PRODUCT SPECIFICATION

FOR

APPROVAL

Model Name	NV156FHM-N65 V8.0
Description	15.6 FHD color TFT-LCD with LED backlight / Anti-Glare surface
Prepared by	Luke / Engineer
Checked by	Ream / Manager
Approved by	/ Dept. Manager

Customer	Lenovo

Please return one copy for confirmation with your signature and comments

BOE

PROPRIETARY NOTE

TITLE : NV156FHM-N65 V8.0

Product Specification

Rev. P1

BOE Optoelectronics Technology Co., Ltd

REVISION HISTORY

( )Preliminary Specification

(√)Final Specification

Revision No.	Page	Description of Changes	Date	Prepared
P0	32	Preliminary Specification	2018.11.16	Liu Jie
P1	10	Color Coordinate Update for YAG LED	2019.05.14	Liu Jie

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Contents

1.0 GENERAL DESCRIPTION

1.1 Introduction

NV156FHM-N65 V8.0 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 1064.3 M (8bit+FRC) colors and color gamut sRGB 100%. 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 eDP1.4b interface compatible.

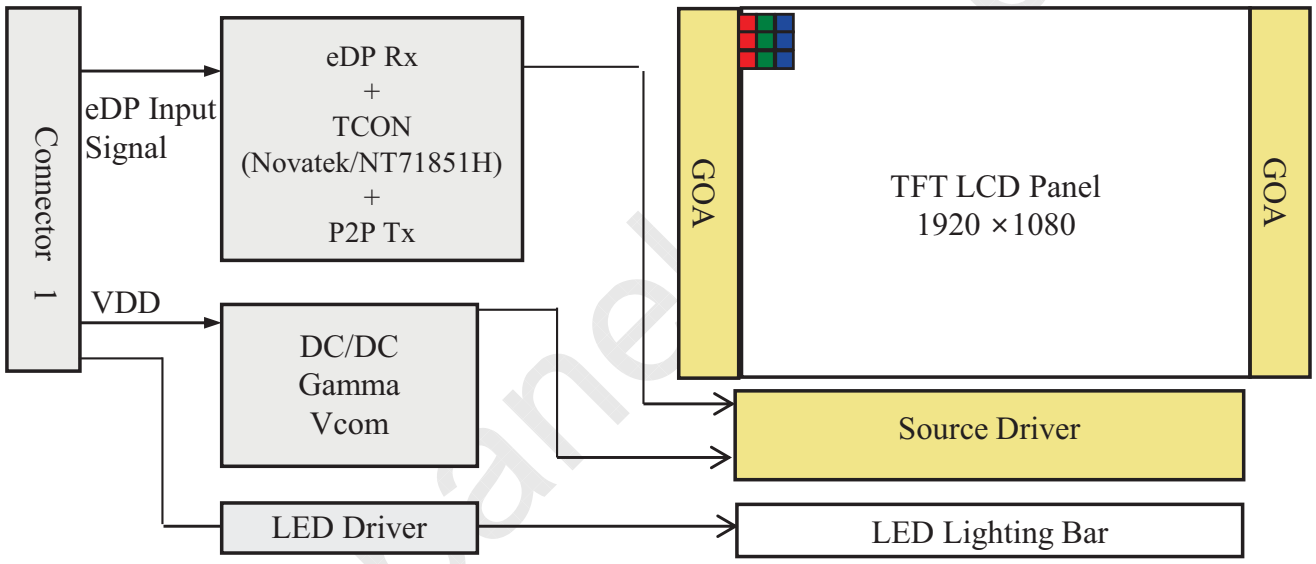


Figure 1. Drive Architecture

1.2 Features

- 2 lane eDP interface with 2.7Gbps link rates
- Thin and light weight
- 1064.3 M (8bit+FRC) color depth, color gamut sRGB 100%.
- Single LED lighting bar (Bottom side/Horizontal Direction)
- Data enable signal mode
- Green product (RoHS & Halogen free product)
- On board LED driving circuit
- Low driving voltage and low power consumption
- On board EDID chip

1.3 Application

- Notebook PC (Wide type)

1.4 General Specification

The followings are general specifications at the model NV156FHM-N65 V8.0. (listed in Table 1)

<Table 1. General Specifications>

Parameter	Specification	Unit	Remarks
Active area	344.120(H) ×193.470(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	1064.3 M (8bit+FRC)		
Color gamut	sRGB 72%.		
Display mode	Normally black		
Dimensional outline	350.66±0.3 (H)*205.25±0.3(V)(W/O PCB)*2.6(Max) 350.66±0.3(H)*216.25±0.5(V) (W/PCB)*2.6(Max)	mm	
Weight	280(max)	g	
Surface treatment	Anti-Glare		
Surface hardness	3H		
Back-light	Bottom edge side, 1-LED lighting bar type		Note 1
Power consumption	P_D : 0.8	W	@Mosaic
	P_{BL} : 4.75	W	
	P_{Total} : 5.55	W	@Mosaic

Notes : 1. LED Lighting Bar (60*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
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.

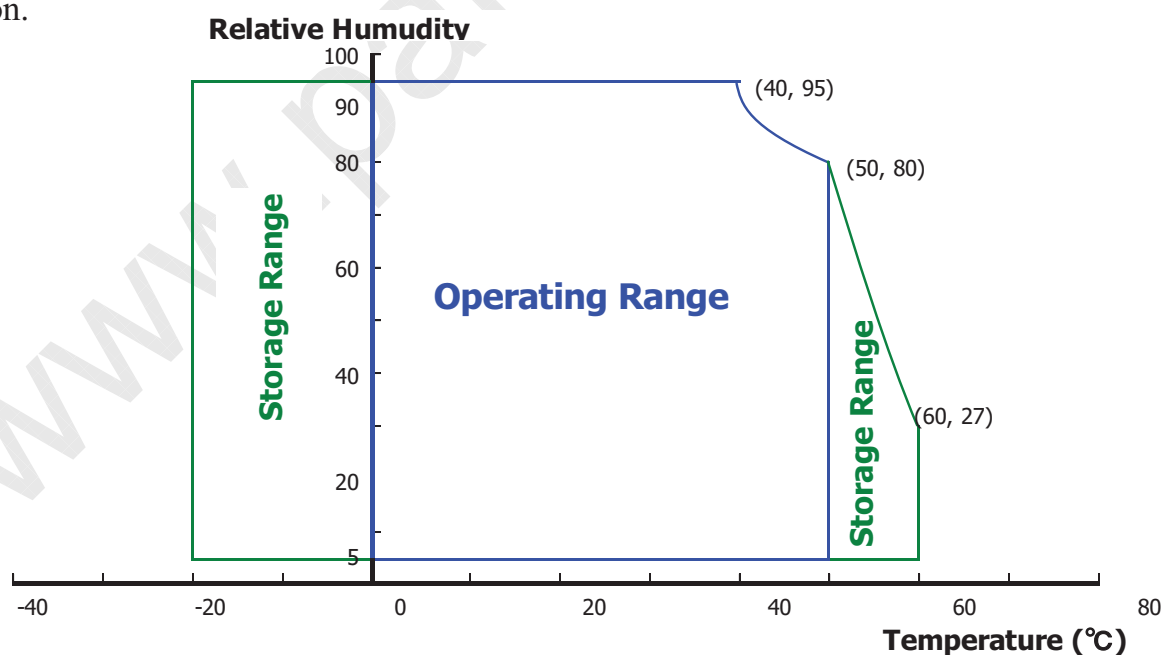


Figure 2. Temperature and Relative Humidity Range

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}	mV	Note 4
BIST Control Level	High Level	2.2	-	3.6	V	
	Low Level	0	-	0.6	V	
Power Supply Current	I_{DD}	-	242	364	mA	Note 1
Power Supply Inrush Current	Inrush	-	-	2	A	Note3
Power Consumption	P_D	-	0.8	1.2	W	Note 1
	P_{BL}	-		4.75	W	Note 2
	P_{total}	-	5.55	5.95	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 patterns

(a) (b)

Figure 3. Power Measure Patterns

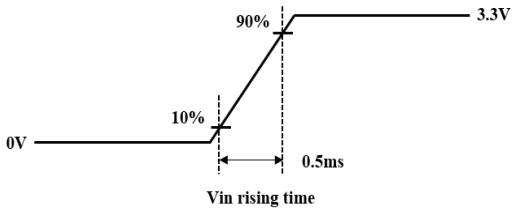


Figure 4. Inrush Measure Condition

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.
5. When peak inrush current， the Vdd should no smaller than 2.5v

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	-	-	2.9	V	
LED Forward Current		I_F	-	24.2	-	mA	
LED Power Consumption		P_{LED}	-	-	4.75	W	Note 1
LED Life-Time		N/A	15,000	-	-	Hour	IF = 24.2mA
Power Supply Voltage for LED Driver		V_{LED}	5	12	21	V	
Power Supply Voltage for LED Driver Inrush		Iled inrush	-	-	2	A	Note 4
EN Control Level	Backlight On		2.2	-	3.6	V	
	Backlight Off		0	-	0.6	V	
PWM Control Level	High Level		2.2	-	3.6	V	
	Low Level		0	-	0.6	V	
PWM Control Frequency		F_{PWM}	200	-	10,000	Hz	
Duty Ratio			1	-	100	%	Note 3

Notes :
1. Power supply voltage12V for LED driver.
   Calculator value for reference IF × VF ×60 /driver efficiency = PLED
2. The LED life-time define as the estimated time to 50% degradation of initial luminous.
3. 1% duty cycle is achievable with a dimming frequency less than 2KHz.
4. Measure condition (Figure 5)

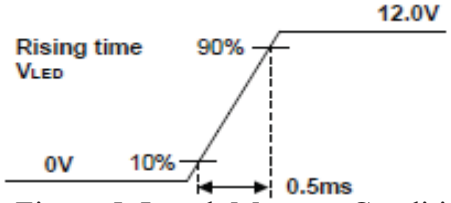


Figure 5. Inrush Measure Condition

3.3 LED Structure

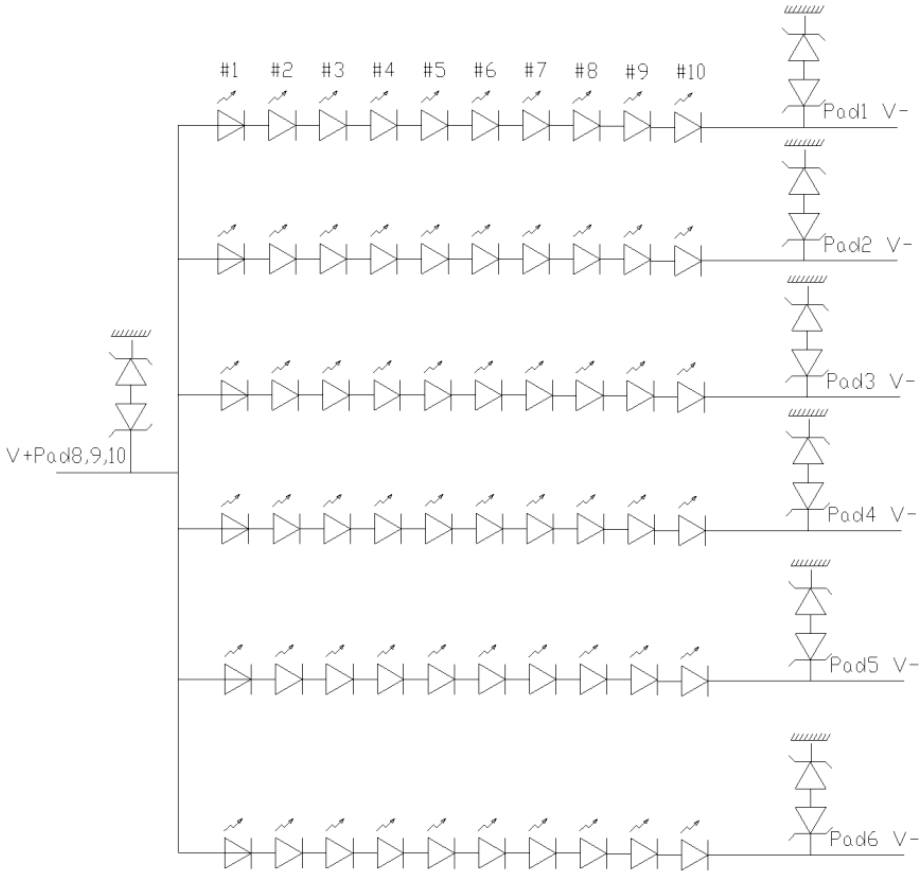


Figure 6. LED Structure

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±2°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 θØ=0 (=θ3) as the 3 o'clock direction (the "right"), θØ=90 (= θ12) as the 12 o'clock direction ("upward"), θØ=180 (= θ9) as the 9 o'clock direction ("left") and θØ=270(= θ6) as the 6 o'clock direction ("bottom"). While scanning θand/or Ø, 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+/- 0.3V at 25°C. Optimum viewing angle direction is 6 '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	Θ = 0°	600	800	-		Note 2
Luminance of White	5 Points	Y_w	Θ = 0° I_{LED} = 24.2mA	425	500	575	cd/m²	Note 3
White Luminance Uniformity	5 Points	ΔY5		80	-	-		Note 4
	13 Points	ΔY13		60	-	-		
White Chromaticity		W_x	Θ = 0°	0.283	0.313	0.343		Note 5
		W_y		0.299	0.329	0.359		
Reproduction of Color	Red	R_x	Θ = 0°	-0.03	0.650	+0.03		
		R_y			0.330			
	Green	G_x			0.320			
		G_y			0.630			
	Blue	B_x			0.160			
		B_y			0.060			
Color Gamut				-	72	-	%	
Response Time (Rising + Falling)		T_{RT}	Ta= 25°C Θ = 0°	-	30	35	ms	Note 6
Cross Talk		CT	Θ = 0°	-	-	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 Θ= 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.

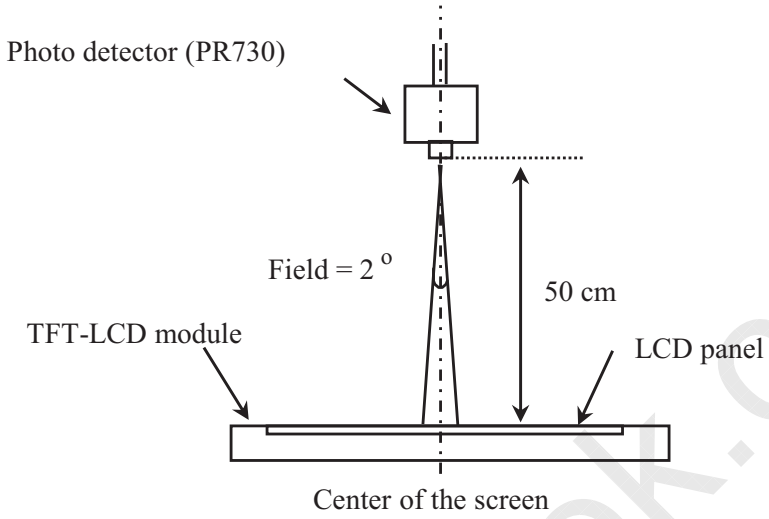
4. The White luminance uniformity on LCD surface is then expressed as : ΔY =Minimum Luminance of 5(or 13) points / Maximum Luminance of 5(or 13) points.(see Figure 8 and Figure 9).

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_f, and 90% to 10% is T_r.

7. 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).

4.3 Optical Measurements



Optical characteristics measurement setup

Figure 7. Measurement Set Up

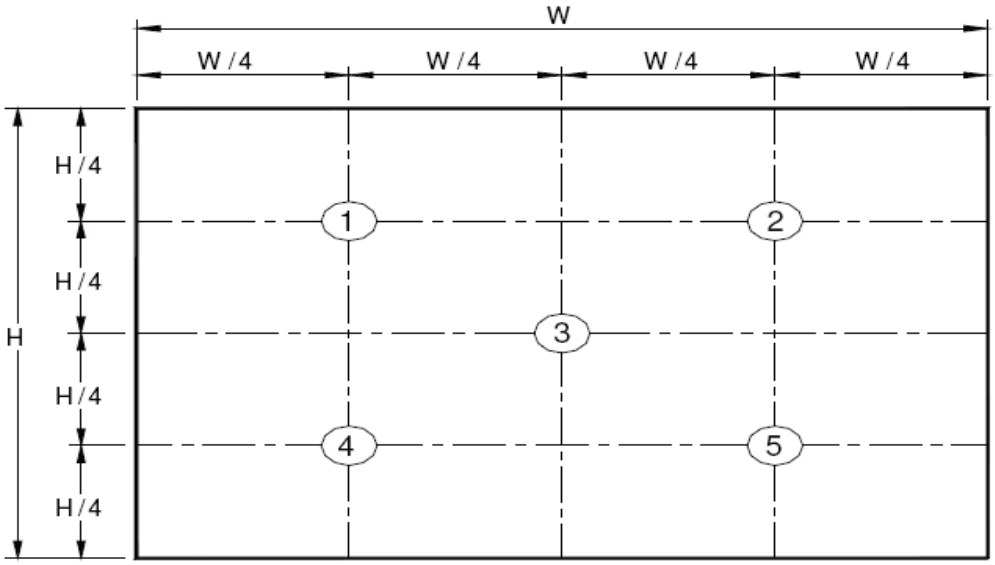


Figure 8. White Luminance and Uniformity Measurement Locations (5 points)

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.

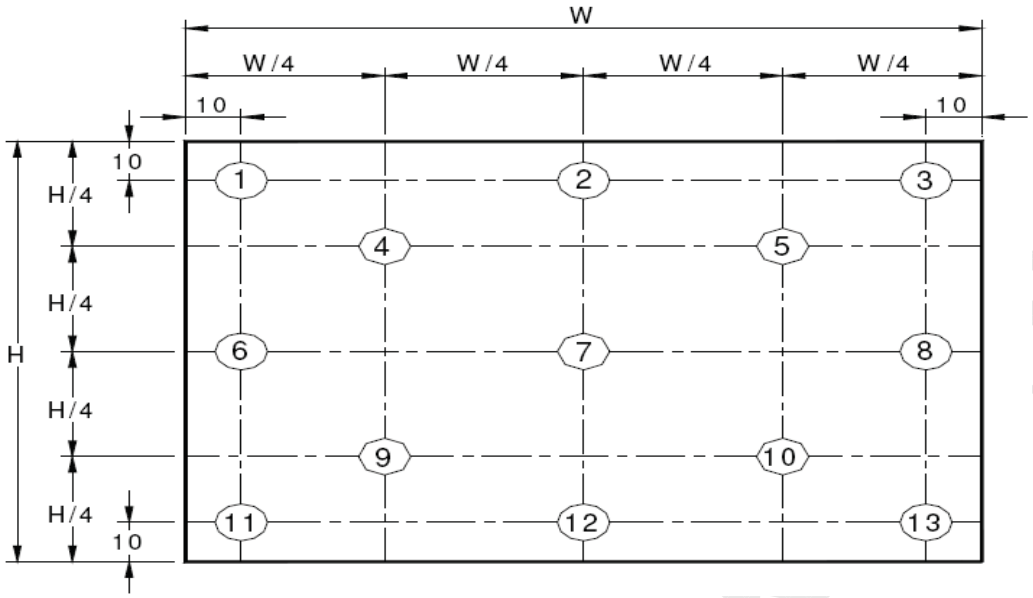


Figure 9. Uniformity Measurement Locations (13 points)

The White luminance uniformity on LCD surface is then expressed as : ΔY5 = Minimum Luminance of five points / Maximum Luminance of five points (see Figure 8) , ΔY13 = Minimum Luminance of 13 points /Maximum Luminance of 13 points (see Figure 9).

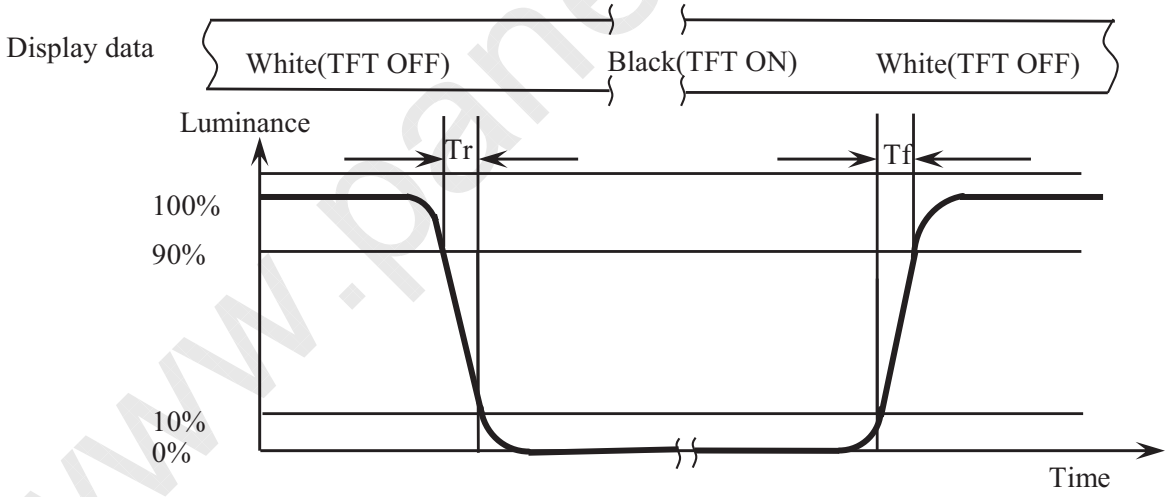
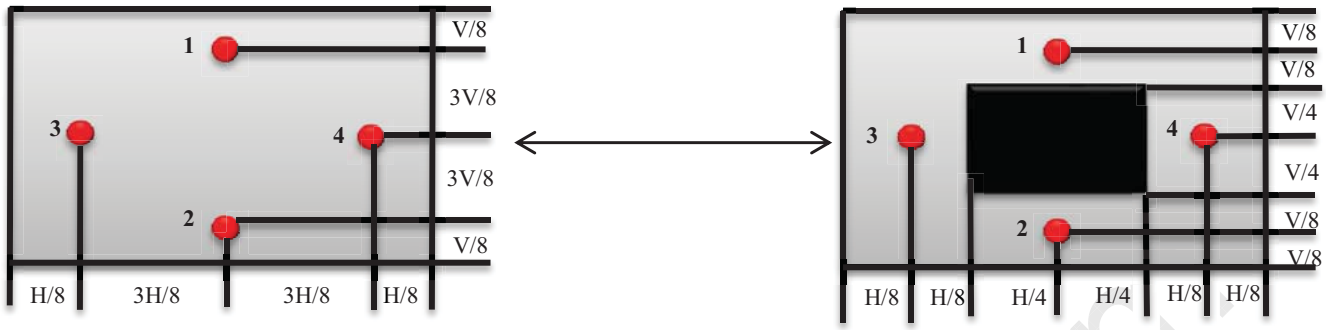


Figure 10. Response Time Testing

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 90% to 10% ,Tf: The luminance to change from 10% to 90% .

The test system : PR810



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

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 (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.(Refer to Figure 11)

The test system: PR730

5.0 INTERFACE CONNECTION

5.1 Electrical Interface Connection

The electronics interface connector is IPEX 20455-030E-66.
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	NC	No Connection
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_ENABLE	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

5.2 eDP Interface

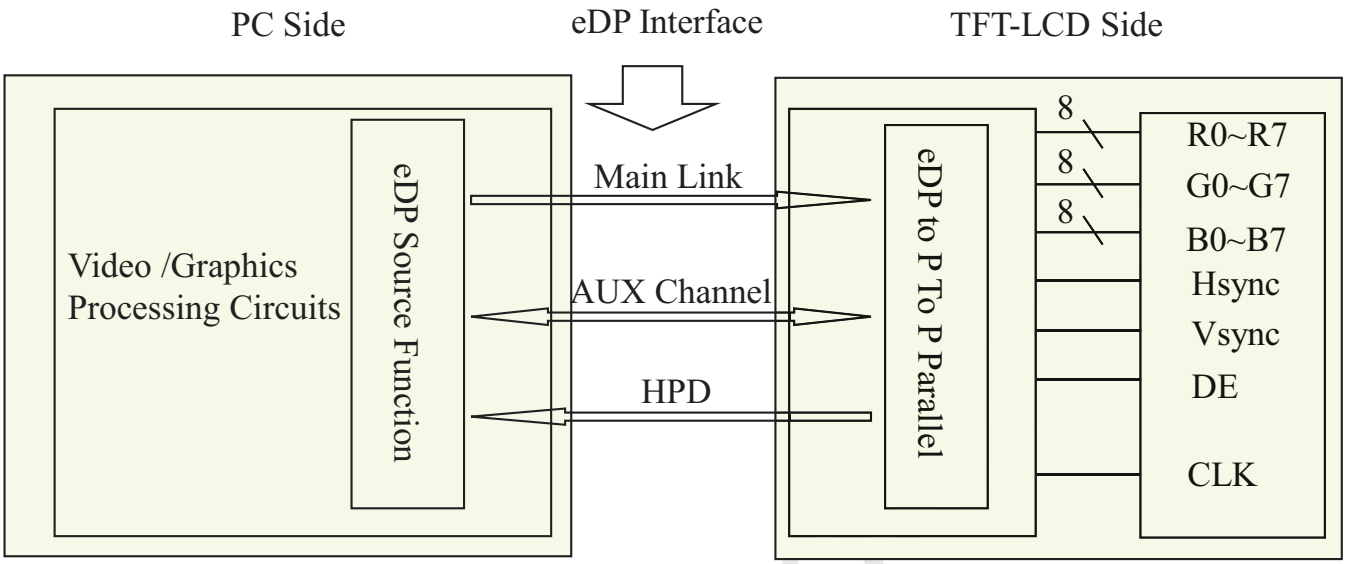


Figure 12. eDP Interface Architecture

Note:
Transmitter : Parade DP501 or equivalent.
Transmitter is not contained in module.

5.3 Data Input Format

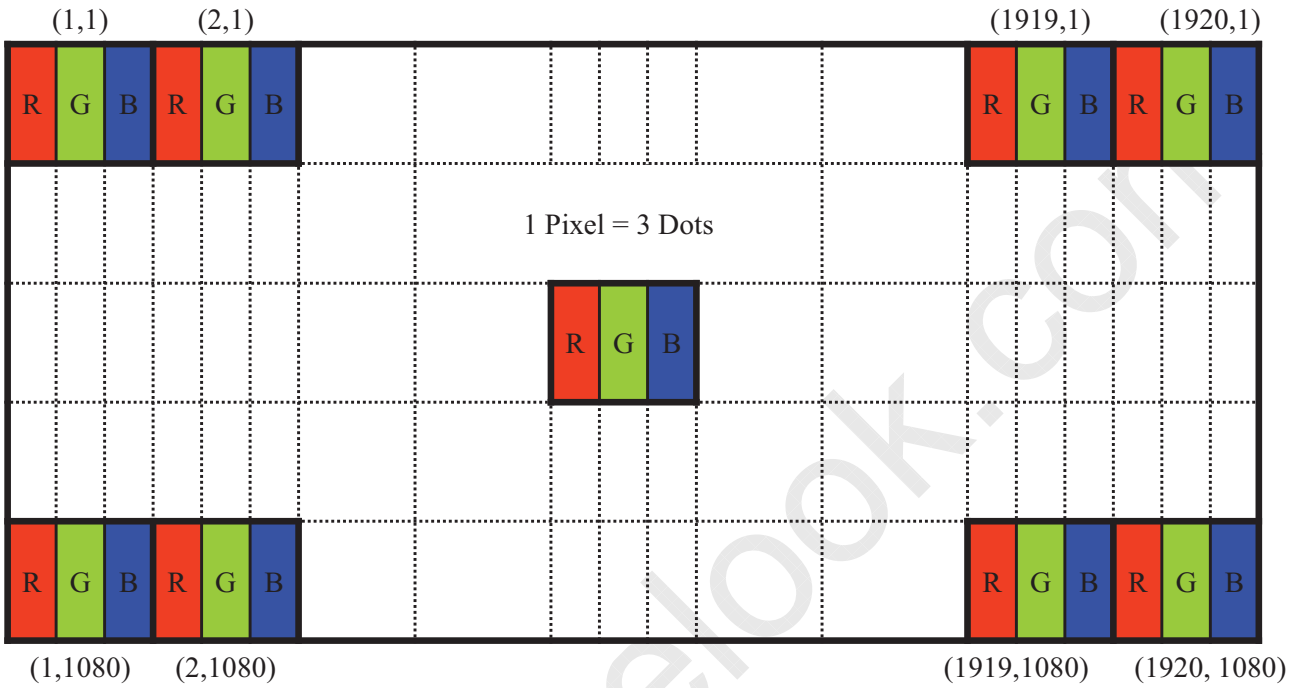


Figure 13. Display Position of Input Data (V-H)

5.5 Back-light & LCM Interface Connection

BLU Interface Connector: STM MSK24022P10.

<Table 7. Pin Assignments for the BLU Connector>

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

6.0 SIGNAL TIMING SPECIFICATION

6.1 The NV156FHM-N65 V8.0 Is Operated By The DE Only

< Table 8. Signal Timing Specification >

Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	138.5	141.7	143.1	MHz
Frame Period		Tv	1110	1112	1115	lines
			-	60	-	Hz
			-	16.67	-	ms
Vertical Display Period		Tvd	-	1080	-	lines
One line Scanning Period		Th	2080	2124	2139	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	VRX-DIFFp-p	120	-	1200	mV	
Rx input DC common mode voltage	VRX_DC_CM	0	-	2	V	
Differential termination resistance	RRX-DIFF	80	100	120	Ω	
Single-ended termination resistance	RRX-SE	40	50	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	

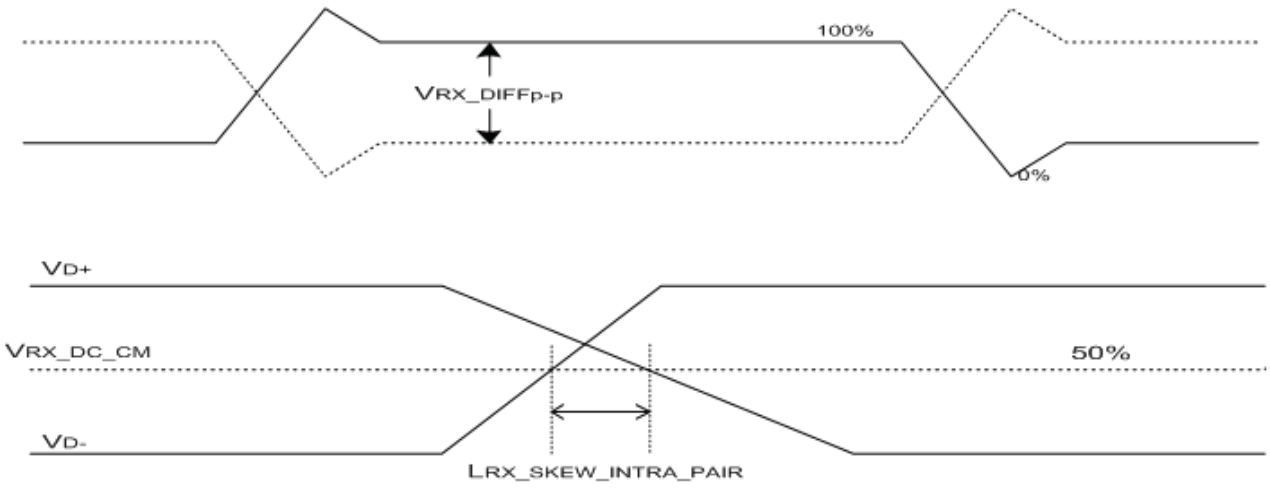


Figure 14. VRX-DIFFp-p & LRX_SKEW_INTRA_PAIR

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	R8	R9	G0	G1	G2	G3	G4	G5	G6	G7	G8	G9	B0	B1	B2	B3	B4	B5	B6	B7	B8	B9
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	0	0	0	0
	Blue	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	1	1	1	1
	Green	0	0	0	0	0	0	0	0	0	0	1	1	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	0	0	1	1	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	1	1	0	0	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	1	1	0	0	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	1	1	1	1	0	0	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	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	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	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	0	0	0	0
	▵	↑										↑										↑									
	▿	↓										↓										↓									
	Brighter	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	0	0	0
	▿	0	1	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	0	0
	Red	1	1	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	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	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
	Darker	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
	▵	↑										↑										↑									
	▿	↓										↓										↓									
	Brighter	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	0	0	0	0	1	1	1	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	0	0	1	1	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	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	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	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	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	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	0	0	0	0
	▵	1	0	0	0	0	0	0	0	0	0	1	0	0	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	0	0	1	0	0	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	1	1	0	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1
	▿	0	1	1	1	1	1	1	1	1	1	0	1	1	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	1	1	1	1

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.

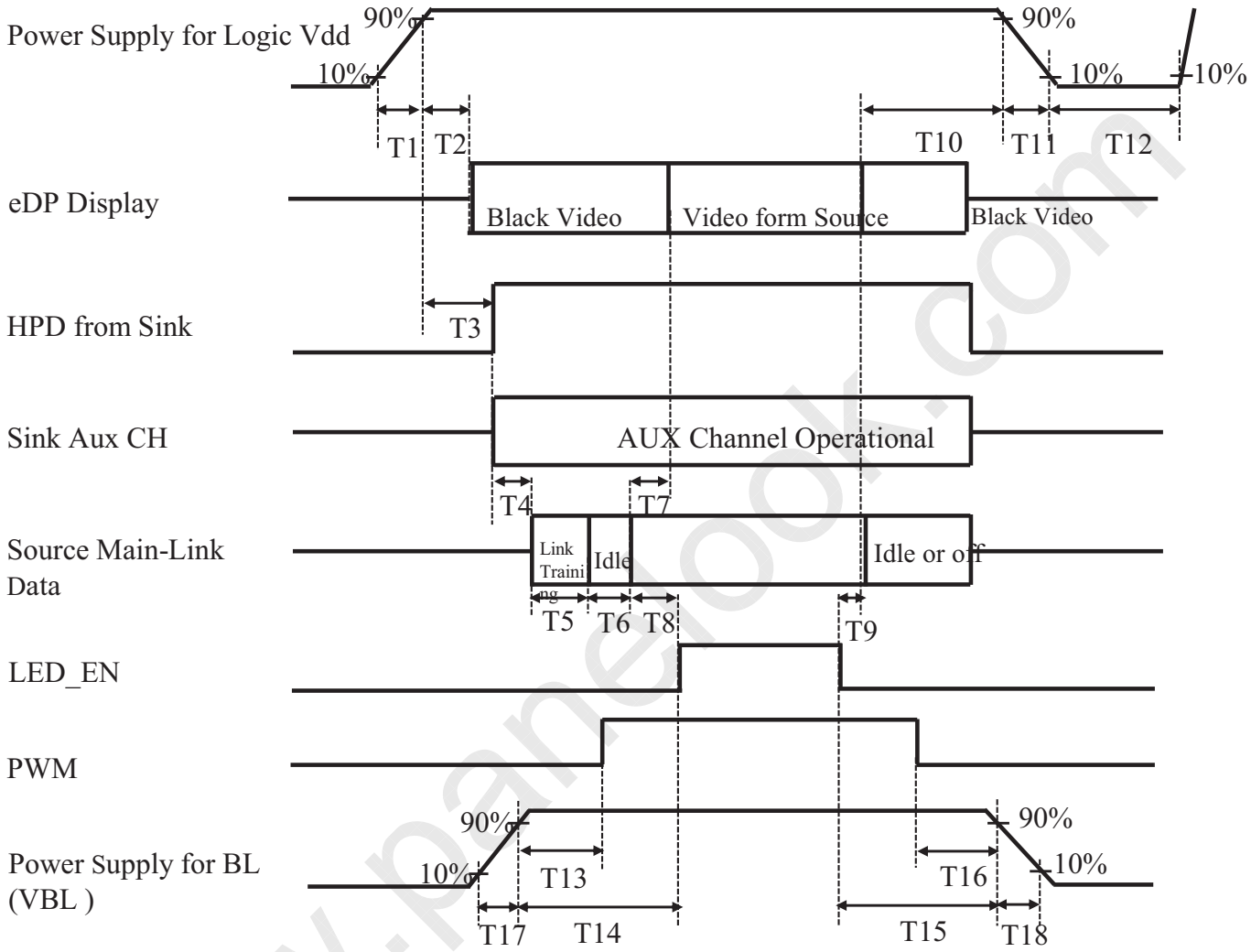


Figure 15. Power Sequence

- 0.5ms ≤ T1 ≤ 10 ms
- 0ms < T2 ≤ 200 ms
- 0ms < T3 ≤ 200 ms
- T3+T4+T5+T6+T8>200ms
- 0ms < T7 ≤ 50ms
- 50ms < T8
- 0ms < T9
- 0ms < T10 < 500 ms
- 0.5ms ≤ T11 ≤ 10 ms
- 500ms ≤ T12
- 0ms < T13
- 0ms < T14
- 0ms < T15
- 0ms < T16
- 0.5ms ≤ T17
- 0.5ms ≤ T18

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.

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	IPEX
Type/ Part Number	20455-030E-66
Mating Housing/ Part Number	I-PEX 20454-030T

10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

Figure 21 shows mechanical outlines for the model NV156FHM-N65 V8.0.
Other parameters are shown in Table 12.

<Table 12. Dimensional Parameters>

Parameter	Specification	Unit
Active Area	344.120 (H) ×193.470(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	1064.3 M (8bit+FRC)	
Display mode	Normally black	
Dimensional outline	350.66±0.3 (H)*205.25±0.3(V)(W/O PCB)*2.6(Max) 350.66±0.3(H)*216.25±0.5(V) (W/PCB)*2.6(Max)	mm
Weight	280 (max)	g

10.2 Mounting

See Figure 21.

10.3 Anti-Glare and Polarizer Hardness.

The surface of the LCD has an Anti-Glare coating to minimize reflection and to reduce scratching.
And 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 30cm from the screen with an overhead light level of 250lux.

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 hr), 60%±3%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 (non-operating)	Air : 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) 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 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 16. 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	B	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					

(2) High voltage caution label

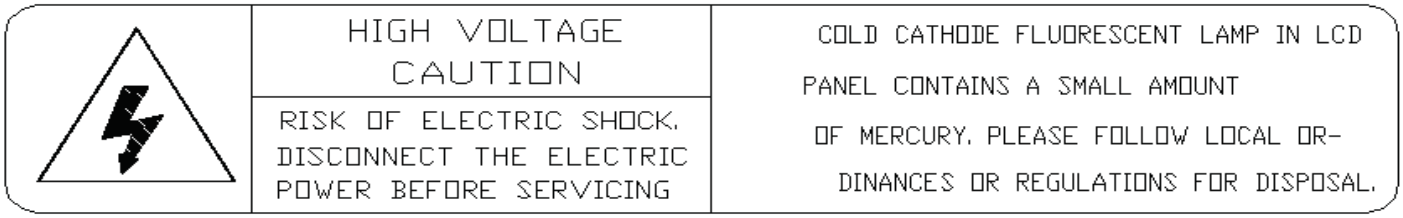


Figure 17. High Voltage Caution Label

(3) Box Label

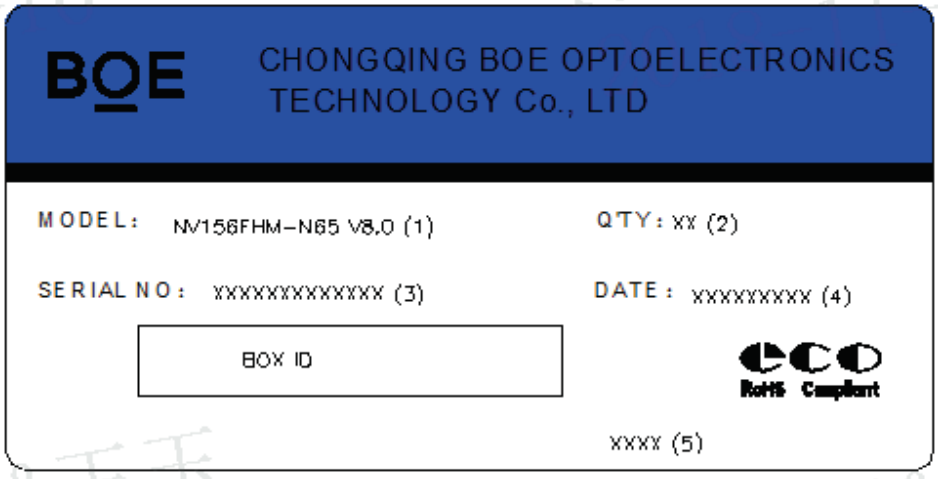


Figure 18. Box Label

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

1. FG-CODE(Before 17 bit)
2. Product quantity
3. Box ID
4. Date
5. FG-Code After four ---8940

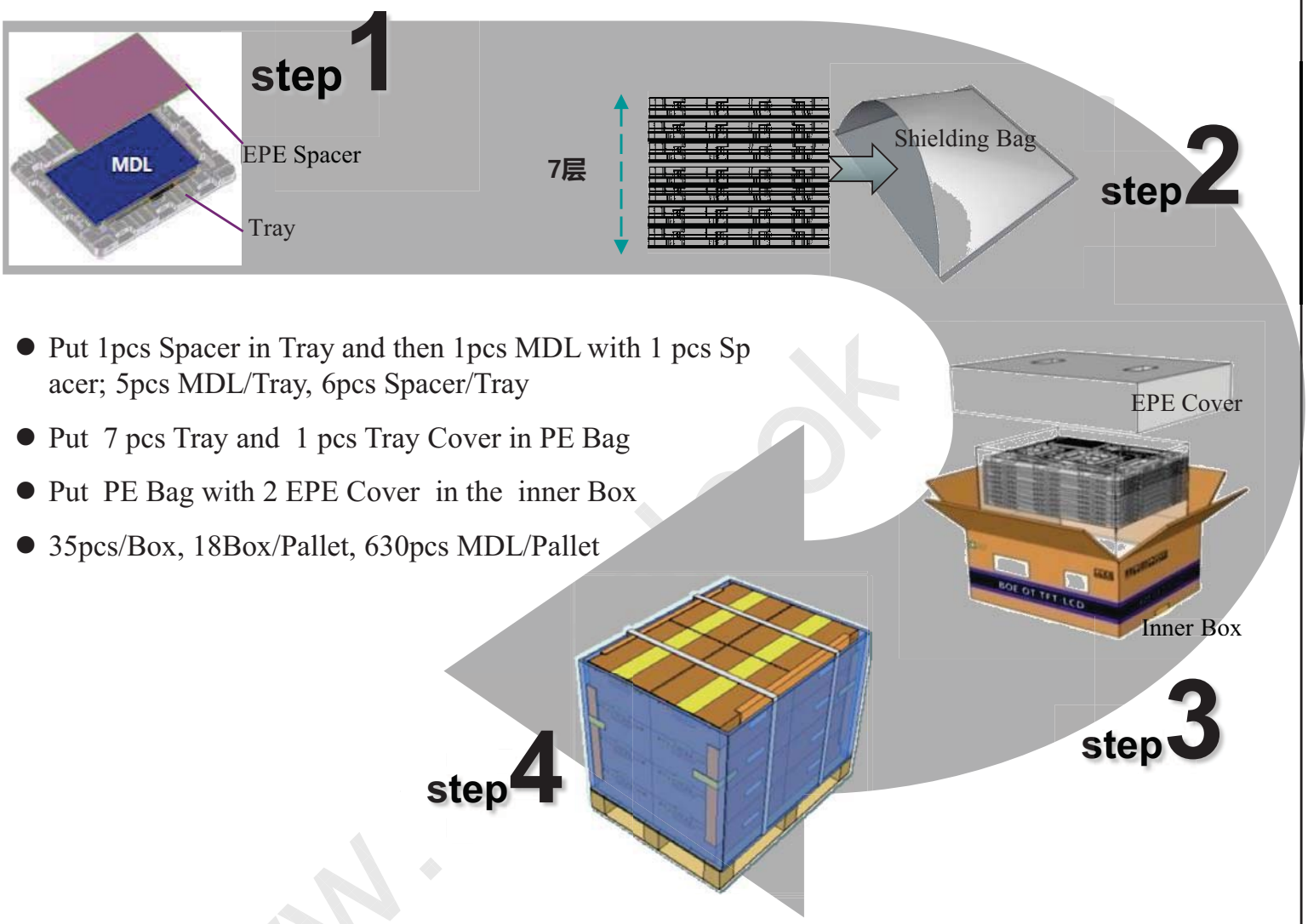
Total Size:100×50mm

<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				

14.0 PACKING INFORMATION

14.1 Packing Order



- Put 1pcs Spacer in Tray and then 1pcs MDL with 1 pcs Spacer; 5pcs MDL/Tray, 6pcs Spacer/Tray
- Put 7 pcs Tray and 1 pcs Tray Cover in PE Bag
- Put PE Bag with 2 EPE Cover in the inner Box
- 35pcs/Box, 18Box/Pallet, 630pcs MDL/Pallet

Figure 19. Packing Order

14.2 Note

- Box dimension: 480mm*350mm*285mm
- Package quantity in one box: 35pcs
- Total weight: 12.51 kg/Box

15.0 MECHANICAL OUTLINE DIMENSION

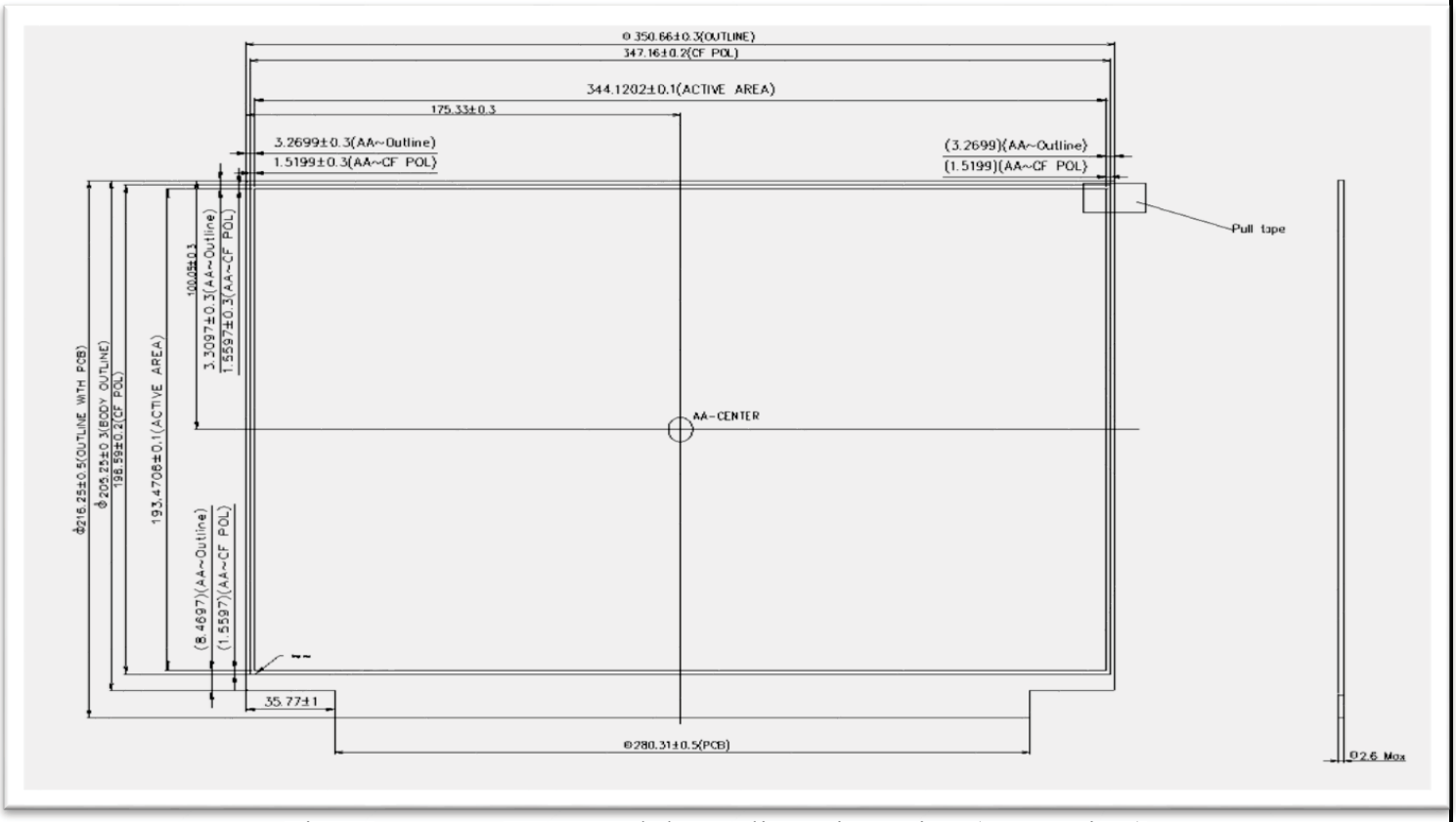


Figure 20. TFT-LCD Module Outline Dimension (Front View)

Note:
1. Warps And Deformation spec 0.5mm Max.
2. EDP connector is measured at PIN 1 and MATING LINE.
3. Key dimensions: ① -⑦
4. Top polarizer is the highest position of LCD, and any other component is below the top polarizer.
5. The MDL border tolerance measure tool is a Vernier Caliper.

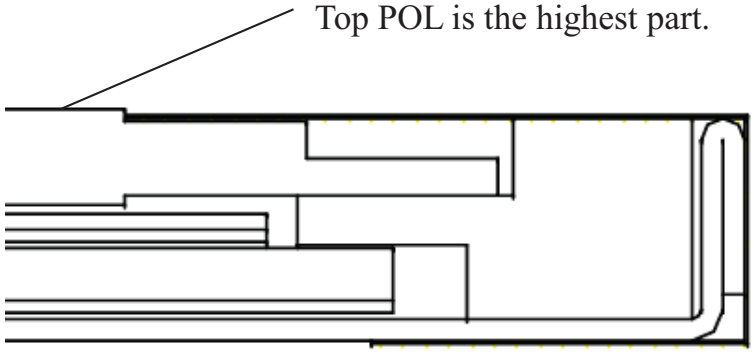


Figure 21. Highest Point Position

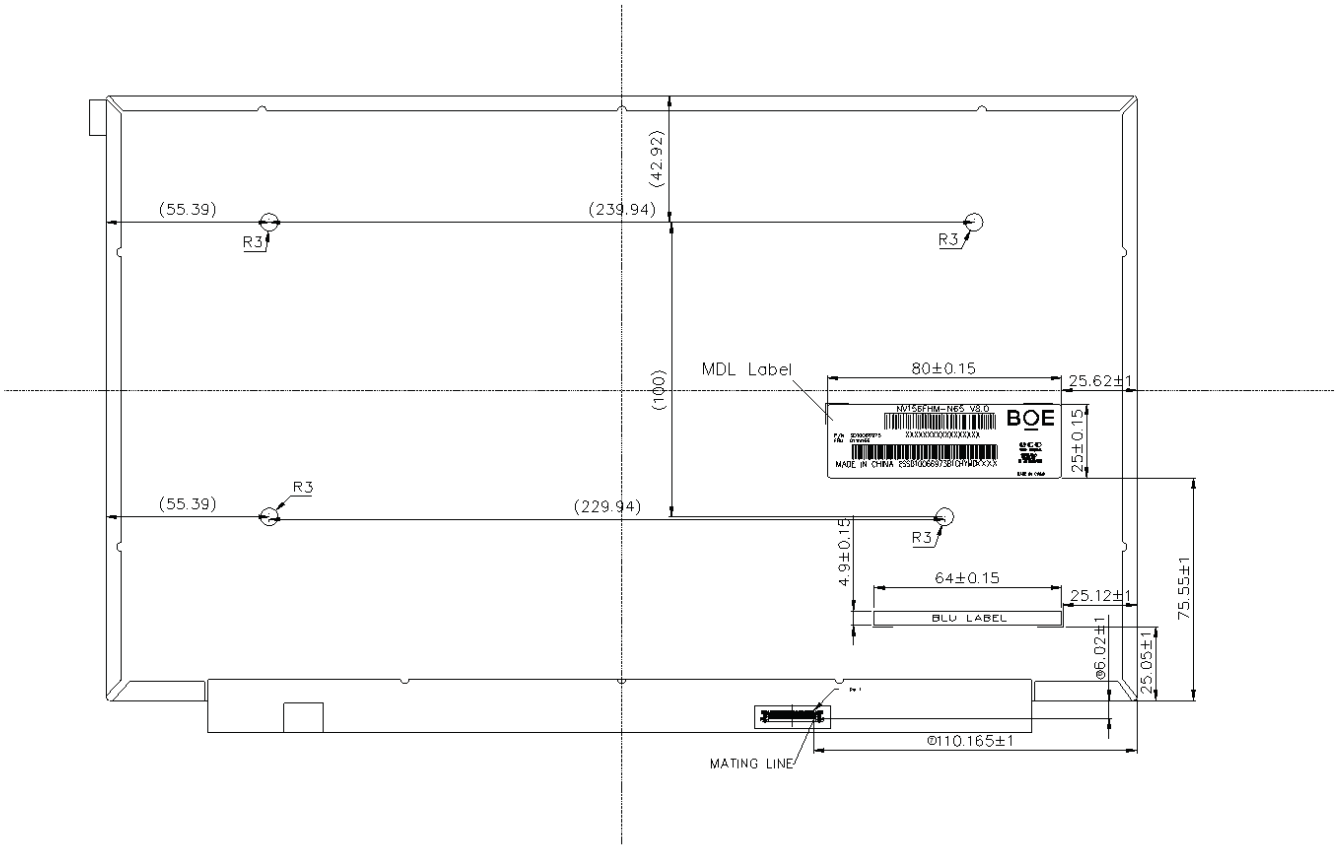


Figure 22. TFT-LCD Module Outline Dimensions (Rear view)

Note:
1. Warps And Deformation spec 0.5mm Max.
2. EDP connector is measured at PIN 1 and MATING LINE.
3. Key dimensions: ① -⑦
4. Top polarizer is the highest position of LCD, and any other component is below the top polarizer.
5. The MDL border tolerance measure tool is a Vernier Caliper.

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	09	9		BOE	ID = BOE
09		E5	229			
0A	ID Product Code	53	83		2131	ID = 2131
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	30	48		48	
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	B5	181		-	Refer to right table
15	Max H image size	22	34		34	34.416 cm (Approx)
16	Max V image size	13	19		19	19.359 cm (Approx)
17	Display Gamma	78	120		2.2	Gamma curve = 2.2
18	Feature support	03	3		-	Refer to right table
19	Red/Green low bits	A8	168		-	Red / Green Low Bits
1A	Blue/White low bits	55	85		-	Blue / White Low Bits
1B	Red x high bits	AE	174	698	0.682	Red (x) = 10101110 (0.682)
1C	Red y high bits	50	80	322	0.314	Red (y) = 01010000 (0.314)
1D	Green x high bits	47	71	286	0.279	Green (x) = 01000111 (0.279)
1E	Green y high bits	AB	171	684	0.668	Green (y) = 10101011 (0.668)
1F	Blue x high bits	27	39	157	0.153	Blue (x) = 00100111 (0.153)
20	BLue y high bits	0F	15	61	0.060	Blue (y) = 00001111 (0.06)
21	White x high bits	50	80	321	0.313	White (x) = 01010000 (0.313)
22	White y high bits	54	84	337	0.329	White (y) = 01010100 (0.329)
23	Established timing 1	00	0		-	Refer to right table
24	Established timing 2	00	0		-	
25	Established timing 3	00	0		-	

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	5C	92		141.7	141.71328MHz Main clock
37		37	55			
38		80	128		1920	Hor Active = 1920
39		CC	204		204	Hor Blanking = 204
3A		70	112		-	4 bits of Hor. Active + 4 bits of Hor. Blanking
3B		38	56		1080	Ver Active = 1080
3C		20	32		32	Ver Blanking = 32
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 = 344.16 mm (Low 8 bits)
43		C2	194		194	Vertical Image Size = 193.59 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

48	Detailed timing/monitor descriptor #2	4A	74		113	113.370624MHz Main clock
49		2C	44			
4A		80	128		1920	Hor Active = 1920
4B		CC	204		204	Hor Blanking = 204
4C		70	112		-	4 bits of Hor. Active + 4 bits of Hor. Blanking
4D		38	56		1080	Ver Active = 1080
4E		20	32		32	Ver Blanking = 32
4F		40	64		-	4 bits of Ver. Active + 4 bits of Ver. Blanking
50		30	48		48	Hor Sync Offset = 48
51		20	32		32	H Sync Pulse Width = 32
52		36	54		3	V sync Offset = 3 line
53		00	0		6	V Sync Pulse width : 6 line
54		58	88		344	Horizontal Image Size = 344.16 mm (Low 8 bits)
55		C2	194		194	Vertical Image Size = 193.59 mm (Low 8 bits)
56		10	16		-	4 bits of Hor Image Size + 4 bits of Ver Image Size
57		00	0		0	Hor Border (pixels)
58		00	0		0	Vertical Border (Lines)
59		1A	26		-	Refer to right above table
5A	Detailed timing/monitor descriptor #3	00	0			Indicates descriptor #3 is a display Descriptor
5B		00	0			
5C		00	0			Reserved
5D		FE	254			Tag：ASCII String
5E		00	0			Reserved
5F		42	66		B	Manufacture name : BOECQ
60		4F	79		O	
61		45	69		E	
62		20	32			
63		43	67		C	
64		51	81		Q	
65		0A	10			
66		20	32			
67		20	32			
68		20	32			
69		20	32			
6A		20	32			
6B		20	32			

6C	Detailed timing/monitor descriptor #4	00	0			Indicates descriptor #4 is a display Descriptor
6D		00	0			
6E		00	0			Reserved
6F		FE	254			Tag：ASCII String
70		00	0			Reserved
71		4E	78		N	Model name : NV156FHM-N65
72		56	86		V	
73		31	49		1	
74		35	53		5	
75		36	54		6	
76		46	70		F	
77		48	72		H	
78		4D	77		M	
79		2D	45		-	
7A		4E	78		N	
7B		36	54		6	
7C		35	53		5	
7D		0A	10			
7E	Extension flag	01	1		2	
7F	Checksum	8F	143	143	-	

80	Tag	02	2		-	
81	Revision Number	03	3		-	
82	Length of Info Frame	0F	15		-	
83	Global Declarations	00	0		-	
84	Tag Code [7:5], Length of data [4:0]	E3	227		-	Colorimetry Data Block , 3 Byte
85	Extended Tag Code	05	5		-	Colorimetry Data Block
86	Colorimetry Support Flags	80	128		-	BT2020RGB
87	Colorimetry Metadata Support Flags	00	0		-	
88	Tag Code [7:5], Length of data [4:0]	E6	230		-	Colorimetry Data Block , 6 Byte
89	Extended Tag Code	06	6		-	HDR Static Metadata Data Block
8A	Supported Electro-Optical Transfer Function	05	5		-	Traditional gamma SDR, SMPTE ST 2084 [2],
8B	SM_0 =1: Static Metadata Type 1	01	1		-	Static Metadata Type 1,
8C	Desired Content Max Luminance data	60	96		-	400 nit
8D	Desired Content Max Frame-average Luminance data	60	96		-	400 nit
8E	Desired Content Min Luminance data	28	40		-	0.00025 nit
8F		00	0		-	Unused
90		00	0			Unused
91		00	0			Unused
92		00	0			Unused
93		00	0			Unused
94		00	0			Unused
95		00	0			Unused
96		00	0			Unused
97		00	0			Unused
98		00	0			Unused
99		00	0			Unused
9A		00	0			Unused
9B		00	0			Unused
9C		00	0			Unused
9D		00	0			Unused
9E		00	0			Unused
9F		00	0			Unused
A0		00	0			Unused
A1		00	0			Unused
A2		00	0			Unused
A3		00	0			Unused
A4		00	0			Unused
A5		00	0			Unused

A6		00	0			Unused
A7		00	0			Unused
A8		00	0			Unused
A9		00	0			Unused
AA		00	0			Unused
AB		00	0			Unused
AC		00	0			Unused
AD		00	0			Unused
AE		00	0			Unused
AF		00	0			Unused
B0		00	0			Unused
B1		00	0			Unused
B2		00	0			Unused
B3		00	0			Unused
B4		00	0			Unused
B5		00	0			Unused
B6		00	0			Unused
B7		00	0			Unused
B8		00	0			Unused
B9		00	0			Unused
BA		00	0			Unused
BB		00	0			Unused
BC		00	0			Unused
BD		00	0			Unused
BE		00	0			Unused
BF		00	0			Unused
C0		00	0			Unused
C1		00	0			Unused
C2		00	0			Unused
C3		00	0			Unused
C4		00	0			Unused
C5		00	0			Unused
C6		00	0			Unused
C7		00	0			Unused

C8		00	0			Unused
C9		00	0			Unused
CA		00	0			Unused
CB		00	0			Unused
CC		00	0			Unused
CD		00	0			Unused
CE		00	0			Unused
CF		00	0			Unused
D0		00	0			Unused
D1		00	0			Unused
D2		00	0			Unused
D3		00	0			Unused
D4		00	0			Unused
D5		00	0			Unused
D6		00	0			Unused
D7		00	0			Unused
D8		00	0			Unused
D9		00	0			Unused
DA		00	0			Unused
DB		00	0			Unused
DC		00	0			Unused
DD		00	0			Unused
DE		00	0			Unused
DF		00	0			Unused
E0		00	0			Unused
E1		00	0			Unused
E2		00	0			Unused
E3		00	0			Unused
E4		00	0			Unused
E5		00	0			Unused
E6		00	0			Unused
E7		00	0			Unused
E8		00	0			Unused
E9		00	0			Unused
EA		00	0			Unused
EB		00	0			Unused

EC		00	0			Unused
ED		00	0			Unused
EE		00	0			Unused
EF		00	0			Unused
F0		00	0			Unused
F1		00	0			Unused
F2		00	0			Unused
F3		00	0			Unused
F4		00	0			Unused
F5		00	0			Unused
F6		00	0			Unused
F7		00	0			Unused
F8		00	0			Unused
F9		00	0			Unused
FA		00	0			Unused
FB		00	0			Unused
FC		00	0			Unused
FD		00	0			Unused
FE		00	0			Unused
FF	Checksum	AA	170			