# Display Elektronik GmbH

## DATA SHEET

### TFT MODULE

# DEM 060160A TMH-PW-N
# 1,45" TFT

*Product Specification*                    *Ver.: 1*

**10.12.2024**

## Revision History

| Revision | Date | Originator | Detail | Remarks |
|---|---|---|---|---|
| 0 | 29.11.2024 | LL | Initial Release | - |
| 1 | 10.12.2024 | LL | Modify Module Parameter<br>Modify Interface Pins Definition<br>Modify Outline Drawing | P4<br>P10<br>P23 |
|  |  |  |  |  |
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**Table of Contents**

## 1.   General Description

The specification is a transmissive type color active matrix liquid crystal display (LCD) which uses amorphous thin film transistor (TFT) as switching devices. This product is composed of a TFT-LCD panel, driver ICs and a backlight unit.

## 2.   Module Parameter

| Features | Details | Unit |
|---|---|---|
| Display Size(Diagonal) | 1.45" | - |
| LCD type | TN TFT | - |
| Display Mode | Transmissive / Normally White | - |
| Resolution | 60 x RGB x160 | Pixels |
| View Direction | 12 O'CLOCK | Best Image |
| View Direction | 6 O'clock | Best Image |
| Module Outline | 15.40 x 39.69 x 2.10    (Note1 ) | mm |
| Active Area | 13.10 x 34.94 | mm |
| Pixel Size | 21.84 x 21.84 | mm |
| Pixel Arrangement | RGB Vertical Stripe | - |
| Display Colors | 262k | - |
| Interface | 4 Wire SPI | - |
| With or without touch panel | Without | - |
| Driver IC | GC9107 | - |
| Operating Temperature | -20～70 | ℃ |
| Storage Temperature | -30～80 | ℃ |
| Weight | TBD | g |

Note 1: Exclusive hooks, posts, FFC/FPC tail etc.

## 3.   Absolute Maximum Ratings

GND=0V, Ta=25ºC

| Item | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Supply Voltage | VCC | -0.3 | 4.6 | V |
| Storage temperature | $T_{STG}$ | **-30** | **+80** | ℃ |
| Operating temperature | $T_{OP}$ | **-20** | **+70** | ℃ |

Note 1: If Ta below 50ºC, the maximal humidity is 90%RH, if Ta over 50ºC, absolute humidity should be less than 60%RH.

Note 2: The response time will be extremely slow when the operating temperature is around -10°C, and the back ground will become darker at high temperature operating.

## 4. DC Characteristics

| Item | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Supply Voltage | VCC | 2.9 | 3.0 | 3.1 | V |
| Logic Low Input Voltage | $V_{IL}$ | GND | - | 0.3*VDD | V |
| Logic High Input Voltage | $V_{IH}$ | 0.7*VDD | - | VDD | V |
| Logic Low Output Voltage | $V_{OL}$ | GND | - | 0.2*VDD | V |
| Logic High Output Voltage | $V_{OH}$ | 0.8*VDD | - | VDD | V |
| Current Consumption All Black | $I_{DD}$ | - | TBD | - | mA |

## 5. Backlight Characteristic

### 5.1. Backlight Characteristics

| Item | Symbol | Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| Forward Voltage | $V_F$ | Ta=25 ºC, $I_F$=20mA/LED | 2.8 | 3.0 | 3.4 | V |
| Forward Current | $I_F$ | Ta=25 ºC, $V_F$=3.0V/LED | - | 20 | - | mA |
| Power Dissipation | $P_D$ | | - | 60 | - | mW |
| Uniformity | Avg | | - | 80 | - | % |
| LED Lifetime (25°C) | - | | - | 30,000 | - | Hrs |
| Drive Method | | Constant Current | | | | |
| LED Configuration | | 1 White LED | | | | |

Note1：LED lifetime defined as follows: The final brightness is at 50% of original brightness.

The environmental conducted under ambient air flow, at Ta=25°C±2ºC, 60%RH±5%,

$I_F$=20mA/LED.

### 5.2. Backlighting Circuit
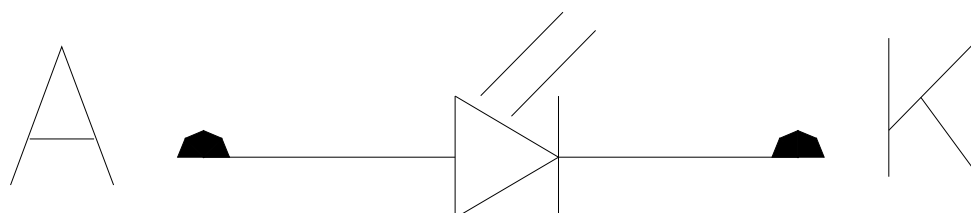
## 6. Optical Characteristics

### 6.1. Optical Characteristics

Ta=25ºC, VCC=3.0V

| | Item | | Symbol | Condition | Specification | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | | | Min. | Typ. | Max. | |
| **Backlight On (Transmissive Mode)** | Luminance on TFT($I_f$=20mA/LED) | | Lv | Normally viewing angle θX = φY =0º | 240 | 300 | - | cd/m² |
| | Contrast Ratio(See 6.3) | | CR | | 500 | 800 | - | |
| | Response Time (See 6.2) | | TR+TF | | - | 30 | 40 | ms |
| | Chromaticity Transmissive (See 6.5) | Red | XR | | - | TBD | - | |
| | | | YR | | - | TBD | - | |
| | | Green | XG | | - | TBD | - | |
| | | | YG | | - | TBD | - | |
| | | Blue | XB | | - | TBD | - | |
| | | | YB | | - | TBD | - | |
| | | White | XW | | - | TBD | - | |
| | | | YW | | - | TBD | - | |
| | Viewing Angle (See 6.4) | Horizontal | θX+ | Center CR≥10 | - | 50 | - | Deg. |
| | | | θX- | | - | 50 | - | |
| | | Vertical | φY+ | | - | 40 | - | |
| | | | φY- | | - | 50 | - | |
| | NTSC Ratio(Gamut) | | | | - | - | - | % |

### 6.2. Definition of Response Time

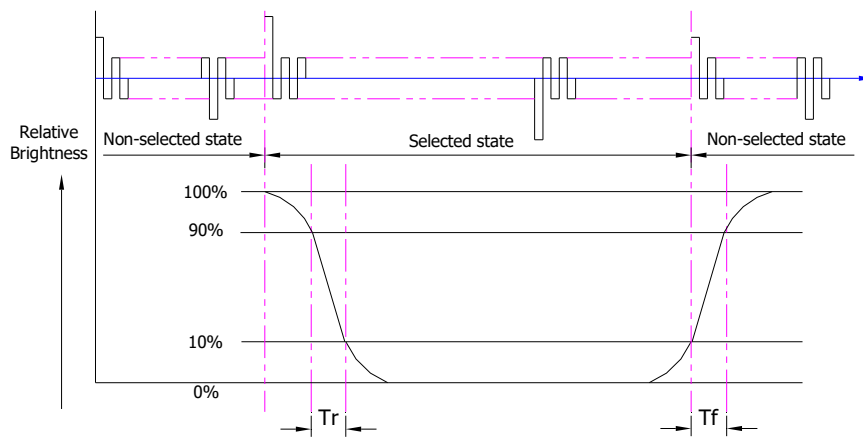#### 6.2.1. Normally Black Type (Negative)
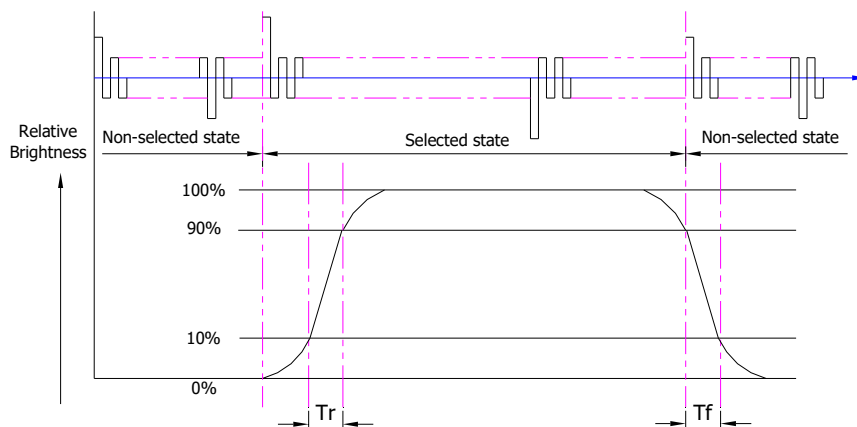


Tr is the time it takes to change form non-selected stage with relative luminance 10% to selected state with relative luminance 90%;

Tf is the time it takes to change from selected state with relative luminance 90% to non-selected state with relative luminance 10%.

Note: Measuring machine: LCD-5100

6.2.2.    Normally White Type (Positive)



Tr is the time it takes to change form non-selected stage with relative luminance 90% to selected state with relative luminance 10%;

Tf is the time it takes to change from selected state with relative luminance 10% to non-selected state with relative luminance 90%;
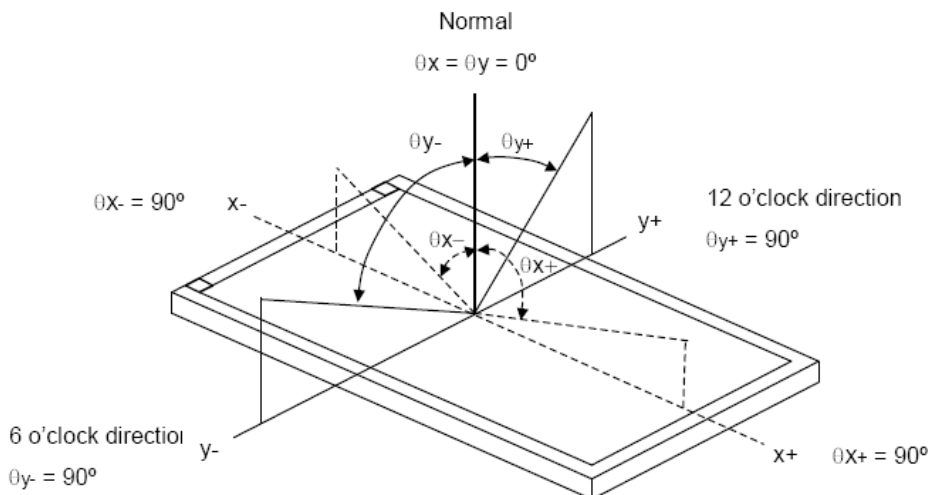
Note: Measuring machine: LCD-5100 or EQUI

### 6.3. Definition of Contrast Ratio

Contrast is measured perpendicular to display surface in reflective and transmissive mode. The measurement condition is:

| Measuring Equipment | Eldim or Equivalent |
|---|---|
| Measuring Point Diameter | 3mm//1mm |
| Measuring Point Location | Active Area centre point |
| Test pattern | A: All Pixels white |
| | B: All Pixel black |
| Contrast setting | Maximum |

Definitions: CR (Contrast) = Luminance of White Pixel / Luminance of Black Pixel

### 6.4. Definition of Viewing Angles



Measuring machine: LCD-5100 or EQUI

### 6.5. Definition of Color Appearance

R,G,B and W are defined by (x, y) on the IE chromaticity diagram

NTSC=area of RGB triangle/area of NTSC triangleX100%

Measuring picture: Red, Green, Blue and White (Measuring machine: BM-7)



CIE 1931 Chromaticity Diagram
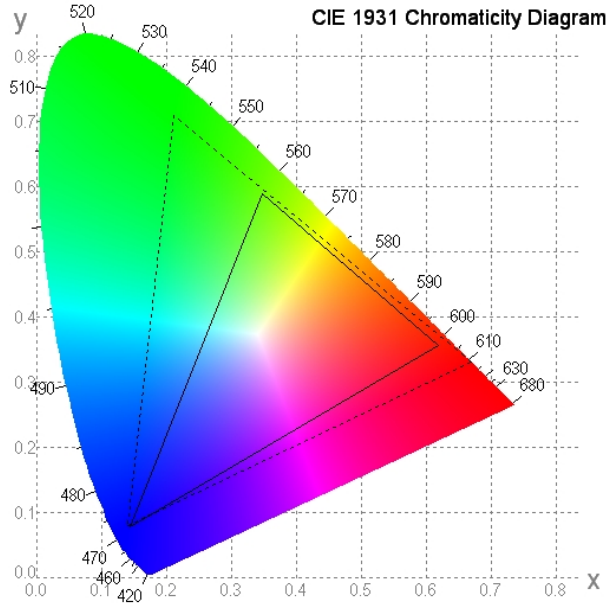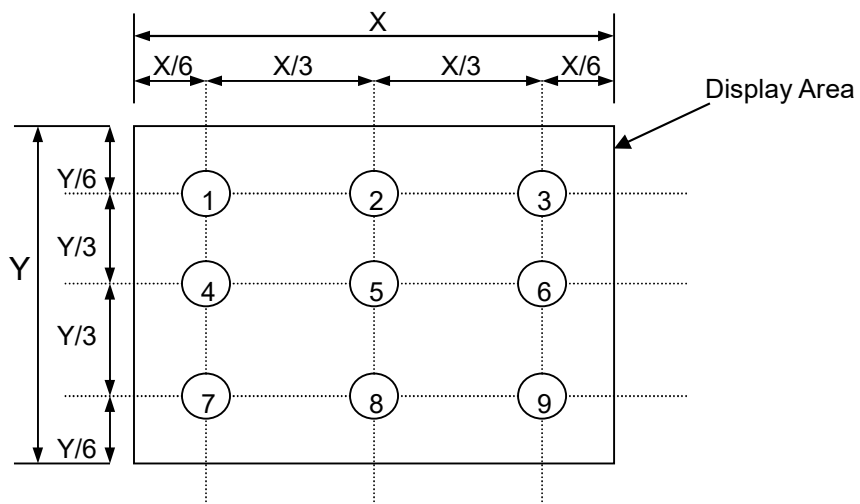
### 6.6. Definition of Surface Luminance, Uniformity and Transmittance

Using the transmissive mode measurement approach, measure the white screen luminance of the display panel and backlight.

6.6.1.    Surface Luminance: $L_V$ = average ($L_{P1}$:$L_{P9}$)

6.6.2.    Uniformity = Minimal ($L_{P1}$:$L_{P9}$) / Maximal ($L_{P1}$:$L_{P9}$) * 100%

6.6.3.    Transmittance = $L_V$ on LCD / $L_V$ on Backlight * 100%

Note: Measuring machine: BM-7

## 7.   Block Diagram and Power Supply
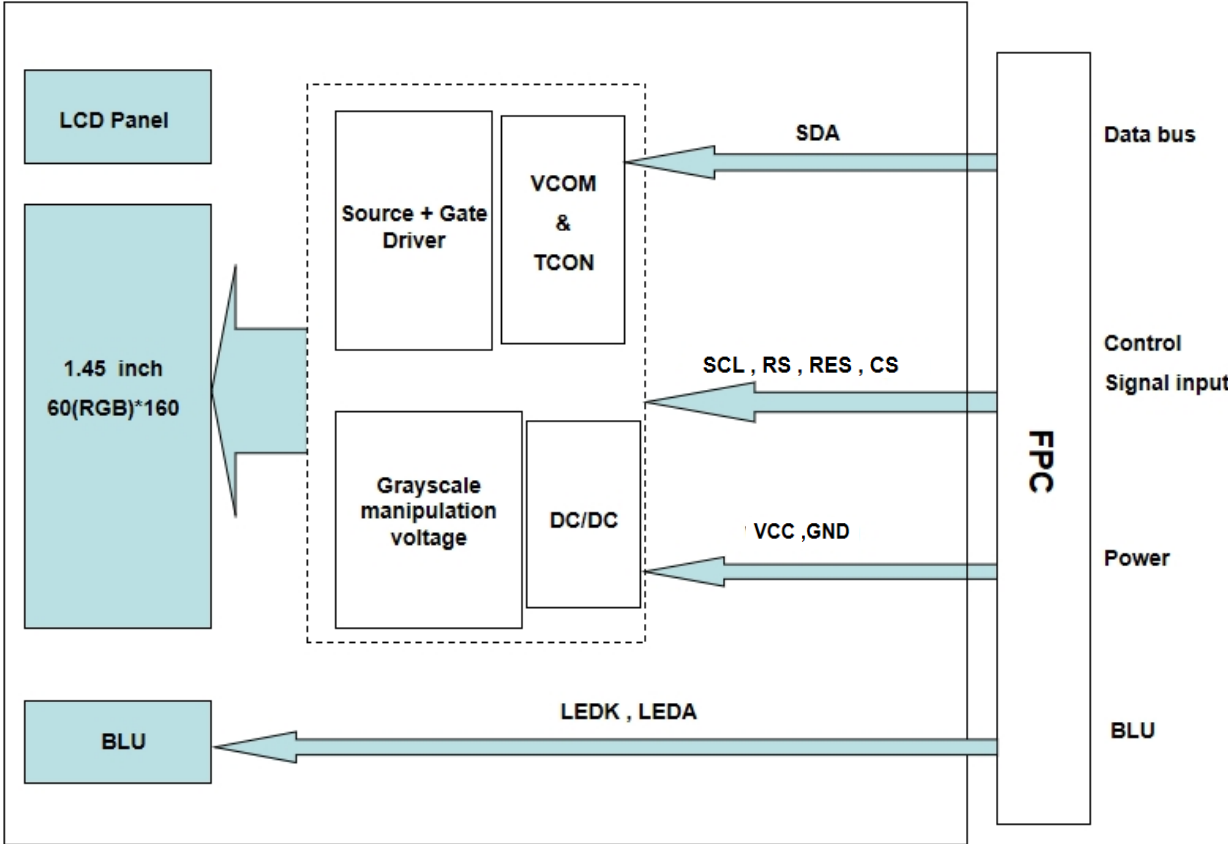
## 8.    Interface Pins Definition

| No. | Symbol | Function | Remark |
|---|---|---|---|
| 1 | NC | No Connection | - |
| 2 | NC | No Connection | - |
| 3 | SDA | SPI interface input/outpur pin | - |
| 4 | SCL | This pin is used to be serial interface clock | - |
| 5 | RS | Display data/command selection pin in 4-line serial interface | - |
| 6 | RES | This signal will reset the device,Signal is active low | - |
| 7 | CS | Chip selection pin,Low enable,High disable | - |
| 8 | GND | Ground | - |
| 9 | NC | No Connection | - |
| 10 | VCC | Power Supply for Analog | - |
| 11 | LEDK | LED Canthode | - |
| 12 | LEDA | LED Anode | - |
| 13 | GND | Ground | - |

## 9. AC Characteristics

### 9.1. Display Serial Interface Timing Characteristics (4-line SPI system)
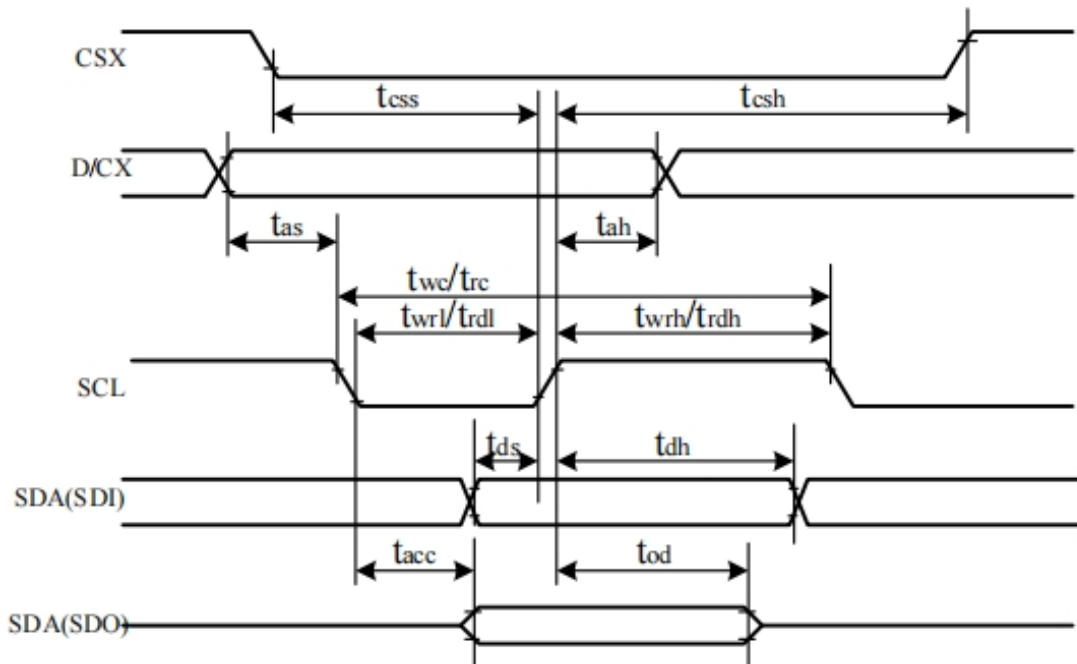


| Signal | Symbol | Parameter | min | max | Unit | Description |
|--------|--------|-----------|-----|-----|------|-------------|
| CSX | tcss | Chip select time (Write) | 20 | - | ns | |
| | tcsh | Chip select hold time (Read) | 40 | - | ns | |
| SCL | twc | Serial Clock Cycle (Write) | 10 | - | ns | |
| | twrh | SCL "H" Pulse Width (Write) | 5 | - | ns | |
| | twrl | SCL "L" Pulse Width (Write) | 5 | - | ns | |
| | trc | Serial Clock Cycle (Read) | 150 | - | ns | |
| | trdh | SCL "H" Pulse Width (Read) | 60 | - | ns | |
| | trdl | SCL "L" Pulse Width (Read) | 60 | - | ns | |
| D/CX | tas | D/CX setup time | 10 | - | ns | |
| | tah | D/CX hold time (Write/Read) | 10 | - | ns | |
| SDA/SDI (Input) | tds | Data setup time (Write) | 5 | - | ns | |
| | tdh | Data hold time (Write) | 5 | - | ns | |
| SDA/SD0 (Output) | tacc | Access time (Read) | 10 | - | ns | For maximum CL=30pF    For minmum CL=8pF |
| | toh | Output disable time (Read) | 20 | 50 | ns | |

Note: Ta = 25 °C, VDDI=1.65V to 3.3V, VDD=2.5V to 3.3V, VSSA=VSSR=0V
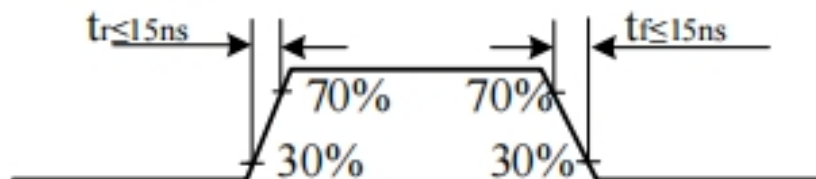
### 9.2. Power ON/OFF Sequence

IOVCC and VCI can be applied in any order.

VCI and IOVCC can be power down in any order.

During power off, if LCD is in the Sleep Out mode, VCI and IOVCC must be powered down minimum

120msec after RESX has been released.

During power off, if LCD is in the Sleep In mode, IOVCC or VCI can be powered down minimum 0msec after RESX has been released.

CSX can be applied at any timing or can be permanently grounded. RESX has priority over CSX.

*Note 1: There will be no abnormal visible effects on the display panel during the Power On/Off Sequences.*

*Note 2: There will be no abnormal visible effects on the display between end of Power On Sequence and before receiving Sleep*

*Out command. Also between receiving Sleep In command and Power Off Sequence.*

*Note 3: If RESX line is not held stable by host during Power On Sequence as defined in the sequence below, then it will be necessary to*

*apply a Hardware Reset (RESX) after Host Power On Sequence is complete to ensure correct operation. Otherwise function is*

*not guaranteed.*

The power on/off sequence is illustrated below
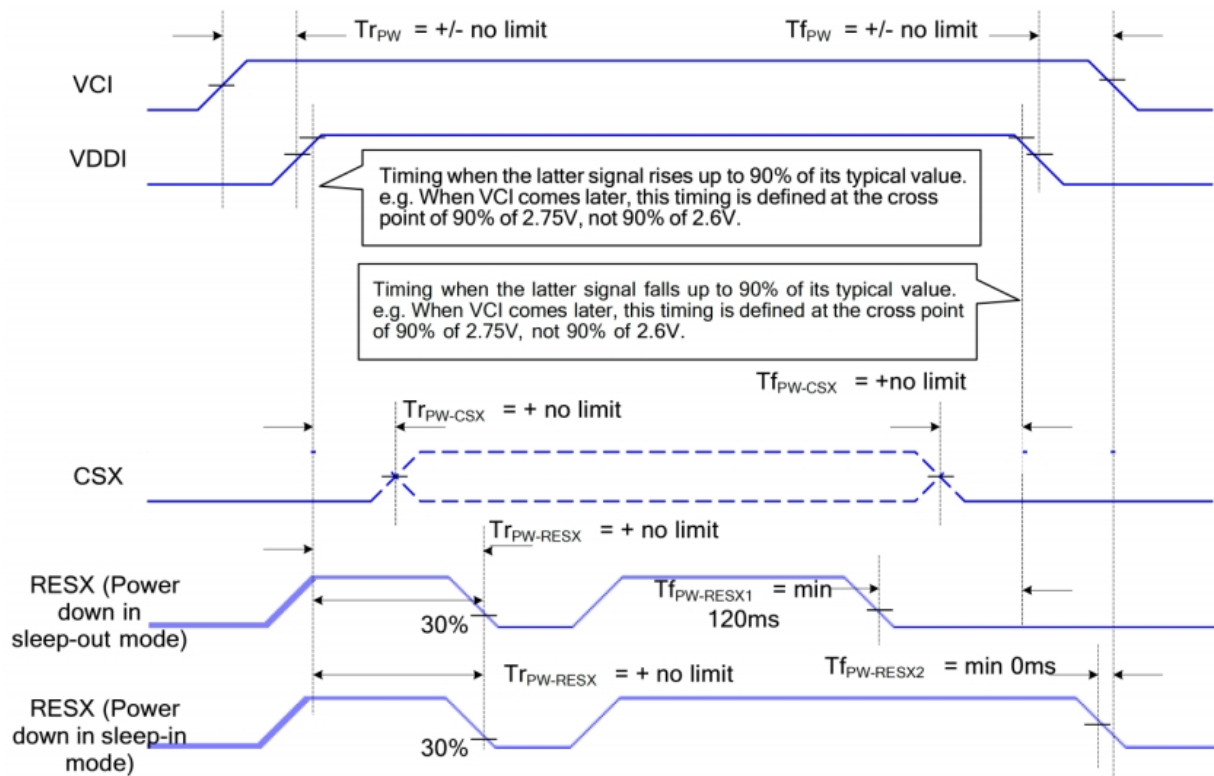
## 10. Quality Assurance

### 10.1. Purpose

This standard for Quality Assurance assures the quality of LCD module products supplied to customer.

### 10.2. Standard for Quality Test

10.2.1.   Sampling Plan:

GB2828.1-2012

Single sampling, general inspection level II

10.2.2.   Sampling Criteria:

Visual inspection: AQL 1.5

Electrical functional: AQL 0.65

10.2.3.   Reliability Test:

Detailed requirement refer to Reliability Test Specification.

### 10.3. Nonconforming Analysis & Disposition

10.3.1.   Nonconforming analysis:

10.3.1.1. Customer should provide overall information of non-conforming sample for their complaints.

10.3.1.2. After receipt of detailed information from customer, the analysis of nonconforming parts usually should be finished in one week.

10.3.1.3. If cannot finish the analysis on time, customer will be notified with the progress status.

10.3.2.   Disposition of nonconforming:

10.3.2.1. Non-conforming product over PPM level will be replaced.

10.3.2.2. The cause of non-conformance will be analyzed. Corrective action will be discussed and implemented.

### 10.4. Agreement Items

Shall negotiate with customer if the following situation occurs:

10.4.1.   There is any discrepancy in standard of quality assurance.

10.4.2.   Additional requirement to be added in product specification.

10.4.3.   Any other special problem.

### 10.5. Standard of the Product Visual Inspection

10.5.1.   Appearance inspection:

10.5.1.1. The inspection must be under illumination about 1000 – 1500 lx, and the distance of view must be at 30cm ± 2cm.

10.5.1.2. The viewing angle should be 45° from the vertical line without reflection light or follows customer's viewing angle specifications.

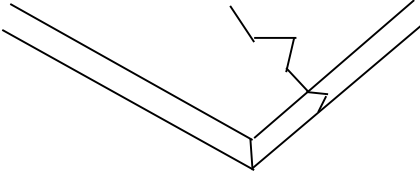10.5.1.3. Definition of area: A Zone: Active Area, B Zone: Viewing Area,
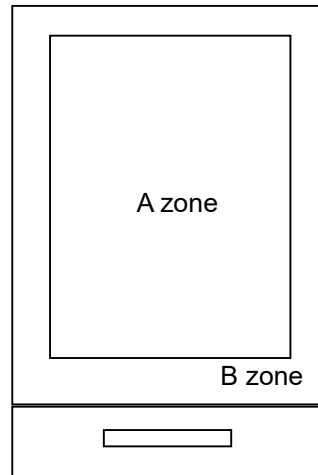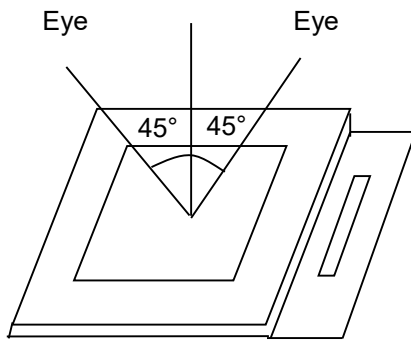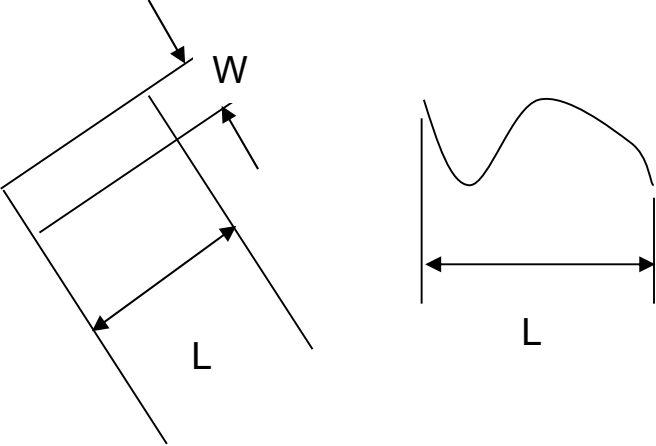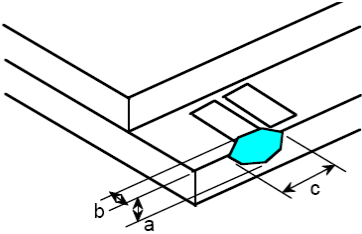
10.5.2. Basic principle:

    10.5.2.1. A set of sample to indicate the limit of acceptable quality level must be discussed by both us and customer when there is any dispute happened.
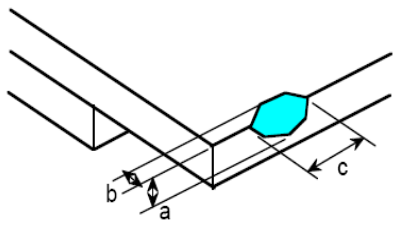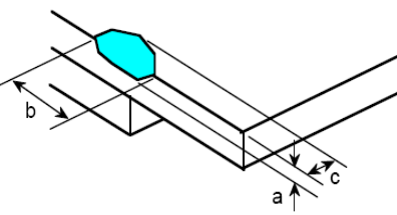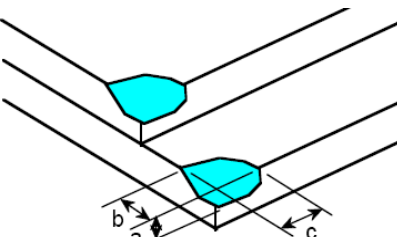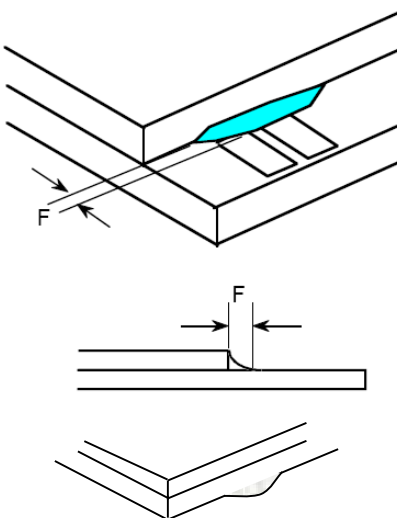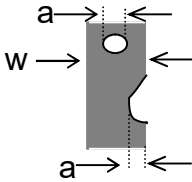
    10.5.2.2. New item must be added on time when it is necessary.

### 10.6. Inspection Specification

| No. | Item | Criteria (Unit: mm) | | |
|-----|------|----------|---|---|
| 01 | Black / White spot Foreign material (Round type) Pinholes Stain Particles inside cell. (Minor defect) |  $\varphi = (a + b)/2$ Distance between 2 defects should more than 3mm apart. | **Size \ Area** | **Acc. Qty** |
| | | | **$\varphi \leq 0.10$** | **Ignore** |
| | | | **$0.10 < \varphi \leq 0.15$** | **2** |
| | | | **$0.15 < \varphi \leq 0.25$** | **1** |
| | | | **$0.25 < \varphi$** | **0** |
| | | | **Total** | **2   no include $\varphi \leq 0.10$** |
| 02 | Electrical Defect (Minor defect) | | | |

| | Display Area | Total | |
|---|---|---|---|
| Bright dot | 0 | 0 | Note1 |
| Dark dot | $N \leq 2$ | $N \leq 2$ | |
| Total dot | $N \leq 2$ | $N \leq 2$ | |
| Mura | Not visible through 5% ND filters. | | Note2 |

Remark:

    1. Bright dot caused by scratch and foreign object accords to item 1.

| 03 | Black and White line Scratch Foreign material (Line type) (Minor defect) | |
|---|---|---|

W

L

L

| Length | Width | Acc. Qty |
|---|---|---|
| / | W ≦ 0.03 | Ignore |
| L ≦ 2.5 | 0.03 ＜ W ≦ 0.05 | 3 |
| L ≦ 2.5 | 0.05 ＜ W ≦ 0.10 | 2 |
| / | 0.1 ＜ W | |
| Total | | 3 |

Distance between 2 defects should more than 3mm apart. Scratches not viewable through the back of the display are acceptable.

| 04 | Glass Crack (Minor defect) | |
|---|---|---|

Crack is potential to enlarge, any type is not allowed.

| 05 | Glass Chipping Pad Area: (Minor defect) | |
|---|---|---|

| Length and Width | Acc. Qty |
|---|---|
| c > 3.0, b< 1.0 | 1 |
| c< 3.0, b< 1.0 | 3 |
| a<Glass Thickness | |

| 06 | Glass　Chipping Rear of Pad Area:<br>(Minor defect) | |
|---|---|---|

| Length and Width | Acc. Qty |
|---|---|
| c > 3.0, b< 1.0 | 1 |
| c< 3.0, b< 1.0 | 2 |
| c< 3.0, b< 0.5 | 4 |
| a<Glass Thickness | |

| 07 | Glass　Chipping Except Pad Area:<br>(Minor defect) | |
|---|---|---|

| Length and Width | Acc. Qty |
|---|---|
| c > 3.0, b< 1.0 | 1 |
| c< 3.0, b< 1.0 | 2 |
| c< 3.0, b< 0.5 | 4 |
| a<Glass Thickness | |

| 08 | Glass Corner Chipping:<br>(Minor defect) | |
|---|---|---|

| Length and Width | Acc. Qty |
|---|---|
| c < 3.0, b< 3.0 | Ignore |
| a<Glass Thickness | |

| 09 | Glass Burr:<br>(Minor defect) | |
|---|---|---|

| Length | Acc. Qty |
|---|---|
| F < 1.0 | Ignore |

Glass burr don't affect assemble and module dimension.

| 10 | FPC Defect:<br>(Minor defect)<br> | 10.1 Dent, pinhole width a<w/3.<br>(w: circuitry width.)<br>10.2 Open circuit is unacceptable.<br>10.3 No oxidation, contamination and distortion. |
|---|---|---|
| 11 | Bubble on Polarizer<br>(Minor defect) | <table><tr><th>Diameter</th><th>Acc. Qty</th></tr><tr><td>φ≤0.20</td><td>Ignore</td></tr><tr><td>0.20 <φ≤0.30</td><td>4</td></tr><tr><td>0.30 <φ≤0.50</td><td>1</td></tr><tr><td>0.50 < φ</td><td>None</td></tr></table> |
| 12 | Dent on Polarizer<br>(Minor defect) | <table><tr><th>Diameter</th><th>Acc. Qty</th></tr><tr><td>φ≤0.20</td><td>Ignore</td></tr><tr><td>0.20 <φ≤0.30</td><td>4</td></tr><tr><td>0.30 <φ≤0.50</td><td>1</td></tr><tr><td>0.50 < φ</td><td>None</td></tr></table> |
| 13 | Bezel | 13.1 No rust, distortion on the Bezel.<br>13.2 No visible fingerprints, stains or other contamination. |
| 14 | PCB | 14.1 No distortion or contamination on PCB terminals.<br>14.2 All components on PCB must same as documented on the BOM/component layout.<br>14.3 Follow IPC-A-600F. |
| 15 | Soldering | Follow IPC-A-610C standard |
| 16 | Electrical Defect<br>(Major defect) | The below defects must be rejected.<br>16.1 Missing vertical / horizontal segment,<br>16.2 Abnormal Display.<br>16.3 No function or no display.<br>16.4 Current exceeds product specifications.<br>16.5 LCD viewing angle defect.<br>16.6 No Backlight.<br>16.7 Dark Backlight.<br>16.8 Touch Panel no function. |

Remark: LCD Panel Broken shall be rejected. Defect out of LCD viewing area is acceptable.

### 10.7. Classification of Defects

10.7.1. Visual defects (Except no / wrong label) are treated as minor defect and electrical defect is major.

10.7.2. Two minor defects are equal to one major in lot sampling inspection.

### 10.8. Identification/marking criteria

Any unit with illegible / wrong /double or no marking/ label shall be rejected.

### 10.9. Packaging

10.9.1. There should be no damage of the outside carton box, each packaging box should have one identical label.

10.9.2. Modules inside package box should have compliant mark.

10.9.3. All direct package materials shall offer ESD protection.

**Note1**: Bright dot is defined as the defective area of the dot is larger than 50% of one sub-pixel area.
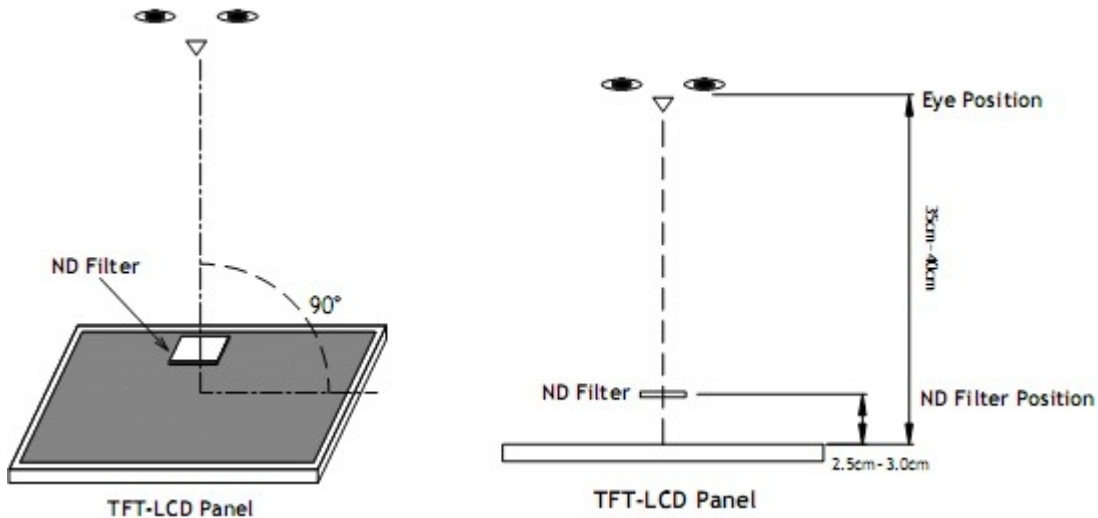


Bright dot: The bright dot size defect at black display pattern. It can be recognized by 2% transparency of filter when the distance between eyes and panel is 350mm±50mm.

Dark dot: Cyan, Magenta or Yellow dot size defect at white display pattern. It can be recognized by 5% transparency of filter when the distance between eyes and panel is 350mm±50mm.

**Note2:** Mura on display which appears darker / brighter against background brightness on parts of display area.

## 11. Reliability Specification

| No | Item | Condition | Quantity | Criteria |
|----|------|-----------|----------|----------|
| 1 | High Temperature Operating | +70°C, 96Hrs | 2 | GB/T2423.2 -2008 |
| 2 | Low Temperature Operating | -20°C, 96Hrs | 2 | GB/T2423.1 -2008 |
| 3 | High Humidity Storage | +50°C, 85%RH, 96Hrs | 2 | GB/T2423.3 -2016 |
| 4 | High Temperature Storage | +80°C, 96Hrs | 2 | GB/T2423.2 -2008 |
| 5 | Low Temperature Storage | -30°C, 96Hrs | 2 | GB/T2423.1 -2008 |
| 6 | Thermal Cycling Test Storage | -10°C, 60min~+60°C, 60min, 20 cycles. | 2 | GB/T2423.22 -2012 |
| 7 | Packing vibration | Frequency range:10Hz~50Hz Acceleration of gravity:5G X, Y, Z 30 min for each direction. | - | GB/T5170.14 -2009 |
| 8 | Electrical Static Discharge | Air:±4kV 150pF/330Ω  5 times <br> Contact:±2kV 150pF/330Ω  5 times | 2 | GB/T17626.2 -2018 |
| 9 | Drop Test (Packaged) | Height:80cm, 1 corner, 3 edges, 6 surfaces. | - | GB/T2423.7 -2018 |

Note1.　No defection cosmetic and operational function allowable.

Note2.　Total current Consumption should be below double of initial value

## 12. Precautions and Warranty

### 12.1. Safety

12.1.1.  The liquid crystal in the LCD is poisonous. Do not put it in your mouth. If the liquid crystal touches your skin or clothes, wash it off immediately using soap and water.

12.1.2.  Since the liquid crystal cells are made of glass, do not apply strong impact on them. Handle with care.

### 12.2. Handling

12.2.1.  Reverse and use within ratings in order to keep performance and prevent damage.

12.2.2.  Do not wipe the polarizer with dry cloth, as it might cause scratch. If the surface of the LCD needs to be cleaned, wipe it swiftly with cotton or other soft cloth soaked with petroleum IPA, do not use other chemicals.

### 12.3. Storage

12.3.1.  Do not store the LCD module beyond the specified temperature ranges.

12.3.2.  Strong light exposure causes degradation of polarizer and color filter.

### 12.4. Metal Pin (Apply to Products with Metal Pins)

12.4.1.  Pins of LCD and Backlight

    12.4.1.1. Solder tip can touch and press on the tip of Pin LEAD during the soldering

    12.4.1.2. Recommended Soldering Conditions

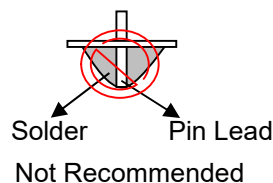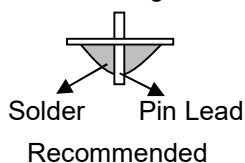        Solder Type: Sn96.3~94-Ag3.3~4.3-Cu0.4~1.1

        Maximum Solder Temperature: 370℃

        Maximum Solder Time: 3s at the maximum temperature

        Recommended Soldering Temp: 350±20℃

        Typical Soldering Time: ≤3s

    12.4.1.3. Solder Wetting

| Solder    Pin Lead | Solder    Pin Lead |
|:---:|:---:|
| Recommended | Not Recommended |

12.4.2.  Pins of EL

    12.4.2.1. Solder tip can touch and press on the tip of EL leads during soldering.

    12.4.2.2. No Solder Paste on the soldering pad on the motherboard is recommended.

    12.4.2.3. Recommended Soldering Conditions

        Solder type: Nippon Alimit Leadfree SR-34, size 0.5mm
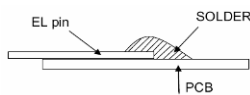
        Recommended Solder Temperature: 270～290℃

        Typical Soldering Time: ≤2s

        Minimum solder distance from EL lamp (body):2.0mm
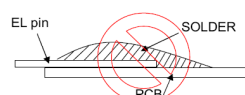
    12.4.2.4. No horizontal press on the EL leads during soldering.

    12.4.2.5. 180° bend EL leads three times is not allowed.

12.4.2.6. Solder Wetting
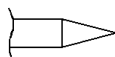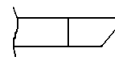


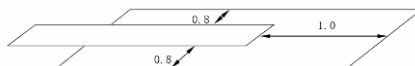Recommended        Not Recommended

12.4.2.7. The type of the solder iron:



Recommended        Not Recommended

12.4.2.8. Solder Pad



## 12.5. Operation

12.5.1. Do not drive LCD with DC voltage

12.5.2. Response time will increase below lower temperature

12.5.3. Display may change color with different temperature

12.5.4. Mechanical disturbance during operation, such as pressing on the display area, may cause the segments to appear "fractured".

12.5.5. Do not connect or disconnect the LCM to or from the system when power is on.

12.5.6. Never use the LCM under abnormal condition of high temperature and high humidity.

12.5.7. Module has high frequency circuits. Sufficient suppression to the electromagnetic interface shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

12.5.8. *Do not display the fixed pattern for long time（we suggest the time not longer than one hour）because it will develop image sticking due to the TFT structure.*

## 12.6. Static Electricity

12.6.1. CMOS LSIs are equipped in this unit, so care must be taken to avoid the electro-static charge, by ground human body, etc.

12.6.2. The normal static prevention measures should be observed for work clothes and benches.

12.6.3. The module should be kept into anti-static bags or other containers resistant to static for storage.

## 12.7. Limited Warranty

12.7.1. Our warranty liability is limited to repair and/or replacement. We will not be responsible for any consequential loss.

12.7.2. If possible, we suggest customer to use up all modules in six months. If the module storage time over twelve months, we suggest that recheck it before the module be used.

12.7.3. After the product shipped, any product quality issues must be feedback within three months, otherwise, we will not be responsible for the subsequent or consequential events.

## 13. Outline Drawing



Backlight LED Circuit: 1×1=1(LED)
If=20mA; Vf=3V