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# Product Specifications

<b>Customer</b>	<b>Standard</b>
<b>Description</b>	<b>2.7" TFT EPD Panel</b>
<b>Model Name</b>	<b>EM027BS013</b>
<b>Date</b>	<b>2016/ 03/ 09</b>
<b>Doc. No.</b>	<b>1P053-00</b>
<b>Revision</b>	<b>06</b>

<b>Customer Approval</b>	
<b>Date</b>	
The above signature represents that the product specifications, testing regulation, and warranty in the specifications are accepted	

	<b>Design Engineering</b>		
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## Revision History

Version	Date	Page (New)	Section	Description
Ver.01	2014/01/03	All	All	Product specification first issued.
Ver.02	2014/01/24	09	1.4	Surface Treatment modify to Anti-Glare.
		10	1.5	Modify thickness.
		17	5.1	Modify pin No.8 function of Terminal Pin Assignment.
		19	5.2	Modify note:(2) of EPD Reference Circuit.
		20	6.2.1	Modify Refresh time and White Chromaticity
Ver.03	2014/07/14	7	-	Delete "PCS" of Glossary of Acronyms
		8	1.2	Add wide temperature support of features
		9	1.4	Modify Table 1-1 FPL model name
		10	1.5	Add HRS TF31-40S of Table 1-3
		12	2.1	Modify Table 2-1 and Figure 2-1
		13	2.2	Modify Table 2-2: add Ultra low temp. -25°C
		20	6.2	Modify refresh time of Table 6-2
		26	8	Precautions add No.15
		28	9	Modify Definition of Labels Figure-1 & Figure -2
Ver.04	2014/08/19	12	2.1	Modify Table 2-1 add Note(3) Modify Note(1)-(c) to No condensation and no frost. Add Note(3)
		13	2.2	Modify test condition Modify Note(1)
		26	8	Precautions :Modify No.(16)
Ver.05	2016/01/29	1 and 2	Cover page	Modified company address.
		10	1.4	Table 1-1, Add driver IC.
		11	1.5	Table 1-2, Weight.
		12	1.9	Figure 1-1 EPD Drawing, Added silicon glue.
		13	2.1	Added Note(1), (d)
		13	2.1	Deleted Figure 2-1 Operating Range of Relative Humidity and Temperature.
		18	5.1	Table 5-1 Terminal Pin Assignment, Modified No.8, 10 and 11.
		20	5.2	Figure 5-1 EPD Reference Circuit, Modified Pin 8, 10 and 11.
		26	7	Modified Figure 7-1 Packing Diagram
28	8	Precautions, Added No. (23).		

Version	Date	Page (New)	Section	Description
Ver.05	2016/01/29	29	9	Modified Figure 9-2 Definition of Model Labels.
		30	9	Modified Figure 9-3 Carton Label.
Ver.06	2016/03/09	25,26	7	Modify Figure 7-1, carton label position & pallet packing way
		29-30	9	Modify Figure 9-1, 9-2 drawing Figure 9-3 carton label size change to 100* 100mm



## Glossary of Acronyms

EPD	Electrophoretic Display (e-Paper Display)
EPD Panel	EPD
EPD Module	EPD with TCon board
TCon	Timing Controller
TFT	Thin Film Transistor
MCU	Microcontroller Unit
FPC	Flexible Printed Circuit
FPL	Front Plane Laminate
SPI	Serial Peripheral Interface
COG	Chip on Glass
PDI	Pervasive Displays Incorporated

## 1 General Description

### 1.1 Overview

This is a 2.7" a-Si, active matrix TFT, Electronic Paper Display (EPD) panel. The panel has such high resolution (117 dpi) that it is able to easily display fine patterns. Due to its bi-stable nature, the EPD panel requires very little power to update and needs no power to maintain an image.

### 1.2 Features

- a-Si TFT active matrix Electronic Paper Display(EPD)
- Resolution: 264 x 176
- Ultra low power consumption
- Super Wide Viewing Angle - near 180°
- Extra thin & light
- SPI interface
- RoHS compliant
- Wide temperature support

### 1.3 Applications

- Electronic shelf label (ESL)
- Reusable container
- Badge

## 1.4 General Specifications

**Table 1-1 General Specification**

Item	Specification	Unit	Note
Outline Dimension	70.42(H) x 45.80(V) x 0.90(T)	mm	(1)
Active Area	57.288(H) x 38.192(V)	mm	
Driver Element	a-Si TFT active matrix	-	
FPL	Aurora M A	-	
Pixel Number	264 x 176	pixel	
Pixel Pitch	0.217 x 0.217 (117dpi)	mm	
Pixel Arrangement	Vertical stripe	-	
Display Colors	Black/White	-	
Surface Treatment	Anti-Glare	-	
Driver IC	G2		

Note (1): Not including the FPC.

## 1.5 Mechanical Specifications

**Table 1-2 Mechanical Specification**

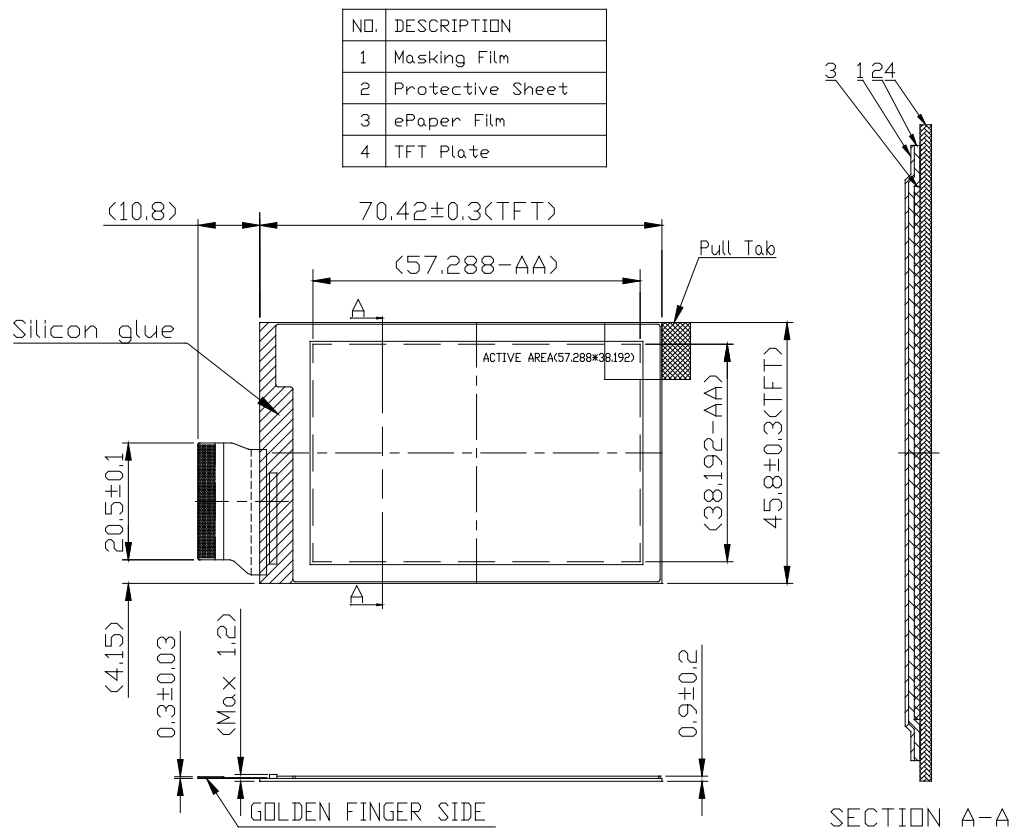
Item		Min.	Typ.	Max.	Unit	Note
Glass Size	Horizontal(H)	70.12	70.42	70.72	mm	
	Vertical(V)	45.50	45.80	46.10	mm	
	Thickness(T)	0.8	1.0	1.2	mm	(1)
Weight		-	-	5.2	6.3	g

Note (1): Not including the Masking Film.

**Table 1-3 FPC Specification**

Item	Pin numbers	Pitch (mm)	Connector	Note
Golden Finger	40	0.5	STARCONN 089H40 or HRS TF31-40S or Compatible	

**Figure 1-1 EPD Drawing**



**General tolerance: ± 0.3mm**

## 2 Absolute Maximum Ratings

### 2.1 Absolute Ratings of Environment

**Table 2-1 Absolute Ratings of Environment**

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Storage Temperature	T <sub>ST</sub>	-20	+ 60	°C	(1), (3)
Operating Ambient Temperature	T <sub>OP</sub>	-20	+ 50	°C	(1), (2), (3)

Note (1):

- (a) 90 %RH Max. ( $T_a \leq 40 \text{ }^\circ\text{C}$ ), where  $T_a$  is ambient temperature.
- (b) Wet-bulb temperature should be 39 °C Max. ( $T_a > 40 \text{ }^\circ\text{C}$ ).
- (c) No condensation and no frost.
- (d) If users like to put the EPD under some extreme condition (e.g. + 60 °C, < 30% RH), the lifetime of EPD may be shorter than warranty lifetime. Please contact PDi sales respective for details.

Note (2): The temperature of panel display surface area should be -20 °C Min. and 50 °C Max. Refresh time depends on operating temperature.

Note (3): In order to keep good performance of EPD, please refer to precaution for storage condition.

## 2.2 Reliability Test Item

**Table 2-2 Reliability Test Items**

Item	Test Condition	Remark
High Temperature Operation	50 °C / 30 %RH for 240h	(1) (2)
Low Temperature Operation	0 °C for 240h	(1) (2)
Ultra Low Temperature Operation	-20 °C for 240h	(1) (2)
High Temperature/Humidity Operation	40 °C / 90 %RH for 168h	(1) (2)
High Temperature Storage	60 °C / 26 %RH for 240h	(1)(2)(3)
Low Temperature Storage	-20 °C for 240h	(1)(2)(3)
High Temperature/Humidity Storage	50 °C / 80 %RH for 168h	(1)(2)(3)
Thermal Cycles ( Non-operation )	1 Cycle:-20°C/30min → 60°C/30min, for 100 Cycles	(1)(2)(3)
Package Drop Test	Drop from 97cm. ( ISTA ) 1 corner, 3 edges, 6 sides. One drop for each.	(1)(2)(3)
Package Random Vibration Test	1.15Grms, 1Hz ~ 200Hz. ( ISTA )	(1)(2)(3)

Note (1): No condensation and no frost during test. End of test, function, mechanical, and optical shall be satisfied.

Note (2): The test result and judgment are based on PDI's 1bit driving waveform, driving fixture and driving system.

Note (3): Stay white pattern for storage and non-operation test.

### 3 Electrical Characteristics

#### 3.1 Absolute Maximum Ratings of Panel

**Table 3-1 Absolute Maximum Ratings of Panel**

Parameter	Symbol	Value		Unit	Note
		Min	Max		
Digital Power	V <sub>DD</sub>	-0.3	6.0	V	
Analog Power	V <sub>CC</sub>	-0.3	6.0	V	
Ground	V <sub>SS</sub>	-		-	Connect V <sub>SS</sub> to Ground

T<sub>a</sub> = 25 ± 2 °C

#### 3.2 Recommended Operation Conditions of Panel

**Table 3-2 Recommended Operation Conditions of Panel**

Parameter	Symbol	Value			Unit	Note
		Min	Typ	Max		
Digital Power	V <sub>DD</sub>	2.3	3.0	3.6	V	
Analog Power	V <sub>CC</sub>	2.3	3.0	3.6	V	
Input Voltage	High	V <sub>IH</sub>	0.8V <sub>DD</sub>	-	V <sub>DD</sub>	/CS, ID, SCLK, SI, /RESET
	Low	V <sub>IL</sub>	V <sub>SS</sub>	-	0.2V <sub>DD</sub>	
Output Voltage	High	V <sub>OH</sub>	0.8V <sub>DD</sub>	-	V <sub>DD</sub>	I <sub>OH</sub> = 0.5mA, SO, BUSY
	Low	V <sub>OL</sub>	V <sub>SS</sub>	-	0.2V <sub>DD</sub>	I <sub>OL</sub> = -0.5mA, SO, BUSY
Input Leakage Current	High	I <sub>IH</sub>	-	-	2.0	uA
	Low	I <sub>IL</sub>	-	-	-2.0	uA
Input Current	I <sub>DD</sub> + I <sub>CC</sub>	-	5	10	mA	(1),(2),(3)



DC/DC Inrush Current	$I_{PEAK}$	-	30	90	mA	(1),(2),(3)
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$T_a = 25 \pm 2 \text{ } ^\circ\text{C}$

Note (1):

**Figure 3-1 Test Pattern of Panel**

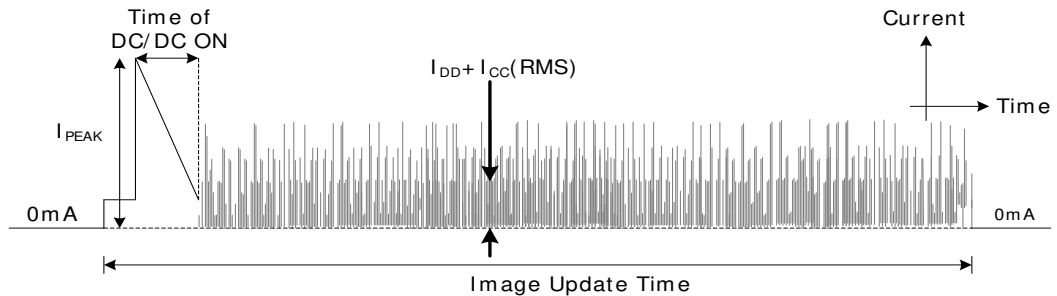


These currents are tested with PDI test jig.

Note (2):

$V_{DD} = V_{CC} = 3.0\text{V}$

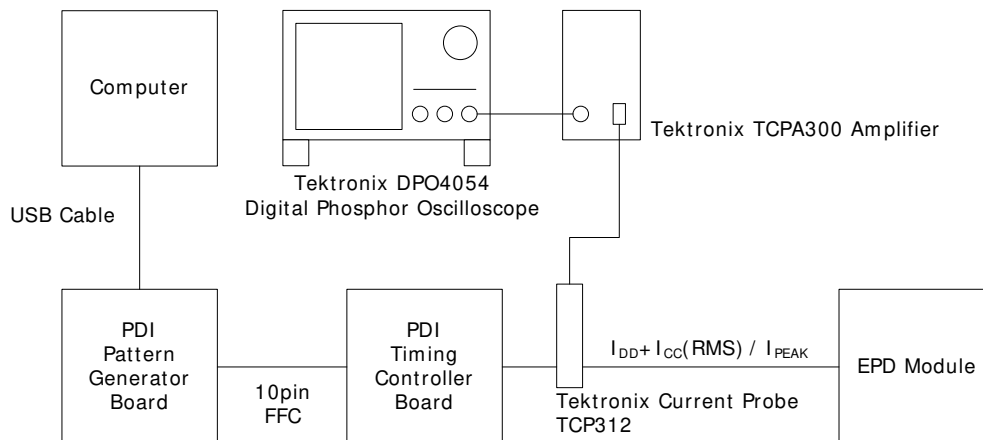
**Figure 3-2 Image Update Current Profile**



The “Time of DC/DC ON” which contains the some current peak of  $V_{GH}/V_{DH}/V_{GL}/V_{DL}/V_{COM}$ .

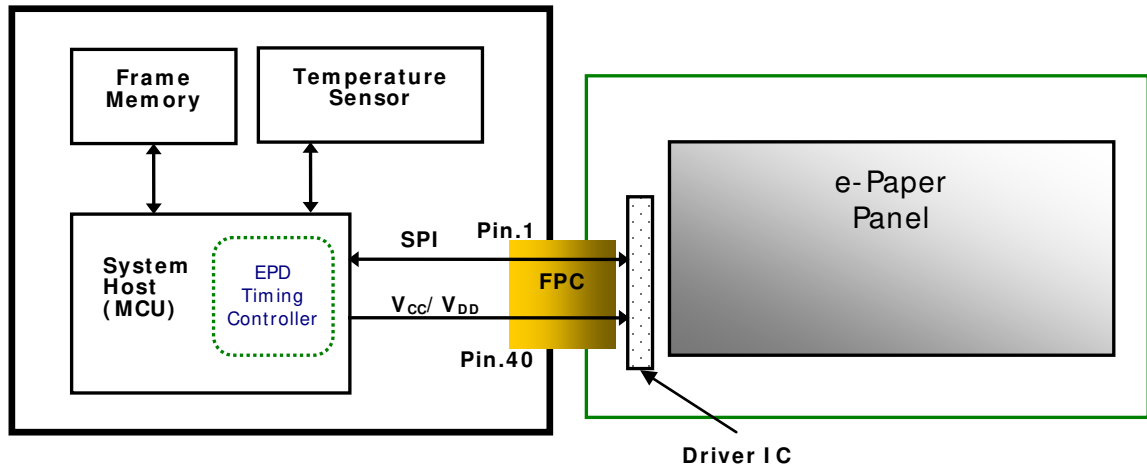
Note (3):

**Figure 3-3 Current Measurement**



## 4 Application Circuit Block Diagram

Figure 4-1 Application Circuit Block Diagram



## 5 Terminal Pin Assignment & Reference Circuit

### 5.1 Terminal Pin Assignment

**Table 5-1 Terminal Pin Assignment**

No.	Signal	Type	Connected to	Function
1	/CS	I	Tcon	Chip Select. Low enable
2	BUSY	O	Tcon	When BUSY = HIGH, EPD stays in busy state that EPD ignores any input data from SPI
3	ID	I	Ground	Connect ID to ground
4	SCLK	I	Tcon	Clock for SPI
5	SI	I	Tcon	Serial input from Timing Controller to EPD
6	SO	O	Tcon	Serial output from EPD to Timing Controller
7	/RESET	I	Tcon	Reset signal. Low enable
8	PWNON	-	NC	For 2.7" is keep open.
9	V <sub>CL</sub>	C	Capacitor	-
10	C42P	-	NC	Not Connected
11	C42M	-		
12	C41P	C	Charge-Pump Capacitor	-
13	C41M	C		-
14	C31M	C	Charge-Pump Capacitor	-
15	C31P	C		-
16	C21M	C	Charge-Pump Capacitor	-
17	C21P	C		-
18	C16M	C	Charge-Pump Capacitor	-
19	C16P	C		-
20	C15M	C	Charge-Pump Capacitor	-
21	C15P	C		-

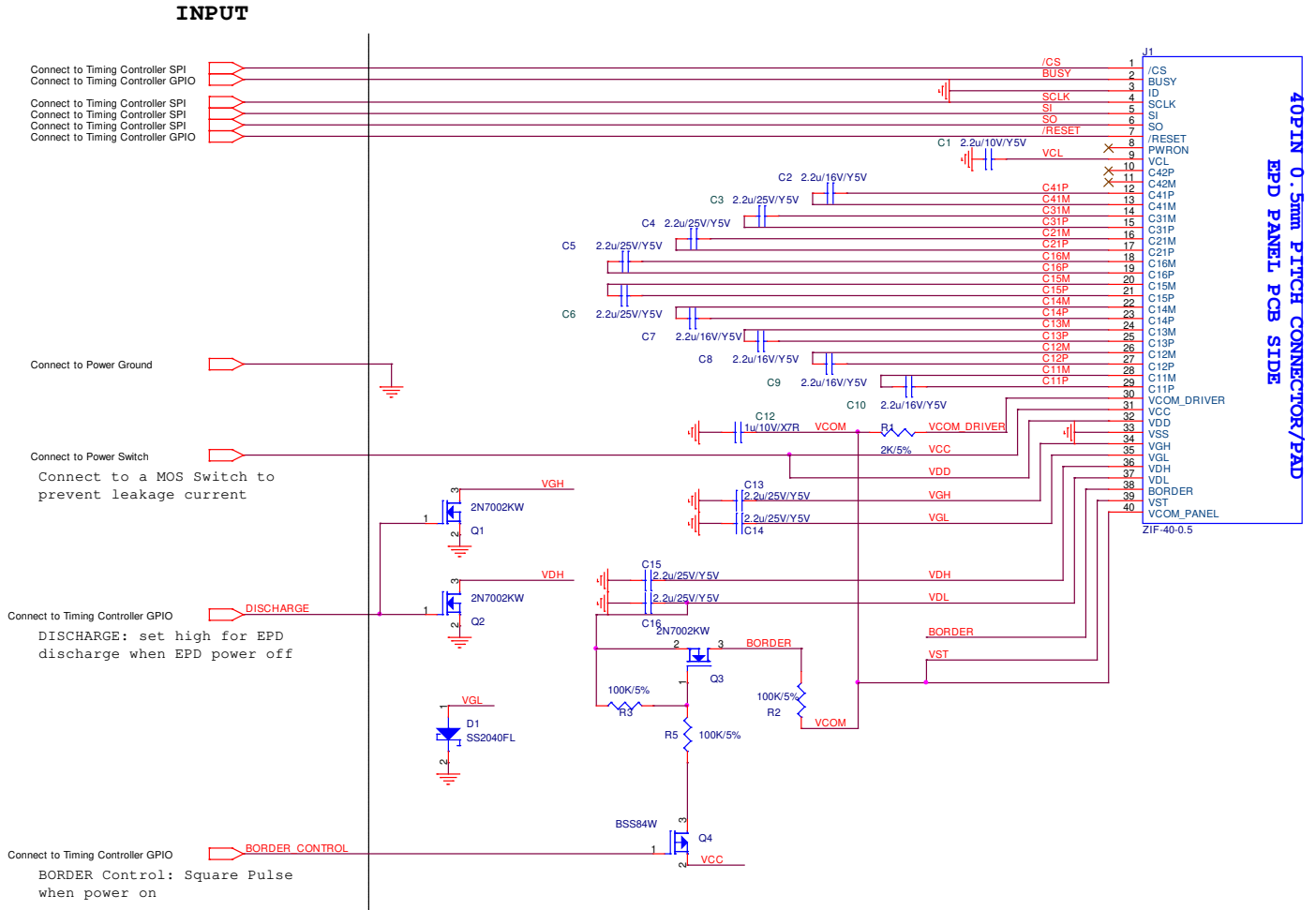
No.	Signal	Type	Connected to	Function
22	C14M	C	Charge-Pump Capacitor	-
23	C14P	C		-
24	C13M	C	Charge-Pump Capacitor	-
25	C13P	C		-
26	C12M	C	Charge-Pump Capacitor	-
27	C12P	C		-
28	C11M	C	Charge-Pump Capacitor	-
29	C11P	C		-
30	V <sub>COM_DRIVER</sub>	RC	Resistor & Capacitor	The signal duty cycle can drive VCOM voltage from source driver IC
31	V <sub>CC</sub>	P	V <sub>CC</sub>	Power supply for analog part of source driver
32	V <sub>DD</sub>	P	V <sub>DD</sub>	Power supply for digital part of source driver
33	V <sub>SS</sub>	P	Ground	-
34	V <sub>GH</sub>	C	Capacitor	-
35	V <sub>GL</sub>	C	Capacitor	-
36	V <sub>DH</sub>	C	Capacitor	-
37	V <sub>DL</sub>	C	Capacitor	-
38	BORDER	I	-	Connect to V <sub>DL</sub> via control circuit for white frame border
39	V <sub>ST</sub>	P	V <sub>COM_PANEL</sub>	-
40	V <sub>COM_PANEL</sub>	C	Capacitor	V <sub>COM</sub> to panel

Note:

Type: I: Input  
 O: Output  
 C: Capacitor  
 RC: Resistor and Capacitor  
 P: Power

## 5.2 Reference Circuit

Figure 5-1 EPD Reference Circuit



Note: (1)  $V_{DD}$  and  $V_{CC}$  must be discharged promptly after power off.

## 6 Optical Characteristics

### 6.1 Test Conditions

**Table 6-1 Optical Measurement Conditions**

Item	Symbol	Value	Unit
Ambient Temperature	Ta	25±2	°C
Ambient Humidity	Ha	50±10	%RH
Supply Voltage	V <sub>CC</sub> & V <sub>DD</sub>	3.0	V

Note: Measure optical at RT (Room Temperature) after pattern update at 25 °C.

### 6.2 Optical Specifications

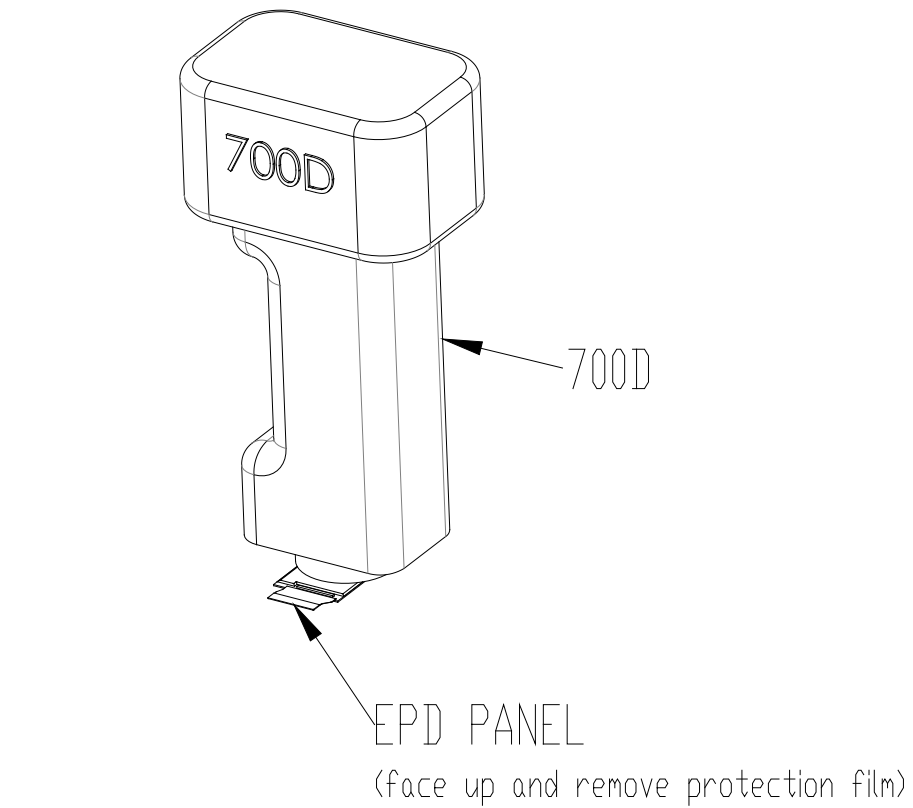
#### 6.2.1 Optical

**Table 6-2 Optical Measurement with D65 light source**

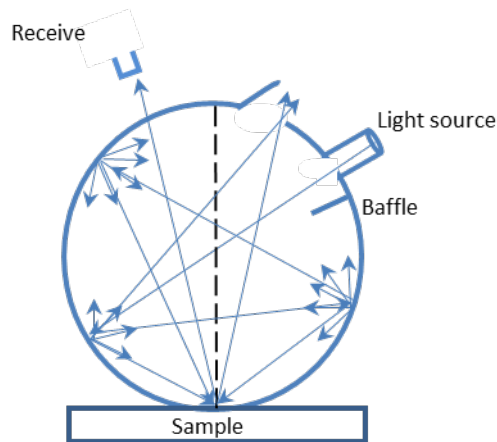
Item	Symbol	Rating			Unit	Note
		Min.	Typ.	Max.		
Contrast ratio	CR	-	10:1	-	-	$\theta_x=\theta_y=0$ (1),(2),(3),(4)
Refresh time	Tr	-	5	-	sec	(3)
White Chromaticity	Wx	-	0.308	-	-	$\theta_x=\theta_y=0$ (1),(4)
	Wy	-	0.331	-		
Reflectance	R%	-	38	-	%	(1),(4)

Note (1): Panel is driven by PDI waveform without masking film and optical measurement by CM-700D with D65 light source and SCE mode.

Figure 6-1 Optical measurement

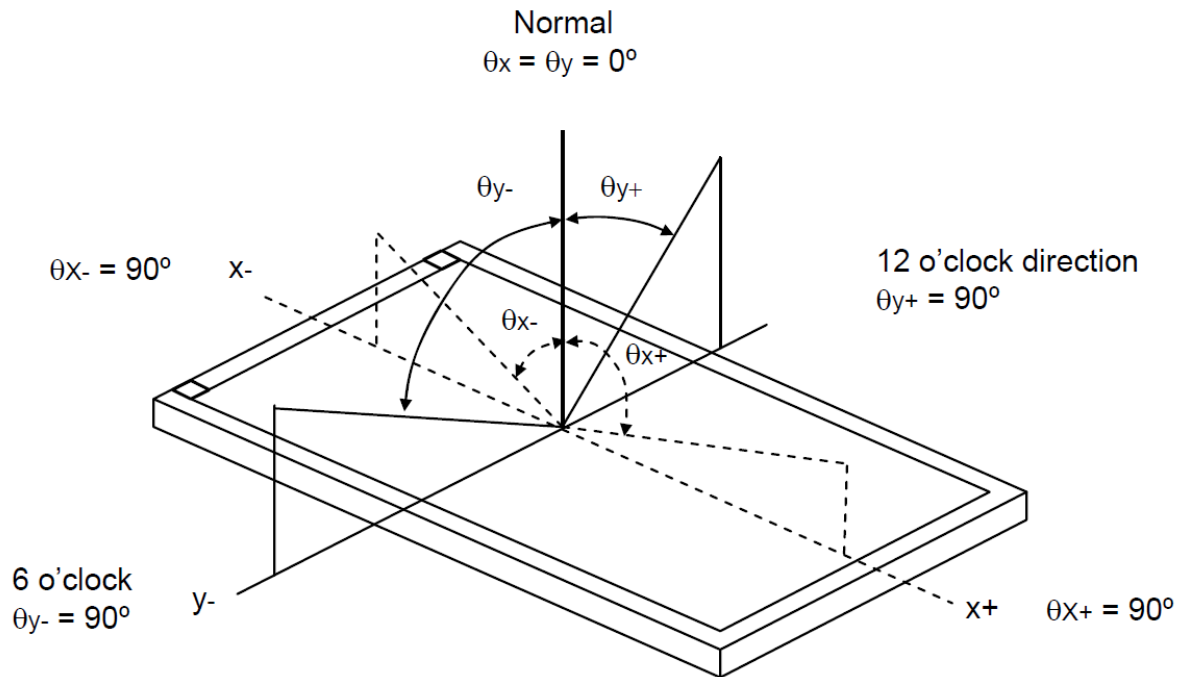


SCE mode



Note (2): Definition of Viewing Angle ( $\theta_x$ ,  $\theta_y$ ):

**Figure 6-2 Definition of Viewing Angle to Measure Contrast Ratio**



Note (3): Refresh time is the time that e-paper particles move not including the power on and off time. The refresh time is measured at 25 °C. The refresh time and contrast ratio varies due to different films, display performance requirements, and ambient temperatures.

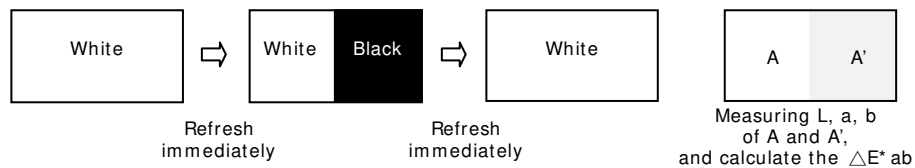
Note (4): Contrast ratio (C.R.): The Contrast ratio is calculated by the following expression.  $C.R. = (R\% \text{ White}) / (R\% \text{ Black})$ . Reflectance is measured at 120 seconds after refresh.



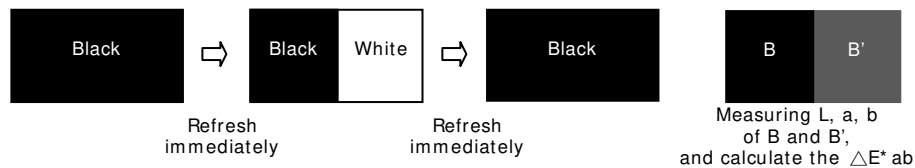
### 6.2.2 Ghosting

Below are two test methods to verify that ghosting within an acceptable range. Test 1 and Test 2 use measured data to calculate Delta E which is a single number representing the distance between two colors in a 3 dimensional color space. Test 1 and Test 2 are performed at 25 °C. Before L, a, b data measurement. The data measurement is at RT.

- Test 1: White to Black Ghosting



- Test 2: Black to White Ghosting



The formula is used to calculate Test1 and Test2. For example of Test 2:  

$$\Delta E^* ab = [ (L_B - L_{B'})^2 + (a_B - a_{B'})^2 + (b_B - b_{B'})^2 ]^{1/2}$$

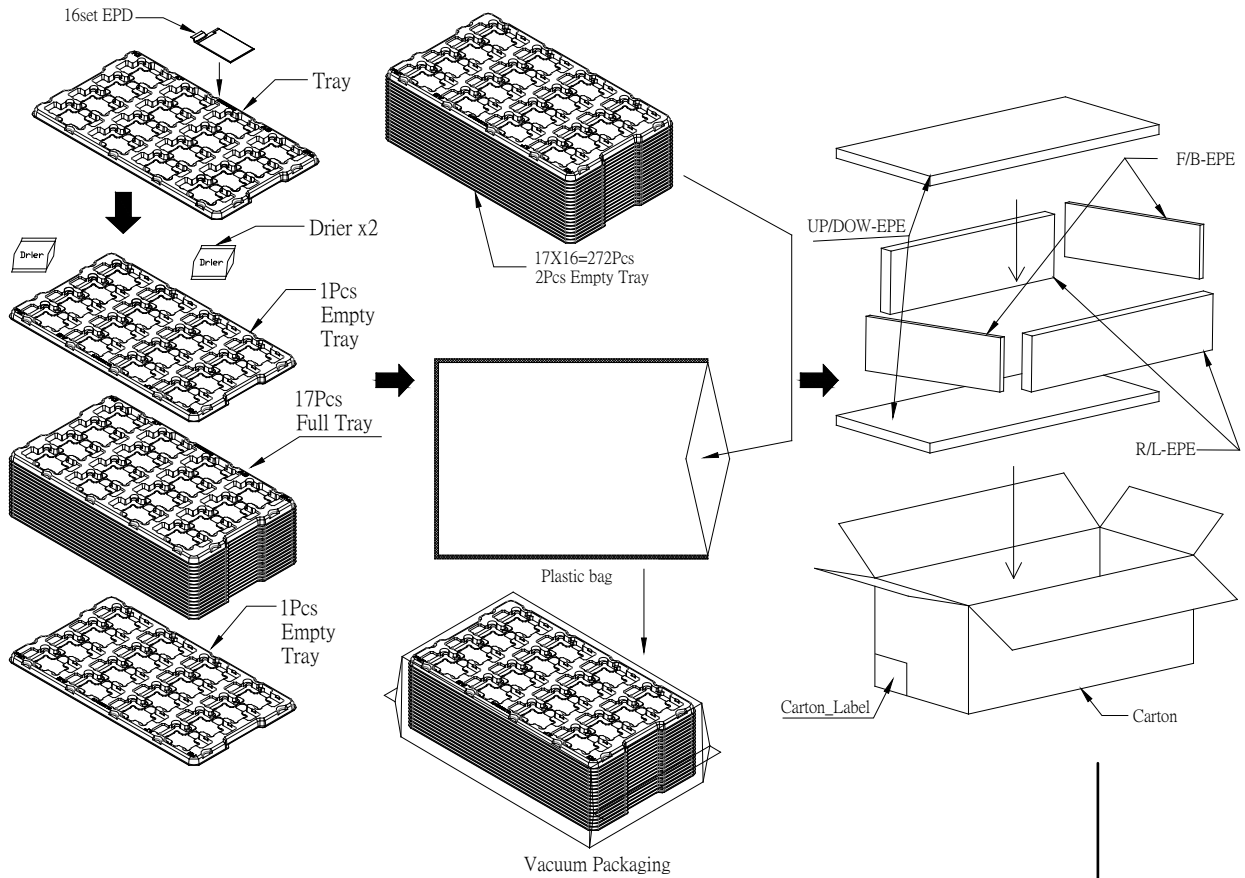
**Table 6-3 Measurement of Ghosting**

Item	Rating		
	Min.	Typ.	Max.
Test 1 ΔE*ab	-	-	2
Test 2 ΔE*ab	-	-	2

Note: Panel is driven by PDI waveform without masking film and optical measurement by CM-700D with D65 light source and SCE mode.

## 7 Packing

Figure 7-1 Packing Diagram



- Note: 1. Carton outline size: 500L X 300W X 200H mm  
 2. Material of tray: A-PET  
 3. Material of plastic bag: PE-LD

