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Product Specifications

Customer	**Standard**
Description	**1.44” TFT EPD Panel**
Model Name	**EK014BS011**
Date	**2016/04/01**
Doc. No.	**1P081-00**
Revision	**03**

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

	Design Engineering		
	Approval	**Check**	**Design**
	蘇 2016.04.01 倉民	蘇 2016.04.01 倉民	陳 2016.04.01 家瑩

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Revision History

Version	Date	Page (New)	Section	Description
Ver.01	2014/09/24	All	All	Product specification first issued.
Ver.02	2015/03/18	1		Amend company address & fax no.
		2		Amend company address
		9	1.4	Table 1-1, Add driver IC.
		28	9	Figure 9-1, Add model labels dimension and position
Ver.03	2016/04/01	12	2.1	1. Modified Table 2-1, Min. value & note (1)(2)(3) 2. Delete Figure 2-1
		13	2.2	1 Modified Table 2-2, low temperature
		21	6.2.1	Modified Figure 6-1, Optical measurement, EPD panel need face up & remove protection film
		24	7	Modified Figure 7-1 Packing Diagram, carton label location
		27	8	Precautions, add item (23)
		29	9	Modified Figure 9-3 Carton Label size 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 1.44" a-Si, active matrix TFT, Electronic Paper Display (EPD) panel. The panel has such high resolution (111 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: 128 x 96
- Ultra low power consumption
- Super Wide Viewing Angle - near 180°
- Extra thin & light
- SPI interface
- RoHS compliant

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	40.512(H) x 28.800(V) x 1.100(T)	mm	(1)
Active Area	29.312(H) x 21.984(V)	mm	
Driver Element	a-Si TFT active matrix	-	
FPL	Aurora Ma	-	
Pixel Number	128 x 96	pixel	
Pixel Pitch	0.229 x 0.229 (111dpi)	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

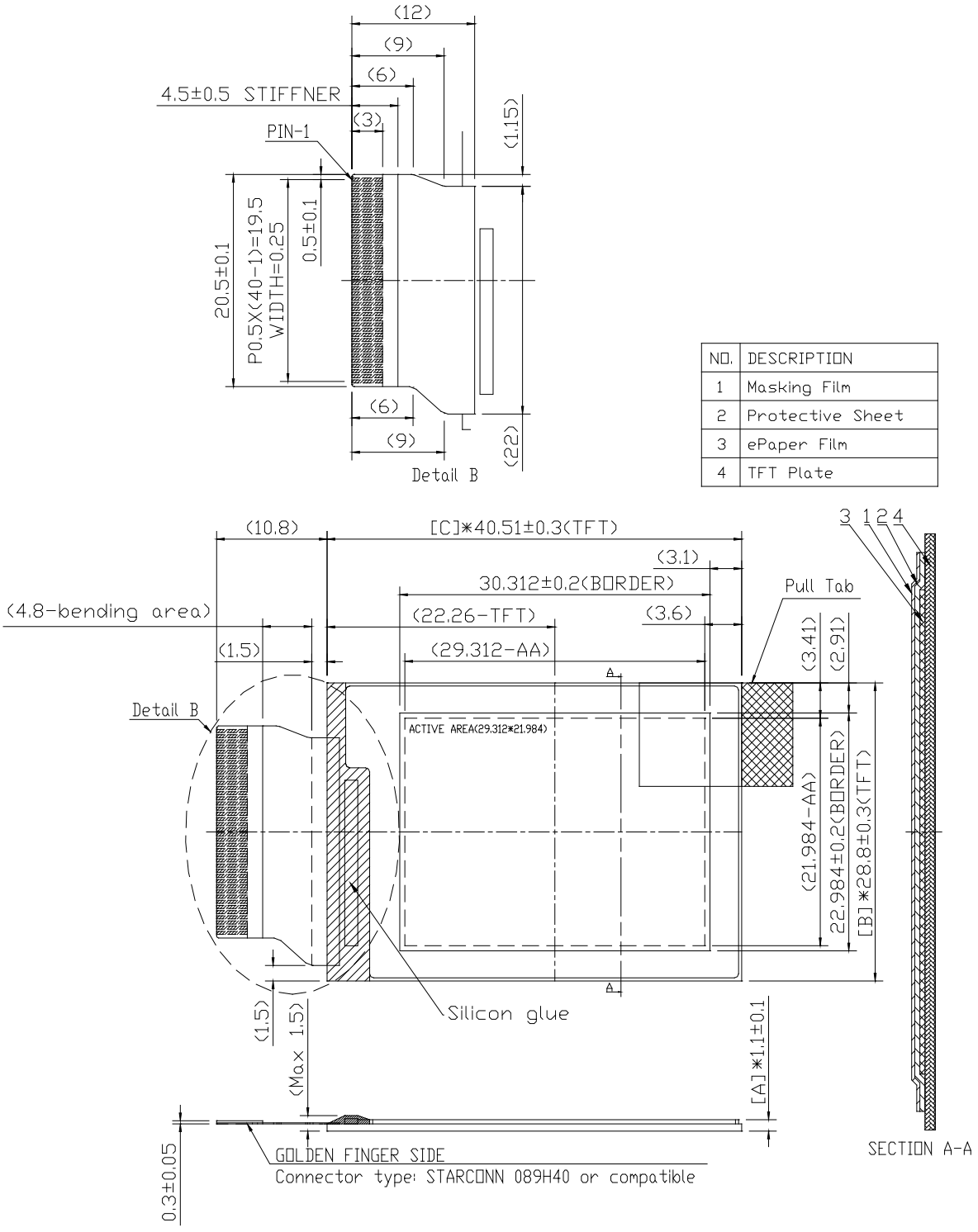
Item		Min.	Typ.	Max.	Unit	Note
Glass Size	Horizontal(H)	40.21	40.51	40.81	mm	
	Vertical(V)	28.50	28.80	31.10	mm	
	Thickness(T)	1.0	1.1	1.2	mm	(1)
Weight		-	2.6	3.2	g	

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_{ST}	-20	+60	ºC	(1), (3)
Operating Ambient Temperature	T_{OP}	-20	+50	ºC	(1), (2), (3)

Note (1):

(a) 90 %RH Max. (Ta ≦ 40 ºC), where Ta is ambient temperature.

(b) Wet-bulb temperature should be 39 ºC Max. (Ta > 40 ºC).

(c) No condensation and no frost.

(d) If users like to put the EPD under some extreme condition (e.g. +60C, < 40% 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 0 ºC Min. and 50 ºC 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 ℃ / 30 %RH for 240h	(1) (2)
Low Temperature Operation	0 ℃ for 240h	(1) (2)
Ultra Low Temperature Operation	-20 ℃ for 240h	(1) (2)
High Temperature/Humidity Operation	40 ℃ / 90 %RH for 168h	(1) (2)
High Temperature Storage	60 ℃ / 26 %RH for 240h	(1) (2)(3)
Low Temperature Storage	-20 ℃ for 240h	(1) (2) (3)
High Temperature/Humidity Storage	50 ℃ / 80 %RH for 168h	(1) (2) (3)
Thermal Cycles (Non-operation)	1 Cycle:-20℃/30min → 60℃/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_{DD}	-0.3	6.0	V	
Analog Power	V_{CC}	-0.3	6.0	V	
Ground	V_{SS}	-		-	Connect V_{SS} to Ground

Ta = 25 ± 2 ºC

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_{DD}	2.3	3.0	3.6	V	
Analog Power		V_{CC}	2.3	3.0	3.6	V	
Input Voltage	High	V_{IH}	$0.8V_{DD}$	-	V_{DD}	V	/CS, ID, SCLK, SI, /RESET
	Low	V_{IL}	V_{SS}	-	$0.2V_{DD}$	V	
Output Voltage	High	V_{OH}	$0.8V_{DD}$	-	V_{DD}	V	I_{OH}= 0.5mA, SO, BUSY
	Low	V_{OL}	V_{SS}	-	$0.2V_{DD}$	V	I_{OL}= -0.5mA, SO, BUSY
Input Leakage Current	High	I_{IH}	-	-	1.0	uA	
	Low	I_{IL}	-	-	-1.0	uA	

Input Current	$I_{DD} + I_{CC}$	-	4	8	mA	(1),(2),(3)
DC/DC Inrush Current	I_{PEAK}	-	30	90	mA	(1),(2),(3)

Ta = 25 ± 2 ºC

Note (1):

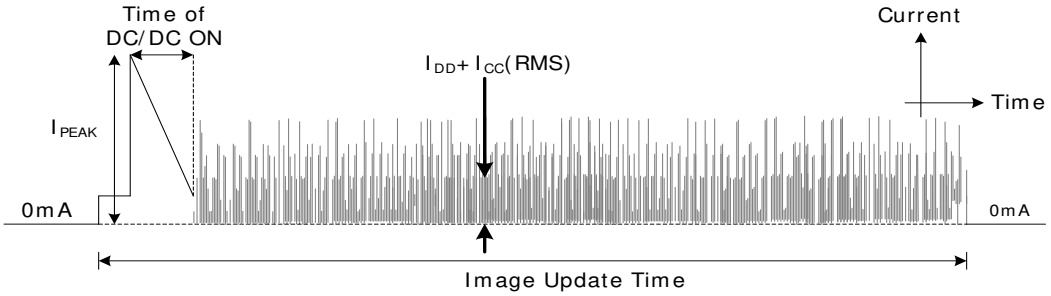
Figure 3-1 Test Pattern of Panel

These currents are tested with PDI test jig.

Note (2):

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

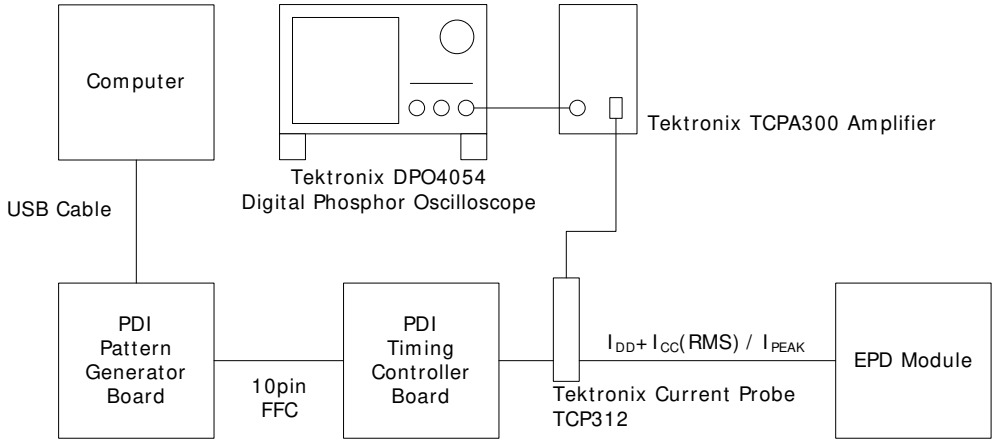
Figure 3-2 Image Update Current Profile



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

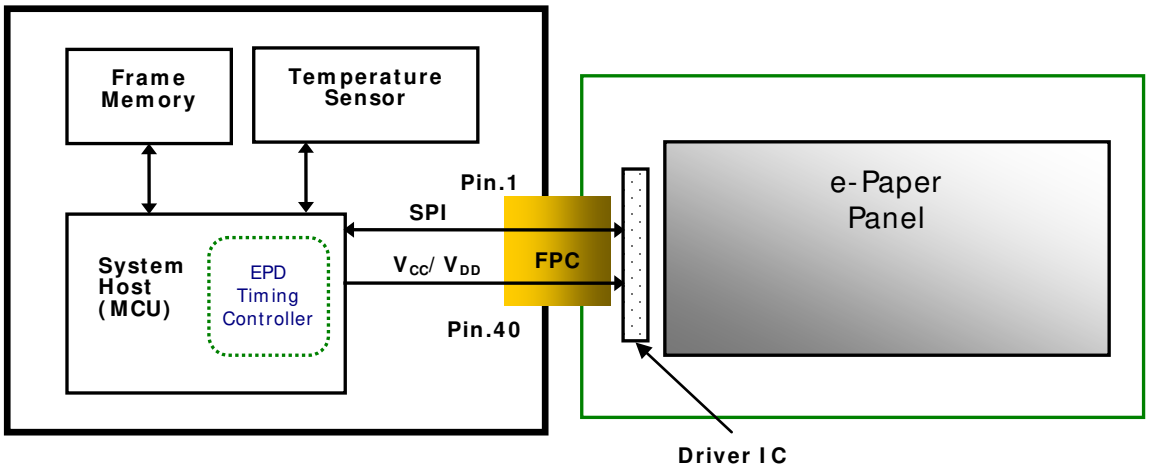
Note (3):

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	ADC_IN	-	BORDER	Connect to BORDER
9	V_{CL}	C	Capacitor	-
10	C42P	C	Charge-Pump Capacitor	-
11	C42M	C		-
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		-

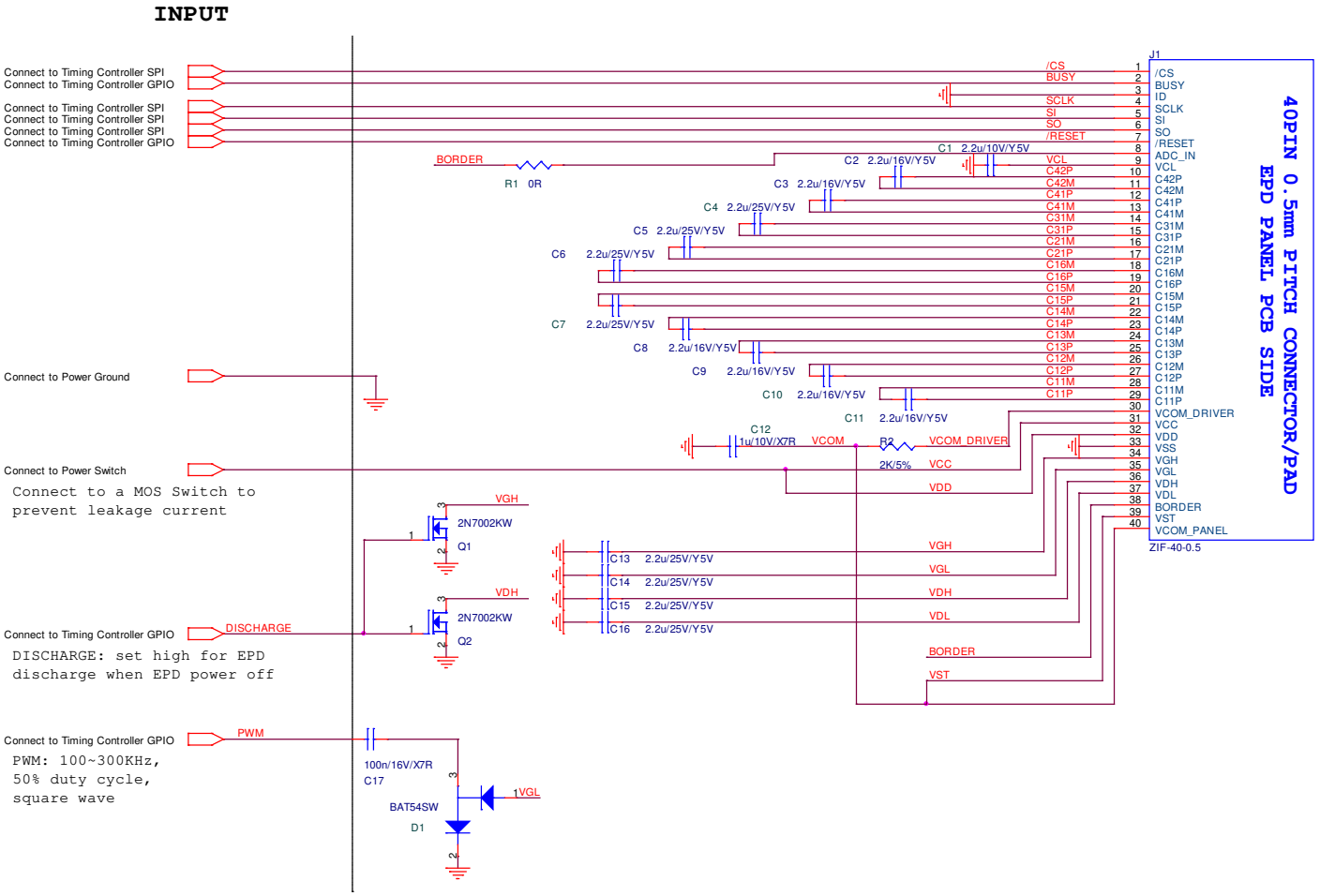
22	C14M	C	Charge-Pump Capacitor	-
23	C14P	C		-
24	C13M	C	Charge-Pump Capacitor	-
25	C13P	C		-
26	C12M	C	Charge-Pump Capacitor	-
27	C12P	C		-
28	C11M	C	Charge-Pump Capacitor	-
29	C11P	C		-
30	V_{COM_DRIVER}	RC	Resistor & Capacitor	The signal duty cycle can drive VCOM voltage from source driver IC
31	V_{CC}	P	V_{CC}	Power supply for analog part of source driver
32	V_{DD}	P	V_{DD}	Power supply for digital part of source driver
33	V_{SS}	P	Ground	-
34	V_{GH}	C	Capacitor	-
35	V_{GL}	C	Capacitor	-
36	V_{DH}	C	Capacitor	-
37	V_{DL}	C	Capacitor	-
38	BORDER	I	ADC_IN	Connect to ADC_IN
39	V_{ST}	P	V_{COM_PANEL}	-
40	V_{COM_PANEL}	C	Capacitor	V_{COM} 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 Test Conditions

Item	Symbol	Value	Unit
Ambient Temperature	Ta	25±2	ºC
Ambient Humidity	Ha	50±10	%RH
Supply Voltage	V_{CC} & V_{DD}	3.0	V

6.2 Optical Specifications

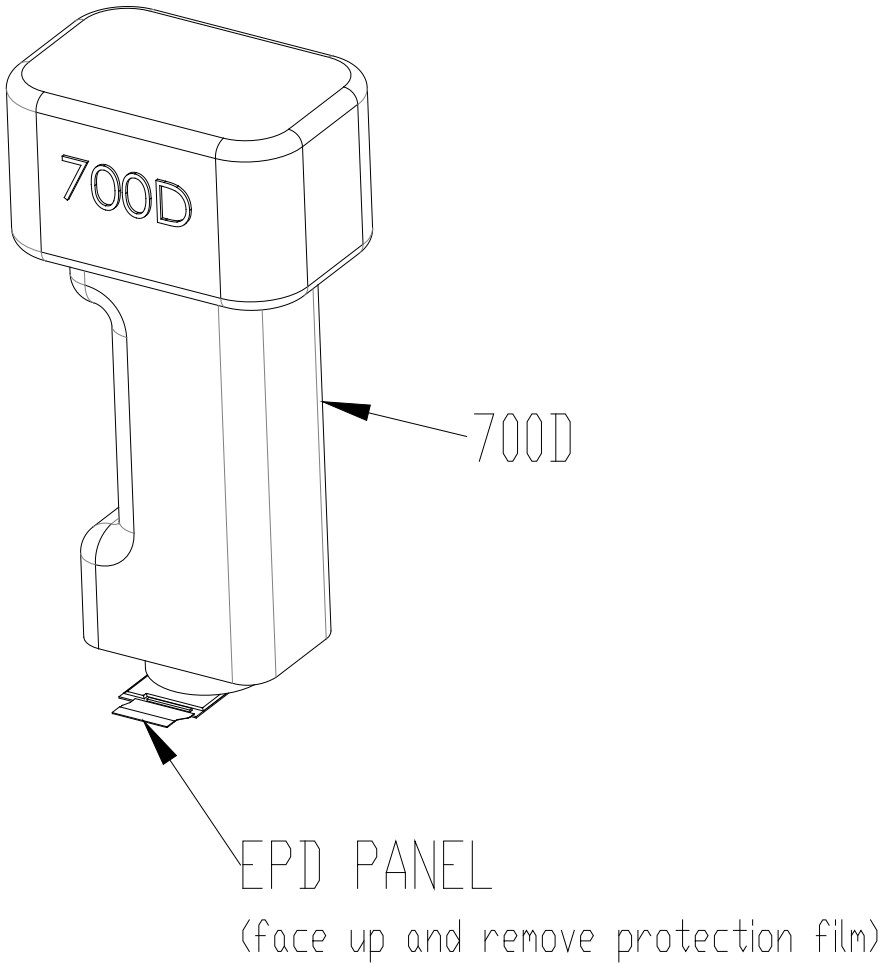
6.3 Optical

Table 6-2 Optical Measurement with D65 light source

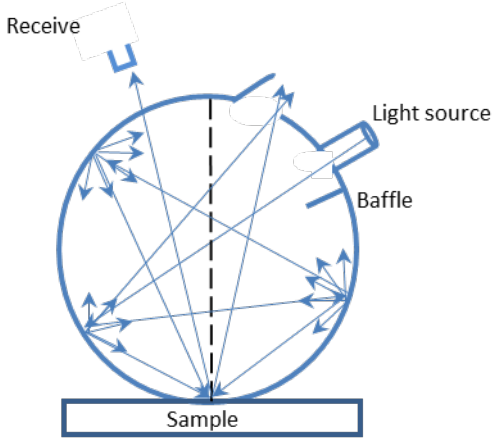
Item	Symbol	Rating			Unit	Note
		Min.	Typ.	Max.		
Contrast ratio	CR	5:1	7:1	-	-	θx=θy=0 (1),(2),(3),(4)
Refresh time	Tr	-	4	-	sec	(3)
White Chromaticity	Wx	-	0.308	-	-	θx=θy=0 (1),(4)
	Wy	-	0.331	-		
Reflectance	R%	-	38	-	%	(1),(4)

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



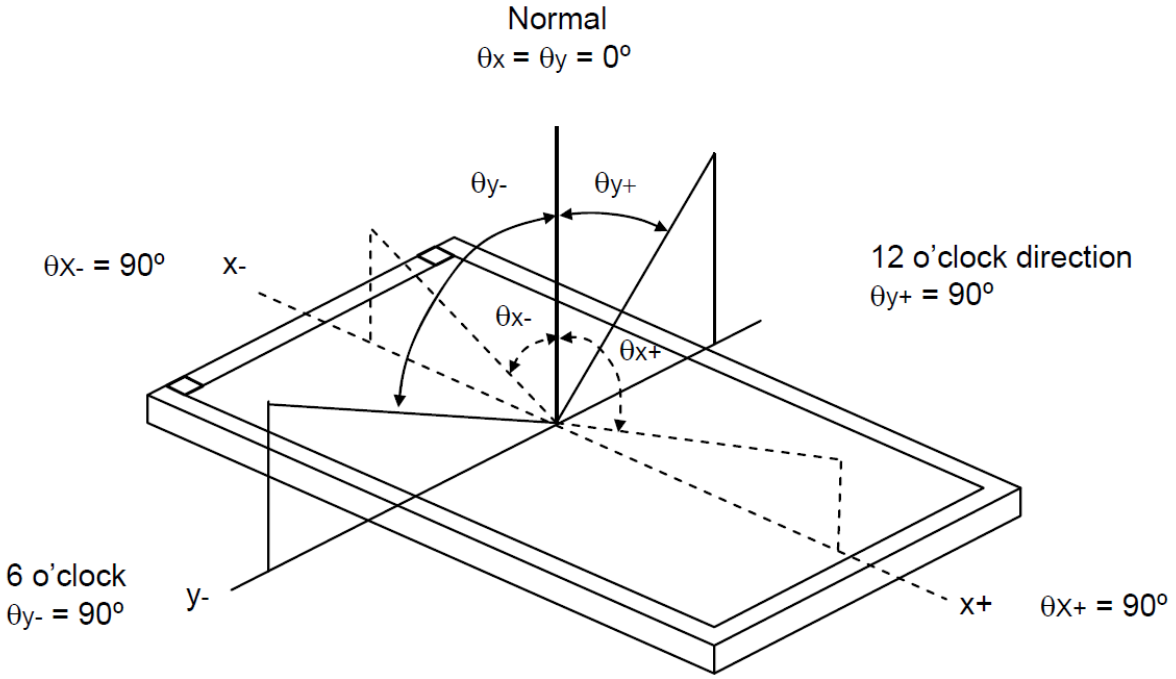
SCE mode



Note (2): Definition of Viewing Angle (θx, θy):

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



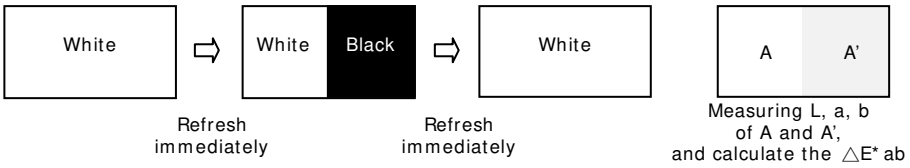
on and off time. The refresh time is measured at 25ºC.The refresh time and contrast ratio varies due to different films, display performance requirements, and ambient temperatures.

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

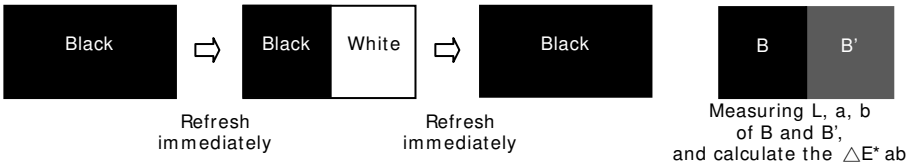
6.4 Ghosting

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 25ºC.

- 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:

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

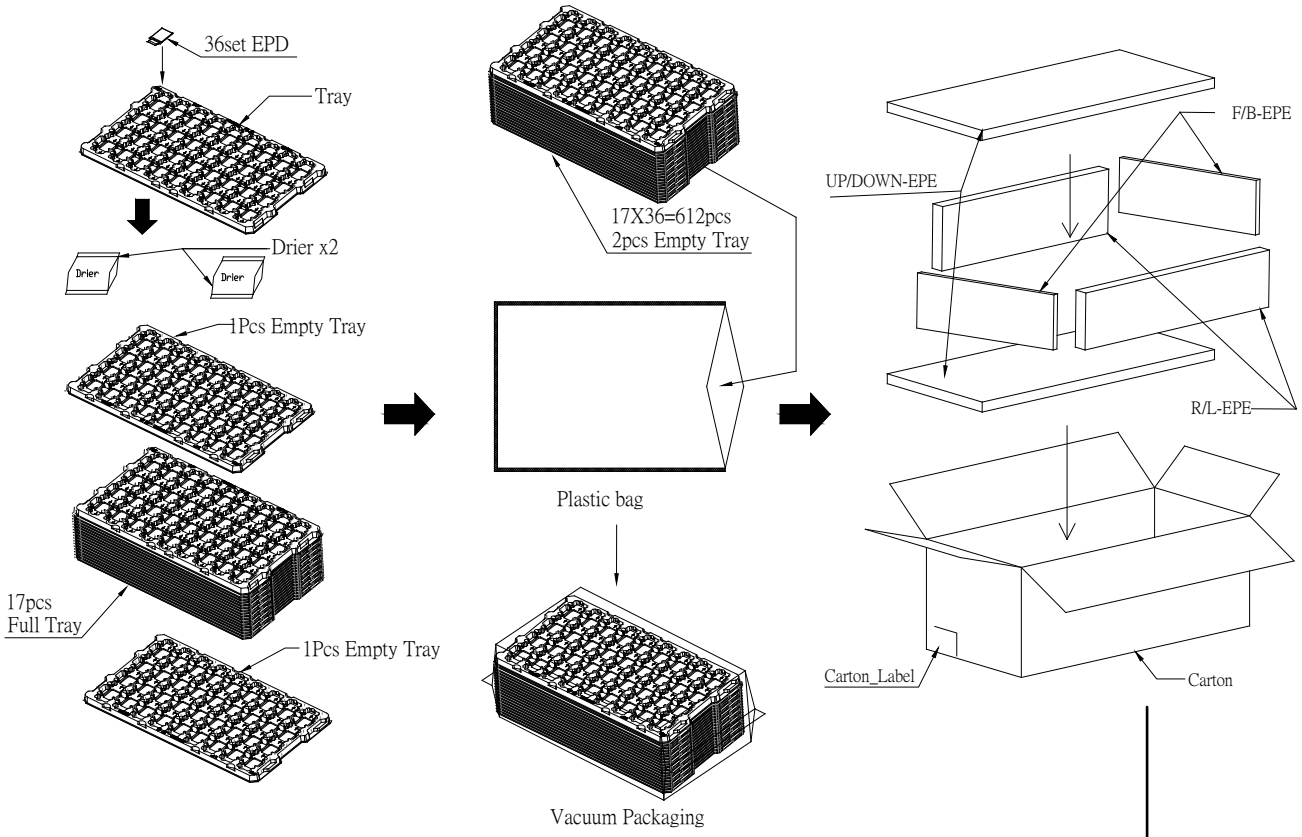
Table 6-3 Measurement of Ghosting

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

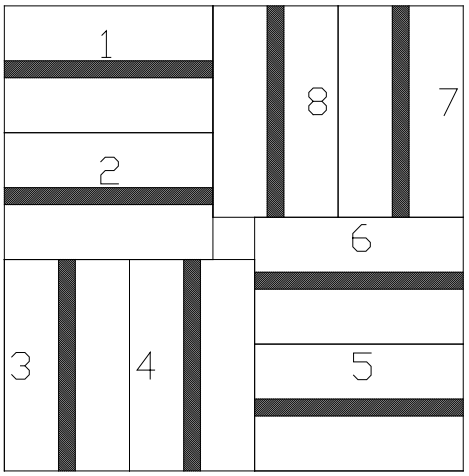
Note: Panel is driven by PDI waveform without masking film and optical measurement by CM-700D with D65 light source and SCE mode.

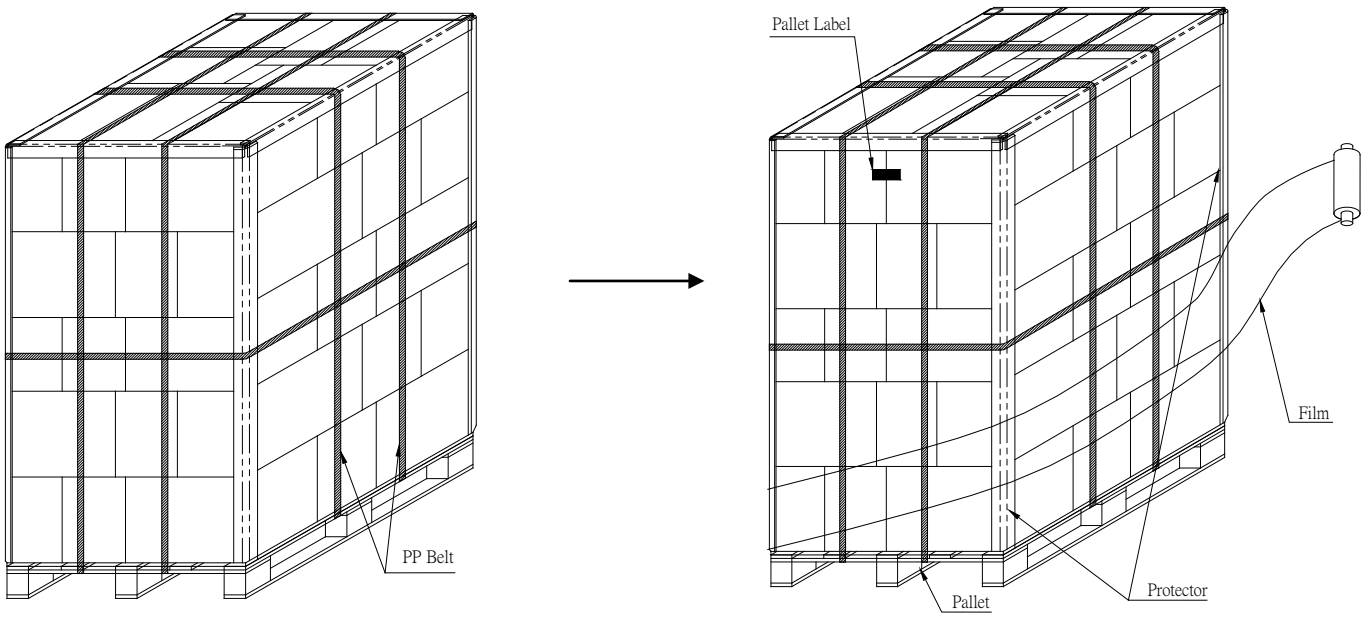
7 Packing

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





612(pcs)x40(BOX)=24480pcs

	1.44” EPD BOX
N.W. :	1.59Kg
G.W. :	4.96 Kg

Sea / Land / Air Transportation