LG Display

LM215WF1 Liquid Crystal Display

SPECIFICATION FOR **APPROVAL**

Product Specification

) Preliminary Specification (•) Final Specification

Title

Ver. 1.0

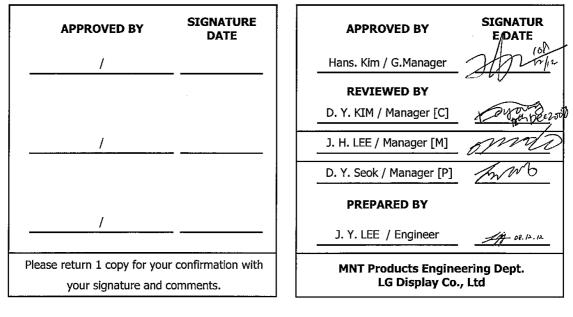
21.5" Full HD TFT LCD

BUYER	HP
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM215WF1
SUFFIX	TLA1

*When you obtain standard approval,

please use the above model name without suffix



Dec. 12.2008



LM215WF1 Liquid Crystal Display

Product Specification

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RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.1	JUL. 23. 2008	-	First Draft(Preliminary)
0.2	SEP. 22. 2008	4	Update Power, weight
		6	Update electrical characteristic (logic power, Inverter power)
		12	Update signal timing spec
		16	Update Color coordinate (RGB)
		23	Update weight (2100g)
0.21	OCT 07, 2008	3, 23	Change POL harness (2H à 3H)
0.3	OCT. 27, 2008	12	Insert page lamp connector
0.31	Nov. 28, 2008	4	Change vertical line at Figure 1.
		20	Response time (Trd & Trr) Swap at Figure 10.
0.4	Dec. 11, 2008	8	Update Lamp Voltage Tolerance ($\pm 10 \rightarrow \pm 20$)
		24	Update GMA Scale specification
1.0	Dec. 12, 2008	-	Final specification

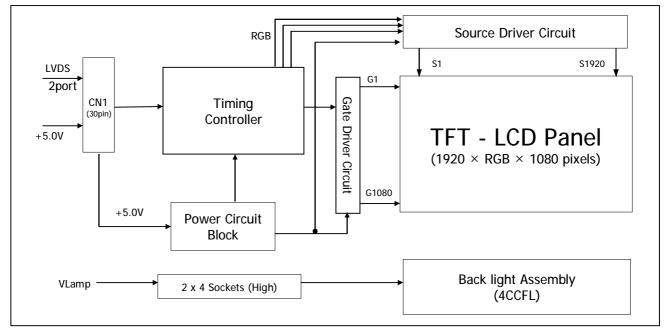


1. General Description

LM215WF1 is a Color Active Matrix Liquid Crystal Display with an integral Cold Cathode Fluorescent Lamp(CCFL) backlight system. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. It has a 21.5inch diagonally measured active display area with Full HD resolution (1080 vertical by 1920 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M(True) colors.

It has been designed to apply the 8Bit 2 port LVDS interface.

It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



General Features

[Figure 1] Block diagram

<u>eenerarreaturee</u>	
Active Screen Size	21.53 inches(546.86mm) diagonal
Outline Dimension	495.6(H) x 292.2(V) x 16.5(D) mm (Typ.)
Pixel Pitch	0.248 mm x 0.248mm
Pixel Format	1920 horiz. By 1080 vert. Pixels RGB stripes arrangement
Color Depth	8-bit (6bit + A FRC)
Luminance, White	300 cd/m ² (Center 1 points)
Viewing Angle(CR>10)	View Angle Free (R/L 170(Typ.), U/D 160(Typ.))
Power Consumption	Total 28.5W(typ)/logic(4.5W), Inverter(24W) @ lamp current 7.5mA
Weight	2100g (typ.)
Display Operating Mode	Transmissive mode, normally white
Surface Treatment	Hard coating(3H), Glare treatment of the front polarizer
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2. Absolute Maximum Ratings

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

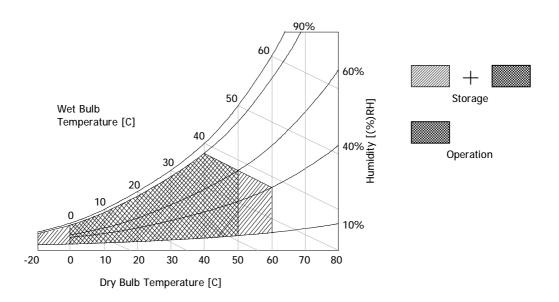
Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Valu	Jes	Units	Notes	
r di diffetei	Symbol	Min	Мах	Units	Notes	
Power Input Voltage	VLCD	0	5.5	Vdc	at 25 \pm 2°C	
Operating Temperature	Тор	0	50	°C		
Storage Temperature	Тѕт	-20	60	°C	1.0	
Operating Ambient Humidity	Нор	10	90	%RH	1, 2	
Storage Humidity	Нѕт	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.

Note : 2. Maximum Storage Humidity is up to 40° C, 70% RH only for 4 corner light leakage Mura.



[Figure 2] Temperature and relative humidity



3. Electrical Specifications

3-1. Electrical Characteristics

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

Table 2. ELECTRICAL CHARACTERISTICS

Parameter		Symbol		Values		Unit	Notes
		Symbol	Min	Тур	Max		
MODULE :							
Power Supply Input Voltage		VLCD	4.5	5.0	5.5	Vdc	
Permissive Power Input Ripple		Vrf	-	-	100	mV	13
Dowor Supply Input Current		ILCD	595	700	805	mA	1
Power Supply Input Current		ILCD	765	900	1035	mA	2
Differential Impedance		Zm	90	100	110	ohm	
Power Consumption		Plcd	3.0	3.5	4.03	Watt	1
Power Consumption		Plcd	3.8	4.5	5.2	Watt	2
Rush current		IRUSH	-	-	3	А	3
LAMP :					-		_
Operating Voltage		VBL	780	800	1000	V _{RMS}	4, 5
		VBL	(8.0mA)	(7.5mA)	(2.5mA)		
Operating Current		BL	2.5	7.5	8.0	mA _{RMS}	4
Established Starting Voltage	_	Vs					4, 6
	at 25 °C				1250	V _{RMS}	
	at 0°C				1550	V _{RMS}	
Operating Frequency		fBL	40	-	70	kHz	7
Discharge Stabilization Time		Ts			3.0	Min	4, 8
Power Consumption		Pbl	-	24	26.4	Watt	9
Life Time			50,000			Hrs	4, 10

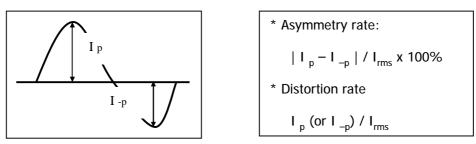
Note : The design of the inverter must have specifications for the lamp in LCD Assembly.

The performance of the Lamp in LCM, for example life time or brightness, is extremely influenced by the characteristics of the DC-AC inverter. So all the parameters of an inverter should be carefully designed so as not to produce too much leakage current from high-voltage output of the inverter.

When you design or order the inverter, please make sure unwanted lighting caused by the mismatch of the lamp and the inverter (no lighting, flicker, etc) never occurs. When you confirm it, the LCD– Assembly should be operated in the same condition as installed in you instrument.



- Note. Do not attach a conducting tape to lamp connecting wire. If the lamp wire attach to a conducting tape, TFT-LCD Module has a low luminance and the inverter has abnormal action. Because leakage current is occurred between lamp wire and conducting tape.
 - 1. The specified current and power consumption are under the V_{LCD} =5.0V, 25 ± 2°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 5ms and rising time of power Input is 500us \pm 20%.(min.).
 - 4. Specified values are for a single lamp.
 - 5. Operating voltage is measured at $25 \pm 2^{\circ}$ C, and follows as below condition. The variance of the voltage is $\pm 10\%$. (Based on single Lamp.) The variance of the voltage is $\pm 20\%$. (Based on system & Test equipment tolerance.)
 - 6. The voltage above V_s should be applied to the lamps for more than 1 second for start-up. (Inverter open voltage must be more than lamp starting voltage.) Otherwise, the lamps may not be turned on. The used lamp current is the lamp typical current.
 - 7. The output of the inverter must have symmetrical(negative and positive) voltage waveform and symmetrical current waveform (Unsymmetrical ratio is less than 10%). Please do not use the inverter which has unsymmetrical voltage and unsymmetrical current and spike wave. Lamp frequency may produce interface with horizontal synchronous frequency and as a result this may cause beat on the display. Therefore lamp frequency shall be as away possible from the horizontal synchronous frequence.
 - Let's define the brightness of the lamp after being lighted for 5 minutes as 100%. T_s is the time required for the brightness of the center of the lamp to be not less than 95%. The used lamp current is the lamp typical current.
 - 9. The lamp power consumption shown above does not include loss of external inverter.
 - The used lamp current is the lamp typical current. ($P_{BL} = V_{BL} \times I_{BL} \times N_{Lamp}$) 10. The life is determined as the time at which brightness of the lamp is 50% compared to that of initial
 - 10. The life is determined as the time at which brightness of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at $25 \pm 2^{\circ}$ C.
 - 11. Requirements for a system inverter design, which is intended to have a better display performance, a better power efficiency and a more reliable lamp, are following.
 - It shall help increase the lamp lifetime and reduce leakage current.
 - a. The asymmetry rate of the inverter waveform should be less than 10%.
 - b. The distortion rate of the waveform should be within $\sqrt{2} \pm 10\%$.
 - * Inverter output waveform had better be more similar to ideal sine wave.

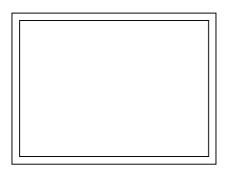


- 12. The inverter which is combined with this LCM, is highly recommended to connect coupling(ballast) condenser at the high voltage output side. When you use the inverter which has not coupling(ballast) condenser, it may cause abnormal lamp lighting because of biased mercury as time goes.
- 13. Permissive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

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- Permissive Power input ripple (V_{LCD} =5.0V, 25°C, fV(frame frequency)=MAX condition)

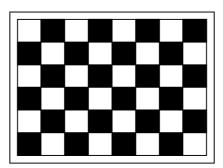




White pattern

Black pattern

• Power consumption (V $_{\rm LCD}$ =5.0V, 25°C, fV (frame frequency=60Hz condition)



Typical power Pattern

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



3-2. Interface Connections

3-2-1. LCD Module

-LCD Connector(CN1). :FI-XB30SL-HF11(JAE), MDF76LBRW-30S-1H (Hirose) or Equivalent - Mating Connector : FI-XC30C2L (Manufactured by JAE) or Equivalent

N o	Symbol	Description	N o	Symbol	Description
1	FR0M	- Signal of odd channel 0 (LVDS)	16	SR1P	+ Signal of even channel 1 (LVDS)
2	RM0P	+ Signal of odd channel 0 (LVDS)	17	GND	Ground
3	FR1M	- Signal of odd channel 1 (LVDS)	18	SR2M	- Signal of even channel 2 (LVDS)
4	FR1P	+ Signal of odd channel 1 (LVDS)	19	SR2P	+ Signal of even channel 2 (LVDS)
5	FR2M	- Signal of odd channel 2 (LVDS)	20	SCLKINM	- Signal of even clock channel (LVDS)
6	FR2P	+ Signal of odd channel 2 (LVDS)	21	SCLKINP	+ Signal of even clock channel (LVDS)
7	GND	Ground	22	SR3M	- Signal of even channel 3 (LVDS)
8	FCLKINM	- Signal of odd clock channel (LVDS)	23	SR3P	+ Signal of even channel 3 (LVDS)
9	FCLKINP	+ Signal of odd clock channel (LVDS)	24	GND	Ground
10	FR3M	- Signal of odd channel 3 (LVDS)	25	NC	NC (reserved I2C communication)
11	FR3P	+ Signal of odd channel 3 (LVDS)	26	NC	NC (reserved I2C communication)
12	SR0M	- Signal of even channel 0 (LVDS)	27	PWM	PWM_OUT for control burst frequency of Inverter
13	SR0P	+ Signal of even channel 0 (LVDS)	28	VLCD	Power +5V
14	GND	Ground	29	VLCD	Power +5V
15	SR1M	- Signal of even channel 1 (LVDS)	30	VLCD	Power +5V

Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION

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 VLCD (power input) pins should be connected together.

3. Input Level of LVDS signal is based on the IEA 664 Standard.

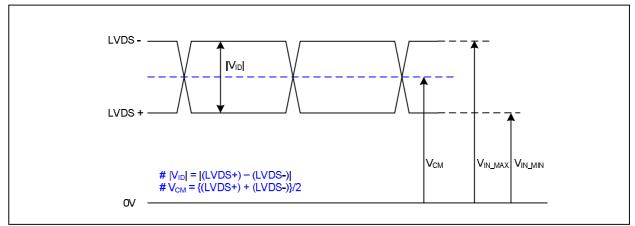






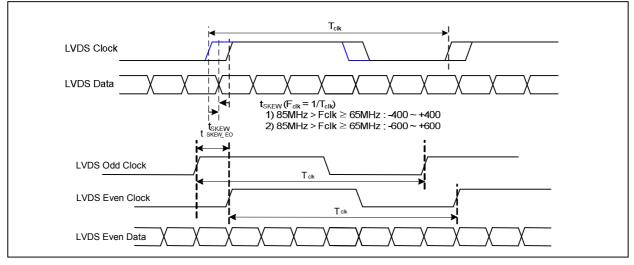
LVDS Input characteristics

1. DC Specification



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

2. AC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skow Margin	t _{skew}	- 400	+ 400	ps	$85MHz > Fclk \ge 65MHz$
LVDS Clock to Data Skew Margin	t _{skew}	- 600	+ 600	ps	$65MHz > Fclk \ge 25MHz$
LVDS Clock to Clock Skew Margin (Even to Odd)	t _{skew_eo}	- 1/7	+ 1/7	T _{clk}	-

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LVDS Odd Clock Telk LVDS Even Clock Telk LVDS Even Data VOUNT

< Clock skew margin between channel >

3. Data Format

1) LVDS 2 Port

						Tclk				1						
RCLK+			∢	-	<u><*4/7</u> Tclk * 1/	7	4	[clk *3/	7 →						MSB	R7
RXin00+/-	OR3	OR2	OR1	ORO	060	OR5	OR4	OR3	OR2	OR1	ORO	OG0	OR5	OR4		R6 R5
RXinO1 +/-	OG4	063	OG2	OGI	OB1	ОВО	005	OG4	063	OG2	OGI	OB1	ОВО	065		R4
RXinO2 +/-	OB5	OB4	ОВЗ	OB2	DE	VSYNC	HSYNC	OB5	OB4	ОВЗ	OB2	DE	VSYNC	HSYNC		R3 R2
RXinC3+/-	OG7	0G6	OR7	OR6	x	ОВ7	OB6	OG7	066	OR7	OR6	x	OB7	OB6		R1
RXinEO+/-	ER3	ER2	ER1	ERO	EG0	ER5	ER4	ER3	ER2	ER1	ERO	EGO	ER5	ER4	LSB	
RXinE1 +/-	EG4	EG3	EG2	EGI	EB1	EBO	EGS	EG4	EG3	EG2	EGI	EB1	ЕВО	EGS	UL.	D = 1st P N = 2nd P
RXinE2+/-	EB5	EB4	EB3	EB2	DE	VSYNC	HSYNC	EB5	EB4	EB3	EB2	DE	VSYNC	HSYNC		
RXinE3+/-	EG7	EG6	ER7	ER6	x	EB7	EB6	EG7	EG6	ER7	ER6	x	EB7	EB6		

< LVDS Data Format >



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

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

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

Note : 1. The high voltage power terminal is colored pink, white The low voltage pin color is sky blue, white.
2. The backlight ground should be common with LCD metal frame.

3. 35001HS-02LD (Locking type)



Down Side



[Figure 5] Backlight connector diagram



3-3. Signal Timing Specifications

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

Table 5. Timing Table

ITEM	Symbol		Min	Тур	Max	Unit	Note
DCLK	Period	tськ	11.42	14.44	15.38	ns	Pixel frequency
DCLK	Frequency	-	60	72	87.5	MHz	: Typ.138.5MHz
	total	thp	1000	1088	1120	tclk	
	Frequency	fн	64	66	83	KHz	
Horizontal	Blanking		40	128	160	tclk	
	valid	twн	960	960	960	tclk/2	
	total	tvp	1090	1100	1160	thp	
Vertical	Frequency	fv	50	60	75	Hz	
vertical	Blanking		10	20	80	tнр	
	valid	twv	1080	1080	1080	tнр	

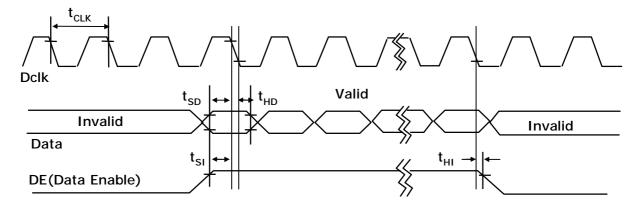
Note:

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

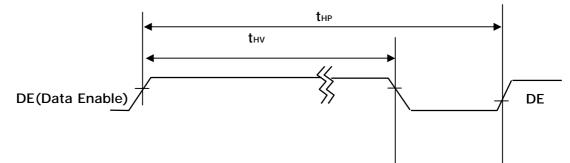


3-4. Signal Timing Waveforms

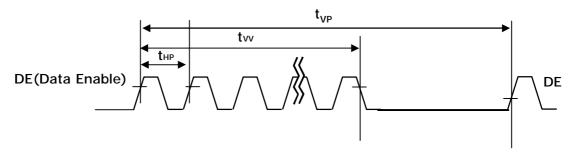
1. DCLK , DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform





3-5. Color Input Data Reference

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

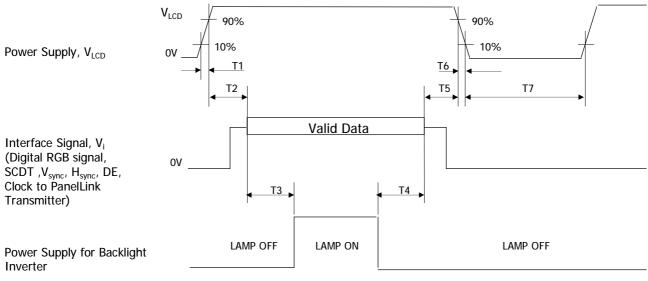
Table 6. COLOR DATA REFERENCE

													Inpu	ut Co	olor	Dat	а									
	Color					RE	Đ							GRI	EEN							BL	UE			
			MS								MS								MS							.SB
	1								R1	R0						G2		G0								B0
	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
Basic	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
Color	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
	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 (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							•																			
	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 (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							•																			
	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 (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							•																			
	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

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3-6. Power Sequence



[Figure 6] Power sequence

Table 7. POWER SEQUENCE

Dennester		Values		11-2-
Parameter	Min	Тур	Мах	Units
T1	0.5	-	10	ms
T2	0.01	-	50	ms
Т3	500	-	-	ms
Τ4	200	-	-	ms
Т5	0.01	-	50	ms
Т6	-	-	-	ms
Τ7	1		-	S

Notes : 1. Please avoid floating state of interface signal at invalid period.

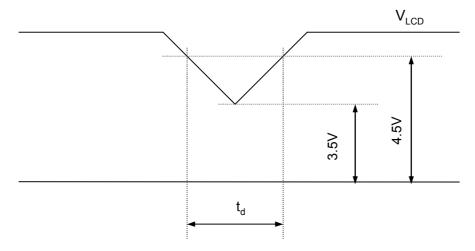
2. When the interface signal is invalid, be sure to pull down the power supply for LCD V_{LCD} to 0V.

3. Lamp power must be turn on after power supply for LCD and interface signal are valid.

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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

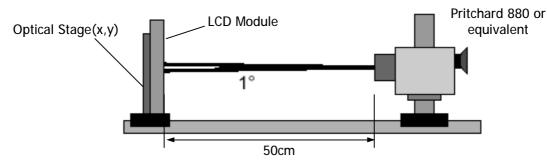
 $V_{\mbox{\scriptsize LCD}}\mbox{-dip}$ conditions should also follow the Power On/Off conditions for supply voltage.



4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at $25\pm2^{\circ}$ 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 8. OPTICAL CHARACTERISTICS	(Ta=25 °C, V_{LCD} =5.0V, f_{V} =60Hz Dclk=69.25MHz, I_{BL} =7.5mA)
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				· · · · · · · · · · · · · · · · · · ·	, 100	v		
	Parame	tor	Symbol		Values		Units	Notes
	Falanie	lei	Symbol	Min	Тур	Max	Units	Notes
Contrast Rat	io		CR	700	1000			1
Surface Lum	inance, v	vhite	L _{WH}	250	300		cd/m ²	2
Luminance V	'ariation		δ_{WHITE}	75			%	3
		Rise Time	Tr _R	-	1.3	2.6	ms	4
Response Til	me	Decay Time	Tr _D	-	3.7	7.4	ms	4
·		total	Т		5		ms	
RED			Rx		0.646			
Color Coordinates	RED	Ry		0.334				
		Gx		0.303				
	GREEN	Gy	Тур	0.616	Тур			
[CIE1931]		DULIE	Вх	-0.03	0.147	+0.03		
		BLUE	Ву		0.067			
			Wx		0.313			
		WHITE	Wy		0.329			
Color Gamut		-			72%			5
Viewing Ang	le (CR>1	0)						
General	Horizor	ntal	θ _H	140	170	-	Deerroc	,
(CR>10)	Vertica	I	θ _v	130	160	-	Degree	6
Luminance u Angular depe	-		LR			1.7		Fig 11
Gray Scale					2.2			7



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

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

It is measured at center point(Location P1)

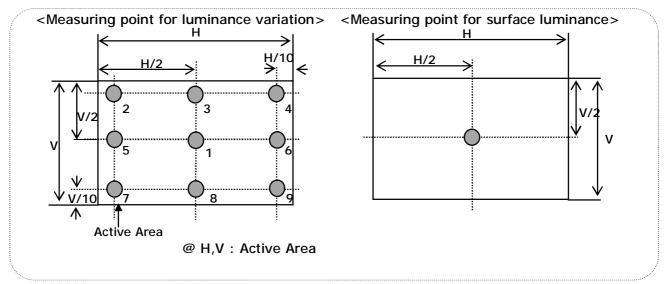
- 2. Surface luminance is the luminance value at center 1 point(1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 9.
- 3. The variation in surface luminance , δ WHITE is defined as :

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

For more information see FIG 9.

- 4. Response time is the time required for the display to transition from black to white (Rise Time, Tr_R) and from white to black (Decay Time, Tr_D). For additional information see FIG 3.
- 5. Color gamut is calculated from CIE 1931 space.
- 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 5.
- 7. Gray scale specification Gamma Value is approximately 2.2. For more information see Table 11.

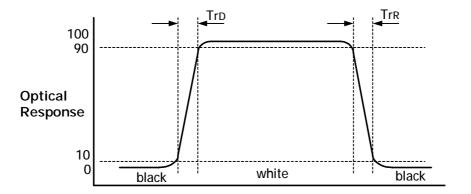




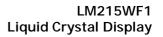
Measuring point for surface luminance $\ \& \ measuring \ point \ for \ luminance \ variation.$

[FIG 9] Measure Point for Luminance

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



[FIG 10] Response Time





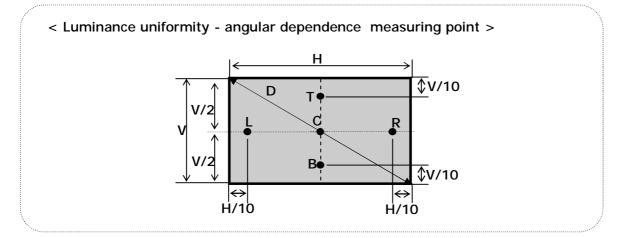
Notes :

Luminance Uniformity - angular - dependence (LR& TB)

TCO '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.

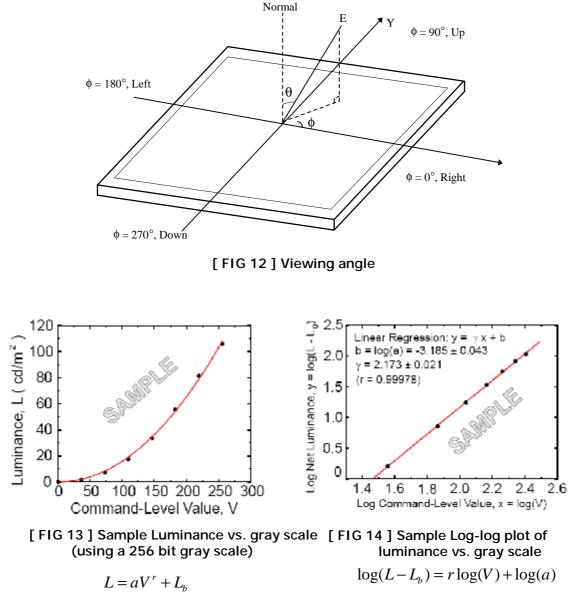
- Test pattern : 80% white pattern
- Test point : 2-point
- Test distance : D * 1.5 = 82cm
- Test method : $L_R = ((L_{max.+30deg.} / L_{min.+30deg.}) + (L_{max.-30deg.} / L_{min.-30deg.})) / 2 T_B = ((L_{max.+15deg.} / L_{min.+15deg.}))$

FIG. 11 Luminance Uniformity angular dependence





Dimension of viewing angle range.



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



Table 10. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.11
31	1.08
63	4.72
95	11.49
127	21.66
159	35.45
191	53.00
223	74.48
255	100



5. Mechanical Characteristics

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

		I		
	Horizontal	495.6mm		
Outline Dimension	Vertical	292.2mm		
	Depth	16.5mm		
Bezel Area	Horizontal	479.84mm		
bezei Area	Vertical	271.31mm		
Active Dicplay Area	Horizontal	476.64mm		
Active Display Area	Vertical	268.11mm		
Weight	2100g(typ)			
Surface Treatment	Hard coating(3H) Glare treatment of the front polarizer			

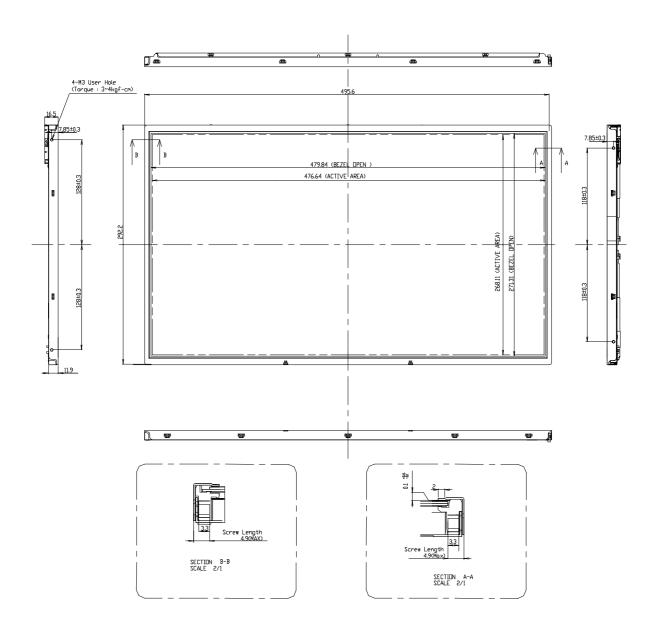
Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.



LM215WF1 Liquid Crystal Display

Product Specification

<FRONT VIEW>

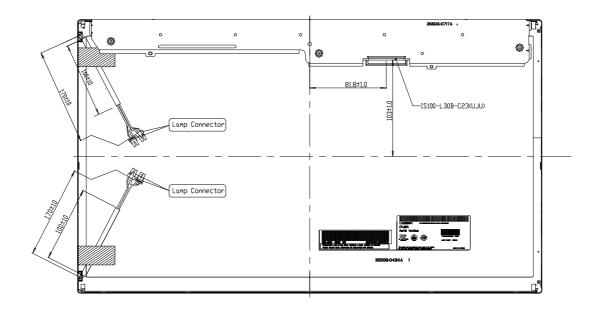




LM215WF1 Liquid Crystal Display

Product Specification

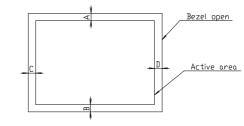
<REAR VIEW>





- 1. Unspecified tolerances to be \pm 0.5mm

- Displicitled toteratics to be 1 0.04M
 Backlight : 4 Cold Cathode Fluorescent Lamps.
 I/F Connector Specification : KDF71G-30S-1H or Equivalent
 Torque of user hole : 30~4.0 kgf-cm
 Tilt and partial disposition tole rance of display area as following
 (1) Y-Direction : (A-BI <= 1.0
 (2) X-Direction : (C-DI <=1.0



7. Do not wind conductive tape around the backlight wires 8. Gap between Bezel and Panel : Max 0.7mm



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 : 10-300Hz Duration : X,Y,Z, 10 min One time each direction
6	Shock test (non-operating)	Shock level : 100G Waveform : half sine wave, 2ms Direction : $\pm X$, $\pm Y$, $\pm Z$ One time each direction
7	Humidity condition Operation	Ta= 40 °C ,90%RH
8	Altitude storage / shipment	0 - 40,000 feet(12192m)



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.

7-2. EMC

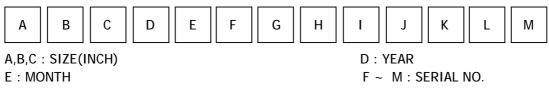
- a) ANSI C63.4 "Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHZ to 40GHz. "American National Standards Institute(ANSI), 1992
- b) C.I.S.P.R "Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology 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



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	А	В	С

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 : 7pcs
- b) Box Size : 370mm x 320mm x 580mm



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 : $V = \pm 200 \text{mV}(\text{Over and under shoot voltage})$
- (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.

Ver. 1.0



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 ionblown 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.