HY-LINE®
COMPUTER COMPONENTS

TFT-Display Datenblatt

Modell LM215WF3-SLA1

Kurzdaten

Hersteller	LG Display
Diagonale	21,5” / 54,6cm
Format	16:9
Auflösung	1920x1080
Backlight	LED/330cd/m²
Temperatur	0...+50°C (Betrieb)

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SPECIFICATION
FOR
APPROVAL

( ) Preliminary Specification
(●) Final Specification

Title	21.5" Full HD TFT LCD

BUYER	APPLE
MODEL	K22

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM215WF3
SUFFIX	SLA1

*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.

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RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.1	Feb. 27. 2009	-	First Draft (Preliminary) without Backlight interface (WLED)
0.2	Mar. 31th. 2009	5	Update LCM Power Consumption
		7	Update ELECTRICAL CHARACTERISTICS
		9	Update LED Bar ELECTRICAL CHARACTERISTICS
		10	Update connector information
		14	Update Backlight Interface
		15	Update Timing Table
		20	Update OPTICAL CHARACTERISTICS
		34	Update EDID (Ver09)
		-	Correct Fig & Table number
0.3	Apr. 2nd, 2009	5, 26	Modify LCM thickness value(11.5mm)
		7	Electrical Characteristics
		27, 28	Update LCM drawings
		34~36	Update EDID
0.4	June. 9th, 2009	5	Update General Features
		9	Update LED Bar ELECTRICAL CHARACTERISTICS
		10	Update connector information (I-PEX → JAE)
		20	Update Color Coordinates Spec
		27,28	Update LCM drawings
		32	Correct Operating precautions (3)
0.5	June. 27th, 2009	7	update Power Consumption
		10	Correct wrong symbol (RM0P → FR0P)
		20	Update color coordinates
		26	Update weight spec
		30	Update LED information (safety)
		31	Update packing form
		34~36	Update EDID table
1.0	Aug. 17th , 2009	7	update Power Consumption
		27~28	Update LCM drawings
1.1	Aug. 27th , 2009	5	update Power Consumption
		28	Update LCM drawings (Dimension)

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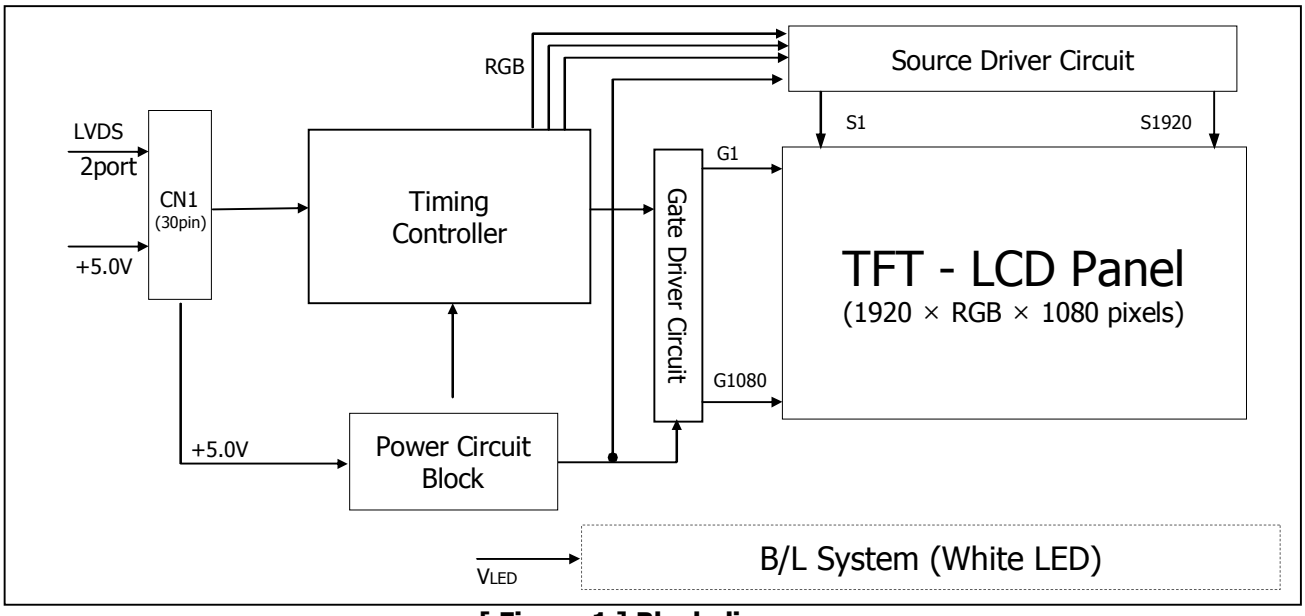
1. General Description

LM215WF3 is a Color Active Matrix Liquid Crystal Display with Light Emitting Diode (White LED) backlight system without LED driver. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally white mode. It has a 21.5inch diagonally measured active display area with Full HD resolution (1080 vertical by 1920 horizontal pixel array) Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M(True) colors.
It has been designed to apply the 8Bit 2 port LVDS interface.
It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



[Figure 1] Block diagram

General Features

Active Screen Size	21.46 inches(545.22mm) diagonal
Outline Dimension	495.6(H) x 305.25(V) x 15.8(D) mm(Typ.)
Pixel Pitch	0.2475 mm x 0.2475mm
Pixel Format	1920 horiz. By 1080 vert. Pixels RGB stripes arrangement
Color Depth	8-bit, 16M colors
Luminance, White	330 cd/m^2 (5point Avg.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 55.83 Watt (Max.) (Max : 11.08 W @V_{LCD}, 44.75 W_ Duty 100% of DC 250 mA_ w/o driver)
Weight	2300 g (typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Hard coating(2H), Glare (Low Reflection treatment of the front polarizer)

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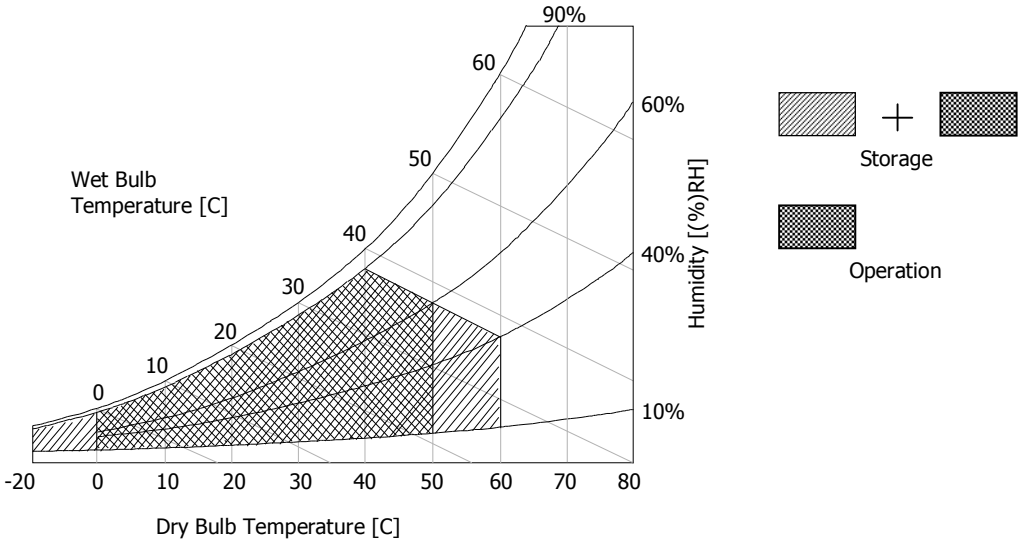
2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VLCD	0	5.5	Vdc	at 25 ± 2°C
Operating Temperature	TOP	0	50	°C	1, 2
Storage Temperature	TST	-20	60	°C	
Operating Ambient Humidity	HOP	10	90	%RH	
Storage Humidity	HST	10	90	%RH	

Note : 1. Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39 °C Max, and no condensation of water.



[Figure 2] Temperature and relative humidity

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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 WLED.

Table 2. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	4.5	5.0	5.5	Vdc	
Permissive Power Input Ripple	V_{RF}	-	-	100	mV	13
Power Supply Input Current	I_{LCD}	743	1062	1380	mA	1
		1193	1704	2215	mA	2
Differential Impedance	Zm	90	100	110	ohm	
Power Consumption	P_{LCD}		5.31	6.90	Watt	1
	P_{LCD}		8.52	11.08	Watt	2
Rush current	I_{RUSH}	-	-	3	A	3

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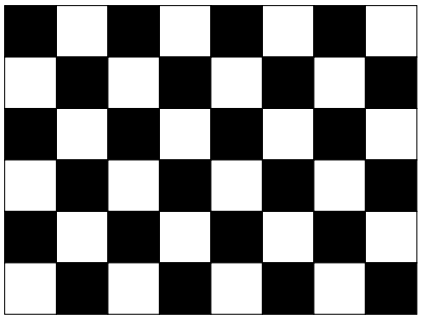
Note.

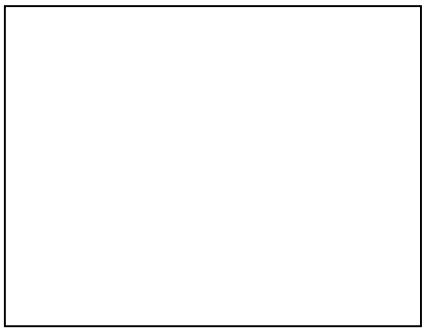
1. The specified current and power consumption are under the V_{LCD}=5.0V, 25 ± 2°C,f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising time of power Input is 1ms(min.)

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

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Table 2-1. LED Bar ELECTRICAL CHARACTERISTICS

Items	Symbol	Spec			Unit	Remark	Notes
		Min	Typ	Max			
LED String Voltage	V_S	55	58	61	Vrms	Ta=25℃, at DC 350 mA	2,7
LED Bar Voltage	V_{Bar}	-	173	179	Vrms	Ta=25℃, at DC 350 mA	3,7
LED String Power	P_S	19.25	20.30	21.35	W	Ta=25℃, at DC 350 mA	3,6,7
LED Bar Power	P_L	-	60.55	62.65	W	Ta=25℃, at DC 350 mA	4,6,7
BL Power	P_{BL}	-	43.25	44.75	W	Ta=25℃, at Duty 100% of DC 250 mA	6,7
LED Life Time	LED_LT	39,000		-	Hrs	Ta=25℃, at Duty 100% of DC 250 mA	5,7
LED Junction Temperature	Tj			150	℃	-	7

LED driver design guide

: The design of the LED driver must have specifications for the LED in LCD Assembly.
The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver.
So all the parameters of an LED driver should be carefully designed and output current should be Constant current control.
When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the LED driver (no lighting, flicker, etc) never occurs.
When you confirm it, the LCD module should be operated in the same condition as installed in your instrument.

1. Specified values are for a single LED bar.
2. The specified current is input LED chip 100% duty current.
3. The specified voltage is input LED string and Bar voltage at typical 350 mA 100% duty current.
4. The specified power consumption is input LED bar power consumption at typical 350 mA 100% duty current.
5. The life is determined as the time at which luminance of the LED is 50% compared to that of initial value at the typical LED current on condition of continuous operating at 25 ± 2°C.
6. The LED power consumption shown above does not include loss of external driver.
   The used LED BL current is the LED typical current.
   String Power Consumption is calculated with $P_S = V_S$ x 350mA
   Bar Power Consumption is calculated with $P_L = V_{Bar}$x 350mA
   BL Power Consumption is calculated with $P_{BL} = V_{Bar}$x 250mA
7. LED operating DC Forward Current and Junction Temperature must not exceed LED Max Ratings.

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3-2. Interface Connections

3-2-1. LCD Module

-LCD Connector(CN1). :FI-X30SSL-HF (JAE), MDF76LBRW-30S-1H (Hirose) or Equivalent
- Mating Connector : FI-XC30C2L (Manufactured by JAE) or Equivalent

Table 3 MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	FR0M	- Signal of odd channel 0 (LVDS)	16	SR1P	+ Signal of even channel 1 (LVDS)
2	FR0P	+ Signal of odd channel 0 (LVDS)	17	GND	Ground
3	FR1M	- Signal of odd channel 1 (LVDS)	18	SR2M	- Signal of even channel 2 (LVDS)
4	FR1P	+ Signal of odd channel 1 (LVDS)	19	SR2P	+ Signal of even channel 2 (LVDS)
5	FR2M	- Signal of odd channel 2 (LVDS)	20	SCLKINM	- Signal of even clock channel (LVDS)
6	FR2P	+ Signal of odd channel 2 (LVDS)	21	SCLKINP	+ Signal of even clock channel (LVDS)
7	GND	Ground	22	SR3M	- Signal of even channel 3 (LVDS)
8	FCLKINM	- Signal of odd clock channel (LVDS)	23	SR3P	+ Signal of even channel 3 (LVDS)
9	FCLKINP	+ Signal of odd clock channel (LVDS)	24	GND	Ground
10	FR3M	- Signal of odd channel 3 (LVDS)	25	CLK_EDID	DDC for Clock
11	FR3P	+ Signal of odd channel 3 (LVDS)	26	DATA_EDID	DDC for Data
12	SR0M	- Signal of even channel 0 (LVDS)	27	V_EDID	DDC for Power 3.3V
13	SR0P	+ Signal of even channel 0 (LVDS)	28	VLCD	Power +5V
14	GND	Ground	29	VLCD	Power +5V
15	SR1M	- Signal of even channel 1 (LVDS)	30	VLCD	Power +5V

Note: 1. All GND(ground) pins should be connected together and to Vss which should also be connected to the LCD's metal frame.
2. All V_{LCD} (power input) pins should be connected together.
3. Input Level of LVDS signal is based on the IEA 664 Standard.

[Figure 4] User Connector diagram

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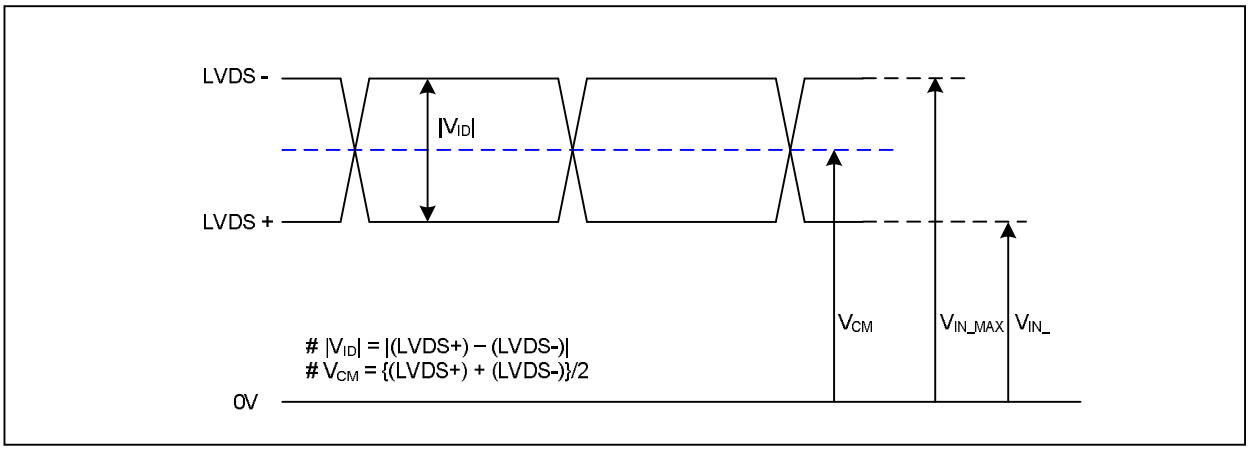
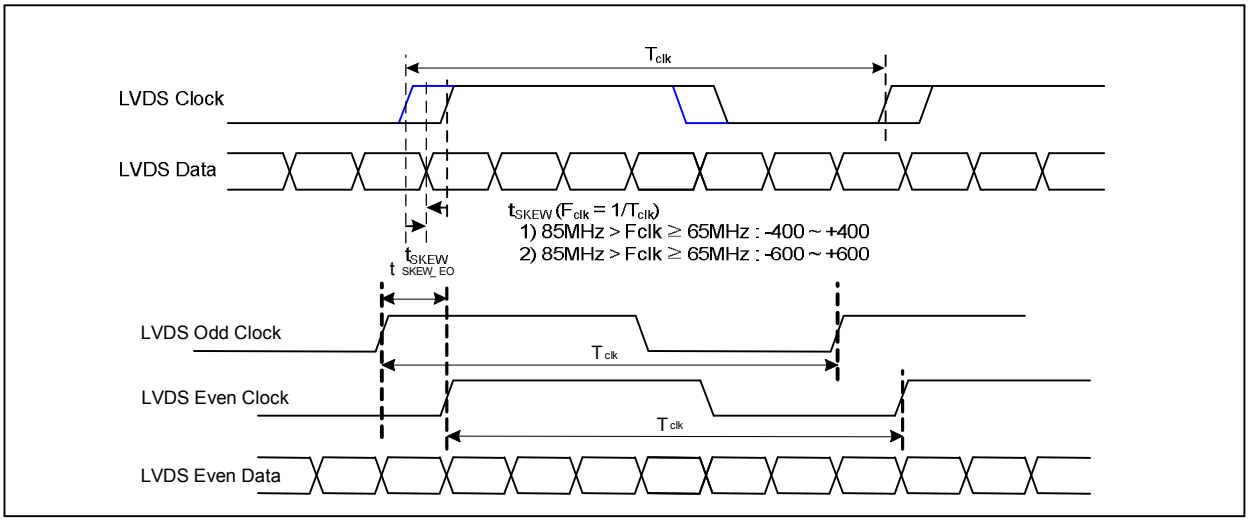
LVDS Input characteristics

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

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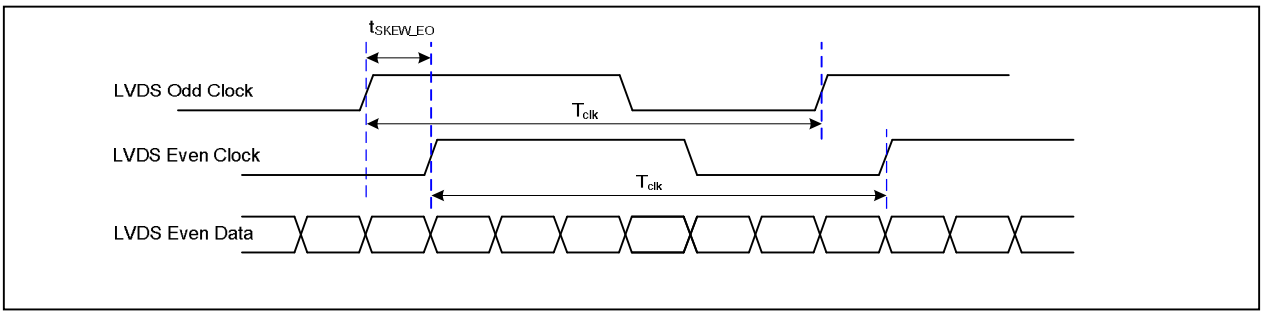
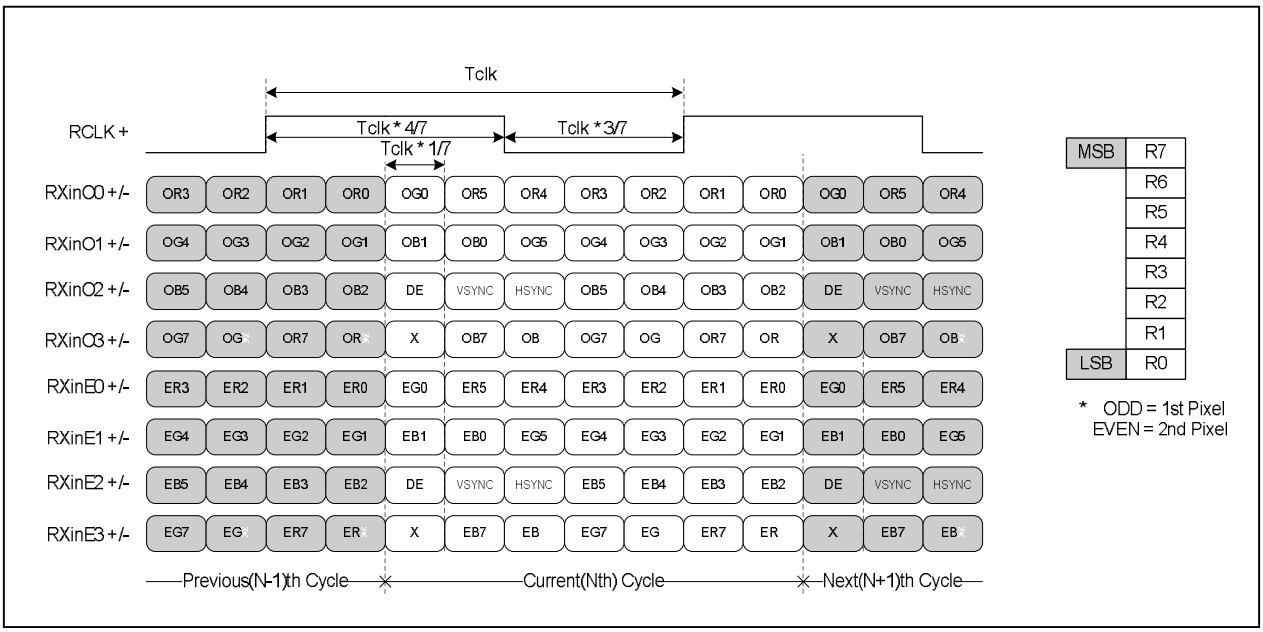


< Clock skew margin between channel >

3. Data Format

1) LVDS 2 Port



< LVDS Data Format >

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This connector is use for synchronized LED Driver.
FFC connector is FN100-Z04B-C20. (Manufactured by UJU)

Table 4 LED synchronized CONNECTOR(CN3) PIN CONFIGURATION

Pin	Symbol	Description	NOTES
1	GND	Ground	
2	EN	Enable	
3	PWM	PWM for synchronized LED Driver	1
4	GSP	GSP for synchronized LED Driver	2

Note : 1. PWM signal follows multiplied Horizontal frequency and level is 3.3V TTL level.
2. GSP frequency follows refresh time and level is 3.3V TTL level
and high width is 1/(Horizotal freq).

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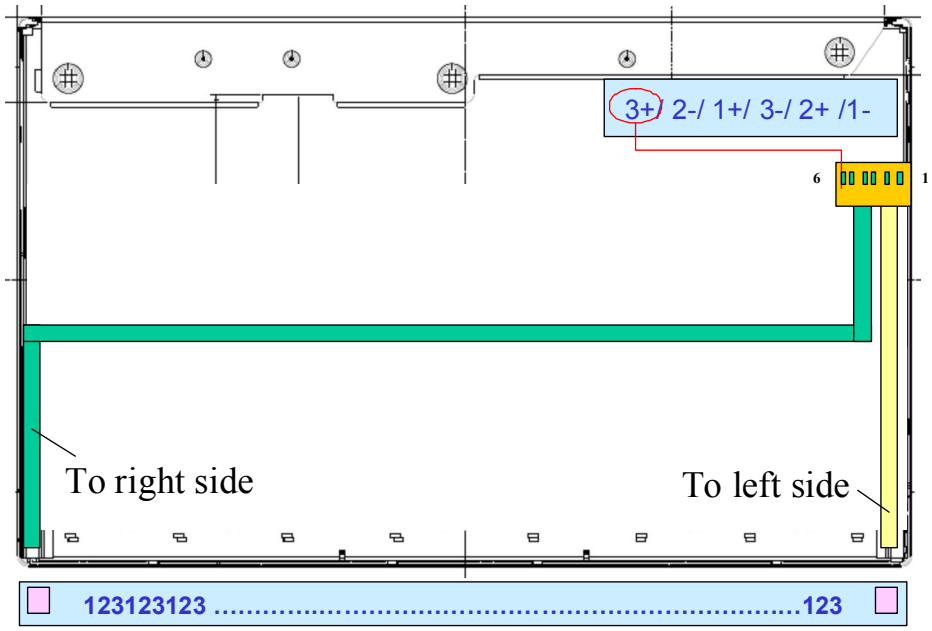
3-2-2. Backlight Interface

Driver connector: H401K-D06N-12B (Manufactured by E&T)
Mating Connector: 4530K-F06N-01R (Manufactured by E&T)

Table 5 LED DRIVER CONNECTOR PIN CONFIGURATION

Pin	Symbol	Description	NOTES
1	LED1-	LED channel 1 cathode – Left bar	
2	LED2+	LED channel 2 Anode – Left bar	
3	LED3-	LED channel 3 cathode – Left bar	
4	LED1+	LED channel 1 Anode – Right bar	
5	LED2-	LED channel 2 cathode – Right bar	
6	LED3+	LED channel 3 Anode – Right bar	



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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 6. Timing Table

ITEM	Symbol		Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	-	14.44	-	ns	
	Frequency	-	-	69.25	-	MHz	
Horizontal	total	t_{HP}	-	1040	-	t_{CLK}	
	Frequency	f_H	-	66.59	-	KHz	
	Blanking		-	80	-	t_{CLK}	
	valid	t_{WH}	-	960	-	$t_{CLK/2}$	
Vertical	total	t_{VP}	-	1111	-	t_{HP}	
	Frequency	f_V	-	60	-	Hz	
	Blanking		-	31	-	t_{HP}	
	valid	t_{WV}	-	1080	-	t_{HP}	

Note:

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

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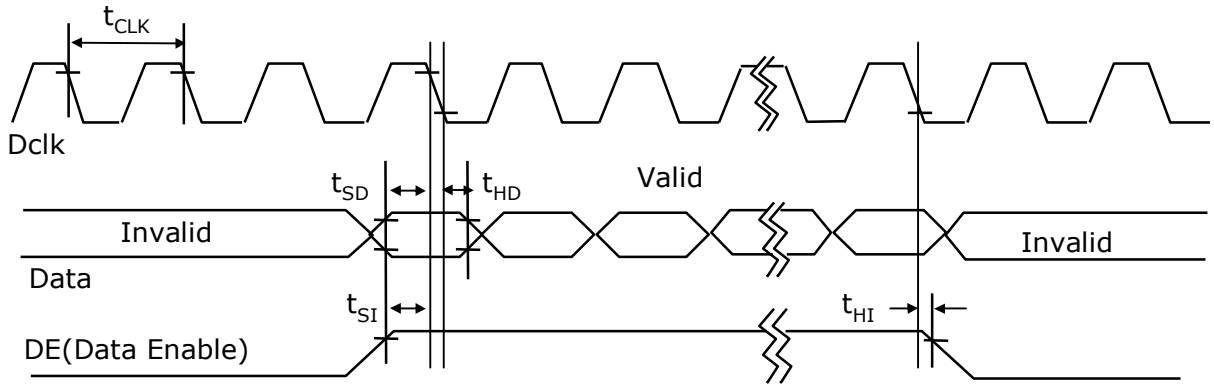
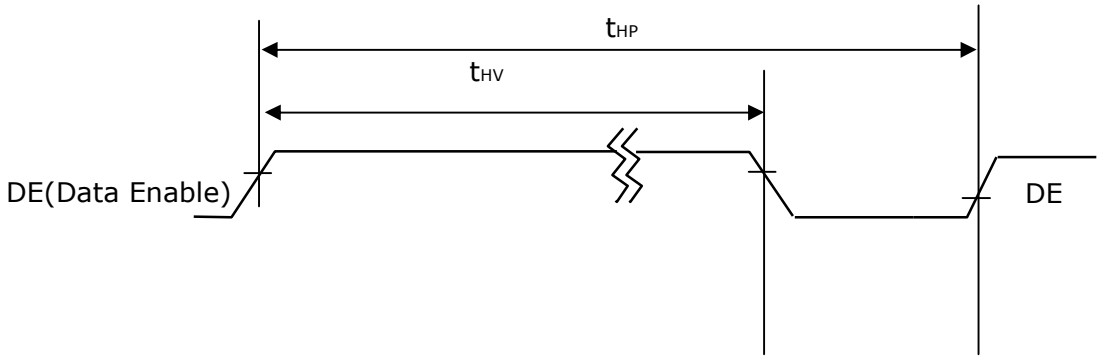
3-4. Signal Timing Waveforms

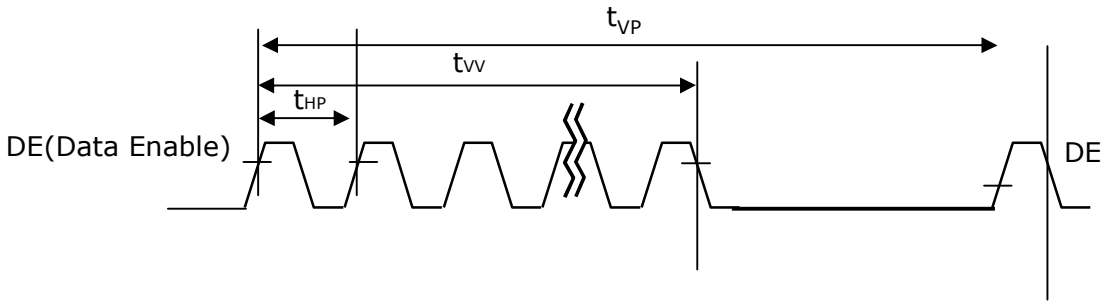
1. DCLK , DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



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3-5. Color Input Data Reference

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

Table 7. COLOR DATA REFERENCE

Color		Input Color Data																							
		RED								GREEN								BLUE							
		MSB							LSB	MSB							LSB	MSB							LSB
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
Basic Color	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Cyan	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	Magenta	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (001)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...					...								...								...			
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	...					...								...								...			
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	GREEN (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
BLUE	BLUE (000) Dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	BLUE (001)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	...					...								...								...			
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

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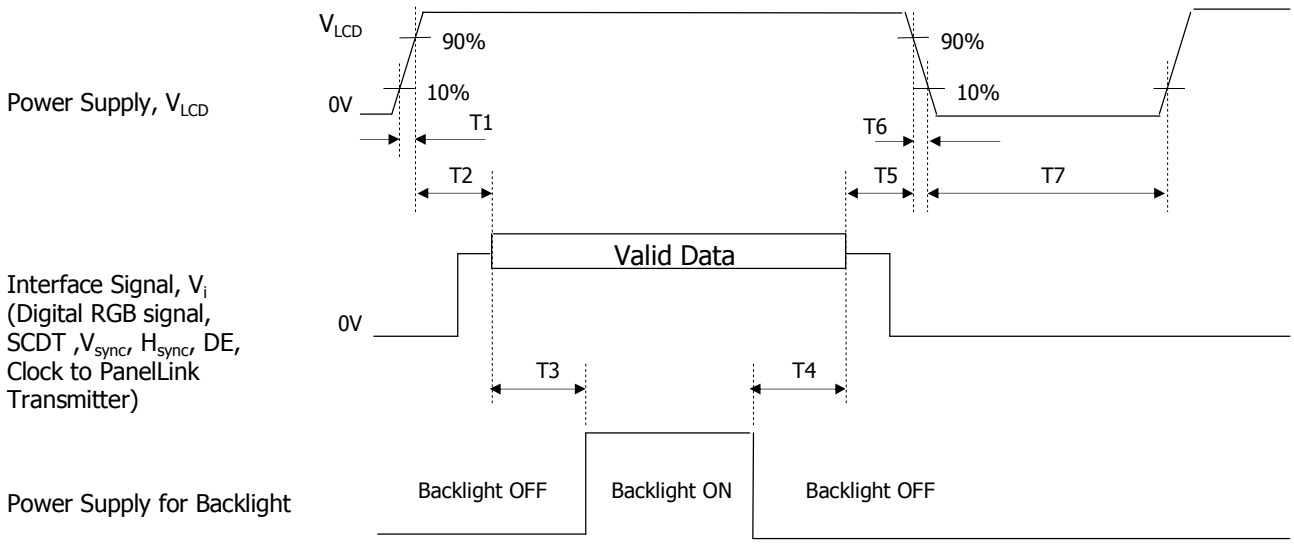
3-6. Power Sequence



[Figure 6] Power sequence

Table 8. POWER SEQUENCE

Parameter	Values			Units
	Min	Typ	Max	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T6	-	-	-	ms
T7	1		-	s

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

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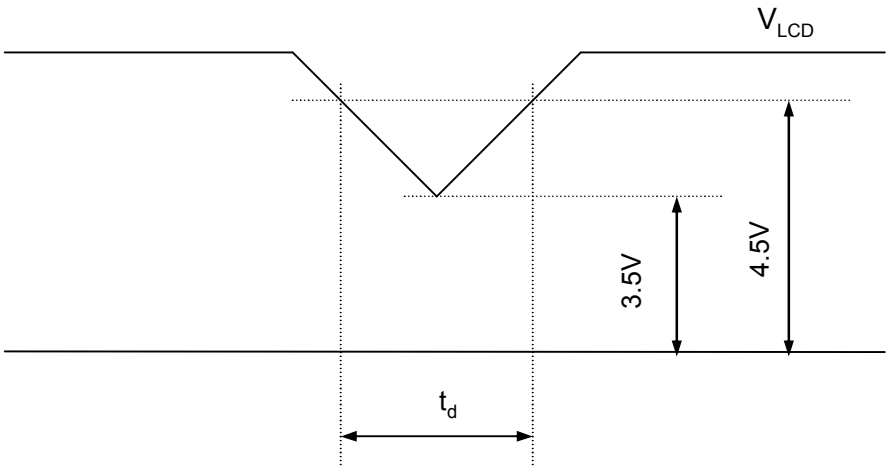
3-7. V_{LCD} Power Dip Condition



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

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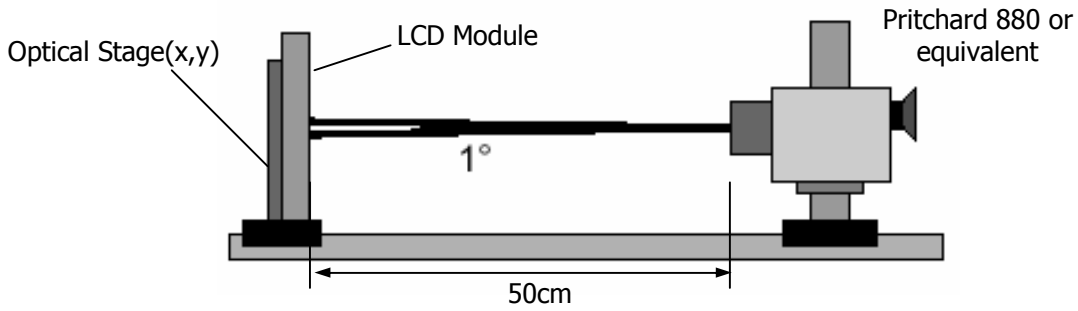
4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 120 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 ° and aperture 1 degree.
FIG. 8 presents additional information concerning the measurement equipment and method.



[Figure 8] Optical characteristic measurement equipment and method

Table 9. OPTICAL CHARACTERISTICS (Ta=25 °C, V_{LCD}=5.0V, f_V=60Hz Dclk=138.5MHz)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WH}	260	330	-	cd/m^2	2
Luminance Variation		δ_{WHITE}			30	%	3
Response Time	Rise Time	Tr_R	-	6.5	12	ms	4.1
	Decay Time	Tr_D	-	7.5	12	ms	4.1
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.651	Typ +0.03		
		Ry		0.333			
	GREEN	Gx		0.305			
		Gy		0.617			
	BLUE	Bx		0.146			
		By		0.050			
	WHITE	Wx		0.313			
		Wy		0.329			
Color Shift	Horizontal	θ_{CST_H}	-	178	-	Degree	5
	Vertical	θ_{CST_V}	-	178	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	6
	Vertical	θ_V	170	178	-		
Effective	Horizontal	θ_{GMA_H}		178	-	Degree	7
	Vertical	θ_{GMA_V}		178	-		
Gray Scale				2.2			8

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

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

It is measured at center point(Location P1)

2. Surface luminance(L_{WH})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 9.
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 :

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

Where L1 to L13 are the luminance with all pixels displaying white at 13 locations.
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 10

5. Color shift is the angle at which the color difference is lower than 0.04.
For more information see FIG 11.
- Color difference (Δu'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

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 12.

7. Effective viewing angle is the angle at which the gamma shift of gray scale is lower than 0.3.
For more information see FIG 13 and FIG 14.

8. Gray scale specification
Gamma Value is approximately 2.2. For more information see Table 10.

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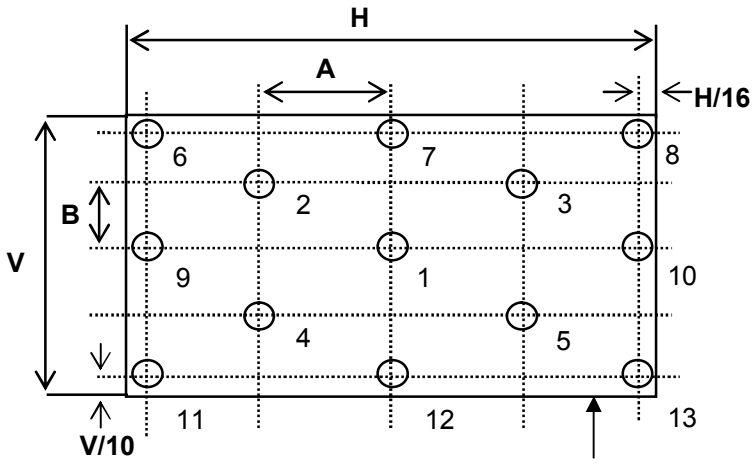
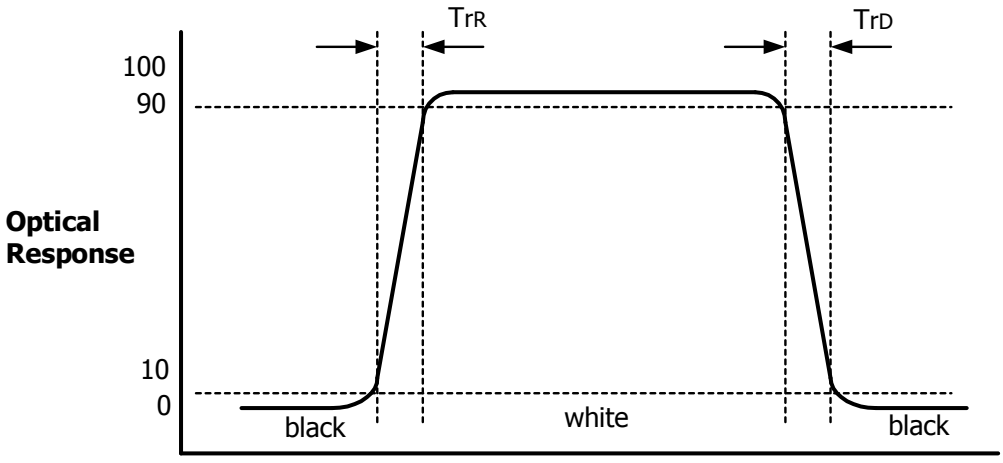
Measuring point for surface luminance & measuring point for luminance variation.



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

[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

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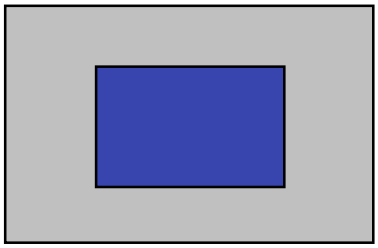
Color shift is defined as the following test pattern and color.



25% Box size

FIG. 11 Test Pattern

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

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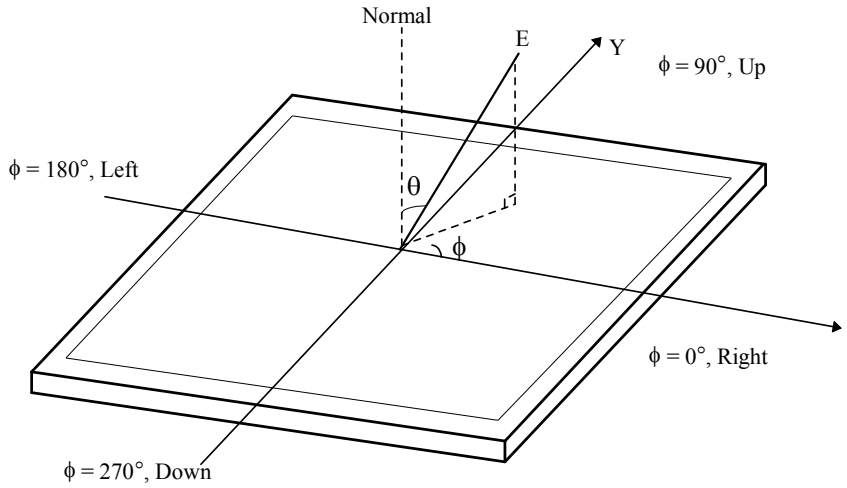
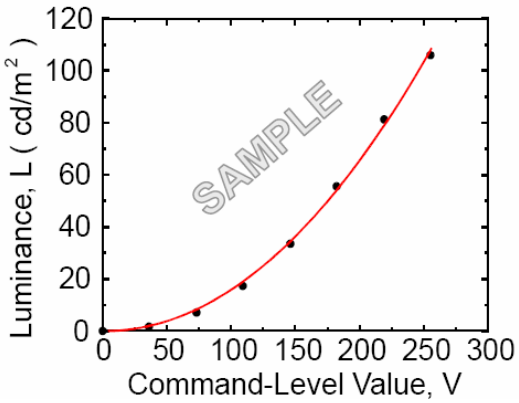
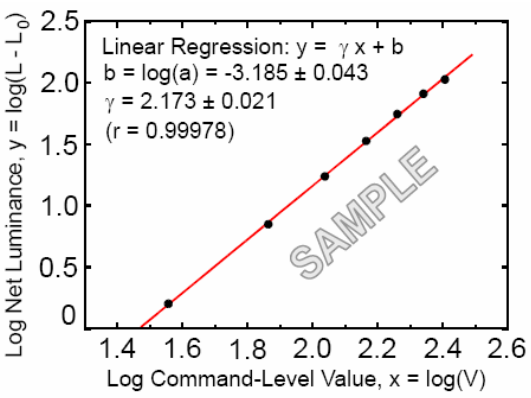
Dimension of viewing angle range.



[FIG 12] Viewing angle



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



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

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

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

Here the Parameter α and γ relate the signal level V to the luminance L.
The GAMMA we calculate from the log-log representation (FIG. 14)

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Table 10. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.10
31	1.08
63	4.71
95	11.5
127	21.7
159	35.5
191	53.1
223	74.5
255	100

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5. Mechanical Characteristics

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

Outline Dimension	Horizontal	495.6mm
	Vertical	305.25mm
	Depth	15.8mm
Bezel Area	Horizontal	479.84mm
	Vertical	272.32mm
Active Display Area	Horizontal	475.2mm
	Vertical	267.3mm
Weight	2300g	
Surface Treatment	Hard coating(2H) Glare, Low Reflection treatment of the front polarizer	

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

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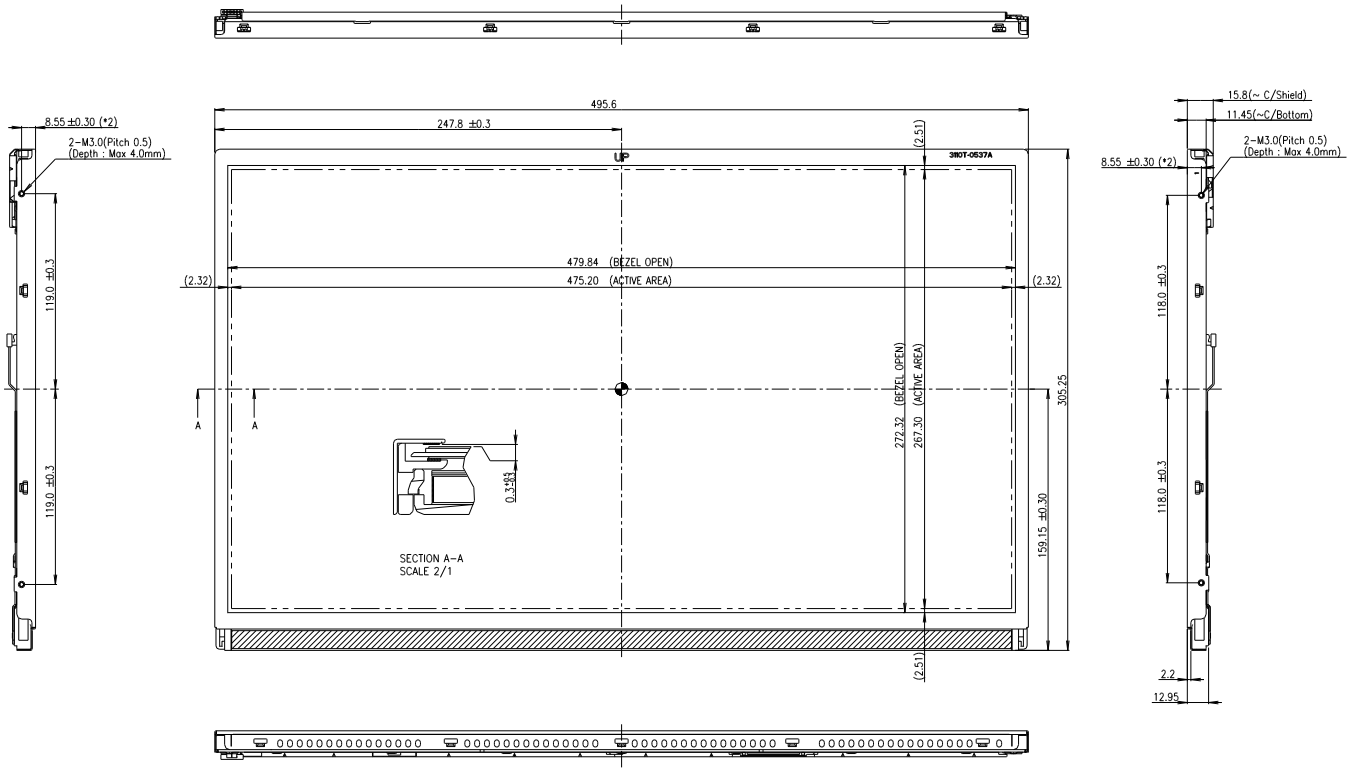
<FRONT VIEW>



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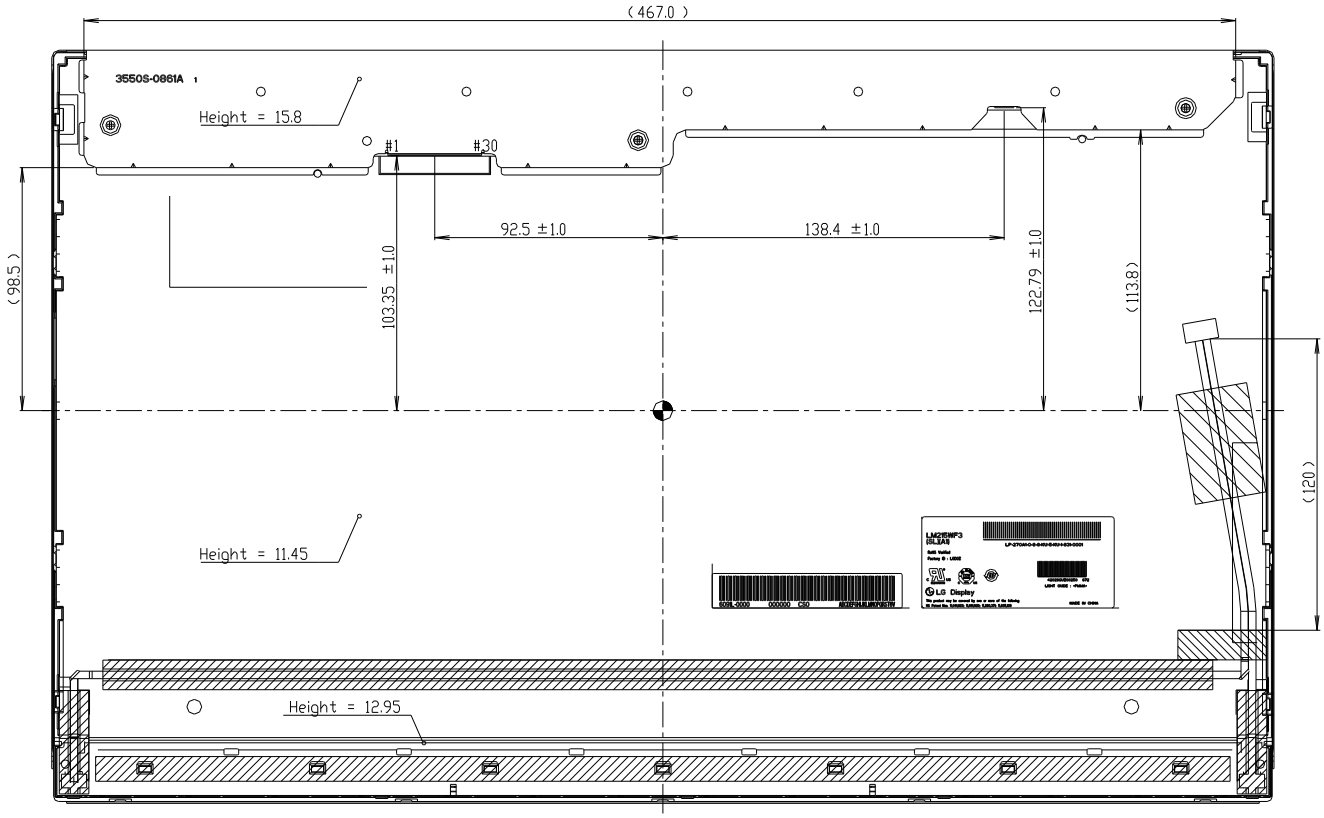
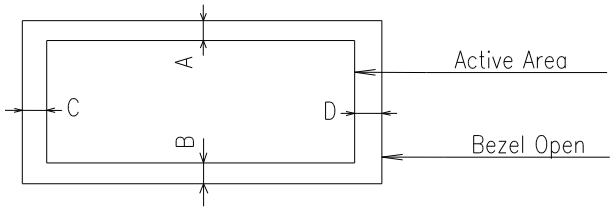
<REAR VIEW>



Notes
1. Unspecified tolerances are to be ±0.5mm.
2. Tilt and partial disposition tolerance of display area
   are following.
   (1) Y-direction : A+B < 11.0mm
   (2) X-direction : C+D < 11.0mm



3. Unspecified contents have to be discussed with designer
4. Both backlight wires and contraction tubes are excluded from outline dimensions.
5. Torque Spec of User Mounting : 7.0 ~ 8.0kgf cm
6. LCM Weight : 2.3kg (Typ.) , 2.4kg (Max.)
7. The ass'y should have no defect in appearance.
8. LCM Flatness spec : Max 0.5mm
   – Measuring method : The gap is less than 0.5 from the flat surface plate to front side.

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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 : ±X, ±Y, ±Z One time each direction
7	Humidity condition Operation	Ta= 40 °C ,90%RH
8	Altitude storage / shipment	0 - 40,000 feet(12192m)

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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) IEC 60950-1:2001, First Edition, The International Electro technical Commission (IEC)
Standard for Safety of Information Technology Equipment.
(Including report of IEC60825-1 Ed. 1.22001, clause 8 and clause 9)

Notes
1. Laser (LED Backlight) Information

Class 1 LED Product IEC60825-1: 2001 Embeded LED Power (Class1) Power: 1 mW (Max.) Wavelength: 452 ~ 630(nm) Width: 0.355~1.46(mm)

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)

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8. Packing

8-1. Designation of Lot Mark

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M

A,B,C : SIZE(INCH)
D : YEAR
E : MONTH
F ~ M : SERIAL NO.

Note

1. YEAR

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Mark	1	2	3	4	5	6	7	8	9	0

2. MONTH

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.
This is subject to change without prior notice.

8-2. Packing Form

a) Package quantity in one box : 7pcs

b) Box Size : 360 * 310 * 562 (mm)

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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 higher 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.

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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.

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10. EDID DATA FOR LM215WF3-SLA1

10-1. EDID Data

LM215WF3-SLA1 EDID1.4 DATA (1920X1080 @60Hz) VER14

Byte# (decimal)	Byte# (HEX)	Field Name	Value (HEX)	Value (BIN)	
0	0	Header	00	0	Header
1	1		FF	11111111	
2	2		FF	11111111	
3	3		FF	11111111	
4	4		FF	11111111	
5	5		FF	11111111	
6	6		FF	11111111	
7	7		00	00000000	
8	8	EISA manufacture code (3character ID) APP	06	00000110	
9	9	EISA manufacture code (Compressed ASCII)	10	00010000	
10	0A	Panel Supplier Reserved-Product Code	BC	10111100	Product ID for LM215WF3-SLA1 = 9CBC
11	0B	(Hex. LSB first)	9C	10011100	
12	0C	32-bit serial #	01	00000001	Vender/ Product ID
13	0D		01	00000001	
14	0E		01	00000001	
15	0F		01	00000001	
16	10	Week of manufacture June 4th week : 26weeks	1A	00011010	
17	11	Year of manufacture	13	00010011	
18	12	EDID Structure version #	01	00000001	EDID Version/
19	13	EDID Revision #	04	00000100	Revision
20	14	Video input Definition =Digital Signal	A0	10100000	Display Parameter
21	15	Max H image size (cm) = 48 cm	30	00110000	
22	16	Max V image size (cm) =27 cm	1B	00011011	
23	17	Display Transfer Characteristic (gamma) = 2.2	78	01111000	
24	18	Feature support (DPMS)	26	00100110	
25	19	Red/Green low Bits (RxRy/GxGy)	6F	01101111	Color characteristic
26	1A	Blue/White Low Bits (BxBy/WxWy)	B1	10110001	
27	1B	Red X Rx = 0.653	A7	10100111	
28	1C	Red Y Ry = 0.334	55	01010101	
29	1D	Green X Gx = 0.300	4C	01001100	
30	1E	Green Y Gy = 0.620	9E	10011110	
31	1F	Blue X Bx = 0.146	25	00100101	
32	20	Blue Y By = 0.050	0C	00001100	
33	21	White X Wx = 0.313	50	01010000	
34	22	White Y Wy = 0.329	54	01010100	
35	23	Established Timing I (00h if not used)	00	00000000	Established Timings
36	24	Established Timing II (00h if not used)	00	00000000	
37	25	Manufacturer's Timings	10	00010000	kAppleNoncoherentTMDSFlag = 0X10, kAppleCoherentTMDSFlag = 0X18
38	26	Standard Timing Identification 1	01	00000001	Standard Timing ID
39	27	Standard Timing Identification 1	01	00000001	
40	28	Standard Timing Identification 2	01	00000001	
41	29	Standard Timing Identification 2	01	00000001	
42	2A	Standard Timing Identification 3	01	00000001	
43	2B	Standard Timing Identification 3	01	00000001	
44	2C	Standard Timing Identification 4	01	00000001	
45	2D	Standard Timing Identification 4	01	00000001	
46	2E	Standard Timing Identification 5	01	00000001	
47	2F	Standard Timing Identification 5	01	00000001	
48	30	Standard Timing Identification 6	01	00000001	
49	31	Standard Timing Identification 6	01	00000001	
50	32	Standard Timing Identification 7	01	00000001	
51	33	Standard Timing Identification 7	01	00000001	
52	34	Standard Timing Identification 8	01	00000001	
53	35	Standard Timing Identification 8	01	00000001	

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54	36	Pixel clock = 138.5MHz	1A	00011010	Detailed Timing Descriptor #1
55	37	1920 X 1080 @ 60Hz	36	00110110	
56	38	Horizontal Active = 1920 Pixels	80	10000000	
57	39	Horizontal Blanking = 160 Pixels	A0	10100000	
58	3A	Horizontal Active : Horizontal Blanking	70	01110000	
59	3B	Vertical Avtive = 1080 Lines	38	00111000	
60	3C	Vertical Blanking = 31 Lines	1F	00011111	
61	3D	Vertical Active : Vertical Blanking	40	01000000	
62	3E	Horizontal Sync. Offset = 48 Pixels	30	00110000	
63	3F	Horizontal Sync Pulse Width = 32 Pixels	20	00100000	
64	40	Vertical Sync. Offset :Vertical Sync Width (3line,5line)	35	00110101	
65	41	Horizontal, Vertical Sync Offset/Width upper 2bits	00	00000000	
66	42	Horizontal Image Size = 475㎜	DB	11011011	
67	43	Vertical Image Size = 267㎜	0B	00001011	
68	44	Horizontal & Vertical Image Size	11	00010001	
69	45	No Horizontal Border	00	00000000	
70	46	No Vertical Border	00	00000000	
71	47	Non-interlaced, Normal display, No stereo, Digital separate sync, H/V pol Negatives	1A	00011010	
72	48	Detailed Timing / Monitor	00	00000000	Detailed Timing Descriptor #2
73	49		00	00000000	
74	4A		00	00000000	
75	4B		01	00000001	
76	4C	Version	00	00000000	
77	4D	Apple edid signature	06	00000110	
78	4E	Apple edid signature	10	00010000	
79	4F	Link Type (LVDS, Dual Link, MSB)	30	00110000	
80	50	Pixel and link component format	11	00010001	
81	51	Panel features	00	00000000	
82	52		00	00000000	
83	53		00	00000000	
84	55		00	00000000	
85	55		00	00000000	
86	56		00	00000000	
87	57		00	00000000	
88	58		0A	00001010	
89	59		20	00100000	
90	5A	Detailed Timing / Monitor	00	00000000	Detailed Timing Descriptor #3 Ascii Data String: LM215WF3-SLA1
91	5B	Descriptor #3	00	00000000	
92	5C	LM215WF3-SLA1	00	00000000	
93	5D		FE	11111110	
94	5E		00	00000000	
95	5F	"L"	4C	01001100	
96	60	"M"	4D	01001101	
97	61	"2"	32	00110010	
98	62	"1"	31	00110001	
99	63	"5"	35	00110101	
100	64	"W"	57	01010111	
101	65	"F"	46	01000110	
102	66	"3"	33	00110011	
103	67	"-"	2D	00101101	
104	68	"S"	53	01010011	
105	69	"L"	4C	01001100	
106	6A	"A"	41	01000001	
107	6B	"1"	31	00110001	

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108	6C	Detailed Timing / Monitor	00	00000000	Detailed Timing Descriptor #4 Monitor Name : Color LCD
109	6D	Descriptor #4	00	00000000	
110	6E	Color LCD	00	00000000	
111	6F		FC	11111100	
112	70		00	00000000	
113	71	C	43	01000011	
114	72	o	6F	01101111	
115	73	l	6C	01101100	
116	74	o	6F	01101111	
117	75	r	72	01110010	
118	76		20	00100000	
119	77	L	4C	01001100	
120	78	c	43	01000011	
121	79	d	44	01000100	
122	7A		0A	00001010	
123	7B		20	00100000	
124	7C		20	00100000	
125	7D		20	00100000	
126	7E	Extension flag	00	00000000	Extension flag
127	7F	Checksum	**BA**	10111010	**Checksum**

10-2. EDID DATA READ/WRITE PROTOCOL

10-2-1. READ Operation

<Start><Slave Address, RW=0><Byte Address><Start><Slave Address, RW=1><Data><Stop>

10-2-2. WRITE Operation

<Start><Slave Address, RW=0><Byte Address><Data><Stop>

- Device Address (Slave Address)

Type	Device (Slave) Address								Hex
IS24C02B	1	0	1	0	0	0	0	RW	**0xA0 + RW**

- Byte Address

Byte Address	
Decimal	0 ~ 127
Hex	0x00 ~ 0x7F

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