

# ***TFT-Display Datenblatt***

Modell ELM220WE1-DN01-TLP1

## **Kurzdaten**

Hersteller	BSK
Diagonale	22" / 55,9 cm
Format	16:10
Auflösung	1680x1050
Backlight	LED / 500 cd/m <sup>2</sup>
Interface	LVDS
Touchscreen	nein
Temperatur	0...+50°C (Betrieb)

**Product Specification**

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 82008 Unterhaching  
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# SPECIFICATION FOR APPROVAL

- ( ) Preliminary Specification  
 (☛) Final Specification

Title	<b>22" WSXGA+ TFT LCD</b>
-------	---------------------------

BUYER	
MODEL	

SUPPLIER	Bi Search Korea Co., Ltd.
*MODEL	ELM220WE1
SUFFIX	DN01-TLP1

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

SIGNATURE	DATE
/	_____
/	_____
/	_____

APPROVED BY	DATE
/ G.Manager	_____
<b>REVIEWED BY</b>	
/ Manager [C]	_____
/ Manager [M]	_____
/ Manager [P]	_____
<b>PREPARED BY</b>	
/ Engineer	_____

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

**Product Engineering Dept.  
 Bi-Search Korea, Inc.**

**Product Specification****Contents**

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**Product Specification****Record of revisions**

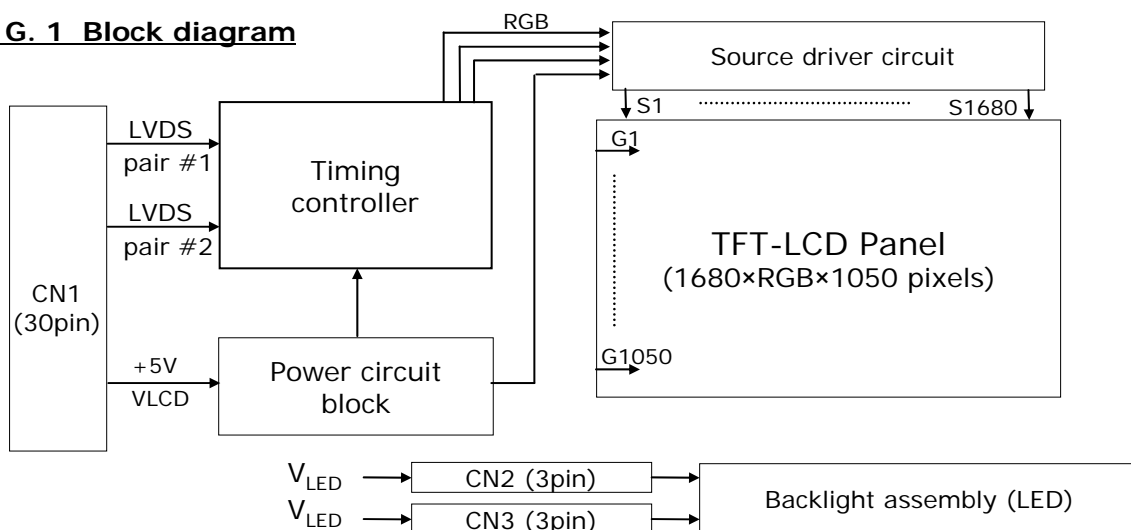
Revision No	Date	Page	Description
Ver. 0.0	April, 26, 2010		First Draft, <a href="#">Preliminary Specifications</a>

**Product Specification**

**1. General description**

ELM220WE1-DN01-TLP1 is a Color Active Matrix Liquid Crystal Display with an integral Light Emitting Diode (LED) 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 22 inch diagonally measured active display area with WSXGA+ resolution (1050 vertical by 1680 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 colors with Advanced-FRC(Frame Rate Control). It has been designed to apply the interface method that enables low power, high speed, low EMI. FPD Link or compatible must be used as a LVDS(Low Voltage Differential Signaling) chip. It is intended to support applications where thin thickness, wide viewing angle, low power are critical factors and graphic displays are important. In combination with the vertical arrangement of the sub-pixels, the LM220WE1-TLP1 characteristics provide an excellent flat panel display for office automation products such as monitors.

**FIG. 1 Block diagram**



**General features**

Active screen size	21.995 inches(558.673mm) diagonal (Aspect ratio 16:10)
Outline Dimension	493.7(H) x 320.1 (V) x 14.5(D) mm (Typ.)
Pixel Pitch	0.282mm x 0.282mm
Pixel Format	1680 horizontal By 1050 vertical Pixels. RGB stripe arrangement
Interface	LVDS 2Port
Color depth	16.7M colors
Luminance, white	500 cd/m <sup>2</sup> ( Center 1Point, Min)
Viewing Angle (CR>10)	R/L 170(Typ.), U/D 160(Typ.)
Power Consumption	Total 38.85W (Typ.), (5.25W@V <sub>LCD</sub> , 33.6W@I <sub>BL</sub> =Dim-100%)
Weight	2,350g (Typ.)
Display operating mode	Transmissive mode, normally White
Surface treatments	Hard coating (3H), Anti-glare treatment of the front polarizer

**Product Specification**

**2. Absolute maximum ratings**

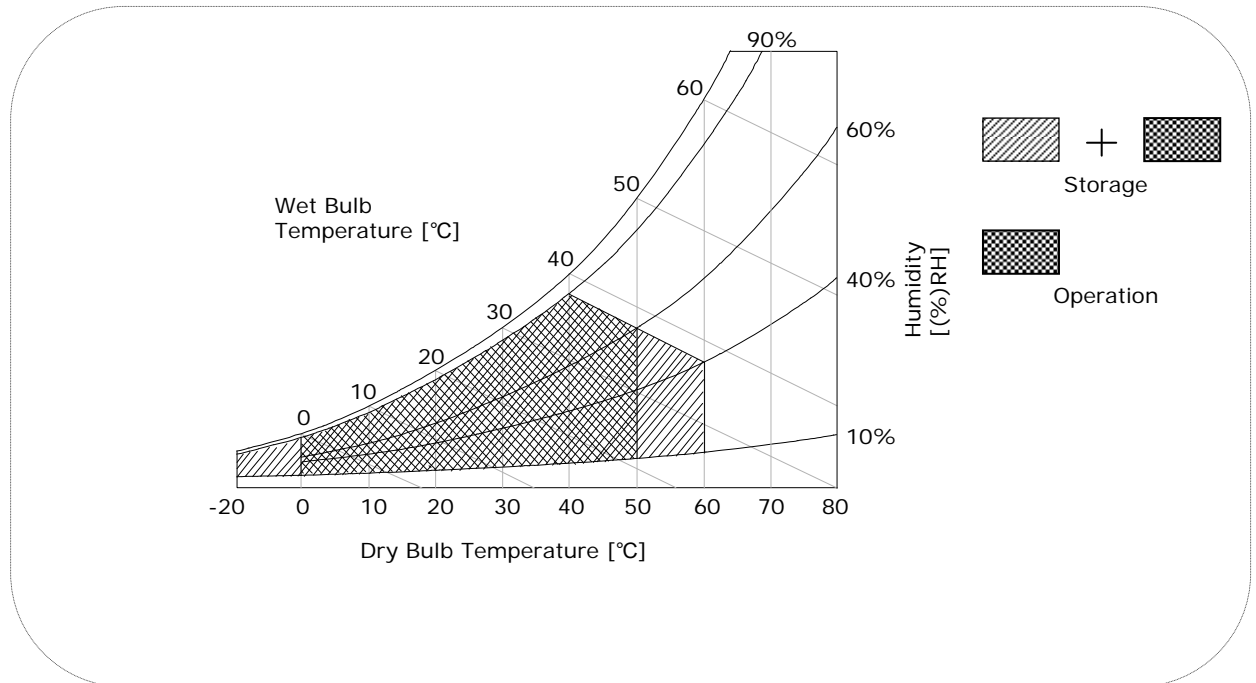
The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

**Table 1. Absolute maximum ratings**

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	$V_{LCD}$	-0.3	+6.0	Vdc	At 25°C
Operating Temperature	$T_{OP}$	0	50	°C	1
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.

**FIG. 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 LED/Backlight, is typically generated by an LED DRIVER. The LED DRIVER 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	$V_{LCD}$	-	-	0.2	V	3
Power Supply Input Current	$I_{LCD-MOSAIC}$	-	1050	1210	mA	1
	$I_{LCD-BLACK}$	-	1220	1380	mA	2
Power Consumption	$P_{LCD}$	-	5.25	6.05	Watt	1
Inrush current	$I_{RUSH}$	-	-	3.5	A	3

Note :

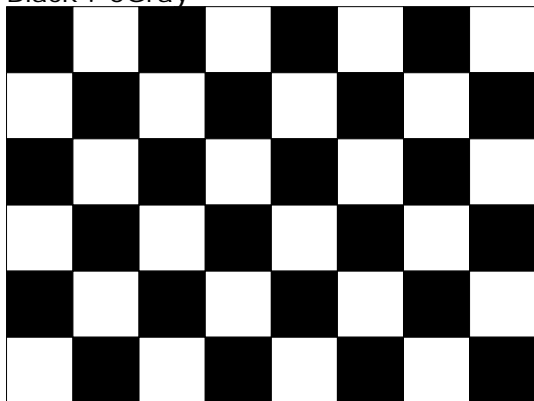
1. The specified current and power consumption are under the  $V_{LCD}=5.0V$ ,  $25 \pm 2^{\circ}C$ ,  $f_v=60Hz$  condition whereas mosaic pattern(8 x 6) is displayed and  $f_v$  is the frame frequency.
2. The current is specified at the maximum current pattern.
3. Permissive power ripple should be measured under  $VCC=5.0V$ ,  $25^{\circ}C$ ,  $f_v$  (frame frequency)=75Hz condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20MHz.
4. The duration of rush current is about 2ms and rising time of power Input is  $500us \pm 20\%$ .

## FIG.3 pattern for Electrical characteristics

## power consumption measurement

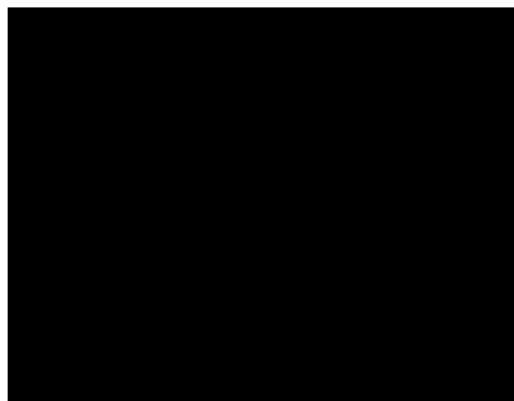
White : 255Gray

Black : 0Gray



Mosaic Pattern(8 x 6)

## power input ripple



Full Black Pattern

## Product Specification

Table 3. Electrical characteristics

Parameter	Symbol	Value			Unit	Note	
		Min	Typ	Max			
<b>LED Driver :</b>							
Power Supply Input Voltage	VBL		24		Vdc	1	
Power Supply Input Current	IBL_A		1.2		A	1(Dim = 100%)	
Power Consumption	PBL	-	28.8	-	W		
Input Voltage for Control System Signals	On/Off	On	V on	2.5	-	5.0	Vdc
		Off	V off	-0.3	-	0.5	Vdc
	Dim Adjust (LED Current Control)	Dim	0	-	100	%	
	Switching Frequency	fo	200	220	240	kHz	
	Dimming Frequency	PWM	0.9	1.1	1.3	kHz	0.0~5.0Volt (PWM Dimming)
<b>LED :</b>							
Life Time		50.000			Hrs	3	

## Notes :

1. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 60minutes at 25±2°C. The specified current and power consumption are under the typical supply Input voltage 12V and Dim = 100%, it is total power consumption.
2. Electrical characteristics are determined within 30 minutes at 25±2°C. The specified currents are under the typical supply Input voltage 12V.
3. The life time (MTTF) is determined as the time which luminance of the LED is 50% compared to that of initial value at the typical LED current (Dim:100%) on condition of continuous operating in LCM state at 25±2°C.
4. The duration of rush current is about 10ms.
5. Even though inrush current is over the specified value, there is no problem if I2T spec of fuse is satisfied.

## Product Specification

### 3-1-1. Input Connector CN1 : SMAW200-10P (YEON-HO or Equivalent )

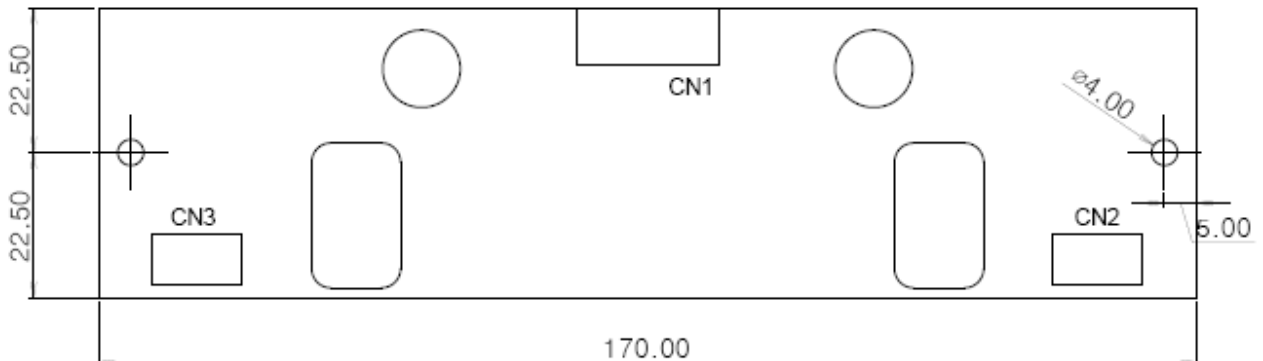
Pin No.	Symbol	Description
1,2,3,4	Vin	Input Voltage : T,B,D $\pm$ 1V
5,6,8,10	GND	GND.
7	ON / OFF (ENABLE)	Power System Return ( 5V:ON, 0V:OFF )
9	PWM_Dim	V <sub>BRT</sub> (Bright adjust : MAX 0 ~ 5V MIN)

### 3-1-2. high Output Connector CN2,CN3 : 20015WR-05A00(YEON-HO or Equivalent)

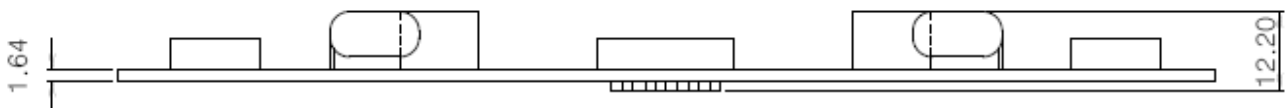
Pin No.	Symbol	Description
1	Vo	Output Voltage Connection to high side of LED
2	Vo	Output Voltage Connection to high side of LED

### 3-1-3.P.W.B Dimensions

\*. Unit : mm  
 \*.Tolerance :  $\pm$  0.3mm



### 3-1-4.Thickness



**Product Specification**

**3-2. Interface connections**

LCD connector(CN1) : GT103-30S-H23 (LSM) , IS100-L30B-C23 (UJU)

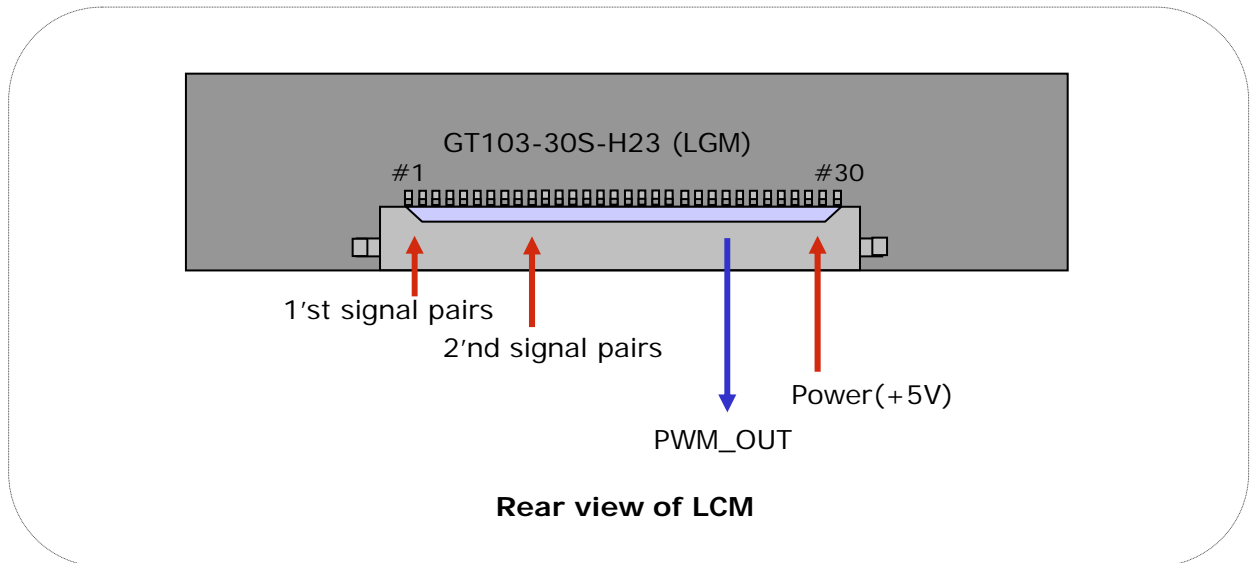
Mating connector : FI-X30H and FI-X30HL (JAE) or Equivalent

**Table 4. Module connector(CN1) pin configuration**

Pin No	Symbol	Description	
1	RX00-	Minus signal of 1st channel 0 (LVDS)	} First Pixel data
2	RX00+	Plus signal of 1st channel 0 (LVDS)	
3	RX01-	Minus signal of 1st channel 1 (LVDS)	
4	RX01+	Plus signal of 1st channel 1 (LVDS)	
5	RX02-	Minus signal of 1st channel 2 (LVDS)	
6	RX02+	Plus signal of 1st channel 2 (LVDS)	
7	GND	Ground	
8	RXOC-	Minus signal of 1st clock channel (LVDS)	} Second Pixel data
9	RXOC+	Plus signal of 1st clock channel (LVDS)	
10	RX03-	Minus signal of 1st channel 3 (LVDS)	
11	RX03+	Plus signal of 1st channel 3 (LVDS)	
12	RXE0-	Minus signal of 2nd channel 0 (LVDS)	
13	RXE0+	Plus signal of 2nd channel 0 (LVDS)	
14	GND	Ground	
15	RXE1-	Minus signal of 2nd channel 1 (LVDS)	} Second Pixel data
16	RXE1+	Plus signal of 2nd channel 1 (LVDS)	
17	GND	Ground	
18	RXE2-	Minus signal of 2nd channel 2 (LVDS)	
19	RXE2+	Plus signal of 2nd channel 2 (LVDS)	
20	RXEC-	Minus signal of 2nd clock channel (LVDS)	
21	RXEC+	Plus signal of 2nd clock channel (LVDS)	
22	RXE3-	Minus signal of 2nd channel 3 (LVDS)	} Second Pixel data
23	RXE3+	Plus signal of 2nd channel 3 (LVDS)	
24	GND	Ground	
25	NC	No Connection (For LCD internal use only.)	
26	NC	No Connection (For LCD internal use only.)	
27	PWM_OUT	Reference signal for burst frequency LED DRIVER control	
28	V <sub>LCD</sub>	Power Supply (5.0V)	
29	V <sub>LCD</sub>	Power Supply (5.0V)	
30	V <sub>LCD</sub>	Power Supply (5.0V)	

## Product Specification

FIG. 4 Connector diagram



## Note:

1. NC: No Connection.
2. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
3. All  $V_{LCD}$  (power input) pins should be connected together.
4. Input Level of LVDS signal is based on the IEA 664 Standard.
5. PWM\_OUT is a reference signal for LED DRIVER control.  
This PWM signal is synchronized with vertical frequency.  
Its frequency is 3 times of vertical frequency, and its duty ratio is 50%.  
If the system don't use this pin, do not connect.

## Product Specification

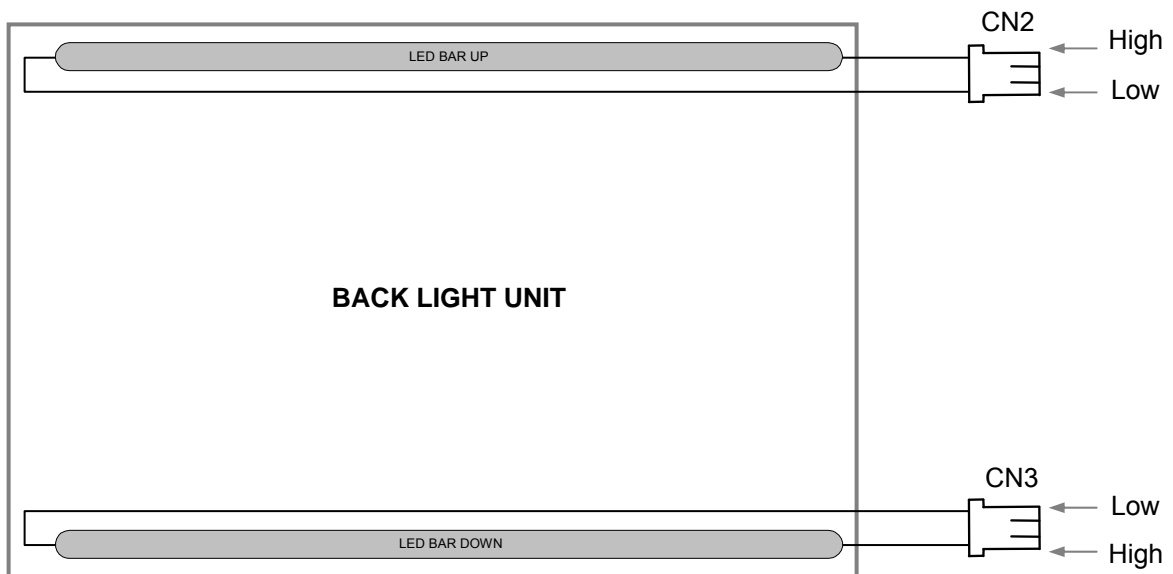
The backlight interface connector is a model 35001HS-02LD manufactured by YEONHO. The mating connector part number are 35001WR-02L(2pin) or equivalent. The pin configuration for the connector is shown in the table below.

**Table 5. Backlight connector pin configuration(CN2,CN3)**

No	Pin	Symbol	Description	Notes
CN2	1	L1	Power supply for LED BAR 1 (Low voltage side), Whiet	2
	2	NC	No Connect	
	3	H1	Power supply for LED BAR 1(High voltage side), Pink	1
CN3	1	L2	Power supply for LED BAR 2 (Low voltage side), White	2
	2	NC	No Connect	
	3	H2	Power supply for LED BAR 2 (High voltage side), Pink	1

Notes: 1. The high voltage power terminal is colored Pink.  
2. The low voltage pin color is White.

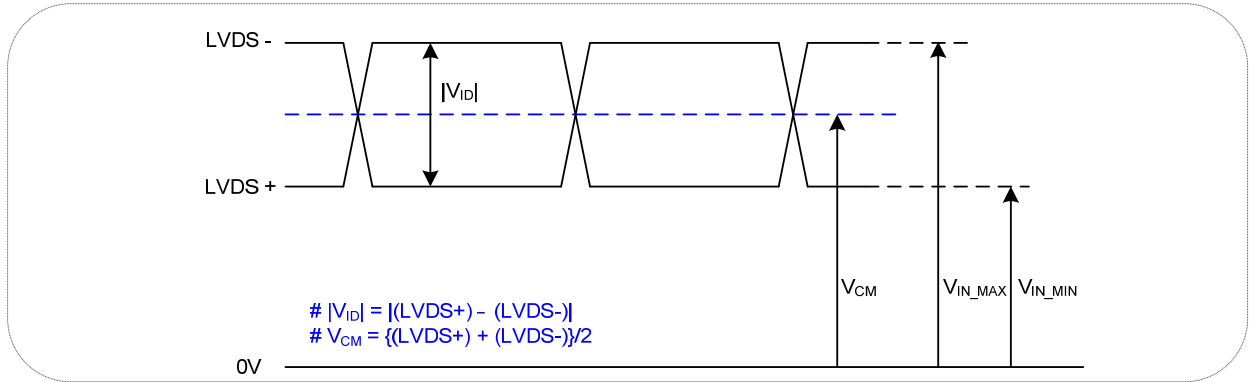
**FIG. 5 Backlight connector diagram**



## Product Specification

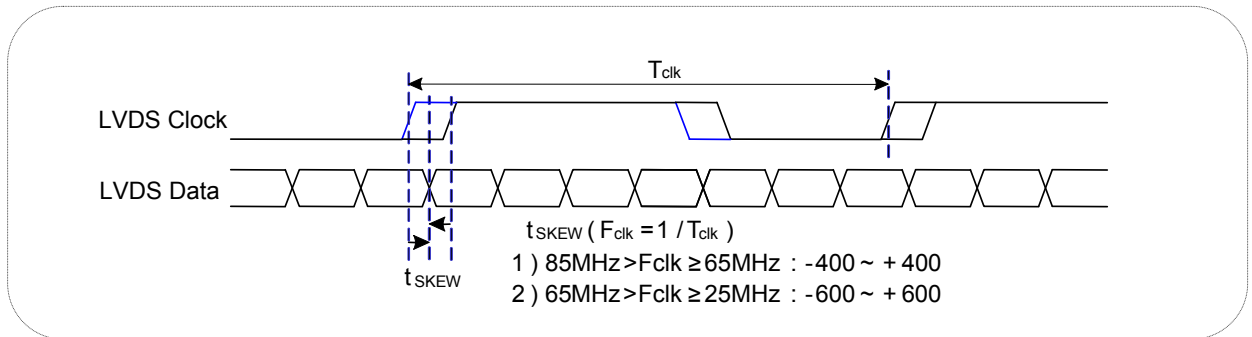
### 3-3. LVDS characteristics

#### 3-3-1. DC Specification



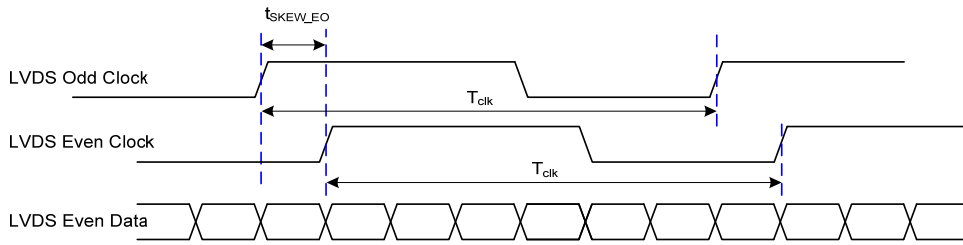
Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$ V_{ID} $	200	600	mV	-
LVDS Common mode Voltage	$V_{CM}$	0.6	1.8	V	-
LVDS Input Voltage Range	$V_{IN}$	0.3	2.1	V	-

#### 3-3-2. AC Specification

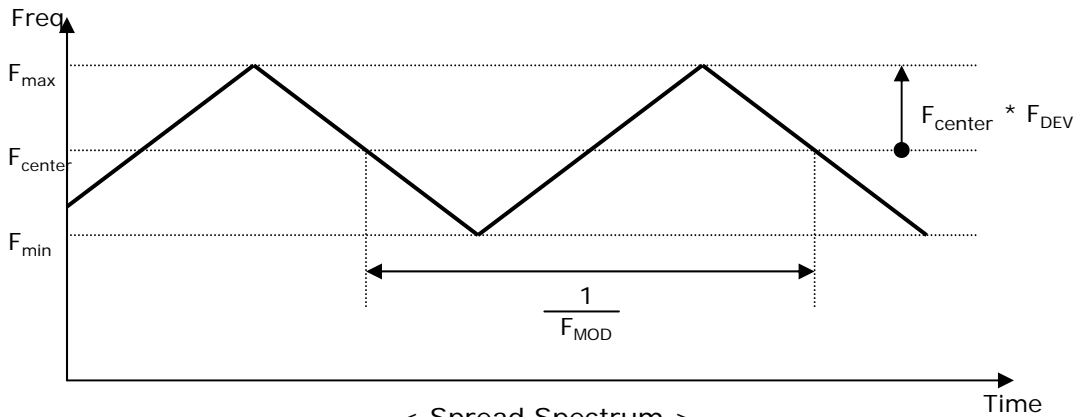


Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	$t_{SKEW}$	-400	+400	ps	$85MHz > F_{clk} \geq 65MHz$
	$t_{SKEW}$	-600	+600	ps	$65MHz > F_{clk} \geq 25MHz$
LVDS Clock to Clock Skew Margin (Even to Odd)	$t_{SKEW\_EO}$	-1/7	+1/7	$T_{clk}$	-
Maximum deviation of input clock frequency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

Product Specification

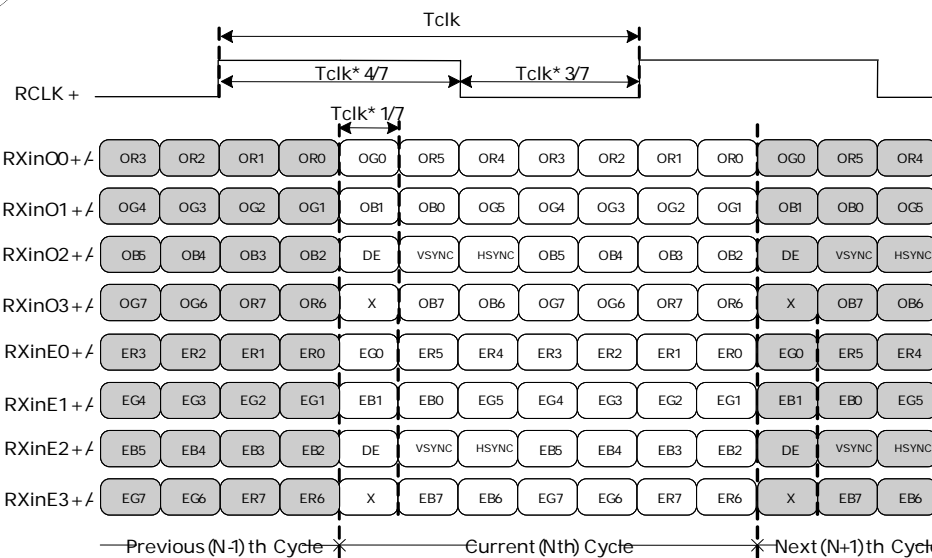


< Clock skew margin between channel >



< Spread Spectrum >

3-3-3. LVDS Data format



MSB	R7
	R6
	R5
	R4
	R3
	R2
	R1
LSB	R0

\* ODD = 1st Pixel  
EVEN = 2nd Pixel

< LVDS Data Format >

## Product Specification

**Table 6. Required signal assignment for Flat Link(NS:DS90CF383) 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 <sub>x</sub> 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 <sub>x</sub> CLKOUT +	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T <sub>x</sub> CLKOUT -	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T <sub>x</sub> OUT2 +	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T <sub>x</sub> 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 <sub>x</sub> OUT1 +	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T <sub>x</sub> OUT1 -	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T <sub>x</sub> OUT0 +	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T <sub>x</sub> 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**

**3-4. 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 7. Timing table**

Parameter		Symbol	Min.	Typ.	Max.	Unit	Notes
D <sub>CLK</sub>	Period	t <sub>CLK</sub>	13.4	16.8	20.1	ns	Pixel frequency : Typ.119MHz
	Frequency	f <sub>CLK</sub>	49.7	59.6	74.5	MHz	
Horizontal	Horizontal Valid	t <sub>HV</sub>	840	840	840	t <sub>CLK</sub>	
	H Period Total	t <sub>HP</sub>	880	920	1200		
	Hsync Frequency	f <sub>H</sub>	54.0	64.8	81.0	kHz	
Vertical	Vertical Valid	t <sub>VV</sub>	1050	1050	1050	t <sub>HP</sub>	
	V Period Total	t <sub>VP</sub>	1060	1080	1300		
	Vsync Frequency	f <sub>V</sub>	50	60	75	Hz	
DE (Data Enable)	DE Setup Time	t <sub>SI</sub>	4	-	-	ns	For D <sub>CLK</sub>
	DE Hold Time	t <sub>HI</sub>	4	-	-		
Data	Data Setup Time	t <sub>SD</sub>	4	-	-	ns	For D <sub>CLK</sub>
	Data Hold Time	t <sub>HD</sub>	4	-	-		

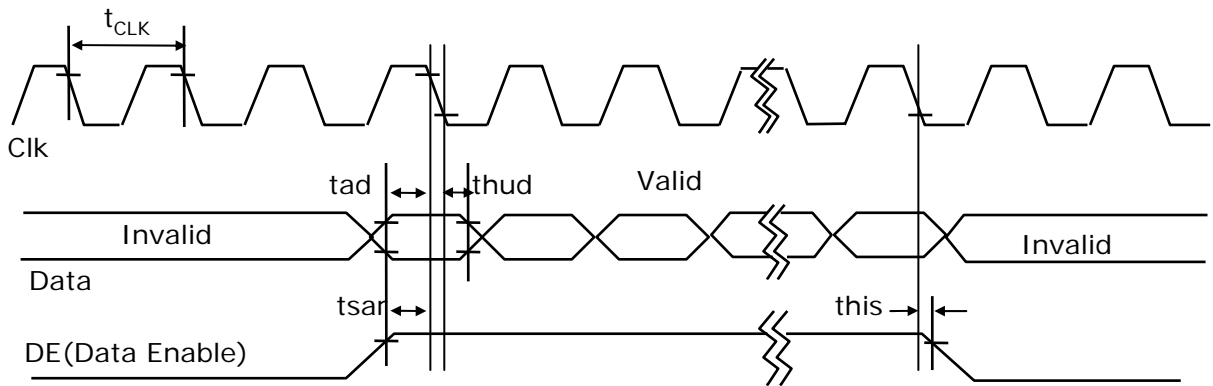
Note:

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.

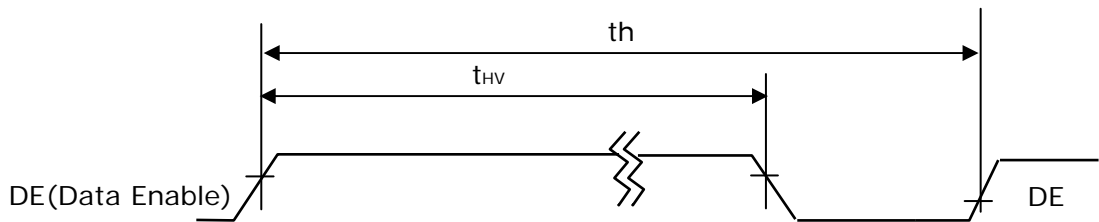
Product Specification

3-5. Signal timing waveforms

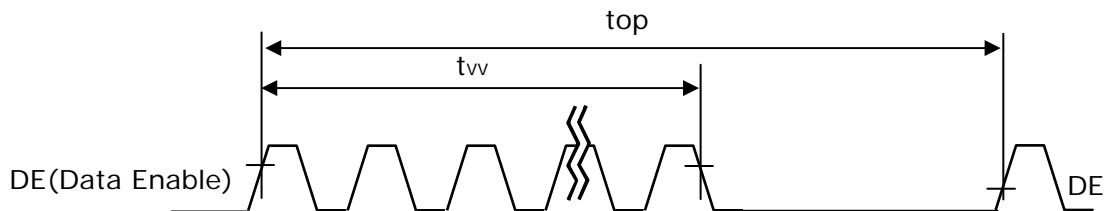
1. D<sub>CLK</sub> , DE , DATA waveforms



2. Horizontal waveform



3. Vertical waveform



## Product Specification

### 3-6. Color input data reference

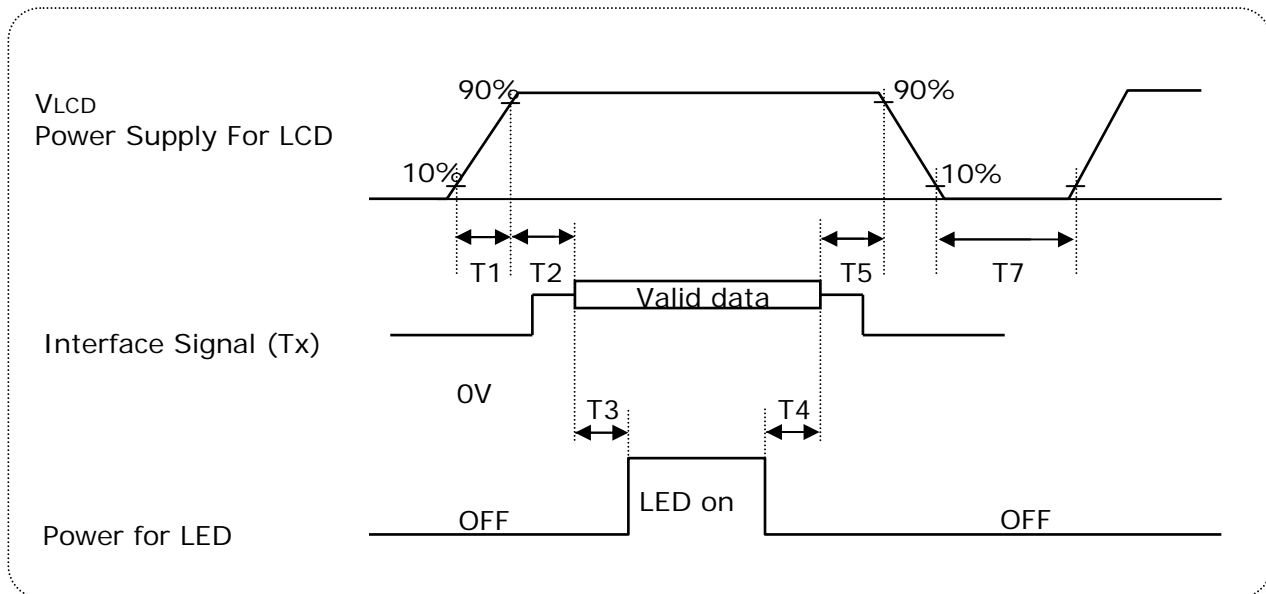
The brightness of each primary color (red, green and blue) is based on the 8bit gray scale data input for the color ; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

**Table 8. 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(002)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Red(253)	1	1	1	1	1	1	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) Bright	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	1	0	0	0	0	0	0	0	0	
	Green(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	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	
	Green(255) Bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	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	1	
	Blue(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	
	Blue(254)	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) Bright	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**

**3-7. Power sequence**



**Table 9. 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	1	-	-	s

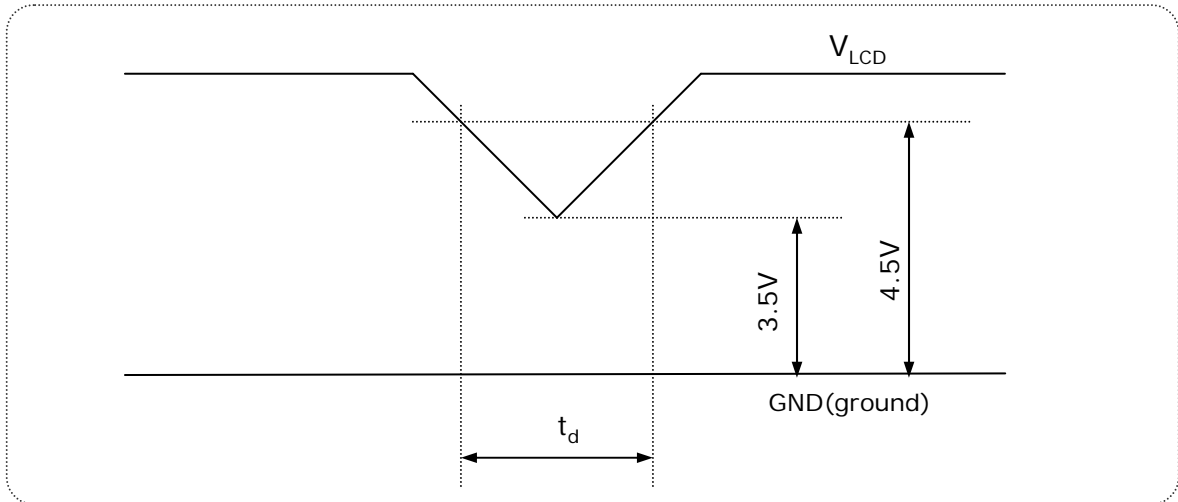
Notes :

1. Please V<sub>LCD</sub> power on only after connecting interface cable to LCD.
2. Please avoid floating state of interface signal at invalid period.
3. When the interface signal is invalid, be sure to pull down the power supply for LCD V<sub>LCD</sub> to 0V.
4. LED power must be turn on after power supply for LCD an interface signal are valid.

Product Specification

3-8.  $V_{LCD}$  Power dip condition

FIG. 6 Power dip condition



1) Dip condition

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

2)  $V_{LCD} < 3.5V$

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

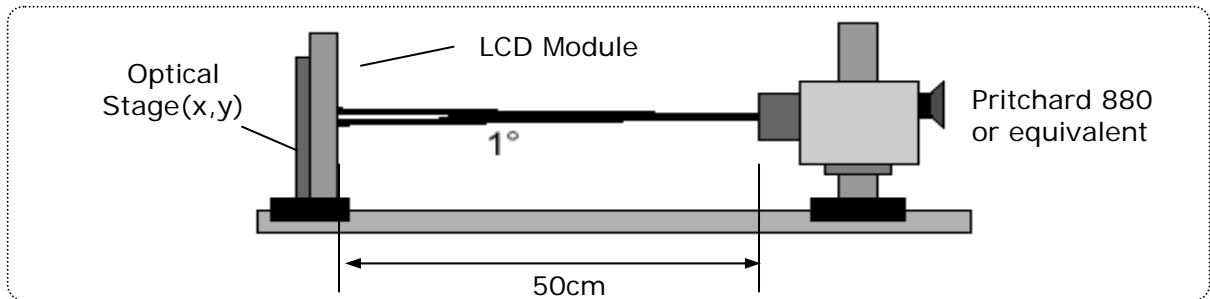
## Product Specification

## 4. Optical specification

Optical characteristics are determined after the unit has been 'ON' for 30 minutes in a dark environment at 25°C. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of  $\Phi$  and  $\theta$  equal to 0°.

FIG. 7 presents additional information concerning the measurement equipment and method.

**FIG. 7 Optical characteristic measurement equipment and method**



**Table 10. Optical characteristics**

T<sub>a</sub>= 25°C, V<sub>LCD</sub>=5.0V, f<sub>v</sub>=60Hz f<sub>CLK</sub>=54MHz, I<sub>BL</sub>=Dim-100%

Parameter	Symbol	Values			Units	Notes	
		Min	Typ	Max			
Contrast Ratio	CR	700	1000	-		1	
Surface Luminance, white	L <sub>WH</sub>	500		-	cd/m <sup>2</sup>	2	
Luminance Variation	$\delta_{\text{WHITE}}$ 9P	75			%	3	
Response Time	Rise Time	Tr <sub>R</sub>	-	1.3	2.6	ms	4
	Decay Time	Tr <sub>D</sub>	-	3.7	7.4	ms	4
Color Coordinates [CIE1931]	RED	Rx	Typ -0.05	0.641	Typ +0.05		
		Ry		0.335			
	GREEN	Gx		0.298			
		Gy		0.611			
	BLUE	Bx		0.147			
		By		0.070			
	WHITE	Wx		0.313			
		Wy		0.329			
Viewing Angle (CR>5)							
	x axis, right ( $\phi=0^\circ$ )	$\theta_r$	75	88		Degree	5
	x axis, left ( $\phi=180^\circ$ )	$\theta_l$	75	88			
	y axis, up ( $\phi=90^\circ$ )	$\theta_u$	70	85			
	y axis, down ( $\phi=270^\circ$ )	$\theta_d$	70	85			
Viewing Angle (CR>10)							
	x axis, right ( $\phi=0^\circ$ )	$\theta_r$	70	85		Degree	5
	x axis, left ( $\phi=180^\circ$ )	$\theta_l$	70	85			
	y axis, up ( $\phi=90^\circ$ )	$\theta_u$	60	75			
	y axis, down ( $\phi=270^\circ$ )	$\theta_d$	70	85			
Crosstalk				1.5	%	8	
Luminance uniformity - Angular dependence (TCO'03)	LR	-	-	1.7		6	

**Product Specification**

Notes :

1. Contrast ratio(CR) is defined mathematically as : It is measured at center point(1)

$$\text{Contrast ratio} = \frac{\text{Surface luminance with all white pixels}}{\text{Surface luminance with all black pixels}}$$

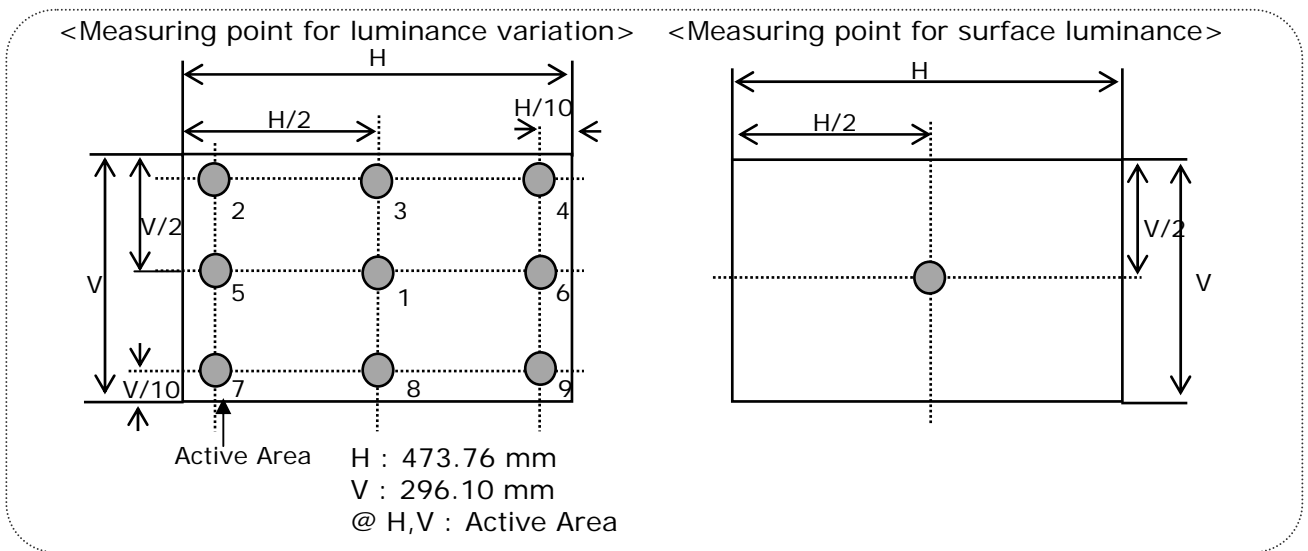
2. Surface luminance is the luminance value at center 1 point(1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 8.

3. The variation in surface luminance ,  $\delta_{\text{WHITE}}$  is defined as

$$\delta_{\text{WHITE}} = \frac{\text{Minimum (P1,P2 .....P9)}}{\text{Maximum (P1,P2 .....P9)}} * 100$$

For more information see Figure 8.

**FIG. 8 Luminance measuring point**



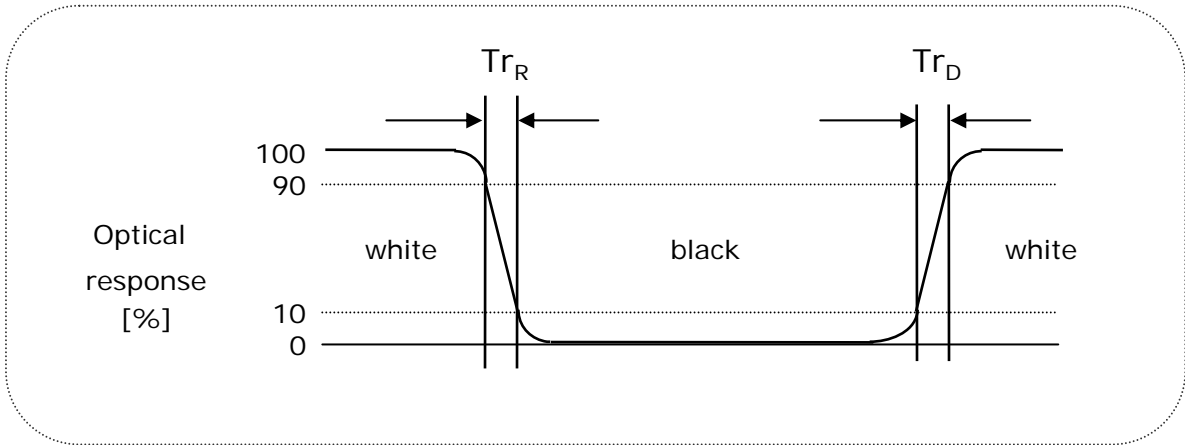
**Product Specification**

Notes :

- Response time is the time required for the display to transition from black to white (Decay Time,  $Tr_D$ ) and from white to black (Rise Time,  $Tr_R$ )  
The sampling rate is 2,500 sample/sec. For additional information see FIG. 9.

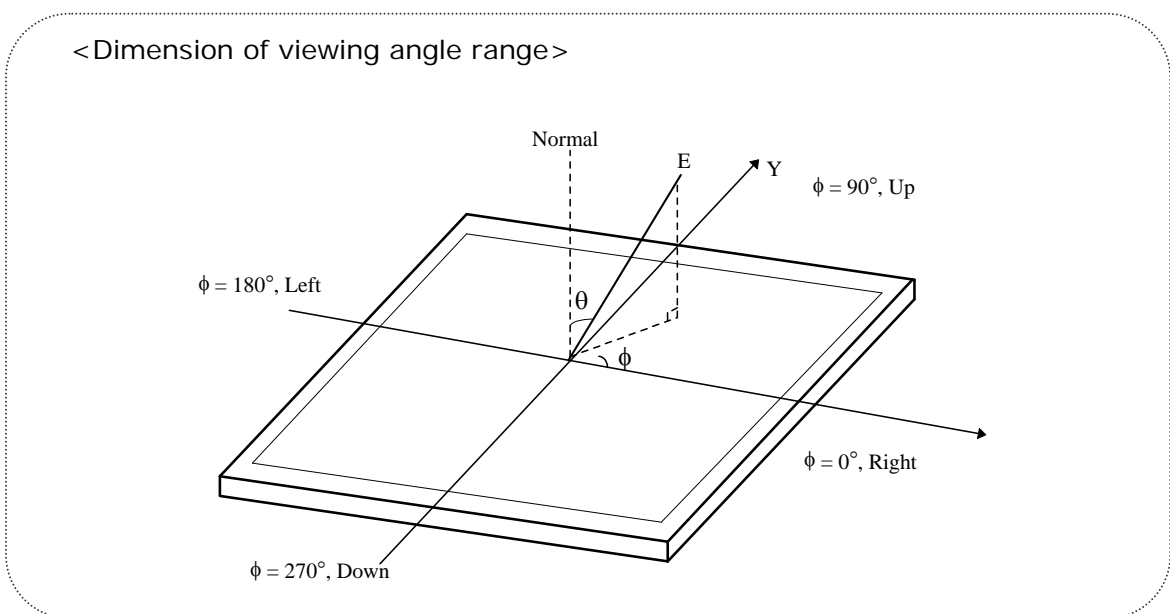
The response time is defined as the following figure and shall be measured by switching the input signal for each gray to gray.

**FIG. 9 Response time**



- 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. 10 .

**FIG. 10 Viewing angle**



**Product Specification**

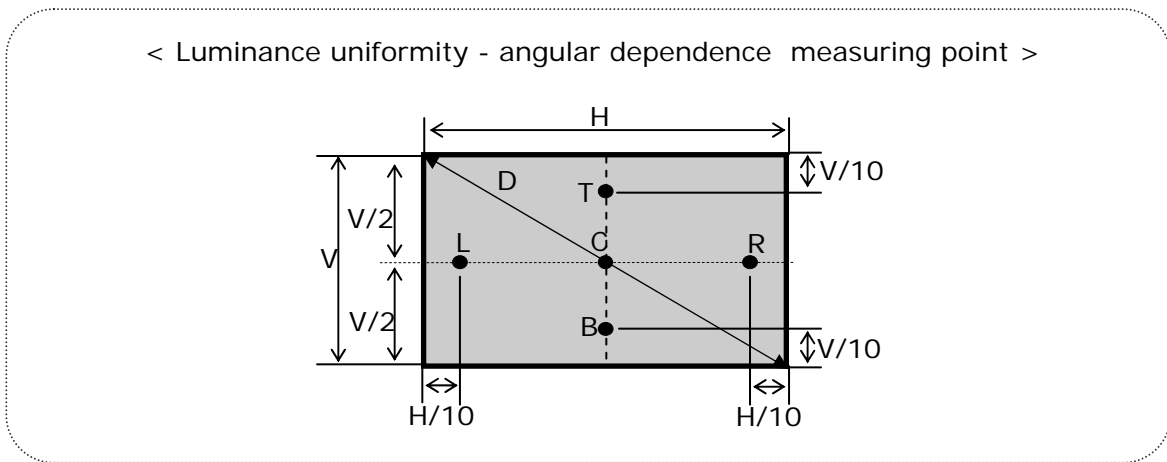
Notes :

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

TCO '03 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 :  $D * 1.5 = 83.82\text{cm}$
- Test method :  $L_R = ((L_{\text{max.}+30\text{deg.}} / L_{\text{min.}+30\text{deg.}}) + (L_{\text{max.}-30\text{deg.}} / L_{\text{min.}-30\text{deg.}})) / 2$   
 $T_B = ((L_{\text{max.}+15\text{deg.}} / L_{\text{min.}+15\text{deg.}})$

**FIG. 11 Luminance Uniformity angular dependence**



7. Gray scale specification

**Table 11. Gray scale**

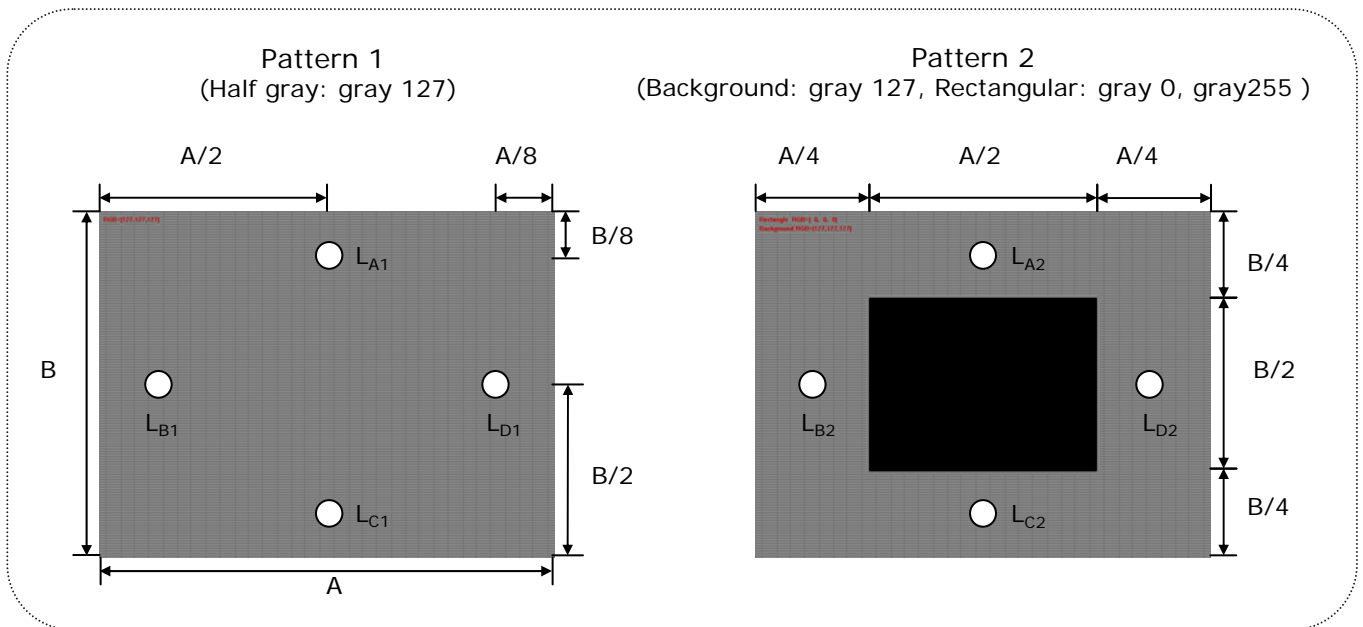
Gray level	Luminance [%] (Typ)
L0	0.14
L31	1.23
L63	4.98
L95	12.30
L127	23.58
L159	40.03
L191	61.30
L223	84.03
L255	100

## Product Specification

Notes :

8. The equation of crosstalk :  $(|L_{A[or C]2} - L_{A[or C]1}| / L_{A[or C]1}) \times 100(\%)$  [Vertical],  
 $(|L_{B[or D]2} - L_{B[or D]1}| / L_{B[or D]1}) \times 100(\%)$  [Horizontal]

**FIG. 12 Crosstalk**



## 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.

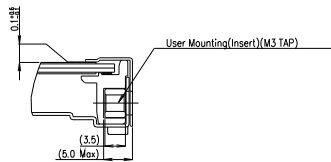
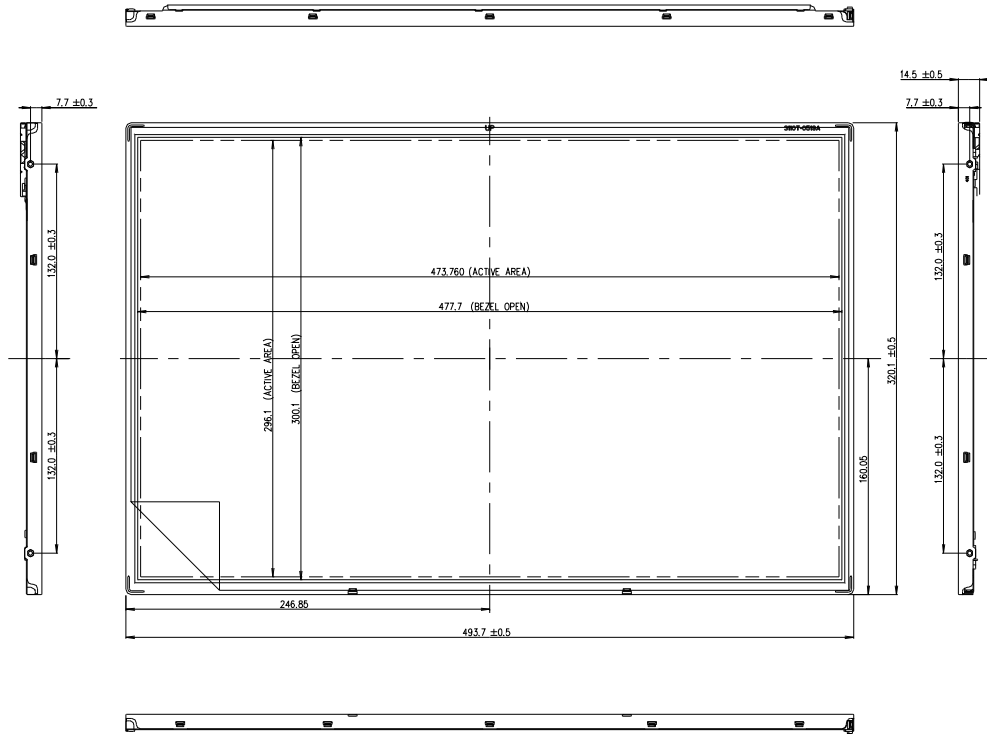
**Table 12. Mechanical characteristics**

Outline dimension	Horizontal	493.7 mm
	Vertical	320.1 mm
	Depth	14.5 mm
Bezel area	Horizontal	477.7 mm
	Vertical	300.1 mm
Active display area	Horizontal	473.76 mm
	Vertical	296.10 mm
Weight	2,350g (Typ.) 2,500 (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.

Product Specification

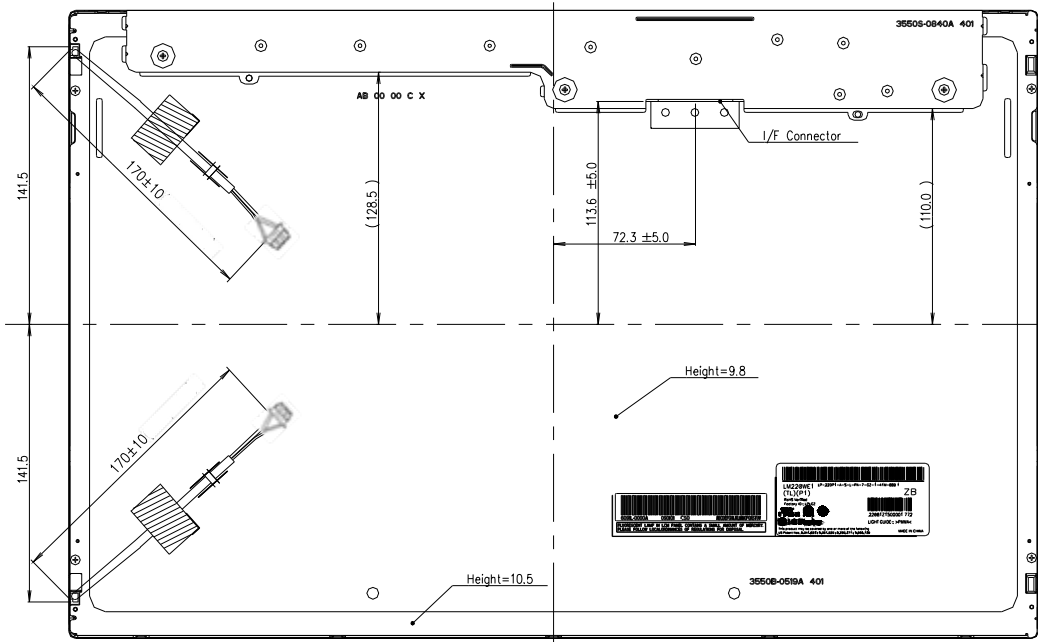
< FRONT VIEW >



SECTION A-A  
SCALE 2/1

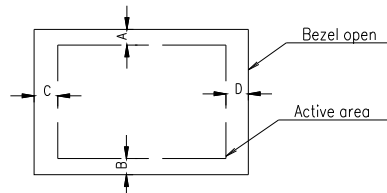
**Product Specification**

**< REAR VIEW >**



**Notes**

1. Backlight : LEDS
2. I/F Connector Specification : 187024-30091(P-TWO), IS100-L30B-C23(UJU)
3. LEDS Connector Specification  
- 35001HS-02LD(Yeonho) <2pin>
4. Torque of user hole : 3.0~3.5kgf-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. LEDS lot No. is marked at backlight connector
7. Do not wind conductive tape around the backlight wires
8. Unspecified tolerances to be ±0.5mm

## Product Specification

### 6. Reliability

**Table 13. Environment test conditions**

No	Test Item	Condition
1	High temperature storage test	Ta= 60°C 240hrs
2	Low temperature storage test	Ta= -20°C 240hrs
3	High temperature operation test	Ta= 50°C 50%RH 240hrs
4	Low temperature operation test	Ta= 0°C 240hrs
5	Vibration test (non-operating)	Wave form : random Vibration level : 1.0GRMS Bandwidth : 10-300Hz Duration : X,Y,Z, 20 min One time each direction
6	Shock test (non-operating)	Shock level : 120G Waveform : half sine wave, 2msec Direction : ±X, ±Y, ±Z One time each direction
7	Altitude operating storage / shipment	0 - 10,000 feet(3,048m) 0 - 40,000 feet(12,192m)

{ Result evaluation criteria }

There should be no change which might affect the practical display function when the display quality test is conducted under normal operating condition.

## 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.

#### 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

**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 : 8pcs

b) Box size : 550mm X 314mm X 401mm

## 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 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 :  $V = \pm 200\text{mV}$  (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 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.

## 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.