# Thin-Film-Transistor LCD Module
# Model: GWTQ35NNF1E1

| Acceptance |
|---|
| |


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Revise Records

| Rev. | Date | Contents | Written | Approved |
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Special Notes

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| Note1. | |
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# Contents

## 1. General Description and Features

GWTQ35NNF1E1 is a TM (Transmissive) type color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as a switching device. This model is composed of a TFT-LCD module, a driver circuit and a back-light unit. The resolution of a 3.5" contains 320RGBx480 dots and can display up to 262k colors. The following table described the features of GWTQ35NNF1E1.

### 1.1 Features

- HVGA(320 x 480 pixels) resolution.
- Display in 262k colors.
- On-chip voltage generator.
- RoHS Compliance

### 1.2 LCD Module

| Item | Specification | Unit |
|---|---|---|
| Screen Size | 3.5 inches | Diagonal |
| Display Resolution | 320 x RGB x 480 | Dot |
| Active Area | 48.96 *73.44 | mm |
| Outline Dimension | 54.66x82.94x2.1 | mm |
| Display Mode | Normally white | -- |
| Pixel Arrangement | RGB Vertical Stripe | -- |
| Display Color | 262k | -- |
| Viewing Direction （gray inversion） | 12 o'clock | -- |
| Input Interface | 4 - line SPI+ RGB 18Bit DBO-DB17 | -- |

## 2. Mechanical Information

| Item | | Min. | Typ. | Max. | Unit | Note |
|---|---|---|---|---|---|---|
| Module Size | Horizontal (H) | -- | 54.66 | -- | mm | -- |
| | Vertical (V) | -- | 82.94 | -- | mm | (1) |
| | Thickness (T) | -- | 2.1 | -- | mm | (1) |

Note (1) Not include FPC.
Refer to the Outline Dimension for further information.

## 3. Electrical Specifications

### 3.1 Absolute Max. Ratings

#### 3.1.1 Absolute Ratings of Environment

If the operating condition exceeds the following absolute maximum ratings, the TFT LCD module may be damaged permanently.

(Ta=25±2°C, $V_{SS}$=GND=0)

| Item | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| Storage temperature | $T_{STG}$ | -30 | +80 | °C | (1) |
| Operating temperature | $T_{OPR}$ | -20 | +70 | °C | (1,2,3) |

Note (1) 95 % RH Max. ( 40 °C ≥ Ta ). Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.

Note (2) In case of below 0°, the response time of liquid crystal (LC) becomes slower and the color of panel becomes darker than normal one. Level of retardation depends on temperature, because of LC's character

Note (3) Only operation is guarantied at operating temperature. Contrast, response time, another display quality are evaluated at +25°C.

### 3.2 Electrical Absolute Rating

#### 3.2.1 TFT-LCD Module

(Voltage Referenced to VSS)

| Item | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| Supply Voltage | VSHD | -0.3 | 4.6 | V | |
| Driver supply voltage | VGH-VGL | -0.3 | +32 | V | |
| Logic input voltage range | VIN | -0.3 | VSHD+0.3 | V | |
| Logic output voltage range | VO | -0.3 | VSHD+0.3 | V | |

#### 3.2.2 Back-Light Unit

(Ta=25±2°C)

| Item | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| Forward current | $I_f$ | -- | (30) | mA | (1) |
| Reverse voltage | $V_R$ | -- | (20) | V | (1) |

Note (1) Permanent damage to the device may occur if maximum values are exceeded or reverse voltage is loaded. Functional operation should be restricted to the conditions described under normal operating conditions.

## 4 Electrical Characteristics

### 4.1 TFT-LCD Module (DC Characteristics)

| Item | Symbol | Min | Typ | Max | Unit | Applicable terminal |
|---|---|---|---|---|---|---|
| Supply voltage for logic | IOVcc | 1.65 | 2.8 | 3.3 | V | |
| Supply voltage for Analog | Vcc | 2.5 | 2.8 | 3.3 | V | |
| Input voltage | VIL | -0.3 | - | 0.3 VCC | V | |
| | VIH | 0.7 Vcc | - | Vcc | V | |
| Input leakage current | ILKG | -1 | | 1 | μA | |
| LED Forward voltage | Vf | 17.4 | 19.2 | 21 | V | IF=20MA |
| Input backlight current | ILED | | 20 | | mA | |

Black Pattern / 0 Gray

Active Area

### 4.2 Backlight Unit

The back-light system is an edge-lighting type with six white LEDs (Light Emitting Diode).

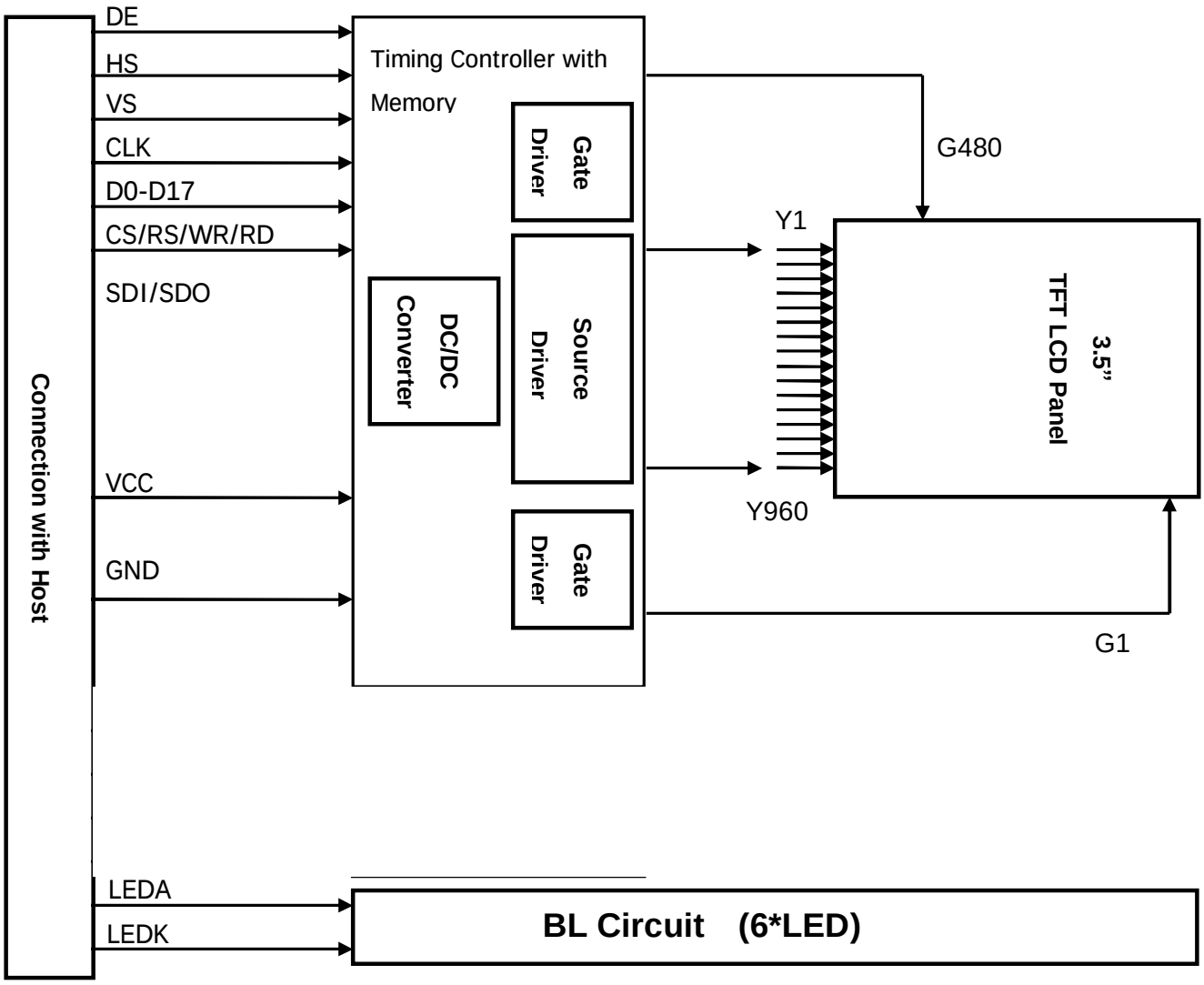
(Ta=25±2°C)

| Item | Symbol | Value | | | Unit | Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| LED Voltage | VL | 17.4 | 19.2 | 21 | V | |
| LED Current | IL | - | 20 | - | mA | |
| Power Consumption | $P_{BL}$ | - | 384 | - | mW | |
| LED Life Time(25℃) | - | (35000) | (50000) | - | hr | |

Note (1) Where $I_B$ = 20mA, $V_F$ = 19.2, $P_{BL} = V_F \times I_B$

## 5 Block Diagram

TFT-LCD Module with Backlight Unit



## 6 Input Terminal Pin Assignment

6.1 Pin Assignment (LCD)

| Pin No. | Symbol | Description |
|---|---|---|
| 1 | GND | Power ground |
| 2-3 | LEDA | Anode of LED backlight |
| 4-5 | LEDK | Cathode of LED backlight |
| 6-7 | GND | Power ground |
| 8 | VCC | Power voltage(2.8V) |
| 9 | IOVCC | Power voltage(1.8/2.8V) |
| 10 | RESET | Reset signal input terminal,active at"L" |
| 11 | VSYNC | Vertical sync input in RGB mode |
| 12 | HSYNC | Horizontal sync input in RGB mode |
| 13 | GND | Power ground |
| 14 | DOTCLK | Pixel clock input in RGB mode |
| 15 | GND | Power ground |
| 16 | DE | Data Enable input in RGB mode |
| 17-34 | DB17-DB0 | Data bus BO-B5 (DB0-DB5), G0-G5(DB6-D11), R0-R5 (DB12-DB17) |
| 35 | SDO | Serial data output pin |
| 36 | SDI/SDA | Serial data input pin |
| 37 | RDX | Read signal |
| 38 | WRX/SCL | Write signal/ Serial clock |
| 39 | D/CX | Data/command select signal |
| 40 | CSX | Chip select signal input terminal,active at"L" |
| 41 | TE | Tearing effect output pin to synchronies MCU to frame writing |
| 42 | NC | (TP XR) If not used, please fix this pin at no connect |
| 43 | NC | (TP YD) If not used, please fix this pin at no connect |
| 44 | NC | (TP XL) If not used, please fix this pin at no connect |
| 45 | NC | (TP YU) If not used, please fix this pin at no connect |

Note:the MPU system interface mode is selected by R1,R2,R3,R4,R5,R6 ON FPC
When R1,R4,R5=0,R2,R3,R6 NC,select 3-SPI+RGB;
When R1,R3,R5=0,R2,R4,R6 NC,use select 4-SPI+RGB;
When R2,R4,R6=0,R1,R3,R5 NC,select i80-system 18 bit interface DB0-DB17 used;
When R2,R3,R6=0,R1,R4,R5 NC,select i80-system 16 bit interface DB0-DB15 used;
When R1,R3,R6=0,R2,R4,R5 NC,select i80-system 8bit interface DB0-DB7 used;
When R1,R4,R6=0,R2,R3,R5 NC,select i80-system 9bit interface DB0-DB8 used;

The red font color is usd 4-SPI+RGB select signal data connected availably mode.

## 7 Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).
Measuring equipment: BM-5A, BM-7,

(Ta=25±2°C)

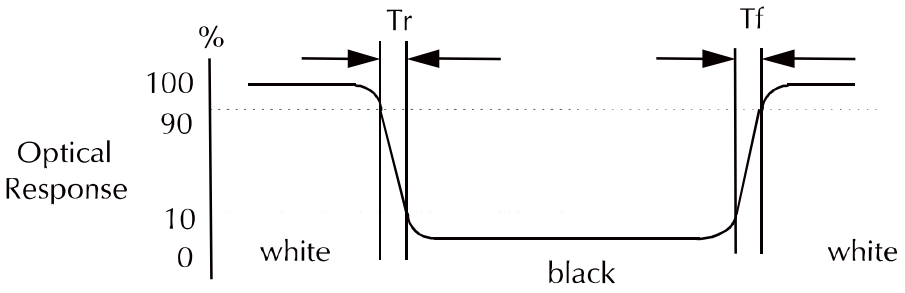
| Item | | Symbol | Condition | Min | Typ | Max | Unit | Note |
|---|---|---|---|---|---|---|---|---|
| Brightness | | B | Normal Viewing Angle | -- | 360 | -- | $cd/m^2$ | -- |
| Response time | | $T_{R+}T_F$ | | -- | 30 | - | ms | -- |
| Brightness uniformity | | $B_{UNI}$ | | 80 | 85 | - | % | |
| Contrast ratio | | CR | | 350 | 500 | -- | -- | -- |
| Color Chromaticity | Red | $R_X$ | | -- | 0.626 | -- | -- | -- |
| | | $R_Y$ | | -- | 0.334 | -- | | |
| | Green | $G_X$ | | -- | 0.277 | -- | -- | |
| | | $G_Y$ | | -- | 0.549 | -- | | |
| | Blue | $B_X$ | | -- | 0.142 | -- | -- | |
| | | $B_Y$ | | -- | 0.122 | -- | | |
| | White | Wx | | -- | 0.303 | -- | -- | |
| | | Wy | | -- | 0.325 | -- | | |
| Viewing Angle | Hor. | $\theta_R$ | CR≥10 | 60 | 70 | -- | Degree | -- |
| | | $\theta_L$ | | 60 | 70 | -- | | |
| | Ver. | $\phi_H$ | | 60 | 70 | -- | | |
| | | $\phi_L$ | | 40 | 60 | -- | | |

a. Test equipment setup

After stabilizing and leaving the panel alone shall be warmed up for the stable operation of LCM, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-5A/BM-7(fast) with a viewing angle of 2° at a distance of 50cm and normal direction.

b. Definition of response time: Tr and Tf

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white".



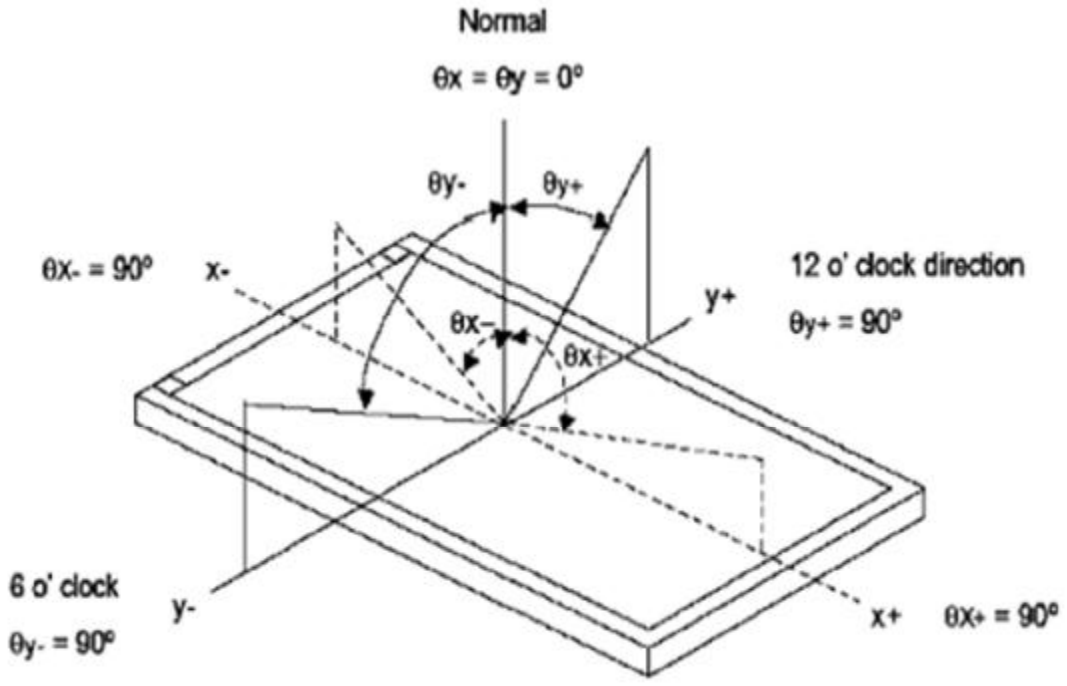

c. Definition of contrast ratio:

$$\text{Contrast Ratio (CR)} = \frac{\text{Brightness measured when LCD is at "white state"}}{\text{Brightness measured when LCD is at "black state"}}$$

d. Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

e. View Angle

: Definition of Viewing Angle $\theta_x$ and $\theta_y$ :



f. Definition of Luminance of White: Luminance of white at the center points

| Light Source of Back-Light Unit | LED Type |
|---|---|

g. Definition of White Uniformity

$$\text{White Uniformity} = \frac{\text{Min. luminance of white among 9-points}}{\text{Max. luminance of white among 9-points}} \times 100\%$$

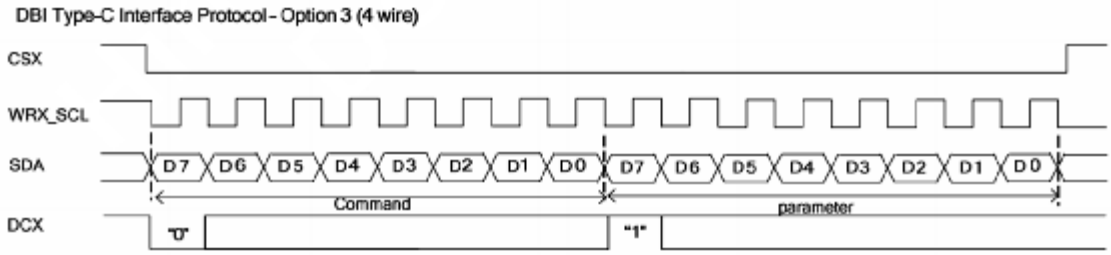
## 8 Interface Timing

### 8.1 Interface

The HX8357-D supports MIPI interfaces: DBI (Display Bus Interface), DPI (Display Pixel Interface), DSI (Display Serial Interface). Where DBI supports (24-/18-/16-/9-/8-bit interface) Parallel Interface (Type B) and Serial interface (Type C Option 1/ Option 3). The interface mode can be selected by IM2-0 pins setting as show in Table 4.1.

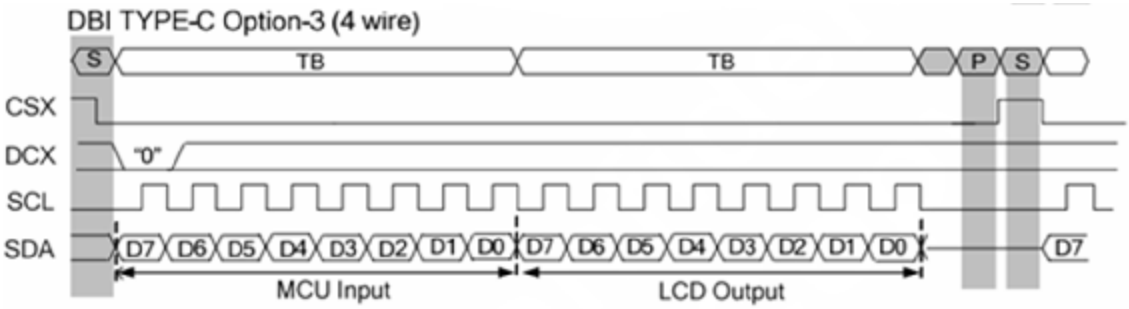
| IM2 | IM1 | IM0 | Interface | WRX_SCL | Data Bus use | |
|---|---|---|---|---|---|---|
| | | | | | Command/ Parament | GRAM |
| 0 | 0 | 0 | DBI TYPE-B 18-bit (DB_EN='0') | WRX | DB7-DB0 | DB17-DB0: 18-bits Data |
| 0 | 0 | 0 | DBI TYPE-B 24-bit(DB_EN='1') | WRX | DB7-DB0 | DB23-DB0: 24-bits Data |
| 0 | 0 | 1 | DBI TYPE-B 9-bit | WRX | DB7-DB0 | DB8-DB0: 9-bits Data |
| 0 | 1 | 0 | DBI TYPE-B 16-bit | WRX | DB7-DB0 | DB15-DB0: 16-bits Data |
| 0 | 1 | 1 | DBI TYPE-B 8-bit | WRX | DB7-DB0 | DB7-DB0: 8-bit Data |
| 1 | 0 | 0 | Not use | - | - | |
| 1 | 0 | 1 | DBI TYPE-C Option 1 | SCL | SDA | |
| 1 | 1 | 0 | MIPI DSI (For HX8357-D01 only) | - | HSI_CP/N , HSI_D0P/N | |
| 1 | 1 | 1 | DBI TYPE-C Option 3 | SCL | SDA | |

### 8.2 DBI TYPE-C Option3(4-Wire) serial date write mode

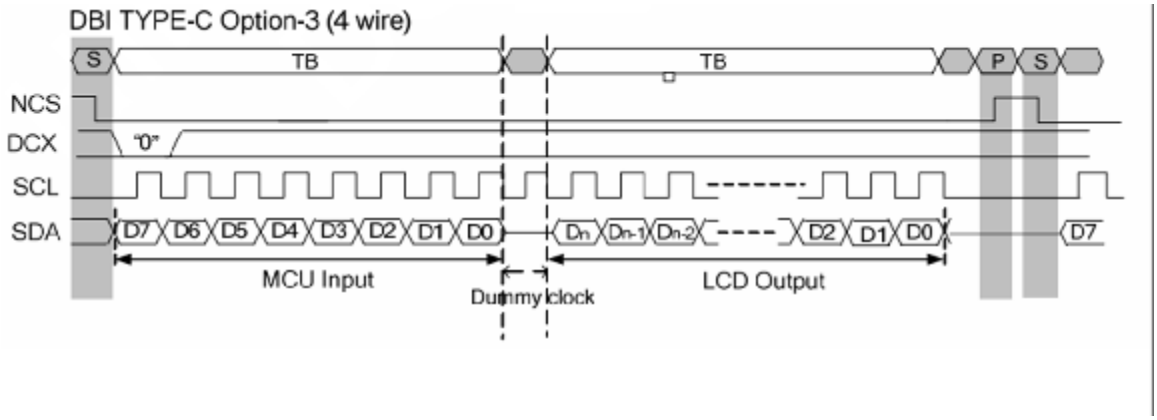



### 8.3 4-Wire read operation in serial peripheral interface

Read 8-bits data commands

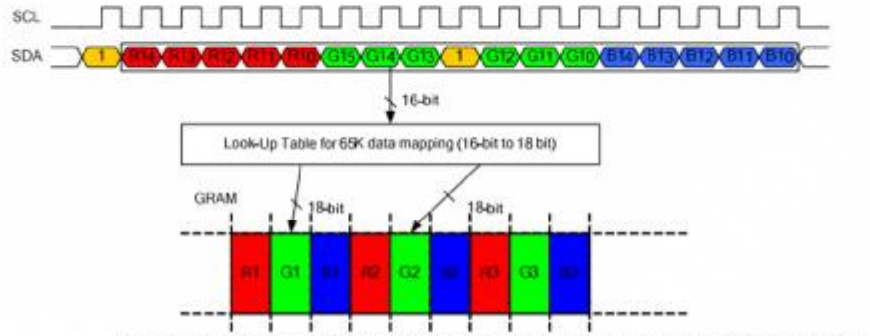


Read over 8-bits data commands

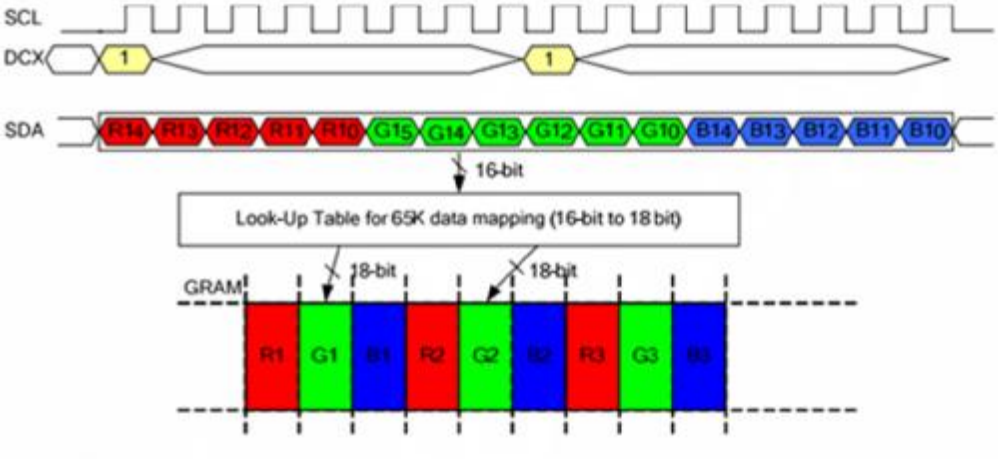



8.4 DBI TYPE-C interface data color coding

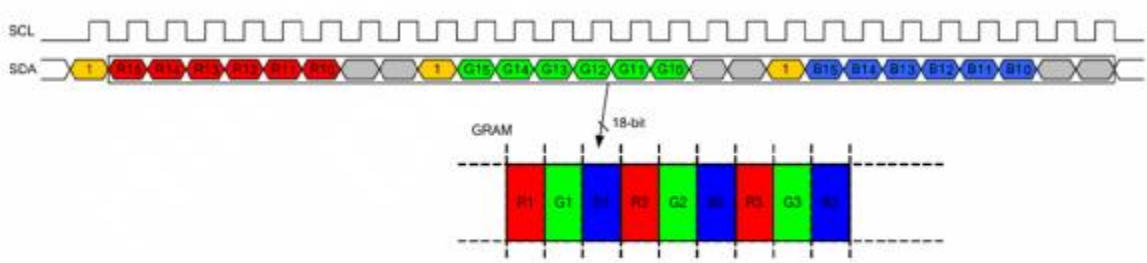
There are two types data format to write display data at Serial data bus Interface and it is as same as 8-bit bus Interface.



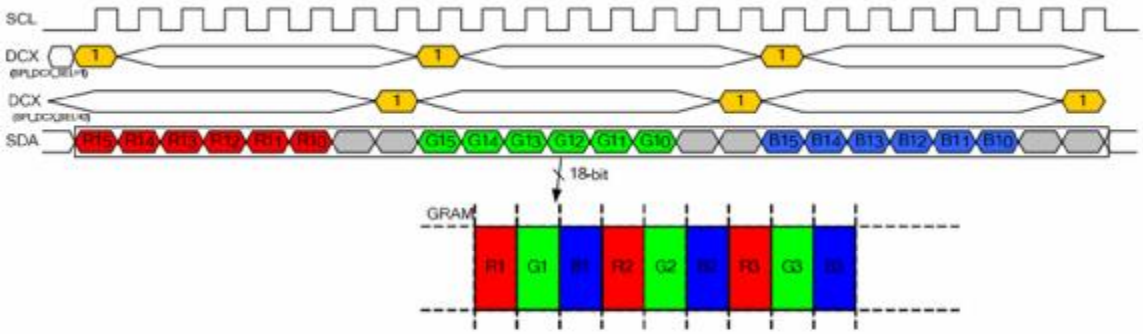

**Write data for RGB 5-6-5-bit input of DBI TYPE-C OPTION 1**




**Write data for RGB 5-6-5-bit input of DBI TYPE-C OPTION 3**




Write data for RGB 6-6-6-bit input of DBI TYPE-C OPTION 1

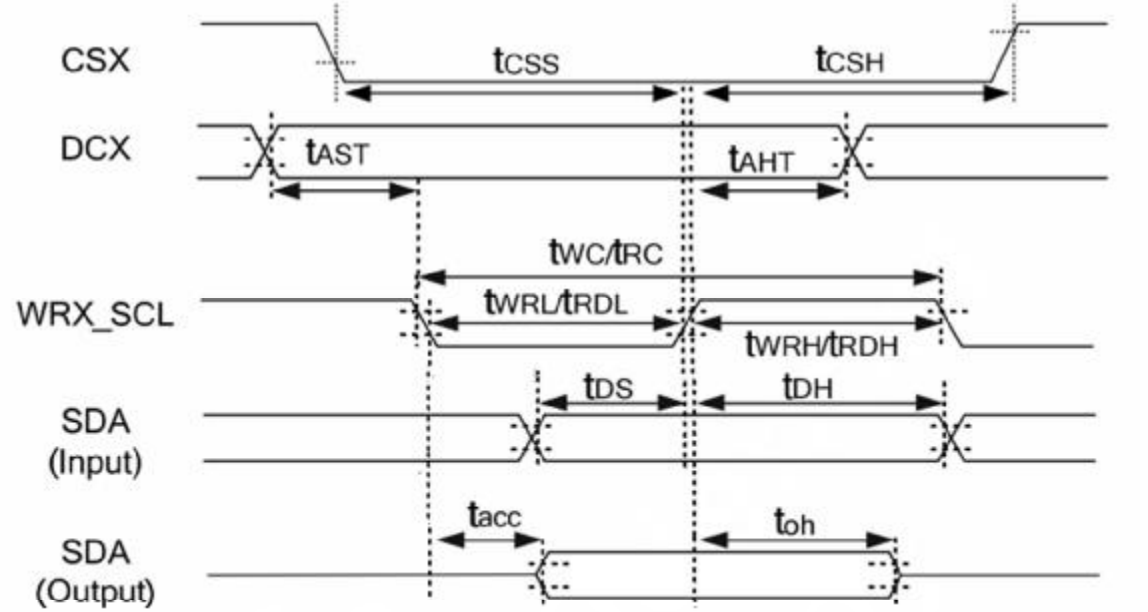



Write data for RGB 6-6-6-bit input of DBI TYPE-C OPTION 3

| Register Command | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Command |
|---|---|---|---|---|---|---|---|---|---|
| 3Ah | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 2CH |
| 05h | R4 | R3 | R2 | R1 | R0 | G5 | G4 | G3 | 65K-Color (1-pixel/ 2-transfer) |
| | G2 | G1 | G0 | B4 | B3 | B2 | B1 | B0 | |
| 06h | R5 | R4 | R3 | R2 | R1 | R0 | x | x | 262K-Color (1-pixel/ 3-transfer) |
| | G5 | G4 | G3 | G2 | G1 | G0 | x | x | |
| | B5 | B4 | B3 | B2 | B1 | B0 | x | x | |

DBI TYPE-C interface GRAM write table

8.5 DBI Type C interface characteristics




**DBI Type C interface characteristics**

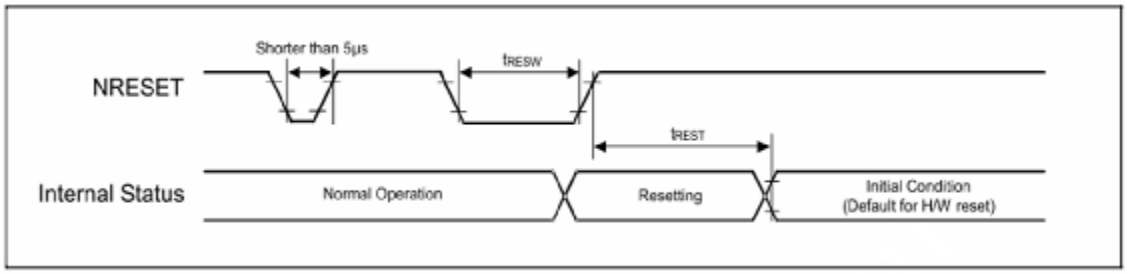
**(VSSA=0V, IOVCC=1.8V, VCI=2.8V, $T_A$ = 25℃)**

| Signal | Symbol | Parameter | Min. | Max. | Unit | Description |
|---|---|---|---|---|---|---|
| CSX | tCSS | Chip select setup time (Write) | 15 | - | ns | - |
| | tCSS | Chip select setup time (Read) | 60 | - | | |
| | tCSH | Chip select hold time (Write) | 15 | - | | |
| | tCSH | Chip select hold time (Read) | 65 | - | | |
| DCX | tAST | Address setup time | 0 | - | ns | - |
| | tAHT | Address hold time (Write/Read) | 10 | - | | |
| WRX_SCL (Write) | tWC | Write cycle | 66 | - | ns | - |
| | tWRH | Control pulse "H" duration | 15 | - | | |
| | tWRL | Control pulse "L" duration | 15 | - | | |
| WRX_SCL (Read) | tRC | Read cycle | 150 | - | ns | - |
| | tRDH | Control pulse "H" duration | 60 | - | | |
| | tRDL | Control pulse "L" duration | 60 | - | | |
| SDA (Input) | tDS | Data setup time | 10 | - | ns | For maximum $C_L$=30pF<br>For minimum $C_L$=8pF |
| | tDH | Data hold time | 10 | - | | |
| SDA (Output) | tACC | Read access time | 10 | 50 | ns | |
| | tOH | Output disable time | 15 | 50 | | |

**Note:** The input signal rise time and fall time (tr, tf) is specified at 15 ns or less.
Logic high and low levels are specified as 30% and 70% of IOVCC for Input signals.

**DBI Type C interface characteristics**

8.6 Reset timing




**Reset input timing**

| Symbol | Parameter | Related Pins | Spec. | | | Note | Unit |
|---|---|---|---|---|---|---|---|
| | | | Min. | Typ. | Max. | | |
| tRESW | Reset low pulse width(1) | NRESET | 10 | - | - | - | µs |
| tREST | Reset complete time(2) | - | 5 | - | - | When reset applied during SLPIN mode | ms |
| | | - | 120 | - | - | When reset applied during SLPOUT mode | ms |

**Reset input timing**

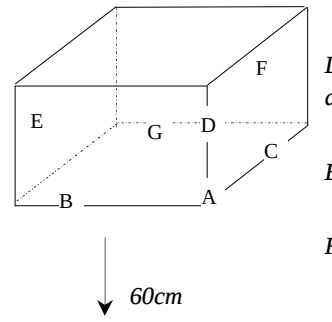
## 9 Reliability Condition for LCD

No change on display and in operation under the following test condition.

Condition: Unless otherwise specified, tests will be conducted under the following condition.

Temperature: 20±5°C Humidity: 65±5%RH

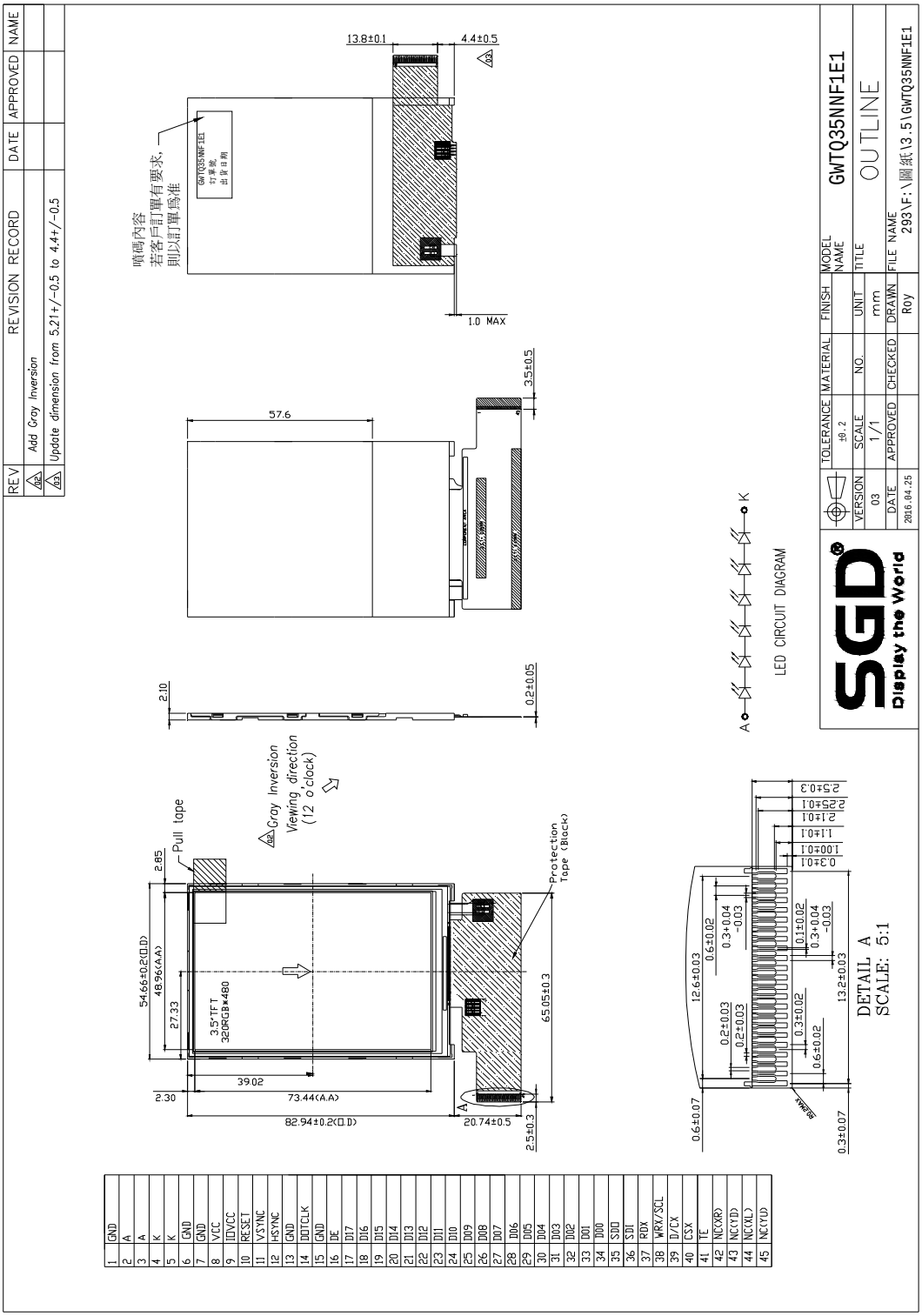
Tests will be not conducted under functioning state.

| No. | Parameter | Condition | Notes |
|---|---|---|---|
| 1 | High Temperature Operating | 70°C±5°C, 120hrs | -- |
| 2 | Low Temperature Operating | -20°C±5°C, 120hrs | -- |
| 3 | High Temperature Storage | 80°C±5°C, 240hrs. | -- |
| 4 | Low Temperature Storage | -30°C±5°C, 240hrs. | -- |
| 5 | High Temperature and High Humidity Operation Test | 60°C±5°C, 90%, 240hrs | -- |
| 6 | Vibration Test | Frequency range : 10Hz ~ 55Hz<br>Amplitude of vibration : 1.5mm Sweep time: 12 min<br>X,Y,Z 2 hours for each direction. | -- |
| 7. | Drop Test | To be measured after dropping from 60cm high on the concrete surface in packing state.<br>  <br>*Dropping method corner dropping*<br>*A corner: once*<br>*Edge dropping*<br>*B, C, D edge: once*<br>*Face dropping*<br>*E, F, G face: once* | -- |

Notes: 1. No dew condensation to be observed.

2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
3. Vibration test will be conducted to the product itself without putting I in a container.

## 10 Dimensional outlines



## 11 Incoming Inspection Standards

### 11.1 Inspection and Environment Conditions

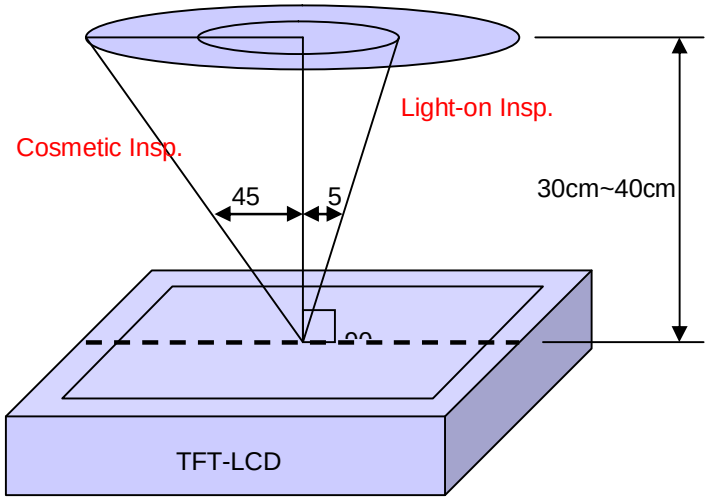
#### 11.1.1 Inspection Conditions:

(1) Inspection Distance: 35 cm±5cm

(2) View Angle:

Light-on Inspection Angle：±5°

Cosmetic Inspection Angle：±45°




(perpendicular to LCD panel surface)

#### 11.1.2 Environment Conditions:

| | | |
|---|---|---|
| Ambient Temperature | | 23℃±5℃ |
| Ambient Humidity | | 55±10%RH |
| Ambient Illumination | Cosmetic Inspection | more than 600 Lux |
| | Functional Inspection | 300~500 Lux |

#### 11.1.3 Sampling Conditions:

(1) Lot Size: Quantity of shipment lot per model

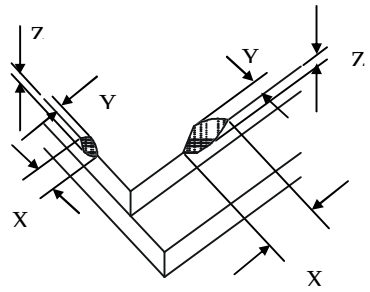
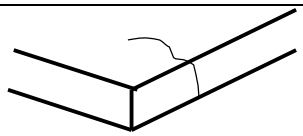
(2) Sampling Method:

| | | |
|---|---|---|
| Sampling Plan | | MIL-STD-105E |
| | | Normal Inspection, Single Sampling |
| | | Level II |
| AQL | Major Defect | 1.0% |
| | Minor Defect | 1.5% |

(3)The classification of Major(MA) and Minor(MI) defects is shown as 3. Inspection Criteria.

### 11.2 Inspection Criteria

11.2.1 Cosmetic Inspection(Panel):

| Item | Judgment Criteria | Classification |
|---|---|---|
| Chipping on Panel/Touch Panel |  X: Ignored ;b≦3.0mm、c≦t ( Bottom glass thickness) | MA |
| Scratch on Panel/Touch Panel *Note-2 | W≦0.05mm or L< 5mm: Ignored<br>0.05mm<W≦0.1mm and L≦5mm: N≦5<br>W>0.1mm or L>5mm: Not allowed | MI |
| Bubble or Dent on Panel/Touch Panel *Note-3 | D≦0.2mm: Ignored<br>0.2mm<D≦0.3mm: N≦5<br>D>0.3mm: Not allowed | MI |
| Panel/Touch Panel Crack |  Not Allowed crack | MA |
| Bezel Deformation | Obvious deformation is not allowed. | MI |
| Bezel Oxidation | Not allowed if it rusts continuously over 1 cm (It is out of warranty with rusted tin plate) | MI |
| Bezel Scratch | No sense of scratch ignored;<br>sense of scratchL≦20mm , W≦0.2 , N≦3 | MI |
| **quash Dent /Flange(Front Side)** | **D(W)≦1,L≦3,N≦3;** | MI |
| B/L High Voltage Wire Denudation | Not allowed | MA |
| Polarizer flaw or leak out resin | Defect is defined as the active area. | MI |

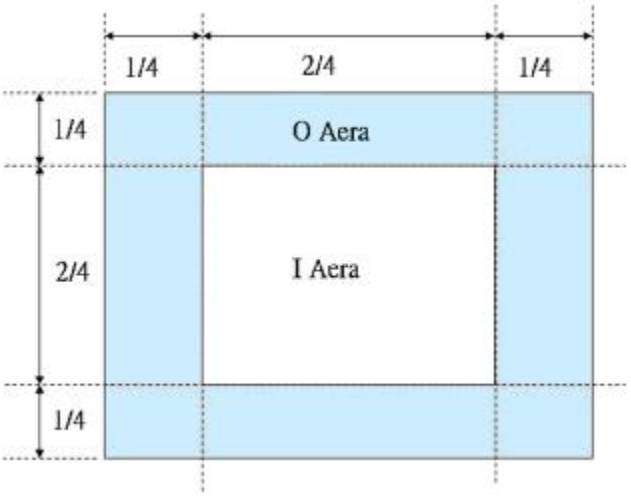
| | | |
|---|---|---|
| Outline Dimension | Must in Spec, refer to related product spec. | MI |

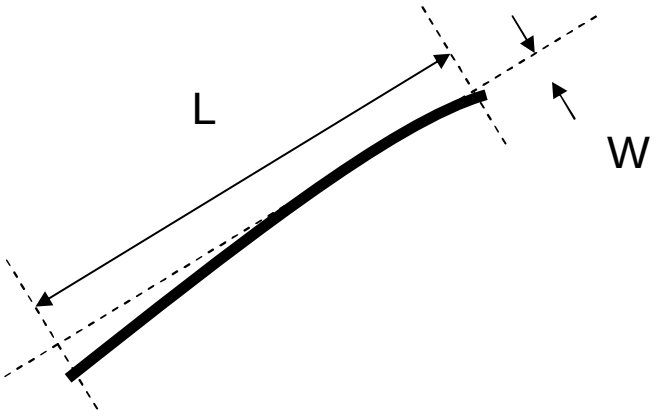
11.2.2 **Functional Inspection:**

| 項目/ Item | 判斷標準/ Judgment Criteria | | | | 分類/ Classification |
|---|---|---|---|---|---|
| | Area(Note1) | | I | O | |
| Point Defect | Bright dot | Random | 2 | | MI |
| | | 2 dots adjacent | 0 | 0 | |
| | | 3 dots adjacent or more | 0 | 0 | |
| | Dark dot | Random | 3 | | |
| | | 2 dots adjacent | 1 | | |
| | | 3 dots adjacent or more | 0 | 0 | |
| | Total Dot Defect | | 5 | | |
| | Distance | Distance between Bright and Bright dot | L≧5mm | | |
| | | Distance between Bright and Dark dot | L≧5mm | | |
| | | Distance between Dark dot | L≧5mm | | |
| | (1) It is defined as Point Defect if defect area＞0.5dot<br>(2) It is ignored if defect area≦0.5dot<br>(3) Weak point defect will be defined as Bright Dot if it can be observed through ND filter 5%( Full Screen Black Inspection) | | | | |
| Line Defect | Obvious vertical or horizontal line defect is not allowed. | | | | MA |
| Mura | Not allowed if it can be observed through ND Filter 6 % | | | | MI |
| Foreign Material in spot shape *Note-3 | D≦0.2mm: Ignored<br>0.2mm<D≦0.5mm: N≦8<br>D>0.5mm: Not allowed | | | | MI |
| Foreign Material in line or spiral shape *Note-4 | W≦0.05mm or L≦5mm: Ignored/不計<br>0.05mm<W≦0.2mm and L1.0mm≦5mm: N≦8<br>W>0.2mm or L>5mm: Not allowed | | | | MI |
| Display Function Abnormal | No Malfunction can be allowed | | | | MA |
| Touch panel Malfunction *Note-5 | No Malfunction can be allowed in AA area. | | | | MA |

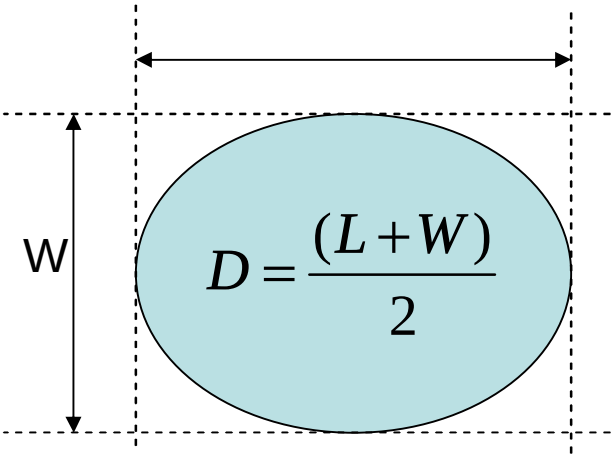
Note-1：I/OArea Definition

Note-2：Polarizer Scratch

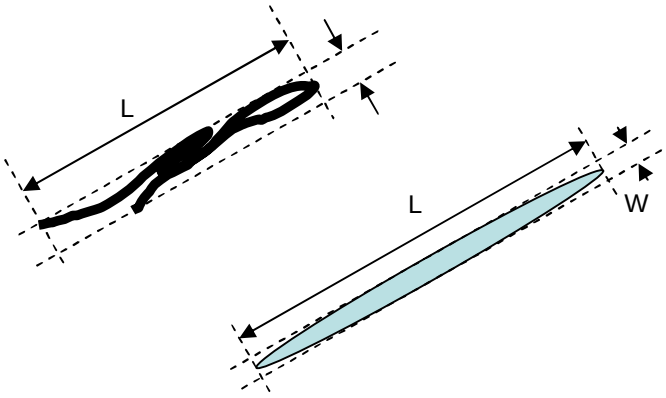



Note-3：Spot Foreign Material
(W ≧L / 4 )




Note-4：Line or Spiral Foreign Material
(W<L / 4)




Note-5：
TP Inspection Area Definition
OD 區