() Preliminary Specification
(V) Final Specification

Module	23.8” Color TFT-LCD
Model Name	M238HVN01.1
Suffix Name	Q0
Document version	D08

Document		
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PREPARED BY	JM Lo	Date : 2015/10/27

CUSTOMER APPROVED AND FEEDBACK		
CUSTOMER		Date:
APPROVED BY		Date :

Note: This Specification is subject to change without notice.

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D03	2015/03/02	26,27	Modify 2D Drawing
D04	2015/03/17	6	Modify Color / Chromaticity Coordinates (CIE)
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1. Handling Precautions

1. Since front polarizer is easily damaged, pay attention 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 other soft cloth.
5. Since the panel is made of glass, it may break or crack if dropped or bumped on hard surface.
6. Since CMOS LSI is used in this module, take care of static electricity and insure human earth when handling.
7. Do not open or modify the Module Assembly.
8. Do not press the reflector sheet at the back of the module to any directions.
9. In case if a Module has to be put back into the packing container slot after once it was taken out from the container, do not press the center of the LED lightbar 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. After installation of the TFT Module into an enclosure, do not twist nor bend the TFT Module even momentary. At designing the enclosure, it should be taken into consideration that no bending/twisting forces are applied to the TFT Module from outside. Otherwise the TFT Module may be damaged.
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. Please avoid touching COF Position while you are doing mechanical design.
14. When storing modules as spares for a long time, the following precaution is necessary:
    a. Store them in a dark place. Do not expose the module to sunlight or fluorescent light.
    b. Keep the temperature between 5℃ and 35℃ at normal humidity.

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2. General Description

This specification applies to the 23.8 inch- wide Color a-Si TFT-LCD Module M238HVN01.1 The display supports the FHD - 1920(H) x 1080(V) screen format and 16.7M colors (8-bit RGB data input). The input interface is Dual channel LVDS and this module doesn't contain an driver board for backlight.

Display Characteristics

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

ITEMS	Unit	SPECIFICATIONS
Screen Diagonal	mm	(23.8")
Active Area	mm	527.04 (H) x 296.46 (V)
Pixels H x V		1920 (x3) x 1080
Pixel Pitch	um	274.5(per one triad)×274.5
Pixel Arrangement		R.G.B. Vertical Stripe
Display Mode		VA Mode, Normally Black
White Luminance (Center)	cd/m^2	250 cd/m^2 (Typ.)
Contrast Ratio		3000(Typ.)
Optical Response Time	msec	16ms (Typ., on/off)
Power Consumption (VDD line + LED line)	Watt	19(Typ .) LCD module:PDD (Typ.)=3.8@White pattern, Fv=60Hz Backlight unit:P_{BLU} (Typ.)=15.2 @Is=70mA
Color gamut(NTSC)	%	72
Weight	Grams	2100 (Typ.)
Physical Size	mm	534.74(H)x313.26(V)x11.6 (D)
Electrical Interface		Dual channel LVDS,8-bits RGB data input
Support Color		16.7M colors
Surface Treatment		Anti-Glare, 3H
Temperature Range Operating Storage (Shipping)	 °C °C	 0 to +50 -20 to +60
RoHS Compliance		RoHS Compliance
TCO	-	TCO 6.0 Compliance

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Optical Characteristics

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

Item	Unit	Conditions	Min.	Typ.	Max.	Note
Viewing Angle	degree	Horizontal (Right) CR = 10 (Left)	75 75	89 89	- -	2-5
		Vertical (Up) CR = 10 (Down)	75 75	89 89	- -	
Contrast ratio		Normal Direction	1800	3000	-	2-4
Response Time	msec	Rising Time	-	10	20	2-6
		Falling Time	-	6	12	
		Rising + Falling	-	16	32	
Color / Chromaticity Coordinates (CIE)		Red x	0.624	0.654	0.684	2-2 2-3
		Red y	0.304	0.334	0.364	
		Green x	0.290	0.320	0.350	
		Green y	0.592	0.622	0.652	
		Blue x	0.124	0.154	0.184	
		Blue y	0.049	0.079	0.109	
Color Coordinates (CIE) White		White x	0.283	0.313	0.343	
		White y	0.299	0.329	0.359	
Central Luminance	cd/m^2		200	250	-	6
Luminance Uniformity	%		75	80	-	7
Crosstalk (in 60Hz)	%				1.5	2-7
Flicker	dB				-20	2-8

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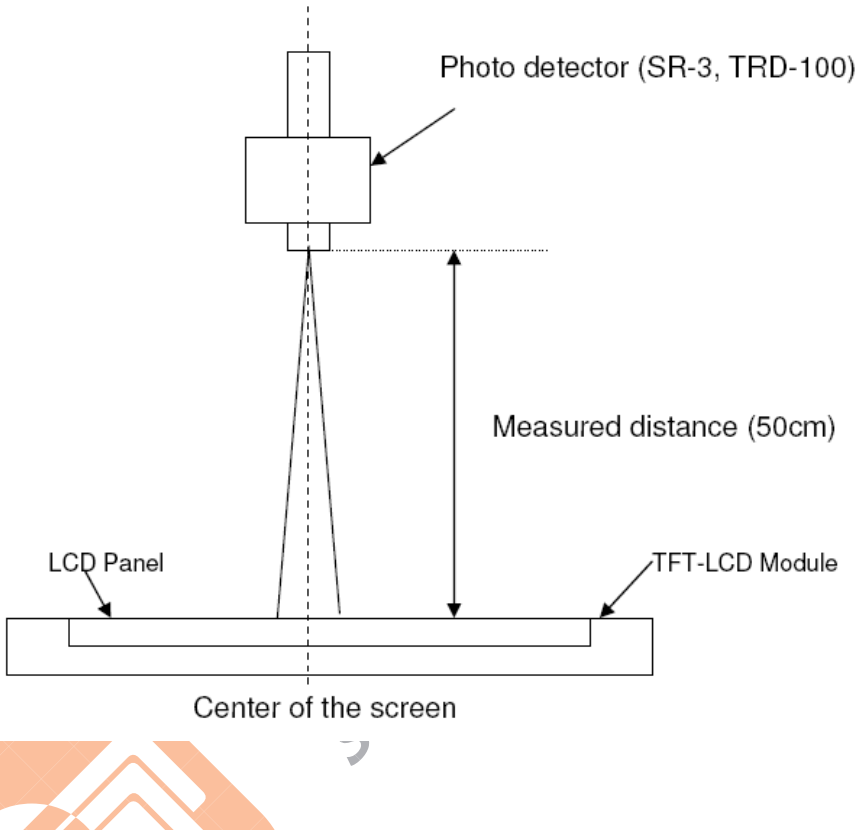
Note 2-2: Equipment setup :

The LCD module should be stabilized at given temperature for 30 minutes to avoid abrupt temperature change during measuring (at surface 35℃). In order to stabilize the luminance, the measurement should be executed after lighting Backlight for 30 minutes in a stable, windless and dark room.



Note 2-3: Luminance Uniformity Measurement

Definition:

$$\text{Luminance Uniformity} = \frac{\text{Minimum Luminance of 9 Points (P1 ~ P9)}}{\text{Maximum Luminance of 9 Points (P1 ~ P9)}}$$

a.Test pattern: White Pattern

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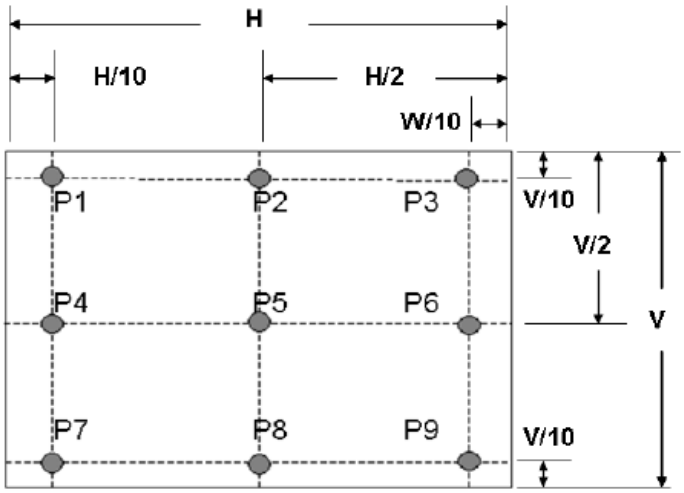

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Note 2-4: Contrast Ratio Measurement

Definition:

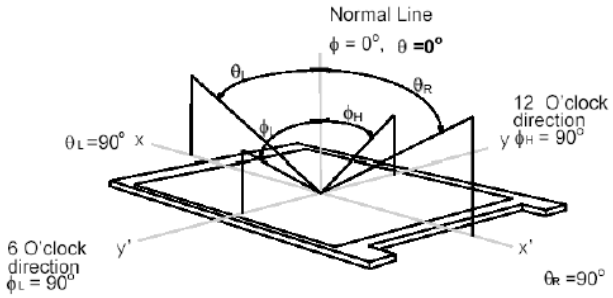
$$\text{Contrast Ratio} = \frac{\text{Luminance of White pattern}}{\text{Luminance of Black pattern}}$$

a. Measured position: Center of screen (P5) & perpendicular to the screen (θ=Φ=0°)

Note 2-5: Viewing angle measurement

Definition: The angle at which the contrast ratio is greater than 10 & 5 .

a. Horizontal view angle: Divide to left & right (θ_L & θ_R)
Vertical view angle: Divide to up & down (Φ_H &Φ_L)



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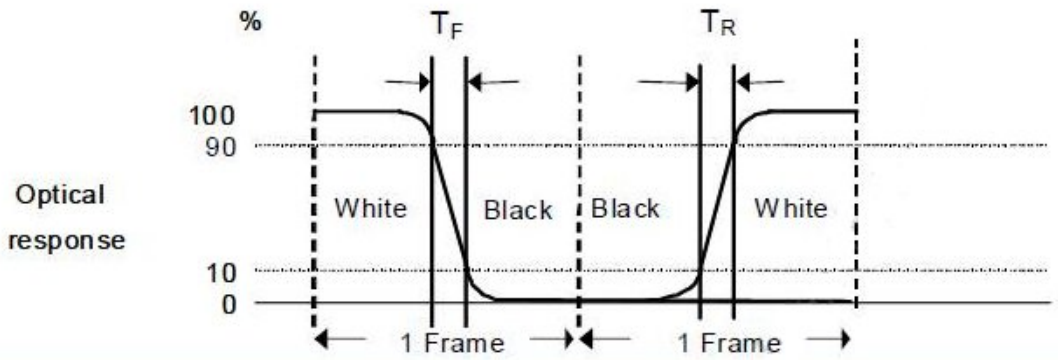
Note 2-6: Response time measurement

The output signals of photo detector are measured when the input signals are changed from "Black" to "White" (rising time, T_R), and from "White" to "Black" (falling time, T_F), respectively. The response time is interval between the 10% and 90% of optical response. (*Black & White color definition: Please refer section 3.4.3)*



Note 2-7: Crosstalk measurement

Definition:

$CT = Max. (CT_H, CT_V)$;

Where

a.Maximum Horizontal Crosstalk :

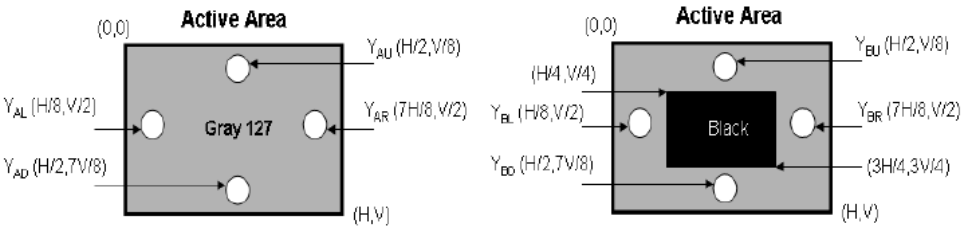
$CT_H = Max. (| Y_{BL} - Y_{AL} | / Y_{AL} \times 100\ \%, | Y_{BR} - Y_{AR} | / Y_{AR} \times 100\ \%)$;

Maximum Vertical Crosstalk:

$CT_V = Max. (| Y_{BU} - Y_{AU} | / Y_{AU} \times 100\ \%, | Y_{BD} - Y_{AD} | / Y_{AD} \times 100\ \%)$;

b. Y_{AU}, Y_{AD}, Y_{AL}, Y_{AR} = Luminance of measured location without Black pattern

Y_{BU}, Y_{BD}, Y_{BL}, Y_{BR} = Luminance of measured location with Black pattern



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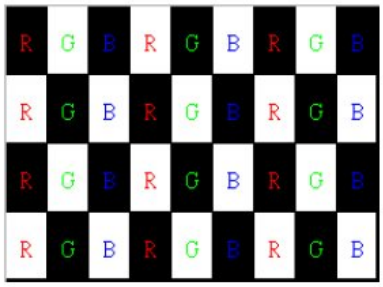
Note 2-8: Flicker measurement

a. Test pattern: It is listed as following.



Gray level = L0

Gray level = L127

R: Red, G: Green, B:Blue

b. Measured position: Center of screen (P5) & perpendicular to the screen (θ=Φ=0°)

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3. Functional Block Diagram

3.1 Block Diagram

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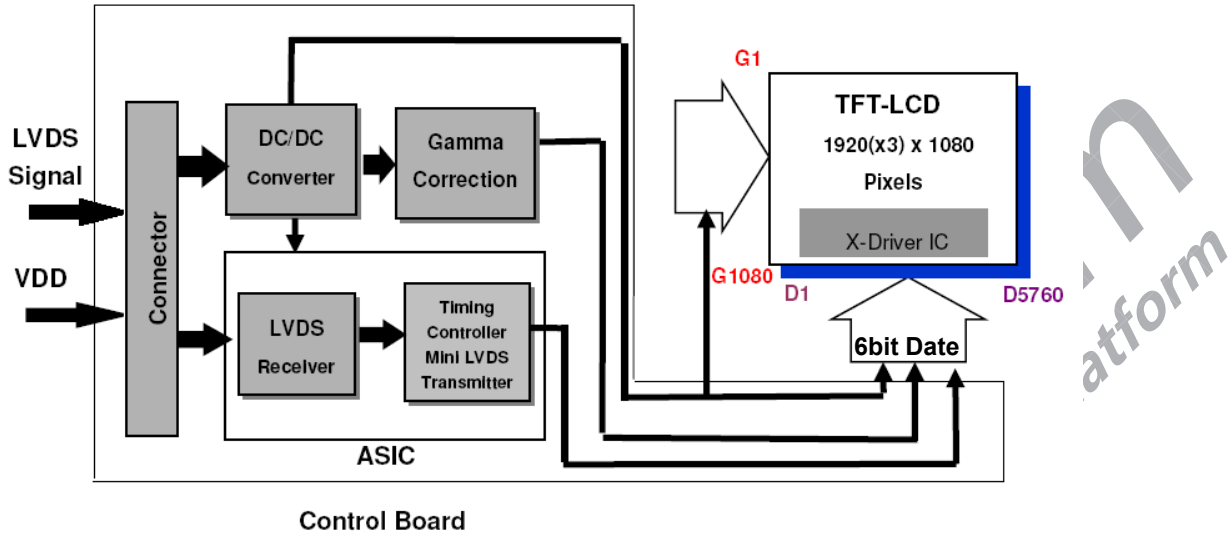
The following shows the block diagram of the 23.8 inch Color TFT-LCD Module.



Interface Connection

Connector Type

TFT-LCD Connector	Manufacturer	P-TWO	STM
	Part Number	187034-3009	MSBKT240P30HB
Mating Connector	Manufacturer	JAE or Compatible	
	Part Number	FI-X30HL(Locked Type)	

Connector Pin Assignment

PIN #	Symbol	Description	Remark
1	RxO0-	Negative LVDS differential data input (Odd data)	
2	RxO0+	Positive LVDS differential data input (Odd data)	
3	RxO1-	Negative LVDS differential data input (Odd data)	
4	RxO1+	Positive LVDS differential data input (Odd data)	
5	RxO2-	Negative LVDS differential data input (Odd data)	
6	RxO2+	Positive LVDS differential data input (Odd data)	
7	GND	Ground	
8	RxOCLK-	Negative LVDS differential clock input (Odd clock)	
9	RxOCLK+	Positive LVDS differential clock input (Odd clock)	
10	RxO3-	Negative LVDS differential data input (Odd data)	
11	RxO3+	Positive LVDS differential data input (Odd data)	
12	RxE0-	Negative LVDS differential data input (Even data)	

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13	RxE0+	Positive LVDS differential data input (Even data)	
14	GND	Ground	
15	RxE1-	Negative LVDS differential data input (Even data)	
16	RxE1+	Positive LVDS differential data input (Even data)	
17	GND	Ground	
18	RxE2-	Negative LVDS differential data input (Even data)	
19	RxE2+	Positive LVDS differential data input (Even data)	
20	RxECLK-	Negative LVDS differential clock input (Even clock)	
21	RxECLK+	Positive LVDS differential clock input (Even clock)	
22	RxE3-	Negative LVDS differential data input (Even data)	
23	RxE3+	Positive LVDS differential data input (Even data)	
24	GND	Must Connect to GND	
25	NC	No connection (for AUO test only. Do not connect)	
26	NC	No connection (for AUO test only. Do not connect)	
27	NC	No connection (for AUO test only. Do not connect)	
28	VDD	Power Supply Input Voltage	
29	VDD	Power Supply Input Voltage	
30	VDD	Power Supply Input Voltage	

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4.Absolute Maximum Ratings

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Backlight Unit

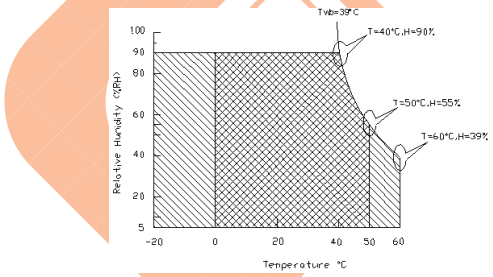
	Symbol	Min	Typ	Max	Unit	Conditions
LED Current	ILED	-	70	77	[mA]	*Note 1,2*

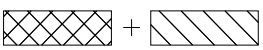
Absolute Ratings of Environment

Item	Symbol	Min.	Max.	Unit	Conditions
Operating Temperature	TOP	0	+50	[°C]	*Note 3*
Center Glass Surface temperature (Operation)	TGS	0	+65	[°C]	
Operation Humidity	HOP	5	90	[%RH]	
Storage Temperature	TST	-20	+60	[°C]	
Storage Humidity	HST	5	90	[%RH]	

Note 1: With in Ta (25°C)
Note 2: Permanent damage to the device may occur if exceeding maximum values
Note 3: For quality perfermance, please refer to AUO IIS(Incoming Inspection Standard).

1. 90% RH Max (Ta ≤39°C)
2. Max wet-bulb temperature at 39°C or less. (Ta ≤39°C)
3. No condensation



Operating Range  Storage Range 

5. Electrical characteristics-TFT LCD Module

Power Specification

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Input power specifications are as following:

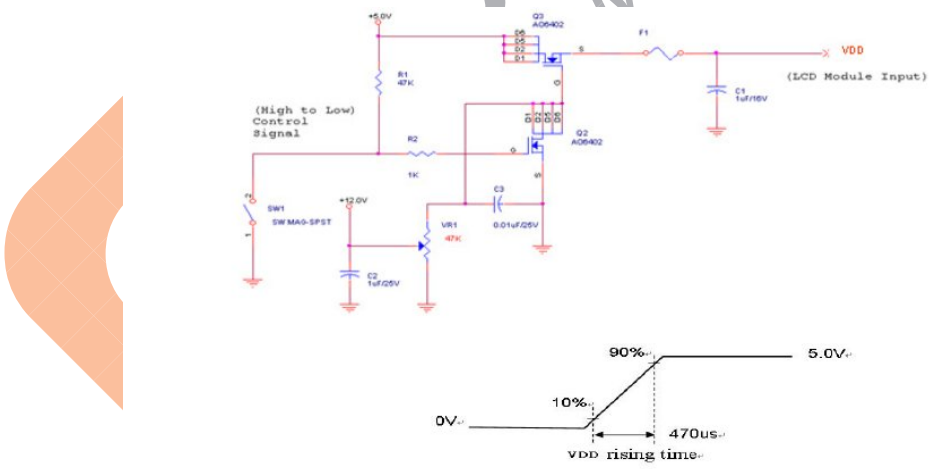
Permanent damage may occur if exceeding the following maximum rating.

Symbol	Description	Min	Max	Unit	Remark
VDD	Power Supply Input Voltage	GND-0.3	6.0	[Volt]	Ta=25□

Recommended Operating Condition

Symbol	Description	Min	Typ	Max	Unit	Remark
VDD	Power supply Input voltage	4.5	5.0	5.5	[Volt]	
IDD	Power supply Input Current (RMS)	-	0.76	1.0	[A]	VDD= 5.0V, All white Pattern , Fv=60Hz
		-	0.86	1.08	[A]	VDD= 5.0V, All white Pattern , Fv=75Hz
PDD	VDD Power Consumption	-	3.8	5.0	[Watt]	VDD= 5.0V, All white Pattern , Fv=60Hz
		-	4.3	5.4	[Watt]	VDD= 5.0V, All white Pattern , Fv=75Hz
IRush	Inrush Current	-	-	3.0	[A]	*Note 3-1*
VDDrp	Allowable VDD Ripple Voltage	-	-	500	[mV]	VDD= 5.0V, All white Pattern , Fv=75Hz

Note 3-1: Measurement conditions:



The duration of VDD rising time: 470us.

Backlight Unit

Parameter guideline for LED driving is under stable conditions at 25°C (Room Temperature):

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Symbol	Parameter	Min.	Typ.	Max.	Unit	Note
IR_{LED}	LED Operation Current	-	70	77	[mA] Note 1	Operating with fixed driving current
V_{LB}	Light Bar Operation Voltage (for reference)	47.6	54.4	57.8	[Volt] Note 2 Note 5	
P_{BLU}	BLU Power consumption (for reference)	13.33	15.2	16.1	[Watt]	
Vf	Forward Voltage	2.8	3.2	3.4	-	
LT_{LED}	LED life Time (Typical)	30,000		-	[Hour] Note 3	

Note 1: Ther specified cruuent is input LED Chip 100% Duty current.

Note 2: Ther value showed in the table is one light bar's operation voltage.

Note 3: Definition of life time brightness becomes 50% of its original value. The minimum life time of LED unit is on the Condition of IRLED= 60mA and 25+/- 2°C (Room temperature)

Note 4: Each LED Light bar consists of 68 pcs LED Package (4 strings x 17 pcs/ string)

Note 5: Recommendation for LED driver power design:

Due to LED component physical characteristic, the forward voltage(Vf) will be increased and slope changed to be flat gradually when operation time increased. AUO strongly recommend the max. design value of LED driver board OVP(over voltage protection) should be 20% higher than max. value of LED string voltage(Vs) at least.

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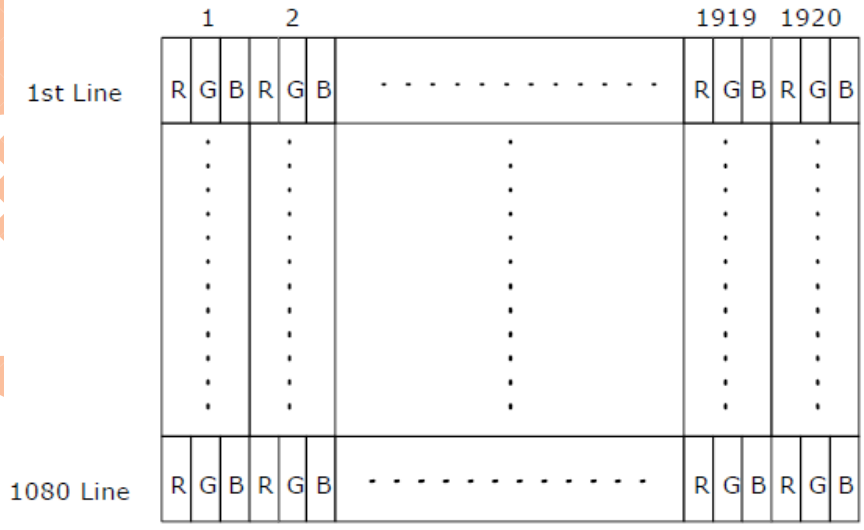
6. Signal Characteristic

Pixel Format Image

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



The input data format

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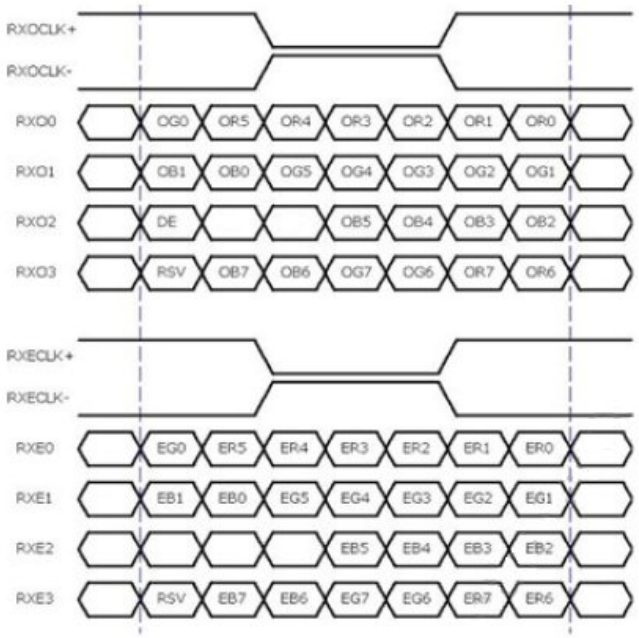

8 Bit Color Bit Order			
MSB	R7	G7	B7
	R6	G6	B6
	R5	G5	B5
	R4	G4	B4
	R3	G3	B3
	R2	G2	B2
	R1	G1	B1
LSB	R0	G0	B0

a. O = "Odd Pixel Data" E = "Even Pixel Data"

b. Refer to 3.4.1 LCD pixel format, the 1st data is 1 (Odd Pixel Data), the 2nd data is 2 (Even Pixel Data) and the last data is 1920 (Even Pixel Data).

Color versus Input Data

The following table is for color versus input data (8bit). The higher the gray level, the brighter the color.

Color	Gray Level	Color Input Data																								Remark
		RED data (MSB:R7, LSB:R0)								GREEN data (MSB:G7, LSB:G0)								BLUE data (MSB:B7, LSB:B0)								
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0	
Black	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
White	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Gray 127	-	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	
Red	L0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Black
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	L255	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Green	L0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Black
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	L255	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	
Blue	L0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	Black
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	L255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	

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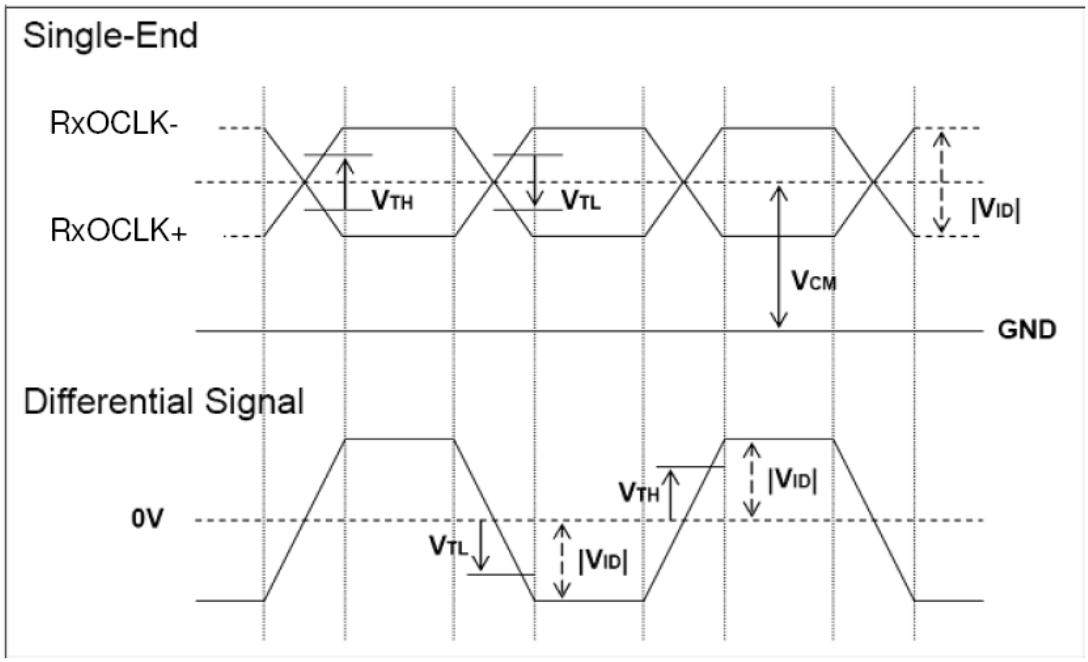
LVDS Specification

a.DC Characteristics

Symbol	Description	Min	Typ	Max	Units	Condition
V_{TH}	LVDS Differential Input High Threshold	-	-	+100	[mV]	V_{CM} = 1.2V
V_{TL}	LVDS Differential Input Low Threshold	-100	-	-	[mV]	V_{CM} = 1.2V
$\lvert V_{ID} \rvert$	LVDS Differential Input Voltage	100	-	600	[mV]	
V_{CM}	LVDS Common Mode Voltage	+1.0	+1.2	+1.5	[V]	V_{TH}-V_{TL} = 200mV

LVDS Signal Waveform:

Use RxOCLK- & RxOCLK+ as example.



b.DC Characteristics

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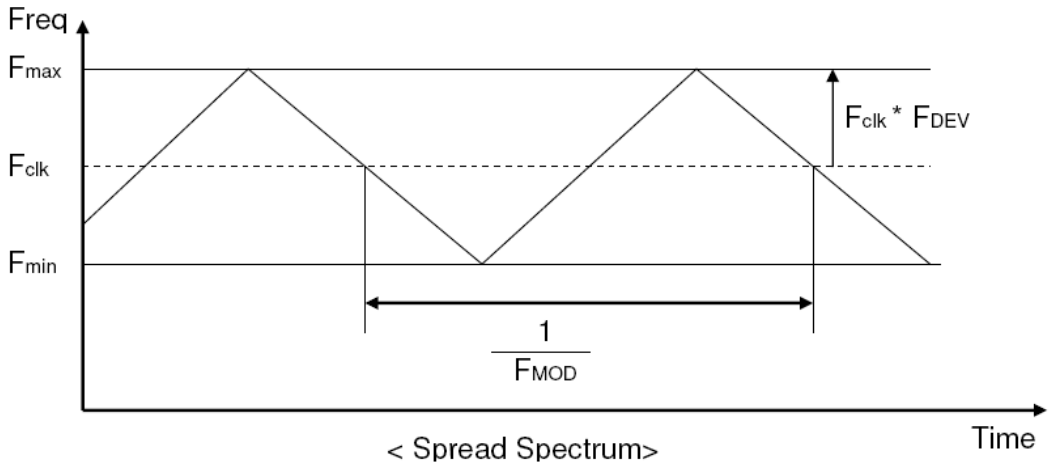
Symbol	Description	Min	Max	Unit	Remark
F_{DEV}	Maximum deviation of input clock frequency during Spread Spectrum	-	± 3	%	
F_{MOD}	Maximum modulation frequency of input clock during Spread Spectrum	-	200	KHz	



< Spread Spectrum>

Fclk: LVDS Clock Frequency

Timing Characteristics

Basically, interface timing described here is not actual input timing of LCD module but close to output timing of SN75LVDS82DGG (Texas Instruments) or equivalent.

Symbol	Description		Min.	Typ.	Max.	Unit	Remark
Tv	Vertical Section	Period	1094	1130	1836	Th	
Tdisp (v)		Active	1080	1080	1080	Th	
Tblk (v)		Blanking	14	50	756	Th	
Fv		Frequency	49	60	76	Hz	
Th	Horizontal Section	Period	1000	1050	1678	Tclk	
Tdisp (h)		Active	960	960	960	Tclk	
Tblk (h)		Blanking	40	90	718	Tclk	
Fh		Frequency	53.7	67.8	90	KHz	*Note 3-3*
Tclk	LVDS Clock	Period	11.2	14.0	18.6	ns	1/Fclk
Fclk		Frequency	53.7	71.2	90.0	MHz	*Note 3-4*

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Note 3-3: The equation is listed as following. Please don't exceed the above recommended value.

Fh (Min.) = Fclk (Min.) / Th (Min.);
Fh (Typ.) = Fclk (Typ.) / Th (Typ.);
Fh (Max.)= Fclk (Max.) / Th (Min.);

Note 3-4: The equation is listed as following. Please don't exceed the above recommended value.

Fclk (Min.) = Fv (Min.) x Th (Min.) x Tv (Min.);
Fclk (Typ.) = Fv (Typ.) x Th (Typ.) x Tv (Typ.);
Fclk (Max.) = Fv (Max.) x Th (Typ.) x Tv (Typ.);

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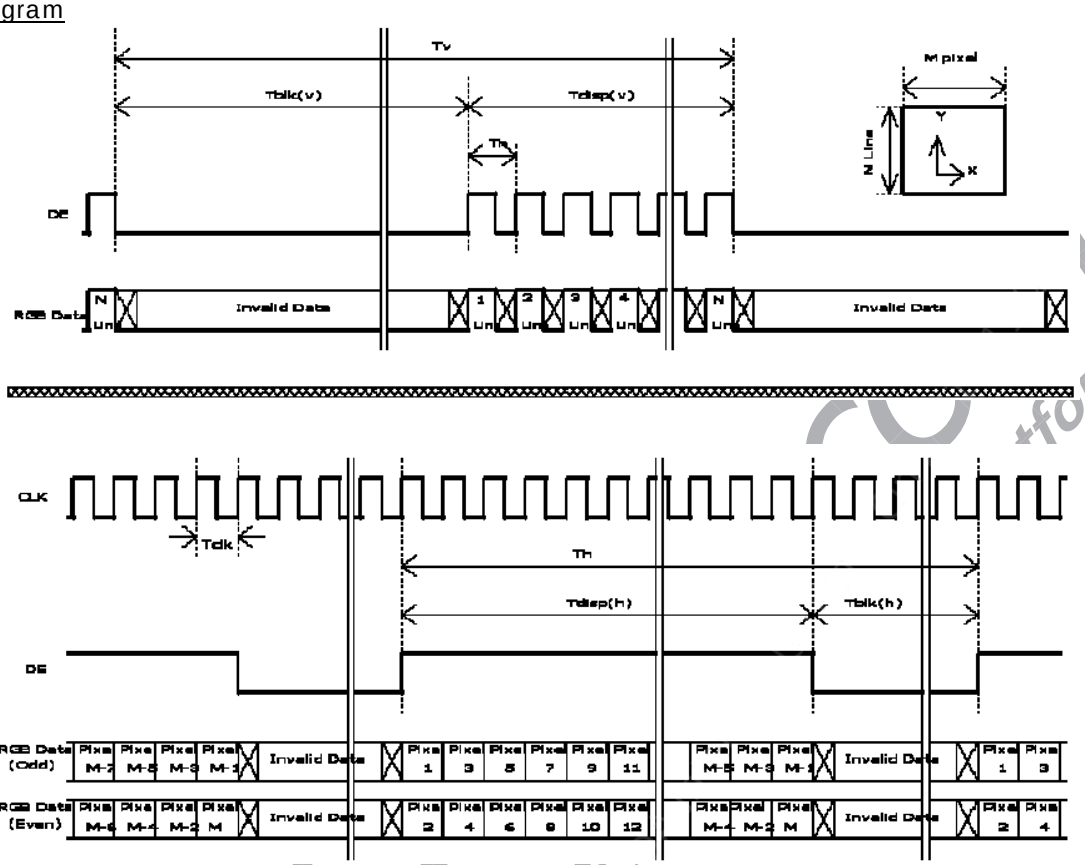
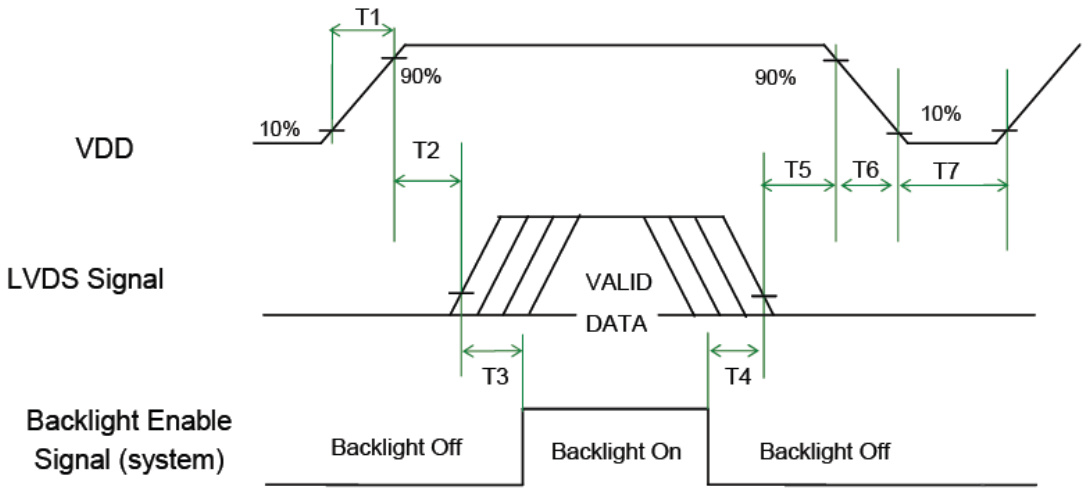
Timing diagram



Power ON/OFF Sequence

VDD power ,LVDS signal and backlight on/off sequence are as following. LVDS signals from any system shall be Hi-Z state when VDD is off.



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Power Sequence Timing

Symbol	Value			Unit	Remark
	Min.	Typ.	Max.		
T1	0.5	-	10	[ms]	
T2	0	-	50	[ms]	
T3	500	-	-	[ms]	
T4	100	-	-	[ms]	
T5	0		50	[ms]	*Note 3-5* *Note 3-6*
T6	0		200	[ms]	*Note 3-6* *Note 3-7*
T7	1000	-	-	[ms]	

Note 3-5 : Recommend setting T5 = 0ms to avoid electronic noise when VDD is off.
Note 3-6 : During T5 period , please keep the level of input LVDS signals with Hi-Z state.
Note 3-7 : Voltage of VDO must decay smoothly after power-off. (customer system decide this value)

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7. Connector & Pin Assignment

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

TFT LCD Module

TFT-LCD Connector	Manufacturer	P-TWO	STM
	Part Number	187034-3009	MSBKT240P30HB
Mating Connector	Manufacturer	JAE or Compatible	
	Part Number	FI-X30HL(Locked Type)	

Connector on Backlight Unit.

This connector is mounted on LED light-bar.

Light-bar Connector

Connector Name / Designation	Light Bar Connector
Manufacturer	CviLux
Type Part Number	CI1406M1VL0-NH

Mating Connector

Connector Name / Designation	Light Bar Connector
Manufacturer	CviLux
Type Part Number	CI1406SL000-NH

LED connector Pin assignment

Pin no.	Signal name
1	IRLED (current out)
2	IRLED (current out)
3	VLED (voltage in)
4	VLED (voltage in)
5	IRLED (current out)
6	IRLED (current out)

8. Reliability Test

Environment test conditions are listed as following Monitor test condition.

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Items	Condition	Remark
Temperature Humidity Bias (THB)	Ta=50˚ C , 80%RH , 300hours	
High Temperature Operation (HTO	Ta=50˚ C ,50%RH , 300hours	
Low Temperature Operation (LTO	Ta=0˚ C , 300hours	
High Temperature Storage (HTS)	Ta=60˚ C , 300hours	
Low Temperature Storage (LTS)	Ta=-20˚ C , 300hours	
Vibration Test (Non-operation)	Acceleration: 1.5 Gms Wave: Random Frequency: 10 - 200 Hz Sweep: 30 Minutes each Axis (X,Y,Z)	
Shock Test (Non-operation)	Acceleration: 50 Gms Wave: Half-sine Active Time: 20 ms Direction: ±X,±Y,±Z(one time for each Axis	
Thermal Shock Test (TST)	-20/30min, 60˚ C/30min, 100 cycles	Note 5-1
ESD (Electro Static Discharge)	Contact Discharge: ± 15KV, 150pF(330 Ω)1sec	Note 5-2
	Air Discharge: ± 15KV, 150pF(330Ω)1sec 8 points, 25 times/ point	

Note 5-1: a. A cycle of rapid temperature change consists of varying the temperature from -20℃ to 60℃, and back again. Power is not applied during the test.
b. After finish temperature cycling, the unit is placed in normal room ambient for at least 4 hours before power on.

Note 5-2: EN61000-4-2, ESD class B: Certain performance degradation allowed
No data lost
Self-recoverable
No hardware failures.

9. Shipping label

The label is on the panel as shown below:

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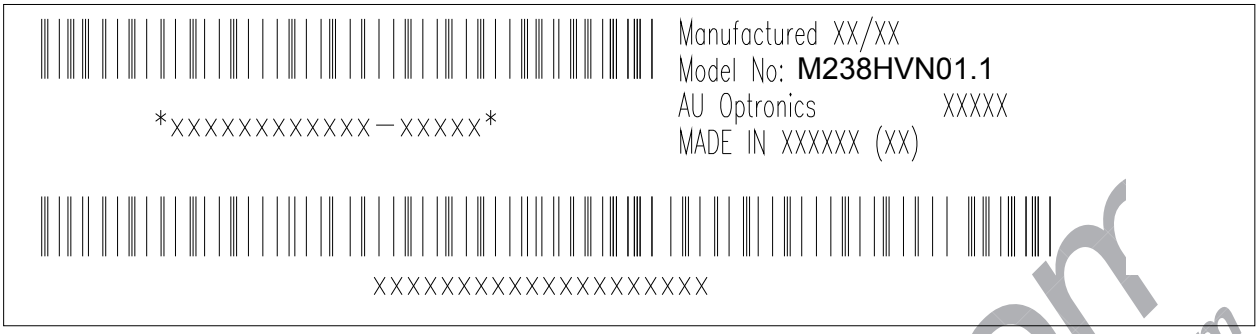

Note 6-1: For Pb Free products, AUO will add for identification.

Note 6-2: For RoHS compatible products, AUO will add for identification.

Note 6-3: For China RoHS compatible products, AUO will add for identification.

Note 6-4: The Green Mark will be presented only when the green documents have been ready by AUO Internal Green Team.

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10. Packing Precautions

TFT-LCD Module (or monitor) should be stand or be placed face up in traffic or storage conditions; please do not keep TFT-LCD Module face down (polarizer side down). Monitor maker should add the notice above in packing description; See the configuration example as below:

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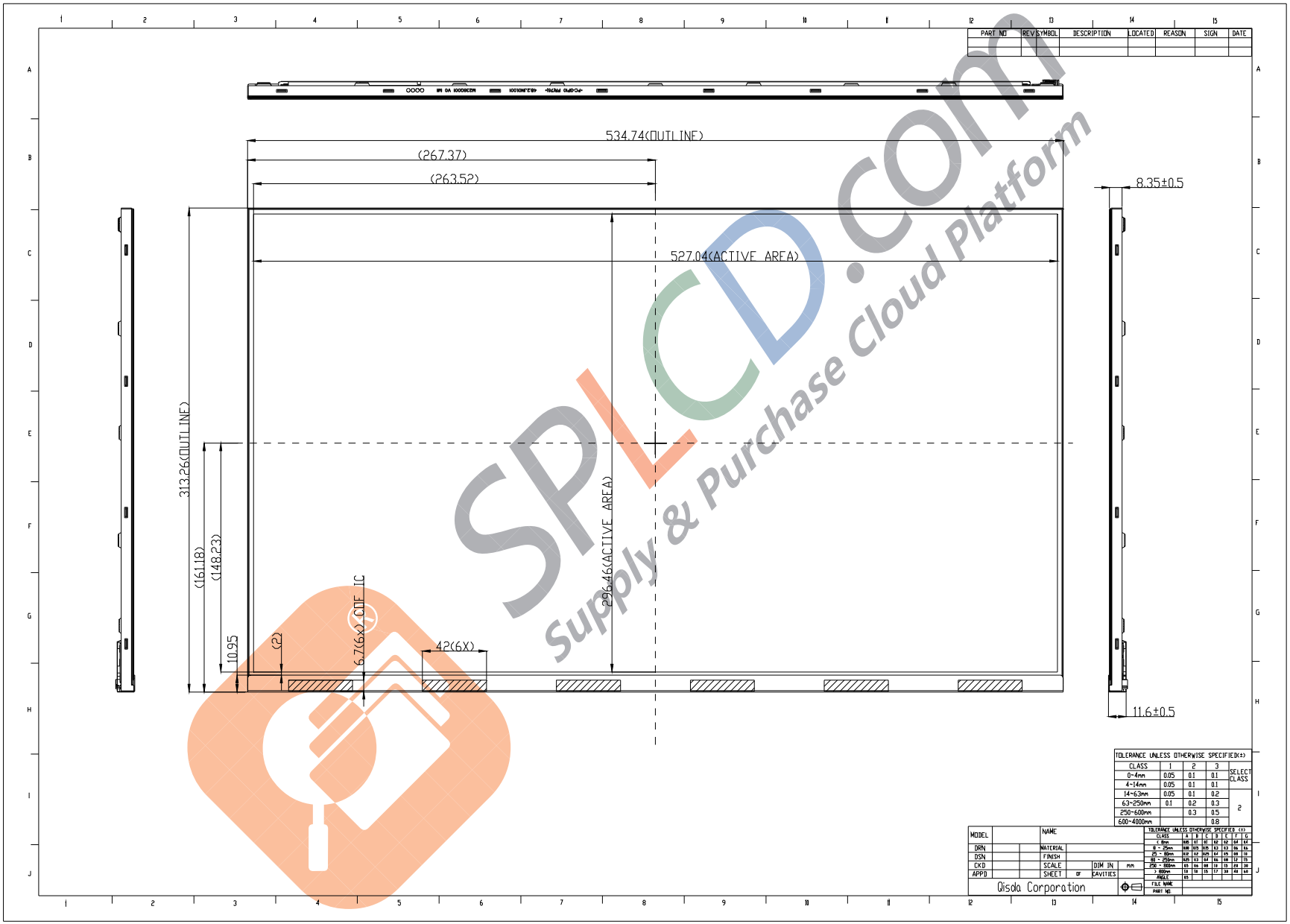

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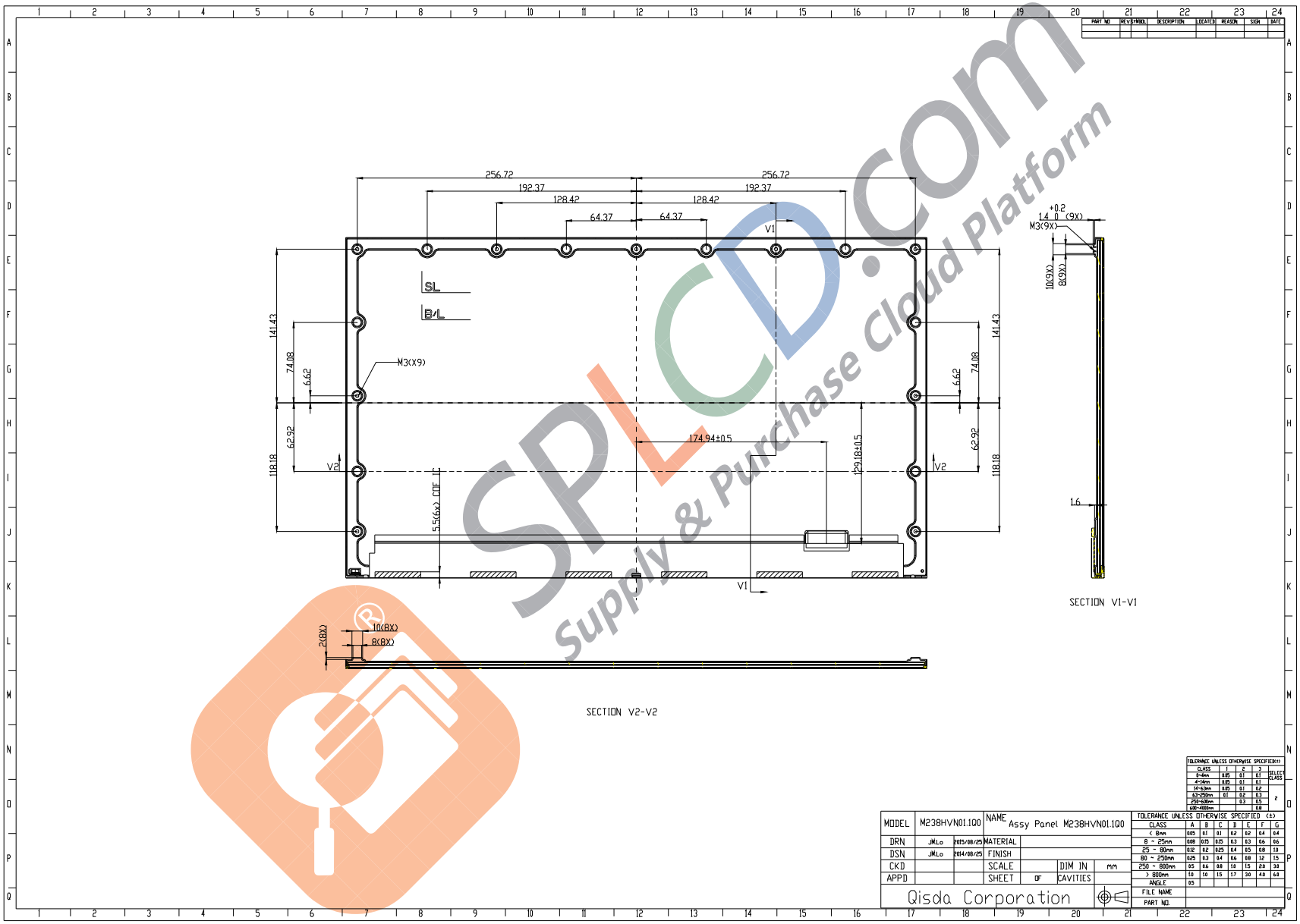

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