TFT-DISPLAY DATENBLATT

LG Display
Modell: LM265SQ1-SLA1

KURZDATEN:

Hersteller	LG Display
Diagonale	26,5"
Format	1:1
Auflösung	1920 x 1920
Backlight	LED / 300 cd/m²
Interface	LVDS
Touchscreen	nein
Temperatur	0...+50 °C (Betrieb)

Product Specification

SPECIFICATION
FOR
APPROVAL

(◆) Preliminary Specification
(   ) Final Specification

Title	26.5" TFT LCD

BUYER	General
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LM265SQ1
SUFFIX	SLA1

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

SIGNATURE	DATE
/	
/	
/	

Please return 1 copy for your confirmation
With your signature and comments.

APPROVED BY	DATE
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Product Specification

RECORD OF REVISIONS

Revision No	Revision Date	Page	Description
0.1	June.11.2014	-	Preliminary version.

Product Specification

1. General Description

LM265SQ1 is a Color Active Matrix Liquid Crystal Display with a Light Emitting Diode (LED) Backlight Assembly without LED Driver. 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 26.5-inch diagonally measured active display area with 1920×1920 resolution (1920 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(True) colors. It has been designed to apply the 8Bit 4 port LVDS interface.
It is intended to support applications where thin thickness, wide viewing angle, low power are critical factors and graphic displays are important. It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.
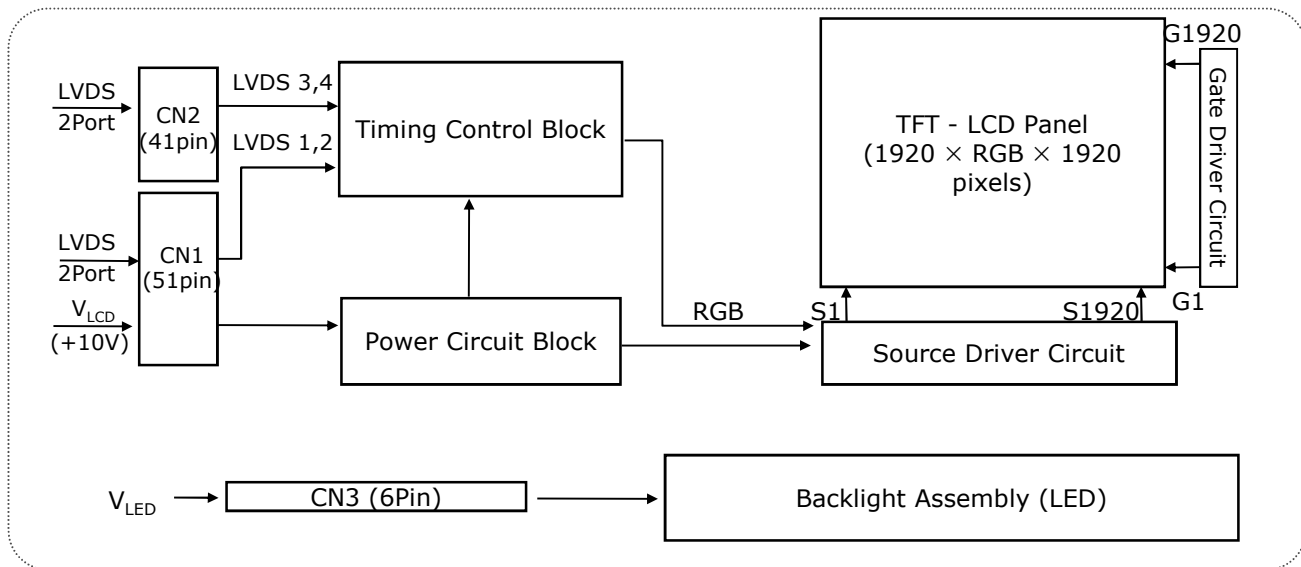
General features

Active Screen Size	26.49 inches (672.85mm) diagonal
Outline Dimension	491.8(H) x 491.8(V) x 13.5(D) mm(Typ.)
Pixel Pitch	0.0826*RGB(H)mm x 0.2478(V)mm
Pixel Format	1920 horizontal By 1920 vertical Pixels. RGB stripe arrangement
Color Depth	16.7M colors, 8Bit
Luminance, White	300 cd/m² (Center 1Point, Typ.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 28.1 W(Typ.) (6.1 W@VLCD_Mosaic, 22.0 Watt @Is=120mA)
Weight	2,210 g (Typ.)
Display Operating Mode	Transmissive mode, normally black
Surface Treatment	Anti-Glare treatment of the front polarizer (Haze25%, 3H)

LG Display

2. Absolute Maximum Ratings

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

Table 1. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Values Min	Values Max	Units	Notes
Power Input Voltage	VLCD	-0.3	11.0	Vdc	at 25 ± 2℃
Operating Temperature	TOP	0	50	℃	1, 2
Storage Temperature	TST	-20	60	℃	1, 2
Operating Ambient Humidity	HOP	10	90	%RH	1, 2
Storage Humidity	HST	10	90	%RH	1, 2
LCM Surface Temperature (Operation)	$T_{Surface}$	0	65	℃	1,4

Note : 1. Temperature and relative humidity range are shown in the figure below.
      Wet bulb temperature should be 39 ℃ Max, and no condensation of water.
  2. Maximum Storage Humidity is up to 40℃, 70% RH only for 4 corner light leakage Mura.
  3. Storage condition is guaranteed under packing condition.
  4. LCM Surface Temperature should be Min. 0℃ and Max. 65℃ under the VLCD=10.0V,
      fV=60Hz, 25℃ ambient Temperature no humidity control and LED string current is typical value.

FIG. 1 Temperature and relative humidity

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	Min	Typ	Max	Unit	Notes
MODULE :						
Power Supply Input Voltage	VLCD	9.5	10	10.5	Vdc	
Permissive Power Input Ripple	VdRF			0.4	V	1
Power Supply Input Current	ILCD_Mosaic	-	610	760	mA	2
	ILCD_White	-	880	1100	mA	3
Power Consumption	Pc_Mosaic	-	6.10	7.60	Watt	2
	PcLCD_White	-	8.80	11.00	Watt	3
Rush current	IRUSH	-	-	4.0	A	4

Note :
1. Permissive power ripple should be measured under V_{LCD} =10.0V, 25°C, fV(frame frequency)=MAX condition and At that time, we recommend the bandwidth configuration of oscilloscope is to be under 20Mhz. See the next page.

2. The specified current and power consumption are under the V_{LCD}=10.0V, 25± 2°C,fV=60Hz condition whereas Typical Power Pattern [Mosaic] shown in the [Figure 2] is displayed.

3. The current is specified at the maximum current pattern.

4. Maximum Condition of Inrush current :
   The duration of rush current is about 5ms and rising time of power Input is 500us ± 20%.(min.).

5. VLCD level must be measured from LCM PCB's two points, between VIN and LCM Ground.
   The measured level need to meet the Power supply input voltage spec.
   (Test condition : maximum power pattern , 25± 2°C, fV=60Hz)

• **Permissive Power input ripple (**V_{LCD} =10V, 25°C, fv (frame frequency)=MAX condition**)**

Full White Pattern

• **Power consumption (**V_{LCD} =10V, 25°C, fV (frame frequency=60Hz condition**)**

Typical power Pattern

Maximum power Pattern

FIG.2 Mosaic pattern(8x6) & Full White Pattern for power consumption measurement

Product Specification

Table 3. LED array ELECTRICAL CHARACTERISTICS

Table 2-2. LED BAR ELECTRICAL CHARACTERISTICS

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	Is	-	120	125	mA	1,2,5
LED String Voltage	Vs	42.8	45.8	48.8	V	1,5
Power Consumption	PBar	-	22.0	23.4	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 15 packages (serial)

LED driver design guide
: The design of the LED driver must have specifications for the LED in LCD Assembly.
The performance of the LED in LCM, for example life time or brightness, is extremely influenced by the characteristics of the LED driver.
So all the parameters of an LED driver should be carefully designed and output current should be Constant current control.
Please control feedback current of each string individually to compensate the current variation among the strings of LEDs.
When you design or order the LED driver, please make sure unwanted lighting caused by the mismatch of the LED and the LED driver (no lighting, flicker, etc) never occurs.
When you confirm it, the LCD module should be operated in the same condition as installed in your instrument.

1. Specified values are for a single LED bar.
2. The specified current is defined as the input current for a single LED string with 100% duty cycle.
3. The LED life time is defined as the time when brightness of LED packages become 50% or less than the initial value under the conditions at Ta = 25±2°C and LED string current is typical value.
4. The power consumption shown above does not include loss of external driver.
   The typical power consumption is calculated as P_{Bar} = Vs(Typ.) x Is(Typ.) x No. of strings.
   The maximum power consumption is calculated as P_{Bar} = Vs(Max.) x Is(Typ.) x No. of strings.
5. LED operating conditions are must not exceed Max. ratings.
6. LGD recommends analog dimming method for Backlight Brightness control to avoid wavy noise.

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3-2. Interface Connections

This LCD module employs two kinds of interface connection, 51-pin and 41-pin connectors are used for the module electronics and 14-pin connectors are used for the integral backlight system.

3-2-1. LCD Module (CN1, CN2)

- LCD Connector(CN1): GT05P-51S-H38-E1500 (manufactured by LSM) or equivalent
- Mating Connector : FI-RE51HL(JAE) or equivalent

Table 3-1. MODULE CONNECTOR(CN1) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	GND	Ground	27	NC	No Connection
2	NC	No Connection	28	R2AN	SECOND LVDS Receiver Signal (A-)
3	NC	No Connection	29	R2AP	SECOND LVDS Receiver Signal (A+)
4	NC	No Connection	30	R2BN	SECOND LVDS Receiver Signal (B-)
5	NC	No Connection	31	R2BP	SECOND LVDS Receiver Signal (B+)
6	Interlace mode	'H'(3.3V) = Enable , 'L' = Disable (Connect High or low, No NC Condition)	32	R2CN	SECOND LVDS Receiver Signal (C-)
7	PBP Select	'H'(3.3V)= PBP Concept , 'L' or NC=normal	33	R2CP	SECOND LVDS Receiver Signal (C+)
8	NC	No Connection	34	GND	Ground
9	NC	No Connection	35	R2CLKN	SECOND LVDS Receiver Clock Signal(-)
10	PWM_OUT	Reference signal for LED Driver control	36	R2CLKP	SECOND LVDS Receiver Clock Signal(+)
11	GND	Ground	37	GND	Ground
12	R1AN	FIRST LVDS Receiver Signal (A-)	38	R2DN	SECOND LVDS Receiver Signal (D-)
13	R1AP	FIRST LVDS Receiver Signal (A+)	39	R2DP	SECOND LVDS Receiver Signal (D+)
14	R1BN	FIRST LVDS Receiver Signal (B-)	40	NC	No Connection
15	R1BP	FIRST LVDS Receiver Signal (B+)	41	NC	No Connection
16	R1CN	FIRST LVDS Receiver Signal (C-)	42	Reserved	No connection or GND
17	R1CP	FIRST LVDS Receiver Signal (C+)	43	Reserved	No connection or GND
18	GND	Ground	44	GND	Ground
19	R1CLKN	FIRST LVDS Receiver Clock Signal(-)	45	GND	Ground
20	R1CLKP	FIRST LVDS Receiver Clock Signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	FIRST LVDS Receiver Signal (D-)	48	VLCD	Power Supply +10.0V
23	R1DP	FIRST LVDS Receiver Signal (D+)	49	VLCD	Power Supply +10.0V
24	NC	No Connection	50	VLCD	Power Supply +10.0V
25	NC	No Connection	51	VLCD	Power Supply +10.0V
26	Reserved	No connection or GND	-	-	-

Notes : 1. All GND(ground) pins should be connected together to the LCD module's metal frame.
    2. All VLCD (power input) pins should be connected together.
    3. All Input levels of LVDS signals are based on the EIA 644 Standard.
    4. Specific pins(pin No. #2~#5) are used for internal data process of the LCD module.
      If not used, these pins are no connection.
    5. PWM_OUT is a reference signal for LED PWM control.
      This PWM signal is synchronized with vertical frequency.
      Its frequency is 3 times of vertical frequency, and its duty ratio is 50%.
      If the system don't use this pin, do not connect.
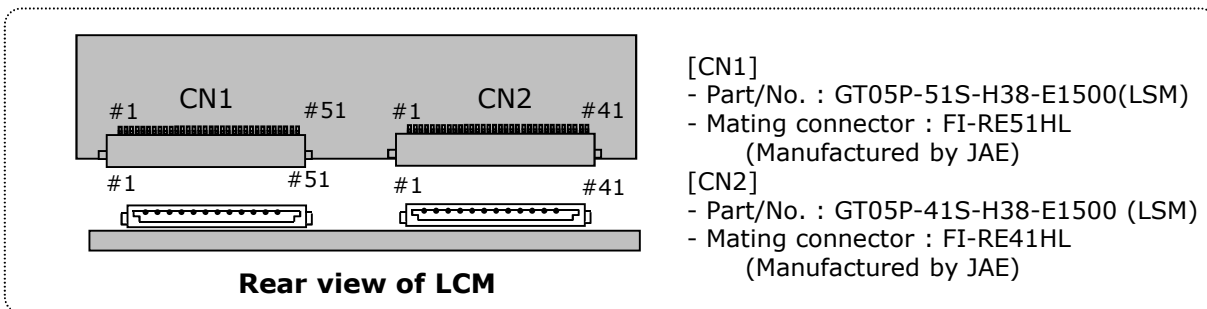
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- LCD Connector(CN2): GT05P-41S-H38-E1500 (manufactured by LSM) or equivalent
- Mating Connector : FI-RE41HL(JAE) or equivalent

Table 3-2. MODULE CONNECTOR(CN2) PIN CONFIGURATION

No	Symbol	Description	No	Symbol	Description
1	NC	No connection(Reserved)	22	NC	No Connection
2	NC	No connection	23	NC	No Connection
3	NC	No connection	24	GND	Ground
4	NC	No connection	25	GND	Ground
5	NC	No connection	26	R4AN	FORTH LVDS Receiver Signal (A-)
6	NC	No connection	27	R4AP	FORTH LVDS Receiver Signal (A+)
7	NC	No connection	28	R4BN	FORTH LVDS Receiver Signal (B-)
8	NC	No connection	29	R4BP	FORTH LVDS Receiver Signal (B+)
9	GND	Ground	30	R4CN	FORTH LVDS Receiver Signal (C-)
10	R3AN	THIRD LVDS Receiver Signal (A-)	31	R4CP	FORTH LVDS Receiver Signal (C+)
11	R3AP	THIRD LVDS Receiver Signal (A+)	32	GND	Ground
12	R3BN	THIRD LVDS Receiver Signal (B-)	33	R4CLKN	FORTH LVDS Receiver Clock Signal(-)
13	R3BP	THIRD LVDS Receiver Signal (B+)	34	R4CLKP	FORTH LVDS Receiver Clock Signal(+)
14	R3CN	THIRD LVDS Receiver Signal (C-)	35	GND	Ground
15	R3CP	THIRD LVDS Receiver Signal (C+)	36	R4DN	FORTH LVDS Receiver Signal (D-)
16	GND	Ground	37	R4DP	FORTH LVDS Receiver Signal (D+)
17	R3CLKN	THIRD LVDS Receiver Clock Signal(-)	38	NC	No Connection
18	R3CLKP	THIRD LVDS Receiver Clock Signal(+)	39	NC	No Connection
19	GND	Ground	40	GND	Ground
20	R3DN	THIRD LVDS Receiver Signal (D-)	41	GND	Ground
21	R3DP	THIRD LVDS Receiver Signal (D+)	-		

Note :
 1. All GND (Ground) pins should be connected together to the LCD module's metal frame.
 2. All VLCD (power input) pins should be connected together.
 3. All Input levels of LVDS signals are based on the EIA 664 Standard.
 4. Always all LVDS signal and clock input should be 4 channels and synchronized.
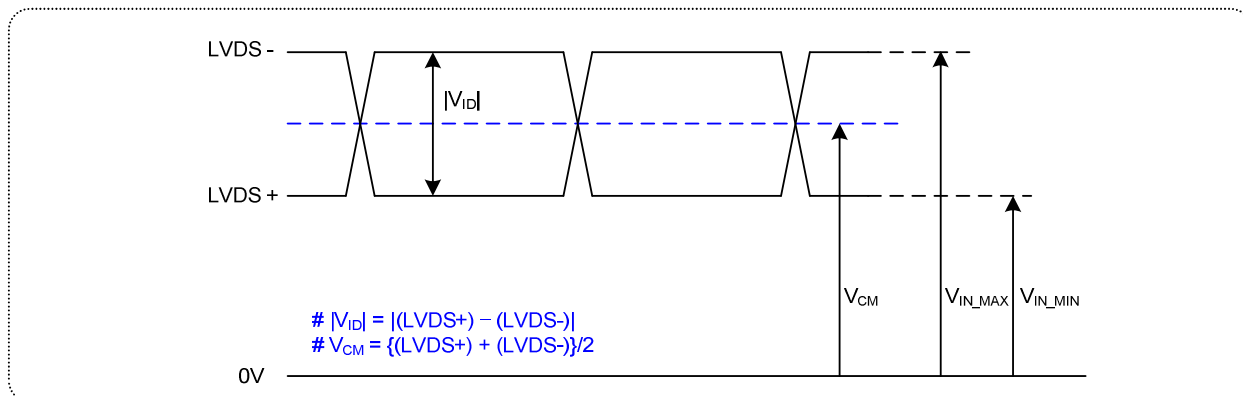

Rear view of LCM

[CN1]
- Part/No. : GT05P-51S-H38-E1500(LSM)
- Mating connector : FI-RE51HL
      (Manufactured by JAE)
[CN2]
- Part/No. : GT05P-41S-H38-E1500 (LSM)
- Mating connector : FI-RE41HL
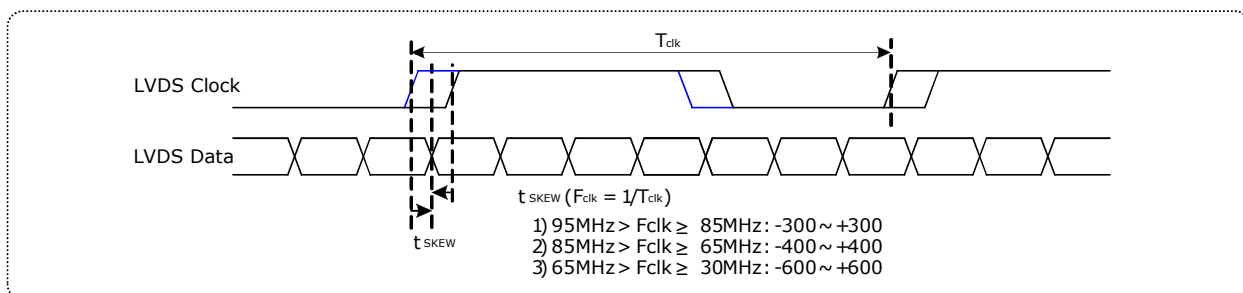   (Manufactured by JAE)

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3-2-2. BACKLIGHT CONNECTOR PIN CONFIGURATION(CN3)

The LED interface connector is a model BM06B-SHJS(HF)_Manufactured by JST or equivalent.
The mating connector is a SHJP-06V-S(HF), SHJP-06V-A-K(HF) or equivalent.
The pin configuration for the connector is shown in the table below.

Pin	Symbol	Description	Notes
1	FB1	Channel1 Current Feedback	
2	FB2	Channel2 Current Feedback	
3	VLED	LED Power Supply	
4	VLED	LED Power Supply	
5	FB3	Channel3 Current Feedback	
6	FB4	Channel4 Current Feedback	

Rear view of LCM

#1

#6

[Figure 5] Backlight connector view

Product Specification

3-3. LVDS characteristics

3-3-1. DC Specification

LVDS −

|V$_{ID}$|

LVDS +

V$_{CM}$ V$_{IN\_MAX}$ V$_{IN\_MIN}$

|V$_{ID}$| = |(LVDS+) − (LVDS-)|
V$_{CM}$ = {(LVDS+) + (LVDS-)}/2

0V

Description	Symbol	Min	Max	Unit	Notes
LVDS Differential Voltage	|V$_{ID}$|	150	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	ΔVCM	-	250	mV	-

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

3-3-2. AC Specification

T$_{clk}$

LVDS Clock

LVDS Data

t$_{SKEW}$ (F$_{clk}$ = 1/T$_{clk}$)
1) 95MHz > Fclk ≥ 85MHz: -300 ~ +300
2) 85MHz > Fclk ≥ 65MHz: -400 ~ +400
3) 65MHz > Fclk ≥ 30MHz: -600 ~ +600

t$_{SKEW}$

Description	Symbol	Min	Max	Unit	Notes
LVDS Clock to Data Skew Margin	t$_{SKEW}$	- 300	+ 300	ps	95MHz > Fclk ≥ 85MHz
	t$_{SKEW}$	- 400	+ 400	ps	85MHz > Fclk ≥ 65MHz
	t$_{SKEW}$	- 600	+ 600	ps	65MHz > Fclk ≥ 30MHz
LVDS Clock to Clock Skew Margin (Even to Odd)	t$_{SKEW\_EO}$	- 1/7	+ 1/7	T$_{clk}$	-

Note 1 :
This SSC specifications are just T-CON operation specification. In case of various system condition, the optimum setting value of SSC can be different. LGD recommend the SI should be adjust the SSC deviation and modulation frequency in order not to happen any kinds of defect phenomenon.
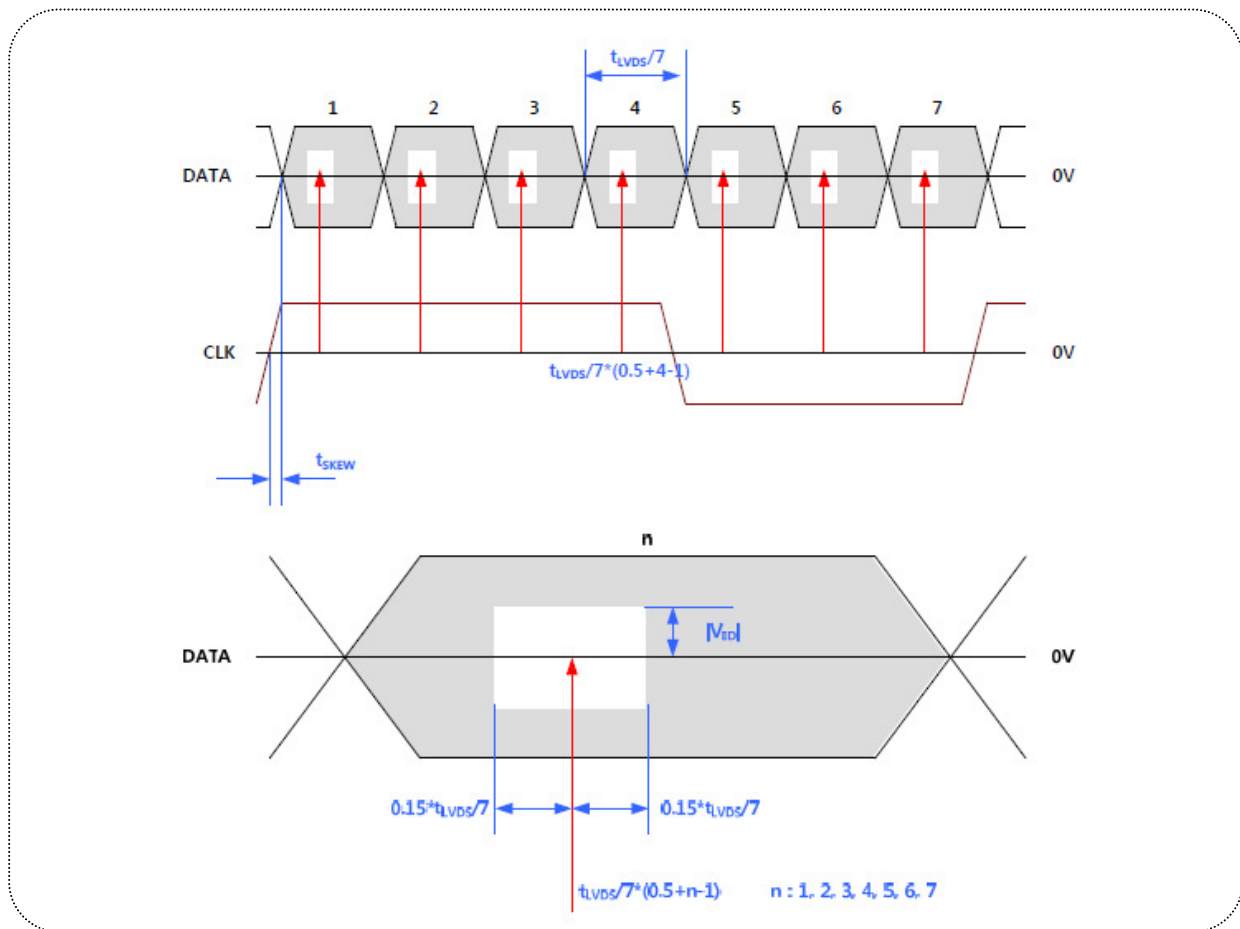
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3-3-2. AC Specification
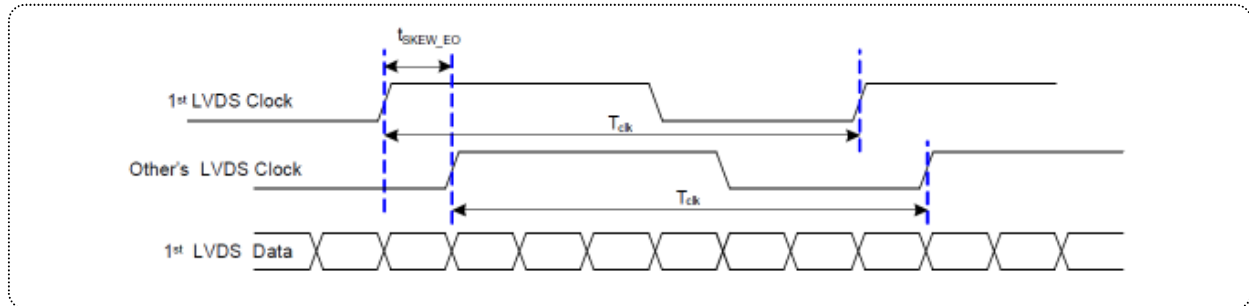
< LVDS Clock to Clock Skew Margin (1st port to other ports >

3-3-3. LVDS effective area Specification
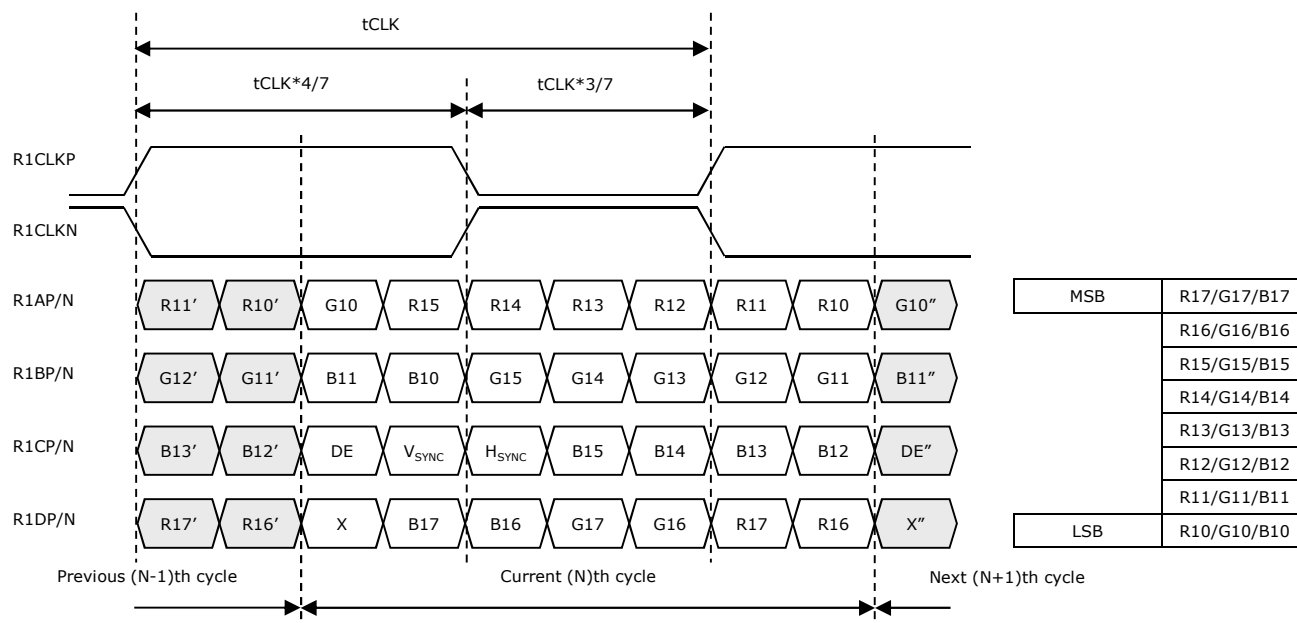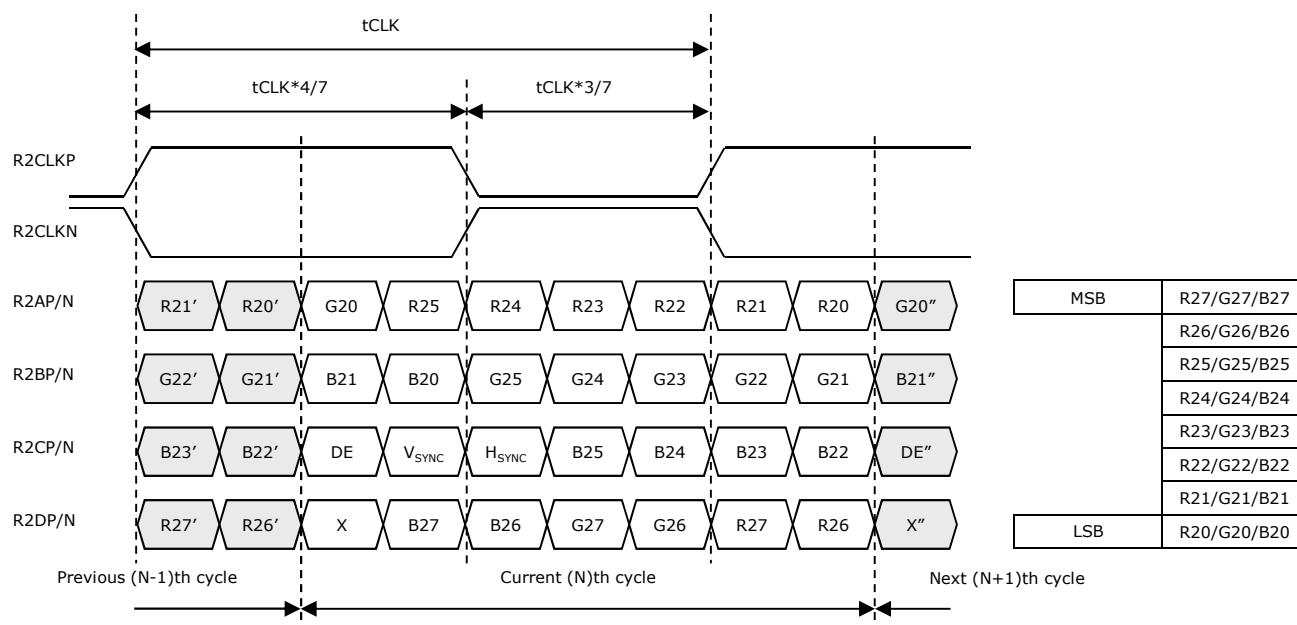

< LVDS effective area spec with skew >

LG Display

3-3-3. LVDS data format (8bit, VESA)

■ **1st LVDS Channel**

MSB	R17/G17/B17
	R16/G16/B16
	R15/G15/B15
	R14/G14/B14
	R13/G13/B13
	R12/G12/B12
	R11/G11/B11
LSB	R10/G10/B10

■ **2nd LVDS Channel**

MSB	R27/G27/B27
	R26/G26/B26
	R25/G25/B25
	R24/G24/B24
	R23/G23/B23
	R22/G22/B22
	R21/G21/B21
LSB	R20/G20/B20

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3-3-3. LVDS data format (8bit, VESA)

■ 3rd LVDS Channel

	MSB	R37/G37/B37
		R36/G36/B36
		R35/G35/B35
		R34/G34/B34
		R33/G33/B33
		R32/G32/B32
		R31/G31/B31
	LSB	R30/G30/B30

■ 4th LVDS Channel

	MSB	R47/G47/B47
		R46/G46/B46
		R45/G45/B45
		R44/G44/B44
		R43/G43/B43
		R42/G42/B42
		R41/G41/B41
	LSB	R40/G40/B40
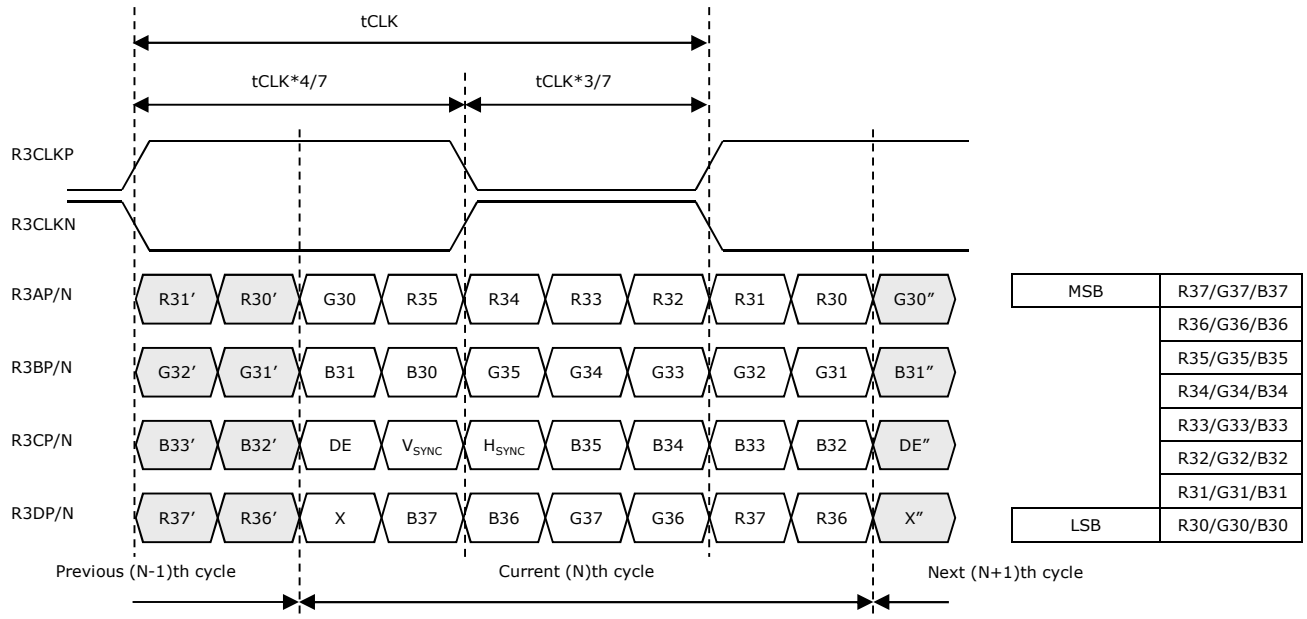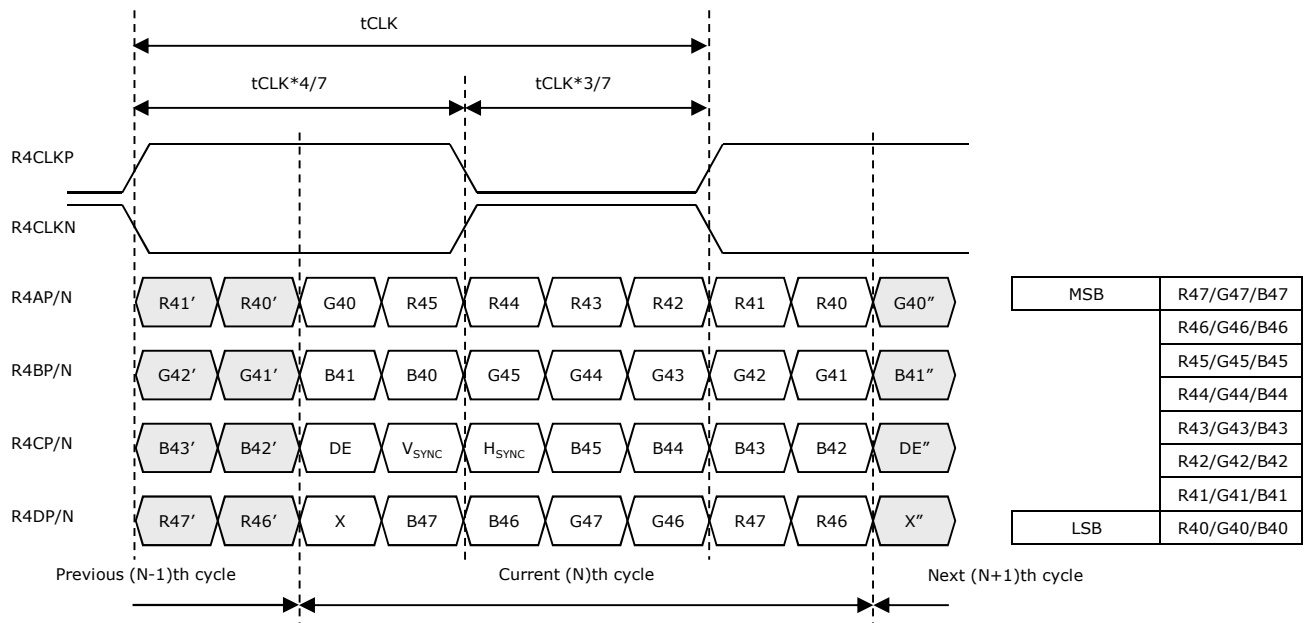
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3-4. Signal Timing Specifications

This is the signal timing required at the input of the User connector. All of the interface signal timing should be satisfied with the following specifications for it's proper operation.

Table 4. TIMING TABLE (VESA COORDINATED VIDEO TIMING)

	Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
DCLK	Period	tCLK	16.5	16.2	16.0	ns	Pixel Frequency : Typ 246.4 MHz
	Frequency	fCLK	60.5	61.6	62.6	MHz	
Hsync	Period	tHP	520	520	520	tCLK	
	Horizontal Valid	tHV	480	480	480	tCLK	
	Horizontal Blank	tHB	40	40	40	tCLK	
	Frequency	fH	116.4	118.4	120.4	KHz	
Vsync	Period	tVP	1974	1975	1976	tHP	
	Vertical Valid	tVV	1920	1920	1920	tHP	
	Vertical Blank	tVB	54	55	56	tHP	
	Frequency	fV	58.94	60	60.95	Hz	

Note: Hsync period and Hsync width-active should be even number times of tCLK.
If the value is odd number   times of tCLK, display control signal can be asynchronous.
In order to operate this LCM a Hsync, Vsync, and DE(data enable) signals should be used.
1. The Input of Hsync & Vsync signal does not have an effect on normal operation
(DE Only Mode). If you use spread spectrum for EMI, add some additional clock to
minimum value for clock margin.
2. The performance of the electro-optical characteristics may be influenced by variance of
the vertical refresh rates.
3. Vsync and Hsync should be keep the above specification.
4. Hsync Period, Hsync Width, and Horizontal Back Porch should be any times of character
number(4).
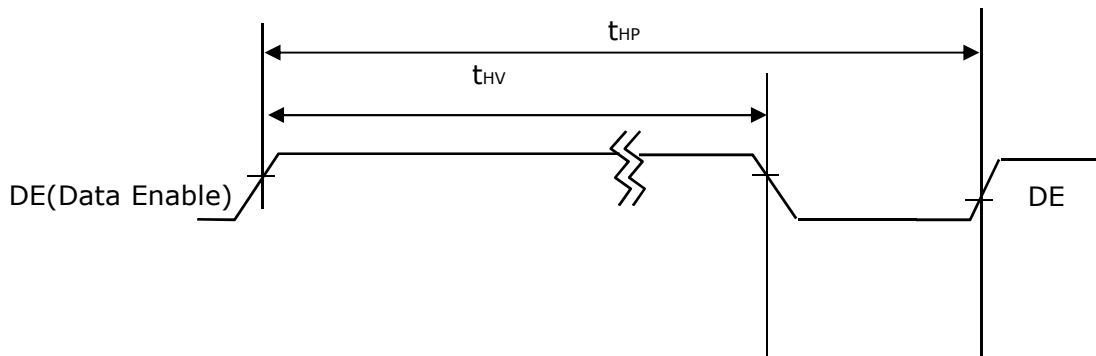5. The polarity of Hsync, Vsync is not restricted.

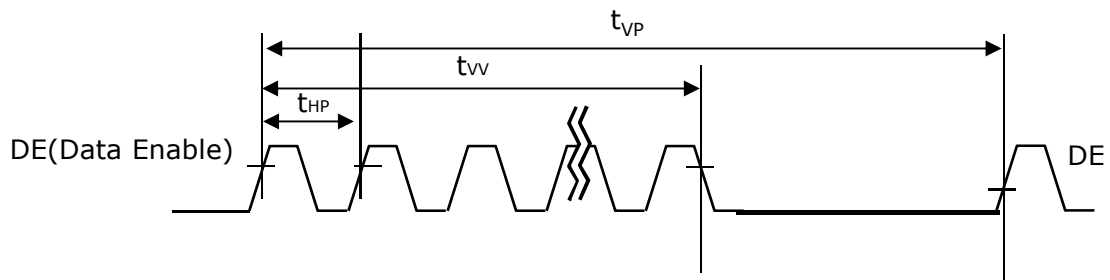## 3-5. Signal Timing Waveforms

1. D$_{CLK}$, DE, DATA waveforms
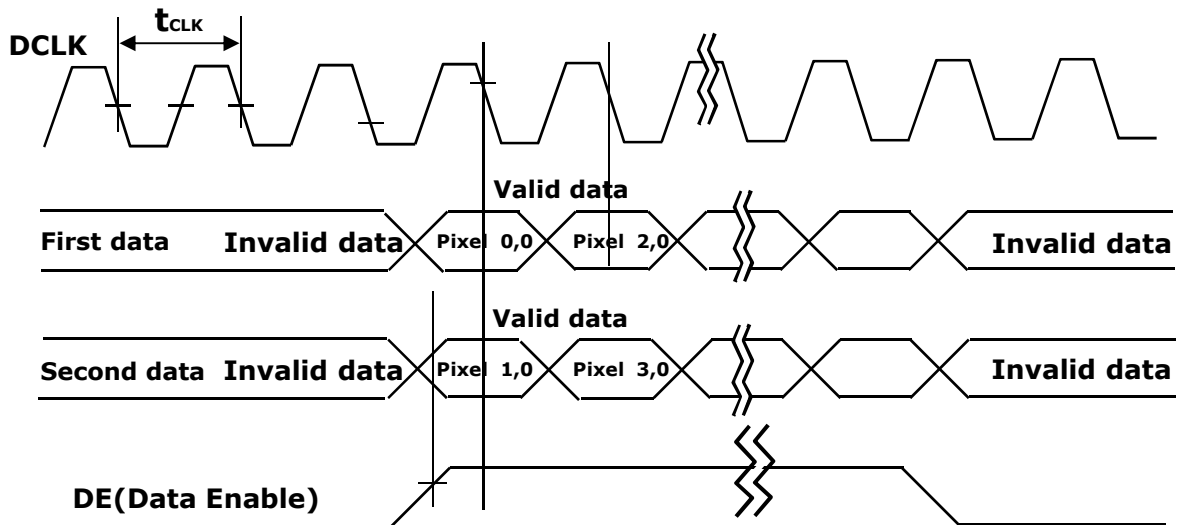
2. Horizontal waveform

3. Vertical waveform

**Product Specification**

3-6. 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 5. COLOR DATA REFERENCE

Color		Input Color Data		
		RED MSB　　　　　　　　　LSB R7 R6 R5 R4 R3 R2 R1 R0	GREEN MSB　　　　　　　　　LSB G7 G6 G5 G4 G3 G2 G1 G0	BLUE MSB　　　　　　　　　LSB 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 (000) Dark	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 (001)	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 (000) Dark	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 (001)	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 (000)Dark	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 (001)	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 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

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3-7. Power Sequence & Dip condition for LCD Module

3-7-1. Power Sequence
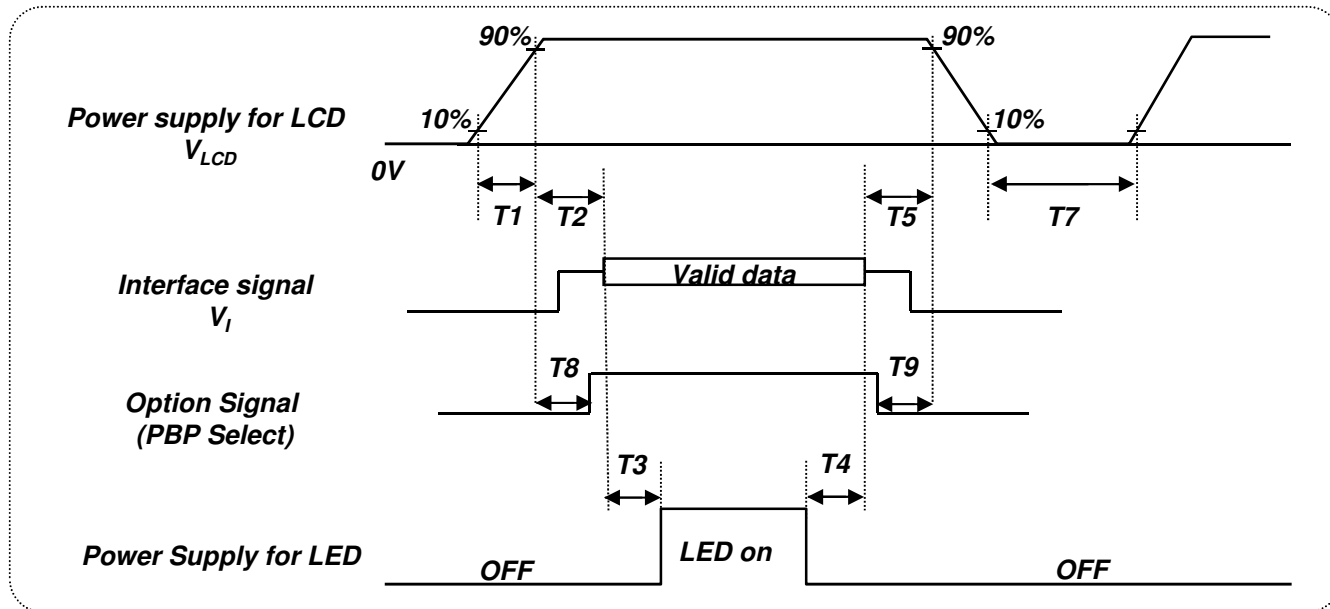
Table 7. POWER SEQUENCE

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
T7	1000	-	-	ms
T8	0	-	T2	ms
T9	0	-	-	ms

Notes : 1. Please VLCD power on only after connecting interface cable to LCD.
   2. Please avoid floating state of interface signal at invalid period.
   3. When the interface signal is invalid, be sure to pull down the power supply for LCD V$_{LCD}$to 0V.
   4. The invalid signal means out of the signal timing specification which define as page 17.
   5. The above power sequence should be satisfied the basic power on/off and
       resolution, timing transition.
   6. LED power must be turn on after power supply for LCD and interface signal are valid.
   7. Recommend to follow Power sequence at these case
      -.AC/DC Power On/Off
      -.Mode change (Resolution, frequency, timing, sleep mode, Color depth change, etc.)
      If not to follow power sequence, there is a risk of abnormal display.

Product Specification

3-7-2. V~LCD~ Power Dip Condition

FIG.5 Power dip condition

1) Dip condition

   $8V \leq V_{LCD} < 9.5V$, $t_d \leq 20ms$

2) $V_{LCD} < 8V$

   V_{LCD}-dip conditions should also follow the Power On/Off conditions for supply voltage.

Product Specification

4. Optical Specifications

Optical characteristics are determined after the unit has been 'ON' for approximately 30 minutes in a dark environment at 25±2°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. 4 presents additional information concerning the measurement equipment and method.
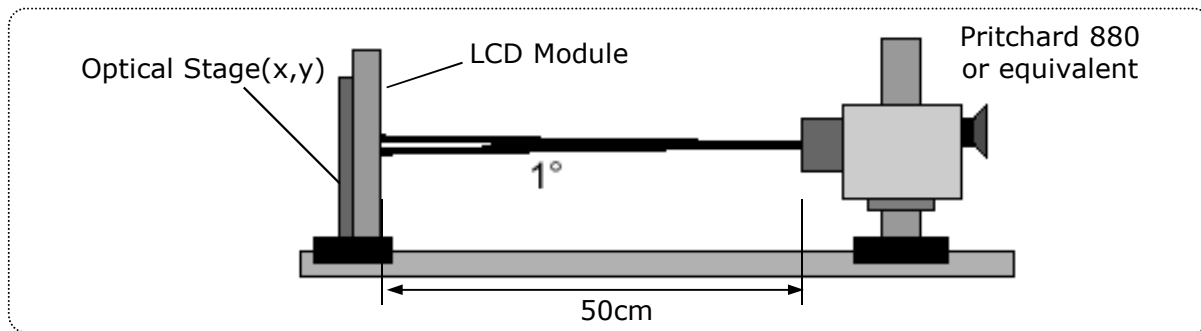
FIG. 4 Optical Characteristic Measurement Equipment and Method

Table 7. OPTICAL CHARACTERISTICS (Ta=25 °C, VLCD=10.0V, fV=60Hz DCLK=246.4MHz, Is=120mA)

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	28	ms	4
Color Coordinates [CIE1931] **(By PR650)**	RED	Rx	Typ -0.03	0.652	Typ +0.03		
		Ry		0.337			
	GREEN	Gx		0.314			
		Gy		0.626			
	BLUE	Bx		0.148			
		By		0.058			
	WHITE	Wx		0.313			
		Wy		0.329			
Color Shift (Avg. Δu'v' < 0.02)	Horizontal	θ_{CST_H}	-	140	-	Degree	5
	Vertical	θ_{CST_V}	-	100	-		
Viewing Angle (CR>10)							
General	Horizontal	θ_H	170	178	-	Degree	6
	Vertical	θ_V	170	178	-		
GSR @ 60dgree (Gamma shift rate)	Horizontal	δ_{Gamma_H}	-	-	20	%	7
	Vertical	δ_{Gamma_V}	-	-	20		
Gray Scale		-		2.2			8

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.8 (By PR880)

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

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

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

4. **Gray to gray response time** is the time required for the display to transition from gray to gray. For additional information see Table 9. **(By RD80S)**

5. **Color shift** is the angle at which the average color difference for all Macbeth is lower than 0.02. For more information see FIG.9 **(By EZ Contrast)**
   - Color difference (Δu'v')

$$u' = \frac{4x}{-2x + 12y + 3} \qquad v' = \frac{9y}{-2x + 12y + 3} \qquad \Delta u'v' = \sqrt{(u'_1 - u'_2)^2 + (v'_1 - v'_2)^2}$$

$$Avg(\Delta u'v') = \frac{\sum_{i=1}^{24}(\Delta u'v')i}{24}$$

u'1, v'1 : u'v' value at viewing angle direction
u'2, v'2 : u'v' value at front (θ=0)
i : Macbeth chart number (Define 23 page)

   - Pattern size : 25% Box size
   - Viewing angle direction of color shift : Horizontal, Vertical

6. **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.10 **(By PR880)**

7. **GSR** is the rate of gamma shift at up, down, left and right 60 degree viewing angle compare with center gamma. For more information see FIG.11 and FIG.12 **(By EZ Contrast)**
   - GSR (δ $_{Gamma}$) is defined as :

$$GSR = \left(1 - \frac{\text{View angle Gamma Value (Up, Down, Reft, Light 60 Degree)}}{\text{Center Gamma Value (0 Degree)}}\right) \times 100$$

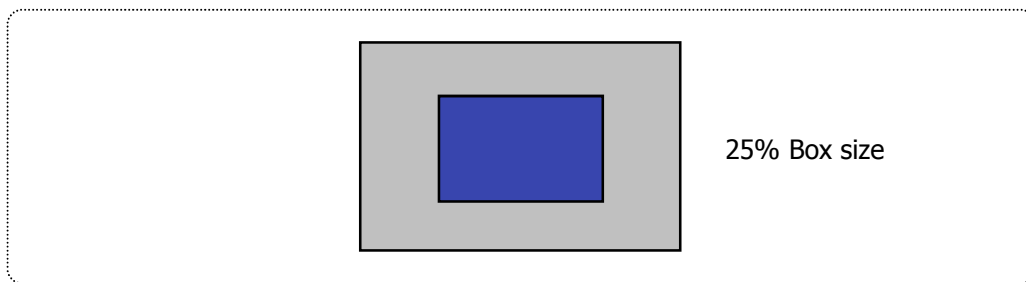**LG Display**

Product Specification

Notes 8. Gamma Value is approximately 2.2. For more information see Table 10.

Measuring point for surface luminance & measuring point for luminance variation.

FIG.8 Measure Point for Luminance

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 ".
    - if system use ODC (Over Driving Circuit) function, Gray to Gary response time may be 5ms~8ms GtG
      * it depends on Overshoot rate.

Table 9. GTG Gray Table

Gray to Gray		Rising Time				
		G255	G191	G127	G63	G0
Falling Time	G255					
	G191					
	G127					
	G63					
	G0					

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G to G(BW) Response time is defined as the following figure and shall be measured by switching the input signal for "Gray(N)" and "Black or White".

Tr   Tf

100
90

Optical Response

10
0

Gray(N)   Gray(M)   Gray(M)   Gray(N)

N, M = 0(Black)~255(White)
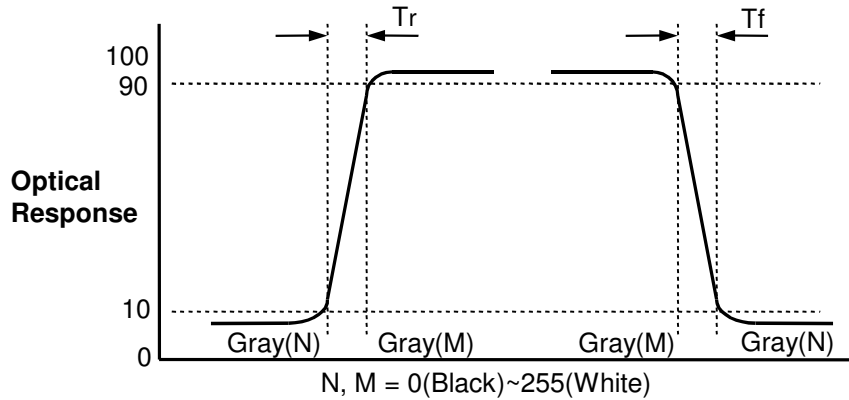
Color shift is defined as the following test pattern and color.

25% Box size

FIG.9 Color Shift Test Pattern

Average RGB values in Bruce RGB for Macbeth Chart

	Dark skin (i=1)	Light skin	Blue sky	Foliage	Blue flower	Bluish green
R	98	206	85	77	129	114
G	56	142	112	102	118	199
B	45	123	161	46	185	178
	Orange	Purplish blue	Moderate red	Purple	Yellow green	Orange yellow
R	219	56	211	76	160	230
G	104	69	67	39	193	162
B	24	174	87	86	58	29
	Blue	Green	Red	Yellow	Magenta	Cyan
R	26	72	197	241	207	35
G	32	148	27	212	62	126
B	145	65	37	36	151	172
	White	Neutral 8	Neutral 6.5	Neutral 5	Neutral 3.5	Black
R	240	206	155	110	63	22
G	240	206	155	110	63	22
B	240	206	155	110	63	22

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Dimension of viewing angle range.
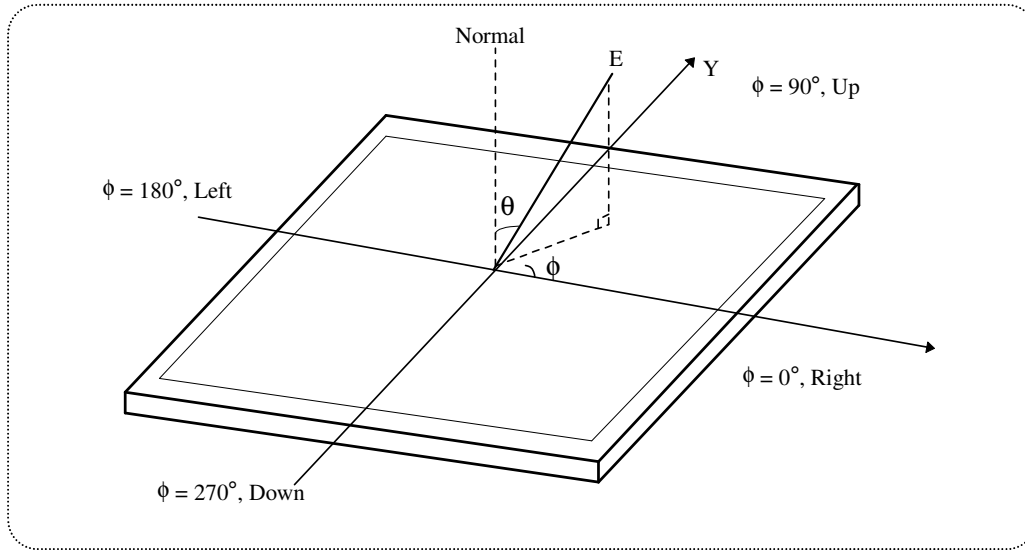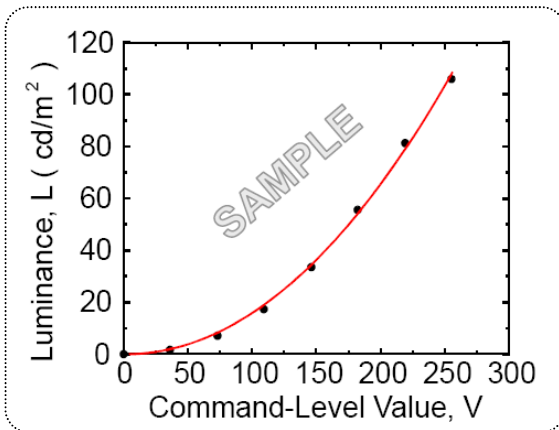

FIG.10 Viewing angle

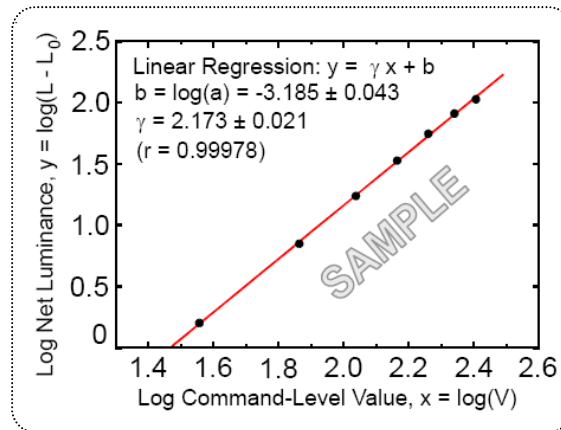**FIG.11 Sample Luminance vs. gray scale (using a 256 bit gray scale)**

$$L = aV^r + L_b$$

FIG.12 Sample Log-log plot of luminance vs. gray scale

$$\log(L - L_b) = r \log(V) + \log(a)$$

Here the Parameter α and γ relate the signal level V to the luminance L.

The GAMMA we calculate from the log-log representation (FIG.11)

Product Specification

Table 9. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.10
15	0.30
31	1.08
47	2.50
63	4.72
79	7.70
95	11.49
111	16.20
127	21.66
143	28.20
159	35.45
175	43.80
191	53.00
207	63.30
223	74.48
239	86.80
255	100

5. 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	491.8 mm
	Vertical	491.8 mm
	Depth	13.5mm
Bezel Area	Horizontal	479.0 mm
	Vertical	479.0 mm
Active Display Area	Horizontal	475.776 mm
	Vertical	475.776 mm
Weight	2,210 g (Typ.) / 2,320 g (Max.)	
Surface Treatment	Anti-Glare treatment of the front polarizer (Haze25%, 3H)	

Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.

Product Specification

<FRONT VIEW>

Product Specification

<REAR VIEW>
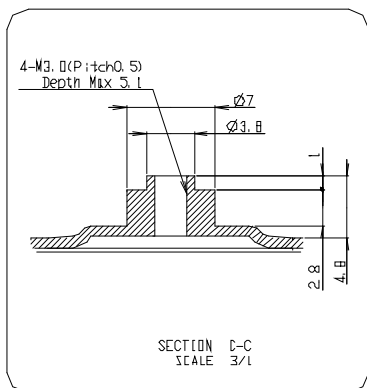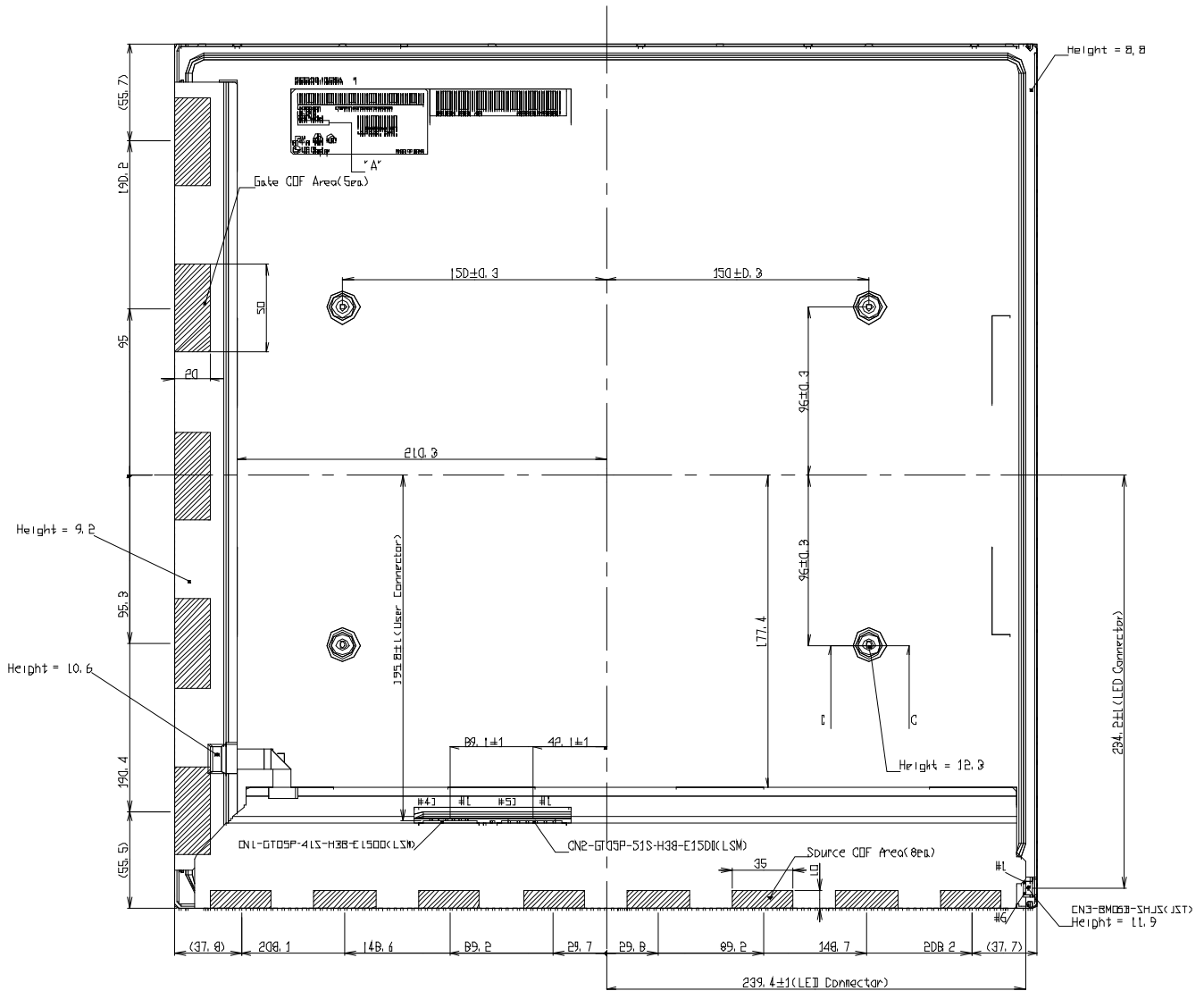
Notes
1-1. I/F Connector Specification(CN1) : GT05P-41S-H38-E1500(LSM)
1-2. I/F Connector Specification(CN2) : GT05P-51S-H38-E1500(LSM)
2. LED Connector Specification(CN3) : JST, BM06B-SHJS(HF)
3. Tilt and partial disposition tolerance of display area are as following.
　(1) Y-direction : ｜A-B｜≦1.4mm
　(2) X-direction : ｜C-D｜≦1.4mm
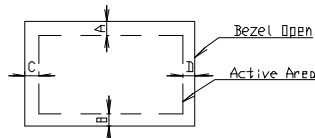
4. Torque spec. of user mounting : 3.0~4.0kgf.cm
5. Unspecified tolerances are to be ±0.5mm
6. the COF area is weak and sensitive, so please don't press the COF area.
7. The "A" pharase as following

Production line	Description
eMPS line	None
LGDGZ line	Factory ID : LGDGZ

SECTION C-C
SCALE 3/1

Product Specification

6. Reliability

Environment test condition

No	Test Item	Condition
1	High temperature storage test	Ta= 60°C 240h
2	Low temperature storage test	Ta= -20°C 240h
3	High temperature operation test	Ta= 50°C 50%RH 240h
4	Low temperature operation test	Ta= 0°C 240h
5	Humidity condition Operation	Ta= 40 °C ,90%RH
6	Altitude operating storage / shipment	0 - 16,400 feet(5,000m) 0 - 40,000 feet(12,192m)
7	Maximum Storage Humidity for 4 corner light leakage Mura.	Max 70%RH , Ta=40℃

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.

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Product Specification

7. International Standards

7-1. Safety

   a) UL 60950-1, Underwriters Laboratories Inc.
     Information Technology Equipment - Safety - Part 1 : General Requirements.
   b) CAN/CSA-C22.2 No. 60950-1-07, Canadian Standards Association.
     Information Technology Equipment - Safety - Part 1 : General Requirements.
   c) EN 60950-1, European Committee for Electrotechnical Standardization (CENELEC).
     Information Technology Equipment - Safety - Part 1 : General Requirements.
   d) IEC 60950-1, The International Electrotechnical Commission (IEC).
     Information Technology Equipment - Safety - Part 1 : General Requirements

7-2. Environment

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

8. Packing

8-1. 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)   D : Year
E : Month   F ~ M : Serial No.

Note:
1. Year

Year	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Mark	A	B	C	D	E	F	G	H	J	K

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.

8-2. Packing Form

a) Package quantity in one box : 10 pcs

b) Box Size : 562 mm X 362 mm X 560 mm

9. PRECAUTIONS

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

9-1. MOUNTING PRECAUTIONS

(1) You must mount a module using holes arranged in rear side.
(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 the 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 bare hand or 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.

9-2. OPERATING PRECAUTIONS

(1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
   V=±200mV(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 guarantee.
(11) When this reverse model is used as a forward-type model (PCB on top side), LGD can not guarantee any defects of LCM.
(12) If the ITLC pin is unused, LCM can not support "Interlaced Scan Method"
(13) Please conduct image sticking test after 2-hour aging with Rolling Pattern and normal temperature.(25~40℃)

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9-3. 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.

9-4. Precautions for strong light exposure

Strong light exposure causes degradation of polarizer and color filter.

9-5. 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.

9-6. 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.