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BSI Standards Publication

Electronic paper displays

Part 1-1: Terminology

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee EPL/47, Semiconductors.

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International Standard IEC 62679-1-1 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
110/554/FDIS	110/573/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 in the IEC 62679 series, published under the general title *Electronic paper displays* 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- withdrawn,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.

ELECTRONIC PAPER DISPLAYS –

Part 1-1: Terminology

1 Scope

This part of IEC 62679 gives the preferred terms, their definitions, as well as the symbols for electronic paper displays (EPDs).

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 60050 (all parts), *International Electrotechnical Vocabulary* (available at www.electropedia.org)

IEC 60027 (all parts); *Letter symbols to be used in electrical technology*

IEC 60617, *Graphical symbols for diagrams*

IEC 60747-1, *Semiconductor devices – Part 1: General*

ISO 80000-1, *Quantities and units – Part 1: General*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60050, as well as the following apply.

3.1 Physical concepts

3.1.1
electronic paper display
EPD
electronic display that shows information by diffuse reflection and holds the image with low power consumption

3.1.2
electrophoretic display
electronic paper display which forms an image by rearranging charged pigment particles using an applied electric field

3.1.3
cholesteric liquid crystal display
liquid crystal phase that exhibits planar nematic ordering in which the directors form a helix that has its axis perpendicular to the plane

[SOURCE: IEC 61747-1:1998, 3.1.3]

3.1.4
powder migration display
electrophoretic display that shows information by the motion of static charged pigment particles in a gas using an applied electric field

3.1.5
bi-stable nematic LCD
electronic display making use of light polarization modulation by bi-stable nematic liquid crystal under the influence of an electric field

3.1.6
electrochromic display
electronic reflective type display that shows information by reversibly changing the colour of suitable materials by chemical oxidation or reduction of the materials at the electrode level

3.1.7
electrodeposition display
electronic reflective type display that shows information by migration of ionized molecules by the exchange of carrier on the electrode

3.1.8
twisting ball display
electronic paper display that modulates the reflected light by rotating dielectric or magnetic balls with coloured hemispheres under the influence of an electric field

3.1.9
electro wetting display
electronic display that modulates the reflected light by electrical hydorophobic effect of oil in water under the influence of an electric field

3.1.10
electrofluidic display
electronic display that modulates the reflected light by moving small volumes of aqueous pigment dispersion in and out of microfluidic cavities under the influence of a spatially modulated voltage

3.1.11
interferometric modulator display
electronic display that modulates the reflected light by microscopic interferometric cavities, each acting as a wavelength-selective mirror that can be switched on or off individually

3.2 General terms

3.2.1
ambient contrast ratio
contrast ratio of a display with both hemispherical diffuse and directional illumination incident onto its surface used to simulate real lighting environments

3.2.2
daylight display colour
colour of a display with both hemispherical diffuse and directional illumination incident onto its surface at a defined geometry, spectra, and illumination levels that simulate a realistic daylight lighting environment

3.2.3
colour gamut volume
single number corresponding to the largest possible range of display colours (including all possible mixtures of the primaries, white W and black K), described as a volume in a three-dimensional colour space such as CIELAB

3.2.4
daylight colour gamut volume
colour gamut volume of a display with both hemispherical diffuse and directional illumination incident onto its surface at a defined geometry, spectra, and illumination level that simulate the environment

3.2.5
image retention
property of a picture element in which the visual information is retained after the power has been removed

3.2.6
electronic paper display module
device that consists of an electronic paper display panel and a driver (optionally a controller)

3.2.7
electronic paper display panel
electronic paper display device without a driver

3.2.8
electronic paper display controller
controller that supplies control signals to an electronic paper display module

3.3 Terms related to ratings and characteristics

3.3.1
electro-optical characteristics
characteristics derived from the variation of an optical property (reflected optical signal) as a function of an electrical driving signal (voltage or current vs. time, commonly referred to as waveform)

3.3.2
fall time
time interval needed to change the reflected optical signal of the device from 90 % to 10 % of the total variation range after switching the module or panel driving signal from the state corresponding to the maximum reflected signal level (100 %) to the minimum reflected signal level (0 %)

SEE: Figure 2.

Note 1 to entry: 0 % is the minimum reference of the reflected optical signal and 100 % is the maximum reference of the reflected optical signal.

3.3.3
electronic paper display driving voltage
voltage that drives an electronic paper display panel

SEE: Figure 1.

3.3.4
module response time
time from the start of the module driving signal until the panel reaches 90% or 10% of the reflected optical signal

SEE: Figure 2.

Note 1 to entry: 0 % is the minimum reference of the reflected optical signal and 100 % is the maximum reference of the reflected optical signal.

3.3.5
module response time (falling)
time interval needed to change the reflected optical signal of the device from 100 % to 10 % of the total variation range after switching the module driving signal from the state corresponding to the maximum reflected signal level (100 %) to the minimum reflected signal level (0 %)

Note 1 to entry: 0 % is the minimum reference of reflected optical signal and 100 % is the maximum reference of reflected optical signal. The module fall time is both the sum of the delay and fall times (see Figure 2).

3.3.6
module response time (rising)
time interval needed to change the reflected optical signal of the device from 0 % to 90 % of the total variation range after switching the module driving signal from the state corresponding to the minimum reflected signal level (0 %) to the maximum reflected signal level (100 %)

Note 1 to entry: 0 % is the minimum reference of reflected optical signal and 100 % is the maximum reference of reflected optical signal (see Figure 2).

3.3.7
rewriting electrical energy
energy required to rewrite an image on the electronic paper displays

3.3.8
image retention duration
period during which an electronic paper display keeps the image after the power is removed

4 Abbreviations

CCT	Correlated colour temperature
CIE	International Commission on Illumination
CIELAB	CIE 1976 (L*a*b*) colour space
DUT	Device under test
EPD	Electronic paper display
ILU	Integrated lighting unit (e.g. an edge-lit front guide plate)
ISO	International Organization for Standardization
LED	Light emitting diode
LMD	Light measuring device
RGB	Red, green, blue
sRGB	Standard RGB colour space as defined in IEC 61966-2-1

5 Technical aspects

5.1 Order of precedence

Where there are conflicting requirements, documents shall rank in the following order of authority:

a) the detail specification;
b) the blank detail specification;
c) the family specification, if any;
d) the sectional specification;
e) the generic specification;
f) the basic specification;

g) any other international (e.g. IEC) documents to which reference is made;

h) a national document.

The same order of precedence shall apply to equivalent national documents.

5.2 Symbols and units

Units, graphical and letter symbols shall be taken from the following standards:

IEC 60027 (all parts); Letter symbols to be used in electrical technology

IEC 60617; Graphical symbols for diagrams

IEC 60747-1; Semiconductor devices – Part 1: General

ISO 80000-1, *Quantities and units – Part 1: General*

Any other units, symbols or terminology peculiar to one of the devices covered by this standard shall be taken from the relevant IEC or ISO standards or derived in accordance with the principles of the standards listed above.

It is recommended to use letter symbols as listed in Table 1 below.

Table 1 – Letter symbols and unit of energy for rewriting

No	Name of quantity	Symbol	Unit	Remarks
001	Panel response time (falling)	T_{p1}	ms	Refer to Figure 2
002	Panel response time (rising)	T_{p2}	ms	Refer to Figure 2
003	Module response time (rising)	T_2	ms	Refer to Figure 2
004	Rise time	t_2	ms	Refer to Figure 2
005	Module response time (falling)	T_1	ms	Refer to Figure 2
006	Fall time	t_1	ms	Refer to Figure 2
007	Rewriting electric energy of logic circuit	W_1	J	
008	Rewriting electric energy of electronic paper display driving circuit	W_2	J	
009	Total rewriting electric energy in the display module	W_0	J	
010 011	Voltage for EPD drive	E_1 E_2	V	Refer to Figure 1

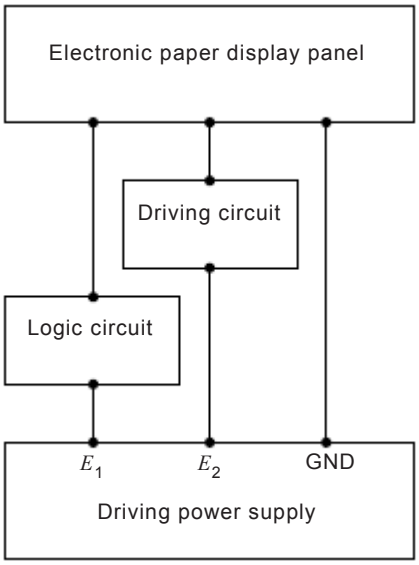
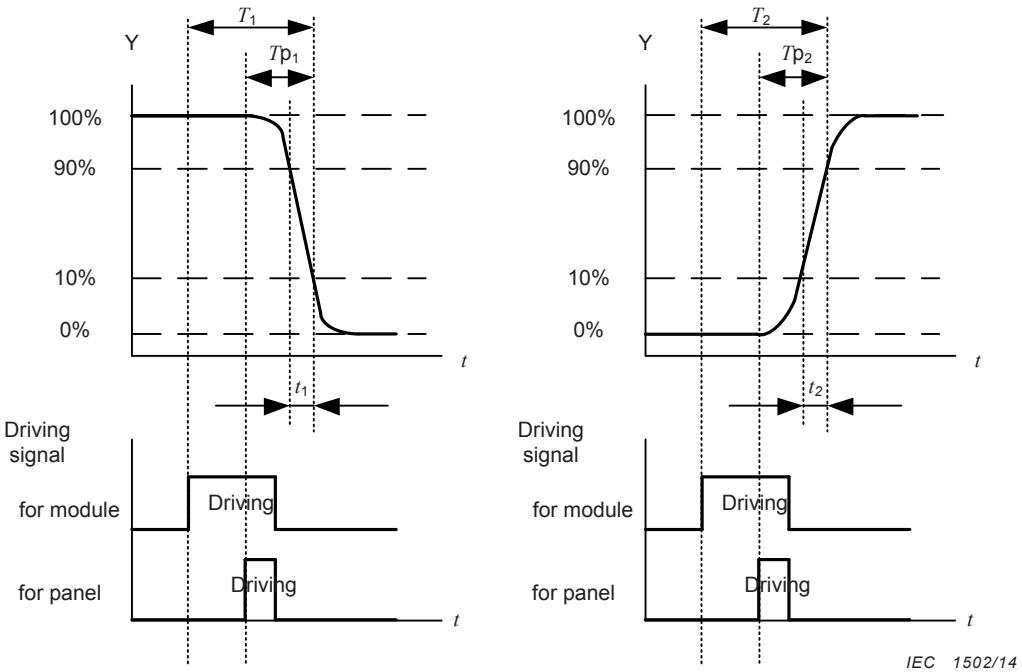


Figure 1 – Block diagram for explanation of supply voltages



Key

T_1 time from start of the module driving signal until panel reaches 10 % of reflected optical signal

T_2 time from start of the module driving signal until panel reaches 90 % of reflected optical signal

T_{p1} time from start of the panel driving signal until panel reaches 10 % of reflected optical signal

T_{p2} time from start of the panel driving signal until panel reaches 90 % of reflected optical signal

t_1 time needed to change the reflected optical signal of panel from 90 % to 10 %

t_2 time needed to change the reflected optical signal of panel from 10 % to 90 %

NOTE The Y axis on the top graphs is normalised.

Figure 2 –Timing chart for explanation of response times

The preferred values of temperature, humidity and pressure for the measurement of characteristics, for tests and for operating conditions, are given in IEC 62679-3-1.

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IEC 60749:1996, *Semiconductor devices – Mechanical and climatic test methods*

IEC 61747-1:1998, *Liquid crystal and solid-state display devices – Part 1: Generic specification*

IEC 61966-2-1, *Multimedia systems and equipment – Colour measurement and management - Part 2-1: Colour management – Default RGB colour space – sRGB*

IEC 62679-3-1, *Electronic paper displays – Part 3-1: Optical measuring methods*

ISO 1101:1983, *Technical drawings – Geometrical tolerancing – Tolerancing of form, orientation, location and run-out – Generalities, definitions, symbols, indications on drawings*

ISO 2859 (all parts), *Sampling procedures for inspection by attributes*

ISO 8601:1988, *Data elements and interchange formats – Information interchange – Representation of dates and times*

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