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Product Specifications

Customer	
Description	12" 3-Colors TFT EPD Panel
Model Name	E2B98FS081
Date	2018/05/02
Doc. No.	TENTATIVE_1P1xx-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
			

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Table of Contents

Revision History.....	6
Glossary of Acronyms.....	7
1 General Description	8
1.1 Overview	8
1.2 Features	8
1.3 Applications	8
1.4 General Specifications	9
1.5 Mechanical Specifications.....	10
2 Absolute Maximum Ratings.....	12
2.1 Absolute Ratings of Environment	12
2.2 Reliability Test Item	13
2.3 Product Warranty.....	13
3 Electrical Characteristics.....	14
3.1 Absolute Maximum Ratings of Panel	14
3.2 Recommended Operation Conditions of Panel	14
4 Application Circuit Block Diagram	16
5 Terminal Pin Assignment & Reference Circuit.....	17
5.1 Terminal Pin Assignment.....	17
5.2 Reference Circuit	19
6 Optical Characteristics.....	20
6.1 Measurement Conditions	20
6.2 Optical Specifications	20
6.2.1 Optical	20
6.2.2 Ghosting	23
7 Packing	24
8 Precautions.....	26
9 Definition of Labels.....	28

List of Figures

Figure 1-1 EPD Drawing 11

Figure 3-1 Test Pattern of Panel 15

Figure 3-2 Image Update Current Profile..... 15

Figure 3-3 Current Measurement 15

Figure 4-1 Application Circuit Block Diagram 16

Figure 5-1 EPD Reference Circuit 19

Figure 6-1 Optical measurement..... 21

Figure 6-2 Definition of Viewing Angle to Measure Contrast Ratio..... 22

Figure 7-1 Packing Diagram 24

Figure 9-1 Model Labels..... 28

Figure 9-2 Definition of Model Labels..... 29

Figure 9-3 Carton Label 30

Figure 9-4 Pallet Label..... 30

List of Tables

Table 1-1 General Specification 9

Table 1-2 Mechanical Specification 10

Table 1-3 FPC Specification 10

Table 2-1 Absolute Ratings of Environment 12

Table 2-2 Reliability Test Items 13

Table 3-1 Absolute Maximum Ratings of Panel 14

Table 3-2 Recommended Operation Conditions of Panel 14

Table 5-1 Terminal Pin Assignment 17

Table 6-1 Optical Measurement Conditions 20

Table 6-2 Optical Measurement with D65 light source 20

Table 6-3 Measurement of Ghosting 23

TENTATIVE

Revision History

Version	Date	Page (New)	Section	Description
01	2018/03/01	All	All	TENTATIVE Product specification first issued.
02	2018/03/26	9	1.4	Add FPL version (R1.2)
		14	3.2	Modify power consumption
		15	3.2	Add the axis labeling to Figure 3-2
03	2018/05/02	14	3.2	Modify power consumption
		15	3.2	Modify test pattern and current profile

Glossary of Acronyms

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

1 General Description

1.1 Overview

This is a 12" a-Si, active matrix TFT, Electronic Paper Display (EPD) panel. The panel has such high resolution (103 dpi) that it can easily display fine patterns. Due to its bi-stable nature, the EPD panel requires low power to update pattern and needs no power to maintain an image.

1.2 Features

- a-Si TFT active matrix Electronic Paper Display(EPD)
- Three colors support: White, Black, Red
- Resolution: 960 x 768
- Ultra-low power consumption
- Super Wide Viewing Angle - near 180°
- Extra thin & light
- SPI interface
- RoHS compliant

1.3 Applications

- e-POP/Signage
- Electronic bulletins
- Office Automation
- Navigator
-

TENTATIVE

1.4 General Specifications

Table 1-1 General Specification

Item	Specification	Unit	Note
Outline Dimension	251.0(H) x 204.08(V) x 1.2(T)	mm	(1)
Active Area	237.6(H) x 190.08(V)	mm	
Driver Element	a-Si TFT active matrix	-	
FPL	Spectra Red (R1.2)	-	
Pixel Number	960 x 768	pixel	
Pixel Pitch	0.2475 x 0.2475 (103dpi)	mm	
Pixel Arrangement	Vertical stripe	-	
Display Colors	Black/White/Red	-	
Surface Treatment	Anti-Glare	-	
Driver IC	Source(IST7132)/Gate(Hx8695)		

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)	250.7	251.0	251.3	mm	
	Vertical(V)	203.78	204.08	204.38	mm	
	Thickness(T)	1.1	1.2	1.3	mm	(1)
Weight		-	123	-	g	

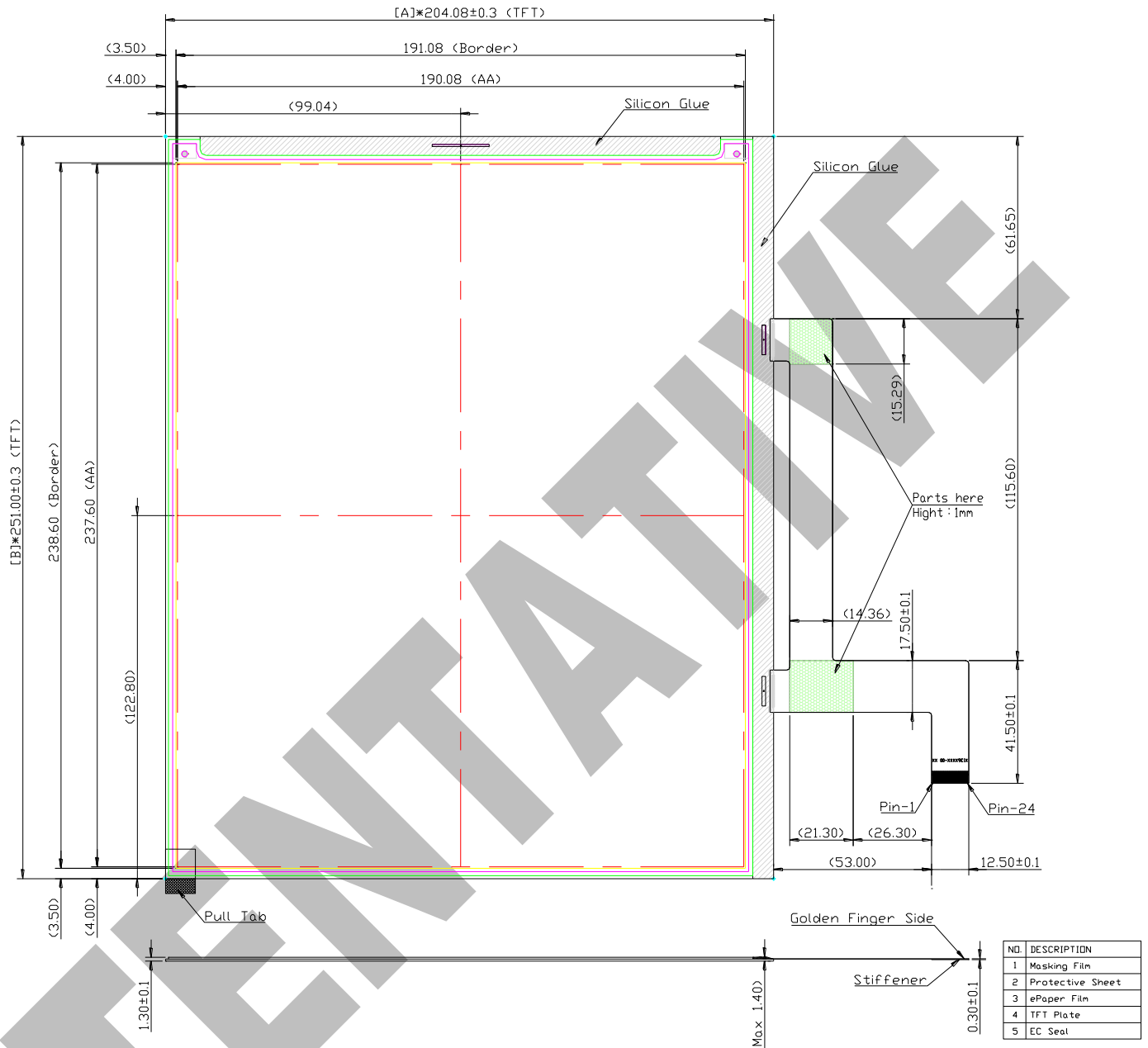
Note (1): Not including the Masking Film.

Table 1-3 FPC Specification

Item	Pin numbers	Pitch (mm)	Connector	Note
Golden Finger	24	0.5	HRS FH34SRJ 24S or Compatible	(1)

Note (1): HRS FH34SRJ 24S is 24-pins connectors. The 24 pins are used to connect FPC pads of EPD. Please refer PDI demo kit for detailed connection.

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),(4)
Storage Humidity	H _{ST}	40	70	%RH	(1),(3),(4)
Operating Ambient Temperature	T _{OP}	10	+40	°C	(1),(2),(3),(4)
Operating Ambient Humidity	H _{OP}	40	70	%RH	(1),(2),(3),(4)
Optimal Storage Temperature	T _{OST}	-10	+35	°C	(1),(3),(4)
Optimal Storage Humidity	H _{OST}	45	65	%RH	(1),(3),(4)

Note (1):

- (a) 70 %RH Max. ($T_a \leq 40 \text{ }^\circ\text{C}$), 40%RH Min. ($T_a \leq 60 \text{ }^\circ\text{C}$) where T_a is ambient temperature.
- (b) No condensation and no frost in absolute ratings of Environment.

Note (2): The temperature of panel display surface area should be 10 °C Min. and 40°C Max. Refresh time depends on operating temperature.

Note (3): Reddish on the edge of black image is normal at high temperature.

Note (4): E Ink Material is Moisture and UV sensitive. The absolute rating operating environments describes the boundary conditions for updating the display while the absolute rating storage environment describe the boundary conditions for a display not updating. While displays are rated to perform according to specification for the warranty period at the absolute specified operating environment, the better the storage condition, the better the E Ink displays will perform. Similar to other moisture and UV sensitive components, we recommend that our displays be stored in temperature and humidity control environments, and whenever possible, under above defined Optimal Storage Condition, away from sunlight, to optimize their performance.

Note (5): The performance of EPD may be degraded under sunlight. Please customer consults PDI if customer wants to use EPD under sunlight.

2.2 Reliability Test Item

Table 2-2 Reliability Test Items

Item	Test Condition	Remark
High Temperature Operation	40 °C / 30 %RH for 240h	(1) (2)
Low Temperature Operation	10 °C for 240h	(1) (2)
High Temperature/Humidity Operation	40 °C / 70 %RH for 240h	(1) (2)
High Temperature Storage	60 °C / 40 %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 240h	(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 with product specification and IIS.

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.

2.3 Product Warranty

Warranty conditions have to be negotiated between PDI and individual customers. PDI provides 13months warranty for all products which are purchased from PDI.

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_{DDIO}	-0.3	5.0	V	
Analog Power	V_{DD}	-0.3	5.0	V	
Ground	V_{SS}	-		-	Connect V_{SS} to Ground

$T_a = 25 \pm 2 \text{ }^\circ\text{C}$

3.2 Recommended Operation Conditions of Panel

Table 3-2 Recommended Operation Conditions of Panel

Parameter	Symbol	Value			Unit	Note
		Min	Typ.	Max		
V_{DDIO} , V_{DD} operation voltage	V_{DDIO} , V_{DD}	2.3	3.0	3.6	V	V_{DDIO} , V_{DD} must be stable. (1)
Input Voltage	High	V_{IH}	$0.8V_{DDIO}$	-	V	
	Low	V_{IL}	-	$0.2V_{DDIO}$	V	
Output Voltage	High	V_{OH}	$0.8V_{DDIO}$	V_{DDIO}	V	$V_{DDIO}=2.4V$ $I_{OUT}=1mA$
	Low	V_{OL}	V_{SS}	$0.2V_{DDIO}$	V	$V_{DDIO}=2.4V$ $I_{OUT}=1mA$
Input Current (standard price / bit_checked)	I_{CC}	-	24.4 / 71.3	-	mA	(1), (2), (3)
Peak Current (standard price / bit_checked)	I_{PEAK}	-	135.6 / 167.1	-	mA	(1), (2), (3)
Power Consumption (standard price / bit_checked)	-	-	1000.4 / 2923.3	-	mAs	(1), (2), (3)

$T_a = 25 \pm 2 \text{ }^\circ\text{C}$

Note (1):

Figure 3-1 Test Pattern of Panel



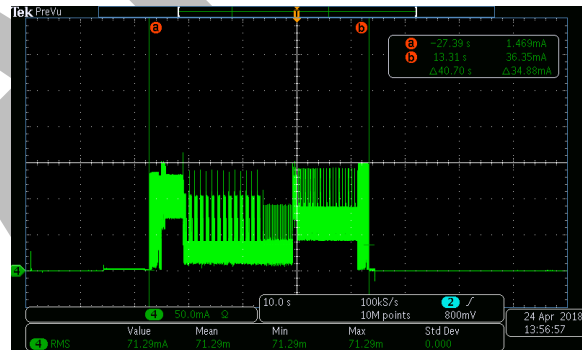
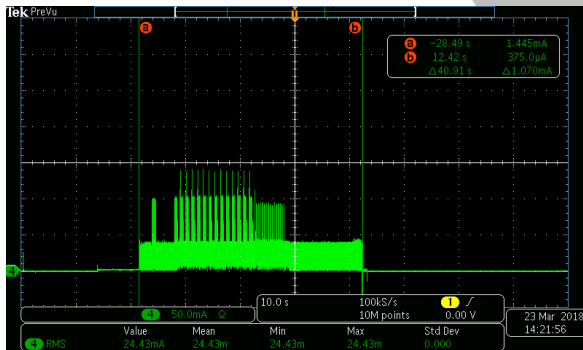
Standard Price

bit_checked

These currents are tested with PDI test jig. And the power must be stable.

Note (2): $V_{DDIO}=V_{DD}=3.0V$

Figure 3-2 Image Update Current Profile

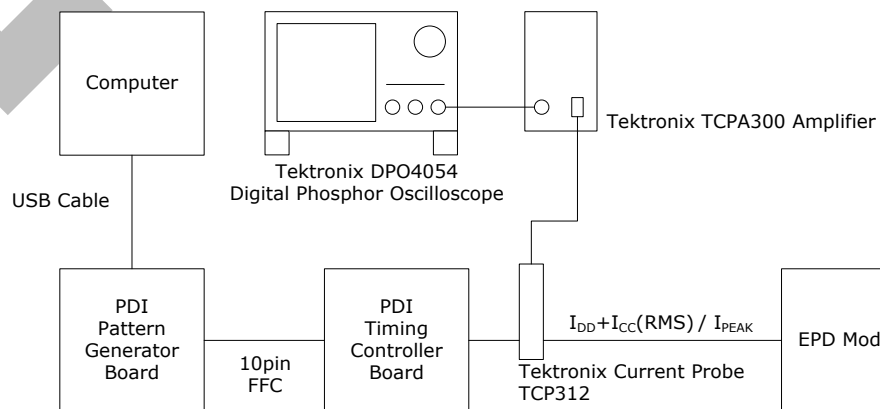


Standard Price

bit_checked

Note (3):

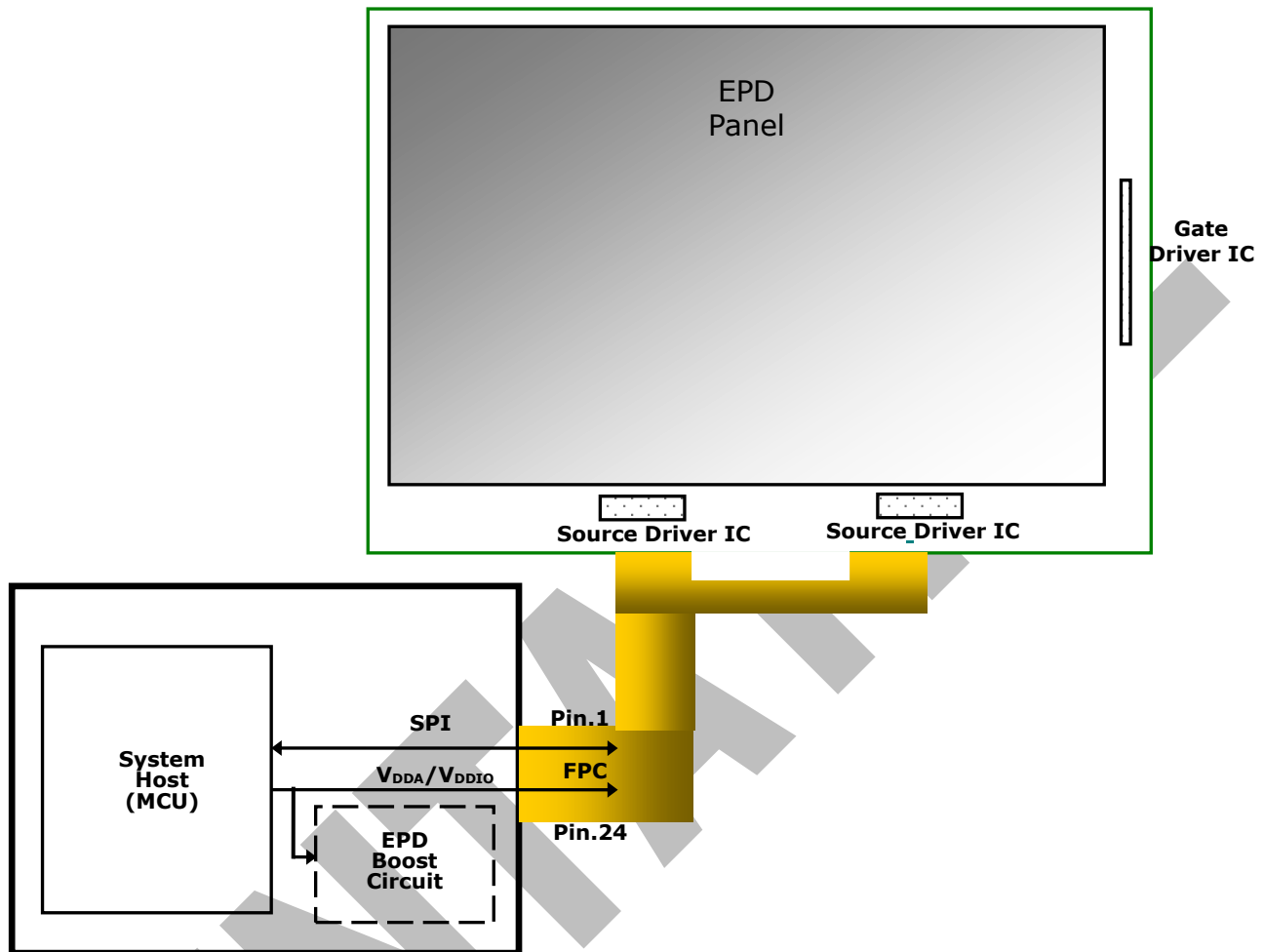
Figure 3-3 Current Measurement



*Set oscilloscope filter to 250MHz and record length to 1M points

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	S_CSB	I	VDDIO or VSS	This pin is the slave chip select.
2	NGDRV	O	Power MOSFET Driver control	This pin is the N-Channel MOSFET Gate Drive Control.
3	RESE	I	Booster Control Input	This pin is the Current Sense Input for the Control Loop.
4	NC	-	-	Not connected
5	VDHR	C	-	A stabilizing capacitor should be connected between VDHR and VSS.
6	NC	-	-	Not connected
7	NC	-	-	Not connected
8	BS	I	VSS	This pin is setting panel interface.
9	M_BUSY	O	Device Busy Signal	This pin is Busy state output pin of the master chip. When Busy is Low, the operation of the chip should not be interrupted, and Command should not be sent.
10	RESETB	I	System Reset	This pin is reset signal input. Active Low.
11	A0	I	VDDIO or VSS	This pin is Data/Command control.
12	M_CSB	I	VDDIO or VSS	This pin is the master chip select.
13	SCL	I	Data Bus	Serial communication clock input.
14	SDA	I	Data Bus	Serial communication data input/output.
15	VDDIO	P	Power Supply	Power for interface logic pins & I/O. It should be connected with VDDIO.
16	VDD	P	Power Supply	Power Supply for the chip.
17	VSS	P	Ground	Ground

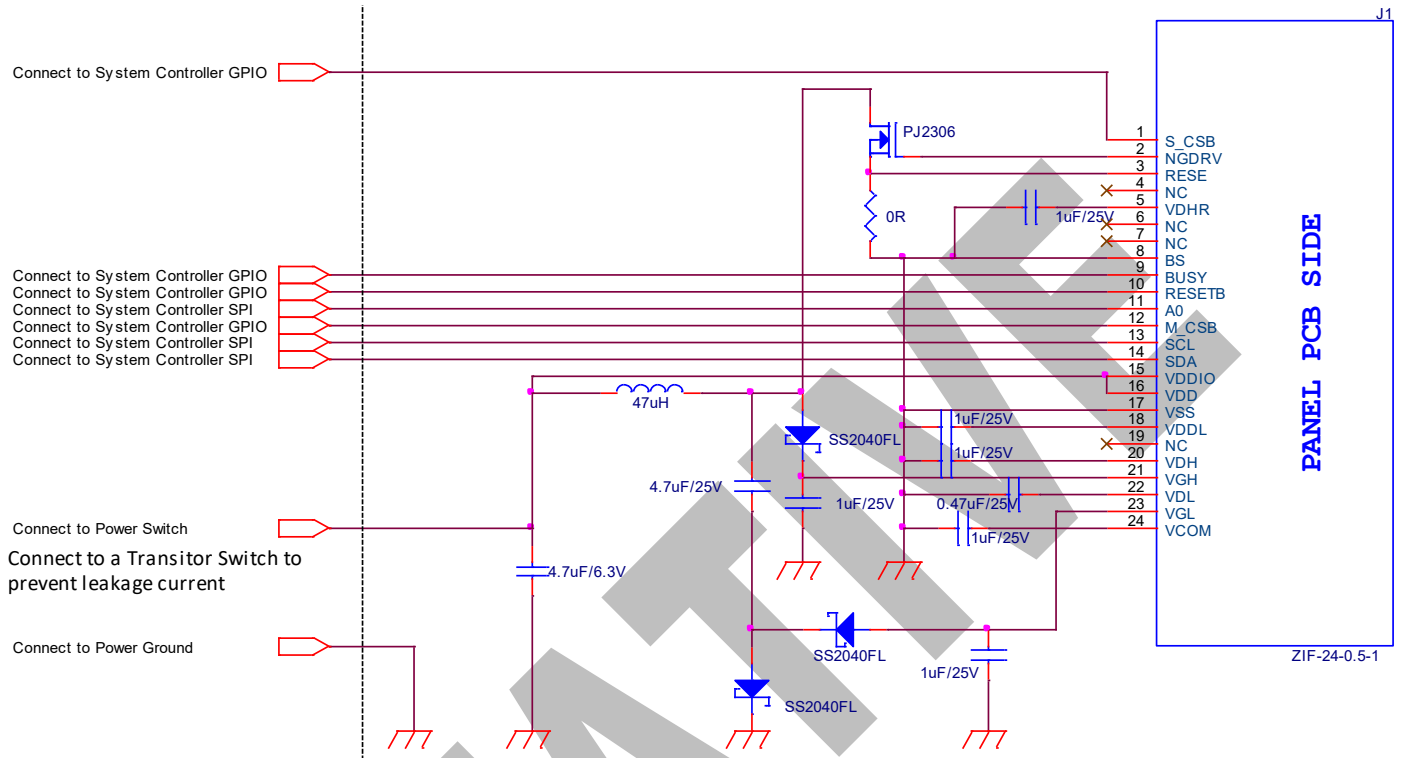
No.	Signal	Type	Connected to	Function
18	VDDL	C	Capacitor	Internal regulator output A capacitor should be connected between VDDL and VSS.
19	NC	-	-	Not connected
20	VDH	C	Capacitor	This pin is the Positive Source driving voltage. A stabilizing capacitor should be connected between VDH and VSS.
21	VGH	C	Capacitor	This pin is the Positive Gate driving voltage. A stabilizing capacitor should be connected between VGH and VSS.
22	VDL	C	Capacitor	This pin is the Negative Source driving voltage. A stabilizing capacitor should be connected between VDL and VSS.
23	VGL	C	Capacitor	A stabilizing capacitor should be connected between VGL and VSS.
24	VCOM	C	Capacitor	This pin is the VCOM driving voltage A stabilizing capacitor should be connected between VCOM and VSS.

Note:

Type: I: Input
 O: Output
 C: Capacitor
 P: Power

5.2 Reference Circuit

Figure 5-1 EPD Reference Circuit



Type	Part	Quantity	Vendor	Note
Inductor	47uH 0.3A ETPRH3D16B-470M, 3.8X3.8X1.8	1pc		
Transistor	PJ2306 SOT-23 N-Channel 30V/3.2A	1pc	PANJIT	(1)
Diode	SS2040FL SOD-123FL	3pcs	PANJIT	(2)
Capacitors	4.7uF/6.3V	1pc	-	
Capacitors	4.7uF/25V	1pc	-	
Capacitors	0.47uF/25V	1pc	-	
Capacitors	1uF/25V	6pcs	-	
Resistors	0R ohm	1pc	-	

Note:

- (1) PJ2306 is a N-Channel Power MOSFET. The specification of selection criteria are $R_{DS} < 100$ mohm (the lower the better), $V_{DSS} = 30V$, $V_{GS-th} < 2.5V @ 250uA$.
- (2) SS2040FL is a Schottky diode needs the V_f as lower as possible, 0.2 to 0.4V and the repetitive peak reverse voltage $> 25V$.

6 Optical Characteristics

6.1 Measurement 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 _{DDA} /V _{DDIO}	3.0	V

Note: Image is updated with above condition.

6.2 Optical Specifications

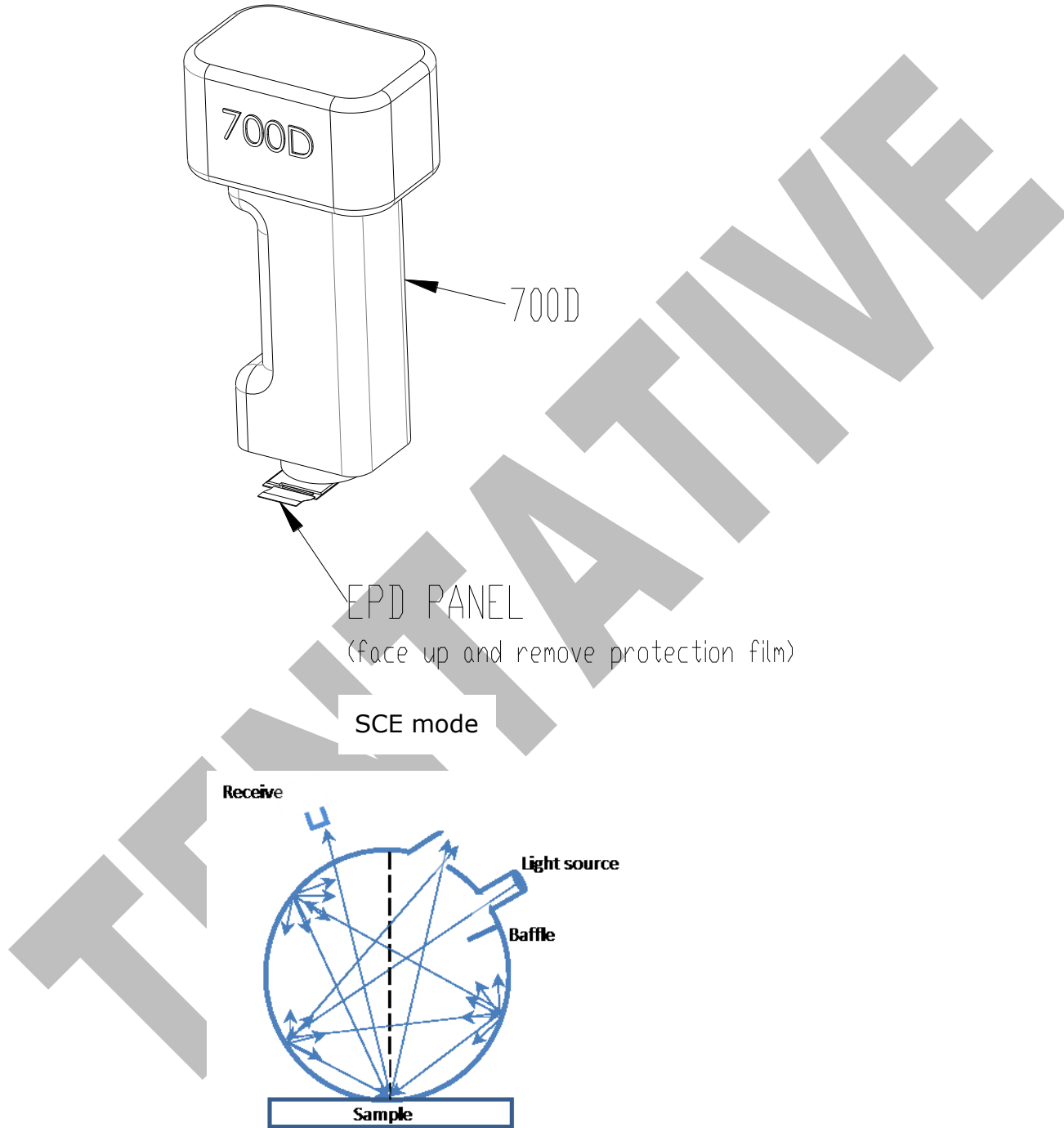
6.2.1 Optical

Table 6-2 Optical Measurement with D65 light source

Item	Color	Symbol	Rating			Unit	Note
			Min.	Typ.	Max.		
Contrast ratio	Black/White	CR	-	22	-	-	$\theta_x=\theta_y=0$ (1),(2),(5),(6)
Refresh time	Black/White/Red	Tr (Black/White/Red)	-	41.0	-	sec	(1),(3),(4),(6)
White state	White	L*	-	68.87	-	-	$\theta_x=\theta_y=0$ (1),(2),(6)
	White	a*	-	-2.45	-		
	White	b*	-	2.84	-		
Red state	Red	L*	-	29.68	-	-	$\theta_x=\theta_y=0$ (1),(2),(6)
	Red	a*	-	40.47	-		
	Red	b*	-	22.52	-		
Reflectance	White	R%	-	39.16	-	%	(1),(2),(6)

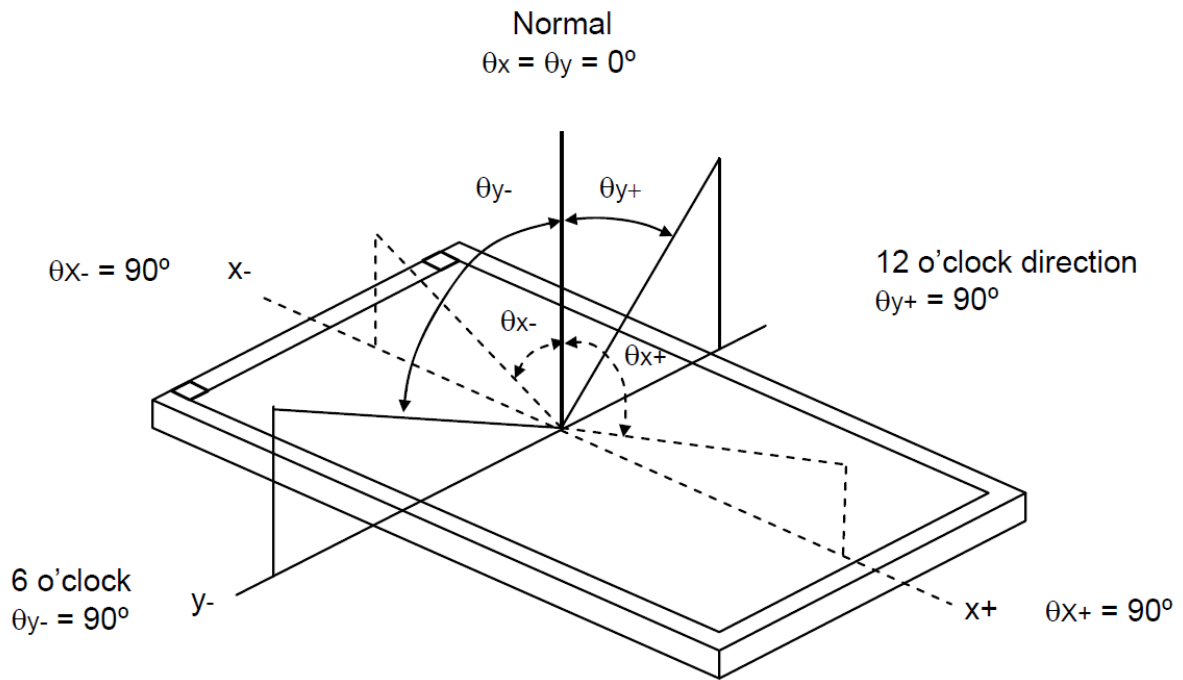
Note (1): Panel is driven by PDI waveform without masking film and optical measurement by CM-700D with D65 light source and SCE mode.

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

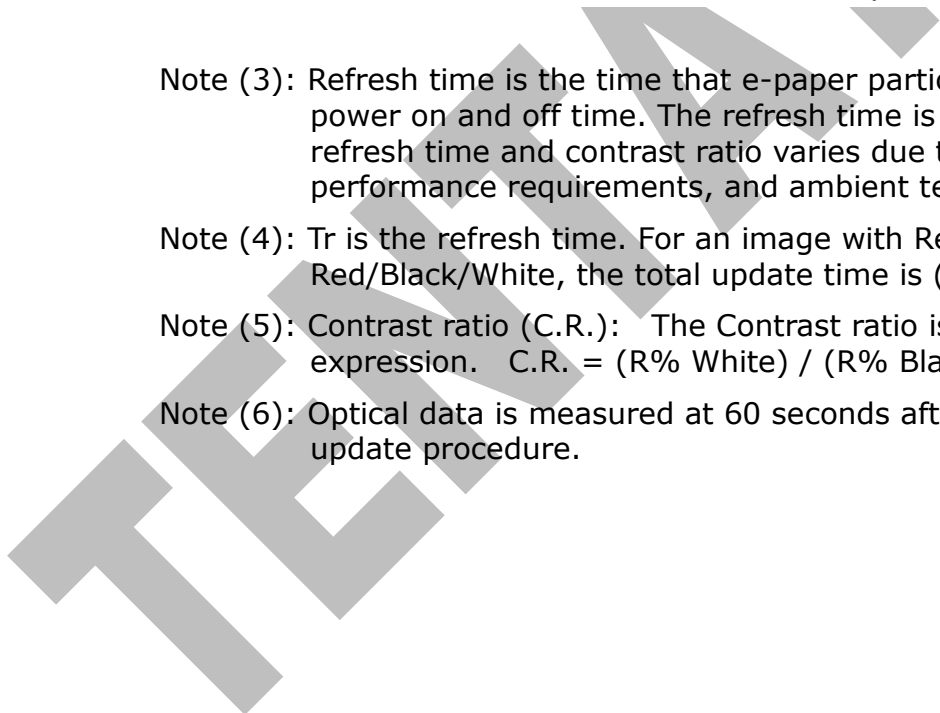


Note (3): Refresh time is the time that e-paper particles move not including the power on and off time. The refresh time is measured at 25 °C. The refresh time and contrast ratio varies due to different films, display performance requirements, and ambient temperatures.

Note (4): T_r is the refresh time. For an image with Red, Red/White, Red/Black, or Red/Black/White, the total update time is (T_r).

Note (5): Contrast ratio (C.R.): The Contrast ratio is calculated by the following expression. $C.R. = (R\% \text{ White}) / (R\% \text{ Black})$.

Note (6): Optical data is measured at 60 seconds after refresh with PDI's global update procedure.



6.2.2 Ghosting

Below is test method to verify if ghosting is within an acceptable range. The measured data (L^* , a^* , b^*) to calculate color different, ΔE_{00} (CIEDE 2000). The condition of measurement is to follow "Table 6-1 Optical Measurement Conditions"

- Ghosting Measurement

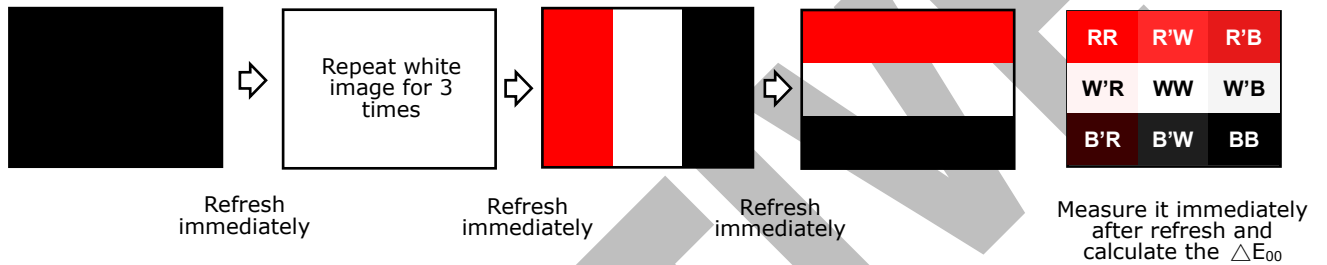


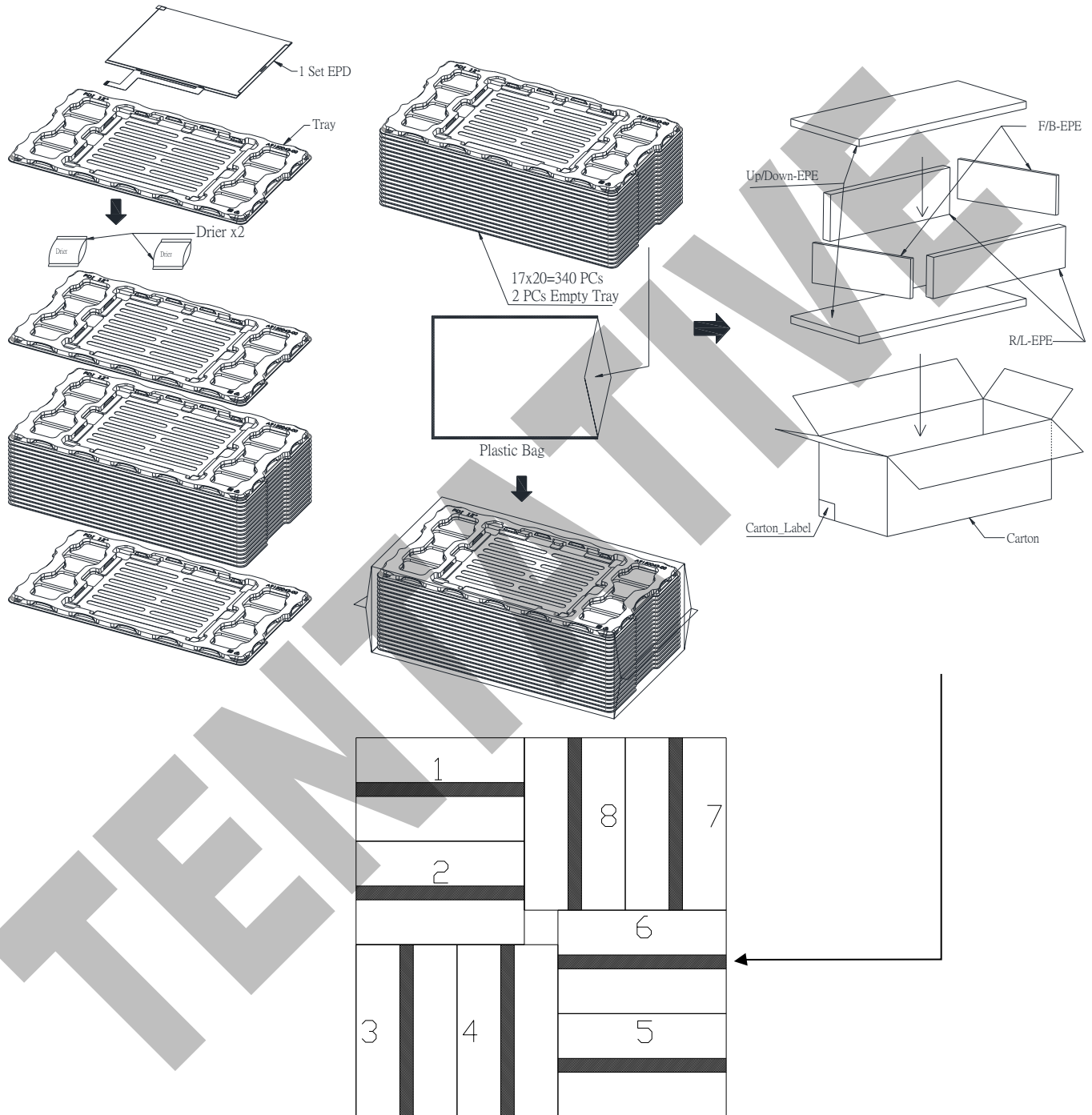
Table 6-3 Measurement of Ghosting

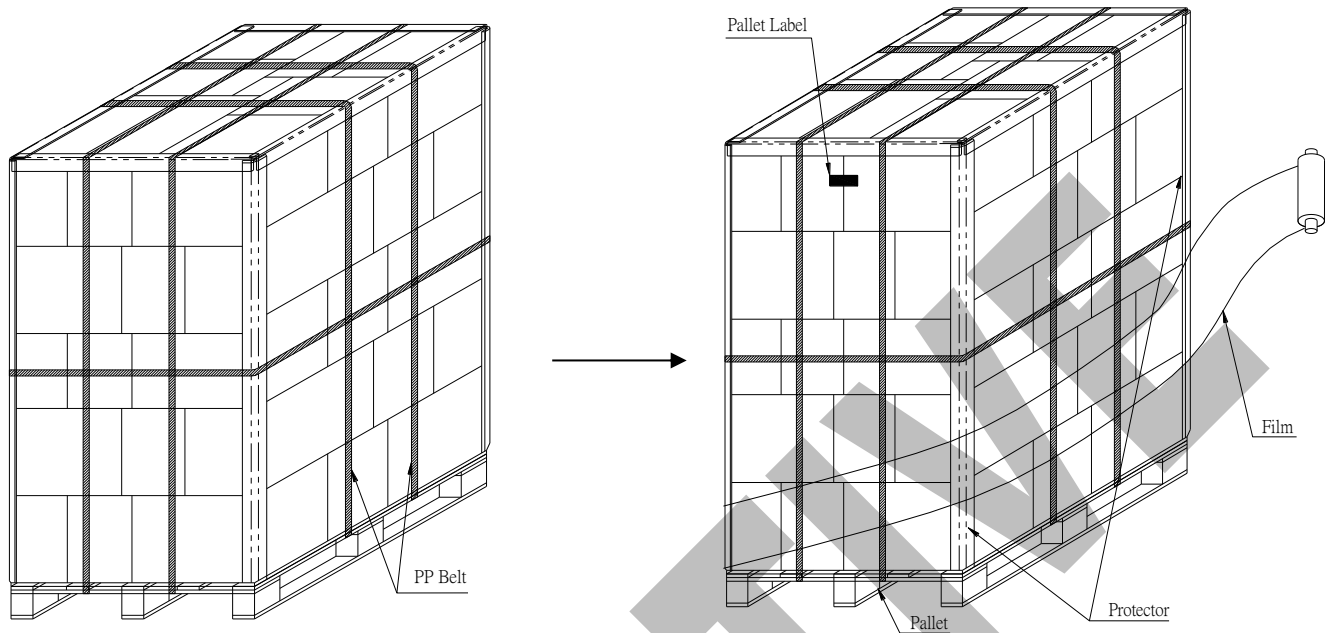
Item	Rating		
	Min.	Typ.	Max.
B'W ΔE_{00}	-	-	2
W'B ΔE_{00}	-	-	2
R'W ΔE_{00}	-	-	TBD
W'R ΔE_{00}	-	-	TBD
B'R ΔE_{00}	-	-	TBD
R'B ΔE_{00}	-	-	TBD

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

7 Packing

Figure 7-1 Packing Diagram





17 (pcs) x 40 (BOX) = 680 pcs

	12" EPD BOX
N.W. :	2.1 Kg
G.W. :	5.8 Kg

Sea / Land / Air Transportation

