11.6 inch
E-paper Display Series

GooDisplay®

GDEH116T91

Dalian Good Display Co., Ltd.

Product Specifications

Customer	**Standard**
Description	**11.6” E-PAPER DISPLAY**
Model Name	**GDEH116T91**
Date	**2021/01/19**
Revision	**3.2**

	Design Engineering		
	Approval	**Check**	**Design**
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Version	Content	Date	Producer
1.0	New release	2018/5/2	
2.0	Increasing the Brand of components	2018/12/7	
3.0	Update the reliabilitytest conditions	2019/6/10	
3.1	Updating	2020/5/28	
3.2	Updating	2021/01/19	

1. General Description

1.1 Overview

GDEH116T91 is an Active Matrix Electrophoretic Display (AMEPD), with interface and a reference system design. The 11.6" active area contains 960×640 pixels, and has 1-bit B/W 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.

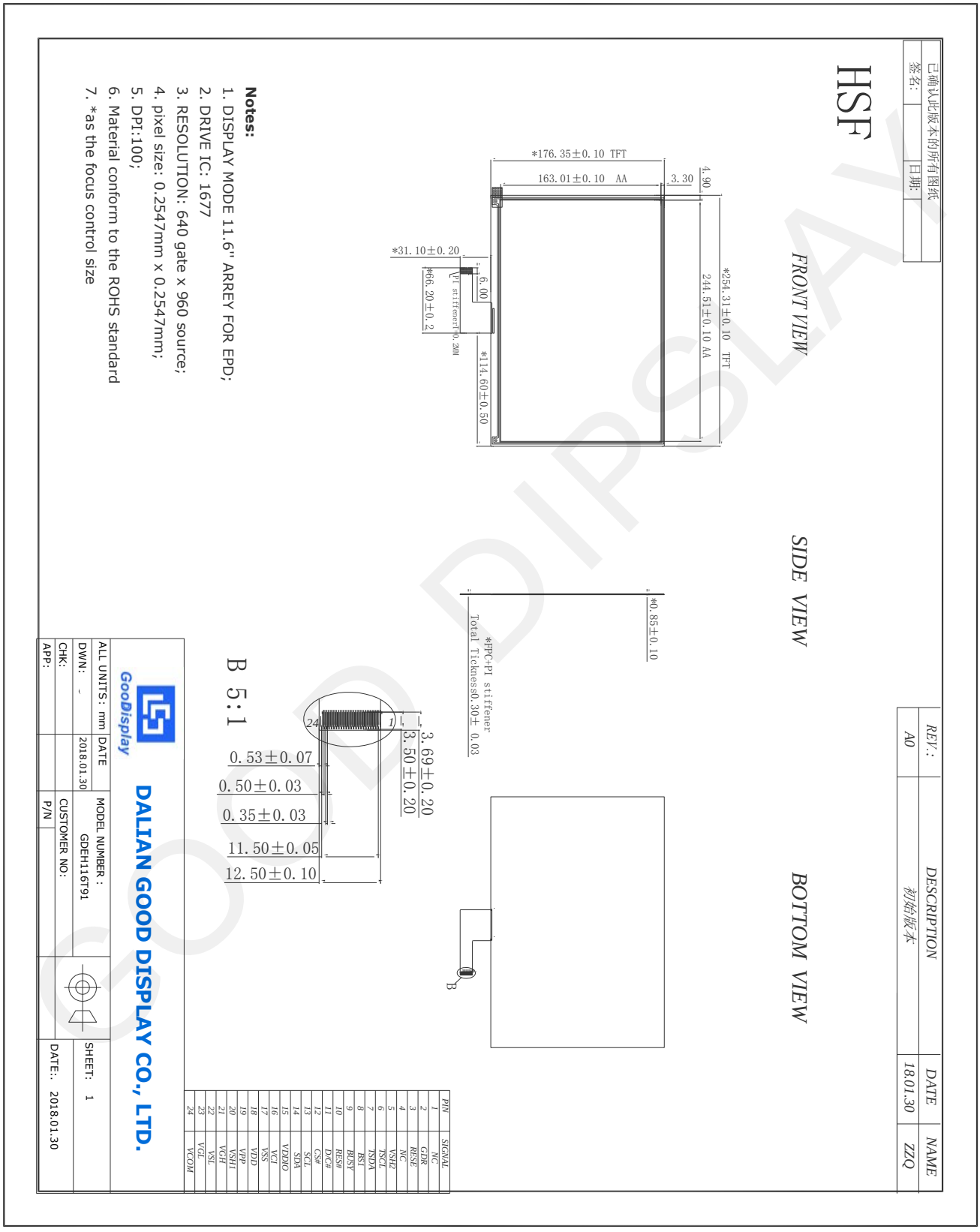
1.2 Features

- 640×960 pixels display
- High contrast
- High reflectance
- Ultra wide viewing angle
- Ultra low power consumption
- Pure reflective mode
- Bi-stable display
- Commercial temperature range
- Landscape, portrait modes
- Hard-coat antiglare display surface
- Ultra Low current deep sleep mode
- On chip display RAM
- Low voltage detect for supply voltage
- High voltage ready detect for driving voltage
- Internal temperature sensor
- Waveform stored in On-chip OTP
- Serial peripheral interface available
- On-chip oscillator
- On-chip booster and regulator control for generating VCOM, Gate and Source driving voltage
- I2C signal master interface to read external temperature sensor/built-in temperature sensor

1.3 Mechanical Specifications

Parameter	Specifications	Unit	Remark
Screen Size	11.6	Inch	
Display Resolution	960(H)×640(V)	Pixel	Dpi:100
Active Area	244.512(H)×163.008(V)	mm	
Pixel Pitch	0.2547×0.2547	mm	
Pixel Configuration	Rectangle		
Outline Dimension	254.31(H)×176.35(V) ×0.85(D)	mm	
Weight	73.0±0.2	g	

1.4 Mechanical Drawing of EPD module



1.5 Input/Output Terminals

Pin #	Single	Description	Remark
1	NC	No connection and do not connect with other NC pins	Keep Open
2	GDR	N-Channel MOSFET Gate Drive Control	
3	RESE	Current Sense Input for the Control Loop	
4	NC	No connection and do not connect with other NC pins e	Keep Open
5	VSH2	Positive Source driving voltage	
6	TSCL	I2C Interface to digital temperature sensor Clock pin	
7	TSDA	I2C Interface to digital temperature sensor Date pin	
8	BS1	Bus selection pin	Note 1.5-5
9	BUSY	Busy state output pin	Note 1.5-4
10	RES #	Reset	Note 1.5-3
11	D/C #	Data /Command control pin	Note 1.5-2
12	CS #	Chip Select input pin	Note 1.5-1
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	Positive Source driving voltage	
21	VGH	Power Supply pin for Positive Gate driving voltage and VSH	
22	VSL	Negative Source driving voltage	
23	VGL	Power Supply pin for Negative Gate driving voltage, VCOM and VSL	
24	VCOM	VCOM driving voltage	

Note 1.5-1: 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 1.5-2: 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.

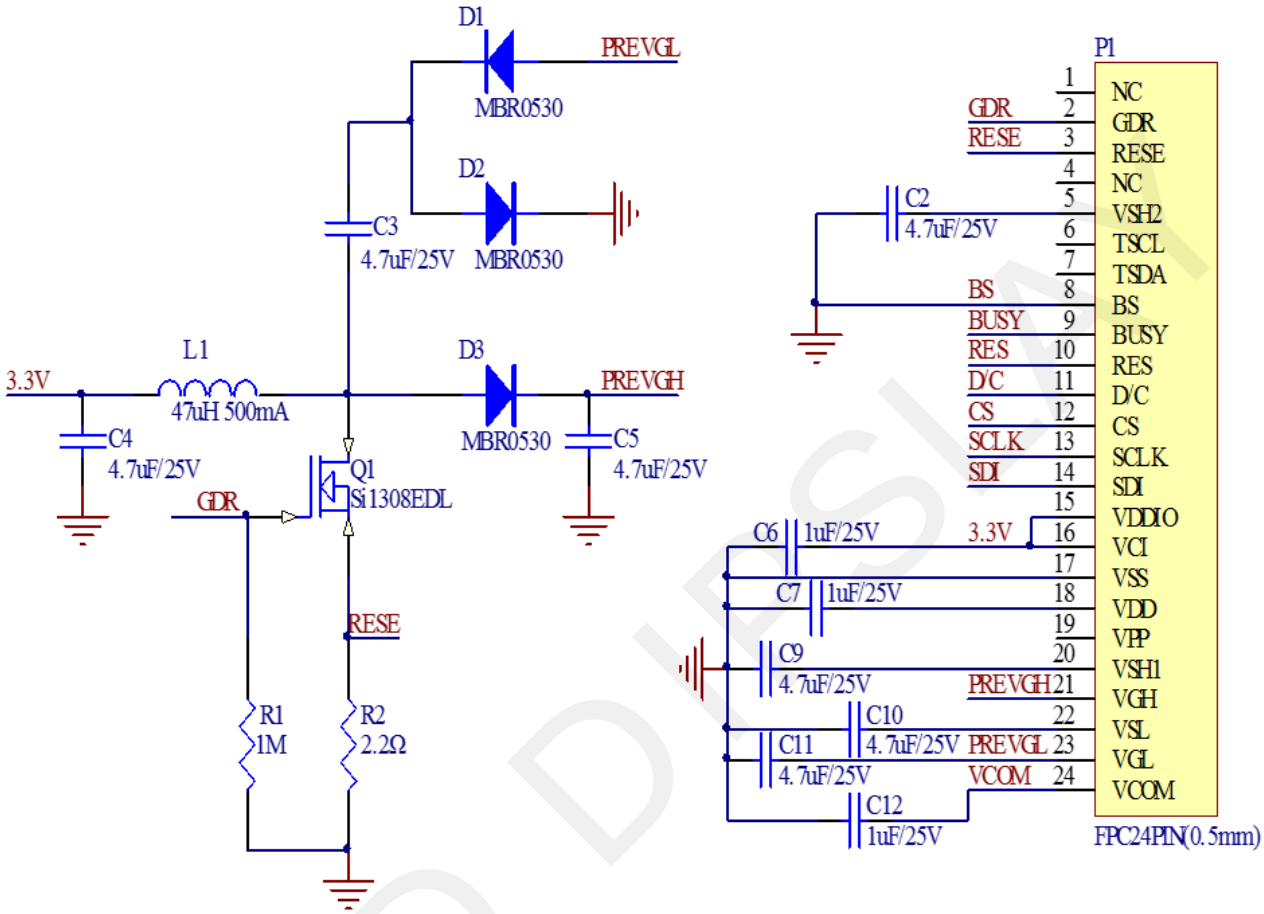
Note 1.5-3: This pin (RES#) is reset signal input. The Reset is active low.

Note 1.5-4: This pin (BUSY) is Busy state output pin. When Busy is High 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 High when the driver IC is working such as:

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

Note 1.5-5: 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.

1.6 Reference Circuit



1.7 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) Good Display '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.

More details about the Development Kit, please click to the following link:

https://www.good-display.com/product/53/

2. Environmental

2.1 HANDLING, SAFETY AND ENVIROMENTAL REQUIREMENTS

WARNING
The display module should be kept flat or fixed to a rigid, curved support with limited bending along the long axis. It should not be used for continual flexing and bending. Handle with care. Should the display break do not touch any material that leaks out. In case of contact with the leaked material then wash with water and soap.

CAUTION
The display module should not be exposed to harmful gases, such as acid and alkali gases, which corrode electronic components.
Disassembling the display module can cause permanent damage and invalidate the warranty agreements.
IPA solvent can only be applied on active area and the back of a glass. For the rest part, it is not allowed.
Observe general precautions that are common to handling delicate electronic components. The glass can break and front surfaces can easily be damaged. Moreover the display is sensitive to static electricity and other rough environmental conditions.

Mounting Precautions
(1) It`s recommended that you consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module.
(2) It`s recommended that you attach a transparent protective plate to the surface in order to protect the EPD. Transparent protective plate should have sufficient strength in order to resist external force.
(3) You should adopt radiation structure to satisfy the temperature specification.
(4) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the PS at high temperature and the latter causes circuit break by electro-chemical reaction.
(5) Do not touch, push or rub the exposed PS with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of PS for bare hand or greasy cloth. (Some cosmetics deteriorate the PS)
(6) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach the PS. Do not use acetone, toluene and alcohol because they cause chemical damage to the PS.
(7) Wipe off saliva or water drops as soon as possible. Their long time contact with PS causes deformations and color fading.

Data sheet status	
Product specification	The data sheet contains final product specifications.

Limiting values
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.
Application information
Where application information is given, it is advisory and dose not form part of the specification.

Product Environmental certification
ROHS
REMARK
All The specifications listed in this document are guaranteed for module only. Post-assembled operation or component(s) may impact module performance or cause unexpected effect or damage and therefore listed specifications is not warranted after any Post-assembled operation.

2.2 Reliability test

	TEST	CONDITION	METHOD	REMARK
1	High-Temperature Operation	T=50℃，RH=30%RH，For 240Hr	IEC 60 068-2-2Bb	
2	Low-Temperature Operation	T = 0℃ for 240 hrs	IEC 60 068-2-2Ab	
3	High-Temperature Storage	T=70℃ RH=40%RH For 240Hr Test in white pattern	IEC 60 068-2-2Bb	
4	Low-Temperature Storage	T = -25℃ for 240 hrs Test in white pattern	IEC 60 068-2-2Ab	
5	High Temperature, High-Humidity Operation	T=40℃，RH=90%RH， For 168Hr	IEC 60 068-2-3CA	
6	High Temperature, High-Humidity Storage	T=60℃，RH=80%RH，For 240Hr Test in white pattern	IEC 60 068-2-3CA	
7	Temperature Cycle	-25℃(30min)~70℃(30min)，100 Cycle Test in white pattern	IEC 60 068-2-14NB	
8	Package Vibration	1.04G,Frequency : 10~500Hz Direction : X,Y,Z Duration:1hours in each direction	Full packed for shipment	
9	Package Drop Impact	Drop from height of 122 cm on Concrete surface Drop sequence:1 corner, 3edges, 6face One drop for each.	Full packed for shipment	
10	UV exposure Resistance	765 W/㎡ for 168hrs,40℃	IEC 60068-2-5 Sa	
11	Electrostatic discharge	Machine model: +/-250V,0Ω,200pF	IEC61000-4-2	

Actual EMC level to be measured on customer application.

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

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

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

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

3. ELECTRICAL CHARACTERISTICS

3.1 ABSOLUTE MAXIMUM RATING

Table 3.1-1: Maximum Ratings

Symbol	Parameter	Rating	Unit
VCI	Logic supply voltage	-0.5 to +6.0	V
TOPR	Operation temperature range	0 to 50	℃
TSTG	Storage temperature range	-25 to 60	℃
-	Humidity range	40~70	%RH

Note: Tstg is the transportation condition，the transport time is within 10 days for -25℃ ~0℃ or 50℃~60℃.

3.2 DC CHARACTERISTICS

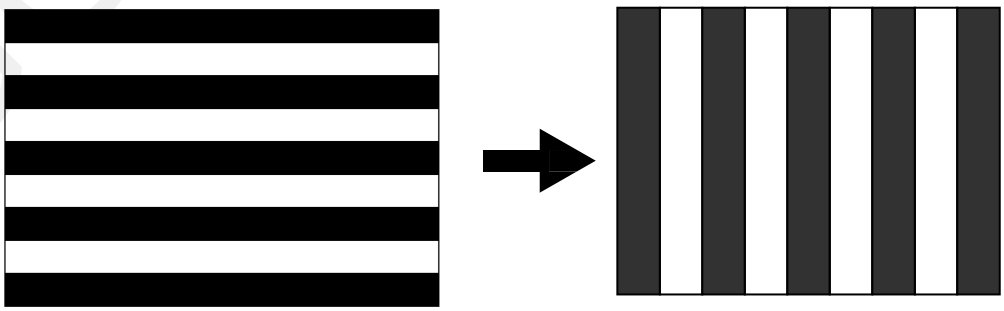
The following specifications apply for: VSS=0V, VCI=3.3V, T_{OPR}=25℃.

Table 3.2-1: DC Characteristics

Symbol	Parameter	Test Condition	Applicable pin	Min.	Typ.		Unit
VCI	VCI operation voltage	-	VCI	2.2	3	3.7	V
VIH	High level input voltage	-	SDA, SCL, CS#, D/C#, RES#, BS1	0.8VDDIO	-	-	V
VIL	Low level input voltage	-		-	-	0.2VDDIO	V
VOH	High level output voltage	IOH = -100uA	BUSY,	0.9VDDIO	-	-	V
VOL	Low level output voltage	IOL = 100uA		-	-	0.1VDDIO	V
Iupdate	Module operating current	-	-	-	10	-	mA
Isleep	Deep sleep mode	VCI=3.3V	-	-		3.5	uA

- The Typical power consumption is measured using associated 25℃ waveform with following pattern transition: from horizontal scan pattern to vertical scan pattern. (Note 3.2-1)
- The listed electrical/optical characteristics are only guaranteed under the controller & waveform provided by Good Display.
- Vcom value will be OTP before in factory or present on the label sticker.

Note 3.2-1
The Typical power consumption



3.3 Serial Peripheral Interface Timing

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

Write mode

Symbol	Parameter	Min	Typ	Max	Unit
fSCL	SCL frequency (Write Mode)			20	MHz
tCSSU	Time CSB has to be low before the first rising edge of SCLK	20			ns
tCSHLD	Time CSB has to remain low after the last falling edge of SCLK	20			ns
tCSHIGH	Time CSB 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 CSB has to be low before the first rising edge of SCLK	100			ns
tCSHLD	Time CSB has to remain low after the last falling edge of SCLK	50			ns
tCSHIGH	Time CSB 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

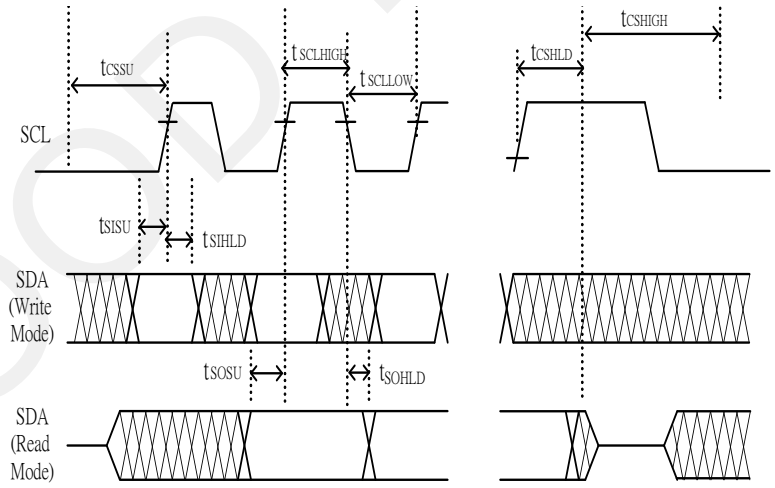


Figure 3.3-1: Serial peripheral interface characteristics

3.4 Power Consumption

Parameter	Symbol	Conditions	TYP	Max	Unit	Remark
Panel power consumption during update	-	25℃		50	mAs	-
Deep sleep mode	-	25℃		3.5	uA	-

Mas=update average current × update time

3.5 MCU Interface

3.5.1 MCU interface selection

GDEH116T91 can support 4-wire or 3-wire serial peripheral MCU interface, which is pin selectable by BS1 pin. The interface pin assignment for different MCU interfaces is shown in Table 3.5-1.

Note
(1) L is connected to VSS
(2) H is connected to VDDIO

Table 3.5-1: Interface pin assignment for different MCU interfaces

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

3.5.2 MCU Serial Peripheral Interface (4-wire SPI)

The 4-wire SPI consists of serial clock SCL, serial data input SDI, D/C# and CS#. The control pins status in 4-wire SPI in writing command/data is shown in Table 3.5-2 and the write procedure in 4-wire SPI is shown in Figure 3.5-1.

Table 3.5-2 : Control pins status of 4-wire SPI

Function	SCL pin	SDI 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

(3) SDI 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.

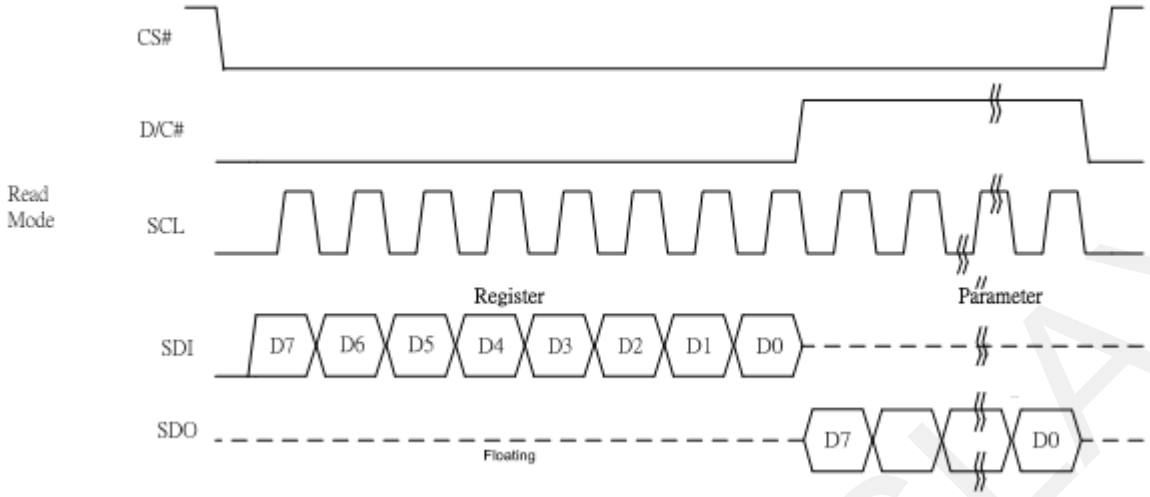


Figure 3.5-1: Read procedure in 4-wire SPI mode

In the read operation, 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 output SDO bit shifting sequence is D7, D6, to D0 bit. Figure 3.5-2 shows the read procedure in 4-wire SPI.

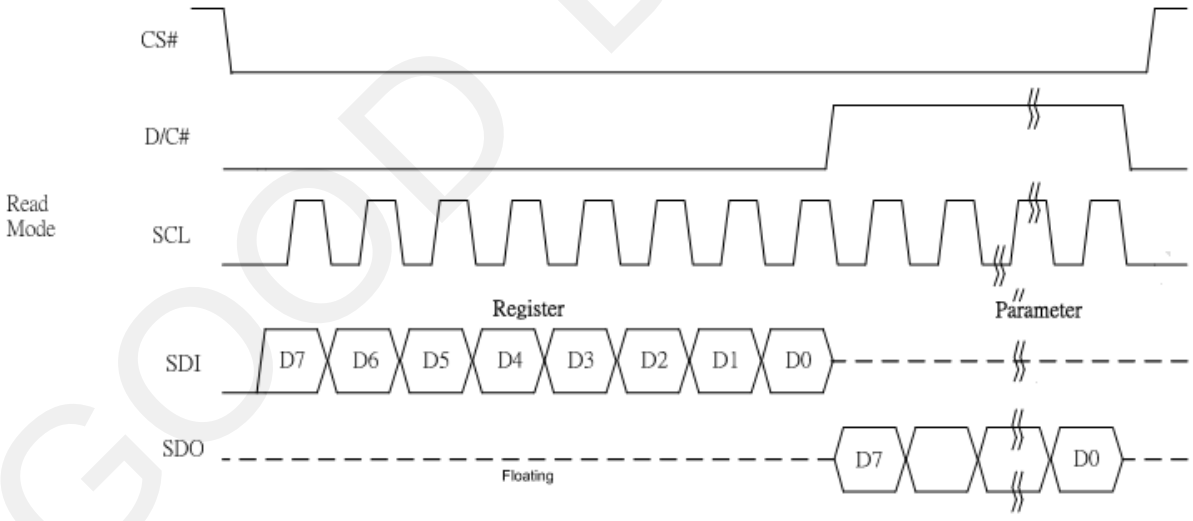


Figure 3.5-2: Read procedure in 4-wire SPI mode

3.5.3 MCU Serial Peripheral Interface (3-wire SPI)

The 3-wire SPI consists of serial clock SCL, serial data input SDI, 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 3.5-3.

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 3.5-3 shows the write procedure in 3-wire SPI

Table 3.5-3 : Control pins status of 3-wire SPI

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

Note:

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

(2) ↑ stands for rising edge of signal

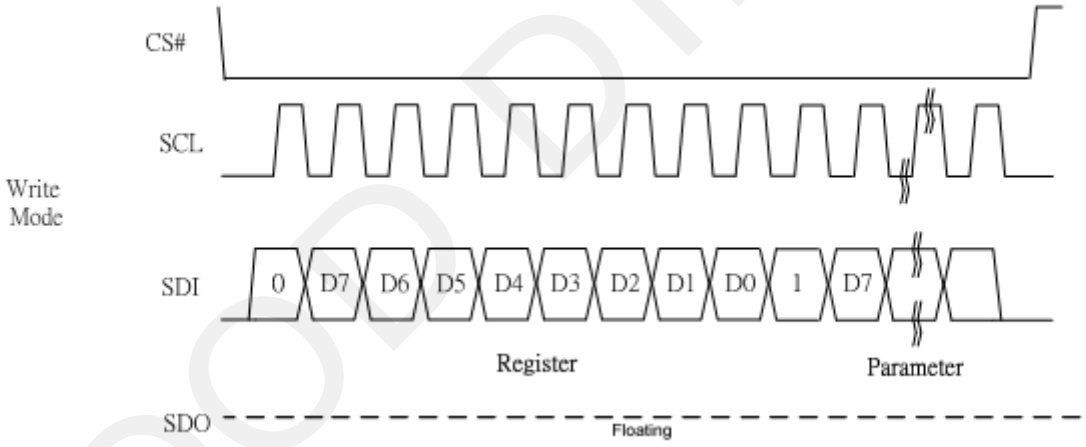


Figure 3.5-3: Write procedure in 3-wire SPI mode

In the read operation, serial 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 output SDO bit shifting sequence is D7, D6, to D0 bit. Figure 3.5-4 shows the read procedure in 3-wire SPI.

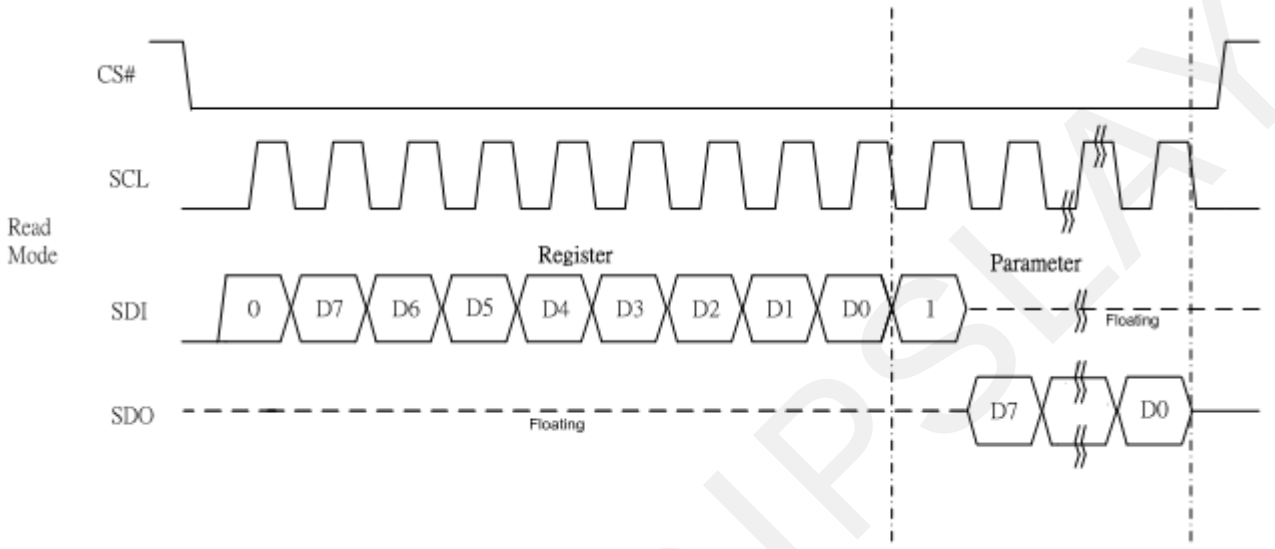
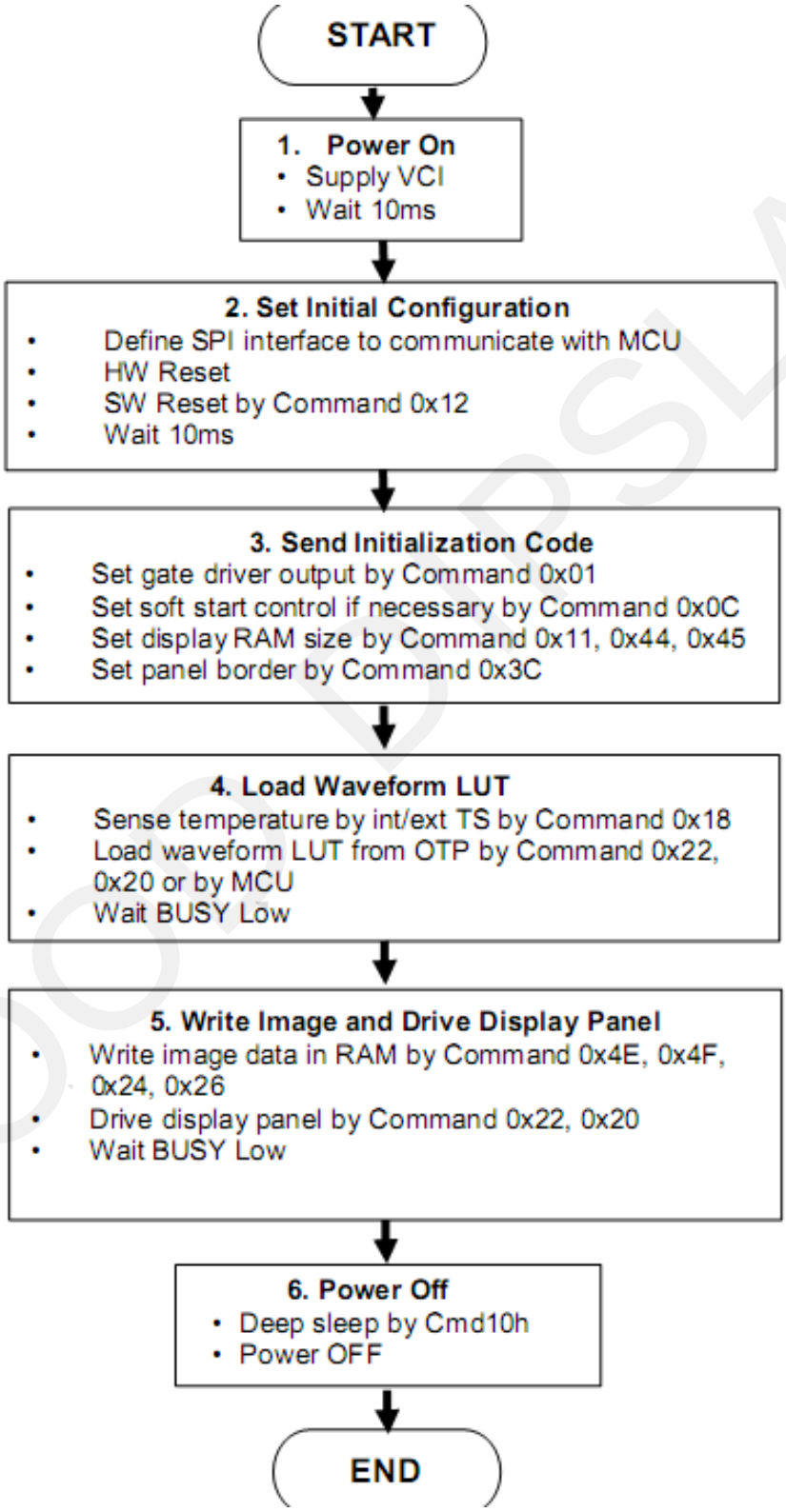


Figure 3.5-4: Read procedure in 3-wire SPI mode

4. Typical Operating Sequence

4.1 Normal Operation Flow



5. COMMAND TABLE

<table>
<tr><td colspan="12">Command Table</td></tr>
<tr><td>R/W#</td><td>D/C#</td><td>Hex</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>Command</td><td>Description</td></tr>
<tr><td>0</td><td>0</td><td>01</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td rowspan="4">Driver Output control</td><td rowspan="4">Gate setting
A[9:0]= 2A7h [POR], 680 MUX
MUX Gate lines setting as (A[9:0] + 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…679 (left and right gate interlaced)
SM=1,
G0, G2, G4 …G678, G1, G3, …G679

B[0]: TB
TB = 0 [POR], scan from G0 to G679
TB = 1, scan from G679 to G0.</td></tr>
<tr><td>0</td><td>1</td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A9</td><td>A8</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td></td><td>0</td><td>0</td><td>0</td><td>B2</td><td>B1</td><td>B0</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>03</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>Gate Driving voltage Control</td><td>Set Gate driving voltage
A[4:0] = 00h [POR]
VGH setting from 12V to 20V
<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>10h</td><td>16.5</td></tr>
<tr><td>07h</td><td>12</td><td>11h</td><td>17</td></tr>
<tr><td>08h</td><td>12.5</td><td>12h</td><td>17.5</td></tr>
<tr><td>09h</td><td>13</td><td>13h</td><td>18</td></tr>
<tr><td>0Ah</td><td>13.5</td><td>14h</td><td>18.5</td></tr>
<tr><td>0Bh</td><td>14</td><td>15h</td><td>19</td></tr>
<tr><td>0Ch</td><td>14.5</td><td>16h</td><td>19.5</td></tr>
<tr><td>0Dh</td><td>15</td><td>17h</td><td>20</td></tr>
<tr><td>0Eh</td><td>15.5</td><td>Other</td><td>NA</td></tr>
<tr><td>0Fh</td><td>16</td><td></td><td></td></tr>
</table></td></tr>
</table>

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
0	1		A7	A6	A5	A4	A3	A2	A1	A2		
0	1		B7	B6	B5	B4	B3	B2	B1	B0		
0	1		C7	C6	C5	C4	C3	C2	C1	C0		

B[7] = 1,
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 -9V to -17V

C[7:0]	VSL
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

Remark:
VSH1> VSH2

<table>
<tr><td colspan="12">Command Table</td></tr>
<tr><td>R/W#</td><td>D/C#</td><td>Hex</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>Command</td><td>Description</td></tr>
<tr><td>0</td><td>0</td><td>0F</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td rowspan="3">Gate scan start position</td><td rowspan="3">Set the scanning start position of the gate driver. The valid range is from 0 to 679.
A[9:0] = 000h [POR]

When TB=0:
SCN [9:0] = A[9:0]
When TB=1:
SCN [9:0] = 679 - A[9:0]</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A9</td><td>A8</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>10</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Deep Sleep mode</td><td rowspan="2">Deep Sleep mode Control:
<table><tr><td>A[1:0] :</td><td>Description</td></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>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</td></tr>
<tr><td>0</td><td>0</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>11</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td rowspan="2">Data Entry mode setting</td><td rowspan="2">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.</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>12</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>1</td><td>0</td><td>SW RESET</td><td>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.</td></tr>
</table>

<table>
<tr><td colspan="12">Command Table</td></tr>
<tr><td>R/W#</td><td>D/C#</td><td>Hex</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>Command</td><td>Description</td></tr>
<tr><td>0</td><td>0</td><td>14</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>HV Ready Detection</td><td>HV ready detection
A[6:0] = 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).</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>15</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td rowspan="2">VCI Detection</td><td rowspan="2">VCI Detection
A[2:0] = 100 [POR] , Detect level at 2.3V
A[2:0] : VCI level Detect
<table><tr><td>A[2:0]</td><td>VCI level</td></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).</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>18</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td rowspan="2">Temperature Sensor Control</td><td rowspan="2">Temperature Sensor Selection
A[7:0] = 48h [POR], external temperatrure sensor
A[7:0] = 80h Internal temperature sensor</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>1A</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td rowspan="3">Temperature Sensor Control (Write to temperature register)</td><td rowspan="3">Write to temperature register.
A[11:0] = 7FFh[POR]</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A11</td><td>A10</td><td>A9</td><td>A8</td><td>A7</td><td>A6</td><td>A5</td><td>A4</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A3</td><td>A2</td><td>A1</td><td>A0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>1B</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td rowspan="3">Temperature Sensor Control (Read from temperature register)</td><td rowspan="3">Read from temperature register.</td></tr>
<tr><td>1</td><td>1</td><td></td><td>A11</td><td>A10</td><td>A9</td><td>A8</td><td>A7</td><td>A6</td><td>A5</td><td>A4</td></tr>
<tr><td>1</td><td>1</td><td></td><td>A3</td><td>A2</td><td>A1</td><td>A0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>

<table>
<tr><td colspan="12">Command Table</td></tr>
<tr><td>R/W#</td><td>D/C#</td><td>Hex</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>Command</td><td>Description</td></tr>
<tr><td>0</td><td>0</td><td>1C</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td rowspan="4">Temperature Sensor Control (Write Command to External temperature sensor)</td><td rowspan="4">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 arameter</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.</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>B7</td><td>B6</td><td>B5</td><td>B4</td><td>B3</td><td>B2</td><td>B1</td><td>B0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>C7</td><td>C6</td><td>C5</td><td>C4</td><td>C3</td><td>C2</td><td>C1</td><td>C0</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>20</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>Master Activation</td><td>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.</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>21</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td rowspan="2">Display Update Control 1</td><td rowspan="2">RAM content option for Display Update
A[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></td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td>0</td><td>0</td><td>22</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td rowspan="2">Display Update Control 2</td><td rowspan="2">Display Update Sequence Option:
Enable the stage for Master Activation
A[7:0]= FFh (POR)
<table><tr><td></td><td>Parameter (in Hex)</td></tr><tr><td>Enable Clock Signal,
Then Enable ANALOG
Then DISPLAY with DISPLAY Mode 1
Then Disable ANALOG
Then Disable OSC</td><td>C7</td></tr><tr><td>Enable Clock Signal,
Then Enable ANALOG
Then DISPLAY with DISPLAY Mode 2
Then Disable ANALOG
Then Disable OSC</td><td>CF</td></tr><tr><td colspan="2"></td></tr><tr><td>Enable Clock Signal,
Then Load LUT with DISPLAY Mode 1</td><td>90</td></tr><tr><td>Enable Clock Signal,
Then Load Temperature value from I2C
Single Master Interface</td><td>B0</td></tr></table></td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
</table>

Then Load LUT with DISPLAY Mode 1	
Enable Clock Signal, Then Load LUT with DISPLAY Mode 2	98
Enable Clock Signal, Then Load Temperature value from I2C Single Master Interface Then Load LUT with DISPLAY Mode 2	B8
Enable Clock Signal, Then Load LUT with DISPLAY Mode 1 To Disable Clock Signal	91
Enable Clock Signal, Then Load Temperature value from I2C Single Master Interface Then Load LUT with DISPLAY Mode 1 To Disable Clock Signal	B1
Enable Clock Signal, Then Load LUT with DISPLAY Mode 2 To Disable Clock Signal	99
Enable Clock Signal, Then Load Temperature value from I2C Single Master Interface Then Load LUT with DISPLAY Mode 2 To Disable Clock Signal	B9
Enable ANALOG Then DISPLAY with DISPLAY Mode 1 Then Disable ANALOG Then Disable OSC	47
Enable ANALOG Then DISPLAY with DISPLAY Mode 2 Then Disable ANALOG Then Disable OSC	4F
To Enable Clock Signal (CLKEN=1)	80
To Enable Clock Signal, then Enable ANALOG (CLKEN=1, ANALOGEN=1)	C0
Enable ANALOG Then DISPLAY with DISPLAY Mode 1	44
Enable ANALOG Then DISPLAY with DISPLAY Mode 2	4C
To DISPLAY with DISPLAY Mode 1	04
To DISPLAY with DISPLAY Mode 2	0C
To Disable ANALOG, then Disable Clock Signal (CLKEN=0, ANALOGEN=0)	03
o Disable Clock Signal (CLKEN=0)	01

Command Table												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	24	0	0	1	0	0	1	0	0	Write RAM (BW)	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
0	0	26	0	0	1	0	0	1	1	0	Write RAM (RED)	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 RAM(BW) / RAM(RED)], 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[6]=1, Normal Mode A[6]=0, Reserve A[3:0] = 09h, duration = 10s. VCOM sense duration = Setting + 1 Seconds
0	1		0	A6	0	0	A3	A2	A1	A0		
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.

Command Table

R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
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	1	0	0		
0	1		0	1	1	0	0	0	1	1		
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		A7	A6	A5	A4	A3	A2	A1	A0		
0	0	2D	0	0	1	0	1	1	0	1	OTP Register Read forDisplay 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 G) [5 bytes] H[7:0]~K[7:0]: Waveform Version (Command 0x37, Byte H to Byte K) [4 bytes]
1	1		A7	A6	A5	A4	A3	A2	A1	A0		
1	1		B7	B6	B5	B4	B3	B2	B1	B0		
1	1		C7	C6	C5	C4	C3	C2	C1	C0		
1	1		D7	D6	D5	D4	D3	D2	D1	D0		
1	1		E7	E6	E5	E4	E3	E2	E1	E0		
1	1		F7	F6	F5	F4	F3	F2	F1	F0		
1	1		G7	G6	G5	G4	G3	G2	G1	G0		
1	1		H7	H6	H5	H4	H3	H2	H1	H0		
1	1		I7	I6	I5	I4	I3	I2	I1	I0		
1	1		J7	J6	J5	J4	J3	J2	J1	J0		
1	1		K7	K6	K5	K4	K3	K2	K1	K0		

A[7:0]	VCOM	A[7:0]	VCOM
08h	-0.2	58h	-2.2
0Ch	-0.3	5Ch	-2.3
10h	-0.4	60h	-2.4
14h	-0.5	64h	-2.5
18h	-0.6	68h	-2.6
1Ch	-0.7	6Ch	-2.7
20h	-0.8	70h	-2.8
24h	-0.9	74h	-2.9
28h	-1	78h	-3
2Ch	-1.1	7Ch	-3.1
30h	-1.2	80h	-3.2
34h	-1.3	84	-3.3
38h	-1.4	88	-3.4
3Ch	-1.5	8C	-3.5
40h	-1.6	90	-3.6
44h	-1.7	94	-3.7
48h	-1.8	98	-3.8
4Ch	-1.9	9C	-3.9
50h	-2	A0	-4
54h	-2.1		

Command Table												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
0	0	34	0	0	1	1	0	1	0	0	CRC calculation	CRC calculation command for OTP content validation. 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 readout Value
1	1		A15	A14	A13	A12	A11	A10	A9	A8		
1	1		A7	A6	A5	A4	A3	A2	A1	A0		
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 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 Mode2 F[6]: PingPong for Display Mode 2 F[7]: PingPong for Display Mode 1 1: Ping-Pong 0: Default G[7:0]~J[7:0] module ID /waveform version. Remarks: A[7:0]~J[7:0] can be stored in OTP
0	1		0	0	0	0	0	0	0	0		
0	1		B7	B6	B5	B4	B3	B2	B1	B0		
0	1		C7	C6	C5	C4	C3	C2	C1	C0		
0	1		D7	D6	D5	D4	D3	D2	D1	D0		
0	1		E7	E6	E5	E4	E3	E2	E1	E0		
0	1		F7	F6	F5	F4	F3	F2	F1	F0		
0	1		G7	G6	G5	G4	G3	G2	G1	G0		
0	1		H7	H6	H5	H4	H3	H2	H1	H0		
0	1		I7	I6	I5	I4	I3	I2	I1	I0		
0	1		J7	J6	J5	J4	J3	J2	J1	J0		
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	A7	A6	A5	A4	A3	A2	A1	A0	A7		
0	1	B7	B6	B5	B4	B3	B2	B1	B0	B7		
0	1	C7	C6	C5	C4	C3	C2	C1	C0	C7		
0	1	D7	D6	D5	D4	D3	D2	D1	D0	D7		
0	1	E7	E6	E5	E4	E3	E2	E1	E0	E7		
0	1	F7	F6	F5	F4	F3	F2	F1	F0	F7		
0	1	G7	G6	G5	G4	G3	G2	G1	G0	G7		
0	1	H7	H6	H5	H4	H3	H2	H1	H0	H7		
0	1	I7	I6	I5	I4	I3	I2	I1	I0	I7		
0	1	J7	J6	J5	J4	J3	J2	J1	J0	J7		

<table>
<tr><td colspan="12">Command Table</td></tr>
<tr><td>R/W#</td><td>D/C#</td><td>Hex</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>Command</td><td>Description</td></tr>
<tr><td>0</td><td>0</td><td>39</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td rowspan="2">OTP program mode</td><td rowspan="2">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</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>3A</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>0</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>3B</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td>Reserved</td><td>Reserved</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>3C</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td rowspan="2">Border Waveform Control</td><td rowspan="2">Select border waveform for VBD
A[7:0] = C0h [POR], set VBD as HIZ.
A [7:6] :Select VBD option
<table>
<tr><td>A[7:6]</td><td>Select VBD as</td></tr>
<tr><td>00</td><td>GS Transition,
Defined in A[1:0]</td></tr>
<tr><td>01</td><td>Fix Level,
Defined in A[5:4]</td></tr>
<tr><td>10</td><td>VCOM</td></tr>
<tr><td>11[POR]</td><td>HiZ</td></tr>
</table>
A [5:4] Fix Level Setting for VBD
<table>
<tr><td>A[5:4]</td><td>VBD level</td></tr>
<tr><td>00[POR]</td><td>VSS</td></tr>
<tr><td>01</td><td>VSH1</td></tr>
<tr><td>10</td><td>VSL</td></tr>
<tr><td>11</td><td>VSH2</td></tr>
</table>
A [1:0] GS Transition setting for VBD
<table>
<tr><td>A[1:0]</td><td>VBD Transition</td></tr>
<tr><td>00[POR]</td><td>LUT0</td></tr>
<tr><td>01</td><td>LUT1</td></tr>
<tr><td>10</td><td>LUT2</td></tr>
<tr><td>11</td><td>LUT3</td></tr>
</table></td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>41</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td rowspan="2">Read RAM Option</td><td rowspan="2">Read RAM Option
A[0]= 0 [POR]
0: Read RAM corresponding to 24h
1: Read RAM corresponding to 26h</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>A0</td></tr>
<tr><td colspan="13"></td></tr>
<tr><td>0</td><td>0</td><td>44</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td rowspan="5">Set RAM X - address Start / End position</td><td rowspan="5">Specify the start/end positions of the window address in the X direction by an address unit for RAM
A[9:0]: XSA[9:0], XStart, POR = 000h
B[5:0]: XEA[9:0], XEnd, POR = 3BFh</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>A9</td><td>A8</td></tr>
<tr><td>0</td><td>1</td><td></td><td>0</td><td>0</td><td>B5</td><td>B4</td><td>B3</td><td>B2</td><td>B1</td><td>B0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>B9</td><td>B8</td></tr>
</table>

<table>
<tr><td colspan="12">Command Table</td></tr>
<tr><td>R/W#</td><td>D/C#</td><td>Hex</td><td>D7</td><td>D6</td><td>D5</td><td>D4</td><td>D3</td><td>D2</td><td>D1</td><td>D0</td><td>Command</td><td>Description</td></tr>
<tr><td>0</td><td>0</td><td>45</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td><td rowspan="5">Set RAM Y-address
Start / End position</td><td rowspan="5">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 = 2A7h</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>A9</td><td>A8</td></tr>
<tr><td>0</td><td>1</td><td></td><td>B7</td><td>B6</td><td>B5</td><td>B4</td><td>B3</td><td>B2</td><td>B1</td><td>B0</td></tr>
<tr><td>0</td><td>1</td><td></td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>-</td><td>B9</td><td>B8</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>46</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td rowspan="2">Auto Write RED RAM
for Regular Pattern</td><td rowspan="2">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
<table><tr><td>A[6:4]</td><td>Height</td><td>A[6:4]</td><td>Height</td></tr><tr><td>000</td><td>8</td><td>100</td><td>128</td></tr><tr><td>001</td><td>16</td><td>101</td><td>256</td></tr><tr><td>010</td><td>32</td><td>110</td><td>512</td></tr><tr><td>011</td><td>64</td><td>111</td><td>960</td></tr></table>A[2:0]: Step Width, POR= 000
Step of alter RAM in X-direction according to Source
<table><tr><td>A[2:0]</td><td>Width</td><td>A[2:0]</td><td>Width</td></tr><tr><td>000</td><td>8</td><td>100</td><td>128</td></tr><tr><td>001</td><td>16</td><td>101</td><td>256</td></tr><tr><td>010</td><td>32</td><td>110</td><td>512</td></tr><tr><td>011</td><td>64</td><td>111</td><td>680</td></tr></table>BUSY pad will output high during operation.</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
<tr><td colspan="12"></td></tr>
<tr><td>0</td><td>0</td><td>47</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td rowspan="2">Auto Write B/W RAM for
Regular Pattern</td><td rowspan="2">Auto Write B/W RAM for Regular Pattern
A[7:0] = 00h [POR]
Auto Write B/W RAM for Regular Pattern
A[7:0] = 00h [POR]
<table><tr><td>A[6:4]</td><td>Height</td><td>A[6:4]</td><td>Height</td></tr><tr><td>000</td><td>8</td><td>100</td><td>128</td></tr><tr><td>001</td><td>16</td><td>101</td><td>256</td></tr><tr><td>010</td><td>32</td><td>110</td><td>512</td></tr><tr><td>011</td><td>64</td><td>111</td><td>960</td></tr></table>A[2:0]: Step Width, POR= 000
Step of alter RAM in X-direction according to Source
<table><tr><td>A[2:0]</td><td>Width</td><td>A[2:0]</td><td>Width</td></tr><tr><td>000</td><td>8</td><td>100</td><td>128</td></tr><tr><td>001</td><td>16</td><td>101</td><td>256</td></tr><tr><td>010</td><td>32</td><td>110</td><td>512</td></tr><tr><td>011</td><td>64</td><td>111</td><td>680</td></tr></table>uring operation, BUSY pad will output high.</td></tr>
<tr><td>0</td><td>1</td><td></td><td>A7</td><td>A6</td><td>A5</td><td>A4</td><td>A3</td><td>A2</td><td>A1</td><td>A0</td></tr>
</table>

Command Table												
R/W#	D/C#	Hex	D7	D6	D5	D4	D3	D2	D1	D0	Command	Description
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[9:0]: 000h [POR].
0	1		A7	A6	A5	A4	A3	A2	A1	A0		
0	1		0	0	0	0	0	0	A9	A8		
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[9:0]: 000h [POR].
0	1		A7	A6	A5	A4	A3	A2	A1	A0		
0	1		0	0	0	0	0	0	A9	A8		
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.

6. Temperature sensor operation

Following is the way of how to sense the ambient temperature of the module. First, use an external temperature sensor to get the temperature value and converted it into HEX format with below mapping table, then send command 0x1A with the HEX temperature value to the module thru the SPI interface.

The temperature value is defined by 12-bit binary. The rules are shown as below.

1. If the Temperature value MSByte bit D11 = 0, then
The temperature is positive and value (DegC) = + (Temperature value) / 16

2. If the Temperature value MSByte bit D11 = 1, then
The temperature is negative and value (DegC) = ~ (2's complement of Temperature value) / 16

12-bit binary (2's complement)	Hexadecimal Value	TR Value [DegC]
0111 1111 1111	7FF	128
0111 1111 1111	7FF	127.9
0110 0100 0000	640	100
0101 0000 0000	500	80
0100 1011 0000	4B0	75
0011 0010 0000	320	50
0001 1001 0000	190	25
0000 0000 0100	4	0.25
0000 0000 0000	0	0
1111 1111 1100	FFC	-0.25
1110 0111 0000	E70	-25
1100 1001 0000	C90	-55

7. Optical characteristics

7.1 Specifications

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

T=25℃

SYMBOL	PARAMETER	CONDITIONS	MIN	TYPE	MAX	UNIT	Note
R	Reflectance	White	30	35	-	%	Note 7-1
Gn	2Grey Level	-	-	DS+(WS-DS)×n(m-1)	-	L*	-
CR	Contrast Ratio	indoor	-	10	-	-	-
Panel's life	-	0℃～30℃		5years	-	-	Note 7-2

M:2

WS : White state, DS : Dark state

Note 7-1 : Luminance meter : Eye - One Pro Spectrophotometer ;

Note 7-2: We guarantee display quality from 0℃～30℃ generally,If operation ambient temperature from 0～50℃，will Offer special waveform by Good Display.
We don't guarantee 5 years pixels display quality for humidity below 45%RH or above 70%RH;

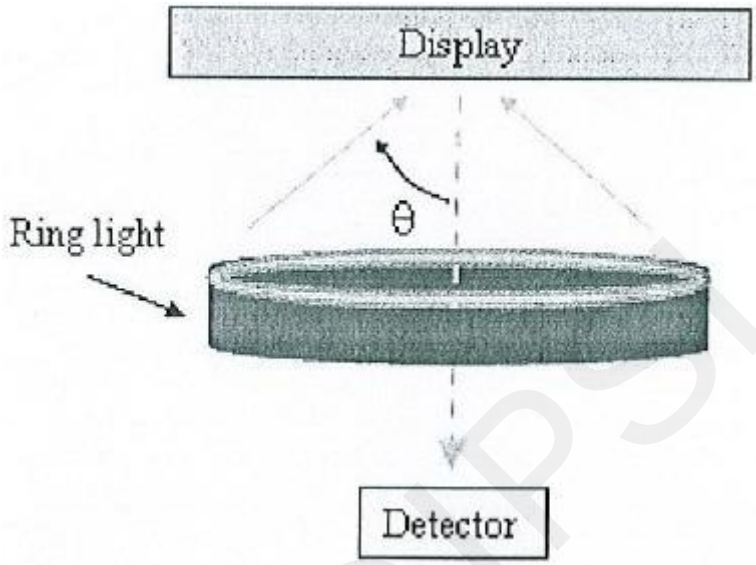
Suggest Updated once a day;

7.2 Definition of contrast ratio

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

R1: white reflectance Rd: dark reflectance

CR = R1/Rd

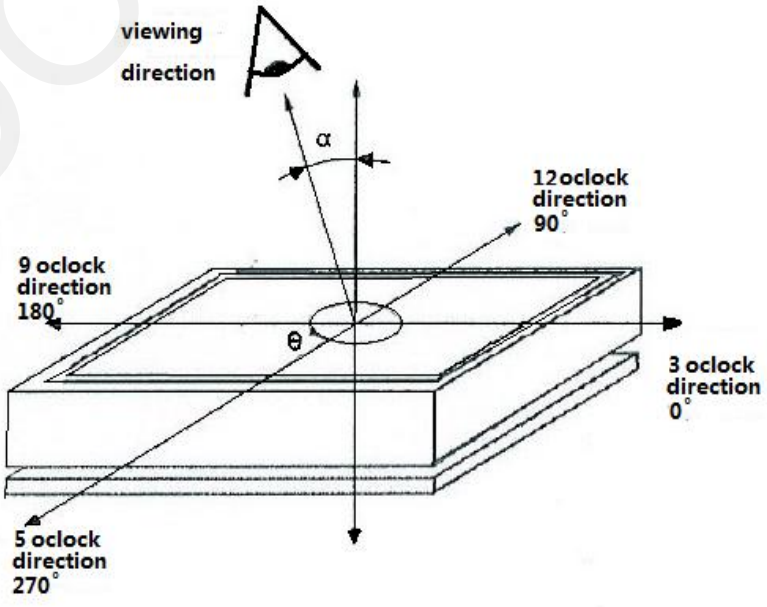


7.3 Reflection Ratio

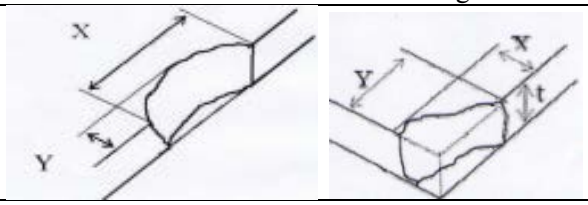
The reflection ratio is expressed as :

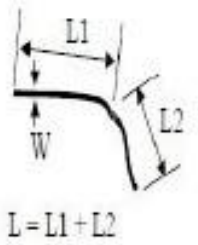
R = Reflectance Factor $_{\text{white board}}$ x (L_{center} / $L_{\text{white board}}$)

L_{center} is the luminance measured at center in a white area (R=G =B=1) . $L_{\text{white board}}$ is the luminance of a standard white board . Both are measured with equivalent illumination source . The viewing angle shall be no more than 2 degrees .

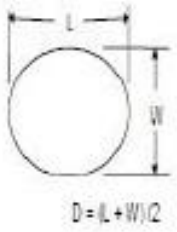


8. Point and line standard

<table>
<tr><th colspan="8">Shipment Inspection Standard</th></tr>
<tr><td colspan="8">Equipment：Electrical test fixture, Point gauge</td></tr>
<tr><td>Outline dimension</td><td>254.31 (H)×176.35(V) ×0.85(D)</td><td>Unit：㎜</td><td>Part-A</td><td>Active area</td><td>Part-B</td><td colspan="2">Border area</td></tr>
<tr><td rowspan="2">Environment</td><td>Temperature</td><td>Humidity</td><td>Illuminance</td><td>Distance</td><td>Time</td><td colspan="2">Angle</td></tr>
<tr><td>19℃～25℃</td><td>55%±5%RH</td><td>800～1300Lux</td><td>300 ㎜</td><td>35Sec</td><td colspan="2"></td></tr>
<tr><td>Defet type</td><td>Inspection method</td><td colspan="3">Standard</td><td colspan="2">Part-A</td><td>Part-B</td></tr>
<tr><td rowspan="4">Spot</td><td rowspan="4">Electric Display</td><td colspan="3">D≤0.4 ㎜</td><td colspan="2">Ignore</td><td>Ignore</td></tr>
<tr><td colspan="3">0.4 ㎜＜D≤0.6 ㎜</td><td colspan="2">N≤4</td><td>Ignore</td></tr>
<tr><td colspan="3">0.6 ㎜＜D≤0.8 ㎜</td><td colspan="2">N≤1</td><td>Ignore</td></tr>
<tr><td colspan="3">D＞0.8 ㎜</td><td colspan="2">Not Allow</td><td>Ignore</td></tr>
<tr><td>Display unwork</td><td>Electric Display</td><td colspan="3">Not Allow</td><td colspan="2">Not Allow</td><td>Ignore</td></tr>
<tr><td>Display error</td><td>Electric Display</td><td colspan="3">Not Allow</td><td colspan="2">Not Allow</td><td>Ignore</td></tr>
<tr><td rowspan="3">Scratch or line defect(include dirt)</td><td rowspan="3">Visual/Film card</td><td colspan="3">L≤2 ㎜，W≤0.1 ㎜</td><td colspan="2">Ignore</td><td>Ignore</td></tr>
<tr><td colspan="3">1.0mm＜L≤9.0mm，0.1＜W≤0.2mm,</td><td colspan="2">N≤2</td><td>Ignore</td></tr>
<tr><td colspan="3">L＞9.0 ㎜，W＞0.2 ㎜</td><td colspan="2">Not Allow</td><td>Ignore</td></tr>
<tr><td rowspan="3">PS Bubble</td><td rowspan="3">Visual/Film card</td><td colspan="3">D≤0.4mm</td><td colspan="2">Ignore</td><td>Ignore</td></tr>
<tr><td colspan="3">0.4mm≤D≤0.6mm</td><td colspan="2">N≤4</td><td>Ignore</td></tr>
<tr><td colspan="3">D＞0.6 mm</td><td colspan="2">Not Allow</td><td>Ignore</td></tr>
<tr><td>Side Fragment</td><td>Visual/Film card</td><td colspan="6">Do not affect the electrode circuit((Corner chipping)
X≤8mm，Y≤1mm, Do not affect the electrode circuit;
Ignore
  </td></tr>
<tr><td rowspan="3">Remark</td><td colspan="7">1.Cannot be defect & failure cause by appearance defect；</td></tr>
<tr><td colspan="7">2.Cannot be larger size cause by appearance defect；</td></tr>
<tr><td colspan="7">L=long W=wide D=point size N=Defects NO</td></tr>
</table>



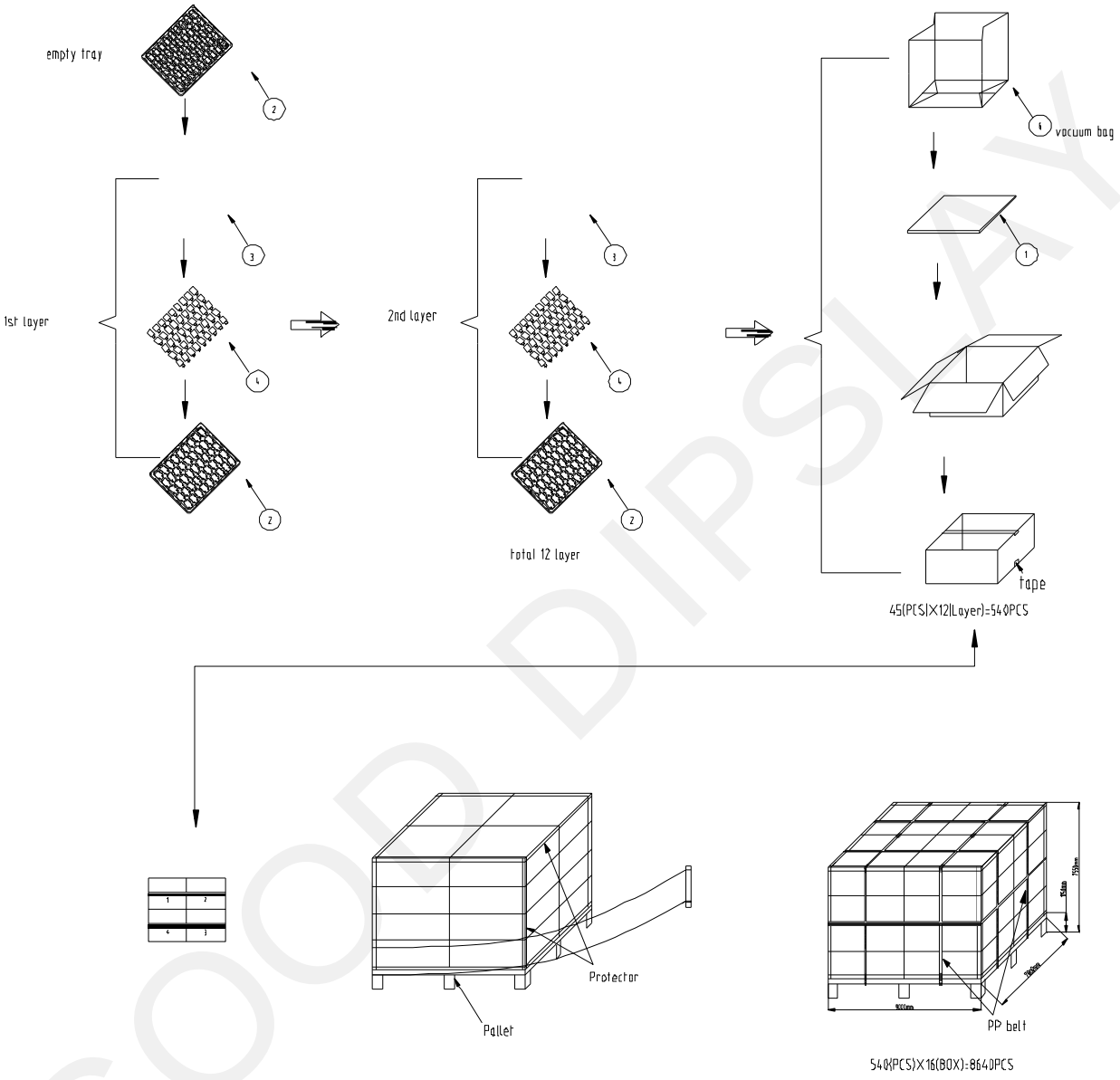
Line Defect



Spot Defect

L=long W=wide D=point size

9. Packing



10. 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.

(7) For more precautions, please click on the link:
https://www.good-display.com/news/80.html