**4D LCD PTY LTD**
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AUSTRALIA
www.4dlcd.com

# 4DLCD-90800480-[RTP/CTP]

## 9.0” TFT Liquid Crystal Display

# DATASHEET

**Document Date: 19th January 2019**
**Document Revision: 1.0**

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Please refer to the 4DLCD website for the latest Revision of this Document

## Revision History

| REVISION | DATE | COMMENT | REMARKS |
|---|---|---|---|
| 1.0 | 19/01/2019 | Initial Draft | Initial Draft Version |

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# 1. General Specification

4DLCD-90800480 is a colour active matrix LCD module incorporating amorphous silicon TFT (Thin Film Transistor). It is composed of a colour TFT-LCD panel, driver IC, FPC and a back light unit and with/without a Resistive/Capacitive Touch Panel (RTP or CTP). The module display area contains 800 x 480 pixels. This product accords with RoHS environmental criterion.

| ITEM | | CONTENTS | UNIT |
|---|---|---|---|
| LCD Type | | TFT / Transmissive / Normally white | |
| Size | | 9.0 | Inch |
| Viewing Direction | | 6:00 (without image inversion) | O'Clock |
| Gray Scale Inversion Direction | | 12:00 | O'Clock |
| LCD (W × H) | | 210.7 x 126.4 | $mm^2$ |
| Active Area (W × H) | | 198 × 111.696 | $mm^2$ |
| Dot Pitch (W × H) | | 0.0825 × 0.2327 | $mm^2$ |
| Number of Dots (Pixels) | | 800 (RGB) × 480 | |
| Driver IC | | Source: EK9716 Gate: EK73002 | |
| Backlight Type | | 33 LEDs | |
| Surface Luminance | 4DLCD-90800480 | 500 (typical) | $cd/m^2$ |
| | 4DLCD-90800480-RTP | 450 (typical) | |
| | 4DLCD-90800480-CTP | 475 (typical) | |
| Interface Type | | TTL | |
| Color Depth | | 16.7M | |
| Pixel Arrangement | | RGB Vertical Stripe | |
| Surface Treatment | | AG | |
| Input Voltage | | 3.3 (typical) | V |
| Weight | 4DLCD-90800480 | 192.8 | g |
| | 4DLCD-90800480-RTP | 275.6 | |
| | 4DLCD-90800480-CTP | 289.0 | |

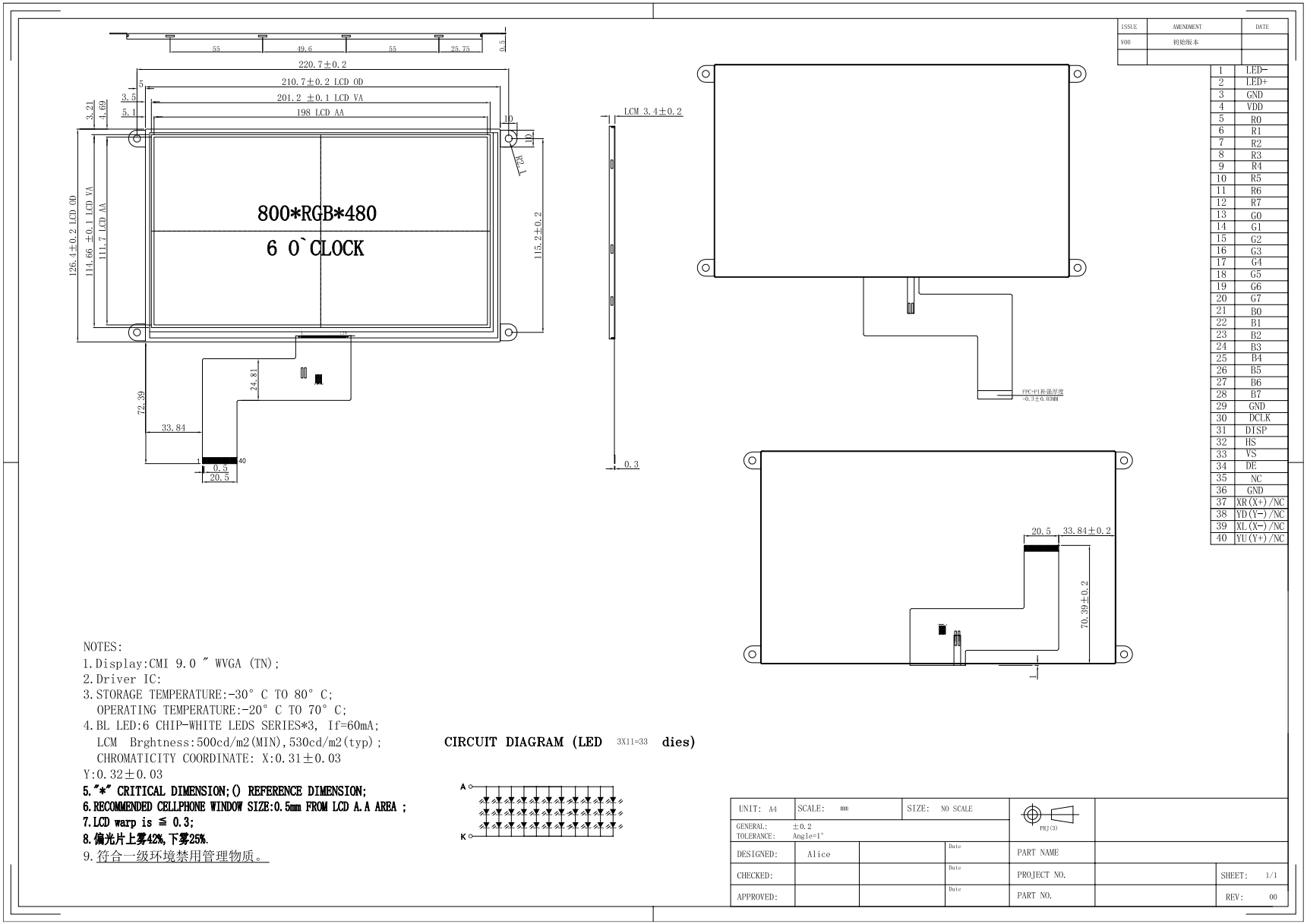
**Note 1:** RoHS compliant

**Note 2:** LCD weight tolerance: ± 5%.

**Part Number Details:**

| | |
|---|---|
| 4DLCD | 4DLCD LCD Display |
| 90800480 | 9.0 inch, 800 x 480 Resolution |
| RTP | Resistive Touch |
| CTP | Capacitive Touch |

## 2. TFT LCD Display Drawing (Non Touch Version)




| ISSUE | AMENDMENT | DATE |
|---|---|---|
| V00 | 初始版本 | |

| | |
|---|---|
| 1 | LED- |
| 2 | LED+ |
| 3 | GND |
| 4 | VDD |
| 5 | R0 |
| 6 | R1 |
| 7 | R2 |
| 8 | R3 |
| 9 | R4 |
| 10 | R5 |
| 11 | R6 |
| 12 | R7 |
| 13 | G0 |
| 14 | G1 |
| 15 | G2 |
| 16 | G3 |
| 17 | G4 |
| 18 | G5 |
| 19 | G6 |
| 20 | G7 |
| 21 | B0 |
| 22 | B1 |
| 23 | B2 |
| 24 | B3 |
| 25 | B4 |
| 26 | B5 |
| 27 | B6 |
| 28 | B7 |
| 29 | GND |
| 30 | DCLK |
| 31 | DISP |
| 32 | HS |
| 33 | VS |
| 34 | DE |
| 35 | NC |
| 36 | GND |
| 37 | XR(X+)/NC |
| 38 | YD(Y-)/NC |
| 39 | XL(X-)/NC |
| 40 | YU(Y+)/NC |

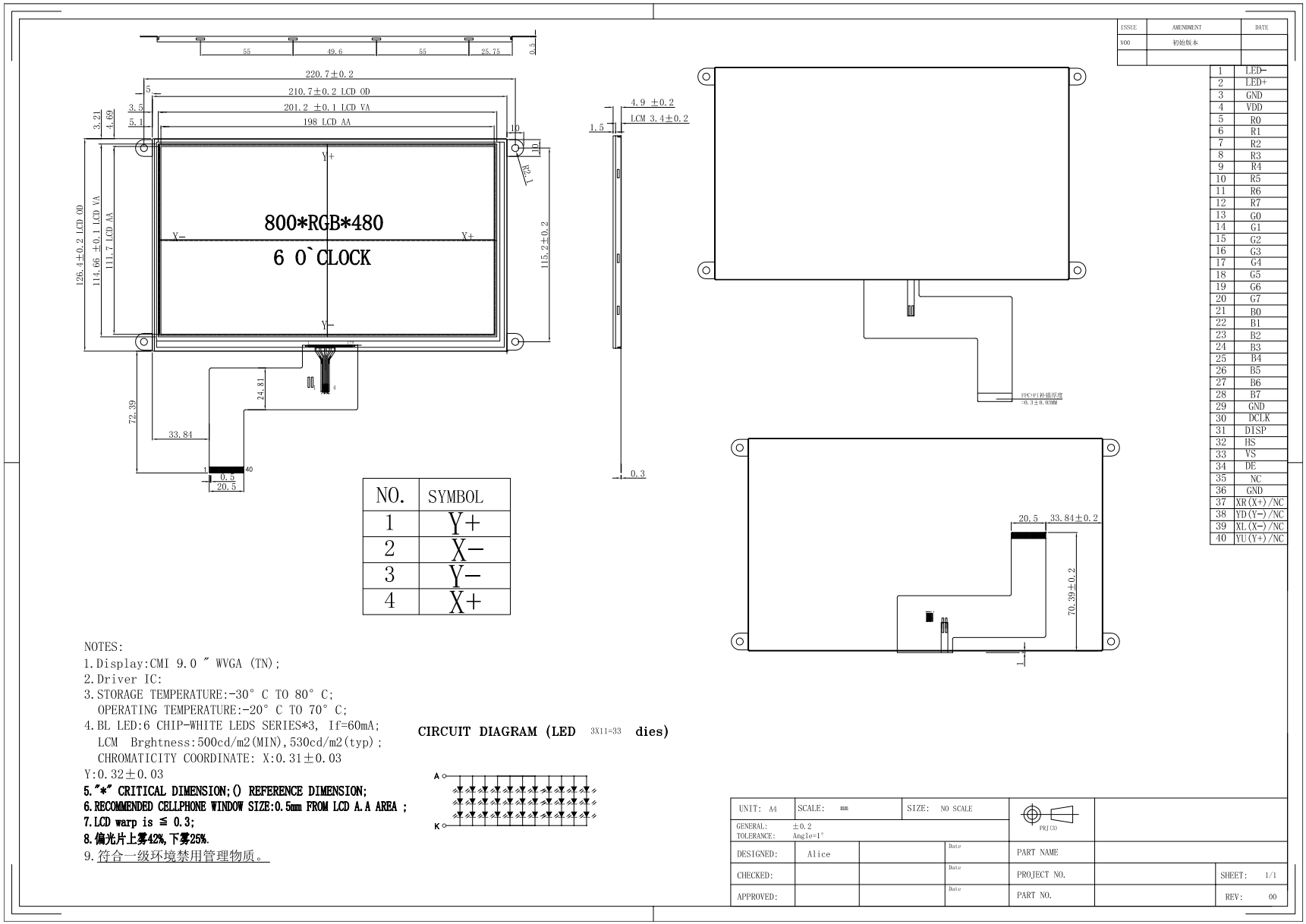
NOTES:
1. Display:CMI 9.0 ″ WVGA (TN);
2. Driver IC:
3. STORAGE TEMPERATURE:-30° C TO 80° C;
   OPERATING TEMPERATURE:-20° C TO 70° C;
4. BL LED:6 CHIP-WHITE LEDS SERIES*3, If=60mA;
   LCM Brghtness:500cd/m2(MIN),530cd/m2(typ);
   CHROMATICITY COORDINATE: X:0.31±0.03
   Y:0.32±0.03
5. **"*" CRITICAL DIMENSION;() REFERENCE DIMENSION;**
6. **RECOMMENDED CELLPHONE WINDOW SIZE:0.5mm FROM LCD A.A AREA ;**
7. **LCD warp is ≦ 0.3;**
8. **偏光片上雾42%,下雾25%.**
9. 符合一级环境禁用管理物质。

**CIRCUIT DIAGRAM (LED 3X11=33 dies)**




| | | | | | |
|---|---|---|---|---|---|
| UNIT: A4 | SCALE: mm | | SIZE: NO SCALE | PRJ(3) | |
| GENERAL TOLERANCE: | ±0.2 Angle=1° | | | | |
| DESIGNED: | Alice | | Date | PART NAME | |
| CHECKED: | | | Date | PROJECT NO. | SHEET: 1/1 |
| APPROVED: | | | Date | PART NO. | REV: 00 |

## 3. TFT LCD Display Drawing (Resistive Touch Version)




| NO. | SYMBOL |
|---|---|
| 1 | Y+ |
| 2 | X− |
| 3 | Y− |
| 4 | X+ |

| ISSUE | AMENDMENT | DATE |
|---|---|---|
| V00 | 初始版本 | |

| | |
|---|---|
| 1 | LED- |
| 2 | LED+ |
| 3 | GND |
| 4 | VDD |
| 5 | R0 |
| 6 | R1 |
| 7 | R2 |
| 8 | R3 |
| 9 | R4 |
| 10 | R5 |
| 11 | R6 |
| 12 | R7 |
| 13 | G0 |
| 14 | G1 |
| 15 | G2 |
| 16 | G3 |
| 17 | G4 |
| 18 | G5 |
| 19 | G6 |
| 20 | G7 |
| 21 | B0 |
| 22 | B1 |
| 23 | B2 |
| 24 | B3 |
| 25 | B4 |
| 26 | B5 |
| 27 | B6 |
| 28 | B7 |
| 29 | GND |
| 30 | DCLK |
| 31 | DISP |
| 32 | HS |
| 33 | VS |
| 34 | DE |
| 35 | NC |
| 36 | GND |
| 37 | XR(X+)/NC |
| 38 | YD(Y−)/NC |
| 39 | XL(X−)/NC |
| 40 | YU(Y+)/NC |

NOTES:
1. Display:CMI 9.0 ″ WVGA (TN);
2. Driver IC:
3. STORAGE TEMPERATURE:-30° C TO 80° C;
   OPERATING TEMPERATURE:-20° C TO 70° C;
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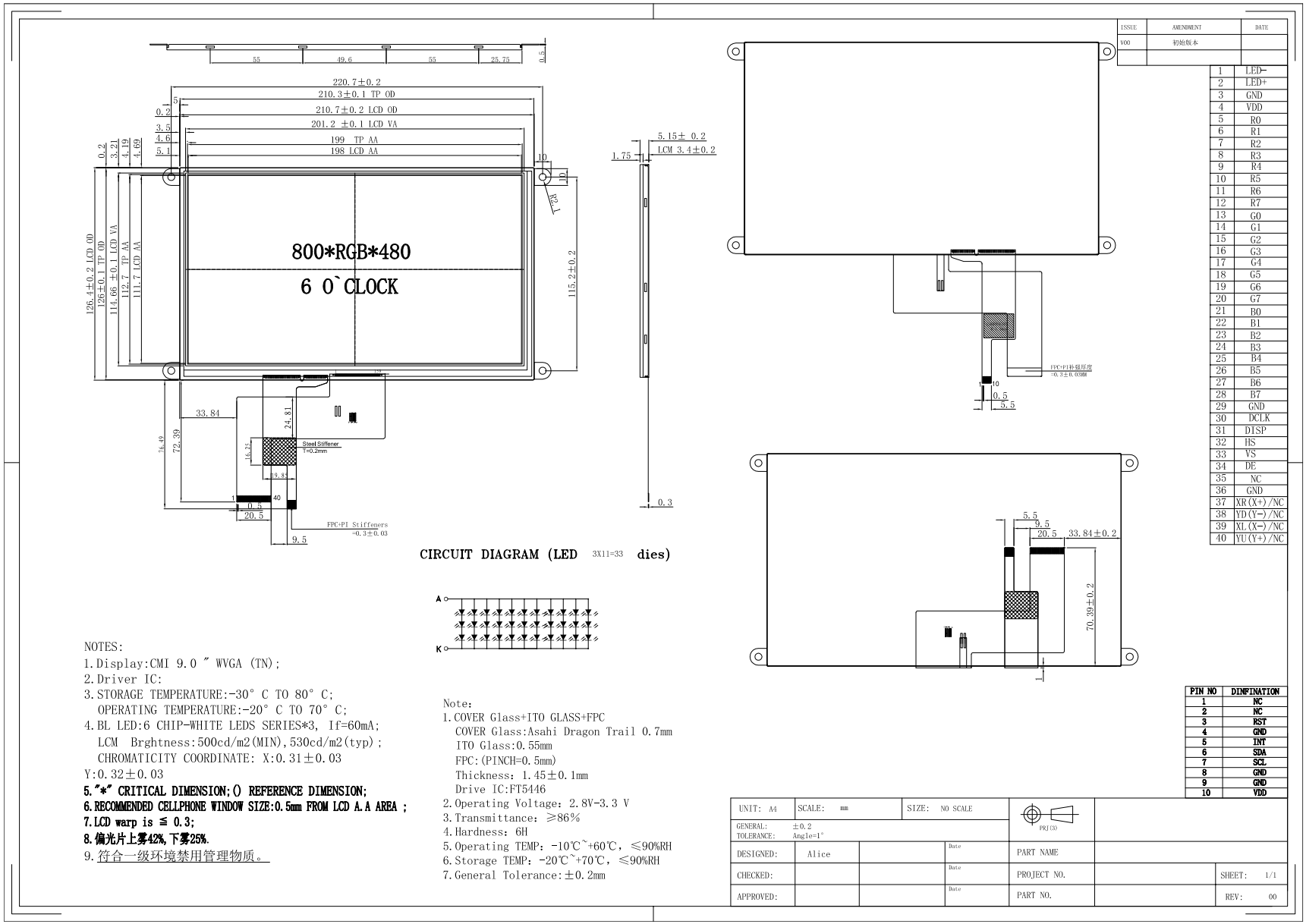
   LCM Brghtness:500cd/m2(MIN),530cd/m2(typ);
   CHROMATICITY COORDINATE: X:0.31±0.03
   Y:0.32±0.03
5. **"*" CRITICAL DIMENSION;() REFERENCE DIMENSION;**
6. **RECOMMENDED CELLPHONE WINDOW SIZE:0.5mm FROM LCD A.A AREA ;**
7. **LCD warp is ≦ 0.3;**
8. **偏光片上雾42%,下雾25%.**
9. 符合一级环境禁用管理物质。

**CIRCUIT DIAGRAM (LED 3X11=33 dies)**




| | | | | | |
|---|---|---|---|---|---|
| UNIT: A4 | SCALE: nn | | SIZE: NO SCALE | PRJ(3) | |
| GENERAL TOLERANCE: | ±0.2 Angle=1° | | | | |
| DESIGNED: | Alice | | Date | PART NAME | |
| CHECKED: | | | Date | PROJECT NO. | SHEET: 1/1 |
| APPROVED: | | | Date | PART NO. | REV: 00 |

# 4. TFT LCD Display Drawing (Capacitive Touch Version)



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## 5. Absolute Maximum Ratings

| PARAMETER | SYMBOL | MIN | MAX | UNIT |
|---|---|---|---|---|
| Supply Voltage for LCD Logic | VDD/VCC | -0.3 | 4.6 | V |
| Supply Voltage for TP Logic | VDD/VCC-VSS | - | - | V |
| Input Voltage for Logic | VIN | VSS-0.5 | VDD | V |
| LED forward current (each LED) | IF | - | 25 | mA |
| Operating Temperature | $T_{OP}$ | -20 | 70 | °C |
| Storage Temperature | $T_{ST}$ | -30 | 80 | °C |
| Humidity | RH | - | 90% (Max 60°C) | RH |

## 6. Electrical Characteristics

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Power Voltage | VDD/DCC | 2.6 | 3.3 | 3.6 | V |
| Input Current | IVDD | - | - | - | mA |
| Input Voltage 'H' Level | $V_{IH}$ | 0.7 VDD | - | VDD | V |
| Input Voltage 'L' Level | $V_{IL}$ | 0 | - | 0.3 VDD | V |

## 7. Electro-Optical Characteristics

| ITEM | | SYM | CONDITION | MIN | TYP | MAX | UNIT | REMARK |
|---|---|---|---|---|---|---|---|---|
| Response Time | | Tr+Tf | θ=0 | - | 25 | - | ms | Figure 1 (4) |
| Contrast Ratio | | Cr | ° | - | 500 | - | - | Figure 2 (1) |
| Luminance Uniformity | | δ WHITE | Ø=0 | - | 60 | - | % | Figure 2 (3) |
| Surface Luminance | | Lv | 4DLCD-90800480 | - | 500 | - | cd/m2 | Figure 2 (2) |
| | | | 4DLCD-90800480-RTP | - | 450 | - | | |
| | | | 4DLCD-90800480-CTP | - | 475 | - | | |
| Viewing Angle Range | | θ | Ø = 90° | 60 | 70 | - | deg | Figure 3 (6) |
| | | | Ø = 270° | 60 | 70 | - | deg | |
| | | | Ø = 0° | 40 | 50 | - | deg | |
| | | | Ø = 180° | 60 | 70 | - | deg | |
| CIE (x,y) Cromacity | Red | x | θ=0° Ø=0° Ta=25 | +/-0.1 | 0.630 | +/-0.1 | | Figure 2 (5) |
| | | y | | | 0.322 | | | |
| | Green | x | | | 0.302 | | | |
| | | y | | | 0.558 | | | |
| | Blue | x | | | 0.142 | | | |
| | | y | | | 0.130 | | | |
| | White | x | | | 0.296 | | | |
| | | y | | | 0.332 | | | |

## 8. Backlight Characteristics

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|
| Voltage for LED backlight | $V_l$ | - | 3.2 | 3.4 | V |
| Current for LED backlight | $I_l$ | - | 80 | 100 | mA |
| LED Life Time | - | 30000 | - | - | Hrs |

**Note:** The LED life time is defined as the module brightness decrease to 50% original brightness at Ta=25°C.

**Note 1**: Contrast Ratio(CR) is defined mathematically as below, for more information see Figure 1.

$$\text{Contrast Ratio} = \frac{\text{Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Average Surface Luminance with all black pixels (P1, P2, P3, P4, P5)}}$$

**Note 2**: Surface luminance is the LCD surface from the surface with all pixels displaying white. For more information, see Figure 2.

Lv = Average Surface Luminance with all white pixels (P1, P2, P3, P4, P5

**Note 3**: The uniformity in surface luminance δ WHITE is determined by measuring luminance at each test position 1 through 5, and then dividing the maximum luminance of 5 points luminance by minimum luminance of 5 points luminance. For more information, see Figure 2.

$$\delta \text{ WHITE} = \frac{\text{Minimum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}{\text{Maximum Surface Luminance with all white pixels (P1, P2, P3, P4, P5)}}$$

**Note 4**: Response time is the time required for the display to transition from white to black (Rise Time, Tr) and from black to white (Decay Time, Tf). For additional information see FIG 1. The test equipment is Autronic-Melchers ConoScope series.

**Note 5**: CIE (x, y) chromaticity, the x, y value is determined by measuring luminance at each test position 1 through 5, and then make average value.

**Note 6**: Viewing angle is the angle at which the contrast ratio is greater than 2. For TFT module the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information, see Figure3.

**Note 7**: For viewing angle and response time testing, the testing data is based on Autronic-Melchers ConoScope series. Instruments for Contrast Ratio, Surface Luminance, Luminance Uniformity, CIE the test data is based on TOPCONs BM-5 photo detector.

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**Figure 1.** The definition of response time

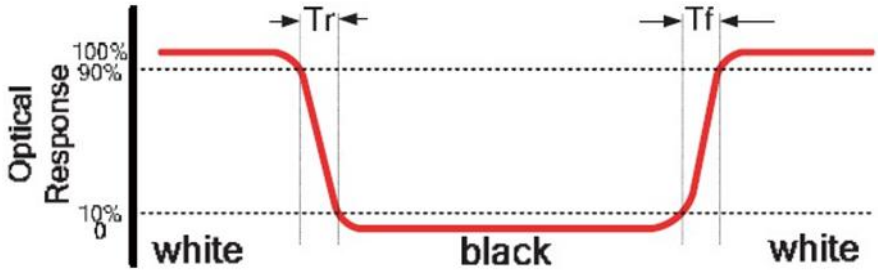



**Figure 2.** Measuring method for Contrast ratio, surface luminance, Luminance uniformity, CIE (x, y) chromaticity

A : 5 mm
B : 5 mm
H, V : Active Area
Light spot size ∅=5mm, 500mm distance from the LCD surface to detector lens
measurement instrument is TOPCON's luminance meter BM-5

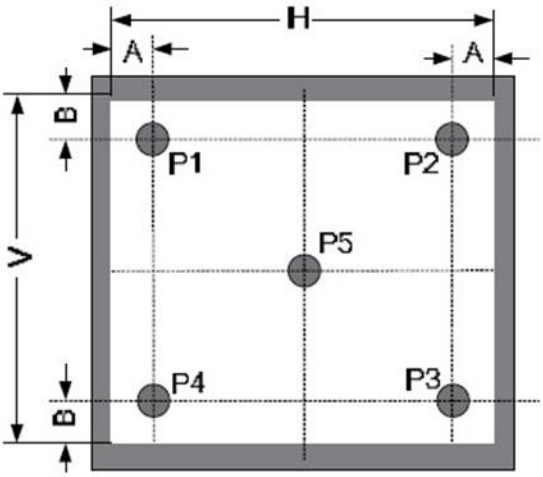
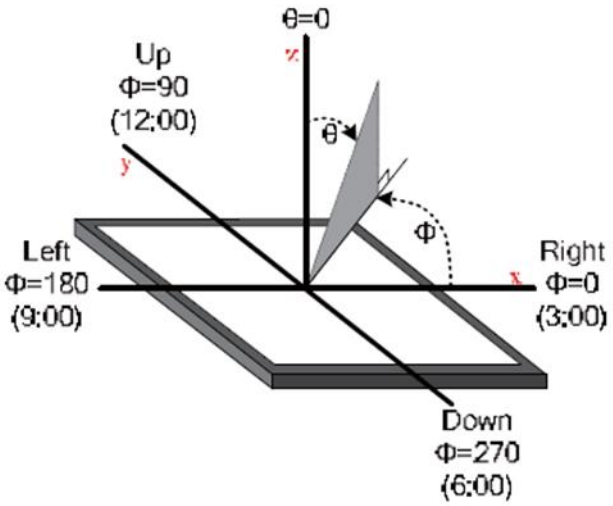



**Figure 3.** The definition of viewing angle

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# 9. Interface Descriptions

## 9.1 LCD Interface

| PIN NO. | SYMBOL | DESCRIPTION | REMARK |
|---|---|---|---|
| 1 | LED- | Cathode of LED Backlight | |
| 2 | LED+ | Anode of LED Backlight | |
| 3 | GND | Ground | |
| 4 | DVDD | Power supply | |
| 5 | R0 | Red data input R0. | |
| 6 | R1 | Red data input R1. | |
| 7 | R2 | Red data input R2. | |
| 8 | R3 | Red data input R3. | |
| 9 | R4 | Red data input R4. | |
| 10 | R5 | Red data input R5. | |
| 11 | R6 | Red data input R6. | |
| 12 | R7 | Red data input R7. | |
| 13 | G0 | Green data input G0. | |
| 14 | G1 | Green data input G1. | |
| 15 | G2 | Green data input G2. | |
| 16 | G3 | Green data input G3. | |
| 17 | G4 | Green data input G4. | |
| 18 | G5 | Green data input G5. | |
| 19 | G6 | Green data input G6. | |
| 20 | G7 | Green data input G7. | |
| 21 | B0 | Blue data input B0. | |
| 22 | B1 | Blue data input B1. | |
| 23 | B2 | Blue data input B2. | |
| 24 | B3 | Blue data input B3. | |
| 25 | B4 | Blue data input B4. | |
| 26 | B5 | Blue data input B5. | |
| 27 | B6 | Blue data input B6. | |
| 28 | B7 | Blue data input B7. | |
| 29 | GND | Ground | |
| 30 | DCLK | Clock for input data. Data latched at rising/falling edge of this signal. Default is falling edge. | |
| 31 | DISP | Standby mode control.(Normally pull high)<br>STBYB=”L”, enter standby mode for power saving. Timing controller source driver will turn off, all outputs are Hi-Z.<br>STBYB=”H”, normal operation. | |
| 32 | HS | Horizontal sync input | |
| 33 | VS | Vertical sync input | |
| 34 | DE | Input data enable control. When DE mode, active High to enable data input(Normally pull low) | |
| 35 | NC | No Connect | |
| 36 | GND | Ground | |
| 37 | XR | The touch panel X right pin | |
| 38 | YD | The touch panel Y down pin | |
| 39 | XL | The touch panel X left pin | |
| 40 | YU | The touch panel Y up pin | |

**Recommended LCD connector:** 40-way, 0.5 mm pitch FFC connector

TFT LCD 4DLCD-90800480-[RTP/CTP]

## 9.2 CTP Interface

| PIN No. | SYMBOL | DESCRIPTION | REMARK |
|---|---|---|---|
| 1 | NC | No Connect | Only connected to the CTP Panel, not connected to the LCD itself |
| 2 | NC | No Connect | |
| 3 | RST | Reset pin | |
| 4 | GND | Ground | |
| 5 | INT | Interrupt signal from CTP | |
| 6 | SDA | I2C SDA | |
| 7 | SCL | I2C SCL | |
| 8 | GND | Ground | |
| 9 | GND | Ground | |
| 10 | VDD | Power Supply (3.3V) | |

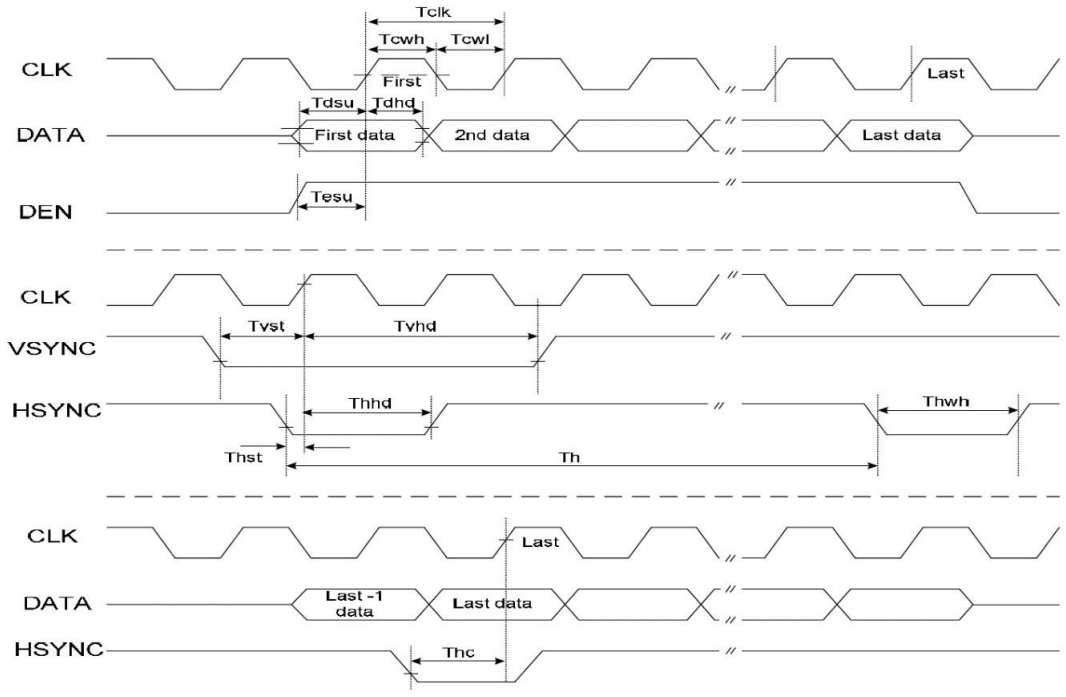
The Capacitive Touch is driven by a **Focaltech FT5446** capacitive touch driver IC, which utilizes an I2C interface, and is capable of 5-point touch.

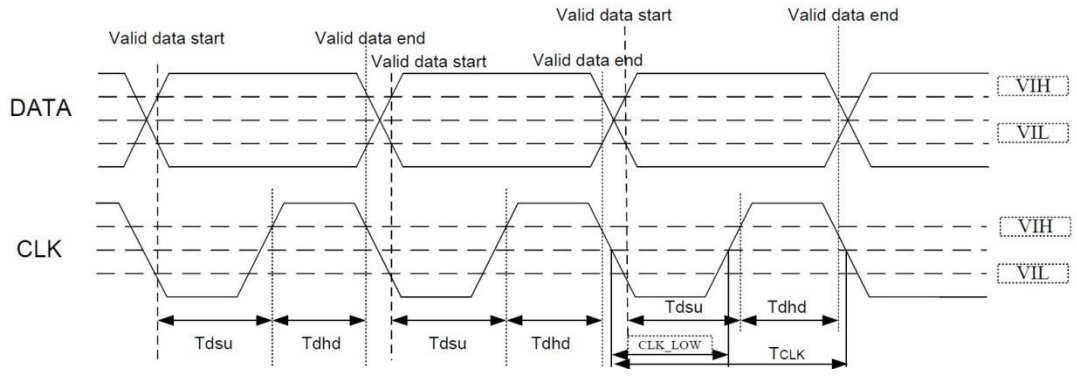
# 10. LCD Timing Details

## 10.1 Timing Chart

| PARAMETER | SYMBOL | MIN | TYP | MAX | UNIT | CONDITION |
|---|---|---|---|---|---|---|
| CLK Clock Time | $T_{clk}$ | 1/Max($F_{CLK}$) | - | 1/Min($F_{CLK}$) | ns | - |
| CLK Pulse Duty | $T_{chw}$ | 40 | 50 | 60 | % | $T_{CLK}$ |
| HSYNC to CLK | $T_{hc}$ | - | - | 1 | CLK | - |
| HSYNC Width | $T_{hwh}$ | 1 | - | - | CLK | - |
| VSYNC Width | $T_{vwh}$ | 1 | - | - | ns | - |
| HSYNC Period Time | $T_h$ | 60 | 63.56 | 67 | ns | - |
| VSYNC Set-up Time | $T_{vst}$ | 12 | - | - | ns | - |
| VSYNC Hold Time | $T_{vhd}$ | 12 | - | - | ns | - |
| HSYNC Setup Time | $T_{hst}$ | 12 | - | - | ns | - |
| HSYNC Hold Time | $T_{hhd}$ | 12 | - | - | ns | - |
| Data Set-up Time | $T_{dsu}$ | 12 | - | - | ns | D00~D23 to CLK |
| Data Hold Time | $T_{dhd}$ | 12 | - | - | ns | D00~D23 to CLK |
| DEN Set-up Time | $T_{esu}$ | 12 | - | - | ns | DEN to CLK |

Timing parameter (VDD=3.3V, GND=0V, Ta=25℃)




Timing parameter (VDD=3.3V, GND=0V, Ta=25℃)

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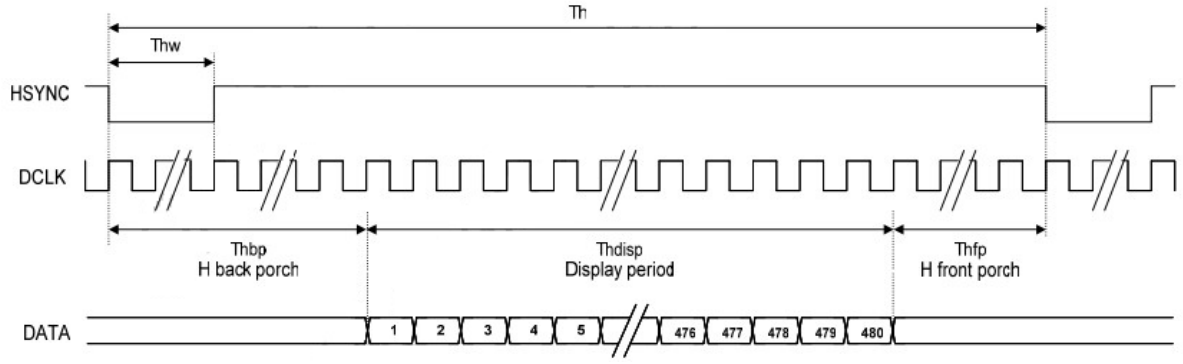
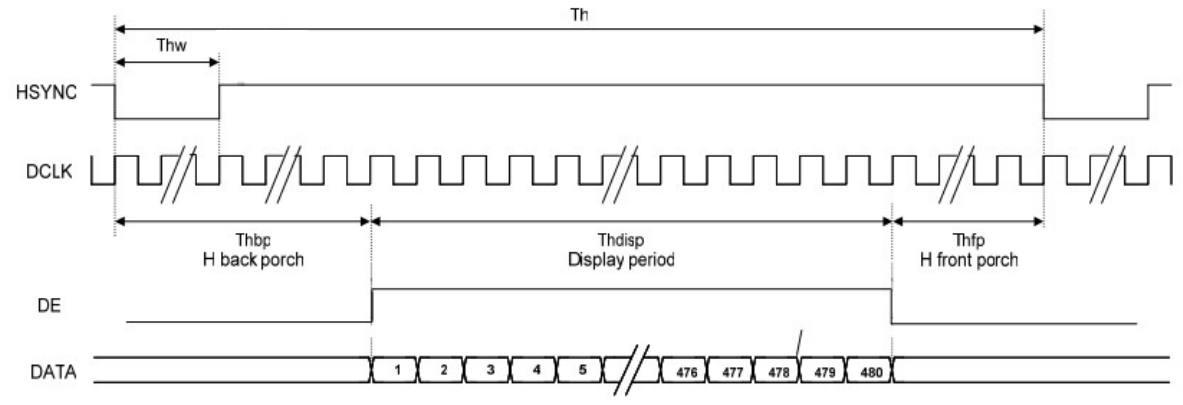
## 10.2 Timing Characteristic

| ITEM | | SYMBOL | MIN | TYP | MAX | UNIT | |
|---|---|---|---|---|---|---|---|
| DCLK Frequency | | Fclk | 20 | 33.3 | 50 | MHz | |
| DCLK Period | | Tclk | - | - | - | Ns | |
| Hsync | Period Time | Th | 908 | 928 | 1088 | DCLK | |
| | Display Period | Thdisp | | 800 | - | DCLK | |
| | Pulse width | tvpw | 1 | 48 | 87 | DCLK | By H BLANKING setting |
| | Back Porch (Blanking) | tvb | 87 | 40 | 1 | DCLK | |
| | Front porch | tvfp | 20 | 40 | 200 | DCLK | |
| Vsync | Period Time | Tv | 517 | 525 | 712 | H | |
| | Display Period | Tvdisp | - | 480 | - | H | |
| | Pulse width | tvpw | 1 | 1 | 3 | H | By V BLANKING setting |
| | Back Porch (Blanking) | tvb | 31 | 31 | 29 | H | |
| | Front porch | tvfp | 5 | 13 | 200 | H | |

## 10.3 SYNC Mode Timing Diagram




## 10.4 SYNC-DE Mode Timing Diagram

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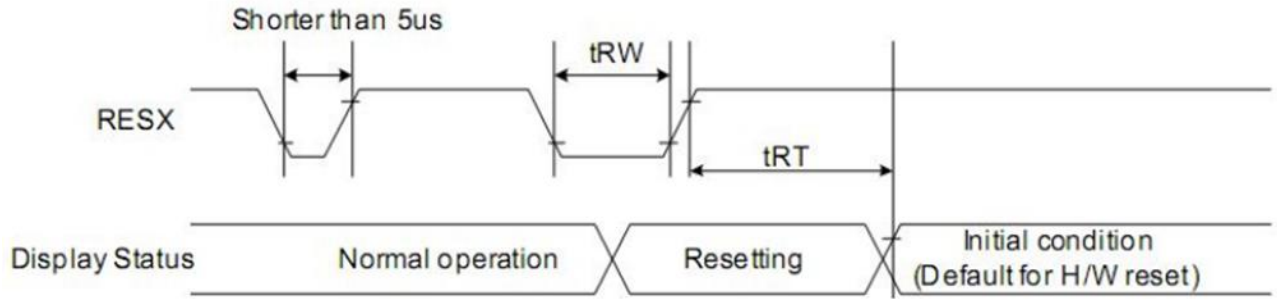
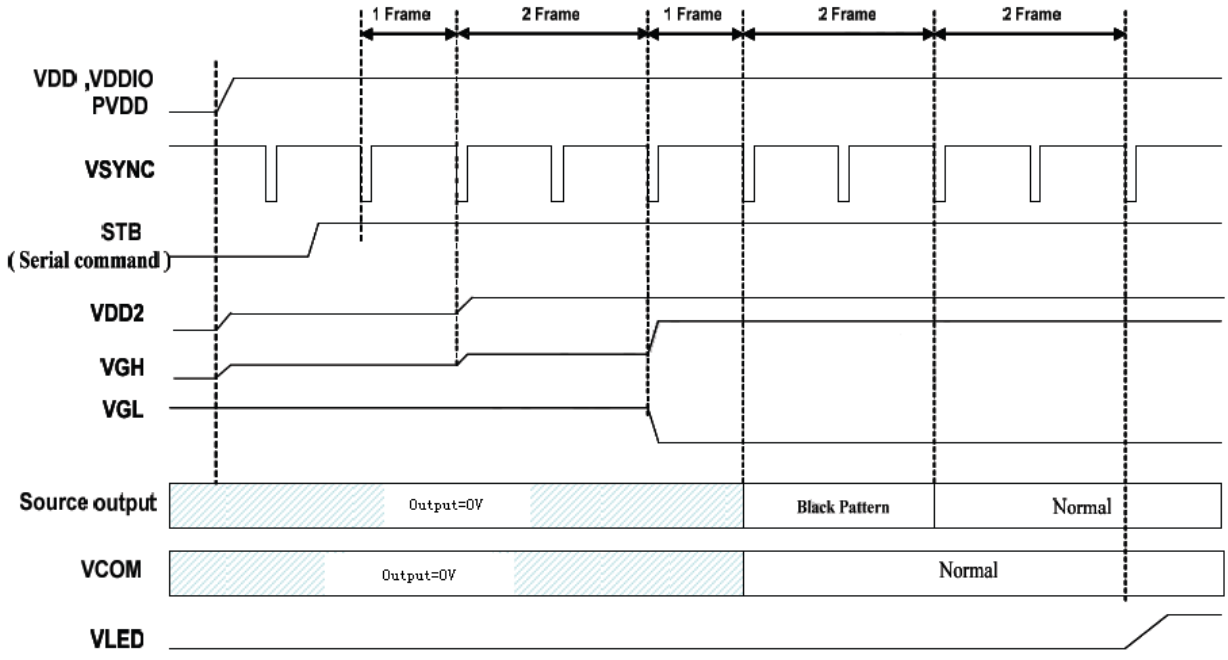
## 10.5 Reset Timing




| SIGNAL | SYMBOL | PARAMETER | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| RESET | tRW | Reset low pulse width | 40 | - | us |
| | tRT | Reset complete time | - | 5 (note1) | ms |
| | | | - | 120 (note2) | ms |

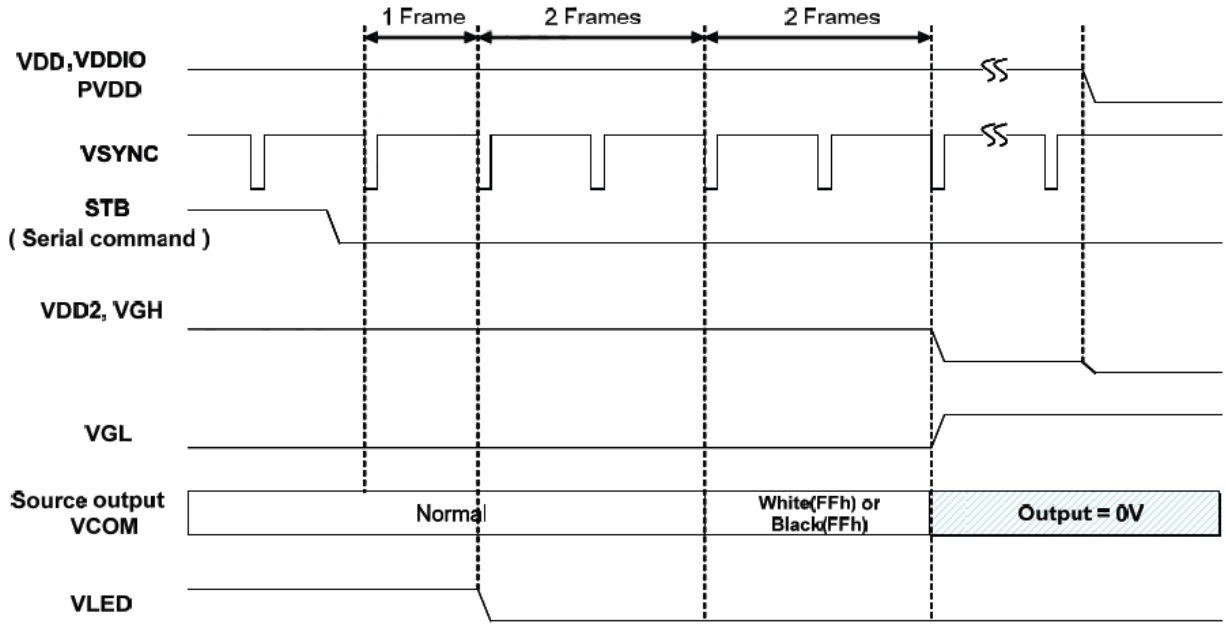
**Note 1**: When reset applied during SLPIN mode
**Note 2**: When reset applied during SLPOUT mode.

## 10.6 Power on Sequence




TFT LCD 4DLCD-90800480-[RTP/CTP]

## 10.7 Power-off Sequence




**Note:**
When normally-black LC is used, please send black pattern to discharge the panel.
When normally-white LC is used, please send white pattern to discharge the panel

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## 11. Reliability Test

| No. | SYMBOL | TEST CONDITION | REMARK |
|---|---|---|---|
| 1 | High Temperature Storage | 80℃±2℃ 96H<br>Restore 2H at 25℃<br>Power off | After test cosmetic and electrical defects should not happen. |
| 2 | Low Temperature Storage | -30℃±2℃ 96H<br>Restore 2H at 25℃<br>Power off | |
| 3 | High Temperature Operation | 70℃±2℃ 96H<br>Power on | |
| 4 | Low Temperature Operation | -20℃±2℃ 96H<br>Power on | |
| 5 | High Temperature & Humidity Operation | 60℃±2℃<br>90%RH 96H<br>Power on | |
| 6 | Temperature Cycle | -20℃←→25℃←→70℃<br>30min 5min 30min<br>After 10 cycles, restore 2H at 25℃<br>Power off | |
| 7 | Vibration Test | 10Hz~150Hz, 100m/s$^2$, 120min | |
| 8 | Shock Test | Half-sinewave, 300m/s$^2$, 11ms | |

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# 12. Precautions for Using LCD Modules

## 12.1 Handing Precautions

- The display panel is made of glass and polarizer. The glass is fragile. It tends to be chipped during handling especially on the edges. Please avoid dropping or jarring. Please be careful not subject it to a mechanical shock by dropping it on impact.
- If the display panel is damaged and the liquid crystal substance leaks out, be sure not to get any of it in your mouth. If the substance contacts your skin or clothes, wash it off using soap and water.
- Do not apply excessive force to the display surface or to the adjoining areas since this may cause the color tone to vary. Do not touch the display with bare hands. This will stain the display area and degraded insulation between terminals (some cosmetics are determined by the polarizer).
- The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully. Do not touch, push or rub the exposed polarizer with anything harder than an HB pencil lead (e.g., glass, tweezers, etc.). Do not put or attach anything on the display area to avoid leaving marks on it. Condensation on the surface and contact with terminals due to cold temperature will damage, stain or contaminate the polarizer. After products are tested at low temperature they must be warmed up in a container before coming into contact with room temperature air.
- If the display surface becomes contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If it is heavily contaminated, moisten the cloth with one of the following solvents
    - Isopropyl alcohol
    - Ethyl alcohol

  Do not scrub hard as it might damage the display surface.

- Solvents other than those mentioned above may damage the polarizer. Especially the following.
    - Water
    - Ketone
    - Aromatic solvents

  Wipe off saliva or water drops immediately, contact with water over a long period of time may cause deformation or color fading. Avoid contact with oil and fat.
- Take necessary precautions to minimize corrosion of the electrode. Corrosion of the electrodes is accelerated by water droplets, moisture condensation or current flow in a high-humidity environment.
- Install the LCD Module by using the mounting holes. When mounting the LCD module, make sure it is free of twisting, warping and distortion. In particular, do not forcibly pull or bend the I/O cable or the backlight cable.
- Do not attempt to disassemble or process the LCD module.
- NC terminal should be open. Do not connect anything on it.
- If the logic circuit power is off, do not apply input signals.
- Control Electro-Static Discharge. Since this module uses a CMOS LSI, the same careful attention should be paid to electrostatic discharge as for an ordinary CMOS IC. To prevent destruction of the elements by static electricity, ensure that an optimum work environment is maintained.

- Before removing the LCM from its packing case or incorporating it into a set, be sure that the module and your body has the same electric potential. Be sure to ground your body when handling the LCD modules.
- To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions. To reduce the generation of static electricity, please ensure that the air in the work environment is not too dry. A relative humidity of 50%-60% is recommended. As much as possible, make the electric potential of your work clothes and that of the work bench the ground potential.
- The LCD module is coated with a film to protect the display surface. Be careful when peeling off this protective film since static electricity may be generated.

- Since the LCM has been assembled and adjusted with a high degree of precision, avoid applying excessive shocks to the module or making any alterations or modifications to it.
  - Do not alter, modify or change the shape of the tab on the metal frame.
  - Do not make extra holes on the printed circuit board, modify its shape or change the positions of components to be attached.
  - Do not damage or modify the pattern writing on the printed circuit board.
  - Absolutely do not modify the zebra rubber strip (conductive rubber) or heat seal connector.
  - Do not drop, bend or twist the LCM.

## 12.2 Storage Precautions

When storing the LCD modules, the following precautions are necessary.

- Store them in a sealed polyethylene bag. If properly sealed, there is no need for the desiccant.
- Store them in a dark place. Do not expose to sunlight or fluorescent light, keep the temperature between 0℃ and 35℃, and keep the relative humidity between 40%RH and 60%RH.
- The polarizer surface should not come in contact with any other objects. (We advise you to store them in an anti-static electricity container in which they were shipped. Some Liquid crystals solidify under low temperature (below the storage temperature range) leading to defective orientation or the generation of air bubbles (black or white). Air bubbles may also be generated if the module is subjected to low temperature.
- If the LCD modules have been operating for a long time showing the same display patterns, the display patterns may remain on the screen as ghost images and a slight contrast irregularity may also appear. A normal operating status can be regained by suspending use for some time. It should be noted that this phenomenon does not adversely affect performance reliability.
- To minimize the performance degradation of the LCD modules resulting from destruction caused by static electricity etc., please avoid holding the following sections when handling the modules'
  - Exposed area of the printed circuit board
  - Terminal electrode sections

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# 13. Legal Information

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