

PRODUCT SPECIFICATION

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



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Revision History

REV	CHANGE DESCRIPTION	DATE	APPR
1.0	Initial release	28 SEP 2023	PRW

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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 Parallel Interface Mode

LCD 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: FH12-15S-0.5SH(55)

² See ILI9163 datasheet for details

3 Specifications

3.1 Absolute Maximum Ratings³

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 Characteristics⁴

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 $T_A = 25^\circ\text{C}$

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

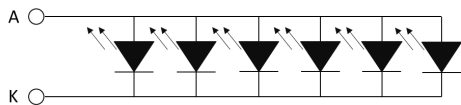


Figure 1: DT028DTFT-IPS Backlight
 1 x 6 = 6 LEDs, $I_F = 120$ mA

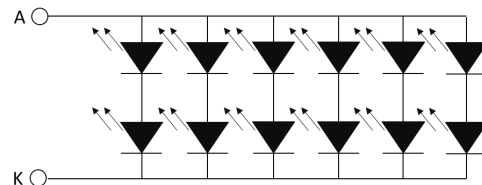


Figure 2: DT028DTFT-IPS-SHB Backlight
 2 x 6 = 12 LEDs, $I_F = 120$ mA

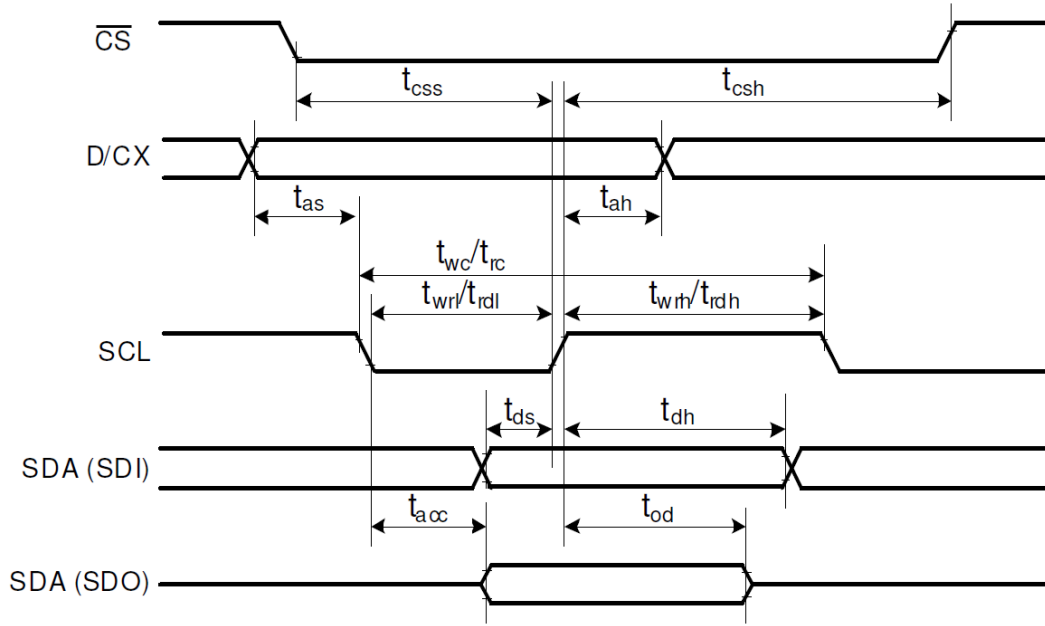
⁵ Backlight Power Consumption
 DT028ETFT-IPS: 480 mW (Max.)
 DT028ETFT-IPS-SHB: 930 mW (Max.)

⁶ LED lifetime is defined as the amount of time it takes for brightness to decrease to 50% of its original value at $T_A = 25^\circ\text{C}$ 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



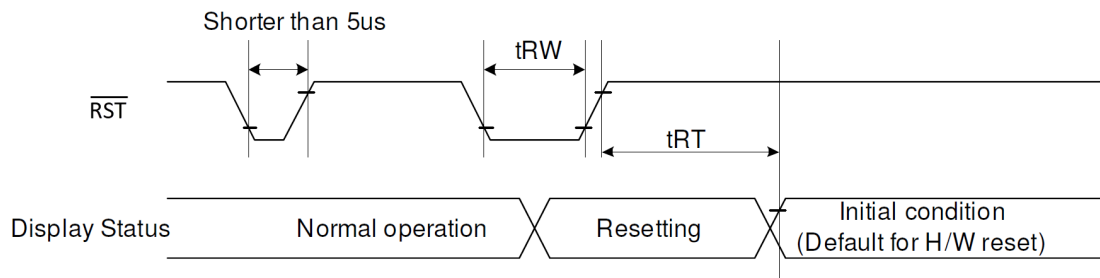
AC TIMING CHARACTERISTICS, 4-LINE SERIAL INTERFACE ⁷					
SIGNAL	PARAMETER		MIN	MAX	UNITS
\overline{CS}	Chip select time (write)	t_{css}	40	–	ns
SCL	Chip select hold time (read)	t_{csh}	40	–	ns
	Serial clock cycle (write)	t_{wc}	100	–	ns
	SCL "H" pulse width (write)	t_{wrh}	40	–	ns
	SCL "L" pulse width (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 $T_A = 25\text{ }^\circ\text{C}$, $V_{DD} = 1.65\text{V} \sim 3.3\text{V}$, $V_{DDIO} = 1.65\text{V} \sim 3.3\text{V}$, $GND = 0\text{ V}$

⁸ Maximum $C_L = 30\text{pF}$; Minimum $C_L = 8\text{pF}$

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

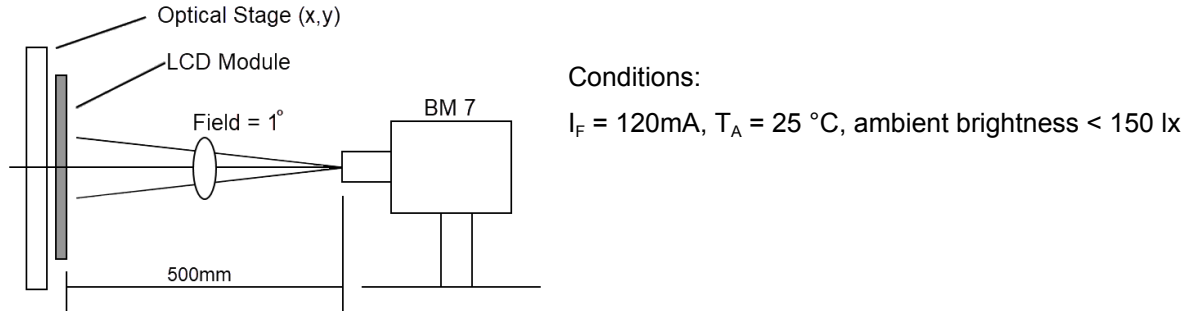


Figure 6: Response Times

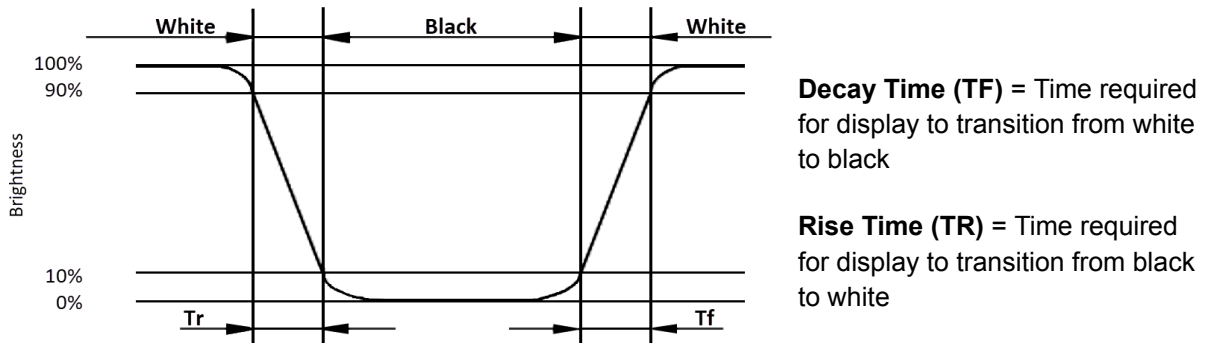


Figure 7: Viewing Angles

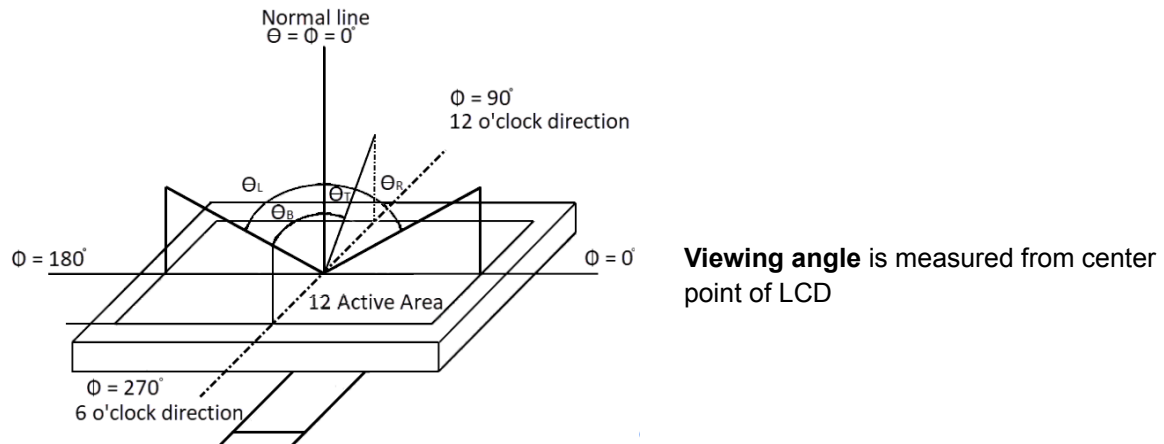
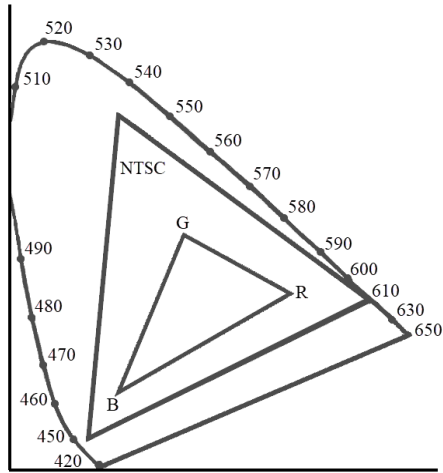


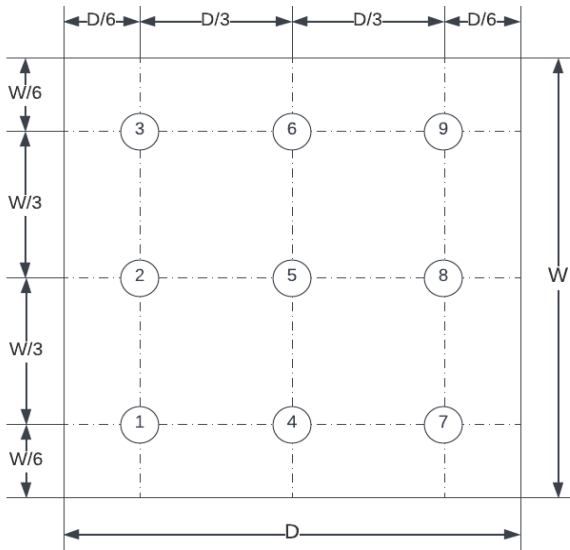
Figure 8: Chromaticity (CIE 1931)



Chromaticity = Area of Δ_{RGB} / Area of Δ_{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	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 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 $+25^{\circ}\text{C} \pm 10^{\circ}\text{C}$ 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

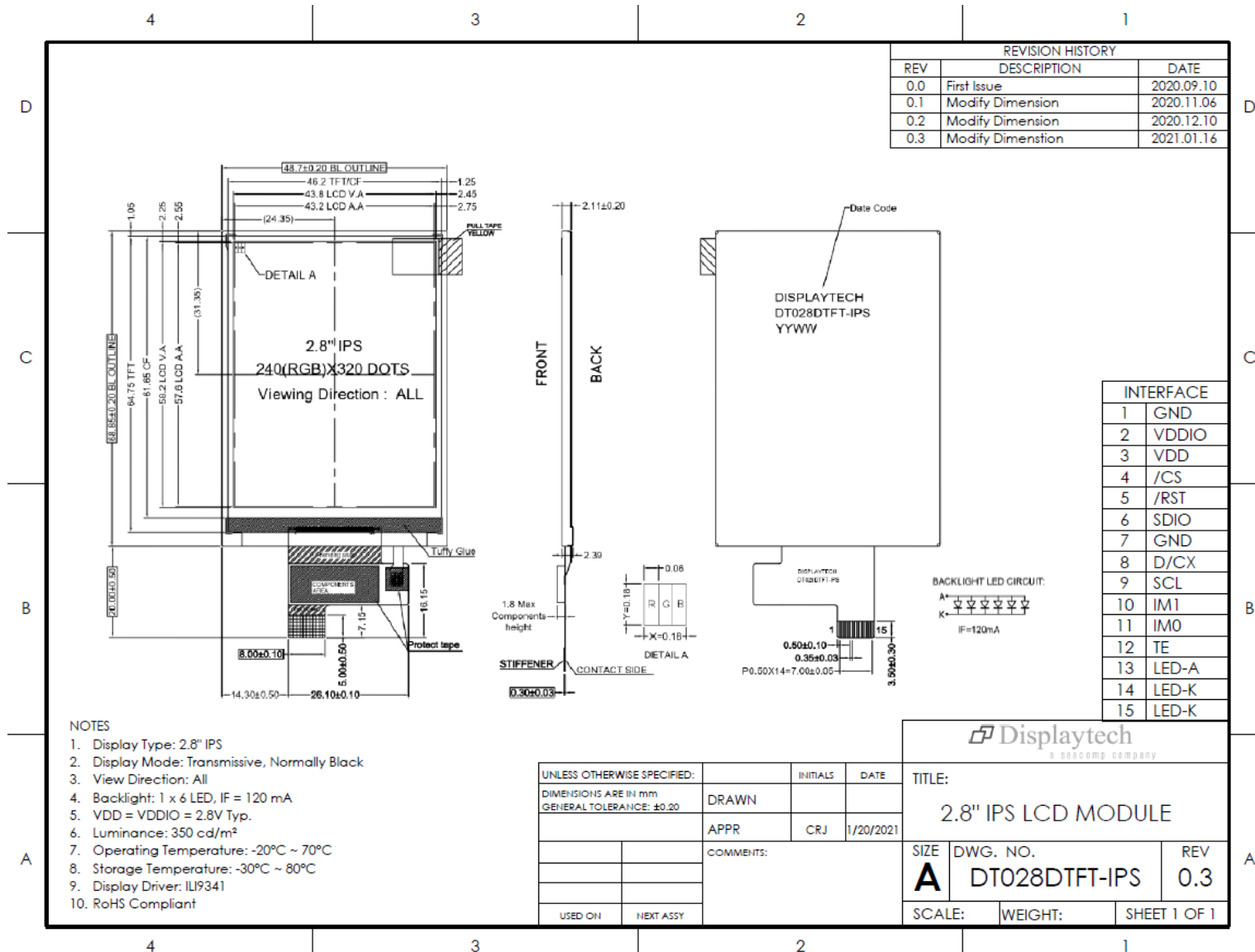
- A. To clean the product, wipe with a soft cloth moistened with ethanol. Do not allow ethanol to get between upper film and bottom glass, as this may cause peeling issues and/or defective operation. Do not use any organic solvent or detergent other than ethanol.

7.6 Cautions for installation and assembly

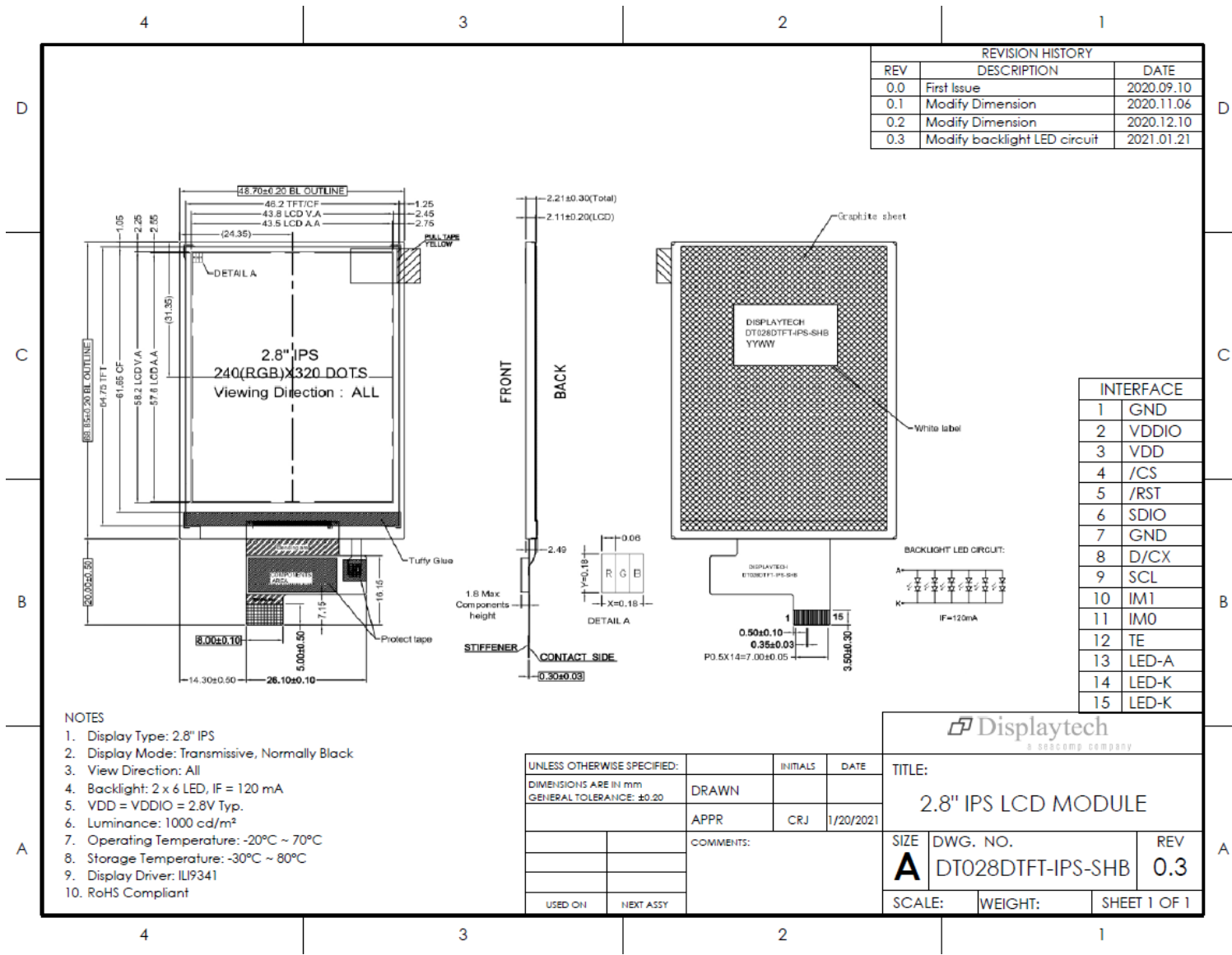
- A. Bezel edge must be positioned between Active area and Viewing area.
- B. For a stable display assembly, Displaytech recommends designing a support for the backside of the display.
- C. Do not display any fixed pattern for long periods of time. If a fixed pattern must be displayed, use a screen saver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

8 Mechanical Drawings

8.1 DT028DTFT-IPS



8.2 DT028DTFT-IPS-SHB



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