SAMSUNG ELECTRONICS

Approval Specification

Customer : DELL / TPV **DATE : 22 / Jul / 2008**

SAMSUNG TFT-LCD

MODEL : **LTM190BT02**

Any Modification of Specification is not allowed without SEC's Permission.

NOTE : Spec for E1909WDD project

Customer's Approval	
SIGNATURE	DATE

PREPARED BY	DATE 22/Jul/'08
APPROVAED BY	DATE 22/Jul/'08

Application Engineering part 1(HD), LCD Business

Samsung Electronics Co . , LTD.

wise view™ SAMSUNG TFT-LCD

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* Revision History

Date	Rev. No	Page	Summary
July 22, 2008	000	all	Approval specification of LTM190BT02 model was issued first.

General Description

Description

LTM190BT02 is a color active matrix liquid crystal display (LCD) that uses amorphous silicon TFT(Thin Film Transistor) as switching components. This model is composed of a TFT LCD panel, a driver circuit and a back light unit. The resolution of a 19.0" is 1440 x 900 and this model can display up to 16.7 millions colors.

Features

- High contrast ratio, high aperture structure
- TN (Twisted Nematic) mode
- Wide Viewing Angle
- High speed response
- WXGA+ (1440 x 900 pixels) resolution
- Low power consumption
- 2 dual CCFLs (Cold Cathode Fluorescent Lamp)
- DE (Data Enable) only mode
- DP (Displayport) interface (1 lane)
- Compact Size Design
- RoHS compliance
- TCO'03 compliance

Applications

- Workstation & desktop monitors
- Display terminals for AV application products
- Monitors for industrial machine

* If the module is used to other applications besides the above, please contact SEC in advance.

General Information

Items	Specification	Unit	Note
Pixel Pitch	0.2835(H) x 0.2835(W)	mm	
Active Display Area	408.24(H) x 255.15(V)	mm	
Surface Treatment	Haze 25%, Hard-coating(3H)		
Display Colors	16.7M (6bit Hi-FRC)	colors	
Number of Pixels	1440 x 900	pixel	
Pixel Arrangement	RGB vertical stripe		
Display Mode	Normally White		
Power Consumption	16.8 Watt (Typ.)		
Luminance of White	300(Typ.)	cd/㎡	

Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	427.5	428.0	428.5	mm	w/o inverter ass'y
	Vertical (V)	277.5	278.0	278.5	mm	
	Depth (D)	-	-	17.5	mm	
Weight		-	-	2,550	g	LCD module only

Note (1) Mechanical tolerance is ± 0.5mm unless there is a special comment.

1. Absolute Maximum Ratings

If the condition exceeds maximum ratings, it can cause malfunction or unrecoverable damage to the device.

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	GND-0.5	6.5	V	(1)
Storage temperature	T_{STG}	-25	60	℃	(2)
Glass surface temperature (Operation)	T_{OPR}	0	50	℃	(2)
Shock (non - operating)	S_{nop}	-	50	G	(3)
Vibration (non - operating)	V_{nop}	-	1.5	Grms	(4)

Note (1) Ta= 25 ± 2 °C

(2) Temperature and relative humidity range are shown in the figure below.
a. 90 % RH Max. (Ta ≤ 39 °C)
b. Maximum wet-bulb temperature at 39 °C or less. (Ta ≤ 39 °C)
c. No condensation
(3) 11ms, sine wave, one time for ±X, ±Y, ±Z axis
(4) 10-300 Hz, Sweep rate 10min, 30min for X,Y,Z axis

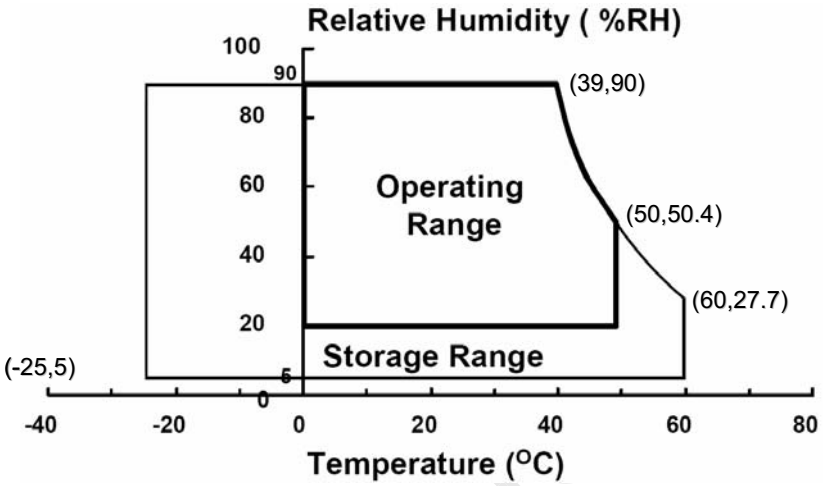

Fig. Temperature and Relative humidity range

2. Optical Characteristics

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The optical characteristics should be measured in a dark room or equivalent.
Measuring equipment : TOPCON RD-80S,SPECTRORADIOMETER SR-3

(Ta = 25 ± 2°C, VDD=5V, fv= 60Hz, fDCLK=51.9MHz, IL = 6.5mArms)

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R	Normal $\Theta_{L,R}=0$ $\Theta_{U,D}=0$ Viewing Angle	600	1000	-		(3) SR-3
Response Time	On/Off	Tr+ Tf		-	5	10	msec	(5) RD-850S
Luminance of White (Center of screen)		Y_L		250	300	-	cd/m2	(6) SR-3
Color Chromaticity (CIE 1931)	Red	Rx		0.610	0.640	0.670		
		Ry		0.300	0.329	0.360		
	Green	Gx		0.270	0.300	0.330		
		Gy		0.570	0.600	0.630		
	Blue	Bx		0.120	0.150	0.180		
		By		0.030	0.060	0.090		
	White	Wx		0.283	0.313	0.343		
		Wy		0.299	0.329	0.359		(7),(8)
Color Chromaticity (CIE 1976)	Red	Ru'		-	0.451	-		SR-3
		Rv'		-	0.523	-		
	Green	Gu'		-	0.125	-		
		Gv'		-	0.563	-		
	Blue	Bu'		-	0.175	-		
		Bv'		-	0.158	-		
	White	Wu'		-	0.198	-		
		Wv'		-	0.468	-		
C.G.L	White	△u'v'		-	0.011	0.02		(9)

* C.G.L : Color Grayscale Linearity

(continue to the next page)

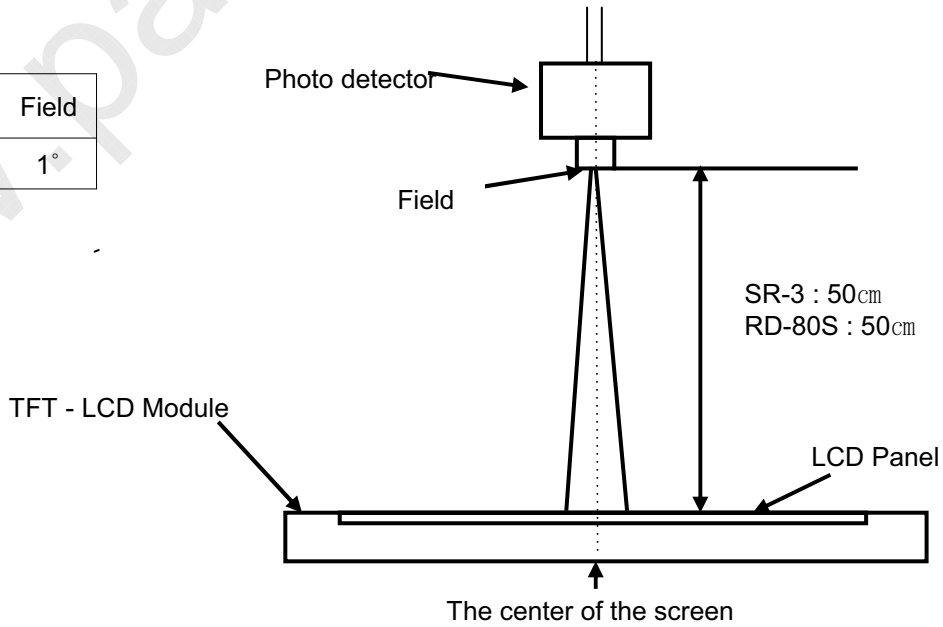
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Color Gamut		-		-	72	-	%	
Color Temperature		-		-	6500	-	K	
Gamma		γ		1.9	2.2	2.5		
Viewing Angle	Hor.	Θ_L	CR≥10(5)	70(80)	80(89)	-	Degrees	(8) EZ-Contrast
		Θ_R		70(80)	80(89)	-		
	Ver.	Θ_U		70(80)	80(89)	-		
		Θ_D		70(80)	80(89)	-		
Brightness Uniformity (9 Points)		B_{uni}		-	-	25	%	(4) SR-3
Cross Modulation		DSHA		-	-	2		(10) SR-3
Flicker		F		-	-	8		(11) SR-3

Note (1) Test Equipment Setup

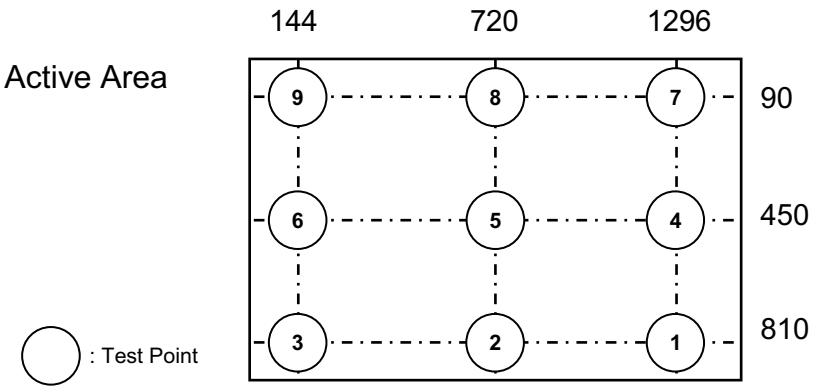
The measurement should be executed in a stable, windless and dark room between 30min after lighting the back light at the given temperature for stabilization of the back light. This should be measured in the center of screen.

Single lamp current : 7.5mA
Environment condition : Ta = 25 ± 2 °C

Photo detector	Field
SR-3	1°



Note (2) Definition of test point



Note (3) Definition of Contrast Ratio (C/R)

: Ratio of gray max (Gmax) & gray min (Gmin) at the center point⑤ of the panel

$$CR = \frac{G\max}{G\min}$$

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note (4) Definition of 9 points brightness uniformity

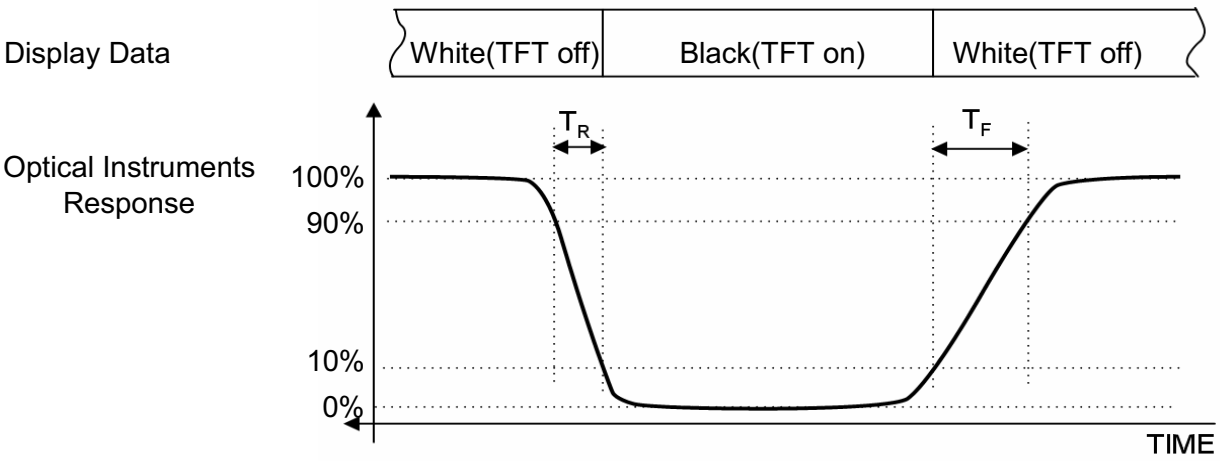
$$Buni = 100 \times \frac{(B\max - B\min)}{B\max}$$

Bmax : Maximum brightness

Bmin : Minimum brightness

Note (5) Definition of Response time

a. On/Off response time : Sum of Tr, Tf



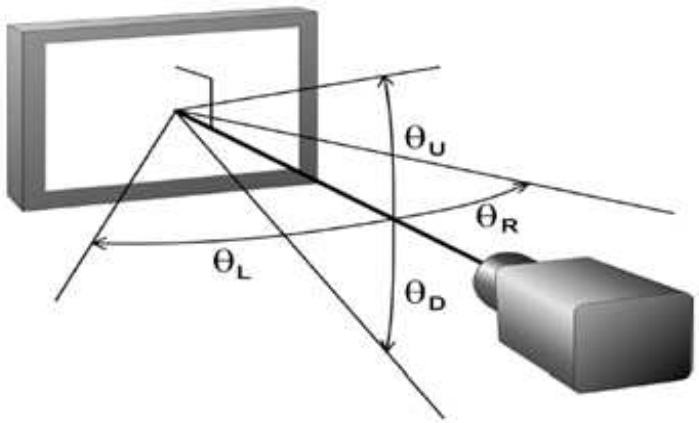
Note (6) Definition of Luminance of White : Luminance of white at center point⑤

Note (7) Definition of Color Chromaticity (CIE 1931, CIE1976)

Color coordinate of Red, Green, Blue & White at center point⑤

Note (8) Definition of Viewing Angle

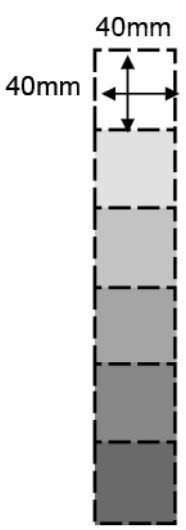
: Viewing angle range (CR ≥10,5)



Note (9) Color Grayscale Linearity

a. Test image : 100% full white pattern with a test pattern as below

b. Test pattern : Squares, 40mm by 40mm in size, filled with 255, 225, 195, 165, 135 and 105 grays steps should be arranged at the center⑤ of the screen.



c. Test method

-1st gray step : move a square of 255 gray level should be moved into the center of the screen and measure luminance and u' and v' coordinates.

- Next gray step : Move a 225 gray square into the center and measure both luminance and coordinates, too.

d. Test evaluation

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

Where A, B : 2 gray levels found to have the largest color differences between them

i.e. get the largest Δu' and Δv' of each 6 pair of u' and v' and calculate the Δu'v'.

Note (10) Definition of Cross Modulation (Crosstalk : DSHA)

$$\text{Crosstalk Modulation Ratio}(D_{SHA}) = \frac{|Y_A - Y_B|}{Y_A} \times 100\ (\%)$$

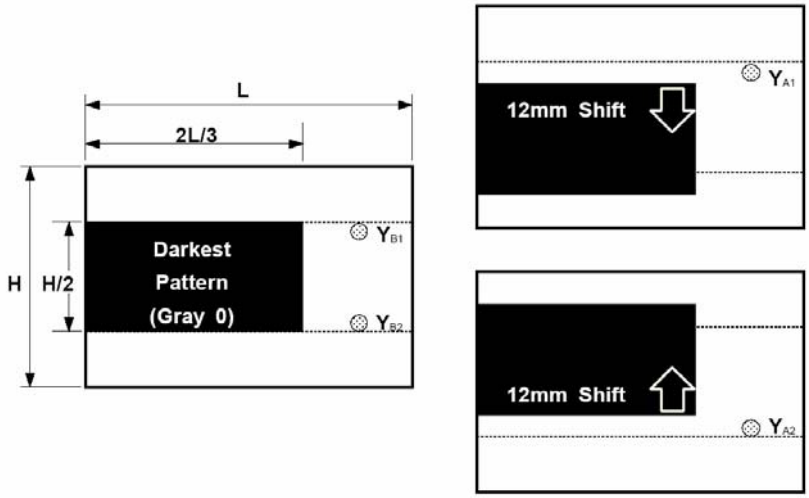
Where YA = luminance with moving a black bar,

YB = luminance without moving a black bar

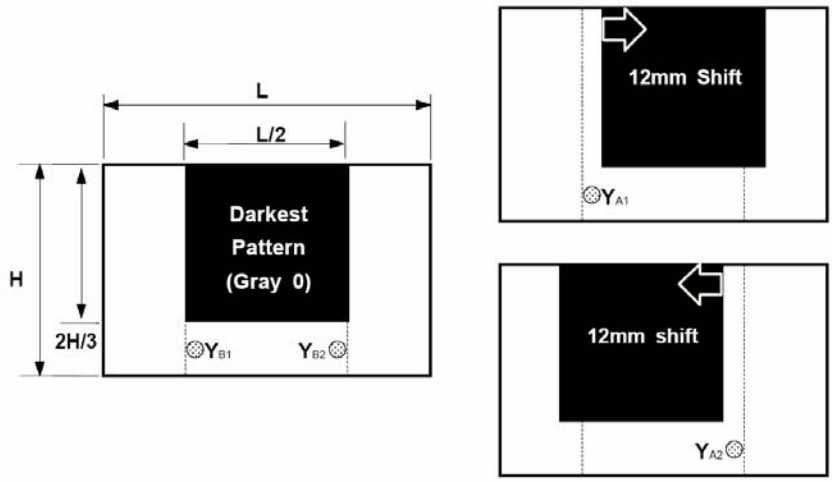
- Measurement angle = 2°Viewing angle, Measurement area = φ12㎜

Background pattern (except black bar) includes gray 1 ~ 63

a. Measurement procedure of Horizontal Crosstalk



b. Measurement procedure of Vertical Crosstalk



Note (11) Flicker level should be measured with 1 dot inversion pattern.

Definition of Flicker level

Flicker level = 1000 * (A-B)

where

$$A = \frac{\left[\pi\left(\frac{10^{0.6556-0.000401\times\log(L(0Hz+30Hz))+0.66^{3}}}{2}\right)^{2} L(0Hz+30Hz)\right]^{0.74}}{\left[\pi\left(\frac{10^{0.6556-0.000401\times\log(L(0Hz+30Hz))+0.66^{3}}}{2}\right)^{2} L(0Hz+30Hz)\right]^{0.74} + 1584.9^{0.74}}$$

$$B = \frac{\left[\pi\left(\frac{10^{0.6556-0.000401\times\log(L(0Hz+30Hz))+0.66^{3}}}{2}\right)^{2} L(0Hz-30Hz)\right]^{0.74}}{\left[\pi\left(\frac{10^{0.6556-0.000401\times\log(L(0Hz+30Hz))+0.66^{3}}}{2}\right)^{2} L(0Hz-30Hz)\right]^{0.74} + 1584.9^{0.74}}$$

where

$$L(0Hz+30Hz) = \left(10^{\frac{0Hz(dB)+b}{20}} + 10^{\frac{30Hz(dB)+b}{20}}\right)/a$$

$$L(0Hz-30Hz) = \left(10^{\frac{0Hz(dB)-b}{20}} - 10^{\frac{30Hz(dB)-b}{20}}\right)/a$$

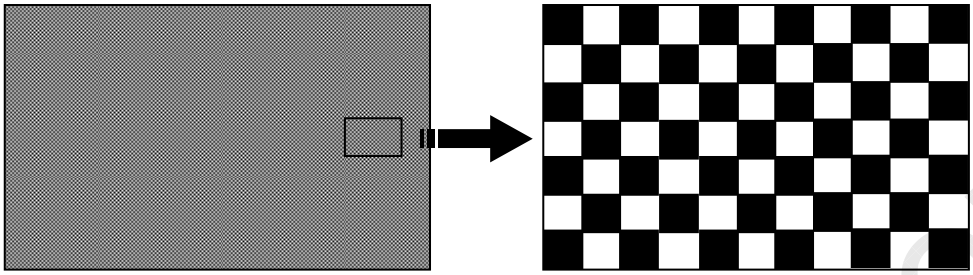
where
a = Proportion Constant of Input brightness to BM-7 and output voltage (V*(㎡/cd))
b = Standard voltage which is proposed to calculate the input voltage to DSA (Dynamic signal analyzer) in DB scale

$$\left(Vref = 10^{b/20}\right)$$

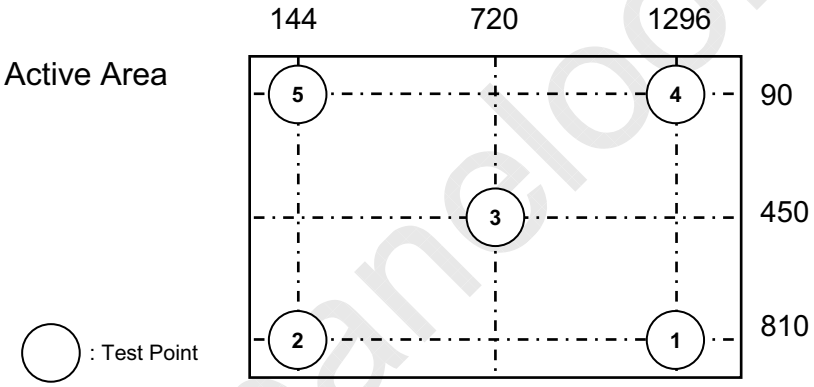
One maximum value of three estimated values of 5 points
Test pattern : For 1-dot inversion driving
(Grey levels of foreground dots on the test panel are G21, G31, G44)

Test point : 5 points of the display area

a. test pattern : 1 dot inversion pattern



b. test point



3. Electrical Characteristics

3.1 TFT LCD Module

The connector for display data & timing signal should be connected.

Ta = 25°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
Interface Type		DP	DP V1.1Va(Rx/Tx)				(2)
Current of Power Supply	(a) Black	I_{DD}	-	1100	-	mA	(3),(4)
	(b) White		-	800	-	mA	
	(c) Dot		-	1300	1500	mA	
Vsync Frequency		f_V	59.55	60	60.45	Hz	
Hsync Frequency		f_H	-	55.47	-	kHz	
Main Frequency		f_{DCLK}	-	88.75	-	MHz	
Rush Current		I_{RUSH}	-	-	3.0	A	(5)

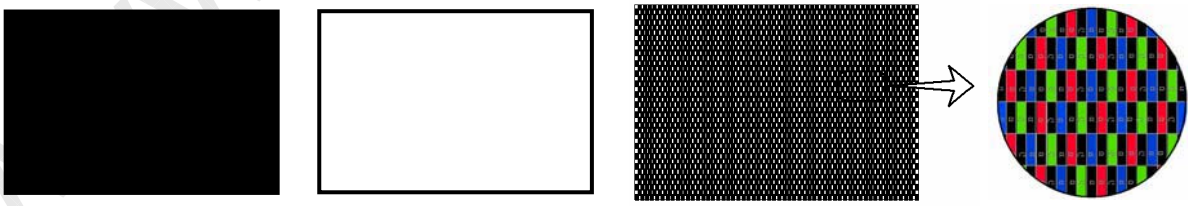
Note (1) The ripple voltage should be controlled under 10% of V_{DD}.

Note (2) Displayport interface characteristics should be based on VESA standard

(3) fV=60Hz, fDCLK = 88.75MHz, VDD = 5.0V, DC Current.

(4) Power dissipation check pattern (LCD Module only)

a) Black Pattern b) White Pattern c) Dot Pattern



3.2 Back Light Unit

The back light unit is an edge - lighting type with 2 dual CCFLs (Cold Cathode Fluorescent Lamp) The characteristics of two dual lamps are shown in the following tables.

Ta=25 ± 2°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current		I_L	3.0	6.5	8.0	mArms	(1)
Lamp Voltage		V_L	-	726	-	Vrms	
Lamp Frequency		f_L	45	-	60	kHz	(2)
Operating Life Time		Hr	50,000	-	-	Hour	(3)
Inverter waveform	Asymmetry rate	Wasy	-	-	10	%	(4)
	Distortion rate	Wdis	1.2726	1.414	1.5554		
Startup Voltage		Vs	-	-	0℃ : 1,480 25℃: 1,170	Vrms	(5)

Note (1) Specified values are for a single lamp.
Lamp current is measured with current meter for high frequency as shown below.
Refer to the following block diagram of the back light unit for more information.

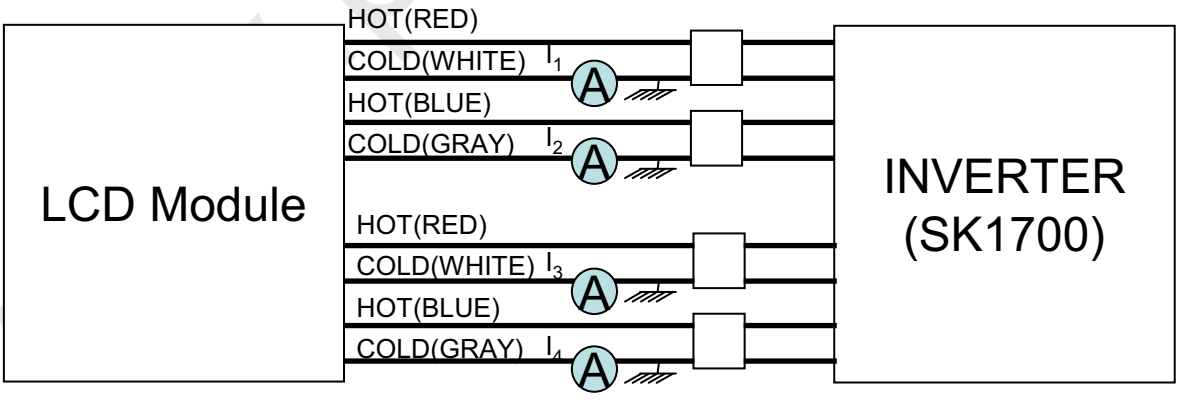


Fig. Measurement point of Lamp Current

(2) Lamp frequency which may produce interference with horizontal synchronous frequency may cause line flow on the display. Therefore lamp frequency should be detached from the horizontal synchronous frequency and its harmonics as far as possible in order to avoid interference.

(3) Life time (Hr) is defined as the time when brightness of a lamp unit itself becomes 50% or less than its original value at the condition of Ta = 25±2°C and I_L = 6.5mArms

(4) Designing a system inverter intended to have better display performance, power efficiency and lamp reliability.

They would help increase the lamp lifetime and reduce leakage current.

a. The measurement should be done at typical lamp current.

b. The asymmetry rate of the inverter waveform should be less than 10%.

c. The distortion rate of the waveform should be √2 with ±10% tolerance.

- Inverter output waveform had better be more similar to ideal sine wave.

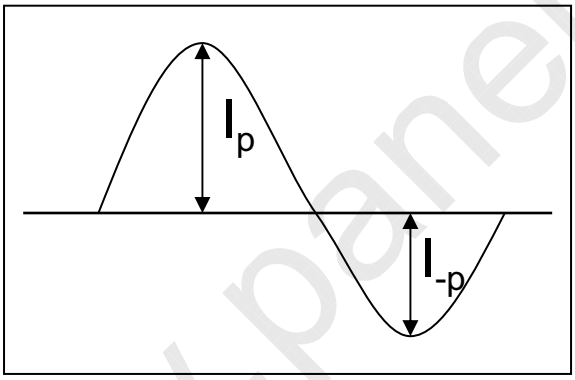


Fig. Wave form of the inverter

▪ Asymmetry rate

$$\frac{|I_p - I_{-p}|}{I_{rms}} \times 100$$

▪ Distortion rate

$$\left|\frac{I_p}{I_{rms}}\right| \text{ or } \left|\frac{I_{-p}}{I_{rms}}\right|$$

(5) If an inverter has shutdown function, it should keep its output for over 1 second even if the lamp connector is open. Otherwise the lamps may not be turned on.

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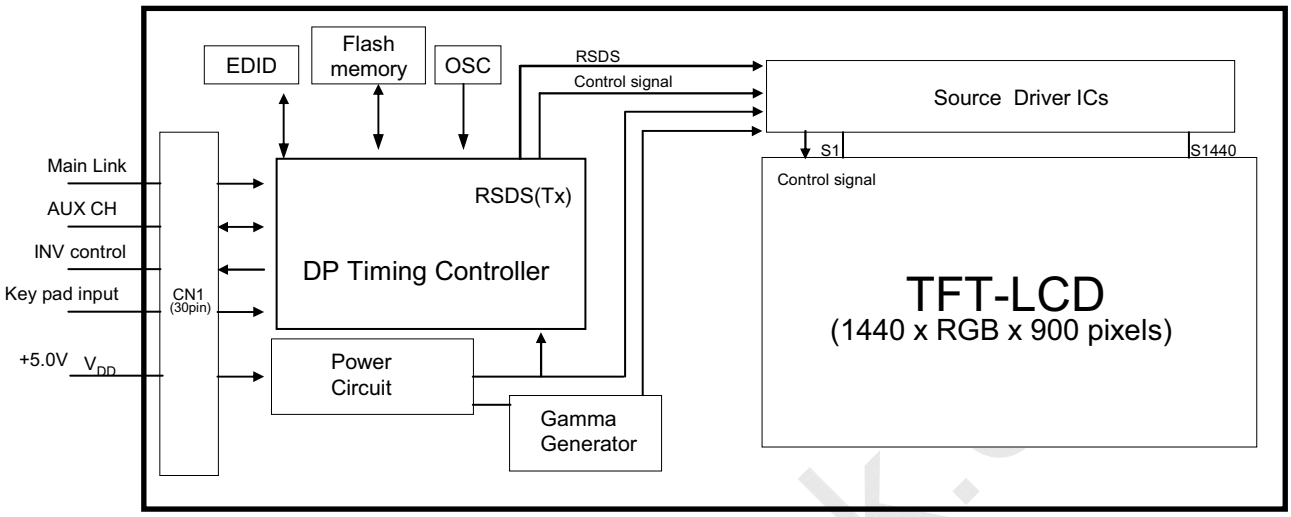
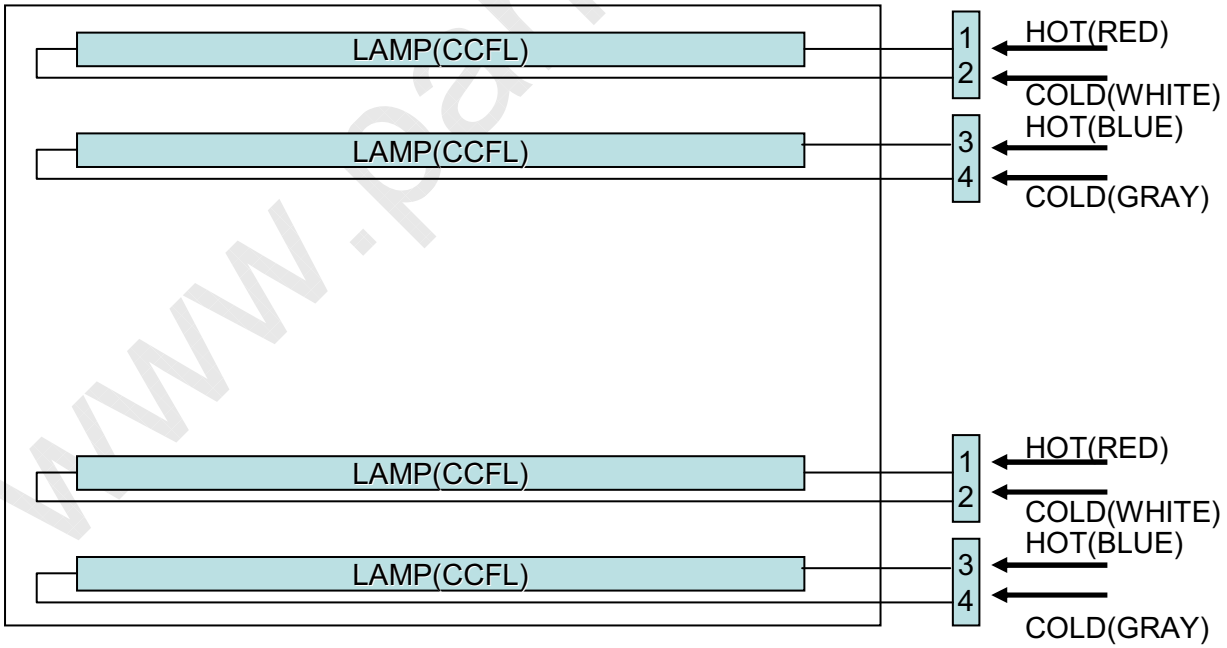
4. BLOCK DIAGRAM

4.1 TFT LCD Module



4.2 Back Light Unit



5. Input Terminal Pin Assignment

5.1. Input Signal & Power (Connector : P-TWO 187034-30091 or equivalent)

PIN NO	SYMBOL	In/Out	Function	Note
1	V_{DD}	In	Power Supply : +5V	
2	V_{DD}			
3	V_{DD}			
4	N/C	-	* For LCD internal use only. Do not connect	
5	N/C	-	* For LCD internal use only. Do not connect	
6	GND	GND	Power Ground	
7	GND			
8	GND			
9	LPM	Out	Low Power Mode High: Normal Operation Mode Low : Power Saving Mode	
10	BKL On/Off	Out	Back Light On :3.3V, Off : 0V	
11	Inverter Dim.	Out	PWM Dimming	(2)
12	Keypad	In	LBADC button detect	(3)
13	3.3V ref	Out	Keypad Ref Voltage	
14	3.3V GND	GND	3.3V Keypad ref GND	
15	LED 1	Out	LED1 control (Green)	
16	LED 2	Out	LED2 control (Orange)	
17	H_GND	GND	High speed Ground	
18	NC	-		
19	NC	-		
20	H_GND	GND	High speed Ground	
21	Lane0 N	In	Negative Main link Lane 0	
22	Lane0 P	In	Positive Main link Lane 0	
23	H_GND	GND	Signal Ground	
24	AUX_CH P	In/Out	Positive Auxiliary Channel	
25	AUX_CH N	In/Out	Negative Auxiliary Channel	
26	H_GND	GND	Signal Ground	
27	HPD	Out	Hot Plug Detect	
28	NC	-	* For LCD internal use only. Do not connect	
29	NC	-	* For LCD internal use only. Do not connect	
30	NC	-	* For LCD internal use only. Do not connect	

Note 1) Pin number starts from Left side

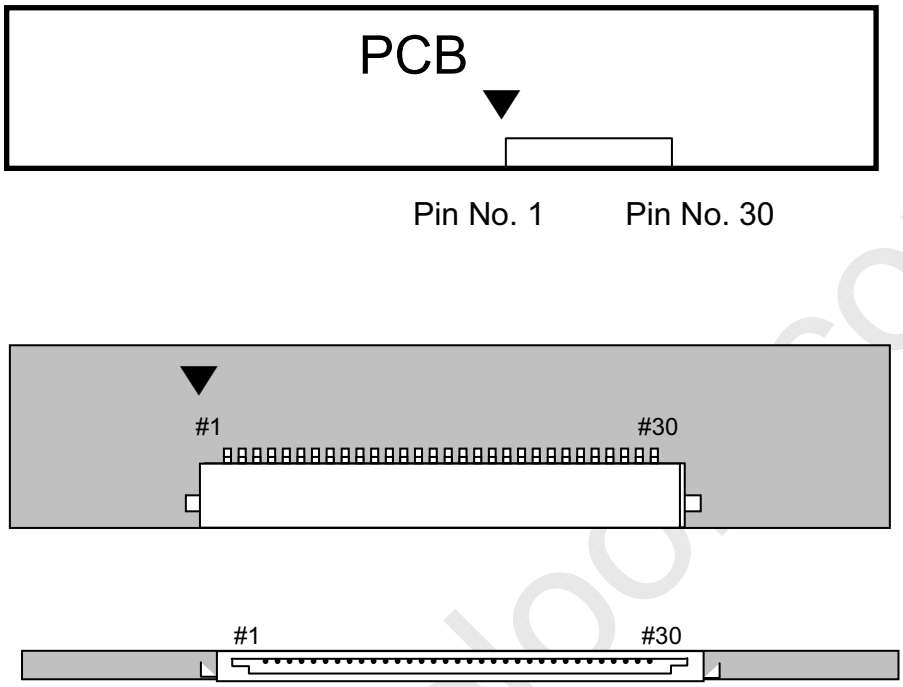


Fig. Connector diagram

a. All GND pins should be connected together and also be connected to the LCD's metal chassis.

b. All power input pins should be connected together.

c. All NC pins should be separated from other signal or power.

Note 2) Brightness control

a. EDID Register Fields

Address	FUNCTION	VALUE	Description
71h	(service area) Dell P/N = XX	00	00000000
72h	(service area) Manufacturer P/N = XX	00	00000000
73h	PWM ratio = 60.0 %	B5h	Level 1
74h	PWM ratio = 54.4 %	BCh	Level 2
75h	PWM ratio = 48.0 %	C4h	Level 3
76h	PWM ratio = 42.4 %	CBh	Level 4
77h	PWM ratio = 36.0 %	D3h	Level 5
78h	PWM ratio = 30.4 %	DAh	Level 6
79h	PWM ratio = 24.8 %	E1h	Level 7
7Ah	PWM ratio = 18.4 %	E9h	Level 8
7Bh	PWM ratio = 12.8 %	F0h	Level 9
7Ch	PWM ratio = 6.4 %	F8h	Level 10
7Dh	PWM ratio = 0 %	FFh	level 11, Max brightness

Upon power up, the TCON will read the last brightness level value stored in the TCON.
Default brightness is Level 10.
Button presses or AUX CH requests establish the new setting.

b. Inverter PWM input requirements (Pin 11 output condition)

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
PWMI Input Low Voltage				0.8	V
PWMI Input High Voltage		2.1			V
PWMI Input Hysteresis			300		mV
PWMI Input Bias Current		-0.3		0.3	µA
PWMI Input Frequency Range		100	210	4K	Hz
PWMI Brightness Setting	PWMI duty cycle = 100%	99.5	100	-	%
	PWMI duty cycle = 50%	49.5	50	50.5	
	PWMI duty cycle= 0%	-	0	0.5	

Note 3) Keypad control

a. Keypad circuit is defined by DDM

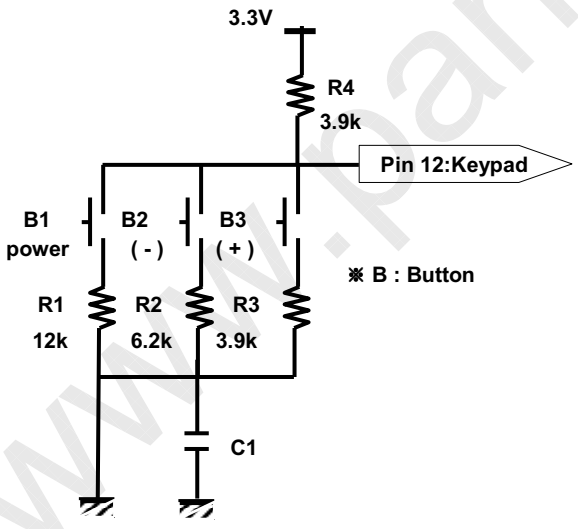
According to DDM spec. and VESA standard ,keypad circuit makes "LEVEL Trigger" signal

b. Keypad input level and Function (Pin 12)

Keypad : Input level(V)	Function
2.49 ± 0.1V	Power On/Off
2.025 ± 0.1V	Brightness decrease (-) : Brightness Level n ➔ n-1
1.65 ± 0.1V	Brightness Increase (+) : Brightness Level n ➔ n+1
1.25 ± 0.1V	Brightness decrease (-) & Brightness Increase (+) : Diagnostic mode
1.42 ± 0.1V	Power On/Off & Brightness Increase (+) : Return to default Mode

* REFERECNE : 3.3V (Pin 13)
** DETECTING DURATION ≥ 0.14s

c. Example of keypad design (Recommendation)



Sequence	Keypad Voltage to DP T-CON
Pressing Button 1	$\frac{R1}{(R1+R4)} \times 3.3V$
Pressing Button 2	$\frac{R2}{(R2+R4)} \times 3.3V$
Pressing Button 3	$\frac{R3}{(R3+R4)} \times 3.3V$

5.2 Back Light Unit

	Pin No.	Input	Color	Function
Upper	1	Hot – 1	Pink	High Voltage
	2	Cold – 1	White	Ground
	3	Hot – 2	Blue	High Voltage
	4	Cold – 2	Gray	Ground
Lower	1	Hot – 1	Pink	High Voltage
	2	Cold – 1	White	Ground
	3	Hot – 2	Blue	High Voltage
	4	Cold – 2	Gray	Ground
	Connect or Part No.	Yeonho 35001HS-02L or equivalent		

6. Interface Timing Characteristics

Safe mode and Native mode are supported

6.1.1 Safe mode : 640x480@60Hz

Timing Name	=	**640 x 480 @ 60Hz;**					
Hor Pixels	=	**640;**	// Pixels				
Ver Pixels	=	**480;**	// Lines				
Hor Frequency	=	31.469;	// KHz	=	31.8 usec	/	line
Ver Frequency	=	59.940;	// Hz	=	16.7 msec	/	frame
Pixel Clock	=	**25.175;**	// MHz	=	39.7 nsec	± 0.5%	
Character Width	=	**8;**	// Pixels	=	317.8 nsec		
Scan Type	=	**NONINTERLACED;**			// H Phase	=	2.0 %
Hor Sync Polarity	=	**NEGATIVE;**	// HBlank	=	18.0% of HTotal		
Ver Sync Polarity	=	**NEGATIVE;**	// VBlank	=	5.5% of VTotal		
Hor Total Time	=	31.778;	// (usec)	=	100 chars	=	800 Pixels
Hor Addr Time	=	25.422;	// (usec)	=	80 chars	=	640 Pixels
Hor Blank Start	=	25.740;	// (usec)	=	81 chars	=	648 Pixels
Hor Blank Time	=	5.720;	// (usec)	=	18 chars	=	144 Pixels
Hor Sync Start	=	26.058;	// (usec)	=	82 chars	=	656 Pixels
// H Right Border	=	0.318;	// (usec)	=	**1** chars	=	8 Pixels
// H Front Porch	=	0.318;	// (usec)	=	**1** chars	=	8 Pixels
Hor Sync Time	=	3.813;	// (usec)	=	**12** chars	=	96 Pixels
// H Back Porch	=	1.589;	// (usec)	=	**5** chars	=	40 Pixels
// H Left Border	=	0.318;	// (usec)	=	**1** chars	=	8 Pixels
Ver Total Time	=	16.683;	// (msec)	=	525 lines	HT – (1.06xHA)	
Ver Addr Time	=	15.253;	// (msec)	=	480 lines	= 4.83	
Ver Blank Start	=	15.507;	// (msec)	=	488 lines		
Ver Blank Time	=	0.922;	// (msec)	=	29 lines		
Ver Sync Start	=	15.571;	// (msec)	=	490 lines		
// V Bottom Border	=	0.254;	// (msec)	=	**8** lines		
// V Front Porch	=	0.064;	// (msec)	=	**2** lines		
Ver Sync Time	=	0.064;	// (msec)	=	**2** lines		
// V Back Porch	=	0.794;	// (msec)	=	**25** lines		
// V Top Border	=	0.254;	// (msec)	=	**8** lines		

6.1.2 Safe mode : 800x600@60Hz

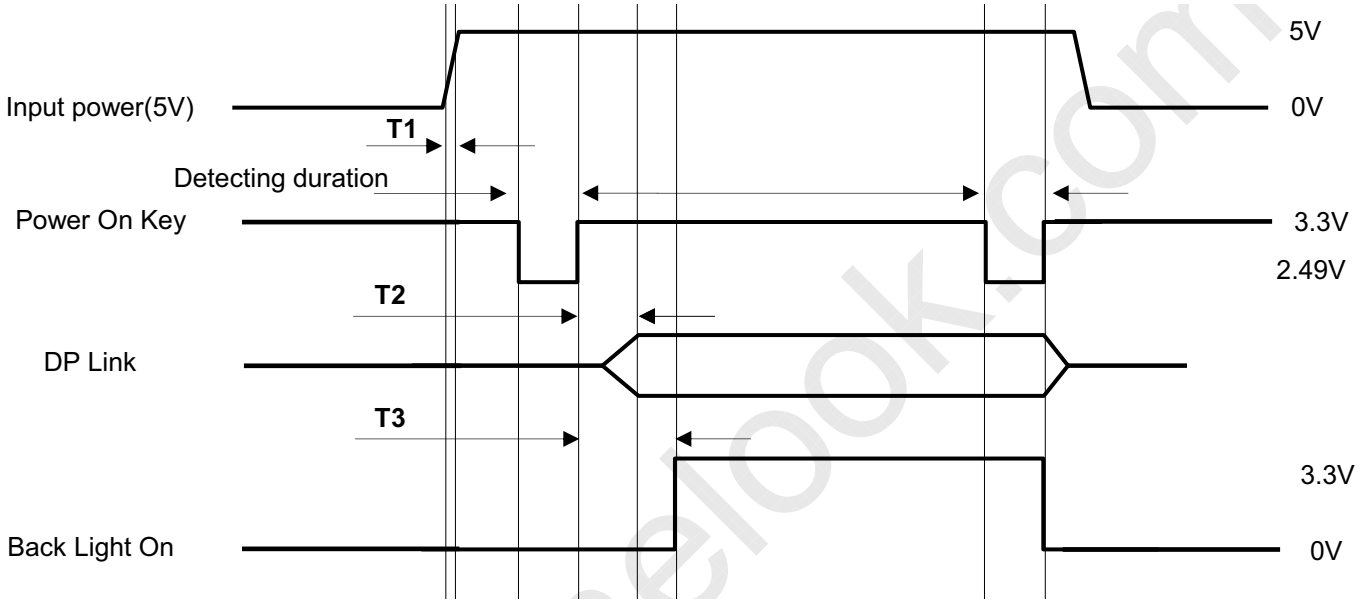
Timing Name	=	**800 x 600 @ 60Hz;**					
Hor Pixels	=	**800;**	// Pixels				
Ver Pixels	=	**600;**	// Lines				
Hor Frequency	=	37.879;	// KHz	=	26.4 usec	/	line
Ver Frequency	=	60.317;	// Hz	=	16.6 msec	/	frame
Pixel Clock	=	**40.000;**	// MHz	=	25.0 nsec		± 0.5%
Character Width	=	**8;**	// Pixels	=	200.0 nsec		
Scan Type	=	**NONINTERLACED;**			// H Phase	=	2.3 %
Hor Sync Polarity	=	**POSITIVE;**	// HBlank	=	24.2% of HTotal		
Ver Sync Polarity	=	**POSITIVE;**	// VBlank	=	4.5% of VTotal		
Hor Total Time	=	26.400;	// (usec)	=	132 chars	=	1056 Pixels
Hor Addr Time	=	20.000;	// (usec)	=	100 chars	=	800 Pixels
Hor Blank Start	=	20.000;	// (usec)	=	100 chars	=	800 Pixels
Hor Blank Time	=	6.400;	// (usec)	=	32 chars	=	256 Pixels
Hor Sync Start	=	21.000;	// (usec)	=	105 chars	=	840 Pixels
// H Right Border	=	0.000;	// (usec)	=	**0** chars	=	0 Pixels
// H Front Porch	=	1.000;	// (usec)	=	**5** chars	=	40 Pixels
Hor Sync Time	=	3.200;	// (usec)	=	**16** chars	=	128 Pixels
// H Back Porch	=	2.200;	// (usec)	=	**11** chars	=	88 Pixels
// H Left Border	=	0.000;	// (usec)	=	**0** chars	=	0 Pixels
Ver Total Time	=	16.579;	// (msec)	=	628 lines		HT – (1.06xHA)
Ver Addr Time	=	15.840;	// (msec)	=	600 lines		= 5.2
Ver Blank Start	=	15.840;	// (msec)	=	600 lines		
Ver Blank Time	=	0.739;	// (msec)	=	28 lines		
Ver Sync Start	=	15.866;	// (msec)	=	601 lines		
// V Bottom Border	=	0.000;	// (msec)	=	**0** lines		
// V Front Porch	=	0.026;	// (msec)	=	**1** lines		
Ver Sync Time	=	0.106;	// (msec)	=	**4** lines		
// V Back Porch	=	0.607;	// (msec)	=	**23** lines		
// V Top Border	=	0.000;	// (msec)	=	**0** lines		

6.2 Native mode : 1440x900@60Hz –Reduce Blanking

Timing Name	= **1.30MA-R (1440x900 Reduced Blanking);**						
Hor Pixels	= **1440;**	// Pixels					
Ver Pixels	= **900;**	// Lines					
Hor Frequency	= 55.469;	// KHz	=	18.0 usec	/	line	
Ver Frequency	= 59.901;	// Hz	=	16.7 msec	/	frame	
Pixel Clock	= **88.750;**	// MHz	=	11.3 nsec		± 0.5%	
Character Width	= **8;**	// Pixels	=	90.1 nsec			
Scan Type	= **NONINTERLACED;**			// H Phase	=	1.0 %	
Hor Sync Polarity	= **POSITIVE;**	// HBlank	=	10.0% of HTotal			
Ver Sync Polarity	= **NEGATIVE**	// VBlank	=	2.8% of VTotal			
Hor Total Time	= 18.028;	// (usec)	=	200 chars	=	1600 Pixels	
Hor Addr Time	= 16.225;	// (usec)	=	180 chars	=	1440 Pixels	
Hor Blank Start	= 16.225;	// (usec)	=	180 chars	=	1440 Pixels	
Hor Blank Time	= 1.803;	// (usec)	=	20 chars	=	160 Pixels	
Hor Sync Start	= 16.766;	// (usec)	=	186 chars	=	1488 Pixels	
// H Right Border	= 0.000;	// (usec)	=	**0** chars	=	0 Pixels	
// H Front Porch	= 0.541;	// (usec)	=	**6** chars	=	48 Pixels	
Hor Sync Time	= 0.361;	// (usec)	=	**4** chars	=	32 Pixels	
// H Back Porch	= 0.901;	// (usec)	=	**10** chars	=	80 Pixels	
// H Left Border	= 0.000;	// (usec)	=	**0** chars	=	0 Pixels	
Ver Total Time	= 16.694;	// (msec)	=	926 lines		HT – (1.06xHA)	
Ver Addr Time	= 16.225;	// (msec)	=	900 lines		= 0.83	
Ver Blank Start	= 16.225;	// (msec)	=	900 lines			
Ver Blank Time	= 0.469;	// (msec)	=	26 lines			
Ver Sync Start	= 16.279;	// (msec)	=	903 lines			
// V Bottom Border	= 0.000;	// (msec)	=	**0** lines			
// V Front Porch	= 0.054;	// (msec)	=	**3** lines			
Ver Sync Time	= 0.108;	// (msec)	=	**6** lines			
// V Back Porch	= 0.306;	// (msec)	=	**17** lines			
// V Top Border	= 0.000;	// (msec)	=	**0** lines			

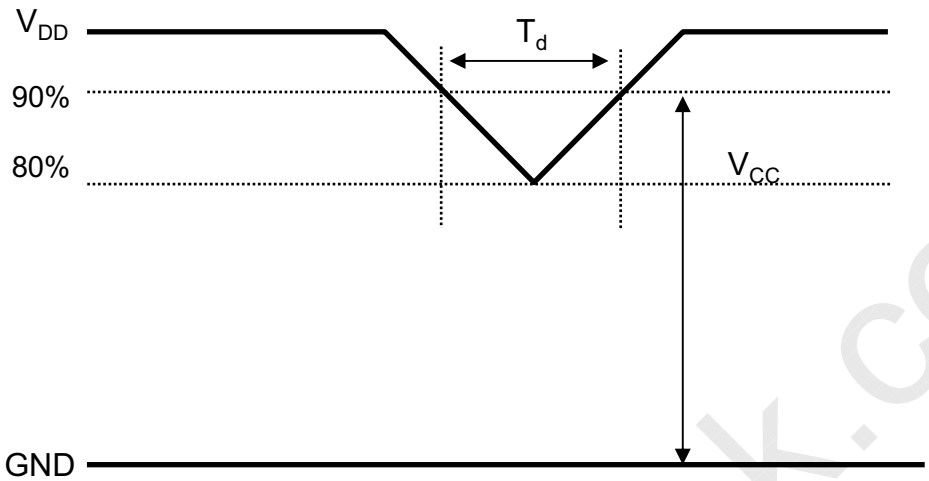
6.3 Power ON/OFF Sequence

To prevent a latch-up or DC operation of the LCD Module, the power on/off sequence should be as the diagram below.



	Min	Max	Remark
T1	300us	10ms	Do not exceed rush current 3A.
T2	-	-	Transmission between T-CON & Graphic card dependant. It is recommended to set within 1 sec to avoid garbage data
T3	1sec	1.5 sec	T-con setting value.
-	0.14 sec	-	Detection duration

6.4 VDD Power Dip Condition



$4.5V \leq V_{DD} \leq 5.5V$
If V_{DD}(typ.) x 80% $\leq V_{CC} \leq V_{DD}$(typ) x 90%
Then, 0<Td ≤20msec

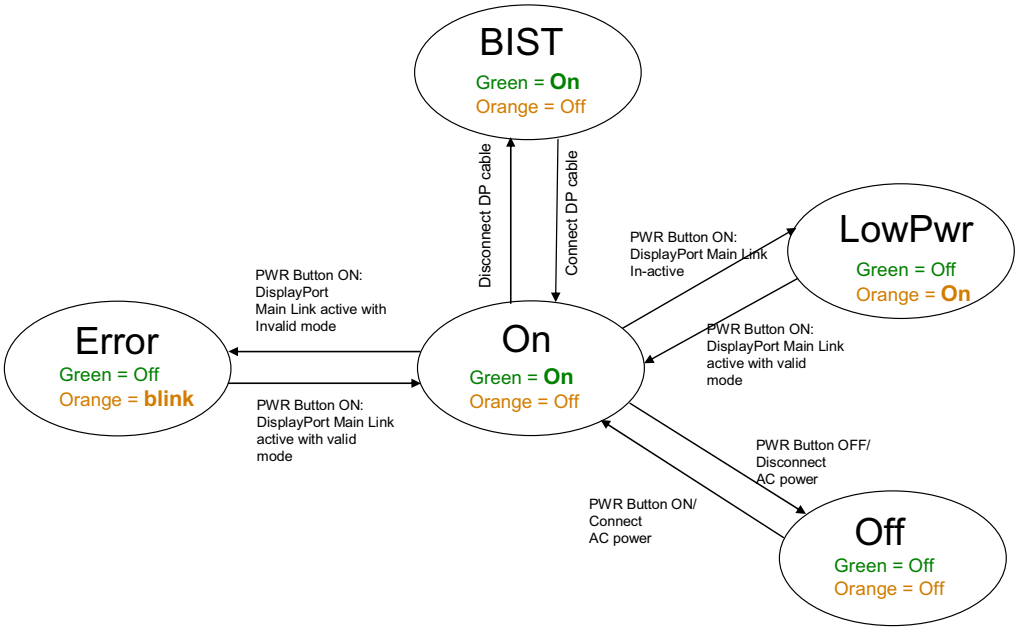
Note (1) The above conditions are for the glitch of the input voltage.
(2) For stable operation of an LCD Module power, please follow them.
i.e., if typ VDD x 80% $\leq$ Vcc $\leq$ typ VDD x 90%, then T_d should be less than 20ms.

6.5 Kick off condition

Based on Following diagram, the mode states switch.

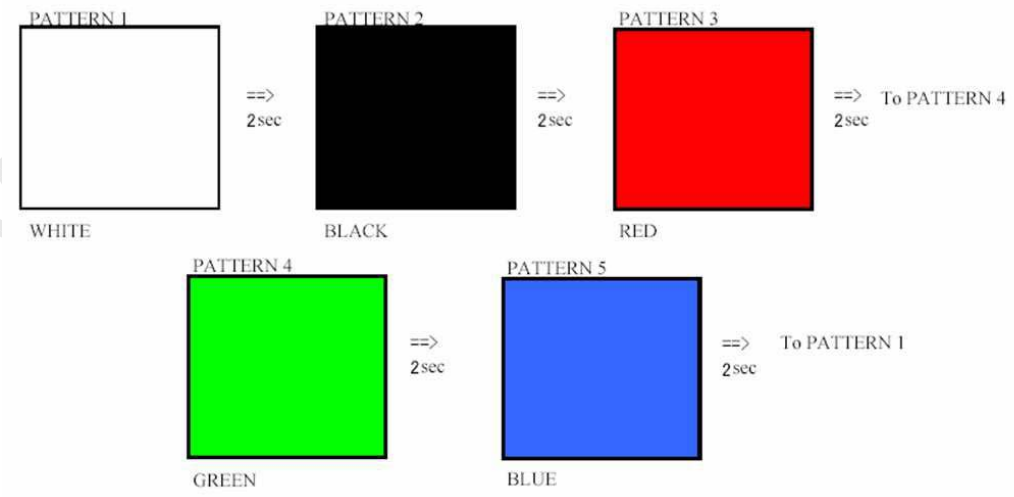
*Green : LED 1 (Pin 15)

** Orange : LED 2(Pin 16)



6.6 BIST Mode

BIST mode will be activated when the DP cable is disconnected from PC and the power up button activated



6.7 LCM (Low Power Mode)

Low power mode (LowPwr) will be kicked off follow the following conditions:

1) Check AC power status
2) Receive MCCS command SET_POWER
3) Main link power down, wait 15sec and enter to the LowPwr (low power-down state)
4) Turn-on the LED2 ON
5). Turn off LCD Backlight

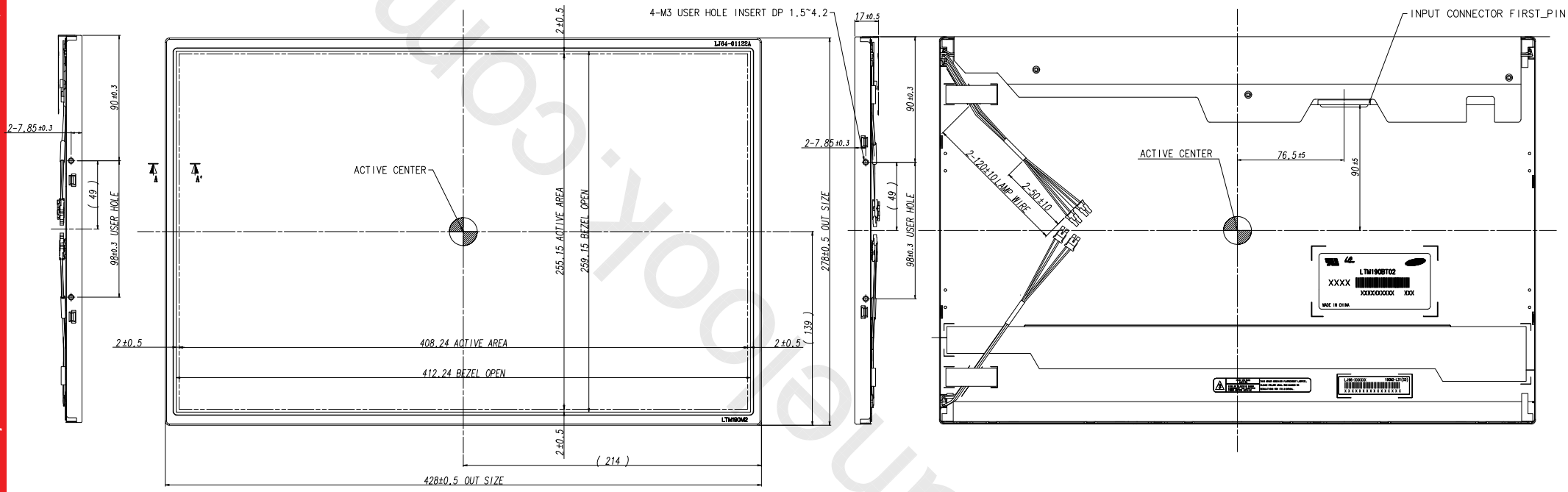
6.8 Error Mode

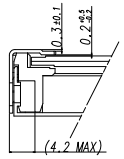
When LCD inputs detect abnormal (non-VESA standard timing),
LCD screen should display black.

7. Outline Dimension

[Refer to the next page]

NO	PART NAME	CODE NO	SPECIFICATION	Q'TY	WEIGHT FINISH	WEIGHT MATERIAL	APPLIED DATE OF MATERIAL	REMARKS





SECTION A-A(S:3/1)
(SIDE MOUNT HOLE)

* NOTES

1. BACKLIGHT : 4 COLD CATHODE FLUORESCENT LAMPS.
2. I/F CONNECTOR SPECIFICATION.
   - MAKER: P-TWO
   - PART NO: 187034-30091
     OR equivalent
3. LAMP CONNECTOR/WIRE SPECIFICATION.
   - MAKER : YEON HO
   - PART NO : 35001HS-02L or equivalent
4. USER MOUNTING TORQUE SPEC : 3 ~ 4 kgf-cm

GENERAL TOLERANCE				REV	DATE	DESCRIPTION OF REVISION				REASON	CHK'D BY
STEP	LEVEL 1	LEVEL 2	LEVEL 3	UNIT	mm	DRA'N BY	DES'D BY	CHK'D BY	APP'D BY	MODEL NAME	LTM190BT02
0 < X ≤ 4	±0.05	±0.1	±0.2	SCALE	1/		J.S.OK				
4 < X ≤ 16	±0.08	±0.15	±0.3	TOLERANCE			08.06.13			PART/SHEET NAME	OUTLINE-DIM.
16 < X ≤ 64	±0.12	±0.25	±0.5	SAMSUNG ELECTRONICS						SPEC. NO	
64 < X ≤ 256	±0.25	±0.4	±0.8							CODE NO.	

8. Reliability Test

Test Items		Conditions	Time/Cycle	Sample
HTOL*		50°C , Bias	500 hrs	12
LTOL*		0°C , Bias	500 hrs	5
THB**		40°C / 95% , Bias	500 hrs	5
HTS***		70°C , No Bias	500 hrs	5
LTS***		-20°C , No Bias	500 hrs	5
Thermal Cycle		-20°C/30min ~ +60°C/30min , No bias	100 cycle	5
Box Drop		1 angle , 3 edge , 6 side , 76 cm		2 Box
Shock (Non-operating)		50G , 11msec Sine wave , ± x/y/z axis	1 time/axis	3
Vibration (Non-operating)		1.47Grms , 5~200 Hz ± x/y/z axis , sweep rate : 10 min	30min/axis	3
ESD	Non-Operating	CDM : 150pF, 330Ω, 9point, 3 times/point	± 10kV	3
	Operating	Contact : 150pF, 330Ω, 100point, once/point	± 8kV	3
		Air(non-contact) : 150pF, 330Ω, 100point, once/point	± 15kV	3
Altitude		Thermal :-10~50℃, 15000ft(Operating), 40000ft(Non-operating)	8Hr	3
		Normal :45℃, 15000ft	10Hr	3

[Result Evaluation Criteria]

Under the display quality test conditions with normal operation state, these should be no change which may affect practical display functions.

* HTOL/ LTOL : High/Low Temperature Operating Life

** THB : Temperature Humidity Bias

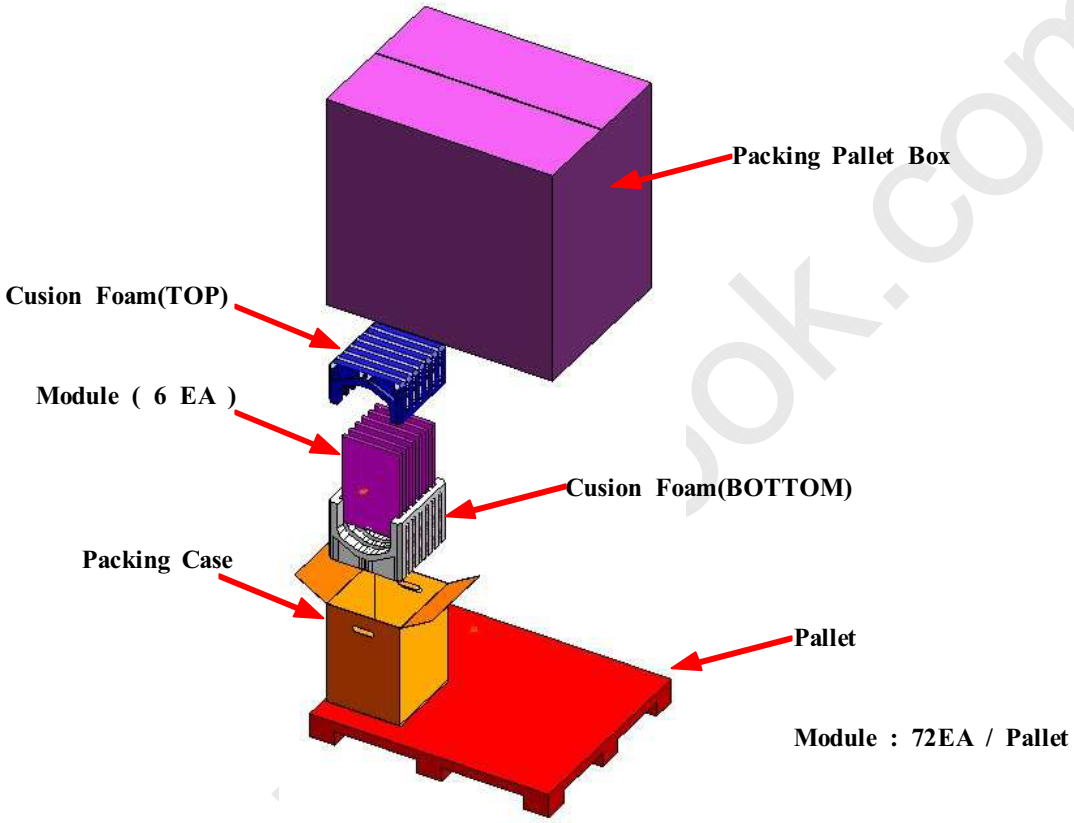
*** HTS/LTS : High/Low Temperature Storage

9. PACKING

9.1 CARTON (Internal Package)

(1) Packing Method

a. Without Inverter



NOTE 1) TOTAL (Packing BOX) : Approx. 16.0㎏

2) Acceptance number of piling : 4 Boxs

3) Packing Case size : 380(W) * 350(D) * 492(H)

4) Packing Pallet Box size : 1074(W) * 778(D) * 1008(H)

10. MARKING & OTHERS

Approval Specification

A nameplate bearing followed by is affixed to a shipped product at the specified location on each product.

(1) Parts number : LTM190BT02

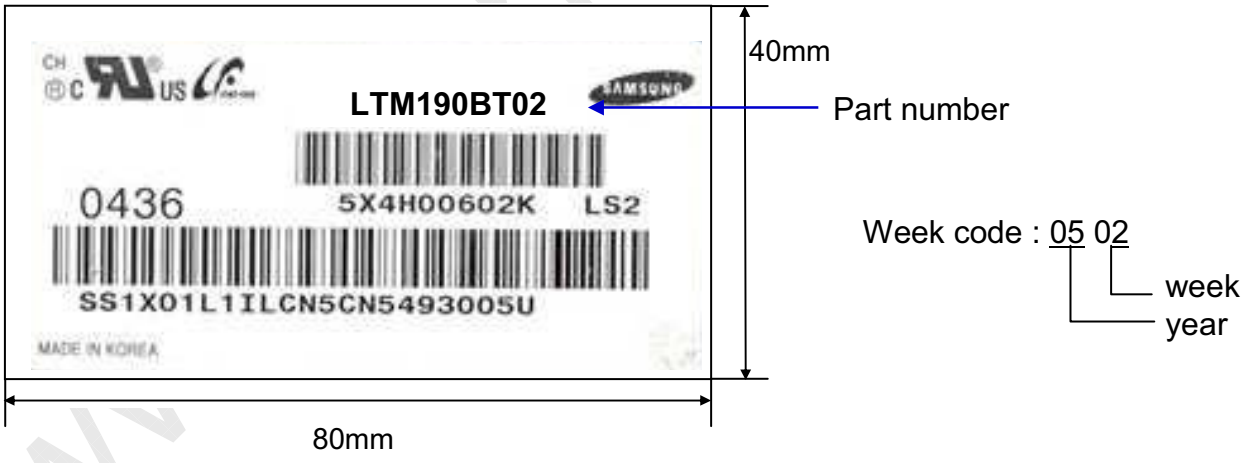
(2) Revision: Three letters

(3) Lot number : X X X X XXX XX X

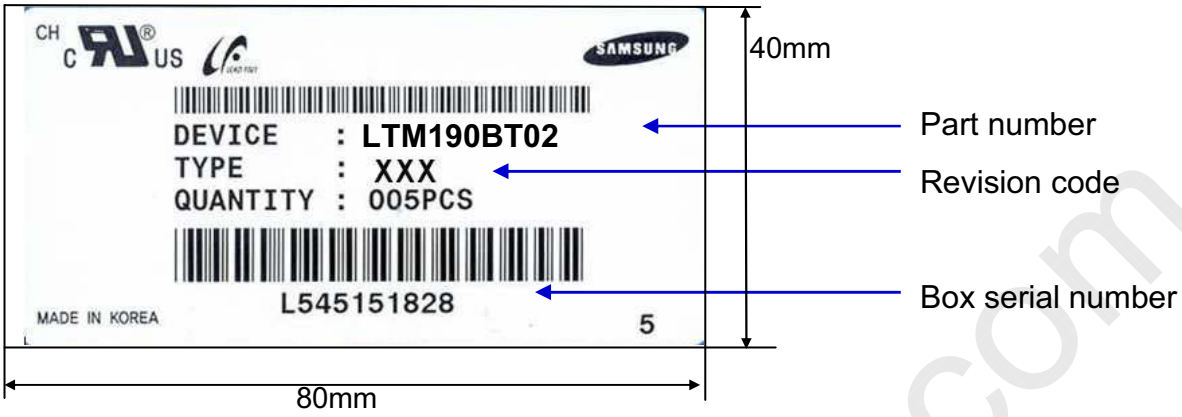
- X XXX: Cell Position No. (In the Glass)
- XX: Glass No. (In the one Lot)
- XXX: Lot No. (Glass)
- X: Month
- X: Year (Note1)
- X: Product code
- X: Line

Note (1) This code indicating year is omitted in the products of KIHENG site.

(4) Nameplate Indication



(5) Packing box attach



(6) Others

a. After service part

Because of narrow bezel structure, lamp cannot be replaced.

11. General Precautions

11.1 Handling

(a) When the module is assembled, it should be attached to the system firmly using all mounting holes. Be careful not to twist and bend the module.

(b) Because the inverter uses high voltages, it should be disconnected from power source before it is assembled or disassembled.

(c) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, it may cause improper operation or damage to the module and CCFT back light.

(d) Note that polarizer films are very fragile and could be damaged easily. Do not press or scratch the surface harder than a HB pencil lead.

(e) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, staining or discoloration may occur.

(f) If the surface of the polarizer is dirty, clean it using absorbent cotton or soft cloth.

(g) Desirable cleaners are water, IPA (Isopropyl Alcohol) or Hexane. Do not use Ketone type materials (ex. Acetone), Ethyl alcohol, Toluene, Ethyl acid or Methyl chloride. It might cause permanent damage to the polarizer due to chemical reaction.

(h) If the liquid crystal material leaks from the panel, it should be kept away from the eyes or mouth . In case of contact with hands, legs or clothes, it must be washed away with soap thoroughly.

(i) Protect the Module from static, or the CMOS Gate Array IC would be damaged.

(j) Use finger-stalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.

(k) Do not disassemble the Module.

(l) Do not pull or fold the lamp wire.

(m) Do not adjust the variable resistor located on the Module.

(n) Protection film for polarizer on the Module should be slowly peeled off just before use so that the electrostatic charge can be minimized.

(o) Pins of I/F connector should not be touched directly with bare hands.

11.2 Storage

(a) Do not leave the Module in high temperature, and high humidity for a long time. It is highly recommended to store the Module with temperature from 0 to 35℃ and relative humidity of less than 70%.

(b) Do not store the TFT-LCD Module in direct sunlight.

(c) The Module should be stored in a dark place. It is prohibited to apply sunlight or fluorescent light in storing.

11.3 Operation

(a) Do not connect or disconnect the Module in the "Power On" condition.

(b) Power supply should always be turned on/off by the item 6.3 "Power on/off sequence"

(c) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference should be done by system manufacturers. Grounding and shielding methods may be important to minimize the interference.

(d) The cable between the back light connector and its inverter power supply should be connected directly with a minimized length. A longer cable between the back light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

11.4 Operation Condition Guide

(a) The LCD product should be operated under normal conditions.
Normal condition is defined as below;
- Temperature : 20±15℃
- Humidity : 65±20%
- Display pattern : continually changing pattern (Not stationary)

(b) If the product will be used in extreme conditions such as high temperature, humidity, display patterns or operation time etc.., It is strongly recommended to contact SEC for Application engineering advice. Otherwise, its reliability and function may not be guaranteed. Extreme conditions are commonly found at Airports, Transit Stations, Banks, Stock market, and Controlling systems.

11.5 Others

(a) Ultra-violet ray filter is necessary for outdoor operation.

(b) Avoid condensation of water. It may result in improper operation or disconnection of electrode.

(c) Do not exceed the absolute maximum rating value. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, and so on)
Otherwise the Module may be damaged.

(d) If the Module keeps displaying the same pattern for a long period of time, the image may be "stuck" to the screen.
To avoid image sticking, it is recommended to use a screen saver.

(e) This Module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.

(f) Please contact SEC in advance when you display the same pattern for a long time.