

SAMSUNG**ELECTRONICS**

Approval



TO : China general

DATE : Jan. 4. 2012

SAMSUNG TFT-LCD**MODEL NO : LTN156AT23-W**

NOTE : Extension code [-W]
→ LTN156AT23-W
Surface type [Glare]

Any modification of Spec is not allowed without SEC's permission

APPROVED BY : _____

PREPARED BY : _____

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Doc.No.

LTN156AT23-W

Rev.No.

04-A00-G-120104

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REVISION HISTORY

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Date	Revision No.	Page	Summary
Jan. 4. 2012	A00	All	The approval specification of 15.6" SMS HD was issued first.

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GENERAL DESCRIPTION

DESCRIPTION

LTN156AT23-W is a color active matrix TFT (Thin Film Transistor) liquid crystal display (LCD) that uses amorphous silicon TFT as switching devices. This model is composed of a TFT LCD panel, a driver circuit and a backlight system. The resolution of a 15.6" contains 1366 x 768 pixels and can display up to 262,144 colors. 6 O'clock direction is the Optimum viewing angle.

FEATURES

- Thin and light weight
- High contrast ratio, high aperture structure
- 1366 x 768 pixels resolution (16:9)
- Fast Response Time
- Low power consumption
- LED BLU Structure
- DE (Data enable) only mode
- 3.3V LVDS Interface
- On board EDID chip
- Pb-free product

APPLICATIONS

- Notebook PC
- If the usage of this product is not for PC application, but for others, please contact SEC

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		
Number of pixel	1366 x 768	pixel	16 : 9
Pixel arrangement	RGB vertical stripe		
Pixel pitch	0.252 (H) x 0.252 (V) (TYP.)	mm	
Display Mode	Normally white		
Surface treatment	Haze 0, Hardness 3H		Glare

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Mechanical Information

Item		Min.	Typ.	Max.	Unit	Note
Module size	Horizontal (H)	358.8	359.3	359.8	mm	
	Vertical (V)	209.0	209.5	210	mm	
	Depth (D)	-	5.1	5.5	mm	(1)
Weight		-	430	450	g	

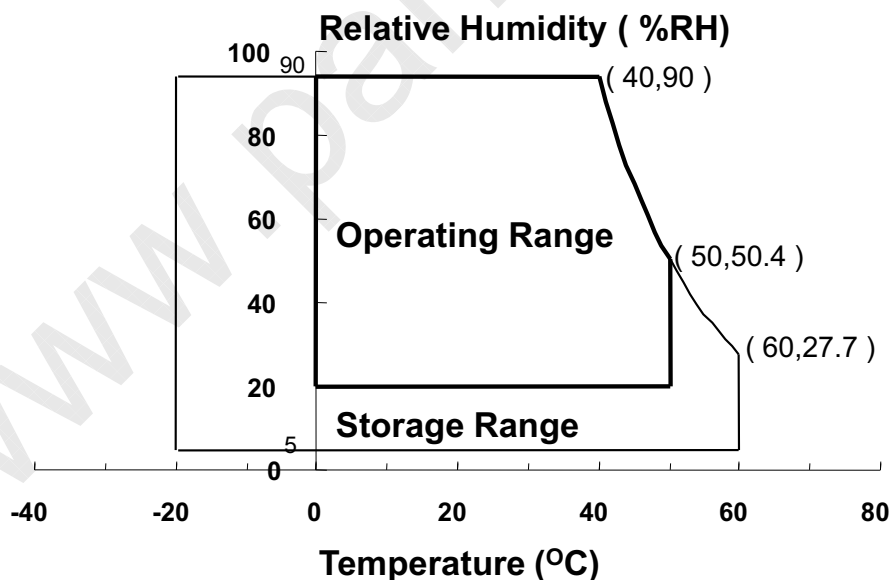
Note (1) Measurement condition of outline dimension
 . Equipment : Vernier Calipers
 . Push Force : 500g .f (minimum)

1. ABSOLUTE MAXIMUM RATINGS

1.1 ENVIRONMENTAL ABSOLUTE RATINGS

Item	Symbol	Min.	Max.	Unit	Note
Storage temperate	TSTG	-20	60	°C	(1), (5)
Operating temperate (Temperature of glass surface)	TOPR	0	50	°C	(1), (5)
Shock (non-operating)	Snop	-	240	G	(2), (4)
Vibration (non-operating)	Vnop	-	2.41	G	(3), (4)

Note (1) Temperature and relative humidity range are shown in the figure below.
 95 % RH Max. ($40\text{ }^{\circ}\text{C} \geq T_a$)
 Maximum wet - bulb temperature at $39\text{ }^{\circ}\text{C}$ or less. ($T_a > 40\text{ }^{\circ}\text{C}$) No condensation



- (2) 2ms, half sine wave, one time for $\pm X$, $\pm Y$, $\pm Z$.
 (3) 5 - 500 Hz, random vibration, 30min for X, Y, Z.
 (4) 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.

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1.2 ELECTRICAL ABSOLUTE RATINGS

(1) TFT LCD MODULE

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

Item	Symbol	Min.	Max.	Unit	Note
Power Supply Voltage	V_{DD}	$V_{DD} - 0.3$	$V_{DD} + 0.3$	V	(1)
Logic Input Voltage	V_{DD}	$V_{DD} - 0.3$	$V_{DD} + 0.3$	V	(1)

Note (1) Within T_a (25 ± 2 °C)

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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 (5).
Measuring equipment : TOPCON SR-3

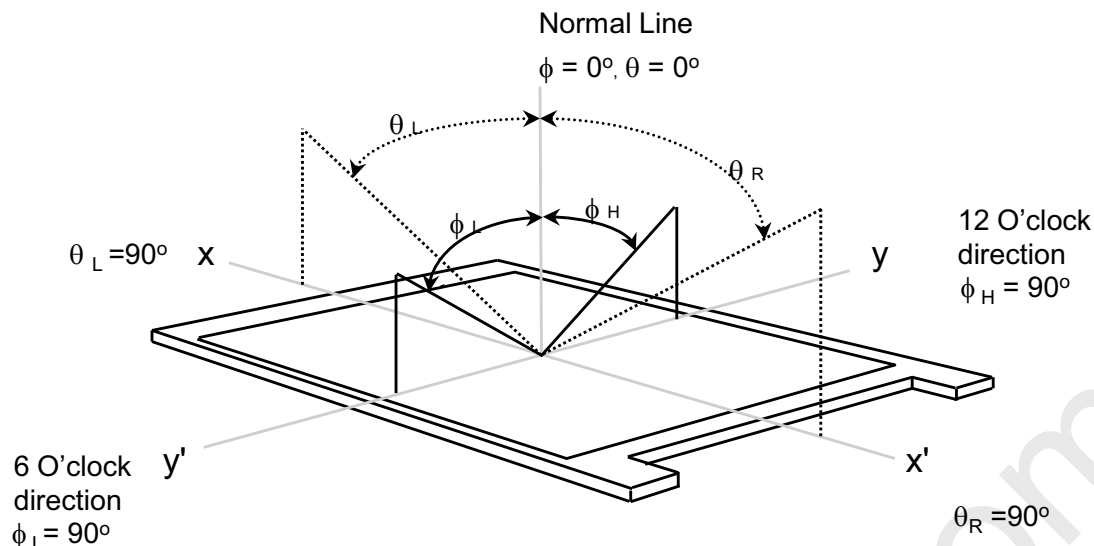
* Ta = 25 ± 2 °C, V_{DD}=3.3V, fv= 60Hz, f_{DCLK} = 70.7MHz, IL = 27mA

Item		Symbol	Condition	Min.	Typ.	Max	Unit	Note
Contrast Ratio (5 Points)		CR	Normal Viewing Angle φ = 0 θ = 0	300	500	-	-	(1), (2), (5)
Response Time at Ta (Rising + Falling)		T _{RT}		-	16	25	msec	(1), (3)
Average Luminance of White (5 Points)		Y _{L,AVE}		255	300	-	cd/m ²	IL=TBDmA (1), (4)
Color Chromaticity (CIE)	Red	R _X		Typ -0.03	Typ +0.03	0.570	-	
		R _Y	0.340					
	Green	G _X	0.330					
		G _Y	0.560					
	Blue	B _X	0.160					
		B _Y	0.135					
	White	W _X	0.313					
		W _Y	0.329					
Viewing Angle	Hor.	θ _L	CR ≥ 10	Degrees	40	45	-	(1), (5) SR-3
		θ _R			40	45	-	
	Ver.	φ _H			15	15	-	
		φ _L			30	30	-	
Color Gamut				-	45	-	%	
13 Points White Variation		δ _L		-	-	1.7	-	(6)

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Note 1) Definition of Viewing Angle : Viewing angle range($10 \leq C/R$)

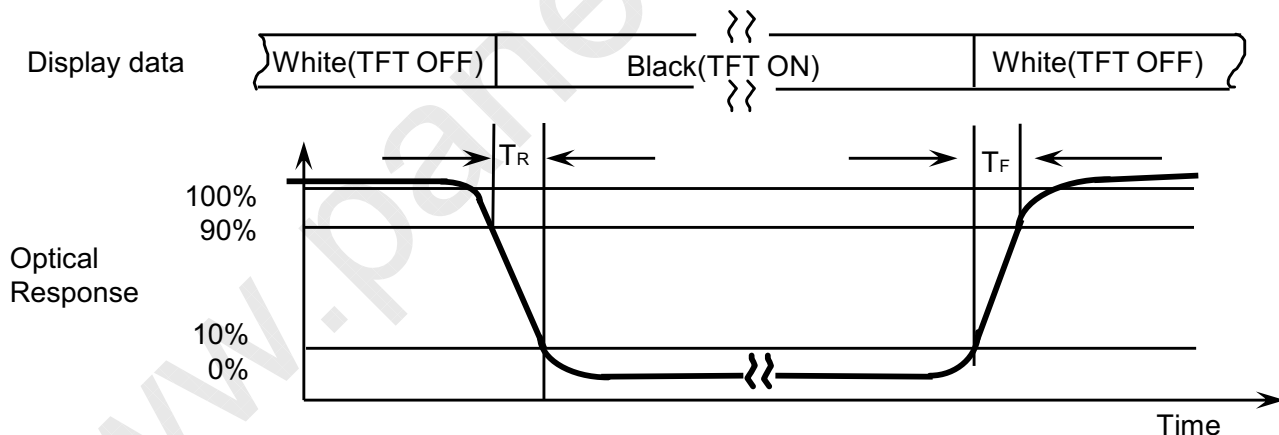


Note 2) Definition of Contrast Ratio (CR) : Ratio of gray max (Gmax) ,gray min (Gmin) at 5 points(4, 5, 7, 9, 10)

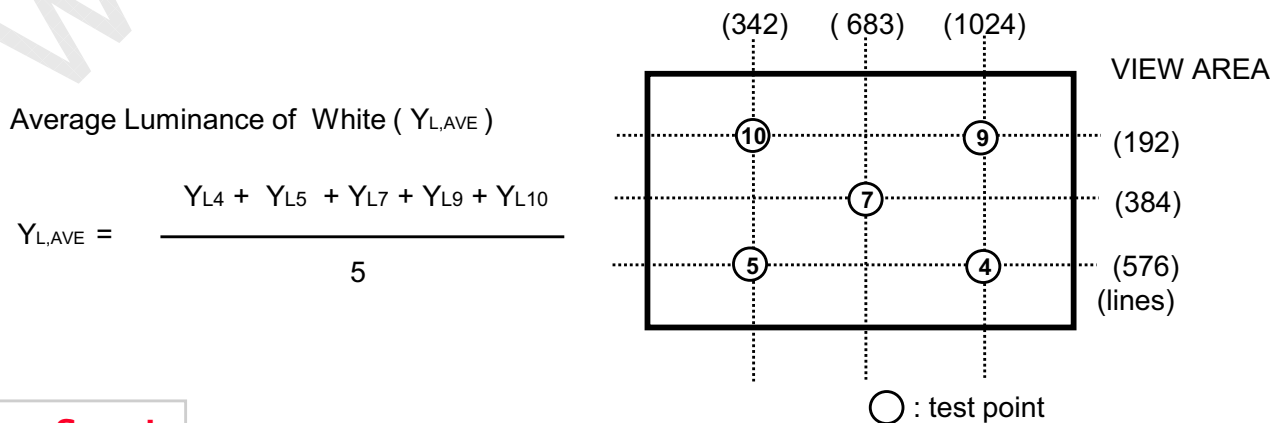
$$CR = \frac{CR(4) + CR(5) + CR(7) + CR(9) + CR(10)}{5}$$

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

Note 3) Definition of Response time :



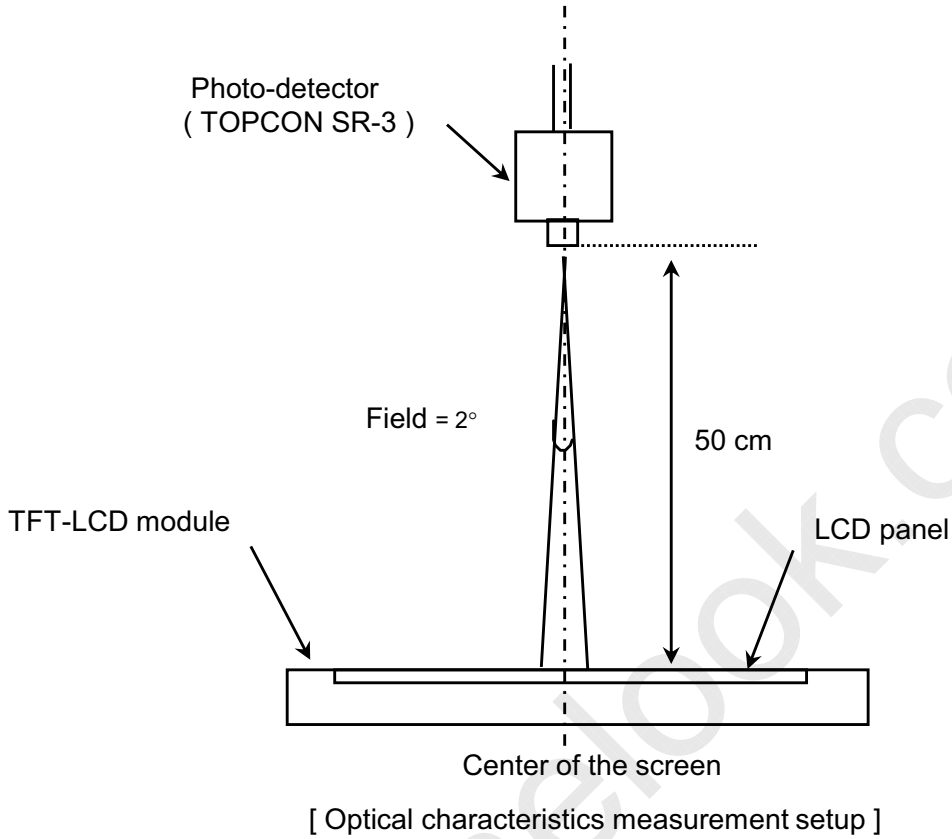
Note 4) Definition of Average Luminance of White : measure the luminance of white at 5 points.



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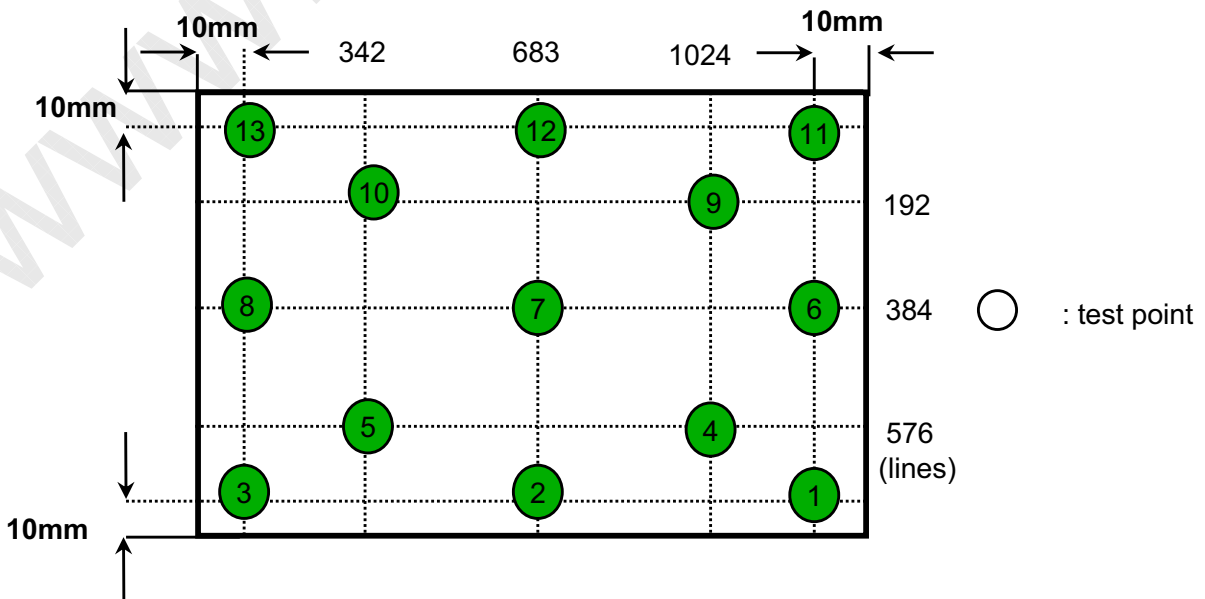
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Note 5) After stabilizing and leaving the panel alone at a given temperature for 30 min , the measurement should be executed. Measurement should be executed in a stable, windless, and dark room. 30 min after lighting the backlight. This should be measured in the center of screen.
 LED current : 27mA
 Environment condition : Ta = 25 ± 2 °C



Note 6) Definition of 13 points white variation (δL), [① ~ ⑬]

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



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3. ELECTRICAL CHARACTERISTICS

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3.1 TFT LCD MODULE

Ta= 25 ± 2°C

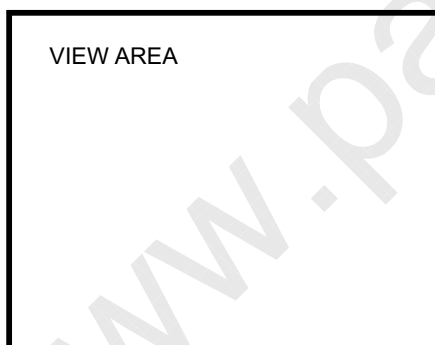
Item	Symbol	Min.	Typ.	Max.	Unit	Note	
Voltage of Power Supply	V _{CC}	3.0	3.3	3.6	V		
Differential Input Voltage for LVDS Receiver Threshold	High	V _{IH}	-	-	+100	mV	V _{CM} = +1.2V
	Low	V _{IL}	-100	-	-	mV	
Vsync Frequency	f _v	-	60	-	Hz		
Main Frequency	f _{DCLK}	-	70.7	-	MHz		
Rush Current	I _{RUSH}	-	-	1.5	A	(4)	
Current of Power Supply	White		200	-	mA	(2),(3)*a	
	Mosaic		220	-	mA	(2),(3)*b	
	V-strip		350	-	mA	(2),(3)*c	

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

(2) f_v = 60Hz, f_{DCLK} = 70.7 MHz, V_{DD} = 3.3V , DC Current.

(3) Power dissipation pattern

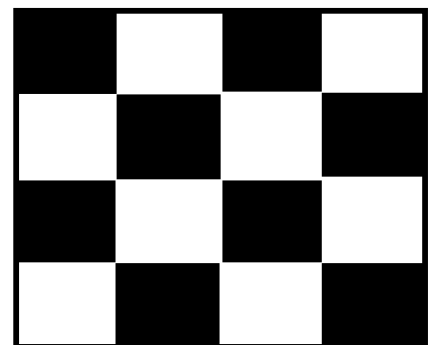
*a) White Pattern



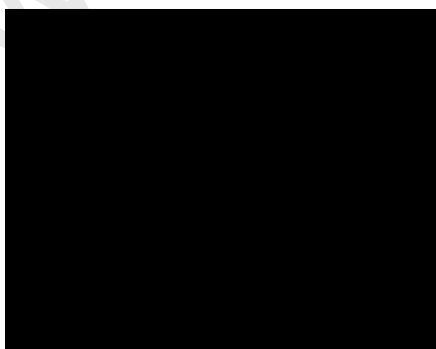
Display Brightest Gray Level →

Display Darkest Gray Level →

*b) Mosaic Pattern



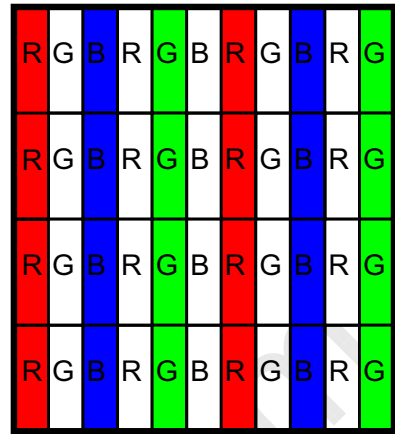
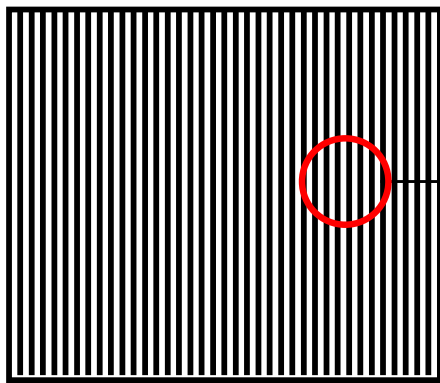
*c) Black Pattern



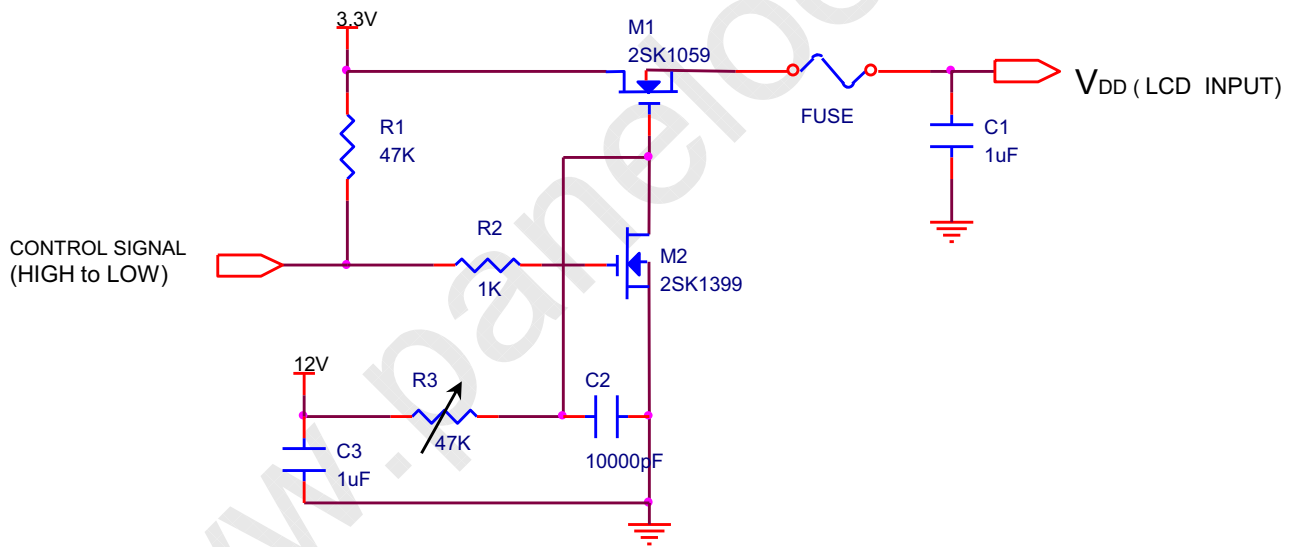
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*d) 1dot Vertical stripe pattern



4) Rush current measurement condition (V_{CC} rising time is 470us)



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3.2 BACK-LIGHT UNIT

Ta= 25 ± 2 °C

Item	Symbol	Min.	Typ.	Max.	Unit	Note
LED Forward Current	IF	-	27	-	mA	
LED Forward Voltage	VF	-	3.2	-	V	
LED Array Voltage	VP	-	36	-	V	
Operating life time	Hr	10000	-	-	W	

3.3 LED Driver

- On board LED Driver (Manufacturer : Richtek)

Ta= 25 ± 2 °C

Item-	Symbol	Min.	Typ.	Max.	Unit	Note
Input Voltage	V _{in}	6	12	24	V	-
Input Current	I	-	320	-	mA	-
EN control level	ON	1.5	3.3	5.0	V	
	OFF	0	0	0.5	V	
PWM control level	ON	1.5	3.3	5.0	V	
	OFF	0	0	0.1	V	
PWM Control Duty Ratio	D	10	-	100	%	
External PWM Dimming Control Frequency (BLIM)	F _{BLIM}	-	1	10	kHz	
Operating Life Time	Hr	10,000	-	-	Hour	

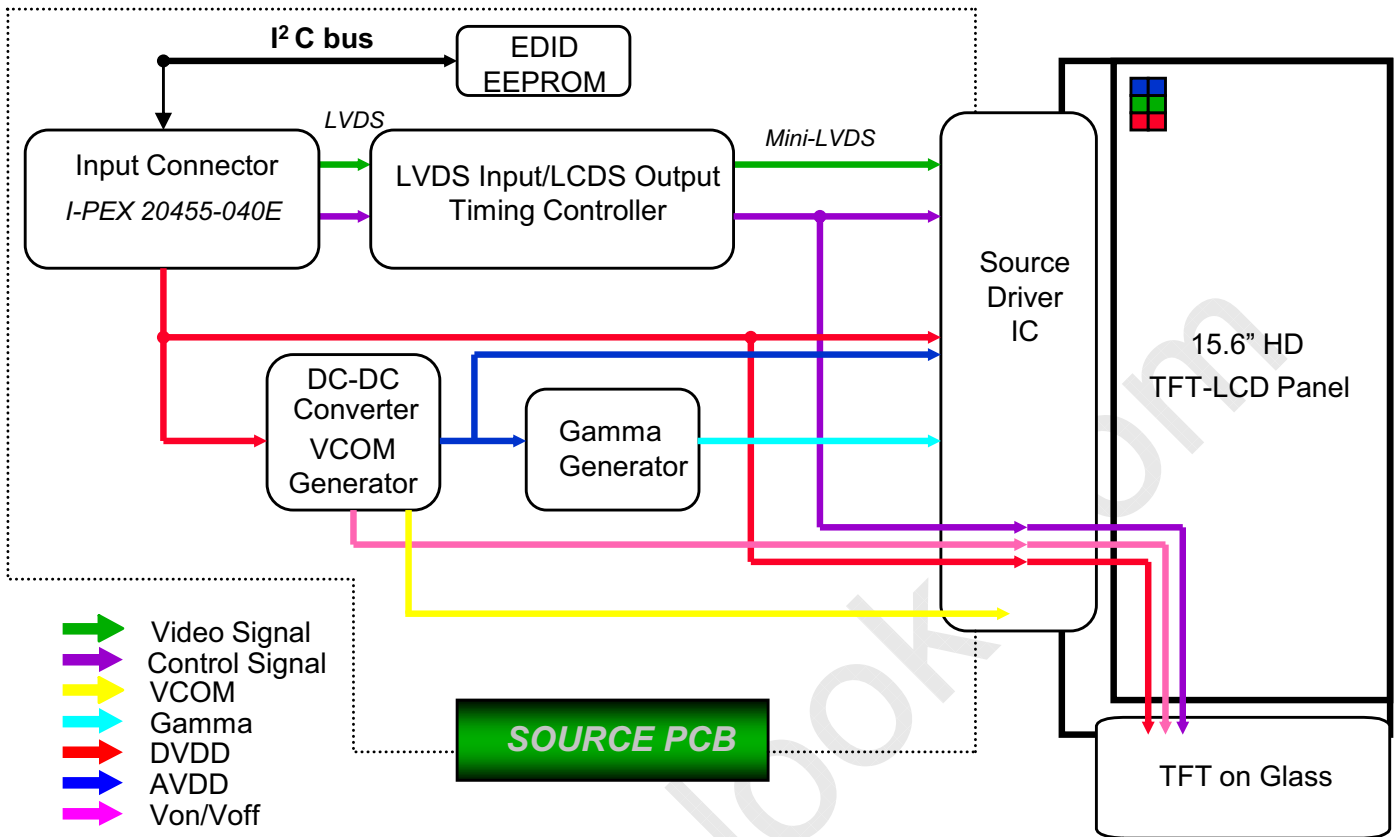
Note (1) Life time (Hr) of LEDs can be defined as the time in which it continues to operate under the condition Ta= 25 ± 2 °C and IF = 27 mArms until one of the following event occurs.
When the brightness becomes 50% or lower than the original.

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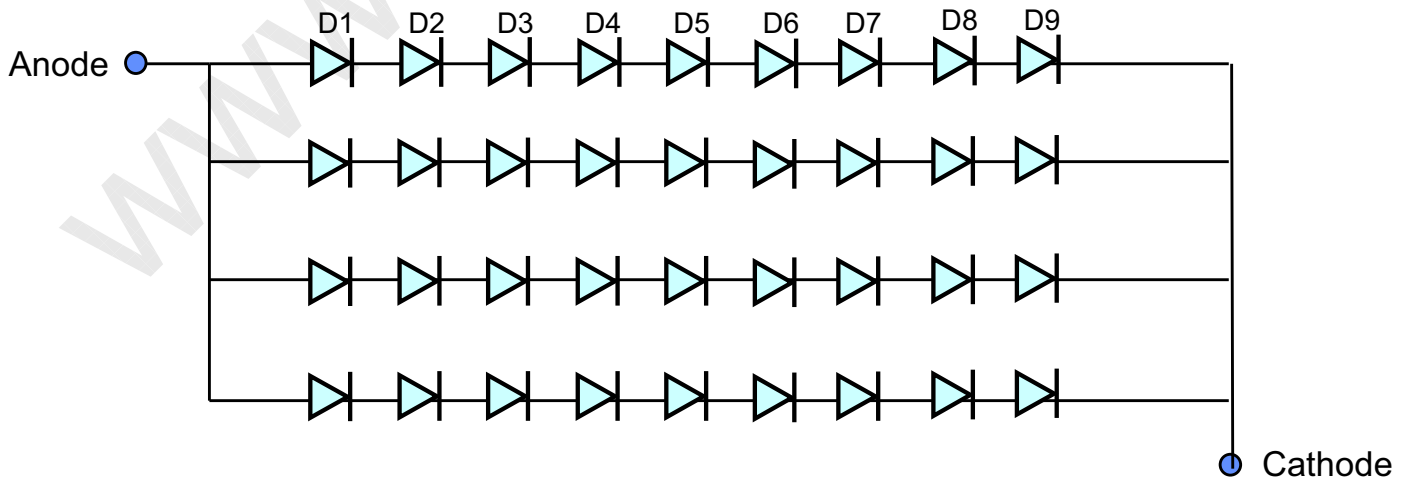
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4. BLOCK DIAGRAM

4.1 TFT LCD Module



4.2 LED connection and placement



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5. INPUT TERMINAL PIN ASSIGNMENT

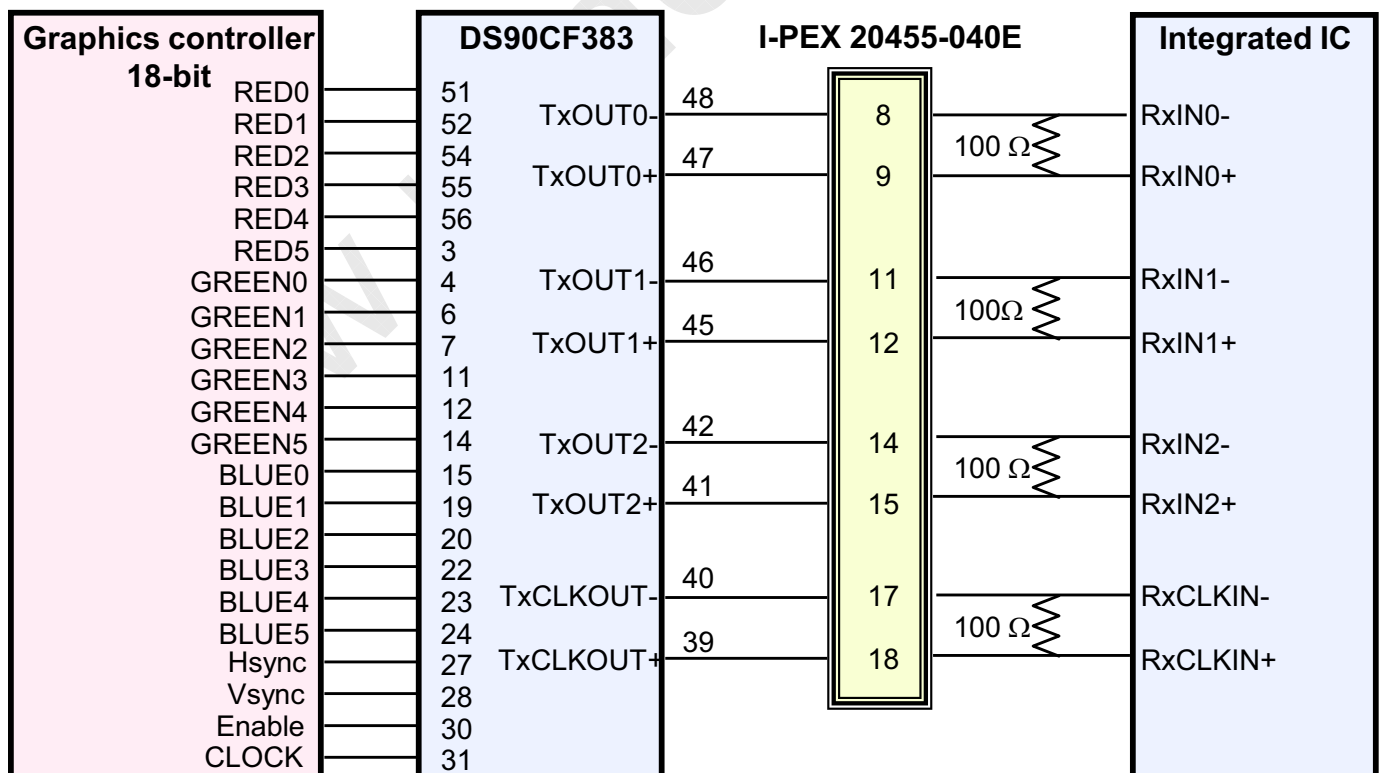
5.1. Input Signal & Power (LVDS, Connector : I-PEX 20455-040E-02S or Compatible)

Pin	Symbol	Function
1	NC	No Connection (Reserved for supplier)
2	VCC	Power Supply, 3.3V (typical)
3	VCC	Power Supply, 3.3V (typical)
4	VCC_EDID	DDC 3.3V power
5	WPN	EDID writing protection
6	CLK_EDID	DDC Clock
7	DATA_EDID	DDC Data
8	RXin0-	- LVDS differential data (R0-R5, G0)
9	RXin0+	+ LVDS differential data (R0-R5, G0)
10	GND	Ground
11	RXin1-	- LVDS differential data (G1-G5, B0-B1)
12	RXn1+	+ LVDS differential data (G1-G5, B0-B1)
13	GND	Ground
14	RXin2-	- LVDS differential data (B2-B5,HS,VS, DE)
15	RXn2+	+ LVDS differential data (B2-B5,HS,VS, DE)
16	GND	Ground
17	ClKIN-	- LVDS differential clock input
18	ClKIN+	+ LVDS differential clock input
19	GND	Ground
20~21	NC	No Connection
22	GND	Ground
23~24	NC	No Connection
25	GND	Ground
26~27	NC	No Connection
28	GND	Ground
29~30	NC	No Connection
31~33	GND	LED Ground
34	NC	No Connection
35	PWM	PWM for luminance control
36	LED_EN	BL On/Off (On: 2.0~3.3V, Off: 0~0.5V)
37	NC	No Connection
38~40	VBL(7~20)	*LED Power Supply 7V-20V

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5.2 LVDS Interface : Transmitter DS90CF363 or Compatible

Pin No.	Name	RGB Signal	Pin No.	Name	RGB Signal
51	TxIN0	R0	14	TxIN14	G5
52	TxIN1	R1	15	TxIN15	B0
54	TxIN2	R2	19	TxIN18	B1
55	TxIN3	R3	20	TxIN19	B2
56	TxIN4	R4	22	TxIN20	B3
3	TxIN6	R5	23	TxIN21	B4
4	TxIN7	G0	24	TxIN22	B5
6	TxIN8	G1	27	TxIN24	Hsync
7	TxIN9	G2	28	TxIN25	Vsync
11	TxIN12	G3	30	TxIN26	DE
12	TxIN13	G4	31	TxCLKIN	Clock

LVDS INTERFACE

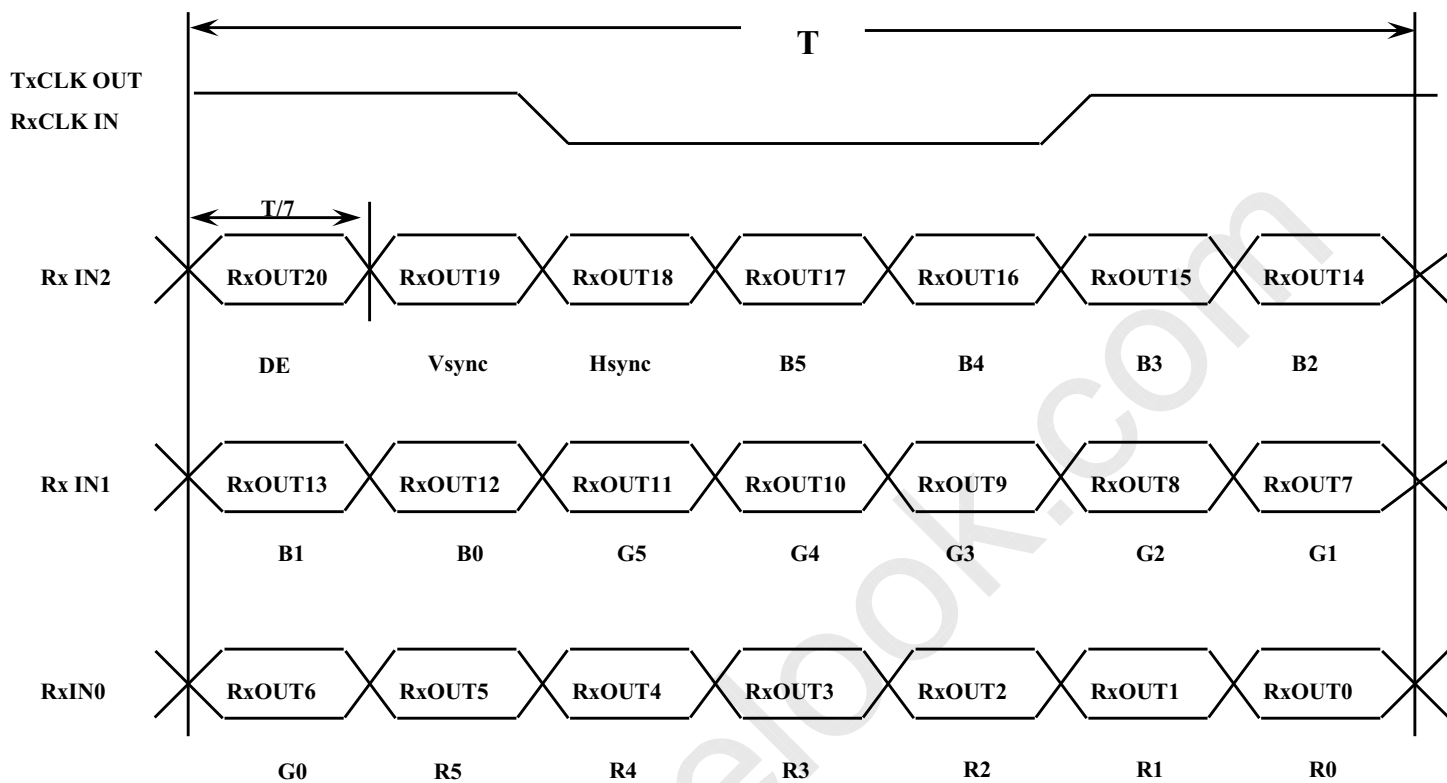
Note : The LCD Module uses a 100ohm resistor between positive and negative lines of each receiver input.

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5.3 Timing Diagrams of LVDS For Transmission

LVDS Receiver : Integrated T-CON



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5.4 Input Signals, 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	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	R0	
	Dark	1	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	R2	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	R3~R60	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	↓	1	0	1	1	1	1	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	R62	
	Red	1	1	1	1	1	1	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	G0	
	Dark	0	0	0	0	0	0	1	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	G2	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	G3~G60	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	↓	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	G61	
	Light	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	G62	
	Green	0	0	0	0	0	0	1	1	1	1	1	1	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	B0	
	Dark	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	B1	
	↑	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	B2	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	B3~B60	
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:	:		
	↓	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	B61	
	Light	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	B62	
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	B63	

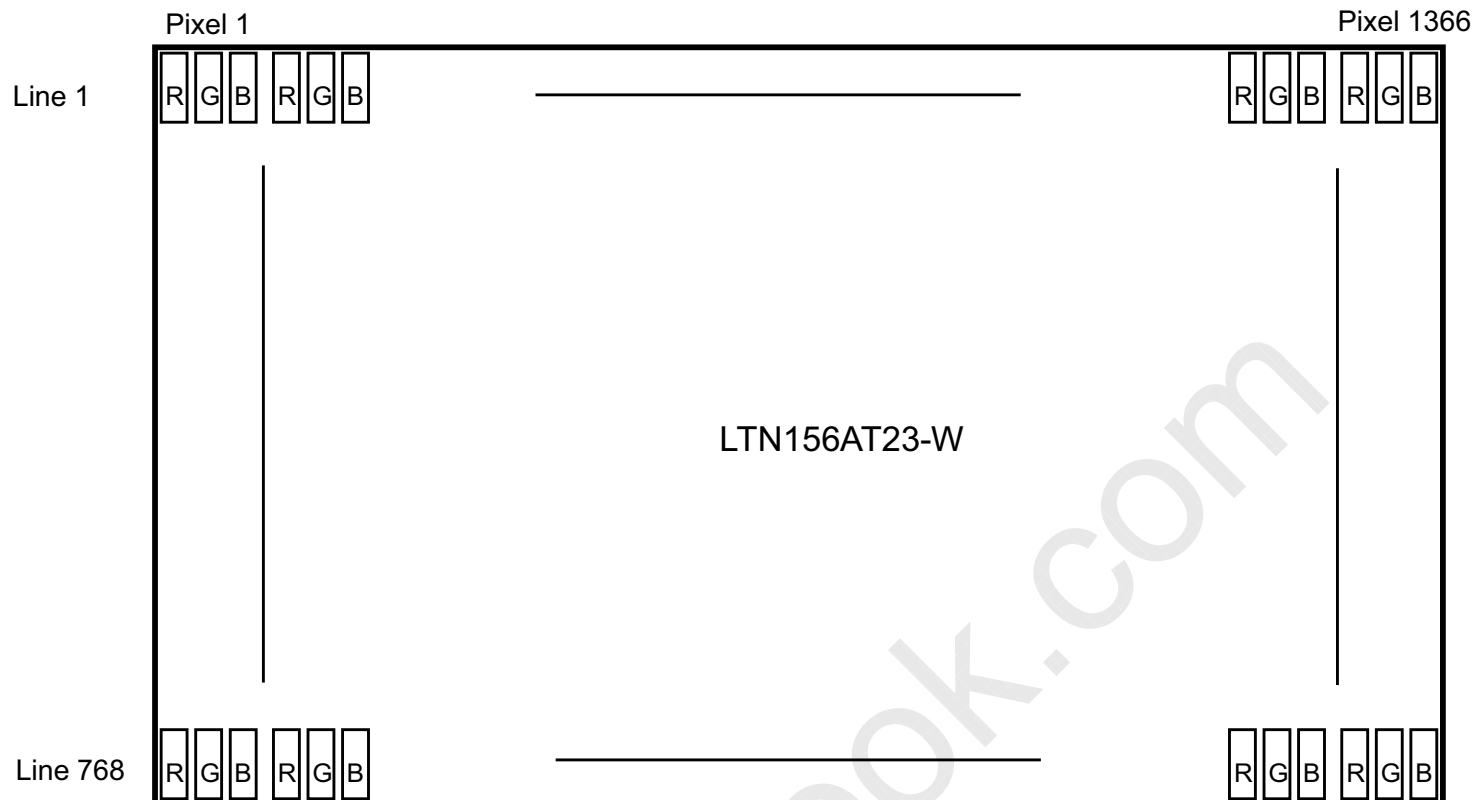
Note 1) MSB = R5,G5,B5, LSB=R0,G0,B0

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

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5.5 Pixel Format in the display



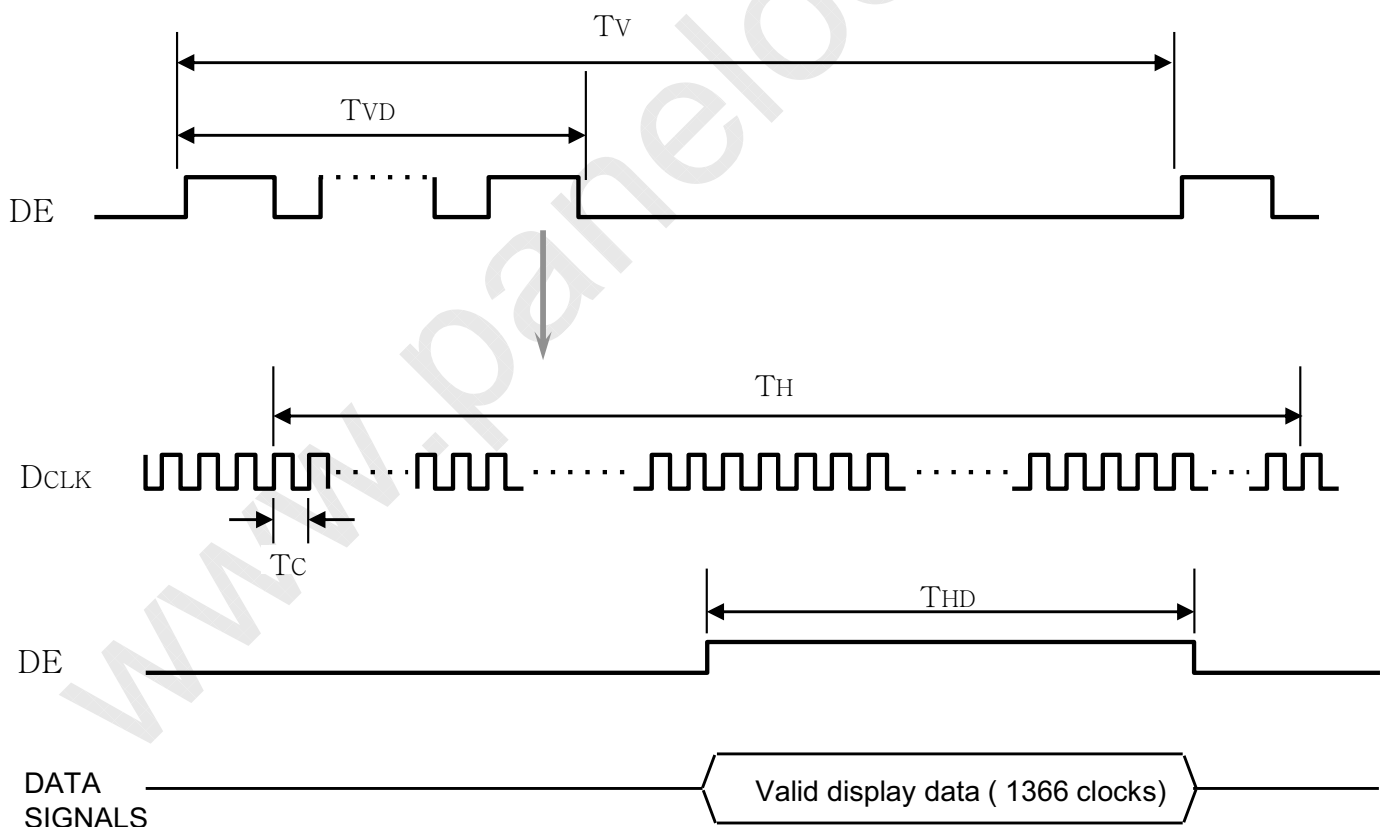
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6. INTERFACE TIMING

6.1 Timing Parameters

Signal	Item	Symbol	Min.	Typ.	Max.	Unit	Note
Main Clock	Frequency	1/TC	66.3	72.33	83.88	MHz	-
Frame Frequency	Cycle	TV	773	790	810	Lines	-
Vertical Active Display Term	Display Period	TVD	-	768	-	Lines	-
One Line Scanning Time	Cycle	TH	1426	1526	1726	Clocks	-
Horizontal Active Display Term	Display Period	THD	-	1366	-	Clocks	-

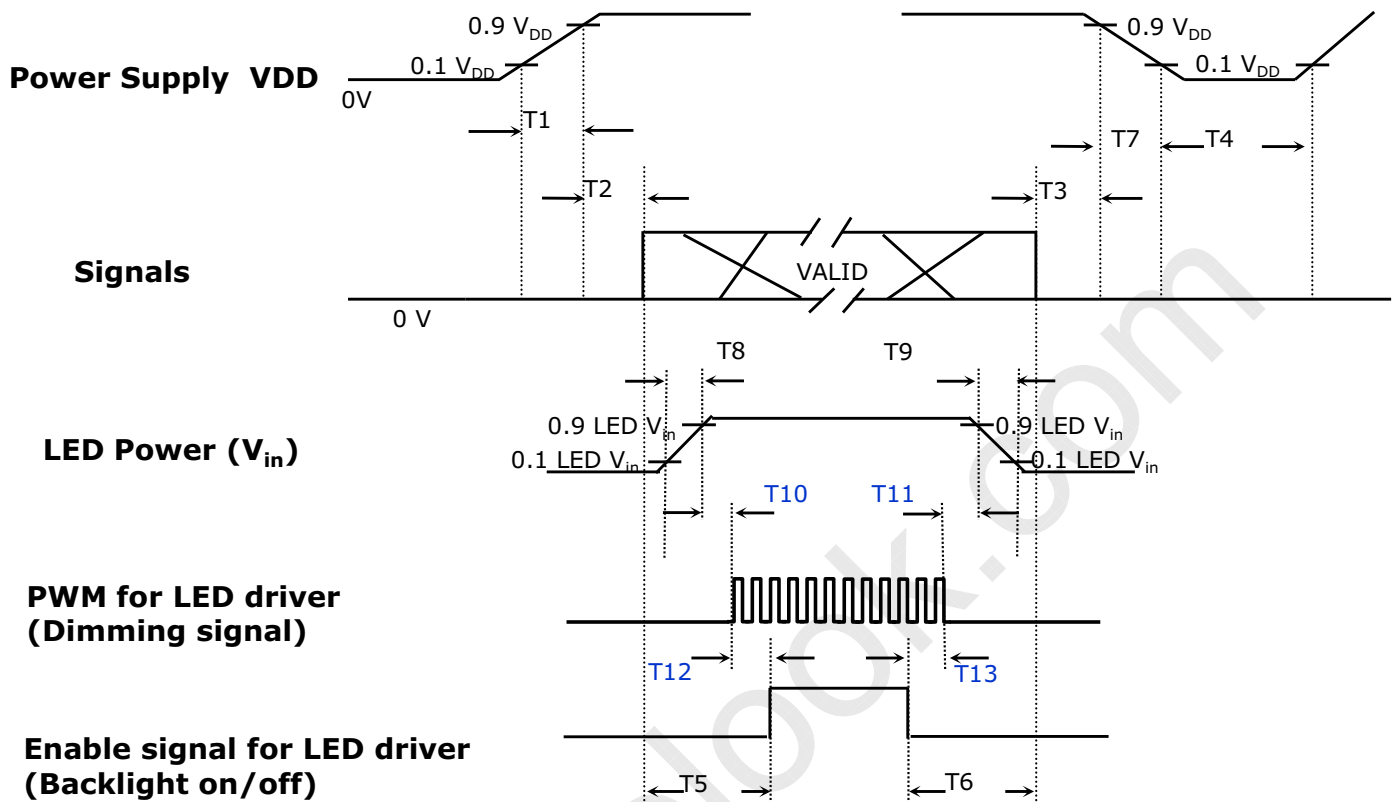
6.2 Timing diagrams of interface signal (DE only mode)



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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.



Power ON/OFF Sequence

Timing (ms)	Remarks
$0.5 < T1 \leq 10$	V _{DD} rising time from 10% to 90%
$0 < T2 \leq 50$	Delay from V _{DD} to valid data at power ON
$0 < T3 \leq 50$	Delay from valid data OFF to V _{DD} OFF at power Off
$500 \leq T4$	V _{DD} OFF time for Windows restart
$200 \leq T5$	Delay from valid data to B/L enable at power ON
$200 \leq T6$	Delay from valid data off to B/L disable at power Off
$0 < T7 \leq 10$	V _{DD} falling time from 90% to 10%
$0.5 < T8 \leq 10$	LED V _{in} rising time from 10% to 90%
$0.5 < T9 \leq 10$	LED V _{in} falling time from 90% to 10%
$0 \leq T10$	Delay from LED driver Vin rising time 90% to PWM ON
$0 \leq T11$	Delay from PWM Off to LED driver Vin falling time 10%, Must Keep rule
$0 \leq T12$	Delay from PWM ON to B/L Enable ON, Must Keep rule
$0 \leq T13$	Delay from B/L Enable Off to PWM Off

Power Sequence & Timing Parameters

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7. MECHANICAL OUTLINE DIMENSION

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Please refer to the next page.

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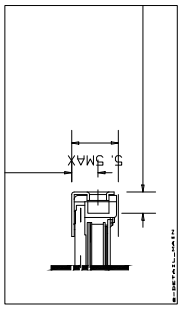
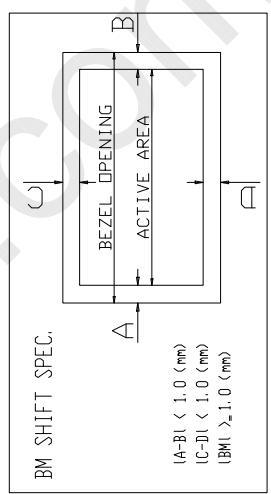
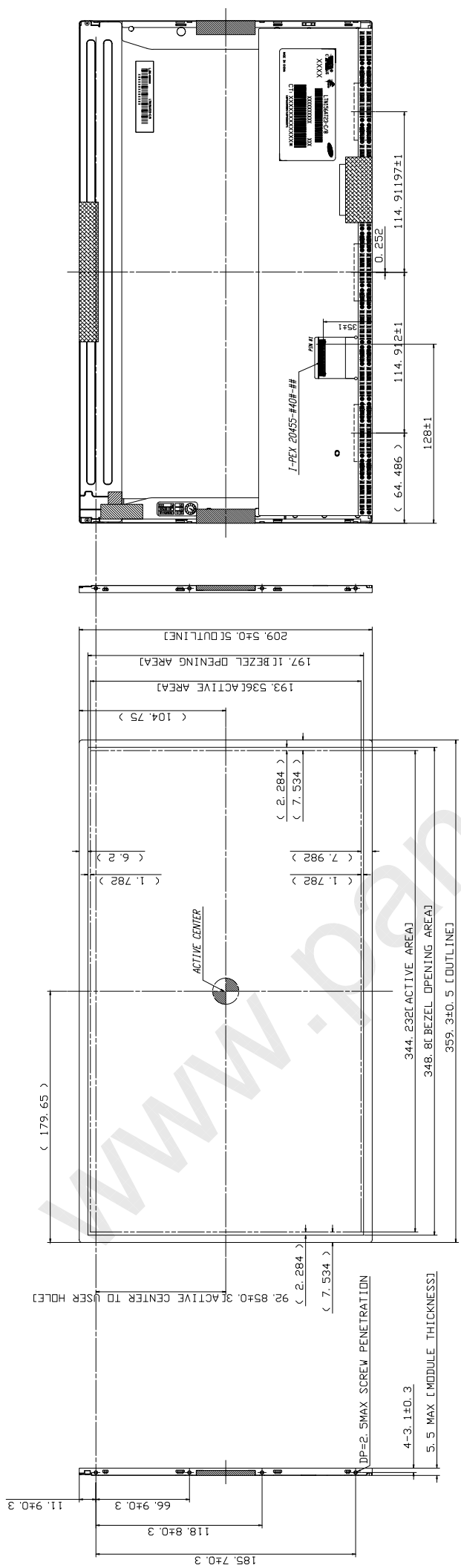
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<USER HOLE SCREW HOLE DEPTH>

- * NOTE
1. SIGNAL INTERFACE CONNECTOR TO BE SPECIFIED AS BELOW.
 - 1. MAKER : I-PEX (Not accept compatible connector basic)
 - 2. INPUT CONNECTOR : I-PEX 20455-040E-12
 2. LED CONNECTOR FOR BACKLIGHT TO BE SPECIFIED AS BELOW.
 - 1. MAKER : LUII Electronics
 - 2. PART NO : 51441-1041
 3. CALIFERS MEASURING FORCE : 750 ± 250 gf/cm
 4. MAXIMUM SCREW TORQUE : MAX 2.5 Kgf-cm
 5. WEIGHT : 450 g MAX
 6. IN ORDER TO AVOID IC DAMAGE, IT IS NOT ALLOW THAT OVERLAPPING OF CABLES OR ANTENNAS, CAMERA, WLAN, WLAN, OVER THESE COF LOCATIONS.

REV.	DATE	DESCRIPTION OF REVISION	REASON
01	2012-07-09	INITIAL RELEASE	INITIAL RELEASE

NO.	NAME	DATE	STATUS
1	DESIGNER	2012-07-09	INITIAL
2	CHECKER	2012-07-09	INITIAL
3	APPROVER	2012-07-09	INITIAL

ITEM NO.	ITEM NAME	QTY	UNIT	REMARKS
1	LCD PANEL	1	PCS	FOR REF. ONLY
2	BEZEL	1	PCS	FOR REF. ONLY
3	ACTIVE AREA	1	PCS	FOR REF. ONLY
4	SCUTLINE	1	PCS	FOR REF. ONLY

NO.	NAME	DATE	STATUS
1	DESIGNER	2012-07-09	INITIAL
2	CHECKER	2012-07-09	INITIAL
3	APPROVER	2012-07-09	INITIAL

NO.	NAME	DATE	STATUS
1	DESIGNER	2012-07-09	INITIAL
2	CHECKER	2012-07-09	INITIAL
3	APPROVER	2012-07-09	INITIAL

8. PACKING

Approval

1. CARTON (Internal Package)

(1) Packing Form

Corrugated cardboard as shock absorber

(2) Packing Method

Packing case(1SET)



PANEL 2ea / SLIT



Putting the Top Pad



Note (1) Total : Approx. 13kg

(2) Acceptance number of piling : 22 sets

(3) Carton size : 283(W) X 401(D) X 263(H)

(4) Max accumulation quantity : 3 cartons

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9. GENERAL PRECAUTIONS

1. Handling

- (a) When the module is assembled, It should be attached to the system firmly using every 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 LED back-light.
- (c) Note that polarizers are very fragile and could 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 some 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 might permanent damage to the polarizer due to chemical reaction.
- (g) 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 thoroughly with soap.
- (h) Protect the module from static , it may cause damage to the C-MOS Gate Array IC.
- (i) Use fingerstalls with soft gloves in order to keep display clean during the incoming inspection and assembly process.
- (j) Do not disassemble the module.
- (k) Do not pull or fold the lamp wire.
- (l) Do not adjust the variable resistor which is located on the back side.
- (m) Protection film for polarizer on the module shall be slowly peeled off just before use so that the electrostatic charge can be minimized.
- (n) Pins of I/F connector shall not be touched directly with bare hands.

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2. 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	<ul style="list-style-type: none"> - 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, we recommend you leave them at a temperature of 20°C and a humidity of 50% for 24 hours. 		

3. OPERATION

- (a) Do not connect, 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) 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 standard limited warranty is only applicable when the module is used for general notebook applications. If used for purposes other than as specified, SEC is not to be held reliable for the defective operations. It is strongly recommended to contact SEC to find out fitness for a particular purpose.

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4. 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. (the supply voltage variation, input voltage variation, variation in part contents and environmental temperature, so on) Otherwise the module may be damaged.
- (d) If the module displays the same pattern continuously for a long period of time, it can be the situation when the image "sticks" to the screen.
- (e) This module has its circuitry PCB's on the rear side and should be handled carefully in order not to be stressed.

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