

LB060X02  
Electrophoretic Display

## Product Specification

SPECIFICATION  
FOR  
APPROVAL

- ( ) Preliminary Specification  
(◆) Final Specification

Title	6.0" XGA EPD		
BUYER	Open向	SUPPLIER	LG Display
MODEL		*MODEL	LB060X02
		SUFFIX	RD01

\*When you obtain standard approval,  
please use the above model name without suffix

SIGNATURE	DATE
/	
/	
/	

Please return 1 copy for your confirmation with your signature and comments.

APPROVED BY	DATE
S. M. Song / G. Manager	Sep. 23. 2011
REVIEWED BY	
C. W. Oh / Manager	Sep. 23. 2011
PREPARED BY	
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Product Engineering Dept. LG Display Co., Ltd	

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**RECORD OF REVISIONS**

Revision No	Date	Page	Description
Ver 1.0	Sep. 23. 2011		First Release

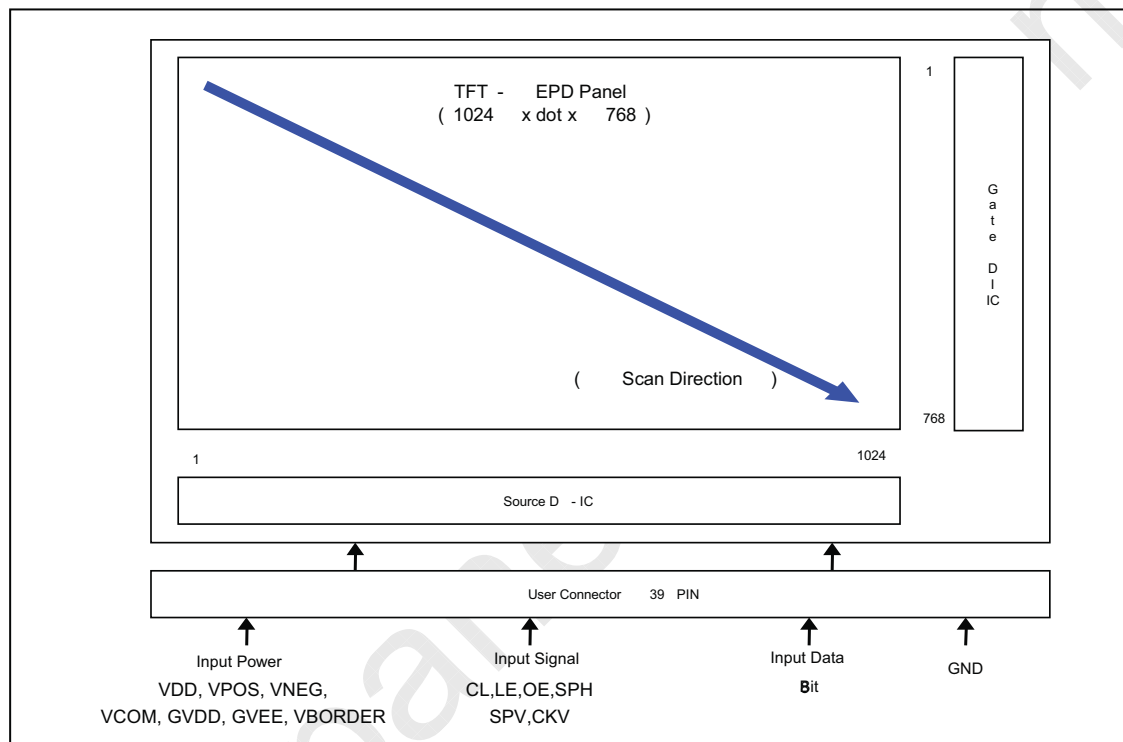
**Ver 1.0**

**Sep. 23. 2011**

**3 / 23**

**LB060X02**  
**Electrophoretic Display****Product Specification****1. General Description**

LB060X02 is a Active Matrix Electrophoretic Display (EPD). The matrix employs a-Si Thin Film Transistor substrate as a active element. It comprises TFT substrate, Electrophoretic front plane laminate (FPL : e-ink film), Protective sheet (PS), Driver IC on plastic and FPCB. It is a reflective type display and has 6.0 inches active area diagonally measured as XGA resolution (1024 horizontal by 768 vertical pixel array). Each pixel has a rectangular shape. The display presents 16 gray level with 4-bit display capability. LB060X02 characteristics are designed to provide high quality for applications such as e-book.

**Figure 1.1 Block diagram****General Features**

Active screen size	6.0 inches diagonal
Outline Dimension	137.9(H) x 104.1(V) x 0.67(D) mm (Typ.)
Pixel Pitch	0.1195(H) x 0.118(V) mm
Pixel Format	1024 Hor. by 768 Ver. Pixels.
Number of Gray	16 Gray Level (Monochrome)
Reflectance	35% (Typ.)
Contrast ratio	12:1 (Typ.)
Viewing Angle (CR≥10)	R/L 140(Typ.), U/D 140(Typ.)
Weight	13.8± 2g
Display operating mode	Reflective mode
Surface treatment	Anti-glare treatment for protective sheet



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### 2. Absolute maximum ratings

The followings are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

**Table 2.1. Absolute Maximum Ratings**

Parameter	Symbol	Values		Units	Notes
		Min.	Max.		
Digital voltage supply range	VDD	-0.3	5	V <sub>dc</sub>	At 25℃, 1, 2
Positive voltage supply range	VPOS	-0.3	20	V <sub>dc</sub>	At 25℃, 1
Negative voltage supply source	VNEG	-20	+0.3	V <sub>dc</sub>	At 25℃, 1
Max. Drive voltage range	VPOS-VNEG	-	40	V <sub>dc</sub>	At 25℃, 1
Gate Line High Voltage	GVDD	-0.3	45	V <sub>dc</sub>	At 25℃, 2
Gate Line Low Voltage	GVEE	-45	+0.3	V <sub>dc</sub>	At 25℃, 2
Gate Line Drive Voltage	GVDD-GVEE	-0.3	50	V <sub>dc</sub>	At 25℃, 2
Operating Temperature	T <sub>OP</sub>	0	+ 50	℃	
Storage Temperature	T <sub>ST</sub>	-25	+ 70	℃	
Operating Ambient Humidity	H <sub>OP</sub>	30	+ 90	%RH	
Storage Humidity	H <sub>ST</sub>	23	+ 90	%RH	

Note : 1. Source IC Power Supply

2. Gate IC Power Supply

3. If you use the device above Absolute Maximum Ratings, it may cause permanently device damage.

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## 3. Electrical specifications

## 3-1. Interface Connections

Table 3.1. Module connector pin configuration

Pin No.	Symbol	Description
1	VNEG	Negative power supply source driver
2	VPOS	Positive power supply source driver
3	VSS	Ground
4	VDD	Digital power supply driver
5	CL	Clock source driver
6	LE	Latch enable source driver
7	OE	Output enable source driver
8	NC	No Connection
9	NC	No Connection
10	VSS	Ground
11	SPH	Start pulse source driver
12	D0	Data signal source driver
13	D1	Data signal source driver
14	D2	Data signal source driver
15	D3	Data signal source driver
16	D4	Data signal source driver
17	D5	Data signal source driver
18	D6	Data signal source driver
19	D7	Data signal source driver
20	NC	No Connection
21	NC	No Connection
22	VCOM	Common connection
23	GVDD	Positive power supply gate driver
24	GVEE	Negative power supply gate driver
25	NC	No Connection
26	NC	No Connection
27	NC	No Connection
28	NC	No Connection
29	NC	No Connection
30	NC	No Connection
31	NC	No Connection
32	SPV	Start pulse gate driver
33	CKV	Clock gate driver
34	VBORDER	Border connection
35	NC	NO Connection
36	NC	NO Connection
37	NC	NO Connection
38	NC	NO Connection
39	VSS	Ground



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### 3-2. Connection Type

SERVICE	CONNECTOR	TYPE NUMBER	NUMBER OF PINS	MATING CONNECTOR
Interface	HIROSE	FH23-39S-0.3SH(A)W	39	Copper foil 0.3mm pitch

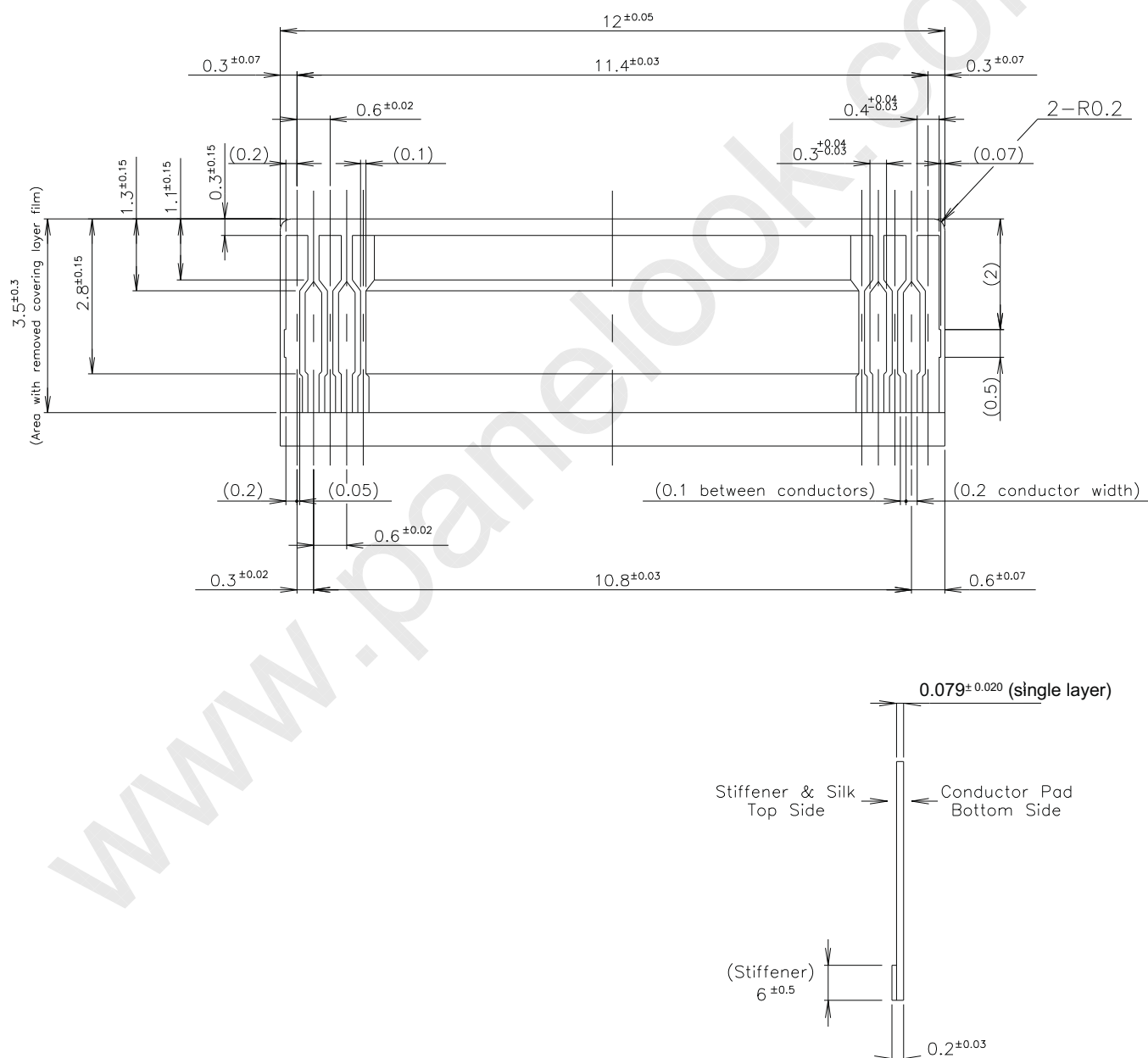


Figure 3.1. Connector Drawings



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### 3-3. Panel DC characteristics

**Table 3.2 DC Characteristics**

(Ta = 25℃)

Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Signal Ground	V <sub>SS</sub>		-	0	-	V
Logic Voltage supply	V <sub>DD</sub>		2.8	3.3	3.6	V
	I <sub>DD</sub>	V <sub>DD</sub> =3.3	-	16.0	16.6	mA
Gate Negative supply	GV <sub>EE</sub>		-21	-20	-19	V
	GI <sub>EE</sub>	GV <sub>EE</sub> =-20	-	3.9	4.1	mA
Gate Positive supply	GV <sub>DD</sub>		21	22	23	V
	GI <sub>DD</sub>	GV <sub>DD</sub> =22	-	3.8	4.0	mA
Source Negative supply	V <sub>NEG</sub>		-15.4	-15	-14.6	V
	I <sub>NEG</sub>	V <sub>NEG</sub> =-15	-	3.8	76.6	mA
Source Positive supply	V <sub>POS</sub>		14.6	15	15.4	V
	I <sub>POS</sub>	V <sub>POS</sub> =15	-	5.2	81.8	mA
Border supply	V <sub>Border</sub>	V <sub>POS</sub> =15	14.6	15	15.4	V
		V <sub>NEG</sub> =-15	-15.4	-15	-14.6	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>		-2.5	adjusted	-0.5	V
	I <sub>COM</sub>		-	2.2	-	mA
Maximum power panel	P <sub>MAX</sub>		-	-	1914.8	mW
Standby power panel	P <sub>STBY</sub>		-	-	0.4	mW
Typical power panel	P <sub>TYP</sub>		-	379.6	-	mW
Operating temperature			0	-	50	℃
Storage temperature			-25	-	70	℃
Image update time	@ 25℃	GC16	-	600	660	ms
		DU	-	260	300	ms

Notes :

- Maximum power consumption image : line by line (horizontal : Black → white . White → Black)
- Typical Power consumption image : From horizontal 4 gray scale pattern to vertical 4 gray scale pattern.
- Standby Power consumption condition : V<sub>DD</sub>=3.3V, logic signal and other power : V<sub>SS</sub>.
- Power consumption depend on image complexity.





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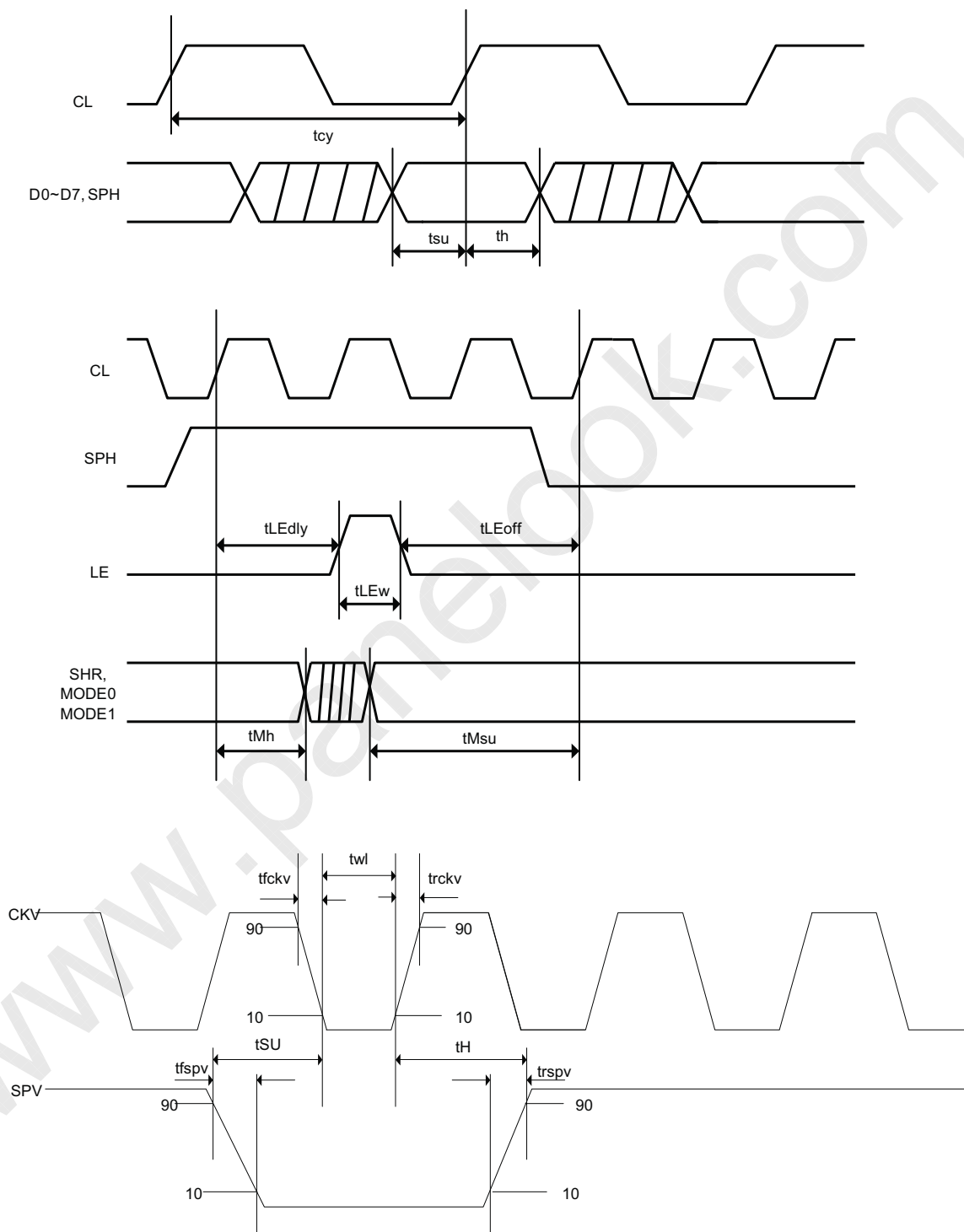
## Product Specification

### 3-4. Panel AC characteristics

**Table 3.3 AC Characteristics**

(Ta = 25℃)

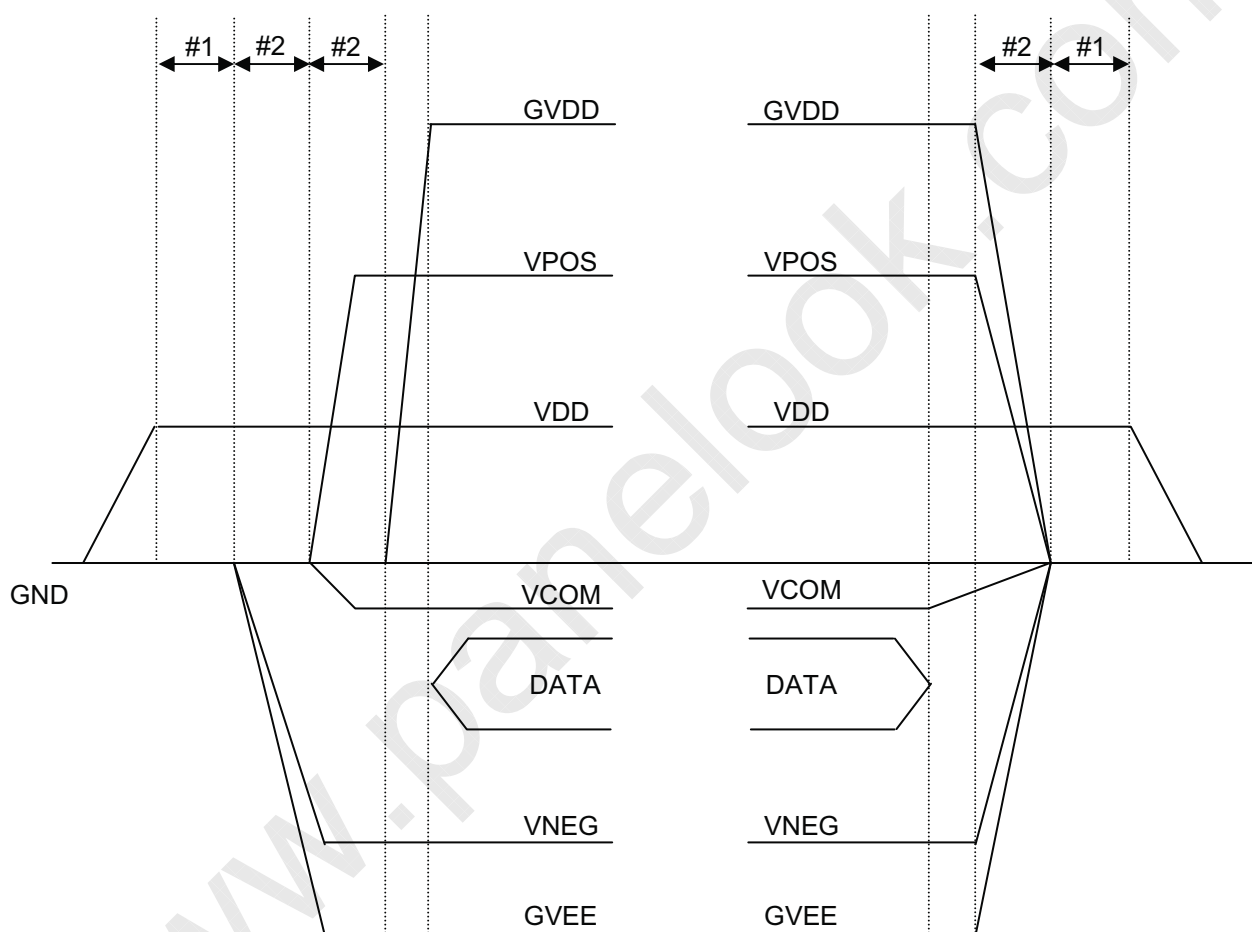
Parameter	Symbol	Conditions	Min	Typ	Max	Unit	App Pin
Clock frequency	fckv		-	-	200	kHz	CKV
Minimum "L" clock pulse width	twL		0.5	-	-	us	
Clock rise time	trckv		-	-	100	ns	
Clock fall time	tfckv		-	-	100	ns	
Data setup time	tSU		100	-	-	ns	CKV,SPV
Data hold time	tH		100	-	-	ns	
Input Signal Rising time	trspv		-	-	100	ns	SPV
Input Signal falling time	tfspv		-	-	100	ns	
Clock CL cycle time	tcy		-	-	40	MHz	Figure 3.2
D0..D7, SPH setup time	tsu		4	-	-	ns	
D0...D7,SPH hold time	th		6	-	-	ns	
LE on delay time	tLEdly		40	-	-	ns	
LE high-level pulse width	tLEw		40	-	-	ns	
LE off delay time	tLEoff		40			ns	

**Product Specification****Figure 3.2 Timing Characteristics**

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**3-5. Power Sequence**

1. VSS → VDD → VNEG → VPOS (Source driver), VCOM
2. GVEE → GVDD (Gate driver)

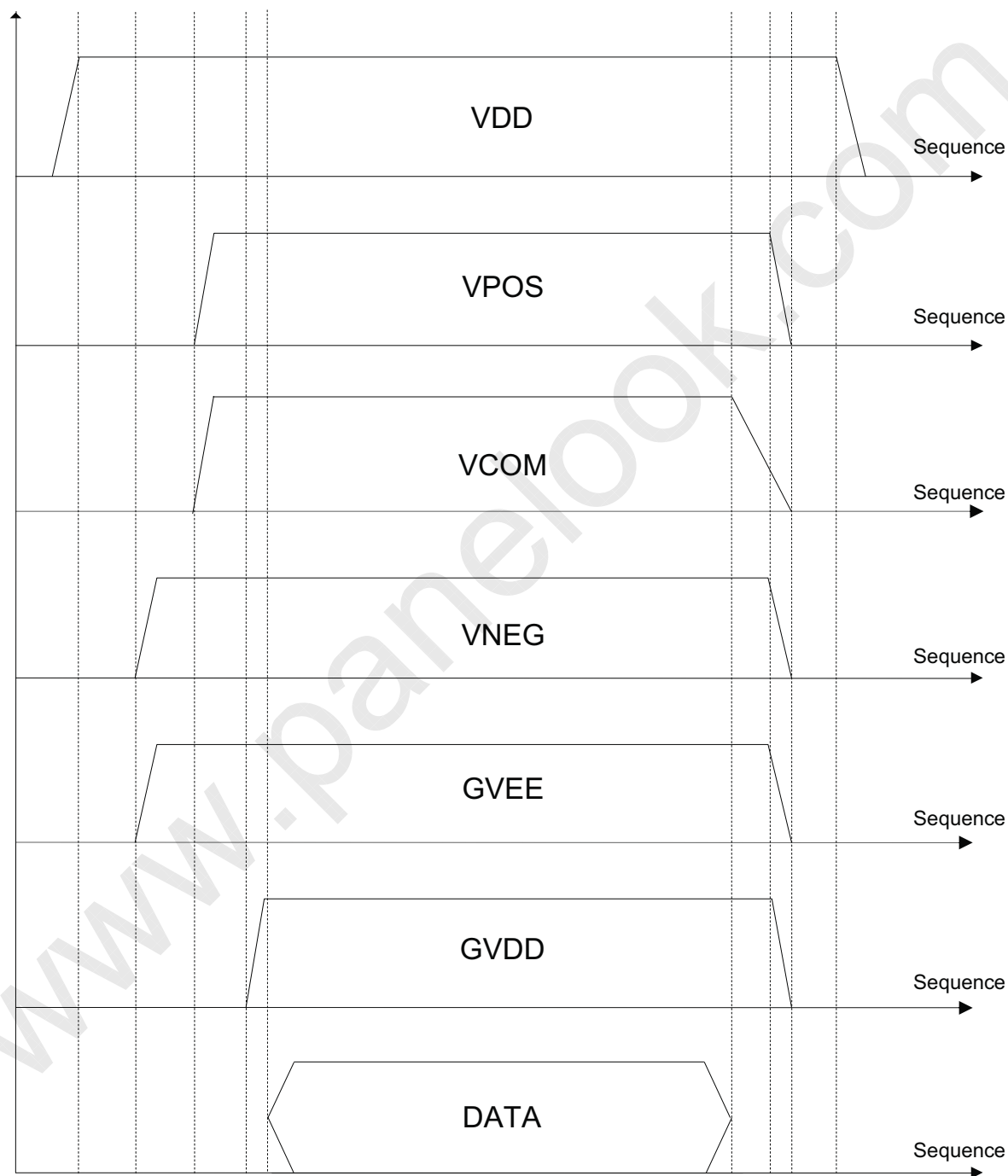
Figure 3.3 Power Sequence timing chart


**Notes :**

- . Min 5ms ≤ #1
- . Min 5ms ≤ #2 ≤ Max 100ms
- . Power on sequence : VDD → VNEG, GVEE → VPOS, VCOM → GVDD → DATA
- . Power off sequence : VCOM, DATA → GVEE, GVDD, VPOS, VNEG → VDD

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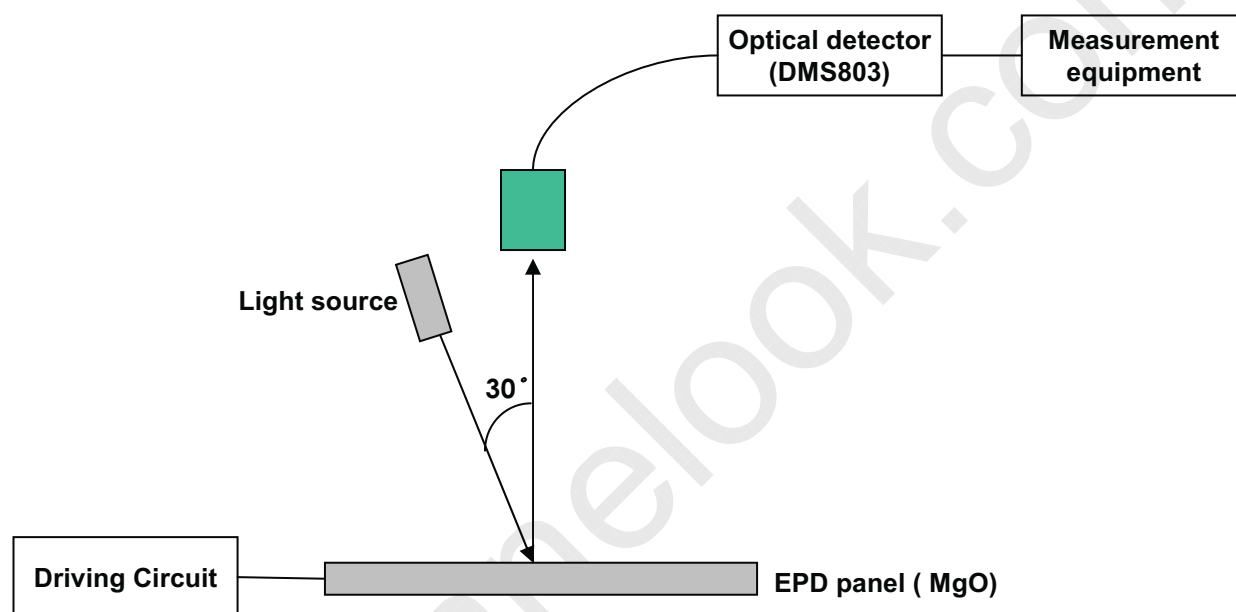
Figure 3.4 Sequence timing chart



**Product Specification****4. Optical Specifications****4-1. Optical characteristics**

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25 °C. The values specified are measured at an approximate distance 50cm from the EPD surface at a viewing angle of  $\Phi$  and  $\theta$  equal to 0 °.

Figure 4.1 presents additional information concerning the measurement equipment and method.



**Figure 4.1 Optical characteristic measurement equipment and method**

**Table 4.1 Optical characteristics**

Parameter	Symbol	Conditions	Values			Units	Notes
			Min.	Typ.	Max.		
Contrast ratio	CR		10	12			1
Reflectance	R	White	30	35		%	2
Update time	T	GC16 (T=0℃)		1400	1540	ms	
		GC16 (T=25℃)		600	660	ms	
		GC16 (T≥33℃)		800	880	ms	
		DU (T=0℃)		580	680	ms	
		DU (T≥18℃)		260	300	ms	

(Ta=25 °C, V<sub>EPD</sub>=± 15.0V, f<sub>V</sub>=85Hz)



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Notes :

1. **Contrast ratio(CR)** is defined mathematically as :

$$\text{Contrast ratio} = \frac{\text{Surface Reflectance with all white pixels}}{\text{Surface Reflectance with all black pixels}}$$

It is measured at center point.

2. Average **Reflectance (R)** is luminance value at center of EPD panel with all pixels displaying white



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### 4-2. Waveform

Waveform file should be available before panel delivery to customer.

Ghosting quality is measured by the reflectance difference between specific area and surface.

Doubts regarding the ghosting quality shall be resolved in good faith through discussions between both parties.

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Table 5.1 provides general mechanical characteristics for the model LB060X02. Please refer to Figure 5.1 regarding the detailed mechanical drawing of the EPD.

**Table 5.1 Mechanical characteristics**

Outside dimensions	Horizontal	137.9 ± 0.35 mm
	Vertical	104.1 ± 0.35 mm
	Thickness	0.671 ± 0.20 mm
Active display area	Horizontal	122.368mm
	Vertical	90.624mm



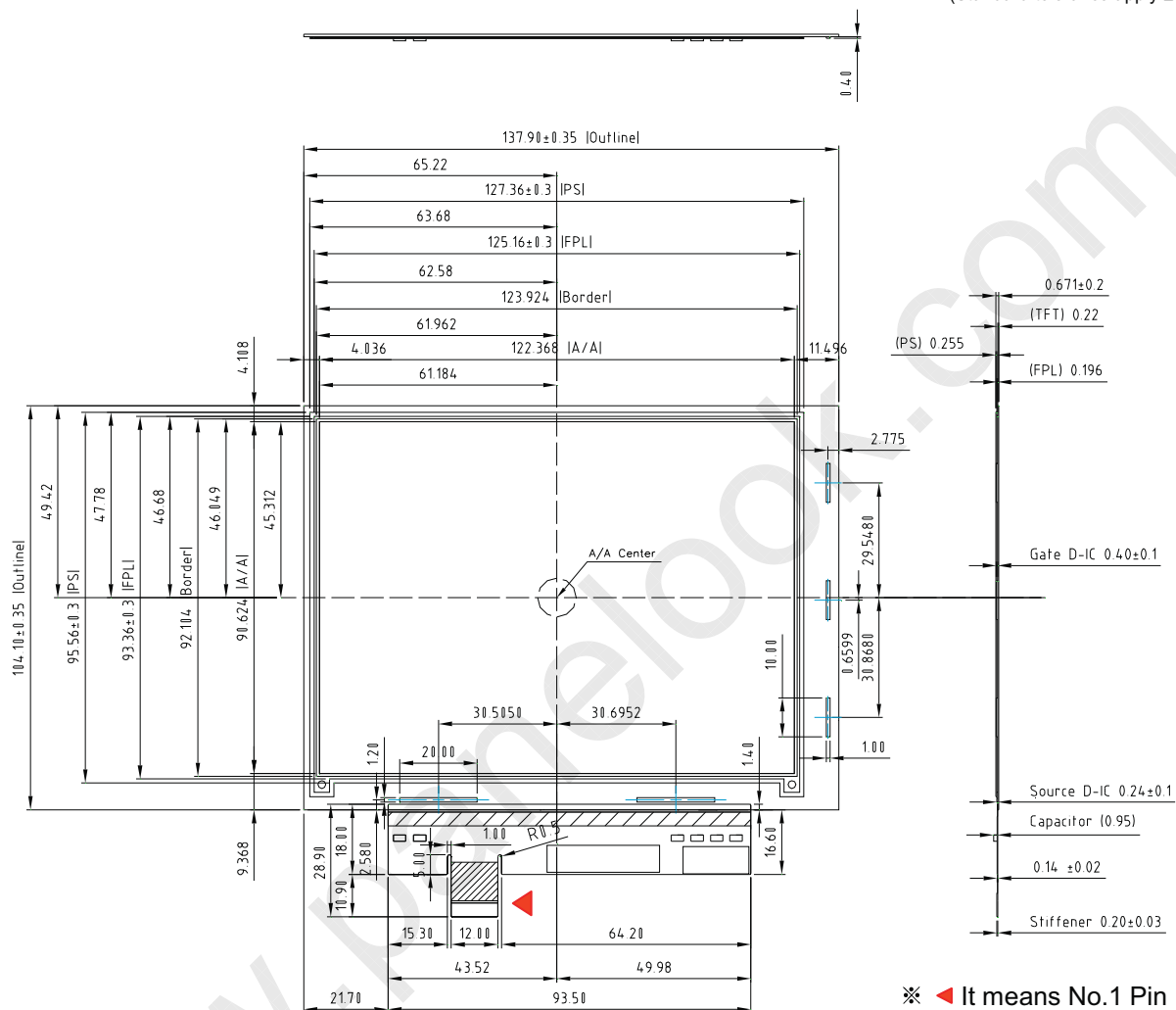


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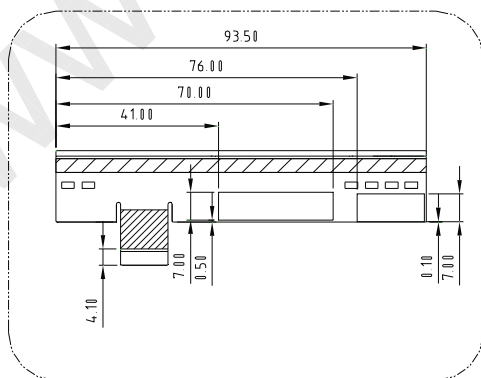
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Figure 5.1 Outline Dimension

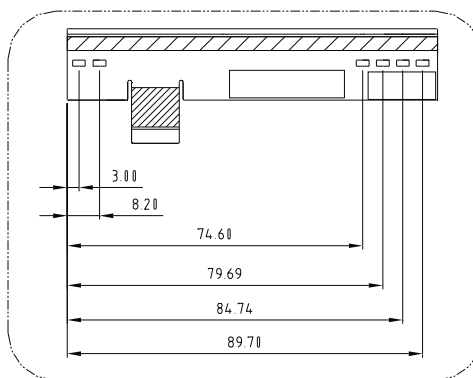
(Standard tolerance apply  $\pm 0.2\text{mm}$ )



FPC Detail Dimension



FPC Detail Dimension





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### 6. Reliability

**Table 6.1 Environment test condition**

No.	Test item	Conditions
1	High temperature storage test	Ta= 70℃ 23%RH 240h
2	Low temperature storage test	Ta= -25℃ 240h
3	High temperature operation test	Ta= 50℃ 30%RH 240h
4	Low temperature operation test	Ta= 0℃ 240h
5	High temperature High Humidity Storage test	Ta= 60℃ 80%RH 240h
6	High temperature High Humidity Operation test	Ta= 40℃ 90%RH 240h
7	Temperature Cycle	1 cycle : [-25℃ 30min] – [70℃ 30min] : 100cycles
8	UV exposure Resistance	765mW/m <sup>2</sup> 40℃ 168h
9	Package Vibration	Frequency : 10~50Hz Vibration level : 1.04G Direction : ±X, ±Y, ±Z Duration : 1 hours for each of the three axes.
10	Package Drop Impact	Drop Height : 76cm on concrete surface Drop Sequence : 1 corner 3 edges 6 faces one time each direction
11	Electrostatic Effect (non-operating)	±250V, 0Ω, 200pF
12	Altitude storage / shipment Storage	260hPa (10,000m) 48h
13	Altitude storage / shipment operation	700hPa (3,000m) 48h

{ Result evaluation criteria }

There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

EPD Panels might have curled after the reliability test.

However this is not a issue unless it is not working stable.



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### 7. Packing

#### 7-1. Designation of Lot Mark

##### a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

A,B,C : SIZE(INCH)

E : MONTH

N~Q : FPL LOT

D : YEAR

F ~ M : SERIAL NO.

R~U : INTERNAL CODE(NO DIGIT)

##### Note

##### 1. YEAR

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

##### 2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

##### b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the front side of the FPC

This is subject to change without prior notice.

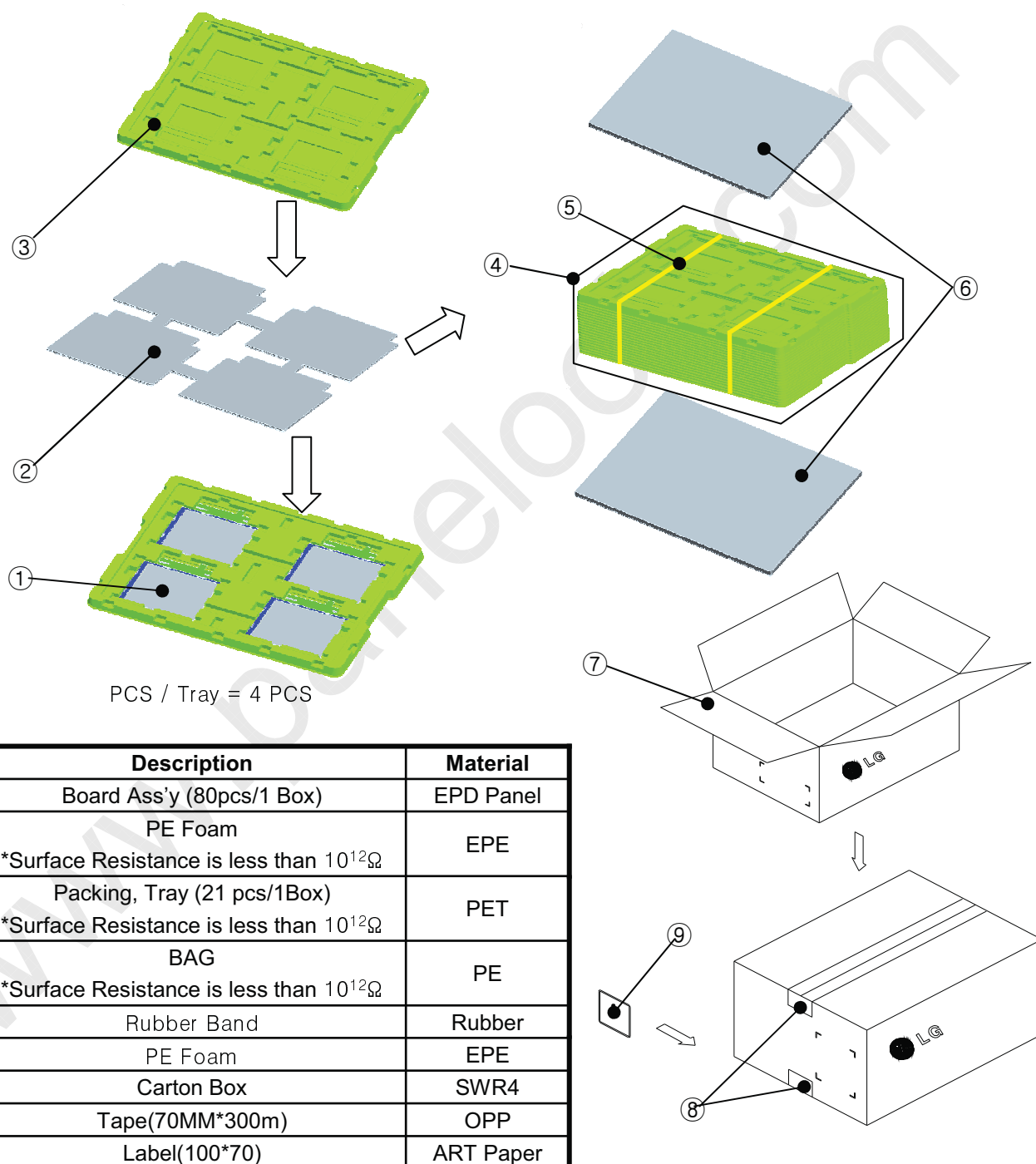


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### 7-2. Packing Form

- a) Package quantity in one box : 80 pcs
- b) Box size : 478mm X 365mm X 244mm.
- c) 1Box = 20 (full tray) + 1 (dummy / top tray) = 21 tray





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### 7-3. Labels

#### a) ID Label



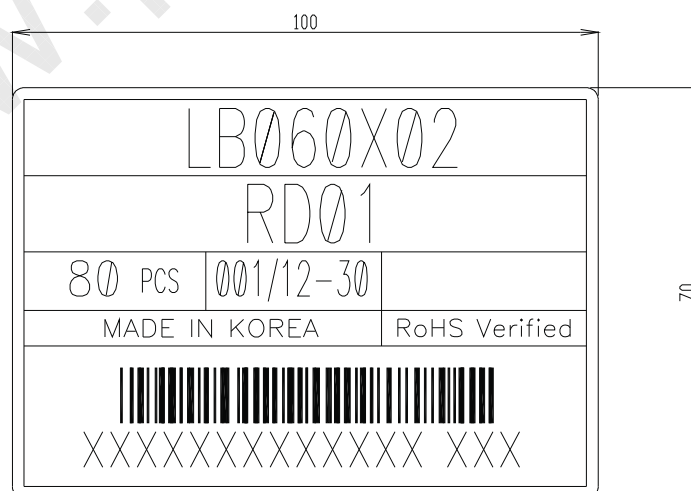
**Figure 7.1 ID Label**

#### b) Vcom Label



**Figure 7.2 Vcom Label**

#### c) Box Label





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### 8. Precautions

Please pay attention to the following when you use this EPD module.

#### 8-1. Mounting Precautions

- (1) It's recommended that you consider the mounting structure so that uneven force(ex. twisted stress or bending stress) is not applied to the module.
- (2) Do not bend or push EPD module, especially around the drive-IC, otherwise it would cause optical, electrical, and mechanical defects.
- (3) 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.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) 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.
- (6) 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)
- (7) 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.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with PS causes deformations and color fading.

#### 8-2. Operating Precautions

- (1) The spike noise causes malfunction of circuits. It should be lower than following voltage :  
 $V=\pm 200\text{mV}$ (Over and under shoot voltage)
- (2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
- (3) Reflectance depends on the temperature. (In lower temperature, it becomes lower.)  
And in lower temperature, update time becomes longer.
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to the PS or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.



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### 8-3. Electrostatic Discharge Control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make sure that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

### 8-4. Precautions for Strong Light Exposure

Strong light exposure causes degradation of quality

### 8-5. Storage

When storing modules as spares for a long time, the following precautions are necessary.

- (1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- (2) The PS surface should not come in contact with any other object.  
It is recommended that they be stored in the container in which they were shipped.

### 8-6. Handling Precautions for Protection Film

- (1) When the protection film is peeled off, static electricity is generated between the film and the PS. This should be done slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition.
- (2) When the protection film is peeled off, do not bend EPD module, especially around the drive-IC. Bending stress cause optical, electrical, and mechanical defects.
- (3) The protection film is attached to the PS with a small amount of glue. If some stress is applied to rub the PS against the PS during the time you peel off the film, the glue is apt to remain on the PS.
- (4) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the PS after the protection film is peeled off.
- (5) You can remove the glue easily. When the glue remains on the PS surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.