

TENTATIVE

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3.5"QHD

TECHNICAL SPECIFICATION

AA035AE01

MITSUBISHI ELECTRIC CORPORATION

Date: Feb.25,'16

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1. APPLICATION

This specification applies to color TFT-LCD module, AA035AE01.

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MITSUBISHI's TFT-LCD module is designed and produced for "General Application" which is described as below.

<General Application>

Computers, office automation equipment, factory automation equipment, test and measurement equipment, communications, medical equipment which has no impact for human life and body, display equipment utilized in transportation system (automobiles, ships, trains, etc) which has no influence on its operation directly or indirectly.

Therefore, MITSUBISHI do not guarantee using our TFT-LCD for other application such as medical equipment, safety equipment, transportation system which might be influenced for its operation because of LCD-TFT, military systems, defense equipment, aerospace equipment, nuclear reactor control systems, and any other application in which there is a direct or indirect risk for human life and body or where high levels of reliability are required. Please confirm your application before using MITSUBISHI's TFT-LCD.

Furthermore, it is mandatory to make contract (document base) by both parties (customer and MITSUBISHI), in case if customers intend to use our TFT-LCD for such application as military systems, defense equipment, aerospace equipment and nuclear reactor control systems, "which has significant impact for human life and body". Otherwise, please do not use MITSUBISHI's TFT-LCD for any cases.

MITSUBISHI has been making continuous effort to improve the reliability of its products. However customers should implement sufficient reliability design of their application equipments such as redundant system design, fail-safe functions and anti-failure features.

MITSUBISHI assumes no responsibility for any damage, including but not limited to damage to human life and body, resulting from the use of the product for the application other than the above mentioned General Application or the use of the product that does not comply with the instructions and the precautions specified in this document.

2. OVERVIEW

AA035AE01 is 3.5" color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs, control circuit, and backlight unit.

By applying 6 bit digital data, 960×540 , 262k-color images are displayed on the 3.5" diagonal screen. Input voltages require 2.5V for digital power supply and 3.2V for analog power supply.

The type of data and control signals are digital and transmitted via LVDS interface per Typ. 37.8 MHz clock cycle.

Driver circuit for LED backlight is not included in this module. General specifications are summarized in the following table:

ITEM	SPECIFICATION
Display Area (mm)	77.76 (H) \times 43.74 (V) (3.5-inch diagonal)
Number of Dots	960×3 (H) \times 540 (V)
Pixel Pitch (mm)	0.081 (H) \times 0.081 (V)
Color Pixel Arrangement	RGB vertical stripe
Display Mode	Normally black
Number of Color	262k
Luminance (cd/m ²)	400
Viewing Angle (CR \geq 10)	-85~85° (H), -85~85° (V)
Surface Treatment	Clear and hard-coating 3H
Electrical Interface	LVDS
Module Size (mm)	90.0 (W) \times 57.0 (H) \times 4.0 (D) *)
Module Mass (g)	43
Backlight Unit	Edge-light, LED

*) W/O FPC

Characteristic value without any note is typical value.

3. ABSOLUTE MAXIMUM RATINGS

ITEM	SYMBOL	MIN.	MAX.	UNIT
LCD Analog Power Supply Voltage	VCC	-0.3	4.0	V
LCD Digital Power Supply Voltage	VDD	-0.3	3.9	V
Logic Input Voltage	VI	-0.3	VDD+0.3V	V
Backlight (LED) Current	IF	--	30	mA
Operation Temperature <small>Note 1),2)</small>	T _{op}	-20	70	°C
Storage Temperature <small>Note 2)</small>	T _{stg}	-30	80	°C

[Note]

1) MIN.: Measured at the center of panel surface, MAX.: Measured at the center of panel back surface

2) Top, Tstg ≤ 40°C : 90%RH max. without condensation

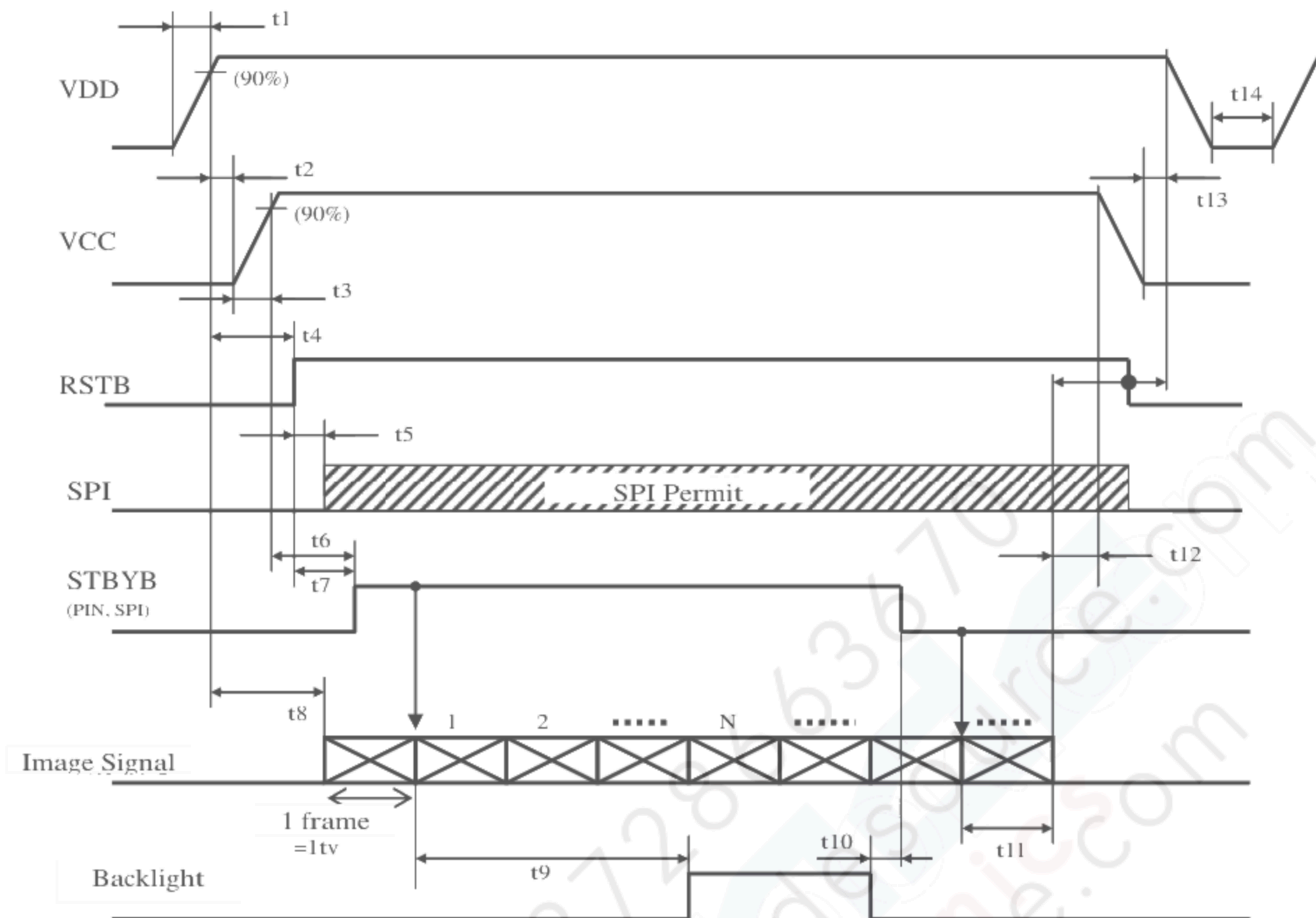
Top, Tstg > 40°C : Absolute humidity shall be less than the value of 90%RH at 40°C without condensation.

4. ELECTRICAL CHARACTERISTICS

(1) TFT- LCD

ITEM		SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks
LCD Analog Power Supply Voltage		VCC	2.75	3.2	3.3	V	*1)
LCD Analog Power Supply Current		ICC	--	55	130	mA	Ta = 25°C *2), *5)
LCD Analog Stand-by Current		ICCS	--	(0.5)	(1)	mA	Ta = 25°C, *3)
LCD Digital Power Supply Voltage		VDD	2.35	2.5	2.7	V	*1)
LCD Digital Power Supply Current		IDD	--	11	25	mA	Ta = 25°C *2), *5)
LCD Digital Stand-by Current		IDDS	--	(250)	(500)	μA	Ta = 25°C, *3)
Logic Input Voltage	High	VIH	0.7 VDD	--	VDD	V	STBYB, RSTB, SPI
	Low	VIL	0	--	0.3 VDD	V	
Logic Output Voltage	High	VOH	VDD-0.4	--	--	V	SDA I _{OH/L} =± 400μA
	Low	VOL	--	--	0.4	V	
Pull-up/Pull-down Resistance		Ri	(400)	(500)	(600)	kΩ	VDD=2.5V
LVDS Input	Differential Input High Threshold Voltage	V _{THLVDS}	--	--	100	mV	V _{CMLVDS} = +1.2V *4)
	Differential Input Low Threshold Voltage	V _{TLLVDS}	-100	--	--	mV	
	Input Voltage Range (Single-End)	V _{LVDS}	0		VDD-1.2+ V _{IDLVDS} /2	V	*4)
	Differential Input Common Mode Voltage	V _{CMLVDS}	V _{IDLVDS} /2		VDD-1.2	V	*4)
	Differential Input Voltage	V _{IDLVDS}	0.2		0.6	V	*4)

*1) Power and signals sequence:



$$0.1\text{ms} < t1 < 10\text{ms}$$

$$0 \leq t2$$

$$0.1\text{ms} < t3 < 10\text{ms}$$

$$50\mu\text{s} \leq t4$$

$$10\text{ms} \leq t5$$

$$0 < t6$$

$$t5 \leq t7$$

$$0 \leq t8$$

$$9t_v \leq t9$$

$$0 \leq t10$$

$$8t_v \leq t11$$

$$0 \leq t12$$

$$0 \leq t13$$

$$200\text{ms} \leq t14$$

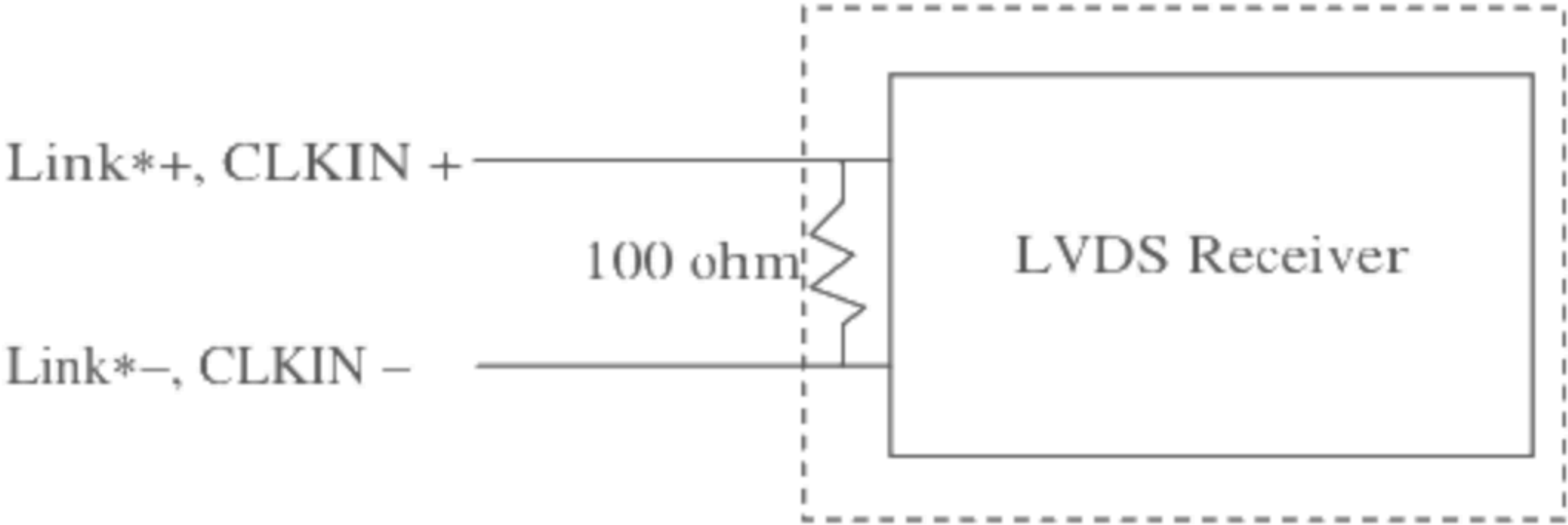
If there is a possibility “t13” cannot be kept the spec, especially when VDD became lower than 2V during VCC applied, over current could occur. To avoid the over current, a reset IC is recommended to insert on VDD line.

*2) VCC = +3.2 V, VDD = +2.5 V, typical timing conditions in section 6

Display image at typical power supply current value is 64-gray-pattern (6 bit)

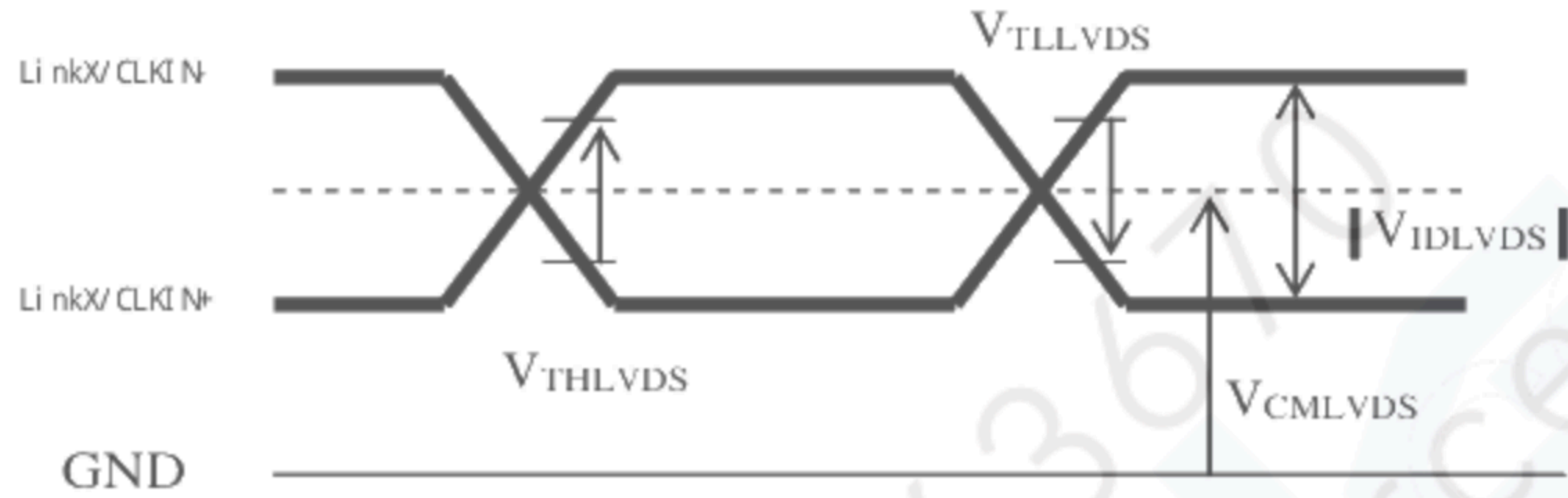
*3) VCC = +3.2 V, VDD = +2.5 V, standby status, no input signal

*4) LVDS Signal

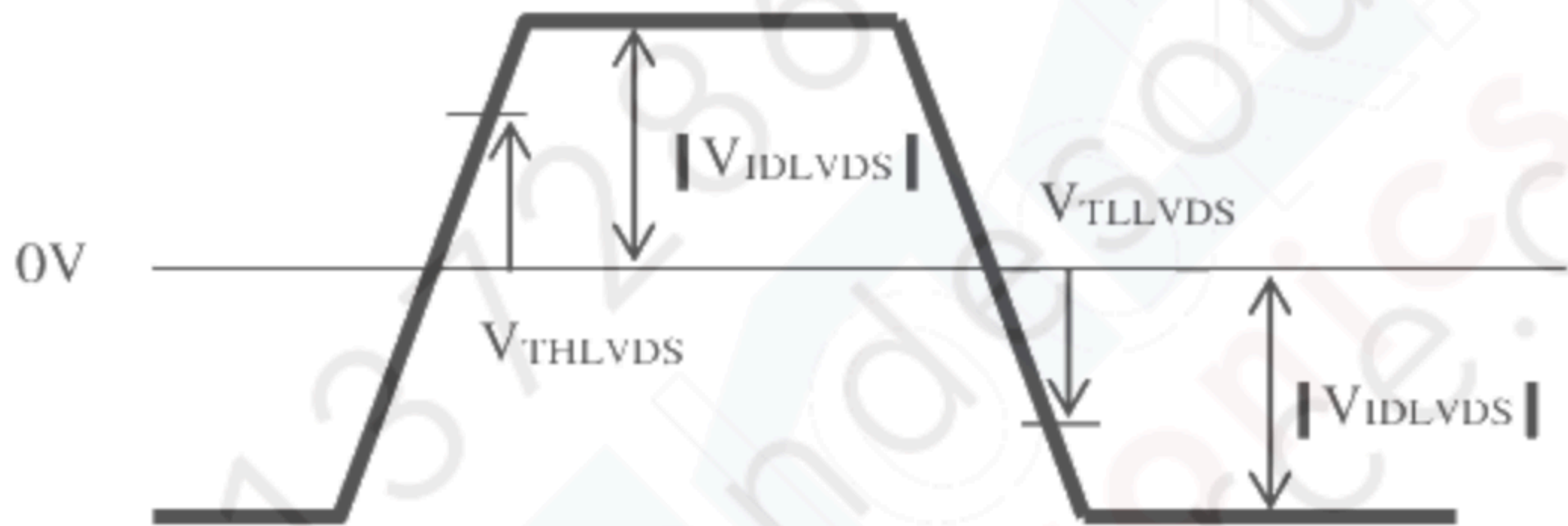


Each pairs of LVDS signals are terminated with 100ohm resistors inside LCD as above block diagram

Single-End



Differential (LinkX/CLKIN+ - LinkX/CLKIN-)



*5) Fuse

Parameter	Fuse Type Name	Supplier	Remark
VCC, VDD	FCC16102AD	Kamaya Electric Co., Ltd.	*)

(2) Backlight

ITEM	SYMBOL	MIN.	TYP.	MAX.	UNIT	Remarks
LED Voltage	VF	--	(15.0)	17.8	V	IF = 20 mA, Ta = 25°C, *2)
		--	--	18.4	V	IF = 20 mA, Ta = 0°C
		--	--	18.9	V	IF = 20 mA, Ta = -20°C
LED Current	IF	--	20.0	--	mA	Ta = 25°C, *1)

[Note]

*1) Constant Current Drive

*2) The Voltage deviation between strings: $|V_{fmax} - V_{fmin}| \leq 2V$

5. INTERFACE PIN CONNECTION

(1) FPC1 (Interface Signal)

Corresponding connector: 20542 Series (Dai-ichi Seiko)

Pin No.	Symbol	I/O	Pull	Function
1	GND	(I)	PU	Connect to GND
2	CSB	I	PD	SPI Chip Select
3	SDA	IO	PD	SPI Data (I/O)
4	GND	G		
5	SCL	I	PD	SPI Clock
6	GND	G		
7	Link 3+	I	*	LVDS Link3 (-, B5, B4, G5, G4, R5, R4)
8	Link 3-	I		LVDS Link3 (-, B5, B4, G5, G4, R5, R4)
9	GND	G		
10	Link 2+	I	*	LVDS Link2 (DE, VS, HS, B3, B2, B1, B0)
11	Link 2-	I		LVDS Link2 (DE, VS, HS, B3, B2, B1, B0)
12	GND	G		
13	Link 1+	I	*	LVDS Link1 (-, -, G3, G2, G1, G0, -)
14	Link 1-	I		LVDS Link1 (-, -, G3, G2, G1, G0, -)
15	GND	G		
16	Link 0+	I	*	LVDS Link0 (-, R3, R2, R1, R0, -, -)
17	Link 0-	I		LVDS Link0 (-, R3, R2, R1, R0, -, -)
18	GND	G		
19	CLKIN+	I	*	LVDS Clock
20	CLKIN-	I		LVDS Clock
21	GND	G		
22	STBYB	I	PU	Stand-by Control (H:Normal, L:Standby)
23	RSTB	I	PU	Reset (H:Normal, L:Reset)
24	GND	G		
25	GND	I		
26	VDD	P		Digital Power Supply 2.5 V
27	VDD	P		Digital Power Supply 2.5 V
28	VCC	P		Analog Power Supply 3.2V
29	VCC	P		Analog Power Supply 3.2V
30	VCC	P		Analog Power Supply 3.2V

*) Metal frame is connected to signal GND.

*) I/O(Attribute): I=Input, IO=Input-Output, P=Power, G=GND

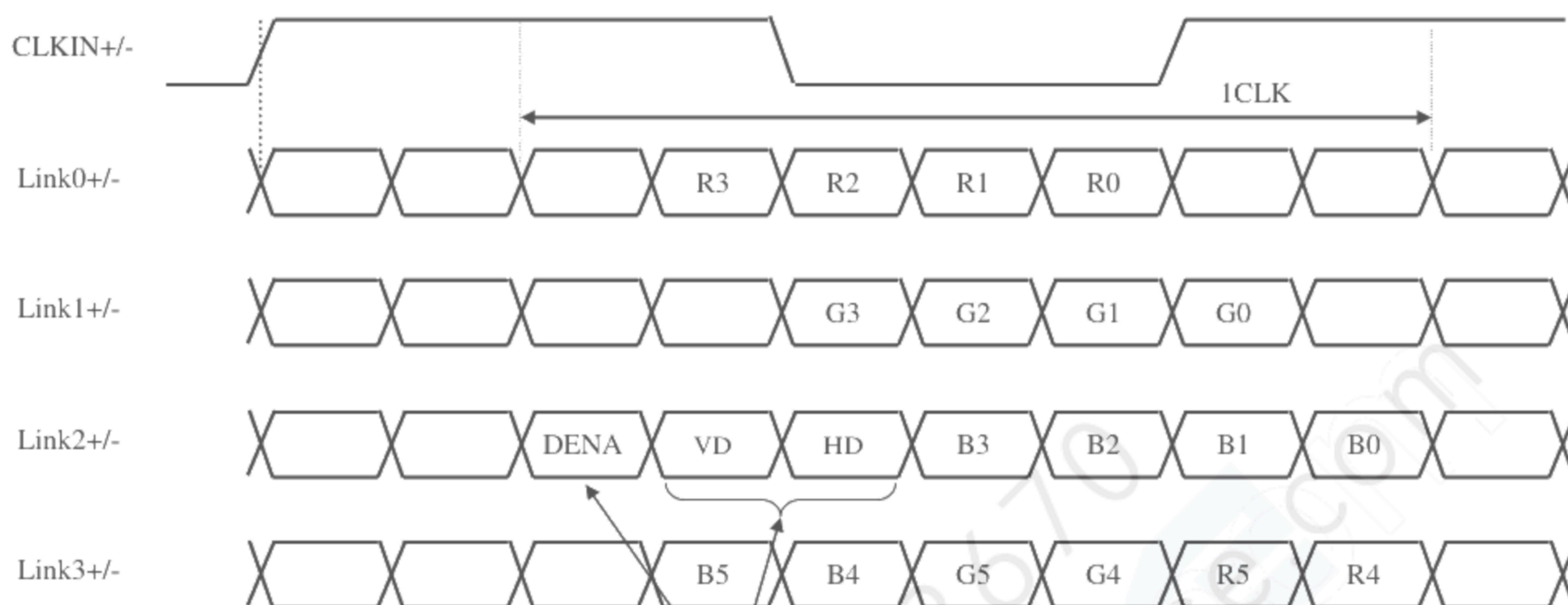
*) Pull(Pull-up/down): PU=Pull-up, PD=Pull-down, * =100Ω terminal resistance

(2) FPC2 (Backlight)

Corresponding connector: 20542 Series (Dai-ichi Seiko)

Pin No.	Symbol	Function
1	LED C 1	LED cathode 1
2	LED A 1	LED anode 1
3	LED A 2	LED anode 2
4	LED C 2	LED cathode 2
5	LED C 3	LED cathode 3
6	LED A 3	LED anode 3

(3) LVDS data mapping



Either DENA or VD/HD is used depending on the mode.

6. INTERFACE TIMING

(1) Timing Specifications

ITEM				SYMBOL	MIN	TYP	MAX	UNIT	Remarks
LVDS Transmitter Input	DCLK	Clock	Frequency	f _{CLK}	32.0	37.8	43.2	MHz	
			Period	t _{CLK}	23.1	26.5	31.3	ns	
	DENA	Horizontal	Active Time	t _{HA}	960	960	960	t _{CLK}	
			Blanking Time	t _{HB}	100	118	240	t _{CLK}	t _{HFP} + t _{HBP}
			Back Porch	t _{HBP}	88	88	88	t _{CLK}	Sync Mode
			Sync Pulse Width	t _{HSW}	1	--	20	t _{CLK}	Sync Mode
			Frequency	f _H	26.7	35.1	39.2	kHz	
			Period	t _H	25.5	28.5	37.5	μs	
		Vertical	Active Time	t _{VA}	540	540	540	t _H	
			Blanking Time	t _{VB}	33	45	60	t _H	t _{VFP} + t _{VBP}
			Back Porch	t _{VBP}	32	32	32	t _H	Sync mode
			Sync Pulse Width	t _{VSW}	1	--	3	t _H	Sync mode
			Frequency	f _V	48.0	59.94	68.4	Hz	
			Period	t _V	14.6	16.7	20.8	ms	
LVDS Input	LVDS Input Data Skew Margin (*)			t _{RSKM}	500	--	--	PS	
	Clock “L” Width			t _{WCLLVDS}	--	3/7	--	t _{CLK}	
	Clock “H” Width			t _{WCHLVDS}	--	4/7	--	t _{CLK}	
SPI	SCL “L” Pulse Width			t _{WL SCL}	50	--	--	ns	For write command
					100	--	--		For read command
	SCL “H” Pulse Width			t _{WH SCL}	50	--	--	ns	For write command
					100	--	--		For read command
	SDA Setup Time			t _{sSDA}	20	--	--	ns	
	SDA Hold Time			t _{hSDA}	20	--	--	ns	
	CSB Setup Time			t _{sCSB}	20	--	--	ns	
	CSB Hold Time			t _{hCSB}	20	--	--	ns	
	CSB “H” Pulse Width			t _{WHCSB}	25	--	--	ns	
	SDA Output Start Time			t _{oSDA}	10	--	--	ns	For read command
	SDA Access Time			t _{acSDA}	--	--	50	ns	For read command
SDA Output Stop Time			t _{zSDA}	--	--	100	ns	For read command	

H-blanking permissible variation is 0 (t_{CLK}) in DE mode and 4 t_{CLK}) in Sync mode.

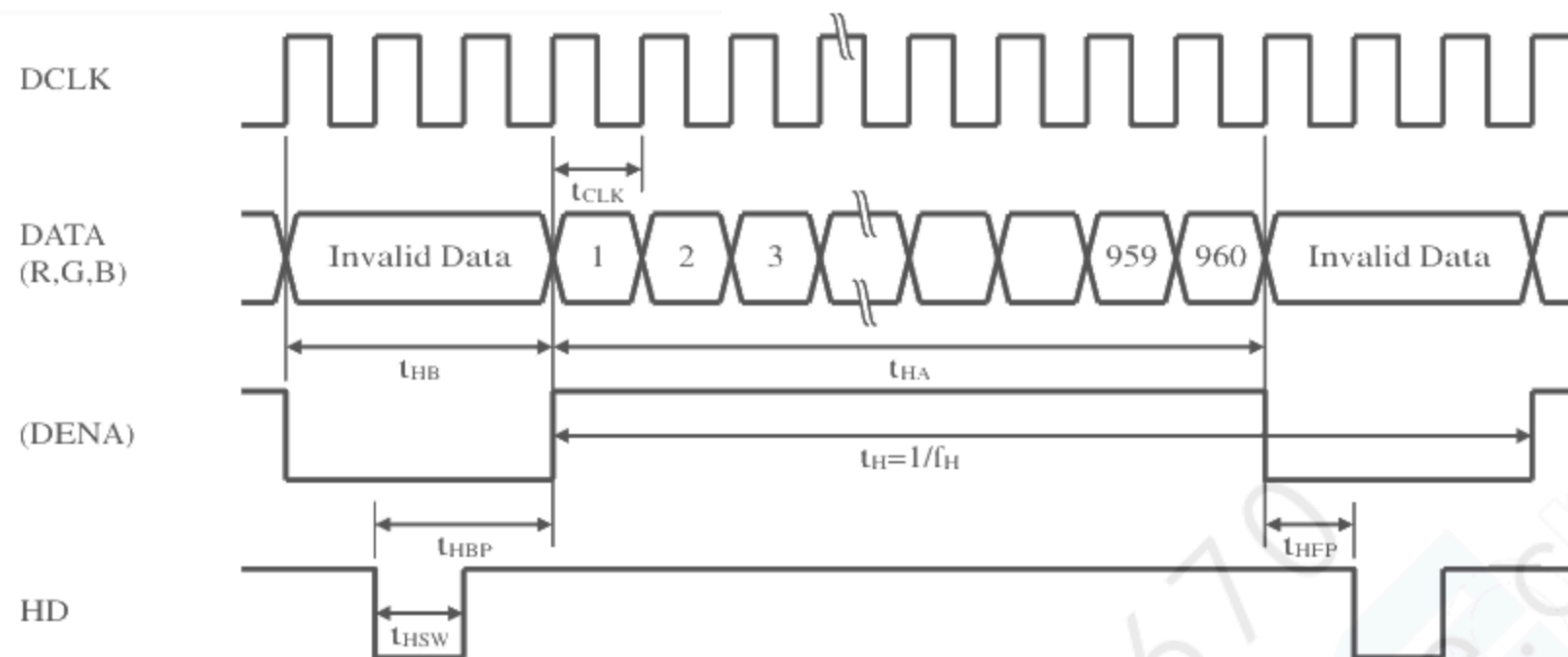
(*) Condition |V_{IDLVD}|=400mV, V_{CMLVD}=1.2V

[Note] 1) DENA(Data Enable) signal is always positive polarity in DE mode.

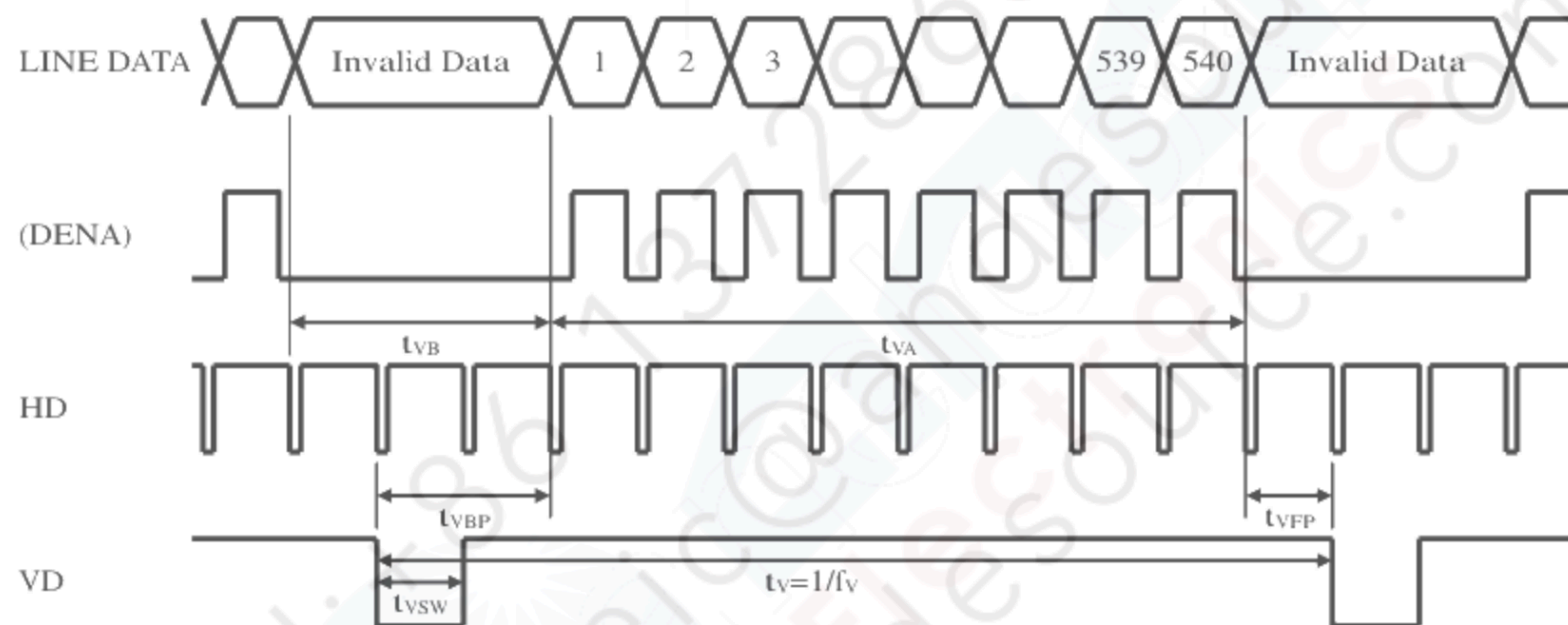
2) DCLK needs to be input during blanking period.

(2) Timing Chart

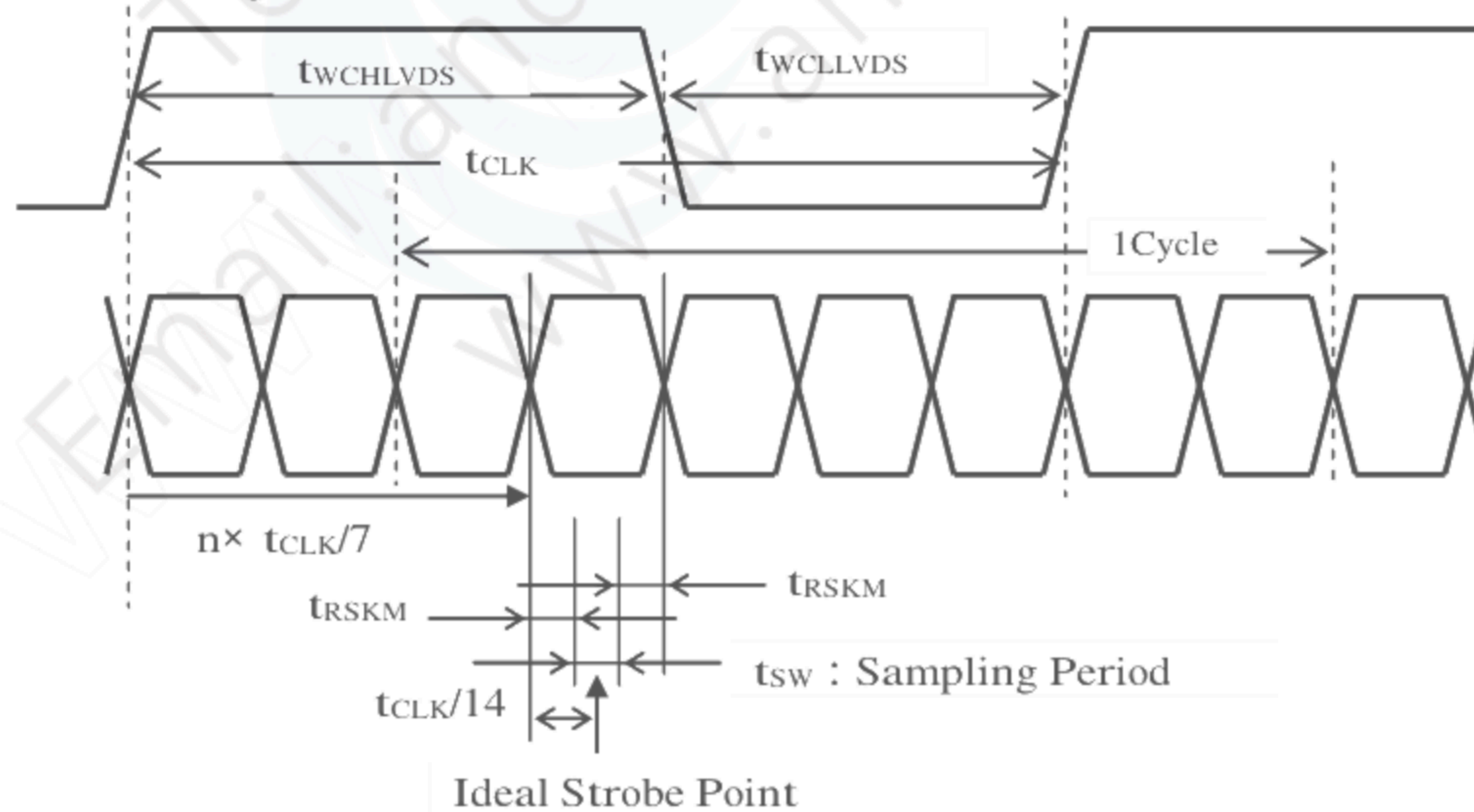
a. Horizontal Timing Chart



b. Vertical Timing Chart

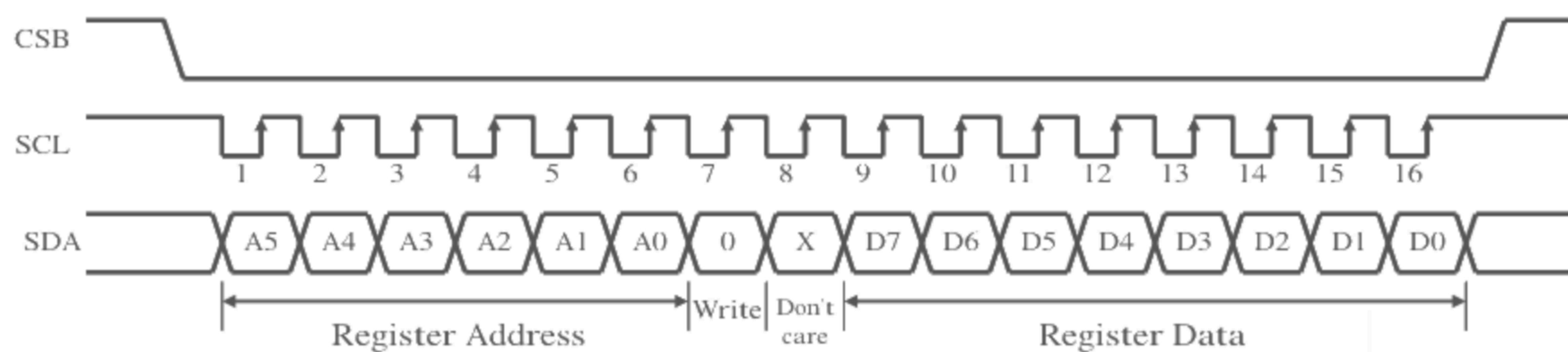


c. LVDS Timing Chart



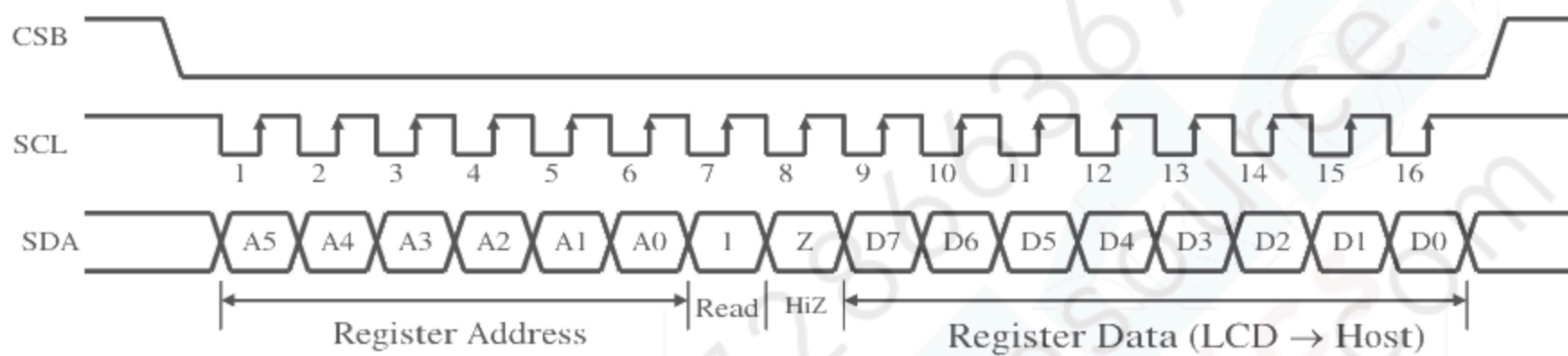
d.SPI Data Format

Write

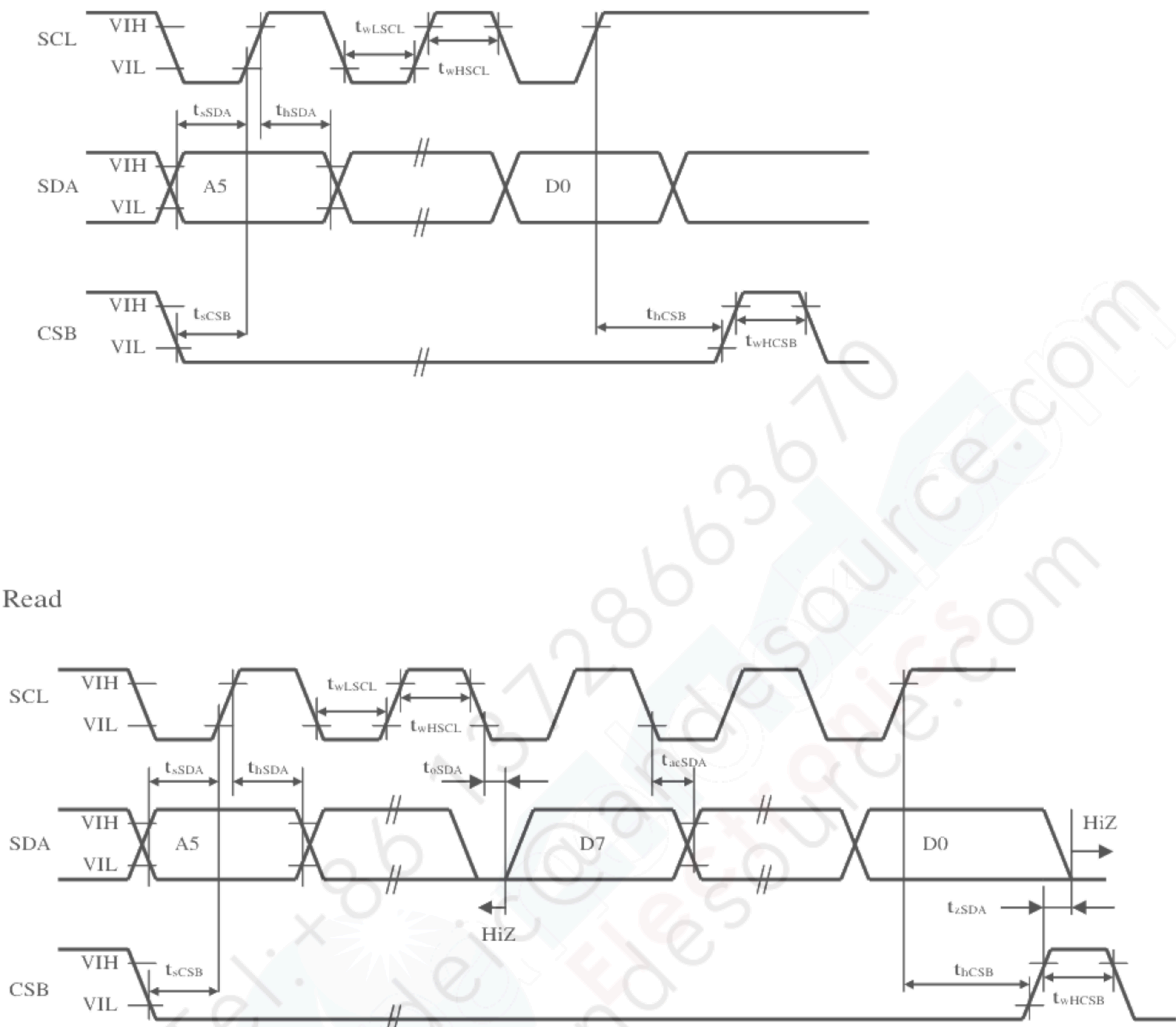


Data is not accepted if there are less or more than 16 cycles for one transaction

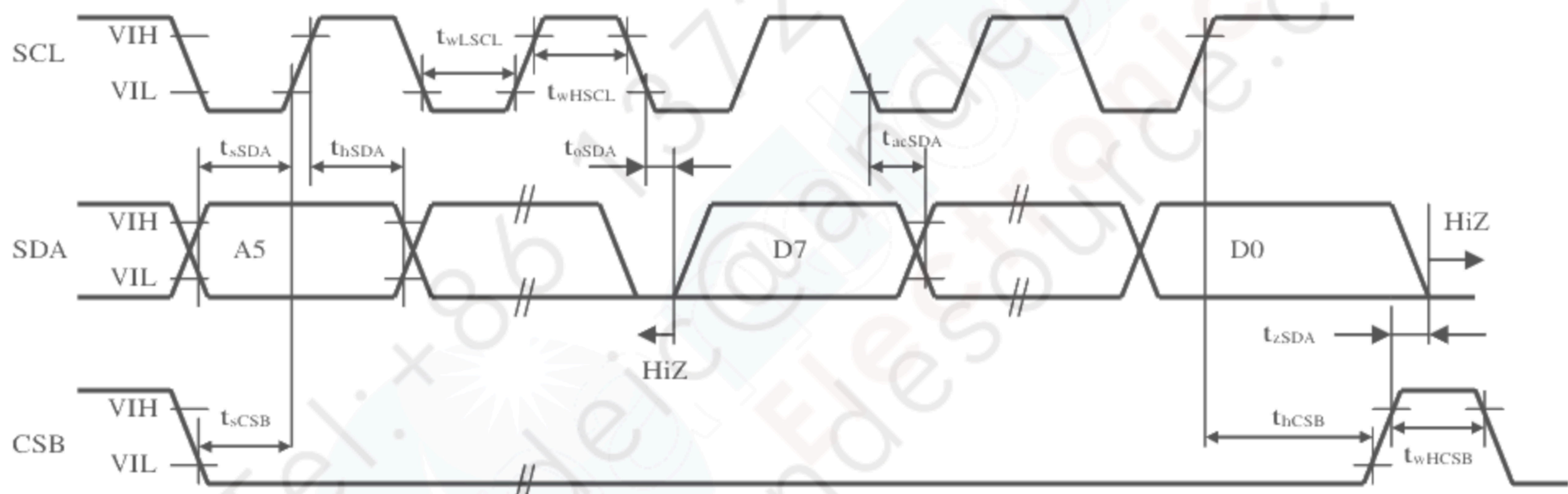
Read



Write



Read



(3) Color Data Assignment

COLOR		INPUT DATA																	
		R DATA						G DATA						B DATA					
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
		MSB					LSB	MSB					LSB	MSB					LSB
BASIC COLOR	BLACK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	CYAN	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	MAGENTA	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	YELLOW	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
	WHITE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
RED	RED(1)	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	RED(2)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(62)	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	RED(63)	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
GREEN	GREEN(1)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	GREEN(2)	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	GREEN(62)	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	GREEN(63)	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
BLUE	BLUE(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
	BLUE(2)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	BLUE(62)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	BLUE(63)	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

[Note]

1) Definition of gray scale

Color (n) --- n indicates gray scale level.

Higher n means brighter level.

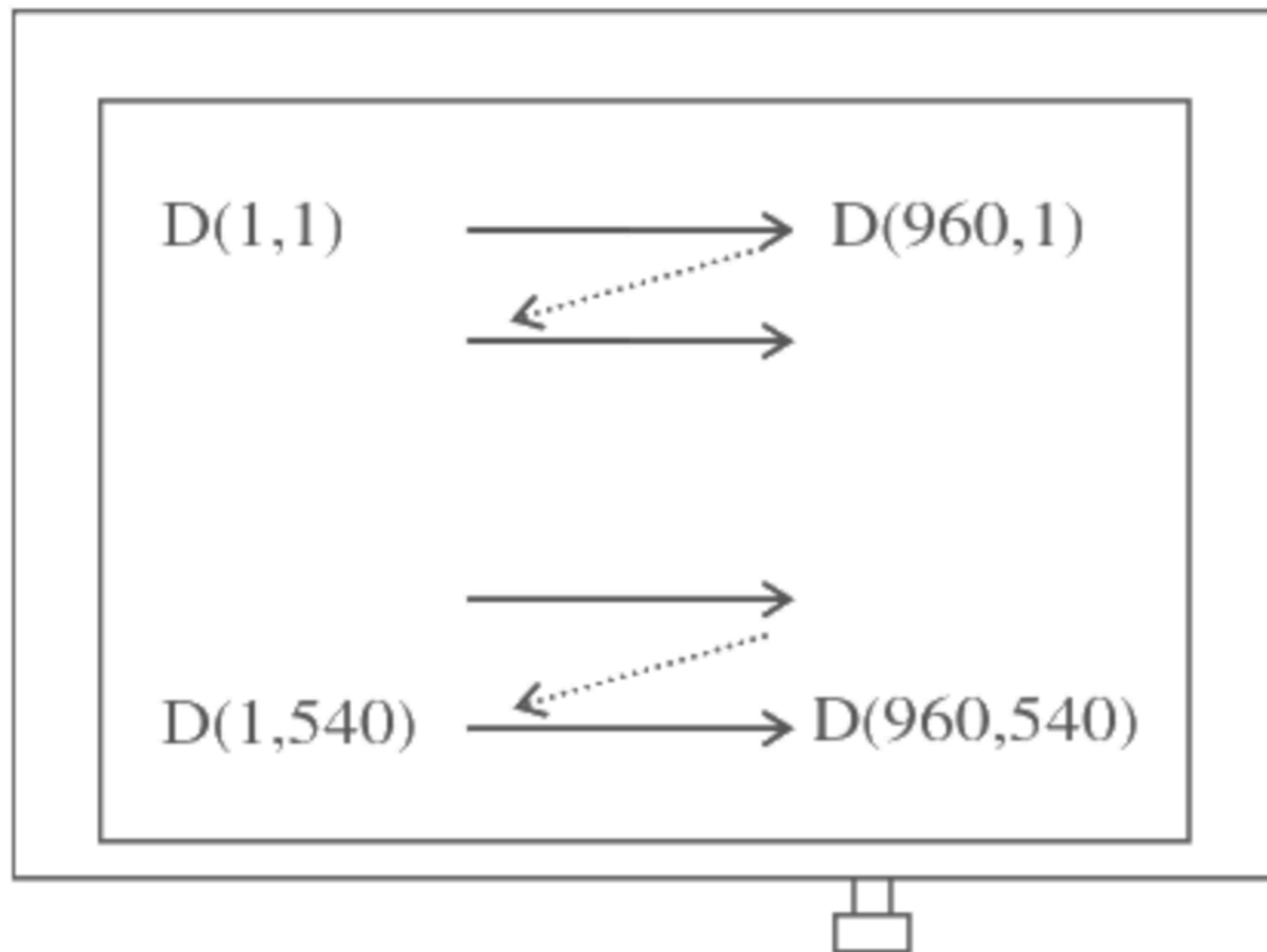
2) Data

1:High, 0: Low

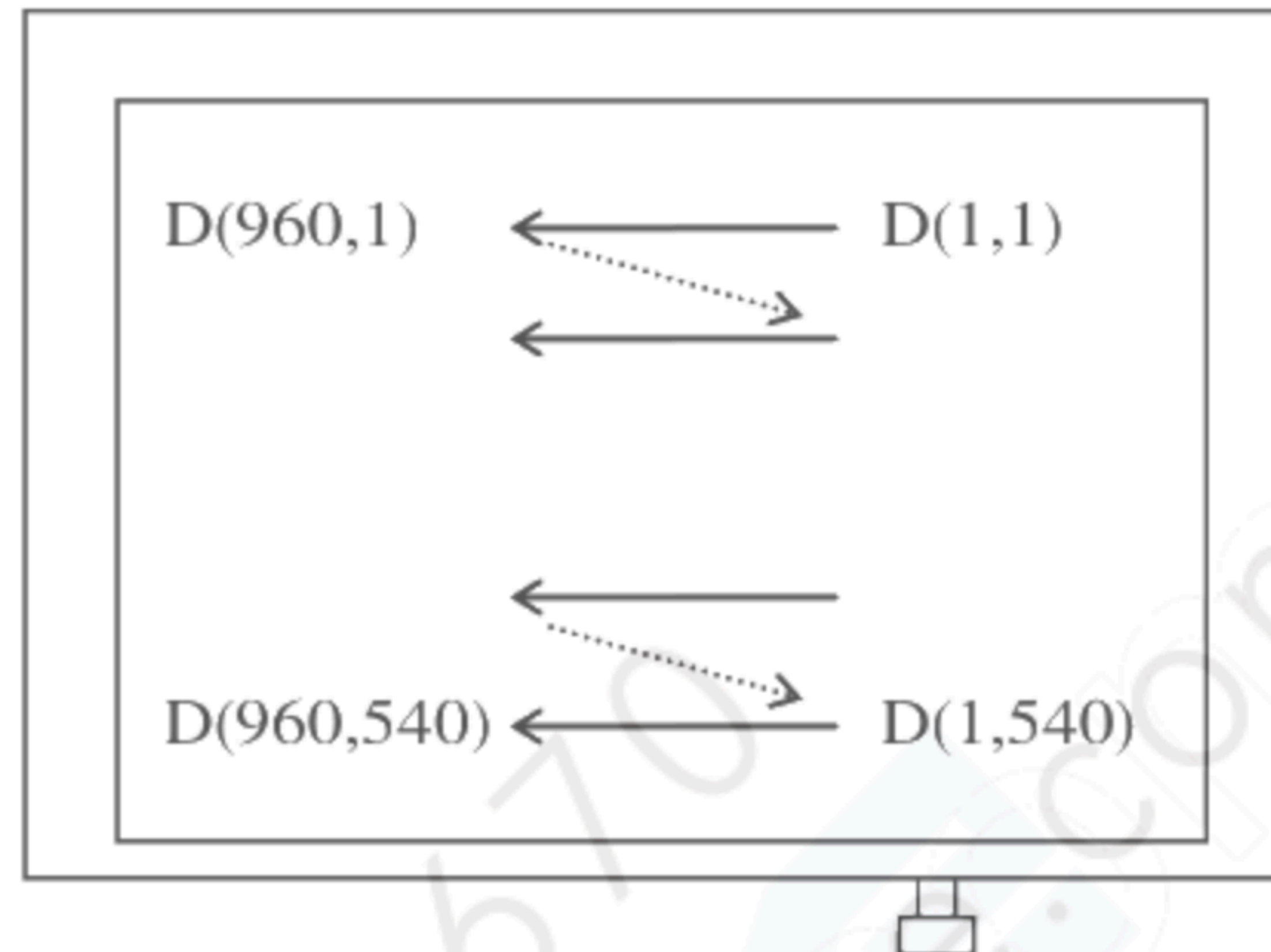
(4) Display Position and Scan Direction

D(X,Y) shows the data number of input signal.

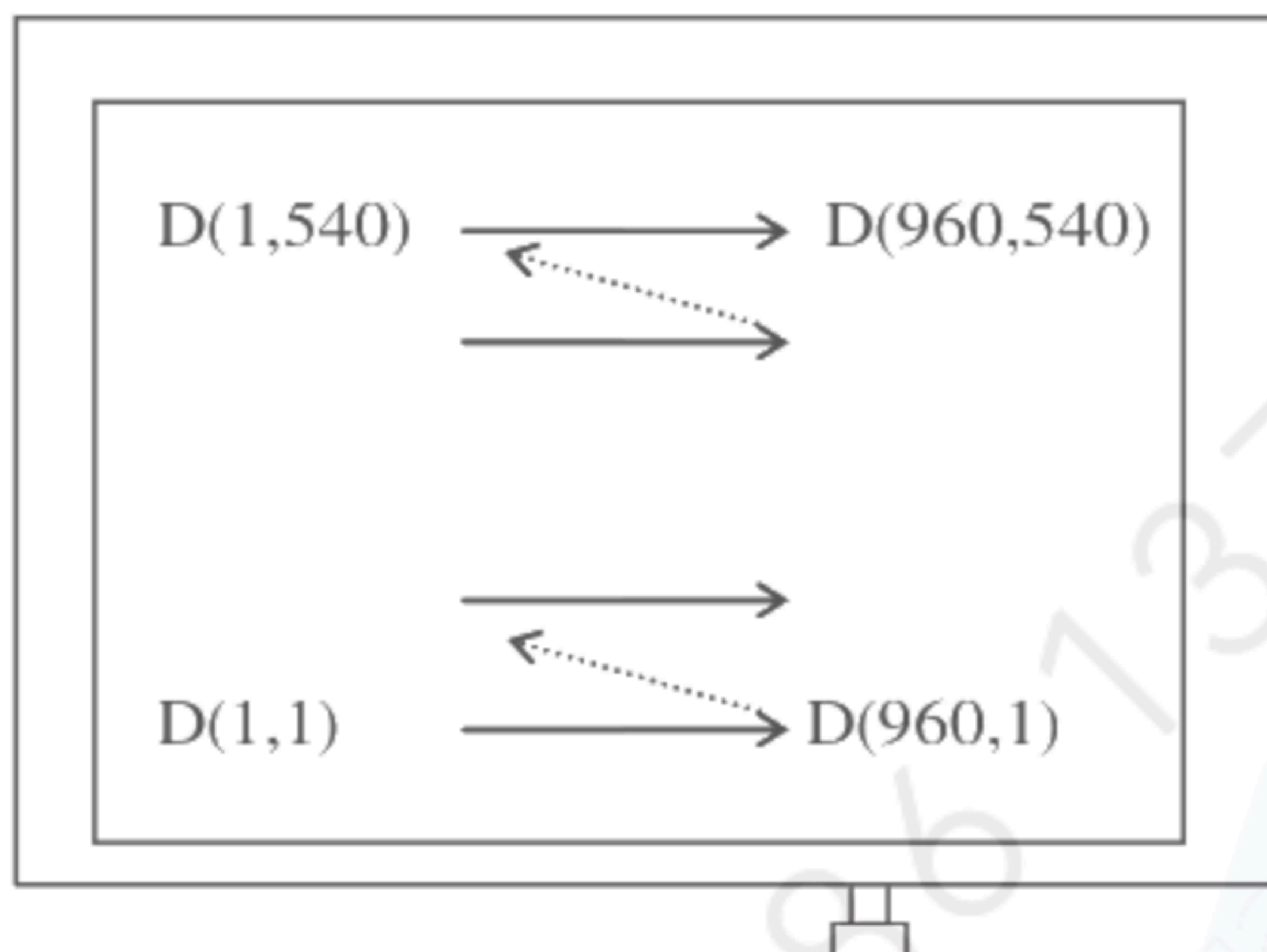
R/L=High, U/D=High



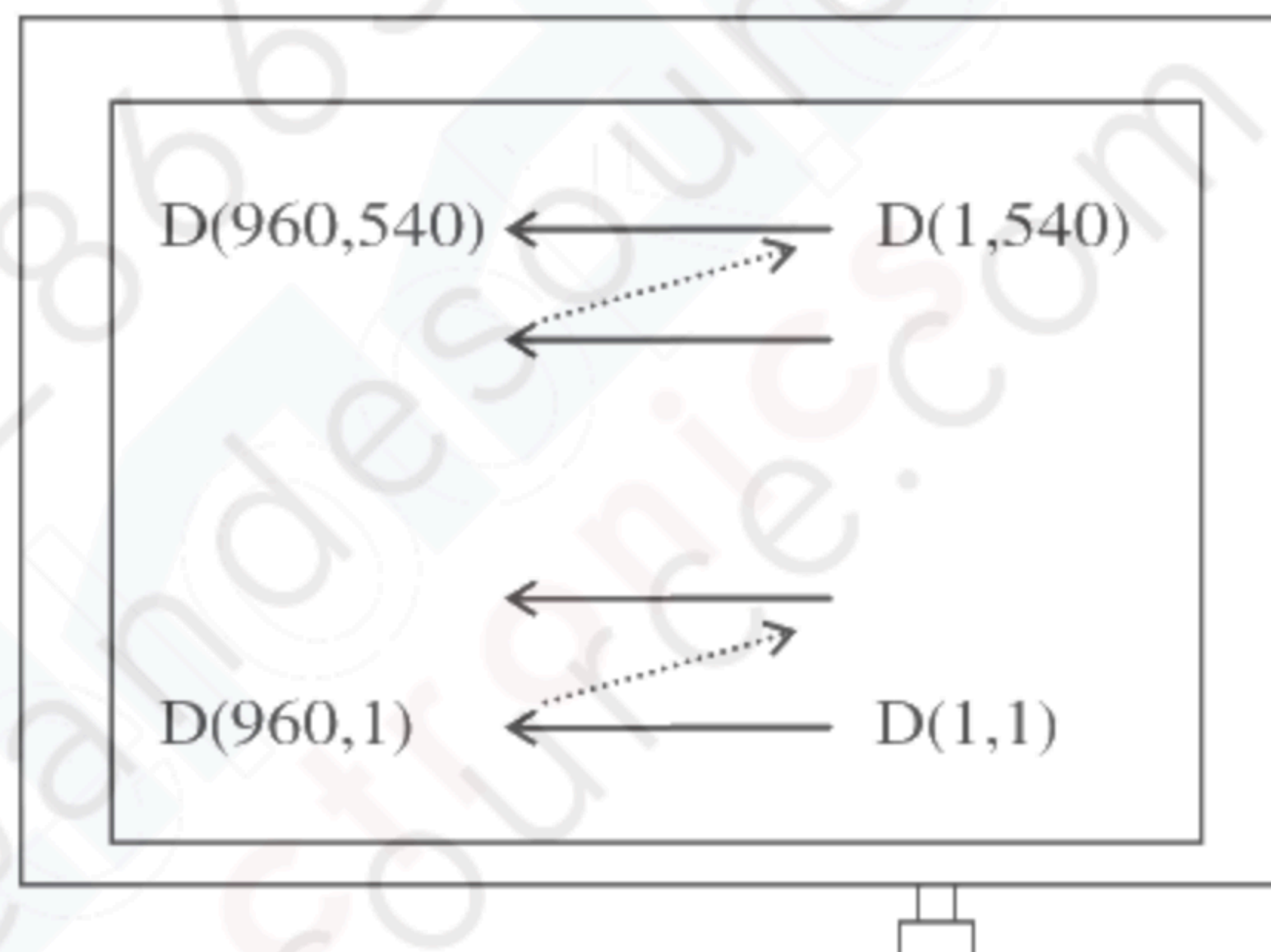
R/L=Low, U/D=High



R/L=High, U/D=Low



R/L=Low, U/D=Low



(5) SPI Register List

Register	A5	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
R00	0	0	0	0	0	0	PWR_EN	—	R/L	U/D	STBYB	GRB	CLKPOL	MODE
							0	—	1	0	1	1	0	1
R01	0	0	0	0	0	1	CABC1	CABC0	HFRC	DIT	BIST	RESL1	RESL0	RESL2
							0	0	0	0	0	0	0	0

R00h

Bit	Name	Default	Description
D7	PWR_EN	0	Set "1" before or at the same time as releasing standby mode and keep it during operation
D6	—	—	—
D5	R/L	1	Refer to "(4) Display Position and Scan Direction"
D4	U/D	0	
D3	STBYB	1	0: Standby Mode, 1: Normal Operation * AND of STBYB pin (pin 22) and STBYB register setting
D2	GRB	1	0: Reset, 1: Normal Operation * AND of RSTB pin (pin 23) and GRB register setting
D1	CLKPOL	0	Set "0"
D0	MODE	1	0: Sync mode (only VD and HD are used) 1: DE mode (only DENA is used)

R01h

Bit	Name	Default	Description
D7	CABC	0	Set "00" on [D7:D6]
D6		0	
D5	HFRC	0	FRC Select
D4	DIT	0	Set "00" on [D5:D4]
D3	BIST	0	Set "0"
D2	RESL	0	Resolution setting
D1		0	Set "001" on [D2:D0]
D0		0	

Recommended Command when Startup

In case of using STBYB pin on FPC1

While STBYB pin is "L", t5 [s] after reset released

R01 ← 0000_0001 (0x31)

R00 ← 10xx_110x (x is "1" or "0" as needed)

Then STBYB pin is set to "H"

In case of using STBYB register (STBYB is fixed to VDD)

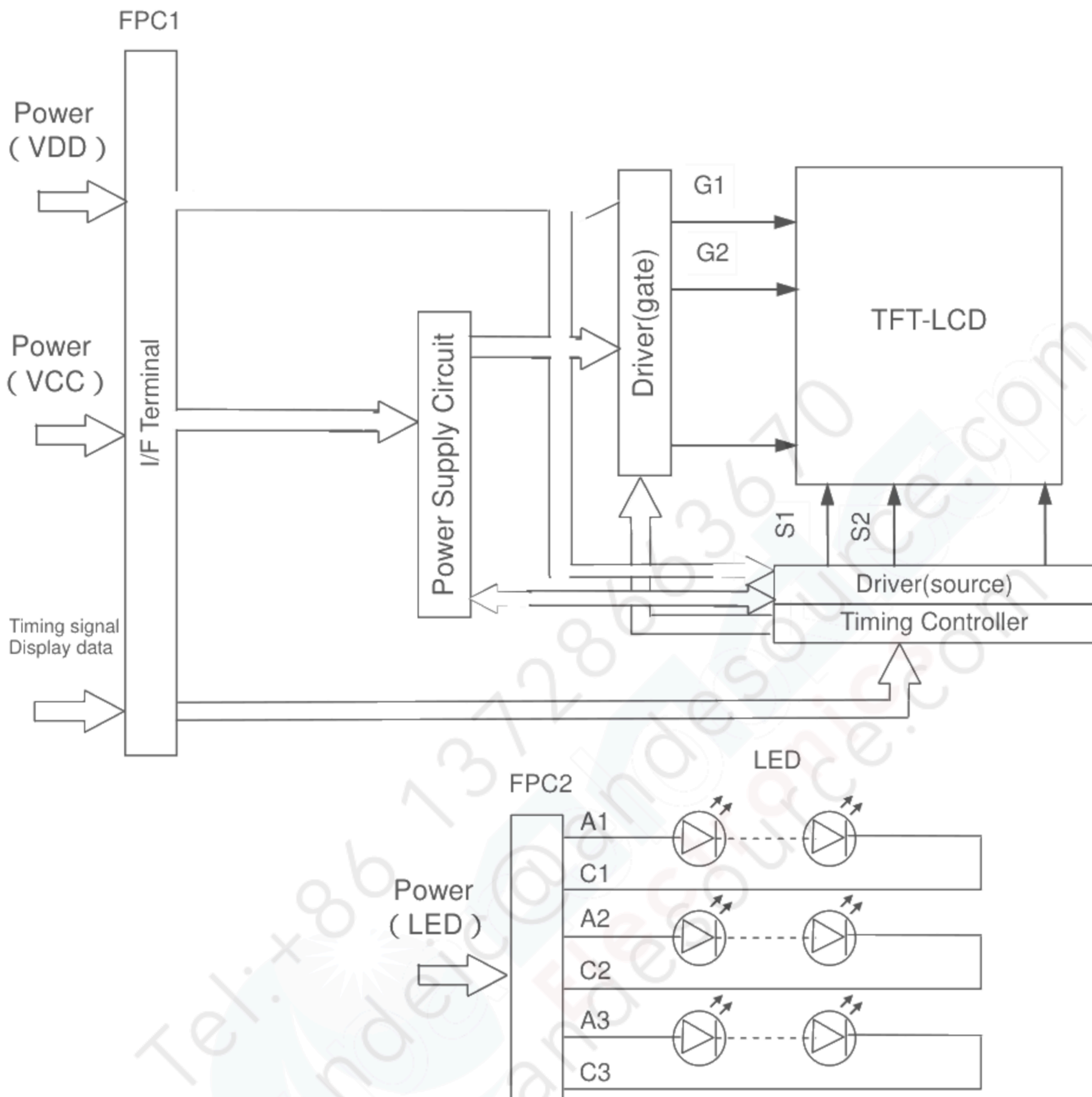
t5 [s] after reset released

R00 ← 00xx_010x (x is "1" or "0" as needed)

R01 ← 0000_0001 (0x31)

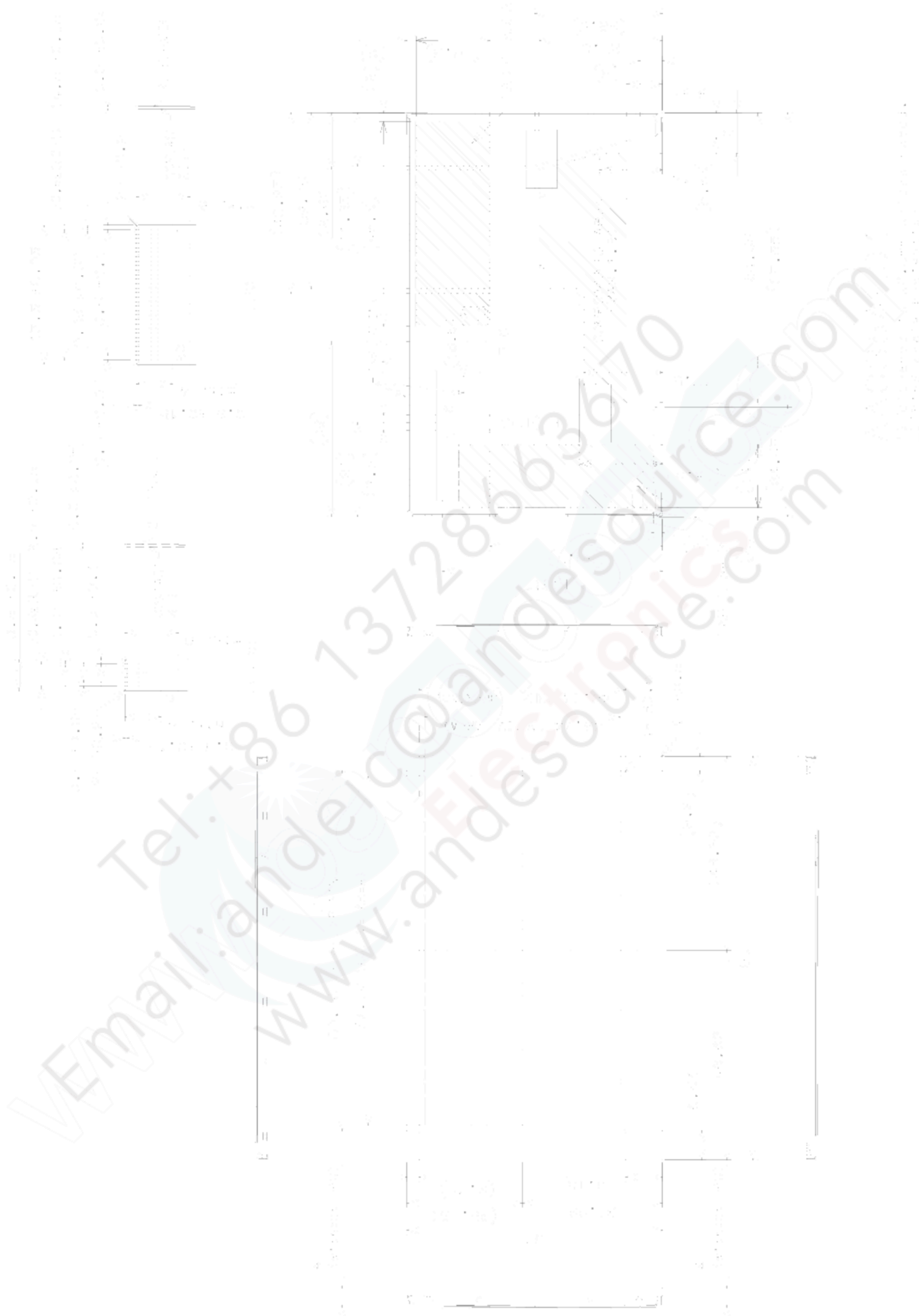
R00 ← 10xx_110x (x is "1" or "0" as needed)

7. BLOCK DIAGRAM



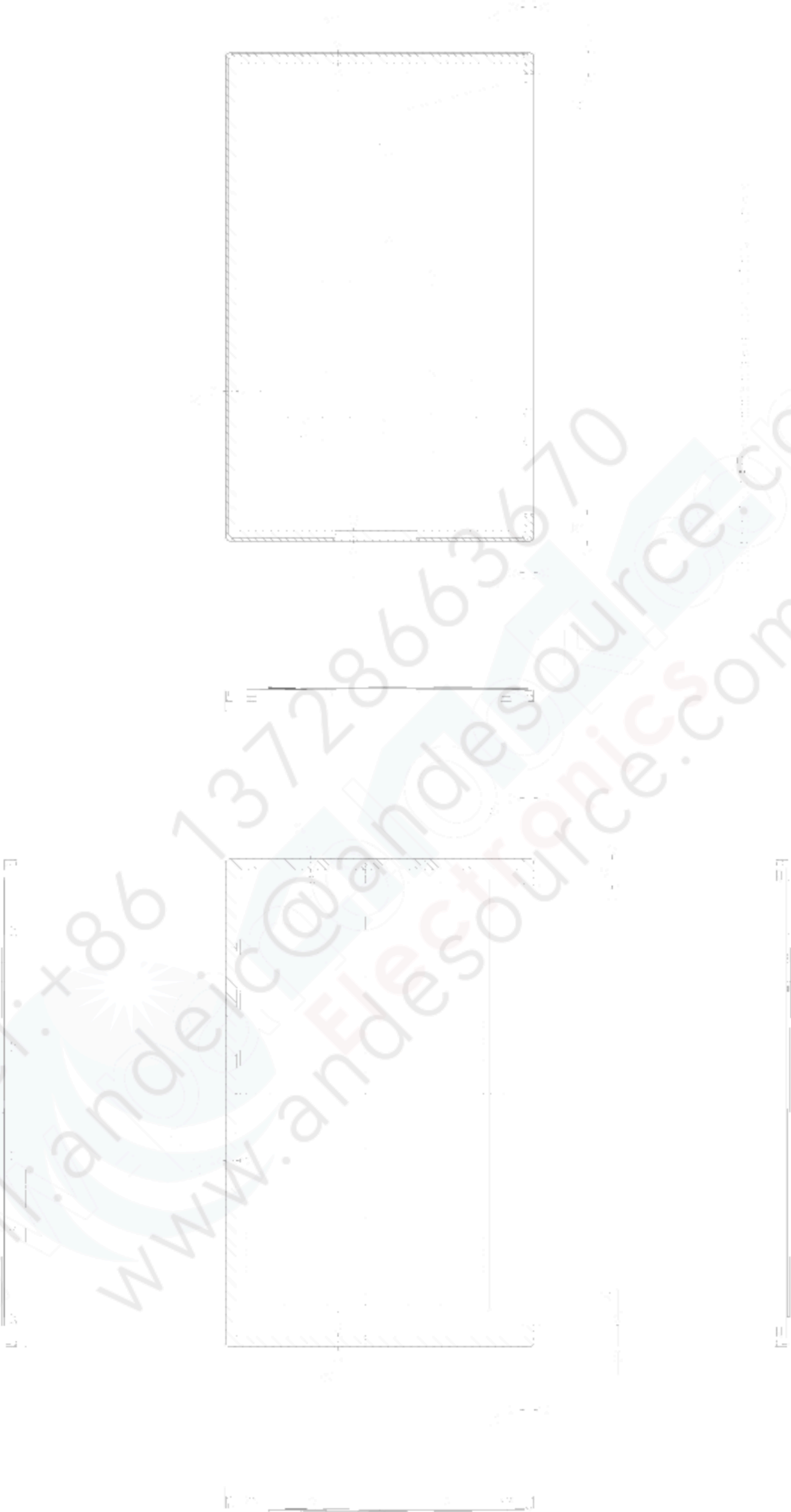
8. MECHANICAL SPECIFICATIONS

(1) Outline Dimensions



(Unit:mm)

(2) Recommended Holding Area



(Unit:mm)

9. OPTICAL CHARACTERISTICS

Ta=25°C, VDD=2.5V, VCC=3.2V, Input Signals: Typ. values shown in Section 6

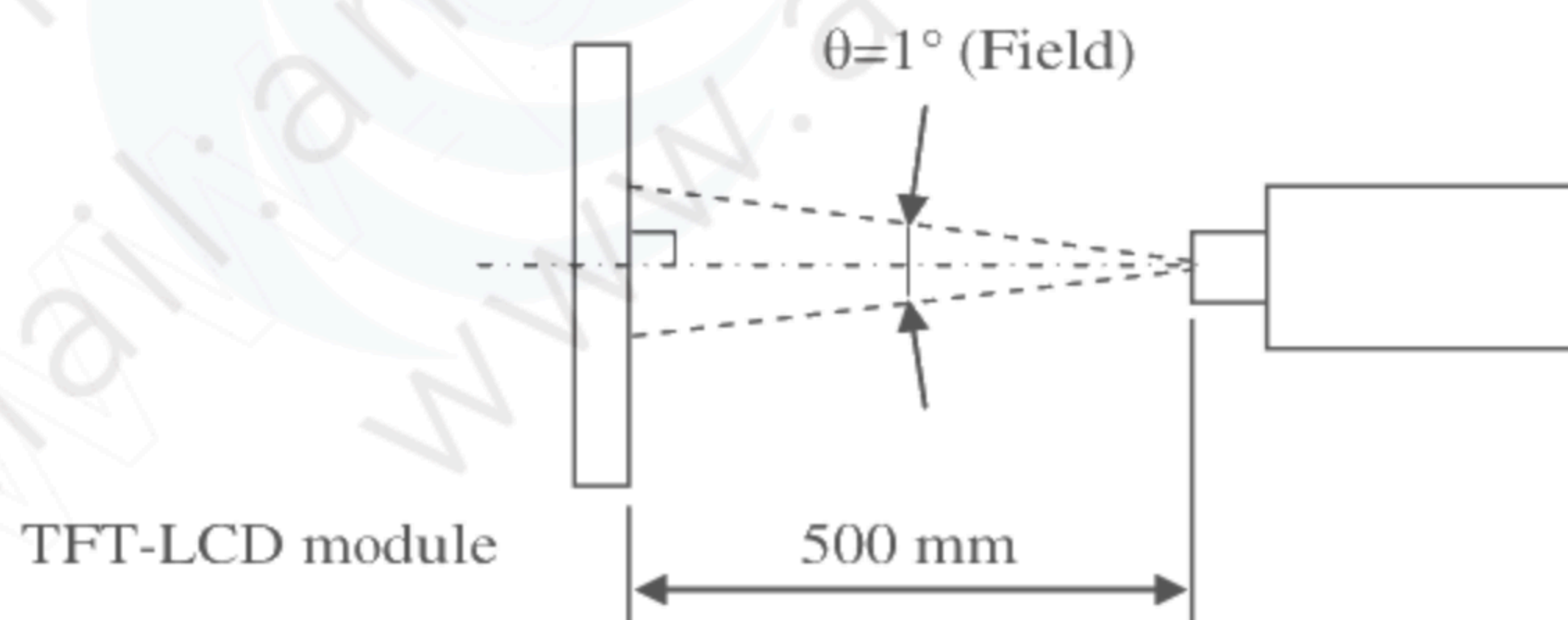
ITEM		SYMBOL	CONDITION	MIN.	TYP.	MAX.	UNIT	Remarks
Contrast Ratio		CR	$\theta_V=0^\circ, \theta_H=0^\circ$	520	800	--	--	*1)*2)*4)
Luminance		Lw	$\theta_V=0^\circ, \theta_H=0^\circ$	320	400	--	cd/m ²	*1)*4)
Luminance Uniformity		ΔLw	$\theta_V=0^\circ, \theta_H=0^\circ$	--	--	30	%	*1)*3)*5)
Response Time		tr	$\theta_V=0^\circ, \theta_H=0^\circ$	--	12	--	ms	*1)*3)*4)
		tf	$\theta_V=0^\circ, \theta_H=0^\circ$	--	12	--	ms	*1)*3)*4)
Viewing Angle	Horizontal	θ_H	CR ≥ 10	-70~70	-85~85	--	--	*1)*4)
	Vertical	θ_V		-70~70	-85~85	--	--	*1)*4)
Image Sticking		tis	2 h	--	--	2	s	*5)
Color Coordinates	Red	Rx	$\theta_V=0^\circ, \theta_H=0^\circ$	0.595	0.635	0.675	--	*1)*4)
		Ry		0.275	0.315	0.355		
	Green	Gx		0.275	0.315	0.355		
		Gy		0.590	0.630	0.670		
	Blue	Bx		0.110	0.150	0.190		
		By		0.025	0.065	0.105		
	White	Wx		0.273	0.313	0.353		
		Wy		0.289	0.329	0.369		

[Note]

These items are measured using EZContrast XL88F(ELDIM) for viewing angle, RD-80SA(TOPCON) for response time and CS-2000 (KONICA MINOLTA) or equivalent equipment for others under the dark room condition (no ambient light) after more than 30 minutes from turning on the backlight unless noted.

Condition: IF = 20 mA

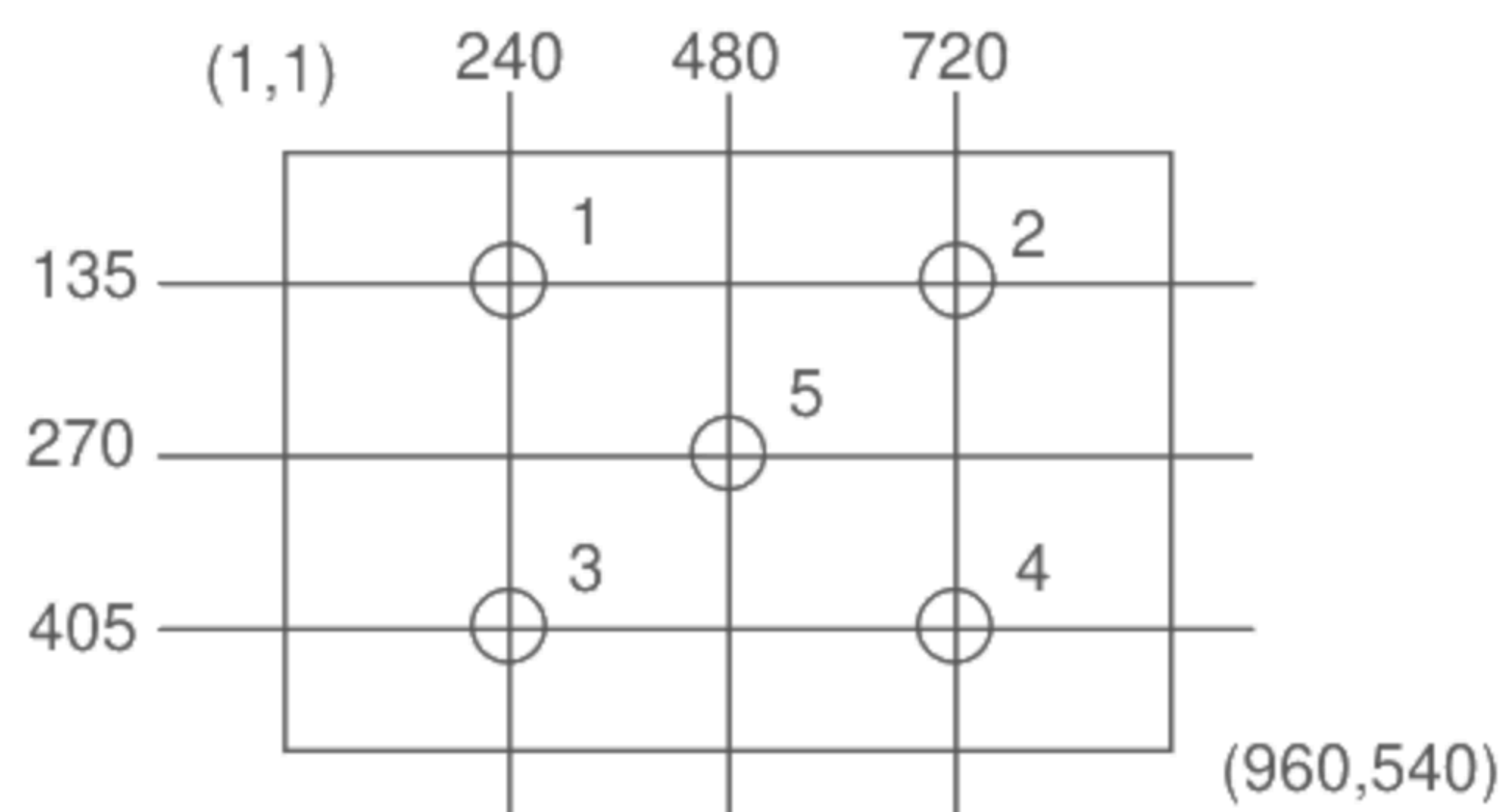
Measurement method for luminance and color coordinates is as follows.



The luminance is measured according to FLAT PANEL DISPLAY MEASUREMENTS STANDARD (VESA Standard).

*1) Measurement Point

Contrast Ratio, Luminance, Response Time, Viewing Angle, Color Coordinates: Display Center
Luminance Uniformity: point 1~5 shown in a figure below



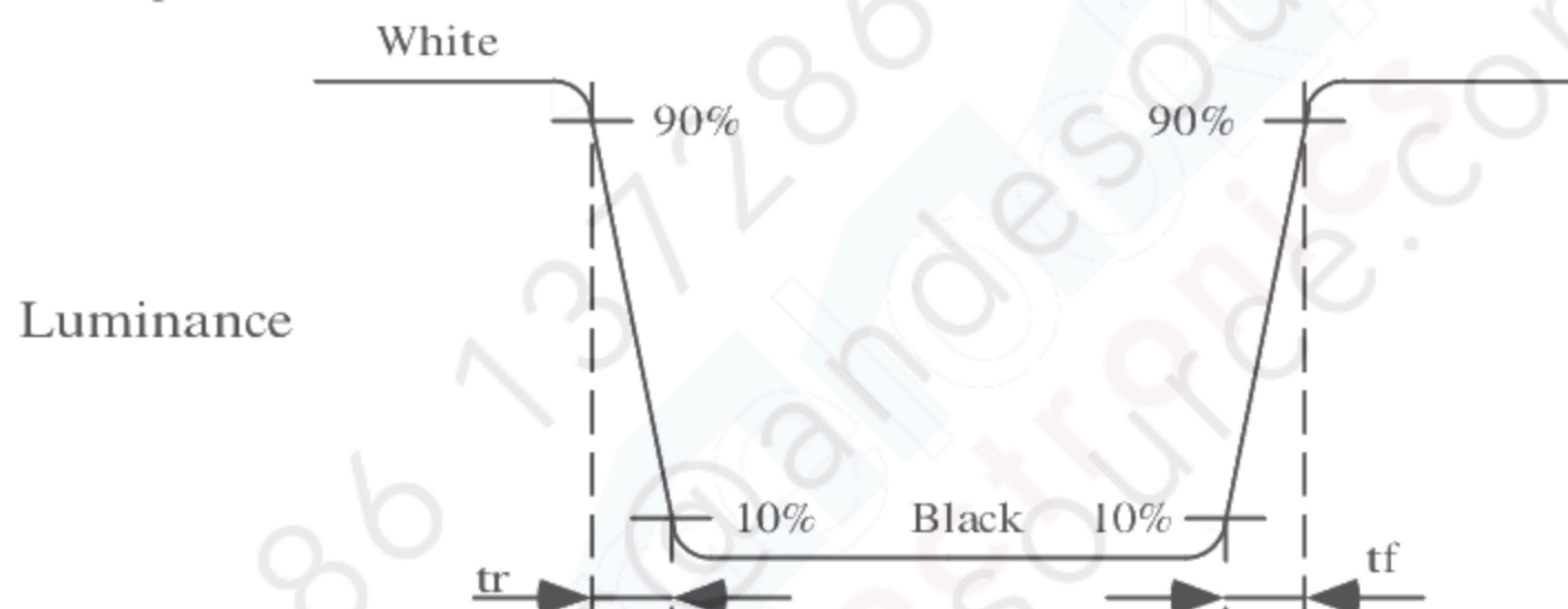
*2) Definition of Contrast Ratio

$CR = \text{Luminance with all white pixels} / \text{Luminance with all black pixels}$

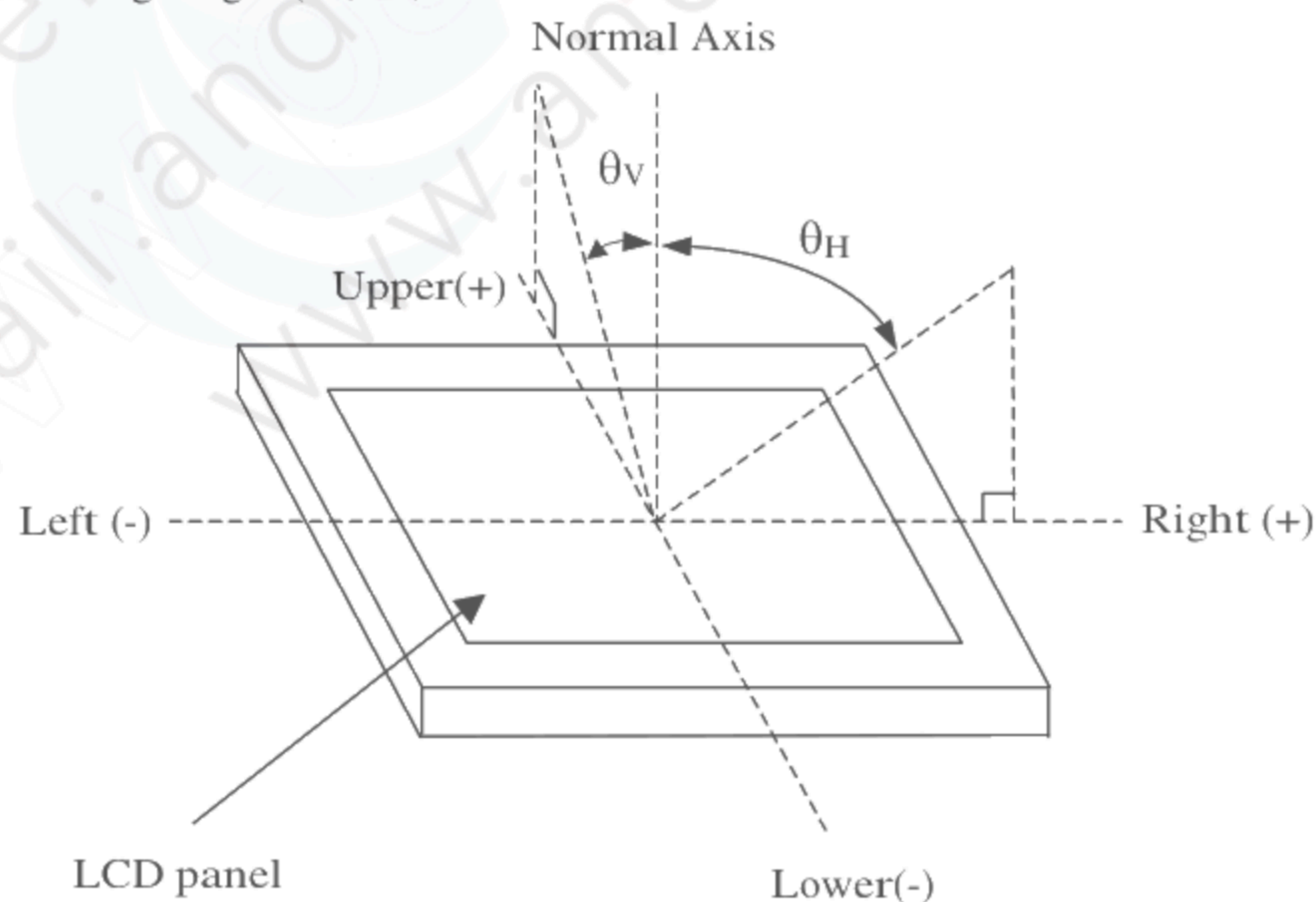
*3) Definition of Luminance Uniformity

$\Delta Lw = [Lw(\text{MAX}) / Lw(\text{MIN}) - 1] \times 100$

*4) Definition of Response Time

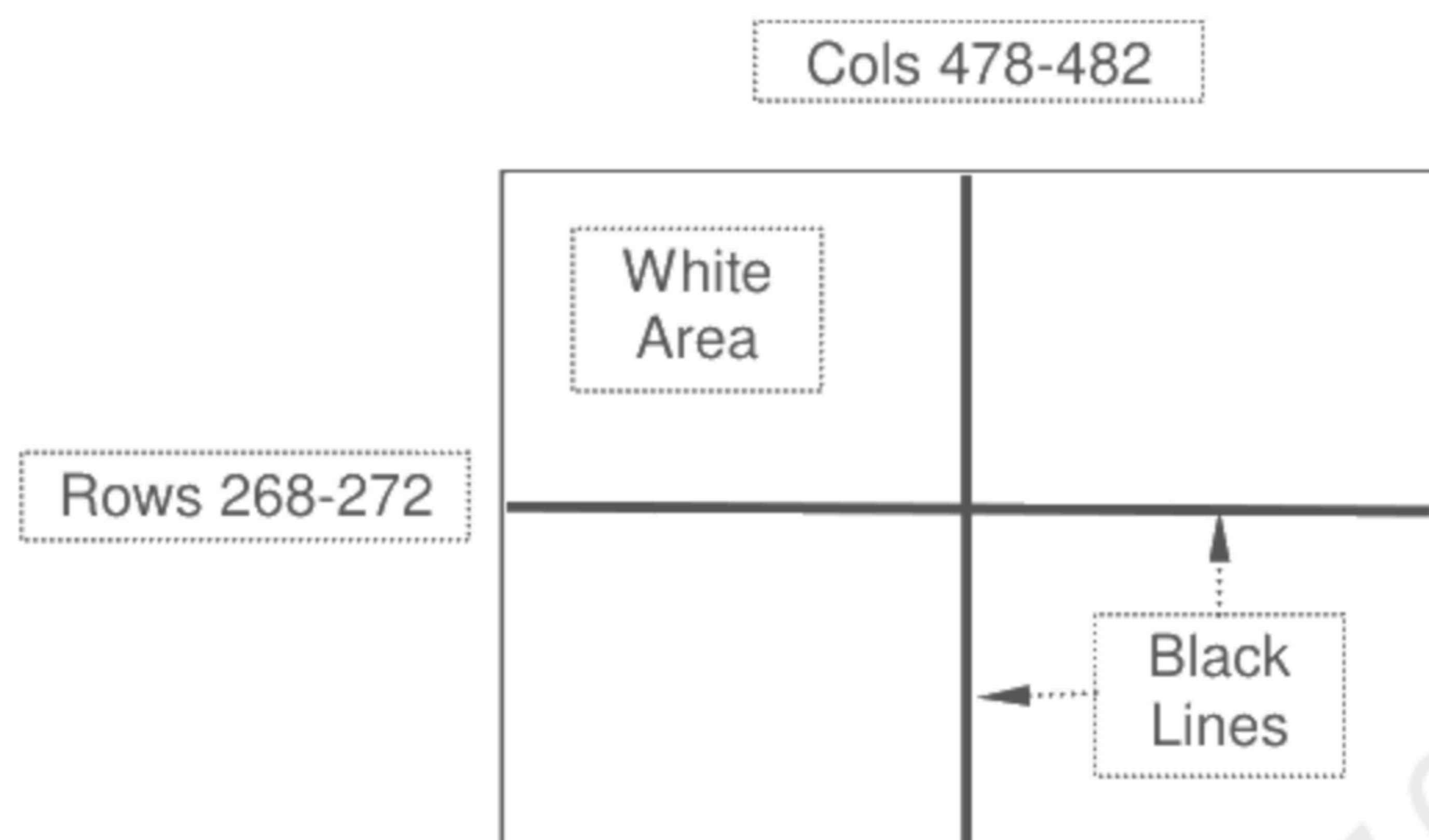


*5) Definition of Viewing Angle (θ_v , θ_H)



*6) Image Sticking

Continuously display the test pattern shown in the figure below for two-hours. Then display a completely white screen. The previous image shall not persist more than two seconds at 25°C.



TEST PATTERN FOR IMAGE STICKING TEST

10. RELIABILITY TEST CONDITION

(1) Temperature and Humidity

ITEM	CONDITIONS
HIGH TEMPERATURE HIGH HUMIDITY OPERATION	40°C, 90%RH, 240 h (No condensation)
HIGH TEMPERATURE OPERATION	70°C, 240 h
LOW TEMPERATURE OPERATION	-20°C, 240 h
HIGH TEMPERATURE STORAGE	80°C, 240 h
LOW TEMPERATURE STORAGE	-30°C, 240 h
THERMAL SHOCK (NON-OPERATION)	-30°C (1h) ~ 80°C(1h), 100 cycles

(2) Shock & Vibration

ITEM	CONDITIONS
SHOCK (NON-OPERATION)	Shock level: 1470m/s ² (150G) Waveform: half sinusoidal wave, 2ms Number of shocks: one shock input in each direction of three mutually perpendicular axis for a total of six shock inputs
VIBRATION (NON-OPERATION)	Vibration level: 9.8m/s ² (1.0G) Waveform: sinusoidal Frequency range: 5 to 500Hz Frequency sweep rate: 0.5 octave /min Duration: one sweep from 5 to 500 Hz in each of three mutually perpendicular axis(each x,y,z axis: 1 hour, total 3 hours)

(3) ESD Test

ITEM	CONDITIONS
CONTACT DISCHARGE (OPERATION)	150pF, 330Ω, ±8kV, 10 times at 1 sec interval
SIGNAL PIN DISCHARGE (NON-OPERATION)	200pF, 0Ω, ±200V, 10 times at 1 sec interval

(4) Judgment standard

The judgment of the above tests should be made as follow:

Pass: Normal display image, no damage of the display function. (ex. no line defect)

Partial transformation of the module parts should be ignored.

Fail: No display image, damage of the display function. (ex. line defect)

11. OTHER FEATURE

(1) Environmental Restriction /Law Compliance

This LCD module complies with RoHS^{*)} directive.

^{*)} RoHS: Restriction of the use of certain hazardous substances in electrical and electronic equipment

(2) Safety Standard Authorization

UL1950 Recognized (UL File# E158720)

(3) Warranty Period

26 months after shipment from our factory

Tel: +86 13728663670
Email: andeic@andesource.com
www.andesource.com

12. HANDLING PRECAUTIONS FOR TFT-LCD MODULE

Please pay attention to the followings in handling TFT-LCD products;

(1) ASSEMBLY PRECAUTION

- a. Please do not bend or wrench the LCD module in assembling. Please do not drop, bend or twist the LCD module in handling.
- b. Please design display housing in accordance with the following guide lines.
 - (a) Housing case must be designed carefully so as not to put stresses on LCD and not to wrench module.
 - (b) Under high temperature environment, performance and life time of LED may heavily shorten. When you design with our LCD product, please consider radiating heat and ventilation for good heat management.
 - (c) Keep sufficient clearance between LCD module back surface and housing when the LCD module is mounted. Approximately 1.0mm of the clearance in the design is recommended taking into account the tolerance of LCD module thickness and mounting structure height on the housing.
 - (d) When some parts, such as, FPC cable and ferrite plate, are installed underneath the LCD module, still sufficient clearance is required, such as 0.5mm. This clearance is, especially, to be reconsidered when the additional parts are implemented for EMI countermeasure.
 - (e) Design the LED driver location and connector position carefully so as not to give stress to LED backlight cable.
 - (f) Keep sufficient clearance between LCD module and the others parts, such as inverter and speaker so as not to interfere the LCD module. Approximately 1.0 mm of the clearance in the design is recommended.
 - (g) To avoid local elevation/decrease of temperature, considering location of heating element, heat release, thermal design should be done.
- c. Please do not push or scratch LCD panel surface with anything hard. And do not soil LCD panel surface by touching with bare hands. (Polarizer film, surface of LCD panel is easy to be flawed.)
- d. Please wipe off LCD panel surface with absorbent cotton or soft cloth in case of it being soiled.

When it was hard to remove the soil on the LCD panel surface, it would be possible to use IPA or Ethanol. However, please wipe carefully not to touch the front frame edge with the wiping cloth. It could generate lint.
- e. If the soil on the panel is removed by air blower, please be careful with below items:

Front side: If the air blew against the edge of the front frame opening area, dust could enter inside LCD through the gap between the front frame and the panel.

Rear side: Please be careful not to peel the FPC. If the air blew against the area between FPC and the rear frame, it could give some stress to the FPC bonding area on the panel.
- f. Please wipe off drops of adhesives like saliva and water on LCD panel surface immediately. They might damage to cause panel surface variation and color change.

- g. Please do not take a LCD module to pieces and reconstruct it. Resolving and reconstructing modules may cause them not to work well.
- h. Please do not touch metal frames with bare hands and soiled gloves. A color change of the metal frames can happen during a long preservation of soiled LCD modules.
- i. Please handle metal frame carefully because edge of metal frame is very sharp.
- j. Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.
- k. Be sure to connect the cables and the connectors correctly.

(2) OPERATING PRECAUTIONS

- a. Please be sure to turn off the power supply before connecting and disconnecting signal input cable.
- b. Please do not change variable resistance settings in LCD module. They are adjusted to the most suitable value. If they are changed, it might happen LCD does not satisfy the characteristics specification.
- c. The interface signal speed is very high. Please pay attention to transmission line design and other high speed signal precautions to satisfy signal specification.
- d. Condensation might happen on the surface and inside of LCD module in case of sudden change of ambient temperature. Please take care so as not to cause any damage mentioned on (1)-e.
- e. Please pay attention not to display the same pattern for very long time. Image sticking might happen on LCD. Although image sticking may disappear as the operation time proceeds, screen saver function is recommended not to cause image sticking.
- f. Please obey the same safe instructions as ones being prepared for ordinary electronic products.

(3) PRECAUTIONS WITH ELECTROSTATICS

- a. This LCD module use CMOS-IC on circuit board and TFT-LCD panel, and so it is easy to be affected by electrostatics. Please be careful with electrostatics by the way of your body connecting to the ground and so on.
- b. Please remove protection film very slowly from the surface of LCD module to prevent from electrostatics occurrence.

(4) STORAGE PRECAUTIONS

LCD should be stored in the room temperature environment with normal humidity. The LCD inventory should be processed by first-in first-out method.

(5) SAFETY PRECAUTIONS

- a. When you waste damaged or unnecessary LCDs, it is recommended to crush LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.
- b. If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.
- c. Be sure to turn off the power supply when inserting or disconnecting the LED backlight cable.
- d. LED driver should be designed carefully to limit or stop its function when over current is detected on the LED.

(6) OTHERS

- a. A strong incident light into LCD panel may cause deterioration to polarizer film, color filter, and other materials, which will degrade the quality of display characteristics. Please do not expose LCD module under strong Ultraviolet rays for a long time.
- b. Please pay attention to a panel side of LCD module not to contact with other materials in preserving it alone.
- c. For the packaging box handling, please see and obey with the packaging specification datasheet.