EV238FHM-N11 Product Specification Rev.P0

BUYER	
SUPPLIER	HEFEI BOE Optoelectronics Technology CO., LTD
FG-Code	EV238FHM-N11

ITEM	BUYER SIGNATURE	DATE

ITEM	SUPPLIER SIGNATURE	DATE
Prepared		
Reviewed		
Approved		

HEFEI BOE OPTOELECTRONICS TECHNOLOGY

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HEFEI BOE OPTOELECTRONICS TECHNOLOGY

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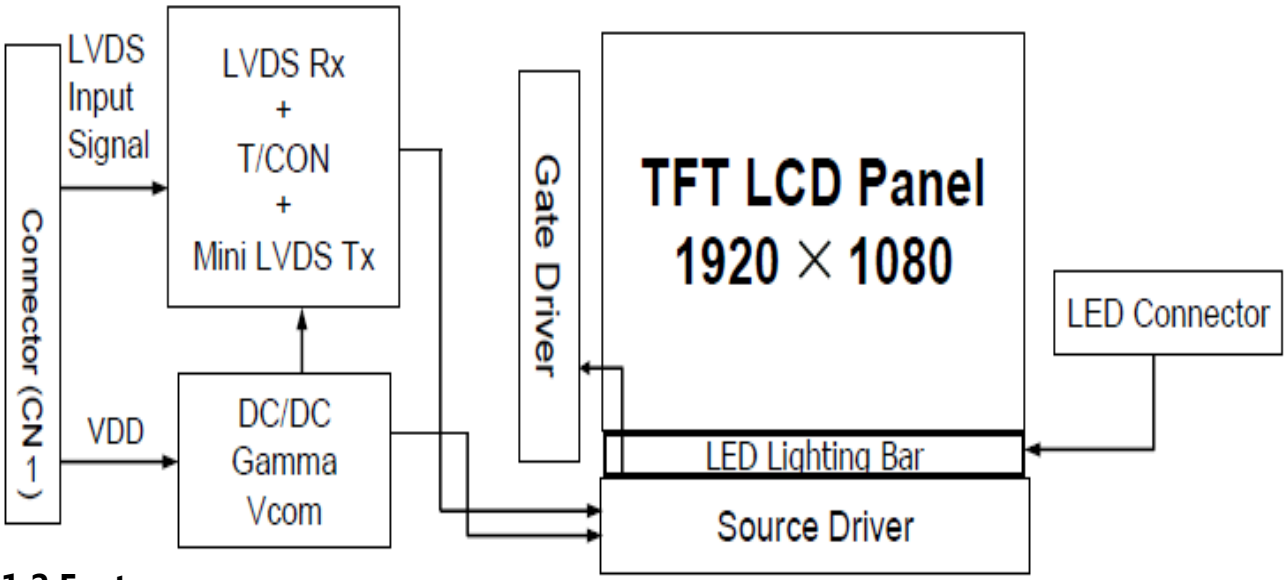
1.0 GENERAL DESCRIPTION

1.1 Introduction

EV238FHM-N11 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 **FHD** resolutions (**1920** horizontal by **1080** vertical 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.**

图示



1.2 Features

- Forward Type;
- LVDS Interface with 2 pixel/clock;
- 6-bit(Hi-FRC) color depth, display 16.7M colors
- Thin and light weight
- **DE (Data Enable)only;**
- High luminance and contrast ratio, low reflection and wide viewing angle
- RoHS compliant

1.3 Application

- Desktop Type of PC & Workstation Use
- Display Terminals for Control System
- Monitors for Process Controller

1.4 General Specification

The followings are general specifications at the model EV238FHM-N11

<Table 1. LCD Module Specifications>

Parameter	Specification	Unit	Remarks
Active Area	**527.04(H)*296.46(V)**	**mm**	
Number Of Pixels	**1920(H)×1080(V)**	**pixels**	
Pixel Pitch	**0.00915(H)×RGB×0.2745(V)**	**mm**	
Pixel Arrangement	**Pixels RGB stripe arrangement**		
Display Mode	**Normally Black**		
Display Colors	**16.7M(6Bits+Hi-FRC)**	colors	
Display Mode	**Normally Black**		
Surface Treatment	**HC**		
Contrast Ratio	**1200:1(typ.)**		
Viewing Angle(CR>10)	**89/89/89/89(typ.)**	**deg.**	
Response Time	**20(typ.)**	**ms**	
Color Gamut	**74%**		
Brightness	240(min)/300(typ)	cd/m2	
Brightness Uniformity	9 point: min 75% 、 typ 80%		
Power Consumption	LCD: 4.2W(Max.)(White Pattern) BLU: 16W(Max.)(w/o Driver)	watt	
Outline Dimension	543.1(H)*317.5(V)*11.1(typ)(LCM)	mm	
Weight	2390(max.)	gram	

2.0 ABSOLUTE MAXIMUM RATINGS

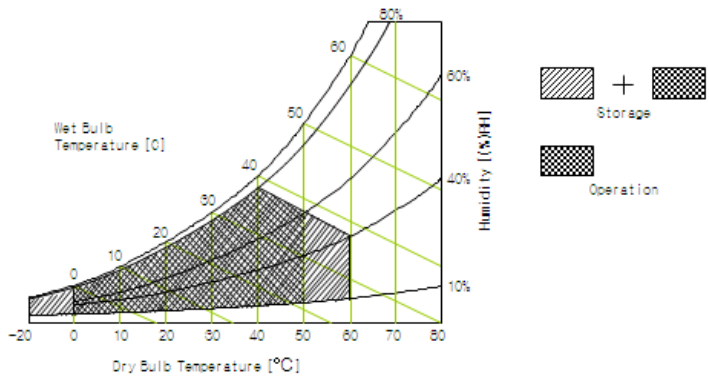
The followings are maximum values which, if exceed, may cause faulty operation or damage to the unit.

< Table 3. Absolute Maximum Ratings>

Parameter	Symbol	Min.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	GND-0.3	6	V	Ta = 25 ℃
Logic Supply Voltage	V_{IN}	VSS-0.3	V_{DD}+0.3	V	
Operating Temperature	T_{OP}	0	+50	℃	1)
Storage Temperature	T_{ST}	-20	+60	℃	1)

Note:

1. These range above is maximum value not the actual operating temperature . Actual Operating temperature is no more than 40℃ and temperature refers to the LCM surface temperature ; Length of operation: No more than 8 hours per day, and no more than 4 hours of continuous use one time.
2. BOE is not responsible for product problems beyond the use conditions.
3. Temperature and relative humidity range are shown in the figure below. Wet bulb temperature should be 39 ℃ max. and no condensation of water.



3.0 ELECTRICAL SPECIFICATIONS

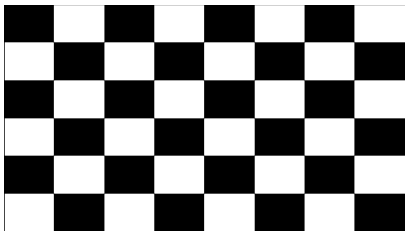
3.1 TFT LCD Module

< Table 4. LCD Module Electrical specifications > [Ta =25±2 ℃]

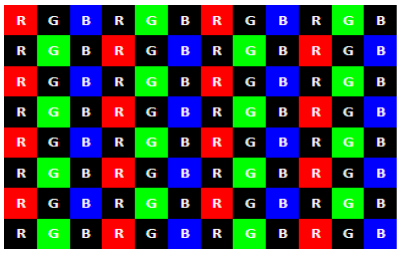
Parameter		Min.	Typ.	Max.	Unit	Remarks
Power Supply Voltage	V_{DD}	4.5	5	5.5	V	Note1
Power Supply Current	I_{DD}	-	TBD	TBD	mA	
In-Rush Current	I_{RUSH}	-	-	3.0	A	Note 2
Permissible Input Ripple Voltage	V_{RF}	-	-	400	mV	Note1,3
High Level Differential Input Threshold Voltage	V_{IH}	+100	-	+300	mV	
Low Level Differential Input Threshold Voltage	V_{IL}	-300	-	-100	mV	
Differential input voltage	$\|V_{ID}\|$	200	-	600	mV	
Differential input common mode voltage	Vcm	1.0	1.2	1.5		V_{IH}=100mV, V_{IL}=-100mV
Power Consumption	P_D	-	TBD	TBD	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 VBAT=3.8V, Frame rate f_V=60Hz and Clock frequency = 156.8MHz. Test Pattern of power supply current

a) Typ : Mosaic 8 x 6 Pattern(L0/L255)



b) Max : skip 1H1V dot(L0/L255)



2. The duration of rush current is about 2ms and rising time of Power Input is 1ms(min)

3.2 Back-Light Unit

Table 5. LED Driver Electrical Specifications > [Ta =25±2 ℃]

Parameter		Min.	Typ.	Max.	Unit	Remarks
LED Light Bar Input Voltage Per Input Pin	VPIN	70	74	84	V	Duty 100%
LED Light Bar Input Current Per Input Pin	IPIN	-	80	-	-	Note1,2
LED Power Consumption	P_{BL}	-	19.5	23	W	Note 3
LED Life-Time	-	50,000	-	-	Hrs	Note 4

Notes: 1. PLED = VLED ×ILED (Without LED converter transfer efficiency)

2. The life time of LED, 10,000Hrs, is determined as the time at which luminance of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at 25 ± 2°C.

3.4 INTERFACE CONNECTION.

3.4.1 Electrical Interface Connection

3.4.1.1 LVDS Connector

- CN1 Module Side Connector : IS100-L30O-C23

Pin No	Symbol	Function	Remark
1	RXO0N	Negative LVDS differential data input	
2	RXO0P	Positive LVDS differential data input	
3	RXO1N	Negative LVDS differential data input	
4	RXO1P	Positive LVDS differential data input	
5	RXO2N	Negative LVDS differential data input	
6	RXO2P	Positive LVDS differential data input	
7	GND	Ground	Note 1
8	RXOCN-	Negative LVDS differential clock input	
9	RXOCP	Positive LVDS differential clock input	
10	RXO3N	Negative LVDS differential data input	
11	RXO3P	Positive LVDS differential data input	
12	RXE0N	Negative LVDS differential data input	
13	RXE0P	Positive LVDS differential data input	
14	GND	Ground	
15	RXE1N	Negative LVDS differential data input	
16	RXE1P	Positive LVDS differential data input	
17	GND	Ground	
18	RXE2N	Negative LVDS differential data input	
19	RXE2P	Positive LVDS differential data input	
20	RXECN	Negative LVDS differential clock input	
21	RXECP	Positive LVDS differential clock input	
22	RXE3N	Negative LVDS differential data input	
23	RXE3P	Positive LVDS differential data input	
24	GND	Ground	
25	SDA	I2C Data (For VCOM tuning)	
26	SCL	I2C Clock (For VCOM tuning)	
27	NC	NC	
28	VIN	Power Supply 5V	
29	VIN	Power Supply 5V	
30	VIN	Power Supply 5V	

3.4.2 Pin assignment for LED Bar

Connector : PF040-B09B-C09 (STM) or equivalent

< Table8. Pin assignment for LED Bar >

Pin No	Symbol	Description	Remarks
1	VLED	LED Anode Power Supply	
2	VLED	LED Anode Power Supply	
3	VLED	LED Anode Power Supply	
4	NC	NC	
5	NC	NC	
6	FB1	LED Cathode Power Supply	
7	FB2	LED Cathode Power Supply	
8	FB3	LED Cathode Power Supply	
9	FB4	LED Cathode Power Supply	

3.4.2LVDS Interface (Tx; THC63LVDF83A or Equivalent)

3.4.2.1 LVDS Interface

	Input Signal	Transmitter		Interface		HR230WU-400 (CN11)	Remark
		Pin No.	Pin No.	System (Tx)	TFT-LCD (Rx)	Pin No.	
LVDS	OR0	51	48 47	OUT0- OUT0+	RXO0- RXO0+	1 2	
	OR1	52					
	OR2	54					
	OR3	55					
	OR4	56					
	OR5	3					
	OG0	4					
	OG1	6	46 45	OUT1- OUT1+	RXO1- RXO1+	3 4	
	OG2	7					
	OG3	11					
	OG4	12					
	OG5	14					
	OB0	15					
	OB1	19					
	OB2	20	42 41	OUT2- OUT2+	RXO2- RXO2+	5 6	
	OB3	22					
	OB4	23					
	OB5	24					
	Hsync	27					
	Vsync	28					
	DE	30					
	MCLK	31	40 39	CLK OUT- CLK OUT+	RXO CLK- RXO CLK+	8 9	
	OR6	50	38 37	OUT3- OUT3+	RXO3- RXO3+	10 11	
	OR7	2					
	OG6	8					
	OG7	10					
	OB6	16					
	OB7	18					
	RSVD	25					

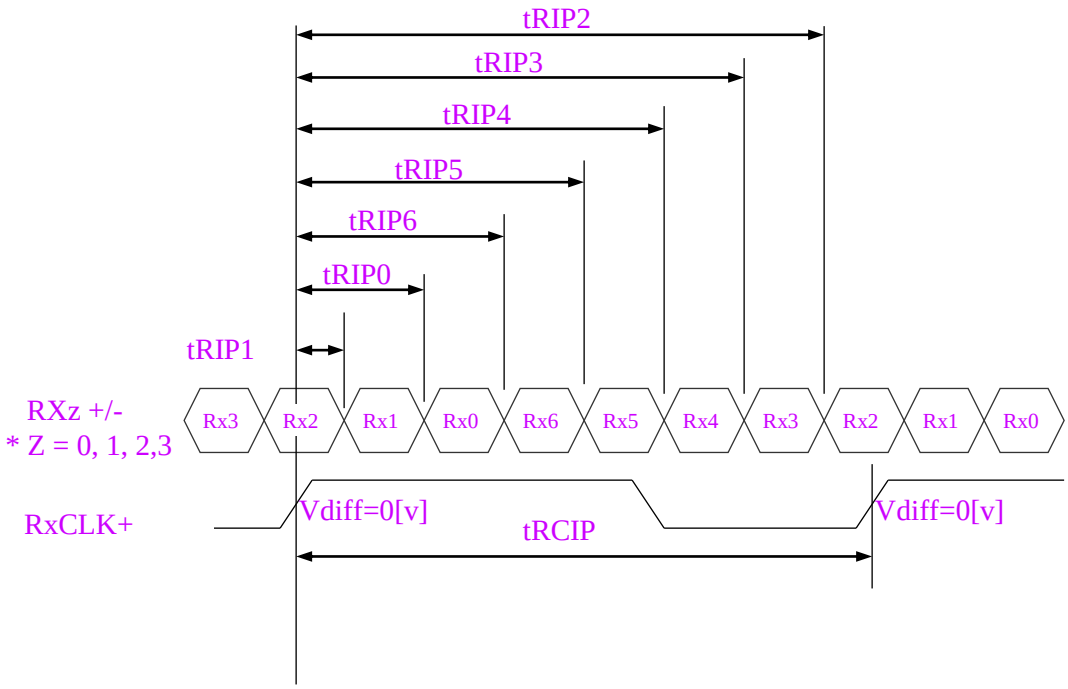
Note: The order of even data is same with old data.

4.2 LVDS Rx Interface Timing Parameter

The specification of the LVDS Rx interface timing parameter is shown in Table 7.

<Table 7. LVDS Rx Interface Timing Specification>

Item	Symbol	Min	Typ	Max	Unit	Remark
CLKIN Period	tRCIP	11.8	12.1	13.05	nsec	
Input Data 0	tRIP1	-0.4	0.0	+0.4	nsec	
Input Data 1	tRIP0	tRCIP/7-0.4	tRCIP/7	tRCIP/7+0.4	nsec	
Input Data 2	tRIP6	2 ×tRCIP/7-0.4	2 ×tRCIP/7	2 ×tRCIP/7+0.4	nsec	
Input Data 3	tRIP5	3 ×tRCIP/7-0.4	3 ×tRCIP/7	3 ×tRCIP/7+0.4	nsec	
Input Data 4	tRIP4	4 ×tRCIP/7-0.4	4 ×tRCIP/7	4 ×tRCIP/7+0.4	nsec	
Input Data 5	tRIP3	5 ×tRCIP/7-0.4	5 ×tRCIP/7	5 ×tRCIP/7+0.4	nsec	
Input Data 6	tRIP2	6 ×tRCIP/7-0.4	6 ×tRCIP/7	6 ×tRCIP/7+0.4	nsec	

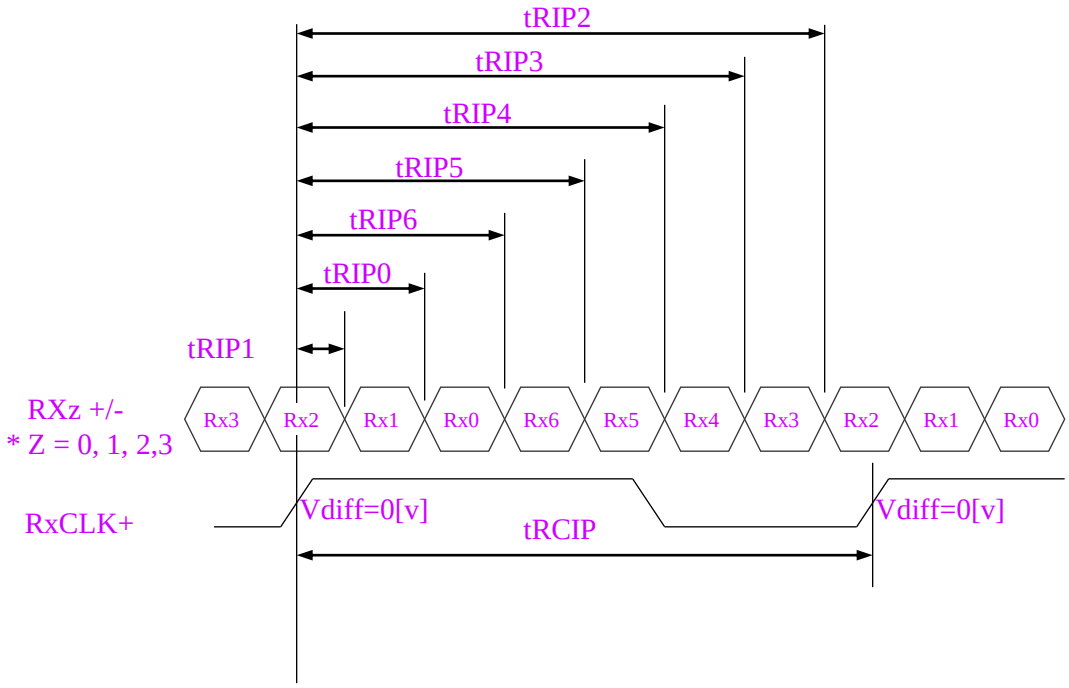


* Vdiff = (RXz+)-(RXz-),…. ,(RXCLK+)-(RXCLK-)

3.6 Interface timing Parameter

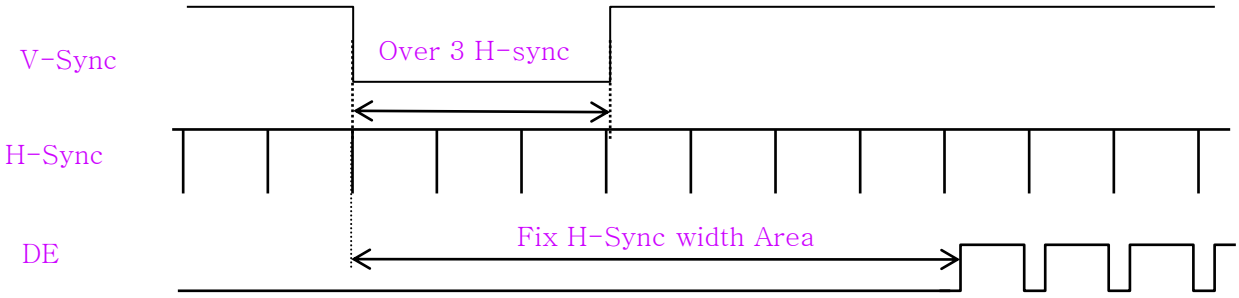
< Table13. Timing Parameter >

Item	Symbol	Min	Typ	Max	Unit	Remark
CLKIN Period	tRCIP	11.8	12.1	13.05	nsec	
Input Data 0	tRIP1	-0.4	0.0	+0.4	nsec	
Input Data 1	tRIP0	tRCIP/7-0.4	tRCIP/7	tRCIP/7+0.4	nsec	
Input Data 2	tRIP6	2 ×tRCIP/7-0.4	2 ×tRCIP/7	2 ×tRCIP/7+0.4	nsec	
Input Data 3	tRIP5	3 ×tRCIP/7-0.4	3 ×tRCIP/7	3 ×tRCIP/7+0.4	nsec	
Input Data 4	tRIP4	4 ×tRCIP/7-0.4	4 ×tRCIP/7	4 ×tRCIP/7+0.4	nsec	
Input Data 5	tRIP3	5 ×tRCIP/7-0.4	5 ×tRCIP/7	5 ×tRCIP/7+0.4	nsec	
Input Data 6	tRIP2	6 ×tRCIP/7-0.4	6 ×tRCIP/7	6 ×tRCIP/7+0.4	nsec	



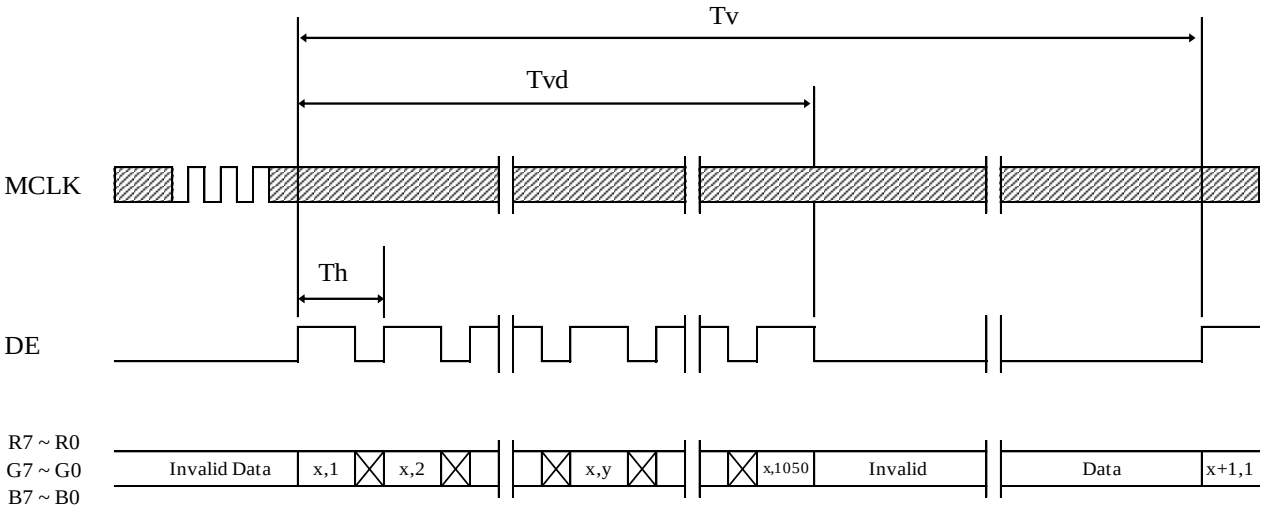
3.6 SIGNAL TIMING WAVEFORMS OF INTERFACE SIGNAL

3.6.1 Sync Timing Waveforms

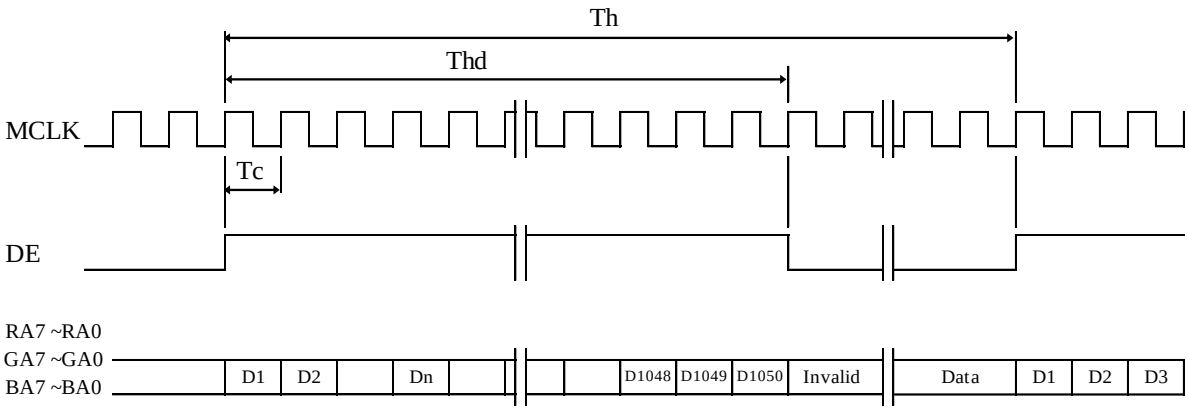


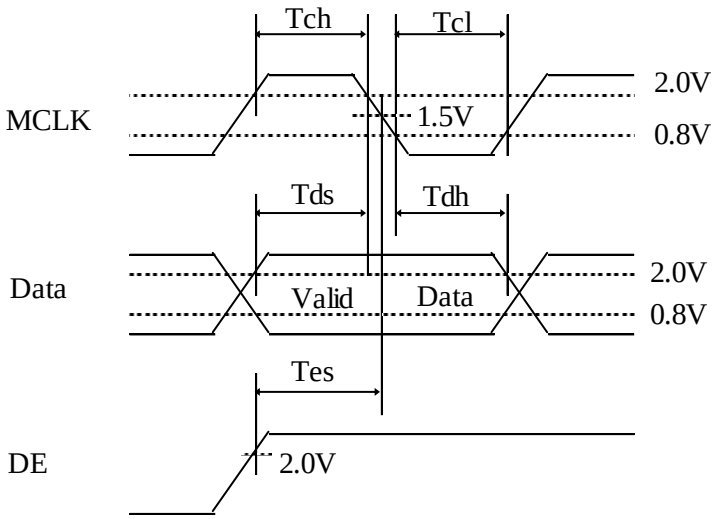
1) Need over 3 H-sync during V-Sync Low
2) Fix H-Sync width from V-Sync falling edge to first rising edge

3.6.2 Vertical Timing Waveforms



3.6.3 Horizontal Timing Waveforms





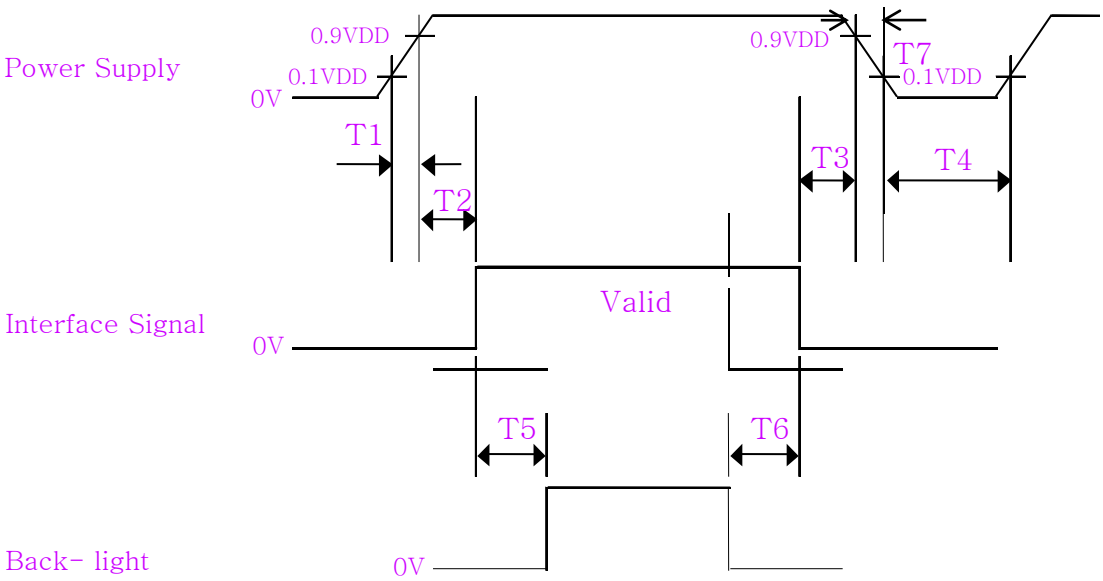
3.7 Input Color Data Mapping

< Table14. Input Signal and Display Color Table >

Color & Gray Scale		Input Data Signal																							
		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

3.8 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



- 0.5 ms ≤ T1 ≤ 10 ms
- 0 ≤ T2 ≤ 50 ms
- 0 ≤ T3 ≤ 50 ms
- 1 sec ≤ T4
- 200 ms ≤ T5
- 200 ms ≤ T6

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.
3. Back Light must be turn on after power for logic and interface signal are valid.
4. T7 decreases smoothly, there is none re-bouncing voltage.

4.0 OPTICAL SPECIFICATIONS

4.1 Overview

The test of optical specifications shall be measured in a dark room (ambient luminance ≤ 1lux and temperature = 25±2℃) with the equipment of Luminance meter system (Gonio meter system and TOPCON BM-5) 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 θØ =0 (=θ3) as the 3 o′ clock direction (the "right"), θØ=90 (= θ12) as the 12 O′ clock direction ("upward"), θØ=180 (= θ9) as the 9 O′ clock direction ("left") and θØ=270(= θ6) 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.

4.2 Optical Specifications

< Table16. Optical Table >

Item	Symbol	Condition	Min	Typ.	Max	Unit	Note
luminance	Bp	θ=0°	340	400	--	cd/m2	Note 1
Maximum Brightness of Black Pattern	Bblk	=0°	---	---	0.65	cd/m2	
Brightness Uniformity	▵Bp		75	80	--	%	Note 2
Color Uniformity	Δu'v' (w.r.t. center)						Note20 Sign the limit sample shall prevail.
	Δu'v'			0.01	0.015		
	Δu'v ′ (worst neighbor			0.003	0.007		
Viewing Angle	**θL**	**Cr≥10**	**80**	**89**	**--**	**deg**	**Note 3**
	θ_R		**80**	**89**	**--**		
	ψ_T		**80**	**89**	**--**		
	ψ_B		**80**	**89**	**--**		
Contrast Ratio	**Cr**	**θ=0° FF=0°**	**1000**	**1200**	**--**	**-**	**Note 4**
Response Time	**Tr+Tf**		**→**	**20**	**25**	**ms**	**Note 5**
	Tgray			**25**	**30**	**ms**	
Color Coordinate of CIE1931	**Rx**	**θ=0°**	**0.613**	**0.643**	**0.673**	**-**	**Note 6**
	Ry		**0.303**	**0.333**	**0.363**		
	Gx		**0.272**	**0.302**	**0.332**		
	Gy		**0.591**	**0.621**	**0.651**		
	Bx		**0.124**	**0.154**	**0.184**		
	By		**0.031**	**0.061**	**0.091**		
	Wx		**0.283**	**0.313**	**0.343**		
	Wy		**0.302**	**0.332**	**0.362**		
NTSC Ratio	**NTSC**	**CIE1931**	**69**	**74**	**79**	**%**	**Note 7**
Color Temperature	**CT**			**6468**			
Flicker	amount	-	-	-	-20	dB	Note 8
Gamma	-		1.9	2.2	2.5		Note 9

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Crosstalk	▵CT	-	-	-	2		Note 10
Reflectance	Rf	@550nm				%	Note 11
Polarization Direction of Front Polarizer	**PdF**			**90°**		**deg**	**Note 12**
Polarization Direction of Rear Polarizer	**PdR**			**0°**		**Deg**	
Luminance decrease ratio		θL=30°			70	%	Note 13
		θR=30°			70	%	
		ψT=30°			70	%	
		ψB=30°			70	%	
Contrast decrease ratio		**θL=30°**			**50**	**%**	**Note 14**
		θR=30°			**50**	**%**	
		ψT=30°			**50**	**%**	
		ψB=30°			**50**	**%**	
Color shift		**θL=30°**			**3**	**JNCD**	**Note 15**
		θR=30°			**3**	**JNCD**	
		ψT=30°			**3**	**JNCD**	
		ψB=30°			**3**	**JNCD**	
Gray inversion angle		ψ=0°				deg	Note 16
Afterimage					3	Minute	Note 17
CABC Test							Note 18
Hot spot	▵Bp	θ=0° =0°	75	80	→	%	Note 19
		θ=0° =0°	80	85	→	%	Every near 9 points

Note1:Luminance measurement

The test condition is at ILED=20mA and measured on the surface of LCD module at 25℃.

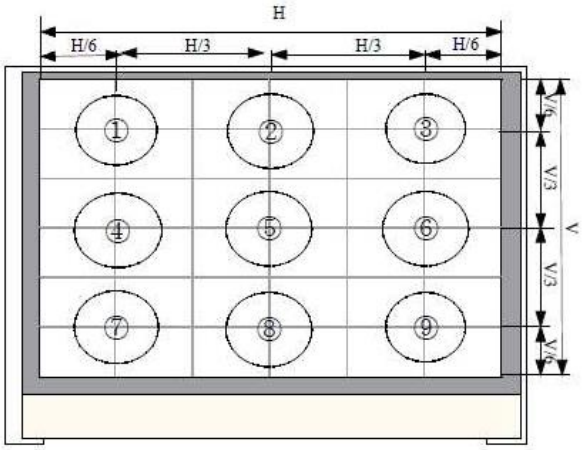
●The data are measured after LEDs are lighted on for more than 5 minutes and LCM displays are fully white. The brightness is the average value of 9 measured spots. Measurement equipment CS2000 or si milar equipments(Field of view:1deg,Distance:50cm)

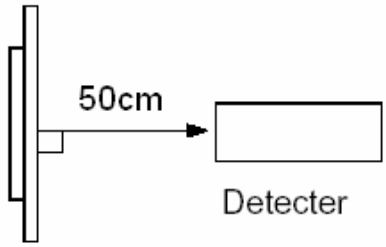
●Measuring surroundings: Dark room.

●Measuring temperature: Ta=25℃.

●Adjust operating voltage to get optimum contrast at the center of the display.

●Measured value at the center point of LCD panel must be after more than 5 minutes while backlight





Note2:Uniformity

●The test condition is at ILED=20mA and measured on the surface of LCD module at 25℃.

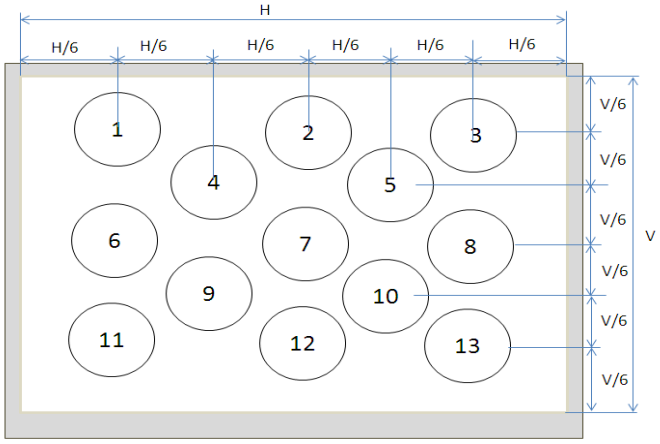
●Measurement equipment:CS2000 or similar equipments

●The luminance uniformity is calculated by using following formula:

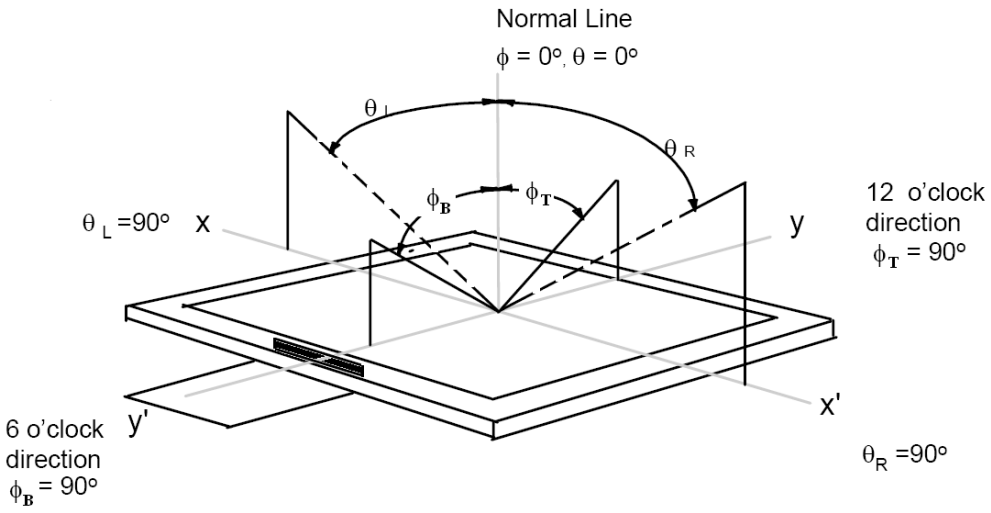
●▵Bp = Bp (Min.) / Bp (Max.)×100 (%)

●Bp (Max.) = Maximum brightness in 13 measured spots

●Bp (Min.) = Minimum brightness in 13 measured spots.



Note 3:**The definition of Viewing Angle**
Refer to the graph below marked by θ and Φ.

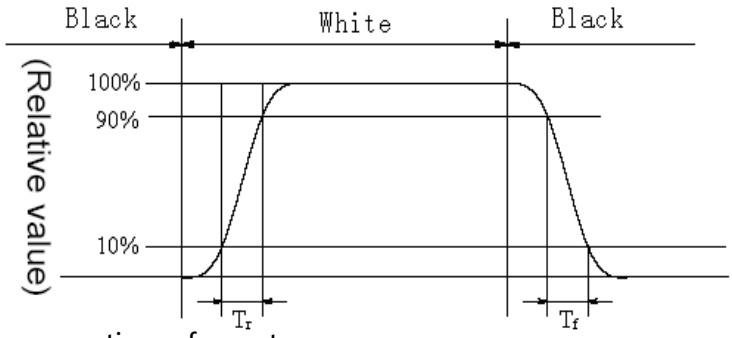


Note4:**The definition of Contrast Ratio** (Test LCM using CS2000 or similar equipments):

$$\text{Contrast Ratio(CR)} = \frac{\text{Luminance When LCD is at "White" state}}{\text{Luminance When LCD is at "Black" state}}$$

(Contrast Ratio is measured in optimum common electrode voltage)

Note5:**Definition of Response time.**(Test LCD using DMS501 or similar equipments):
The output sign also photo detector are measured when the input sign also are changed from "black" to "white" (Voltage falling time)and from "white" to "black" (Voltage rising time), respectively . The response time is defined as the time interval between the 10% and 90% of amplitudes . Refer to figures below.



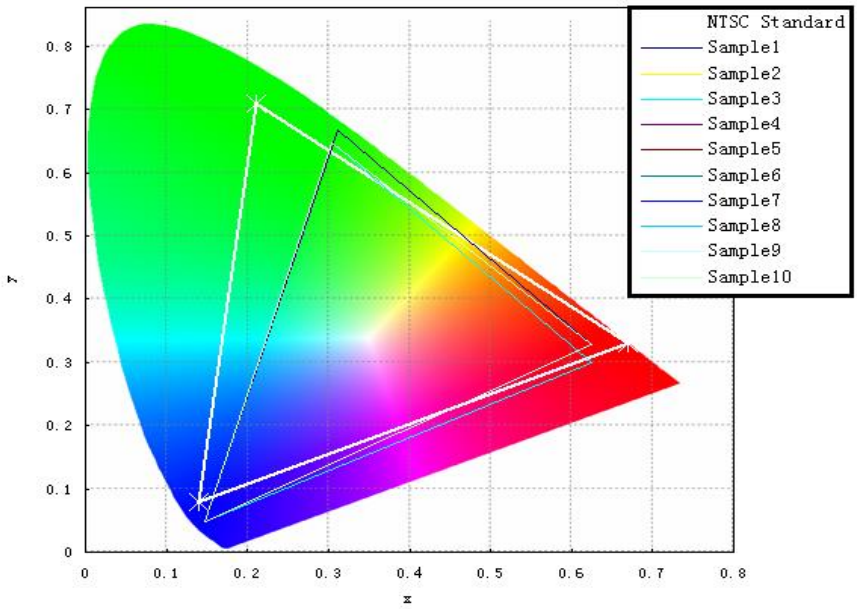
	L0	L1	L2	L3	L4	L5	L6	L7
L0	■							
L1		■						
L2			■					
L3				■				
L4					■			
L5						■		
L6							■	
L7								■

Response time of gray to gray:
Measurement equipment: DMS501 or similar equipments.
Test method: we define 8 grays L0-L7,the grays of L0-L7 were defined as:0,36,73, 109, 146, 182, 219, 255. Theoutputsignalsofphotodetectoraremeasuredwhentheinputsignalsarechanged from "Lx" to "Ly", x, y= [0, 7]. The response time is defined as the time interval between the 10% and 90% of amplitudes. The result of the test can be noted as below:

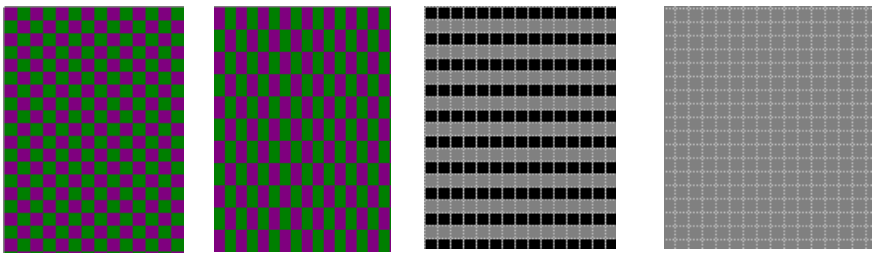
Note 6: Color Coordinates of CIE 1931
The test condition is at ILED=20mA and measured on the surface of LCD module at 25℃.
Measurement equipment:CS2000 or similar equipments
The Color Coordinate (CIE 1931) is the measurement of the center of the display shown in below figure.

Note 7: Definition of Color of CIE Coordinate and NTSC Ratio.

$$S = \frac{\text{area of RGB triangle}}{\text{area of NTSC triangle}} \times 100\%$$



Note 8: **Flicker**
- Measurement equipment :CA-210 or similar equipments
- Measuring temperature: Ta=25℃.
- Test method: JEITA method
- Test pattern : Refer to below(Test Pattern should be full-fill of display screen)



1 Dot Inversion, 2 Dot Inversion , Line Inversion , Frame Inversion
The point should be marked is, for line and frame inversion, the background of Flicker Test Pattern
- "gray " are defined as middle gray scale .For example, RGB 24bit "gray" defined as below:

R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

For Dot inversion, the RGB data for first pixel is (127, 0, 127), the RGB data for the second pixel is (0, 127 , 0).

●Frame Frequency Requirement before test： The LCD must be tuned to more than 65HZ before measu rement.

●Measurement Point: the center of display active area

●Conversion of Flicker ratio:

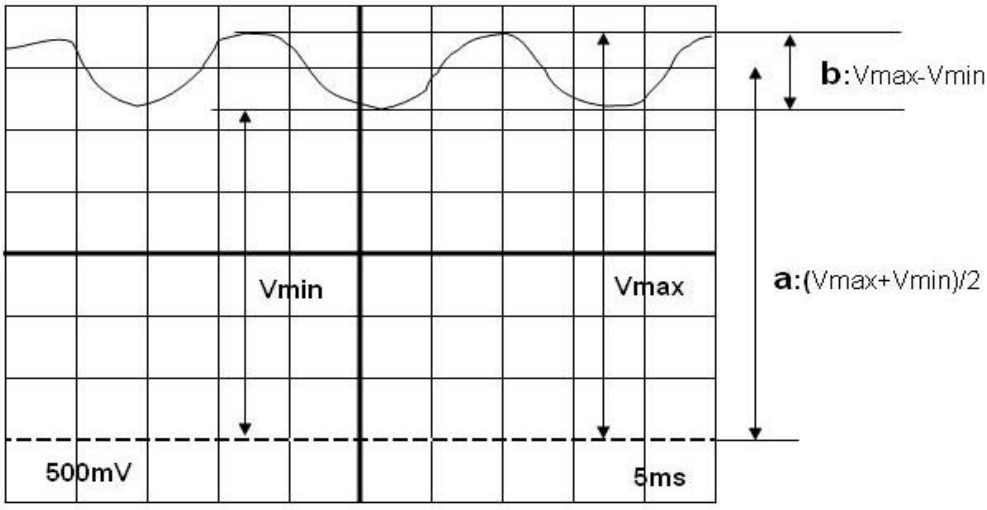
Flicker [dB] = 10 x log[Px/P0]

Where

Px: Maximum power spectrum of AC component after passing through integrator

P0: Power spectrum of DC component after passing through integrator

AC component=b (Refer to below diagram)



Note 9: gamma curve control

●For gamma curve control, HUAWEI’ s request as below:

●1,the whole curve’ s tolerance must control within +/-0.3, HUAWEI will test the gray scale below: 0, 8, 16, 25, 33, 41, 49, 58, 66, 74, 82, 90, 99, 107, 115, 123, 132, 140, 148, 156, 165, 173, 181, 189, 19 7,206, 214, 222, 230, 239, 247, 255

Note 10:Crosstalk

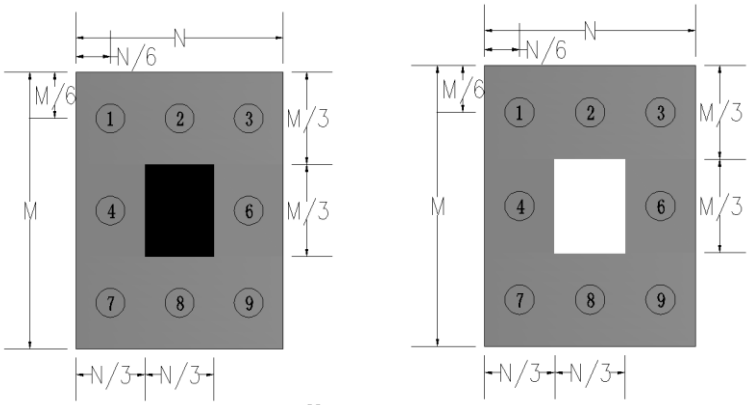
●There should be no visible cross-talk in normal direction of the display when the two ” Cross-talk Test Patterns ” below are loaded.

●Measurement equipment:CS2000 or similar equipments

●The point should be marked is, the background of Cross-talk Test Pattern- “gray ” are defined as middle gray scale . For example, RGB 24bit “gray” defined as below:

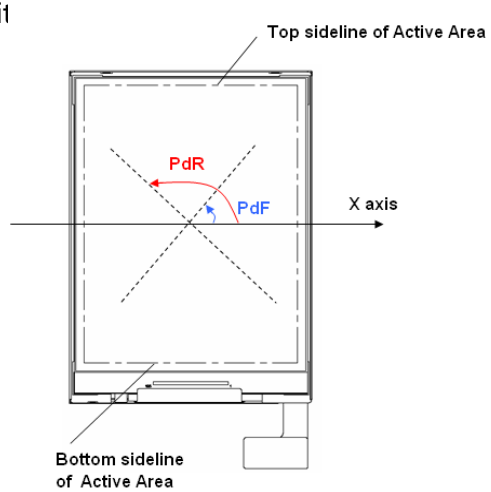
R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

●▵Bpn = Bpn (gray) / Bpn (white)
Which n means the dot No. In the Cross-talk Test Pattern ;
Bpn (gray) means the brightness of the No.n spots in Cross-talk Test Pattern;
Bpn (white) means the brightness of the No.n spots in Full white Test Pattern;
●▵Bp (Max.) = Maximum value in ▵Bp1~▵Bp9, except the No. 5 spot.
●▵Bp (Min.) = Minimum value in ▵Bp1~▵Bp9, except the No.5 spot.
●▵CT=▵Bp (Max.)/▵Bp(Min.).
●▵CT must be less than 1.10



Cross-talk Test Pattern

Note 12: Polarization Direction Definition
●Viewing direction is normal user viewing direction which is vertical to the display surface
●The polarizer which is closer to viewer is defined as Front Polarizer
●The polarizer which is on the rear side of viewer is defined as Rear Polarizer
●The X axis is defined as parallel line to top & bottom sidelines of the Active Area
●PdF which is marked in blue arrow is polarization degree of Front polarizer
●PdB which is marked in red arrow is polarization degree of Back polarizer
●The polarization degree parameter must be indicated in range of 0deg to 180deg according to abov e definit



Note 13: **Definition of Luminance decrease ratio**

- Refer to the graph of note 9.
- Test pattern : Full White
- The luminance decrease ratio is calculated by using following formula:

$$\text{Luminance decrease Ratio}=1-\frac{\text{Luminance test at } \theta_L/\theta_R/\psi_T/\psi_B=30^\circ}{\text{Luminance test at } \theta_L/\theta_R/\psi_T/\psi_B=0^\circ}$$

Note 14: **Definition of Contrast decrease ratio**

- Refer to the graph of note 9.
- Using contrast test method.
- The contrast decrease ratio is calculated by using following formula:

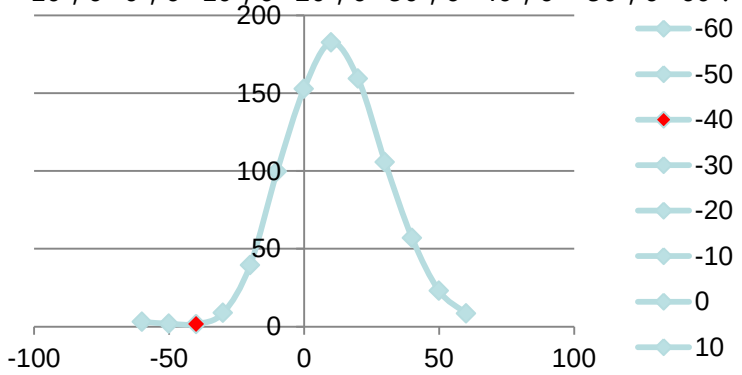
$$\text{Contrast decrease Ratio}=1-\frac{\text{Contrast test at } \theta_L/\theta_R/\psi_T/\psi_B=30^\circ}{\text{Contrast test at } \theta_L/\theta_R/\psi_T/\psi_B=0^\circ}$$

Note15: Color Shift JNCD

- For JNCD measure:
- Fix on one pattern like white pattern,
- On the condition θ=0 F=0°, we can get the color coordinate (u1', v1') and onθL=30° we can get anot her color coordinate (u2', v2')
- Delta = Square Root((u2' - u1')^2 + (v2' - v1')^2)
- JNCD stands for "Just Noticeable Color Difference"
- For the (u', v') color space JNCD=0.0040.
- 2JNCD means Delta u' v' <0.0080
- For color shift we need to measure white/red/green/blue pattern.
- This Requirement is from our customer and we have test some of our phone display and the result is OK.

Note 16: **Definition of gray inversion angle**

- Refer to the graph of note 9.
- Using luminance test method.
- Test pattern : 128 gray
- If the viewing direction is 12 o' clock ,then test the luminance while θ=-60°,θ=-50°, θ=-40°, θ=-30°, θ=-20°, θ=-10°, θ=0°, θ=10°, θ=20°, θ=30°, θ=40°, θ=-50°, θ=60°. The luminance test as figure below:



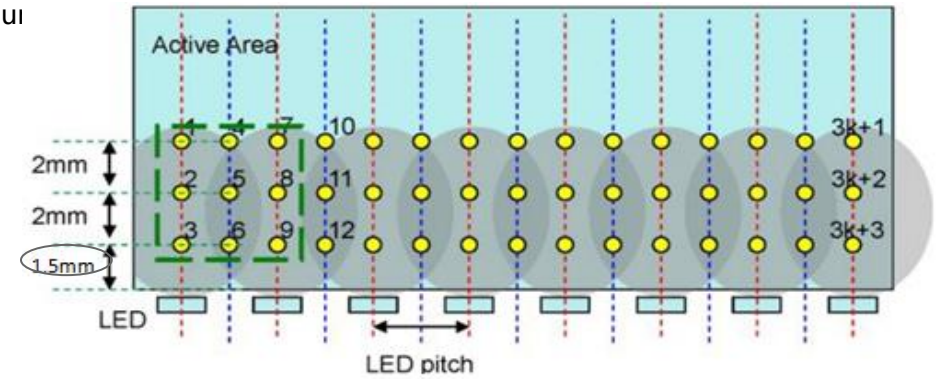
Note 17: **After image judgment**
Power on the LCD 1 hour at tessellated picture(8*8)，then switch to 128 gray picture or Flicker picture, if the afterimage can’t be seen within 3 minutes, the LCD is OK.

Note 18: **CABC Test**
- Measurement equipment :CS-2000 or similar equipments
- Testing picture: CABC Brightness-Gray and APL FIX gamma test picture.
- Test method:
- Power on LCD, test Brightness-Gray picture, drawing the brightness-gray curve, confirm save the power’s scale.

Test APL FIX gamma picture, drawing the APL FIX gamma curve, assurance the curve is smooth.

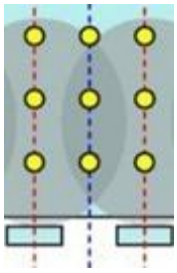
Note 19: Hot spot Test
- (Based on VESA-2.0-306-1)
- Equipment used by: Imaging Photometer system
- The goal of this measurement is to evaluate the uniformity of between the worst case bright and dark spots found along the LED launching area of the module.

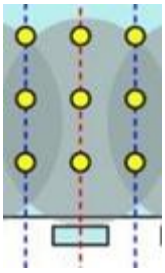
1. The backlight is to be measured ad the module level, using the drive circuit contained on the LCD module or the recommended circuit.
2. The backlight shall be allowed to warm up for 1 minute for this test.
3. The display shall be driven with all white pixels with the contrast set to optimal.
4. The luminance shall be measured directly in front of the LEDs(“Hot areas”) and directly between the LEDs(“Dark areas”) along the launching area edge of the panel. The measurement spot size of the “hot” and “dark” locations shall be 5mm in diameter.
5. Hot Spot ui



Hot spot uniformity=L Min/L Max

- Every near 9 points define





Note 20: Color uniformity

●Measurement Conditions

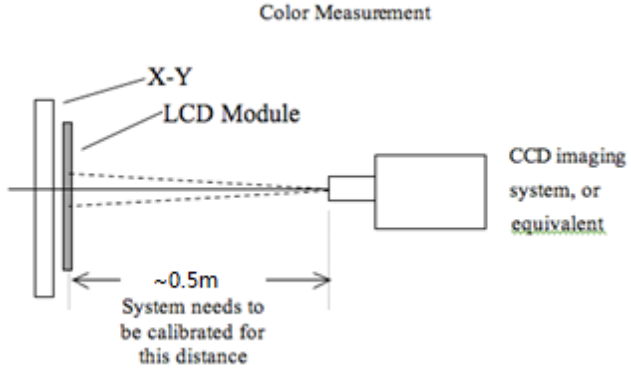
Recommended measuring equipment for color is ICPMI16 Colorimeter or similar CCD type equipment. The optical characteristics are determined after the unit has been 'ON' and stable at the following con ditions:

Maximum brightness

Dark environment

Ambient temperature at 25°C ± 2°C

●Optical measurement system

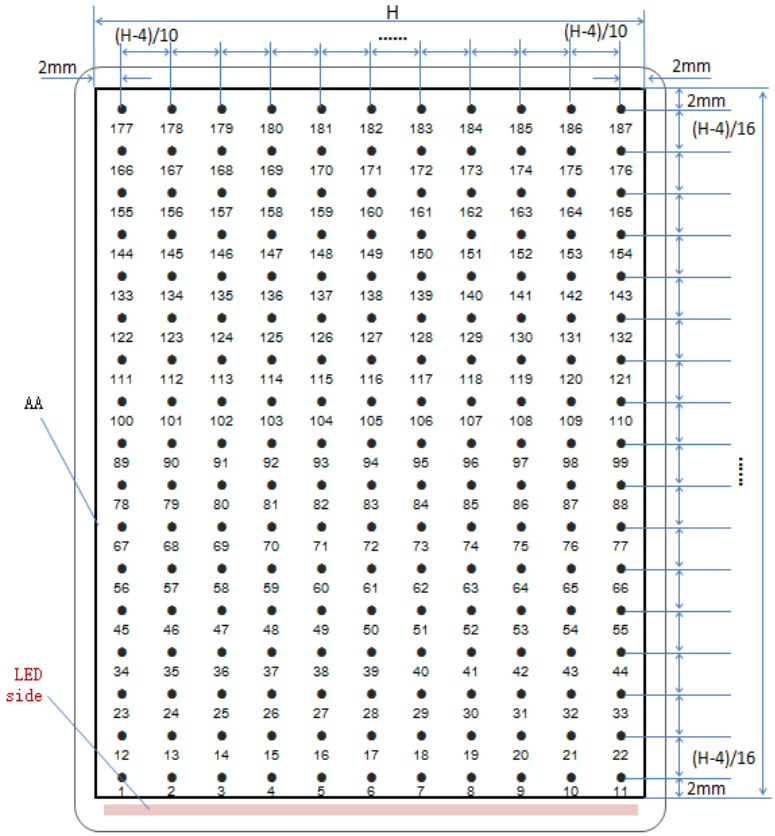


●Total 187 measure points should set as shown in the following figures. The CIE 1976 Standards shall be used.

●The color difference is calculated by using following formula:

Max (△u′ v′ -A) (the max △u′ v′ value between two random point of 187 point)

Max (△u′ v′ -B) (the max △u′ v′ value between two adjacent point in column and row of 187point)



5.0 RELIABLITY TEST

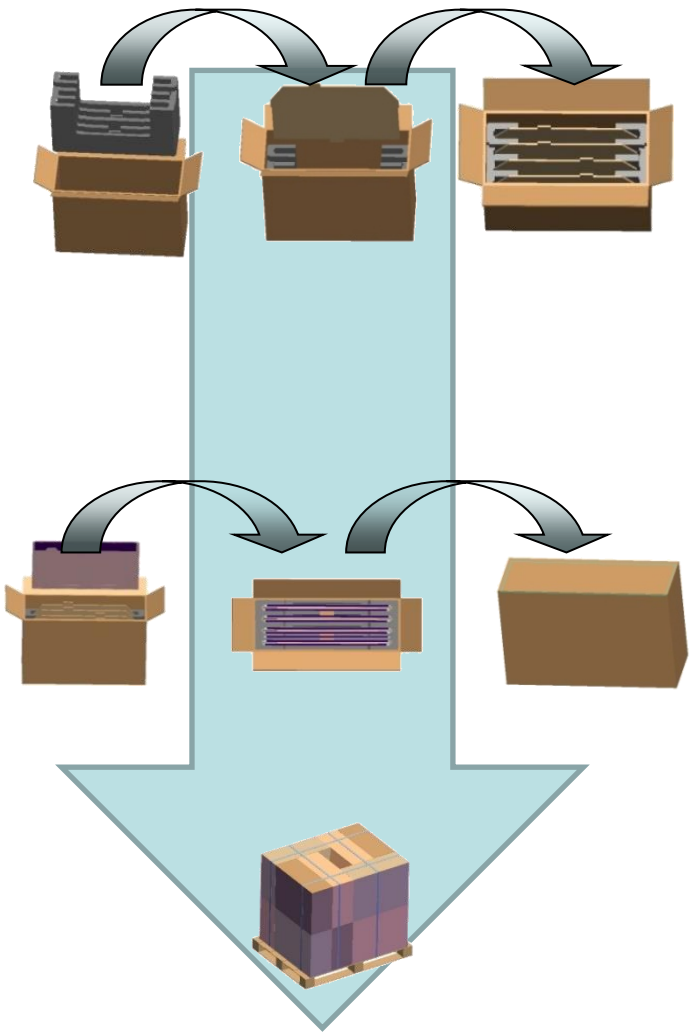
The Reliability test items and its conditions are shown in below.

<Table 17. Reliability Test Parameters >

No	Test Items	Conditions
1	High temperature storage test	60℃，240hr storage
2	Low temperature storage test	-20℃，240hr storage
3	High temperature & high humidity (operation test)	50℃ 80%RH，240hr operation
4	Low temperature operation test	0℃，240hr operation
5	High temperature operation test	50℃，240hr operation
6	Thermal Shock Test	-20℃~60℃（0.5hr），100cycles
7		
8		
9		
10		
11		
12		
13		
14		
…		

6.0 PACKING INFORMATION(产品形态：)

Packing procedure:



-.将2ea EPS Pad、1ea EPS Bottom放入纸箱中
-.将Paper Pad放入Bottom的槽中
容量: 1pcs Paper Pad/槽,4pcs Paper Pad/Inner Box

-.先将Panel装入PE Bag中,然后将其放置于Paper Pad两侧,贴附有保护膜的Panel一侧与Paper Pad相贴,依次装满整箱
-.将EPS Cover盖上,并封箱
-.容量: 2pcs Panel/槽,8pcs Panel/Box

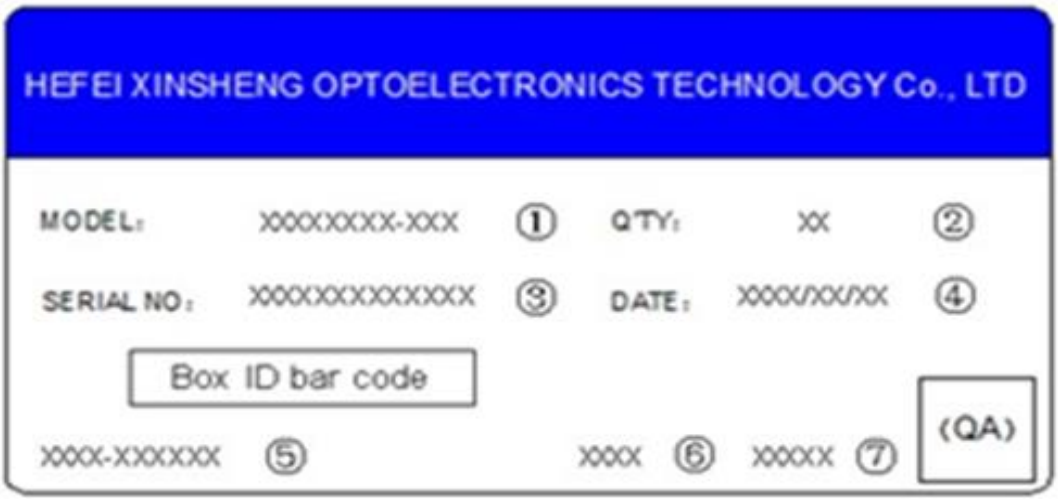
-. 单Pallet上旋转放6eaBox/层, 共2层,共计12ea Box
-. 单Pallet 用8ea纸护角防护, 缠绕膜裹包
容量:96pcs Panel/Pallet

6.1 Packing Note(产品形态：LCM)

- Box Dimension: 619mm(W) x 238mm(D) x 448mm(H)
- Package Quantity in one Box: 8pcs

6.2 Box label (产品形态：)

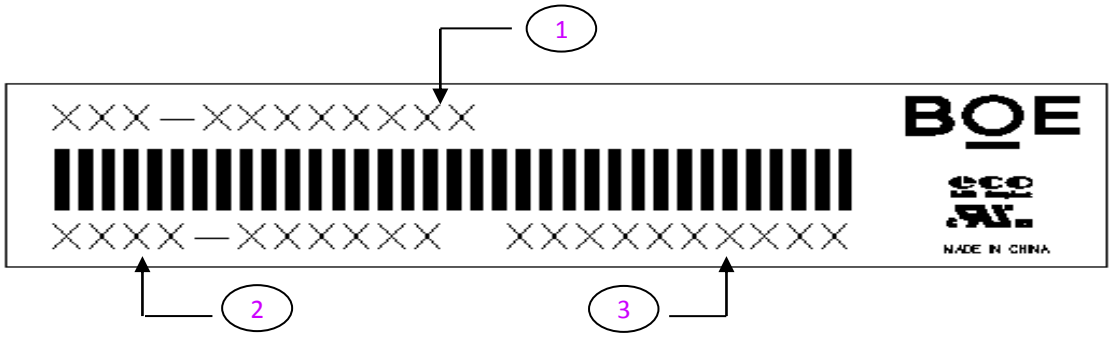
序列号标注部分需打印, 说明如下:
1.FG-CODE(前12位)
2. 产品数量
3. Box ID
4. 包装日期
5.客户端物料号(客户端)----暂不打印
6.FG-Code后四位
7.供应商代码 ----暂不打印
Total Size:110×55mm



Box ID编码规则

Digit / Code	1	2	3	4	5	6	7	8	9	10	11	12	13
Code	S	L	S	5	1	2	3	D	0	0	0	6	8
Description	Products GBN		Grade	Line	Year		Month	Revision Code	Serial No				

7.0 Product Label



序列号标注部分需打印, 说明如下:

1. **FG-CODE(前12位)**
2. **PPID - - 暂不打印**
3. **MDL ID 及其条形码**

Total Size:48×12mm

Remark:

具体标签格式，详见CIM系统维护内容

MDL ID编码规则

Digit / Code	1	2	3	4	5	6	7	8	9	10	11	12	13
Code	S	L	S	5	1	2	3	5	9	0	0	0	0
Description	Model Code /GBN		Grade	Line	Year		Month	Model Extension Code		Serial No 00001-ZZZZZZ			

8.0 Handling & Cautions

8.1 Mounting Method

- The panel of the LCD consists of two thin glasses with polarizers which easily get damaged. So extreme care should be taken when handling the LCD.
- Excessive stress or pressure on the glass of the LCD should be avoided. Care must be taken to insure that no torsional or compressive forces are applied to the LCD unit when it is mounted.
- If the customer's set presses the main parts of the LCD, the LCD may show the abnormal display. But this phenomenon does not mean the malfunction of the LCD and should be pressed by the way of mutual agreement.
- To determine the optimum mounting angle, refer to the viewing angle range in the specification for each model.
- Mount a LCD module with the specified mounting parts.

8.2 Caution of LCD Handling and Cleaning

- Since the LCD is made of glass, do not apply strong mechanical impact or static load onto it. Handling with care since shock, vibration,and careless handling may seriously affect the product. If it falls from a high place or receives a strong shock, the glass may be broken.
- The polarizers on the surface of panel are made from organic substances. Be very careful for chemicals not to touch the polarizers or it leads the polarizers to be deteriorated.
- If the use of a chemical is unavoidable, use soft cloth with solvent (recommended below) to clean the LCD ‘s surface with wipe lightly.
  -IPA(Isopropyl Alcohol), Ethyl Alcohol, Trichlorotriflorothane
- Do not wipe the LCD's surface with dry or hard materials that will damage the polarizers and others. Do not use the following solvent.
  -Water, Ketone, Aromatics
- It is recommended that the LCD be handled with soft gloves during assembly, etc. The polarizers on the LCD's surface are vulnerable to scratch and thus to be damaged by sharp particles.
- Do not drop water or any chemicals onto the LCD's surface.
- A protective film is supplied on the LCD and should be left in place until the LCD is required for operation.
- The ITO pad area needs special careful caution because it could be easily corroded. Do not contact the ITO pad area with HCFC,Soldering flux,Chlorine,Sulfur,saliva or fingerprint. To prevent the ITO corrosion, customers are recommended that the ITO area would be covered by UV or silicon.

8.3 Caution Against Static Charge

- The LCD modules use C-MOS LSI drivers, so customers are recommended that any unused input terminal would be connected to Vdd or Vss, do not input any signals before power is turn on, and ground you body, work/assembly area, assembly equipments to protect against static electricity.
- Remove the protective film slowly, keeping the removing direction approximate 30-degree not vertical from panel surface, If possible, under ESD control device like ion blower, and the humidity of working room should be kept over 50%RH to reduce the risk of static charge.
- Avoid the use work clothing made of synthetic fibers. We recommend cotton clothing or other conductivity-treated fibers.
- In handling the LCD, wear non-charged material gloves. And the conducting wrist to the earth and the conducting shoes to the earth are necessary.

8.4 Caution For operation

- It is indispensable to drive the LCD within the specified voltage limit since the higher Voltage than the limit causes the shorter LCD's life. An electro-chemical reaction due to DC causes undesirable deterioration of the LCD so that the use of DC drive should avoid.
- Do not connect or disconnect the LCD to or from the system when power is on.
- Never use the LCD under abnormal conditions of high temperature and high humidity.
- When expose to drastic fluctuation of temperature (hot to cold or cold to hot) ,the LCD may be affected; Specifically, drastic temperature fluctuation from cold to hot ,produces dew on the LCD's surface which may affect the operation of the polarizer and the LCD.
- Response time will be extremely delayed at lower temperature than the operating temperature range and on the other hand at higher temperature LCD may turn black at temperature above its operational range. However those phenomena do not mean malfunction or out of order with the LCD. The LCD will revert to normal operation once the temperature returns to the recommended temperature range for normal operation.
- Do not display the fixed pattern for a long time because it may develop image sticking due to the LCD structure. If the screen is displayed with fixed pattern, use a screen saver.

8.5 Packaging

- Modules use LCD element, and must be treated as such.
  -Avoid intense shock and falls from a height.
  -To prevent modules from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity for long periods.

8.6 Storage

- A slight dew depositing on terminals is a cause for electro-chemical reaction resulting in terminal open circuit. Relative humidity of the environment should therefore be kept below 60%RH.
- Original protective film should be used on LCD’ s surface (polarizer). Adhesive type protective film should be avoided, because it may change color and/or properties of the polarizers.
- Do not store the LCD near organic solvents or corrosive gasses.
- Keep the LCD safe from vibration, shock and pressure.
- Black or white air-bubbles may be produced if the LCD is stored for long time in the lower temperature or mechanical shocks are applied onto the LCD.
- In the case of storing for a long period of time for the purpose or replacement use, the following ways are recommended.
  -Store in a polyethylene bag with sealed so as not to enter fresh air outside in it.
  -Store in a dark place where neither exposure to direct sunlight nor light is.
  -Keep temperature in the specified storage temperature range.
  -Store with no touch on polarizer surface by the anything else. If possible, store the LCD in the packaging situation LCD when it was delivered.

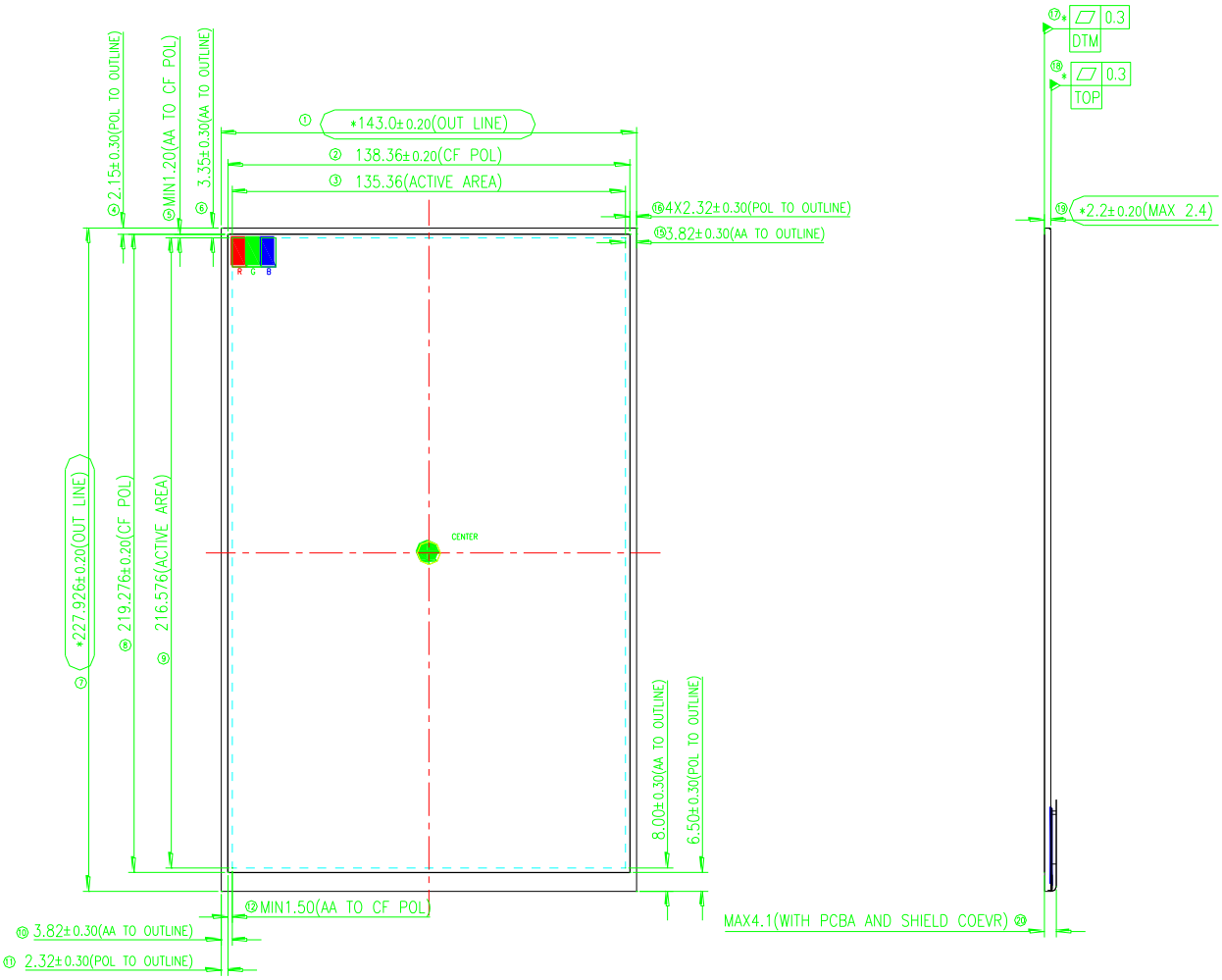
8.7 Safety

- For the crash damaged or unnecessary LCD, it is recommended to wash off liquid crystal by either of solvents such as acetone and ethanol an should be burned up later.
- In the case the LCD is broken, watch out whether liquid crystal leaks out or not. If your hands touch the liquid crystal, wash your hands cleanly with water an soap as soon as possible.
- If you should swallow the liquid crystal, first, wash your mouth thoroughly with water, then drink a lot of water and induce vomiting, and then, consult a physician.
- If the liquid crystal should get in your eyes, flush your eyes with running water for at least fifteen minutes.
- If the liquid crystal touches your skin or clothes, remove it and wash the affected part of your skin or clothes with soap and running water.

9.0 APPENDIX

Mechanical Drawing

Drawing Attachment: Front



Mechanical Drawing

Drawing Attachment: Back