

Product Information

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SAMSUNG TFT-LCD
MODEL NO. : LTA230W1-L02

Note:

Any Modification of Spec is not allowed without SEC's permission.

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General Description

* Description

LTA230W1-L02 is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as a switching devices. This model is composed of a TFT LCD panel, a driver circuit and a back-light system. The resolution of a 23.0" contains 1366 x 768 pixels and can display up to 16.7 million colors with wide viewing angle of 85° or higher in all directions.

* Features

- High contrast ratio, high aperture structure
- APVA (Advanced Patterned Vertical Align) mode
- Wide viewing angle ($\pm 170^\circ$)
- High speed response
- WXGA (1366 x 768 pixels) resolution (16:9)
- Low Power consumption
- 6 Direct U-Type CCFL (Cold Cathode Fluorescent Lamp)
- LVDS (Low-Voltage Differential Signal) interface.(1pixel/clock)

* Applications

Home-alone Multimedia TFT-LCD TV
 Display terminals for AV application products
 High Definition TV (HD TV)

* General information

Items	Specification	Unit	Note
Display area	508.125(H) × 285.696(V)	mm	
Driver element	a-Si TFT active matrix		
Display colors	16.7M (true)	colors	16,777,216
Number of pixels	1366 x 768	pixel	16:9
Pixel arrangement	RGB Vertical Stripe		
Pixel pitch	0.372(H) × 0.372(W)	mm	
Display mode	Normally Black		
Surface treatment	Haze 44%, Hard-coating(3H)		conductive pol

*** Mechanical information (Panel Module Only)**

Item		Min.	Typ.	Max.	Note
Module size	Horizontal(H)	545.0	546.0	547.0	mm
	Vertical(V)	317.3	318.3	319.3	mm
	Depth(D)	45.3	46.3	47.3	mm (With Inverter)
Weight		-	-	3,000	g

1. Absolute Maximum Ratings

1.1 Absolute ratings of environment

Item	Symbol	Min.	Max.	Unit	Note
Storage temperature	T _{STG}	-20	65	°C	(1)
Operating temperature (Ambient temperature)	T _{OPR}	0	50	°C	(1)
	T _{sur}	0	65	°C	(2)
Shock (non - operating)	Snop	-	50	G	(3),(5)
Vibration (Non - operating)	Vnop	-	1.5	G	(4),(5)

Note (1) Temperature and relative humidity range are shown in the figure below.

93.8 % RH Max. (40 °C ≥ Ta)

Maximum wet-bulb temperature at 39 °C or less. (Ta > 40 °C) No condensation.

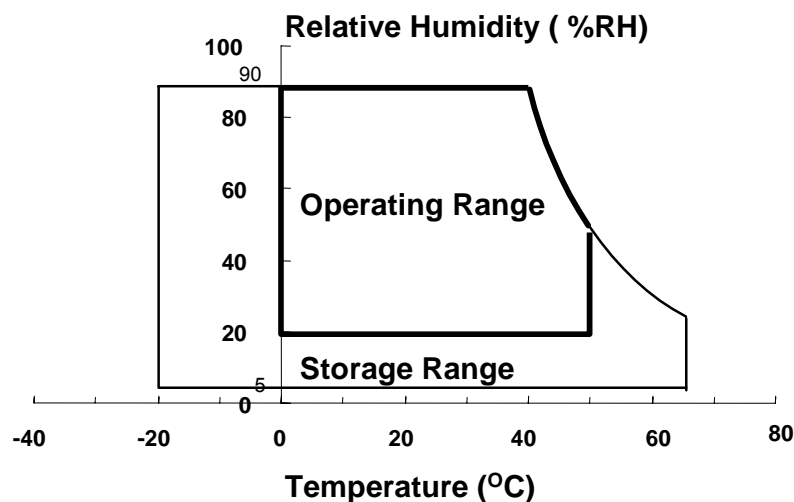
(2) Abnormal visual problems by panel surface temperature can be occurred in specific range. But materials(ex : polarizer) are not damaged permanently in this range, T_{sur}.

(3) 11ms, sine wave, 1 time for ±X, ±Y, ±Z axis

(4) 10~300Hz/1.5G

(10min/cycle, 30min for X,Y,Z axis)

(5) At testing Vibration and Shock, the fixture in holding the Module to be tested have to be hard and rigid enough so that the Module would not be twisted or bent by the fixture.



1.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD Module

(V_{ss} = GND = 0 V)

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	VDD	V _{ss} -0.5	6.5	V	(1)

NOTE (1) Within Ta (25 ± 2 °C)

(2) BACK-LIGHT UNIT

(Ta = 25 ± 2°C)

ITEM	SYMBOL	MIN.	MAX.	UNIT	NOTE
Power Supply Voltage/ Inverter	V _{CC}	21.6	26.4	V	(1)
Lamp Current	I _L	4.0	7.0	mArms	(2),(3)
Lamp Frequency	F _L	55	65	kHz	(2)

NOTE (1) Inverter Input power

- (2) Permanent damage to the device may occur if maximum values are exceeded. Functional operation should be restricted to the conditions described under Normal Operating Conditions.
- (3) Specified values are for a single lamp.

2. Optical Characteristics

The following items are measured under stable conditions. The optical characteristics should be measured in a dark room or equivalent state with the methods shown in Note (1).

Measuring equipment : TOPCON BM-5A , BM-7, PHOTO RESEARCH PR650

* Ta = 25 ± 2°C , VDD=5.0V, fv= 60Hz, f_{CLK}=80 MHz, IL = 6.5mA_{rms}

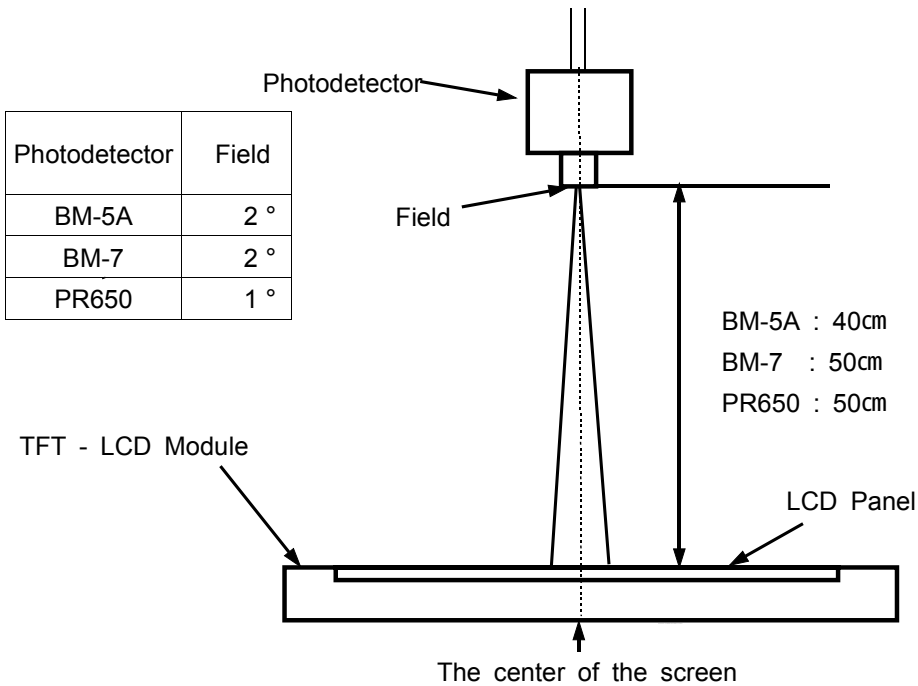
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note	
Contrast Ratio (Center of screen)	C/R		500	800	-		(3) BM-5A	
Response Time (DCC2 On)	Rising	Tr	-	8	10	msec	(4) BM-7	
	Falling	Tf	-	6	8			
	gray	Tg	-	8	-			
Luminance of White (Center of screen)	YL	Normal φ = 0 θ = 0	450	500	-	cd/m ²	(5) BM-5A	
Color Chromaticity (CIE 1931)	Red	Rx	Viewing Angle	TYP. -0.03	0.640	TYP. +0.03	(6) PR650	
		Ry			0.333			
	Green	Gx			0.275			
		Gy			0.595			
	Blue	Bx			0.143			
		By			0.064			
	White	Wx			0.280			
		Wy			0.290			
Color Temperature	k		-	10000	-			
Viewing Angle	Hor.	θ L	C/R ≥ 10	75	85	-	Degrees	(7) BM-5A
		θ R		75	85	-		
	Ver.	φ H		75	85	-		
		φ L		75	85	-		
Brightness Uniformity (9 points)	Buni		-	-	25	%	(8) BM-5A	

Note 1) Test Equipment Setup

After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the back-light. This should be measured in the center of screen.

A single lamp current : 6.5 mA

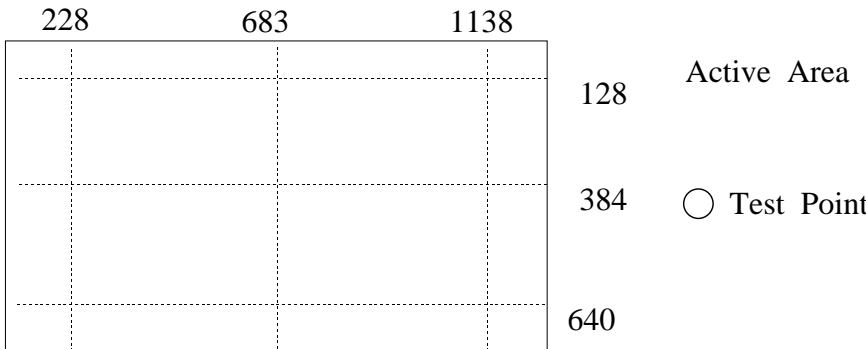
Environment condition : $T_a = 25 \pm 2 \text{ }^\circ\text{C}$



Photodetector	Field
BM-5A	2 °
BM-7	2 °
PR650	1 °

Optical Measuring Equipment Setup

Note 2) Definition of test point



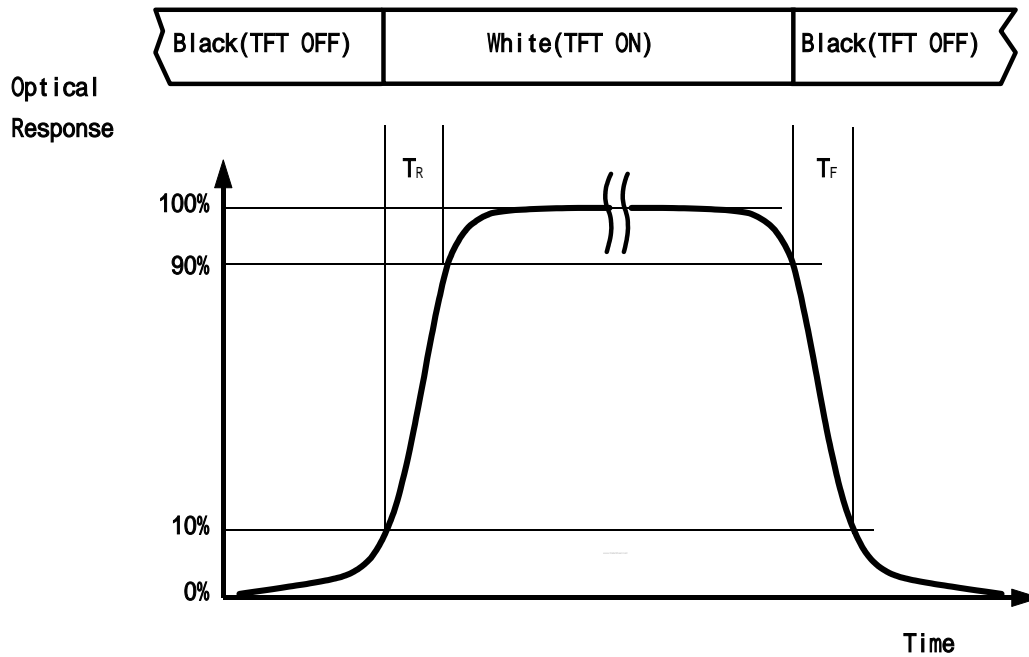
Note 3) Definition of Contrast Ratio (C/R) : Ratio of gray max (Gmax) & gray min (Gmin) at the center point(5) of the panel

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

Gmax : Luminance with all pixels white

Gmin : Luminance with all pixels black

Note 4) Definition of Response time : Sum of Tr ,Tf

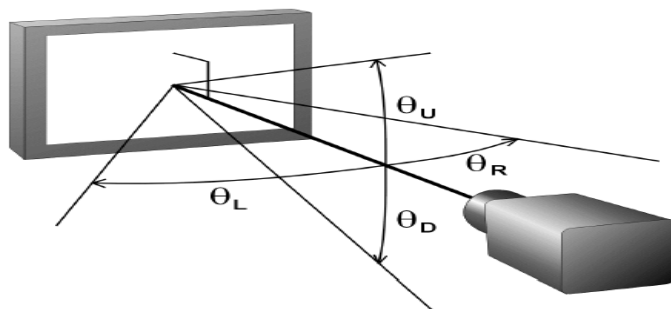


Note 5) Definition of Luminance of White : Luminance of white at center point(5).

Note 6) Definition of Color Chromaticity (CIE 1931)

Color coordinate of Red , Green , Blue & White at center point(5).

Note 7) Definition of Viewing Angle : Viewing angle range ($CR \geq 10$)



Note 8) Definition of 9 points brightness uniformity

$$B_{uni} = 100 * \frac{(B_{max} - B_{min})}{B_{max}}$$

B_{max} : Maximum brightness

B_{min} : Minimum brightness

3. Electrical Characteristics

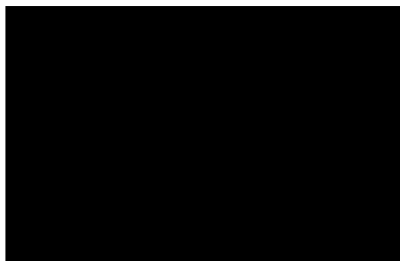
3.1 TFT LCD MODULE

Ta = 25°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply	V _{DD}	4.5	5.0	5.5	V	(1)
Power Consumption	(a)Black	-	1020	1120	mA	(2),(3), (5)
	(b)White	-	1100	1200	mA	
	(c)N-Pattern	-	1620	1800	mA	
Vsync Frequency	f _V	48	60	66	Hz	
Hsync Frequency	f _H	43	48	53	kHz	
Main Frequency	f _{DCLK}	65	80	90	MHz	
Rush Current	I _{RUSH}	-	-	5	A	(4)

- Note
- (1) Main pixel clock frequency is the value which is measured at the input of LVDS transmitter.
 - (2) f_V=60Hz, f_{DCLK} =80MHz, V_{DD} = 5.0V, DC Current.
 - (3) Power dissipation check pattern(LCD Module only)

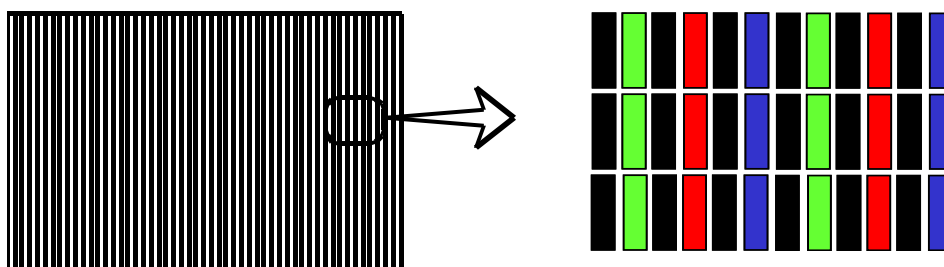
(a) Black Pattern



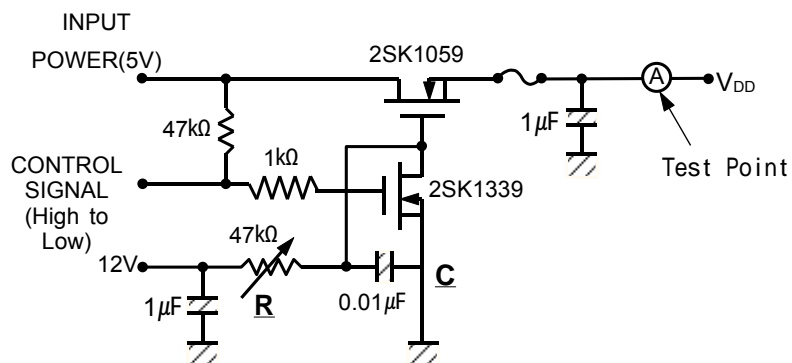
(b) White Pattern



(C) N-pattern



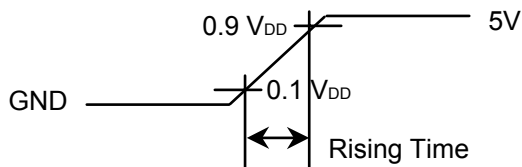
(4) Measurement Conditions (Rising time =470 μ s)



Note : Control Signal : High(+5V) -->Low(Ground)

All Signal lines to panel except for power 5V : Ground

The rising time of supplied voltage is controlled to 470us by R and C value.



(5) Power Consumption Except for Inverter power consumption

3.2 BACK-LIGHT UNIT

The back-light system is an direct - lighting U-type with 6 CCFTs (Cold Cathode Fluorescent Tube) The characteristics of 6 direct lamps are shown in the following tables.

Ta=25 ± 2°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Lamp Current	I _L	4.0	6.5	7.0	mArms	(1)
Lamp Voltage	V _L	1730	1760	1820	Vrms	(1)
Lamp Frequency	f _L	(55)	60	(65)	kHz	(2)
Operating Life Time	Hr	50,000 (25)	-	-	Hour	(3) at 6mA
Start up Voltage	Vs	-	-	0 :2800	Vrms	(4)
				25 :2230		

Note) The waveform of the inverter output voltage must be area symmetric and the design of the inverter must have specifications for the modularized lamp.

Specified values are for a single lamp.

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

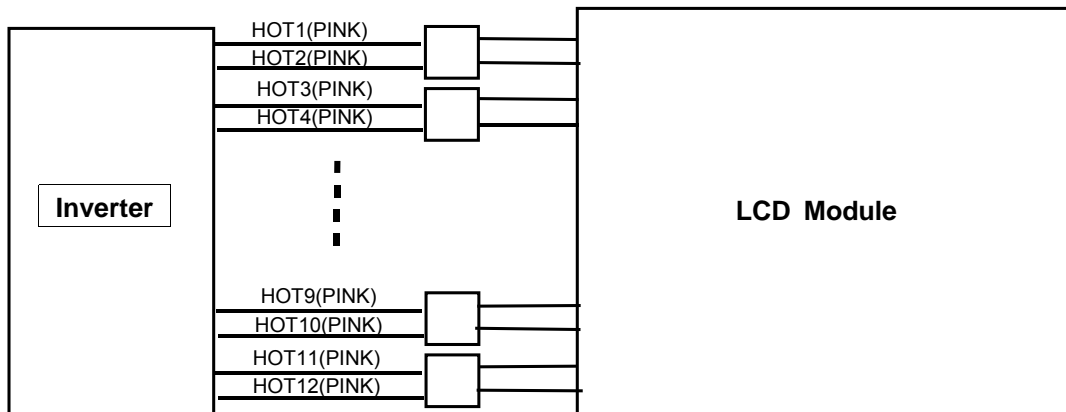
When you design or order the inverter, please make sure that a poor lighting caused by the mismatch of the back-light and the inverter(miss lighting, flicker, etc.) never occur. When you confirm it, the module should be operated in the same condition as it is installed in your instrument.

Note (1) lamp current is measured with current meter.

Refer to the following block diagram of the back-light unit for more information.

Lamp Voltage Min : Lamp Current 7.0 mArms

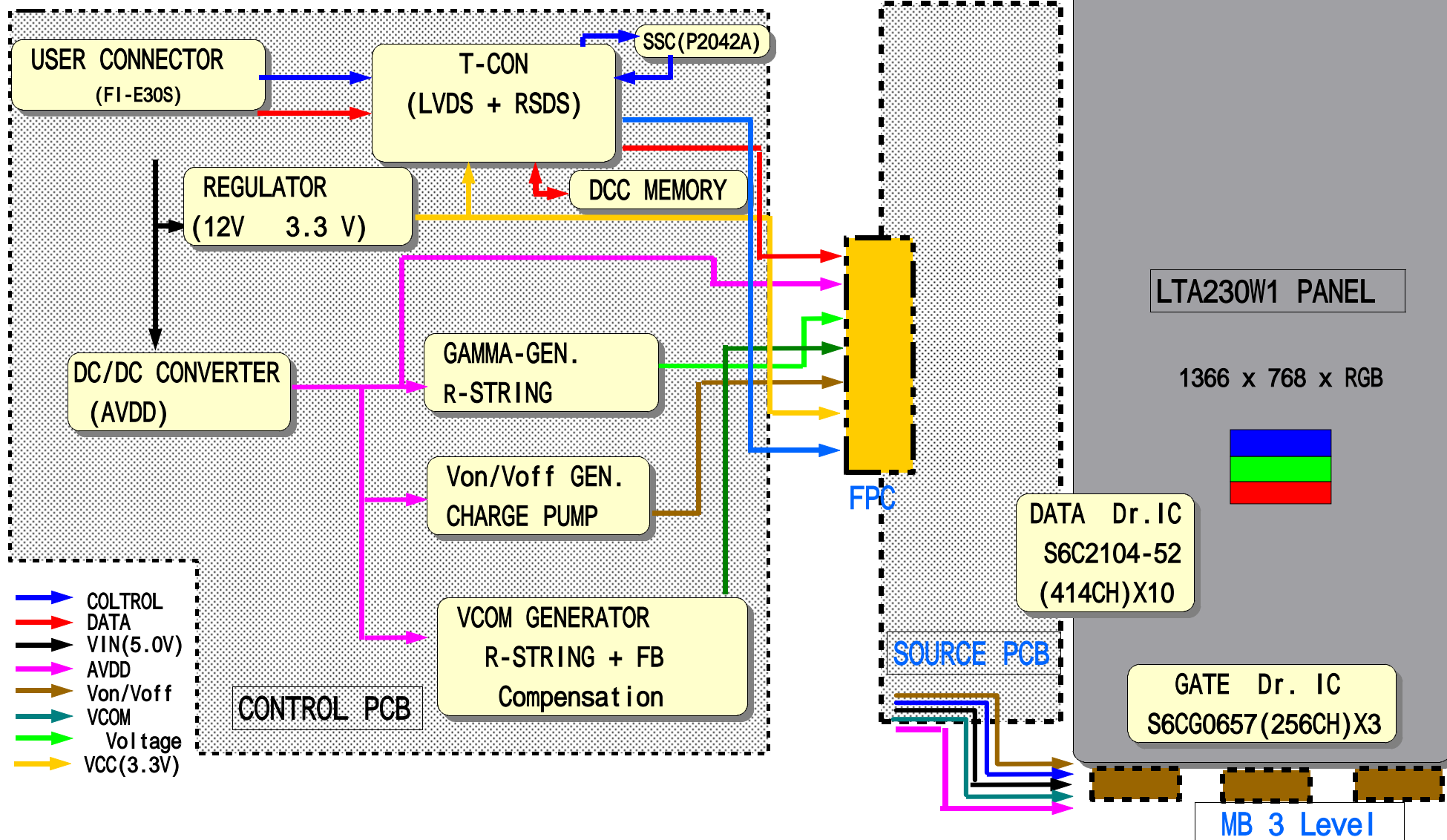
Lamp Voltage Max : Lamp Current 4.0 mArms



- (2) Lamp frequency may produce interference with horizontal synchronous frequency and this may cause line flow on the display.
- (3) Life time (Hr) of a lamp is defined as the time in which it continues to operate under the condition of $T_a = 25 \pm 2^\circ\text{C}$ and $IL = 7.0\text{mA rms(max)}$ for a lamp until the brightness becomes 50% or lower than its original value.
- (4) If an inverter has shutdown function it should keep its output for more than 1 second even if the lamp connector open. Otherwise the lamps may not to be turned on.

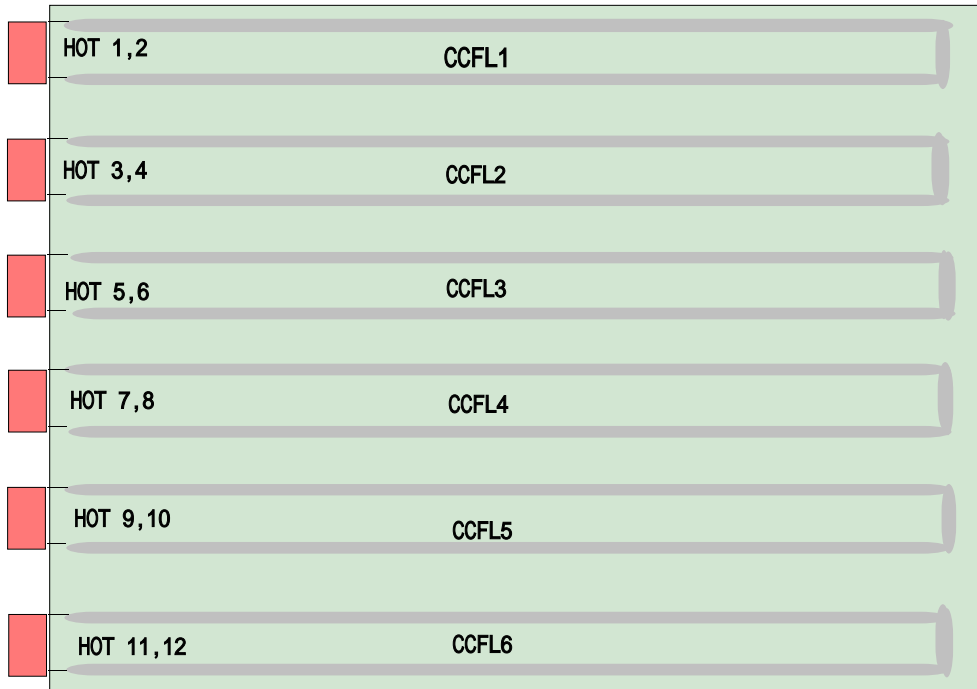
4. Block Diagram

4.1 TFT LCD MODULE



4.2 BACL-LIGHT UNIT

HOT : HIGH VOLTAGE (Part NO. : 20015WR-07L01 (Yeonho))



5. Input Terminal Pin Assignment

5.1. Input Signal & Power : Connector FI-E30S (JAE)

No.	Pin Name	No	Pin Name
1	N.C.*	16	GND
2	N.C.*	17	RxIN3-
3	N.C.*	18	RxIN3+
4	GND	19	GND
5	RxIN0-	20	N.C.*
6	RxIN0+	21	LVDS OPTION**
7	GND	22	N.C.*
8	RxIN1-	23	GND
9	RxIN1+	24	GND
10	GND	25	GND
11	RxIN2-	26	Vin
12	RxIN2+	27	Vin
13	GND	28	Vin
14	RxCLK-	29	Vin
15	RxCLK+	30	Vin

* NOT CONNECTED : THIS PINS ARE ONLY USED FOR SEC INTERNAL OPERATIONS.

** LVDS OPTION : IF THIS PIN : HIGH (3.3V) or Open VESA LVDS FORMAT
 OTHERWISE : LOW (GND) JEIDA LVDS FORMAT

5.2 LVDS Interface

-LVDS Receiver : Tcon (LVDS Rx merged)

-Pixel data (single data)

LVDS Signal	Input Data	VESA	JEIDA
RxIN0	RxOUT0	R0	R2
	RxOUT1	R1	R3
	RxOUT2	R2	R4
	RxOUT3	R3	R5
	RxOUT4	R4	R6
	RxOUT6	R5	R7
	RxOUT7	G0	G2
RxIN1	RxOUT8	G1	G3
	RxOUT9	G2	G4
	RxOUT12	G3	G5
	RxOUT13	G4	G6
	RxOUT14	G5	G7
	RxOUT15	B0	B2
	RxOUT18	B1	B3
RxIN2	RxOUT19	B2	B4
	RxOUT20	B3	B5
	RxOUT21	B4	B6
	RxOUT22	B5	B7
	RxOUT24	HSYNC	HSYNC
	RxOUT25	VSYNC	VSYNC
	RxOUT26	DE	DE
RxIN3	RxOUT27	R6	R0
	RxOUT5	R7	R1
	RxOUT10	G6	G0
	RxOUT11	G7	G1
	RxOUT16	B6	B0
	RxOUT17	B7	B1
	RxOUT23		

5.3 INVERTER UNIT : Inverter input pin configuration (Connector : S14B-PH-SM3-TB(JST))

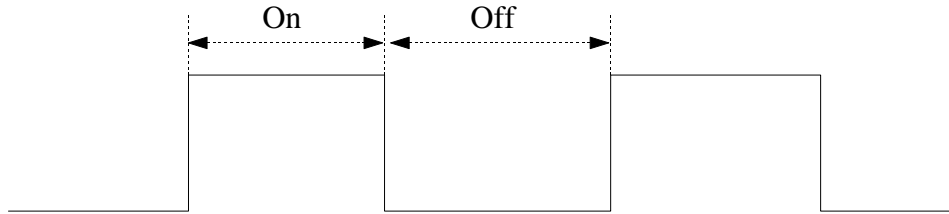
PIN NO.	PIN Configuration (FUNCTION)
1	AWG24 24.0 V
2	AWG24 24.0 V
3	AWG24 24.0 V
4	AWG24 24.0 V
5	AWG24 24.0 V
6	AWG24 GND
7	AWG24 GND
8	AWG24 GND
9	AWG24 GND
10	AWG24 GND
11	N.C
12	BACKLIGHT ON ~ OFF / ON:2.4 - 5.5 V, OFF: -0.3 - 0.8 V
13	Max : 3.3V , Min : 0V
14	Max : 100% , Min : 20%

5.4 Inverter specification

Item	Symbol	Condition	Min	Typ	Max	Unit	Note
Input Voltage	Vin	-	21.6	24.0	26.4	V	
Input Current	Iin	Vin=24.0V, Vbr=5.0V after 2hr aging	-	2.8	4.0	A	
Back-Light On/Off Control	On/Off	Enable the inverter	2.4	-	5.5	V	
		Disable the inverter	-0.3	-	0.8	V	
Lamp Current	Iout (max)	Adim=3.3V(max)	6.5	7.0	7.5	mArms	
		Adim=0V(min)	3.5	4.0	4.5		
PWM Frequency	Freq	VIN=24.0V Vbr=5.0V	120		240	Hz	
Open Lamp Voltage	Vopen	VIN=24.0V Vbr=5.0V	1480	-	-	Vrms	
Striking Time	Ts	No load, 0 VIN=24.0V Vbr=5.0V	1	1.5	2.0	sec	

$V_{br} = 5.0V$ means 100% of PWM dimming

Note(1) High Duty = $On / (On + Off)$



5.5 Input Signal, Basic Display Colors and Gray Scale of Each Color

COLOR	DISPLAY	DATA SIGNAL																					GRAY SCALE LEVEL			
		RED							GREEN							BLUE										
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4		B5	B6	B7
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	-
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	-
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	-
	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	-
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	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	-
GRAY SCALE OF RED	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R0	
	DARK	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R1	
		0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2	
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R252
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	LIGHT	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R253	
		0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R254	
	RED	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R255	
GRAY SCALE OF GREEN	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G0	
	DARK	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	G1	
		0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	G2	
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G252	
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	LIGHT	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	G253	
		0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	G254	
	GREEN	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	G255	
GRAY SCALE OF BLUE	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	B0	
	DARK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	B1	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	B2	
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B252	
		:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	B253	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	B254	
	BLUE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	B255	

Note) Definition of Gray :

Rn : Red Gray, Gn : Green Gray, Bn : Blue Gray (n = Gray level)

Input Signal : 0 = Low level voltage, 1 = High level voltage

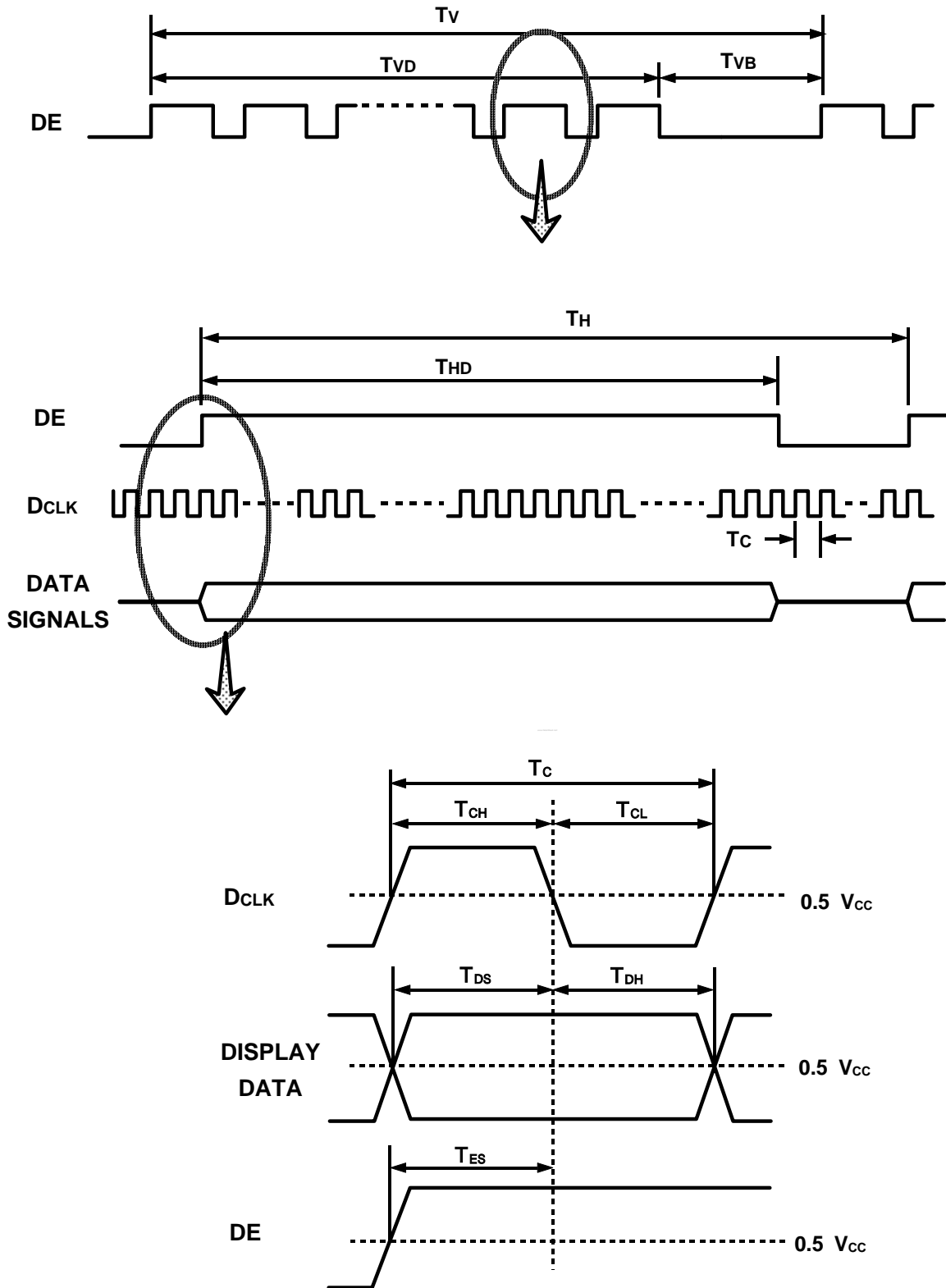
6. Interface Timing

6.1 Timing Parameters (DE only mode)

SIGNAL	ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	NOTE
Clock	Frequency	1/TC	65	80	90	MHz	-
Hsync		F _h	44	47.3	53	KHz	-
Vsync		F _v	48	60	66	Hz	-
Vertical Active Disply Term	Display Period	T _{VD}	-	768	-	lines	-
	Vertical Total	T _V	773	838	~	lines	-
Horizontal Active Display Term	Display Period	T _{HD}	-	1366	-	clocks	-
	Horizontal Total	T _H	1570	1600	1700	clocks	-

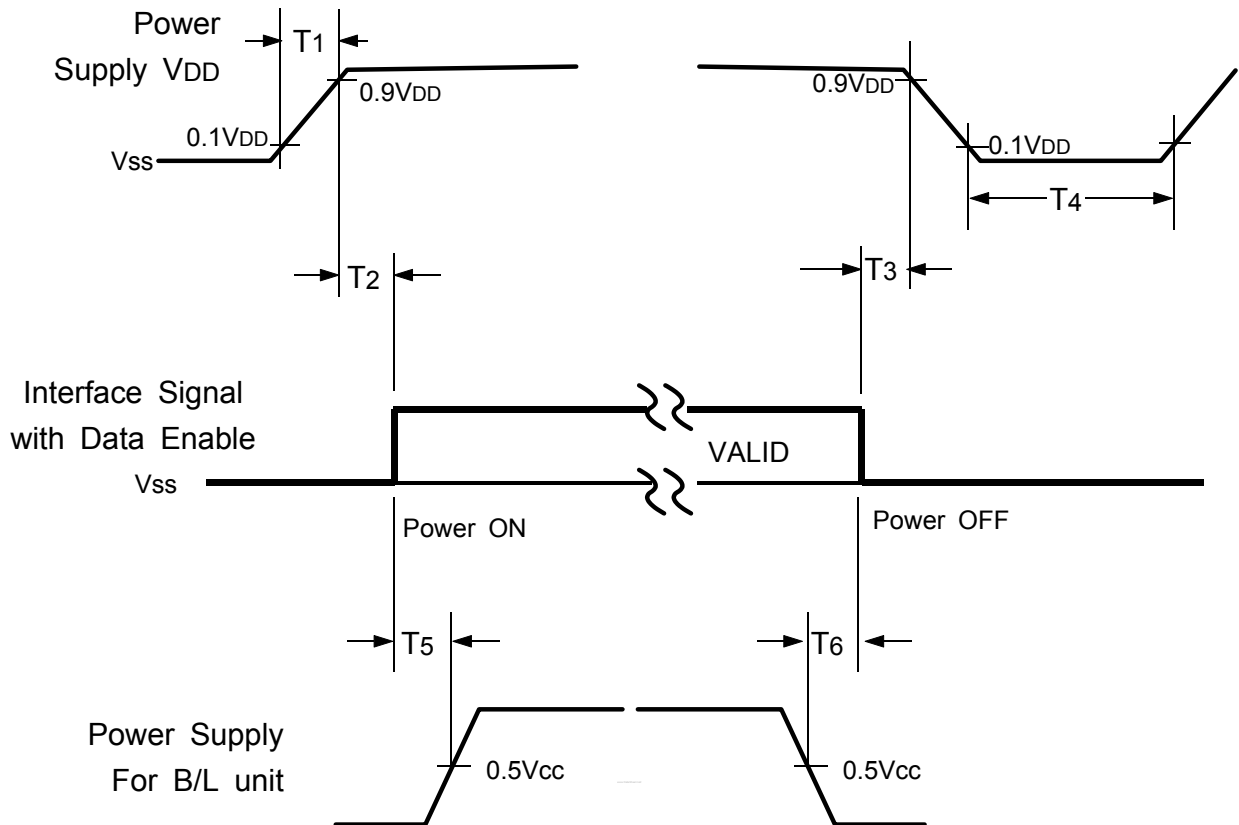
Note) This product is DE only mode. The input of Hsync & Vsync signal does not have an effect on normal operation.

6.2 Timing diagrams of interface signal (DE only mode)



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.

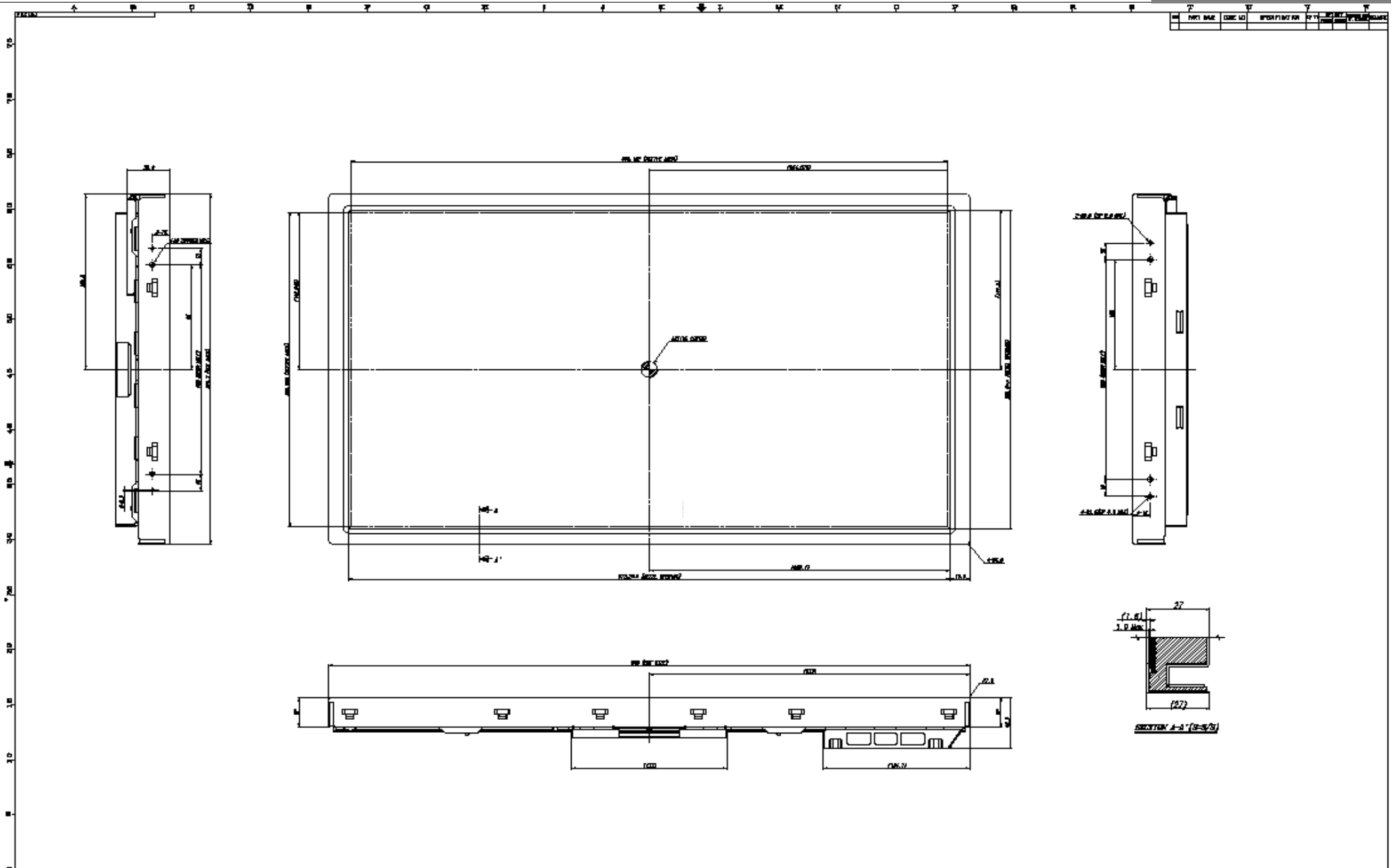


- 0 < T1 30msec
- 0 < T2 50msec
- 0 < T3 50msec
- 300msec T4
- 500 msec T5(Recommand Value)
- 100 msec T6(Recommand Value)

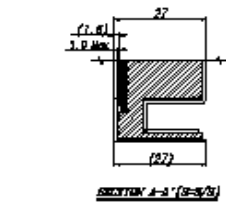
NOTE.

- (1) The supply voltage of the external system for the module input should be the same as the definition of VDD.
- (2) Apply the lamp voltage within the LCD operation range. When the back-light turns on before the LCD operation or the LCD turns off before the back-light turns off, the display may momentarily become abnormal screen.
- (3) In case of VDD = off level, please keep the level of input signals on the low or keep a high impedance.
- (4) T4 should be measured after the module has been fully discharged between power off and on period.
- (5) Interface signal shall not be kept at high impedance when the power is on.

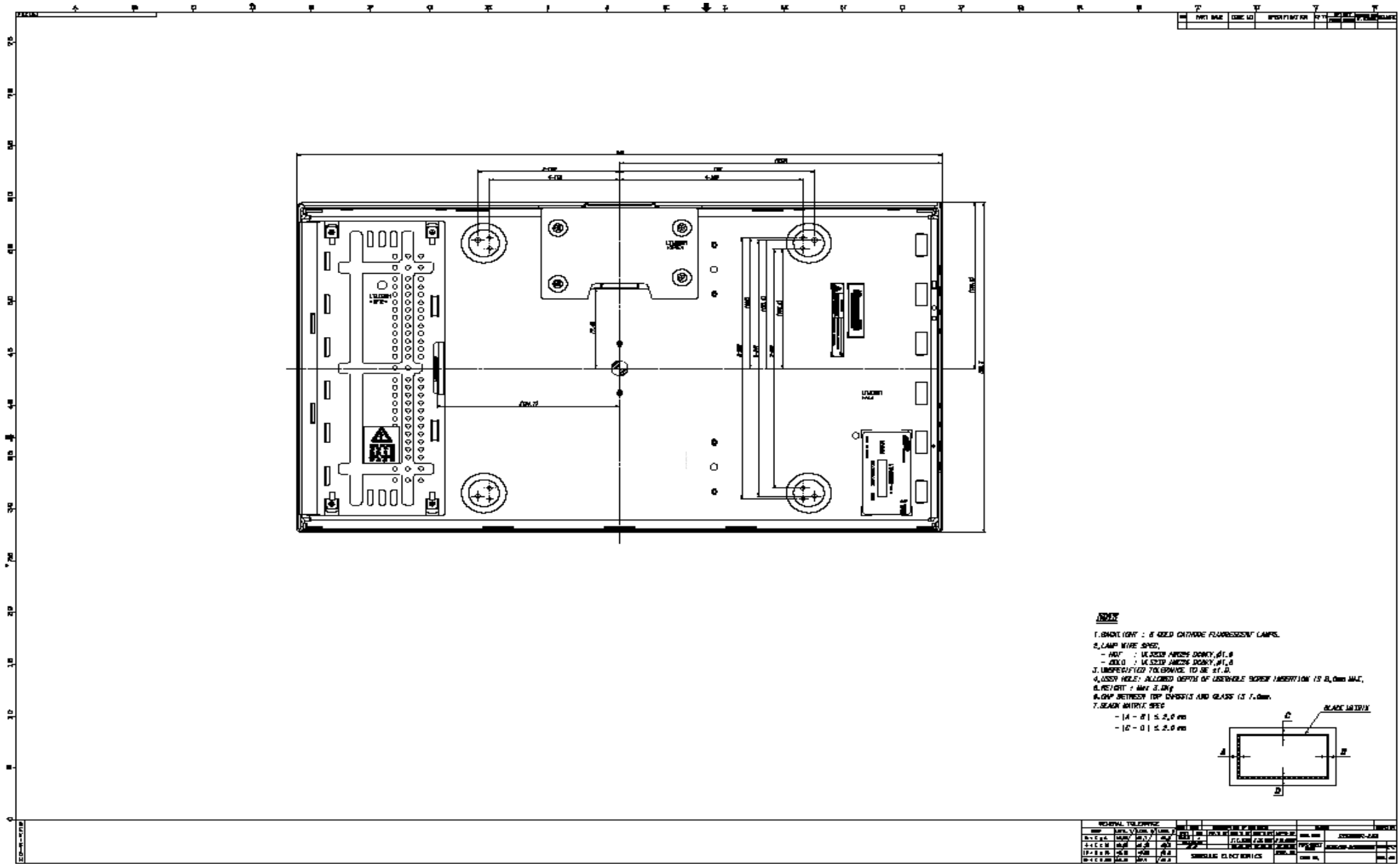
7. Outline Dimension(Front View)



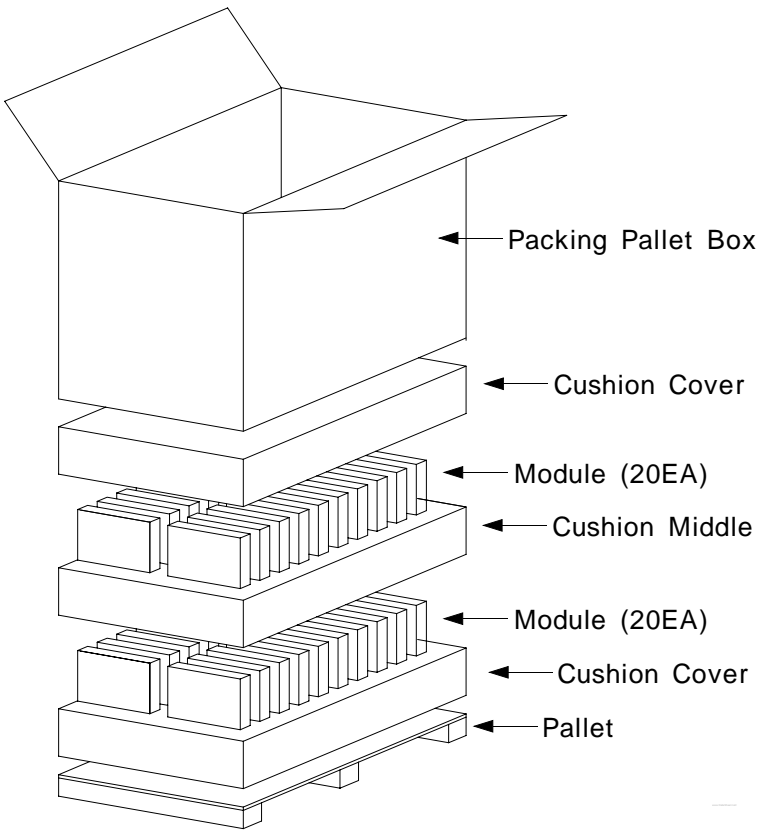
REV	DATE	BY	CHKD	APPV	REMARKS



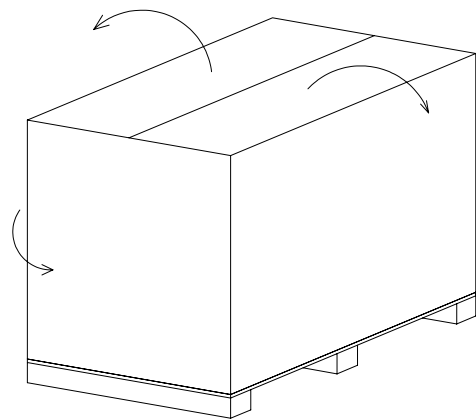
NO.	REV.	DATE	BY	CHKD	APPV	REMARKS



8. PACKING



→ Direction : Be able to open it.



* Packing Specification

ITEM	Specification	Remark
LCD Packing	40ea / Box (Packing-Pallet Box)	1. 3.0kg/LCD(40ea) 2. 3.7kg/Cushion Cover(2ea) 3. 5.5kg/Cushion Middle(1ea) 4. 8.7kg/Packing-Pallet Box(1ea) 5. Cushion Material : EPS 6. Packing Pallet Box Material : DW4
Pallet	1 Box/Pallet	1. Pallet weight : 8.8kg 2. 141.6kg/Pallet , Total : 150.4kg/Pallet
Packing Direction	Vertical	
Pallet Size	H x V x Height	1265mm(H) x 1145mm(V) x 928mm(Height)

9. MARKING & OTHERS

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

(1) Parts number : LTA230W1-L02-XXXX

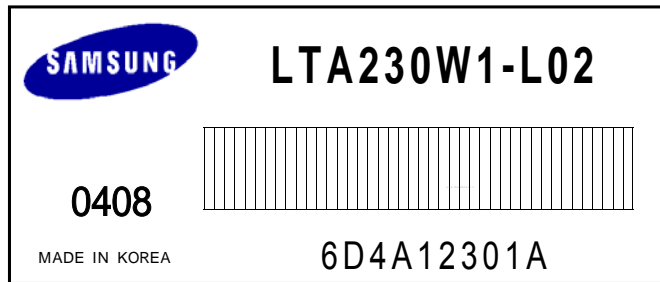
(2) Revision : One letter

(3) Control : One letter

(4) Lot number : $\frac{6}{1} \frac{D}{2} \frac{4}{3} \frac{A}{4} \frac{123}{5} \frac{01}{6} \frac{A}{7}$

- 6 : Line
- D : Device
- 4 : Year
- A : Month
- 123 : LOT NO
- 01 : GLASS NO
- A : CELL NO

(5) Nameplate Indication



(6) Bar code marking for Customer

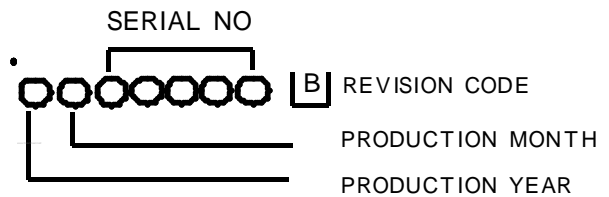
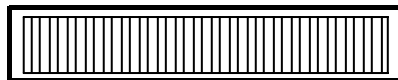
The bar code marking is attached to module backside.

- 1) MODEL NAME : LTA230W1-L02-XXXX
- 2) SAMSUNG
- 3) MADE IN KOREA
- 4) PRODUCTION NUMBER
- 5) USER MODEL NAME

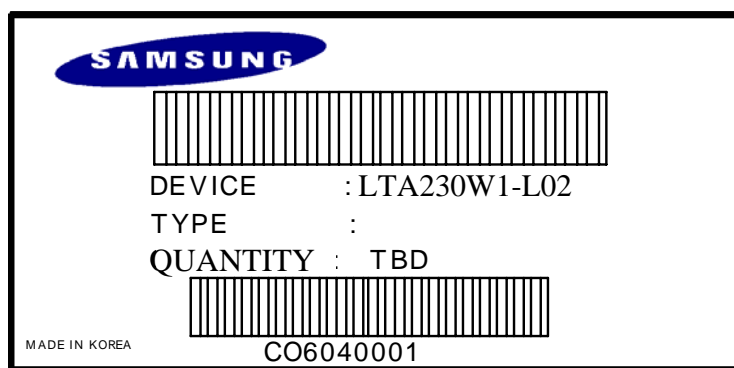
Bar code shows

a) User model name

LTA230W1-L02-0006



(7) Packing box attach



10. General Precautions

10.1 Handling

- (a) When the module is assembled into a system, it should be attached firmly using all mounting holes. Be careful not to twist and bend the modules.
- (b) Refrain from strong mechanical shock and / or any force to the module. In addition to damage, this may cause improper operation or damage to the module and CCFL back-light.
- (c) Note that polarizers are very fragile and can be easily damaged. Do not press or scratch the surface harder than a HB pencil lead.
- (d) Wipe off water droplets or oil immediately. If you leave the droplets for a long time, Staining and discoloration may occur.
- (e) If the surface of the polarizer is dirty, clean it using absorbent cotton or soft cloth.
- (f) The 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 may cause permanent polarizer damage due to the chemical reaction.
- (g) If the liquid crystal material leaks from the panel, it should be kept away from the eyes and mouth. In case of contact with skin or clothes, thoroughly wash it away with soap and water.
- (h) Protect the module from static electricity. It may cause damage to the C-MOS Gate Array IC.
- (i) Use finger-stalls with soft gloves to keep display clean during the incoming inspection and the assembly process.
- (j) Do not disassemble the module.
- (k) Do not pull or fold the lamp wire.
- (l) Do not adjust the variable resistor located on the back side.
- (m) I/F connector pins should not be touched directly with bare hands.

10.2 Storage

- (a) Do not expose the module in high temperature, and/or high humidity for a long time. It is highly recommended to store the module within the temperature from 0 to 35°C and relative humidity of less than 70%.
- (b) Do not store the TFT-LCD module in direct sunlight. The module shall be stored in a dark place. Prolonged exposure to sunlight or fluorescent light during the storage will damage the module.

10.3 Operation

- (a) Do not connect or disconnect the module in the “Power On” condition.
- (b) Power supply should always be turned on/off by following item 6.3 “ Power on/off sequence “.
- (c) The 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 minimize the interference.
- (d) The cable between the back-light connector and its inverter power supply should be at the minimum length possible to be connected directly. The longer cable between the back-light and the inverter may cause lower luminance of lamp(CCFT) and may require higher startup voltage(Vs).

Operation Condition Guide

- (a) The LCD product should to be operated under normal conditions.
Normal condition is defined as below;
 - Temperature : 20 ± 15
 - Humidity : $65 \pm 20\%$
 - 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.

10.4 Others

- (a) Use Ultra-violet light filters if outdoor operation is necessary.
- (b) Avoid water condensation. Moisture may penetrate sensitive electrical connections resulting in improper operation.
- (c) Do not exceed the absolute maximum rating values. (supply voltage variation, input voltage variation, variation in part contents and environmental temperature, etc..) Otherwise, the module may be damaged.
- (d) If the module displays the same pattern continuously for a long period of time, it can result in the situation where the image “sticks” (remains) on the screen.
We recommend that you should discuss SEC when you want the module to be operated in displaying the same pattern for a long time.
- (e) The module has sensitive PCB circuitry on the back side and should be handled carefully in order prevent stress and possible failure.