

**1.54 inch
E-paper Display Series**

BLGDEW0154Z04

1 General Description

1.1 Overview

The display is a TFT active matrix electrophoretic display, with interface and a reference system design. The 1.54" active area contains 200×200 pixels, and has 1-bit black/white and highlight red full display capabilities. An integrated circuit contains gate buffer, source buffer, interface, timing control logic, oscillator, DC-DC, SRAM, LUT, VCOM, and border are supplied with each panel.

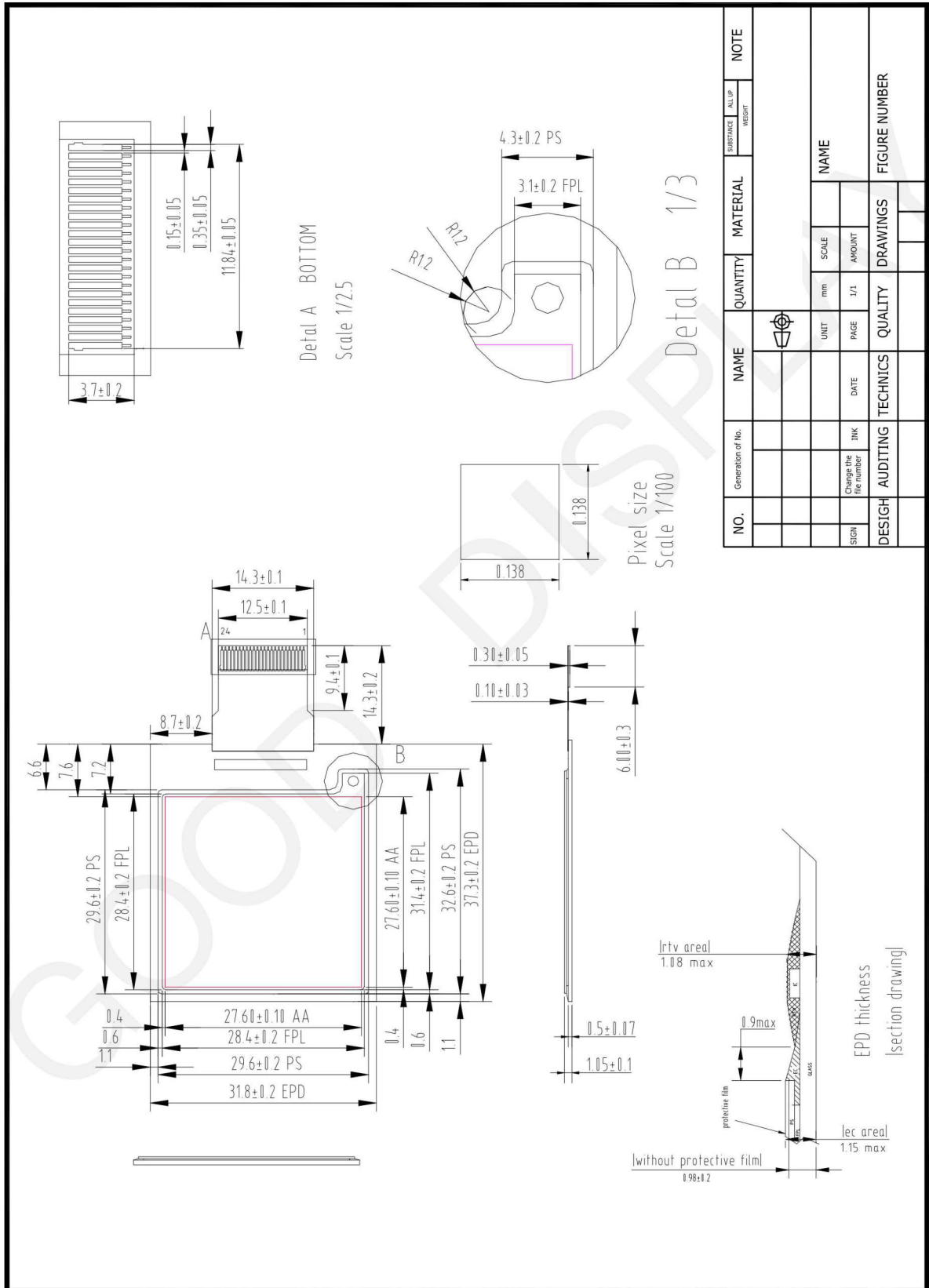
1.2 Feature

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 deep 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

1.3 Mechanical Specifications

| Parameter | Specifications | Unit | Remark |
|---------------------|--------------------------|-------|----------|
| Screen Size | 1.54 | Inch | |
| Display Resolution | 200(H)×200(V) | Pixel | Dpi: 184 |
| Active Area | 27.6(H)×27.6(V) | mm | |
| Pixel Pitch | 0.138×0.138 | mm | |
| Pixel Configuration | Square | | |
| Outline Dimension | 31.8(H)×37.3(V) ×1.05(D) | mm | |
| Weight | 2.18±0.5 | g | |

1.4 Mechanical Drawing of EPD module



1.5 Input/Output Terminals

1.5-1) Pin out List

| Pin # | Type | Single | Description | Remark |
|-------|------|--------|--------------------------------------------------------------------|-----------|
| 1 | | NC | No connection and do not connect with other NC pins | Keep Open |
| 2 | O | GDR | N-Channel MOSFET Gate Drive Control | |
| 3 | O | RESE | Current Sense Input for the Control Loop | |
| 4 | C | VGL | Negative Gate driving voltage | |
| 5 | C | VGH | Positive Gate driving voltage | |
| 6 | O | TSCL | I ² C Interface to digital temperature sensor Clock pin | |
| 7 | I/O | TSDA | I ² C Interface to digital temperature sensor Date pin | |
| 8 | I | BS1 | Bus selection pin | Note 1-5 |
| 9 | O | BUSY | Busy state output pin | Note 1-4 |
| 10 | I | RES # | Reset | Note 1-3 |
| 11 | I | D/C # | Data /Command control pin | Note 1-2 |
| 12 | I | CS # | Chip Select input pin | Note 1-1 |
| 13 | I/O | D0 | serial clock pin (SPI) | |
| 14 | I/O | D1 | serial data pin (SPI) | |
| 15 | I | VDDIO | Power for interface logic pins | |
| 16 | I | VCI | Power Supply pin for the chip | |
| 17 | | VSS | Ground | |
| 18 | C | VDD | Core logic power pin | |
| 19 | | NC | No connection and do not connect with other NC pins | Keep Open |
| 20 | C | VSH | Positive Source driving voltage | |
| 21 | C | PREVGH | Power Supply pin for VGH and VSH | |
| 22 | C | VSL | Negative Source driving voltage | |
| 23 | C | PREVGL | Power Supply pin for VCOM, VGL and VSL | |
| 24 | C | VCOM | VCOM driving voltage | |

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

Note 1-4: 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:

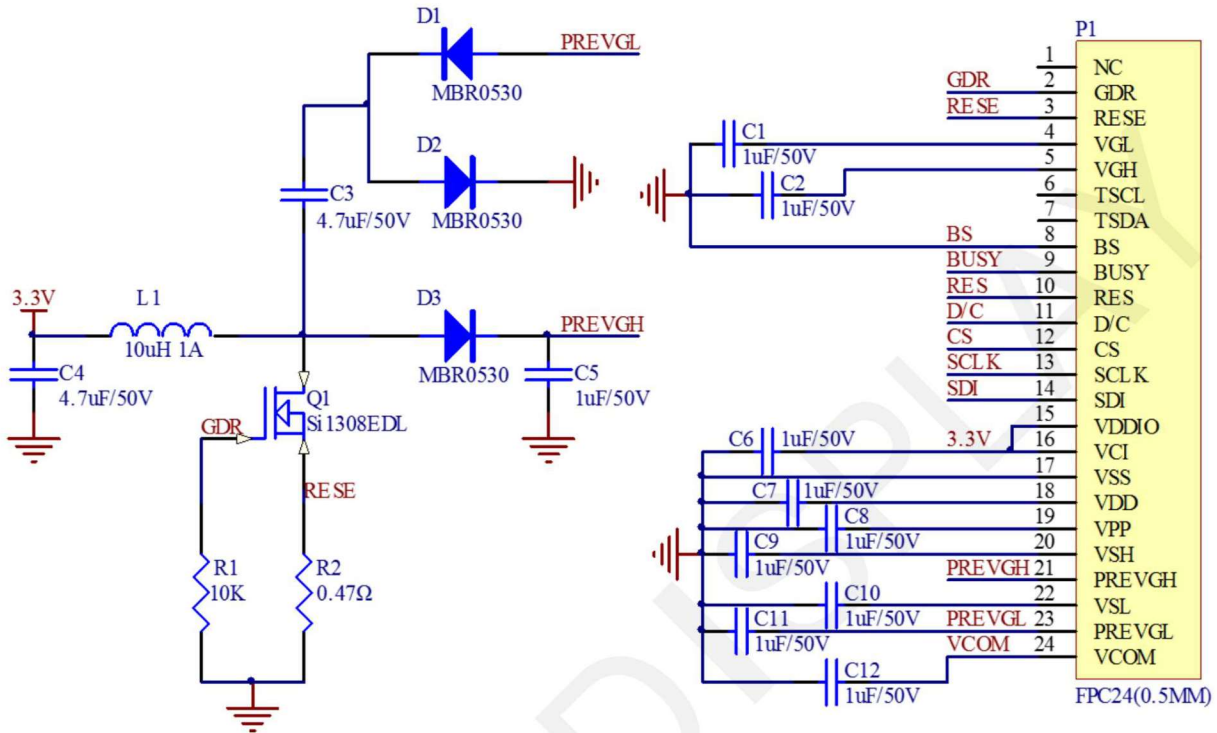
- Outputting display waveform; or
- Communicating with digital temperature sensor

Note 1-5: 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.

Table: Bus interface selection

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

1.6 Reference Circuit



Note :

1. Inductor L1 is wire-wound inductor. There are no special requirements for other parameters.
2. Suggests using Si1304BDL or Si1308EDL TUBE MOS (Q1) , otherwise it may affect the normal boost of the circuit.
3. The default circuit is 4-wire SPI. If the user wants to use 3-wire SPI, the resistor R4 can be removed when users design.
4. Default voltage value of all capacitors is 50V.

2. Environmental

2.1 Handling, Safety and Environmental 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 does not form part of the specification. | |

| Product Environmental certification |
|--------------------------------------------|
| RoHS |

2.2 Reliability test

| | TEST | CONDITION | METHOD | REMARK |
|----|-------------------------------------------|------------------------------------------------------------------------------------------------------------------|--------------------------|--------|
| 1 | High-Temperature Operation | T = 40°C, RH=30% for 240 hrs | IEC 60 068-2-2Bp | |
| 2 | Low-Temperature Operation | T = 0°C for 240 hrs | IEC 60 068-2-2Ab | |
| 3 | High-Temperature Storage | T = +60°C, RH=40% for 240 hrs Test in white pattern | IEC 60 068-2-2Bp | |
| 4 | Low-Temperature Storage | T = -25°C for 240 hrs Test in white pattern | IEC 60 068-2-2Ab | |
| 5 | High Temperature, High-Humidity Operation | T=+40°C, RH=90% for 240 hrs | IEC 60 068-2-3CA | |
| 6 | High Temperature, High-Humidity Storage | T=+50°C, RH=80% for 240 hrs Test in white pattern | IEC 60 068-2-3CA | |
| 7 | Temperature Cycle | [-25°C 30mins]→[+60°C 30mins], 50cycles Test in white pattern | IEC 60 068-2-14NB | |
| 8 | UV exposure Resistance | 765 W/m ² for 168 hrs, 40°C | IEC 60 068-2-5 Sa | |
| 9 | Electrostatic discharge | Machine Model: +/-200V 0 OHM 200PF | IEC61000-4-2 | |
| 10 | Package Vibration | 1.04G, Frequency : 10~500Hz Direction : X,Y,Z Duration: 1 hours 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, 6 face One drop for each. | Full packed for shipment | |

Actual EMC level to be measured on customer application.

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

3. Electrical Characteristics

3.1 Absolute maximum rating

| Parameter | Symbol | Rating | Unit |
|-----------------------|--------|------------------|------|
| Logic Supply Voltage | VCI | -0.5 to +3.6 | V |
| Logic Input Voltage | VIN | -0.5 to VCI +0.5 | V |
| Logic Output Voltage | VOUT | -0.5 to VCI +0.5 | V |
| Operating Temp. range | TOPR | 0 to +40 | °C |
| Storage Temp. range | TSTG | -25 to +60 | °C |
| Humidity range | - | 40~70 | %RH |

***Note: Avoid direct sunlight.**

3.2 Panel DC Characteristics

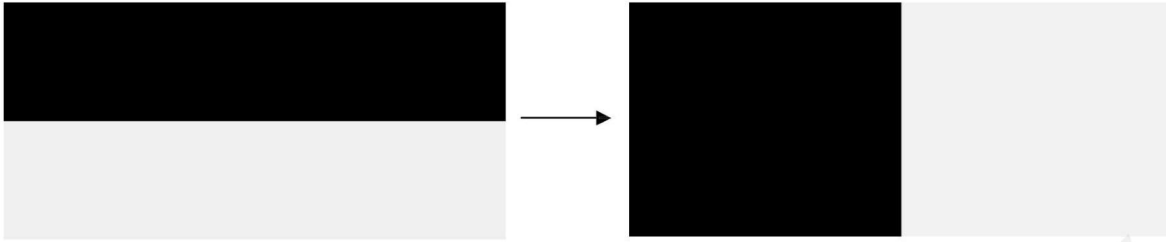
The following specifications apply for : VSS = 0V, VCI = 3.0V, TA = 25°C

| Parameter | Symbol | Conditions | Min | Typ | Max | Unit |
|---------------------------|----------------------|---------------------------------------------------------------|--------|------|--------|------|
| Single ground | VSS | - | - | 0 | - | V |
| Logic Supply Voltage | VCI | - | 2.3 | 3.0 | 3.6 | V |
| High level input voltage | VIH | - | 0.8VCI | - | - | V |
| Low level input voltage | VIL | - | - | - | 0.2VCI | V |
| High level output voltage | VOH | IOH= -100uA | 0.9VCI | - | - | V |
| Low level output voltage | VOL | IOH= 100uA | - | - | 0.1VCI | V |
| Image update current | I _{UPDATE} | - | - | 8 | 10 | mA |
| Standby panel current | I _{standby} | - | - | - | 5 | uA |
| Power panel (update) | P _{UPDATE} | - | - | 26.4 | 40 | mW |
| Standby power panel | P _{STBY} | - | - | - | 0.0165 | mW |
| Operating temperature | - | - | 0 | - | 40 | °C |
| Storage temperature | - | - | -25 | - | 60 | °C |
| Image updateTime at 25°C | - | - | - | 8 | 12 | Sec |
| Sleep mode current | VCI | DC/DC off No clock No input load Ram data not retain | - | 2 | 5 | uA |

- The Typical power consumption is measured with following pattern transition: from horizontal 2 gray scale pattern to vertical 2 gray scale pattern.(Note 3-1)
- 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 Good Display
- Vcom is recommended to be set in the range of assigned value $\pm 0.1V$.

Note 3-1

The Typical power consumption



3.3 Panel AC Characteristics

3.3-1) MCU Interface

3.3-1-1) MCU Interface Selection

In this module, there are 4-wire SPI and 3-wire SPI that can communicate with MCU. The MCU interface mode can be set by hardware selection on BS1 pins. When it is “Low”, 4-wire SPI is selected. When it is “High”, 3-wire SPI (9 bits SPI) is selected.

| Pin Name | Data/Command Interface | | Control Signal | | |
|---------------|------------------------|------|----------------|------|------|
| Bus interface | D1 | D0 | CS# | D/C# | RES# |
| SPI4 | SDin | SCLK | CS# | D/C# | RES# |
| SPI3 | SDin | SCLK | CS# | L | RES# |

Table 3-1: MCU interface assignment under different bus interface mode

Note 3-2: L is connected to VSS

Note 3-3: H is connected to VCI

3.3-1-2) MCU Serial Interface (4-wire SPI)

The 4-wire SPI consists of serial clock SCLK, serial data SDIN, D/C#, CS#. In SPI mode, D0 acts as SCLK, D1 acts as SDIN.

| Function | CS# | D/C# | SCLK |
|---------------|-----|------|------|
| Write Command | L | L | ↑ |
| Write data | L | H | ↑ |

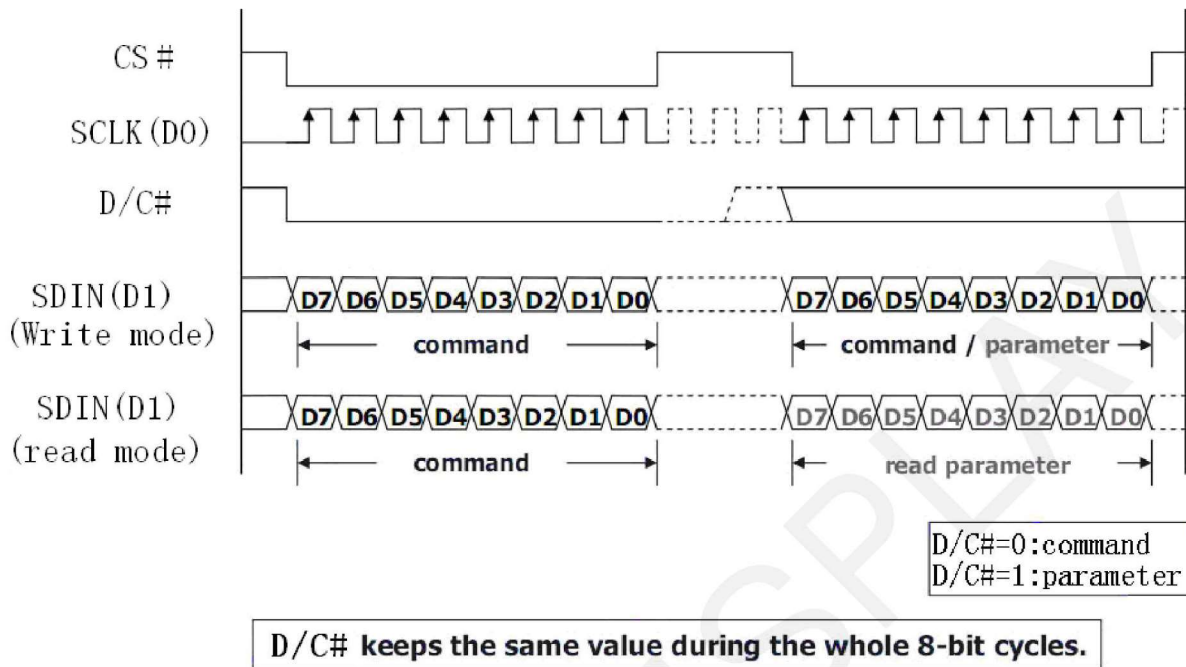
Table 3-2: Control pins of 4-wire Serial Peripheral interface

Note 3-9: ↑stands for rising edge of signal

SDIN is shifted into an 8-bit shift register in the order of D7, D6, ... D0. The data byte in the shift register is written to the Graphic Display Data RAM (RAM) or command register in the same clock.

Under serial mode, only write operations are allowed.

Figure 3-1: Write procedure in 4-wire Serial Peripheral Interface mode



3.3-1-3) MCU Serial Interface (3-wire SPI)

The 3-wire serial interface consists of serial clock SCLK, serial data SDIN and CS#.

In 3-wire SPI mode, D0 acts as SCLK, D1 acts as SDIN, The pin D/C# can be connected to an external ground.

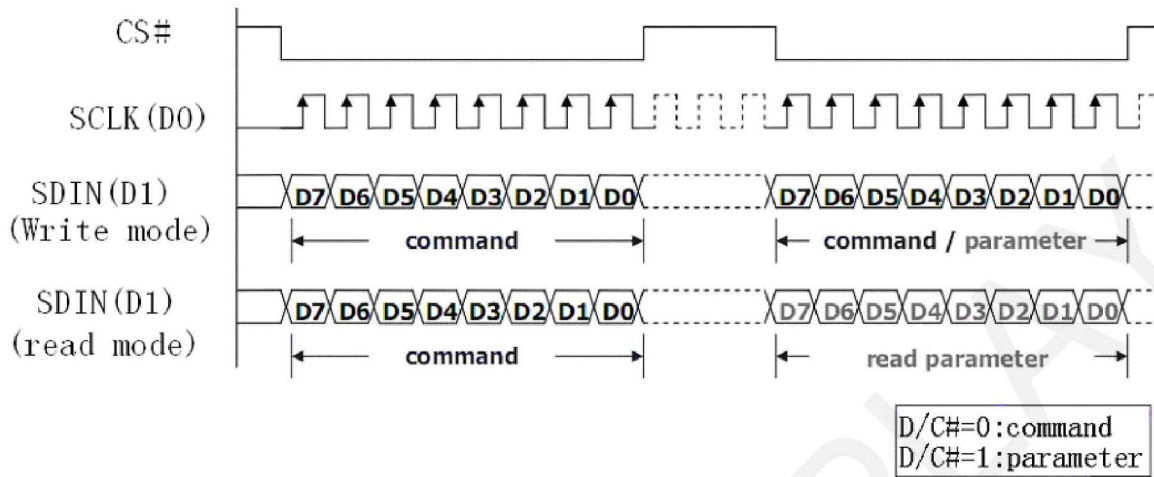
The operation is similar to 4-wire serial interface while D/C# pin is not used. There are altogether 9-bits will be shifted into the shift register on every ninth clock in sequence: D/C# bit, D7 to D0 bit. The D/C# bit (first bit of the sequential data) will determine the following data byte in shift register is written to the Display Data RAM (D/C# bit= 1) or the command register (D/C# bit = 0). Under serial mode, only write operations are allowed.

| Function | CS# | D/C# | SCLK |
|---------------|-----|---------|------|
| Write Command | L | Tie LOW | ↑ |
| Write data | L | Tie LOW | ↑ |

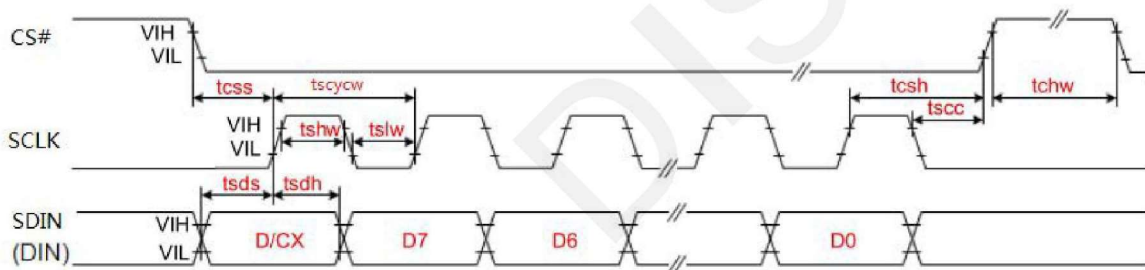
Table 3-3: Control pins of 3-wire Serial Peripheral Interface

Note 3-10: ↑stands for rising edge of signal

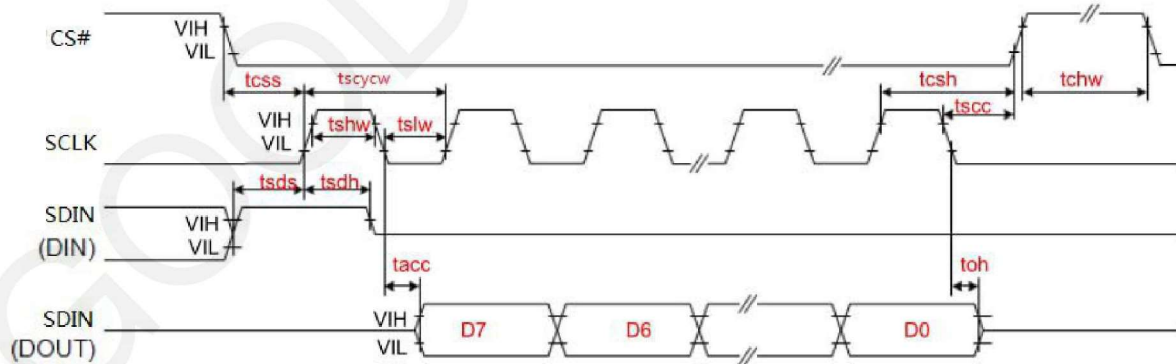
Figure 3-2: Write procedure in 3-wire Serial Peripheral Interface mode



3.3-2) Timing Characteristics of Series Interface



3-wire Serial Interface – Write



3-wire Serial Interface – Read

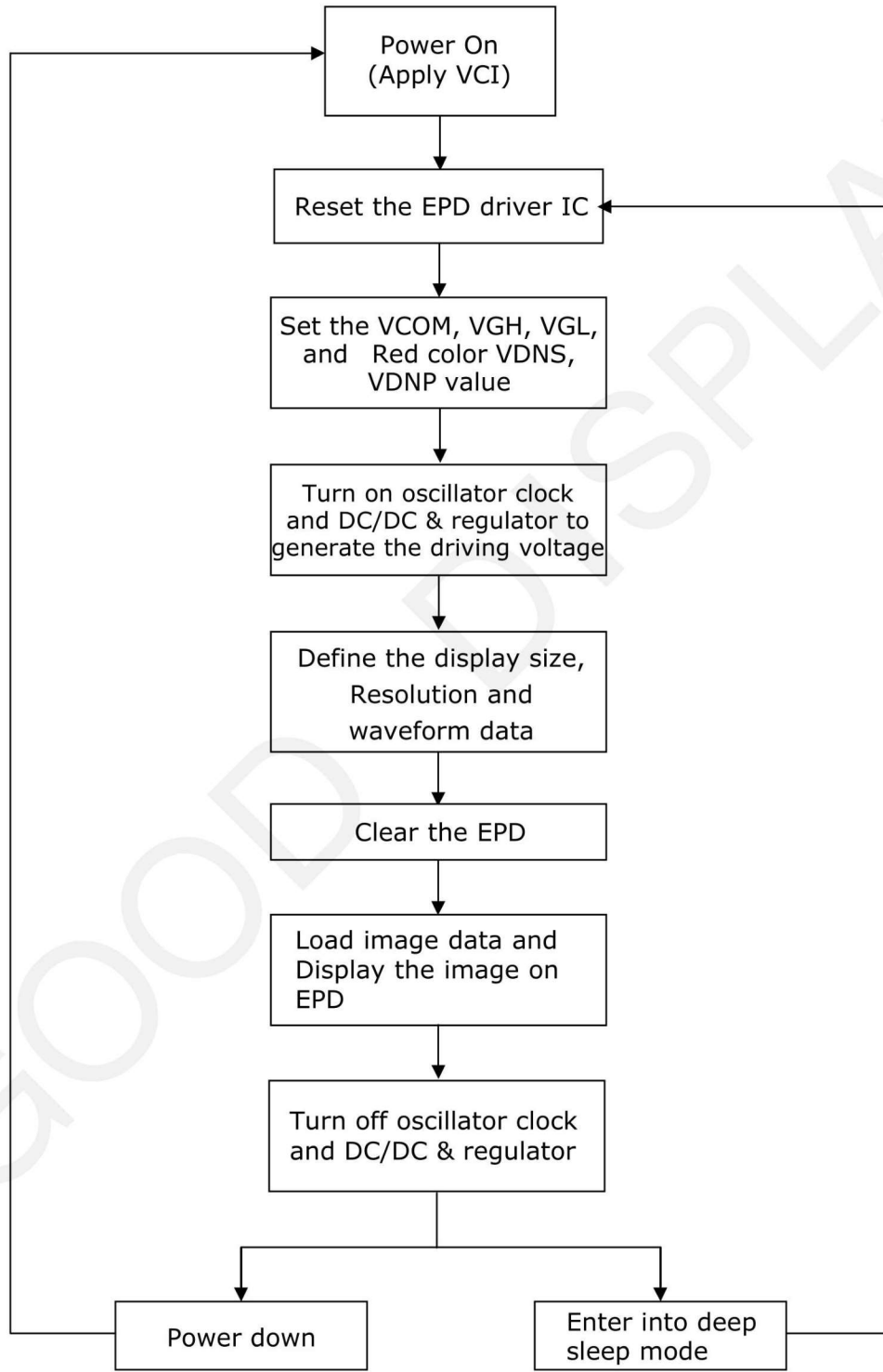
| Symbol | Signal | Parameter | Min | Typ | Max | Unit |
|----------------------|-------------------------|-----------------------------|-----|-----|-----|------|
| SERIAL COMMUNICATION | | | | | | |
| tcss | CSB | Chip Select Setup Time | 60 | - | - | ns |
| tcsH | | Chip Select Hold Time | 65 | - | - | ns |
| tscC | | Chip Select Setup Time | 20 | - | - | ns |
| tchW | | Chip Select Setup Time | 40 | - | - | ns |
| tscycW | SCL | Serial clock cycle (write) | 100 | - | - | ns |
| tshW | | SCL "H" pulse width (write) | 35 | - | - | ns |
| tslW | | SCL "L" pulse width (write) | 35 | - | - | ns |
| tscycR | | Serial clock cycle (Read) | 150 | - | - | ns |
| tshR | | SCL "H" pulse width (Read) | 60 | - | - | ns |
| tslR | | SCL "L" pulse width (Read) | 60 | - | - | ns |
| tsds | SDIN (DIN) (DOUT) | Data setup time | 30 | - | - | ns |
| tsdh | | Data hold time | 30 | - | - | ns |
| tacc | | Access time | 10 | - | - | ns |
| toh | | Output disable time | 15 | - | - | ns |

3.4 Power Consumption

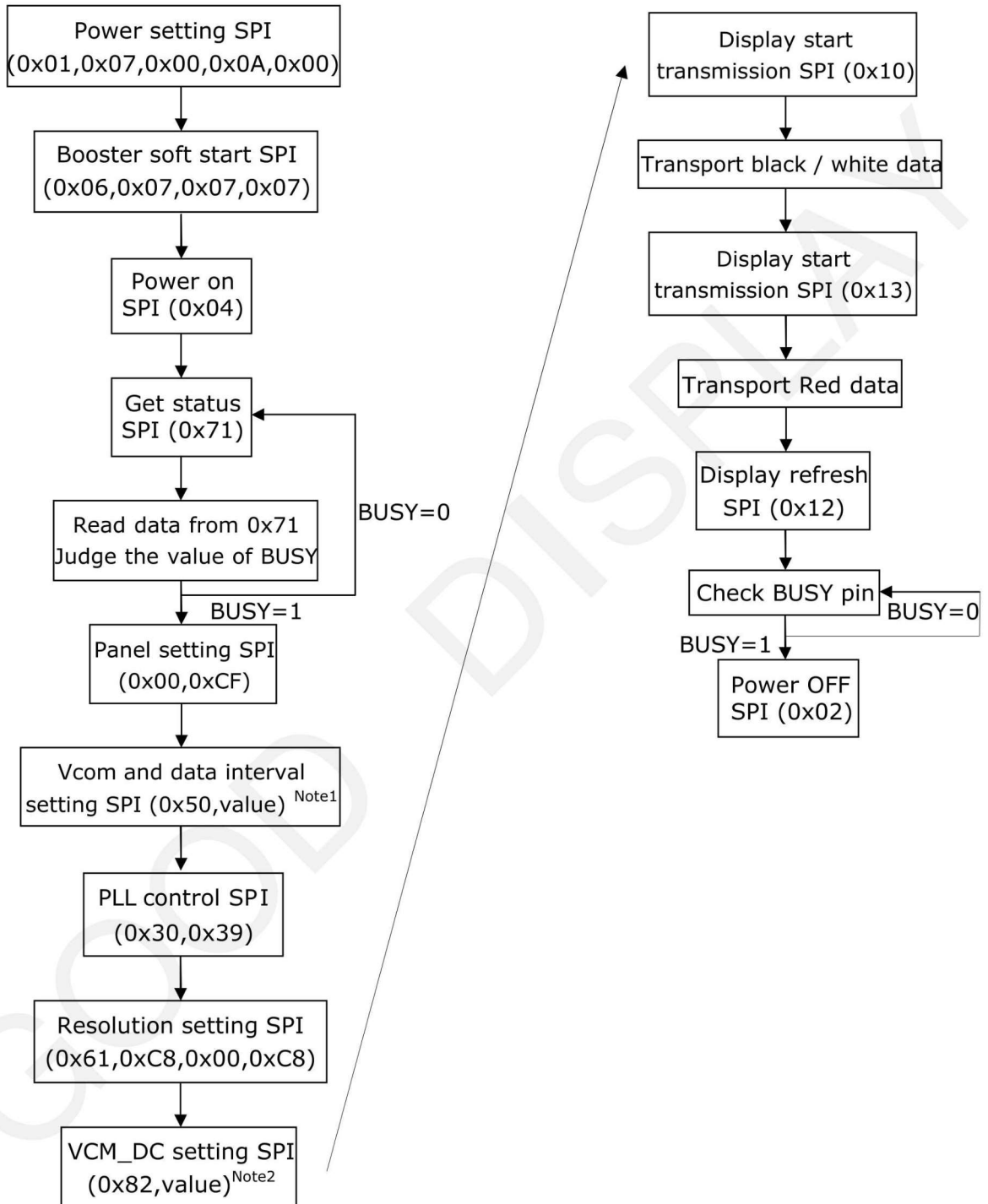
| Parameter | Symbol | Condition | TYP | Max | Unit | Remark |
|---------------------------------------|--------|-----------|------|--------|------|--------|
| Panel power consumption during update | - | 25°C | 26.4 | 40 | mW | - |
| Power consumption in standby mode | - | 25°C | - | 0.0165 | mW | - |

4. Typical Operating Sequence

4.1 Normal Operation Flow



4.2 Reference Program Code



Note1: When value=0x57, border will be drive to black after refresh. When value=0x17, the border is set to floating.

Note2: Different EPD with different VCOM value, Good Display will provide different values according to different batches of EPD.

5. Waveform LUT control software

For every bunch of EPD the waveform data is different, so you may receive the waveform LUT from Good Display. You just need to use the follow sequence to download the waveform into driver IC.

| sequence | command | Action Description | remark |
|----------|---------|----------------------|-----------------------------|
| 1 | 04 | Power on | Send cmd 04 |
| 2 | 20 | VCOM LUT Setting | Send cmd 20data lut_vcom0[] |
| 3 | 21 | White LUT Setting | Send cmd 21data lut_w[] |
| 4 | 22 | Black LUT Setting | Send cmd 22data lut_b[] |
| 5 | 25 | RED VCOM LUT Setting | Send cmd 25data lut_vcom1[] |
| 6 | 26 | RED0 LUT Setting | Send cmd 26data lut_red0[] |
| 7 | 27 | RED1 LUT Setting | Send cmd 27data lut_red1[] |

Note: To download the waveform into driver ic, you must send command 04 first, then send 20, 21, 22, 25, 26, 27 command.

The data of lut_vcom0[],lut_w[],lut_b[],lut_vcom1[],lut_red0[],lut_red1[],each batch of EPD is different. Good Display will support the data after you receive the EPD.

6. Command Table

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|----------------------|----------------------|-----|------------------|------------------|--------------|--------------|--------------|---------------|--------------|--------------|--------------|---------|
| R01H | PWR | W | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (01H) |
| | 1 st Para | W | 1 | - | - | - | - | - | - | VDS_EN | VDG_EN | 03H |
| | 2 nd Para | W | 1 | - | - | - | - | - | - | 0 | 0 | 00H |
| | 3 rd Para | W | 1 | | | | VDPS_L V4 | VDPS_ LV3 | VDPS_L V2 | VDPS_ LV1 | VDPS_ V0 | 08H |
| 4 nd Para | W | 1 | | | | VDNS_L V4 | VDNS_ LV3 | VDNS_L LV2 | VDNS_ LV1 | VDNS_ LV0 | 08H | |
| R02H | POF | W | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | (02H) |
| R04H | PON | W | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | (04H) |
| R06H | BTST | W | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | (E2H) |
| | 1 st Para | W | 1 | - | 0 | 0 | BT_PH A4 | BT_P HA3 | 1 | 1 | 1 | 0FH |
| | 2 nd Para | W | 1 | - | 0 | 0 | BT_PH B4 | BT_P HB3 | 1 | 1 | 0 | 0EH |
| 3 rd Para | W | 1 | - | - | - | BT_PHC 4 | BT_P HC3 | 1 | 0 | 1 | 0DH | |
| R10H | DTM1 | W | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | (10H) |
| | 1 st Para | W | 1 | KPxI1 [0] | KPxI2[1] | KPxI2 [0] | KPxI3[1] | KPxI3 [0] | KPxI4[1] | KPxI4 [0] | KPxI1[1] | 00H |
| | | W | 1 | | | | | | | | | 00H |
| M th Para | W | 1 | KPxI(N -1)[1] | KPxI(N- 1)[0] | KPxIN [1] | KPxIN[0] | | | | | | 00H |
| R12H | DRF | W | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | (12H) |
| R13H | DTM2 | W | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | (13H) |
| | 1 st Para | W | 1 | PRxI1 | PRxI2 | PRxI3 | PRxI4 | PRxI5 | PRxI6 | PRxI7 | PRxI8 | 00H |
| | | W | 1 | | | | | | | | | 00H |
| M th Para | W | 1 | PRxI(N -1) | PRxIN | | | | | | | 00H | |

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| R30H | PLL | W | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | (30H) |
| | 1 st Para | W | 0 | - | - | M2 | M1 | M0 | N2 | N1 | N0 | 3CH |
| R40H | TSC | W | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | (40H) |
| | 1 st Para | R | 1 | D10 | D9 | D8 | D7 | D6/TS3 | D5/TS2 | D4/TS1 | D3/TS0 | 00H |
| R41H | 2 nd Para | R | 1 | D2 | D1 | D0 | - | - | - | - | - | 00H |
| | TSE | W | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | (41H) |
| | 1 st Para | W | 1 | TSE | - | - | - | - | - | - | - | 00H |
| R42H | TSW | W | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | (42H) |
| | 1 st Para | W | 1 | WATTR7 | WATTR6 | WATTR5 | WATTR4 | WATTR3 | WATTR2 | WATTR1 | WATTR0 | 00H |
| | 2 nd Para | W | 1 | WMSB7 | WMSB6 | WMSB5 | WMSB4 | WMSB3 | WMSB2 | WMSB1 | WMSB0 | 00H |
| | 3 rd Para | W | 1 | WLSB7 | WLSB6 | WLSB5 | WLSB4 | WLSB3 | WLSB2 | WLSB1 | WLSB0 | 00H |
| R43H | TSR | W | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 1 | (43H) |
| | 1 st Para | R | 1 | RMSB7 | RMSB6 | RMSB5 | RMSB4 | RMSB3 | RMSB2 | RMSB1 | RMSB0 | 00H |
| | 2 nd Para | R | 1 | RLSB7 | RLSB6 | RLSB5 | RLSB4 | RLSB3 | RLSB2 | RLSB1 | RLSB0 | 00H |
| R50H | CDI | W | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | (50H) |
| | 1 st Para | W | 1 | - | - | - | DDX | CDI3 | CDI2 | CDI1 | CDI0 | 17H |
| R61H | TRES | W | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | (61H) |
| | 1 st Para | W | 1 | HRES7 | HRES6 | HRES5 | HRES4 | HRES3 | HRES2 | HRES1 | 0 | 00H |
| | 2 nd Para | W | 1 | - | - | - | - | - | - | - | HRES8 | 00H |
| | 3 rd Para | W | 1 | VRES7 | VRES6 | VRES5 | VRES4 | VRES3 | VRES2 | VRES1 | VRES0 | 00H |
| R82H | VDCS | W | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | (82H) |
| | 1 st Para | W | 1 | - | - | VDCS5 | VDCS4 | VDCS3 | VDCS2 | VDCS1 | VDCS0 | 00H |

Power Setting Register

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|----------|----------------------|-----|----|----|----|-----------------------|----------------------|----------------------|----------------------|----------------------|----------------------|---------|
| R01H | PWR | W | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (01H) |
| | 1 st Para | W | 1 | - | - | - | - | - | - | VDS_EN | VDG_EN | 03H |
| | 2 nd Para | W | 1 | - | - | - | - | - | - | 0 | 0 | 00H |
| | 3rd Para | W | 1 | - | - | - | VDPS_L V4 | VDPS_L V3 | VDPS_L V2 | VDPS_L V1 | VDPS_L V0 | 08H |
| 4th Para | W | 1 | - | - | - | VDNS_L LV4 | VDNS_L V3 | VDNS_L V2 | VDNS_L V1 | VDNS_L V0 | 08H | |

| Name | Control | Value | Function Description |
|--------------|---------------------------|-------|----------------------------------------------------------------------------------------|
| VDS_EN | Source Power Selection | 0 | External positive source voltage from VDH pin and negative source voltage from VDL pin |
| | | 1 | Internal voltage generation circuit for both VDH/VDL |
| VDG_EN | Gate Power Selection | 0 | External positive source voltage from VDH pin and negative source voltage from VDL pin |
| | | 1 | Internal voltage generation circuit for both VDH/VDL |
| VDPS_LV[4:0] | Source Voltage-Level(Red) | - | Internal positive source voltage level for red LUT (range: 2.4V ~ 8.0V / step:0.2V) |
| VDNS_LV[4:0] | Source Voltage-Level(Red) | - | Internal negative source voltage level for red LUT (range: -2.4V ~ -8.0V / step:0.2V) |

Note: For this panel the 2ndPara must set as 0x00.

Power OFF

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|------------|-----|----|----|----|----|----|----|----|----|----|---------|
| R02H | POF | W | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | (02H) |

After the Power Off command, driver will power off based on the power off Sequence, BUSY will become "0". This command will turn off charge pump, T-con, source driver, gate driver, VCOM, and temperature sensor, but register data will be kept until VDD becomes OFF.

SD output and Vcom will base on previous condition. It may have 2 conditions: 0V or floating. This command can be active only when BUSY = "1".

Power ON / Setting

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|----|----|----|----------------|----------------|----|----|----|---------|
| R04H | PON | W | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | (04H) |
| R06H | BTST | W | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | (06H) |
| | 1 st Para | W | 1 | - | 0 | 0 | BT_PHA4 | BT_PHA3 | 1 | 1 | 1 | 0FH |
| | 2 nd Para | W | 1 | - | 0 | 0 | BT_PHB4 | BT_PHB3 | 1 | 1 | 0 | 0EH |
| | 3 rd Para | W | 1 | - | - | - | BT_PHC4 | BT_PHC3 | 1 | 0 | 1 | 0DH |

| Name | Control | Value | Description |
|-------------------------------------------|------------------|-------|-------------|
| BT_PHA[4:3] BT_PHB[4:3] BT_PHC[4:3] | Driving Strength | 00 | 1 |
| | | 01 | 2 |
| | | 10 | 3 |
| | | 11 | 4 |

NOTE: For this panel, You 'd better to set these bits's (BT_PHA \BT_PHB\BT_PHC) value to 00.

Data Start Transmission 1 / Data Stop Command (B/W)

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|------------------|----|----------------|----|--------------|----|--------------|----|---------|
| R10H | DTM1 | W | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | (10H) |
| | 1 st Para | W | 1 | KPixel1[1:0] | | KPixel2[1:0] | | KPixel3[1:0] | | KPixel4[1:0] | | 00H |
| | | W | 1 | ... | | ... | | ... | | ... | | 00H |
| | M th Para | W | 1 | KPixel(n-1)[1:0] | | KPixel(n)[1:0] | | - | - | - | - | 00H |

This Command starts transmitting data and write them into SRAM. To complete data transmission, command DSP(Data transmission Stop) must be issued. Then the chip will start to send data/VCOM for panel.

| | KPixel(x)[1:0] | LUT |
|------------|----------------|-------|
| When DDX=0 | 00 | White |
| | 11 | Black |
| When DDX=1 | 00 | Black |
| | 11 | White |

This command can be active only when BUSY = "1".

Data Refresh Command

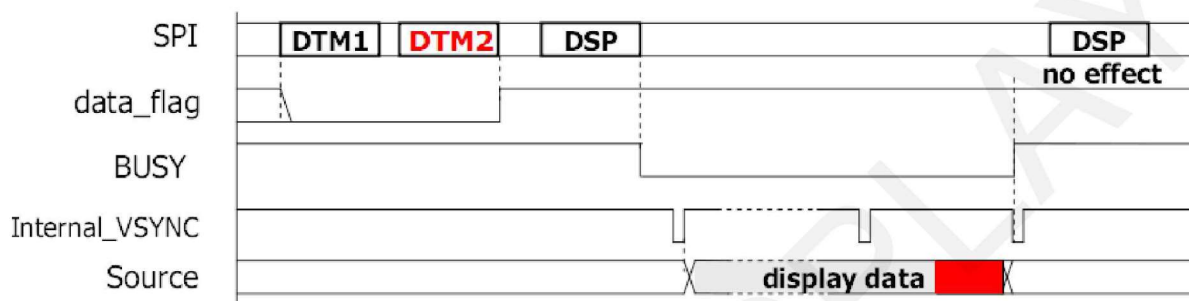
| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|------------|-----|----|----|----|----|----|----|----|----|----|---------|
| R12H | DRF | W | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | (12H) |

While user sent this command, driver will refresh display (data/VCOM) according to SRAM data and LUT.

This command can be active only when BUSY = "1". After display refresh command, BUSY signal will become "0".

Data Start Transmission 1&2 / Data Stop Command(B/W/Red)

| Code | Inst/Par | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|-----------|-------|-------|-------|-------|-------|-------|-------|---------|
| R13H | DTM2 | W | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 1 | (13H) |
| | 1 st Para | W | 1 | PRxI1 | PRxI2 | PRxI3 | PRxI4 | PRxI5 | PRxI6 | PRxI7 | PRxI8 | 00H |
| | | W | 1 | | | | | | | | | 00H |
| | M th Para | W | 1 | PRxI(N-1) | PRxIN | | | | | | | 00H |



1. <data_flag>=1 while writing both DTM1 and DTM2 parameters fully (B/W/Red)
2. SEG/BG/VCOM change based on internal frame clock

PLL Control

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|----|----|----|----|----|----|----|----|---------|
| R30H | PLL | W | 0 | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | (30H) |
| | 1 st Para | W | 0 | - | - | M2 | M1 | M0 | N2 | N1 | N0 | 3CH |

Note: For this panel the R30H Must be set as follow:

- When Temperature ≥ 30 value=0x39;
 When Temperature < 30 value=0x2A.

Temperature Sensor Command

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|-----|----|----|----|--------|--------|--------|--------|---------|
| R40H | TSC | W | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | (40H) |
| | 1 st Para | R | 1 | D10 | D9 | D8 | D7 | D6/TS3 | D5/TS2 | D4/TS1 | D3/TS0 | 00H |
| | 2 nd Para | R | 1 | D2 | D1 | D0 | - | - | - | - | - | 00H |

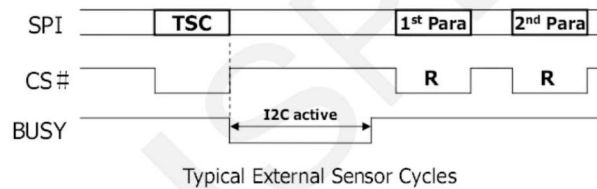
Internal Sensor Mapping

| TS[3:0] | temperature |
|---------|-------------|
| 0000 | 0 °C |
| 0001 | 5 °C |
| 0010 | 10 °C |
| 0011 | 15 °C |
| 0100 | 20 °C |
| 0101 | 25 °C |
| 0110 | 30 °C |
| 0111 | 35 °C |
| 1000 | 40 °C |
| 1001 | 45 °C |
| 1010 | 50 °C |

External LM75 Sensor Mapping (D10~D0)

Table 10. Temp register value

| 11-bit binary (2's complement) | Hexadecimal value | Decimal value | Value |
|-----------------------------------|-------------------|---------------|-------------|
| 011 1111 1000 | 3F8 | 1016 | +127.000 °C |
| 011 1111 0111 | 3F7 | 1015 | +126.875 °C |
| 011 1111 0001 | 3F1 | 1009 | +126.125 °C |
| 011 1110 1000 | 3E8 | 1000 | +125.000 °C |
| 000 1100 1000 | 0C8 | 200 | +25.000 °C |
| 000 0000 0001 | 001 | 1 | +0.125 °C |
| 000 0000 0000 | 000 | 0 | 0.000 °C |
| 111 1111 1111 | 7FF | -1 | -0.125 °C |
| 111 0011 1000 | 738 | -200 | -25.000 °C |
| 110 0100 1001 | 649 | -439 | -54.875 °C |
| 110 0100 1000 | 648 | -440 | -55.000 °C |



Temperature Sensor Setting

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|-----|----|----|----|----|----|----|----|---------|
| R41H | TSE | W | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | (41H) |
| | 1 st Para | W | 1 | TSE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 00H |

| Name | Control | Value | Description |
|------|------------------------------|-------|-----------------------------|
| TSE | Temperature Sensor Selection | 0 | Internal temperature sensor |
| | | 1 | External temperature sensor |

VCOM and Data Interval Setting Command

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|----------------------|-----|----|----|----|----|-----|------|------|------|------|---------|
| R50H | CDI | W | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | (50H) |
| | 1 st Para | W | 1 | - | - | - | DDX | CDI3 | CDI2 | CDI1 | CDI0 | 17H |

Note: For this panel the R50H Must be set as 0x17.

Resolution Setting Command

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|-------------|-----|----|-------|-------|-------|-------|-------|-------|-------|-------|---------|
| R61H | TRES | W | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | (61H) |
| | 1st Para | W | 1 | HRES7 | HRES6 | HRES5 | HRES4 | HRES3 | HRES2 | HRES1 | 0 | 00H |
| | 2nd Para | W | 1 | - | - | - | - | - | - | - | HRES8 | 00H |
| | 3rd Para | W | 1 | VRES7 | VRES6 | VRES5 | VRES4 | VRES3 | VRES2 | VRES1 | VRES0 | 00H |

| Name | Control | Description |
|-----------|-----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HRES[7:0] | Horizontal Resolution | (1) Horizontal resolution setting (HRES[0] is forced to '0') (2) Minimum active SD channel = S0 (3) Maximum active SD channel = min_active SD + HRES[7:0] - 1 |
| VRES[8:0] | Vertical Resolution | (1) Vertical resolution setting (2) Minimum active GD channel = G0 (3) Maximum active GD channel = min_active GD + VRES[8:0] - 1 |

Resolution setting(R61H) has higher priority than RES[1:0](R00H).

Note : For this panel R61H 's value must be 0xC8, 0x00, 0xC8.

VCOM-DC Setting

| Code | Inst/Para | R/W | DC | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Default |
|------|-------------|-----|----|----|----|-------|-------|-------|-------|-------|-------|---------|
| R82H | VDCS | W | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | (82H) |
| | 1st Para | W | 1 | - | - | VDCS5 | VDCS4 | VDCS3 | VDCS2 | VDCS1 | VDCS0 | 0CH |

| VDCS[5:0] | VCOM Value | VDCS[5:0] | VCOM Value |
|-----------|------------|-----------|------------|
| 000000 | 0v | | |
| 000001 | -0.1v | 011011 | -2.7v |
| 000010 | -0.2v | 011100 | -2.8v |
| 000011 | -0.3v | 011101 | -2.9v |
| 000100 | -0.4v | 011110 | -3.0v |
| 000101 | -0.5v | | |
| 000110 | -0.6v | 111111 | |

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°C

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYPE | MAX | UNIT | Note |
|--------------|-------------------|------------|-----|----------------------------|-----|------|-----------|
| R | Reflectance | White | 30 | 35 | - | % | Note 7-1 |
| RS_a | Red State a value | Red | 30 | 35 | 45 | | |
| Gn | 2Grey Level | - | - | $DS+(WS-DS) \times n(m-1)$ | - | L* | - |
| CR | Contrast Ratio | indoor | 8 | | - | - | - |
| Panel's life | | 0°C~40°C | | 1000000 times or 5 years | | 7 | Note 10-2 |

WS: White state, DS: Dark state

Gray state from Dark to White : DS、WS

m: 2

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

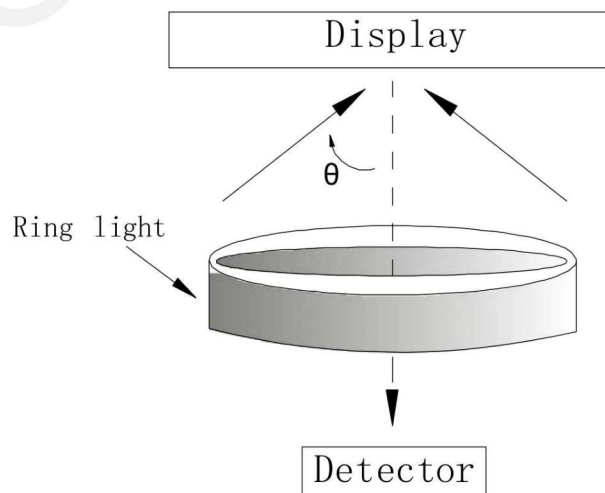
Note 7-2: When work in temperature below 0 degree or above 40 degree, we do not recommend because the panel's life will not be guaranteed. Each update interval time should be minimum at 180 seconds.

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

$$CR = R1/Rd$$

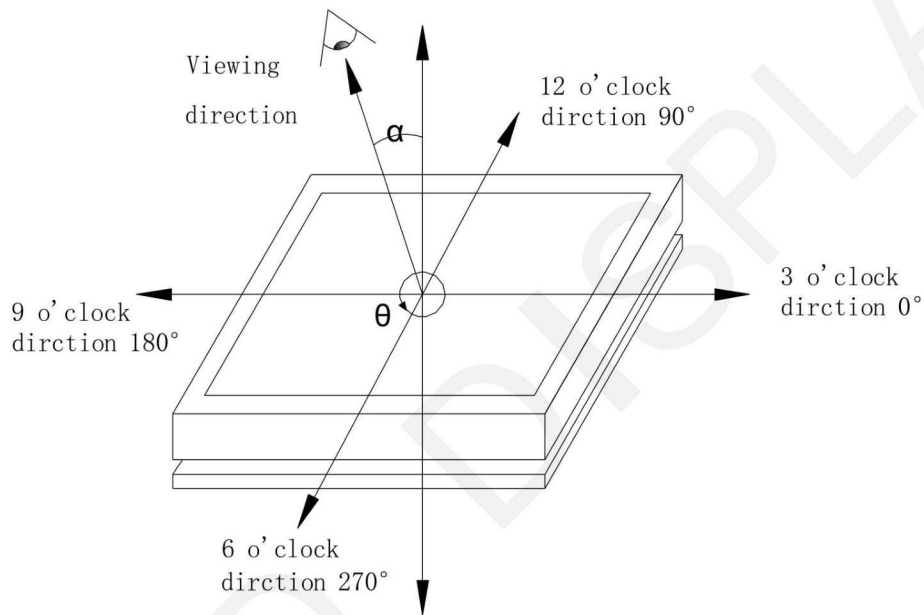


7.3 Reflection Ratio

The reflection ratio is expressed as :

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

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



8. Point and line standard

Shipment Inseption Standard

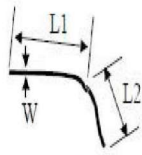
Equipment: Electrical test fixture, Point gauge

Outline demension:

31.8(H) ×37.32(V) ×1.05(D)

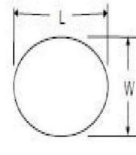
Unit: mm

| Environment | Temperature | Humidity | Illuminance | Distance | Time | Angle |
|---------------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------|---------------------------------|----------|--------|-------------------------------------|
| | 23±2°C | 55±5%RH | 1200~1500Lux | 300 mm | 35Sec | |
| appearance standard | Defet type | Defect size | | | Part-A | Note |
| | Dot Defect | D ≤ 0.25mm | | | Ignore | The defect is below protection film |
| | | 0.25mm < D ≤ 0.52mm | | | 4 | |
| | | 0.52mm < D ≤ 0.65mm | | | 1 | |
| | | 0.65mm < D | | | 0 | |
| | 1.Edge glue lost 2.Burr 3.AI-I film over EPD 4.Edge dent 5.Edge protrusion 6.Dimension | Distance from edge ≤ 0.2mm | | | Ignore | |
| | Edge dot defect (Microcup Damage) | Distance from edge ≤ 0.75mm | | | Ignore | |
| | Diffusion length of wiping solution | Distance from edge ≤ 0.5mm | | | Ignore | |
| | Microcup residue (at Vcom pad) | Distance from edge ≤ 0.5mm | | | Ignore | |
| | Display unwork | Electric Display | Not Allow | | | |
| | Display error | Electric Display | Not Allow | | | |
| | PS PET warping | Vsual | cannot beyond 1/2 of the border | | | |
| | Protector hurt | Vsual | L≤2 mm, W≤0.05 mm, Ignore; | | | |
| | | | L>2 mm, W>0.05 mm, Not Allow; | | | |
| Adhesive coating | Vsual | Bubble:D≤0.65 & N≤2 | | | | |
| Packing | Vsual | cannot be dirty and breakdown;must be marked and identified | | | | |
| Remark | 1.Cannot be defect&failure cause by appearance defect; | | | | | |
| | 2.Cannot be larger size cause by appearance defect; | | | | | |



$$L = L1 + L2$$

Line Defect



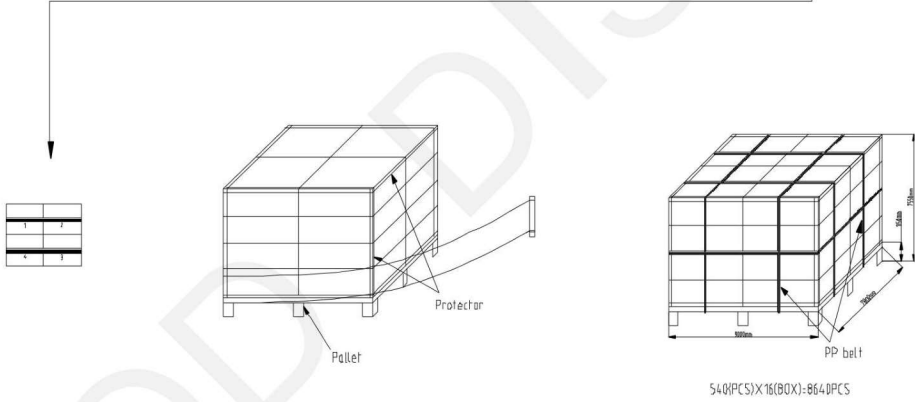
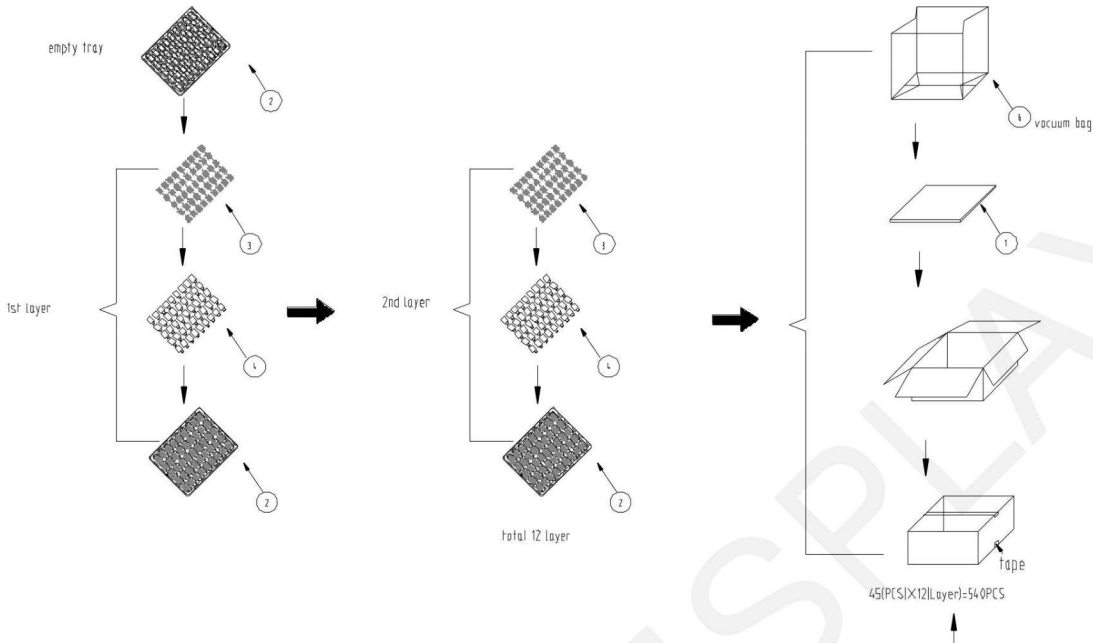
$$D = (L + W) / 2$$

Spot Defect

L=long W=wide D=point size

| Edition | Content | Date |
|---------|-------------|-------------|
| 1 | New edition | Sep.30.2013 |
| | | |
| | | |

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.