Product Specification

AU OPTRONICS CORPORATION

(✓) Preliminary Specifications

( ) Final Specifications

Module	**15.6"FHD Color TFT-LCD**
Model Name	**G156HTN02.1**
Note	**LED backlight with driving circuit design**

Customer	**Date**	**Approved by**	**Date**
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Note: This Specification is subject to change without notice.		**AV BU Marketing Division AU Optronics Corporation**	

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Record of Revision

Version and Date	Page	Old Description	New Description	Remark
0.0 2015/07/31	All	1st Edition for Customers (Preliminary Specifications)		
0.0 2015/08/20	All	2nd Edition for Customers (Preliminary Specifications)		
0.0 2015/12/03	All	Please ref. the file of "G156HTN02_1_Record of Revision".		

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 without flammability grade are used in the TFT-LCD module. The TFT-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

G156HTN02.1 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) x1080(V) screen and 16.7M colors (RGB 8-bits data driver) with LED backlight driving circuit.

G156HTN02.1 is designed for a display unit of industrial machine.

2.1 General Specification

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

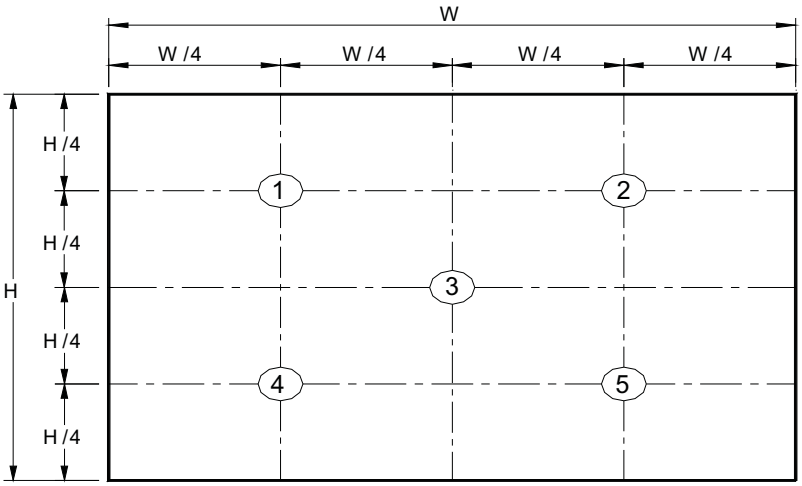
Items	Unit	Specifications			
Screen Diagonal	[inch]	15.6"			
Active Area	[mm]	344.16(H) x 193.59(V)			
Pixels H x V		1920 x 3(RGB) x 1080			
Pixel Pitch	[mm]	0.17925 x 0.17925			
Pixel Format		R.G.B. Vertical Stripe			
Display Mode		TN Mode, Normally White			
White Luminance (Center) (ILED=50mA,Note: ILED is LED current)	[cd/m^2]	1000 Typ. 800 Min.			
Luminance Uniformity		80% (5 points, Typ.)			
Contrast Ratio		700:1 (Typ.)			
Response Time	[ms]	8 (Typ.)/ 16 (Max.)			
Nominal Input Voltage VDD	[Volt]	+3.3 (Typ.)			
LCD Power Consumption	[Watt]	4.752 W (Max.)			
LED Power Consumption	[Watt]	14.4W (Max.)			
Weight	[Grams]	1040 (Max.)			
Physical Size **Without bracket.**	[mm]		Min.	Typ.	Max.
		Length	363.3	363.8	364.3
		Width	215.4	215.9	216.4
		Thickness	11.5	12	12.5
Electrical Interface		Two channel LVDS			
Surface Treatment		Anti-glare (Haze=25%)			
Support Color		16.7M Colors (RGB 8-bits)			
Temperature Range Operating Storage (Non-Operating)	 [°C] [°C]	 -10 to +70 -20 to +70			

2.2 Optical Characteristics

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

Item		Unit	Conditions	Min.	Typ.	Max.	Note
Central Luminance ILED=45mA		cd/m2		320	400	---	1, 3, 4
Viewing Angle		degree	Horizontal (Right) CR = 10 (Left)	60	80	---	3, 8
				60	80	---	
			Vertical (Upper) CR = 10 (Lower)	45	70	---	
				50	70	---	
Luminance Uniformity			5 Points	75	80	---	1, 2, 3
Contrast Ratio				400	700	---	3, 5
Cross talk				---	---	4	3, 6
Response Time		msec	Rising + Falling	---	8	16	3, 7
Color / Chromaticity Coodinates	Red	Rx	CIE 1931	0.587	0.637	0.687	3
		Ry		0.293	0.343	0.393	
	Green	Gx		0.276	0.326	0.376	
		Gy		0.575	0.625	0.675	
	Blue	Bx		0.105	0.155	0.205	
		By		0.002	0.052	0.102	
	White	Wx		0.263	0.313	0.363	
		Wy		0.279	0.329	0.379	
NTSC		%		-	72	-	

Note 1: 5 points position (Ref: Active area)

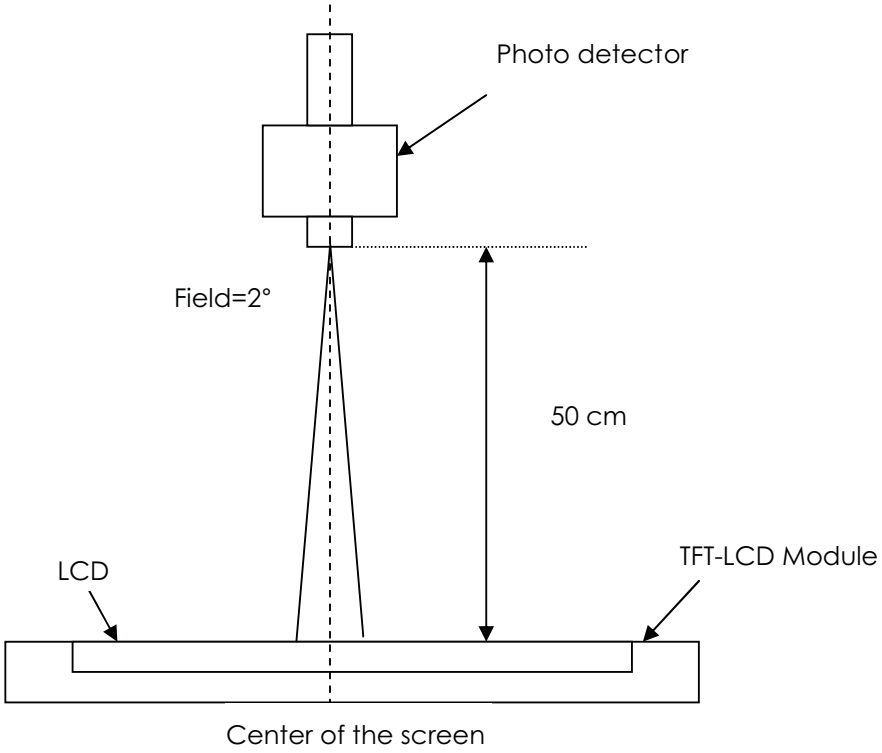


Note 2: The luminance uniformity of 5 points is defined by dividing the maximum luminance values by the minimum test point luminance

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

Note 3: Measurement method

The LCD module should be stabilized at given temperature for 30 minutes to avoid abrupt temperature change during measuring. In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 30 minutes in a stable, windless and dark room, and it should be measured in the center of screen.



Note 4 : Definition of Average Luminance of White (Y_L):

Measure the luminance of gray level 63 at 5 points , Y_L = [L (1)+ L (2)+ L (3)+ L (4)+ L (5)] / 5

L (x) is corresponding to the luminance of the point X at Figure in Note (1).

Note 5 : Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

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

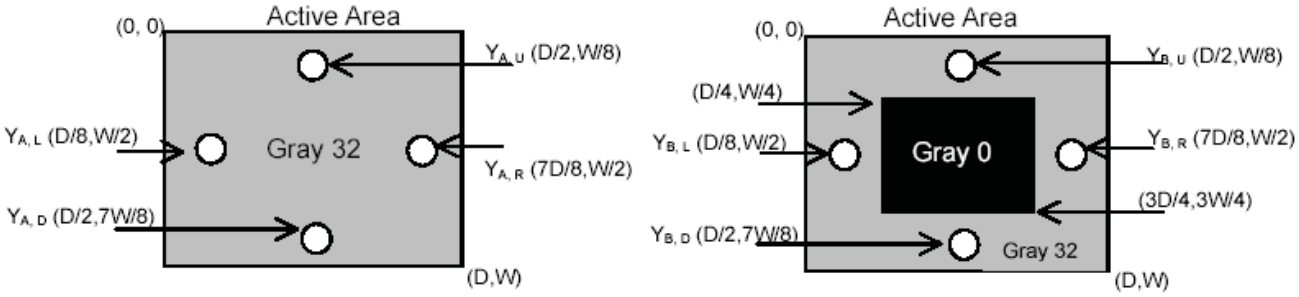
Note 6 : Definition of Cross Talk (CT)

$CT = | Y_B - Y_A | / Y_A \times 100$ (%)

Where

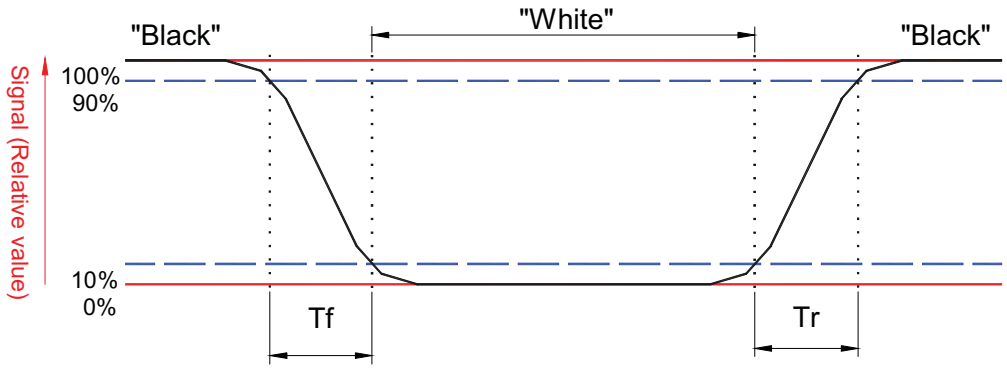
Y_A = Luminance of measured location without gray level 0 pattern (cd/m^2)

Y_B = Luminance of measured location with gray level 0 pattern (cd/m2)



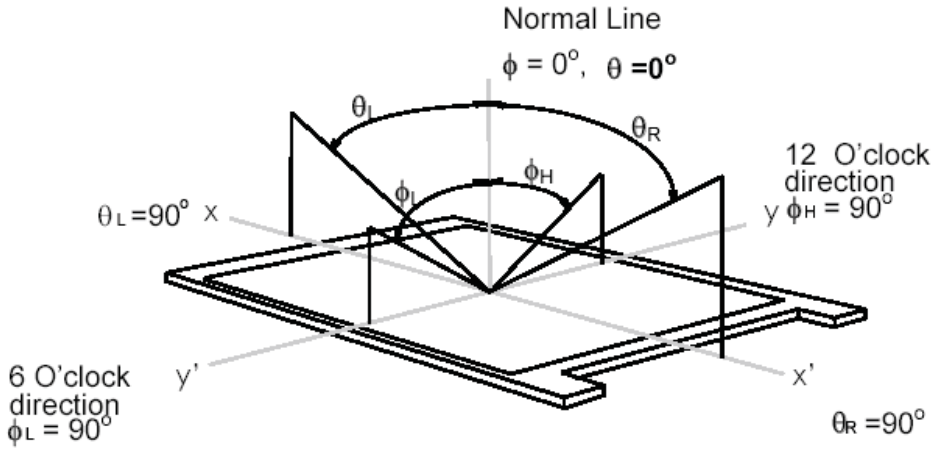
Note 7: Definition of response time:

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.



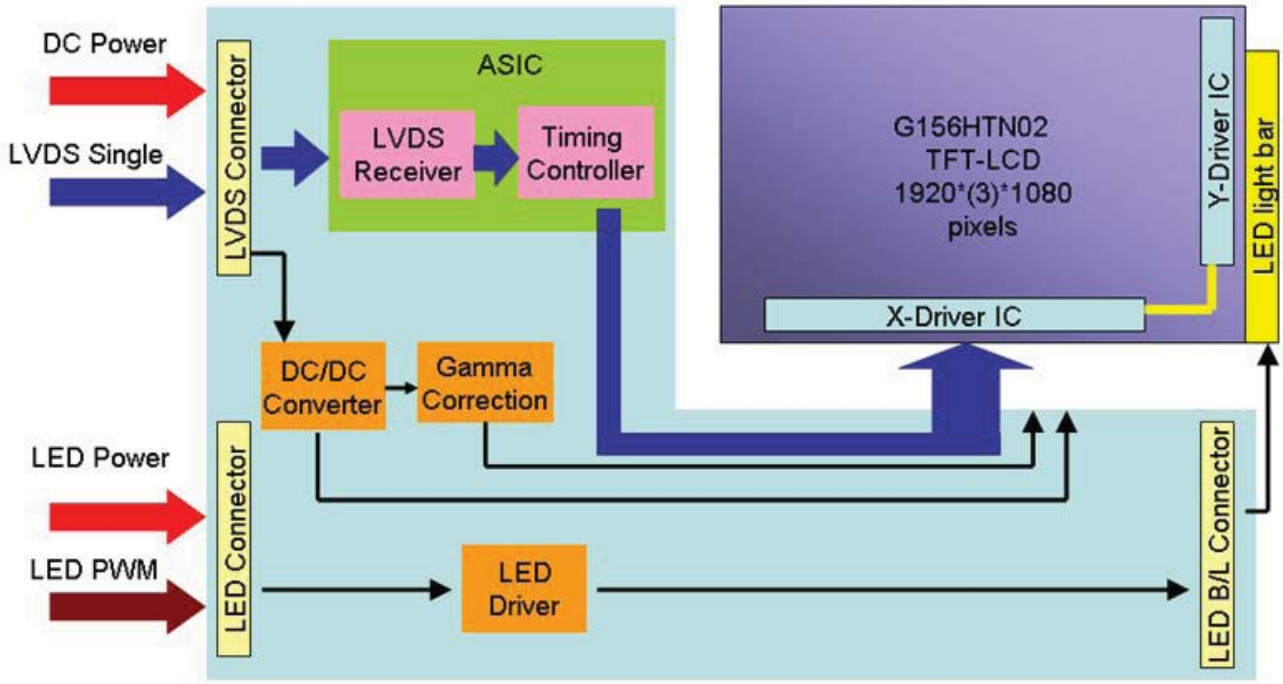
Note 8. Definition of viewing angle

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 inch 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 Voltage	VDD	-0.3	+4.0	[Volt]	Note 1,2
BL Input Voltage	VLED	-0.3	+15.0	[Volt]	Note 1,2
Signal Voltage	RinI-/+, ClkIN-/+	-0.3	VDD+0.3	[Volt]	Note 1, I=0,1,2,3
Signal Voltage	VLED_EN VPWM_EN	-0.3	VLED	[Volt]	Note 1,2

4.2 Absolute Ratings of Environment

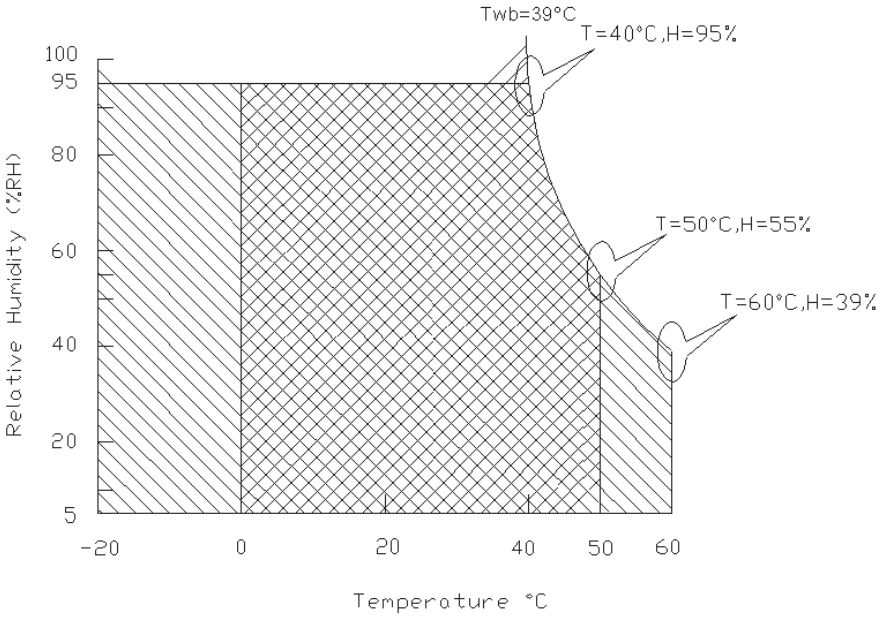
Item	Symbol	Min	Max	Unit	Conditions
Operating Temp.	TOP	-10	+70	[°C]	Note 4
Operation Humidity	HOP	8	95	[%RH]	Note 4
Storage Temperature	TST	-20	+70	[°C]	Note 4
Storage Humidity	HST	5	95	[%RH]	Note 4

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)



Operating Range Storage Range +

5. Electrical Characteristics

5.1 TFT LCD Module

5.1.1 Power Specification

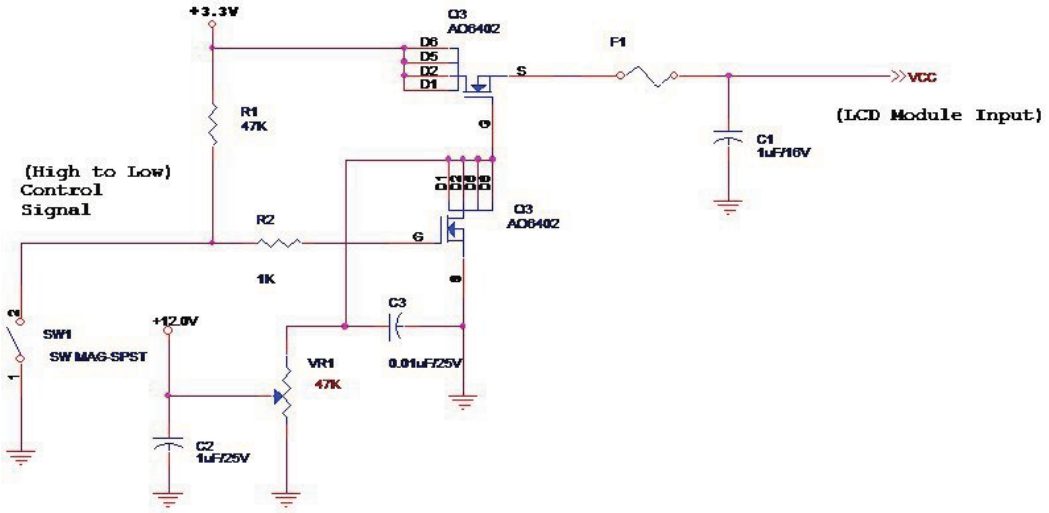
Input power specifications are as follows;

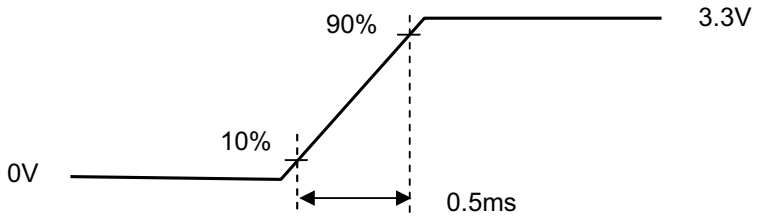
The power specification are measured under 25□ and frame frequency under 60Hz

Symble	Parameter	Min	Typ	Max	Units	Note
VDD	Logic/LCD Drive Voltage	3.0	3.3	3.6	[Volt]	
PDD	VDD Power	-	3.3	4.752	[Watt]	Note 1
IDD	IDD Current	-	1200	1440	[mA]	Note 1
IRush	Inrush Current	-	-	2	[A]	Note 2
VDDrp	Allowable Logic/LCD Drive Ripple Voltage	-	-	200	[mV] p-p	

Note 1: Maximum Measurement Condition : Red Pattern

Note 2: Measure Condition





Vin rising time

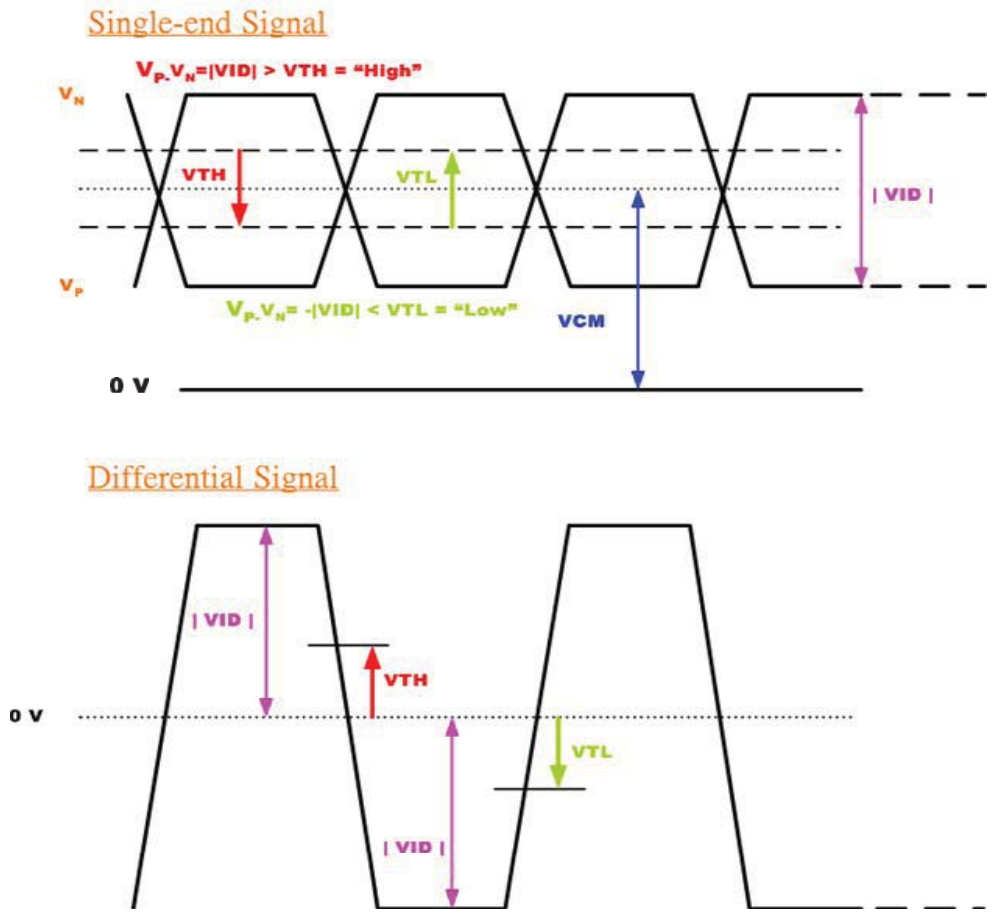
5.1.2 Signal Electrical Characteristics

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

Signal electrical characteristics are as follows;

Symbol	Parameter	Min	Typ	Max	Units	Condition
V_{TH}	Differential Input High Threshold	-	-	+100	[mV]	V_{CM} = 1.2V Note 1
V_{TL}	Differential Input Low Threshold	-100	-	-	[mV]	V_{CM} = 1.2V Note 1
$\lvert V_{ID} \rvert$	Input Differential Voltage	100	400	600	[mV]	Note 1
V_{CM}	Differential Input Common Mode Voltage	+1.1	-	+1.45	[Volt]	V_{TH}-V_{TL} = 200mV (max) Note 1

Note 1: LVDS Signal Waveform



5.2 Backlight Unit

5.2.1 LED characteristics

Parameter	Symbol	Min	Typ	Max	Units	Condition
Backlight Power Consumption	PLED	-	-	14.4W	[Watt]	(Ta=25□), Note 1
LED Life-Time	N/A	-	50,000	-	Hour	(Ta=25□), Note 2

Note 1: Calculator value for reference P_{LED} = V_F (Normal Distribution) * I_F (Normal Distribution) / Efficiency

Note 2: LED lifetime is defintion: brightness is decreased to 50% of the initial value. LED lifetime is restricted under normal condition, ambient temperature=25℃ and LED operating IF = 45mA.

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 Input current	ILED	-	1.2	1.37	[A]	
LED Enable Input High Level	VLED_EN	2.5	-	6	[Volt]	
LED Enable Input Low Level		-	-	0.8	[Volt]	
PWM Logic Input High Level	VPWM_EN	2.7	-	6	[Volt]	
PWM Logic Input Low Level		-	-	0.8	[Volt]	
PWM Input Frequency	FPWM	200	-	15K	Hz	
PWM Duty Ratio	Duty	5	-	100	%	
LED Inrush Current	ILEDRush	_	_	3	[A]	

Note 1: Ta means ambient temperature of TFT-LCD module.

Note 2: VCC, ICC, PCC are defined for LED backlight. (100% duty of PWM)

Note 3: I_F, V_F are defined for one channel LED. There are four LED channels in back light unit.

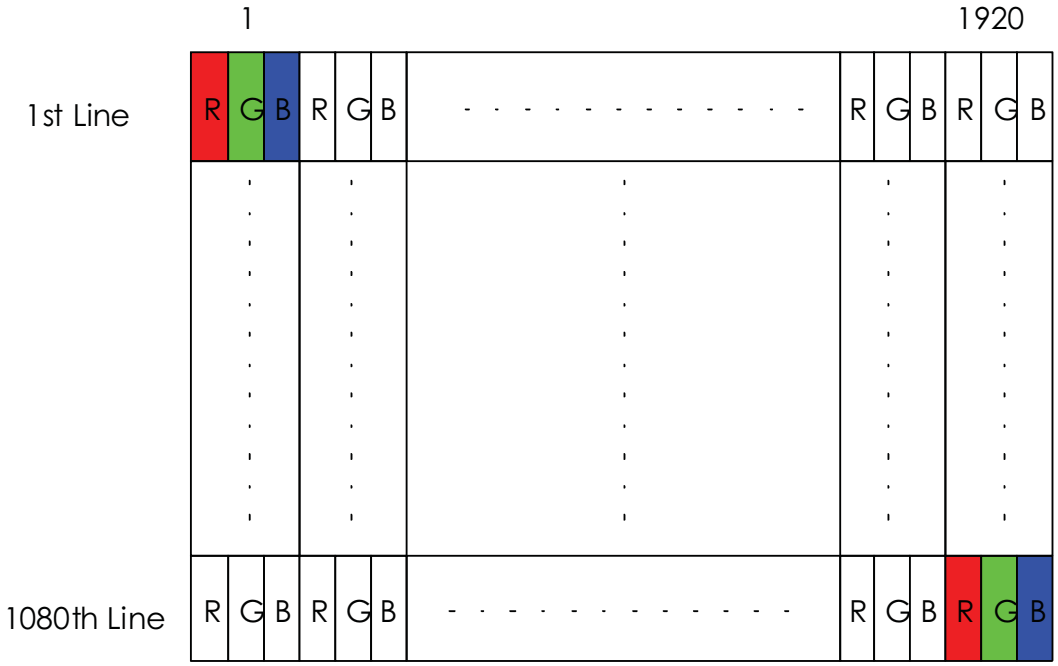
Note 4: If module is driven by high current or at high ambient temperature & humidity condition. The operating life will be reduced.

Note 5: Operating life means brightness goes down to 50% intial brightness. Minimum operating life time is estimated data.

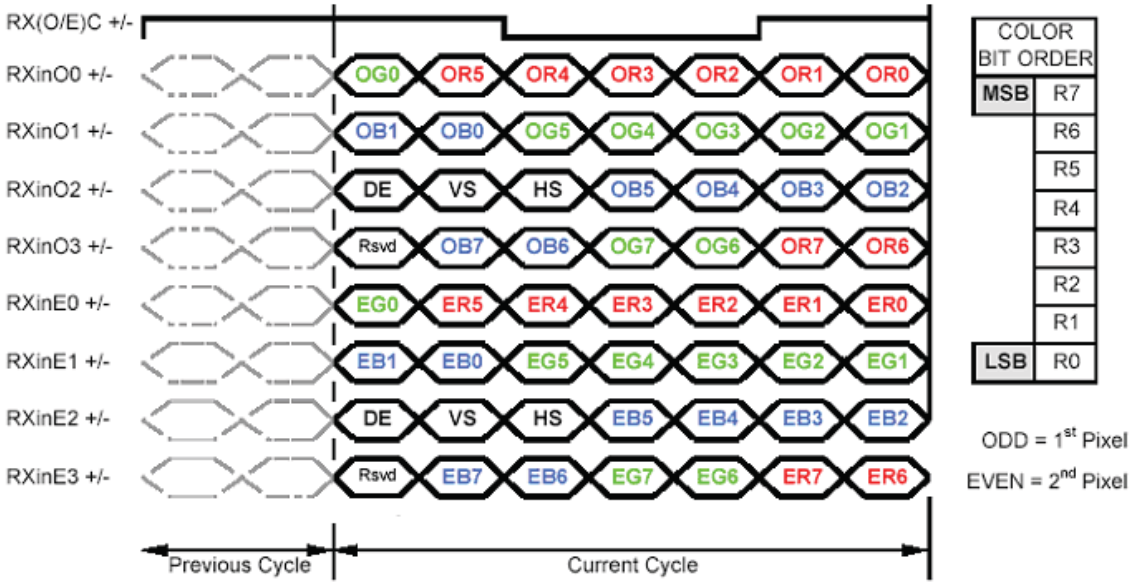
6. Signal Interface Characteristic

6.1 Pixel Format Image

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



6.2 The Input Data Format



6.3 Signal Description

The module using one LVDS receiver SN75LVDS82(Texas Instruments) or compatible. LVDS is a differential signal technology for LCD interface and high speed data transfer device. LVDS transmitters shall be SN75LVDS83(negative edge sampling) or compatible. The first LVDS port(RxOxxx) transmits odd pixels while the second LVDS port(RxExxx) transmits even pixels.

CN1		
Pin	**Signal**	**Description**
1	RxOIN0-	Negative LVDS differential data input (Odd data)
2	RxOIN0+	Positive LVDS differential data input (Odd data)
3	RxOIN1-	Negative LVDS differential data input (Odd data)
4	RxOIN1+	Positive LVDS differential data input (Odd data)
5	RxOIN2-	Negative LVDS differential data input (Odd data, DSPTMG)
6	RxOIN2+	Positive LVDS differential data input (Odd data, DSPTMG)
7	GND	Power Ground
8	RxOCLKIN-	Negative LVDS differential clock input (Odd clock)
9	RxOCLKIN+	Positive LVDS differential clock input (Odd clock)
10	RxOIN3-	Negative LVDS differential data input (Odd data)
11	RxOIN3+	Positive LVDS differential data input (Odd data)
12	RxEIN0-	Negative LVDS differential data input (Even data)
13	RxEIN0+	Positive LVDS differential data input (Even data)
14	GND	Power Ground
15	RxEIN1-	Positive LVDS differential data input (Even data)
16	RxEIN1+	Negative LVDS differential data input (Even data)
17	GND	Power Ground
18	RxEIN2-	Negative LVDS differential data input (Even data)
19	RxEIN2+	Positive LVDS differential data input (Even data)
20	RxECLKIN-	Negative LVDS differential clock input (Even clock)
21	RxECLKIN+	Positive LVDS differential clock input (Even clock)
22	RxEIN3-	Negative LVDS differential data input (Even data)
23	RxEIN3+	Positive LVDS differential data input (Even data)
24	GND	Power Ground
25	GND	Power Ground
26	GND	Power Ground
27	GND	Power Ground
28	VDD	Power +3.3V
29	VDD	Power +3.3V

30	VDD	Power +3.3V

CN2		
Pin	**Signal**	**Description**
1	VLED	+12V
2	VLED	+12V
3	GND	Ground
4	GND	Ground
5	VLED_EN	LED enable pin
6	VPWM_EN	System PWM Single Input

6.4 Interface Timing (LVDS)

6.4.1 Timing Characteristics

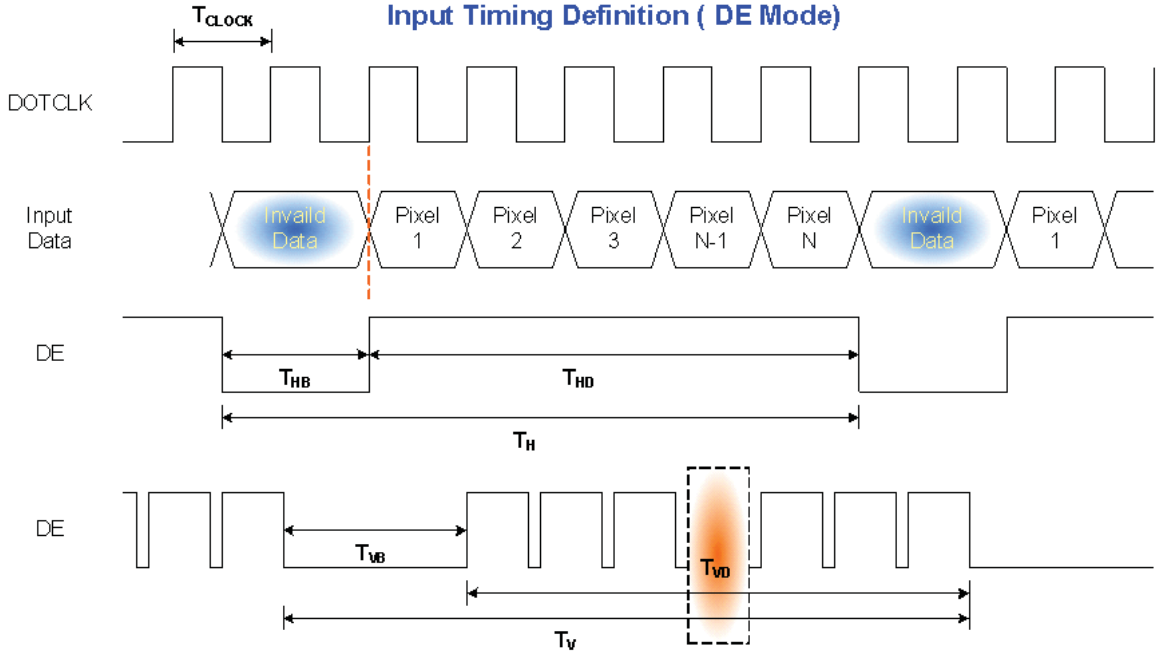
Basically, interface timings should match the 1920x1080/ 60Hz manufacturing guide line timing.

Parameter		Symbol	Min.	Typ.	Max.	Unit
Frame Rate		-	40	60	61	Hz
Clock frequency		1/ T_{Clock}	50	70.93	75	MHz
Horizontal Section	Period	T_H	1050	1065	1075	T_{clock}
	Active	T_{HD}	960			
	Blanking	T_{HB}	90	105	115	
Vertical Section	Period	T_V	1090	1110	1130	T_{line}
	Active	T_{VD}	1080			
	Blanking	T_{VB}	10	30	50	

Note 1: DE mode only.

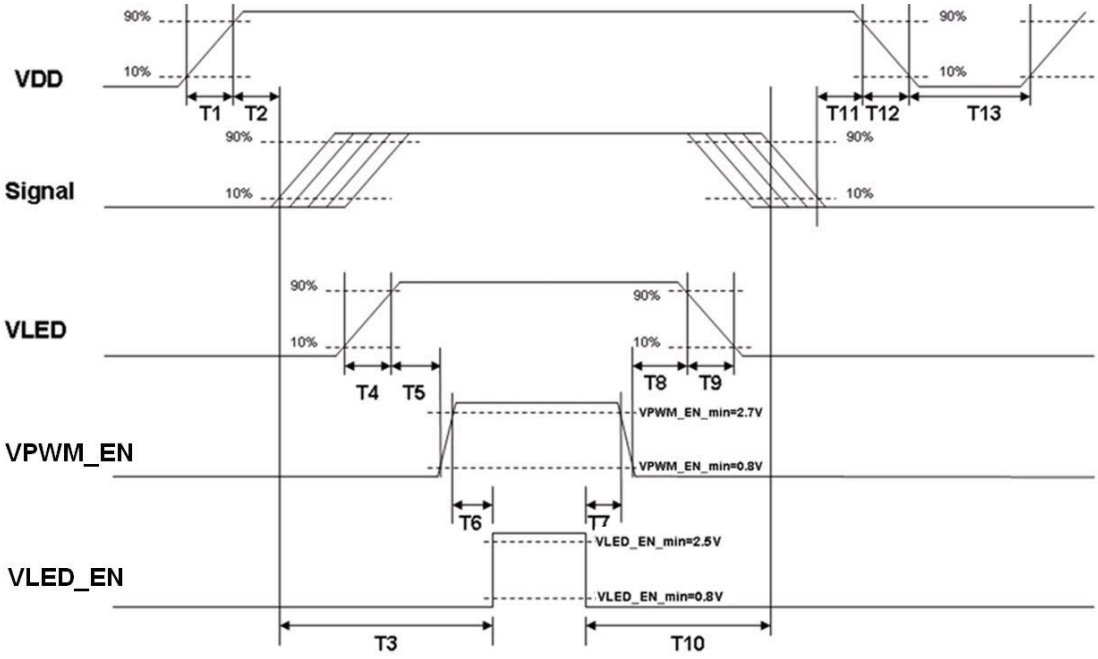
6.4.2 Timing Diagram

Input Timing Definition (DE Mode)



6.5 Power ON/OFF Sequence

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



Power ON/OFF sequence timing

Parameter	Value			Units
	Min.	Typ.	Max.	
T1	0.1	-	10	[ms]
T2	30	40	50	[ms]
T3	220	-	-	[ms]
T4	0.5	-	200	[ms]
T5	10	-	-	[ms]
T6	10	-	-	[ms]
T7	0	-	-	[ms]
T8	10	-	-	[ms]
T9	-	-	10	[ms]
T10	110	-	-	[ms]
T11	0	16	50	[ms]
T12	-	-	10	[ms]
T13	1000	-	-	[ms]

The above on/off sequence should be applied to avoid abnormal function in the display. Please make sure to turn off the power when you plug the cable into the input connector or pull the cable out of the connector.

7. 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.

7.1 TFT LCD Module

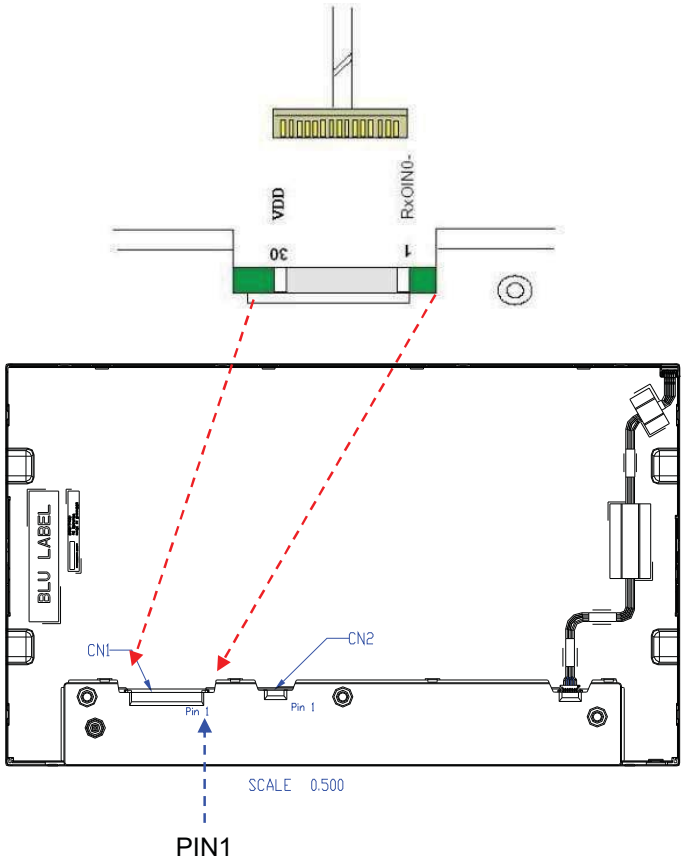
7.1.1 Connector(CN1)

Connector Name / Designation	Interface Connector / Interface card
Manufacturer	Hirose
Type Part Number	DF14H-30P-1.25H (56)
Mating Housing Part Number	DF14H-30S-1.25C

7.1.2 Pin Assignment(CN1)

Pin#	Signal Name	Pin#	Signal Name
1	RxOIN0-	2	RxOIN0+
3	RxOIN1-	4	RxOIN1+
5	RxOIN2-	6	RxOIN2+
7	GND	8	RxOCLKIN-
9	RxOCLKN+	10	RxOIN3-

11	RxOIN3+	12	RxEIN0-
13	RxEIN0+	14	GND
15	RxEIN1-	16	RxEIN1+
17	GND	18	RxEIN2-
19	RxEIN2+	20	RxECLKIN-
21	RxECLKIN+	22	RxEIN3-
23	RxEIN3+	24	GND
25	GND	26	GND
27	GND	28	VDD
29	VDD	30	VDD



7.2 Backlight Unit

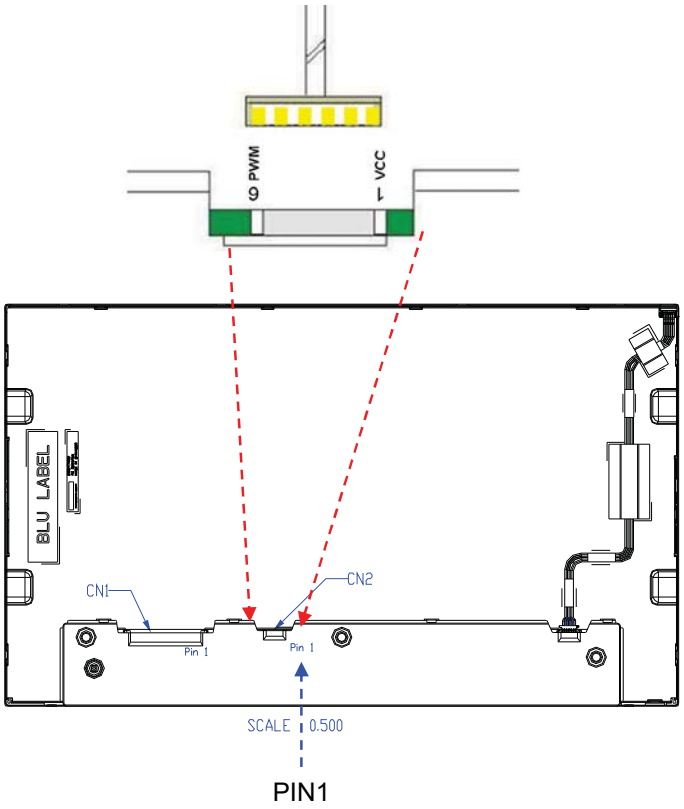
Physical interface is described as for the connector on module. These connectors are capable of accommodating the following signals and will be following components.

7.2.1 Connector (CN2)

Connector Name / Designation	LED Connector
Manufacturer	Hirose
Type Part Number	DF14A-6P-1.25H(56)
Mating Housing Part Number	DF14A-6S-1.25C

7.2.2 LED Driver Connector Pin Assignment (CN2)

Pin#	Signal Name	Pin#	Signal Name
1	VLED	2	VLED
3	GND	4	GND
5	VLED_EN	6	VPWM_EN



8. Panel Reliability Test

8.1 Vibration Test

Test Spec:

- Test method: Non-Operation
- Acceleration: 1.5 G
- Frequency: 10 - 500Hz Random
- Sweep: 30 Minutes each Axis (X, Y, Z)

8.2 Shock Test

Test Spec:

- Test method: Non-Operation
- Acceleration: 220 G , Half sine wave
- Active time: 2 ms
- Pulse: X,Y,Z one time for each side

8.3 Reliability Test

Items	Required Condition	Note
Temperature Humidity Bias	Ta= 40˚C, 90%RH, 300h	Note 1,2
High Temperature Operation	Ta= 70˚C , Dry, 300h	
Low Temperature Operation	Ta= -10˚C, 300h	
High Temperature Storage	Ta= 70˚C, Dry, 300h	
Low Temperature Storage	Ta= -20˚C, 300h	
Thermal Shock Test	Ta=-20˚C to 60˚C, Duration at 30 min, 100 cycles	
ESD	Contact Discharge: ±8 KV, 150pF(330Ω) 1sec, 8Points, 25times/point Air Discharge: ±15 KV, 150pF(330Ω) 1sec, 8Points, 25times/point	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.

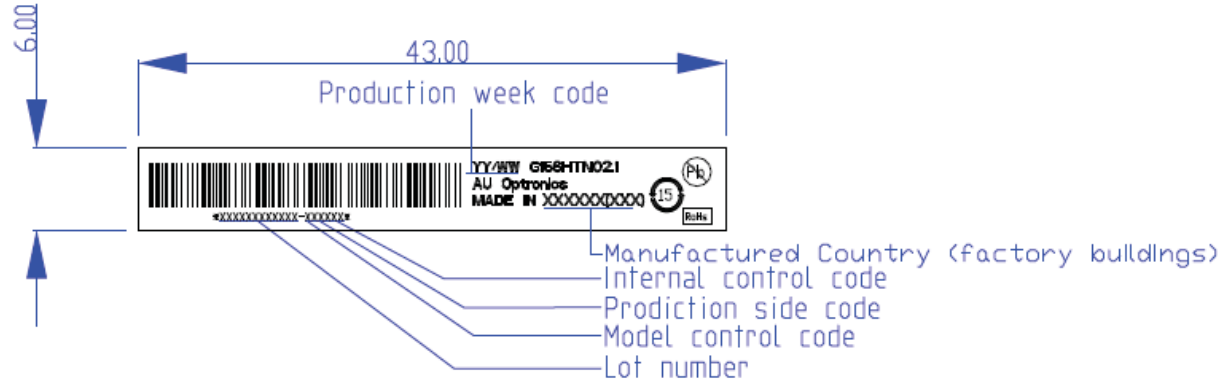
Note 2:

- 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

9. Label and Packing

9.1 Shipping Label & Backlight Label Format

Shipping Label:



Backlight Label:



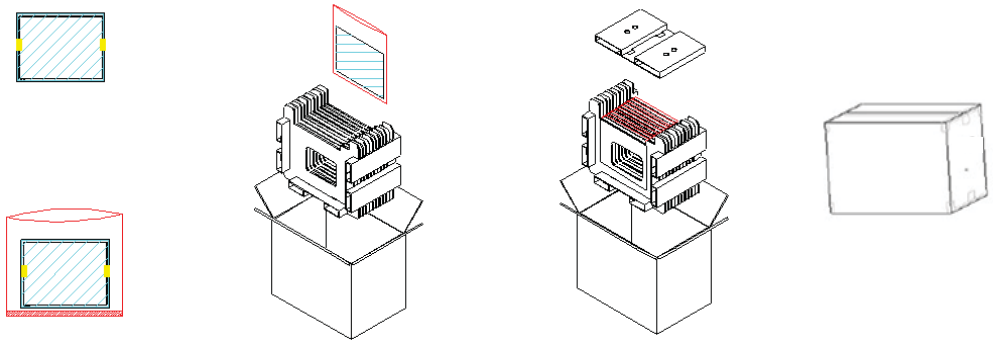
Note 1: For Pb Free products, AUO will add for identification.

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



Max capacity：14 TFT-LCD module per carton

Max weight: 18.5 kg per carton

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

Pallet size： 1150 mm * 910 mm * 132mm

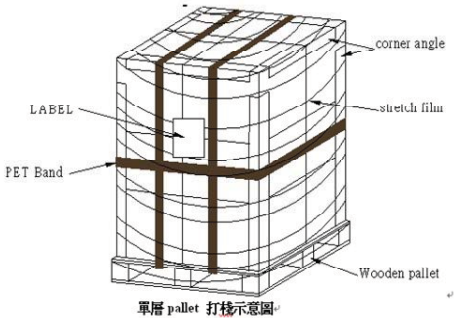
Box stacked

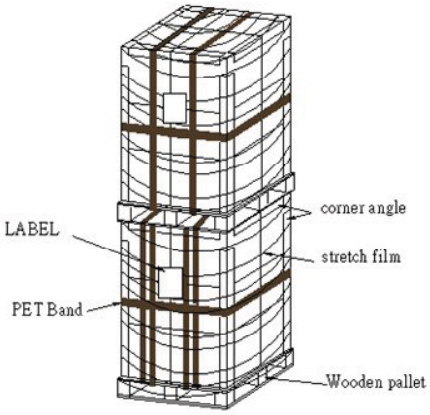
Module by air：(2 *3) *4 layers，one pallet put 24 boxes，total 336pcs module

Module by sea：(2 *3) *4 layers+(2 *3) *1 layers， two pallet put 30 boxes，total 420pcs module

Module by sea_HQ：(2 *3) *4 layers+(2 *3) *2 layers， two pallet put 42 boxes，total 504pcs module

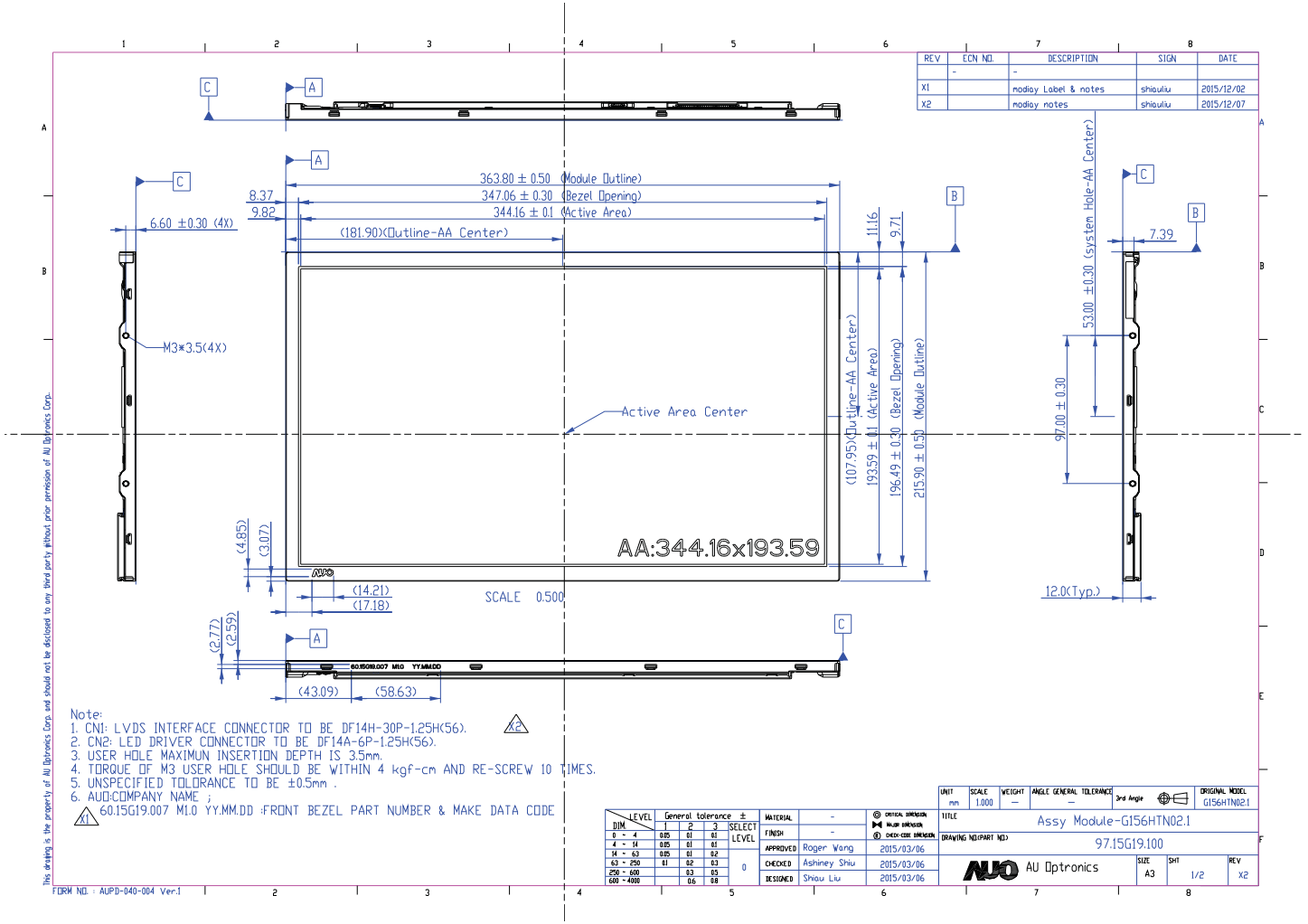
9.3 Shipping Package of Palletizing Sequence





10 .Mechanical Characteristics

10.1 LCM Outline Dimension (Front View)



10.2 LCM Outline Dimension (Rear View)

