PRODUCT SPECIFICATION

2.4” IPS LCD Module with SPI Interface

DT024ETFT-IPS, DT024ETFT-IPS-SHB

Displaytech
a seacomp company

Revision 1.0
10 August 2023

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Revision History

REV	DESCRIPTION	DATE	APPR
1.0	Initial release	14 AUG 2023	PRW

Table of Contents

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[1]			
PIN	NAME	TYPE	DESCRIPTION
1	GND	PWR	Ground
2	VDDIO	PWR	Power supply, logic
3	VDD	PWR	Power supply, analog
4	$\overline{CS}$	I	Chip select (active low)
5	$\overline{RESET}$	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.[2]
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

[1] Recommended mating connector: 5051101592 (or equivalent)
[2] See ILI9163 datasheet for details

3 Specifications

3.1 Absolute Maximum Ratings[3]

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[4]

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 x V_{DDIO}	–	V_{DDIO}	V
Logic Input, Low	V_{IL}	GND	–	0.3 x V_{DDIO}	V
Logic Output, High	V_{OH}	0.8 * V_{DDIO}	–	V_{DDIO}	V
Logic Output, Low	V_{OL}	GND	–	0.2 x V_{DDIO}	V

[3] Operation outside of the maximum ratings listed below may result in permanent damage to the LCD.
[4] T_A = 25°C

LED BACKLIGHT						
PARAMETER			MIN	TYP	MAX	UNITS
Forward Current	I_F		30	40	60	mA
Forward Voltage	V_F	DT024ETFT-IPS[5]	8.4	–	9.9	V
		DT024ETFT-IPS-SHB[6]	16.8	–	19.8	
LED Lifetime[7]			–	30,000	–	Hrs

3.2.1 LED Backlight Circuit

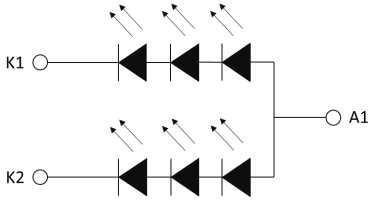


Figure 1: DT024ETFT-IPS Backlight
2 x 3 = 6 LEDs, I_F = 40 mA

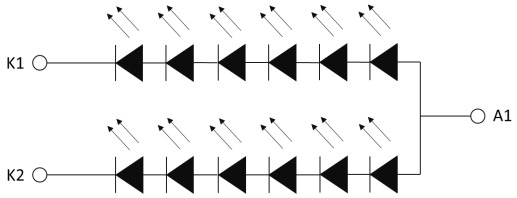


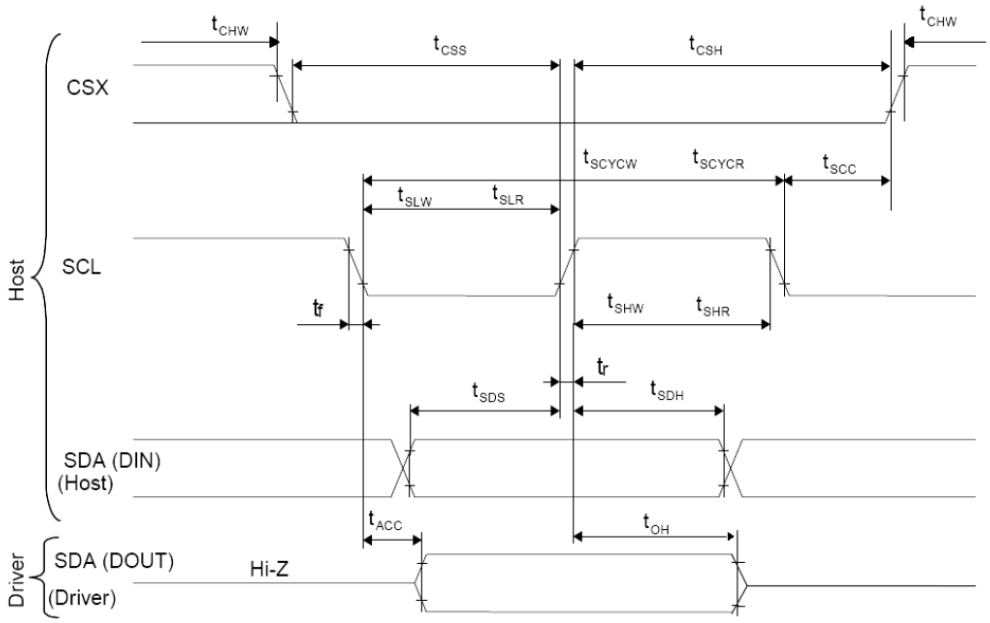
Figure 2: DT024ETFT-IPS-SHB Backlight
2 x 6 = 12 LEDs, I_F = 40 mA

[5] DT024ETFT-IPS backlight power consumption: 594mW (Max.)
[6] DT024ETFT-IPS-SHB backlight power consumption: 1.19W (Max.)
[7] 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°C and I_F=40mA. 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

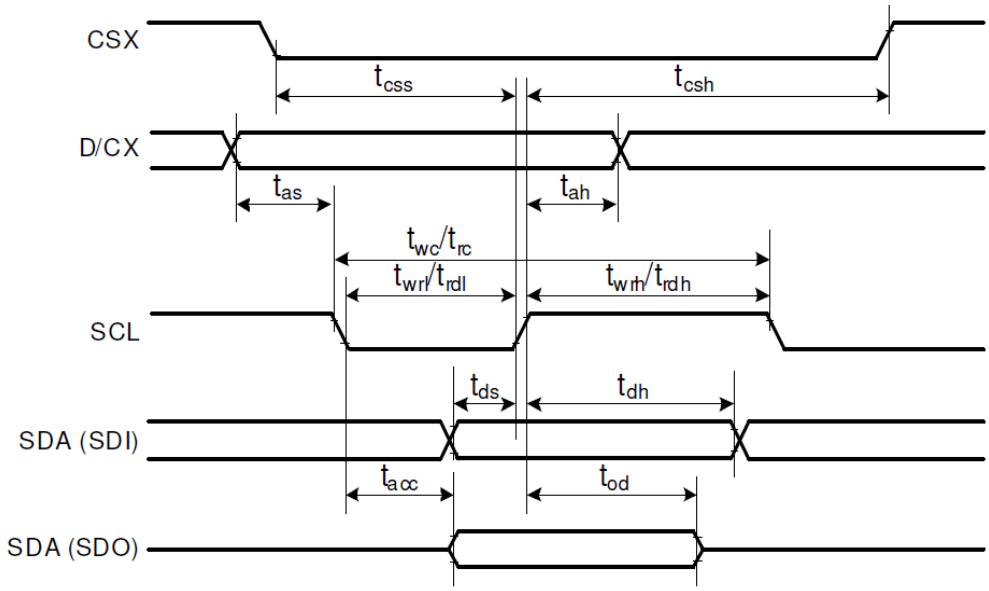


AC TIMING CHARACTERISTICS, 3-LINE SERIAL INTERFACE					
SIGNAL	PARAMETER		MIN	MAX	UNITS
SCL	Serial clock cycle (write)	t_{SCYCW}	100	–	nS
	SCL “H” pulse width (write)	t_{SHW}	40	–	nS
	SCL “L” pulse width (write)	t_{SLW}	40	–	nS
	Serial clock cycle (read)	t_{SCYCR}	150	–	nS
	SCL “H” pulse width (read)	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)[8]	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

[8] Maximum C_L = 30pF; Minimum C_L = 8pF

4.2 4-Line Serial Interface

Figure 4: 4-Line Serial Interface Timing

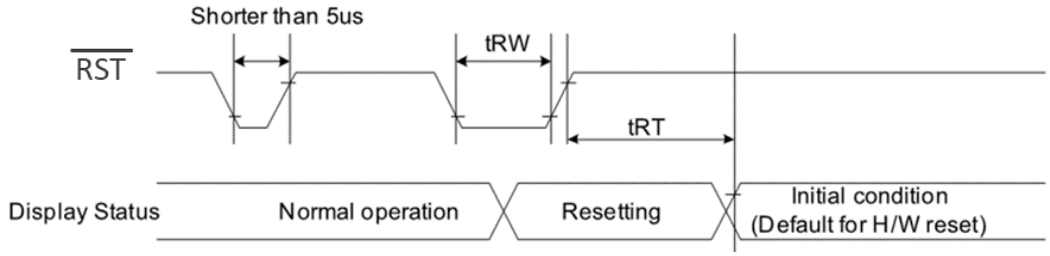


AC TIMING CHARACTERISTICS, 4-Line Serial Interface					
SIGNAL	PARAMETER		MIN	MAX	UNITS
$\overline{CS}$	Chip select time (write)	t_{CSS}	40	–	nS
SCL	Chip select hold time (read)	t_{CSH}	40	–	nS
	Serial clock cycle (write)	t_{WC}	100	–	nS
	SCL “H” pulse width (write)	t_{WRH}	40	–	nS
	SCL “L” pulse width (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)[9]	Access time (read)	t_{ACC}	10	–	nS
	Output disable time (read)	t_{OD}	10	50	nS

[9] Maximum C_L = 30pF; Minimum C_L = 8pF

4.4 Reset Timing

Figure 5: Reset Timing



RESET TIMING[10]				
PARAMETER		MIN	MAX	UNIT
Reset pulse duration	t_{RW}	10	–	μS
Reset cancel	t_{RT}	–	5	mS
		–	120	mS

[10] Refer to ILI9341 driver datasheet for details

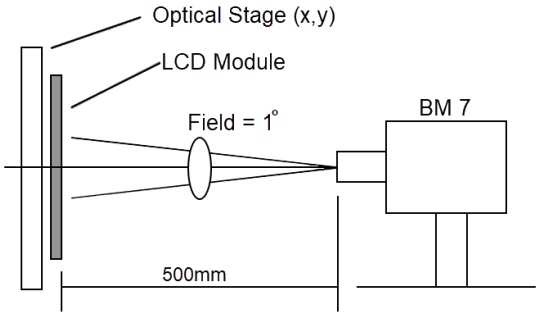
5 Optical Characteristics

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

[11] See Section 5.1, Figure 3
[12] Viewing Angle (Θ) = 0°
[13] See Section 5.1, Figure 7
[14] See Section 5.1, Figure 4
[15] Contrast Ratio (CR) ≥ 10
[16] See Section 5.1, Figure 5
[17] See Section 5.1, Figure 6

5.1 Figures

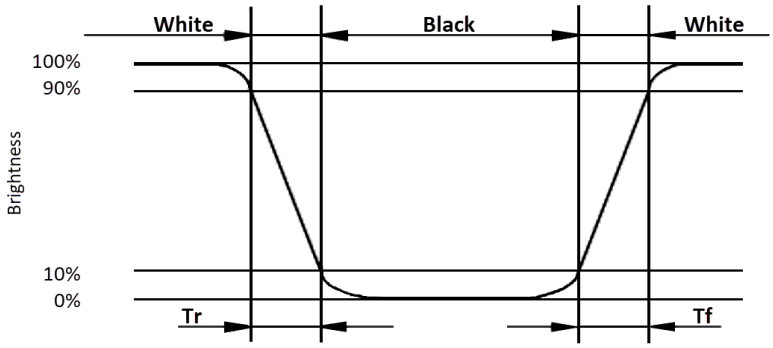
Figure 3: Optical Measurement System



Conditions:

I_F = 40 mA, T_A = 25 °C, ambient brightness < 150 lx

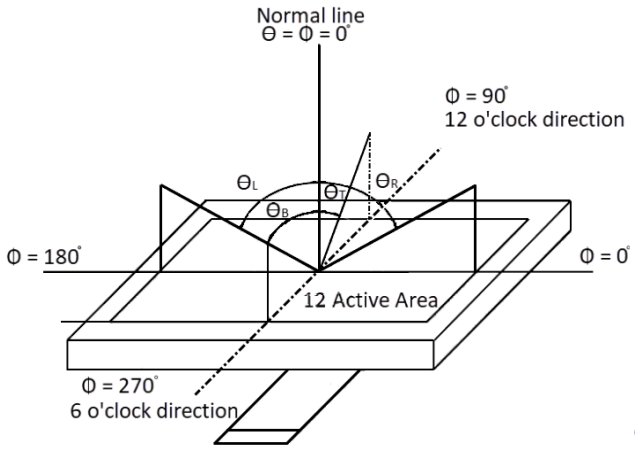
Figure 4: Response Times



Decay Time (TF) = Time required for display to transition from white to black

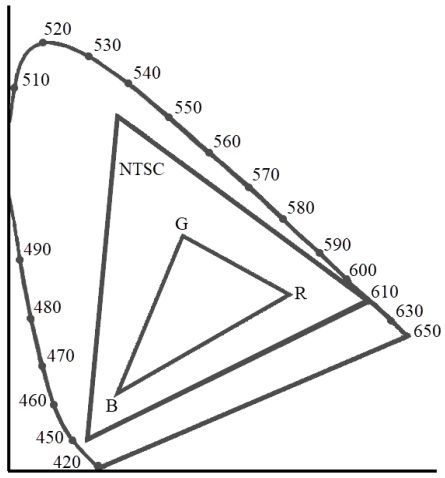
Rise Time (TR) = Time required for display to transition from black to white

Figure 5: Viewing Angles



Viewing angle is measured from center point of LCD

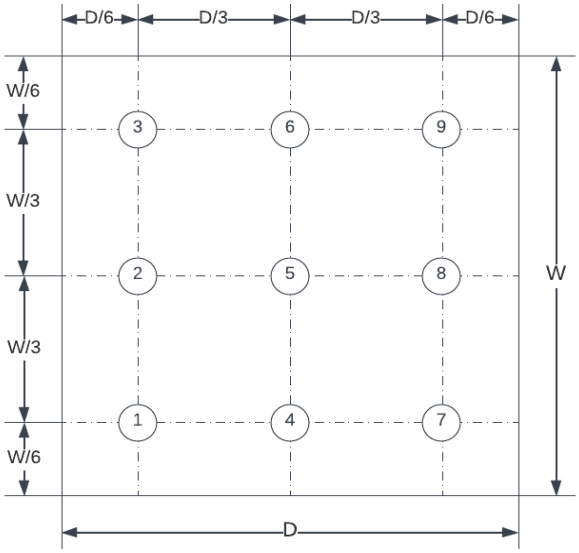
Figure 6: Chromaticity (CIE 1931)



Chromaticity = Area of $\triangle_{RGB}$ / Area of $\triangle_{NTSC}$

* 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.[18]

ITEM UNDER TEST	TEST CONDITION
High temp operation	T_A = 70 °C, 120 Hrs.
Low temp operation	T_A = -20 °C, 120 Hrs.
High temp storage	T_S = 80 °C, 120 Hrs.
Low temp storage	T_S = -30 °C, 120 Hrs.
High temp & high humidity storage	T_S = 60 °C, 120 Hrs., 90% RH
Thermal shock (non-operation)	-30 °C, 30 min → 80 °C, 30 min Change time: 5 min, 10 cycles
ESD (operation)	C = 150 pF, R = 330 Ω, 5 points/panel Air: ±8 KV, 5 times Contact: ±4 KV, 5 times
Vibration (non-operation)	Frequency range 10 - 55 Hz. Stroke: 1.5 mm Sweep 10 Hz → 55 Hz → 10 Hz 2 hours for each direction of X, Y, Z
Package drop test	Height 80 cm 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 No cracks on LCD panel
Alignment of LCD panel	No bubbles in LCD panel No alignment defects in LCD active area
Electrical current	Within device specifications
Function / Display	No broken circuits, no short circuits No black lines No other display defects

[18] 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°C ±10°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

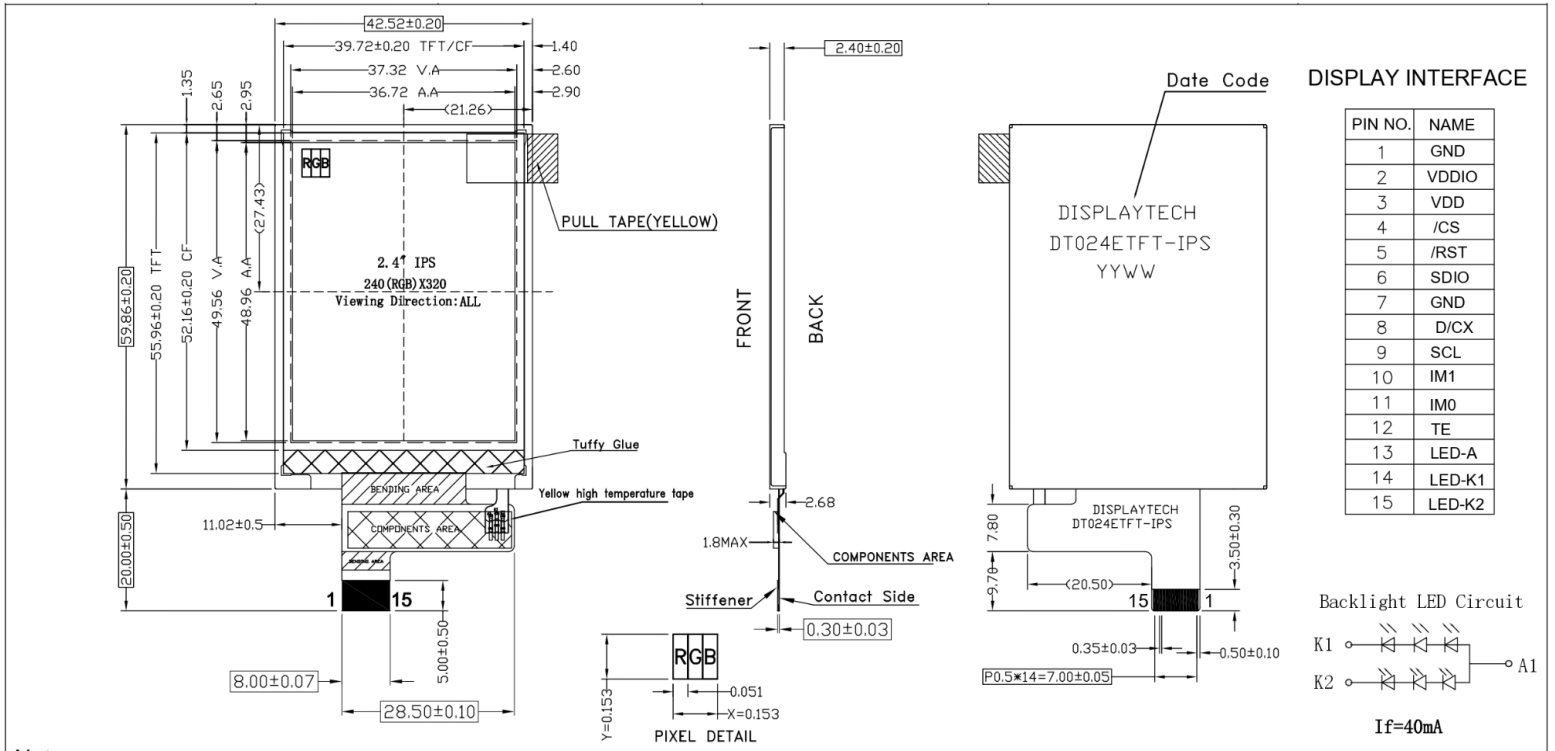
A. To clean the product, wipe with a soft cloth moistened with ethanol. Do not allow ethanol to get between upper film and bottom glass, as this may cause peeling issues and/or defective operation. Do not use any organic solvent or detergent other than ethanol.

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/m²(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 P/N from ILI9341 to ILI9341V	2021.01.21

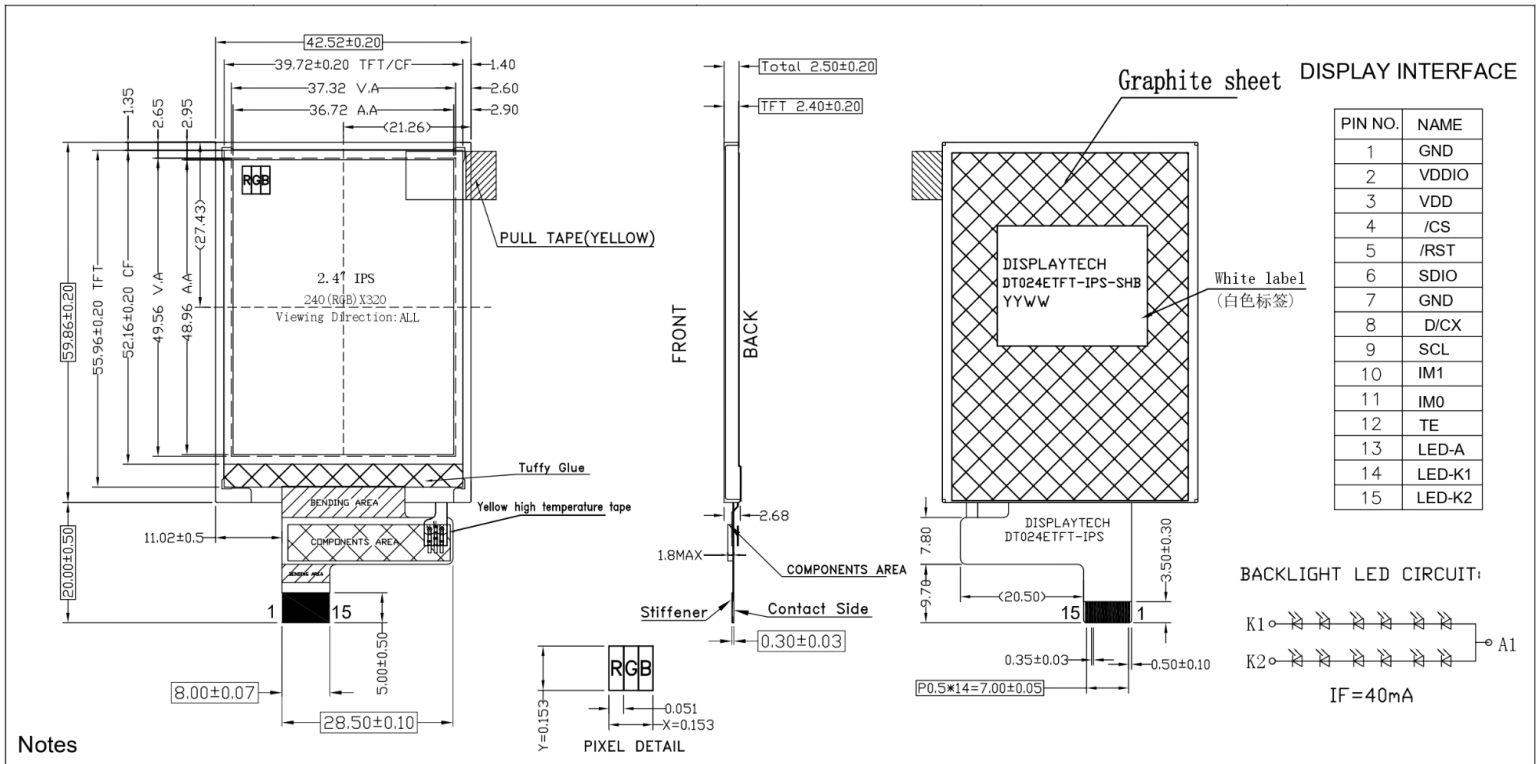
Displaytech a seacomp company

Mod.Name: DT024ETFT-IPS

SCALE	SHEET
NTS	1/1

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

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.Luminace : 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

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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.	2021.01.21
	Modify IC P/N from ILI9341 to ILI9341V	2021.01.22

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Mod.Name	DT024ETFT-IPS-SHB	SCALE	SHEET
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UNIT	SIZE	DESIGNER	CHECK	APPROVER	FILE NAME
mm	A4	Felix Feng	Ken Li	Jones Hsieh	**Count Dwg.**