



LM290WW2
Liquid Crystal Display

Product Specification

SPECIFICATION FOR APPROVAL

(●) Preliminary Specification
() Final Specification

Title	29" Wide Full HD TFT LCD
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BUYER		SUPPLIER	LG Display Co., Ltd.
MODEL		*MODEL	LM290WW2
		SUFFIX	SSC1

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

<p>APPROVED BY</p> <p>_____ / _____</p> <p>SIGNATURE</p> <p>_____</p> <p>DATE</p> <p>_____</p>	<p>APPROVED BY</p> <p>W.K. Kweon / G. Manager</p> <p>_____</p> <p>REVIEWED BY</p> <p>J. W. Lee / Manager [C]</p> <p>_____</p> <p>Y. H. Hwang / Manager [M]</p> <p>_____</p> <p>J. C. Lim / Manager [P]</p> <p>_____</p> <p>PREPARED BY</p> <p>B. S. Kang / Engineer</p> <p>_____</p>
<p>Please return 1 copy for your confirmation with your signature and comments.</p>	<p>IT/Mobile Development Division 1 LG Display Co., Ltd</p>

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RECORD OF REVISIONS

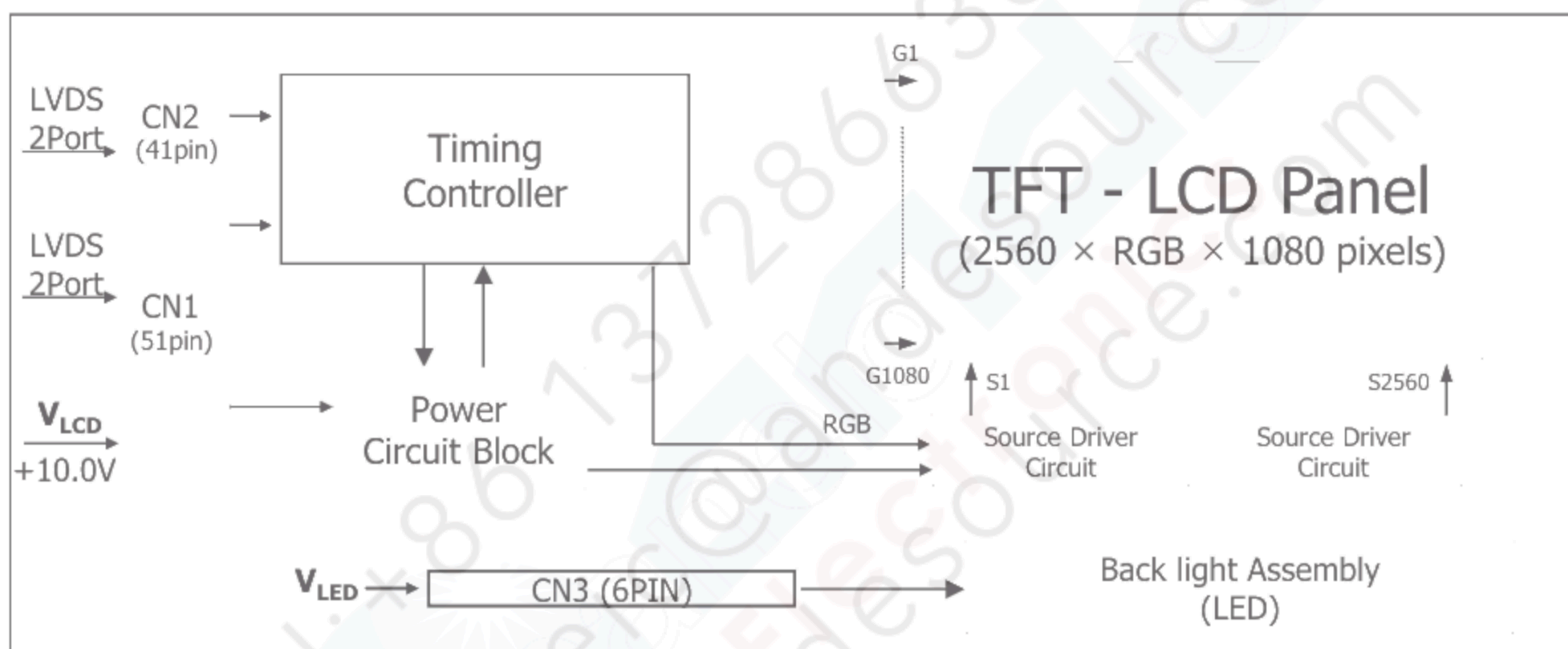
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Product Specification

1. General Description

LM290WW2-SSC1 is a Color Active Matrix Liquid Crystal Display Light Emitting Diode (White LED) backlight system 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 29-inch diagonally measured active display area with Wide Full HD resolution (1080 vertical by 2560 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.



[FIG. 1] Block diagram

General Features

Active Screen Size	29.0 inches(73.03cm) (Aspect ratio 21:9)
Outline Dimension	693.6(H) x 308.9(V) x 17.0(D, Top :11.0) mm (Typ.)
Pixel Pitch	0.0876(H) x 0.2628(V) mm
Pixel Format	2560(H) x 1080(V) Pixels. Pixels RGB stripes arrangement
Color Depth	16.7 Million, 6 Bit + A-FRC
Luminance, White	250 cd/m ² (Center 1 Point, Typ.)
Viewing Angle(CR>10)	View Angle Free (R/L 178(Typ.), U/D 178(Typ.))
Power Consumption	Total 16.8W(Typ.) (5.3W @ V _{LCD} 11.5W @ Is=60mA)
Weight	Typ : 3,110g
Display Operating Mode	Transmissive mode, normally black
Panel type	Reverse type
Surface Treatment	Anti-glare treatment of the front polarizer (Haze 25%, 3H)

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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 1. Absolute maximum ratings

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Power Supply Input Voltage	V_{LCD}	-0.3	+13.0	Vdc	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

Note : 1. Temperature and relative humidity range are shown in the figure below.

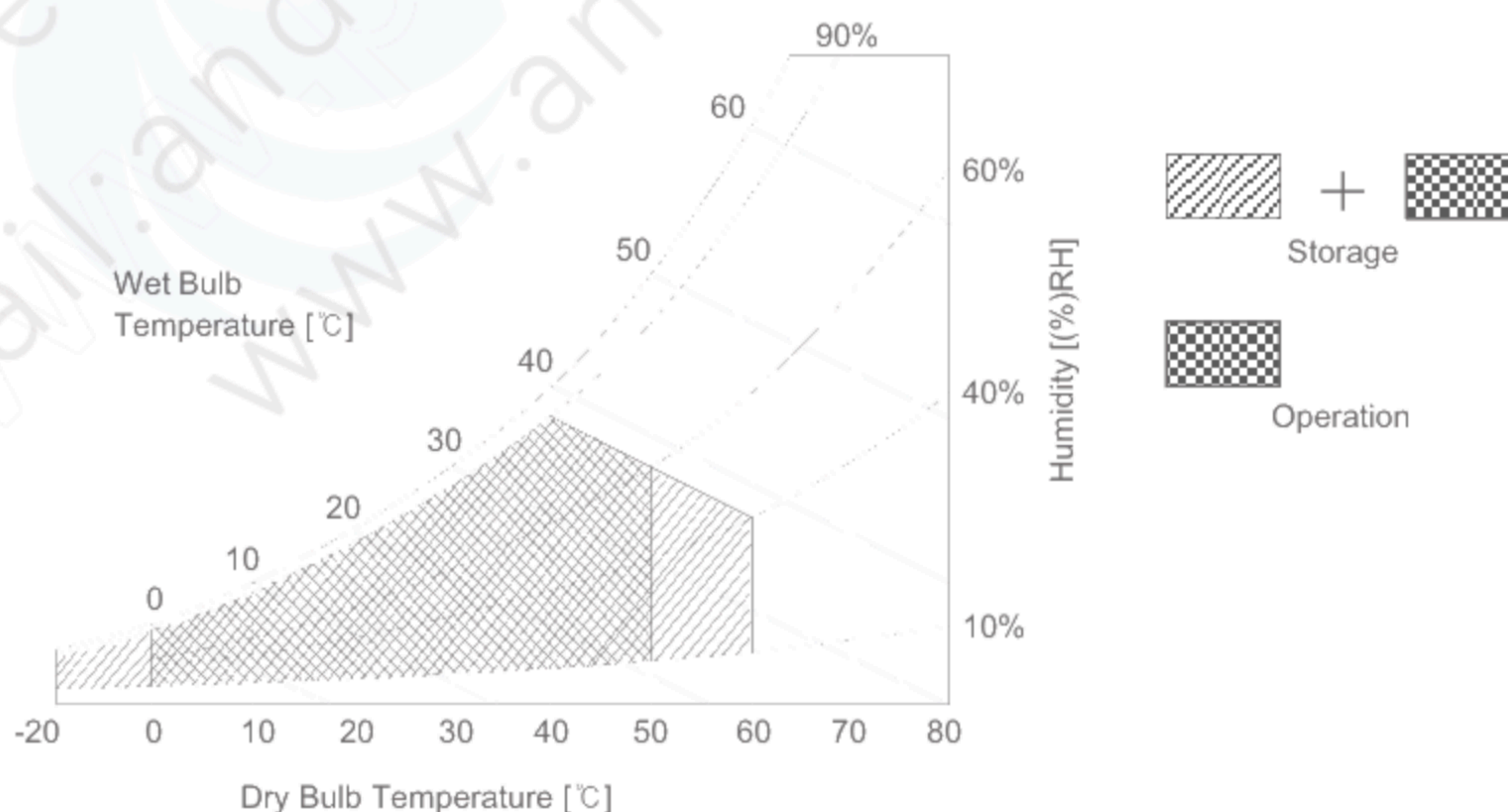
Wet bulb temperature should be 39 °C Max, and no condensation of water.

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 Min. 0 °C and Max. 65 °C under the VLCD=12.0V, fV=60Hz, 25 °C ambient Temp. no humidity control and LED string current is typical value.

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 other 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}	9.5	10.0	10.5	V	
Permissive Power Input Ripple	V _{ripple}	-	-	400	mVp-p	1
Power Supply Input Current	I _{LCD} TYP	-	0.530	0.660	A	2
	I _{LCD} MAX	-	0.710	0.880	A	3
Power Consumption	P _c TYP	-	5.3	6.6	Watt	2
	P _c MAX	-	7.1	8.8	Watt	3
Rush current	IRUSH	-	-	3	A	4

Note :

1. Permissive power ripple should be measured under $V_{LCD}=10.0V$, $25^{\circ}C$, $f_V(\text{frame frequency})=60Hz$ 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 $V_{LCD}=10.0V$, $25^{\circ}C$, $f_V=60Hz$ condition whereas mosaic pattern(8 x 6) is displayed and f_V is the frame frequency.
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 0.5ms (min.).
5. V_{LCD} level must be measured at two points on LCM PCB - between V_{LCD} (test point) and LCM Ground.
The measured results need to meet the Power supply input voltage specification.
(Test condition : maximum power pattern , $25^{\circ}C$, $f_V=60Hz$)

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- **Permissive Power input ripple** ($V_{LCD} = 10.0V$, $25^{\circ}C$, fV (frame frequency)=60Hz condition)

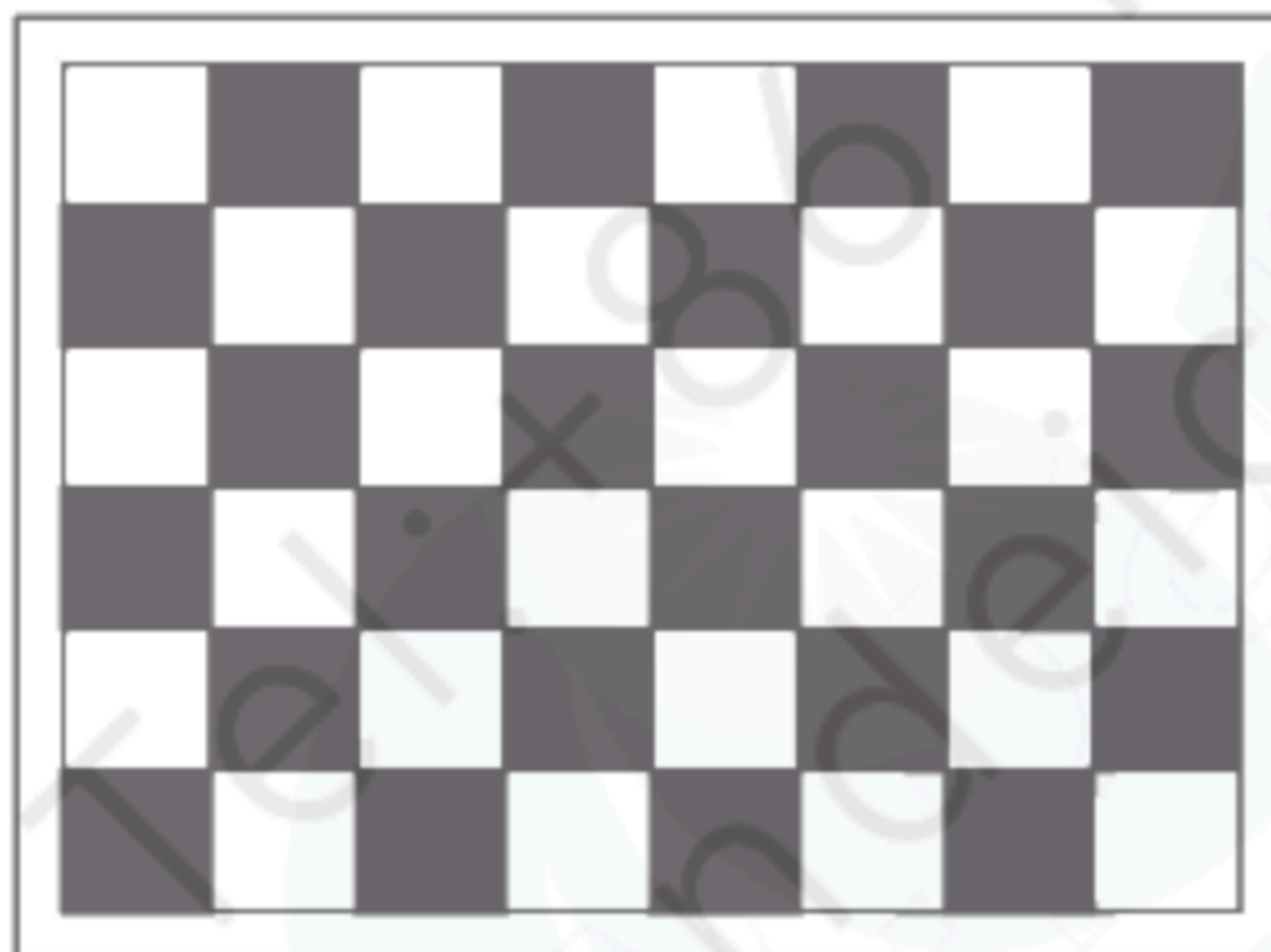


White pattern



Black pattern

- **Power consumption** ($V_{LCD} = 10V$, $25^{\circ}C$, fV (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. Electrical Characteristics (Backlight System)

Parameter	Symbol	Values			Unit	Notes
		Min.	Typ.	Max.		
LED String Current	Is	-	60	65	mA	1, 2, 5
LED String Voltage	Vs	44.3	47.9	51.5	V	1, 5
Power Consumption	PBar	-	11.5	12.4	Watt	1, 2, 4
LED Life Time	LED_LT	30,000	-	-	Hrs	3

Notes) The LED Bar consists of 72 LED packages, 4 strings (parallel) x 18 packages (serial) x 1 bar

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. The 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 $T_a = 25 \pm 2^\circ\text{C}$ 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 $P_{\text{Bar}} = V_s(\text{Typ.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.
 The maximum power consumption is calculated as $P_{\text{Bar}} = V_s(\text{Max.}) \times I_s(\text{Typ.}) \times \text{No. of strings}$.
5. LED operating conditions are must not exceed Max. ratings.

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3-2. Interface Connections

This LCD module employs two kinds of interface connection, 51 pin connector and 41 pin connector are used for the module electronics.

3-2-1. LCD Module

Table 3-1. Module Connector (CN1) Pin Configuration

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

No	Symbol	Description	No	Symbol	Description
1	GND	Ground	27	Reserved	No connection or GND
2	NC	No Connection	28	R2AN	2nd LVDS Channel Signal (A-)
3	NC	No Connection	29	R2AP	2nd LVDS Channel Signal (A+)
4	I2C	SDA	30	R2BN	2nd LVDS Channel Signal (B-)
5	I2C	SCL	31	R2BP	2nd LVDS Channel Signal (B+)
6	NC	No Connection	32	R2CN	2nd LVDS Channel Signal (C-)
7	PBP Select	'H'= PBP Concept , 'L'=normal	33	R2CP	2nd LVDS Channel Signal (C+)
8	NC	No Connection	34	GND	Ground
9	Interlace mode	'H'(3.3V) = Enable , 'L' = Disable (Connect High or low, No NC Condition)	35	R2CLKN	2nd LVDS Channel Clock Signal(-)
10	PWM_OUT	PWM_OUT Reference signal for LED dimming control	36	R2CLKP	2nd LVDS Channel Clock Signal(+)
11	GND	Ground	37	GND	Ground
12	R1AN	1st LVDS Channel Signal (A-)	38	R2DN	2nd LVDS Channel Signal (D-)
13	R1AP	1st LVDS Channel Signal (A+)	39	R2DP	2nd LVDS Channel Signal (D+)
14	R1BN	1st LVDS Channel Signal (B-)	40	NC	No Connection
15	R1BP	1st LVDS Channel Signal (B+)	41	NC	No Connection
16	R1CN	1st LVDS Channel Signal (C-)	42	Reserved	No connection or GND
17	R1CP	1st LVDS Channel Signal (C+)	43	GND	Ground
18	GND	Ground	44	GND	Ground (AGP)
19	R1CLKN	1st LVDS Channel Clock Signal(-)	45	GND	Ground
20	R1CLKP	1st LVDS Channel Clock Signal(+)	46	GND	Ground
21	GND	Ground	47	NC	No connection
22	R1DN	1st LVDS Channel Signal (D-)	48	VLCD	Power Supply +10.0V
23	R1DP	1st LVDS Channel 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			

Note : PBP = Picture By Picture

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Table 3-2 Module Connector (CN2) Pin Configuration

- LCD Connector(CN2): GT05P-41S-H38-E1500 (manufactured by LSM) or equivalent
- Mating Connector : FI-RE41HL(JAE) or equivalent

No	Symbol	Description	No	Symbol	Description
1	NC	No connection	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	RA4N	4th LVDS Channel Signal (A-)
6	NC	No connection	27	RA4P	4th LVDS Channel Signal (A+)
7	NC	No connection	28	RB4N	4th LVDS Channel Signal (B-)
8	NC	No connection	29	RB4P	4th LVDS Channel Signal (B+)
9	GND	Ground	30	RC4N	4th LVDS Channel Signal (C-)
10	RA3N	3rd LVDS Channel Signal (A-)	31	RC4P	4th LVDS Channel Signal (C+)
11	RA3P	3rd LVDS Channel Signal (A+)	32	GND	Ground
12	RB3N	3rd LVDS Channel Signal (B-)	33	RCLK4N	4th LVDS Channel Clock Signal(-)
13	RB3P	3rd LVDS Channel Signal (B+)	34	RCLK4P	4th LVDS Channel Clock Signal(+)
14	RC3N	3rd LVDS Channel Signal (C-)	35	GND	Ground
15	RC3P	3rd LVDS Channel Signal (C+)	36	RD4N	4th LVDS Channel Signal (D-)
16	GND	Ground	37	RD4P	4th LVDS Channel Signal (D+)
17	RCLK3N	3rd LVDS Channel Clock Signal(-)	38	NC	No Connection
18	RCLK3P	3rd LVDS Channel Clock Signal(+)	39	NC	No Connection
19	GND	Ground	40	GND	Ground
20	RD3N	3rd LVDS Channel Signal (D-)	41	GND	Ground
21	RD3P	3rd LVDS Channel Signal (D+)			

Figure 4. Module Connector Diagram

[Rear view of LCM]

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Note :

1. All GND (Ground) pins should be connected together to the LCD module's metal frame.
2. All V_{LCD} (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.
5. ITLC is Interlace mode selection pin. (L : Normal Mode, H : Interlace mode)
If you don't use this pin, it should be connected to GND.
(Low level Input Voltage : GND ~ 0.4V, High level Input Voltage : 1.6 ~ 3.6V,
Absolute maximum ratings : - 0.5 ~ 4V)
6. 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.

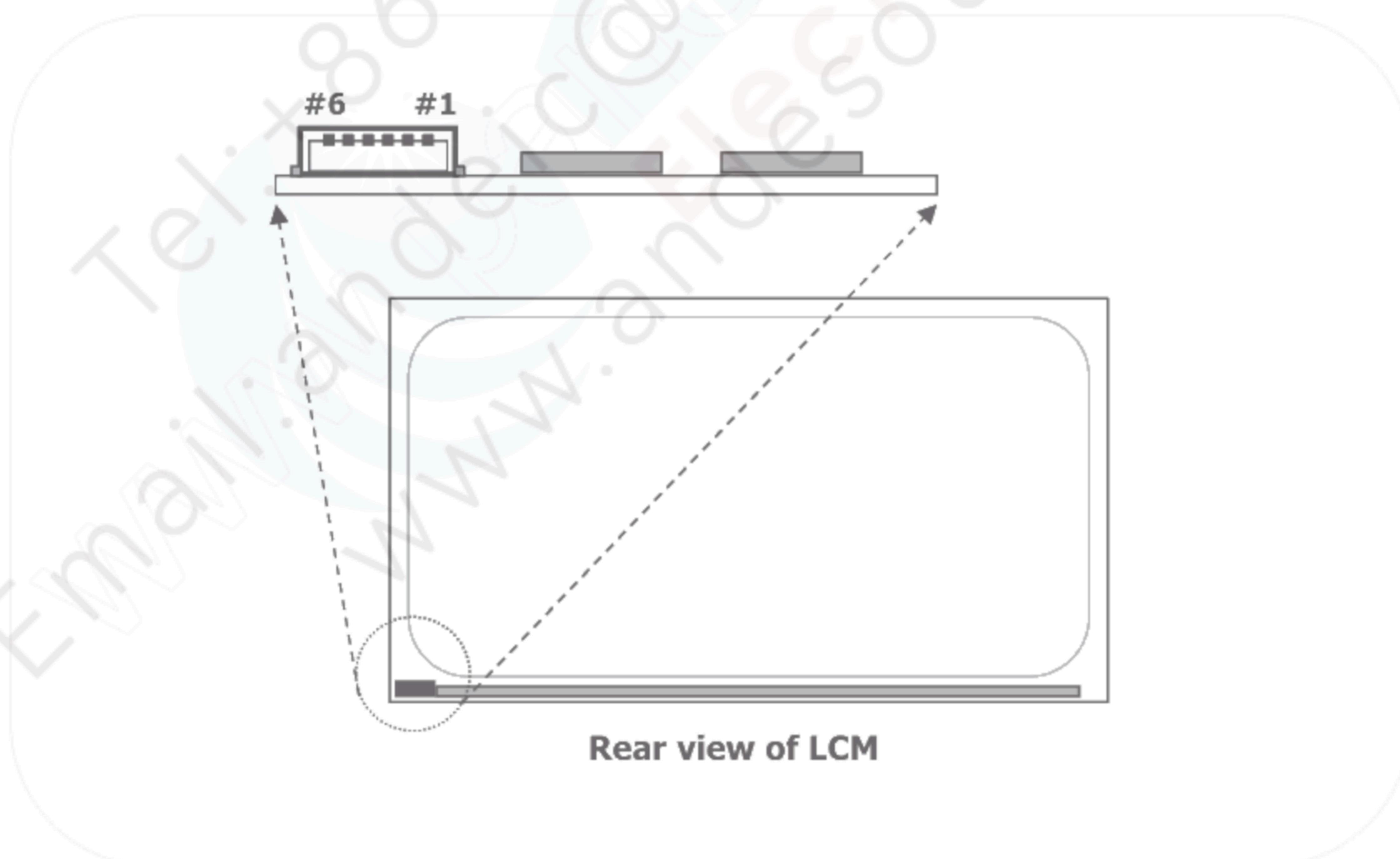
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3-2-2. Backlight system

Table 4. BACKLIGHT CONNECTOR PIN CONFIGURATION

The LED interface connector is a model SM06B-SHJH(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	Channel4 Current Feedback	
2	FB2	Channel3Current Feedback	
3	VLED	LED Power Supply	
4	VLED	LED Power Supply	
5	FB3	Channel1 Current Feedback	
6	FB4	Channel2 Current Feedback	

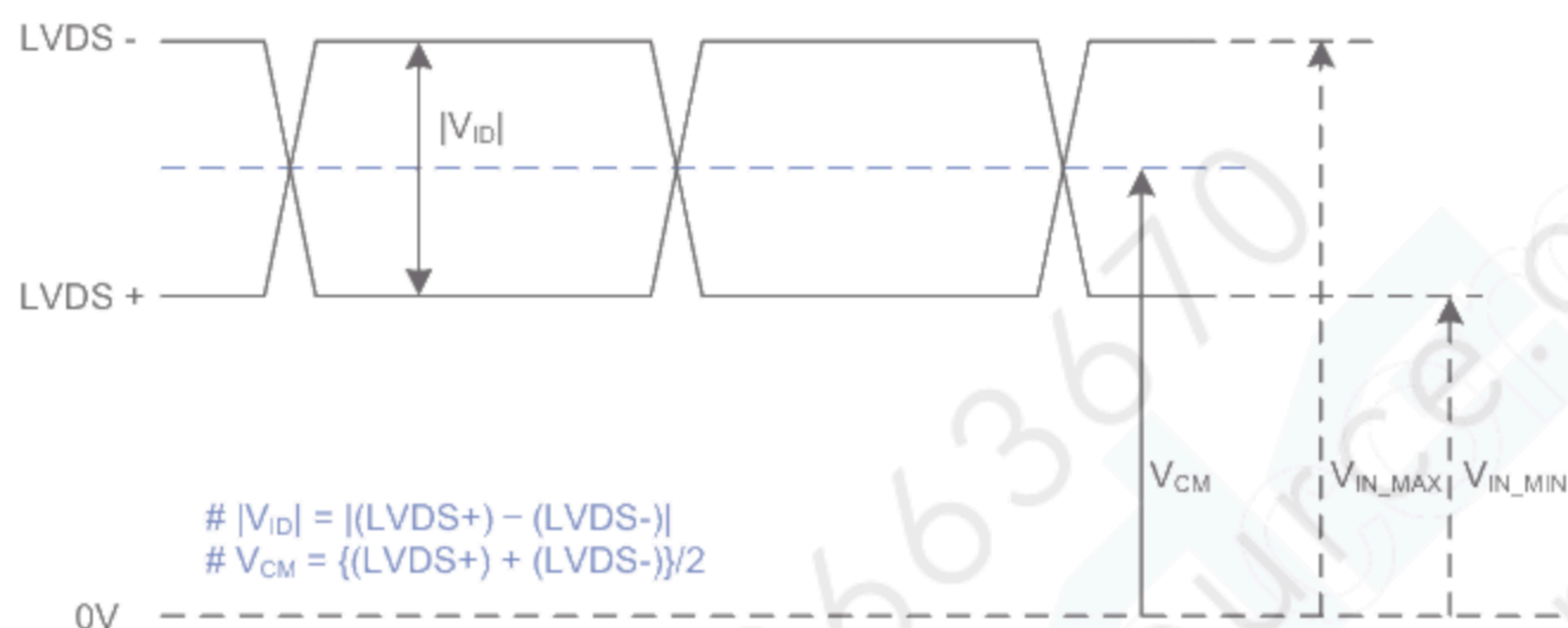


[Figure 5] Backlight connector view

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3-3. LVDS characteristics

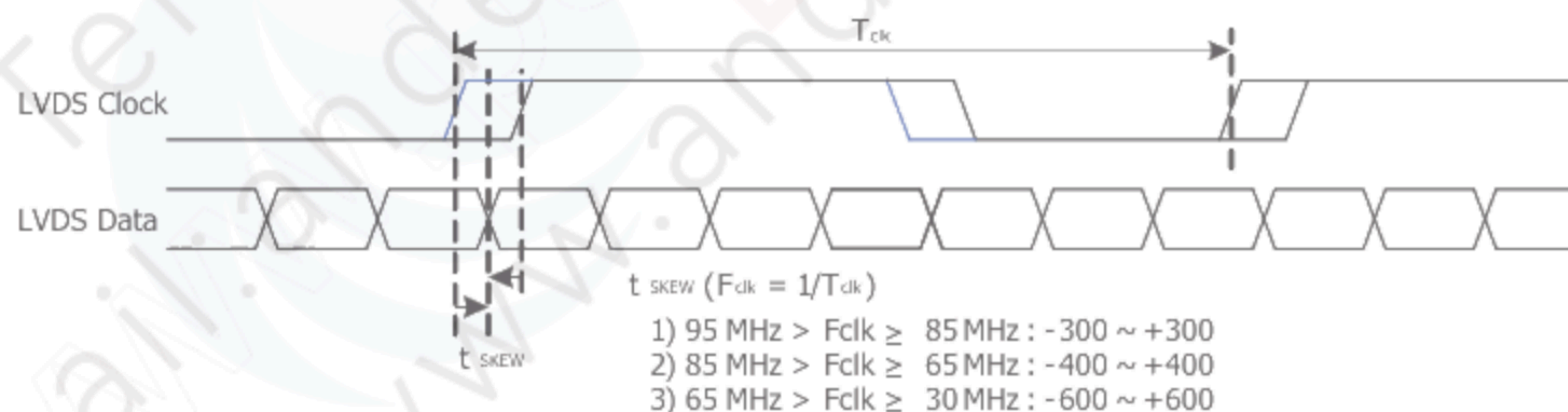
3-3-1. DC Specification



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	-

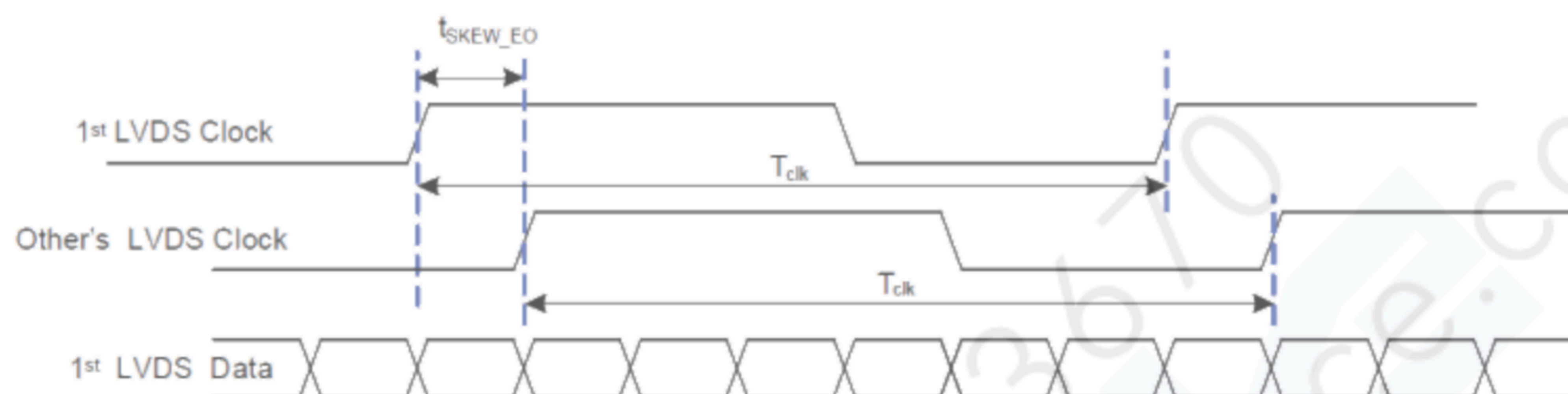
Notes : Dose not have any Noise & Peaking in LVDS Signal

3-3-2. 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}	-

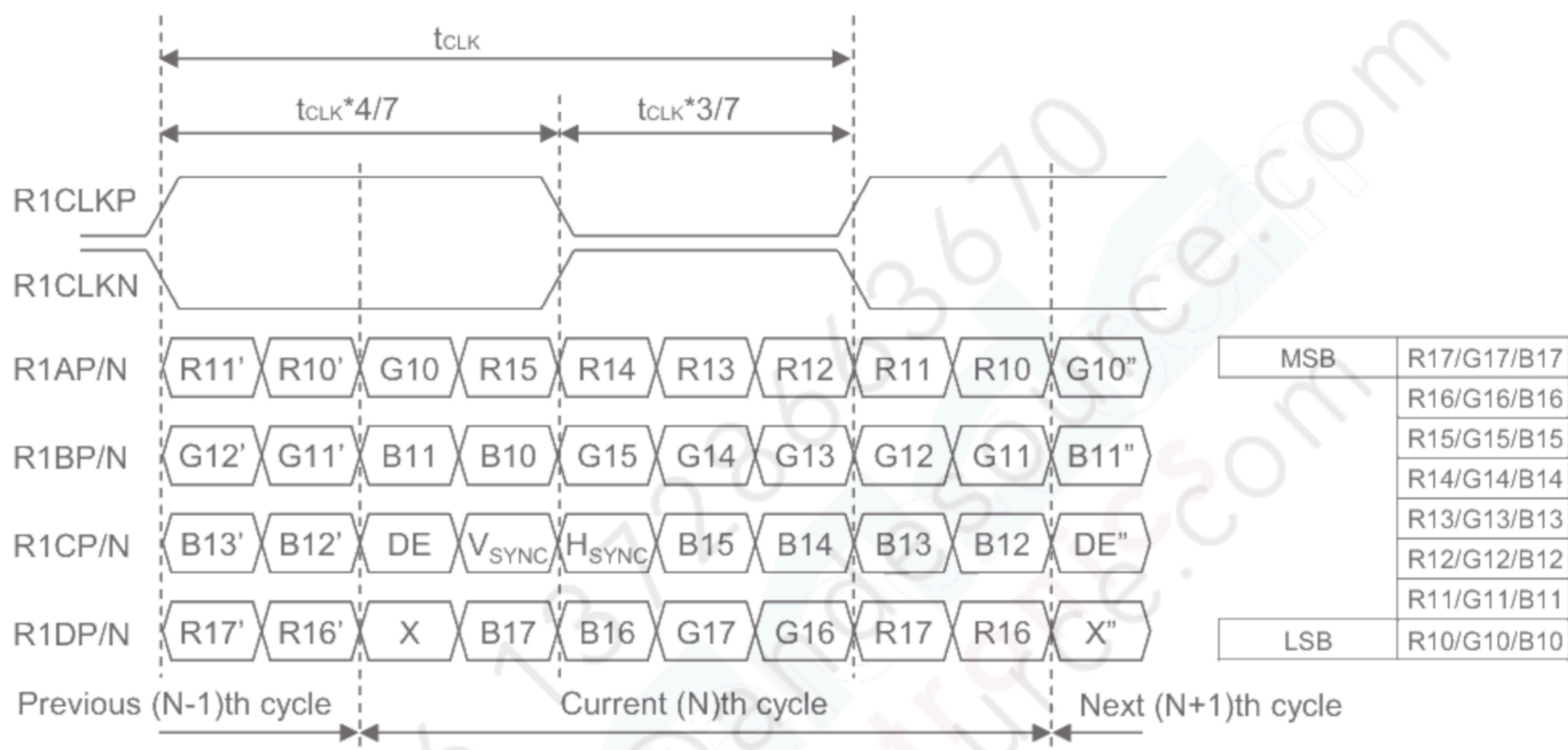
Product Specification

3-3. LVDS characteristics**3-3-2. AC Specification**< LVDS Clock to Clock Skew Margin (1st port to other ports) >

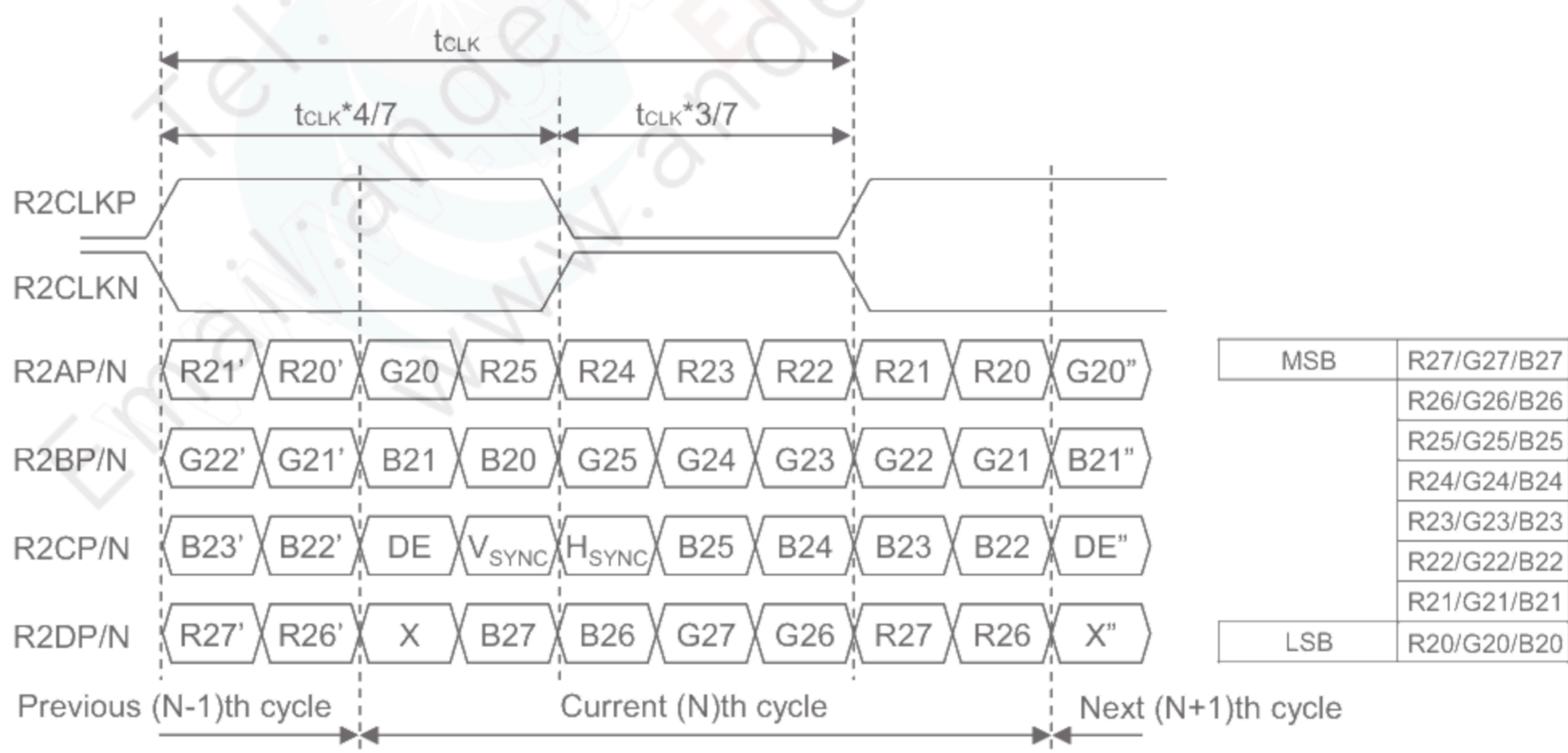
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3-3-3. LVDS data format (8bit, VESA)

1st LVDS Channel



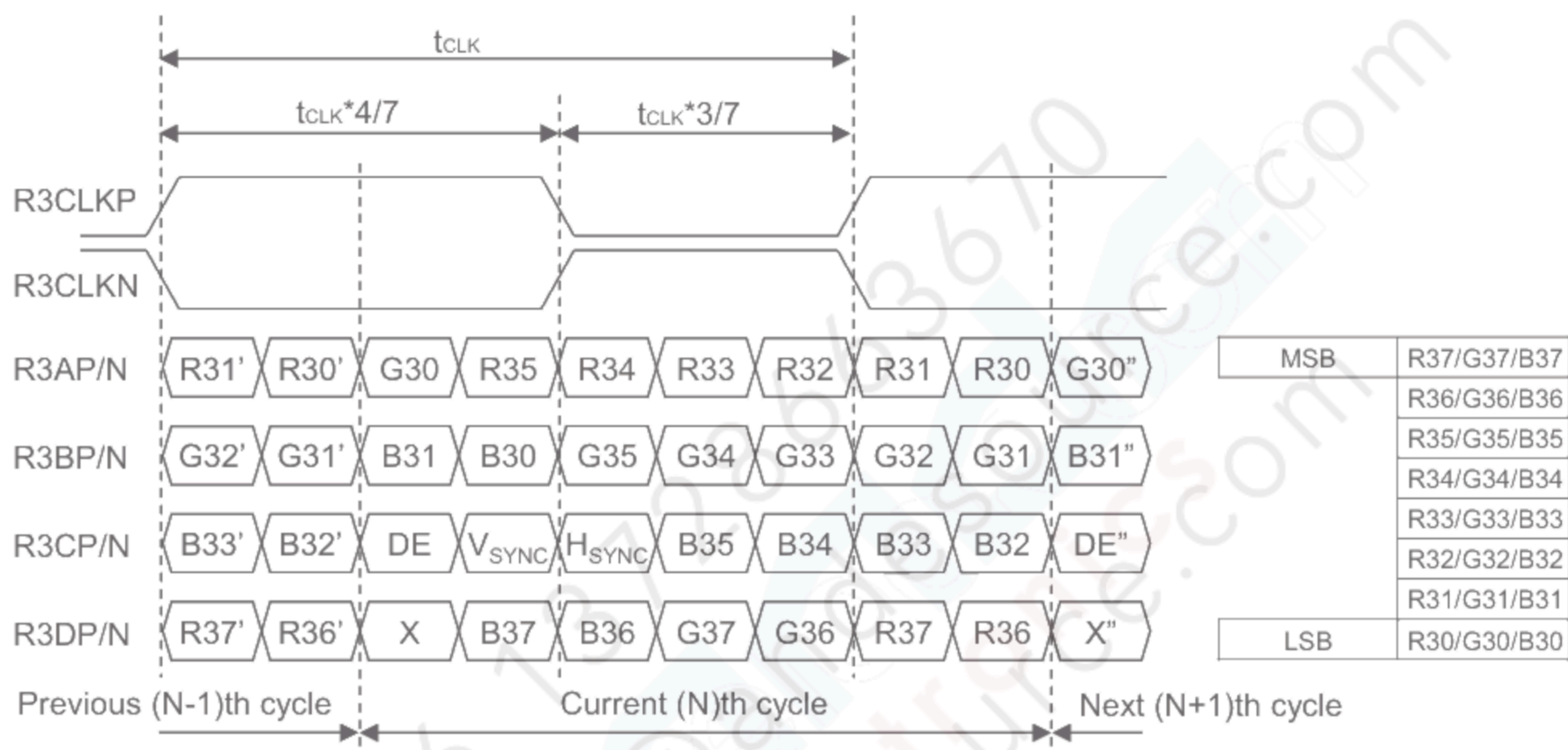
2nd LVDS Channel



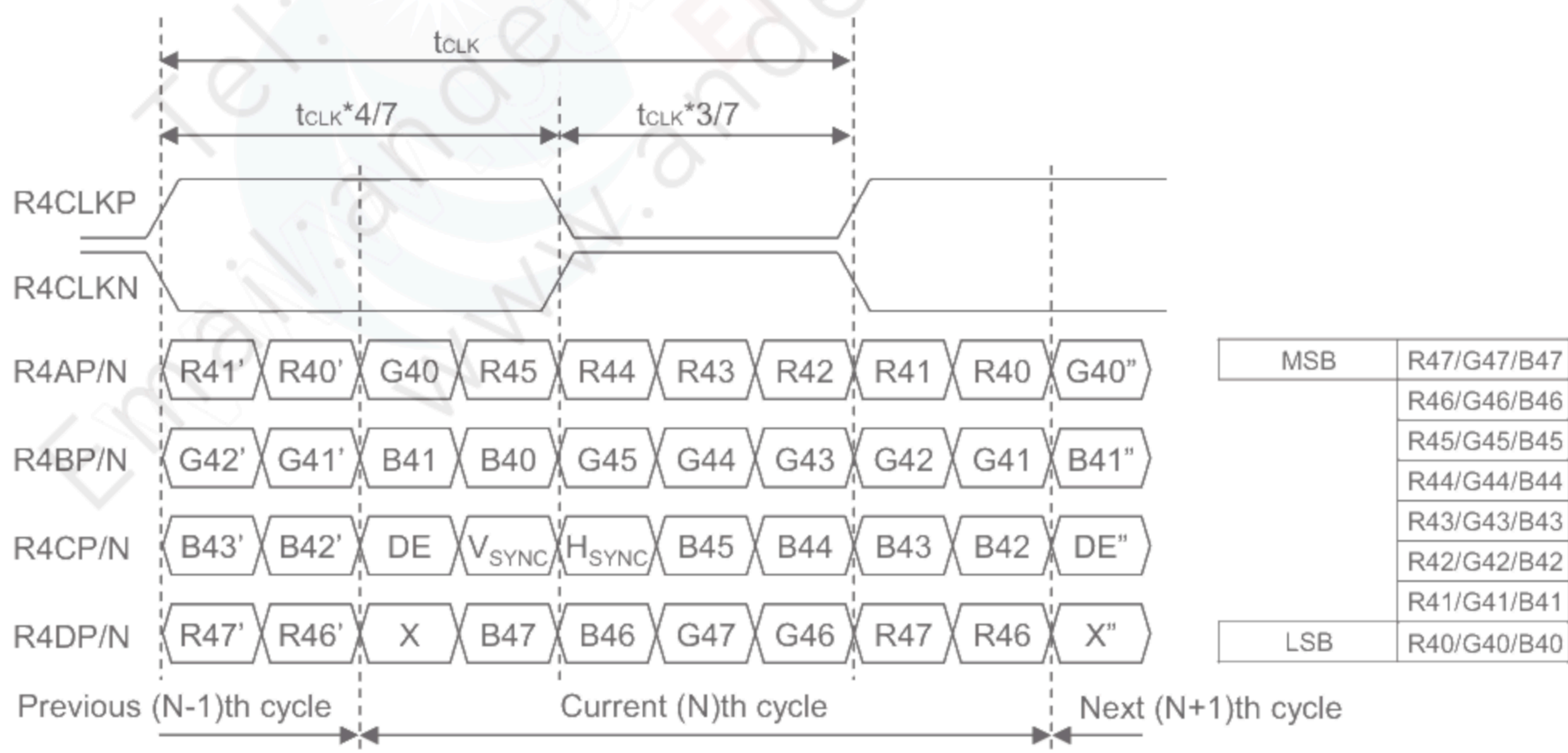
Product Specification

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

■ 3rd LVDS Channel

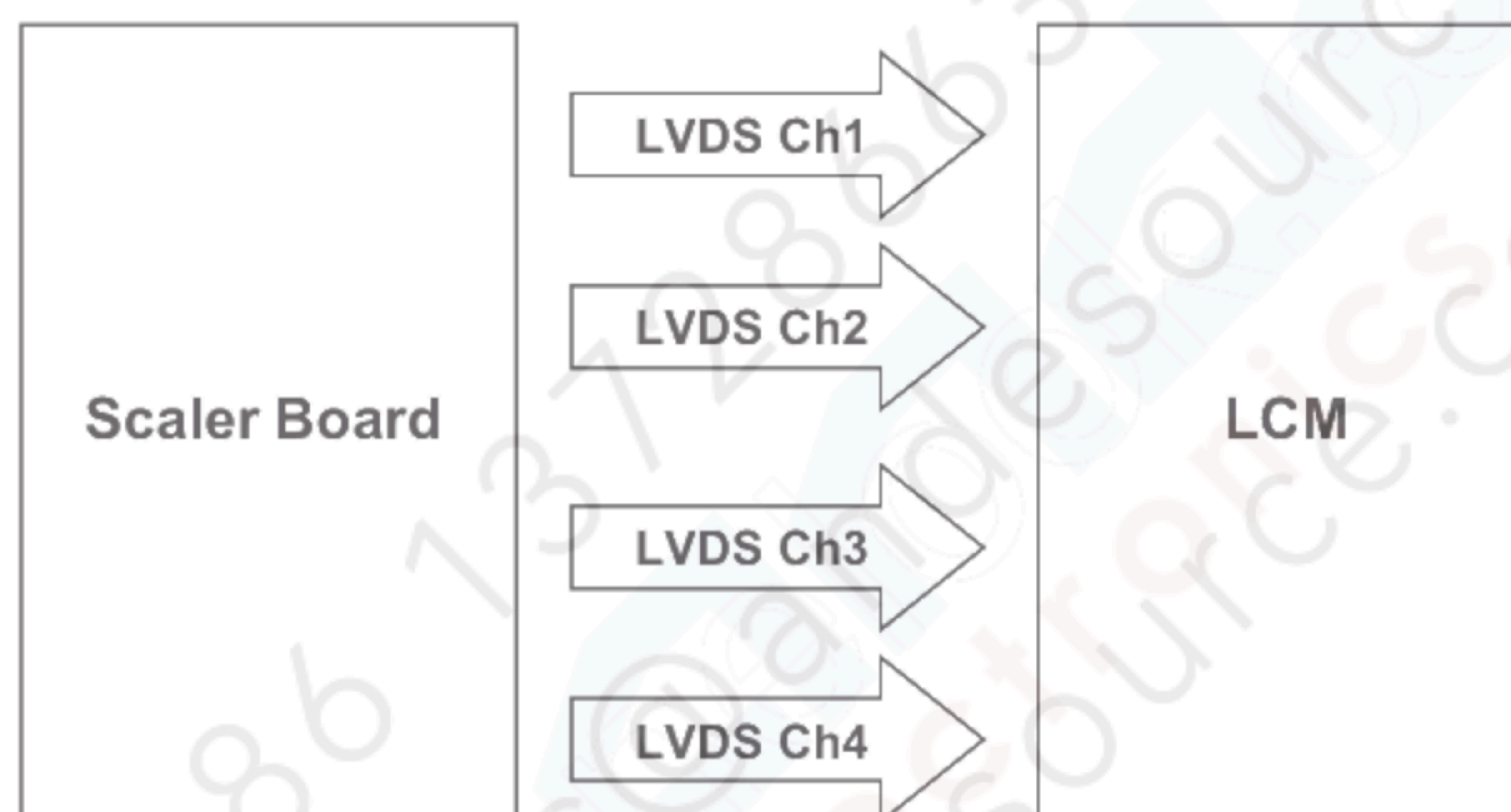


■ 4th LVDS Channel



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3-3-4. LVDS description of Dual Screen



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

LVDS Ch1 : 1 → 5 → ... 1273 → 1277 → 1281 → 1285 → ... 2553 → 2557

LVDS Ch2 : 2 → 6 → ... 1274 → 1278 → 1282 → 1286 → ... 2554 → 2558

LVDS Ch3 : 3 → 7 → ... 1275 → 1279 → 1283 → 1287 → ... 2555 → 2559

LVDS Ch4 : 4 → 8 → ... 1276 → 1280 → 1284 → 1288 → ... 2556 → 2560

■ PBP (Dual Screen, Pin # 7 of CN1 = High)

LVDS Ch1 : 1 → 3 → 5 → 7 → ... 1273 → 1275 → 1277 → 1279

LVDS Ch2 : 2 → 4 → 6 → 8 → ... 1274 → 1276 → 1278 → 1280

LVDS Ch3 : 1281 → 1283 → 1285 → 1287 → ... 2553 → 2555 → 2557 → 2559

LVDS Ch4 : 1282 → 1284 → 1286 → 1288 → ... 2554 → 2556 → 2558 → 2560

Note : PBP = Picture By Picture

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3-4. Signal Timing Specifications

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

Table 5 . Timing Table

Parameter		Symbol	Min.	Typ.	Max.	Unit	Notes
D _{CLK}	Period	t _{CLK}	17.2	21.6	25.9	ns	Pixel frequency : Typ. 185.58MHz
	Frequency	f _{CLK}	38.7	46.4	58.0	MHz	
Hsync	Horizontal Valid	t _{HV}	640	640	640	t _{CLK}	
	H Period Total	t _{HP}	688	696	712		
	Hsync Frequency	f _H	55.6	66.7	83.3	kHz	
Vsync	Vertical Valid	t _{VV}	1080	1080	1080	t _{HP}	For D _{CLK}
	V Period Total	t _{VP}	1093	1111	1330		
	Vsync Frequency	f _V	48	60	75	Hz	

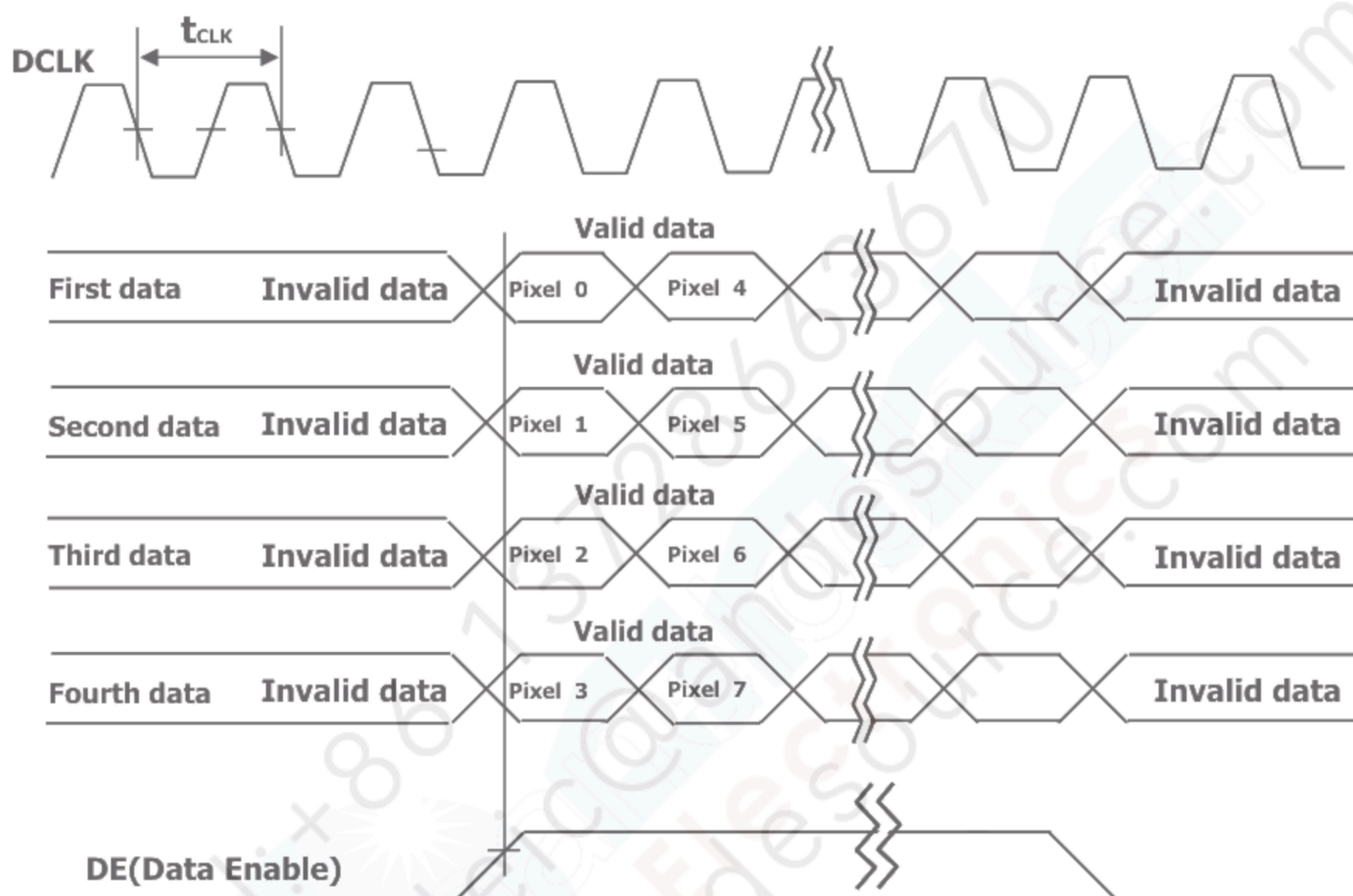
Note : Hsync period and Hsync width-active should be even number times of t_{CLK} . If the value is odd number times of t_{CLK} , display control signal can be asynchronous. In order to operate this LCM a Hsync, Vsync, and DE(data enable) signals should be used.

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 Horizontal Valid and H Period Total should be any times of of character number(4).
5. The polarity of Hsync, Vsync is not restricted.
6. The Max frequency of 2560X1080 resolution is 58Mhz

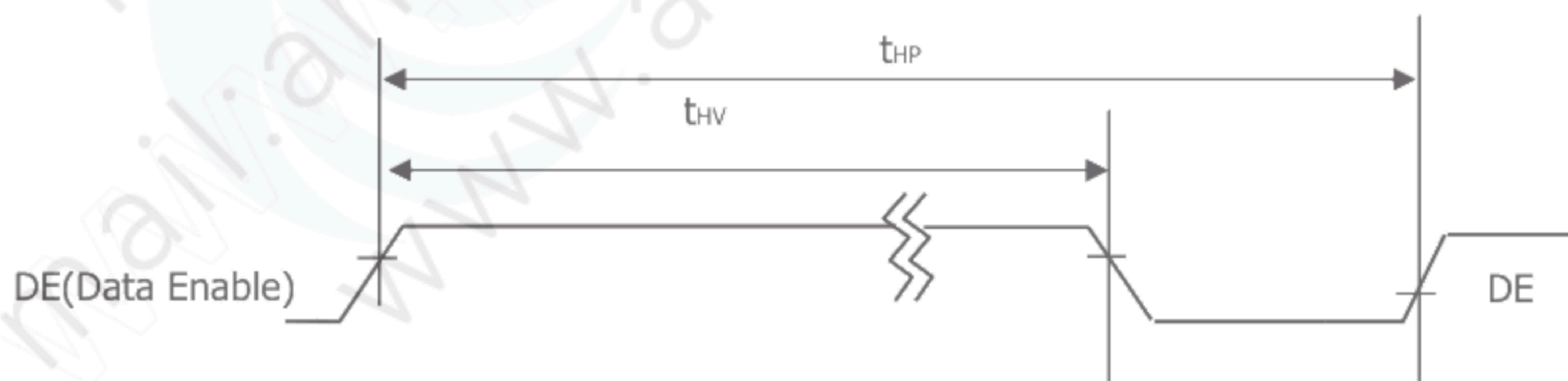
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3-5. Signal Timing Waveforms

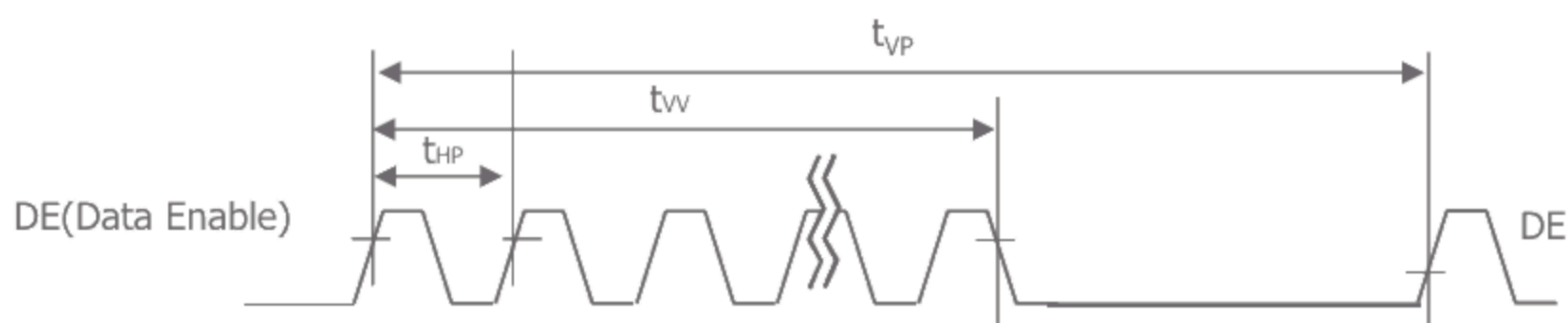
1. DCLK, DE, DATA waveforms



2. Horizontal waveform



3. Vertical waveform



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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 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(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(002)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Red(253)	1	1	1	1	1	1	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) Bright	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(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Green(253)	0	0	0	0	0	0	0	0	1	1	1	1	1	1	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) Bright	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(002)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-----	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Blue(253)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	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) Bright	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

3-7. Power Sequence

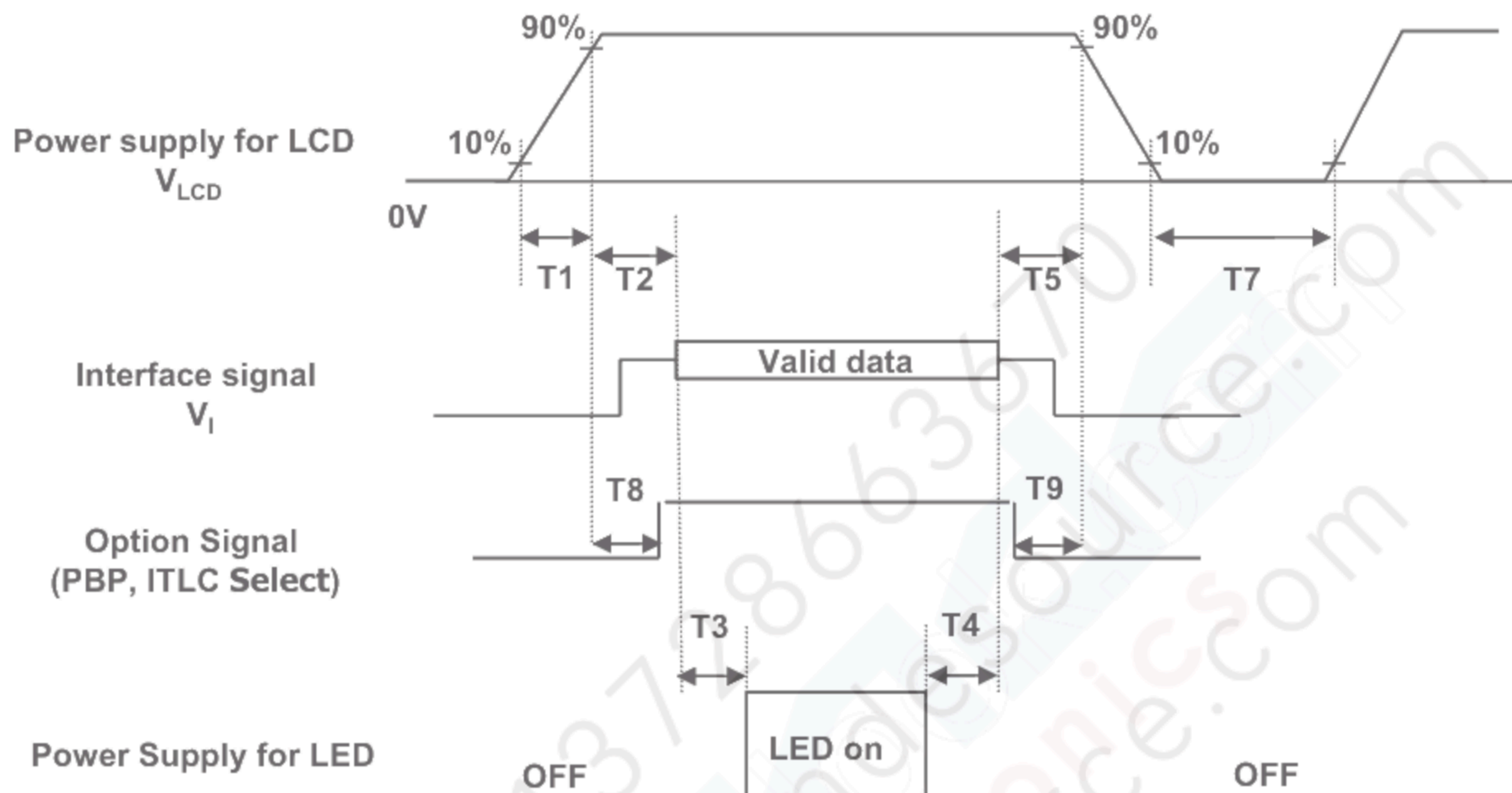


Table 9. Power Sequence

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

Notes :

- Recommend to follow Power sequence at these case
 - AC/DC Power On/Off
 - Mode change (Resolution, frequency, timing, sleep mode, Color depth change, etc.)
- Please V_{LCD} power on only after connecting interface cable to LCD.
- Please avoid floating state of interface signal at invalid period.
- When the interface signal is invalid, be sure to pull down the power supply for LCD V_{LCD} to 0V.
- LED power must be turn on after power supply for LCD an interface signal are valid.
- It must be no valid signal at SCL & SDA line for 500ms, after VLCD input to LCD
- If VLCD Power is Changed during on status, be sure to Pull down the LED Power on to 0V

Product Specification

3-8. VLCD Power Dip Condition

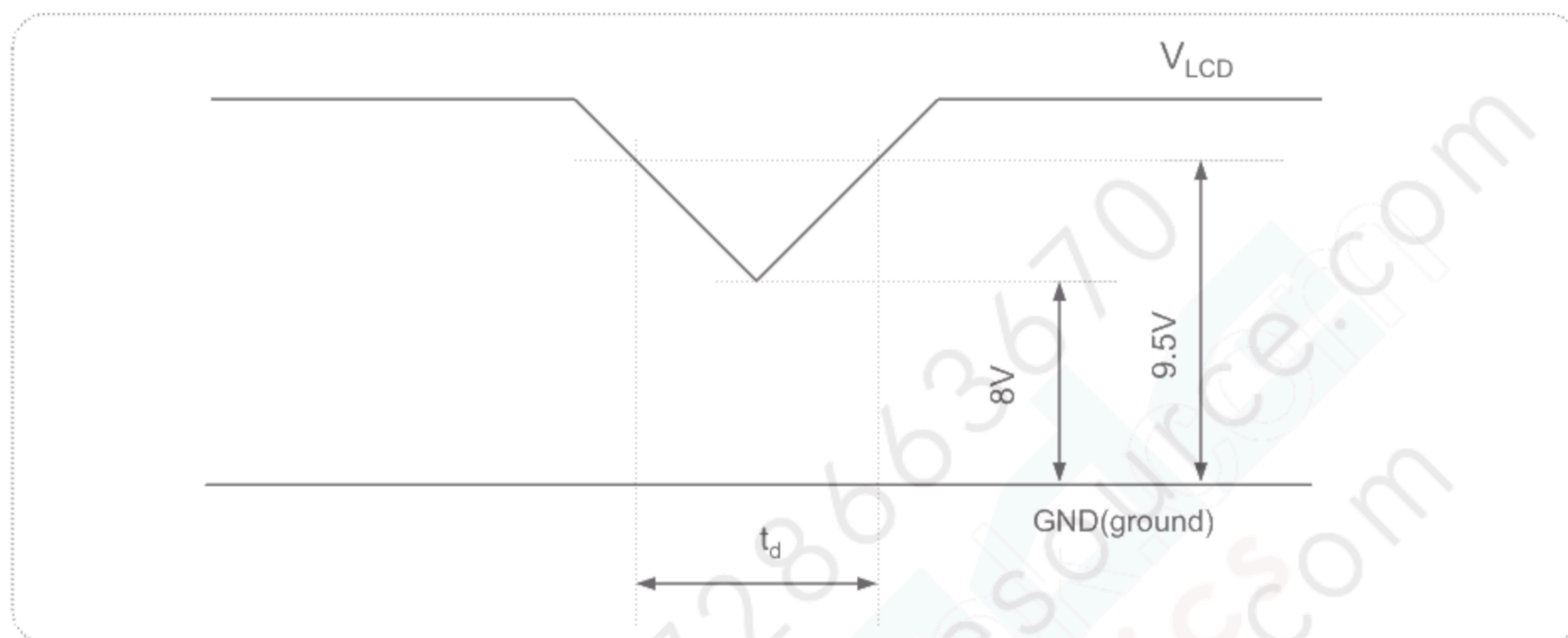


FIG.5 Power dip condition

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 $25 \pm 2^\circ\text{C}$. 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.

Figure. 6 presents additional information concerning the measurement equipment and method.

Figure 6. Optical Characteristic Measurement Equipment and Method

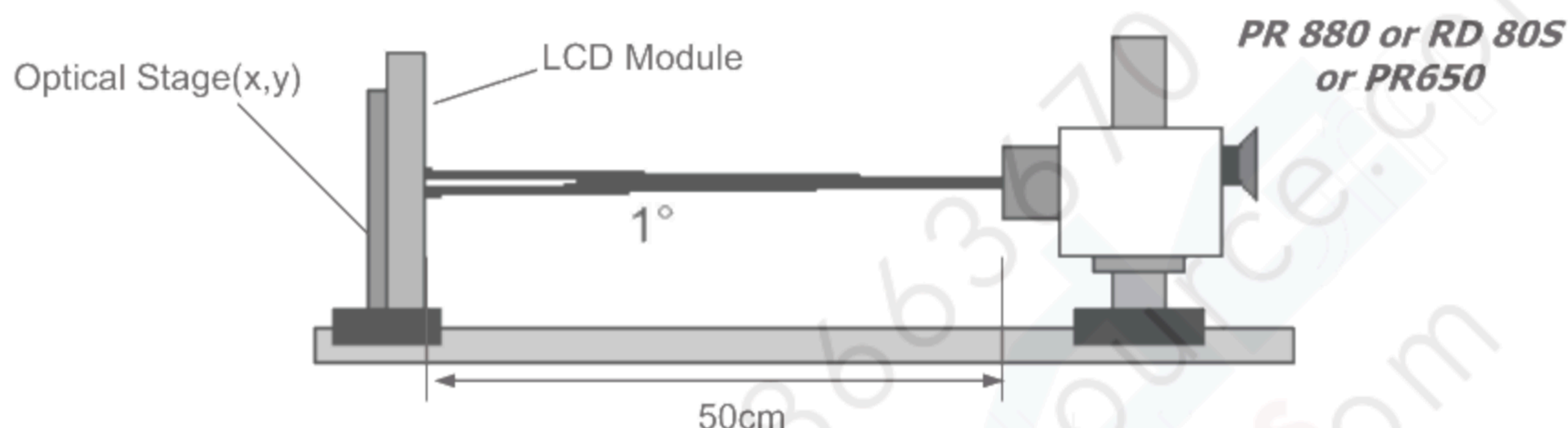


Table 8. Optical Characteristics

($T_a = 25^\circ\text{C}$, $V_{\text{LCD}} = 10.0\text{V}$, $f_v = 60\text{Hz}$, $D_{\text{CLK}} = 185.58\text{MHz}$, $I_s = 60\text{mA}$)

Parameter		Symbol	Values			Units	Notes
			Min	Typ	Max		
Contrast Ratio		CR	700	1000	-		1
Surface Luminance, white		L _{WHITE}	200	250	-	cd/m ²	2
Luminance Variation		δ _{WHITE}	75	-	-	%	3
Response Time	GTG	T _{GTG_AVR}	-	14	28	ms	4
Color Gamut			-	sRGB	-	%	
Color Coordinates [CIE1931] (By PR650)	RED	R _x		0.660			
		R _y		0.331			
	GREEN	G _x		0.306			
		G _y	Typ	0.609	Typ		
	BLUE	B _x	-0.03	0.149	+0.03		
		B _y		0.062			
	WHITE	W _x		0.313			
		W _y		0.329			
Color Shift	Horizontal	θ _{CST_H}	-	178	-	Degree	5
	Vertical	θ _{CST_V}	-	178	-		
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 :

It is measured at center point (1)

$$\text{Contrast ratio} = \frac{\text{Surface luminance with all white pixels}}{\text{Surface luminance with all black pixels}}$$

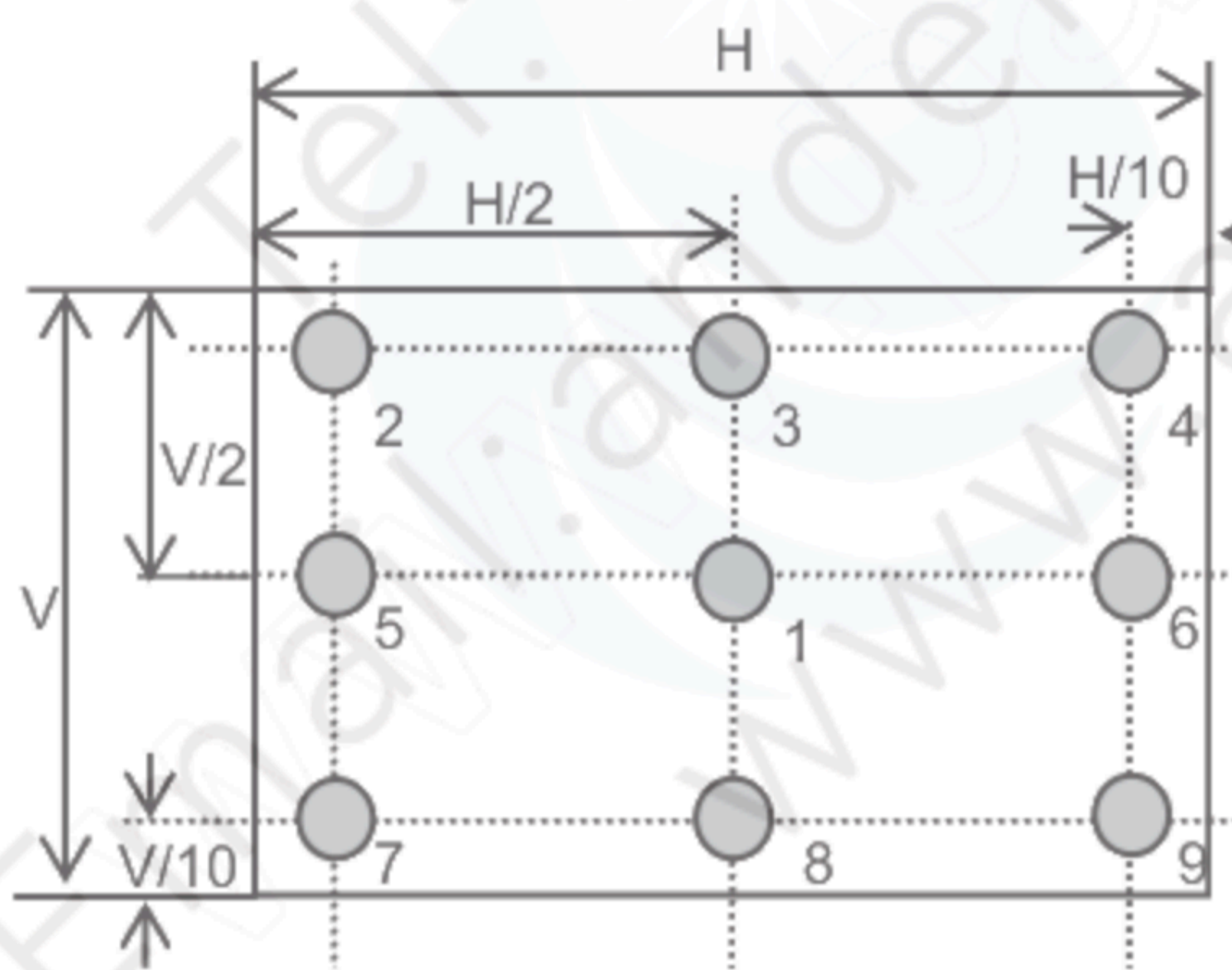
2. **Surface luminance** is the luminance value at center 1 point (1) across the LCD surface 50cm from the surface with all pixels displaying white.
For more information see Figure 7.

3. The **variation in surface luminance** , δ_{WHITE} is defined as :

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

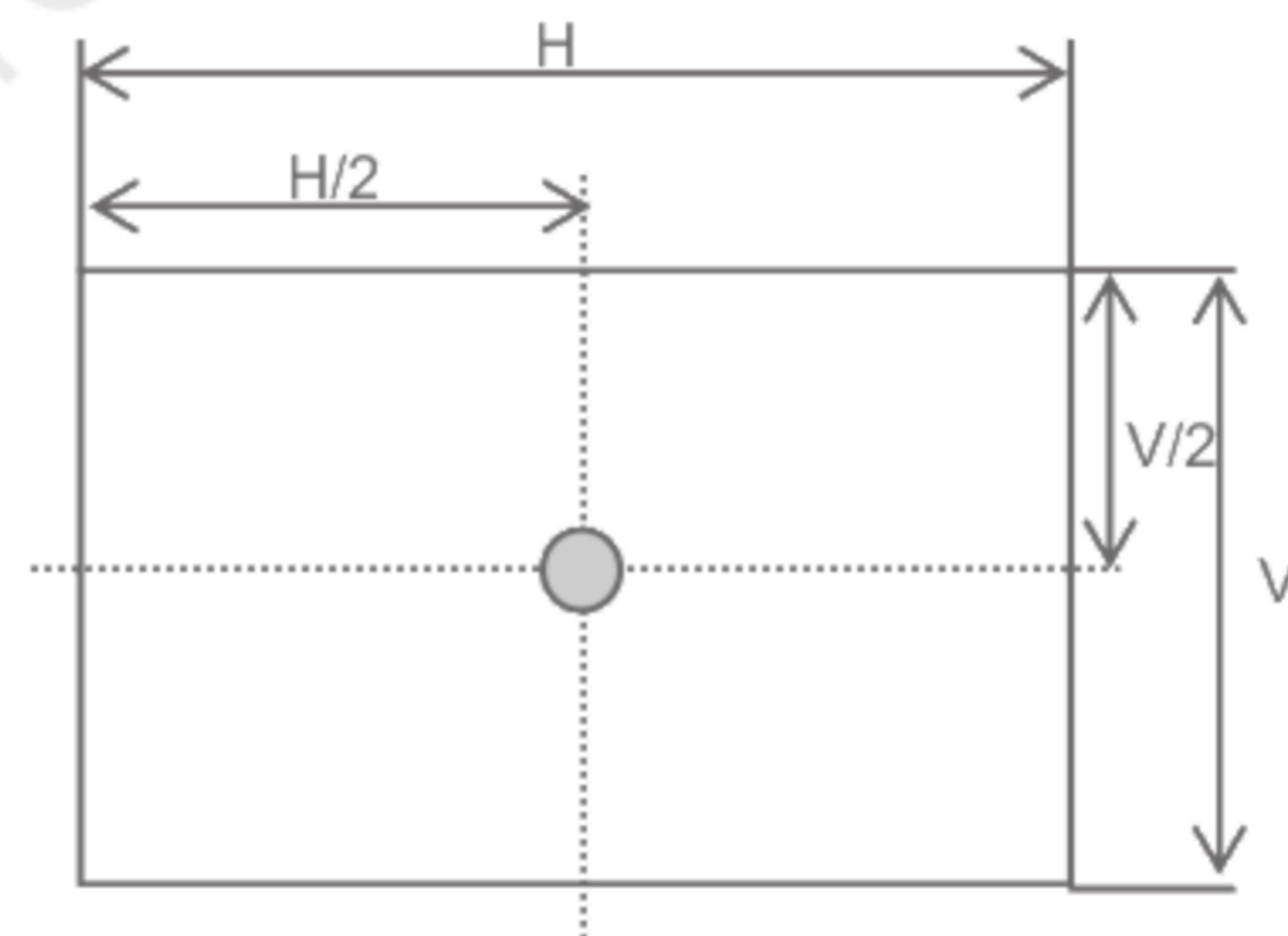
For more information see Figure 7.

Figure 7. Luminance measuring point



@ H,V : Active Area

<Measuring point for luminance variation>



<Measuring point for surface 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 10. 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 "Black or White".

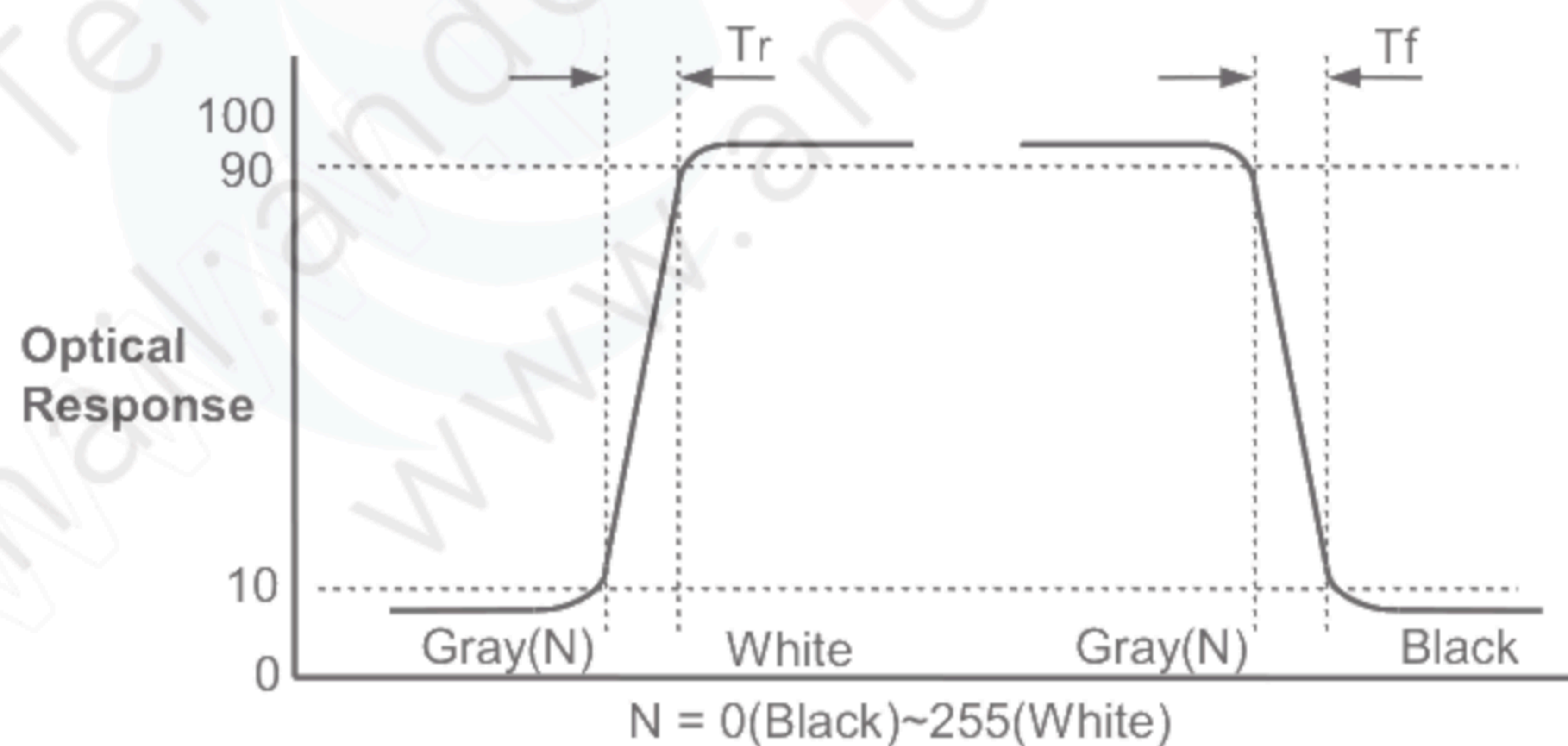


Figure 8. Response Time

Product Specification

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 ($\Delta u'v'$)

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

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

u'_1, v'_1 : $u'v'$ value at viewing angle direction

u'_2, v'_2 : $u'v'$ value at front ($\theta=0$)

i : Macbeth chart number (Define 23 page)

- Pattern size : 25% Box size

- Viewing angle direction of color shift : Horizontal, Vertical

Color shift is defined as the following test pattern and color.

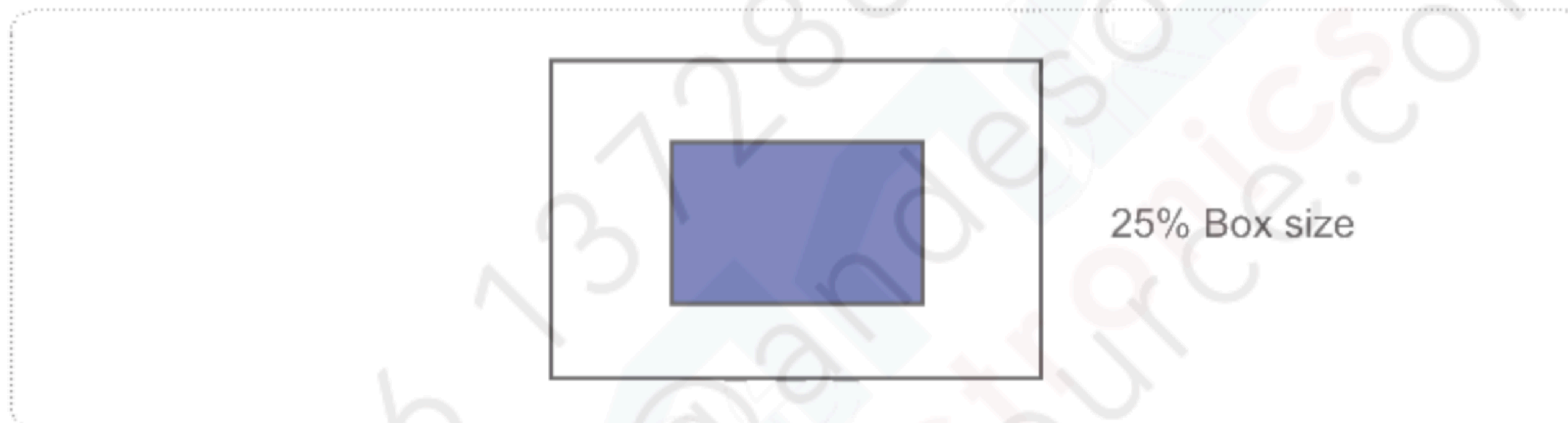


Figure 9. Color Shift Test Pattern

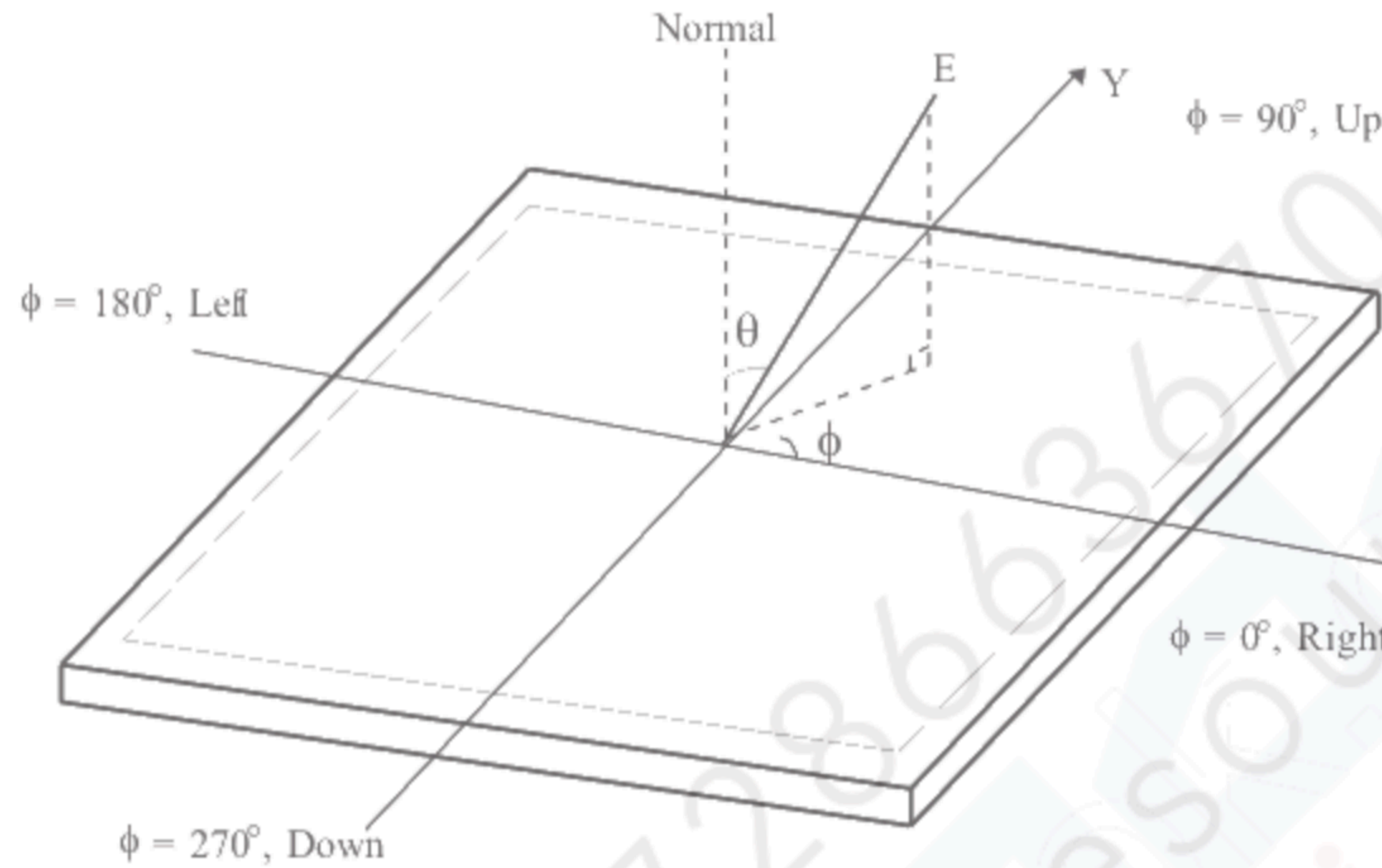
Average RGB values in Bruce RGB for Macbeth Chart

	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

Product Specification

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 Figure 10 .

Figure 10. Viewing Angle



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.10 and FIG.11 (**By EZ Contrast**)

- GSR (δ Gamma) is defined as :

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

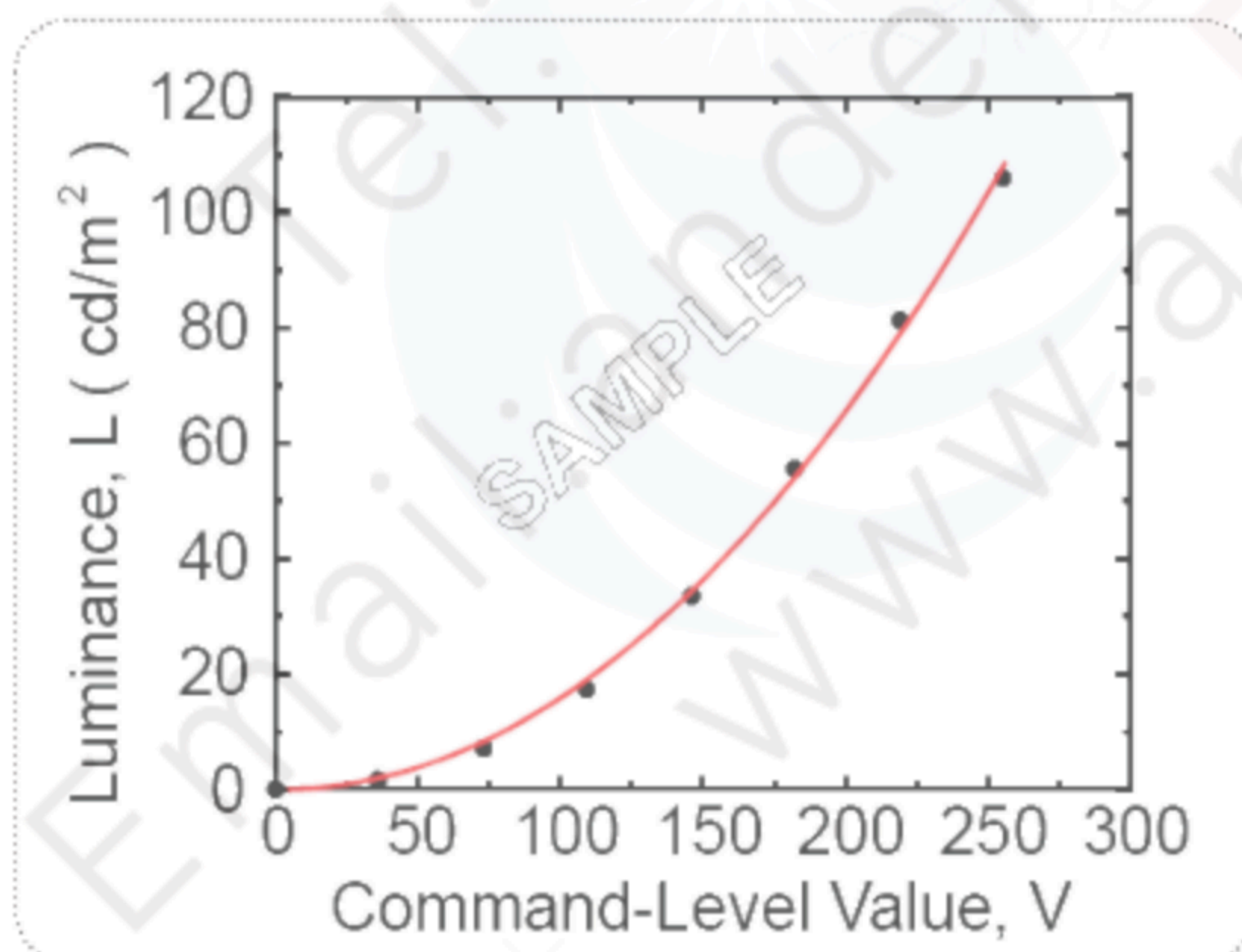


Figure11. Sample Luminance vs. gray scale
(using a 256 bit gray scale)

$$L = aV^r + L_b$$

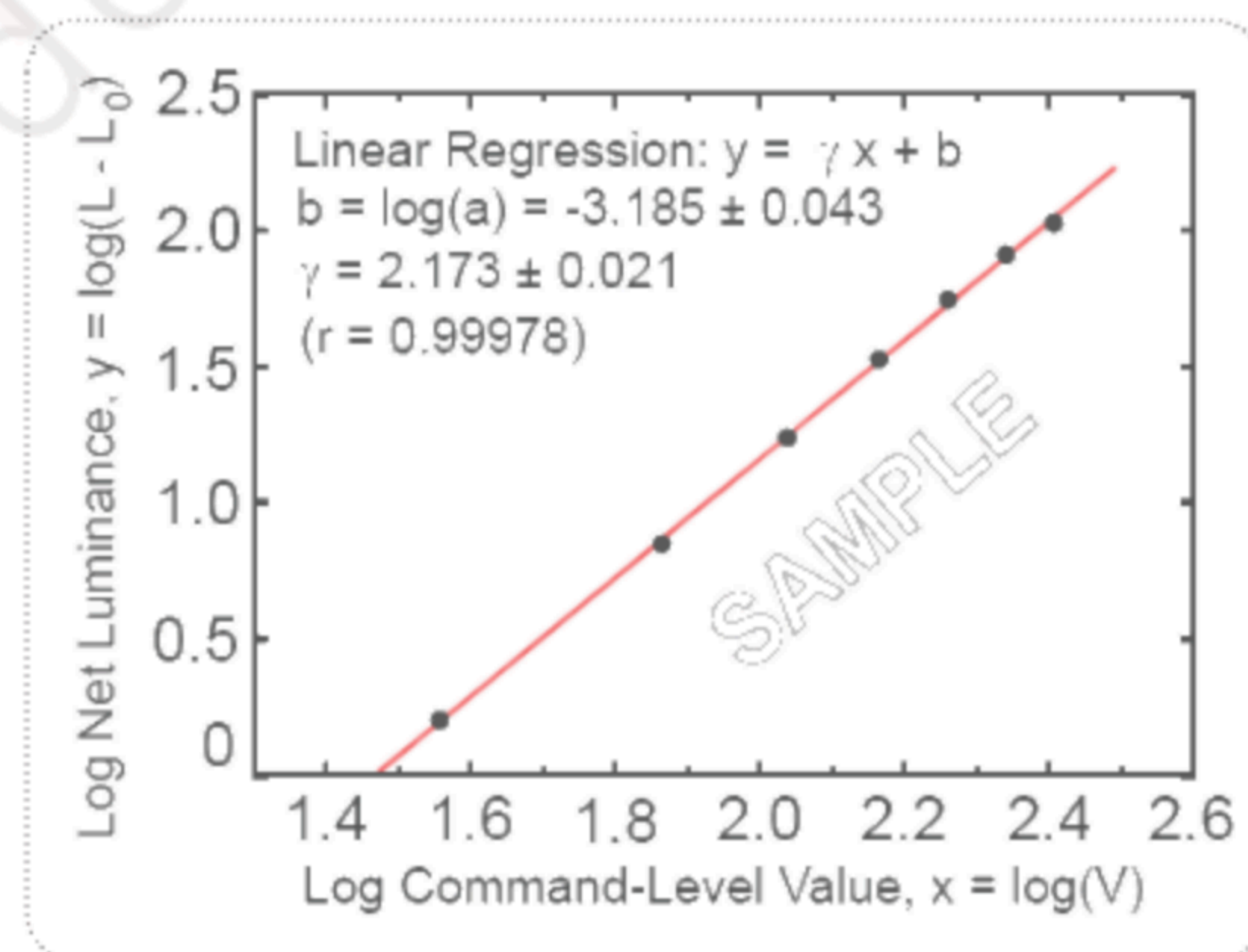


Figure 12. Sample Log-log plot of
luminance vs. gray scale

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

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

The GAMMA we calculate from the log-log representation (Figure 12.)

Product Specification

8. Gray scale specification

Gamma Value is approximately 2.2.

Table 11. Gray Scale Specification

Gray Level	Relative Luminance [%] (Typ.)
0	0.1
15	0.3
31	1.08
47	2.5
63	4.72
79	7.7
95	11.49
111	16.2
127	21.66
143	28.2
159	35.45
175	43.8
191	53.00
207	63.3
223	74.48
239	86.8
255	100

Product Specification

5. Mechanical Characteristics

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

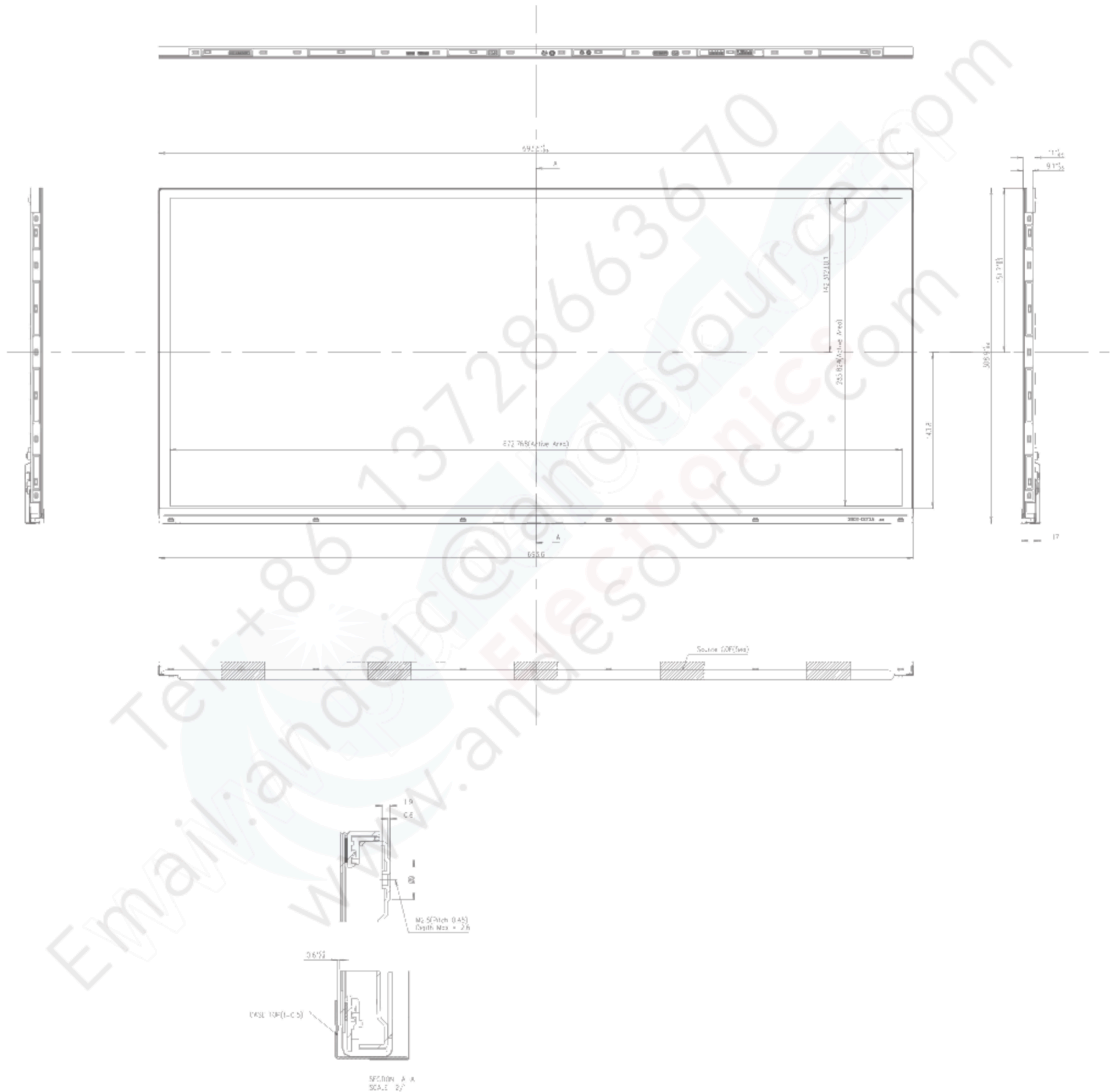
Table 15. Mechanical characteristics

Outline Dimension	Horizontal	693.6 mm
	Vertical	308.9 mm
	Depth	17.0 mm (Top : 11mm)
Bezel Area	Horizontal	-
	Vertical	-
Active Display Area	Horizontal	672.768 mm
	Vertical	283.824 mm
Weight	Typ. : 3,110g , Max : 3,265g	
Surface Treatment	Hard coating (3H), Anti-glare treatment of the front polarizer	

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

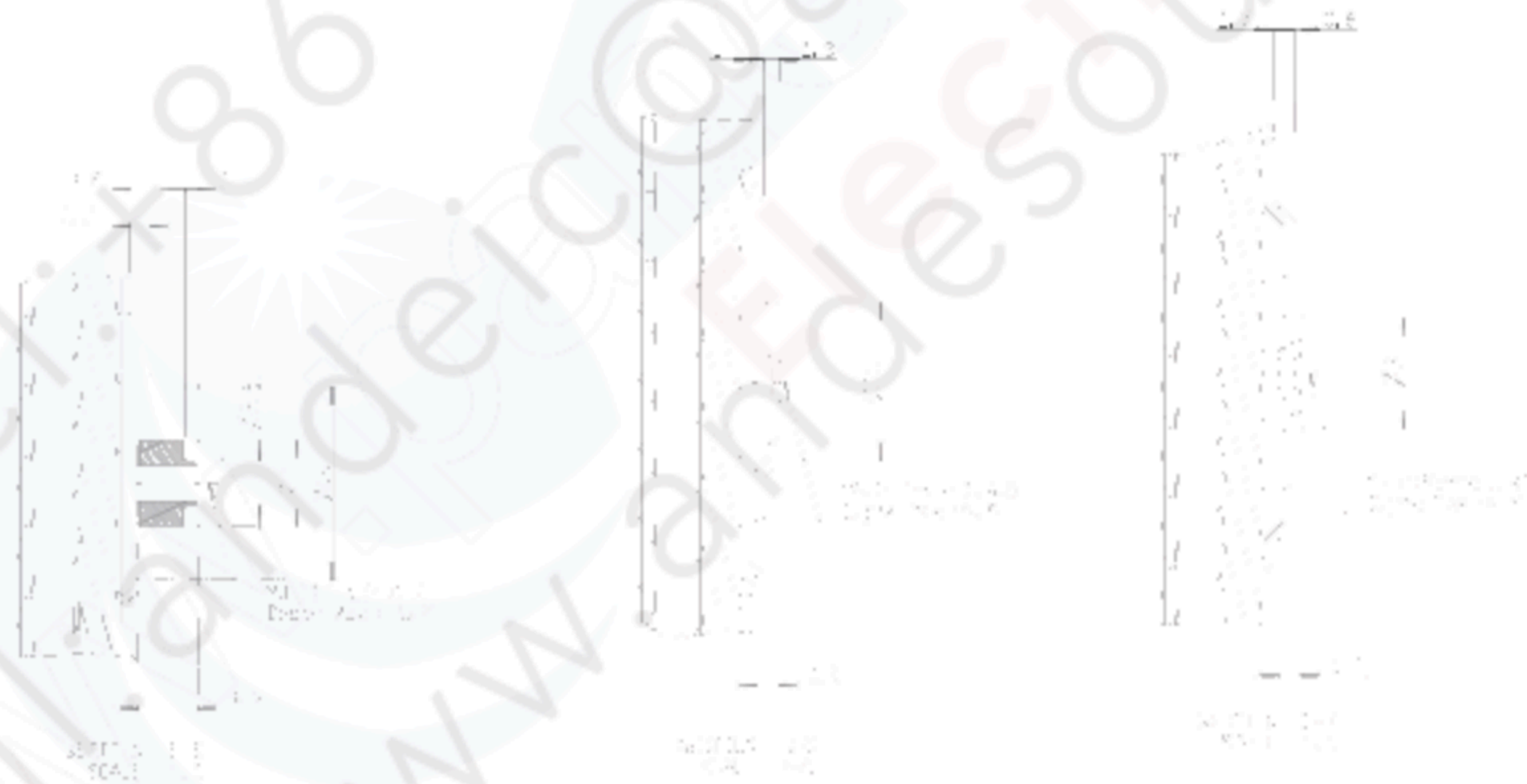
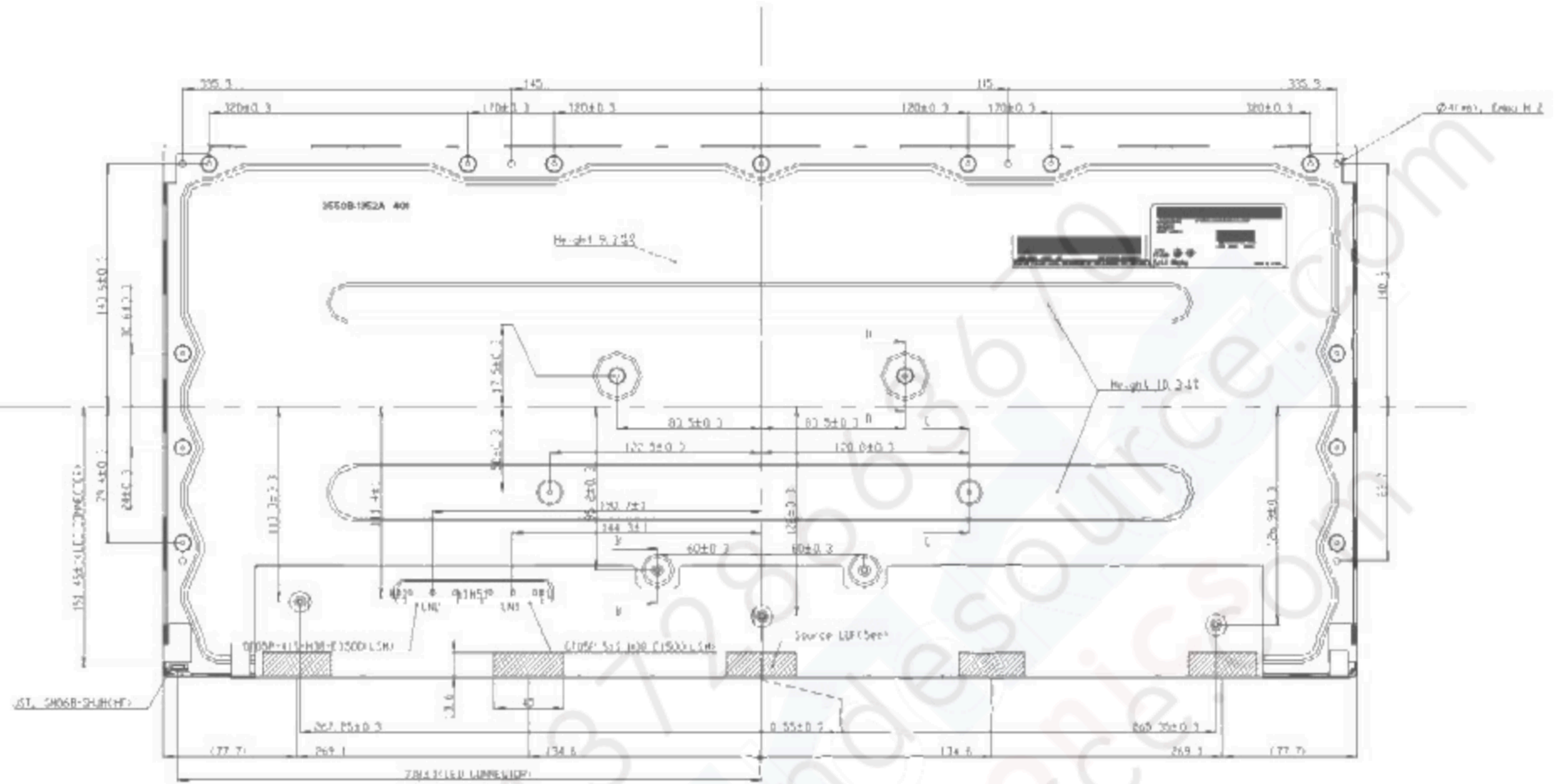
Product Specification

<FRONT VIEW>

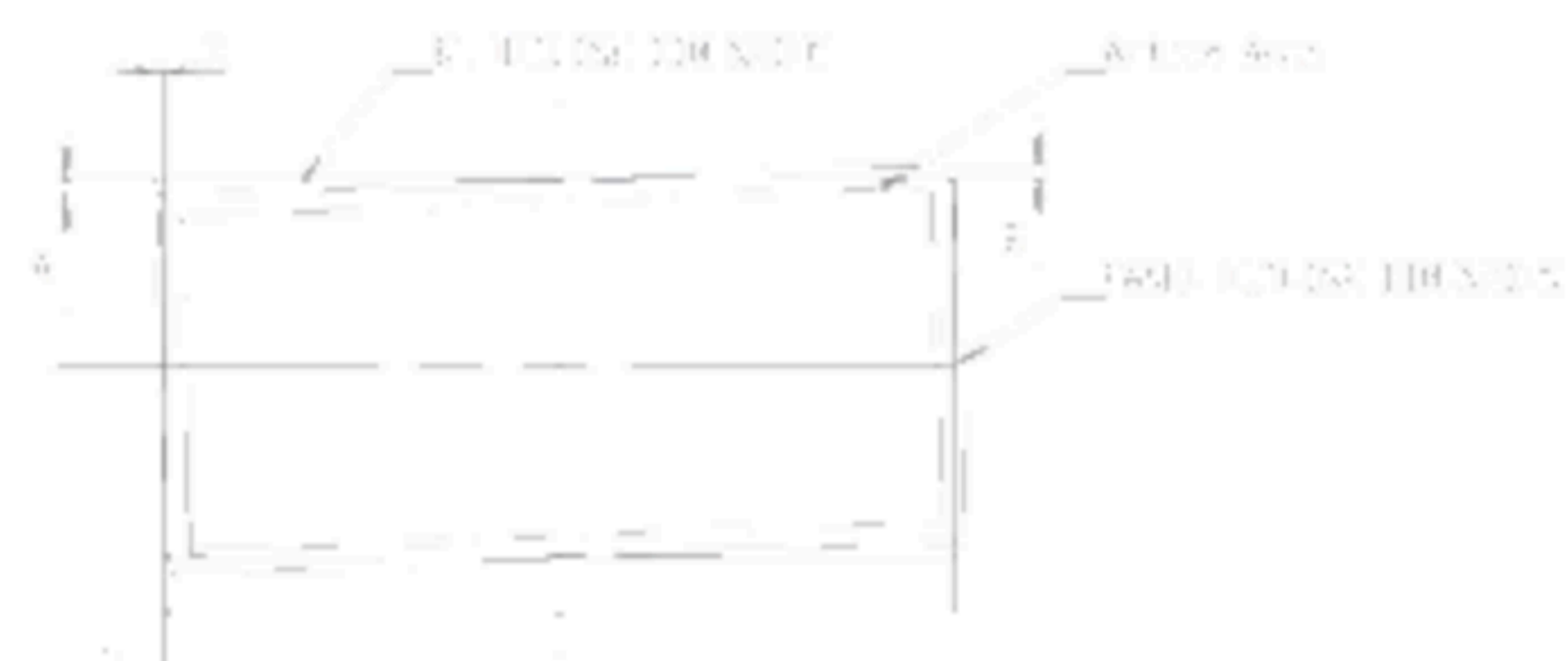


Product Specification

<REAR VIEW>



1. The panel is a 15.5 inch (392mm) wide panel.
 2. The panel is a 15.5 inch (392mm) high panel.
 3. The panel is a 15.5 inch (392mm) deep panel.
 4. The panel is a 15.5 inch (392mm) wide panel.
 5. The panel is a 15.5 inch (392mm) high panel.
 6. The panel is a 15.5 inch (392mm) deep panel.



1. The panel is a 15.5 inch (392mm) wide panel.
 2. The panel is a 15.5 inch (392mm) high panel.
 3. The panel is a 15.5 inch (392mm) deep panel.
 4. The panel is a 15.5 inch (392mm) wide panel.
 5. The panel is a 15.5 inch (392mm) high panel.
 6. The panel is a 15.5 inch (392mm) deep panel.

Product Specification

6. Reliability

Table 13. Environment test conditions

No	Test Item	Condition	Notes
1	High temperature storage test	Ta= 60°C 240h	1
2	Low temperature storage test	Ta= -20°C 240h	1
3	High temperature operation test	Ta= 50°C 50%RH 240h	1
4	Low temperature operation test	Ta= 0°C 240h	1
5	Altitude operating storage / shipment	0 - 16,400 feet(5,000m) 0 - 40,000 feet(12,192m)	

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

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

Product Specification

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 : 14 pcs

b) Box Size : 814mm×542mm×400mm

Product Specification

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 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 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.

9-2. 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 minimize 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) 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 °C)

Product Specification

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.