Version: 2.0

Technical Specification

MODEL NO: 2.36inch e-Paper (G)

The content of this information is subject to be changed without notice.

Revision History

Rev.	Issued Date	Revised Contents
0.1	2021.5.12	Tentative
1.0	2021.6.30	Update 5. Input/Output Interface
		Update 7-2 Display Module DC characteristics
		Update 8. Optical Characteristics
		Update 10. Reliability Test
		Update 11. Block Diagram
		Update 12. Packing
		Update 13. Definition of Labels
2.0	2021.11.01	Update 4. Mechanical Drawing of EPD Module
		Update 7-2 Display Module DC characteristics
		Update 12. Packing

TECHNICAL SPECIFICATION

CONTENTS

1. Application

This display is a reflective electrophoretic E Ink® Spectra™ 3100 technology display module on an active matrix TFT substrate. The panel is capable of displaying black, white, yellow and red images depending on the associated lookup table used. The circuitry on the panel includes an integrated gate and source driver, timing controller, oscillator, DC-DC boost circuit, and memory to store the frame buffer and lookup tables, and additional circuitry to control VCOM and BORDER settings.

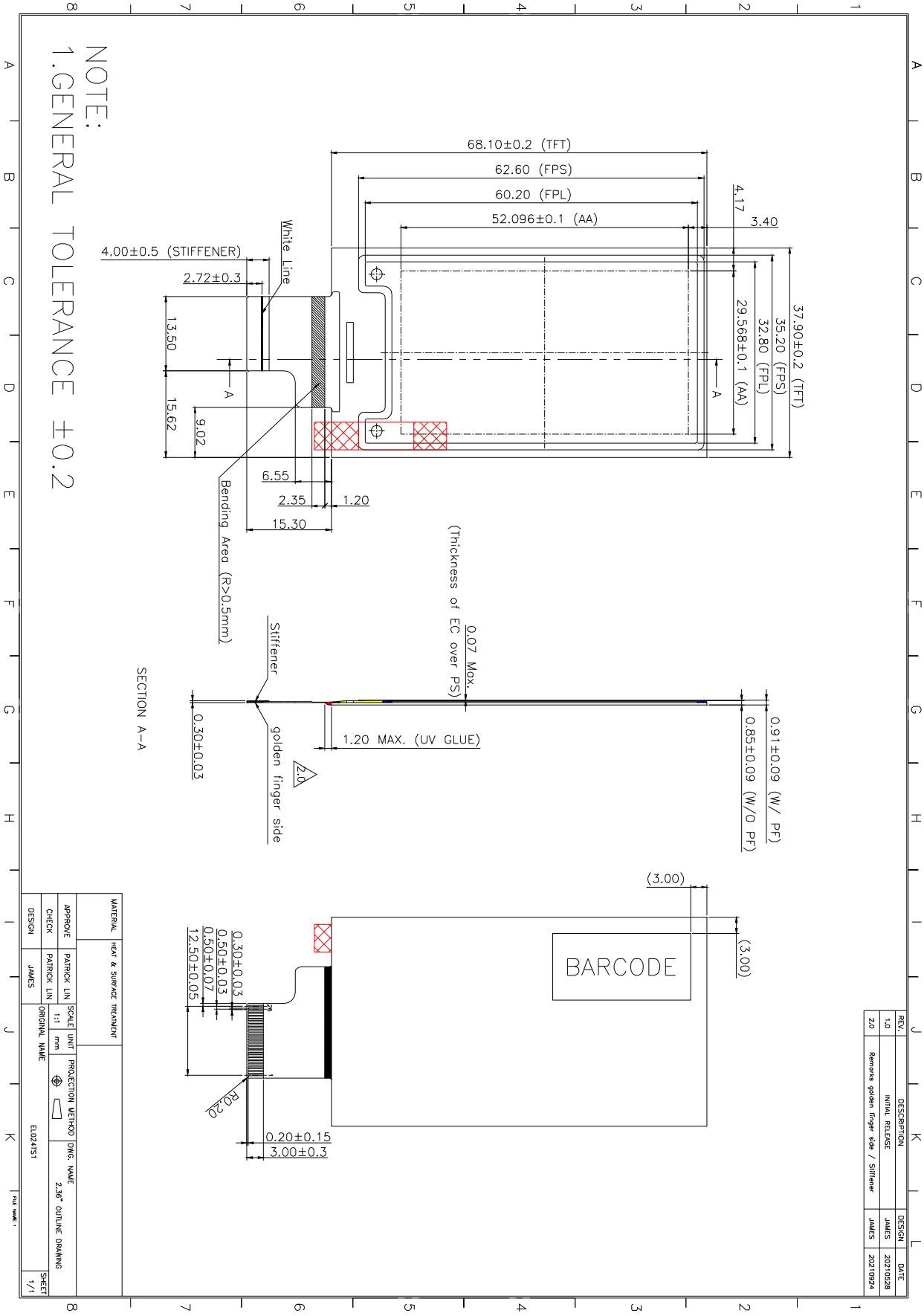
2. Features

- Highlight Red and Yellow color
- High contrast
- High reflectance
- Ultra wide viewing angle
- Ultra low power consumption
- Pure reflective mode
- Bi-stable
- Antiglare hard-coated front-surface
- Low current deep sleep mode
- On chip display RAM
- Waveform stored in On-chip OTP
- Serial peripheral interface available
- On-chip oscillator
- On-chip booster and regulator control for generating VCOM, Gate and source driving voltage
- I2C Signal Master Interface to read external temperature sensor
- Available in COG package

3. Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	2.36	Inch	
Display Resolution	296 (H) × 168 (V)	Pixel	PPi: 144
Active Area	52.096 (H) × 29.568 (V)	mm	
Pixel Pitch	0.176 × 0.176	mm	Square
Outline Dimension	68.1 (H) × 37.9 (V) × 0.85 (D)	mm	Without masking film
Module Weight	4.49±0.5	g	

4. Mechanical Drawing of EPD Module



5. Input/Output Interface

5-1) Connector type: FH34SRJ-26S-0.5SH

Pin Assignment (26-pin)

Pin Assignment			
Pin #	**Type**	**Single**	**Description**
1		NC	No connection and do not connect with other NC pins
2	O	GDR	N-Channel MOSFET Gate Control
3	P	TFT_VCOM	TFT_VCOM driving voltage
4	P	VDD_1.8	Digital Power Input
5	O	TSCL	I2C Interface to digital temperature sensor Clock pin
6	I/O	TSDA	I2C Interface to digital temperature sensor Data pin
7	I	BS0	Bus selection pin; H: 4-wire IF. **L: 3-wire IF. (Default)**
8	O	BUSY_N	Busy state output pin
9	I	RES#	Reset
10	I	D/C#	Data /Command control pin
11	I	CS#	Chip Select input pin
12	I	SCL	serial clock pin (SPI)
13	I/O	SDA	serial data pin (SPI)
14	P	VDD	I/O Power Input
15	P	VDD	Analog Power Input
16	P	GND	Ground
17	P	VSL_LV2	Negative Source driving voltage
18	P	VSL_LV	Negative Source driving voltage
19	P	VSL	Negative Source driving voltage
20		NC	No connection and do not connect with other NC pins
21	P	VSH_LV2	Positive Source driving voltage
22	P	VSH_LV	Positive Source driving voltage
23	P	VGH	Positive Gate driving voltage
24	P	VSH	Positive Source driving voltage
25	P	VGL	Negative Gate driving voltage
26	P	VCOM	VCOM 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 (D/C#) is 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 commands should not be issued to the module. The driver IC will put Busy pin low when the driver IC is working such as:

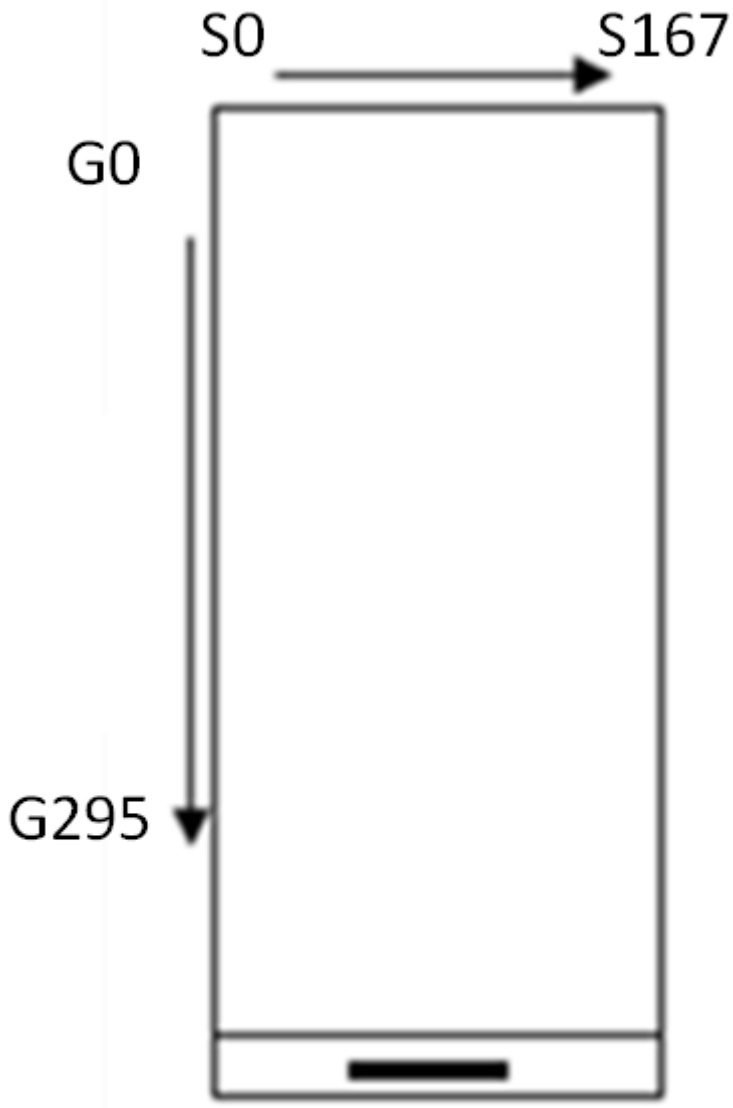
- Outputting display waveform; or
- Communicating with digital temperature sensor

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

Table: Bus interface selection

BS0	MPU Interface
H	4-lines serial peripheral interface (SPI)
L	3-lines serial peripheral interface (SPI) – 9 bits SPI

Panel Scan direction



6. Command Table

W/R: 0: Write cycle 1: Read cycle C/D: 0: Command 1: Data D7~D0: -: Don't care

	Command	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0	Registers	Setting
1	Power OFF	0	0	0	0	0	0	0	0	1	0		02h
		0	1	0	0	0	0	0	0	0	0		00h
2	Power ON	0	0	0	0	0	0	0	1	0	0		04h
3	Deep Sleep	0	0	0	0	0	0	0	1	1	1		07h
		0	1	1	0	1	0	0	1	0	1		A5h
4	Data Start transmission	0	0	0	0	0	1	0	0	0	0		10h
		0	1	#	#	#	#	#	#	#	#		--
		0	1	..	..	..	..	..	..	..	..		--
		0	1	#	#	#	#	#	#	#	#		--
5	Data Refresh	0	0	0	0	0	1	0	0	1	0		12h
		0	1	0	0	0	0	0	0	0	1		01h

(1) Power OFF (R02H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Power OFF	0	0	0	0	0	0	0	0	1	0
	0	1	0	0	0	0	0	0	0	0

(2) Power ON (R04H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Power ON	0	0	0	0	0	0	0	1	0	0

(3) Deep Sleep (R07H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Deep Sleep	0	0	0	0	0	0	0	1	1	1
	0	1	1	0	1	0	0	1	0	1

Remark: To Exit Deep Sleep mode, User required to send HWRESET to the driver.

(4) Data Start transmission (R10H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Data Start transmission	0	0	0	0	0	1	0	0	0	0
	0	1	#	#	#	#	#	#	#	#
	0	1	..	..	..	..	..	..	..	..
	0	1	#	#	#	#	#	#	#	#

After this command, data entries will be written into the RAM until another command is written.

(5) Data Refresh (R12H)

Action	W/R	C/D	D7	D6	D5	D4	D3	D2	D1	D0
Data Refresh	0	0	0	0	0	1	0	0	1	0
	0	1	0	0	0	0	0	0	0	1

When this command is received. IC will start the refresh process. BUSY_N will become “0”. After the refresh process is finished, BUSY_N will become “1”.

7. Electrical Characteristics

7-1 Absolute Maximum Ratings:

Parameter	Symbol	Rating	Unit
Digital power	VDD 1.8	-0.5 to +2.0	V
Analog power	VDD	-0.5 to +3.6	V
Operating Temp. range	T_{OPR}	0 to +40	℃
Storage Temp. range	T_{STG}	-25 to +60	℃

Note: 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 chapter.

7-2 Display Module DC characteristics

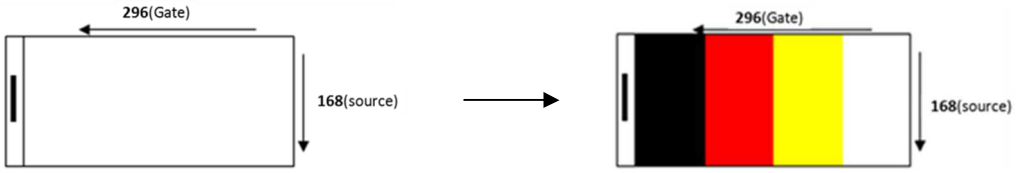
The following specifications apply for: VIO = 3.0V, VDD_1.8 = 1.8V, TA = 25℃

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	20.0	21	V
VGL	Negative Gate driving voltage		-21	-20.0	-19	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	VCOM_DC	VSH+ VCOM_DC	V
VIL	Low level input voltage	Digital input pins	-	--	0.8	V
VIH	High level input voltage	Digital input pins	2.2	--	--	V
VOH	High level output voltage	Digital input pins, IOH= 8 mA	2.4	--	--	V
VOL	Low level output voltage	Digital input pins, IOL= 8 mA	--	--	0.4	V
IMSTB	Module stand-by current	Stand-by mode	--	21	--	uA
IMDS	Module deep sleep current	Deep sleep mode	--	1	--	uA
Inc	Inrush Current	High Loading Pattern	--	31	48.3	mA
IMOPR	Module operating current	TYP Loading Pattern	--	7.5	13.1	mA
		High Loading Pattern	--	10.6	17.3	mA
P	Operation Power Dissipation	TYP Loading Pattern VDD=3.0V with DC-DC	--	22.5	39.3	mW
		High Loading Pattern VDD=3.0V with DC-DC	--	31.8	51.9	mW
PSTBY	Standby Power Dissipation	VDD=3.0V	--	63	--	uW

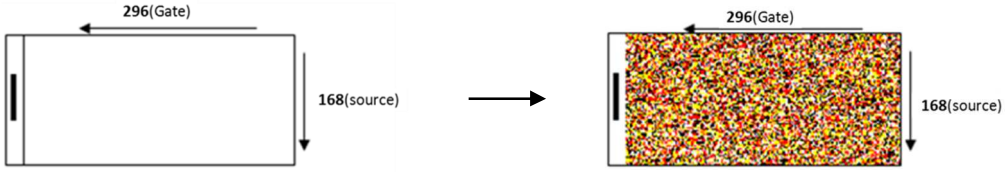
Note: The Module operating current data is measured by using Oscilloscope, and extract the Mean value.

- The typical power consumption is measured using associated 25C waveform with following pattern transition: from full white pattern to color stripe pattern. (Note 7-1)
- The high loading power consumption is measured using associated 25C waveform with following pattern transition: from full white pattern to noise pattern (including random scattering of 4 colors) (Note 7-2)
- The minimum VDD value by 2.4V is based on typical application pattern with stable and continuing power supply. It does not apply on high loading pattern such as Note 7-2.
- The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by E Ink
- Vcom value has been set in the IC chip on the panel.

Note 7-1
The typical power consumption



Note 7-2
The high loading power consumption



7-3 Panel AC Characteristics

7-3-1 MCU Interface

7-3-1-1 MCU Interface Selection

In this module, there are 4-wire SPI and 3-wire SPI that can communicate with MCU. The MCU interface mode can be set by hardware selection on BS0 pins. When it is “High”, 4-wire SPI is selected. When it is “Low”, 3-wire SPI (9 bits SPI) is selected.

Pin Name	Data/Command Interface		Control Signal		
Bus interface	SDA	SCL	CS#	D/C#	RES#
SPI4	SDIN	SCLK	CS#	D/C#	RES#
SPI3	SDIN	SCLK	CS#	L	RES#

Table 7-1: MCU interface assignment under different bus interface mode

Note 7-3: L is connected to GND

Note 7-4: H is connected to VDD

7-3-1-2 MCU Serial Interface (4-wire SPI)

The 4-wire SPI consists of serial clock SCLK, serial data SDA, D/C#, CS#.

Function	CS#	D/C#	SCLK
Write Command	L	L	↑
Write data	L	H	↑

Table 7-2: Control pins of 4-wire Serial Peripheral interface

Note 7-5: ↑stands for rising edge of signal

SDA is shifted into an 8-bit shift register in the order of D7, D6, ... D0. The data byte in the shift register is written to the Graphic Display Data RAM (RAM) or command register in the same clock. Under serial mode, only write operations are allowed.

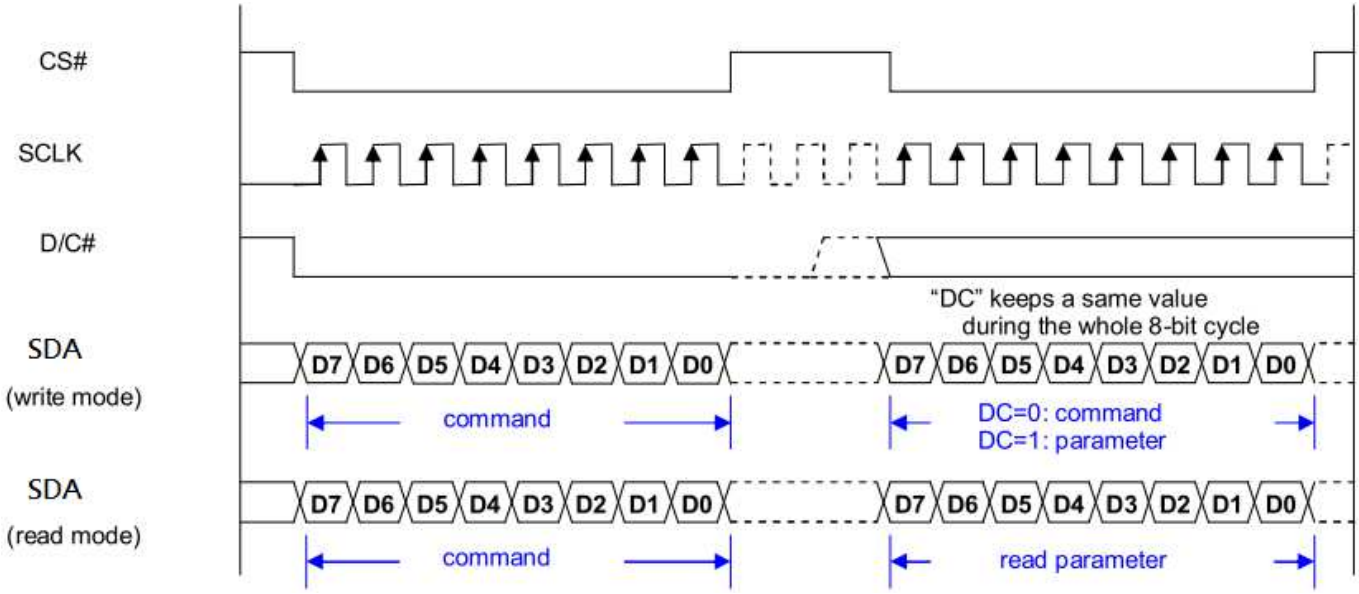


Figure 7-1: Write procedure in 4-wire Serial Peripheral Interface mode

7-3-1-3 MCU Serial Interface (3-wire SPI)

The 3-wire serial interface consists of serial clock SCLK, serial data SDA and CS#.

In 3-wire SPI mode, the pin D/C# can be connected to an external ground.

The operation is similar to 4-wire serial interface while D/C# pin is not used. There are altogether 9-bits will be shifted into the shift register on every ninth clock in sequence: D/C# bit, D7 to D0 bit. The D/C# bit (first bit of the sequential data) will determine the following data byte in shift register is written to the Display Data RAM (D/C# bit = 1) or the command register (D/C# bit = 0).Under serial mode, only write operations are allowed.

Function	CS#	D/C#	SCLK
Write Command	L	Tie LOW	↑
Write data	L	Tie LOW	↑

Table 7-3: Control pins of 3-wire Serial Peripheral Interface

Note 7-6: ↑stands for rising edge of signal

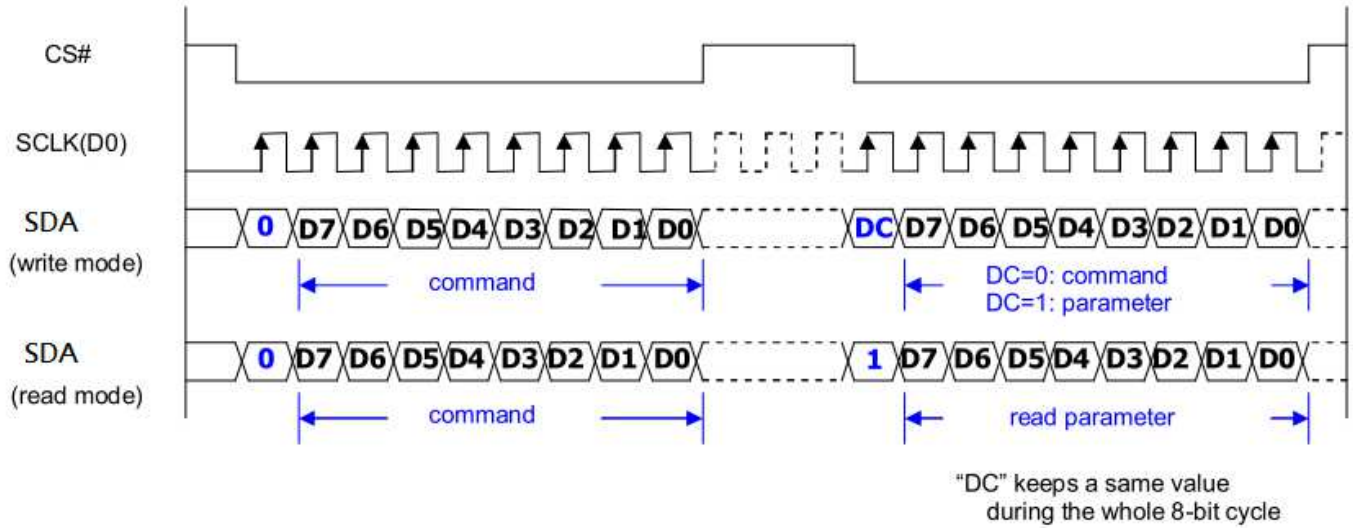
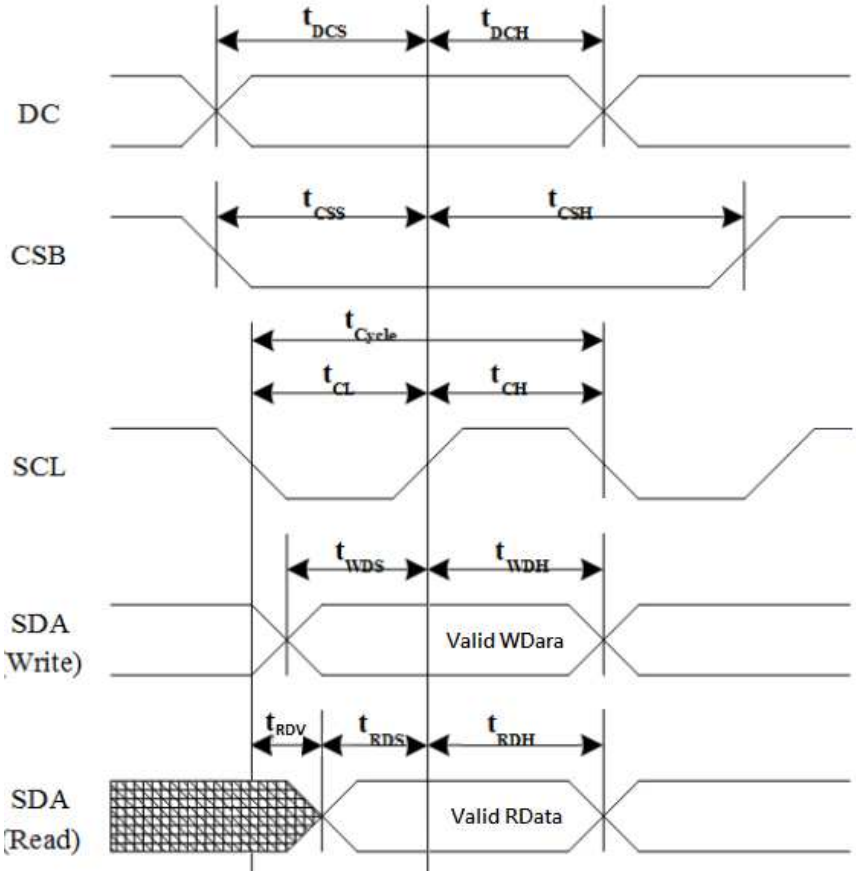


Figure 7-2: Write procedure in 3-wire Serial Peripheral Interface mode

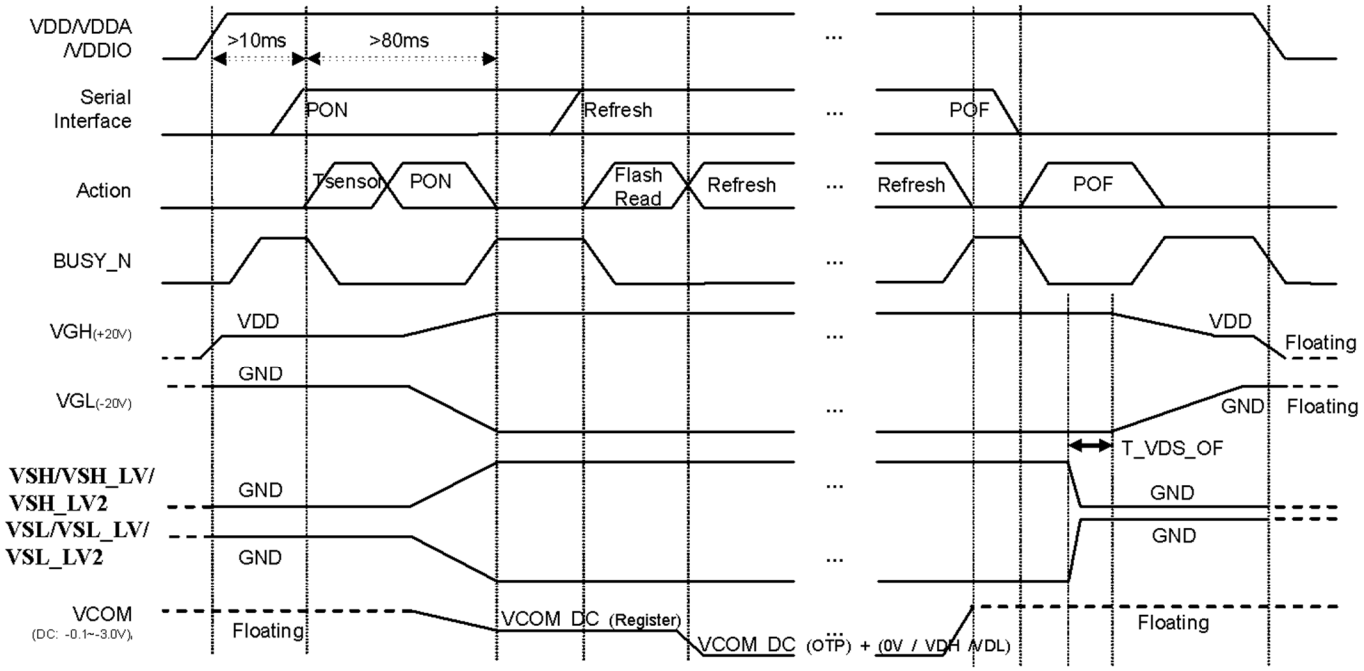
7-3-2 Timing Characteristics of Series Interface



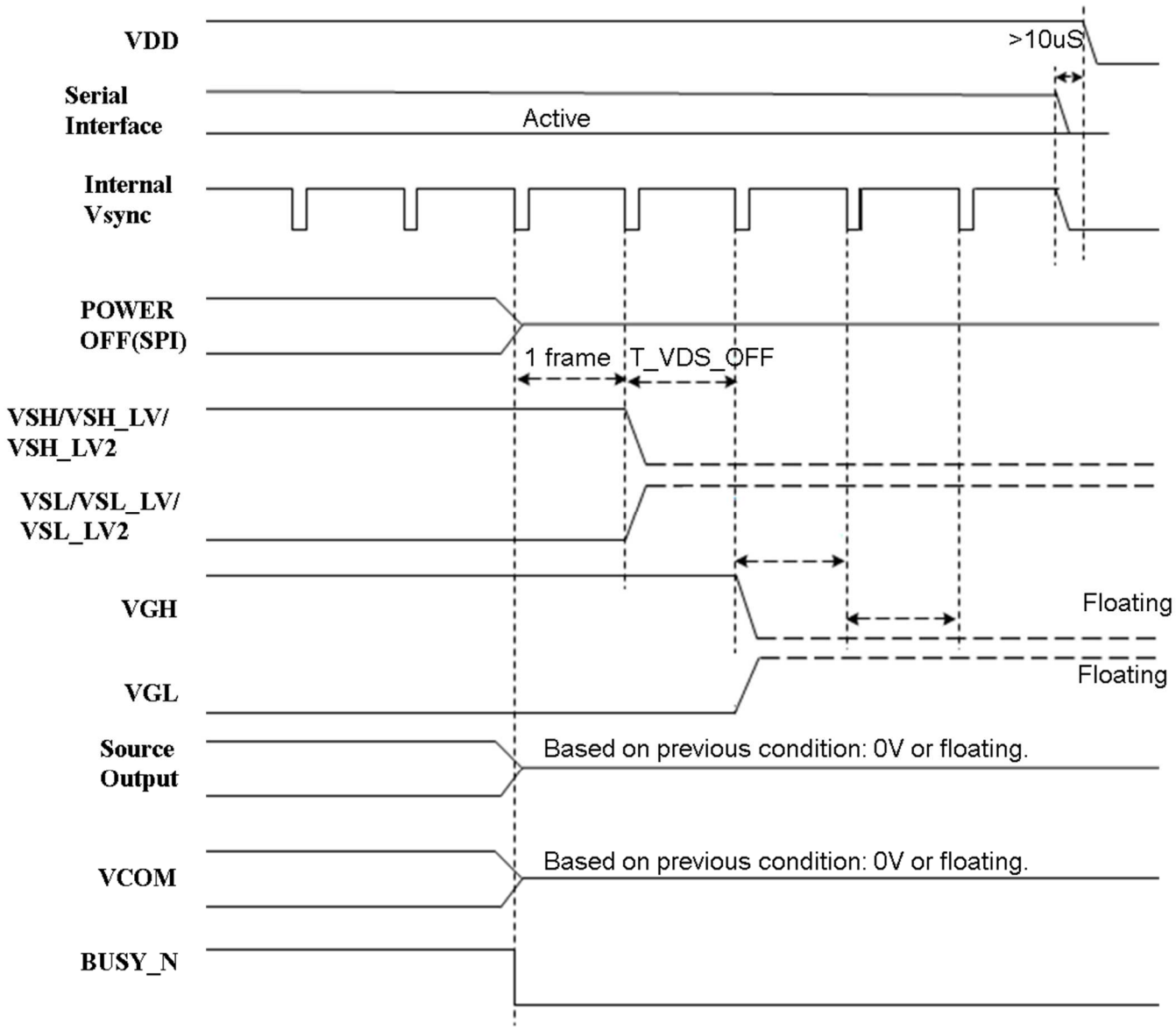
Symbol	Signal	Parameter	Min	Max	Unit
tDCS	D/C#	Setup time for D/C#	15	-	ns
tDCS		Hold time for D/C#	15	-	ns
tCCS	CS	Setup time for CS	15	-	ns
tCSH		Hold time for CS	15	-	ns
tCycle	SCL	Serial clock cycle	42	-	ns
tCL		Low period for SCL	25	-	ns
tCH		High period for SCL	25	-	ns
tWDS	SDA	Setup time for SDA (Write)	15	-	ns
tWDH		Hold time for SDA (Write)	15	-	ns
tRDS		Setup time for SDA (Read)	15	-	ns
tRDH		Hold time for SDA (Read)	15	-	ns
tRDV		SDA drive time while read	15	-	ns

7-3-3 Power On/Off Characteristics

Power ON Sequence



Power OFF Sequence



8. Optical Characteristics

8-1) Specification

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

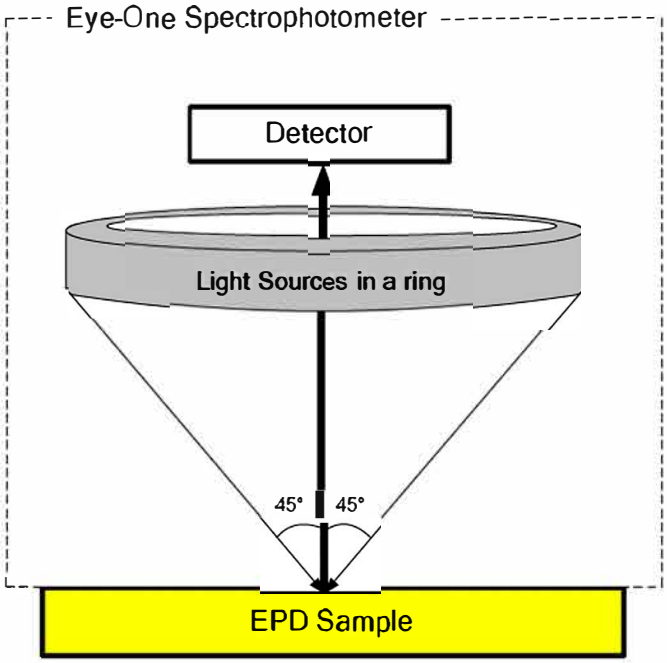
Symbol	Parameter	Conditions	Temperature	Min	Typ.	Max	Unit	Note
R	Reflectance	White	25℃	30	34	-	%	Note 8-1
CR	Contrast Ratio	-	25℃	10	15	-		-
RS_L*	Red State L*value	Red	25℃	23	26			Note 8-1
RS_a	Red State a* value	Red	25℃	35	39	-		Note 8-1
YS_L*	Yellow State L*value	Yellow	25℃	52	57			Note 8-1
YS_b*	Yellow State b*value	Yellow	25℃	58	66			Note 8-1
T_{update}	Update time	Red/Yellow	25℃		14		sec	
RS_L*	Red State L* value	Red	0℃	22	26			Note 8-1
RS_a*	Red State a* value	Red	0℃	30	35			Note 8-1
YS_L*	Yellow State L*value	Yellow	0℃	50	56			Note 8-1
YS_b*	Yellow State b*value	Yellow	0℃	51	60			Note 8-1
T_{update}	Update time	Red/Yellow	0℃		40		sec	

WS: White state, DS: Dark state, RS: Red state, YS: Yellow state
Note 8-1：Luminance meter：Eye – One Pro Spectrophotometer

8-2) Definition of contrast ratio

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

CR = Rl/Rd



8-3) Reflection Ratio

The reflection ratio is expressed as：

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

L_{center} is the luminance measured at center in a white area (R=G=B=1). $L_{\text{white board}}$ 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.

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 Final product specifications subjected to changes without notice.
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.	

10. Reliability Test

	TEST	CONDITION	REMARK
1	High Temperature Storage	Ta= 60°C 40% RH, 240Hrs	(Test in White pattern)
2	Low Temperature Storage	Ta= -25°C, 240Hrs	(Test in White pattern)
3	High Temperature Operation	Ta= 40°C 35% RH, 240Hrs	
4	Low Temperature Operation	Ta= 0°C, 240Hrs	
5	High-Temperature, High-Humidity Operation	T = +40°C, RH = 80%, 240Hrs	
6	High Temperature, High-Humidity Storage	Ta= 60°C 80% RH, 240Hrs	(Test in White Pattern)
7	Heat Shock	-25°C(30 min) ~60°C(30 min) 50 cycle, 1Hr/cycle	(Test in White pattern)
8	Electrostatic Discharge	(Machine model) +/- 200V 0Ω, 200pF	Non-operation

Actual EMC level to be measured on customer application.

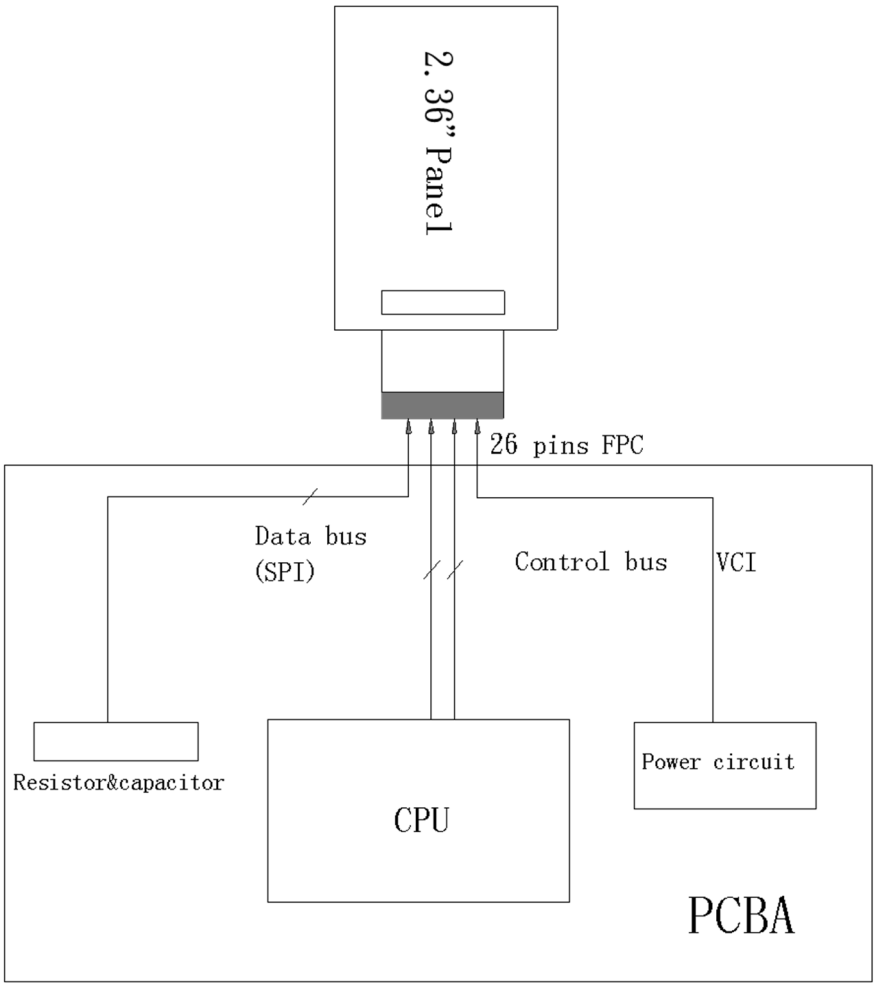
Note：The protective film must be removed before temperature test.

< Criteria >

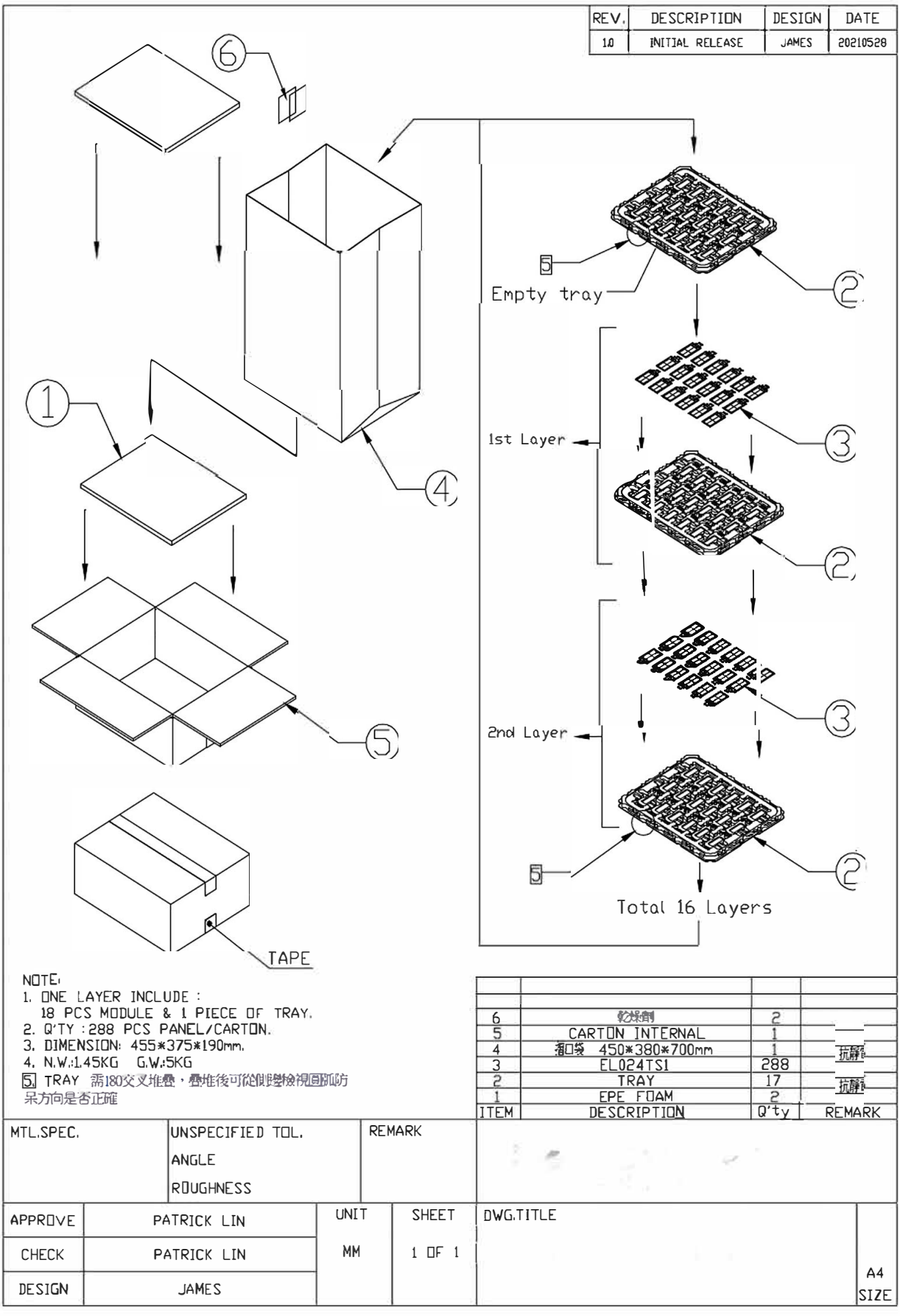
In the standard conditions, there is not display function NG issue occurred.

All the cosmetic specification is judged before the reliability stress.

11. Block Diagram



12. Packing


REV.
DESCRIPTION
DESIGN
DATE
1.0
INITIAL RELEASE
JAMES
20210528
Empty tray
1st Layer
2nd Layer
Total 16 Layers
TAPE
NOTE:
1. ONE LAYER INCLUDE :
18 PCS MODULE & 1 PIECE OF TRAY.
2. Q'TY : 288 PCS PANEL/CARTON.
3. DIMENSION: 455*375*190mm.
4. N.W.:1.45KG G.W.:5KG
5. TRAY 需180交叉堆疊，疊堆後可從側壁檢視圓弧方呆方向是否正確
6 乾燥劑 2
5 CARTON INTERNAL 1
4 海口袋 450*380*700mm 1 抗靜電
3 EL024TS1 288
2 TRAY 17 抗靜電
1 EPE FOAM 2
ITEM DESCRIPTION Q'ty REMARK
MTL.SPEC.
UNSPECIFIED TOL.
ANGLE
ROUGHNESS
REMARK
APPROVE PATRICK LIN
CHECK PATRICK LIN
DESIGN JAMES
UNIT MM
SHEET 1 OF 1
DWG.TITLE
A4 SIZE