

**Display Elektronik GmbH**

# DATA SHEET

**E-Paper Display**

**DEE 250122A – W**

2,1“

**E-PAPER DISPLAY**

**Product Specification**

**Ver.: 0**

**25.03.2015**

<b>File Name</b>	<b>Specification for 2,1" E-Paper</b>	<b>Module Name</b>	<b>DEE 250122A-W</b>
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## **Specification for 2,1" E-Paper Display**

**Model NO. : DEE 250122A-W**

<b>Prepared by</b>	<b>Checked by</b>	<b>Approved by</b>

### **Customer approval**

<b>Customer</b>	<b>Approved by</b>	<b>Date of approval</b>

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<b>Version</b>	<b>Content</b>	<b>Date</b>	<b>Producer</b>
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## 1 General Description

DEE 250122A-W is an Active Matrix Electrophoretic Display(AM EPD), with interface and a reference system design. The 2.1" active area contains 250x122 pixels, and has 2-bit full display capabilities. The module is a TFT-array driving electrophoretic display, with integrated circuits including gate buffer, source buffer, MCU interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM. Module can be used in portable electronic devices, such as Electronic Shelf Label (ESL) System.

## 2 Features

- ◆ 250×122 pixels display
- ◆ White reflectance above 30%
- ◆ Contrast ratio above 8:1
- ◆ Ultra wide viewing angle
- ◆ Ultra low power consumption
- ◆ Pure reflective mode
- ◆ Bi-stable display
- ◆ Commercial temperature range
- ◆ Landscape, portrait modes
- ◆ Hard-coat antiglare display surface
- ◆ Ultra Low current deep sleep mode
- ◆ On chip display RAM
- ◆ Waveform stored in On-chip OTP
- ◆ Serial peripheral interface available
- ◆ On-chip oscillator
- ◆ On-chip booster and regulator control for generating VCOM, Gate and Source driving voltage
- ◆ I<sup>2</sup>C signal master interface to read external temperature sensor

## 3 Application

Electronic Shelf Label System

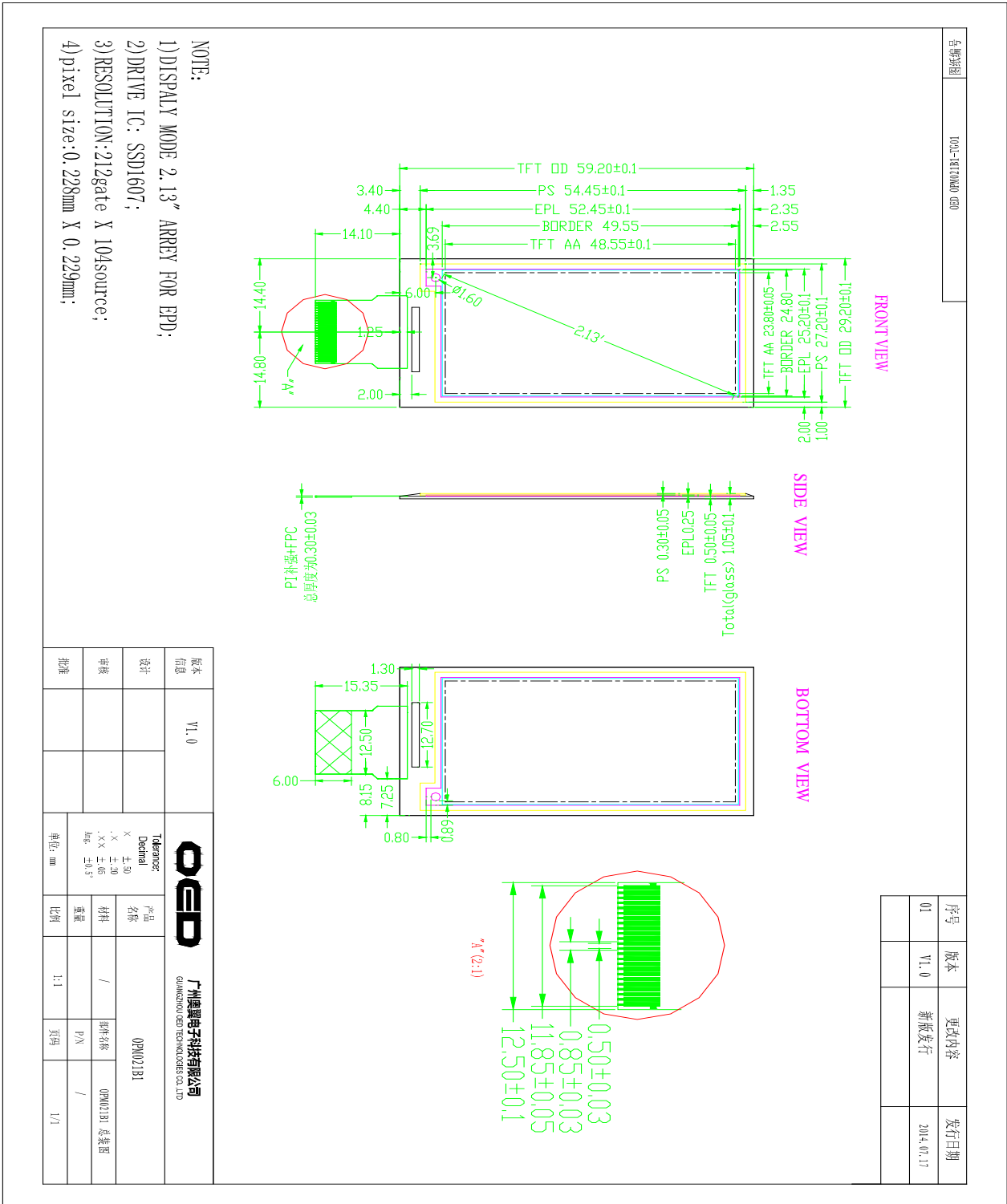
## 4 Mechanical Specification

### 4.1 Dimension

<b>Parameter</b>	<b>Specifications</b>	<b>Unit</b>	<b>Remark</b>
Screen Size	2.13	Inch	
Display Resolution	250(H)×122(V)	Pixel	
Active Area	23.80×48.55	mm	
Pixel Pitch	0.228×0.229	mm	
Pixel Configuration	Rectangle		
Outline Dimension	29.2(H)×59.2 (V) ×1.05(D)	mm	
Weight	3.5±0.5	g	

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## 4.2 Mechanical Drawing of EPD Module



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## 5 Input/output Pin Assignment

No.	Name	I/O	Description	Remark
1	NC		Do not connect with other NC pins	
2	GDR	O	N-Channel MOSFET Gate Drive Control	
3	RESE	I	Current Sense Input for the Control Loop	
4	VGL	C	Negative Gate driving voltage	
5	VGH	C	Positive Gate driving voltage	
6	TSCL	O	I <sup>2</sup> C Interface to digital temperature sensor Clock pin	
7	TSDA	I/O	I <sup>2</sup> C Interface to digital temperature sensor Data pin	
8	BS1	I	Bus Interface selection pin	Note 5-4
9	BUSY	O	Busy state output pin	Note 5-3
10	RES#	I	Reset signal input. Active Low.	
11	D/C#	I	Data /Command control pin	Note 5-2
12	CS#	I	Chip select input pin	Note 5-1
13	D0	I	Serial Clock pin (SPI)	
14	D1	I	Serial Data pin (SPI)	
15	VDDIO	P	Power Supply for interface logic pins It should be connected with VCI	
16	VCI	P	Power Supply for the chip	
17	VSS	P	Ground	
18	VDD	C	Core logic power pin VDD can be regulated internally from VCI. A capacitor should be connected between VDD and VSS under all circumstances	
19	VPP	P	Power Supply for OTP Programming	
20	VSH	C	Positive Source driving voltage	
21	PREVGH	C	Power Supply pin for VGH and VSH	
22	VSL	C	Negative Source driving voltage	
23	PREVGL	C	Power Supply pin for VCOM, VGL and VSL	
24	VCOM	C	VCOM driving voltage	

I = Input Pin, O = Output Pin, I/O = Bi-directional Pin (Input/Output), P = Power Pin, C = Capacitor Pin

Note 5-1: This pin is the chip select input connecting to the MCU. The chip is enabled for MCU communication only when CS# is pulled LOW.

Note 5-2: This pin is Data/Command control pin connecting to the MCU in 4-wire SPI mode. When the pin is



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pulled HIGH, the data at D1 will be interpreted as data. When the pin is pulled LOW, the data at D1 will be interpreted as command.

Note 5-3: This pin is Busy state output pin. When Busy is High, the operation of chip should not be interrupted, command should not be sent, e.g., The chip would put Busy pin High when

- Outputting display waveform
- Programming with OTP
- Communicating with digital temperature sensor

Note 5-4: Bus interface selection pin

<b>BS1 State</b>	<b>MCU Interface</b>
L	4-lines serial peripheral interface(SPI)
H	3- lines serial peripheral interface(SPI) - 9 bits SPI

## 6 Electrical Characteristics

### 6.1 Absolute Maximum Rating

<b>Parameter</b>	<b>Symbol</b>	<b>Rating</b>	<b>Unit</b>
Logic supply voltage	$V_{CI}$	-0.5 to +3.6	V
Logic Input voltage	$V_{IN}$	-0.5 to $V_{CI} + 0.5$	V
Logic Output voltage	$V_{OUT}$	-0.5 to $V_{CI} + 0.5$	V

Note: Maximum ratings are those values beyond which damages to the device may occur. Functional operation should be restricted to the limits in the Panel DC Characteristics tables.

### 6.2 Panel DC Characteristics

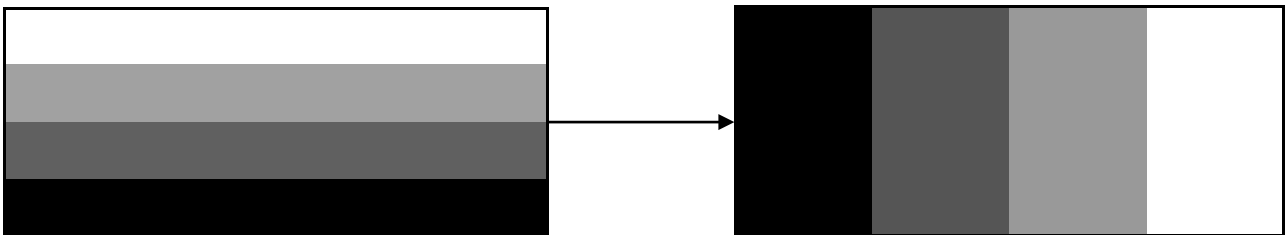
The following specifications apply for:  $V_{SS}=0V$ ,  $V_{CI}=3.0V$ ,  $T_{OPR}=25^{\circ}C$ .

<b>Parameter</b>	<b>Symbol</b>	<b>Condition</b>	<b>Applicable pin</b>	<b>Min.</b>	<b>Typ.</b>	<b>Max.</b>	<b>Unit</b>
Logic supply voltage	$V_{CI}$	-	$V_{CI}$	2.4	3.0	3.7	V
High level input voltage	$V_{IH}$	-	-	$0.8 V_{CI}$	-	-	V
Low level input voltage	$V_{IL}$	-	-	-	-	$0.2 V_{CI}$	V
High level output voltage	$V_{OH}$	$IOH = -100\mu A$	-	$0.9 V_{CI}$	-	-	V
Low level output voltage	$V_{OL}$	$IOL = 100\mu A$	-	-	-	$0.1 V_{CI}$	V
OTP Program voltage	$V_{PP}$	-	$V_{PP}$	-	7.5	-	V
Typical power panel	$P_{TYP}$	-	-	-	24	36	mW
Standby power panel	$P_{STPY}$	-	-	-	0.006	-	mW
Typical operating current	$I_{opr\_VCI}$	-	-	-	8.0	-	mA
Sleep mode current	$I_{slp\_VCI}$	$V_{CI}=3.3V$ DC/DC OFF No clock No output load Ram data retain	$V_{CI}$	-	35	50	$\mu A$

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Deep sleep mode current	Idslp_VCI	VCI=3.3V DC/DC OFF No clock No output load Ram data not retain	VCI	-	2	5	uA
Operation temperature range	T <sub>OPR</sub>	-	-	0	-	50	°C
Storage temperature range	T <sub>STG</sub>	-	-	-20	-	70	°C

- Notes: 1. The typical power is measured with following transition:from horizontal 4 gray scale pattern to vertical 4 gray scale pattern. (Figure 10-2)
2. The standby power is the consumed power when the panel controller is in standby mode.
3. The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by DISPLAY.



**Figure 10-2 The typical power consumption measure pattern**

### 6.3 Panel DC Characteristics(Driver IC Internal Regulators)

The following specifications apply for: VSS=0V, VCI=3.0V, T<sub>OPR</sub> =25°C.

Parameter	Symbol	Condition	Applicable pin	Min.	Typ.	Max.	Unit
VCOM output voltage	VCOM	-	VCOM	-4.0	-	-0.2	V
Gate output voltage	V <sub>GATE</sub>	-	G0-249	-20	-	+22	V
Gate output peak to peak voltage	V <sub>GATE(p-p)</sub>	-	G0-249	-	42	-	V
Positive Source output voltage	V <sub>SH</sub>	-	S0-121	+10	15	+17	V
Negative Source output voltage	V <sub>SL</sub>	-	S0-121	-	-15	-	V

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## 6.4 Panel AC Characteristics

### 6.4.1 MCU Interface Selection

Pin Name	Data/Command Interface		Control Signal		
	D1	D0	CS#	D/C#	RES#
4-wire SPI	SDIN	SCLK	CS#	D/C#	RES#
3-wire SPI	SDIN	SCLK	CS#	L	RES#

### 6.4.2 MCU Serial Interface (4-wire SPI)

The serial interface consists of serial clock SCLK, serial data SDIN, D/C#, CS#. In 4-wire SPI mode, D0 acts as SCLK, D1 acts as SDIN.

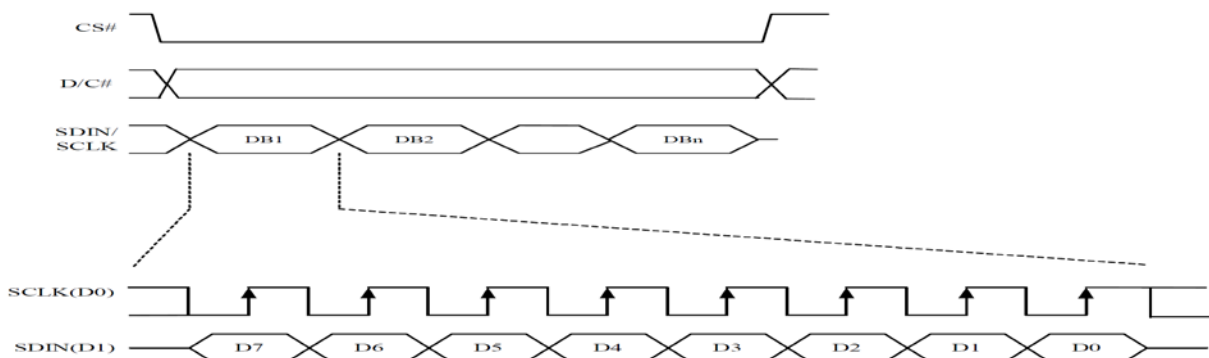
Function	CS#	D/C#	SCLK
Write command	L	L	↑
Write data	L	H	↑

Note: ↑ stands for rising edge of signal

**Table10-4-2: Control pins of 4-wire Serial interface**

SDIN is shifted into an 8-bit shift register on every rising edge of SCLK in the order of D7, D6, ... D0. D/C# is sampled on every eighth clock and the data byte in the shift register is written to the Graphic Display Data RAM (RAM) or command register in the same clock.

Under serial mode, only write operations are allowed.



**Figure 10-4-2: Write procedure in 4-wire SPI mode**

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### 6.4.3 MCU Serial Interface (3-wire SPI)

The 3-wire serial interface consists of serial clock SCLK, serial data SDIN and CS#. In 3-wire SPI mode, D0 acts as SCLK, D1 acts as SDIN.

The operation is similar to 4-wire serial interface while D/C# pin is not used. There are altogether 9-bits will be shifted into the shift register on every ninth clock in sequence: D/C# bit, D7 to D0 bit. The D/C# bit (first bit of the sequential data) will determine the following data byte in the shift register is written to the Display Data RAM

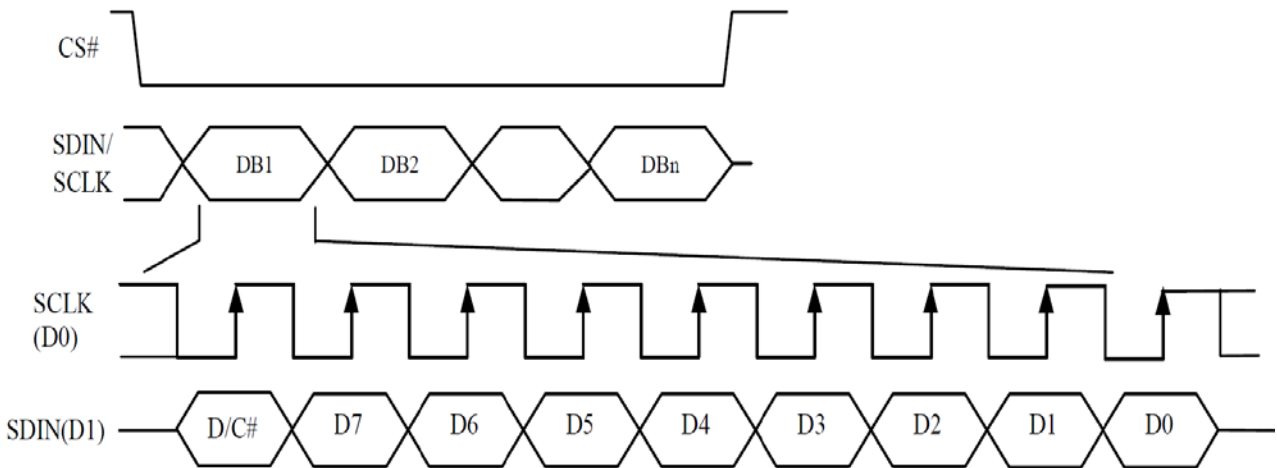
(D/C# bit = 1) or the command register (D/C# bit = 0).

Under serial mode, only write operations are allowed.

Function	CS#	D/C#	SCLK
Write command	L	Tie	↑
Write data	L	Tie	↑

Note: ↑ stands for rising edge of signal

**Table 10-4-3: Control pins of 3-wire Serial interface**

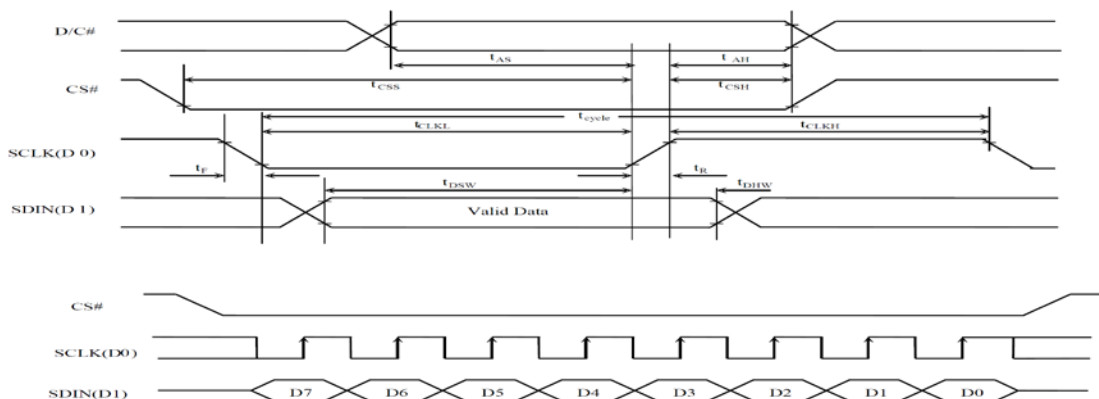


**Figure 10-4-3: Write procedure in 3-wire SPI mode**

### 6.4.4 Interface Timing

The following specifications apply for: VSS=0V, VCI=3.0V, T<sub>OPR</sub> =25°C.

Symbol	Parameter	Test Condition	Applicable pin	Min.	Typ.	Max.	Unit
Fosc	Internal Oscillator frequency	VCI=2.4 to 3.3V	CL	0.95	1	1.05	MHz



**Figure 10-4-4: Serial interface characteristics**

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(V<sub>CI</sub> - V<sub>SS</sub> = 2.4V to 3.3V, T<sub>OPR</sub> = 25°C, CL=20pF)

Symbol	Parameter	Min.	Typ.	Max.	Unit
t <sub>cycle</sub>	Clock Cycle Time	250	-	-	ns
t <sub>AS</sub>	Address Setup Time	150	-	-	ns
t <sub>AH</sub>	Address Hold Time	150	-	-	ns
t <sub>CSS</sub>	Chip Select Setup Time	120	-	-	ns
t <sub>CSH</sub>	Chip Select Hold Time	60	-	-	ns
t <sub>DSW</sub>	Write Data Setup Time	50	-	-	ns
t	Write Data Hold Time	15	-	-	ns
t <sub>CLKL</sub>	Clock Low Time	100	-	-	ns
t <sub>CLKH</sub>	Clock High Time	100	-	-	ns
t <sub>R</sub>	Rise Time [20% ~ 80%]	-	-	15	ns
t <sub>F</sub>	Fall Time [20% ~80%]	-	-	15	ns

**Table 10-4-4: Serial Interface Timing Characteristics**

## 7 Optical Specification

Measurements are made with that the illumination is under an angle of 45 degrees, the detection is perpendicular unless otherwise specified.

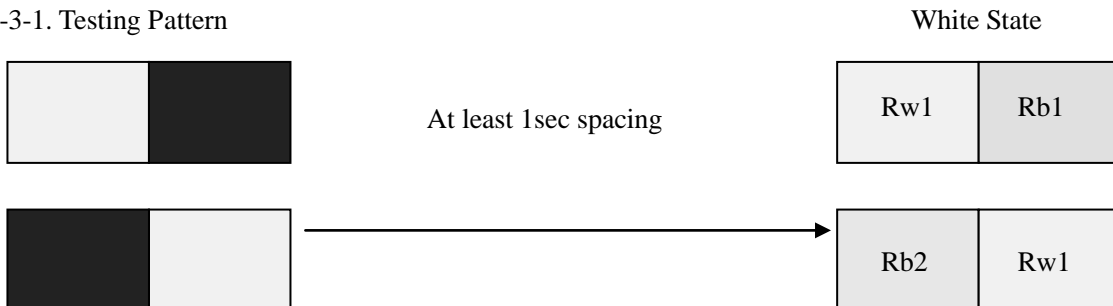
Symbol	Parameter	Conditions	Values			Units	Notes
			Min.	Typ.	Max		
R	White Reflectivity	White	30	35	-	%	11-1
CR	Contrast Ratio		8:1	10:1	-	-	11-2
白△L 24h	Reduce		-	≤4	-	-	-
T <sub>update</sub>	Image update time	at 25 °C	-	1800	-	ms	-
Ghosting	Image sticking		-2.0	1.0	2.0	-	11-3

Notes: 11-1. Luminance meter: Eye-One Pro Spectrophotometer.

11-2. CR=Surface Reflectance with all white pixel/Surface Reflectance with all black pixels.

11-3. Ghosting Testing:

11-3-1. Testing Pattern



11-3-2. Refresh process: Init ---- GC White ---- 4 checkerboard Pattern GC ---- GC White.

11-3-3. Measuring the reflectance of all 4 checkerboard areas when final white state by Eye-one device.

11-3-4. Rw: reflectance of area transited from white state

Rb: reflectance of area transited from dark(black) state

11-3-5. Calculating averages of WS-to-WS and DS-to-WS transitions:

$Rw(ave)=(Rw1+Rw2)/2$ ,  $Rb(ave)=(Rb1+Rb2)/2$ ,  $G=Rw(ave)-Rb(ave)$ .

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## 8 Handling, Safety, and Environment Requirements

### Warning

The display glass may break when it is dropped or bumped on a hard surface. Handle with care. Should the display break, do not touch the electrophoretic material. In case of contact with electrophoretic material, wash with water and soap.

### Caution

The display module should not be exposed to harmful gases, such as acid and alkali gases, which corrode electronic components. Disassembling the display module.

Disassembling the display module can cause permanent damage and invalidates the warranty agreements.

Observe general precautions that are common to handling delicate electronic components. The glass can break and front surfaces can easily be damaged. Moreover the display is sensitive to static electricality and other rough environmental conditions.

### Data sheet status

Product specification

This data sheet contains final product specifications.

### Limiting values

Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

### Application information

Where application information is given, it is advisory and does not form part of the specification.

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## 9 Reliability Test

No.	T	C	M	
1	High-Temperature Operation	T = +50°C, RH = 30% for 240 hrs	IEC 60 068-2-2Bp	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
2	Low-Temperature Operation		IEC 60 068-2-2Ab	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
3	High-Temperature Storage	T = +70°C, RH=23% for 240 hrs	IEC 60 068-2-2Bp	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
4	Low-Temperature Storage	T = -25°C for 240 hrs	IEC 60 068-2-1Ab	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
5	High-Temperature, High-Humidity Operation	T = +40°C, RH = 90% for 168 hrs	IEC 60 068-2-3CA	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
6	High Temperature, High-Humidity Storage	T = +60°C, RH=80% for 240hrs	IEC 60 068-2-3CA	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
7	Thermal Shock	1 cycle:[-25°C 30min]→[+70 °C 30 min] : 100 cycles	IEC 60 068-2-14	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
8	Package Vibration	1.04G, Frequency: 10~500Hz Direction: X,Y,Z Duration: 1 hours in each direction	Full packed for shipment	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
9	Package Drop Impact	Drop from height of 122 cm on concrete surface. Drop sequence: 1 corner, 3edges, 6 faces One drop for each	Full packed for shipment	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
10	Electrostatic Effect (non-operating)	Machine model +/- 250V, 0Ω, 200pF	IEC 62179, IEC 62180	At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.
11	Stylus Tapping	POLYACETAL Pen:Top R0.8mm Load: 200gf;Speed:30times/min; Speed: 30times/min Total 13,500times		At the end of the test, electrical, mechanical, and optical specifications shall be satisfied.

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## 10 Block Diagram

