


|                      |            |                  |            |
|----------------------|------------|------------------|------------|
| MDT0280A8SH-SPI      | 240 x 320  | SPI Interface    | TFT Module |
| <b>Specification</b> |            |                  |            |
| Version: 1           |            | Date: 11/11/2021 |            |
| <b>Revision</b>      |            |                  |            |
| 1                    | 09/11/2021 | First issue      |            |

| Display Features      |                        |  |              |
|-----------------------|------------------------|---|--------------|
| Display Size          | 2.80"                  |   |              |
| Resolution            | 240 x 320              |   |              |
| Orientation           | Portrait               |   |              |
| Appearance            | RGB                    |   |              |
| Logic Voltage         | 3.3V                   |   |              |
| Interface             | SPI                    |   |              |
| Brightness            | 500 cd/m <sup>2</sup>  |   |              |
| Touchscreen           | ---                    |   |              |
| Module Size           | 50.00 x 69.20 x 2.30mm |   |              |
| Operating Temperature | -20°C ~ +70°C          |   |              |
| Pinout                | 20 way FFC             |   | Box Quantity |
| Pitch                 | 0.5mm                  | ---   | ---          |

\* - For full design functionality, please use this specification in conjunction with the ST7789V specification.(Provided Separately)

| Display Accessories |             |
|---------------------|-------------|
| Part Number         | Description |
|                     |             |
|                     |             |
|                     |             |

| Optional Variants |         |
|-------------------|---------|
| Appearances       | Voltage |
|                   |         |
|                   |         |
|                   |         |



## Summary

TFT 2.8" is a TN transmissive type color active matrix TFT liquid crystal display that use amorphous silicon TFT as switching devices. This module is composed of a TFT\_LCD module, It is usually designed for industrial application and this module follows RoHs,

## General Specifications

- Size: 2.8"
- Dot Matrix: 240 x RGB x 320(TFT) dots
- Module dimension: 50.0(W) x 69.2(H) x 2.3(D) mm
- Active area: 43.2 x 57.6 mm
- Pixel pitch: 0.18 x 0.18 mm
- LCD type: TFT, Normally White, Transmissive
- TFT Interface: SPI
- TFT Driver IC: ST7789V or Equivalent
- View Direction: 6 o'clock
- Gray Scale Inversion Direction: 12 o'clock
- Aspect Ratio: Portrait
- Backlight Type: LED, Normally White
- With /Without TP: Without TP
- Surface: Glare

\*Color tone slight changed by temperature and driving voltage.



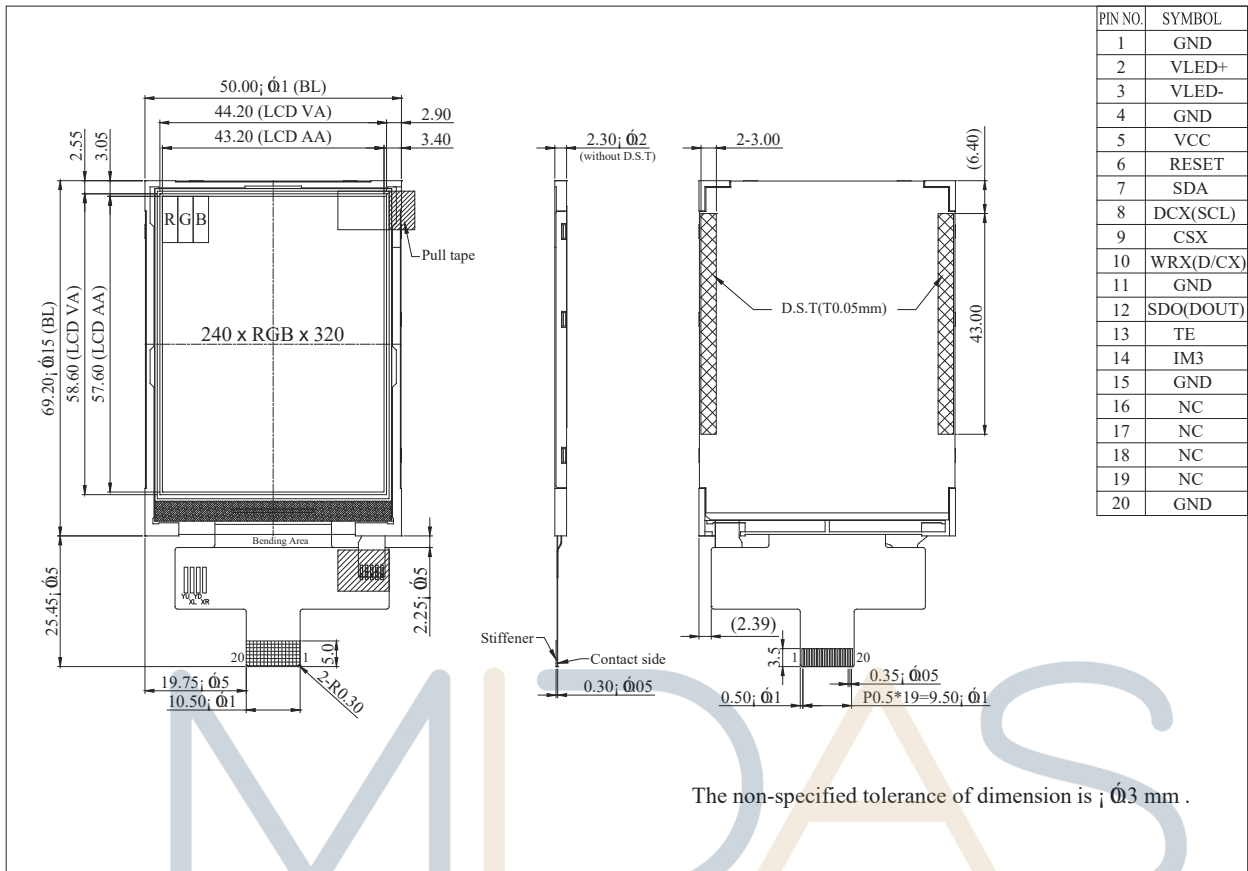
# Interface

## 1. LCM PIN Definition

| NO    | Symbol    | Function  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
|-------|-----------|---|-----|---------------------------|---------------------|-----|--------------------|----------|---|---|---|---|------------------------|-------------|---|---|---|---|---------------------------|---------------------|
| 1     | GND       | Ground  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 2     | VLED+     | Anode of LED backlight.   |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 3     | VLED-     | Cathode of LED backlight.   |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 4     | GND       | Ground  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 5     | VCC       | Power supply  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 6     | RESET     | System reset pin. (RESX) signal is active low   |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 7     | SDA       | When IM3: Low, SPI interface input/output pin.<br>When IM3: High, SPI interface input pin.<br>The data is latched on the rising edge of the SCL signal.<br>If not used, please fix this pin at VDDI or DGND level.  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 8     | DCX(SCL)  | This pin is used to be serial interface clock.<br>DCX='1': display data or parameter.<br>DCX='0': command data.<br>If not used, please fix this pin at VDDI or DGND.  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 9     | CSX       | Chip selection pin<br>Low enable. High disable.   |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 10    | WRX(D/CX) | Display data/command selection pin in 4-line serial interface.<br>Second Data lane in 2 data lane serial interface.<br>If not used, please fix this pin at VDDI or DGND.  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 11    | GND       | Ground  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 12    | SDO(DOUT) | SPI interface output pin.<br>The data is output on the falling edge of the SCL signal.<br>If not used, let this pin open.   |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 13    | TE        | Tearing effect signal is used to synchronize MCU to frame memory writing. If not used, please let this pin open   |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 14    | IM3       | The MCU interface mode select.<br><table border="1"> <thead> <tr> <th>IM3</th> <th>IM2</th> <th>IM1</th> <th>IM0</th> <th>MPU Interface Mode</th> <th>Data pin</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>4-line 8bit serial I/F</td> <td>SDA: in/out</td> </tr> <tr> <td>1</td> <td>1</td> <td>1</td> <td>0</td> <td>4-line 8bit serial I/F II</td> <td>SDA:in/<br/>SDO: out</td> </tr> </tbody> </table> | IM3 | IM2                       | IM1                 | IM0 | MPU Interface Mode | Data pin | 0 | 1 | 1 | 0 | 4-line 8bit serial I/F | SDA: in/out | 1 | 1 | 1 | 0 | 4-line 8bit serial I/F II | SDA:in/<br>SDO: out |
| IM3   | IM2       | IM1   | IM0 | MPU Interface Mode        | Data pin            |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 0     | 1         | 1   | 0   | 4-line 8bit serial I/F    | SDA: in/out         |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 1     | 1         | 1   | 0   | 4-line 8bit serial I/F II | SDA:in/<br>SDO: out |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 15    | GND       | Ground  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 16-19 | NC        | No connect  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |
| 20    | GND       | Ground  |     |                           |                     |     |                    |          |   |   |   |   |                        |             |   |   |   |   |                           |                     |



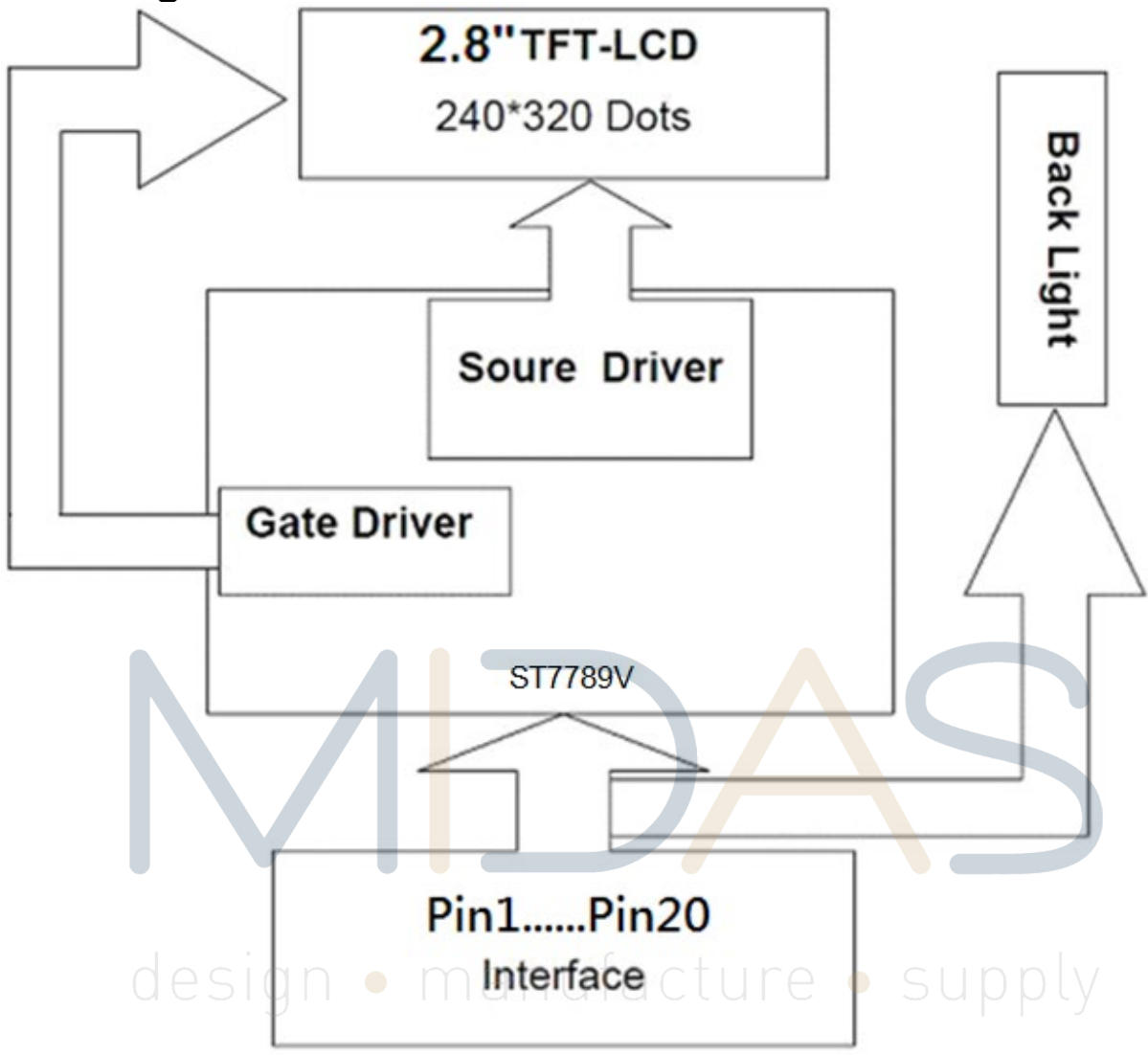
# Contour Drawing



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# Block Diagram



## Absolute Maximum Ratings

| Item                  | Symbol | Min | Typ | Max | Unit |
|-----------------------|--------|-----|-----|-----|------|
| Operating Temperature | TOP    | -20 | —   | +70 | °C   |
| Storage Temperature   | TST    | -30 | —   | +80 | °C   |

Note: Device is subject to be damaged permanently if stresses beyond those absolute maximum ratings listed above

- Temp.  $\leq 40^{\circ}\text{C}$ , 90% RH MAX. Temp.  $> 40^{\circ}\text{C}$ , Absolute humidity shall be less than 90% RH at  $40^{\circ}\text{C}$

## Electrical Characteristics

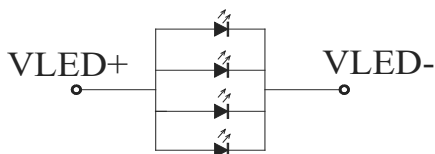
### 1. Operating conditions

| Item                      | Symbol          | Min | Typ | Max  | Unit |
|---------------------------|-----------------|-----|-----|------|------|
| Supply Voltage For Analog | V <sub>CC</sub> | 2.4 | 3.3 | 3.6  | V    |
| Supply Current For LCM    | I <sub>CC</sub> | —   | 6.7 | 10.0 | mA   |

### 2. LED driving conditions

| Parameter         | Symbol            | Min.   | Typ. | Max. | Unit | Remark     |
|-------------------|-------------------|--------|------|------|------|------------|
| LED current       | —                 | —      | 80   | —    | mA   | —          |
| Power Consumption | —                 | 224    | 256  | 272  | mW   | —          |
| LED voltage       | V <sub>LED+</sub> | 2.8    | 3.2  | 3.4  | V    | Note 1     |
| LED Life Time     | —                 | 50,000 | —    | —    | Hr   | Note 2,3,4 |

Note 1 : There are 1 Groups LED



Back Light Circuit

Note 2 : T<sub>a</sub> = 25 °C

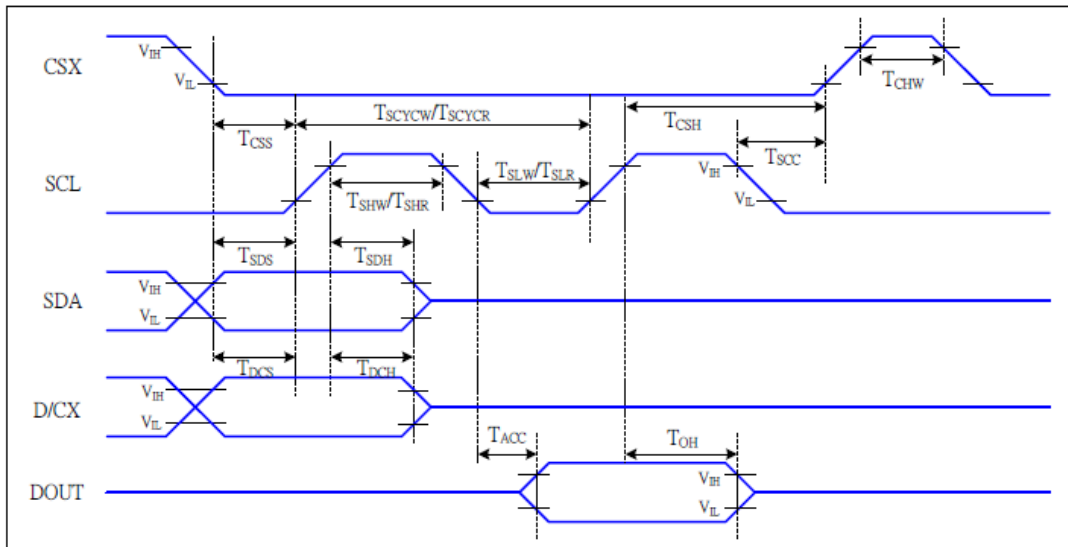
Note 3 : Brightness to be decreased to 50% of the initial value

Note 4 : The single LED lamp case



# AC Characteristics

## 1. Serial Interface Characteristics (4-line serial)



**Figure 1 4-line serial Interface Timing Characteristics**

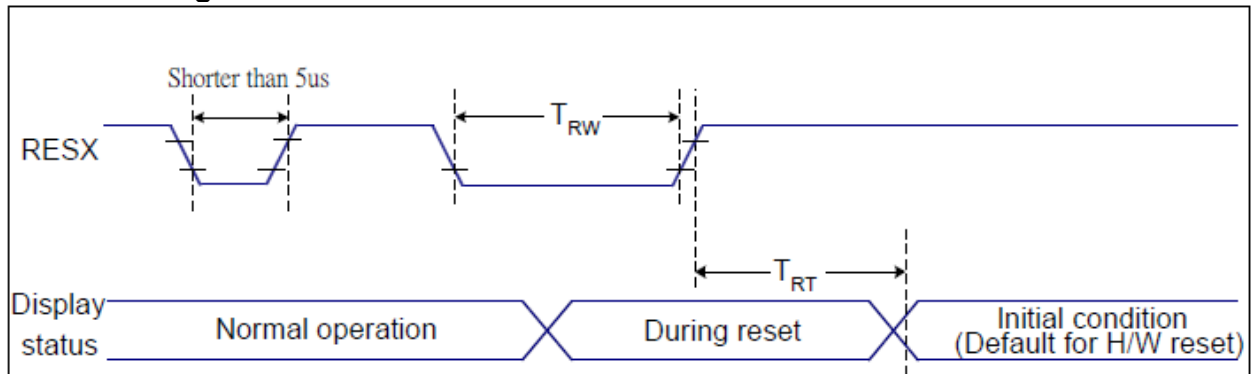
VDDI=1.65 to 3.6V, VDD=2.4 to 3.6V, AGND=DGND=0V, Ta=25 °C

| Signal       | Symbol             | Parameter                      | MIN | MAX | Unit | Description                  |
|--------------|--------------------|--------------------------------|-----|-----|------|------------------------------|
| CSX          | T <sub>css</sub>   | Chip select setup time (write) | 15  |     | ns   |                              |
|              | T <sub>csh</sub>   | Chip select hold time (write)  | 15  |     | ns   |                              |
|              | T <sub>css</sub>   | Chip select setup time (read)  | 60  |     | ns   |                              |
|              | T <sub>scc</sub>   | Chip select hold time (read)   | 65  |     | ns   |                              |
|              | T <sub>chw</sub>   | Chip select "H" pulse width    | 40  |     | ns   |                              |
| SCL          | T <sub>scycw</sub> | Serial clock cycle (Write)     | 16  |     | ns   | -write command & data<br>ram |
|              | T <sub>shw</sub>   | SCL "H" pulse width (Write)    | 7   |     | ns   |                              |
|              | T <sub>slw</sub>   | SCL "L" pulse width (Write)    | 7   |     | ns   |                              |
|              | T <sub>scycr</sub> | Serial clock cycle (Read)      | 150 |     | ns   | -read command & data<br>ram  |
|              | T <sub>shr</sub>   | SCL "H" pulse width (Read)     | 60  |     | ns   |                              |
|              | T <sub>slr</sub>   | SCL "L" pulse width (Read)     | 60  |     | ns   |                              |
| D/CX         | T <sub>dcs</sub>   | D/CX setup time                | 10  |     | ns   |                              |
|              | T <sub>dch</sub>   | D/CX hold time                 | 10  |     | ns   |                              |
| SDA<br>(DIN) | T <sub>sdh</sub>   | Data setup time                | 7   |     | ns   |                              |
|              | T <sub>sdh</sub>   | Data hold time                 | 7   |     | ns   |                              |
| DOUT         | T <sub>acc</sub>   | Access time                    | 10  | 50  | ns   | For maximum CL=30pF          |
|              | T <sub>oh</sub>    | Output disable time            | 15  | 50  | ns   | For minimum CL=8pF           |

**Table 1 4-line serial Interface Characteristics**

Note : The rising time and falling time (Tr, Tf) of input signal are specified at 15 ns or less. Logic high and low levels are specified as 30% and 70% of VDDI for Input signals.

## 2. Reset Timing:



**Figure 2 Reset Timing**

VDDI=1.65 to 3.6V, VDD=2.4 to 3.6V, AGND=DGND=0V,  $T_a=25\text{ }^\circ\text{C}$

| 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            |      |

### Notes:

1. 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 ( $t_{RT}$ ) within 5 ms after a rising edge of RESX.
2. 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   |

3. 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.
4. Spike Rejection also applies during a valid reset pulse as shown below:



## Optical Characteristics

| Item  | Symbol | Condition.                        | Min                               | Typ.  | Max.  | Unit              | Remark            |        |
|---|--------|-----------------------------------|-----------------------------------|-------|-------|-------------------|-------------------|--------|
| Response time                                     | Tr     | $\theta=0^\circ$ 、 $\Phi=0^\circ$ | -                                 | 4     | 8     | ms                | Note 3            |        |
|   | Tf     |                                   | -                                 | 12    | 24    | ms                |                   |        |
| Contrast ratio                                    | CR     | At optimized viewing angle        | 400                               | 500   | -     | -                 | Note 4            |        |
| Color Chromaticity                                | White  | Wx                                | $\theta=0^\circ$ 、 $\Phi=0^\circ$ | 0.253 | 0.303 | 0.353             | Note 2,6,7        |        |
|   |        | Wy                                |                                   | 0.275 | 0.325 | 0.375             |                   |        |
| Viewing angle<br>(Gray Scale Inversion Direction) | Hor.   | $\Theta_R$                        | $CR \geq 10$                      | 35    | 45    | -                 | Deg.              | Note 1 |
|   |        | $\Theta_L$                        |                                   | 35    | 45    | -                 |                   |        |
|   | Ver.   | $\Phi_T$                          |                                   | 40    | 50    | -                 |                   |        |
|   |        | $\Phi_B$                          |                                   | 10    | 20    | -                 |                   |        |
| Brightness  | -      | -                                 | 400                               | 500   | -     | cd/m <sup>2</sup> | Center of display |        |
| Uniformity  | (U)    | -                                 | 75                                | -     | -     | %                 | Note5             |        |

Ta=25±2°C

Note 1: Definition of viewing angle range

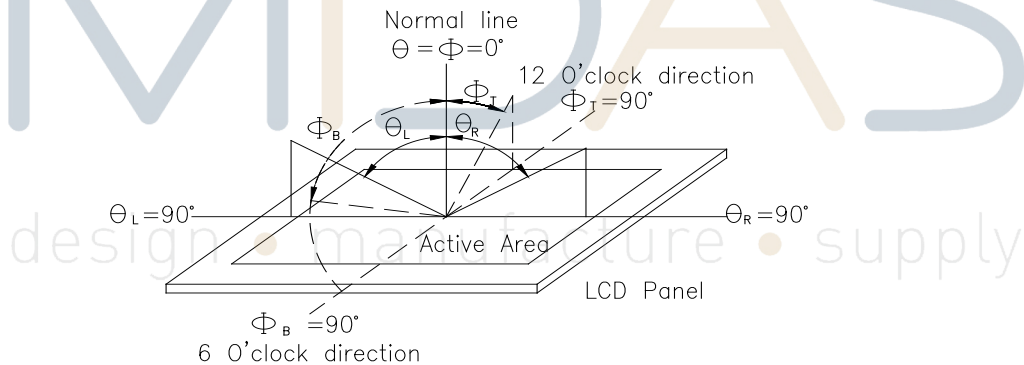


Fig. 10.1. Definition of viewing angle

Note 2: Test equipment setup:

After stabilizing and leaving the panel alone at a driven temperature for 10 minutes, the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. Optical specifications are measured by Topcon BM-7 or BM-5 luminance meter 1.0° field of view at a distance of 50cm and normal direction.



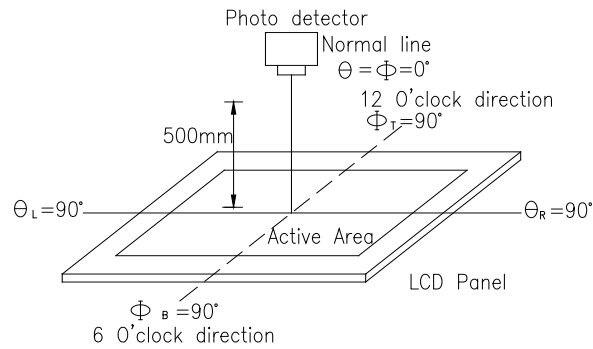
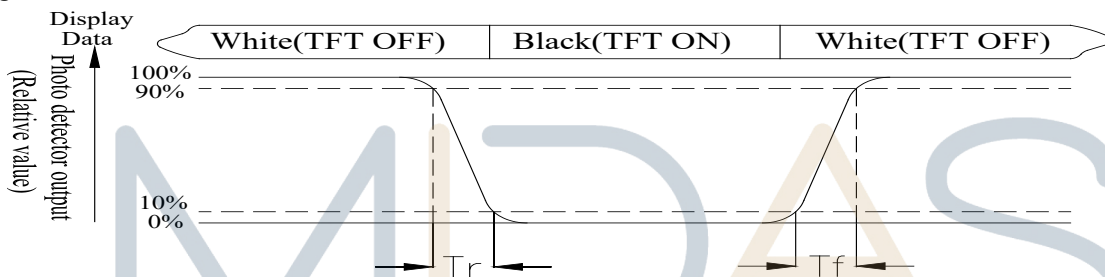


Fig. 10.2. Optical measurement system setup

**Note 3: Definition of Response time:**

The response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time,  $T_r$ , is the time between photo detector output intensity changed from 90% to 10%. And fall time,  $T_f$ , is the time between photo detector output intensity changed from 10% to 90%



**Note 4: Definition of contrast ratio:**

The contrast ratio is defined as the following expression.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD on the "White" state}}{\text{Luminance measured when LCD on the "Black" state}}$$



Note 5: Definition of Luminance Uniformity

Active area is divided into 9 measuring areas (reference the picture in below). Every measuring point is placed at the center of each measuring area.

Luminance Uniformity (U) =  $L_{min}/L_{max} \times 100\%$

L = Active area length

W = Active area width

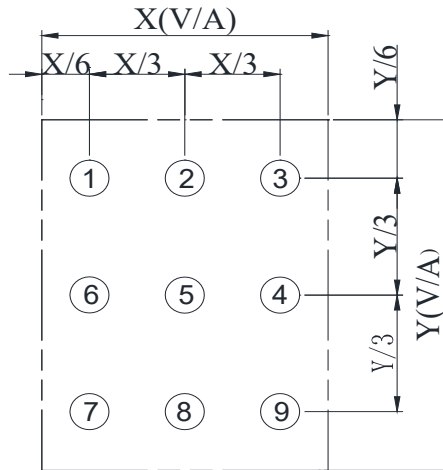


Fig10.3. Definition of uniformity

Note 6: Definition of color chromaticity (CIE 1931)

Color coordinates measured at the center point of LCD

Note 7: Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

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# Reliability

Content of Reliability Test (Wide temperature, -20°C~70°C)

| Environmental Test                   |  |  |      |
|--------------------------------------|--|--|------|
| Test Item                            | Content of Test  | Test Condition   | Note |
| High Temperature storage             | Endurance test applying the high storage temperature for a long time.  | 80°C<br>96hrs  | 2    |
| Low Temperature storage              | Endurance test applying the low storage temperature for a long time.   | -30°C<br>96hrs   | 1,2  |
| High Temperature Operation           | Endurance test applying the electric stress (Voltage & Current) and the thermal stress to the element for a long time.   | 70°C<br>96hrs  | —    |
| Low Temperature Operation            | Endurance test applying the electric stress under low temperature for a long time.   | -20°C<br>96hrs   | 1    |
| High Temperature/ Humidity Operation | The module should be allowed to stand at 40°C,90%RH max  | 40°C,90%RH<br>96hrs  | 1,2  |
| Thermal shock resistance             | The sample should be allowed stand the following 10 cycles of operation<br><div style="text-align: center;"> <p style="margin: 0;">-20°C    25°C    70°C</p> <p style="margin: 0;">30min    5min    30min</p> <p style="margin: 0;">1 cycle</p> </div> | -20°C/70°C<br>10 cycles  | —    |
| Vibration test                       | Endurance test applying the vibration during transportation and using.   | Total fixed amplitude : 1.5mm<br>Vibration<br>Frequency : 10~55Hz<br>One cycle 60 seconds to 3 directions of X,Y,Z for Each 15 minutes | 3    |
| Static electricity test              | Endurance test applying the electric stress to the terminal.   | VS=±600V(contact)<br>,±800v(air),<br>RS=330Ω<br>CS=150pF<br>10 times   | —    |

Note1: No dew condensation to be observed.

Note2: The function test shall be conducted after 4 hours storage at the normal Temperature and humidity after remove from the test chamber.

Note3: The packing have to including into the vibration testing.

