SPECIFICATION
FOR
APPROVAL

(◆) Preliminary Specification
( ) Final Specification

Title	**6.0” SVGA EPD**

BUYER	
MODEL	

SUPPLIER	**LG.Philips LCD Co., Ltd.**
*MODEL	**LB060S01**
SUFFIX	**FD01**

*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**
/	
REVIEWED BY	
/	
PREPARED BY	

Product Engineering Dept.
LG. Philips LCD Co., Ltd

CONTENTS

NO.	ITEM	Page
-	COVER	1
-	CONTENTS	2
-	RECORD OF REVISIONS	3
1	GENERAL DESCRIPTION	4
2	ABSOLUTE MAXIMUM RATINGS	5
3	ELECTRICAL SPECIFICATIONS	6
3-1	ELECTRICAL CHARACTERISTICS	6
3-2	INTERFACE CONNECTIONS	7
3-3	CONNECTION TYPE	8
3-4	PANEL DC CHARACTERISTICS	9
3-5	PANEL AC CHARACTERISTICS	10
3-6	POWER SEQUENCE	12
4	OPTICAL SPECIFICATIONS	14
5	MECHANICAL CHARACTERISTICS	17
6	RELIABILITY	19
7	PACKING	20
8	PRECAUTIONS	21

RECORD OF REVISIONS

Revision No	Date	Page	Description
Ver 0.1	Nov.06, 2007		First Draft

Product Specification

1. General Description

LB060S01-FD01 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 glass and FPCB. It is a reflective type display and has 6.0 inches active area diagonally measured as SVGA resolution (800 horizontal by 600 vertical pixel array). Each pixel has a rectangular shape. The display presents 8 gray level with 3-bit display capability.
LB060S01-FD01 characteristics are designed to provide high quality for applications such as e-book.

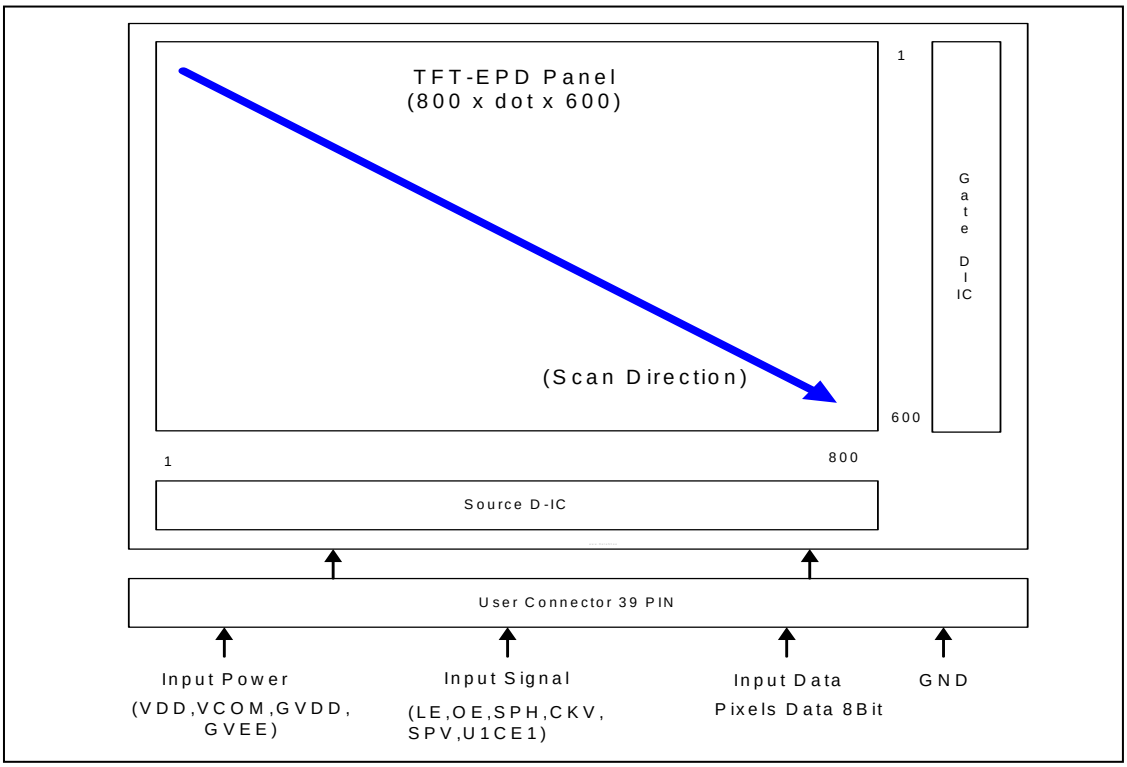


Figure 1.1 Block diagram

General Features

Active screen size	6.0 inches diagonal
Outline Dimension	137.9(H) x 104.1(V) x 1.081 (D) mm(Typ.)
Pixel Pitch	0.153(H) x 0.151(V) mm
Pixel Format	800 horiz. by 600 vert. Pixels.
Number of Gray	8 Gray Level (Monochrome)
Reflectance	35% (Typ.)
Contrast ratio	6 : 1 (Min.)
Viewing Angle (CR≥6)	R/L 140(Typ.), U/D 140(Typ.)
Weight	30±5g
Display operating mode	Reflective mode
Surface treatment	Anti-glare treatment for protective sheet

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_{dc}	At 25°C, 1, 2
Positive voltage supply range	VPOS	-0.3	20	V_{dc}	At 25°C, 1
Negative voltage supply source	VNEG	-20	+0.3	V_{dc}	At 25°C, 1
Max. Drive voltage range	VPOS-VNEG	-	40	V_{dc}	At 25°C, 1
Power source Voltage(1)	GVCC-VGL	-0.3	6	V_{dc}	At 25°C, 2
Gate Line High Voltage	VGH	-0.3	45	V_{dc}	At 25°C, 2
Gate Line Low Voltage	VGL	-45	+ 0.3	V_{dc}	At 25°C, 2
Gate Line Drive Voltage (1)	VGH-VGL	-0.3	50	V_{dc}	At 25°C, 2
Input voltage	VIN	-0.3	VDD+0.3	V_{dc}	At 25°C, 2
Operating Temperature	T_{OP}	0	＋50	℃	
Storage Temperature	T_{ST}	-25	＋70	℃	
Operating Ambient Humidity	H_{OP}	30	＋90	%RH	
Storage Humidity	H_{ST}	23	+ 90	%RH	

Note : 1. Source IC Power Supply
2. Gate IC Power Supply

3. Electrical specifications

3-1. Electrical characteristics

This display requires six power inputs, which are employed to power the EPD electronics and to drive the TFT array and e-ink.

Table 3.1. Electrical Characteristics

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
MODULE :						
Power Supply Input Voltage(1)	VDD	2.8	3.3	3.6	V	2
Power Supply Input Voltage(2)	VGH	15	22	23	V	2
Power Supply Input Voltage(3)	VGL	-22	-20	-15	V	2
Power Supply Input Voltage(4)	VGH-VGL	30	-	45	V	2
Input Voltage	VIN	0	-	VDD	V	
Power Supply Input Voltage(5)	VPOS	9	+15	+17	V	1
Power Supply Input Voltage(6)	VNEG	-9	-15	-17	V	1
Max. Drive voltage range	VPOS-VNEG	-	-	34	V	1
Operational frequency	fGSC	-	-	200	KHz	2
Operational frequency	CLK	-	-	25.0	Mhz	VCC=3.3V,1

Notes :

1. Source IC Power Supply
2. Gate IC Power Supply

3-2. Interface Connections

Table 3.2. 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	NC	No Connection
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	GVEE	Negative power supply gate driver
26	NC	No Connection
27	GMODE2	Output mode selection gate driver
28	GMODE1	Output mode selection gate driver
29	NC	No Connection
30	NC	No Connection
31	U1CE1	Cascade sequence gate driver
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	NC	No Connection

3-3. Connection Type

SERVICE	CONNECTOR	TYPE NUMBER	NUMBER OF PINS	MATING CONNECTOR
Interface	JST	39XFL-RSM1-S-H-TB	39	Copper foil 0.3mm pitch

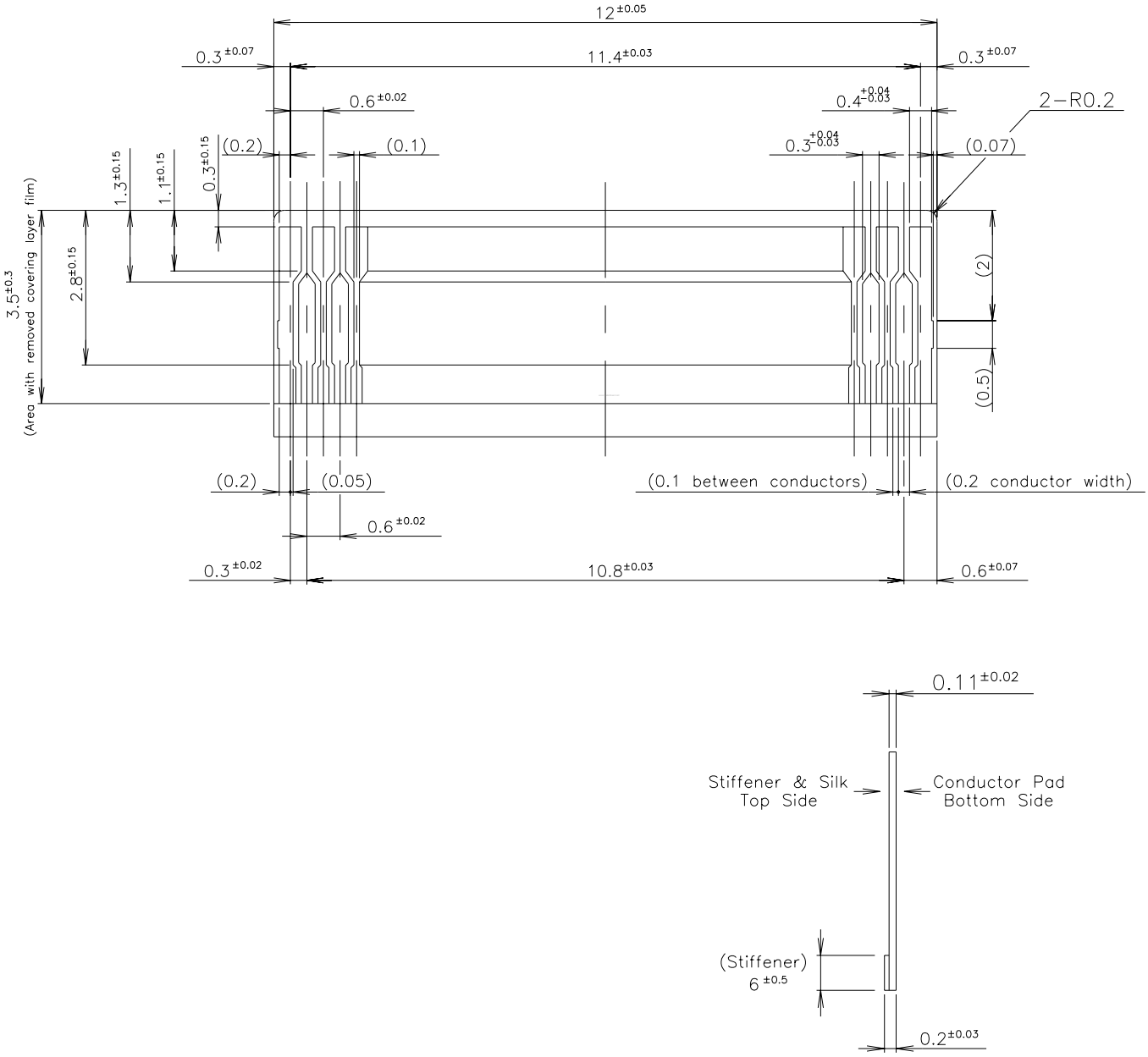


Figure 3.1. Connector Drawings

3-4. Panel DC characteristics

Table 3.3 DC Characteristics

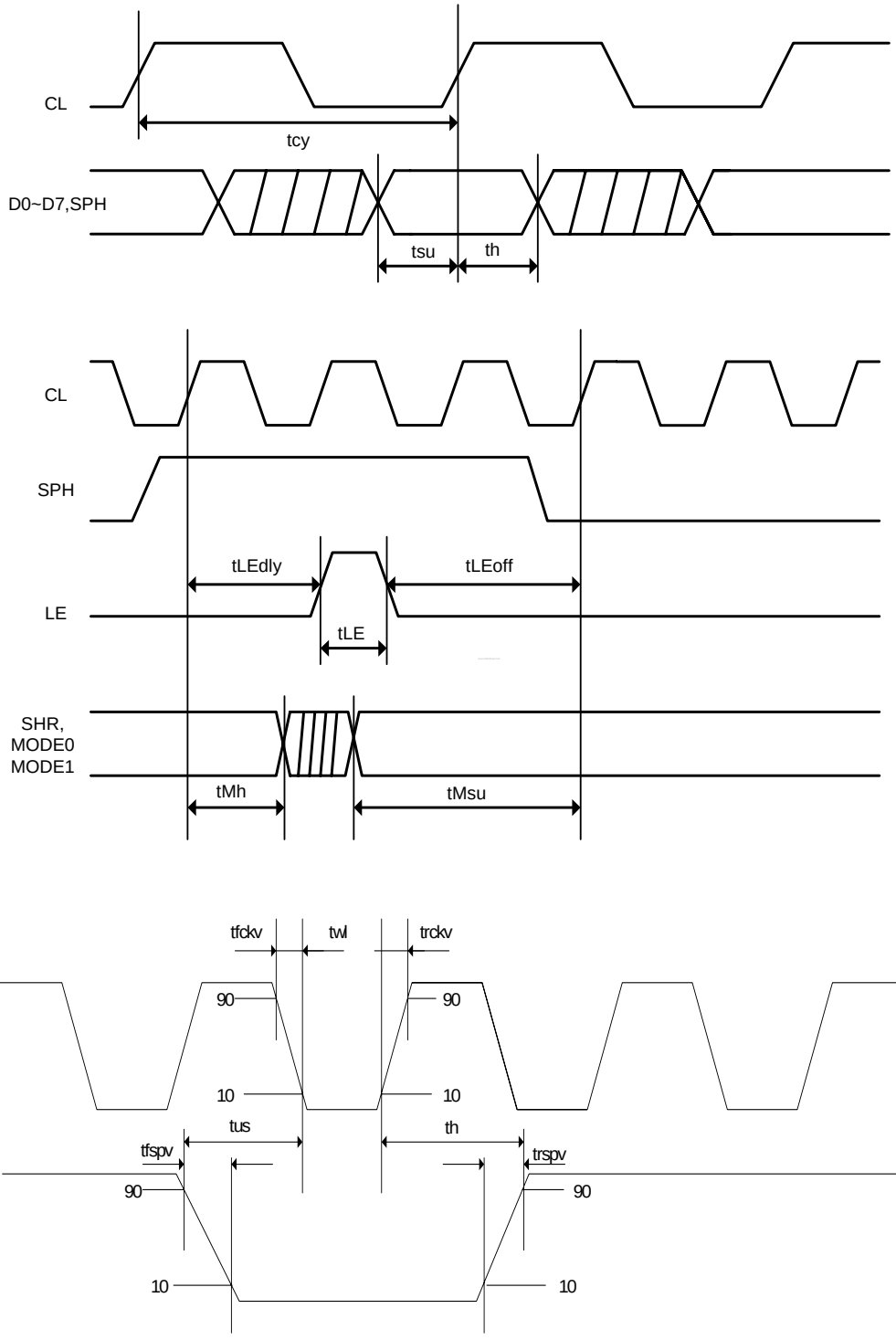
Parameter	Symbol	Conditions	Min	Typ	Max	Unit
Signal	Vss		-	0	-	V
Logic Voltage supply	V_{DD}		2.8	3.3	3.6	V
	I_{VDD}	V_{DD}=3.3	-	6	10	mA
Gate Negative supply	GV_{EE}		-21	-20	-19	V
	GI_{EE}	GV_{EE}=-20	-	1	3	mA
Gate Positive supply	GV_{DD}		21	22	23	V
	GI_{VDD}	GV_{DD}=-22	-	0.5	1	mA
Source Negative supply	V_{NEG}		-15.4	-15	-14.6	V
	I_{NEG}	V_{NEG}=-15	-	10	30	mA
Source Positive supply	V_{POS}		14.6	15	15.4	V
	I_{POS}	V_{POS}=15	-	10	30	mA
Asymmetry source	V_{asym}	V_{POS} + V_{NEG}	-100	0	100	mV
Common voltage	V_{COM}		-2.5	adjusted	-0.5	V
	I_{COM}		-	0.2	-	mA
Maximum power panel	P_{MAX}		-	1,000	1,100	mW
Standby power panel	P_{STBY}		-	-	TBD	mW
Typical power panel	P_{TYP}		-	TBD	-	mW
Operating temperature			0	-	50	℃
Storage temperature			-25	-	70	℃
Image update time		GC (T＜ 10℃)	-	1180	1580	ms
		GC (T≥ 10℃)	-	780	980	ms

3-5. Panel AC characteristics

Table 3.4 AC Characteristics

Parameter	Symbol	Conditions	Min	Typ	Max	Unit	App Pin
Clock frequency	fckv		-	-	200	kHz	CKV
Minimum “L” clock pulse width	twL		0.5	-	-	us	
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		-	-	25	MHz	Figure 3.2
D0..D7, SPH setup time	tsu		4	-	-	ns	
D0...D7,SPH hold time	th		8	-	-	ns	
LE on delay time	tLEdly		40	-	-	ns	
LE high-level pulse width	tLEw		40	-	-	ns	
LE off delay time	tLEoff		40			ns	

Figure 3.2 Timing Characteristics



3-6. Power Sequence

1. VSS ➔ VDD ➔ VNEG ➔ VPOS (Source driver)
2. GVEE ➔ GVDD (Gate driver)

Figure 3.3 Sequence timing chart

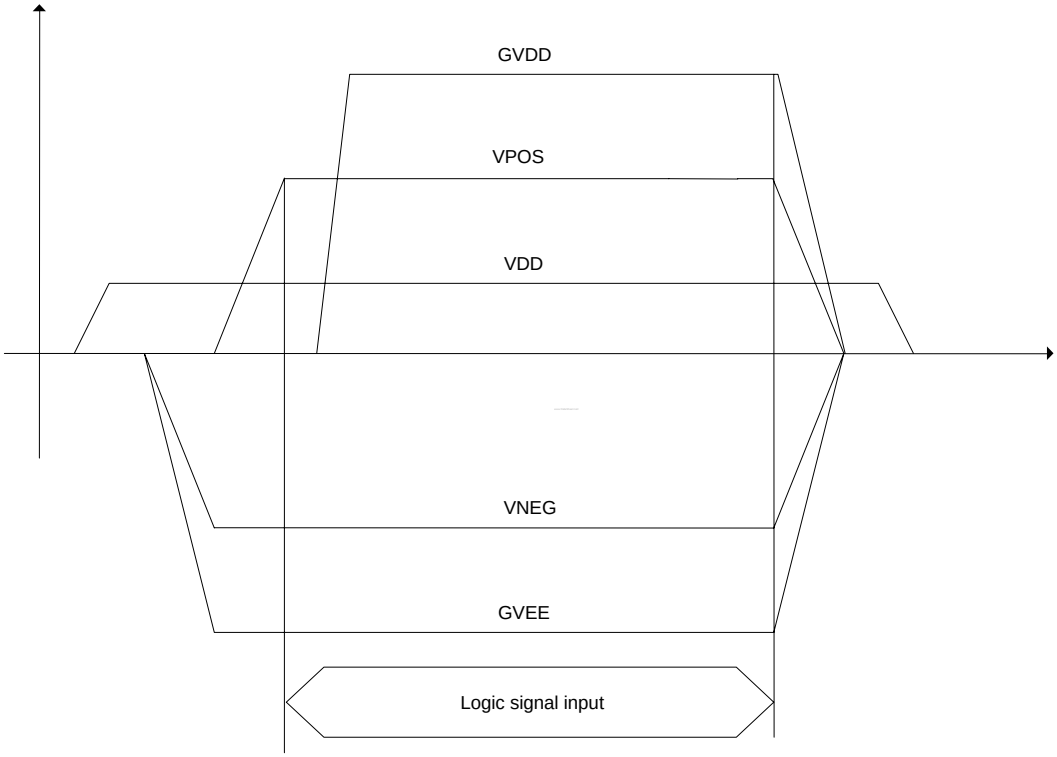
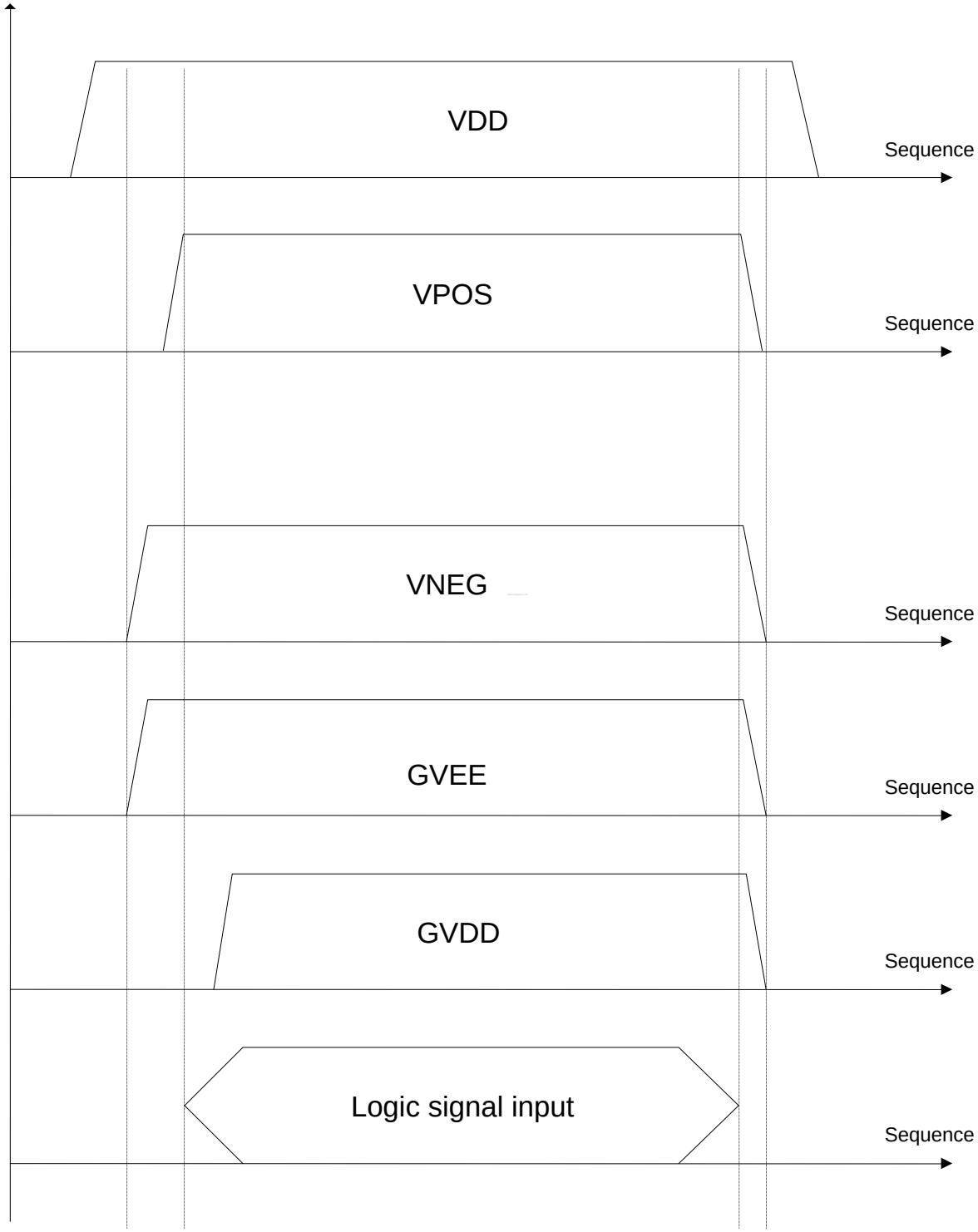


Figure 3.4 Sequence timing chart



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 Φ and θ equal to 0 °.

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

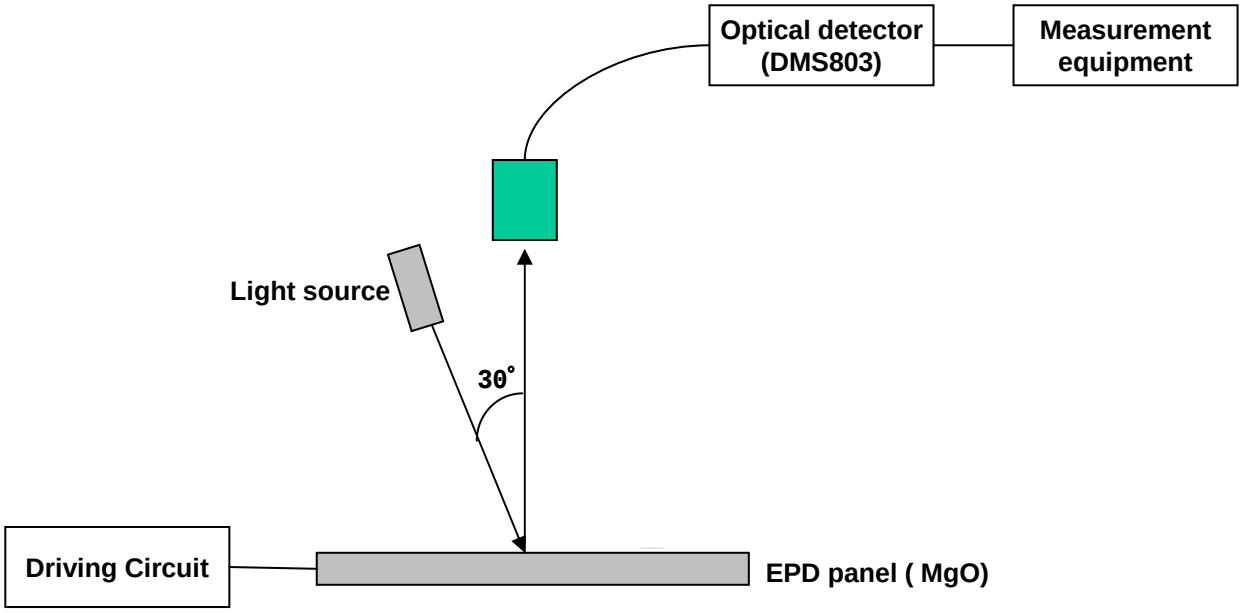


Figure 4.1 Optical characteristic measurement equipment and method

Table 4.1 Optical characteristics (Ta=25 °C, V_{EPD}=±15.0V, f_V=50Hz Dclk=8.3MHz)

Parameter	Symbol	Conditions	Values			Units	Notes
			Min.	Typ.	Max.		
Contrast ratio	CR		6	7			1
Reflectance	R	White	30	35		%	2
Viewing angle : Φ = 0° (3 o'clock) Φ = 90° (12 o'clock) Φ = 180° (9 o'clock) Φ = 270° (6 o'clock)	Θ	CR≥6			 70 70 70 70	 Deg Deg Deg Deg	3
Update time	T	GC (T< 10°C) GC (T≥ 10°C)		1180 780	1580 980	ms ms	

Notes :

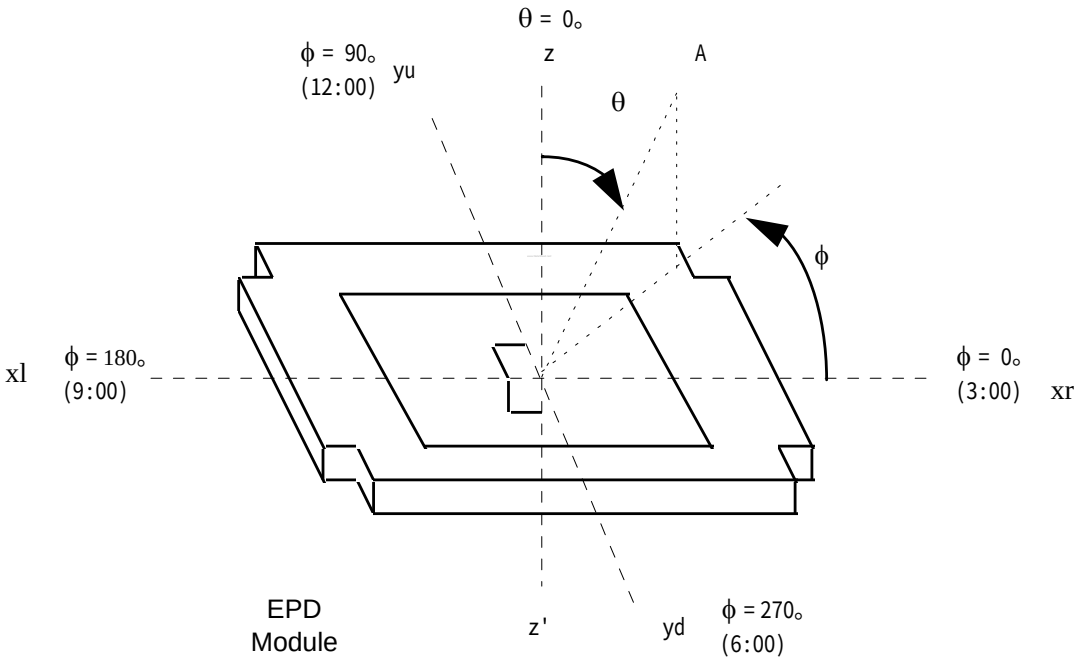
1. **Contrast ratio(CR)** is defined mathematically as :

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

It is measured at center point.

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

3. **Viewing angle(general)** is the angle at which the contrast ratio is greater than 6.



Φ = azimuthal angle, Θ = polar angle

Figure 4.2 Dimension of Viewing angle range

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.

5. Mechanical Characteristics

Table 5.1 provides general mechanical characteristics for the model LB060S01-FD01. Please refer to Figure 5.1 regarding the detailed mechanical drawing of the EPD.

Table 5.1 Mechanical characteristics

Outside dimensions	Horizontal	137.9 ± 0.2mm
	Vertical	104.1 ± 0.2mm
	Thickness	1.081 ± 0.1mm
Active display area	Horizontal	122.4mm
	Vertical	90.6mm

Figure 5.1 Outline Dimension

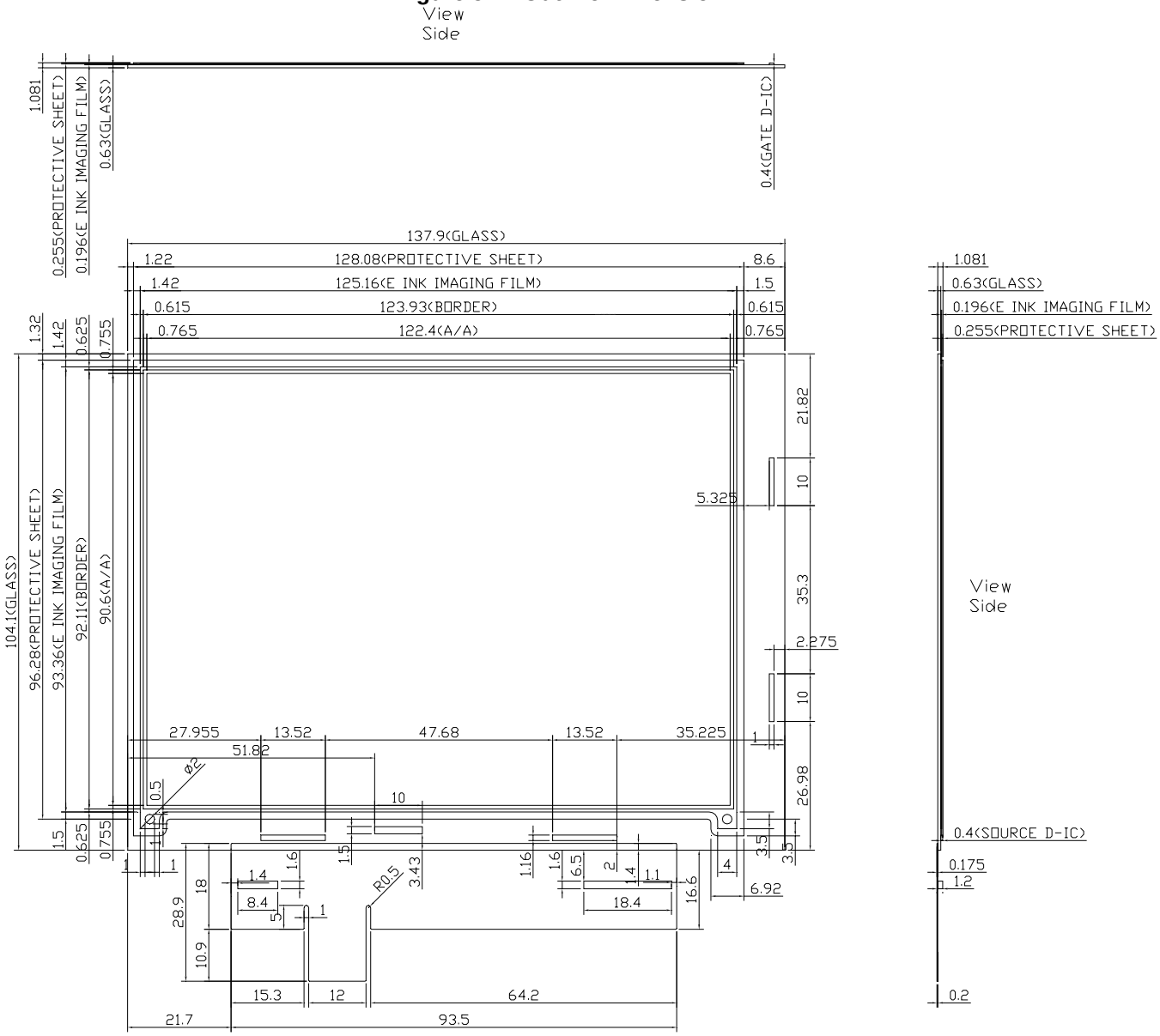
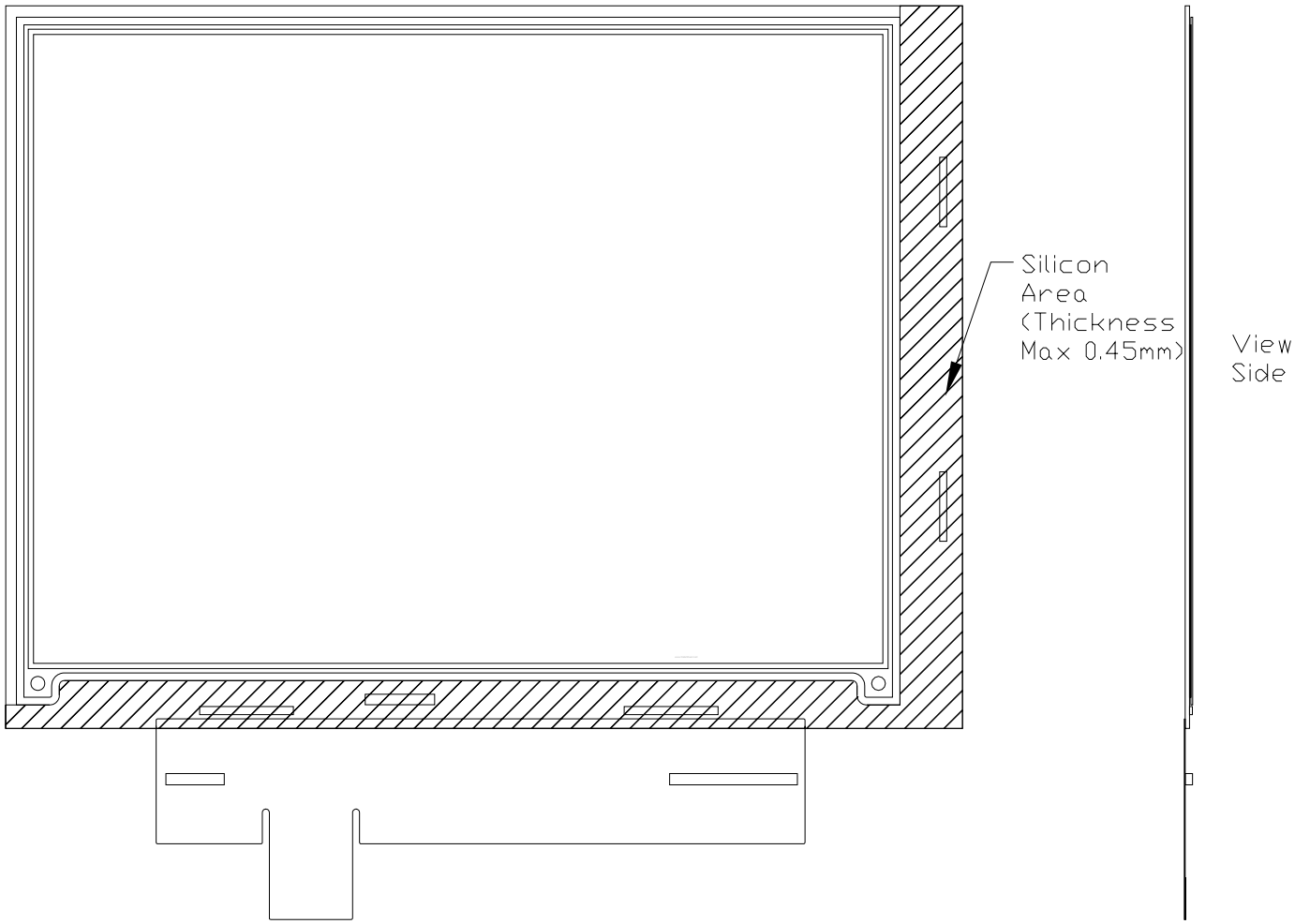


Figure 5.2 Silicon Area and Thickness



6. Reliability

Table 6.1 Environment test condition

No.	Test item	Conditions
1	High temperature storage test	Ta= 70°C 23%RH 240h
2	Low temperature storage test	Ta= -25°C 240h
3	High temperature operation test	Ta= 50°C 30%RH 240h
4	Low temperature operation test	Ta= 0°C 240h
5	High temperature High Humidity Storage test	Ta= 60°C 80%RH 240h
6	High temperature High Humidity Operation test	Ta= 40°C 90%RH 240h
7	Temperature Cycle	1 cycle : [-25°C 30min] – [70°C 30min] : 100cycles
8	UV exposure Resistance	765mW/m^2 40°C 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 : 122cm on concrete surface Drop Sequence : 1 corner 3 edges 6 faces one time each direction
11	Electrostatic Effect (non-operating)	±250V, 0Ω, 200pF
12	Stylus Tapping	POLYACETAL Pen : Top R0.4mm Load : 300gf Speed : 5 times/sec Total : (min.) 5,000 times

{ 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.

7. Packing

7-1. Packing Form

a) Package quantity in one box : 80 pcs

b) Box size : 475mm X 348mm X 230mm.

c) 1Box = 20 (full tray) + 1 (dummy / top tray) = 21 tray

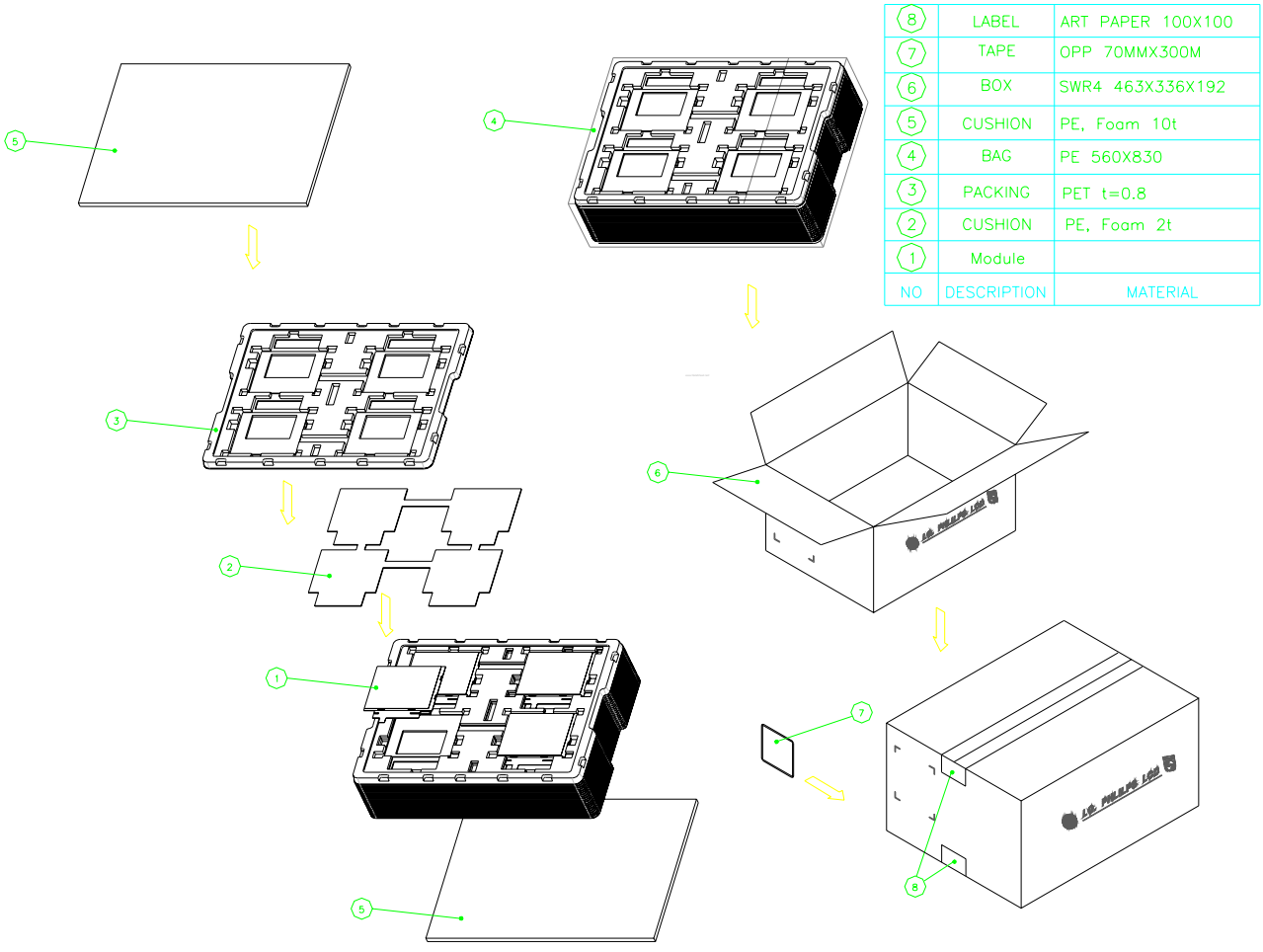


Figure 7.1 Packing Form

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) 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.

8-2. Operating Precautions

(1) The spike noise causes malfunction of circuits. It should be lower than following voltage :
V=±200mV(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.

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) 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.
(3) 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.
(3) 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.