PRODUCT SPECIFICATION

2.8” IPS LCD Module with SPI Interface
DT028DTFT-IPS, DT028DTFT-IPS-SHB

Displaytech
a seacomp company

Revision 1.1
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Revision History

REV	CHANGE DESCRIPTION	DATE	APPR
1.0	Initial release	28 SEP 2023	PRW
1.1	Correct pin description, pins 10 & 11	25 MAR 2024	KRK

Table of Contents

1 Overview

The **DT028DTFT-IPS** and **DT028DTFT-IPS-SHB** are 2.8” color IPS LCD modules, each composed of a LCD panel, display driver, FPC cable with SPI interface, and LED backlight. The display’s active area has a resolution of 240 x 320 pixels. The **DT028DTFT-IPS-SHB**, with twice the number of backlight LEDs, is available as a “super high-bright” alternative to the **DT028DTFT-IPS**.

1.1 Applications

- Video Systems
- Mobile Systems
- Wearable devices

1.2 Features

- Size 2.8 Inches
- Resolution 240 (RGB) x 320 Pixels
- Interface 4-Line SPI
- Type IPS, Transmissive, Normally black
- Module Dimensions
  - DT028DTFT-IPS 48.70 mm (W) x 68.85 mm (L) x 2.11 mm (H)
  - DT028DTFT-IPS-SHB 48.70 mm (W) x 68.85 mm (L) x 2.21 mm (H)
- Active Area 43.20 mm (W) x 57.60 mm (L)
- Pixel Pitch 0.18mm (W) x 0.18mm (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	$\overline{RST}$	I	Display reset, active low
6	SDIO	IO	Serial input/output
7	GND	PWR	Ground
8	D/CX	I/O	Display data/command selection (0: Command, 1: Data)
9	SCL	I	Serial clock
10	IM1	I	See LCD Parallel Interface Mode Selection table
11	IM0	I	See LCD 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 LCD Serial Interface Mode

LCD PARALLEL INTERFACE MODE SELECTION		
IM1	IM0	MODE
0	1	3-wire 9-bit data serial interface II
1	0	4-wire 8-bit data serial interface II

[1] Recommended mating connector: FH12-15S-0.5SH(55)
[2] See ILI9341 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	–	150	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 * V_{DDIO}	–	V_{DDIO}	V
Logic Input, Low	V_{IL}	GND	–	0.3 * V_{DDIO}	V
Logic Output, High	V_{OH}	0.8 * V_{DDIO}	–	V_{DDIO}	V
Logic Output, Low	V_{OL}	GND	–	0.2 * V_{DDIO}	V

[3] Operation outside of maximum rating may result in permanent damage to the display.
[4] T_A = 25°C

LED BACKLIGHT[5]						
PARAMETER			MIN	TYP	MAX	UNITS
Forward Current	I_F		–	120	150	mA
Forward Voltage	V_F	DT028DTFT-IPS	2.9	–	3.2	V
		DT028DTFT-IPS-SHB	5.8	–	6.2	
LED Lifetime[6]	–		–	30,000	–	Hrs

3.2.1 LED Backlight Circuit

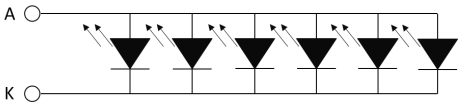


Figure 1: DT028DTFT-IPS Backlight
1 x 6 = 1 LEDs, I_F = 120 mA

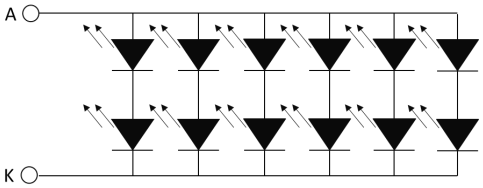


Figure 2: DT028DTFT-IPS-SHB Backlight
2 x 6 = 12 LEDS, I_F = 120 mA

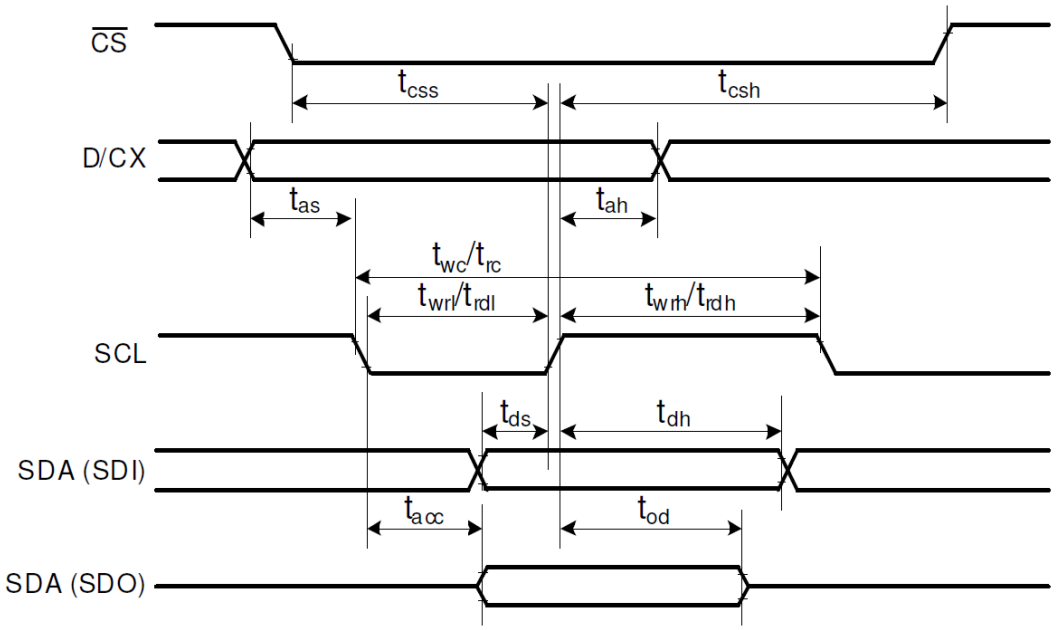
[5] Backlight Power Consumption
DT028ETFT-IPS: 480 mW (Max.)
DT028ETFT-IPS-SHB: 930 mW (Max.)

[6] 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= 120 mA. LED lifetime may decrease if operating current, I_F, is larger than 120 mA.

4 Command/AC Timing

4.1 Serial Interface, 4-Line

Figure 3: 4-Line Serial Interface Timing Diagram

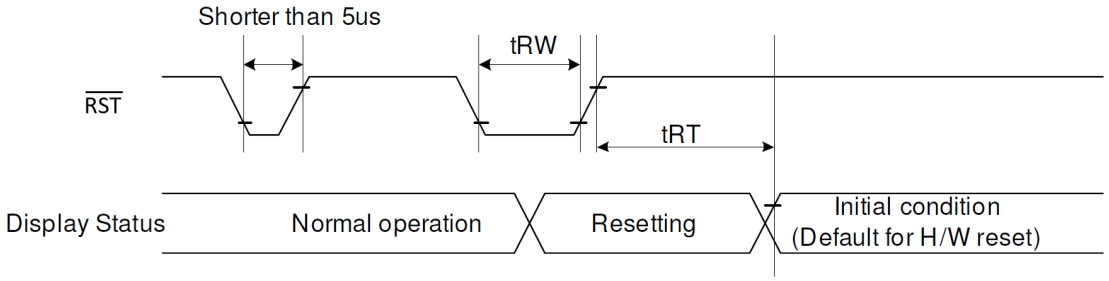


AC TIMING CHARACTERISTICS, 4-LINE SERIAL INTERFACE[7]					
SIGNAL	PARAMETER		MIN	MAX	UNITS
$\overline{CS}$	Chip select time (write)	t_{css}	40	–	ns
SCL	Chip select hold time (read)	t_{csh}	40	–	ns
	Serial clock cycle (write)	t_{wc}	100	–	ns
	SCL “H” pulse width (write)	t_{wrh}	40	–	ns
	SCL “L” pulse 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	–	
SDA/SDI (In)	Data setup time (write)	t_{ds}	30	–	ns
	Data hold time (write)	t_{dh}	30	–	ns
SDA/SDO (Out)[8]	Access time (read)	t_{acc}	10	–	ns
	Output disable time (read)	t_{od}	10	50	ns

[7] T_A = 25 °C, V_{DD} = 1.65V ~ 3.3V, V_{DDIO} = 1.65V ~ 3.3V, GND = 0 V
[8] Maximum C_L = 30pF; Minimum C_L = 8pF

4.2 Reset Timing

Figure 4: Reset Timing Diagram



RESET TIMING				
PARAMETER		MIN.	MAX.	UNIT
Reset pulse duration	t_{RW}	10	–	μs
Reset cancel[9]	t_{RT}	–	5	ms
		–	120	ms

[9] Refer to LCD driver datasheet for details.

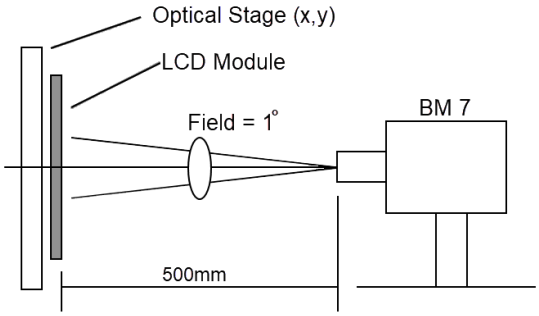
5 Optical Specification

OPTICAL CHARACTERISTICS[10]						
PARAMETER			MIN.	TYP.	MAX.	UNIT
Contrast Ratio[11,12]		CR	600	800	–	–
Response Time[13]		T_{ON} / T_{OFF}	–	30	40	mS
View Angles[14,15]		ΘT	–	80	–	Deg.
		ΘB	–	80	–	
		ΘL	–	80	–	
		ΘR	–	80	–	
Chromaticity[16]	DT028DTFT-IPS	X_{WHT}	TYP. - 0.0300	.3065	TYP. + 0.0300	-
		Y_{WHT}		.3604		
		X_{RED}		.6451		
		Y_{RED}		.3234		
		X_{GRN}		.3182		
		Y_{GRN}		.6228		
		X_{BLU}		.1064		
		Y_{BLU}		.0664		
	DT028DTFT-IPS-SHB	X_{WHT}	TYP. 0.0300	0.2979	TYP. 0.0300	–
		Y_{WHT}		0.3462		
		X_{RED}		0.6487		
		Y_{RED}		0.3236		
		X_{GRN}		0.3218		
		Y_{GRN}		0.6100		
		X_{BLU}		0.1073		
		Y_{BLU}		0.0677		
Luminance[12]	DT028DTFT-IPS	L	280	350	–	Cd/m^2
	DT028DTFT-IPS-SHB		800	1000	–	
Uniformity[12]		U	80	–	–	%

[10] See Section 5.1, Figure 5
[11] Viewing Angle (Θ) = 0°
[12] See Section 5.1, Figure 9
[13] See Section 5.1, Figure 6
[14] Contrast Ratio (CR) ≥ 10
[15] See Section 5.1, Figure 7
[16] See Section 5.1, Figure 8

5.1 Figures

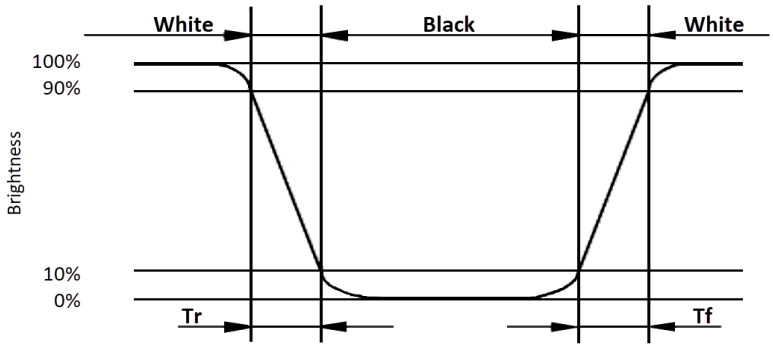
Figure 5: Optical Measurement System



Conditions:

I_F = 120mA, T_A = 25 °C, ambient brightness < 150 lx

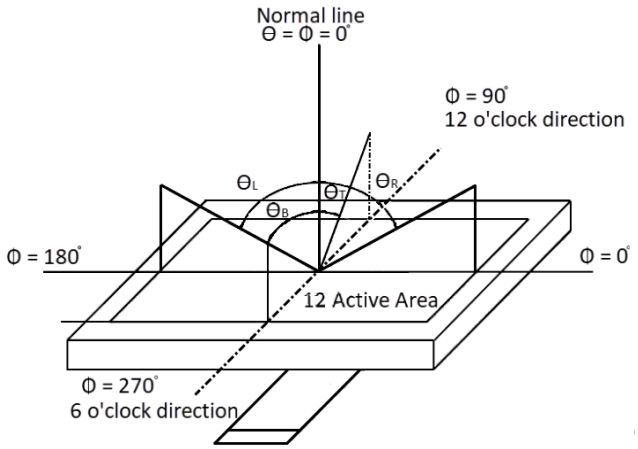
Figure 6: Response Times



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

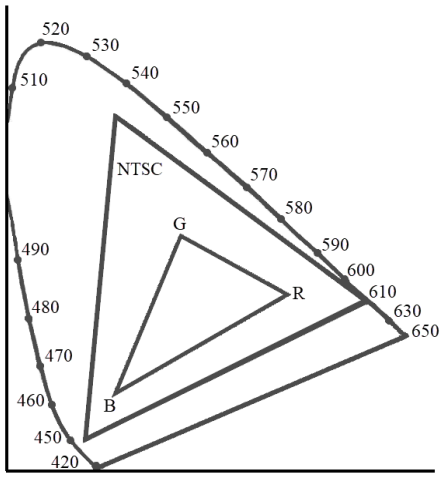
Rise Time (TR) = Time required for display to transition from black to white

Figure 7: Viewing Angles



Viewing angle is measured from center point of LCD

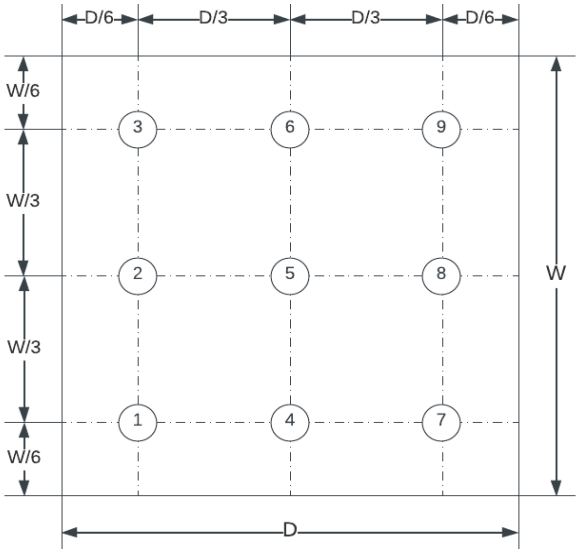
Figure 8: Chromaticity (CIE 1931)



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

* Color coordinates measured at center point of LCD

Figure 9: 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.[17]

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	Ts = 80 °C, 120 Hrs.
Low temp storage	Ts = -30 °C, 120 Hrs.
High temp & high humidity storage	Ts = 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 Hz ~ 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	Drop 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

[17] 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

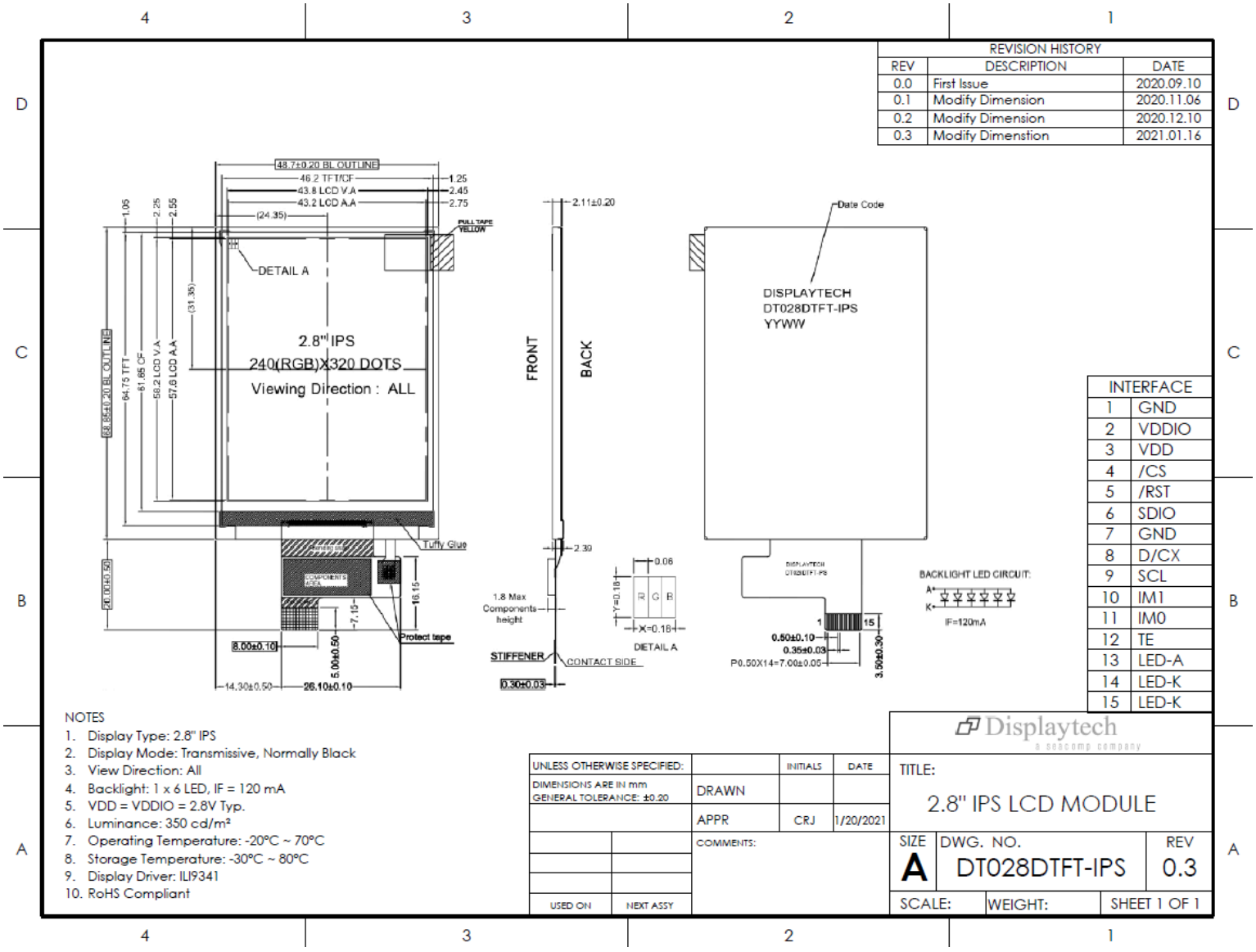
A. To clean the product, wipe with a soft cloth moistened with ethanol. Do not allow ethanol to get between upper film and bottom glass, as this may cause peeling issues and/or defective operation. Do not use any organic solvent or detergent other than ethanol.

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.

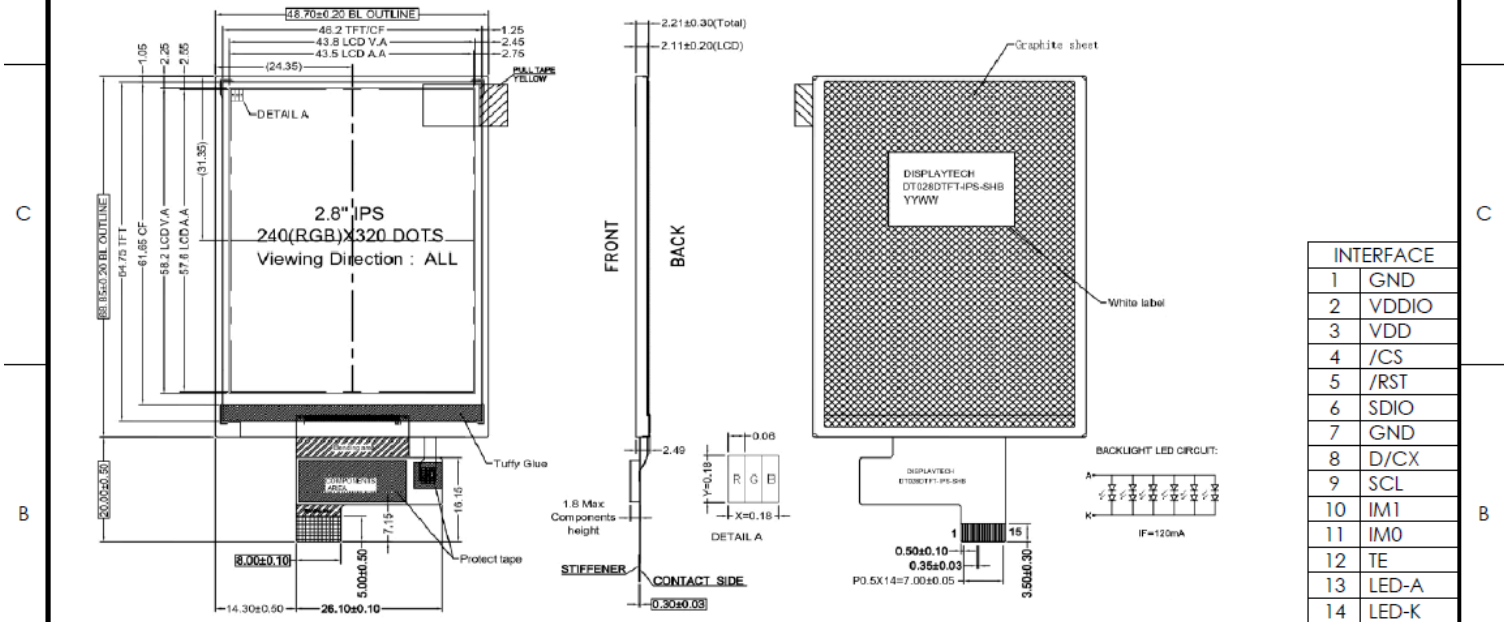
8 Mechanical Drawings

8.1 DT028DTFT-IPS



8.2 DT028DTFT-IPS-SHB

REVISION HISTORY		
REV	DESCRIPTION	DATE
0.0	First Issue	2020.09.10
0.1	Modify Dimension	2020.11.06
0.2	Modify Dimension	2020.12.10
0.3	Modify backlight LED circuit	2021.01.21



INTERFACE	
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-K
15	LED-K

NOTES
1. Display Type: 2.8" IPS
2. Display Mode: Transmissive, Normally Black
3. View Direction: All
4. Backlight: 2 x 6 LED, IF = 120 mA
5. VDD = VDDIO = 2.8V Typ.
6. Luminance: 1000 cd/m²
7. Operating Temperature: -20°C ~ 70°C
8. Storage Temperature: -30°C ~ 80°C
9. Display Driver: ILI9341
10. RoHS Compliant

UNLESS OTHERWISE SPECIFIED:		INITIALS	DATE
DIMENSIONS ARE IN mm GENERAL TOLERANCE: ±0.20	DRAWN		
	APPR	CRJ	1/20/2021
	COMMENTS:		
USED ON	NEXT ASSY		

Displaytech
a seacomp company

TITLE:
2.8" IPS LCD MODULE

SIZE	DWG. NO.	REV
A	DT028DTFT-IPS-SHB	0.3
SCALE:	WEIGHT:	SHEET 1 OF 1