

Product Specification**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 | 16 |
| 6 | DEFECT SPECIFICATIONS | 18 |
| 7 | RELIABILITY | 22 |
| 8 | PACKING | 23 |
| 9 | PRECAUTIONS | 24 |

Product Specification**RECORD OF REVISIONS**

| Revision No | Date | Page | Description |
|--------------------|--------------------|-------------|--------------------|
| Ver 1.0 | Dec.16.2008 | | Final CAS |

Product Specification

1. General Description

LB060S01 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 16 gray level with 4-bit display capability. LB060S01 characteristics are designed to provide high quality for applications such as e-book.

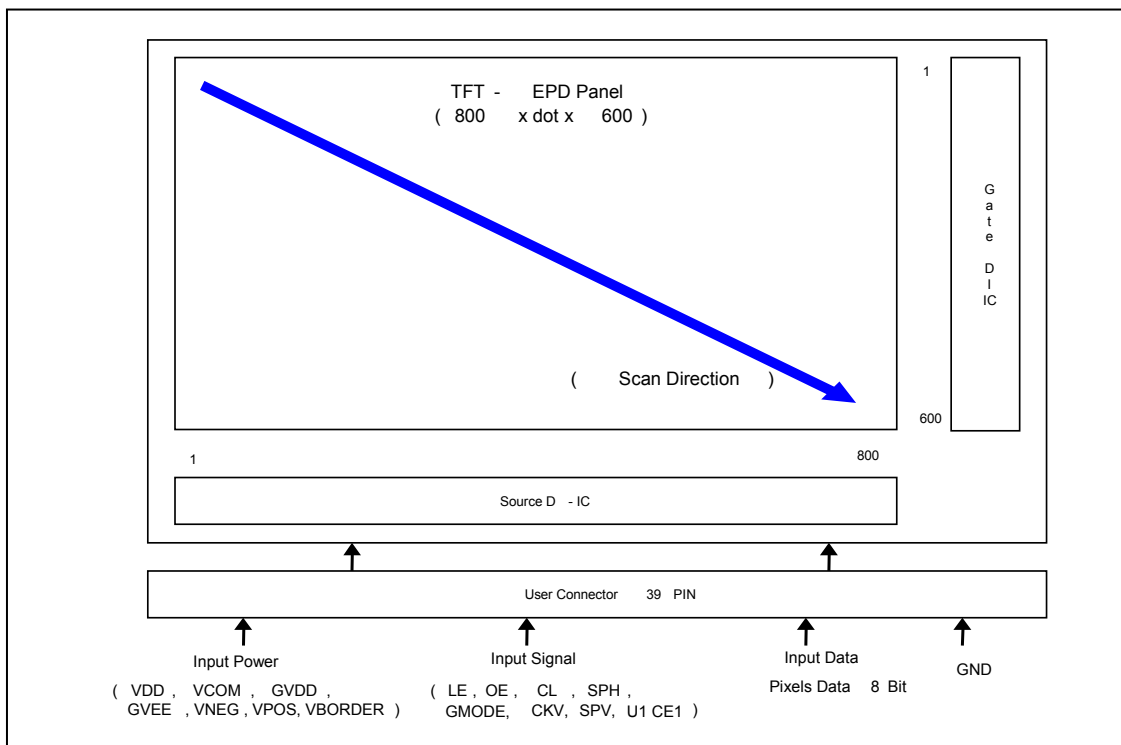


Figure 1.1 Block diagram

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 | 16 Gray Level (Monochrome) |
| Reflectance | 35% (Typ.) |
| Contrast ratio | 7 : 1 (Typ.) |
| 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 |

Product Specification
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 |
| Gate Line High Voltage | GVDD | -0.3 | 45 | V _{dc} | At 25°C, 2 |
| Gate Line Low Voltage | GVEE | -45 | + 0.3 | V _{dc} | At 25°C, 2 |
| Gate Line Drive Voltage | GVDD-GVEE | -0.3 | 50 | V _{dc} | At 25°C, 2 |
| Operating Temperature | T _{OP} | 0 | + 50 | °C | |
| Storage Temperature | T _{ST} | -25 | + 70 | °C | |
| 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

Product Specification

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 | 1,2 |
| Power Supply Input Voltage(2) | GVDD | 15 | 22 | 23 | V | 2 |
| Power Supply Input Voltage(3) | GVEE | -22 | -20 | -15 | V | 2 |
| Power Supply Input Voltage(4) | GVDD-GVEE | 30 | - | 45 | V | 2 |
| 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 | CL | - | - | 25.0 | MHz | VDD=3.3V,1 |

Notes :

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

Product Specification
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 | NC | No Connection |
| 28 | GMODE | 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 |

Product Specification

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 |

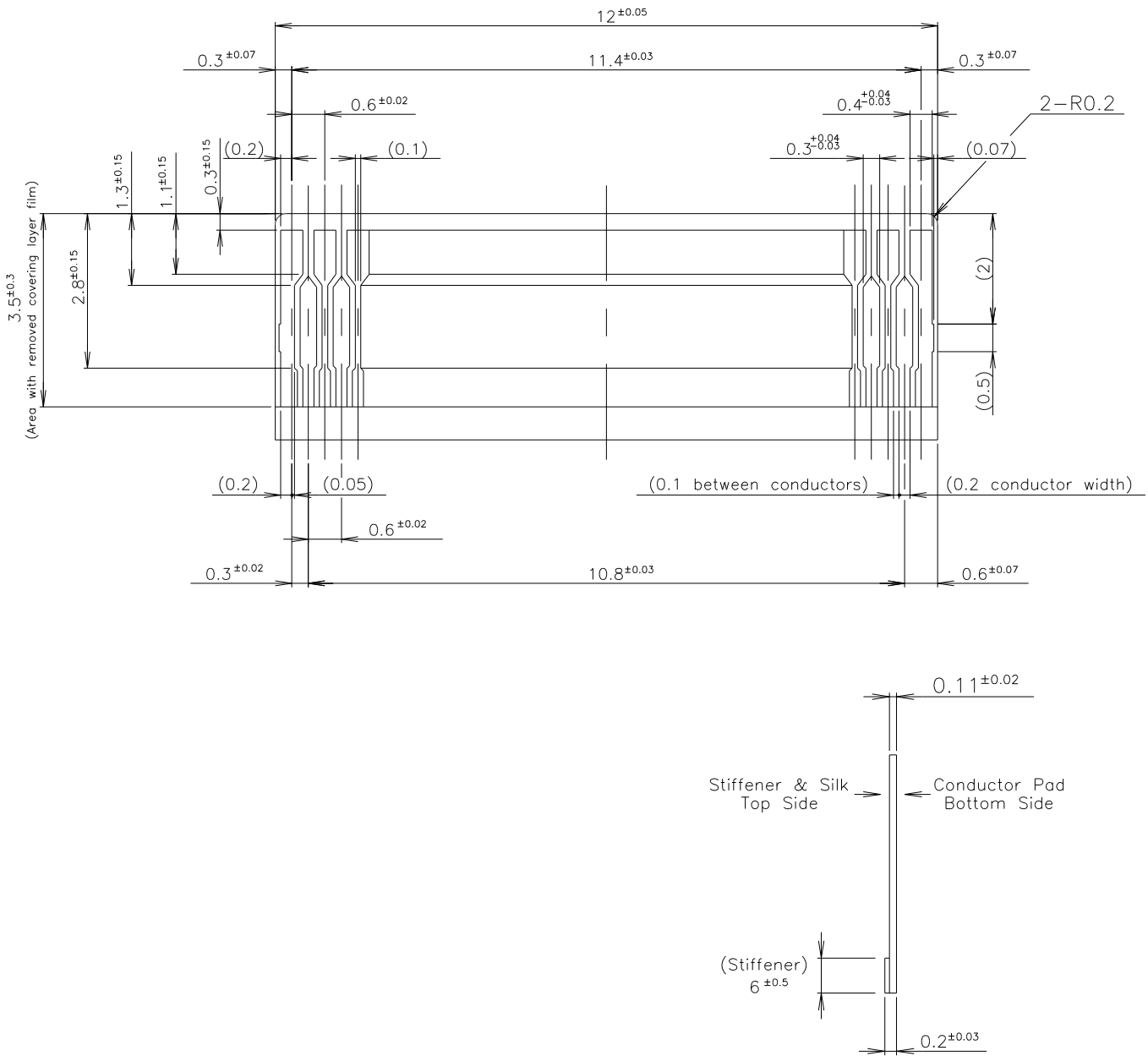


Figure 3.1. Connector Drawings

Product Specification
3-4. Panel DC characteristics
Table 3.3 DC Characteristics

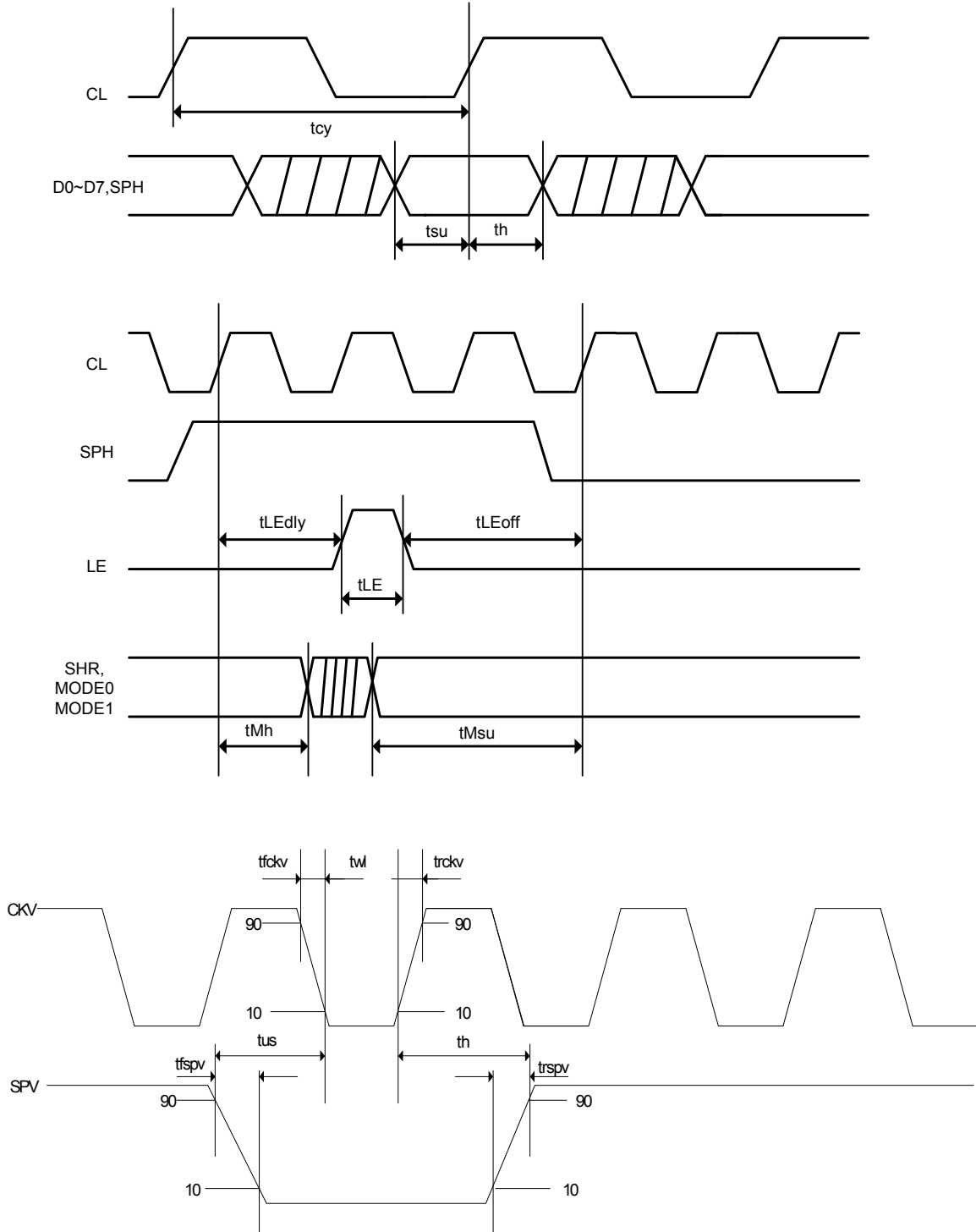
| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|------------------------|-------------------|-------------------------------------|-------|----------|-------|------|
| Signal | V _{SS} | | - | 0 | - | V |
| Logic Voltage supply | V _{DD} | | 2.8 | 3.3 | 3.6 | V |
| | I _{VDD} | V _{DD} =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 | °C |
| Storage temperature | | | -25 | - | 70 | °C |
| Image update time | | GC (T < 10°C) | - | 1180 | 1580 | ms |
| | | GC (T ≥ 10°C) | - | 780 | 980 | ms |

Product Specification
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 | |

Product Specification

Figure 3.2 Timing Characteristics

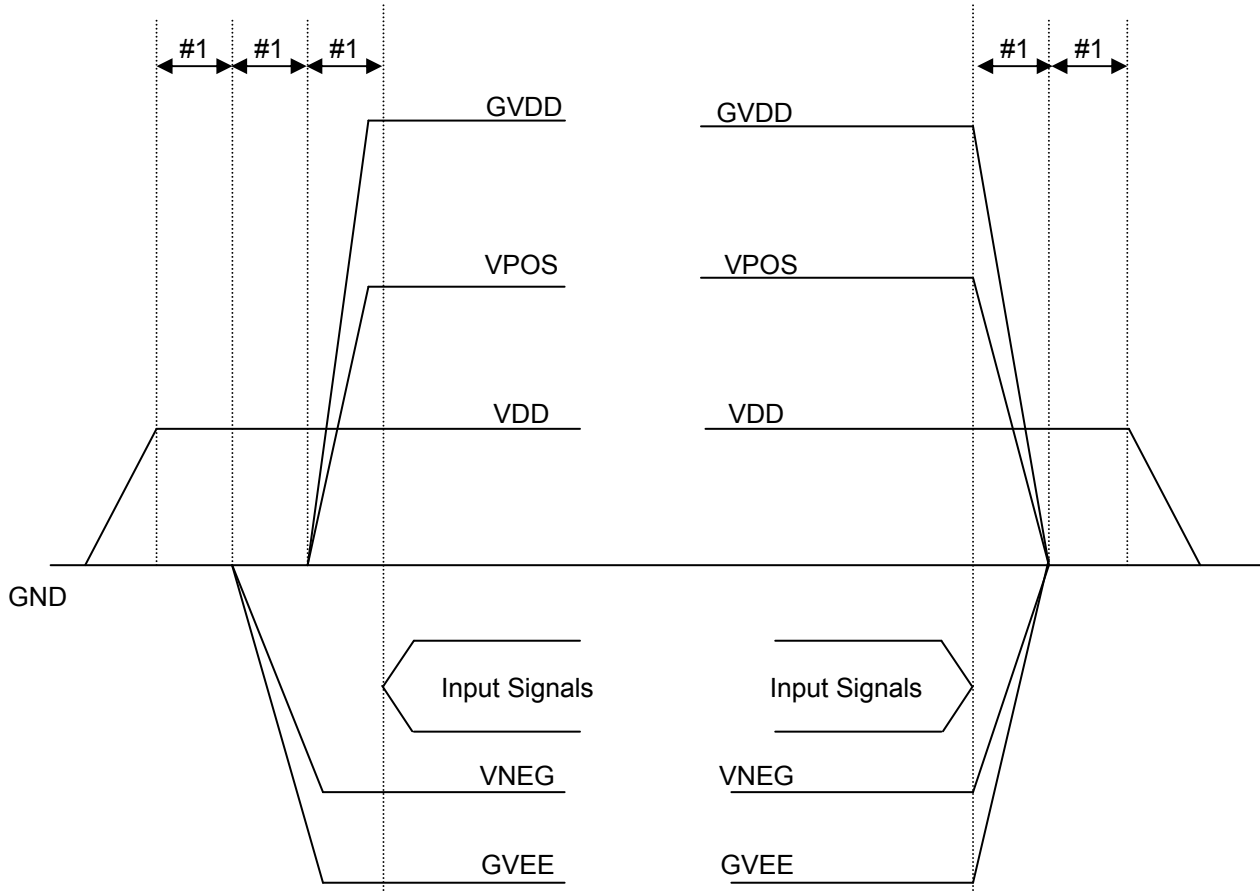


Product Specification

3-6. Power Sequence

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

Figure 3.3 Power Sequence timing chart

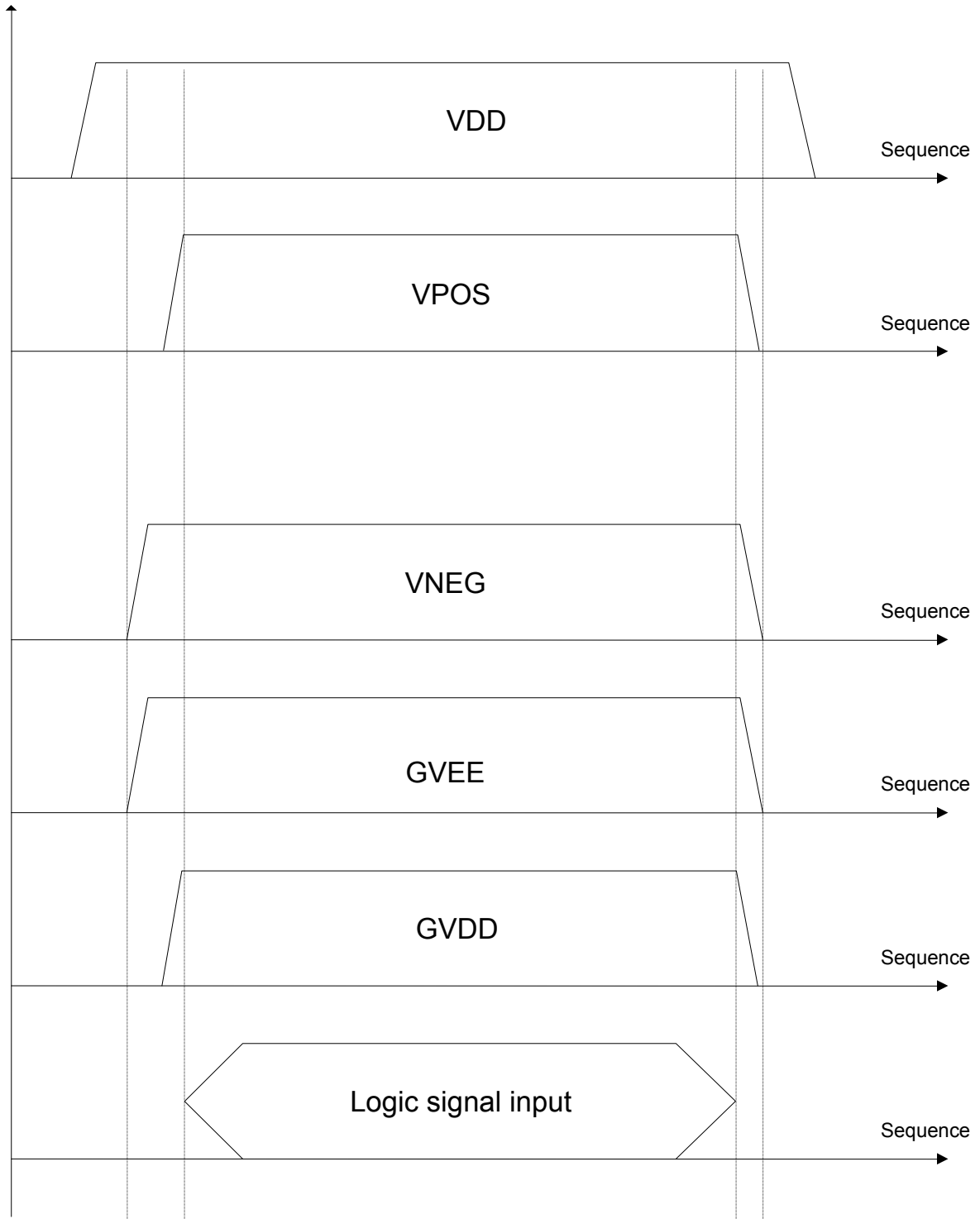


Notes :

- . Min < 5ms ~ #1 ~ Max < 100ms
- . Power on sequence : VDD → VNEG, GVEE → VPOS → Input Signals, GVDD
- . Power off sequence : Input Signals → GVEE, VGDD, VPOS, VNEG → VDD

Product Specification

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 Φ and θ equal to 0 °.

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

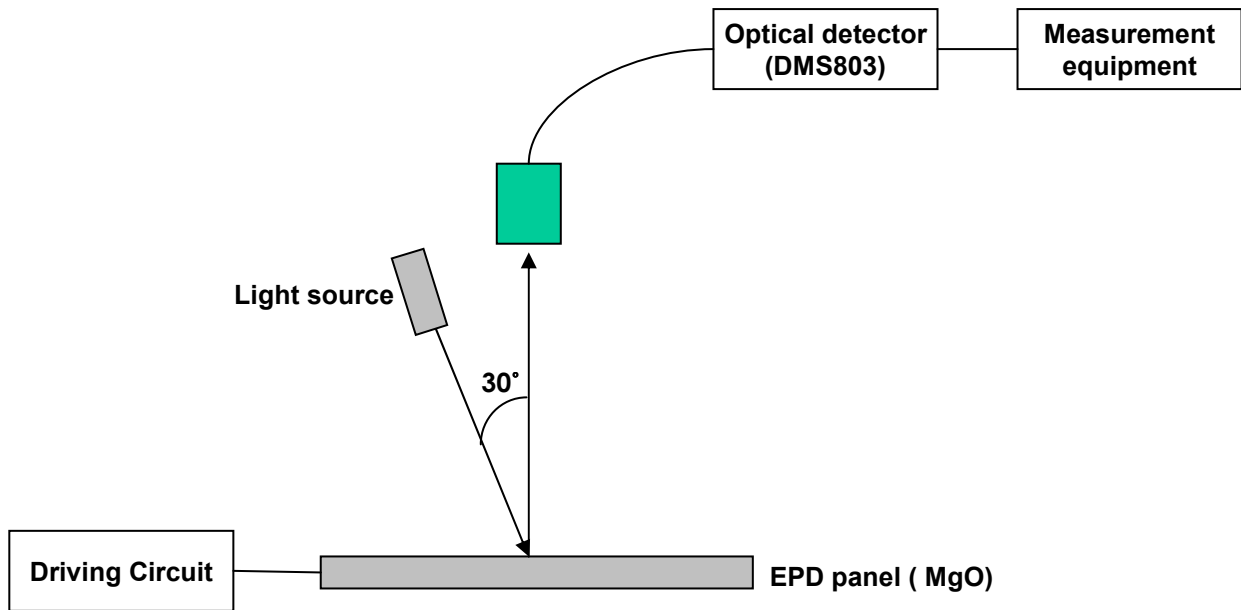


Figure 4.1 Optical characteristic measurement equipment and method

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 |
| Update time | T | GC (T < 10°C) | | 1180 | 1580 | ms | |
| | | GC (T ≥ 10°C) | | 780 | 980 | ms | |

Product Specification

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.

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.

Product Specification

5. Mechanical Characteristics

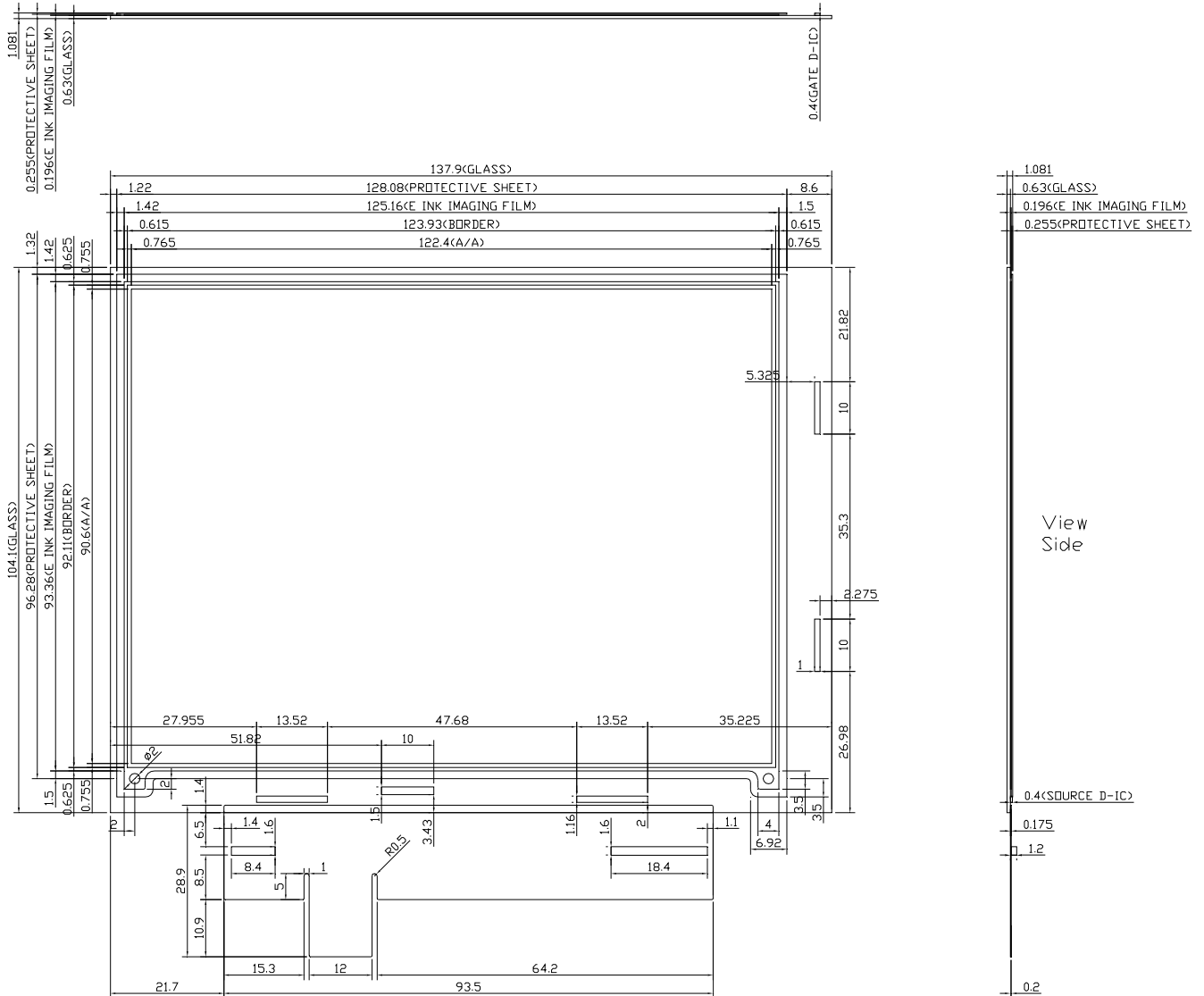
Table 5.1 provides general mechanical characteristics for the model LB060S01. Please refer to Figure 5.1 regarding the detailed mechanical drawing of the EPD.

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 |

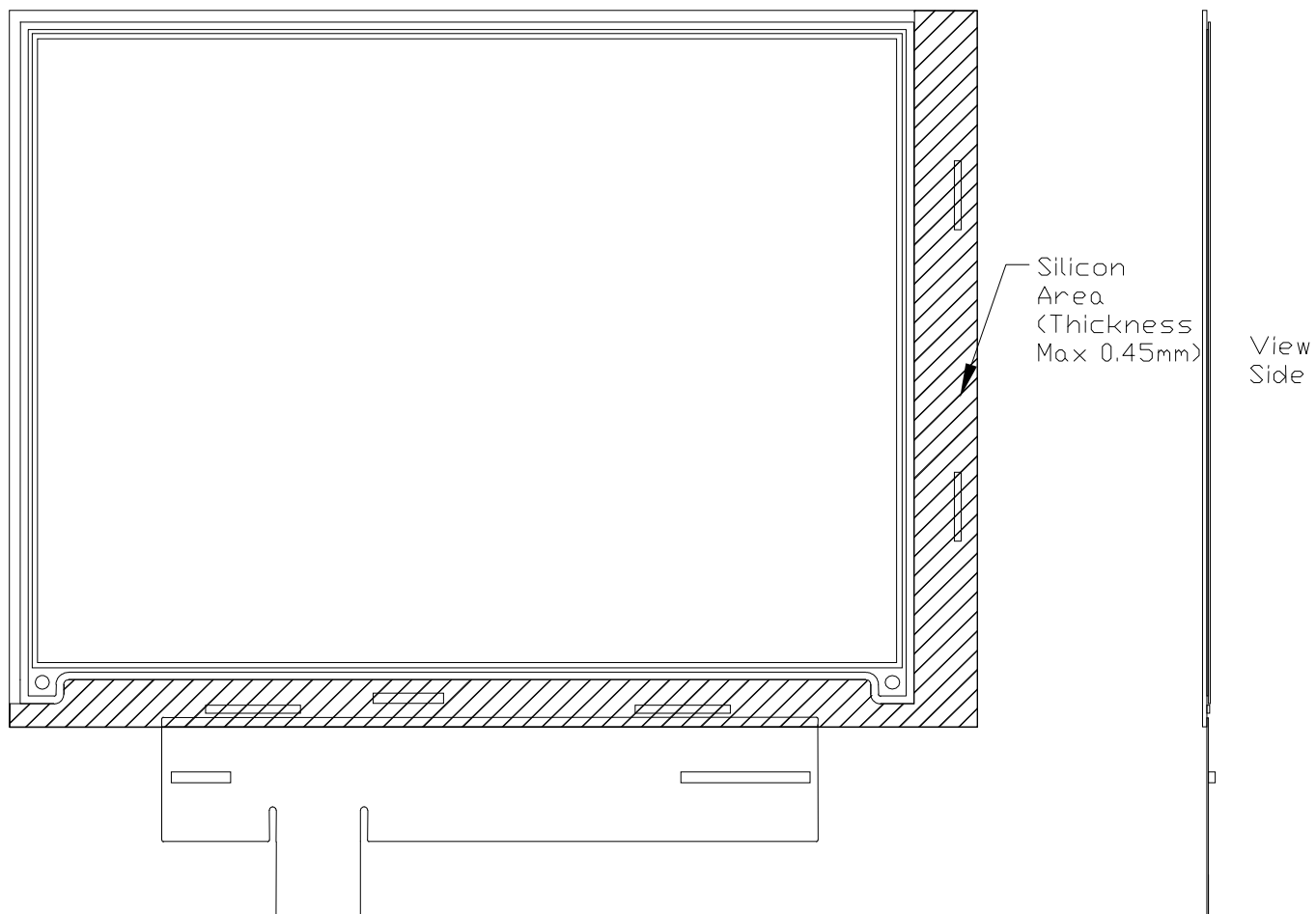
Figure 5.1 Outline Dimension

View
Side



Product Specification

Figure 5.2 Silicon Area and Thickness



Product Specification

6. Defect Specifications

6-1. Inspection Method

6.1.1. Ambient conditions

- a. Temperature : **23±5 °C**
- b. Humidity : **40 ~ 70 %**
- c. Ambient Luminance : **1000lux ~ 2000lux**
- d. Supply Voltage : **Typ. Value described on a specification**

6.1.2. Viewing distance

The distance between the EPD and the inspector's eyes shall be at least 30±10cm.

6.1.3. Viewing Angle

Display Quality : The inspection shall be conducted at $\Theta \Phi = \pm 45 \text{ deg.}$

6-2. Zone Definition

A zone : Active area (defined in 5.)

B zone : Border area (defined in 5.)

C zone : no-active and border area including assemble parts (Out side of B zone)

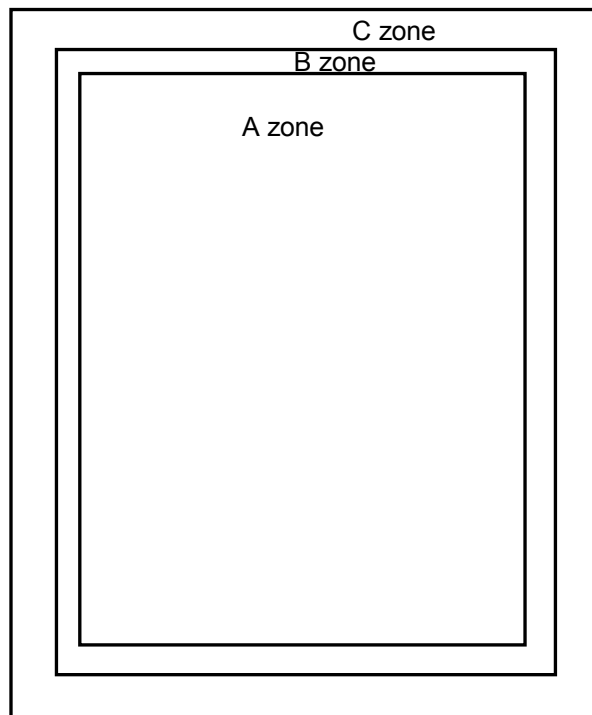


Figure 6.1 Zone Definition

Product Specification

6-3. Cosmetic Criteria

Table 6.1 Cosmetic Criteria

| Item | | Zone | Criteria | | Remarks | |
|-----------------------|--|------|---|-------------------------------------|--------------------|--|
| Name | Cause | | Size (mm) | | | N |
| SPOT | B/W spot, Dent in glass or protection sheet, foreign mat. Swell, Dot defect | A | D < 0.15 0.15 ≤ D < 0.35 0.35 ≤ D | | Ignore ≤ 5 0 | Keep two dot distance more than 10mm |
| | | B | D < 0.35 0.35 < D ≤ 0.5 0.5 < D | | Ignore ≤ 5 0 | |
| | | C | Ignore | | | |
| Watermark | Foreign material of surface | A | 0 | | | |
| | | B | W ≤ D/2(D:border width) L ≤ 2mm | | ≤ 5 | |
| | | C | Ignore | | | |
| Scratch / Particle | Scratch on glass or Particle on protection sheet | A | L ≤ 1.0 1.0 < L ≤ 5.0 5.0 < L | W ≤ 0.1 0.1 < W ≤ 0.5 0.5 < W | Ignore ≤ 5 0 | |
| | | B | L ≤ 1.0 1.0 < L ≤ 10.0 10.0 < L | W ≤ 0.1 0.1 < W ≤ 0.5 0.5 < W | Ignore ≤ 5 0 | |
| | | C | Ignore | | | |
| Air bubble | Air bubble | A | D1,D2 ≤ 0.2 0.2 < D1,D2 ≤ 0.5 0.5 < D1,D2 | | Ignore ≤ 5 0 | |
| | | B | Ignore | | | |
| | | C | Ignore | | | |
| Dimple | | - | (TBD) | | | |

- Definition for L/W and D (major axis)
- All defect of A-Zone shown on above table should be kept the distance more than 15mm each other.

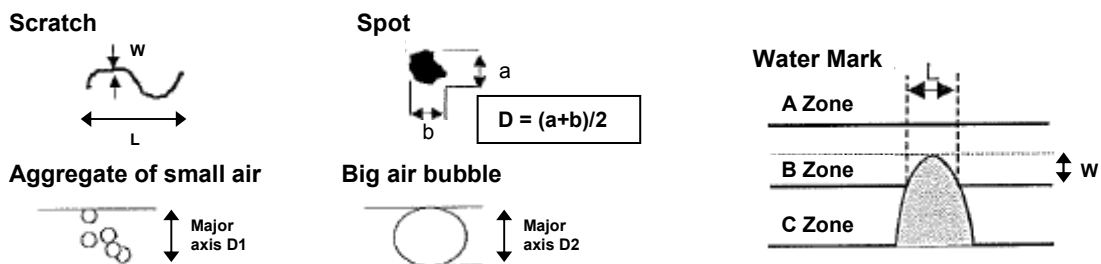


Figure 6.2 Cosmetic Criteria

Product Specification

6-4. Outline Criteria

6-4-1. Curl For Panel

- Method -

1. To prepare the flat standard-base.
2. To keep the flat standard-base on 3 pins, which are same length on the flat base (below figure).
3. The dial-gauge is set on the flat base, and perpendicular to the flat base.
4. To adjust a height of the dial-gauge probe to the same length of other 3 pins.
5. To reset the dial-gauge meter.
6. To exchange the flat standard-base for the product from back side, and measure the highest value "t"

- Criteria -

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

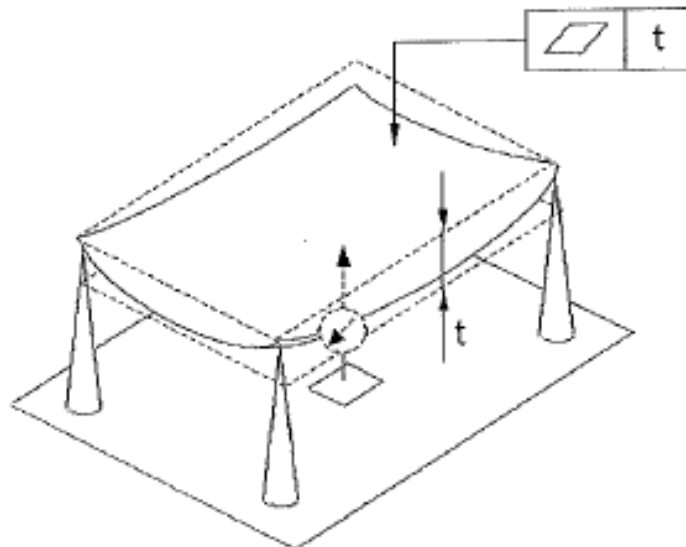


Figure 6.3 Curl of Panel

Product Specification

6-5. Glass Chipping and Crack

Table 6.2 Chipping and Crack

| Item | Size (mm) | | N | Remarks |
|------------------------|-------------------------|---------|------------|--------------------------------|
| Chipping | W ≤ 10 | L ≤ 1.0 | Negligible | Nothing to do with thickness T |
| | | L > 1.0 | None | |
| | W > 10 | | None | |
| Crack (*) | - | | None | V-shaped chipping included |
| Chipping on the corner | Showing on below figure | | | |

* “Crack” means the one which would progress further.

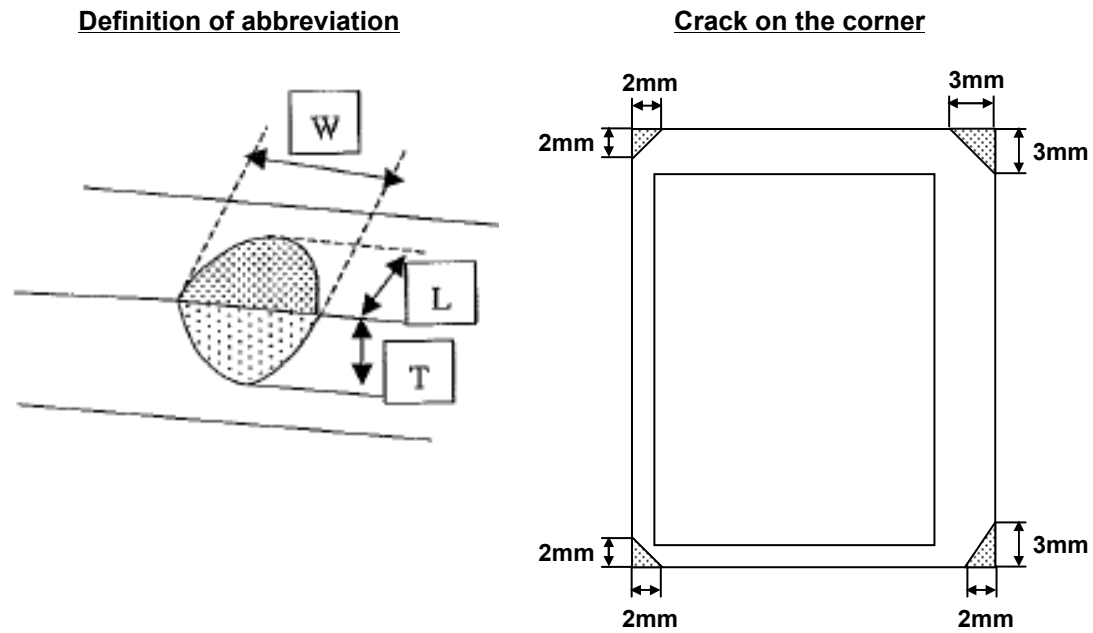


Figure 6.4 Chipping and Crack on the corner

Product Specification
7. Reliability
Table 7.1 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 | 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.

Product Specification

8. Packing

8-1. 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

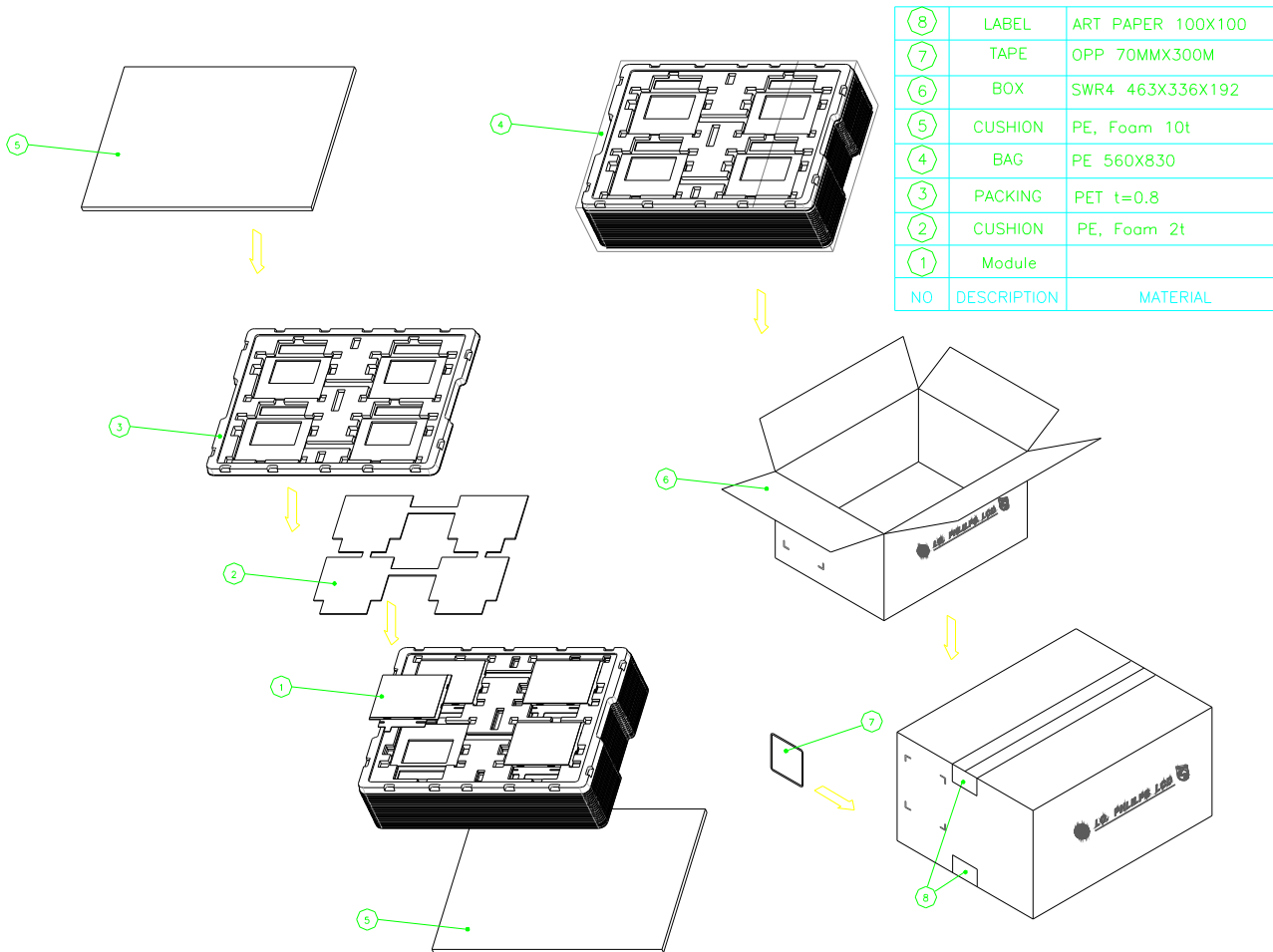


Figure 8.1 Packing Form

Product Specification

9. Precautions

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

9-1. 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.

9-2. 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.

Product Specification**9-3. 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.

9-4. Precautions for Strong Light Exposure

Strong light exposure causes degradation of quality

9-5. 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.

9-6. 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.