

1.54inch e-Paper (E)

User Manual



Revision History

[illegible]

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1. OVERVIEW

The display is an Active Matrix E Ink® Spectra™ 6 technology display module, with interface and a reference system design. The 1.54" active area contains 240*240 pixels, and has 3-bit B/W/R/Y/B/G 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 each panel.



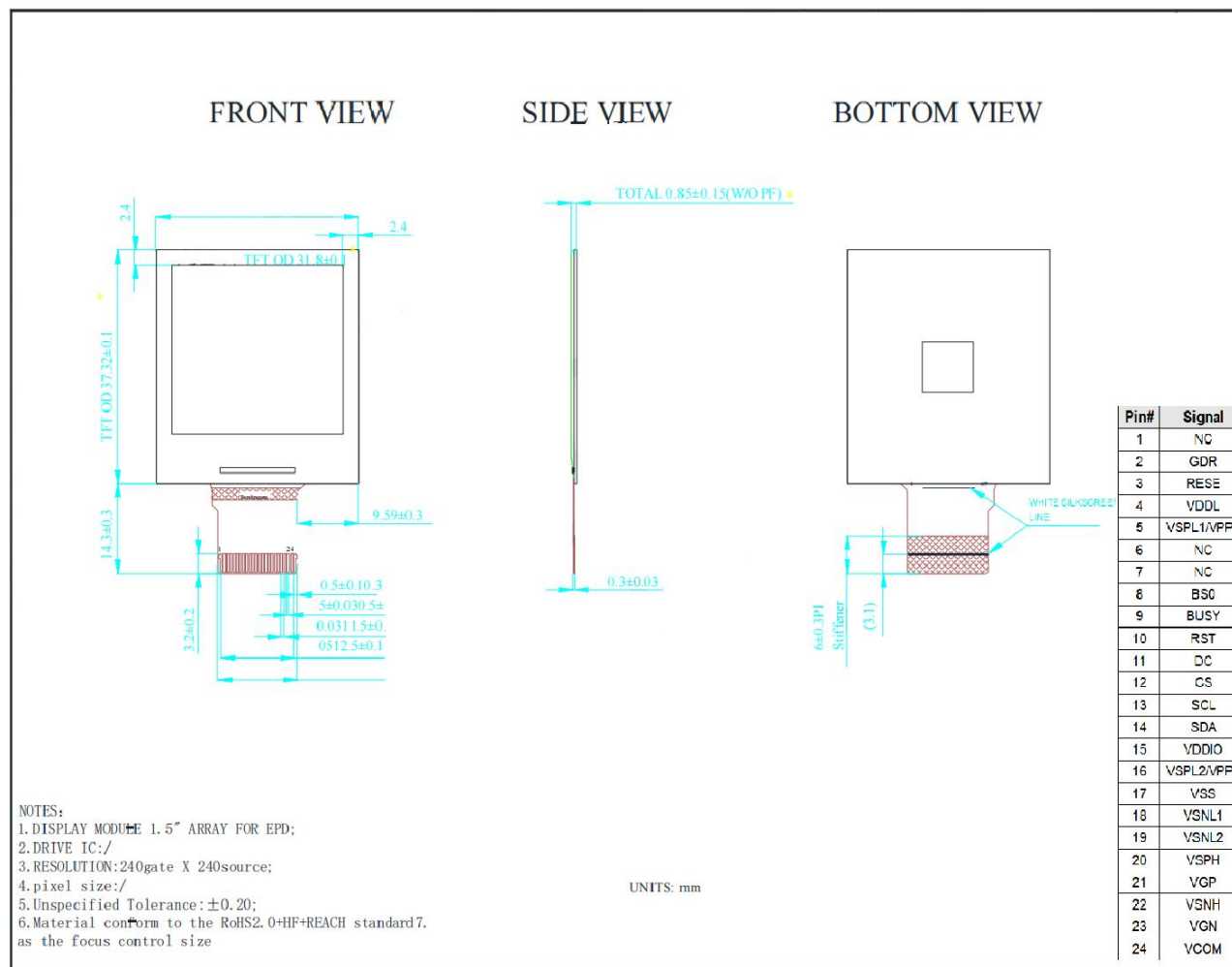
2. FEATURES

- ✧ 240*240 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-coated anti-glare display surface
- ✧ Ultra-low current deep sleep mode
- ✧ On-chip display RAM
- ✧ Low-voltage detection for supply voltage
- ✧ High-voltage readiness detection for driving voltage
- ✧ Internal temperature sensor
- ✧ 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. MECHANICAL SPECIFICATIONS

No.	Parameter	Specifications	Unit	Remark
1	Screen Size	1.54	inch	
2	Display Resolution	240(H)×240(V)	pixels	
3	Active Area	27.00×27.00	mm ²	
4	Pixel Pitch	0.1125×0.1125	mm ²	
5	Pixel Configuration	Rectangle		
6	Outline Dimension	31.8(H)×37.32(V)×0.85(D)	mm ³	Without masking film
7	Weight	1.5±0.5	g	

4. MECHANICAL DRAWING OF EPD MODULE



5. PIN ASSIGNMENT

Pin#	Signal	Description	Remark
1	NC	No connection and do not connect to other NC	Keep Open
2	GDR	This pin is N-MOS gate control	
3	RESE	Current sense input for control loop	
4	VDDL		
5	VSPL1/VPP1	Positive source voltage for Red	
6	NC	No connection and do not connect to other NC	Keep Open
7	NC	No connection and do not connect to other NC	Keep Open
8	BS0	Input interface setting	Note 5-5
9	BUSY	This pin indicates the driver status	Note 5-4
10	RST	Global reset pin	Note 5-3
11	DC	Serial communication Command/Data input	Note 5-2
12	CS	Serial communication chip select	Note 5-1
13	SCL	Serial communication clock input	
14	SDA	Serial communication data input	
15	VDDIO	IO voltage supply	
16	VSPL2/VPP2		
17	VSS	Digital ground	
18	VSNL1	Negative source voltage	
19	VSNL2	Negative source voltage	
20	VSPH	Positive source voltage	
21	VGP	Positive gate voltage	
22	VSNH	Negative source voltage	
23	VGN	Negative gate voltage	
24	VCOM	VCOM driving voltage	

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

Note 5-2: This pin (DC) 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 (RST_N) is reset signal input. The Reset is active low.

Note 5-4: This pin (BUSY_N) is busy state output pin. When Busy is High, the operation of chip should not be interrupted and no commands should be issued to the module. The driver IC will put Busy pin High during operations such as waveform output or digital temperature sensor communication.

Note 5-5: This pin (BS) 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.

6. ELECTRICAL CHARACTERISTICS

6.1 ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Rating	Unit	Humidity	Unit	Note
V _{DD}	Logic supply voltage	-0.3 to +6.0	V	-	-	
T _{OPR}	Operation temperature range	0 to 50	°C	45 to 70	%	
T _{TTG}	Transportation temperature range	-25 to 50	°C	45 to 70	-	Note 6-2
T _{STG}	Storage temperature	-25 to 50	°C	45 to 70	%	Maximum storage time: 5 years

Note 6-1: We guarantee display quality for single-pixel operation between 0 °C and 35 °C, but only guarantee the barcode readability between 35 °C and 40 °C. Under normal use, it is recommended to refresh the display every 24 hours.

Note 6-2: Maximum ratings are limits beyond which permanent damage to the device may occur. Functional operation must be restricted to the values specified in the Electrical Characteristics chapter.

Note 6-3: T_{TTG} refers to the transport temperature condition. The transport duration shall not exceed 10 days when the ambient temperature is between -25 °C and 0 °C, or between 50 °C and 60 °C.

Note 6-4: When storing the four-color product, the display should be kept white and placed face up. To improve display performance, we recommend periodically displaying full-black and full-white patterns to clear the screen, especially after prolonged refresh cycles.

Note 6-5: Due to the inherent characteristics of FPL, we do not guarantee the display quality of yellow characters on a white background, nor of white characters on a yellow background.

6.2 DC CHARACTERISTICS

The following specifications apply for: V_{SS}=0V, V_{DD}=3.0V, T_{OPR} =25°C.

Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
V _{DD}	VDD operation voltage	-	2.4	3.0	3.6	V
V _{IH}	High level input voltage	-	0.7V _{IO}	-	V _{IO}	V
V _{IL}	Low level input voltage	-	GND	-	0.3V _{VDD}	V
V _{OH}	High level output voltage	I _{OH} = 400μA	V _{IO} -0.4	-	-	V
V _{OL}	Low level output voltage	I _{OL} = -400μA	GND	-	GND+0.4	V
I _{update}	Module operating current	-	-	TBD	-	mA
I _{sleep}	Deep sleep mode	V _{CI} =3.3V	-	TBD	-	μA

Typical power consumption is measured using the associated 25°C waveform, with the pattern transition set from horizontal scan to vertical scan.

The listed electrical and optical characteristics are guaranteed only when using the controller and waveform provided.

6.3 POWER CONSUMPTION (PRICE TAG SCREEN)

Parameter	Symbol	Condition	Typ.	Max.	Unit	Remark
Panel power consumption during update	-	25°C	TBD	-	mAs	-
Deep sleep mode	-	25°C	TBD	-	μA	-

mAs = average update current (mA) × update time (s)

6.4 OPTICAL CHARACTERISTICS

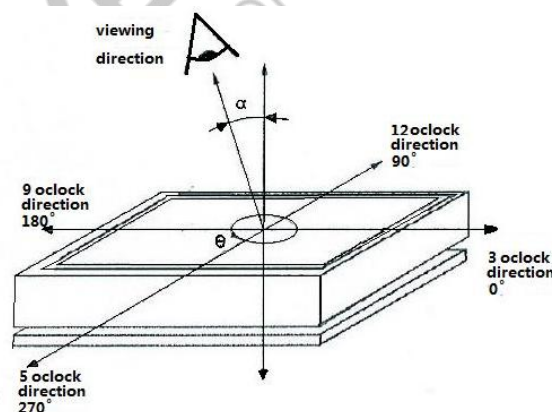
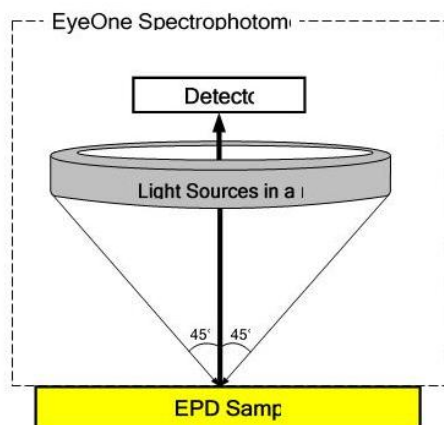
6.4.1 Optical Measurement Conditions

Item	Symbol.	Value	Unit	Note
Ambient Temperature	Ta	25±2	°C	Indoor testing
Ambient Humidity	Ha	50±5	%RH	-
Supply Voltage	VCC, VDDIO	3.0	V	-
Illuminance	-	800~1300	Lux	-

Note 6-6: Image is updated with above conditions

6.4.2 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): $CR = RI/Rd$



6.4.3 Reflection Ratio

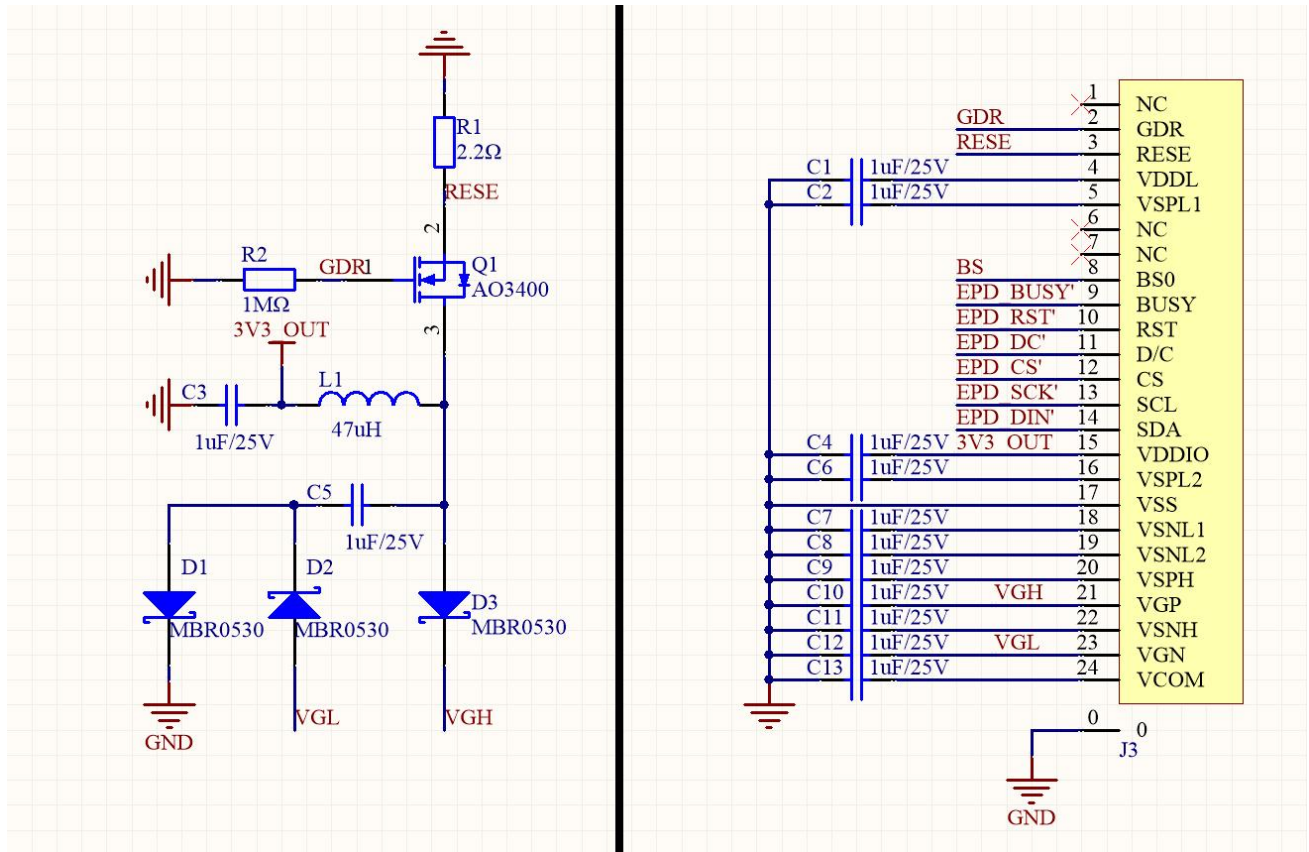
The reflection ratio is expressed as:

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

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.

7. APPLICATION CIRCUIT



8. RELIABILITY

No.	Test	Condition	Remark
1	High-Temperature Operation	T=40°C, RH=35%, 240hrs	
2	Low-Temperature Operation	T=0°C, 240hrs	
3	High-Temperature Storage	T=40°C, RH = 35%, 240hrs	Test in white pattern
4	Low-Temperature Storage	T= -25°C, 240hrs	Test in white pattern
5	High-Temperature, High-Humidity Operation	T=40°C, RH=90%, 168hrs	
6	High-Temperature, High-humidity Storage	T=50°C, RH=90%, 240hrs	Test in white pattern
7	Temperature Cycle	-25°C(30min)~60°C(30min), 100 cycles	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 test from a height of 100 cm onto a concrete surface. Drop sequence: 1 corner, 3 edges, 6 faces One drop for each	Full packed for shipment
10	UV exposure Resistance	765 W/m ² for 168hrs, 40°C	
11	Electrostatic Discharge (no-operation)	+/-200v, 0Ω, 200PF	

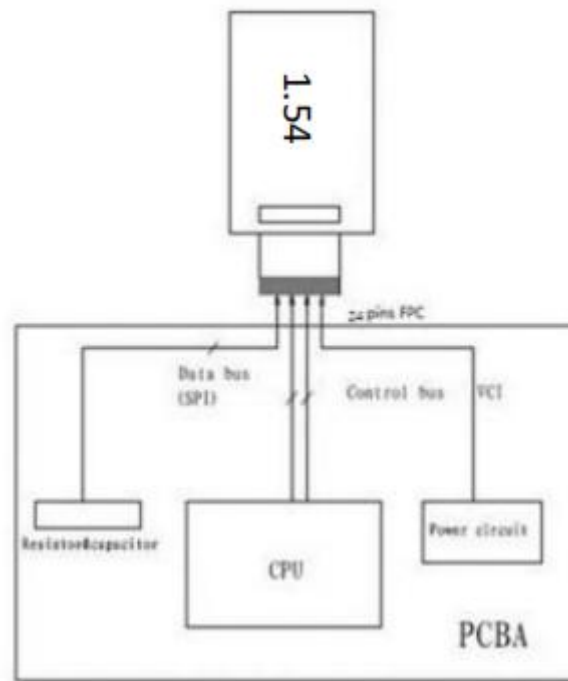
Actual EMC level shall be measured on the customer's application.

Note 8-1: Maintain a white pattern during storage and non-operation testing.

Note 8-2: During operation, use a black/white pattern with a hold time of 150 seconds.

Note 8-3: After placing the device at 20 – 25 °C for 2 hours, continue testing.

9. BLOCK DIAGRAM



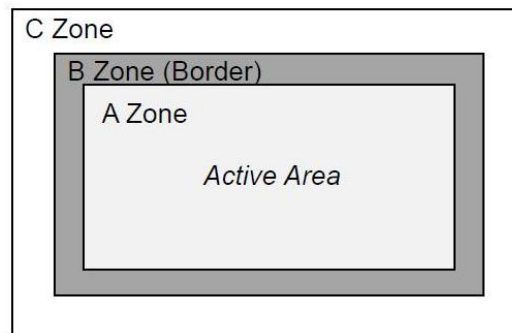
10. SHIPMENT INSPECTION SPECIFICATIONS

10.1 ZONE DEFINITION

A Zone: Active Area

B Zone: Border Area

C Zone: From B Zone edge to panel edge



10.2 LINE AND SPOT DEFECT DIMENSIONS



10.3 POINT AND LINE STANDARDS

Shipment Inspection Standard						
Equipment: Electrical test fixture, Point gauge						
Outline dimension	31.8(H)×37.32 (V) ×0.85(D)	Unit: mm	Part-A	Active area	Part-B	Border area
Environment	Temperature	Humidity	illuminance	Distance	Time	Angle
	19℃～25℃	50±5%RH	800~1300Lux	300 mm	35Sec	45°
Defect type	Inspection method	Standard		Part-A	Part-B	
Spot	Electric Display	D≤0.25 mm		Ignore	Ignore	
		0.25 mm < D≤0.4 mm		N≤4	Ignore	
		D>0.4 mm		Not Allow	Ignore	
Display malfunction	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	L≤2 mm,W≤0.2 mm		Ignore	Ignore	
		2.0mm < L≤5.0mm,0.2 < W≤0.3mm,		N≤2	Ignore	
		L > 5 mm,W > 0.3 mm		Not Allow	Ignore	
PS Bubble	Visual/Film card	D≤0.2mm		Ignore	Ignore	
		0.2mm≤D≤0.35mm		N≤4	Ignore	
		D>0.35 mm		Not Allow	Ignore	
Corner /Edge chipping	Visual/Film card	X≤6mm,Y≤0.4mm, Do not affect the electrode circuit (Edge chipping)				
		X≤1mm,Y≤1mm, Do not affect the electrode circuit((Corner chipping) Ignore				
		 				
TFT warping	For 1.5~7.5inch, T≤2mm; For above 7.5inch, T≤3mm					
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					

11. HANDLING, SAFETY, AND ENVIRONMENTAL 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 there is dust on the surface, gently wipe it with absorbent cotton or a dust-free cloth. It is recommended to use anhydrous ethanol to clean the adhesive used to attach 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.	
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.	