Version: <u>0.41</u>

Technical Specification

MODEL NO: 4.01inch e-Paper F

The content of this information is subject to be changed without

notice. Please contact Waveshare for further information.

Revision History

Rev.	Issued Date	Revised Contents
Tentative 0.1	20200110	New
Tentative 0.2	20200225	Add all in one IC technical data
Tentative 0.3	20200608	Adapt to new spec format
Tentative 0.4	20200612	Update drawing
Tentative 0.41	20200727	Modify storage temperature range

TECHNICAL SPECIFICATION

CONTENTS

1. Application

The display is a reflective electrophoretic E Ink® Gallery Palette™ display module based on glass active matrix TFT substrate and E Ink® Advanced Color ePaper (ACeP®) technology. It has 4.01" active area with 640(H) x 400(V) pixels, the display is capable to display images with 7 colors driven by the all in one display controller and the associated waveform file.

2. Features

- High contrast reflective/electrophoretic technology
- 640(H) x 400(V) display
- Seven colours
- Ultra wide viewing angle
- Ultra low power consumption
- Pure reflective mode
- Bi-stable
- Commercial temperature range
- Landscape type.
- Plastic substrate.
- All in one IC that integrated source driver, gate driver, TCON, PMIC and OTP memory in the module.

3. Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	4.01	Inch	
Display Resolution	640(H) x 400(V)	Pixel	
Active Area	86.4(H) x 54.0(V)	mm	
Pixel Pitch	0.135(H) x 0.135(V)	mm	188dpi
Pixel Configuration	Square		
Outline Dimension	96.80(H) x 68.70(V) × 0.91 (D)	mm	
Module Weight	TBD	g	
Number of Gray	7 colors		Include white
Display operating mode	Reflective mode		
Surface treatment	AG		

4. Mechanical Drawing of EPD Module

NOTES:
1. GENERAL TOLERANCE : ±0.3mm
2. ( ) means for reference
3. Outline to FPL inside 1mm is sensitive area.

* 68.70±0.20 (Outline, TFT)
55.20(Border)
54.00±0.10 (AA)
5.20
*24.80±0.30
5.20
*37.15±0.30
* 96.80±0.20 (Outline, TFT)
86.40±0.10 (AA)
87.60(Border)

ZIF Connector
Barcode
Component Area

0.30±0.03
Max.1.00(Component Height)
* 0.98±0.10 (W/ PF)
0.91±0.10 (W/O PF)
*0.070MAX. (Thickness of EC over FPS)

MATERIAL | HEAT & SURFACE TREATMENT
APPROVE | Barry Yu
CHECK | May Lee
DESIGN | Botsang Huang

SCALE 1:1 | UNIT mm
ORIGINAL NAME
PROJECTION METHOD
DWG. NAME
FILE NAME
SHEET 1/1

REV. 1.0 | DESCRIPTION 1st released | DESIGN Botsang Huang | DATE 2020/06/10

5. Output Interface

5-1) Recommended Connector Type of Panel

Pitch 0.5 mm ZIF connector.

5-2) Pin Assignment of Panel

Pin #	Signal	I/O	Description	Remark
1	MFCSB	I	MCU to flash/EEprom chip select	
2	GDR	O	N-Channel MOSFET Gate Drive Control	
3	RESE	O	Current Sense Input for the Control Loop	
4	VSL_LV	P	Negative source driver voltage (low voltage)	
5	VSH_LV	P	Positive source driver voltage (low voltage)	
6	TSCL	O	I2C Interface to digital temperature sensor Clock pin	
7	TSDA	I/O	I2C Interface to digital temperature sensor Data pin	
8	BS1	I	Bus selection pin; L: 4-wire IF. H: 3-wire IF.	
9	BUSY_N	O	Busy state output pin	
10	RST_N	I	Reset	
11	D/C	I	Data /Command control pin	
12	CSB	I	Chip Select input pin	
13	SCL	O	Serial clock pin (SPI)	
14	SDA	I/O	Serial data pin (SPI)	
15	VDDIO	P	Power for interface logic pins	
16	VDD	P	Power Supply pin for the chip	
17	VSS	P	Ground	
18	VDD_1.8	P	Core logic power pin	
19	FMSDO	O	Flash/EEprom to MCU data output	Cannot share pin with
20	VSH	P	Positive Source driving voltage	
21	VGH	P	Power Supply pin for VGH , VSH and VSH_LV	
22	VSL	P	Negative Source driving voltage	
23	VGL	P	Power Supply pin for VCOM, VGL, VSL and VSL_LV	
24	VCOM	P	VCOM driving voltage	

5-3) Panel Scan Directions

Source scan direction

S0 → S639

G0

(0,0)

S639

Border

G399

G399

Gate scan direction
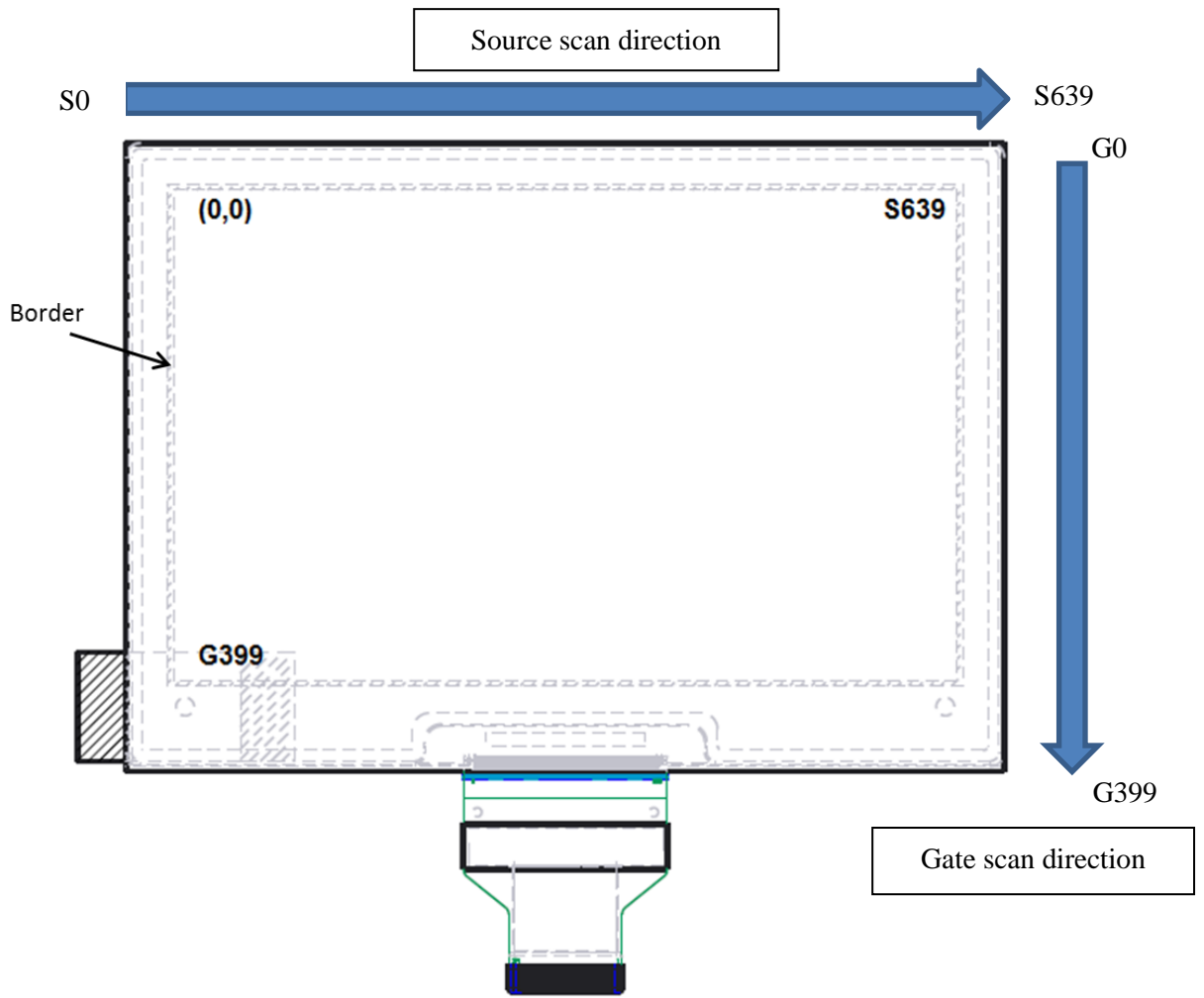
6. Electrical Characteristics

6-1) Absolute Maximum Ratings of panel only

Parameter	Symbol	Rating	Unit	Remark
Logic supply voltage	VDD	-0.5 to +4.0	V	--
Logic Input voltage	VIN	-0.5 to VDD+0.5	V	--
Logic Output voltage	VOUT	-0.5 to VDD+0.5	V	--
Operation temperature range	TOPR	+15 to +35	°C	--
Storage temperature range	TSTG	-25 to +50	°C	--

Maximum ratings are those values beyond which damages to the device may occur. Functional operation should be restricted to the limits in the Electrical Characteristics tables or Pin Description section

This device contains circuitry to protect the inputs against damage due to high static voltages or electric fields; however, it is advised that normal precautions be taken to avoid application of any voltage higher than maximum rated voltages to this high impedance circuit. For proper operation it is recommended that VDD be constrained to the range GND < VDD. Reliability of operation is enhanced if unused input is connected to an appropriate logic voltage level (e.g., either GND or VDD). Unused outputs must be left open. This device may be light sensitive. Caution should be taken to avoid exposure of this device to any light source during normal operation. This device is not radiation protected.

6-2) Panel DC Characteristics

The following specifications apply for : GND=0V, VDD=3.0V, VDD_1.8=1.8V, TOPR=25C

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
VDD	VDD supply operation voltage		2.3	3	3.6	V
VDD_1.8	VDD_1.8 logic operation voltage		1.7	1.8	1.9	V
VGH	Positive Gate driving voltage		19	20	21	V
VGL	Negative Gate driving voltage		-21	-20	-19	V
VSH	Positive Source driving voltage		14.8	15	15.2	V
VSL	Negative Source driving voltage		-15.2	-15	-14.8	V
VSH_LV			4.8	5	5.2	V
VSL_LV			-5.2	-5	-4.8	V
VSL_LV2			-11.2	-11	-10.8	V
VCOM	VCOM_DC output voltage		-4	Adjusted	-0.1	V
VIH	High level input		0.8VDD			V

	voltage						
VIL	Low level input voltage					0.2VDD	V
VOH	High level output voltage	IOH = -100uA	0.8VDD				V
VOL	Low level output voltage	IOL = 100uA				0.2VDD	V
I_{MSTB}	Module stand-by current	Stand-by mode	--	TBD			mA
Inc	Inrush Current		--	TBD			A
I_{MOPR}	Module operating current		--	TBD			mA
P	Operation Power Dissipation	VDD=3.3V with DC-DC	--	TBD			mW
P_{STBY}	Standby Power Dissipation	VDD=3.3V	--	TBD			mW

6-3) Regulators characteristics

Symbol	Parameter	Applicable pin	Test Condition	Min.	Typ.	Max.	Unit
IVSH	VSH current	VSH	VSH = +15V			6000	uA
IVSH_LV	VSH_LV current	VSH_LV	VSH_LV = +5V			6000	uA
IVSL_LV	VSL_LV current	VSL_LV	VSL_LV = -5V			6000	uA
IVSL_LV2	VSL_LV2 current	VSL_LV2	VSL_LV2 = -11V			6000	uA
IVSL	VSL current	VSL	VSL = -15V			6000	uA
IVSH	VSH current	VSH	VSH = +15V			6000	uA

6-4) Panel AC characteristics

The following specifications apply for: VDD - VSS = 2.3V to 3.6V, TOPR = 25°C, CL=20pF

Table : Serial Peripheral Interface Timing Characteristics.

Write mode:

Symbol	Parameter	Min.	Typ.	Max.	Unit
t_{CSS}	CSB select setup time	60			ns
t_{CSH}	CSB select hold time	65			ns
t_{SCC}	CSB deselect setup time	20			ns
t_{CHW}	CSB deselect hold time	40			ns
t_{SCYCW}	Serial clock cycle (Write)	100			ns
t_{SHW}	SCL "H" pulse width (Write)	35			ns
t_{SLW}	SCL "L" pulse width (Write)	35			ns
t_{SCYCL}	Serial clock cycle (Read)	150			ns
t_{SHR}	SCL "H" pulse width (Read)	60			ns

t$_{SLR}$	SCL "L" pulse width (Read)	60			ns
t$_{SDS}$	Data setup time	30			ns
t$_{SDH}$	Data hold time	30			ns
t$_{ACC}$	Access time	10			ns
t$_{OH}$	Output disable time	15			ns

6-5) Refresh Rate

The module applied at a maximum refresh rate of 50 Hz.

Parameter	Min	Max
Refresh Rate	-	50 Hz

6-5) Data transmission waveform
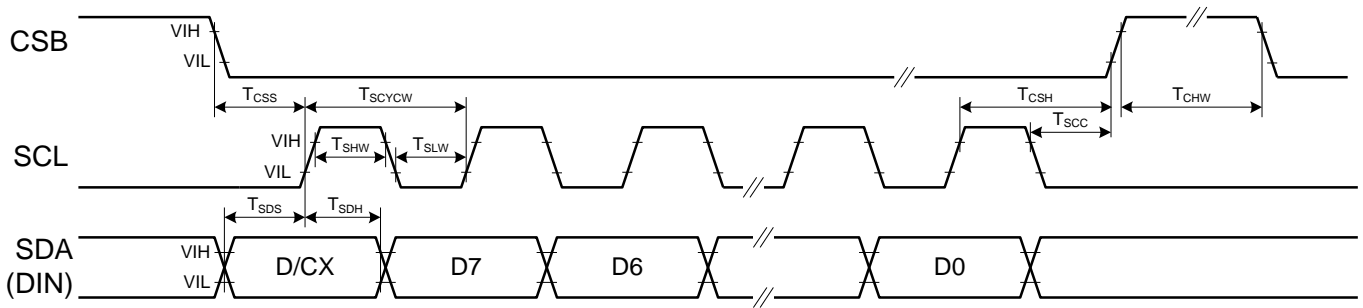
3 pin serial interface characteristics (write mode)
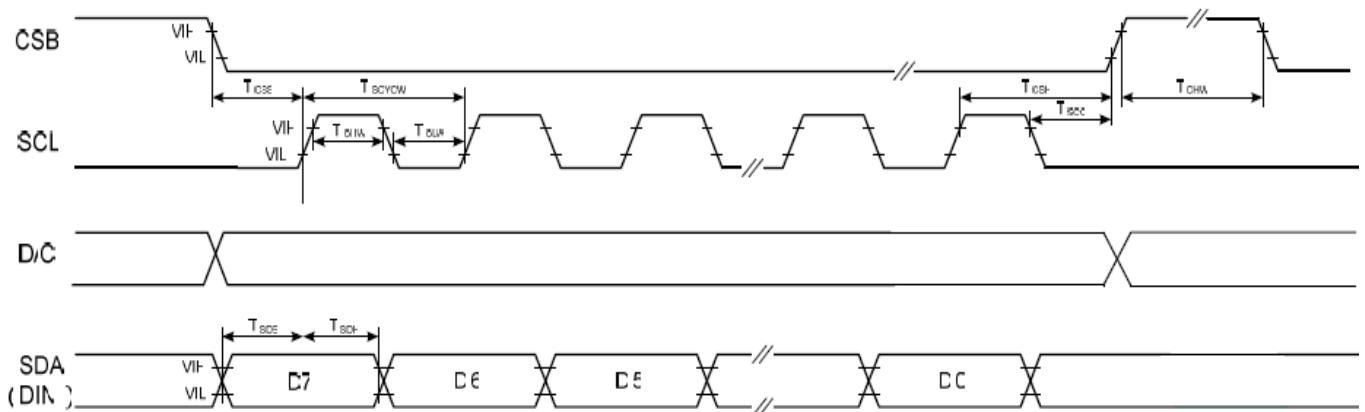
4 pin serial interface characteristics (write mode)

7. Power Sequence

In order to prevent IC fail in power on resetting, the power sequence must be followed as below.

7-1) Power on Sequence

1. Power ON VDD
2. After VDD become stable, wait at least 10ms , keep RST_N pin LOW (logic low) for at least 100us and then HIGH (logic high).
3. After set RST_N pin High (logic high), wait for BUSY_N pin output High (logic high). Then send command for initial setting by SPI interface.
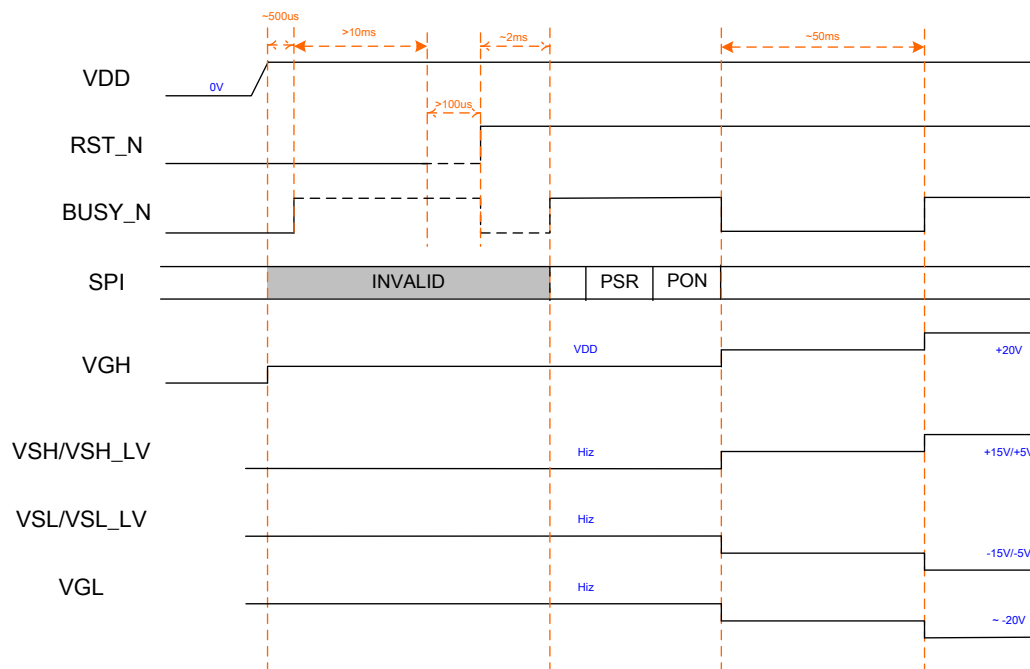
Power on sequence

7-2) Power off Sequence

VCOM, Source Power [VSH/VSH_LV/VSL/VSL_LV], Gate Power [VGH/VGL] off position can be selected by PFS (register 0x03 B byte).
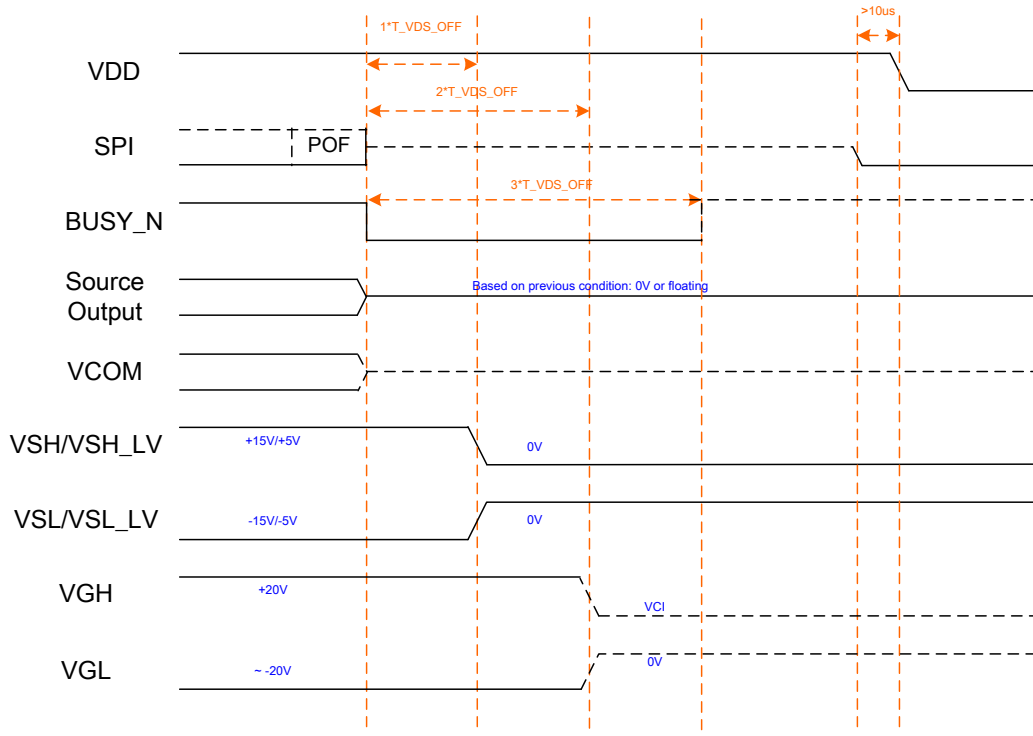
Power off sequence

8. Optical Characteristics

9-1) Specifications

Measurements are made with that the illumination is under an angle of 45 degrees, the detector is perpendicular unless otherwise specified.

T = 25°C

| Item	Parameter	Test Condition	Spec			
			L*	a*	b*	dE2000
Optical Characteristics Evaluation	Color Performance (CIELAB)	Black	TBD	TBD	TBD	dE2000 <TBD
		White	TBD	TBD	TBD	
		Blue	TBD	TBD	TBD	
		Green	TBD	TBD	TBD	
		Red	TBD	TBD	TBD	
		Yellow	TBD	TBD	TBD	
		Orange	TBD	TBD	TBD	
	CR	White/Dark	Min: TBD	Typ: TBD	-	

Note 9-1：Measuring Instrument: Minolta CM-25cG
Note 9-2：Performance values at 25.5°C ambient

9-2)Definition of contrast ratio

The contrast ratio (CR) is the ratio between the reflectance in a full white area (Rl) and the reflectance in a dark area (Rd):

CR = Rl/Rd
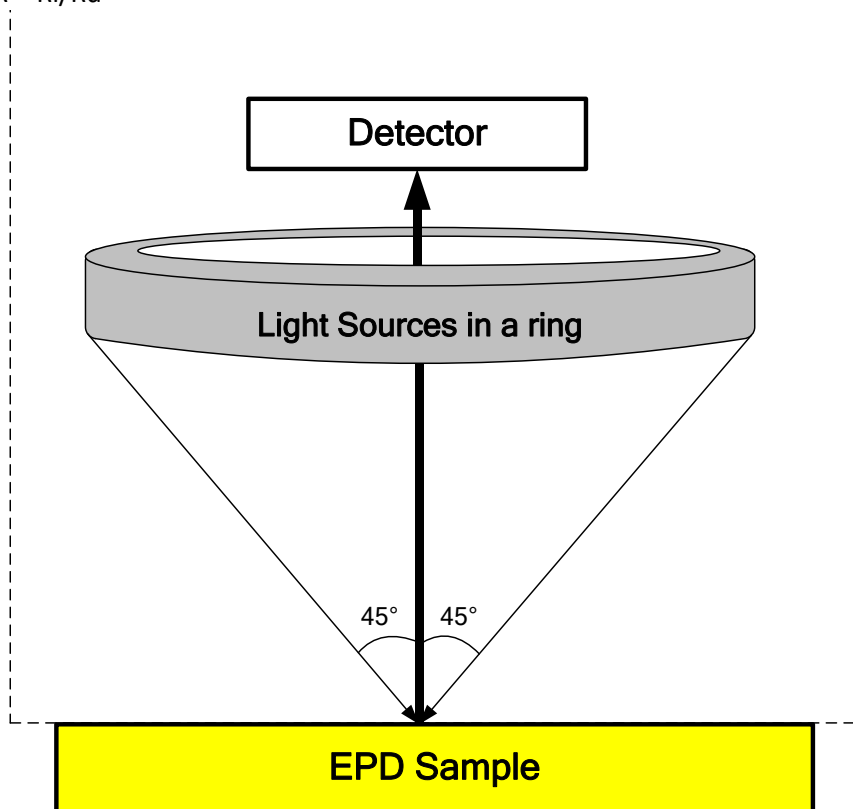
9-3)Reflection Ratio

The reflection ratio is expressed as：
R = Reflectance Factorwhite board × (Lcenter / Lwhite board)
Lcenter is the luminance measured at center in a white area (a* ~ b* ~ 0). Lwhite board is the luminance of a standard white board. Both are measured with equivalent illumination source. The viewing angle shall be no more than 2 degrees.

9-4)Definition of Color Performance & Saturation ratio

The Spectroradiometer Minolta CM-25cG is used to measure color image to obtain L*, a*, b*. Collect L*, a*, b* and then determine the color space.
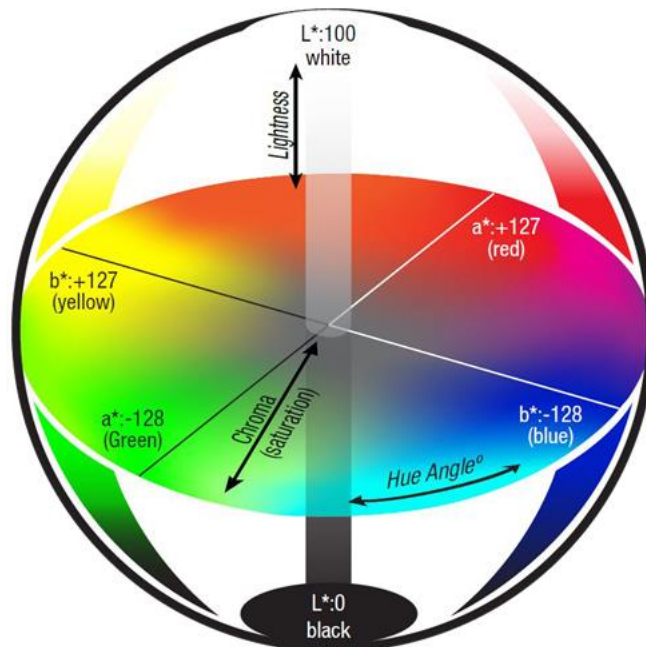
9. Handling, Safety and Environmental Requirements and Remark

WARNING
The display glass may break when it is dropped or bumped on a hard surface. Handle with care. Should the display break, do not touch the electrophoretic material. In case of contact with electrophoretic material, wash with water and soap.

CAUTION
The display module should not be exposed to harmful gases, such as acid and alkali gases, which corrode electronic components.
Disassembling the display module can cause permanent damage and invalidate the warranty agreements.
IPA solvent can only be applied on active area and the back of a glass. For the rest part, it is not allowed.

Mounting Precautions
(1) It`s recommended that you consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module.
(2) It`s recommended that you attach a transparent protective plate to the surface in order to protect the EPD. Transparent protective plate should have sufficient strength in order to resist external force.
(3) You should adopt radiation structure to satisfy the temperature specification.
(4) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the PS at high temperature and the latter causes circuit break by electro-chemical reaction.
(5) Do not touch, push or rub the exposed PS with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of PS for bare hand or greasy cloth. (Some cosmetics deteriorate the PS)
(6) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach the PS. Do not use acetone, toluene and alcohol because they cause chemical damage to the PS.
(7) Wipe off saliva or water drops as soon as possible. Their long time contact with PS causes deformations and color fading.

Data sheet status	
Product specification	This data sheet contains formal product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

REMARK
All The specifications listed in this document are guaranteed for module only. Post-assembled operation or component(s) may impact module performance or cause unexpected effect or damage and therefore listed specifications is not warranted after any Post-assembled operation.

10. Reliability Test

	Test	Condition	Method	Remark
1	High-Temperature Operation	T= +35°C, RH = 35% for 240 hrs	IEC 60 068-2-2Be	--
2	Low-Temperature Operation	T= +15°C, RH = 35% for 240 hrs	IEC 60 068-2-1Ae	--
3	High-Temperature Storage	T = +50°C, RH = 30% for 240 hrs	IEC 60 068-2-2Bb	
4	Low-Temperature Storage	T = -25°C for 240 hrs	IEC 60 068-2-1Ab	
5	High-Temperature, High-Humidity Operation	T= +35°C, RH = 80% for 240 hrs	IEC 60 068-2-78	
6	High Temperature, High- Humidity Storage	T = +50°C, RH = 80% for 240hrs	IEC 60 068-2-78	--
7	Temperature Cycle	1 cycle:[-25°C 30min]→[+60°C 30 min] : 50 cycles	IEC 60 068-2-14Nb	--
8	Electrostatic Effect (non-operating)	(Machine model)+/- 250V 0Ω, 200pF	IEC 62179, IEC 62180	--

[Criteria]

In the standard conditions, there is not display function NG issue occurred. (including: line defect ,no image). All the cosmetic specification is judged before the reliability stress.

11. Block Diagram

12. Border Difinition

Border

MATERIAL | HEAT & SURFACE TREATMENT
APPROVE | Barry Yu
CHECK | May Lee
DESIGN | Botsang Huang

SCALE | UNIT
1:1 | mm

ORIGINAL NAME

PROJECTION METHOD

DWG. NAME

REV | DESCRIPTION | DESIGN | DATE
1.0 | 1st released | Botsang Huang

SHEET
1/1

13. Packing

REV	DESCRIPTION	DESIGN	DATE
01	INITIAL RELEASE	Botsang Huang	2020/04/29
02			

NOTE:
1. One layer include:
   6 pcs module & 1pcs tray & 1pcs EPE sheet

2. Q'TY: 108 pcs panel/carton.
3. Dimension: 445*365*170mm
4. 正反堆叠

ITEM	DESCRIPTION	Q'TY	REMARK
7	30g 加厚複合紙活礦乾燥劑73*95mm	2	
6	EPE SHEET	12	
5	CARTON INTERNAL	1	
4	摺口袋450*380*580mm	1	抗靜電
3	AC040TC1	108	
2	TRAY	13	抗靜電
1	EPE FOAM	2	

MTL.SPEC.		UNSPECIFIED TOL'S ±5.0mm	REMARK		
		ANGLE			
		ROUGHNESS			

APPROVE	May Lee	2020/04/29	SCALE 1:1	UNIT mm	SHEET 1 OF 1	DWG.TITLE PACKING
CHECK	May Lee	2020/04/29				
DESIGN	Botsang Huang	2020/04/29	MTL.NO.		DWG.NO.	A4 SIZE