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1. Operating Precautions

- 1) Since front polarizer is easily damaged, please be cautious and not to scratch it.
- 2) Be sure to turn off power supply when inserting or disconnecting from input connector.
- 3) Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
- 4) When the panel surface is soiled, wipe it with absorbent cotton or soft cloth.
- 5) Since the panel is made of glass, it may be broken or cracked if dropped or bumped on hard surface.
- 6) Since CMOS LSI is used in this module, take care of static electricity and insure human earth when handling.
- 7) Do not open nor modify the module assembly.
- 8) Do not press the reflector sheet at the back of the module to any direction.
- 9) In case if a module has to be put back into the packing container slot after it was taken out from the container, do not press the center of the CCFL Reflector edge. Instead, press at the far ends of the CFL Reflector edge softly. Otherwise the TFT Module may be damaged.
- 10) At the insertion or removal of the Signal Interface Connector, be sure not to rotate nor tilt the Interface Connector of the TFT Module.
- 11) After installation of the TFT Module into an enclosure (Notebook PC Bezel, for example), do not twist nor bend the TFT Module even momentary. At designing the enclosure, it should be taken into consideration that no bending/twisting forces are applied to the TFT Module from outside. Otherwise the TFT Module may be damaged.
- 12) Cold cathode fluorescent lamp in LCD contains a small amount of mercury. Please follow local ordinances or regulations for disposal.
- 13) Small amount of materials having no flammability grade is used in the LCD module. The LCD module should be supplied by power complied with requirements of Limited Power Source (IEC60950 or UL1950), or be applied exemption.
- 14) The LCD module is designed so that the CFL in it is supplied by Limited Current Circuit (IEC60950 or UL1950). Do not connect the CFL in Hazardous Voltage Circuit.
- 15) Severe temperature condition may result in different luminance, response time and lamp ignition voltage.
- 16) Continuous operating TFT-LCD display under low temperature environment may accelerate lamp exhaustion and reduce luminance dramatically.
- 17) The data on this specification sheet is applicable when LCD module is placed in landscape position.
- 18) Continuous displaying fixed pattern may induce image sticking. It's recommended to use screen saver or shuffle content periodically if fixed pattern is displayed on the screen.

2. General Description

G104SN02 V1 is a Color Active Matrix Liquid Crystal Display composed of a TFT-LCD display, a driver circuit, and a backlight system. The screen format is intended to support SVGA (800(H) x 600(V)) screen and 16.2M (RGB 8-bits) or 262k colors (RGB 6-bits). All input signals are LVDS interface compatible. Inverter card of backlight is not included.

G104SN02 V1 is designed for industrial display applications.

2.1 Display Characteristics

The following items are characteristics summary on the table under 25 °C condition:

| Items | Unit | Specifications |
|--------------------------------|---------|--------------------------------------|
| Screen Diagonal | [inch] | 10.4 |
| Active Area | [mm] | 211.2 (H) x 158.4 (V) |
| Pixels H x V | | 800 x 3(RGB) x 600 |
| Pixel Pitch | [mm] | 0.264 x 0.264 |
| Pixel Arrangement | | R.G.B. Vertical Stripe |
| Display Mode | | TN, Normally White |
| Nominal Input Voltage VDD | [Volt] | 3.3 (typ.) |
| Typical Power Consumption | [Watt] | 6.5W (IRCFL=6mA, Black pattern) |
| Weight | [Grams] | 495 (typ.) |
| Physical Size | [mm] | 243.0(H) x 184.0(V) x 10.6(D) (typ.) |
| Electrical Interface | | 1 channel LVDS |
| Surface Treatment | | Anti-glare, Hardness 3H |
| Support Color | | 16.2M / 262K colors |
| Temperature Range Operating | [°C] | -30 to +85 |
| Storage (Non-Operating) | [°C] | -30 to +85 |
| RoHS Compliance | | RoHS Compliance |

2.2 Optical Characteristics

The optical characteristics are measured under stable conditions at 25°C (Room Temperature):

| Item | Unit | Conditions | Min. | Typ. | Max. | Note |
|--|----------------------|--------------------------------------|------|------|------|------|
| White Luminance | [cd/m ²] | IRCFL= 6mA (center point) | 320 | 400 | - | 1 |
| Uniformity | % | 5 Points | 65 | 75 | - | 2, 3 |
| Contrast Ratio | | | 400 | 500 | - | 4 |
| Response Time | [msec] | Rising | - | 10 | 20 | 5 |
| | [msec] | Falling | - | 20 | 30 | |
| | [msec] | Raising + Falling | - | 30 | 50 | |
| Viewing Angle | [degree] | Horizontal (Right) CR = 10 (Left) | 60 | 70 | - | 6 |
| | [degree] | | 60 | 70 | - | |
| | [degree] | Vertical (Upper) CR = 10 (Lower) | 45 | 55 | - | |
| Color / Chromaticity Coordinates (CIE 1931) | | Red x | 0.54 | 0.57 | 0.60 | |
| | | Red y | 0.29 | 0.32 | 0.35 | |
| | | Green x | 0.29 | 0.32 | 0.35 | |
| | | Green y | 0.53 | 0.56 | 0.59 | |
| | | Blue x | 0.13 | 0.16 | 0.19 | |
| | | Blue y | 0.12 | 0.15 | 0.18 | |
| | | White x | 0.29 | 0.32 | 0.35 | |
| | | White y | 0.30 | 0.33 | 0.36 | |
| Color Gamut | % | | | 45 | - | |

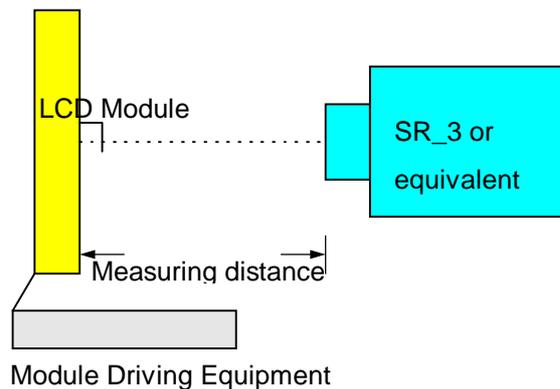
Note 1: Measurement method

Equipment Pattern Generator, Power Supply, Digital Voltmeter, Luminance meter (SR_3 or equivalent)

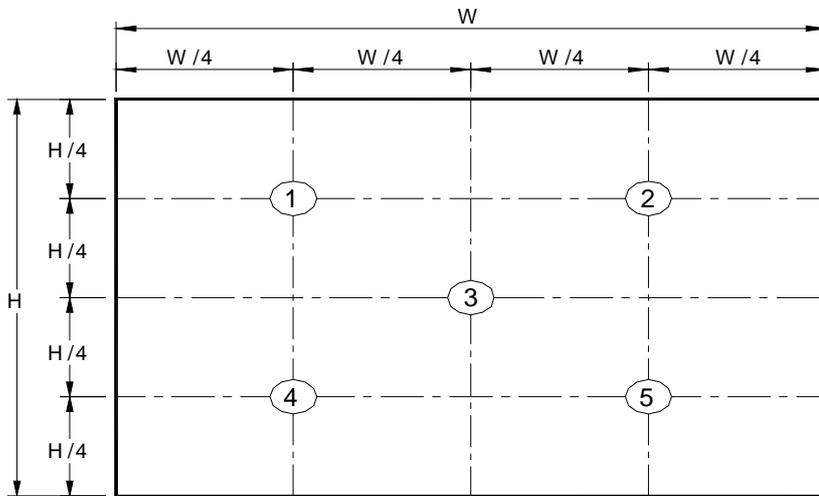
Aperture 1° with 50cm viewing distance

Test Point Center

Environment < 1 lux



Note 2: Definition of 5 points position (Display active area: 211.2mm (H) x 158.4mm (V))



Note 3: The luminance uniformity of 5 points is defined by dividing the minimum luminance values by the maximum test point luminance

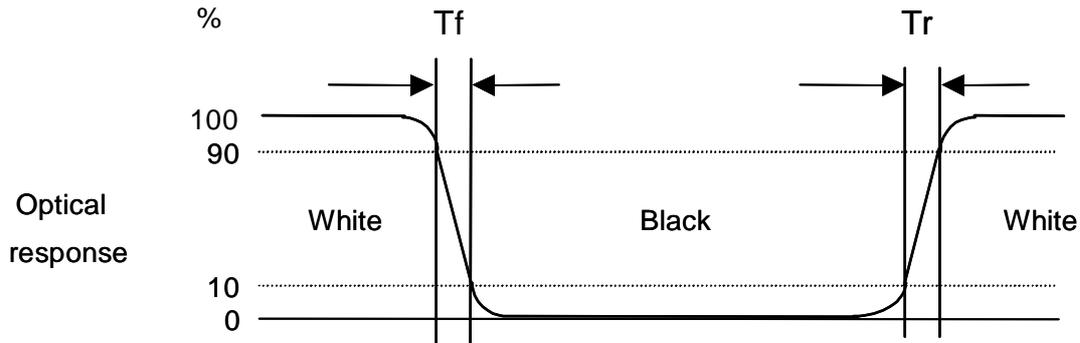
$$\delta_{w9} = \frac{\text{Minimum Brightness of five points}}{\text{Maximum Brightness of five points}}$$

Note 4: Definition of contrast ratio (CR):

$$\text{Contrast ratio (CR)} = \frac{\text{Brightness on the "White" state}}{\text{Brightness on the "Black" state}}$$

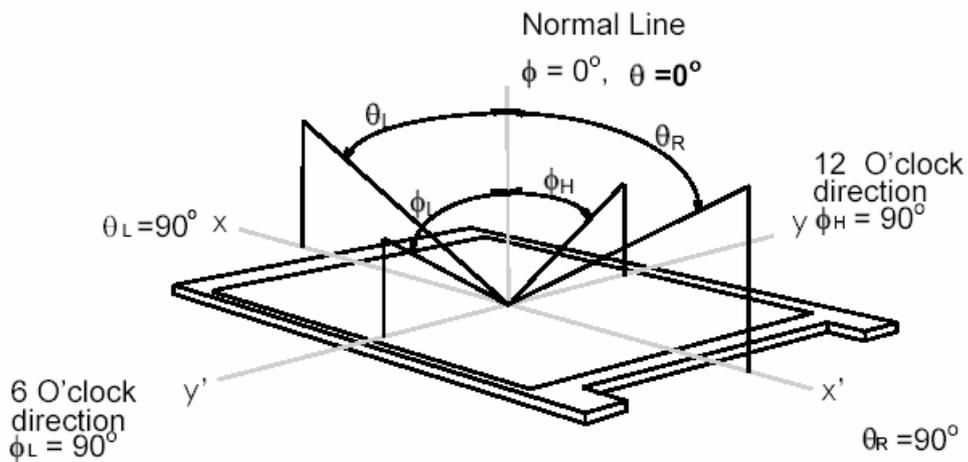
Note 5: Definition of response time:

The output signals of photo detector are measured when the input signals are changed from “White” to “Black” (falling time) and from “Black” to “White” (rising time), respectively. The response time interval is between 10% and 90% of amplitudes. Please refer to the figure as below.



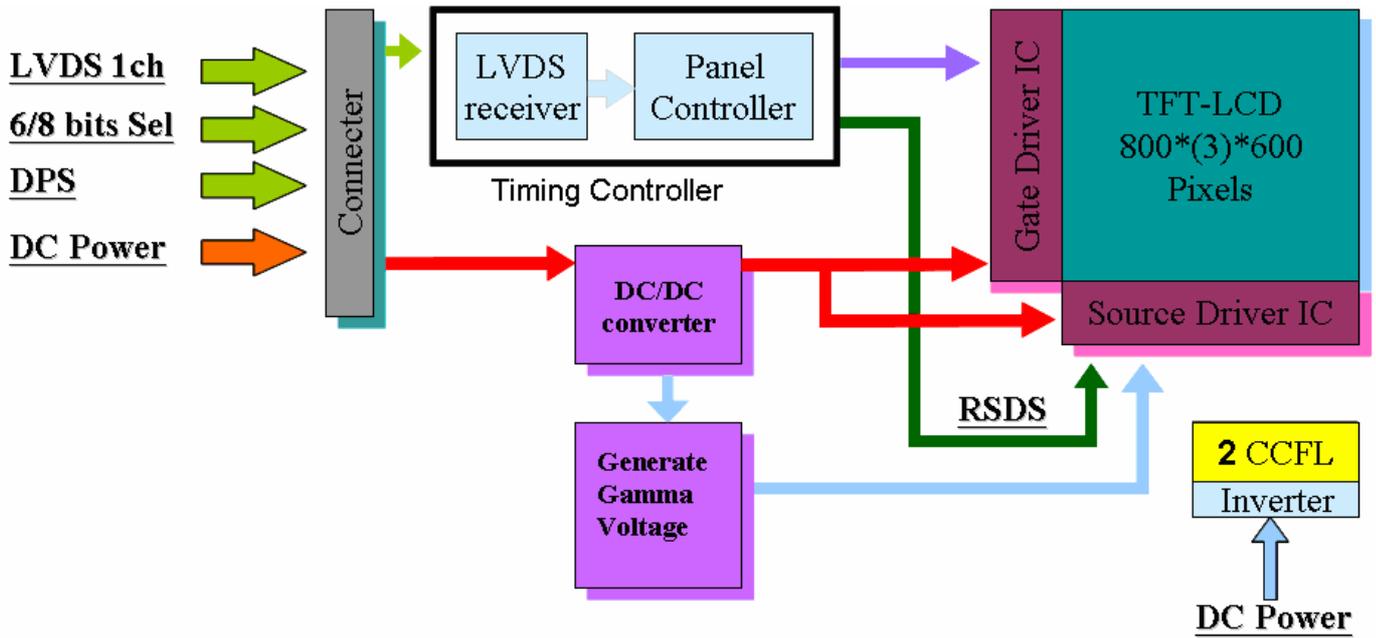
Note 6: Definition of viewing angle

Viewing angle is the measurement of contrast ratio ≥ 10 , at the screen center, over a 180° horizontal and 180° vertical range (off-normal viewing angles). The 180° viewing angle range is broken down as below: 90° (θ) horizontal left and right, and 90° (Φ) vertical high (up) and low (down). The measurement direction is typically perpendicular to the display surface with the screen rotated to its center to develop the desired measurement viewing angle.



3. Functional Block Diagram

The following diagram shows the functional block of the 10.4 inch color TFT/LCD module:



4. Absolute Maximum Ratings

4.1 Absolute Ratings of TFT LCD Module

| Item | Symbol | Min | Max | Unit |
|-----------------|--------|------|------|--------|
| Logic/LCD Drive | Vin | -0.3 | +4.0 | [Volt] |

4.2 Absolute Ratings of Environment

| Item | Symbol | Min | Max | Unit |
|-----------------------|--------|-----|-----|-------|
| Operating Temperature | TOP | -30 | +85 | [°C] |
| Operation Humidity | HOP | 5 | 95 | [%RH] |
| Storage Temperature | TST | -30 | +85 | [°C] |
| Storage Humidity | HST | 5 | 95 | [%RH] |

Note: Maximum Wet-Bulb should be 39°C and no condensation.

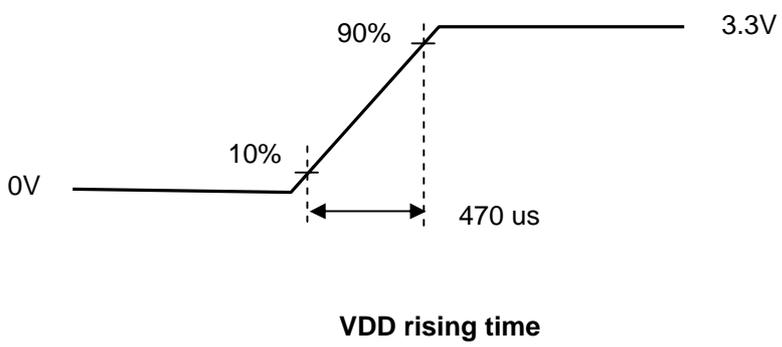
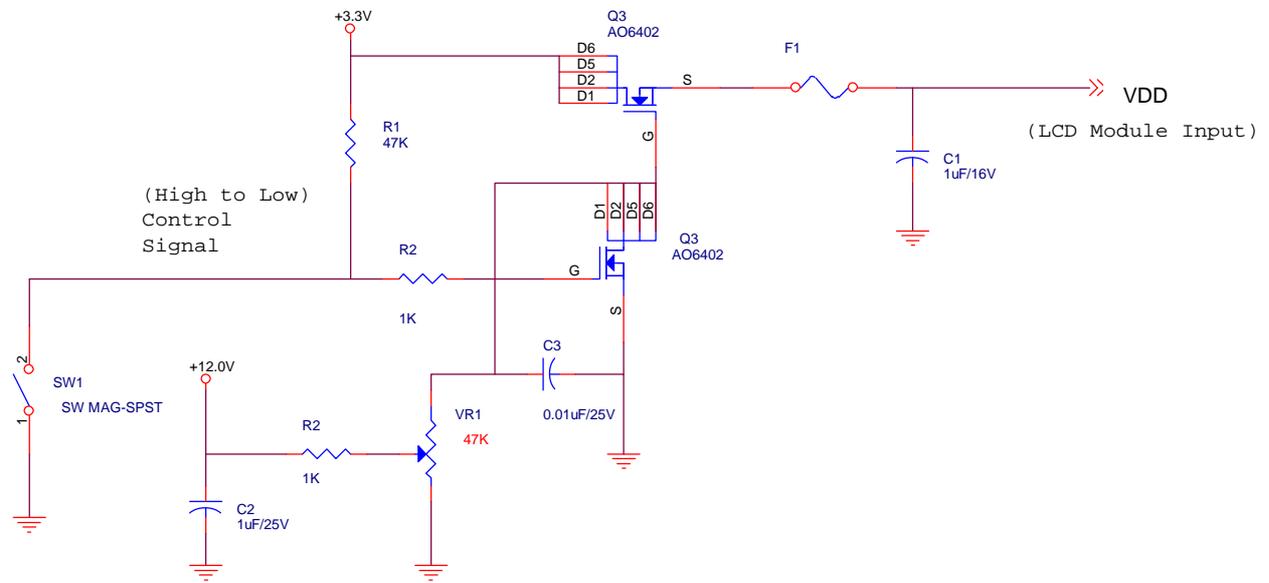
5. Electrical Characteristics

5.1 TFT LCD Module

5.1.1 Power Specification

| Symbol | Parameter | Min | Typ | Max | Units | Remark |
|--------|--|-----|-----|-----|-------------|--|
| VDD | Logic/LCD Drive Voltage | 3.0 | 3.3 | 3.6 | [Volt] | |
| IDD | VDD Current | | 240 | | [mA] | VDD=3.3V, Black Pattern |
| PDD | VDD Power | | 0.8 | | [Watt] | VDD=3.3V, Black Pattern |
| Irush | LCD Inrush Current | | | 1.5 | [A] | Note 1; VDD=3.3V Black Pattern, Rising time=470us |
| VDDrp | Allowable Logic/LCD Drive Ripple Voltage | | | 100 | [mV] p-p | VDD=3.3V, Black Pattern |

Note 1: Measurement condition:



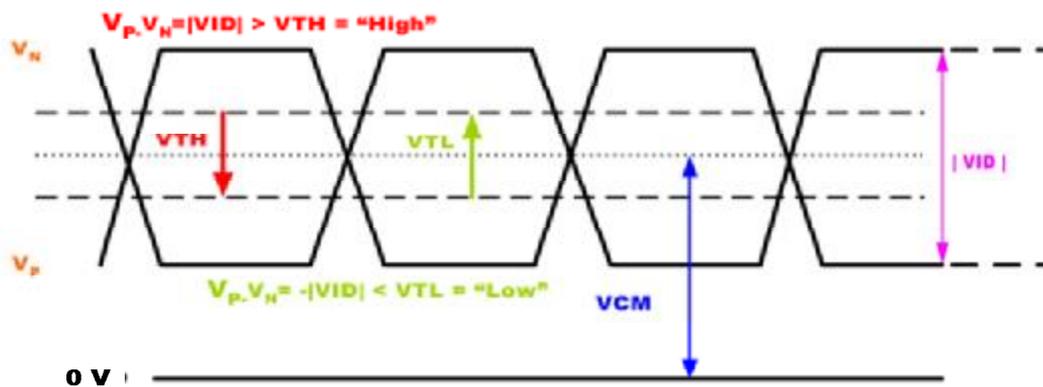
5.1.2 Signal Electrical Characteristics

Input signals shall be low or Hi-Z state when VDD is off.

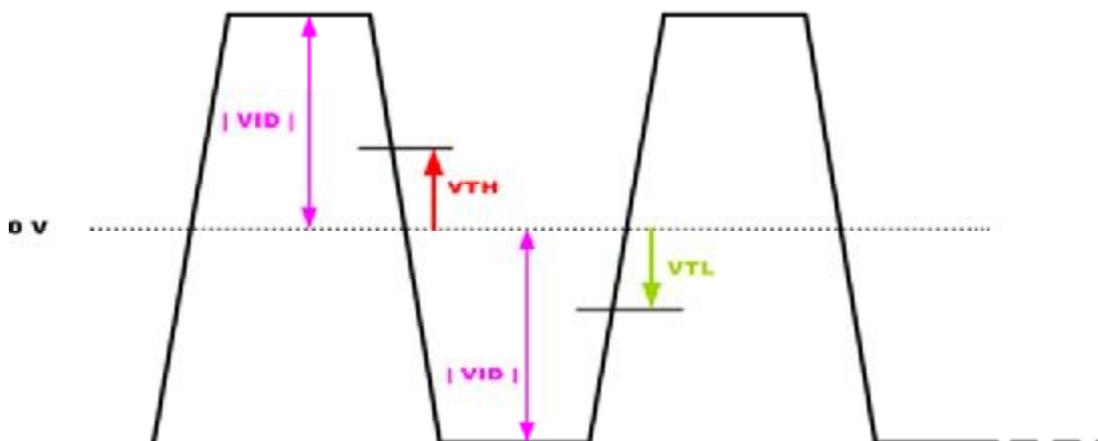
| Symbol | Item | Min. | Typ. | Max. | Unit | Remark |
|------------------|--|------|------|------|------|--|
| V _{TH} | Differential Input High Threshold | | | 100 | [mV] | V _{CM} =1.2V |
| V _{TL} | Differential Input Low Threshold | 100 | | | [mV] | V _{CM} =1.2V |
| VID | Input Differential Voltage | 100 | 400 | 600 | [mV] | |
| V _{ICM} | Differential Input Common Mode Voltage | 1.1 | | 1.45 | [V] | V _{TH} /V _{TL} =±100mV |

Note: LVDS Signal Waveform.

Single-end Signal



Differential Signal



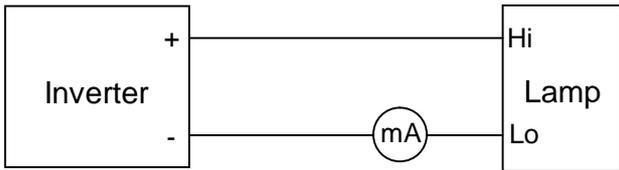
5.2 Backlight Unit

5.2.1 Parameter guideline for CCFL

Following characteristics are measured under a stable condition using an inverter at 25°C (Room Temperature):

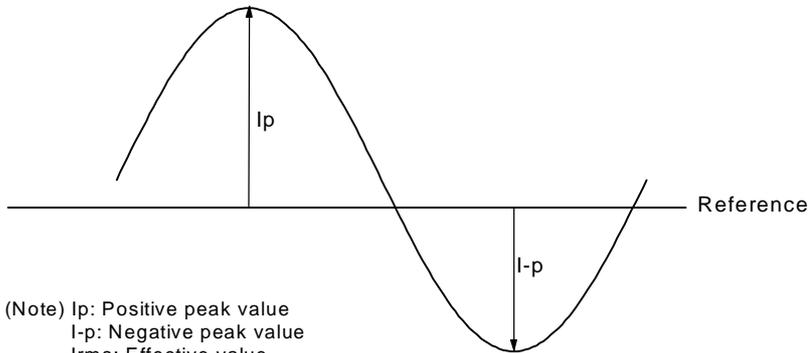
| Symbol | Parameter | Min. | Typ. | Max. | Unit | Remark |
|--------------------------------|---|--------|------|------|---------------|--|
| IRCFL | CCFL operation range | | 6.0 | 6.5 | [mA] rms | (Ta=25°C) Note 1 |
| FCFL | CCFL Frequency | 40 | | 60 | [KHz] | (Ta=25°C) Note 2 |
| ViCFL (0°C) (reference) | CCFL Ignition Voltage | | | 1160 | [Volt] rms | (Ta= 0°C) |
| ViCFL (25°C) (reference) | CCFL Ignition Voltage | | | 890 | [Volt] rms | (Ta=25°C) |
| VCFL | CCFL Discharge Voltage | 423 | 470 | 517 | [Volt] rms | (Ta=25°C) Note 3 IRCFL=6 mA VCFL = Typ±10% |
| PCFL | CCFL Power Consumption (inverter excluded) | | 5.64 | | [Watt] | (Ta=25°C) Note 3 IRCFL=6 mA |
| Lamp Life | | 50,000 | - | | Hrs | (Ta=25°C) Note 4 IRCFL = 6 mA |

Note 1: IRCFL is defined as the return current of an inverter. (In Figure. 1)



(Figure. 1: Measurement of return current)

A stable IRCFL is a current without flicker or biasing waveform provided by inverter that ensures the backlight perform to its specification. The ideal sine waveform should be symmetric in positive and negative polarities and the asymmetry rate of the inverter waveform should be below 10%.



DC Bias = $(|I_p - I_p| / I_{rms}) \times 100\% < 10\%$

Crest Factor = $I_p \text{ or } (I-p) / I_{rms}$ should have the range within 1.414_{+10%}

It is recommended to use the inverter with detection circuit (ie: balance and protection circuit) to avoid overvoltage, overcurrent, or mismatching waveform.

Note 2: CCFL frequency should be carefully determined to avoid interference between inverter and TFT LCD.

Higher frequency will induce higher leakage current and further impact lamp life.

Note 3: Calculator value for reference ($IRCFL \times VCFL \times 2 = PCFL$).

Note 4: The definition of lamp life means when any of following conditions happen:

- a) Luminance falls to 50% or less of the initial value.
- b) Normal lighting is no more available (flickering, pink lighting, no lighting, etc.)
- c) Lamp voltage or lighting start voltage exceeds the specified value.

Lamp life time shortens according to

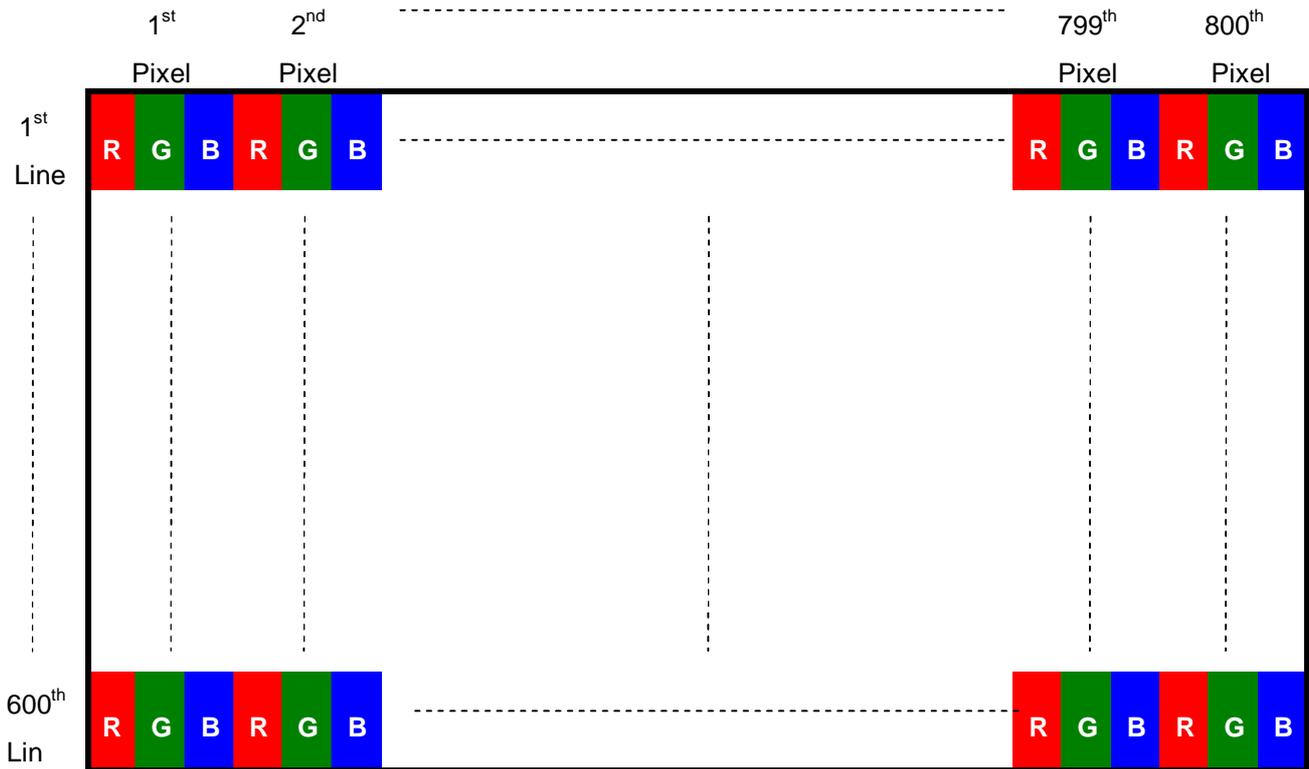
- d) Placing methodology: mercury is unevenly distributed in portrait mounting
- e) Environmental condition: low temperature reduces the presence of mercury vapor, which results in approximately lamp life of 1,000 hours
- f) CCFL surface temperature: Presence of gradient in lamp surface temperature causes uneven mercury migration
- g) Inverter design: its resonance capacitor should be fine-tuned with the impedance of CCFL
- h) Over driving current (> 6.5 mA) shortens lamp life time dramatically.

Note 5: The display is with dual lamp design, and the CCFL current in above table refers to each lamp

6. Signal Characteristic

6.1 Pixel Format Image

Following figure shows the relationship between input signal and LCD pixel format.



6.2 Scanning Direction

The following figures show the image seen from the front view. The arrow indicates the direction of scan.

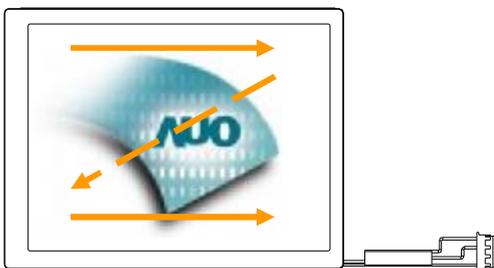


Fig. 1 Normal scan (Pin4, DPS = Low or NC)

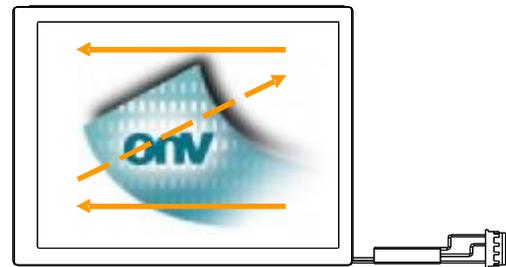


Fig. 2 Reverse scan (Pin4, DPS = High)

6.3 Pin Description

The module using a LVDS receiver embaded in AUO's ASIC. LVDS is a differential signal technology for LCD interface and a high-speed data transfer device.

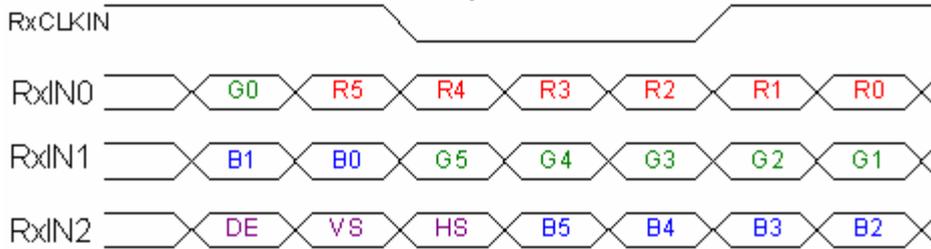
| Input Signal Interface | | |
|------------------------|----------|--|
| Pin No. | Symbol | Description |
| 1 | VDD | Power Supply, 3.3V (typical) |
| 2 | VDD | Power Supply, 3.3V (typical) |
| 3 | GND | Ground |
| 4 | DPS | Reverse Scan Function [H: Enable; L/NC: Disable] |
| 5 | RxIN0- | LVDS receiver signal channel 0 |
| 6 | RxIN0+ | LVDS Differential Data Input (R0, R1, R2, R3, R4, R5, G0) |
| 7 | GND | Ground |
| 8 | RxIN1- | LVDS receiver signal channel 1 |
| 9 | RxIN1+ | LVDS Differential Data Input (G1, G2, G3, G4, G5, B0, B1) |
| 10 | GND | Ground |
| 11 | RxIN2- | LVDS receiver signal channel 2 |
| 12 | RxIN2+ | LVDS Differential Data Input (B2, B3, B4, B5, HS, VS, DE) |
| 13 | GND | Ground |
| 14 | RxCLKIN- | LVDS receiver signal clock |
| 15 | RxCLKIN+ | |
| 16 | GND | Ground |
| 17 | RxIN3- | LVDS receiver signal channel 3, NC for 6 bit LVDS Input |
| 18 | RxIN3+ | LVDS Differential Data Input (R6, R7, G6, G7, B6, B7, RSV) |
| 19 | RSV | Reserved for AUO internal test. Please treat it as NC. |
| 20 | SEL68 | 6/ 8bits LVDS data input selection [H: 8bits L/NC: 6bit] |

- Note:
1. Input Signals shall be in low status when VDD is off.
 2. NC means "No Connection".
 3. RSV means "Reserved".

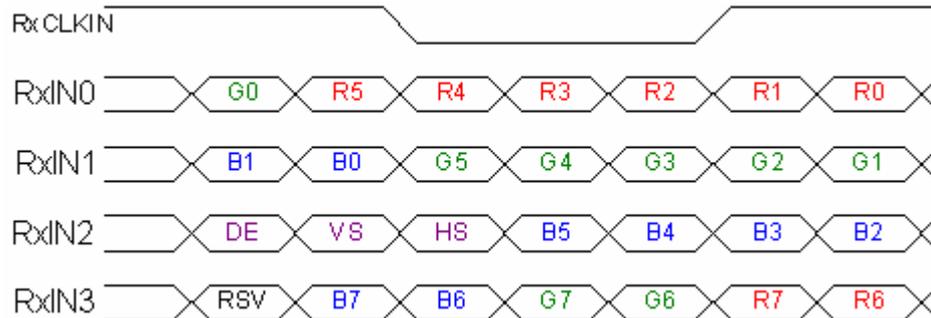
6.4 The Input Data Format

6.4.1 SEL68

SEL68 = “Low” or “NC” for 6 bits LVDS Input



SEL68 = “High” for 8 bits LVDS Input



Note1: Please follow PSWG.

Note2: R/G/B data 7:MSB, R/G/B data 0:LSB

| Signal Name | Description | Remark |
|-------------|-------------------------------|--|
| R7 | Red Data 7 | Red-pixel Data For 8Bits LVDS input MSB: R7 ; LSB: R0 For 6Bits LVDS input MSB: R5 ; LSB: R0 |
| R6 | Red Data 6 | |
| R5 | Red Data 5 | |
| R4 | Red Data 4 | |
| R3 | Red Data 3 | |
| R2 | Red Data 2 | |
| R1 | Red Data 1 | |
| R0 | Red Data 0 | |
| G7 | Green Data 7 | Green-pixel Data For 8Bits LVDS input MSB: G7 ; LSB: G0 For 6Bits LVDS input MSB: G5 ; LSB: G0 |
| G6 | Green Data 6 | |
| G5 | Green Data 5 | |
| G4 | Green Data 4 | |
| G3 | Green Data 3 | |
| G2 | Green Data 2 | |
| G1 | Green Data 1 | |
| G0 | Green Data 0 | |
| B7 | Blue Data 7 | Blue-pixel Data For 8Bits LVDS input MSB: B7 ; LSB: B0 For 6Bits LVDS input MSB: B5 ; LSB: B0 |
| B6 | Blue Data 6 | |
| B5 | Blue Data 5 | |
| B4 | Blue Data 4 | |
| B3 | Blue Data 3 | |
| B2 | Blue Data 2 | |
| B1 | Blue Data 1 | |
| B0 | Blue Data 0 | |
| RxCLKIN | LVDS Data Clock | |
| DE | Data Enable Signal | When the signal is high, the pixel data shall be valid to be displayed. |
| VS | Vertical Synchronous Signal | |
| HS | Horizontal Synchronous Signal | |

Note: Output signals from any system shall be low or Hi-Z state when VDD is off.

6.5 Interface Timing

6.5.1 Timing Characteristics

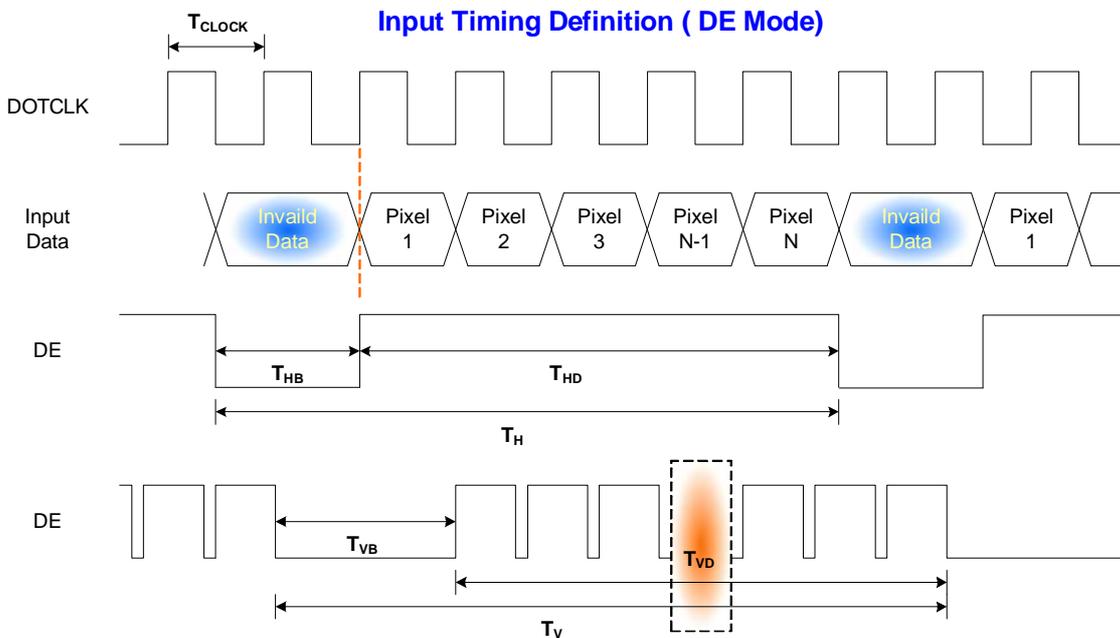
| Signal | Parameter | Symbol | Min. | Typ. | Max. | Unit | |
|--------------|--------------------|---------------|----------|------|------|------|-------------|
| Clock Timing | Clock Frequency | $1/T_{Clock}$ | 30 | 40 | 50 | MHz | |
| Vsync Timing | Vertical Section | Period | T_V | 608 | 628 | 1024 | T_{Line} |
| | | Active | T_{VD} | -- | 600 | -- | |
| | | Blanking | T_{VB} | 8 | 28 | 424 | |
| Hsync Timing | Horizontal Section | Period | T_H | 960 | 1056 | 1060 | T_{Clock} |
| | | Active | T_{HD} | -- | 800 | -- | |
| | | Blanking | T_{HB} | 160 | 256 | 260 | |

Note: Frame rate is 60 Hz.

Note: DE mode.

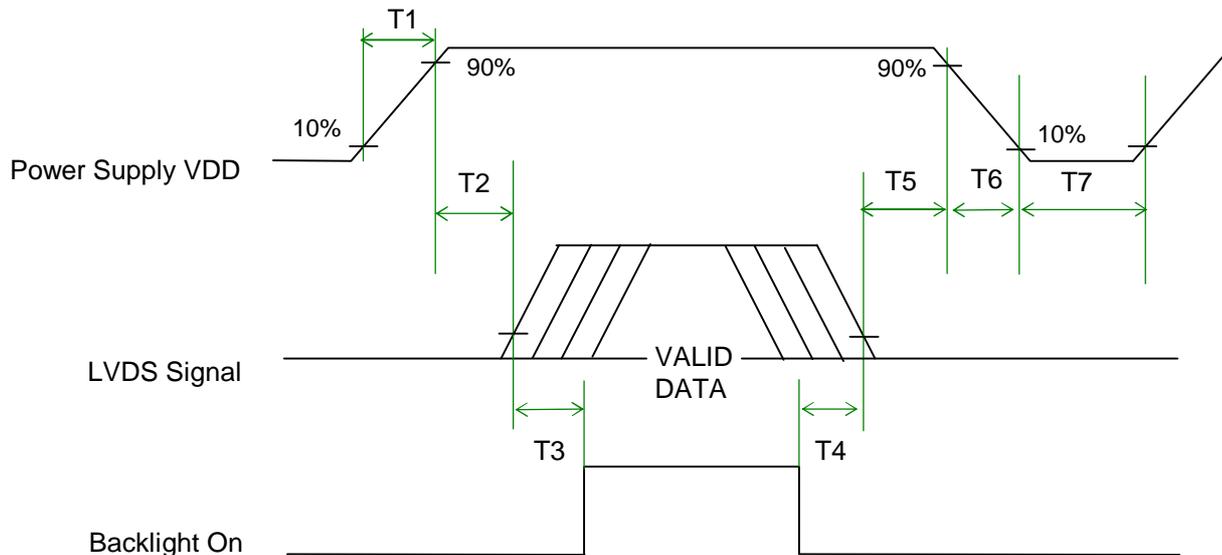
Note : Typical value refer to VESA STANDARD

6.5.2 Input Timing Diagram



6.6 Power ON/OFF Sequence

VDD power and lamp on/off sequence is as below. Interface signals are also shown in the chart. Signals from any system shall be Hi-Z state or low level when VDD is off.



Power ON/OFF sequence timing

| Parameter | Value | | | Units |
|-----------|-------|------|------|-------|
| | Min. | Typ. | Max. | |
| T1 | 0.5 | - | 10 | ms |
| T2 | 0 | - | 50 | ms |
| T3 | 180 | - | | ms |
| T4 | 180 | - | | ms |
| T5 | 0 | - | 50 | ms |
| T6 | 0 | - | 10 | ms |
| T7 | 500 | - | - | ms |

The above on/off sequence should be applied to avoid abnormal function in the display. Please make sure to turn off the power when you plug the cable into the input connector or pull the cable out of the connector.

7. Connector & Pin Assignment

Physical interface is described as for the connector on module. These connectors are capable of accommodating the following signals and will be following components.

7.1 TFT LCD Module: LVDS Connector

| Connector Name / Designation | Signal Connector |
|------------------------------|----------------------------|
| Manufacturer | STM or compatible |
| Connector Model Number | MSB24013P20A or compatible |
| Adaptable Plug | P24013P20 or compatible |

7.2 Backlight Unit: Lamp Connector

| Connector Name / Designation | Lamp Connector |
|------------------------------|--------------------------|
| Manufacturer | JST or compatible |
| Connector Model Number | BHR-03VS-1 or compatible |
| Mating Model Number | BHMR-03V or compatible |

7.3 Lamp Connector Pin Assignment

| Pin# | Symbol | Cable color | Signal Name |
|------|--------|-------------|-------------------|
| 1 | LV | White | Lamp Low Voltage |
| 2 | HV | Blue | Lamp High Voltage |
| 3 | HV | Pink | Lamp High Voltage |

Cable length: 60 ± 5 mm

Connector-output position: right side (front view)

Lamp assembly design shall be easy for replacement and repair

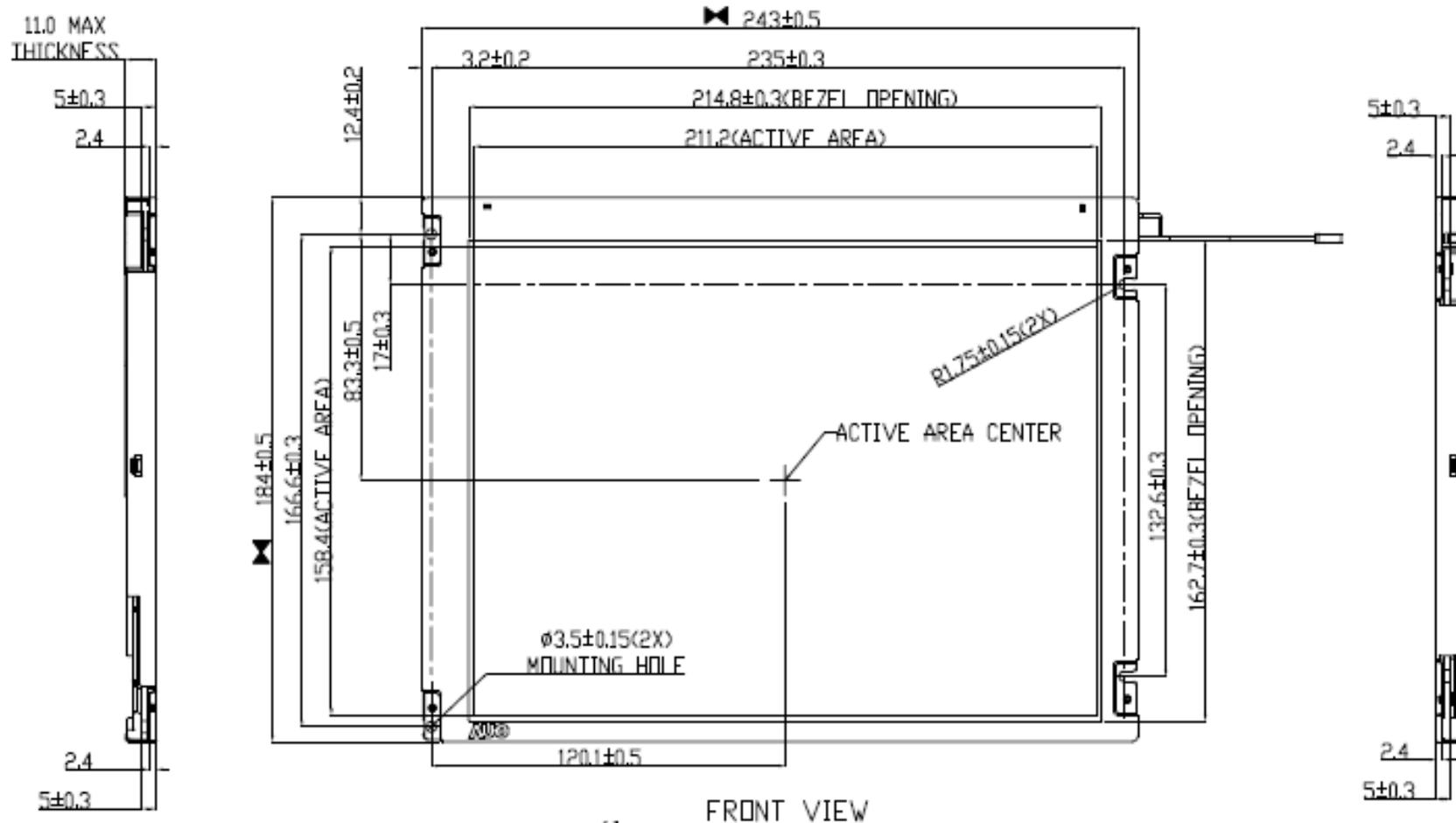
8. Reliability Test Criteria

| Items | Required Condition | Note |
|--------------------------------|---|--------|
| Temperature Humidity Bias | 40°C / 90%, 300 hours | |
| High Temperature Operation | 85°C, 300 hours | |
| Low Temperature Operation | -30°C, 300 hours | |
| Hot Storage | 85°C, 300 hours | |
| Cold Storage | -30°C, 300 hours | |
| Thermal Shock Test | -20°C / 30 min, 60°C / 30 min, 100cycles, 40°C minimum ramp rate | |
| Hot Start Test | 85°C / 1Hr min. power on/off per 5 minutes, 5 times | |
| Cold Start Test | -30°C / 1Hr min. power on/off per 5 minutes, 5 times | |
| Shock Test (Non-Operating) | 50G, 20ms, Half-sine wave, (±X, ±Y, ±Z) | |
| Vibration Test (Non-Operating) | 1.5G, (10~200Hz, Sine wave) 30 mins/axis, 3 direction (X, Y, Z) | |
| On/off test | On/10 sec, Off/10 sec, 30,000 cycles | |
| ESD | Contact Discharge: ± 8KV, 150pF(330Ω) 1sec, 8 points, 25 times/ point Air Discharge: ± 15KV, 150pF(330Ω) 1sec, 8 points, 25 times/ point | Note 1 |
| EMI | 30-230 MHz, limit 40 dBu V/m, 230-1000 MHz, limit 47 dBu V/m | |

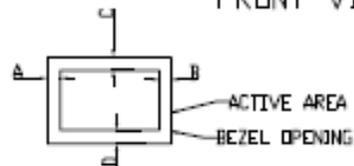
Note1: According to EN61000-4-2, ESD class B: Some performance degradation allowed. No data lost
Self-recoverable. No hardware failures.

9. Mechanical Characteristics

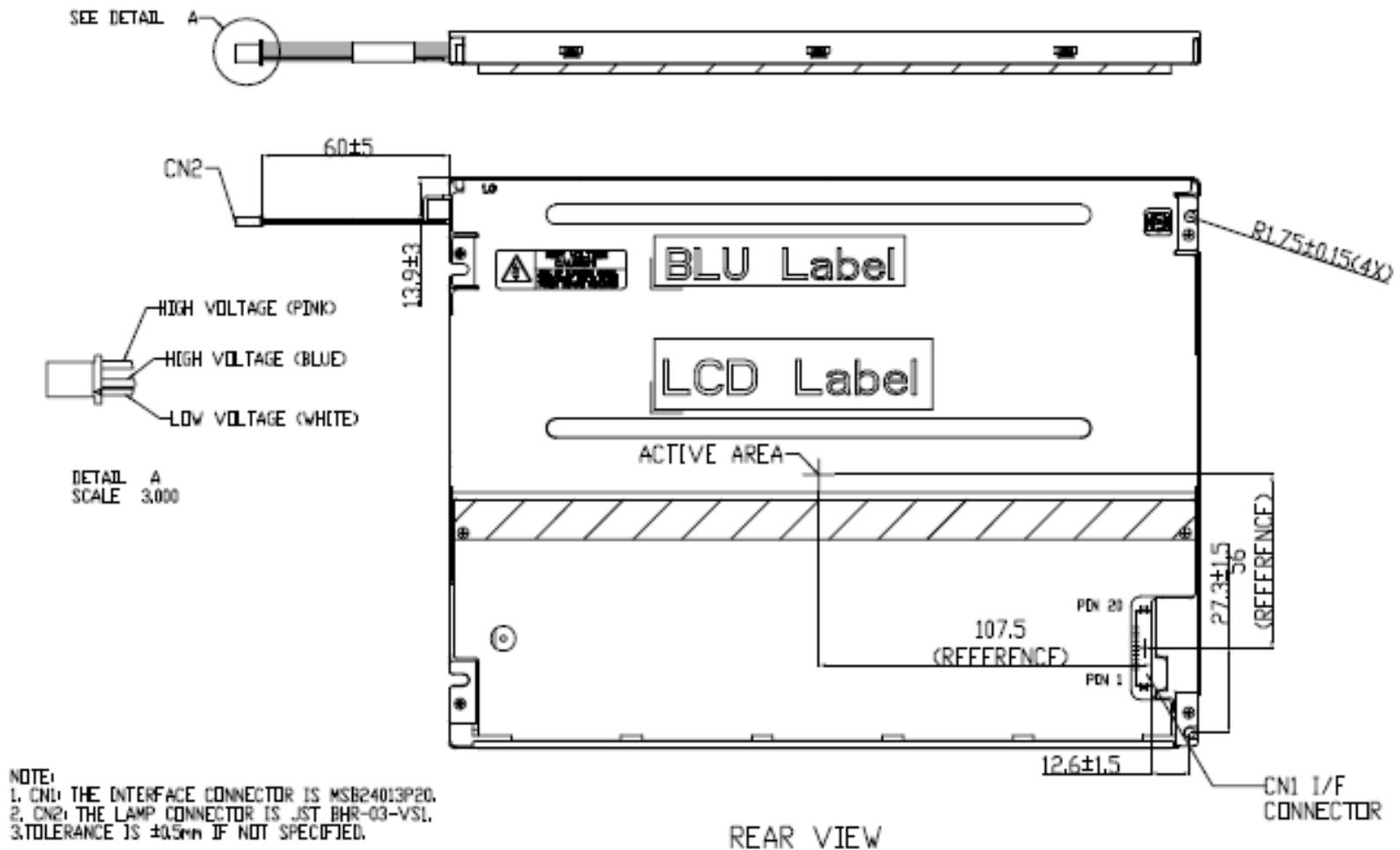
9.1 LCM Outline Dimension (Front View)



NOTE
 1. BLIND QUANTITY TOLERANCE OF DISPLAY AREA SHOWN AS RIGHT:
 X-DIRECTION: IA-BK=±0mm
 Y-DIRECTION: IC-DK=±0mm
 2. TOLERANCE IS ± 0.5 mm IF NOT SPECIFIED.

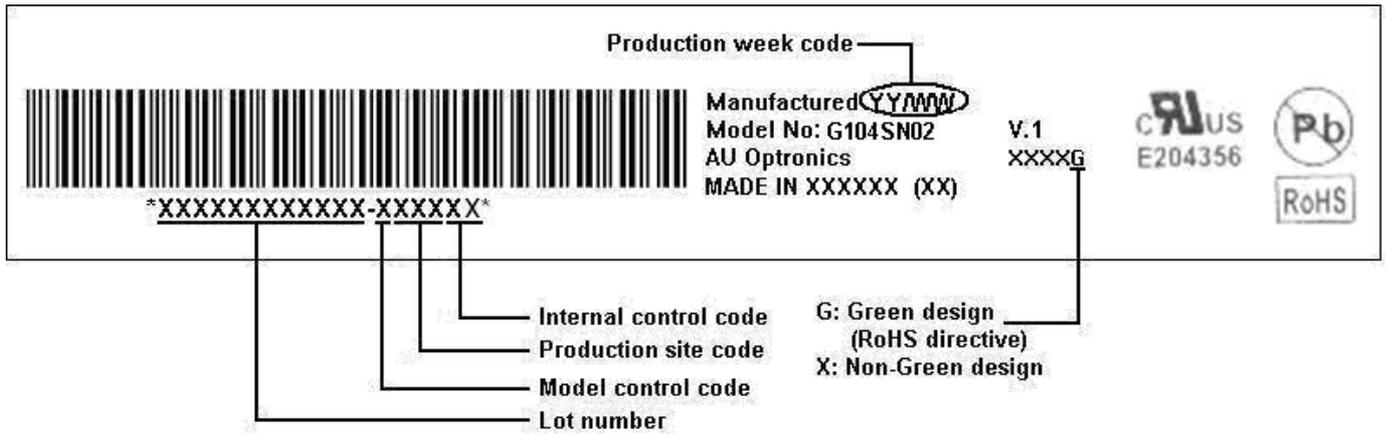


9.2 LCM Outline Dimension (Rear View)

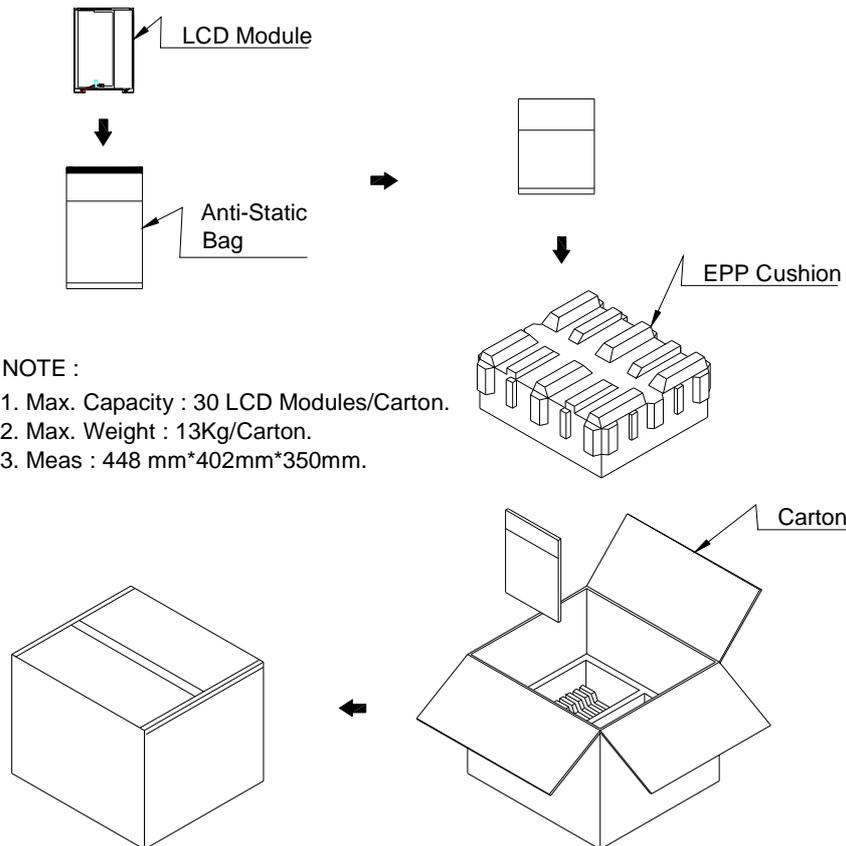


10. Label and Packaging

10.1 Shipping Label (on the rear side of TFT-LCD display)



10.2 Carton Package



11 Safety

11.1 Sharp Edge Requirements

There will be no sharp edges or comers on the display assembly that could cause injury.

11.2 Materials

11.2.1 Toxicity

There will be no carcinogenic materials used anywhere in the display module. If toxic materials are used, they will be reviewed and approved by the responsible AUO toxicologist.

11.2.2 Flammability

All components including electrical components that do not meet the flammability grade UL94-V1 in the module will complete the flammability rating exception approval process.

The printed circuit board will be made from material rated 94-V1 or better. The actual UL flammability rating will be printed on the printed circuit board.

11.3 Capacitors

If any polarized capacitors are used in the display assembly, provisions will be made to keep them from being inserted backwards.

11.4 National Test Lab Requirement

The display module will satisfy all requirements for compliance to:

UL 60950

U.S.A. Information Technology Equipment