

Product Specification

SPECIFICATION FOR APPROVAL

(●) Preliminary Specification
 () Final Specification

Title	23.8" Full HD TFT LCD
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BUYER	
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM238WF5
SUFFIX	SSJ1

*When you obtain standard approval,
 please use the above model name without suffix

APPROVED BY	SIGNATURE	DATE
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Please return 1 copy for your confirmation with your signature and comments.

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Product Specification

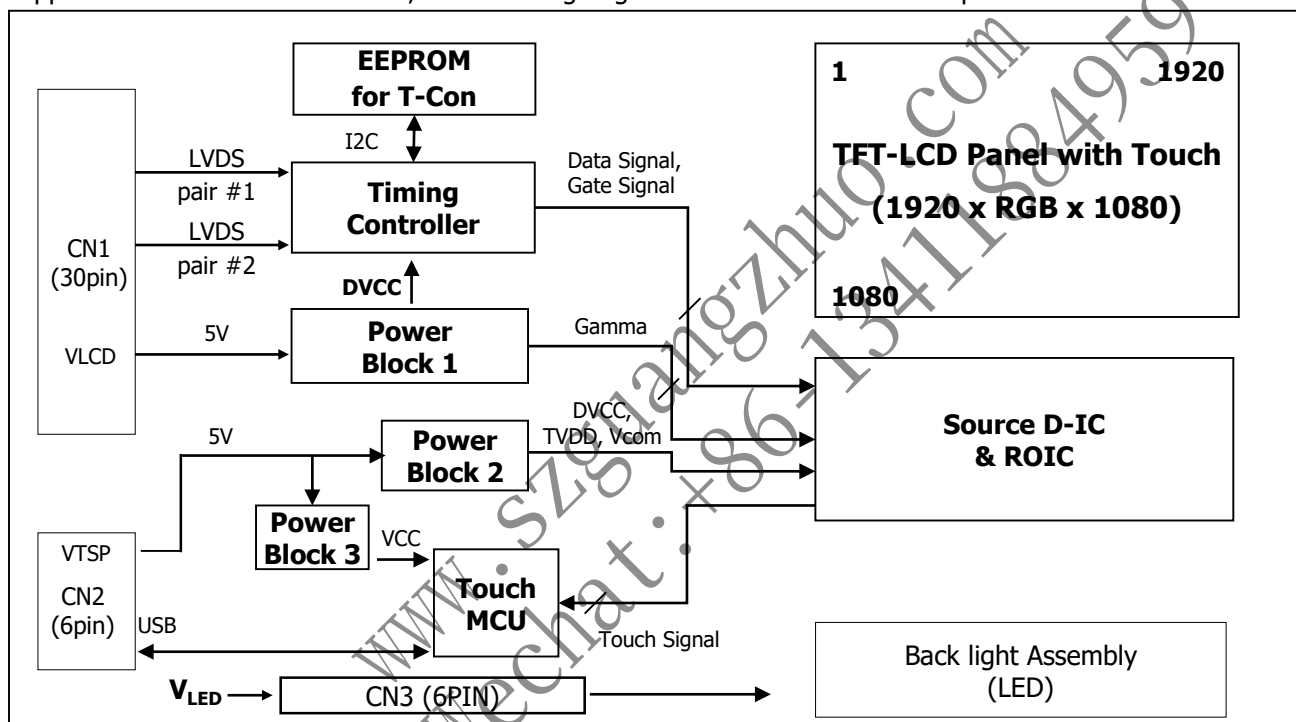
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1. General Description

LM238WF5 is a Color Active Matrix Liquid Crystal Display with Advanced In-cell Touch System. The matrix employs a-Si Thin Film Transistor as the active element. It is a transmissive type display operating in the normally black mode. It has a 23 inch diagonally measured active display area with FHD resolution (1080 vertical by 1920 horizontal pixel array). Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes. Gray scale or the brightness of the sub-pixel color is determined with a 8-bit gray scale signal for each dot, thus, presenting a palette of more than 16,7M colors with A-FRC (Advanced Frame Rate Control). It has been designed to apply the 8Bit 2 port LVDS interface. It is intended to support applications where thin thickness, wide viewing angle and touch function are important.



[Figure 1] Block diagram

General Features

Active Screen Size	23.8 inches(604.70mm) diagonal
Outline Dimension	535.12(H) x 313.12(V) x 11.15(D) mm (Typ.)
Pixel Pitch	0.2745 mm x 0.2745 mm
Pixel Format	1920 horiz. By 1080 vert. Pixels RGB stripes arrangement
Color Depth	16.78M colors (6bit + A-FRC)
Luminance, White	300 cd/m ² (Center 1 Point, Typ.)
Viewing Angle(CR>10)	R/L 178° (Typ.), U/D 178° (Typ.)
Power Consumption	Total 14.2 Watt (2.8 Watt @V _{LCD} , 11.9 Watt @Is=70mA)
Weight	2,200 g (Typ.)
Display Operating Mode	Transmissive mode, normally black
Panel type	Reverse type
Surface Treatment	Anti-glare treatment of the polarizer (Haze 25%, 3H)
Low Blue Light Panel	The ratio of light in the range from 415nm - 455nm compared to 400nm - 500nm shall be less than 50%

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2. Absolute Maximum Ratings

The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 2-1. Absolute Maximum Ratings

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	V_{LCD}	-0.3	+6.0	V_{DC}	At 25°C
Operating Temperature	T_{OP}	0	50	°C	1,2,3
Storage Temperature	T_{ST}	-20	60	°C	
Operating Ambient Humidity	H_{OP}	10	90	%RH	
Storage Humidity	H_{ST}	10	90	%RH	
LCM Surface Temperature(Operation)	$T_{surface}$	0	65	°C	1,4

Notes:

- 1) Temperature and relative humidity range are shown in the figure below.
Wet bulb temperature should be 39°C Max, and no condensation of water.
- 2) Maximum storage humidity is up to 40°C, 70% RH only for 4 corner light leakage mura.
- 3) Storage condition is guaranteed under packing condition.
- 4) LCM surface temperature should be measured under the condition of $V_{LCD} = Typ$, $f_v = 60Hz$, $T_a = 25°C$, no humidity and typical LED string current.

* f_v = Frame frequency
 * T_a = Ambient temperature

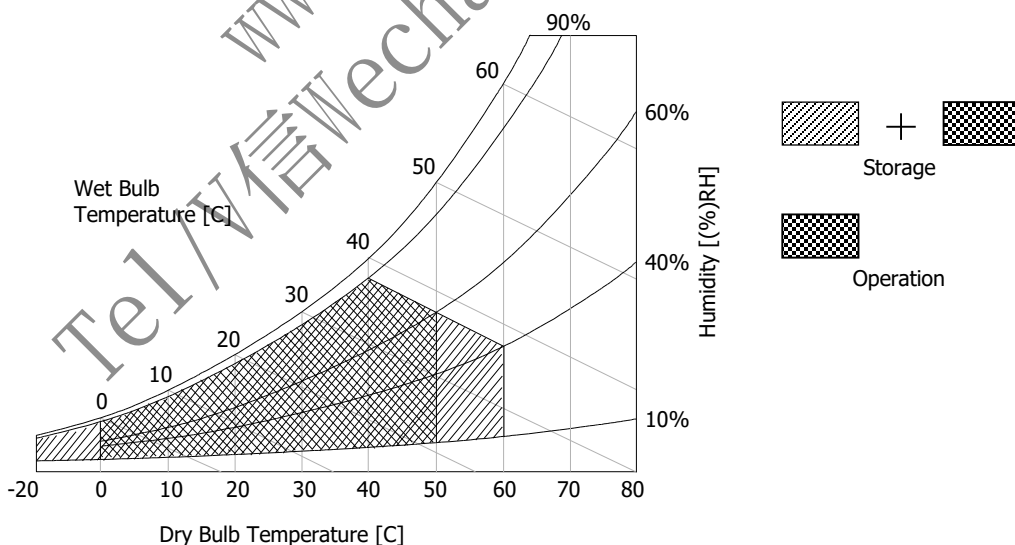


FIG.2 Temperature And Relative Humidity

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3. Electrical Specifications

3-1. Electrical Characteristics

It requires two power inputs. One is employed to power the LCD electronics and to drive the TFT array and liquid crystal. The second input power for the LED/Backlight, is typically generated by a LED Driver. The LED Driver is an external unit to the LCDs.

Table 2-1. ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min	Typ	Max		
VLCD :						
Power Supply Input Voltage	VLCD	4.5	5	5.5	Vdc	
Permissive Power Input Ripple	VdRF_L			400	mVp-p	1
Power Supply Input Current	ILCD	-	305	381	mA	2
		-	320	400	mA	3
Power Consumption	P _{C_L} TYP	-	1.53	1.91	Watt	2
	P _{C_L} MAX	-	1.60	2.00	Watt	3
Rush current	IRUSH_L	-	-	3	A	4
VTSP :						
Power Supply Input Voltage	VTSP	4.5	5	5.5	Vdc	
Permissive Power Input Ripple	VdRF_T				mVp-p	1
Power Supply Input Current	ITSP	-	240	300	mA	2
		-	390	488	mA	3
Power Consumption	P _{C_T} TYP	-	1.20	1.50	Watt	2
	P _{C_T} MAX	-	1.95	2.44	Watt	3
Rush current	IRUSH_T	-	-	0.5	A	4

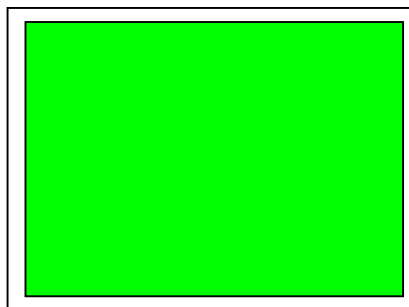
Notes :

1. Permissive power ripple should be measured under the condition of $V_{LCD}=5.0V$, $25^{\circ}C$, $f_v=\max$.
Refer to page 7 for the pattern and more information.
2. The specified current and power consumption can be measured under the $V_{LCD}=5.0V$, $25^{\circ}C$, $f_v=60Hz$ and the pattern should be changed according to the typical or maximum power condition.
The max. current can be measured only with the maximum power pattern.
See the page 7 for details.
3. Maximum condition of inrush current :
The duration of rush current is about 5ms and rising time of power input is $500\mu s \pm 20\%$. (min.).
4. V_{LCD} level must be measured between two points on PCB of LCM [V_{LCD} (test point) ~ LCM Ground]
(Test condition : maximum power pattern, $25^{\circ}C$, $f_v=60Hz$)

* f_v =frame frequency

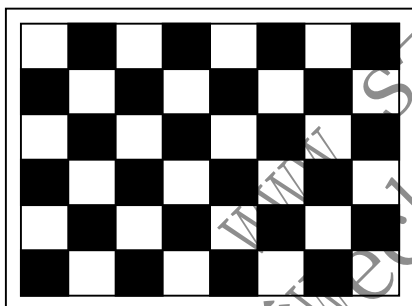
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- **Permissive Power input ripple** ($V_{LCD} = 5.0V$, $25^{\circ}C$, f_v (frame frequency)=MAX condition)

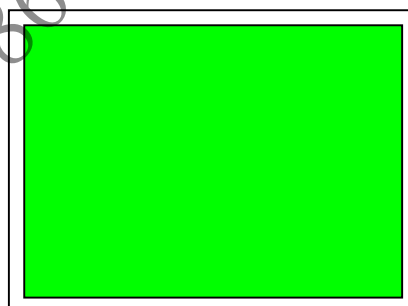


Green 255 pattern

- **Power consumption** ($V_{LCD} = 5V$, $25^{\circ}C$, f_v (frame frequency)=60Hz condition)



Typical power Pattern



Maximum power Pattern

FIG.3 Mosaic pattern & White Pattern for power consumption measurement

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Table 2-2. LED Bar ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	Is	-	70	75	mA	1, 2, 5
LED String Voltage	Vs	39.5	42.5	45.5	V	1, 5
Power Consumption	PBar	-	11.9	12.8	Watt	1, 2, 4
LED Life Time	LED_LT	30,000	-	-	Hrs	3

Notes) The LED Bar consists of 60 LED packages, 4 strings (parallel) x 15packages (serial)

1. The specified values are for single LED bar.
2. The specified current is defined as the input current for single LED string with 100% duty cycle.
3. The specified voltage is the input LED string voltage at typical current 100% duty cycle.
4. The LED life time is defined as the time when brightness of LED itself reach to the 50% of initial value under the conditions at $T_a = 25 \pm 2^\circ\text{C}$ and typical LED string current.
5. The power consumption shown above does not include the loss of external LED driver.
 The typical power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Typ.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.
 The maximum power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Max.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.

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3-2. Interface connections

3-2-1. LCD Module

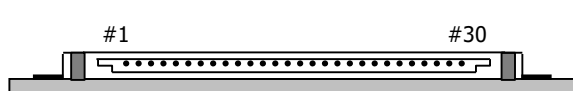
- LCD connector(CN1) : GT103-30S-H23(LSM) or equivalent
- Mating connector : FI-X30C2L (Manufactured by JAE) or equivalent

Table 3. Module connector (CN1) pin configuration

No	Symbol	Description	No	Symbol	Symbol
1	RX00-	Minus signal of odd channel 0 (LVDS)	16	RXE1+	Plus signal of even channel 1 (LVDS)
2	RX00+	Plus signal of odd channel 0 (LVDS)	17	GND	Ground
3	RX01-	Minus signal of odd channel 1 (LVDS)	18	RXE2-	Minus signal of even channel 2 (LVDS)
4	RX01+	Plus signal of odd channel 1 (LVDS)	19	RXE2+	Plus signal of even channel 2 (LVDS)
5	RX02-	Minus signal of odd channel 2 (LVDS)	20	RXEC-	Minus signal of even clock channel (LVDS)
6	RX02+	Plus signal of odd channel 2 (LVDS)	21	RXEC+	Plus signal of even clock channel (LVDS)
7	BIST	L(GND): Black, H(3.3V): Rotational Pattern	22	RXE3-	Minus signal of even channel 3 (LVDS)
8	RXOC-	Minus signal of odd clock channel (LVDS)	23	RXE3+	Plus signal of even channel 3 (LVDS)
9	RXOC+	Plus signal of odd clock channel (LVDS)	24	GND	Ground
10	RX03-	Minus signal of odd channel 3 (LVDS)	25	NC	No connection (I2C serial interface for LCM)
11	RX03+	Plus signal of odd channel 3 (LVDS)	26	NC	No connection.(I2C serial interface for LCM)
12	RXE0-	Minus signal of even channel 0 (LVDS)	27	ITLC	Interlace image sticking reduction mode selection
13	RXE0+	Plus signal of even channel 0 (LVDS)	28	VLCD	Power Supply +5.0V
14	GND	Ground	29	VLCD	Power Supply +5.0V
15	RXE1-	Minus signal of even channel 1 (LVDS)	30	VLCD	Power Supply +5.0V

Notes :

1. All GND(ground) pins should be connected together to the LCD module's metal frame.
2. All VLCD (input power) pins should be connected together.
3. All input level of LVDS signals are based on the EIA 644 standard.
4. ITLC is used for image sticking reduction in interlace mode.
 (L: Normal mode, H: Interlace image sticking reduction mode)
 This pin should be connected to GND in normal mode.
 (Low level Input Voltage : GND ~ 0.4V, High level Input Voltage : 1.6 ~ 3.6V)



Rear view of LCM

[FIG. 4] Connector diagram

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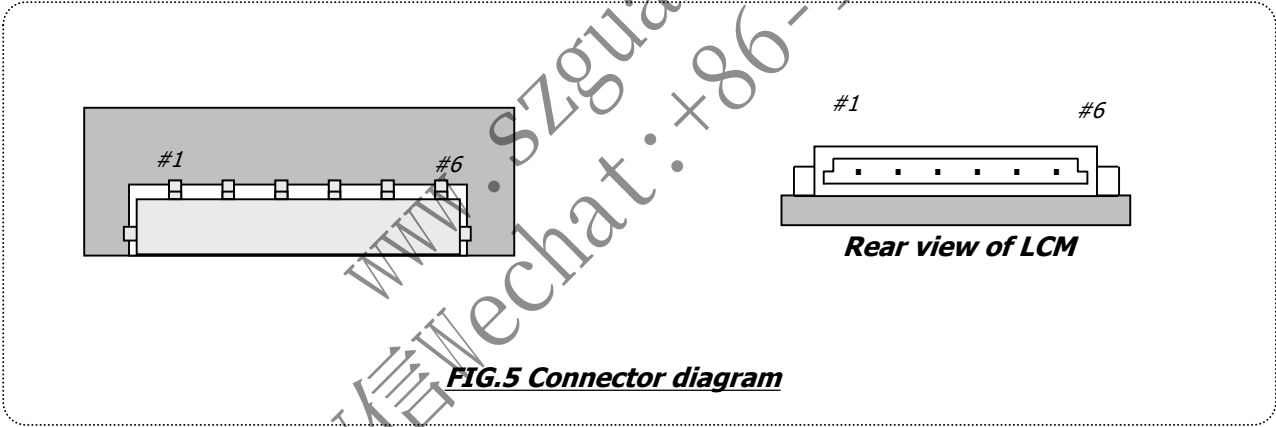
3-2. Interface Connections

3-2-2. LCD Module

- LCD Connector(CN2) : DF14A-6P-1.25H(HIROSE)
 - Mating Connector : DF14-6S-1.25C (Manufactured by JAE) or Equivalent

Table 4. Module connector (CN2) pin configuration

No	Symbol	Description
1	VTSP	Power for USB interface (5V)
2	USB -	USB Data (-) for Touch
3	USB +	USB Data (+) for Touch
4	GND	Ground
5	GND	Ground
6	GND	Ground



LGD Highly recommendation :
 Please recommend that you must shield the USB cable

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Table 5. REQUIRED SIGNAL ASSIGNMENT FOR Flat Link (TI:SN75LVDS83) Transmitter

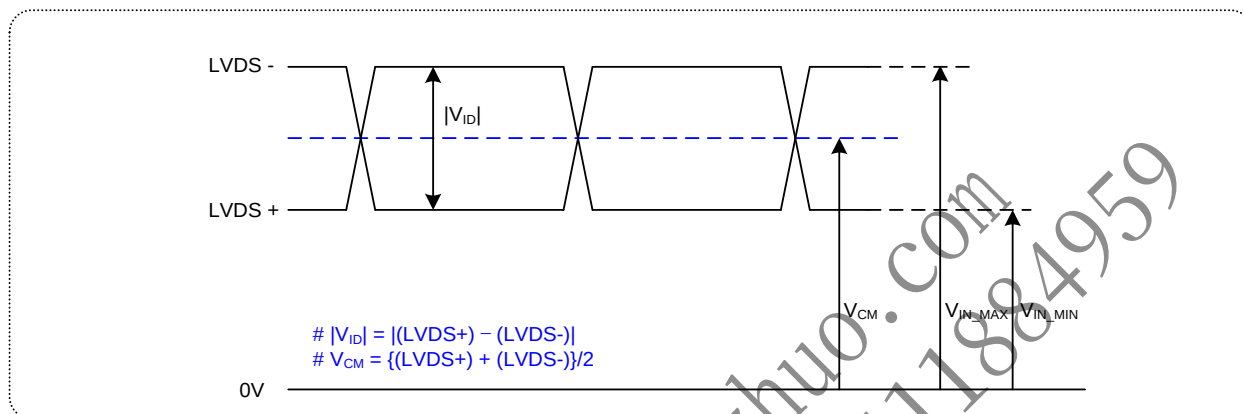
Pin #	Pin Name	Require Signal	Pin #	Pin Name	Require Signal
1	Vcc	Power Supply for TTL Input	29	GND	Ground pin for TTL
2	D5	TTL Input (R7)	30	D26	TTL Input (DE)
3	D6	TTL Input (R5)	31	T _x CLKIN	TTL Level clock Input
4	D7	TTL Input (G0)	32	PWR DWN	Power Down Input
5	GND	Ground pin for TTL	33	PLL GND	Ground pin for PLL
6	D8	TTL Input (G1)	34	PLL Vcc	Power Supply for PLL
7	D9	TTL Input (G2)	35	PLL GND	Ground pin for PLL
8	D10	TTL Input (G6)	36	LVDS GND	Ground pin for LVDS
9	Vcc	Power Supply for TTL Input	37	T _x OUT3+	Positive LVDS differential data output 3
10	D11	TTL Input (G7)	38	T _x OUT3-	Negative LVDS differential data output 3
11	D12	TTL Input (G3)	39	T _x CLKOUT +	Positive LVDS differential clock output
12	D13	TTL Input (G4)	40	T _x CLKOUT -	Negative LVDS differential clock output
13	GND	Ground pin for TTL	41	T _x OUT2 +	Positive LVDS differential data output 2
14	D14	TTL Input (G5)	42	T _x OUT2 -	Negative LVDS differential data output 2
15	D15	TTL Input (B0)	43	LVDS GND	Ground pin for LVDS
16	D16	TTL Input (B6)	44	LVDS Vcc	Power Supply for LVDS
17	Vcc	Power Supply for TTL Input	45	T _x OUT1 +	Positive LVDS differential data output 1
18	D17	TTL Input (B7)	46	T _x OUT1 -	Negative LVDS differential data output 1
19	D18	TTL Input (B1)	47	T _x OUT0 +	Positive LVDS differential data output 0
20	D19	TTL Input (B2)	48	T _x OUT0 -	Negative LVDS differential data output 0
21	GND	Ground pin for TTL Input	49	LVDS GND	Ground pin for LVDS
22	D20	TTL Input (B3)	50	D27	TTL Input (R6)
23	D21	TTL Input (B4)	51	D0	TTL Input (R0)
24	D22	TTL Input (B5)	52	D1	TTL Input (R1)
25	D23	TTL Input (RSVD)	53	GND	Ground pin for TTL
26	Vcc	Power Supply for TTL Input	54	D2	TTL Input (R2)
27	D24	TTL Input (HSYNC)	55	D3	TTL Input (R3)
28	D25	TTL Input (VSYNC)	56	D4	TTL Input (R4)

Notes : 1. Refer to LVDS Transmitter Data Sheet for detail descriptions.
 2. 7 means MSB and 0 means LSB at R,G,B pixel data

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LVDS Input characteristics

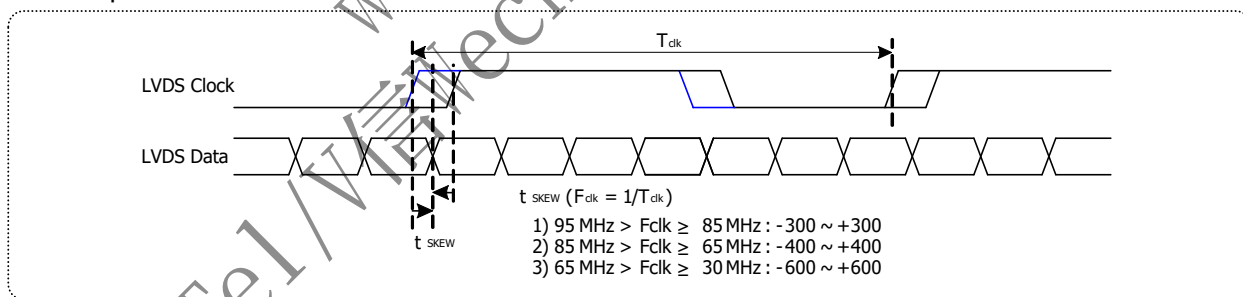
1. DC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	$ V_{ID} $	200	600	mV	-
LVDS Common mode Voltage	V_{CM}	1.0	1.5	V	-
LVDS Input Voltage Range	V_{IN}	0.7	1.8	V	-
Change in common mode Voltage	ΔV_{CM}	-	250	mV	-

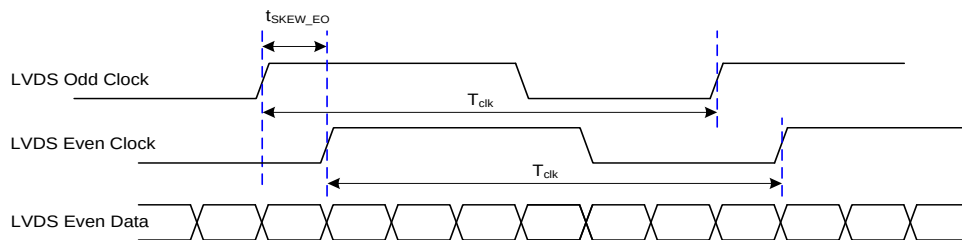
Notes : Dose not have any Noise & Peaking in LVDS Signal

2. AC Specification



Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t_{SKEW}	- 300	+ 300	ps	$95\text{MHz} > F_{clk} \geq 85\text{MHz}$
	t_{SKEW}	- 400	+ 400	ps	$85\text{MHz} > F_{clk} \geq 65\text{MHz}$
	t_{SKEW}	- 600	+ 600	ps	$65\text{MHz} > F_{clk} \geq 30\text{MHz}$
LVDS Clock to Clock Skew Margin (Even to Odd)	t_{SKEW_EO}	- 1/7	+ 1/7	T_{clk}	-

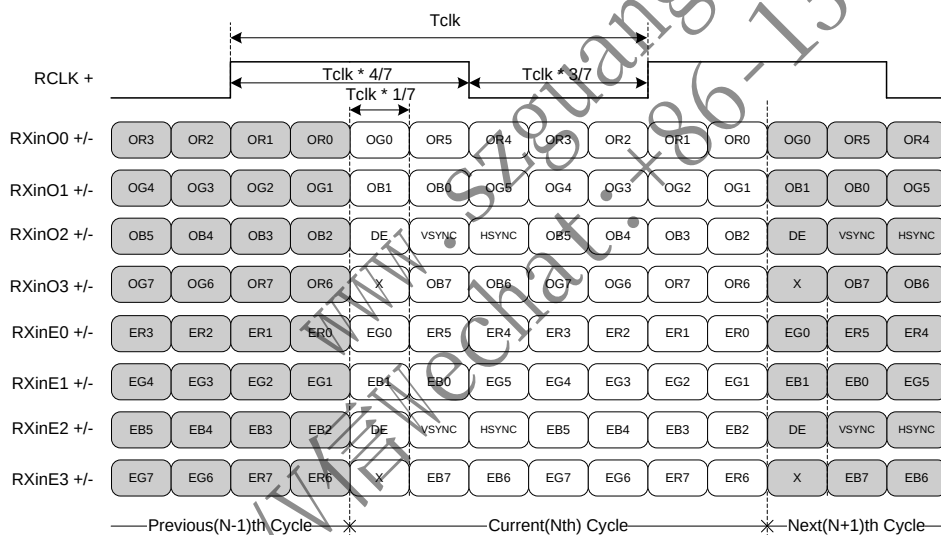
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< Clock skew margin between channel >

3. Data Format

1) LVDS 2 Port



MSB	R7
	R6
	R5
	R4
	R3
	R2
	R1
LSB	R0

* ODD = 1st Pixel
 EVEN = 2nd Pixel

< LVDS Data Format >

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3-2-3. Backlight Connector Pin Configuration

The LED interface connector is 10035WS-H06D(HF)_wire-locking type manufactured by Yeonho or equivalent. The mating connector is a SHJP-06V-S(HF) or 10035HS-H06C(HF) or equivalent. The pin configuration for the connector is shown in the table below.

Table 3-4. LED Connector Pin Configuration

Pin	Symbol	Description	Notes
1	FB1	Channel1 current feedback	
2	FB2	Channel2 current feedback	
3	VLED	LED power supply (Common anode)	
4	VLED	LED power supply (Common anode)	
5	FB3	Channel3 current feedback	
6	FB4	Channel4 current feedback	

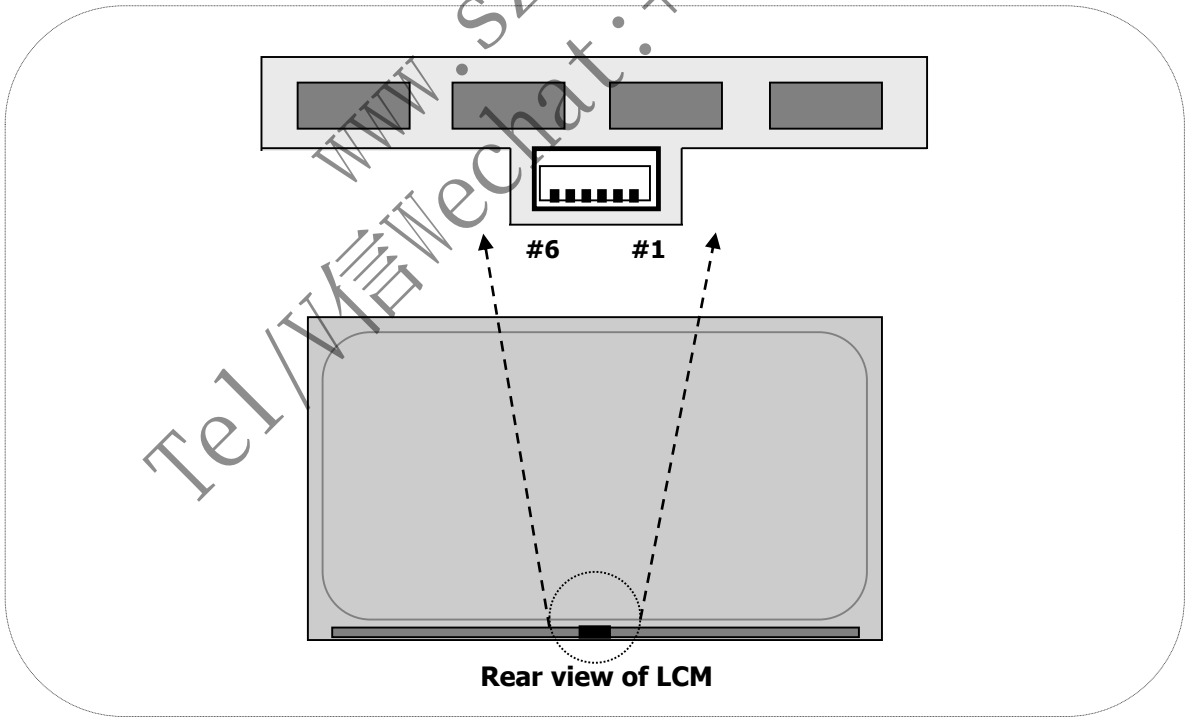


FIG.3-2 Backlight Connector View

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3-3. Signal Timing Specifications

This is the signal timing requirement from the signal transmitter. All of the interface signal timing should be satisfied with the following specifications for its proper operation.

Table 3-5. Timing Table

ITEM	Symbol		Min.	Typ.	Max.	Unit	Note
DCLK	Period	tCLK	11.11	13.89	16.7	ns	Pixel frequency (Typ. 144Mhz)
	Frequency	-	60	72	90	MHz	
Hsync	Period	tHP	1024	1088	1120	tCLK	1,3,4
	Horizontal Valid	tHV	960	960	960	tCLK	
	Horizontal Blank	tHB	64	128	160		
	Frequency	fH	54.17	66	88.27	KHz	
	Width	tWH	16	32	48	tCLK	
	Horizontal Back Porch	tHBP	32	48	64		
	Horizontal Front Porch	tHFP	16	48	48		
Vsync	Period	tVP	1090	1100	1160	tHP	2,4
	Vertical Valid	tVV	1080	1080	1080	tHP	
	Vertical Blank	tVB	10	20	80	tHP	
	Frequency	fV	48	60	75	Hz	
	Width	tWV	2	4	16	tHP	
	Vertical Back Porch	tVBP	5	8	32		
	Vertical Front Porch	tVFP	3	8	32		

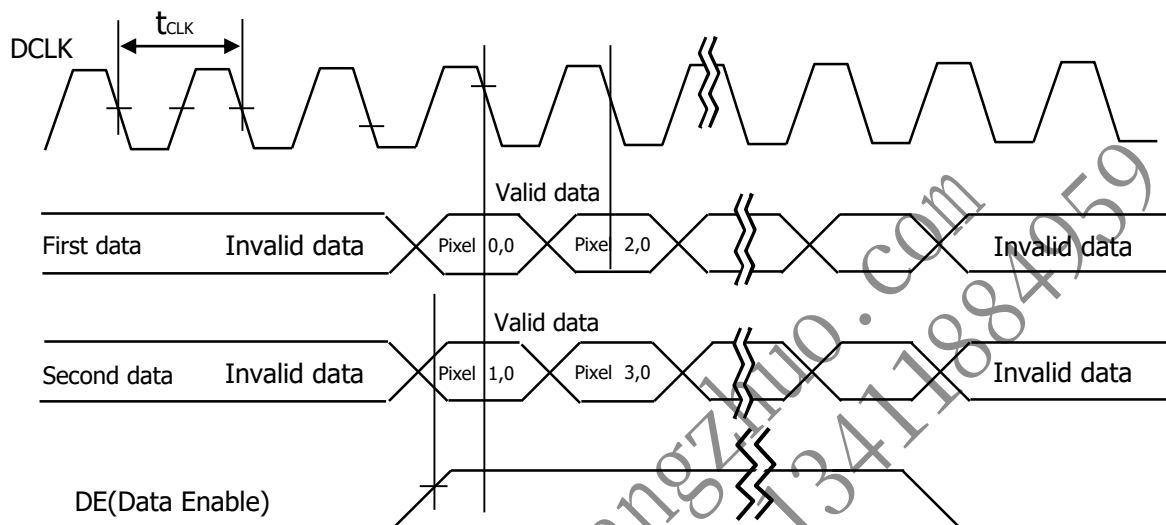
Notes:

- 1) The value of Hsync Period, Hsync Width and Hsync valid should be even number times of tCLK. If the value is odd number times of tCLK, it can make asynchronous signal timing and cause abnormal display.
- 2) The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.
- 3) The value of Hsync Period, Hsync Width, and Horizontal Back Porch should be divided by 4 without a remainder.
- 4) The polarity of Hsync, Vsync is not restricted.
- 5) The max Vsync period 1348 can be used if it does not exceed DCLK 90MHz

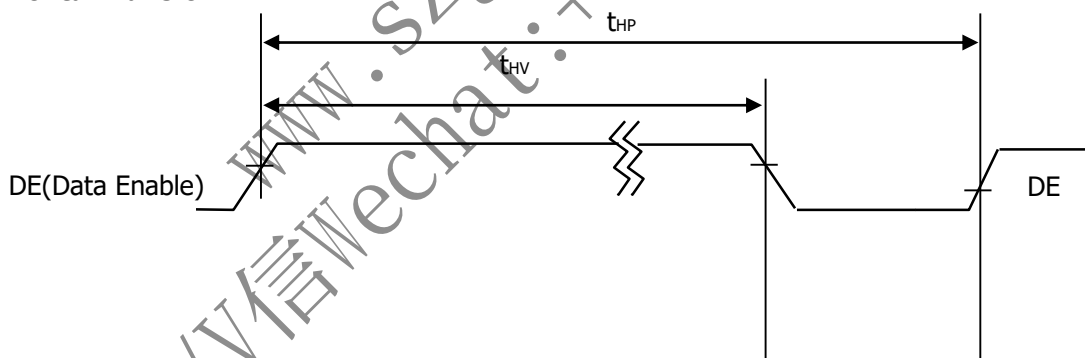
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3-4. Signal Timing Waveforms

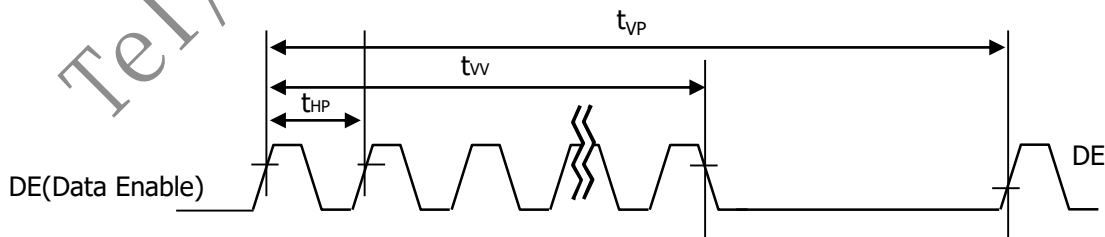
1. DCLK, DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



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3-5. Color Data Reference

The brightness of each primary color(Red,Green,Blue) is based on the 8-bit gray scale data input for the color; the higher the binary input, the brighter the color.

The table below provides a reference for color versus data input.

Table 3-6. Color Data Reference

Color		Input Color Data																							
		RED								GREEN								BLUE							
		MSB				LSB				MSB				LSB				MSB				LSB			
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	B5	B4	B3	B2	B1	B0
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
	Red (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Green (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Blue (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
	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
	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
RED	RED (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (1)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	...	...								...								...							
	RED (254)	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED (255)	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN (0)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	...	...								...								...							
	GREEN (254)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	GREEN (255)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
BLUE	BLUE (0)	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 (1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
	...	...								...								...							
	BLUE (254)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0
	BLUE (255)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

Product Specification

3-6. Power sequence

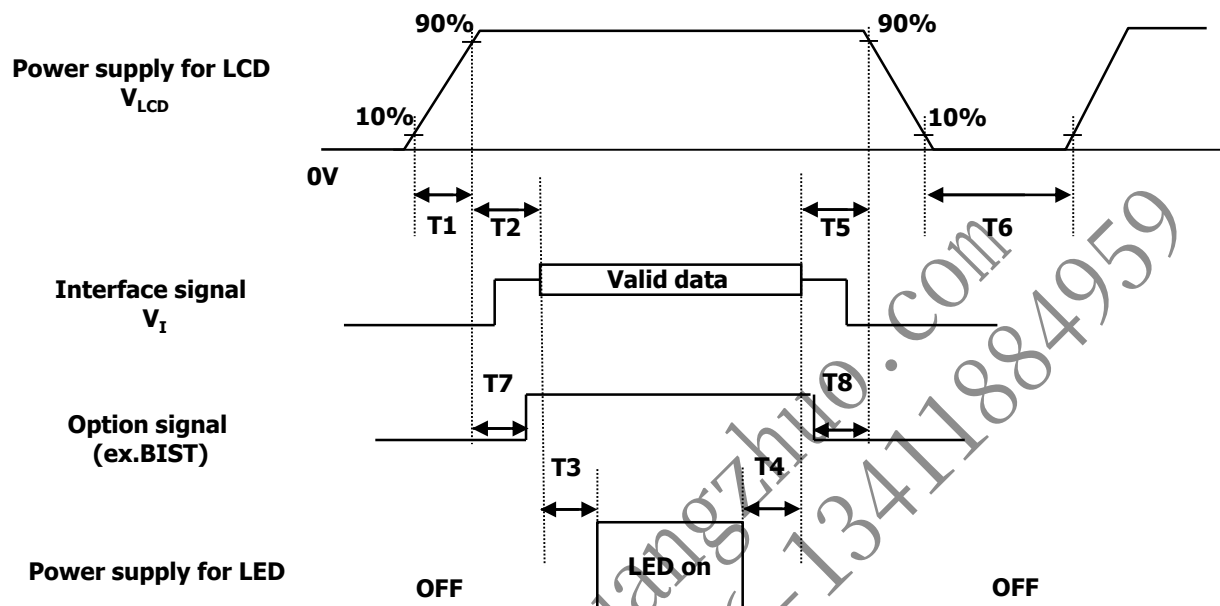


Table 9. Power sequence

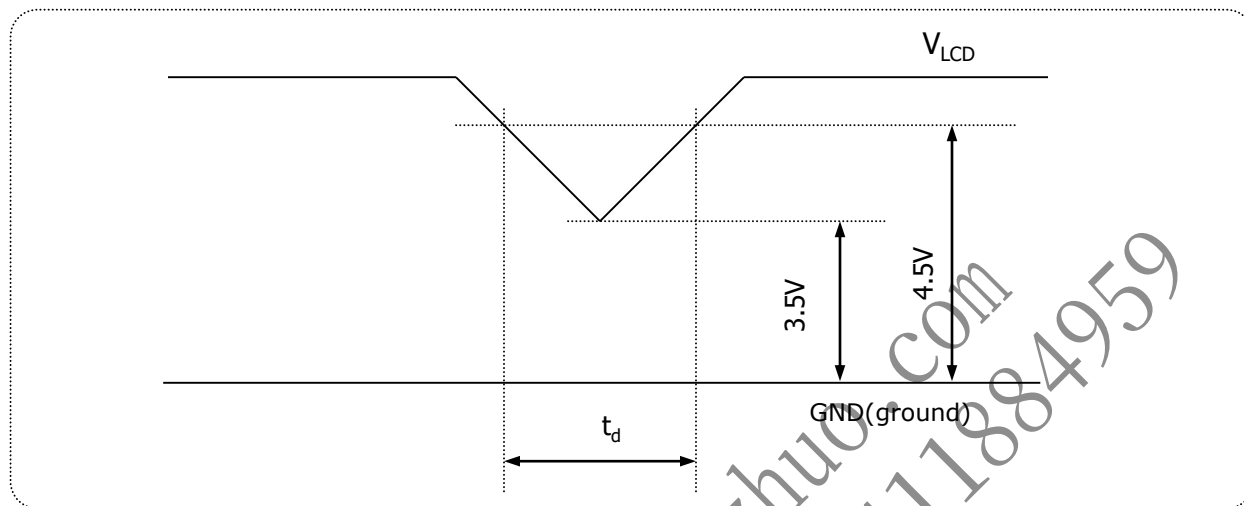
Parameter	Values			Units
	Min.	Typ.	Max.	
T1	0.5	-	10	ms
T2	0.01	-	50	ms
T3	500	-	-	ms
T4	200	-	-	ms
T5	0.01	-	50	ms
T6	1000	-	-	ms
T7	0.5	-	T2	ms
T8	0	-	-	ms

Notes :

- Power sequence should be kept all the time including below cases for normal operation.
 - AC/DC Power On/Off
 - Mode change (resolution, frequency, timing, sleep mode, color depth change, etc.)
 The violation of power sequence can cause a significant trouble in display and reliability.
- Please avoid floating state of interface signal during signal invalid period.
- When the interface signal is invalid, be sure to pull down the V_{LCD} (0V).
- Please turn off the power supply for LED when the level of V_{LCD} changes to prevent noise issue.
- When measuring valid data starting point, it can be measured that LVDS signal starts swing.

Product Specification

3-7. Power Dip Condition



[FIG. 7] Power dip condition

For proper operation, stable power supply of V_{LCD} is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification in previous page exactly.

1) Dip condition

$$3.5V \leq V_{LCD} < 4.5V, t_d \leq 20ms$$

Product Specification

4.Touch Specifications

4-1. General Specifications

The contents provide general characteristics for the model LM238WF5

	Item		Spec	Notes
General Specification	System OS		Win10	
	System		Self Capacitive type	
	Multi Touch Points		10 points	
	Active touch area		Same as LCD A/A	
	Sensor	Type.	Advanced In-Cell Touch	
		Sensor Channel Pitch	6.588mm (X) x 8.235mm (Y)	
	Touch IC Information	IC	MIT-411M	Melfas
		Firmware	TBD	
		PID	TBD	
	Number of Sensor Channel		80ea (X) x 36ea (Y)	
	Interface		HID-USB	USB 2.0

Product Specification

4-2. Power Sequence for Touch

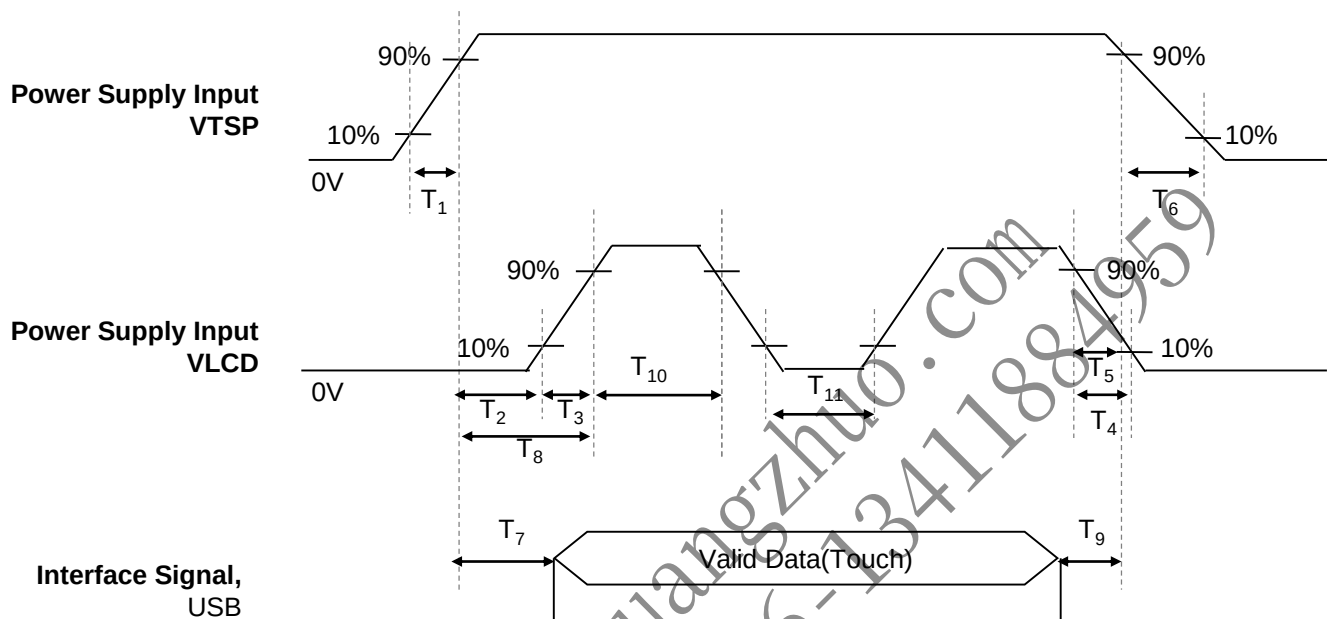


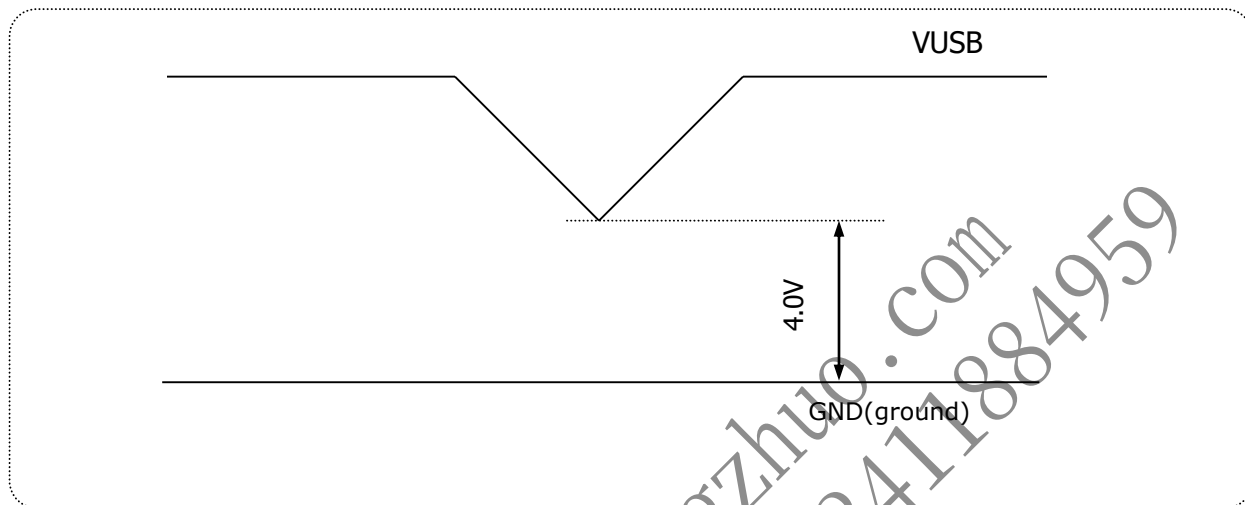
Table 10. POWER SEQUENCE TABLE

Parameter	Value			Units	Notes
	Min.	Typ.	Max.		
T ₁	0.5	-	10	ms	
T ₂	0	-	-	ms	
T ₃	0.5	-	10	ms	
T ₄	0.5	-	30	ms	
T ₅	0	-	-	ms	
T ₆	-	-	300	ms	
T ₇	200	-	-	ms	
T ₈	0.5	-	1500	ms	T ₂ + T ₃
T ₉	0	-	-	ms	
T ₁₀	1000	-	-	ms	
T ₁₁	800	-	-	ms	

Note) 1. Follow the T₈₋₁ in the S3-wake condition

Product Specification

4-3. VUSB Power Dip Condition



[FIG. 8] Power dip condition

For proper operation, stable power supply of VUSB is necessary and power dip is allowed only in below condition. Except this condition, power on/off should follow power sequence specification in previous page exactly.

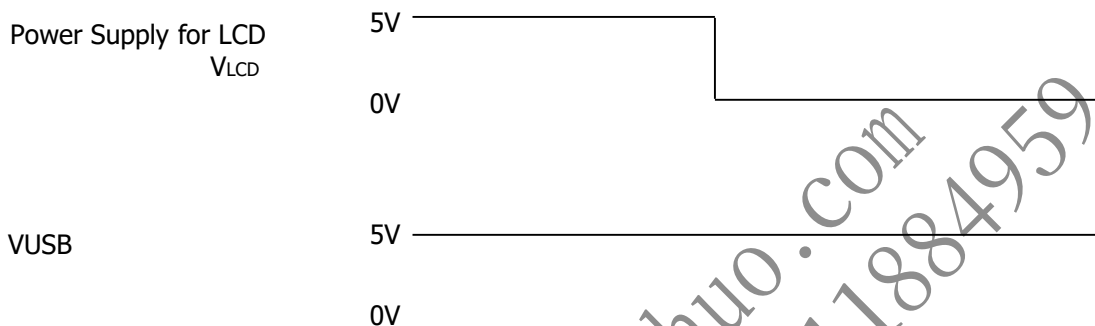
1) Dip condition

$$4.0V \leq VUSB$$

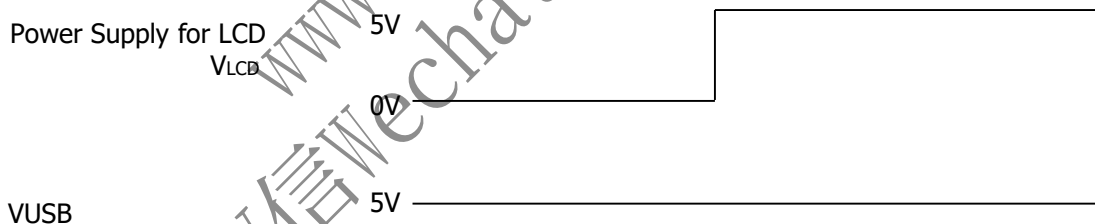
Product Specification

4-4. Power Sequence for Touch (Sleep Mode)

1. Enter Sleep Mode



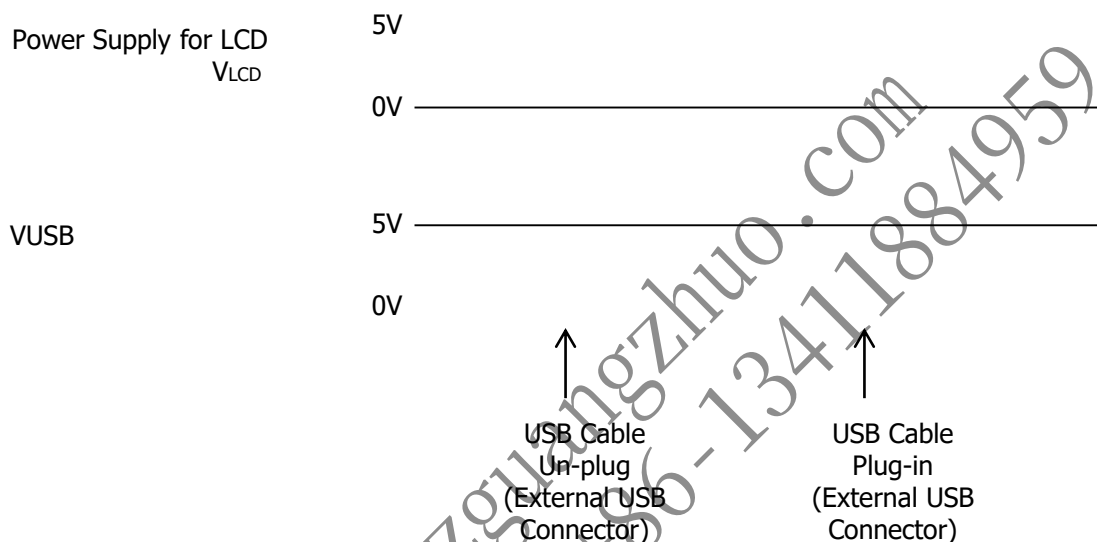
2. Exit Sleep Mode



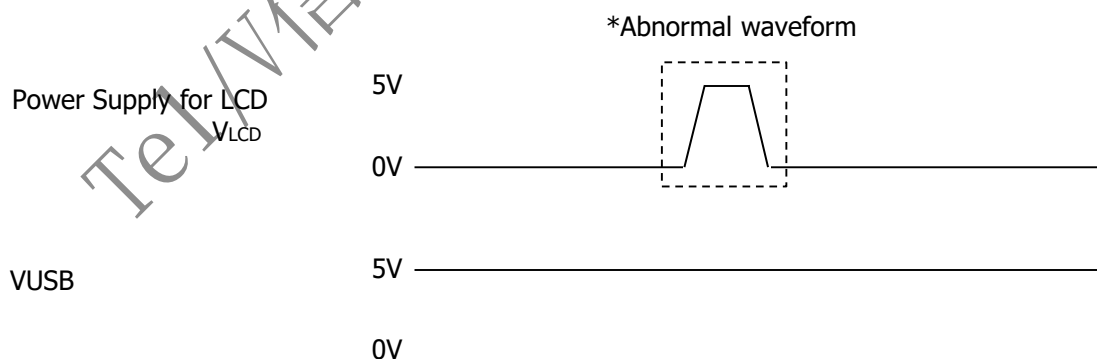
Product Specification

3. During Sleep Mode

Always keep VUSB high even if the user plugs in or un-plug the USB cable from the external USB Connector on the Monitor



During VUSB High, the abnormal input of VLCD is strictly prohibited.



*Note : Abnormal waveform is any noise & peaking under 800ms on time

Product Specification

5. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at $25 \pm 2^\circ\text{C}$. The values specified are at an approximate distance 50cm from the LCD surface at a viewing angle of Φ and θ equal to 0° and aperture 1 degree.

FIG.8 presents additional information concerning the measurement equipment and method.

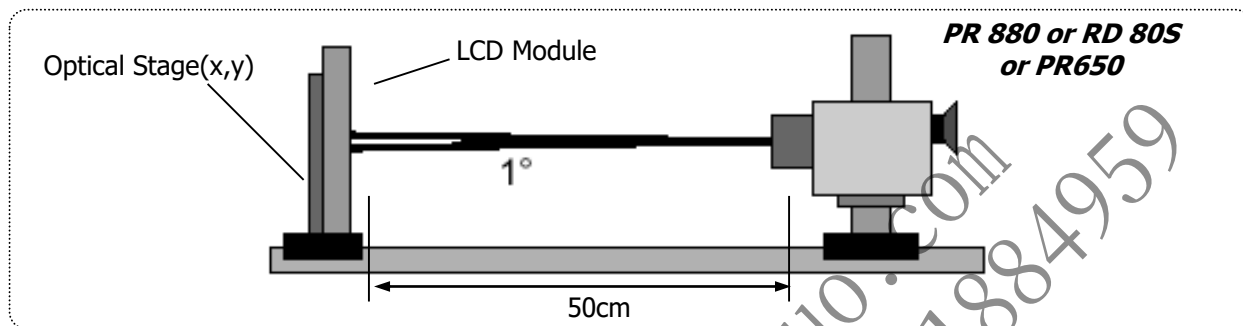


FIG.8 Optical Characteristic Measurement Equipment and Method

Table 11. OPTICAL CHARACTERISTICS ($T_a = 25^\circ\text{C}$, $V_{LCD} = \text{Typ}$, $f_V = 60\text{Hz}$, $D_{clk} = \text{Typ}$, $I_S = \text{TypA}$)

Parameter		Symbol	Values			Units	Notes
			Min.	Typ.	Max.		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L_{WH}	240	300	-	cd/m ²	2
Luminance Variation		δ_{WHITE}	75	-	-	%	3
Response Time	Gray to Gray	T_{GTG_AVR}	-	14	25	ms	4
Color Gamut (CIE 1931)		sRGB	-	99	-	%	
Color Coordinates [CIE 1931] (By PR650)	Red	Rx	Typ -0.03	(0.670)	Typ +0.03		
		Ry		(0.324)			
	Green	Gx		(0.310)			
		Gy		(0.613)			
	Blue	Bx		(0.145)			
		By		(0.062)			
	White	Wx	Typ	0.313	Typ		
		Wy	-0.025	0.329	+0.025		
Color Temperature		-	-	6500	-	K	
Viewing Angle (CR>10, General)	Horizontal	θ_H	170	178	-	Degree	5
	Vertical	θ_V	170	178	-		
Gray Scale		-		2.2			6

Product Specification

Notes :

1. Contrast Ratio(CR) is defined mathematically as : **(By PR880)**

$$\text{Contrast Ratio} = \frac{\text{Surface Luminance with all white pixels}}{\text{Surface Luminance with all black pixels}}$$

It is measured at center point(Location P1)

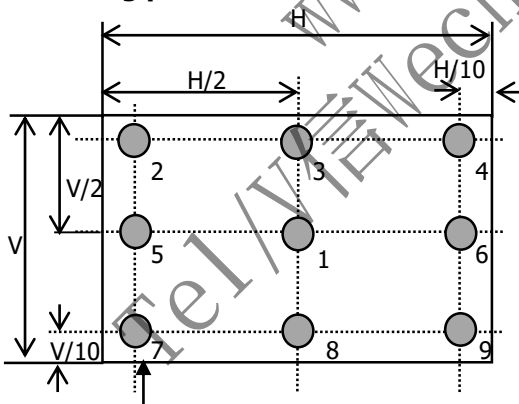
2. Surface luminance(L_{WH}) is luminance value at Center 1 point(P1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG.9 **(By PR880)**

3. The variation in surface luminance , δ WHITE is defined as : **(By PR880)**

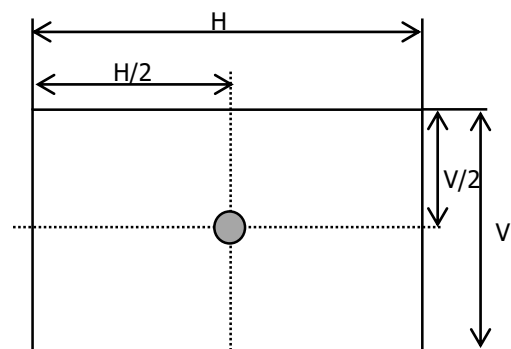
$$\delta_{WHITE} = \frac{\text{Minimum}(L_{P1}, L_{P2}, \dots, L_{P9})}{\text{Maximum}(L_{P1}, L_{P2}, \dots, L_{P9})} \times 100$$

Where L1 to L9 are the luminance with all pixels displaying white at 9 locations.
 For more information see FIG.8

<Measuring point for luminance variation>



<Measuring point for surface luminance>



Active Area

H : 527.04 mm
 V : 296.46 mm
 @ H,V : Active Area

[FIG.9] Measure point for luminance

Product Specification

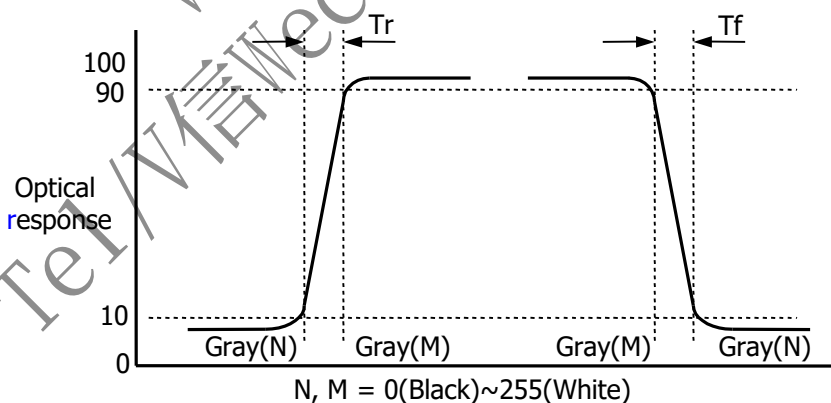
4. The Gray To Gray response time is defined as the following figure and shall be measured by switching the input signal for "Gray To Gray".

- Gray step : 5 Step
- TGTG_AVR is the total average time at rising time and falling time for "Gray To Gray".
- By RD80S

Table 12. GTG Gray table

Gray To Gray		Rising time				
		G255	G191	G127	G63	G0
Falling time	G255					
	G191					
	G127					
	G63					
	G0					

Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Gray(M)".



[FIG. 10] Response Time

Product Specification

5. Viewing angle is the angle at which the contrast ratio is greater than 10. The angles are determined for the horizontal or x axis and the vertical or y axis with respect to the z axis which is normal to the LCD surface. For more information see FIG.11 **(By PR880)**

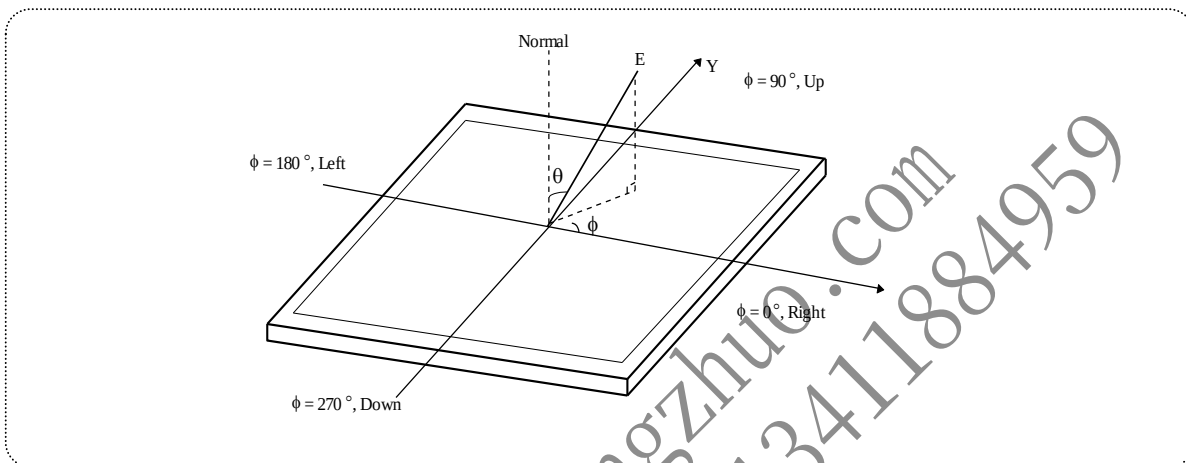


FIG.4-4 Viewing Angle

6. Gamma Value is approximately 2.2. For more information see Table 13.

Table 13. Gray Scale Specification

Gray Level	Relative Luminance [%](Typ)
0	0.10
15	0.31
31	1.08
47	2.53
63	4.72
79	7.70
95	11.5
111	16.1
127	21.7
143	28.1
159	35.5
175	43.7
191	53.0
207	63.2
223	74.5
239	86.7
255	100

Product Specification

6. Mechanical Characteristics

The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

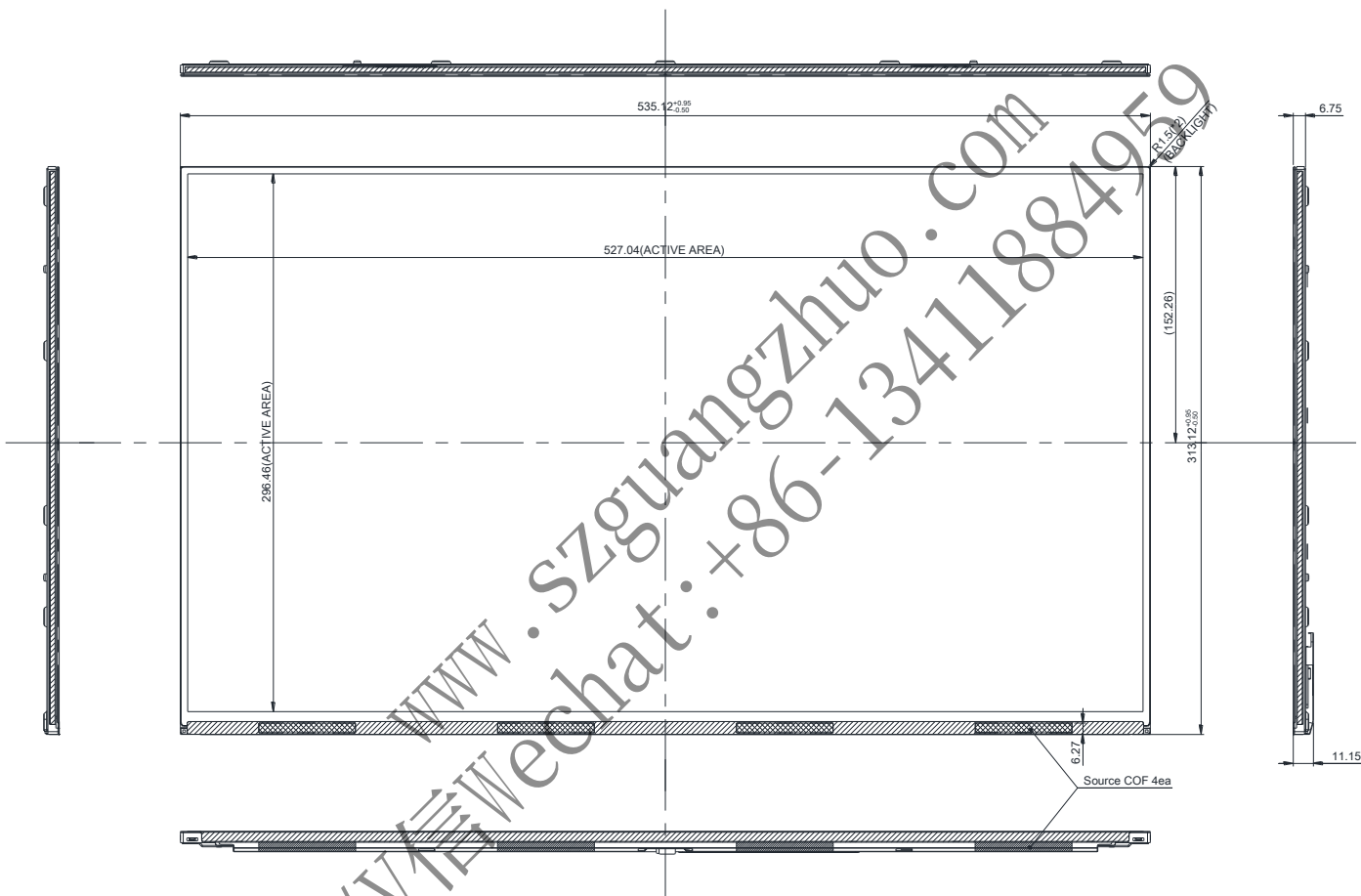
Outline Dimension	Horizontal	535.12 mm
	Vertical	313.12 mm
	Depth	11.15 mm
Bezel Area	Horizontal	-
	Vertical	-
Active Display Area	Horizontal	527.04 mm
	Vertical	296.46 mm
Weight	2,200g (Typ.), 2310g(Max)	
Surface Treatment	Anti-Glare treatment of the front polarizer(Haze25%, 3H)	

Note: Please refer to a mechanical drawing in terms of tolerance at the next page.

- Outline dimensions (horizontal, vertical and outside depth) are measured by using vernier calipers.
- The inside depth dimensions are measured by using height gauge, when LCM is put face down onto a flat surface.

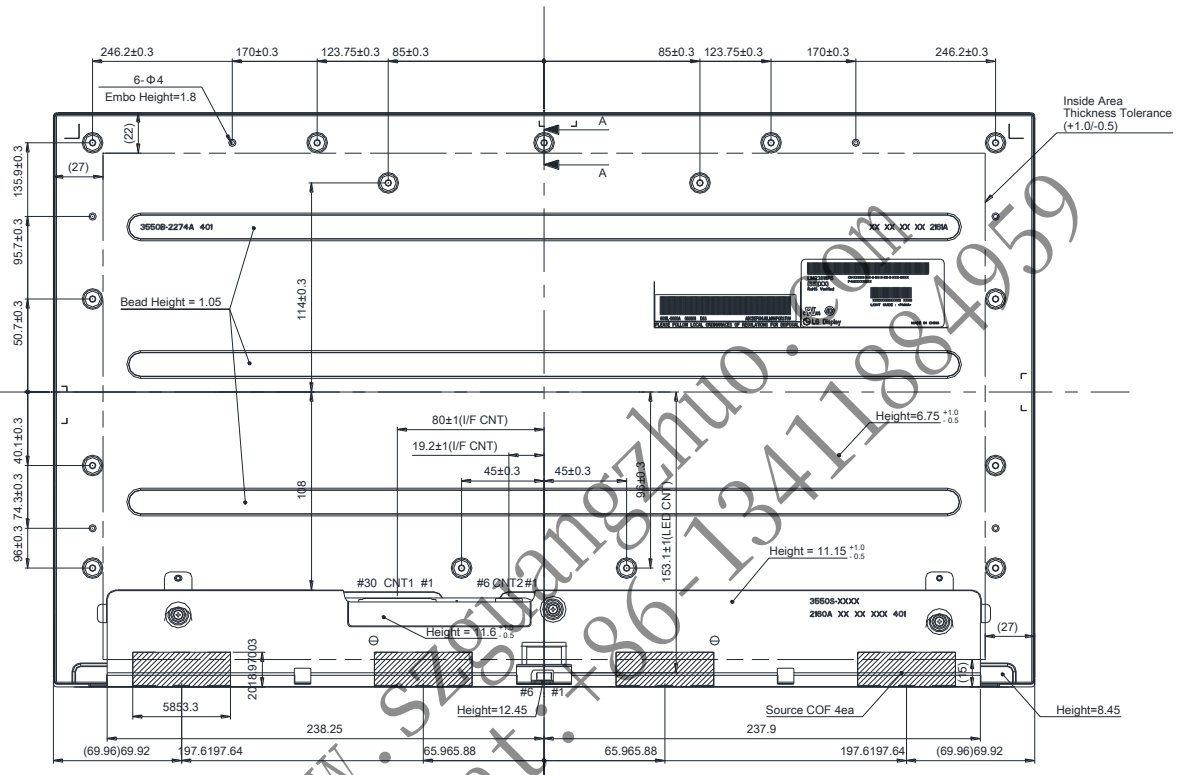
Product Specification

<FRONT VIEW>



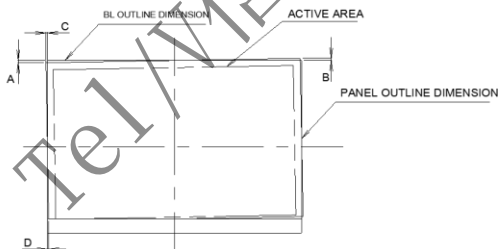
Product Specification

<Rear View>

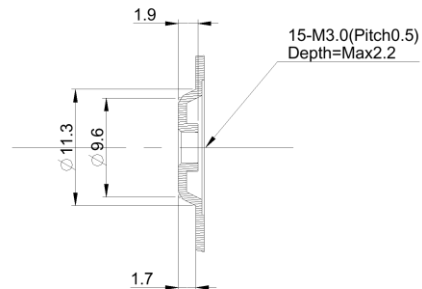


NOTES

1. I/F CONNECTOR SPECIFICATION
- CNT1 : IS100-L30O-C23(UJU)
- CNT2 : DF14A-6P-1.25H(HIROSE)
2. LED CONNECTOR SPECIFICATION : YEONHO, D035WS-H06D(HF) OR EQUIVALENT
3. TORQUE OF USER HOLE : 3.0~4.0kgf-cm
4. TILT AND PARTIAL DISPOSITION TOLERANCE OF DISPLAY AREA AS FOLLOWING
(1) Y-DIRECTION : $-0.45 \leq A \leq 0.45$, $-0.45 \leq B \leq 0.45$
(2) X-DIRECTION : $-0.45 \leq C \leq 0.45$, $-0.45 \leq D \leq 0.45$



5. UNSPECIFIED TOLERANCES TO BE ± 0.5
6. THE LCM WARP (WARPAGE) IS LESS THAN 1.0 ON THE SURFACE PLATE
7. THE COF AREA IS WEAK & SENSITIVE, SO PLEASE DON'T PRESS THE COF AREA
8. UNDEFINED HEIGHT SHOULD FOLLOW THE 3D MODELING DATA



SECTION A-A
SCALE 2/1

LGD Highly recommendation :

System chassis or frame should be designed to keep the IPS Panel flat as it is vulnerable to panel light-leakage caused by deformation.

Product Specification

7. Reliability

Environment test condition

No	Test Item	Condition	Notes
1	High temperature storage test	$T_a = 60^{\circ}\text{C}$, 240h	1
2	Low temperature storage test	$T_a = -20^{\circ}\text{C}$, 240h	1
3	High temperature operation test	$T_a = 50^{\circ}\text{C}$, 50%RH, 240h	1
4	Low temperature operation test	$T_a = 0^{\circ}\text{C}$, 240h	1
5	Humidity condition operation	$T_a = 40^{\circ}\text{C}$, 90%RH	1
6	Altitude Operating Storage / Shipment	0 - 10,000 feet (3,048m) 0 - 40,000 feet (12,192m)	
7	Maximum storage humidity for 4 corner light leakage Mura	Max 70%RH, $T_a = 40^{\circ}\text{C}$	

Note 1) Result Evaluation Criteria:

TFT-LCD panels test should take place after cooling enough at room temperature.

In the standard condition, there should be no particular problems that may affect the display function.

* T_a = Ambient Temperature

Product Specification

8. International Standards

8-1. Safety

- a) IEC 62368-1, The International Electro-technical Commission(IEC).
Audio/video, Information and Communication Technology Equipment - Safety - Safety Requirements.
- b) EN 62368-1, European Committee for Electro-technical Standardization (CENELEC)
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- c) UL 62368-1, UL LLC.
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- d) CAN/CSA C22.2 No.62368-1, Canadian Standards Association (CSA).
Audio/video, Information and Communication Technology Equipment - Safety Requirements
- e) IEC 60950-1, The International Electro technical Commission (IEC).
Information Technology Equipment - Safety - Part 1 : General Requirements

8-2. Environment

- a) RoHS, Directive 2011/65/EU of the European Parliament and of the council of 8 June 2011

Product Specification

9. Packing

9-1. Designation of Lot Mark

a) Lot Mark

A	B	C	D	E	F	G	H	I	J	K	L	M
---	---	---	---	---	---	---	---	---	---	---	---	---

A,B,C: Size(Inch)

E: Month

D: Year

F ~ M: Serial No.

Notes:

1) Year

Year	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Mark	K	L	M	N	P	R	S	T	U	V

2) Month

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mark	1	2	3	4	5	6	7	8	9	A	B	C

b) Location of Lot Mark

Serial No. is printed on the label. The label is attached to the backside of the LCD module.

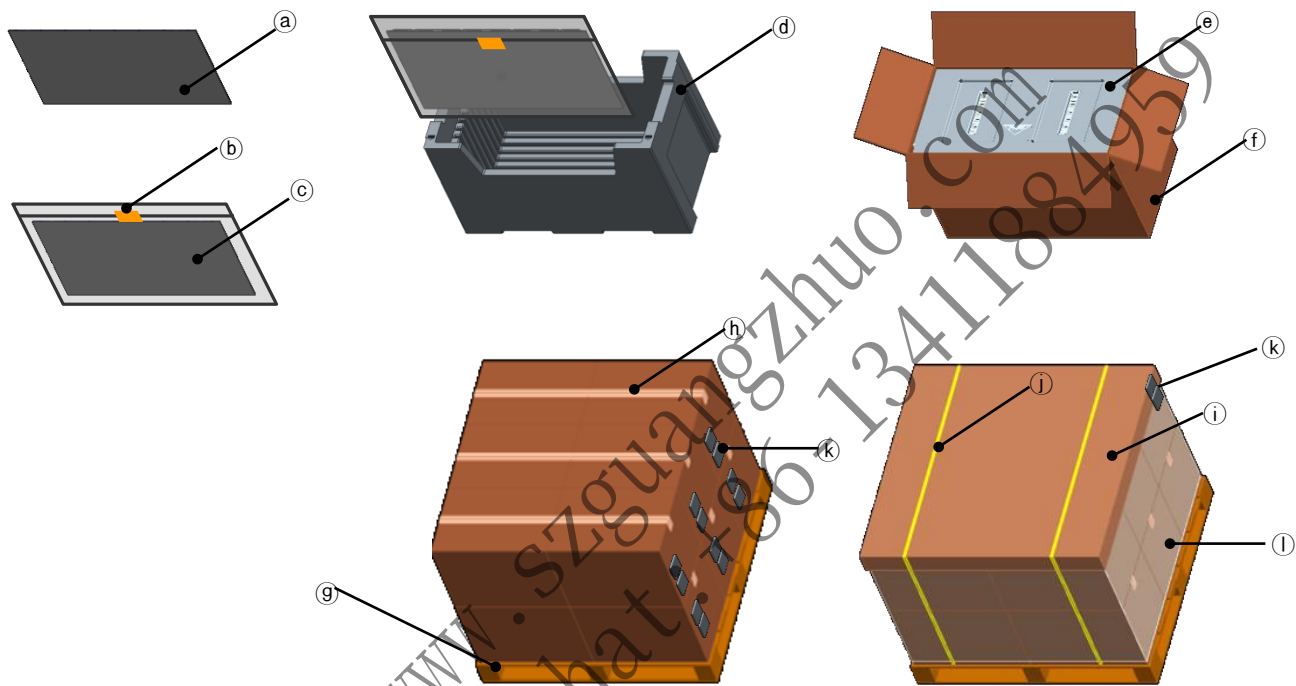
This is subject to change without prior notice.

Product Specification

9-2. Packing Form

- a) Package Quantity In One Box: 10 ea
 Package Quantity In One Pallet: 120 ea
 b) Packing Size: 635 mm x 370 mm x 400 mm
 c) Pallet ASS'Y Size: 1140 mm x 1300 mm x 930 mm

* LCM Direction(Insert to Bottom Packing): COF Down



No.	Description	Material
(a)	LCM	-
(b)	Tape	OPP
(c)	AL-Bag	AL
(d)	Packing,Bottom	EPS
(e)	Packing,Top	EPS
(f)	Box	Paper(SW)
(g)	Pallet	Plywood
(h)	Tape	OPP
(j)	Angle Cover	Paper(SW)
(i)	BAND	PP
(k)	LABEL	YUPO PAPER
(l)	Wrap	-

Product Specification

10. PRECAUTIONS

Please pay attention to the followings when you use this TFT LCD module.

10-1. MOUNTING PRECAUTIONS

- (1) You must mount a module using holes arranged in four corners or four sides.
- (2) You should consider the mounting structure so that uneven force (ex. Twisted stress) is not applied to the module. And the case on which a module is mounted should have sufficient strength so that external force is not transmitted directly to the module.
- (3) Please attach the surface transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to resist external force.
- (4) You should adopt radiation structure to satisfy the temperature specification.
- (5) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
- (6) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment. Do not touch the surface of polarizer for greasy cloth. (Some cosmetics are detrimental to the polarizer.)
- (7) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
- (8) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
- (9) Do not open the case because inside circuits do not have sufficient strength.
- (10) As The IPS panel is sensitive & slim, please recommend the metal frame of the system supports the panel by the double side-mount.

10-2. OPERATING PRECAUTIONS

- (1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
 $V = \pm 200\text{mV}$ (Over and under shoot voltage)
- (2) Response time depends on the temperature. (In lower temperature, it becomes longer.)
- (3) Brightness depends on the temperature. (In Higher temperature, it becomes lower.)
 And in lower temperature, response time (required time that brightness is stable after turned on) becomes longer.
- (4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
- (5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
- (6) 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 minimized the interference.
- (7) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
- (8) A screw which is fastened up the steels should be a machine screw.
 (if not, it causes metallic foreign material and deal LCM a fatal blow)
- (9) Please do not set LCD on its edge.
- (10) When LCMs are used for public display defects such as Yogore, image sticking can not be guaranteed.
- (11) LCMs cannot support "Interlaced Scan Method"
- (12) When this reverse model is used as a forward-type model (PCB on top side), LGD can not guarantee any defects of LCM.
- (13) Please conduct image sticking test after 2-hour aging with Rolling Pattern and normal temperature. (25~40°C)

Product Specification

10-3. Electrostatic discharge control

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

10-4. Precautions for strong light and hazardous material exposure

Strong light exposure causes degradation of polarizer and color filter.

The LCM should be avoided direct contact with Hazardous materials such as sulfur, acetic acid, chlorine, etc. These materials may cause chemical reaction such as sulfurization, corrosion, discoloration, etc.

10-5. Storage

When storing modules as spares for a long time, the following precautions are necessary.

- (1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
- (2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

10-6. Handling precautions for protection film

- (1) The protection film is attached to the bezel with a small masking tape.
When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
- (2) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the bezel after the protection film is peeled off.
- (3) You can remove the glue easily. When the glue remains on the bezel surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.