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Customer: DELL

Product Specification

Rev. P0

(DELL DPN : D2W2X)

Nanjing BOE Display Technology Co.,Ltd

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TFT-LCD P1 2021.06.21 1 OF 42

A4(210 X 297)

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1.0 GENERAL DESCRIPTION

1.1 Introduction

NE156FHM-NX2 is a color active matrix TFT LCD module using IGZO TFT's (Thin Film Transistors) as an active switching devices. This module has a 15.6inch diagonally measured active area with Full-HD resolutions (1920 horizontal by 1080 vertical pixel array). Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical stripe and this module can display 16.7M(6bit+FRC) color and color gamut 45%. The TFT-LCD panel used for this module is a low reflection and higher color type. Therefore, this module is suitable for Notebook PC. The LED driver for back-light driving is built in this model.

All input signals are eDP1.3 interface compatible.

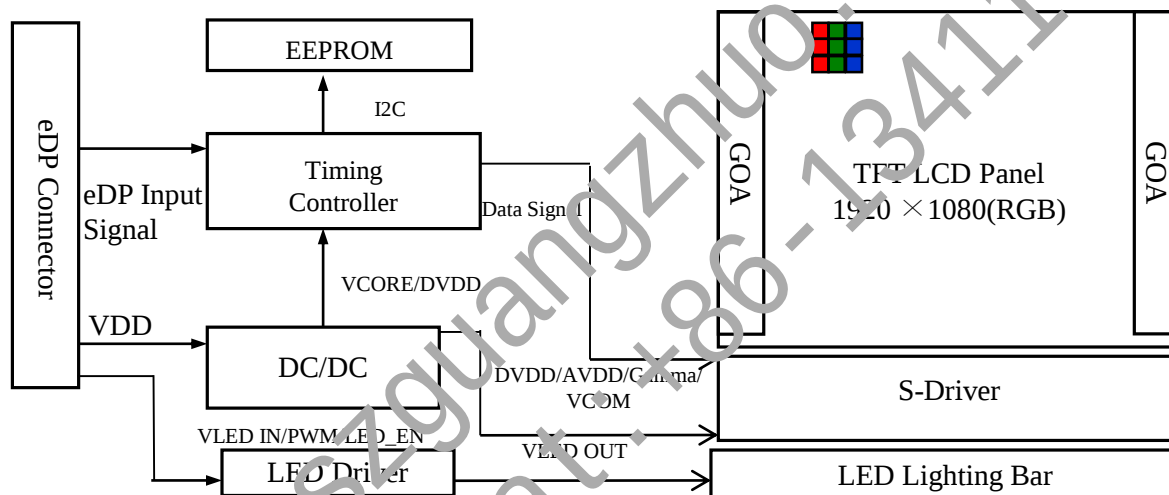


Figure 1. Drive Architecture

1.2 Features

- 4 lane eDP interface with 2.7Gbps link rates
- 16.7M(6bit+FRC) color depth, color gamut 45%
- Single LED lighting bar (Bottom side/Horizontal Direction)
- Data enable signal mode
- Side mounting frame
- Green product (RoHS & Halogen free product)
- On board LED driving circuit
- Low driving voltage and low power consumption
- On board EDID chip
- DPCL Version 1.4
- Function : PSR/SDRRS/CABC/BIST/FRC

1.3 Application

- Notebook PC

1.4 General Specification

The followings are general specifications at the model NE156FHM-NX2. (listed in Table 1)

<Table 1. General Specifications>

Parameter	Specification	Unit	Remarks
Active area	344.16 (H) × 193.59 (V)	mm	
Number of pixels	1920 (H) × 1080 (V)	pixels	
Pixel pitch	179.25(H) × 179.25(V)	mm	
Pixel arrangement	RGB Vertical stripe		
Display colors	16.7M(6bit+FRC)		
Color gamut	45%		
Display mode	Normally Black		
Dimensional outline	350.66(H) × 216.245(V) (W/PCB) × 3.2(Max.) 350.66(H) × 205.24(V) (W/O PCB) × 3.2 (Max.)	mm	
Weight	360(Max.)	g	
Surface treatment	Glare		
Surface hardness	3H		
Back-light	Bottom edge side, 1-LED lighting bar type		Note 1
Power consumption	P_D : 1.27(Max.)	W	@Mosaic
	P_{BL} : 3.25(Max.)	W	
	P_{Total} : 4.52(Max.)	W	@Mosaic

Notes : 1. LED Lighting Bar (45*LED Array)

2.0 ABSOLUTE MAXIMUM RATINGS

The followings are maximum values which, if exceed, may cause faulty operation or damage to the unit. The operational and non-operational maximum voltage and current values are listed in Table 2.

< Table 2. Absolute Maximum Ratings>

Ta=25+/-2°C

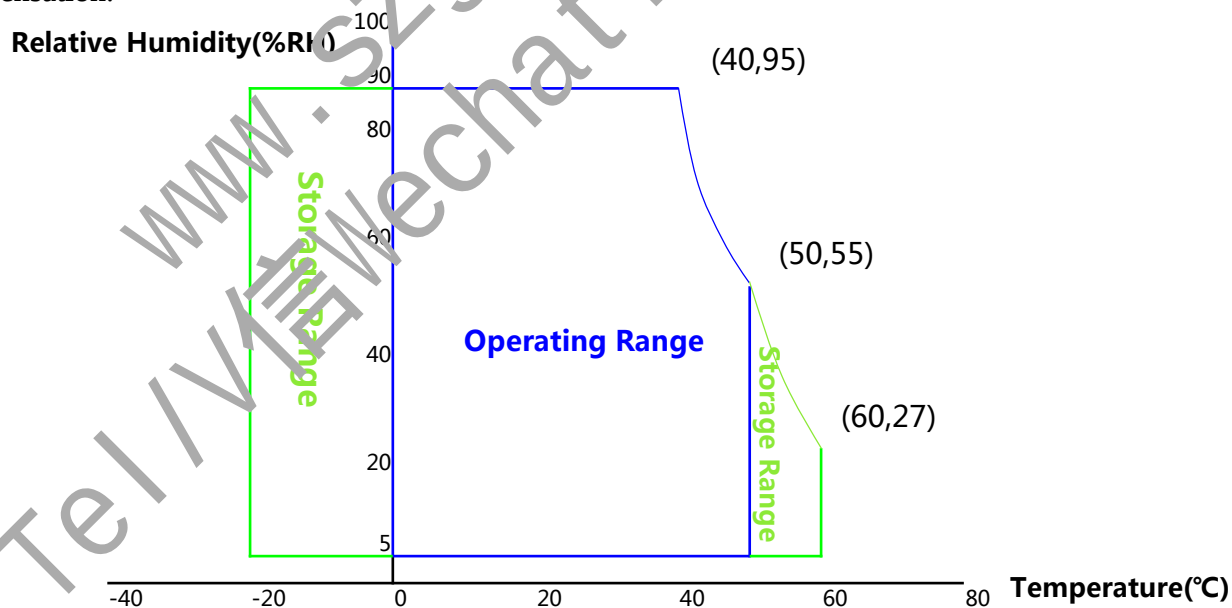
Parameter	Symbol	Min.	Max.	Unit	Remarks
Power Supply Voltage	V _{DD}	-0.3	4.0	V	Note 1
eDP input Voltage	V _{eDP}	0	2.0	V	
Logic Supply Voltage	V _{IN}	V _{SS} -0.3	V _{DD} +0.3	V	
Operating Temperature	T _{OP}	0	+50	°C	Note 2
Storage Temperature	T _{ST}	-20	+60	C	

Notes :

1. Permanent damage to the device may occur if maximum values are exceeded functional operation should be restricted to the condition described under normal operating conditions.

2. Temperature and relative humidity range are shown in the figure below.

95 % RH Max. (40 °C ≥ Ta) Maximum wet-bulb temperature at 39°C or less.(Ta >40°C)No condensation.



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3.0 ELECTRICAL SPECIFICATIONS

3.1 Electrical Specifications

< Table 3. Electrical Specifications >

Ta=25+/-2°C

Parameter		Min.	Typ.	Max.	Unit	Remarks
Power Supply Voltage	V _{DD}	3.0	3.3	3.6	V	Note 1
Permissible Input Ripple Voltage	V _{RF}	-10% VDD	-	+10% VDD	V	Note 4
CABC Control Level	High Level	0.7*V _{DIO}	-	-	V	@V _{DDIO} =2.5 V Note 5
	Low Level	-	-	0.25*V _{DDIO}	V	
BIST Control Level	High Level	0.7*V _{DIO}	-	-	V	
	Low Level	-	-	0.25*V _{DDIO}	V	
Power Supply Inrush Current	I _{Inrush}	-	-	2	A	Note3
Power Supply Current	Mosaic I _{DD}	-	304	-	mA	
Power Consumption	Mosaic P _M	-	1.02	1.27	W	
	BLU P _{BL}	-	2.94	3.25	W	Note 2
	Total P _{total}	-	3.96	4.52	W	Note 1

3.0 ELECTRICAL SPECIFICATIONS

3.1 Electrical Specifications

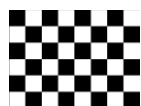
Notes :

1. The supply voltage is measured and specified at the interface connector of LCM.

The current draw and power consumption specified is for 3.3V at 25 °C.(Typ. value for reference)

a) Mosaic pattern 8*8

b) R/G/B patterns



(a)



(b)

Figure 3. Power Measure Patterns

2. Calculated value for reference ($V_{LED} \times I_{LED}$)

3. Measure condition (Figure 4)

4. Input voltage range:3.0~3.6V.Test condition: Oscilloscope bandwidth 20MHz, AC coupling

5. CABC&BIST setting

Pin No	Define	Enable	Disable
1	CABC	Pull High	Pull Low/Floating
14	BIST	Pull High	Pull Low/Floating

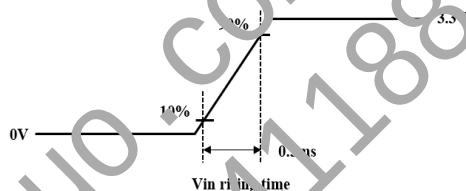


Figure 4. In us1 Measure Condition

3.2 Backlight Unit

< Table 4. LED Driving Guideline Specifications > Ta=25+/-2°C

Parameter		Min.	Typ.	Max.	Unit	Remarks
LED Forward Voltage	V _F	-	-	3.0	V	
LED Forward Current	I _F	-	20	-	mA	
LED Power Input Voltage	V _{LED}	5	12	21	V	
LED Power Input Current	I _{LED}	-	-	271	mA	Note 1
LED Power Consumption	P _{LED}	-	-	3.25	W	
Power Supply Voltage for LED Driver Inrush	Iled inrush	-	-	1.5	A	
LED Life-Time	N/A	15,000	-		Hour	I _F = 20mA Note 2
EN Control Level	Backlight On	1.2	-	VDD	V	Note 4
	Backlight Off	0	-	0.6	V	
PWM Control Level	High Level	1.75	-	VDD	V	
	Low Level	0	-	0.625	V	
PWM Control Frequency	F _{PWM}	200	-	2,000	Hz	
Duty Ratio		5	-	100	%	Note 3

- Notes :
1. The current and power consumption with LED Driver are under the VLED = 12.0V , 25°C, PWM Duty 100% .
 2. The LED life-time defines the estimated time to 50% degradation of initial luminous.
 3. Measure condition (Figure 5).
 - 4.LED_EN&PWM setting

Pin No	Define	Enable	Disable
22	LED_EN	Pull High	Pull Low/Floating
23	PWM	Pull High	Pull Low/Floating

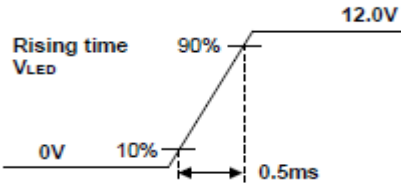


Figure 5. Inrush Measure Condition

3.3 LED Structure

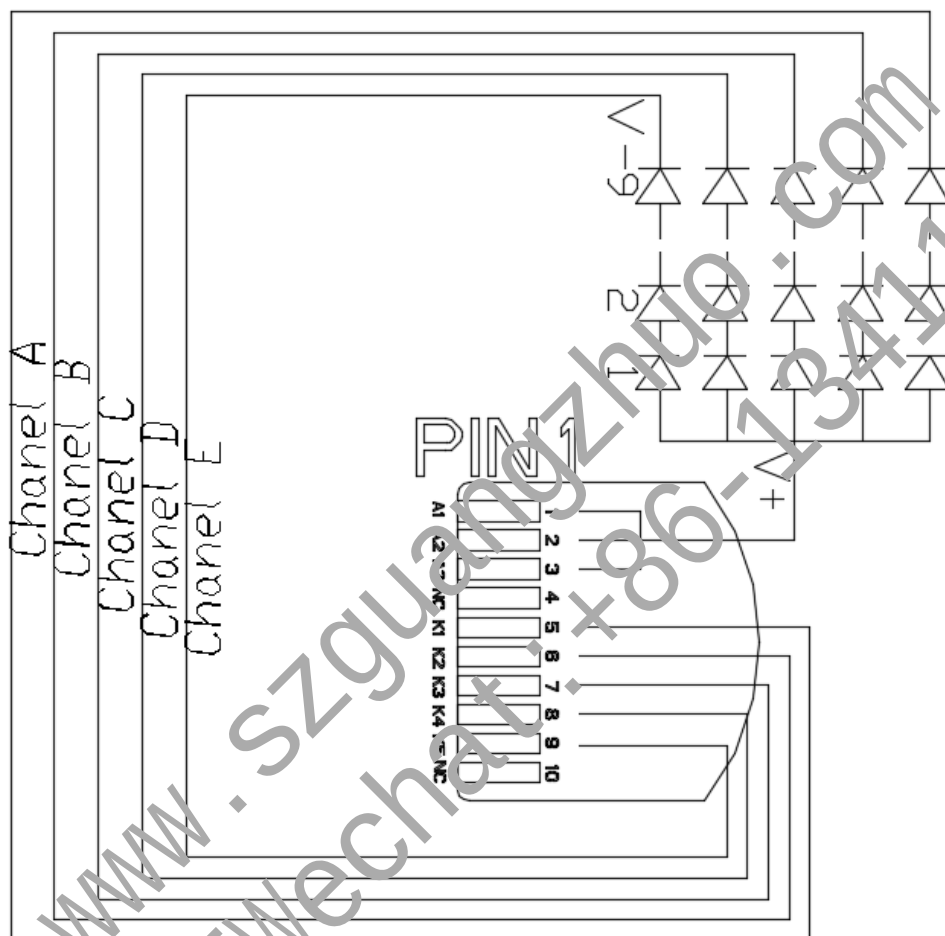


Figure 6. LED Structure

4.0 OPTICAL SPECIFICATION

4.1 Overview

The test of optical specifications shall be measured in a dark room (ambient luminance ≤ 1 lux and temperature = $25 \pm 2^\circ\text{C}$) with the equipment of luminance meter system (PR730&PR810) and test unit shall be located at an approximate distance 50cm from the LCD surface at a viewing angle of θ and ϕ equal to 0° . We refer to $\theta=0$ ($=03$) as the 3 o'clock direction (the "right"), $\theta=90$ ($=012$) as the 12 o'clock direction ("upward"), $\theta=180$ ($=09$) as the 9 o'clock direction ("left") and $\theta=270$ ($=06$) as the 6 o'clock direction ("bottom"). While scanning θ and/or ϕ , the center of the measuring spot on the display surface shall stay fixed. The backlight should be operating for 30 minutes prior to measurement. VDD shall be $3.3 \pm 0.3\text{V}$ at 25°C . Optimum viewing angle direction is 6 o'clock.

4.2 Optical Specifications

<Table 5. Optical Specifications>

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Viewing Angle Range	Horizontal	Θ_3	CR = 10 $\Theta = 0^\circ$ $I_{LED} = 17.4\text{mA}$	80	85	-	Deg.	Note 1
		Θ_9		80	85	-	Deg.	
	Vertical	Θ_{12}		80	85	-	Deg.	
		Θ_6		80	85	-	Deg.	
Luminance Contrast Ratio		CR	$\Theta = 0^\circ$	700	1000	-		Note 2
Luminance of White	5 Points	Y	$\Theta = 0^\circ$ $I_{LED} = 17.4\text{mA}$	212.5	250	-	cd/m ²	Note 3
White Luminance Uniformity	5 Points	ΔY_5		1.25	-	-		Note 4
	13 Points	ΔY_{13}		1.6	-	-		
White Chromaticity		W_x	$\Theta = 0^\circ$	0.283	0.313	0.343		Note 5
		W_y		0.299	0.329	0.359		
Reproduction of Color	Red	R_x	$\Theta = 0^\circ$	Typ.-0.03	0.595	Typ.+0.03		
		R_y			0.362			
	Green	G_x			0.346			
		G_y			0.555			
	Blue	B_x			0.158			
		B_y			0.107			
Color Gamut				35	45	-	%	NTSC
Response Time (Rising + Falling)		T _{RT}	Ta= 25°C $\Theta = 0^\circ$	-	25	30	ms	Note 6
Cross Talk		CT	$\Theta = 0^\circ$	-	-	2.0	%	Note 7

Notes :

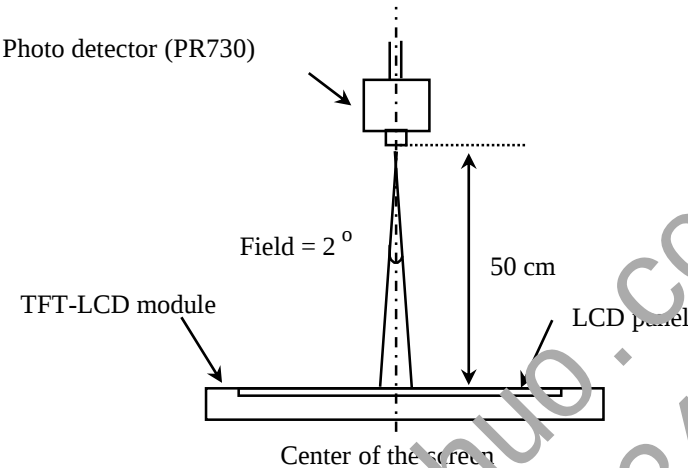
1. Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing angles are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface (see Figure 7).
2. Contrast measurements shall be made at viewing angle of $\Theta = 0$ and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black) state. (see Figure 7) Luminance Contrast Ratio (CR) is defined mathematically.

$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

3. Center Luminance of white is defined as luminance values of 5 point average across the LCD surface. Luminance shall be measured with all pixels in the view field set first to white. This measurement shall be taken at the locations shown in Figure 8 for a total of the measurements per display.
4. The White luminance uniformity on LCD surface is then expressed as : $\Delta Y = \text{Minimum Luminance of 5(or 13) points} / \text{Maximum Luminance of 5(or 13) points}$. (see Figure 8 and Figure 9).
5. The color chromaticity coordinates specified in Table 5 shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.
6. The electro-optical response time measurements shall be made as Figure 10 by switching the "data" input signal ON and OFF. The times needed for the luminance to change from 10% to 90% is T_r , and 90% to 10% is T_f .
7. Cross-Talk of one area of the LCD surface by another shall be measured by comparing the luminance (Y_A) of a 25mm diameter area, with all display pixels set to a gray level, to the luminance (Y_B) of that same area when any adjacent area is driven dark. (See Figure 11).

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4.3 Optical Measurements



Optical characteristics measurement setup

Figure 7. Measurement Set Up

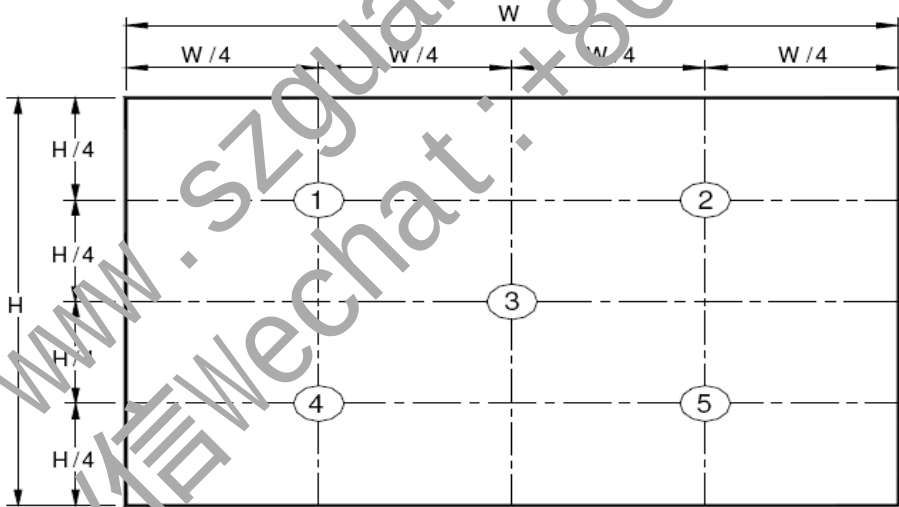


Figure 8. White Luminance and Uniformity Measurement Locations (5 points)

Center Luminance of white is defined as luminance values of center 5 points across the LCD surface. Luminance shall be measured with all pixels in the view field set first to white. This measurement shall be taken at the locations shown in Figure 7 for a total of the measurements per display.

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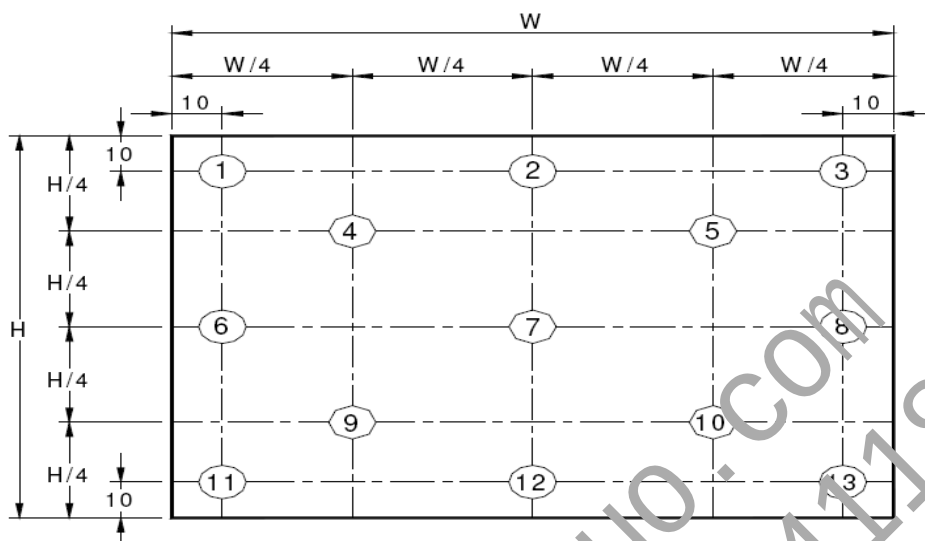


Figure 9. Uniformity Measurement Locations (13 points)

The White luminance uniformity on LCD surface is then expressed as: ΔY_5 = Minimum Luminance of five points / Maximum Luminance of five points (see Figure 8), ΔY_{13} = Minimum Luminance of 13 points / Maximum Luminance of 13 points. (see Figure 9).

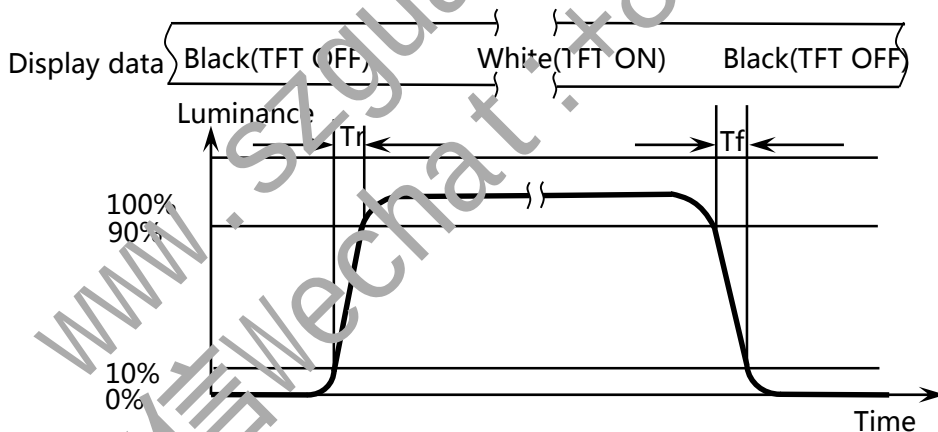
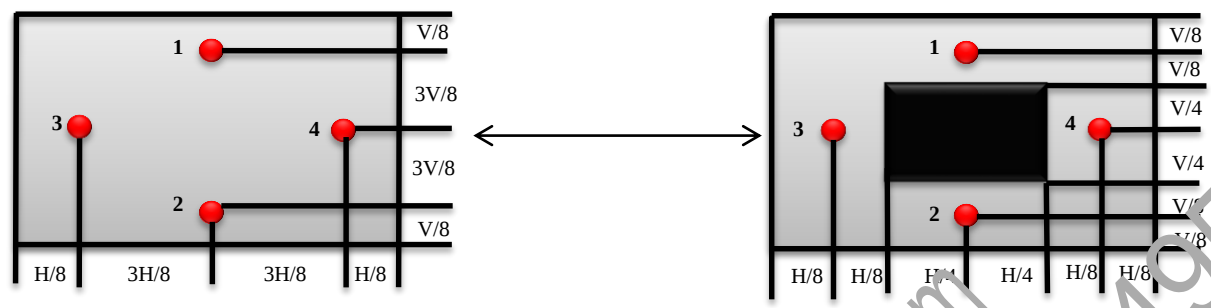


Figure 10. Response Time Testing

The electro-optical response time measurements shall be made as shown in Figure 10 by switching the “data” input signal ON and OFF. Tr: The luminance to change from 10% to 90%, Tf: The luminance to change from 90% to 10%.



$$\text{Cross Talk (\%)} = \left| \frac{Y_B - Y_A}{Y_A} \right| \times 100$$

Figure 11. Cross Talk Modulation Test Description

Where:

- Y_A = Initial luminance of measured area (cd/m²)
- Y_B = Subsequent luminance of measured area (cd/m²)

The location 1/2/3/4 measured will be exactly the same in both patterns. The test background gray is from L64 to L192.Take the largest data as the result.

Cross Talk of one area of the LCD surface by another shall be measured by comparing the luminance (Y_A) of a 25mm diameter area, with all display pixels set to a gray level, to the luminance (Y_B) of that same area when any adjacent area is driven dark.(Refer to Figure 11)

The test system: PR730

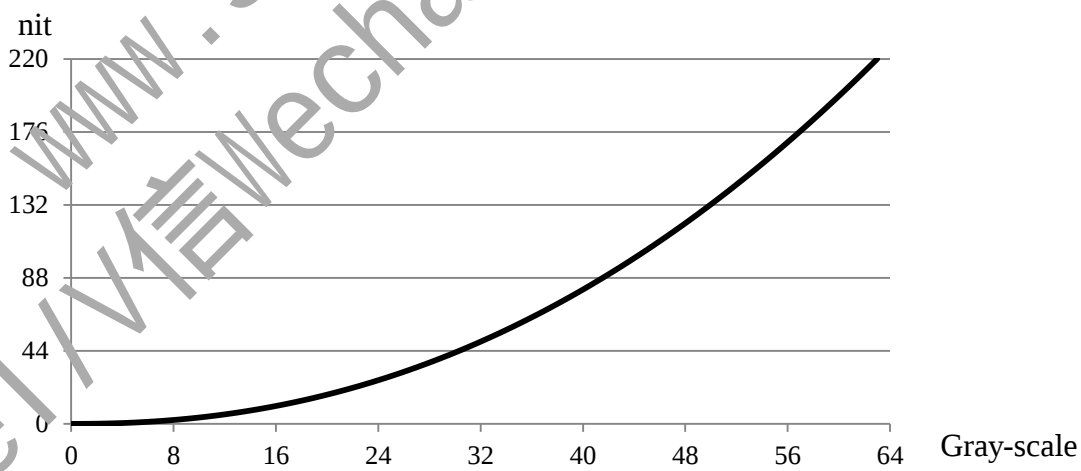


Figure 12. Brightness and Gray-scale Contrast

5.0 INTERFACE CONNECTION

5.1 Electrical Interface Connection

The electronics interface connector is 20455-040E-76 (I-PEX) or Compatible.
The connector interface pin assignments are listed in Table 6.

<Table 6. Pin Assignments for the Interface Connector>

Terminal	Symbol	Function	Remark
PIN No.	Symbol		
1	CABC	CABC Function	
2	H_GND	High Speed Ground	Note1
3	Lane3_N	Complement Signal Link Lane 3	
4	Lane3_P	True Signal Link Lane 3	
5	H_GND	High Speed Ground	
6	Lane2_N	Complement Signal Link Lane 2	
7	Lane2_P	True Signal Link Lane 2	
8	H_GND	High Speed Ground	
9	Lane1_N	Complement Signal Link Lane 1	
10	Lane1_P	True Signal Link Lane 1	
11	H_GND	High Speed Ground	
12	Lane0_N	Complement Signal Link Lane 0	
13	Lane0_P	True Signal Link Lane 0	
14	H_GND	High Speed Ground	
15	AUX_CH_P	True Signal Auxiliary Channel	
16	AUX_CH_N	Complement Signal Auxiliary Channel	
17	H_GND	High Speed Ground	
18	LCD_VCC	LCD logic and driver power(3.3V)	
19	LCD_VCC	LCD logic and driver power(3.3V)	
20	LCD_VCC	LCD logic and driver power(3.3V)	
21	LCD_VCC	LCD logic and driver power(3.3V)	
22	BIST	BIST PIN	
23	LCD_GND	LCD logic and driver ground	
24	LCD_GND	LCD logic and driver ground	
25	LCD_GND	LCD logic and driver ground	
26	LCD_GND	LCD logic and driver ground	
27	HPD	HPD Signal	
28	BL_GND	Backlight ground	
29	BL_GND	Backlight ground	

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30	BL_GND	Backlight ground	
31	BL_GND	Backlight ground	
32	BL_ENABLE	Backlight on/off	
33	BL_PWM_DIM	System PWM	
34	NC	Reserved for LCD for manufacturer's use	Note2
35	NC	Reserved for LCD for manufacturer's use	
36	BL_PWR	Backlight power	
37	BL_PWR	Backlight power	
38	BL_PWR	Backlight power	
39	BL_PWR	Backlight power	
40	NC	NC	

Notes:

1. The shielding case is connected with signal GND.
2. Don't input any signals or any powers into a NC pin. Keep the NC pin open.

5.2 eDP Interface

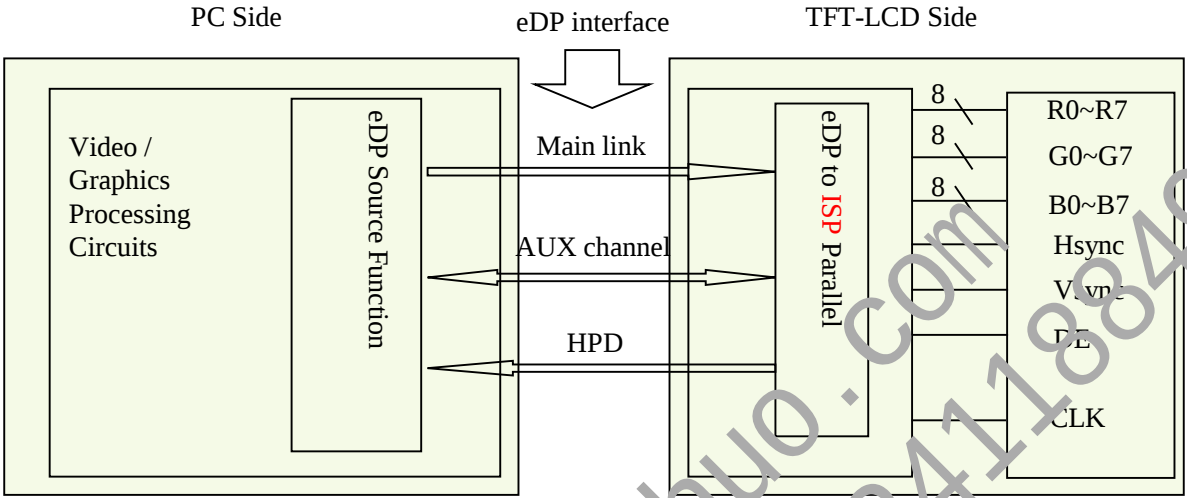


Figure 13. eDP Interface Architecture

5.3 Data Input Format

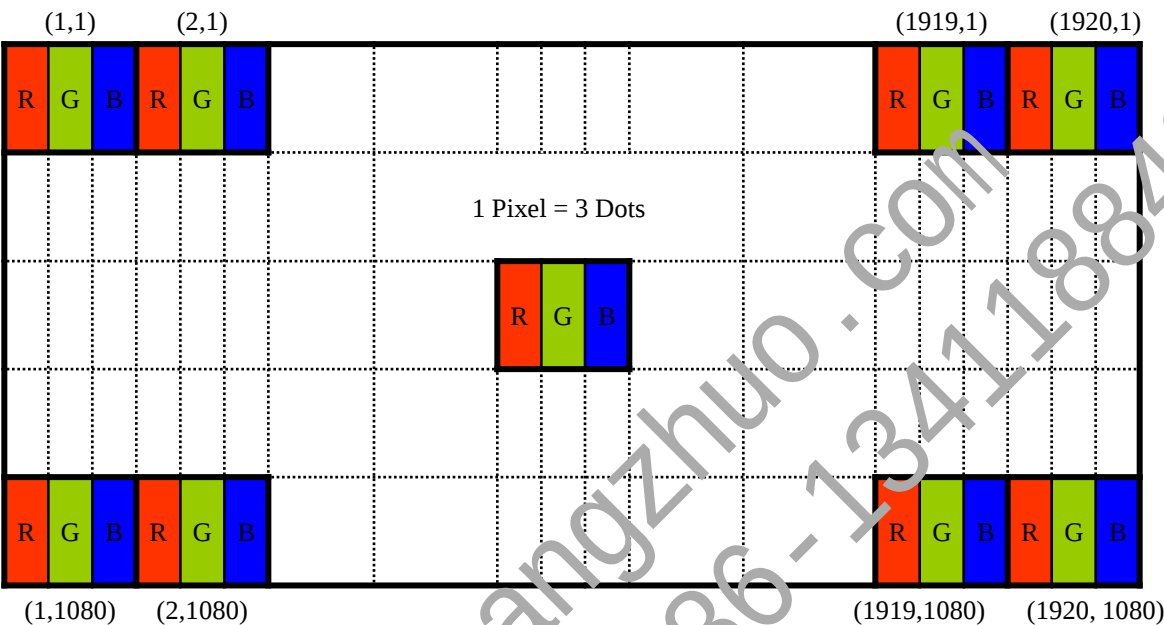


Figure 14 Display Position of Input Data (V-H)

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5.4 Back-light & LCM Interface Connection

BLU Interface Connector: 20542-010E-01 (I-PEX) or Compatible.

<Table 7. Pin Assignments for the BLU Connector>

Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	VLED	LED anode connection	6	LED	LED cathode connection
2	VLED	LED anode connection	7	LED	LED cathode connection
3	VLED	LED anode connection	8	LED	LED cathode connection
4	NC	No Connection	9	LED	LED cathode connection
5	LED	LED cathode connection	10	LED	LED cathode connection

6.0 SIGNAL TIMING SPECIFICATION

6.1 The NE156FHM-NX2 Is Operated By The DE Only

< Table 8. Signal Timing Specification >

Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	167.7	335.47	-	MHz
Frame Period		Tv	1120	1282	3340	lines
			-	120	-	Hz
			-	6.5	-	ms
Vertical Display Period		Tvd	-	1080	-	lines
One line Scanning Period		Th	2140	2180	2300	clocks
Horizontal Display Period		Thd	-	1920	-	clocks

Note : The above is as optimized setting.

6.2 eDP Rx Interface Timing Parameter

The specification of the eDP Rx interface timing parameter is shown in Table 9.

<Table 9. eDP Main-Link RX TP4 Package Pin Parameters>

Item	Symbol	Min	Typ	Max	Unit	Remark
Spread spectrum clock (Link clock down-spreading)	SSC	-	-	0.5	%	
Differential peak-to-peak input voltage at package pins	$V_{RX-DIFFp-p}$	120	-	1200	mV	
Rx input DC common mode voltage	$V_{RX_DC_CM}$	0	-	2	V	
Differential termination resistance	$R_{RX-DIFF}$	-	100	-	Ω	
Single-ended termination resistance	R_{RX-SE}	40	-	60	Ω	
Rx short circuit current limit	I_{RX_SHORT}	-	-	50	mA	
Intra-pair skew at Rx package pins (HBR) RX intra-pair skew tolerance at HBR	$L_{RX_SKEW_INTRA_PAIR}$	-	-	50	ps	
AC Coupling Capacitor	C_{SOURCE_ML}	75		200	nF	Source side

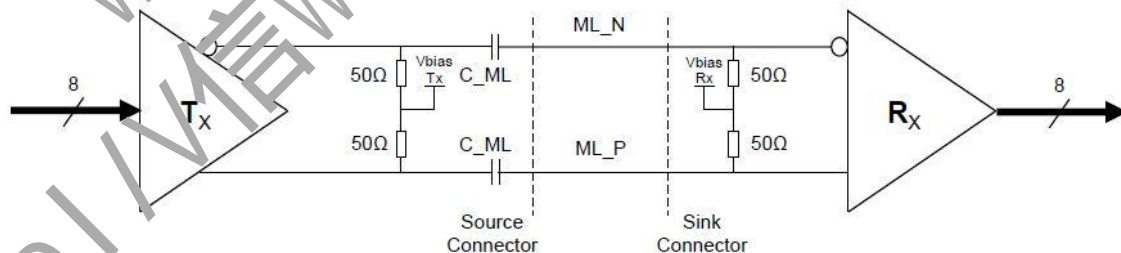


Figure 15. Main link differential pair

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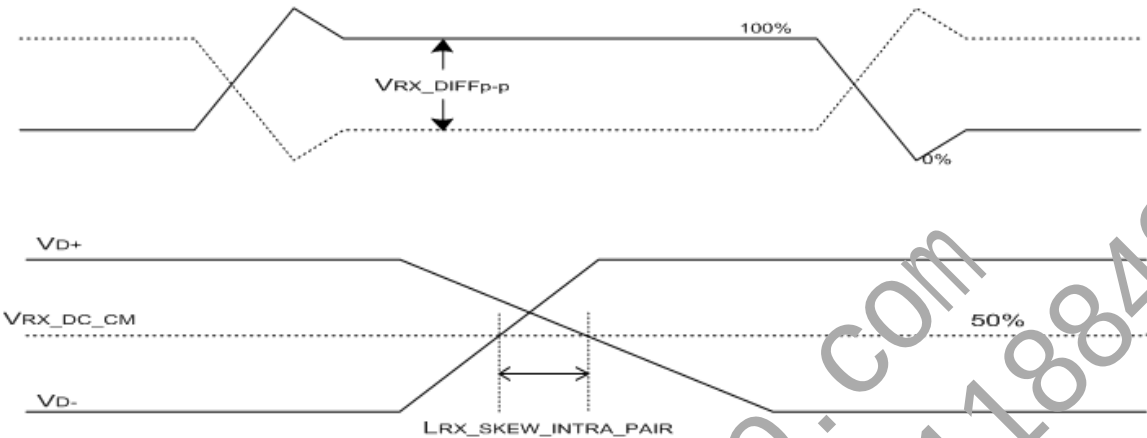


Figure 16. VRX-DIFFp-p & LRX_SKEW_INTRA_PAIR

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<Table 10. HPD Characteristics>

Item	Symbol	Min	Typ	Max	Unit	Remark
HPD voltage	V _{HPD}	2.25	-	3.6	V	Sink side
Hot Plug Detection Threshold	-	2.0	-	-	V	Source side
Hot Unplug Detection Threshold	-	-	-	0.8V	V	
HPD_IRQ Pulse Width	HPD_IRQ	0.5	-	1	ms	
HPD_TimeOut	-	2.0	-	-	ms	

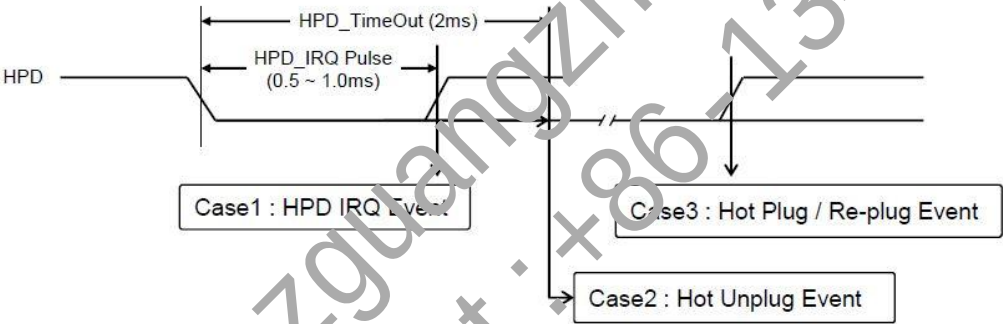


Figure 17. HPD Events

<Table 11. AUX Characteristics>

Item	Symbol	Min	Typ	Max	Unit	Remark
AUX unit interval	U _{IAUX}	0.4	0.5	0.6	Us	
AUX peak-to-peak input differential voltage	V _{AUX-RX-DIFFp-p}	0.29	-	1.38	V	Sink Side Connector Pin
AUX CH termination DC resistance	R _{AUX-TERM}	80	100	120	Ohm	
AUX DC common mode voltage	V _{AUX-DC-CM}	0	-	2	V	
AUX turn around common mode voltage	V _{AUX-TURN-CM}			3.3	V	
AUX short circuit current limit	I _{AUX-SHORT}	-	-	90	mA	
AUX AC Coupling Capacitor	C _{SOURCE-AUX}	75		200	nF	Source side

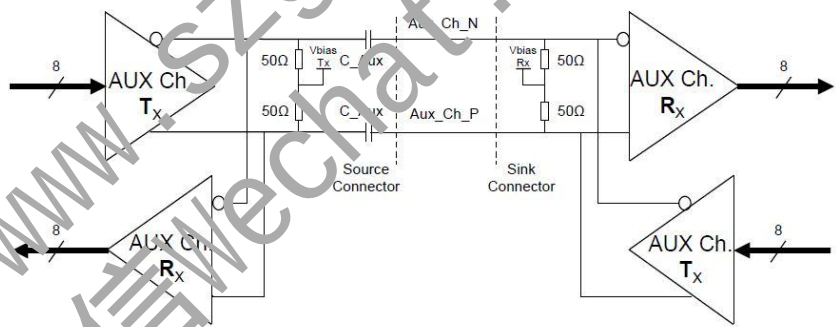


Figure 18. AUX differential pair

7.0 INPUT SIGNALS, BASIC DISPLAY COLORS & GRAY SCALE OF COLORS

<Table 12. Input Signal & Basic Display Colors & Gray Scale of Colors >

	Colors & Gray scale	Data signal																							
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Light Blue	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Purple	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Gray scale of Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△																								
	▽																								
	Brighter	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	▽	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gray scale of Green	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△																								
	▽																								
	Brighter	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	▽	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Gray scale of Blue	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	△																								
	▽																								
	Brighter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1
	▽	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Gray scale of White & Black	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	Darker	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	△																								
	▽																								
	Brighter	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1
	▽	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

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8.0 POWER SEQUENCE

To prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown in below.

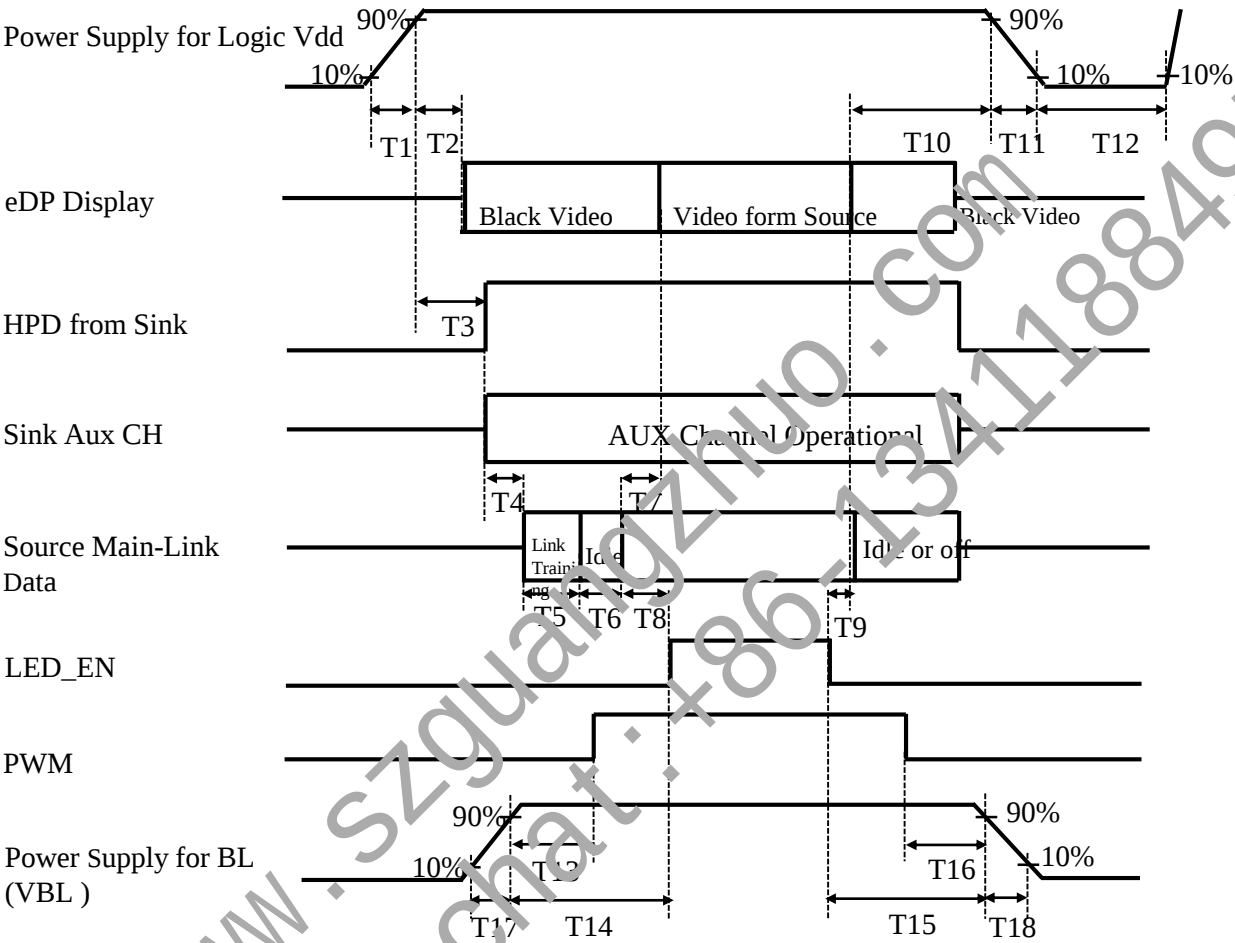


Figure 19. Power Sequence

- 0.5ms ≤ T1 ≤ 10 ms
 - 0ms ≤ T2 ≤ 200 ms
 - 0ms ≤ T3 ≤ 200 ms
 - 0ms ≤ T13
 - 0.5ms ≤ T14 ≤ 10 ms
 - 0ms ≤ T17
- 0ms ≤ T7 ≤ 50ms
 - 0ms ≤ T10 ≤ 500 ms
 - 1ms ≤ T11 ≤ 10 ms
 - 500ms ≤ T12
 - 100ms ≤ T15
 - 0ms ≤ T16

Notes:

1. When the power supply VDD is 0V, keep the level of input signals on the low or keep high impedance.
2. Do not keep the interface signal high impedance when power is on. Back Light must be turn on after power for logic and interface signal are valid.

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9.0 Connector Description

Physical interface is described as for the connector on LCM.

These connectors are capable of accommodating the following signals and will be following component.

9.1 TFT LCD Module

< Table 13. Signal Connector >

Connector Name /Description	For Signal Connector
Manufacturer	STM or Compatible
Type/ Part Number	I-PEX 20453-040E-76 or Compatible
Mating Housing/ Part Number	I-PEX 20453-040T or Compatible

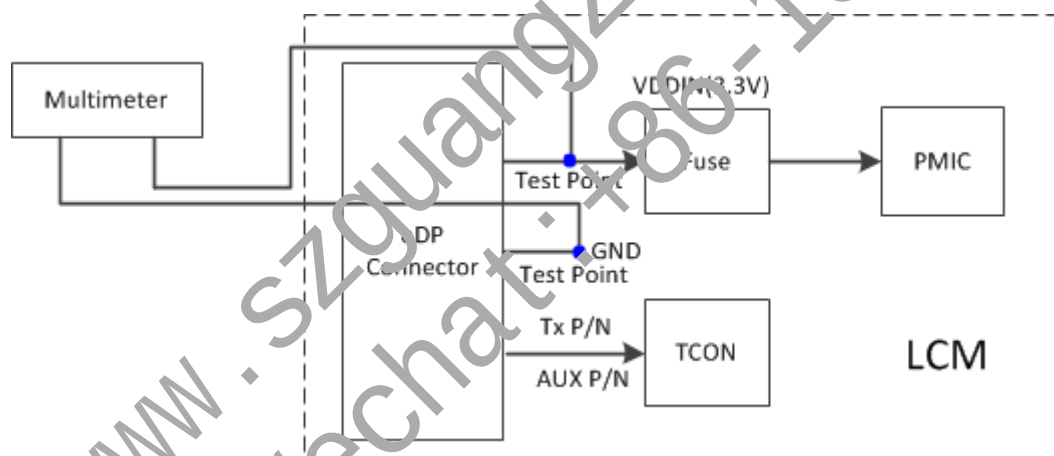
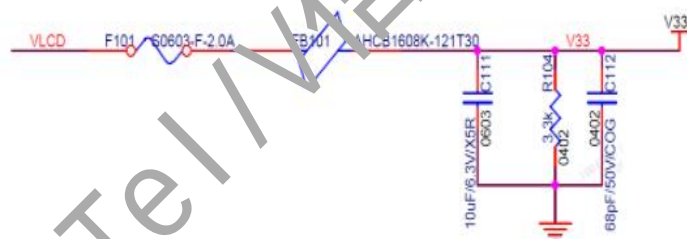


Figure 20. RC Loading Test Schematic Diagram



Item	RC Loading	
0D2W2X	R	C
	TBD	TBD

Figure 21. VCC Loop R/C Loading Parameter

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10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

Figure 26 shows mechanical outlines for the model NE156FHM-NX2.
Other parameters are shown in Table 14.

<Table 14. Dimensional Parameters>

Parameter	Specification	Unit
Active Area	344.16 (H) × 193.59(V)	mm
Number of pixels	1920 (H) X 1080 (V) (1 pixel = R + G + B dots)	pixels
Pixel pitch	179.25(H) X 179.25(v)	um
Pixel arrangement	RGB Vertical stripe	
Display colors	16.7M(6bit+FRC)	
Display mode	Normally Black	
Dimensional outline	350.66(H) × 216.245(V) (W/PCB) × 3.2(Max.) 350.66 (H) × 205.24(V)(W/O PCB) × 3.2 (Max.)	mm
Weight	360 (Max.)	g

10.2 Mounting

See Figure 26.

10.3 Anti-Glare and Polarizer Haldress.

The surface of the LCD has an Glare coating to minimize reflection and a coating to reduce scratching.

10.4 Light Leakage

There shall not be visible light from the back-lighting system around the edges of the screen as seen from a distance 50cm from the screen with an overhead light level of 350lux.

11.0 RELIABILITY TEST

The reliability test items and its conditions are shown in below.

<Table 15. Reliability Test>

No	Test Items	Conditions	Remark
1	High temperature storage test	Ta = 60°C , 240 hrs	
2	Low temperature storage test	Ta = -20°C , 240 hrs	
3	High temperature & high humidity operation test	Ta = 40°C , 95%RH, 240 hrs	
4	High temperature operation test	Ta = 50°C , 240 hrs	
5	Low temperature operation test	Ta = 0°C , 240 hrs	
6	Vibration test (non-operating)	Frequency:5~50Hz/ Vibration width : 1.54mm :22~500Hz/ Acceleration: 12.25m/s2 Sweep time:3minutes Test period:15 minutes for the direction of X 15 minutes for the direction of Y 1 hour for the direction of Z (Total 1.5 hours)	
7	Shock test (non-operating)	Max acceleration: 686m/s2,Pulse width:11ms Max acceleration: 2352 m/s2,Pulse width:2ms Half sine wave direction: ± X, ± Y, ± Z Once for each direction	
8	Electro-static discharge test (operating)	150pF[330Ω] Panel center, Around the module: One time f or each position <Contact: non-operation> ± 10KV <Contact: operation> ± 8KV <Air : non-operation> ± 20KV <Air : operation> ± 15KV	

Notes :

[Result Evaluation Criteria] Under the display quality test condition with normal operation state.

Do not change these condition as such changes may affect practical display function.

[Normal operation state] temperature : + 15°C~ + 35°C, Humidity : 45~75%,

Atmospheric pressure : 86~106kPa

12.0 HANDLING & CAUTIONS

- (1) Cautions when taking out the module
 - Pick the pouch only, when taking out module from a shipping package.
- (2) Cautions for handling the module
 - As the electrostatic discharges may break the LCD module, handle the LCD module with care. Peel a protection sheet off from the LCD panel surface as slowly as possible.
 - As the LCD panel and back - light element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.
 - As the surface of the polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.
 - Do not pull the interface connector in or out while the LCD module is operating.
 - Put the module display side down on a flat horizontal plane.
 - Handle connectors and cables with care.
- (3) Cautions for the operation
 - When the module is operating, do not lose CLK, ENAB signals. If any one of these signals is lost, the LCD panel would be damaged.
 - Obey the supply voltage sequence. If wrong sequence is applied, the module would be damaged.
- (4) Cautions for the atmosphere
 - Dew drop atmosphere should be avoided.
 - Do not store and/or operate the LCD module in a high temperature and/or humidity atmosphere. Storage in an electro-conductive polymer packing pouch and under relatively low temperature atmosphere is recommended.
- (5) Cautions for the module characteristic
 - Do not apply fixed pattern data signal to the LCD module at product aging.
 - Applying fixed pattern for a long time may cause image sticking.
- (6) Other cautions
 - Do not disassemble and/or re-assemble LCD module.
 - Do not re-adjust variable resistor or switch etc.
 - When returning the module for repair or etc. Please pack the module not to be broken. We recommend to use the original shipping packages.

13.0 LABEL

(1) Product Label

- ① .Dell PPID NO. (2D barcode)

② FG-CODE

③ DELL DP/N NO.

④ Dell PPID NO.

⑤ Module ID

⑥ Module ID barcode
- Total Size:48×12mm



Figure 22. Product Label

Module ID Naming Rule:

Digit Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Code	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Description	Product Name		Product Grade	Facility Code	Year		Month	Model Extension Code (Last 4 Digits FG Code)				Serial NO.					

<Table 16. Module ID Naming Rule>

(2) Box label

- ① FG-CODE(Before 12bit)
- ② Product Quantity (XX Pcs/Carton)
- ③ BOX ID
- ④ Date of Packing
- ⑤ BOX ID Barcode
- ⑥ DELL DP/N
- ⑦ FG-code After four
- ⑧ MFG ID

Total Size:100×50mm

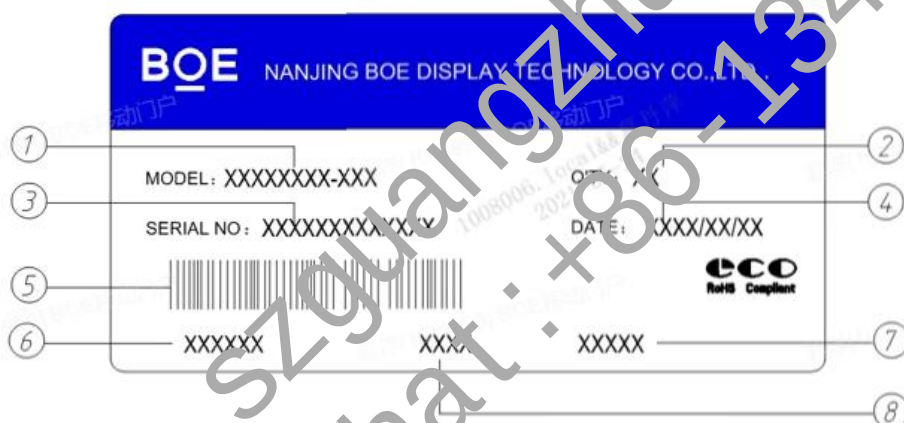


Figure 23. Box Label

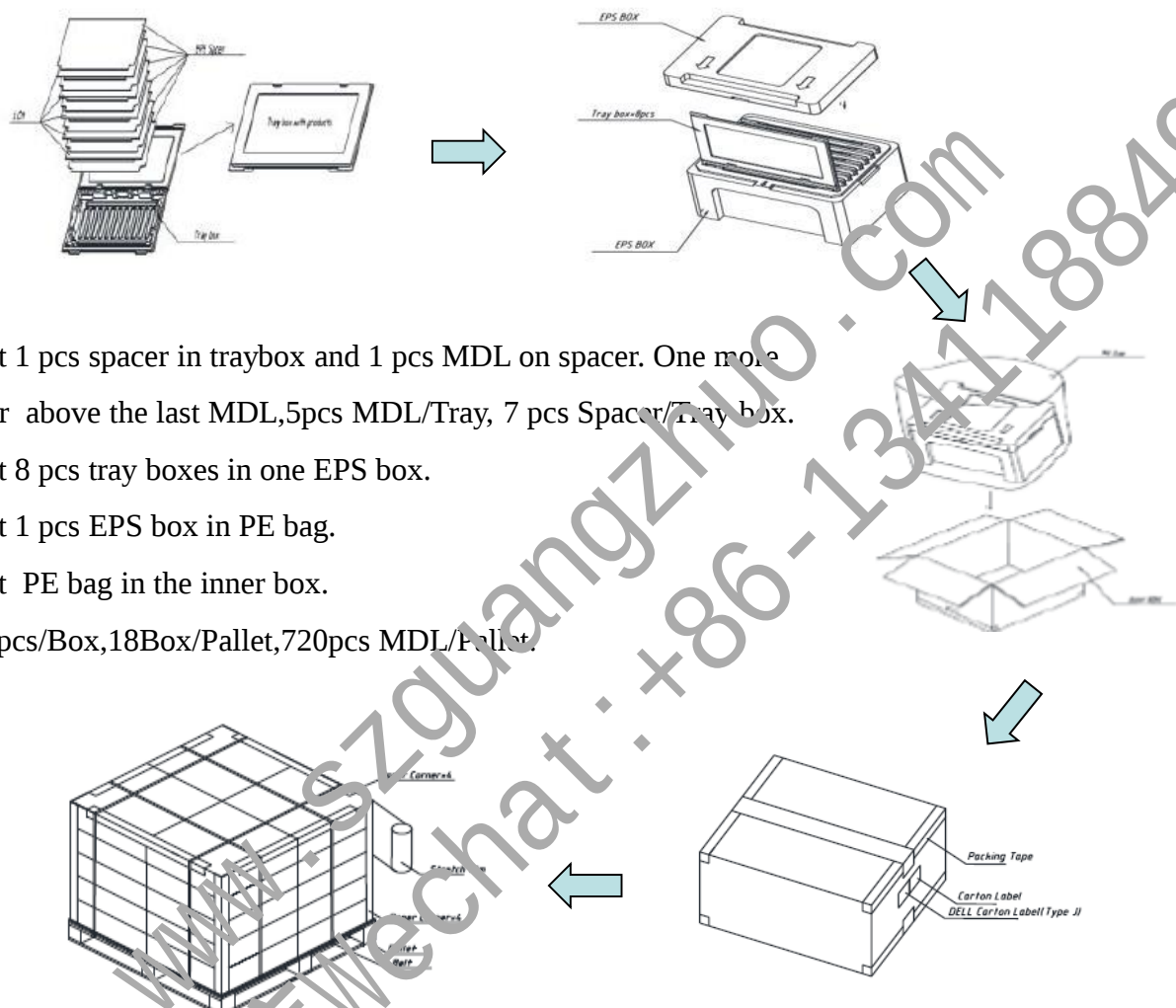
BOX ID Naming Rule:

Digit	1	2	3	4	5	6	7	8	9	10	11	12	13
Code	X	X	X	X	X	X	X	X	X	X	X	X	X
Description	Product Name		Product Grade	Facility Code	Year		Month	Revision	Box Serial NO.				

<Table 17. Box Label Naming Rule >

14.0 PACKING INFORMATION

14.1 Packing Order



- Put 1 pcs spacer in traybox and 1 pcs MDL on spacer. One more spacer above the last MDL, 5 pcs MDL/Tray, 7 pcs Spacer/Tray box.
- Put 8 pcs tray boxes in one EPS box.
- Put 1 pcs EPS box in PE bag.
- Put PE bag in the inner box.
- 40 pcs/Box, 18 Box/Pallet, 720 pcs MDL/Pallet.

Figure 25. Packing Order

14.2 Note

- Box dimension: 520mm*415mm*29.6mm
- Package quantity in one box: 40 pcs
- Total weight: 18.75kg $\pm$ 10% /Box

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15.0 MECHANICAL OUTLINE DIMENSION

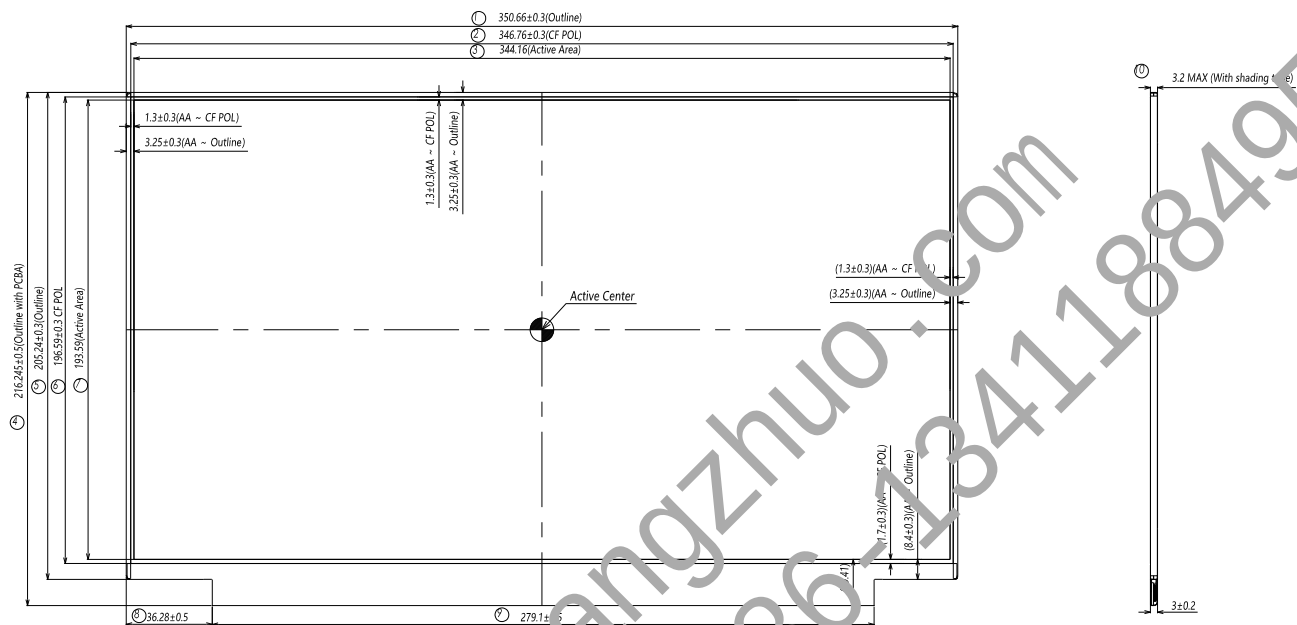


Figure 26. TFT-LCD Module Outline Dimension (Front View)

NOTES:

- 1.LCD HIGHEST PORTION IS TOP POLARIZER AND OTHER LCM MATERIALS IS LOWER THAN TOP POLARIZER
- 2.WARPS AND DEFORMATIONS ARE 0.5 mm MAX
3. "(O)" MEANS REFERENCE DIMENSIONS

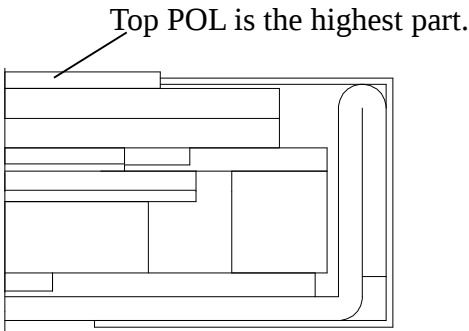


Figure 27. Highest Point Position

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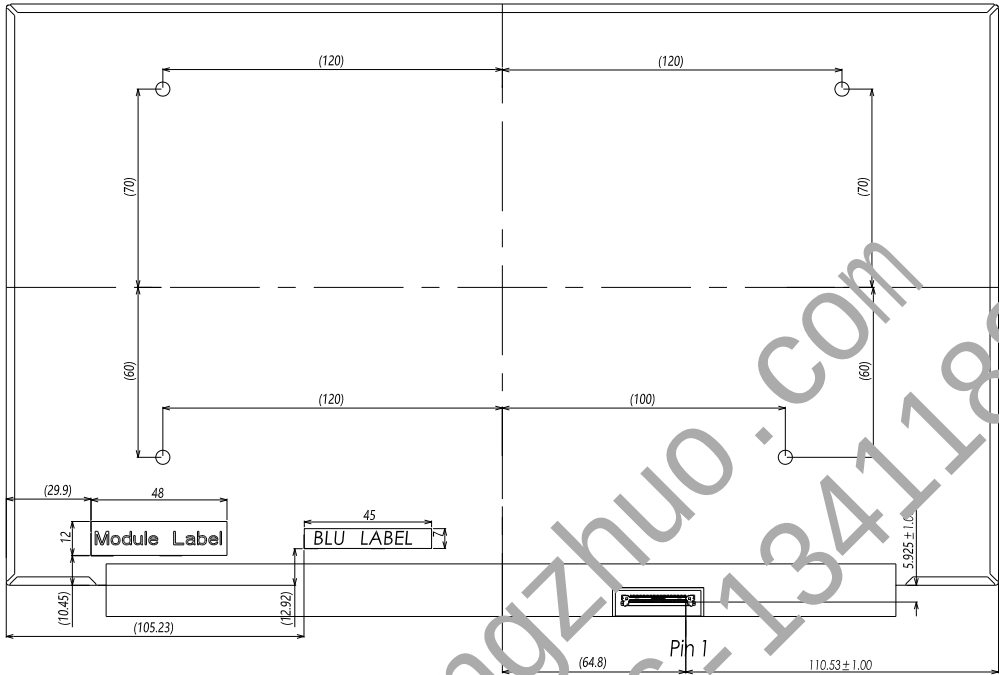


Figure 28. TFT-LCD Module Outline Dimensions (Rear view)

NOTES:

- 1.LCD HIGHEST PORTION IS TOP POLARIZER AND OTHER LCM MATERIALS IS LOWER THAN TOP POLARIZER
- 2.WARPS AND DEFORMATIONS ARE 0.5 mm MAX
- 3. "()" MEANS REFERENCE DIMENSIONS

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16.0 EDID Table

Address (HEX)	Function	Hex	Dec	crc	Input values.	Notes
00	Header	00	0		0	EDID Header
01		FF	255		255	
02		FF	255		255	
03		FF	255		255	
04		FF	255		255	
05		FF	255		255	
06		FF	255		255	
07		00	0		0	
08	ID Manufacturer Name	38	56		NCP	ID = NCP
09		70	112			
0A	ID Product Code	5F	95		95	ID = 95
0B		00	0			
0C	32-bit serial No.	00	0		0	
0D		00	0		0	
0E		00	0		0	
0F		00	0		0	
10		00	0		0	
10	Week of manufacture	37	55		55	
11	Year of Manufacture	1F	31		2021	Manufactured in 2021
12	EDID Structure Ver.	01	1		1	EDID Ver 1.0
13	EDID revision #	04	4		4	Dis. Rev. 0.4
14	Video input definition	A5	165		-	Refer to right table
15	Max H image size	22	34		34	34 cm (Approx)
16	Max V image size	13	19		19	19 cm (Approx)
17	Display Gamma	78	120		1.2	Gamma curve = 2.2
18	Feature support	03	3		-	
19	Red/Green low bits	68	104		-	Red / Green Low Bits
1A	Blue/White low bits	50	80		-	Blue / White Low Bits
1B	Red x high bits	98	152	609	0.595	Red (x) = 10011000 (0.595)
1C	Red y high bits	5C	92	370	0.362	Red (y) = 01011100 (0.362)
1D	Green x high bits	58	88	368	0.346	Green (x) = 01011000 (0.346)
1E	Green y high bits	8E	142	568	0.555	Green (y) = 10001110 (0.555)
1F	Blue x high bits	28	40	161	0.158	Blue (x) = 00101000 (0.158)
20	Blue y high bits	1B	27	101	0.107	Blue (y) = 00011011 (0.107)
21	White x high bits	50	80	160	0.113	White (x) = 01010000 (0.313)
22	White y high bits	54	84	336	0.329	White (y) = 01010100 (0.329)
23	Established timing 1	00	0		-	
24	Established timing 2	00	0		-	
25	Established timing 3	00	0		-	
26	Standard timing #1	01	1			Not Used
27		01	1			
28		01	1			
29	Standard timing #2	01	1			Not Used
2A		01	1			
2B		01	1			
2C	Standard timing #4	01	1			Not Used
2D		01	1			
2E		01	1			
2F	Standard timing #5	01	1			Not Used
30		01	1			
31		01	1			
32	Standard timing #7	01	1			Not Used
33		01	1			
34		01	1			
35	Standard timing #8	01	1			Not Used
36		01	1			
37		01	1			
37	Detailed timing/monitor descriptor #1	33	131		335.5	335.47MHz Main clock
38		80	128		1920	Hor Active = 1920
39		4	4		260	Hor Blanking = 260
3A		71	113		-	4 bits of Hor. Active + 4 bits of Hor. Blanking
3B		38	56		1080	Ver Active = 1080
3C		CA	202		202	Ver Blanking = 202
3D		40	64		-	4 bits of Ver. Active + 4 bits of Ver. Blanking
3E		30	48		48	Hor Sync Offset = 48
3F		20	32		32	H Sync Pulse Width = 32
40		35	53		3	V sync Offset = 3 line
41		00	0		5	V Sync Pulse width : 5 line
42		58	88		344	Horizontal Image Size = 344 mm (Low 8 bits)
43		C2	194		194	Vertical Image Size = 194 mm (Low 8 bits)
44		10	16		-	4 bits of Hor Image Size + 4 bits of Ver Image Size
45		00	0		0	Hor Border (pixels)
46		00	0		0	Vertical Border (Lines)
47		1A	26		-	Refer to right table

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48	Detailed timing/monitor descriptor #2	00	0			Indicates descriptor #3 is a display Descriptor
49		00	0			
4A		00	0			Reserved
4B		FD	253			Tag : ASCII String
4C		00	0			Reserved
4D		30	48		48	
4E		78	120		120	
4F		9A	154		154	
50		9A	154		154	
51		22	34		34	
52	Detailed timing/monitor descriptor #3	01	1		1	
53		0A	10		10	
54		20	32			
55		20	32			
56		20	32			
57		20	32			
58		20	32			
59		20	32			
5A		00	0			
5B		00	0			
5C	Detailed timing/monitor descriptor #4	00	0			ASCII Data Sting Tag
5D		FE	254			
5E		00	0			
5F		44	68		D	
60		32	50		2	
61		57	87		W	Dell P/N:D2W2X
62		32	50		2	
63		58	88		X	
64		80	128		1000000	EDID Revision:A00
65		4E	78		N	
66	Detailed timing/monitor descriptor #5	45	69		E	
67		31	49		1	
68		35	53		5	BOE PN
69		32	54		6	
6A		46	70		F	
6B		48	72		H	
6C		00	0			
6D		00	0			Flag
6E		00	0			
6F		00	0			Data Type Tag: Manufacturer Specified Data 00
70	Detailed timing/monitor descriptor #6	00	0			Flag
71		01	1		-	6-bit Color Depth & FRC
72		41	65		-	WLED & singal light bar & one light bar
73		21	33		-	Frame rate 40Hz~65Hz
74		96	150		-	Light Controller:PWM & Max. Luminance220
75		00	0		-	Front Surface:Ture Life & RGB v-stripe
76		10	16		-	with DBC
77		00	0		-	no Motion Blur & no Active Gamma
78		00	0		-	no Wireless Enhancement & no In-Cell Scanner
79		0A	10		-	2 Lane edp
7A	Extension flag	01	1		-	Built-In Self Test
7B		0A	10			Format :
7C		20	32			terminate with ASCII code 0Ah
7D		20	32			and pad field with ASCII code 20h
7E	Checksum	01	1		2	0 : 1个EDID; N-1: N个EDID
7F	Checksum	81	129	129	-	

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80	Header	70				
81		13				
82		79				
83		00				
84		00				
85		03				
86		01				
87		14				
88	ID Manufacturer Name	81				
89		41				
8A	ID Product Code	00				
8B		04				
8C	32-bit serial No.	7F				
8D		07				
8E		03				
8F		01				
90	Week of manufacture	2F				
91	Year of Manufacture	00				
92	EDID Structure Ver.	1F				
93	EDID revision #	00				
94	Video input definition	37				
95	Max H image size	04				
96	Max V image size	C9				
97	Display Gamma	00				
98	Feature support	02				
99	Red/Green low bits	00				
9A	Blue/White low bits	04				
9B	Red x high bits	00				
9C	Red y high bits	00				
9D	Green x high bits	00				
9E	Green y high bits	00				
9F	Blue x high bits	00				
A0	Blue y high bits	00				
A1	White x high bits	00				
A2	White y high bits	00				
A3	Established timing 1	00				
A4	Established timing 2	00				
A5	Established timing 3	00				
A6	Standard timing #1	00				
A7		00				
A8	Standard timing #2	00				
A9		00				
AA	Standard timing #3	00				
AB		00				
AC	Standard timing #4	00				
AD		00				
AE	Standard timing #5	00				
AF		00				
B0	Standard timing #6	00				
B1		00				
B2	Standard timing #7	00				
B3		00				
B4	Standard timing #8	00				
B5		00				
B6	Detailed timing/monitor descriptor #1	00				
B7		00				
B8		00				
B9		00				
BA		00				
BB		00				
BC		00				
BD		00				
BE		00				
BF		00				
C0		00				
C1		00				
C2		00				
C3		00				
C4		00				
C5		00				
C6		00				
C7		00				

17.0 GENERAL PRECAUTIONS

17.1 HANDLING

(1) When the module is assembled, It should be attached to the system firmly using every mounting holes.

Be careful not to twist or bend the modules.

(2) Refrain from strong mechanical shock or any force to the module. Otherwise, it may cause improper operation or damage to the module.

(3) Note that polarizers are very fragile and could be easily damaged. Do not press or scratch the surface harder than 1 HB pencil lead.

(4) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.

(5) If the surface of the polarizer is dirty, clean it using some absorbent cotton or soft cloth.

(6) The desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Do not use ketone type materials(ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might permanently damage to the polarizer due to chemical reaction.

(7) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, legs or clothes, it must be washed away thoroughly with soap.

(8) Protect the module from static, it may cause damage to the module.

(9) Use fingerstalls with soft gloves to keep display clean during the incoming inspection and assembly process.

(10) Do not disassemble the module.

(11) Do not pull or fold the LED FPC.

(12) Do not touch any component which is located on the back side.

(13) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.

(14) Pins of connector shall not be touched directly with bare hands.

17.2 STORAGE

(1) Do not leave the module in high temperature, and high humidity for a long time. It is highly recommended to store the module with temperature from 0 to 35°C and relative humidity of less than 70%.

(2) Do not store the TFT-LCD module in direct sunlight.

(3) The module shall be stored in a dark place. It is prohibited to apply sunlight or fluorescent light during the store.

17.3 OPERATION

- (1) Do not connect, disconnect the module in the “ Power On” condition.
- (2) Power supply should always be turned on/off by following item 8.0 “ Power on/off sequence “.
- (3) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.
- (4) The standard limited warranty is only applicable when the module is used for general notebook applications. If used for purposes other than as specified, BOE is not to be held reliable for the defective operations. It is strongly recommended to contact BOE to find out fitness for a particular purpose.

17.4 OTHERS

- (1) Avoid condensation of water. It may result in improper operation or disconnection of electrode.
- (2) Do not exceed the absolute maximum rating value. (the supply voltage variation, input voltage variation, Variation in part contents and environmental temperature, etc.) Otherwise the module may be damaged.
- (3) If the module displays the same pattern continuously for a long period of time, it can be the situation when The “ image sticks” to the screen.
- (4) This module has its circuitry PCB’s on the rear or bottom side and should be handled carefully to avoid being stressed.