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System solutions

OEM Solutions

Custom Display

Mechanical design



Product Specifications



Customer	Standard
Description	1.54" E-PAPER DISPLAY
Model Name	ET015EPT01
Date	2023/08/09
Revision	1.0

	Design Engineering		
	Approval	Check	Design



REVISION HISTORY

Rev	Date	Item	Page	Remark
1.0	09.08.2023	New Creation	ALL	

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1. Over View

ET015EPT01 is a TFT active matrix electrophoretic display with capacitive touch panel-FT6336U . The 1.54" active area contains 200×200 pixels, and has 1-bit black/white 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.

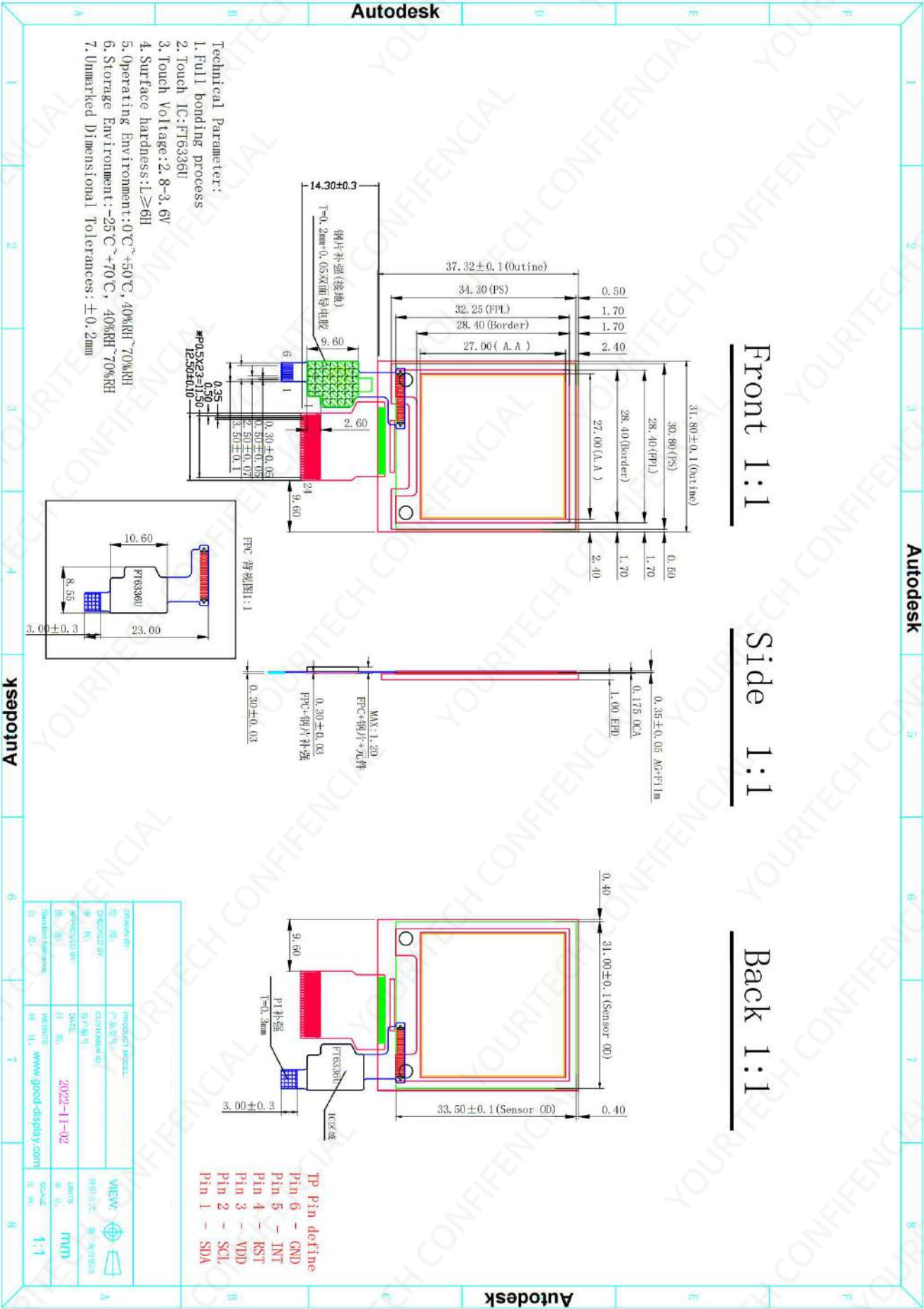
2.Features

- High contrast
- High reflectance
- Ultra wide viewing angle
- Ultra low power consumption
- Pure reflective mode
- Bi-stable
- Commercial temperature range
- Landscape, portrait mode
- Antiglare hard-coated front-surface
- Low current sleep mode
- On chip display RAM
- 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 IC thickness 300um
- With capacitive touch panel-FT6336U, Channel number 14
- Touch panel operating voltage: 3.3V

3.Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	1.54	Inch	
Display Resolution	200(H)×200(V)	Pixel	Dpi:184
Active Area	27.0(H)×27.0(V)	mm	
Pixel Pitch	0.14×0.14	mm	
Pixel Configuration	Square		
Outline Dimension	31.80(H)×37.32(V) ×1.62(D)	mm	
Weight	3.15±0.5	g	

4. Mechanical Drawing of EPD module



5. Input /Output Pin Assignment

No.	Name	I/O	Description	Remark
1	NC		Do not connect with other NC pins	Keep Open
2	GDR	O	N-Channel MOSFET Gate Drive Control	
3	RESE	I	Current Sense Input for the Control Loop	
4	NC	NC	Do not connect with other NC pins	Keep Open
5	VSH2	C	Positive Source driving voltage(Red)	
6	TSCL	O	I ² C Interface to digital temperature sensor Clock pin	
7	TSDA	I/O	I ² C Interface to digital temperature sensor Data pin	
8	BS1	I	Bus Interface selection pin	Note 5-5
9	BUSY	O	Busy state output pin	Note 5-4
10	RES#	I	Reset signal input. Active Low.	Note 5-3
11	D/C#	I	Data /Command control pin	Note 5-2
12	CS#	I	Chip select input pin	Note 5-1
13	SCL	I	Serial Clock pin (SPI)	
14	SDA	I	Serial Data pin (SPI)	
15	VDDIO	P	Power Supply for interface logic pins It should be connected with VCI	
16	VCI	P	Power Supply for the chip	
17	VSS	P	Ground	
18	VDD	C	Core logic power pin VDD can be regulated internally from VCI. A capacitor should be connected between VDD and VSS	
19	VPP	P	FOR TEST	
20	VSH1	C	Positive Source driving voltage	
21	VGH	C	Power Supply pin for Positive Gate driving voltage and VSH1	
22	VSL	C	Negative Source driving voltage	
23	VGL	C	Power Supply pin for Negative Gate driving voltage VCOM and VSL	
24	VCOM	C	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) 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 (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. Please refer to below Table.

BS1 State	MCU Interface
L	4-lines serial peripheral interface(SPI) - 8 bits SPI
H	3- lines serial peripheral interface(SPI) - 9 bits SPI

6. Command Table

Command Table												Command	Description																																																						
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0																																																									
0	0	01	0	0	0	0	0	0	0	1	Driver Output control	Gate setting A[8:0]= C7h [POR], 200 MUX MUX Gate lines setting as (A[8:0] + 1).																																																							
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		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...199 (left and right gate interlaced) SM=1, G0, G2, G4 ...G198, G1, G3, ...G199 B[0]: TB TB = 0 [POR], scan from G0 to G199 TB = 1, scan from G199 to G0.																																																							
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		<table><tr><th>A[4:0]</th><th>VGH</th><th>A[4:0]</th><th>VGH</th></tr><tr><td>00h</td><td>20</td><td>0Dh</td><td>15</td></tr><tr><td>03h</td><td>10</td><td>0Eh</td><td>15.5</td></tr><tr><td>04h</td><td>10.5</td><td>0Fh</td><td>16</td></tr><tr><td>05h</td><td>11</td><td>10h</td><td>16.5</td></tr><tr><td>06h</td><td>11.5</td><td>11h</td><td>17</td></tr><tr><td>07h</td><td>12</td><td>12h</td><td>17.5</td></tr><tr><td>08h</td><td>12.5</td><td>13h</td><td>18</td></tr><tr><td>07h</td><td>12</td><td>14h</td><td>18.5</td></tr><tr><td>08h</td><td>12.5</td><td>15h</td><td>19</td></tr><tr><td>09h</td><td>13</td><td>16h</td><td>19.5</td></tr><tr><td>0Ah</td><td>13.5</td><td>17h</td><td>20</td></tr><tr><td>0Bh</td><td>14</td><td>Other</td><td>NA</td></tr><tr><td>0Ch</td><td>14.5</td><td></td><td></td></tr></table>	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	
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[7]/B[7] = 0, VSH1/VSH2 voltage setting from 9V to 17V	C[7] = 0, VSL setting from -5V to -17V	
A/B[7:0]			VSH1/VSH2			A/B[7:0]			VSH1/VSH2			C[7:0]			VSL
8Eh			2.4			AFh			5.7			0Ah			-5
8Fh			2.5			B0h			5.8			0Ch			-5.5
90h			2.6			B1h			5.9			0Eh			-6
91h			2.7			B2h			6			10h			-6.5
92h			2.8			B3h			6.1			12h			-7
93h			2.9			B4h			6.2			14h			-7.5
94h			3			B5h			6.3			16h			-8
95h			3.1			B6h			6.4			18h			-8.5
96h			3.2			B7h			6.5			1Ah			-9
97h			3.3			B8h			6.6			1Ch			-9.5
98h			3.4			B9h			6.7			1Eh			-10
99h			3.5			BAh			6.8			20h			-10.5
9Ah			3.6			BBh			6.9			22h			-11
9Bh			3.7			BCh			7			24h			-11.5
9Ch			3.8			BDh			7.1			26h			-12
9Dh			3.9			BEh			7.2			28h			-12.5
9Eh			4			BFh			7.3			2Ah			-13
9Fh			4.1			C0h			7.4			2Ch			-13.5
A0h			4.2			C1h			7.5			2Eh			-14
A1h			4.3			C2h			7.6			30h			-14.5
A2h			4.4			C3h			7.7			32h			-15
A3h			4.5			C4h			7.8			34h			-15.5
A4h			4.6			C5h			7.9			36h			-16
A5h			4.7			C6h			8			38h			-16.5
A6h			4.8			C7h			8.1			3Ah			-17
A7h			4.9			C8h			8.2			Other			NA
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						

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											Command	Description																											
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0																													
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] Bit Description of each byte: A[6:0] / B[6:0] / C[6:0]:																											
0	1		1	A ₆	A ₅	A ₄	A ₃	A ₂	A ₁	A ₀		<table><tr><th>Bit[6:4]</th><th>Driving Strength Selection</th></tr><tr><td>000</td><td>1(Weakest)</td></tr><tr><td>001</td><td>2</td></tr><tr><td>010</td><td>3</td></tr><tr><td>011</td><td>4</td></tr><tr><td>100</td><td>5</td></tr><tr><td>101</td><td>6</td></tr><tr><td>110</td><td>7</td></tr><tr><td>111</td><td>8(Strongest)</td></tr></table>	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[6:4]	Driving Strength Selection																																						
000	1(Weakest)																																						
001	2																																						
010	3																																						
011	4																																						
100	5																																						
101	6																																						
110	7																																						
111	8(Strongest)																																						
0	1		1	B ₆	B ₅	B ₄	B ₃	B ₂	B ₁	B ₀	<table><tr><th>Bit[3:0]</th><th>Min Off Time Setting of GDR [Time unit]</th></tr><tr><td>0000 ~ 0011</td><td>NA</td></tr><tr><td>0100</td><td>2.6</td></tr><tr><td>0101</td><td>3.2</td></tr><tr><td>0110</td><td>3.9</td></tr><tr><td>0111</td><td>4.6</td></tr><tr><td>1000</td><td>5.4</td></tr><tr><td>1001</td><td>6.3</td></tr><tr><td>1010</td><td>7.3</td></tr><tr><td>1011</td><td>8.4</td></tr><tr><td>1100</td><td>9.8</td></tr><tr><td>1101</td><td>11.5</td></tr><tr><td>1110</td><td>13.8</td></tr><tr><td>1111</td><td>16.5</td></tr></table>	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
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																																						
0	1		1	C ₆	C ₅	C ₄	C ₃	C ₂	C ₁	C ₀	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																												
0	1		0	0	D ₅	D ₄	D ₃	D ₂	D ₁	D ₀	<table><tr><th>Bit[1:0]</th><th>Duration of Phase [Approximation]</th></tr><tr><td>00</td><td>10ms</td></tr><tr><td>01</td><td>20ms</td></tr><tr><td>10</td><td>30ms</td></tr><tr><td>11</td><td>40ms</td></tr></table>	Bit[1:0]	Duration of Phase [Approximation]	00	10ms	01	20ms	10	30ms	11	40ms																		
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		<table><tr><th>A[1:0]</th><th>Description</th></tr><tr><td>00</td><td>Normal Mode [POR]</td></tr><tr><td>01</td><td>Enter Deep Sleep Mode 1</td></tr><tr><td>11</td><td>Enter Deep Sleep Mode 2</td></tr></table>	A[1:0]	Description	00	Normal Mode [POR]	01	Enter Deep Sleep Mode 1	11	Enter Deep Sleep Mode 2																			
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												Command	Description												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0															
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.												
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													
0	1		0	0	0	0	0	A ₂	A ₁	A ₀			<table><tr><th>A[2:0]</th><th>VCI level</th></tr><tr><td>011</td><td>2.2V</td></tr><tr><td>100</td><td>2.3V</td></tr><tr><td>101</td><td>2.4V</td></tr><tr><td>110</td><td>2.5V</td></tr><tr><td>111</td><td>2.6V</td></tr><tr><td>Other</td><td>NA</td></tr></table> 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).	A[2:0]	VCI level	011	2.2V	100	2.3V	101	2.4V	110	2.5V	111	2.6V
A[2:0]	VCI level																								
011	2.2V																								
100	2.3V																								
101	2.4V																								
110	2.5V																								
111	2.6V																								
Other	NA																								
0	0	18	0	0	0	1	1	0	0	0	Temperature Sensor Control	Temperature Sensor Selection A[7:0] = 48h [POR], external temperature 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[11:0] = 7FFh [POR]													
0	1		A ₁₁	A ₁₀	A ₉	A ₈	A ₇	A ₆	A ₅	A ₄															
0	1		A ₃	A ₂	A ₁	A ₀	0	0	0	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 ₁₁	A ₁₀	A ₉	A ₈	A ₇	A ₆	A ₅	A ₄															
1	1		A ₃	A ₂	A ₁	A ₀	0	0	0	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.													

Command Table																								
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description												
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] <table><tr><td>A[7:6]</td><td>Select no of byte to be sent</td></tr><tr><td>00</td><td>Address + pointer</td></tr><tr><td>01</td><td>Address + pointer + 1st parameter</td></tr><tr><td>10</td><td>Address + pointer + 1st parameter + 2nd pointer</td></tr><tr><td>11</td><td>Address</td></tr></table> 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.	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[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																							
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	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 <table><tr><td>0000</td><td>Normal</td></tr><tr><td>0100</td><td>Bypass RAM content as 0</td></tr><tr><td>1000</td><td>Inverse RAM content</td></tr></table> A[3:0] BW RAM option <table><tr><td>0000</td><td>Normal</td></tr><tr><td>0100</td><td>Bypass RAM content as 0</td></tr><tr><td>1000</td><td>Inverse RAM content</td></tr></table>	0000	Normal	0100	Bypass RAM content as 0	1000	Inverse RAM content	0000	Normal	0100	Bypass RAM content as 0	1000	Inverse RAM content
0000	Normal																							
0100	Bypass RAM content as 0																							
1000	Inverse RAM content																							
0000	Normal																							
0100	Bypass RAM content as 0																							
1000	Inverse RAM content																							
0	1		A ₇	A ₆	A ₅	A ₄	A ₃	A ₂	A ₁	A ₀														
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														

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																																						
												<table><tr><th>Operating sequence</th><th>Parameter (In Hex)</th></tr><tr><td>Enable clock signal</td><td>80</td></tr><tr><td>Disable clock signal</td><td>01</td></tr><tr><td colspan="2"></td></tr><tr><td>Enable clock signal → Enable Analog</td><td>C0</td></tr><tr><td>Disable Analog → Disable clock signal</td><td>03</td></tr><tr><td colspan="2"></td></tr><tr><td>Enable clock signal → Load LUT with DISPLAY Mode 1 → Disable clock signal</td><td>91</td></tr><tr><td>Enable clock signal → Load LUT with DISPLAY Mode 2 → Disable clock signal</td><td>99</td></tr><tr><td colspan="2"></td></tr><tr><td>Enable clock signal → Load temperature value → Load LUT with DISPLAY Mode 1 → Disable clock signal</td><td>B1</td></tr><tr><td>Enable clock signal → Load temperature value → Load LUT with DISPLAY Mode 2 → Disable clock signal</td><td>B9</td></tr><tr><td colspan="2"></td></tr><tr><td>Enable clock signal → Enable Analog → Display with DISPLAY Mode 1 → Disable Analog → Disable OSC</td><td>C7</td></tr><tr><td>Enable clock signal → Enable Analog → Display with DISPLAY Mode 2 → Disable Analog → Disable OSC</td><td>CF</td></tr><tr><td colspan="2"></td></tr><tr><td>Enable clock signal → Enable Analog → Load temperature value → DISPLAY with DISPLAY Mode 1 → Disable Analog → Disable OSC</td><td>F7</td></tr><tr><td>Enable clock signal → Enable Analog → Load temperature value → DISPLAY with DISPLAY Mode 2 → Disable Analog → Disable OSC</td><td>FF</td></tr></table>	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
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Enable clock signal → Enable Analog → Load temperature value → DISPLAY with DISPLAY Mode 2 → Disable Analog → Disable OSC	FF																																															
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	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.
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	2B	0	0	1	0	1	0	1	1	Write Register for VCOM Control	This command is used to reduce glitch when ACVCOM toggle. Two data bytes D04h and D63h should be set for this command.
0	1		0	0	0	0	0	0	1	0		
0	1		0	1	1	0	0	0	0	1		

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Command Table																																																																												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description																																																																
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																																																																		
												<table> <tr> <th>A[7:0]</th><th>VCOM</th><th>A[7:0]</th><th>VCOM</th></tr> <tr><td>08h</td><td>-0.2</td><td>44h</td><td>-1.7</td></tr> <tr><td>0Ch</td><td>-0.3</td><td>48h</td><td>-1.8</td></tr> <tr><td>10h</td><td>-0.4</td><td>4Ch</td><td>-1.9</td></tr> <tr><td>14h</td><td>-0.5</td><td>50h</td><td>-2</td></tr> <tr><td>18h</td><td>-0.6</td><td>54h</td><td>-2.1</td></tr> <tr><td>1Ch</td><td>-0.7</td><td>58h</td><td>-2.2</td></tr> <tr><td>20h</td><td>-0.8</td><td>5Ch</td><td>-2.3</td></tr> <tr><td>24h</td><td>-0.9</td><td>60h</td><td>-2.4</td></tr> <tr><td>28h</td><td>-1</td><td>64h</td><td>-2.5</td></tr> <tr><td>2Ch</td><td>-1.1</td><td>68h</td><td>-2.6</td></tr> <tr><td>30h</td><td>-1.2</td><td>6Ch</td><td>-2.7</td></tr> <tr><td>34h</td><td>-1.3</td><td>70h</td><td>-2.8</td></tr> <tr><td>38h</td><td>-1.4</td><td>74h</td><td>-2.9</td></tr> <tr><td>3Ch</td><td>-1.5</td><td>78h</td><td>-3</td></tr> <tr><td>40h</td><td>-1.6</td><td>Other</td><td>NA</td></tr> </table>	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
A[7:0]	VCOM	A[7:0]	VCOM																																																																									
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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																																																																		

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
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.
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 [153 bytes], which contains the content of VS[nX-LUTm], TP[nX], RP[n], SR[nXY], and FR[n] 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 SSD1681 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		

Command Table												Command	Description
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0			
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] E[7:0] Display Mode for WS[31:24] F[3:0] Display Mode for WS[35:32] 0: Display Mode 1 1: Display Mode 2 F[6]: PingPong 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	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	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 Remark: User is required to EXACTLY follow the reference code sequences	
0	1		0	0	0	0	0	0	A ₁	A ₀			

Command Table												Command	Description	
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0				
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		
0	1		A ₇	A ₆	A ₅	A ₄	0	A ₂	A ₁	A ₀				
													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[2] GS Transition control	
											A[2]	GS Transition control		
											0	Follow LUT (Output VCOM @ RED)		
											1	Follow LUT		
											A [1:0] GS Transition setting for VBD			
											A[1:0]	VBD Transition		
											00	LUT0		
											01	LUT1		
											10	LUT2		
											11	LUT3		
0	0	3F	0	0	1	1	1	1	1	1	End Option (EOPT)	Option for LUT end A[7:0]= 02h [POR]		
0	1		A ₇	A ₆	A ₅	A ₄	A ₃	A ₂	A ₁	A ₀				
													22h	Normal.
											07h	Source output level keep previous output before power off		
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 ₆				
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 ₆				

7. Electrical Characteristics

7-1. Absolute maximum rating

Parameter	Symbol	Rating	Unit
Logic supply voltage	V _{CI}	-0.5 to +4.0	V
Logic Input voltage	V _{IN}	-0.5 to V _{CI} +0.5	V
Logic Output voltage	V _{OUT}	-0.5 to V _{CI} +0.5	V
Operating Temp range	TOPR	0 to +50	°C
Storage Temp range	TSTG	-25 to +70	°C
Optimal Storage Humidity	HSTGo	55±10	%RH
Touch Panel Operating Voltage	-	2.8~3.6	V
Touch Panel Operating Current	-	4.32	mA
Touch Panel Standby Current	-	55	μA

7-2. Panel DC Characteristics

The following specifications apply for: V_{SS}=0V, V_{CI}=3.0V, TOPR = 23°C

Parameter	Symbol	Conditions	Applicable pin	Min.	Typ.	Max	Units
Single ground	V _{SS}	-		-	0	-	V
Logic supply voltage	V _{CI}	-	V _{CI}	2.2	3.0	3.7	V
Core logic voltage	V _{DD}		V _{DD}	1.7	1.8	1.9	V
High level input voltage	V _{IH}	-	-	0.8 V _{CI}	-	-	V
Low level input voltage	V _{IL}	-	-	-	-	0.2 V _{CI}	V
High level output voltage	V _{OH}	I _{OH} = - 100μA	-	0.9 V _{CI}	-	-	V
Low level output voltage	V _{OL}	I _{OL} = 100μA	-	-	-	0.1 V _{CI}	V
Typical power	P _{TYP}	V _{CI} =3.0 V	-	-	4.5	-	mW
Deep sleep mode	P _{STPY}	V _{CI} =3.0 V	-	-	0.003	-	mW
Typical operating current	I _{opr_VCI}	V _{CI} =3.0 V	-	-	1.5	-	mA
Full update time	-	25 °C	-	-	2	-	sec
Fast update time	-	25 °C	-	-	1.5	-	sec
Partial update time	-	25 °C	-	-	0.26	-	sec
Sleep mode current	I _{slp_VCI}	DC/DC off No clock No input load Ram data retain	-	-	20		uA
Deep sleep mode current	I _{dslp_VCI}	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;

Partial refresh: The screen does not flicker during the refresh process.

Note: 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.

The Typical power consumption is measured with following pattern transition: from horizontal 2 gray scale pattern to vertical 2 gray scale pattern.(Note 7-1)The standby power is the consumed power when the panel controller is in standby mode. The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by YOURITECH Vcom is recommended to be set in the range of assigned value $\pm 0.1V$.

Note 7-1 The Typical power consumption



7-3. Panel AC Characteristics

7-3-1. MCU Interface

7-3-1-1. MCU Interface selection

The module can support 3-wire/4-wire serial peripheral. MCU interface is pin selectable by BS1 shown in Table 7-1.

	Pin Name					
MCU Interface	BS1	RES#	CS#	D/C#	SCL	SDA
4-wire serial peripheral interface (SPI)	L	RES#	CS#	DC#	SCL	SDA
3-wire serial peripheral interface (SPI) – 9 bits SPI	H	RES#	CS#	L	SCL	SDA

Table 7-1 : Interface pins assignment under different MCU interface

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

7-3-1-2. MCU Serial 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 6-2 and the write procedure 4-wire SPI is shown in Table 7-2

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

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

Note:

- (1) L is connected to VSS and H is connected to VDDIO
- (2) ↑ stands for rising edge of signal
- (3) SDA (Write Mode) 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.

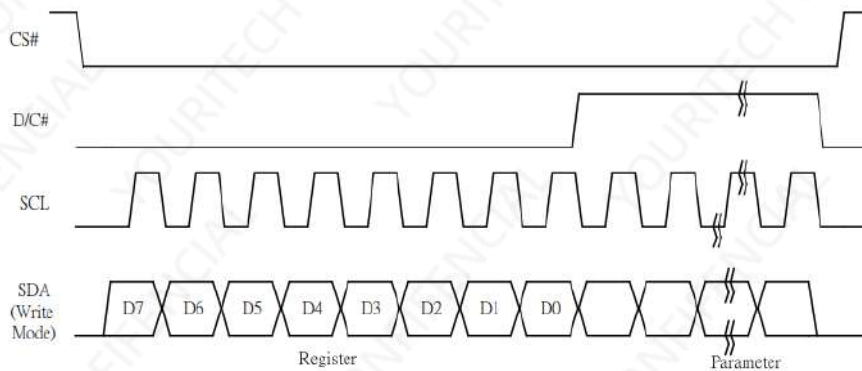


Figure 7-1 : Write procedure in 4-wire SPI mode

In the read operation (Command 0x1B, 0x27, 0x2D, 0x2E, 0x2F, 0x35). After CS# is pulled low, the first byte sent is command byte, D/C# is pulled low. After command byte sent, the following byte(s) read are data byte(s), so D/C# bit is then pulled high. An 8-bit data will be shifted out on every clock falling edge. The serial data SDA bit shifting sequence is D7, D6, to D0 bit. Figure 6-2 shows the read procedure in 4-wire SPI.

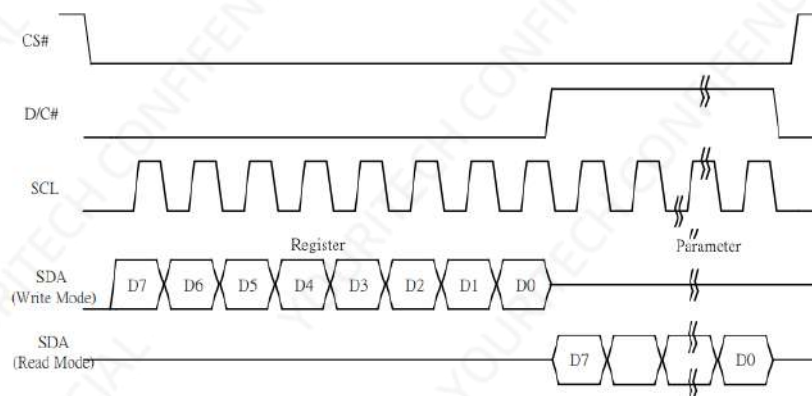


Figure 7-2 : Read procedure in 4-wire SPI mode

7-3-1-3. MCU 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-wire SPI 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.

In the write operation, a 9-bit data will be shifted into the shift register on every 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. Table 6-3 shows the write procedure in 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

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

Note:

- (1) L is connected to VSS and H is connected to VDDIO
- (2) ↑ stands for rising edge of signal

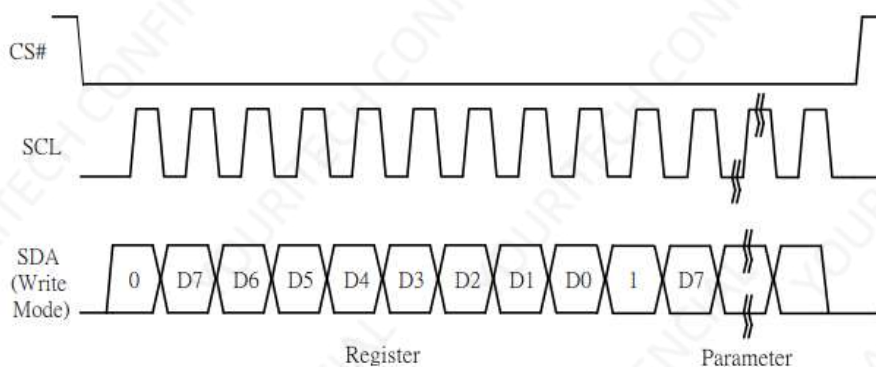


Figure 7-3 : Write procedure in 3-wire SPI

In the read operation (Register 0x1B, 0x27, 0x2D, 0x2E, 0x2F, 0x35). SDA data are transferred in the unit of 9 bits. After CS# pull low, the first byte is command byte, the D/C# bit is as 0 and following with the register byte. After command byte send, the following byte(s) are data byte(s), with D/C# bit is 1. After D/C# bit sending from MCU, an 8-bit data will be shifted out on every clock falling edge. The serial data SDA bit shifting sequence is D7, D6, to D0 bit. Figure 7-4 shows the read procedure in 3-wire SPI.

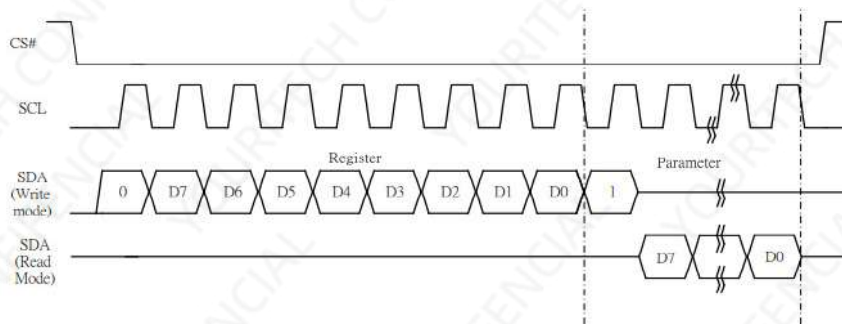


Figure 7-4 : Read procedure in 3-wire SPI mode

7-3-2. Serial Peripheral Interface

Write mode

Symbol	Parameter	Min	Typ	Max	Unit
f _{SCL}	SCL frequency (Write Mode)	-	-	20	MHz
t _{CSSU}	Time CS# has to be low before the first rising edge of SCLK	60	-	-	ns
t _{CSHLD}	Time CS# has to remain low after the last falling edge of SCLK	65	-	-	ns
t _{CSHIGH}	Time CS# has to remain high between two transfers	100	-	-	ns
t _{SCLHIGH}	Part of the clock period where SCL has to remain high	25	-	-	ns
t _{SCLLOW}	Part of the clock period where SCL has to remain low	25	-	-	ns
t _{SISU}	Time SI (SDA Write Mode) has to be stable before the next rising edge of SCL	10	-	-	ns
t _{SIHLD}	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
f _{SCL}	SCL frequency (Read Mode)	-	-	2.5	MHz
t _{CSSU}	Time CS# has to be low before the first rising edge of SCLK	100	-	-	ns
t _{CSHLD}	Time CS# has to remain low after the last falling edge of SCLK	50	-	-	ns
t _{CSHIGH}	Time CS# has to remain high between two transfers	250	-	-	ns
t _{SCLHIGH}	Part of the clock period where SCL has to remain high	180	-	-	ns
t _{SCLLOW}	Part of the clock period where SCL has to remain low	180	-	-	ns
t _{SOSU}	Time SO(SDA Read Mode) will be stable before the next rising edge of SCL	-	50	-	ns
t _{SOHLD}	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

Table 7-4: Serial Peripheral Interface Timing Characteristics

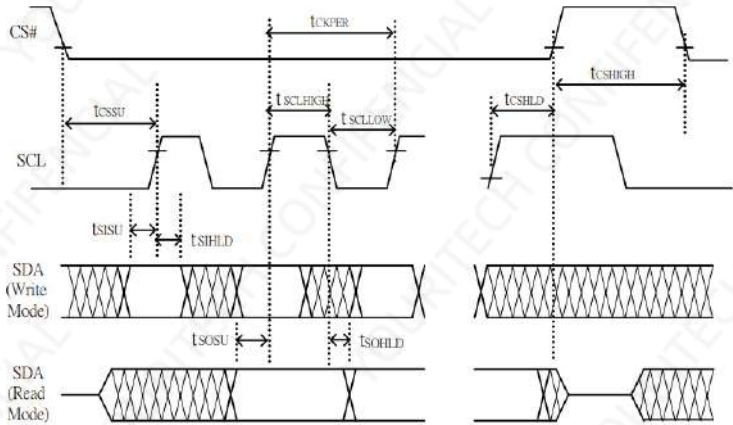
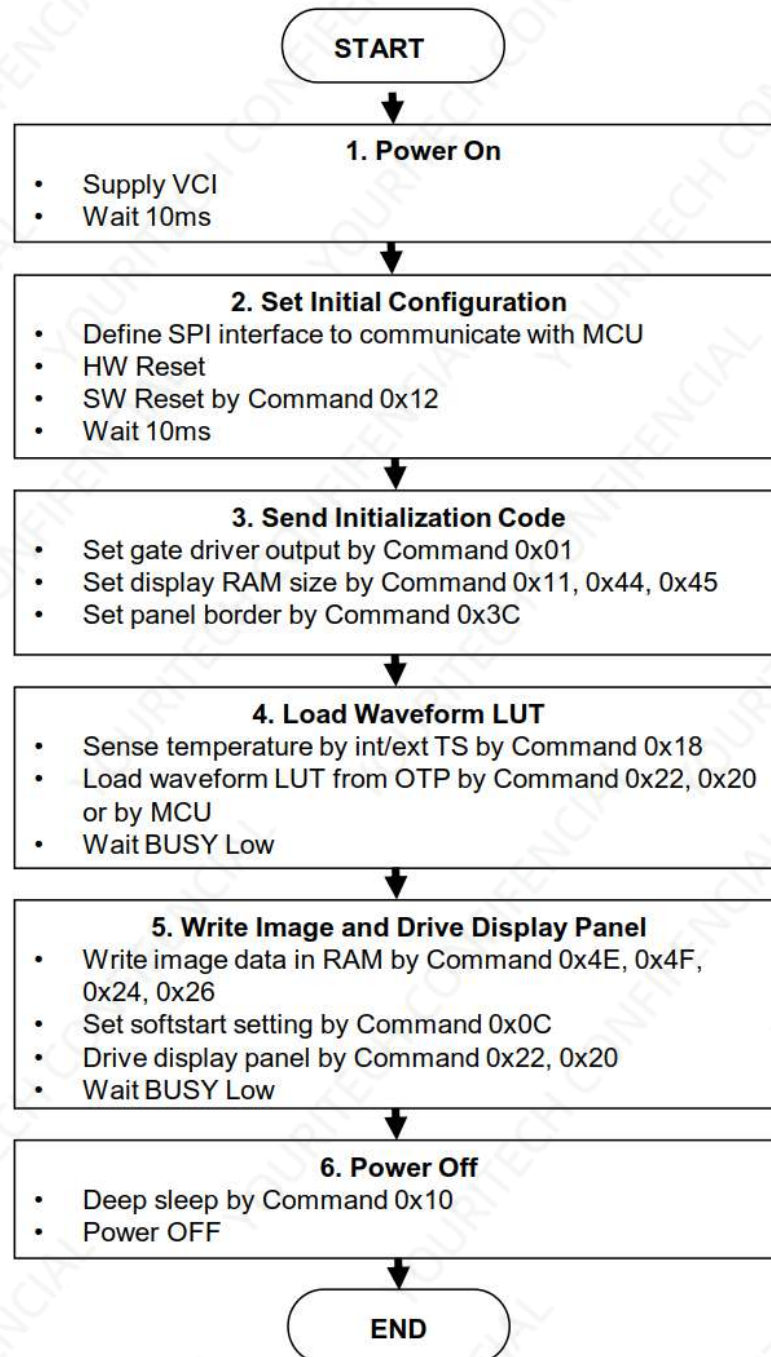


Figure 7-5: SPI timing diagram

8.Operation Flow and Code Sequence

8-1. General operation flow to drive display panel



9. Optical Specifications

9.1. Specifications

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

Symbol	Parameter	Conditions	Min	Typ.	Max	Units	Notes
R	White Reflectivity	White	30	35	-	%	9-1
CR	Contrast Ratio	Indoor	8:1		-		9-2
GN	2Grey Level	-		$DS+(WS-DS)*n(m-1)$			9-3
T update	Image update time	at 25 °C		3	-	sec	
Life		Topr		1000000times or 5years			

Notes:

9-1. Luminance meter: Eye-One Pro Spectrophotometer.

9-2. CR=Surface Reflectance with all white pixel/Surface Reflectance with all black pixels.

9-3. WS: White state, DS: Dark state

10. Handling, Safety and Environment Requirements

WARNING
The display glass may break when it is dropped or bumped on a hard surface. Handle with care. Should the display break, do not touch the electrophoretic material. In case of contact with electrophoretic material, wash with water and soap.

CAUTION
The display module should not be exposed to harmful gases, such as acid and alkali gases, which corrode electronic components. Disassembling the display module can cause permanent damage and invalidate the warranty agreements.

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.

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

11. Reliability test

	TEST	CONDITION	METHOD	REMARK
1	High-Temperature Operation	T = 50°C, RH=35% for 240 hrs	When the experimental cycle finished, the EPD samples will be taken out from the high temperature environmental chamber and set aside for a few minutes. As EPDs return to room temperature, testers will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-2Bp.	When experiment finished, the EPD must meet electrical performance standards.
2	Low-Temperature Operation	T = 0°C for 240 hrs	When the experimental cycle finished, the EPD samples will be taken out from the low temperature environmental chamber and set aside for a few minutes. As EPDs return room temperature, testers will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-2Ab.	When experiment finished, the EPD must meet electrical performance standards.
3	High-Temperature Storage	T = +70°C, RH=35% for 240 hrs Test in white pattern	When the experimental cycle finished, the EPD samples will be taken out from the high temperature environmental chamber and set aside for a few minutes. As EPDs return to room temperature, testers will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-2Bp.	When experiment finished, the EPD must meet electrical performance standards.
4	Low-Temperature Storage	T = -25°C for 240 hrs Test in white pattern	When the experimental cycle finished, the EPD samples will be taken out from the low temperature environmental chamber and set aside for a few minutes. As EPDs return to room temperature, testers will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-2Ab	When experiment finished, the EPD must meet electrical performance standards.
5	High Temperature, High-Humidity Operation	T=+40°C, RH=80% for 240 hrs	When the experimental cycle finished, the EPD samples will be taken out from the environmental chamber and set aside for a few minutes. As EPDs return to room temperature, testers will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-3CA.	When experiment finished, the EPD must meet electrical performance standards.
6	High Temperature, High-Humidity Storage	T=+50°C, RH=80% for 240 hrs Test in white pattern	When the experimental cycle finished, the EPD samples will be taken out from the environmental chamber and set aside for a few minutes. As EPDs return to room temperature, testers will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-3CA.	When experiment finished, the EPD must meet electrical performance standards.

7	Temperature Cycle	[-25℃ 30mins] →[Temperature rise 30mins] [+70℃, RH=35% 30mins] →[Temperature drop 30mins], 1cycle=2hrs, 50 cycles Test in white pattern	1. Samples are put in the Temp & Humid. Environmental Chamber. Temperature cycle starts with -25℃, storage period 30 minutes. After 30 minutes, it needs 30min to let temperature rise to 60℃. After 30min, temperature will be adjusted to 60℃, RH=35% and storage period is 30 minutes. After 30 minutes, it needs 30min to let temperature rise to -25℃. One temperature cycle (2hrs) is complete. 2. Temperature cycle repeats 50 times. 3. When 50 cycles finished, the samples will be taken out from experiment chamber and set aside a few minutes. As EPDs return to room temperature, tests will observe the appearance, and test electrical and optical performance based on standard# IEC 60 068-2-14NB.	When experiment finished, the EPD must meet electrical performance standards.
8	UV exposure Resistance	765 W/m ² for 168 hrs, 40℃	Standard# IEC 60 068-2-5 Sa	
9	Electrostatic discharge	Machine Model: +/-250V, 0Ω, 200PF	Standard# IEC61000-4-2	
10	Package Vibration	1.04G, Frequency: 10~500Hz Direction: X, Y, Z Duration: 1hours in each direction	Full packed for shipment	
11	Package Drop Impact	Drop from height of 122 cm on Concrete surface Drop sequence: 1 corner, 3 edges, 6face One drop for each.	Full packed for shipment	

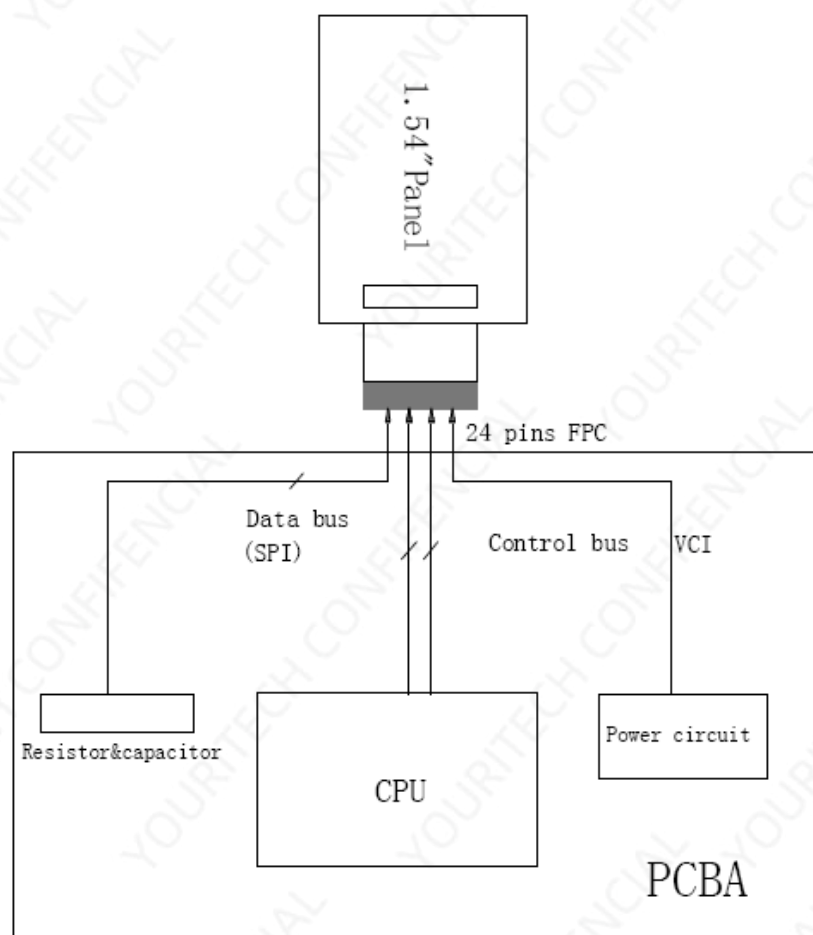
Actual EMC level to be measured on customer application.

Note: (1) The protective film must be removed before temperature test.

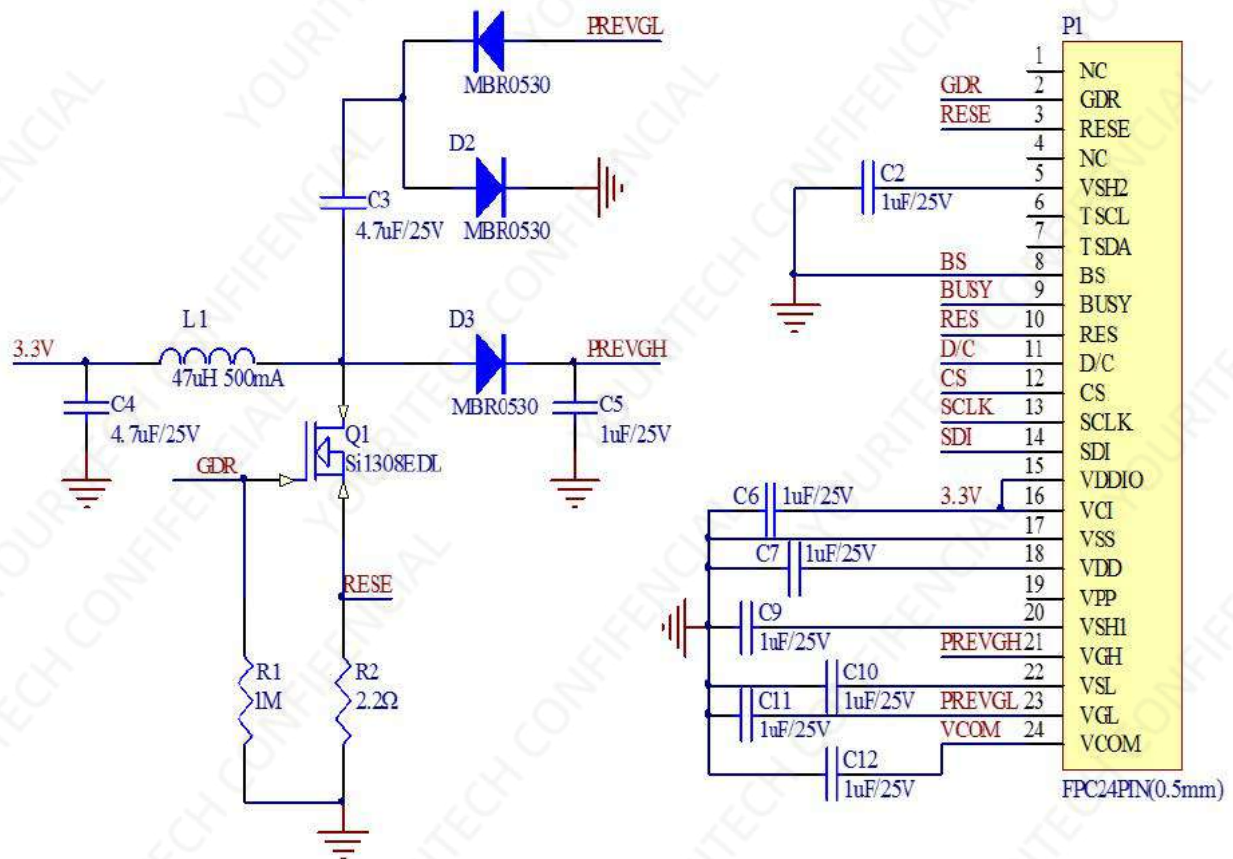
(2) There's temperature vs display quality limitation in our display module, we guarantee 1 pixel display quality from 5℃ ~ 30℃, and 2 pixel display quality for 0℃ ~ 5℃ & 30℃ ~ 40℃.

(3) In order to make sure the display module can provide the best display quality, the update should be made after putting the display module in stable temperature environment for 4 hours at 25℃.

12. Block Diagram



13. Reference Circuit



Part Name	Requirements for spare part
C1—C12	0603/0805; X5R/X7R; Voltage Rating: $\geq 25V$
R1、R2	0603/0805; 1% variation, $\geq 0.05W$
D1—D3	MBR0530: 1) Reverse DC Voltage $\geq 30V$ 2) $I_o \geq 500mA$ 3) Forward voltage $\leq 430mV$
Q1	Si1308EDL: 1) Drain-Source breakdown voltage $\geq 30V$ 2) $V_{gs(th)} \leq 1.5V$ 3) $R_{ds(on)} \leq 400m\Omega$
L1	refer to NR3015: $I_o = 500mA(max)$
P1	24pins, 0.5mm pitch

14. Matched Development Kit

Our Development Kit designed for SPI E-paper Display aims to help users to learn how to use E-paper Display more easily. It can refresh black-white E-paper Display and three-color (black, white and red/Yellow) YOUR ITECH `s E-paper Display. And it is also added the functions of USB serial port, Raspberry Pi and LED indicator light ect. DESPI Development Kit consists of the development board and the pinboard.

15. Point and line standard

Shipment Inseption Standard

Part-A: Active area

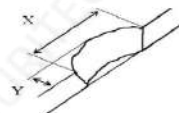
Part-B: Border area

Equipment: Electrical test fixture, Point gauge

Outline dimension:

31.8(H) × 37.32(V) × 0.98(D)

Unit: mm

Environment	Temperature	Humidity	Illuminance	Distance	Time	Angle
	23 ± 2°C	55 ± 5%RH	1200 ~ 1500Lux	300 mm	35 Sec	
Name	Causes	Spot size			Part-A	Part-B
Spot	B/W spot in glass or protection sheet, foreign mat. Pin hole	D ≤ 0.15mm			Ignore	Ignore
		0.15mm < D ≤ 0.25mm			2	
		0.25mm < D			0	
Scratch or line defect	Scratch on glass or Scratch on FPL or Particle is Protection sheet.	Length	Width		Part-A	Ignore
		L ≤ 1.0mm	W ≤ 0.1 mm		Ignore	
		1.0 mm < L ≤ 2.5mm	0.1 mm < W ≤ 0.2mm		2	
		2.5 mm < L	0.2mm < W		0	
Air bubble	Air bubble	D1, D2 ≤ 0.15 mm			Ignore	Ignore
		0.15 mm < D1,D2 ≤ 0.2mm			2	
		0.2mm < D1, D2			0	
Side Fragment						
	X ≤ 3mm, Y ≤ 0.5mm & display is ok, Ignore					

Remarks: Spot define: That only can be seen under WS or DS defects.

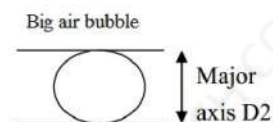
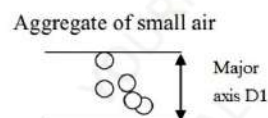
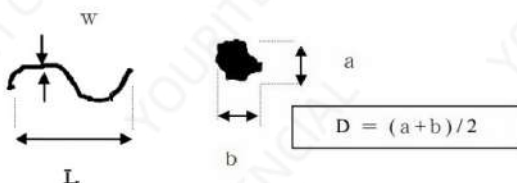
Any defect which is visible under gray pattern or transition process but invisible under black and white is disregarded.

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

Spot: $W > 1/4L$ Scratch or line defect: $W \leq 1/4L$

Definition for L/W and D (major axis)

FPC bonding area pad doesn't allowed visual inspection.



Note: AQL = 0.4

16. 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) 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.