深圳市拓普微科技开发有限公司
SHENZHEN TOPWAY TECHNOLOGY CO., LTD.

LMT156PAQFDA

LCD Module User Manual

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Rev.	Descriptions	Edit	Release Date
0.1	Preliminary release	Liyongzheng	2024-06-22

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1. General Specification

Signal Interface :	LVDS (2 port), 24bit VESA
Display Technology :	a-Si TFT active matrix
Display Mode :	Transmissive, Normally Black
Screen Size(Diagonal) :	15.6 inch
Outline Dimension :	350.66 x 205.24 x 6.1(Max) (mm) (see attached drawing for details)
Active Area :	344.16x 193.59 (mm)
Number of dots :	1920(RGB) x 1080
Color Depth :	16.7M
Pixel Pitch :	0.17925 x 0.17925(mm)
Pixel Configuration :	R.G.B. Vertical Stripe
Backlight :	White LED
Viewing Direction :	Full
Surface Treatment :	Anti-Glare
Operating Temperature	-10 ~ +60°C
Storage Temperature :	-20 ~ +70°C

2. Block Diagram

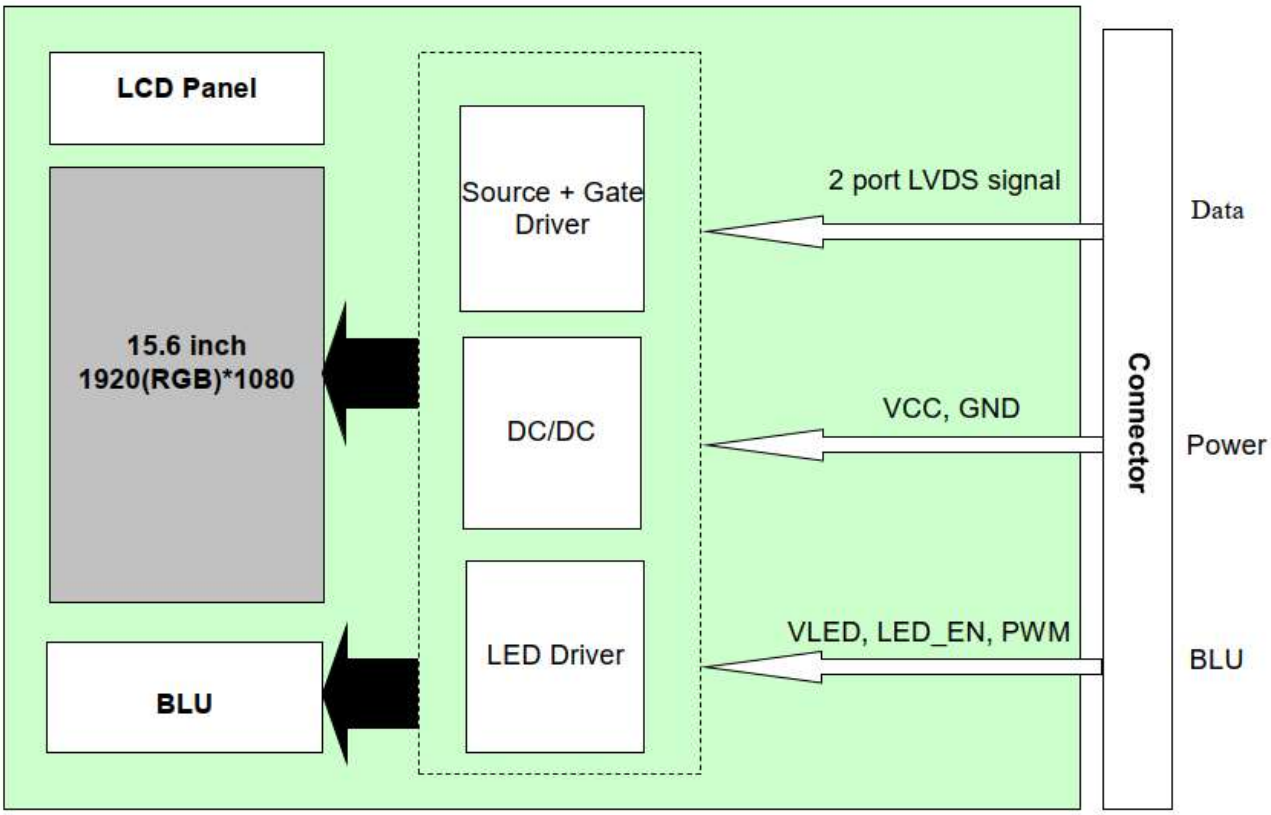


Figure 2.1 LCD Module Block Diagram

3. Terminal Function

3.1 K1 Pin assignment (LCD Interface)

Connector Information	
LCD Module connector	MSAK24025P40D
Matching connector	I-PEX-20454-240T or equivalent

Table 3.1.1 Connector information

No	Symbol	I/O	Description	Comment
1	VCC	P	+3.3V input voltage	
2	VCC	P	+3.3V input voltage	
3	VCC	P	+3.3V input voltage	
4	GND	P	Ground	
5	GND	P	Ground	
6	ORX0-	I	-LVDS differential data input (R0~R5,G0)	
7	ORX0+	I	+LVDS differential data input (R0~R5 G0)	
8	ORX1-	I	-LVDS differential data input (G1~G5,B0,B1)	
9	ORX1+	I	+LVDS differential data input (G1~G5,B0,B1)	
10	GND	P	Ground	
11	ORX2-	I	-LVDS differential data input (B2~B5,-,-,DE)	
12	ORX2+	I	+LVDS differential data input (B2~B5,-,-,DE)	
13	ORXC-	I	-LVDS differential Clock input	
14	ORXC+	I	+LVDS differential Clock input	
15	GND	P	Ground	
16	ORX3-	I	-LVDS differential data input (R6~R7,G6~G7,B6~B7)	
17	ORX3+	I	+LVDS differential data input (R6~R7,G6~G7,B6~B7)	
18	GND	P	Ground	
19	ERX0-	I	-LVDS differential data input (R0~R5,G0)	
20	ERX0+	I	+LVDS differential data input (R0~R5,G0)	
21	ERX1-	I	-LVDS differential data input (G1~G5,B0,B1)	
22	ERX1+	II	+LVDS differential data input (G1~G5,B0,B1)	
23	GND	P	Ground	
24	ERX2-	I	-LVDS differential data input (B2~B5,-,-,-)	
25	ERX2+	I	+LVDS differential data input (B2~B5,-,-,-)	
26	ERXC-	I	-LVDS differential Clock input	
27	ERXC+	I	+LVDS differential Clock input	
28	GND	P	Ground	
29	ERX3-	I	-LVDS differential data input (R6~R7,G6~G7,B6~B7)	
30	ERX3+	I	+LVDS differential data input (R6~R7,G6~G7,B6~B7)	
31	GND	P	Ground	

32	GND	P	Ground	
33	GND	P	Ground	
34	NC	N	No connection	
35	PWM	I	Dimming control signal	
36	LED_EN	I	Backlight on/off control signal(1:on, 0:off)	
37	NC	N	No connection	
38	VLED	P	Backlight power supply :+12V	
39	VLED	P	Backlight power supply :+12V	
40	VLED	P	Backlight power supply :+12V	

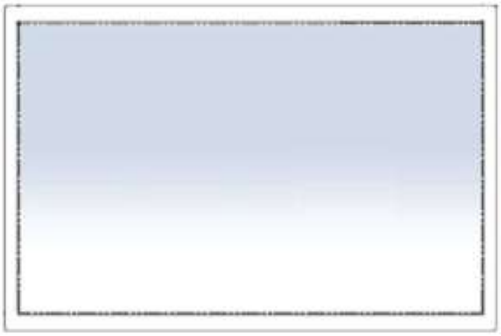
Table 3.1.2 Pin Assignment for LCD Interface

Note1: I/O definition: I---Input, O---Output, P---Power/Ground, N---No connection

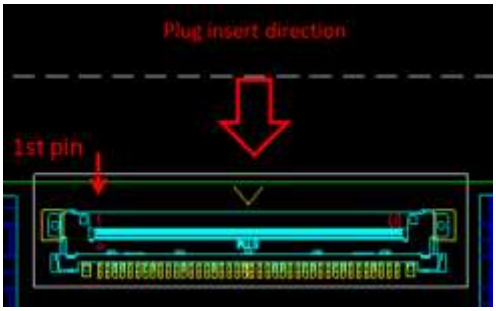
Note2: All of the GND pins should be connected to the system ground.

Note3: Display direction

PCB side ➡



Note4: 1st pin location



4. Absolute maximum rating

Item	Symbol	MIN	MAX	Unit	Remark
Power Voltage	VCC	-0.3	5.0	V	Note 1
Operating Temperature	Top	-10	60	℃	
Storage Temperature	Tst	-20	70	℃	
Relative Humidity Note 2	RH	--	≤95	%	Ta≤40℃
		--	≤85	%	40℃＜Ta≤50℃
		--	≤55	%	50℃＜Ta≤60℃
		--	≤36	%	60℃＜Ta≤70℃
		--	≤24	%	70℃＜Ta≤80℃
Absolute Humidity	AH	--	≤70	g/m³	Ta＞70℃

Table 4.1 Absolute Maximum Ratings

Note1: Input voltage include all in put data.

Note2: Ta means the ambient temperature. It is necessary to limit the relative humidity to the specified temperature range. Condensation on the module is not allowed.

Note3: The absolute maximum rating values of this product are not allowed to be exceeded at any times. A module should be used with any of the absolute maximum ratings exceeded, the characteristics of the module may not be recovered, or in an extreme condition, the module may be permanently damaged.

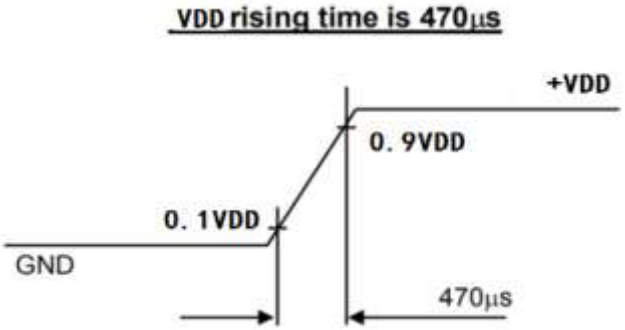
5. Electrical Characteristics

5.1 DC Characteristics for Panel Driving

Item		Symbol	MIN	TYP	MAX	Unit	Remark
Supply Voltage		VCC	3.2	3.3	3.4	V	Without ripple
VCC current		IVCC	--	246	369	mA	
Input Signal Voltage	Low Level	VIL	DGND	--	0.2×VCC	V	
	High Level	VIH	0.8×VCC	--	VCC	V	
Power Consumption	60Hz	P	--	811.8	1217.7	mW	White pattern
Inrush current		Irush	--	--	1.5	A	Note 1

Table 5.1.1 Operating Voltages

Note1: To test the current dissipation, using the “white pattern” shown



5.2 DC Characteristics for Driving Backlight

Item		Symbol	MIN	TYP	MAX	Unit	Remark
VLED		VLED	10.8	12	13.2	V	
VLED Current		IVLED	--	411	616.5	mA	
Backlight Power Consumption		P	--	4932	7398	mW	
PWM frequency		F	200	--	20K	Hz	
PWM duty		D	3	--	100	%	
PWM signal	High level	--	1.6	-	-	V	
	Low level	--	-	-	0.7	V	
LED_EN signal	High level	--	1.6	-	-	V	
	Low level	--	-	-	0.7	V	
LED life time		--	30000	--	-	Hrs	

Table 5.2.1 LED Backlight Characteristics

Note1: According to LED driver IC characteristics, the minimum value of VELD_PWM duty may vary with VLED_PWM frequency, higher the frequency, bigger the duty
Note2: Optical performance should be evaluated at Ta=25℃ only.
Note3: If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced.
Note4: Operating life means brightness goes down to 50% of initial brightness. Typical operating life time is estimated data.

5.3 Recommended Power ON/OFF Sequence

Symbol	Min	Typ	Max	Unit	Remark
t1	1	-	3	ms	
t2	-	-	1	ms	
t3	200	-	-	ms	
t4	1	-	-	ms	Note 1
t5	2	-	-	ms	
t6	2	-	-	ms	
t7	2	-	-	ms	
t8	2	-	-	ms	
t9	1	-	-	ms	
t10	200	-	-	ms	
t11	200	-	-	ms	
t12	1	-	3	ms	
t13	1000	-	-	ms	

Table 5.3.1 Power on sequence

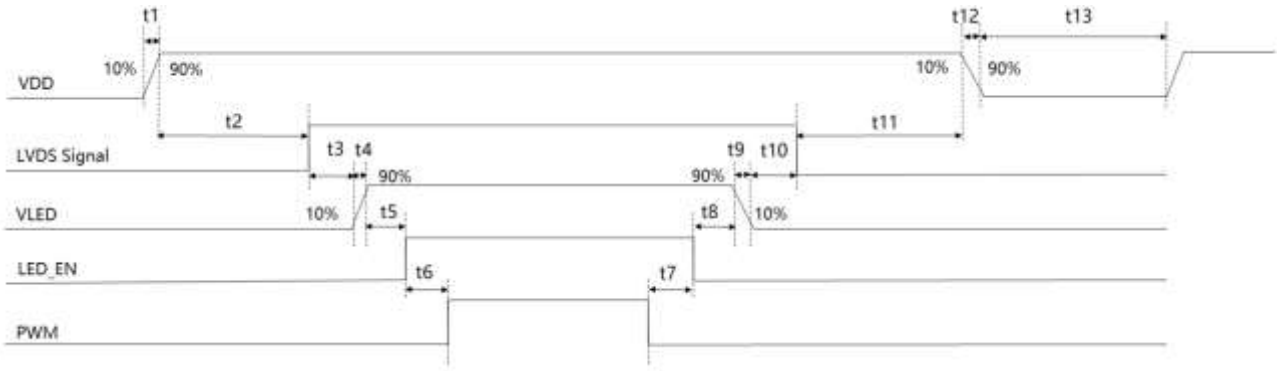


Figure 5.3.1 Power on sequence

Note1: Display at least two black frames before signal off. It is advised that backlight turned on later than display
Note2: The low level of these signals and analog powers are GND level.
Note3: All of the power and signals should be kept at GND level before power on. If there are residual voltages on them, the LCD might not work properly.
Note4: The power on/off sequence is the first version. It will be updated when the design is fixed.
Note5: Keep LED_EN at low level until the display has stabilized.

5.4 LVDS DC electrical characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Condition
Differential Input high Threshold voltage	R_{xVTH}	-	-	0.1	V	R_{xVCM}=1.2V
Differential Input Low Threshold voltage	R_{xVTL}	-0.1	-	-	V	
Input voltage range (signaled-end)	R_{xVIN}	0	-	VCC-1.0	V	
Differential Input common Mode voltage	R_{xVCM}	0.6	1.2	2.4-|VID|/2	V	
Differential Input voltage	$\|V_{ID}\|$	0.1	0.4	0.6	V	

Table 5.4.1 LVDS DC Characteristics

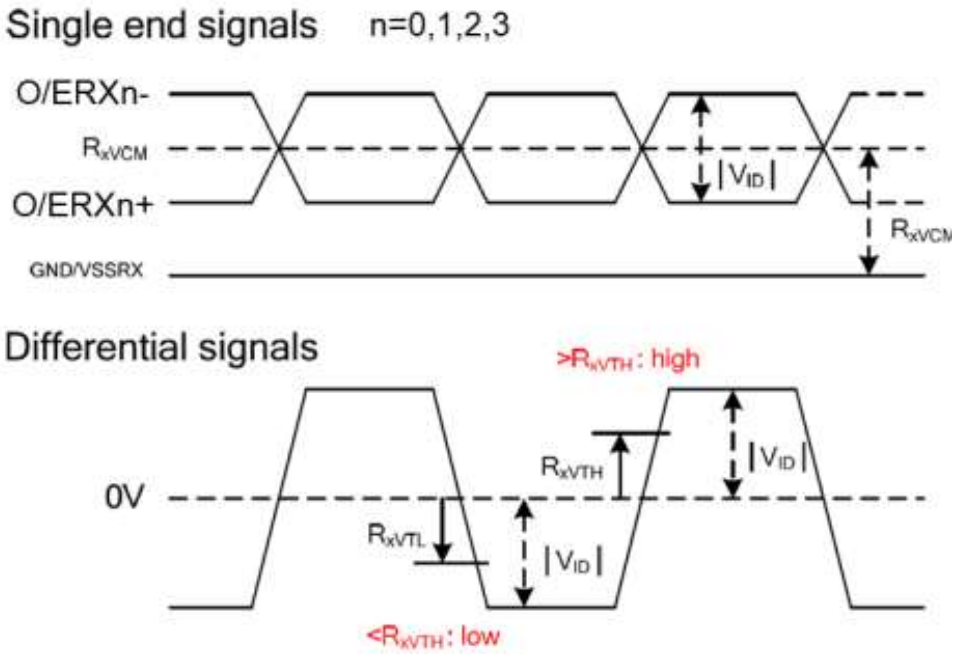


Figure 5.4.1 LVDS DC Characteristics

5.5 LVDS AC electrical characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Condition
1data bit time	UI	-	1/7	-	RxTCLK	
Clock high time	T_{LVCH}	-	4	-	UI	
Clock low time	T_{LVCL}	-	3	-	UI	
Position1	Tpos1	-0.2	0	0.2	UI	
Position2	Tpos2	0.8	-	1.2		
Position3	Tpos3	0.8	1	1.2		
Position4	Tpos4	1.8	-	2.2		
Position5	Tpos5	1.8	2	2.2		
Position6	Tpos6	2.8	-	3.2		
Position7	Tpos7	2.8	3	3.2		
Position8	Tpos8	3.8	-	4.2		
Position9	Tpos9	3.8	4	4.2		
Position10	Tpos10	4.8	-	5.2	UI	
Position11	Tpos11	4.8	5	5.2		
Position12	Tpos12	5.8	-	6.2		
Position13	Tpos13	5.8	6	6.2		
Position14	Tpos14	6.8	-	7.2		

Table 5.5.1 LVDS AC Characteristics

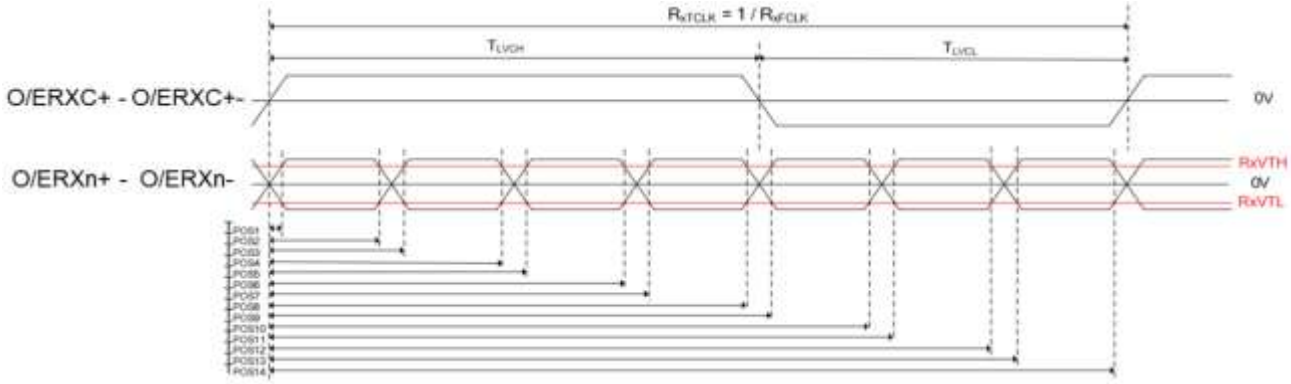


Figure 5.5.1 LVDS DC Characteristics

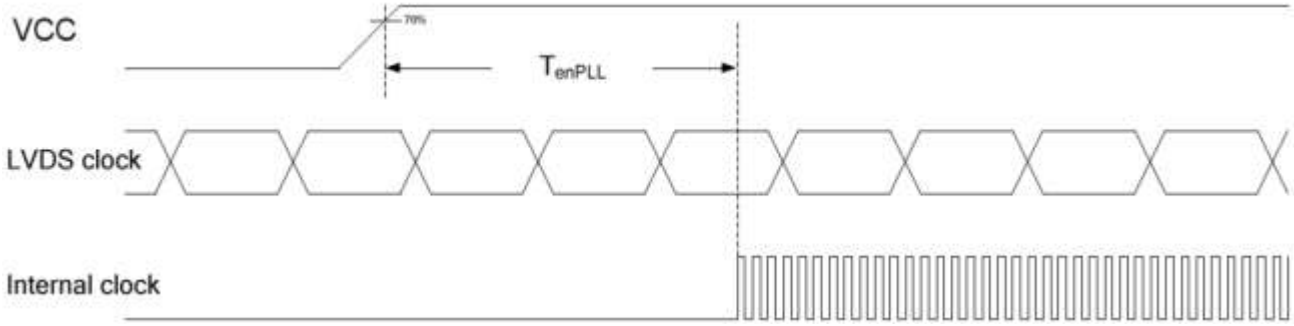


Figure 5.5.2 LVDS DC Characteristics

6. Timing Chart

6.1 Timing Characteristics

Parameter	Symbol	Value			Unit	Note
		min	typ	max		
CLK frequency	t_{clk}	66.5	67.87	75	MHz	Note 1
Horizontal blanking time	t_{HBT}	48	50	99	t_{clk}	$t_{HBP} + t_{HFP}$
Horizontal display area	t_{HD}		960		t_{clk}	
Horizontal period	t_H	1008	1010	1059	t_{clk}	
Horizontal pulse width	t_{HPW}	2	2	2	t_{clk}	
Vertical blanking time	t_{VBT}	20	40	100	t_H	$t_{VBP} + t_{VFP}$
Vertical display area	t_{VD}		1080		t_H	
Vertical period	t_V	1100	1120	1180	t_H	
Vertical pulse width	t_{VPW}	--	2	--	t_H	
Frame rate	Fr		60		Hz	

Table 6.1.1 Input Timing Parameters

Note1: 1port LVDS timing setting. It is necessary to keep tH and tV within recommend value.

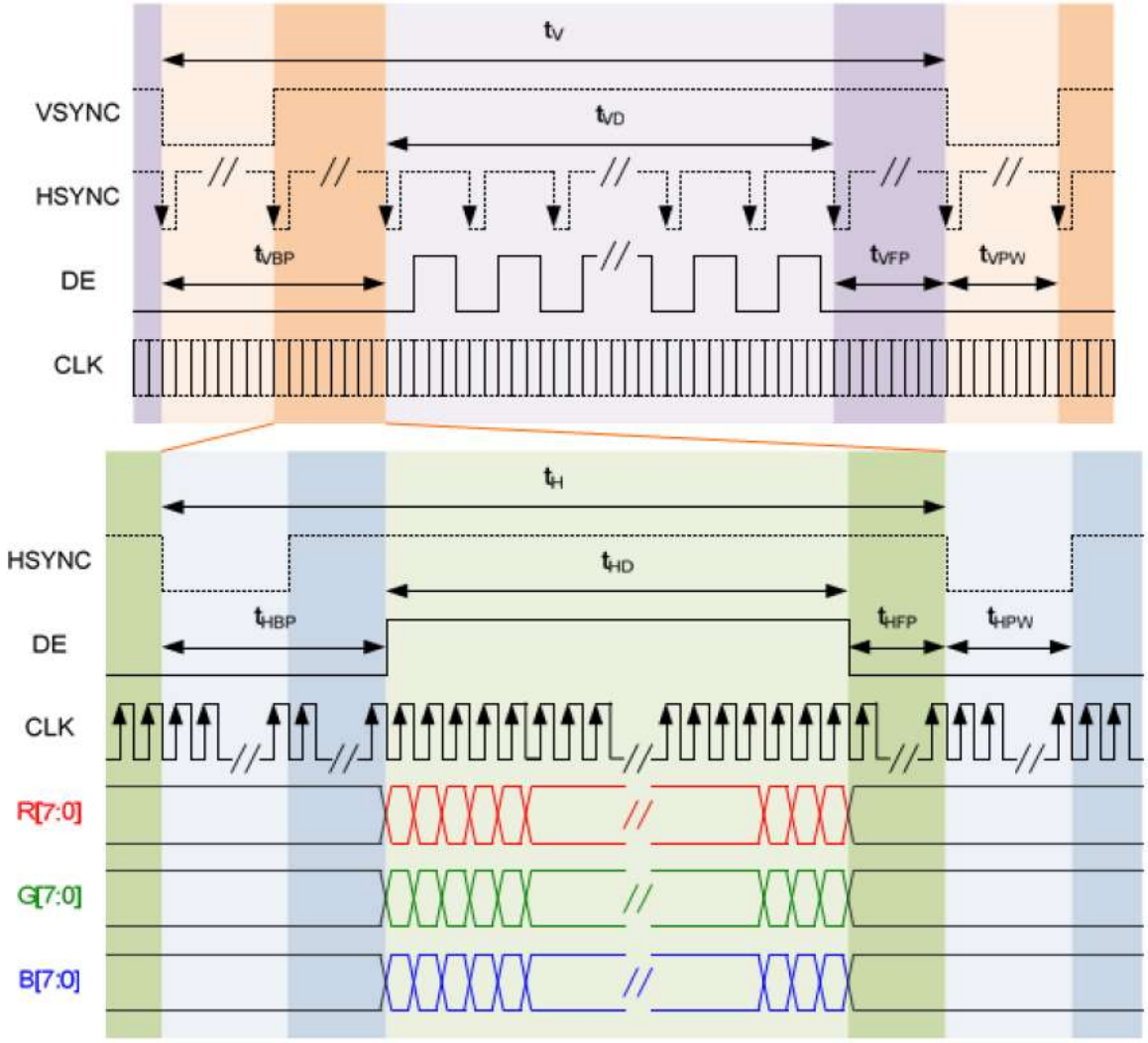


Figure 6.1.1 Clock and Data Input Timing Diagram

6.2 LVDS data mapping

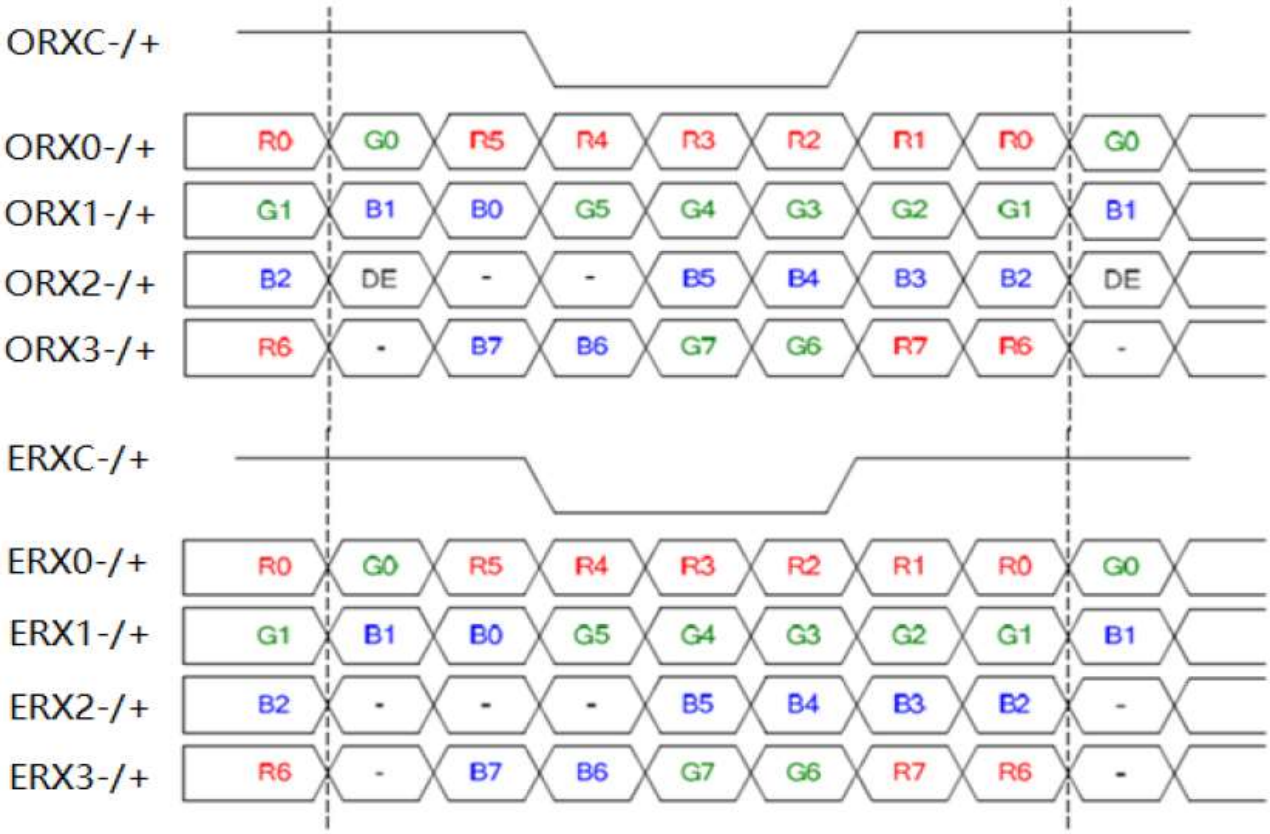


Table 6.2.1 LVDS data mapping (VESA standard)

7. Optical Characteristics

Item		Symbol	Condition	Min	Typ	Max	Unit	Remark
View Angles		θT	CR≧10	78	88	--	degree	Note 2,3
		θB		78	88	--		
		θL		78	88	--		
		θR		78	88	--		
Contrast Ratio		CR	θ=0°	1500	2000	--		Note 3
Response Time		T_{ON}	25℃	--	35	40	ms	Note 4
		T_{OFF}						
Chromaticity	**White**	x	Backlight is on	0.254	0.304	0.354		Note 1,5
		y		0.273	0.323	0.373		
	Red	x		0.591	0.641	0.691		Note 1,5
		y		0.293	0.343	0.393		
	Green	x		0.284	0.334	0.384		Note 1,5
		y		0.577	0.627	0.677		
	Blue	x		0.105	0.155	0.205		Note 1,5
		y		0.001	0.051	0.101		
Uniformity		U	-	70	75	--	%	Note 6
NTSC		-	-	67	72	--	%	Note 5
Luminance		L	-	300	350	--	cd/m^2	Note 7

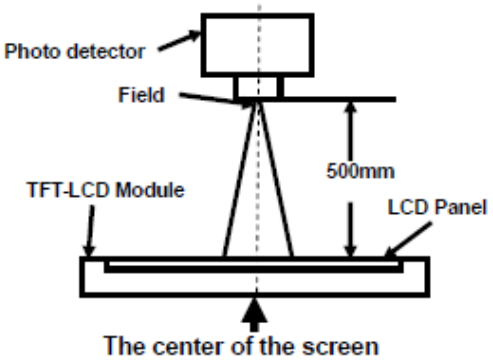
Table 7.1 Optical Parameters

Test Conditions:

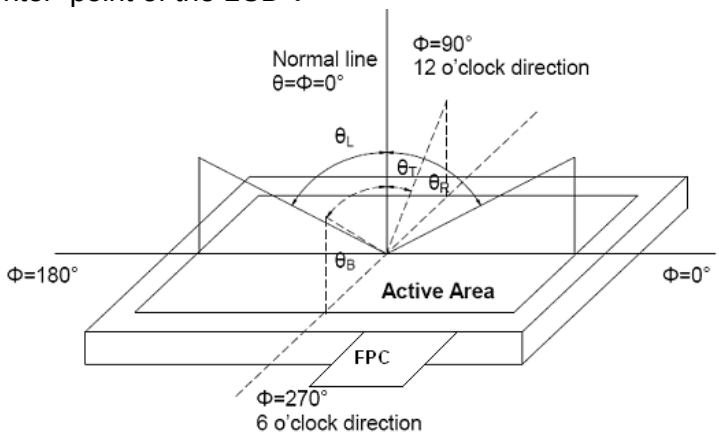
1. The ambient temperature is 25℃.
2. The test systems refer to Note 1 and Note 2.

Note 1: Definition of optical measurement system.

The optical characteristics should be measured in dark room. After 5 Minutes operation, the optical characteristics are measured at the center point of the LCD screen.



Note 2: Definition of viewing angle range and measurement system. Viewing angle is measured at the center point of the LCD 。



Note 3: Definition of contrast ratio

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

Note 4: Definition of Response time

For SFT LCM, the response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time (Tr) is the time between photo detector output intensity changed from 10% to 90%. And fall time (Tf) is the time between photo detector output intensity changed from 90% to 10%.

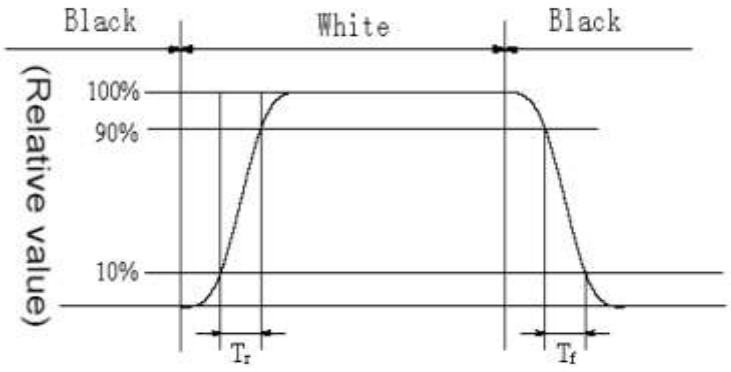


Fig3. Response Time Testing(SFT)

Note 5: Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

Note 6: Definition of Luminance Uniformity

Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

Luminance Uniformity (U) = Lmin/ Lmax

L-------Active area length W----- Active area width

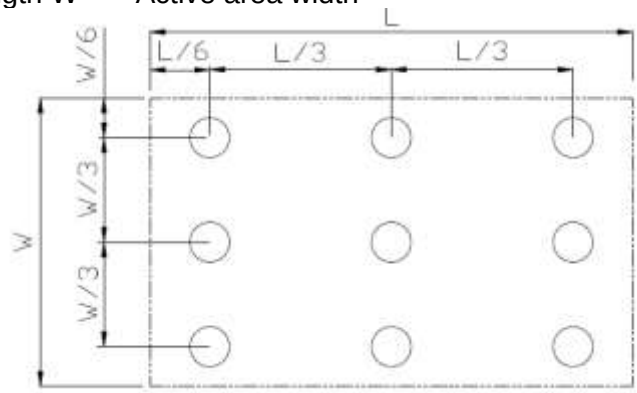


Fig4. Luminance Uniformity Measurement Locations(9 points)

Lmax: The measured Maximum luminance of all measurement position.

Lmin: The measured Minimum luminance of all measurement position.

Note 7: Definition of Luminance:

Measure the luminance of white state at center point.

8. LCD Module Design and Handling Precautions

- Please ensure V0, VCOM is adjustable, to enable LCD module get the best contrast ratio under different temperatures, view angles and positions.
- Normally display quality should be judged under the best contrast ratio within viewable area. Unexpected display pattern may com out under abnormal contrast ratio.
- Never operate the LCD module exceed the absolute maximum ratings.
- Never apply signal to the LCD module without power supply. （No Hot-plugging）
- WARNING! Be aware of (if any) frame grounding of the LCD Module connection with the system which may cause safety issue(e.g. electric shock,etc).
- Keep signal line as short as possible to reduce external noise interference.
- IC chip (e.g. TAB or COG) is sensitive to light. Strong light might cause malfunction. Light sealing structure casing is recommended.
- Make sure there is enough space (with cushion) between case and LCD panel, to prevent external force passed on to the panel; otherwise that may cause damage to the LCD and degrade its display result.
- Avoid showing a display pattern on screen for a long time (continuous ON segment).
- LCD module reliability may be reduced by temperature shock.
- When storing and operating LCD module, avoids exposure to direct sunlight, high humidity, high or low temperature. They may damage or degrade the LCD module.
- Never leave LCD module in extreme condition (max./min storage/operate temperature) for more than 48hr.
- Recommend LCD module storage conditions is 0℃~40℃ <80%RH.
- LCD module should be stored in the room without acid, alkali and harmful gas.
- Avoid dropping & violent shocking during transportation, and no excessive pressure press, moisture and sunlight.
- LCD module can be easily damaged by static electricity. Please maintain an optimum anti-static working environment to protect the LCD module. (eg. ground the soldering irons properly)
- Be sure to ground the body when handling LCD module.
- Only hold LCD module by its sides. Never hold LCD module by applying force on the heat seal or TAB.
- When soldering, control the temperature and duration avoid damaging the backlight guide or diffuser which might degrade the display result such as uneven display.
- Never let LCD module contact with corrosive liquids, which might cause damage to the backlight guide or the electric circuit of LCD module.
- Only clean LCD with a soft dry cloth, Isopropyl Alcohol or Ethyl Alcohol. Other solvents (e.g. water) may damage the LCD.
- Never add force to components of LCD module. It may cause invisible damage or degrade the module's reliability.
- When mounting LCD module, please make sure it is free from twisting, warping and bending.

8. 液晶显示模块设计和使用须知

- 请注意 VO, VCOM 的设定，以确保液晶显示模块在不同的使用温度下以及在不同的视角和位置观察模块显示，均能达到最佳对比度，请务必将应用电路上设置为对比度可调。
- 请注意液晶显示模块的显示品质判定是指在正常对比度下以及视窗(V.A)范围内进行的，非正常对比度下液晶可能会出现非预期的显示不良，应注意区分。
- 请勿在最大额定值以外使用液晶显示模块。
- 请勿在没有接通电源的条件下，给液晶显示模块输送信号。（禁止热插拔）
- 警告！使用前需评估液晶显示模块的金属框架/壳体地(如有)与整机关系和安全性(如：漏电安全性，等)。
- 请尽可能缩短信号线的连接，以避免对液晶显示模块的信号干扰。
- 集成电路因 IC 芯片(如 TAB 或 COG)对紫外线极为敏感，强光环境下可能会引起液晶显示模块功能失效，故应采用不透光的外壳。
- 请在液晶显示模块与外壳之间保留足够的空间(可使用衬垫)，以缓冲外力对液晶显示模块的损坏或因受力不均而产生的显示不匀等异常现象。
- 避免液晶显示屏在某一画面下长时间点亮，否则有出现残影的风险；请通过软件每隔一段时间改变一次画面。
- 液晶显示模块的可靠性可能因温度冲击而降低。
- 请勿在阳光直射、高湿、高温或低温下储存和使用液晶显示模块，这将造成液晶显示模块的损坏或失效。
- 请勿在极限环境(最大/最小存储/工作温度)下使用或放置液晶显示模块超过 48 小时以上。
- 液晶显示模块建议存储条件为：0℃~40℃ <80%RH。
- 请勿让液晶显示模块存储于带有 酸性，碱性，有害气体环境之中。
- 在运输过程中，请勿让液晶显示模块跌落与猛烈震动，同时避免 异常挤压，高湿度，与 阳光照射
- 液晶显示模块极易受静电损坏，请务必保证液晶显示模块在防静电的工作环境中使用或保存。(如：烙铁正确接地,等)
- 拿取液晶显示模块时需注意操作人员的接地情况。
- 请手持液晶显示模块的边沿取放模块，防止热压纸或 TAB 部位受力。
- 焊接液晶模块时，请注意控制烙铁的温度、焊接时间，
  以免烫坏导光板或偏光片，导致显示不匀等不良现象发生。
- 请勿使用洗板水等腐蚀性液体接触液晶模块，以免腐蚀导光板或模块电路。
- 仅可使用柔软的干布，异丙醇或乙醇清洁液晶屏表面，其他任何溶剂(如:水)都有可能损坏液晶模块。
- 请勿挤压液晶显示模块上的元器件，以避免产生潜在的损坏或失效而影响产品可靠性。
- 装配液晶显示模块时，请务必注意避免液晶显示模块的扭曲或变形。

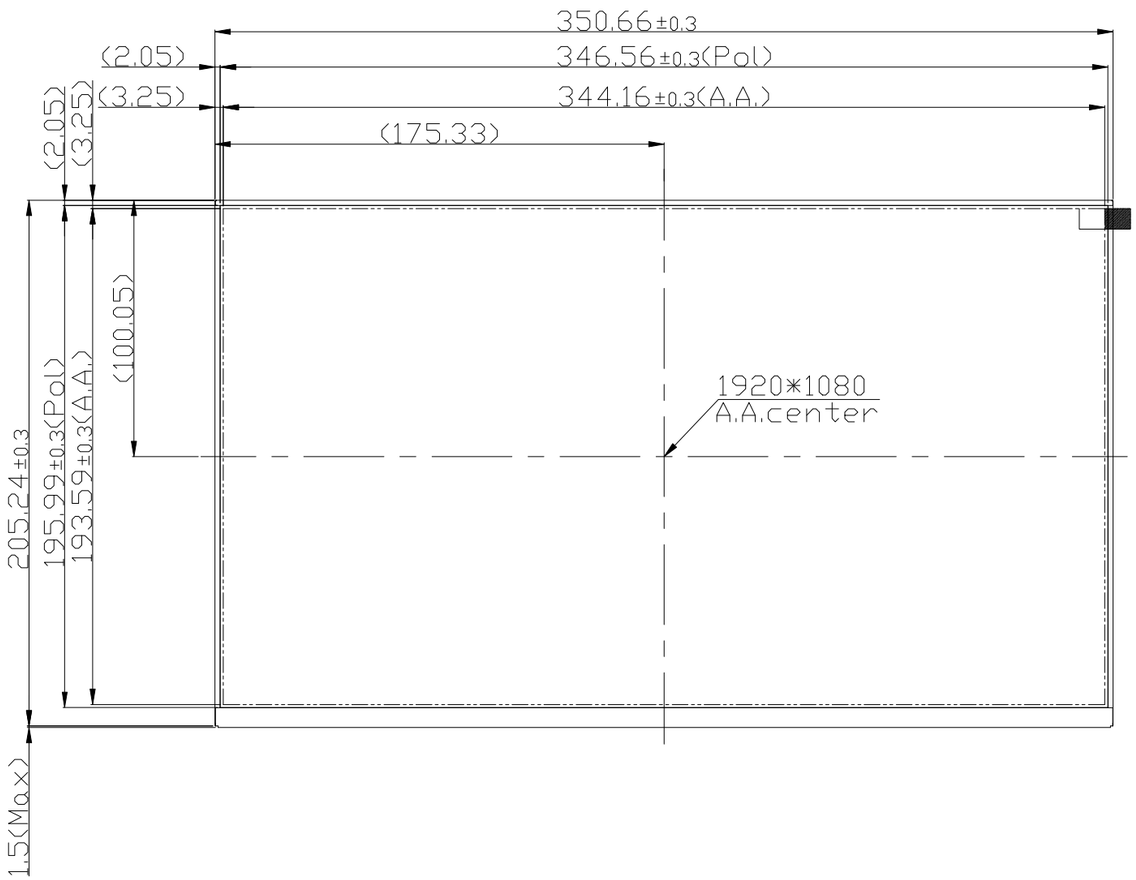
- Do not add excessive force on surface of LCD, which may cause the display color change abnormally.
- LCD panel is made with glass. Any mechanical shock (e.g. dropping from high place) will damage the LCD module.
- Protective film is attached on LCD screen. Be careful when peeling off this protective film, since static electricity may be generated.
- Polarizer on LCD gets scratched easily. If possible, do not remove LCD protective film until the last step of installation.
- When peeling off protective film from LCD, static charge may cause abnormal display pattern. The symptom is normal, and it will turn back to normal in a short while.
- LCD panel has sharp edges, please handle with care.
- Never attempt to disassemble or rework LCD module.
- If display panel is damaged and liquid crystal substance leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes promptly wash it off using soap and water.

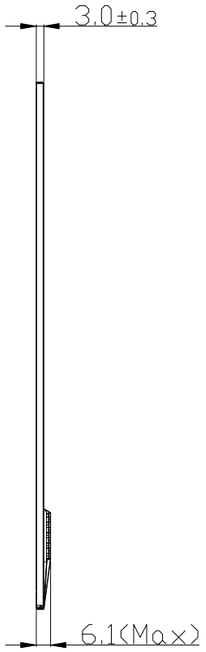
- 请勿挤压液晶显示屏表面，这将导致显示颜色的异常。
- 液晶屏由玻璃制作而成，任何机械碰撞(如从高处跌落)均有可能损坏液晶显示模块。
- 液晶屏表面带有保护膜，揭除保护膜时需要注意可能产生的静电。
- 因液晶显示屏表面的偏光片极易划伤，安装完成之前请尽量不要揭下保护膜。
- 请缓慢揭除保护膜，在此过程中液晶显示屏上可能会产生静电线，此为正常情况，可在短时间内消失。
- 请注意避免被液晶显示屏的边缘割伤。
- 请不要试图拆卸或改造液晶显示模块。
- 当液晶显示屏出现破裂，内部液晶液体可能流出；相关液体不可吞吃，绝对不可接触嘴巴，如接触到皮肤或衣服，请使用肥皂与清水彻底清洗.

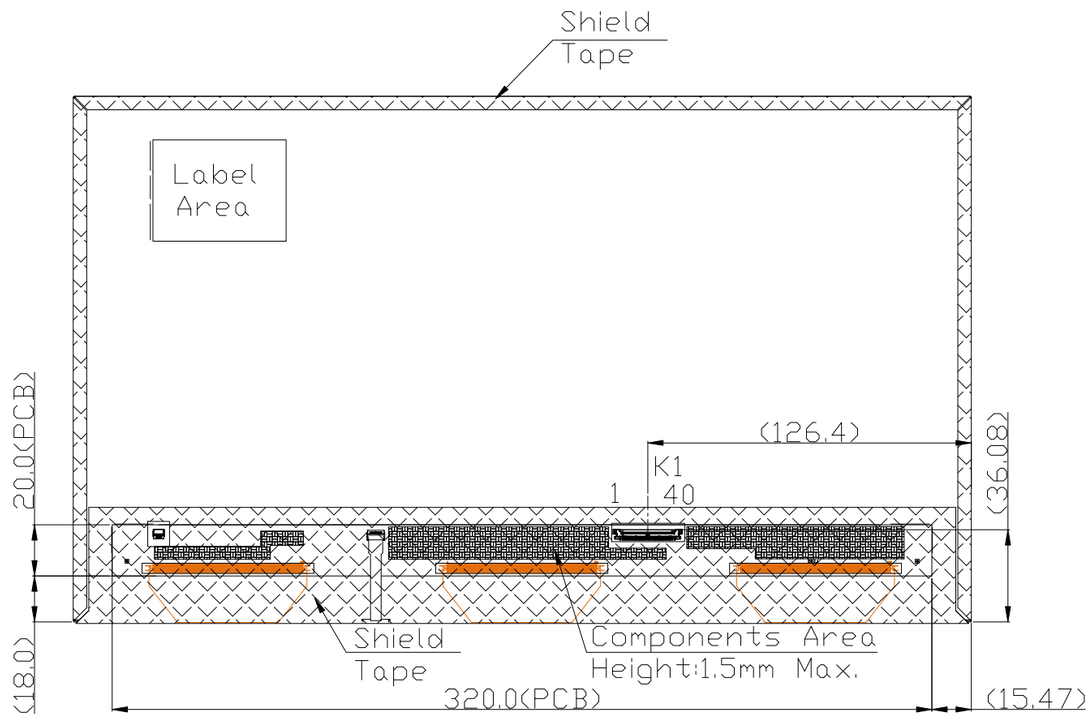
Warranty

This product has been manufactured to our company's specifications as a part for use in your company's general electronic products. It is guaranteed to perform according to delivery specifications. For any other use apart from general electronic equipment, we cannot take responsibility if the product is used in medical devices, nuclear power control equipment, aerospace equipment, fire and security systems, or any other applications in which there is a direct risk to human life and where extremely high levels of reliability are required. If the product is to be used in any of the above applications, we will need to enter into a separate product liability agreement.

- We cannot accept responsibility for any defect, which may arise form additional manufacturing of the product (including disassembly and reassembly), after product delivery.
- We cannot accept responsibility for any defect, which may arise after the application of strong external force to the product.
- We cannot accept responsibility for any defect, which may arise due to the application of static electricity after the product has passed our company's acceptance inspection procedures.
- When the product is in CCFL models, CCFL service life and brightness will vary according to the performance of the inverter used, leaks, etc. We cannot accept responsibility for product performance, reliability, or defect, which may arise.
- We cannot accept responsibility for intellectual property of a third part, which may arise through the application of our product to our assembly with exception to those issues relating directly to the structure or method of manufacturing of our product.







Note:
*1. LCD Display Type : TFT,Transmissive(Full View)
*2. Pixel Arrangment : RGB-STRIPE
*3. Operating Voltage : 3.3V
*4. Color Depth : 16.7M Colors
*5. Backlight : White LED
*6. Interface : LVDS_24bit(VESA)
*7. Backlight Supply : 411mA (Constant Current VF=12V typ.)
*8. Terminal :
K1 : MSAK24025P40D
*9. Operating Temperature : -10°C~60°C
*10. Storage Temperature : -20°C~70°C
*11. Unmarked Tolerace : ≤150,±0.3;>150,±0.5

K1 Terminal	
No	Pin Name
1	VCC
2	VCC
3	VCC
4	GND
5	GND
6	RX0-
7	RX0+
8	RX1-
9	RX1+
10	GND
11	RX2-
12	RX2+
13	RXC-
14	RXC+
15	GND
16	RX3-
17	RX3+
18	GND
19	ERX0-
20	ERX0+

K1 Terminal	
No	Pin Name
21	ERX1-
22	ERX1+
23	GND
24	ERX2-
25	ERX2+
26	ERXC-
27	ERXC+
28	GND
29	ERX3-
30	ERX3+
31	GND
32	GND
33	GND
34	NC
35	PWM
36	LED_EN
37	NC
38	VLED
39	VLED
40	VLED

Rev	Note	Date
A	Revise Outline	Liyongzheng 2024-06-13

Dwg Title: LMT156PAQFDA Outline Dwg
Dwg No.: MK-008327a-1-1
Date: 2024-01-22
Scale: 2/5 | Tol.: - | Unit: mm | Paper Size: A3
Approved | Checked | Drawn: Liyongzheng

TOPWAY