SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	20.1” WSXGA+ TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG.Philips LCD Co., Ltd.
*MODEL	LM201W01
SUFFIX	STB1

*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	
C. K. Lee / Manager	
PREPARED BY	
S. H. Choe / Engineer	

MNT Products Engineering Dept.
LG. Philips LCD Co., Ltd

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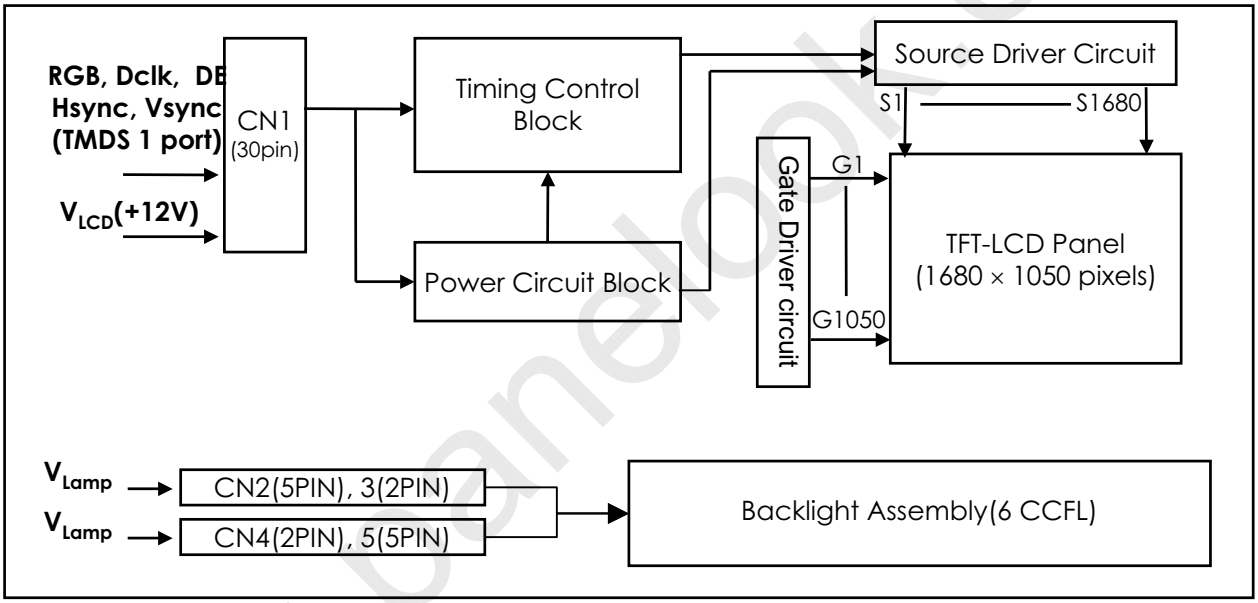
RECORD OF REVISIONS

Revision No	Revision Date	Page	DESCRIPTION
1.0	Oct. 23, 2007	-	**Final Specification**

1. General Description

LM201W01 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 black mode. It has a 20.1 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(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.



General Features

Active Screen Size	20.1 inches(511.133mm) diagonal (Aspect ratio 16:10)
Outline Dimension	459.4(H) x 296.4 (V) x 22.8(D) mm (Typ.)
Pixel Pitch	0.258mm x 0.258mm
Pixel Format	1680 horiz. By 1050 vert. Pixels RGB strip arrangement
Color Depth	8bit, 16,7 M colors
Luminance, White	280 cd/m^2 (5 points Avg.)
Viewing Angle (CR>10)	Viewing Angle Free (R/L 178(Typ.), U/D 178(Typ))
Power Consumption	Total 39.05 Watt(Typ.) (6.08 Watt@VLCD, 32.97 Watt@300cd/[LAMP=7mA])
Weight	2,850 g (Typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(3H) & Anti-glare (Haze 25%) treatment of the front polarizer

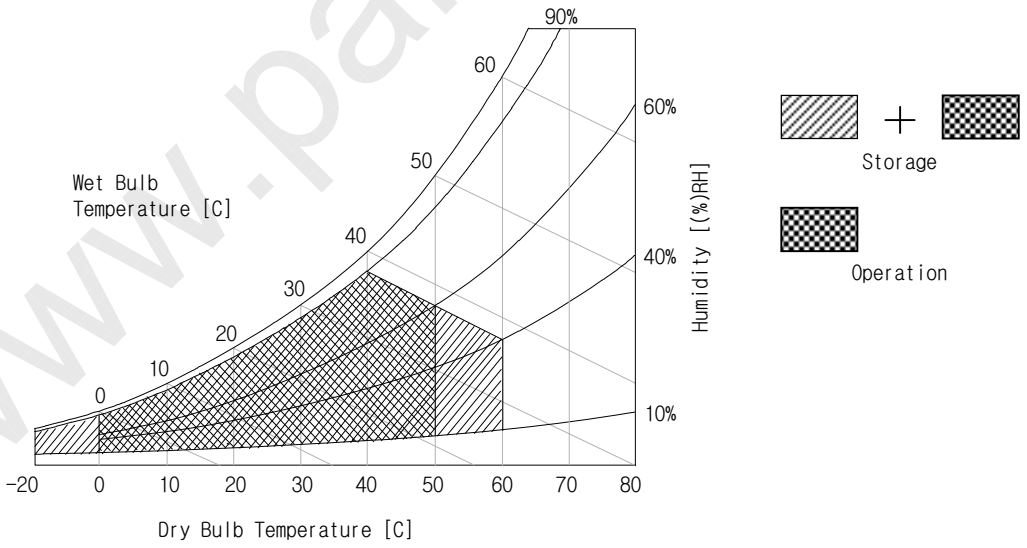
2. Absolute Maximum Ratings

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	-0.3	14.0	Vdc	at 25 ± 2 °C
Operating Temperature	TOP	0	50	°C	1
Storage Temperature	TST	-20	60	°C	1
Operating Ambient Humidity	HOP	10	90	%RH	1
Storage Humidity	HST	10	90	%RH	1

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.



3. Electrical Specifications

3-1. Electrical Characteristics

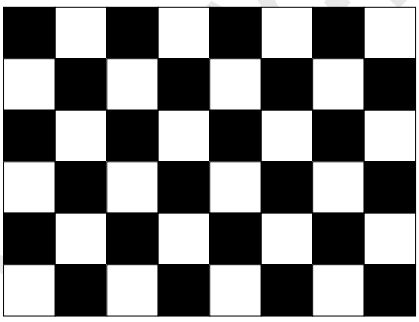
It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCDs.

Table 2_1. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	11.4	12.0	12.6	Vdc	
Permissive Power Input Ripple	V_{dRF}			400	mV_{p-p}	
Power Supply Input Current	I_{LCD}	-	507	583	mA	1
		-	663	862	mA	2
Power Consumption	P_{LCD}	-	6.08	7.00	Watt	1
Rush current	I_{RUSH}	-	-	3	A	3

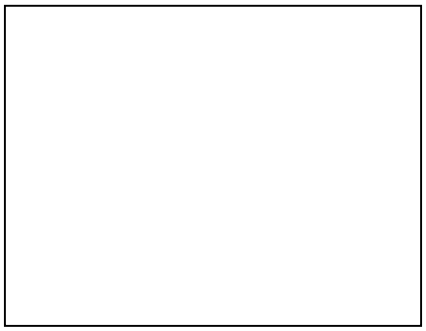
Note :
1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C,f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.).

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

Table 2_2. ELECTRICAL CHARACTERISTICS

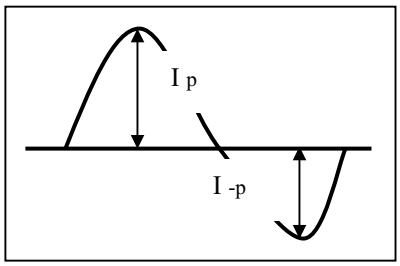
Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
LAMP :						
Operating Voltage	V_{BL}	770(7.5mA)	785(7mA)	885(3mA)	V_{RMS}	1, 2
Operating Current	I_{BL}	3.0	7.0	7.5	mA_{RMS}	1
Established Starting Voltage	Vs					1, 3
at 25 °C				1300	V_{RMS}	
at 0 °C				1600	V_{RMS}	
Operating Frequency	f_{BL}	40	60	70	kHz	4
Discharge Stabilization Time	Ts			3	Min	1, 5
Power Consumption	P_{BL}		32.97	36.27	Watt	6
Life Time		50,000			Hrs	1, 7

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.

※ 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. Specified values are for a single lamp.
2. Operating voltage is measured at 25 ± 2°C. The variance of the voltage is ± 10%.
3. 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.
4. 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.
5. 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%.
6. The lamp power consumption shown above does not include loss of external inverter.
The used lamp current is the lamp typical current. ($P_{BL} = V_{BL} \times I_{BL} \times N_{Lamp}$)
7. 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°C.

8. 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.
   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}

9. 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.
10. In case of edgy type back light with over 4 parallel lamps, input current and voltage wave form should be synchronized

3-2. Interface Connections

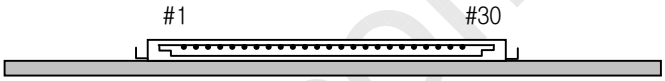
—LCD Connector(CN1) : KDF71G-30S-1H (Manufactured by HIROSE) or FI-X30SSL-HF (Manufactured by JAE)
—Mating Connector : FI-X30C2L (Manufactured by JAE) or Equivalent

Table 3. MODULE CONNECTOR(CN1) PIN CONFIGURATION

Pin No	Symbol	Description
1	GND	Ground
2	GND	Ground
3	RX2+	TMDS Low Voltage Differential Signal Input Data 2(+)
4	RX2-	TMDS Low Voltage Differential Signal Input Data 2(-)
5	GND	Ground
6	RX1+	TMDS Low Voltage Differential Signal Input Data 1(+)
7	RX1-	TMDS Low Voltage Differential Signal Input Data 1(-)
8	GND	Ground
9	RX0+	TMDS Low Voltage Differential Signal Input Data 0(+)
10	RX0-	TMDS Low Voltage Differential Signal Input Data 0(-)
11	GND	Ground
12	RXC+	TMDS Low Voltage Differential Signal Input Data C(+)
13	RXC-	TMDS Low Voltage Differential Signal Input Data C(-)
14	GND	Ground
15	VHDCP_VCC	HDCP VCC (5V)
16	NC	NC
17	NC	NC
18	NC	NC
19	GND	Ground
20	GND	Ground
21	GND	Ground
22	V_{LCD}	Power Supply 12.0V
23	V_{LCD}	Power Supply 12.0V
24	V_{LCD}	Power Supply 12.0V
25	POWER-ON	Power Control 3.3V(H:90%, L:10%)
26	HSYNC	Hsync Output
27	VSYNC	Vsync Output
28	GND	Ground
29	HDCP_CLK	HDCP DDC_CLK
30	HDCP_DATA	HDCP DDC_DATA

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 TMDS signal is based on the Digital Visual Interface (DVI 1.0) Standard.

User Connector Diagram



Rear view of LCM

KDF71G-30S-1H (HIROSE) or
FI-X30SSL-HF (JAE)

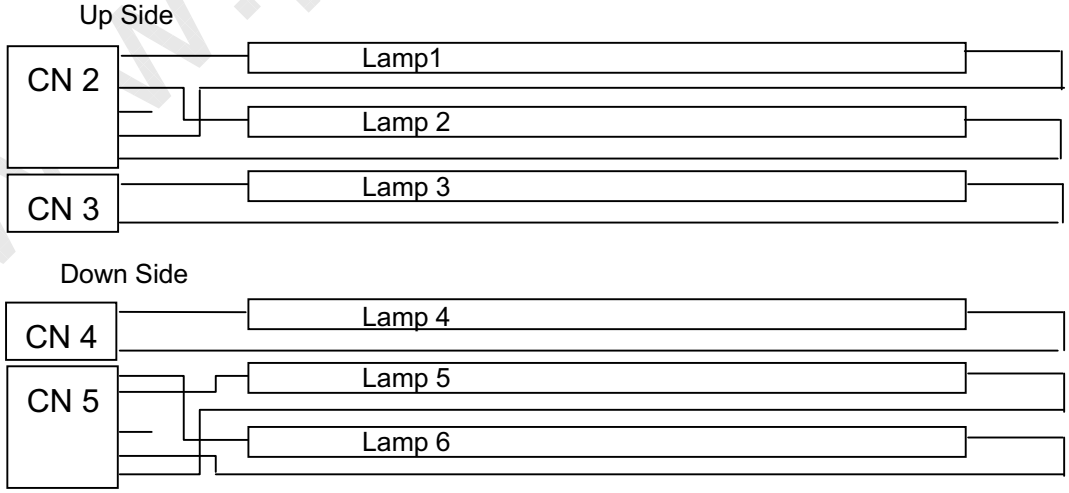
Table 4. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN2,CN3,CN4,CN5)

The backlight interface connector is a model BHSR-02VS-1(or 1674817-1:manufactured by AMP)(CN3/CN4) and BHR-05VS-1(CN2/CN5) manufactured by JST. The mating connector part number are SM02B-BHSS-1-TB(2pin), SM04(9-E2)B-BHS-1-TB(5pin) or equivalent. The pin configuration for the connector is shown in the table below.

No	Pin	Symbol	Description	Notes
CN2	1	HV	Power supply for lamp 1(High voltage side) - White	1
	2	HV	Power supply for lamp 2(High voltage side) – Gray	1
	3	NC	NC	
	4	LV	Power supply for lamp 1(Low voltage side) – White	2
	5	LV	Power supply for lamp 2(Low voltage side) – Black	2
CN3	1	HV	Power supply for lamp 3(High voltage side) - Sky Blue	1
	2	LV	Power supply for lamp 3(Low voltage side) - Blue	2
CN4	1	HV	Power supply for lamp 4(High voltage side) - Sky Blue	1
	2	LV	Power supply for lamp 4(Low voltage side) - Blue	2
CN5	1	HV	Power supply for lamp 6(High voltage side) - White	1
	2	HV	Power supply for lamp 5(High voltage side) - Gray	1
	3	NC	NC	
	4	LV	Power supply for lamp 6(Low voltage side) - White	2
	5	LV	Power supply for lamp 5(Low voltage side) - Black	2

Notes: 1. The high voltage power terminal is colored White, Sky Blue, Gray
2. The low voltage pin color is White, Blue, Black .

<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_1. Timing Table 1 (VESA COORDINATED VIDEO TIMING)

ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	8.40	8.40	8.40	ns	
	Frequency	-	119	119	119	MHz	
Hsync	Period	t_{HP}	1840	1840	1840	t_{CLK}	
	Frequency	f_H	64.674	64.674	64.674	KHz	
	Width	t_{WH}	32	32	32	t_{CLK}	
Vsync	Period	t_{VP}	1080	1080	1080	t_{HP}	
	Frequency	f_V	59.883	59.883	59.883	Hz	
	Width	t_{WV}	6	6	6	t_{HP}	
DE (Data Enable)	Horizontal Valid	t_{HV}	1680	1680	1680	t_{CLK}	
	Horizontal Back Porch	t_{HBP}	80	80	80		
	Horizontal Front Porch	t_{HFP}	48	48	48		
	Horizontal Blank	-	160	160	160		
	Vertical Valid	t_{VV}	1050	1050	1050	t_{HP}	
	Vertical Back Porch	t_{VBP}	21	21	21		
	Vertical Front Porch	t_{VFP}	3	3	3		
	Vertical Blank	-	30	30	30		

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

1. The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

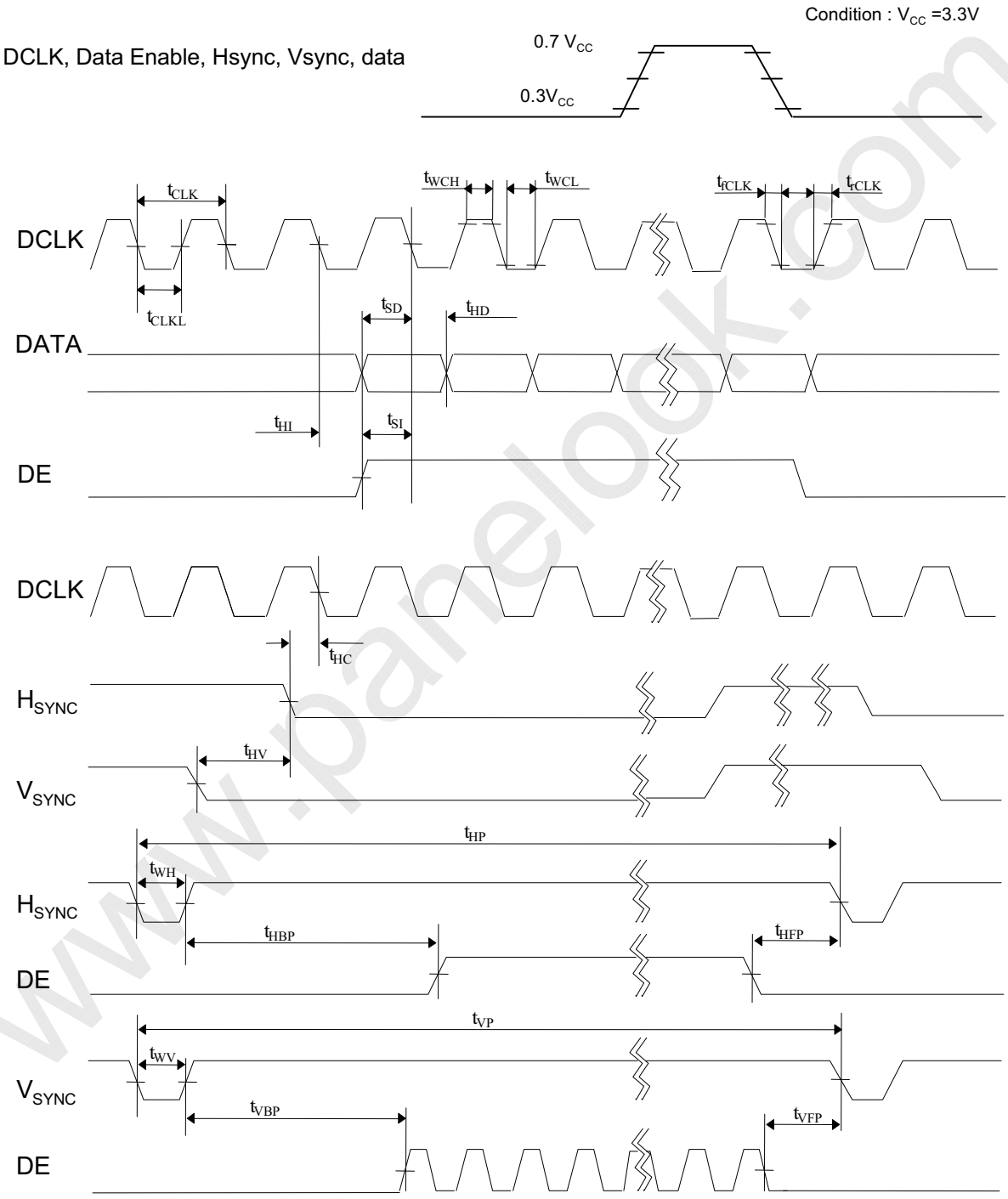
Table 5_2. Timing Table 2

ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Period	tCLK	10.554	10.554	10.554	ns	
	Frequency	-	94.75	94.75	94.75	MHz	
Hsync	Period	tHP	1840	1840	1840	tCLK	
	Frequency	fH	51.495	51.495	51.495	KHz	
	Width	tWH	32	32	32	tCLK	
Vsync	Period	tVP	1074	1074	1074	tHP	
	Frequency	fV	47.947	47.947	47.947	Hz	
	Width	tWV	6	6	6	tHP	
DE (Data Enable)	Horizontal Valid	tHV	1680	1680	1680	tCLK	
	Horizontal Back Porch	tHBP	80	80	80		
	Horizontal Front Porch	tHFP	48	48	48		
	Horizontal Blank	-	160	160	160		
	Vertical Valid	tVV	1050	1050	1050	tHP	
	Vertical Back Porch	tVBP	15	15	15		
	Vertical Front Porch	tVFP	3	3	3		
	Vertical Blank	-	24	24	24		

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

1. : The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
2. Vsync and Hsync should be keep the above specification.
3. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

3-4. Signal Timing Waveforms



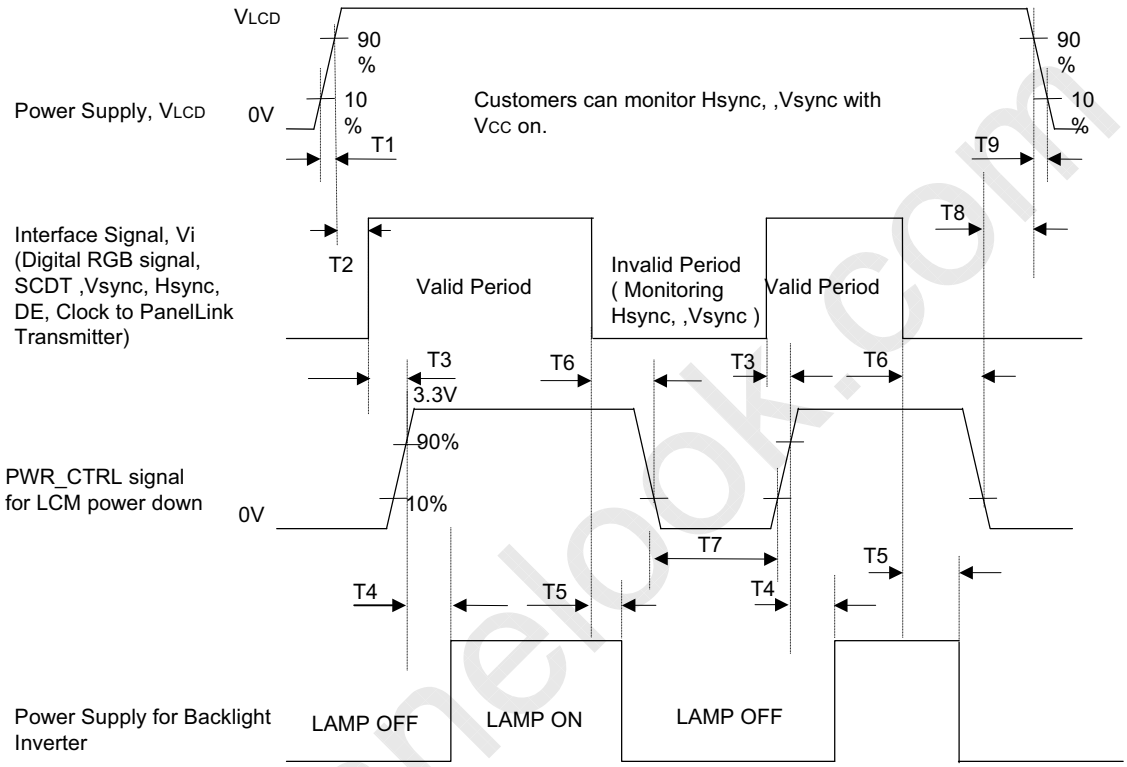
3-5. Color Data Reference

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

Table 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

3-6. Power Sequence



Parameter	Min	typical	Max	Units
T1	0.5	–	10	ms
T2	0	–	–	ms
T3	–	–	300	ms
T4	100	–	–	ms
T5	–	–	80	ms
T6	–	–	80	ms
T7	400	–	–	ms
T8	50	–	–	ms
T9	–	–	200	ms

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

4. Optical Specification

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25±2°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 °.
FIG. 1 presents additional information concerning the measurement equipment and method.

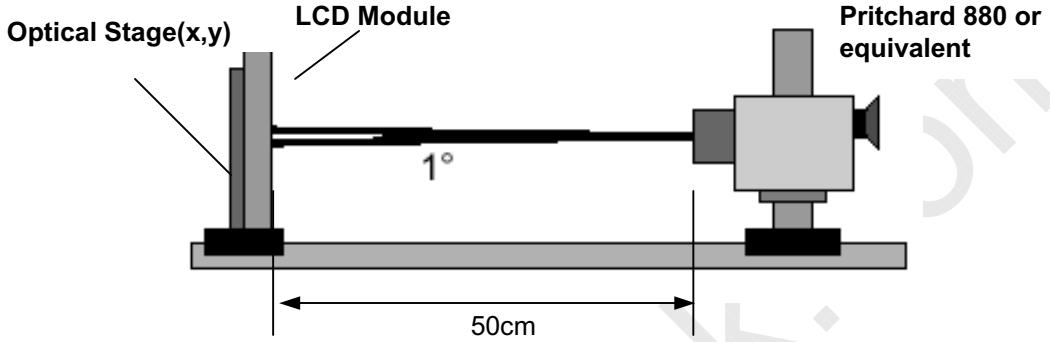


FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS Ta=25 °C, V_{LCD}=12.0V, fv=60Hz Dclk=119MHz, I_{BL}=7mA

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	500	800	-		1
Surface Luminance, 5pts ave		L_{WH}	230	280	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	-	-	35	%	3
Response Time	Rise Time	Tr_R	-	7	10	ms	4
	Decay Time	Tr_D	-	7	14	ms	4
	Gray To Gray	T_{GTG_AVR}	-	12	-	ms	5
		T_{GTG_MAX}	-	16	-	ms	5
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.640	Typ +0.03		
		Ry		0.340			
	GREEN	Gx		0.290			
		Gy		0.615			
	BLUE	Bx		0.145			
		By		0.070			
	WHITE	Wx		0.313			
		Wy		0.329			
Color shift							6
	Horizontal	θ_{CST_H}	-	176	-	degree	
	Vertical	θ_{CST_V}	-	176	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	degree	7
	Vertical	θ_V	170	178	-		
Effective	Horizontal	θ_{GMA_H}	-	176	-	degree	8
	Vertical	θ_{GMA_V}		176			
Gray Scale				2.2			9

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

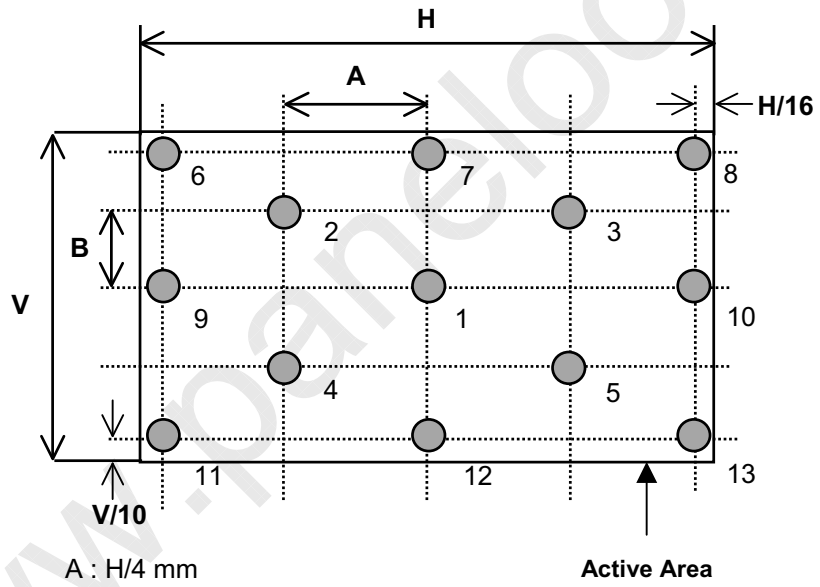
$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

2. **Surface luminance** is luminance value at 5 points average across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 2.
L_{WH} = = Average[$L_{on}1, L_{on}2, L_{on}3, L_{on}4, L_{on}5$]

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

$$\delta_{WHITE} = \frac{\text{Maximum}(L_{on1}, L_{on2}, \ldots L_{on13}) - \text{Minimum}(L_{on1}, L_{on2}, \ldots L_{on13})}{\text{Average}(L_{on1}, L_{on2}, \ldots L_{on5})} \times 100(\%)$$

Measuring point for surface luminance & measuring point for luminance variation



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

FIG. 2 Measure Point for Luminance

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

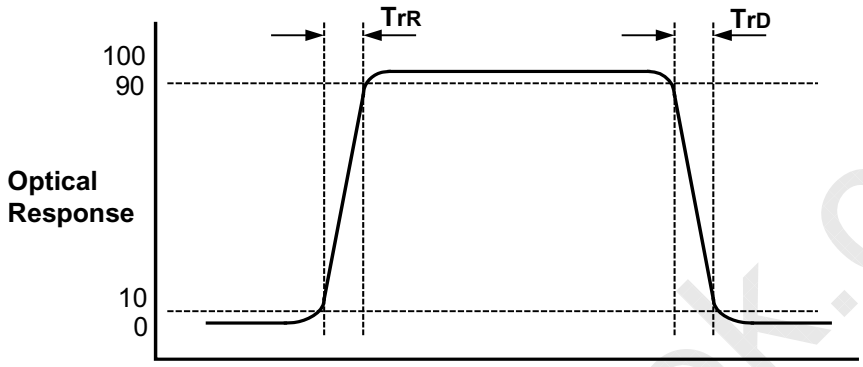


FIG. 3 Response Time

5. **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
- T_{GTG_AVR} is the total average time at rising time and falling time for "Gray To Gray ".
- T_{GTG_MAX} is the max time at rising time or falling time for "Gray To Gray ".

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

6. **Color shift** is the angle at which the color difference is lower than 0.04.

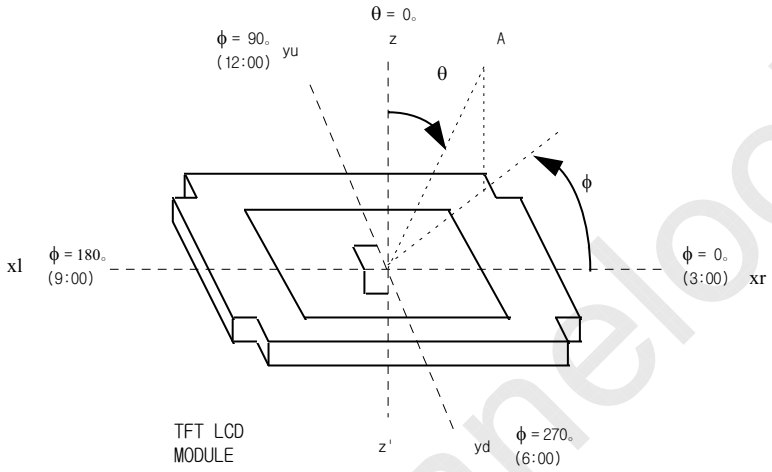
- Color difference ($\Delta u'v'$)

$$u' = \frac{4x}{-2x + 12y + 3} \qquad v' = \frac{9y}{-2x + 12y + 3}$$

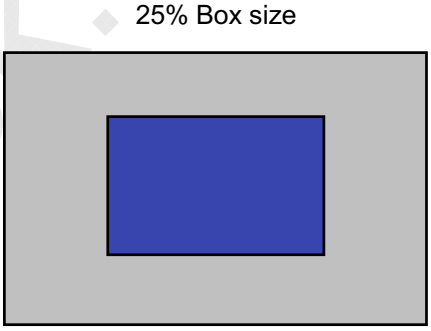
$$\Delta u'v' = \sqrt{(u'_1-u'_2)^2+(v'_1-v'_2)^2}$$

u'1, v'1 : u'v' value at viewing angle direction
u'2, v'2 : u'v' value at front (Θ=0)

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



Viewing angle direction



Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin	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

7. **Viewing angle(general)** is the angle at which the contrast ratio is greater than 10.

8. **Effective viewing angle** is the angle at which the gamma shift of gray scale is lower than 0.3.

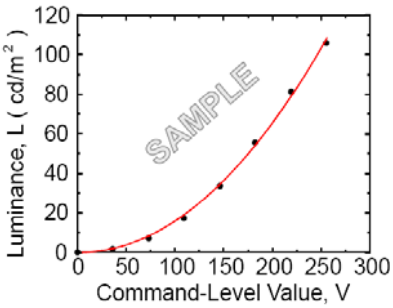


Fig. 1. Sample Luminance vs. gray scale (using a 256 bit gray scale).

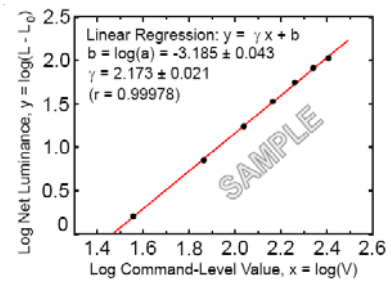


Fig. 2. Sample Log-log plot of luminance vs. gray scale.

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

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

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. 2)

9. **Gray scale specification**
Gamma Value is approximately 2.2. For more information see Table 8.

Table 8. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.12
31	1.20
63	4.57
95	11.3
127	21.4
159	35.2
191	52.8
223	74.4
255	100

10. **TCO '03 item regarding Display characteristic** is satisfied.

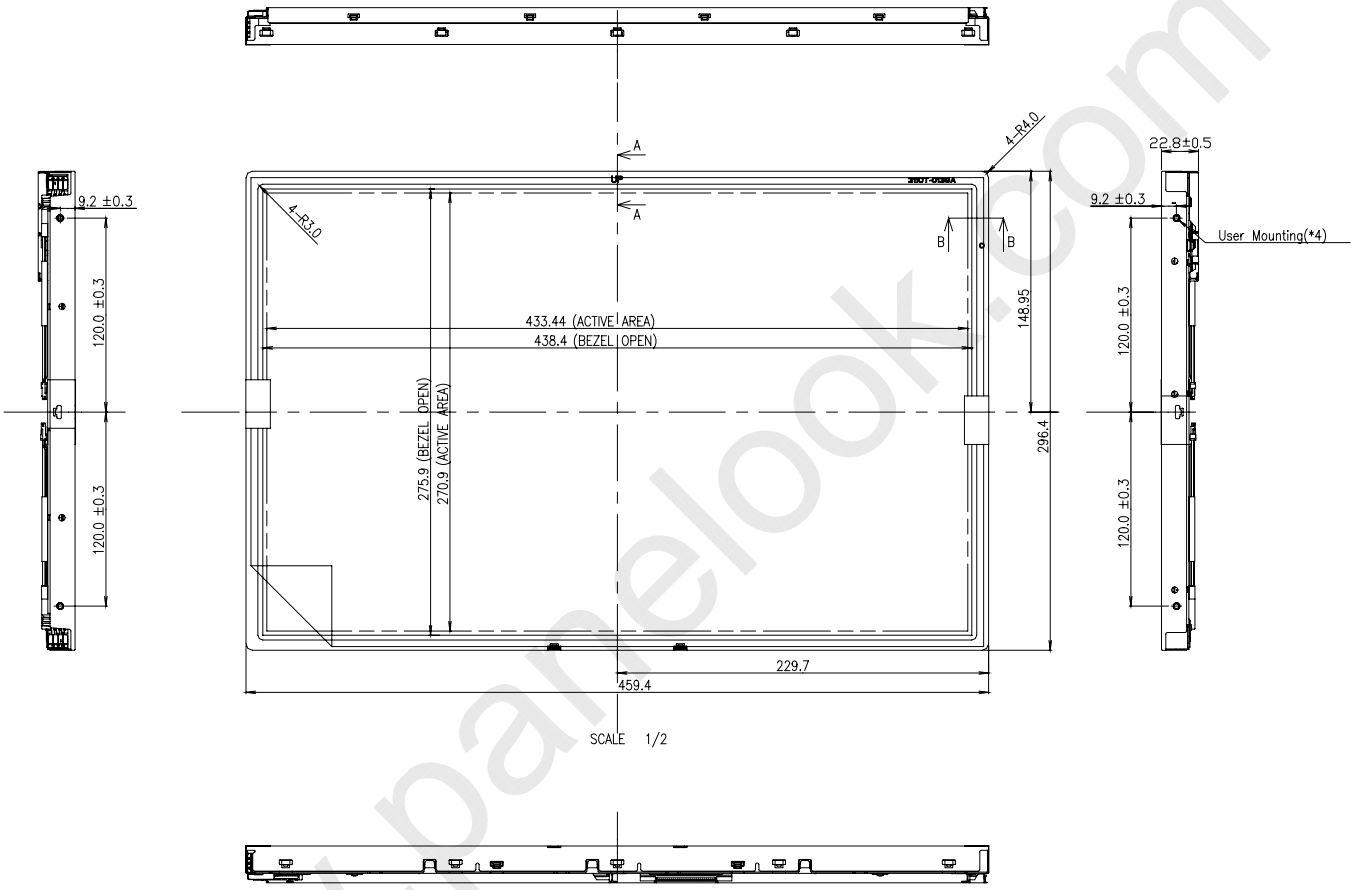
5. Mechanical Characteristics

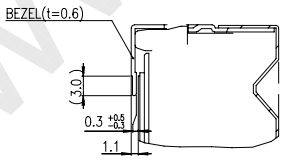
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	459.4mm
	Vertical	296.4mm
	Depth	22.8mm
Bezel Area	Horizontal	438.4mm
	Vertical	275.9mm
Active Display Area	Horizontal	433.44mm
	Vertical	270.90mm
Weight	2,850g (Typ.), 3,000g (Max.)	
Surface Treatment	Hard coating(3H) Anti-glare(25%) treatment of the front polarizer	

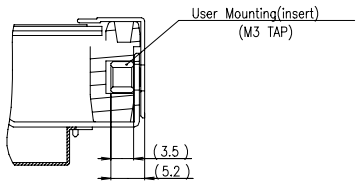
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

<FRONT VIEW>



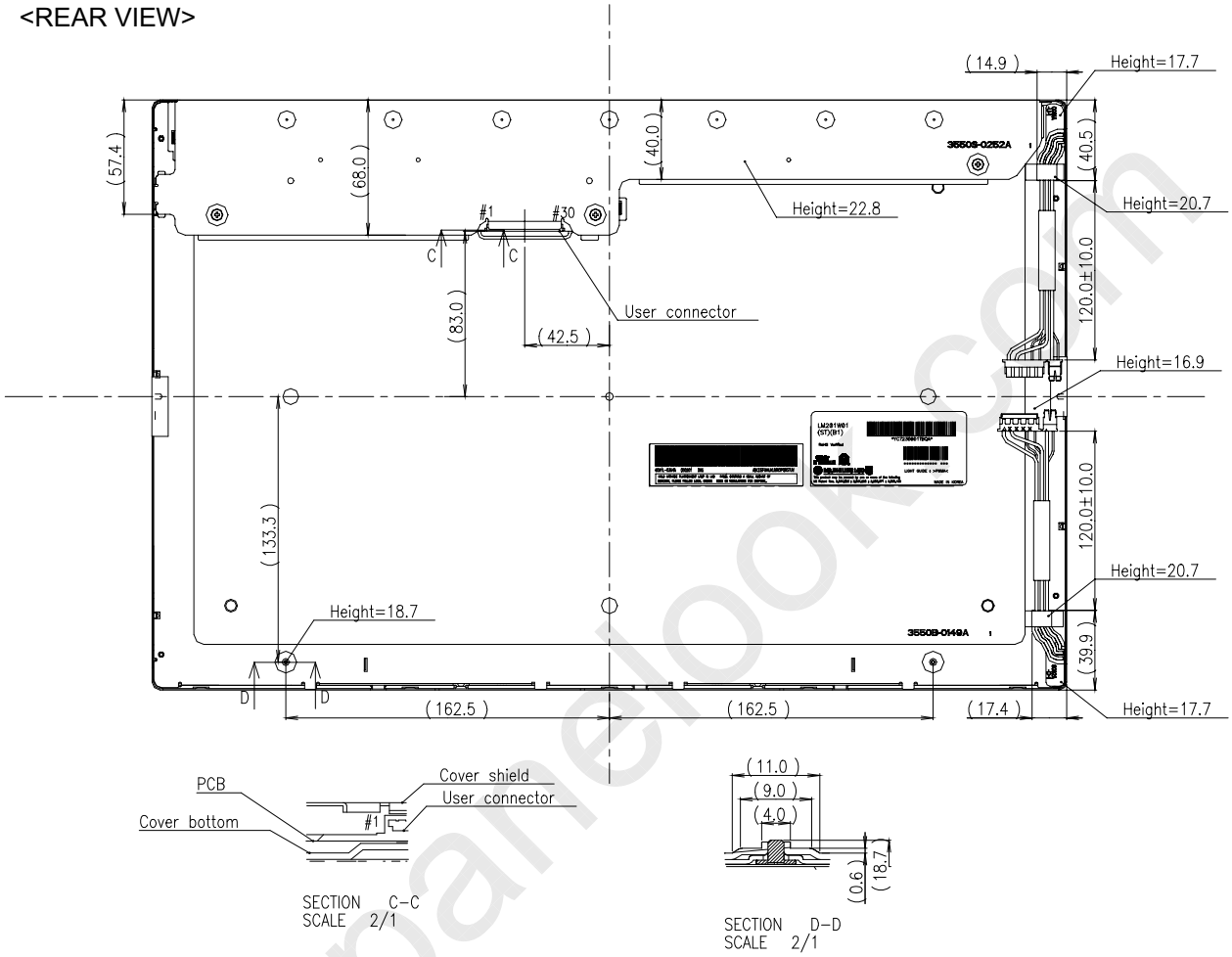


SECTION A–A
SCALE 2/1



SECTION B–B
SCALE 2/1

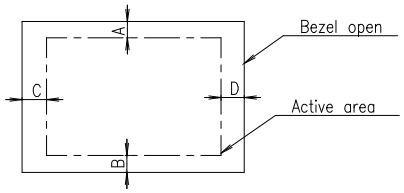
<REAR VIEW>



SECTION C–C
SCALE 2/1

SECTION D–D
SCALE 2/1

Notes
1. Backlight : 6 Cold Cathode Fluorescent Lamps
2. I/F Connector Specification : KDF71G-30S-1H(HIROSE)
3. Lamp Connector Specification
   - BHR-05VS-1(JST) or Compatible
   - 1674817-1(AMP)/ BHSR-02VS-1(JST) or Compatible
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

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 : 1.0G RMS Bandwidth : 10-500Hz 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	Altitude operating storage / shipment	0 - 10,000 feet(3048m) 0 - 40,000 feet(12,192m)

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 Electrotechnical 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 Electrotechnical Standardization.(CENELEC), 1998
(Including A1: 2000)

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 : 4pcs

b) Box Size : 233mm × 381mm × 556mm

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 metallic foreign material and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.

9-3. ELECTROSTATIC DISCHARGE CONTROL

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

9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

9-5. STORAGE

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

(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°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.