WINSTAR

WINSTAR Display
華凌光電股份有限公司

MODULE NO:
WAOG128096EBLWA00000
SPECIFICATION

CUSTOMER:

APPROVED BY	
PCB VERSION	
DATE	

FOR CUSTOMER USE ONLY

SALES BY	APPROVED BY	CHECKED BY	PREPARED BY

ISSUED DATE:

E-Paper Specification

Content:

MODLE NO：

RECORDS OF REVISION			DOC. FIRST ISSUE
VERSION	DATE	REVISED PAGE NO.	SUMMARY
0	2013.03.25		First issue
A	2013.05.09		Modify EPD Drawing

1.Module Classification Information

W	A	O	G	128096	E	B	L	W	A	00000
①	②	③	④	⑤	⑥	⑦	⑧	⑨	⑩	⑪

①	Brand：WINSTAR DISPLAY CORPORATION	
②	A：EPAPER	
③	IC Type：X→Tab Type, C→COB Type , O→COG Type	
④	Display Type：N→ ICON Type H→Character Type, G→Graphic Type	
⑤	Display Font. 128*96 dot	
⑥	Model serials ：E→Eink	
⑦	Display Color	B→Black & White ; R→Red & White ; L→Blue & White ; G→Gold & White ;
⑧	Back Plan Type：	P→FR4 ; L→Glass F→P1 ; F→PET
⑨	Module Type	W→Winstar D→Custom
⑩	Control board	0：Without Control board A : With TC Control board
⑪	Special Code	

2. General Description

2.1 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.

2.2 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

2.3 Applications

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

2.4 General Specifications

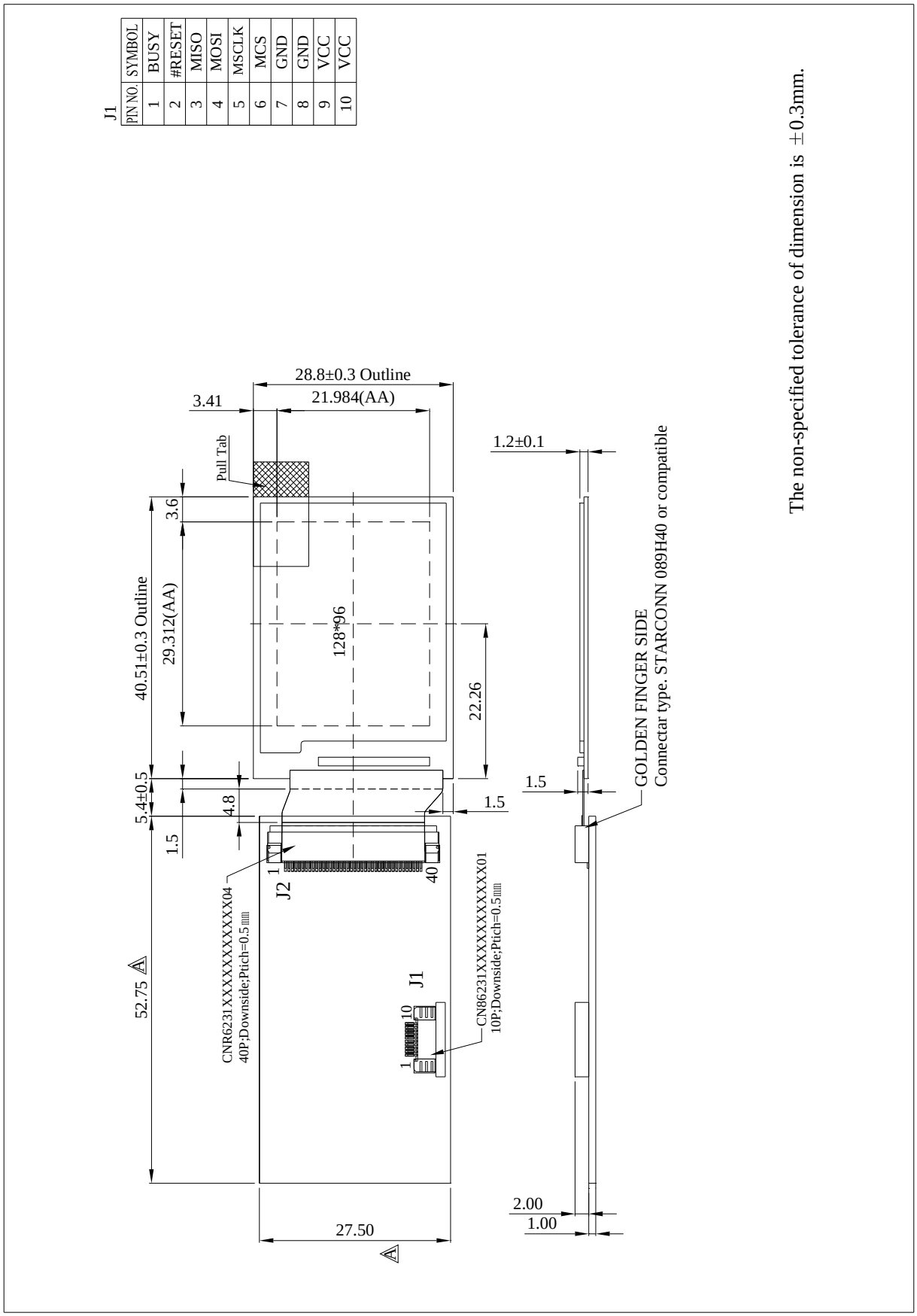
Table 2-1 General Specification

Item	Specification	Unit	Note
Outline Dimension	98.66(H) x 28.800(V) x 3.0	mm	(1)
Active Area	29.312(H) x 21.984(V)	mm	
Driver Element	a-Si TFT active matrix	-	
FPL	V110	-	
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	-	
MCU IC	ATMEGA88PA		

Note (1): including the FPC.

Note (1): Not including the Masking Film

Figure 2-1 EPD Drawing



3. Absolute Maximum Ratings

3.1 Absolute Ratings of Environment

Table 3-1 Absolute Ratings of Environment

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Storage Temperature	TST	-20	+60	ºC	(1)
Operating Ambient Temperature	TOP	0	+50	ºC	(1), (2)

Note (1):

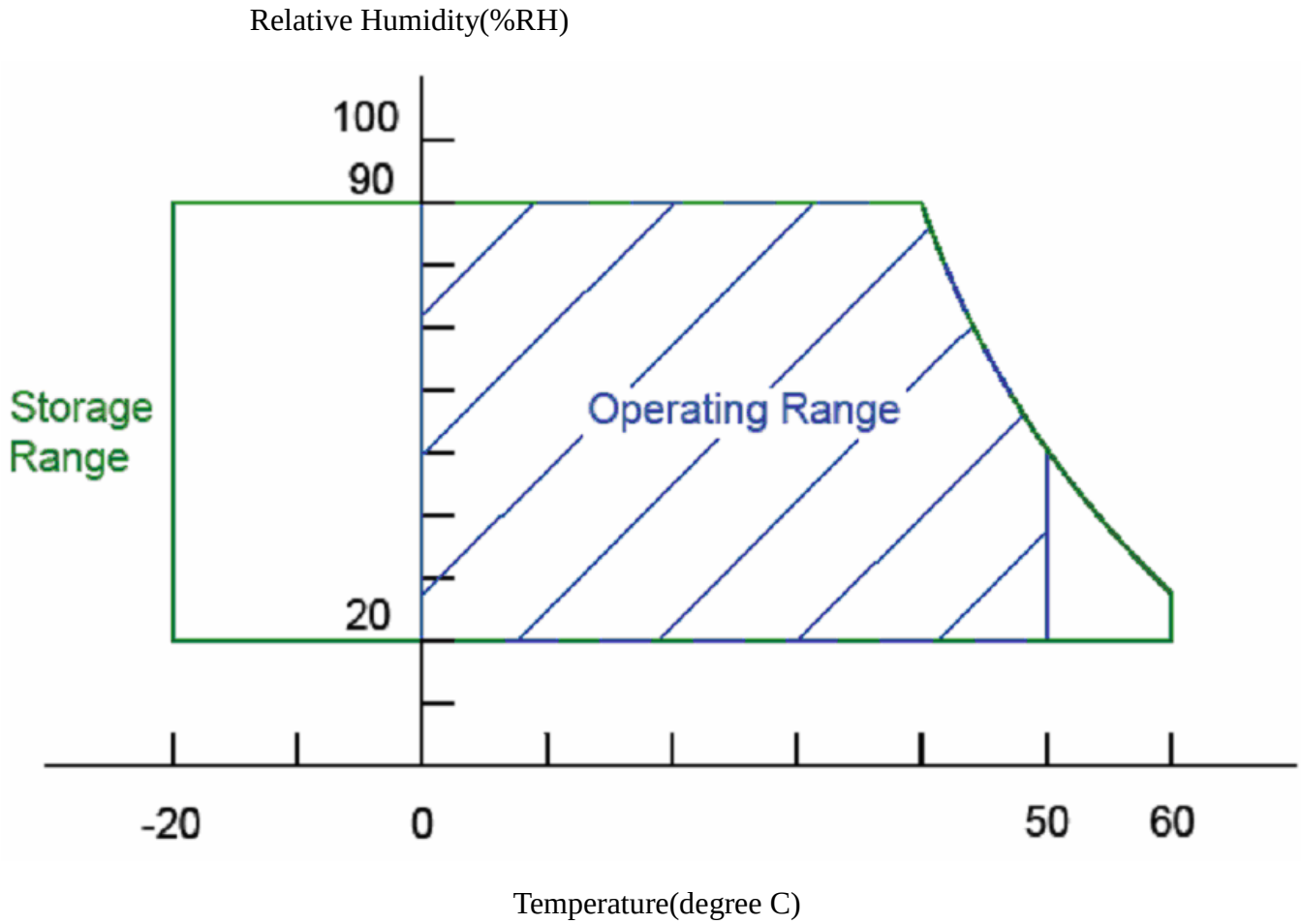
(a) 90 %RH Max. (Ta ≦ 40 ºC), where Ta is ambient temperature.

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

(c) No condensation.

Note (2): The temperature of panel display surface area should be 0 ºC Min. and 50 ºC Max. Refresh time depends on operation temperature.

Figure 3-1 Operating Range of Relative Humidity and Temperature



3.2 Reliability Test Item

Table 3-2 Reliability Test Items

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

Note (1): End of test, function, mechanical, and optical shall be satisfied.

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

4. Electrical Characteristics

4.1 Absolute Maximum Ratings of Panel

Table 4-1 Absolute Maximum Ratings of Panel

Parameter	Symbol	Value		Unit	
		Min	Max		
Digital Power	VCC	-0.3	5.0	V	
Ground	VSS	-		-	Connect VSS to Ground

Ta = 25 ± 2 ºC

4.2 Recommended Operation Conditions of EPM

Table 4-2 Recommended Operation Conditions of EPM

Parameter		Symbol	Value			Unit	Note
			Min	Typ	Max		
Digital Power		VCC	2.7	3	3.3	V	
Input Voltage	High	VIH	0.6Vcc	-	Vcc+0.5	V	/CS, ID, SCLK, SI, /RESET
	Low	VIL	-0.5	-	0.3Vcc	V	
Output Voltage	High	VOH	2.3	-	-	V	IOH=-10mA, VCC=3V ,SO, BUSY
	Low	VOL	-	-	0.6	V	IOL=10mA,VCC=3V SO, BUSY
Input Leakage Current(I/O Pin)	High	IIH	-	-	1.0	uA	
	Low	IIL	-	-	1.0	uA	
Input Current		I_{CC}	2	-	6	mA	not include inrush current
DC/DC Inrush Current		I_{PEAK}	-	42	-	mA	

Ta = 25 ± 2 ºC

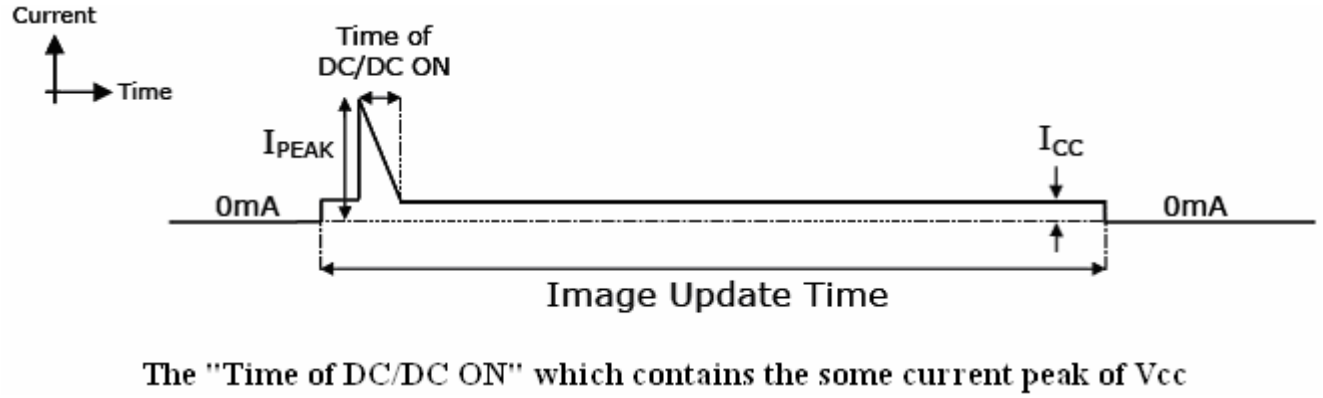
Note (1):

Figure 4-1 Test Pattern of Panel

Note (2):

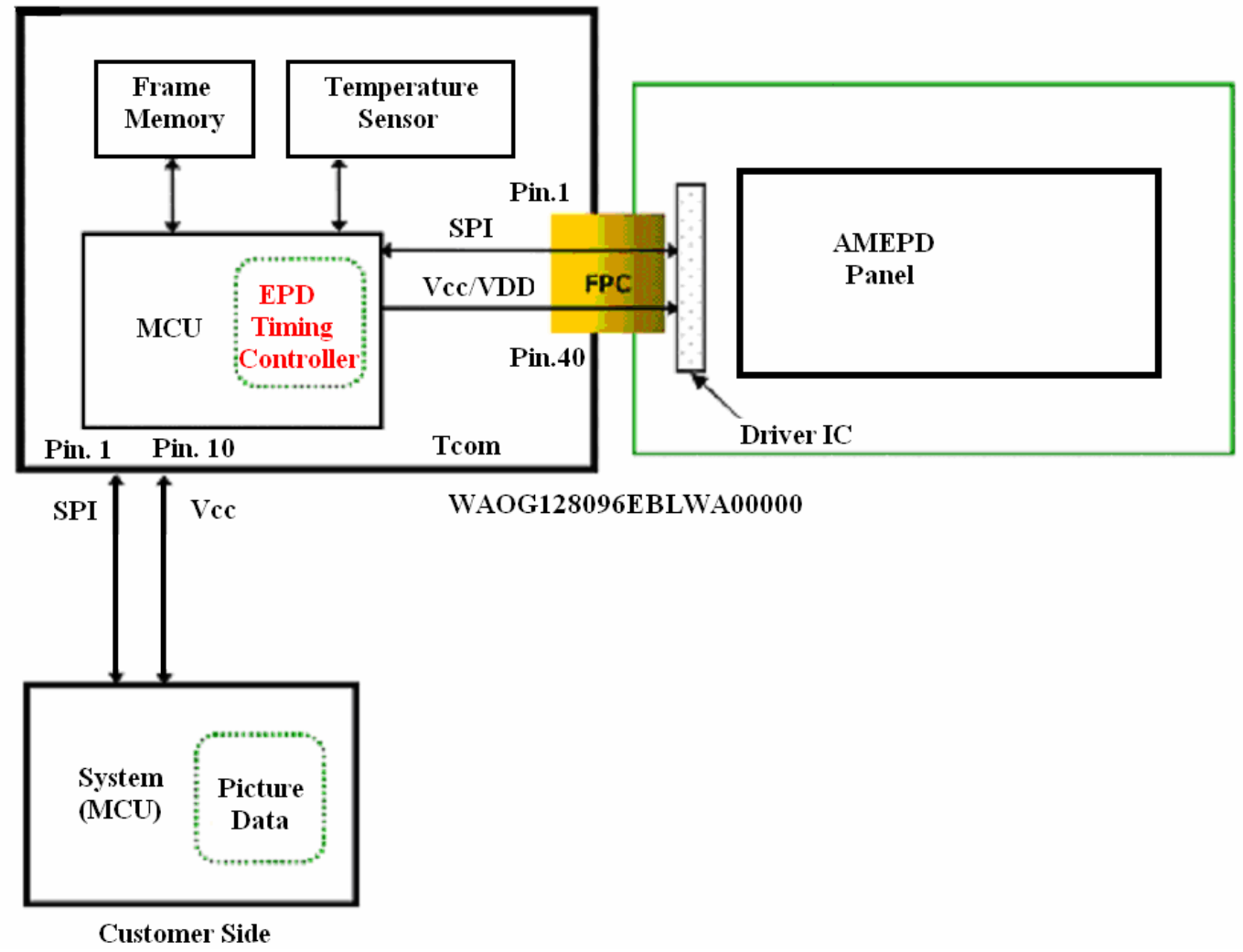
V_{CC}=3.0V

Figure 4-2 Image Update Current Profile



5. Application Circuit Block Diagram

Figure 5-1 Application Circuit Block Diagram



6. Terminal Pin Assignment & Reference Circuit

6.1 Terminal Pin Assignment

Table 6-1 Terminal Pin Assignment

No.	Signal	Type	Connected to	Function
1.	BUSY	O	MCU	When BUSY = 1,EPD stays in busy state that EPD ignores any input data from SPI.
2.	#RESET	I	MCU	/RESET must be “H” when host MCU uses EPD. Apply to 1.44” ,2 “ ,2.7”
3.	MISO	O	MCU	Serial output from EPD to host MCU
4.	MOSI	I	MCU	Serial input from MCU to host EPD
5.	MSCLK	I	MCU	Clock for SPI
6.	MCS	I	MCU	Chip select. Low enable.
7.	GND	P	Ground	
8.	GND	P	Ground	
9.	Vcc	P	Vcc	Power for Digital circuit.
10.	Vcc	P	Vcc	Power for Digital circuit.

NOTE : (1) Connector Type : 10pin , pitch 0.5mm ZIF Connector

(2) I : Input O : Output P : Power

Interface Timing

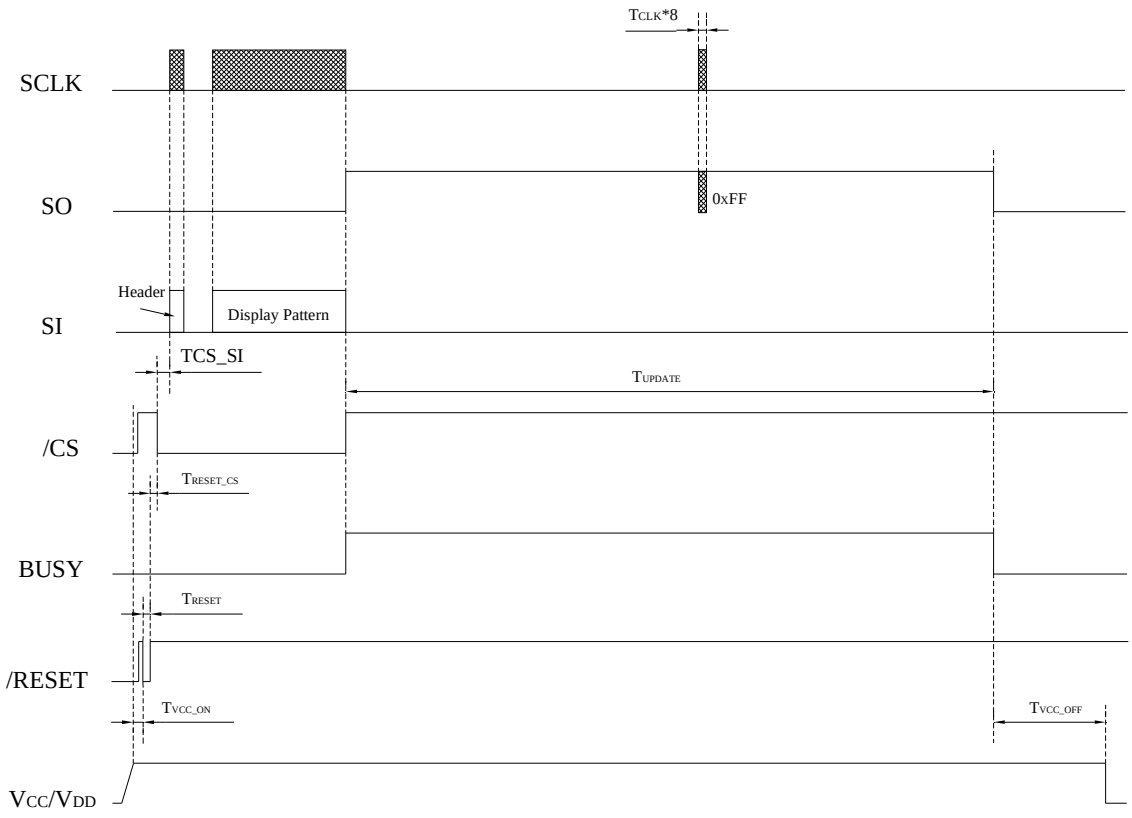


Figure 6.1 Power ON/OFF Sequence

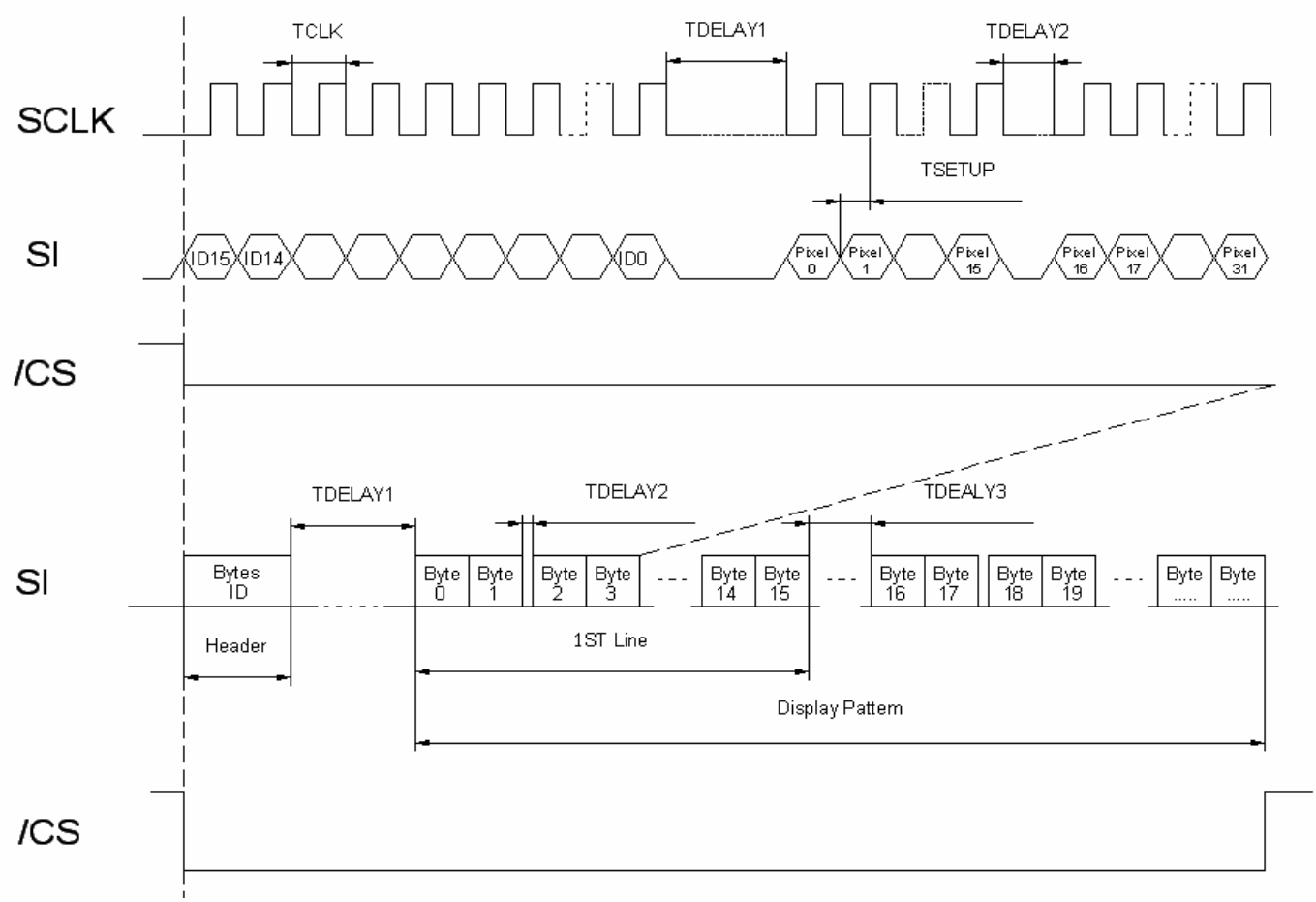


Figure 6.2 Data Transmission Sequence

Panel Size	Header ID(15~0)
1.44"	0X01A0

Item	Symbol	Min.	Typ.	Max.	Unit	Note
V_{CC} range	V_{CC}	2.7	3.0	3.3	Volt	
V_{CC} setup time	$T_{VCC\text{-}on}$	10	-	-	ms	
V_{CC} hold time	$T_{VCC\text{-}off}$	1	-	500	ms	
SCLK clock period	T_{CLK}	16	16	-	us	
SI setup time	T_{SETUP}	40	50	60	%	% of T_{CLK}
Delay time 1	T_{DELAY1}	120	-	150	ms	
Delay time 2	T_{DELAY2}	1	1	-	T_{CLK}	
Delay time 3	T_{DELAY3}	1	-	-	ms	
Reset time	T_{RESET}	5	-	-	ms	
Update time	T_{UPDATE}	-	1	5	sec	
Reset CS Time	$T_{RESET\text{-}CS}$	19	-	-	ms	$T_{RESET\text{-}CS}+T_{CS\text{-}SI}$ Must ≥ 20 ms
CS SI time	$T_{CS\text{-}SI}$	1	-	-	ms	

Table 6-2 Parameter settings

6.2 Bitmap Data Format

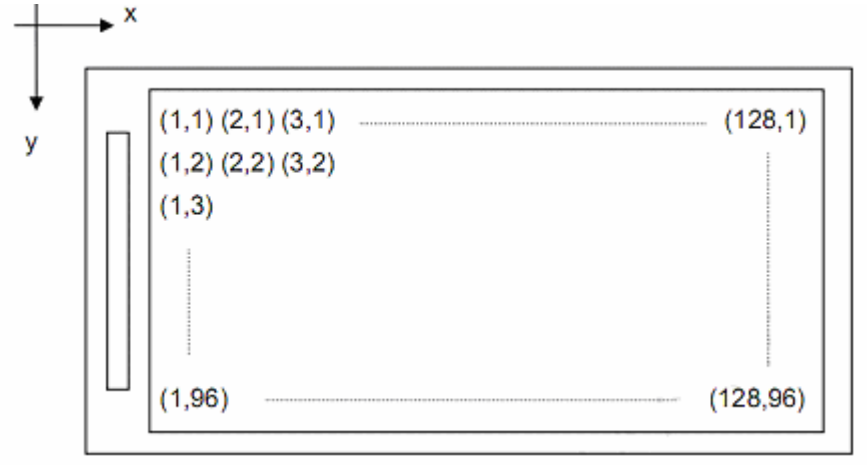


Figure 6.3 1.44”(128*96)EPD Panel

Gate Line 1 : (1,1) → (2,1) → (3,1) →....→ (128,1) →
Gate Line N : (1,N) → (2,N) → (3,N) →....→ (128,N) →
Gate Line 96 : (1,96) → (2,96) → (3,96) →....→ (128,96)
*** Line 1 →Line 2 →Line 3 → ⋯ →Line 96**
*** Total data quantity : 128*96 = 1536bytes**

6.3 Driving Flowchart

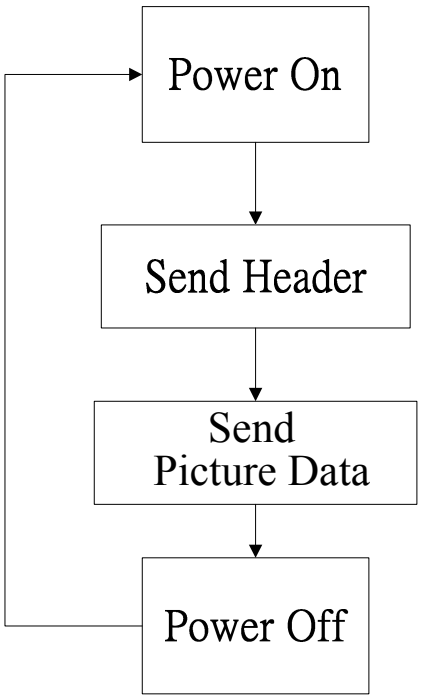


Figure 6.4 Driving Flowchart

7. Optical Characteristics

7.1 Test Conditions

Table 7-1 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

7.2 Optical Specifications

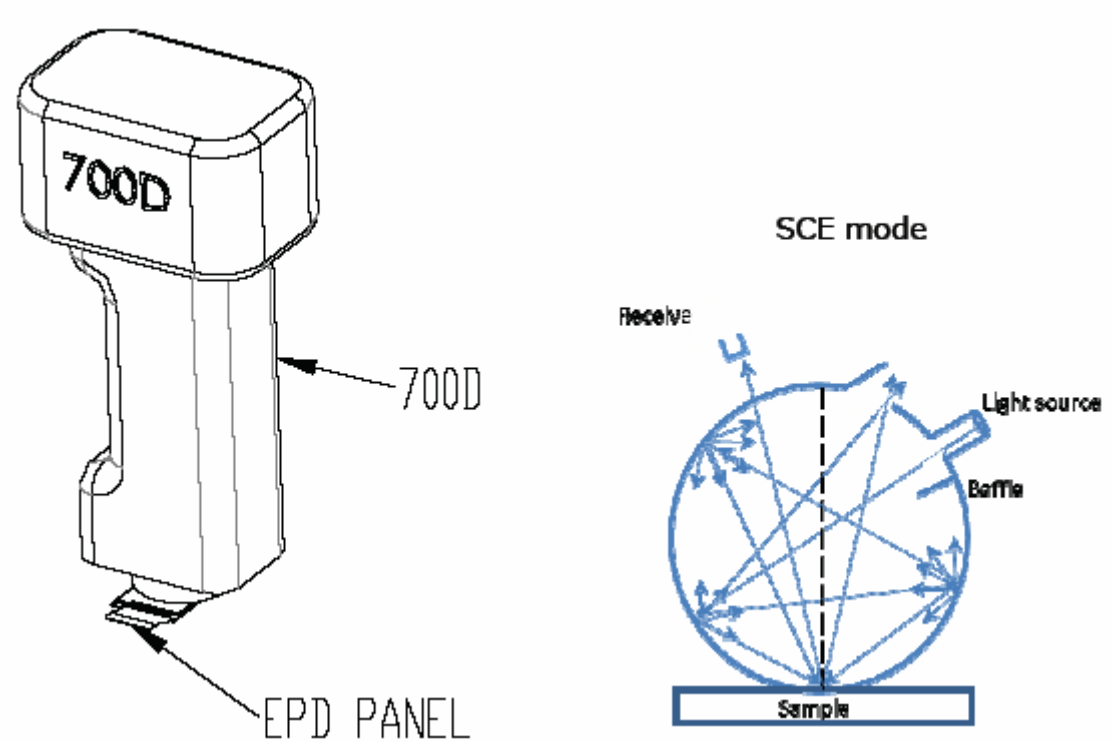
7.2.1 Optical

Table 7-2 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	-	2.2	-	sec	(3)
Operation temperature	Wx	-	0.313	-	-	θx=θy=0 (1),(4)
White Chromaticity	Wy	-	0.338	-		
Reflectance	R%	25	32	-	%	(1),(4)

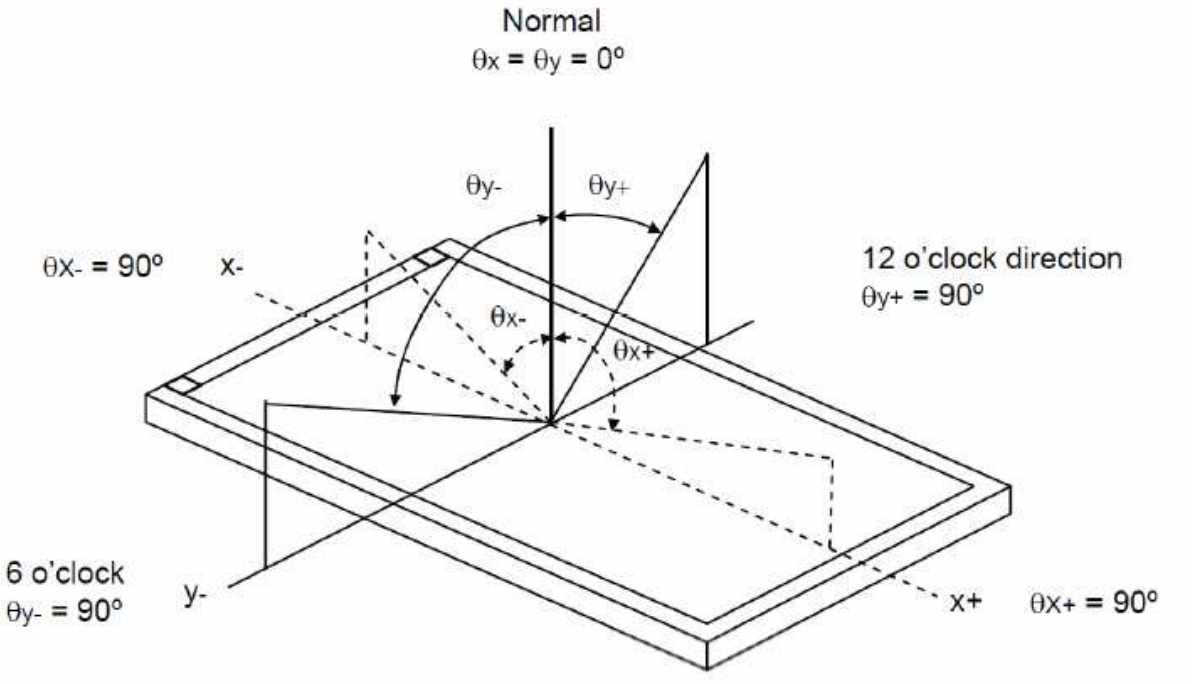
Note (1): Panel is driven by WS waveform without masking film and optical measurement by CM-700D with D65 light source and SCE mode.

Figure 7-1 Optical measuremen



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

Figure 7-2 Definition of Viewing Angle to Measure Contrast Ratio



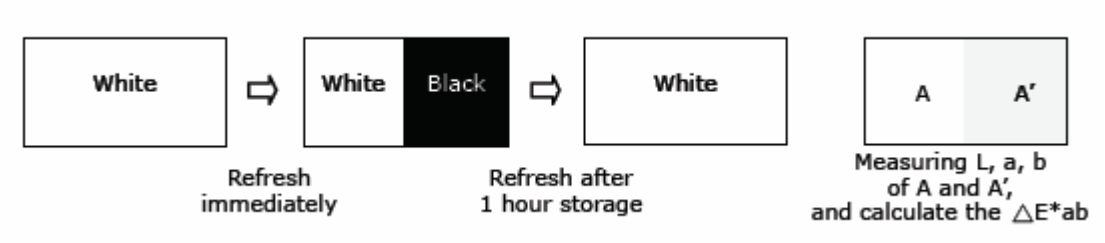
Note (3): Refresh time is the time that e-paper particles move not including the power on and off time. The refresh time is measured at 25ºC.The refresh time and contrast ratio varies due to different films, display performance requirements, and ambient temperatures.

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.

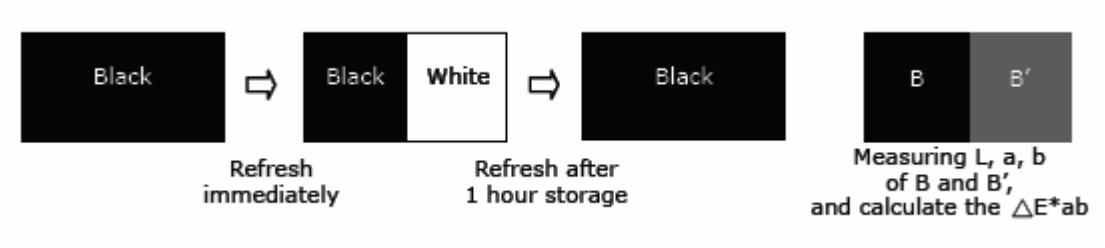
7.2.2 Ghosting

Below are three 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, 2, and 3 are performed at 25ºC

Test 1: White to Black Ghosting



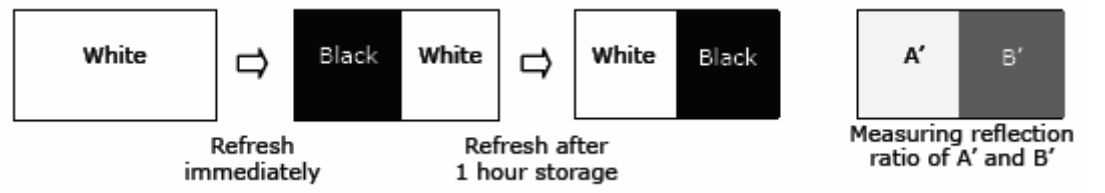
Test 2: Black to White Ghosting



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

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

Test 3: PCS (for barcode application)



PCS =((White Reflection Ratio A' – Black Reflection Ratio B') / White Reflection Ratio B') x 100%
@ 630nm (wavelength of bar-code reader)

Table 7-3 Measurement of Ghosting

Item	Rating		
	Min.	Typ.	Max.
Test 1 △E*ab	-	-	2
Test 2 △E*ab	-	-	2
Test 3 PCS	0.75	-	-

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

8. Precautions

1. The EPD Panel / Module is manufactured from fragile materials such as glass and plastic, and may be broken or cracked if dropped. Please handle with care. Do not apply force such as bending or twisting to the EPD panel during assembly.
2. It is recommended to assemble or install EPD panels in a clean working area. Dust and oil may cause electrical shorts or degrade the protection sheet film.
3. Do not apply pressure to the EPD panel in order to prevent damaging it.
4. Do not connect or disconnect the interface connector while the EPD panel is in operation.
5. Please support the bezel with your finger while connecting the interface cable such as the FPC.
6. Do not stack the EPD panels / Modules.
7. Do not press the FPC on the glass edge or Pull FPC up / down to 90°.
8. Do not touch the FPC lead connector.
9. Wear a Wrist Strap (Grounding connect) when handling and during assembly. Semicondu ctor devices are included in the EPD Panel / Module and they should be handled with care to prevent any electrostatic discharge (ESD). (An Ion Fan may be needed in assembly operation to reduce ESD risk.)
10. Keep the EPD Panel / Module in the specified environment and original packing boxes when storage in order to avoid scratching.
11. Do not disassemble or reassemble the EPD panel.
12. Use a soft dry cloth without chemicals for cleaning. The surface of the protection sheet film is very soft and easily scratched.
13. Be mindful of moisture to avoid its penetration into the EPD panel, which may cause damage during operation.
14. High temperature, high humidity, sunlight or fluorescent light may degrade the EPD panel’s performance. Please do not expose the unprotected EPD panel to high temperature, high humidity, sunlight, or fluorescent for long periods of time. It is highly recommended to store the EPD panel in a dark place without condensation, a temperature range of 15ºC to 35ºC, and humidity from 30%RH to 60%RH.
15. The ink used for marking the Panel ID number is erased easily by solvent. Please avoid using solvent to clean the EPD panel.
16. The EPD is vacuum packed.
17. Before approved by WS and customer, products and produ ct specifications may be subject to change without notice. Confirm that you have received th e latest product standards or specifications before final design, purchase or use.
18. WS makes every attempt to ensure that its products are of high quality and reliability. However, contact WS sales office before using the product in an application that demands especially high quality and reliability or where its failure or malfunction may directly threaten hu man life or cause risk of bodily injury, such as aerospace, aeronautics, nuclear power, combustion control, transportation, traffic, safety equipment or medical equipment for life support.
19. Design your application so that the product is used within the ranges guaranteed by WS particularly

for maximum rating, operating supply voltage range, heat radiation characteristics, installation conditions and other characteristics. WS bears no responsibility for failure or damage when used beyond the guaranteed ranges. Even within the guaranteed ranges, consider normally foreseeable failure rates or failure modes in semiconductor devices and employ systemic measures such as fail safes, so that the equipment incorporating WS product does not cause bodily injury, fire or other consequential damage due to operation of the WS product.

20. This product is not designed to be radiation resistant.