Customer	**STANDARD**
Description	**12” TFT EPD Panel**
Model Name	**E2B98KS063**
Date	**2024/08/01**
Doc. No.	**1P411-00**
Revision	**01**

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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Revision History

Version	Date	Page (New)	Section	Description
01	2024/08/01	All	All	Specification first issued

Glossary of Acronyms

COG	Chip on Glass
EPD	Electrophoretic Display (e-Paper Display)
EPD Module	EPD with TCon board
EPD Panel	EPD
FPC	Flexible Printed Circuit
FPL	Front Plane Laminate
IIS	Incoming Inspection Standard
ISTA	International Safe Transit Association
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 TFT active matrix Electronic Paper Display (EPD) module. The module has such high resolution (103 dpi) that it is able to easily display fine patterns. Due to its bi-stable nature, the EPD module 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: 960 x 768
- Ultra low power consumption
- Super Wide Viewing Angle - near 180°
- SPI interface
- RoHS compliant

1.3 Applications

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

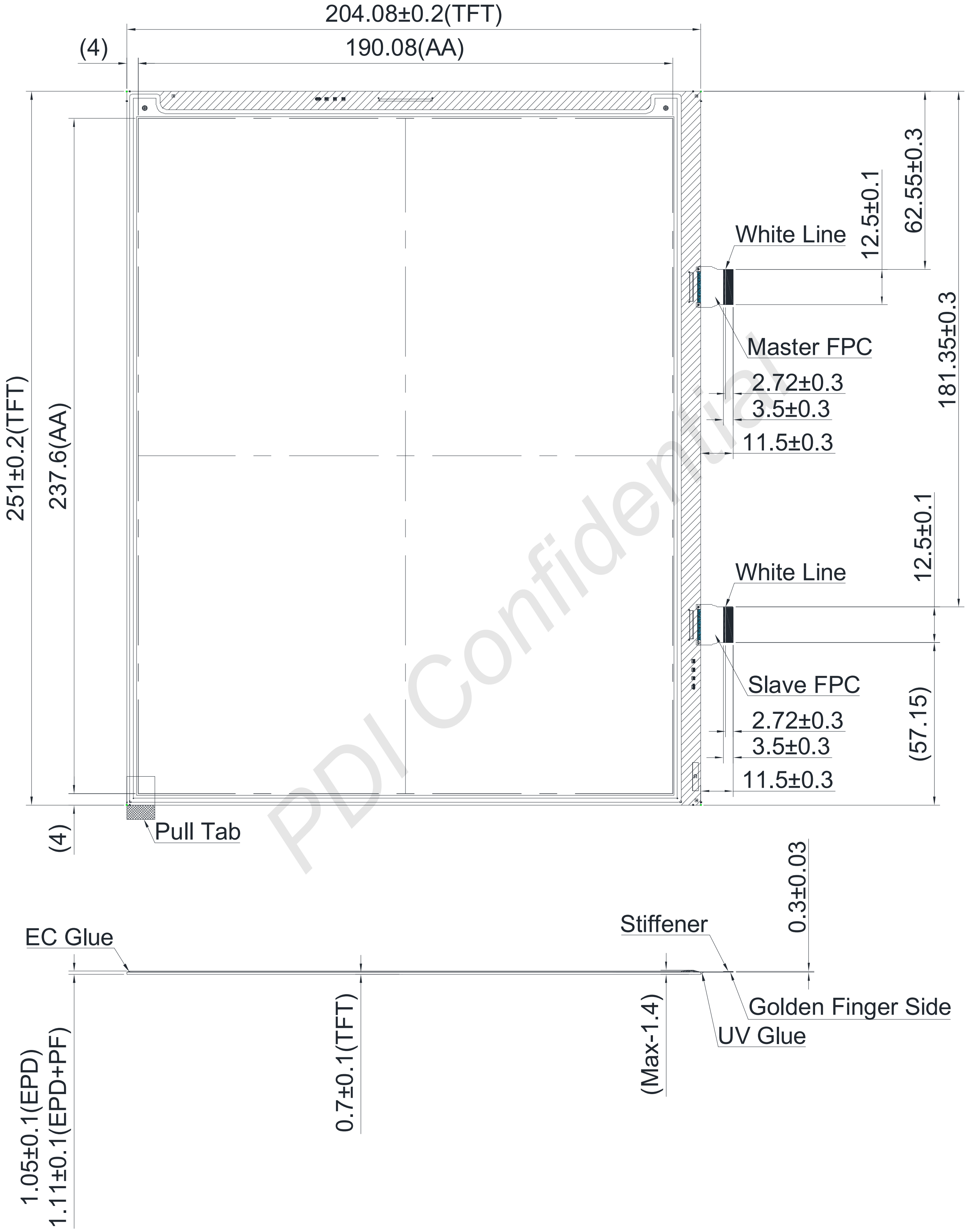
1.4 General Specifications

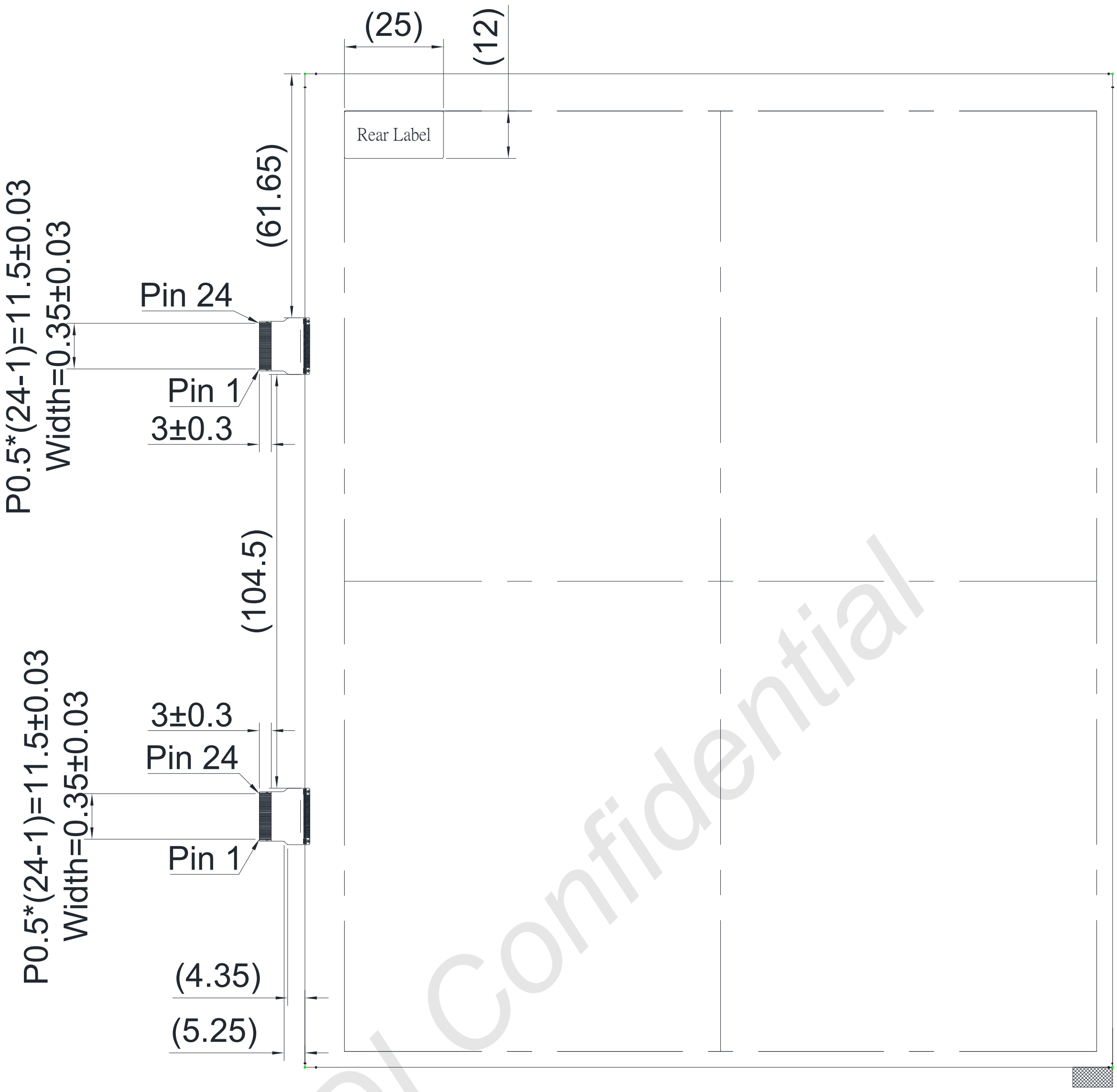
Table 1-1 General Specification

Item	Specification	Unit	Note
Outline Dimension	204.08(H) x 251(V) x 1.05(T)	mm	(1)
Active Area	190.08(H) x 237.6(V)	mm	
Driver Element	a-Si TFT active matrix	-	
FPL	Wide temperature	-	
Pixel Number	768 x 960	pixel	
Pixel Pitch	0.2475 x 0.2475 (103dpi)	mm	
Pixel Arrangement	Vertical stripe	-	
Display Colors	Black/White	-	
Surface Treatment	Anti-Glare	-	
Weight	110	g	

Note (1): Not including the FPC.

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}	-25	+70	°C	(1),(2)
Storage Humidity	H_{ST}	30	90	%RH	(1),(2)
Operating Ambient Temperature	T_{OP}	-15	60	°C	(1),(3)
Operating Ambient Humidity	H_{OP}	30	90	%RH	(1),(3)
Optimal Storage Temperature	T_{OST}	-10	35	°C	(1),(2)
Optimal Storage Humidity	H_{OST}	40	60	%RH	(1),(2)

Note (1):

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

(b) No condensation and no frost in absolute ratings of Environment.

Note (2): 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 (3): The performance of EPD may be degraded under sunlight. Please customer consults PDI if customer wants to use EPD under sunlight.

Note (4): Fast update mode is supported at 0~50°C. (Please execute normal update mode when the image gets worse.)

2.2 Reliability Test Item

Table 2-2 Reliability Test Items

Item	Test Condition	Remark
High Temperature Operation	60°C / 30 %RH for 240h	(1) (2)
Low Temperature Operation	-15°C for 240h	(1) (2)
High Temperature/Humidity Operation	40°C / 90 %RH for 240h	(1) (2)
High Temperature Storage	70°C / 30 %RH for 240h	(1)(2)(3)
Low Temperature Storage	-25°C for 240h	(1)(2)(3)
High Temperature/Humidity Storage	60°C / 80 %RH for 240h	(1)(2)(3)
Thermal Cycles (non-operation)	1 Cycle: -20°C /30min → 70°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 13 months 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		
Supply Voltage	V_{DD}, V_{DDIO}	-0.3	5.0	V	
Ground	GND	-		-	Connect to Ground

T_a = 25 ± 2 °C

3.2 Recommended Operation Conditions of Panel

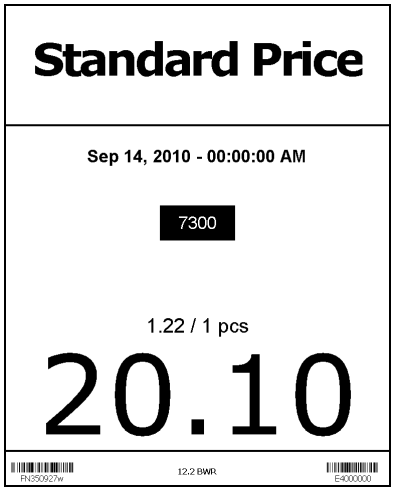
Table 3-2 Recommended Operation Conditions of Panel

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
V_{DDIO}, V_{DD} operation voltage		V_{DDIO}, V_{DD}	2.3	3.0	3.6	V	
Input Voltage	High	V_{IH}	0.8V_{DDIO}	-	V_{DDIO}	V	V_{DDIO}=V_{DD}
	Low	V_{IL}	V_{SS}	-	0.2V_{DDIO}	V	
Output Voltage	High	V_{OH}	0.8V_{DDIO}	-	V_{DDIO}	V	V_{DDIO}=V_{DD}=2.4V I_{OUT}=1mA
	Low	V_{OL}	V_{SS}	-	0.2V_{DDIO}	V	V_{DDIO}=V_{DD}=2.4V I_{OUT}=-1mA,
Input Current		I_{DD}	-	33.1	-	mA	(1), (2), (3)
Peak Current		I_{PEAK}	-	99.3	-	mA	

T_a = 25 ± 2 °C

Note (1):

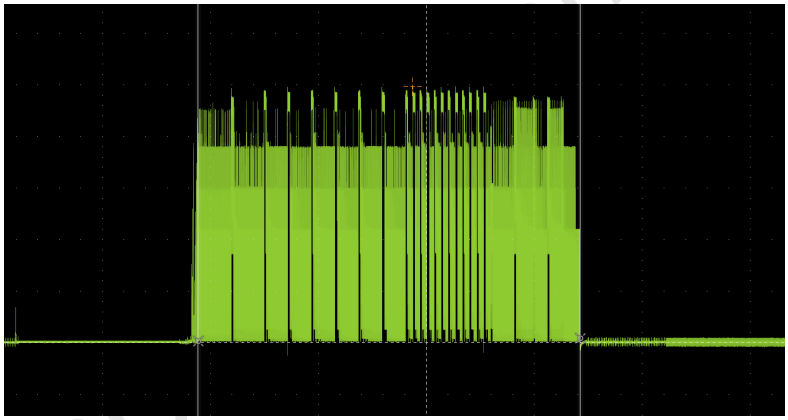
Figure 3-1 Test Pattern of Panel



These currents are tested with PDI test jig.

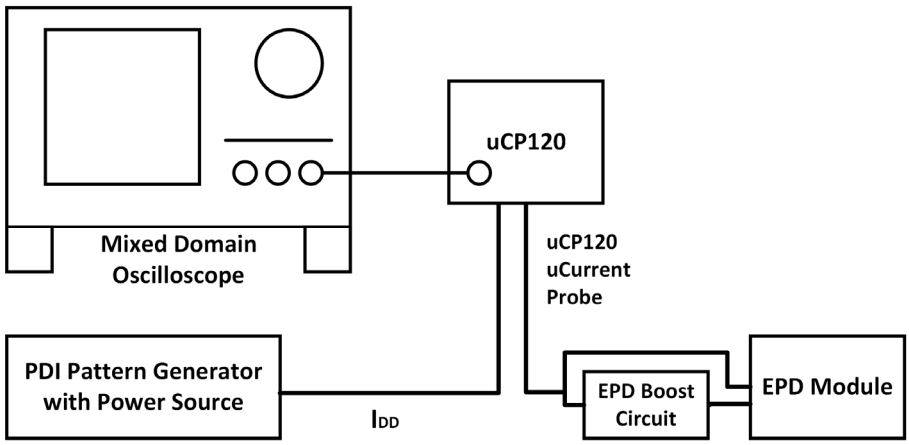
Note (2): $V_{DDIO}=V_{DD}=3.0V$

Figure 3-2 Image Update Current Profile



Note (3):

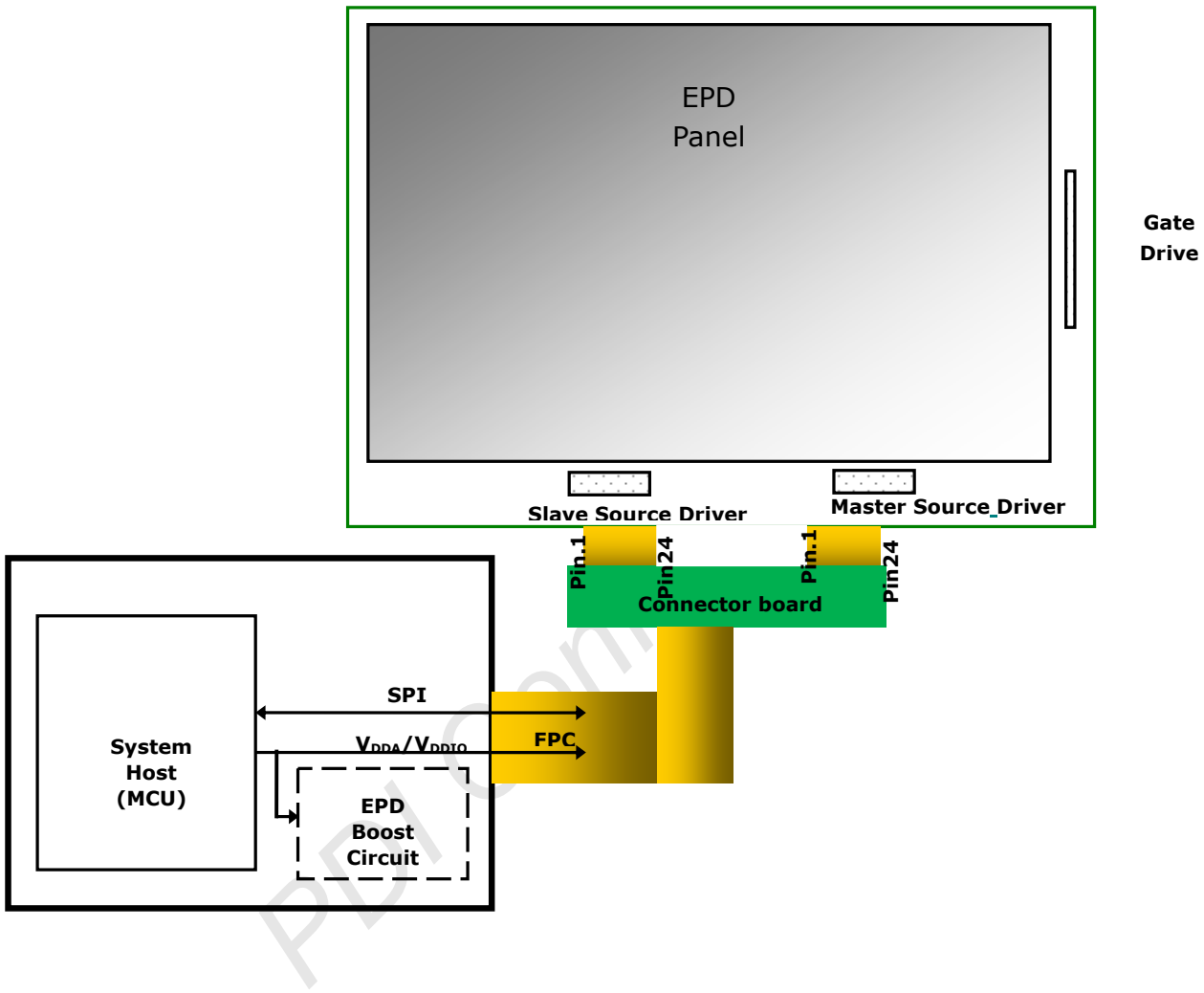
Figure 3-3 Current Measurement



*Set oscilloscope filter to >200MHz and record length to 10M 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 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.There are two FPCs on EPD panel. Please refer PDI demo kit for detailed connection.

Table 5-2 Terminal Pin Assignment (Master FPC)

No.	Signal	Type	Connected to	Function
1	FSYNC	I/O	Slave FSYNC	Cascade line frame sync
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	INTERNAL_VPP	P	Master & Slave VPP Pin	MTP power (internal)
5	VDHR	C	Capacitor	This pin is the VDHR driving voltage. A stabilizing capacitor should be connected between VDHR and VSS.
6	LNSYNC	I/O	Slave LNSYNC pin	Cascade line sync
7	CLK	I/O	Slave CLK pin	Cascade clock
8	BS	I	GND	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 GND	This pin is Data/Command control.
12	M_CSB	I	VDDIO or GND	This pin is the Master chip select.
13	SCL	I	Data Bus	Serial communication clock input.

No.	Signal	Type	Connected to	Function
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	GND	Ground
18	VDDL	C	Capacitor	Internal regulator output A capacitor should be connected between VDDL and GND.
19	VPP	P	INTERNAL_VPP& Slave VPP	MTP power
20	VDH	C	Capacitor	This pin is the Positive Source driving voltage. A stabilizing capacitor should be connected between VDH and GND.
21	VGH	C	Capacitor	This pin is the Positive Gate driving voltage A stabilizing capacitor should be connected between VGH and GND.
22	VDL	C	Capacitor	This pin is the Negative Source driving voltage. A stabilizing capacitor should be connected between VDL and GND.
23	VGL	C	Capacitor	This pin is the Negative Gate driving voltage. A stabilizing capacitor should be connected between VGL and GND.
24	VCOM	C	Capacitor	This pin is the VCOM driving voltage A stabilizing capacitor should be connected between VCOM and GND.

Table 5-3 Terminal Pin Assignment (Slave FPC)

No.	Signal	Type	Connected to	Function
1	FSYNC	I/O	Master FSYNC pin	Cascade line frame sync
2	NC	-	-	Not connected
3	NC	-	-	Not connected
4	NC	-	-	Not connected
5	VDHR	C	Master VDHR Pin	This pin is the VDHR driving voltage. A stabilizing capacitor should be connected between VDHR and VSS.
6	LNSYNC	I/O	Master LNSYNC pin	Cascade line sync
7	CLK	I/O	Master CLK pin	Cascade clock
8	BS	I	GND	This pin is setting panel interface.

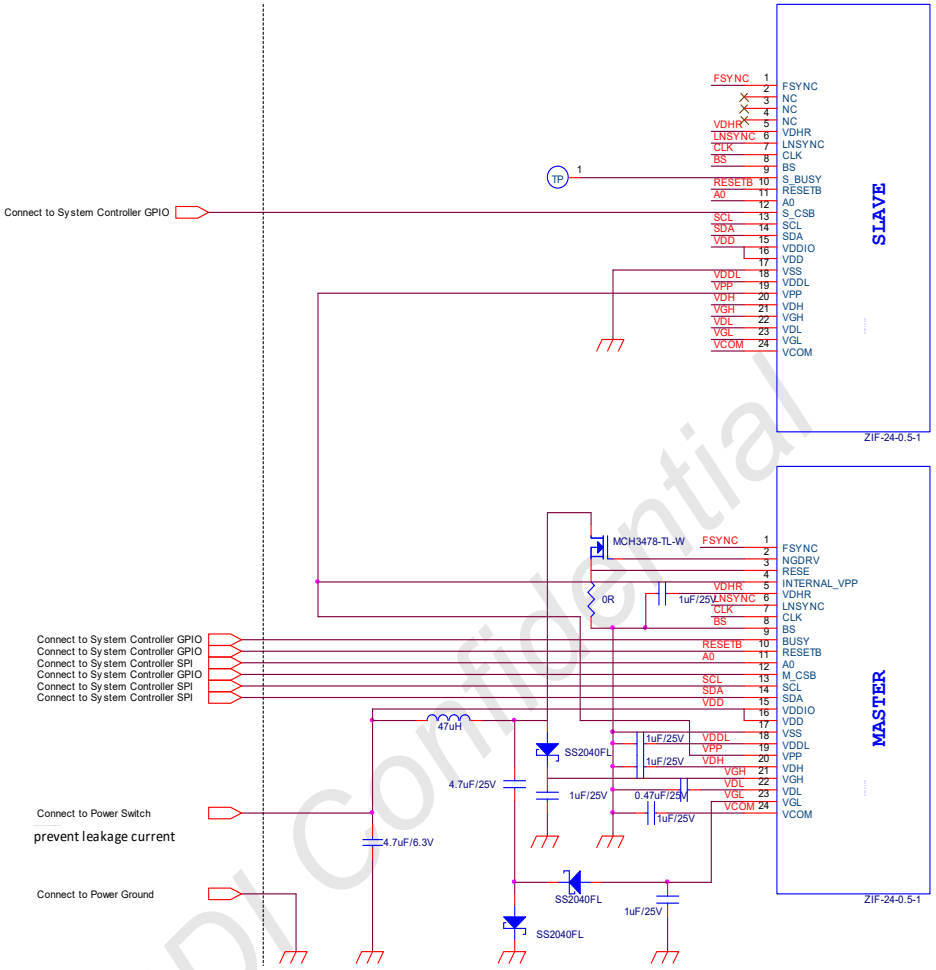
No.	Signal	Type	Connected to	Function
9	S_BUSY	O	Device Busy Signal	This pin is Busy state output pin of the slave chip. When Busy is Low, the operation of the chip should not be interrupted, and Command should not be sent.
10	RESETB	I	System Reset	This pin is reset signal input. Active Low.
11	A0	I	VDDIO or GND	This pin is Data/Command control.
12	S_CSB	I	VDDIO or GND	This pin is the Slave 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	GND	Ground
18	VDDL	C	Master VDDL Pin	Internal regulator output A capacitor should be connected between VDDL and GND.
19	VPP	P	INTERNAL_VPP	MTP power
20	VDH	C	Master VDH Pin	This pin is the Positive Source driving voltage. A stabilizing capacitor should be connected between VDH and GND.
21	VGH	C	Master VGH Pin	This pin is the Positive Gate driving voltage A stabilizing capacitor should be connected between VGH and GND.
22	VDL	C	Master VDL Pin	This pin is the Negative Source driving voltage. A stabilizing capacitor should be connected between VDL and GND.
23	VGL	C	Master VGL Pin	This pin is the Negative Gate driving voltage. A stabilizing capacitor should be connected between VGL and GND.
24	VCOM	C	Master VCOM Pin	This pin is the VCOM driving voltage A stabilizing capacitor should be connected between VCOM and GND.

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	1pc	ARLITECH	
Transistor	MCH3478 SOT-23 N-Channel 30V/2A	1pc	ON Semiconductor	(1)
Diode	SS2040FL SOD-123FL	3pcs	PANJIT	(2)

Note:

(1) MCH3478 (ON Semiconductor) is a N-Channel Power MOSFET. The specification of selection criteria is R_{DS}<235m ohm (the lower the better), V_{DSS}=30V, V_{GS}=2.5V@ID=0.5A.

(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_{DDIO} & V_{DD}	3.0	V

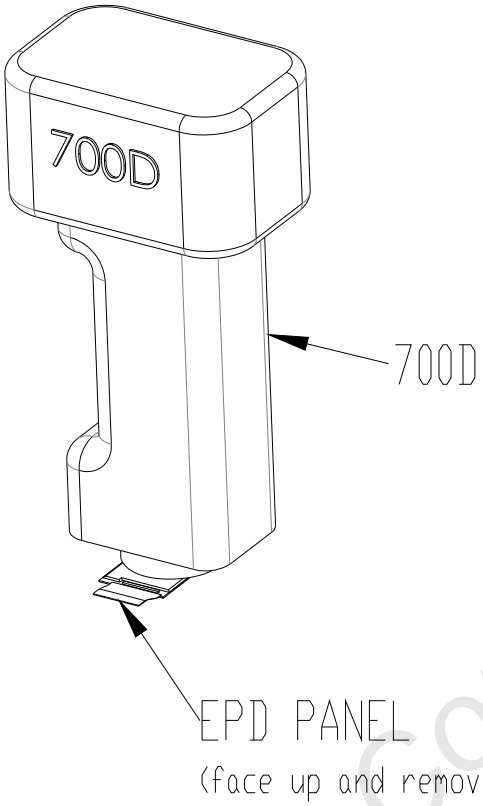
6.2 Optical Specifications

Table 6-2 Optical Measurement with D65 light source

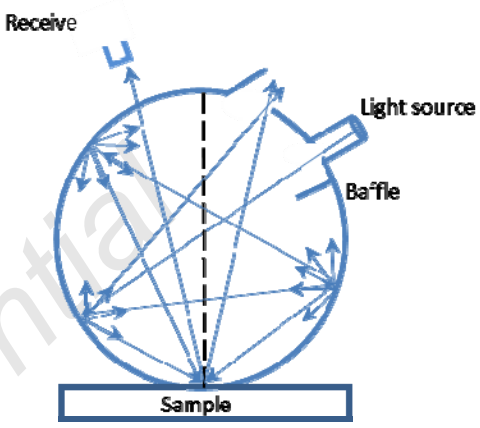
Item	Symbol	Rating			Unit	Note
		Min.	Typ.	Max.		
Contrast ratio	CR	-	11	-	-	θx=θy=0 (1),(2),(4),(5)
Refresh time	Tr	-	3.5	-	sec	(1),(3),(5)
White state	L*	-	70	-	-	θx=θy=0 (1),(2),(5)
	a*	-	-2.6	-		
	b*	-	1.7	-		
Reflectance	R%	36	-	-	%	(1),(2),(5)

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

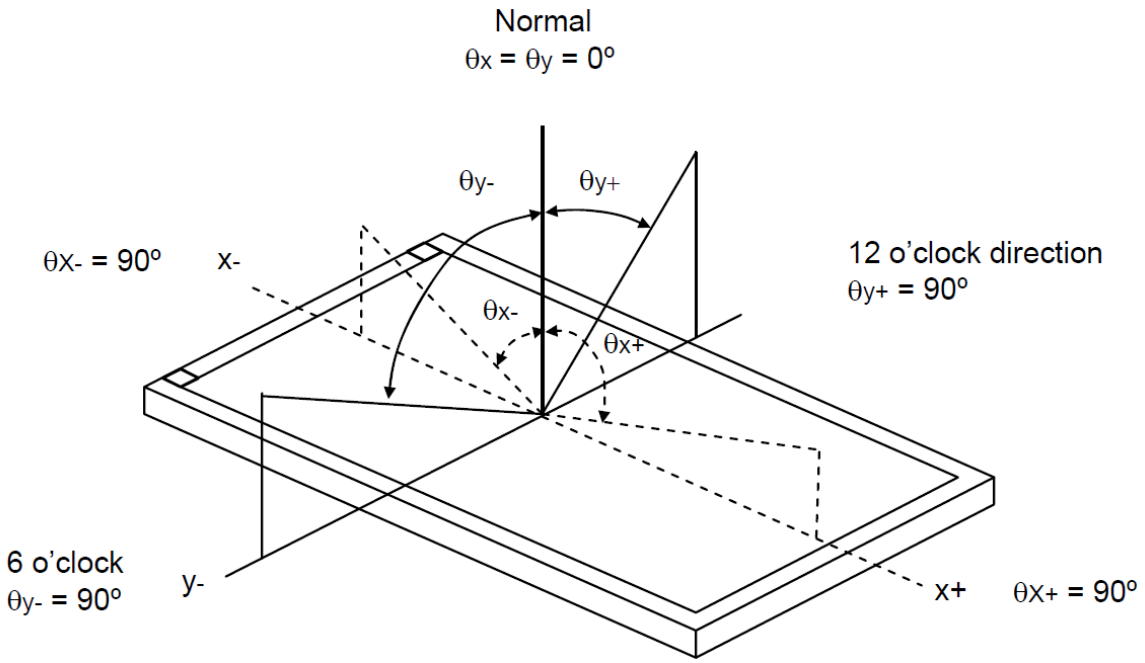


SCE mode



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 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% White) / (R% Black).

Note (5): Optical data is measured at 60 seconds after refresh with PDI's global update procedure.

6.3 Ghosting

Below are two test methods to verify if ghosting is within an acceptable range. Test 1 and Test 2 use measured data to calculate color different, $\triangle E_{00}$ (CIEDE 2000).

The condition of measurement is to follow " Table 6-1 Optical Measurement Conditions".

- Test 1: White to Black Ghosting

- Test 2: Black to White Ghosting

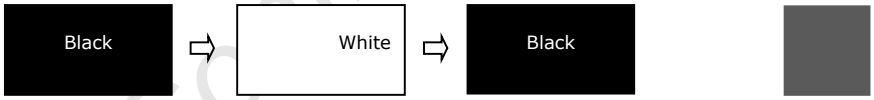


Table 6-3 Measurement of Ghosting

Item	Rating		
	Min.	Typ.	Max.
Test 1 $\triangle E_{00}$	-	-	2
Test 2 $\triangle E_{00}$	-	-	2

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