* The date(Create Date, Approved Date, Check Date) is based on Korean standard time(GMT+9)

Created Date	2010-07-23 19:48 (Korea Time)
Requested by	윤석재 (BS Module그룹 / 과장 , 82-31-610-9654)
Subject	[Formal Approval] EAJ61327601/2 LGD 21.5"W Plus10 250nits(LM215WF1-TLE1/2)

EDMS Attributes

Biz Map	Procure Materials and Services > Develop Procurement Strategy		
Team Map	BS Sourcing팀 > BS Module전략Sourcing그룹		
Doc Type	Approval	Retention	5 Year
Info Type			
Security Grade	Internal use (Only)	Doc Language	Korean

Component Development Information

Model : W2243TE, LSM2150, W2246S, W2246V, W2246PM, W2230S
Approval type : New (●) ECR() Limit () Revision () 4M ()
HSMS (RoHS) : Complete (●) Limit Approval () Warranty Approval ()
Reliability test : Needless ( ) Need (Test Report No: ●)
Module Name : LM215WF1-TLE1_ZBD(P/N : EAJ61327601)
LM215WF1-TLE2_Non-ZBD(P/N : EAJ61327602)
Maker : LG Display
Specification : LM215WF1-TLE1/2 FHD 21.5INCH 1920X1080 250CD COLOR 72% 16/9 1000:1 V/A 160/170, R/T 5ms
Key parts list : Fab P6, C/F LGD, Pol LGC, T-con SiW, S-IC Lusem, G-IC GIP, B/L ass'y Heesung
Lamp Heesung, B/L sheet Diffuser+Prism+Diffuser
Development History : LGD 21.5"W Plus10 250nits Module Development

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★Safety Standard Parts [안전규격부품 List]
Power Cord, Power Plug, X / Y-Capacitor, Power Switch, Fuse, SMPS Trans, Stand-By Trans, Photo coupler, Insulation (절연) Resistor, Discharge (방전)Resistor, Fusing Resistor, FBT,CPT, CPT Socket, DY, D-Coil, Line Filter, PCB Material, Front / Back-cover Material, Relay(1-2차간), Varistor, Adaptor, PSU(Power supply unit)
★EMC Standard Parts [전파규격 부품 List]
Power Plug, Line Filter, X-Capacitor, Y-Capacitor, SMPS Trans, Tuner, Saw-Filter, Shield Case, Oscillator, Pattern Change
★Green [유해물질 확인사항]
This item must meet the standards of LG Electronics for six major substances as designated by RoHS for control.

Approval Line

Approval Type	Status	Approved Date	Approved by / Comment
Agree	Approved	2010-07-24 12:33	HUI KANG (LGEND R&D.COMPONENT DEVELOPMENT GROUP / assist manager) Comment : ok
Agree	Approved	2010-07-24 14:02	xiaodong li (LGEND R&D.COMPONENT DEVELOPMENT GROUP / manager a) Comment : OK
Agree	Approved	2010-07-24 14:10	HUAN CHEN (LGEND R&D.MNT PLANNING GROUP / assist manager) Comment : OK
Agree	Approved	2010-07-26 09:14	danyang huang (LGEND R&D.MNT PLANNING GROUP / manager b)
Agree	Approved	2010-07-26 11:12	황동선 (LGEND R&D.MNT S/W GROUP / 수석연구원) Comment : ok
Approval	Approved	2010-07-26 15:44	박동호 (BS Module그룹 / 부장)

정길식 (Monitor기구개발그룹 / 책임연구원)
김진훈 (BS Module그룹 / 차장)
윤시열 (MonitorR&D기획그룹 / 수석연구원)
정동원 (BS Outsourcing1그룹 / 차장)
한정석 (LGEND R&D.Power GROUP / 책임연구원)
송재학 (Monitor QA그룹 / 차장)
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한상석 (LGEND R&D.MNT DEVELOPMENT GROUP / 책임연구원)
손상익 (BS Module그룹 / 과장)
이기형 (MonitorR&D기획그룹 / 선임연구원)
최찬용 (BS Module그룹 / 대리)
송성호 (Monitor회로개발그룹 / 선임연구원)
김경진 (부품품질보증계 / 기사)

CC	허희준 (MonitorR&D기획그룹 / 선임연구원) 류동우 (BS Module그룹 / 과장) 이송화 (BS Module그룹 / 대리) 김영주 (MonitorR&D기획그룹 / 연구원) 이성수 (평택규격그룹 / 주임연구원) 이지수 (BS Module그룹 / 사원) 윤석재 (BS Module그룹 / 과장) 엄정훈 (BS Module그룹 / 과장) 이재민 (Monitor회로개발그룹 / 수석연구원) 황동선 (LGEND R&D.MNT S/W GROUP / 수석연구원) 김종태 (Monitor회로개발그룹 / 수석연구원) 김주만 (LGEIN R&D DISPLAY ELECT GROUP / 수석연구원) 박일준 (LGEIN R&D DISPLAY MECH GROUP / 수석연구원) 이명규 (평택규격그룹 / 수석연구원) 차상호 (평택규격그룹 / 책임연구원) 윤성욱 (평택규격그룹 / 책임연구원) 김명욱 (Monitor회로개발그룹 / 수석연구원) 박강식 (부품품질보증계 / 기정) 박철진 (부품품질보증계 / 기정) SARWO SOVIANDY SIJABAT (LGEIN R&D DISPLAY LCD MNT PART / sr. supervisor) pinquan zhou (LGEND R&D.MNT MASS PRODUCTION GROUP / senior manager B) xiaodong li (LGEND R&D.COMPONENT DEVELOPMENT GROUP / manager a) QIU YU (LGEND R&D.Power GROUP / manager b) xiaoyong zhang (LGEND R&D.MNT DEVELOPMENT GROUP / manager a) REN MING JIN (LGEND R&D.MNT MASS PRODUCTION GROUP / manager b) jian dong (SQA GROUP / Operator3) ke zhu (LGEND R&D.MNT MECHANIC GROUP / assist manager) CHENG XIANG ZHANG (LGEND PRODUCTION.MANUFACTURING GROUP / Operator2) wenxue li (LGEND R&D.MNT PLANNING GROUP / assist manager) guozhe zheng (LGEND PRODUCTION.CIRCUIT.PURCHASING GROUP / manager b) jie sun (LGEND R&D.MNT MASS PRODUCTION GROUP / officer 2) li zhao (LGEND R&D.MNT MASS PRODUCTION GROUP / officer 3) HUI KANG (LGEND R&D.COMPONENT DEVELOPMENT GROUP / assist manager) su yuan (LGEND R&D.MNT PLANNING GROUP / officer 1) yong qing (LGEND R&D.MNT PLANNING GROUP / assist manager) FEI SUN (LGEND PRODUCTION.MATERIAL GROUP / Operator2) YU GUANG FEI (SQA GROUP / assist manager) YU HAO ZHU (LGEND R&D.MNT MECHANIC GROUP / officer 1)
EDMS Doc Link	
Attached Local Files	CAS_LM215WF1-TLE1.pdf IIS_LM215WF1-TLE1.pdf CAS_LM215WF1-TLE2.pdf IIS_LM215WF1-TLE2.pdf LM215WF1-TLE1 Document.zip

SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	21.5" Full HD TFT LCD

BUYER	LGE
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM215WF1
SUFFIX	TLE1

*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.

APPROVED BY	SIGNATURE / DATE
S. G. Hong / G.Manager	
REVIEWED BY	
K. H. Choi / Manager [C]	2010.8.6
K. H. Moon / Manager [M]	
M. S. KANG / Manager [P]	
PREPARED BY	
S. Y. KIM / Engineer	10.7.6

MNT Products Engineering Dept.
LG Display Co., Ltd

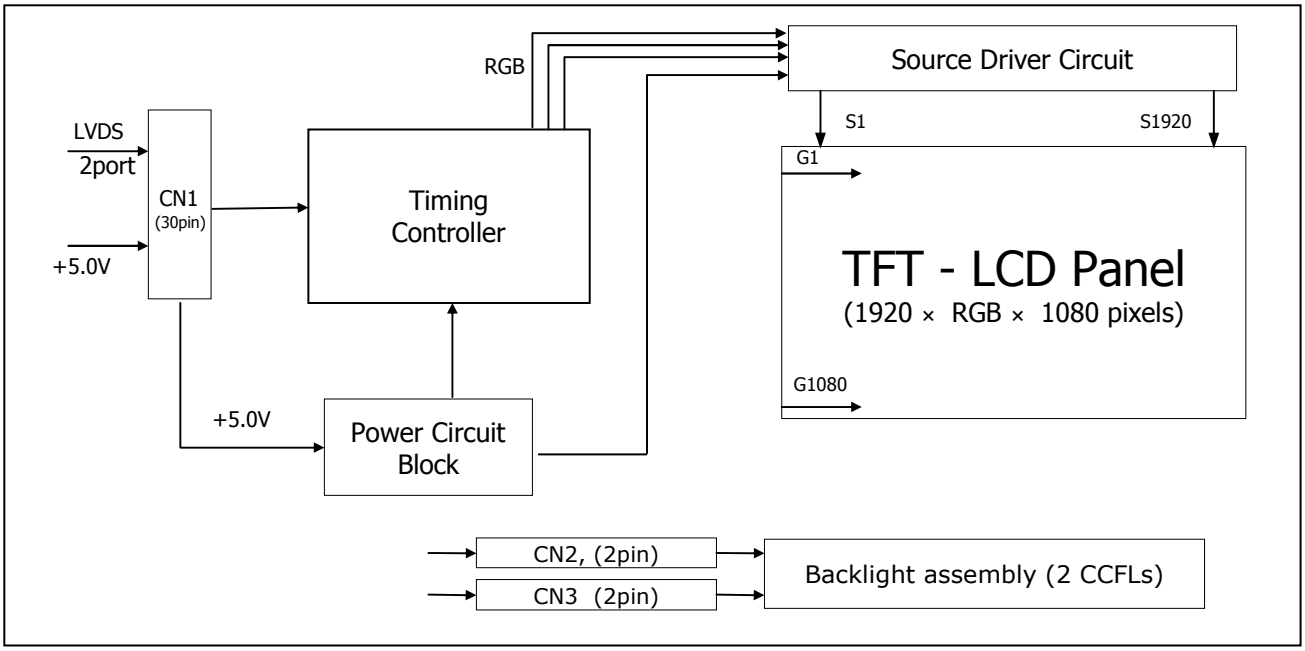
Contents

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.1	Dec. 23. 2009	-	First Draft(Preliminary)
0.2	Mar. 08. 2010	4	Power Consumption update
		6	Power Supply Input Current update
		18	OPTICAL CHARACTERISTICS Dclk 69.25 → 144 MHz
			Luminance uniformity-Angular dependence (TCO '03 → 5.0)
		21	Luminance Uniformity-angular–dependence (LR& TB) update
1.0	July. 06. 2010	-	Final CAS
		27	Rear view 2D drawing update

1. General Description

LM215WF1 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) backlight system. 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 21.5inch diagonally measured active display area with Full HD resolution (1080 vertical by 1920 horizontal 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(True) colors.
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 14.5(D) mm (Typ.)
Pixel Pitch	0.248 mm x 0.248mm
Pixel Format	1920 horiz. By 1080 vert. Pixels RGB stripes arrangement
Color Depth	8-bit (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 17.21 W(Typ.), (4.97 W@V_{LCD} , 12.24 W@I_{BL} = 8.5mA)
Weight	1900g[Typ.]
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer

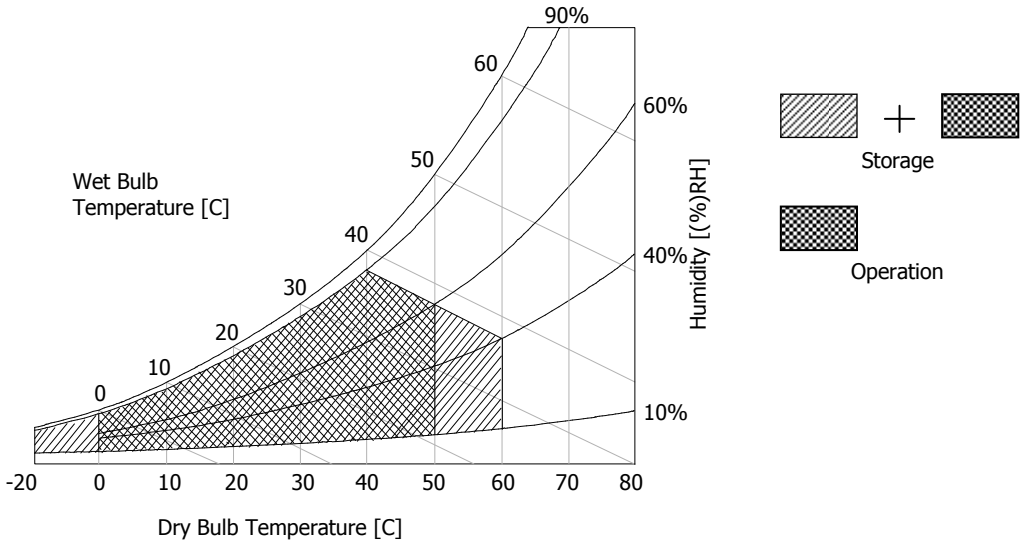
2. Absolute Maximum Ratings

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	0	6.0	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. Maximum Storage Humidity is up to 40℃, 70% RH only for 4 corner light leakage Mura.



[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 CCFL, is typically generated by an inverter. The inverter is an external unit to the LCDs.

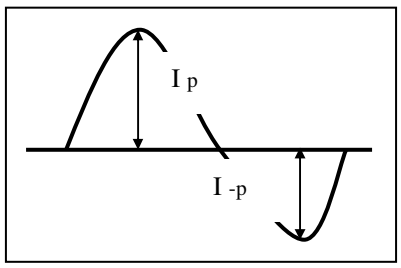
Table 2. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	4.5	5.0	5.5	Vdc	
Permissive Power Input Ripple	V_{RF}	-	-	100	mV	13
Power Supply Input Current	I_{LCD}	695	993	1291	mA	1
		900	1285	1671	mA	2
Power Consumption	P_{LCD}		4.97	6.46	Watt	1
	P_{LCD}		6.43	8.36	Watt	2
Rush current	I_{RUSH}	-	-	3	A	3
LAMP :						
Operating Voltage	V_{BL}	710 (9.0mA)	720 (8.5mA)	920 (2.5mA)	V_{RMS}	4, 5
Operating Current	I_{BL}	2.5	8.5	9.0	mA_{RMS}	4
Established Starting Voltage	Vs					4, 6
at 25 ℃				1050	V_{RMS}	
at 0 ℃				1450	V_{RMS}	
Operating Frequency	f_{BL}	40	-	70	kHz	7
Discharge Stabilization Time	Ts			3.0	Min	4, 8
Power Consumption	P_{BL}	-	12.24	13.46	Watt	9
Life Time		50,000			Hrs	4, 10

Note : The design of the inverter must have specifications for the lamp in LCD Assembly.
The performance of the Lamp in LCM, for example life time or brightness, is extremely influenced by the characteristics of the DC-AC inverter. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.
When you design or order the inverter, please make sure unwanted lighting caused by the mismatch of the lamp and the inverter (no lighting, flicker, etc) never occurs. When you confirm it, the LCD–Assembly should be operated in the same condition as installed in you instrument.

Note. Do not attach a conducting tape to lamp connecting wire. If the lamp wire attach to a conducting tape, TFT-LCD Module has a low luminance and the inverter has abnormal action. Because leakage current is occurred between lamp wire and conducting tape.

1. The specified current and power consumption are under the V_{LCD}=5.0V, 25 ± 2℃,f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 5ms and rising time of power Input is 500us ± 20%.(min.).
4. Specified values are for a single lamp.
5. Operating voltage is measured at 25 ± 2℃. The variance of the voltage is ± 10%.
6. The voltage above V_S should be applied to the lamps for more than 1 second for start-up. (Inverter open voltage must be more than lamp starting voltage.) Otherwise, the lamps may not be turned on. The used lamp current is the lamp typical current.
7. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform (Unsymmetrical ratio is less than 10%). Please do not use the inverter which has unsymmetrical voltage and unsymmetrical current and spike wave. Lamp frequency may produce interface with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequency and from its harmonics in order to prevent interference.
8. Let's define the brightness of the lamp after being lighted for 5 minutes as 100%. T_S is the time required for the brightness of the center of the lamp to be not less than 95%. The used lamp current is the lamp typical current.
9. The lamp power consumption shown above does not include loss of external inverter. The used lamp current is the lamp typical current. ($P_{BL} = V_{BL} \times I_{BL} \times N_{Lamp}$)
10. The life is determined as the time at which brightness of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at 25 ± 2℃.
11. Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp, are following. It shall help increase the lamp lifetime and reduce leakage current.
    a. The asymmetry rate of the inverter waveform should be less than 10%.
    b. The distortion rate of the waveform should be within √2 ±10%.
    * Inverter output waveform had better be more similar to ideal sine wave.



* Asymmetry rate:

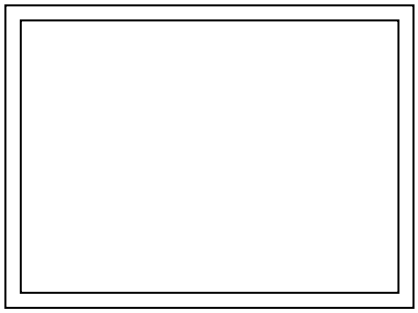
$| I_p - I_{-p} | / I_{rms} \times 100\%$

* Distortion rate

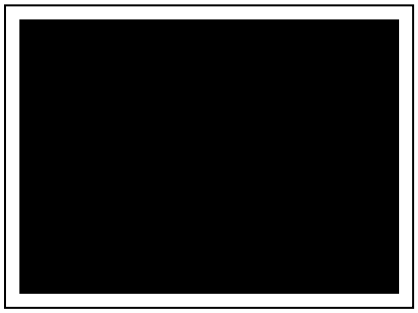
I_p (or I_{-p}) / I_{rms}

12. The inverter which is combined with this LCM, is highly recommended to connect coupling(ballast) condenser at the high voltage output side. When you use the inverter which has not coupling(ballast) condenser, it may cause abnormal lamp lighting because of biased mercury as time goes.
13. Permissive power ripple should be measured under V_{LCD} =12.0V, 25℃, fV(frame frequency)=MAX condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20Mhz. See the figure 3.
14. In case of edgy type back light with over 4 parallel lamps, input current and voltage wave form should be synchronized

• **Permissive Power input ripple (**V_{LCD} =5.0V, 25℃, fV(frame frequency)=MAX condition**)**

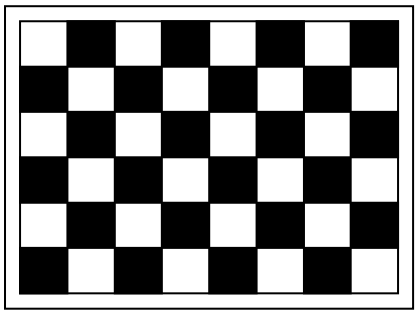


White pattern



Black pattern

• **Power consumption (**V_{LCD} =5.0V, 25℃, fV (frame frequency=60Hz condition**)**



Typical power Pattern

[Figure 3] Mosaic pattern & Black Pattern for power consumption measurement

3-2. Interface Connections

3-2-1. LCD Module

-LCD Connector(CN1). :IS100-L30B-C23 (UJU) or Equivalent
- Mating Connector : FI-XC30C2L (Manufactured by JAE) or Equivalent

Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION

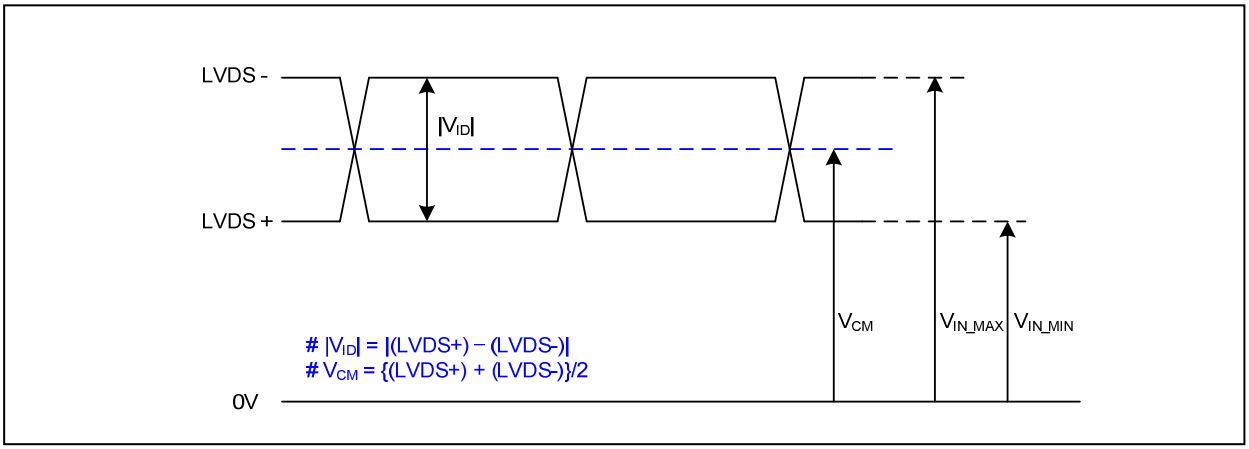
No	Symbol	Description	No	Symbol	Description
1	FR0M	- Signal of odd channel 0 (LVDS)	16	SR1P	+ Signal of even channel 1 (LVDS)
2	FR0P	+ Signal of odd channel 0 (LVDS)	17	GND	Ground
3	FR1M	- Signal of odd channel 1 (LVDS)	18	SR2M	- Signal of even channel 2 (LVDS)
4	FR1P	+ Signal of odd channel 1 (LVDS)	19	SR2P	+ Signal of even channel 2 (LVDS)
5	FR2M	- Signal of odd channel 2 (LVDS)	20	SCLKINM	- Signal of even clock channel (LVDS)
6	FR2P	+ Signal of odd channel 2 (LVDS)	21	SCLKINP	+ Signal of even clock channel (LVDS)
7	GND	Ground	22	SR3M	- Signal of even channel 3 (LVDS)
8	FCLKINM	- Signal of odd clock channel (LVDS)	23	SR3P	+ Signal of even channel 3 (LVDS)
9	FCLKINP	+ Signal of odd clock channel (LVDS)	24	GND	Ground
10	FR3M	- Signal of odd channel 3 (LVDS)	25	NC	NC (reserved I2C communication)
11	FR3P	+ Signal of odd channel 3 (LVDS)	26	NC	NC (reserved I2C communication)
12	SR0M	- Signal of even channel 0 (LVDS)	27	PWM	PWM_OUT for control burst frequency of Inverter
13	SR0P	+ Signal of even channel 0 (LVDS)	28	VLCD	Power +5V
14	GND	Ground	29	VLCD	Power +5V
15	SR1M	- Signal of even channel 1 (LVDS)	30	VLCD	Power +5V

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.

[Figure 4] User Connector diagram

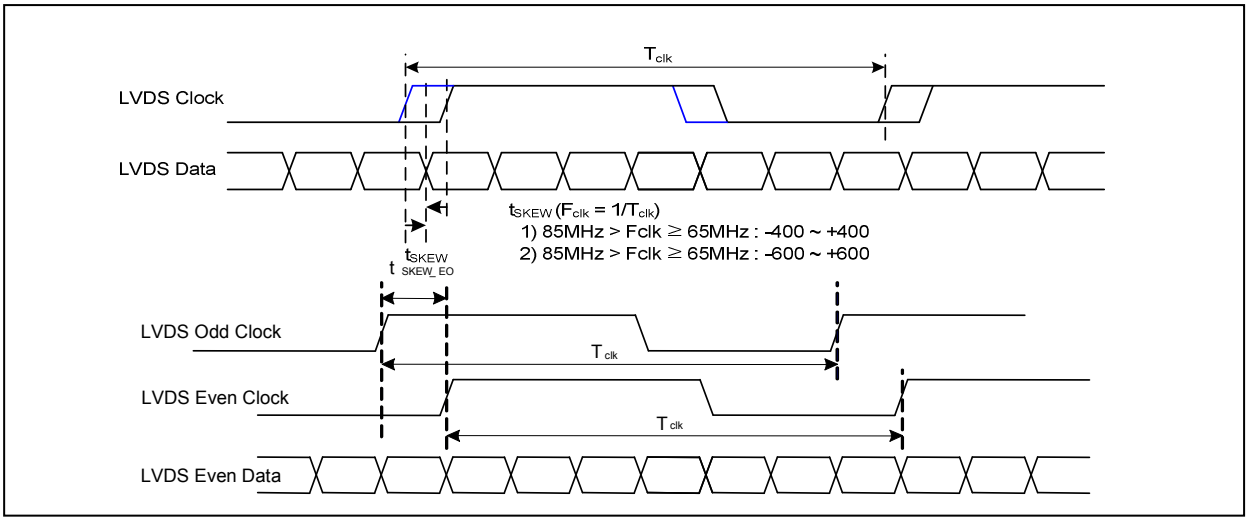
LVDS Input characteristics

1. DC Specification

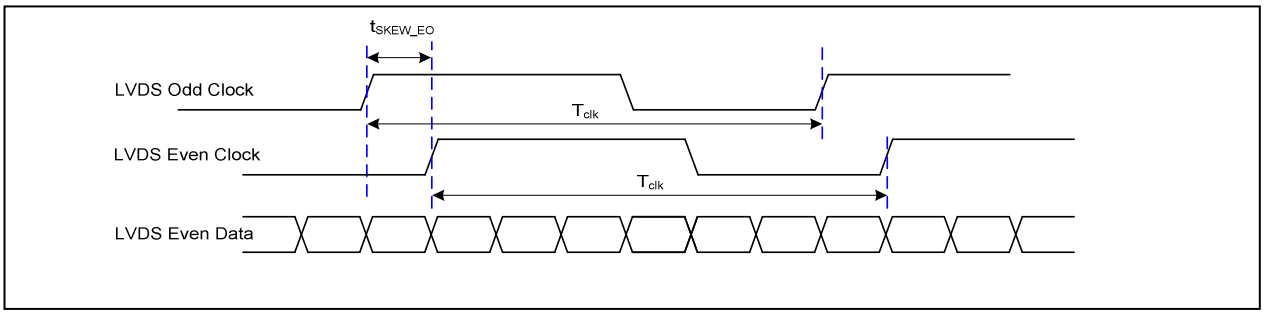


Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$\|V_{ID}\|$	200	600	mV	-
LVDS Common mode Voltage	V_{CM}	0.6	1.8	V	-
LVDS Input Voltage Range	V_{IN}	0.3	2.1	V	-

2. AC Specification



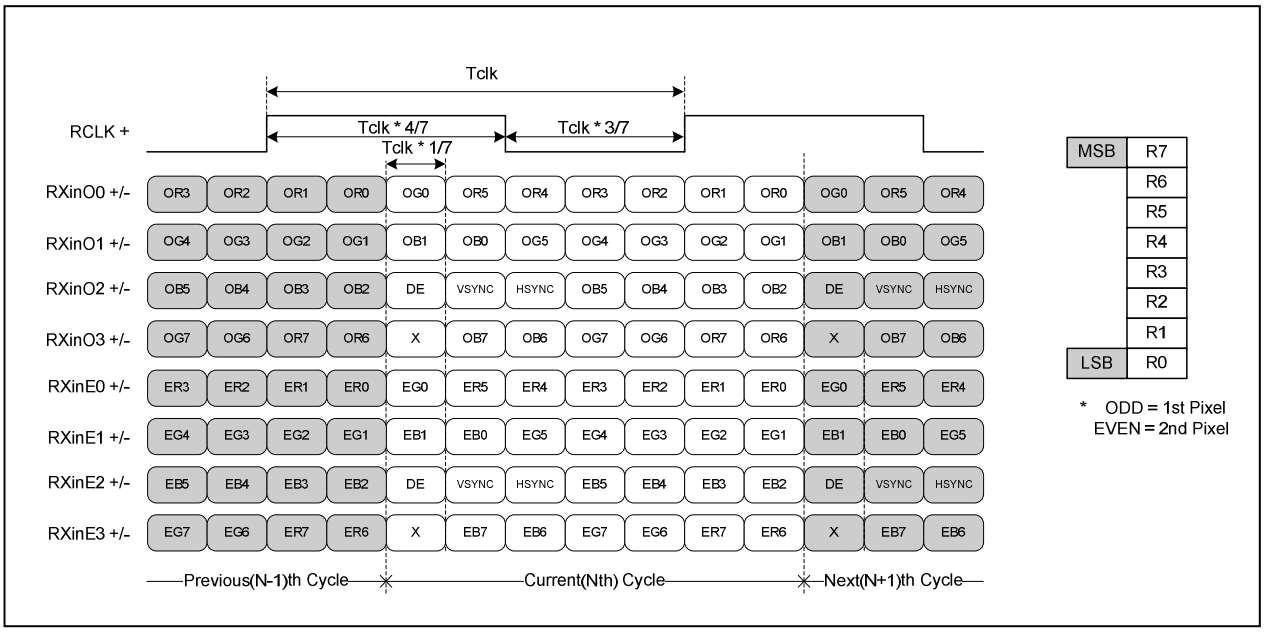
Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 25MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-



< Clock skew margin between channel >

3. Data Format

1) LVDS 2 Port



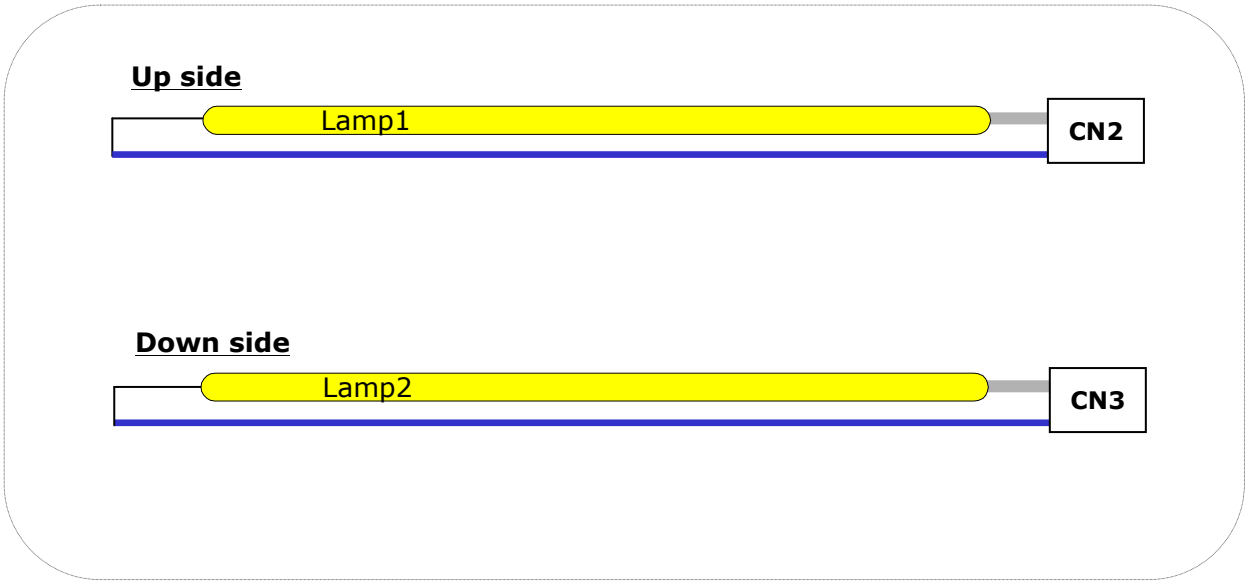
< LVDS Data Format >

Table 4. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN2,CN3)

The backlight interface connector is a model 35001HS-02LD manufactured by Yeonho. The mating connector part number are 35001WR-02L or equivalent. The pin configuration for the connector is shown in the table below.

Pin	Symbol	Description	Notes
1	HV	High Voltage for Lamp	1
2	LV	Low Voltage for Lamp	2

Notes: 1. The high voltage power terminal is colored gray.
2. The low voltage pin color is blue.



[Figure 5] Backlight connector diagram

3-3. Signal Timing Specifications

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

Table 5. Timing Table

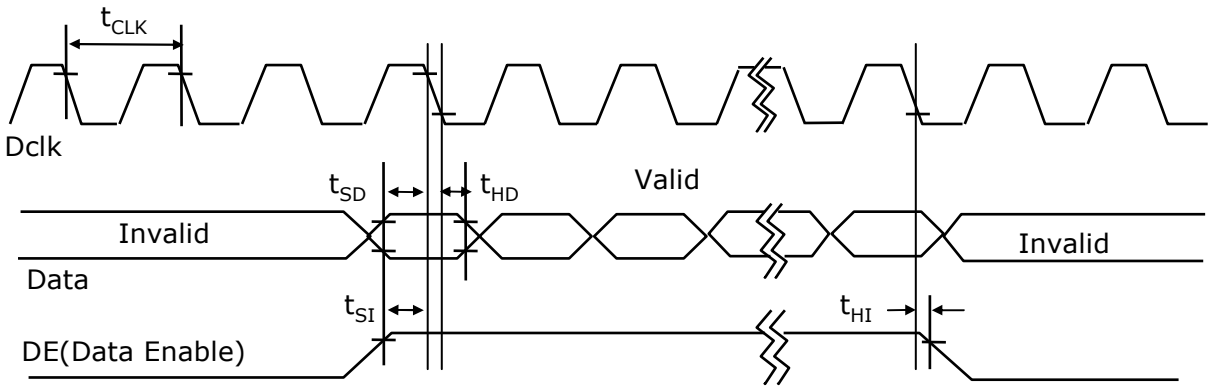
ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	11.42	14.44	15.38	ns	Pixel frequency : Typ.144MHz
	Frequency	-	60	72	87.5	MHz	
Horizontal	total	t_{HP}	1000	1088	1120	t_{CLK}	
	Frequency	f_H	64	66	83	KHz	
	Blanking		40	128	160	t_{CLK}	
	valid	t_{WH}	960	960	960	$t_{CLK/2}$	
Vertical	total	t_{VP}	1090	1100	1160	t_{HP}	
	Frequency	f_V	50	60	75	Hz	
	Blanking		10	20	80	t_{HP}	
	valid	t_{WV}	1080	1080	1080	t_{HP}	

Note:

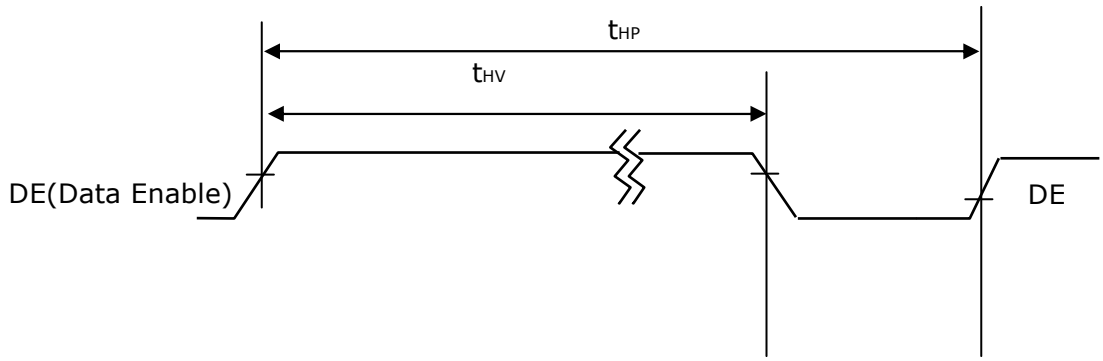
1. DE Only mode operation. The input of Hsync & Vsync signal does not have an effect on LCD normal operation.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.

3-4. Signal Timing Waveforms

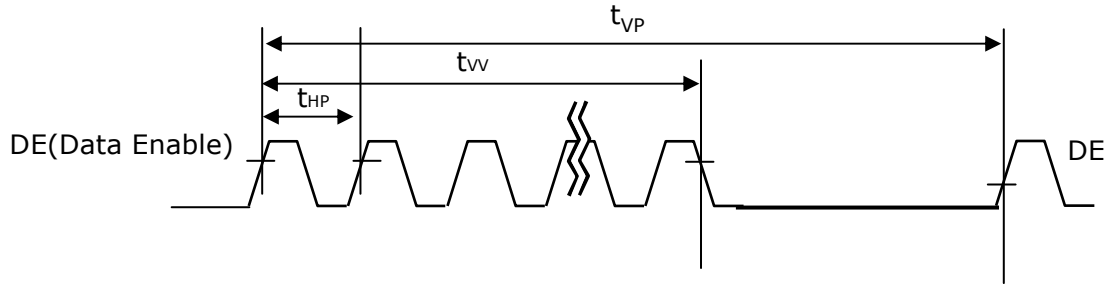
1. DCLK , DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



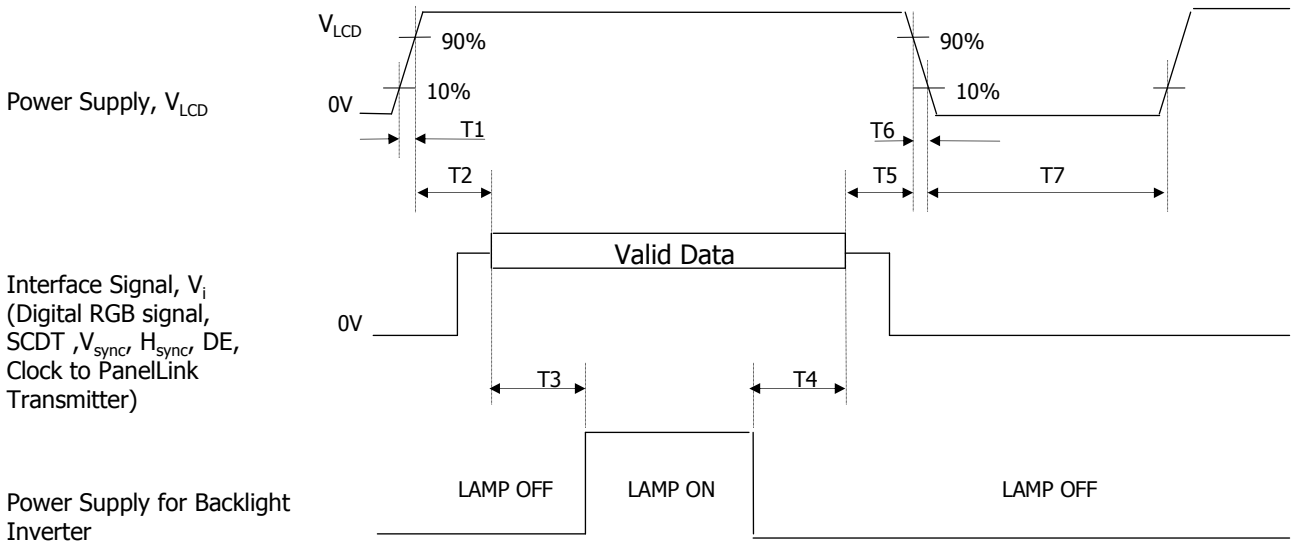
3-5. Color Input Data Reference

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



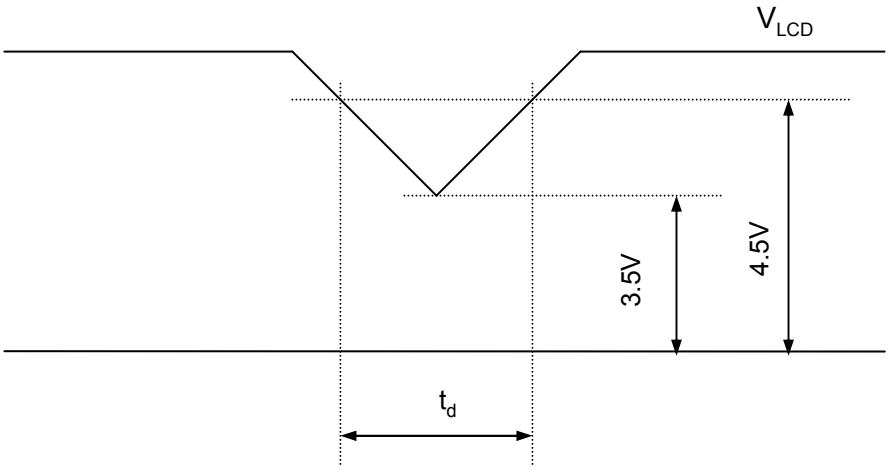
[Figure 6] Power sequence

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
T6	-	-	-	ms
T7	1		-	s

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



[Figure 7] Power dip condition

1) Dip condition

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

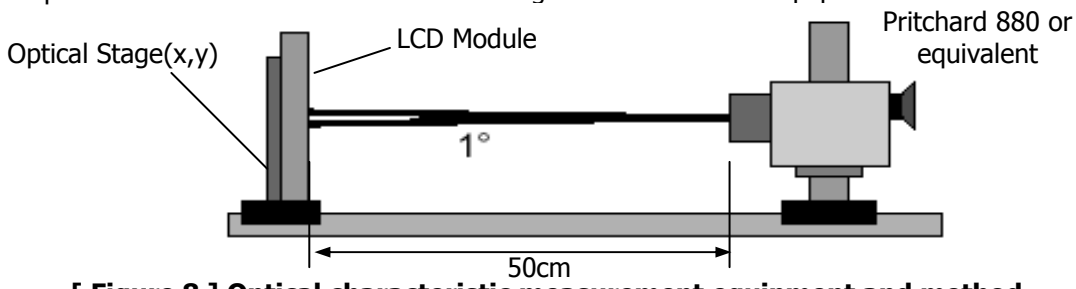
2) $V_{LCD} < 3.5V$

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. 1 presents additional information concerning the measurement equipment and method.



[Figure 8] Optical characteristic measurement equipment and method

Table 8. OPTICAL CHARACTERISTICS (Ta=25 ℃, V_{LCD}=5.0V, f_V=60Hz Dclk=144MHz, I_{BL}=8.5mA)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000			1
Surface Luminance, white		L_{WH}	200	250		cd/m²	2
Luminance Variation		δ_{WHITE}	75			%	3
Response Time	Rise Time	Tr_R	-	1.3	2.6	ms	4
	Decay Time	Tr_D	-	3.7	7.4	ms	4
	total	T		5		ms	
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.646	Typ +0.03		
		Ry		0.334			
	GREEN	Gx		0.303			
		Gy		0.616			
	BLUE	Bx		0.147			
		By		0.067			
	WHITE	Wx		0.313			
		Wy		0.329			
Color Gamut				72%		Degree	5
Viewing Angle (CR>5)							
	x axis, right(ϕ=0°)	θr	75	88	-	Degree	6
	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	6
	x axis, left (ϕ=180°)	θl	70	85	-		
	y axis, up (ϕ=90°)	θu	60	75	-		
	y axis, down (ϕ=270°)	θd	70	85	-		
Luminance uniformity-Angular dependence (TCO 5.0)		LR			1.73		Fig 11
Gray Scale				2.2			7

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

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

It is measured at center point(Location P1)

2. Surface luminance is the luminance value at center 1 point(1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 9.

3. The variation in surface luminance , δ WHITE is defined as :

$$\delta_{WHITE} = \frac{\text{Minimum}(L_{P1}, L_{P2}, \ldots L_{P9})}{\text{Maximum}\,(L_{P1}, L_{P2}, \ldots L_{P9})} \times 100$$

For more information see FIG 9.

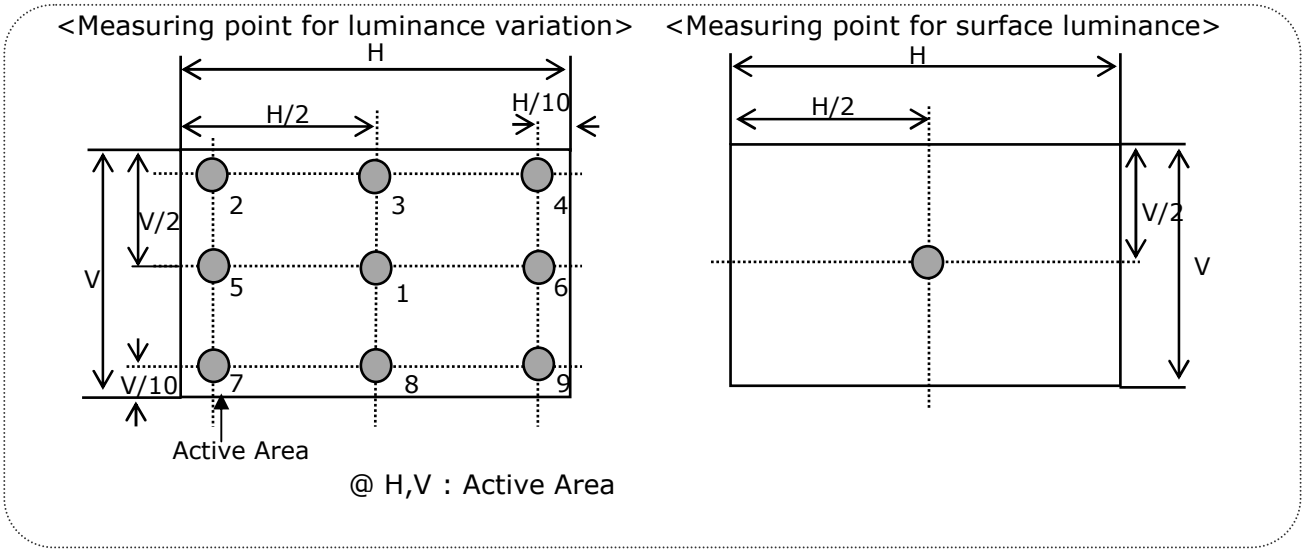
4. Response time is the time required for the display to transition from white to black (Rise Time, Tr_R) and from black to white (Decay Time, Tr_D). For additional information see FIG 10.

5. Color gamut is calculated from CIE 1931 space.

6. Viewing angle is the angle at which the contrast ratio is greater than 5 or 10. 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 5.

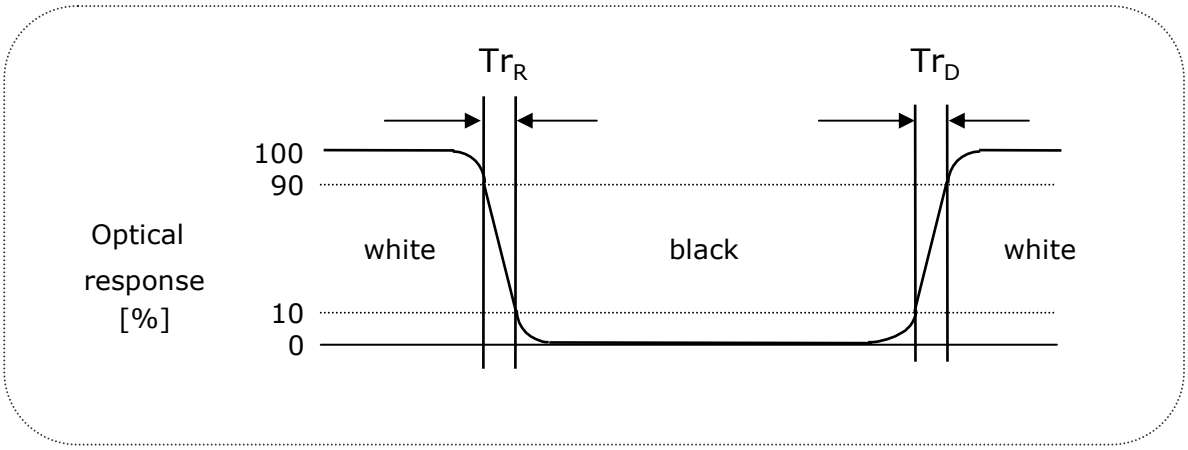
7. Gray scale specification
Gamma Value is approximately 2.2. For more information see Table 11.

Measuring point for surface luminance & measuring point for luminance variation.



[FIG 9] Measure Point for Luminance

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



[FIG 10] Response Time

Notes :

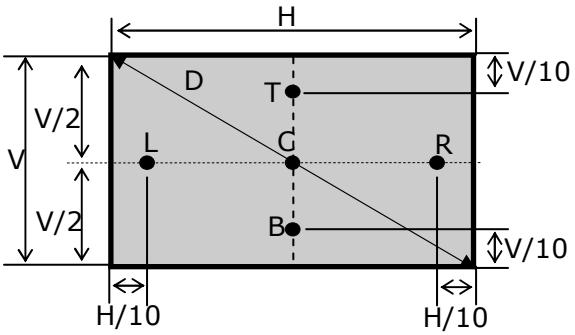
Luminance Uniformity - angular – dependence (LR& TB)

TCO 5.0 Luminance uniformity – angular dependence, is the capacity of the FPD to maintain a certain luminance level independently of the viewing direction, The angular-dependent luminance uniformity is defined as the ratio of maximum luminance to minimum luminance in the specified measurement areas.

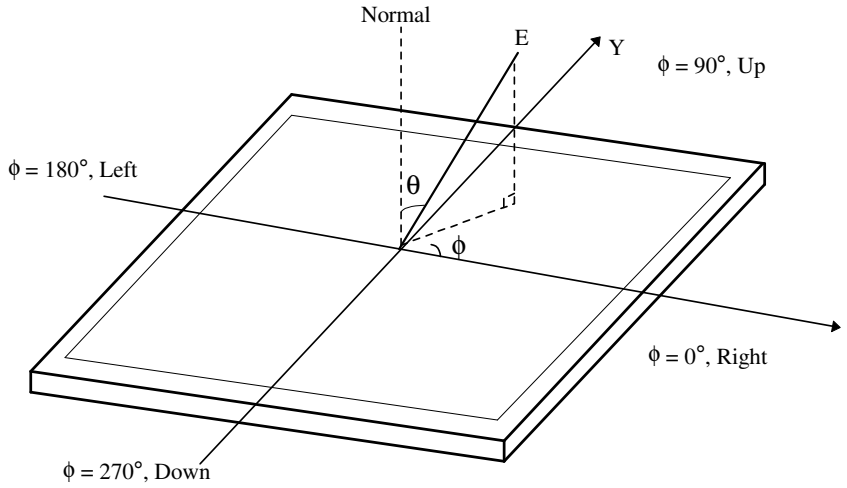
- Test pattern : Full white 4 ° × 4 ° square size, back ground shall be set to 80% image loading, RGB 204, 204, 204
- Test luminance : ≥150cd/㎡
- Test point : 5-point
- Test distance : D * 1.5 = 82㎝
- Test method : $L_R = ((L_{max.+30deg.} / L_{min.+30deg.}) + (L_{max.-30deg.} / L_{min.-30deg.})) / 2$
  $T_B = ((L_{max.+15deg.} / L_{min.+15deg.})$

FIG. 11 Luminance Uniformity angular dependence

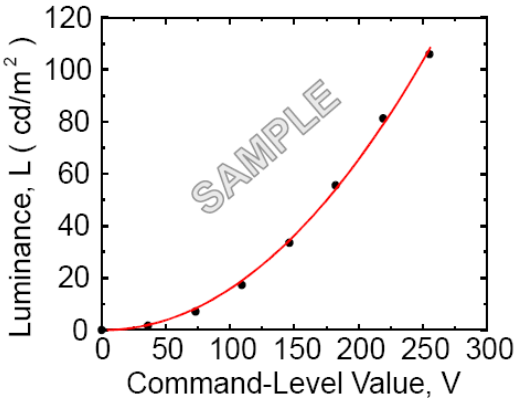
< Luminance uniformity - angular dependence measuring point >



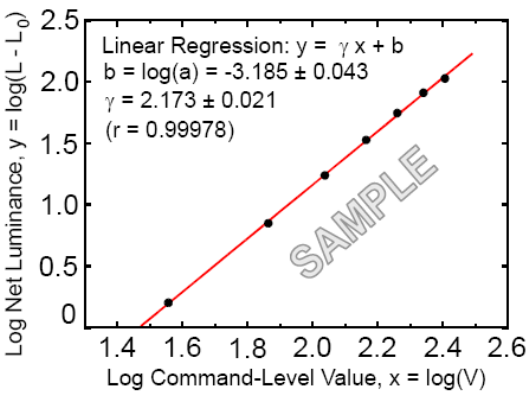
Dimension of viewing angle range.



[FIG 12] Viewing angle



[FIG 13] Sample Luminance vs. gray scale (using a 256 bit gray scale)



[FIG 14] Sample Log-log plot of luminance vs. gray scale

$$L = aV^{r} + L_b$$

$$\log(L - L_b) = r\log(V) + \log(a)$$

Here the Parameter α and γ relate the signal level V to the luminance L.
The GAMMA we calculate from the log-log representation (FIG. 7)

Table 10. 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	53.00
223	74.48
255	100

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 ± 0.5mm
	Vertical	292.2mm ± 0.5mm
	Depth	14.5mm ± 0.5mm
Bezel Area	Horizontal	479.8mm
	Vertical	271.3mm
Active Display Area	Horizontal	476.64mm
	Vertical	268.11mm
Weight	1900g [Typ], 2000g [Max]	
Surface Treatment	Hard coating(3H) Anti-glare treatment of the front polarizer	

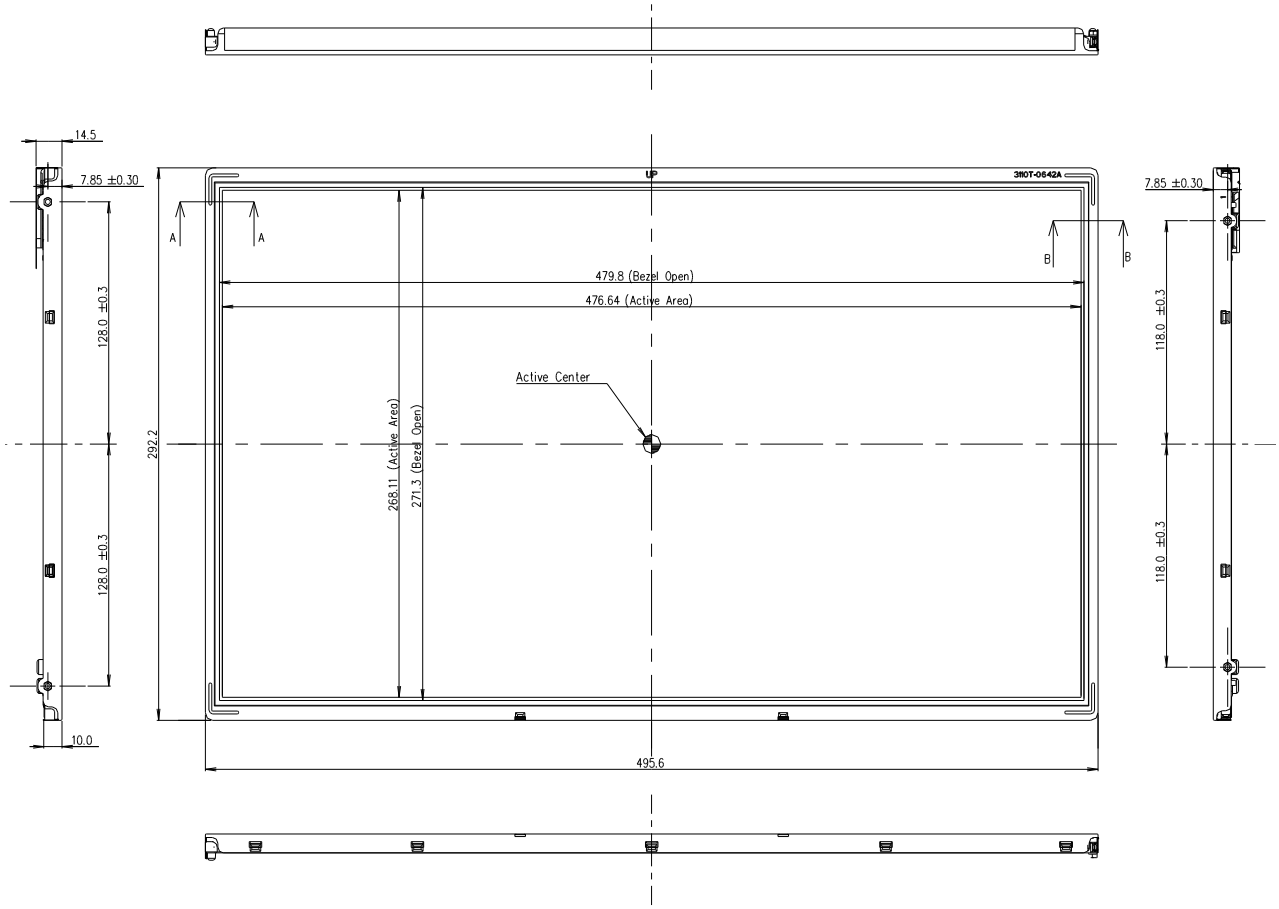
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

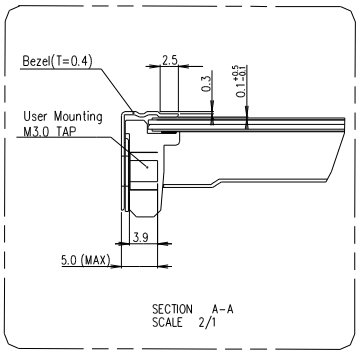
6. Reliability

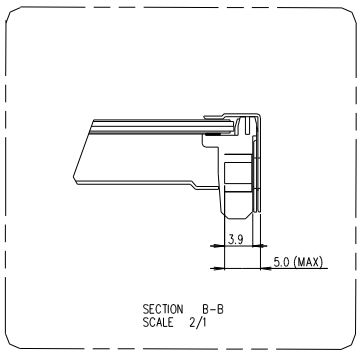
Environment test condition

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 : 1.0G 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)

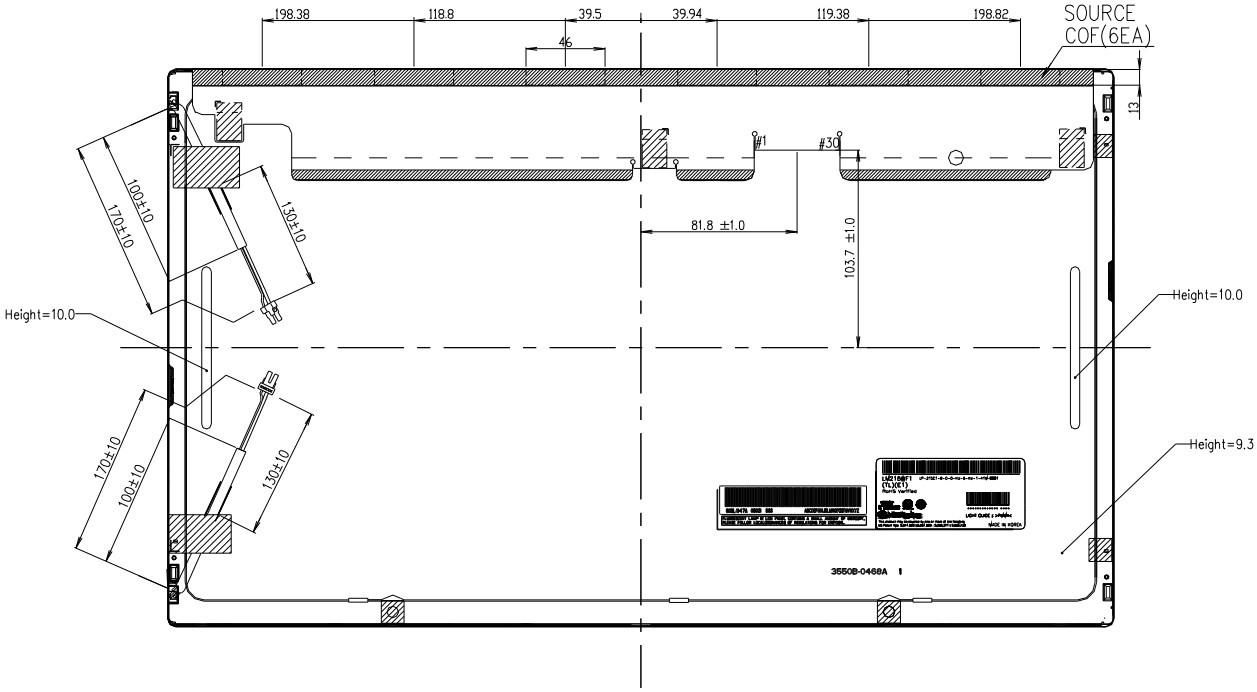
<FRONT VIEW>


14.5
7.85 ±0.30
128.0 ±0.3
128.0 ±0.3
10.0
UP
3M0T-0642A
A
A
B
B
479.8 (Bezel Open)
476.64 (Active Area)
Active Center
292.2
268.11 (Active Area)
271.3 (Bezel Open)
495.6
7.85 ±0.30
118.0 ±0.3
118.0 ±0.3

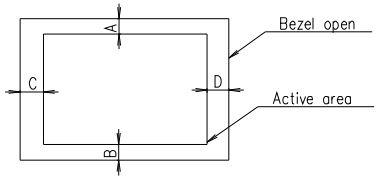

Bezel(T=0.4)
2.5
0.3
0.1+0.5 -0.1
User Mounting
M3.0 TAP
3.9
5.0 (MAX)
SECTION A-A
SCALE 2/1


3.9
5.0 (MAX)
SECTION B-B
SCALE 2/1

<REAR VIEW>



Notes
1. Backlight : 2 Cold Cathode Fluorescent Lamps
2. Lamp Connector Specification
   – 35001HS-02LD(Yeonho) <2pin> or equivalent
3. I/F Connector Specification : IS100-L30B-C23(UJU)
4. Torque of user hole : 3.0~4.0kgf-cm
5. Tilt and partial disposition tolerance of display area as following
   (1) Y-Direction : IA-BI ≤ 1.0
   (2) X-Direction : IC-DI ≤ 1.0



6. Lamp(CCFL) lot No. is marked at backlight connector
7. Do not wind conductive tape around the backlight wires
8. Unspecified tolerances to be ±0.5mm

7. International standards

7-1. Safety

a) UL 60950-1:2003, First Edition, Underwriters Laboratories, Inc.,
Standard for Safety of Information Technology Equipment.
b) CAN/CSA C22.2, No. 60950-1-03 1st Ed. April 1, 2003, Canadian Standards Association,
Standard for Safety of Information Technology Equipment.
c) EN 60950-1:2001, First Edition,
European Committee for Electro-technical Standardization(CENELEC)
European Standard for Safety of Information Technology Equipment.
d) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

7-2. EMC

a) ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHZ to 40GHz. "American National Standards Institute(ANSI),1992
b) C.I.S.P.R "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." International Special Committee on Radio Interference.
c) EN 55022 "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment." European Committee for Electro-technical Standardization.(CENELEC), 1998 (Including A1: 2000)

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

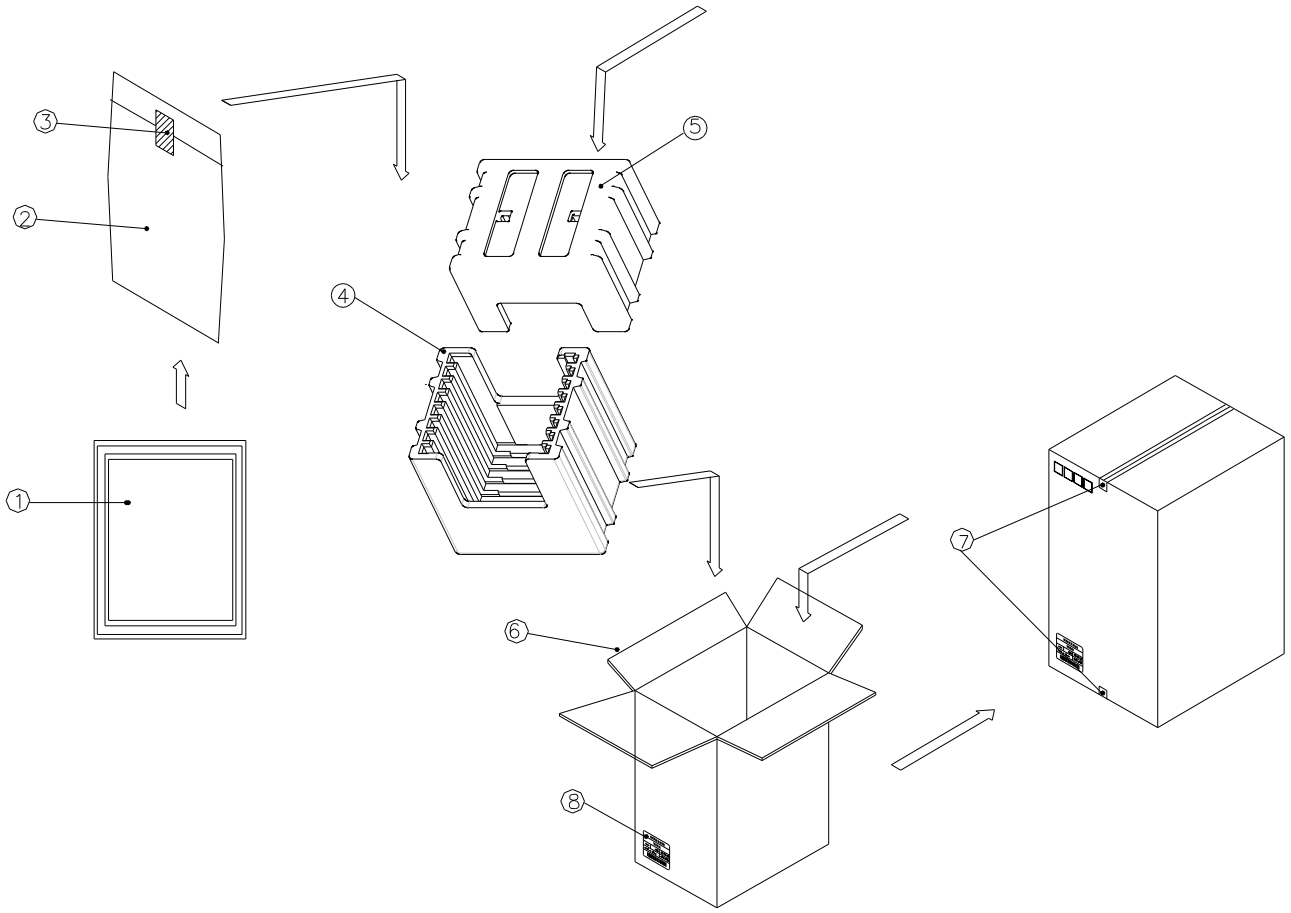
b) Location of Lot Mark

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 Assy Form

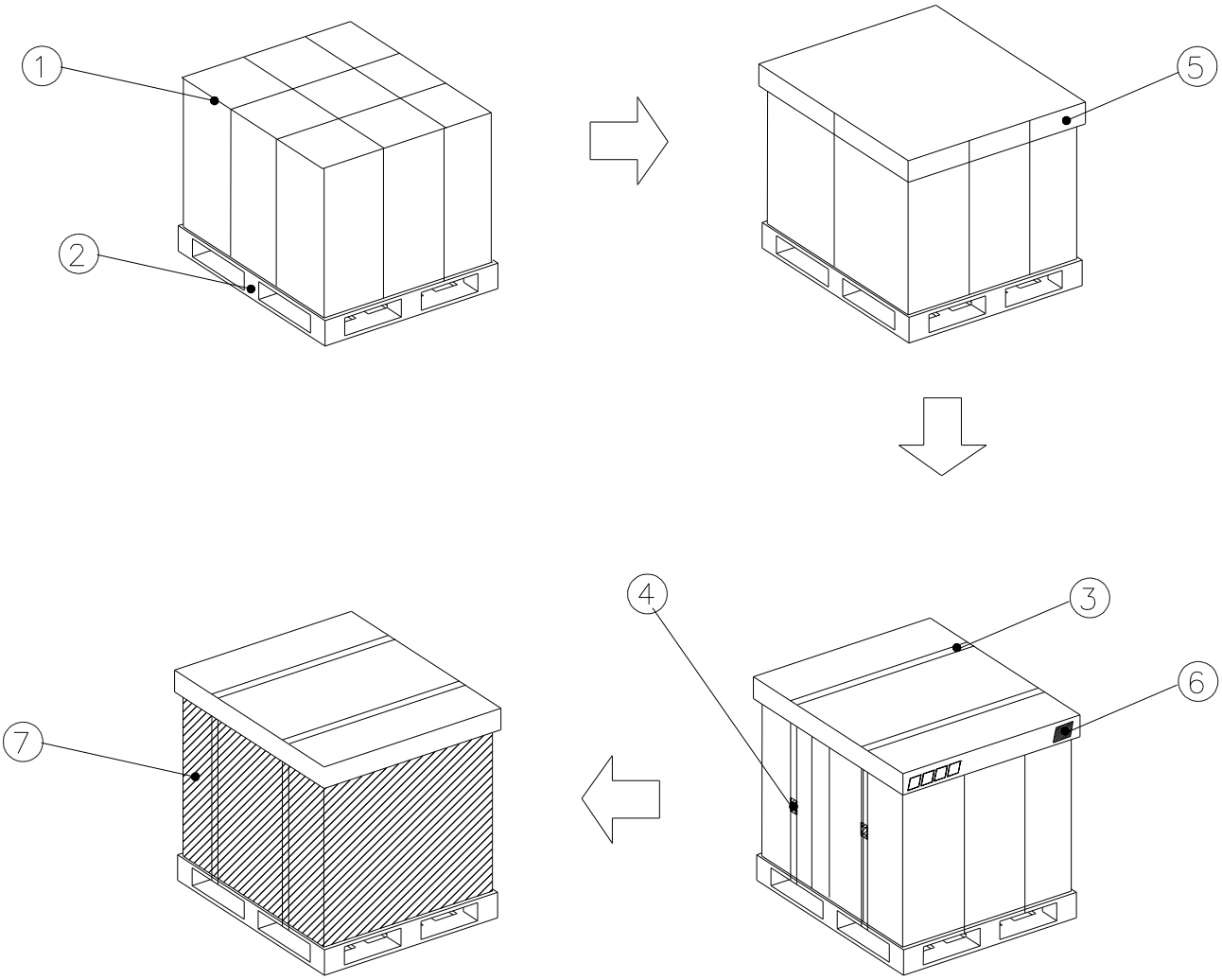
a) Package quantity in one box : 8 pcs

b) Box Size : 370mm x 320mm x 580mm



NO.	DESCRIPTION	MATERIAL
1	LCM	
2	BAG	PE
3	TAPE	OPP
4	PACKING, BOTTOM	EPS
5	PACKING, TOP	EPS
6	BOX	PAPER, SW
7	TAPE	OPP
8	LABEL	ART

8-3. Pallet Assy Form



NO.	DESCRIPTION	MATERIAL
1	PACKING ASS'Y	-
2	PALLET	PLYWOOD_1140X990X117.5
3	BAND	PP
4	BAND, CLIP	CLIP
5	ANGLE Cover	PAPER, SW
6	LABEL	ART
7	WRAP	LLDPE

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 four 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 lower temperature, it becomes longer.)
(3) Brightness depends on the temperature. (In lower 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 not be operated its full characteristics perfectly.
(8) A screw which is fastened up the steels should be a machine screw (if not, it causes metal 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.