

TFT Product Specification

- ◇ PRELIMINARY SPECIFICATION
- ◆ APPROVED SPECIFICATION

Part Number: FLC-215MML2000SA2

Description: TFT 21.5''W 1920*1080 Full HD LVDS 16.7M color 400CD

Prepared by: Natalie

Version : 1.0

Approved by	
Date	

Revision History

Version	Date	Page	Description	Note
V1.0	2020/7/06		First Edition	

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1. GENERAL DESCRIPTION

1.1 Description

21.5" is a Color Active Matrix Liquid Crystal Display Module composed of a TFT LCD panel and LED backlight system. The screen format is intended to support FHD 1920x1080 screen and 16.7M colors.

1.2 Product Summary

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

No.	Item	Specification	Unit
1	Display Size	21.5	Inch
2	Pixel Number	1920 (H) x RGB x 1080 (V)	Pixels
3	Outline Dimension	497.60 (H) × 287 (V) × 13.52 (D)	mm
4	Active Area	476.06 (H) × 267.79 (V)	mm
5	Display Colors	16.7M	--
6	Pixel Arrangement	RGB vertical stripe	--
7	Display Mode	Normally Black / Transmissive	--
8	Electrical Interface	LVDS	--
9	Surface Treatment	AG type, 3H hard coating, Haze 25	--
10	Brightness	400 (Typ.)	cd/m ²
11	Contrast Ratio	1000 (Typ.)	--
12	Power Consumption (Typ)	Total 22.35(Max) @Cell 4.05W / Blu 16.8W(Max)	W

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2. ABSOLUTE MAXIMUM RATING

2.1 Electrical Absolute Rating

Item	Symbol	Values			Unit	Note
		Min	Typ	Max		
Power supply voltage	VCC	-0.3	-	6	V	(1)
Logic Input Voltage	VIN	-0.3	-	3.6	V	
LED Converter Voltage	LED V _{in}	0	12	18	V	Duty=100% (1)(2)
LED Enable Voltage	LED EN	0	3.3/5	7	V	
Backlight Adjust	LED PWM	0	3.3/5	7	V	(1), (2) Pulse Width \leq 10msec. and Duty \leq 25%

Note (1) Permanent damage to the device may occur if max values are exceeded. Function operation should be restricted to the conditions described under normal operating conditions.

(2) Specified values are for input pin of LED light bar at Ta=25 \pm 2 $^{\circ}$ C

2.2 Environment Absolute Rating

Item	Symbol	Values			Unit	Note
		Min	Typ	Max.		
Operating Temperature	T _{op}	0		60	$^{\circ}$ C	Ta=25 $^{\circ}$ C
Storage Temperature	T _{stg}	-20		60	$^{\circ}$ C	

Note (1) Temperature and relative humidity range is shown in the figure below,

(a) 90% RH Max.. (b) Wet-bulb temperature should be 39 $^{\circ}$ C Max. (c) No condensation

(2) The temperature of panel surface should be 0 $^{\circ}$ C min. and 60 $^{\circ}$ C max. under Vcc=5V Fr=60Hz, typical LED string current. Any condition of ambient operating temperature, the surface of active area should be keeping not higher than 60 $^{\circ}$ C

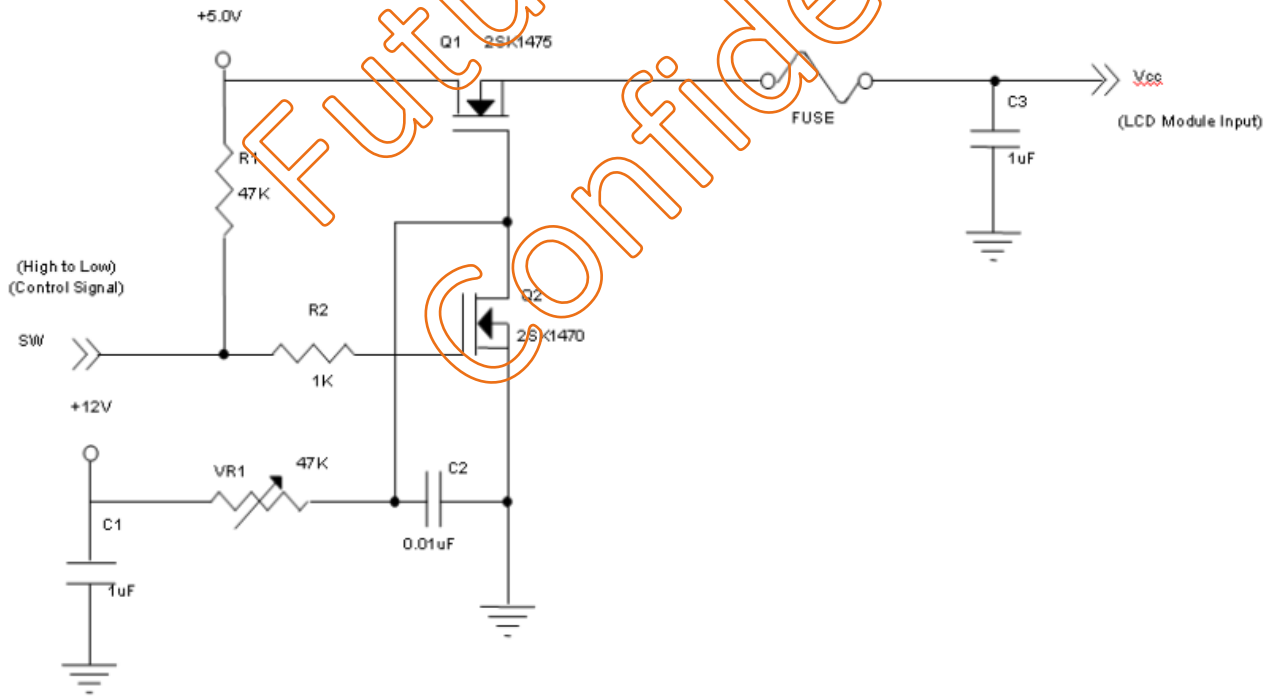
3. ELECTRICAL CHARACTERISTICS

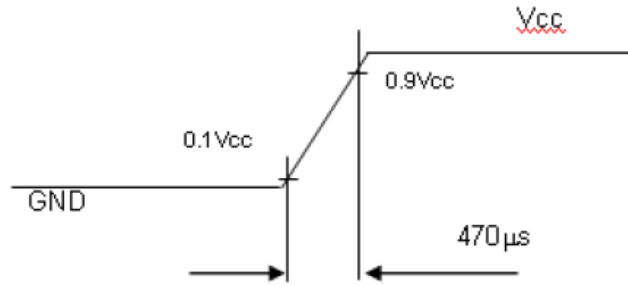
3.1 LCM

Parameter		Symbol	Value			Unit	Note
			Min.	Typ.	Max.		
Power Supply Voltage		VCC	4.5	5	5.5	V	
Ripple Voltage		V _{RP}	--	--	300	mV	
Rush Current		I _{RUSH}	--	--	3.0	A	(2)
Power Supply Current	White		--	550	640	mA	(3)
	Black		--	530	620	mA	
	Vertical Stripe		--	700	810	mA	
Power Consumption		P _{LC} D	--	3.5	4.05	W	(4)
LVDS differential input voltage		V _{ID}	100	--	600	mV	-
LVDS common input voltage		V _{CM}	1.0	1.2	1.4	V	-
Differential Input High Threshold Voltage		V _{TH}			+100	mV	
Differential Input Low Threshold Voltage		V _{TL}	-100			mV	

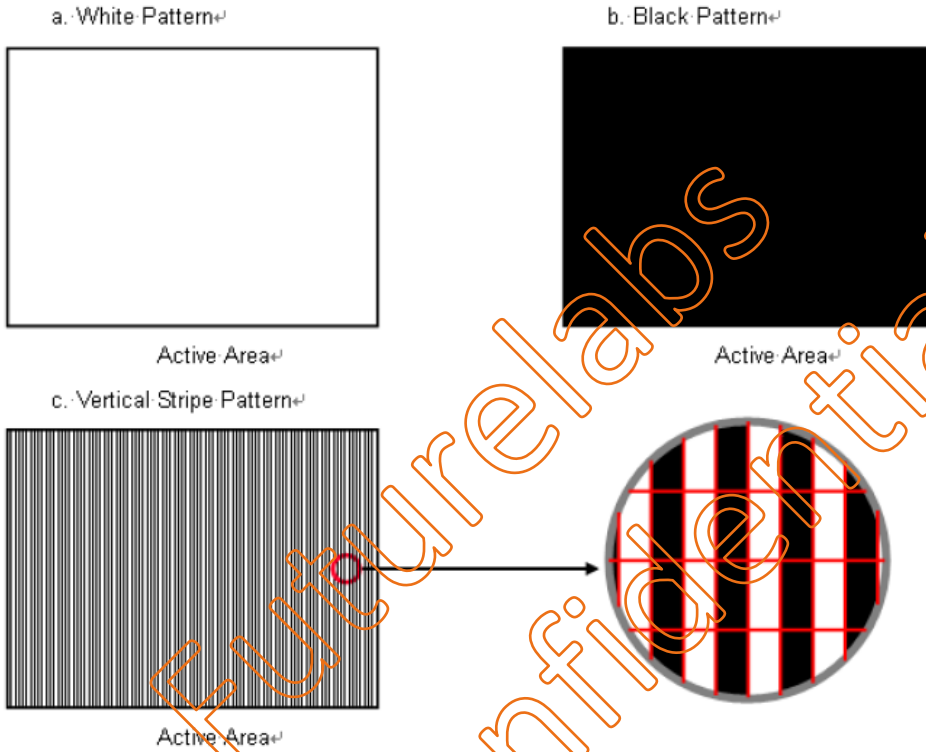
Note (1) The assembly should be always operated within above ranges. $T_a = 25 \pm 2 \text{ }^\circ\text{C}$

Note (2) Measurement Conditions:



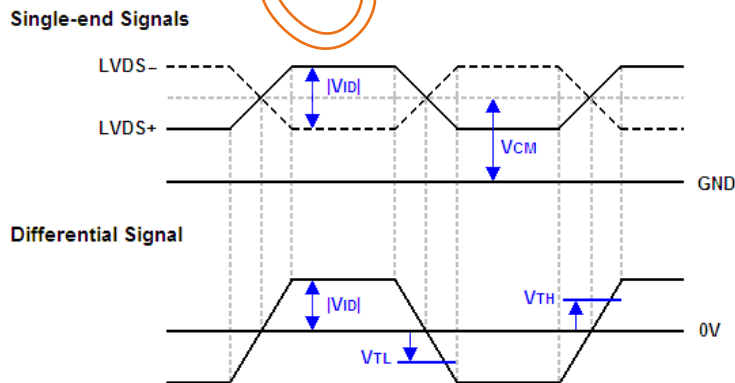


Note (3) The specified power supply current is under the conditions at $V_{CC}=5V$, $F_r=60Hz$, whereas a power dissipation check pattern below is displayed

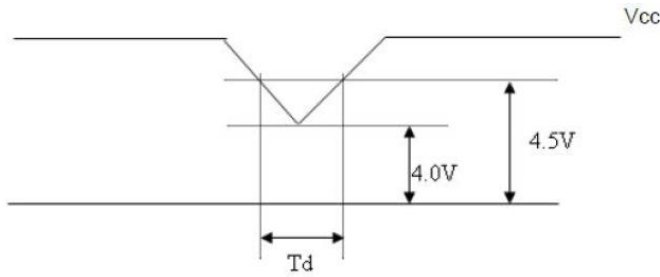


Note (4) The power consumption is specified at the pattern with the max current.

Note (5) The LVDS input characteristics are as follows:



Note (6) Power Dip condition



Dip condition: $4.0 \leq V_{cc} \leq 4.5$, $T_d \leq 20\text{ms}$

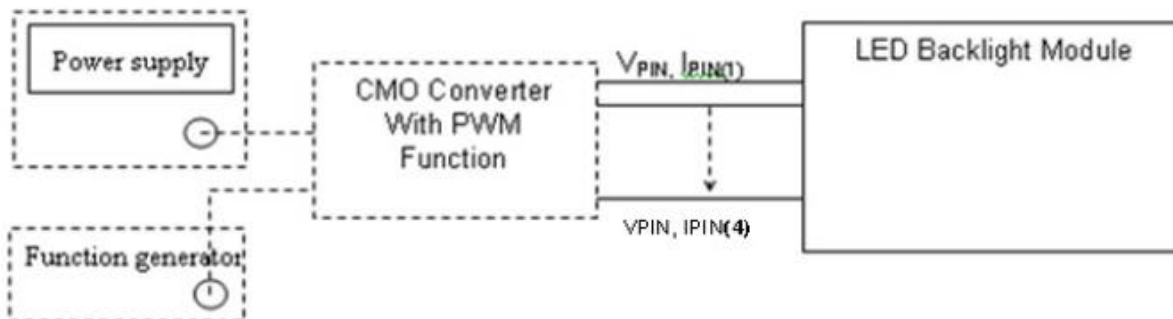
3.2 Backlight Unit

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

Symbol	Parameter	Min.	Typ.	Max.	Unit	Note
LED Vin	Converter Power Supply Voltage	10.8	12	13.2	V	
Ii	Converter Power Supply Current	1.0	1.2	1.4	A	LED Vin= 12V Duty=100%
Iirsh	Converter Input Rush Current			5	A	LED Vin rising = 1mS
PLED	Power Consumption		14.4	16.8	W	LED Vin= 12V Duty=100%
LED_EN	EN Control Level Backlight on	2.0	5	5.5	V	
	EN Control Level Backlight off	0	0	0.15	V	
LED_PWM	PWM Control Level LED_PWM	2.0	3.3	5.0	V	
	PWM Control Level PWM Low Level	0	0	0.15	V	
	PWM Control Duty Ratio	5	--	100	%	@200Hz
fPMW	PWM Control Frequency	190	200	20K	Hz	
LL	LED LifeTime	50000			Hrs	

Note (1) LED light bar input voltage and current are measured by utilizing a true RMS multimeter as shown below:

Note (2) The lifetime of LED is estimated data and defined as the time when it continues to operate under the conditions at $T_a = 25 \pm 2$ °C and Duty 100% $I = (60)\text{mA}$ until the brightness becomes $\leq 50\%$ of its original value. Operating LED under high temperature environment will reduce life time and lead to color shift..



4. SIGNAL CHARACTERISTICS

4.1 Interface Timing

4.1.1 Timing Characteristics:

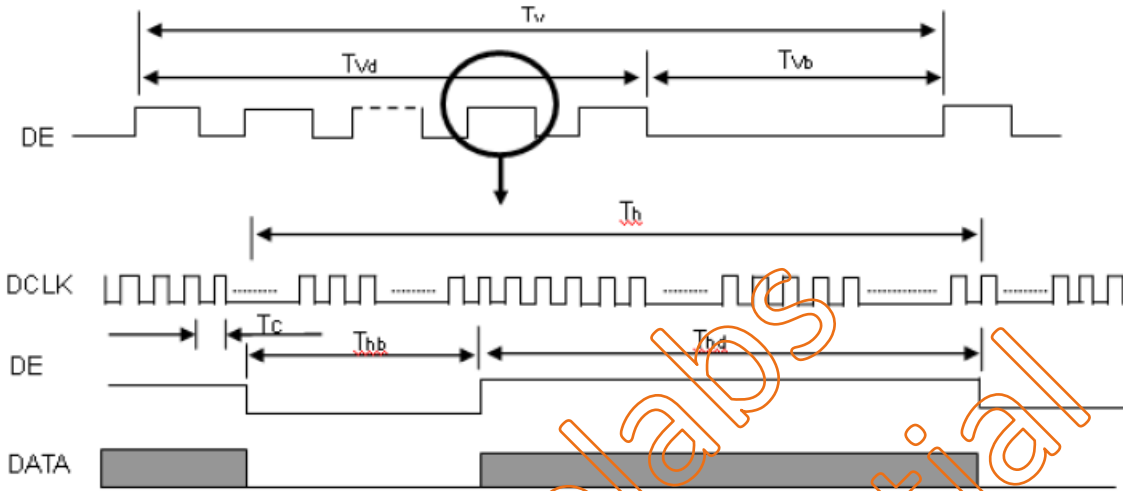
Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
LVDS Clock	Frequency	Fc	57.5	74.25	97.98	MHZ	
	Period	Tc	--	13.47	--	ns	
	Input cycle to cycle jitter	Trcl	-0.02*Tc	--	0.02*T _c	ns	(4)
	Input Clock to data skew	TLVCCS	-0.02*Tc	--	0.02*T _c		(5)
	Spread spectrum modulation range	F _{clk_in_mod}	Fc*0.97*Fc	--	Fc*1.03	MHz	(6)
	Spread spectrum modulation frequency	F _{SSM}	--	--	100	KHz	
Vertical Display Term	Frame Rate	Fr	49	60	77	Hz	
	Total	Tv	1110	1125	1251	Th	Tv=Tvd+Tvb
	Display	Tvd	1080	1080	1080	Th	--
	Blank	Tvb	Tv-Tvd	Tv-Tvd	Tv-Tvd	Th	--
Horizontal Display Term	Total	Th	1050	1100	1150	Tc	Th=Thd+Thb
	Display	Thd	960	960	960	Tc	--
	Blank	Thb	Th-Thd	Th-Thd	Th-Thd	Tc	--

Note: Because this module is operated by DE only mode, Hsync and Vsync input signals are ignored.

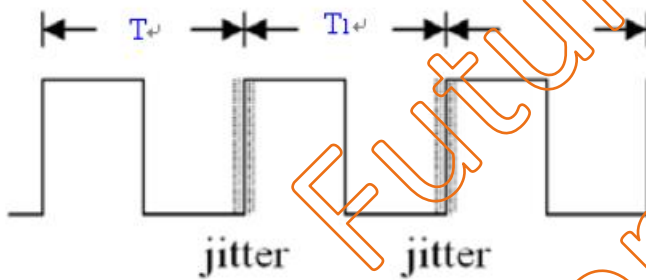
$$F_c = F_r \times T_v \times T_h$$

Please make sure the range of pixel clock has follow the below equation and Fc, Fr, Tv, Th not allowed to get beyond the min or max spec.

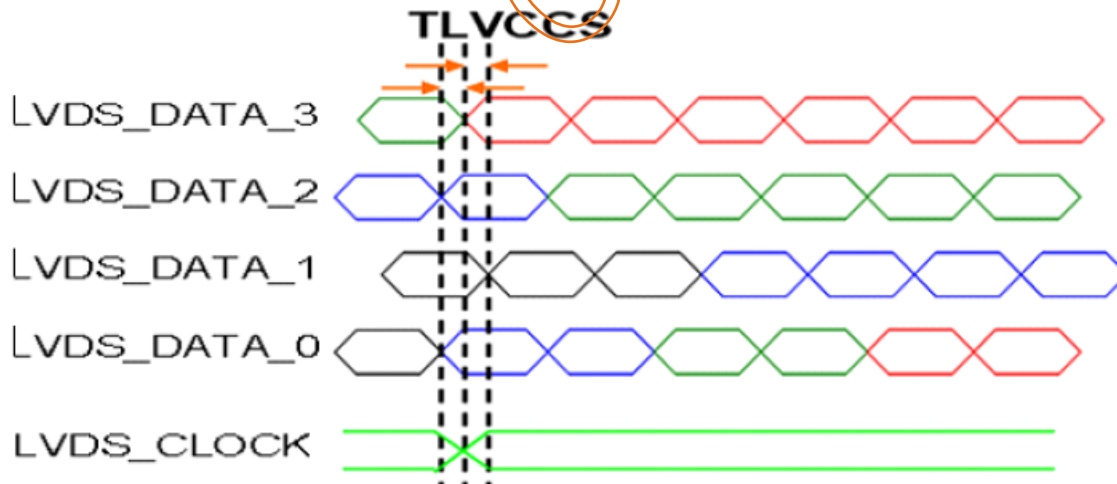
INPUT SIGNAL TIMING DIAGRAM



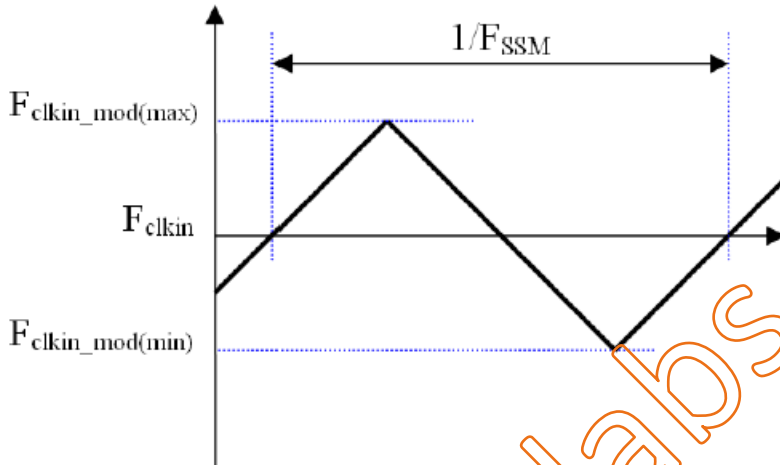
Note (3) The input clock cycle-to-cycle jitter is defined as below figures. $Trcl = |T1 - T|$



Note (4) Input Clock to data skew is defined as below figures.

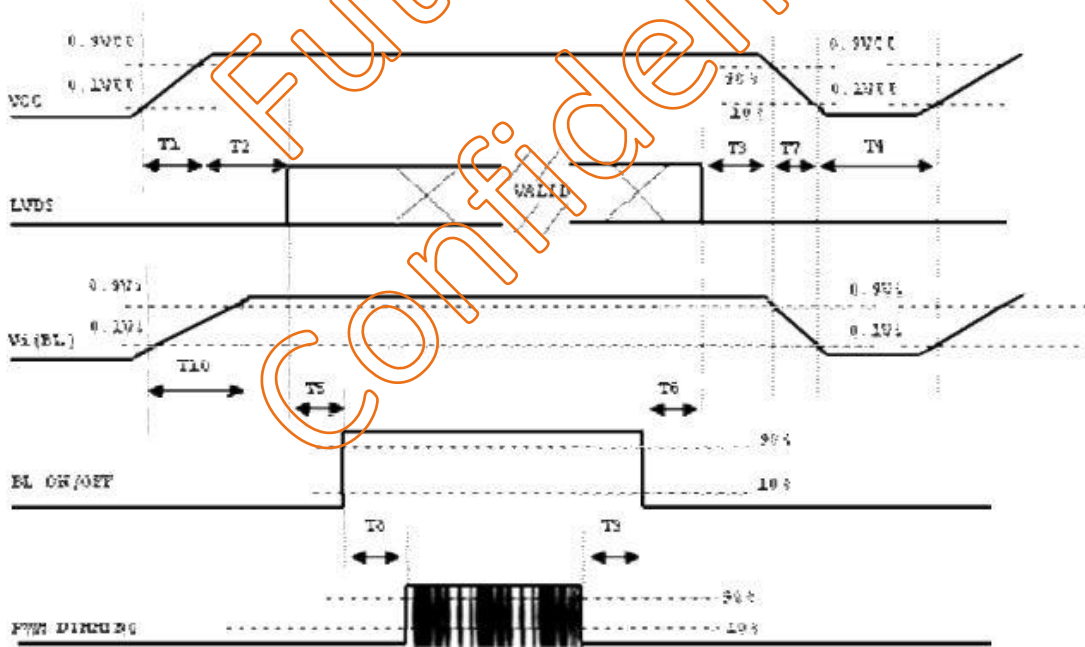


Note (5) The SSCG (Spread spectrum clock generator) is defined as below figures.



4.1.2 Power ON/OFF Sequence

To prevent a latch-up or DC operation of LCD assembly, the power on/off sequence should be as the diagram below.



Timing specifications :

Parameters	Values			Units	Note
	Min	Typ.	Max		
T1	0.5		10	ms	
T2	0		50	ms	
T3	0		50	ms	
T4	500		-	ms	
T5	450		-	ms	
T6	200		-	ms	
T7	10		100	ms	
T8	10		-	ms	
T9	10		-	ms	
T10	20		50	ms	

Note (1) The supply voltage of the external system for the module input should be the same as the definition of Vcc.

Note (2) When the backlight turns on before the LCD operation of the LCD turns off, the display may momentarily become abnormal screen.

Note (3) In case of VCC = off level, please keep the level of input signals on the low or keep a high impedance.

Note (4) T4 should be measured after the module has been fully discharged between power off and on period.

Note (5) Interface signal shall not be kept at high impedance when the power is on.

Note (6) Futurelabs won't take any responsibility for the products which are damaged by the customers not following the Power Sequence.

Note (7) There might be slight electronic noise when LCD is turned off (even backlight unit is also off). To avoid this symptom, we suggest "Vcc falling timing" to follow "T7 spec".

Note (8) There might be slight electronic noise when LCD is turned off (even backlight unit is also off). To avoid this symptom, we suggest "Vcc falling timing" to follow "t6 spec".

5. INTERFACE PIN DESCRIPTION

5.1 LCM Connector PIN Assignment

	Symbol	Description	Note
1	RX00-	Negative LVDS differential data input. ChannelO0(odd)	-
2	RX00+	Positive LVDS differential data input. ChannelO0(odd)	-
3	RX01-	Negative LVDS differential data input. ChannelO1(odd)	-
4	RX01+	Positive LVDS differential data input. ChannelO1(odd)	-
5	RX02-	Negative LVDS differential data input. ChannelO2(odd)	-
6	RX02+	Positive LVDS differential data input. ChannelO2(odd)	-
7	GND	Ground	-
8	RXOC-	Negative LVDS differential clock input. (odd)	-
9	RXOC+	Positive LVDS differential clock input. (odd)	-
10	RX03-	Negative LVDS differential data input. ChannelO3(odd)	-
11	RX03+	Positive LVDS differential data input. ChannelO3(odd)	-
12	RXE0-	Negative LVDS differential data input. ChannelE0(even)	-
13	RXE0+	Positive LVDS differential data input. ChannelE0(even)	-
14	GND	Ground	-
15	RXE1-	Negative LVDS differential data input. ChannelE1(even)	-
16	RXE1+	Positive LVDS differential data input. ChannelE1(even)	-
17	GND	Ground	-
18	RXE2-	Negative LVDS differential data input. ChannelE2(even)	-
19	RXE2+	Positive LVDS differential data input. ChannelE2(even)	-
20	RXEC-	Negative LVDS differential clock input. (even)	-
21	RXEC+	Positive LVDS differential clock input. (even)	-
22	RXE3-	Negative LVDS differential data input. ChannelE3(even)	-
23	RXE3+	Positive LVDS differential data input. ChannelE3(even)	-
24	GND	Ground	-
25	NC	For LCD internal use only, Do not connect	-
26	NC	For LCD internal use only, Do not connect	-
27	NC	For LCD internal use only, Do not connect	-
28	Vcc	+5V power supply	-
29	Vcc	+5V power supply	-
30	Vcc	+5V power supply	-

Note (1) Connector Part No.:

P-TWO:187098-30091 or FCN:WF13-422-3033 or Foxconn:GS23301-0321R-7H

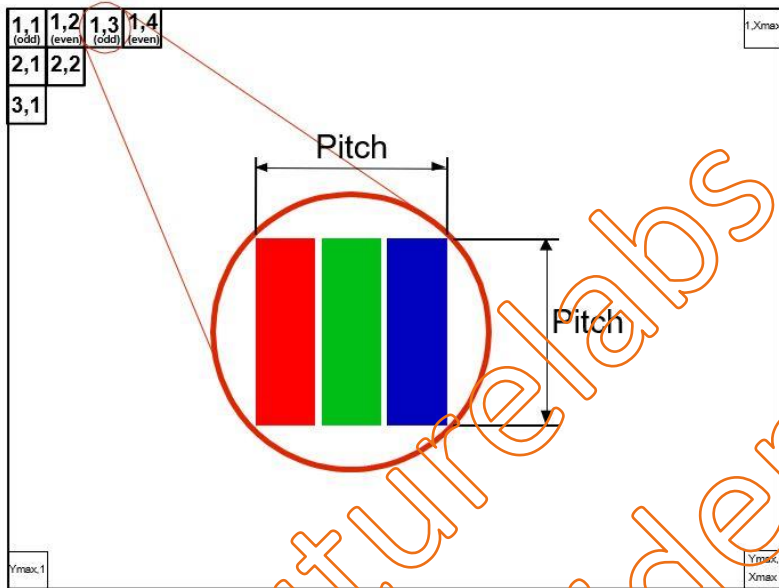
Note (2) User's connector Part No:

Mating Wire Cable Connector Part No.: FI-X30H(JAE) or FI-X30HL(JAE)

Mating FFC Cable Connector Part No.: 217007-013001 (P-TWO) or JF05X030-1 (JAE).

Note (3) The first pixel is odd.

Note (4) Input signal of even and odd clock should be the same timing.



5.2 LVDS INPUT SIGNAL SPECIFICATIONS

LVDS DATA MAPPING TABLE

LVDS Channel O0	LVDS output	D7	D6	D4	D3	D2	D1	D0
	Data order	OG0	OR5	OR4	OR3	OR2	OR1	OR0
LVDS Channel O1	LVDS output	D18	D15	D14	D13	D12	D9	D8
	Data order	OB1	OB0	OG5	OG4	OG3	OG2	OG1
LVDS Channel O2	LVDS output	D26	D25	D24	D22	D21	D20	D19
	Data order	DE	NA	NA	OB5	OB4	OB3	OB2
LVDS Channel O3	LVDS output	D23	D17	D16	D11	D10	D5	D27
	Data order	NA	OB7	OB6	OG7	OG6	OR7	OR6
LVDS Channel E0	LVDS output	D7	D6	D4	D3	D2	D1	D0
	Data order	EG0	ER5	ER4	ER3	ER2	ER1	ER0
LVDS Channel E1	LVDS output	D18	D15	D14	D13	D12	D9	D8
	Data order	EB1	EB0	EG5	EG4	EG3	EG2	EG1
LVDS Channel E2	LVDS output	D26	D25	D24	D22	D21	D20	D19
	Data order	DE	NA	NA	EB5	EB4	EB3	EB2
LVDS Channel E3	LVDS output	D23	D17	D16	D11	D10	D5	D27
	Data order	NA	EB7	EB6	EG7	EG6	ER7	ER6

5.3 COLOR DATA INPUT ASSIGNMENT

The brightness of each primary color (red, green and blue) is based on the 8-bit gray scale data input for the color. The higher the binary input, the brighter the color. The table below provides the assignment of color versus data input.

Color		Data Signal																							
		Red								Green								Blue							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Colors	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
	Red	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	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	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 Scale Of Red	Red(0) / Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red(1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red(2)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	Red(253)	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red(254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Red(255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Gray Scale Of Green	Green(0) / Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Green(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
	Green(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	
	Green(254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	
	Green(255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	
Gray Scale Of Blue	Blue(0) / Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Blue(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	
	Blue(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮	⋮		
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	
	Blue(254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	
	Blue(255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	

Note (1) 0: Low Level Voltage, 1: High Level Voltage

5.4 Backlight and LED Driver Connector PIN Assignment

Pin No	Symbol	Description
1	GND	Ground
2	GND	Ground
3	GND	Ground
4	LED PWM	PWM Dimming HI 3.3V ; LOW 0V
5	LED EN	ENABLE 3.3V
6	NC	NC
7	VIN	12V Input Power
8	VIN	12V Input Power
9	VIN	12V Input Power

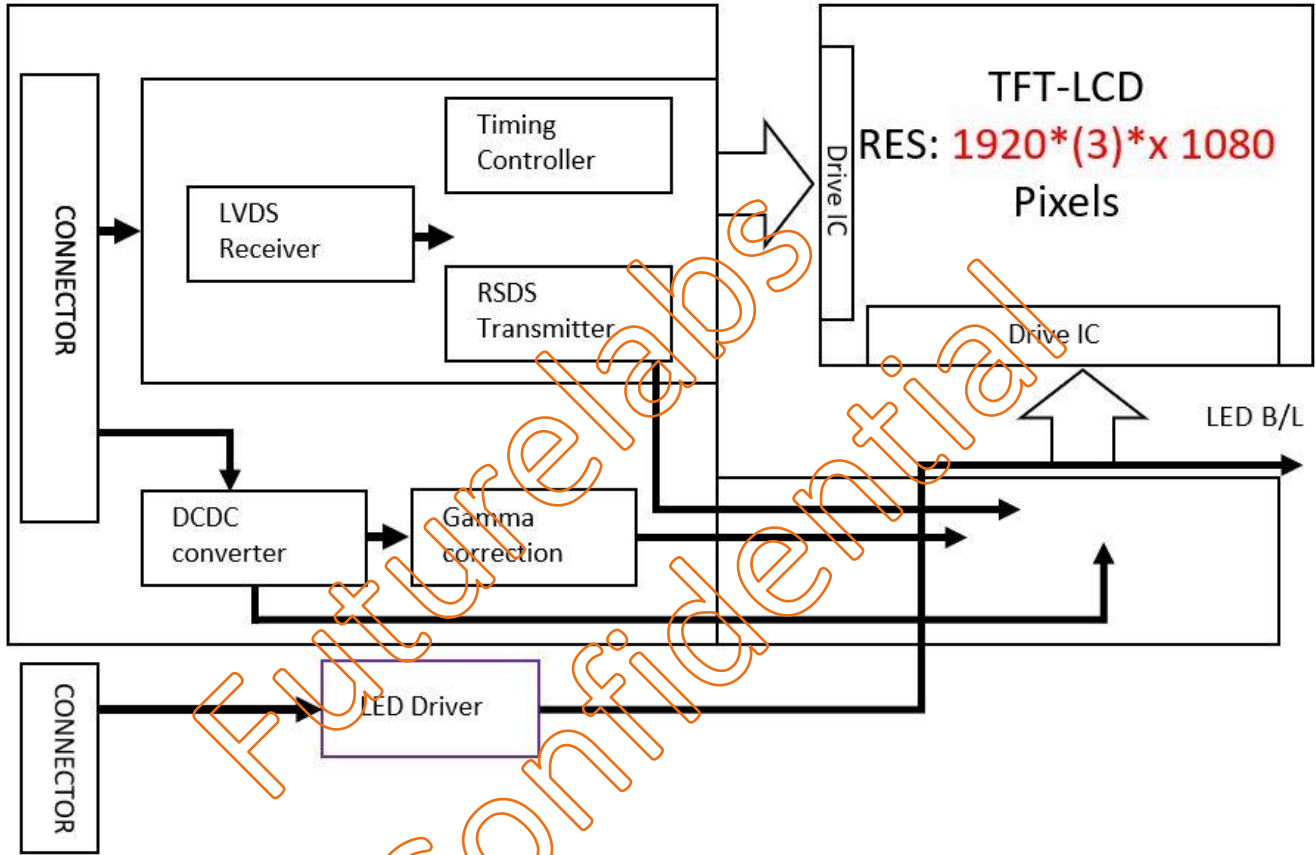
Note (1) Connector(wire type): SMT(MS2409H1) or equivalent.

Note (2) User's mating connector part No.: SMT(P24049)

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6. BLOCK DIAGRAM

The following diagram shows the functional block of the TFT module:



7. OPTICAL CHARACTERISTIC

The optical characteristics are measured under stable conditions at room temperature.

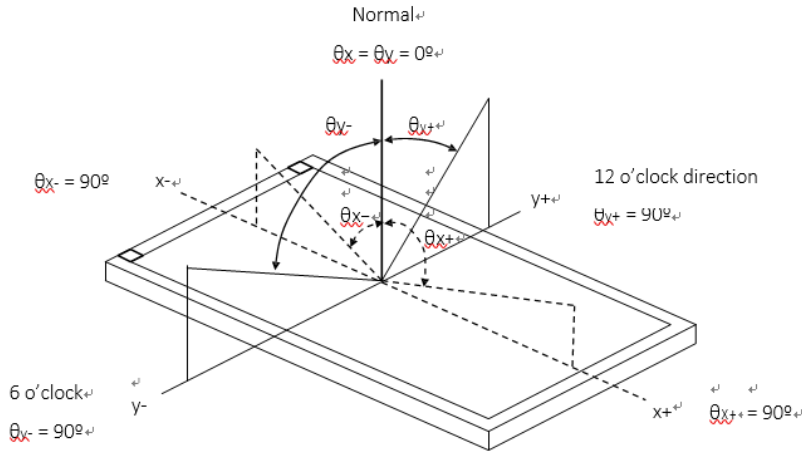
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note	
Contrast Ratio		CR	$\theta_x=0^\circ, \theta_y=0^\circ$ Viewing angle at normal direction	700	1000		-	(2)(5)	
Response Time		TR		-	8		s	(3)	
		TF		-	7		ms		
Center Luminance of White		Lc			320	400	-	cd/m ²	(4)(5)
White Variation		δW			75	--	--	%	(5)(6)
Chromaticity	Red	Rx		Viewing angle at normal direction	Typ.	0.680	Typ.	+0.03	(1)
		Ry				0.339			
	Green	Gx				0.324			
		Gy				0.613			
	Blue	Bx				-0.03			
		By	0.049						
	White	Wx	0.313						
		Wy	0.329						
Viewing Angle	Horizontal	θ_{x+}	CR \geq 10	170	178	-	Deg.	(1)(5)	
		θ_{x-}		170	178	-			
	Vertical	θ_{y+}		170	178	-			
		θ_{y-}		170	178	-			

The following optical specifications shall be measured in a darkroom or equivalent state (ambient luminance <2 lux, and at room temperature).

The ambient temperature is 25°C \pm 2°C and ambient humidity is 50 \pm 10 %RH.

Note 1: Definition of Viewing Angle

Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing angles are determined for the horizontal or the vertical clock direction with respect to the optical axis which is normal to the LCD surface

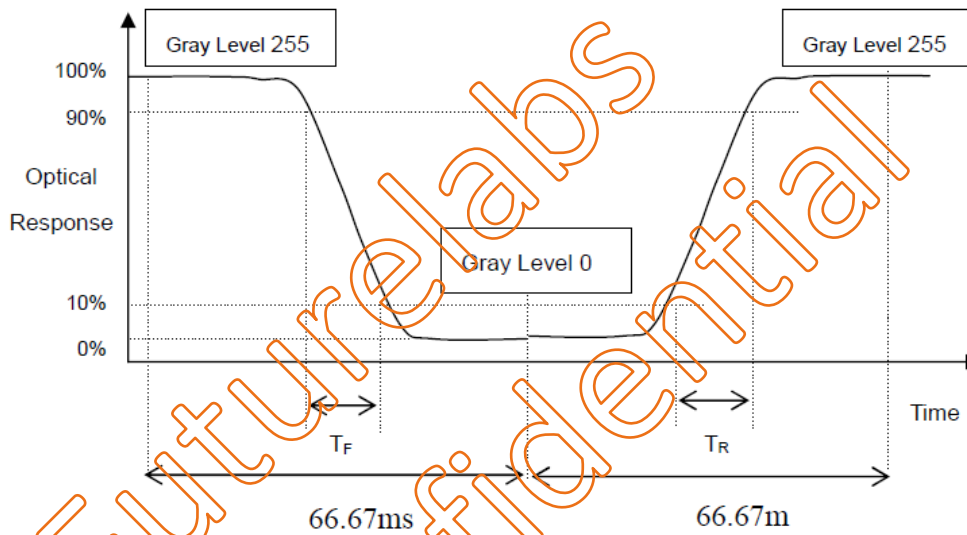


Note 2: Definition of Contrast Ratio (CR)

Measure the viewing angle of $\Theta = 0$ and at the center of the LCD surface. Luminance with all pixels in white state divide by Luminance with all pixels in Black state

Note 3 Definition of Response Time:

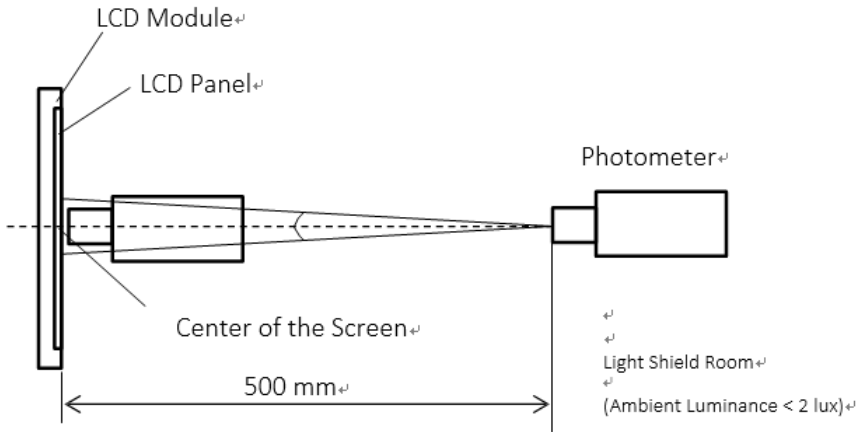
The response time is set initially by defining the "Rising Time (T_R)" and the "Falling Time (T_F)" respectively. Please refer the figure to the followings:



Note 4: Definition of Brightness (Lc)

Measure the center area of the panel and the viewing angle of the $\theta_x = \theta_y = 0^\circ$

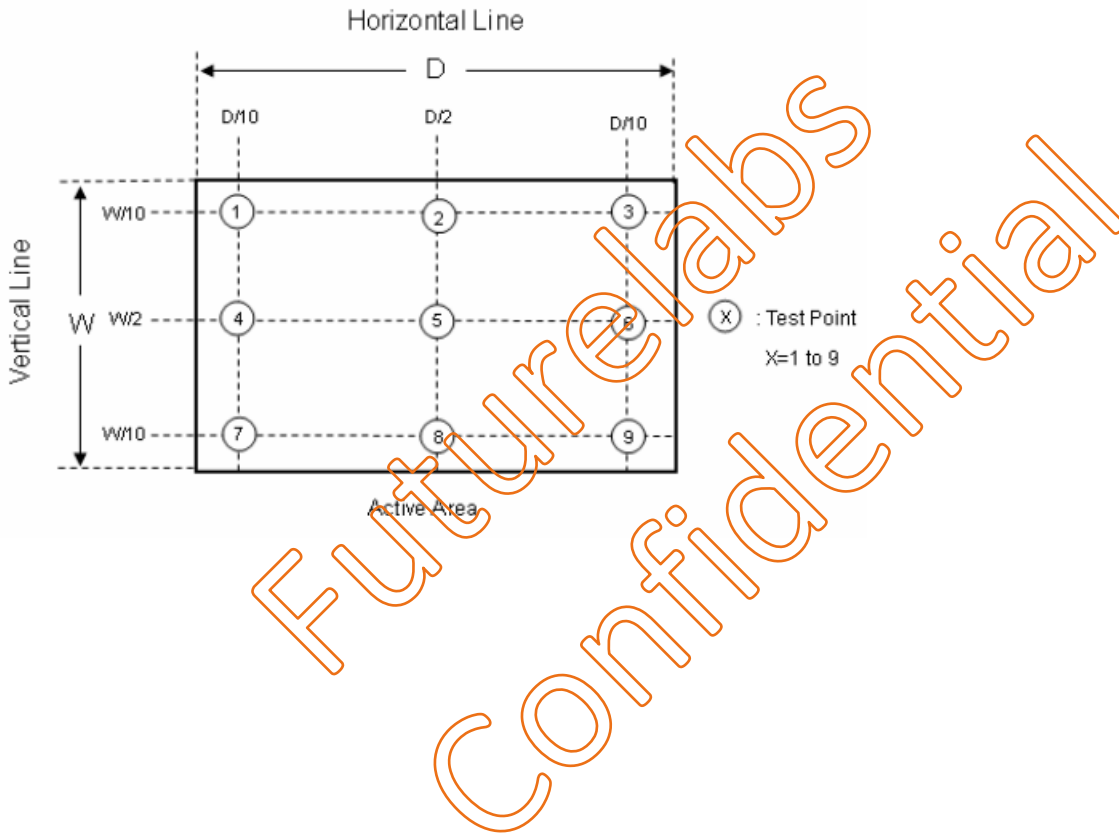
Note 5: The method of optical measurement:



Note 6: Definition of White Variation (δW):

Measure the luminance of gray level 255 at 5 points

$$\delta W = \text{Maximum [L (1), L (2), L (3), L (4) \sim L (9)]} / \text{Minimum [L (1), L (2), L (3), L (4) \sim L (9)]}$$



9. PRECAUTION AND PRODUCT HANDLING

- Do not apply the external force such as bending or twisting to the LCD panel and backlight during assembly.
- Do not insert and plug out the input connector while the LCD panel is operating.
- Do not take apart the panel or frame from LCD module assembly or insert anything into the backlight unit.
- Do not keep the same pattern in a long period of time, it may cause image sticking on LCD panel. Can use shuffle content periodically if fixed pattern is displayed on the screen.
- Do not touch the display area with bare hands, this will stain the display area.
- Pay attention to handle lead wire of backlight, that is not tugged in connect with LED driver.
- Do not change variable resistance inel, it may cause no characteristics specification.
- The surface of LCD panel's polarizer is very soft and easily scratched, please use a very soft dry cloth without chemicals for cleaning.
- To avoid the static electricity to damage the CMOS LSI, the operator should be grounded when in contact with the LCD panel, and also to all electrical equipment.
- Need to follow the correct power frequency when LCD panel is connecting and operating, this can avoid damage to CMOS LSI during latch-up.
- Need to store the LCD panel indoor without the exposure of sunlight where the temperature is $25^{\circ}\text{C} \pm 5^{\circ}\text{C}$ and the humidity is below 60% RH.