PRODUCT SPECIFICATION

EPD NO: MF-12132-M001F-H

CUSTOMER: _____

APPROVED BY CUSTOMER	
Approved by	Remark

APPROVED BY Ink Cubic			
Prepared by	Checked by		Approved by
	EE	ME	
Hao Tong	Chuanqing Wu	Hao Tong	Shengjun Zhu

Version	Content	Date	Producer
A0	New release	2022/7/7	Wu

CONTENTS

1.General Description

Ink Cubic-M001F-H is an Active Matrix Electrophoretic Display (AMEPD), with interface and a reference system design. The2.13”active area contains 122×250pixels, and has 1-bit B/W/R full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM and border are supplied with eachpanel.

2. Features

- 122×250 pixels display
- High contrast
- High reflectance
- Ultra wide viewing angle
- Ultra low power consumption
- Pure reflective mode
- Bi-stable display
- Commercial temperature range
- Landscape, portrait modes
- Hard-coat antiglare display surface
- Ultra Low current deep sleep mode
- On chip display RAM
- Low voltage detect for supply voltage
- High voltage ready detect for driving voltage
- Internal temperature sensor
- 10-byte OTP space for module identification
- 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/ built-in temperature sensor

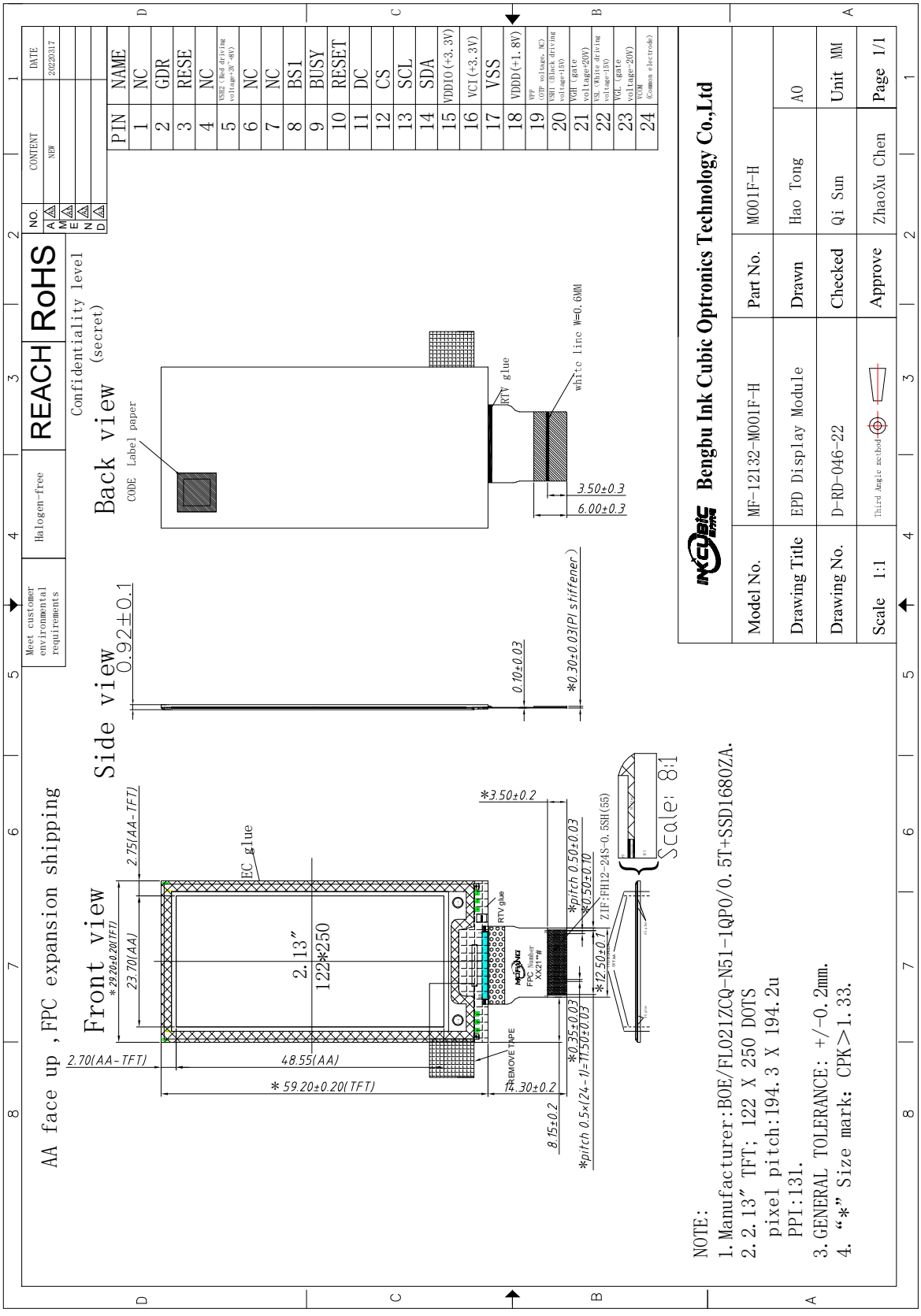
3.Application

Electronic Shelf Label System

4.Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	2.13	Inch	
Display Resolution	122(H)×250(V)	Pixel	Dpi:130
Active Area	23.7(H)×48.55(V)	mm	
Pixel Pitch	0.194×0.194	mm	
Pixel Configuration	Rectangle		
Outline Dimension	29.2(H)×59.2 (V) ×0.92（D）	mm	
Weight	3.15±0.5	g	

5.Mechanical Drawing of EPD module



6.Input/Output Terminals

Pin #	Single	Description	Remark
1	NC	No connection and do not connect with other NC pins	Keep Open
2	GDR	N-Channel MOSFET Gate Drive Control	
3	RESE	Current Sense Input for the Control Loop	
4	NC	No connection and do not connect with other NC pins	Keep Open
5	VSH2	Positive Source driving voltage	
6	NC	No connection and do not connect with other NC pins	Keep Open
7	NC	No connection and do not connect with other NC pins	Keep Open
8	BS1	Bus selection pin	Note 6-5
9	BUSY	Busy state output pin	Note 6-4
10	RES #	Reset signal input.	Note 6-3
11	D/C #	Data /Command control pin	Note 6-2
12	CS #	The chip select input connecting to the MCU.	Note 6-1
13	SCL	Serial clock pin for interface.	
14	SDA	Serial data pin for interface.	
15	VDDIO	Power input pin for the Interface.	
16	VCI	Power Supply pin for the chip	
17	VSS	Ground (Digital)	
18	VDD	Core logic power pin	
19	VPP	Power Supply for OTP Programming	
20	VSH1	Positive Source driving voltage	
21	VGH	Power Supply pin for Positive Gate driving voltage and VSH	
22	VSL	Negative Source driving voltage	
23	VGL	Power Supply pin for Negative Gate driving voltage, VCOM and VSL	
24	VCOM	VCOM driving voltage	

Note 6-1: This pin (CS#) is the chip select input connecting to the MCU. The chip is enabled forMCU communication: only when CS# is pulled LOW.

Note 6-2: This pin (D/C#) is Data/Command control pin connecting to the MCU. When the pin ispulled HIGH, the data will be interpreted as data. When the pin is pulled LOW, the data will be interpreted as command.

Note 6-3: This pin (RES#) is reset signal input. The Reset is active low.

Note 6-4: This pin (BUSY) is Busy state output pin. When Busy is High ,the operation of chip shouldnot be interrupted and any commands should not be issued to the module. The driver IC will put Busypin High when the driver IC is working such as:

- Outputting display waveform; or

- Communicating with digital temperature sensor

Note 6-5: This pin (BS1) is for 3-line SPI or 4-line SPI selection. When it is “Low”, 4-line SPI isselected. When it is “High”, 3-line SPI (9 bits SPI) is selected

7.MCU Interface

7.1MCU interface selection

The Ink Cubic-M001F-H can support 3-wire/4-wire serial peripheral interface. In the Module, theMCU interface is pin selectable by BS1 pins shown in.

Table 7-1: MCU interface selection

BS1	MPU Interface
L	4-lines serial peripheral interface (SPI)
H	3-lines serial peripheral interface (SPI) - 9 bits SPI

7.2 MCU Serial Peripheral Interface (4-wire SPI)

The 4-wire SPI consists of serial clock SCL, serial data SDA, D/C# and CS#. The control pins status in 4-wire SPI in writing command/data is shown in Table 7-2 and the write procedure 4-wire SPI is shown in Figue 7-2.

Table 7-2 : Control pins status of 4-wire SPI

Function	SCL pin	SDA pin	D/C# pin	CS# pin
Write command	↑	Command bit	L	L
Write data	↑	Data bit	H	L

Note:

(1) L is connected to VSS and H is connected to VDDIO

(2) ↑ stands for rising edge of signal

In the write mode, SDA is shifted into an 8-bit shift register on each rising edge of SCL in the

CS#

order ofD7, D6, ... D0. The level of D/C# should be kept over the whole byte. The data byte in the shift register is written to the Graphic Display Data RAM (RAM)/Data Byte register or command Byte register according to D/C# pin.

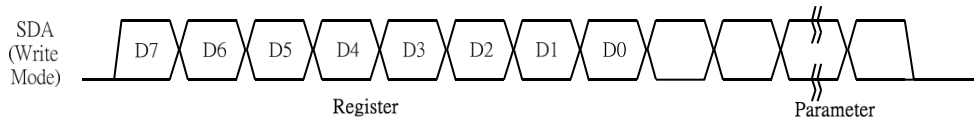


Figure 7-1: Write procedure in 4-wire SPI mode

In the Read mode:

1. After driving CS# to low, MCU need to define the register to be read.
2. SDA is shifted into an 8-bit shift register on each rising edge of SCL in the order of D7, D6, ...D0 with D/C# keep low.
3. After SCL change to low for the last bit of register, D/C# need to drive to high.
4. SDA is shifted out an 8-bit data on each falling edge of SCL in the order of D7, D6, ⋯ D0.
5. Depending on register type, more than 1 byte can be read out. After all byte are read, CS# needto drive to high to stop the read operation.

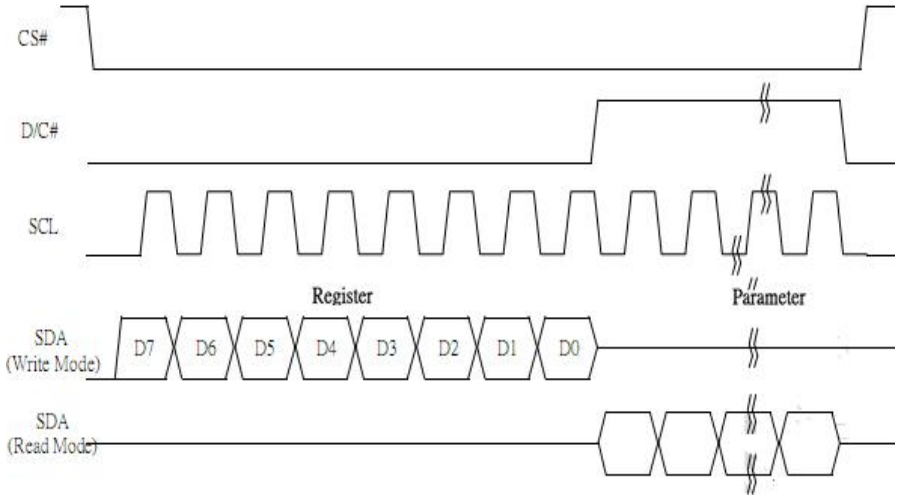


Figure 7-2: Read procedure in 4-wire SPI mode

In the write mode, SDA is shifted into an 8-bit shift register on each rising edge of SCL in the order ofD7, D6, ... D0. The level of D/C# should be kept over the whole byte. The data byte in the shift register is written to the Graphic Display Data RAM (RAM)/Data Byte register or command Byte register according to D/C# pin

7.3MCU Serial Peripheral Interface (3-wire SPI)

The 3-wire SPI consists of serial clock SCL, serial data SDA and CS#. The operation is similar to 4-wireSPI while D/C# pin is not used and it must be tied to LOW. The control pins status in 3-wire SPI is shown in Table 7-3.

Table 7-3 : Control pins status of 3-wire SPI

Function	SCL pin	SDA pin	D/C# pin	CS# pin
Write command	↑	Command bit	Tie LOW	L
Write data	↑	Data bit	Tie LOW	L

Note:

(1) L is connected to V_{SS} and H is connected to V_{DDIO}

(2) ↑ stands for rising edge of signal

In the write operation, a 9-bit data will be shifted into the shift register on each clock rising edge. The bit shifting sequence is D/C# bit, D7 bit, D6 bit to D0 bit. The first bit is D/C# bit which determines the following byte is command or data. When D/C# bit is 0, the following byte is command. When D/C# bit is 1, the following byte is data. shows the write procedure in 3-wire SPI

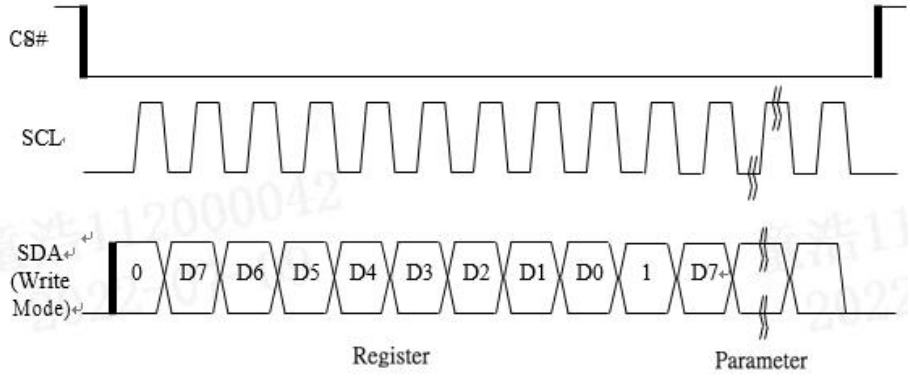


Figure 7-3: Write procedure in 3-wire SPI mode

In the Read mode:

1. After driving CS# to low, MCU need to define the register to be read.
2. D/C#=0 is shifted thru SDA with one rising edge of SCL
3. SDA is shifted into an 8-bit shift register on each rising edge of SCL in the order of D7, D6, ...D0.
4. D/C#=1 is shifted thru SDA with one rising edge of SCL
5. SDA is shifted out an 8-bit data on each falling edge of SCL in the order of D7, D6, ⋯ D0.
6. Depending on register type, more than 1 byte can be read out. After all byte are read, CS# needto drive to high to stop the read operation.

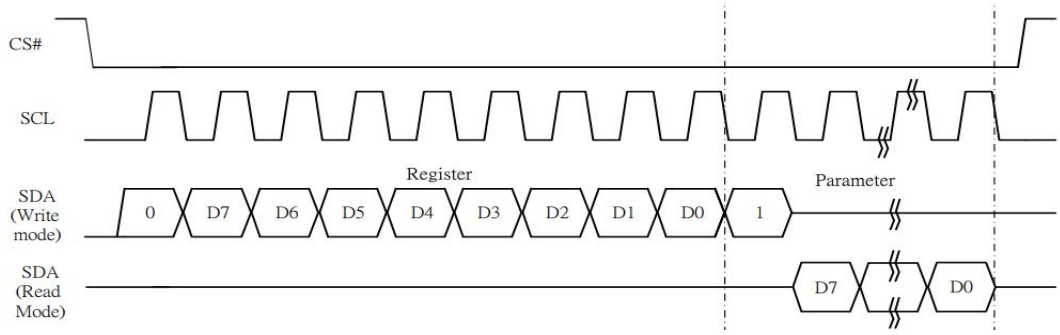


Figure 7-4: Read procedure in 3-wire SPI mode

8.Reference Circuit

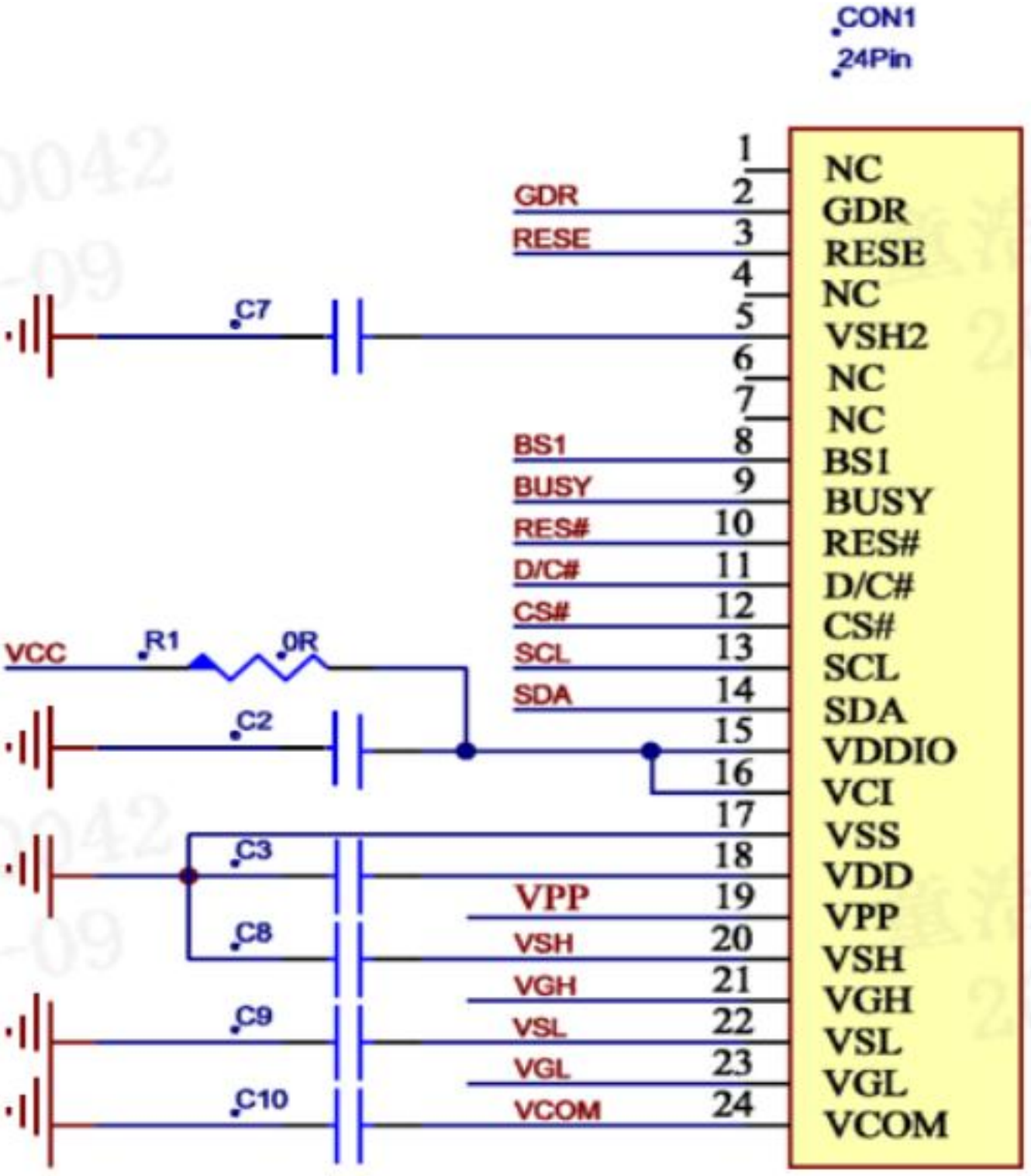


Figure. 8-1

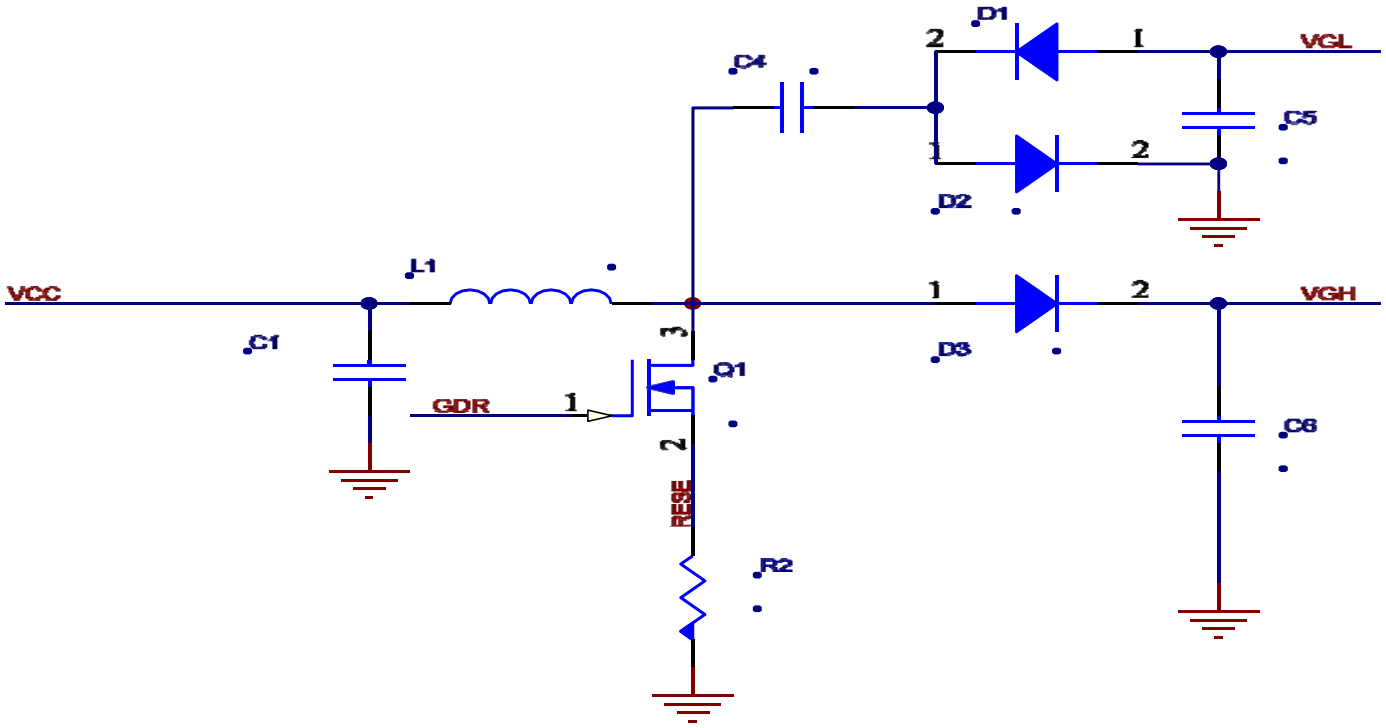


Figure. 8-2

Part Name	SSD1680 Value /quirement/Reference Part
C1—C9	1uF/0603;X5R/X7R;Voltage Rating: 25V
C10	1uF/0603;X7R;Voltage Rating: 25V
D1—D3	MBR0530 1) Reverse DC voltage≥30V 2) Forward current≥500mA 3)Forward voltage≤430mV
R2	2.2 Ω/0603：1% variation
Q1	NMOS:Si1304BDL/NX3008NBK 1） Drain-Source breakdown voltage ≥30V 2） Vgs（th）=0.9（Typ），1.3V（Max） 3） Rds on≤ 2.1Ω @ Vgs=2.5V
L1	47uH/CDRH2D18、LDNP-470NC Maximum DC current~420mA Maximum DC resistance~650mΩ

9.Absolute Maximum Rating

Table 9-1: Maximum Ratings

Symbol	Parameter	Rating	Unit	Humidity	Unit	Note
V_{CI}	Logic supply voltage	-0.5 to +6.0	V	-	-	
T_{OPR}	Operation temperature range	0 to 40	℃	45 to70	%	Note 9-1
Tttg	Transportation temperature range	-25 to 60	℃	45 to70	%	Note 9-2
Tstg	Storage condition	0 to 40	℃	45 to70	%	Maximum storage time: 5 years
-	After opening the package	0 to 40	℃	45 to70	%	

Note 9-1： We guarantee the single pixel display quality for 0-35℃, but we only guarantee the barcode readable for 35-40℃. Normal use is recommended to refresh every 24 hours.

Note 9-2: Tttg is the transportation condition, the transport time is within 10 days for -25℃~0℃ or 40℃~60℃.

Note 9-3： When the three-color product is stored. The display screen should be kept white and face up. In addition, please be sure to refresh the e-paper every three months.

10.DC Characteristics

The following specifications apply for: VSS=0V, VCI=3.3V, T_{OPR}=25°C.

Table 13-1: DC Characteristics

Symbol	Parameter	Test Condition	Applicable pin	Min.	Typ.	Max.	Unit
VCI	VCI operation voltage	-	VCI	2.2	3	3.7	V
VIH	High level input voltage	-	SDA, SCL, CS#, D/C#, RES#, BS1	0.8VDDIO			V
VIL	Low level input voltage	-		-	-	0.2VDDIO	V
VOH	High level output voltage	IOH = -100uA	BUSY	0.9VDDIO	-	-	V
VOL	Low level output voltage	IOL = 100uA		-	-	0.1VDDIO	V
Iupdate	Module operating current	-	-	-	3	-	mA
Isleep	Deep sleep mode	VCI=3.3V	-	-	-	3	uA

The Typical power consumption is measured using associated 25℃ waveform with followingpattern transition: from horizontal scan pattern to vertical scan pattern. (Note10-1)

- The listed electrical/optical characteristics are only guaranteed under the controller &waveform provided by Ink Cubic.
- Vcom value will be OTP before in factory or present on the label sticker.

Note 10-1

The Typical power consumption

11.Serial Peripheral Interface Timing and Command Table

11.1 Serial Peripheral Interface Timing

The following specifications apply for: VSS=0V, VCI=2.2V to 3.7V, T_{OPR}=25℃ , CL=20pF

Write mode

Symbol	Parameter	Min	Typ	Max	Unit
fSCL	SCL frequency (Write Mode)			20	MHz
tCSSU	Time CS# has to be low before the first rising edge of SCLK	60			ns
tCSHLD	Time CS# has to remain low after the last falling edge of SCLK	65			ns
tCSHIGH	Time CS# has to remain high between two transfers	100			ns
tSCLHIGH	Part of the clock period where SCL has to remain high	25			ns
tSCLLOW	Part of the clock period where SCL has to remain low	25			ns
tSISU	Time SI (SDA Write Mode) has to be stable before the next rising edge of SCL	10			ns
tSIHLD	Time SI (SDA Write Mode) has to remain stable after the rising edge of SCL	40			ns

Read mode

Symbol	Parameter	Min	Typ	Max	Unit
fSCL	SCL frequency (Read Mode)			2.5	MHz
tCSSU	Time CS# has to be low before the first rising edge of SCLK	100			ns
tCSHLD	Time CS# has to remain low after the last falling edge of SCLK	50			ns
tCSHIGH	Time CS# has to remain high between two transfers	250			ns
tSCLHIGH	Part of the clock period where SCL has to remain high	180			ns
tSCLLOW	Part of the clock period where SCL has to remain low	180			ns
tSOSU	Time SO(SDA Read Mode) will be stable before the next rising edge of SCL		50		ns
tSOHLD	Time SO (SDA Read Mode) will remain stable after the falling edge of SCL		0		ns

Note: All timings are based on 20% to 80% of VDDIO-VSS

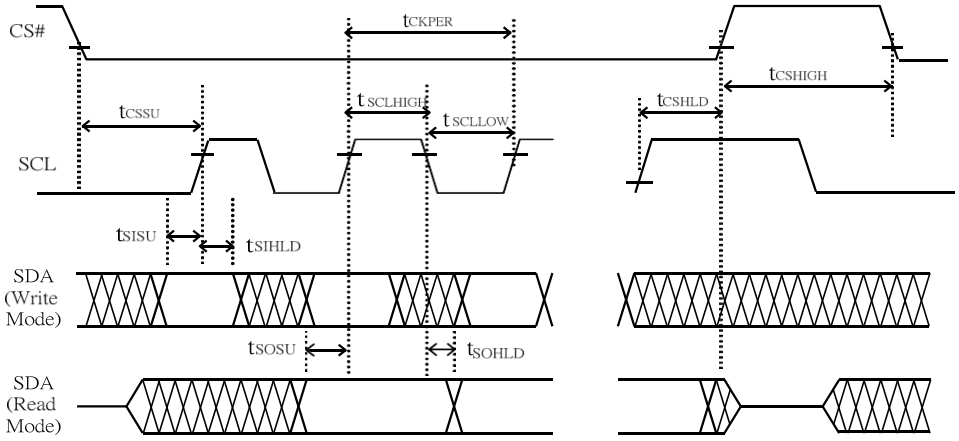


Figure 11-1: SPI timing diagram

11.2 Command Table

Please refer to IC Spec.

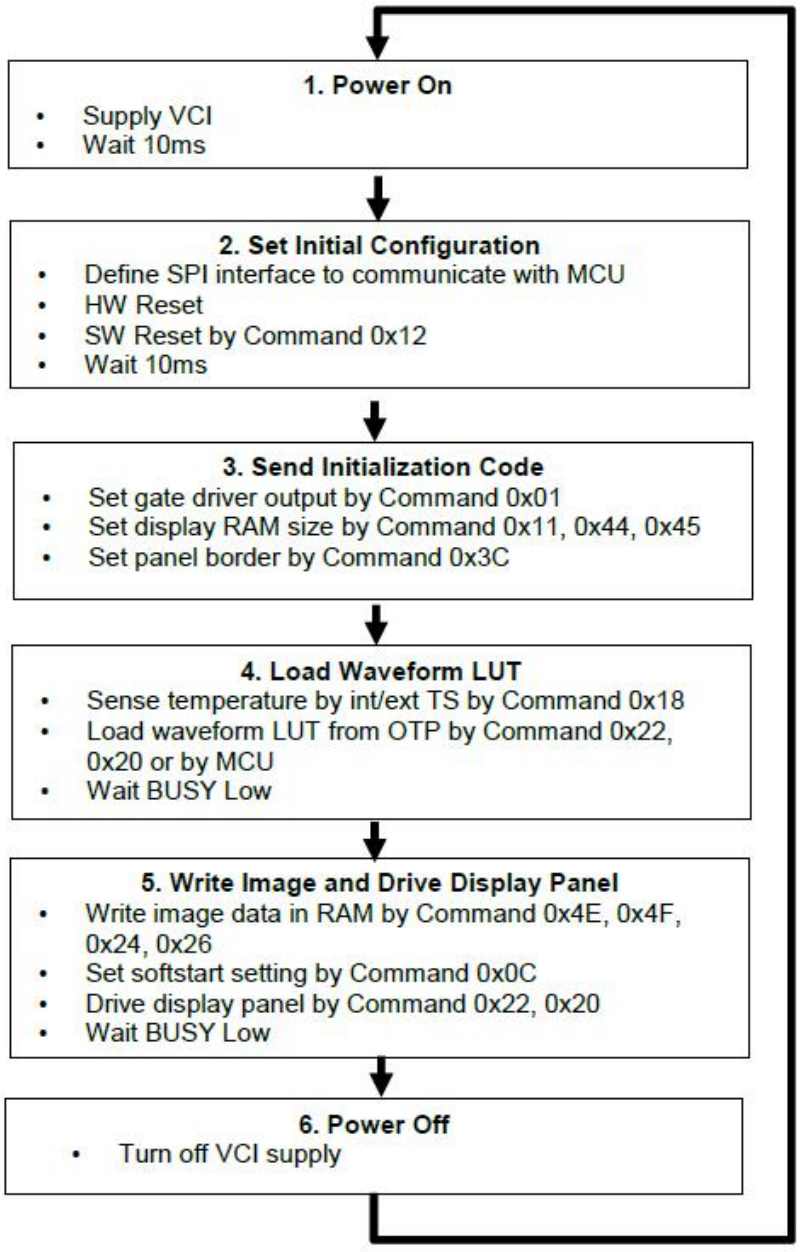
12.Power Consumption

Parameter	Symbol	Conditions	TYP	Max	Unit	Remark
Panel power consumption during update	-	25℃	-	100	mAs	-
Deep sleep mode	-	25℃	-	3	uA	-

mAs=update average current ×update time

13.Typical Operating Sequence

13.1Normal Operation Flow



14.Optical characteristics

14.1Specifications

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

T=25℃

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP.	MAX	UNIT	Note
CR	Contrast Ratio	-	15	20	-		-
KS	Black State L* value		-	10	14		Note 14-1
	Black State a* value		-	-	5		Note 14-1
WS	White State L* value		62	64	-		Note 14-1
RS	Red State L* value	Red	24	26	-		Note 14-1
	Red State a* value	Red	37	40	-		Note 14-1
Panel’s life	-	0℃～40℃		5years	-	-	Note 14-2
Panel	Image Update	Storage and transportation	-	Update the white screen	-	-	-
	Update Time	Operation	-	Suggest Updated once a day	-	-	-

WS : White state, KS : Black state, RS: Red state

Note 14-1 : Luminance meter : i - One Pro Spectrophotometer

Note 14-2:We don't guarantee 5 years pixels display quality for humidity below 45%RH or above 70%RH;
Suggest Updated once a day;

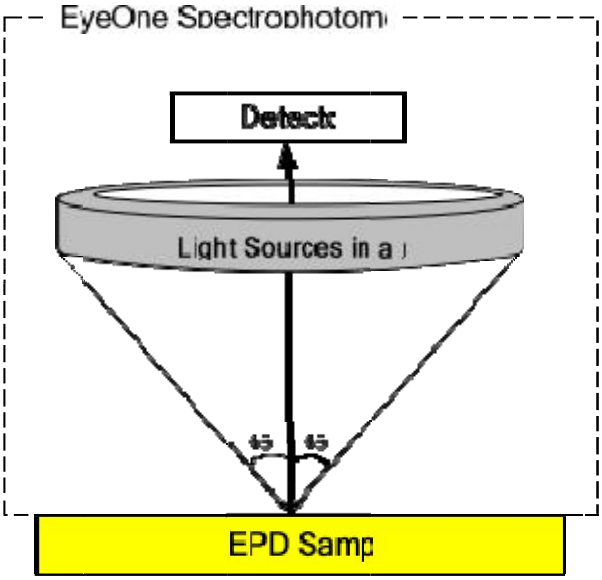
Note 14-3: To increases the black and white screen clear screen when red has refreshed for a long time , the effect is better。

14.2 Definition of contrast ratio

The contrast ratio (CR) is the ratio between the reflectance in a full white area (R1) and the reflectance in a dark area (Rd)() :

R1: white reflectance Rd: dark reflectance

CR = R1/Rd

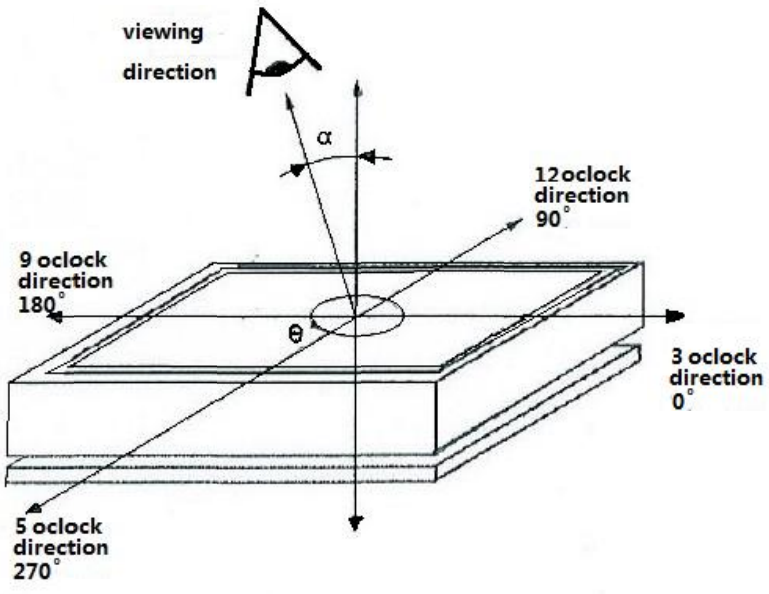


14.3 Reflection Ratio

The reflection ratio is expressed as:

R = Reflectance Factor $_{\text{white board}}$ x (L_{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 whiteboard. Both are measured with equivalent illumination source. The viewing angle shall be no more than 2 degrees.



15.Handling, Safety and Enviromental Requirements

WARNING
The display module should be kept flat or fixed to a rigid, curved support with limited bending along the long axis. It should not be used for continual flexing and bending. Handle with care. Should the display break do not touch any material that leaks out. In case of contact with the leaked material then 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.
Observe general precautions that are common to handling delicate electronic components. The glass can break and front surfaces can easily be damaged . Moreover the display is sensitive to static electricity and other rough environmental conditions.

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	The 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 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 dose not form part of the specification.

Product Environmental certification
ROHS
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.

16.Reliability test

	TEST	CONDITION	REMARK
1	High-Temperature Operation	T=40℃, RH=35%RH, For 240Hr	
2	Low-Temperature Operation	T = 0℃ for 240 Hr	
3	High-Temperature Storage	T=60℃ RH=35%RH For 240Hr	Test in white pattern
4	Low-Temperature Storage	T = -25℃ for 240 Hr	Test in white pattern
5	High Temperature, High-Humidity Operation	T=40℃,RH=80%RH, For 240Hr	
6	High Temperature, High-Humidity Storage	T=50℃,RH=80%RH,For 240Hr	Test in white pattern
7	Temperature Cycle	-25℃(30min)~60℃(30min),50 Cycle	Test in white pattern
8	Package Vibration	1.04G,Frequency : 20~200Hz Direction : X,Y,Z Duration: 30 minutes in each direction	Full packed for shipment
9	Package Drop Impact	Drop from height of 100 cm on Concrete surface Drop sequence:1 corner, 3edges, 6face One drop for each.	Full packed for shipment
10	Electrostatic discharge	HBM:330Ω,150pF	Air +/-4KV;Contact +/-2KV
11	UV Exposure Resistance	765 W/㎡ for 168hrs,40 ℃	

Actual EMC level to be measured on customer application.

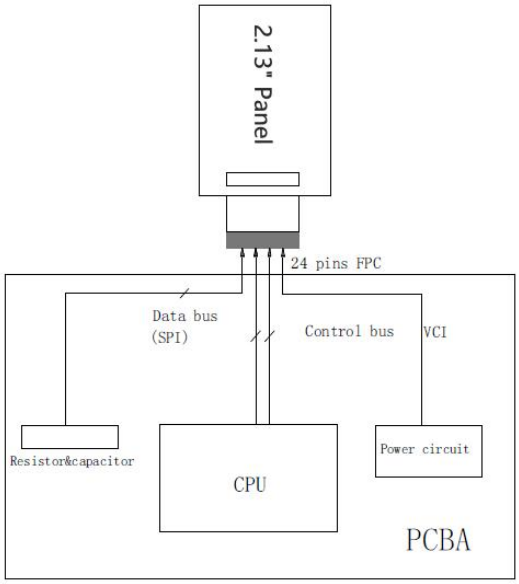
Note1：Stay white pattern for storage and non-operation test.

Note2：Operation is black/white/red pattern , hold time is 150S.

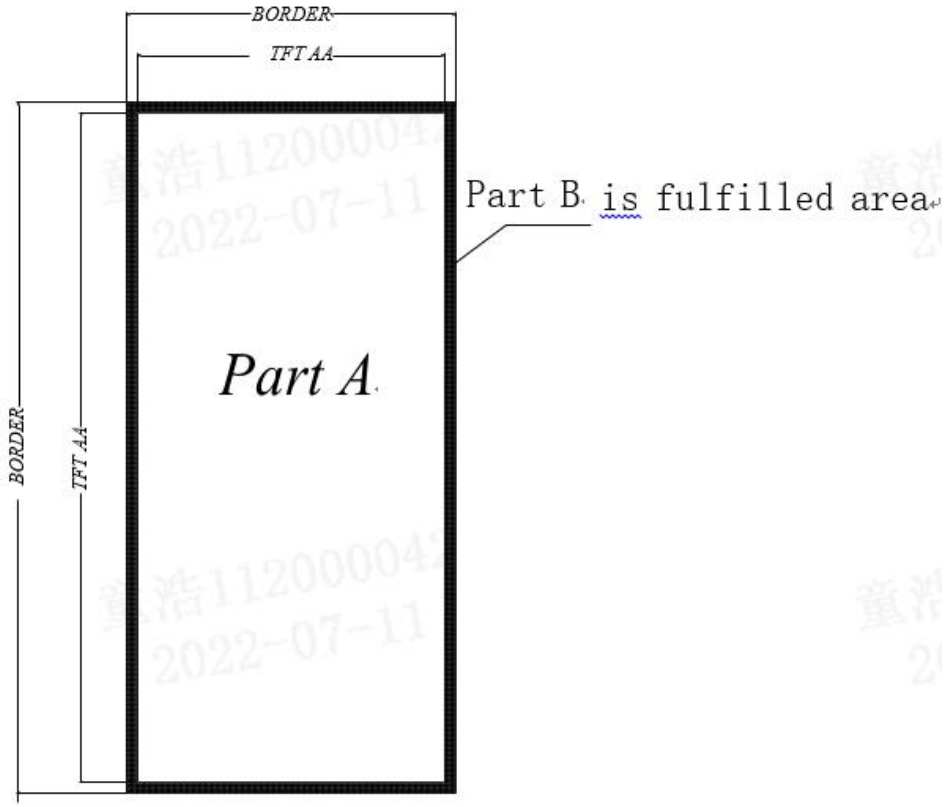
Note3：The function ,appearance, opticals should meet the requirements of the test before and after the test.

Note4: Keep testing after 2 hours placing at 20℃-25℃

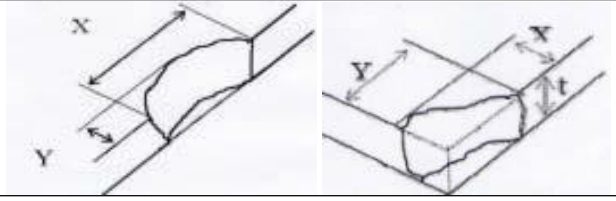
17.Block Diagram



18.PartA/PartB Specification



19.Point and line standard

Shipment Inspection Standard						
Equipment：Electrical test fixture, Point gauge						
Outline dimension	29.2(H)×59.2(V) ×0.92(D)	Unit：㎜	Part-A	Active area	Part-B	Border area
Environment	Temperature	Humidity	Illuminance	Distance	Time	Angle
	19℃～25℃	55%±5%RH	600～1200Lux	300 ㎜	35Sec	
Defect type	Inspection method	Standard		Part-A		Part-B
Spot	Electric Display	D≤0.25 ㎜		Ignore		Ignore
		0.25 ㎜＜D≤0.4 ㎜		N≤4		Ignore
		D＞0.4 ㎜		Not Allow		Ignore
Display unwork	Electric Display	Not Allow		Not Allow		Ignore
Display error	Electric Display	Not Allow		Not Allow		Ignore
Scratch or line defect(include dirt)	Visual/Film card	W≤0.1㎜		Ignore		Ignore
		L≤3.0mm 0.1＜W≤0.25mm		N≤2		Ignore
		L＞5 ㎜,W＞0.3 ㎜		Not Allow		Ignore
PS Bubble	Visual/Film card	D≤0.25mm		Ignore		Ignore
		0.25mm≤D≤0.4mm		N≤4		Ignore
		D＞0.4 mm		Not Allow		Ignore
Side Fragment	Visual/Film card	X≤3mm,Y≤0.5mm, Do not affect the electrode circuit (Edge chipping) N≤2; X≤2mm,Y≤2mm, Do not affect the electrode circuit(Corner chipping) N≤2;				
						

Remark	
	1.Cannot be defect & failure cause by appearance defect;
	2.Cannot be larger size cause by appearance defect;
	L=long W=wide D=point size N=Defects NO

Note1 : OQC inspection: One-time sampling plan for GB/T 2828.1-2012 , Inspection Level II, CR: AC/Re=0/1, MA=0.4, MI=1.0.

Note2: Spot define: That only can be seen under White State or Dark State defects

Note3: Any defect which is visible under gray pattern or transition process but invisible under black and white is disregarded.

Note4:Any defect must be judged by Optical Microscope.

Note5:Here is definition of the “Spot” and “Scratch or line defect”

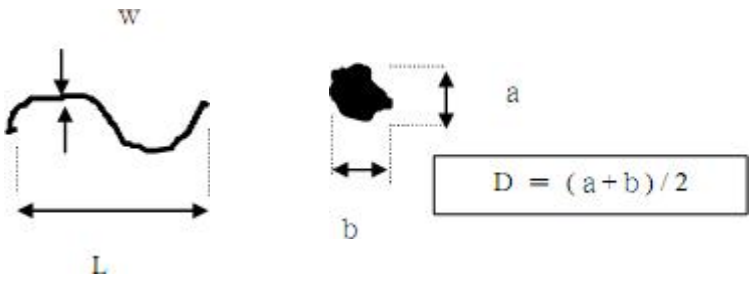
Spot: W>1/4L

Scratch or line defect :W ≤ 1/4L

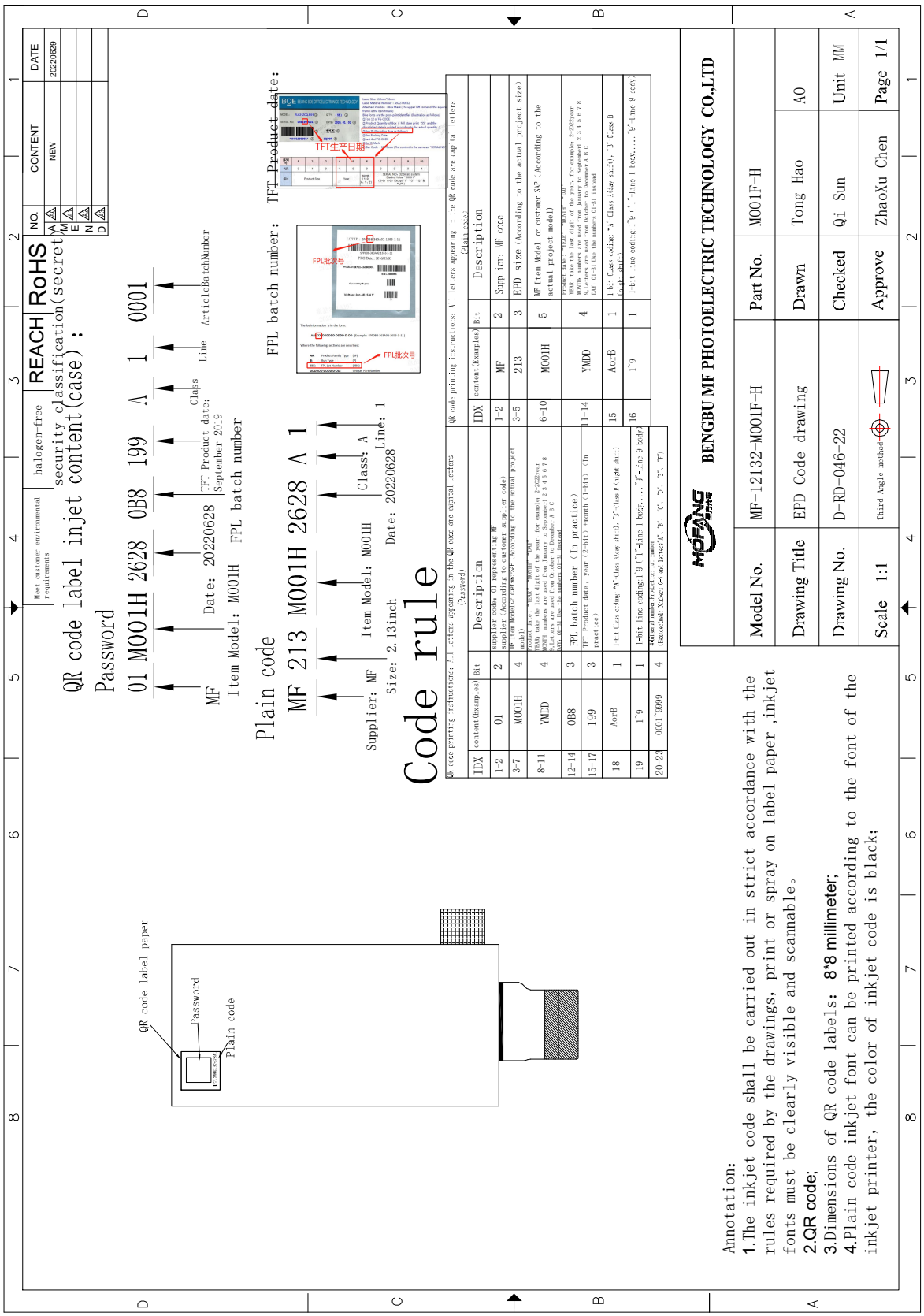
Note6:Definition for L/W and D （major axis）

Note7：FPC bonding area pad doesn’t allowed visual inspection

Note8：



20.Barcode


QR code label paper
Password
Plain code
Code rule
Annotation:
1.The inkjet code shall be carried out in strict accordance with the rules required by the drawings, print or spray on label paper ,inkjet fonts must be clearly visible and scannable。
2.QR code;
3.Dimensions of QR code labels: 8*8 millimeter;
4.Plain code inkjet font can be printed according to the font of the inkjet printer, the color of inkjet code is black;
BENGBU MF PHOTOELECTRIC TECHNOLOGY CO.,LTD
Model No. MF-12132-M001F-H
Drawing Title EPD Code drawing
Drawing No. D-RD-046-22
Scale 1:1
Part No. M001F-H
Drawn Tong Hao
Checked Qi Sun
Approve ZhaoXu Chen
A0
Unit MM
Page 1/1

21.Packing

RoHS HF

	Material	Quantiy
1	Outer box	1
2	Plastic tray	11*2=22
3	Antistatic bag	2
4	Poam separator	2
5	Poam separator	1
6	Pearl pad	80
7	desiccant	4
8	EPD	240*2=480
9	pallet	1/24

The top of the empty pallet:1PCS

4PCS of pearl pads on top of each finished plate
Specification:T=1MM

Each plastic plate placed on products for the number 24PCS
Two pallets stacked cross 180 degrees
Stacked layer has 10 layer,including the top and bottom empty plates.

EPD

Antistatic bag:1PCS
Specifications:625*435*0.1MM
Packaging:Antistatic tape seal heat seal,no vacuum
Desiccants:2PCS

Rubber band

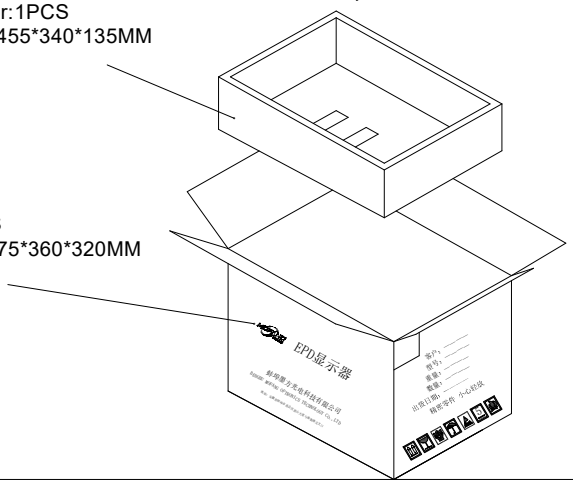
desiccant

Foam separator:1PCS
Specifications:455*340*135MM

Foam separator:1PCS
Specifications:455*340*10MM

Foam separator:1PCS
Specifications:455*340*135MM

Outer box:1PCS
Specifications:475*360*320MM



pallet stack up