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TITLE : NV156FHM-N4M

Preliminary Product Specification

Rev. 0

(DELL DPN : RC0D9)

BOE Optoelectronics Technology Co., Ltd

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S8-64-8C-090	TFT-LCD	0	2019.02.13	1 OF 34

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A4(210 X 297)

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(√)Preliminary Specification
()Final Specification

Revision No.	Page	Description of Changes	Date	Prepared
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P1	26,30-34	Ver.X10→Ver.X11	2018.11.26	Li Lu
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1.0 GENERAL DESCRIPTION

1.1 Introduction

NV156FHM-N4M is a color active matrix TFT LCD module using amorphous silicon TFT's (Thin Film Transistors) as an active switching devices. This module has a 15.6 inch 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 6bit+2FRC colors and color gamut 72%. 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.

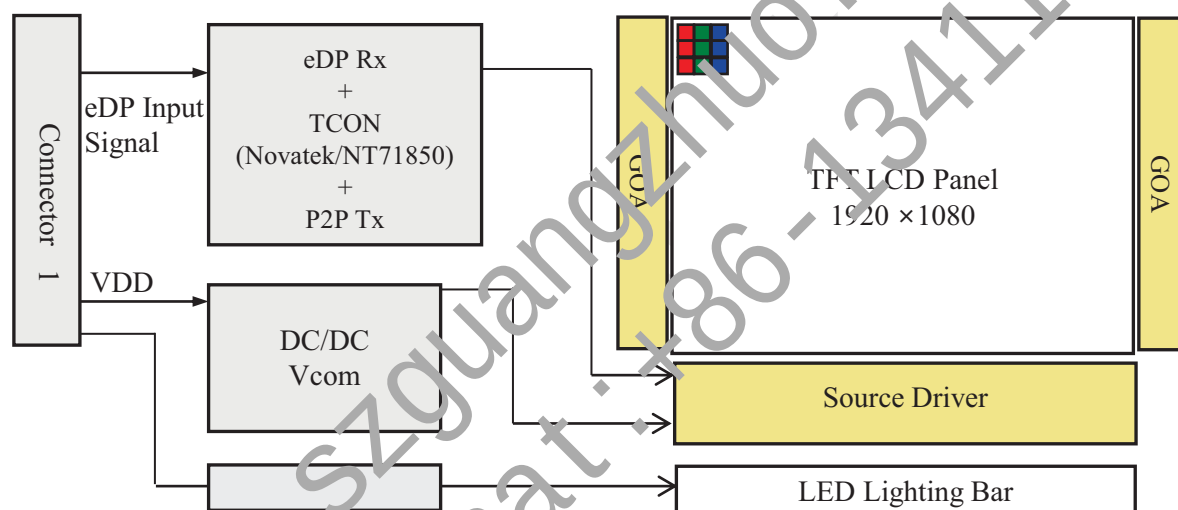


Figure 1. Drive Architecture

1.2 Features

- 2 lane eDP interface with 2.7Gbps link rates
- Thin and light weight
- 6bit+2FRC color depth, color gamut 72%
- Single LED lighting bar (Bottom side/Horizontal Direction)
- Green product (RoHS & Halogen free product)
- On board LED driving circuit
- Low driving voltage and low power consumption
- On board ELID chip

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1.3 Application

- Notebook PC (Wide type)

1.4 General Specification

The followings are general specifications at the model NV156FHM-N4M. (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)	um	
Pixel arrangement	RGB Vertical stripe		
Display colors	6bit+2FRC		
Color gamut	72%		
Display mode	Normally Black		
Dimensional outline	350.66±0.3(H)×205.69±0.3(V)×1.6 Max for FP C(V)×3.15(Max) 350.66±0.3(H)×205.69±0.3(V)×1.6 Max for FP C(V)×5.4(Max)(with PCB)	mm	
Weight	380 (max)	g	
Surface treatment	AG		
Surface hardness	2H		
Back-light	Bottom edge side, 1-LED lighting bar type		Note 1
Power consumption	P _D : 0.9	W	@Mosaic
	P _{BL} : 4.2	W	@Max
	P _{Total} : 5.1	W	@Mosaic

Notes : 1. LED Lighting Bar (50*LED Array)

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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
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.

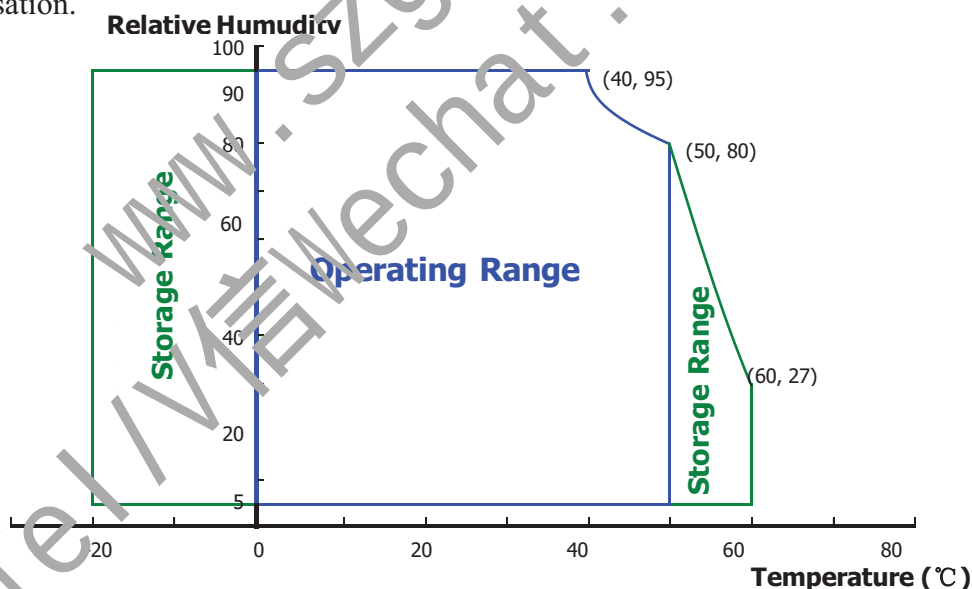


Figure 2. Temperature and Relative Humidity Range

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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%*V _{DD}	-	10%*V _{DD}	V	Note 4
CABC Control Level	High Level	2	2.5	3.6	V	
	Low Level	0	-	0.8	V	
BIST Control Level	High Level	2	2.5	3.6	V	
	Low Level	0	-	0.8	V	
Power Supply Current	I _{DD}	-	273	485	mA	Note 1
Power Supply Inrush Current	I _{inrush}	-	-	2.0	A	Note 3
Power Consumption	P _D	-	0.9	1.6	W	Note 1
	P _{BL}	-	-	4.2	W	Note 2
	P _{total}	-	5.1	5.8	W	Note 1

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.

a) Typ : Mosaic pattern 8*8

b) Max : R/G/B pattern



Figure 3. Power Measure Patterns

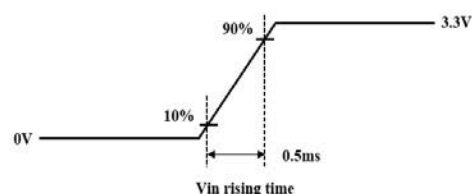


Figure 4. Inrush Measure Condition

2. Calculated value for reference (V_{LED} × I_{LED})

3. Measure condition (Figure 4)

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

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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	-	23	-	mA
LED Power Consumption		P _{LED}	-	-	4.2	W
LED Life-Time		N/A	15,000	-	-	Hour
Power Supply Voltage for LED Driver		V _{LED}	5	12	21	V
Power Supply Voltage for LED Driver Inrush		I _{led inrush}	-	-	2	A
EN Control Level	Backlight On		2.0	-	3.6	V
	Backlight Off		0	-	0.6	V
PWM Control Level	High Level		2.0	-	3.6	V
	Low Level		0	-	0.6	V
PWM Control Frequency		F _{PWM}	200	-	2,000	Hz
Duty Ratio			5	-	100	%

Notes :

1. Power supply voltage 2V for LED driver.

Calculator value for reference $I_F \times V_F \times 50 / \text{driver efficiency} = P_{LED}$

2. The LED life-time define as the estimated time to 50% degradation of initial luminous.

3. Measure condition (Figure 5)

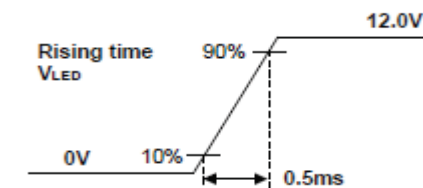


Figure 5. Inrush Measure Condition

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3.3 LED Structure

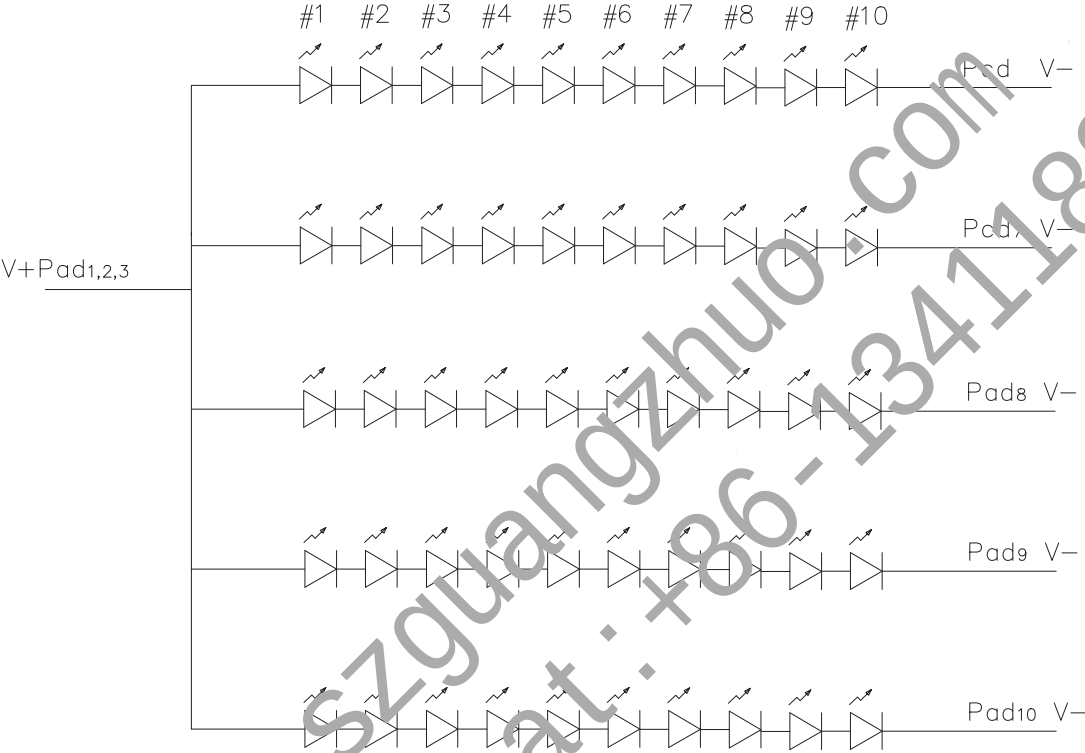


Figure 6. LED Structure

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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 $\theta\phi=0$ ($=\theta_3$) as the 3 o'clock direction (the "right"), $\theta\phi=90$ ($=\theta_{12}$) as the 12 o'clock direction ("upward"), $\theta\phi=180$ ($=\theta_9$) as the 9 o'clock direction ("left") and $\theta\phi=270$ ($=\theta_6$) 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	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	$\Theta = 0^\circ$	600	700			Note 2
Luminance of White	5 Points	Y_1	$\Theta = 0^\circ$ LED = 23mA	255	300	-	cd/m ²	Note 3
White Luminance Uniformity	5 Points	ΔY_5		80	-	-		Note 4
	13 Points	ΔY_{13}		65	-	-		
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	$\Theta = 0^\circ$	-0.03	0.653	+0.03		
		R_y			0.340			
	Green	G_x			0.317			
		G_y			0.629			
	Blue	B_x			0.153			
		B_y			0.064			
Color Gamut				68	72	-	%	
Response Time (Rising + Falling)		T_{RT}	Ta= 25°C $\Theta = 0^\circ$	-	30	35	ms	Note 6
Cross Talk		CT	$\Theta = 0^\circ$	-	-	2.0	%	Note 7

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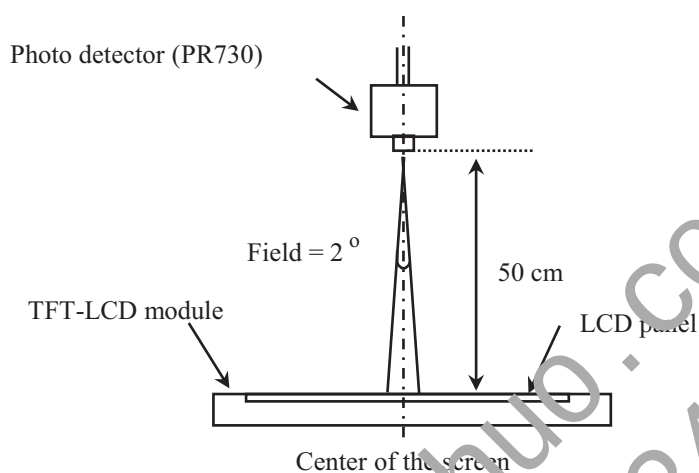
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Notes : - Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing angles are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface (see Figure 7). - 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. $CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$ - 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. - 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). - 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. - 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. - Cross-Talk of one area of the LCD surface by another shall be measured by comparing the luminance (YA) of a 25mm diameter area, with all display pixels set to a gray level, to the luminance (YB) 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

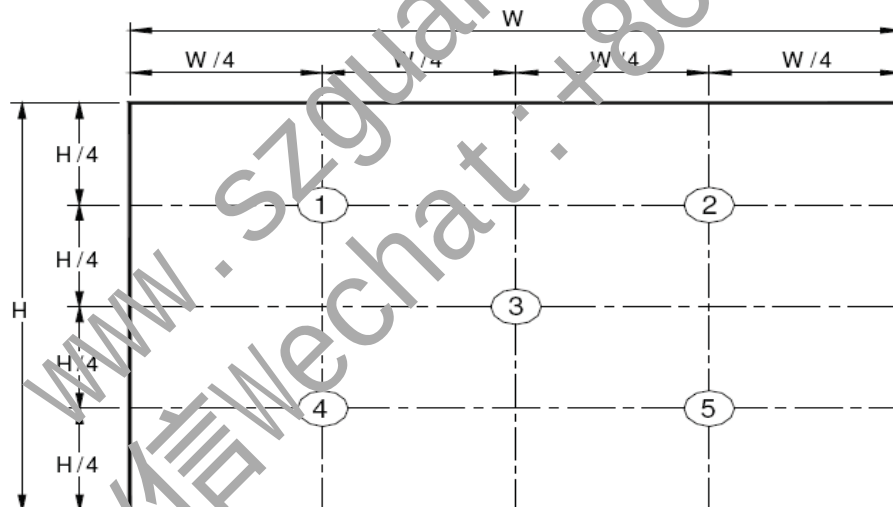


Figure 8. White Luminance and Uniformity Measurement Locations (5 points)

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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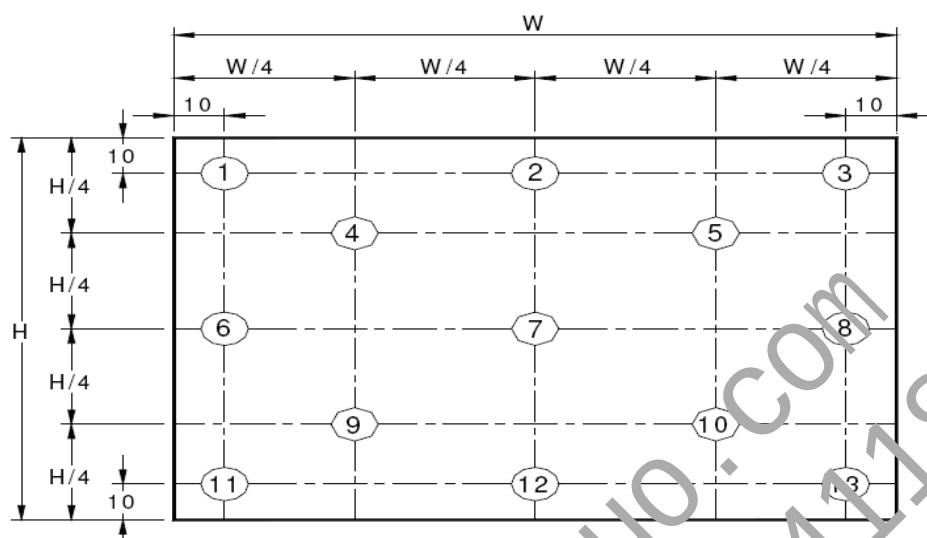


Figure 9. Uniformity Measurement Locations (13 points)

The White luminance uniformity on LCD surface is then expressed as : $\Delta Y5$ = Minimum Luminance of five points / Maximum Luminance of five points (see Figure 8) , $\Delta Y13$ = Minimum Luminance of 13 points / Maximum Luminance of 13 points (see Figure 9).

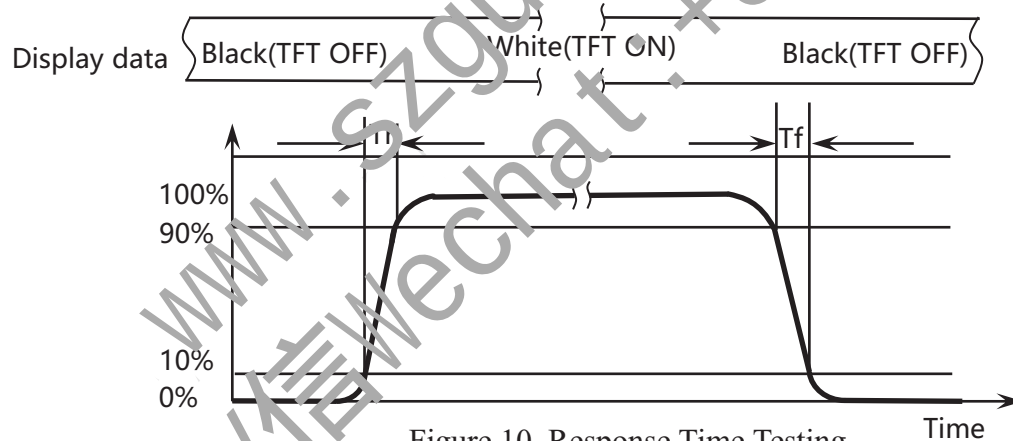


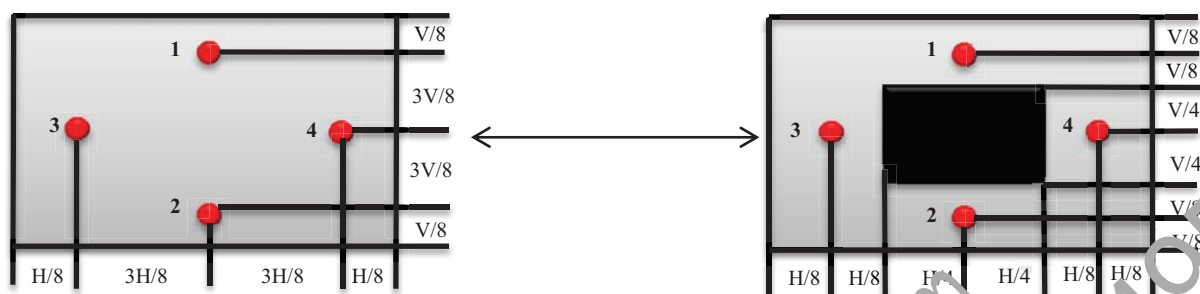
Figure 10. Response Time Testing

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

The test system : PR810

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

Figure 11. Cross Talk Modulation Test Description

Where:

Y_A = Initial luminance of measured area (cd/m^2)

Y_B = Subsequent luminance of measured area (cd/m^2)

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

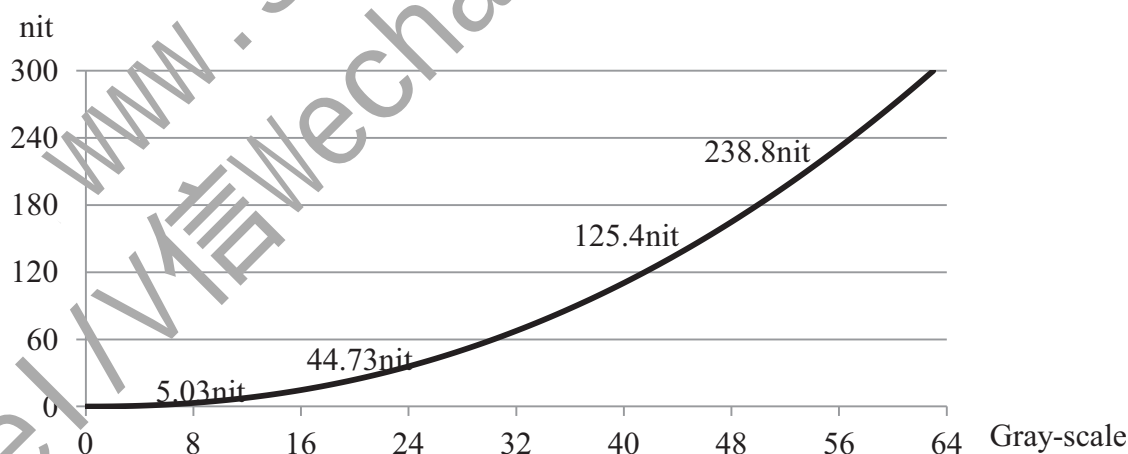


Figure 12. Brightness and Gray-scale Contrast

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5.0 INTERFACE CONNECTION

5.1 Electrical Interface Connection

The electronics interface connector is I-PEX 20455-030E-66 or Compatible.

The connector interface pin assignments are listed in Table 6.

<Table 6. Pin Assignments for the Interface Connector>

Terminal	Symbol	Functions
Pin No.	Symbol	Description
1	CABC_EN	CABC_Function
2	H_GND	Ground
3	LANE1_N	eDP RX channel 1 negative
4	LANE1_P	eDP RX channel 1 positive
5	H_GND	Ground
6	LANE0_N	eDP RX Channel 0 Negative
7	LANE0_P	eDP RX Channel 0 Positive
8	H_GND	Ground
9	AUX_CH_P	eDP AUX CH Positive
10	AUX_CH_N	eDP AUX CH Negative
11	H_GND	Ground
12	LCD_VCC	Power Supply, 3.3V (typ.)
13	LCD_VCC	Power Supply, 3.3V (typ.)
14	BIST	Panel Self Test Enable
15	H_GND	Ground
16	H_GND	Ground
17	HPD	Hot Plug Detect Output
18	BL_GND	LED Ground
19	BL_GND	LED Ground
20	BL_GND	LED Ground
21	BL_GND	LED Ground
22	BL_EN_BLE	LED Enable Pin(+3.3V Input)
23	BL_PWM	System PWM Signal Input
24	NC	No Connection
25	NC	No Connection
26	BL_POWER	LED Power Supply 5V-21V
27	BL_POWER	LED Power Supply 5V-21V
28	BL_POWER	LED Power Supply 5V-21V
29	BL_POWER	LED Power Supply 5V-21V
30	NC	No Connection

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5.2 eDP Interface

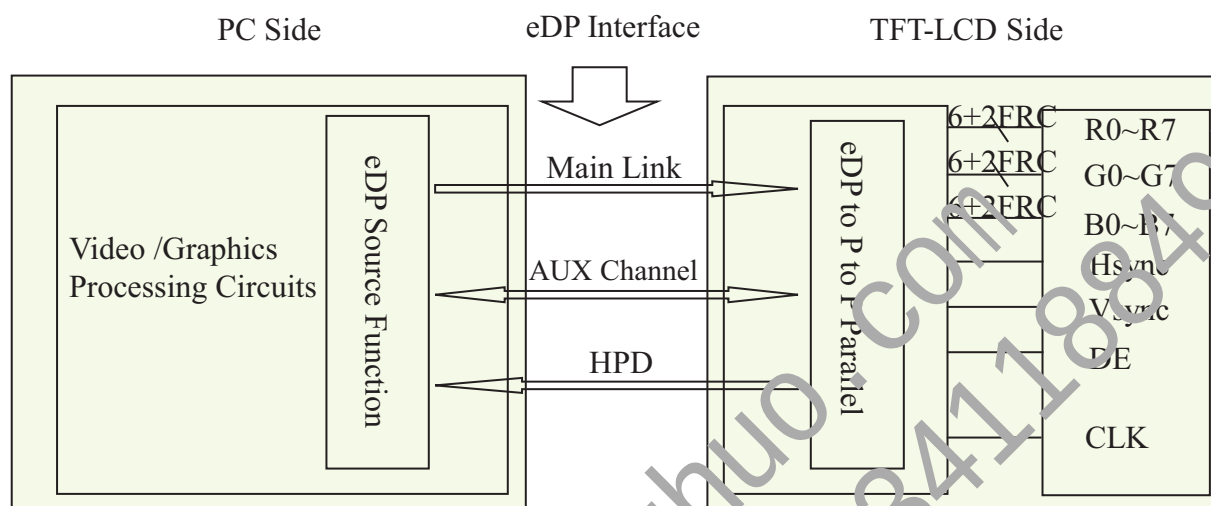


Figure 13. eDP Interface Architecture

Note:

Transmitter : Parade DP501 or equivalent.

Transmitter is not contained in module

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5.3 Data Input Format

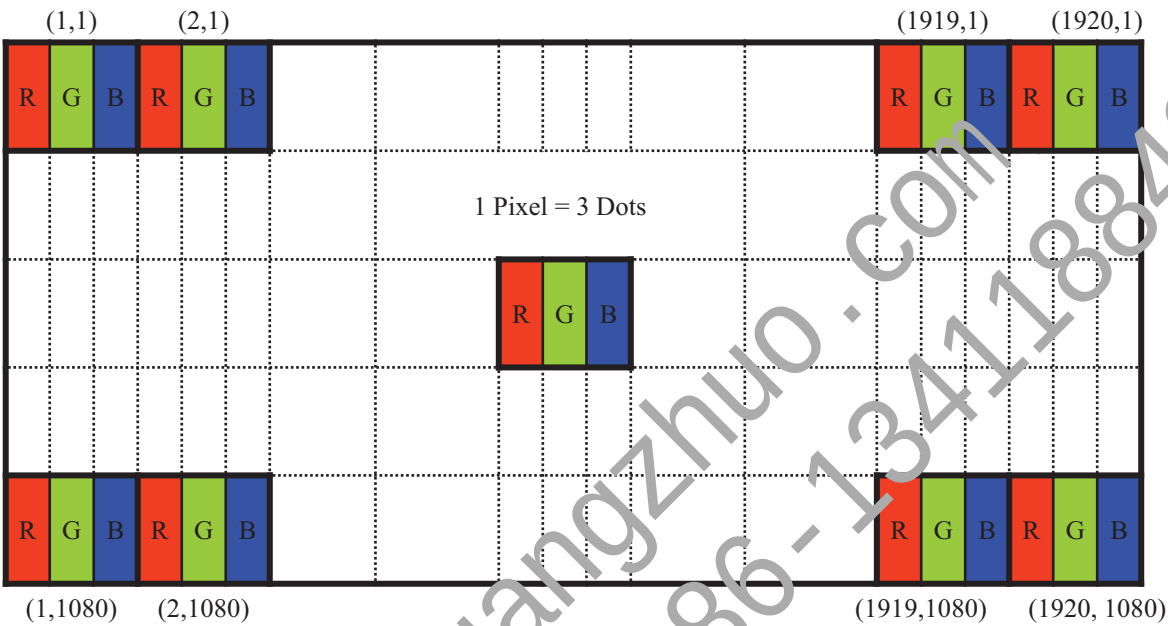


Figure 14 Display Position of Input Data (V-H)

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5.4 Back-light & LCM Interface Connection

BLU Interface Connector: STM MSK2402200 or Compatible.

<Table 7. Pin Assignments for the BLU Connector>

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

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6.0 SIGNAL TIMING SPECIFICATION

6.1 The NV156FHM-N4M Is Operated By The DE Only

< Table 8. Signal Timing Specification >

Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	140.8	147.7	153	MHz
Frame Period		Tv	1128	1140	1150	lines
			-	60	-	Hz
			-	16.7	-	ms
Vertical Display Period		Tvd	-	1080	-	lines
One line Scanning Period		Th	2080	2160	2220	clocks
Horizontal Display Period		Thd	-	1920	-	clocks

Note : The above is as optimized setting.

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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	-	0.5	%	
Differential peak-to-peak input voltage at package pins	VRX-DIFFp-p	120	-	1200	mV	
Rx input DC common mode voltage	VRX_DC_CM	0	-	2	V	
Differential termination resistance	RRX-DIFF	80	-	120	Ω	
Single-ended termination resistance	RRX-SE	40	-	60	Ω	
Rx short circuit current limit	IRX_SHORT	-	-	50	mA	
Intra-pair skew at Rx package pins (HBR) RX intra-pair skew tolerance at HBR	LRX_SKEW_INTRA_PAIR	-	-	60	ps	

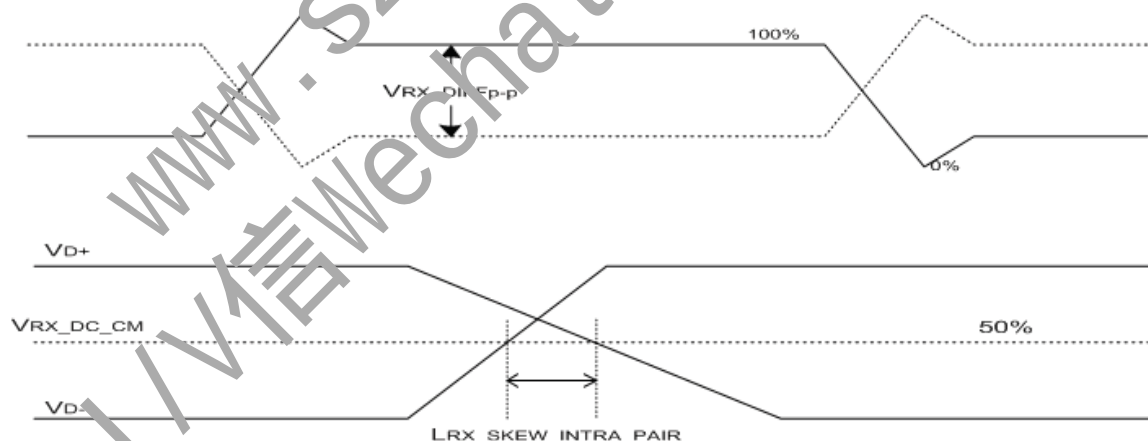


Figure 15. VRX-DIFFp-p & LRX_SKEW_INTRA_PAIR

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

<Table 10. 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	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	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	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	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	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	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	0	0		
	White	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	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	0	0		
	△	1	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	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	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	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	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	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	0	0	1	0	0	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	0	0		
	△					↑																							
	▽					↓																							
	Brighter	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0		
	▽	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	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	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	0	0	1	0	0	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	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	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	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	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	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	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	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	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	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	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.

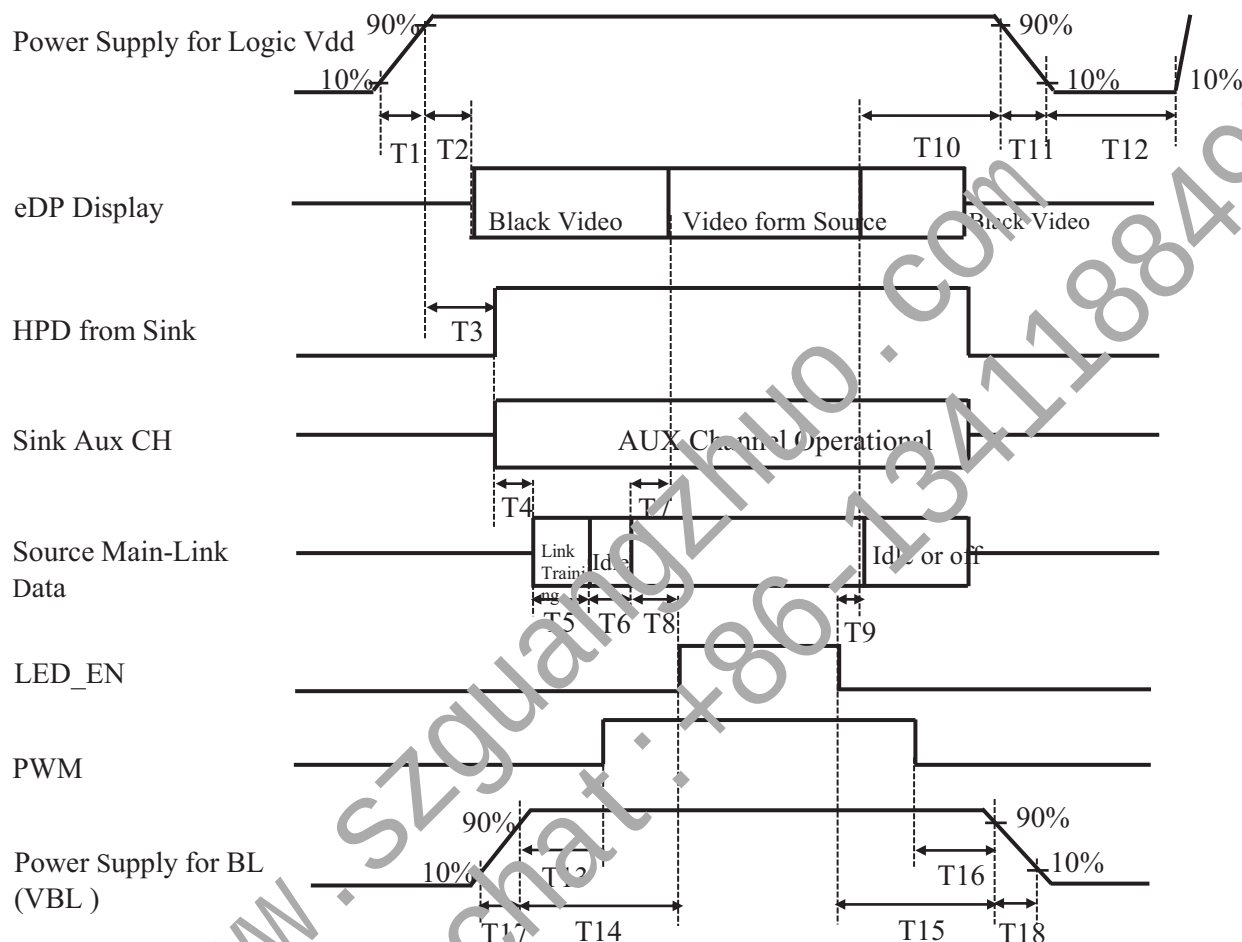


Figure 16. Power Sequence

- $0.5\text{ms} \leq T1 \leq 10\text{ms}$
- $0\text{ms} < T2 \leq 200\text{ms}$
- $0\text{ms} < T3 \leq 200\text{ms}$
- $T3+T4+T5+T6+T8 \geq 200\text{ms}$
- $0\text{ms} < T7 \leq 50\text{ms}$
- $50\text{ms} < T8$
- $0\text{ms} < T9$
- $0\text{ms} < T10 < 500\text{ms}$
- $0.5\text{ms} \leq T11 \leq 10\text{ms}$
- $500\text{ms} \leq T12$
- $0\text{ms} < T13$
- $0\text{ms} < T14$
- $0\text{ms} < T15$
- $0\text{ms} < T16$
- $0.5\text{ms} \leq T17$
- $0.5\text{ms} \leq T18$

Notes

- When the power supply VDD is 0V, keep the level of input signals on the low or keep high impedance.
- 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 components.

9.1 TFT LCD Module

< Table 11. Signal Connector >

Connector Name /Description	For Signal Connector
Manufacturer	I-PEX or Compatible
Type/ Part Number	20455-030E-60 or Compatible
Mating Housing/ Part Number	I-PEX 20454-030T or Compatible

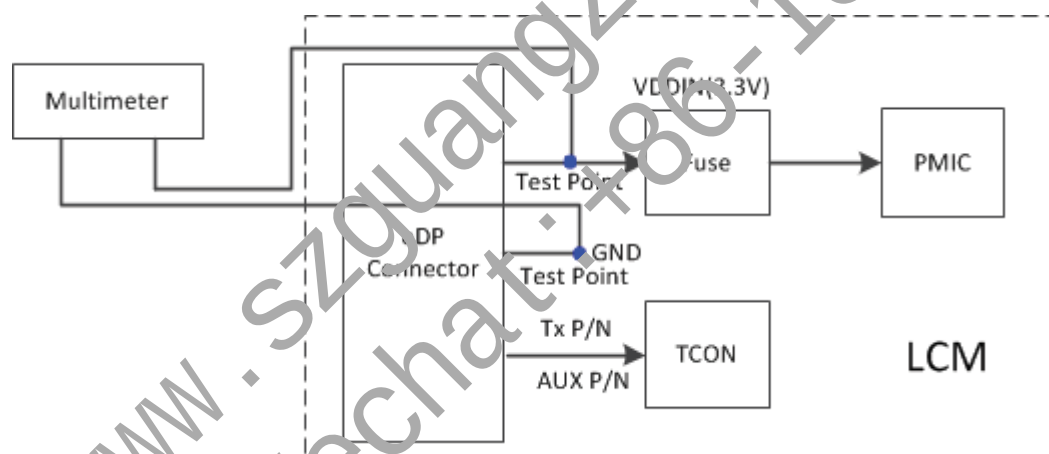
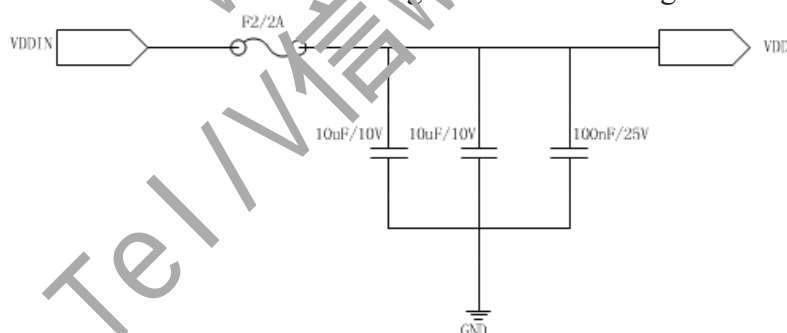


Figure 17. RC Loading test schematic diagram



Item	RC Loading	
RC0D9	R	C
	7.49K	38.6uF

Figure 18. VCC Loop R/C Loading Parameter

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10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

Figure 23 shows mechanical outlines for the model NV156FHM-N4M.
Other parameters are shown in Table 12.

<Table 12. 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	6bit-2FRC	
Display mode	Normally Black	
Dimensional outline	350.66±0.3(H)×205.69±0.3(V)×1.6 Max for FPC(V)×3.15 (Max) 350.66±0.3(H)×205.69±0.3(V)×1.6 Max for FPC(V)×5.4 (Max)(with PSB)	mm
Weight	380(Max)	g

10.2 Mounting

See Figure 23.

10.3 Anti-Glare and Polarizer Hardness.

The surface of the LCD has an Anti-Glare coating to minimize reflection to reduce scratching.

The polarizer hardness is 3H.

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.

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11.0 RELIABILITY TEST

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

<Table 13. Reliability Test>

No	Test Items	Conditions
1	High temperature storage test	Ta = 60°C , 60%RH, 240 hrs
2	Low temperature storage test	Ta = -20°C , 240 hrs
3	High temperature & high humidity operation test	Ta = 50°C , 80%RH, 240 hrs
4	High temperature operation test	Ta = 50°C , 60%RH, 240 hrs
5	Low temperature operation test	Ta = 0°C , 240 hrs
6	Thermal shock	Ta = -20 °C → 60 °C (0.5 h), 60%~83%RH, 100 cycle
7	Vibration test (non-operating)	Ta = 25°C , 60%RH, 1.5G, 10~500Hz, Sine X,Y,Z / Sweep rate : 1 hour
8	Shock test (non-operating)	Ta = 25°C , 60%RH, 220G, Half Sine Wave 2msec ± X, ± Y, ± Z Once for each direction
9	Electro-static discharge test (Operating)	ESD : 150 pF, 330Ω, ±15 KV Contact : 150 pF, 330Ω, ±8 KV Ta = 25°C , 60%RH

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) Caution 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.

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(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 characteristics

- 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

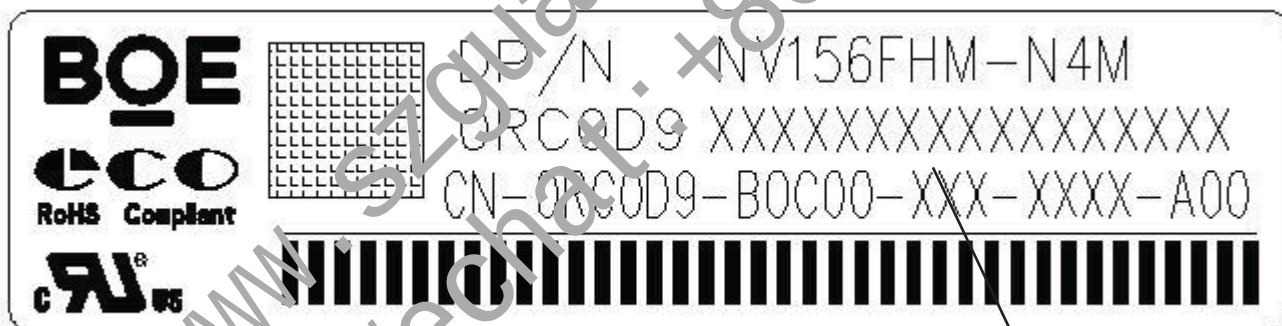


Figure 19. Product Label

Module ID Naming Rule

<Table 14. Module ID Naming Rule>

Digit Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Code	1	9	A	F	1	7	8	8	D	3	8	0	0	0	0	6	8
Description	Product Name		Product Grade	B8	Year		Month	Model Extension Code (Last 4 Digits of FG CODE)				Serial No. 00001-ZZZZZZ					

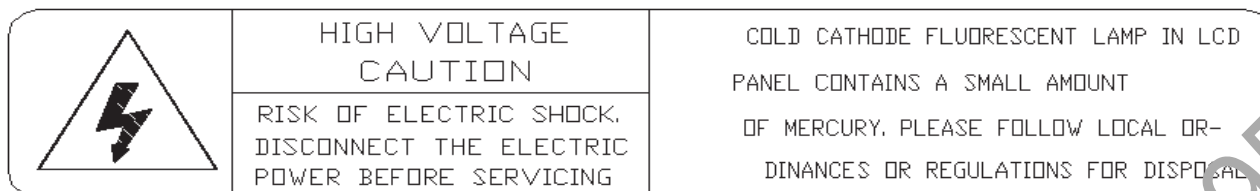
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(2) High voltage caution label



(3) Box Label

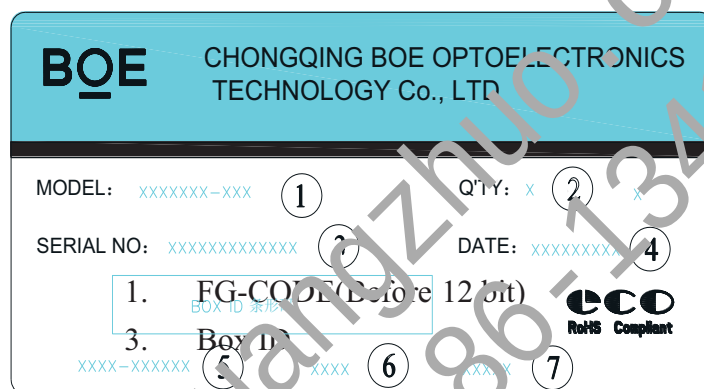


Figure 21. Box Label

Serial number marked part needs to print, show as follows:

- Figure 20. High Voltage Caution Label
- Product quantity
 - Date
 - The client section material number(The client)
 - FG-Code After four
 - The supplier code
- Total Size:100×50mm

<Table 15. Box Label Naming Rule >

Digit Code	1	2	3	4	5	6	7	8	9	10	11	12	13
Code	B	9	A	F	1	7	8	N	0	0	3	2	7
Description	Product Name		Product Grade	B8	Year		Month	Revision	BOX Serial Number				

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14.0 PACKING INFORMATION

14.1 Packing Order

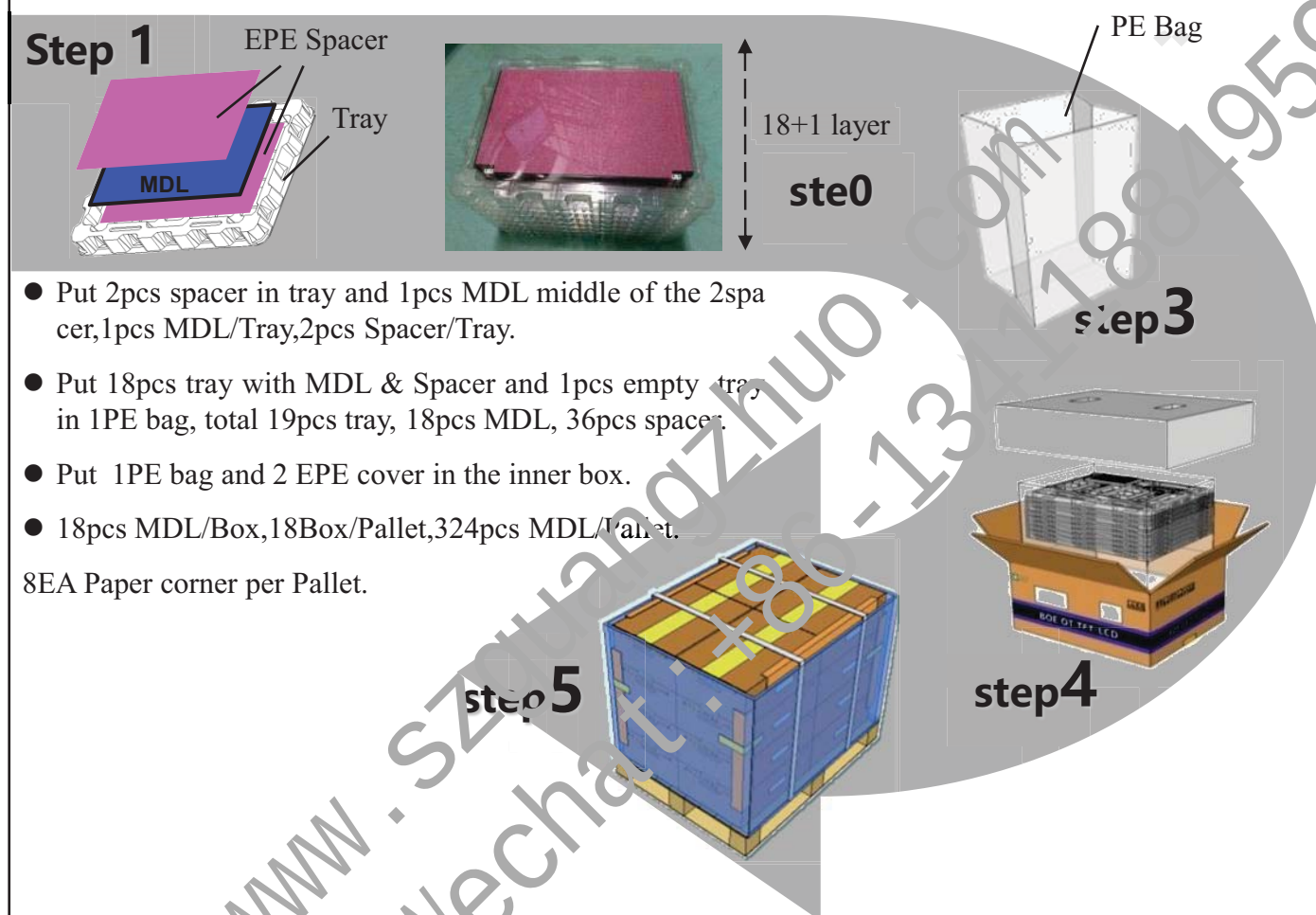


Figure 22. Packing Order

14.2 Note

- Box dimension: 480mm×350mm×285mm
- Package quantity in one box: 18pcs
- Total weight: 12.14kg/Box

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15.0 MECHANICAL OUTLINE DIMENSION

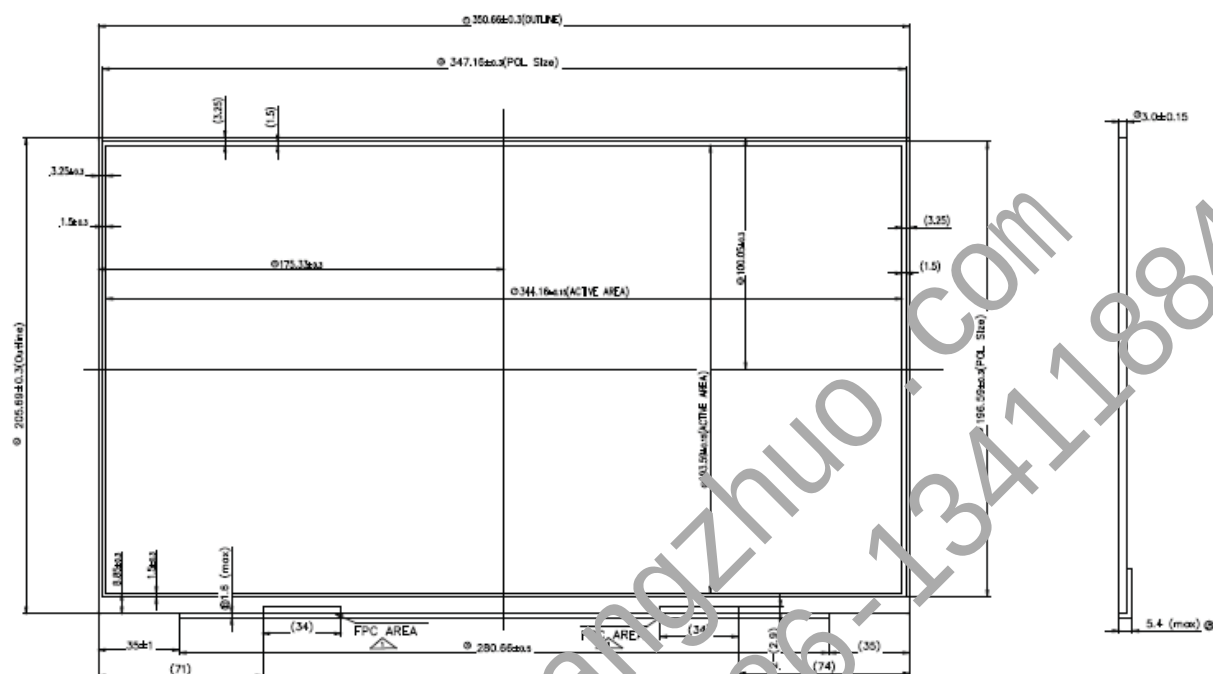


Figure 23. TTT-LCM Module Outline Dimension (Front View)

Note:

1. Top Polarizer is the highest part.
2. Curve Spec: $0 \leq a \leq 0.5\text{mm}$.
3. No light leakage from all 4 corners of LCM.
4. Size Unit: mm.
5. General Tolerance: $\pm 0.5\text{mm}$
6. Critical sizes: ①-⑮ SPI controlled sizes: ①-④, ⑪
7. Sizes measured by vernier caliper (pressed) : ①-④, ⑪, ⑮
 Sizes measured by 3D: ⑤ ⑥ ⑨ ⑩ ⑫ ⑬
 Sizes measured by thickness gauge: ⑭
8. Cell Tape arch height: Y direction $\leq 0.8\text{mm}$
 Z direction(front) $\leq 1.8\text{mm}$
 Z direction (behind) $\leq 1.5\text{mm}$

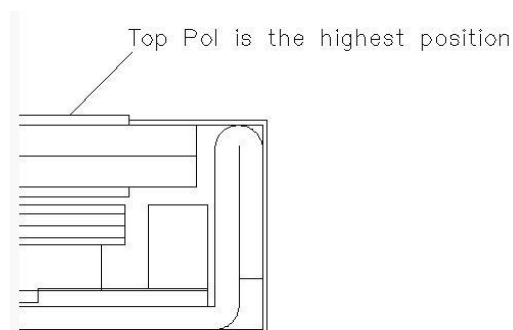


Figure 24. Highest Point Position

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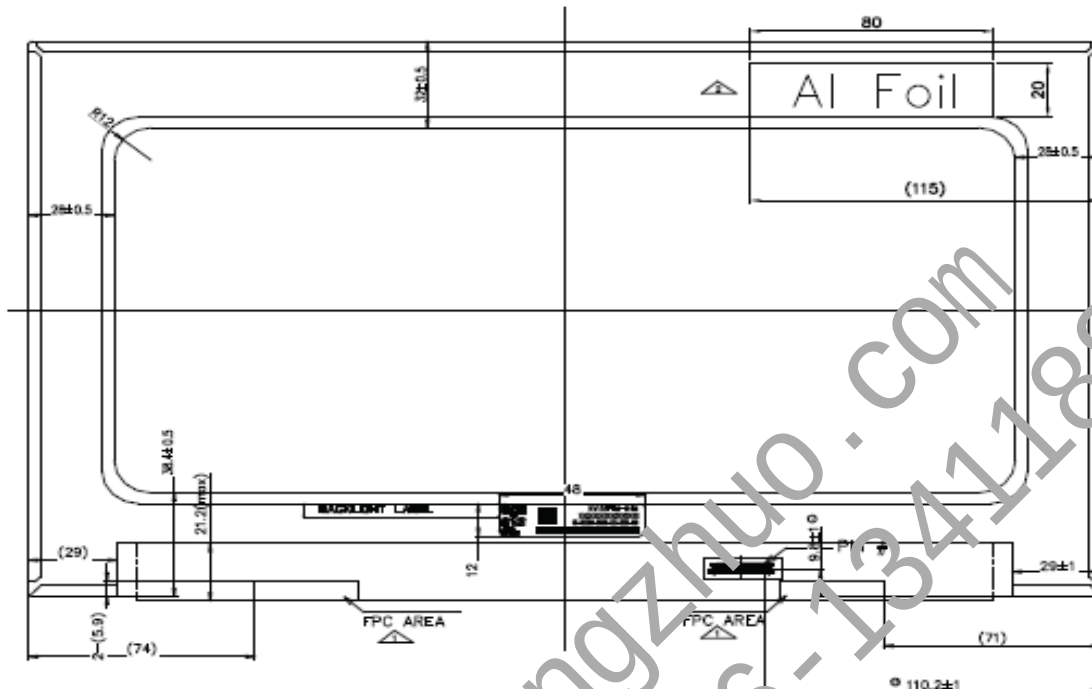


Figure 25. TFT-LCD Module Outline Dimensions (Rear view)

Note:

1. Top Polarizer is the highest part.
2. Curve Spec: $0 \leq a \leq 0.5\text{mm}$.
3. No light leakage from all 4 corners of LCM.
4. Size Unit: mm.
5. General Tolerance: $\pm 0.5\text{mm}$
6. Critical sizes: ①-⑮ SPI controlled sizes: ①-④, ⑪
7. Sizes measured by vernier caliper (pressed) : ①-④, ⑪, ⑮
 Sizes measured by 3D. ⑤⑥⑨⑩⑫⑬
 Sizes measured by thickness gauge: ⑭
8. Cell Tape arch height: Y direction $\leq 0.8\text{mm}$
 Z direction (front) $\leq 1.8\text{mm}$
 Z direction (behind) $\leq 1.5\text{mm}$

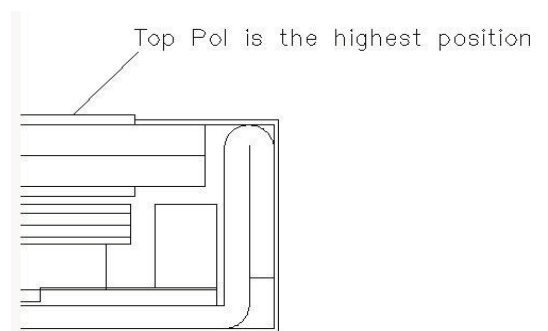


Figure 24. Highest Point Position

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16.0 EDID Table

Address (HEX)	Function	Hex	Dec	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	09	9	BOE	ID = BOE
09		E5	229		
0A	ID Product Code	1A	26	2074	ID = 2074
0B		08	8		
0C	32-bit serial No.	00	0	0	
0D		00	0	0	
0E		00	0	0	
0F		00	0	0	
10	Week of manufacture	23	35	35	
11	Year of Manufacture	1C	28	2018	Manufactured in 2018
12	EDID Structure Ver.	01	1	1	EDID Ver 1.0
13	EDID revision #	04	4	4	EDID Rev. 0.4
14	Video input definition	A5	165		Video Signal Interface
15	Max H image size	22	34	34	34cm (Approx)
16	Max V image size	13	19	19	19cm (Approx)
17	Display Gamma	78	120	2.2	Gamma curve = 2.2
18	Feature support	02	2	-	Feature Support
19	Red/Green low bits	44	68	-	Red / Green Low Bits
1A	Blue/White low bits	65	101	-	Blue / White Low Bits
1B	Red x high bits	A7	167	0.653	Red (x) = 10100111 (0.653)
1C	Red y high bits	57	87	0.340	Red (y) = 01010111 (0.340)
1D	Green x high bits	51	81	0.317	Green (x) = 01010001 (0.317)
1E	Green y high bits	A1	161	0.629	Green (y) = 10100001 (0.629)
1F	Blue x high bits	27	39	0.153	Blue (x) = 00100111 (0.153)
20	Blue y high bits	10	16	0.064	Blue (y) = 00010000 (0.064)
21	White x high bits	50	80	0.313	White (x) = 01010000 (0.313)
22	White y high bits	54	84	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	-	

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BOE		PRODUCT GROUP			REV	ISSUE DATE
		Customer Spec			0	2019.02.13
26	Standard timing #1	01	1		Not Used	
27		01	1			
28	Standard timing #2	01	1		Not Used	
29		01	1			
2A	Standard timing #3	01	1		Not Used	
2B		01	1			
2C	Standard timing #4	01	1		Not Used	
2D		01	1			
2E	Standard timing #5	01	1		Not Used	
2F		01	1			
30	Standard timing #6	01	1		Not Used	
31		01	1			
32	Standard timing #7	01	1		Not Used	
33		01	1			
34	Standard timing #8	01	1		Not Used	
35		01	1			
36	Detailed timing/monitor descriptor #1	B6	182	147.7	147.744MHz Main clock	
37		39	57			
38		80	128	1920	Hor Active = 1920	
39		F0	240	240	Hor Blanking = 240	
3A		70	112	-	4 bits of Hor. Active + 4 bits of Hor. Blanking	
3B		58	56	1080	Ver Active = 1080	
3C		3C	60	60	Ver Blanking = 60	
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		36	54	3	V sync Offset = 3 line	
41		00	0	6	V Sync Pulse width : 6 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	-	Detailed timing Definition		
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		Customer Spec			0	2019.02.13
48	Detailed timing/monitor descriptor #2	00	0	0.0	-	
49		00	0		-	
4A		00	0	0	-	
4B		00	0	0	-	
4C		00	0	-	-	
4D		00	0	0	-	
4E		00	0	0	-	
4F		00	0	-	-	
50		00	0	0	-	
51		00	0	0	-	
52		00	0	0	-	
53		00	0	0	-	
54		00	0	0	-	
55		00	0	0	-	
56		00	0	-	-	
57		00	0	-	-	
58		00	0	-	-	
59		00	0	-	-	
5A	Detailed timing/monitor descriptor #3	00	0	ASCII Data Sting Tag		
5B		00	0			
5C		00	0			
5D		FF	254			
5E		00	0			
5F		52	82	R	Dell P/N:RC0D9	
60		43	67	C		
61		30	48	0		
62		44	68	D		
63		39	57	9		
64		80	128	10000000	EDID:A00	
65		4E	78	N	BOE PN	
66		56	86	V		
67		31	49	1		
68	35	53	5			
69	4E	78	N			
6A	34	52	4			
6B	4D	77	M			
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BOE		PRODUCT GROUP			REV	ISSUE DATE
		Customer Spec			0	2019.02.13
6C	Detailed timing/monitor descriptor #4	00	0		Flag	
6D		00	0			
6E		00	0			
6F		00	0		Data Type Tag: Manufacturer Specified Data 00	
70		00	0		Flag	
71		01	1	-	Color Depth : 6bit +2 bit FRC : Supports	
72		41	65	-	Lamps of LED Light Bars : one Configuration : single light bar Panel Illumination : WLED	
73		01	1	-	Intel sDRAC : No Supports	
74		9E	158	-	Digtale/PWM : PWM only Maximum Typical Luminance : 300	
75		00	0	-	Pixel Structure : RGB v-strip Transflective : no AG/Glossy : Anti-Glare	
76		10	1	-	Bynamic Backlight Control : DBC type 1 Color Management : NTSC	
77		00	0	-	Active Gamma Control : no support(default) Montion Blur : no support(default)	
78		00	0	-	In-Cell Scanner : no support(default) Wireless Enhancement Hardware : no support(default)	
79		0A	10	-	In-Cell Touch : no support(default) Interface : eDP Overdrive : no support(default) Interface Channels : two	
7A		01	1	-	3-D Hardware Support : no support(default) Electronic Privacy : no electronic privacy hardware control BIST Hardware support : support(default)	
7B		0A	10		Format : terminate with ASCII code 0Ah and pad field with ASCII code 20h	
7C		20	32			
7D		20	32			
7E	Extension flag	00	0	1	0 : 1個EDID ; N-1 : N个EDID	
7F	Checksum	AE	174	-	Checksum	
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