SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	215" Full HD TFT LCD

BUYER	LGE
MODEL	

SUPPLIER	LG. Display Co., Ltd.
*MODEL	LM215WF4
SUFFIX	TLA3

*When you obtain standard approval,
please use the above model name without suffix

APPROVED BY	SIGNATURE / DATE
/	
/	
/	

Please return 1 copy for your confirmation with your signature and comments.

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Contents

Product Specification

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
1.0	Feb. 05. 2010		Final CAS (LM215WF4-TLA3)

1. General Description

LM215WF4 is a Color Active Matrix Liquid Crystal Display with a Light Emitting Diode (White LED) backlight system without LED driver. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally White mode. It has a 215 inch diagonally measured active display area with FHD resolution (1080 vertical by 1920horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M colors with A-FRC(Advanced Frame Rate Control).
It has been designed to apply the 8Bit 2 port LVDS interface.
It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.

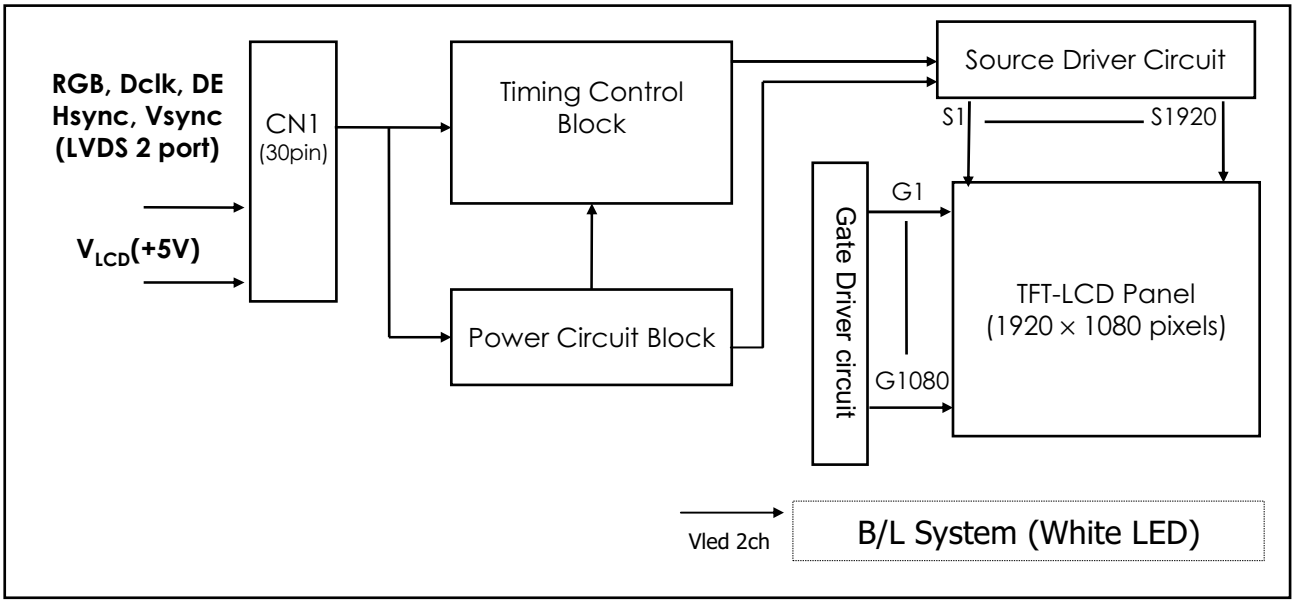


Figure 1. Block diagram

General Features

Active Screen Size	21.53 inches(546.86mm) diagonal
Outline Dimension	495.6(H) x 292.2(V) x 11.5(D) mm (Typ.)
Pixel Pitch	0.248 mm x 0.248mm
Pixel Format	1920 horiz. By 1080 vert. Pixels RGB stripes arrangement
Color Depth	16.7M colors (6bit + A FRC)
Luminance, White	250 cd/m^2 (Center 1 points)
Viewing Angle(CR>10)	View Angle Free (R/L 170(Typ.), U/D 160(Typ.))
Power Consumption	Total 16.2W (Typ.), (3.5W@V_{LCD} , 12.7W@I_{BL} =110mA)
Weight	1550g(Typ.), 1630g(Max.)
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer
Color Gamut	68% CIE1931

2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VLCD	4.5	5.5	Vdc	at 25 ± 2℃
Operating Temperature	TOP	0	50	℃	1, 2
Storage Temperature	TST	-20	60	℃	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	10	90	%RH	

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.
Note : 2. Storage condition is guaranteed under packing condition.

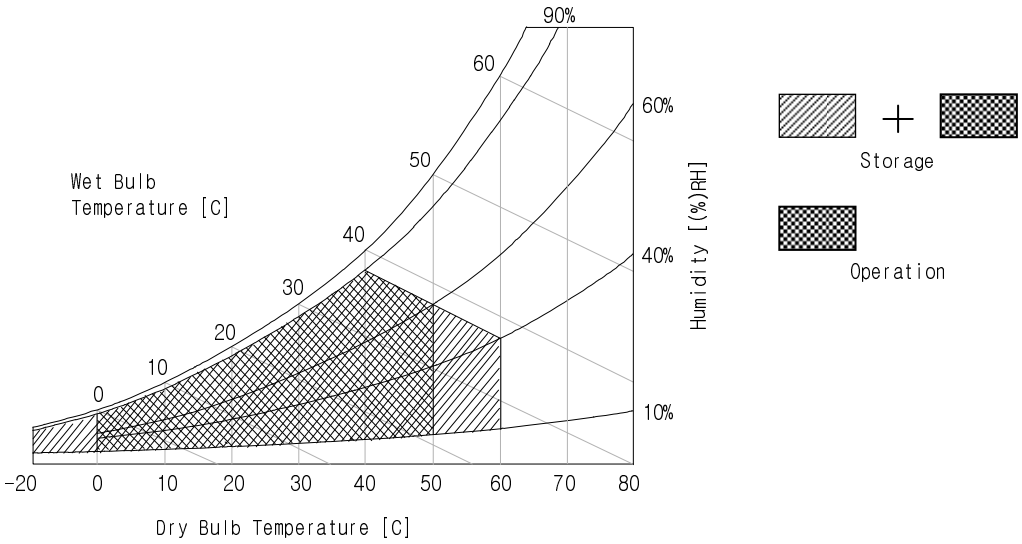


Figure 2. Temperature and relative humidity

3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the LED/Backlight, is typically generated by an LED driver. The driver is an external unit to the LCDs.

Table 2-1. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	4.5	5	5.5	Vdc	
Permissive Power Input Ripple	V_{dRF}			400	mV_{p-p}	1
Differential Impedance	Zm	90	100	110	Ohm	
Power Supply Input Current	I_{LCD}	-	700	805	mA	2
		-	900	1035	mA	3
Power Consumption	$P_{C\ TYP}$	-	3.5		Watt	2
	$P_{C\ MAX}$	-	4.5		Watt	3
Rush current	I_{RUSH}	-	-	3.0	A	4

Note :

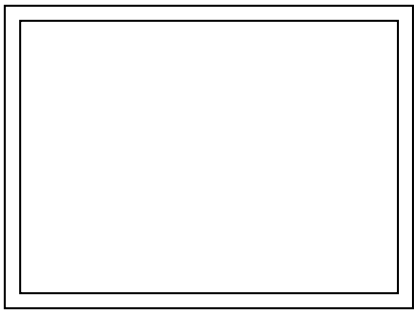
1. Permissive power ripple should be measured under VCC=5.0V, 25℃, fV(frame frequency)=MAX condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20Mhz. See the next page.

2. The specified current and power consumption are under the V_{LCD}=5.0V, 25 ± 2℃,f_V=60Hz condition whereas Mosaic and max power pattern shown in the [Figure 3] is displayed.

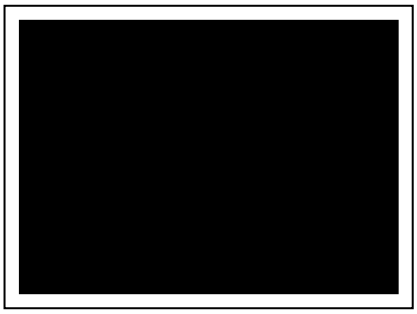
3. The current is specified at the maximum current pattern.

4. Maximum Condition of Inrush current :
   The duration of rush current is about 2ms and rising time of Input Voltage is 1ms(min.).
   At any rising time of Input voltage, Keep the I2T Value by below Condition
   Condition : I2T < 32*2ms

• **Permissive Power input ripple (**VCC=5.0V, 25℃, fV(frame frequency)=MAX condition**)**

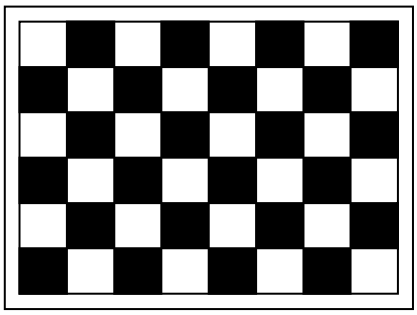


White pattern

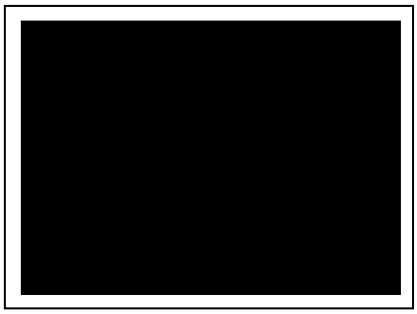


Black pattern

• **Power consumption (**VCC=5.0V, 25℃, fV (frame frequency=60Hz condition**)**



Typical power Pattern



Max power Pattern

Figure 3. Mosaic pattern & Black Pattern for power consumption measurement

Table 2_2. LED Bar ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
LED :							1,7
LED String Current	Is		-	110	130	mA	2,7
LED String Voltage	Vs		54.0	57.6	61.2	V	3,7
Power Consumption	PBar		11.9	12.7	13.5	Watt	4,6,7
LED Life Time	LED_LT		30,000	-	-	Hrs	5,7
LED Junction Temperature	Tj		-	-	70	℃	7

LED driver design guide

: The design of the LED driver must have specifications for the LED in LCD Assembly.
The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver.
So all the parameters of an LED driver should be carefully designed and output current should be Constant current control.
When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the LED driver (no lighting, flicker, etc) never occurs.
When you confirm it, the LCD module should be operated in the same condition as installed in your instrument.

1. Specified values are for a single LED bar.
2. The specified current is input LED chip 100% duty current.
3. The specified voltage is input LED string voltage at typical 110 mA 100% duty current.
4. The specified power consumption is input LED bar power consumption at typical 110 mA 100% duty current.
5. The life 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℃.
6. The LED bar power consumption shown above does not include loss of external driver.
   The used LED string current is the LED typical current.
   Typ Power Consumption is calculated with PBar = Vs(Typ.) x Is(Typ.) x Nstring
   Max Power Consumption is calculated with PBar = Vs(Max.) x Is(Typ) x Nstring
7. LED operating DC Forward Current and Junction Temperature must not exceed LED Max Ratings at 25 ± 2℃.

3-2. Interface Connections

This LCD employs Two interface connections, a 30 pin connector is used for the module electronics and a 4Pin Connector is used for the integral backlight system.

3-2-1. LCD Module

- LCD Connector(CN1): GT103-30S-HF15-E2500, (Manufactured by LSC)
- Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Symbol
1	FR0M	Minus signal of odd channel 0 (LVDS)	16	SR1P	Plus signal of even channel 1 (LVDS)
2	FR0P	Plus signal of odd channel 0 (LVDS)	17	GND	Ground
3	FR1M	Minus signal of odd channel 1 (LVDS)	18	SR2M	Minus signal of even channel 2 (LVDS)
4	FR1P	Plus signal of odd channel 1 (LVDS)	19	SR2P	Plus signal of even channel 2 (LVDS)
5	FR2M	Minus signal of odd channel 2 (LVDS)	20	SCLKINM	Minus signal of even clock channel (LVDS)
6	FR2P	Plus signal of odd channel 2 (LVDS)	21	SCLKINP	Plus signal of even clock channel (LVDS)
7	GND	Ground	22	SR3M	Minus signal of even channel 3 (LVDS)
8	FCLKINM	Minus signal of odd clock channel (LVDS)	23	SR3P	Plus signal of even channel 3 (LVDS)
9	FCLKINP	Plus signal of odd clock channel (LVDS)	24	GND	Ground
10	FR3M	Minus signal of odd channel 3 (LVDS)	25	NC	No Connection
11	FR3P	Plus signal of odd channel 3 (LVDS)	26	NC	No Connection
12	SR0M	Minus signal of even channel 0 (LVDS)	27	PWM_OUT	For Control Burst frequency of Inverter
13	SR0P	Plus signal of even channel 0 (LVDS)	28	V_{LCD}	Power Supply +5.0V
14	GND	Ground	29	V_{LCD}	Power Supply +5.0V
15	SR1M	Minus signal of even channel 1 (LVDS)	30	V_{LCD}	Power Supply +5.0V

Note: 1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
2. All V_{LCD} (power input) pins should be connected together.
3. Input Level of LVDS signal is based on the IEA 664 Standard.

Rear view of LCM

GT103-30S-HF15-E2500(LSC)

[Figure 4] Connector diagram

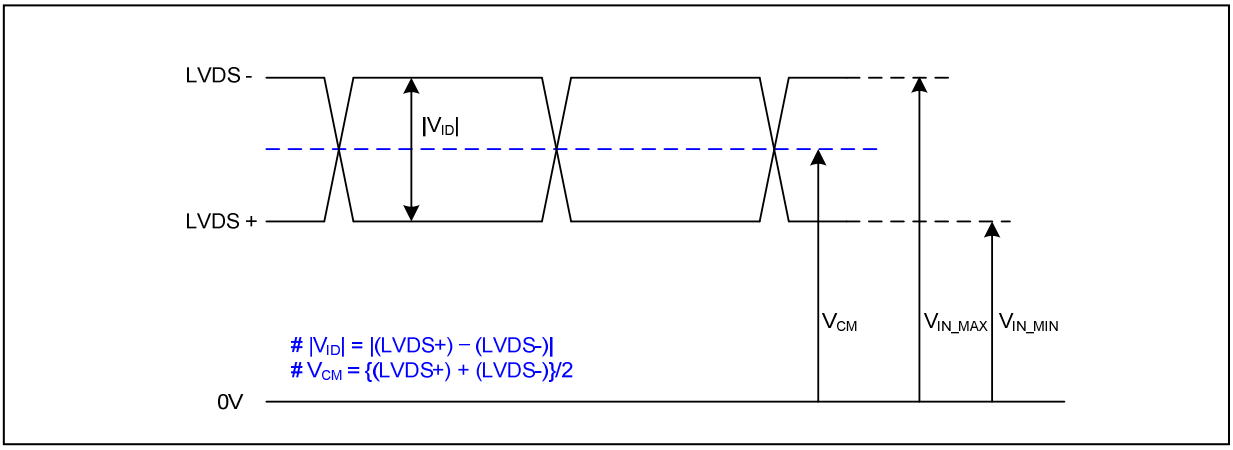
Table 4. REQUIRED SIGNAL ASSIGNMENT FOR Flat Link (TI:SN75LVDS83) Transmitter

Pin #	Pin Name	Require Signal	Pin #	Pin Name	Require Signal
1	Vcc	Power Supply for TTL Input	29	GND	Ground pin for TTL
2	D5	TTL Input (R7)	30	D26	TTL Input (DE)
3	D6	TTL Input (R5)	31	T_X CLKIN	TTL Level clock Input
4	D7	TTL Input (G0)	32	PWR DWN	Power Down Input
5	GND	Ground pin for TTL	33	PLL GND	Ground pin for PLL
6	D8	TTL Input (G1)	34	PLL Vcc	Power Supply for PLL
7	D9	TTL Input (G2)	35	PLL GND	Ground pin for PLL
8	D10	TTL Input (G6)	36	LVDS GND	Ground pin for LVDS
9	Vcc	Power Supply for TTL Input	37	TxOUT3+	Positive LVDS differential data output 3
10	D11	TTL Input (G7)	38	TxOUT3−	Negative LVDS differential data output 3
11	D12	TTL Input (G3)	39	T_X CLKOUT+	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T_X CLKOUT−	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T_X OUT2+	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T_X OUT2−	Negative LVDS differential data output 2
15	D15	TTL Input (B0)	43	LVDS GND	Ground pin for LVDS
16	D16	TTL Input (B6)	44	LVDS Vcc	Power Supply for LVDS
17	Vcc	Power Supply for TTL Input	45	T_X OUT1+	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T_X OUT1−	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T_X OUT0+	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T_X OUT0−	Negative LVDS differential data output 0
21	GND	Ground pin for TTL Input	49	LVDS GND	Ground pin for LVDS
22	D20	TTL Input (B3)	50	D27	TTL Input (R6)
23	D21	TTL Input (B4)	51	D0	TTL Input (R0)
24	D22	TTL Input (B5)	52	D1	TTL Input (R1)
25	D23	TTL Input (RSVD)	53	GND	Ground pin for TTL
26	Vcc	Power Supply for TTL Input	54	D2	TTL Input (R2)
27	D24	TTL Input (HSYNC)	55	D3	TTL Input (R3)
28	D25	TTL Input (VSYNC)	56	D4	TTL Input (R4)

Notes : Refer to LVDS Transmitter Data Sheet for detail descriptions.

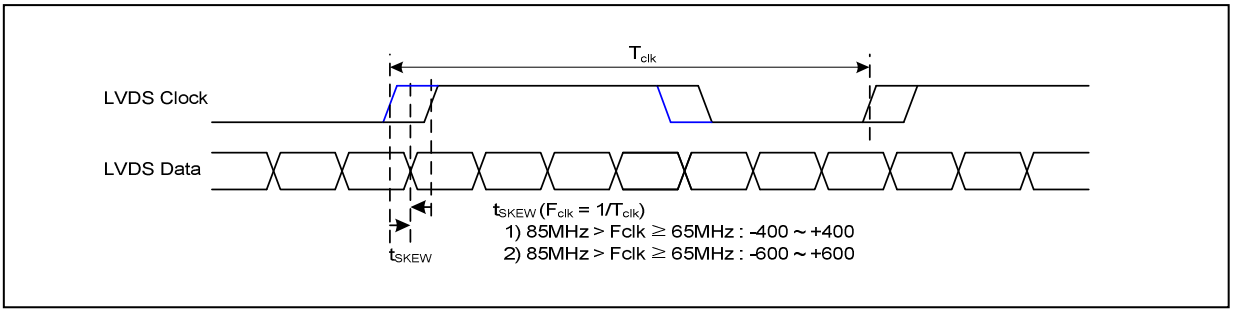
LVDS Input characteristics

1. DC Specification

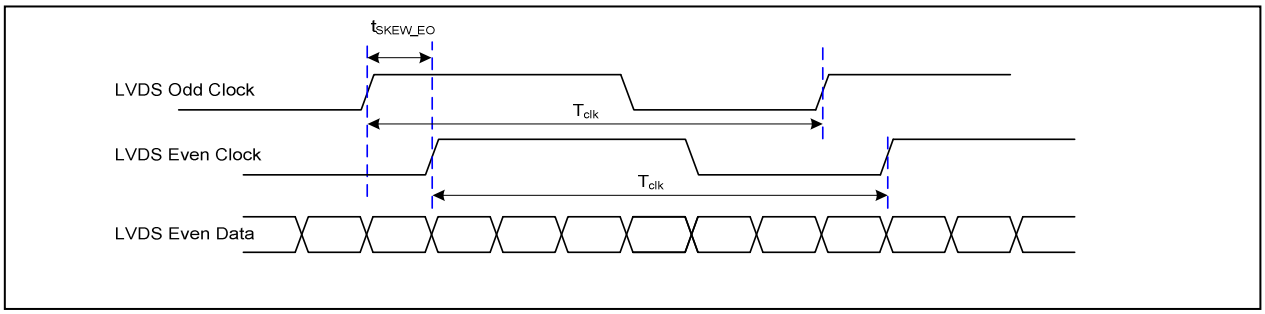


Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	100	600	mV	-
LVDS Common mode Voltage	V_{CM}	0.6	1.8	V	-
LVDS Input Voltage Range	V_{IN}	0.3	2.1	V	-

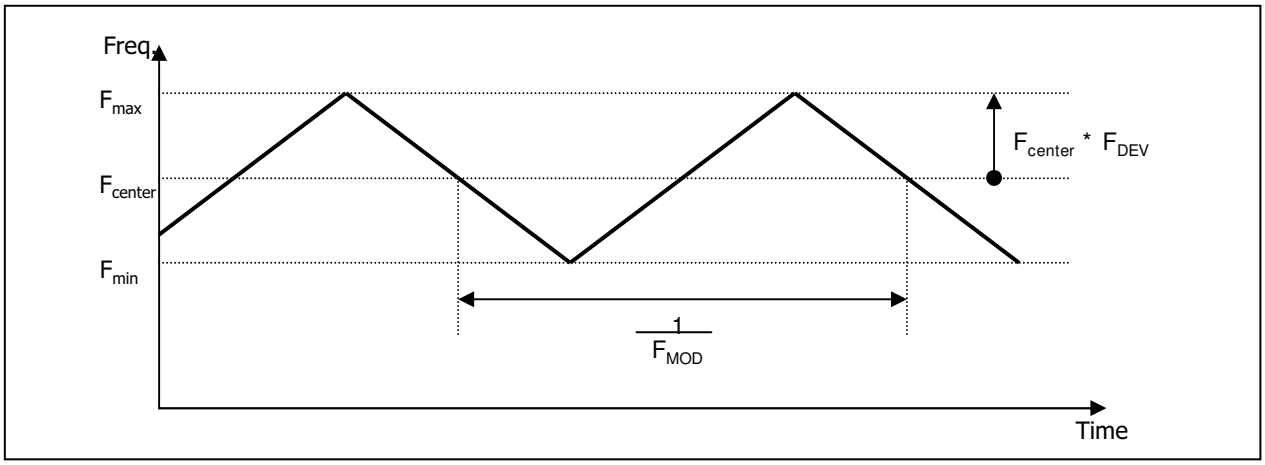
2. AC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 25MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-
Maximum deviation of input clock frequency during SSC	F_{DEV}	-	± 3	%	-
Maximum modulation frequency of input clock during SSC	F_{MOD}	-	200	KHz	-



< Clock skew margin between channel >



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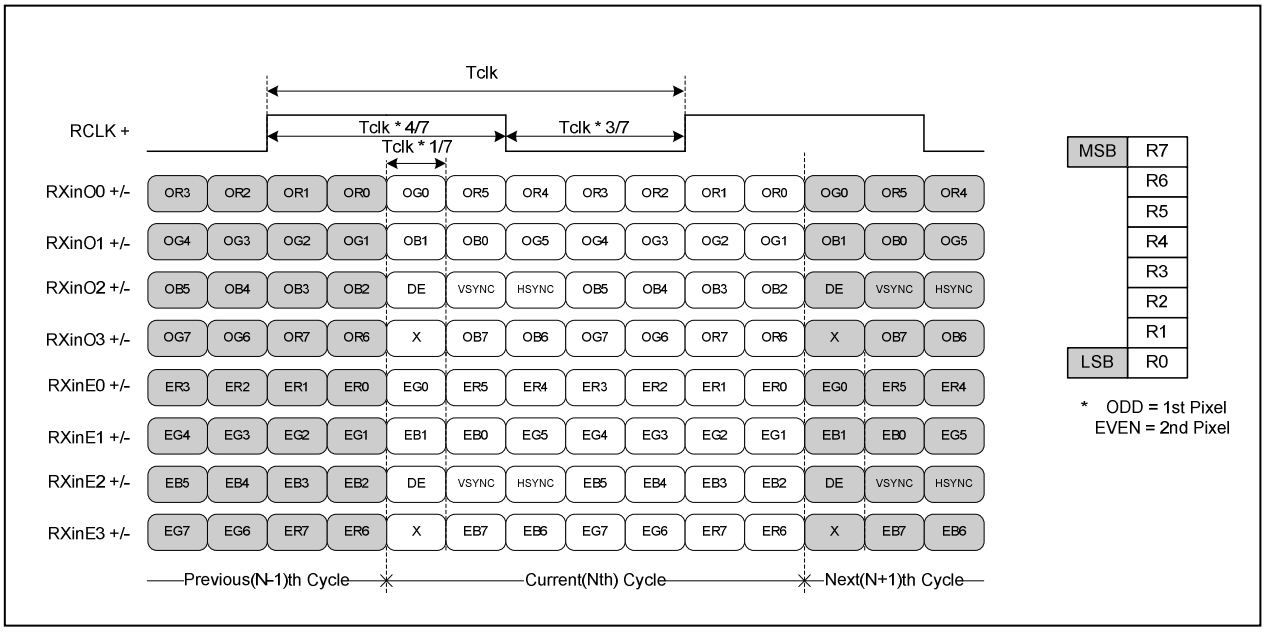
3. Data Format

1) LVDS 2 Port



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2) LVDS 1 Port

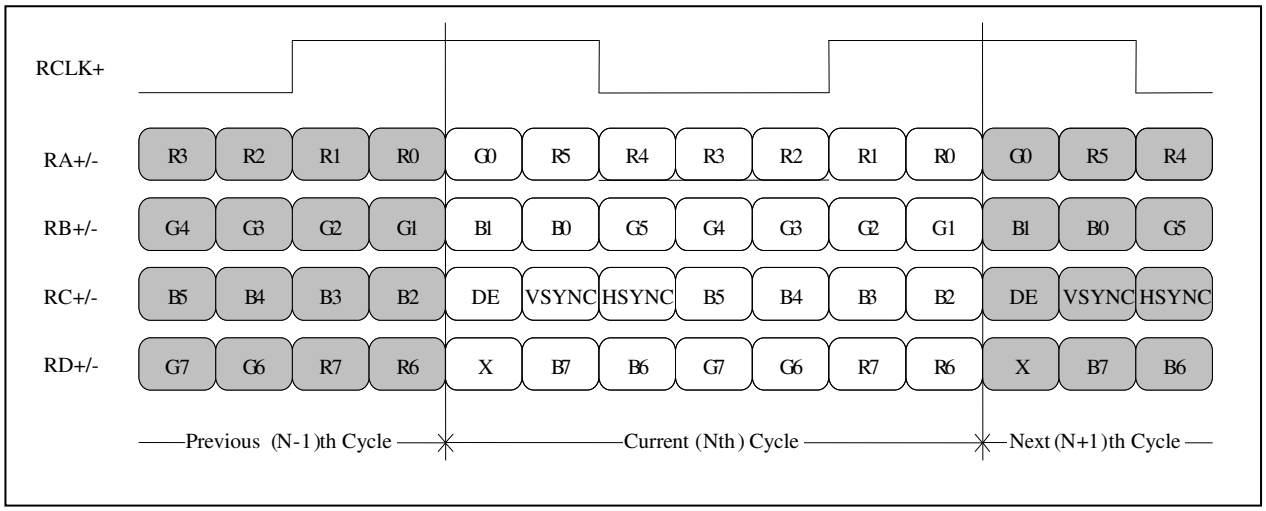
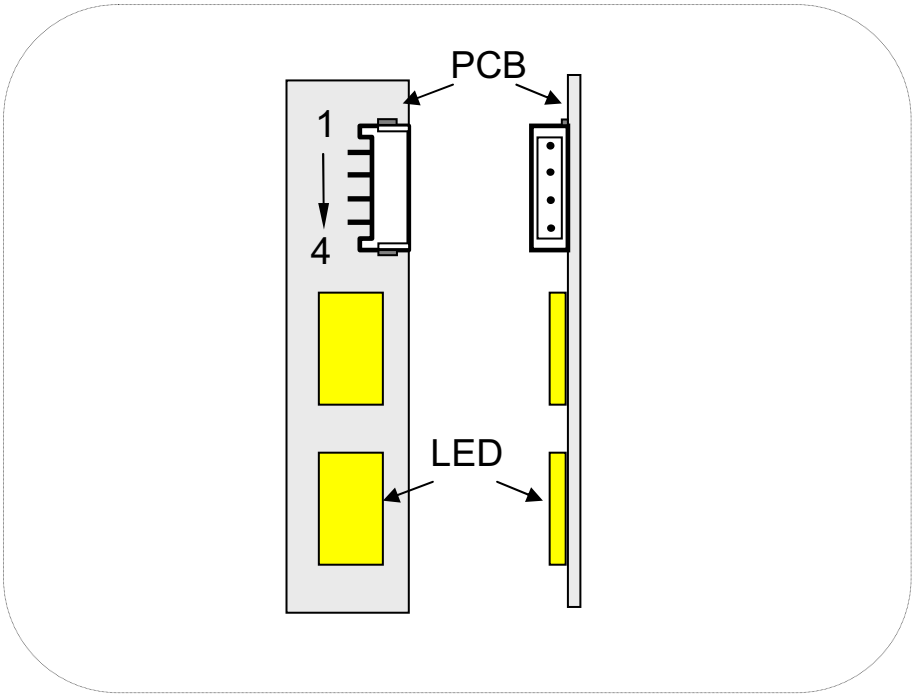


Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION

The LED interface connector is a model FN100-Z04B-C20 manufactured by UJU.
The mating connector a FFC/FPC marked LED interface connector specification.
The pin configuration for the connector is shown in the table below.

Pin	Symbol	Description	Notes
1	NC	No Connection	
2	FB1	Channel1 Current Feedback	
3	FB2	Channel2 Current Feedback	
4	VLED	LED Power Supply	



[Figure 5] Backlight connector diagram

3-3. Signal Timing Specifications

This is signal timing required at the input of the TMDS transmitter. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

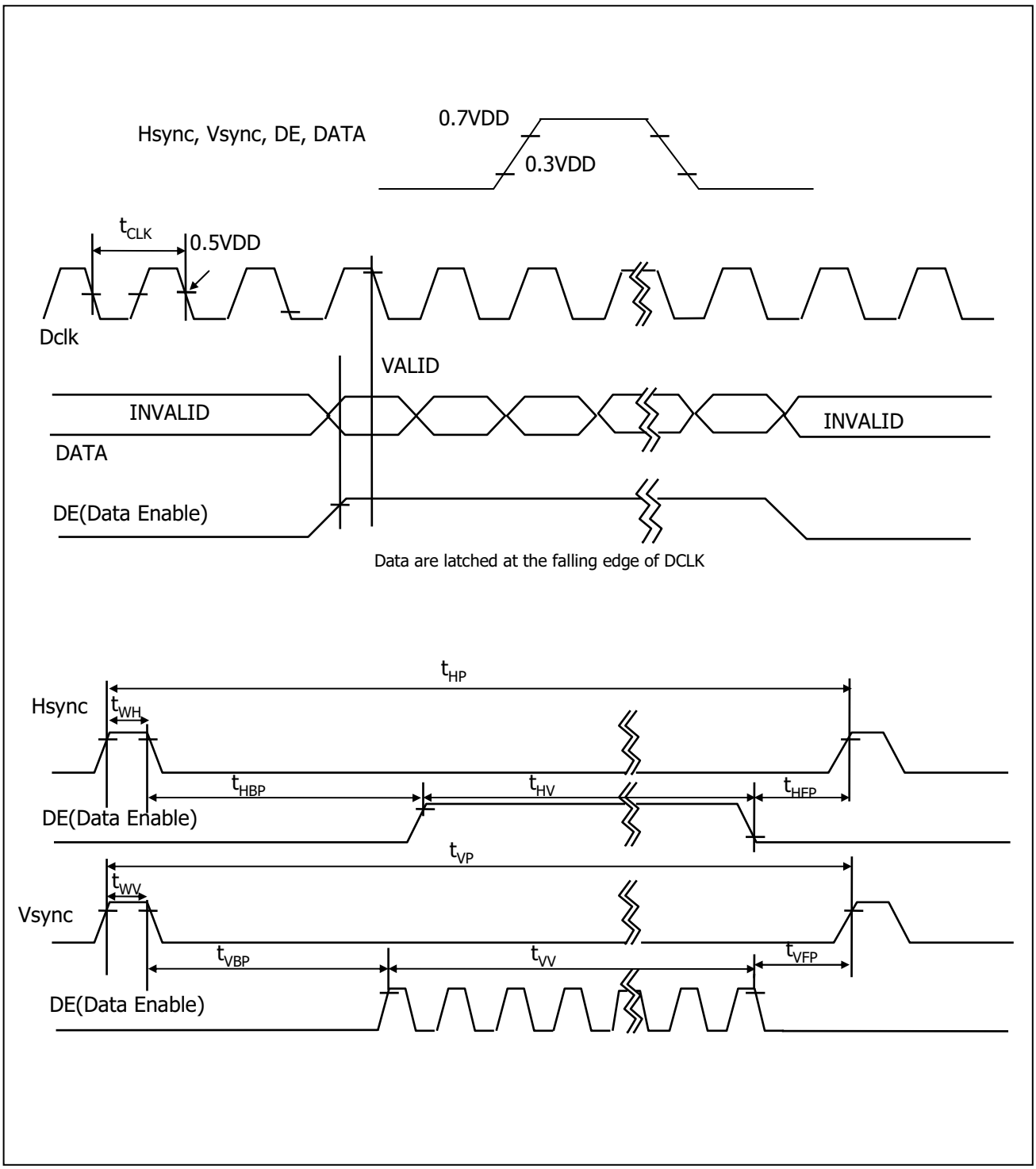
Table 5. TIMING TABLE

ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	11.43	13.89	16.67	ns	
	Frequency	-	60	72	87.5	MHz	5
Hsync	Period	tHP	1000	1088	1120	tCLK	
	Horizontal Valid	tHV	960	960	960	tCLK	
	Horizontal Blank	tHB	40	128	160		
	Frequency	fH	64	66	83	KHz	
	Width	tWH	8	32	48	tCLK	
	Horizontal Back Porch	tHBP	16	48	64		
	Horizontal Front Porch	tHFP	16	48	48		
Vsync	Period	tVP	1090	1100	1160	tHP	
	Vertical Valid	tVV	1080	1080	1080	tHP	
	Vertical Blank	tVB	10	20	80	tHP	
	Frequency	fV	50	60	75	Hz	
	Width	tWV	2	4	16	tHP	
	Vertical Back Porch	tVBP	5	8	32		
	Vertical Front Porch	tVFP	3	8	32		

Note: Hsync period and Hsync width-active should be even number times of tCLK. If the value is odd number times of tCLK, display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsyn, and DE(data enable) signals should be used.

1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of of character number(4).
4. The polarity of Hsync, Vsync is not restricted.
5, The Max frequency of 1920X1080 resoution is 82.5Mhz

3-4. Signal Timing Waveforms



3-5. Color Data Reference

The Brightness of each primary color(red,green,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 a reference for color versus data input.

Table 6. COLOR DATA REFERENCE

Color		Input Color Data																							
		RED								GREEN								BLUE							
		MSB							LSB	MSB							LSB	MSB							LSB
		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 Color	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 (255)	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 (255)	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 (255)	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
RED	RED (000) Dark	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 (001)	0	0	0	0	0	0	0	1	0	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	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	0
GREEN	GREEN (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	...					...								...								...			
	GREEN (254)	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 (255)	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	BLUE (000) Dark	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 (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...					...								...								...			
	BLUE (254)	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 (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3-6. Power Sequence

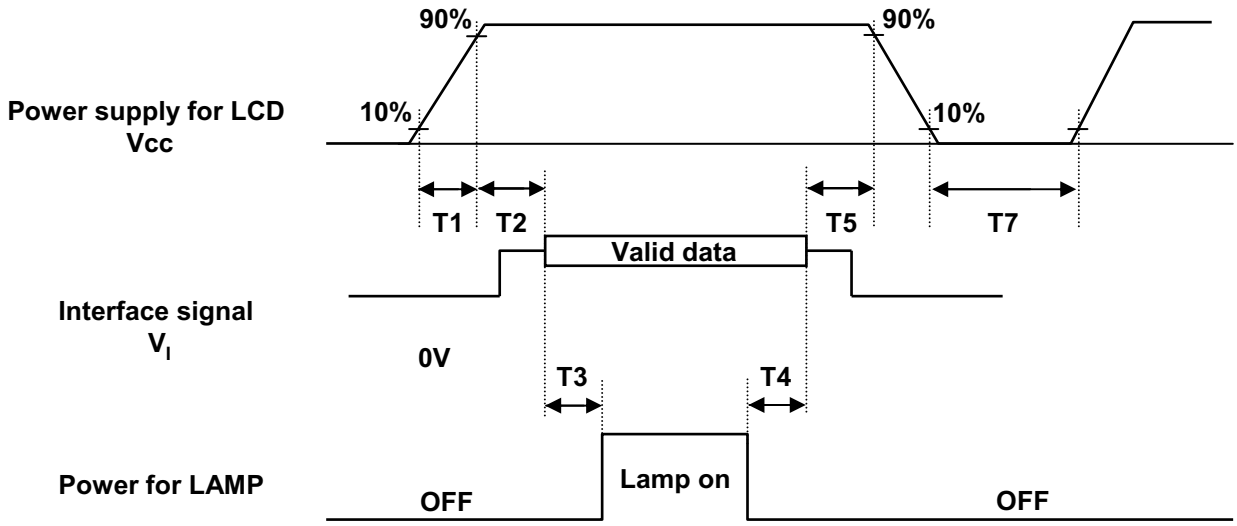


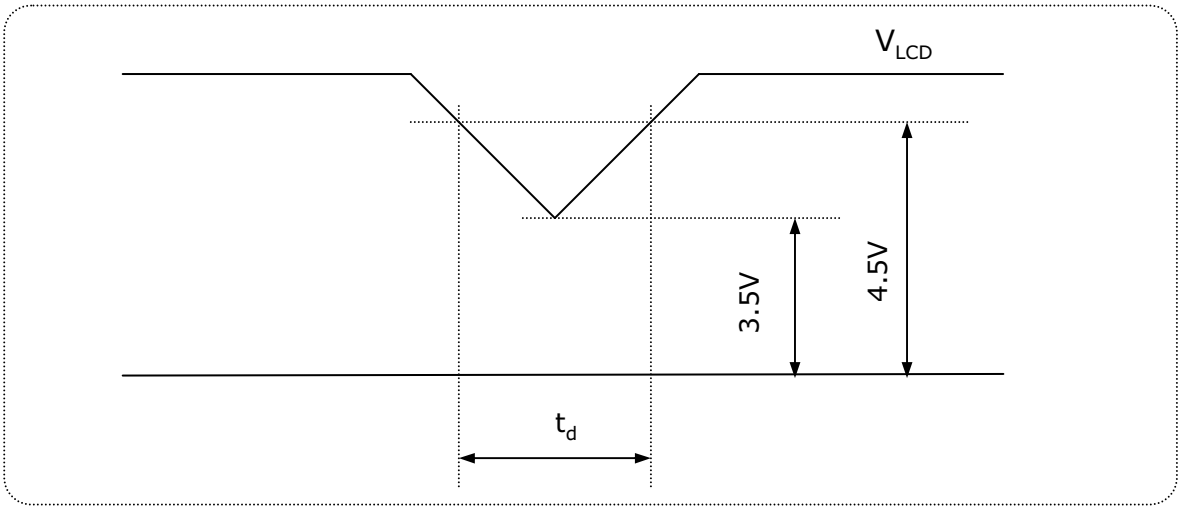
Table 7. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T7	500		-	ms

Notes : 1. Please avoid floating state of interface signal at invalid period.
2. When the interface signal is invalid, be sure to pull down the power supply for LCD V_{LCD} to 0V.
3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

3-7. V_{LCD} Power Dip Condition

The V_{LCD} dip condition is caused by the PWM IC initialization.



1) Dip condition

$3.5V \leq V_{LCD} < 4.5V$, $t_d \leq 20ms$

2) $V_{LCD} < 3.5V$

V_{LCD}-dip conditions should also follow the Power On/Off conditions for supply voltage.

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at 25± 2℃. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 ° and aperture 1 degree.

FIG. 6 presents additional information concerning the measurement equipment and method.

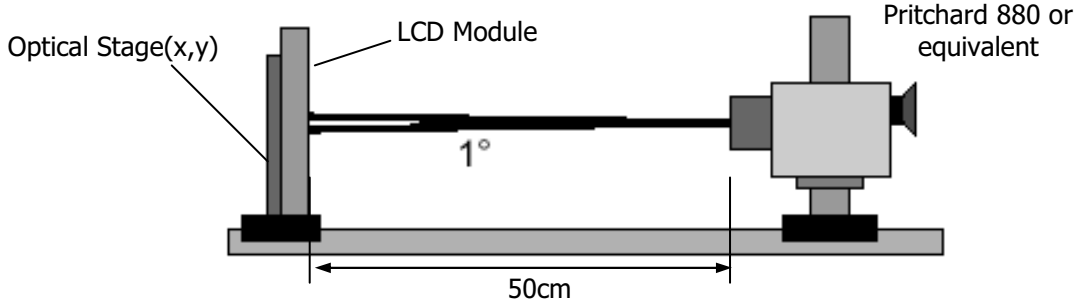


FIGURE. 6 Optical Characteristic Measurement Equipment and Method

Table 8. OPTICAL CHARACTERISTICS (Ta=25 ℃, V_{LCD}=5V, f_V=60Hz Dclk=144MHz, ILED=110mA)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WH}	200	250	-	cd/m^2	2
Luminance Variation		δ_{WHITE} 9P	75	-	-	%	3
Response Time	Rise Time	Tr_R	-	1.3	2.6	ms	4
	Decay Time	Tr_D	-	3.7	7.4	ms	4
Color Coordinates [CIE1931] (By PR650)	RED	Rx	Typ -0.03	0.631	Typ +0.03		
		Ry		0.349			
	GREEN	Gx		0.341			
		Gy		0.622			
	BLUE	Bx		0.152			
		By		0.058			
	WHITE	Wx		0.313			
		Wy		0.329			
Viewing Angle (CR>5)							
	x axis, right(ϕ=0°)	θr	75	88	-	Degree	5
	x axis, left (ϕ=180°)	θl	75	88	-		
	y axis, up (ϕ=90°)	θu	70	85	-		
	y axis, down (ϕ=270°)	θd	70	85	-		
Viewing Angle (CR>10)							
	x axis, right(ϕ=0°)	θr	70	85	-	Degree	5
	x axis, left (ϕ=180°)	θl	70	85	-		
	y axis, up (ϕ=90°)	θu	60	75	-		
	y axis, down (ϕ=270°)	θd	70	85	-		
Gray Scale (Gamma)			-	2.2	-		6
Cross talk			-	-	1.5	%	7
Luminance uniformity - Angular dependence (TCO 5.0)		LR	-	-	1.7		8

Notes 1. **Contrast Ratio(CR)** is defined mathematically as : (By PR880)

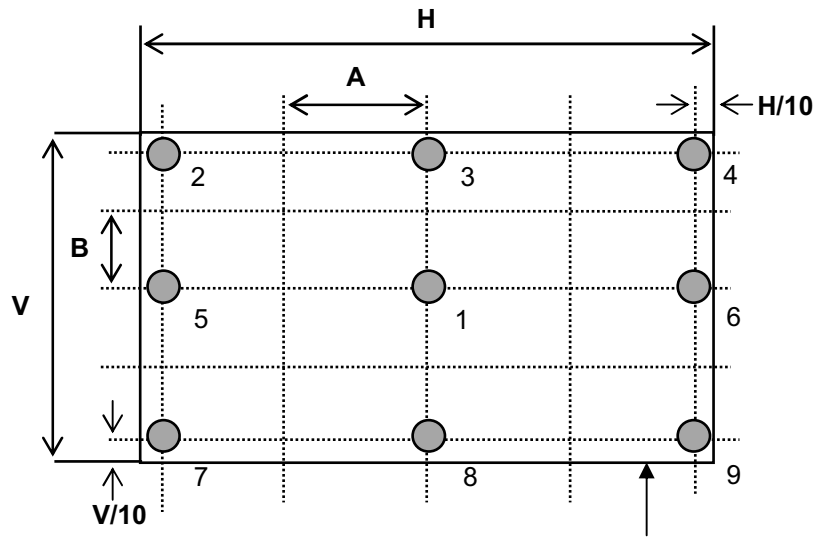
$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

2. **Surface luminance** is luminance value at No.1 point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 7. (By PR880)

3. **The variation in surface luminance , δ WHITE** is defined as : (By PR880)

$$\delta_{WHITE} = \frac{\text{Minimum}(L_{on1}, L_{on2}, \ldots L_{on9})}{\text{Maximum}(L_{on1}, L_{on2}, \ldots L_{on9})} \times 100(\%)$$

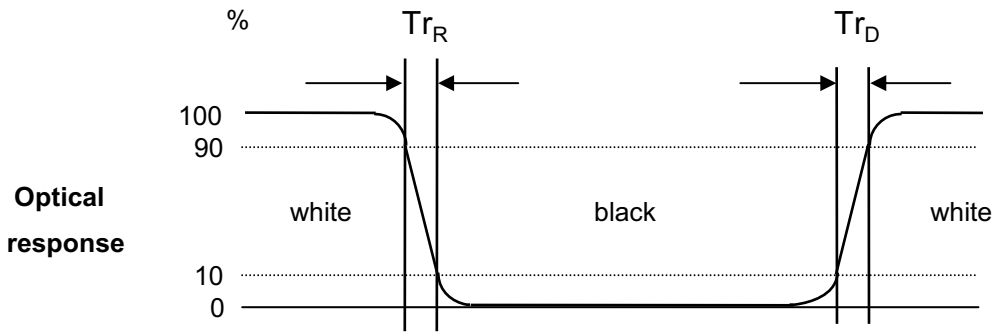
Measuring point for surface luminance & measuring point for luminance variation



A : H/4 mm
B : V/4 mm
@ H,V : Active Area

[FIGURE 7] Measure Point for Luminance

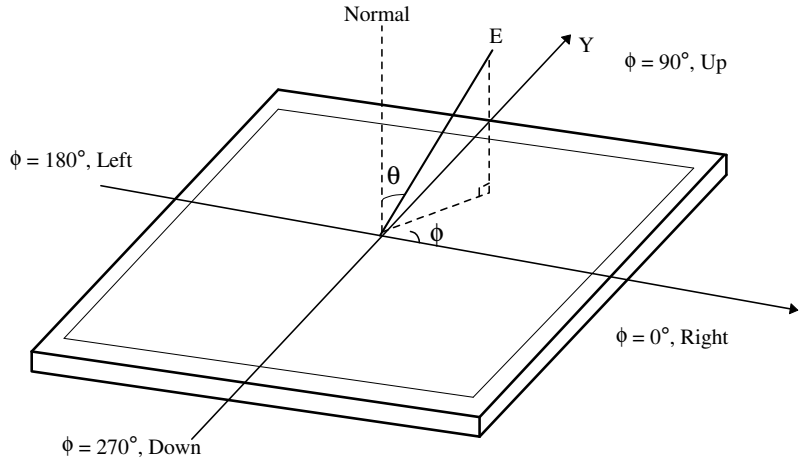
4. **The response time** is defined as the following figure and shall be measured by switching the input signal for "black" and "white".
Response time is the time required for the display to transition from white to black (Rise Time, T_{rR}) and from black to white (Decay Time, T_{rD}). (By RD80S)



[FIGURE 8] Response Time

5. **Viewing angle** is the angle at which the contrast ratio is greater than 10 or 5. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG. 9 . (By PR880)

<Dimension of viewing angle range>



[FIGURE 9] Viewing angle

6. **Gray scale** specification

Gamma Value is approximately 2.2. For more information see Table 9

Table 9. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.11
31	1.08
63	4.72
95	11.49
127	21.66
159	35.45
191	53.0
223	74.48
255	100

7. **Cross talk** specification

The equation of crosstalk : $(|L_{A[or\ C]2}-L_{A[or\ C]1}|/L_{A[or\ C]1})\times100(\%)$ [Vertical],
$(|L_{B[or\ D]2}-L_{B[or\ D]1}|/L_{B[or\ D]1})\times100(\%)$ [Horizontal]

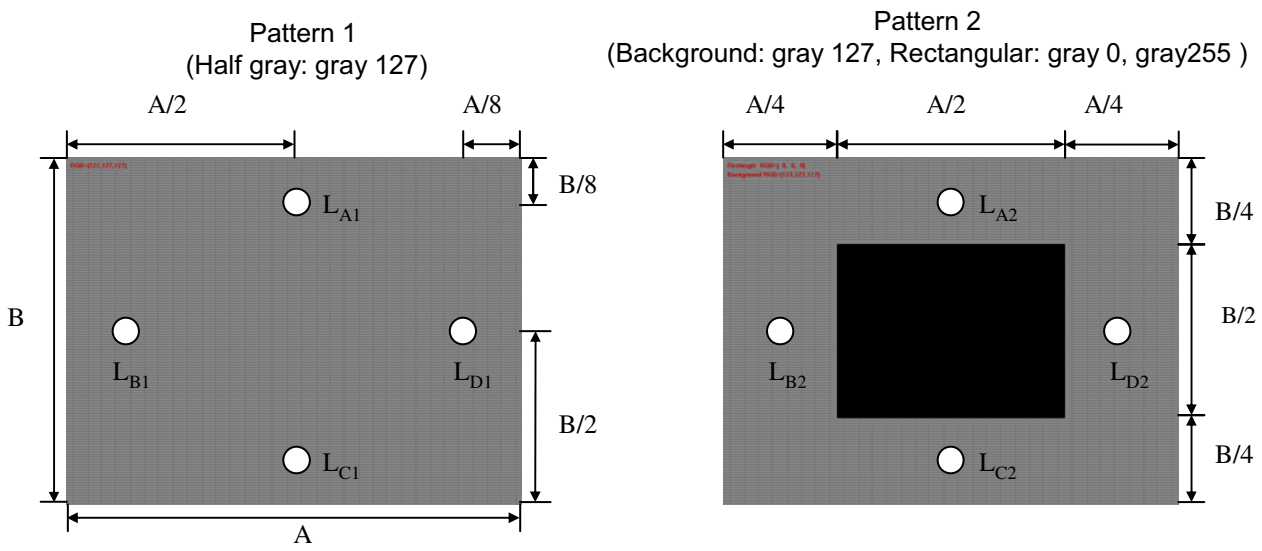


Figure 10. Crosstalk

8. **Luminance Uniformity - angular – dependence** (LR& TB)

TCO 5.0 Luminance uniformity – angular dependence, is the capacity of the VDU to present the same Luminance level independently of the viewing direction.
The angular-dependent luminance uniformity is calculated as the ratio of maximum luminance to minimum luminance in the specified measurement areas.

- Test pattern : 80% white pattern
- Test point : 2-point
- Test distance : D * 1.5 = 76.22㎝
- Test method : $L_R = ((L_{max.+30deg.} / L_{min.+30deg.}) + (L_{max.-30deg.} / L_{min.-30deg.})) / 2$
  $T_B = ((L_{max.+15deg.} / L_{min.+15deg.})$

< Luminance uniformity - angular dependence measuring point >

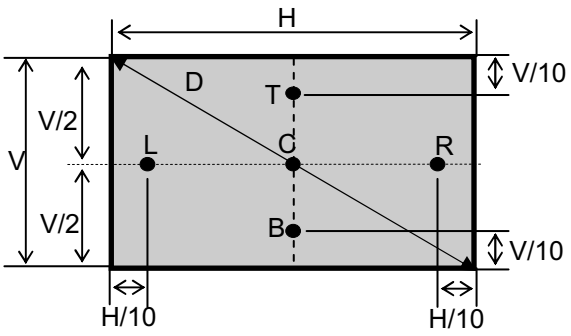


Figure 11. Luminance Uniformity angular dependence

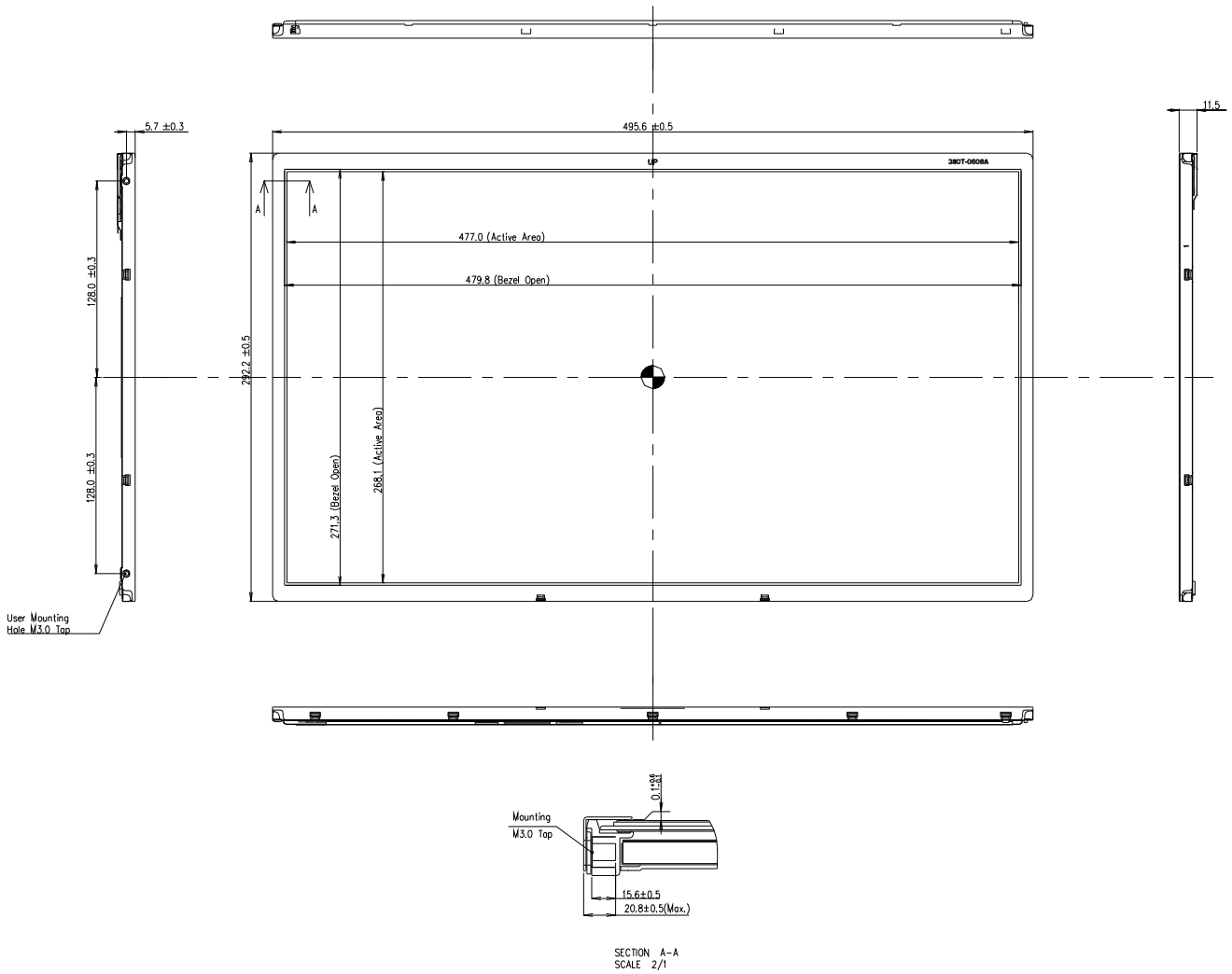
5. Mechanical Characteristics

The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	495.6mm
	Vertical	292.2mm
	Depth	11.5 mm
Bezel Area	Horizontal	479.8mm
	Vertical	271.3mm
Active Display Area	Horizontal	476.64mm
	Vertical	268.11mm
Weight	1550g(typ.), 1630g(Max.)	
Surface Treatment	Hard coating(3H) Anti-glare treatment of the front polarizer	

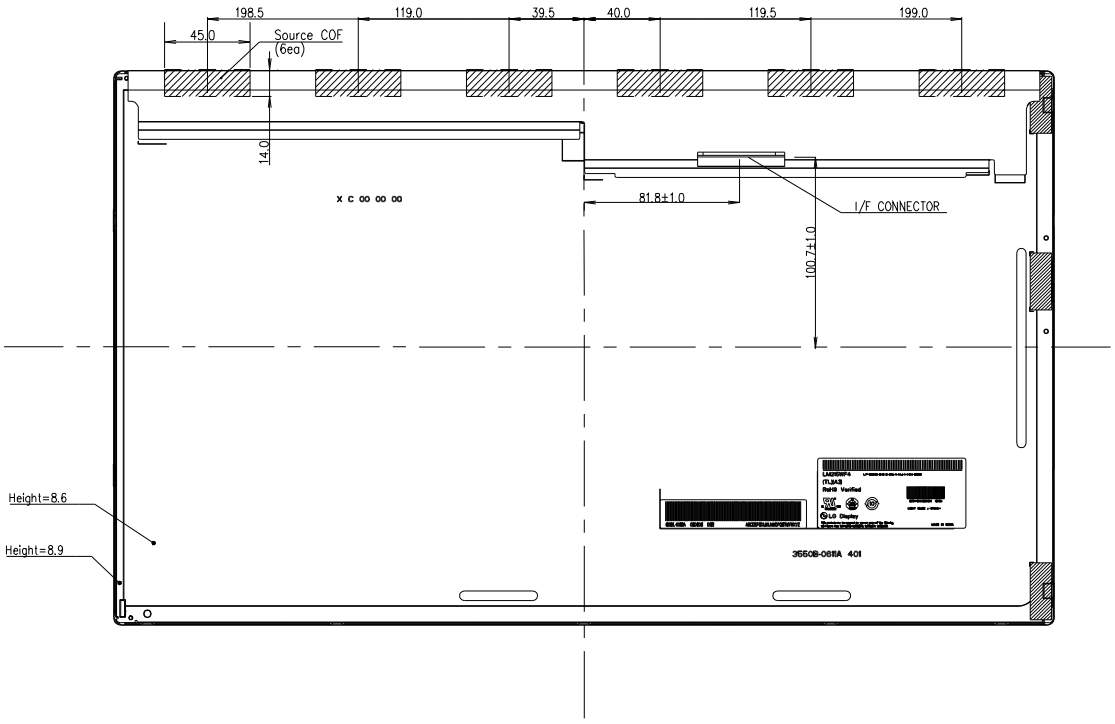
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

<FRONT VIEW>

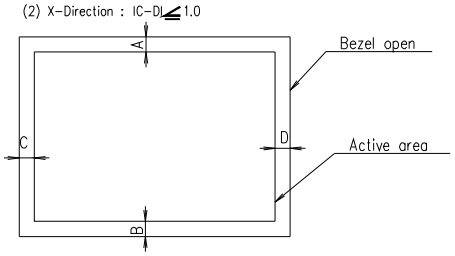


Product Specification

<REAR VIEW>



NOTES
1. Backlight has 1 LED Array Ass'y
2. I/F Connector Specification : GT103-30S-HF15-E2500(LSC) or Equivalent
3. Torque of user hole : 3.0~4.0kgf-cm
4. Tilt and partial disposition tolerance of display area as following
   (1) Y-Direction : IA-BI ≤ 1.0
   (2) X-Direction : IC-DI ≤ 1.0



5. Unspecified tolerances to be ±0.5mm
6. LCM Weight : 1550g(Typ.) 1630g(Max)
7. The ass'y should have no defect in appearance
8. Designer's approval is required before mass-production

6. Reliability

Environment test condition

No	Test Item	Condition
1	High temperature storage test	Ta= 60℃ 240h
2	Low temperature storage test	Ta= -20℃ 240h
3	High temperature operation test	Ta= 50℃ 50%RH 240h
4	Low temperature operation test	Ta= 0℃ 240h
5	Vibration test (non-operating)	Wave form : random Vibration level : 1.00G RMS Bandwidth : 10-300Hz Duration : X, Y, Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100G Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
7	Humidity condition Operation	Ta= 40 ℃ ,90%RH
8	Altitude storage / shipment	0 - 40,000 feet(12192m)

7. International Standards

7-1. Safety

a) UL 60950-1, Second Edition, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.

b) CAN/CSA C22.2 No.60950-1-07, Second Edition, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.

c) EN 60950-1:2006 + A11:2009, European Committee for Electrotechnical Standardization(CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.

d) IEC 60950-1:2005, Second Edition, The International Electrotechnical Commission (IEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.
(Including report of IEC60825-1:2001 clause 8 and clause 9)

Notes
1. Laser (LED Backlight) Information

Class 1M LED Product IEC60825-1 : 2001 Embedded LED Power (Class1M) Power : 4.44 mW (Max.) Wavelength : 258 ~ 622 (nm) Width : 1.5 x 0.6 (mm)

2. Caution
: LED inside.
Class 1M laser (LEDs) radiation when open.
Do not open while operating.

7-2. EMC

a) ANSI C63.4 "American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz." American National Standards Institute (ANSI), 2003.

b) CISPR 22 "Information technology equipment – Radio disturbance characteristics – Limit and methods of measurement." International Special Committee on Radio Interference (CISPR), 2005.

c) CISPR 13 "Sound and television broadcast receivers and associated equipment – Radio disturbance characteristics – Limits and method of measurement." International Special Committee on Radio Interference (CISPR), 2006.

7-3. Environment

a) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

8. Packing

8-1. Designation of Lot Mark

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M

A,B,C : SIZE(INCH)
D : YEAR
E : MONTH
F ~ M : SERIAL NO.

Note

1. YEAR

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mark	1	2	3	4	5	6	7	8	9	0

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

8-2. Packing Form

a) Package quantity in one box : 10pcs

b) Box size :364mm X314mm X593mm

9. PRECAUTIONS

Please pay attention to the followings when you use this TFT LCD module.

9-1. MOUNTING PRECAUTIONS

(1) You must mount a module using holes arranged in four corners or left sides.
(2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
(3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to the resist external force.
(4) You should adopt radiation structure to satisfy the temperature specification.
(5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
(6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics are detrimental to the polarizer.)
(7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
(8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(9) Do not open the case because inside circuits do not have sufficient strength.

9-2. OPERATING PRECAUTIONS

(1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
V=± 200mV(Over and under shoot voltage)
(2) Response time depends on the temperature.(In higher temperature, it becomes longer.)
(3) Brightness depends on the temperature. (In higher temperature, it becomes lower.)
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
(4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
(5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.
(7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
(8) A screw which is fastened up the steels should be a machine screw.
(if not, it causes metallic foreign material and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.

9-3. ELECTROSTATIC DISCHARGE CONTROL

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

9-5. STORAGE

When storing modules as spares for a long time, the following precautions are necessary.

(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5℃ and 35℃ at normal humidity.
(2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

9-6. HANDLING PRECAUTIONS FOR PROTECTION FILM

(1) The protection film is attached to the bezel with a small masking tape.
When the protection film is peeled off, static electricity is generated between the film and polarizer.
This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
(2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.
(3) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.