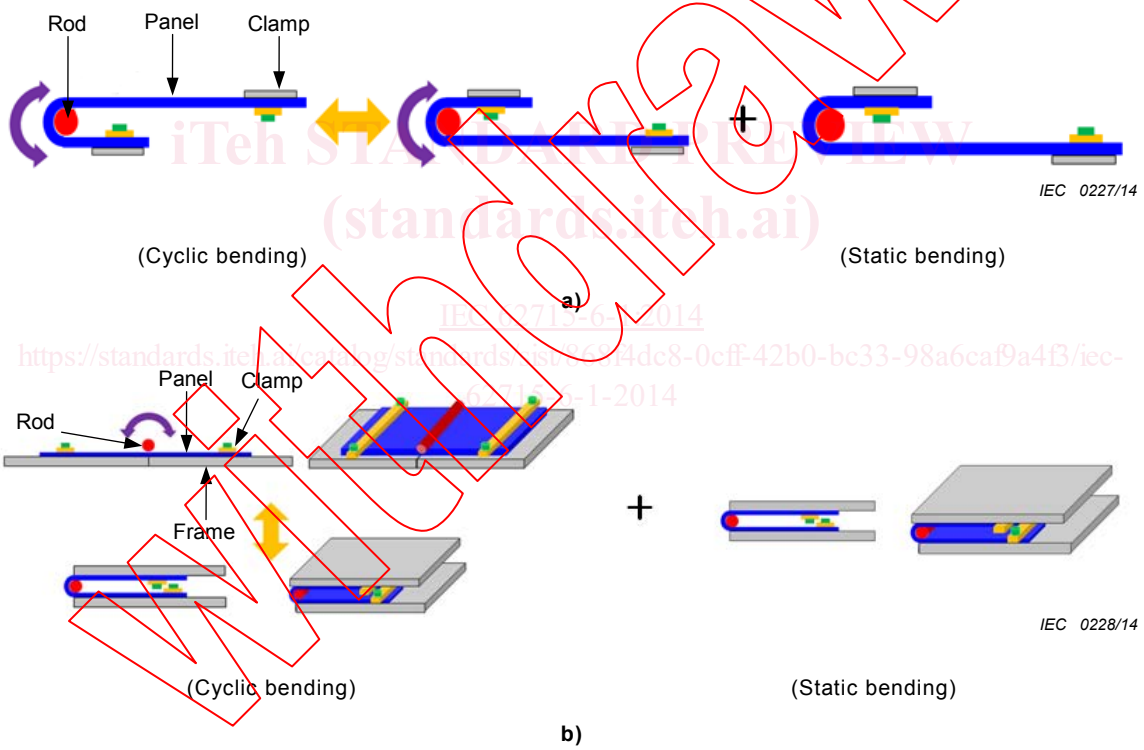


Figure 3 – Apparatus for combined bending tests consisting of cyclic bending test and static bending test

5.5 Rolling test

5.5.1 General

This test is especially applicable for evaluating the rolling properties of a flexible display module after a flexible display is rolled out, rolled in, or remains in the shape of a roll.

5.5.2 Purpose

The objective of this test is to provide a standard procedure for evaluating the robustness of the rolling properties of the flexible display panel.

5.5.3 Test apparatus

The specimen shall be firmly clamped with a gripping part on the roller side and on the stationary side. The roller shall be reciprocated at a fixed distance, speed, and rolling number as in Figure 4. The roller side has the slot where the edge of the specimen is inserted and clamped. The roller repeatedly shuttles along the roller shaft and the specimen does not touch the plate of the equipment during the rolling test as shown in Figure 4. During the test, the FPC and the driver shall be carefully handled in order not to cause twist damage on them. The COF method is preferable in order to avoid the occurrence of twist damage on the driver IC during the bending test.

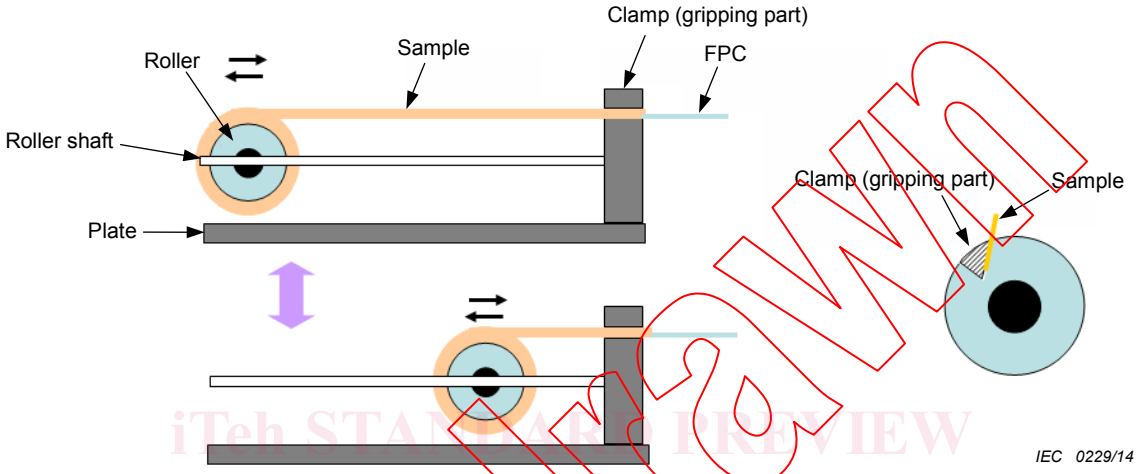


Figure 4 – Apparatus for rolling test

5.5.4 Test procedure

A fixed area of the specimen shall be cyclically wounded and unwounded around the roller. The winding rate and the cycle count will be controlled. The test conditions and settings shall be reported to ensure reproducibility.

5.6 Torsion test

5.6.1 General

This test is applicable for evaluating the torsion properties of a flexible display module after being subjected to torsion during a certain period of time. For flexible displays, torsion is likely to happen easily during usage.

5.6.2 Purpose

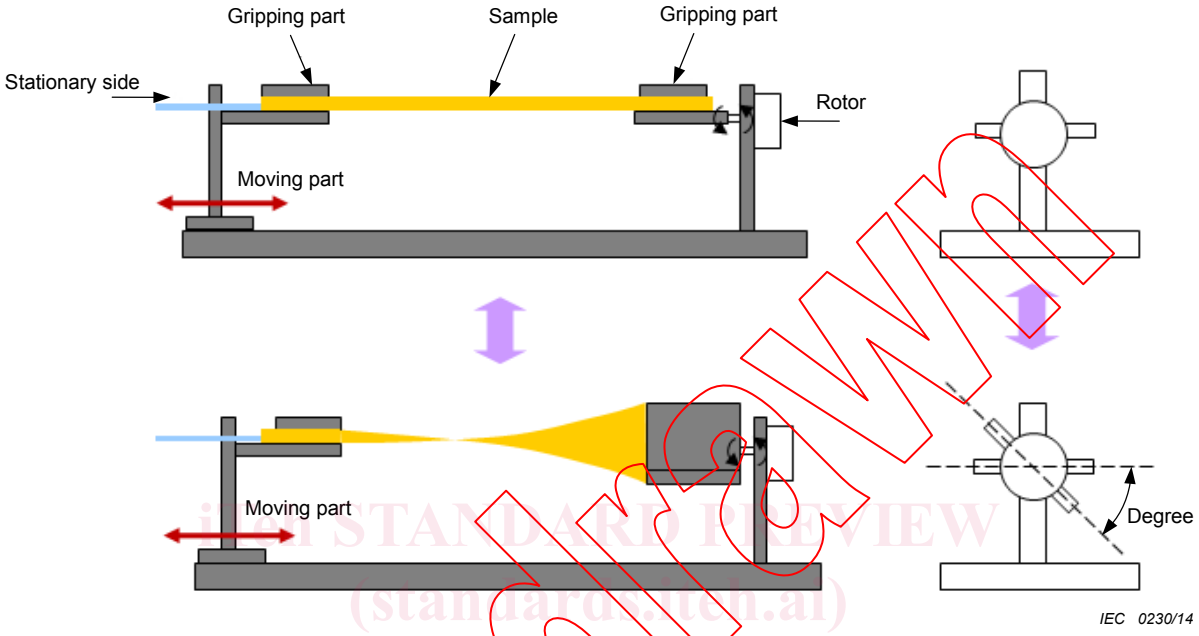
The objective of this test is to provide a standard procedure for evaluating the robustness of a flexible display device against cyclic torsion stress which might typically happen in the application.

5.6.3 Test apparatus

The specimen shall be firmly clamped and twisted at a certain degree of torsion angle, as shown in Figure 5, during the test. The specimen shall be securely clamped with an appropriate gripping part. During the test, the FPC and the driver shall be carefully handled in order not to cause twist damage on them. The edge of the sample with the FPC and the driver IC in the stationary side shall be fixed in order to avoid the occurrence of twist damage during the bending test. When the sample is twisted, the extra tension is applied on the side of the sample in addition to the twist tension. Therefore, the moving part in the stationary side shall move forward and backward during the test because the extra and unnecessary tension applied on the sample should be removed as shown in Figure 5a) and b).

5.6.4 Test procedure

The specimen shall repeatedly be twisted counter clockwise and clockwise at a fixed degree of twisting, a certain speed, and a certain number of twists. The test conditions of the torsion test such as twist speed and number of twists should be mentioned because the characteristics of the display panel image quality might depend on the test conditions mentioned in Clause 4.



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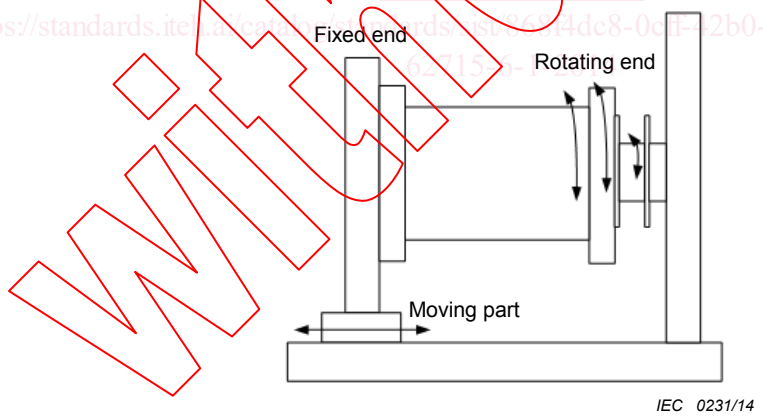

b)

Figure 5 – Apparatus for diverse torsion test

5.7 Tension test

5.7.1 General

This test is applicable for evaluating the tension properties of a flexible display module after being subjected to a constant tension at the moment of the change between folding and unfolding and between roll-in and roll-out (see Figure 6).