PRODUCT SPECIFICATION FOR LCD MODULE

Revision: 1.0

Model No: LS1600I01-E-V1

Module Type: COG+FPC+B/L

APPROVED SIGNATURE

■ Approved Product Specification only

□ Approved Product Specification and Samples

Prepared By	Checked By	Approved By

Contents

目录

1. General Description

1.1 Introduction

LS1600I01-E-V1 is a color active matrix TFT LCD module using amorphous silicon TFT's(Thin Film Transistors) as an active switching devices. This module has a 16 inch diagonally measured active area with FHD resolutions (1920 horizontal by 1080vertical pixel array). Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical Stripe and this module can display 16.7M colors. The TFT-LCD panel used for this module is a low reflection and higher color type. Therefore, this module is suitable for Notebook PC. The LED Driver for back-light driving is built in this model. All input signals are eDP1.2 interface compatible.

1.2 Features

- 2 lane eDP1.2 Interface with 2.7Gbps Link Rates
- Thin and light weight
- 6-bit+FRC color depth, display 16.7M colors
- Single LED Lighting Bar. (Down side/Horizontal Direction)
- Green Product (RoHS & Halogen free product)
- On board LED Driving circuit
- Low driving voltage and low power consumption
- On board EDID chip

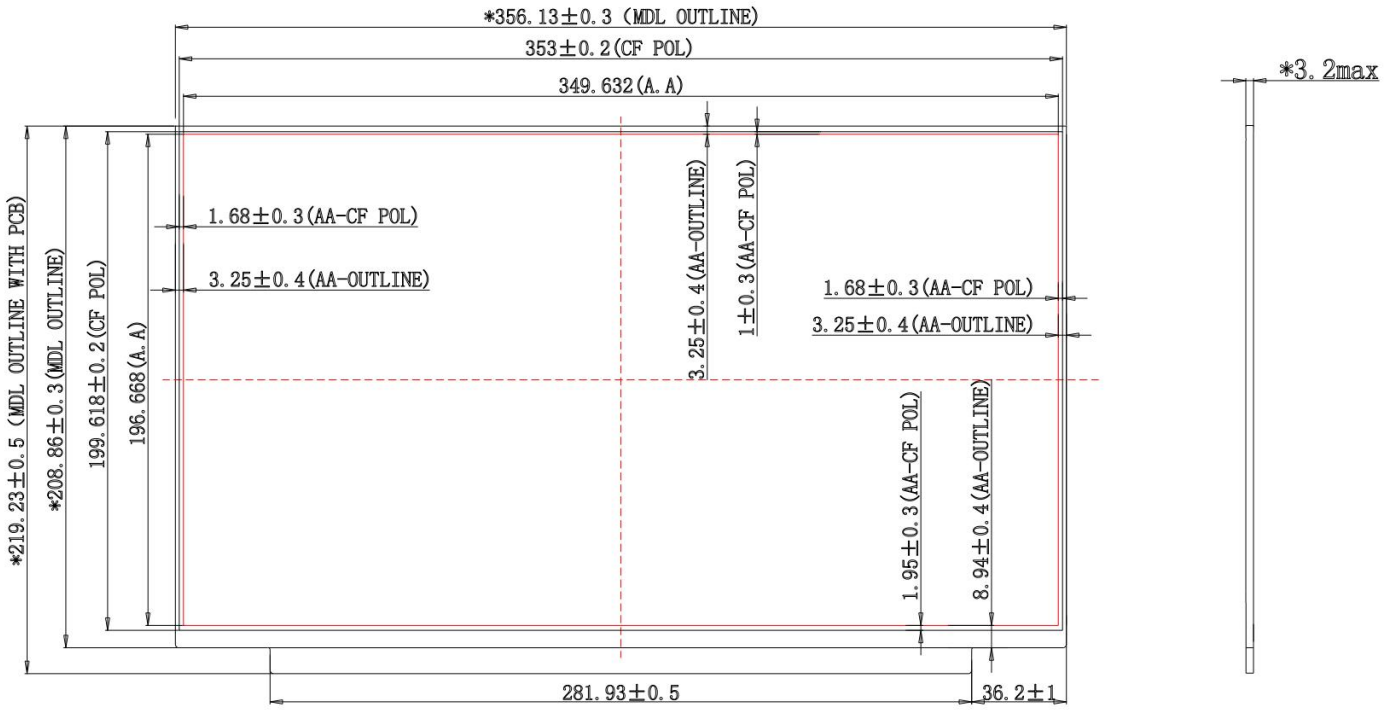
2. Physical Features

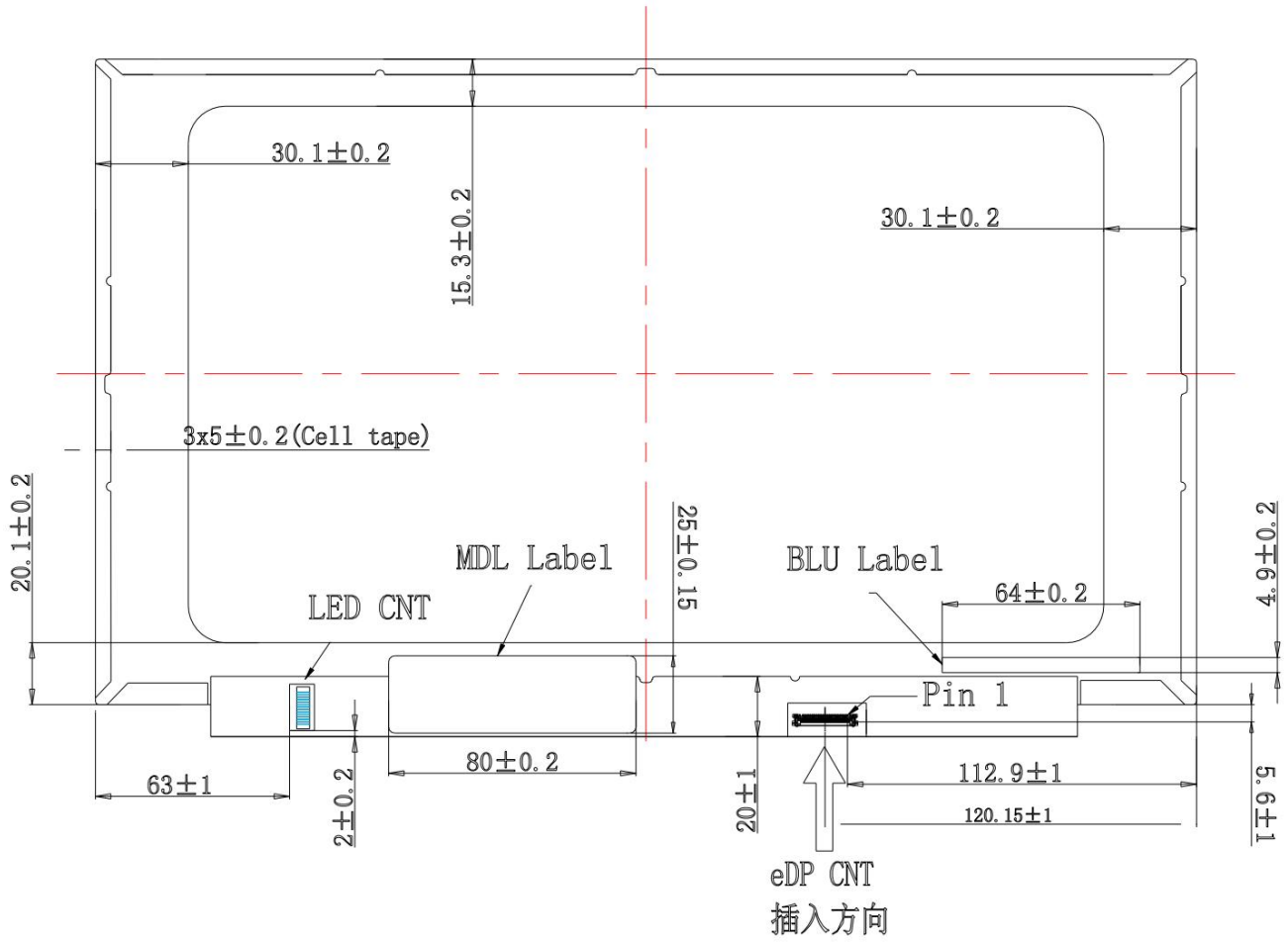
Display Mode	TFT-LCD Module
	Active matrix TFT, Transmissive type
Display Format	Graphic 1920(RGB)×1080 Dot-matrix
Input Data	EDP
Viewing Direction （Grayscale Inversion）	Free（IPS）

3. Mechanical Specification

Item	Specification	Unit
Module size (H×V×D)	356.13 ×219.23 ×3.2	mm
Number of dots	1920(RGB) ×1080	pixel
Active area (H×V)	349.632×196.668	mm

4. Outline Dimension

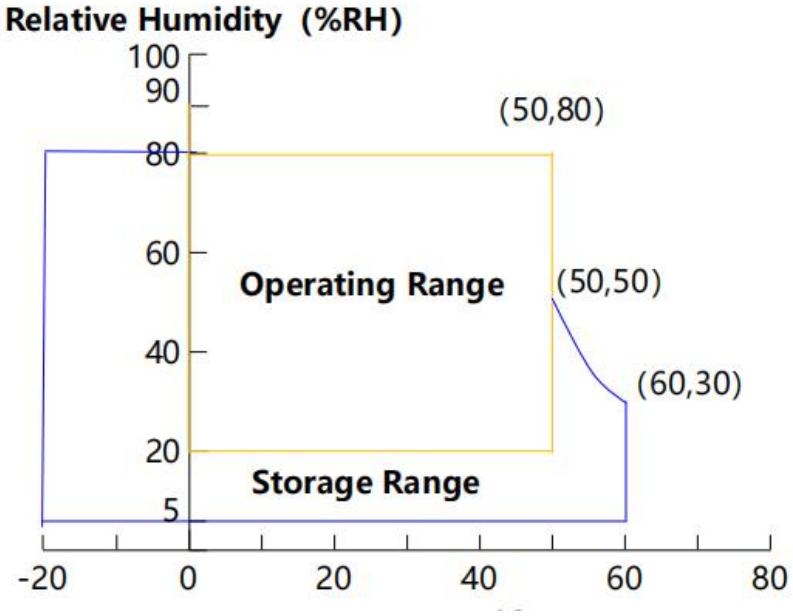




5. Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	-0.3	4.0	V	Note 1
Logic Supply Voltage	V_{IN}	V_{ss}-0.3	V_{DD}+0.3	V	
Operating Temperature	T_{OP}	0	+50	℃	Note 2
Storage Temperature	T_{ST}	-20	+60	℃	

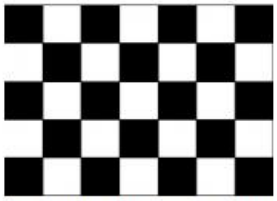
Note 1 : Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39 ℃ max. and no condensation of water.

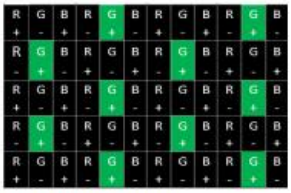


6. Electrical Characteristics

Parameter		Min.	Typ.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	3.0	3.3	3.6	V	Note 1
Permissible Input Ripple Voltage	V_{RF}	-	-	100	mV	At V_{DD} = 3.3V
Power Supply Current	I_{DD}	-	384	1000	mA	Note 1
Rush Current	IRUSH	-	2	3	A	Note 2
Differential Input Voltage	V_{ID}	200	-	600	mV	
Power Consumption	P_D	-	0.9	3	W	Note 1
	P_{BL}	-	2.92	3.56	W	Note 3
	P_{total}	-	3.82	6.56	W	

Notes : 1. The supply voltage is measured and specified at the interface connector of LCM.
The current draw and power consumption specified is for 3.3V at 25°C.
a) Typ : Mosaic 7X5 (L0/L255) b) Max : Vline Subline (L255)) c) Flicker Pattern





2 : The duration of rush current is about 2ms and rising time of Power Input is 1ms(min)
3. Calculated value for reference (V_{LED} × I_{LED})

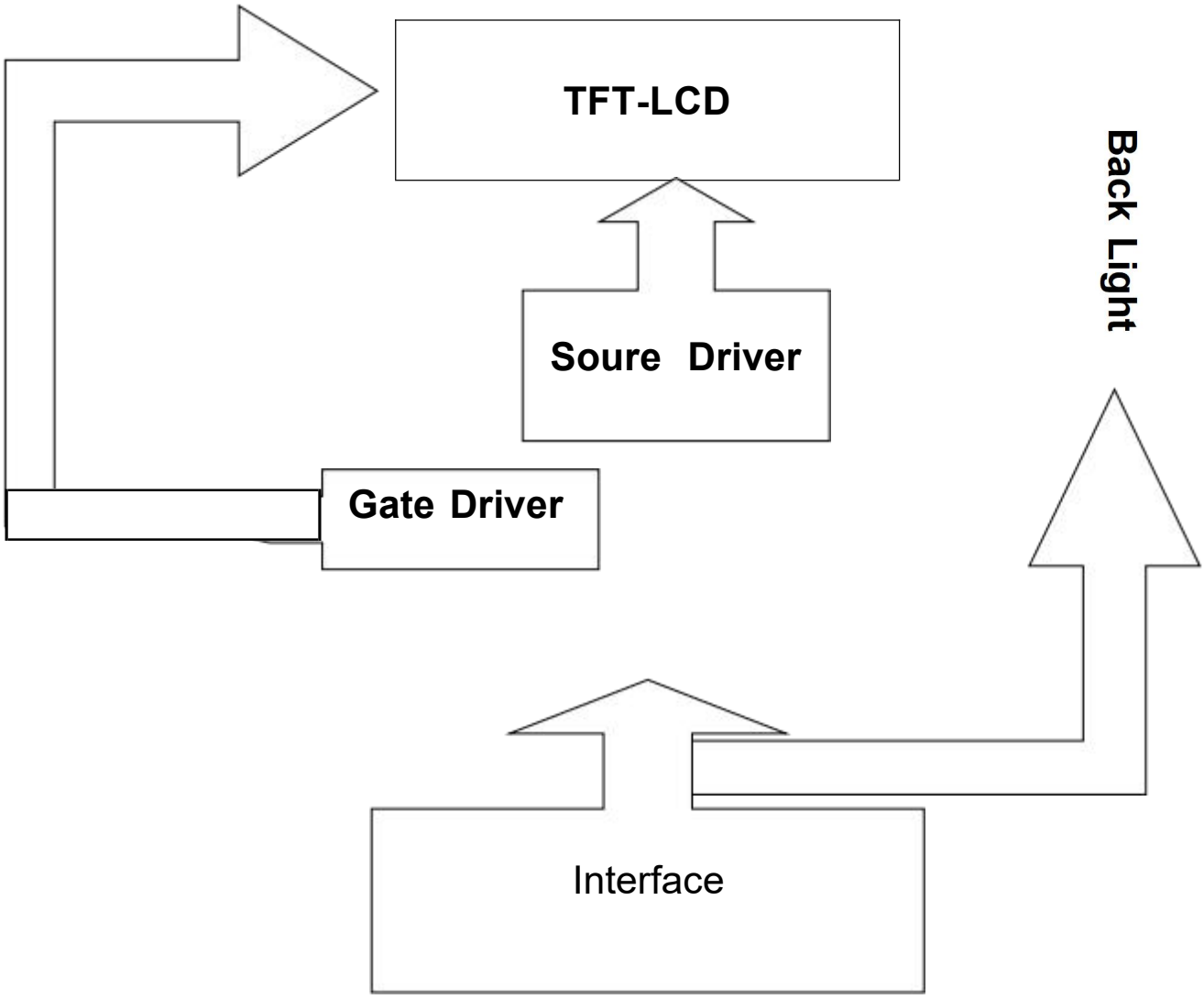
7.Backlight Unit

Parameter			Min.	Typ.	Max.	Unit	Remarks
LED Forward Voltage		V_F	-	2.8	2.9	V	-
LED Forward Current		I_F	-	21	-	mA	-
LED Power Consumption		P_{LED}		2.92	-	W	Note 1
LED Life-Time		N/A	15000	-	-	Hour	IF＝21mA
Power supply voltage for LED Driver		V_{LED}	5	12	21	V	
EN Control Level	Backlight on		2.2		5.0	V	
	Backlight off		0		0.6	V	
PWM Control Level	PWM High Level		2.2		5.0	V	
	PWM Low Level		0		0.6	V	
PWM Control Frequency		F_{PWM}	100	-	10,000	Hz	
Duty Ratio		-	1	-	100	%	Note3

Notes : 1. LED Power Calculator Value for reference IF × VF ×48ea= PLED
2. The LED Life-time define as the estimated time to 50% degradation of initial luminous.

8. Module Function Description

8-1. Block Diagram Of LCM



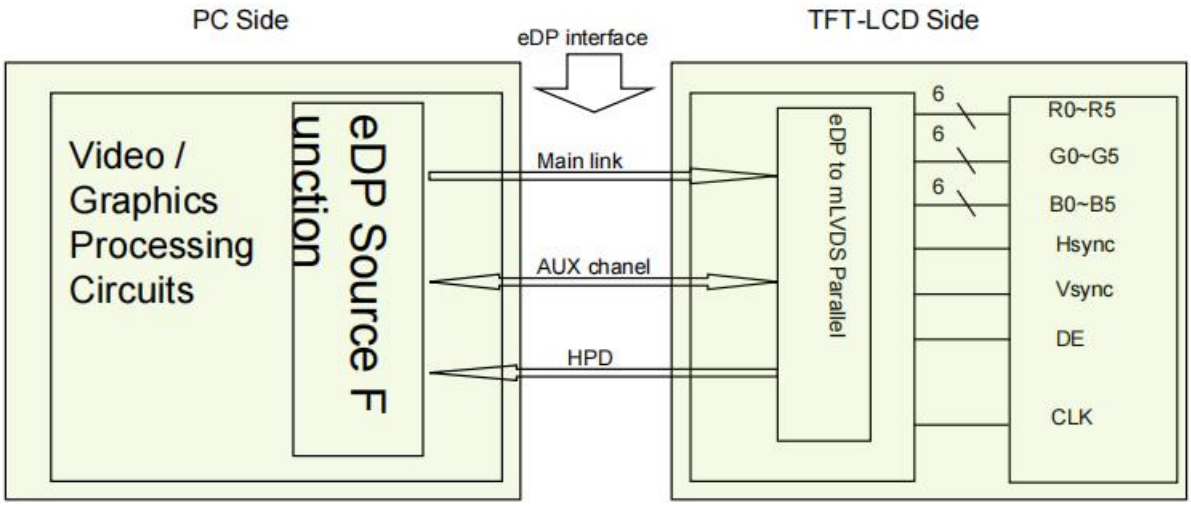
8-2. Pin Description

The electronics interface connector is STM MSAK24025P30.
The connector interface pin assignments are listed in Table 5.

<Table 5. Pin Assignments for the Interface Connector>

Terminal	Symbol	Functions
Pin No.	Symbol	Description
1	NC	NO CONNECTION
2	H_GND	Ground
3	LANE1_N	eDP RX channel 1 negative
4	LANE1_P	eDP RX channel 1 positive
5	H_GND	Ground
6	LANE0_N	eDP RX channel 0 negative
7	LANE0_P	eDP RX channel 0 positive
8	H_GND	Ground
9	AUX_CH_P	eDP AUX CH positive
10	AUX_CH_N	eDP AUX CH negative
11	H_GND	Ground
12	LCD_VCC	Power Supply, 3.3V (typ.)
13	LCD_VCC	Power Supply, 3.3V (typ.)
14	LCD_Self_Test	Panel self test enable
15	H_GND	Ground
16	H_GND	Ground
17	HPD	Hot plug detect output
18	BL_GND	LED Ground
19	BL_GND	LED Ground
20	BL_GND	LED Ground
21	BL_GND	LED Ground
22	BL_ENABLE	LED enable pin(+3.3V Input)
23	BL_PWM	System PWM Signal Input
24	NC	NO CONNECTION
25	NC	NO CONNECTION
26	BL_POWER	LED Power Supply 5V-21V
27	BL_POWER	LED Power Supply 5V-21V
28	BL_POWER	LED Power Supply 5V-21V
29	BL_POWER	LED Power Supply 5V-21V
30	NC	NO CONNECTION

eDP Interface



Note. Transmitter : Parade DP501 or equivalent.
Transmitter is not contained in Module.

eDP Input signal

<Table 6. eDP

Lane 0	Lane 1
R0-5:0|G0-5:4	R1-5:0|G1-5:4
G0-3:0|B0-5:2	G1-3:0|B1-5:2
B0-1:0|R2-5:0	B1-1:0|R3-5:0
G2-5:0|B2-5:4	G3-5:0|B3-5:4
B2-3:0|R4-5:2	B3-3:0|R5-5:2
R4-1:0|G4-5:0	R5-1:0|G5-5:0
B4-5:0|R6-5:4	B5-5:0|R7-5:4
R6-3:0|G6-5:2	R7-3:0|G7-5:2
G6-1:0|B6-5:0	G7-1:0|B7-5:0

Back-light & LCM Interface Connection

Interface Connector: **STM MSK24022P10 or DEREN BOE-120521-01**

<Table 7. Pin Assignments for the BLU & LCM Connector>

Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	Vout	LED anode connection	6	NC	No Connection
2	Vout	LED anode connection	7	LED1	LED cathode connection
3	Vout	LED anode connection	8	LED2	LED cathode connection
4	NC	NC	9	LED3	LED cathode connection
5	GND	GROUND	10	LED4	LED cathode connection

8-3 Timing Characteristics

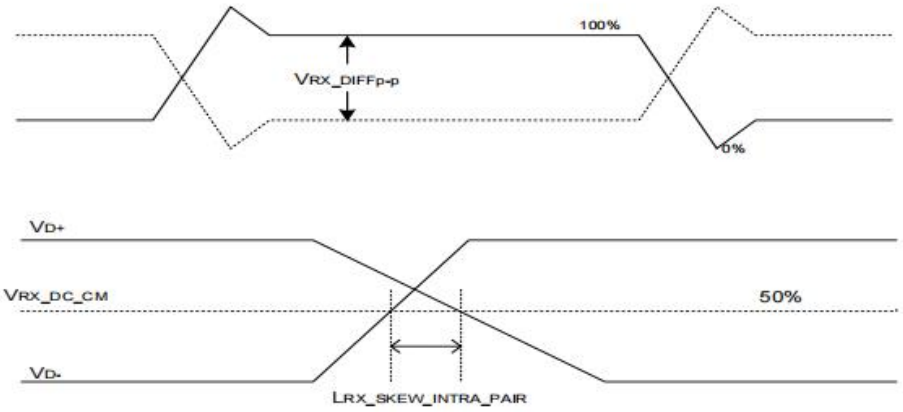
Item		Symbols	Min	Typ	Max	Unit
Clock	Frequency	1/Tc	101	149.6	155	MHz
Frame Period		Tv	1090	1140	1200	lines
			-	60	-	Hz
			-	16.7	-	ms
Vertical Display Period		Tvd	-	1080	-	lines
One line Scanning Period		Th	2080	2187	2300	clocks
Horizontal Display Period		Thd	-	1920	-	clocks

eDP Rx Interface Timing Parameter

The specification of the eDP Rx interface timing parameter is shown in Table 9.

<Table 9. eDP Rx Interface Timing Specification>

Item	Symbol	Min	Typ	Max	Unit	Remark
Spread spectrum clock	ssc	0		0.5	%	
Differential peak-to-peak input voltage at package pins	VRX-DIF Fp-p	120	0	1200	mV	
Rx input DC common mode voltage	VRX_DC _CM	0	-	2	V	
Differential termination resistance	RRX-DIF F	80	-	100	Ω	
Single-ended termination resistance	RRX-SE	40	-	60	Ω	
Rx short circuit current limit	IRX_SHO RT	-	-	20	mA	
Intra-pair skew at Rx package pins (HBR) RX intra-pair skew tolerance at HBR	LRX_SKE W_ INTRA_P AIR	-	-	60	ps	



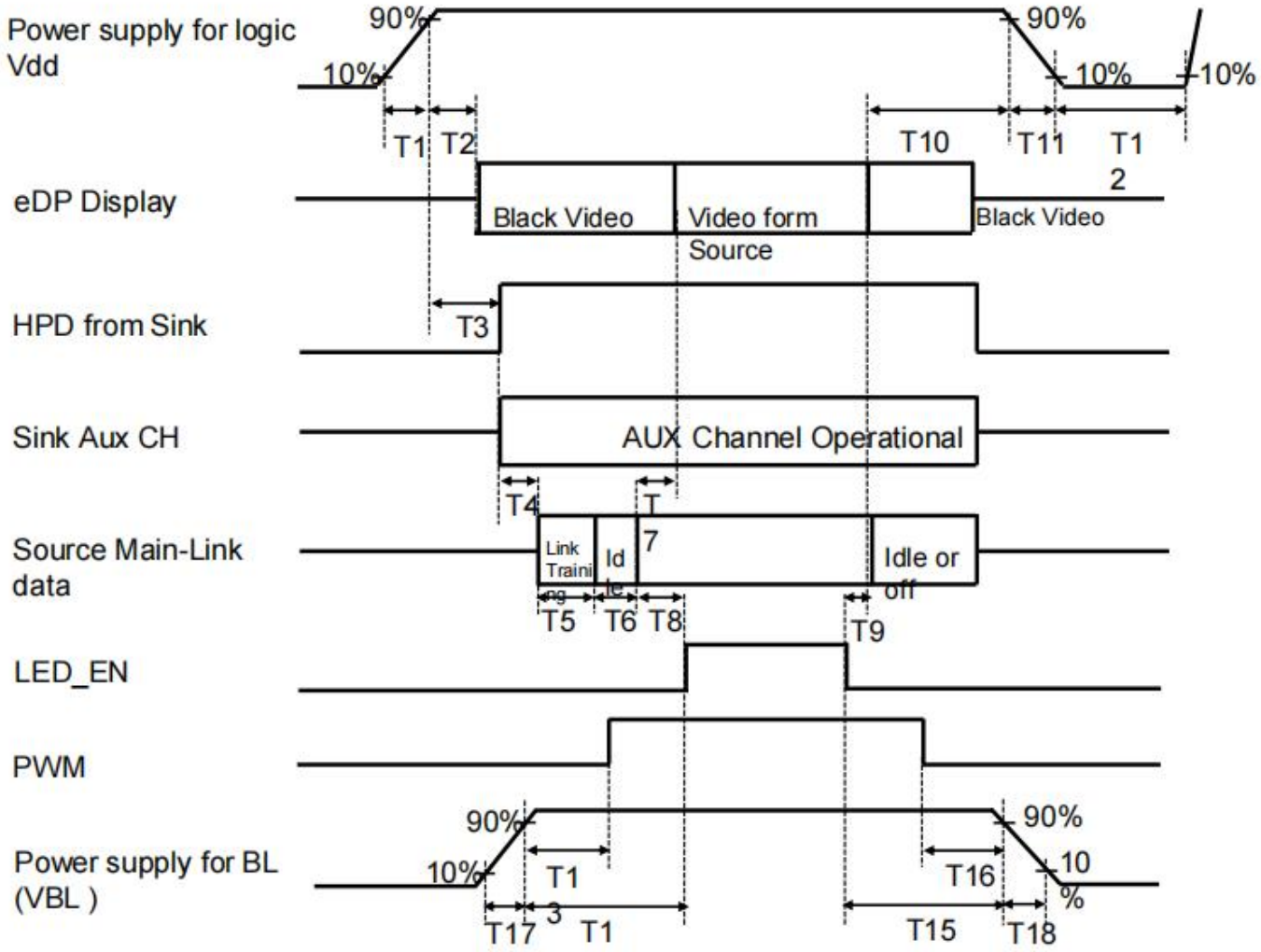
Input Signals , Basic Display Colors & Gray Scale Of Colors

<Table 10. Data Signal Table>

	Colors & Gray scale	Data signal																	
		R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	B4	B5
Basic colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Light Blue	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Purple	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
Gray scale of Red	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△ ▽			↑ ↓						↑ ↓						↑ ↓			
	Brighter	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	▽	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Gray scale of Green	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	1	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
	△ ▽			↑ ↓						↑ ↓						↑ ↓			
	Brighter	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0
	▽	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Gray scale of Blue	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	0	0	0	0	0	0	1	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	△ ▽			↑ ↓						↓ ↓						↑ ↓			
	Brighter	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
	▽	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
Gray scale of White & Black	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
	Darker	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0
	△ ▽			↑ ↓						↑ ↓						↑ ↓			
	Brighter	1	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1
	▽	0	1	1	1	1	1	0	1	1	1	1	1	0	1	1	1	1	1
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

POWER SEQUENCE

To prevent a latch-up or DC operation of the LCD module, the power on/off sequence shall be as shown in below



- 0.5ms ≤ T1 ≤ 10 ms
- 0ms ≤ T2 ≤ 200 ms
- 0ms ≤ T3 ≤ 200 ms
- 0ms ≤ T13
- 0ms ≤ T14
- 0ms ≤ T17
- T3+T4+T5+T6+T8>T2(max)=200ms

- 0ms ≤ T7 ≤ 50ms
- 0ms ≤ T9
- 0ms ≤ T10 ≤ 500 ms
- 0 ms ≤ T11 ≤ 10 ms
- 150ms ≤ T12
- 0ms ≤ T15
- 0ms ≤ T16
- 0ms ≤ T18

Notes:

1. When the power supply VDD is 0V, keep the level of input signals on the low or keep high impedance.
2. Do not keep the interface signal high impedance when power is on.
   Back Light must be turn on after power for logic and interface signal are valid.

9. Electro-Optical Characteristics

The test of optical specifications shall be measured in a dark room (ambient luminance 1 lux and temperature=25 2℃) with the equipment of Luminance meter system (Goniometer system and PR730) and test unit shall be located at an approximate distance 180cm from the LCD surface at a viewing angle of θ and Φ equal to 0 . We refer to $\theta_{Ø=0}$ (=θ_3) as the 3 o'clock direction (the "right"), $\theta_{Ø=90}$ (= θ_{12}) as the 12 o'clock direction ("upward"), $\theta_{Ø=180}$ (= θ_9) as the 9 o'clock direction ("left") and $\theta_{Ø=270}$(= θ_6) as the 6 o'clock direction ("bottom"). While scanning θ and/or Ø, the center of the measuring spot on the Display surface shall stay fixed. The measurement shall be executed after 30 minutes warm-up period. VDD shall be 12.0V at 25 C. Optimum viewing angle direction is 6 'clock.

< Table 11. Optical Table >

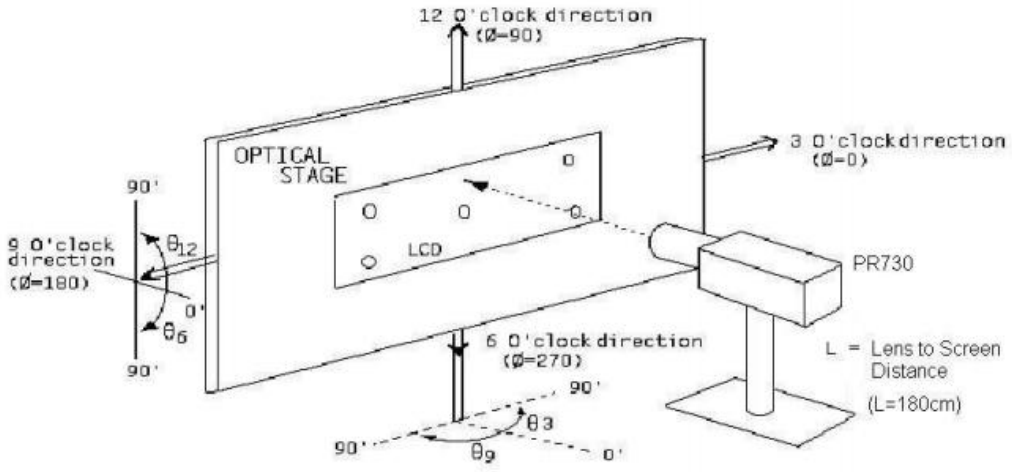
Parameter		Symbol	Condition	Min	Typ	Max	Unit	Remark
Viewing Angle	Horizontal	Θ_3	CR > 10	80	85	-	Deg.	Note 1
		Θ_9		80	85	-	Deg.	
	Vertical	Θ_{12}		80	85	-	Deg.	
		Θ_6		80	85	-	Deg.	
Brightness		Lv	Θ = 0 (Center) Normal Viewing Angle	213	250	-	nit	
Contrast ratio		CR		700:1	1000:1	-		Note 2
White luminance uniformity		ΔY		80	-	-	%	5point
				65	-	-	%	13point
Reproduction of color	White	W_x		TYP. - 0.03	0.313	TYP. + 0.03		Note 4
		W_y			0.329			
	Red	R_x			0.595			
		R_y			0.331			
	Green	G_x			0.339			
		G_y			0.554			
	Blue	B_x			0.158			
		B_y			0.087			
Color Gamut				42	45	-	%	
Response Time	Tr+Tf	T_g		-	30	35	ms	Note 5

Note :

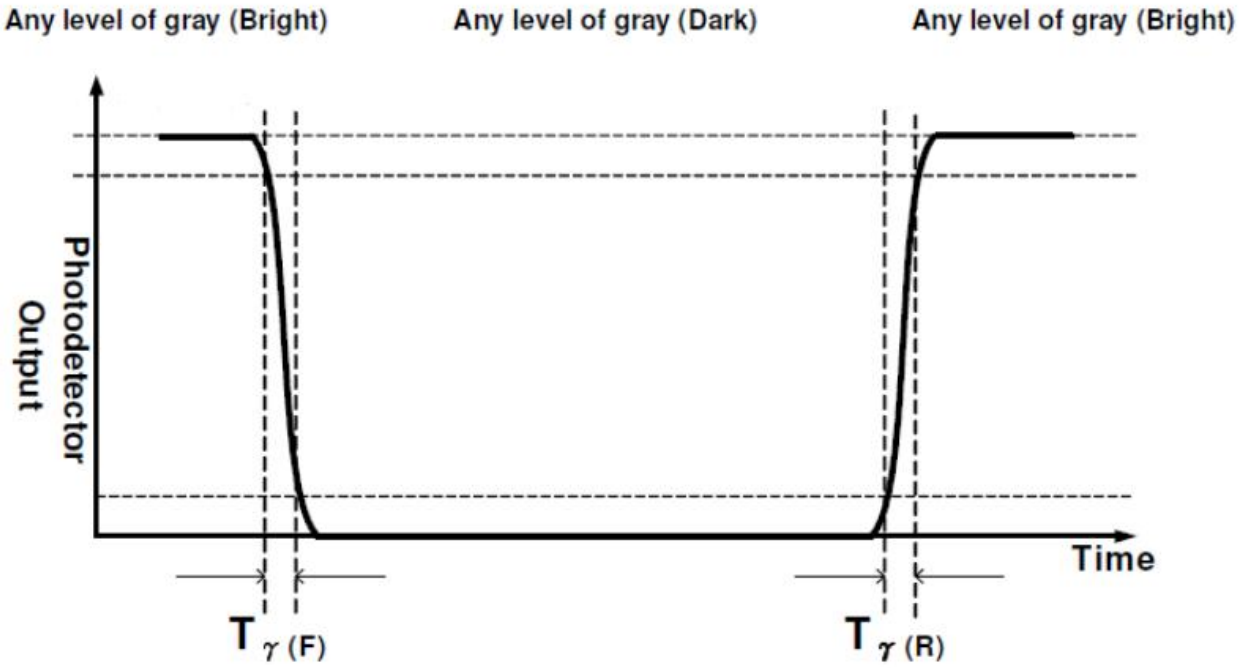
1. Viewing angle is the angle at which the contrast ratio is greater than 10. The viewing are determined for the horizontal or 3, 9 o'clock direction and the vertical or 6, 12 o'clock direction with respect to the optical axis which is normal to the LCD surface.
2. Contrast measurements shall be made at viewing angle of $\theta = 0°$ and at the center of the LCD surface. Luminance shall be measured with all pixels in the view field set first to white, then to the dark (black) state. (See Figure 1 shown in Appendix) Luminance Contrast Ratio (CR) is defined mathematically.

$$CR = \frac{\text{Luminance when displaying a white raster}}{\text{Luminance when displaying a black raster}}$$

< Figure 1. Measurement Set Up >



< Figure 2. Response Time Testing >



10.Records Of Version

Version	Revise Date	Page	Content
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