4inch e-Paper

User Manual

Revision History

Version	Content	Date	Page
1.0	New creation	2024/09/05	All

Contents

1. OVERVIEW

The 4-inch e-Paper is a reflective electrophoretic E Ink® Spectra™ 6 Display module based on glass active matrix TFT substrate. It has 4.0” active area with 400(H) x 600(V) pixels. The panel can display vivid color that include black, white, yellow, red, green and blue depending on the associated lookup table used. The display is capable to display images with full colors driven by the all-in-one display controller and the associated waveform file.

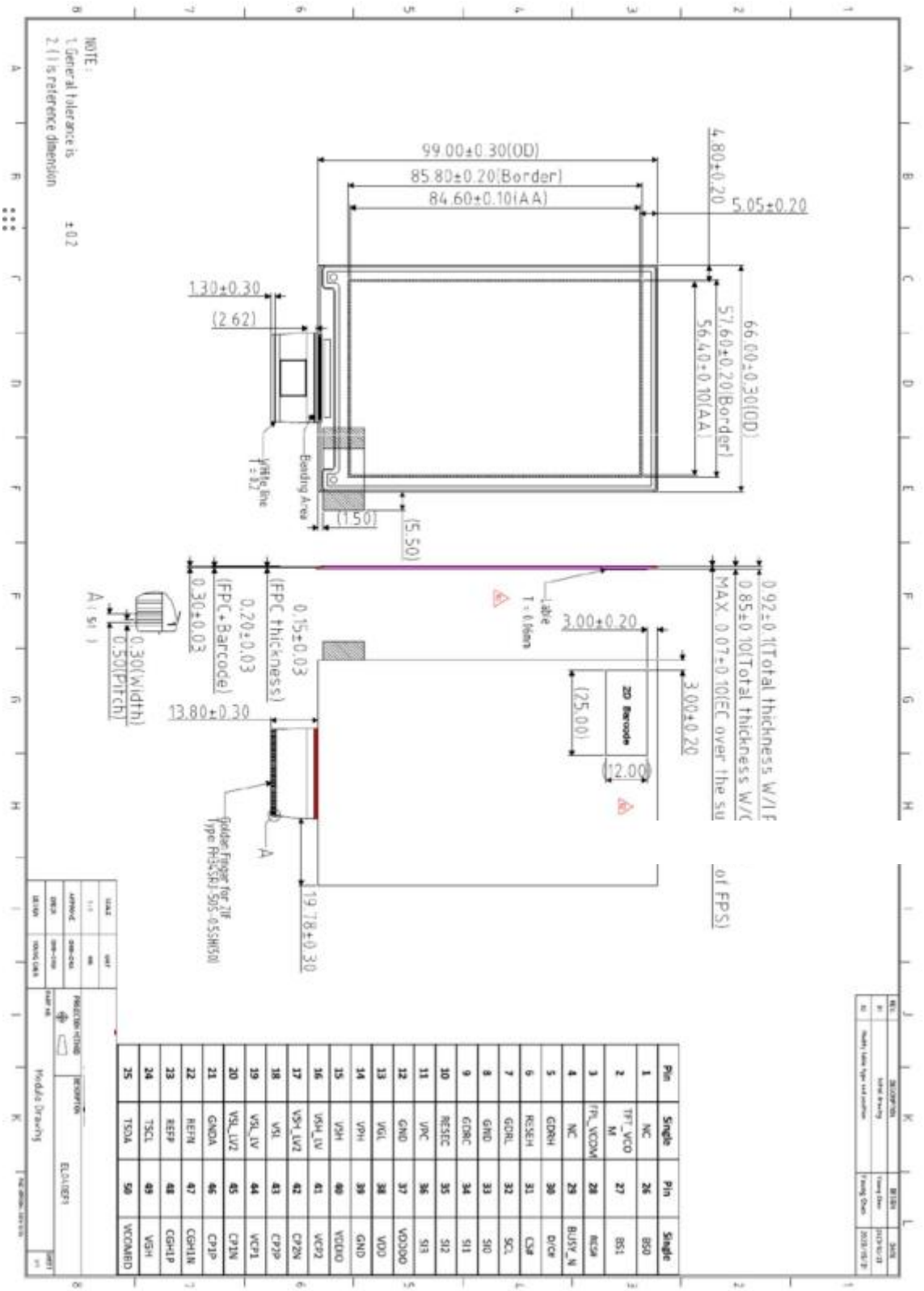
2. FEATURES

- ✧ High contrast reflective/electrophoretic technology
- ✧ 400(H) x 600(V) display
- ✧ Full colours
- ✧ Ultra wide viewing angle
- ✧ Ultra low power consumption
- ✧ Pure reflective mode
- ✧ Bi-stable display
- ✧ Commercial temperature range
- ✧ Portrait type
- ✧ Glass substrate
- ✧ All in one IC that integrated source driver, gate driver, TCON, PMIC and OTP memory in the module.

3. MECHANICAL SPECIFICATION

Parameter	Specification	Unit	Remark
Screen Size	4.0	Inch	
Display Resolution	400(H) x 600(V)	Pixel	
Active Area	56.4(H) x 84.6(V)	mm	
Pixel Pitch	0.141(H) x 0.141(V)	mm	180PPI
Pixel Configuration	Square		
Outline Dimension	66.0 (H) × 99.0(V) × 0.85(D)	mm	W/oPF
Module Weight	11.92±1.19	g	
Display Operating Mode	Reflective Mode		
Surface Treatment	AG		

4. MECHANICAL DRAWING OF EPD MODULE



Pin	Single	Pin	Single
1	NC	26	BS0
2	TFT_VCOM	27	BS1
3	FPL_VCOM	28	RESA
4	NC	29	BUSY_N
5	GDRH	30	D/C#
6	RESE#	31	CS#
7	GDRL	32	SCL
8	GND	33	SI0
9	GDRC	34	SI1
10	RESEC	35	SI2
11	VPC	36	SI3
12	GND	37	VDDIO
13	VGL	38	VDD
14	VPH	39	GND
15	VSH	40	VGDIO
16	VSH_LV	41	VCP2
17	VSH_LV2	42	CP2N
18	VSL	43	CP2P
19	VSL_LV	44	VCP1
20	VSL_LV2	45	CP1N
21	GNDA	46	CP1P
22	REFN	47	CGH1N
23	REFP	48	CGH1P
24	TSCL	49	VGH
25	TSDA	50	VCOMREG

5. INPUT/OUTPUT INTERFACE

5.1 CONNECTOR TYPE: GOLDEN FINGER FOR ZIF TYPE FH34RJ-50S-0.5SH(50)

5.1.1 PIN ASSIGNMENT

NO.	Type	Name	Description
1		NC	No connection and do not connect with other NC pins
2	P	TFT_VCOM	TFT_VCOM driving voltage
3	P	FPL_VCOM	FPL_VCOM driving voltage
4		NC	NC
5	I/O	GDRH	N-channel MOSFET Gate Drive Control
6	I/O	RESEH	Current Sense Input for the Control Loop
7		GDRL	Reserved
8	P	GND	Ground
9	I/O	GDRC	P-channel MOSFET Gate Drive Control
10	I/O	RESC	Current Sense Input for the Control Loop
11	P	VPC	VPC driving voltage
12	P	GND	Ground
13	P	VGL	Negative Gate driving voltage
14	P	VPH	VPH driving voltage
15	P	VSH	Positive Source driving voltage
16	P	VSH_LV	Positive Source driving voltage
17	P	VSH_LV2	Positive Source driving voltage
18	P	VSL	Negative Source driving voltage
19	P	VSL_LV	Negative Source driving voltage
20	P	VSL_LV2	Negative Source driving voltage
21	P	GNDA	Ground; Connect to GND
22		REFN	Reserved
23		REFP	Reserved
24	O	TSCL	I2C Interface to digital temperature sensor Clock pin
25	I/O	TSDA	I2C Interface to digital temperature sensor Data pin
26	I	BS0	Bus selection pin; L: 4-wire IF. H: 3-wire IF. (Default)
27	I	BS1	Bus selection pin; L: refer to BS0. (Default) H: Standard 4-wire SPI/dual SPI/quad SPI
28	I	RES#	Reset
29	O	BUSY_N	Busy state output pin
30	I	D/C#	Data /Command control pin (D/C)
31	I	CS#	Chip Select input pin (CSB)
32	I	SCL	Serial clock pin (SPI)
33	I/O	SI0	Serial data pin (SPI)

NO.	Type	Name	Description
34	I/O	SI1	Serial data pin, reserved
35	I/O	SI2	Serial data pin, reserved
36	I/O	SI3	Serial data pin, reserved
37	P	VDDDO	Core logic power pin, Connect to VDDO
38	P	VDD	Supply voltage
39	P	GND	Ground, Connect to GNDA
40	P	VDDIO	Supply voltage
41	P	VCP2	Charge Pump Pin
42	P	CP2N	Charge Pump Pin
43	P	CP2P	Charge Pump Pin
44	P	VCP1	Charge Pump Pin
45	P	CP1N	Charge Pump Pin
46	P	CP1P	Charge Pump Pin
47		CGH1N	Charge Pump Pin, Reserved
48		CGH1P	Charge Pump Pin, Reserved
49	P	VGH	Positive Gate driving voltage
50	P	VCOMBD	VCOMBD driving voltage

Note 5-1: This pin (CS#) is the chip select input connecting to the MCU. The chip is enabled for MCU communication only when CS# is pulled LOW.

Note 5-2: This pin is (D/C#) Data/Command control pin connecting to the MCU. When the pin is pulled HIGH, the data will be interpreted as data. When the pin is pulled LOW, the data will be interpreted as command.

Note 5-3: This pin (RES#) is reset signal input. The Reset is active low.

Note 5-4: This pin (Busy_N) is Busy state output pin. When Busy is Low, the operation of chip should not be interrupted and any command should not be issued to the module. The driver IC would put Busy pin Low when the driver IC is working such as:

-Outputting display waveform; or

-Programming with OTP

-Communicating with digital temperature sensor

Note 5-5: This pin (BS0) is for 3-line SPI or 4-line SPI selection. When it is "Low", 4-line SPI is selected. When it is "High", 3-line SPI (9 bits SPI) is selected. Please refer to below Table:

Table: Bus Interface Selection

BS1 State	MCU Interface
L	4-line serial peripheral interface (SPI)
H	3- line serial peripheral interface (SPI) - 9 bits SPI

6. ELECTRICAL CHARACTERISTICS

6.1 ABSOLUTE MAXIMUM RATING

Parameter	Symbol	Min	Max	Unit
Logic supply voltage	VDD	+2.4	+3.6	V
Tst	Storage Temperature	-25	60	℃
Top	Operating Temperature	0	50	℃

Note 6-1: Maximum ratings are those values beyond which damages to the device may occur.

Note 6-2: Functional operation should be restricted to the limits by Chapter "6. Electrical Characteristics".

6.2 PANEL DC CHARACTERISTICS

The following specifications apply for: VDD = 3.0V, TA = 25℃

DIGITAL DC CHARACTERISTICS						
Symbol	**Parameter**	**Conditions**	**Min.**	**Typ.**	**Max.**	**Unit**
VDD	Logic supply voltage	-	2.4	3.0	3.6	V
VGH	Positive Gate driving voltage	-	19.0	20.0	21.0	V
VGL	Negative Gate driving voltage		-21.0	-20.0	-19.0	V
VSH	Positive source driving voltage	-	14.5	15.0	15.5	V
VSL	Negative source driving voltage	-	15.5	-15.0	-14.5	V
VCOM_DC	VCOM_DC output voltage	-	-4.0	Adjusted	-0.3	V
VCOM_AC	VCOM_AC output voltage	-	VSL+VCOM_DC	-	VSH+VCOM_DC	V
VIL	Low level input voltage	Digital Input Pins	0	-	0.2 x VDD	V
VIH	High level input voltage	Digital Input Pins	0.8xVDD	-	VDD	V
VOH	High level output voltage	Digital Input Pins IOH=8 mA	0.8xVDD	-	-	V
VOL	Low level output voltage	Digital Input Pins IOL=8 mA	0	-	0.2xVDD	V
IMSTB	Module stand-by current	Stand-by mode	-	55.6	-	uA
IMDS	Module deep sleep current	Deep sleep mode	-	1.1	-	uA
I_{NC}	Inrush Current	High loading pattern	-	61.7	65.4	mA
IMOPR	Module Operating Current	TYP loading pattern	-	15.4	22.7	mA

		High loading pattern		32.3	48.3	
P	Operation Power Dissipation	TYP loading pattern VDD=3.0V with DC-DC	--	46.2	68.2	mw
		High loading pattern VDD=3.0V with DC-DC		96.9	144.9	
PSTBY	Standby Power Dissipation	VDD=3.0V	-	166.8	-	uw

Note 6-3: The module operating current data is measured by using oscilloscope, and extract the mean value.

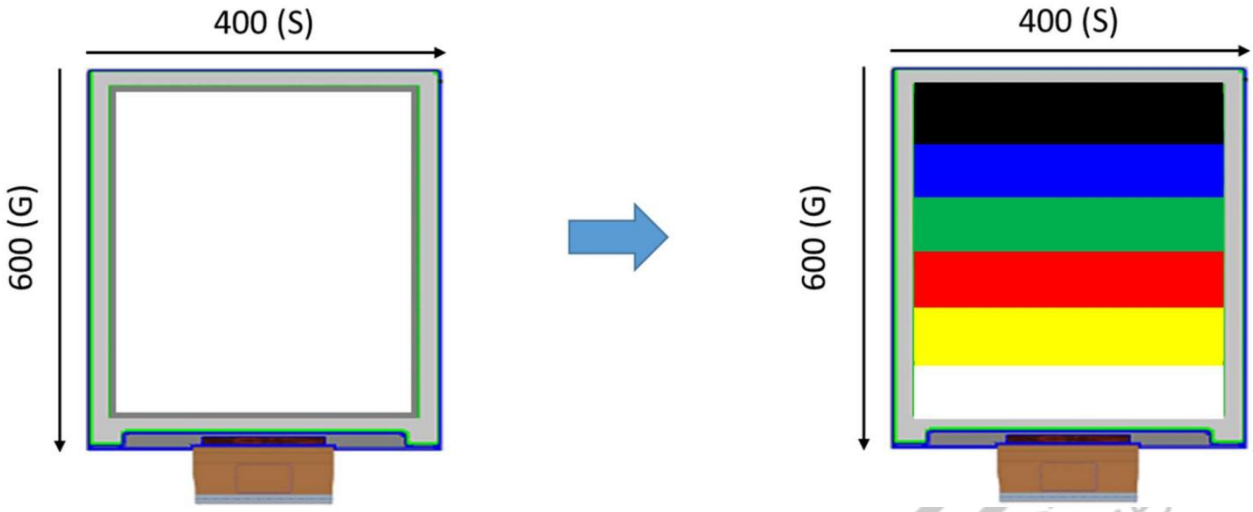
Note 6-4: The typical power consumption is measured using associated 25C waveform with following pattern transition: from full white pattern to color stripe pattern. (Note 6-8)

Note 6-5: The high loading (Max) power consumption is measured using associated 25C waveform with following pattern transition: from full white pattern to noise pattern (including random scattering of 6 colors). (Note 6-9)

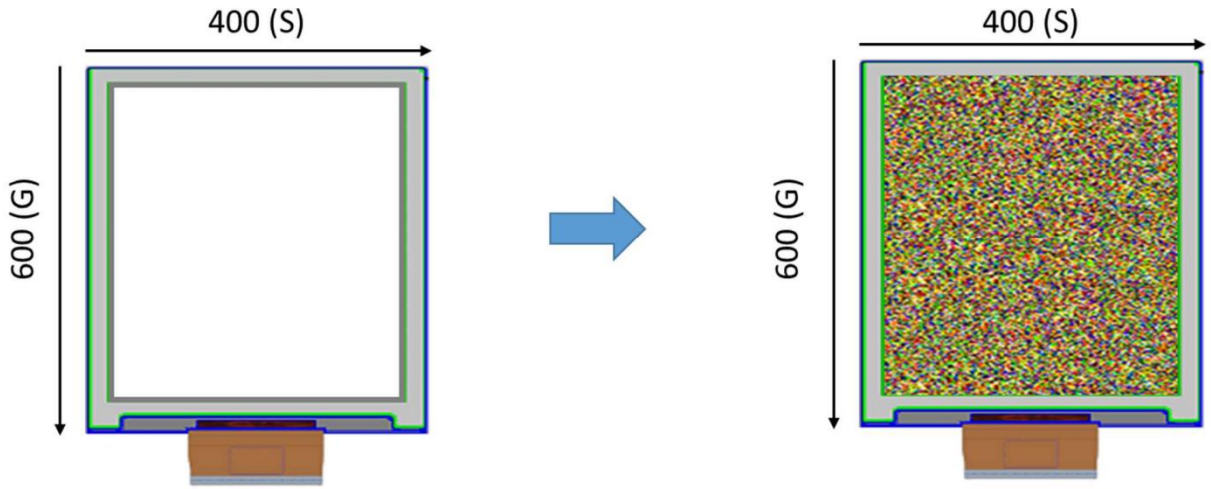
Note 6-6: The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by E Ink.

Note 6-7: Vcom value has been set in the IC on the panel.

Note 6-8: The typical power consumption



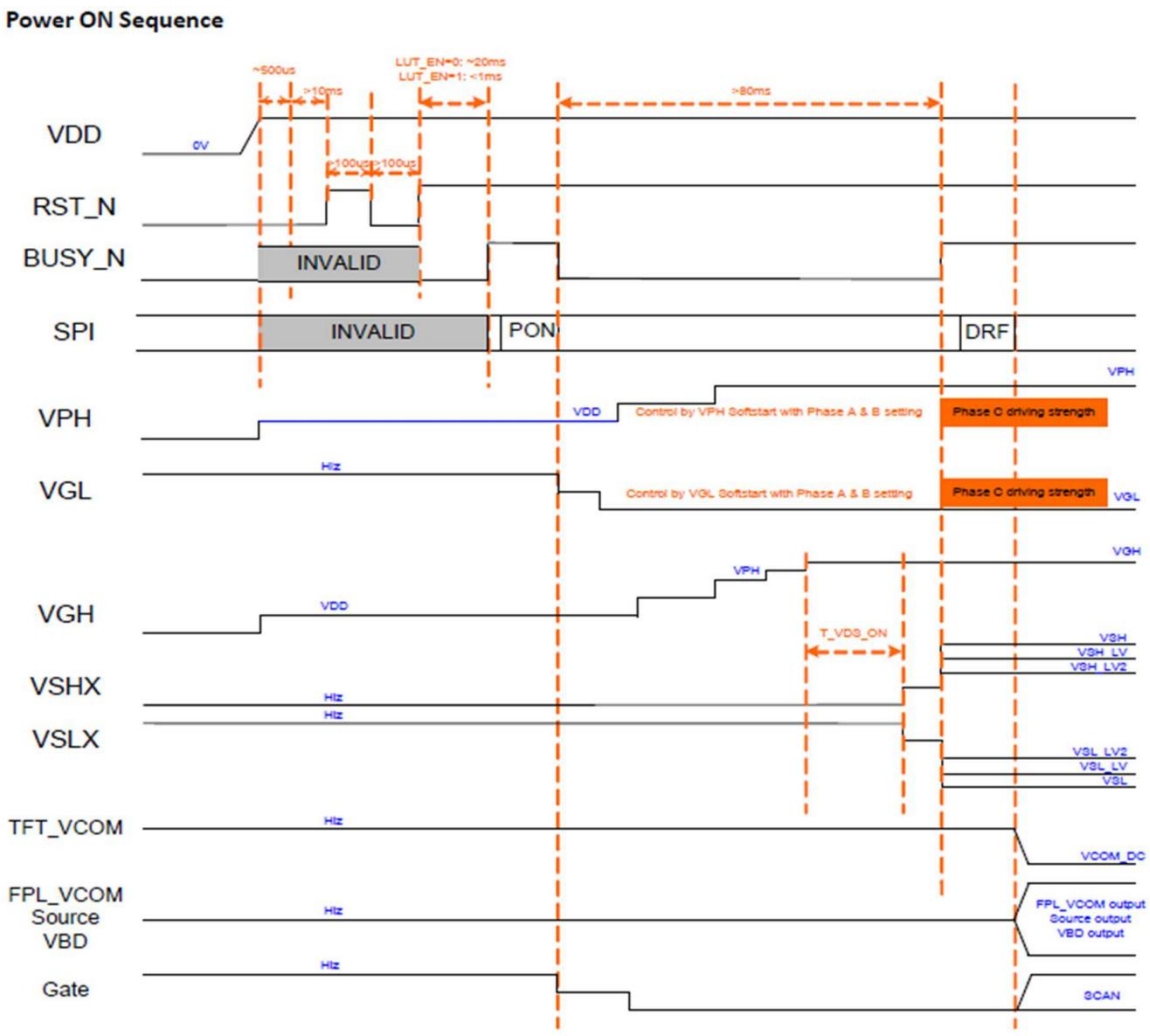
Note 6-9: The high loading power consumption



7. POWER SEQUENCE

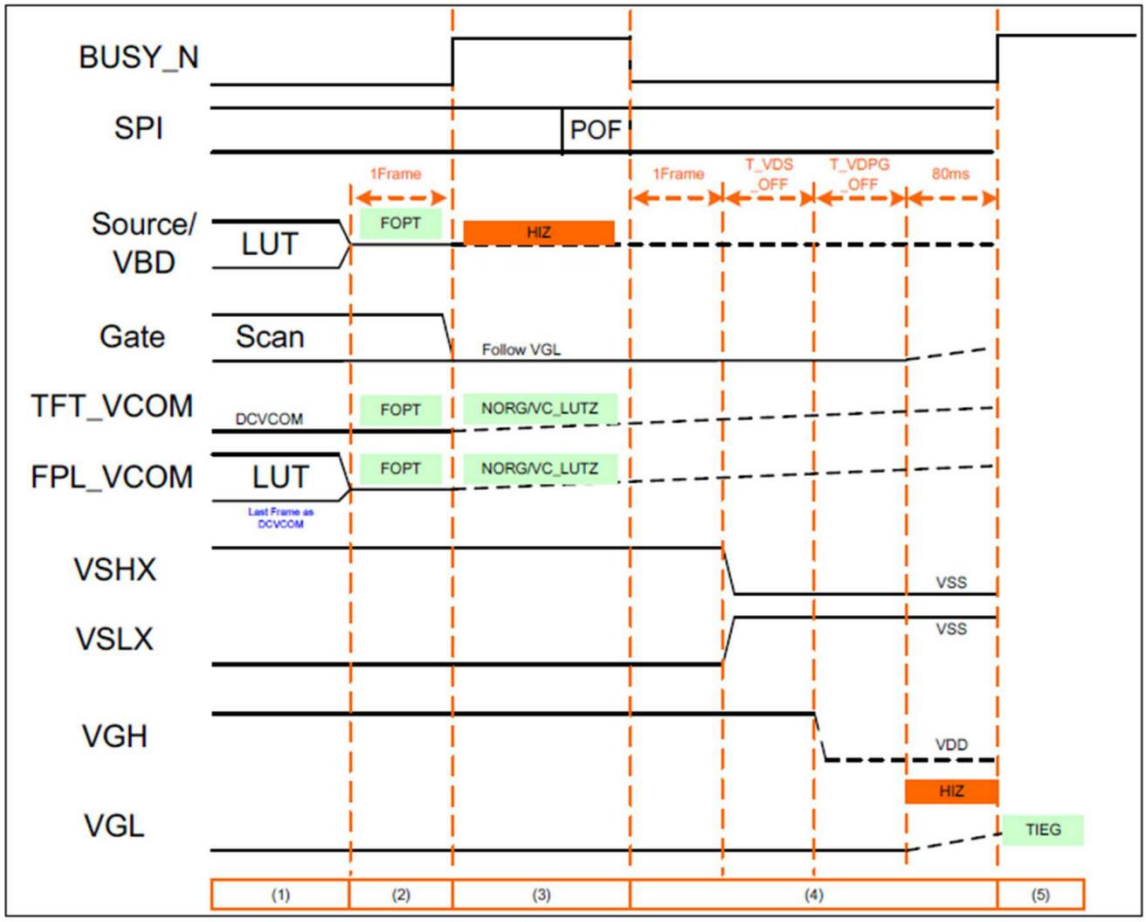
In order to prevent IC fail in power on resetting, the power sequence must be followed as below:

7.1 POWER ON SEQUENCE DISPLAY



7.2 POWER OFF SEQUENCE DISPLAY

Power OFF Sequence



8. OPTICAL CHARACTERISTICS

8.1 SPECIFICATION

Measurements are under illumination 45/0, the detector is perpendicular to surface unless otherwise specified.

Symbol	Parameter	Conditions	Temperature	Min	Typ.	Max	Units	Notes
R	Reflectance	White	25℃	30	34	-	%	8-1
CR	Contrast Ratio	-	25℃	15	22	-		-
T update	update time	-	25℃	-	12	-	sec	-

Symbol	Parameter	Conditions	Temperature	L*Typ.	a*Typ.	b*Typ.	△E2000 Max.	Notes
WS	White state L*/a*/b*	White	25℃	66.5	-4	0	6	8-1
DS	Dark state L*/a*/b*	Dark	25℃	12	7	-11	6	8-1
RS	Red state L*/a*/b*	Red	25℃	26.5	41	30	6	8-1
YS	Yellow state L*/a*/b*	Yellow	25℃	62	-11	65	6	8-1
BS	Blue state L*/a*/b*	Blue	25℃	34	3.5	-37	6	8-1
GS	Green state L*/a*/b*	Green	25℃	35	-22	15	8	8-1

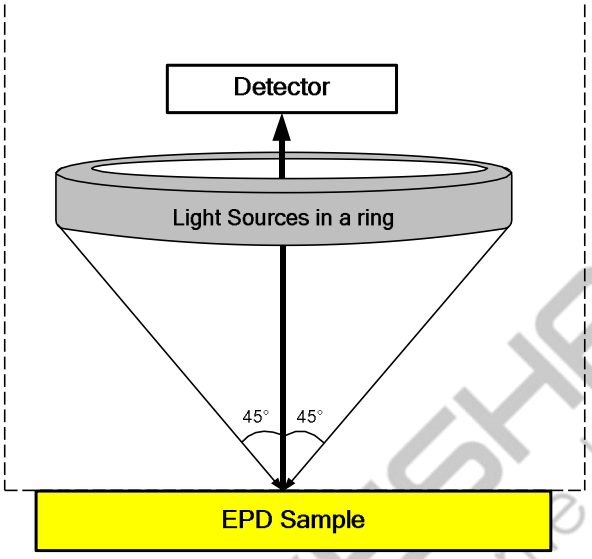
Note 8- 1: Luminance meter: Eye-One Pro plus Spectrophotometer.

WS: White state, DS: Dark state, RS: Red state, YS: Yellow state, BS: Blue state, GS: Green state

8.2 DEFINITION OF CONTRAST RATIO

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

CR=RI/Rd



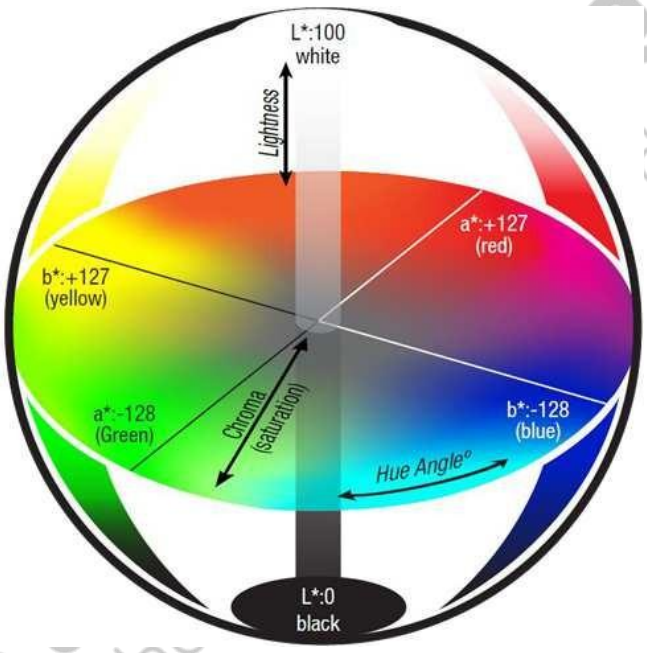
8.3 REFLECTION RATIO

The reflection ratio is expressed as:

R = Reflectance Factor$_{white\ board}$ × (L_{center} / $L_{white\ board}$)

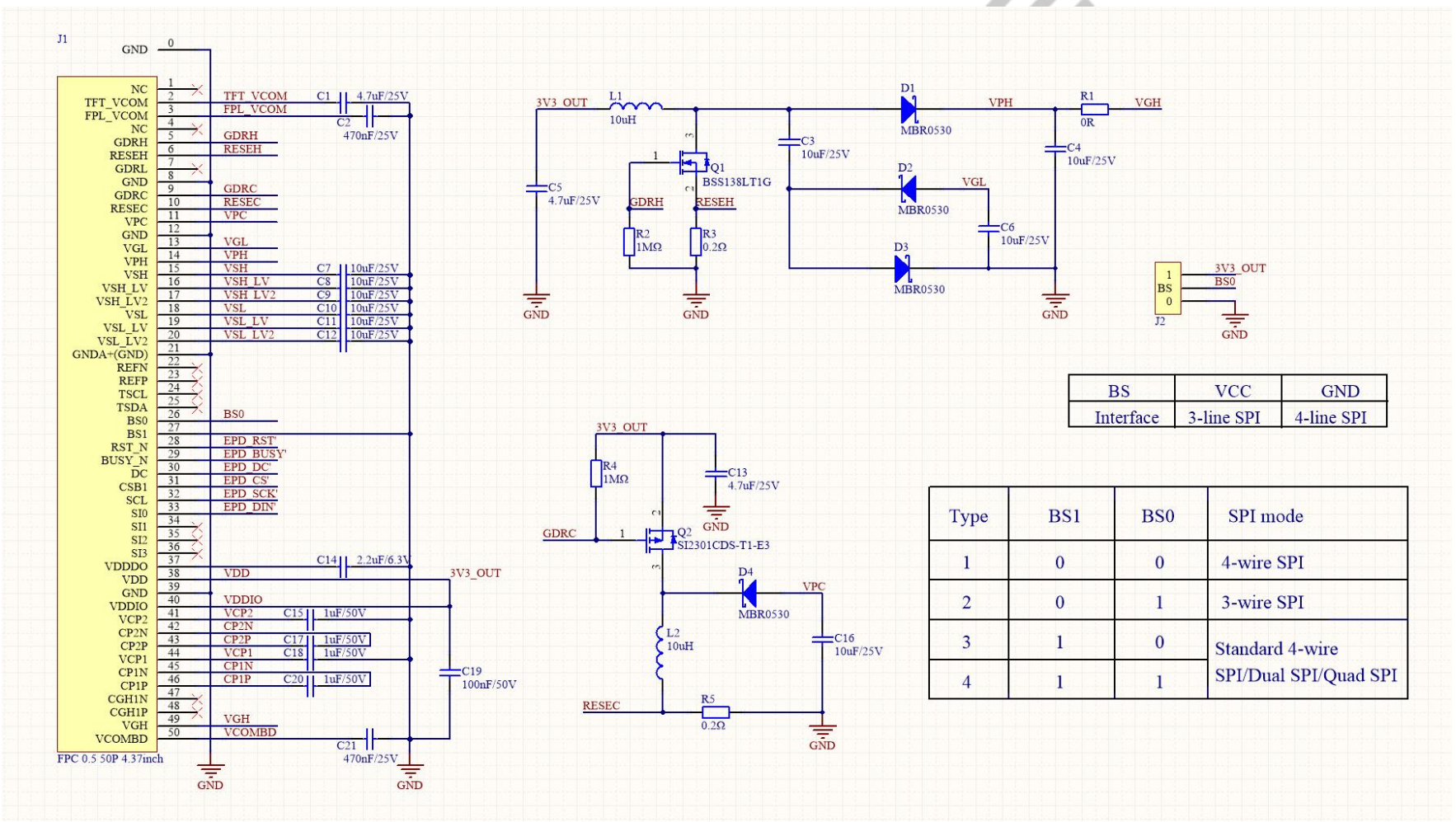
Lcenter is the luminance measured at center in a white area (a* ~ b* ~ 0). $L_{white\ board}$ is the luminance of a standard white board. Both are measured with equivalent illumination source. The viewing angle shall be no more than 2 degrees.

8.3 DEFINITION OF COLOR PERFORMANCE & SATURATION RATIO



The Spectroradiometer One Pro3 plus was used to measure color image to obtain L*, a*, b*. Collect L*, a*, b* and then determine the color space.

9. REFERENCE CIRCUIT



BS	VCC	GND
Interface	3-line SPI	4-line SPI

Type	BS1	BS0	SPI mode
1	0	0	4-wire SPI
2	0	1	3-wire SPI
3	1	0	Standard 4-wire SPI/Dual SPI/Quad SPI
4	1	1	

10. HANDLING, SAFETY, AND ENVIRONMENT REQUIREMENTS

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.

Disassembling the display module can cause permanent damage and invalidates 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.

The module storage environment must under reliability test storage item's criteria.

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 final 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.	

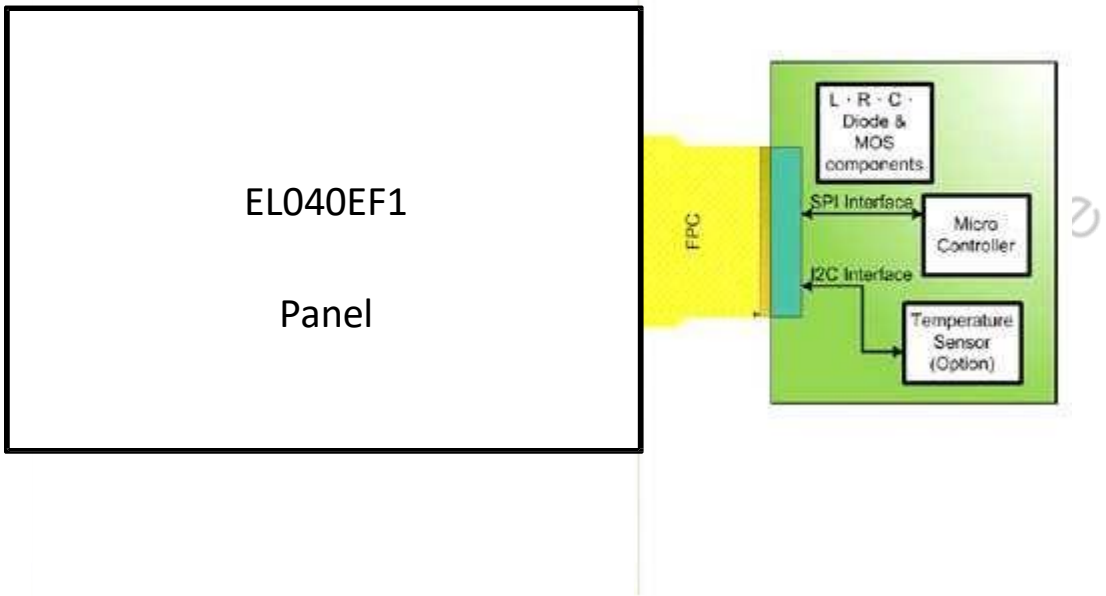
11. RELIABILITY TEST

NO	Test items	Test condition	Method
1	High-Temperature Operation	T = +50°C, RH = 30% for 240 hrs	IEC 60 068-2-2Be
2	Low-Temperature Storage	T = 0°C for 240 hrs	IEC 60 068-2-1Ae
3	High-Temperature, High-Humidity Operation	T = +40°C, RH = 90% for 240 hrs	IEC 60 068-2-78
4	Low-Temperature Storage	T = −25°C for 240 hrs (Test in white pattern)	IEC 60 068-2-1Ab
5	High-Temperature High-Humidity Storage	T = +60°C, RH = 80% for 240hrs (Test in White Pattern)	IEC 60 068 2-3CA
6	High-Temperature Storage	T = +60°C, RH = 35% for 240hrs (Test in White Pattern)	IEC 60 068-2-2Bb
7	Temperature Cycle	T = −25°C +60°C, 50 Cycle 30min 30min (Test in white pattern)	IEC 068-2-14 Nb
8	Electrostatic Effect (non-operating)	(Machine model) ± 250 V 0Ω, 200pF	IEC 62179, IEC 62180

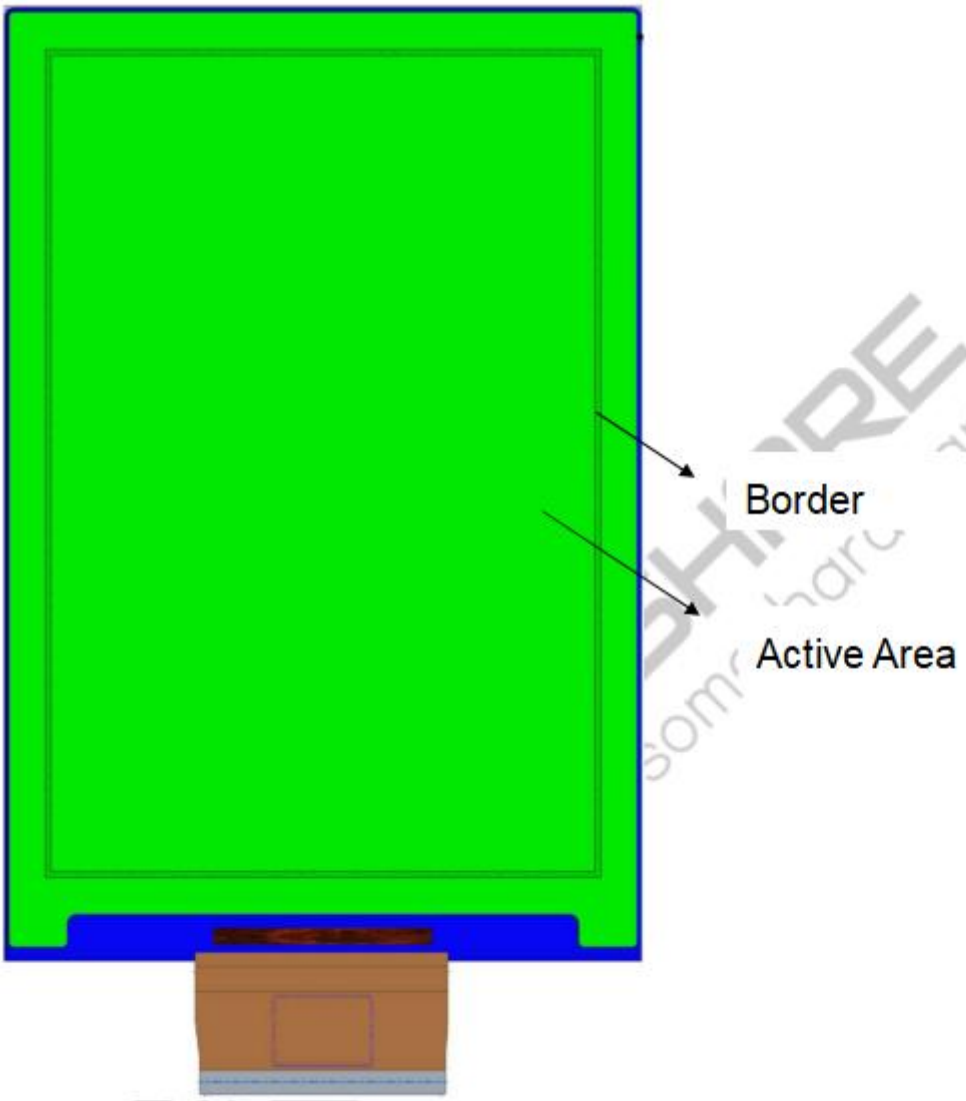
[Criteria]

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.

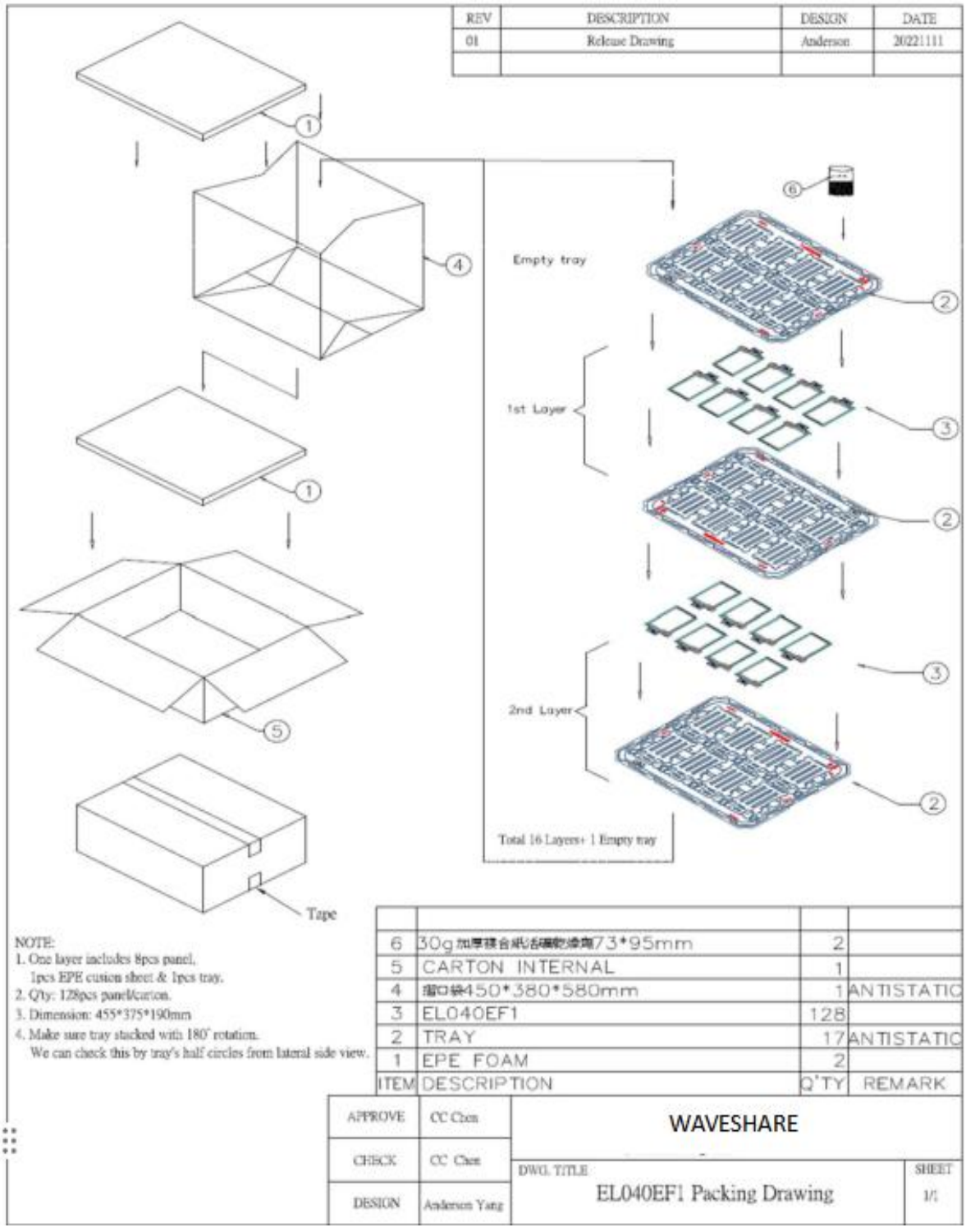
12. BLOCK DIAGRAM



13. BORDER DEFINITION



14. PACKAGE


REV
DESCRIPTION
DESIGN
DATE
01
Release Drawing
Anderson
20221111
Empty tray
1st Layer
2nd Layer
Total 16 Layers+ 1 Empty tray
Tape
NOTE:
1. One layer includes 8pcs panel,
1pcs EPE cusion sheet & 1pcs tray.
2. Qty: 128pcs panel/carton.
3. Dimension: 455*375*190mm
4. Make sure tray stacked with 180° rotation.
We can check this by tray's half circles from lateral side view.
6 30g 73*95mm 2
5 CARTON INTERNAL 1
4 450*380*580mm 1 ANTISTATIC
3 EL040EF1 128
2 TRAY 17 ANTISTATIC
1 EPE FOAM 2
ITEM DESCRIPTION Q'TY REMARK
APPROVE CC Chen
CHECK CC Chen
DESIGN Anderson Yang
WAVESHARE
DWG. TITLE
EL040EF1 Packing Drawing
SHEET
1/1