2.13inch E-Paper RBW

Product Specifications

Customer	**Standard**
Description	**2.13 E-paper Display**
Model Name	**2.13inch E-Paper RBW**
Date	**2023/04/08**
Revision	**1.0**

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1. General Description

1.1 Over View

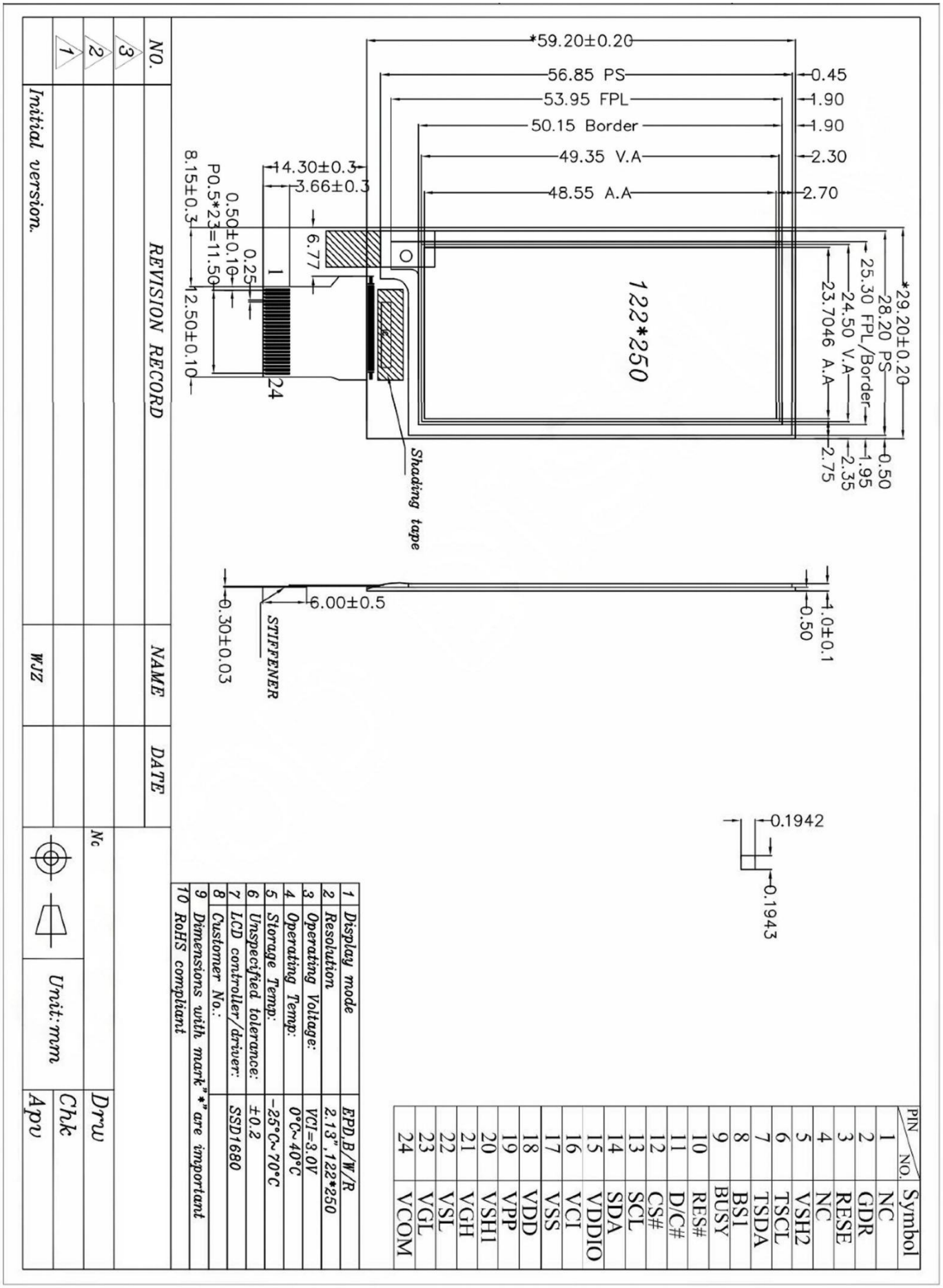
2.13inch e-Paper RBW is an Active Matrix Electrophoretic Display (AMEPD), with interface and a reference system design. The 2.13” active area contains 250 × 122 pixels, and has 1-bit Black/White and highlight Red full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM and border are supplied with each panel.

1.2 Features

- 250 × 122 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
- Waveform can stored in On-chip OTP or written by MCU
- 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

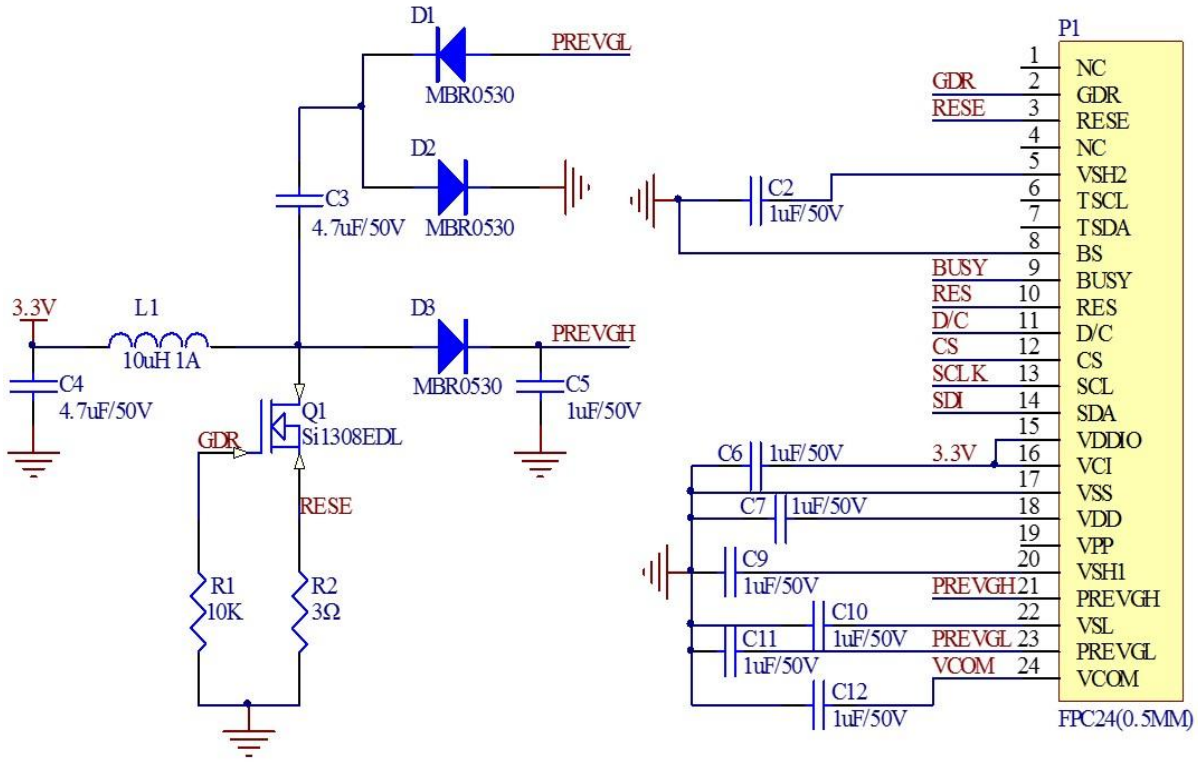
1.3 Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	2.13	Inch	
Display Resolution	250(V) × 122(H)	Pixel	Dpi:130
Active Area	48.55 (V) × 23.7 (H)	mm	
Pixel Pitch	0.1943 × 0.1943	mm	
Pixel Configuration	Square		
Outline Dimension	59.2(V) × 29.2(H) × 1.05(D)	mm	
Weight	3.2 ± 0.5	g	



1.4 Mechanical Drawing of EPD module

1.5 Reference Circuit



Note:

1. Inductor L1 is wire-wound inductor. There are no special requirements for other parameters.
2. Suggests using Si1304BDL or Si1308EDL TUBE MOS (Q1) , otherwise it may affect the normal boost of the circuit.
3. The default circuit is 4-wire SPI.
4. Default voltage value of all capacitors is 50 V.

1.6 Input/Output Pin Assignment

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 e	Keep Open
5	VSH2	This pin is Positive Source driving voltage	
6	TSCL	I^2C Interface to digital temperature sensor Clock pin	
7	TSDA	I^2C Interface to digital temperature sensor Date pin	
8	BS1	Bus selection pin	Note 1.6-5
9	BUSY	Busy state output pin	Note 1.6-4
10	RES #	Reset	Note 1.6-3
11	D/C #	Data /Command control pin	Note 1.6-2
12	CS #	Chip Select input pin	Note 1.6-1
13	SCL	serial clock pin (SPI)	
14	SDA	serial data pin (SPI)	
15	VDDIO	Power for interface logic pins	
16	VCI	Power Supply pin for the chip	
17	VSS	Ground	
18	VDD	Core logic power pin	
19	VPP	Power Supply for OTP Programming	
20	VSH1	This pin is Positive Source driving voltage	
21	VGH	This pin is Positive Gate driving voltage	
22	VSL	This pin is Negative Source driving voltage	
23	VGL	This pin is Negative Gate driving voltage	
24	VCOM	These pins are VCOM driving voltage	

Note 1.6-1: 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 1.6-2: 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 1.6-3: This pin (RES#) is reset signal input. The Reset is active low.

Note 1.6-4: This pin(BUSY#) is state output pin. When Busy is High, the operation of chip should not be interrupted, command should not be sent. The chip would put Busy pin High when - Outputting display waveform -Communicating with digital temperature sensor.

Note 1.6-5: This pin (BS1) 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.

2. COMMAND TABLE

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	01	0	0	0	0	0	0	0	1	Driver Output control	Gate setting A[8:0]= 127h [POR], 296 MUX MUX Gate lines setting as (A[8:0] + 1). B [2:0] = 000 [POR]. Gate scanning sequence and direction B[2]: GD Selects the 1st output Gate GD=0 [POR], G0 is the 1st gate output channel, gate output sequence is G0,G1, G2, G3, … GD=1, G1 is the 1st gate output channel, gate output sequence is G1, G0, G3, G2, … B[1]: SM Change scanning order of gate driver. SM=0 [POR], G0, G1, G2, G3…295 (left and right gate interlaced) SM=1, G0, G2, G4 …G294, G1, G3, …G295 B[0]: TB TB = 0 [POR], scan from G0 to G295 TB = 1, scan from G295 to G0.
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		0	0	0	0	0	0	0	A_8		
0	1		0	0	0	0	0	B_2	B_1	B_0		
0	0	03	0	0	0	0	0	0	1	1	Gate Driving voltage Control	Set Gate driving voltage A[4:0] = 00h [POR] VGH setting from 10V to 20V
0	1		0	0	0	A_4	A_3	A_2	A_1	A_0		

A[4:0]	VGH	A[4:0]	VGH
00h	20	0Dh	15
03h	10	0Eh	15.5
04h	10.5	0Fh	16
05h	11	10h	16.5
06h	11.5	11h	17
07h	12	12h	17.5
08h	12.5	13h	18
07h	12	14h	18.5
08h	12.5	15h	19
09h	13	16h	19.5
0Ah	13.5	17h	20
0Bh	14	Other	NA
0Ch	14.5		

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	04	0	0	0	0	0	1	0	0	Source Driving voltage Control	Set Source driving voltage A[7:0] = 41h [POR], VSH1 at 15V B[7:0] = A8h [POR], VSH2 at 5V. C[7:0] = 32h [POR], VSL at -15V Remark: VSH1>=VSH2
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		

A[7]/B[7] = 1,
VSH1/VSH2 voltage setting from 2.4V to 8.8V

A/B[7:0]	VSH1/VSH2	A/B[7:0]	VSH1/VSH2
8Eh	2.4	AFh	5.7
8Fh	2.5	B0h	5.8
90h	2.6	B1h	5.9
91h	2.7	B2h	6
92h	2.8	B3h	6.1
93h	2.9	B4h	6.2
94h	3	B5h	6.3
95h	3.1	B6h	6.4
96h	3.2	B7h	6.5
97h	3.3	B8h	6.6
98h	3.4	B9h	6.7
99h	3.5	BAh	6.8
9Ah	3.6	BBh	6.9
9Bh	3.7	BCh	7
9Ch	3.8	BDh	7.1
9Dh	3.9	BEh	7.2
9Eh	4	BFh	7.3
9Fh	4.1	C0h	7.4
A0h	4.2	C1h	7.5
A1h	4.3	C2h	7.6
A2h	4.4	C3h	7.7
A3h	4.5	C4h	7.8
A4h	4.6	C5h	7.9
A5h	4.7	C6h	8
A6h	4.8	C7h	8.1
A7h	4.9	C8h	8.2
A8h	5	C9h	8.3
A9h	5.1	CAh	8.4
AAh	5.2	CBh	8.5
ABh	5.3	CCh	8.6
ACh	5.4	CDh	8.7
ADh	5.5	CEh	8.8
AEh	5.6	Other	NA

A[7]/B[7] = 0,
VSH1/VSH2 voltage setting from 9V to 17V

A/B[7:0]	VSH1/VSH2	A/B[7:0]	VSH1/VSH2
23h	9	3Ch	14
24h	9.2	3Dh	14.2
25h	9.4	3Eh	14.4
26h	9.6	3Fh	14.6
27h	9.8	40h	14.8
28h	10	41h	15
29h	10.2	42h	15.2
2Ah	10.4	43h	15.4
2Bh	10.6	44h	15.6
2Ch	10.8	45h	15.8
2Dh	11	46h	16
2Eh	11.2	47h	16.2
2Fh	11.4	48h	16.4
30h	11.6	49h	16.6
31h	11.8	4Ah	16.8
32h	12	4Bh	17
33h	12.2	Other	NA
34h	12.4		
35h	12.6		
36h	12.8		
37h	13		
38h	13.2		
39h	13.4		
3Ah	13.6		
3Bh	13.8		

C[7] = 0,
VSL setting from -5V to -17V

C[7:0]	VSL
0Ah	-5
0Ch	-5.5
0Eh	-6
10h	-6.5
12h	-7
14h	-7.5
16h	-8
18h	-8.5
1Ah	-9
1Ch	-9.5
1Eh	-10
20h	-10.5
22h	-11
24h	-11.5
26h	-12
28h	-12.5
2Ah	-13
2Ch	-13.5
2Eh	-14
30h	-14.5
32h	-15
34h	-15.5
36h	-16
38h	-16.5
3Ah	-17
Other	NA

0	0	08	0	0	0	0	1	0	0	0	Initial Code Setting OTP Program	Program Initial Code Setting The command required CLKEN=1. Refer to Register 0x22 for detail. BUSY pad will output high during operation.
0	0	09	0	0	0	0	1	0	0	1	Write Register for Initial Code Setting	Write Register for Initial Code Setting Selection A[7:0] ~ D[7:0]: Reserved Details refer to Application Notes of Initial Code Setting
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
0	1		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
0	0	0A	0	0	0	0	1	0	1	0	Read Register for Initial Code Setting	Read Register for Initial Code Setting

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	0C	0	0	0	0	1	1	0	0	Booster Soft start Control	Booster Enable with Phase 1, Phase 2 and Phase 3 for soft start current and duration setting. A[7:0] -> Soft start setting for Phase1 = 8Bh [POR] B[7:0] -> Soft start setting for Phase2 = 9Ch [POR] C[7:0] -> Soft start setting for Phase3 = 96h [POR] D[7:0] -> Duration setting = 0Fh [POR]
0	1		1	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		1	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		1	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
0	1		0	0	D_5	D_4	D_3	D_2	D_1	D_0		

Bit Description of each byte:
A[6:0] / B[6:0] / C[6:0]:

Bit[6:4]	Driving Strength Selection
000	1(Weakest)
001	2
010	3
011	4
100	5
101	6
110	7
111	8(Strongest)

Bit[3:0]	Min Off Time Setting of GDR [Time unit]
0000 ~ 0011	NA
0100	2.6
0101	3.2
0110	3.9
0111	4.6
1000	5.4
1001	6.3
1010	7.3
1011	8.4
1100	9.8
1101	11.5
1110	13.8
1111	16.5

D[5:0]: duration setting of phase
D[5:4]: duration setting of phase 3
D[3:2]: duration setting of phase 2
D[1:0]: duration setting of phase 1

Bit[1:0]	Duration of Phase [Approximation]
00	10ms
01	20ms
10	30ms
11	40ms

0	0	10	0	0	0	1	0	0	0	0	Deep Sleep mode	Deep Sleep mode Control:
0	1		0	0	0	0	0	0	A_1	A_0		

A[1:0] :	Description
00	Normal Mode [POR]
01	Enter Deep Sleep Mode 1
11	Enter Deep Sleep Mode 2

After this command initiated, the chip will enter Deep Sleep Mode, BUSY pad will keep output high.
Remark:
To Exit Deep Sleep mode, User required to send HWRESET to the driver

Command Table												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	11	0	0	0	1	0	0	0	1	Data Entry mode setting	Define data entry sequence A[2:0] = 011 [POR] A [1:0] = ID[1:0] Address automatic increment / decrement setting The setting of incrementing or decrementing of the address counter can be made independently in each upper and lower bit of the address. 00 –Y decrement, X decrement, 01 –Y decrement, X increment, 10 –Y increment, X decrement, 11 –Y increment, X increment [POR] A[2] = AM Set the direction in which the address counter is updated automatically after data are written to the RAM. AM= 0, the address counter is updated in the X direction. [POR] AM = 1, the address counter is updated in the Y direction.
0	1		0	0	0	0	0	A_2	A_1	A_0		
0	0	12	0	0	0	1	0	0	1	0	SW RESET	It resets the commands and parameters to their S/W Reset default values except R10h-Deep Sleep Mode During operation, BUSY pad will output high. Note: RAM are unaffected by this command.
0	0	14	0	0	0	1	0	1	0	0	HV Ready Detection	HV ready detection A[7:0] = 00h [POR] The command required CLKEN=1 and ANALOGEN=1. Refer to Register 0x22 for detail. After this command initiated, HV Ready detection starts. BUSY pad will output high during detection. The detection result can be read from the Status Bit Read (Command 0x2F).
0	1		0	A_6	A_5	A_4	0	A_2	A_1	A_0		A[6:4]=n for cool down duration: 10ms x (n+1) A[2:0]=m for number of Cool Down Loop to detect. The max HV ready duration is 10ms x (n+1) x (m) HV ready detection will be trigger after each cool down time. The detection will be completed when HV is ready. For 1 shot HV ready detection, A[7:0] can be set as 00h.

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	15	0	0	0	1	0	1	0	1	VCI Detection	VCI Detection A[2:0] = 100 [POR] , Detect level at 2.3V A[2:0] : VCI level Detect A[2:0] VCI level 011 2.2V 100 2.3V 101 2.4V 110 2.5V 111 2.6V Other NA The command required CLKEN=1 and ANALOGEN=1 Refer to Register 0x22 for detail. After this command initiated, VCI detection starts. BUSY pad will output high during detection. The detection result can be read from the Status Bit Read (Command 0x2F).
0	1		0	0	0	0	0	A_2	A_1	A_0		
0	0	18	0	0	0	1	1	0	0	0	Temperature Sensor Control	Temperature Sensor Selection A[7:0] = 48h [POR], external temperatrure sensor A[7:0] = 80h Internal temperature sensor
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	0	1A	0	0	0	1	1	0	1	0	Temperature Sensor Control (Write to temperature register)	Write to temperature register. A[7:0] = 7Fh [POR]
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	0	1B	0	0	0	1	1	0	1	1	Temperature Sensor Control (Read from temperature register)	Read from temperature register.
1	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	0	1C	0	0	0	1	1	1	0	0	Temperature Sensor Control (Write Command to External temperature sensor)	Write Command to External temperature sensor. A[7:0] = 00h [POR], B[7:0] = 00h [POR], C[7:0] = 00h [POR], A[7:6] A[7:6] Select no of byte to be sent 00 Address + pointer 01 Address + pointer + 1st parameter 10 Address + pointer + 1st parameter + 2nd pointer 11 Address A[5:0] – Pointer Setting B[7:0] – 1st parameter C[7:0] – 2nd parameter The command required CLKEN=1. Refer to Register 0x22 for detail. After this command initiated, Write Command to external temperature sensor starts. BUSY pad will output high during operation.
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	20	0	0	1	0	0	0	0	0	Master Activation	Activate Display Update Sequence The Display Update Sequence Option is located at R22h. BUSY pad will output high during operation. User should not interrupt this operation to avoid corruption of panel images.
0	0	21	0	0	1	0	0	0	0	1	Display Update Control 1	RAM content option for Display Update A[7:0] = 00h [POR] B[7:0] = 00h [POR] A[7:4] Red RAM option 0000 Normal 0100 Bypass RAM content as 0 1000 Inverse RAM content A[3:0] BW RAM option 0000 Normal 0100 Bypass RAM content as 0 1000 Inverse RAM content B[7] Source Output Mode 0 Available Source from S0 to S175 1 Available Source from S8 to S167
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		B_7	0	0	0	0	0	0	0		
0	0	24	0	0	1	0	0	1	0	0	Write RAM (Black White) / RAM 0x24	After this command, data entries will be written into the BW RAM until another command is written. Address pointers will advance accordingly For Write pixel: Content of Write RAM(BW) = 1 For Black pixel: Content of Write RAM(BW) = 0

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	22	0	0	1	0	0	0	1	0	Display Update Control 2	Display Update Sequence Option: Enable the stage for Master Activation A[7:0]= FFh (POR)
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		

Operating sequence	Parameter (in Hex)
Enable clock signal	80
Disable clock signal	01
Enable clock signal → Enable Analog	C0
Disable Analog → Disable clock signal	03
Enable clock signal → Load LUT with DISPLAY Mode 1 → Disable clock signal	91
Enable clock signal → Load LUT with DISPLAY Mode 2 → Disable clock signal	99
Enable clock signal → Load temperature value → Load LUT with DISPLAY Mode 1 → Disable clock signal	B1
Enable clock signal → Load temperature value → Load LUT with DISPLAY Mode 2 → Disable clock signal	B9
Enable clock signal → Enable Analog → Display with DISPLAY Mode 1 → Disable Analog → Disable OSC	C7
Enable clock signal → Enable Analog → Display with DISPLAY Mode 2 → Disable Analog →Disable OSC	CF
Enable clock signal →Enable Analog → Load temperature value → DISPLAY with DISPLAY Mode 1 → Disable Analog → Disable OSC	F7
Enable clock signal →Enable Analog → Load temperature value → DISPLAY with DISPLAY Mode 2 → Disable Analog → Disable OSC	FF

0	0	26	0	0	1	0	0	1	1	0	Write RAM (RED) / RAM 0x26	After this command, data entries will be written into the RED RAM until another command is written. Address pointers will advance accordingly. For Red pixel: Content of Write RAM(RED) = 1 For non-Red pixel [Black or White]: Content of Write RAM(RED) = 0
0	0	27	0	0	1	0	0	1	1	1	Read RAM	After this command, data read on the MCU bus will fetch data from RAM. According to parameter of Register 41h to select reading RAM0x24/ RAM0x26, until another command is written. Address pointers will advance accordingly. The 1st byte of data read is dummy data.

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	28	0	0	1	0	1	0	0	0	VCOM Sense	Enter VCOM sensing conditions and hold for duration defined in 29h before reading VCOM value. The sensed VCOM voltage is stored in register The command required CLKEN=1 and ANALOGEN=1 Refer to Register 0x22 for detail. BUSY pad will output high during operation.
0	0	29	0	0	1	0	1	0	0	1	VCOM Sense Duration	Stabling time between entering VCOM sensing mode and reading acquired. A[3:0] = 9h, duration = 10s. VCOM sense duration = (A[3:0]+1) sec
0	1		0	1	0	0	A_3	A_2	A_1	A_0		
0	0	2A	0	0	1	0	1	0	1	0	Program VCOM OTP	Program VCOM register into OTP The command required CLKEN=1. Refer to Register 0x22 for detail. BUSY pad will output high during operation.
0	0	2C	0	0	1	0	1	1	0	0	Write VCOM register	Write VCOM register from MCU interface A[7:0] = 00h [POR]
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		

A[7:0]	VCOM	A[7:0]	VCOM
08h	-0.2	44h	-1.7
0Ch	-0.3	48h	-1.8
10h	-0.4	4Ch	-1.9
14h	-0.5	50h	-2
18h	-0.6	54h	-2.1
1Ch	-0.7	58h	-2.2
20h	-0.8	5Ch	-2.3
24h	-0.9	60h	-2.4
28h	-1	64h	-2.5
2Ch	-1.1	68h	-2.6
30h	-1.2	6Ch	-2.7
34h	-1.3	70h	-2.8
38h	-1.4	74h	-2.9
3Ch	-1.5	78h	-3
40h	-1.6	Other	NA

Command Table												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	2D	0	0	1	0	1	1	0	1	OTP Register Read for Display Option	Read Register for Display Option: A[7:0]: VCOM OTP Selection (Command 0x37, Byte A) B[7:0]: VCOM Register (Command 0x2C) C[7:0]~G[7:0]: Display Mode (Command 0x37, Byte B to Byte F) [5 bytes] H[7:0]~K[7:0]: Waveform Version (Command 0x37, Byte G to Byte J) [4 bytes]
1	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
1	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
1	1		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
1	1		E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0		
1	1		F_7	F_6	F_5	F_4	F_3	F_2	F_1	F_0		
1	1		G_7	G_6	G_5	G_4	G_3	G_2	G_1	G_0		
1	1		H_7	H_6	H_5	H_4	H_3	H_2	H_1	H_0		
1	1		I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0		
1	1		J_7	J_6	J_5	J_4	J_3	J_2	J_1	J_0		
1	1		K_7	K_6	K_5	K_4	K_3	K_2	K_1	K_0		
0	0	2E	0	0	1	0	1	1	1	0	User ID Read	Read 10 Byte User ID stored in OTP: A[7:0]]~J[7:0]: UserID (R38, Byte A and Byte J) [10 bytes]
1	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
1	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
1	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
1	1		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
1	1		E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0		
1	1		F_7	F_6	F_5	F_4	F_3	F_2	F_1	F_0		
1	1		G_7	G_6	G_5	G_4	G_3	G_2	G_1	G_0		
1	1		H_7	H_6	H_5	H_4	H_3	H_2	H_1	H_0		
1	1		I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0		
1	1		J_7	J_6	J_5	J_4	J_3	J_2	J_1	J_0		
0	0	2F	0	0	1	0	1	1	1	1	Status Bit Read	Read IC status Bit [POR 0x01] A[5]: HV Ready Detection flag [POR=0] 0: Ready 1: Not Ready A[4]: VCI Detection flag [POR=0] 0: Normal 1: VCI lower than the Detect level A[3]: [POR=0] A[2]: Busy flag [POR=0] 0: Normal 1: BUSY A[1:0]: Chip ID [POR=01] Remark: A[5] and A[4] status are not valid after RESET, they need to be initiated by command 0x14 and command 0x15 respectively.
1	1		0	0	A_5	A_4	0	0	A_1	A_0		
0	0	30	0	0	1	1	0	0	0	0	Program WS OTP	Program OTP of Waveform Setting The contents should be written into RAM before sending this command. The command required CLKEN=1. Refer to Register 0x22 for detail. BUSY pad will output high during operation.

Command Table												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	31	0	0	1	1	0	0	0	1	Load WS OTP	Load OTP of Waveform Setting The command required CLKEN=1. Refer to Register 0x22 for detail. BUSY pad will output high during operation.
0	0	32	0	0	1	1	0	0	1	0	Write LUT register	Write LUT register from MCU interface [227 bytes], which contains the content of VS[nX-LUTm], TP[nX], RP[n], SR[nXY], FR and XON[nXY] Refer to Session 6.7 WAVEFORM SETTING
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		:	:	:	:	:	:	:	:		
0	1		.	..	.	.	.	.	.	.		
0	0	34	0	0	1	1	0	1	0	0	CRC calculation	CRC calculation command For details, please refer to SSD1680A application note. BUSY pad will output high during operation.
0	0	35	0	0	1	1	0	1	0	1	CRC Status Read	CRC Status Read A[15:0] is the CRC read out value
1	1		A_{15}	A_{14}	A_{13}	A_{12}	A_{11}	A_{10}	A_9	A_8		
1	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	0	36	0	0	1	1	0	1	1	0	Program OTP selection	Program OTP Selection according to the OTP Selection Control [R37h and R38h] The command required CLKEN=1. Refer to Register 0x22 for detail. BUSY pad will output high during operation.
0	0	37	0	0	1	1	0	1	1	1	Write Register for Display Option	Write Register for Display Option A[7] Spare VCOM OTP selection 0: Default [POR] 1: Spare B[7:0] Display Mode for WS[7:0] C[7:0] Display Mode for WS[15:8] D[7:0] Display Mode for WS[23:16] 0: Display Mode 1 1: Display Mode 2 F[6]: Ping-Pong for Display Mode 2 0: RAM Ping-Pong disable [POR] 1: RAM Ping-Pong enable G[7:0]~J[7:0] module ID /waveform version. Remarks: 1) A[7:0]~J[7:0] can be stored in OTP 2) RAM Ping-Pong function is not support for Display Mode 1
0	1		A_7	0	0	0	0	0	0	0		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
0	1		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
0	1		E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0		
0	1		0	F_6	0	0	F_3	F_2	F_1	F_0		
0	1		G_7	G_6	G_5	G_4	G_3	G_2	G_1	G_0		
0	1		H_7	H_6	H_5	H_4	H_3	H_2	H_1	H_0		
0	1		I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0		
0	1		J_7	J_6	J_5	J_4	J_3	J_2	J_1	J_0		

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	38	0	0	1	1	1	0	0	0	Write Register for User ID	Write Register for User ID A[7:0]]~J[7:0]: UserID [10 bytes] Remarks: A[7:0]~J[7:0] can be stored in OTP
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		C_7	C_6	C_5	C_4	C_3	C_2	C_1	C_0		
0	1		D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0		
0	1		E_7	E_6	E_5	E_4	E_3	E_2	E_1	E_0		
0	1		F_7	F_6	F_5	F_4	F_3	F_2	F_1	F_0		
0	1		G_7	G_6	G_5	G_4	G_3	G_2	G_1	G_0		
0	1		H_7	H_6	H_5	H_4	H_3	H_2	H_1	H_0		
0	1		I_7	I_6	I_5	I_4	I_3	I_2	I_1	I_0		
0	1		J_7	J_6	J_5	J_4	J_3	J_2	J_1	J_0		
0	0	39	0	0	1	1	1	0	0	1	OTP program mode	OTP program mode A[1:0] = 00: Normal Mode [POR] A[1:0] = 11: Internal generated OTP programming voltage : User is required to EXACTLY follow the reference code sequences
0	1		0	0	0	0	0	0	A_1	A_0		
0	0	3C	0	0	1	1	1	1	0	0	Border Waveform Control	Select border waveform for VBD A[7:0] = C0h [POR], set VBD as HIZ. A [7:6] :Select VBD option A[7:6] — Select VBD as 00 — GS Transition, Defined in A[2] and A[1:0] 01 — Fix Level, Defined in A[5:4] 10 — VCOM 11[POR] — HiZ A [5:4] Fix Level Setting for VBD A[5:4] — VBD level 00 — VSS 01 — VSH1 10 — VSL 11 — VSH2 A [1:0] GS Transition setting for VBD VBD Level Selection: 00b: VCOM ; 01b: VSH1; 10b: VSL; 11b: VSH2 A[1:0] — VBD Transition 00 — LUT0 01 — LUT1 10 — LUT2 11 — LUT3
0	1		A_7	A_6	A_5	A_4	0	0	A_1	A_0		
0	0	3F	0	0	1	1	1	1	1	1	End Option (EOPT)	Option for LUT end Data bytes should be set for this command or programmed into Waveform setting. 22h — Normal. 07h — Source output level keep previous output before power off
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	41	0	1	0	0	0	0	0	1	Read RAM Option	Read RAM Option A[0]= 0 [POR] 0 : Read RAM corresponding to RAM0x24 1 : Read RAM corresponding to RAM0x26
0	1		0	0	0	0	0	0	0	A_0		
0	0	44	0	1	0	0	0	1	0	0	Set RAM X - address Start / End position	Specify the start/end positions of the window address in the X direction by an address unit for RAM A[5:0]: XSA[5:0], XStart, POR = 00h B[5:0]: XEA[5:0], XEnd, POR = 15h
0	1		0	0	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		0	0	B_5	B_4	B_3	B_2	B_1	B_0		
0	0	45	0	1	0	0	0	1	0	1	Set Ram Y- address Start / End position	Specify the start/end positions of the window address in the Y direction by an address unit for RAM A[8:0]: YSA[8:0], YStart, POR = 000h B[8:0]: YEA[8:0], YEnd, POR = 127h
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		0	0	0	0	0	0	0	A_8		
0	1		B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0		
0	1		0	0	0	0	0	0	0	B_8		
0	0	46	0	1	0	0	0	1		0	Auto Write RED RAM for Regular Pattern	Auto Write RED RAM for Regular Pattern A[7:0] = 00h [POR] A[7]: The 1st step value, POR = 0 A[6:4]: Step Height, POR= 000 Step of alter RAM in Y-direction according to Gate
0	1		A_7	A_6	A_5	A_4	0	A_2	A_1	A_0		

A[6:4]	Height	A[6:4]	Height
000	8	100	128
001	16	101	256
010	32	110	296
011	64	111	NA

A[2:0]: Step Width, POR= 000
Step of alter RAM in X-direction according to Source

A[2:0]	Width	A[2:0]	Width
000	8	100	128
001	16	101	176
010	32	110	NA
011	64	111	NA

BUSY pad will output high during operation.

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	47	0	1	0	0	0	1	1	1	Auto Write B/W RAM for Regular Pattern	Auto Write B/W RAM for Regular Pattern A[7:0] = 00h [POR] A[7]: The 1st step value, POR = 0 A[6:4]: Step Height, POR= 000 Step of alter RAM in Y-direction according to Gate
0	1		A_7	A_6	A_5	A_4	0	A_2	A_1	A_0		

A[6:4]	Height	A[6:4]	Height
000	8	100	128
001	16	101	256
010	32	110	296
011	64	111	NA

A[2:0]: Step Width, POR= 000
Step of alter RAM in X-direction according to Source

A[2:0]	Width	A[2:0]	Width
000	8	100	128
001	16	101	176
010	32	110	NA
011	64	111	NA

During operation, BUSY pad will output high.

0	0	4E	0	1	0	0	1	1	1	0	Set RAM X address counter	Make initial settings for the RAM X address in the address counter (AC) A[5:0]: 00h [POR].
0	1		0	0	A_5	A_4	A_3	A_2	A_1	A_0		
0	0	4F	0	1	0	0	1	1	1	1	Set RAM Y address counter	Make initial settings for the RAM Y address in the address counter (AC) A[8:0]: 000h [POR].
0	1		A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0		
0	1		0	0	0	0	0	0	0	A_8		
0	0	7F	0	1	1	1	1	1	1	1	NOP	This command is an empty command; it does not have any effect on the display module. However it can be used to terminate Frame Memory Write or Read Commands.

3. Environmental

3.1 HANDLING, SAFETYAND ENVIROMENTAL 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 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.	
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.

3.2 Reliability test

	TEST	CONDITION
1	High-Temperature Operation	T=70°C, RH=40%RH, For 240hrs Test in white pattern
2	Low-Temperature Operation	T = -25°C for 240 hrs Test in white pattern
3	High-Temperature Storage	T=40°C , RH=35%RH, For 240 hrs
4	Low-Temperature Storage	T = 0°C, for 240 hrs
5	High Temperature, High Humidity Operation	T=40°C, RH=80%RH, For 240hrs
6	High Temperature, High Humidity Storage	T=50°C, RH=80%RH, For 240hrs Test in white pattern
7	Temperature Cycle	-25°C (30min) ~ 70°C(30min), 50 Cycle Test in white pattern
8	UV exposure Resistance	765 W/m² for 168hrs, 40°C
9	ESD Gun	Air+/-15KV; Contact+/-8KV (Test finished product shell, not display only) Air+/-8KV; Contact+/-6KV (Naked EPD display, no including IC and FPC area) Air+/-4KV; Contact+/-2KV (Naked EPD display, including IC and FPC area)

Note: Put in normal temperature for 1hour after test finished, display performance is ok.

4. Electrical Characteristics

4.1 ABSOLUTE MAXIMUM RATING

Symbol	Parameter	Rating	Unit
V CI	Logic supply voltage	-0.5 to +6.0	V
V IN	Logic Input voltage	-0.5 to VCI +0.5	V
V OUT	Logic Output voltage	-0.5 to VCI +0.5	V
T OPR	Operation temperature range	0~40	°C
T STG	Storage temperature range	-25~70	°C
T STGo	Optimal Storage Temp	23 ± 2	°C
H STGo	Optimal Storage Humidity	55 ± 10	%RH

* Note: Avoid direct sunlight.

Table 4.1-1: Maximum Ratings

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.

4.2 DC CHARACTERISTICS

The following specifications apply for: VSS=0V, VCI=3.0V, TOPR=25°C.

Table 4.2-1: DC Characteristics

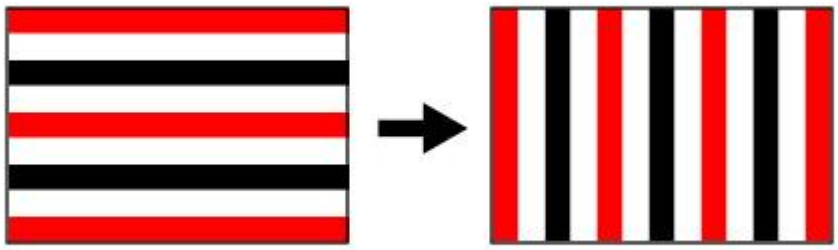
Symbol	Parameter	Test Condition	Applicable pin	Min.	Typ.	Max.	Unit
VSS	Single ground	--		-	0	-	V
VCI	VCI operation voltage		VCI	2.2	3.0	3.7	V
VDD	Core logic voltage		VDD	1.7	1.8	1.9	V
VIH	High level input voltage	-	--	0.8 VCI	-	-	V
VIL	Low level input voltage	-	--	-	-	0.2 VCI	V
VOH	High level output voltage	IOH = -100uA	--	0.9 VCI	-	-	V
VOL	Low level output voltage	IOL = 100uA	--	--	-	0.1 VCI	V
PTYP	Typical power	VCI = 3.0V	--	--	9	--	mW
PSTPY	Deep sleep mode	VCI = 3.0V		--	0.003	--	mW
Iopr_VCI	Typical operating current	VCI = 3.0V		-	3	--	mA
-	Image update time	25°C			14		sec
Idslp_VCI	Module operating current	DC/ DC off No clock No input load Ram data retain	-	-	20		uA
Islp_VCI	Deep sleep mode	DC/ DC off No clock No input load Ram data not retain	-	-	1	5	uA

Notes:
1) Refresh time: the time it takes for the whole process from the screen change to the screen stabilization.
2) The difference between different refresh methods:
Full refresh: The screen will flicker several times during the refresh process; Fast Refresh: The screen will flash once during the refresh process;

During the fast refresh or partial refresh of the electronic paper, it is recommended to add a full-screen refresh after 5 consecutive operations to reduce the accumulation of afterimages on the screen.

1. The typical power is measured with following transition from horizontal pattern to vertical pattern.(Note4.2-1)
2.The deep sleep power is the consumed power when the panel controller is in deep sleep mode.
3.The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by Seengreat.

Note 4.2-1
The Typical power consumption



4.3 Serial Peripheral Interface Timing

The following specifications apply for: VDDIO - VSS = 2.2V to 3.7V, TOPR = 25 °C, 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

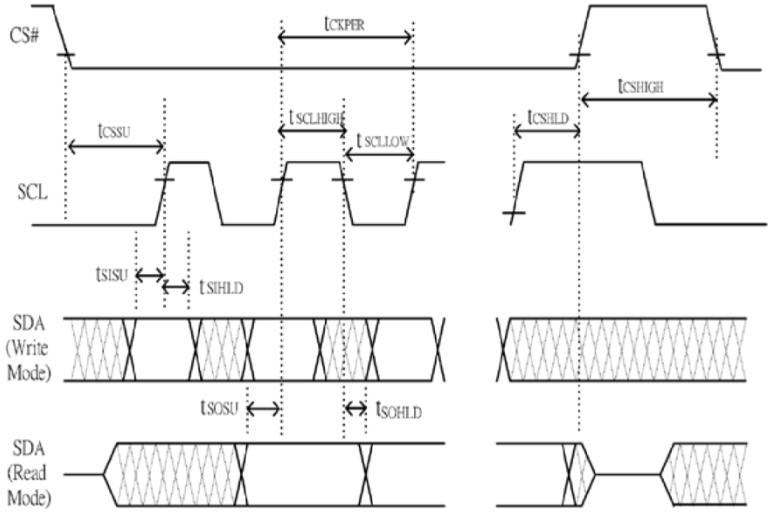


Figure 4.3-1 : Serial peripheral interface characteristics

4.4 MCU Interface

4.4-1 MCU interface selection

The 2.13inch e-paper can support 3-wire/4-wire serial peripheral interface.
In the Module, the MCU interface is pin selectable by BS1 pins shown in.

Table 4.4-1: MCU interface selection

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

Note: L is connected to VSS and H is connected to VDDIO

4.4-2 MCU Serial Peripheral Interface (4-wire SPI)

The 4-wire serial interface consists of serial clock SCL, serial data SDA and CS#. This interface also supports Write mode and Read mode.

Table 4.4-2 : 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 every rising edge of SCL in the order of D7, 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.

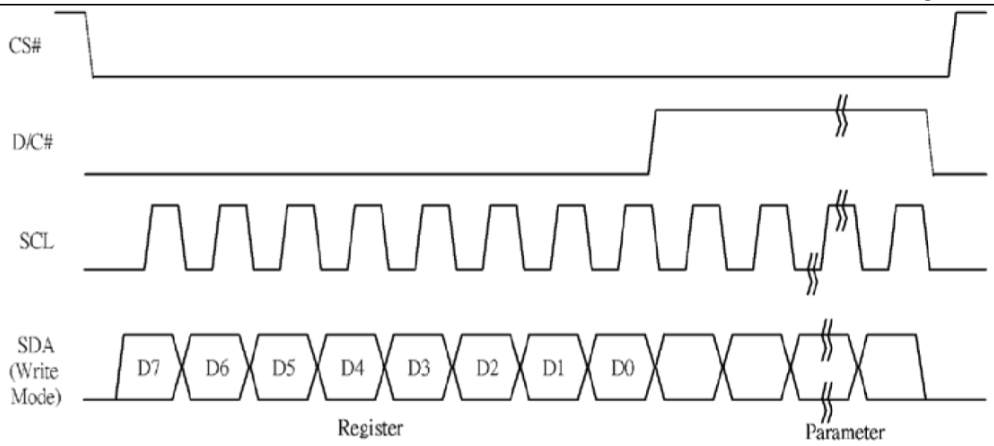


Figure 4.4-1: Write procedure in 4-wire SPI mode

In the read mode:

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

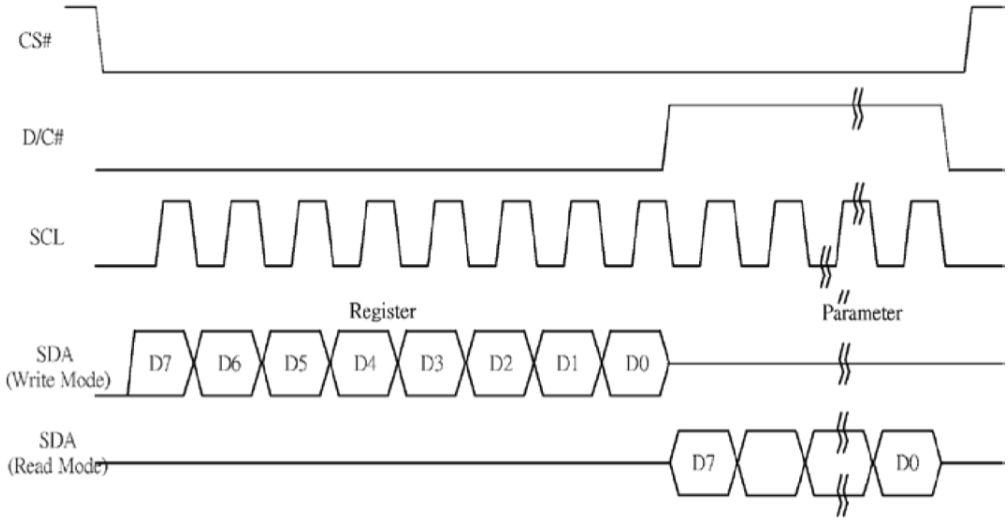


Figure 4.4-2: Read procedure in 4-wire SPI mode

4.4-3 MCU Serial Peripheral Interface (3-wire SPI)

The 3-wire serial interface consists of serial clock SCL, serial data SDA and CS#. This interface also supports Write mode and Read mode.

Table 4.4-3 : Control pins status of 3-wire SPI

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

Note:

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

(2)↑ stands for rising edge of signal

In the write operation:

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 the shift register is written to the Display Data RAM (D/C# bit = 1) or the command register (D/C# bit = 0).

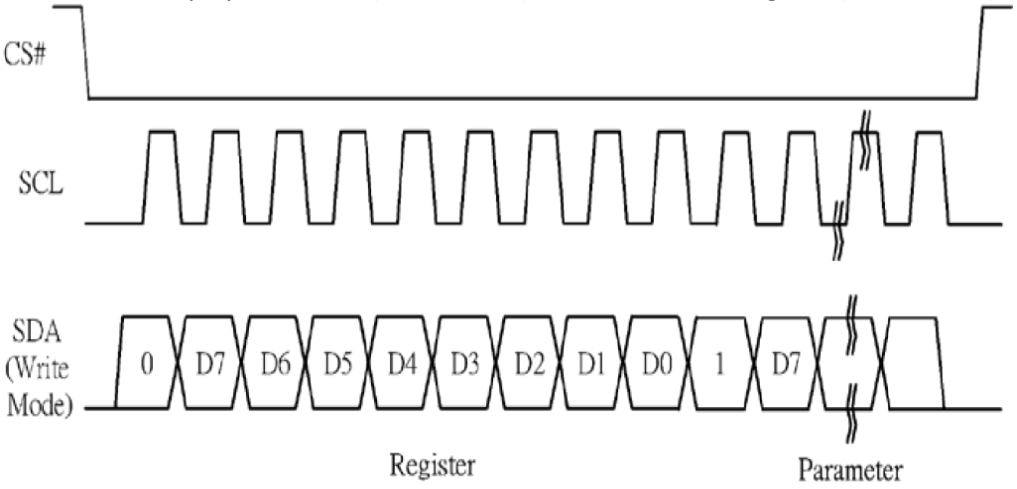


Figure 4.4-3: Write procedure in 3-wire SPI mode

In the read mode:

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

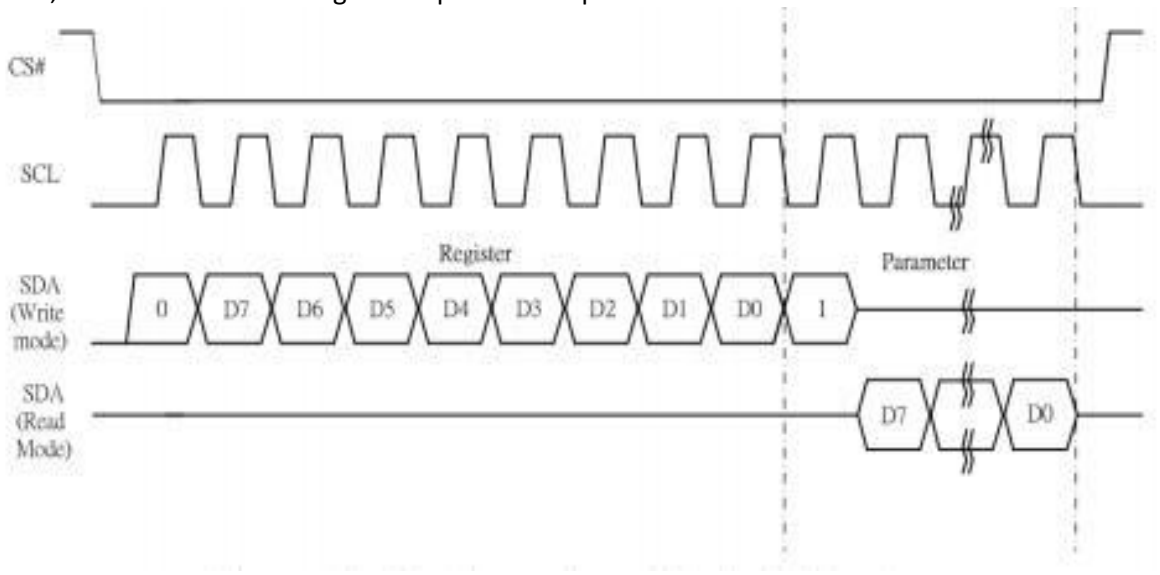
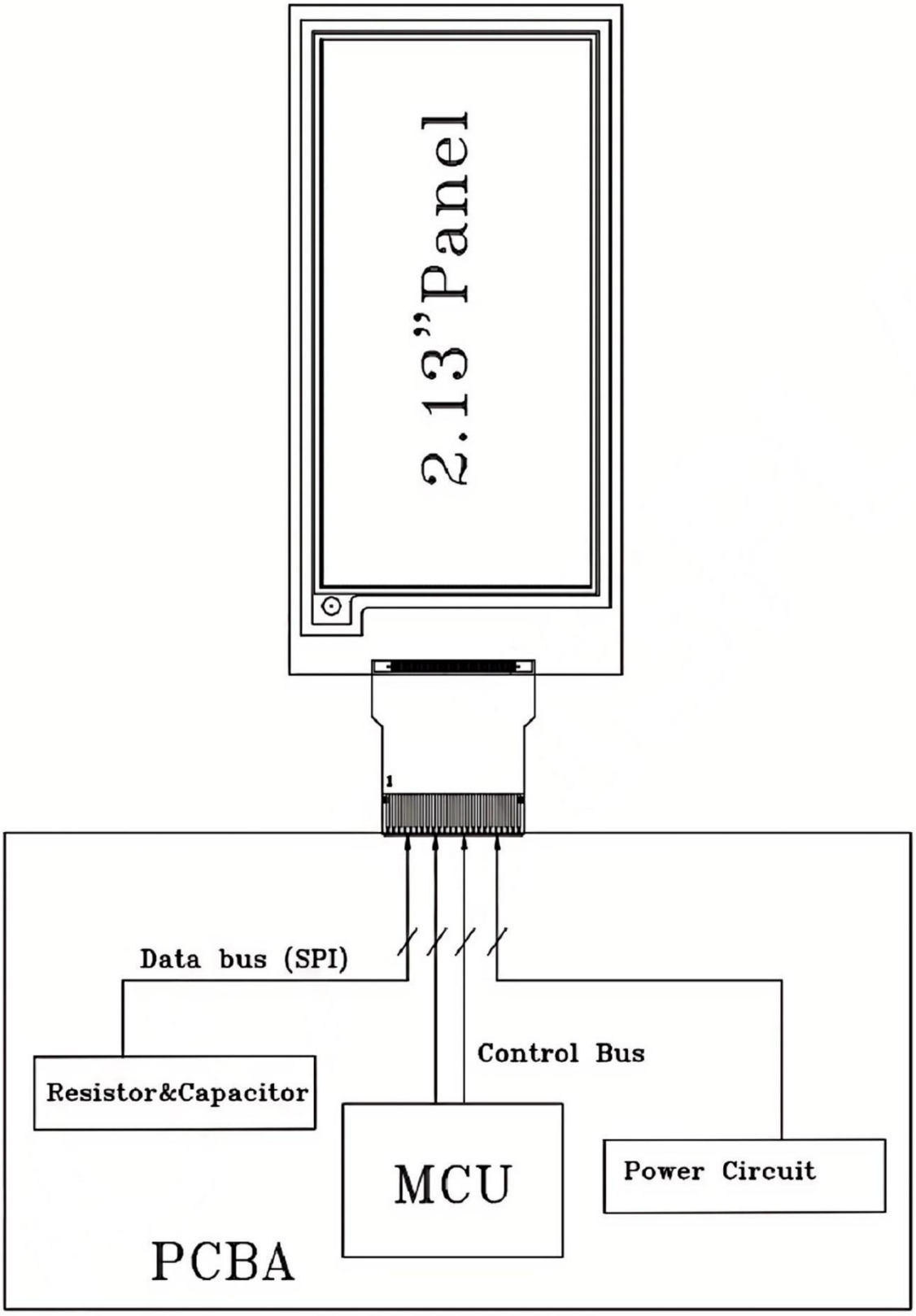


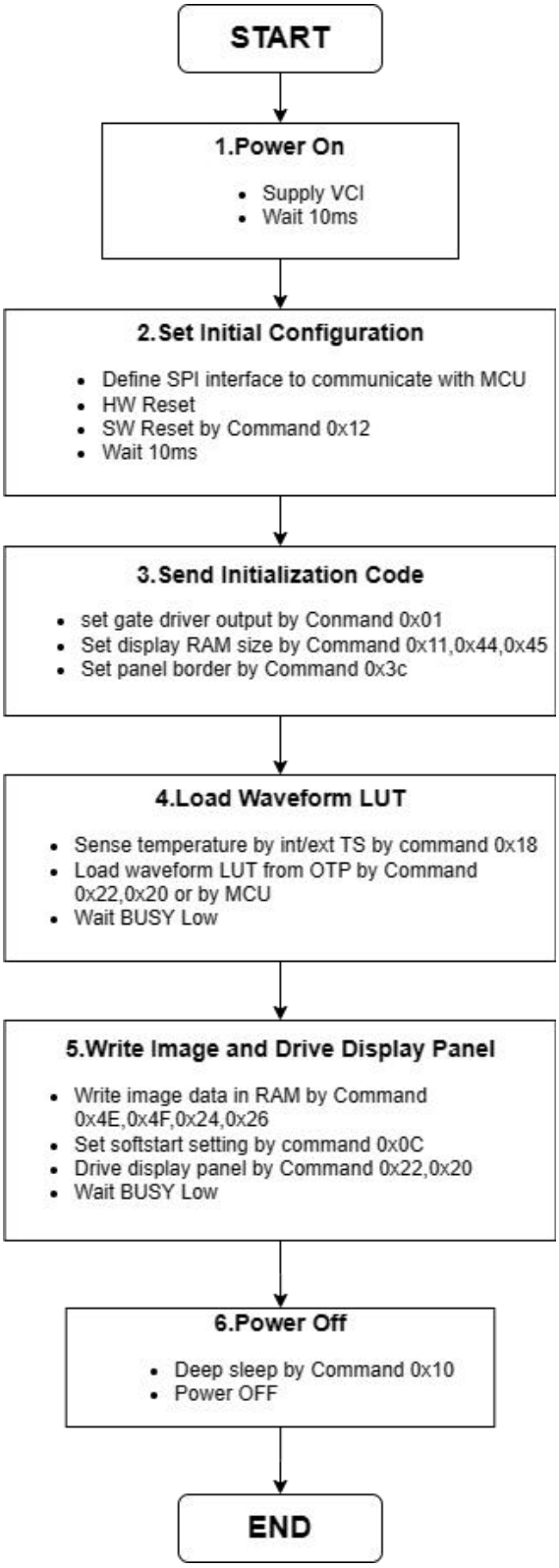
Figure 4.4-4: Read procedure in 3-wire SPI mode

4.4 Block Diagram



5. Typical Operating Sequence

5.1 General operation flow to drive display panel



5.2 Normal Program Reference Code

ACTION	VALUE/DATA	COMMENT
POWER ON		
delay	10ms	
PIN CONFIG		
RESE#	low	Hardware reset
delay	200us	
RESE#	high	
delay	200us	
Read busy pin		Wait for busy low
Command 0x12		Software reset
Read busy pin		Wait for busy low
Command 0x01	Data 0xF9 0x00 0x00	Set display size and driver output control
Command 0x11	Data 0x01	Ram data entry mode
Command 0x44	Data 0x01 0x10	Set Ram X address
Command 0x45	Data 0xF9 0x00 0x00 0x00	Set Ram Y address
Command 0x3C	Data 0xC0	Set border
SET VOLTAGE AND LOAD LUT		
Command 0x2C	Data 0x70	Set VCOM value
Command 0x03	Data 0x17	Gate voltage setting
Command 0x04	Data 0x41 0x00 0x32	Source voltage setting
Command 0x32	Write 224bytes LUT	Load LUT
LOAD IMAGE AND UPDATE		
Command 0x4E	Data 0x01	Set Ram X address counter
Command 0x4F	Data 0xF9 0x00	Set Ram Y address counter
Command 0x24	4000bytes	Load image (128/8*250)(BW)
Command 0x22	Data 0XC7	Image update
Command 0x4E	Data 0x01	Set Ram X address counter
Command 0x4F	Data 0xF9 0x00	Set Ram Y address counter
Command 0x26	4000bytes	Load image (128/8*250)(R)
Command 0x22	Data 0XC7	Image update
Command 0x20		
Read busy pin		
Command 0x10	Data 0X01	Enter deep sleep mode
POWER OFF		

6. Optical characteristics

6.1 Specifications

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

T=25°C

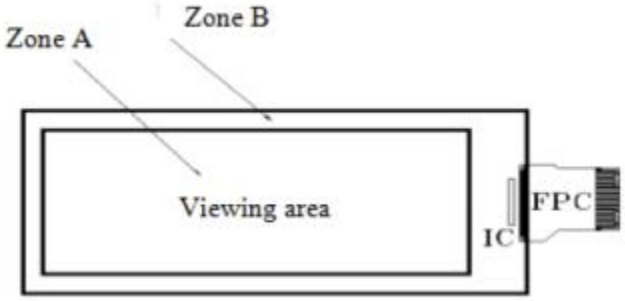
SYMBOL	PARAMETER	CONDITIONS	MIN	TYPE	MAX	UNIT	Note

R	White Reflectivity	white	30	35	-	%	Note 6-1
GN	2Grey Level	-	-	DS+(WS-DS)×n(m-1)	-		
CR	Contrast Ratio	Indoor	8:1		-	-	Note 6-2
Life	-	Topr		1000000times or 5years	-	-	

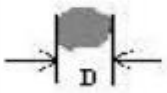
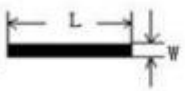
m:2
WS : White state
DS : Dark stat
Note 6-1: Luminance meter : Eye - One Pro Spectrophotometer.
Note 6-2: CR=Surface Reflectance with all white pixel/Surface Reflectance with all black pixels.

7. Point and line standard

Temperature: 25 ± 3°C; Humidity: 55 ± 10%RH; Brightness: 1200~1500LUX; distance: 20-30CM; Angle: Relate 30°surround.

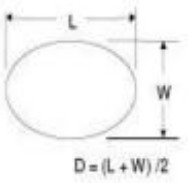
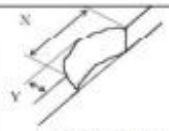


7.1 Electric inspection standard

NO.	Item	Standard	Defect level	Method	Scope
1	Display	Display complete Display uniform	MA	Visual inspection	Zone A
2	Black/White spots	 D≤0.25mm，Allowed 0.25mm＜D≤0.4mm。N≤3，and Distance≥5mm 0.4mm＜D Not Allow	MI		
3	Black/White spots (No switch)	 L≤0.6mm，W≤0.2mm，N≤1 L≤2.0mm,W＞0.2mm，Not Allow L＞0.6mm，Not Allow		Visual/ Inspection card	
4	Ghost image	Allowed in switching process	MI	Visual inspection	

5	Flash spots/ Larger FPL size	Flash spots in switching, Allowed FPL size larger than viewing area, Allowed	MI	Visual/ Inspection card	Zone A Zone B
6	Display wrong/Missing	All appointed displays are showed correct	MA	Visual inspection	Zone A
7	Short circuit/ Circuit break/ Display abnormal	Not Allow			

7.2 Appearance inspection standard

NO.	Item	Standard	Defect level	Method	Scope
1	B/W spots /Bubble/ Foreign bodies/ Dents	 D≤0.25mm，Allowed 0.25mm＜D≤0.4mm，N≤3 D＞0.4mm，Not Allow	MI	Visual inspection	Zone A
2	Glass crack	Not Allow	MA	Visual / Microscope	Zone A Zone B
3	Dirty	Allowed if can be removed	MI		Zone A Zone B
4	Chips/Scratch/ Edge crown	 X≤3mm,Y≤0.5mmAnd without affecting the electrode is permissible  2mm≤X or 2mm≤Y Not Allow  W≤0.1mm,L≤5mm, No harm to the electrodes and N≤2 allow	MI	Visual / Microscope	Zone A Zone B

8. Precautions

(1) Do not apply pressure to the EPD panel in order to prevent damaging it.

(2) Do not connect or disconnect the interface connector while the EPD panel is in operation.

(3) Do not touch IC bonding area. It may scratch TFT lead or damage IC function.

(4) Please be mindful of moisture to avoid its penetration into the EPD panel, which may cause damage during operation.

(5) If the EPD Panel / Module is not refreshed every 24 hours, a phenomena known as "Ghosting" or "Image Sticking" may occur. It is recommended to refreshed the ESL / EPD Tag every 24 hours in use case. It is recommended that customer ships or stores the ESL / EPD Tag with a completely white image to avoid this issue

(6) High temperature, high humidity, sunlight or fluorescent light may degrade the EPD panel's performance. Please do not expose the unprotected EPD panel to high temperature, high humidity, sunlight, or fluorescent for long periods of time.