



Product Specification

G156XTN01.2

AU OPTRONICS CORPORATION

() Preliminary Specification

(V) Final Specification

Module	15.6 Inch Color TFT-LCD
Model Name	G156XTN01.2

<table><tr><td>Customer</td><td>Date</td></tr><tr><td> </td><td> </td></tr><tr><td>Checked & Approved by</td><td>Date</td></tr><tr><td> </td><td> </td></tr></table>	Customer	Date			Checked & Approved by	Date			<table><tr><td>Approved by</td><td>Date</td></tr><tr><td><u>Sean Lin</u></td><td><u>01/20/2020</u></td></tr><tr><td>Prepared by</td><td>Date</td></tr><tr><td><u>Sandy Su</u></td><td><u>01/20/2020</u></td></tr></table>	Approved by	Date	<u>Sean Lin</u>	<u>01/20/2020</u>	Prepared by	Date	<u>Sandy Su</u>	<u>01/20/2020</u>
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Customer's sign back page	General Display Business Division / AU Optronics corporation																

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Record of Revision

Version	Date	Page	Old description	New Description																																																																																												
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1. Operating Precautions

- 1) Since front polarizer is easily damaged, please be cautious and not to scratch it.
- 2) Be sure to turn off power supply when inserting or disconnecting from input connector.
- 3) Wipe off water drop immediately. Long contact with water may cause discoloration or spots.
- 4) When the panel surface is soiled, wipe it with absorbent cotton or soft cloth.
- 5) Since the panel is made of glass, it may be broken or cracked if dropped or bumped on hard surface.
- 6) To avoid ESD (Electro Static Discharge) damage, be sure to ground yourself before handling TFT-LCD Module.
- 7) Do not open nor modify the module assembly.
- 8) Do not press the reflector sheet at the back of the module to any direction.
- 9) In case if a module has to be put back into the packing container slot after it was taken out from the container, do not press the center of the LED light bar edge. Instead, press at the far ends of the LED light bar edge softly. Otherwise the TFT Module may be damaged.
- 10) At the insertion or removal of the Signal Interface Connector, be sure not to rotate nor tilt the Interface Connector of the TFT Module.
- 11) TFT-LCD Module is not allowed to be twisted & bent even force is added on module in a very short time. Please design your display product well to avoid external force applying to module by end-user directly.
- 12) Small amount of materials having no flammability grade is used in the LCD module. The LCD module should be supplied by power complied with requirements of Limited Power Source (IEC60950 or UL1950), or be applied exemption.
- 13) Severe temperature condition may result in different luminance, response time and lamp ignition voltage.
- 14) Continuous operating TFT-LCD display under low temperature environment may accelerate lamp exhaustion and reduce luminance dramatically.
- 15) The data on this specification sheet is applicable when LCD module is placed in landscape position.
- 16) Continuous displaying fixed pattern may induce image sticking. It's recommended to use screen saver or shuffle content periodically if fixed pattern is displayed on the screen.



2. General Description

This specification applies to the 15.6 inch-wide Color a-Si TFT-LCD Module G156XTN01.2. The display supports the HD - 1366(H) x 768(V) screen format and 16.7M colors (RGB 6-bits+3-FRC data). Display input signals are eDP(Embedded DisplayPort) interface and this module contains with an LED driver for backlight and touch panel function.

2.1 Display Characteristics

The following items are characteristics summary on the table under 25°C condition:

ITEMS	Unit	SPECIFICATIONS			
Screen Diagonal	[inch]	15.6"			
Active Area	[mm]	344.232 (H) x 193.536 (V)			
Resolution		1366 x 768			
Pixel Pitch	[mm]	0.252 x 0.252			
Pixel Arrangement		R.G.B. Vertical Stripe			
Display Mode		TN Mode, Normally White			
Nominal Input Voltage VDD	[Volt]	+3.3 (typ.)			
LCD Power Consumption	[Watt]	0.63W (Typ.), 0.76 W (Max.) (all black pattern)			
Backlight Consumption Power	[Watt]	4.77W (Typ.), 5.72 W (Max.) (all black pattern)			
Weight	[g]	860 (Typ.)			
Physical Size Include bracket	[mm]		Min.	Typ.	Max.
		Length	363.3	363.8	364.3
		Width	215.4	215.9	216.4
		Thickness	-	9.07	9.57
Electrical Interface		eDP1.2			
Surface Treatment		Anti-Glare, 3H			
Support Color		16.7M			
Temperature Range					
Operating	[°C]	-30 to 85			
Storage (Non-Operating)	[°C]	-30 to 85			
RoHS Compliance		Yes			

2.2 Optical Characteristics

The optical characteristics are measured under stable conditions at 25 °C(Room Temperature:

Item	Unit	Conditions	Min.	Typ.	Max.	Note
White Luminance (Center)	cd/m ²	I _{LED} =45mA (center point)	360	450		1
Luminance Uniformity	%	5 points	70	75	-	2,3
Contrast ratio	--		500	800	-	4
Response Time	msec	Rising (Tr)+ Falling (Tf)	-	10	-	5
Viewing Angle	[degree]	Horizontal CR >= 10	(Right) 75	85	-	6
			(Left) 75	85	-	
		Vertical CR >= 10	(Upper) 60	70	-	
			(Lower) 70	80	-	
Color / Chromaticity Coordinate (CIE 1931)	--	Red x	0.570	0.620	0.670	
		Red y	0.300	0.350	0.400	
		Green x	0.274	0.324	0.374	
		Green y	0.570	0.620	0.670	
		Blue x	0.103	0.153	0.203	
		Blue y	0.054	0.104	0.154	
		White x	0.263	0.313	0.363	
		White y	0.279	0.329	0.379	
Color Gamut	%	CIE 1931	-	62	-	

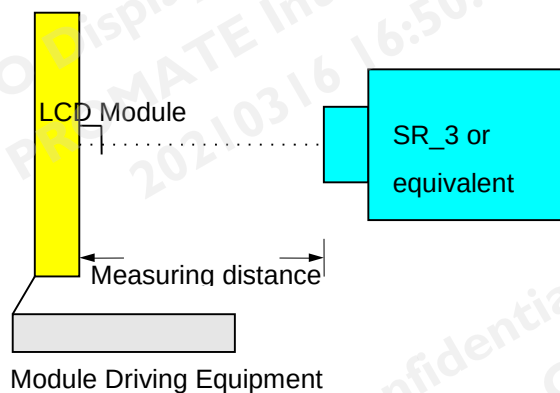
Note 1: Measurement method

Equipment Pattern Generator, Power Supply, Digital Voltmeter, Luminance meter (SR_3 or equivalent)

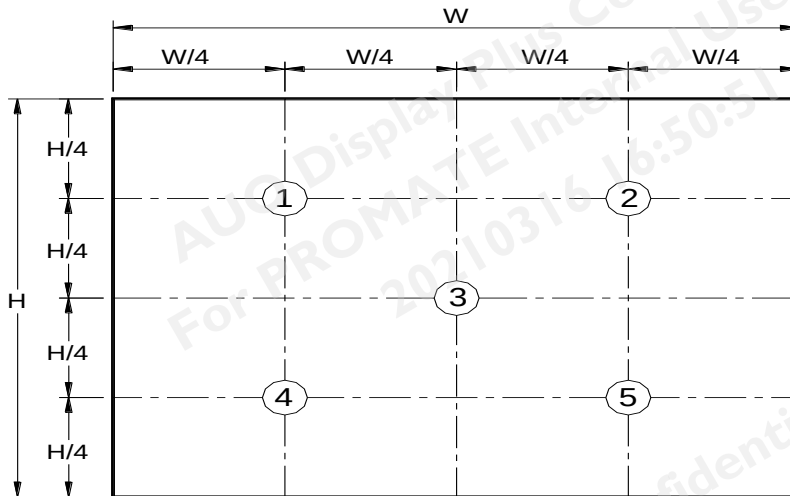
Aperture 1ø with 50cm viewing distance

Test Point Center

Environment < 1 lux



Note 2: Definition of 5 points position



Note 3: The luminance uniformity of 5 points is defined by dividing the minimum luminance values by the maximum test point luminance

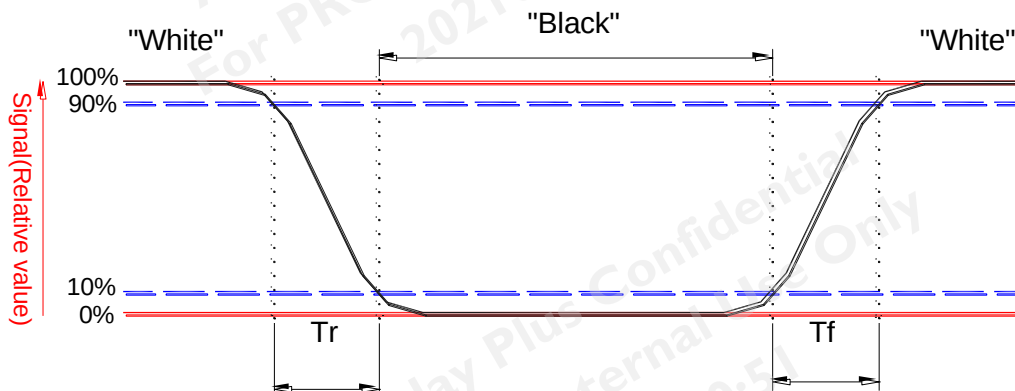
$$\delta_{w5} = \frac{\text{Minimum Brightness of five points}}{\text{Maximum Brightness of five points}}$$

Note 4: Definition of contrast ratio (CR):

$$\text{Contrast ratio (CR)} = \frac{\text{Brightness on the "White" state}}{\text{Brightness on the "Black" state}}$$

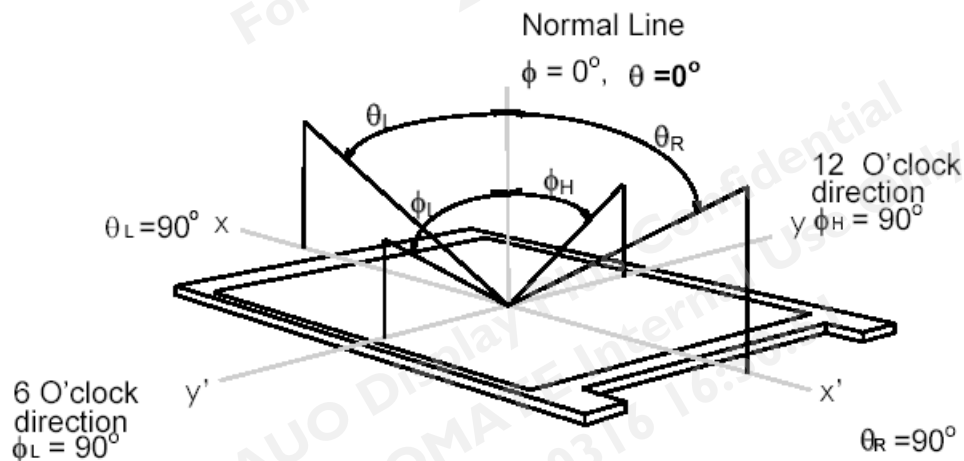
Note 5: Definition of Response time:

The output signals of photo detector are measured when the input signals are changed from "White" to "Black" (falling time) and from "Black" to "White" (rising time), respectively. The response time interval is between 10% and 90% of amplitudes. Please refer to the figure as below.



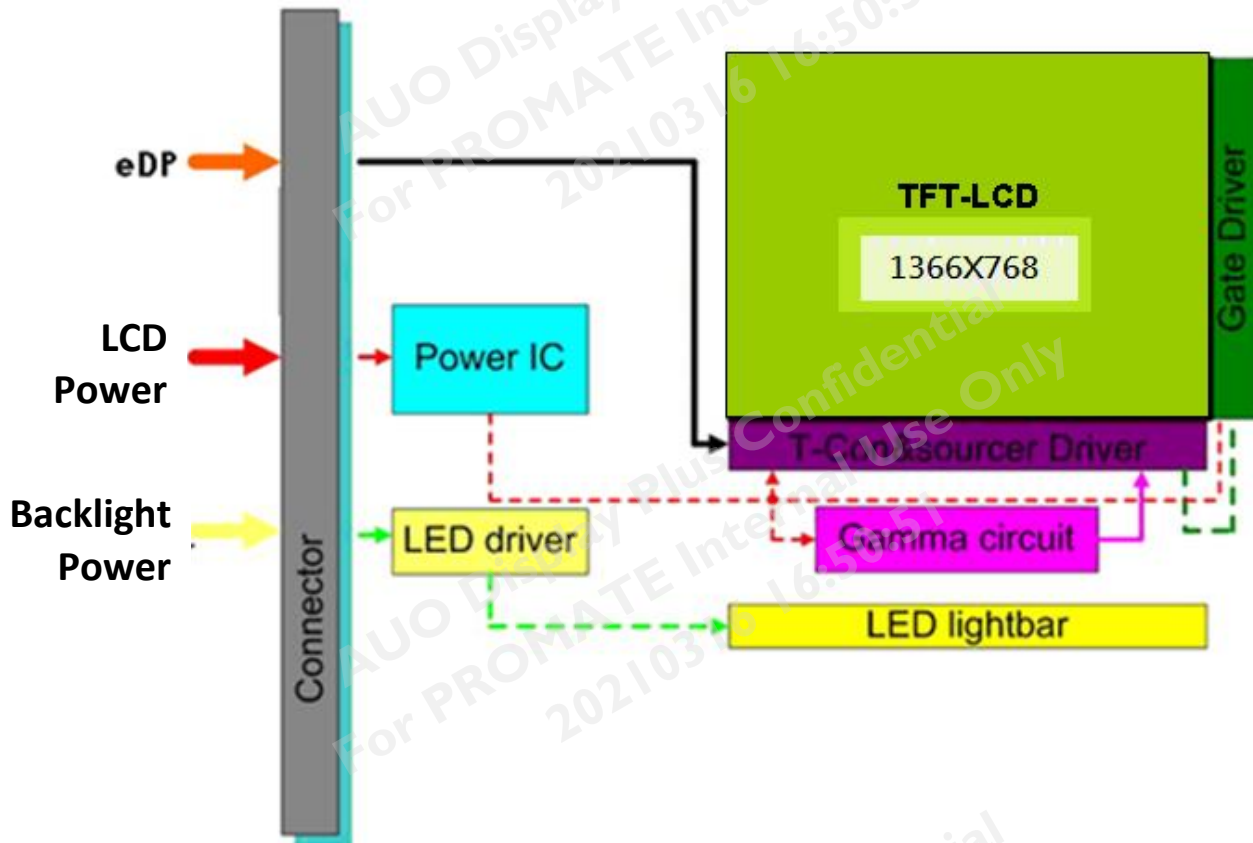
Note 6: Definition of viewing angle

Viewing angle is the measurement of contrast ratio ≥ 10 , at the screen center, over a 180° horizontal and 180° vertical range (off-normal viewing angles). The 180° viewing angle range is broken down as below: 90° (θ) horizontal left and right, and 90° (ϕ) vertical high (up) and low (down). The measurement direction is typically perpendicular to the display surface with the screen rotated to its center to develop the desired measurement viewing angle.



3. Functional Block Diagram

The following diagram shows the functional block of the 15.6 inch Color TFT-LCD Module:



I/F PCB connector:

IPEX 20455-030E-12 or compatible

Housing Type:

IPEX 20453-030T-11 or compatible

4. Absolute Maximum Ratings

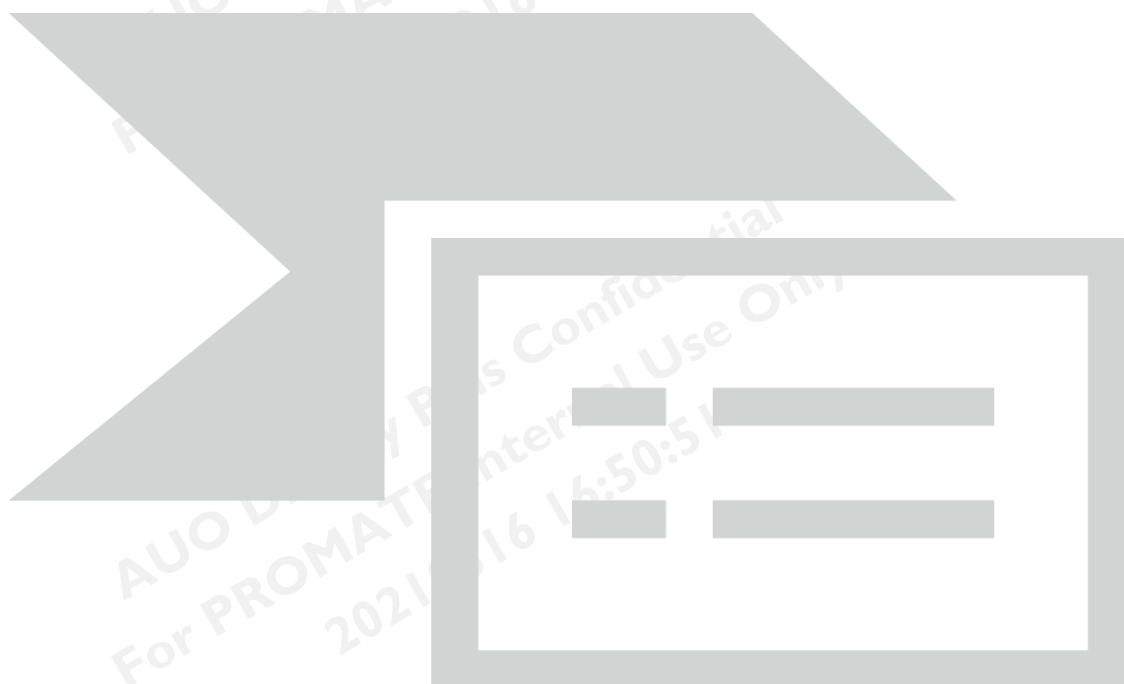
4.1 Absolute Ratings of TFT LCD Module

Item	Symbol	Min	Max	Unit
Logic/LCD Drive Voltage	VDD	0	4.0	[Volt]

4.2 Absolute Ratings of Environment

Item	Symbol	Min.	Max.	Unit
Operating Temperature	TOP	-30	+85	[°C]
Operation Humidity	HOP	5	90	[%RH]
Storage Temperature	TST	-30	+85	[°C]
Storage Humidity	HST	5	90	[%RH]

Note: Maximum Wet-Bulb should be 39 °C and no condensation.



5. Electrical characteristics

5.1 TFT LCD Module

5.1.1 Power Specification

Input power specifications are as following:

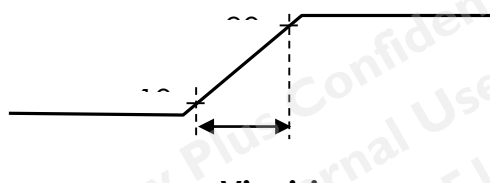
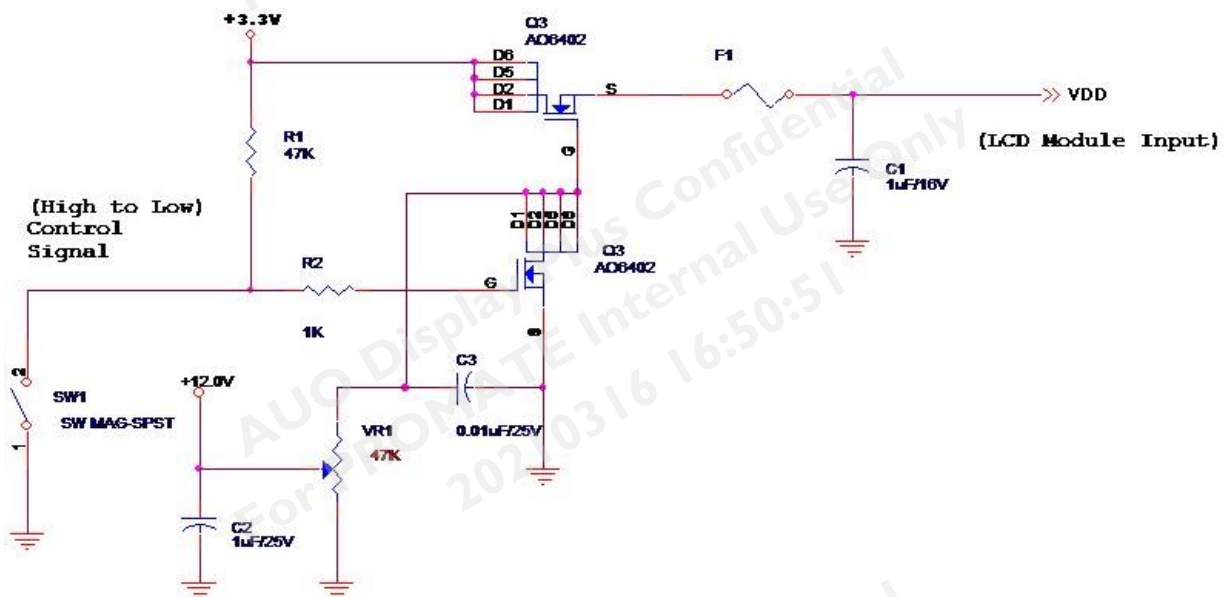
Symbol	Parameter	Min	Typ	Max	Unit	Conditions
VDD	Logic/LCD Drive Voltage	3.0	3.3	3.6	[Volt]	
PDD	VDD Power	-	0.63	0.76	[Watt]	All Black Pattern (VDD=3.3V, at 60Hz), Note 1
IDD	IDD Current	-	0.19	0.23	[A]	All Black Pattern (VDD=3.3V, at 60Hz), Note 2
IRush	LCD Inrush Current	-	-	2.0	[A]	Note 1
VDDrp	Allowable Logic/LCD Drive Ripple Voltage	-	-	100	[mV] p-p	All Black Pattern (VDD=3.3V, at 60Hz)

Note 1 : Maximum Measurement Condition : White Pattern at 3.3V driving voltage. ($P_{max}=V_{3.3} \times I_{white}$)

Typical Measurement Condition: Mosaic Pattern

Note 2 : Current fuse is built in a module. Current capacity of power supply for VDD should be larger than 1.5A, so that the fuse can be opened at the trouble of electrical circuit of module.

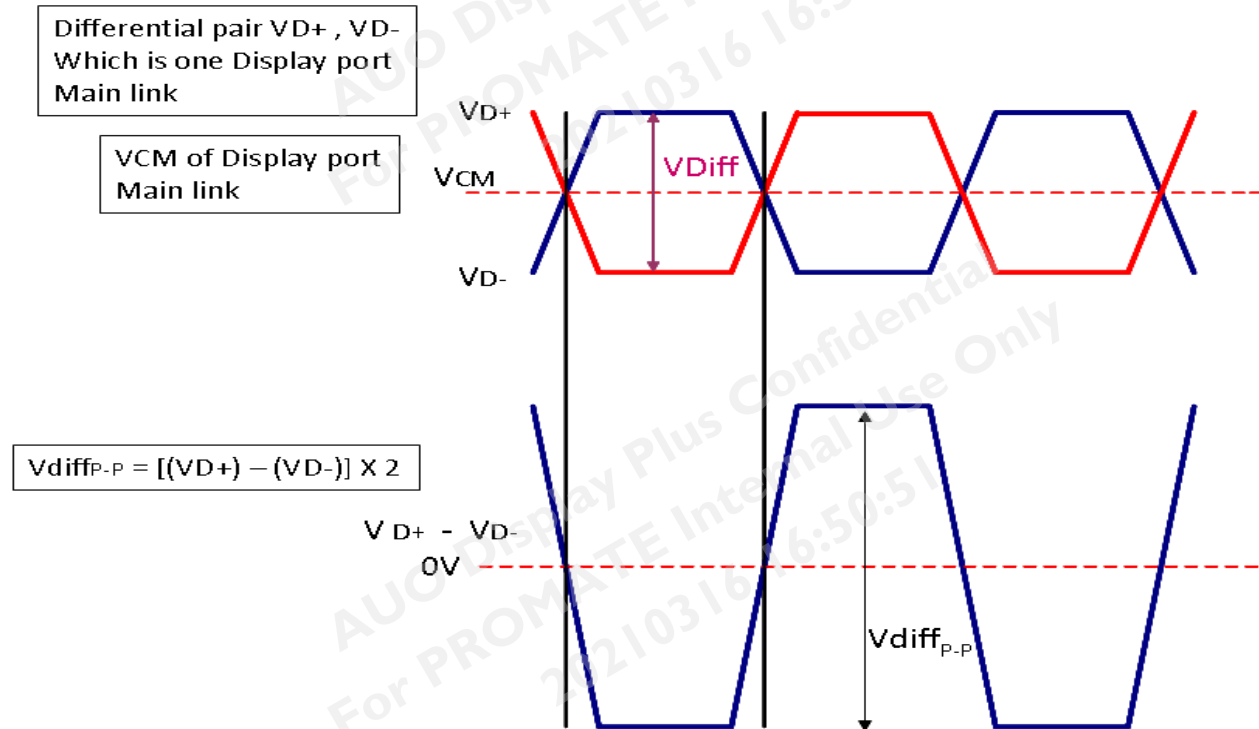
Note 3 : Measure Condition



5.1.2 Signal Electrical Characteristics

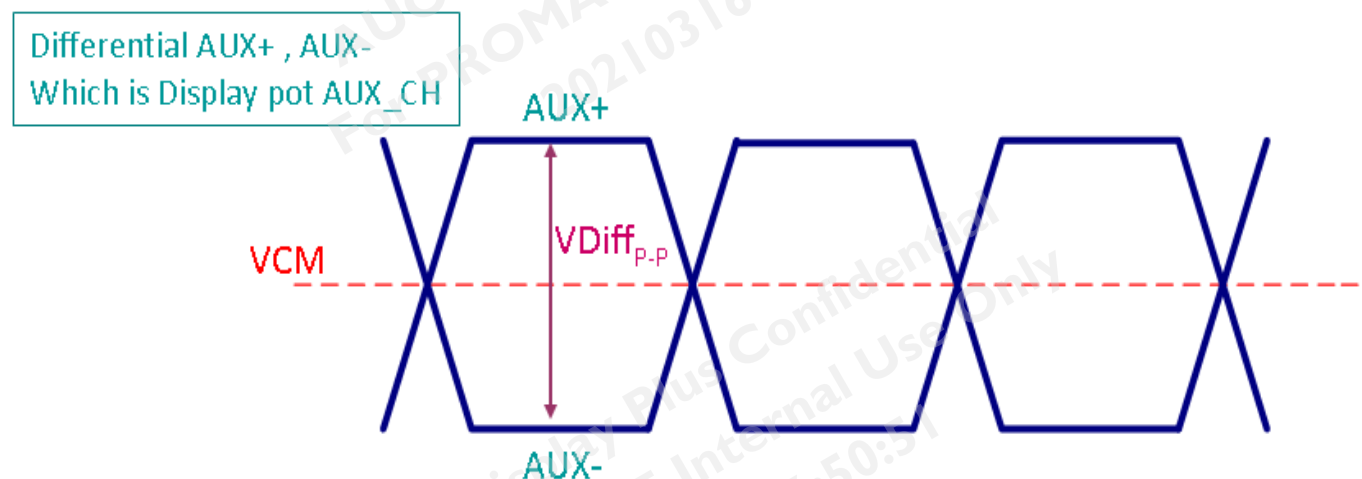
Signal electrical characteristics are as follows:

Display Port main link signal:



Display port main link					
		Min	Typ	Max	unit
VCM	RX input DC Common Mode Voltage		0		V
VDiff_{P-P}	Peak-to-peak Voltage at a receiving Device	150		1320	mV

Display Port AUX_CH signal:



Display port AUX_CH					
		Min	Typ	Max	unit
VCM	AUX DC Common Mode Voltage		0		V
VDiff _{p-p}	AUX Peak-to-peak Voltage at a receiving Device	0.4	0.6-	0.8	V

Follow as VESA display port standard V1.1a.

Display Port VHPD signal:

Display port VHPD					
		Min	Typ	Max	unit
VHPD	HPD Voltage	2.25	-	2.75	V

Follow as VESA display port standard V1.1a.

5.2 Backlight Unit

Following characteristics are measured under stable condition using a LED driving board at 25°C(Room Temperature).

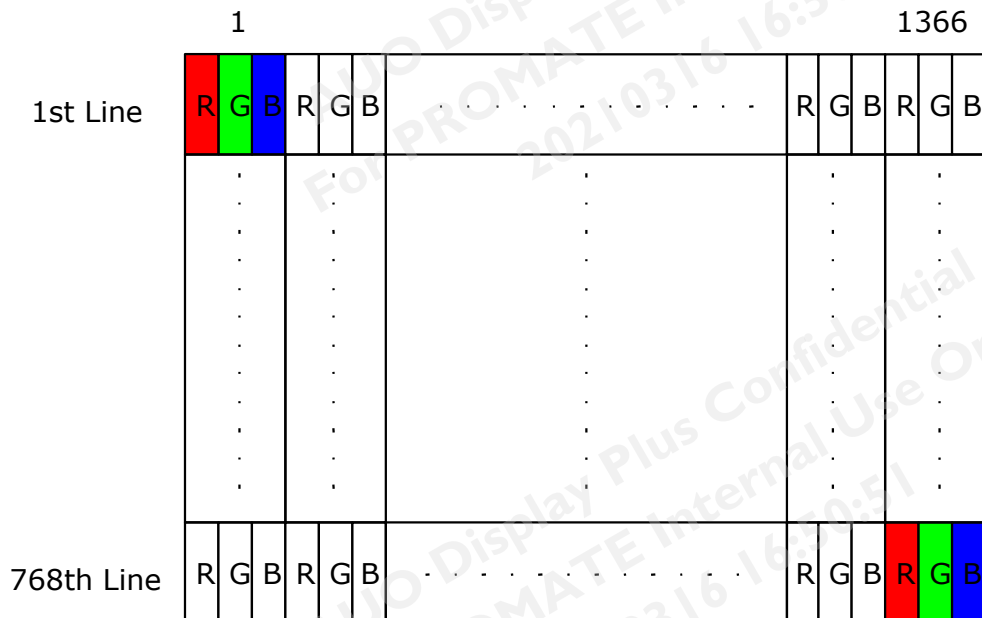
Symbol	Parameter	Min	Typ	Max	Units	Remark
VLED (Note 1)	LED Power Supply	10.8	12	13.2	[Volt]	Define as Connector Interface (Ta=25°C)
VLED_EN	LED Enable Input High Level	2.5	--	5.5	[Volt]	
	LED Enable Input Low Level	--	--	0.5	[Volt]	
VPWM_EN	PWM Logic Input High Level	2.5	--	5.5	[Volt]	
	PWM Logic Input Low Level	--	--	0.5	[Volt]	
FPWM	PWM Input Frequency	200	--	20K	Hz	
Duty	PWM Duty Ratio	5	--	100	%	
ILED	Input Current	-	0.4	0.48	A	100% Dimming
PLED	Power Consumption	-	4.77	5.72	Watt	
LTLED	LED Life-Time	50000	-	-	Hrs	Ta = 25°C

Note 1: Measured on panel VLED ; Ta means ambient temperature of TFT-LCD module.

6. Signal Characteristic

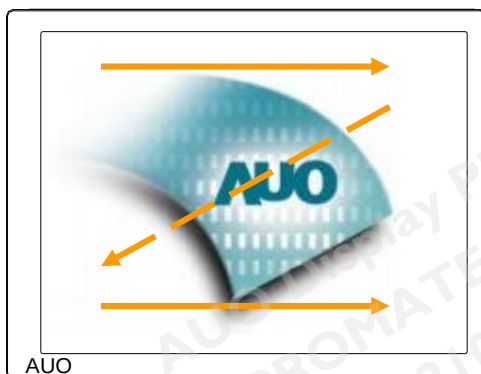
6.1 Pixel Format Image

Following figure shows the relationship of the input signals and LCD pixel format.



6.2 Scanning Direction

The following figures show the image seen from the front view. The arrow indicates the direction of scan.



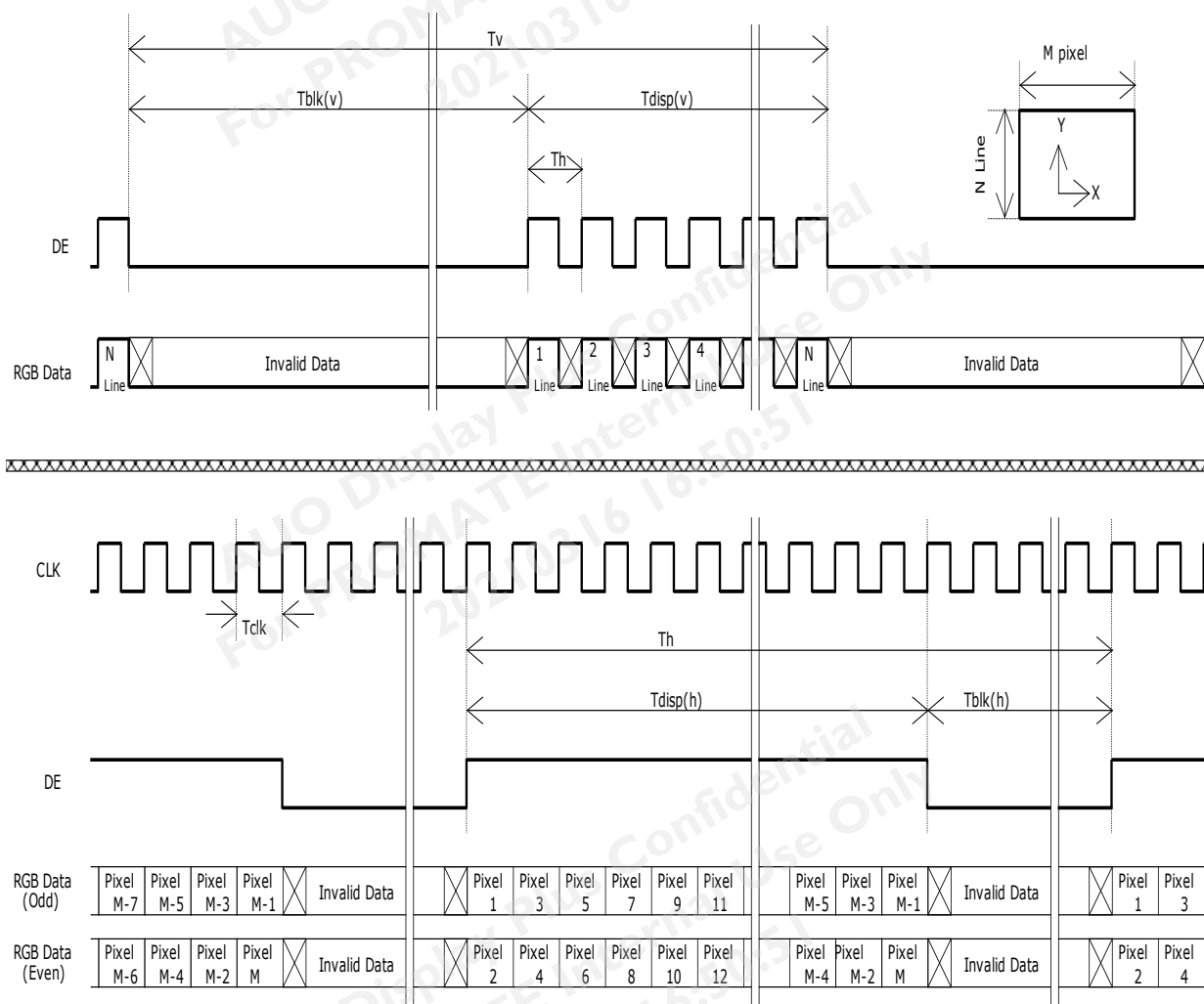
6.3 Timing Characteristics

Basically, interface timings should match the 1366x768 /60Hz manufacturing guide line timing.

Parameter		Symbol	Min.	Typ.	Max.	Unit
Frame Rate		F	48	60	-	Hz
Clock frequency		1/ T _{Clock}	65	76.3	80	MHz
Vertical Section	Period	T _V	790	816	888	T _{Line}
	Active	T _{VD}	768			
	Blanking	T _{VB}	22	48	120	
Horizontal Section	Period	T _H	1500	1558	1936	T _{Clock}
	Active	T _{HD}	1366			
	Blanking	T _{HB}	144	192	570	

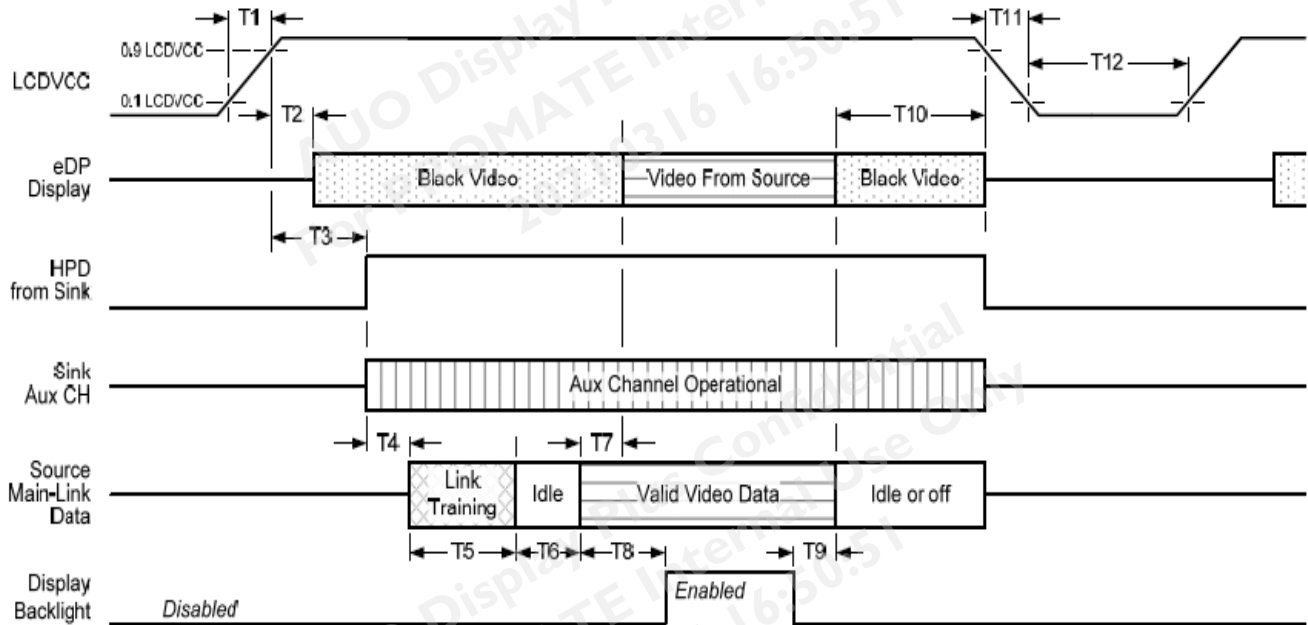
- Note:**
1. The maximum clock frequency = (1366+B)*(768+A)*60<80MHz
 2. Support DE mode only.
 3. Typical value refer to VESA STANDARD

Timing diagram



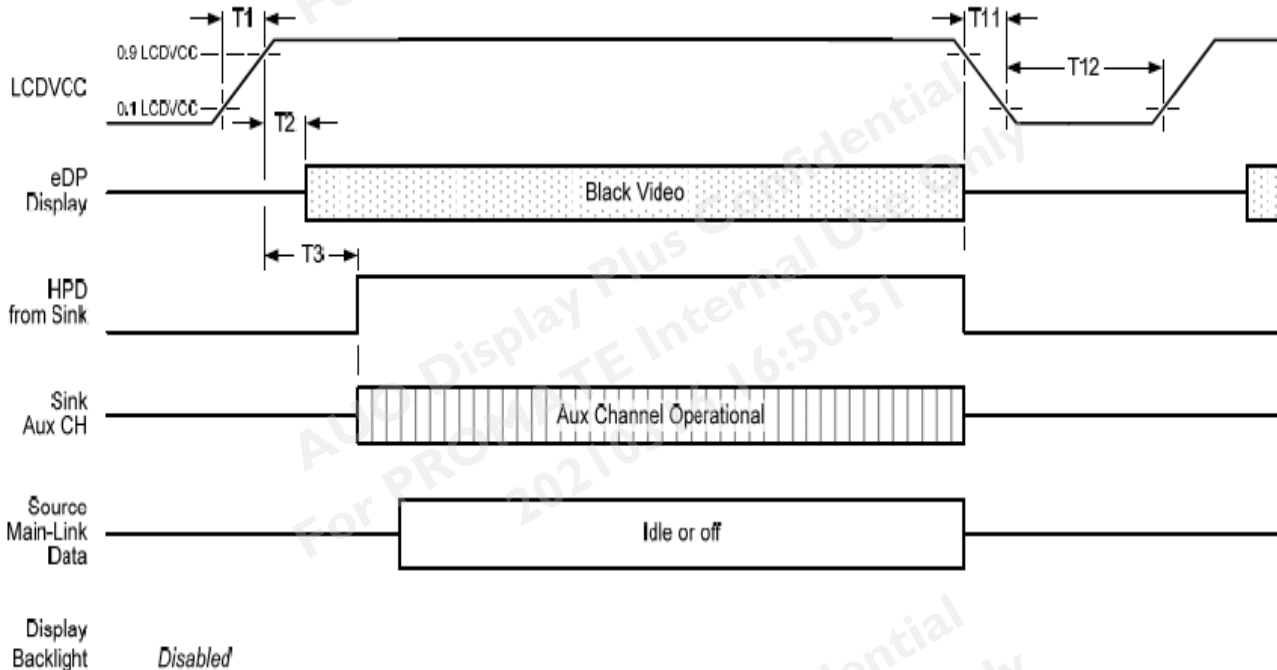
6.4 Power ON/OFF Sequence

Display Port panel power sequence:



Display port interface power up/down sequence, normal system operation

Display Port AUX_CH transaction only:



Display port interface power up/down sequence, AUX_CH transaction only

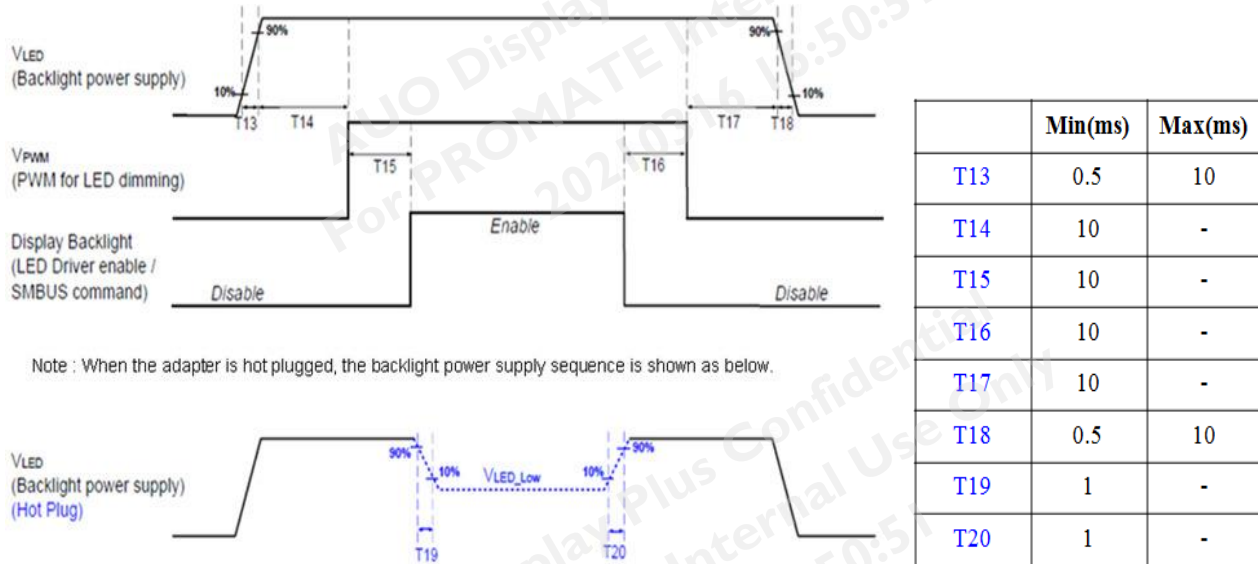


Display Port panel power sequence timing parameter:

Timing parameter	Description	Reqd. by	Limits			Notes
			Min.	Typ.	Max.	
T1	power rail rise time, 10% to 90%	source	0.5ms		10ms	
T2	delay from LCDVDD to black video generation	sink	0ms		200ms	prevents display noise until valid video data is received from the source
T3	delay from LCDVDD to HPD high	sink	0ms		200ms	sink AUX_CH must be operational upon HPD high.
T4	delay from HPD high to link training initialization	source				allows for source to read link capability and initialize.
T5	link training duration	source				dependant on source link to read training protocol.
T6	link idle	source				Min accounts for required BS-Idle pattern. Max allows for source frame synchronization.
T7	delay from valid video data from source to video on display	sink	0ms		50ms	max allows sink validate video data and timing.
T8	delay from valid video data from source to backlight enable	source				source must assure display video is stable.
T9	delay from backlight disable to end of valid video data	source				source must assure backlight is no longer illuminated.
T10	delay from end of valid video data from source to power off	source	0ms		500ms	
T11	power rail fall time, 90% to 10%	source			200ms	
T12	power off time	source	500ms			

- Note1:** The sink must include the ability to generate black video autonomously. The sink must automatically enable black video under the following conditions:
- upon LCDVDD power on (within T2 max)-when the "Novideostream_Flag" (VB-ID Bit 3) is received from the source (at the end of T9).
 - when no main link data, or invalid video data, is received from the source. Black video must be displayed within 64ms (typ) from the start of either condition. Video data can be deemed invalid based on MSA and timing information, for example.
- Note 2:** The sink may implement the ability to disable the black video function, as described in Note 1, above, for system development and debugging purpose.
- Note 3:** The sink must support AUX_CH polling by the source immediately following LCDVDD power on without causing damage to the sink device (the source can re-try if the sink is not ready). The sink must be able to respond to an AUX_CH transaction with the time specified within T3 max.

Display Port panel B/L power sequence timing parameter:



6.5 Connector & Pin Assignment

Physical interface is described as for the connector on module. These connectors are capable of accommodating the following signals and will be following components.

6.5.1 TFT-LCD Signal: eDP Interface

Connector Name / Designation	Interface Connector / Interface card
Manufacturer	IPEX or Compatible
Type Part Number	IPEX 20455-030E-12 or Compatible
Mating Housing Part Number	IPEX 20453-030T-11 or Compatible

6.5.2 Pin Assignment

The module input signal is eDP 30 pin, and the input eDP lane is a differential signal technology for LCD interface and high speed data transfer device.

PIN No	Symbol	Function
1	NC	No Connect
2	VLED	Backlight power (10.8V~13.2V)
3	VLED	Backlight power (10.8V~13.2V)
4	VLED	Backlight power (10.8V~13.2V)
5	VLED	Backlight power (10.8V~13.2V)
6	NC	No connect
7	NC	No connect
8	VPWM_EN	System PWM signal Input
9	VLED_EN	Backlight On / Off
10	BL_GND	Backlight_ground
11	BL_GND	Backlight_ground
12	BL_GND	Backlight_ground
13	BL_GND	Backlight_ground
14	HPD	HPD signal pin
15	LCD GND	LCD logic and driver ground
16	LCD GND	LCD logic and driver ground
17	NC	No connect
18	VDD	LCD logic and driver power
19	VDD	LCD logic and driver power
20	H_GND	High Speed Ground
21	AUX_CH_N	Comp Signal Auxiliary Ch.
22	AUX_CH_P	True Signal Auxiliary Ch.
23	H_GND	High Speed Ground
24	Lane0_P	Comp Signal Link Lane 0
25	Lane0_N	True Signal Link Lane0
26	H_GND	High Speed Ground
27	NC	Not used (eDP Lane 1)
28	NC	Not used (eDP Lane 1)
29	H_GND	High Speed Ground
30	NC	No Connect

Connector Illustration



Note1: Pin1 start from **right** side of PCBA on LCM.

Note2: Input signals shall be low or High-impedance state when VDD is off.

7. Reliability Test Criteria

Environment test conditions are listed as following table.

Items	Required Condition	Note
Temperature Humidity Bias (THB)	Ta= 50 °C, 80%RH, 300hours	
High Temperature Operation (HTO)	Ta= 85 °C, 300hours	
Low Temperature Operation (LTO)	Ta= -30 °C, 300hours	
High Temperature Storage (HTS)	Ta= 85 °C, 300hours	
Low Temperature Storage (LTS)	Ta= -30 °C, 300hours	
Thermal Shock Test (TST)	-20 °C /30min, 60 °C /30min, 100 cycles	
Hot Start Test	85 °C /1 Hr min. Power on/off per 5 minutes, 5 times	
Cold Start Test	-30 °C /1 Hr min. Power on/off per 5 minutes, 5 times	
Shock Test (Non-operation)	50G,20ms,Half-sine wave,(+X,+Y,+Z)	
Vibration Test (Non-operation)	1.5G, 10~200~10Hz, Sine wave 30mins/axis, 3 direction (X, Y, Z)	
On/Off Test	On/10sec, Off/10sec, 30,000 cycles	
ESD	Contact : ± 8KV/ operation, Class B Air : ± 15KV / operation, Class B	Note 1
EMI	30-230 MHz, limit 40 dBu V/m, 230-1000 MHz, limit 47 dBu V/m	

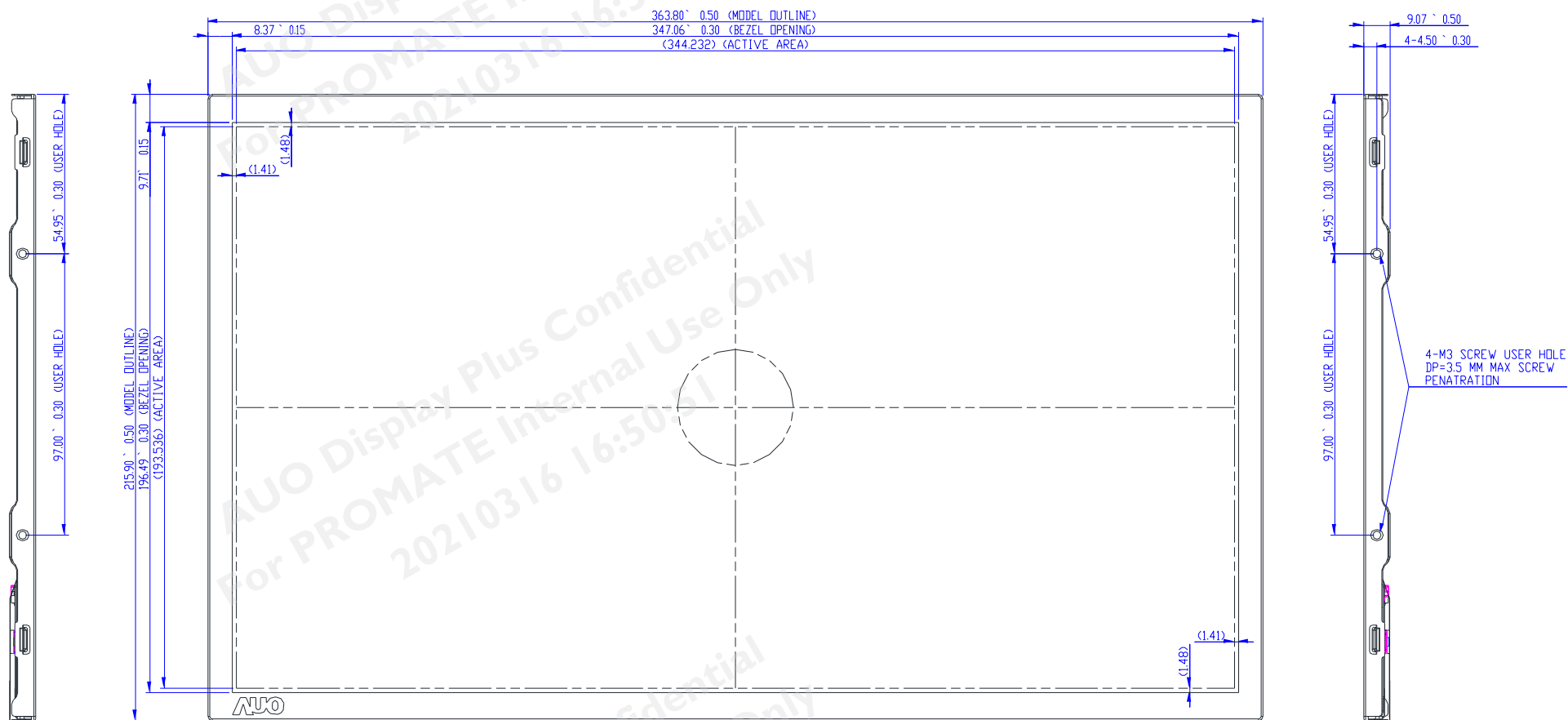
Note 1: According to EN61000-4-2 , ESD class B: Some performance degradation allowed. No data lost
Self-recoverable. No hardware failures.

Note 2:

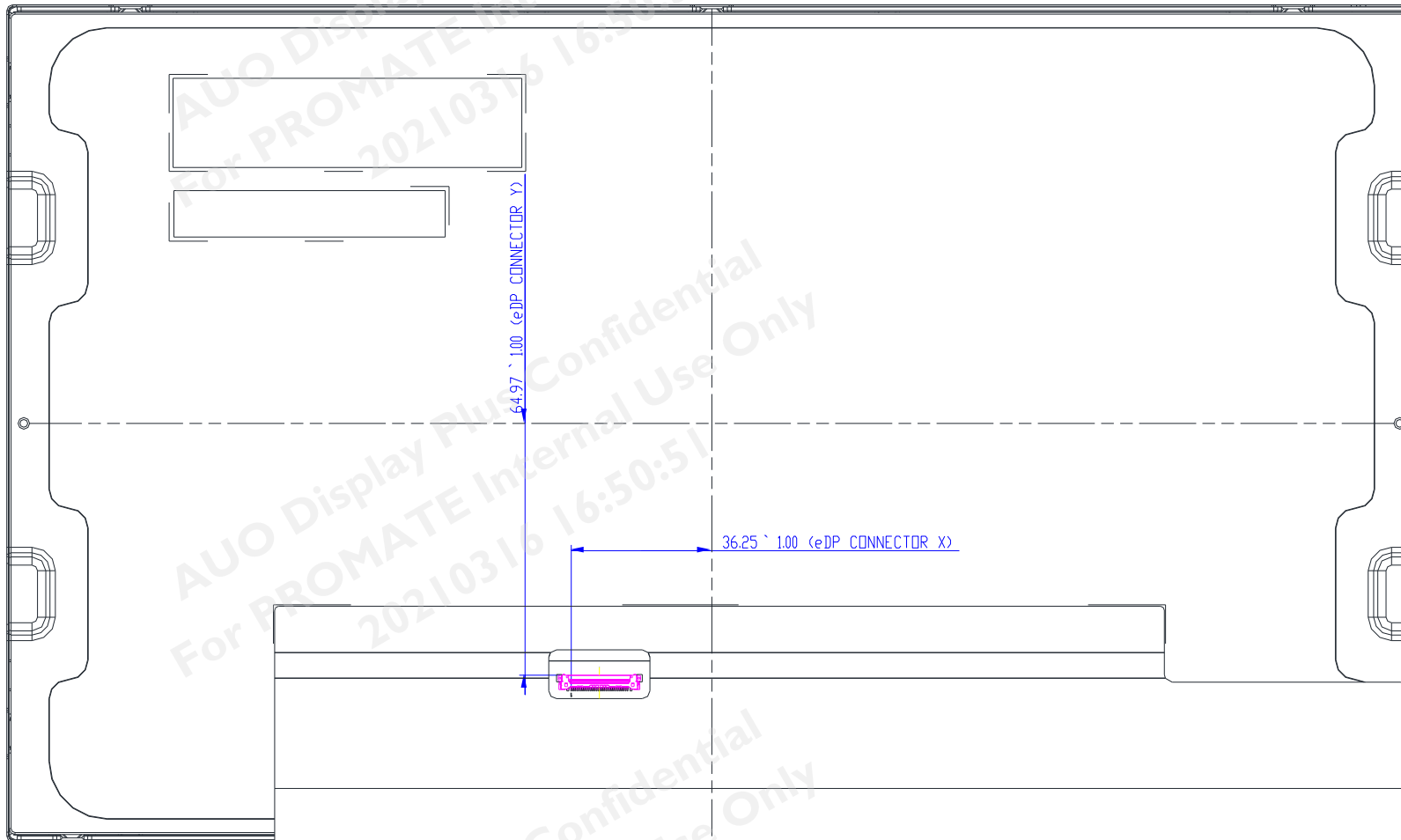
- Water condensation is not allowed for each test items.
- Each test is done by new TFT-LCD module. Don't use the same TFT-LCD module repeatedly for reliability test.
- The reliability test is performed only to examine the TFT-LCD module capability. No function failure occurs. Mura shall be ignored after high temperature reliability test.
- To inspect TFT-LCD module after reliability test, please store it at room temperature and room humidity for 24 hours at least in advance.

8. Mechanical Characteristics

8.1 LCM Outline Dimension (Front View)

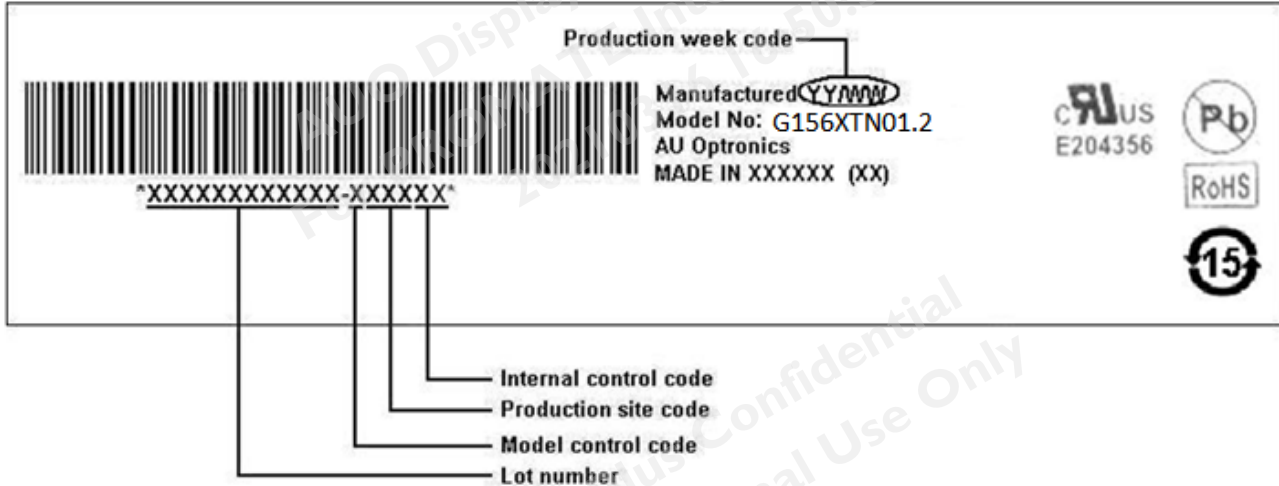


8.2 LCM Outline Dimension (Rear View)

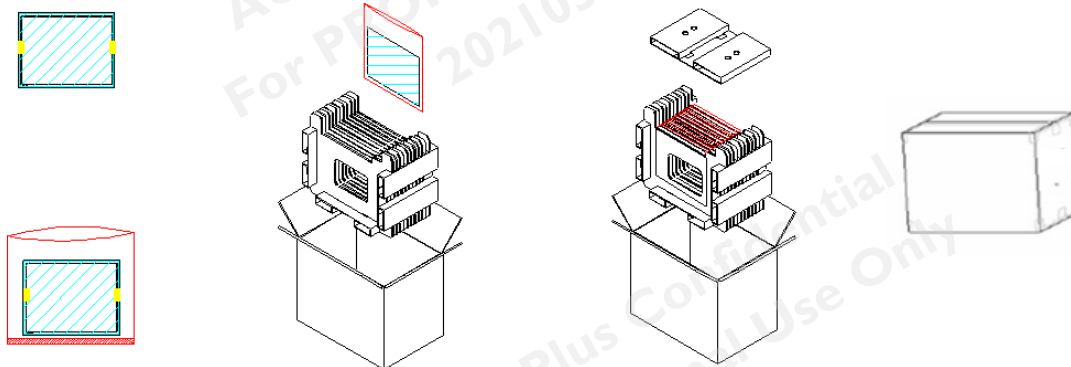


9. Shipping and Package

9.1 Shipping Label (on the rear side of TFT-LCD display)



9.2 Carton & Pallet Package



Max capacity : 16 TFT-LCD module per carton

Max weight: 15.3 kg per carton

Outside dimension of carton: 450mm(L)*375mm(W)*319mm(H)

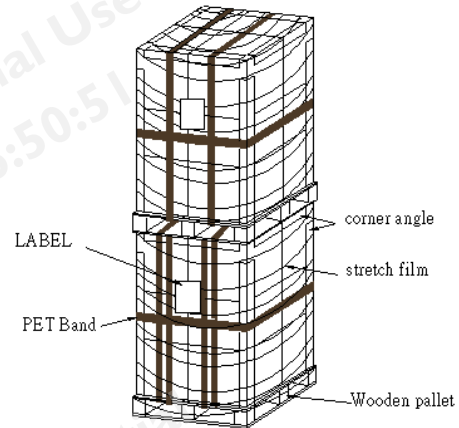
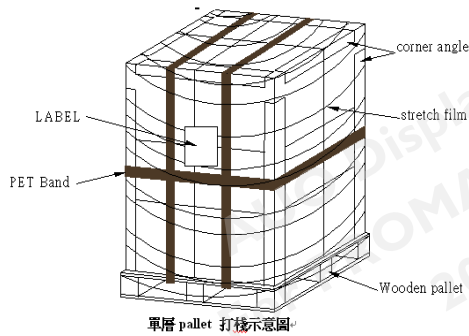
Pallet size : 1150 mm* 910 mm*132mm

Box stacked

Module by air : (2 *3) *4 layers , one pallet put 24 boxes, total 384pcs module

Module by sea : (2 *3) *4 layers+(2 *3) *1 layers, two pallet put 30 boxes, total 480pcs module

Module by sea_HQ : (2 *3) *4 layers+(2 *3) *2 layers, two pallet put 42 boxes, total 576 pcs module



10. Safety

10.1 Sharp Edge Requirements

There will be no sharp edges or comers on the display assembly that could cause injury.

10.2 Materials

10.2.1 Toxicity

There will be no carcinogenic materials used anywhere in the display module. If toxic materials are used, they will be reviewed and approved by the responsible AUO toxicologist.

10.2.2 Flammability

All components including electrical components that do not meet the flammability grade UL94-V1 in the module will complete the flammability rating exception approval process.

The printed circuit board will be made from material rated 94-V1 or better. The actual UL flammability rating will be printed on the printed circuit board.

10.3 Capacitors

If any polarized capacitors are used in the display assembly, provisions will be made to keep them from being inserted backwards.

10.4 National Test Lab Requirement

The display module will satisfy all requirements for compliance to:

UL 60950-1 second edition

U.S.A. Information Technology Equipment