Product Specification

SPECIFICATION
FOR
APPROVAL

(●) Preliminary Specification
( ) Final Specification

Title	21.3” 3M Portrait TFT LCD

BUYER	
MODEL	

SUPPLIER	LG Display Co., Ltd.
*MODEL	LB213QX2
SUFFIX	SL01

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

	SIGNATURE	DATE
	/	
	/	
	/	

APPROVED BY	SIGNATURE DATE
S.H. Lee / G.Manager	
REVIEWED BY	
J.G. Lee / Manager [C]	
W.Y. Noh / Manager [M]	
S.H. Han / Manager [O]	
D.H. Nam / Manager [P]	
PREPARED BY	
H.D. Moon / Engineer	

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

Product engineering dept.
LG Display Co., Ltd

Product Specification

Contents

Product Specification

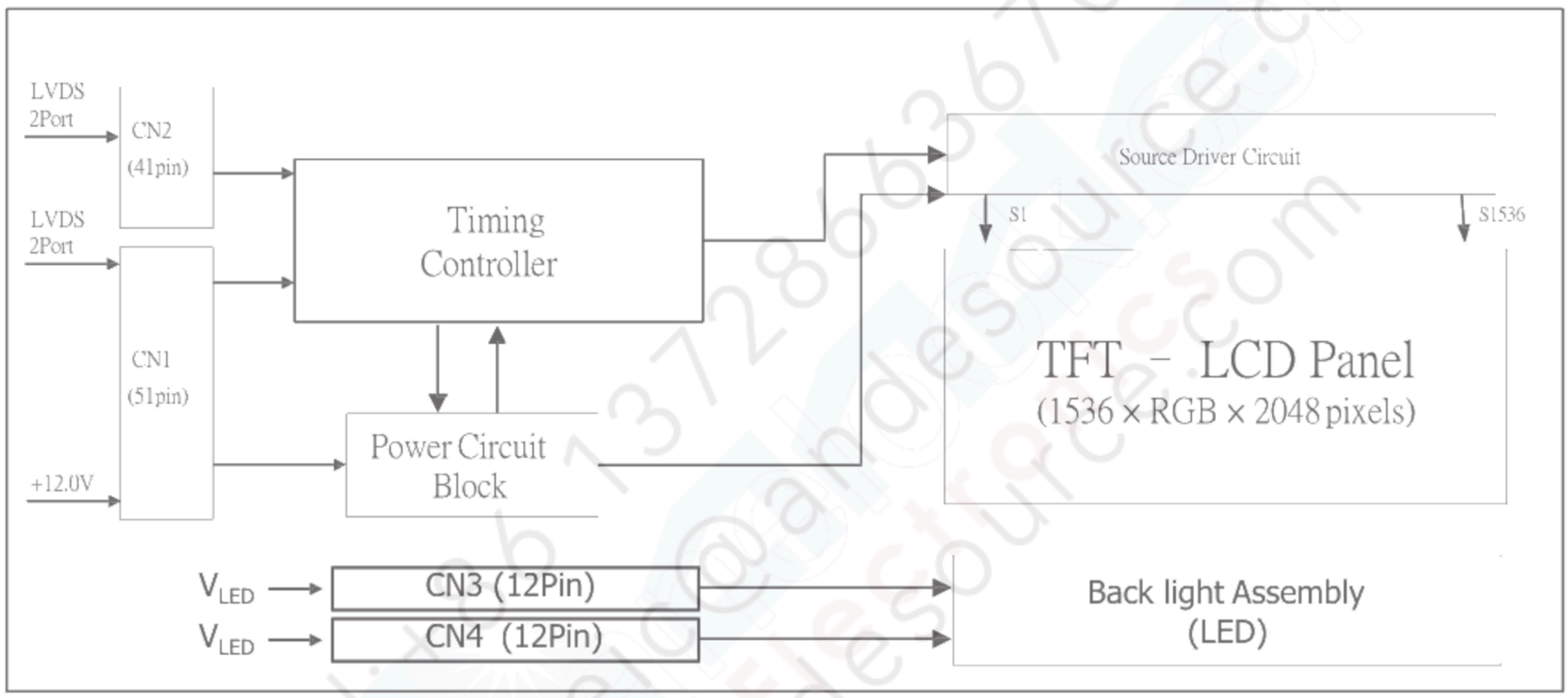
RECORD OF REVISIONS

Revision No	Revision Date	Page	Before	After	Application Date
0.0	Nov. 17 2020	-	First Draft (Preliminary)		

Product Specification

1. General Description

LB213 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 21.3inch diagonally measured active display area with 3M resolution (1536 horizontal by 2048 vertical 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 real 10-bit gray scale signal for each dot, thus, presenting a palette of 1,073,741,824 colors. It has been designed to apply LVDS 4port interface. It is intended to support displays where high brightness, super wide viewing angle, high color saturation, and high color are important.



[FIG.1] Block diagram

General Features

Active Screen Size	21.3inches(54.14cm) (Aspect ratio 3:4)
Outline Dimension	336.0(H) x 453.1(V) x 18.0(D) mm (Typ.)
Pixel Pitch	0.2115 [mm] X 0.2115 [mm]
Pixel Format	1536 horiz. By 2048 vert. Pixels RGB stripes arrangement
Color Depth	1,073,741,824 Colors (Real 10bit)
Luminance, White	(1100) cd/m^2 (Center 1P Typ.)
Viewing Angle (CR>10)	View Angle (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	(42.62) W(Typ.) (Logic : (5.42) W@Mosaic, B/L: (37.2) W @ (50)mA
Weight	(2,700) g (Typ.), (2,840) g (Max.)
Display Operating Mode	Transmissive mode, Normally Black,
Panel type	Forward type
Surface Treatment	Anti-Glare treatment of the front polarizer(3H)

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

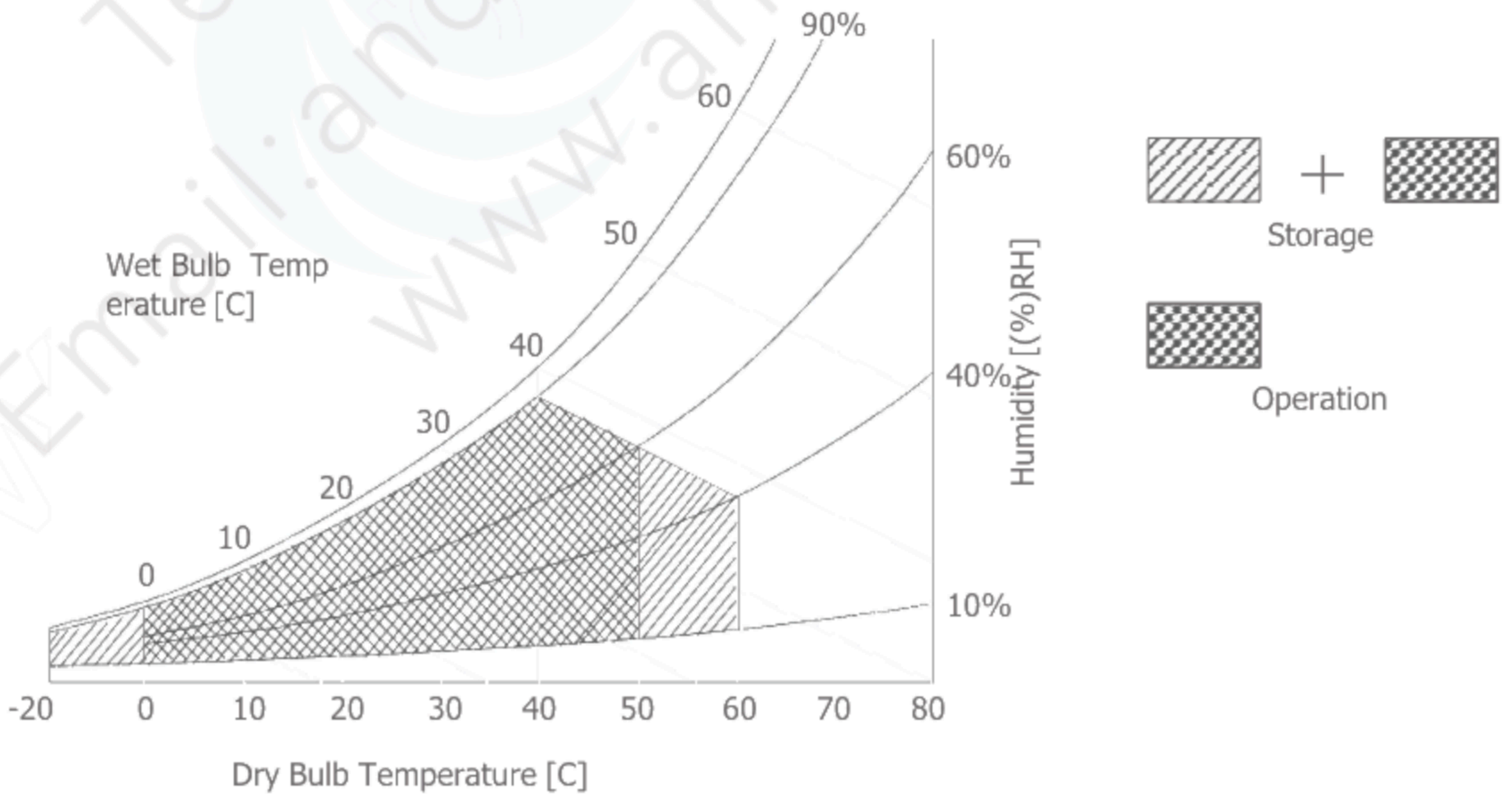
Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	V_{LCD}	-0.3	+13.0	Vdc	At 25℃
Operating Temperature	T_{OP}	0	50	°C	1,2,,3
Storage Temperature	T_{ST}	-20	60	°C	
Operating Ambient Humidity	H_{OP}	10	90	%RH	
Storage Humidity	H_{ST}	10	90	%RH	
LCM Surface Temperature (Operation)	$T_{surface}$	0	65	℃	1, 4

Notes :

1. Temperature and relative humidity range are shown in the figure below. W et bulb temperature should be 39 °C 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 measured under the condition of V_{LCD}=12.0V, fv=60Hz, T_a=25℃, no humidity and typical LED string current.

※. T_a= Ambient temperature

FIG. 2 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 li quid 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		
MODULE :						
Power Supply Input voltage	V_{LCD}	11.5	12.0	12.5	Vdc	4
Permissive Power Input Ripple	V_{dRF}	-		400	mVp-p	1
Power Supply Input Current	$I_{LCD-MOSAIC}$	-	(0.451)	(0.564)	A	2
	$I_{LCD-WHITE}$	-	(0.535)	(0.669)	A	2
Power Consumption	$P_{LCD-MOSAIC}$	-	(5.42)	(6.77)	Watt	2
	$P_{LCD-WHITE}$	-	(6.42)	(8.03)	Watt	2
Rush Current	I_{RUSH}	-	-	3.5	A	3

Notes :

1. Permissive power ripple should be measured under the condition of V_{LCD}=12.0V, 25°C,*fv=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}=12.0V, 25°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 500us ± 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°C, f_V=60Hz)

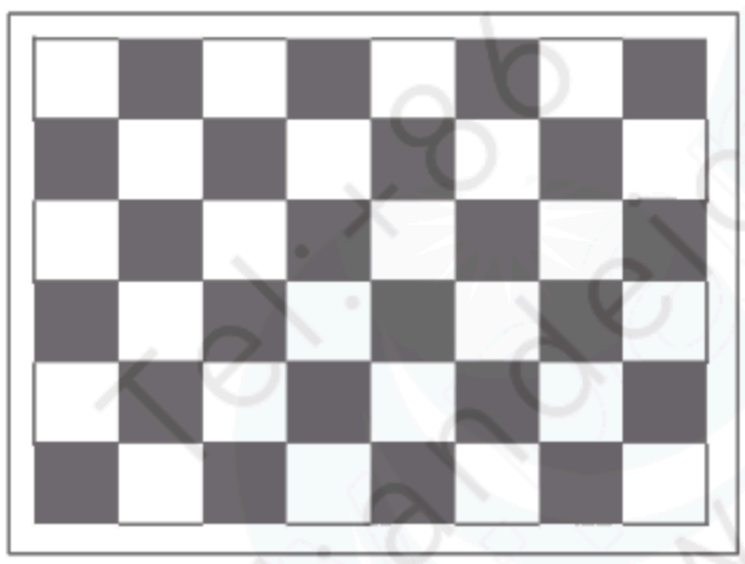
* fv=frame frequency

- **Permissive power input ripple** (V_{LCD} =12V, 25°C, fv (frame frequency)=Max. condition)

White pattern

For the exact ripple measurement, the condition of max. 20Mhz is recommended in the bandwidth configuration of oscilloscope.

- **Power consumption** (V_{LCD} =12V, 25°C, fv (frame frequency=60Hz condition)



Typical power pattern

Maximum power pattern

[FIG. 3] Mosaic pattern & White pattern for power consumption measurement

Table 2-2. Electrical characteristics of LED bar in normal operating condition

Parameter	Symbol	Values			Units	Notes
		Min.	Typ.	Max.		
LED string current	Is	-	(50)		mA	1, 2
LED string voltage	Vs	(59.8)	(62.0)	(64.2)	V	1, 3
Power consumption	P_{Bar}	-	(37.2)	(38.5)	Watt	1, 2, 5
LED life time	LED_LT	50,000	-	-	Hour	4

Notes) The LED consists of 132 LED packages, 12 strings (parallel) x 11 packages (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 estimated value and not guaranteed value.
   The LED life time is defined as the time when brightness of LED itself reach to become 50% or less than the initial value under the conditions at Ta = 25 ± 2°C and LED string current is typical value.
5. The power consumption shown above does not include the loss of external LED driver. Th e 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.

3-2. Interface connections

3-2-1. LCD Module

- LCD Connector(CN1): GT05S-51S-H38 (LS MTRON) or FI-RXE51S-HFS(JAE) or equivalent.
- Mating Connector : FI-RE51HL(JAE) or compatible

Table 3. 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 (I2C serial interface for LCM)	30	R2BN	SECOND LVDS Receiver signal (B-)
5	NC	No Connection (I2C serial interface for LCM)	31	R2BP	SECOND LVDS Receiver signal (B+)
6	GND	Ground (This pin should be connected to GND)	32	R2CN	SECOND LVDS Receiver signal (C-)
7	LVDS Format	'H'(3.3V)= MSTAR Concept, 'L'=normal (Connect High or low, No NC Condition)	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	R2EN	SECOND LVDS Receiver signal (E-)
15	R1BP	FIRST LVDS Receiver signal (B+)	41	R2EP	SECOND LVDS Receiver signal (E+)
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 +12.0V
23	R1DP	FIRST LVDS Receiver signal (D+)	49	VLCD	Power Supply +12.0V
24	R1EN	FIRST LVDS Receiver signal (E-)	50	VLCD	Power Supply +12.0V
25	R1EP	FIRST LVDS Receiver signal (E+)	51	VLCD	Power Supply +12.0V
26	Reserved	No connection or GND	-	-	-

Notes :

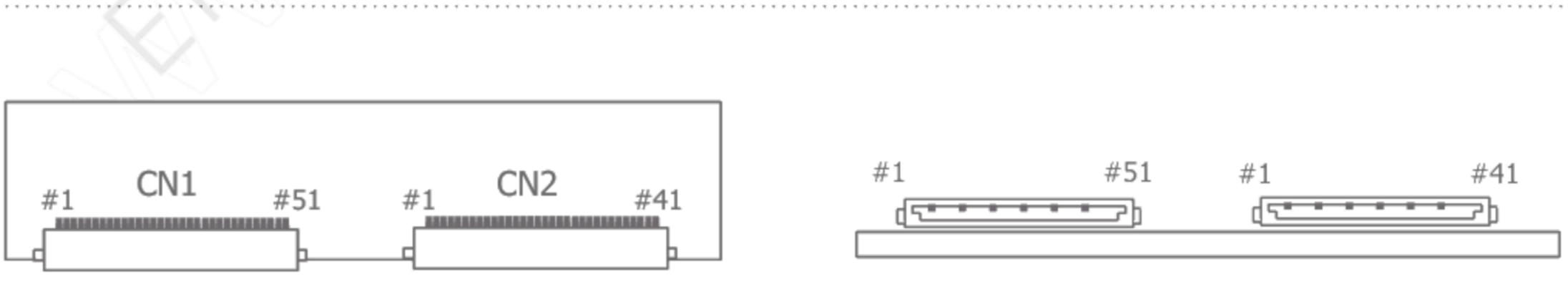
1. All GND(ground) pins should be connected together to the LCD module's metal frame.
2. All V_{LCD} (input power) pins should be connected together.
3. All input level of LVDS signals are based on the EIA 644 standard.
4. PWM_OUT is a reference signal for LED PWM control. This PWM signal is synchronized with vertical frequency. If the system don't use this pin, do not connect.

- LCD Connector(CN2): FI-RXE41S-HF(JAE) or equivalent.
- Mating Connector : FI-RE41HL(Manufactured by JAE) or compatible

Table 3-2. Module connector (CN2) pin configuration

No	Symbol	Description	No	Symbol	Description
1	NC	No connection(Reserved)	22	R3EN	THIRD LVDS Receiver Signal (E-)
2	NC	No connection	23	R3EP	THIRD LVDS Receiver Signal (E+)
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	R4EN	FORTH LVDS Receiver Signal (E-)
18	R3CLKP	THIRD LVDS Receiver Clock Signal(+)	39	R4EP	FORTH LVDS Receiver Signal (E+)
19	GND	Ground	40	GND	Ground
20	R3DN	THIRD LVDS Receiver Signal (D-)	41	GND	Ground
21	R3DP	THIRD LVDS Receiver Signal (D+)	-		

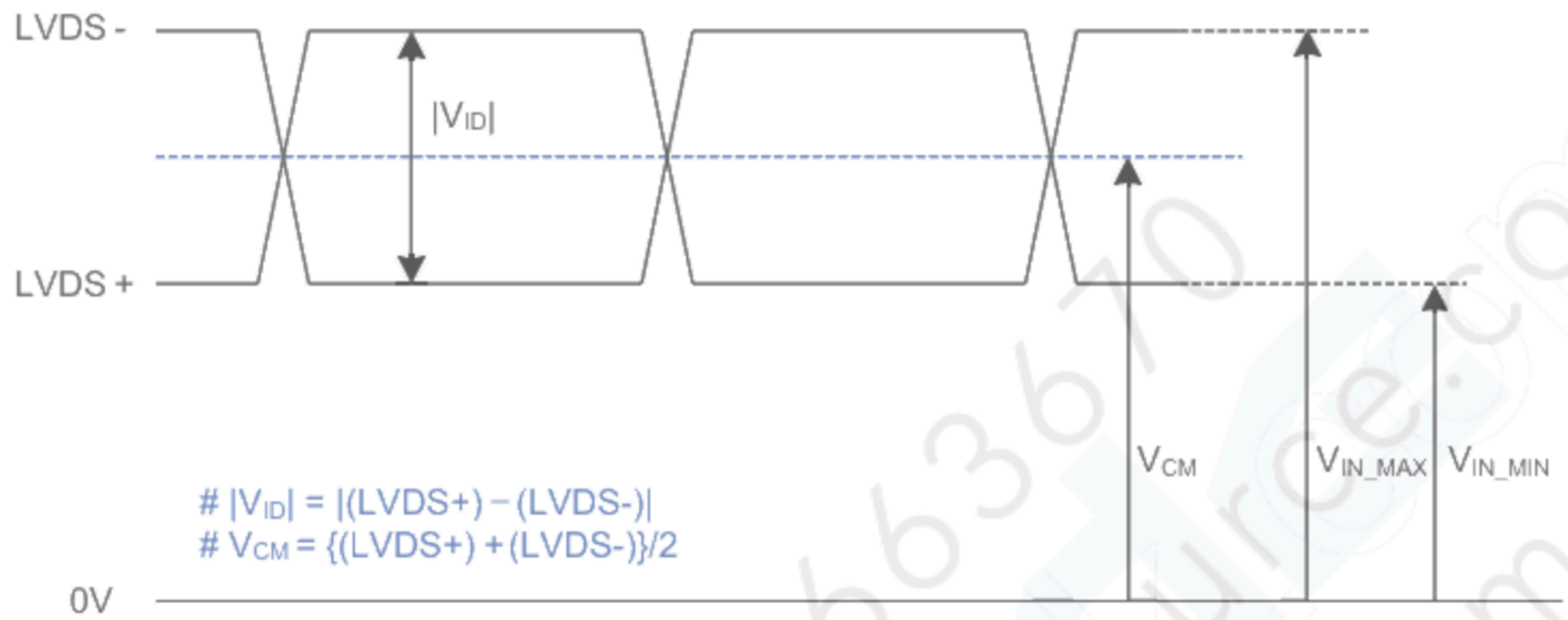
Notes :
1. All GND(ground) pins should be connected together to the LCD module's metal frame.



[FIG. 4] Connector diagram

3-2-2. LVDS Input specifications

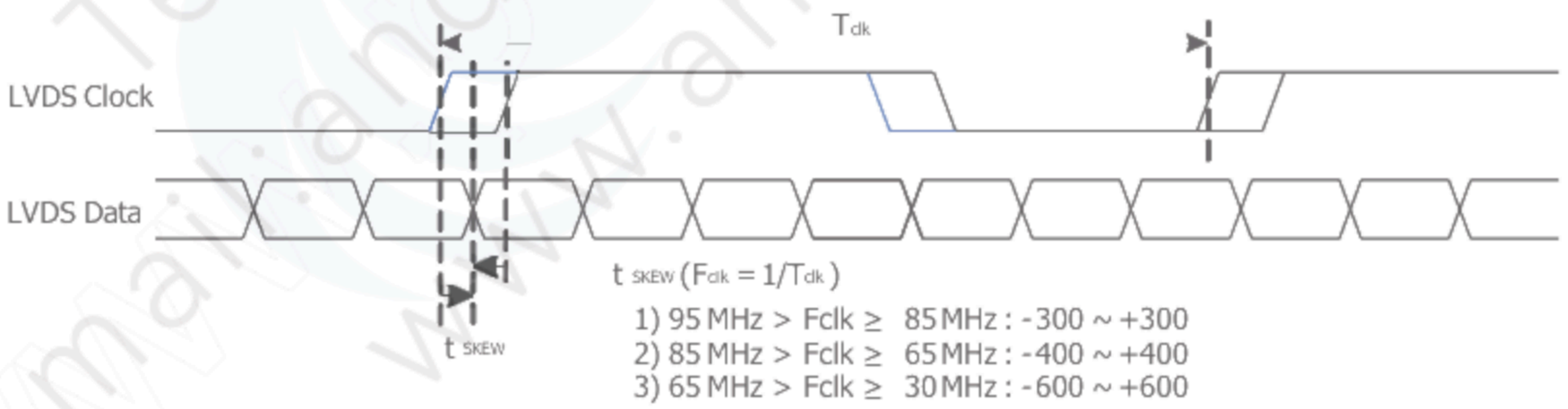
1. DC Specification



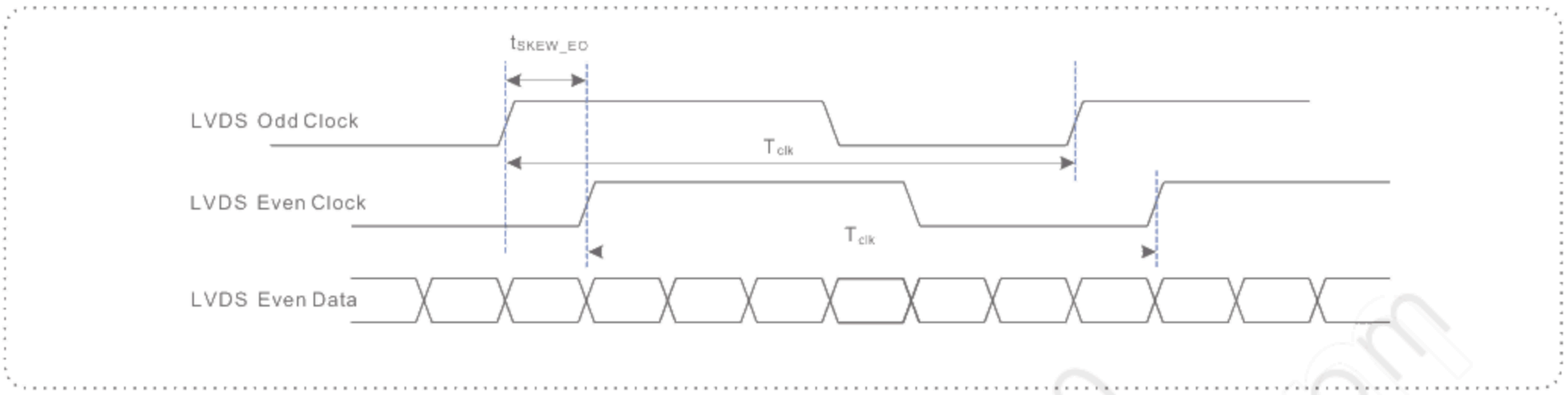
Description	Symbol	Min	Max	Unit	Notes
LVDS Differential voltage	$\|V_{ID}\|$	150	600	mV	-
LVDS Common mode voltage	V_{CM}	1.0	1.5	V	-
LVDS Input voltage range	V_{IN}	0.7	1.8	V	-
Change in common mode voltage	ΔV_{CM}	-	250	mV	-

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	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}	-

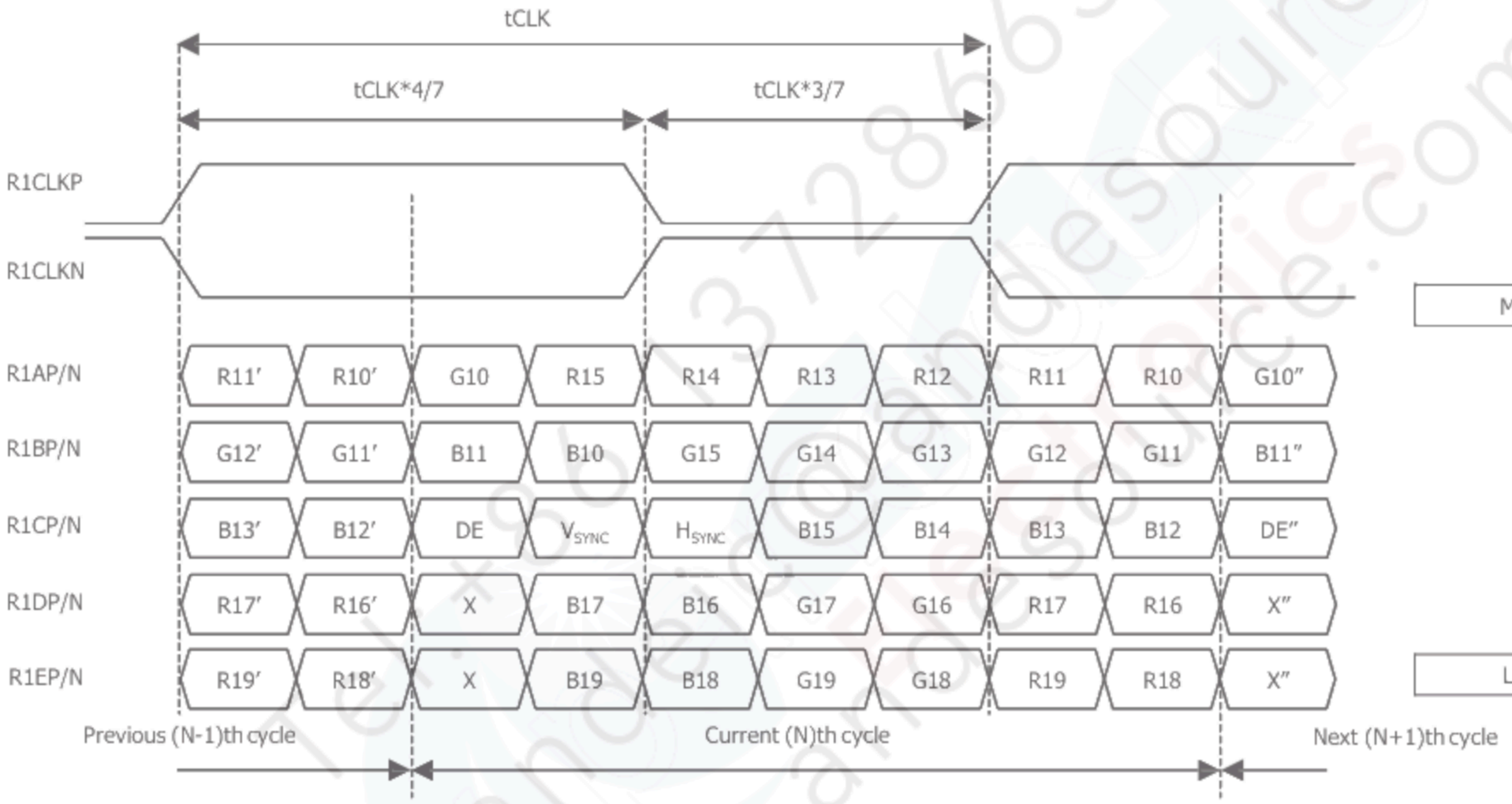


< Clock skew margin between channel >

3. Data Format

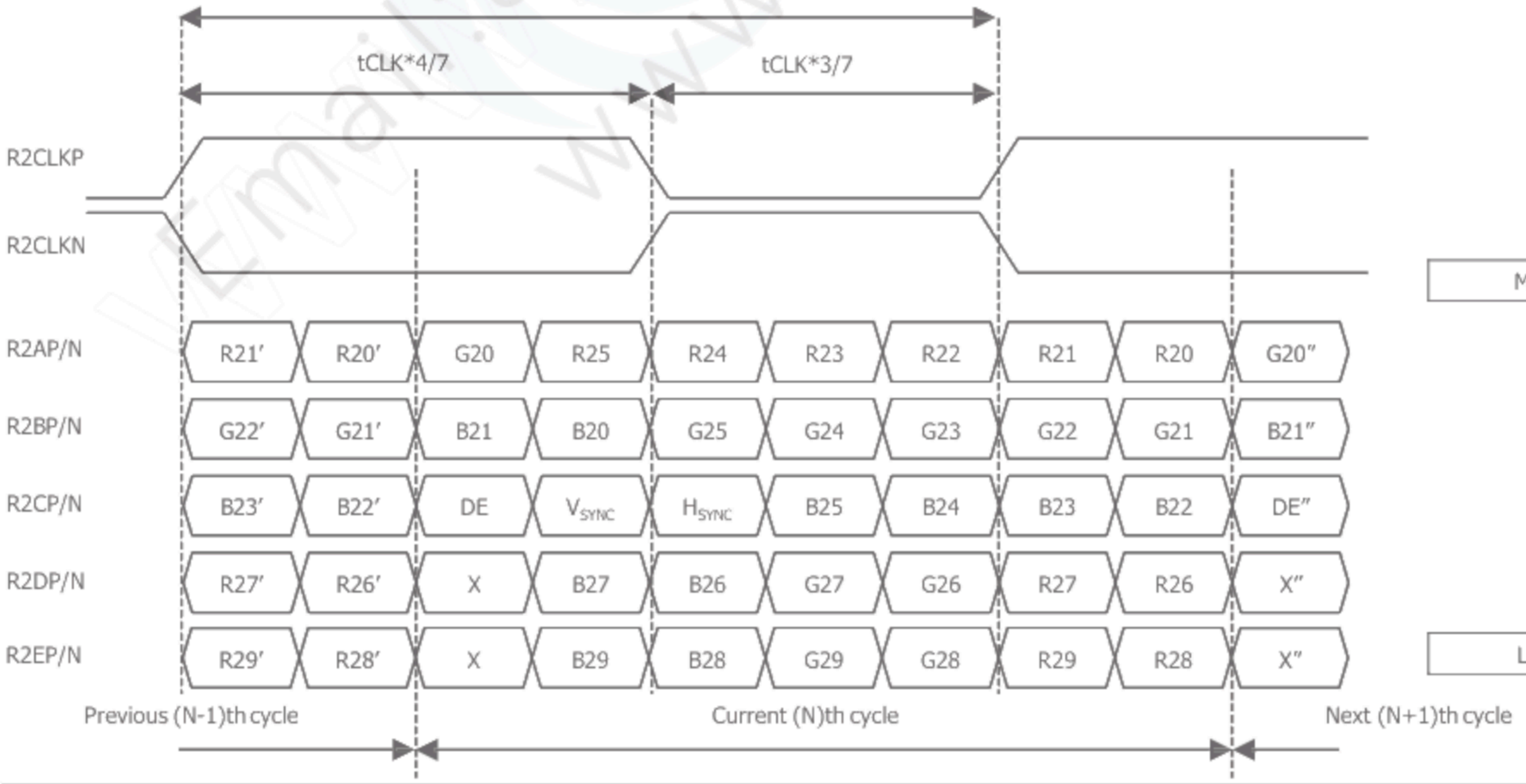
1) LVDS 4 Port (10Bit, VESA)

■ 1st LVDS Channel



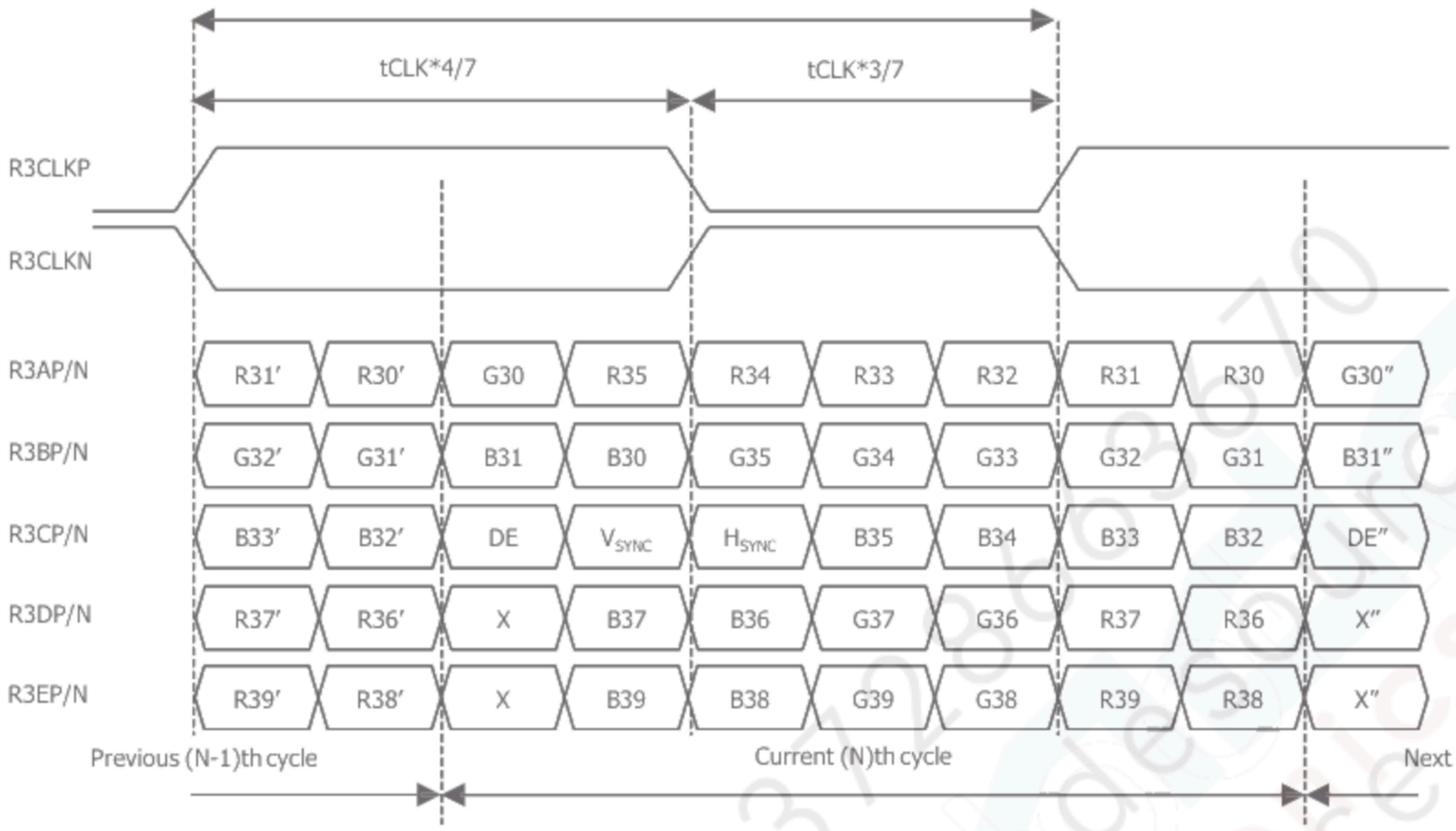
MSB	R19/G19/B19
	R18/G18/B18
	R17/G17/B17
	R16/G16/B16
	R15/G15/B15
	R14/G14/B14
	R13/G13/B13
	R12/G12/B12
	R11/G11/B11
LSB	R10/G10/B10

■ 2nd LVDS Channel



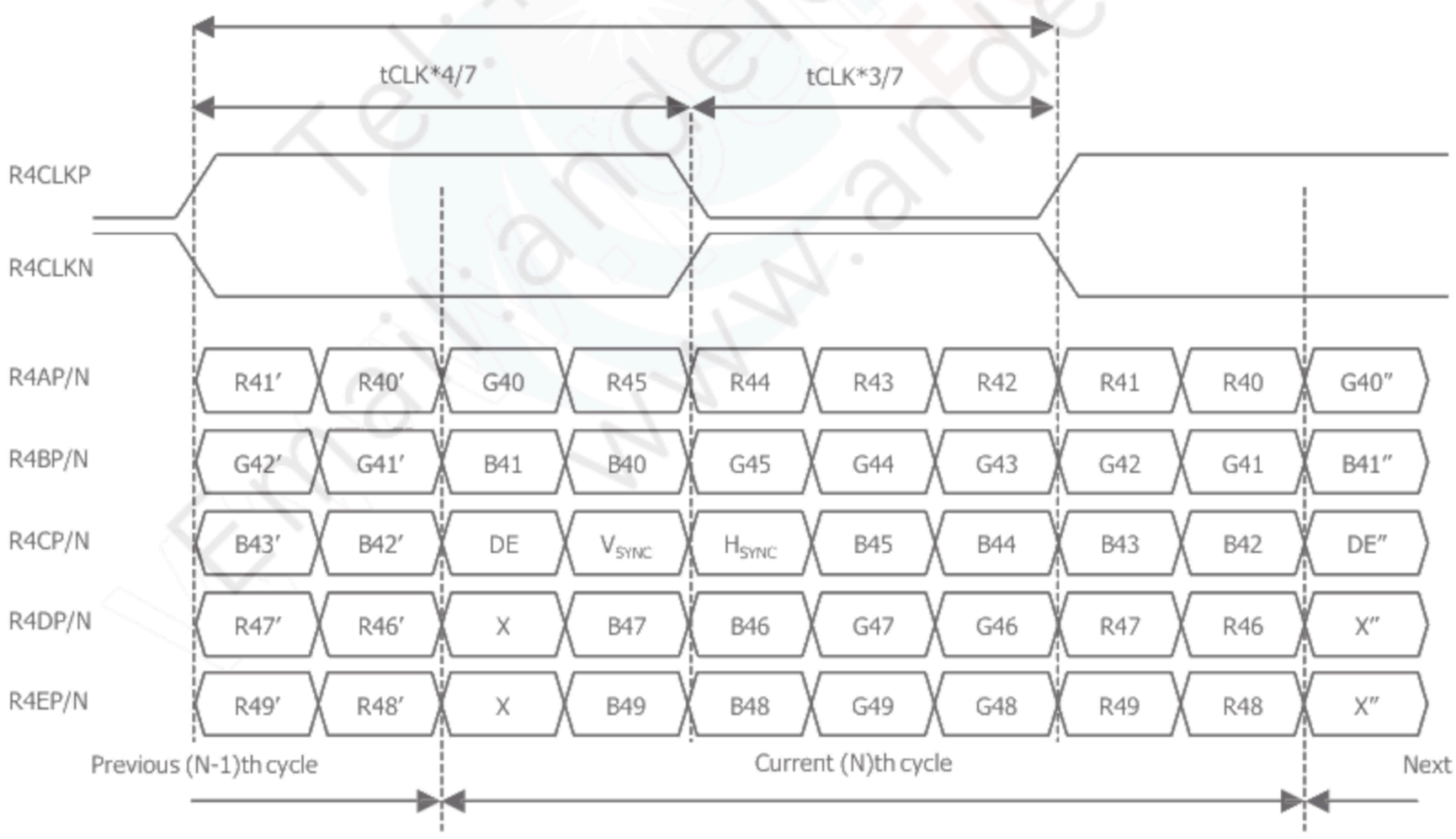
MSB	R29/G29/B29
	R28/G28/B28
	R27/G27/B27
	R26/G26/B26
	R25/G25/B25
	R24/G24/B24
	R23/G23/B23
	R22/G22/B22
	R21/G21/B21
LSB	R20/G20/B20

■ 3rd LVDS Channel



MSB	R39/G39/B39
	R38/G38/B38
	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

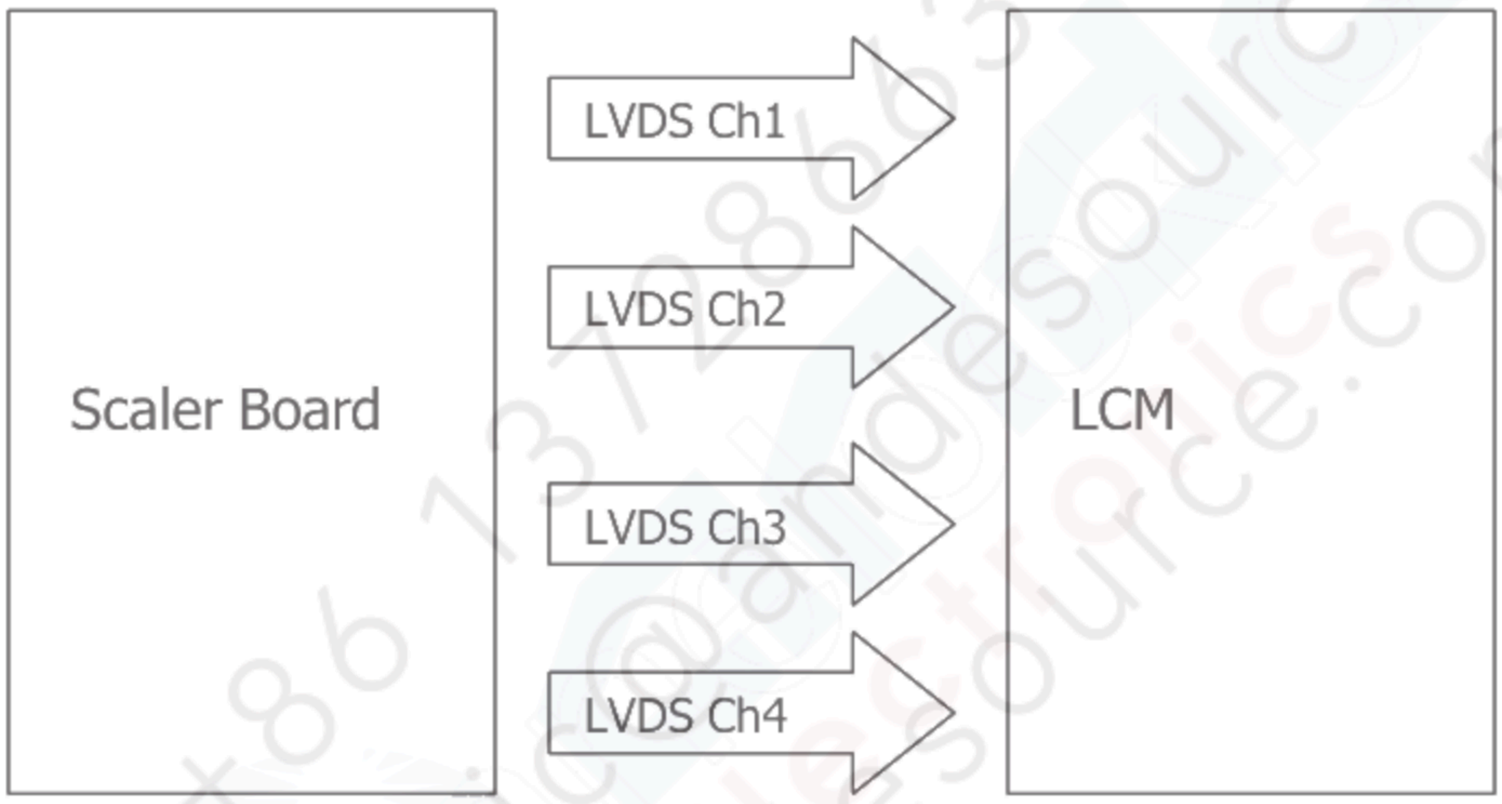
■ 4th LVDS Channel



MSB	R49/G49/B49
	R48/G48/B48
	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

4. LVDS description of Dara Re-Arrange

1 2 3 4 5 6 7 8 ...	...761 762 763 764 765 766 767 768	769 770 771 772 773 ...	... 1529 1530 1531 1532 1533 1534 1535 1536



■ Normal (Single Screen, Pin # 7 of CN1 = Low)

LVDS Ch1 : 1 → 5 → ... 761 → 765 → 769 → 773 → ... 1529 → 1533

LVDS Ch2 : 2 → 6 → ... 762 → 766 → 770 → 774 → ... 1530 → 1534

LVDS Ch3 : 3 → 7 → ... 763 → 767 → 771 → 775 → ... 1531 → 1535

LVDS Ch4 : 4 → 8 → ... 764 → 768 → 772 → 776 → ... 1532 → 1536

■ DRA (Data Re-Arrange, Pin # 7 of CN1 = High)

LVDS Ch1 : 1 → 3 → 5 → 7 → ... 761 → 763 → 765 → 767

LVDS Ch2 : 2 → 4 → 6 → 8 → ... 762 → 764 → 766 → 768

LVDS Ch3 : 769 → 771 → 773 → 775 → ... 1529 → 1531 → 1533 → 1535

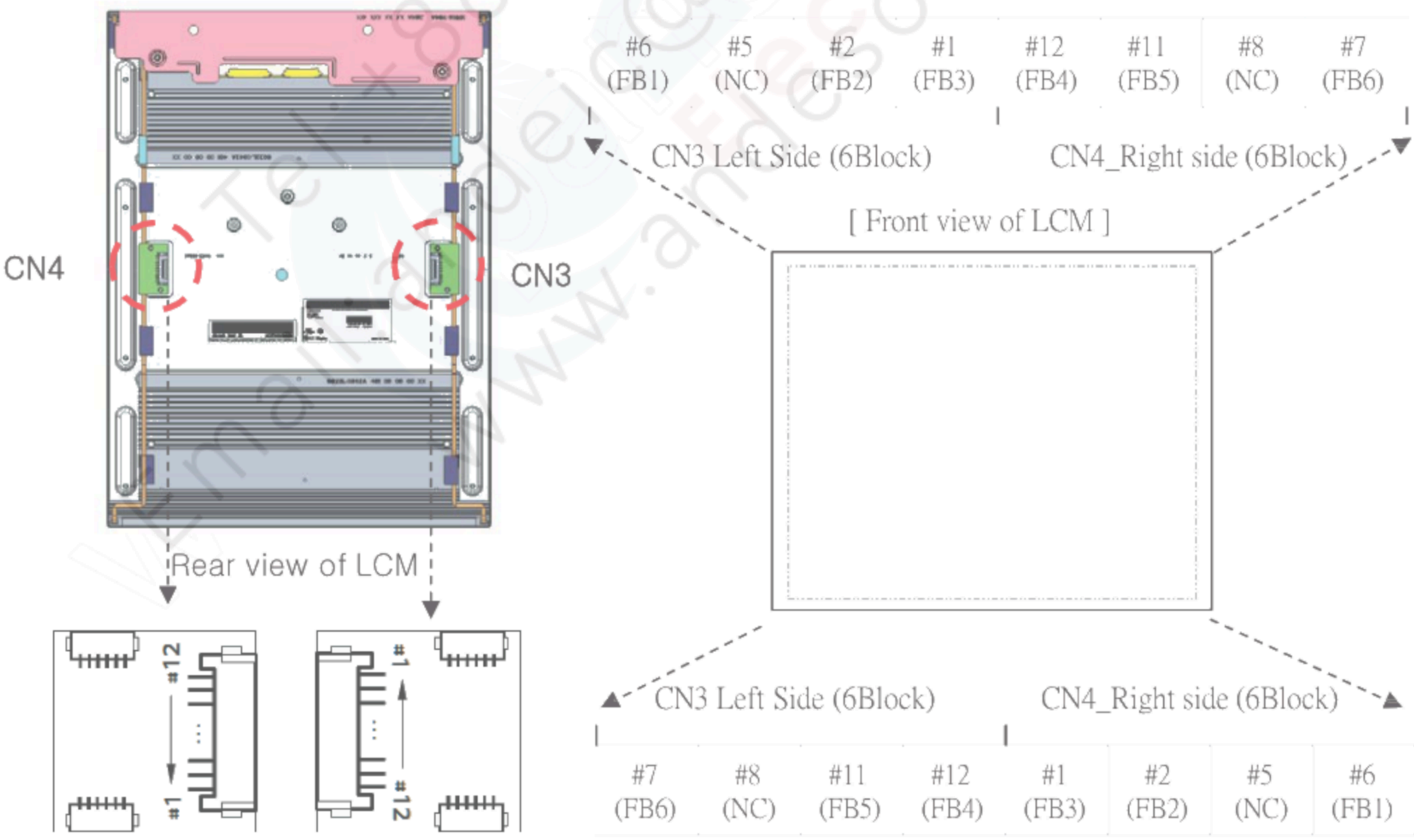
LVDS Ch4 : 770 → 772 → 774 → 776 → ... 1530 → 1532 → 1534 → 1536

3-2-3. Backlight connector pin configuration (CNT3, CNT4)

The LED wire cable connector is a model 20037WR-H12 Manufactured by Yeonho.
The mating connector is a SMH200-12.

Table 4. Backlight connector pin configuration

Pin	Symbol	Pin-description (CN3,4)	Remark
#1	FB3	Channel3 Current Feedback	CN3, CN4 in front view
#2	FB2	Channel2 Current Feedback	
#3	V LED	LED power supply (common anode)	
#4	V LED	LED power supply (common anode)	
#5	NC	NC	
#6	FB1	Channel1 Current Feedback	
#7	FB6	Channel6 Current Feedback	
#8	NC	NC	
#9	V LED	LED power supply (common anode)	
#10	V LED	LED power supply (common anode)	
#11	FB5	Channel5 Current Feedback	
#12	FB4	Channel6 Current Feedback	



[FIG. 5] Backlight connector view

3-3. Signal timing specifications

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

Table 5. Timing table

ITEM	Symbol		Min.	Typ.	Max.	Unit	Note
DCLK	Period	tCLK	17.586	17.938	18.304	ns	Pixel frequency :typ 223Mhz @60Hz
	Frequency	-	54.63	55.75	56.86	MHz	
Hsync	Period	tHP	440	448	456	tCLK	1,3,4
	Horizontal Valid	tHV	384	384	384	tCLK	
	Horizontal Blank	tHB	56	64	72		
	Frequency	fH	122.0	124.4	126.9	KHz	
	Width	tWH	8	8	8	tCLK	
	Horizontal Back Porch	tHBP	12	16	20		
	Horizontal Front Porch	tHFP	36	40	44		
Vsync	Period	tVP	2074	2074	2076	tHP	2,4
	Vertical Valid	tVV	2048	2048	2048	tHP	
	Vertical Blank	tVB	26	26	28	tHP	
	Frequency	fV	58.8	60	61.2	Hz	
	Width	tWV	4	4	4	tHP	
	Vertical Back Porch	tVBP	12	12	13		
	Vertical Front Porch	tVFP	10	10	11		

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.

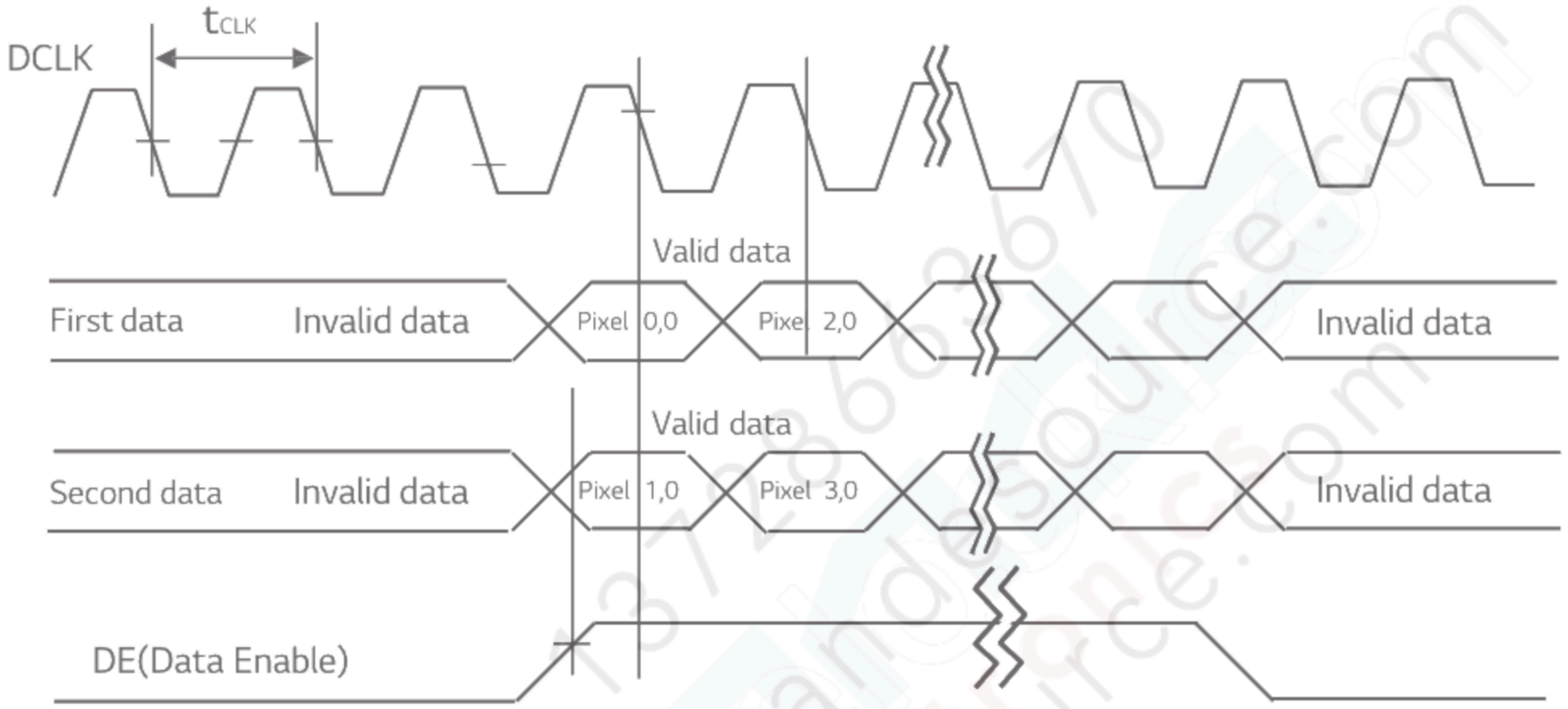
2.The performance of the electro-optical characteristics may be influenced by variance of the vertical refresh rates.

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.

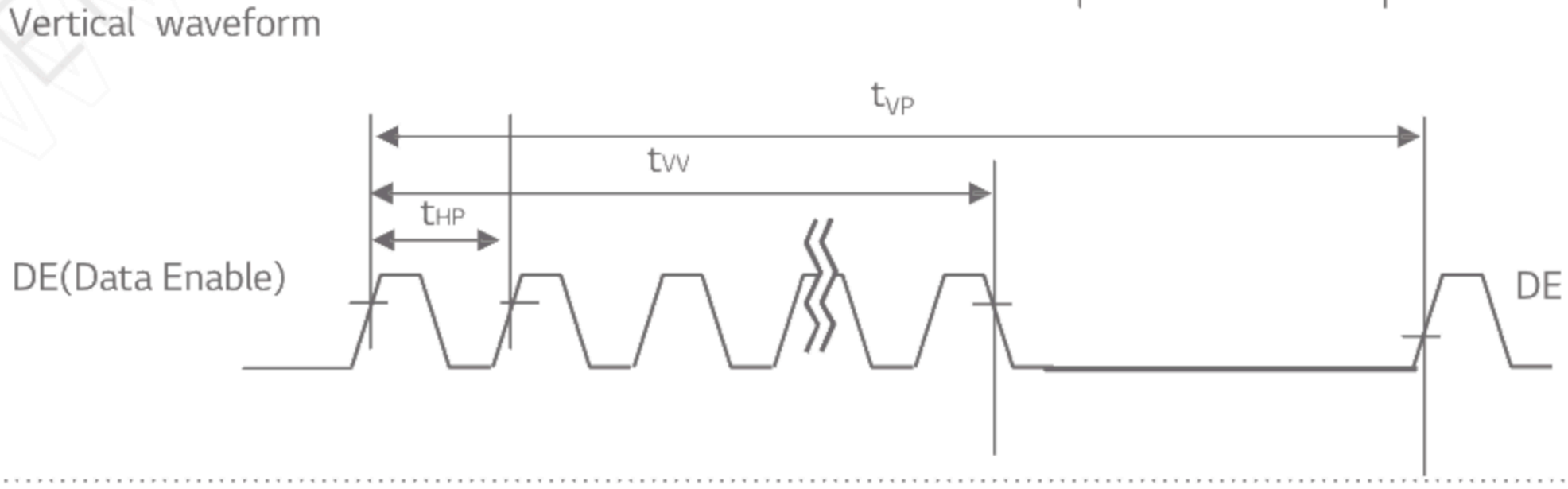
3-4. Signal timing waveforms

1. DCLK , DE, DATA waveforms



2. Horizontal waveform

3. Vertical waveform



3-5. Color input data reference

The brightness of each primary color(red, green, blue) is based on the 10-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 inp ut.

Table 6. Color data reference

Color		Input Color Data		
		RED MSB LSB	GREEN MSB LSB	BLUE MSB LSB
		R9 R8 R7 R6 R5 R4 R3 R2 R1 R0	G9 G8 G7 G6 G5 G4 G3 G2 G1 G0	B9 B8 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 0 0 0 0 0 0
	Red (1023)	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	Green (1023)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0
	Blue (1023)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1
	Cyan	0 0 0 0 0 0 0 0 0 0	1 1 1 1 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 1 1	0 0 0 0 0 0 0 0 0 0	1 1 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 1 1 1 1	0 0 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 1 1 1 1 1 1
RED	RED (000)	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 0 0 0 0 0
	RED (001)	0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	…	…	…	…
	RED (1022)	1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
	RED (1023)	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0
GREEN	GREEN (000)	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 0 0 0 0 0
	GREEN (001)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 1	0 0 0 0 0 0 0 0 0 0
	…	…	…	…
	GREEN (1022)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 0	0 0 0 0 0 0 0 0 0 0
	GREEN (1023)	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1	0 0 0 0 0 0 0 0 0 0
BLUE	BLUE (000)	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 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 0 0 0 0 0 0 1
	…	…	…	…
	BLUE (1022)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 0
	BLUE (1023)	0 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0	1 1 1 1 1 1 1 1 1 1

3-6. Power sequence

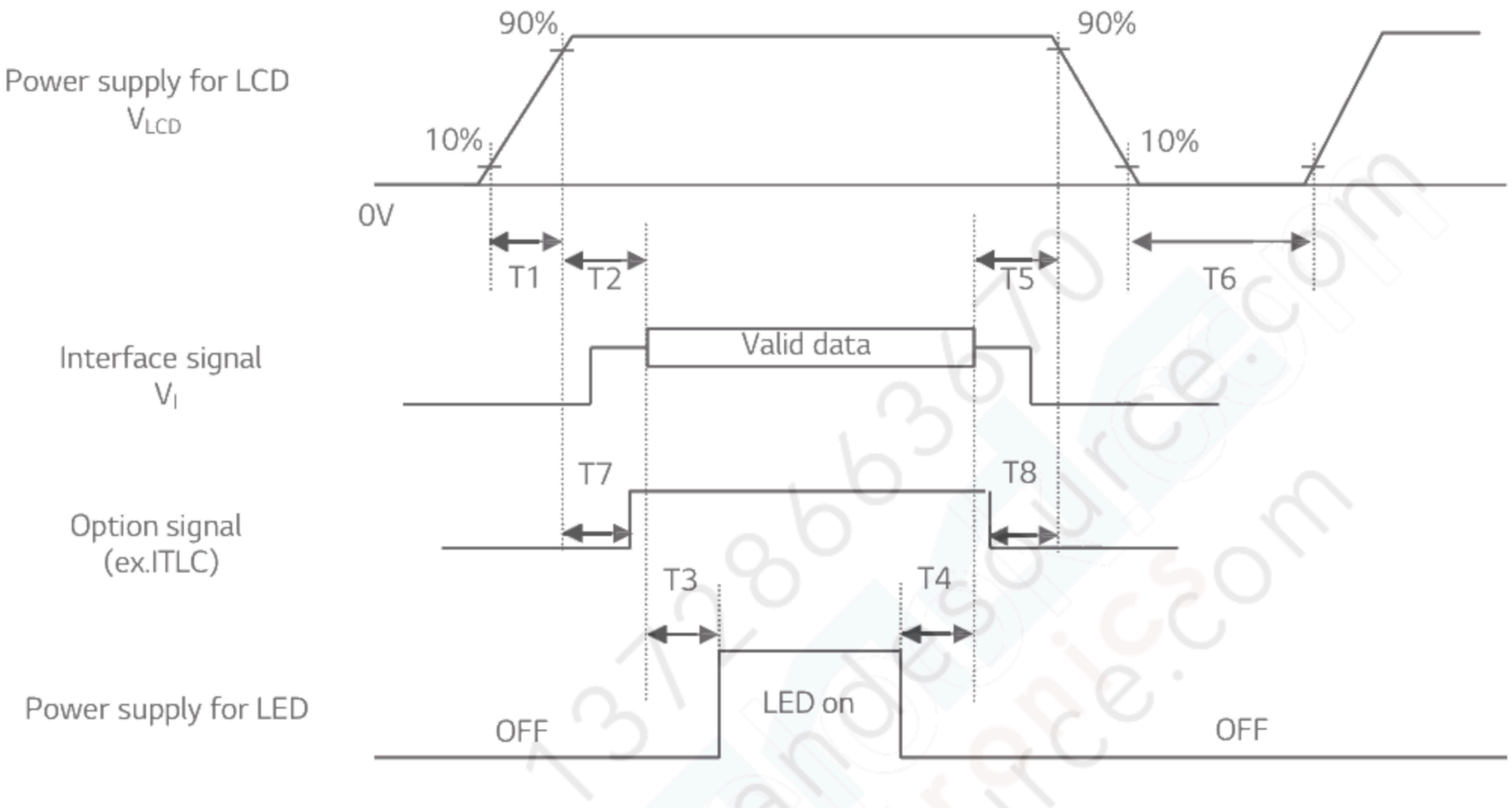


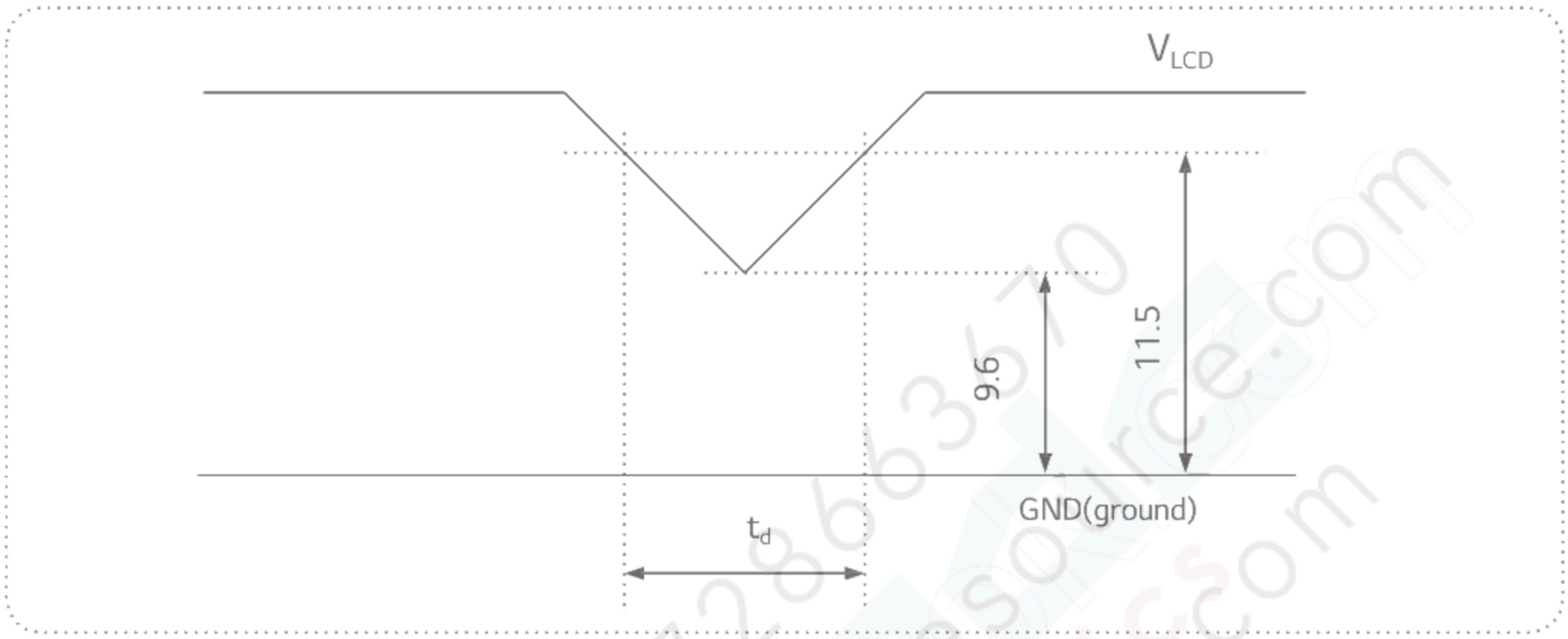
Table 8-1. Power sequence

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 :

1. 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.
2. Please avoid floating state of interface signal during signal invalid period.
3. When the interface signal is invalid, be sure to pull down the $V_{LCD.}$(0V).
4. Please turn off the power supply for LED when the level of V_{LCD} changes to prevent noise issue.
5. When measuring valid data starting point, it can be measured that LVDS signal starts swing.

3-7. V_{LCD} Power dip condition



[FIG. 6] 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.

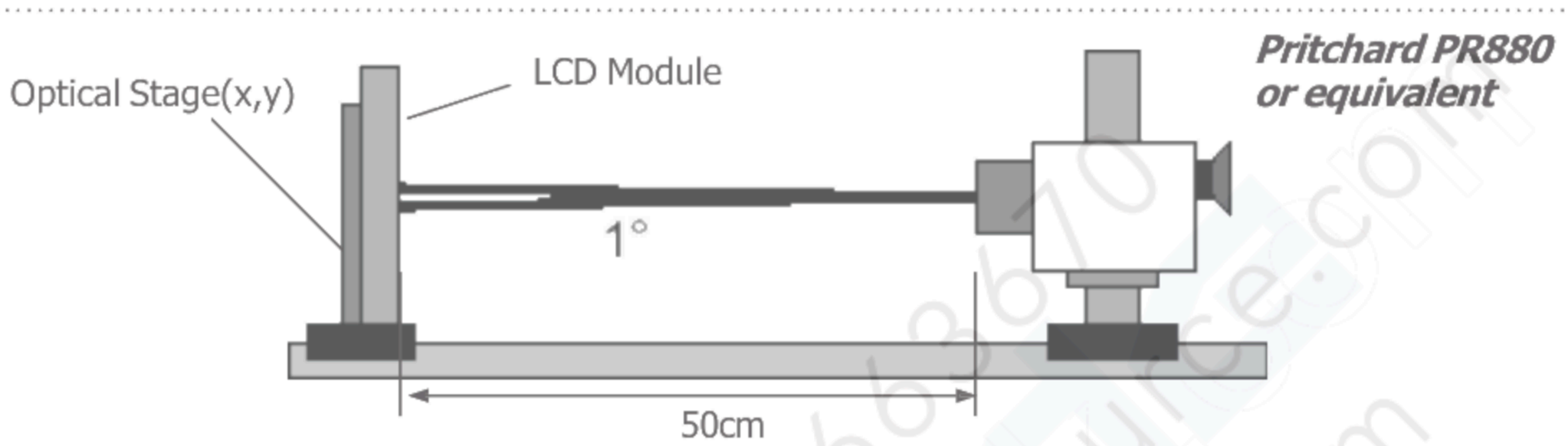
1) Dip condition

$9.6V \leq V_{LCD} < 11.4V$, $t_d \leq 20ms$

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. 7 presents additional information concerning the measurement equipment and method.



[FIG.7] Optical Characteristic Measurement Equipment And Method

Table 8. OPTICAL CHARACTERISTICS (Ta=25°C, V_{LCD}=12.0V, f_V=60Hz, Dclk=223MHz, I_{BL}=(50)mA)

Parameter		Symbol	Values			Units	Notes
			Min.	Typ.	Max.		
Contrast Ratio		CR	(1200)	(1800)	-		1
Surface luminance, white		L_{WH}	(880)	(1100)	-	cd/m²	2
Luminance variation		δ_{WHITE}	75	-	-	%	3
Response time	On/Off	TR+TD	-	(25)	(30)	ms	4
Color gamut (CIE1931)		NTSC	-	(72)	-	%	
Color coordinates [CIE1931] *(By PR650)*	Red	Rx	Typ. -0.03	(0.655)	Typ . +0.03		
		Ry		(0.336)			
	Green	Gx		(0.315)			
		Gy		(0.617)			
	Blue	Bx		(0.147)			
		By		(0.052)			
	White	Wx		(0.299)			
		Wy		(0.325)			
Color temperature		-	-	(7300)	-	K	
Viewing angle (CR>10, General)	Horizontal	θ_H	170	178	-	Degree	5
	Vertical	θ_V	170	178	-		
Gray Scale		-		2.2			6

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)

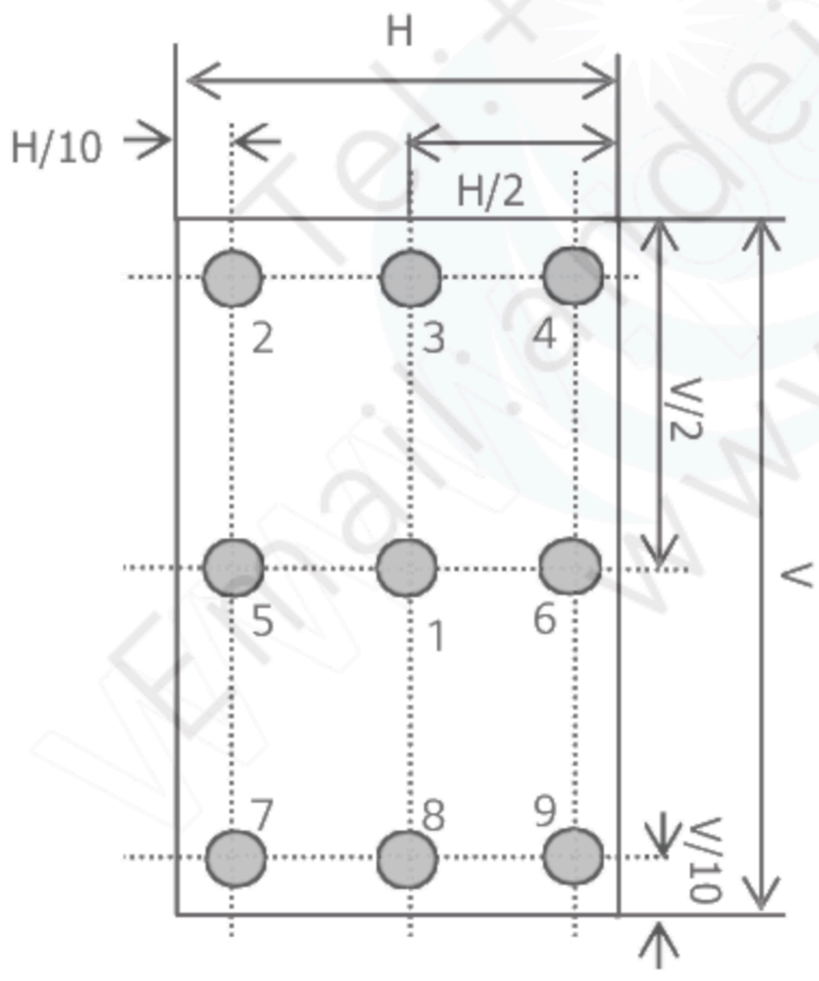
2. Surface luminance(L_{WH})is luminance value at Center 1 point(P1) across the LCD surface 50cm from the surface with all pixels displaying white. For more information see FIG.7 ***(By PR880)***

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

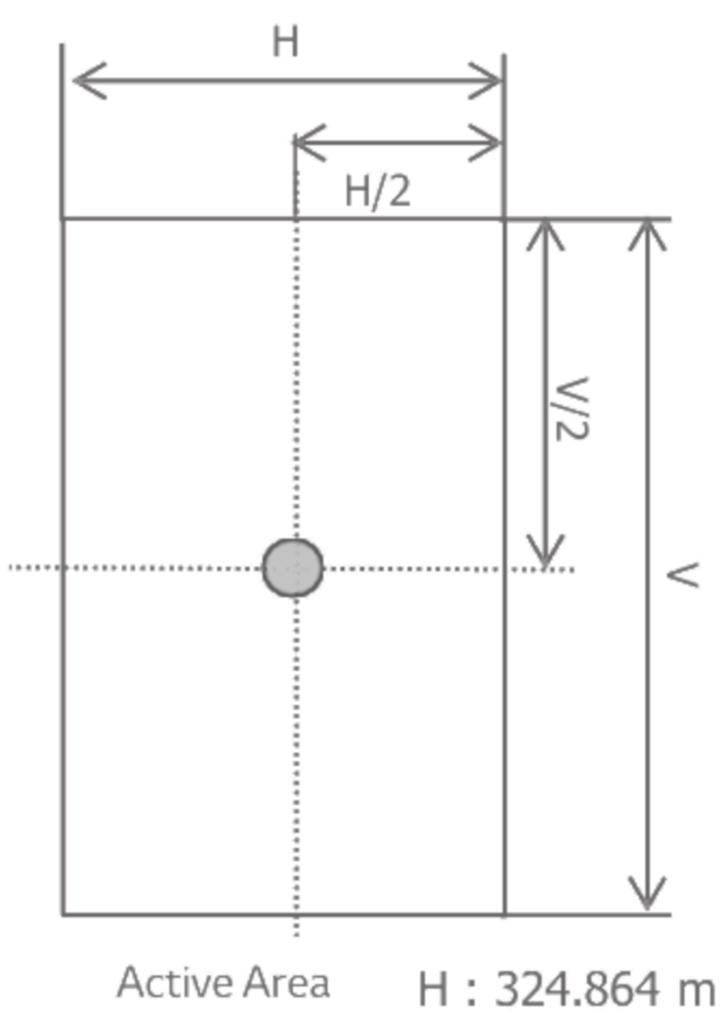
$$\delta_{WHITE} = \frac{\text{Minimum}(L_{P1}, L_{P2}, \ldots\ldots, L_{P9})}{\text{Maximum}(L_{P1}, L_{P2}, \ldots\ldots, L_{P9})} \times 100(\%)$$

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

<Measuring point for luminance variation>



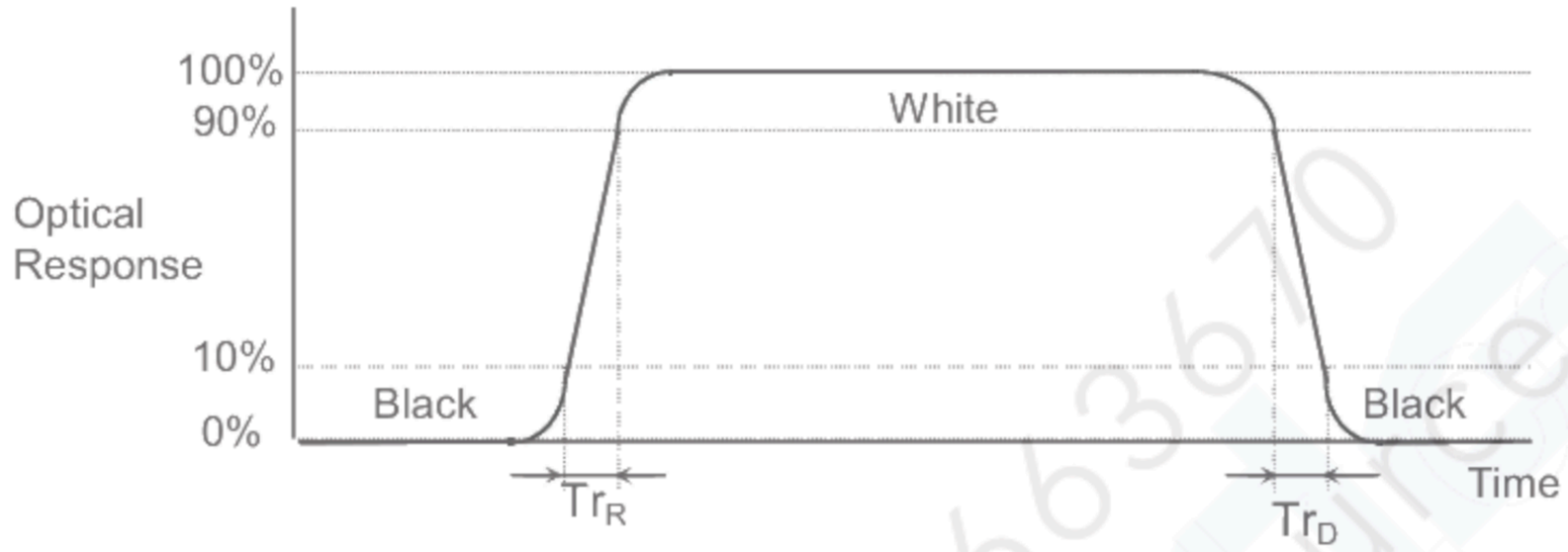
<Measuring point for surface luminance>



H : 324.864 mm
V : 433.152 mm
@ H,V : Active Area

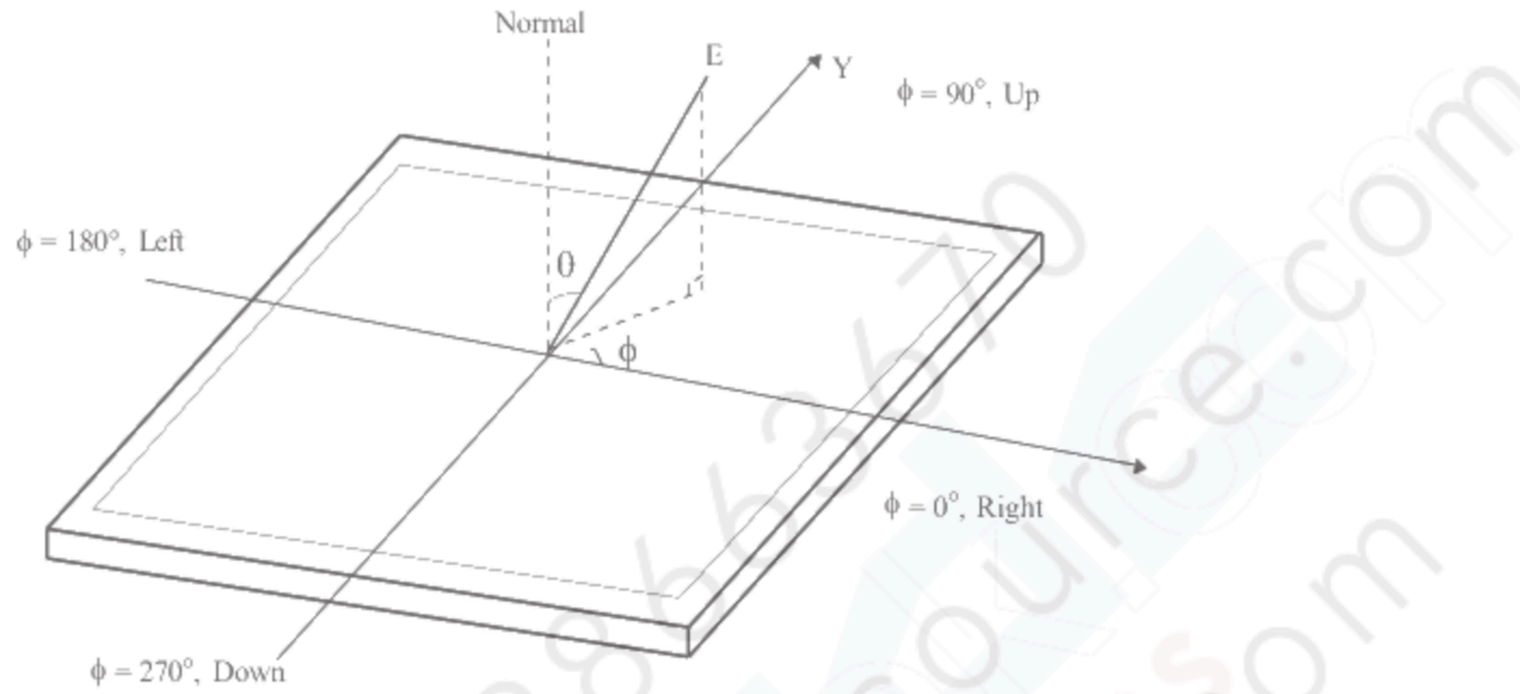
[FIG.8] Measure point for luminance

4. Response time is obtained by measuring the transition time of photo detector output, when input si gnals are applied to make center point “black” and “white”. For more information, see the FIG. 9.



[FIG. 9] Response Time

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



[FIG. 10] Viewing angle

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

Table 10. Gray Scale Specification

Gray Level	**Relative Luminance [%]** (Typ)
0	0.10
63	0.30
127	1.08
191	2.50
255	4.71
319	7.70
383	11.52
447	16.18
511	21.72
575	28.15
639	35.51
703	43.81
767	53.07
831	63.30
895	74.52
959	86.75
1023	100

5. Mechanical Characteristics

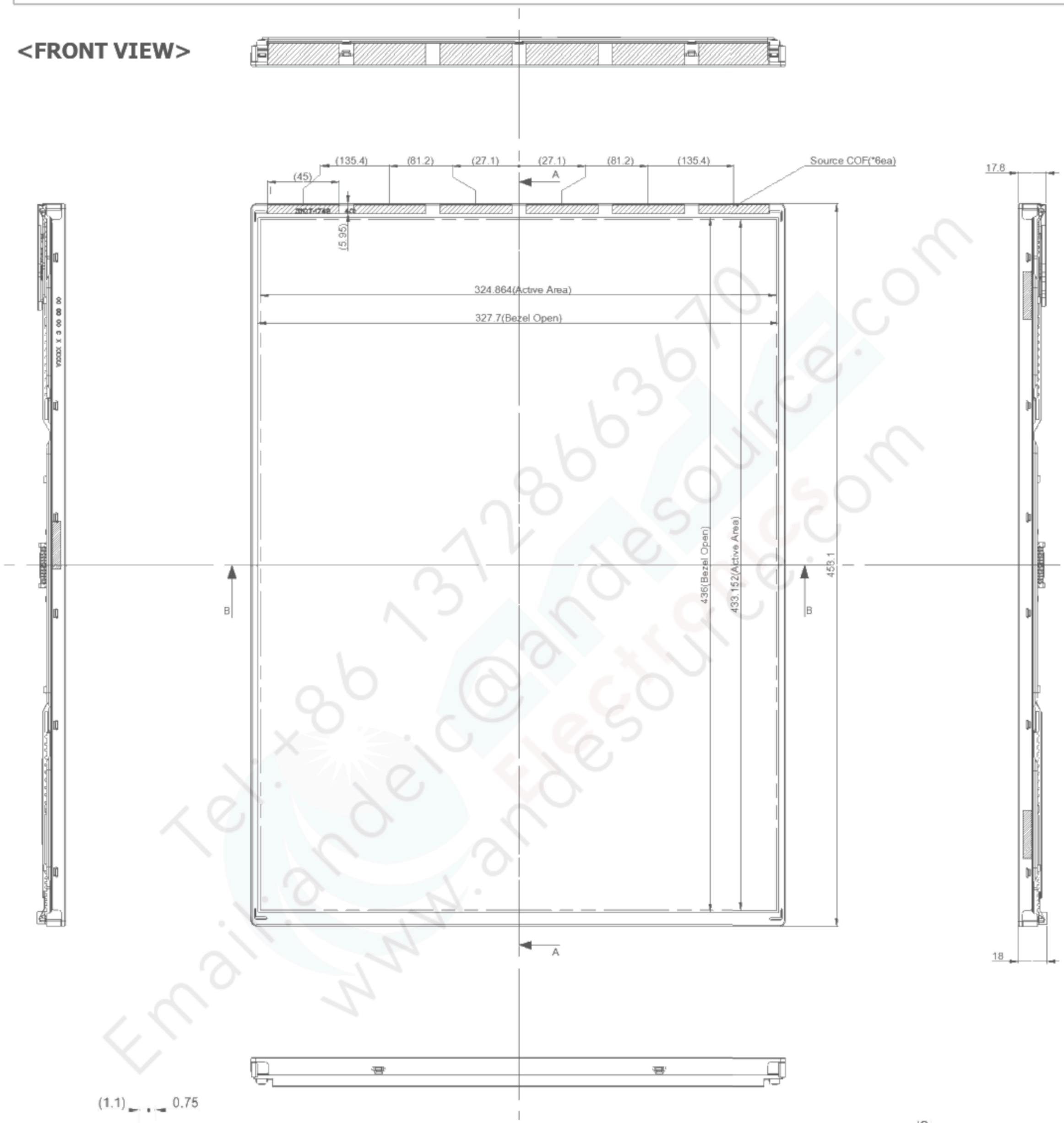
The contents provide general mechanical characteristics. In addition the figures in the next page are detailed mechanical drawing of the LCD.

Outline Dimension	Horizontal	336.0 mm
	Vertical	453.1mm
	Depth	18.0mm
Bezel Area	Horizontal	(up) 9.97, (down) 9.97
	Vertical	(left) 5.57 (right) 5.57
Active Display Area	Horizontal	324.864mm
	Vertical	433.152mm
Weight	(2,700)g (Typ.), (2,840)g (Max.)	
Surface Treatment	Anti-Glare treatment of the front polarizer(3H)	

Notes : Please refer to a mechanic drawing in terms of tolerance at the next page.
Outline dimensions (horizontal, vertical and outside depth) are measured by using vernier calipers.

Product Specification

<FRONT VIEW>

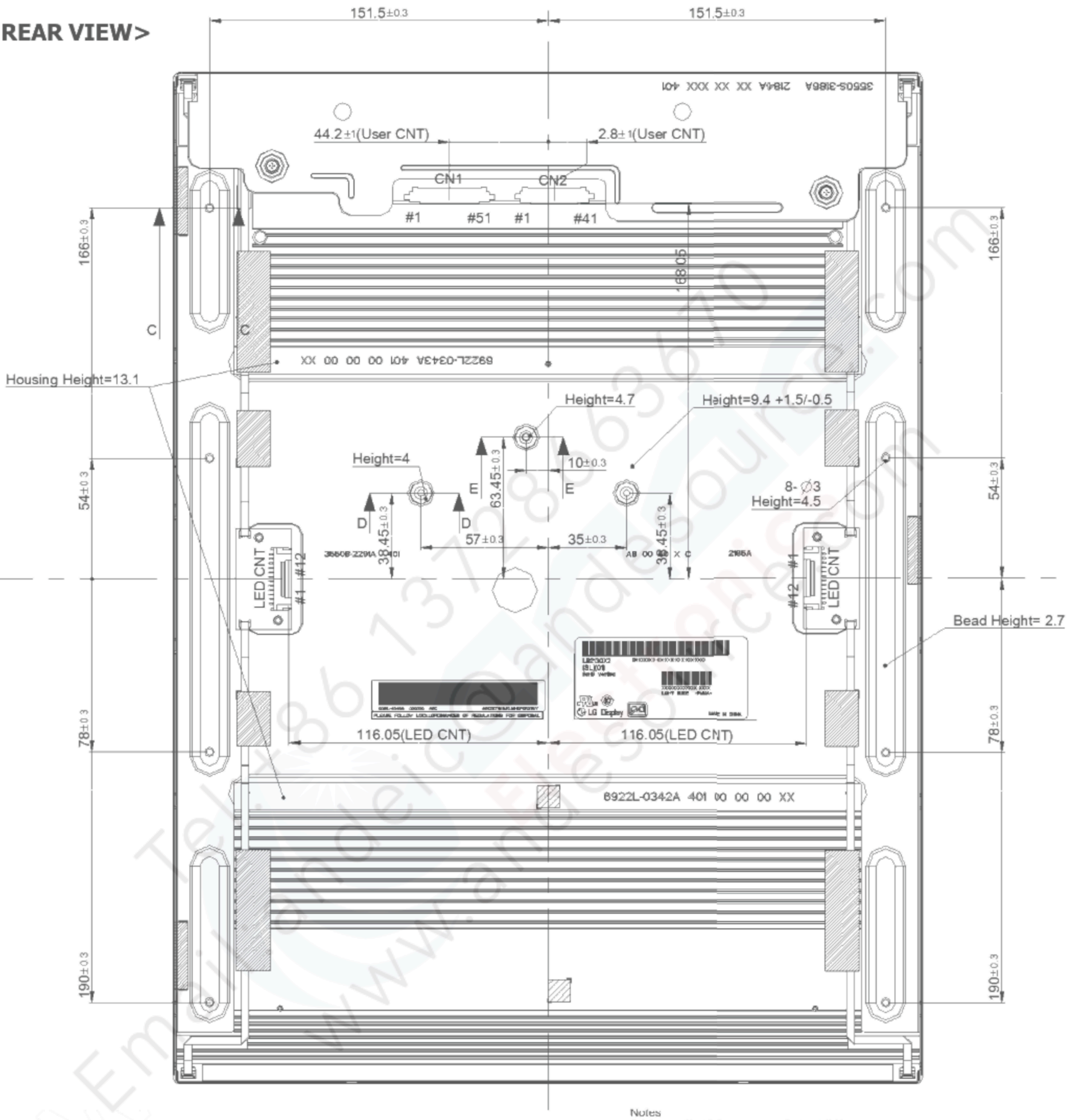


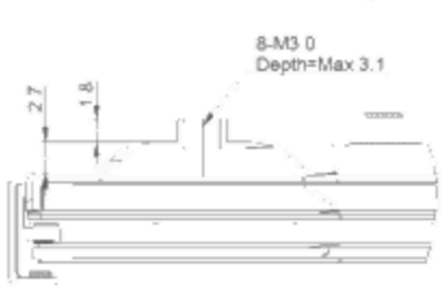
SECTION A-A
SCALE 2/1

SECTION B-B
SCALE 2/1

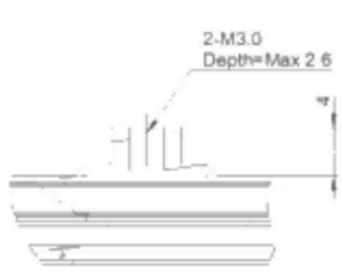
Product Specification

<REAR VIEW>

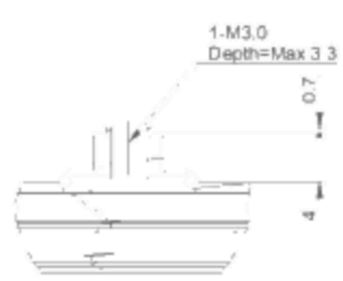




SECTION C-C
SCALE 2/1
(8ea)



SECTION D-D
SCALE 2/1
(2ea)



SECTION E-E
SCALE 2/1

Notes

1. Unspecified tolerances are to be ± 0.5mm.
2. 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

3. Torque SPEC of Mounting : 3.0 ~4.0kgf.cm, M3.0 Machine Screw
4. I/F Connector Specification : IS050-C41B-C39-C(UJU) or FI-RXE41S-HF(JAE) or Compatible.
5. LED Connector Specification : 05010HR-H06C3(YEONHO) or Compatible.
6. The LCM warp(warpage) is less than 1.0mm on the surface plate.
7. The COF area is weak and sensitive, so please don't press the COF area.
8. Unspecified height should follow 3D modeling data.

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	Vibration test (non-operating)	Wave form : random Vibration level : 1.0G RMS Bandwidth : 10-300Hz Duration : X,Y,Z, 10 min One time each direction
7	Shock test (non-operating)	Shock level : 100Grms Waveform : half sine wave, 2ms Direction : ±X, ±Y, ±Z One time each direction
8	Altitude Operating Storage / Shipment	 0 – 10,000 feet (3,048m) 0 - 40,000 feet (12,192m)
9	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.

※. T_a= Ambient Temperature

7. International Standards

7-1. 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). Informa
tion 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)
E : Month

D : Year
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

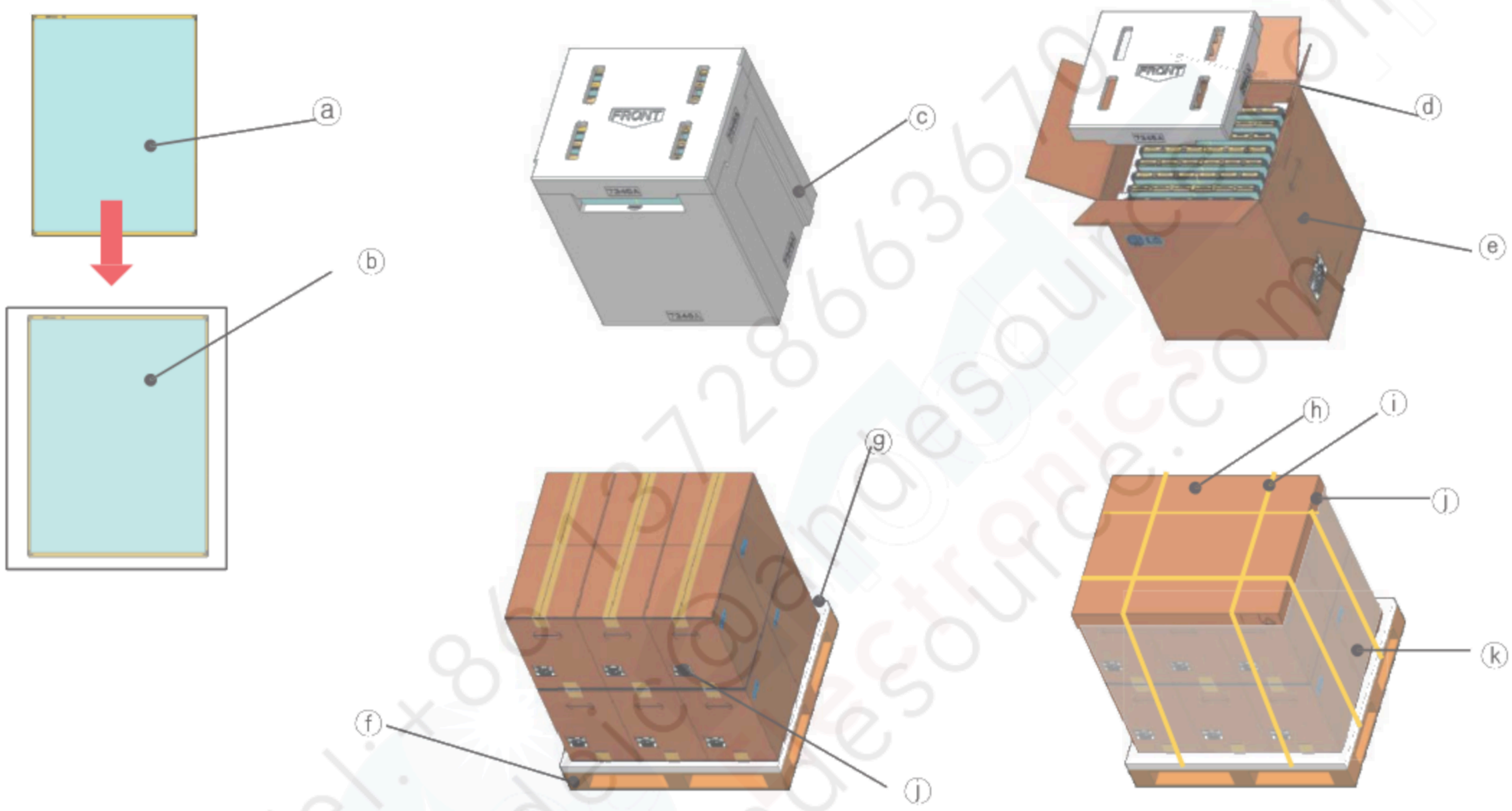
b) Location of lot mark

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 : 8ea P
ackage quantity in one Pallet : 96ea
b) Box Size : 418mm X 365mm X 516mm
C) Pallet Ass'y Size: 1140mm X 870mm X 1170mn

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



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

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 mat erials like chamois soaks with petroleum benzene. Normal-hexane is recommended for cleanin g the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcoho l 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) System frame should not have an interference with panel which can cause LC Leakage/Panel Cr ack due to the contraction of system frame at low temperature condition or panel damage by a ny other circumstances.

9-2. Operating Precautions

1) Response time depends on the temperature.(In lower temperature, it becomes longer.)
2) 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.
3) Be careful for condensation at sudden temperature change. Condensation makes damage to p olarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
4) When fixed patterns are displayed for a long time, remnant image is likely to occur.
5) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference s hall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.
6) Please do not give any mechanical and/or acoustical impact to LCM. Otherwise, LCM can't be operated its full characteristics perfectly.
7) 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)
8) Please do not set LCD on its edge.
9) When LCMs are used for public display, defects such as Yogore & image sticking can not be guaranteed.
10) LCMs cannot support "Interlaced Scan Method"
11) When this forward model is used as a reverse-type model (PCB on bottom side) at storage and operation, LGD can not guarantee any defects of LCM.
12) Please conduct image sticking test after 2-hour aging with Rolling Pattern at normal temperature.(25~40℃)

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 and hazardous materials 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.

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.