

YES OPTOELECTRONICS CO.,LTD

# SPECIFICATIONS

Product NO: YMS540960-047AAAMFGN

DATE: FEB.28.2020

Prepared by	Approved by
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CUSTOMER'S APPROVAL

APPROVED BY: \_\_\_\_\_ DATE: \_\_\_\_\_

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## REVISION HISTORY

Rev	Date	Item	Page	Remark
1.0	MAR.18.2016	New Creation	ALL	
2.0	JAN.11.2017	Update Mechanical Drawing Add Reliability test Add Border definition Add Block Diagram	P5 P18 P20 P21	
2.1	FEB.28.2020	Add Inspection standard	P22-25	

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## 1. General Description

YMS540960-047AAAMFGN is a reflective electrophoretic YES technology display module based on active matrix TFT substrate. It has 4.7" active area with 540 x 960 pixels, the display is capable to display images at 2-16 gray levels (1-4 bits) depending on the display controller and the associated waveform file it used.

YMS540960-047AAAMFGN is for mobile phone use only.

## 2.Features

- High contrast reflective/electrophoretic technology
- 540 x 960 dots resolution
- High reflectance
- Ultra wide viewing angle
- Ultra low power consumption
- Pure reflective mode
- Bi-stable
- Commercial temperature range
- Landscape, portrait mode

## 3. Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	4.7	Inch	
Display Resolution	540 (H)×960(V)	Pixel	
Active Area	58.32 (H)×103.68 (V)	mm	
Pixel Pitch	0.108 (H) × 0.108 (V)	mm	
Pixel Configuration	Rectangle		
Outline Dimension	62.5 (W) × 113.9 (H) × 0.872 (D)	mm	
Module Weight	12 ±2	g	
Number of Gray	16 Gray Level (monochrome)		
Display operating mode	Reflective mode		

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## 5. Input / Output Terminals

5-1) Connector type: PANASONIC AXE644224

### Pin Assignment

Pin	Symbol	Description	Remark
1	VNEG	Negative power supply source driver	
2	VPOS	Positive power supply source driver	
3	GND	Ground	
4	GND	Ground	
5	NC	NC	
6	GND	Ground	
7	VDD	Digital power supply drivers (3.3V)	
8	GND	Ground	
9	GND	Ground	
10	XCL	Clock source driver	
11	XLE	Latch enable source driver	
12	XOE	Output enable source driver	
13	XSTL	Start pulse source driver	
14	D0	Data signal source driver	
15	D1	Data signal source driver	
16	D2	Data signal source driver	
17	D3	Data signal source driver	
18	D4	Data signal source driver	
19	D5	Data signal source driver	
20	D6	Data signal source driver	
21	D7	Data signal source driver	
22	NC	NC	
23	TEST	Eink internal test pin	Note1
24	VCOM	Common connection	
25	VGG	Positive power supply gate driver	
26	VCOM	Common connection	
27	VGG	Positive power supply gate driver	
28	GND	Ground	
29	GND	Ground	
30	BORDER	Border connection	
31	VEE	Negative power supply gate driver	
32	BORDER	Border connection	
33	VEE	Negative power supply gate driver	
34	GND	Ground	
35	GND	Ground	
36	CKV	Clock gate driver	
37	SPV	Start pulse gate driver	
38	MODE 1	Output mode selection gate driver	
39	NC	NC	
40	NC	NC	

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YES

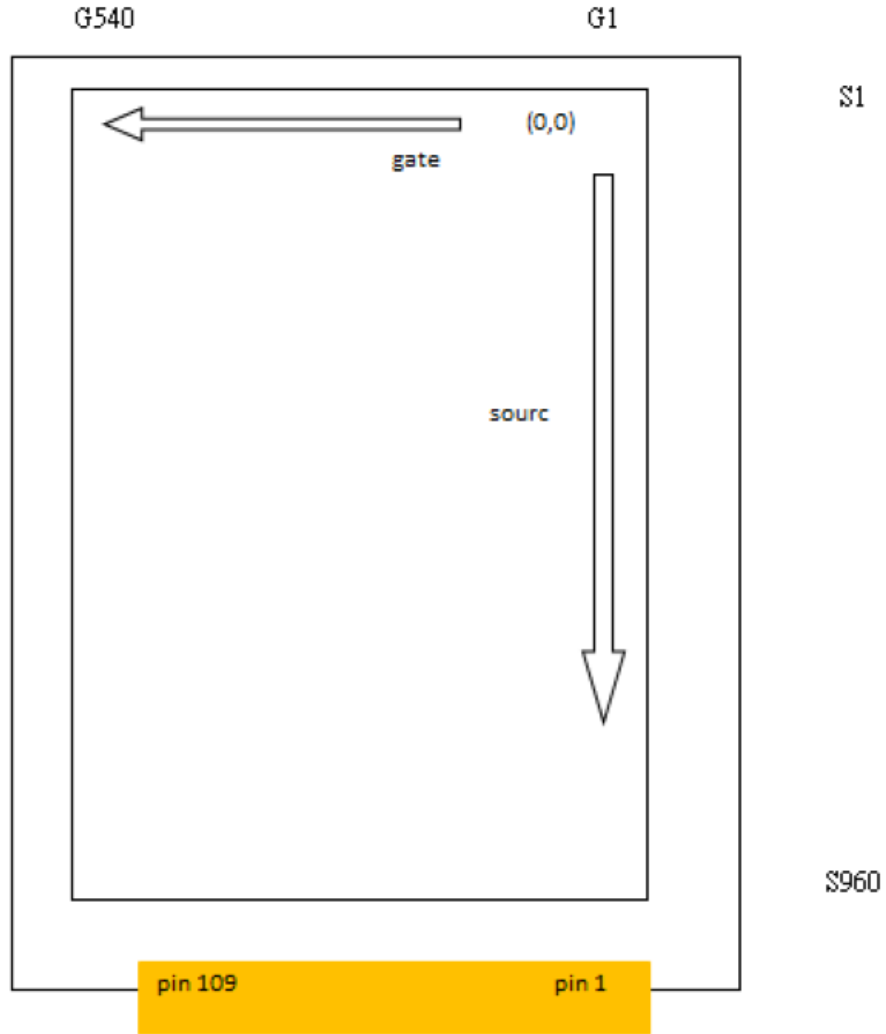
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Pin	Symbol	Description	Remark
41	NC	NC	
42	NC	NC	
43	NC	NC	
44	NC	NC	

**Note1:Please connect to VDD voltage.**

5-2) Panel Scan direction



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## 6. Display Module Electrical Characteristics

### 6-1) Absolute maximum rating

Parameter	Symbol	Rating	Unit	Remark
Logic Supply Voltage	VDD	-0.3 to +7	V	--
Positive Supply Voltage	V <sub>POS</sub>	-0.3 to +18	V	--
Negative Supply Voltage	V <sub>NEG</sub>	+0.3 to -18	V	--
Max .Drive Voltage Range	V <sub>POS</sub> - V <sub>NEG</sub>	36	V	--
Supply Voltage	VGG	-0.3 to +45	V	--
Supply Voltage	VEE	-25.0 to +0.3	V	--
Supply Range	VGG-VEE	-0.3 to +45	V	--
Operating Temp. Range	TOTR	0 to +50	°C	--
Storage Temperature	TSTG	-25 to +70	°C	--

### 6-2) Display Module DC characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Signal ground	V <sub>SS</sub>		-	0	-	V
Logic Voltage supply	V <sub>DD</sub>		3.0	3.3	3.6	V
	I <sub>VDD</sub>	V <sub>DD</sub> =3.3V	-	0.7	1.65	mA
Gate Negative supply	V <sub>GL</sub>		-21	-20	-19	V
	I <sub>GL</sub>	V <sub>GL</sub> = -20V	-	0.77	3.1	mA
Gate Positive supply	V <sub>GH</sub>		21	22	23	V
	I <sub>GH</sub>	V <sub>GH</sub> = 22V	-	0.7	1.6	mA
Source Negative supply	V <sub>NEG</sub>		-15.4	-15	-14.6	V
	I <sub>NEG</sub>	V <sub>NEG</sub> = -15V	-	4.57	20	mA
Source Positive supply	V <sub>POS</sub>		14.6	15	15.4	V
	I <sub>POS</sub>	V <sub>POS</sub> = 15V	-	4.43	22	mA
Border supply	V <sub>COM</sub>		-	Adjusted	-	v
Asymmetry source	V <sub>Asym</sub>	V <sub>POS</sub> +V <sub>NEG</sub>	-800	0	800	mV
Common voltage	V <sub>COM</sub>		-	Adjusted	-	V
	I <sub>COM</sub>		-	0.08	-	mA
Panel Power	P		-	170	950	mW
Standby power panel	P <sub>STBY</sub>		-	-	0.1	mW
Operating temperature			0	-	50	°C
Storage temperature			-25	-	70	°C

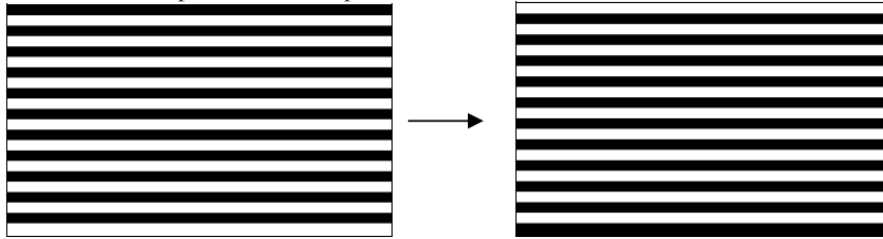
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- The maximum power consumption is measured using 85Hz waveform with following pattern transition: from pattern of repeated 1 consecutive black scan lines followed by 1 consecutive white scan line to that of repeated 1 consecutive white scan lines followed by 1 consecutive black scan lines. (Note 7-1)
- The Typical power consumption is measured using 85Hz waveform with following pattern transition: from horizontal 4 gray scale pattern to vertical 4 gray scale pattern. (Note 7-2)
- The standby power is the consumed power when the panel controller is in standby mode.
- The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by YES.
- Vcom is recommended to be set in the range of assigned value  $\pm 0.1V$ .
- The maximum I<sub>COM</sub> inrush current is about 480 mA

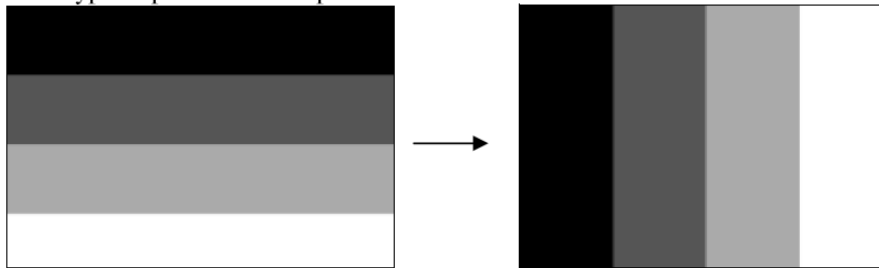
Note 6-1

The maximum power consumption



Note 6-2

The Typical power consumption



6-3) Refresh Rate

The module YMS540960-047AAAMFGN is applied at a maximum screen refresh rate of 85Hz.

	Min	Max
<b>Refresh Rate</b>	-	85Hz

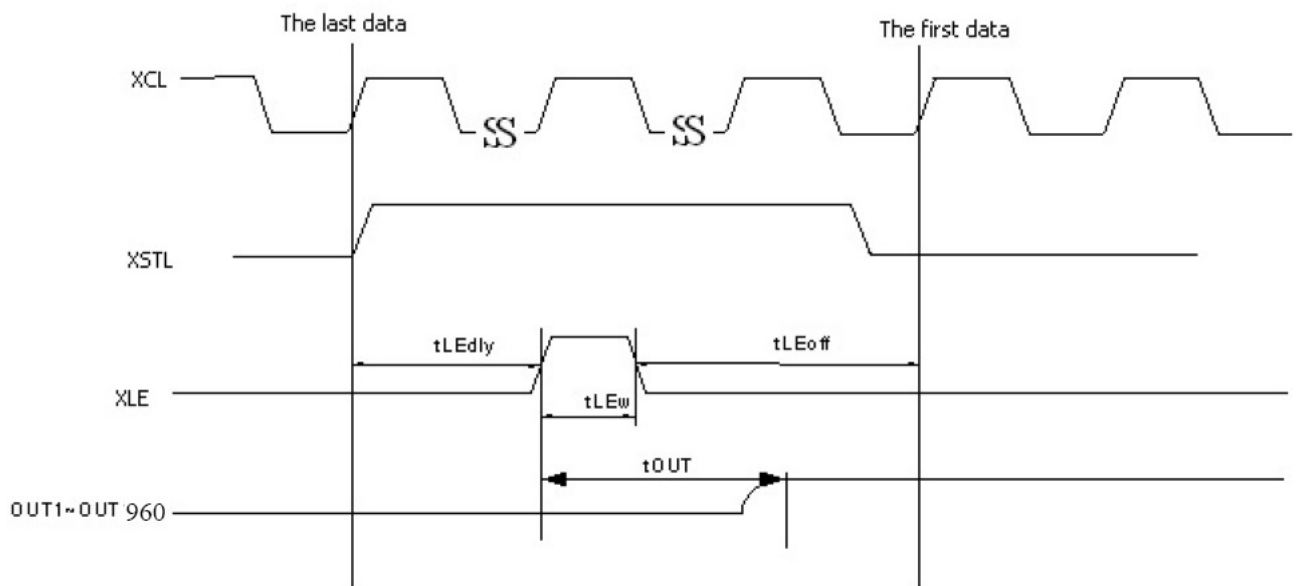
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### 6-4) Display Module AC characteristics

VDD=3.0V to 3.6V, unless otherwise specified.

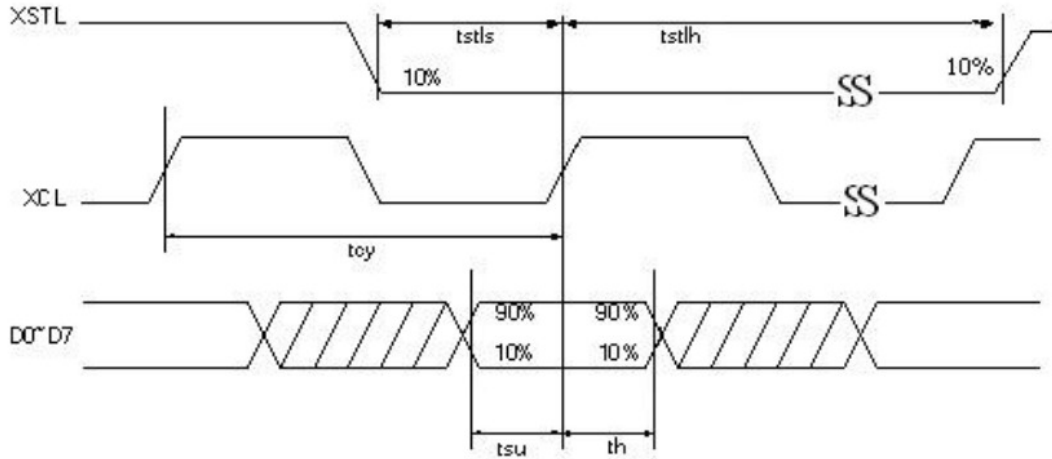
Parameter	Symbol	Min.	Typ.	Max.	Unit
Clock frequency	fckv	-	-	200	kHz
Minimum "L" clock pulse width	twL	0.5	-	-	us
Minimum "H" clock pulse width	twH	0.5	-	-	us
Clock rise time	trckv	-	-	100	ns
Clock fall time	tfckv	-	-	100	ns
SPV setup time	tSU	100	-	twH-100	ns
SPV hold time	tH	100	-	twH-100	ns
Pulse rise time	trspv	-	-	100	ns
Pulse fall time	tfspv	-	-	100	ns
Clock XCL cycle time	tcy	16.67	50	-	ns
D0 .. D7 setup time	tsu	8	-	-	ns
D0 .. D7 hold time	th	8	-	-	ns
XSTL setup time	tstls	0.5*tcy	-	0.8*tcy	ns
XSTL hold time	tstlh	0.5*tcy	-	240*tcy-tstls	ns
XLE on delay time	tLEdly	3.5*tcy	-	-	ns
XLE high-level pulse width (When VCC=3.0V to 3.6V)	tLEw	300	-	-	ns
XLE off delay time	tLEoff	200	-	-	ns
Output setting time to +/- 30mV(C <sub>load</sub> =200pF)	tout	-	-	20	us

#### OUTPUT LATCH CONTROL SIGNALS

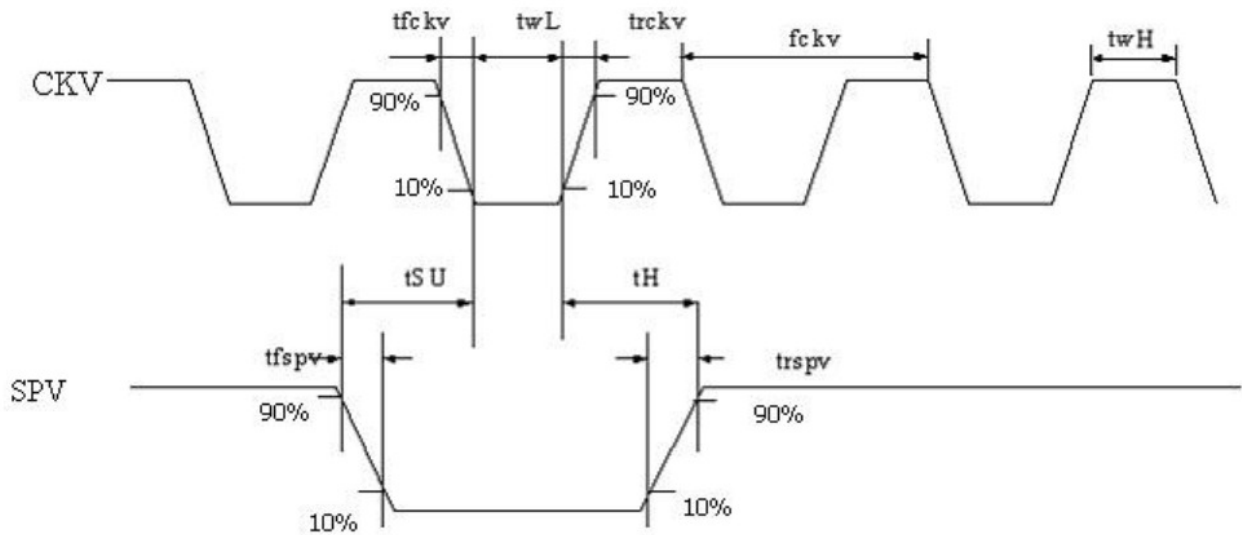


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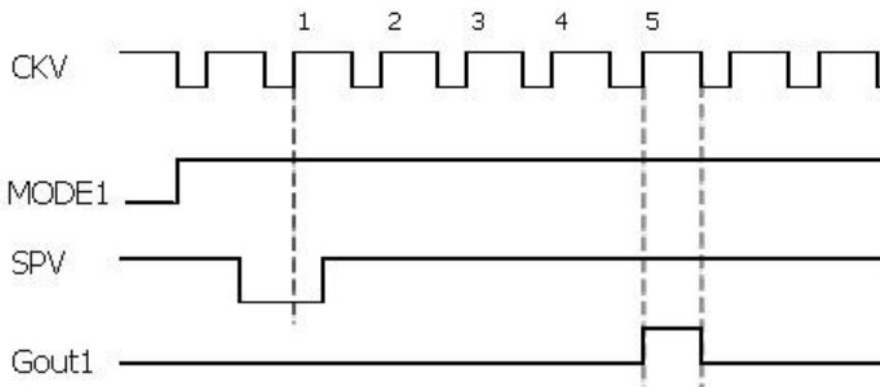
CLOCK & DATA TIMING



CKV & SPV TIMING



GATE OUTPUT TIMING



Note : First gate line on timing  
After 5CKV , gate line is on .

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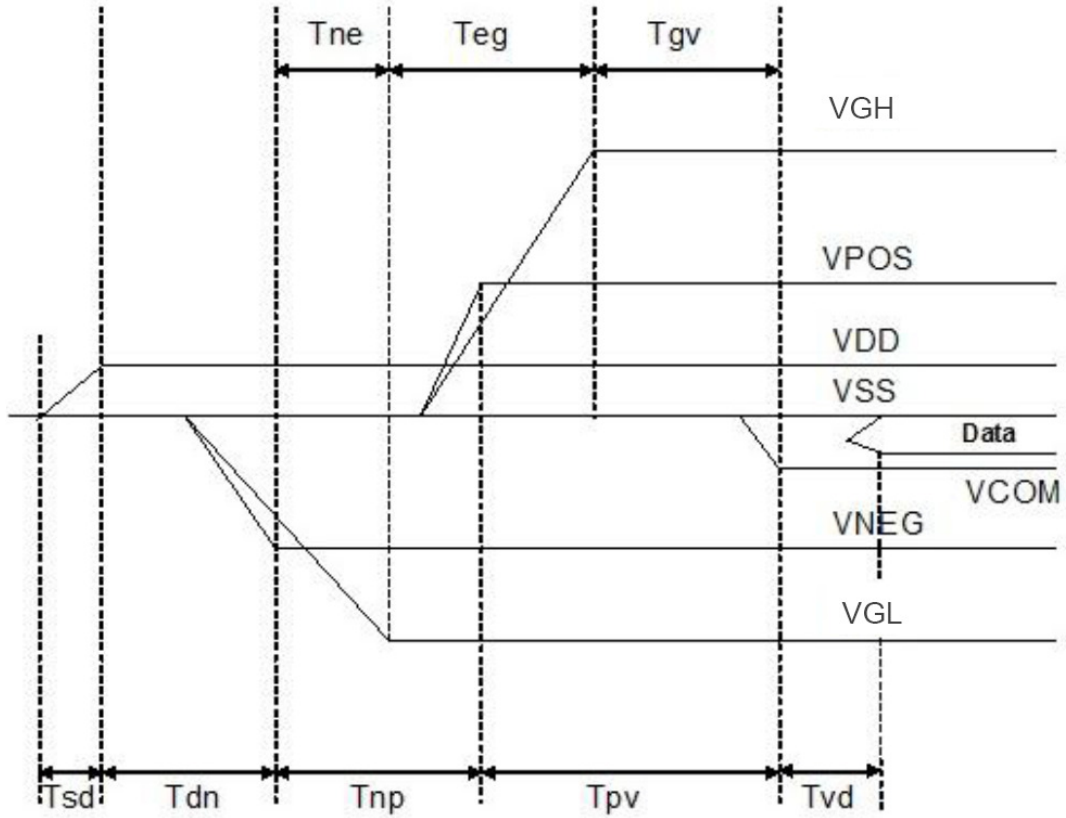
## 7. Power Sequence

Power Rails must be sequenced in the following order :

1. VSS → VDD → VNEG → VPOS (Source driver) → VCOM

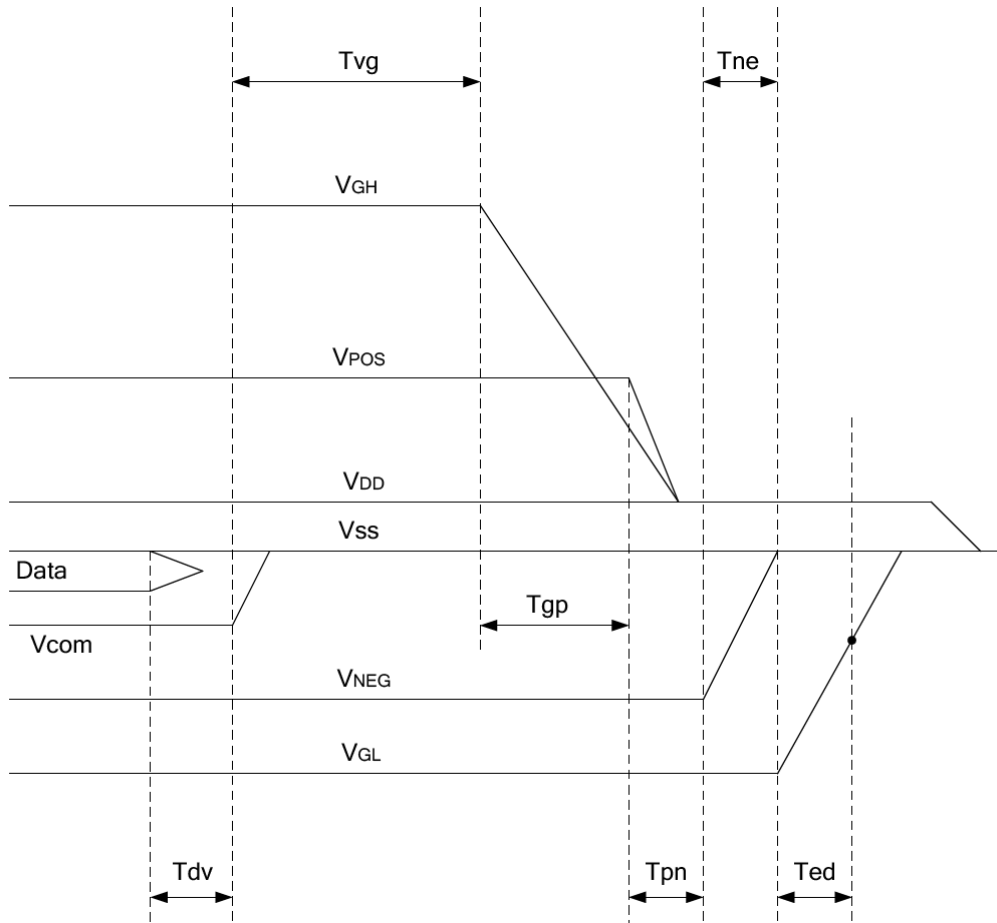
2. VSS → VDD → VGL → VGH (Gate driver)

POWER ON



	Min	Max
Tsd	30us	-
Tdn	100us	-
Tnp	1000us	-
Tpv	100us	-
Tvd	100us	-
Tne	0us	-
Teg	1000us	-
Tgv	100us	-

POWER OFF



	Min	Max	
Tdv	100 $\mu$ s	-	
Tvg	0 $\mu$ s	-	
Tgp	0 $\mu$ s	-	
Tpn	0 $\mu$ s	-	
Tne	0 $\mu$ s	-	
Ted	0.5s	-	Discharged point @ -7.4 Volt

Note1 : Supply voltages decay through pull-down resistors.

Note2 : Begin to turn off VGL power after VNEG and VPOS are completely or almost discharged to GND state.

Note3 : VGL must remain negative of Vcom during decay period

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## 8. Optical characteristics

### 8-1) Specifications

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

T = 25°C

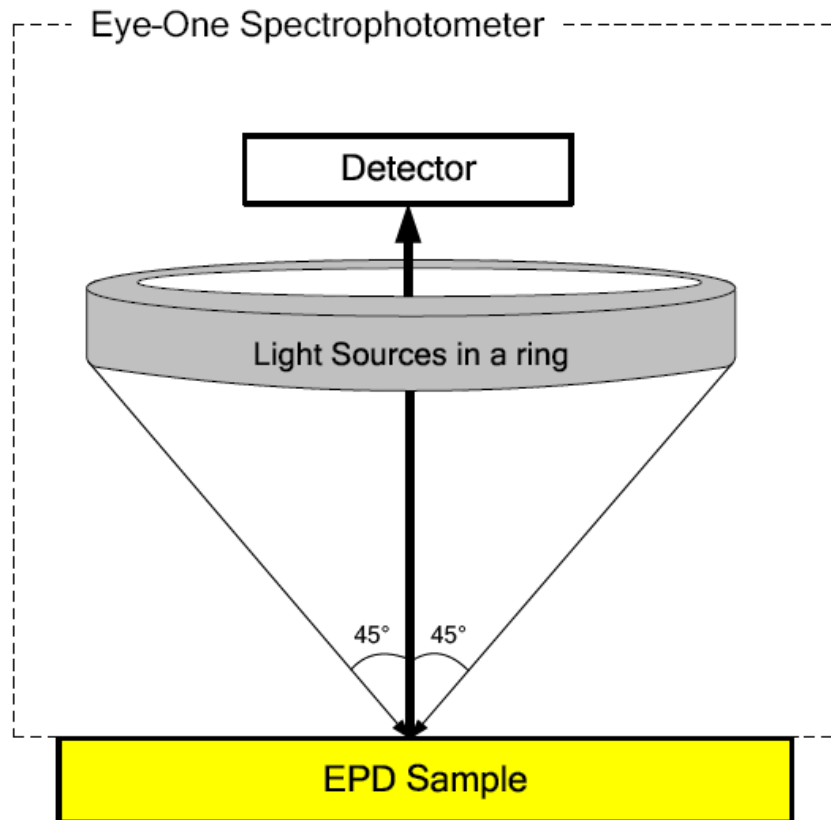
Symbol	Parameter	Conditions	Min	Typ.	Max	Unit	Note
R	Reflectance	White	30	35	-	%	Note 8-1
Gn	N <sup>th</sup> Grey Level	-	-	$DS+(WS-DS) \times n/(m-1)$	-	L*	-
CR	Contrast Ratio	-	10	12	-		-

WS: White state , DS: Dark state, Gray state from Dark to White :DS、G1、G2...、Gn...、Gm-2、WS  
m:4、8、16 when 2、3、4 bits mode

Note 8-1: Luminance meter: Eye – One Pro Spectrophotometer

### 8-2) Definition of contrast ratio

The contrast ratio (CR) is the ratio between the reflectance in a full white area (RI) and the reflectance in a dark area (Rd):  $CR = RI / Rd$



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## 8-3) Reflection Ratio

The reflection ratio is expressed as:

$$R = \text{Reflectance Factor}_{\text{white board}} \times (L_{\text{center}} / L_{\text{white board}})$$

$L_{\text{center}}$  is the luminance measured at center in a white area (R=G=B=1).  $L_{\text{white board}}$  is the luminance of a standard white board.

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## 9. HANDLING, SAFETY AND ENVIRONMENTAL 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.

### REMARK

All The specifications listed in this document are guaranteed for module only. Post-assembled operation or component(s) may impact module performance or cause unexpected effect or damage and therefore listed specifications is not warranted after any Post-assembled operation.

### 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 can cause permanent damage and invalidate the warranty agreements.

IPA solvent can only be applied on active area and the back of a glass. For the rest part, it is not allowed.

### Mounting Precautions

(1) It's recommended that you consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module.

(2) It's recommended that you attach a transparent protective plate to the surface in order to protect the EPD. Transparent protective plate should have sufficient strength in order to resist external force.

(3) You should adopt radiation structure to satisfy the temperature specification.

(4) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the PS at high temperature and the latter causes circuit break by electro-chemical reaction.

(5) Do not touch, push or rub the exposed PS with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of PS for bare hand or greasy cloth. (Some cosmetics deteriorate the PS)

(6) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach the PS. Do not use acetone, toluene and alcohol because they cause chemical damage to the PS.

(7) Wipe off saliva or water drops as soon as possible. Their long time contact with PS causes deformations and color fading.

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**Data sheet status**

Product specification	This data sheet contains formal product specifications.
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**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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## 10. Reliability test

	TEST	CONDITION	METHOD	REMARK
1	High-Temperature Operation	T = +50 °C, RH = 30% for 240 hrs	IEC 60 068-2-2Bp	
2	Low-Temperature Operation	T = 0 °C for 240 hrs	IEC 60 068-2-2Ab	
3	High-Temperature Storage	T = +70 °C, RH=40% for 240 hrs Test in white pattern	IEC 60 068-2-2Bp	
4	Low-Temperature Storage	T = -25 °C for 240 hrs Test in white pattern	IEC 60 068-2-1Ab	
5	High-Temperature, High-Humidity Operation	T = +40 °C, RH = 90% for 168 hrs	IEC 60 068-2-3CA	
6	High Temperature, High- Humidity Storage	T = +60 °C, RH=80% for 240hrs Test in white pattern	IEC 60 068-2-3CA	
7	Temperature Cycle	-25 °C → +70 °C, 100 Cycles 30min 30min Test in white pattern	IEC 60 068-2-14	
8	Solar radiation test	765 W/m <sup>2</sup> for 168hrs, 40 °C Test in white pattern	IEC60 068-2-5Sa	
9	Package Vibration	1.04G, Frequency: 10~500Hz Direction: X,Y,Z Duration: 1 hours in each direction	Full packed for shipment	
10	Package Drop Impact	Drop from height of 122 cm on concrete surface. Drop sequence: 1 corner, 3 edges, 6 faces One drop for each.	Full packed for shipment	
11	Electrostatic Effect (non-operating)	(Machine model)+/- 250V 0 Ω, 200pF	IEC 62179, IEC 62180	

Actual EMC level to be measured on customer application

Note: The protective film must be removed before temperature test.

## &lt; Criteria &gt;

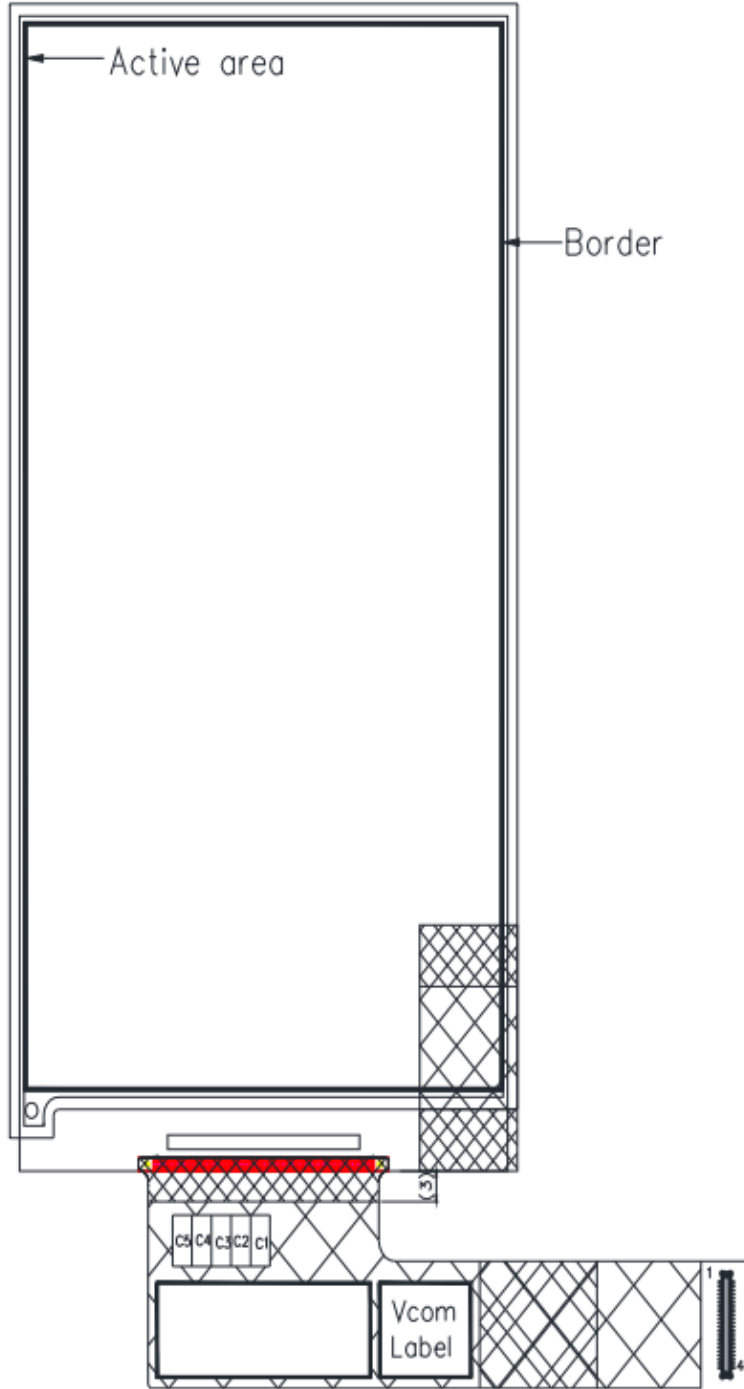
In the standard conditions, there is not display function NG issue occurred. (including : line defect ,no image). All the cosmetic specification is judged before the reliability stress.

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11.Bar Code definition  
TBD

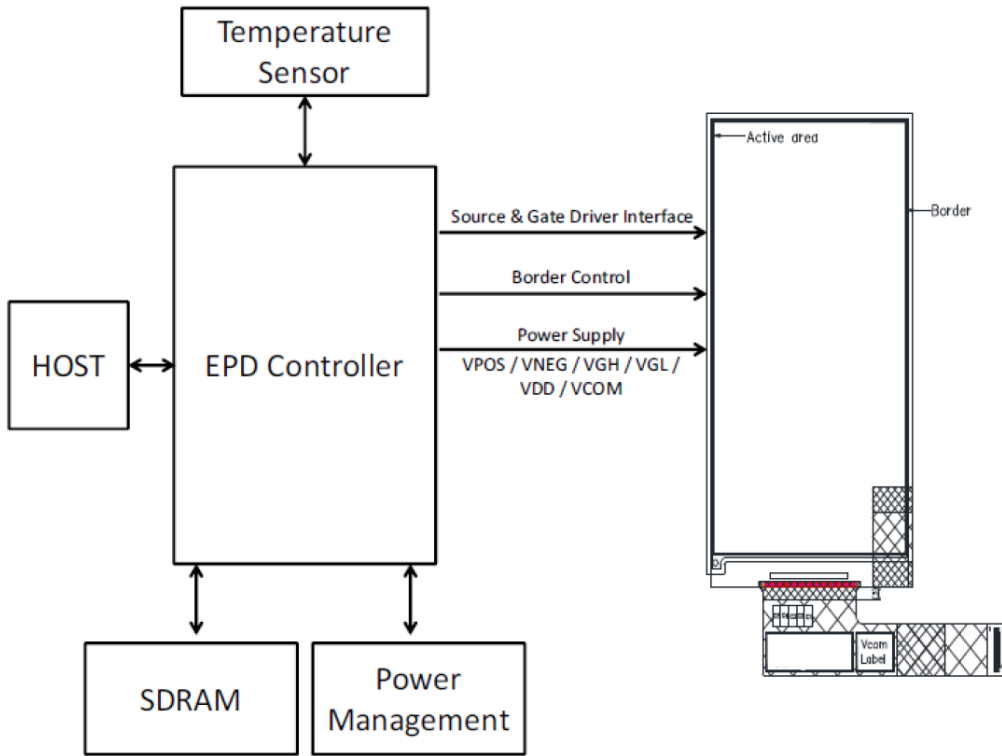
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## 12.Border definition



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### 13.Block Diagram



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14. Inspection standard

14.1. Cosmetic specification

14.1.1 This cosmetic inspection shall be applied to 4.7 inch EPD module that supplied by YES .

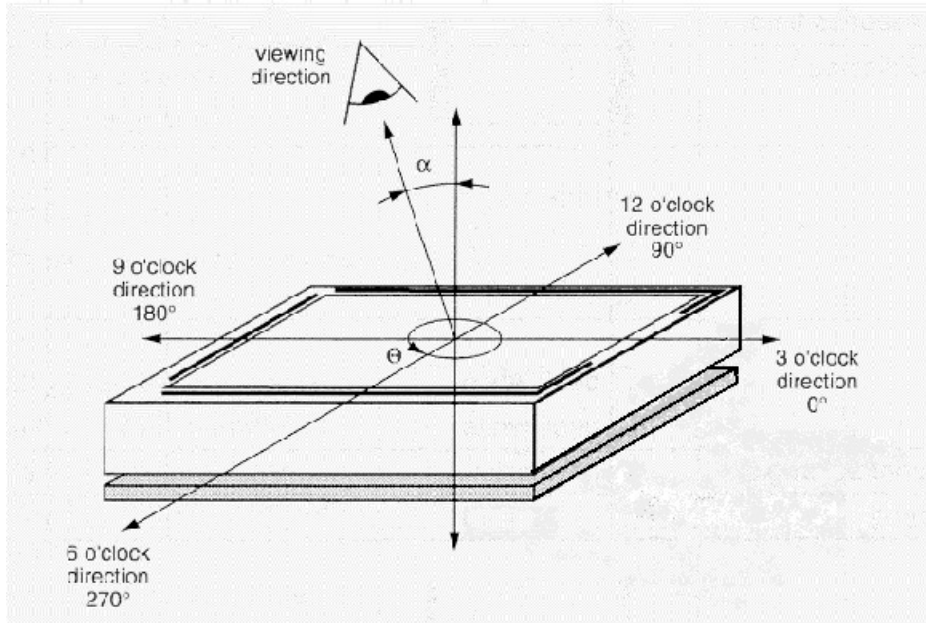
14.1.2 Inspection condition

14.1.2.1 Viewing Angle (Major axis x)

14.1.2.1.1 The inspection shall be conducted within viewing angle range.

$\alpha = \pm 45^\circ$  inspection under non-operating condition.

$\alpha = \pm 45^\circ$  inspection under operating condition.



14.1.2.2 Environment condition

14.1.2.2.1 Ambient Temperature :  $25 \pm 5^\circ\text{C}$

14.1.2.2.2 Ambient Humidity: 40 – 70%RH

14.1.2.2.3 Due date of storage: 12 months

14.1.2.2.4 ESD should be control under  $\pm 200\text{V}$

14.1.3 Sampling condition

14.1.3.1 Lot size: Quantity of shipment lot per model.

14.1.3.2 Sampling type: Normal inspection, single sampling.

14.1.3.3 Inspection Level: Level II

Sampling table: ISO2859 (Also known as MIL-STD-105E II), unless otherwise agreed in writing.

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14.1.4 Acceptance Quality Level (AQL)

14.1.4.1 Major defect: 0.65

14.1.4.2 Minor defect: 1.25

14.1.5 Classification of defects

Defects are classified as either a major or minor defect defined as below.

14.1.5.1 Major defect

It is a defect that is likely to result in failure or to reduce materially the usability of the product for the intended function.

14.1.5.2 Minor defect

It is a defect that will not result in functioning problem with deviation classified.

14.2. Quality criteria

14.2.1 Inspection condition

Ambient Luminance · · · 1000lux ~ 1300 lux; Typical is setting around 1150lux +/- 150.

Temperature : 23°C±5°C

Humidity: 40 – 70%

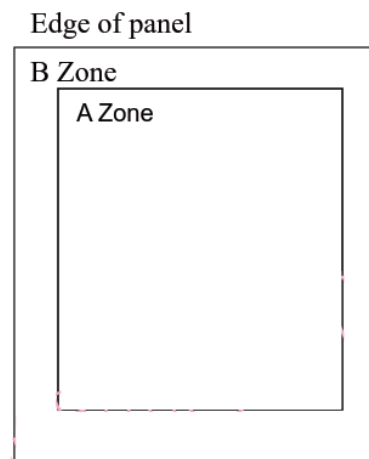
Supply Voltage: Typical value described on a specification

Viewing Distance and Angle : 30 +/- 10cm, θφ = +/-45deg.

14.2.2 Zone Definition

A Zone: EPD Active area.

B Zone: EPD black printing ink area.



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### 14.2.3 Cosmetic criteria

The items are shown a table below. Other items and standard values, applicable zones are to be decided by agreement. A limited sample shall be made to decide standards.

#### Major Defects:

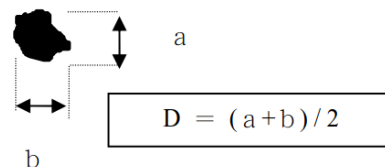
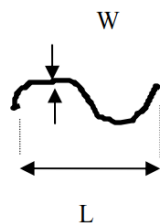
Item	Description	Classification
No display	No display show on screen due to malfunction	Major
Line defect	Line missing or unusual appear when display	Major
Abnormal display	Unusual pattern or function displayed	Major

#### Minor Defects:

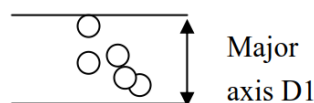
Name	Item		Criteria		Specific Zone	
		Causes				
Spot	B/W spot in glass or protection sheet, foreign mat. Swell. Dot defect	<b>Spot Size</b>		<b>A Zone</b>	<b>B &amp; C Zone</b>	
		$D \leq 0.3\text{mm}$		Ignore	Ignore	
		$0.20\text{mm} < D \leq 0.50\text{mm}$		8		
		$D > 0.50\text{mm}$		0		
Scratch or line defect	Scratch on glass or Scratch on FPL or Particle is Protection sheet.	<b>Length</b>	<b>Width</b>	<b>A Zone</b>	Ignore	
		$L \leq 2.0\text{ mm}$	$W \leq 0.2\text{ mm}$	Ignore		
		$2.0\text{ mm} < L \leq 8.0\text{ mm}$	$0.2\text{ mm} < W \leq 0.5\text{ mm}$	5		
		$L > 8.0\text{ mm}$	$W > 0.5\text{ mm}$	0		
Air bubble	Air bubble	$D1, D2 \leq 0.5\text{ mm}$		Ignore	Ignore	
		$0.5\text{ mm} \leq D1, D2 \leq 1.0\text{ mm}$		5		
		$D1, D2 > 1.0\text{ mm}$		0		
Mura	Judge at deep gray pattern	Acceptable if invisible through 8% ND filter at deep gray pattern		Ignore	Ignore	

#### Remarks:

- Spot define: That only can be seen under WS or DS defects.
- Any defect which is visible under gray pattern or transition process but invisible under black and white is disregarded.
- Any defects in border area is disregarded. Any defects in AA area is judged by specification of the "Spot" and "Scratch or line defect".
- Here is definition of the "Spot" and "Scratch or line defect".  
Spot:  $W > 1/4L$   
Scratch or line defect:  $W \leq 1/4L$
- Definition for L/W and D (major axis)



Aggregate of small air



Big air bubble



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14.2.4 Outline criteria

14.2.4.1 Curl for Panel (a part of glass)

- Method -

- 1, to prepare the flat stage.
- 2, to put a panel on it (below figure).
- 3, to use a thickness gauge to measure the high value "t" on every corner of panel

- Criteria -

$$t \leq 1.0\text{mm}$$



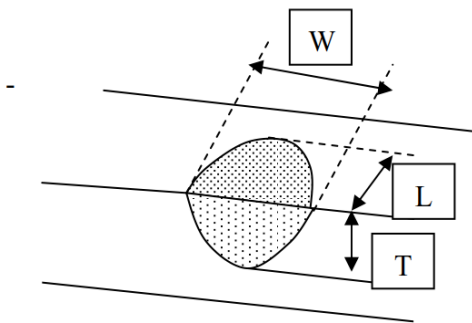
14.2.4.2 Glass Chipping and Crack (Minor)

Item	Size(Unit:mm)		Number	Remark
Chipping	$W \leq 10 \text{ mm}$	$L \leq 1.0 \text{ mm}$	Negligible	nothing to do with thickness T
		$L > 1.0 \text{ mm}$	None	
	$W > 10 \text{ mm}$		None	
Chipping on the corner	Showing on below figure			
Crack (*)	-		None	V-shaped chipping included (Note)

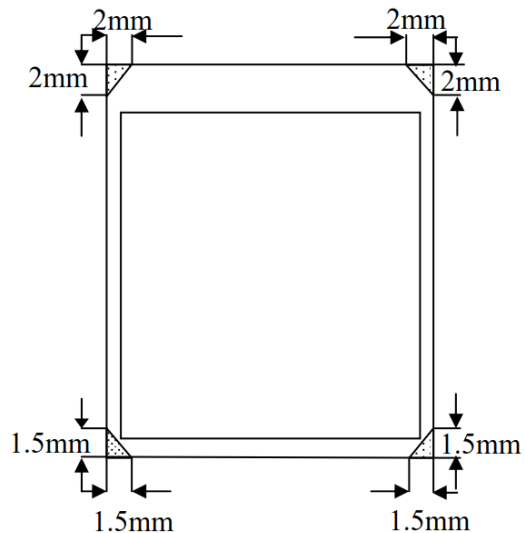
\* "Crack" means the one which would progress further.

Note: Inspection by naked eye.

Definition of abbreviation



Chipping on the corner



15.Packing

TBD

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