PV156FHM-N20

Final Product Specification

Rev. 0

CHONGQING BOE OPTOELECTRONICS TECHNOLOGY CO.,LTD

REVISION HISTORY

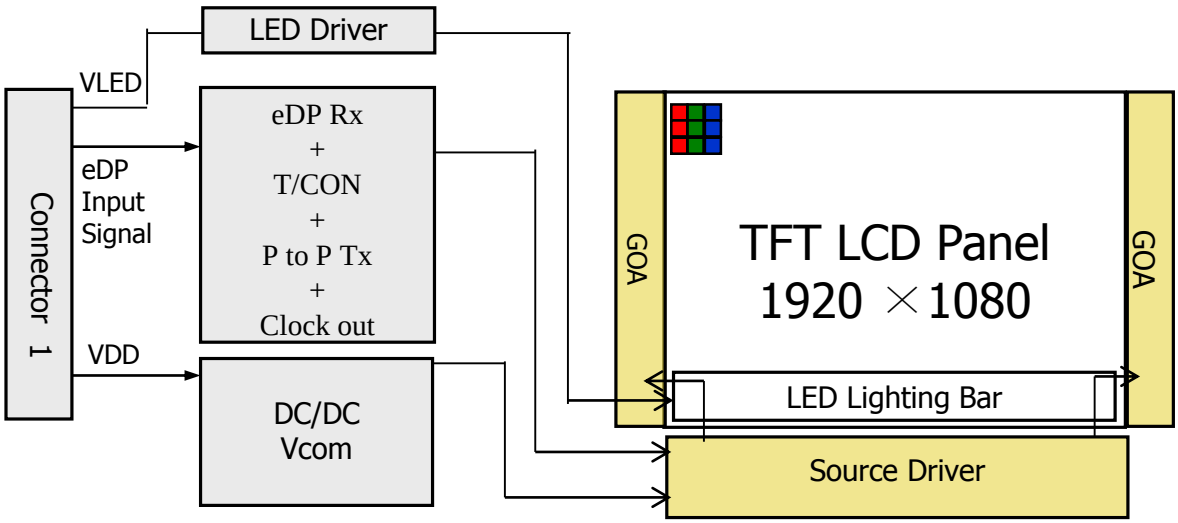
REV.	ECN No.	DESCRIPTION OF CHANGES	DATE	PREPARED
P1	-	Initial Release	2019.11.20	Li Lu
0	-	Final Release	2020.03.24	Li Lu

Contents

1.0 GENERAL DESCRIPTION

1.1 Introduction

PV156FHM-N20 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 FHD resolutions (1920 horizontal by 1080vertical pixel array). Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical Stripe and this module can display 262,144 colors. 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 eDP1.2 interface compatible.



1.2 Features

- 2 lane eDP Interface with 2.7Gbps Link Rates
- Thin and light weight
- 6-bit color depth, display 262K colors
- Single LED Lighting Bar. (Down side/Horizontal Direction)
- Green Product (RoHS & Halogen free product)
- On board LED Driving circuit
- Low driving voltage and low power consumption
- On board EDID chip

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1.3 Application

- ATM/VTM Device
- Cash Register Device
- Self-Service Terminal Device
- Desktop Display Device
- Financial Payment Device

1.4 General Specification

The followings are general specifications at the model PV156FHM-N20 (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	0.17925 (H) X 0.17925 (V)	mm	
Pixel arrangement	RGB Vertical stripe		
Display colors	262K	colors	
Display mode	Normally Black		
Dimensional outline	359.5(H)*223.8(V) (W/PCB)*3.2(Max)	mm	
Weight	350 max	g	
Thickness	3.2max	mm	
Surface treatment	AG		
Back-light	Lower Down side, 1-LED Lighting Bar type		Note 1
Power consumption	P_D : 1.0	W	@mosaic
	P_{BL} :5.3(max)	W	
	P_{total} :6.3	W	@mosaic

Notes : 1. LED Lighting Bar (40*LED Array)

2.0 ABSOLUTE MAXIMUM RATINGS

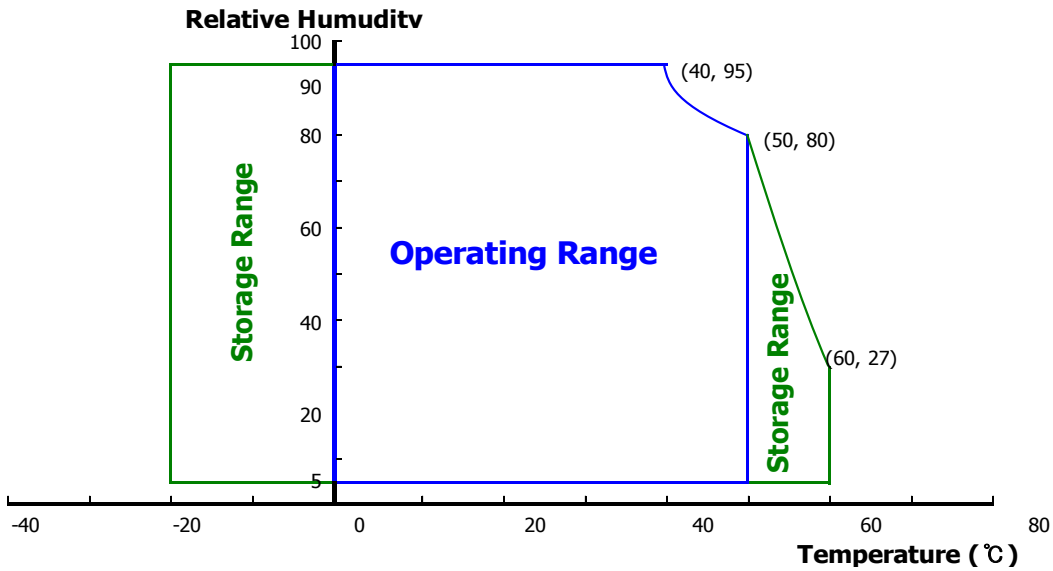
The followings are maximum values which, if exceed, may cause faulty operation or damage to the unit. The operational and non-operational maximum voltage and current values are listed in Table 2.

< 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	℃	Note 2
Storage Temperature	T_{ST}	-20	+60	℃	

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 ^{O}C ≥ Ta)
Maximum wet - bulb temperature at 39 ^{O}C or less. (Ta > 40 ^{O}C) No condensation.



3.0 ELECTRICAL SPECIFICATIONS

3.1 Electrical Specifications

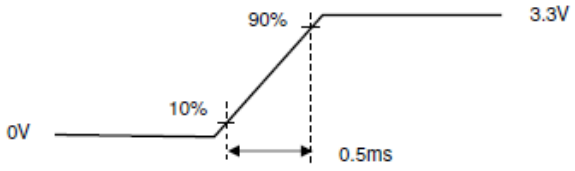
< Table 3. Electrical specifications > Ta=25+/-2°C

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}	-	-	100	mV	At V_{DD} = 3.3V
Power Supply Current	I_{DD}	-	273	452	mA	Note 1
Power Supply Inrush Current	Inrush	-	-	2.0	A	Note3
Differential Input Voltage	V_{ID}	120	-	1200	mV	
Power Consumption	P_D	-	1.0	1.5	W	Note 1
	P_{BL}	-	-	5.3	W	Note 2
	P_{total}	-	-	6.8	W	

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℃.
a) Typ. : Mosaic Pattern
b) Max.: R/G/B patterns

2. IF × VF ×40/ efficiency = PLED

3. Measure Condition



Vin rising time

3.2 Backlight Unit

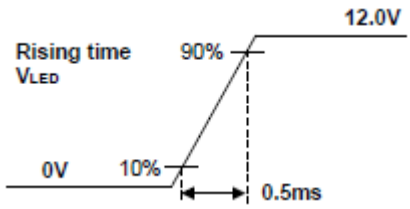
< Table 4. LED Driving guideline specifications > Ta=25+/-2°C

Parameter			Min.	Typ.	Max.	Unit	Remarks
LED Forward Voltage		V_F	-	-	3.1	V	-
LED Forward Current		I_F	-	34	-	mA	-
LED Power Consumption		P_{LED}		-	4.96	W	Note 1
LED Power Inrush Current		Irush			1.5	A	Note4
LED Life-Time		N/A	30,000	-	-	Hour	I_F = 34mA
Power supply voltage for LED Driver		V_{LED}	8	12	21	V	
EN Control Level	Backlight on		2.2		5.0	V	
	Backlight off		0		0.6	V	
PWM Control Level	PWM High Level		2.2		5.0	V	
	PWM Low Level		0		0.6	V	
PWM Control Frequency		F_{PWM}	200	-	10,000	Hz	
Duty Ratio		-	1	-	100	%	Note3

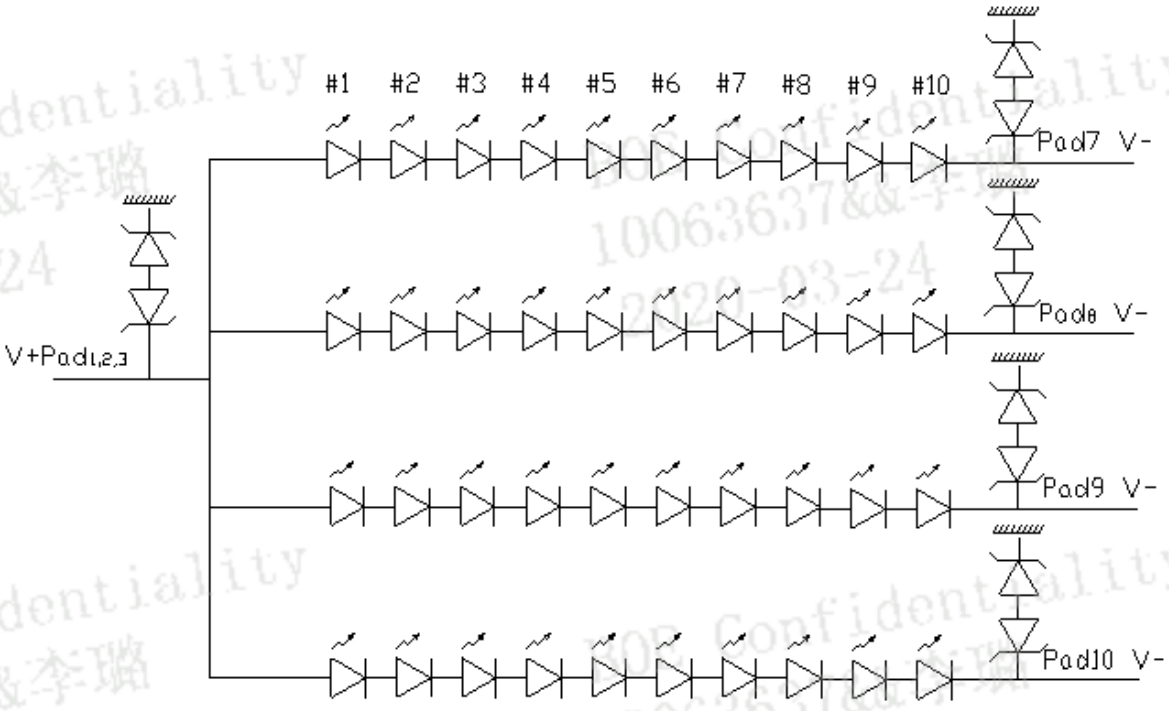
Notes : 1. Power supply voltage12V for LED Driver

Calculator Value for $I_F \times V_F \times 40 / 0.85\%$(efficiency) = P_{LED}

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 1KHz.
4. Test condition:



3.3 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℃) with the equipment of Luminance meter system (Goniometer system and PR730) 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	-	85	-	Deg.	Note 1
		Θ_9		-	85	-	Deg.	
	Vertical	Θ_{12}		-	85	-	Deg.	
		Θ_6		-	85	-	Deg.	
Luminance Contrast ratio		CR	Θ = 0°	-	800			Note 2
Luminance of White	5 Points	Y_w	Θ = 0° I_{LED} = 34mA	320	400	-	cd/m^2	Note 3
White Luminance uniformity	5 Points	ΔY5		80	-	-		Note 4
	13 Points	ΔY13		65	-	-		
White Chromaticity		x_w	Θ = 0°	0.283	0.313	0.343		Note 5
		y_w		0.299	0.329	0.359		
Reproduction of color	Red	x_R	Θ = 0°	-0.03	0.59	+0.03		
		y_R			0.35			
	Green	x_G			0.33			
		y_G			0.555			
	Blue	x_B			0.153			
		y_B			0.119			
Gamut					45		%	
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 1).

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 1) 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 2 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 2 and FIGURE 3).

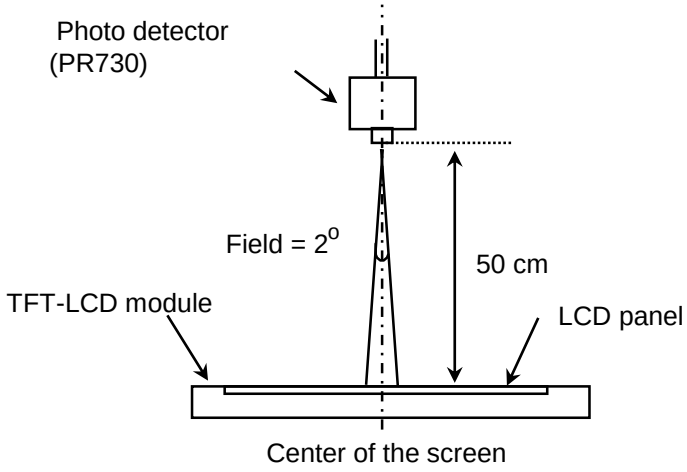
5. The color chromaticity coordinates specified in Table 5 shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.

6. The electro-optical response time measurements shall be made as FIGURE 4 by switching the "data" input signal ON and OFF. The times needed for the luminance to change from 10% to 90% is Tr, and 90% to 10% is Td.

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 5).

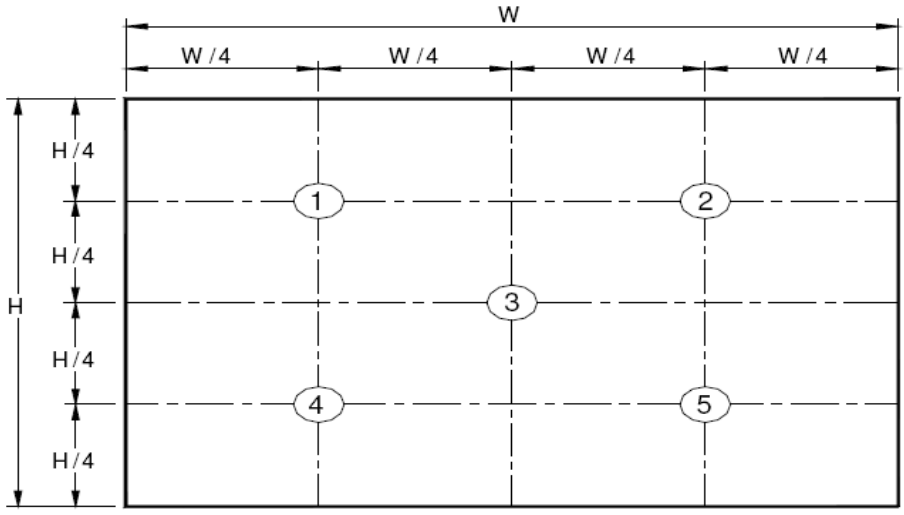
4.3 Optical measurements

Figure 1. Measurement Set Up



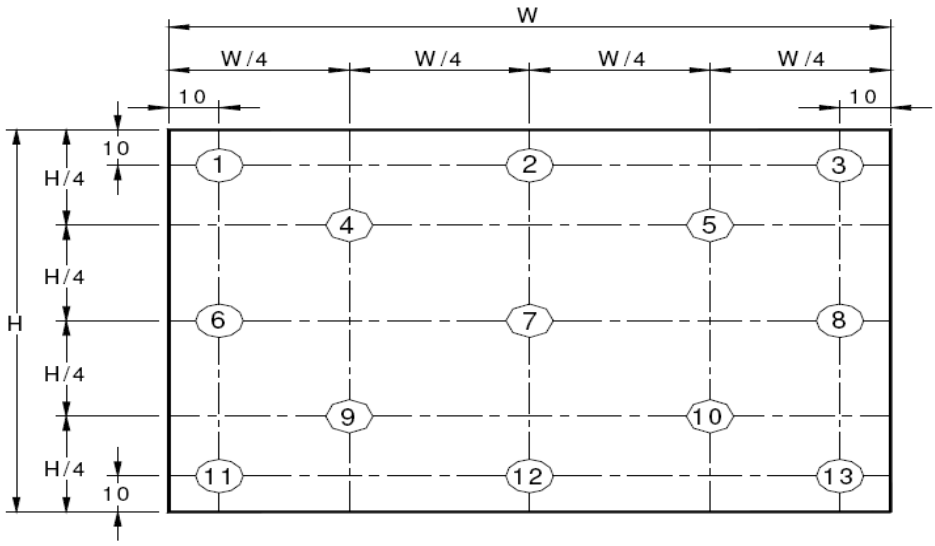
Optical characteristics measurement setup

Figure 2. White Luminance and Uniformity Measurement Locations (5 points)



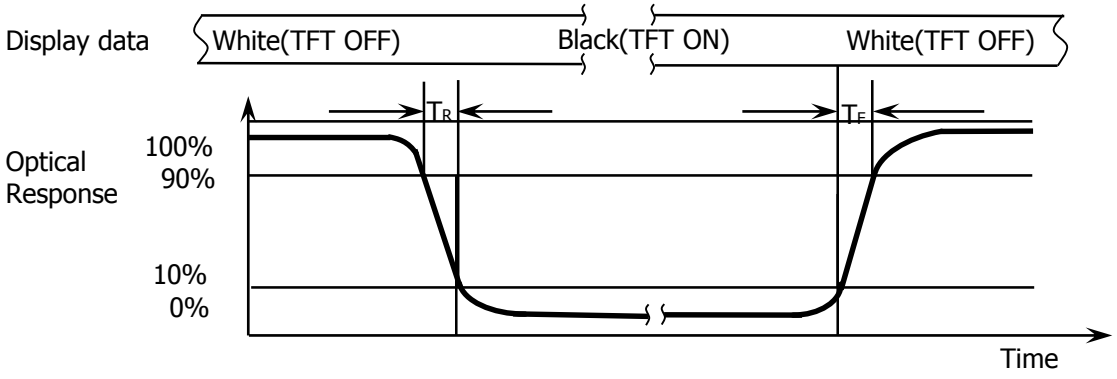
Center Luminance of white is defined as luminance values of center 5 points across the LCD surface. Luminance shall be measured with all pixels in the view field set first to white. This measurement shall be taken at the locations shown in FIGURE 2 for a total of the measurements per display.

Figure 3. Uniformity Measurement Locations (13 points)



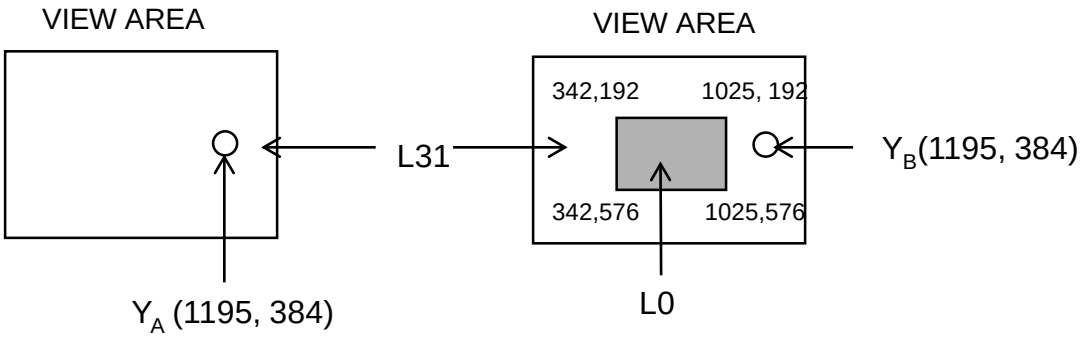
The White luminance uniformity on LCD surface is then expressed as : ΔY5 = Minimum Luminance of five points / Maximum Luminance of five points (see FIGURE 2) , ΔY13 = Minimum Luminance of 13 points /Maximum Luminance of 13 points (see FIGURE 3).

Figure 4. Response Time Testing



The electro-optical response time measurements shall be made as shown in FIGURE 4 by switching the “data” input signal ON and OFF. The times needed for the luminance to change from 10% to 90% is Td and 90% to 10% is Tr.

Figure 5. Cross Modulation Test Description



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

Where:

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

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

The location measured will be exactly the same in both patterns

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 5).

5.0 INTERFACE CONNECTION.

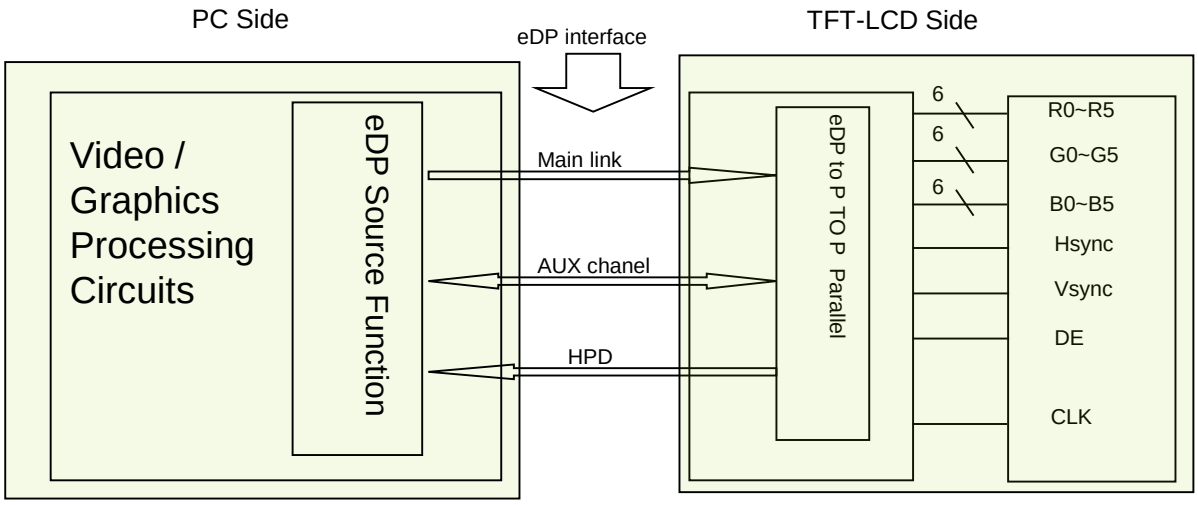
5.1 Electrical Interface Connection

The electronics interface connector is UJU IS050-L30B-C10(30P).
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	LCD_Self_Test	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 8V-21V
27	BL_POWER	LED Power Supply 8V-21V
28	BL_POWER	LED Power Supply 8V-21V
29	BL_POWER	LED Power Supply 8V-21V
30	NC	No Connection

5-2. eDP Interface



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

5.3.eDP Input signal

Lane 0	Lane 1
R0-5:0|G0-5:4	R1-5:0|G1-5:4
G0-3:0|B0-5:2	G1-3:0|B1-5:2
B0-1:0|R2-5:0	B1-1:0|R3-5:0
G2-5:0|B2-5:4	G3-5:0|B3-5:4
B2-3:0|R4-5:2	B3-3:0|R5-5:2
R4-1:0|G4-5:0	R5-1:0|G5-5:0
B4-5:0|R6-5:4	B5-5:0|R7-5:4
R6-3:0|G6-5:2	R7-3:0|G7-5:2
G6-1:0|B6-5:0	G7-1:0|B7-5:0

5.4 Back-light & LCM Interface Connection

Interface Connector: **STM MSK24022P10**

<Table 7. Pin Assignments for the BLU & LCM Connector>

Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	Vout	LED anode connection	6	NC	No Connection
2	Vout	LED anode connection	7	LED1	LED cathode connection
3	Vout	LED anode connection	8	LED2	LED cathode connection
4	NC	No Connection	9	LED3	LED cathode connection
5	GND	GND	10	LED4	LED cathode connection

6.0 SIGNAL TIMING SPECIFICATION

6.1 The PV156FHM-N20 is operated by the DE only.

Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	139.7	141.4	150.4	MHz
Frame Period		Tv	1100	1120	1140	lines
			-	60	-	Hz
			-	16.7	-	ms
Vertical Display Period		Tvd	-	1080	-	lines
One line Scanning Period		Th	2080	2100	2100	clocks
Horizontal Display Period		Thd	-	1920	-	clocks

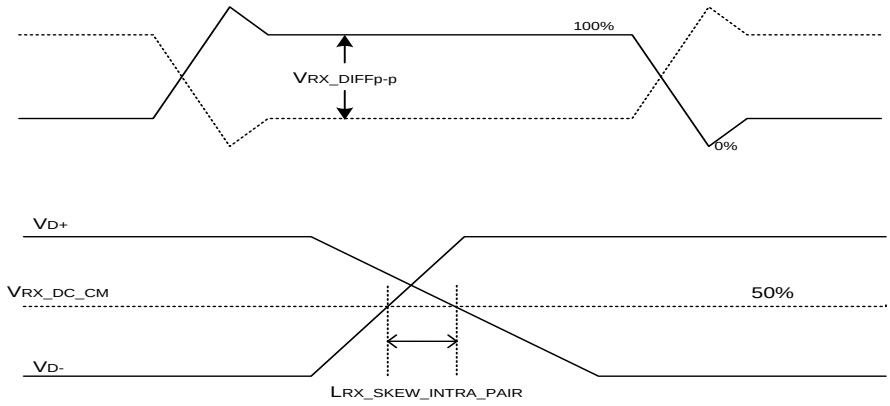
Note※: This Module can support frame refresh rate 60Hz .

6.2 eDP Rx Interface Timing Parameter

The specification of the eDP Rx interface timing parameter is shown in Table 8.

<Table 8. eDP Rx Interface Timing Specification>

Item	Symbol	Min	Typ	Max	Unit	Remark
Spread spectrum clock	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	-	2.0	V	
Differential termination resistance	$R_{RX-DIFF}$	80	100	120	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	$L_{RX\_SKEW\_INTRA\_PAIR}$	-	-	60	ps	



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

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

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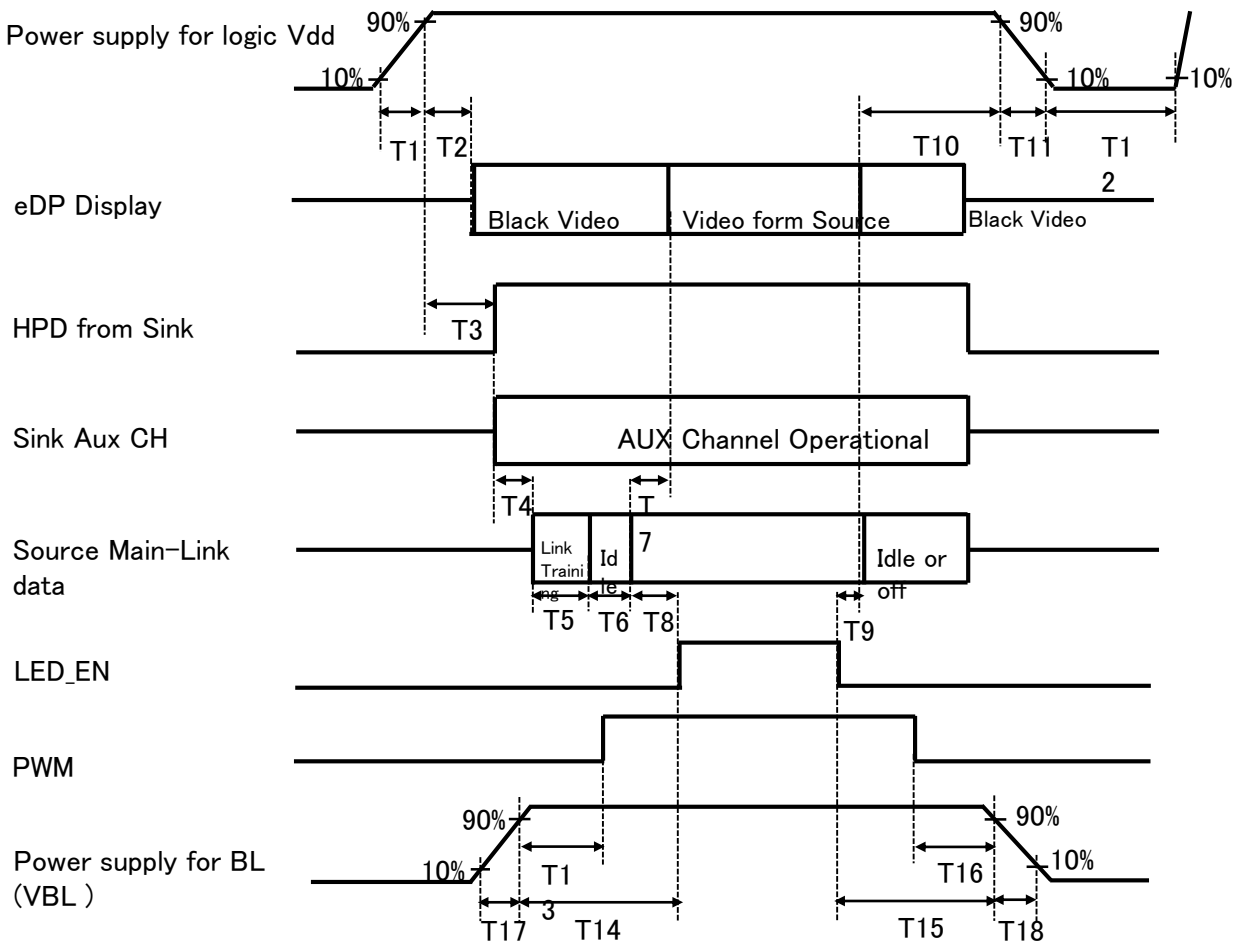
8.0 POWER SEQUENCE

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



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

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

Connector Name /Description	**For Signal Connector**
Manufacturer	UJU
Type/ Part Number	IS050-L30B-C10 or Compatible
Mating housing/ Part Number	I-PEX 20454-030T or Compatible

10.0 MECHANICAL CHARACTERISTICS

10.1 Dimensional Requirements

FIGURE 6 shows mechanical outlines for the model PV156FHM-N20 .
Other parameters are shown in Table 9.

<Table 9. Dimensional Parameters>

Parameter	Specification	Unit
Active Area	344.16 (H) ×193.59(V)	
Number of pixels	1920 (H) X 1080 (V) (1 pixel = R + G + B dots)	
Pixel pitch	0.17925 (H) X 0.17925 (V)	mm
Pixel arrangement	RGB Vertical stripe	
Display colors	262K	
Display mode	Normally Black	
Dimensional outline	359.5(H)*223.8(V) (W/PCB)*3.2(Max)	mm
Weight	350(Max)	gram
Back Light	Connector : MSK24022P10	
	LED, Horizontal-LED Array type	

10.2 Mounting

See FIGURE 6.

10.3 Anti-Glare and Polarizer Hardness.

The surface of the LCD has an AG 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 10. Reliability test>

No	Test Items	Conditions
1	High temperature storage test	Ta = 60 ℃, 240 hrs
2	Low temperature storage test	Ta = -20 ℃, 240 hrs
3	High temperature & high humidity operation test	Ta = 50 ℃, 80%RH, 240 hrs
4	High temperature operation test	Ta = 50 ℃, 240 hrs
5	Low temperature operation test	Ta = 0 ℃, 240 hrs
6	Thermal shock	Ta = -20 ℃ ↔ 60 ℃ (0.5 hr), 100 cycle
7	Vibration test (non-operating)	1.5G, 10~500Hz,Half Sine X,Y,Z / Sweep rate : 1 hour
8	Shock test (non-operating)	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

12.0 PRECAUTIONS

Please pay attention to the followings when you use this TFT LCD Panel.

12.1 Mounting Precautions

•Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

•You must mount a Panel using specified mounting holes (Details refer to the drawings)

•You should consider the mounting structure so that uneven force (ex. Twisted stress, Concentrated stress)is not applied to the Panel. And the case on which a Panel is mounted should have sufficient strength so that external force is not transmitted directly to the Panel.

•Do not apply mechanical stress or static pressure on Panel; Abnormal display cause by pressing some parts of Panel during assembly process , do not belong to product failure, the press should be agreed by two sides.

•Determine the optimum mounting angle, refer to the viewing angle range in the specification for each model.

•Do not apply mechanical stress or static pressure on Panel , and avoid impact, vibration and falling.

•Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.

•Protection film for polarizer on the Panel should be slowly peeled off before display.

•Be careful to prevent water & chemicals contact the Panel surface.

•You should adopt radiation structure to satisfy the temperature specification.

•Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.

Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics are detrimental to the polarizer.)

•When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane & alcohol is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene , because they cause chemical damage to the polarizer.

•Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading..

- This Panel has its circuitry PCB's on the rear side and Driver IC, should be handled carefully in order not to be stressed.
- Avoid impose stress on PCB and Driver IC during assembly process ,Do not drawing, bending, COF package & wire
- Do not disassemble the Panel.

12.2 Operating Precautions

- Do not connector or disconnect the cable to/from the Panel at the "Power On" Condition.
- When the Panel is operating, do not lose CLK, ENAB signals. If any one of these signals is lost, the Panel would be damaged.
- Obey the supply voltage sequence. If wrong sequence is applied, the Panel would be damaged.
- Do not allow to adjust the adjustable resistance or switch
- The electrochemical reaction caused by DC voltage will lead to LCD Panel degradation, so DC drive should be avoided.
- The LCD Panels use C-MOS LSI drivers, so customers are recommended that any unused input terminal would be connected to Vdd or Vss, do not input any signals before power is turn on, and ground you body, work/assembly area, assembly equipment to protect against static electricity.
- Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on) Otherwise the Panel may be damaged.
- Panel has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.
- Design the length of cable to connect between the connector for back-light and the converter as shorter as possible and the shorter cable shall be connected directly , The long cable between back-light and Converter may cause the Luminance of LED to lower and need a higher startup voltage
- The cables should be as short as possible between System Board and PCB interface.
- Connectors are precision devices to transmit electrical signals, and operators should plug in parallel
- Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.

12.3 Electrostatic Discharge Precautions

- Avoid the use work clothing made of synthetic fibers. We recommend cotton clothing or other conductivity-treated fibers.
- Since a Panel is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc.
- Do not close to static electricity to avoid product damage.
- Do not touch interface pin directly.

12.4 Precautions for Strong Light Exposure

- Do not leave the Panel operation or storage in Strong light . Strong light exposure causes degradation of polarizer and color filter.

12.5 Precautions for Storage

A. Atmosphere Requirement

ITEM	UNIT	MIN	MAX
Storage Temperature	(℃)	5	40
Storage Humidity	(%rH)	40	75
Storage Life	6 months		
Storage Condition	• The storage room should be equipped with a dark and good ventilation facility. • Prevent products from being exposed to the direct sunlight, moisture and water. • The product need to keep away from organic solvent and corrosive gas. • Be careful for condensation at sudden temperature change. • Storage condition is guaranteed under packing conditions.		

B. Package Requirement

•The product should be placed in a sealed polythene bag.

•Product Should be placed on the pallet, Which is away from the floor, Be cautions not to pile the product up.

•The polarizer surface should not come in contact with any other object. It is recommended that they be stored in the container in which they were shipped.

•As the original protective film, do not use the adhesive protective film to avoid change of Pol color and characteristic.

12.6 Precautions for protection film

- Remove the protective film slowly, keeping the removing direction approximate 30-degree not vertical from panel surface, If possible, under ESD control device like ion blower, and the humidity of working room should be kept over 50%RH to reduce the risk of static charge.
- People who peeled off the protection film should wear anti-static strap and grounded well.

12.7 Appropriate Condition for Display

-Generally large-sized LCD Panels are designed for consumer applications . Accordingly, long-term display application can cause uneven display including image sticking. To optimize Panel's lifetime and function, several operating usages are required.

1. Normal operating condition

- Temperature: 20±15℃
- Operating Ambient Humidity : 55±20%
- Display pattern: dynamic pattern (Real display)
- Well-ventilated place is recommended to set up display system

2. Special operating condition

a. Ambient condition

- Well-ventilated place is recommended to set up display system.

b. Power and screen save

- Periodical power-off or screen save is needed after long-term display.

c. As the low temperature, the response time is greatly delayed. As the high temperatures (higher than the operating temperature) the LCD Panel may turn black screen. The above phenomenon cannot explain the failure of the display. When the temperature returns to the normal operating temperature, the LCD Panel will return to normal display.

d. When expose to drastic fluctuation of temperature (hot to cold or cold to hot） ,the LCD Panel may be affected; Specifically, drastic temperature fluctuation from cold to hot ,produces dew on the LCD Panel ‘s surface which may affect the operation of the polarizer and LCD Panel

e. Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on) Otherwise the Panel may be damaged.

f. Product reliability and functions are only guaranteed when the product is used under right operation usages. If product will be used in extreme conditions such as high temperature, high humidity, high altitude, special display images, running time, long time operation, outdoor operation, etc. It is strongly recommended to contact BOE for filed application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at airports, transit stations, banks, stock market and controlling systems.

3. Operating usages to protect against image sticking due to long-term static display.

a. Suitable operating time: under 20 hours a day.

b. Static information display recommended to use with moving image.

- Cycling display between 5 minutes' information(static) display and 10 seconds' moving image.

c. Background and character (image) color change

- Use different colors for background and character, respectively.
- Change colors themselves periodically.

d. Avoid combination of background and character with large different luminance.

1) Abnormal condition just means conditions except normal condition.

2) Black image or moving image is strongly recommended as a screen save

12.8 Other Precautions

A. LC Leak

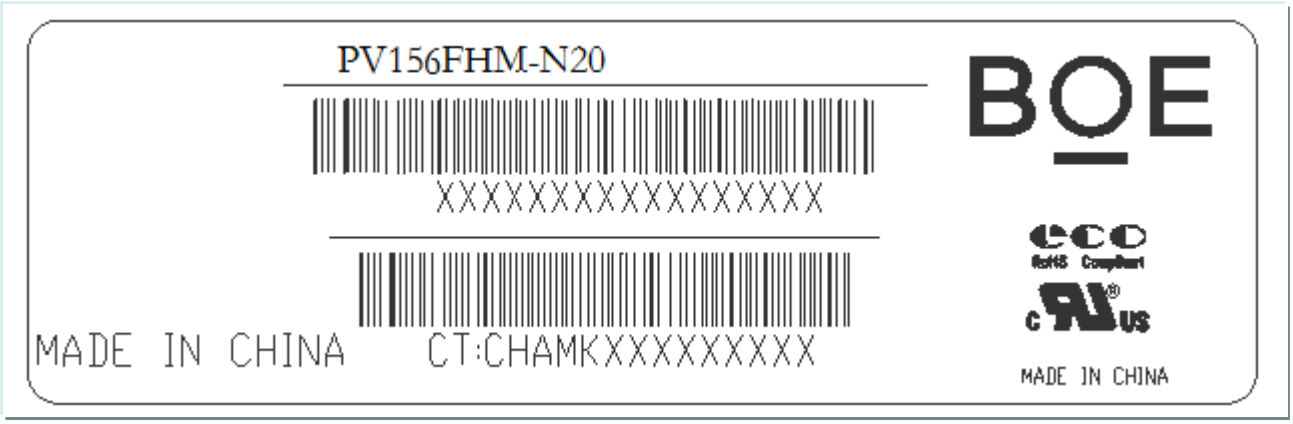
- If the liquid crystal material leaks from the panel, it is recommended to wash the LC with acetone or ethanol and then burn it.
- If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth. In case of contact with hands, skin or clothes, it has to be washed away thoroughly with soap.
- If LC in mouth, mouth need to be washed, drink plenty of water to induce vomiting and follow medical advice.
- If LC touch eyes, eyes need to be washed with running water at least 15 minutes.

B. Rework

- When returning the Panel for repair or etc., Please pack the Panel not to be broken. We recommend to use the original shipping packages.

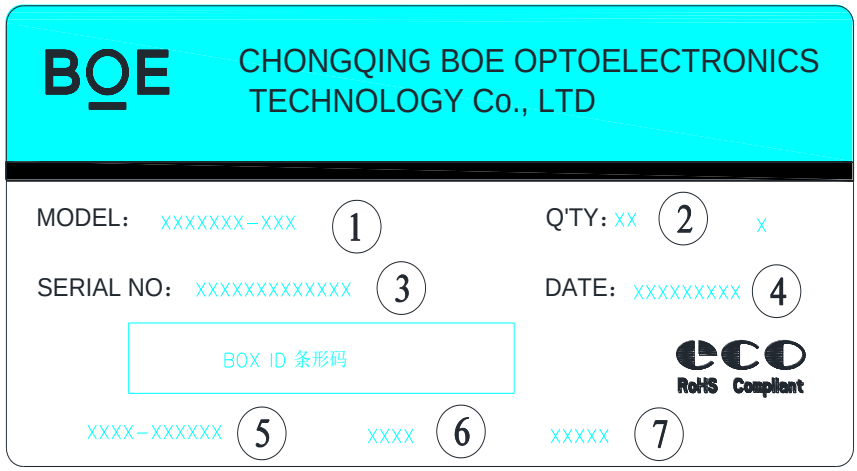
13.0 LABEL

(1) MDL label



Digit / Code	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Code	S	L	S	5	1	2	3	5	9	4	2	0	0	0	1	D	B
Description	Model Code /GBN		Grade	Line	Year		Month	Model Extension Code (Last 4 Digits Of FGCOD)				Serial No 00001-ZZZZZZ					

(2) Box label



The marked part of serial number needs to print, show as follows:

1. FG - CODE (The first 12 digits) 2. The number of products
3. Box ID 4.Packing date
5. Material number (the client)
6. The last four digits of FG - Code
7. Supplier code - no printing, the space reserved

Total Size: 110 x 55 mm

Digit / Code	1	2	3	4	5	6	7	8	9	10	11	12	13
Code	S	L	S	F	1	2	3	D	0	0	0	6	8
Description	Products GBN		Grade	Line	Year		Month	Revision Code	Serial No				

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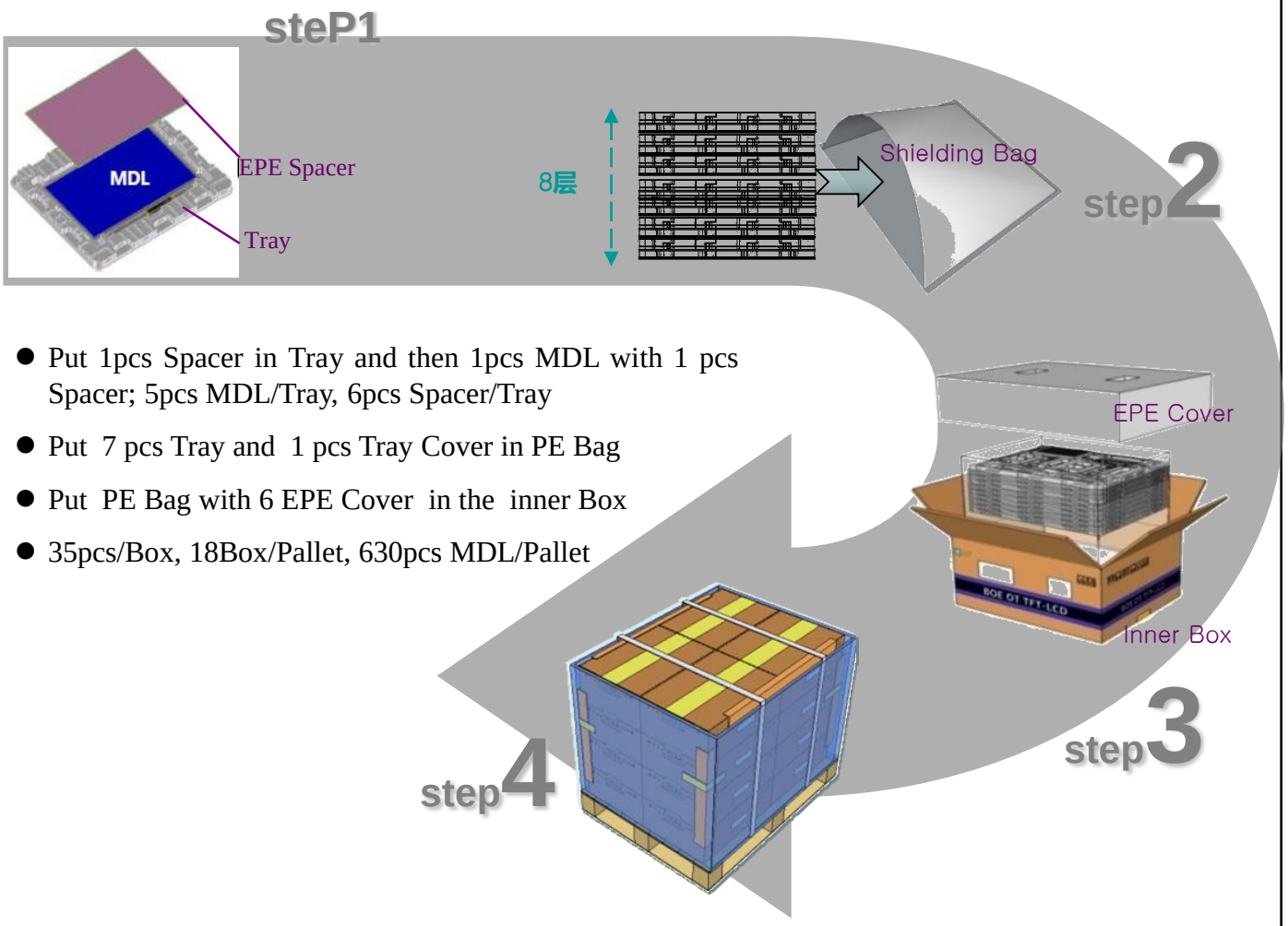
14.0 PACKING INFORMATION

14.1 Packing order



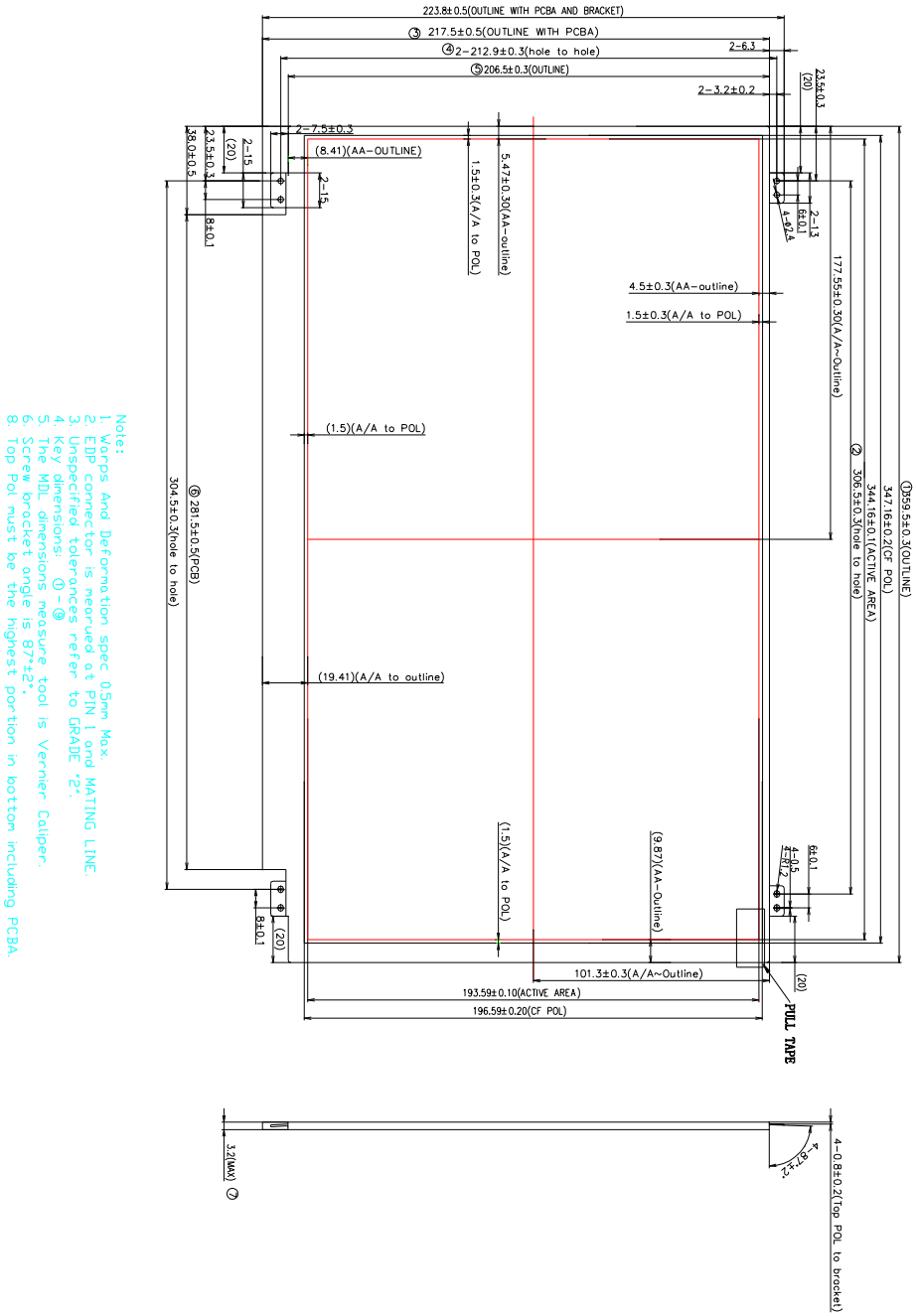
- Put 1pcs Spacer in Tray and then 1pcs MDL with 1 pcs Spacer; 5pcs MDL/Tray, 6pcs Spacer/Tray
- Put 7 pcs Tray and 1 pcs Tray Cover in PE Bag
- Put PE Bag with 6 EPE Cover in the inner Box
- 35pcs/Box, 18Box/Pallet, 630pcs MDL/Pallet

14.2 Notes

- Box dimension: 480mm*350mm*285mm
- Package quantity in one box: 35pcs
- Total weight: 15.7kg/Box

15.0 MECHANICAL OUTLINE DIMENSION

Figure 6. TFT-LCD Module Outline Dimension (Front View)



Note:
1. Warps And Deformation spec 0.5mm Max.
2. EDP connector is mearued at PIN 1 and MATING LINE.
3. Unspecified tolerances refer to GRADE "2".
4. Key dimensions: ①-③
5. The MDL dimensions measure tool is Vernier Caliper.
6. Screw bracket angle is 87°±2°.
8. Top Pol must be the highest portion in bottom including PCBA.

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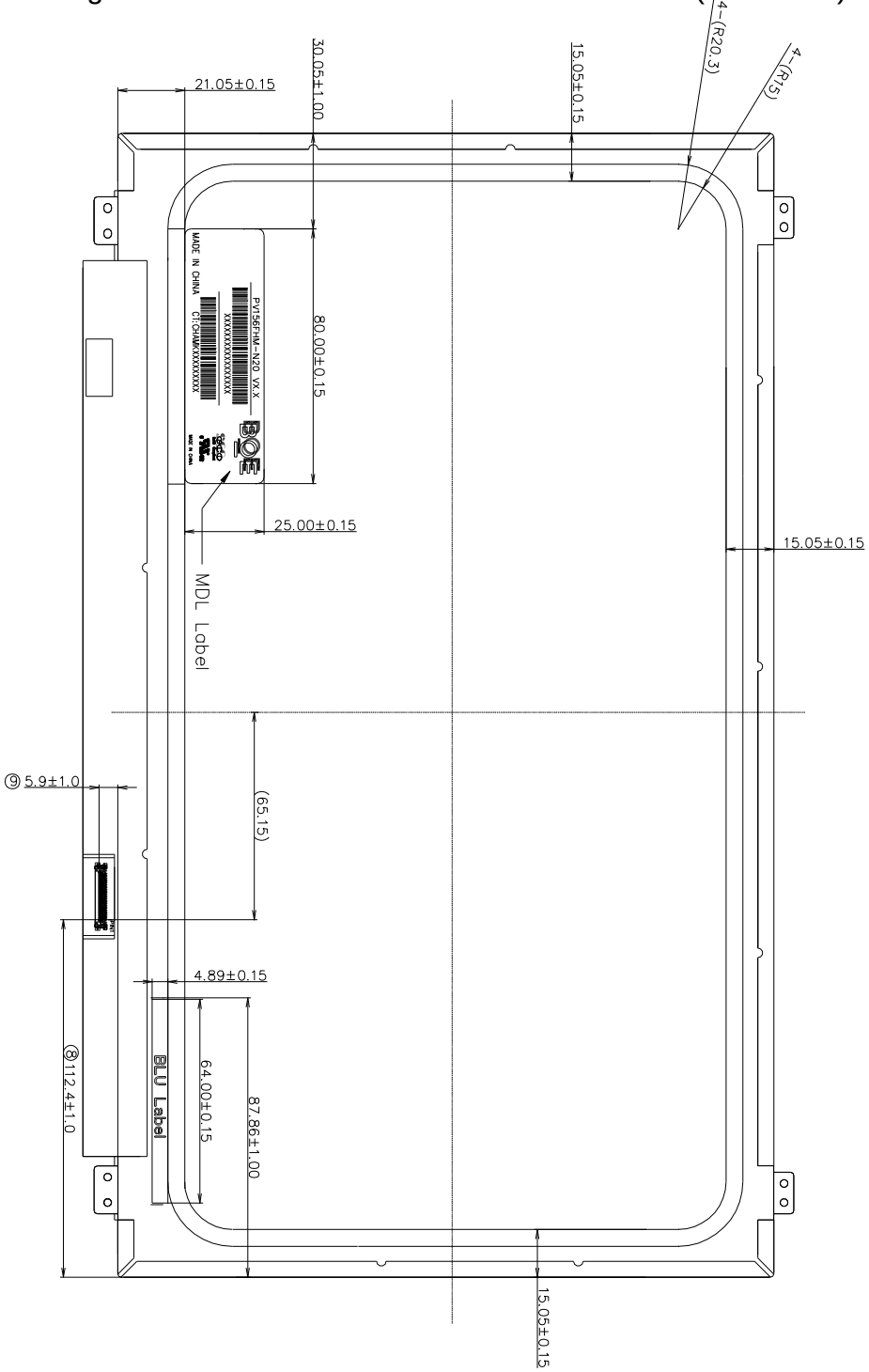
Figure 7. TFT-LCD Module Outline Dimensions (Rear view)



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16.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	D1	209		2257	ID = 2257
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	1C	28		28	
11	Year of Manufacture	1D	29		2019	Manufactured in 2019
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	95	149		-	digital signal/DP input
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		2.2	Gamma curve = 2.2
18	Feature support	02	2		-	RGB display, Preferred Timming mode
19	Red/Green low bits	24	36		-	Red / Green Low Bits
1A	Blue/White low bits	10	16		-	Blue / White Low Bits
1B	Red x high bits	97	151	606	0.592	Red (x) = 10010111 (0.592)
1C	Red y high bits	59	89	358	0.348	Red (y) = 01011001 (0.348)
1D	Green x high bits	54	84	336	0.329	Green (x) = 01010100 (0.329)
1E	Green y high bits	8E	142	571	0.558	Green (y) = 10001110 (0.558)
1F	Blue x high bits	27	39	156	0.153	Blue (x) = 00100111 (0.153)
20	BLue y high bits	1E	30	122	0.120	Blue (y) = 00011110 (0.12)
21	White x high bits	50	80	320	0.313	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	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	20	32		141.1	141.12MHz Main clock
37		37	55			
38		80	128		1920	Hor Active = 1920
39		B4	180		180	Hor Blanking = 180
3A		70	112		-	4 bits of Hor. Active + 4 bits of Hor. Blanking
3B		38	56		1080	Ver Active = 1080
3C		28	40		40	Ver Blanking = 40
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		C1	193		193	Vertical Image Size = 193 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		-	RGB display, Preferred Timming mode

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48	Detailed timing/monitor descriptor #2	00	0			0MHz Main clock
49		00	0			
4A		00	0			Hor Active = 0
4B		00	0			Hor Blanking = 0
4C		00	0		-	4 bits of Hor. Active + 4 bits of Hor. Blanking
4D		00	0		1080	Ver Active = 0
4E		00	0		40	Ver Blanking = 0
4F		00	0		-	4 bits of Ver. Active + 4 bits of Ver. Blanking
50		00	0		100	Hor Sync Offset = 0
51		00	0		100	H Sync Pulse Width = 0
52		00	0		20	V sync Offset = 0 line
53		00	0		20	V Sync Pulse width : 0 line
54		00	0		344	Horizontal Image Size = 0 mm (Low 8 bits)
55		00	0		193	Vertical Image Size = 0 mm (Low 8 bits)
56		00	0		-	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		-	
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			

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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		50	80		P	Model name:PV156FHM-N20
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		32	50		2	
7C		30	48		0	
7D		0A	10			
7E	Extension flag	00	0		1	0 ：1個EDID；N-1：N个EDID
7F	Checksum	7D	125	125	-	