

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

Created Date	2010-10-22 09:58 (Korea Time)		
Requested by	최찬용 (BS Module그룹 / 대리 , 82-031-610-9903)		
Subject	[Formal Approval] EAJ61548701(LGD 20"W WLED eIPS_LM200WD4-SLB1)		
EDMS Attributes	Biz Map	Procure Materials and Services > Develop Procurement Strategy	
	Team Map	BS Sourcing팀 > BS Module전략Sourcing그룹	
	Doc Type	Approval	Retention 6 Month
	Info Type		
	Security Grade	Internal use (Only)	Doc Language

Component Development Information

Model : IPS206T-PNX

Approval type : New (●) Limit () Revision () 4M ()

HSMS (RoHS) : Complete (●) Limit Approval () Warranty Approval ()

Reliability test : Needless () Need (Test Report No: ●)

Class Name : LCD,Module-TFT

Part Number : EAJ61548701

Maker : LG Display

Specification : LM200WD4-SLB1 HD+ 20.0INCH 1600X900 250CD COLOR 72% 16/9 1000:1, ZBD,14ms(GTG),178/178

Key part list : Fab:P6,Module Assy:GZ,C/F:LGD,Pol: LGC,S-IC:Lusem,GIP,T-con:SiW,B/L ass'y:New Optics,

WLED LGIT(7020PKG), Sheet Structure : Prism+Diffuser 2ea

Development History : LGD 20"W WLED eIPS New Module development

★ 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 [전자규격 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	2010-10-25 14:28	hui kang (LGEND R&D.COMPONENT DEVELOPMENT GROUP / assist manager) Comment : ok
Agree	Approved	2010-10-25 15:01	xiaodong li (LGEND R&D.COMPONENT DEVELOPMENT GROUP / manager a) Comment : OK	
Agree	Approved	2010-10-26 09:58	huan chen (LGEND R&D.MNT PLANNING GROUP / assist manager) Comment : OK	
Agree	Approved	2010-10-26 12:49	danyang huang (LGEND R&D.MNT PLANNING GROUP / manager b)	
Agree	Approved	2010-10-26 16:16	김철회 (LGEND R&D.MNT MECHANIC GROUP / 선임연구원) Comment : 확인합니다	
Agree	Approved	2010-10-26 16:22	한상석 (LGEND R&D.MNT DEVELOPMENT GROUP / 책임연구원) Comment : OK	
Approval	Approved	2010-10-26 16:24	윤석재 (BS Module그룹 / 과장) Comment : ok	
Approval	Approved	2010-10-26 16:37	박동호 (BS Module그룹 / 부장) Comment : ok	
김진훈 (BS Module그룹 / 차장) 윤시열 (MonitorR&D기획그룹 / 수석연구원) 송재학 (Monitor품질보증그룹 / 차장) 김승호 (LGEIN R&D DISPLAY ELECT GROUP / 책임연구원)				

CC	<p>정지현 (LGEIN HE PURCHASING GROUP / 과장) 박동호 (BS Module그룹 / 부장) 손상익 (BS Module그룹 / 과장) 이기형 (MonitorR&D기획그룹 / 선임연구원) 최찬용 (BS Module그룹 / 대리) 김경진 (LCD TV부품품질보증계 / 기사) 허희준 (MonitorR&D기획그룹 / 선임연구원) 류동우 (BS Module그룹 / 과장) 신준호 (Monitor회로개발그룹 / 주임연구원) 손현우 (Monitor회로개발그룹 / 선임연구원) 박종철 (Monitor회로개발그룹 / 주임연구원) 김부영 (MonitorR&D기획그룹 / 주임연구원) 이송화 (BS Module그룹 / 대리) 김영주 (MonitorR&D기획그룹 / 연구원) 이동렬 (Monitor회로개발그룹 / 연구원) 이지수 (BS Module그룹 / 사원) 양선연 (Monitor회로개발그룹 / 주임연구원) 임창성 (Monitor품질보증그룹 / 과장) 김아련 (MonitorR&D기획그룹 / 주임연구원) 윤석재 (BS Module그룹 / 과장) 이종수 (BS Module그룹 / 대리) 엄정훈 (BS Module그룹 / 과장) 박경열 (BS Module그룹 / 과장) 황동선 (LGEND R&D.MNT S/W GROUP / 수석연구원) 김종태 (Monitor회로개발그룹 / 수석연구원) 배권일 (BS SQE그룹 / 부장) 김명욱 (Monitor회로개발그룹 / 수석연구원) 배덕호 (Monitor기구개발그룹 / 책임연구원) 박강식 (LCD TV부품품질보증계 / 기정) 이규호 (LCD TV부품품질보증계 / 기정) 박철진 (LCD TV부품품질보증계 / 기정) pinquan zhou (LGEND R&D.MNT MASS PRODUCTION GROUP / senior manager B) qiu Yu (LGEND R&D.Power GROUP / manager b) xiaoyong zhang (LGEND R&D.MNT DEVELOPMENT GROUP / manager a) jian dong (SQA GROUP / Operator3) ke zhu (LGEND R&D.MNT MECHANIC GROUP / assist manager) hongfa Wang (LGEND PRODUCTION.Circuit Supply GROUP / assist manager) wenxue li (LGEND R&D.MNT PLANNING GROUP / assist manager) guozhe zheng (LGEND PRODUCTION.Mechanical Supply Gr / 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) yuan yuan (LGEND R&D.MNT DEVELOPMENT GROUP / assist manager) hui shi (SQA GROUP / assist manager) Jing Li (LGEND R&D.MNT DEVELOPMENT GROUP / assist manager) su yuan (LGEND R&D.MNT PLANNING GROUP / officer 1) yong qing (LGEND R&D.MNT PLANNING GROUP / assist manager) xiangtai jin (LGEND R&D.COMPONENT DEVELOPMENT GROUP / officer 1) di zhao (LGEND R&D.MNT PLANNING GROUP /)</p>
EDMS Doc Link	
Attached Local Files	<p>📄 [LGE Approval] CAS_LM200WD4-SLB1(Updated).pdf 📄 [LGE Approval] IIS_LM200WD4-SLB1.pdf 📄 LM200WD4-SLB1 TCO05 document.pdf 📄 LM200WD4-SLB1 Safety document.zip 📄 LM200WD4-SLB1 Key part & Module comparison sheet.zip 📄 LM200WD4-SLB1 LGD Test report.zip</p>

Product Specification

**SPECIFICATION
FOR
APPROVAL**

- () Preliminary Specification
- (●) Final Specification

Title	20" HD+ TFT LCD
-------	-----------------

BUYER	LGE
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM200WD4
SUFFIX	SLB1

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

APPROVED BY	SIGNATURE	DATE
_____ / _____	_____	_____
_____ / _____	_____	_____
_____ / _____	_____	_____

APPROVED BY	SIGNATURE	DATE
J. H. Park / G.Manager	_____	_____
REVIEWED BY		
S. H. Kim / Manager [C]	_____	_____
Y. S. Chung / Manager [M]	_____	_____
G. T. Kim / Manager [P]	_____	_____
PREPARED BY		
T. K. Kim / Engineer	_____	_____

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

**MNT Products Engineering Dept.
LG Display Co., Ltd**

Product Specification
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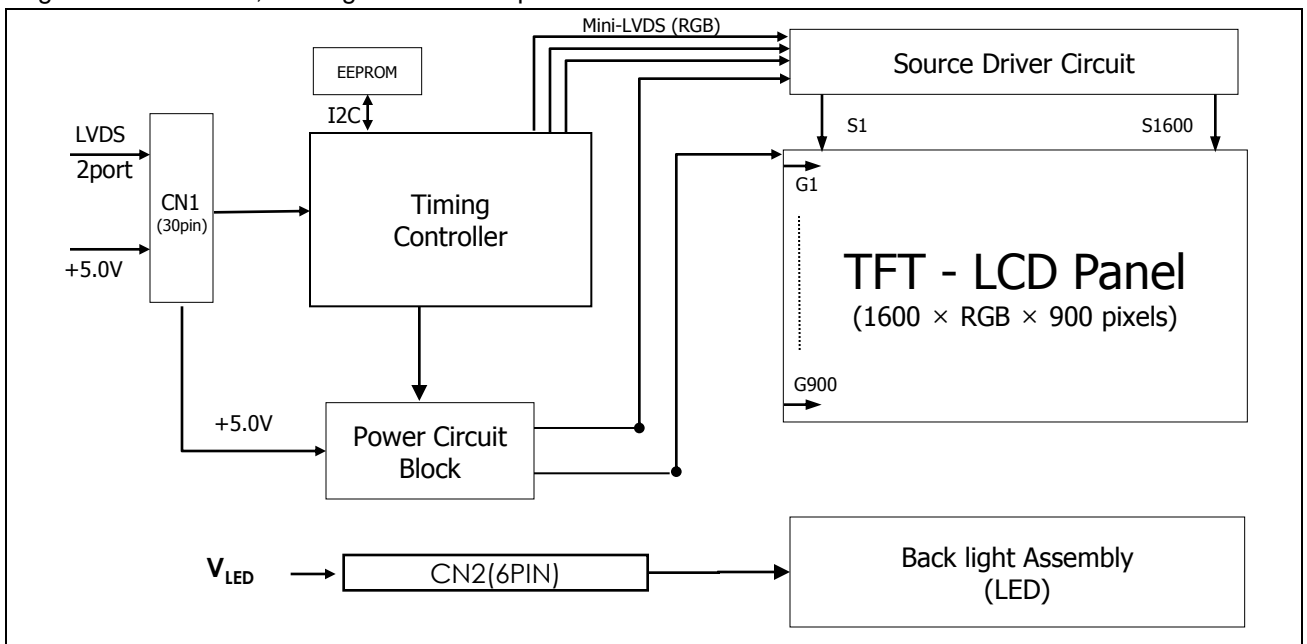
Product Specification

1. General Description

LM200WD4 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 black mode. It has a 20 inch diagonally measured active display area with HD+ resolution (900 vertical by 1600horizontal 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	20.0 inches (508.05mm) diagonal
Outline Dimension	462.8(H) x 272.0(V) x 10.2(D) mm(Typ.)
Pixel Pitch	0.2766x 0.2766(V)mm
Pixel Format	1600 horiz. By 900 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 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 20.17 Watt (Typ.) (3.27 Watt @V _{LCD} , 16.9 Watt @I _s =110mA)
Weight	1120 g (typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(3H), Anti-glare treatment of the front polarizer

Product Specification

2. Absolute Maximum Ratings

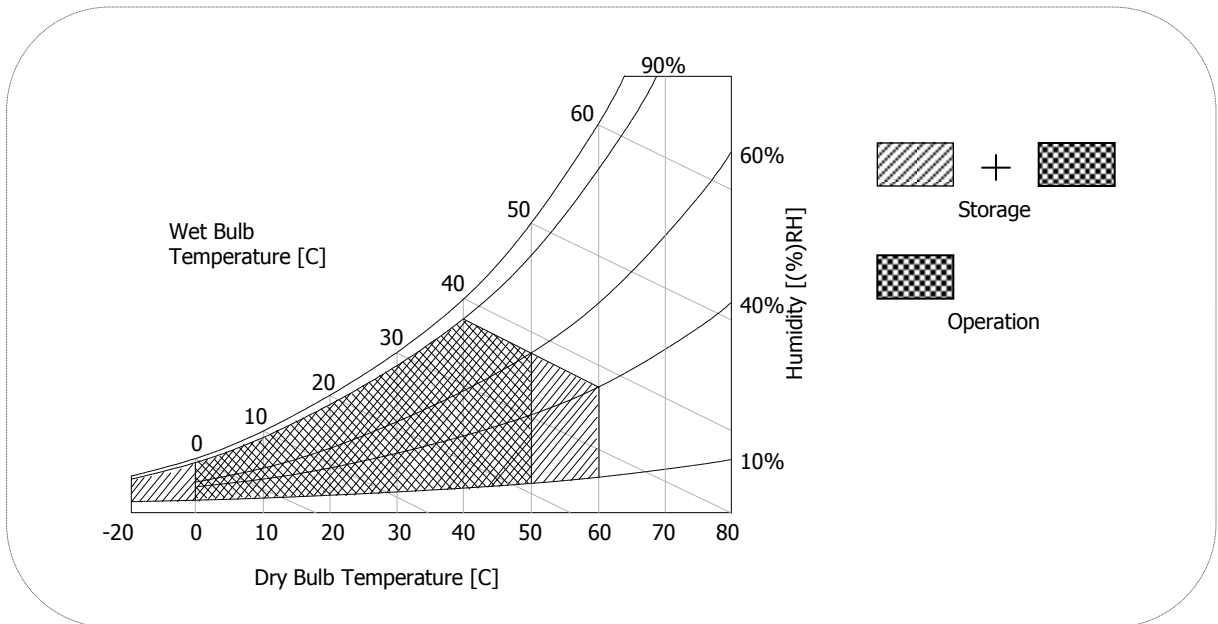
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	V _{LCD}	-0.3	6.0	V _{dc}	at 25 ± 2°C
Operating Temperature	T _{OP}	0	50	°C	1, 2, 3
Storage Temperature	T _{ST}	-20	60	°C	
Operating Ambient Humidity	H _{OP}	10	90	%RH	
Storage Humidity	H _{ST}	10	90	%RH	

- Note : 1. Temperature and relative humidity range are shown in the figure below.
 Wet bulb temperature should be 39 °C Max, and no condensation of water.
 2. Maximum Storage Humidity is up to 40°C, 70% RH only for 4 corner light leakage Mura.
 3. Storage condition is guaranteed under packing condition

[Figure 2] Temperature and relative humidity



Product Specification

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 2-1. ELECTRICAL CHARACTERISTICS

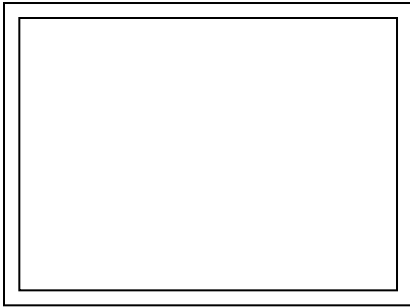
Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V _{LCD}	4.5	5.0	5.5	Vdc	
Permissive Power Input Ripple	V _{dRF}			100	mV _{p-p}	1
Power Supply Input Current	I _{LCD}	-	653	750	mA	2
		-	752	865	mA	3
Power Consumption	P _c TYP	-	3.27	3.75	Watt	2
	P _c MAX	-	3.76	4.33	Watt	3
Rush current	I _{RUSH}	-	-	3.0	A	4

Note :

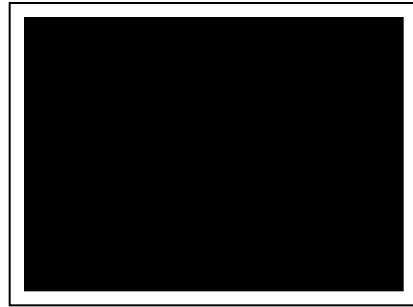
1. Permissive power ripple should be measured under V_{LCD} =5.0V, 25°C, fV(frame frequency)=MAX condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20Mhz. See the next page.
2. The specified current and power consumption are under the V_{LCD}=5.0V, 25 ± 2°C, 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 5ms and rising time of power Input is 500us ± 20%.(min.).

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- **Permissive Power input ripple** ($V_{LCD} = 5.0V$, $25^{\circ}C$, fV (frame frequency)=MAX condition)

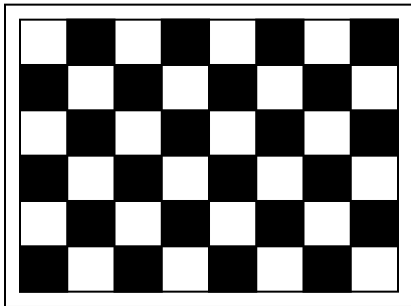


White pattern

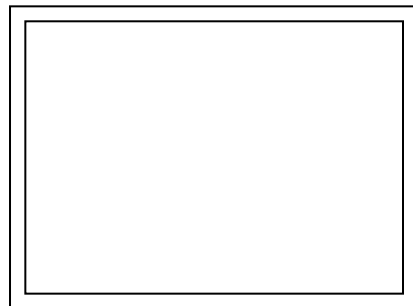


Black pattern

- **Power consumption** ($V_{LCD} = 5.0V$, $25^{\circ}C$, fV (frame frequency)=60Hz condition)



Typical power Pattern



Maximum power Pattern

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

Product Specification
Table 2-2. LED Bar ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
LED :							1,7
LED String Current	Is		-	110	120	mA	2,7
LED String Voltage	Vs		34.8	38.4	42.0	V	3,7
Power Consumption	PBar		-	16.9	18.5	Watt	4,6,7
LED Life Time	LED_LT		30,000	-	-	Hrs	5,7

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.

Please control feedback current of each string individually to compensate the current variation among the strings of LEDs.

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 and Bar 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 $25 \pm 2^{\circ}\text{C}$.
6. The LED bar power consumption shown above does not include loss of external driver.

The used LED bar current is the LED typical current.

Min Power Consumption is calculated with $P_{\text{Bar}} = V_{\text{s}}(\text{Min.}) \times I_{\text{s}}(\text{Typ.}) \times N_{\text{string}}$

Max Power Consumption is calculated with $P_{\text{Bar}} = V_{\text{bar}}(\text{Max.}) \times I_{\text{s}}(\text{Typ.}) \times N_{\text{string}}$

Product Specification

3-2. Interface Connections

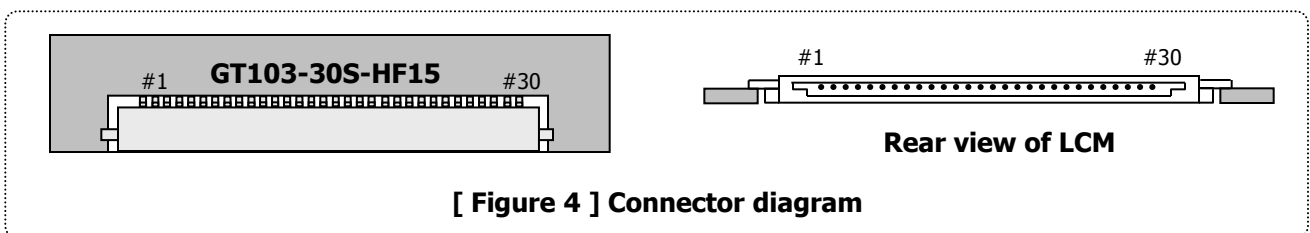
3-2-1. LCD Module

- LCD Connector(CN1). : GT103-30S-HF15 (LSM) , IS100-L300-C23 (UJU)
- 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 (I2C Serial interface for LCM)
11	FR3P	Plus signal of odd channel 3 (LVDS)	26	NC	No Connection.(I2C Serial interface for LCM)
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

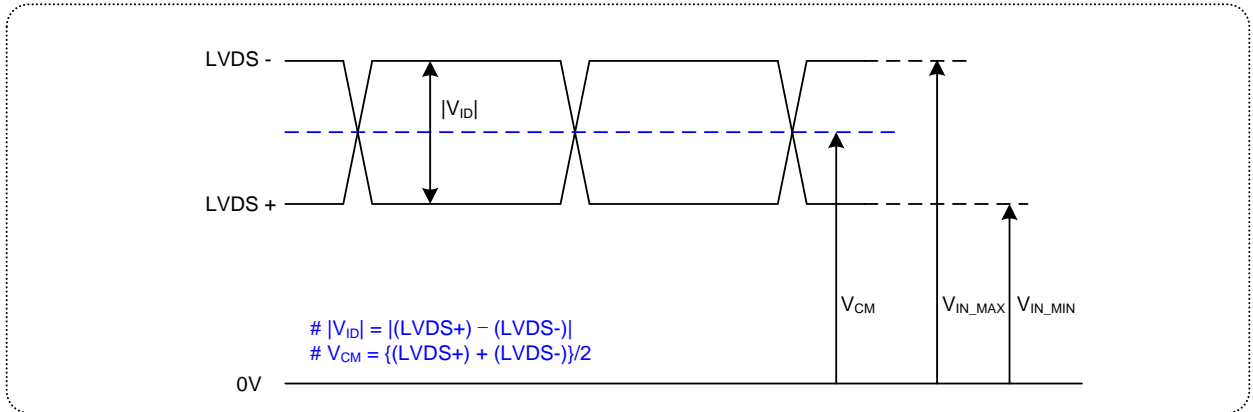
- Note:
1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
 2. All V_{LCD} (power input) pins should be connected together.
 3. Input Level of LVDS signal is based on the IEA 664 Standard.
 4. PWM_OUT signal controls the burst frequency of a inverter.
 This signal is synchronized with vertical frequency.
 It's frequency is 3 times of vertical frequency, and it's duty ratio is 50%.
 If you don't use this pin, it is no connection.



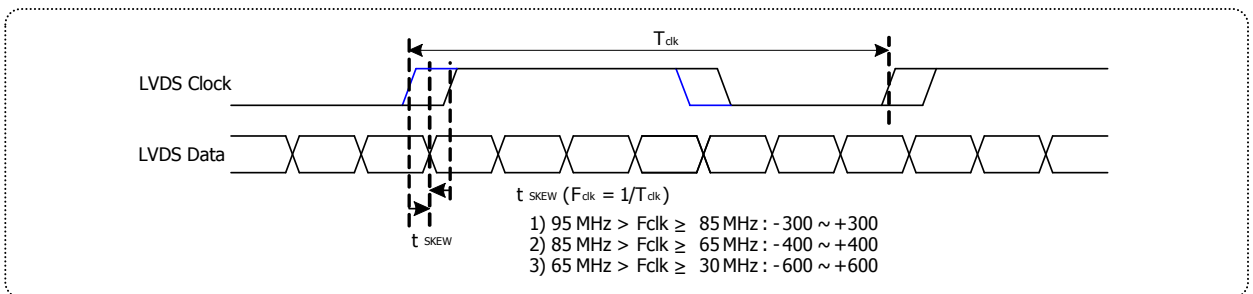
Product Specification
Table 4. REQUIRED SIGNAL ASSIGNMENT FOR Flat Link (TI:SN75LVDS83) Transmitter

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 : 1. Refer to LVDS Transmitter Data Sheet for detail descriptions.
 2. 7 means MSB and 0 means LSB at R,G,B pixel data

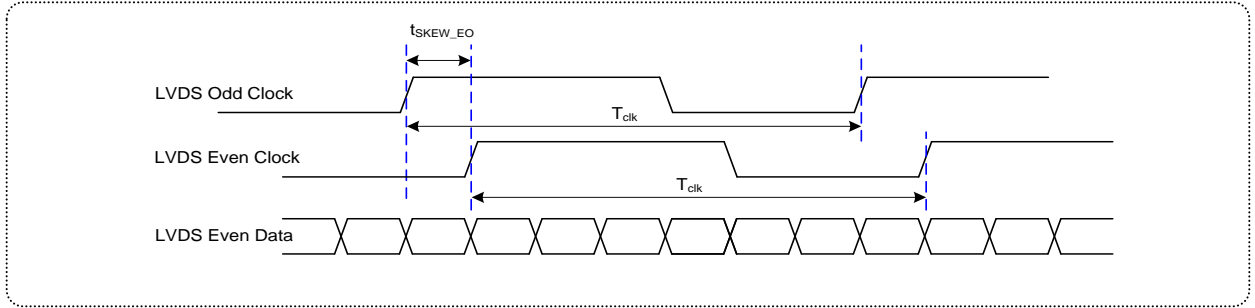
Product Specification
LVDS Input characteristics
1. DC Specification


Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$ V_{ID} $	200	600	mV	-
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔV_{CM}	-	250	mV	-

2. AC Specification


Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 300	+ 300	ps	95MHz > Fclk ≥ 85MHz
	t_{SKEW}	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t_{SKEW}	- 600	+ 600	ps	65MHz > Fclk ≥ 30MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-

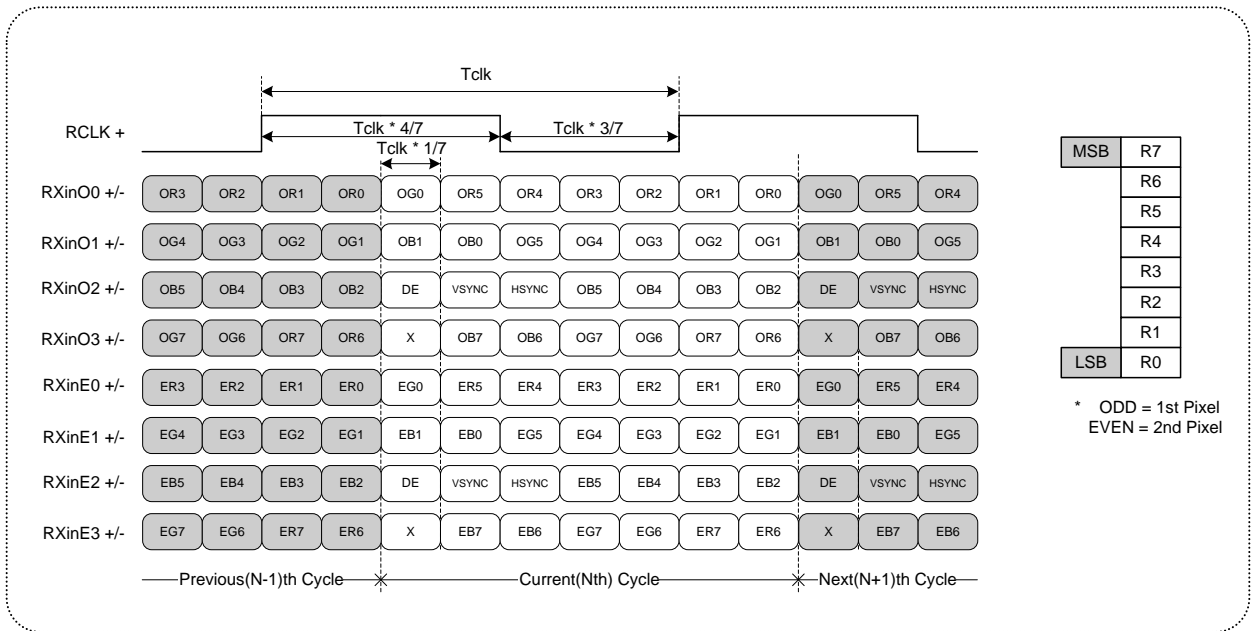
Product Specification



< Clock skew margin between channel >

3. Data Format

1) LVDS 2 Port



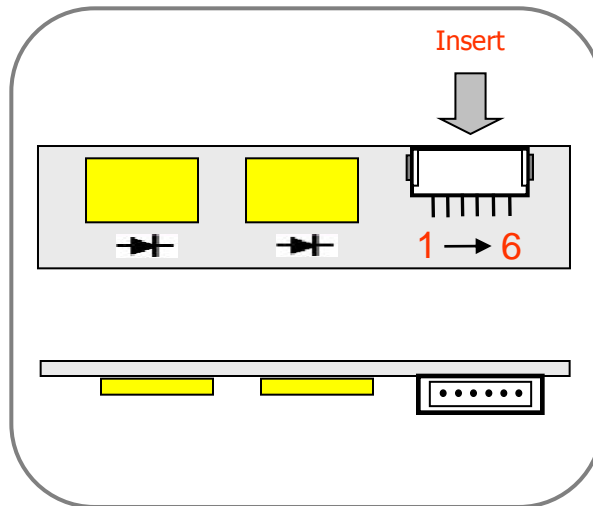
< LVDS Data Format >

Product Specification

Table 5. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN2)

The LED interface connector is a model 10019HR-H06B manufactured by Yeonho. The pin configuration for the connector is shown in the table below.

Pin	Symbol	Description	Notes
1	FB1	Channel1 Current Feedback	
2	FB2	Channel2 Current Feedback	
3	VLED	LED Power Supply	
4	VLED	LED Power Supply	
5	FB3	Channel3 Current Feedback	
6	FB4	Channel4 Current Feedback	



[Figure 5] Backlight connector diagram

Product Specification
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 its proper operation.

Table 6. TIMING TABLE

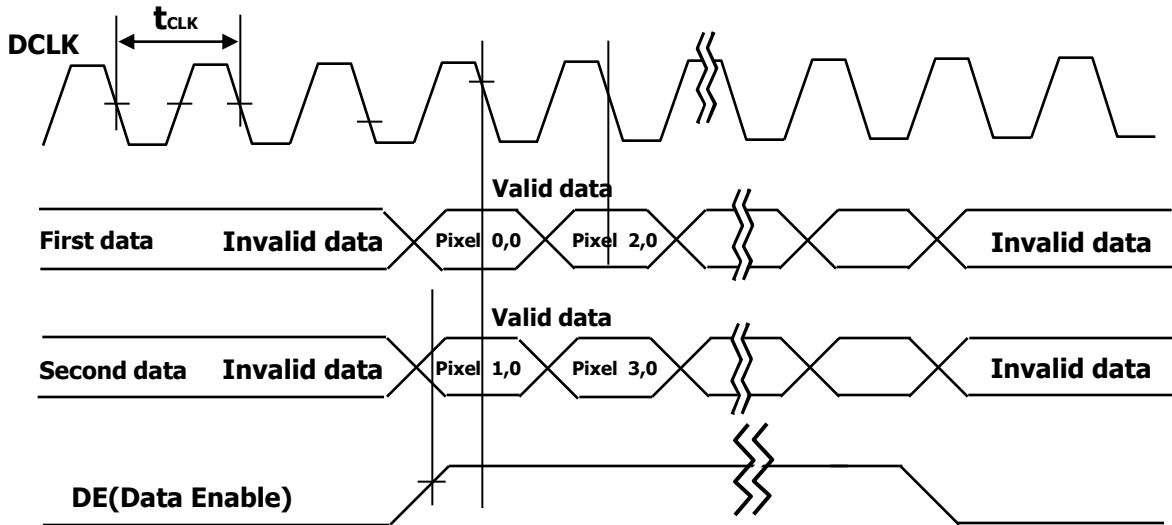
Parameter		Symbol	Min.	Typ.	Max.	Unit	Notes
D _{CLK}	Period	t _{CLK}	14.6	18.5	23.1	ns	Pixel frequency : Typ.108.0MHz
	Frequency	f _{CLK}	43.2	54.0	68.4	MHz	
Horizontal	Horizontal Valid	t _{HV}	800	800	800	t _{CLK}	
	H Period Total	t _{HP}	840	900	1200		
	Hsync Frequency	f _H	48.0	60.0	76.0	kHz	
Vertical	Vertical Valid	t _{VV}	900	900	900	t _{HP}	
	V Period Total	t _{VP}	908	1000	1300		
	Vsync Frequency	f _V	48	60	76	Hz	
DE (Data Enable)	DE Setup Time	t _{SI}	4	-	-	ns	For D _{CLK}
	DE Hold Time	t _{HI}	4	-	-		
Data	Data Setup Time	t _{SD}	4	-	-	ns	For D _{CLK}
	Data Hold Time	t _{HD}	4	-	-		

Note:

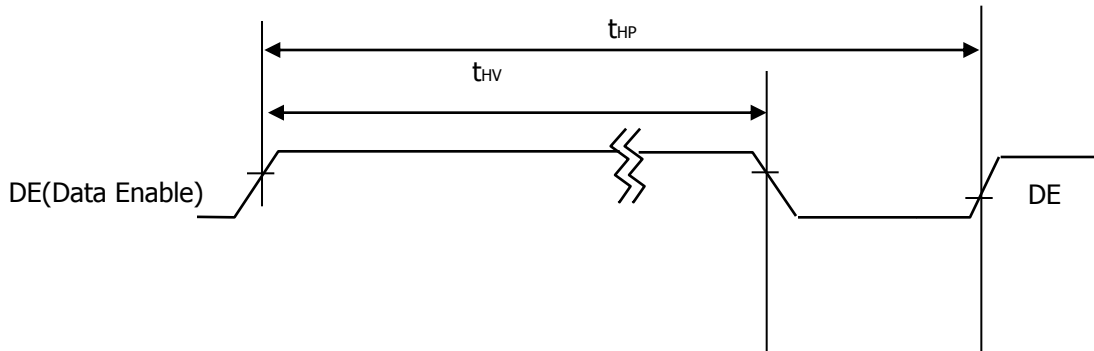
1. DE Only mode operation. The input of Hsync & Vsync signal does not have an effect on LCD normal operation.
2. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
3. Horizontal period should be even.

3-4. Signal Timing Waveforms

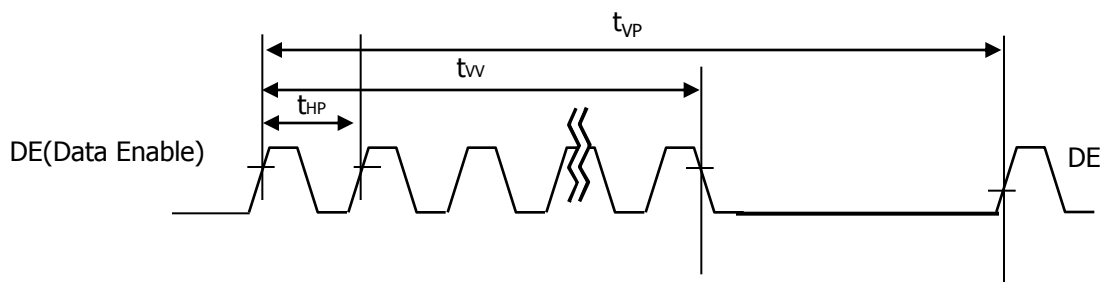
1. DCLK, DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



Product Specification
3-5. Color Input Data Reference

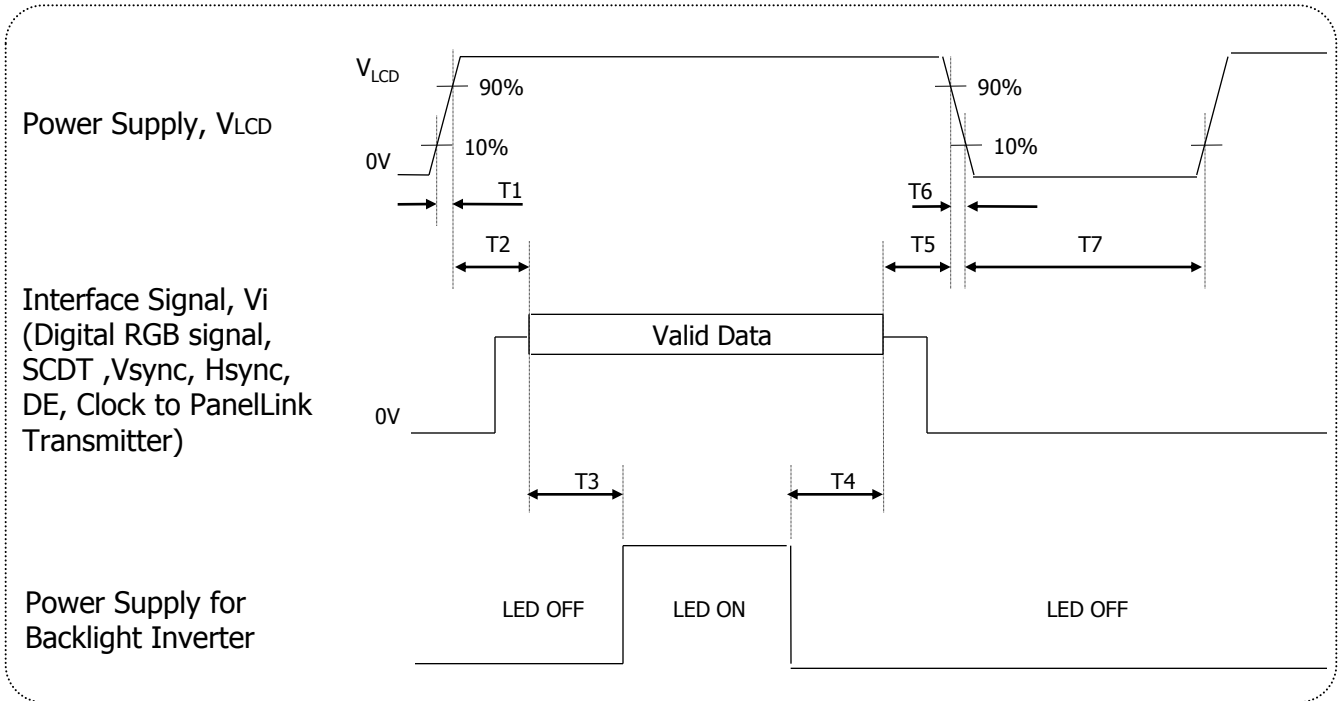
The Brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 7. 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

Product Specification

3-6. Power Sequence



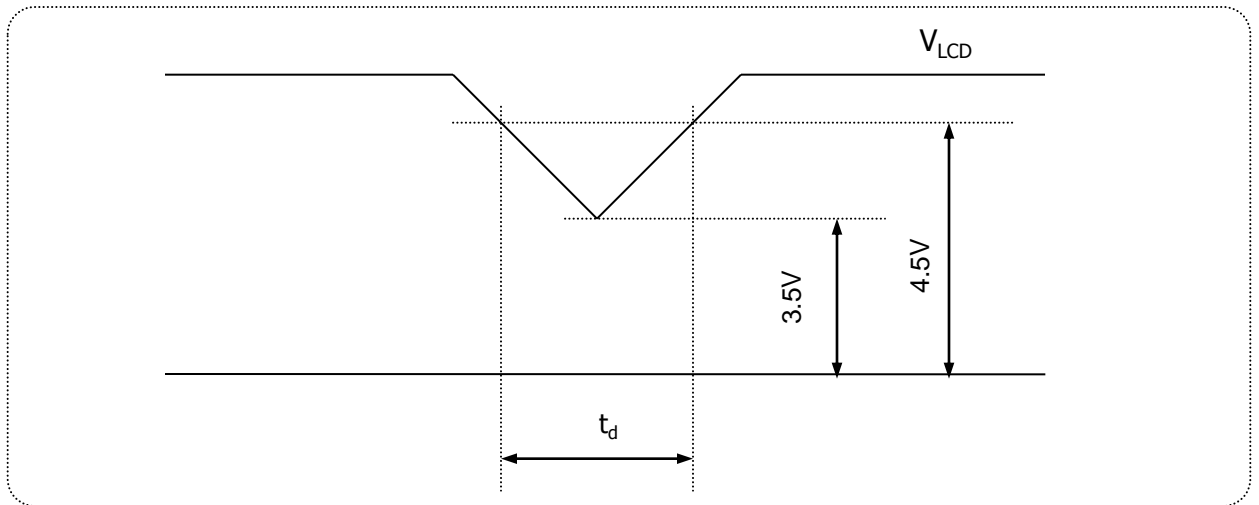
[Figure 6] Power sequence

Table 8. 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	1000	-	-	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. LED 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

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

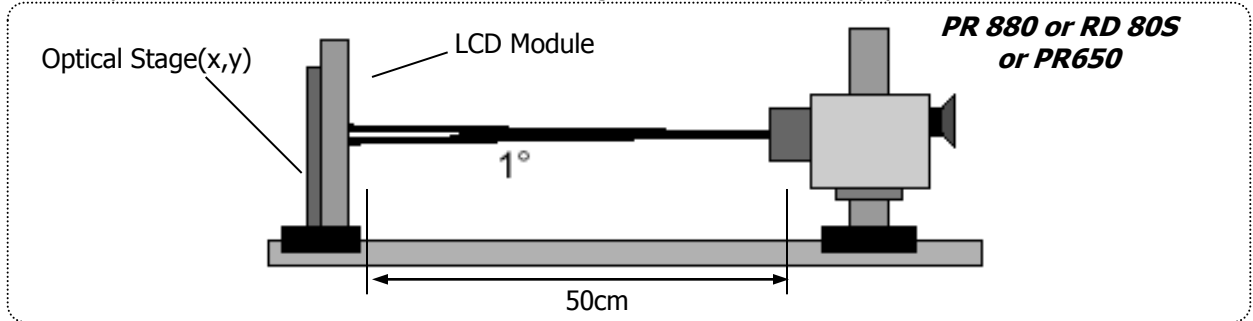
2) $V_{LCD} < 3.5V$

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

Product Specification
4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at $25 \pm 2^\circ\text{C}$. 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 9. OPTICAL CHARACTERISTICS

($T_a=25^\circ\text{C}$, $V_{\text{LCD}}=5.0\text{V}$, $f_v=60\text{Hz}$ Dclk=108MHz, $I_s=110\text{mA}$)

Parameter	Symbol	Values			Units	Notes	
		Min	Typ	Max			
Contrast Ratio	CR	600	1000	-		1	
Surface Luminance, white	L_{WH}	200	250	-	cd/m ²	2	
Luminance Variation	δ_{WHITE}	75	-	-	%	3	
Response Time	Gray To Gray	$T_{\text{GTG_AVR}}$	-	14	25	ms	4
	Gray-to-Gray (BW)	G to G _{BW}	-	8	-	ms	10,12 Reference
	Gray-to-Gray (BW(σ))	G to G _{BW(σ)}}	-	1.0	-	-	11,12 Reference
Color Coordinates [CIE1931] (By PR650)	RED	Rx	-	0.638	-	-	-
		Ry	-	0.332	-	-	-
	GREEN	Gx	-	0.302	-	-	-
		Gy	Typ -0.03	0.627	Typ +0.03	-	-
	BLUE	Bx	-	0.153	-	-	-
		By	-	0.073	-	-	-
	WHITE	Wx	-	0.313	-	-	-
	Wy	-	0.329	-	-	-	
Color Shift (Avg. $\Delta u'v' < 0.02$)	Horizontal	$\theta_{\text{CST_H}}$	-	100	-	Degree	5
	Vertical	$\theta_{\text{CST_V}}$	-	140	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_{H}	170	178	-	Degree	6
	Vertical	θ_{V}	170	178	-		
GSR @ 60dgree (Gamma shift rate)	Horizontal	$\delta_{\text{Gamma_H}}$	-	-	20	%	7
	Vertical	$\delta_{\text{Gamma_V}}$	-	-	20		
WPT (White Point Tracking)		-	-300	G255 CCT	+700	K	8
Color gamut (CG, CIE1931)		-	-	72	-	%	
Gray Scale		-	-	2.2	-		9

Product Specification

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

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

It is measured at center point(Location P1)

2. Surface luminance(L_{WH})is luminance value at Center 1 point(P1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG.8 (By PR880)

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

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

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations.
 For more information see FIG.9

4. Gray to gray response time is the time required for the display to transition from gray to gray.
 For additional information see Table 10. **(By RD80S)**

5. Color shift is the angle at which the average color difference for all Macbeth is lower than 0.02.
 For more information see FIG.10 **(By EZ Contrast)**
 - Color difference (Δu'v')

$$u' = \frac{4x}{-2x + 12y + 3} \quad v' = \frac{9y}{-2x + 12y + 3} \quad \Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

$$\text{Avg}(\Delta u'v') = \frac{\sum_{i=1}^{24} (\Delta u'v')_i}{24}$$

u'1, v'1 : u'v' value at viewing angle direction
 u'2, v'2 : u'v' value at front (θ=0)
 i : Macbeth chart number (Define 22 page)

- Pattern size : 25% Box size
- Viewing angle direction of color shift : Horizontal, Vertical

6. Viewing angle is the angle at which the contrast ratio is greater than 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.11 **(By PR880)**

7. GSR is the rate of gamma shift at up, down, left and right 60 degree viewing angle compare with center gamma. For more information see FIG.11 and FIG.12 **(By EZ Contrast)**
 - GSR (δ_{Gamma}) is defined as :

$$\text{GSR} = \left(1 - \frac{\text{View angle Gamma Value (Up, Down, Reft, Light 60 Degree)}}{\text{Center Gamma Value (0 Degree)}} \right) \times 100$$

8. WPT (White Point Tracking) is the variation of color temperature between G255 and G63.
(By PR650)

Product Specification

Notes 9. Gamma Value is approximately 2.2. For more information see Table 11.

Notes 10. Response time is the time required for the display to transit from any gray to white (Rise Time, TrR) and from any gray to black (Decay time, TrD).

G to GBW Spec stands for average value of all measured points. (By RD80S)

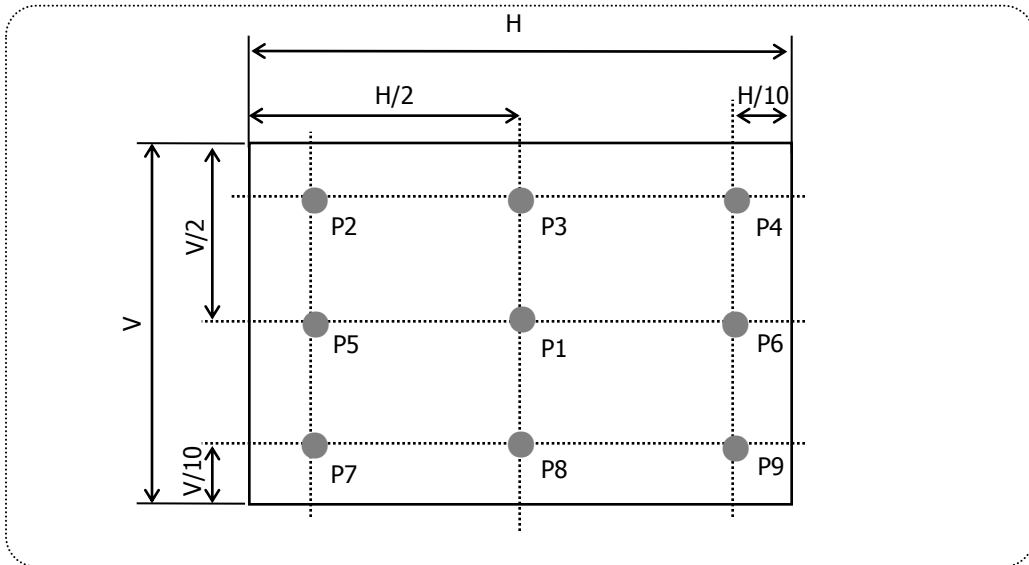
Notes 11. It is the standard deviation of G to GBW data.

$$G \text{ to } G_{BW} (\sigma) = \sqrt{\frac{\sum(X_i - u)^2}{N}}$$

Xi = BW individual Data
 u = BW Data average
 N : The number of Data

Notes 12. This is not used for product spec, but for end-user marketing purpose

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



[Figure 9] _Measure Point for Luminance

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

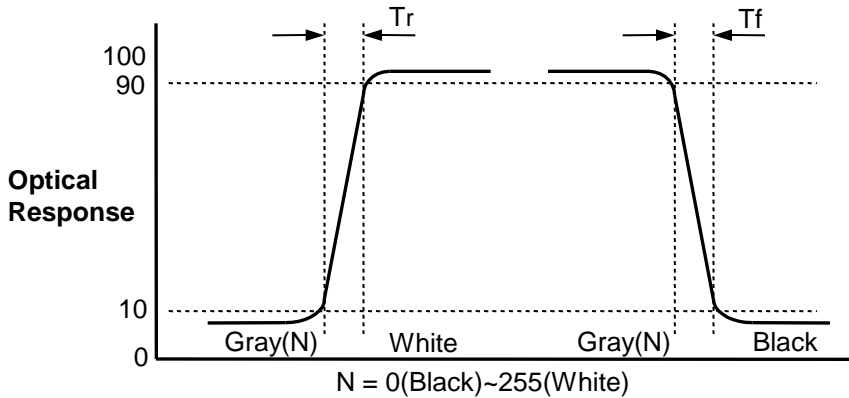
- Gray step : 5 Step
- TGTG_AVR is the total average time at rising time and falling time for "Gray To Gray".
- if system use ODC (Over Driving Circuit) function, Gray to Gary response time may be 5ms~8ms GtG
- * it depends on Overshoot rate.

Table. 10 GTG Gray Table

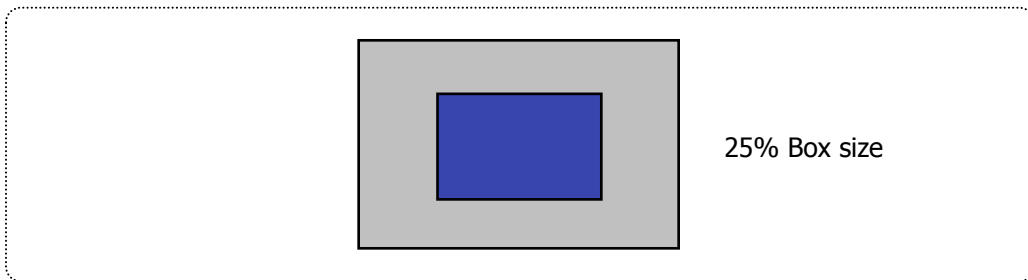
Gray to Gray		Rising Time				
		G255	G191	G127	G63	G0
Falling Time	G255					
	G191					
	G127					
	G63					
	G0					

Product Specification

G to G(BW) Response time is defined as the following figure and shall be measured by switching the input signal for “Gray(N)” and “Black or White”.



Color shift is defined as the following test pattern and color.



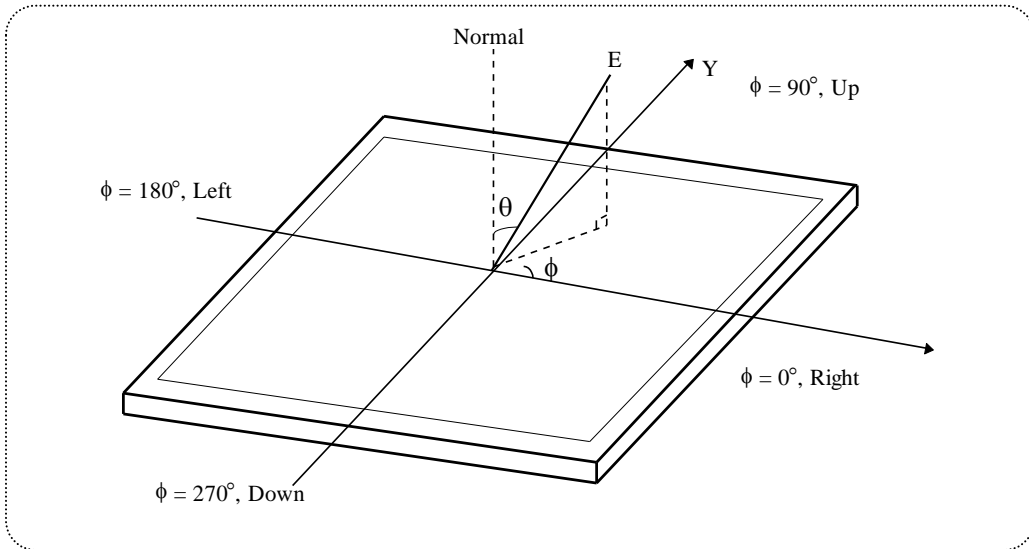
[Figure 10] Color Shift Test Pattern

Average RGB values in Bruce RGB for Macbeth Chart

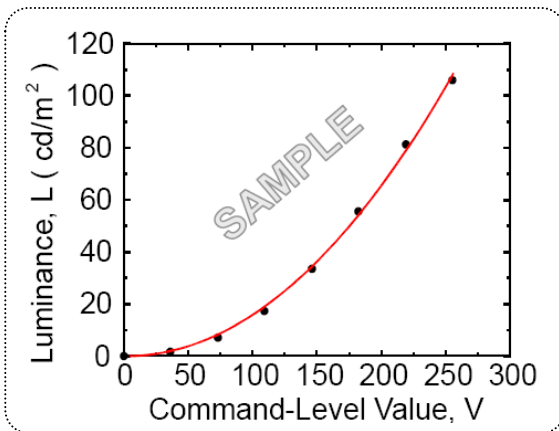
	Dark skin (i=1)	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	98	206	85	77	129	114
G	56	142	112	102	118	199
B	45	123	161	46	185	178
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	219	56	211	76	160	230
G	104	69	67	39	193	162
B	24	174	87	86	58	29
	Blue	Green	Red	Yellow	Magenta	Cyan
R	26	72	197	241	207	35
G	32	148	27	212	62	126
B	145	65	37	36	151	172
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	Black
R	240	206	155	110	63	22
G	240	206	155	110	63	22
B	240	206	155	110	63	22

Product Specification

Dimension of viewing angle range.

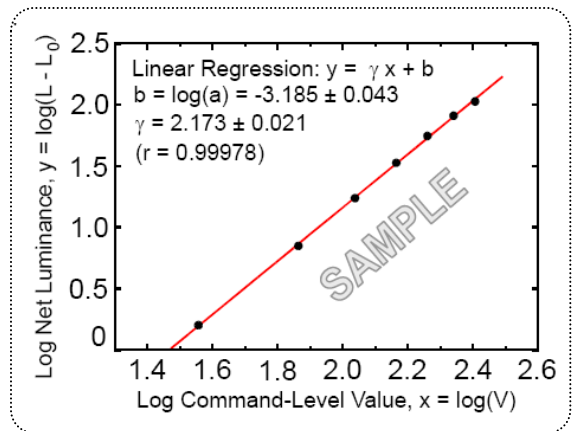


[Figure 11] Viewing angle



[Figure .12] Sample Luminance vs. gray scale (using a 256 bit gray scale)

$$L = aV^r + L_b$$



[Figure .13] Sample Log-log plot of luminance vs. gray scale

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

Here the Parameter a and gamma relate the signal level V to the luminance L.
The GAMMA we calculate from the log-log representation (FIG.12)

Product Specification

Table 11. 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

Product Specification
5. Mechanical Characteristics

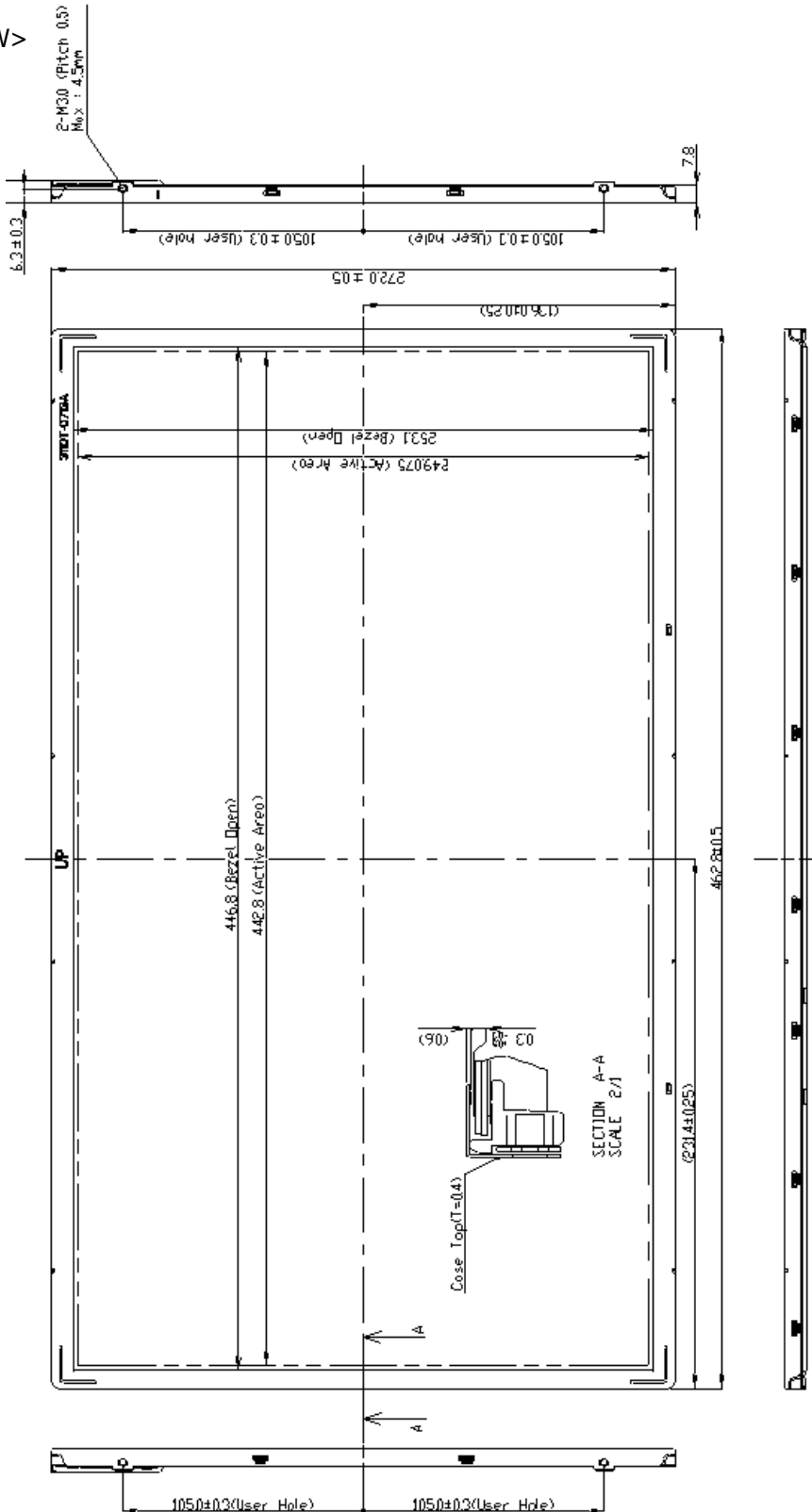
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	462.8 mm
	Vertical	272.0 mm
	Depth	10.2 mm
Bezel Area	Horizontal	446.8 mm
	Vertical	253.1 mm
Active Display Area	Horizontal	442.8 mm
	Vertical	249.1 mm
Weight	Typ : 1120 g , Max : 1180 g	
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.

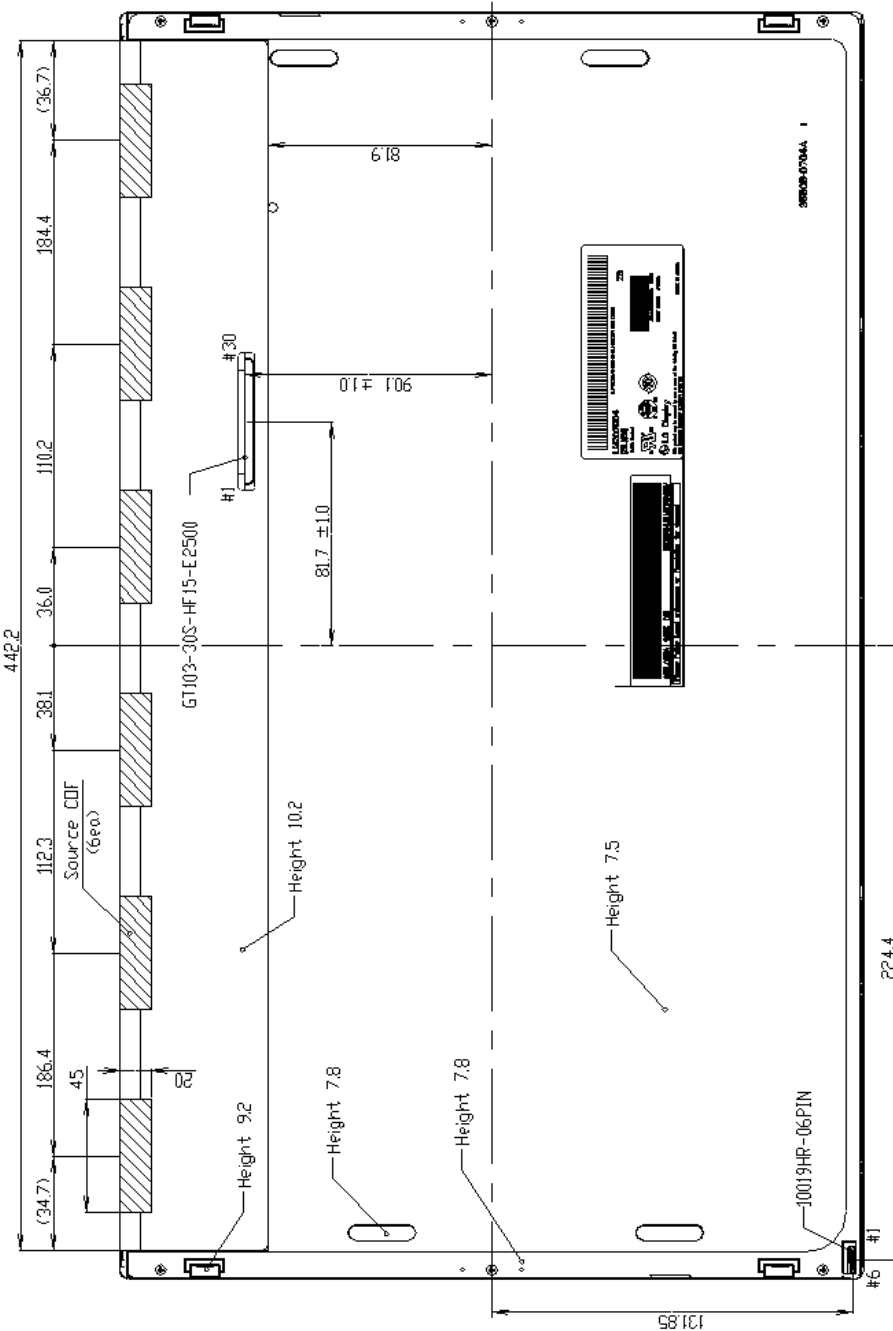
Product Specification

<FRONT VIEW>



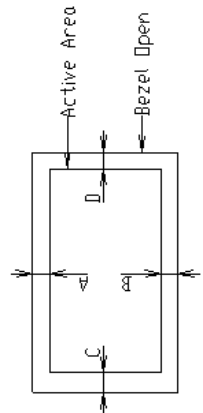
Product Specification

<REAR VIEW>



Notes

1. I/F Connector Specification : GT103-30S-HF15-E2500
2. LED Connector Specification : 10019HR-06PIN
3. Torque of user hole : 2.5~3.5 Kgf-cm
4. Tilt and partial disposition tolerance of display area as following
 - (1) Y-Direction : $1A-BI \leq 1.0$
 - (2) X-Direction : $1C-DI \leq 1.0$



5. Unspecified tolerances to be $\pm 0.5\text{mm}$
6. The CDF area is weak & sensitive, So, please don't press the CDF area.

LGD Highly recommendation :

As The IPS panel is sensitive & slim, please recommend the metal frame of the system supports the panel by the double side-mount.

Product Specification
6. Reliability

Environment test condition

No	Test Item	Condition
1	High temperature storage test	Ta= 60°C 240h
2	Low temperature storage test	Ta= -20°C 240h
3	High temperature operation test	Ta= 50°C 50%RH 240h
4	Low temperature operation test	Ta= 0°C 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 : 120G Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
7	Humidity condition Operation	Ta= 40 °C ,90%RH
8	Altitude operating storage / shipment	0 - 10,000 feet(3,048m) 0 - 40,000 feet(12,192m)
9	Maximum Storage Humidity for 4 corner light leakage Mura.	Max 70%RH , Ta=40°C

Product Specification

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)

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 on the reduction of the use of certain hazardous substances in electrical and electronic equipment. January 2003

Product Specification

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)

E : MONTH

D : YEAR

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 : 12 pcs

b) Box Size : 355mm X 305mm X 560mm

Product Specification

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 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.
- (10) As The IPS panel is sensitive & slim, please recommend the metal frame of the system supports the panel by the double side-mount.

9-2. OPERATING PRECAUTIONS

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
 $V = \pm 200\text{mV}$ (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'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.
- (10) When LCMs are used for public display defects such as Yogure, image sticking can not be guarantee.

Product Specification

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°C and 35°C 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.