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Product Specifications

Customer	Standard
Description	4.41" TFT EPD Panel
Model Name	E1441CS021
Date	2015/02/02
Doc. No.	1P095-00
Revision	02

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

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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 4.41" a-Si, active matrix TFT, Electronic Paper Display (EPD) panel. The panel has such high resolution (113dpi) 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: 400 x 300
- 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	98.504(H) x 80.400(V) x 0.9(T)	mm	(1)
Active Area	89.6(H) x 67.2(V)	mm	
Driver Element	a-Si TFT active matrix	-	
FPL	Aurora Mb	-	
Pixel Number	400 x 300	pixel	
Pixel Pitch	0.224 x 0.224 (113dpi)	mm	
Pixel Arrangement	Vertical stripe	-	
Display Colors	Black/White	-	
Surface Treatment	Anti-Glare	-	

Note (1): Not including the FPC.

1.5 Mechanical Specifications

Table 1-2 Mechanical Specification

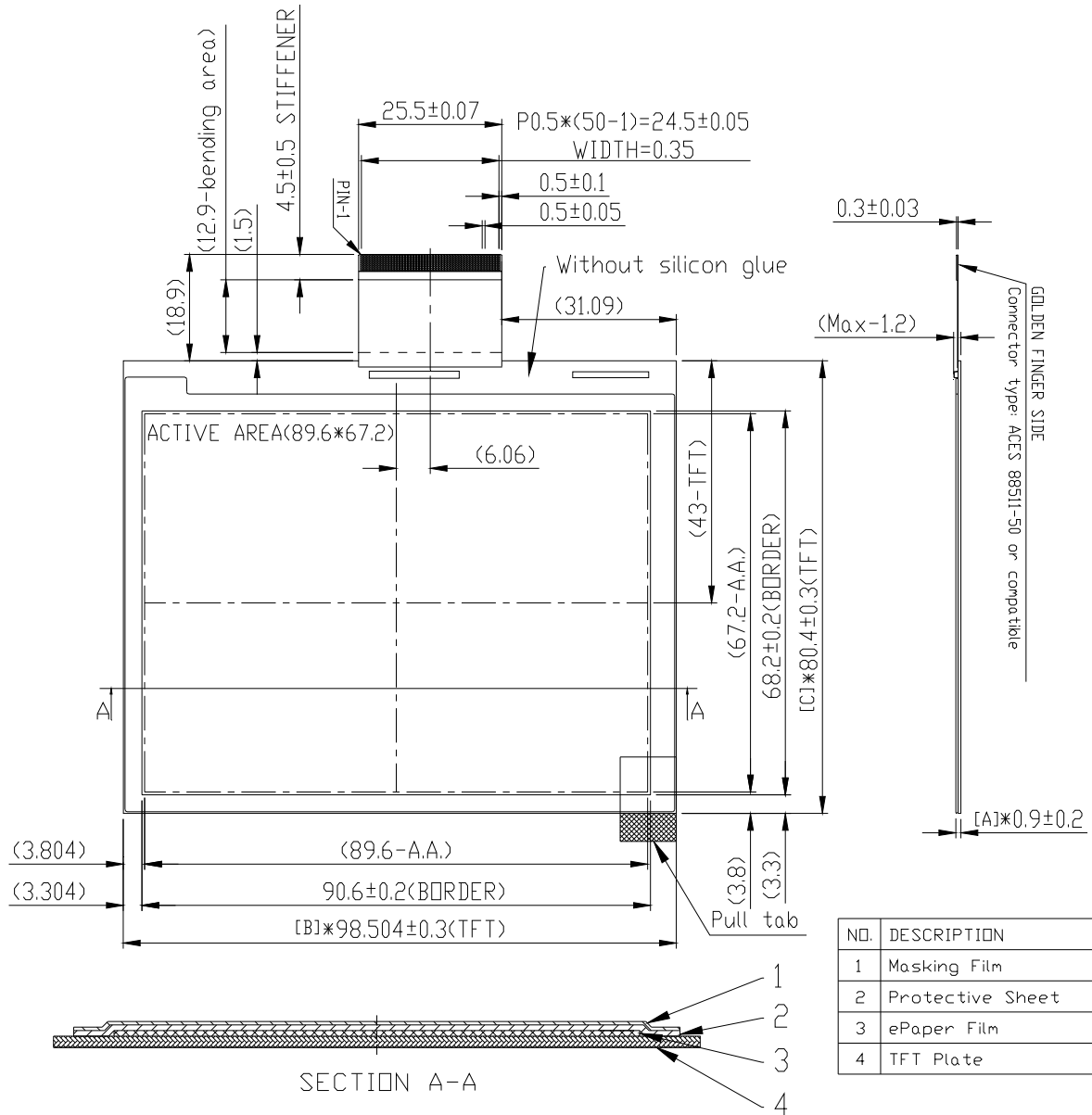
Item		Min.	Typ.	Max.	Unit	Note
Glass Size	Horizontal(H)	98.204	98.504	98.804	mm	
	Vertical(V)	80.100	80.400	80.700	mm	
	Thickness(T)	0.7	0.9	1.1	mm	(1)
Weight			12.8	15.4	g	

Note (1): Not including the Masking Film.

Table 1-3 FPC Specification

Item	Pin numbers	Pitch (mm)	Connector	Note
Golden Finger	50	0.5	ACES 88511-50 or HRS TF31-50S 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	°C	(1), (3)
Operating Ambient Temperature	T _{OP}	0	+50	°C	(1), (2), (3)

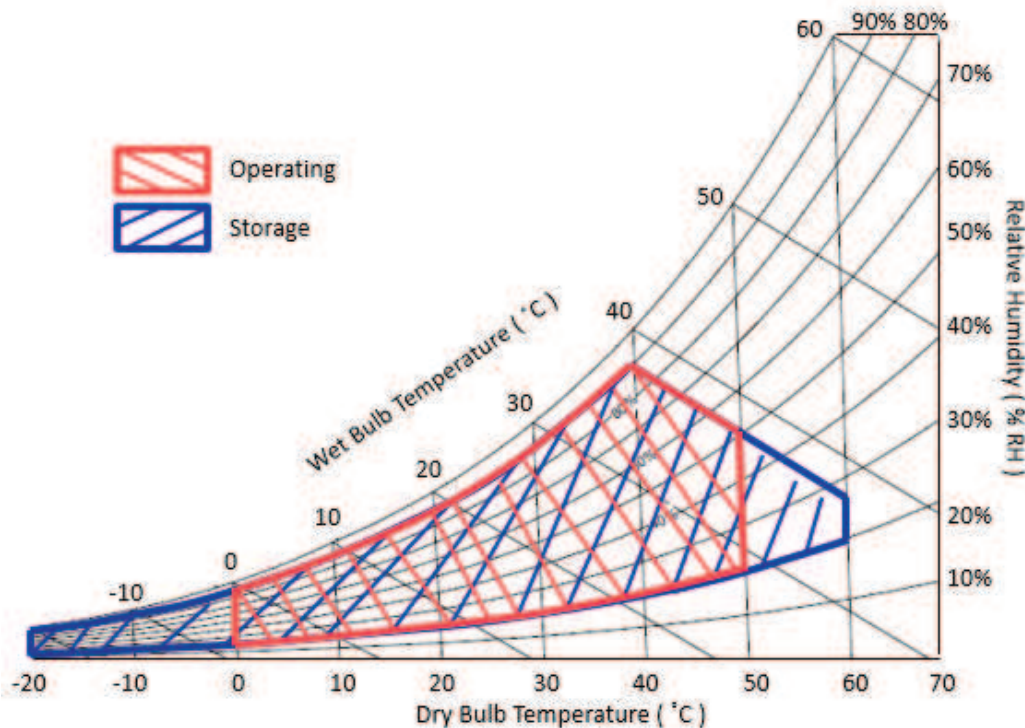
Note (1):

- (a) 90 %RH Max. ($T_a \leq 40$ °C), where T_a is ambient temperature.
- (b) Wet-bulb temperature should be 39 °C Max. ($T_a > 40$ °C).
- (c) No condensation and no frost.

Note (2): The temperature of panel display surface area should be 0 °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.

Figure 2-1 Operating Range of Relative Humidity and Temperature



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)
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 _{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 °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 _{DD}	2.7	3.0	3.6	V	
Analog Power	V _{CC}	2.7	3.0	3.6	V	
Input Voltage	High	V _{IH}	0.8V _{DD}	-	V _{DD}	/RESET, /CS, ID, SCLK, SI, OE123, U_D, CKV, STV_IN
	Low	V _{IL}	V _{SS}	-	0.2V _{DD}	
Output Voltage	High	V _{OH}	0.8V _{DD}	-	V _{DD}	I _{OH} =0.5mA, SO, STV_OUT
	Low	V _{OL}	V _{SS}	-	0.2V _{DD}	I _{OL} =-0.5mA, SO, STV_OUT
Input Leakage Current	High	I _{IH}	-	-	2.0	uA
	Low	I _{IL}	-	-	-2.0	uA
Input Current	I _{DD} + I _{CC}	-	6	12	mA	(1),(2),(3)
DC/DC Inrush Current	I _{PEAK}	-	30	100	mA	(1),(2),(3)

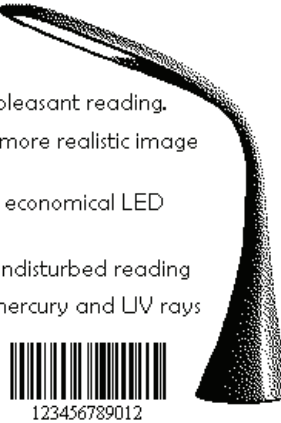
Ta = 25 ± 2 °C

Note (1):

Figure 3-1 Test Pattern of Panel

**CHIMEI
LED DeskLamp**

- Flicker free LED lighting for pleasant reading.
- Natural color rendition for a more realistic image reproduction.
- Long-life, energy-saving, and economical LED lighting.
- V-CLUT Anti-glare Filter for undisturbed reading
- Green lighting free of lead, mercury and UV rays with zero pollution.

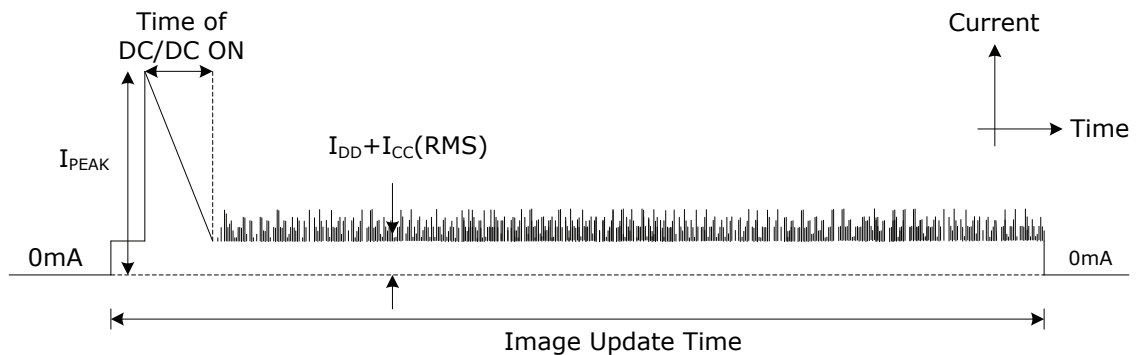


These currents are tested with PDI test jig.

Note (2):

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

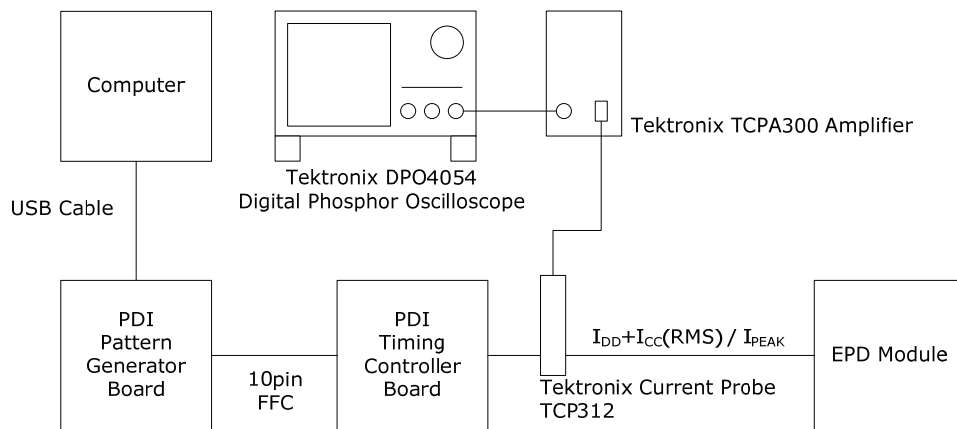
Figure 3-2 Image Update Current Profile



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

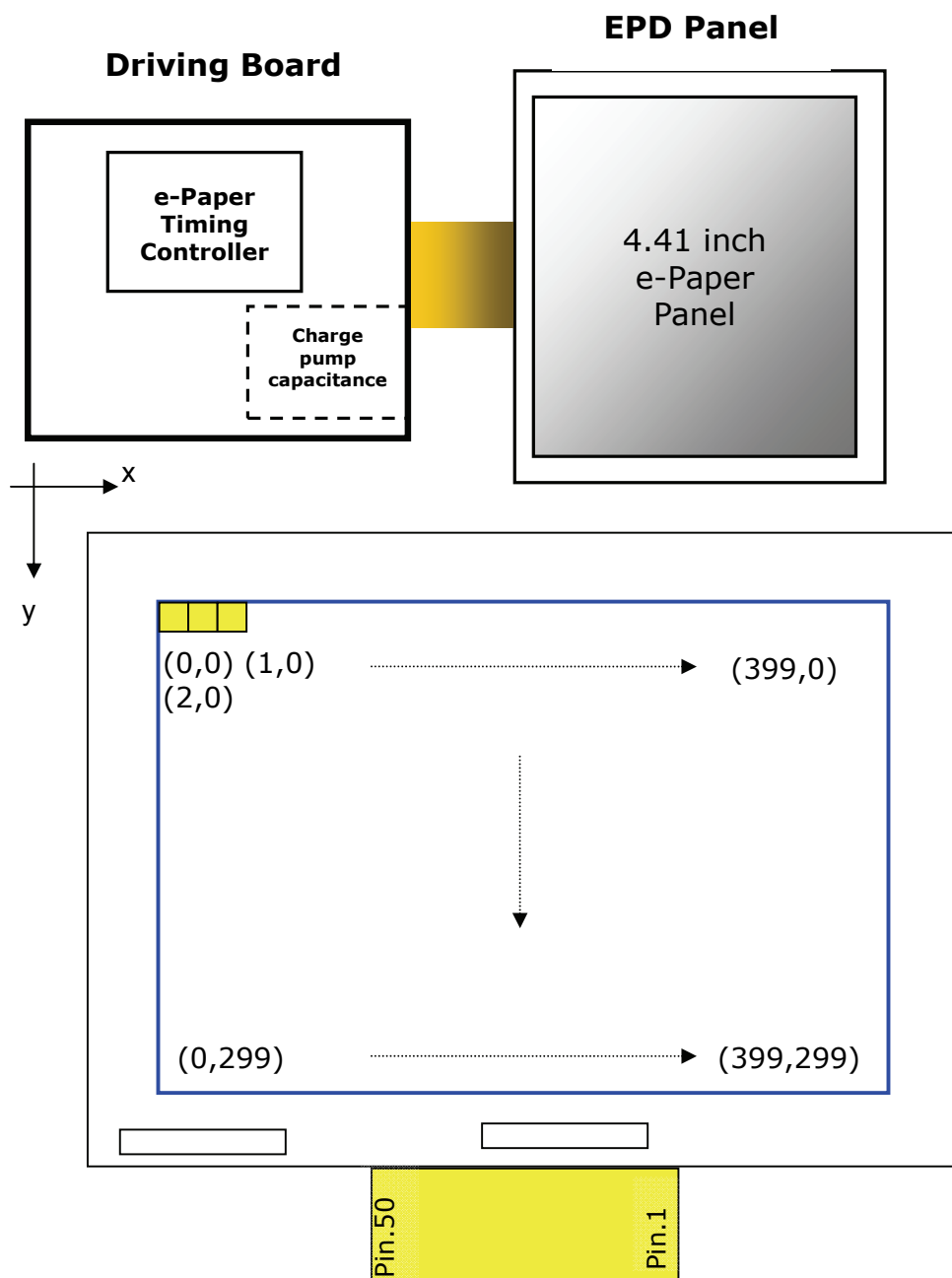
Note (3):

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	V _{ST}	P	V _{COM_PANEL}	Power supply for TFT storage capacitors.
2	BORDER	P	Not connect	
3	V _{COM_PANEL}	P	Capacitor	V _{COM} to panel.
4	V _{DL}	P	Capacitor	Negative power supply for data driver
5	V _{DH}	P	Capacitor	Positive power supply for data driver
6	V _{GL}	P	Capacitor	Negative power supply for gate driver
7	V _{GH}	P	Capacitor	Positive power supply for gate driver
8	V _{SS}	P	Ground	
9	V _{DD}	P	V _{DD}	Power supply for digital part of source driver
10	V _{CC}	P	V _{CC}	Power supply for analog part of source driver
11	V _{COM_DRIVER}	RC	Resistor & Capacitor	The signal duty cycle can drive V _{COM} voltage from source driver IC
12	C11P	C	Capacitor	
13	C11M	C	Capacitor	
14	C12P	C	Capacitor	
15	C12M	C	Capacitor	
16	C13P	C	Capacitor	
17	C13M	C	Capacitor	
18	C14P	C	Capacitor	
19	C14M	C	Capacitor	
20	C15P	C	Capacitor	
21	C15M	C	Capacitor	

22	C16P	C	Capacitor	
23	C16M	C	Capacitor	
24	C21P	C	Capacitor	
25	C21M	C	Capacitor	
26	C31P	C	Capacitor	
27	C31M	C	Capacitor	
28	C41M	C	Capacitor	
29	C41P	C	Capacitor	
30	C42M	C	Not connect	
31	C42P	C	Not connect	
32	V _{CL}	C	Capacitor	V _{COM} driver power supply
33	IF0	I	Not connect	Panel interface mode setting
34	IF1	I	Not connect	Panel interface mode setting
35	/RESET	I	TCon	Reset pin, low active
36	V _{SS}	P	Ground	
37	SO	O	TCon	Serial output from EPD to host MCU
38	SI	I	TCon	Serial input from host MCU to EPD
39	SCLK	I	TCon	Clock for SPI
40	ID	I	Ground	Panel interface mode setting
41	/CS	I	TCon	Chip select, low active
42	OE123	I	TCon	Output enable for gate driver. When OE123 = 1, all gate outputs are disable
43	U_D	I	V _{DD}	Gate scanning direction control
44	CKV	I	TCon	Clock input of gate driver
45	STV_IN	I	TCon	Start pulse in for shift register of gate driver
46	STV_OUT	O	Not connect	Start pulse out
47	V _{EE}	P	Capacitor	Negative power supply of gate driver
48	V _{GG}	P	Capacitor	Positive power supply of gate driver

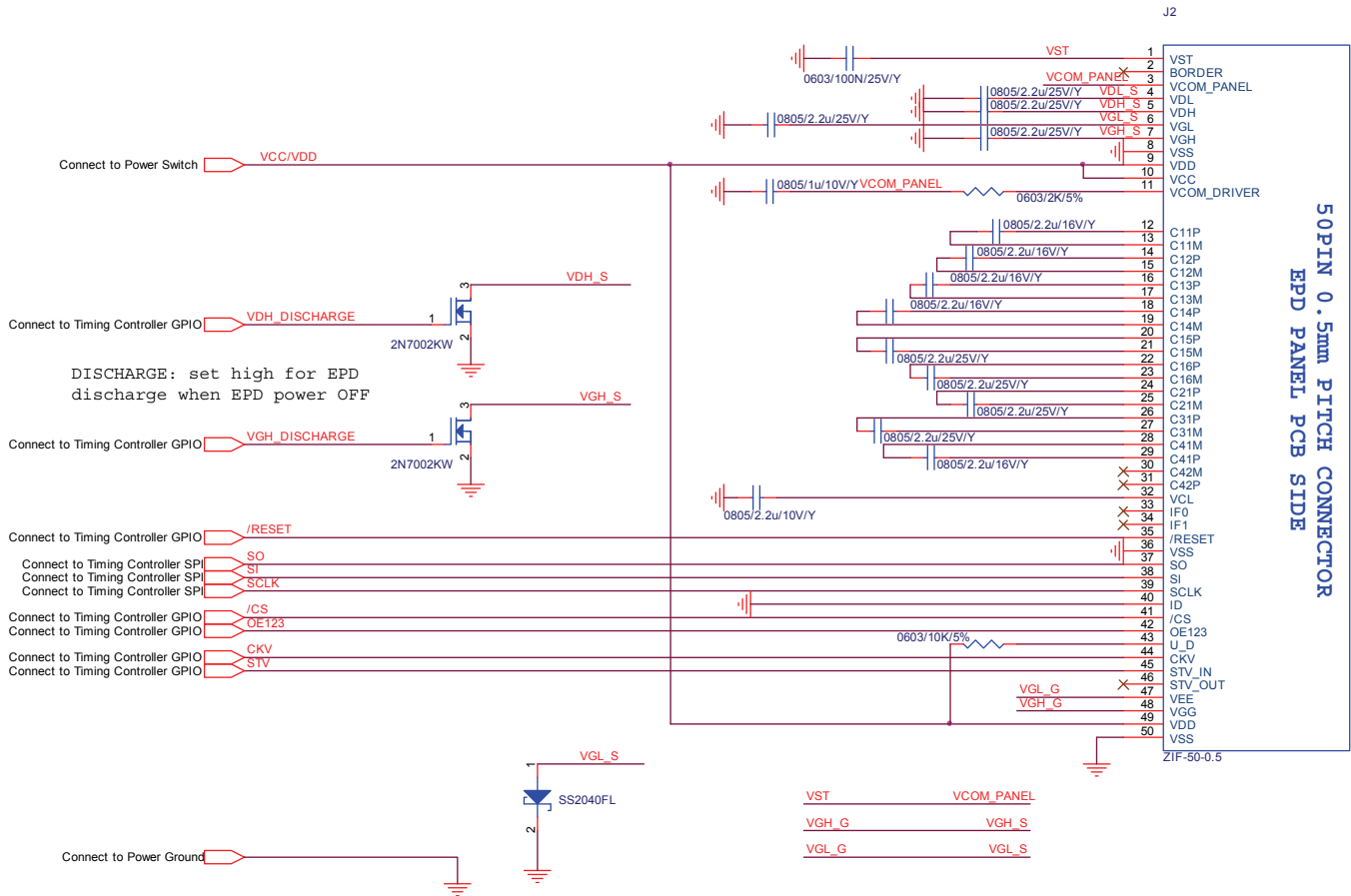
49	V _{DD}	P	Capacitor	Power supply for digital part of gate driver
50	V _{SS}	P	Ground	

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 Measurement Conditions

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

6.2 Optical Specifications

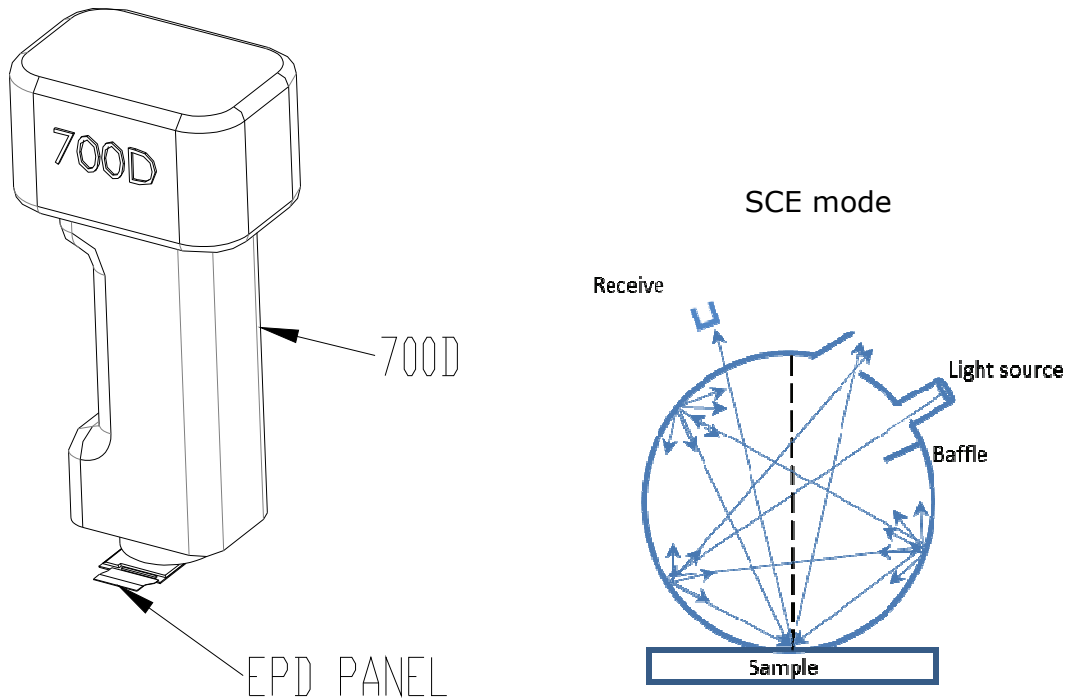
6.2.1 Optical

Table 6-2 Optical Measurement with D65 light source

Item	Symbol	Rating			Unit	Note
		Min.	Typ.	Max.		
Contrast ratio	CR	-	7:1	-	-	$\theta_x=\theta_y=0$ (1),(2),(3),(4)
Refresh time	Tr	-	2.6	-	sec	(3)
White Chromaticity	Wx	-	0.30	-	-	$\theta_x=\theta_y=0$ (1),(4)
	Wy	-	0.33	-		
Reflectance	R%	-	32	-	%	(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.

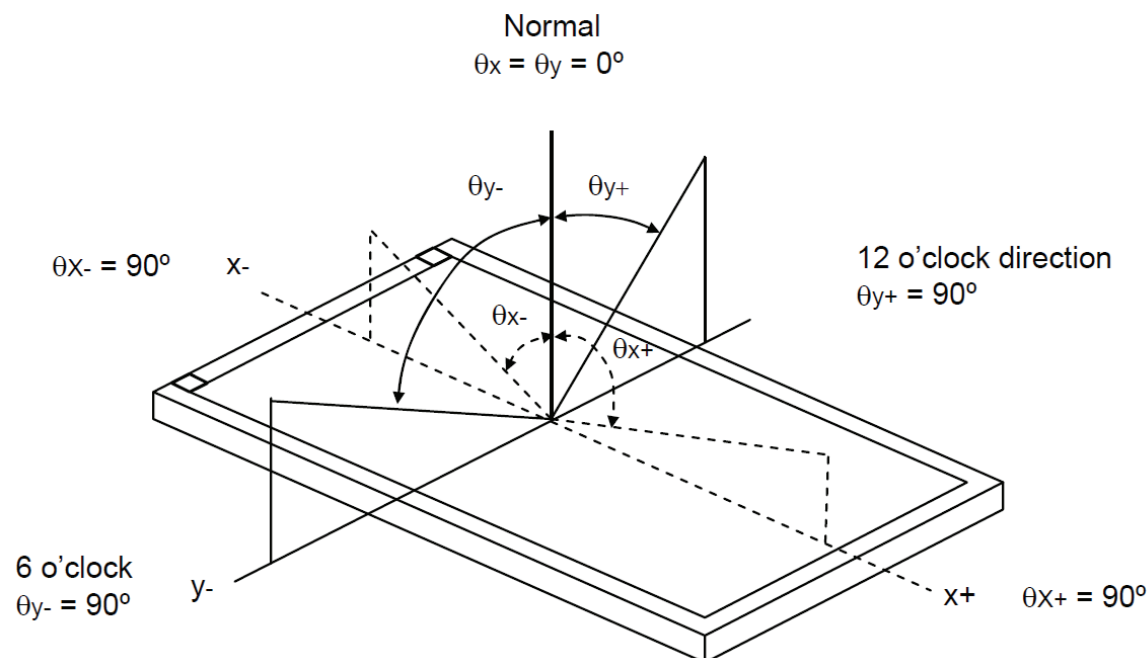
Figure 6-1 Optical measurement



Note (2): Definition of Viewing Angle (θ_x, θ_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



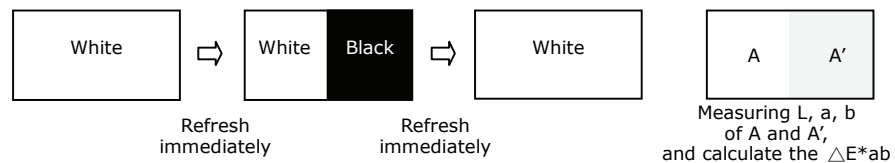
on and off time. The refresh time is measured at 25°C. The refresh time and contrast ratio varies due to different films, display performance requirements, and ambient temperatures.

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.

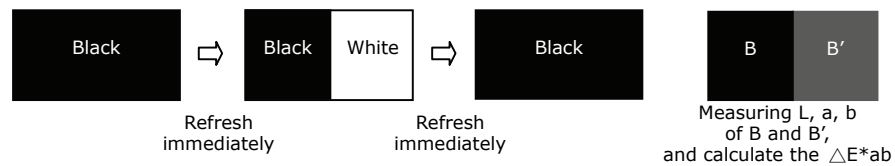
6.2.2 Ghosting

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 2 are performed at 25°C.

- 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.