Product Specification

SPECIFICATION
FOR
APPROVAL

(　) **Preliminary Specification**
(●) **Final Specification**

Title	30.0" WQXGA TFT LCD

BUYER	HP
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM300WQ5
SUFFIX	SDA1

*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
J.H PARK / G.Manager	_____

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J.H KIM / Manager [C]	_____
K.H MOON / Manager [M]	_____
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PREPARED BY

H.J PARK / Engineer	_____

MNT Products Engineering Dept.
LG Display Co., Ltd

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RECORD OF REVISIONS

Revision No	Data	Page	Description
Ver. 0.0	APR 24, 2009	-	Preliminary specification
Ver. 0.1	APR 30. 2009	16	Added the color gamut specification and expression "with ODC"
Ver. 0.2	MAY 06. 2009	4	Block Diagram change. (Not fixed)
		8	30pin connector pin map change. (22~29pin)
		9	Added page9 for 20pin power connector
Ver. 0.3	JUN 09. 2009	9	Changed 20 pin CNT pin map
		15	Updated power sequence
Ver. 0.4	JUN 17. 2009	4, 7	Updated Inverter Electrical Characteristics (CCFL)
		17	Changed DCR spec
		23, 24	Updated Mechanical Drawing (CCFL)
Ver. 0.5	AUG 27. 2009	8	Changed 30pin connector pin map (22~25pin)
		9	Changed 20pin connector pin map
		11	Changed Inverter 14pin connector pin map (11 pin)
		13	Added single mode timing table
		29	Added operating precaution 9-2 (10)
Ver. 0.6	OCT 27. 2009	4, 6	Updated electrical characteristics
		15	Changed color data reference
		20	Changed to gray response time table
		21	Changed Average RGB values table
Ver. 0.7	NOV 09. 2009	16	Changed T3 (1400ms)
		26	Reliability
Ver. 0.8	JAN 26. 2010	18	Changed GTG Spec.(5ms → 7ms)
		25	Changed rear side tape shape and quantity.
Ver. 1.0	MAR. 10. 2010	-	Final Specification

LM300WQ5
Liquid Crystal Display

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1. General Description

The LM300WQ5 LCD 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. This TFT-LCD has a 30.0 inch diagonally measured active display area with WQXGA resolution(2560 vertical by 1600 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 luminance of the sub-pixel color is determined with a 10-bit gray scale signal for each dot, thus, presenting a palette of more than 1,073,741,824 colors.

The LM300WQ5 has been designed to apply the DisplayPort^{TM} as the interface method to enables a simple and low-cost implementation in both the host and monitor.
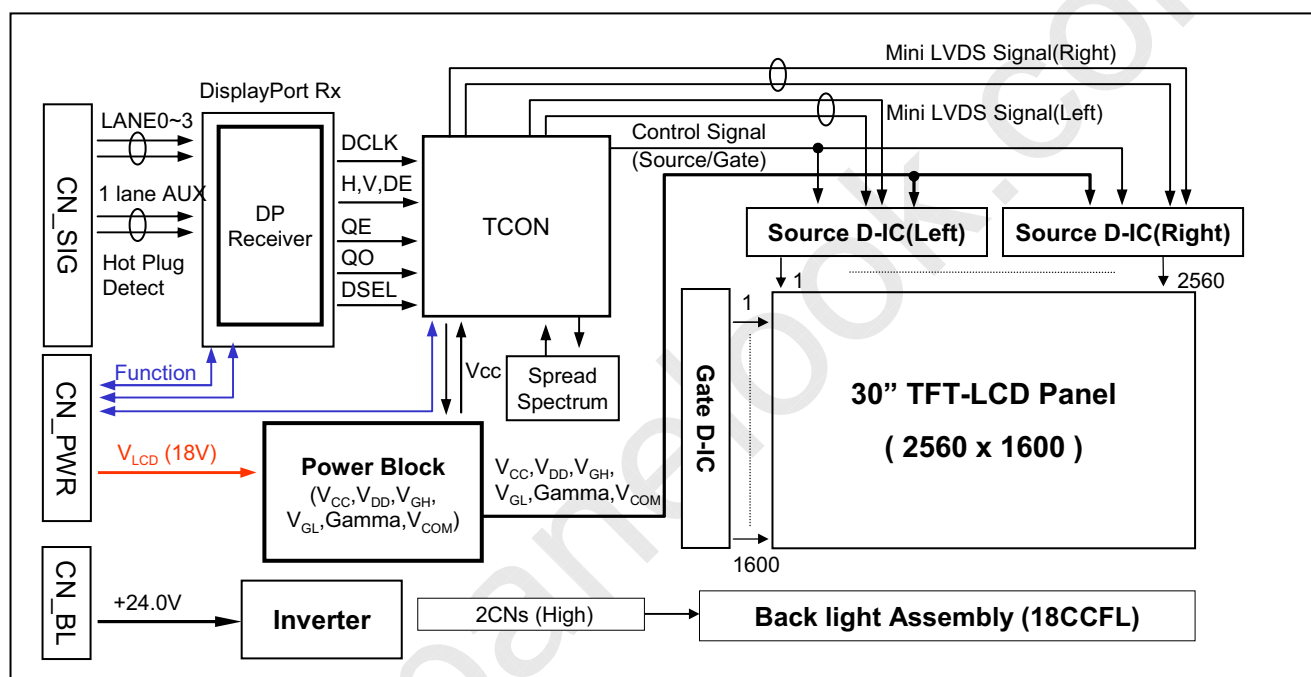

Figure 1. Block diagram

General Features

Active screen size	30.0 inches (756.228mm) diagonal
Outline Dimension	677.30(H) x 436.80(V) x 42.30(D) mm(Typ.)
Pixel Pitch	0.2505 mm x 0.2505 mm
Pixel Format	2560 horizontal By 1600 vertical Pixels. RGB stripe arrangement
Color Depth	10-bit, 1,073,741,824 color
Luminance, White	370 cd/m^2 (1 point Avg)
Viewing Angle(CR>10)	Viewing Angle Free(R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 123 Watt(Typ.), (15 Watt @V$_{LCD}$, 108W @370cd)
Weight	5100 g
Display Operating Mode	Transmissive mode, Normally Black
Surface Treatments	Hard coating (3H), Anti-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	Values		Units	Notes
		Min.	Max.		
Power Supply Input Voltage for Panel	V_{LCD}	-0.3	21.0	V_{dc}	At 25℃ ± 2℃
Operating Temperature	T_{OP}	0	50	℃	1
Storage Temperature	T_{ST}	-20	60	℃	
Operating Ambient Humidity	H_{OP}	10	90	%RH	
Storage Humidity	H_{ST}	10	90	%RH	

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

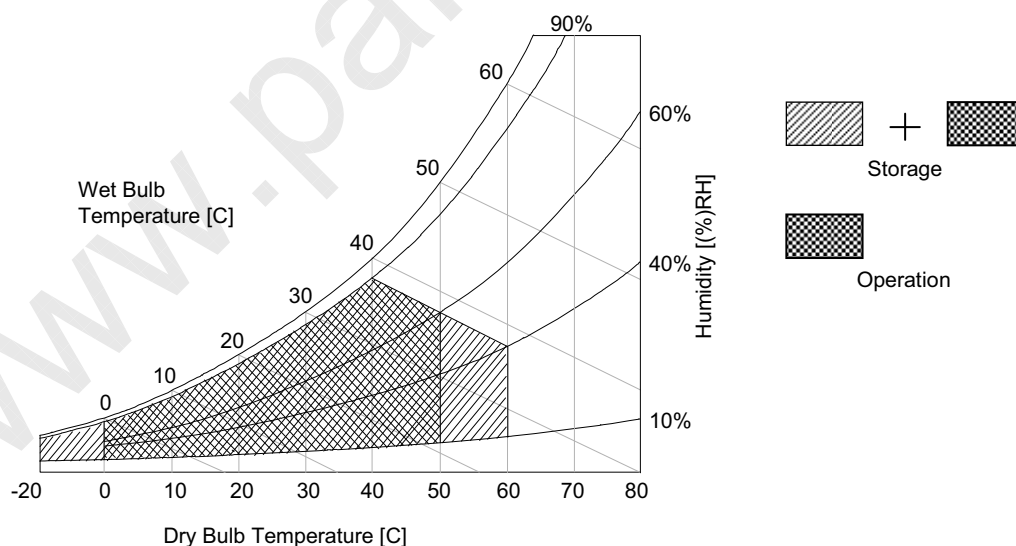Figure 2. Temperature and relative humidity

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3. Electrical Specifications

3-1. Electrical Characteristics

It requires three power inputs. One & two are employed to power the LCD electronics and to drive the TFT array and liquid crystal. The third input power for the CCFL, is typically generated by an inverter. The inverter is an external unit to the LCDs.
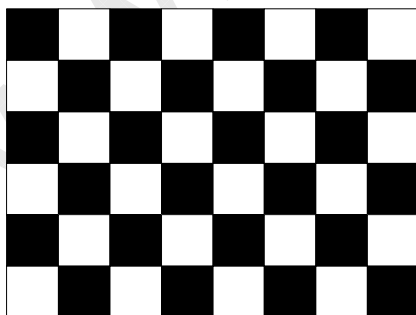
Table 2. Electrical Characteristics

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input Voltage	V_{LCD}	17	18	19	Vdc	
Permissive Power Input Ripple	V_{dRF}			400	mV_{p-p}	
Power Supply Input Current	I_{LCD}	700	830	960	mA	1
		-	1080	1400	mA	2
Power Consumption	P_{LCD}		15	17.3	Watt	1
Rush current	I_{RUSH}	-	-	4	A	3

Note :
1. The specified current and power consumption are under the V_{LCD}=18.0V, 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

Maximum current pattern

Mosaic Pattern(8 x 6)   White Pattern

[Figure 3] Mosaic pattern : for power consumption measurement

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Table 3. INVERTER Electrical Characteristics

Parameter	Symbol	Condition	Values			Unit	Notes
			Min.	Typ.	Max.		
Inverter :							
Input Voltage	V_{BL}		22	24	26	V	1
Input Current	I_{BL}	V_{BR} = 3.3V		4.5	5.4	A	2
Input Power	PBL	V_{BR} = 3.3V		108	130	Watt	2
B/L on/off control	VON/OFF	Lamp ON = High	2.0	-	5.0	V	
		Lamp OFF =Low	0.0	-	0.8	V	
Brightness Adj	VBR		0	-	3.3	V	
LAMP :							
Life time			40,000			Hrs	3

Notes :

1. The input voltage ripple is limited below 400mVp-p.

2. The specified current and power consumption are under the typical supply Input voltage, 24V.

3. The life is determined as the time at which luminance of the lamp is 50% compared to that of initial value at the typical lamp current on condition of continuous operating at $25 \pm 2°C$.

4. Electrical characteristics are determined after the unit has been 'ON' and stable for approximately 30min in a dark environment at 25 °C± 2°C.

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3-2. Interface Connections

This LCD employs three kinds of interface connections. A 30-pin connector is used for DisplayPort signals from the host computer. A 20-pin connector is used for LCD module power and LCM controls signal from external monitor control circuits. And 14-pin connector is used for the inverter for backlight system.

3-2-1. Signal Interface

The DisplayPort signal interface connector is KDF71G-30S-1H(500)(manufactured by Hirose) or equivalent. The pin configuration for the 30 pin connector is shown in the table below.

Table 4. 30Pin Connector pin configuration(For DisplayPort)

| Pin No.	Symbol	Description	Pin No.	Symbol	Description
1	Reserved	NC	16	Lane 3P	True Signal for Main Link 3
2	Reserved	NC	17	Lane 3N	Component Signal for Main Link 3
3	H_GND	High Speed Ground for Auxiliary Channel	18	H_GND	High Speed Ground
4	AUX_CH N	Component Signal for Auxiliary Channel	19	Reserved	LCD Vender use/No Connection
5	AUX_CH P	True Signal for Auxiliary Channel	20	Reserved	LCD Vender use/No Connection
6	H_GND	High Speed Ground for Main Link 0	21	HPD	Hot Plug Detect Signal
7	Lane 0P	True Signal for Main Link 0	22	H_GND	High Speed Ground
8	Lane 0N	Component Signal for Main Link 0	23	UART_RX	For DP RX Firmware update
9	H_GND	High Speed Ground for Main Link 1	24	UART_TX	For DP RX Firmware update
10	Lane 1P	True Signal for Main Link 1	25	H_GND	High Speed Ground
11	Lane 1N	Component Signal for Main Link 1	26	Reserve	NC
12	H_GND	High Speed Ground for Main Link 2	27	Reserve	NC
13	Lane 2P	True Signal for Main Link 2	28	Reserve	NC
14	Lane 2N	Component Signal for Main Link 2	29	Reserve	NC
15	H_GND	High Speed Ground for Main Link 3	30	Reserved	NC

Notes : 1. Interface Chips
                : gm68020 x 1ea (DisplayPort Receiver, GENESIS)
            2. Connector
                2.1 Connector(Receptacle) : KDF71G-30S-1H(500)(Hirose) or equivalent.
                2.2 Mating Connector(Plug) : FI-X30H and FI-X30HL or its equivalent.
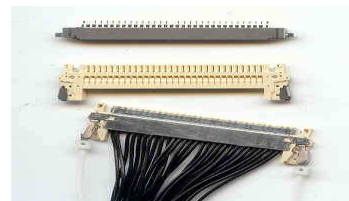
3-2-2. Power Connector

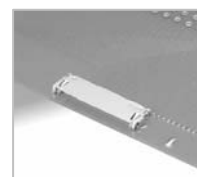The Power connector is DF19G-20P-1H(56) or equivalent.

The pin configuration for the 20 pin connector is shown in the table below.

Table 5. 20Pin Connector pin configuration (Power Connector)

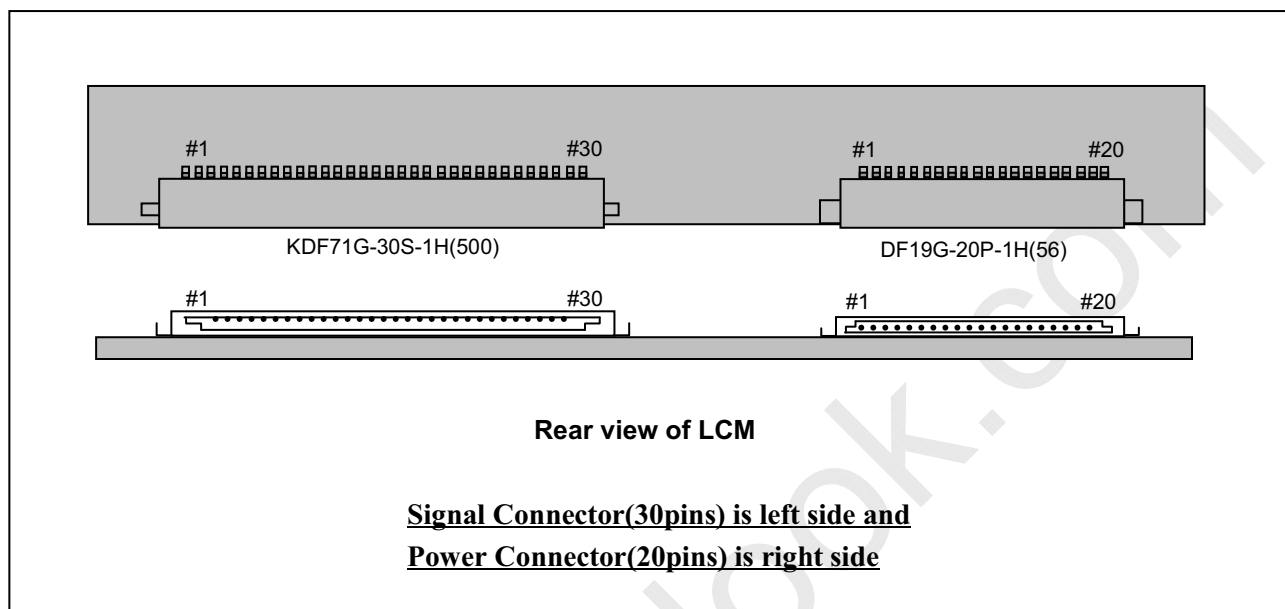| Pin No.	Symbol	I/O	Description	Notes
1	LCM_SDA	I/O	NC	
2	LCM_SCL	I	NC	
3	PWR_ON	I	LCM on signal input. (3.3V)	
4	GND		Ground	
5	DDC_SDA	I/O	NC	
6	DDC_SCL	O	NC	
7	AGP	I	Auto pattern generation. (High is enable, Low / NC is disable)	
8	GND		Ground	
9	HS_OUT	O	NC	
10	VS_OUT	O	NC	
11	PWM	O	PWM Signal output for synchronized Inverter	
12	GND		Ground	
13	DCR_BR	O	Brightness voltage output for DCR function.	
14	GND		Ground	
15	VLCD	I	LCD Power (18V)	
16	VLCD	I	LCD Power (18V)	
17	VLCD	I	LCD Power (18V)	
18	GND		Ground	
19	GND		Ground	
20	GND		Ground	

Notes : 1. Connector

1) Connector(Receptacle) : DF19G-20P-1H(56) or Equivalent.
2) Mating Connector(Plug) : DF19G-20S-1C or Equivalent.

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[Figure 4] Connector diagram

#1   #30   #1   #20

KDF71G-30S-1H(500)   DF19G-20P-1H(56)

#1   #30   #1   #20

Rear view of LCM

Signal Connector(30pins) is left side and
Power Connector(20pins) is right side

Notes:
1. All GND(ground) pins should be connected together and should also be connected to the LCD's metal frame.
2. All power input pins should be connected together.
3. All NC pins should be separated from other signal or power.

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3-2-3. Inverter Connector for Backlight

The inverter connector is S14B-PH-SM3-TB (manufactured by YeonHo) or equivalent
The pin configuration for the 14 pin connector is shown in the table below.

Table 5. 14Pin Connector Pin Configuration (Inverter Connector)

Pin	Symbol	Description	Notes
1	V_{BL}	Power Supply, +24V	
2	V_{BL}	Power Supply, +24V	
3	V_{BL}	Power Supply, +24V	
4	V_{BL}	Power Supply, +24V	
5	V_{BL}	Power Supply, +24V	
6	GND	Power Ground	
7	GND	Power Ground	
8	GND	Power Ground	
9	GND	Power Ground	
10	GND	Power Ground	
11	PWM	PWM Signal Input for Synchronized Inverter	
12	V_{ON}	BL On/Off Control signal	ON : 2.0V~5.0V OFF : 0.0~0.8V
13	V_{BR}	PWM Dimming Control Signal	Max3.3V/Min0.0V
14	NC	NC	

1. Connector
   1) Connector(Receptacle) : S14B-PHA-SM3-TB (YeonHo) or equivalent
   2) Mating Connector(Plug) : PHR14 or its equivalent
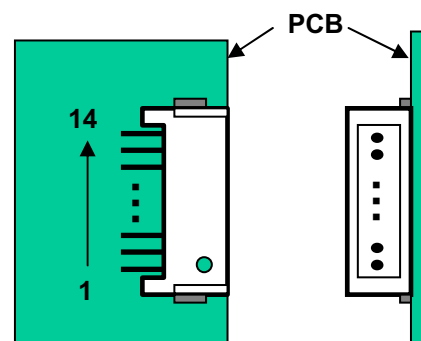
Rear view of LCM

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3-3. Signal Timing Specifications

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

Table 6. TIMING TABLE 1 (Resolution : 2560x1600)

ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	7.45	7.45	7.45	ns	Pixel Frequency : Typ 268.5㎒
	Frequency	f_{CLK}	(133.25)	134.25	(135.25)	MHz	
Hsync	Width-Total	t_{HT}	2720	2720	2720	t_{CLK}	
	Period	t_{HP}	10.13	10.13	10.13	us	
	Frequency	f_H	98.71	98.71	98.71	KHz	
	Width	t_{WH}	32	32	32	t_{CLK}	
Vsync	Width-Total	t_{VT}	1646	1646	1646	t_{HP}	
	Period	t_{VP}	16.68	16.68	16.68		
	Frequency	f_V	59.97	59.97	59.97	Hz	
	Width	t_{WV}	6	6	6	t_{HP}	
Data Enable	Horizontal Valid	t_{HV}	2560	2560	2560	t_{CLK}	
	Horizontal Back Porch	t_{HBP}	80	80	80		
	Horizontal Front Porch	t_{HFP}	48	48	48		
	Horizontal Blank	-	160	160	160		$t_{WH}+ t_{HBP}+ t_{HFP}$
	Vertical Valid	t_{VV}	1600	1600	1600	t_{HP}	
	Vertical Back Porch	t_{VBP}	38	38	38		
	Vertical Front Porch	t_{VFP}	2	2	2		
	Vertical Blank	-	46	46	46		$t_{WV}+ t_{VBP}+ t_{VFP}$

Note: 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 of character number(8).
4. The polarity of Hsync, Vsync is not restricted.

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Table 8. TIMING TABLE 2 (Single mode: 1280x800)

PS ON : Low

ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	14.08	14.08	14.08	ns	
	Frequency	f_{CLK}	71.00	71.00	71.00	MHz	Single
Hsync	Width-Total	t_{HP}	1440	1440	1440	t_{CLK}	
	Period	t_{HP}	20.28	20.28	20.28	us	
	Frequency	f_H	49.31	49.31	49.31	KHz	
	Width	t_{WH}	32	32	32	t_{CLK}	
Vsync	Width-Total	t_{VT}	823	823	823	t_{HP}	
	Period	t_{VP}	16.69	16.69	16.69	ms	
	Frequency	f_V	59.91	59.91	59.91	Hz	
	Width	t_{WV}	6	6	6	t_{HP}	
Data Enable	Horizontal Valid	t_{HV}	1280	1280	1280	t_{CLK}	
	Horizontal Back Porch	t_{HBP}	80	80	80		
	Horizontal Front Porch	t_{HFP}	48	48	48		
	Horizontal Blank	-	160	160	160		$t_{WH}+ t_{HBP}+ t_{HFP}$
	Vertical Valid	t_{VV}	800	800	800	t_{HP}	
	Vertical Back Porch	t_{VBP}	15	15	15		
	Vertical Front Porch	t_{VFP}	2	2	2		
	Vertical Blank	-	23	23	23		$t_{WV}+ t_{VBP}+ t_{VFP}$

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.,Vsync and DE(data enable) signals should be used.

1. The performance of the electro-optical characteristics are may be influenced by variance of the vertical refresh rates.
2. Vsync, Hsync should be keep the above specification.
3. Hsync Period should be a double number of character (8).
4. The polarity of Hsync, Vsync is not restricted.

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3-4. Signal Timing Waveforms

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3-5. Color Input Data Reference

The brightness of each primary color (red,green and blue) is based on the 10-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 MSB　　　　　　　　　　LSB R9 R8 R7 R6 R5 R4 R3 R2 R1 R0	GREEN MSB　　　　　　　　　　LSB G9 G8 G7 G6 G5 G4 G3 G2 G1 G0	BLUE MSB　　　　　　　　　　LSB B9 B8 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 0 0 0 0 0 0
	Red (1023)	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	Green (1023)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0
	Blue (1023)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1
	Cyan	0 0 0 0 0 0 0 0 0 0	1 1 1 1 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 1 1	0 0 0 0 0 0 0 0 0 0	1 1 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 1 1 1 1	0 0 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 1 1 1 1 1 1
RED	RED (000)	0 0 0 0 0 0 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 0 0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	. . .	. . .	. . .	. . .
	RED (1022)	1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	RED (1023)	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
GREEN	GREEN (000)	0 0 0 0 0 0 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 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0
	. . .	. . .	. . .	. . .
	GREEN (1022)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0
	GREEN (1023)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0
BLUE	BLUE (000)	0 0 0 0 0 0 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 0 0 0 0 0 0 1
	. . .	. . .	. . .	. . .
	BLUE (1022)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 0
	BLUE (1023)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1

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3-6. Power Sequence for Panel
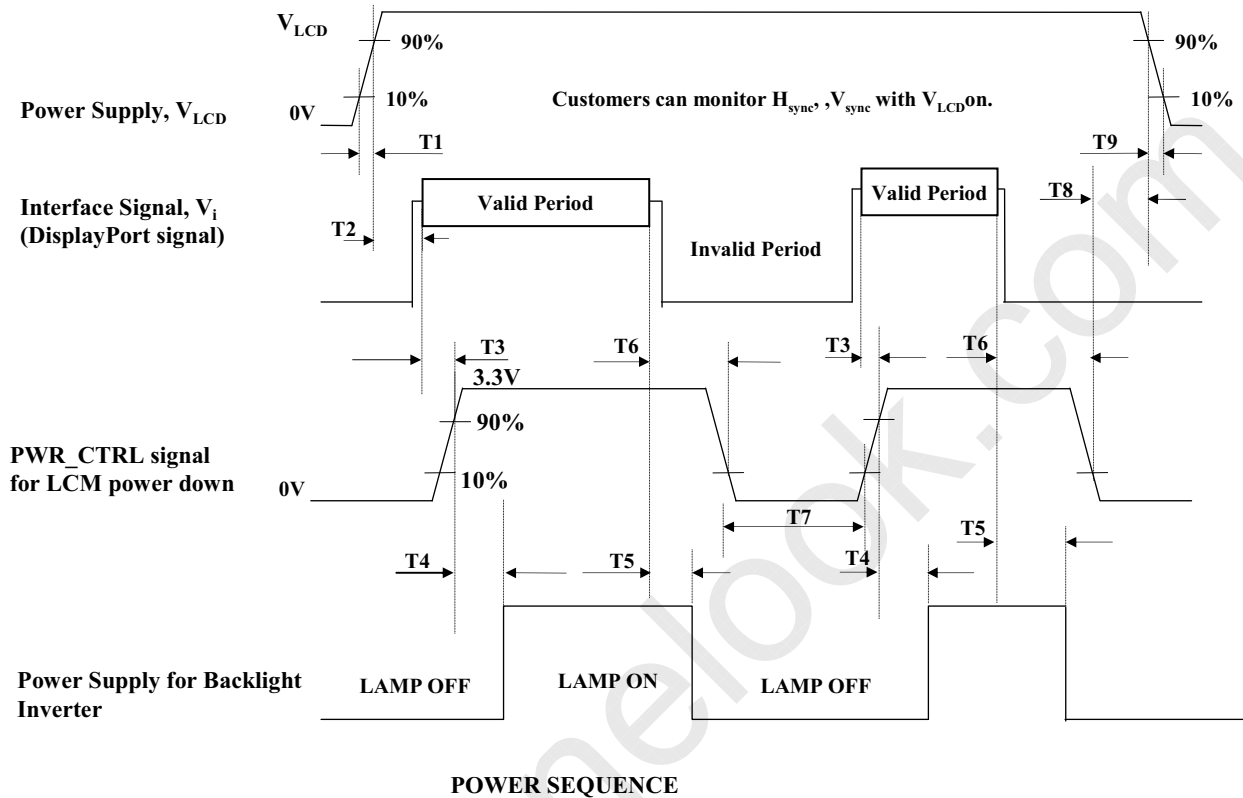
POWER SEQUENCE

Table 8. Power Sequence

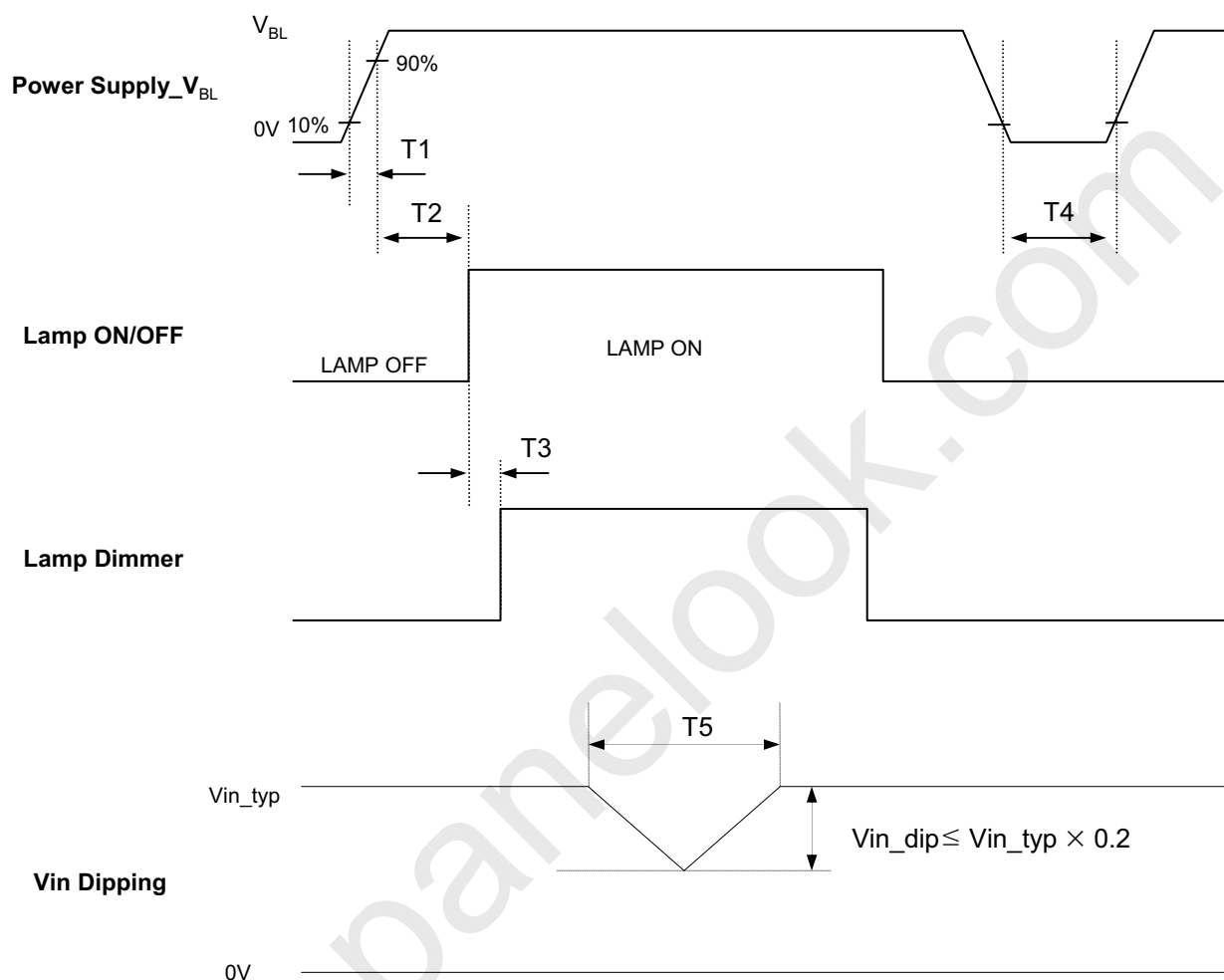| Parameter	Values			Units
	Min.	Typ.	Max.	
T1	-		30	ms
T2	-	-	-	ms
T3	1400		-	ms
T4	100		-	ms
T5	-		80	ms
T6	-		80	ms
T7	400		-	ms
T8	50		-	ms
T9	-		10	ms

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 and interface signal are valid.

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3-7. Power Sequence for Inverter

Table 9. Power Sequence

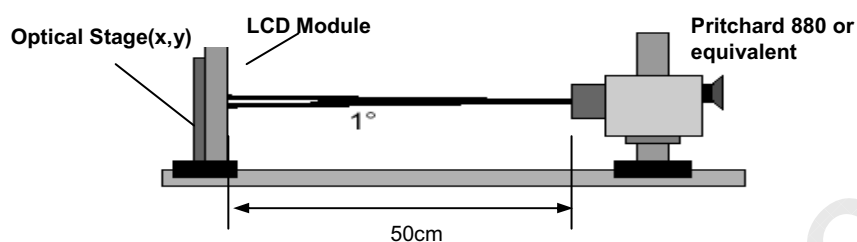| Parameter	Values			Units	Notes
	Min.	Typ.	Max.		
T1	10	-	-	ms	
T2	200	-	-	ms	
T3	-	-	50	ms	
T4	500	-	-	ms	
T5	-	-	10	ms	

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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 °C.   The values specified are measured at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 °.
 Figure. 5 presents additional information concerning the measurement equipment and method.

[Figure 5] Optical characteristic measurement equipment and method

Table 10. Optical characteristics   (Ta=25±2°C, V_{LCD}=18V, f_V=60Hz, CLK=134.25MHz)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000			1
		DCR	2100	3000			
Surface Luminance, white		L_{WH}	300	370		cd/m^2	2
Luminance Variation		δ_{WHITE}	75	-	-	%	3
Luminance Uniformity (angular dependant)			-	-	1.7	TCO '99	
Response Time	Rise Time	Tr_R	-	6	12	ms	4
	Decay Time	Tr_D	-	6	12	ms	4
	Gray To Gray (with ODC)	T_{GTG_AVR}	-	7	-	ms	5
		T_{GTG_MAX}	-	17	-	ms	5
Color Coordinates [CIE1931]	RED	Rx	Typ -0.03	0.678	Typ +0.03		
		Ry		0.309			
	GREEN	Gx		0.210			
		Gy		0.692			
	BLUE	Bx		0.146			
		By		0.055			
	WHITE	Wx		0.313			
		Wy		0.329			
Color shift	Horizontal	θ_{CST_H}	-	176	-	degree	6
	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
Color Gamut [CIE1976]		CG		117.5			

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

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

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 6.

$$L_{WH} = L_{on1}$$

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

$$\delta_{WHITE} = \frac{\text{Minimum}(L_{on1}, L_{on2}, \ldots L_{on9})}{\text{Maximum}(L_{on1}, L_{on2}, \ldots L_{on9})} \times 100(\%)$$

Measuring point for surface luminance & measuring point for luminance variation
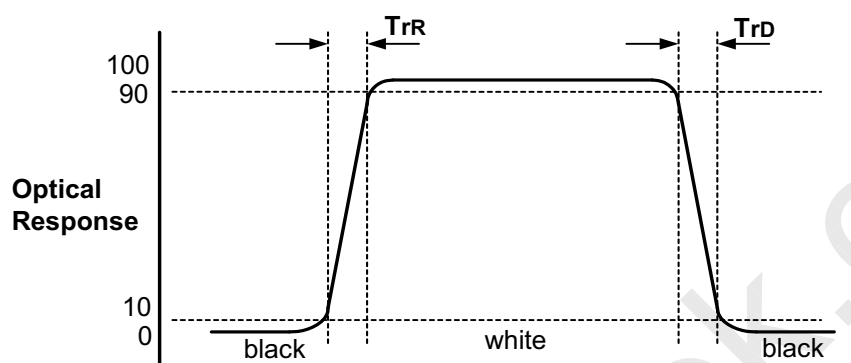

A : H/4 mm
B : V/4 mm
@ H,V : Active Area
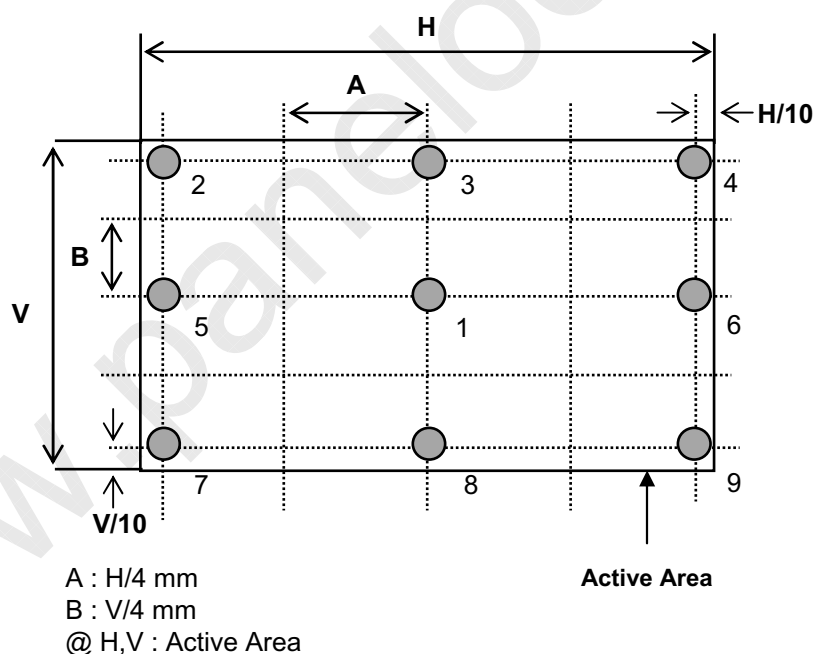
[Figure 6] **Measure Point for Luminance**

Product Specification

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}).

[Figure 7] **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				
		G1023	G767	G511	G255	G0
Falling Time	G1023					
	G767					
	G511					
	G255					
	G0					

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

- Color difference($\triangle$ u'v')
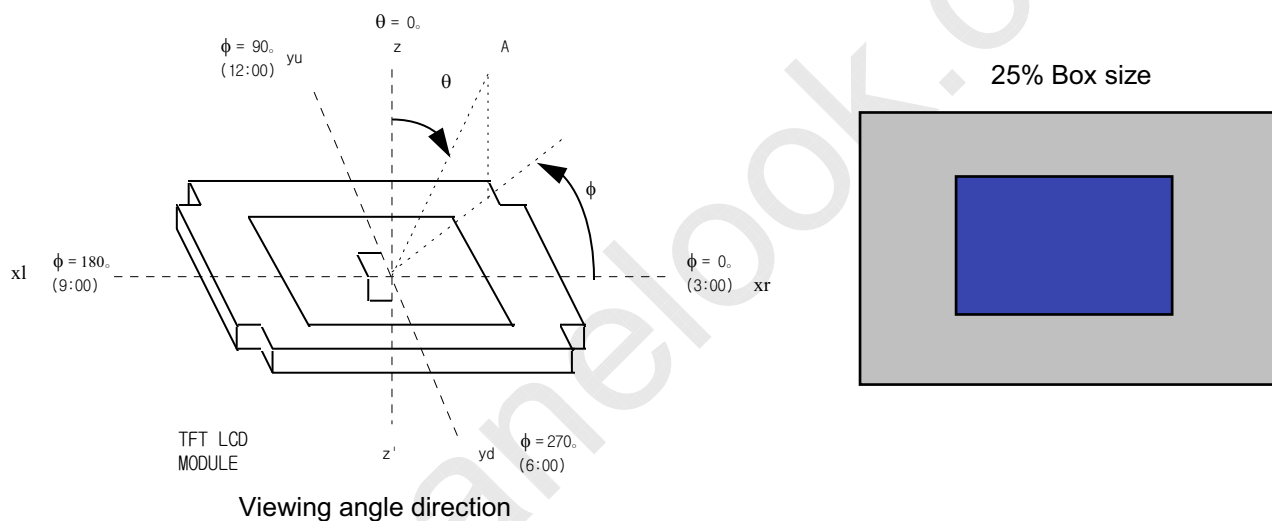
$$u'= \frac{4x}{-2x + 12y + 3} \qquad v'= \frac{9y}{-2x + 12y +3}$$

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

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

25% Box size

Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	395	827	343	311	519	459
G	227	571	451	411	475	799
B	183	495	647	187	743	715
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	879	227	847	307	643	923
G	419	279	271	159	775	651
B	99	699	351	347	235	119
	Blue	Green	Red	Yellow	Magenta	cyan
R	107	291	791	967	831	143
G	131	595	111	851	251	507
B	583	263	151	147	607	691
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	black
R	963	827	623	443	255	91
G	963	827	623	443	255	91
B	963	827	623	443	255	91

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7. **General viewing angle** 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.
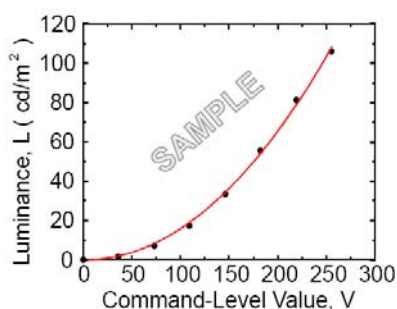

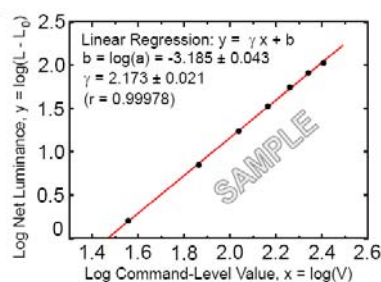Fig. 1. Sample Luminance vs. gray scale (using a 256 bit gray scale).

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

9. Gray scale specification

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

Table 11. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.3
127	1.2
255	4.68
383	11.7
511	21.2
639	35.2
767	53.0
895	75.4
1023	100

Product Specification

5. Mechanical Characteristics

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

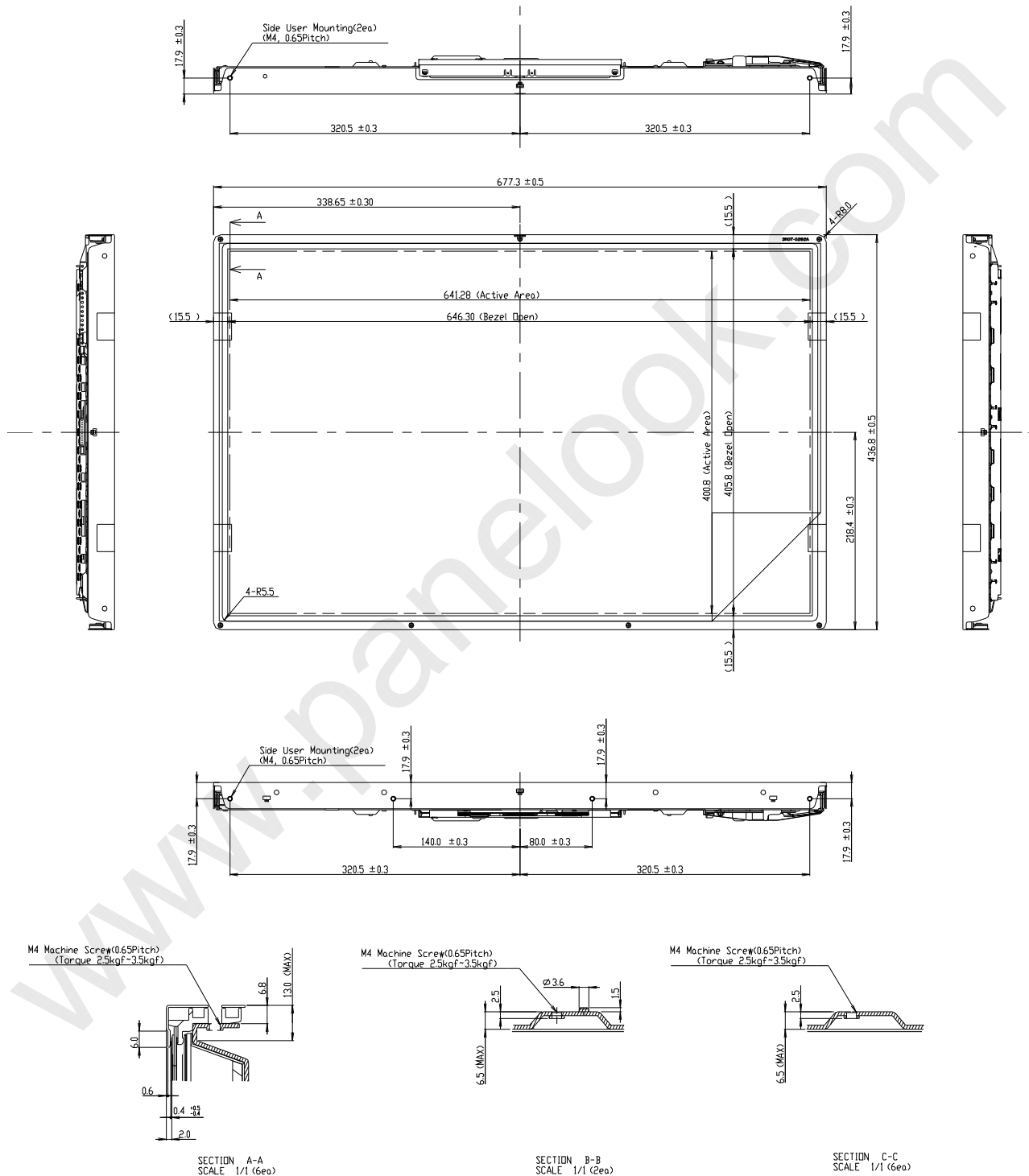### Table 12. Mechanical characteristics

Outline Dimension	Horizontal	677.30 mm
	Vertical	436.80 mm
	Depth	42.30 mm
Bezel Area	Horizontal	646.30 mm
	Vertical	405.80 mm
Active Display Area	Horizontal	641.28 mm
	Vertical	400.8 mm
Weight	5100g (Typ.), 5400g (Max.)	
Surface Treatment	Hard coating(3H) Anti-glare(13%) treatment of the front polarizer	

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

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Product Specification

<FRONT VIEW>

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Product Specification

<REAR VIEW>

Notes
1. Unspecified tolerances are to be ±0.5mm.
2. Both backlight wires and contraction tubes are excluded from outline dimensions.
3. Tilt and partial disposition tolerance of display area are as following.
   (1) Y-direction : |A-B| ≤ 1.4mm
   (2) X-direction : |A-B| ≤ 1.4mm

4. User Connector Specification : KDF71G-30S-1H
5. Power Connector Specification : DF19G-20P-1H

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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	Altitude 　　　operating 　　　storage / shipment	0 - 16,400 feet(5000m) 0 - 40,000 feet(12,192m)

Product Specification

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)

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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 : 5 pcs

b) Box size : 756mm X 343mm X 515mm

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9. Precautions

Please pay attention to the following when you use this TFT LCD module.

9-1. Mounting Precautions

(1) You must mount a module using holes (refer 23~24 page)
(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 a 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 describe 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 determined 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$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 metal foreign material and deal LCM a fatal blow)
(9) Please do not set LCD on its edge.
(10) When LCMs are used for public display defects such as Yogure, image sticking can not be guarantee.

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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 or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.