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■ Preliminary Specifications

☐ Final Specifications

Title	23.8-inch LCM Product Specifications
Model Name	ET238UH02-R
Version	P1

Customer Approved by Date
Notice: This Specification is subject to change without notice.

Approved By	Prepared By
Leo 2024-08-14	Aurice 2024-08-14

REVISION HISTORY

(●) Preliminary specification
( ) Final specification

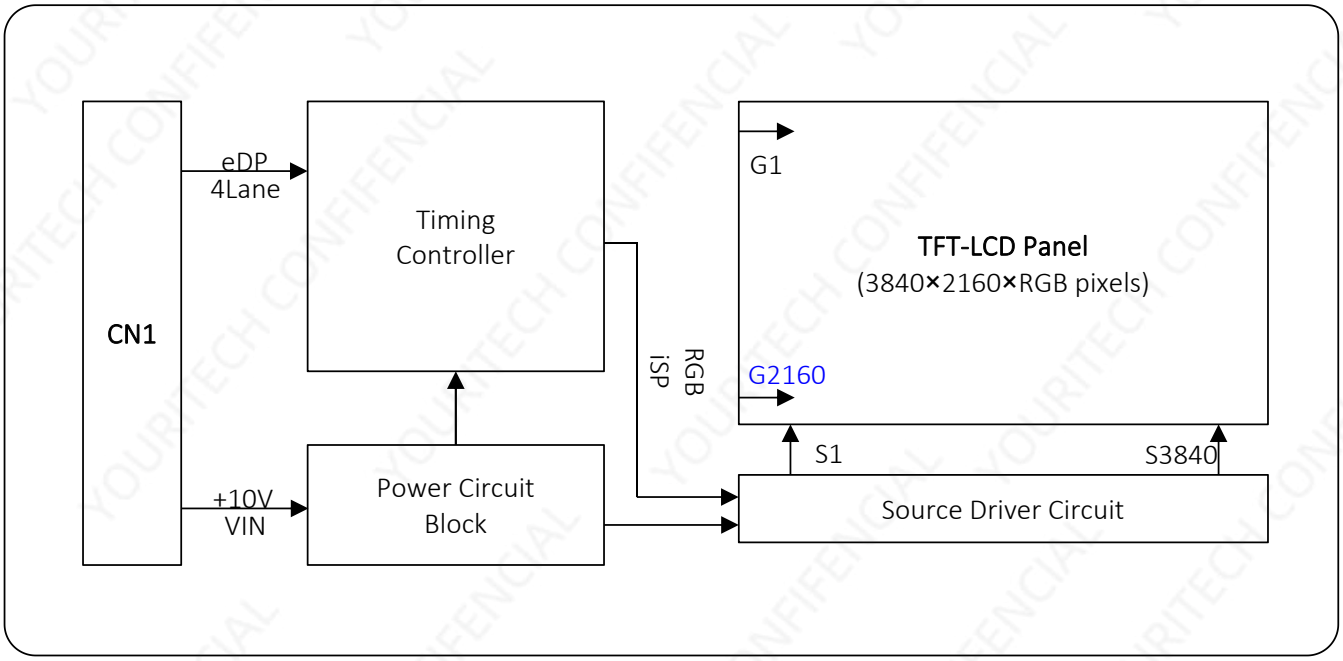
Revision No.	Page	Description of changes	Date	Prepared
Ver. P0		Initial Release	2024.06.07	Aurice
Ver. P1		Update some parameters	2024.08.14	Aurice

Contents

1.0 GENERAL DESCRIPTION

1.1 Introduction

RCT238QWV-E51 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 23.8 inch diagonally measured active area with UHD resolutions (3840 horizontal by 2160 vertical pixel array). Each pixel is divided into RED, GREEN, BLUE dots which are arranged in vertical stripe and this module can display 1.07B colors. The TFT-LCD panel used for this module is adapted for a low reflection and higher color type.



1.2 Features

- eDP Interface with 4Lane
- 10bit (input) color depth , display 1.07B colors (8bit+FRC output)
- High contrast ratio, low reflection and wide viewing angle
- DE (Data Enable) only
- RoHS/Halogen Free
- Gamma Correction
- Reverse type

1.3 Application

- Desktop Type of PC & Workstation Use
- Slim-Size Display for Stand-alone Monitor
- Display Terminals for Control System
- Monitors for Process Controller

1.4 General Specification

The followings are general specifications at the model ET238UH02-R

<Table 1. General Specifications>

Parameter	Specification	Unit	Remarks
Active area	525.888(H) × 295.812(V)	mm	
Number of pixels	3840(H) ×2160(V)	pixels	
Pixel pitch	0.13695 (H) ×0.13695(V)	mm	
Pixel arrangement	RGB Vertical stripe		
Display colors	1.07B	colors	8bit+FRC output
Display mode	Normally Black		
Dimensional outline	550.46(H) x325.04(V) x9.1(D) typ.	mm	Detail refer to drawing
Weight	1980	g	
Surface Treatment	Haze 25%, 3H		

2.0 ABSOLUTE MAXIMUM RATINGS

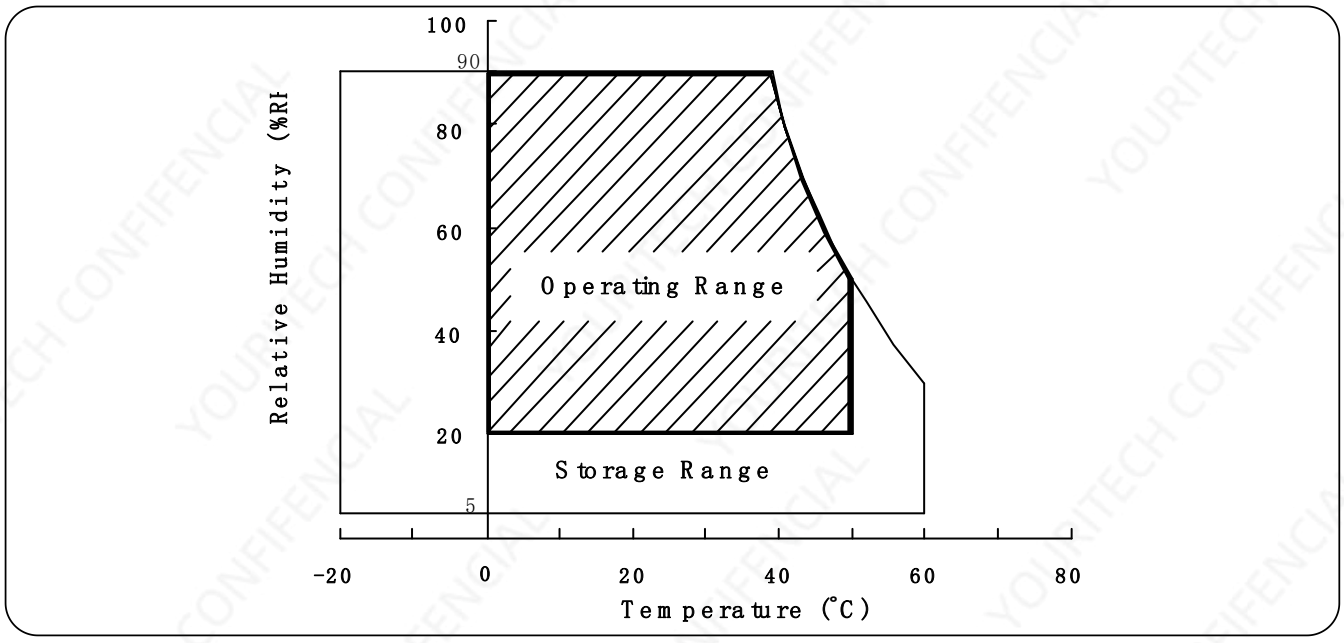
The followings are maximum values which, if exceed, may cause faulty operation or damage to th e unit. The operational and non-operational maximum voltage and current values are listed in Ta ble 2.

< Table 2. Absolute Maximum Ratings> [VSS=GND=0V]

Parameter	Symbol	Min.	Max.	Unit	Remarks
Power Supply Voltage	V_{IN}	-0.3	12.0	V	Ta = 25 ℃
Bist Function Voltage (3)	V_{BIST}	-0.3	3.3+0.3	V	
HPD Voltage	VHPD	-0.3	3.3+0.3	V	
Operating Temperature	T_{OP}	-0	+50	℃	(1)
Storage Temperature	T_{ST}	-20	+60	℃	(1)
LCM Surface Temperature (Operation)	Tsurface	0	+65	℃	(2)

Note : (1) Temperature and relative humidity range are shown in the figure below.Wet bulb temperature should be 39 ^{O}C max. and no condensation of water.

(2) Panel Surface Temperature should be Min. 0^{O}C and Max. +65^{O}C under the V_{IN} = 10.0V, Frame rate =60Hz, 25^{O}C ambient Temp. no humidity control and LED string current is typical value.



3.0 ELECTRICAL SPECIFICATIONS

3.1 Electrical Specifications

< Table 3. Electrical specifications > [Ta =25±2 °C]

Parameter.		Min.	Typ.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	9	10.0	12	V	Note1
Power Supply Current	$I_{DD\ Typ.}$	-	480	510	mA	
	$I_{DD\ max}$	-	890	940	mA	
In-Rush Current	I_{RUSH}	-	2.0	3.0	A	Note 2
Permissible Input Ripple Voltage	V_{RF}	-	-	800	mV	Note1,3
Power Consumption	$P_{D\ Typ}$ -60Hz	-	4.8	5.1	W	Note1,5
	$P_{D\ Typ}$ -62Hz	-	4.85	5.15	W	
	$P_{D\ white}$ -60Hz	-	4.75	5.05	W	
	$P_{D\ white}$ -62Hz	-	4.8	5.1	W	
	$P_{D\ Max}$ -60Hz	-	8.8	9.3	W	
	$P_{D\ Max}$ -62Hz	-	8.9	9.4	W	Note 4
	P_{BL}	-	TBD	TBD	W	
	$P_{total\ Typ.}$	-	TBD	TBD	W	
	$P_{total\ Max}$		TBD	TBD	W	Note 6

3.2 Backlight Driving

The backlight system is edge-lighting type with white-LED.

(It is usually required to measure under the following condition: Ta=25℃±2℃)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Supply voltage	V_{BL}	-	34.5	38.4	V	BL_PWR
Current dissipation	I_{BL}	-	600	-	mA	
Power consumption	P_{BL}	-	20.7	-	W	
LED Life time	-	-	50000	-	hrs	

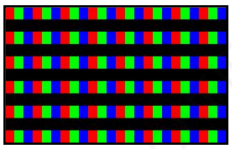
LED Connector Type : CI1406M1HRY-NH (Cvilux)

PIN	Symbol	Description
1	K1	Current Feedback(-)
2	K2	Current Feedback(-)
3	A3	LED Power Supply(+)
4	A4	LED Power Supply(+)
5	K5	Current Feedback(-)
6	K6	Current Feedback(-)

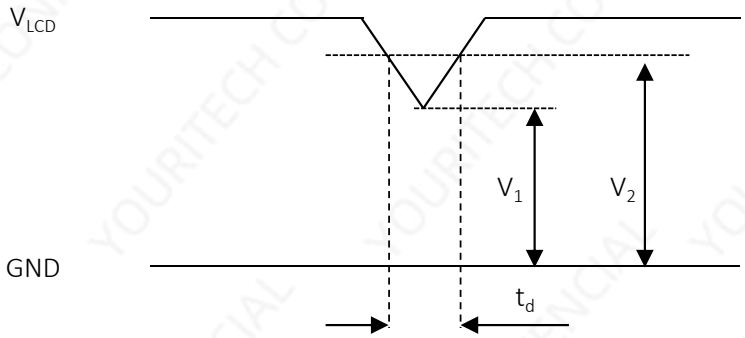
Note : 1. The supply voltage is measured and specified at the interface connector of LCM.
The current draw and power consumption specified is for VDD=10.0V, Frame rate=60Hz
Clock frequency = 533.3 MHz. Test Pattern of power supply current is


a) Typ : Color Test


b) Full white


c) Max : Skip Sub-pixel 255

2. Duration of rush current is about 2 ms and rising time of VDD is 520 μs ± 20%.
3. Ripple Voltage should be covered by Input voltage Spec.
4. Calculated value for reference (Input pins*VPIN ×IPIN) excluding inverter loss.
5. For logic power consumption, it is measured under patterns of Note 1.
6. Test measure refer to Energy Star 8.0 Program Requirements@200nit.
7. For proper operation, stable power supply of VDD is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification exactly.



V1 = 9.5, V2 = 9.75, td = 20ms.

4.0 OPTICAL SPECIFICATION

4.1 Overview

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 TOPCONE PR730) and test unit shall be located at an approximate distance 50cm from the LCD surface at a viewing angle of θ and Φ equal to 0°. We refer to $\theta_{\emptyset=0}$ (=θ_3) as the 3 o'clock direction (the "right"), $\theta_{\emptyset=90}$ (= θ_{12}) as the 12 o'clock direction ("upward"), $\theta_{\emptyset=180}$ (= θ_9) as the 9 o'clock direction ("left") and $\theta_{\emptyset=270}$(= 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. V_{IN} shall be 10.0V ±5% at 25°C. Optimum viewing angle direction is 6 'clock.

4.2 Optical Specifications

[V_{IN} = 10 V, Frame rate = 60 Hz, Clock = 533.3 MHz

Parameter		Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Viewing Angle range	Horizontal	Θ_3	CR > 10	85	89	-	Deg.	Note (1)
		Θ_9		85	89	-	Deg.	
	Vertical	Θ_{12}		85	89	-	Deg.	
		Θ_6		85	89	-	Deg.	
Luminance Contrast ratio		CR	Θ = 0° (Center) Normal Viewing Angle	900	1300			Note (2)
LCM Luminance		Trans		400	500		%	Note (3)
White luminance uniformity		ΔY		70	-		%	Note (4)
Reproduction of color	White	W_x		0.255	0.295	0.335	-	Note (5)
		W_y		0.295	0.335	0.375	-	
	Red	R_x		TBD	TBD	TBD	-	
		R_y		TBD	TBD	TBD	-	
	Green	G_x		TBD	TBD	TBD	-	
		G_y		TBD	TBD	TBD	-	
	Blue	B_x		TBD	TBD	TBD	-	
		B_y		TBD	TBD	TBD	-	
Response Time	GTG	T_g			14	20	ms	Note (6)

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 θ= 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.

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

(3) Center Luminance of white is defined as the LCD surface. Luminance shall be measured with all pixels in the view field set first to white. This measurement shall be taken at the locations shown in FIGURE 2 for a total of the measurements per display.

(4) The White luminance uniformity on LCD surface is then expressed as :
ΔY = (Minimum Luminance of 9points / Maximum Luminance of 9points) * 100 (See FIGURE 2 shown in Appendix).

(5) The color chromaticity coordinates specified in Table 4. shall be calculated from the spectral data measured with all pixels first in red, green, blue and white. Measurements shall be made at the center of the panel.

(6) Response time Tg is the average time required for display transition by switching the input signal as below table and is based on Frame rate fV =60Hz to optimize.

5.1Electrical Interface Connection

5.1.1 LCD input

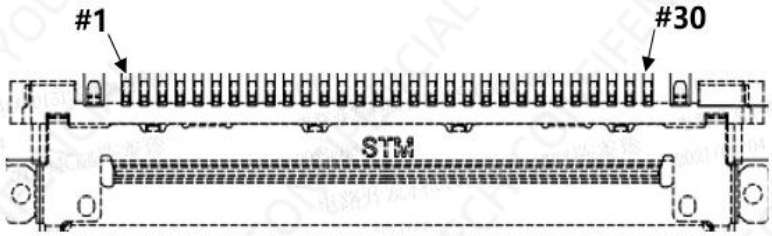
CN101 Module Side Connector STM MSAK24025P30 or Equivalent

Pin No	Symbol	Function	Remark
1	VDD	Power Supply (10.0V)	
2	VDD	Power Supply (10.0V)	
3	VDD	Power Supply (10.0V)	
4	VDD	Power Supply (10.0V)	
5	VDD	Power Supply (10.0V)	
6	GND	Ground	
7	GND	Ground	
8	NC	No connection	
9	NC	No connection	
10	GND	Ground	
11	HPD	Hot Plug Detection Signal	
12	GND	Ground	
13	DAUXN	Negative Signal for Auxiliary Chanel	
14	DAUXP	Positive Signal for Auxiliary Chanel	
15	GND	Ground	
16	DRX0P	Positive Signal For eDP Lane0	
17	DRX0N	Negative Signal For eDP Lane0	
18	GND	Ground	
19	DRX1P	Positive Signal For eDP Lane1	
20	DRX1N	Negative Signal For eDP Lane1	
21	GND	Ground	
22	DRX2P	Positive Signal For eDP Lane2	
23	DRX2N	Negative Signal For eDP Lane2	
24	GND	Ground	
25	DRX3P	Positive Signal For eDP Lane3	
26	DRX3N	Negative Signal For eDP Lane3	
27	GND	Ground	
28	GND	Ground	
29	NC	No connection	
30	BIST	BIST Function	BIST

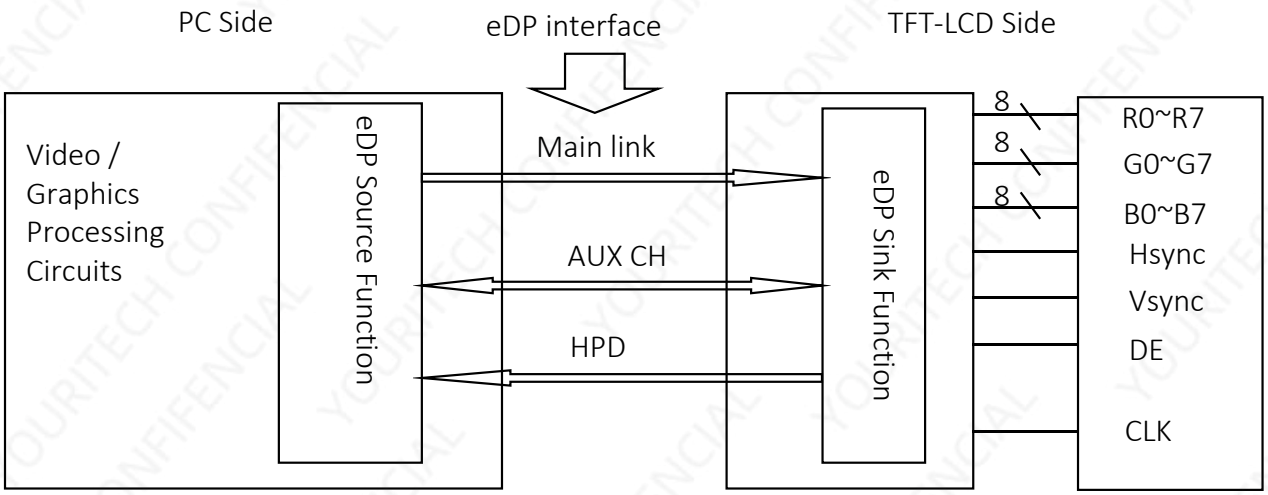
Note 1: H: White-Black-Red-Green-Blue Pattern Aging, L: Black Pattern, when no eDP signal.

Note 2: All GND pin should be connected together with Ground.

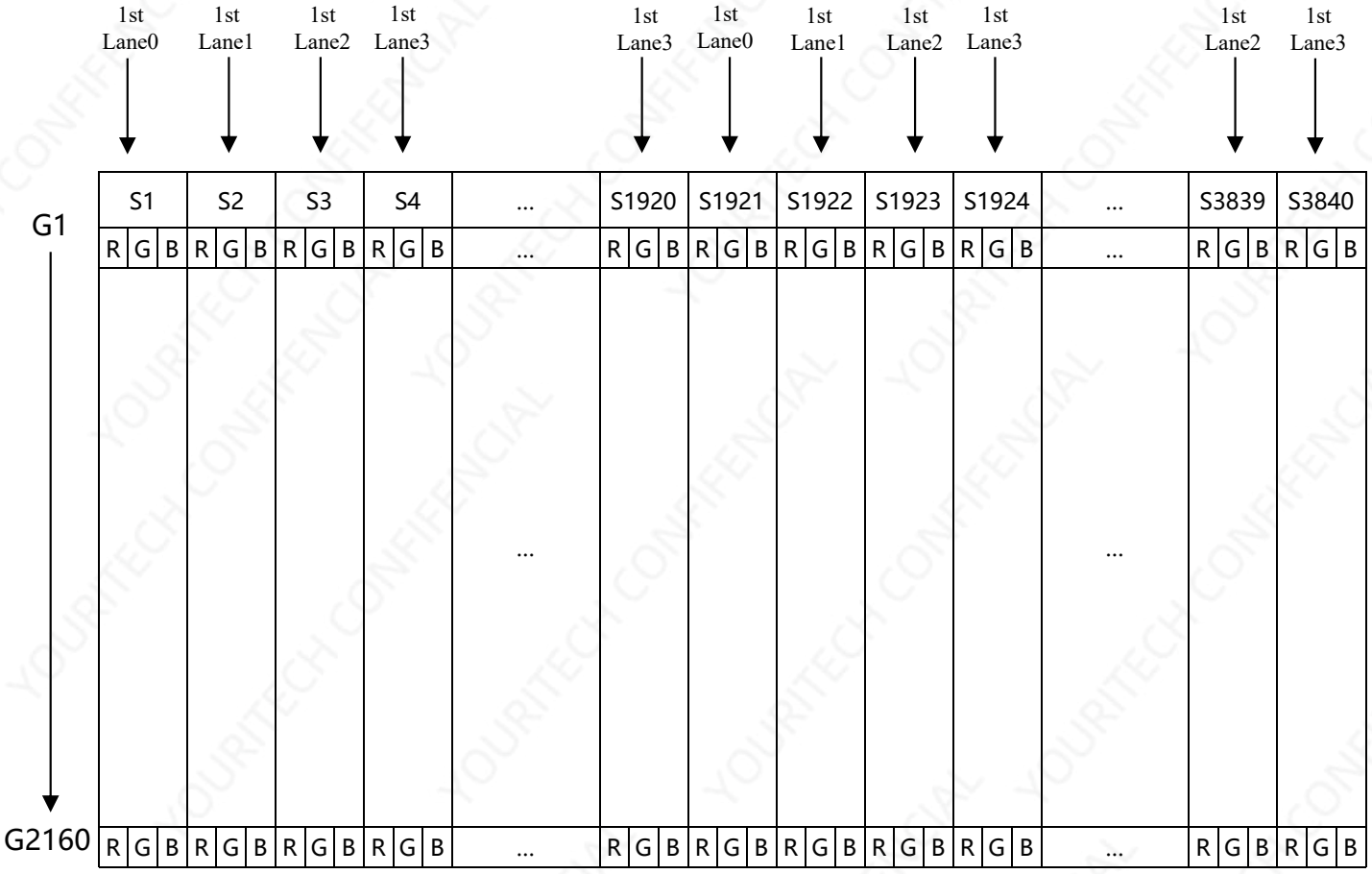
5.1.2 Connector Diagram



5.2.eDP Interface



5.2.1 eDP Pixel Format

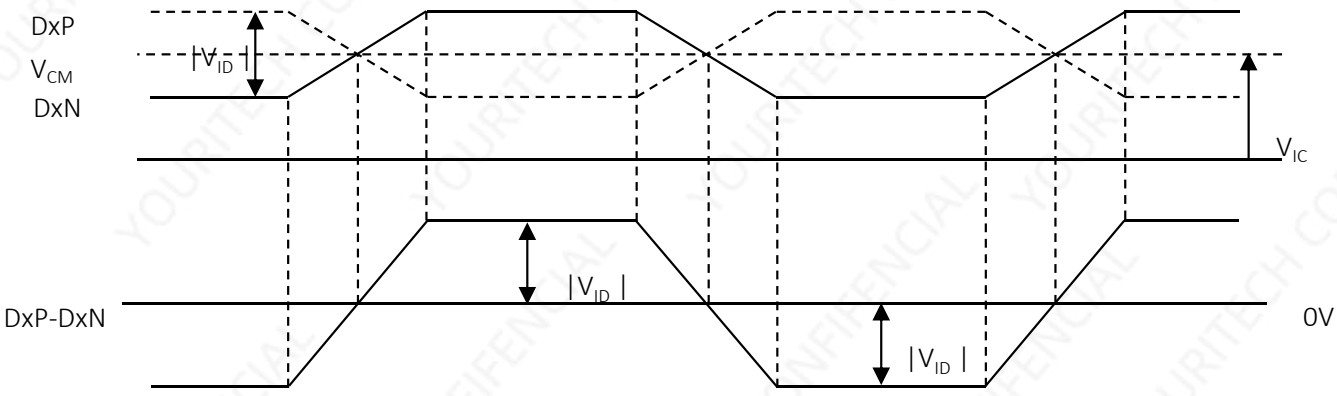


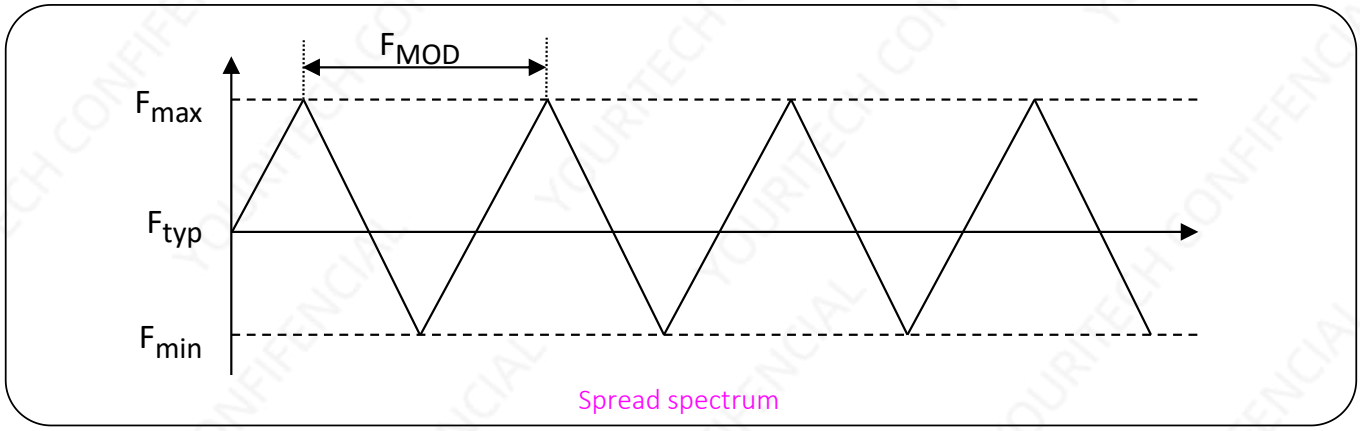
Note:
1st Lane0 : 1, 5, ……, 3837 Pixel →4n+1 N=0~959
1st Lane1 : 2, 6, ……, 3838 Pixel →4n+2 N=0~959
1st Lane2 : 3, 7, ……, 3839 Pixel →4n+3 N=0~959
1st Lane3 : 4, 8, ……, 3840 Pixel →4n+4 N=0~959

5.3eDP Rx Interface Timing Parameter

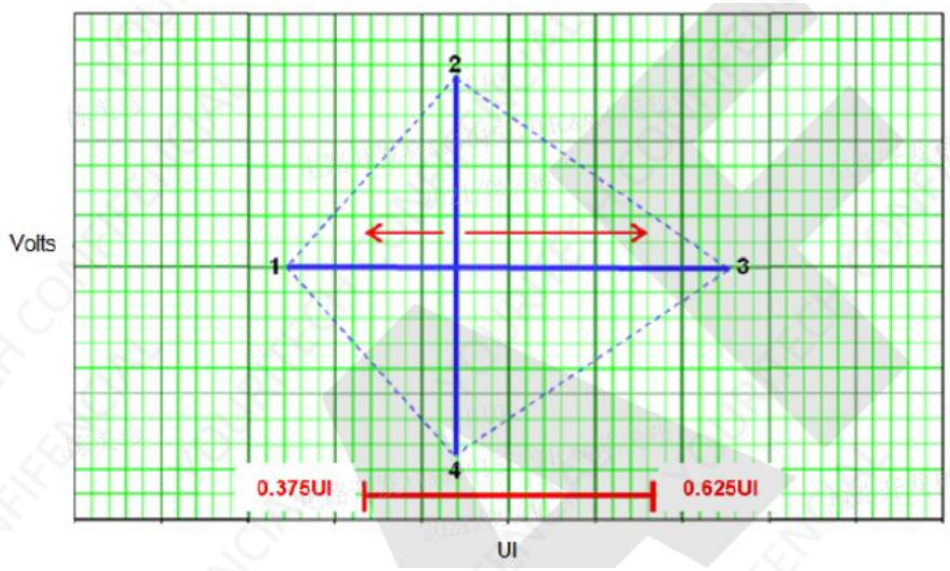
5.3.1 Main link Signal

Item	Symbols	Min	Typ	Max	Unit	Remark
Spread spectrum clock	SSC	-0.5	-	+0	%	
Module Frequency	FMOD	30	-	33	KHz	
Main link swing voltage	$\|V_{ID}\|$	100	-	1320	mv	
Main link common mode voltage	V_{IC}	0	-	2.0	V	





5.3.2 Main Link Eye Diagram

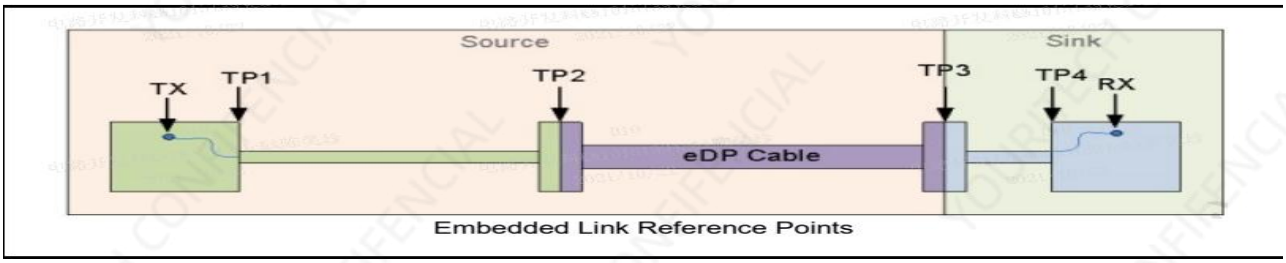


[TP3_EQ EYE Mask]

Point	HBR2@ TP3_EQ EYE Mask Vertices	Voltage(V)
1	Any UI location(x),where the EYE width is open from x to x+0.5UI	0.0000
2	Any passing UI location between 0.375 and 0.625UI	0.0375
3	Ponit 1+0.5UI	0.0000
4	Same as Point 2	-0.0375

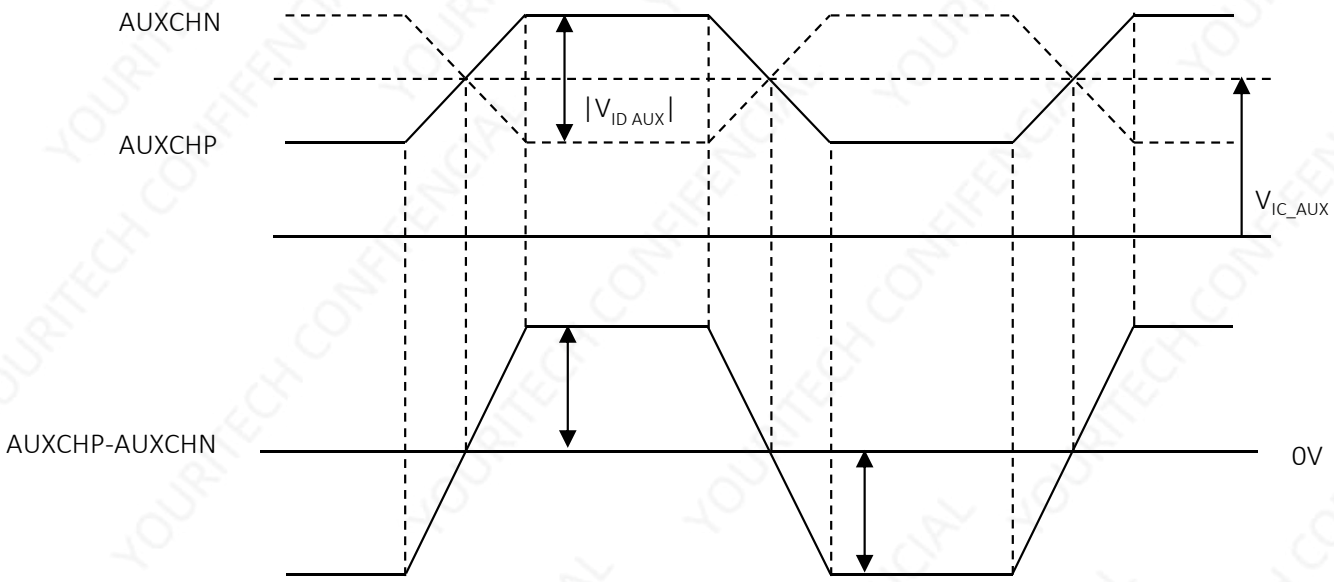
[eDP TP3_EQ EYE Mask Vertices]

Remark: TP3_EQ-After Reference RX Equalizer



5.3.3 AUX_CH Signal

Item	Symbols	Min	Typ	Max	Unit	Remark
AUX Peak-to-peak voltage at Connector Pins of Receiving	$\|V_{ID\ AUX}\|$	0.27	-	1.36	V	
AUX DC common mode voltage	V_{AUX-CM}	0	-	2	V	



5.4.4 HDP Signal

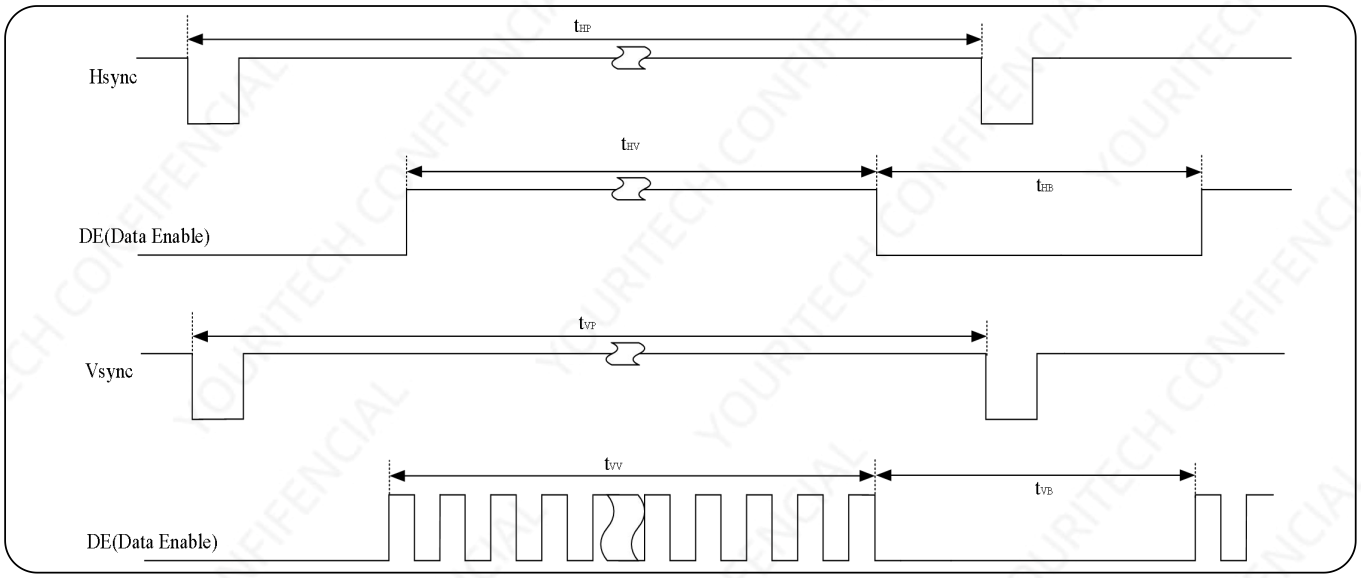
Item	Symbols	Min	Typ	Max	Unit	Remark
HPD Voltage	VHPD	3.135	3.3	3.465	V	

6.0 SIGNAL TIMING SPECIFICATION

6.1 The ET238UH02-R is operated by the DE only.

Item	Symbols		Min	Typ	Max	Unit	Remark
DCLK	Period	tCLK	1.81	1.88	2.25	ns	
	Frequency	-	444.4	533.3	551	MHz	
Hsync	Period	tHP	4000	4000	4088	tCLK	
	Horizontal Valid	tHV	3840	3840	3840	tCLK	
	Horizontal Blank	tHB	160	160	248		
	Frequency	fH	111	133.3	137	KHz	
Vsync	Period	tVP	2213	2222	2290	tHP	
	Vertical Valid	tVV	2160	2160	2160	tHP	
	Vertical Blank	tVB	53	62	130	tHP	
	Frequency	fV	50	60	62	Hz	

6.2 SIGNAL TIMING WAVEFORMS

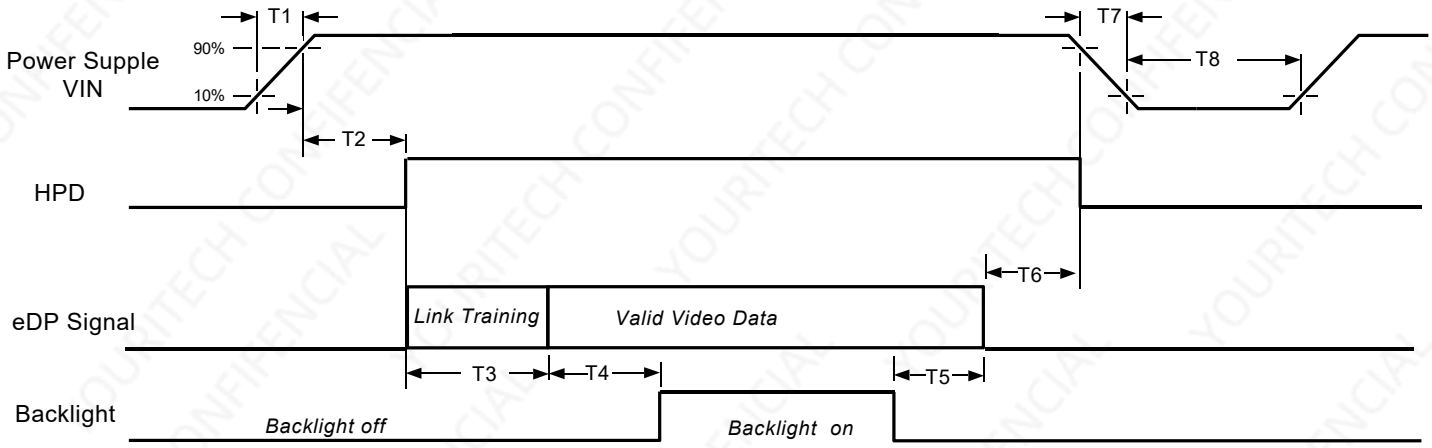


7.0 INPUT SIGNALS, BASIC DISPLAY COLORS & GRAY SCALE OF COLORS

Color & Gray Scale		RED DATA								GREEN DATA								BLUE DATA							
		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
	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
	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
	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
	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
	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	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	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	△	↑								↑								↑							
	▽	↓								↓								↓							
	Brighter	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	▽	1	1	1	1	1	1	1	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
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
	△	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	△	↑								↑								↑							
	▽	↓								↓								↓							
	Brighter	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
	▽	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	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
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	△	↑								↑								↑							
	▽	↓								↓								↓							
	Brighter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
	▽	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	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
Gray Scale of WHITE	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	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
	Darker	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
	△	↑								↑								↑							
	▽	↓								↓								↓							
	Brighter	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1
	▽	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	0	1	1	1	1	1	1	1	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

8.0 POWER SEQUENCE

VIN power,eDP signal and backlight on/off sequence are as following. eDP signals from any sys tem shall be Hi-Z state when VIN is off.



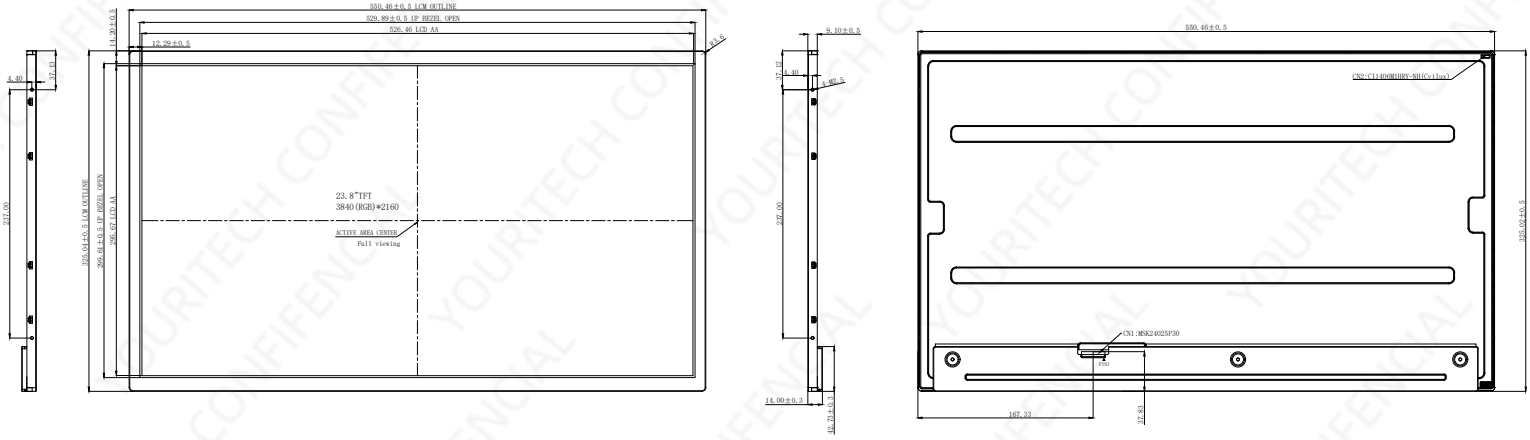
Timing Parameter	Value			Remarks
	Min.	Typ.	Max.	
T1	0.5ms	-	10ms	
T2	0ms	-	200ms	
T3	0ms	-	-	During T3 Period, eDP link training time by customer's system.
T4	500ms	-	-	
T5	200ms	-	-	
T6	0ms	-	50ms	Recommend setting T6=0ms to avoid electronic noise when VIN is off. During T6 period, please keep the level of input eDP signals wit h Hi-Z state.
T7	0ms	-	200ms	T7 decreases smoothly, there is none re-bouncing voltage.
T8	1000ms	-	-	

Notes:

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

9.0 MECHANICAL CHARACTERISTICS

9.1 Dimensional Requirements



10.0 RELIABLITY TEST

The Reliability test items and its conditions are shown in below.

<Table 6. Reliability Test Parameters >

No	Test Items	Conditions
1	High temperature storage test	Ta = 60 ℃, 240 hrs
2	Low temperature storage test	Ta = −20 ℃, 240 hrs
3	High temperature & high humidity operation test	Ta = 50 ℃, 80%RH, 240hrs
4	High temperature operation test	Ta = 50 ℃, 240hrs
5	Low temperature operation test	Ta = 0℃, 240hrs
6	Thermal shock	Ta = −20 ℃ ↔ 60 ℃ (0.5 hr), 100 cycle
7	Electro-static discharge test	Contact : 150 pF, 330Ω, 8 KV

11.0 APPENDIX

Figure 1. Measurement Set Up

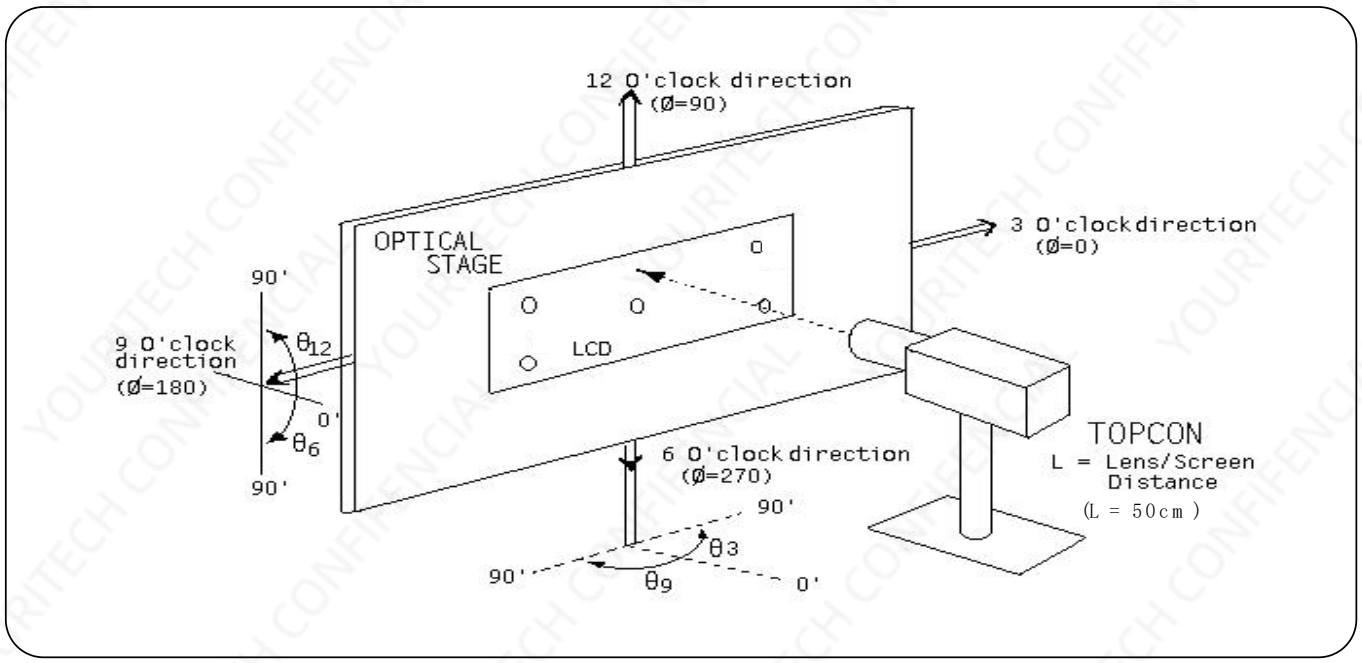
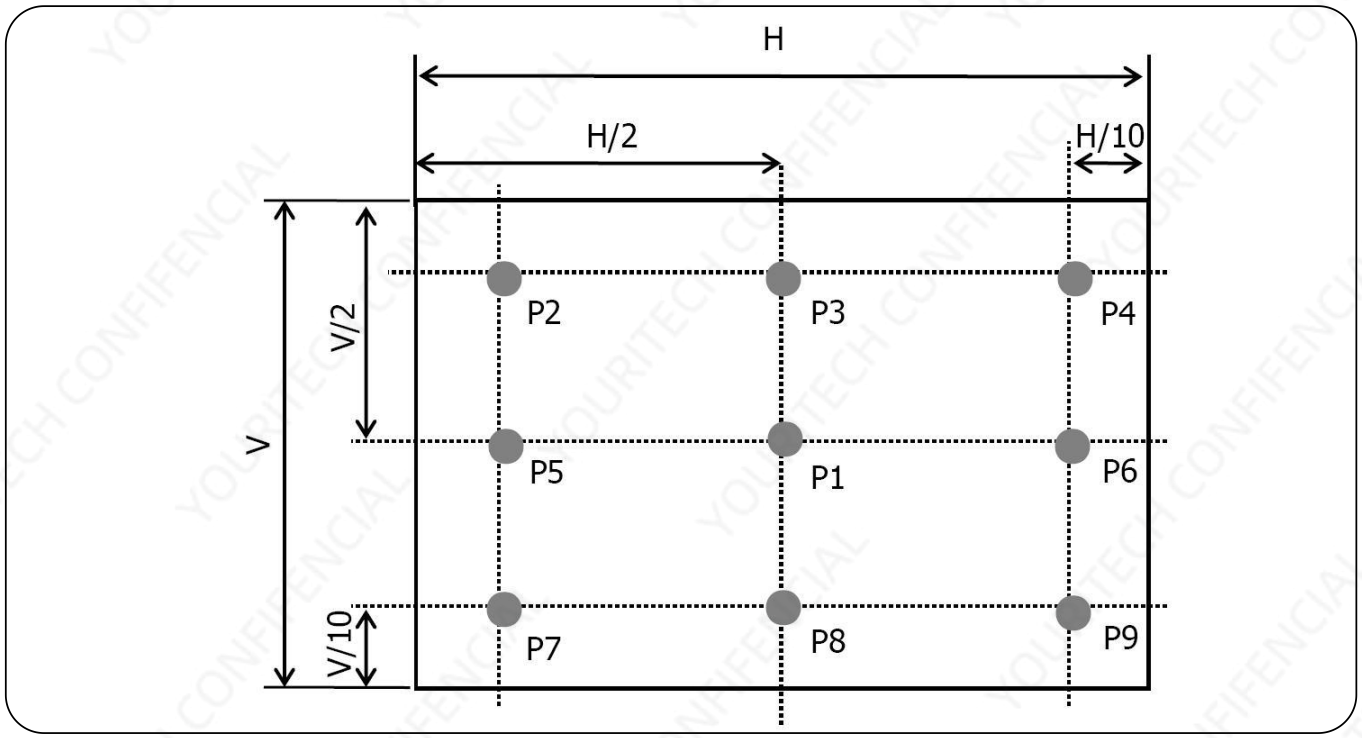


Figure 2. White Luminance and Uniformity Measurement Locations (9 points)



The Gray to Gray response time is defined as the following figure and shall be measured by switching the input signal for “Gray To Gray “.
- Gray step : 17 Step
- TGTG_AVR is the total average time at rising time and falling time for “Gray To Gray “.

<Table 7. GTG Gray Table>

Measured Response Time		Target																
		0	15	31	47	63	79	95	111	127	143	159	175	191	207	223	239	255
Start	0																	
	15																	
	31																	
	47																	
	63																	
	79																	
	95																	
	111																	
	127																	
	143																	
	159																	
	175																	
	191																	
	207																	
	223																	
	239																	
	255																	

Each time in below table is defined as Figure 3 and shall be measured by switching the input signal for “any level of gray(bright)”and “any level of gray(dark)”.

Figure 3. Response Time Testing