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
Checked & Approved by	**Date**

Approved by	Date
Prepared by	**Date**

Note: This Specification is subject to change without notice.

NBBU Marketing Division
AU Optronics Corporation

Contents

Product Specification
AU OPTRONICS CORPORATION

Record of Revision

Version and Date	Page	Old Description	New Description	Remark
0.0 2015/05/15	All	1st Edition for Customers		

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 16.2M colors (RGB 6-bits+2FRC 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/m2]	400 Typ. 320 Min.			
Luminance Uniformity		TBD (5 points, Max.)			
Contrast Ratio		500:1 (Typ.)			
Response Time	[ms]	8 (Typ.)/ 16 (Max.)			
Nominal Input Voltage VDD	[Volt]	+3.3 (Typ.)			
LCD Power Consumption	[Watt]	3.76 W (Max.)			
LED Power Consumption	[Watt]	10.6 W (Max.)			
Weight	[Grams]	TBD (Max.)			
Physical Size **Without bracket.**	[mm]		Min.	Typ.	Max.
		Length	363.3	363.8	364.3
		Width	215.4	215.9	216.4
		Thickness	8.8	9.3	9.8
Electrical Interface		Two channel LVDS			
Surface Treatment		Anti-glare (Haze=25%)			
Support Color		16.2M Colors (RGB 6-bits +2FRC)			
Temperature Range Operating Storage (Non-Operating)	[ₒC] [ₒC]	-10 to +70 -20 to +70			

2.2 Optical Characteristics

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

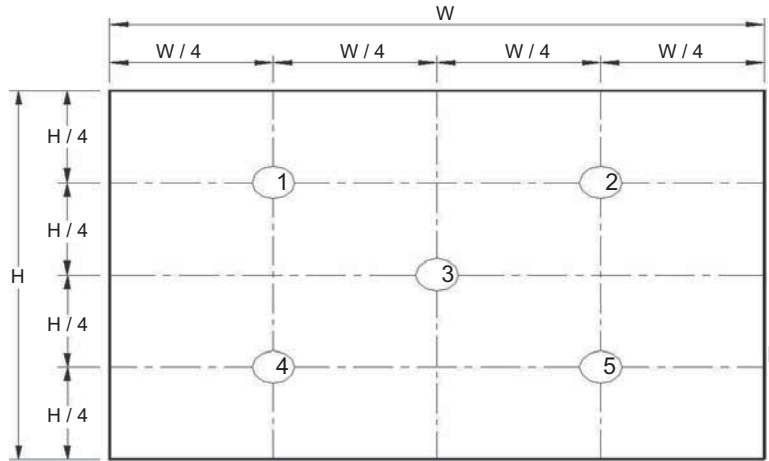| Item		Unit	Conditions		Min.	Typ.	Max.	Note
Central Luminance ILED=50mA		cd/m2			320	400	---	1, 4, 5
Viewing Angle		degree	Horizontal CR = 10	(Right)	60	70	---	4, 9
				(Left)	60	70	---	
			Vertical CR = 10	(Upper)	45	60	---	
				(Lower)	50	60	---	
Luminance Uniformity			5 Points		---	---	TBD	1, 3, 4
			13 Points		---	---	TBD	2, 3, 4
Contrast Ratio					400	500	-	4, 6
Cross talk					---	---	4	4, 7
Response Time		msec	Rising + Falling		---	8	16	4, 8
Color / Chromaticity Coodinates	Red	Rx	CIE 1931		TBD	TBD	TBD	4
		Ry			TBD	TBD	TBD	
	Green	Gx			TBD	TBD	TBD	
		Gy			TBD	TBD	TBD	
	Blue	Bx			TBD	TBD	TBD	
		By			TBD	TBD	TBD	
	White	Wx			TBD	*0.313	TBD	
		Wy			TBD	*0.329	TBD	
NTSC		%			-	72	-	

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

W

W / 4   W / 4   W / 4   W / 4

H / 4

H / 4

H

H / 4

H / 4

1   2

3

4   5

Note 2: 13 points position (Ref: Active area)

W

W /4   W /4   W /4   W /4

1 0   1 0

1 0

H /4

H /4

H

H /4

H /4

1 0

1   2   3

4   5

6   7   8

9   1 0

1 1   1 2   1 3
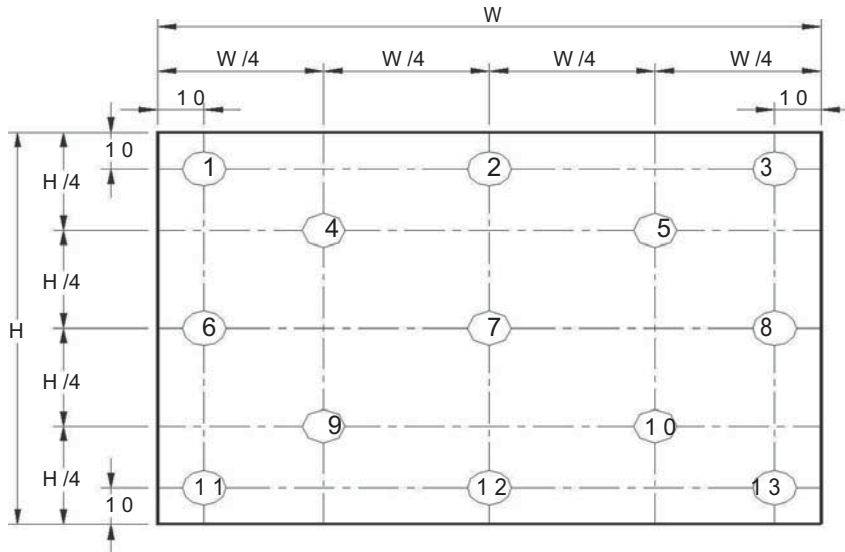
Note 3: The luminance uniformity of 5 or13 points is defined by dividing the maximum luminance values by the minimum test point luminance

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

$$\delta W13 = \frac{\text{Maximum Brightness of thirteen points}}{\text{Minimum Brightness of thirteen points}}$$

Note 4: 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.

Photo detector

Field=2°

50 cm

TFT-LCD Module

LCD

Center of the screen
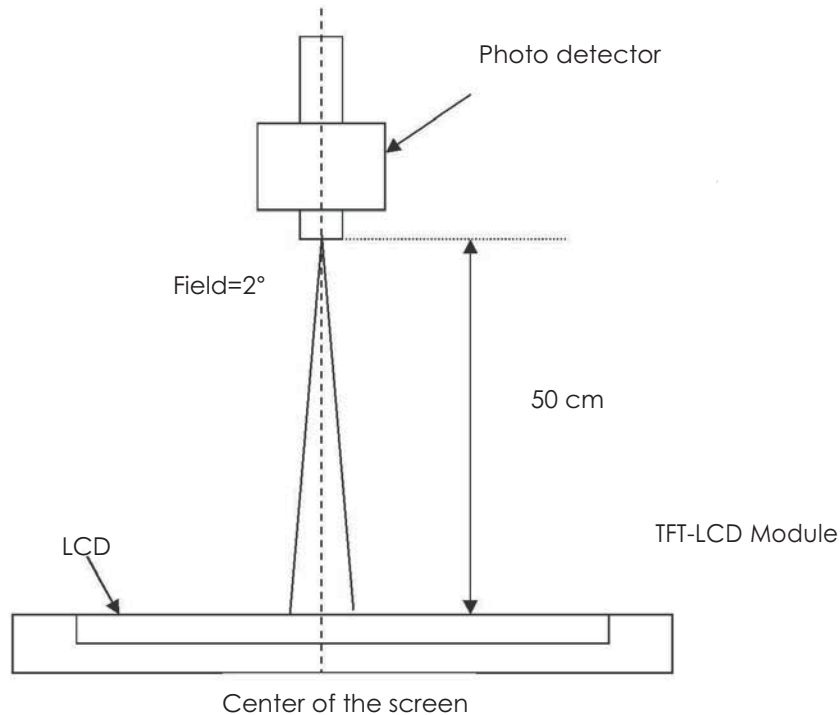
Note 5: Definition of Average Luminance of White (Y_L):

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 6: Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

$$\frac{\text{Brightness on the "White" state}}{\text{Brightness on the "Black" state}}$$
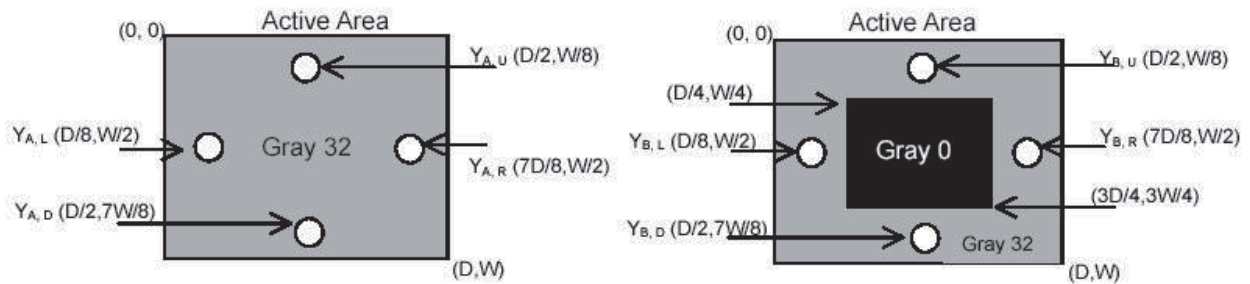
Note 7 : Definition of Cross Talk (CT)

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

Where

Y_A = Luminance of measured location without gray level 0 pattern (cd/m²)

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

Note 8: 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.
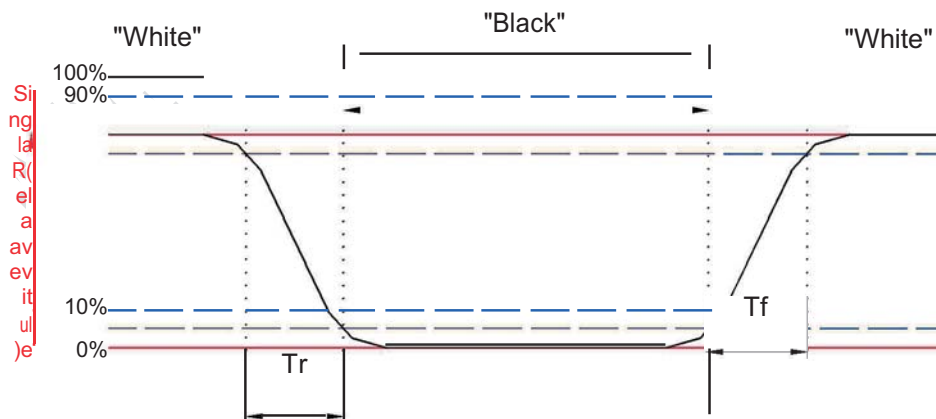
Note 9. Definition of viewing angle

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.
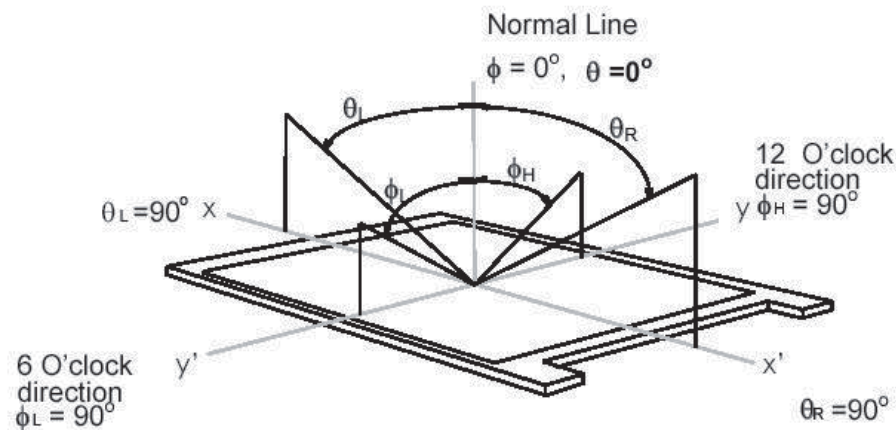
Crosstalk above for viewing angle under 3D mode is defined as below:

Crosstalk_Left(%) = $L_{black}R_{white}$ / $L_{white}R_{black}$

Where

Crosstalk_Left(%) means left eye crosstalk;

L_{black} means left eye black signal;
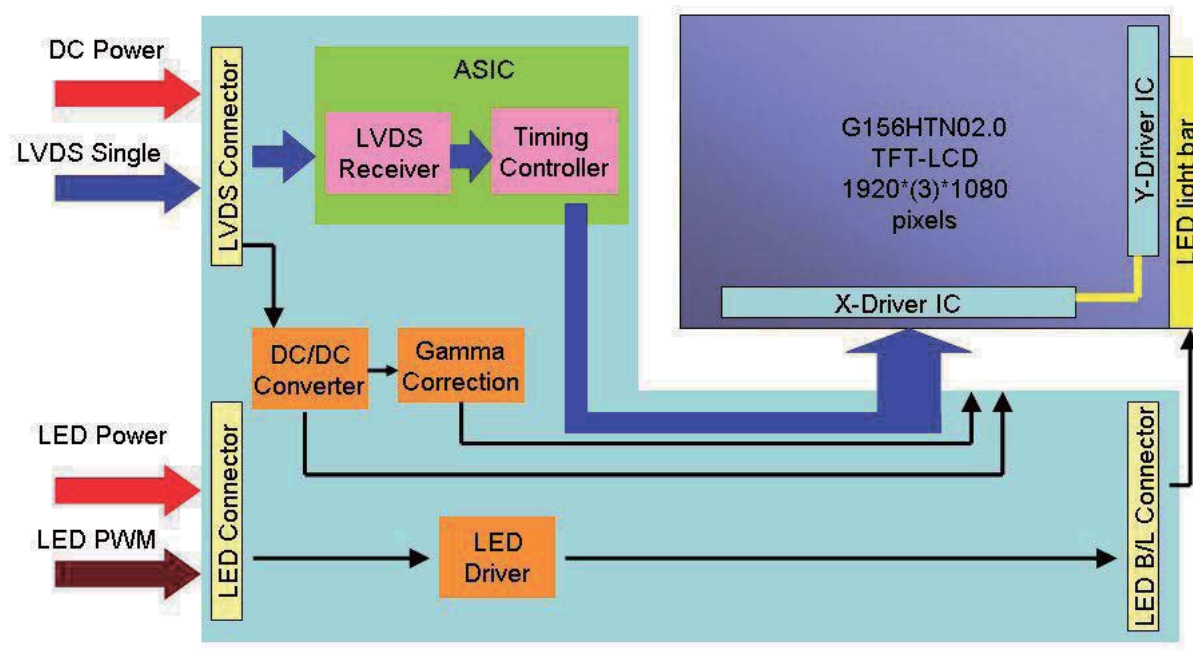
R_{white} means right eye white signal;

L_{white} means left eye white signal;

R_{black} means right eye black signal;

Right eye crosstalk is defined by analogy.

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	Vin	-0.3	+5.0	[Volt]	Note 1,2

4.2 Absolute Ratings of Environment

Item	Symbol	Min	Max	Unit	Conditions
Operating Temp.	TOP	0	+50	[₀C]	Note 4
Operation Humidity	HOP	8	95	[%RH]	Note 4
Storage Temperature	TST	-20	+60	[₀C]	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)

Twb=39°C

T=40°C,H=95%

T=50°C,H=55%

T=60°C,H=39%
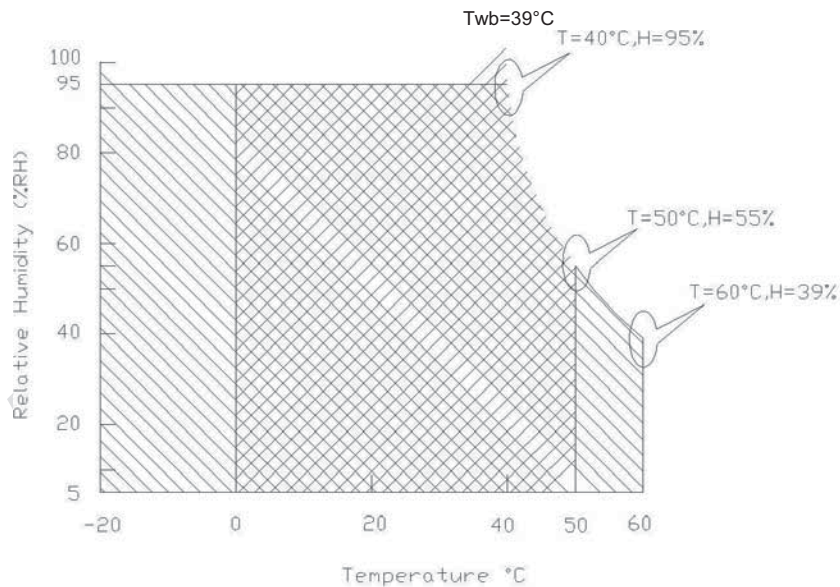
Operating Range   Storage Range   +

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	-	3.14	3.76	[Watt]	Note 1
IDD	IDD Current	-	950	1140	[mA]	Note 1
IRush	Inrush Current	-	-	TBD	[mA]	Note 2
VDDrp	Allowable Logic/LCD Drive Ripple Voltage	-	-	TBD	[mV] p-p	

Note 1: Maximum Measurement Condition：Red Pattern

Note 2: Measure Condition
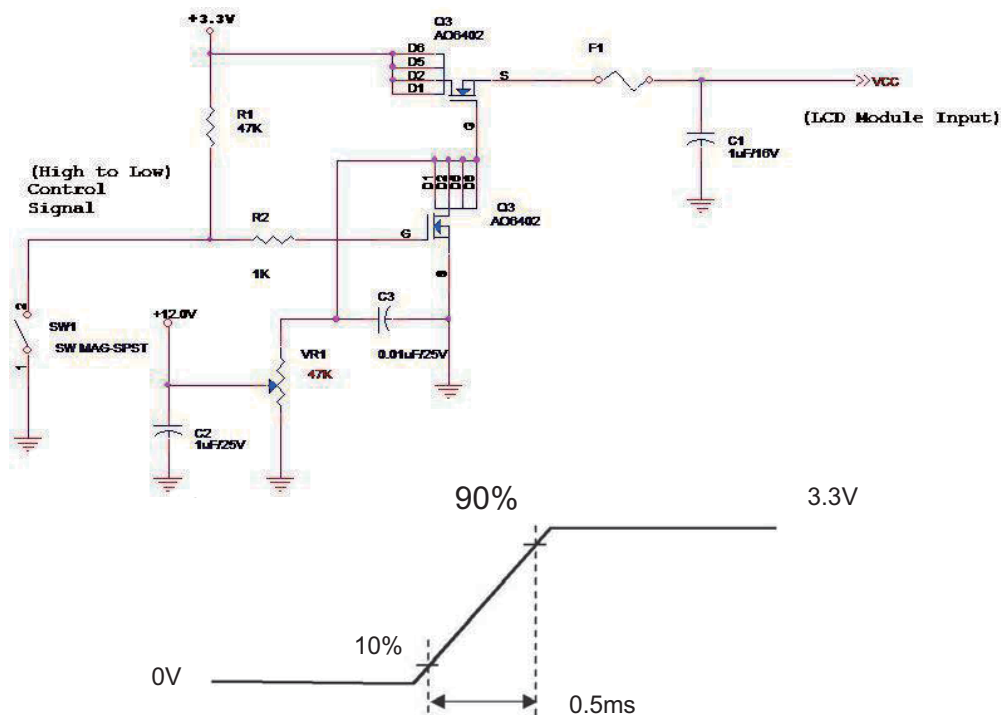
Vin rising time

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;

Parameter	Condition	Min	Max	Unit
V_{TH}	Differential Input High Threshold (Vcm=+1.2V)	---	100	[mV]
V_{TL}	Differential Input Low Threshold (Vcm=+1.2V)	-100	----	[mV]
$|V_{ID}|$	Differential Input Voltage	100	600	[mV]
V_{CM}	Differential Input Common Mode Voltage	1.125	1.375	[V]

Note 1: LVDS Signal Waveform
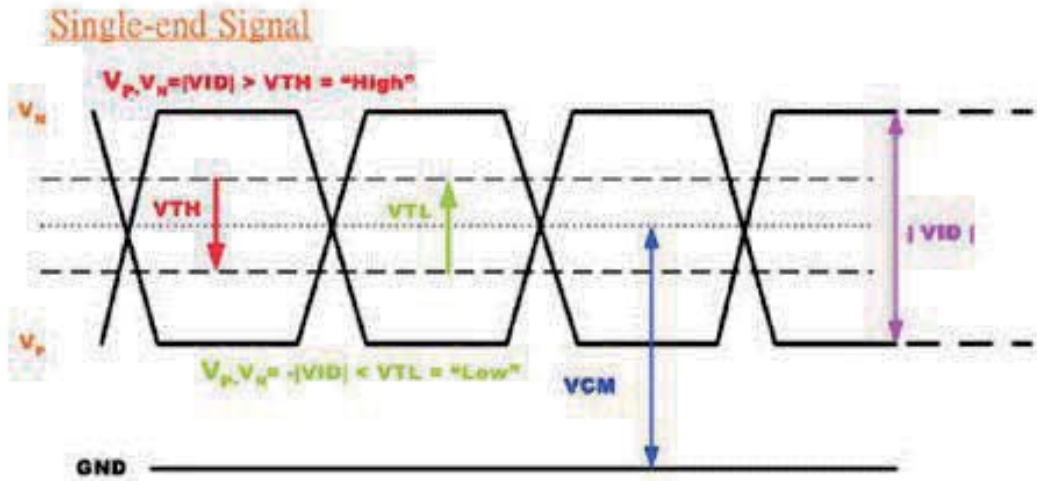
5.2 Backlight Unit

5.2.1 LED characteristics

Parameter	Symbol	Min	Typ	Max	Units	Condition
Backlight Power Consumption	PLED	-	-	10.6W	[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: The LED life-time define as the estimated time to 50% degradation of initial luminous.

### 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	-	5	[Volt]	
LED Enable Input Low Level		-	-	0.8	[Volt]	
PWM Logic Input High Level	VPWM_EN	2.5	-	5	[Volt]	
PWM Logic Input Low Level		-	-	0.8	[Volt]	
PWM Input Frequency	FPWM	200	-	15K	Hz	
PWM Duty Ratio	Duty	5	-	100	%	

6. Signal Interface Characteristic

6.1 Pixel Format Image

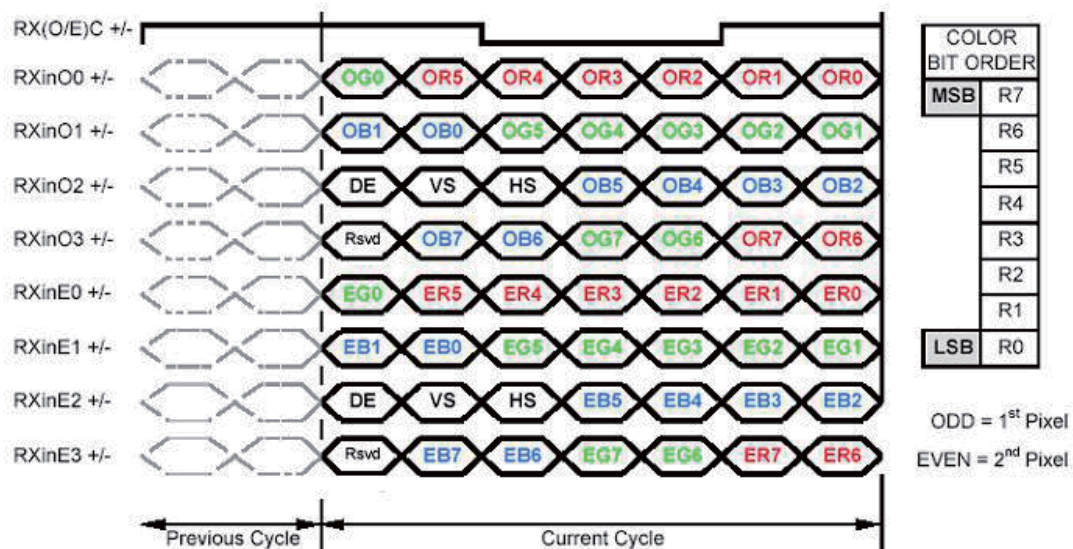Following figure shows the relationship of the input signals and LCD pixel format.
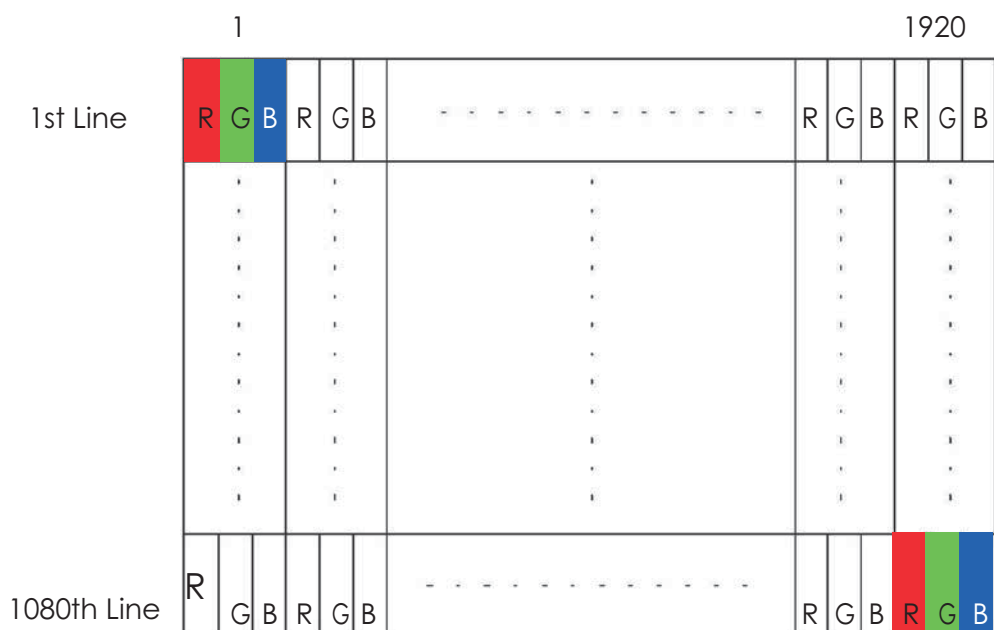
6.2 The Input Data Format

6.3 Signal Description

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

| PIN #	SIGNAL NAME	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	POWER	Power +5V
29	POWER	Power +5V
30	POWER	Power +5V

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	60	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
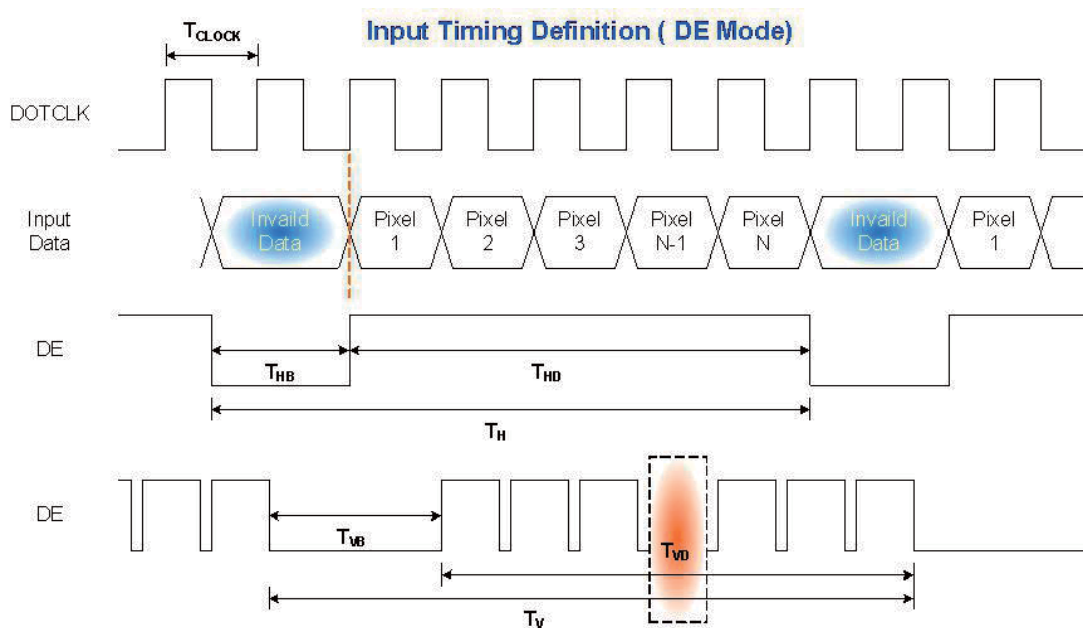
6.5 Power ON/OFF Sequence

LED on/off sequence is as follows. Interface signals are also shown in the chart.
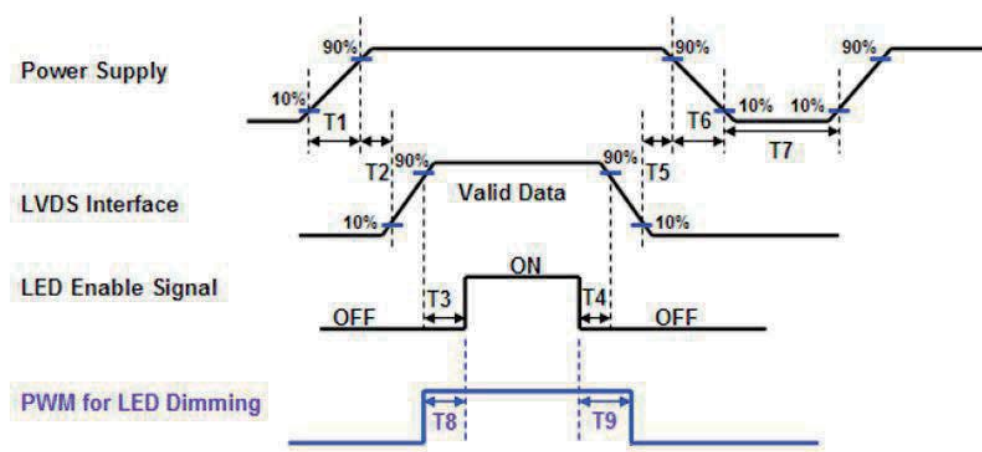
Power Sequence Timing			
	Value		
Parameter	Min.	Max.	Units
T1	0.5	10	ms
T2	60	70	
T3	400	-	
T4	400	-	
T5	0	50	
T6	0	10	
T7	500	-	
T8	10	180	
T9	10	180	

Note 1: If T4<400ms, The display garbage may occur. We suggest T4>400ms to avoid the display garbage.

Note 2: If T1 < 0.5ms, the inrush current may cause the damage of fuse. If T1 < 0.5ms, the inrush current I2t is under typical melt of fuse Spec., there is no mentioned problem.

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

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

7.1.1 Pin Assignment

Pin#	Signal Name	Pin#	Signal Name
1	RxOIN0-	2	RxOIN0+
3	RxOIN1-	4	RxOIN1+
5	RxOIN2-	6	RxOIN2+
7	GND	8	RxOCLKIN-
9	RxOCLKIN+	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	POWER
29	POWER	30	POWER

7.2 Backlight Unit

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

Connector Name / Designation	Lamp Connector / Backlight lamp
Manufacturer	HRS
Type Part Number	DF14A-6P-1.25H
Mating Type Part Number	DF14-6S-1.25C

7.2.1 LED Driver Connector Pin Assignment

Pin No.	Symbol	Description
Pin1	VLED	12V input
Pin2	VLED	12V input
Pin3	GND	GND
Pin4	GND	GND
Pin5	On/OFF	3.3-5V:ON, 0V:OFF
Pin6	Dimming	PWM

Note1: Start from right side
Note2: Connector Illustration

PIN1

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 : ±8 KV (TBD) Air : ±15 KV (TBD)	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 ex mine 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. Shipping and Package

9.1 Shipping Label Format

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

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

Note 3: For China RoHS compatible products, AUO will add ⑮ 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
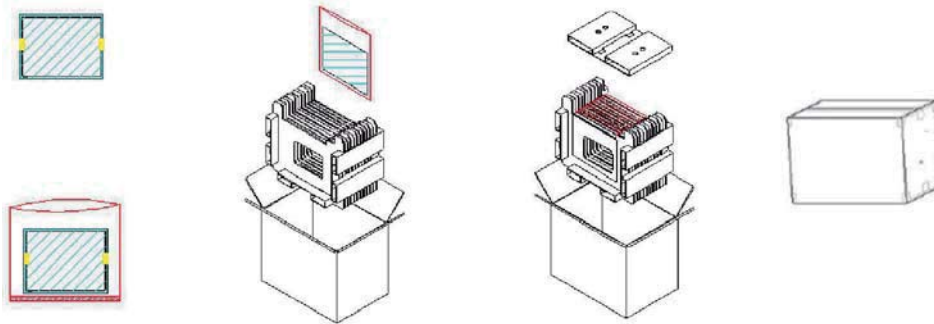
Max capacity：16 TFT-LCD module per carton

Max weight: 16.3 kg per carton

Outside dimension of carton: 450mm(L)*375mm(W)*319mm(H)
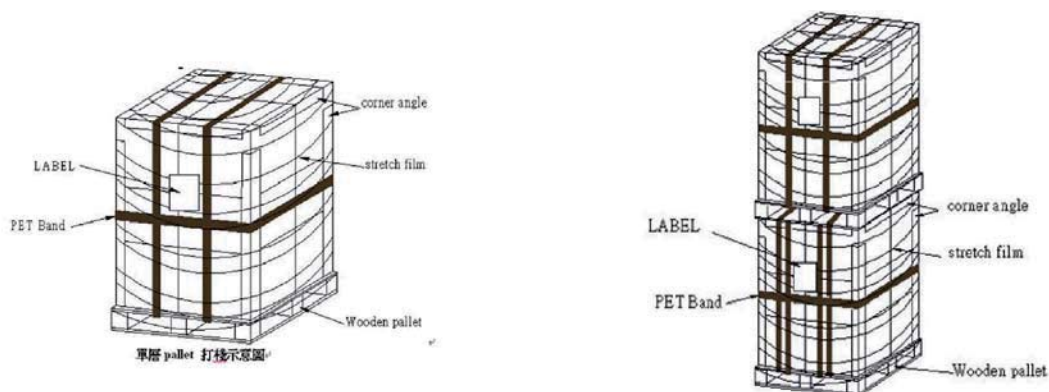
Pallet size： 1150 mm * 910 mm * 132mm

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

9.3 Shipping Package of Palletizing Sequence

Product Specification
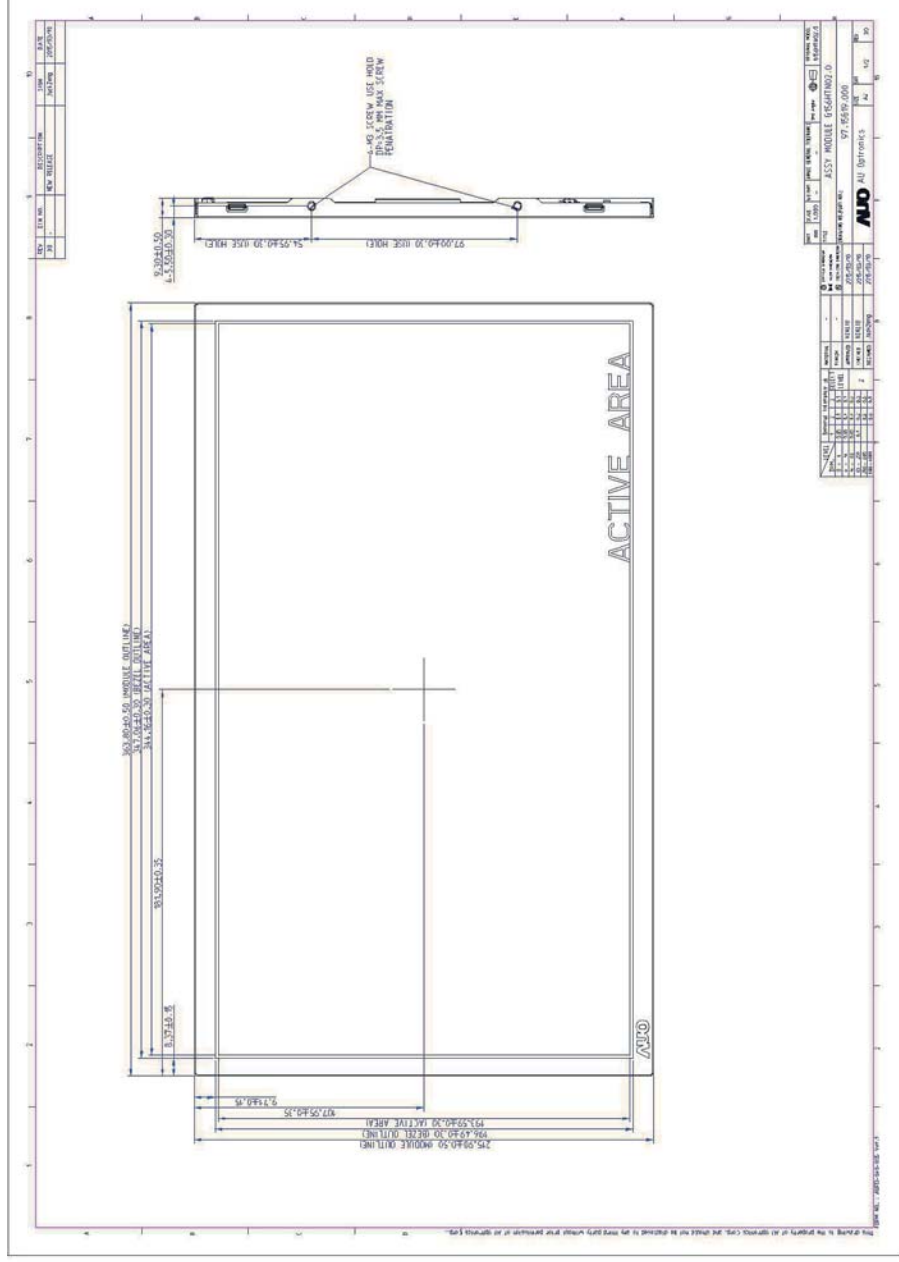**AU OPTRONICS CORPORATION**

10 .Mechanical Characteristics
10.1 LCM Outline Dimension (Front View)

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10.2 LCM Outline Dimension (Rear View)