SAMSUNG

SAMSUNG DISPLAY

PRODUCT SPECIFICATION

(√) PRODUCT INFORMATION
( ) APPROVAL SPECIFICATION

This Product Information is subject to change after 3 months of issuing date

CUSTOMER	Wells Gardner	**MODEL**	LTM230HL07
PROGRAM		**EXTENSION CODE**	-D

CUSTOMER APPROVAL & FEEDBACK

ARPPROVED BY	13 / Mar. / '13	Claire Lee	
PREPARED BY	13 / Mar. / '13	Kyle Choi	

Application Engineering Group

Samsung Display Co., Ltd.

Product Configuration Approval Sheet

Description

Items	Content
Customer	Wells Gardner
Product Name	LTM230HL07-D
Project Name	

Customer System Configuration

Items		Content
System Name		-
Purpose		-
IC	Scalar	-
	LED Driver	-
Input Interface		-
OS (AIO)		-
Graphic Card (AIO)		-

Notice : SDC product approval spec guarantee a above customer system.

Contents

Revision History

Version	Date	Page	Description
P0.0	13. Mar., 2013	All	Product information

1. General Description

Overview

LTM230HL07 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 23.0" is 1920 x 1080 (FHD) and this model can display up to 16.7 million colors.

Features

Application - Workstation & Desktop monitors - Display terminals for AV Products - Monitors for Industrial machine
DE (Data Enable) only mode
LVDS (Low Voltage Differential Signaling) interface (2pixel/clock)
RoHS, Halogen Free
Reverse type Landscape display White LED Edge slim Backlight (1-side)
TCO 6.0 compliance

General Information

Items	Specification	Unit
Pixel Pitch	0.2652(H) x 0.2652(W)	mm
Active Display Area	509.184(H) x 286.416(V)	mm
Surface Treatment	AG type, Haze 25% , Hard coating (3H)	-
Display Colors	16.7M (Hi-FRC)	colors
Number of Pixels	1,920 x 1080	pixel
Pixel Arrangement	RGB vertical stripe	-
Display Mode	Normally Black	-
Luminance of White	300(Typ.)	cd/㎡
Power Consumption	Total TBD(16.5W) Typ. (Panel 4.25W / BLU 12.24W)	W

Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	532.7	533.2	533.7	mm	-
	Vertical (V)	311.5	312.0	312.5	mm	
	Depth (D)	-	-	11.0	mm	-
Weight		-	-	(2300)	g	LCD module only

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

2. 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)
Operating Temperature	T_{OPR}	0	50	℃	(2)
Storage temperature	T_{STG}	-20	60	℃	
Glass surface temperature (Operation)	T_{SUF}	0	65	℃	(3)

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) The maximum operating temperature of LCD module is defined with surface temperature of active area. Under any conditions, the maximum ambient operating temperature should be keeping the surface of active area not higher than 65 °C

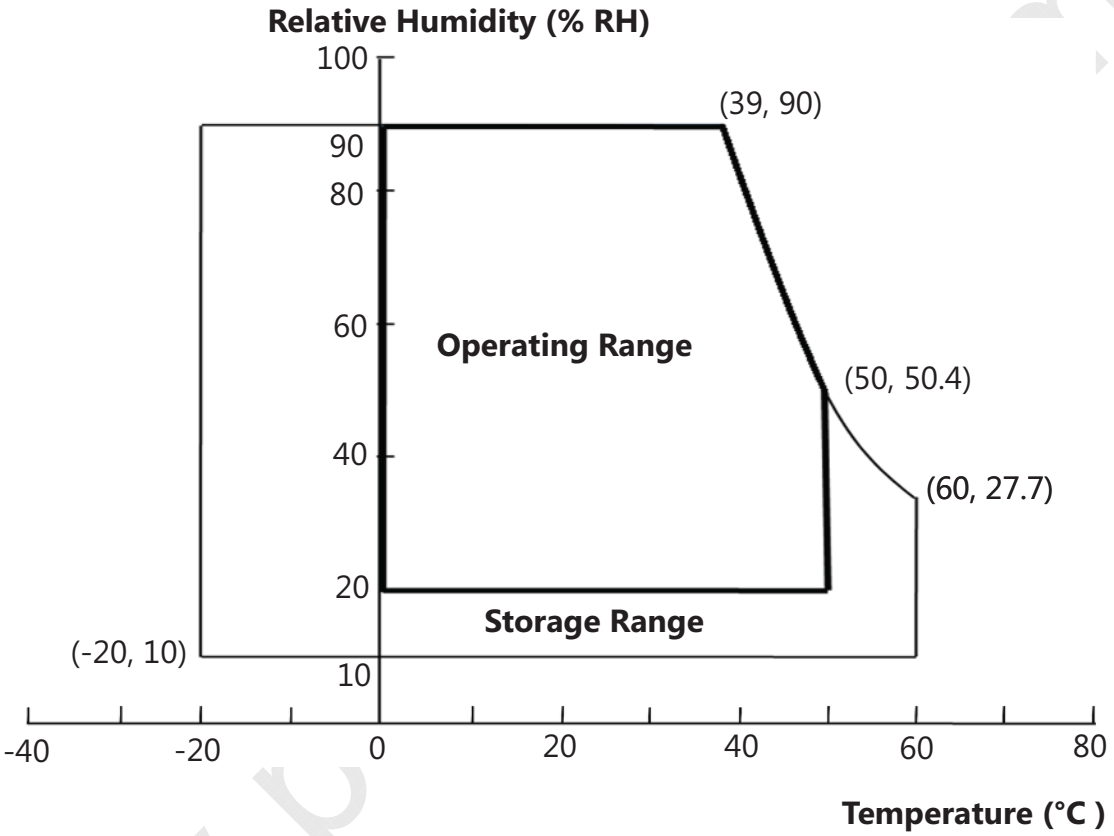


Fig. Temperature and Relative Humidity range

3. Optical Characteristics

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

(Ta = 25 ± 2°C, VDD=5V, fv= 60Hz, f_{DCLK}=67.3MHz, If =360mA)

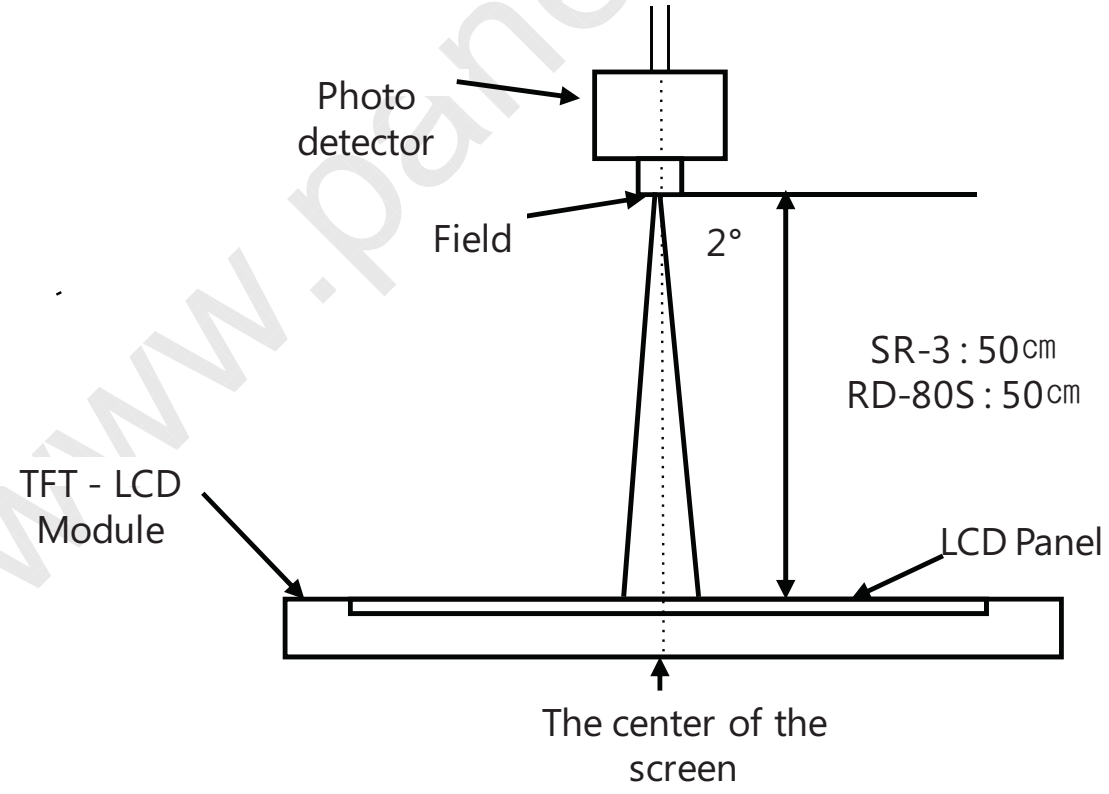
Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio (Center of screen)		C/R		600	1000	-		(3) SR-3
Response Time		G to G		-	12	-	msec	(5) RD-80S
Luminance of White (Center of screen)		Y_L		250	300	-	cd/m^2	(6) SR-3
Brightness Uniformity (9 Points)		B_{uni}		-	-	25	%	(4) SR-3
Color Chromaticity (CIE 1931)	Red	Rx	Normal $\theta_{L,R}$=0 $\theta_{U,D}$=0 Viewing Angle	- 0.030	(0.650)	+0.030		(7),(8) SR-3
		Ry			(0.333)			
	Green	Gx			(0.316)			
		Gy			(0.612)			
	Blue	Bx			(0.152)			
		By			(0.067)			
	White	Wx			0.313			
		Wy			0.329			
Color Chromaticity (CIE 1976)	Red	Ru'		-	(0.456)	-		
		Rv'		-	(0.526)	-		
	Green	Gu'		-	(0.131)	-		
		Gv'		-	(0.567)	-		
	Blue	Bu'		-	(0.174)	-		
		Bv'		-	(0.171)	-		
	White	Wu'		-	0.198	-		
		Wv'		-	0.468	-		

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Color Gamut		-		-	72	-	%	
Color Temperature		-		-	6500	-	K	
Viewing Angle	Hor.	θ_L	CR≥10	85	89	-	Degrees	(8) EZ-Contrast
		θ_R		85	89	-		
	Ver.	θ_U		85	89	-		
		θ_D		85	89	-		

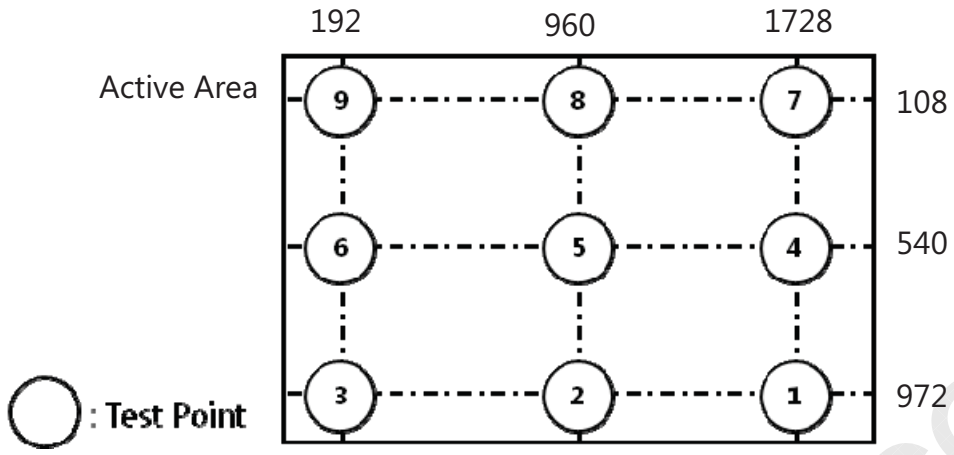
Note (1) Test Equipment Setup

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 the screen.

LED forward current : If = 360mA Environment condition : Ta = 25 ± 2 °C



(2) Definition of test point



(3) Definition of Contrast Ratio (CR)

: Ratio of gray max (G_{max}) & gray min (G_{min}) at the center point⑤ of the panel

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

G_{max} : Luminance with all white pixels
G_{min} : Luminance with all black pixels

(4) Definition of 9 points brightness uniformity

$$B_{uni} = 100 \times \frac{B_{max} - B_{min}}{B_{max}}$$

B_{max} : Maximum brightness
B_{min} : Minimum brightness

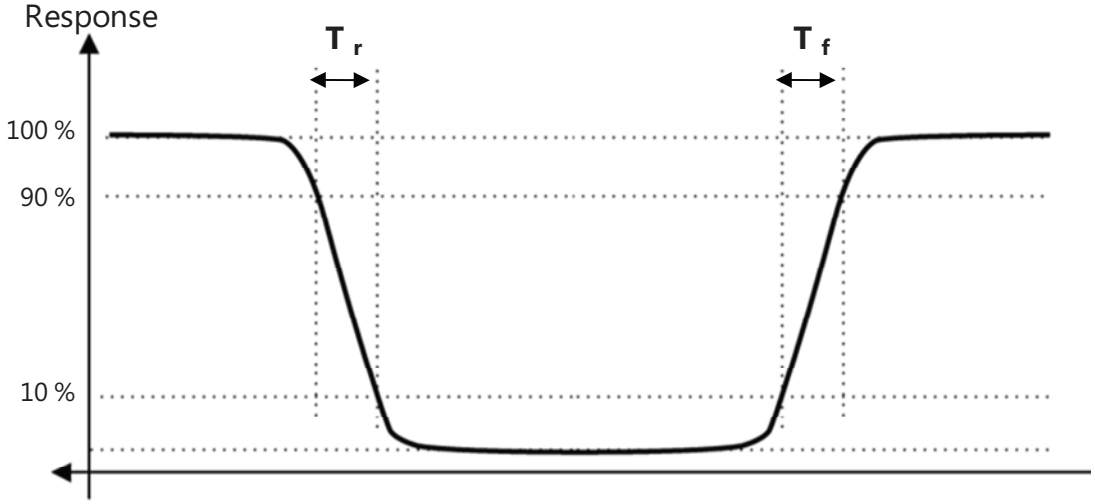
(5) Definition of Response time

GtoG : The time of transitions between specific gray levels

- 31 → 63, 63 → 95, 95 → 127, 127 → 159, 159 → 191 , 191 → 223 grays and vice versa
- G to G typ. : Average time of rising and falling for gray transition except the transition

Optical Instruments

Response



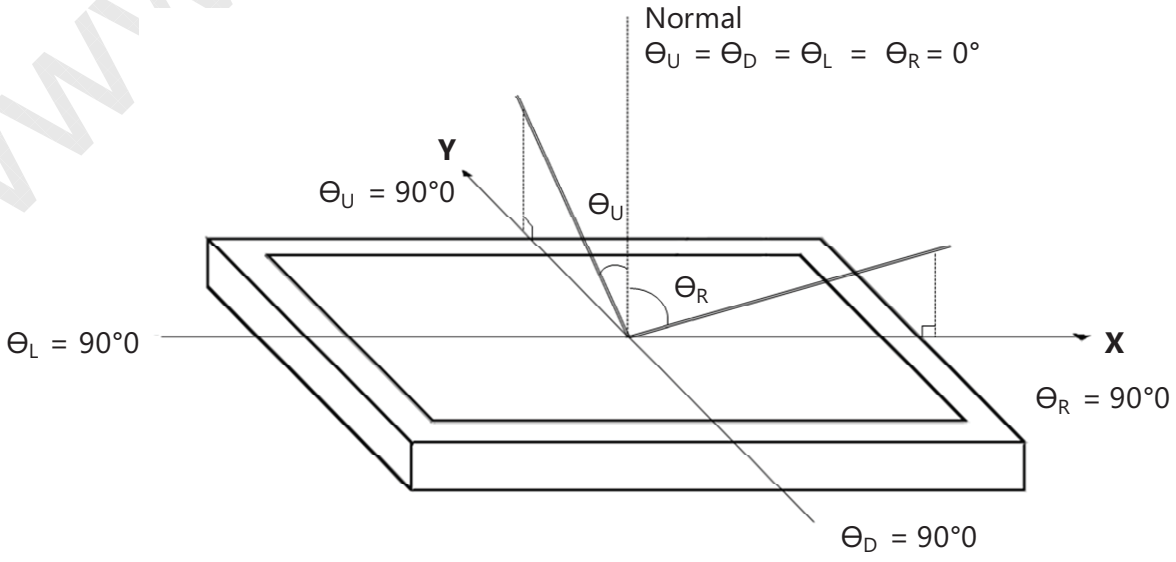
(6) Definition of Luminance of White : Luminance of white at center point (5)

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

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

(8) Definition of Viewing Angle

: Viewing angle range (CR ≥ 10)



4. Block Diagram

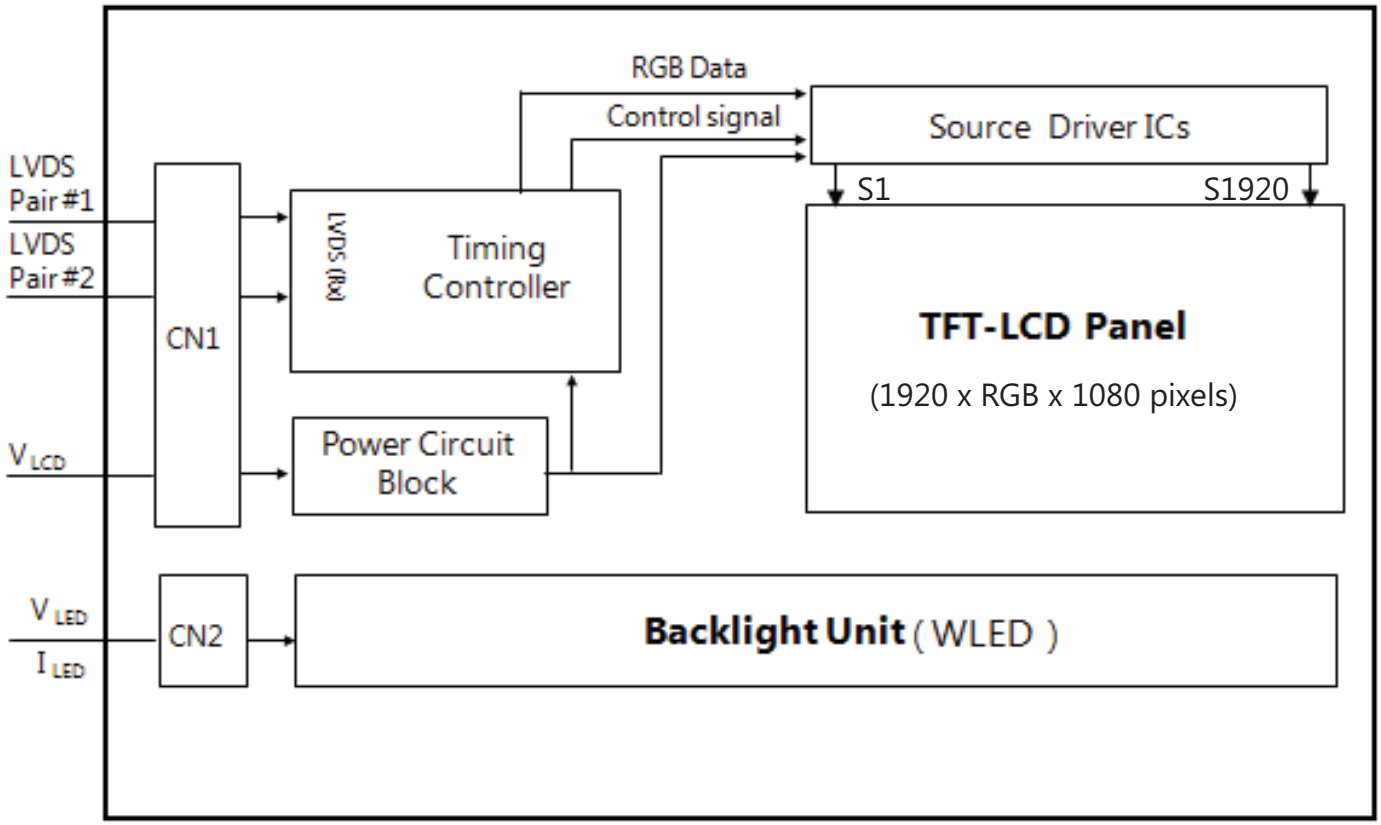


Fig. Function Block Diagram

Note (1) The connector of display data & timing signal should be connected

5. Electrical Characteristics

5.1 TFT LCD Module

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

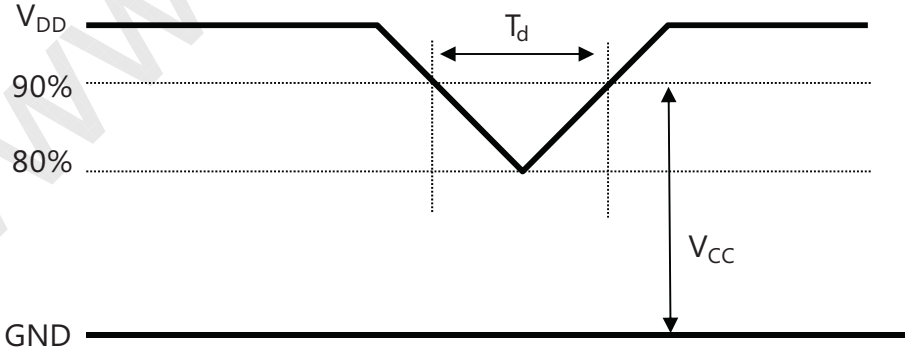
Ta=25 ± 2°C

Item		Symbol	Min.	Typ.	Max.	Unit	Note
Voltage of Power Supply		V_{DD}	4.5	5.0	5.5	V	(1)
Power Dip Condition		V_{CC}	4.0	-	V_{DD}	V	(2)
		T_d	0	-	20	msec	
Current of Power Supply	(a) White	I_{DD}	-	850	-	mA	(3),(4)
	(b) Black		-	500	-	mA	
	(c) Mosaic		-	650	-	mA	
	(d) Dot			750	-	mA	
Power Consumption		P_{LCD}	-	(4.3W)	-	Watt	(4),(5)
Rush Current		I_{RUSH}	-	-	3.0	A	(6)

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

(2) Definition of V_{DD} Power Dip

- The above conditions are for the glitch of the input voltage.
- For stable operation of an LCD Module power, please follow them.



$4.5V \le V_{DD} \le 5.5V$

If V_{DD}(Typ.) x 80% $\le V_{CC} \le V_{DD}$(Typ.) x 90%,

then 0<Td ≤20msec

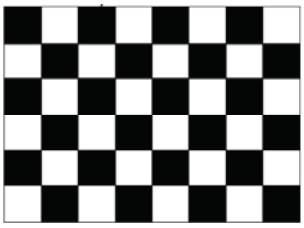
(3) f_V=60Hz, f_{DCLK} = 67.3Hz, V_{DD} = 5.0V, DC Current.

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

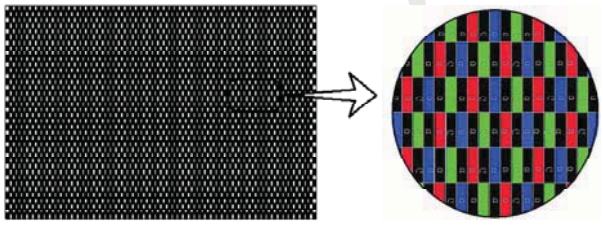
a) White Pattern

b) Black Pattern

c)Mosaic Pattern

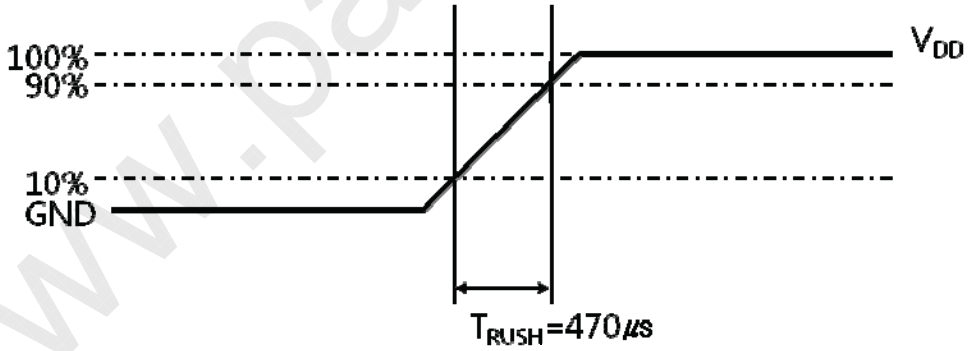


d) Dot Pattern



(5) The power consumption is specified whereas Dot pattern is displayed at f_V=60Hz, f_{DCLK} = 67.3MHz, V_{DD} = 5.0V

(6) Measurement Condition



Rush Current I_{RUSH} can be measured when T_{RUSH}. is 470μs

5.2 Backlight Unit

The characteristics of LED bar Ta=25 ± 2°C.

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED Forward Current	I_F	-	(360)	(390)	mA	(1),(2)
LED Array Voltage	V_P	-	(34.0)	(37)	V	(1)
Power Consumption	P_{BLU}	-	(12.24)	-	Watt	(3)
Operating Life Time	Hr	40,000	-	-	Hour	(4)

Note (1) The specification shown above are not for the converter output, but for the LED bar.
- The LED bar consists of 33 LED packages ; 3 parallel X 11 serial
- LED current is defined at 100% duty ratio of LED driver

(2) The LED Forward current for single LED channel is Typ.120mA
- The output current of converter in the system should be transmitted to the LED bar constantly.
- It is recommended to control the returned signal respectively for even distribution of current to each channel of LED bar

(3) The power consumption is specified at typical current 360mA with 100% duty ratio
- It does not include power loss of external LED driver circuit block
- Typical power consumption $P_{BLU} = I_F$ (Typ.) x V_P (Typ.)

(4) Life time(Hr) is defined as the time when brightness of a LED package itself becomes 50% or less than its original value at the condition of Ta=25 ± 2°C and I_F =360mA.

5.3 LVDS Characteristics

5.3.1. LVDS Input Characteristics

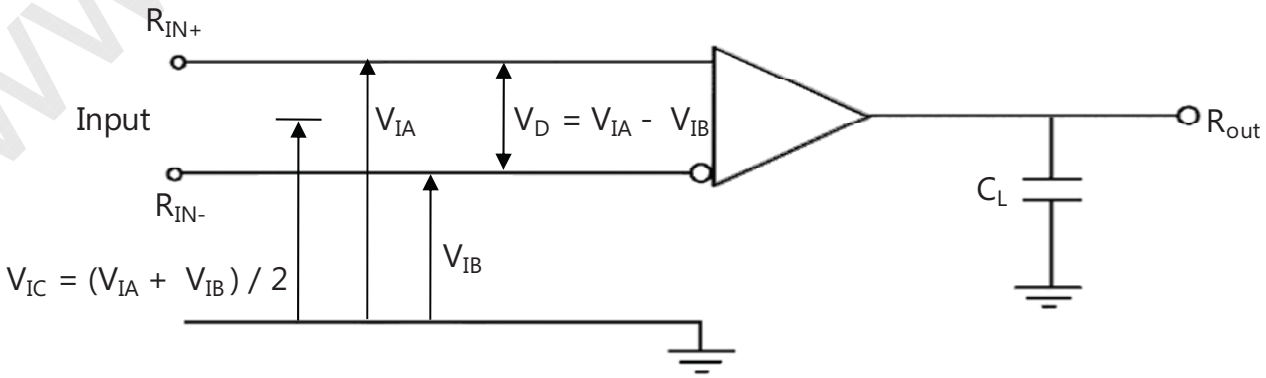
Ta=25 ± 2°C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Differential Input Voltage for LVDS receiver threshold	High	-	-	+50	mV	(1)
	Low	-50	-	-	mV	
LVDS skew	t_{SKEW}	-300	-	300	ps	(2)
Differential input voltage	$\|V_{id}\|$	100	-	600	mV	(3)
Input voltage range(single ended)	V_{in}	0.7	-	1.7	V	(3)
Common mode voltage	V_{cm}	1.0	1.2	1.4	V	(3)

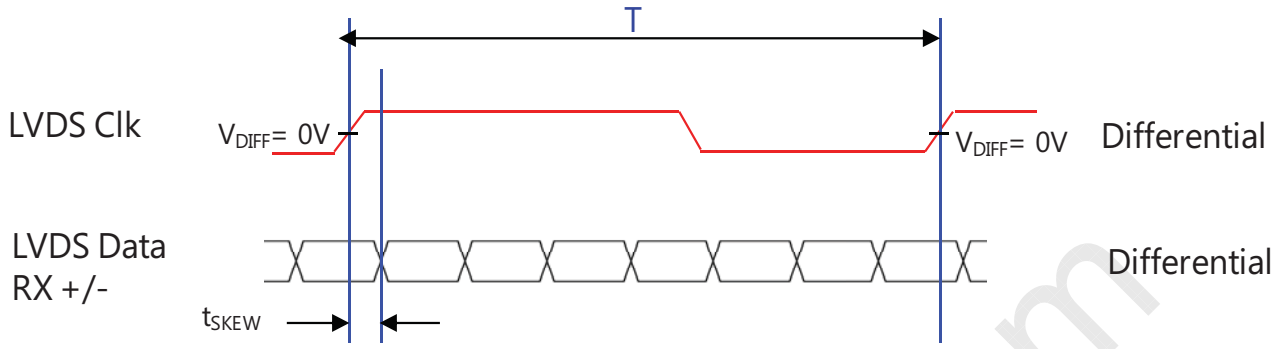
Note (1) Differential receiver voltage definitions and propagation delay and transition time test circuit

a. All input pulses have frequency of 10MHz, t_R or t_F =1ns

b. C_L includes all probe and fixture capacitance

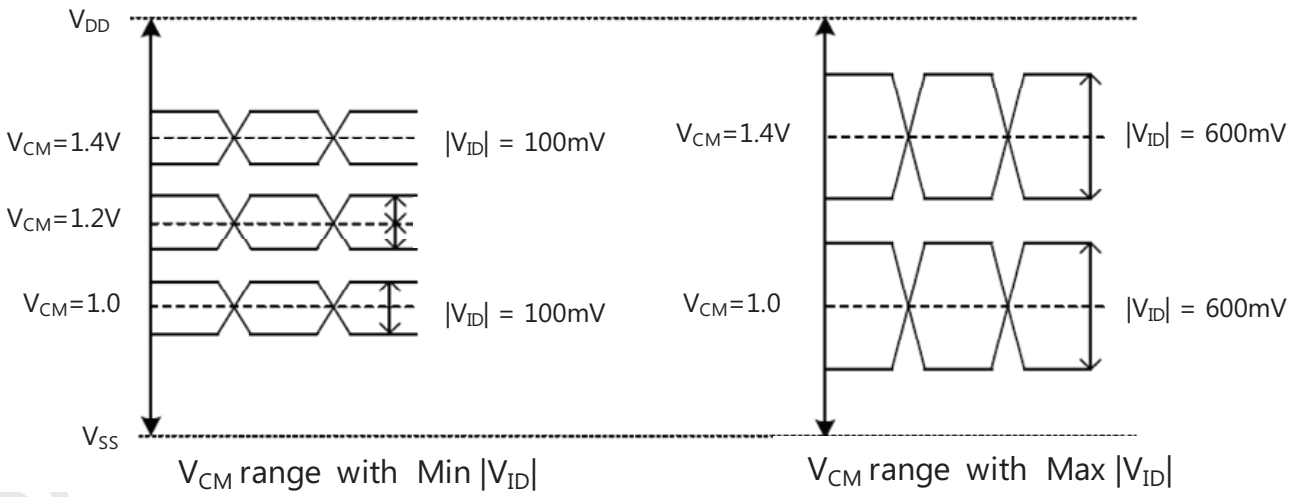


(2) LVDS Receiver DC parameters are measured under static and steady conditions which may not be reflective of its performance in the end application.



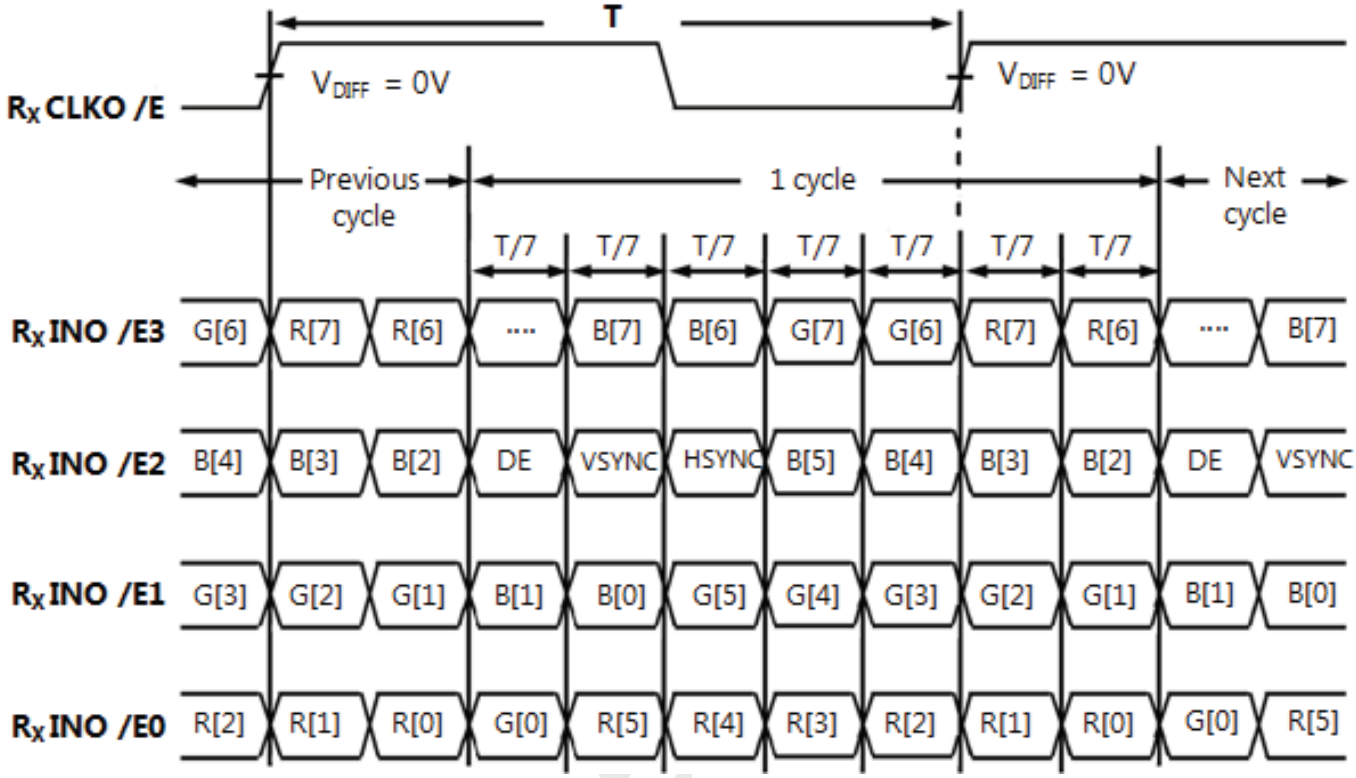
where t_{SKEW} : skew between LVDS clock & LVDS data,
T : 1 period time of LVDS clock
cf. (-/+) of 300psec means LVDS data goes before or after LVDS clock

(3) Definition of V_{ID} and V_{CM} using single-end signals



5.3.2. LVDS Data Format

Timing Diagrams of LVDS For Transmitting
- LVDS Receiver : Integrated T-CON



5.4 Interface Timing Specification

5.4.1. Timing Parameters

SIGNAL	ITEM	SYMBOL	Min.	Typ.	Max.	Unit	Note
Clock	Frequency	$1/T_C$	56.4	67.3	83.0	MHz	-
Hsync		F_H	54.2	66.0	83.8	kHz	-
Vsync		F_V	49	60	75	Hz	-
Vertical Display Term	Active Display Period	T_{VD}	1080	1080	1080	Lines	-
	Vertical Total	T_V	1105	1111	1118	Lines	-
Horizontal Display Term	Active Display Period	T_{HD}	960	960	960	Clocks	2pixel/clock
	Horizontal Total	T_H	990	1010	1040	clocks	2pixel/clock

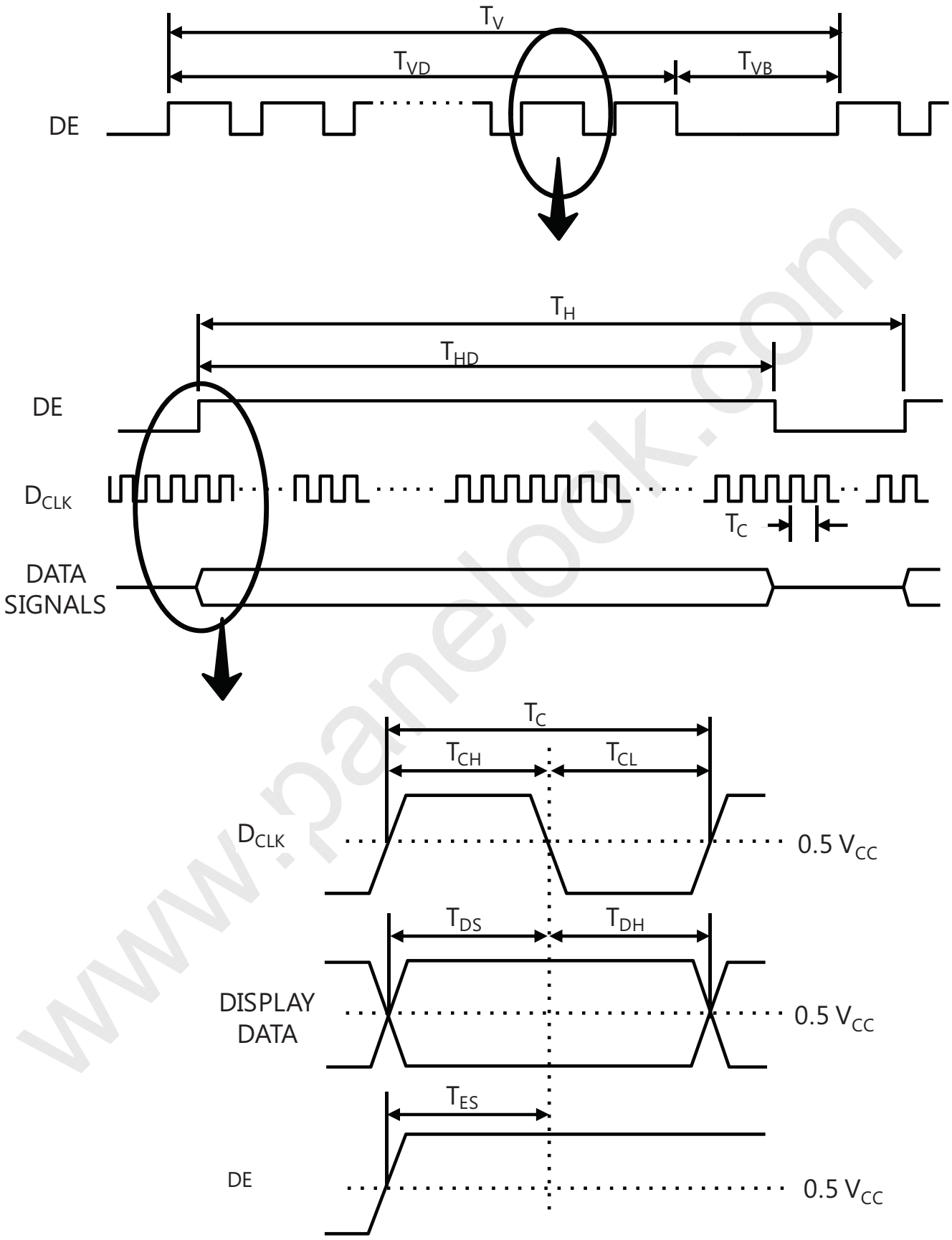
Note (1) DE only mode
- While operation, DE signal should be have the same cycle.

(2) Best operation clock frequency is 67.3MHz(60Hz)

(3) Max, Min variation range is at main clock typical value 67.3MHz

(4) Main frequency Max is 83.0MHz without spread spectrum

5.4.2. Timing diagrams of interface signal (DE only mode)



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

COLOR	DISPLAY (8bit)	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	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	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	0	R2
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			. . .
	↓ LIGHT	1	0	1	1	1	1	1	1	0	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	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	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	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	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	0	G2
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			. . .
	↓ LIGHT	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	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	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	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	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	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	0	B2
		:	:	:	:	:	:			:	:	:	:	:	:			:	:	:	:	:	:			. . .
	↓ LIGHT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	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	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	1	B255

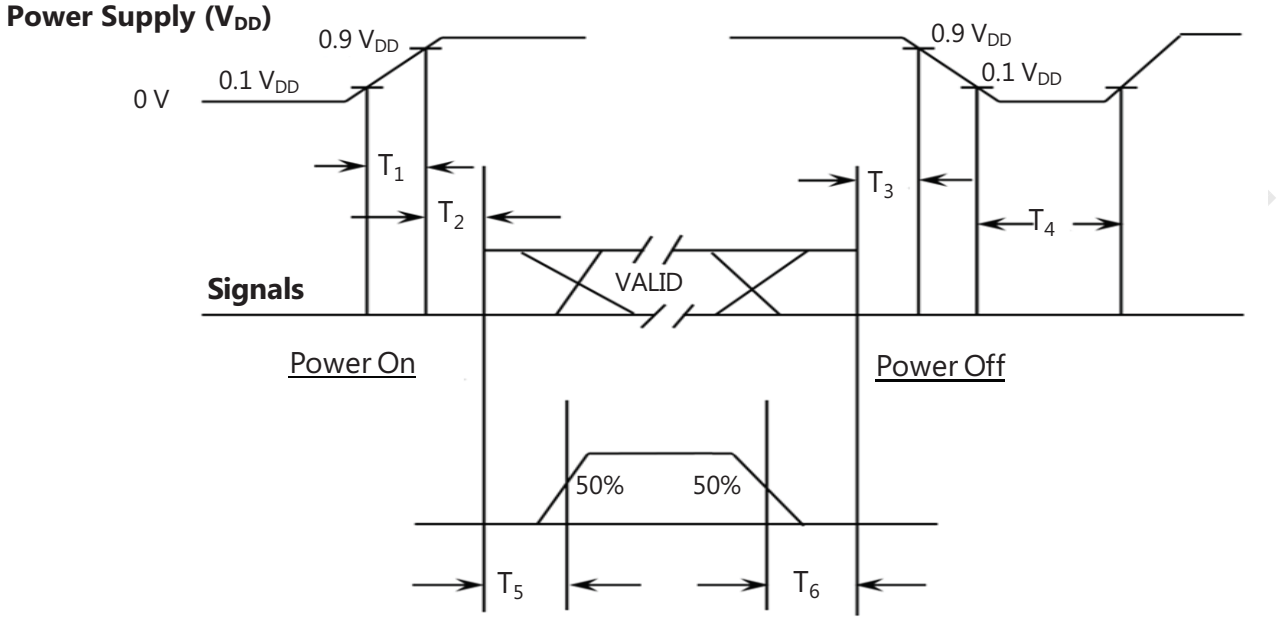
Note (1) Definition of Gray

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

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

5.6 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.



SYMBOL	Min.	Typ.	Max.	Unit	Description
T_1	0.5	-	10	ms	V_{DD} rising time from 10% to 90%
T_2	0.01	-	50	ms	The time from V_{DD} to valid data at power ON
T_3	0.01	-	50	ms	The time from valid data off to V_{DD} off at power Off
T_4	1	-	-	s	V_{DD} off time for Windows restart
T_5	500	-	-	ms	The time from valid data to B/L enable at power ON
T_6	100	-	-	ms	The time from valid data off to B/L disable at power Off

Note (1) The supply voltage of the external system of the Module input should be the same as the definition of VDD.

(2) Apply the BLU power within the LCD operation range. When the back light Is turned on before the LCD operation or the LCD is turned off before the back light Is turned off, the display may momentarily show abnormal screen.

(3) In case of V_{DD} = off level, please keep the level of input signals low or keep a high impedance.

(4) T4 should be measured after the Module has been fully discharged between the Period of power off and on period.

(5) Interface signal should not be kept at high impedance when the power is on.

5.7 Input Terminal Pin Assignment

5.7.1. Input signal & Power Pin Assignment

Connector : UJU IS100-L30B-C23 or equivalent

Pin No.	Symbol	Function
1	RXO0N	Negative LVDS differential data output
2	RXO0P	Positive LVDS differential data output
3	RXO1N	Negative LVDS differential data output
4	RXO1P	Positive LVDS differential data output
5	RXO2N	Negative LVDS differential data output
6	RXO2P	Positive LVDS differential data output
7	BIST	L(GND) = Black, H(3.3V) = Built-in patterns toggle
8	RXOC-	Negative Sampling Clock (ODD data)
9	RXOC+	Positive Sampling Clock (ODD data)
10	RXO3N	Negative LVDS differential data output
11	RXO3P	Positive LVDS differential data output
12	RXE0N	Negative LVDS differential data output
13	RXE0P	Positive LVDS differential data output
14	GND	High speed ground
15	RXE1N	Negative LVDS differential data output
16	RXE1P	Positive LVDS differential data output
17	GND	High speed ground
18	RXE2N	Negative LVDS differential data output
19	RXE2P	Positive LVDS differential data output
20	RXEC-	Negative Sampling Clock (EVEN data)
21	RXEC+	Positive Sampling Clock (EVEN data)
22	RXE3N	Negative LVDS differential data output
23	RXE3P	Positive LVDS differential data output
24	GND (INTREV)	*Optional, L(GND) = normal, H(3.3V) = For Interlaced source
25	NC	* Reserved for LCD manufacturer's use (SDA)
26	NC	* Reserved for LCD manufacturer's use (SCL)
27	NC	* Reserved for LCD manufacturer's use (WPN)
28	VDD	Power Supply : +5V
29	VDD	
30	VDD	

Note (1) If the system already uses the 25, 26pins, it should keep under GND level
The voltage applied to those pins should not exceed -200mV.

(2) Pin number starts from the left

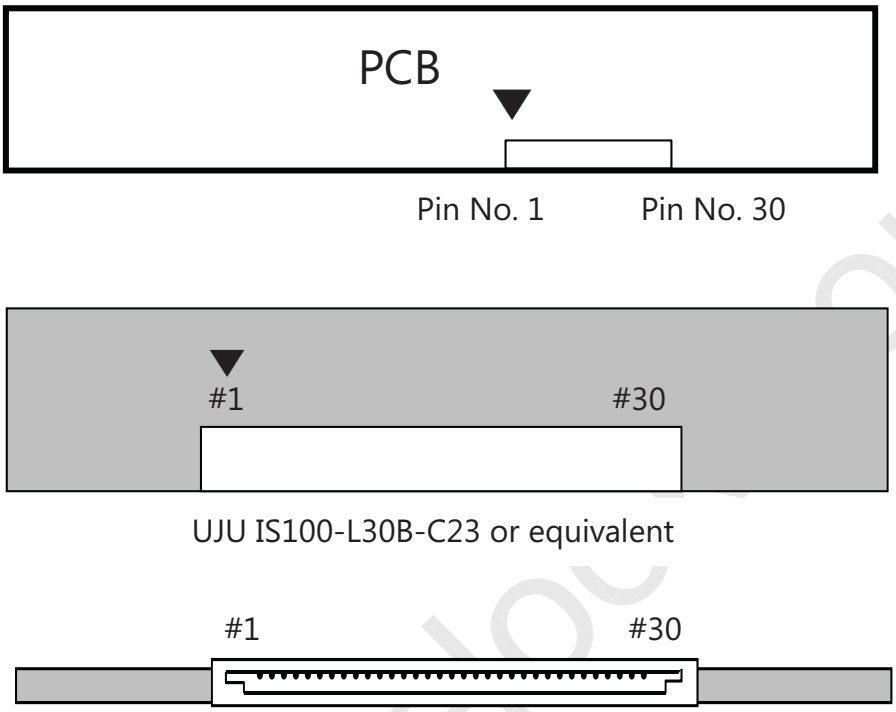


Fig. Connector diagram

(3) All GND pins should be connected to each other and also be connected to the LCD's metal chassis.

(4) All power input pins should be connected to each other.

(5) All NC pins should be separated from other signal or power

5.7.2. LED Connector Pin assignment

Connector : Molex 104086-0410 pr equivalent
- The mating type connector : Molex 104085-0410 or equivalent

Pin No.	Symbol	Function
1	Vin	LED power input
2	RTN 1	Channel 1 LED return
3	RTN 2	Channel 2 LED return
4	RTN 3	Channel 3 LED return

Note (1) Pin number starts from the left

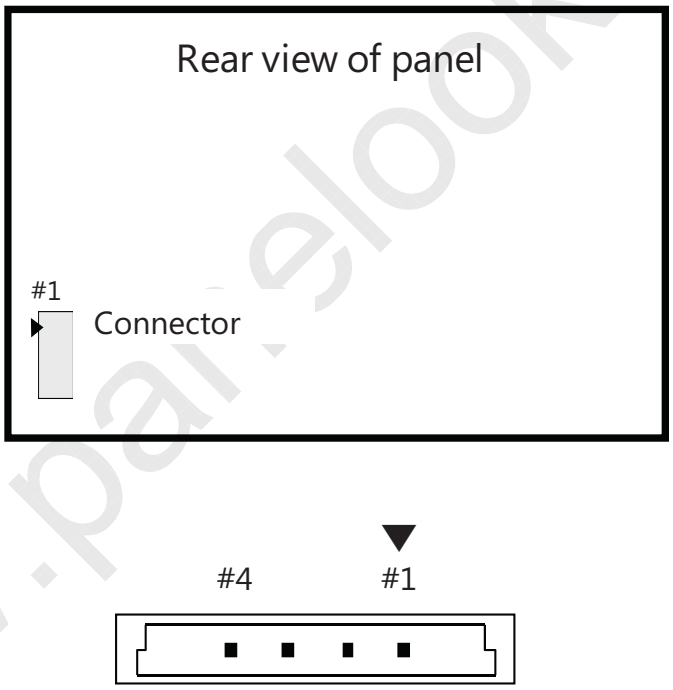


Fig. Connector diagram

6. Outline Dimension

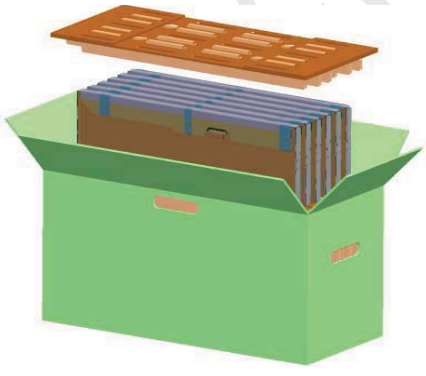
[Refer to the next page]

7. Packing

7.1 Carton

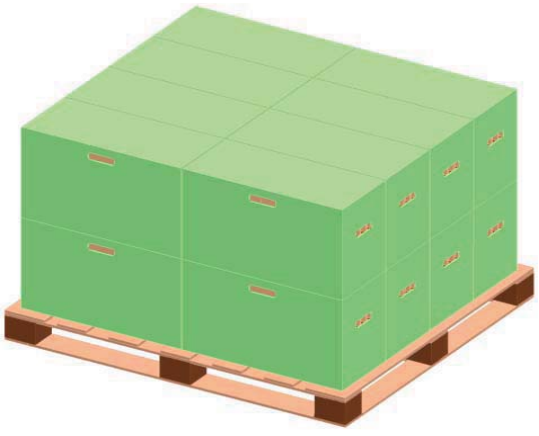
Item	Packing form	Specification
Weight	-	- Total Weight (Including Pallet) : 370Kg
Packing case	12 panels in a case	- Packing Case Size : 263*625*372 - Material : Paper (SW,DW)
Pallet box	16 cases in a box 192 panels in a box	- Packing Pallet Box Size : 1072*1270*730 - Material : Paper (SW)
Pallet	-	- Pallet Size : 1270*1150*122 - Material : Wood

LTM230HL07 Module
(12 EA)



PACKING-Case

Packing Pallet box

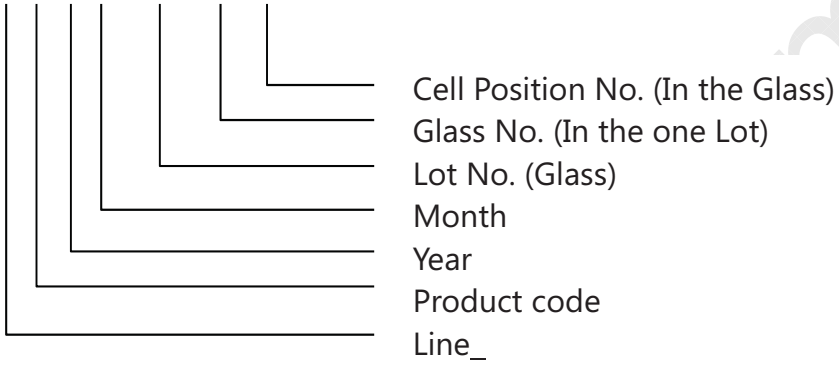


Wood Pallet

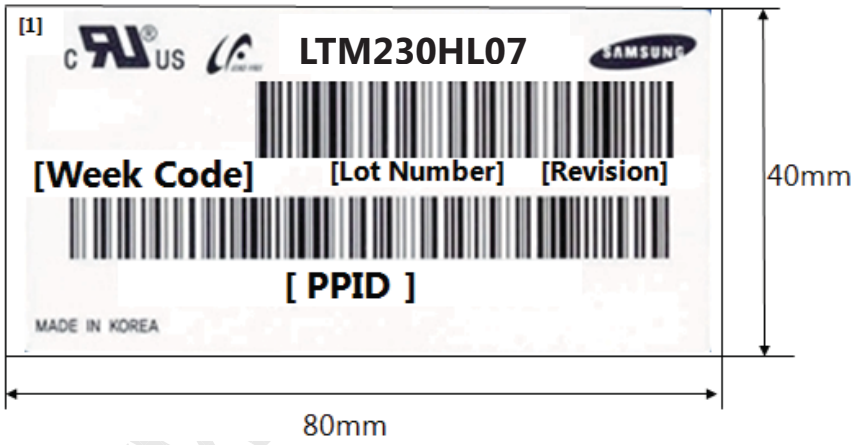
7.2 Marking

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

(1) Parts number : LTM230HL07
(2) Revision: Three letters
(3) Lot number : X X X X XXX XX X



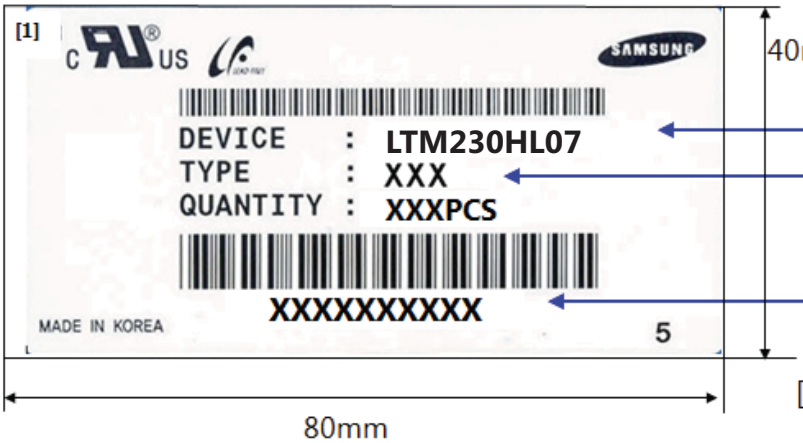
(4) Nameplate Indication



Week code : 11 09
week
year

[1] : Manufacturing site

(5) Packing box attach



Part number
Revision code
Box serial number

[1] : Manufacturing site

8. General Precautions

8.1 Handling Precautions

A. When assembling LCD module into its system, using all the mounting holes is strongly suggested.

B. Keep LCD module from any external shock or force which can cause physical damage to LCD module. It may cause improper operation or damage to LCD module.

C. Polarizer films are very fragile. It could be damaged easily. Do not press or scratch the surface harder than a HB pencil lead.

D. Wipe off water droplets or oil immediately. Water drops or oils can cause permanent stain or discoloration.

E. To clean LCD module, please use IPA (Isopropyl Alcohol) or Hexane.

F. Do not use ketone type material (ex. Acetone), ethyl alcohol, toluene, ethyl acid or methyl chloride. Using these could cause permanent polarizer damage to the LCD module.

G. If the liquid crystal leaks from LCD module, keep it away from human eyes or mouth. In case of contact with human body or clothes, it should be washed with soap thoroughly.

H. Protect LCD module from static discharge.

I. To keep the LCD module clean, make sure to wear fabric gloves and finger coats when you are inspecting and/or assembling the unit.

J. Do not disassemble LCD module.

K. Protection film on LCD module display area should be slowly peeled off just before assembly to prevent static discharge.

L. Pins of the Interface connector should not be touched directly with bare hands.

8.2 Storage Precautions

It is highly recommended to comply with the criteria in the table below

Item	Unit	Min.	Max.
Storage Temperature	(℃)	5	40
Storage Humidity	(%rH)	35	75
Storage life	12 months		
Storage Condition	- The storage room should provide good ventilation and temperature Control . - Products should not be placed on the floor, but on the Pallet away from a wall . - Prevent products from direct sunlight, moisture nor water; Be cautious of a build up of condensation. - Avoid other hazardous environment while storing goods. - If products delivered or kept in conditions of over the storage period of 3 months, the recommended temperature or humidity range, it is recommended to leave them at a temperature of 20℃ and a humidity of 50% for 24 hours.		

8.3 Operating Precautions

A. If the module is used to other applications besides the recommendation on General Description, please contact SAMSUNG for application engineering device in advance

B. Do not connect or disconnect the LCD module when it is set to the "Power On" condition.

C. Input power should always follow '5.6 Power on/off sequence'

D. Polarizer films are very fragile. It could be damaged easily. Do not press or scratch the Polarizer films

E. LCD module contains electrical circuits that operate in high frequencies. To minimize electromagnetic interference, be sure to sufficiently ground and shield the LCD module and system.

F. If LCD module containing system is out of SAMSUNG 's operating condition, SAMSUNG can not guarantee LCD module operating properly.

G. If the product will be used in extreme conditions such as high temperature, humidity, display patterns, operation time, etc., it is strongly recommended to contact SAMSUNG for application engineering device. Otherwise, the reliability and function of the module may not be guaranteed. Extreme conditions are commonly found at airports, transit stations, banks, stocks, markets, and controlling systems.

H. Ultra-violet ray filter is necessary for outdoor operation.

I. If the module keeps displaying the same pattern for a long period of time, the image maybe burned in to the screen. To avoid image retention, it is recommended to use a screen saver.

J. This module has its PCB's circuitry on the rear side and should be handled carefully in order to avoid stress.

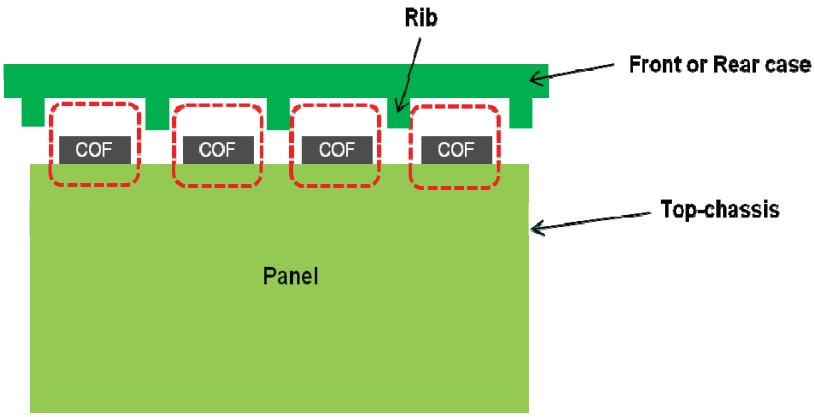
K. Please contact SAMSUNG beforehand, if you plan to display the same pattern for a long period of time.

L. Any foreign materials brought into an LCD module by external forced-airflow are not guaranteed by SAMSUNG .

8.4 Design Guide for System

A. The LED driver should be designed in compliance with the specifications of LED bar strictly to make the LED in LCD module perform as expected

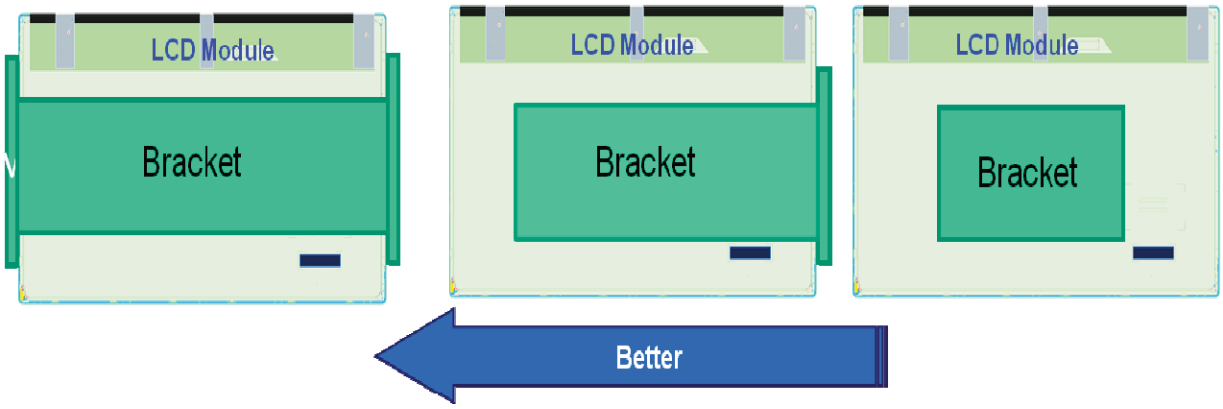
B. It is recommended that you locate the rib on the front or rear cover not to be placed on the spot where D-IC is located on the upper or left of LCD module.



C. It is recommended that assemble the bracket which has two sides with holes for assembly.

D. It is recommended that you design the bracket with the structure which covers the sides of module when designing the bracket for customer.

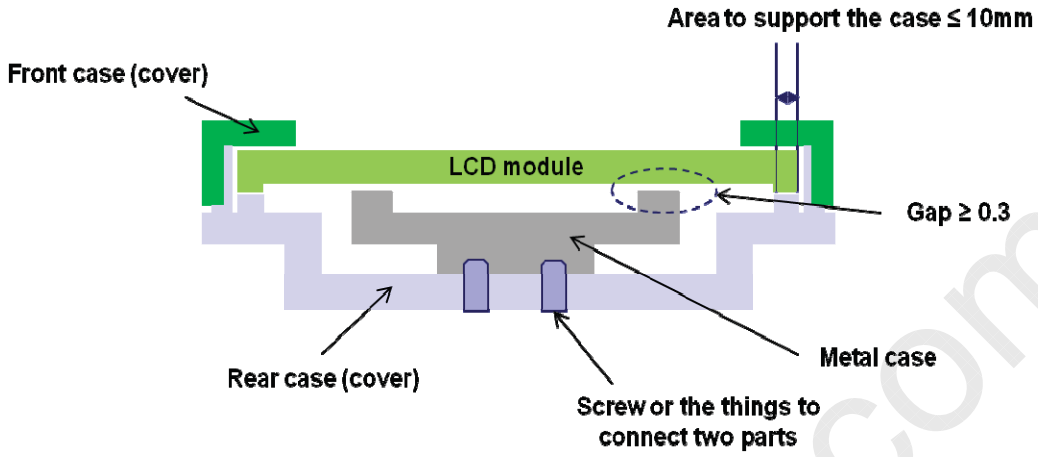
E. It is recommended that you design the bracket not to be interfered with the SET at the area where the PBA of module is located.



F. It is recommended that more than 0.3 mm is allowable as a gap between the metal case and the rear of module.

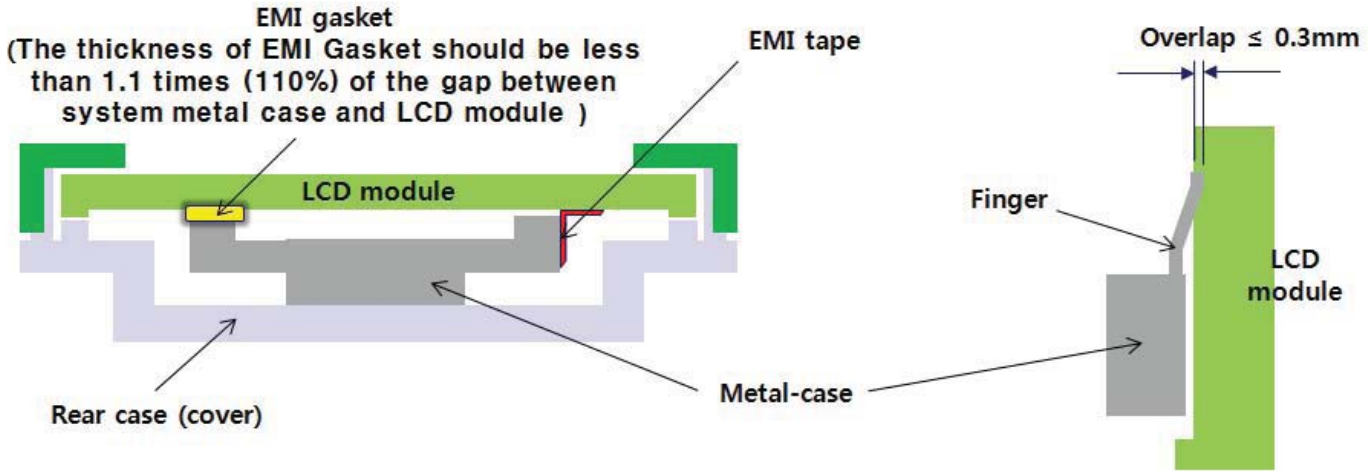
G. It is recommended that structure to support the module shall be far away 10mm from the edge of border.

H. It is recommended that metal case (or board) shall be affixed to the rear case at the spot where is far away 10mm from the edge of border.



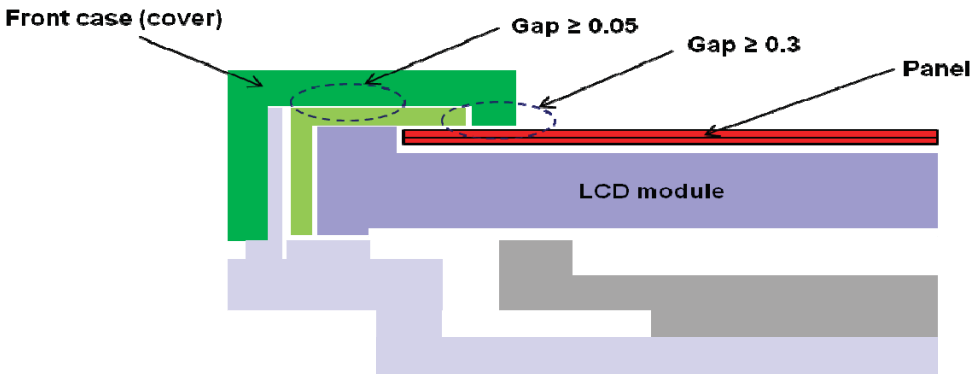
I. When applying the measures described below to reduce the level of EMI which occurs between the metal cover and the rear of module.

J. If you use Finger, less than 0.3mm is allowable for overlap.

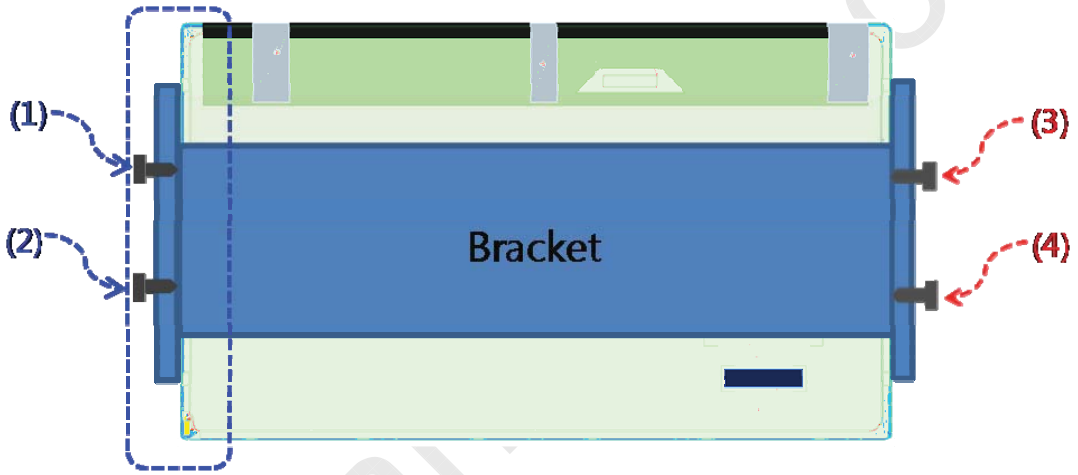


K. It is recommended that more than 0.3mm gap between the front case (or cover) and the panel glass is allowable.

L. It is recommended that more than 0.05mm gap between the front case and the top chassis is allowable.



M. It is recommended that insert the screws into user holes from the ones on the parts, which the light comes out to ones in the corresponding parts.



N. It is recommended that design the metal frame and the top chassis to be in parallel with having no gap after inserting the side screw.