



SAMSUNG DISPLAY



Product Specification

CUSTOMER	Toshiba
DATE OF ISSUE	2013.04.30

MODEL NO.	LTN156AT30
EXTENSION CODE	-601

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IT Development Team Samsung Display Co., Ltd	

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REVISION HISTORY

[illegible]

1. GENERAL DESCRIPTION

DESCRIPTION

The LTN156AT30-601 uses a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFTs as switching components. This model is composed of a TFT LCD panel, a driver circuit, and a backlight unit. This 15.6" model has a resolution of 1366 x 768 pixels and can display up to 262,144 colors.

FEATURES

High contrast ratio
HD (1366 x 768 pixels) resolution
Low power consumption
Fast Response
LED back light with an embedded LED driver
DE (Data enable) only mode
3.3V LVDS Interface
Onboard EDID chip

APPLICATIONS

Notebook PC

If the intent to use this product is for other purpose, please contact Samsung Display.

GENERAL INFORMATION

Item	Specification	Unit	Note
Display area	344.232 (H) x 193.536 (V) (15.6" diagonal)	mm	
Driver Element	a-Si TFT active matrix		
Display colors	262,144 (6bit)		
Number of pixel	1366 *768 (HD)	Pixel	16:9
Pixel Arrangement	RGB vertical stripe		
Pixel pitch	0.252 (H) x 0.252 (V) (TYP.)	mm	
Display Mode	Normally white, TN mode		
Thickness of glass	0.5	mm	
Surface treatment	Haze 25%, Hardness 3H		Anti-Glare
Environmental safe regulation	Pb Free, Halogen Free		
Power Consumption	Total 3.24W(Typ) @Logic 0.7W(Typ) BLU 2.54W (Typ) Total 3.6W(Max)		Mosaic PTN

MECHANICAL INFORMATION

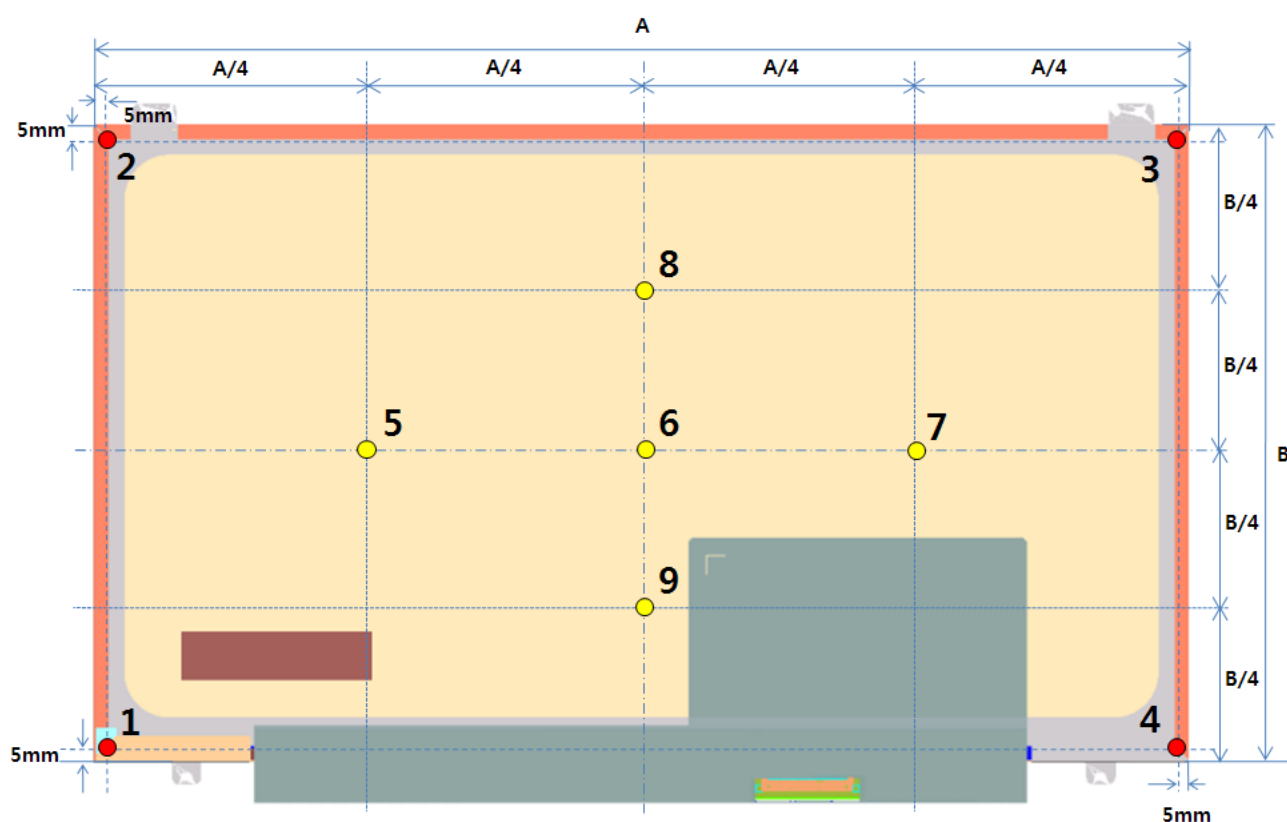
	Item	Min.	Typ.	Max.	Unit	Note
Module Size	Horizontal (H)	359.0	359.5	360.0	mm	
	Vertical (V)	206.1	206.6	207.1	mm	w/o flange & PCB
		223.3	223.8	224.3	mm	with flange & PCB
	Depth (D)	-	3.4	3.8	mm	(1)
	Weight	-	383	420	g	

NOTE (1) Measuring method for thickness

Force to be applied for measurement (1,2,3,4 Part) : The 200gf when using the height gauge.

Force to be applied for measurement (5,6,7,8,9 Part) : The 30gf when using the height gauge.

Force to be applied for measurement (COF Part) : The 50gf when using the height gauge.



This picture is reference for measurement. Appearance may be different according to each model type.

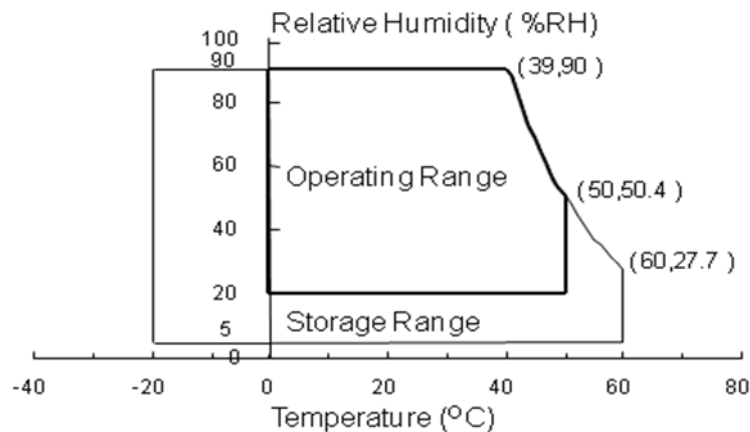
2. ABSOLUTE MAXIMUM RATINGS

2.1 ENVIRONMENTAL ABSOLUTE RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Storage temperate	TSTG	-20	60	°C	(1)
Operating temperature (Temperature of glass surface)	TOPR	0	50	°C	(1)
Shock (non-operating)	Snop	-	240	G	(2), (4)
Vibration (non-operating)	Vnop	-	2.41	G	(3), (4)

Note (1) The range of temperature and relative humidity is shown in the graph below 90% RH Max. .

(39°C ≥ Ta) If the temperature is higher than 40 °C, the maximum temperature of wet-bulb shall be less than 39°C. No condensation



(2) Vibrate $\pm X$, $\pm Y$, and $\pm Z$ axis in the shape of the half sine wave one time for 2ms.

(3) Vibrate the X, Y, and Z randomly within a 5 - 500 Hz range for 30min.

(4) When testing a vibration and a shock, the fixture, which holds the module to be tested, shall be hard and rigid in order for the module not to be twisted or bent by the fixture.

2.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD MODULE

$V_{LCD_VCC} = 3.3V$, $V_{SS} = GND = 0V$

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{LCD_VCC}	$V_{SS} - 0.3$	4.0	V	(1), (2)
LVDS Input Voltage	V_{LVDS}	$V_{SS} - 0.3$	2.0		

Note (1) Within T_a (25 ± 2 °C)

(2) Permanent damage to the device may occur if exceed maximum values.

(2) BACKLIGHT UNIT

$V_{SS} = GND = 0V$

Item	Symbol	Min.	Max.	Unit	Note
BLU Supply Voltage	V_{BL_PWR}	$V_{SS} - 0.3$	26.5	V	(1), (2)
BLU Supply Current	I_{BL_PWR}	-	0.9	A	(1), (2) $V_{in}=12V$ Duty 100%

Note (1) Within T_a (25 ± 2 °C)

(2) Permanent damage to the device may occur if exceed maximum values

2.3 THE OTHERS

(1) STATIC ELECTRICITY PRESSURE RESISTANCE

Item	Test Conditions	Remark
CONTACT DISCHARGE	150pF, 330Ω, $\pm 8kV$, 200points, 1 time/point	Operating
AIR DISCHARGE	150pF, 330Ω, $\pm 15kV$, 200points, 1 time/point	Operating

3. OPTICAL CHARACTERISTICS

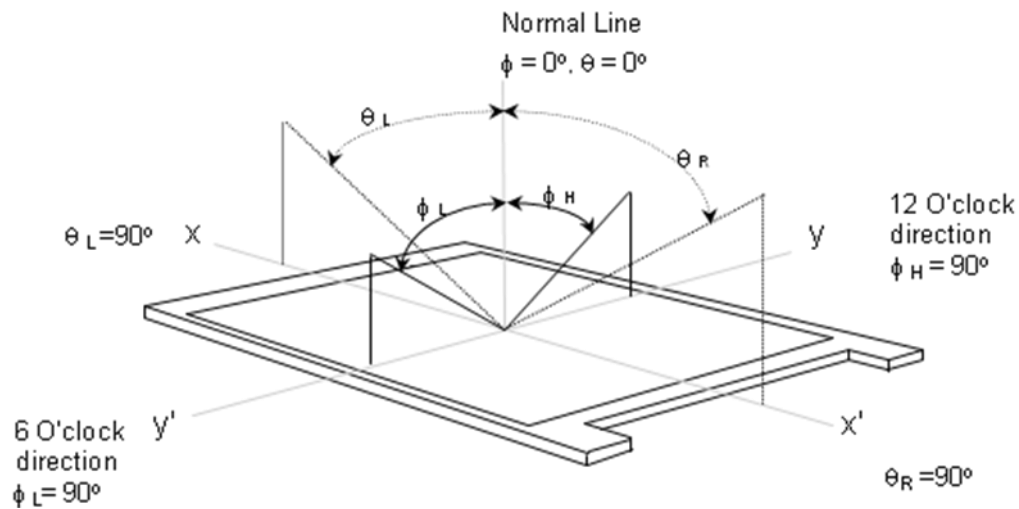
The following items are measured under the stable conditions.* The optical characteristics should be measured in the dark room or the equivalent environment by the methods shown in the Note (5).

Measuring equipment: TOPCON SR-3

$T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$, $V_{\text{LCD VCC}} = 3.3\text{V}$, $f_v = 60\text{Hz}$, $f_{\text{DCLK}} = 72.33\text{MHz}$, $I_F = 100\%$ duty

Item		Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Contrast Ratio		CR	Normal Viewing Angle $\phi = 0$ $\theta = 0$	300	500	-	-	(1),(2),(5)
Response time (Rising + Falling)		T_{RT}		-	16	25	msec	(1),(3)
Average Luminance of White (5 Points)		Y_{LAVE}		170	200	-	cd/m^2	IF=100% Duty (1),(4)
Cross Modulation		DSHA		-	1.0	2.0	%	(7)
Color Chromaticity (CIE)	Red	R_x		-0.03	0.575	+0.03		(1),(5)
		R_y			0.335			
	Green	G_x			0.340			
		G_y			0.560			
	Blue	B_x			0.160			
		B_y			0.125			
	White	W_x			0.313			
		W_y			0.329			
Viewing Angle	Hor.	θ_L	$\text{CR} \geq 10$ At center	40	45	-	Degrees	(1),(5)
		θ_H		40	45	-		
	Ver.	ϕ_H		10	15	-		
		ϕ_L		30	35	-		
Color Gamut		CG		41	45	-	%	
White variation (13P)		δ_L		-	1.44	1.6		(6)

Note (1) The definition of viewing angle: The range of viewing angle ($10 \leq C/R$)

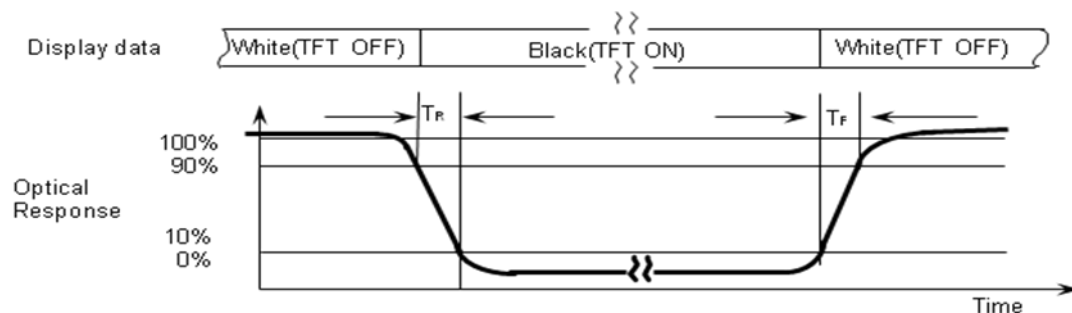


Note (2) The definition of contrast ratio (CR): The ratio of max. gray and min gray at 5 points (4, 5, 7, 9, and 10)

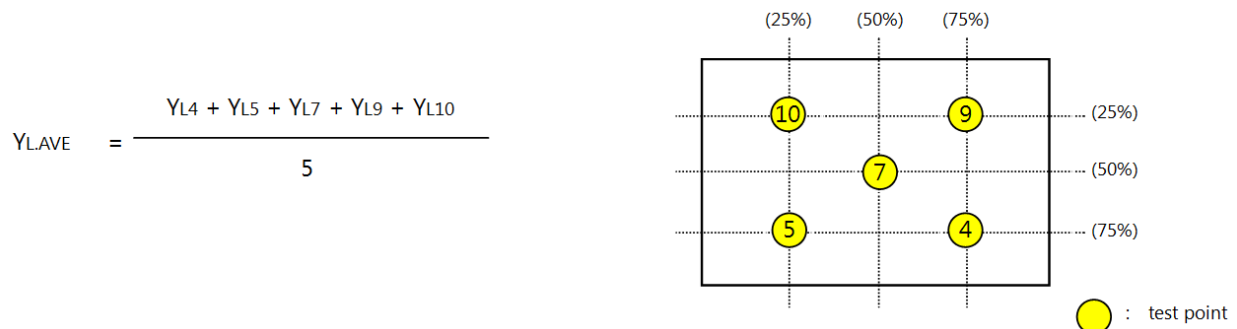
$$CR = \frac{CR(4) + CR(5) + CR(7) + CR(9) + CR(10)}{5}$$

Points = ④, ⑤, ⑦, ⑨, ⑩ at the figure of Note(6).

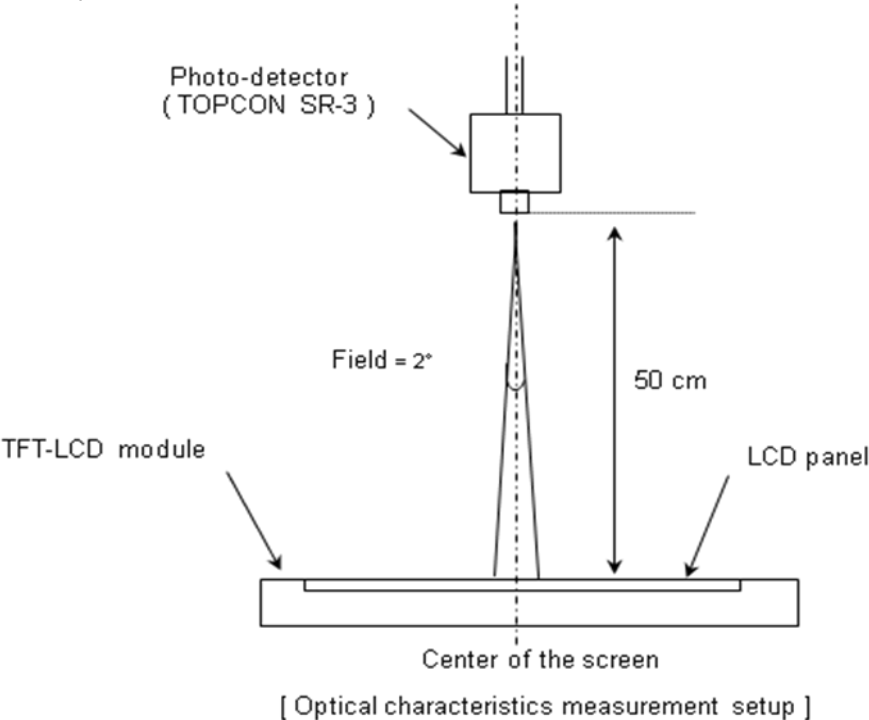
Note (3) The definition of Response time: Subtotal of the time, during which the transmission changes from 10% to 90% when the TFT turns on and off.



Note (4) The definition of average luminance of white: Measure the luminance of white at 5 points.

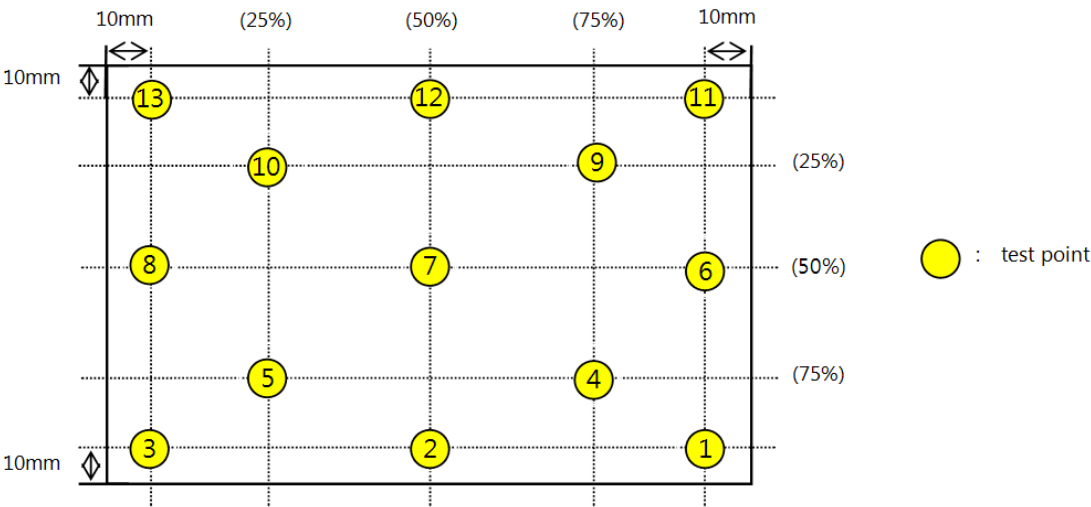


Note (5) Measure the panel, which is left for 30 min. at the normal temp. after leaving it for 30 min with turning the back light on at the rating. The measurement should be executed under the condition including the ambient temp., $25^{\circ}\text{C} \pm 2^{\circ}\text{C}$, the dark room, windless (removed the direct wind), and no vibration.



Note (6) The definition of white variation at 13 points (δL)

$$\delta L = \frac{\text{Maximum luminance of 13 points}}{\text{Minimum luminance of 13 points}}$$



Note (7) The definition of crosstalk (Cross modulation)

: The phenomenon, which the contrast ratio is decreased by the interference of signal between pixels
 Crosstalk Calculation Method

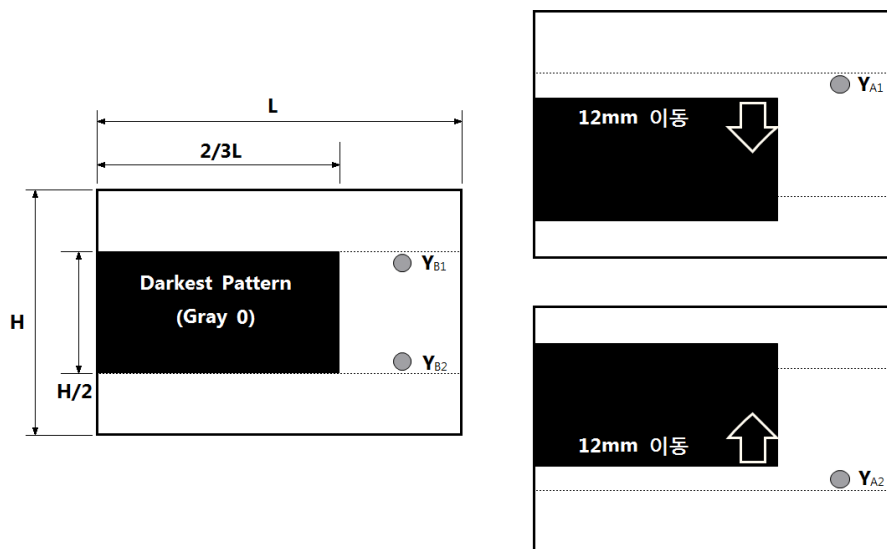
$$\text{Crosstalk Modulation Ratio}(D_{\text{SHA}}) = \frac{|Y_A - Y_B|}{Y_A} \times 100 (\%)$$

Where

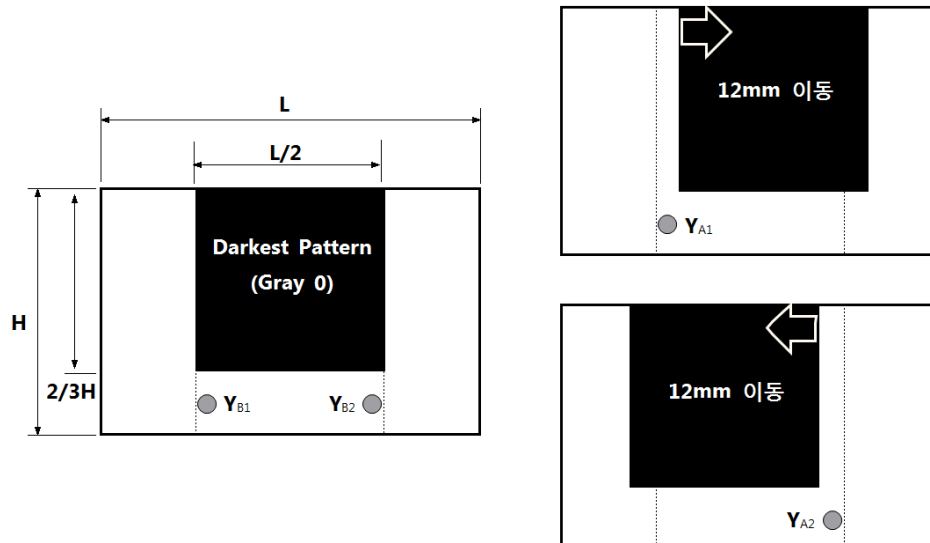
Y_A, Y_B = Measured under the 2° viewing angle (Measured area: $\psi 12$ mm)

The rectangle area, which excludes the black-colored rectangle includes the range, which is from 1 gray to 63 gray.

1) The method of measurement for horizontal-crosstalk

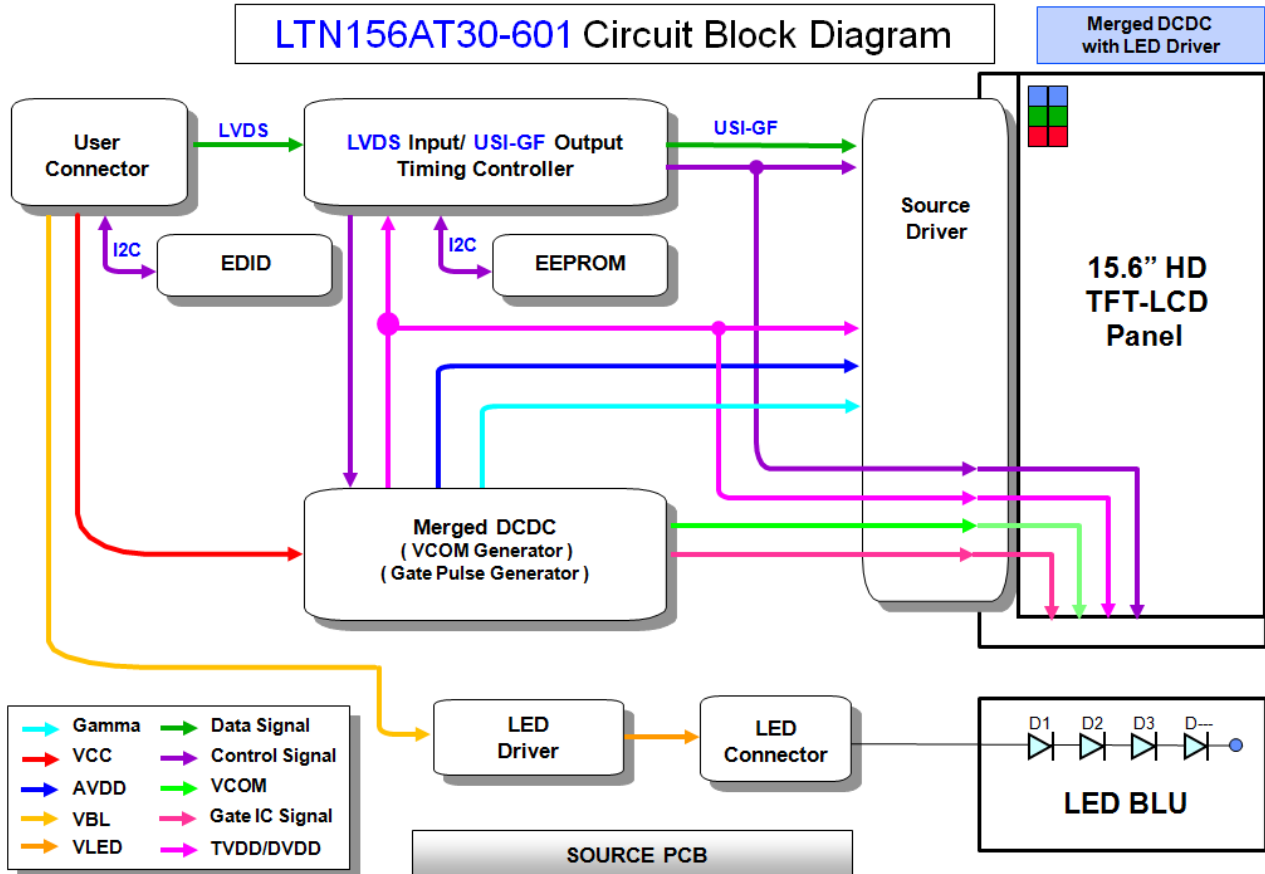


2) The method of measurement for vertical-crosstalk



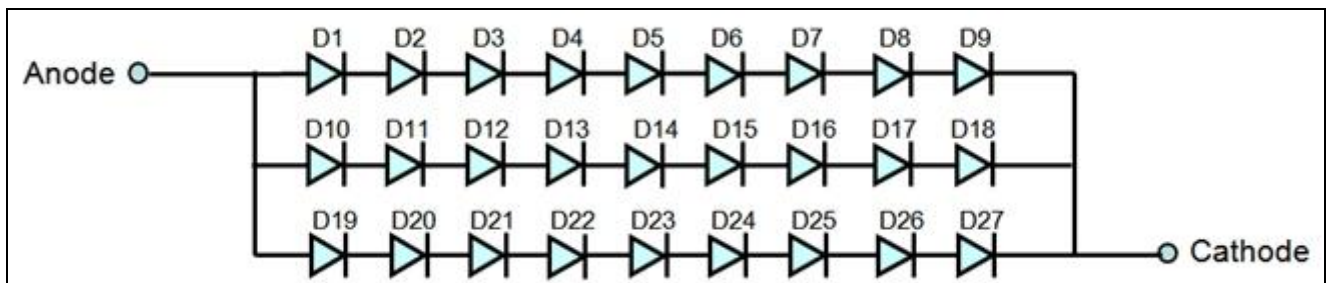
4. BLOCK DIAGRAM

4.1 TFT LCD MODULE



4.2 THE STRUCTURE OF LED PLACEMENT

(3channels x 9ea = 27ea)



5. ELECTRICAL CHARACTERISTICS

5.1 TFT LCD MODULE

Ta = 25 ± 2 °C

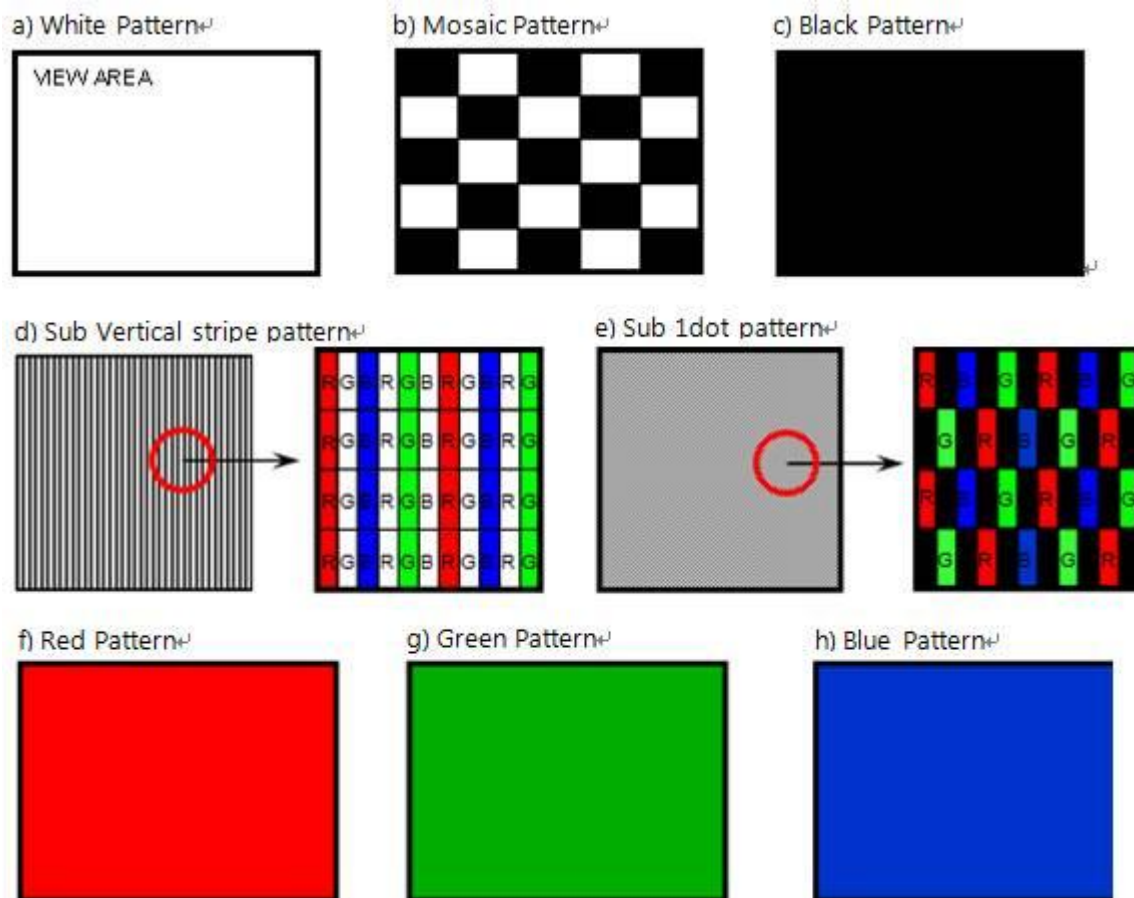
Item		Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply Voltage		V _{LCD_VCC}	3.0	3.3	3.6	V	
T-CON TTL Input Voltage	High	V _{IH}	0.7 V _{LCD_VCC}	-	-	V	(1)
	Low	V _{IL}	-	-	0.3 V _{LCD_VCC}	V	
Vsync	60Hz	f _V	-	60	-	Hz	(3)
	50Hz	f _V	-	50	-	Hz	
	40Hz	f _V	-	40	-	Hz	
Hsync	60Hz	f _H	46.50	47.40	48.60	kHz	
Main Frequency	60Hz	f _{DCLK}	67.24	72.33	83.88	MHz	(3)
	50Hz	f _{DCLK}	-	60.28	-	MHz	
	40Hz	f _{DCLK}	-	48.22	-	MHz	
Rush Current		I _{RUSH}	-	-	1.5	A	(6)
Input Current	White	I _{LCD_VCC}	-	212	242	mA	(2), (4)
	Mosaic	I _{LCD_VCC}	-	212	242	mA	
	Black	I _{LCD_VCC}	-	212	242	mA	
	V.Stripe	I _{LCD_VCC}	-	400	450	mA	
	Red	I _{LCD_VCC}	-	400	450	mA	(2), (4)
	Green	I _{LCD_VCC}	-	400	450	mA	
	Blue	I _{LCD_VCC}	-	400	450	mA	
	1Dot	I _{LCD_VCC}	-	400	450	mA	(2), (4)
Logic Input Power Consumption		P _{LCD_VCC}	-	0.7	0.8	W	(4)*(b)
EDID Input Voltage		V _{EDID}	3.0	3.3	3.6	V	
EDID Input Current		I _{EDID}	-	-	5	mA	
Skew		PS	-400	-	400	ps	(2)

Note (1) The data pins for display and signal pins for timing should be connected. (GND= 0V)

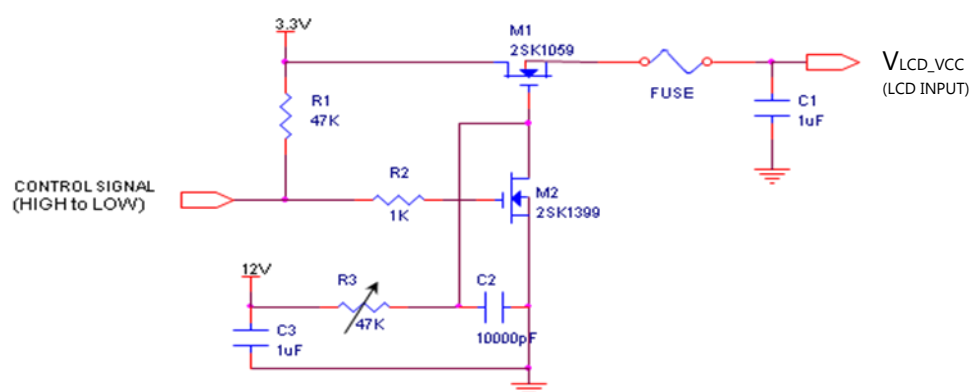
(2) f_V = 60Hz, f_{DCLK} = 72.33MHz, V_{LCD_VCC} = 3.3V, DC Current.

(3) In the case of 40Hz & 50Hz for sDRRS, FOS, Flicker & Brightness are not guaranteed, because their level might be different from 60Hz operation.

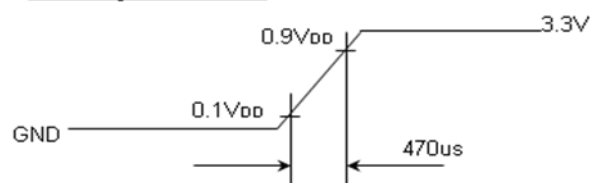
Note (4) The dissipation pattern for power



Note (6) The condition for measurement for rush current



V_{DD} rising time is 470us



5.2 BACK LIGHT UNIT

Ta = 25 ± 2 °C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED Forward Current	IF	-	25	-	mA	
LED Forward Voltage	VF	3.0	3.2	3.4	V	IF = 20mA
LED Array Voltage	VP	-	28.8	-	V	
LED Power Consumption	P	-	2.54	2.8	W	
LED Life time	Hr	15,000	-	-	Hours	(1)
LED Counts	Q	-	27	-	EA	

Note (1) The life time (Hr) of LEDs can be defined as the time during which it continues to operate under the condition, which the Ta is 25 ± 2 °C and IF= 25.0 mArms until the one of the following events occurs when the brightness becomes 50% or lower than the original.

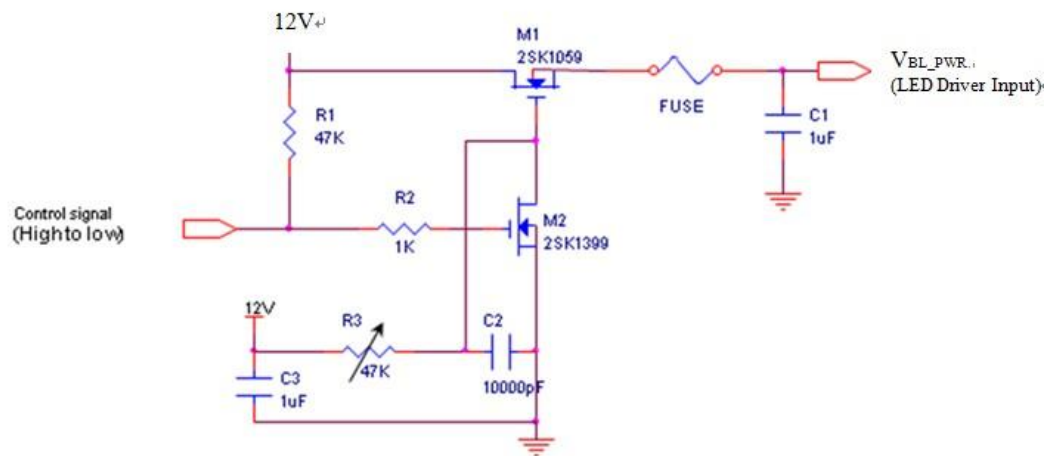
5.3 LED DRIVER

The manufacturer of LED driver: Richtek RT8510

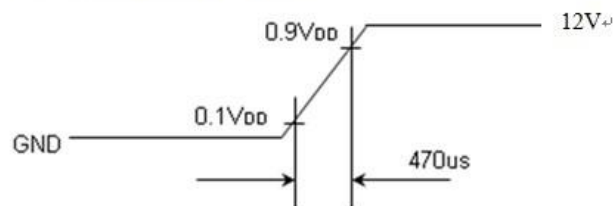
Ta= 25 ± 2 °C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Input Voltage	V _{BL_PWR}	7	12	21	V	
Input Current	I _{BL_PWR}	-	212	233	mA	Vin=12V Duty 100%
PWM duty Ratio	D _{BL_PWM_DIM}	1	-	100	%	
External PWM Frequency	F _{BL_PWM_DIM}	0.2	1	2	kHz	APS ON
		0.12	1	2	kHz	APS OFF
PWM Resolution	R _{BL_PWM_DIM}	0.8	-	-	%	APS ON
		0.3	-	-	%	APS OFF
In-Rush Current	I _{RUSH_BL_PWR}	-	-	1.5	A	(1)
EN Control Level	High	V _{BL_ENABLE}	2.0	-	5.0	V
	Low		0.0	-	0.8	V
PWM Control Level	High	V _{BL_PWM_DIM}	2.0	-	5.0	V
	Low		0.0	-	0.8	V
VBL_PWR @ LED Driver On	V _{BL_PWR}	7	-	21	V	
VBL_PWR @ LED Driver Off	V _{BL_PWR}	0	-	2	V	
Operating frequency	FO	0.8	1.0	1.2	kHz	
Efficiency	η	-	85	-	%	

Note (1) Rush current measurement condition



The V_{BL_PWR} rising time is 470us.



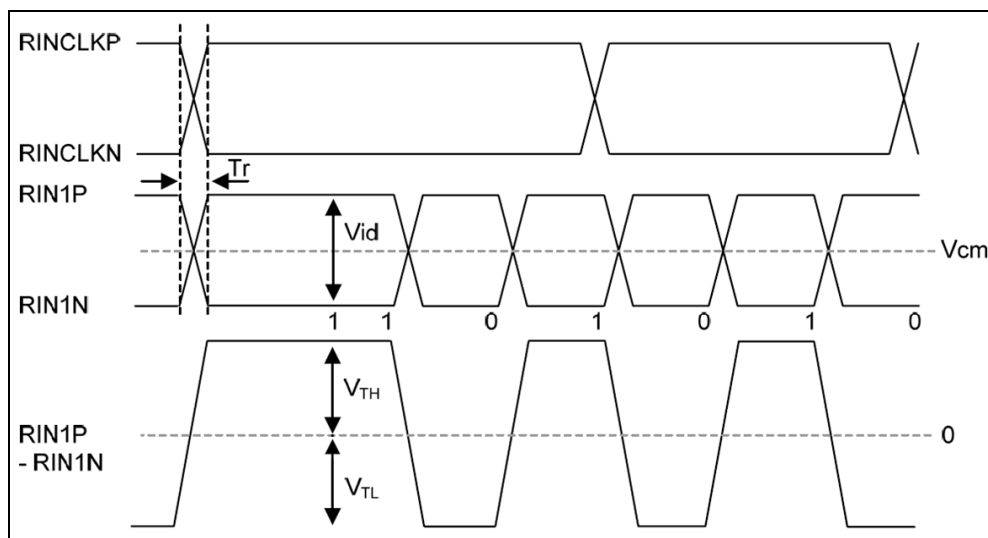
5.4 LVDS INTERFACE

5.4.1 LVDS DC Specifications

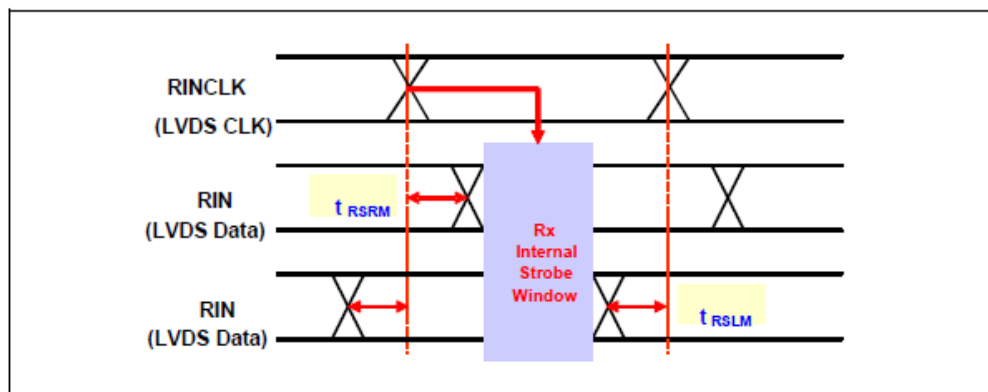
Characteristics	Symbol	Min.	Typ.	Max.	Unit	Conditions
Differential input high threshold voltage	V_{TH}	-	-	+100	mV	$V_{CM} = 1.2V$
Differential input low threshold voltage	V_{TL}	-100	-	-	mV	
Differential input voltage	$ V_{ID} $	100	400	600	mV	
Common mode voltage	V_{CM}	0.4	1.2	1.6	V	$ V_{ID} = 100mV$

5.4.2 LVDS AC Specifications

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Remarks
ROUTCLK frequency	f_{RCP}	67.24	72.33	83.88	MHz	
LVDS RX Skew (Strobe) Right Margin	85MHz	-	-	400	ps	
	50MHz	-	-	700	ps	
LVDS RX Skew (Strobe) Left Margin	85MHz	-400	-	-	ps	
	50MHz	-700	-	-	ps	



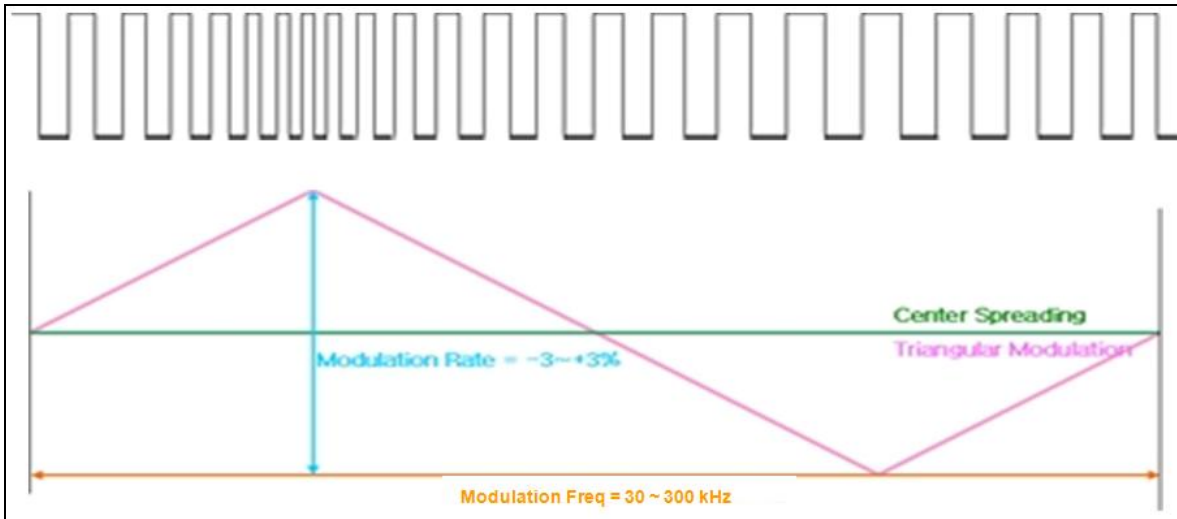
< The definition of LVDS DC characteristics >



< The definition of LVDS Receiver Skew (Strobe) Margin >

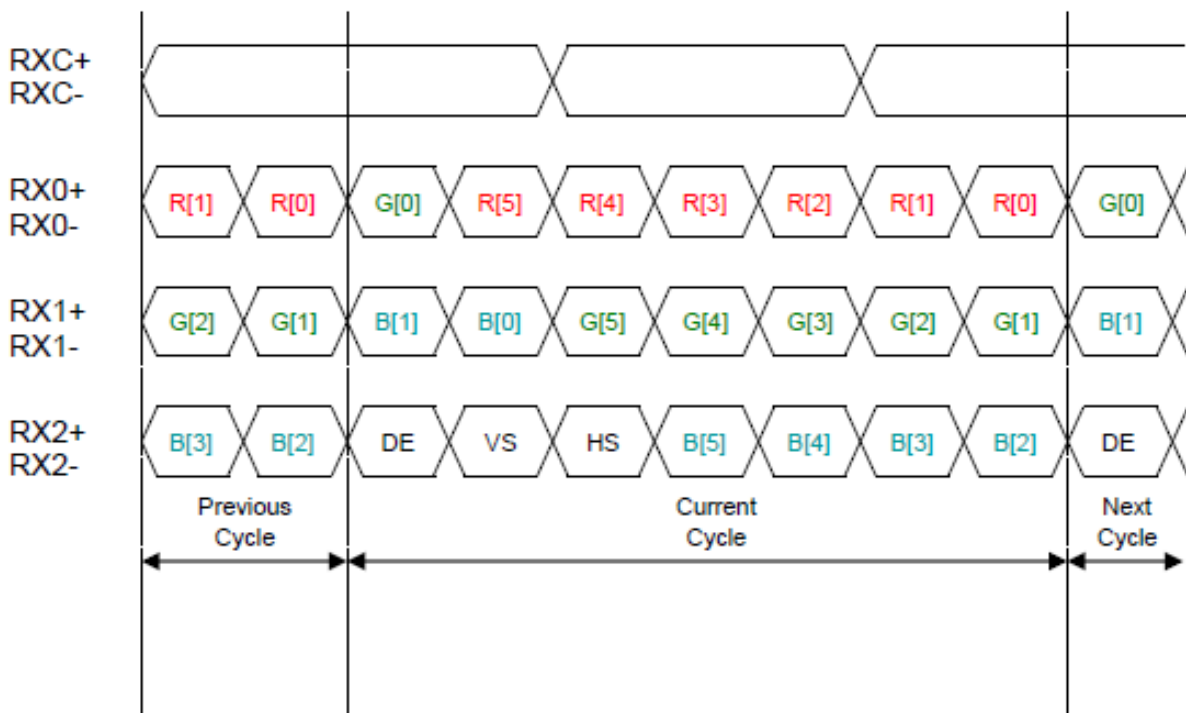
5.4.3 LVDS SSC Specification

Characteristics	Symbol	Min.	Typ.	Max.	Unit	Remarks
Modulation Rate	F_{mr}	-3	0	+3	%	
Modulation Frequency	F_{mf}	30	-	300	kHz	@ MAINCLK = 72.33MHz



< Definition of SSC (Spread Spectrum Clock) >

5.4.4 Timing diagrams of LVDS transmission

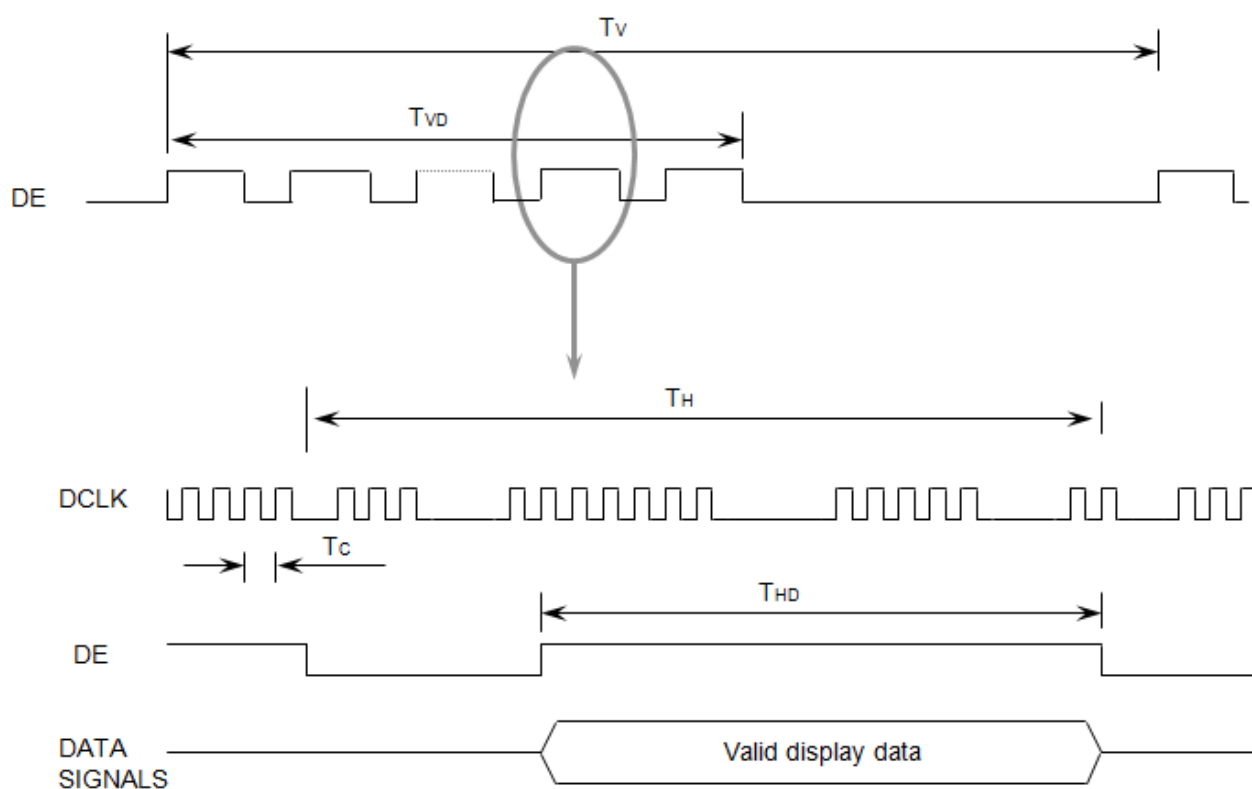


5.5 INTERFACE TIMING

5.5.1 TIMING PARAMETERS

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Frame Frequency	Cycle	T_V	775	790	810	Lines	
Vertical active in the display term	Display Period	T_{VD}	-	768	-	Lines	
Scanning time in one line	Cycle	T_H	1446	1526	1726	Clocks	
Horizontal active in the display term	Display Period	T_{HD}	-	1366	-	Clocks	

5.5.2 TIMING DIAGRAMS OF INTERFACE SIGNAL



5.6 INPUT COLOR DATA MAPPING

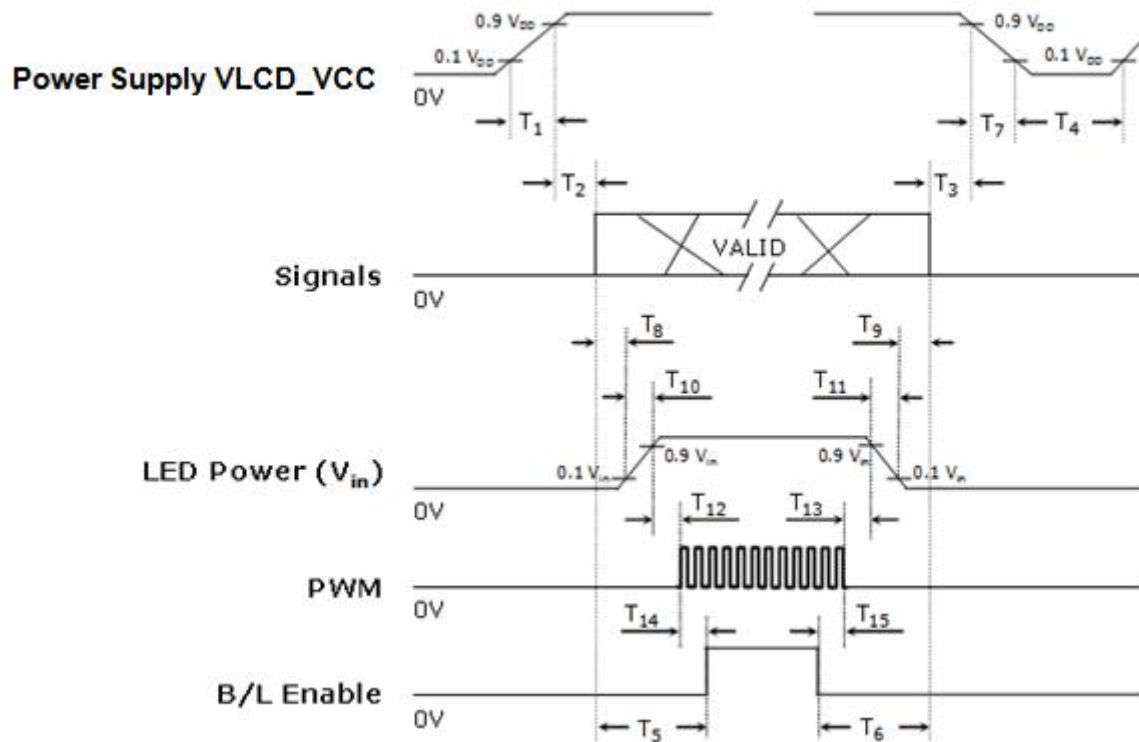
Color	Display	Data Signal																		Gray Scale Level
		Red						Green						Blue						
		R0	R1	R2	R3	R4	R5	G0	G1	G2	G3	G4	G5	B0	B1	B2	B3	45	B5	
Basic Colors	Black	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	-
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	-
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	-
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	-
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1	-
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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	-
Gray Scale Of Red	Black	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	R1
	↑	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	R2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R61
	Light	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R62
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	R63
Gray Scale Of Green	Black	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	1	0	0	0	0	0	0	0	0	0	0	0	G1
	↑	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	G2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	G61
	Light	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	G62
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	G63
Gray Scale Of Blue	Black	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	1	0	0	0	0	0	B1
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	B2
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B60
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	
	↓	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	B61
	Light	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	B62
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	B63

Note (1) Definition of gray: Rn: Red gray, Gn: Green gray, Bn: Blue gray (n=gray level)

Note (2) Input signal: 0 =Low level voltage, 1=High level voltage

5.7 POWER ON/OFF SEQUENCE

To prevent the product from being latched up or the DC in the LCD module from starting an operation, the order to turn the power on and off should be changed to the order as shown in the diagram below.



Timing (ms)	Remarks
$0.5 < T_1 \leq 10$	V _{LCD_VCC} rising time from 10% to 90%
$0 < T_2 \leq 50$	Interval from V _{LCD_VCC} to valid data at power ON
$0 < T_3 \leq 50$	Interval from valid data OFF to V _{LCD_VCC} OFF at power Off
$150 \leq T_4$	V _{LCD_VCC} OFF time for Windows restart
$200 \leq T_5$	Interval from valid data to B/L enable at power ON
$0 < T_6$	Interval from valid data off to B/L disable at power Off
$0 < T_7 \leq 10$	V _{LCD_VCC} falling time from 90% to 10%
$10 < T_8$	Interval from valid data on to LED driver V _{in} rising time 10%
$10 < T_9$	Interval from LED driver V _{in} falling time 10% to valid data Off
$0.5 < T_{10} \leq 10$	LED V _{in} rising time from 10% to 90%
$0.5 < T_{11} \leq 10$	LED V _{in} falling time from 90% to 10%
$0 < T_{12}$	Interval from LED driver V _{in} rising time 90% to PWM ON
$0 < T_{13}$	Interval from PWM Off to LED driver V _{in} falling time 90%
$0 \leq T_{14}$	Interval from PWM ON to B/L Enable ON
$0 \leq T_{15}$	Interval from B/L Enable Off to PWM Off

The backlight may be flashed if the interface signal remains floated when the above-mentioned signal becomes invalid.

- Note
- (1) The power voltage from system shall be supplied to the input pin of LCD constantly.
 - (2) Enable the voltage to the LED within the range, which the LCD is operated. The screen becomes white when turning the back-light on before the LCD is operated or turning the LCD off before turning the back-light off. Operation or the LCD turns off before the back-light turns off; the display may momentarily become white.
 - (3) Don't leave the system at a high impedance state, which the interface signal is out for a long time after the V_{LCD_VCC} is enabled.
 - (4) The T4 should be measured the module is fully discharged.
 - (5) The interface signal shall not maintain the high impedance when the power is on.

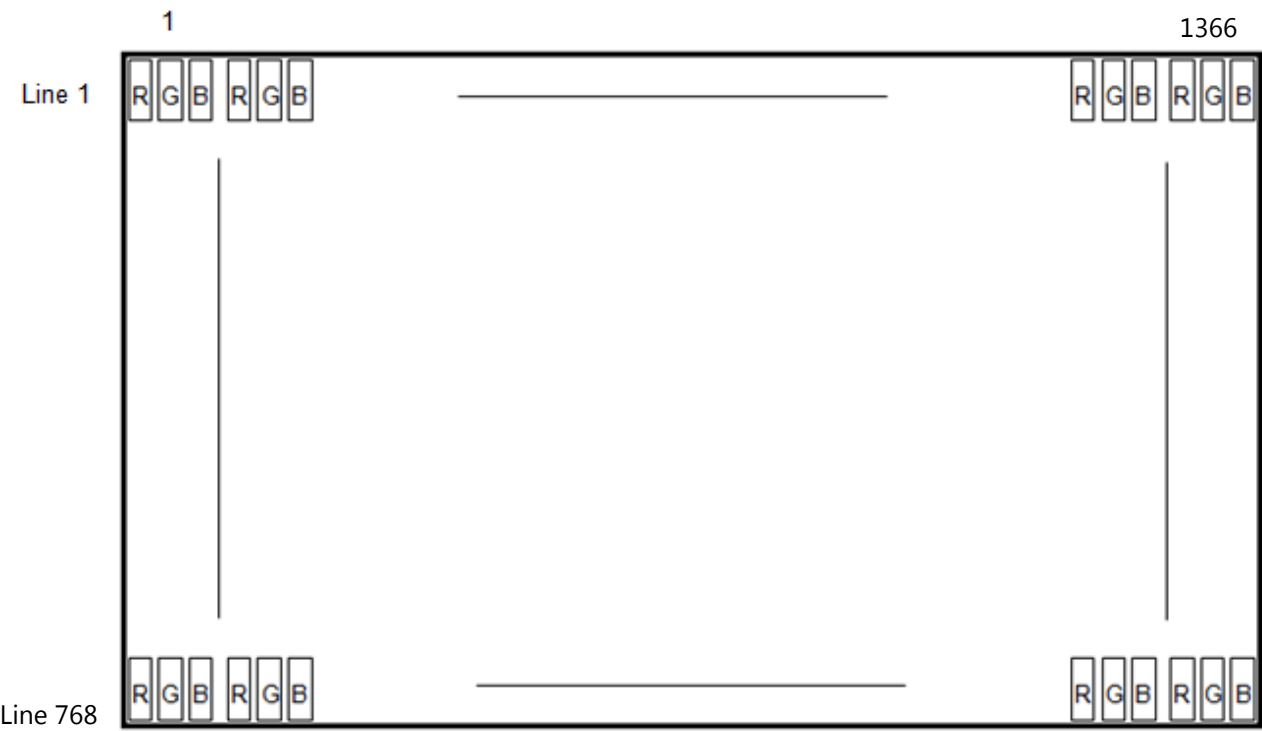
5.8 INPUT TERMINAL PIN ASSIGNMENT

5.8.1 INPUT SIGNAL & POWER

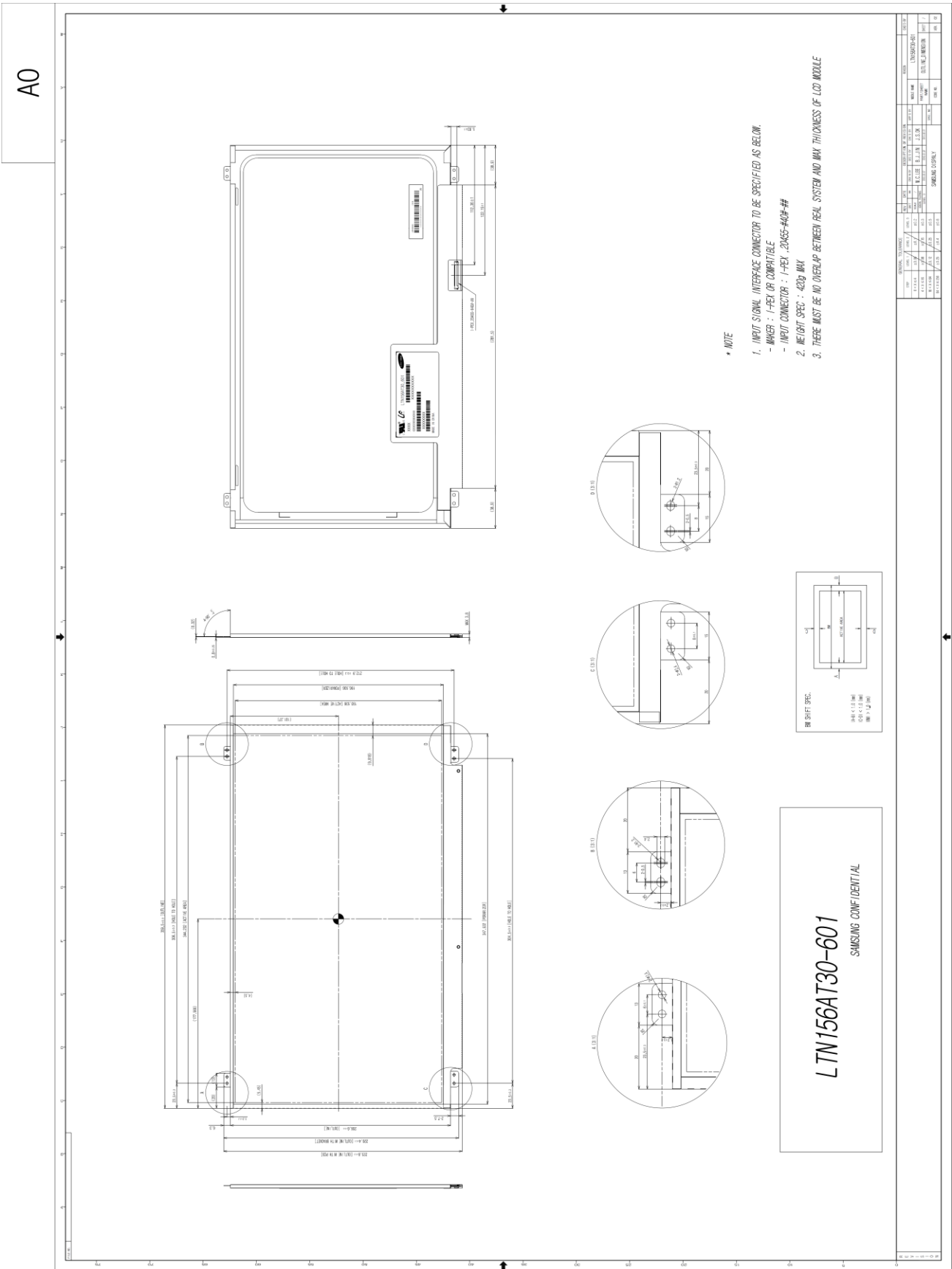
(LVDS, Connector: 20455-040E-0, I-PEX or the equipment with the equivalent capability)

Pin	Symbol	Function
1	NC	Hot Plug Detect or No connection (optional)
2	LCD_VCC	LCD logic and driver IC Power (3.3V typ.)
3	LCD_VCC	LCD logic and driver IC Power (3.3V typ.)
4	VCC_EDID	DDC power
5	NC (WPN)	Reserved for the use by LCD manufacturer (WPN)
6	CLK_EDID	DDC clock
7	DAT_EDID	DDC data
8	RX0-	Negative LVDS differential data input for pixel
9	RX0+	Positive LVDS differential data input for pixel
10	H_GND	High speed ground
11	RX1-	Negative LVDS differential data input for pixel
12	RX1+	Positive LVDS differential data input for pixel
13	H_GND	High speed ground
14	RX2-	Negative LVDS differential data input for pixel
15	RX2+	Positive LVDS differential data input for pixel
16	H_GND	High speed ground
17	RXC-	Negative LVDS differential clock input for pixel
18	RXC+	Positive LVDS differential clock input for pixel
19	LCD_GND	LCD logic and driver IC Ground
20	NC	No connection
21	NC	No connection
22	LCD_GND	LCD logic and driver IC Ground
23	NC	No connection
24	NC	No connection
25	LCD_GND	LCD logic and driver IC Ground
26	NC	No connection
27	NC	No connection
28	LCD_GND	LCD logic and driver IC Ground
29	NC	No connection
30	NC	No connection
31	BL_GND	Backlight ground
32	BL_GND	Backlight ground
33	BL_GND	Backlight ground
34	NC	Hot Plug Detect or No connection (optional)
35	BL_PWM_DIM	Signal input for the system PWM for dimming
36	BL_ENABLE	Backlight on/off
37	NC	APS on/off or No connection (optional)
38	BL_PWR	Backlight power
39	BL_PWR	Backlight power
40	BL_PWR	Backlight power

6. PIXEL FORMAT



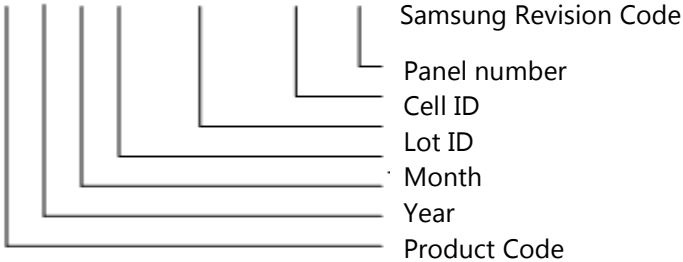
7. OUTLINE DIMENSION



8. MARKING

A nameplate is affixed to the specified location on each product.

(1)Parts number : LTN156AT30
 (2)Revision code : 3 letters
 (3)Lot number : X X X X XXX XX X 601



Samsung Revision Code
 Panel number
 Cell ID
 Lot ID
 Month
 Year
 Product Code

9. GENERAL PRECAUTIONS

9.1 STORAGE

We highly recommend to comply with the criteria in the table below.

ITEM	Unit	Min.	Max.
Storage Temperature	(°C)	5	40
Storage Humidity	(%rH)	35	75
Storage Life	12 months		
Storage Condition	- The storage room should be equipped with a good ventilation facility, which has a temperature controlling system. - Products should be placed on the pallet, which is away from the wall not on the floor. - Prevent products from being exposed to the direct sunlight, moisture, and water; Be cautious not to pile the products up. - Avoid storing products in the environment, which other hazardous material is placed. - If products are delivered or kept in the storage facility more than 3 months, we recommend you to leave products under the condition including a 20°C temperature and a humidity of 50% for 24 hours. - If you store semi-manufactured products for more than 3 months, bake the products under the condition including the 50°C temp. and the 10% humidity for 24hrs after being used.		

10. APPENDIX

Only Internal

[OPTICAL CHARACTERISTICS]

The following items are measured under the stable conditions.* The optical characteristics should be measured in the dark room or the equivalent environment by the methods shown in the Note (5).

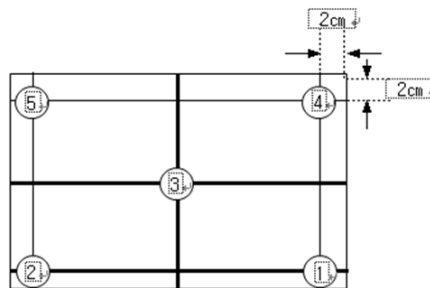
Measuring equipment: TOPCON SR-3

$T_a = 25 \pm 2 \text{ }^{\circ}\text{C}$, $V_{\text{LCD_VCC}} = 3.3\text{V}$, $f_v = 60\text{Hz}$, $f_{\text{DCLK}} = 72.33\text{MHz}$, IF = 100% duty

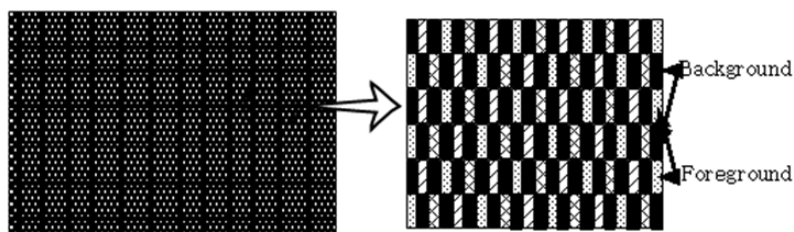
Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Note
Flicker	F		-	3.2	5.2		(8)

Note (8) The definition of flicker: The phenomenon, which the pixel on the screen of LCD panel blinks.

- 1) Calculate the figure with observing the standard for the measurement for the flicker.
- 2) Measurement point



- 3) Pattern to measure the flicker: Inverting driving of DOT



[LED DRIVER]

The manufacturer of LED driver: Richtek RT8510

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

Item	Symbol	Min.	Typ.	Max.	Unit	Note
OVP driving Voltage	V_{OVP}	-	-	42	V	

[ELECTRICAL CHARACTERISTICS]

TFT LCD MODULE

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

Item	Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply Voltage Ripple	Active Period $V_{\text{LCD_VCC_RI PPLE}}$	-	-	0.05 * $V_{\text{LCD_VCC}}$	V	(1)

Note (1) $f_v = 60\text{Hz}$, $f_{\text{DCLK}} = 72.33\text{MHz}$, $V_{\text{LCD_VCC}} = 3.3\text{V}$, Sub Dot Pattern