SPECIFICATION
FOR
APPROVAL

(●) Preliminary Specification
( ) Final Specification

Title	27.0” QHD TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM270WQ1
SUFFIX	SDFJ

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

APPROVED BY	SIGNATURE / DATE
/	
/	
/	

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

APPROVED BY	SIGNATURE / DATE
S Y Park / G.Manager	
REVIEWED BY	
S J So / Manager	
PREPARED BY	
S R Yoo / Engineer	

MNT Products Engineering Dept.
LG Display Co., Ltd.

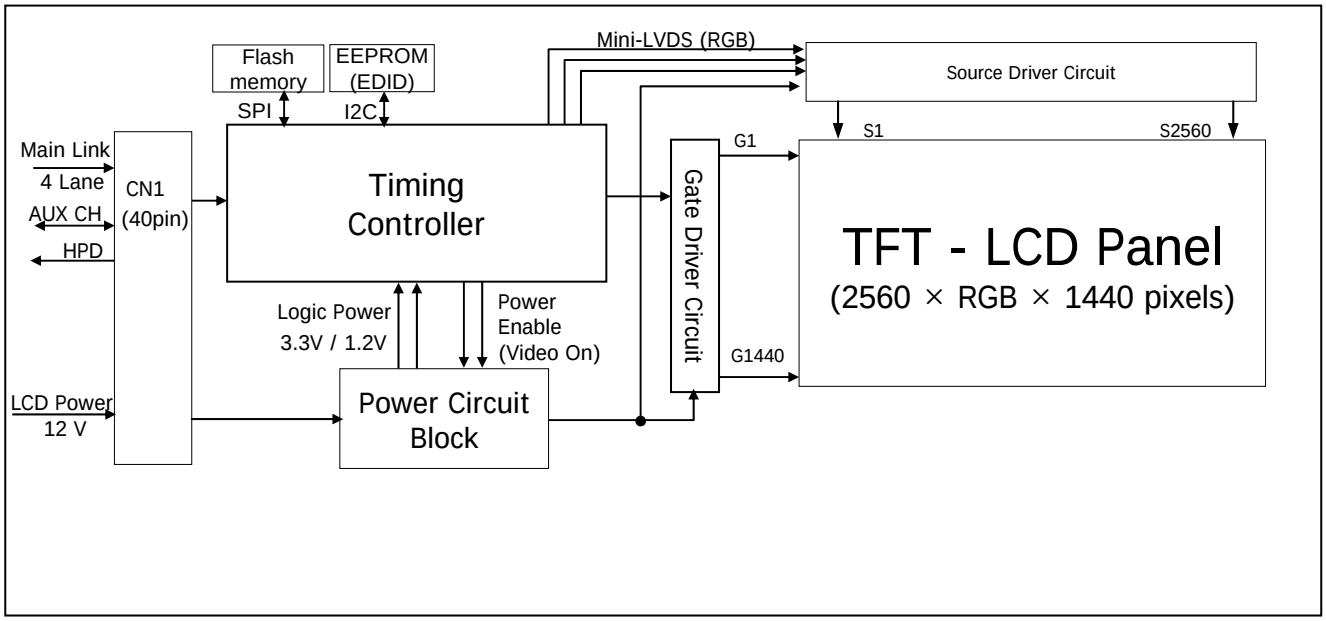
Contents

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.0	Dec. 17. 2012	-	First Draft (Preliminary)

1. General Description

LM270WQ1 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 black mode. It has a 27inch diagonally measured active display area with QHD resolution (2560 vertical by 1440 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 10-bit gray scale signal for each dot, thus, presenting a palette of more than 1.07B colors with FRC (Frame Rate Control).
It has been designed to apply the 10-bit 4Lane Display port interface.
It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



General Features

Active Screen Size	27.0 inches(68.47cm) diagonal
Outline Dimension (W/O COF)	609.44(H) x 350.46(V) x 1.75(D) mm(Typ.)
Pixel Pitch	0.2331 mm x 0.2331 mm
Pixel Format	2560 horiz. By 1440 vert. Pixels RGB stripes arrangement
Color Depth	8-bit, 16,777,216 colors
Luminance, White	440 cd/m^2 (Center 1 point, Typ.)
Viewing Angle (CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	22.62 Watt @V_{LCD}
Weight	920g (typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Glare (Low Reflection treatment of the front polarizer)
HDCP	HDCP key implemented in Tcon (DP628)

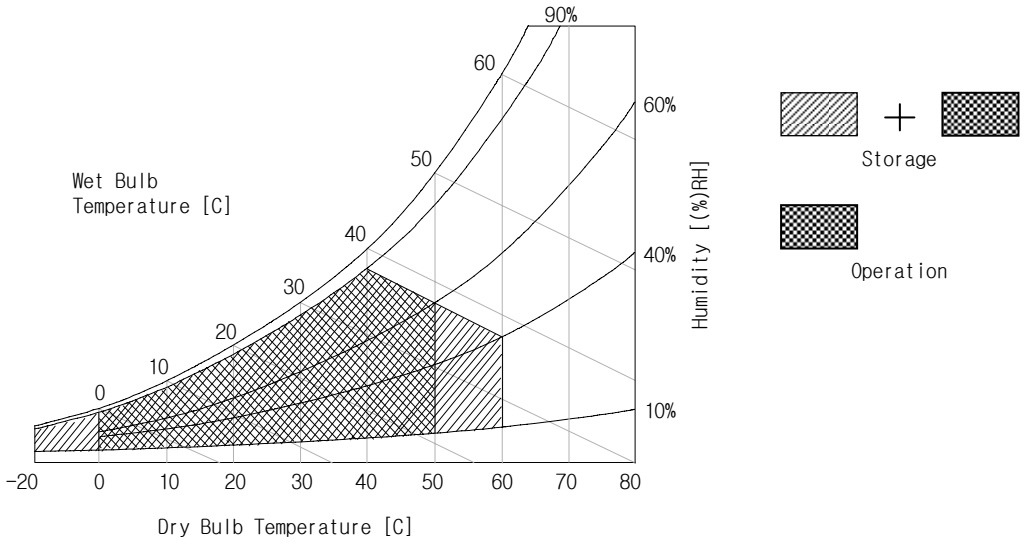
2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Input Voltage	VLCD	-0.3	14	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.
2. Storage condition is guaranteed under packing condition (with Al-Bag).



3. Electrical Specifications

3-1. Electrical Characteristics

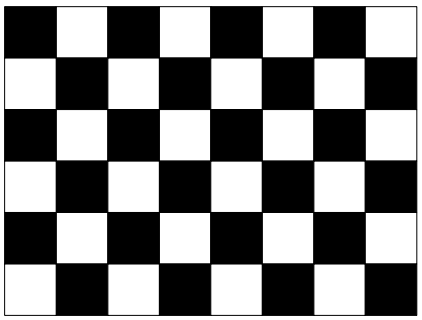
It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the DP Rx.

Table 2-1-1. ELECTRICAL CHARACTERISTICS (Normal Mode)

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
MODULE :						
Power Supply Input voltage	VLCD	11.6	12.0	12.4	Vdc	
Permissive Power Input Ripple	VdRF	-		400	mVp-p	
Power Supply Input Current	ILCD	-	900	1170	mA	1
		-	1450	1885	mA	2
Power Consumption	PLCD	-	10.80	14.04	Watt	1
			17.40	22.62	Watt	2
Rush Current	IRUSH_VLCD	-	-	3.0	A	3

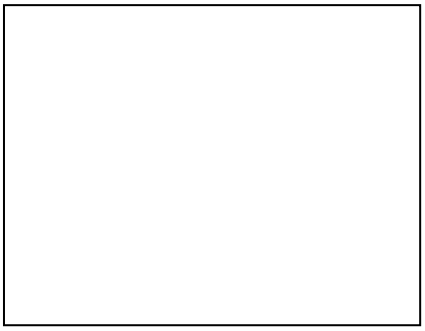
Note :
1. The specified current and power consumption are under the V_{LCD}=12.0V, 25 ± 2°C,f_V=60Hz condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
2. The current is specified at the maximum current pattern.
3. The duration of rush current is about 2ms and rising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

White : 255Gray
Black : 0Gray



Mosaic Pattern(8 x 6)

Maximum current pattern



White Pattern

3-2. Interface Connections

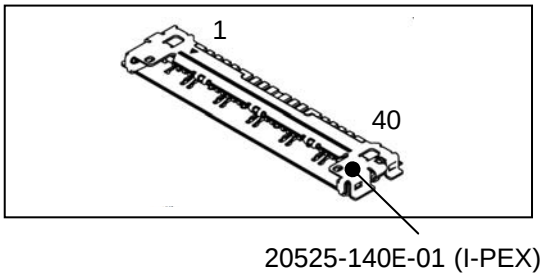
3-2-1. LCD Module

- LCD Connector(CN1) : 20525-140E-01 (manufactured by I-PEX)
  The pin configuration for the 40 pin connector is shown in the table below.

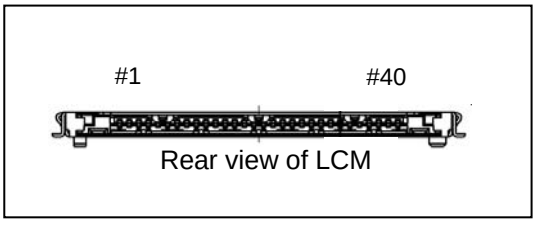
Table 3-1. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No.	Symbol	Description	No.	Symbol	Description
1	VIN	12V for LCM main power	21	HPD	Hot Plug Detect Signal
2	VIN	12V for LCM main power	22	GND	High Speed Ground for Auxiliary Channel
3	VIN	12V for LCM main power	23	AUX_CHN	Component Signal for Auxiliary
4	VIN	12V for LCM main power	24	AUX_CHP	True Signal for Auxiliary Channel
5	VIN	12V for LCM main power	25	GND	High Speed Ground for Main Link 0
6	VIN	12V for LCM main power	26	Lane0P	True Signal for Main Link 0
7	GND	Ground	27	Lane0N	Components Signal for Main Link 0
8	GND	Ground	28	GND	High Speed Ground for Main Link 1
9	GND	Ground	29	Lane1P	True Signal for Main Link 1
10	GND	Ground	30	Lane1N	Components Signal for Main Link 1
11	GND	Ground	31	GND	High Speed Ground for Main Link 2
12	GND	Ground	32	Lane2P	True Signal for Main Link 2
13	GND	Ground	33	Lane2N	Components Signal for Main Link 2
14	DDC_SDA	DDC Data	34	GND	High Speed Ground for Main Link 3
15	DDC_SCL	DDC Clock	35	Lane3P	True Signal for Main Link 3
16	GND	Ground	36	Lane3N	Components Signal for Main Link 3
17	I2C_SDA	I2C Data	37	GND	High Speed Ground
18	I2C_SCL	I2C Clock	38	VIDEO_ON	Video status from DP Rx
19	GND	Ground	39	VSYNC	Vertical sync output from DP Rx
20	SPDIF	Audio output from DP Rx	40	GND	Ground

Notes : 1. Connector
2.1 Connector (Receptacle) : 20525-140E-01(I-PEX)
2.2 Mating Connector (Plug) : TBD(I-PEX)



20525-140E-01 (I-PEX)



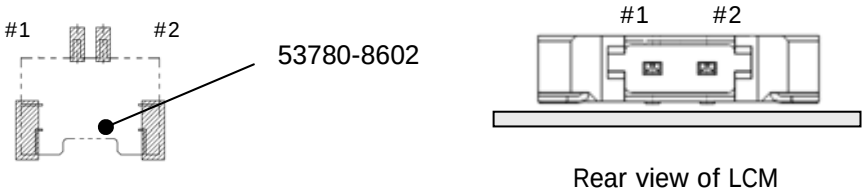
3-2. Interface Connections

3-2-2. Sync Connector

This connector is used for synchronized LED Driver.
The connector is 53780-8602. (Manufactured by MOLEX)

Table 4. LED SYNCHRONIZED CONNECTOR(CN2) PIN CONFIGURATION

Pin	Symbol	Description	NOTES
1	DXP	Positive connection to remote temp. sensor	
2	DXN	Negative connection to remote temp. sensor	



[Figure 3-1] Thermal Sensor Connector diagram

3-3. Signal Timing Specifications

All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

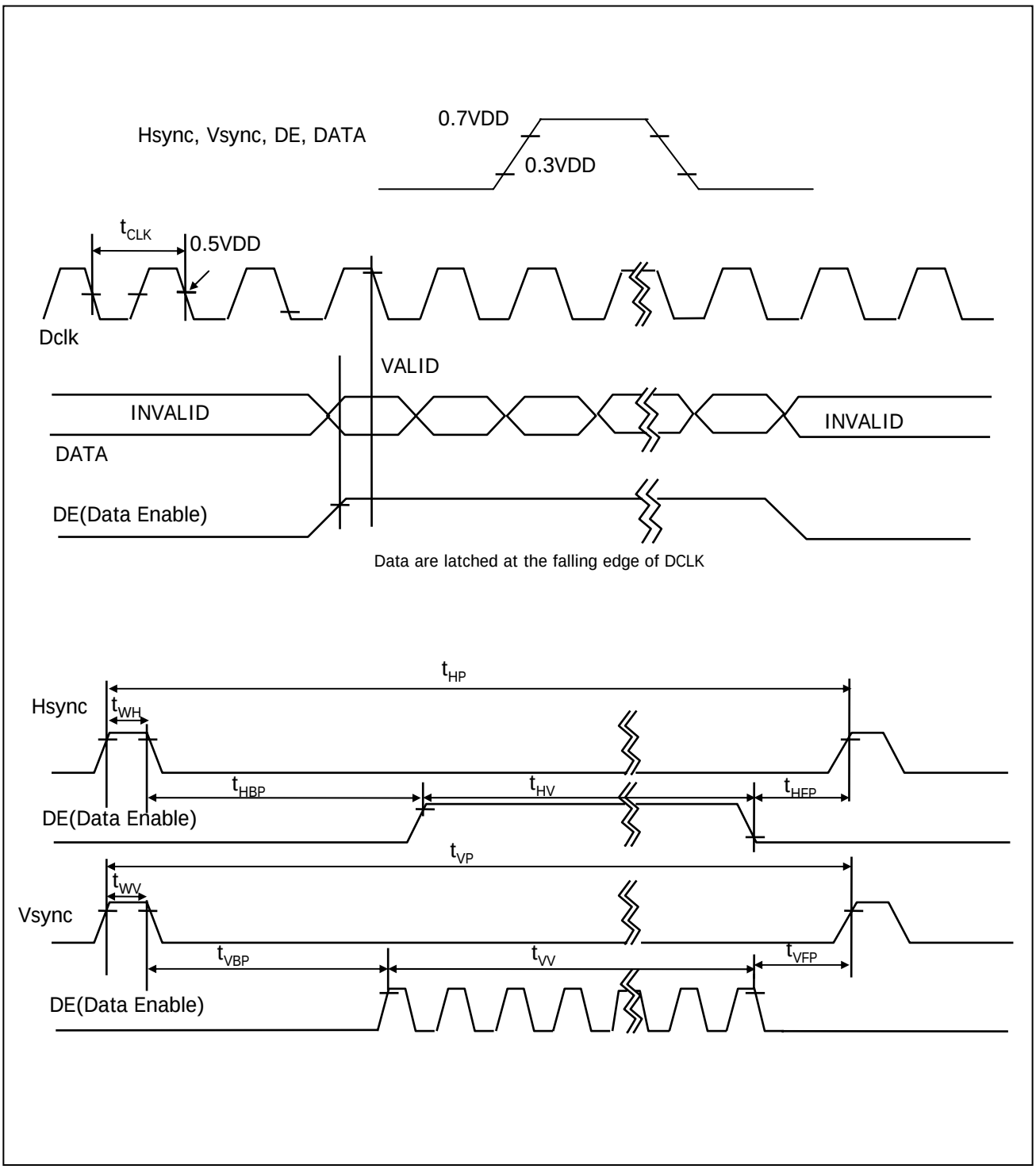
Table 6_1. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

ITEM		SYMBOL	Min	Typ	Max	Unit	Note
DCLK	Period	t_{CLK}	4.14	4.14	4.14	ns	
	Frequency	f_{CLK}	241.5	241.5	241.5	MHz	-
Hsync	Period	t_{HP}	2720	2720	2720	t_{CLK}	
	Width-Active	t_{WH}	32	32	32		
Vsync	Period	t_{VP}	1481	1481	1481	t_{HP}	
	Frequency	f_V	59.95	59.95	59.95	Hz	
	Width-Active	t_{WV}	5	5	5	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}	1440	1440	1440	t_{HP}	
	Vertical Back Porch	t_{VBP}	33	33	33		
	Vertical Front Porch	t_{VFP}	3	3	3		
	Vertical Blank	-	41	41	41		$t_{WV}+ t_{VBP}+ t_{VFP}$

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, Vsync, 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.

3-4. Signal Timing Waveforms



3-5. Color Data Reference

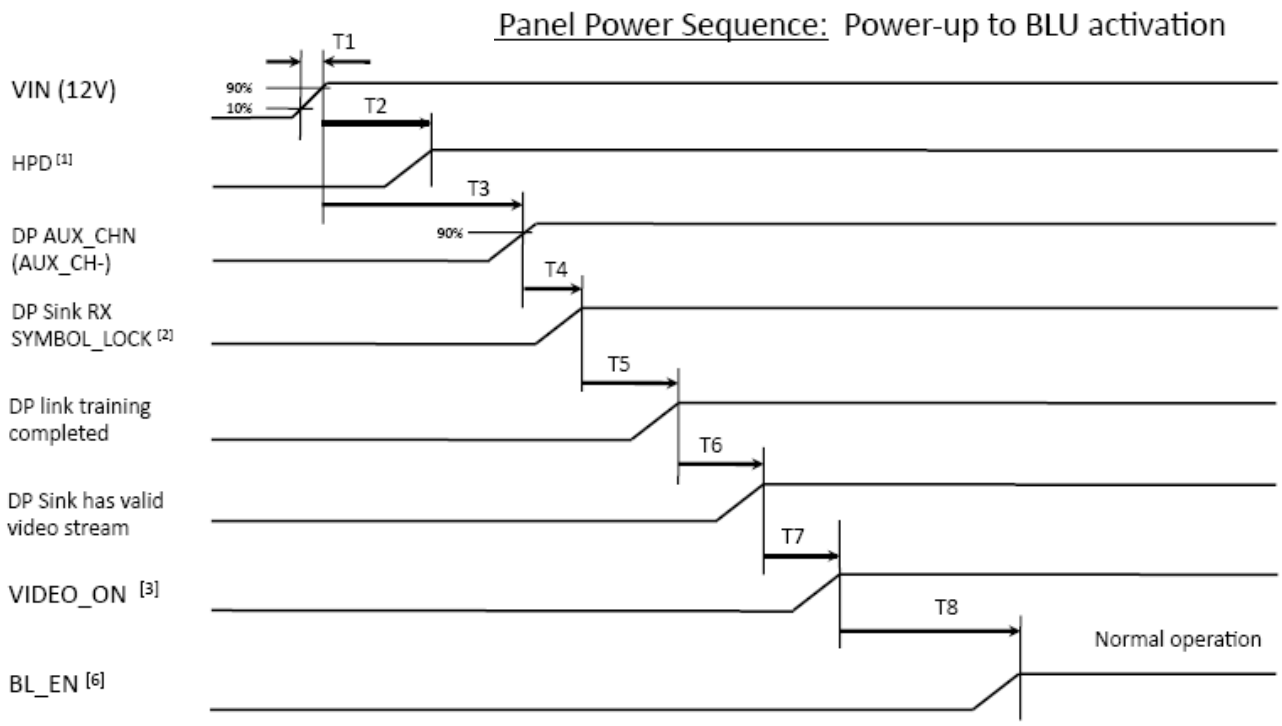
The Brightness of each primary color(red,green,blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color. The table below provides a reference for color versus data input.

Table 7. COLOR DATA REFERENCE

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

3-6. Power Sequence

3-6-1. Power Sequence



Parameter	Min	Max	Units
T1	**0.4**	10	ms
T2	0	-	ms
T3	-	-	ms
T4	0	-	ms
T5	0	-	ms

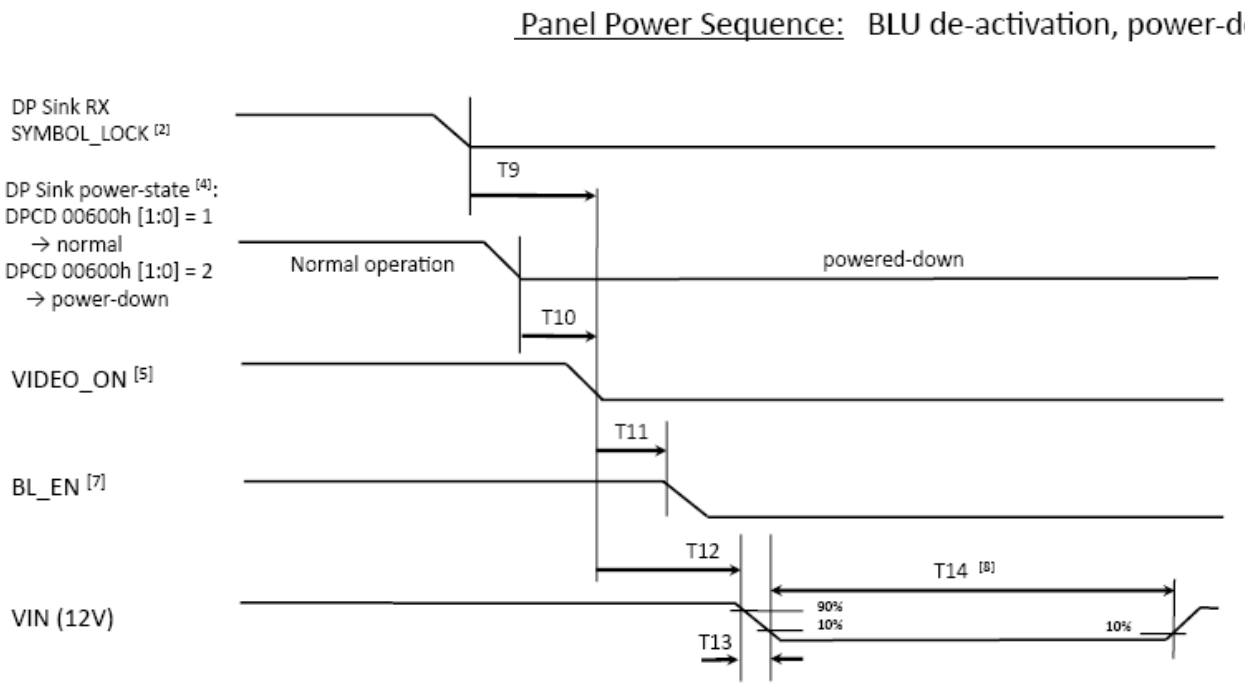
Parameter	Min	Max	Units
T6	0	-	ms
T7	0	200	ms
T8	**500**	-	ms

Notes : [1] HPD is asserted high by Sink at power-up
[2] SYMBOL_LOCK indicated by contents of Sink DPCD registers 00202h to 00205h
[3] VIDEO_ON asserted high by Sink when video to panel is valid
[6] BL_EN is an active-high MLB enable signal for panel BLU

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

3-6. Power Sequence

3-6-1. Power Sequence



Parameter	Min	Max	Units
T9	0	10	ms
T10	0	5	ms
T11	-	10	ms
T12	0	-	ms
T13	0.01	1000	ms
T14	250	-	ms

Notes : [2] SYMBOL_LOCK indicated by contents of Sink DPCD registers 00202h to 00205h
[4] Power-state set by Source in Sink DPCD register 00600h
[5] VIDEO_ON asserted low by Sink because of :
1) loss of SYMBOL_LOCK or
2) DP Sink is powered down
[7] BL_EN must be asserted low by system as rapidly as possible when video is invalid to avoid visible artifacts
[8] T14 defines minimum off-time for 12V power
[9] min. times of 0 indicate precedence ordering of events, e.g. where actual timing is TBD

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at 25±2°C. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0 ° and aperture 1 degree.

FIG. 1 presents additional information concerning the measurement equipment and method.

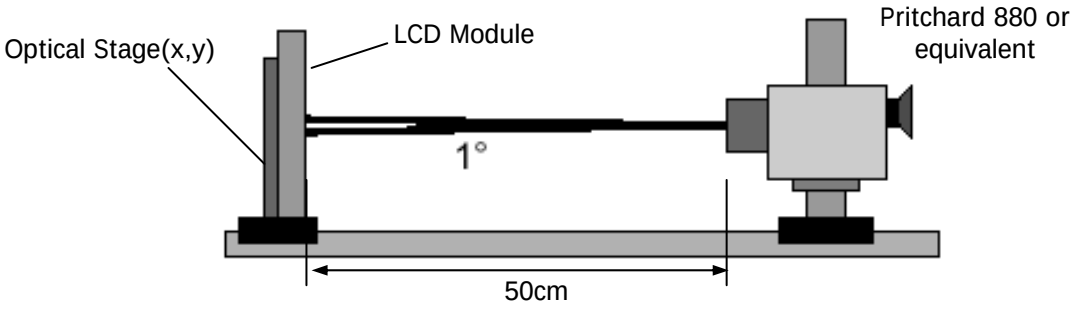


FIG. 1 Optical Characteristic Measurement Equipment and Method

Table 9. OPTICAL CHARACTERISTICS (Ta=25 °C, V_{LCD}=12.0V, f_V=60Hz Dclk=242.28MHz)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WH}	TBD	TBD	-	cd/m^2	2
Luminance Variation		δ_{WHITE}	TBD			%	3
Response Time	Rise Time	Tr_R	-	6.5	14	ms	4.1
	Decay Time	Tr_D	-	7.5	14	ms	4.1
Color Coordinates [CIE1931]	RED	Rx	Typ TBD	TBD	Typ TBD		
		Ry		TBD			
	GREEN	Gx		TBD			
		Gy		TBD			
	BLUE	Bx		TBD			
		By		TBD			
	WHITE	Wx		TBD			
		Wy		TBD			
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

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 No.1 point across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG 2.

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

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

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations.
For more information see FIG 2.

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 shift is the angle at which the color difference is lower than 0.04.
For more information see FIG 4.
- 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 5.

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 6 and FIG 7.

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

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

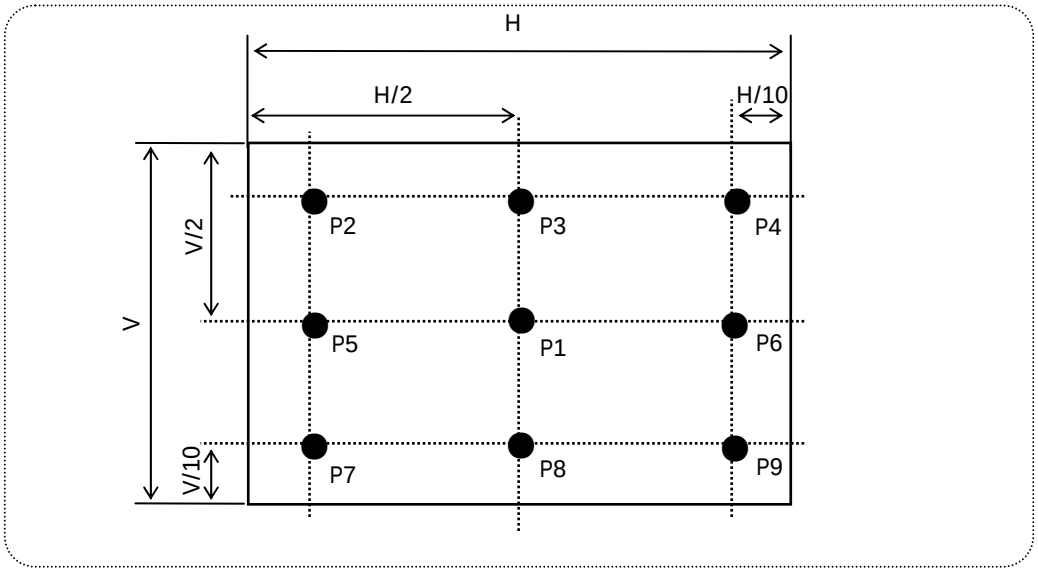


FIG. 2 Measure Point for Luminance

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

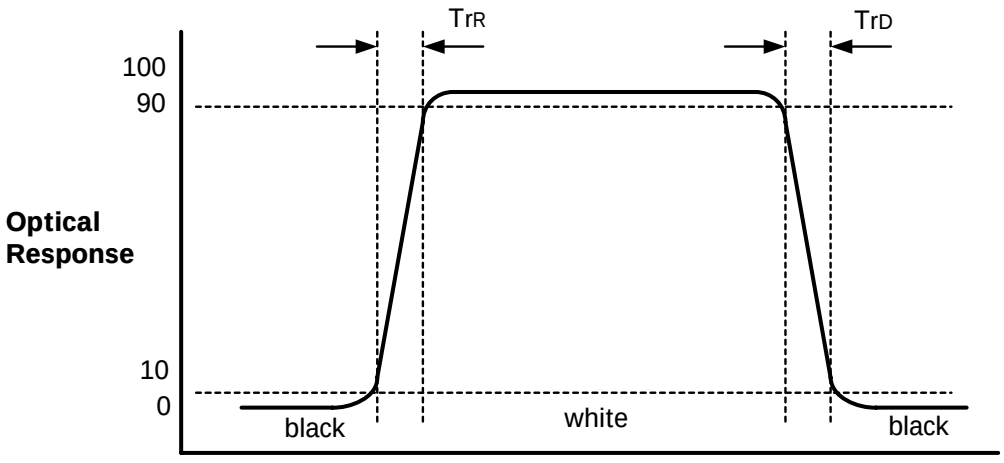
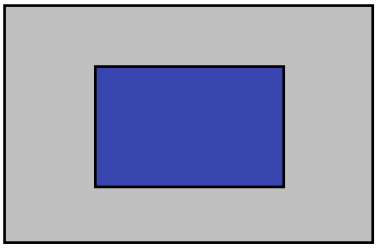


FIG. 3. Response Time

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



25% Box size

FIG. 5 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

Dimension of viewing angle range.

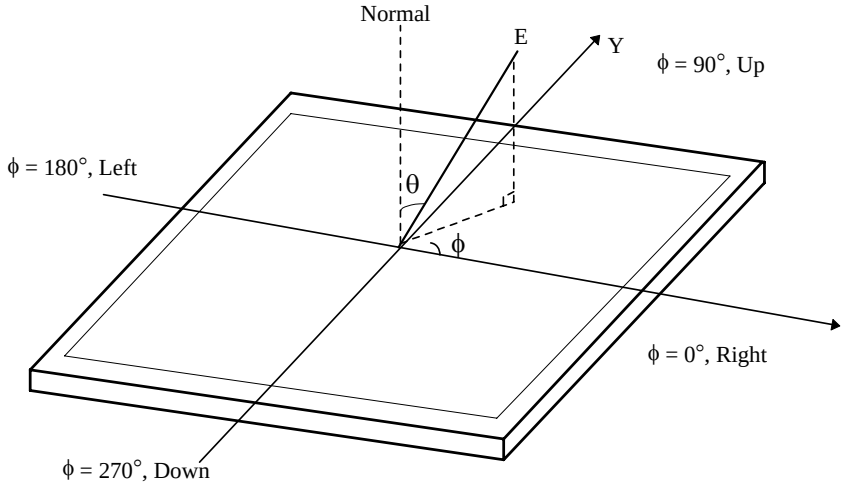


FIG. 6 Viewing angle

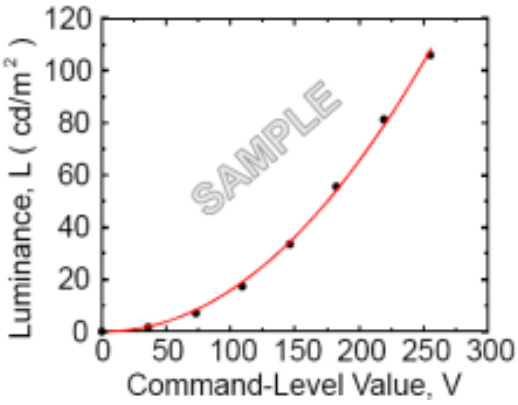


FIG. 7 Sample Luminance vs. gray scale (using a 256 bit gray scale)

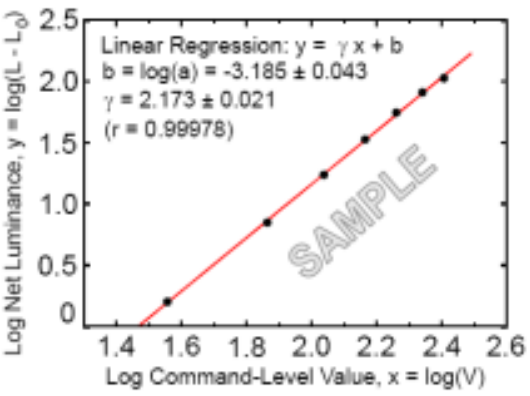


FIG. 8 Sample Log-log plot of luminance vs. gray scale

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

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

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. 8)

Table 10. Gray Scale Specification

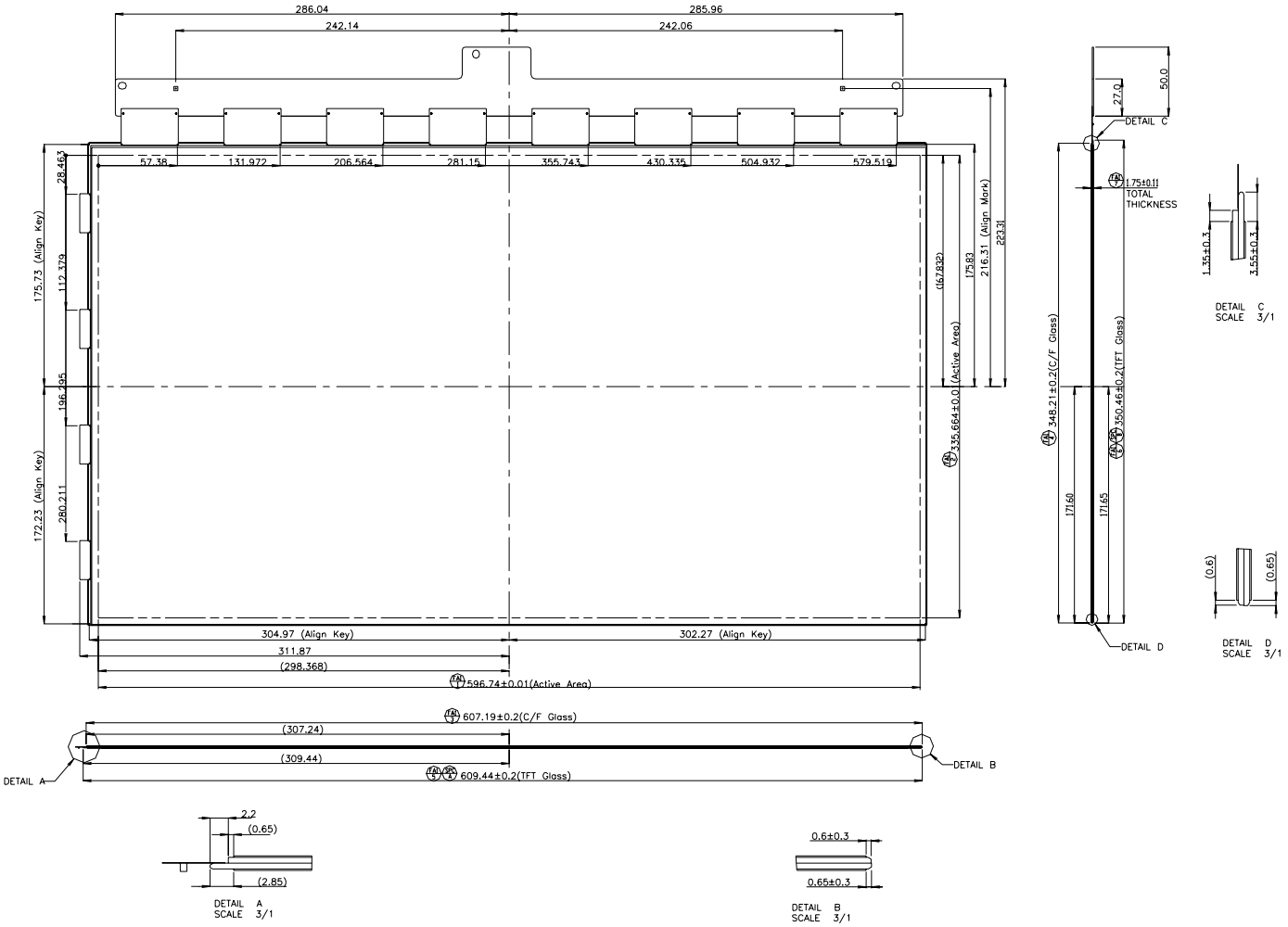
Gray Level	Relative Luminance [%] (Typ.)
0	0.10
31	1.08
63	4.71
95	11.5
127	21.7
159	35.5
191	53.1
223	74.5
255	100

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 (W/O)	Horizontal	609.44 mm
	Vertical	350.46 mm
	Depth	1.75 mm
Bezel Area	Horizontal	N/A mm
	Vertical	N/A mm
Active Display Area	Horizontal	596.74mm
	Vertical	335.66mm
Weight	920 g (Typ.)	
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.



Notes
1. THIS DRAWING DESCRIBES HOW TO ASSEMBLY PANEL, PWB ASS'Y & COF.
2. UNSPECIFIED TOLERANCES ARE ±0.2mm.
3. POLARIZER SIZES ARE:
   - UPPER POLARIZER : 605.94±0.3 X 346.26±0.3 X 0.175
   - LOWER POLARIZER : 605.94±0.3 X 346.26±0.3 X 0.175

7. International Standards

7-1. Environment

a) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

8. Packing

8-1. Packing Form

a) Package quantity in one box : 12 pcs

b) Box Size : 720 mm X 560 mm X 140 mm

9. PRECAUTIONS

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

9-1. MOUNTING PRECAUTIONS

(1) 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.
(2) You should adopt radiation structure to satisfy the temperature specification.
(3) 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.
(4) 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.)
(5) 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.
(6) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(7) Mechanical structure for backlight system should be designed for sustaining drive ass'y safely.

9-2. OPERATING PRECAUTIONS

(1) The spike noise causes the miss-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) 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.
(4) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(5) 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.
(6) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.

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.