

# PRODUCT SPECIFICATION

2.4" IPS LCD Module with SPI Interface  
DT024ETFT-IPS, DT024ETFT-IPS-SHB

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Revision 1.0  
10 August 2023

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## Revision History

| REV | DESCRIPTION     | DATE        | APPR |
|-----|-----------------|-------------|------|
| 1.0 | Initial release | 14 AUG 2023 | PRW  |
|     |                 |             |      |
|     |                 |             |      |
|     |                 |             |      |
|     |                 |             |      |

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# 1 Overview

The **DT024ETFT-IPS** and **DT024ETFT-IPS-SHB** are 2.4” color IPS LCD modules, each composed of a LCD panel, display drivers, FPC display cable with SPI interface, and adjustable LED backlight unit. The display’s active area has a resolution of 240 x 320 pixels. The DT024ETFT-IPS-SHB, with twice the number of backlight LEDs, is available as a “super high-bright” alternative to the DT024ETFT-IPS.

## 1.1 Applications

- Video Systems
- Mobile Systems
- Wearable devices

## 1.2 Features

- |                     |   |
|---------------------|---|
| • Size              | 2.4 Inches                                |
| • Resolution        | 240 (RGB) x 320 Pixels                    |
| • Type              | IPS, Normally Black, Transmissive         |
| • Interface         | 3-Line SPI, 4-Line SPI                    |
| • Module Dimensions |   |
| ○ DT024ETFT-IPS     | 42.52 mm (W) x 59.86 mm (L) x 2.40 mm (H) |
| ○ DT024ETFT-IPS-SHB | 42.52 mm (W) x 59.86 mm (L) x 2.50 mm (H) |
| • Active Area       | 36.72 mm (W) x 48.96 mm (L)               |
| • Pixel Pitch       | 0.153 mm (W) x 0.153 mm (L)               |
| • Viewing Direction | All                                       |
| • Backlight Type    | LED, White                                |
| • LCD Driver        | ILI9341                                   |

## 1.3 Acronyms

- |       |                             |
|-------|-----------------------------|
| • FPC | Flexible Printed Circuit    |
| • LCD | Liquid Crystal Display      |
| • LED | Light Emitting Diode        |
| • RGB | Red-Green-Blue              |
| • SPI | Serial-Peripheral Interface |

## 2 Pin Descriptions

| LCD INTERFACE <sup>1</sup> |                           |      |  |
|----------------------------|---------------------------|------|--|
| PIN                        | NAME                      | TYPE | DESCRIPTION  |
| 1                          | GND                       | PWR  | Ground   |
| 2                          | VDDIO                     | PWR  | Power supply, logic  |
| 3                          | VDD                       | PWR  | Power supply, analog   |
| 4                          | $\overline{\text{CS}}$    | I    | Chip select (active low)   |
| 5                          | $\overline{\text{RESET}}$ | I    | Display reset, (active low)  |
| 6                          | SDIO                      | I/O  | Serial input/output  |
| 7                          | GND                       | PWR  | Ground   |
| 8                          | D/CX                      | I    | Data/Command selection (0: Command, 1: Data)                           |
| 9                          | SCL                       | I    | Serial clock   |
| 10                         | IM1                       | I    | See MCU Parallel Interface Mode Selection table                        |
| 11                         | IM0                       | I    | See MCU Parallel Interface Mode Selection table                        |
| 12                         | TE                        | O    | Tearing effect (active high). Leave open when not in use. <sup>2</sup> |
| 13                         | LED-A                     | PWR  | LED backlight, anode   |
| 14                         | LED-K                     | PWR  | LED backlight, cathode   |
| 15                         | LED-K                     | PWR  | LED backlight, cathode   |

### 2.1 MCU Parallel Interface Mode

| PARALLEL INTERFACE MODE SELECTION |     |        |
|-----------------------------------|-----|--------|
| IM1                               | IM0 | MODE   |
| 0                                 | 0   | 8-bit  |
| 0                                 | 1   | 16-bit |
| 1                                 | 0   | 9-bit  |
| 1                                 | 1   | 18-bit |

<sup>1</sup> Recommended mating connector: 5051101592 (or equivalent)

<sup>2</sup> See ILI9163 datasheet for details

## 3 Specifications

### 3.1 Absolute Maximum Ratings<sup>3</sup>

| ELECTRICAL                 |            |      |                  |       |  |
|----------------------------|------------|------|------------------|-------|--|
| PARAMETER                  |            | MIN  | MAX              | UNITS |  |
| Supply Voltage, Analog     | $V_{DD}$   | -0.3 | 4.6              | V     |  |
| Supply Voltage, Logic      | $V_{DDIO}$ | -0.3 | 4.6              | V     |  |
| Logic Input Voltage        | $V_{IN}$   | -0.3 | $V_{DDIO} + 0.3$ | V     |  |
| Logic Output Voltage       | $V_{OUT}$  | -0.3 | $V_{DDIO} + 0.3$ | V     |  |
| Forward Current, Backlight | $I_F$      | 30   | 60               | mA    |  |

| ENVIRONMENTAL         |          |     |     |       |  |
|-----------------------|----------|-----|-----|-------|--|
| PARAMETER             |          | MIN | MAX | UNITS |  |
| Operating Temperature | $T_{OP}$ | -20 | 70  | °C    |  |
| Storage Temperature   | $T_{ST}$ | -30 | 80  | °C    |  |

### 3.2 Electrical Characteristics<sup>4</sup>

| POWER                  |            |     |     |     |       |
|------------------------|------------|-----|-----|-----|-------|
| PARAMETER              |            | MIN | TYP | MAX | UNITS |
| Supply Voltage, Analog | $V_{DD}$   | 2.5 | 2.8 | 3.3 | V     |
| Supply Voltage, Logic  | $V_{DDIO}$ | 2.5 | 2.8 | 3.3 | V     |
| Supply Current         | $I_{DD}$   | –   | 10  | 15  | mA    |

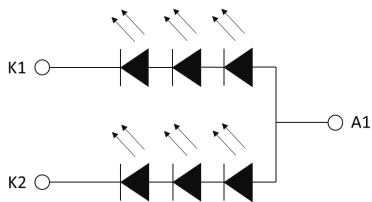
| LOGIC              |          |                       |     |                       |       |
|--------------------|----------|-----------------------|-----|-----------------------|-------|
| PARAMETER          |          | MIN                   | TYP | MAX                   | UNITS |
| Logic Input, High  | $V_{IH}$ | $0.7 \times V_{DDIO}$ | –   | $V_{DDIO}$            | V     |
| Logic Input, Low   | $V_{IL}$ | GND                   | –   | $0.3 \times V_{DDIO}$ | V     |
| Logic Output, High | $V_{OH}$ | $0.8 \times V_{DDIO}$ | –   | $V_{DDIO}$            | V     |
| Logic Output, Low  | $V_{OL}$ | GND                   | –   | $0.2 \times V_{DDIO}$ | V     |

<sup>3</sup> Operation outside of the maximum ratings listed below may result in permanent damage to the LCD.

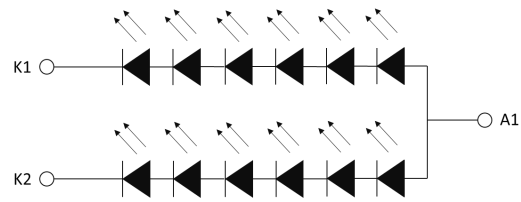
<sup>4</sup>  $T_A = 25^\circ\text{C}$

| LED BACKLIGHT             |       |                                |        |      |       |
|---------------------------|-------|--------------------------------|--------|------|-------|
| PARAMETER                 |       | MIN                            | TYP    | MAX  | UNITS |
| Forward Current           | $I_F$ | 30                             | 40     | 60   | mA    |
| Forward Voltage           | $V_F$ | DT024ETFT-IPS <sup>5</sup>     | –      | 9.9  | V     |
|                           |       | DT024ETFT-IPS-SHB <sup>6</sup> | –      | 19.8 |       |
| LED Lifetime <sup>7</sup> |       | –                              | 30,000 | –    | Hrs   |

### 3.2.1 LED Backlight Circuit



**Figure 1:** DT024ETFT-IPS Backlight  
 2 x 3 = 6 LEDs,  $I_F = 40$  mA



**Figure 2:** DT024ETFT-IPS-SHB Backlight  
 2 x 6 = 12 LEDs,  $I_F = 40$  mA

<sup>5</sup> DT024ETFT-IPS backlight power consumption: 594mW (Max.)

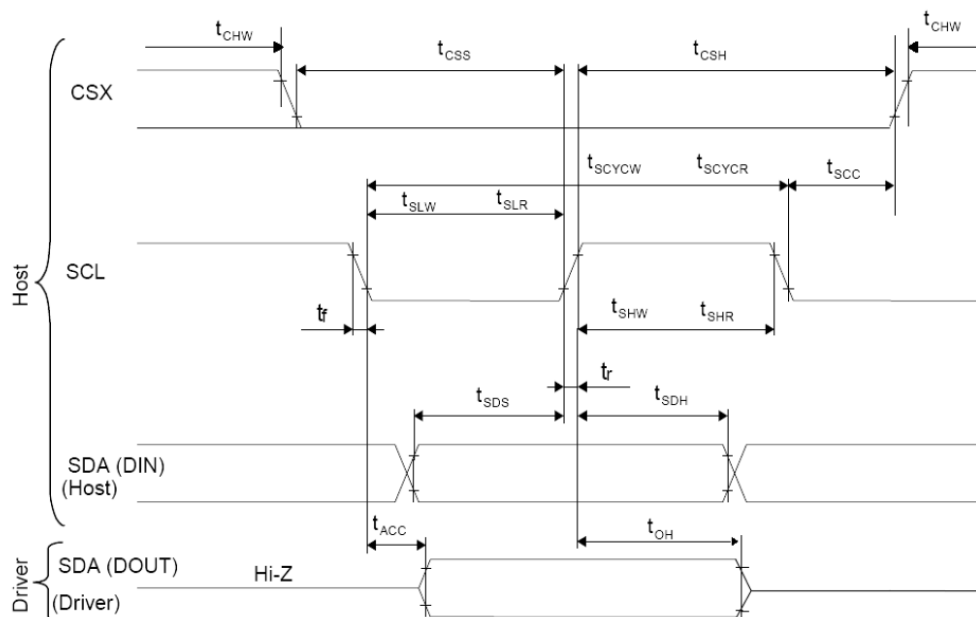
<sup>6</sup> DT024ETFT-IPS-SHB backlight power consumption: 1.19W (Max.)

<sup>7</sup> LED lifetime is defined as the amount of time it takes for brightness to decrease to 50% of its original value at  $T_A=25^\circ\text{C}$  and  $I_F=40\text{mA}$ . LED lifetime may decrease if operating current,  $I_F$ , is larger than 40mA.

## 4 AC Timing Characteristics

### 4.1 3-Line Serial Interface

Figure 3: 3-Line Serial Interface Timing



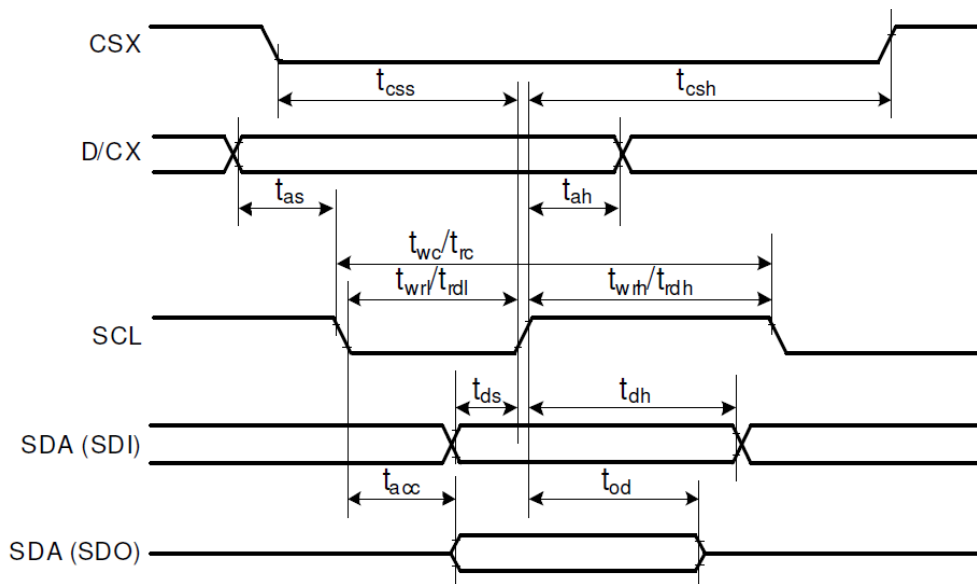
| AC TIMING CHARACTERISTICS, 3-LINE SERIAL INTERFACE |                             |             |     |     |       |
|--|-----------------------------|-------------|-----|-----|-------|
| SIGNAL   | PARAMETER                   |             | MIN | MAX | UNITS |
| SCL  | Serial clock cycle (write)  | $t_{SCYCW}$ | 100 | –   | nS    |
|  | SCL “H” pulse width (write) | $t_{SHW}$   | 40  | –   | nS    |
|  | SCL “L” pulse width (write) | $t_{SLW}$   | 40  | –   | nS    |
|  | Serial clock cycle (read)   | $t_{SCYCR}$ | 150 | –   | nS    |
|  | SCL “H” pulse width (read)  | $t_{SHR}$   | 60  | –   | nS    |
|  | SCL “L” pulse width (read)  | $t_{SLR}$   | 60  | –   | nS    |
| SDIO (Input)                                       | Data setup time (write)     | $t_{SDS}$   | 30  | –   | nS    |
|  | Data hold time (write)      | $t_{SDH}$   | 30  | –   | nS    |
| SDIO (Output) <sup>8</sup>                         | Access time (read)          | $t_{ACC}$   | 10  | –   | nS    |
|  | Output disable time (read)  | $t_{OH}$    | 10  | 50  | nS    |
| $\overline{CS}$                                    | SCL - CSX                   | $t_{SCC}$   | 20  | –   | nS    |
|  | CSX “H” pulse width         | $t_{CHW}$   | 40  | –   | nS    |
|  | CSX SCL time                | $t_{CSS}$   | 60  | –   | nS    |
|  |                             | $t_{CSH}$   | 65  | –   | nS    |

<sup>8</sup> Maximum  $C_L = 30\text{pF}$ ; Minimum  $C_L = 8\text{pF}$



## 4.2 4-Line Serial Interface

Figure 4: 4-Line Serial Interface Timing

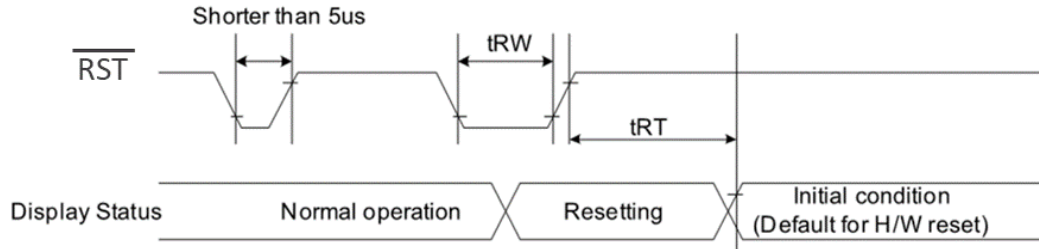


| AC TIMING CHARACTERISTICS, 4-Line Serial Interface |                              |           |     |     |       |
|--|------------------------------|-----------|-----|-----|-------|
| SIGNAL   | PARAMETER                    |           | MIN | MAX | UNITS |
| $\overline{CS}$                                    | Chip select time (write)     | $t_{css}$ | 40  | –   | nS    |
| SCL  | Chip select hold time (read) | $t_{csh}$ | 40  | –   | nS    |
|  | Serial clock cycle (write)   | $t_{wc}$  | 100 | –   | nS    |
|  | SCL "H" pulse width (write)  | $t_{wrh}$ | 40  | –   | nS    |
|  | SCL "L" pulse width (write)  | $t_{wrl}$ | 40  | –   | nS    |
|  | Serial clock cycle (read)    | $t_{rc}$  | 150 | –   | nS    |
|  | SCL "H" pulse width (read)   | $t_{rdh}$ | 60  | –   | nS    |
|  | SCL "L" pulse width (read)   | $t_{rdl}$ | 60  | –   | nS    |
| D/CX   | D/CX setup time              | $t_{as}$  | 10  | –   |       |
|  | D/CX hold time (write/read)  | $t_{ah}$  | 10  | –   |       |
| SDIO (Input)                                       | Data setup time (write)      | $t_{ds}$  | 30  | –   | nS    |
|  | Data hold time (write)       | $t_{dh}$  | 30  | –   | nS    |
| SDIO (Output) <sup>9</sup>                         | Access time (read)           | $t_{acc}$ | 10  | –   | nS    |
|  | Output disable time (read)   | $t_{od}$  | 10  | 50  | nS    |

<sup>9</sup> Maximum  $C_L = 30\text{pF}$ ; Minimum  $C_L = 8\text{pF}$

## 4.4 Reset Timing

Figure 5: Reset Timing



| RESET TIMING <sup>10</sup> |          |     |     |         |
|----------------------------|----------|-----|-----|---------|
| PARAMETER                  |          | MIN | MAX | UNIT    |
| Reset pulse duration       | $t_{RW}$ | 10  | –   | $\mu S$ |
| Reset cancel               | $t_{RT}$ | –   | 5   | mS      |
|                            |          | –   | 120 | mS      |

<sup>10</sup> Refer to ILI9341 driver datasheet for details

## 5 Optical Characteristics

| OPTICAL CHARACTERISTICS <sup>11</sup> |                                    |        |        |            |         |                   |
|---------------------------------------|------------------------------------|--------|--------|------------|---------|-------------------|
| PARAMETER                             |                                    | MIN.   | TYP.   | MAX.       | UNIT    |                   |
| Contrast Ratio <sup>12,13</sup>       | CR                                 | 600    | 800    | –          | –       |                   |
| Response Time <sup>14</sup>           | T <sub>ON</sub> / T <sub>OFF</sub> |        | 30     | 40         | mS      |                   |
| View Angles <sup>15,16</sup>          | ΘT                                 | –      | 80     | –          | Degrees |                   |
|                                       | ΘB                                 | –      | 80     | –          |         |                   |
|                                       | ΘL                                 | –      | 80     | –          |         |                   |
|                                       | ΘR                                 | –      | 80     | –          |         |                   |
| Chromaticity <sup>17</sup>            | X <sub>WHT</sub>                   | 0.3050 | 0.3250 | 0.3450     | –       |                   |
|                                       | Y <sub>WHT</sub>                   | 0.3404 | 0.3604 | 0.3804     |         |                   |
|                                       | X <sub>RED</sub>                   | 0.6351 | 0.6551 | 0.6751     |         |                   |
|                                       | Y <sub>RED</sub>                   | 0.3034 | 0.3234 | 0.3432     |         |                   |
|                                       | X <sub>GRN</sub>                   | 0.3282 | 0.3482 | 0.3682     |         |                   |
|                                       | Y <sub>GRN</sub>                   | 0.5828 | 0.6028 | 0.6228     |         |                   |
|                                       | X <sub>BLU</sub>                   | 0.0864 | 0.1064 | 0.1264     |         |                   |
|                                       | Y <sub>BLU</sub>                   | 0.0364 | 0.0564 | 0.0764     |         |                   |
| Luminance <sup>13</sup>               | DT024ETFT-IPS                      | L      | –      | 350        | –       | Cd/m <sup>2</sup> |
|                                       | DT024ETFT-IPS-SHB                  |        | –      | 1000 (SHB) | –       |                   |
| Uniformity <sup>13</sup>              | U                                  | 80     | –      | –          | %       |                   |

<sup>11</sup> See Section 5.1, Figure 3

<sup>12</sup> Viewing Angle (Θ) = 0°

<sup>13</sup> See Section 5.1, Figure 7

<sup>14</sup> See Section 5.1, Figure 4

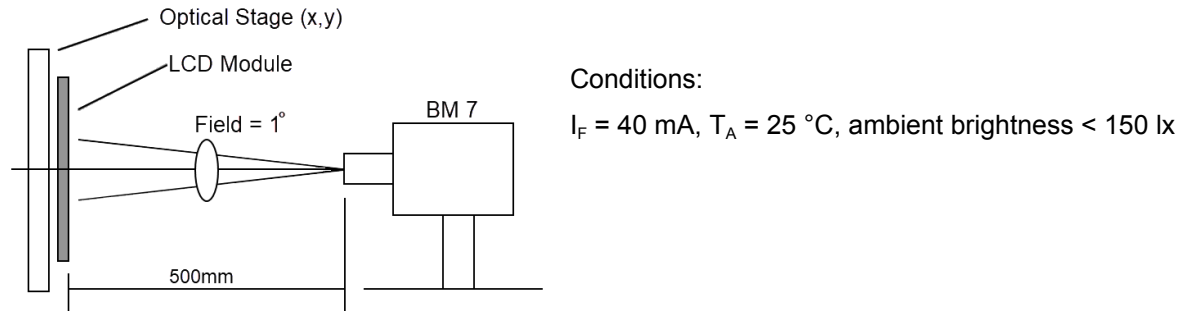
<sup>15</sup> Contrast Ratio (CR) ≥ 10

<sup>16</sup> See Section 5.1, Figure 5

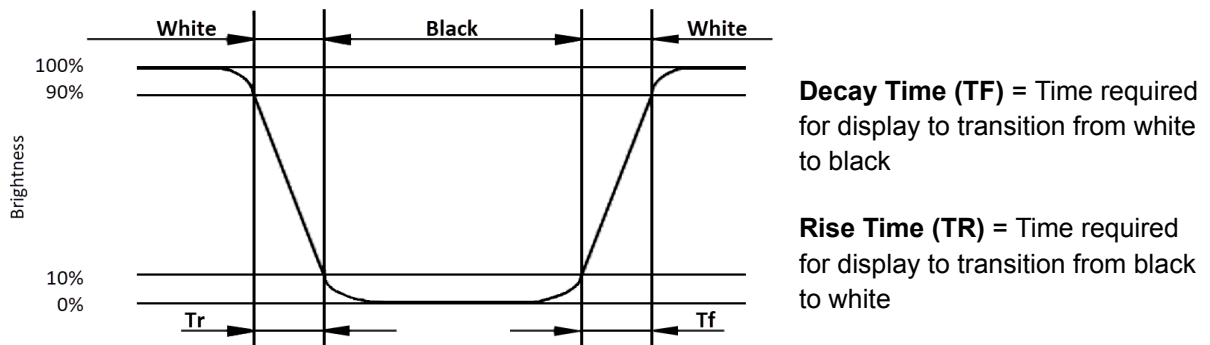
<sup>17</sup> See Section 5.1, Figure 6

## 5.1 Figures

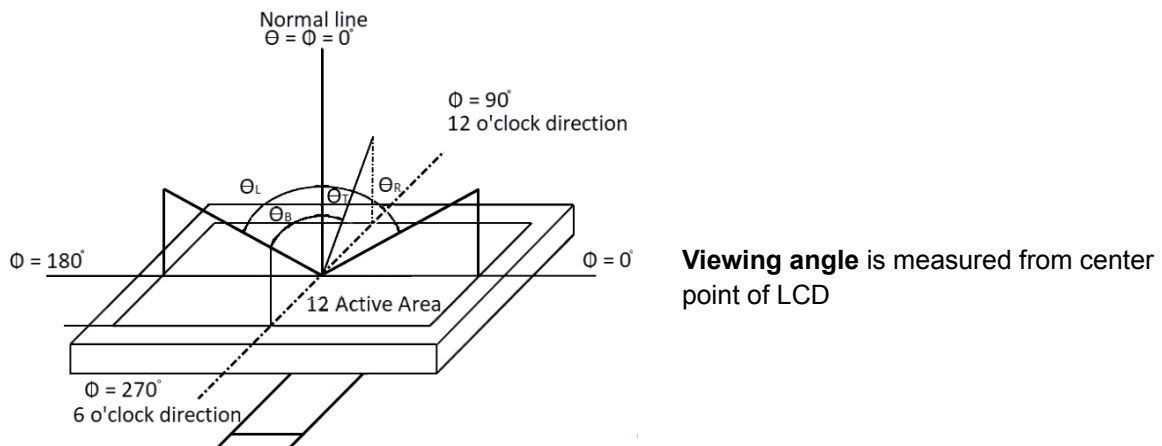
**Figure 3: Optical Measurement System**



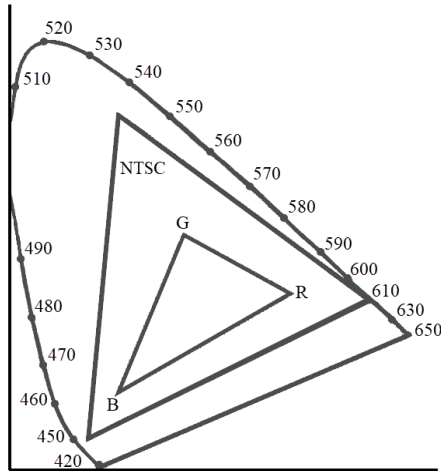
**Figure 4: Response Times**



**Figure 5: Viewing Angles**



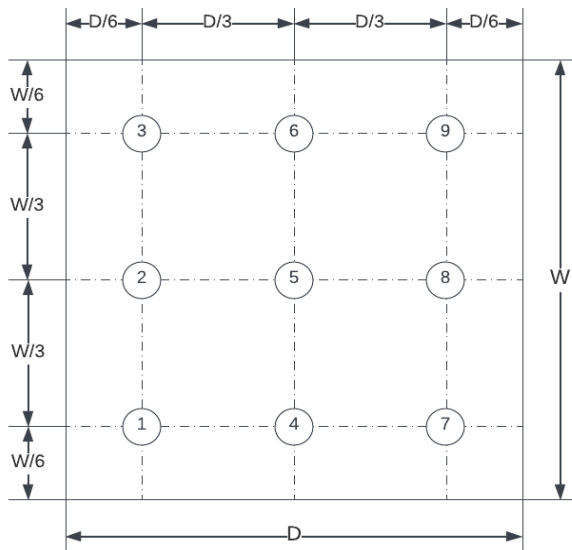
**Figure 6: Chromaticity (CIE 1931)**



**Chromaticity** = Area of  $\Delta_{RGB}$  / Area of  $\Delta_{NTSC}$

\* Color coordinates measured at center point of LCD

**Figure 7: Luminance Uniformity**



**Luminance** is defined as the brightness of all white pixels at the center of the display area at optimum contrast.

**Uniformity** is determined by measuring Luminance at 9 points and calculating  $Luminance_{MIN} / Luminance_{MAX}$

**Contrast Ratio** =  $\frac{Surface\ Luminance_{WhitePixels}}{Surface\ Luminance_{BlackPixels}}$

## 6 Environmental/Reliability Tests

Judgment is based on inspection performed after testing, per criteria described in the Inspection Criteria table.<sup>18</sup>

| ITEM UNDER TEST                   | TEST CONDITION  |
|-----------------------------------|---|
| High temp operation               | $T_A = 70\text{ }^\circ\text{C}$ , 120 Hrs.   |
| Low temp operation                | $T_A = -20\text{ }^\circ\text{C}$ , 120 Hrs.  |
| High temp storage                 | $T_S = 80\text{ }^\circ\text{C}$ , 120 Hrs.   |
| Low temp storage                  | $T_S = -30\text{ }^\circ\text{C}$ , 120 Hrs.  |
| High temp & high humidity storage | $T_S = 60\text{ }^\circ\text{C}$ , 120 Hrs., 90% RH   |
| Thermal shock (non-operation)     | $-30\text{ }^\circ\text{C}$ , 30 min $\rightarrow$ $80\text{ }^\circ\text{C}$ , 30 min<br>Change time: 5 min, 10 cycles                       |
| ESD (operation)                   | C = 150 pF, R = 330 $\Omega$ , 5 points/panel<br>Air: $\pm 8\text{ KV}$ , 5 times<br>Contact: $\pm 4\text{ KV}$ , 5 times                     |
| Vibration (non-operation)         | Frequency range 10 - 55 Hz.<br>Stroke: 1.5 mm<br>Sweep 10 Hz $\rightarrow$ 55 Hz $\rightarrow$ 10 Hz<br>2 hours for each direction of X, Y, Z |
| Package drop test                 | Height 80 cm<br>1 corner, 3 edges, 6 surfaces   |

### 6.1 Inspection Criteria

All testing shall be judged based upon the criteria in this table.

| INSPECTION ITEM        | CRITERIA  |
|------------------------|---|
| Appearance             | No cracks on FPC<br>No cracks on LCD panel  |
| Alignment of LCD panel | No bubbles in LCD panel<br>No alignment defects in LCD active area                  |
| Electrical current     | Within device specifications  |
| Function / Display     | No broken circuits, no short circuits<br>No black lines<br>No other display defects |

<sup>18</sup> Functional test shall be conducted after 4 hours of storage at normal temperature and humidity, after LCD is removed from test chamber.

## 7 Precautions for Use of LCD Modules

### 7.1 Safety

Liquid crystal in LCD is poisonous. Do not put in mouth. If liquid crystal comes in contact with skin or clothes, wash it off immediately using soap and water.

### 7.2 Handling

- A. The LCD panel is made of plate glass. Do not subject the panel to mechanical shock or excessive force on its surface.
- B. In order to ensure reliability, do not hold product by flexible printed circuit (FPC) cable.
- C. Provide space so that panel does not come into contact with other components.
- D. To protect the product from external force, apply a covering lens (acrylic board or similar) and keep an appropriate gap between them.
- E. Transparent electrodes may be disconnected if the panel is used in an environment where dew condensation is present.
- F. Properties of semiconductor devices may be affected when exposed to light, possibly resulting in IC malfunctions. To prevent such malfunctions, design and mounting layout should be done in such a way that IC is not exposed to light in actual use.

### 7.3 Static electricity

- A. Ground soldering iron tips, tools and testers when they are in operation.
- B. Ground your body when handling the products.
- C. Power on the LCD module before applying the voltage to the input terminals.
- D. Do not apply voltage which exceeds the absolute maximum rating.
- E. Store the products in an anti-electrostatic bag or container.

### 7.4 Storage

- A. Store product in a dark place at  $+25^{\circ}\text{C} \pm 10^{\circ}\text{C}$  with low humidity (40% RH ~ 60% RH). Do not expose the display to sunlight or fluorescent light.
- B. Storage in a clean environment, free from dust, active gas, and solvent.

### 7.5 Cleaning

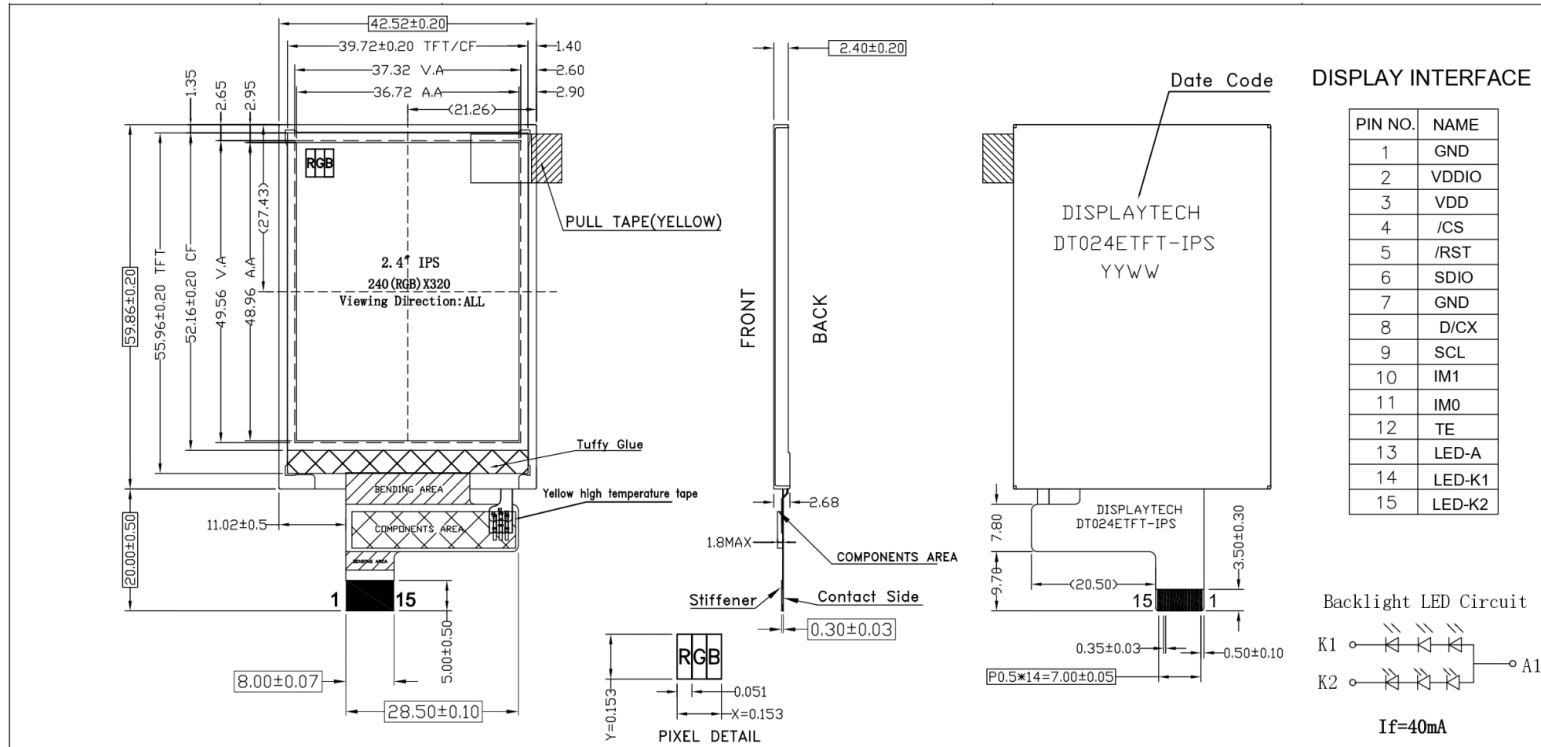
- A. To clean the product, wipe with a soft cloth moistened with ethanol. Do not allow ethanol to get between upper film and bottom glass, as this may cause peeling issues and/or defective operation. Do not use any organic solvent or detergent other than ethanol.

### 7.6 Cautions for installation and assembly

- A. Bezel edge must be positioned between Active area and Viewing area.
- B. For a stable display assembly, Displaytech recommends designing a support for the backside of the display.
- C. Do not display any fixed pattern for long periods of time. If a fixed pattern must be displayed, use a screen saver in order to avoid image persistence.

## 8 Mechanical Drawings

### 8.1 DT024ETFT-IPS



**Notes**

1. Display Type: 2.4" IPS
2. Display Mode: Transmissive/Normally Black
3. Viewing Direction: ALL
4. Backlight : 6PCS WHITE LED , If=40mA
5. Display Driver IC. : ILI9341V
6. VDD=VDDIO =2.8V
7. Luminance : 350 cd/m<sup>2</sup> (Typ.)
8. Operating Temperature: -20°C to 70°C ; Storage Temperature: -30°C to 80°C
9. General Tolerance : ±0.20mm
10. Environmental Protections Requirements(s): RoHS
11. (.)=Reference Dimension; □=Critical/Inspection Dimension

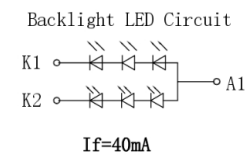
Count drawing & Spec.revision record during discussion with customer

| Rec. | Revision                               | Content Description | Date       |
|------|--|---------------------|------------|
| #00  | FIRST ISSUE                            |                     | 2020.09.10 |
| #01  | Modify Dimension                       |                     | 2020.11.06 |
| #02  | Modify Dimension                       |                     | 2020.11.25 |
| #03  | Modify Dimension                       |                     | 2021.01.18 |
|      | Modify IC PIN from ILI9341 to ILI9341V |                     | 2021.01.21 |

|                          |      |               |        |             |            |
|--------------------------|------|---------------|--------|-------------|------------|
| <p>a seacomp company</p> |      |               |        |             |            |
|                          |      |               |        | SCALE       | SHEET      |
| Mod.Name                 |      | DT024ETFT-IPS |        | NTS         | 1/1        |
| UNIT                     | SIZE | DESIGNER      | CHECK  | APPROVER    | FILE NAME  |
| mm                       | A4   | Felix Feng    | Ken Li | Jones Hsieh | Count Dwg. |

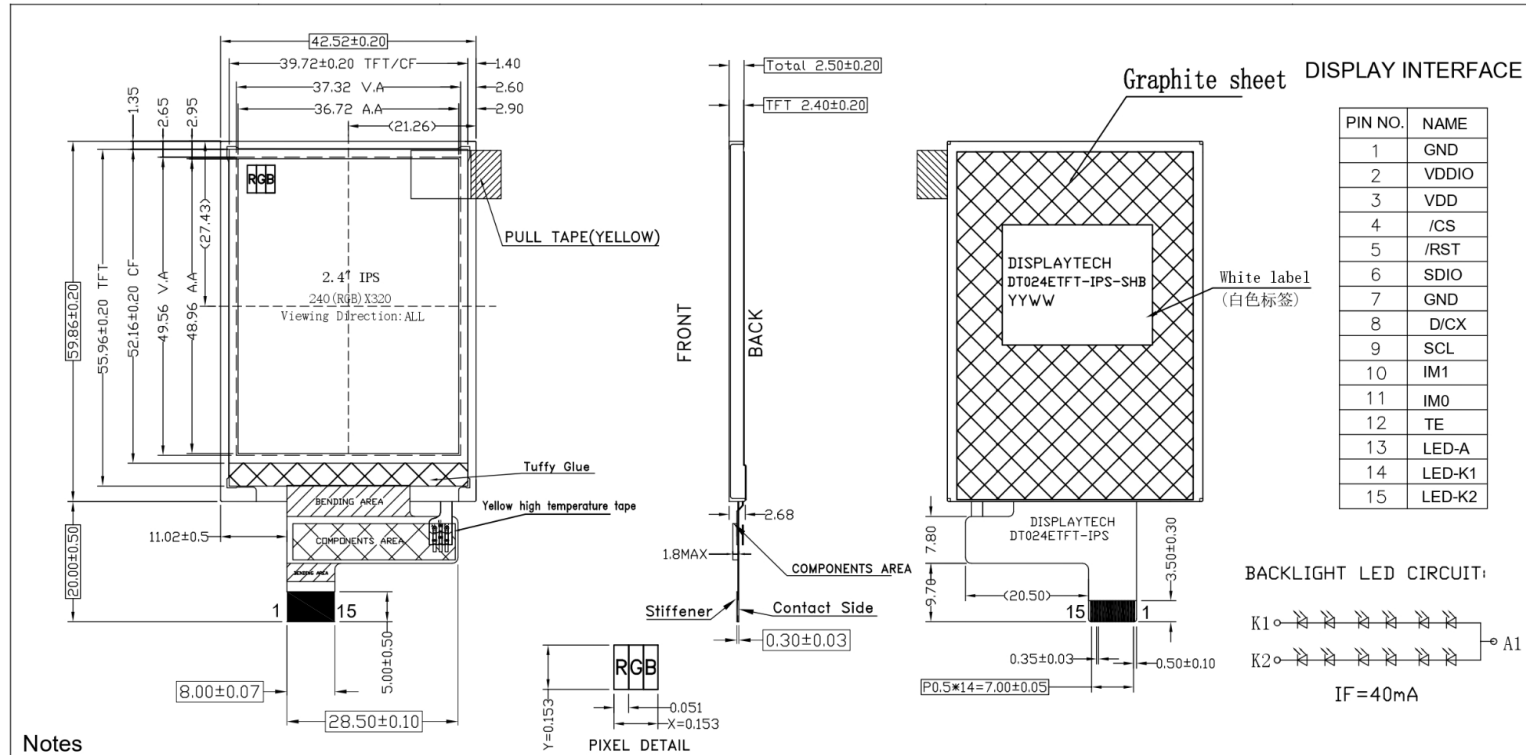
**DISPLAY INTERFACE**

| PIN NO. | NAME   |
|---------|--------|
| 1       | GND    |
| 2       | VDDIO  |
| 3       | VDD    |
| 4       | /CS    |
| 5       | /RST   |
| 6       | SDIO   |
| 7       | GND    |
| 8       | D/CX   |
| 9       | SCL    |
| 10      | IM1    |
| 11      | IM0    |
| 12      | TE     |
| 13      | LED-A  |
| 14      | LED-K1 |
| 15      | LED-K2 |





## 8.2 DT024ETFT-IPS-SHB



### Notes

1. Display Type: 2.4" IPS
2. Display mode: TRANSMISSIVE/Normally Black
3. Viewing Direction: ALL
4. Back light : 12PCS WHITE LED(2\*6), IF=40mA
5. LCM DRIVER IC. : ILI9341V
6. VDD=IOVCC =2.8V
7. Luminance : 1000(Typ.)
8. Operating Temperature: -20°C to 70°C; Storage Temperature: -30°C to 80°C
9. General tolerance : ±0.2mm
10. Environmental Protections Requirements(s): RoHS
11. ( )=Reference Dimension;   =Critical/Inspection Dimension

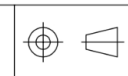
Count drawing & Spec.revision record during discussion with customer

| Rec. | Revision content description  | Date                     |
|------|---|--------------------------|
| #00  | FIRST ISSUE   | 2020.09.10               |
| #01  | Modify Dimension  | 2020.11.06               |
| #02  | Modify Dimension  | 2020.11.25               |
| #03  | Modify backlight led circuit.<br>Modify IC PIN from ILI9341 to ILI9341V | 2021.01.21<br>2021.01.22 |



Mod.Name DT024ETFT-IPS-SHB

| UNIT | SIZE | DESIGNER   | CHECK  | APPROVER    | FILE NAME  |
|------|------|------------|--------|-------------|------------|
| mm   | A4   | Felix Feng | Ken Li | Jones Hsieh | Count Dwg. |



| SCALE | SHEET |
|-------|-------|
| NTS   | 1/1   |

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