

PRODUCT SPECIFICATION **FOR LCD MODULE**

Revision: 1.0

Model No: LS156I02-E-V1

Module Type: COG+FPC+B/L

APPROVED SIGNATURE

- Approved Product Specification only
- Approved Product Specification and Samples

<u>Prepared By</u>	<u>Checked By</u>	<u>Approved By</u>

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1. General Description

LS156I02-E-V1 is a 15.6inch FHD TFT Liquid Crystal Display opencell with LED Backlight unit and 30 pins eDP interface. This module supports 1920×1080 FHD mode and can display 16.7M colors.

2. Physical Features

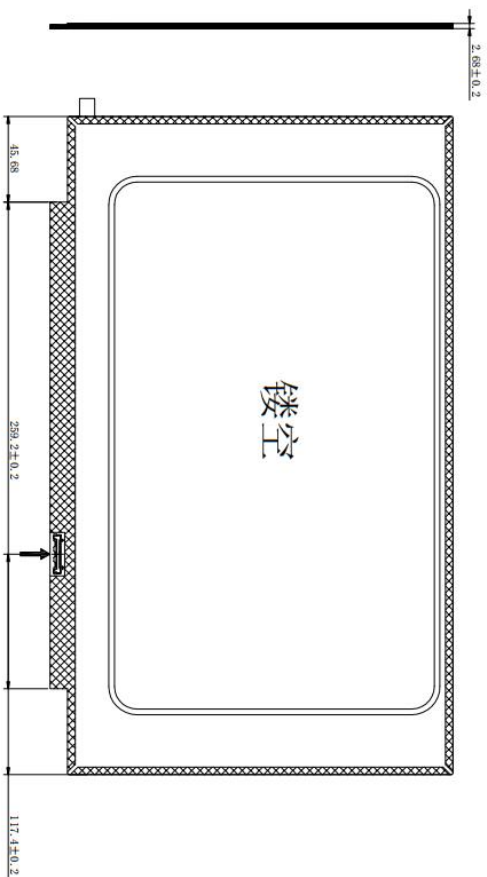
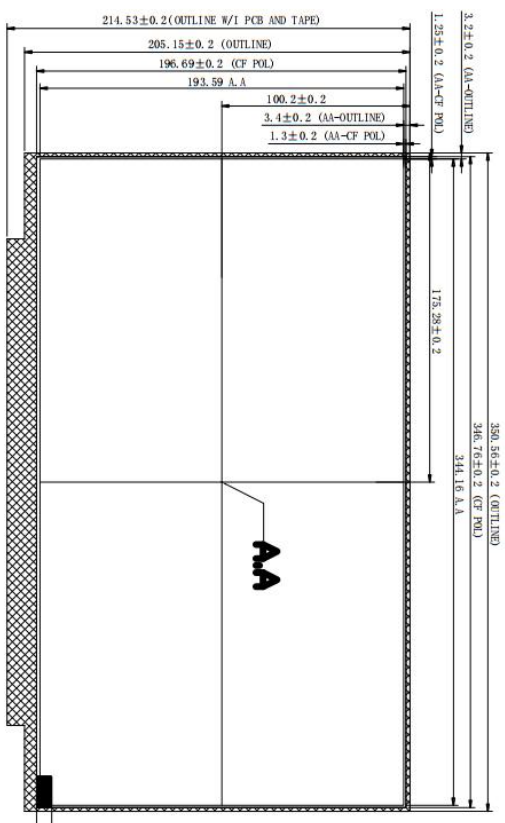
Display Mode	TFT-LCD Module
	Active matrix TFT, Transmissive type
Display Format	Graphic 1920(RGB)×1080 Dot-matrix
Input Data	EDP1.2
Viewing Direction (Grayscale Inversion)	Free (IPS)

3. Mechanical Specification

Item	Specification	Unit
Module size (H×V×D)	350.56 ×214.53 ×2.68	mm
Number of dots	1920(RGB) ×1080	pixel
Active area (H×V)	344.16×193.59	mm

4. Outline Dimension

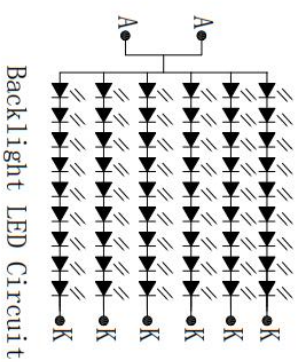
RoHS



PIN ASSIGNMENT

1	NC	6	ML0+	11	H_GND	16	GND	21	BL_GND	26	LED_VCCS
2	H_GND	7	ML0+	12	VCCS	17	HPD	22	LED_EN	27	LED_VCCS
3	ML1+	8	H_GND	13	VCCS	18	BL_GND	23	LED_PWM	28	LED_VCCS
4	ML1+	9	AUX+	14	B1ST	19	BL_GND	24	NC	29	LED_VCCS
5	H_GND	10	AUX-	15	GND	20	BL_GND	25	NC	30	NC

ITEM	SYMBOL	MIN	TYP	MAX	UNIT	T=25°C
Luminous (Without PET)	IV	200	220		cd/m ²	
Chromaticity Coordinates Without PET	X	(0.3190)	(0.3216)			
	Y	(0.3302)	(0.3327)			
Uniformity			80		%	
Backlight voltage	VF	26.1	27	27.9	V	
Backlight current	IF		120		mA	

REV.: 

Backlight LED Circuit

REV 修改	DATE 日期	DESCRIPTION 修改内容	REVISER 修改者

TYPE	模组成品图	MATERIAL		PAGE 页次	1/1	APPROVED 承认	
MODEL NO. 模组号	LS156102-E-V1	EDITION 版本号	01	第三视角		CHECK 核对	
PART NO. 料号		DATE 日期	2023.08.11			DESIGNED 设计者	

5. Absolute Maximum Ratings

Item	Symbol	Value		Unit	Note
		Min.	Max.		
Power Supply Voltage	VCCS	-0.3	+4	V	(1)
Logic Input Voltage	V _{IN}	-0.3	+3.6	V	
Converter Input Voltage	LED_VCCS	-0.3	26	V	(1)
Converter Control Signal Voltage	LED_PWM _i	-0.3	+3.6	V	(1)
Converter Control Signal Voltage	LED_EN	-0.3	+3.6	V	(1)

Note (1) Stresses beyond those listed in above “ELECTRICAL ABSOLUTE RATINGS” may cause permanent damage to the device. Normal operation should be restricted to the conditions described in “ELECTRICAL CHARACTERISTICS”.

6. Electrical Characteristics

Parameter		Symbol	Value			Unit	Note
			Min.	Typ.	Max.		
Power Supply Voltage		VCCS	3.0	3.3	3.6	V	(1)
BIST Control Level		BIST on	2.2	3.3	3.6	V	(1)
		BIST off	0	-	0.5	V	(1)
Ripple Voltage		V _{RP}	-	-	100	mV	(1)
Inrush Current		I _{RUSH}	-	-	1.5	A	(1)(2)
Power Supply Current	Mosaic	-	-	180	228	mA	(3)

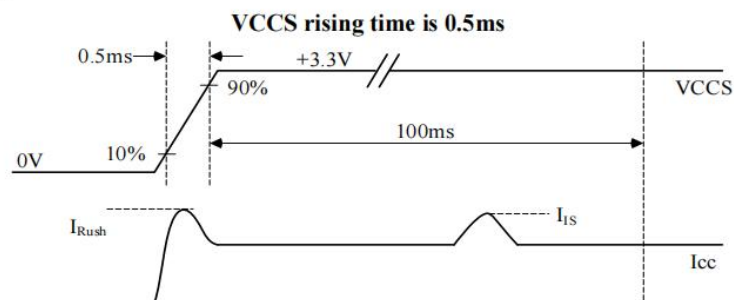
Note (1) The ambient temperature is $T_a = 25 \pm 2^\circ\text{C}$.

Note (2) I_{RUSH}: the maximum current when VCCS is rising

I_{IS}: the maximum current of the first 100ms after power-on

Measurement Conditions: Shown as the following figure.

Test pattern: Mosaic



LED CONVERTER SPECIFICATION

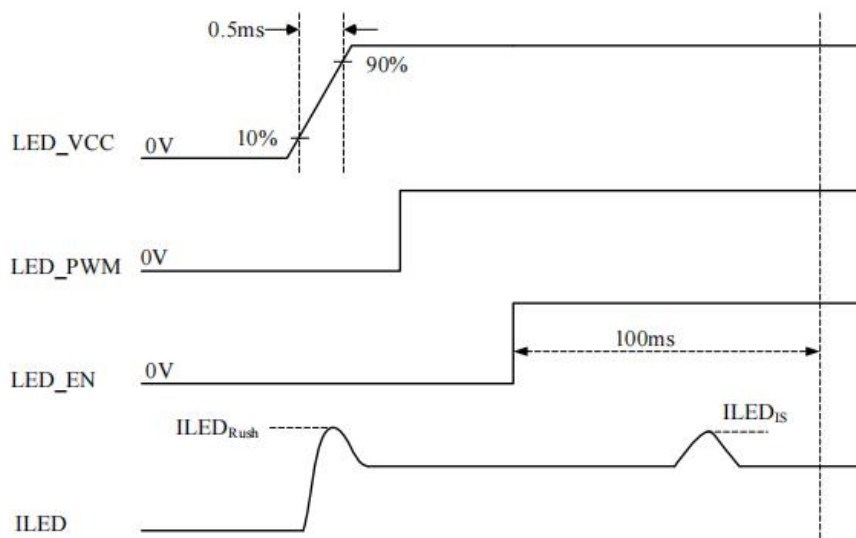
Parameter		Symbol	Value			Unit	Note
			Min.	Typ.	Max.		
Converter Input power supply voltage		LED_Vccs	5.0	12.0	21.0	V	
Converter Inrush Current		I _{LED_RUSH}	-	-	1.5	A	(1)
EN Control Level	Backlight On		1.5	-	3.6	V	
	Backlight Off		0	-	0.5	V	
PWM Control Level	PWM High Level		1.5	-	3.6	V	
	PWM Low Level		0	-	0.5	V	
PWM Control Duty Ratio			1	-	100	%	
PWM Control Permissive Ripple Voltage		V _{PWM_pp}	-	-	100	mV	
PWM Control Frequency		f _{PWM}	200	-	2000	Hz	
LED Power consumption		P _L	-	-	3.85	W	(2)
LED Power Current	LED_VCCS = Typ.	I _{LED}	-	-	275	mA	(3)

Note (1) I_{LED_RUSH}: the maximum current when LED_VCCS is rising,

I_{LED_IS}: the maximum current of the first 100ms after power-on,

Measurement Conditions: Shown as the following figure. LED_VCCS = Typ, Ta = 25 ± 2 °C, f_{PWM} = 200 Hz, Duty=100%.

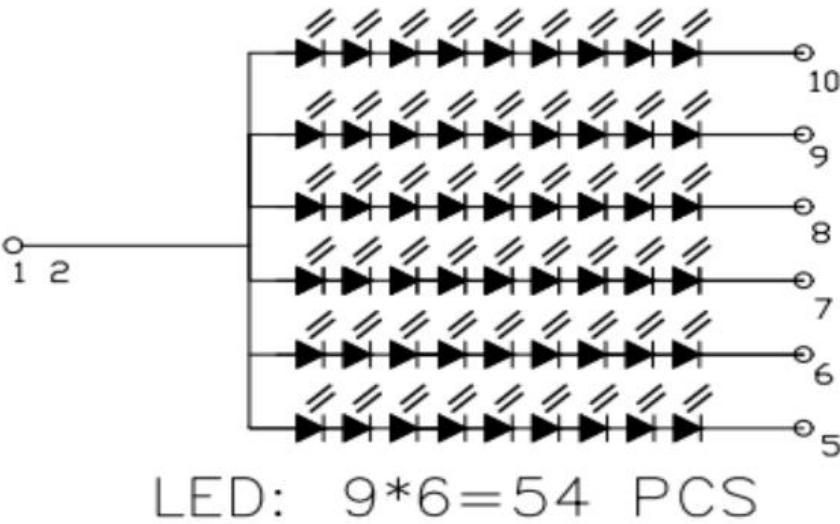
VLED rising time is 0.5ms



Note (2) $P_L = I_L \times V_L$ (With LED converter transfer efficiency);

Note (3) The specified LED power supply current is under the conditions at “LED_VCCS = Typ.”, $T_a = 25 \pm 2^\circ\text{C}$, fPWM = 200 Hz, Duty=100%.

4.4.1 RECOMMENDED BACKLIGHT UNIT



$T_a = 25 \pm 2^\circ\text{C}$

Parameter	Symbol	Value			Unit	Note
		Min.	Typ.	Max.		
LED Light Bar Power Supply Voltage	VL	-	27		V	(1)(2)(3) (Duty100%)
LED Light Bar Power Supply Current	IL	-	120	-	mA	
LED Luminance	Y_{LI}				nit	

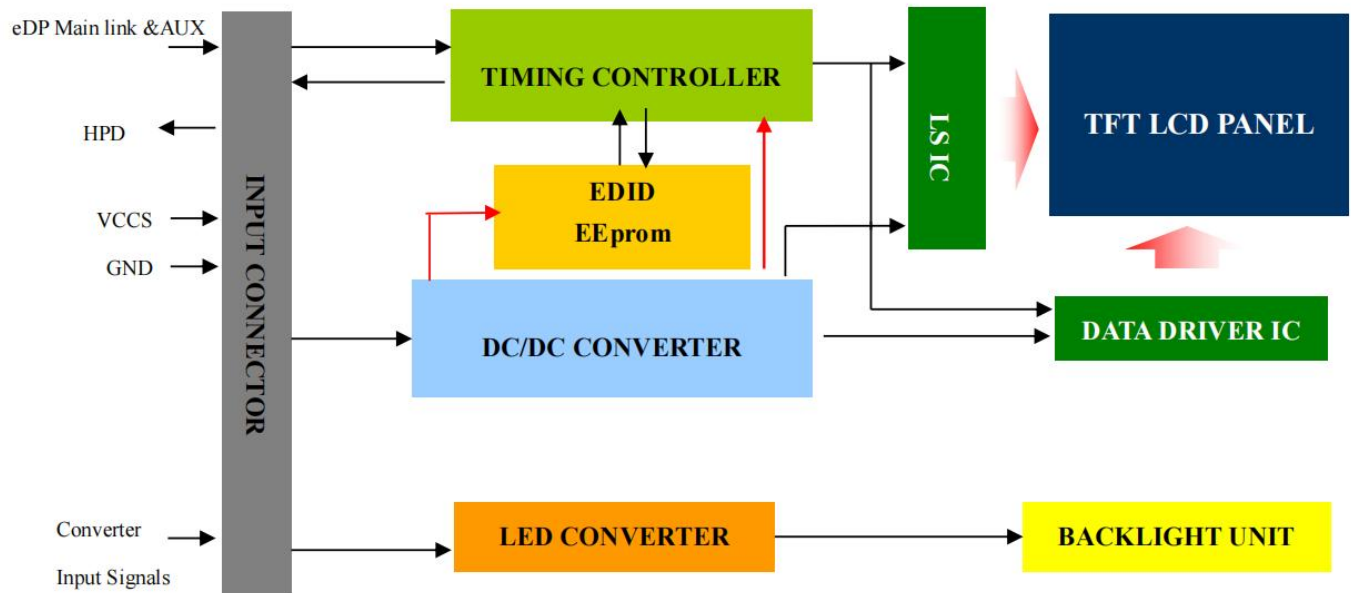
Note (1) LED current is measured by utilizing a high frequency current meter :

Note (2) For better LED light bar driving quality, it is recommended to utilize the adaptive boost converter with current balancing function to drive LED light-bar.

Note(3):Recommended B/L :6S9P

7. Module Function Description

7- 1. Block Diagram Of LCM



7-2. Pin Description

Pin	Symbol	Description	Note
1	NC	No Connection , Please let it open	(2)
2	H_GND	High Speed Ground	
3	ML1-	Complement Signal-Lane 1	
4	ML1+	True Signal-Main Lane 1	
5	H_GND	High Speed Ground	
6	ML0-	Complement Signal-Lane 0	
7	ML0+	True Signal-Main Lane 0	
8	H_GND	High Speed Ground	
9	AUX+	True Signal-Auxiliary Channel	
10	AUX-	Complement Signal-Auxiliary Channel	
11	H_GND	High Speed Ground	
12	VCCS	Power Supply +3.3V (typical)	
13	VCCS	Power Supply +3.3V (typical)	
14	BIST	Built-In Self Test (active high)	
15	GND	Ground	
16	GND	Ground	
17	HPD	Hot Plug Detect	
18	BL_GND	BL Ground	
19	BL_GND	BL Ground	
20	BL_GND	BL Ground	
21	BL_GND	BL Ground	
22	LED_EN	BL_Enable Signal of LED Converter	
23	LED_PWM	PWM Dimming Control Signal of LED Converter	
24	NC	No Connection , Please let it open	(2)
25	NC	No Connection , Please let it open	(2)
26	LED_VCCS	LED Power Supply	
27	LED_VCCS	LED Power Supply	
28	LED_VCCS	LED Power Supply	
29	LED_VCCS	LED Power Supply	
30	NC	No Connection (Reserve)	

Note (1) The pixel is shown in the following figure.

Note(2) This pin used for CSOT internally, please let it floating on customer side.

7-3 INPUT SIGNAL TIMING SPECIFICATIONS

eDP AUX Channel Characteristics

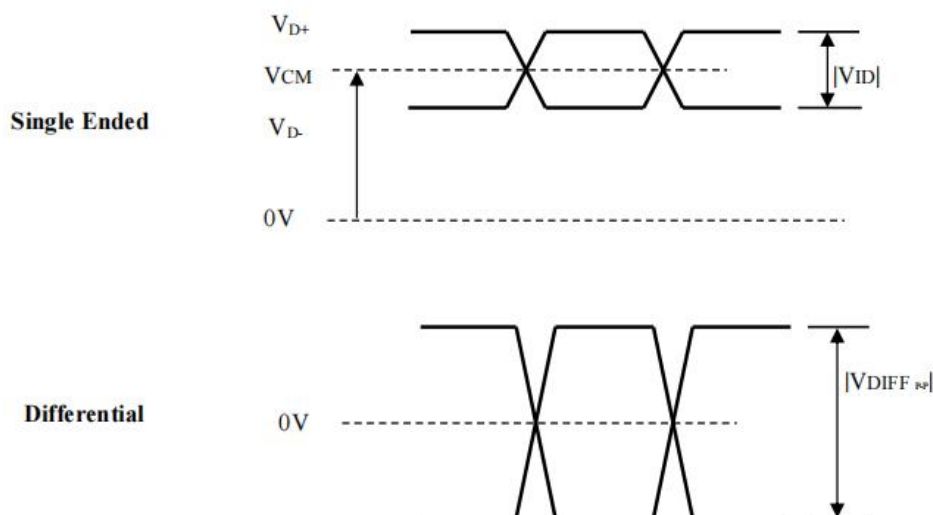
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Unit Interval for AUX channel	UI_{AUX}	0.4	-	0.6	μs	
Peak-to-peak voltage at TP1	$V_{AUX-DIFF-pp}$	0.39	-	1.38	V	
AUX DC Common mode Voltage	$V_{AUX-DC-CM}$	0	-	2	V	
AUX Short current limit	I_{AUX_SHORT}	-	-	90	mA	
AUX CH termination DC resistor	R_{AUX_TERM}	80	100	120	Ω	Differential input
AUX AC coupling capacitor	C_{AUX}	75	-	200	nF	
Number of pre-charge pulses	Pre-charge pulses	10	-	16		

4.5.2 eDP Main Link Receiver Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Link clock down spreading	Down_Spread_Amplitude	0		0.5	%	
Differential Peak-to-peak Input Voltage at Rx package pins	$V_{RX-DIFF-pp}$	120	-	1200	mV	
Differential termination resistance	$R_{RX-TERM}$	90	100	110	Ω	
RX short circuit Current Limit	$I_{RX-SHORT}$	-	-	50	mA	
Lane Intra-pair Skew at RX package pins	$T_{RX-SKEW-INTRA-PAIR-High-Bit-Rate}$	-	-	50	ps	

4.5.3 eDP AUX Channel Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Hot plug Detect	V_{HPD}	2.25	-	3.6	V	



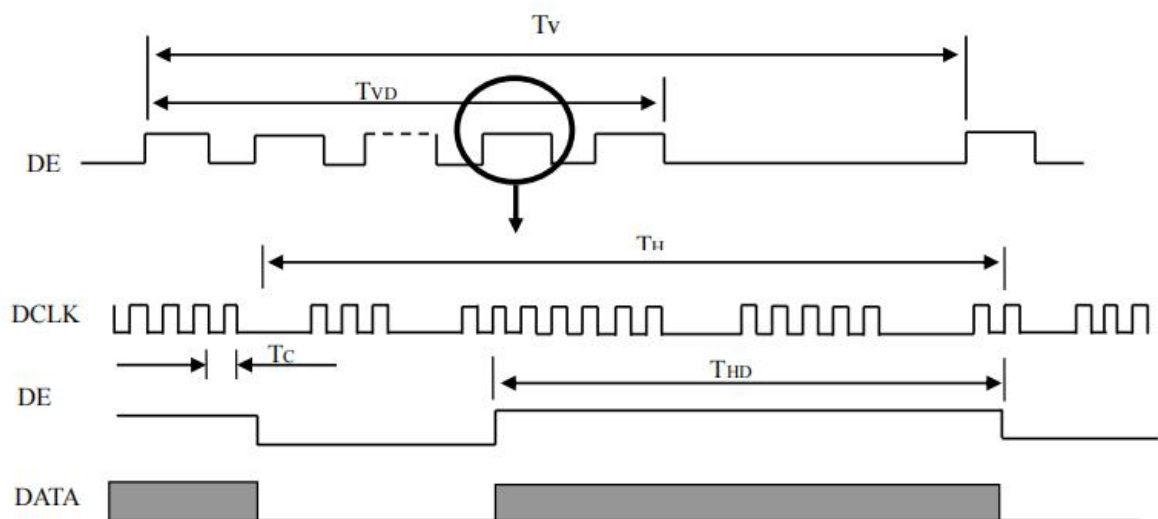
4.6 DISPLAY TIMING SPECIFICATIONS

The input signal timing specification is showed as the following table and timing diagram.

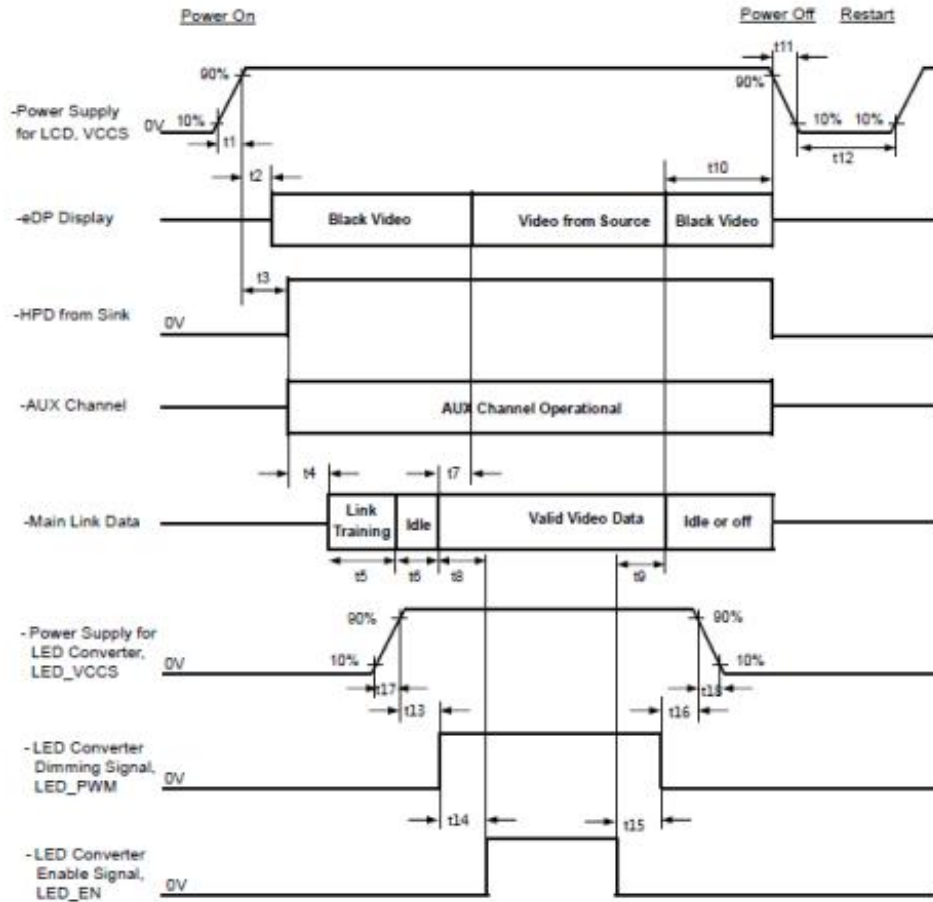
Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
DCLK	Frequency	1/Tc	-	147.84	-	MHz	-
DE	Vertical Total Time	TV	-	1120	-	TH	-
	Vertical Active Display Period	TVD	1080	1080	1080	TH	-
	Vertical Active Blanking Period	TVB	-	40	-	TH	-
	Horizontal Total Time	TH	-	2200	-	Tc	-
	Horizontal Active Display Period	THD	1920	1920	1920	Tc	-
	Horizontal Active Blanking Period	THB	-	280	-	Tc	-

Note (1) Display timing signal should be contained and transferred by Display Port Main Link stream data packing described in VESA Display Port Standard V1.4b.

INPUT SIGNAL TIMING DIAGRAM



4.7 POWER ON/OFF SEQUENCE



Symbol	Description	Min	Typ.	Max	Unit	Note
t1	Power rail rise time, 10% to 90%	0.5		10	ms	
t2	Delay from LCD,VCCS to eDP Display	0		200	ms	
t3	Delay from LCD,VCCS to HPD high	0		200	ms	
t4	Delay from Sink AUX to link training initialization	-		-	ms	(5)
t5	Link training duration	-		-	ms	(5)
t6	Link idle	-		-	ms	(5)
t7	Delay from valid video data from Source to video on display	0		50	ms	
t8	Delay from valid video data from Source to backlight on	50		-	ms	(5)
t9	Delay from backlight off to end of valid video data	0		-	ms	
t10	Delay from end of valid video data from Source to power off	0		500	ms	

t11	VCCS power rail fall time, 90% to 10%	0.5		10	ms	(1)
t12	VCCS Power off time	500		-	ms	
t13	Delay from VCC to PWM	0		-	ms	
t14	Delay from PWM to LED ENABLE	0		-	ms	
t15	Delay from LED ENABLE to PWM Disable	0		-	ms	
t16	Delay from PWM Disable to VBL 90%	0		-	ms	
t17	Delay from VBL 10% to VBL 90%	0.5		-	ms	
t18	VBL power rail fall time, 90% to 10%	0.5		-	ms	

Note (1) Please follow the power on/off sequence described above. Otherwise, the LCD module might abnormal display or be damaged.

Note (2) Please avoid floating state of interface signal at invalid period. When the interface signal is invalid, be sure to pull down the power supply of LCD VCCS to 0 V.

Note (3) The backlight must be turned on after the power supply for the logic and the interface signal is valid.
The backlight must be turned off before the power supply for the logic and the interface signal is invalid.

Note (4) Please follow the LED backlight power sequence as above. If the customer could not follow, it might cause backlight flash issue during display ON/OFF or damage the LED backlight controller

Note (5) $T4+T5+T6+T8 > 80\text{ms}$

8. Electro-Optical Characteristics

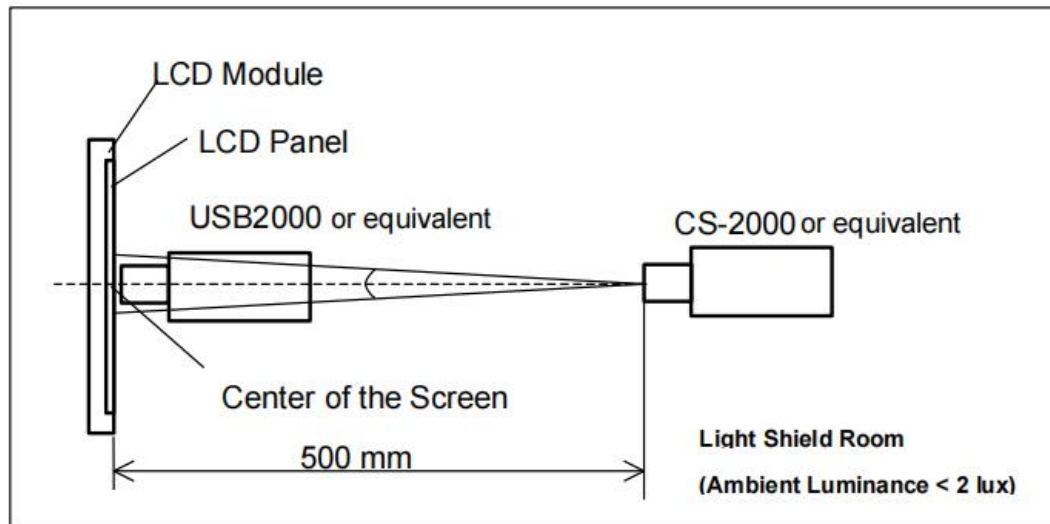
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Response time		Tr +Tf	$\theta_x = \theta_y = 0$	---	20	25	ms	Note 1
Contrast Ratio		CR		1000	1200	---	---	Note 2
Color Chromaticity (CIE1931)	White	W x	$\theta_x = \theta_y = 0$	---	0.304	---	---	
		W y		---	0.33	---	---	
Viewing angle	θ_T		CR > 10	85	89	---	Deg.	Note 3
	θ_B			85	89	---		
	θ_L			85	89	---		
	θ_R			85	89	---		
Luminance ($I_F = 16mA$)		L		255	300	---	cd/m2	Note4

※The measurement shall be taken 5 minutes after lighting the LCM at the following rating.

※The optical characteristics shall be measured in a dark room or equivalent, and CR need to do Auto Vcom.

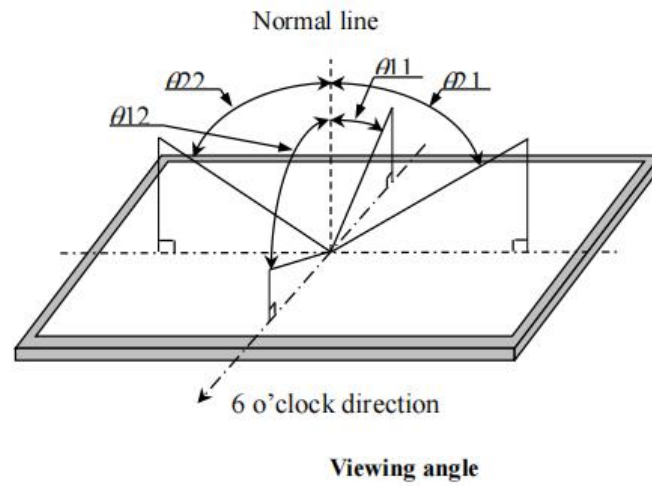
Note (1) Measurement of viewing angle range

Note (2) Measurement of luminance and Chromaticity and Contrast.



Measurement of Contrast, Luminance, Chromaticity, White variation, Crosstalk and Color temperature variation

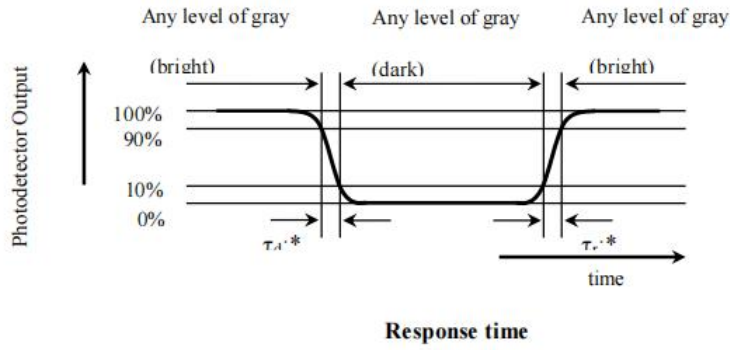
Note (3) Definitions of viewing angle range:



Note (4) Definition of contrast ratio:

The contrast ratio is defined as the following.

$$\text{Contrast Ratio} = \frac{\text{Luminance(Brightness) with all pixels white}}{\text{Luminance(Brightness) with all pixels Black}}$$



Note (5) Definition of response time:

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white" .

Note (6) This shall be measured at center of the screen.

Note (7) The Luminance of White is the average of 5 points measurements (4,5,7,9,10) showing in the Fig.9-5.

Note (8) Definition of white uniformity:

White uniformity of 5 points is defined as the
following with 5 measurements(4,5,7,9,10).

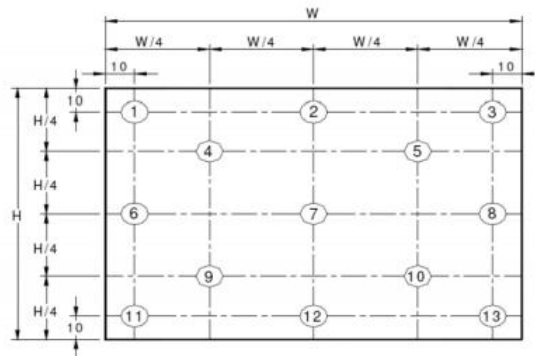


Fig.9-5

$$\delta_{W1} = \frac{\text{Maximum Luminance of 5 Points(Brightness)}}{\text{Minimum Luminance of 5 Points(Brightness)}}$$

White uniformity of 13 points is defined as the following with 13 measurements(1~13).

$$\delta_{W2} = \frac{\text{Maximum Luminance of 13 Points(Brightness)}}{\text{Minimum Luminance of 13 Points(Brightness)}}$$

9.Records Of Version

Version	Revise Date	Page	Content
00		ALL	New released