() Preliminary Specifications

(✓) Final Specifications

Module	15.6”FHD Color TFT-LCD
Model Name	G156HAN05.004
Note	LED backlight with driving circuit design

Company	**Approved by** LeaDer Feng **Date** 2024/9/4
Checked & Approved by **Date**	**Prepared by** CH Tsai 2024/9/4
	General Display Business Unit / AUO Display Plus Corporation

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Record of Revision

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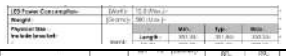
1.0	2020/5/4	5		
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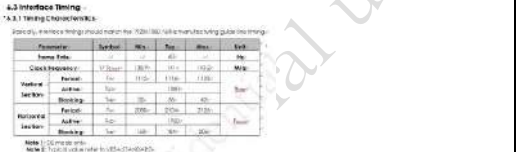
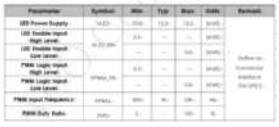
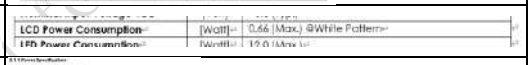
		18		
1.1	2021/11/1	14		
1.2	2024/09/04	5		
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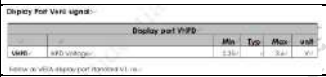
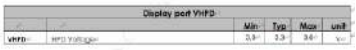
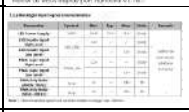
		13		
		14		
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1. Handling Precautions

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 Discharde) 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

G156HAN05.0 is a Color Active Matrix Liquid Crystal Display composed of a TFT LCD panel, a driver circuit, and LED backlight system. The screen format is intended to support the 16:9 FHD, 1920(H) x 1080(V) screen and 16.2M colors (RGB 6-bits+2FRC data driver) with LED backlight driving circuit. All input signals are eDP(Embedded DisplayPort) interface compatible.

G156HAN05.0 is designed for a display unit of notebook style personal computer and industrial machine.

2.1 General Specification

The following items are characteristics summary on the table at 25 ℃ condition:

Items	Unit	Specifications			
Screen Diagonal	[mm]	15.6"			
Active Area	[mm]	344.16 x 193.59			
Resolution		1920 x 3(RGB) x 1080			
Pixel Pitch	[mm]	0.17925 x 0.17925			
Pixel Arrangement		R.G.B. Vertical Stripe			
Display Mode		AHVA, Normally Black			
Nominal Input Voltage VDD	[Volt]	+3.3 (Typ.)			
LCD Power Consumption	[Watt]	0.66 (Max.) @White Pattern			
LED Power Consumption	[Watt]	12.0 (Max.)			
Weight	[Grams]	580 (Max.)			
Physical Size Include bracket	[mm]		**Min.**	**Typ.**	**Max.**
		Length	351.34	351.84	352.34
		Width	208.38	208.88	209.38
		Thickness	--	6.0	6.5
Electrical Interface		2 Lane eDP1.2			
Surface Treatment		HC, 3H			
Support Color		16.2M colors			
Temperature Range **Operating** **Storage (Non-Operating)**	 [°C] [°C]	 -10 to +60 -20 to +70			
RoHS Compliance		Yes			

2.2 Optical Characteristics

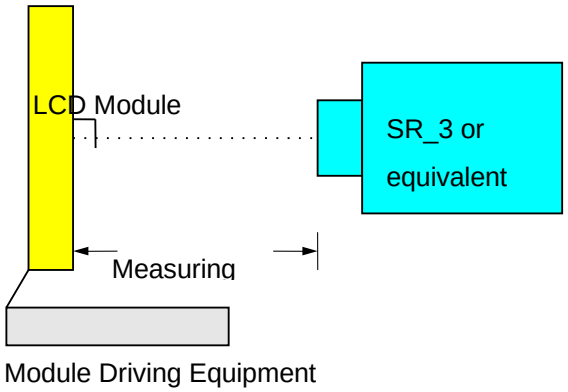
The optical characteristics are measured under stable conditions at 25℃ (Room Temperature) :

Item		Unit	Conditions	Min.	Typ.	Max.	Note
White Luminance		cd/m²	I_{LED}=60mA Center average	400	500	-	1, 2
Luminance Uniformity		%	5 Points	75	80		1, 2 , 3
Contrast Ratio		--		700	1000	-	1, 4
Response Time		msec	Rising + Falling	-	25	35	1, 5
Viewing Angle		degree	Horizontal (Right) CR = 10 (Left)	80 80	89 89	- -	1, 6
			Vertical (Upper) CR = 10 (Lower)	80 80	89 89	- -	
Color / Chromaticity Coodinates (CIE 1931)	**Red**	Rx	CIE 1931	0.596	0.646	0.696	4
		Ry		0.283	0.333	0.383	
	Green	Gx		0.249	0.299	0.349	
		Gy		0.582	0.632	0.682	
	Blue	Bx		0.103	0.153	0.203	
		By		0.000	0.049	0.099	
	White	Wx		0.263	0.313	0.363	
		Wy		0.279	0.329	0.379	
Color Gamut		%		-	72	-	

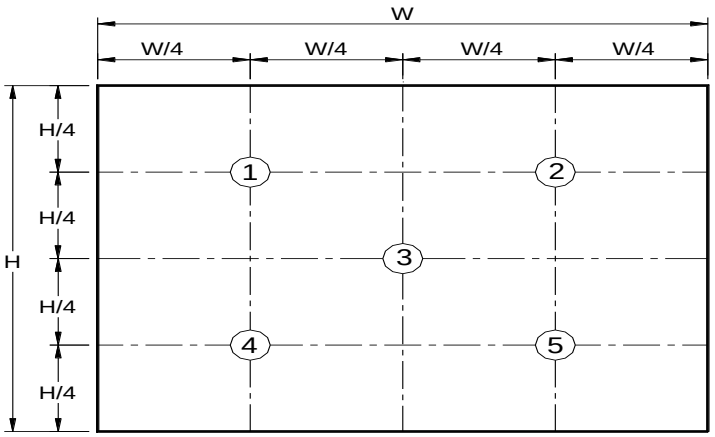
Note 1: Measurement method

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

Aperture 1◦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

$$\delta_{W5} = \frac{\text{Minimum Brightness of five points}}{\text{Maximum Brightness of five points}}$$

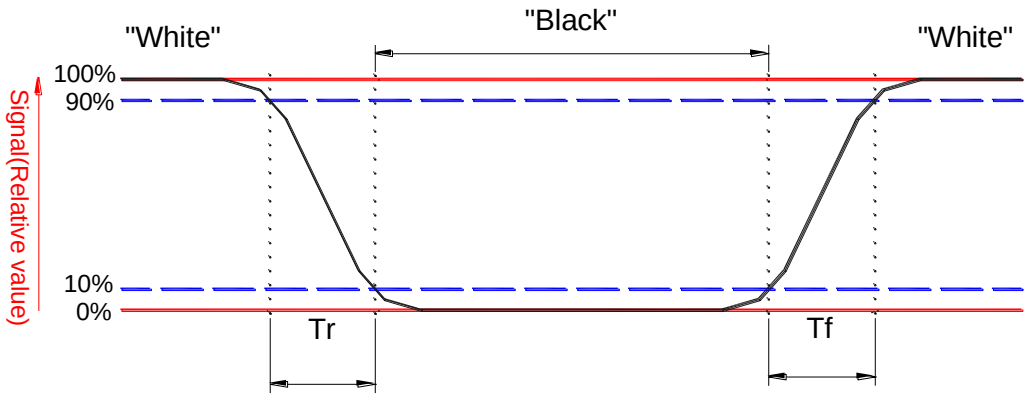
Note 4 : Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

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

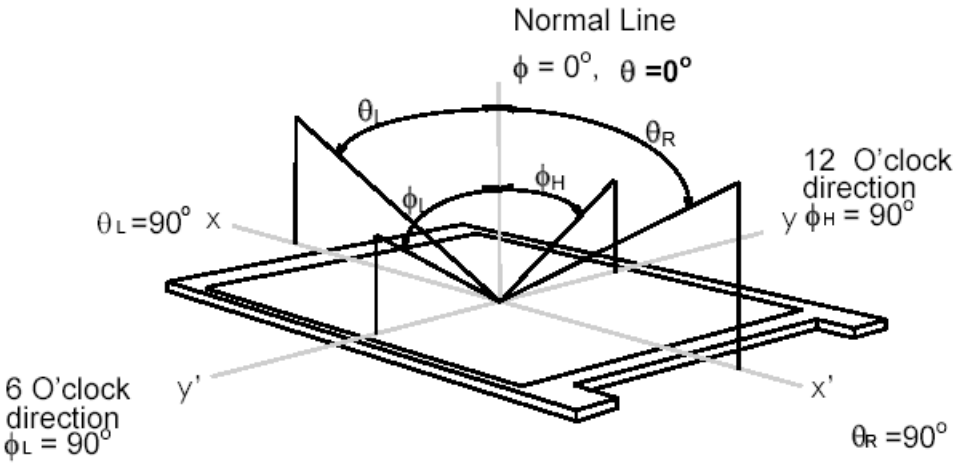
Note 5: Definition of response time:

The output signals of BM-7 or equivalent are measured when the input signals are changed from "Black" to "White" (falling time) and from "White" to "Black" (rising time), respectively. The response time interval between the 10% and 90% of amplitudes. Refer to figure as below.



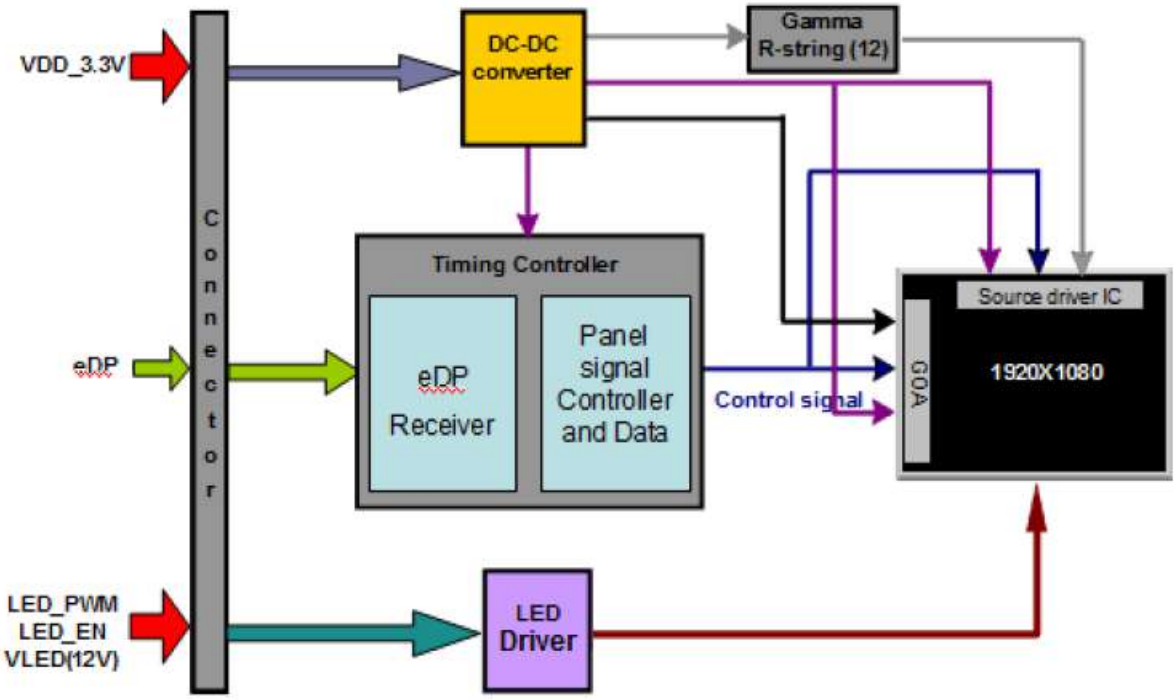
Note 6: Definition of viewing angle

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 follows; 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 about its center to develop the desired measurement viewing angle.



3. Functional Block Diagram

The following diagram shows the functional block of the 15.6 inches wide Color TFT/LCD module.



4. Absolute Maximum Ratings

An absolute maximum rating of the module is as following:

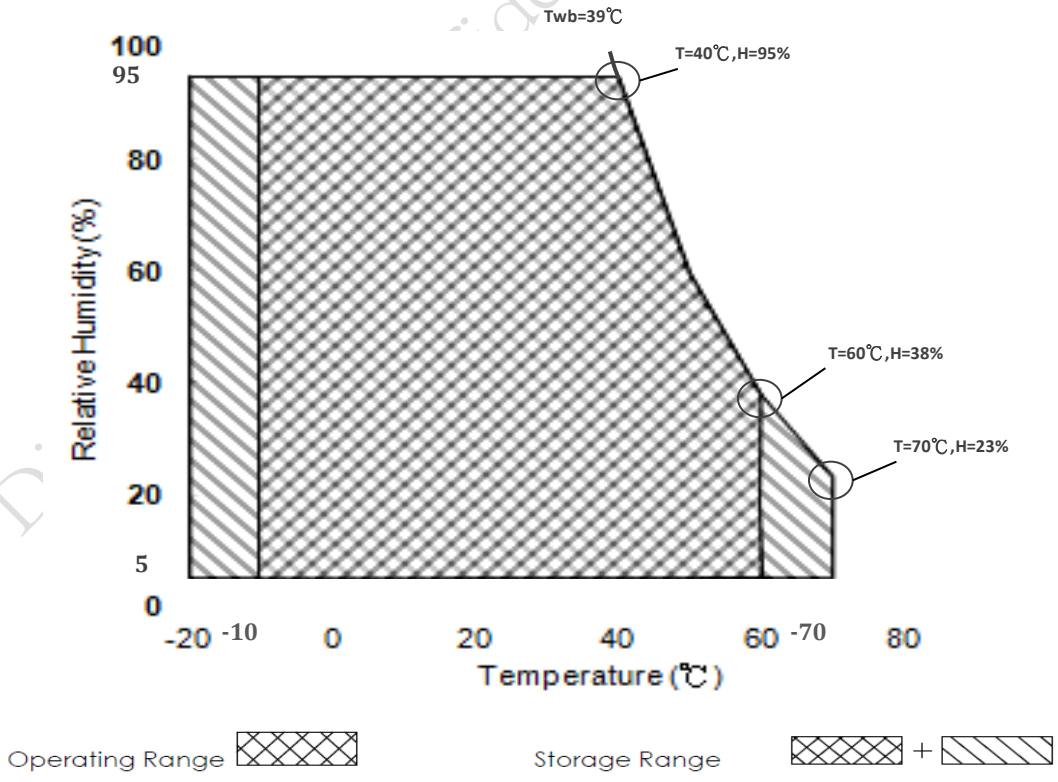
4.1 Absolute Ratings of TFT LCD Module

Item	Symbol	Min	Max	Unit	Conditions
Logic/LCD Drive	Vin	-0.3	+4.0	[Volt]	Note 1,2

4.2 Absolute Ratings of Environment

Item	Symbol	Min	Max	Unit	Conditions
Operating	TOP	-10	+60	[°C]	Note 4
Operation Humidity	HOP	5	95	[%RH]	Note 4
Storage Temperature	TST	-20	+70	[°C]	Note 4
Storage Humidity	HST	5	95	[%RH]	Note 4

Note 1: At Ta (25℃)
Note 2: Permanent damage to the device may occur if exceed maximum values
Note 3: LED specification refer to section 5.2
Note 4: For quality performance, please refer to AUO IIS (Incoming Inspection Standard).



5. Electrical Characteristics

5.1 TFT LCD Module

5.1.1 Power Specification

Input power specifications are as follows;

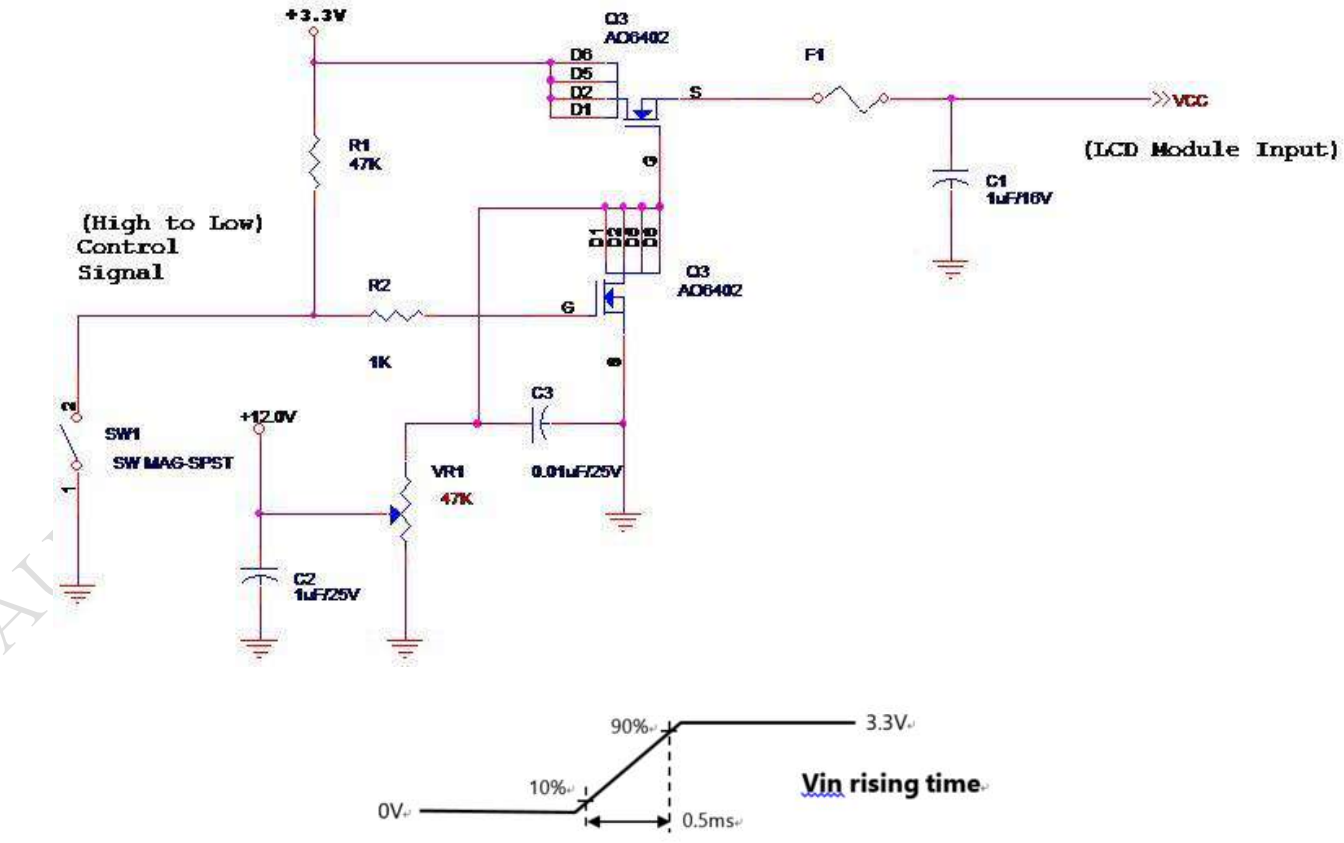
The power specification are measured under 25℃ and frame frenquency under 60Hz.

Symble	Parameter	Min	Typ	Max	Units	Remark
VDD	Logic/LCD Drive Voltage	3.0	3.3	3.6	[Volt]	
PDD	VDD Power	-	0.6	0.66	[Watt]	@White Pattern (VDD=3.3V, at 60Hz)
				1.5		@R/G/B Pattern (VDD=3.3V, at 60Hz)
IDD	IDD Current	-	-	500	[mA]	Note 1
IRush	Inrush Current	-	-	2000	[mA]	Note 2
VDDrp	Allowable Logic/LCD Drive Ripple Voltage	-	-	100	[mV] p-p	All Black Pattern (VDD=3.3V, at 60Hz)

Note 1 : PDD(typ)@ White pattern Maximum Power; PDD(Max)@ R/G/B pattern Maximum Power

IDD(Max)=PDD(Max) / VDD(Min)

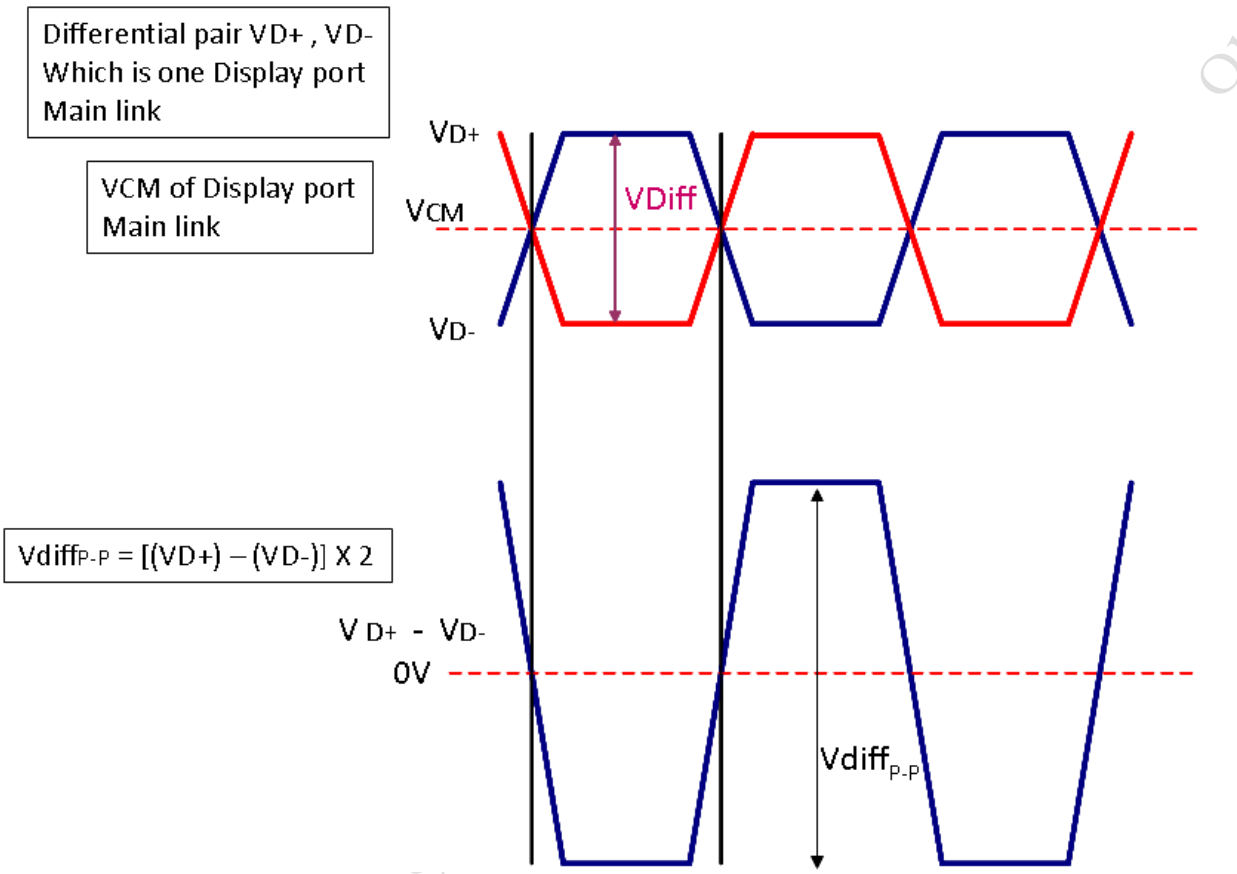
Note 2 : Measure Condition



5.1.2 Signal Electrical Characteristics

Input signals shall be low or High-impedance state when VDD is off. Signal electrical characteristics are as follows;

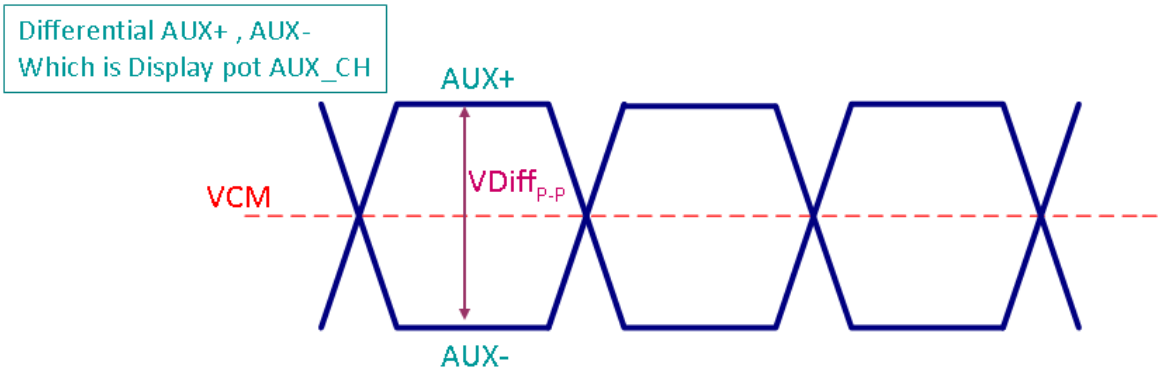
Display Port main link signal:



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

Fallow as VESA display port standard V1.1a

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

Fallow as VESA display port standard V1.1a.

Display Port VHPD signal:

Display port VHPD					
		Min	Typ	Max	unit
VHPD	HPD Voltage	3.0	3.3	3.6	V

5.2 Backlight Unit

5.2.1 LED characteristics

Parameter	Symbol	Min	Typ	Max	Units	Condition
Backlight Power Consumption	PLED	-	10.8	12.0	[Watt]	(Ta=25℃), Note 1 Vin =12V
LED Life-Time	N/A	50,000		-	Hour	(Ta=25℃), Note 2,3

Note 1: Ta means ambient temperature of TFT-LCD module. Calculator value for reference PLED = VF (Normal Distribution) * IF (Normal Distribution) / Efficiency

Note 2: If G156HAN05.0 module is driven at high ambient temperature & humidity condition. The operating life will be reduced.

Note 3: Operating life means brightness goes down to 50% initial brightness. Min. operating life time is estimated data.

5.2.2 Backlight input signal characteristics

Parameter	Symbol	Min	Typ	Max	Units	Remark
LED Power Supply	VLED	10.8	12.0	13.2	[Volt]	Define as Connector Interface (Ta=25℃)
LED Enable Input High Level	VLED_EN	2.5	-	-	[Volt]	
LED Enable Input Low Level		-	-	0.8	[Volt]	
PWM Logic Input High Level	VPWM_EN	2.5	-	-	[Volt]	
PWM Logic Input Low Level		-	-	0.8	[Volt]	
PWM Duty Ratio (200Hz~5KHz)	Duty	5	-	100	%	
PWM Duty Ratio (5KHz~20KHz)	Duty	15	-	100	%	

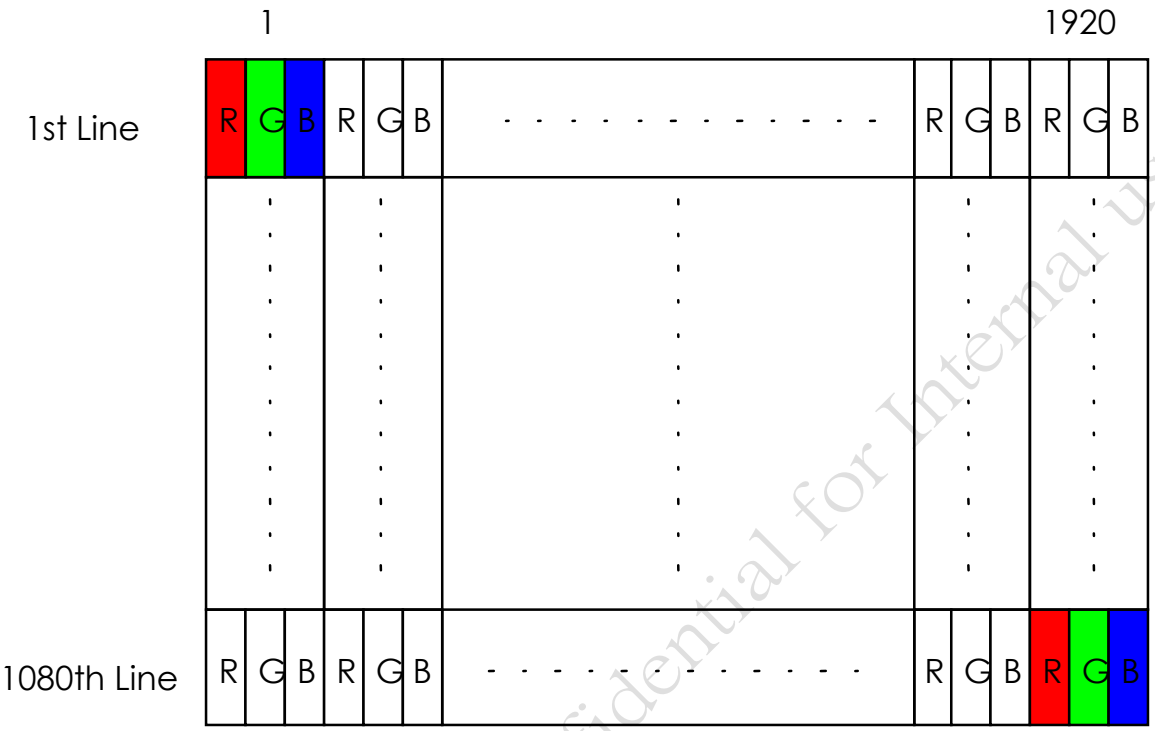
Note 1 : Recommanded system pull up/down resistor no bigger than 10kohm.

Note 2 : If the PWM duty ratio(min) is set between 5% to 1%，the PWM input frequency should be set below 1KHz . The brightness-duty characteristic might not be able to keep in it's linearity if the dimming control is operated in 1% to 5% range.

6. Signal Interface Characteristic

6.1 Pixel Format Image

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



6.2 Integration Interface Requirement

6.2.1 Connector Description

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

Connector Name / Designation	For Signal Connector
Manufacturer	IPEX or compatible
Type / Part Number	IPEX 20765-030E-11A or compatible
Mating Housing/Part Number	IPEX 20453-030T-11 or compatible

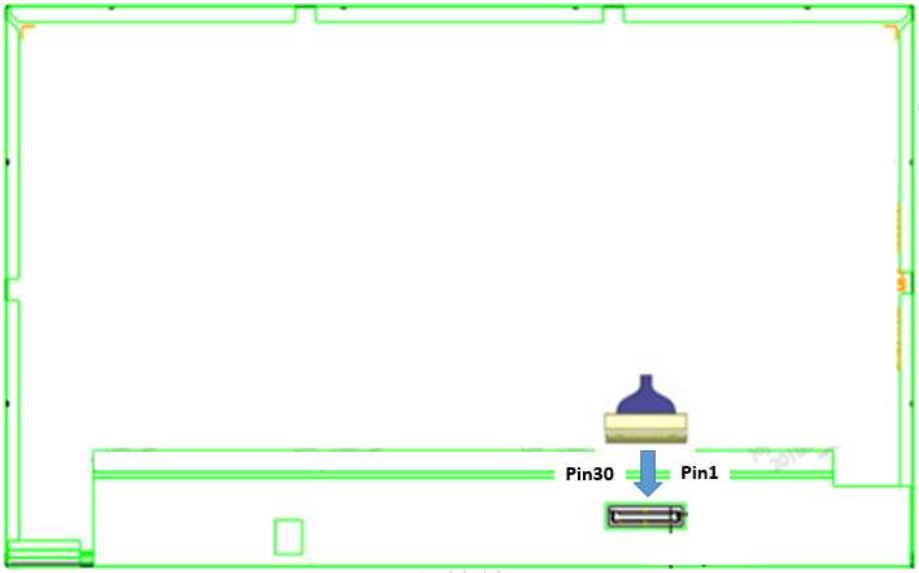
6.2.2 Pin Assignment (2 Lane)

eDP lane is a differential signal technology for LCD interface and high speed data transfer device.

PIN No	Symbol	Function
1	NC	No Connect (Reserved for CM)
2	BL_PWR	Backlight power
3	BL_PWR	Backlight power
4	BL_PWR	Backlight power
5	BL_PWR	Backlight power
6	NC	No connect (Reverse for AUO TEST only)
7	NC	No connect (Reverse for AUO TEST only)
8	BL PWM DIM	System PWM signal Input
9	BL_Enable	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 (Reverse for LCD Panel Self Test Enable)
18	LCD_VCC	LCD logic and driver power
19	LCD_VCC	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	True Signal Link Lane 0
25	Lane0_N	Comp Signal Link Lane 0
26	H_GND	High Speed Ground
27	Lane1_P	True Signal Link Lane 1

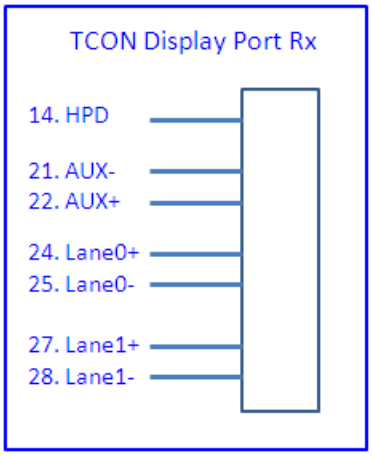
28	Lane1_N	Comp Signal Link Lane 1
29	H_GND	High Speed Ground
30	NC	No Connect

6.2.3 Connector Illustration



Note1：Input signals shall be low or High-impedance state when VDD is off. Internal circuit of eDP inputs are as following.

Note3：Connector Illustration



6.3 Interface Timing

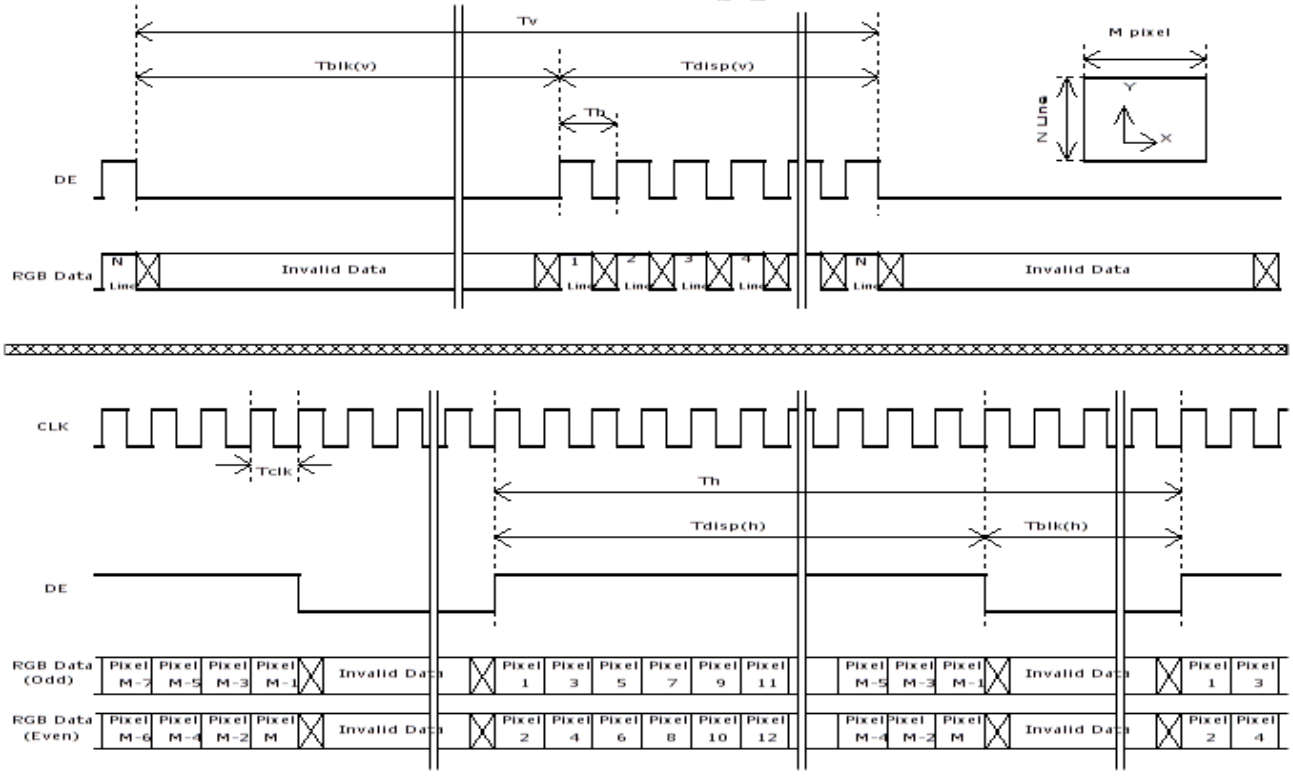
6.3.1 Timing Characteristics

Basically, interface timings should match the 1920x1080 /60Hz manufacturing guide line timing.

Parameter		Symbol	Min.	Typ.	Max.	Unit
Frame Rate		-	-	60	-	Hz
Clock frequency		1/ T_{Clock}	138.9	141	143.2	MHz
Vertical Section	Period	T_V	1112	1116	1122	T_{Line}
	Active	T_{VD}	1080			
	Blanking	T_{VB}	32	36	42	
Horizontal Section	Period	T_H	2080	2104	2126	T_{Clock}
	Active	T_{HD}	1920			
	Blanking	T_{HB}	160	184	206	

Note 1 : DE mode only

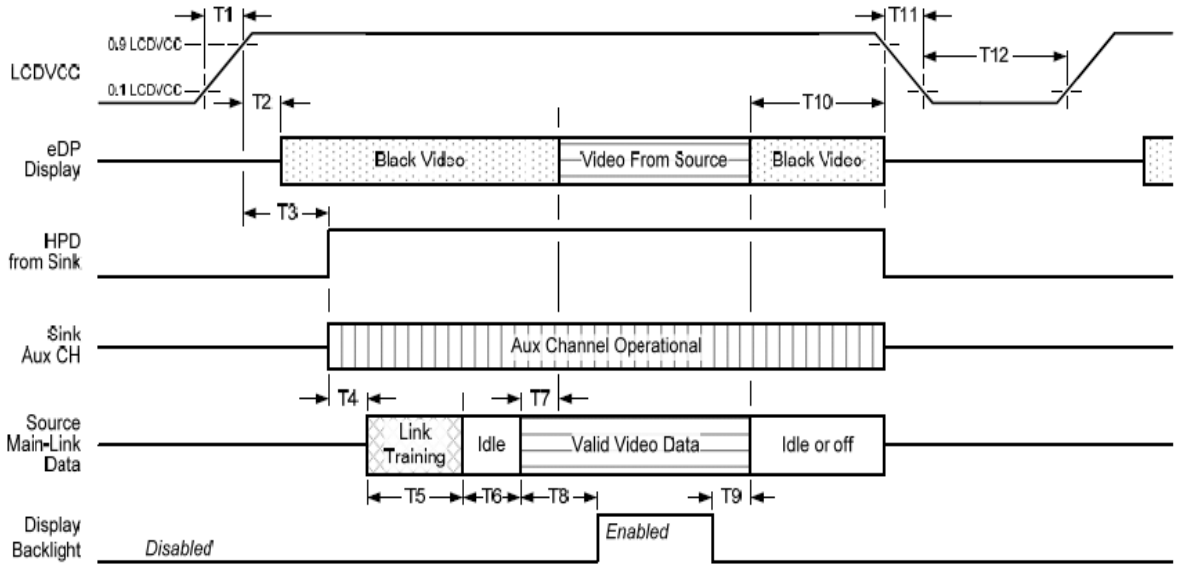
6.3.2 Input Timing Diagram



6.4 Power ON/OFF Sequence

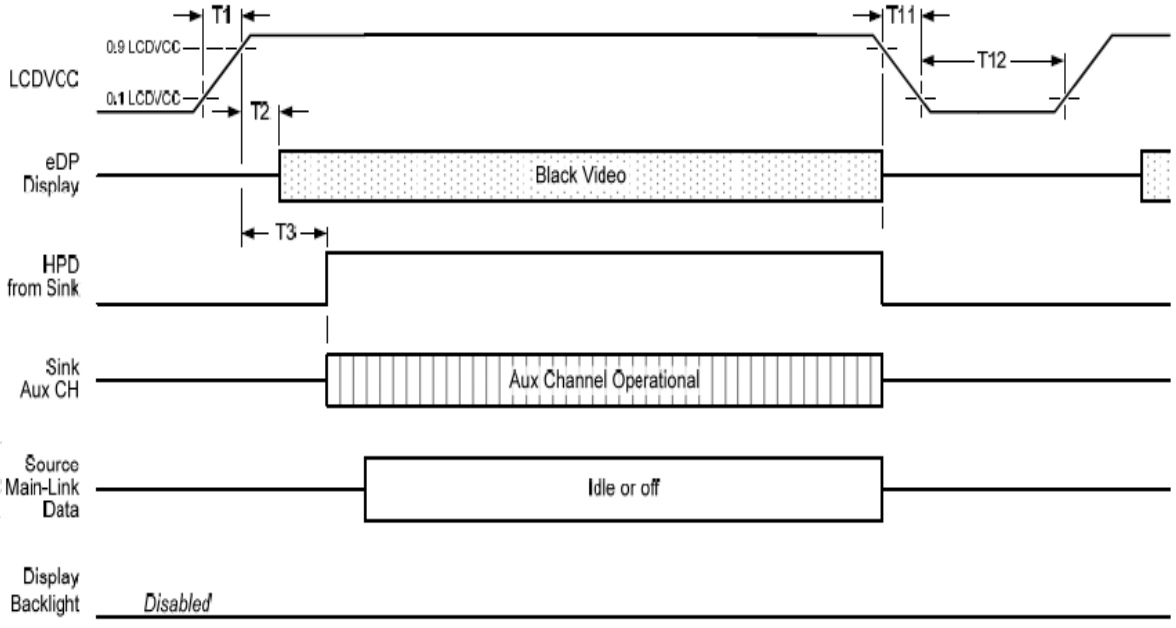
Power on/off sequence is as follows. Interface signals and LED on/off sequence are also shown in the chart.
Signals from any system shall be Hi-Z state or low level when VDD is off

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:

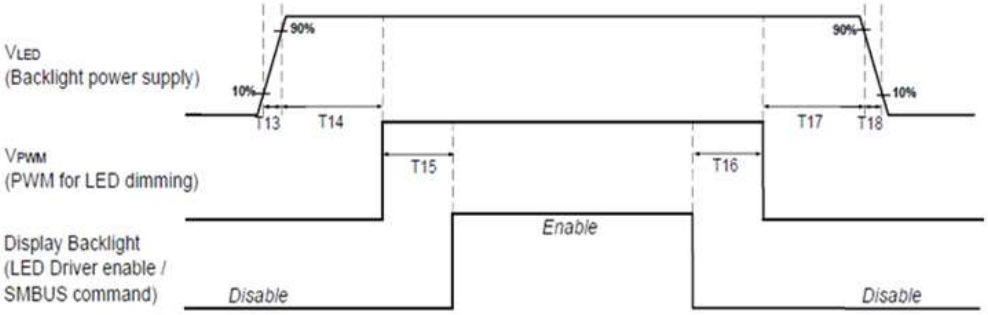
Timing parameter	Description	Reqd. by	Limits			Notes
			Min.	Typ.	Max.	
T1	power rail rise time, 10% to 90%	source	0.5ms		10ms	
T2	delay from LCDVDD to black video generation	sink	0ms		200ms	prevents display noise until valid video data is received from the source
T3	delay from LCDVDD to HPD high	sink	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, 905 to 10%	source			10ms	
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 (with in 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 LCD VDD 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:

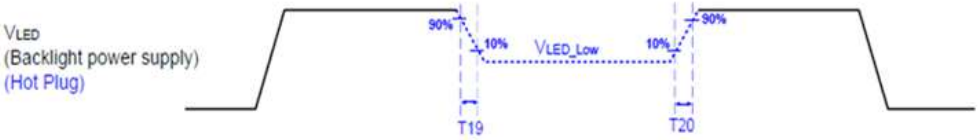


	Min (ms)	Max (ms)
T13	0.5	10
T14	10	-
T15	10	-
T16	10	-
T17	10	-
T18	0.5	10
T19	1*	-
T20	1*	-

Seamless change: T19/T20 = 5xT_{PWM}*

*T_{PWM}= 1/PWM Frequency

Note : When the adapter is hot plugged, the backlight power supply sequence is shown as below.



7. Panel Reliability Test

Items	Required Condition	Note
Temperature Humidity Bias	Ta= 40℃, 90%RH, 300h	Note 1,2
High Temperature Operation	Ta= 60℃, 300h	
Low Temperature Operation	Ta= 0℃, 300h	
High Temperature Storage	Ta= 70℃,300h	
Low Temperature Storage	Ta= -20℃, 300h	
Thermal Shock Test	Ta= -20℃to 60℃, Duration at 30 min, 100 cycles	
Vibration	Test method: Non-Operation Acceleration: 1.5 G Frequency: 10 - 200Hz Random Sweep: 30 minutes each axis (X, Y, Z)	
Mechanical Shock	Test method: Non-Operation Acceleration: 220 G; Wave: Half-sine Active time: 2ms Direction: ±X,±Y,±Z (one time for each axis)	
ESD	Contact : ±8 KV / Operation, Class B Air : ±15 KV / Operation, Class B	Note 1

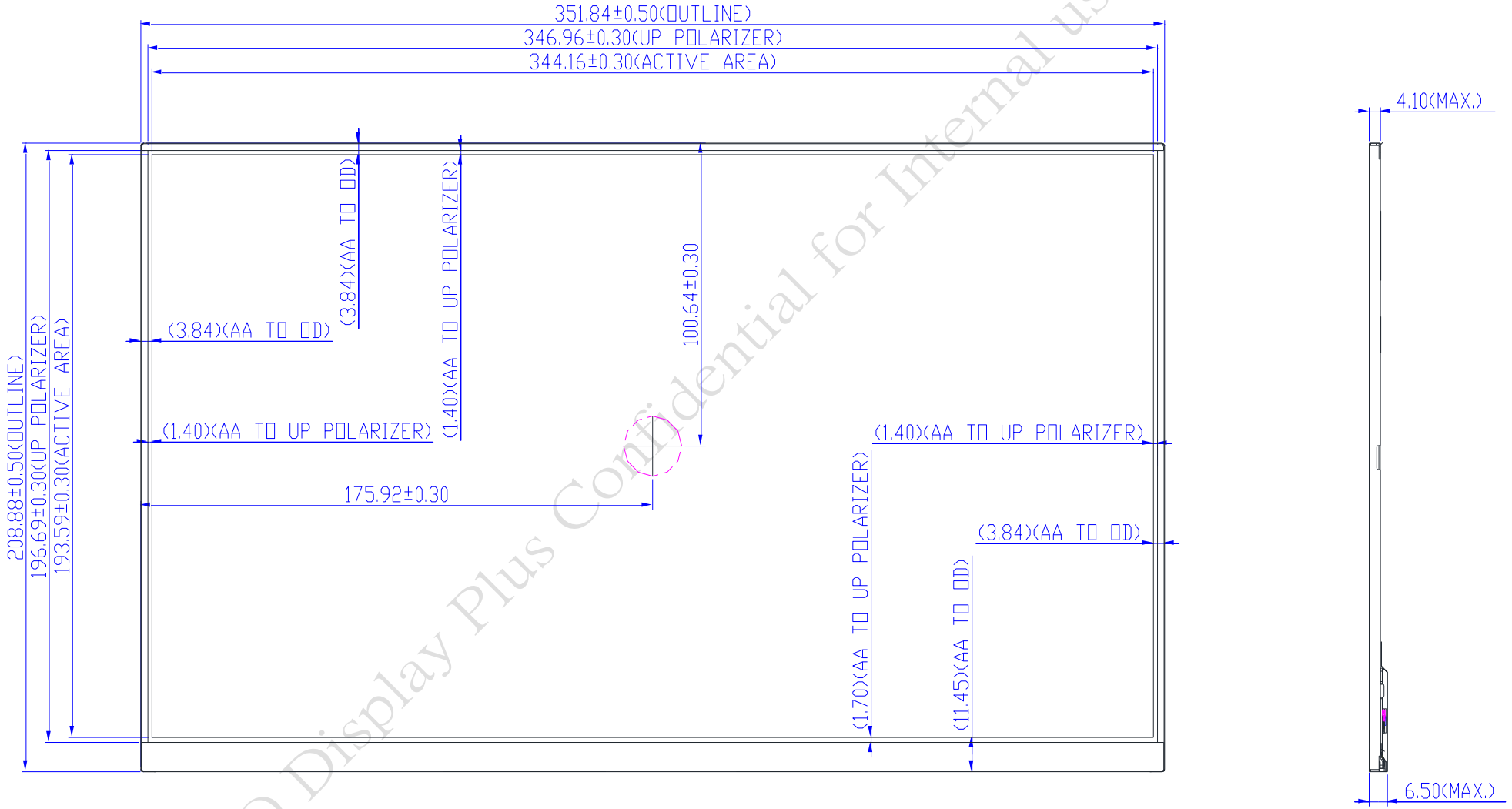
Note 1: According to EN 61000-4-2 , ESD class B: Some performance degradation allowed. Self-recoverable. No data lost, No hardware failures.

Note 2:

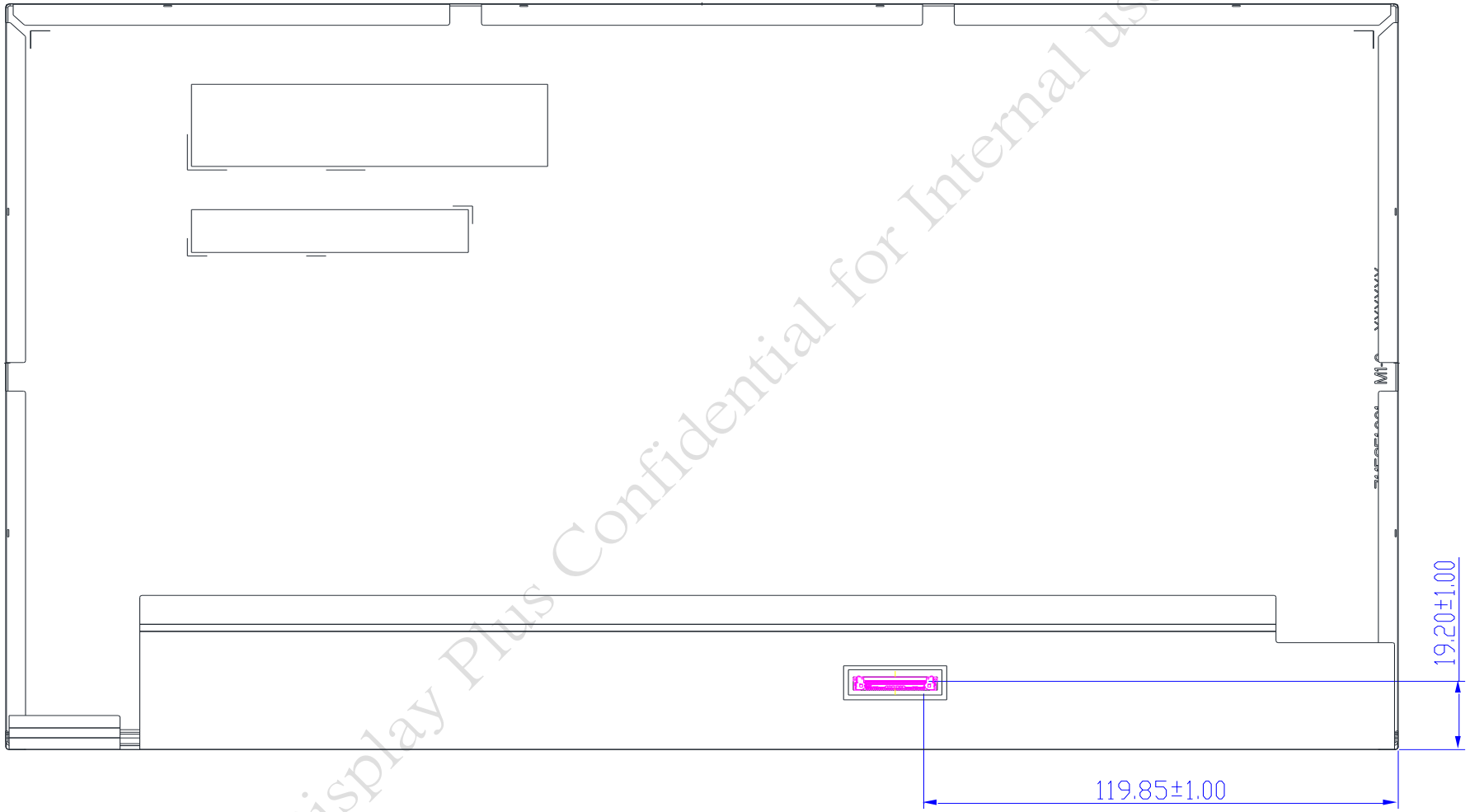
- Water condensation is not allowed for each test items.
- Each test is done by new TFT-LCD module. Don't use the same TFT-LCD module repeatedly for reliability test.
- The reliability test is performed only to examine the TFT-LCD module capability.
- To inspect TFT-LCD module after reliability test,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

8. Mechanical Characteristics

8.1 LCM Outline Dimension (Front View)

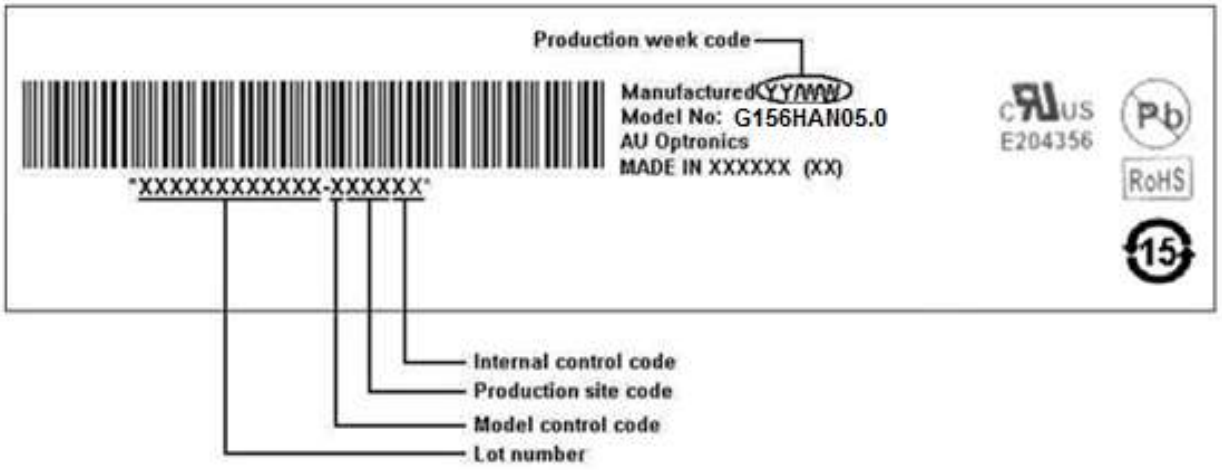


8.2 LCM Outline Dimension (Rear View)



9. Shipping and Package

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



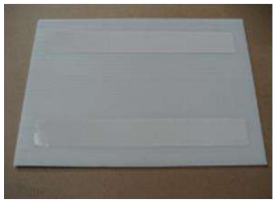
Note 1: For Pb Free products, AUO will add for identification.

Note 2: For RoHS compatible products, AUO will add for identification.

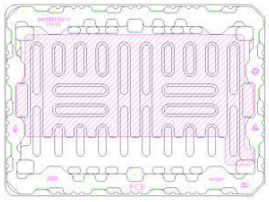
Note 3: For China RoHS compatible products, AUO will add for identification.

Note 4: The Green Mark will be presented only when the green documents have been ready by AUO Internal Green Team.

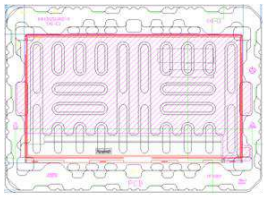
9.2 Carton Package



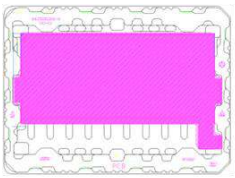
1、Put out PP Board



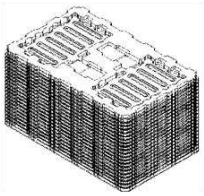
2、Tray placed on PP Board



3、Put 1Pcs EPE Spacer into Tray
4、Put 1pcs panel on First Spacer , **CF upwards in Tray**



6、Finally,
Put 1pcs Spacer on Second Panel、**1 Pcs Tray contained 1pcs Panel + 2pcs Spacer**



7、Stack 19 layers PET tray as the method mention above (18tray+1dummy tray)

8、Insert the package from the sideway of the Antistatic Bag. Pack the bag, and then tape with scotch tape.

9、Placing EPE into carton

10、Placing trays into carton

11、Cover with EPE cushion

12、Sealing the carton with packing tape

Max capacity：18 TFT-LCD module per carton

Max weight: 10kg per carton

Outside dimension of carton:485mm(H)*375mm(W)*340mm(H)

Pallet size： 1150 mm * 980 mm * 132mm

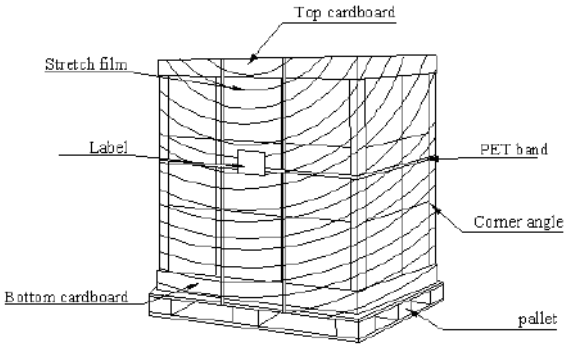
Box stacked

Module by air：(2*3) *4 layers，one pallet put 24 boxes，total 432 pcs module

Module by sea：(2*3) *4 layers + (2*3) *1 layers， two pallet put 30 boxes，total 540 pcs module

Module by sea_HQ：(2*3) 4 layers + (2*3) *2 layers， two pallet put 36 boxes，total 648 pcs module

9.3 Shipping Package of Palletizing Sequence



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

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 International Safety Standard Compliance

The TFT-LCD Module will satisfy all requirements for compliance to IEC/UL 62368-1.

11. Handling guide

This is a thin and slime LCD model, and please be cautious when pulling it out of package or assembling it onto platform. Careless handlings, e.g. twist, bending, pressing, or collision, will result malfunction of LCD models.

(1) Handling method notice

Do not lift and hold the panel with single hand at right or left side from tray.

Lift and hold the panel up with both hands from tray.

(2) On the table notice

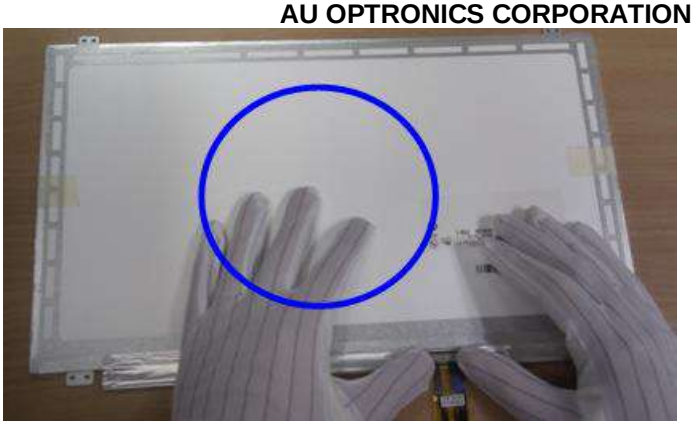
Do not press edge of panel to avoid glass broken.

Do not press the surface of the panel to avoid the glass broken or polarizer scratch.

Do not put anything or tool on the panel to avoid the glass broken or polarizer scratch.

(3) Cable assembly notice

Do not insert the connector with single hand and touching the PCBA.



Insert the connector by pushing right and left edge.