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INTERNATIONAL STANDARD

colour inside

Liquid crystal display devices –
Part 20-3: Visual inspection – Active matrix colour liquid crystal display modules

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LIQUID CRYSTAL DISPLAY DEVICES –

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FOREWORD

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International Standard IEC 61747-20-3 has been prepared by IEC technical committee 110: Electronic display devices.

This first edition cancels and replaces the first edition of IEC 61747-5-2 published in 2011. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) document numbering was changed to align with the new numbering of IEC 61747.

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

FDIS	Report on voting
110/725/FDIS	110/740/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 parts of the IEC 61747 series, under the general title *Liquid crystal 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 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- withdrawn,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
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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.

INTRODUCTION

This part of IEC 61747 facilitates the visual inspection of the image defect of LCD modules by human eyes subjectively. Visual inspection is performed at specified conditions and criteria. The objective measurement method of visual image defects with an instrument will be studied and standardized.

LIQUID CRYSTAL DISPLAY DEVICES –

Part 20-3: Visual inspection – Active matrix colour liquid crystal display modules

1 Scope

This part of IEC 61747 gives the details of the quality assessment procedures and provides general rules for visual inspection of the active area of transmissive type active matrix colour liquid crystal display modules by the human eye. Furthermore, this standard includes defect definitions and the method for visual defect inspection.

NOTE 1 Mura is excluded from this standard because it was not clearly specified at the time this standard was developed.

NOTE 2 Restrictions on defect types, number, and sizes are specified in the quality contract (customer acceptance specification and incoming inspection specification).

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 61747-10-2:2014, *Liquid crystal display devices – Part 10-2: Environmental, endurance and mechanical test methods – Environmental and endurance*

3 Terms, definitions and abbreviations

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

3.1 General

3.1.1
visual inspection
method of checking display defects with the human eye

Note 1 to entry: The limitation on display defects depends on supplier and customer. Therefore a limit sample, with well-defined observation and operational conditions, can be used as a reference for the defect level.

3.2
defect
any observable abnormal phenomenon appearing in the active display area

EXAMPLE Figure 1 shows a classification of defects into two categories. The first category is classified as defects with a clear boundary, and the second category is classified as defects with an unclear boundary. The latter category is not yet well defined, and hence difficult to evaluate. For this reason, defects in the second category are excluded from this standard.

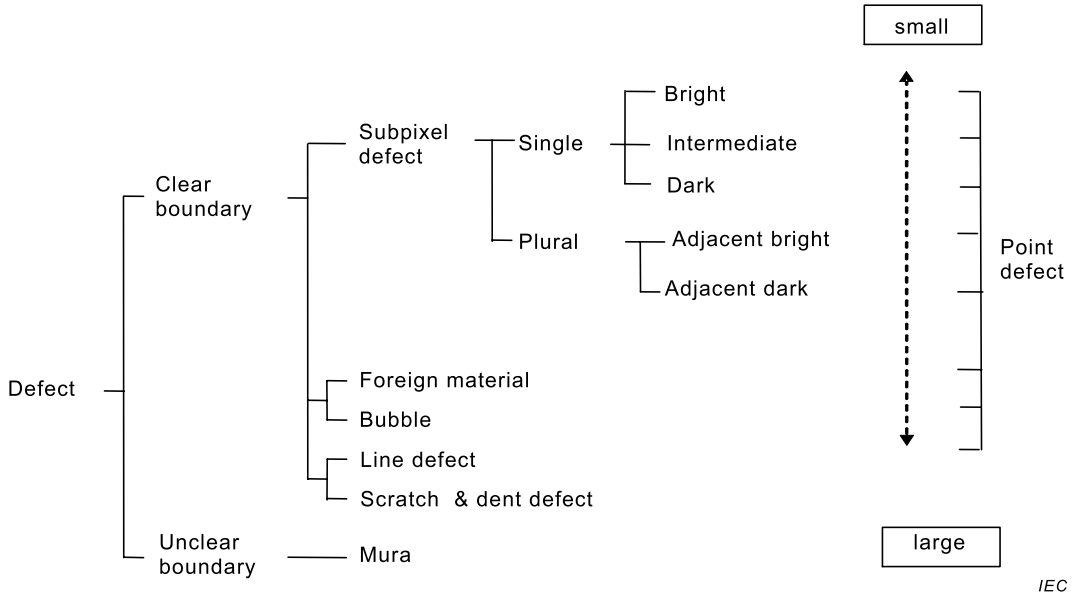

Figure 1 – Classification of defects by visual inspection

3.2.1
subpixel defect
defect in the smallest pixel element when it appears in a state different from the intended one

EXAMPLE Bright subpixels appear on a dark pattern, and dark subpixels appear on a bright pattern.

3.2.2
bright subpixel defect
defect which appears bright on the screen when a dark pattern is displayed

EXAMPLE Figure 2 a) shows a single subpixel bright defect of red, green, and blue respectively. Figure 2 b) shows two adjacent bright subpixel defects connected or disconnected in a horizontal and/or vertical one-pixel area. Figure 2 c) shows three adjacent bright subpixel defects connected in three horizontal and/or vertical subpixel areas.

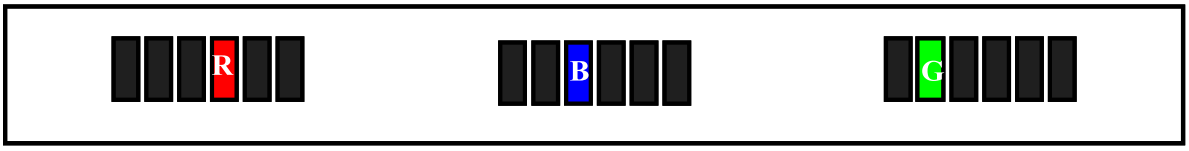

Figure 2 a) – Examples of one bright subpixel defect

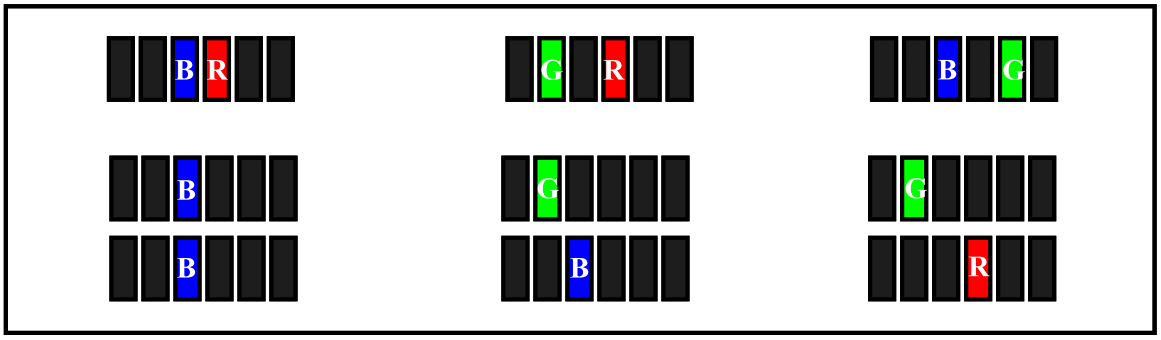

Figure 2 b) – Examples of two adjacent bright subpixel defects

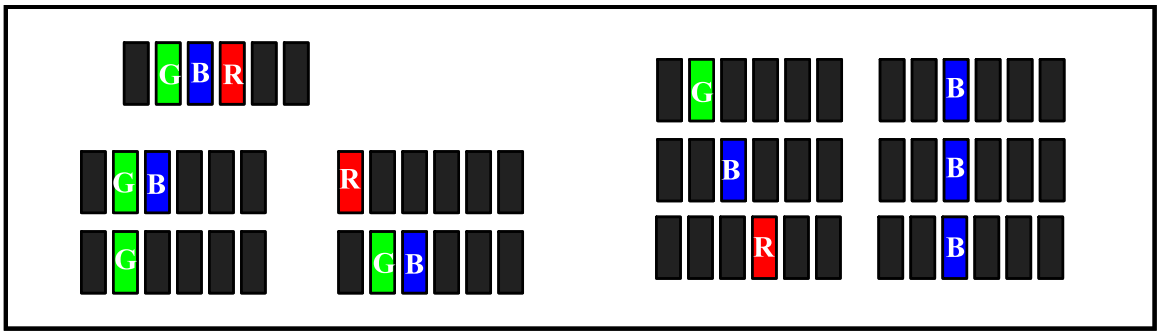

Figure 2 c) –Examples of three adjacent bright subpixel defects

Figure 2 – Examples of bright subpixel and adjacent subpixel defects in case of an RGB primary colour display

3.2.3
dark subpixel defect
defect which appears dark on the screen when a bright pattern is displayed

EXAMPLE Figure 3 a) shows a single subpixel defect of the dark-type of red, green, blue, respectively. Figure 3 b) shows two adjacent dark subpixel defects connected or disconnected in a horizontal and/or vertical one-pixel area. Figure 3 c) shows three adjacent dark subpixel defects connected in three horizontal and/or vertical subpixel areas.

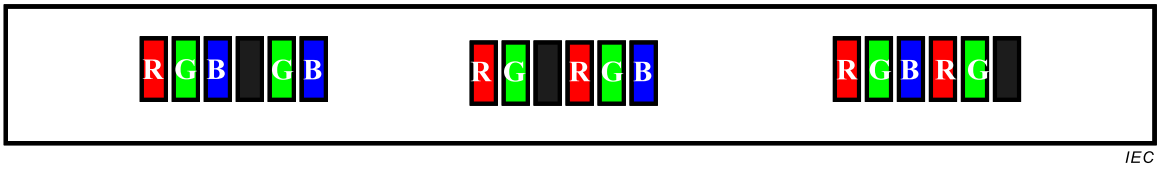

Figure 3 a) – One dark subpixel defect

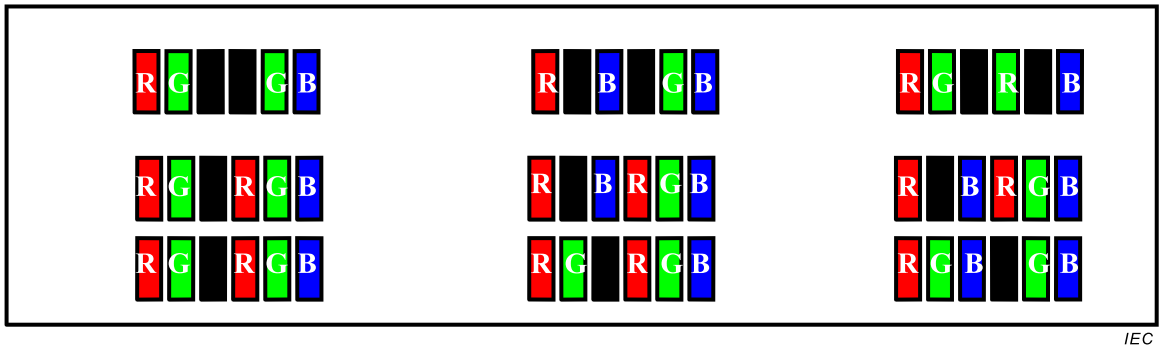

Figure 3 b) – Two adjacent dark subpixel defects

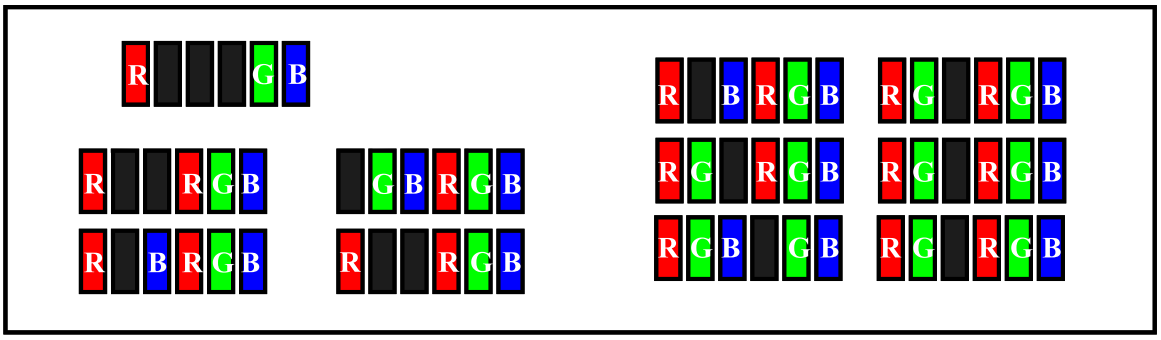

Figure 3 c) – Three adjacent dark subpixel defects

Figure 3 – Examples of dark subpixel and adjacent subpixel defects in case of RGB primary colour display

3.2.4
intermediate subpixel defect
defect which appears with an intermediate luminance level on the screen when a bright or dark pattern is displayed

3.2.5
cluster subpixel defect
at least two subpixel defects in a specified area or within a specified distance with many subpixel defects

EXAMPLE Figure 4 a) and Figure 4 b) show an example of bright and dark cluster subpixel defects in which the minimum distance between the defects is specified. "d_h" and "d_v" stand for horizontal and vertical minimum distance.

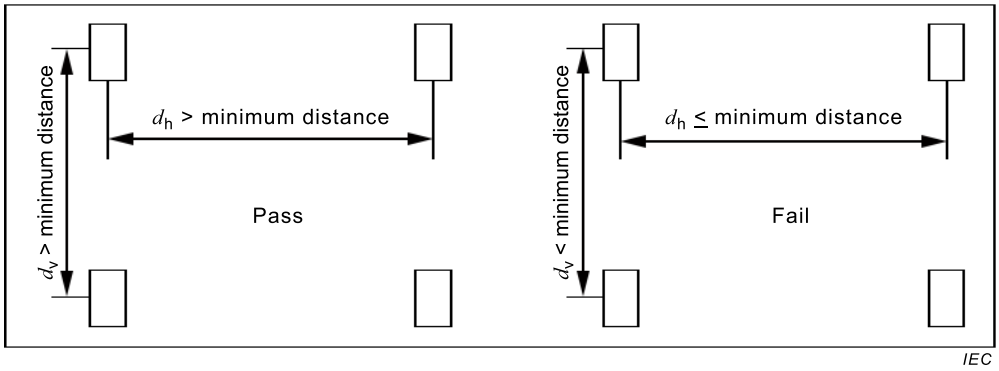

Figure 4 a) – Bright subpixel defect to bright subpixel defect

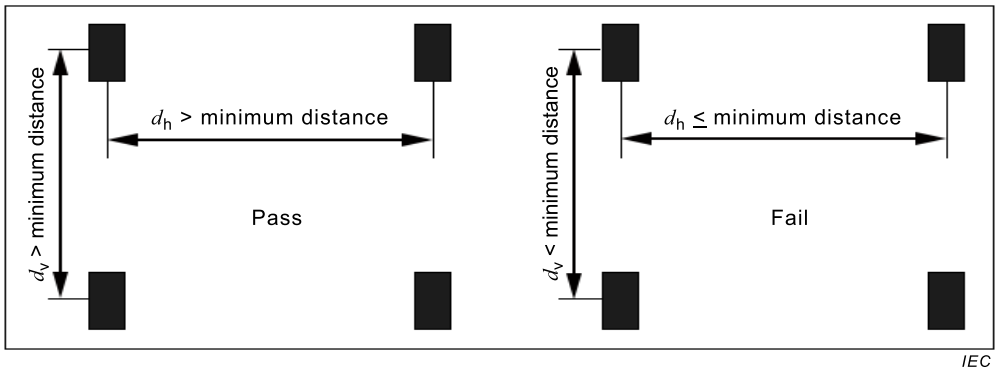

Figure 4 b) – Dark subpixel defect to dark subpixel defect

Figure 4 – Examples of minimum distance between subpixel defects

3.2.6
line defect
vertical or horizontal line which appears in the bright or dark state when a dark or bright pattern is displayed

3.2.7
bright line defect
line that appears bright on the screen when a dark pattern is displayed

3.2.8
dark line defect
line that appears dark on the screen when a bright pattern is displayed

3.2.9
scratch and dent defect
defect on top of or underneath the polarizer or other optical components in the active display area

3.2.10
scratch defect
light (white) line that can be seen over a darker background and does not vary in size

3.2.11
dent defect
light (white) spot that can be seen over a darker background and does not vary in size

3.2.12
foreign material defect
defect that is located between the panel and backlight unit

3.2.13
bubble defect
defect that is caused by a cavity or gas in the liquid crystal material in the paste of the polarizer/reflector

3.2.14
light leakage defect
light that is visible between the top case (chassis) and outer black matrix in a bezel open area

EXAMPLE Figure 5 shows an example of a light leakage defect.

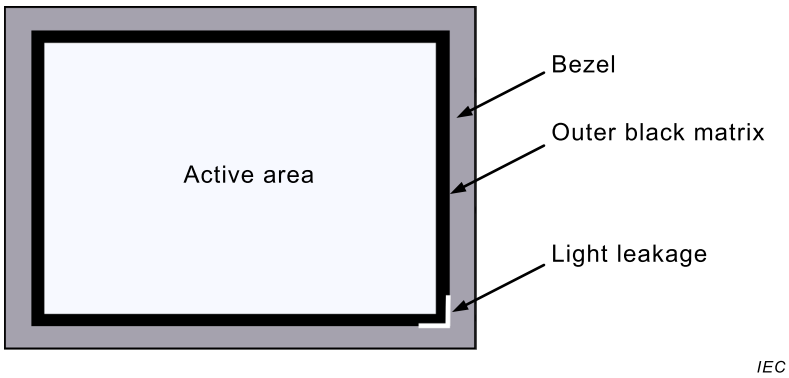

Figure 5 – Example of light leakage between the top case and outer black matrix

3.2.15
mura
non-uniformity
visual imperfection in luminance or chromaticity

[SOURCE: IEC 61747-1-2:2014, 3.3.20]

3.3 Abbreviations

DUT device under test

4 Visual inspection method and criteria

4.1 Standard inspection conditions

4.1.1 Ambient conditions

4.1.1.1 Temperature and humidity

All visual inspection shall be carried out at the temperature specified in IEC 61747-10-2:2014, Clause 4.

All visual inspection shall be carried out at the humidity specified in IEC 61747-10-2:2014, Clause 4.

4.1.1.2 Illuminance

All visual inspection shall be carried out at the illumination levels as specified in the detail specification. The illumination level shall be adjusted in such a way that it allows for an accurate visual inspection.

4.1.2 Visual inspection conditions

4.1.2.1 Viewing angle range

The inspection shall be conducted within the specified viewing angle range of the liquid crystal display modules.

4.1.2.2 Viewing distance

The distance between the DUT and the inspector's eyes should be set at optimum distance. The optimum distance depends on pixel size, display size, application type, and defect size.

4.1.3 Electrical driving conditions

4.1.3.1 Driving supply voltage or current of DUT

The specified voltage and/or current shall be supplied to the DUT.

4.1.3.2 Test pattern

Test patterns shall be specified in the detail specification. For example, the test patterns for visual inspection are the full raster of white, black, grey and all primary colour patterns under the specified luminance range.

4.2 Standard inspection method

4.2.1 Setup of inspection equipment and liquid crystal display modules

The DUT will be installed on a rotatable fixture to enable changes in the horizontal and vertical viewing direction range. Alternatively, the inspector moves around and the DUT is fixed.

Turn on the direct current power supply and pattern generator and warm up for stabilization. Supply the driving voltage and pattern to the DUT. The warm-up time of the DUT shall be sufficiently long to obtain a stable signal, necessary for the visual inspection.

4.2.2 Inspector and limit sample for visual inspection

The inspector shall have (corrected-to) normal vision, normal colour vision and shall be periodically trained with specified limit samples in order to accurately carry out the visual examination.

4.2.3 Inspection and record of result

The inspector shall carry out the visual inspection based on the specified procedure and record the result on recording sheets with the specified inspection conditions.

4.3 Criteria

4.3.1 Bright subpixel defects

The maximum number of bright defects shall be specified in the specification.

– One subpixel: To be specified in the detail specification.
– Adjacent subpixels: To be specified in the detail specification.
– Total amount of bright subpixels: To be specified in the detail specification.

4.3.2 Dark subpixel defects

The maximum number of dark defects shall be specified in the specification.

– One subpixel: To be specified in the detail specification.
– Adjacent subpixels: To be specified in the detail specification.
– Total amount of dark subpixels: To be specified in the detail specification.

4.3.3 Intermediate subpixel defects

The maximum number of intermediate defects shall be specified in the specification.

– One subpixel: To be specified in the detail specification.
– Adjacent subpixels: To be specified in the detail specification.
– Total amount of subpixels: To be specified in the detail specification.

4.3.4 Cluster subpixel defects

The maximum number of cluster defects shall be specified in specification.

The minimum distance between subpixel defects (d_v and d_h, see Figure 4) shall also be specified.

– Cluster subpixels: To be specified in the detail specification.

4.3.5 Bright line defects

All types of bright line defects such as vertical, horizontal or cross are not allowed.

4.3.6 Dark line defects

All types of dark line defects such as vertical, horizontal or cross are not allowed.

4.3.7 Scratch and dent defects

The criteria for scratch and dent defects are provided in Table 1 and Figure 6. The symbol of "a" and "b" indicates the major axis and minor axis of the polarizer defect. Extraneous substances which can be wiped out, such as fingerprints or particles, are not considered a defect. Scratches and dents located on the black matrix (outside of the active area) are not considered defects.

Table 1 – Criteria for scratch and dent defects

Item		Criteria
Scratches	Linear ($a > 2b$)	Minimum ≤ width [mm] ≤ maximum, minimum ≤ length [mm] ≤ maximum, N (number of defects)≤ maximum
Dents	Circular ($a \leq 2b$)	Minimum ≤ average diameter, $(a + b)/2$ [mm] ≤ maximum, N (number of defects) ≤ maximum

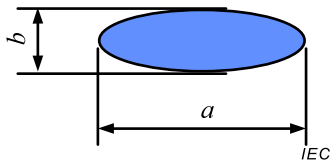

Figure 6 – Shape of scratch and dent defects

4.3.8 Foreign material and bubble defects

The criteria for foreign material such as dust, thread, etc, located inside the DUT, and bubbles such as air, gas, etc., are provided in Table 2 and Figure 7.

Table 2 – Criteria for foreign material and bubble defects

Item	Criteria
Foreign material	N (number of defects): maximum size of defects < max [a, b]
Bubbles	N (number of defects): maximum size of defects < max [a, b]

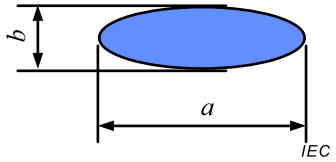

Figure 7 – Shape of foreign material and bubble defects

4.3.9 Light leakage defects

There shall be no visible light from the backlight unit around the edges of the screen.

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IEC 61747-20-2, *Liquid crystal display devices – Part 20-2: Visual inspection – Monochrome matrix liquid crystal display modules (excluding all active matrix liquid crystal display modules)*

IEC 61747-30-1, *Liquid crystal display devices – Part 30-1: Measuring methods for liquid crystal display modules – Transmissive type*

ISO 9241-307, *Ergonomics of human-system interaction- Part 307: Analysis and compliance test methods for electronic visual displays*

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