

Product Specification

14.9" COLOR TFT-LCD MODULE

MODEL NAME: HX-C149HAX01

< ◆ > Preliminary Specification

< > Final Specification

Note: The content of this specification is subject to change.

A. General Description

HX-C149HAX01 is a LTPS & transmissive type Thin Film Transistor Liquid crystal Display (TFT-LCD) with iTP (in cell Touch panel) technology. This model is composed of a TFT-LCD, a driver, FPC (flexible printed circuit) , and a backlight unit with a capacitive touch sensor. TCON (timing controller) is also embedded in source driver.

The appropriate design measures should be taken to ensure reliability and safety when AUO's devices are used for equipment such as:

- Transportation control and safety equipment (i.e. automobiles, Train)

Customer can set some information on it such as:

Traffic signals / Gas leakage sensor breakers / Alarm equipment / Various safety devices etc.

devices shall not be used for equipment that requires extremely high level of reliability, such as:

- Military and space applications
- Nuclear power control equipment
- Medical equipment for life support

B. Features

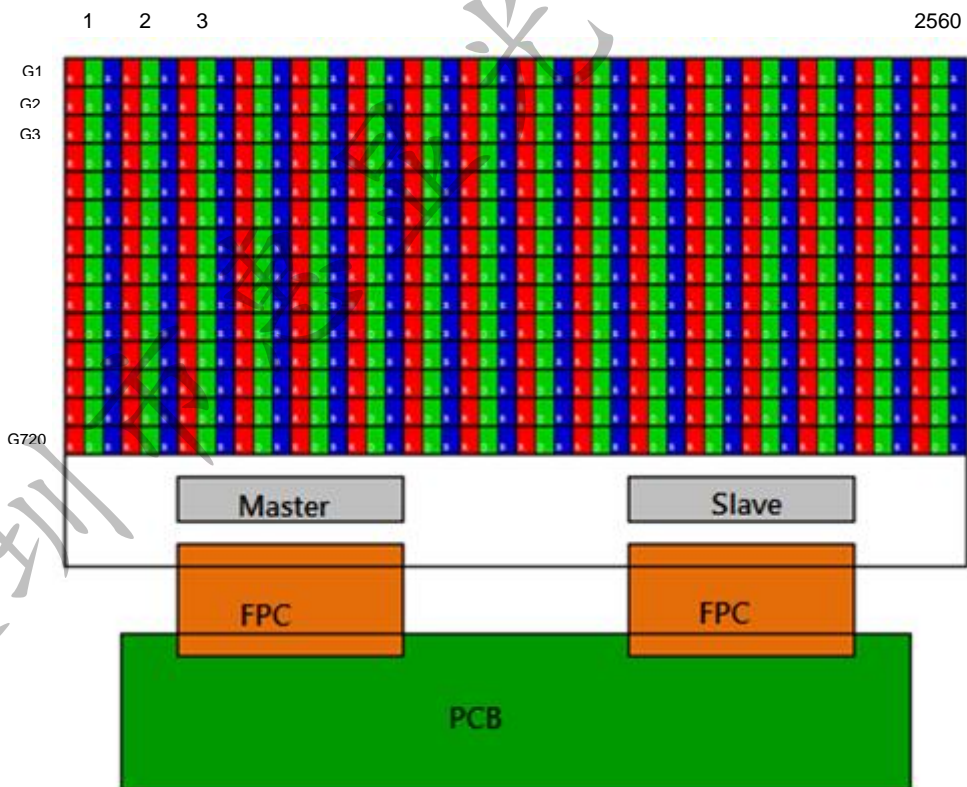
- 14.9-inch (32:9) display
- 2560 RGB x 720 resolution in RGB stripe arrangement
- Interfaces: MIPI INPUT(1 PORTS)
- Advanced Hyper View Angle – Normal Black wide view technology
- RoHs compliance

C. Physical Specifications

1. TFT LCD Panel

| NO. | Item | Unit | Specification | Remark |
|-----|---------------------|-------------------|------------------------|--------|
| 1 | Display Resolution | dot | 2560RGB(H)×720(V) | |
| 2 | Active Area | mm | 354.816(H)×99.792(V) | |
| 3 | Screen Size | inch | 14.9(Diagonal) | |
| 4 | Dot Pitch | mm | 0.0462RGB(H)×0.1386(V) | |
| 5 | Color Configuration | - | R.G.B. Stripe | Note 1 |
| 6 | Color Depth | - | 16.7M Colors | |
| 7 | Overall Dimension | mm | 364(H)×113(V)×3.0(T) | Note 2 |
| 8 | LCM Luminance | cd/m ² | 350(typ) | |
| 9 | Display Mode | - | Normally Black (AHVA) | |

Note 1: Below figure shows horizontal stripe arrangement.



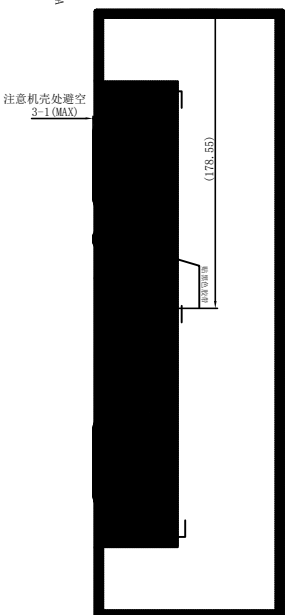
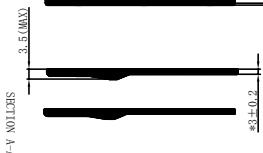
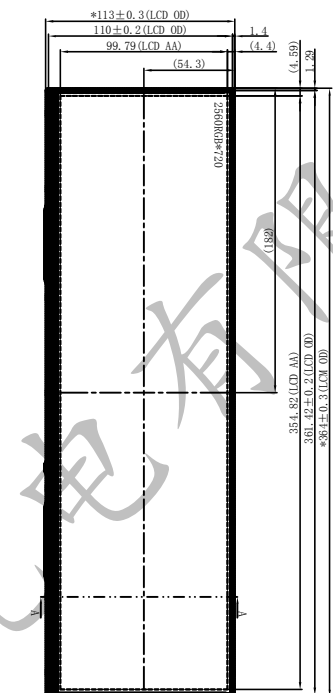
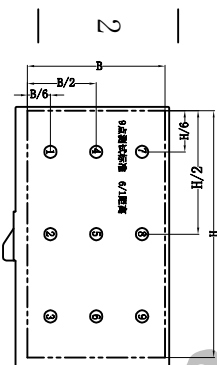
2. In cell TP

| NO. | Item | Unit | Specification | Remark |
|-----|-------------------------|------|----------------------|--------|
| 1 | Screen size | inch | 14.9" | |
| 2 | TP Active Area | mm | 354.816(H)×99.792(V) | |
| 3 | AA Channel (Resolution) | - | 80(H)×20(V) | |
| 4 | Sensor Pitch | mm | 4.44(H)×4.99(V) | |
| 5 | Sensor Mode | - | Capacitance touch | |
| 6 | Interface | - | I2C | |
| 7 | Viewing angle (CR ≥ 10) | | Typ:80/80/80/80 | |
| 8 | Driver IC | | FT8201P | |
| 9 | Interface | | MIPI | |

2.1 Touch performance specification

| NO. | Item | | Specification | Remark |
|-----|-------------------|------------|------------------------------|-------------------------|
| 1 | Touch type | | In-cell touch | |
| 2 | Touch size | | 6~25Φ | |
| 3 | Large Finger size | | Rejection > 25Φ | |
| 4 | Response Time | | 40ms(Typ)/50ms(Max) | |
| 5 | Report rate | | 60Hz | |
| 6 | Multi Touch | | 10 Points | |
| 7 | Finger Separation | | ≥11mm | 6Φ, Center to Center |
| 8 | Accuracy | Point Acc. | ±1.0mm (excluding edge area) | 9Φ, Finger (w/o Glove) |
| 9 | | Linearity | ±1.0mm (excluding edge area) | |
| 10 | | Point Acc. | ±2.0mm (including edge area) | |
| 11 | | Linearity | ±2.0mm (including edge area) | |
| 12 | Point Jitter | | < 1.0mm | Repeat & Fixed |
| 13 | Glove Touch | | < 1.5mm thickness | 1.1t glass, Leather, 9Φ |
| 14 | Gesture | | Support | |

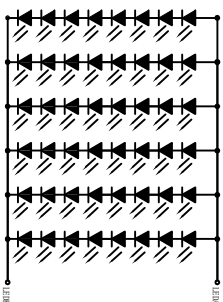
4.0 DIMENSIONAL DRAWING

[illegible]

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| Item(項目) | Symbol (符號) | min. | typ. | max. | Unit | Condition (測試條件) |
|---------------------------|-----------------------|-----------|------|------|-------------------|---------------------|
| Main screen 主屏 (ID) | Lv (由 front 1 均均均) | 8000 | 8500 | xxxx | cd/m ² | (照度測試值) |
| | Avg | 75 | 80 | | % | |
| | Coordinate (坐標值) | X 0.24 | 0.29 | 0.34 | | |
| | Y | 0.26 | 0.31 | 0.36 | | Lv=xxxx mcd |
| Main screen 主屏 (ID) | Lv (由 front 1 均均均) | 300 | 350 | | cd/m ² | (照度測試值) |
| | Avg | 75 | 80 | | % | |
| | Coordinate (坐標值) | X 0.26 | 0.31 | 0.36 | | |
| | Y | 0.28 | 0.33 | 0.38 | | |
| Forward Voltage (正向電壓) | Vf | 23.2 | 24.8 | 26.4 | V | |

| | | | | |
|---|-------------------------|---------------------------------|----|-----------------------------|
| 9 | | | | |
| CUSTOMER Approver 客户承认 | CUSTOMER'S NAME 客户名称 | DESIGN 设计 | | |
| CUSTOMER'S CODE 客户型号 Supplier'S CODE 供应商型号 | HX-C149HAX01 REV:02 | EDITION: 版本 EDITION 版本 | A0 | CHECK 审核 REVIEW 确认 |
| 10 | | | | |

E. Electrical Specifications

1. Absolute Maximum Ratings

| Items | Symbol | Values | | Unit | Condition |
|-----------------------|----------|--------|------|------|-----------|
| | | Min. | Max. | | |
| Storage Temperature | T_{ST} | -25 | +70 | °C | |
| Operating Temperature | T_{OP} | -20 | +60 | °C | |

Note 1: Functional operation should be restricted under ambient temperature 25°C.
Maximum ratings are those values beyond which damages to the device may occur.
Functional operation should be restricted to the limits in the Electrical Characteristics.

2. DC Electrical Characteristics

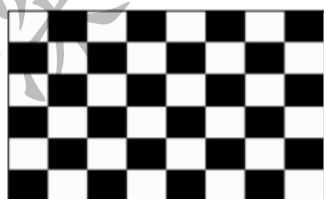
The following items are measured under stable condition and suggested application circuit.

a. LCD Power Specification

| Parameter | | Symbol | Min | Typ. | Max. | Unit | Notes |
|----------------------|--------|-----------|--------|-------|---------|------|-------|
| Power Supply Voltage | | V_{LCD} | (3.25) | 3.3 | (3.5) | V | |
| Power Supply Current | Mosaic | I_{LCD} | - | 0.61 | (0.65) | A | 1 |
| | White | I_{LCD} | - | 0.801 | (1.135) | | |

<Note>

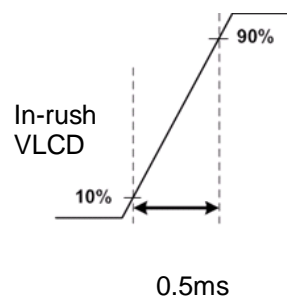
- The specified current and power consumption are under the $V_{LCD}=3.25V$, $T_a=25\pm2^\circ C$, $f_v=60Hz$ condition.
 - $PLCD(Typ) = I_{LCD}(Typ) * V_{LCD}(Typ)$, $PLCD(Max) = I_{LCD}(Max) * V_{LCD}(Typ)$
 - Test condition is the V_{LCD} voltage range between 3.25V~3.5V on the rising time 0.5ms, please see below picture.
($V_{LCD}=3.3V$, $T_a=25\pm2^\circ C$, $f_v=60Hz$)
 - The recommended operating conditions show the range in which the device can operate normally.
 - LED_PWM, TOUCH_EN, MUTE, HVR, LCD_Test, SCL_Touch, SDA_Touch, RESET
 - Interrupt, SDA_Touch
- *VISH: Input Single-Ended High Threshold Voltage / VISL: Input Single-Ended Low Threshold Voltage
*VROSH: Reverse Output Single-Ended High Voltage / VROSL: Reverse Output Single-Ended Low Voltage



[Mosaic 8x6]



[White]



INTERFACE CONNECTION

Module Input Signal & Power

- FPC Signal interface : 50 Pin.(HX-C149HAX01.1)

<Table Display Interfacer>

| | | | |
|----|-------------|--|---|
| 1 | GND | | |
| 2 | TP_INT | | Touch I2C interrupt(note: io is 1.8V) |
| 3 | TP_SDA | | Touch I2C data(note: io is 1.8V) |
| 4 | TP_SCL | | Touch I2C clock(note: io is 1.8V) |
| 5 | TP_RESET | | Touch part reset pin (note: io is 1.8V) |
| 6 | GND | | Ground |
| 7 | NC | | Internal used |
| 8 | GND | | Ground |
| 9 | MIPI_D0_N | | MIPI Differential Data0 Input |
| 10 | MIPI_D0_P | | MIPI Differential Data0 Input |
| 11 | GND | | Ground |
| 12 | MIPI_D1_N | | MIPI Differential Data1 Input |
| 13 | MIPI_D1_P | | MIPI Differential Data1 Input |
| 14 | GND | | Ground |
| 15 | MIPI_D2_N | | MIPI Differential Data2 Input |
| 16 | MIPI_D2_P | | MIPI Differential Data2 Input |
| 17 | GND | | Ground |
| 18 | MIPI_DCLK_N | | MIPI Differential CLOCK Input |
| 19 | MIPI_DCLK_P | | MIPI Differential CLOCK Input |
| 20 | GND | | Ground |
| 21 | MIPI_D3_N | | MIPI Differential Data3 Input |
| 22 | MIPI_D3_P | | MIPI Differential Data3 Input |
| 23 | GND | | GND |
| 24 | NC | | NC |
| 25 | NC | | NC |
| 26 | GND | | Ground |

| | | | |
|----|-------|--|-----------------------|
| 27 | NC | | NC |
| 28 | NC | | NC |
| 29 | GND | | Ground |
| 30 | NC | | NC |
| 31 | NC | | NC |
| 32 | GND | | Ground |
| 33 | NC | | NC |
| 34 | NC | | NC |
| 35 | GND | | Gound |
| 36 | NC | | NC |
| 37 | NC | | NC |
| 38 | GND | | Ground |
| 39 | VDD | | Power supply , 3.3V |
| 40 | VDD | | Power supply , 3.3V |
| 41 | GND | | Ground |
| 42 | NC | | NC |
| 43 | NC | | NC |
| 44 | RESET | | RESX 1.8V |
| 45 | NC | | NC |
| 46 | NC | | NC |
| 47 | LED_K | | LED backlight (Anode) |
| 48 | LED_K | | LED backlight (Anode) |
| 49 | LED_A | | LED backlight (Anode) |
| 50 | LED_A | | LED backlight (Anode) |

b. Backlight Driving Conditions

| Parameter | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark |
|-----------------|-----------|--------------------------------|-------|------|-------|------|-------------------------|
| LED Current | I_F | at 25°C | 160 | 180 | 200 | mA | For each string Note |
| Forward Voltage | V_F | $I_F=80\text{ mA}$ at -30°C | | | | V | |
| | | $I_F=80\text{ mA}$ at 25°C | 23.2 | 24.8 | 26.4 | V | |
| | | $I_F=80\text{ mA}$ at 85°C | | | | V | |
| LED Power | P_{LED} | | 6.912 | 7.68 | 8.704 | W | Note 2 |
| | | | | | | | |
| | | | | | | | |

Note 1: LED backlight is 48 LEDs (6strings, 8pcs for each string).

Note 2: The LED supply power is for 6 string of LED @20mA

Note 3: Be sure your system can provide enough voltage driving capability (larger than TBD V is recommended) to provide 80mA for each LED or the brightness is possible to be below spec.

Note 4: The LED lifetime 20,000hrs means after normal use at 80mA, under +25°C, the brightness of LED decreases to 50% of original level.

Note 5: The LED lifetime 10,000hrs means after normal use at 80mA, under +25°C, the brightness of LED decreases to 80% of original level.

transmission.

5) Case of combined LCD, external I/F will be followed to specification of LCD maker.

4. Protocol Requirement

System Concept

- 1) H/U and LCD communicate through LVDS.
- 2) Coaxial cable is used as physical I/F between H/U and LCD
- 3) See below table for internal communication protocol in LCD.

| Video | Touch INT | Touch Information | Power / State | Operation State |
|-----------|-----------|-------------------|---------------|-----------------|
| Dual oLDI | GPIO | I2C | GPIO | I2C |

4) Maximum 6GHz data can be transferred between H/U and LCD.

I2C Slave Address for Ser/Des

| Item | IC Maker | Address | | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 |
|--------------|------------------------|-----------------|-----------------|----|----|----|----|----|----|----|----|
| | | 7bit (D7~D1) | 8bit (D7~D0) | | | | | | | | |
| Deserializer | Maxim | 0x48 | 0x90 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 0 |
| LCD IC | Focaltech LCD driver | 0x50 | 0xA0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| | Focaltech Touch driver | 0x38 | 0x70 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |

※ Detailed Address information can be modified in development process.

Requirement for Alert and Touch

- 1) Alert and Touch signal use same address to transfer information.
- 2) Alert needs 4 bytes to transfer packet information and alert signal.
- 3) Packet information + (6 * the number of touch) bytes are need for touch signal.
- 4) Requirement for alert and touch signal can be modified in development process.

Basic Structure of Alert Signal

1) Packet info

| Address | Register name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---------|---------------|-------|--------|-------|-------|-------|-------|-------|-------|
| 0x0210 | Packet info | Alert | Length | | | | | | |

① Bit 7

- "0": Touch Event
- "1": Alert Event Packet

② Bit 0~6 (Length)

- How many bytes will be transferred is determined by these bits.

2) Packet Content for Vendor Specific Alert Event

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| Address | Register name | Packet Content |
|---------|--------------------------|--------------------------|
| 0x0211 | Alert type | Vendor specific alert |
| 0x0212 | Vendor specific alert ID | Vendor specific alert ID |
| 0x0213 | Information | Monitoring information |

- ① Alert type: Transfer wanted alert packet to H/U. (Distinguish alert situation)
- ② Information: Transfer the state of touch operating to AP.
- 0x00: Normal operation
 - 0x20: Abnormal touch sensing

Basic Structure of Touch Signal

1) 6 bytes information will be transferred to H/U when touch event is occurred.

| Address | Register name | Bit 7 | Bit 6 | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---------|----------------------|---------------------------|--------|-------|-------|---------------------------|-------|-------|-------|
| 0x0211 | Finger info | Touch | Screen | Hover | Palm | Finger ID | | | |
| 0x0212 | XY coordinate (High) | Y coordinate (Bit11~Bit8) | | | | X coordinate (Bit11~Bit8) | | | |
| 0x0213 | X coordinate (Low) | X coordinate (Bit7~Bit0) | | | | | | | |
| 0x0214 | Y coordinate (Low) | Y coordinate (Bit7~Bit0) | | | | | | | |
| 0x0215 | Z (Pressure) | Z (Pressure) | | | | | | | |
| 0x0216 | Radius | Radius (unit: mm) | | | | | | | |

① 0x0211

- bit 7 (touch): 1 Touch occurrence
- bit 6 (screen): 1 Key touch occurrence
- bit 5 (hover): Not used
- bit 4 (palm): Not used
- bit 3~0 (finger id): Unique id for each touch occurrence

② 0x0212 ~ 0x0214

- x, y coordinate (12bits each)

③ 0x0215

- z (pressure): Decide whether touch is released or not.

④ 0x0216

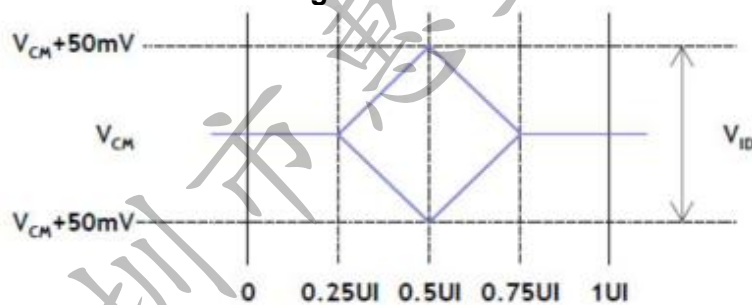
- radius: finger size

2) When multi touch event is occurred, information (6 byte * the number of touch) will be transferred to H/U.

I2C bus maximum speed 400KHz

5. AC Electrical Characteristics

a. Differential signal AC characteristics



※ UI : Unit Interval

| Parameter | Symbol | Value | | | Unit | Note |
|--|-----------|--------|-----|-----|------|------|
| | | Min | Typ | Max | | |
| Input Common Mode Voltage | V_{CM} | 1.1 | 1.3 | 1.5 | V | 1 |
| Deserializer Coax Input High Threshold | V_{IDH} | (100) | - | - | mV | 2 |
| Deserializer Coax Input Low Threshold | V_{IDL} | (-100) | - | - | mV | |

Note 1. $V_{CM} = \{ (V_{IN+}) + (V_{IN-}) \} / 2$

Note 2. $V_{ID} = | (V_{IN+}) - (V_{IN-}) |$

6. Input Timing Diagram

| Parameter | | Symbol | Panel Resolution | | | | | | Unit |
|----------------|----------------|---------------------|----------------------------|--------|--------|----------------------------|-------|-------|-------------------|
| | | | 2560xRGBx720 (One Port) | | | 2560xRGBx720 (Two Port) | | | |
| | | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| DCLK Frequency | | 1/t _{DCLK} | 116.66 | 120.93 | 133.80 | 58.33 | 60.47 | 66.90 | MHz |
| Horizontal | Period | t _h | 2624 | 2720 | 2760 | 1312 | 1360 | 1380 | t _{DCLK} |
| | Display Period | t _{hd} | 2560 | | | 1280 | | | t _{DCLK} |
| Vertical | Period | t _v | 741 | 741 | 808 | 741 | 741 | 808 | t _H |
| | Display Period | t _{vd} | 720 | | | 720 | | | t _H |
| Frame Rate | | FR | 60 | | | 60 | | | Hz |

NOTE: (1) FR (Frame Rate) = DCLK / t_h / t_v

※ Above table can be modified in development process

$$t_{HP} = t_{HV} + t_{HBP} + t_{HFP}$$

$$t_{VP} = t_{VV} + t_{VBP} + t_{VFP}$$

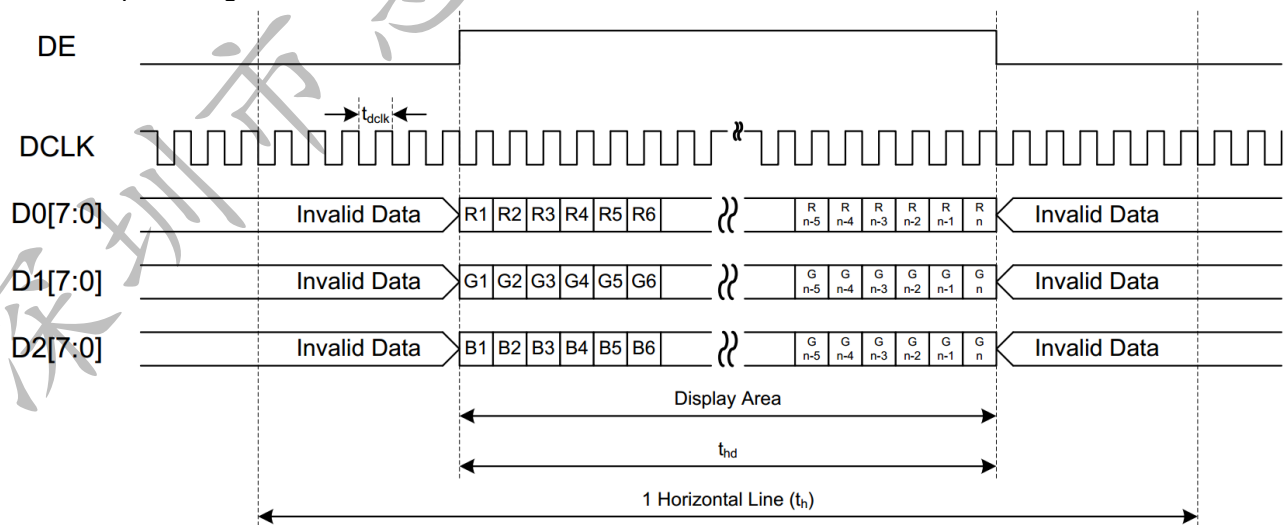
※

If modify the video timing parameter, FT8201P need to change the initial code (currently the initial code is set with Typ. video timing) and re-confirm TP performance.
System video timing only can set to typical value, minimum value is tolerance, if system would like to use minimum value, need re-confirm TP performance and display quality

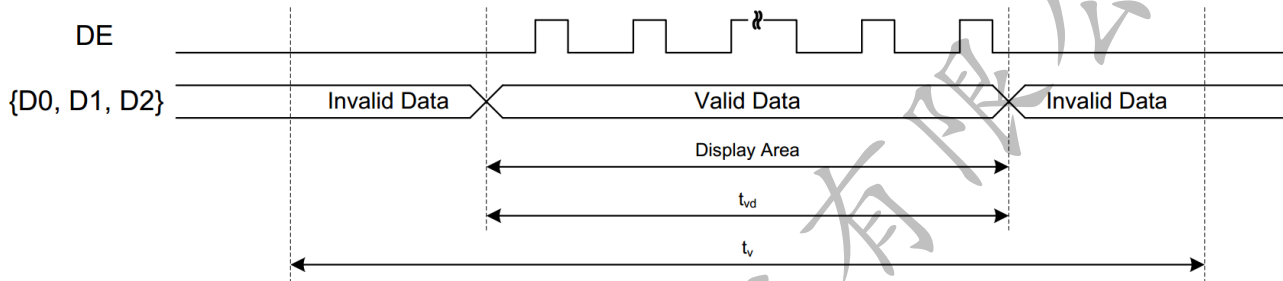
b. Timing Diagram

All specifications below are base on 60Hz

Horizontal input timing at DE mode is:



Vertical input timing at DE mode is:



c. Differential Input Data Format

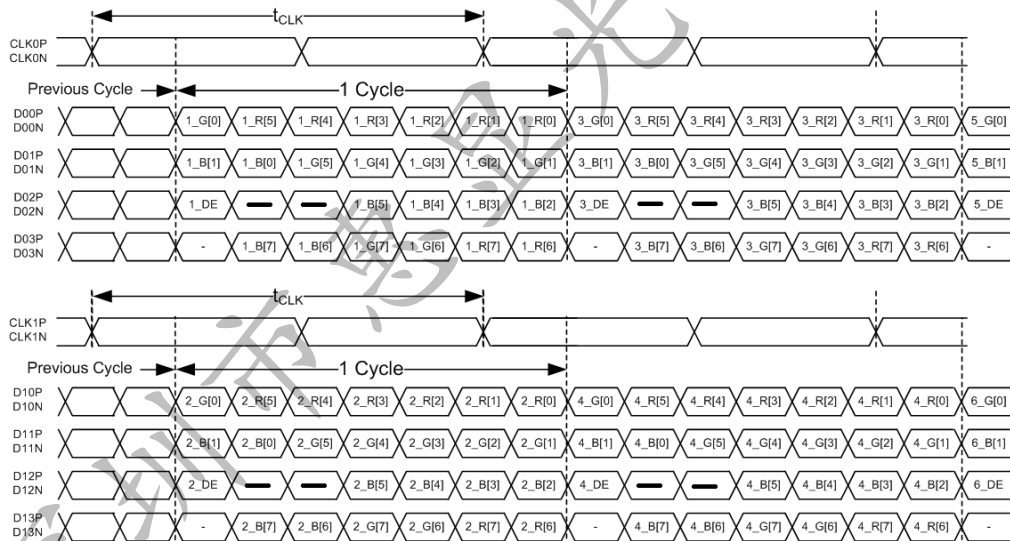


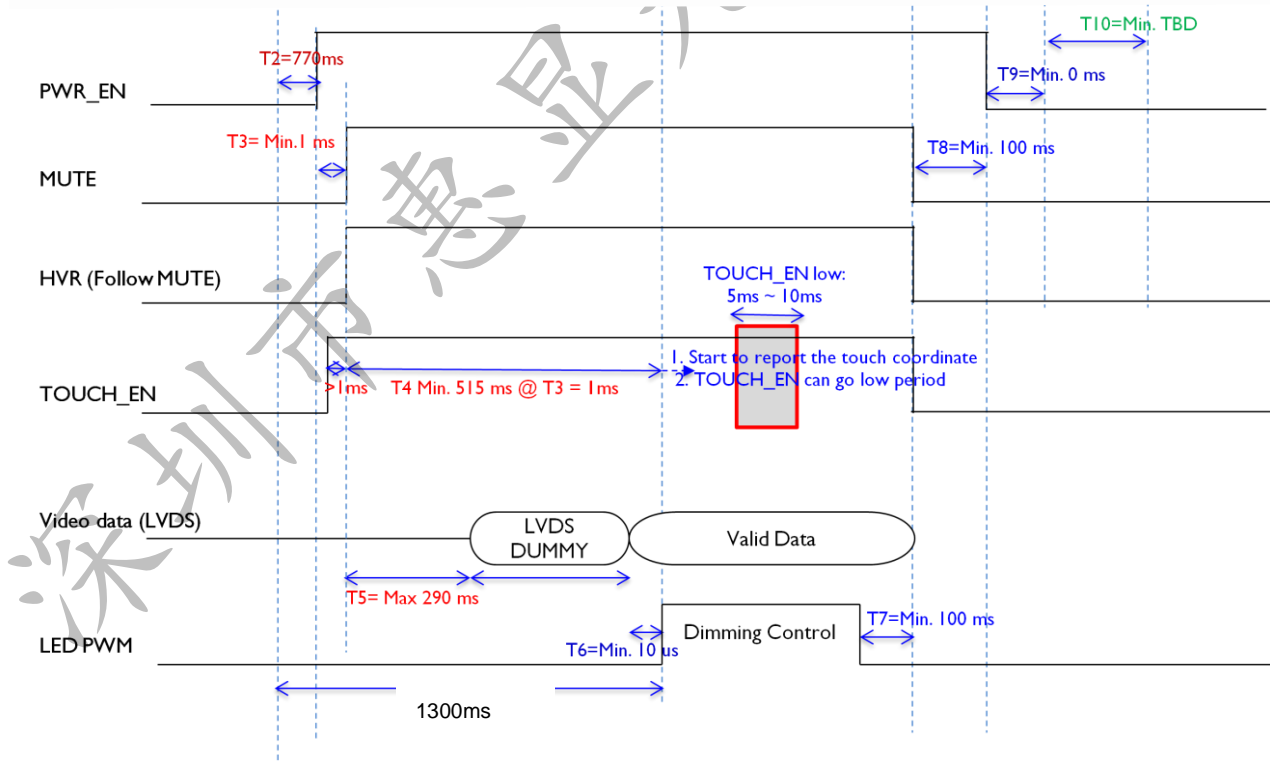
Fig.1 LVDS input data VESA format

7. Power on/off sequence

The LCD adopts high voltage driver IC, so it could be permanently damaged under a wrong power on/off sequence. The suggested LCD power sequence is below:

a. Power on sequence: (TBD.)

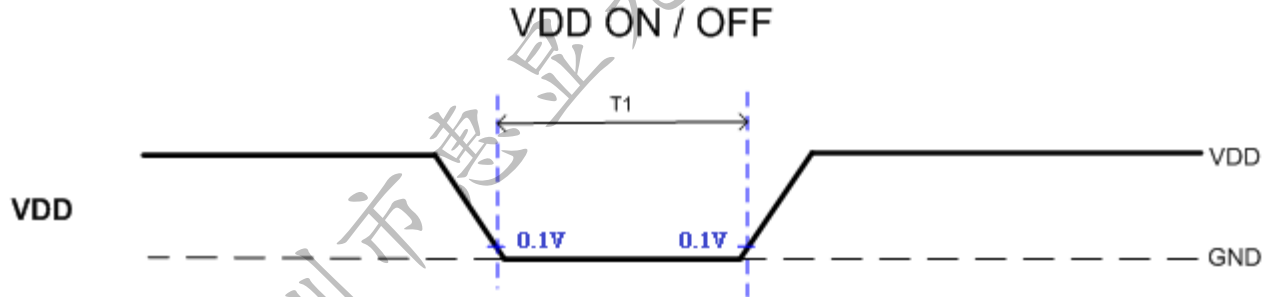
| Parameter | Value | | | Unit |
|-----------|-------|------|------|------|
| | Min. | Typ. | Max. | |
| T1 | (0.5) | - | (10) | ms |
| T2 | 10 | | 770 | ms |
| T3 | 1 | | 30 | ms |
| T4 | 515 | | | ms |
| T5 | | | 290 | ms |
| T6 | 10 | | | us |
| T7 | 100 | | | ms |
| T8 | 100 | | | ms |
| T9 | 0 | | | ms |
| T10 | 100 | | | ms |



1. All signals must be discharge to zero voltage when power off.
2. Power on sequence is follow system limit to meet driver IC requirement

b. Repower ON / OFF (other signal need to follow normal power on/off sequence)

| Parameter | Value | | | Unit |
|-----------|-------|------|------|------|
| | Min. | Typ. | Max. | |
| T1 | 100 | -- | - | ms |



F. Optical specifications

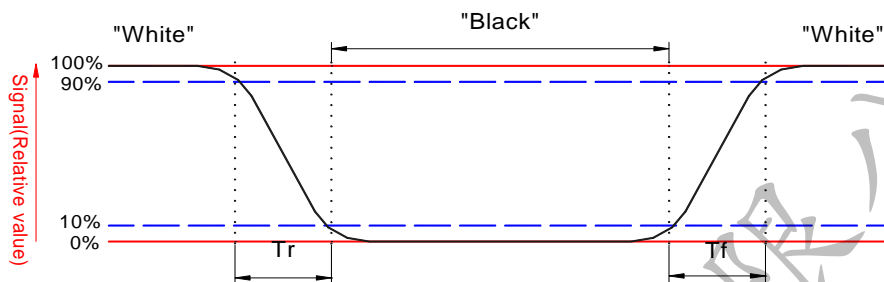
| Item | | Symbol | Condition | Min. | Typ. | Max. | Unit | Remark |
|---|--------------------------------|----------------|------------------------------------|---------|----------------------|---------|-------------------|--------------|
| Response Time | Rise Fall | Tr+Tf | $\theta = 0^{\circ}$, Ta=25°C | - | - | 20 | ms | Note 3 |
| | | Tr+Tf | $\theta = 0^{\circ}$, Ta=-20°C | - | - | 150 | ms | |
| | | Tr+Tf | $\theta = 0^{\circ}$, Ta=-30°C | - | - | 400 | ms | Note 3, 4 |
| Contrast ratio | | CR | $\theta = 0^{\circ}$ | 1200 | 1500 | - | | Note 5, 6, 7 |
| Viewing Angle | Top Bottom Left Right | | $CR \geq 10$ | | 89 89 89 89 | | deg. | Note 8, 9 |
| Brightness | | Y _L | $\theta = 0^{\circ}$ | 300 | 350 | - | cd/m ² | Note 1,2,10 |
| White Chromaticity | | W _x | $\theta = 0^{\circ}$ | (0.263) | (0.293) | (0.323) | | Note 9 |
| | | W _y | $\theta = 0^{\circ}$ | (0.290) | (0.320) | (0.350) | | |
| White Chromaticity (after white calibration under L50~L255) | | W _x | $\theta = 0^{\circ}$ | (0.288) | (0.293) | (0.298) | | |
| | | W _y | $\theta = 0^{\circ}$ | (0.315) | (0.320) | (0.325) | | |
| Red Chromaticity | | R _x | $\theta = 0^{\circ}$ | (0.610) | (0.640) | (0.670) | | |
| | | R _y | $\theta = 0^{\circ}$ | (0.300) | (0.330) | (0.360) | | |
| Green Chromaticity | | G _x | $\theta = 0^{\circ}$ | (0.270) | (0.300) | (0.330) | | |
| | | G _y | $\theta = 0^{\circ}$ | (0.570) | (0.600) | (0.630) | | |
| Blue Chromaticity | | B _x | $\theta = 0^{\circ}$ | (0.112) | (0.150) | (0.180) | | |
| | | B _y | $\theta = 0^{\circ}$ | (0.030) | (0.060) | (0.090) | | |
| Color Gamut | | NTSC | $\theta = 0^{\circ}$ | - | 70.8 | - | % | |
| Uniformity White | | | 9-point, $\theta = 0^{\circ}$ | 80 | - | - | % | Note 11 |
| Uniformity Black | | | 9-point, $\theta = 0^{\circ}$ | 50 | - | - | % | Note 11 |
| Reflectance | | SCI | $\theta = 0^{\circ}$, Ta=25°C | | | 2 | % | Note 4, 12 |

Note 1: Measurement should be performed in the dark room, optical ambient temperature $= 25^\circ\text{C}$, and backlight current $I_L = 85\text{ mA}$

Note 2: To be measured on the center area of panel with a field angle of 1° by [Instrument-System goniometer system DMS-series](#), after 10 minutes operation and warm up 30 minutes.

Note 3: Definition of response time:

The output signals of photo detector are measured when the input signals are changed from “black” to “white”(rising time) and from “white” to “black”(falling time), respectively.



Note 4: Data for reference only, will not measure during ORT(Ongoing Reliability Test).

Note 5: From liquid crystal characteristics, response time will become slower and the color of panel will become darker when ambient temperature is below 25°C.

Note 6: Contrast ratio is calculated with the following formula.

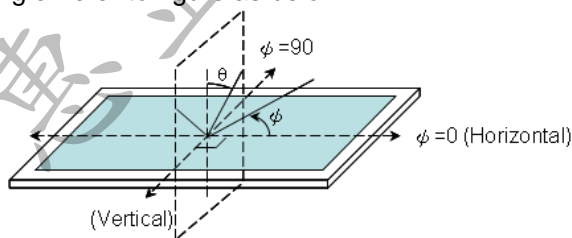
$$\text{Contrast ratio} = \frac{\text{Photo detector output when LCD is at "White" state}}{\text{Photo detector output when LCD is at "Black" state}}$$

Note 7: White : RGB data = "11111111"

Black : RGB data = "00000000"

100% transmission is defined as the transmission of LCD panel when all the input terminals of Module are electrically opened.

Note 8: Definition of viewing angle: refer to figure as below.



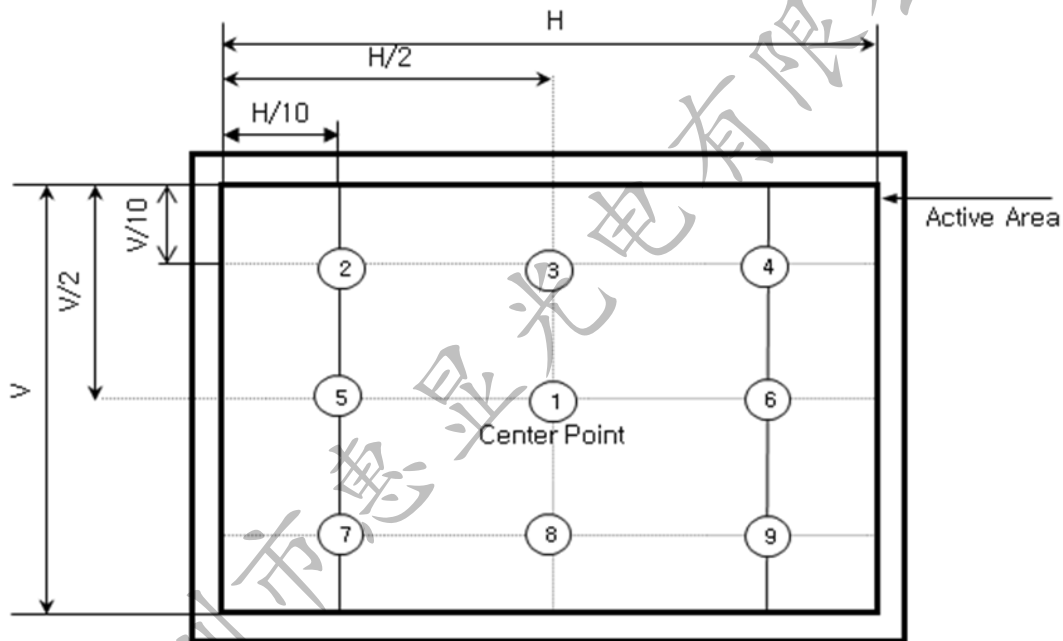
Note 9: The viewing angles are measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

If user finds panel that is out of color range, AUO will proceed to RMA (Return Material Authorisation) Process to exchange panel piece by piece without the failure rate counting.

Note 10: Brightness is measured at the center of the display with white pattern in 80mA driving current

Note 11: Luminance Uniformity is defined as following within the 9 measurements (L1~L9),

$$\text{Luminance Uniformity}(\%) = \frac{\text{Minimum luminance(brightness)}}{\text{Maximum luminance(brightness)}}$$



Note 12: Measured by Konica Minolta CM-2600d, SCI method. Illuminant: D65, Observer: CIE 1964/10°, Illumination system: d/8 (diffuse illumination, 8-degree viewing)

G. Reliability Test:

1. Reliability Test Items:

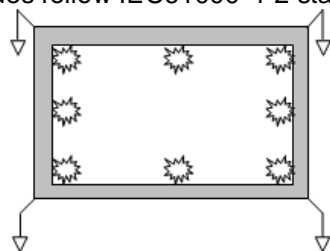
| No. | Test items | Conditions | | Remark |
|-----|-----------------------------------|--|------------------|------------------------------|
| 1 | High temperature storage | Ta= 70℃ | 240Hrs | Note1 |
| 2 | Low temperature storage | Ta= -25℃ | 240Hrs | |
| 3 | High temperature operation | Ta= 60℃ | 240Hrs | |
| 4 | Low temperature operation | Ta= -20℃ | 240Hrs | Note1, 3 |
| 5 | High temperature and hig humidity | Ta= 60℃, 90% RH | 240Hrs | Operation |
| 6 | Heat shock | -20℃~60℃/100 cycles 0.5Hrs/cycle | | Non-operation |
| 7 | Electrostatic discharge | Contact = ± 8 kV, class B (R=330Ω ,C=150pF) Air= ± 15 kV, class B (R=330Ω ,C=150pF) 10 times for each point. | | Operation (Note 4) |
| 8 | Vibration | Frequency range | 8~33.3Hz | JIS D1601,A10 Condition A |
| | | Stoke | 1.3mm | |
| | | Sweep | 2.9G, 33.3~400Hz | |
| | | Cycle | 15min. | |
| | | 2 hours for each direction of X, Z 4 hours for Y direction | | |
| 9 | Mechanical shock | 100G, 6ms, ±X,±Y,±Z 3 times for each direction | | |
| 10 | Vibration (with carton) | Random vibration: 0.015G ² /Hz from 5~200Hz -6dB/Octave from 200~500Hz | | IEC 68-34 |
| 11 | Drop (with carton) | Height: 60cm 1 corner, 3 edges, 6 surfaces | | |

Note 1: Ta: Ambient temperature.



Note 2: In the standard condition, there is not display function NG issue occurred. All the cosmetic specification is judged before the reliability stress.

Note 3: Short time operation between -40℃~-30℃ doesn't provide full performance but a correct image on the LCD. The LCD is guaranteed to suffer no permanent damage.

Note 4: Test techniques follow IEC61000-4-2 standard. Test points and pattern as below.



2. Image Stacking Condition:

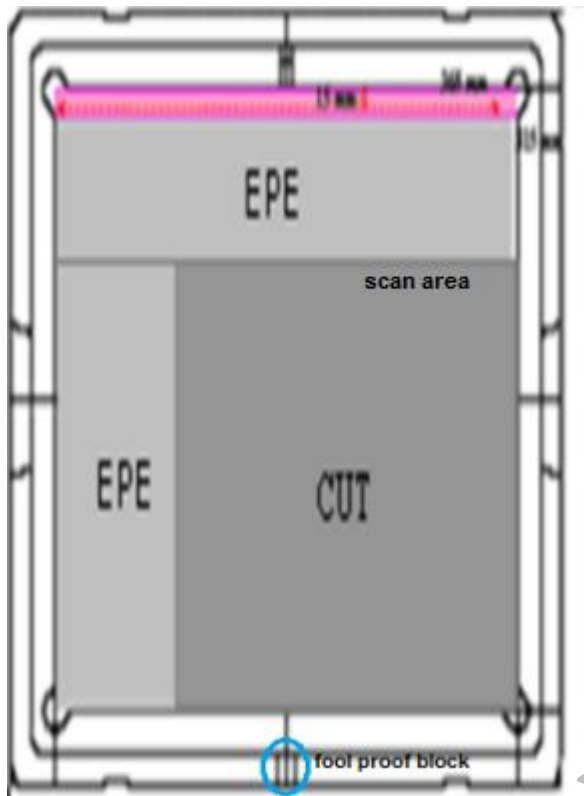
| Test Item | IS Evaluation | |
|-----------------|--|--|
| Test conditions | Room temp(25℃) | Hi temp(70℃) Low temp(-20℃) |
| | 1) Aging Pattern 8x6 Chess Pattern 2) Judge Pattern - 127 Gray Pattern 3) Judge Method - Keep aging-pattern within 0.5 hour / 3 hrs, then switch to Judge pattern to verification. | 1) Aging Pattern 8x6 Chess Pattern 2) Judge Pattern - 127 Gray Pattern 3) Judge Method - Keep aging-pattern within 1 hour, then switch to Judge pattern to verification. |
| Judge Criteria | Slightly visible & disappeared within 3 min. (judge by naked-eyes) | |
| Pattern |  < 8x6 Chess Pattern > |  < 127 Gray Pattern > |

5. PACKAGE INFORMATION

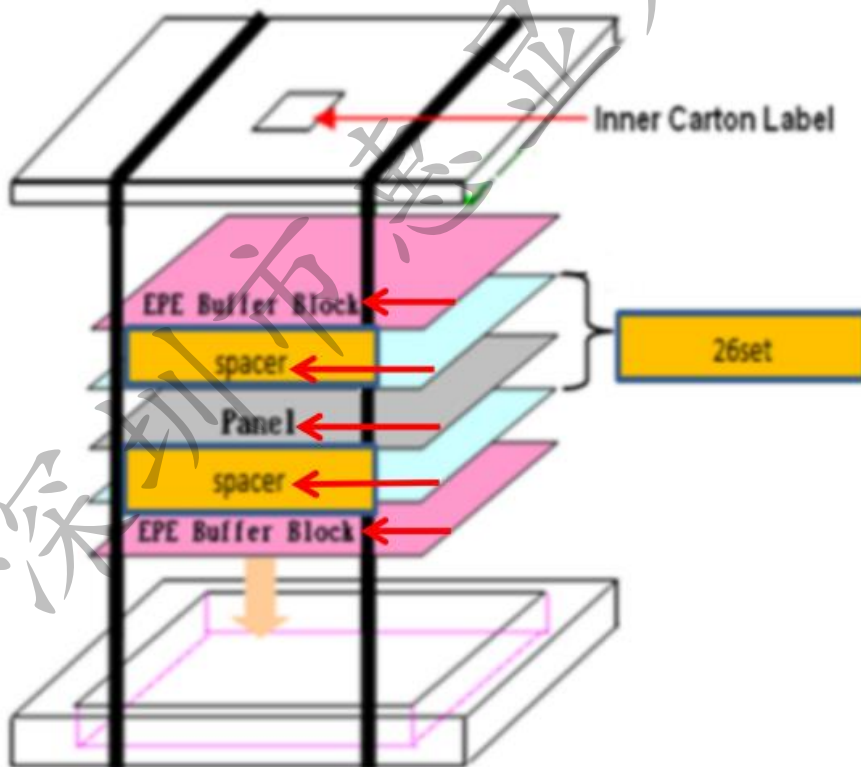
5.1. CUT Package Form

5.1.1. Packaging

Packaging: The scan area away from the fool proof block; CF side are uniformly upward.



The packing quantity : 25 CUT



5.1.2. Package Stacking
Stacking mode : Eight DP boxes on the stack.



5.2. Product Keeping Requirements

| Item | Condition | Unit | Remark |
|---------------------|-----------|--------|--------|
| Storage Temperature | 20±10 | °C | |
| Storage Humidity | 60±20 | % (RH) | |
| Warranty | 6 | months | Note1 |

Note1. The period is within 6 months since the date of shipping out under normal using and storage conditions.

K. Incoming Inspection Standard (IIS)

| Revision History | | | | |
|------------------|-----------|------|---------------------------------------|------------|
| Rev. | Date | Page | Description of Revision | Revised by |
| 1 | 2020/4/8 | - | Initial Specification Release | Simon Liu |
| 1-1 | 2020/4/23 | 3 | Add weak bright dot judgment and spec | Simon Liu |
| 1-2 | 2020/5/19 | 6,7 | Add the Stain defect spec. | Simon Liu |
| | | | | |
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1. Scope:

The incoming inspection standards shall be applied to TFT-LCD Modules (hereinafter called "Modules") that supplied by AU Optonics Corporation (hereinafter called "seller").

2. Incoming inspection:

The buyer (customer) shall inspect the modules within twenty calendar days of the delivery date (the "inspection period") at its own cost. The results of the inspection (acceptance or rejection) shall be recorded in writing, and a copy of this writing will be promptly sent to the seller. The buyer may, under commercially reasonable reject procedures, reject an entire lot in the delivery involved if, within the inspection period ,such samples of modules within such lot show an unacceptable number of defects in accordance with this incoming inspection standards, provided however that the buyer must notify the seller in writing of any such rejection promptly, and not later than within three business days of the end of the inspection period. Should the buyer fail to notify the seller within the inspection period, the buyer's right to reject the modules shall be lapsed and the modules shall be deemed to have been accepted by the buyer.

3. Inspection sampling method:

Unless otherwise agree in writing, the method of incoming inspection shall be based on ANSI-ASQC-1.4Z-2003.

3-1. Lot size : Quantity per shipment lot per model.

3-2. Sampling type : Normal inspection, single sampling.

3-3. Sampling level : Level II.

3-4. Acceptable quality level (AQL) :

3-4-1. Major defect: AQL=1.0 %.

3-4-2. Minor defect: AQL=2.5 %.

4. Inspection instruments:

4-1. A single 20W fluorescent lamp.

4-2. Pattern generator/ Video board: AU video board or equivalent. The output of the signal should comply with the specifications provided by AU.

4-3. Luminance colorimeter: Topcon SR-3 or equivalent model.

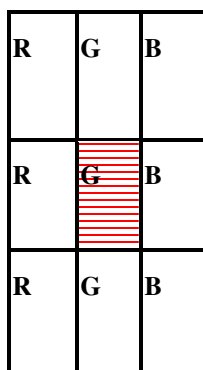
6. Electrical inspection specification:

| | Inspection Item | | Specification |
|----|-------------------|--|----------------|
| 1. | Line defect | | Can't be seen. |
| 2. | Bright dots | | ≤ 6 dots |
| 3. | Dark dots | | ≤ 7 dots |
| 4. | Total dots defect | | ≤ 8 dots |
| 5. | Continuous defect | Two continuous bright dots: | ≤ 2 pairs |
| | | Over three continuous bright dots (vertical, horizontal, oblique): | ≤ 1 pairs |
| | | Two continuous dark dots (vertical, horizontal, oblique): | ≤ 3 pairs |
| | | Over three continuous dark dots (vertical, horizontal, oblique): | ≤ 2 pairs |
| | | Distance between 2 Bright dots: | Disregarded |
| | | Distance between 2 Dark dots: | Disregarded |
| 6. | | Distance between Dark dot and Bright Dot: | Disregarded |
| 7. | Mura | | 5 % ND filter |

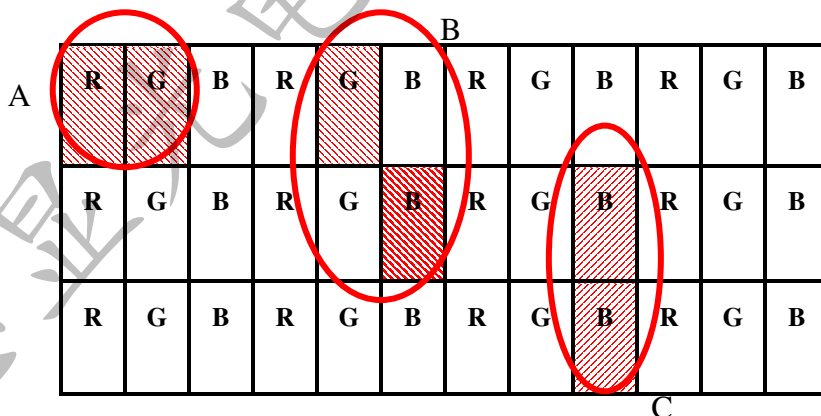
Note)

- For pixel defect, one sub pixel (dot) is defined for one pixel.
- Definition of two continuous bright dots: Only for two continuous dots (included vertical, horizontal, oblique type)
- Flicker adjust pattern define as dot inversion.(Red/Blue 32 level,60Hz Frame rate, sub pixel checking mode)
- Defect area (of dot defect) should be larger than 1/2 are of sub pixel to be count as one dot defect.
- Adjacent-dot defect should be observed under the same display pattern of any one of white/Black/Green/Blue/Red/Gray pattern
- Dot defect diagram

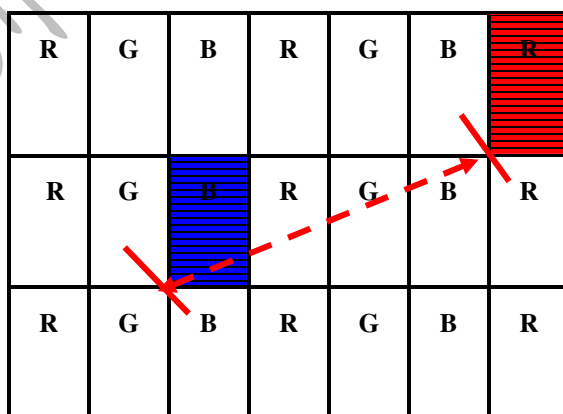
One dot (Bright /Dark)



Two continuous dots (Bright/Dark)



- Definition of distance between defect dots as following



A: Distance between defect dots

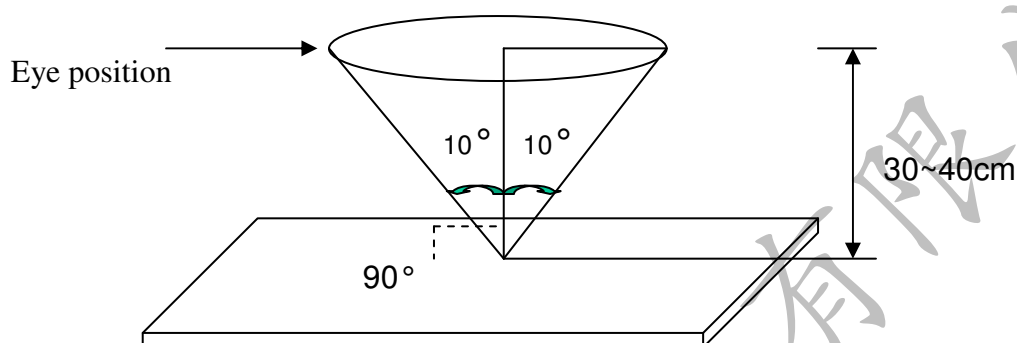


Defect Dot

7. Appearance specification:

7.1 Judgment conditions

1. Room temperature : 20 ~ 25℃.
2. Humidity: 65±5% RH.
3. Illumination: Fluorescent light (Day-Light Type) display surface illumination to be 300 ~ 700 Lux. (standard 500Lux.)
4. To be a distance about 35±5 cm in front of LCD unit, viewing line should be perpendicular to the surface of the module judge the visual appearance with human's eyes.
5. Take off the protector of polarizer while judging the display area.
6. If there is any question while judging, check the panel again while operating.



7.2 Appearance inspection specification

| 7.2 Appearance inspection specification | | | | | | | |
|---|--|-------------------------------|---------------------------------|------|-----------------|-------|-------------|
| Judge area | Judge item | | Inspection specification | | Judge criterion | | |
| | | | | | Major | Minor | |
| Active area | Particles, scratch and bubbles in display area | Circular | Average diameter: D (mm) | | | ○ | |
| | | | D<0.5mm | | | | Disregarded |
| | | | 0.5≤D≤1 | | | | n≤5 |
| | | | 1<D | | | | n=0 |
| | | Linear | Width: W (mm) Length: L (mm) | | | ○ | |
| | | | W<0.1mm | | | | Disregarded |
| | | | 0.1mm≤W≤0.2 | L≤15 | | | n≤5 |
| | | | 0.2<W | | | | n=0 |
| Bezel | Scratch | No harm | | | ○ | | |
| | Wrap | No dangerous | | ○ | | | |
| | Sunken | No harm | | ○ | | | |
| Label (S/N, B/L, WEEK) | No label | No | | ○ | | | |
| | Overlap Label (triple) | | | | ○ | | |
| | Invert label | | | ○ | | | |
| | Broken | | | ○ | | | |
| | Dirt | Word can be read. | | ○ | | | |
| | Not clear | | | | ○ | | |
| | Word out of shape | | | | ○ | | |
| | Mistake | No | | | ○ | | |
| | Position | Be attached on right position | | | ○ | | |
| | Screw | Not enough (Q'ty) | No | | ○ | | |
| Limp | | Grounding OK | | | ○ | | |

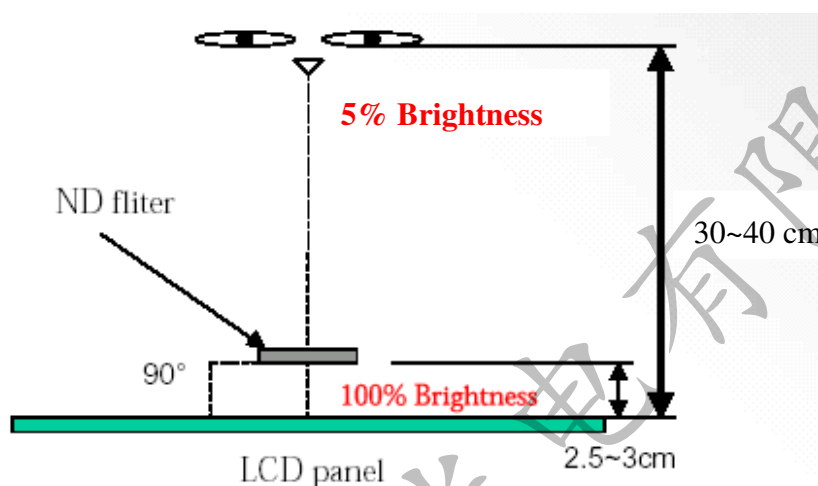
| | | | | |
|-------------|-------------------|--|---|--|
| Solder | Appearance | Can't see the abnormal color, shape, hurt, dirt (fused goods, etc). If it is necessary, please prepare sample. | ○ | |
| White Sheet | Broken | No | ○ | |
| Connector | Connection status | No correct connection | ○ | |
| FPC/FFC | Broken | No | ○ | |

Note 1: Extraneous substances that can be wiped out, like Finger point, Particles are not considered as a defect.

Note 2: Defects on the Black Matrix (outside of Active Area) are not considered as a defect.

Note 3: Mura criteria: judged by ND filter 5%, and can't be seen under the ND filter 5%

Note 4: ND filter use method The inspection method of ND Filter - holding ND filter in front of the panel around **2.5~3.0cm** and examine the panel from **35±5** cm in the front view for **1** seconds.



8. Outside dimension specification:

As the outside dimension, weight of the modules, please refer to product specification for more detail.

Note: Thickness doesn't include bending reason.

9. Precaution:

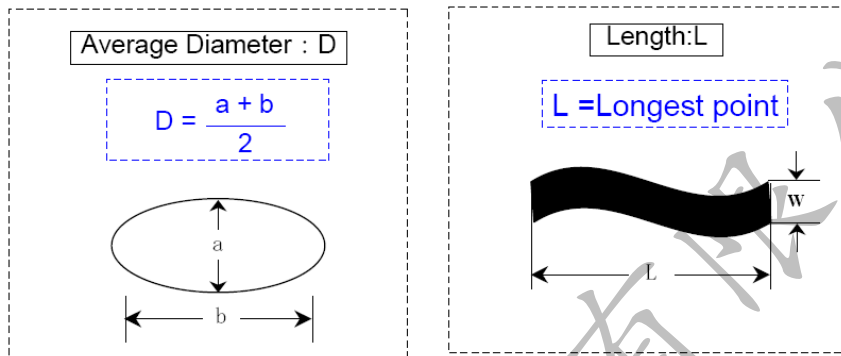
Please pay attention to the following items when you use the LCD Module with back-light unit.

1. Do not twist or bend the module and prevent the unsuitable external force for display module during assembly.
2. Adopt measures for good heat radiation. Be sure to use the module with in the specified temperature.
3. Avoid dust or oil mist during assembly.
4. Follow the correct power sequence while operating. Do not apply the invalid signal, otherwise, it will cause improper shut down and damage the module.
5. Less EMI: it will be more safety and less noise.
6. Please operate module in suitable temperature. The response time & brightness will drift by different temperature.
7. Avoid to display the fixed pattern (exclude the white pattern) in a long period, otherwise, it will cause image sticking.
8. Be sure to turn off the power when connecting or disconnecting the circuit.
9. Polarizer scratches easily, please handle it carefully.
10. Display surface never likes dirt or stains.
11. A dewdrop may lead to destruction. Please wipe off any moisture before using module.
12. Sudden temperature changes cause condensation, and it will cause polarizer damaged.
13. High temperature and humidity may degrade performance. Please do not expose the module to the direct sunlight and so on.
14. Acetic acid or chlorine compounds are not friends with TFT display module.
15. Static electricity will damage the modules; please do not touch the module without any grounded device.
16. Do not disassemble and reassemble the module by self.
17. Be careful do not touch the rear side directly because of the backlight high voltage.
18. No strong vibration or shock. It will cause module broken.
19. Storage the modules in suitable environment with regular packing.
20. Be careful of injury from a broken display module. Please avoid the pressure adding to the surface (front or rear side) of modules, because it will cause the display non-uniformity or other function issue.

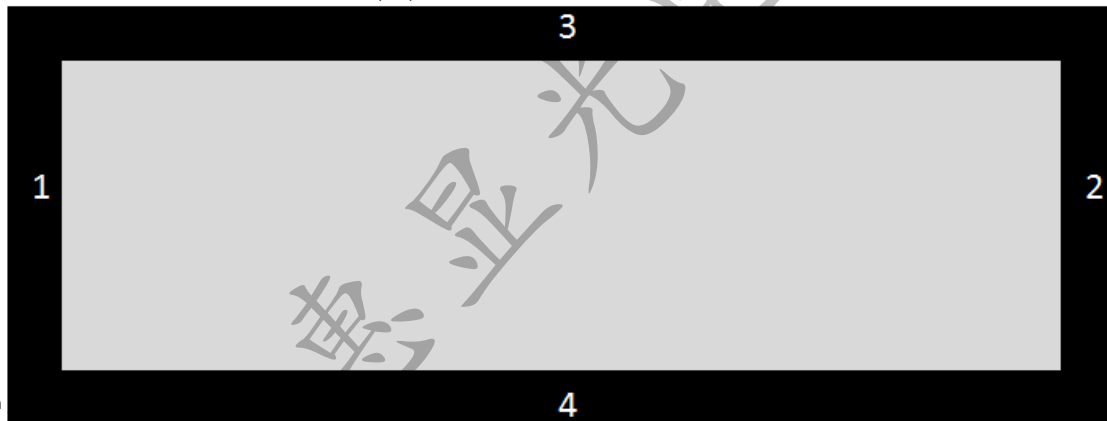
Note:

1. Bubble defect is defined as the defects appears on active display+Seamless area
2. The extraneous substance is defined as it can be observed when the module is power on/off.
3. The extraneous substance is not considered as s defect when it can be wiped out, e.g. finger prints and particles on the surface of the LCD modules.
4. The definition of D (average diameter) and L (length) is defined as follows:

D: Average Diameter; L: Length W: Width



5. BM Lack & Ink over flow defect: Judges in front view by visual inspecting under 500~1000 Lux.
6. BM area: BM lack can have ink refinishing in the back side but it is no defect appearance or color difference by visual inspecting.
7. The definition of BM area 1, 2, 3 & 4 is defined as follows.



7. Inspection judgment:

7-1. The judgment of the shipped lot (acceptance or rejection) should follow the sampling plan of ANSI-ASQC-1.4Z-2003, single sampling, normal inspection, level II.

7-2. If the number of defects is equal to or less than the applicable acceptance level, the lot shall be accepted.

7-3. If the number of defects is more than the applicable acceptance level, the lot shall be rejected and the buyer should inform the seller of the result of incoming inspection in writing.

8. Precaution:

Please pay attention to the following items when you use the LCD Modules:

- 8-1 Do not twist or bend the module and prevent the unsuitable external force for display module during assembly.
- 8-2 Adopt measures for good heat radiation. Be sure to use the module with in the specified

- temperature.
- 8-3 Avoid dust or oil mist during assembly.
 - 8-4 Follow the correct power sequence while operating. Do not apply the invalid signal, otherwise, it will cause improper shut down and damage the module.
 - 8-5 Less EMI: it will be more safety and less noise.
 - 8-6 Please operate module in suitable temperature. The response time & brightness will drift by different temperature.
 - 8-7 Avoid being displayed the fixed pattern (exclude the white pattern) in a long period, otherwise, it will cause image sticking.
 - 8-8 Be sure to turn off the power when connecting or disconnecting the circuit.
 - 8-9 Polarizer scratches easily, please handle it carefully.
 - 8-10 Display surface never likes dirt or stains.
 - 8-11 Dew may lead to destruction. Please wipe off any moisture before using module.
 - 8-12 Sudden temperature changes cause condensation, and it will cause polarizer damaged.
 - 8-13 High temperature and humidity may degrade performance. Please do not expose the module to the direct sunlight and so on.
 - 8-14 Acetic acid or chlorine compounds are not friends with TFT display module.
 - 8-15 Static electricity will damage the module, please do not touch the module without any grounded device.
 - 8-16 Do not disassemble and reassemble the module by self.
 - 8-17 Be careful do not touch the rear side directly.
 - 8-18 No strong vibration or shock. It will cause module broken.
 - 8-19 Storage the modules in suitable environment with regular packing.
 - 8-20 Be careful of injury from a broken display module.
 - 8-21 Please avoid the pressure adding to the surface (front or rear side) of modules, because it will cause the display non-uniformity or other function issue.
 - 8-22 It was forbidden to bend the FPC upward to the panel surface.