



TFT DISPLAY MODULE

Product Specification

| | | | |
|----------------------|------------------|-------|--|
| Customer | Standard | | |
| Product Number | DMT024QVNTNT0-2A | | |
| Customer Part Number | | | |
| Customer Approval | | Date: | |

Internal Approvals

| Product Mgr | Doc. Control | Electr. Eng |
|----------------|----------------|----------------|
| Luo Luo | Luo Luo | David Hardman |
| Date: 08/01/18 | Date: 08/01/18 | Date: 08/01/18 |

Revision Record

| Rev. | Date | Page | Chapt. | Comment | ECR no. |
|------|-----------|------|--------|---|---------|
| 1.0 | 08-Jan-18 | All | All | Initial Release An upgrade version of ex- DET024QVF2H-C | ECN8025 |
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Table of Contents

| | | |
|------------|---|-----------|
| 1.0 | MAIN FEATURES | 5 |
| 2.0 | MECHANICAL SPECIFICATION | 6 |
| 2.1 | Mechanical Characteristics | 6 |
| 2.2 | Mechanical Drawing | 7 |
| 3.0 | ELECTRICAL SPECIFICATION | 8 |
| 3.1 | Absolute Maximum Ratings | 8 |
| 3.2 | Electrical Characteristics | 8 |
| 3.3 | Interface Pin Assignment | 9 |
| 3.3.1 | TFT Pin Assignment | 9 |
| 3.4 | Timing Characteristics | 10 |
| 3.4.1 | Serial Interface Timing Characteristics (3-line serial) | 10 |
| 3.4.3 | Reset Timing Characteristics | 13 |
| 4.0 | OPTICAL SPECIFICATION | 15 |
| 4.1 | Optical Characteristics | 15 |
| 4.1.1 | Test Method | 16 |
| 5.0 | BACKLIGHT SPECIFICATION | 17 |
| 5.1 | LED Driving Conditions | 17 |
| 5.2 | LED Circuit | 17 |
| 6.0 | QUALITY ASSURANCE SPECIFICATION | 18 |
| 6.1 | Delivery Inspection Standards | 18 |
| 6.1.1 | Inspection Conditions | 18 |
| 6.1.2 | Environmental Conditions | 18 |
| 6.1.3 | Sampling Conditions | 18 |
| 6.1.4 | Definition of Area | 19 |
| 6.1.5 | Basic Principle | 19 |
| 6.1.6 | Inspection Criteria | 20 |
| 6.1.7 | Classification of Defects | 23 |
| 6.1.8 | Identification / marking criteria | 23 |
| 6.2 | Dealing with Customer Complaints | 23 |
| 6.2.1 | Non-conforming analysis | 23 |

| | |
|---|-----------|
| 6.2.2 Handling of non-conforming displays | 23 |
| 7.0 RELIABILITY SPECIFICATION..... | 24 |
| 7.1 Reliability Tests | 24 |
| 8.0 HANDLING PRECAUTIONS | 25 |

1.0 Main Features

| Item | Contents |
|-----------------------|-----------------------------------|
| Screen Size | 2.4" Diagonal |
| Display Format | 240 x RGB x 320 Dots |
| N° of Colour | 262K |
| Active Area | 36.72 mm (H) x 48.96 mm (V) |
| LCD Type | TFT |
| Mode | IPS Transmissive / Normally Black |
| Viewing Direction | Full view |
| Interface | 18 bit RGB (+SPI) |
| Driver IC | ST7789V |
| Backlight Type | LED |
| Operating Temperature | -20°C ~ +70°C |
| Storage Temperature | -30°C ~ +80°C |
| RoHS compliant | Yes |

2.0 Mechanical Specification

2.1 Mechanical Characteristics

| Item | Characteristic | Unit |
|--------------------|--|------|
| Display Format | 240 x RGB x 320 Dots | Dots |
| Overall Dimensions | 42.72 mm (H) x 60.4 mm (V) x 1.93 mm (D) | mm |
| Active Area | 36.72 mm (H) x 48.96 mm (V) | mm |
| pixel Pitch | 153 (H) x 153 (V) | μm |
| Weight | 9 | g |

3.0 Electrical Specification

3.1 Absolute Maximum Ratings

| Item | Symbol | Condition | Min | Max | Unit | Note |
|----------------------------------|--------|-----------|------|-----|------|-------|
| Power Supply Voltage | VCI | | -0.3 | 4.6 | V | |
| Digital Interface Supply Voltage | IOVCC | | -0.3 | 4.6 | V | |
| Operating Temperature | TOP | | -20 | 70 | °C | 1 |
| Storage Temperature | TST | | -30 | 80 | °C | 1,2,3 |

Note 1. 90 % RH Max for Ta<50 °C, and 60% RH for Ta≥50°C.

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

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

3.2 Electrical Characteristics

| Item | Symbol | Condition | Min | Typ | Max | Unit | Note |
|----------------------------------|--------|-----------|--------------|-----|--------------|------|------|
| Supply Voltage | VCI | Ta=25°C | 2.4 | 2.8 | 3.3 | V | |
| Digital Interface Supply Voltage | IOVCC | Ta=25°C | 1.65 | 1.8 | 3.3 | V | |
| Input Voltage for Logic | VIH | | 0.7 IOVCC | - | IOVCC | V | |
| | VIL | | GND | - | 0.3 IOVCC | V | |
| Output Voltage for Logic | VOH | | 0.8 IOVCC | - | IOVCC | V | |
| | VOL | | GND | - | 0.2 IOVCC | V | |
| Current Consumption | IDD | | - | 8.5 | - | mA | 1 |

Note 1: The specified power consumption is under the conditions of VCI=2.8V, FV=60Hz.

3.3 Interface Pin Assignment

3.3.1 TFT Pin Assignment

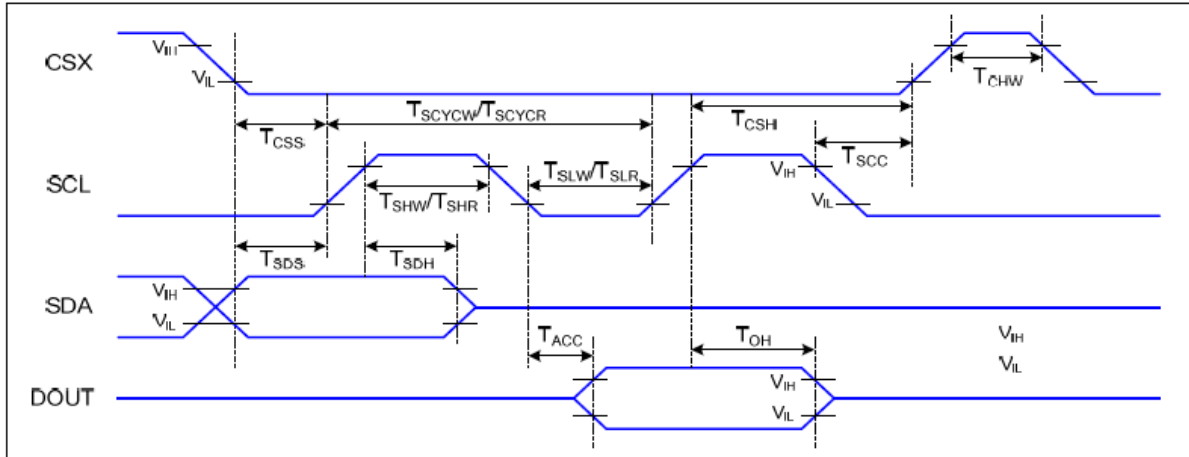
Recommended connector: MOLEX 502250-3591

| No. | Symbol | Function |
|-----|---------------|-------------------------------|
| 1 | GND | Ground |
| 2 | DOTCLK | Pixel clock signal |
| 3 | GND | Ground |
| 4 | VSYNC | Vertical sync |
| 5 | HSYNC | Horizontal sync |
| 6 | ENABLE | Data enable |
| 7 | DB17 (R5) | Data bus |
| 8 | DB16 (R4) | |
| 9 | DB15 (R3) | |
| 10 | DB14 (R2) | |
| 11 | DB13 (R1) | |
| 12 | DB12 (R0) | |
| 13 | DB11 (G5) | |
| 14 | DB10 (G4) | |
| 15 | DB9 (G3) | |
| 16 | DB8 (G2) | |
| 17 | IOVCC | Digital power supply |
| 18 | DB7 (G1) | Data bus |
| 19 | DB6 (G0) | |
| 20 | DB5 (B5) | |
| 21 | DB4 (B4) | |
| 22 | DB3 (B3) | |
| 23 | DB2 (B2) | |
| 24 | DB1 (B1) | |
| 25 | DB0 (B0) | |
| 26 | /CS (CSX) | Chip select signal active low |
| 27 | SCL | Data/Command select signal |
| 28 | SDI | Serial data input signal |
| 29 | /RESET (RESX) | Reset signal active low |
| 30 | VCI | Analogue power supply |
| 31 | SDO | Serial data output signal |
| 32 | LED+ | LED power supply (+) |
| 33 | GND | Ground |
| 34 | LED- | LED power supply (-) |
| 35 | GND | Ground |

3.4 Timing Characteristics

Please refer to ST7789V datasheet for more information

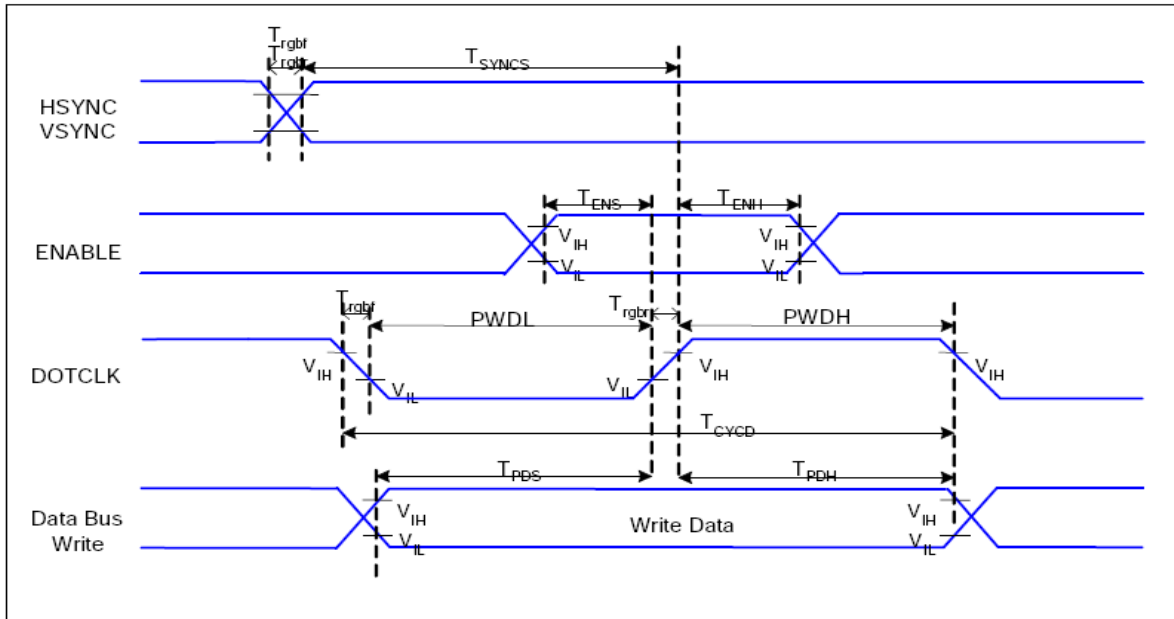
3.4.1 Serial Interface Timing Characteristics (3-line serial)



VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=-30 to 70 °C

| Signal | Symbol | Parameter | Min | Max | Unit | Description |
|--------------|-------------|--------------------------------|-----|-----|------|---------------------|
| CSX | T_{CSS} | Chip select setup time (write) | 15 | | ns | |
| | T_{CSH} | Chip select hold time (write) | 15 | | ns | |
| | T_{CSS} | Chip select setup time (read) | 60 | | ns | |
| | T_{SCC} | Chip select hold time (read) | 65 | | ns | |
| | T_{CHW} | Chip select "H" pulse width | 40 | | ns | |
| SCL | T_{SCYCW} | Serial clock cycle (Write) | 66 | | ns | |
| | T_{SHW} | SCL "H" pulse width (Write) | 15 | | ns | |
| | T_{SLW} | SCL "L" pulse width (Write) | 15 | | ns | |
| | T_{SCYCR} | Serial clock cycle (Read) | 150 | | ns | |
| | T_{SHR} | SCL "H" pulse width (Read) | 60 | | ns | |
| | T_{SLR} | SCL "L" pulse width (Read) | 60 | | ns | |
| SDA (DIN) | T_{SDS} | Data setup time | 10 | | ns | |
| | T_{SDH} | Data hold time | 10 | | ns | |
| DOUT | T_{ACC} | Access time | 10 | 50 | ns | For maximum CL=30pF |
| | T_{OH} | Output disable time | 15 | 50 | ns | For minimum CL=8pF |

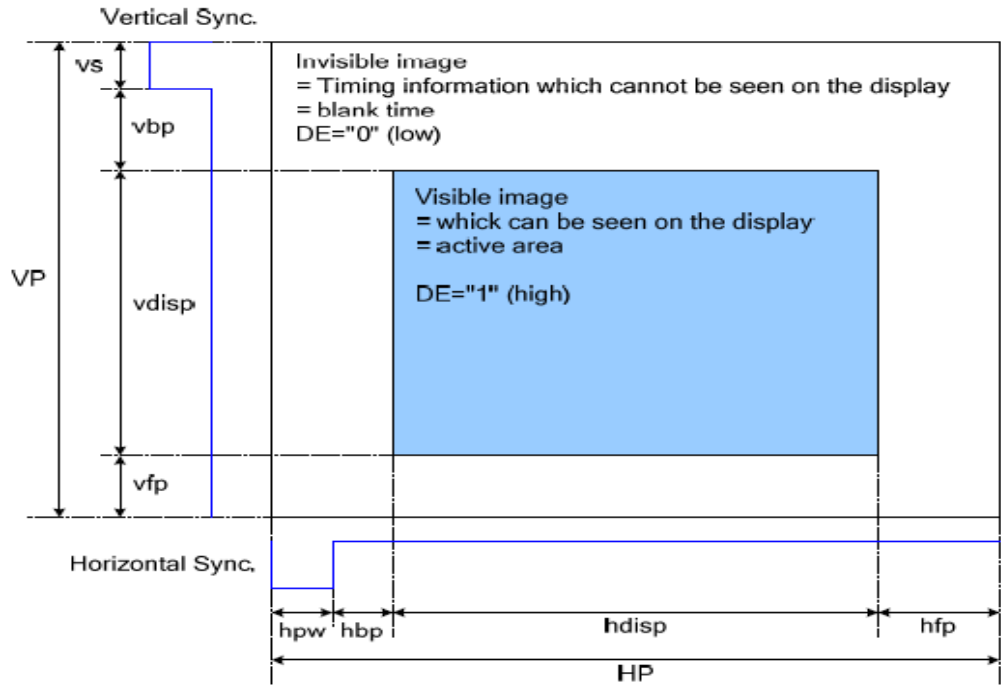
3.4.2 18-bit Parallel RGB Timing Characteristics



$V_{DDI}=1.65$ to $3.3V$, $V_{DD}=2.4$ to $3.3V$, $AGND=DGND=0V$, $T_a=-30$ - 70 °C

| Signal | Symbol | Parameter | MIN | MAX | Unit | Description |
|--------------|-------------------------|-------------------------------|-----|-----|------|-------------|
| HSYNC, VSYNC | T_{SYNCS} | VSYNC, HSYNC Setup Time | 30 | - | ns | |
| ENABLE | T_{ENS} | Enable Setup Time | 25 | - | ns | |
| | T_{ENH} | Enable Hold Time | 25 | - | ns | |
| DOTCLK | PWDH | DOTCLK High-level Pulse Width | 60 | - | ns | |
| | PWDL | DOTCLK Low-level Pulse Width | 60 | - | ns | |
| | T_{CYCD} | DOTCLK Cycle Time | 120 | - | ns | |
| | T_{rghr} , T_{rghf} | DOTCLK Rise/Fall time | - | 20 | ns | |
| DB | T_{PDS} | PD Data Setup Time | 50 | - | ns | |
| | T_{PDH} | PD Data Hold Time | 50 | - | ns | |

The display operation via the RGB interface is synchronized with the VSYNC, HSYNC, and DOTCLK signals. The data can be written only within the specified area with low power consumption by using window address function. The back porch and front porch are used to set the RGB interface timing.



Please refer to the following table for the setting limitation of RGB interface signals.

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|------------------------------|--------|------|------|------------|-------|
| Horizontal Sync. Width | hpw | 2 | 10 | hpw+hbp=31 | Clock |
| Horizontal Sync. Back Porch | hbp | 4 | 10 | | Clock |
| Horizontal Sync. Front Porch | hfp | 2 | 38 | - | Clock |
| Vertical Sync. Width | vs | 1 | 4 | vs+vbp=127 | Line |
| Vertical Sync. Back Porch | vbp | 1 | 4 | | Line |
| Vertical Sync. Front Porch | vfp | 1 | 8 | - | Line |

Note:

1. Typical value are related to the setting of dot clock is 7MHz and frame rate is 70Hz..
2. If the setting of hpw is 10 dot clocks and hbp is 10 dot clocks, the setting of HBP in command B1h is 20 dot clocks
3. In with ram mode, $hpw+hbp+hfp \geq 22$

3.4.3 Reset Timing Characteristics

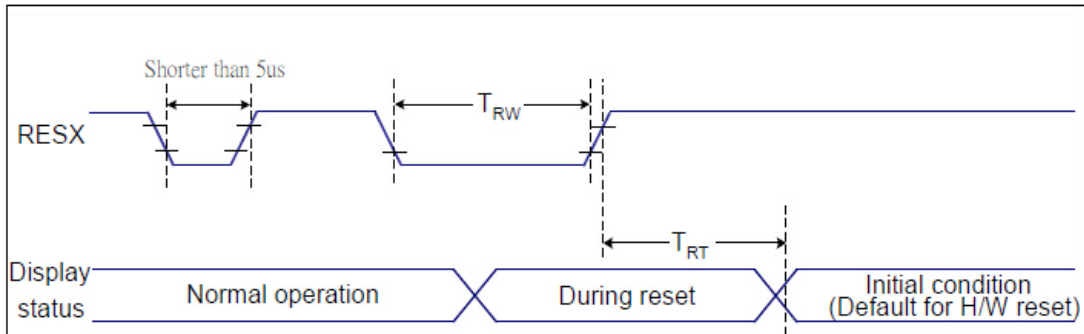


Figure 7 Reset Timing

VDDI=1.65 to 3.3V, VDD=2.4 to 3.3V, AGND=DGND=0V, Ta=25°C

| Related Pins | Symbol | Parameter | MIN | MAX | Unit |
|--------------|--------|----------------------|--------------------|---------------|------|
| RESX | TRW | Reset pulse duration | 10 | - | us |
| | TRT | Reset cancel | - | 5 (Note 1, 5) | ms |
| | | | 120 (Note 1, 6, 7) | ms | |

Table 9 Reset Timing

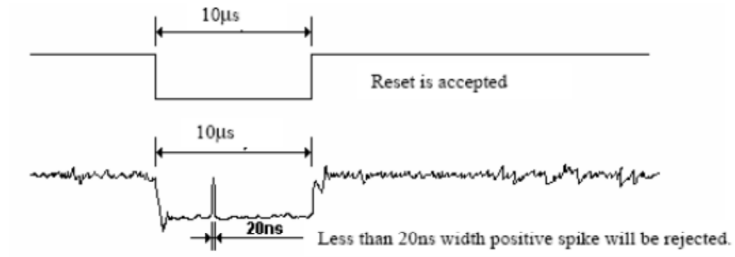
Notes:

- The reset cancel includes also required time for loading ID bytes, VCOM setting and other settings from NVM (or similar device) to registers. This loading is done every time when there is HW reset cancel time (tRT) within 5 ms after a rising edge of RESX.
- Spike due to an electrostatic discharge on RESX line does not cause irregular system reset according to the table below:

| RESX Pulse | Action |
|---------------------|----------------|
| Shorter than 5us | Reset Rejected |
| Longer than 9us | Reset |
| Between 5us and 9us | Reset starts |

- During the Resetting period, the display will be blanked (The display is entering blanking sequence, which maximum time is 120 ms, when Reset Starts in Sleep Out –mode. The display remains the blank state in Sleep In –mode.) and then return to Default condition for Hardware Reset.

- Spike Rejection also applies during a valid reset pulse as shown below:



5. When Reset applied during Sleep In Mode.
6. When Reset applied during Sleep Out Mode.
7. It is necessary to wait 5msec after releasing RESX before sending commands. Also Sleep Out command cannot be sent for 120msec.

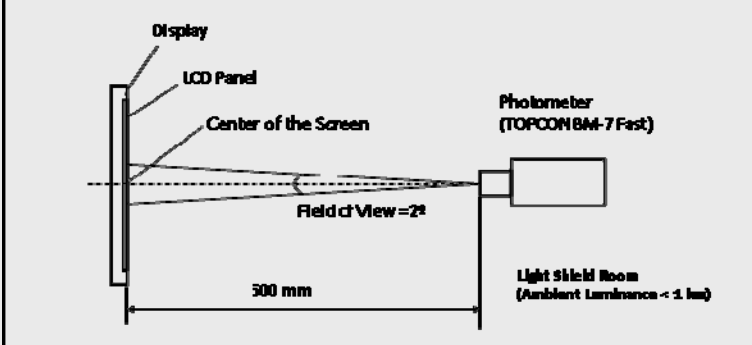
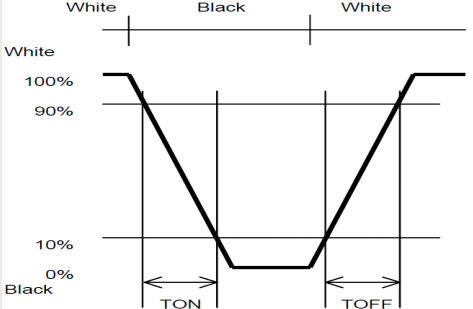
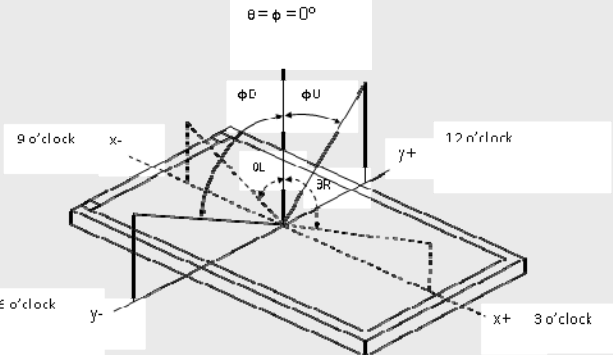
4.0 Optical Specification

4.1 Optical Characteristics

Measuring instruments: LCD-5100, Eldim, Topcon BM-7
 Driving condition: IOVCC = VCI = 2.8V, VSS = 0V
 Backlight: IF=20mA
 Measured temperature: Ta = 25 °C

| Item | Symbol | Condition | Min | Typ | Max | Unit | Note | |
|-------------------------|--------|---|--------------|-------|-------|-------------------|------|---|
| Response Time | TR+TF | $\theta=\phi=0^\circ$ Normal Viewing Angle | - | 35 | 45 | ms | 2 | |
| Contrast Ratio | CR | | 640 | 800 | - | | 3 | |
| Viewing Angle | Left | θ_L | CR \geq 10 | 80 | - | deg | 4 | |
| | Right | θ_R | | 80 | - | deg | | |
| | Up | ϕ_U | | 80 | - | deg | | |
| | Down | ϕ_D | | 80 | - | deg | | |
| Colour Chromaticity | Red | Rx | CR \geq 10 | 0.613 | 0.633 | 0.653 | - | 5 |
| | | Ry | | 0.316 | 0.336 | 0.356 | - | |
| | Green | Gx | | 0.302 | 0.322 | 0.342 | - | |
| | | Gy | | 0.585 | 0.605 | 0.625 | - | |
| | Blue | Bx | | 0.126 | 0.146 | 0.166 | - | |
| | | By | | 0.028 | 0.048 | 0.068 | - | |
| | White | Wx | | 0.270 | 0.310 | 0.350 | - | |
| | | Wy | | 0.291 | 0.331 | 0.371 | - | |
| Centre Brightness | | | 420 | 500 | - | cd/m ² | 6 | |
| Brightness Distribution | | | 80 | - | - | % | 7 | |

4.1.1 Test Method

| Note | Item | Test Method |
|------|---|--|
| 1 | Setup | <p>The display should be stabilised at a given temperature for 30 minutes to avoid abrupt temperature change during measuring. In order to stabilise the luminance, measurements should be executed after lighting the backlight for 30 minutes in a windless room.</p>  |
| 2 | Response time | <p>Measure output signal waveform by the luminance meter when raster of window pattern is changed from white to black and from black to white.</p>  |
| 3 | Contrast ratio | <p>Measure maximum brightness and minimum brightness at the centre of the screen by displaying raster or window pattern. Then calculate the ratio between these two values.</p> $\text{Contrast Ratio (CR)} = \frac{\text{Brightness of unselected position (white)}}{\text{Brightness of selected position (black)}}$ |
| 4 | Viewing angle Horizontal θ Vertical ϕ | <p>Move the luminance meter from right to left and up and down and determinate the angles where contrast ratio is 10</p>  |
| 5 | Colour chromaticity | Measure chromaticity coordinates x and y of CIE1931 colorimetric system |
| 6 | Centre brightness | Measure the brightness at the centre of the screen |
| 7 | Brightness distribution | <p>(Brightness distribution) = $100 \times B/A \%$ A: max. brightness of the 9 points B: min. brightness of the 9 points</p> |

5.0 Backlight Specification

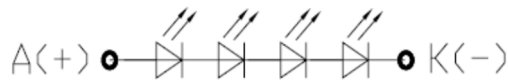
5.1 LED Driving Conditions

| Item | Symbol | Condition | Min | Typ | Max | Unit |
|-------------------|--------|-----------|-------|-------|-------|------|
| Forward Current | IF | Ta=25 °C | - | 20 | - | mA |
| Forward Voltage | VF | Ta= 25°C | 3.0*4 | 3.2*4 | 3.4*4 | V |
| Reverse Voltage | VR | Ta= 25°C | - | | 30 | V |
| Power Consumption | PBL | Ta= 25°C | - | 256 | - | mW |
| LED life time | Hr | | - | 50k | - | hour |

Note:

- The lifetime of the LED is defined as a period till the brightness of the LED decreases to the half of its initial value.
- This figure is given as a reference purpose only, and not a guarantee.
- This figure is estimated for an LED operating alone.
The performance of an LED may differ when assembled as a monitor together with a TFT panel due to different environmental temperature.
- Estimated lifetime could vary on a different temperature and usually higher temperature could reduce the life significantly.

5.2 LED Circuit



BLU CIRCUIT DIAGRAM

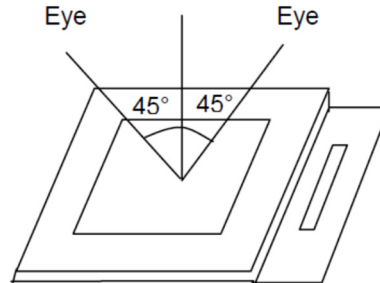
6.0 Quality Assurance Specification

6.1 Delivery Inspection Standards

6.1.1 Inspection Conditions

Inspection distance: 30 cm ± 2 cm

Viewing angle: ±45°



6.1.2 Environmental Conditions

Ambient temperature: 25°C ±5°C

Ambient humidity: 65±10% RH

Ambient illumination: 300~700 lux

6.1.3 Sampling Conditions

1. Lot size: quantity of shipment lot per model
2. Sampling method:

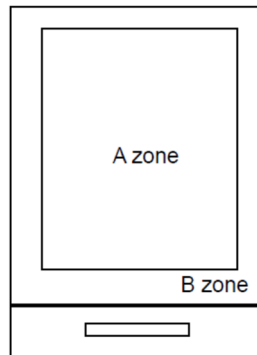
| Sampling Plan | | GB/T 2828-2003 |
|---------------|--------------|-----------------------------|
| | | Normal inspection, Class II |
| AQL | Major Defect | 0.65% |
| | Minor Defect | 1.5% |

| No | Items to be inspected | Criteria | Classification of defects |
|----|-----------------------|---|---------------------------|
| 1 | Functional defects | 1) No display, Open or miss line 2) Display abnormally, Short 3) Backlight no lighting, abnormal lighting. 4) TP no function | Major |
| 2 | Missing | Missing component | |
| 3 | Outline dimension | Overall outline dimension beyond the drawing is not allowed | |
| 4 | Colour tone | Colour unevenness, refer to limited sample | Minor |
| 5 | Spot Line defect | Light dot , Dim spot, Polarizer Bubble; Polarizer accidented spot. | |
| 6 | Soldering appearance | Good soldering, peeling off is not allowed. | |

6.1.4 Definition of Area

A zone: active area

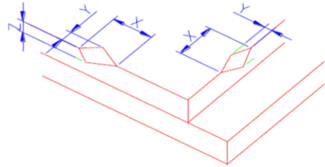
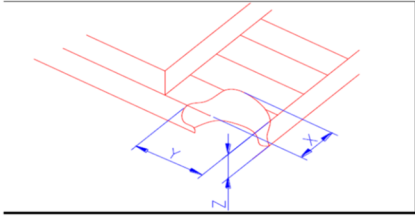
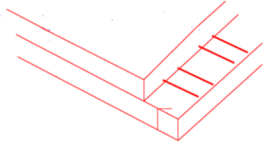
B zone: viewing area

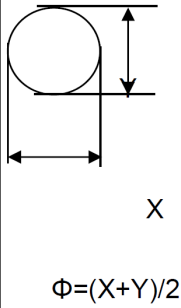


6.1.5 Basic Principle

A set of samples to indicate the limit of acceptable quality level shall be discussed should a dispute occur.

6.1.6 Inspection Criteria

| Number | Items | Criteria(mm) | | | | | | |
|---|---|---|----|---|--------|--------|--------------------------------|----|
| 1.0 LCD Crack/Broken NOTE: X: Length Y: Width Z: Height L: Length of ITO, T: Height of LCD | (1) The edge of LCD broken |  <table border="1" data-bbox="879 589 1362 719"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>≤3.0mm</td> <td><Inner border line of the seal</td> <td>≤T</td> </tr> </tbody> </table> | X | Y | Z | ≤3.0mm | <Inner border line of the seal | ≤T |
| | X | Y | Z | | | | | |
| | ≤3.0mm | <Inner border line of the seal | ≤T | | | | | |
| (2)LCD corner broken |  <table border="1" data-bbox="935 999 1310 1084"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>≤3.0mm</td> <td>≤L</td> <td>≤T</td> </tr> </tbody> </table> | X | Y | Z | ≤3.0mm | ≤L | ≤T | |
| X | Y | Z | | | | | | |
| ≤3.0mm | ≤L | ≤T | | | | | | |
| (3) LCD crack |  <p data-bbox="1043 1357 1193 1424">Crack Not allowed</p> | | | | | | | |

| 2.0 | <p>Spot defect</p>  <p>$\Phi=(X+Y)/2$</p> | ① light dot (LCD/TP/Polarizer black/white spot , light dot, pinhole, dent, stain) | | | | | | | | | | | | | | | | | | | | | | | |
|--|---|---|-------------------|----------------|---|---|---|-----------------|--------|------------------|--------|-------------------------|----------------------------------|-------------------------|----------------------------------|-------------------------|---|-------------------------|---|--------------|---|--------------|---|--|--|
| | | <table border="1"> <thead> <tr> <th rowspan="2">Zone Size (mm)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.10$</td> <td colspan="3">Ignore</td> </tr> <tr> <td>$0.10 < \Phi \leq 0.20$</td> <td colspan="3">3(distance $\geq 10\text{mm}$)</td> </tr> <tr> <td>$0.20 < \Phi \leq 0.25$</td> <td colspan="3">2</td> </tr> <tr> <td>$\Phi > 0.3$</td> <td colspan="3">0</td> </tr> </tbody> </table> | Zone Size (mm) | Acceptable Qty | | | A | B | C | $\Phi \leq 0.10$ | Ignore | | | $0.10 < \Phi \leq 0.20$ | 3(distance $\geq 10\text{mm}$) | | | $0.20 < \Phi \leq 0.25$ | 2 | | | $\Phi > 0.3$ | 0 | | |
| | | Zone Size (mm) | | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | |
| | | | A | B | C | | | | | | | | | | | | | | | | | | | | |
| | | $\Phi \leq 0.10$ | Ignore | | | | | | | | | | | | | | | | | | | | | | |
| $0.10 < \Phi \leq 0.20$ | 3(distance $\geq 10\text{mm}$) | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.20 < \Phi \leq 0.25$ | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi > 0.3$ | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| ② Dim spot (LCD/TP/Polarizer dim dot, light leakage, dark spot) | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th rowspan="2">Zone Size (mm)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.1$</td> <td colspan="3">Ignore</td> </tr> <tr> <td>$0.10 < \Phi \leq 0.20$</td> <td colspan="3">3(distance $\geq 10\text{mm}$)</td> </tr> <tr> <td>$0.20 < \Phi \leq 0.25$</td> <td colspan="3">2</td> </tr> <tr> <td>$\Phi > 0.3$</td> <td colspan="3">0</td> </tr> </tbody> </table> | Zone Size (mm) | Acceptable Qty | | | A | B | C | $\Phi \leq 0.1$ | Ignore | | | $0.10 < \Phi \leq 0.20$ | 3(distance $\geq 10\text{mm}$) | | | $0.20 < \Phi \leq 0.25$ | 2 | | | $\Phi > 0.3$ | 0 | | | | |
| Zone Size (mm) | | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | | | |
| | A | B | C | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi \leq 0.1$ | Ignore | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.10 < \Phi \leq 0.20$ | 3(distance $\geq 10\text{mm}$) | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.20 < \Phi \leq 0.25$ | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi > 0.3$ | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| ③ Polarizer accidented spot | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Zone Size (mm) | | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | | | |
| | A | B | C | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi \leq 0.2$ | Ignore | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < \Phi \leq 0.5$ | 2(distance $\geq 10\text{mm}$) | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi > 0.5$ | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| ④ Pixel bad points (light dot, Dim dot, color dot) | | | | | | | | | | | | | | | | | | | | | | | | | |
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| Zone Size (mm) | | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | | | |
| | A | B | C | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi \leq 0.1$ | Ignore | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.15 < \Phi \leq 0.2$ | 2(distance $\geq 10\text{mm}$) | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi > 0.2$ | 0 | | | | | | | | | | | | | | | | | | | | | | | | |
| ⑤ Polarizer Bubble | | | | | | | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th rowspan="2">Zone Size (mm)</th> <th colspan="3">Acceptable Qty</th> </tr> <tr> <th>A</th> <th>B</th> <th>C</th> </tr> </thead> <tbody> <tr> <td>$\Phi \leq 0.2$</td> <td colspan="3">Ignore</td> </tr> <tr> <td>$0.3 < \Phi \leq 0.4$</td> <td colspan="3">3(distance $\geq 10\text{ m}$)</td> </tr> <tr> <td>$0.4 < \Phi \leq 0.5$</td> <td colspan="3">2</td> </tr> <tr> <td>$\Phi > 0.5$</td> <td colspan="3">0</td> </tr> </tbody> </table> | Zone Size (mm) | Acceptable Qty | | | A | B | C | $\Phi \leq 0.2$ | Ignore | | | $0.3 < \Phi \leq 0.4$ | 3(distance $\geq 10\text{ m}$) | | | $0.4 < \Phi \leq 0.5$ | 2 | | | $\Phi > 0.5$ | 0 | | | | |
| Zone Size (mm) | | Acceptable Qty | | | | | | | | | | | | | | | | | | | | | | | |
| | A | B | C | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi \leq 0.2$ | Ignore | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.3 < \Phi \leq 0.4$ | 3(distance $\geq 10\text{ m}$) | | | | | | | | | | | | | | | | | | | | | | | | |
| $0.4 < \Phi \leq 0.5$ | 2 | | | | | | | | | | | | | | | | | | | | | | | | |
| $\Phi > 0.5$ | 0 | | | | | | | | | | | | | | | | | | | | | | | | |

| | | | | | | |
|-----|--|--|--------------|----------------|---|---|
| 3.0 | Line defect (LCD/TP /Polarizer backlight black/white line, scratch, stain) | Width(mm) | Length(m) | Acceptable Qty | | |
| | | | | A | B | C |
| | | $\Phi \leq 0.03$ | Ignore | Ignore | | |
| | | $0.03 < W \leq 0.04$ | $L \leq 3.0$ | N \leq 2 | | |
| | | $0.04 < W \leq 0.05$ | $L \leq 2.0$ | N \leq 1 | | |
| | $0.05 < W$ | Define as spot defect | | | | |
| 4.0 | Electronic Components SMT | Not allow missing parts, solderless connection, cold solder joint, mis match. The positive and negative polarity opposite | | | | |
| 5.0 | Display color& Brightness | 1. Color: Measuring the color coordinates, The measurement standard according to the datasheet or samples. 2. Brightness: Measuring the brightness of White screen, The measurement standard according to the datasheet or Samples. | | | | |
| 6.0 | LCD Mura | By 5% ND filter invisible. | | | | |

Criteria (functional items)

| Number | Items | Criteria (mm) |
|--------|-----------------------|---------------|
| 1 | No display | Not allowed |
| 2 | Missing segment | Not allowed |
| 3 | Short | Not allowed |
| 4 | Backlight no lighting | Not allowed |
| 5 | TP no function | Not allowed |

6.1.7 Classification of Defects

Visual defects (except no or wrong label) are treated as minor defects, while electrical defects are treated as major defects.

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

6.1.8 Identification / marking criteria

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

6.2 Dealing with Customer Complaints

6.2.1 Non-conforming analysis

Purchaser should supply Densitron with detailed data of non-conforming sample.

After accepting it, Densitron should complete the analysis in two weeks from receiving the sample.

If the analysis cannot be completed on time, Densitron must inform the purchaser.

6.2.2 Handling of non-conforming displays

If any non-conforming displays are found during customer acceptance inspection which Densitron is clearly responsible for, return them to Densitron.

Both Densitron and customer should analyse the reason and discuss the handling of non-conforming displays when the reason is not clear.

Equally, both sides should discuss and come to agreement for issues pertaining to modification of Densitron quality assurance standard.

7.0 Reliability Specification

7.1 Reliability Tests

| Test Item | | Test Condition | | Sample Size |
|-----------------|-----------------------------|---|-----|-------------|
| Durability Test | High Temperature Operation | Ta= 70°C | 96h | 3pcs |
| | Low Temperature Operation | Ta=-20°C | 96h | 3pcs |
| | Temperature Cycle Operation | -20°C ↔ 70°C ON/OFF, 20 cycles. ON time over 10 seconds, OFF time over 10 seconds | | 3pcs |
| | High Temperature Storage | Tp= 80°C | 96h | 3pcs |
| | Low Temperature Storage | Tp= -30°C | 96h | 3pcs |
| | ESD Test | 150pF, 330Ω, ±6KV (Contact)/±8KV (Air), 5 Points/panel, 10 times/point | | 3pcs |
| | Thermal Shock Resistance | The sample should be allowed to stand the following 5 cycles of operation: LTS for 30 minutes -> normal temperature for 5 minutes -> HTS for 30 minutes -> normal temperature for 5 minutes, as one cycle, then taking it out and drying it at normal temperature, and allowing it stand for 24 hours | | 3pcs |
| | Box Drop Test | 1 Corner 3 Edges 6 faces, 66 cm (Medium Box) | | 1 box |

Note: Ta=ambient temperature Tp= Panel temperature

Notes:

1. No dew condensation to be observed.
2. The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.
3. No cosmetic or functional defects should be allowed.
4. Total current consumption should be less than twice the initial value.

8.0 Handling Precautions

Safety

If the LCD panel breaks, be careful not to get the liquid crystal fluid in your mouth or in your eyes.

If the liquid crystal touches your skin or clothes, wash it off immediately using soap and plenty of water.

Mounting and Design

Place a transparent plate (e.g. acrylic, polycarbonate or glass) on the display surface to protect the display from external pressure. Leave a small gap between the transparent plate and the display surface.

When assembling with a zebra connector, clean the surface of the pads with alcohol and keep the surrounding air very clean.

Design the system so that no input signal is given unless the power supply voltage is applied.

Caution during LCD cleaning

Lightly wipe the display surface with a soft cloth soaked with Isopropyl alcohol, Ethyl alcohol or Trichlorotrifluoroethane.

Do not wipe the display surface with dry or hard materials that will damage the polariser surface.

Do not use aromatic solvents (toluene and xylene), or ketonic solvents (ketone and acetone).

Caution against static charge

As the display uses C-MOS LSI drivers, connect any unused input terminal to VDD or VSS. Do not input any signals before power is turned on. Also, ground your body, work/assembly table and assembly equipment to protect against static electricity.

Packaging

Displays use LCD elements, and must be treated as such. Avoid strong shock and drop from a height. To prevent displays from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

Caution during operation

It is indispensable to drive the display within the specified voltage limit since excessive voltage shortens its life. Direct current causes an electrochemical reaction with remarkable deterioration of the display quality. Give careful consideration to prevent direct current during ON/OFF timing and during operation. Response time is extremely delayed at temperatures lower than the operating temperature range while, at high temperatures, displays become dark. However, this phenomenon is reversible and does not mean a malfunction or a display that has been permanently damaged. If the display area is pushed on hard during operation, some graphics will be abnormally displayed but returns to a normal condition after turning off the display once. Even a small amount of condensation on the contact pads (terminals) can cause an electro-chemical reaction which causes missing rows and columns. Give careful attention to avoid condensation.

Storage

Store the display in a dark place where the temperature is $25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ and the humidity below 50%RH. Store the display in a clean environment, free from dust, organic solvents and corrosive gases. Do not crash, shake or jolt the display (including accessories).