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**Company
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MODEL

A035QN05 V4

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APPROVAL FOR SPECIFICATIONS ONLY (Spec. Ver. 1.0)
APPROVAL FOR SPECIFICATIONS AND ES SAMPLE (Spec. Ver. 1.0)
APPROVAL FOR SPECIFICATIONS AND CS SAMPLE (Spec. Ver. 1.0)
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Product Specification 3.5" COLOR TFT-LCD MODULE

Model Name : **A035QN05 V4**

Planned Lifetime:

Phase-out Control:

EOL Schedule:

< > Preliminary Specification
< ◆ > Final Specification

Note: The content of this specification is subject to change.

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Record of Revision

Version	Revise Date	Page	Content
0.0	2017/11/07	All	First Draft
0.1	2017/11/20	36	Update Packing Form
		37	Update Outline dimension
		38-42	Modify N0 10/11 Command
0.2	2018/06/05	6	Update Weight: TBD to 18.5 +/- 2(g)
		10	Update Backlight driving conditions: Backlight Current_IL
		33	Update Color Rank_X: D~G/ Y: C~F, excluded BGC
		37	Update F. Outline Dimension Drawing
		38-42	Modify No 10/11 Command: BCh/3Ch --> BBh/3Bh
1.0	2018/10/08	-	Final Draft

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A. General Information

NO.	Item	Unit	Specification	Remark
1	Screen Size	inch	3.5(Diagonal)	
2	Display Resolution	dot	320RGB(H)×240(V)	
3	Overall Dimension	mm	76.90(H) × 63.90(V) × 2.35 (T)	Note 1
4	Active Area	mm	70.32(H)×52.74(V)	
5	Pixel Pitch	mm	0.07325(R.G.B)×0.21975(V)	
6	Color Configuration	--	R. G. B. Stripe	
7	Color Depth	--	16.7M Colors	
8	NTSC Ratio	%	45	
9	Display Mode	--	Normally White	
10	Weight	--	18.5 +/- 2(g)	
11	Viewing direction	--	6 o'clock (gray inversion)	
12	Panel surface treatment	--	Anti-Glare, Hardness 3H	

Note 1: Refer to F. Outline Dimension

B. Electrical Specifications

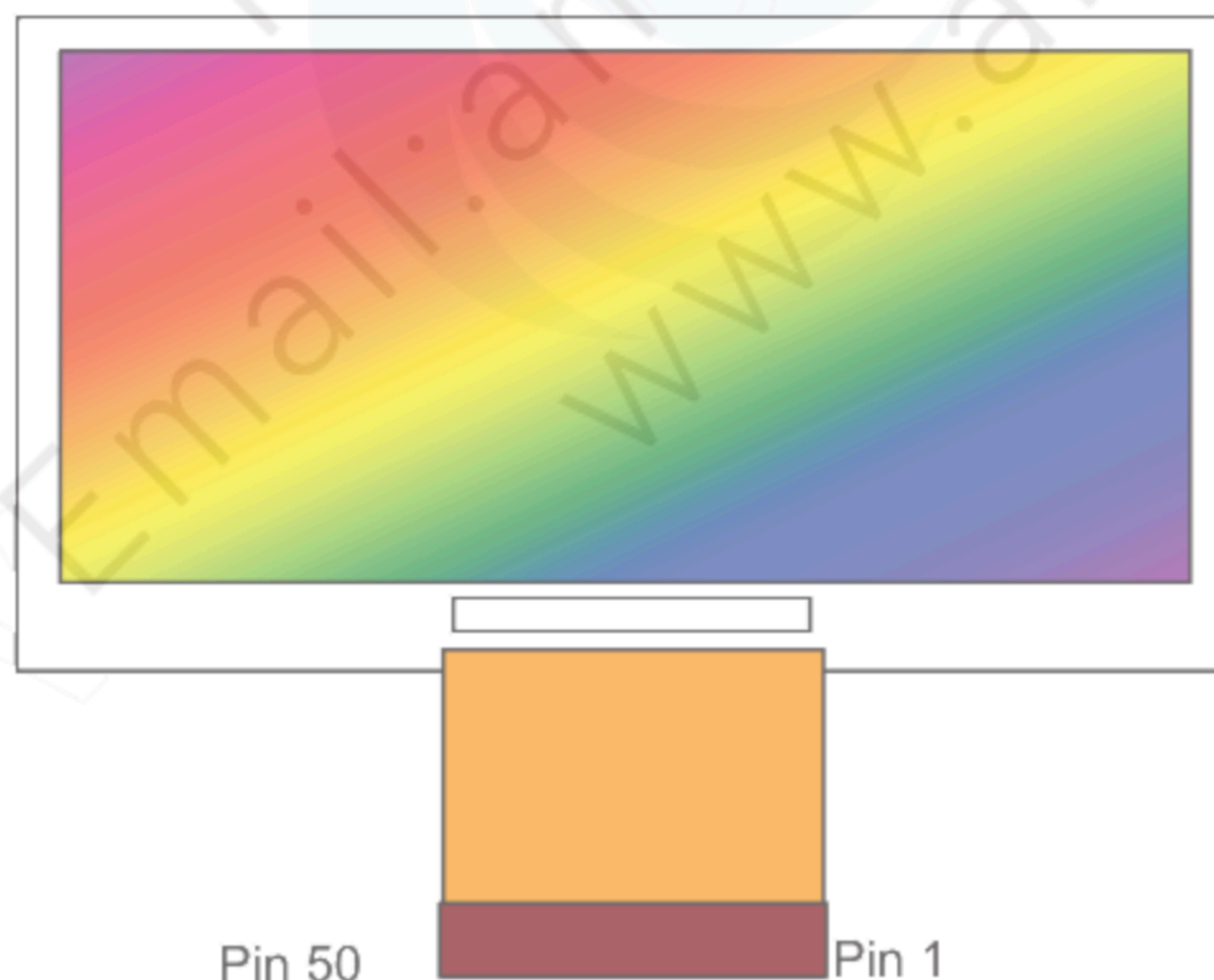
1. Pin Assignment

No.	Pin Name	I/O	Description	Remarks
1	V _{L+}	P	Backlight LED anode	
2	V _{L-}	P	Backlight LED cathode	
3	Dummy	I/O	Touch panel right electrode (R)	Reserve for TP
4	Dummy	I/O	Touch panel bottom electrode (B)	Reserve for TP
5	Dummy	I/O	Touch panel left electrode (L)	Reserve for TP
6	Dummy	I/O	Touch panel top electrode (U)	Reserve for TP
7	VCOM	I	Common electrode driving voltage	
8	GND	G	Power Grounding	
9	DOTCLK	I	Data clock Input	
10	GND	G	Power Grounding	
11	VSYNC	I	Vertical sync input	
12	HSYNC	I	Horizontal sync input	
13	DATA0	I	Serial data	
14	DATA 1	I	Serial data	
15	DATA 2	I	Serial data	
16	DATA 3	I	Serial data	
17	DATA 4	I	Serial data	
18	DATA 5	I	Serial data	
19	DATA 6	I	Serial data	
20	DATA 7	I	Serial data (MSB)	
21	VDDIO	P	Voltage input pin for logic I/O	
22	RESET	I	System reset pin	Fixed to VDDIO if not used.
23	SCL	I	Clock input pin in serial mode	
24	CSB	I	Chip select pin of serial interface	
25	SDA	I	Data input pin in serial mode	
26	GND	G	Power Grounding	
27	VDD	P	Booster input voltage pin	
28	VCC	C	Stabilizing capacitor	
29	C4M	C	Pins to connect capacitance for power circuitry	
30	C4P	C	Pins to connect capacitance for power circuitry	
31	VINT3	C	Intermediate voltage for charge pump	

32	VDD	P	Booster input voltage pin	
33	VINT1	C	Intermediate voltage for charge pump	
34	C2P	C	Pins to connect capacitance for power circuitry	
35	C2M	C	Pins to connect capacitance for power circuitry	
36	C1P	C	Pins to connect capacitance for power circuitry	
37	C1M	C	Pins to connect capacitance for power circuitry	
38	GND	G	Power Grounding	
39	C3P	C	Pins to connect capacitance for power circuitry	
40	C3M	C	Pins to connect capacitance for power circuitry	
41	VINT2	C	Intermediate voltage for charge pump	
42	C5P	C	Pins to connect capacitance for power circuitry	
43	C5M	C	Pins to connect capacitance for power circuitry	
44	VGH	C	Pins to connect capacitance for power circuitry	
45	C6P	C	Pins to connect capacitance for power circuitry	
46	C6M	C	Pins to connect capacitance for power circuitry	
47	VGL	C	Pins to connect capacitance for power circuitry	
48	VCOMH	C	Power setting capacitor for VCOM	
49	VCOML	C	Power setting capacitor for VCOM	
50	VCOM	I	Common electrode driving voltage	

I : Input, O : Output, C : Capacitor, P : Power, D : Dummy

Note: Definition of scanning direction, Refer to figure as below :



2. Absolute Maximum Ratings

a. Absolute Ratings of TFT LCD Module

Item	Symbol	Min	Max	Unit
Logic/LCD drive Voltage	VDD / VDDIO	-0.3	4	[Volt]

b. Absolute Ratings of Environment

Item	Symbol	Min	Max	Unit
Operating Temperature	TOP	-10	70	[°C]
Operation Humidity	HOP	5	90	[%RH]
Storage Temperature	TST	-40	80	[°C]
Storage Humidity	HST	5	90	[%RH]

Note1: Maximum Wet-Bulb should be 39 °C and no condensation.

Note2: Only operation is guaranteed. Optical performance should be evaluated at 25 °C only.

3. Electrical Characteristics

The following items are measured under stable condition and suggested application circuit.

a. TFT- LCD Panel (GND=0V)

Parameter		Symbol	Min	Typ	Max	Unit	Note
Power Supply		VDD	3.0	3.3	3.6	V	
		VDDIO	1.65	3.3	3.6	V	
Frame Frequency		f _{Frame}		60		Hz	
Dot Data Clock	CCIR656 mode	DCLK		27		MHz	
Input Signal Voltage		V _{IL}	0		0.3 x VDDIO	V	
		V _{IH}	0.7 x VDDIO		VDDIO	V	
Current Consumption		IVDD		15		mA	

Note 1: Frame rate is 60Hz. Test pattern is the following picture.

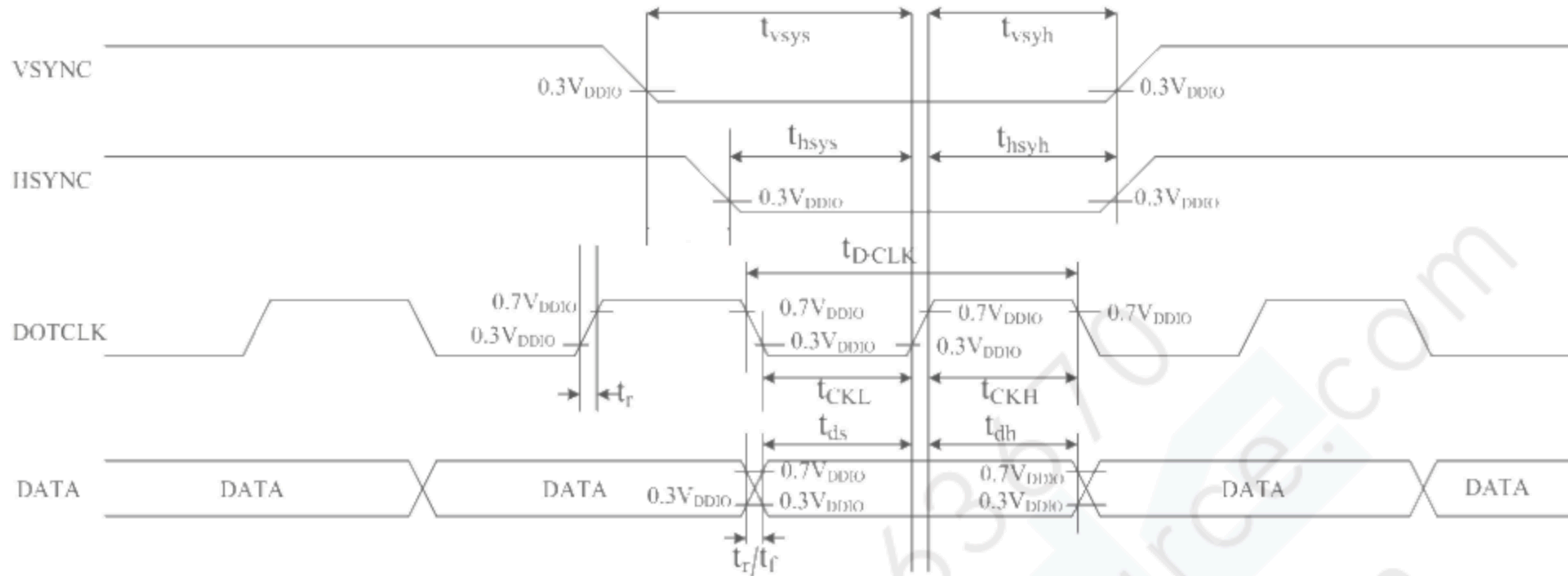


b. Backlight driving conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
Backlight Current	I _L	---	13.6	---	mA	
Backlight voltage	V _L	---	(17.1)	18.6	V	
LED lifetime	Time	---	20,000	---	hrs	Ta. = 25°C, I _L = 13.6mA

4. AC Timing

a. Display General Information



Characteristics	Symbol	Target Min	Target Typ	Target Max	Units	Remark
DOTCLK time	t_{DCLK}	-	37	-	nSec	27MHz
DOTCLK duty cycle	t_{CW}	40	50	60	%	
Vertical Sync. Setup Time	t_{vsys}	12	-	-	nSec	
Vertical Sync. Hold Time	t_{vsyh}	12	-	-	nSec	
Horizontal Sync. Setup Time	t_{hsys}	12	-	-	nSec	
Horizontal Sync. Hold Time	t_{hsyh}	12	-	-	nSec	
DOTCLK Low Period	t_{CKL}	14.8	18.5	22.2	nSec	27MHz
DOTCLK High Period	t_{CKH}	14.8	18.5	22.2	nSec	27MHz
Data Setup Time	t_{ds}	12	-	-	nSec	
Data Hold Time	t_{dh}	12	-	-	nSec	
Rise/Fall Time	t_r/t_f	-	-	6.5	nSec	27MHz

b. 8-bit Serial Interface

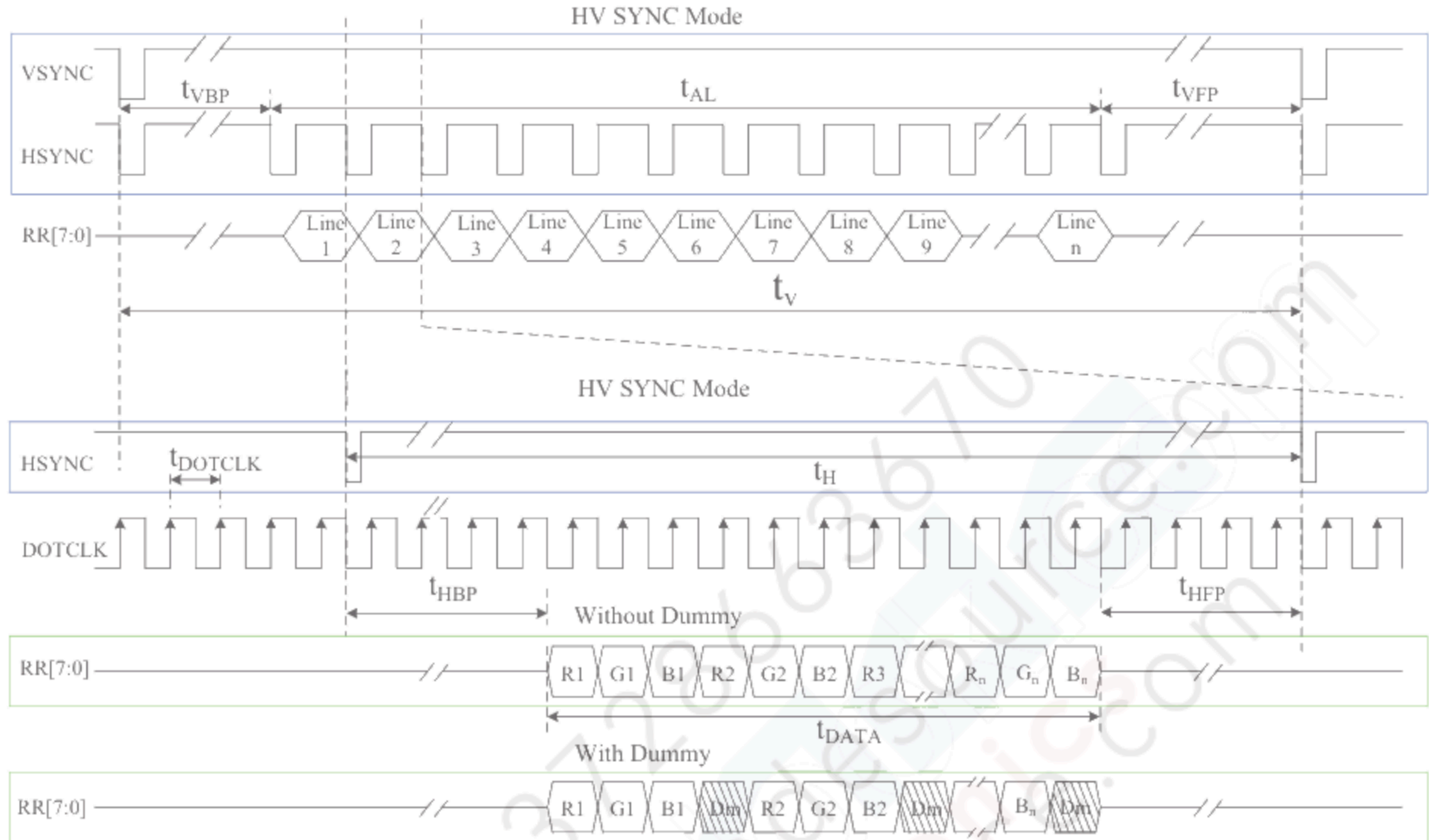


Table: 8-bit Serial Interface HV Sync. Mode without Dummy Timing Characteristics

Parameter		Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK frequency		$1/t_{\text{DOTCLK}}$	13.5	27	30	MHz	
HSYNC	Period	t_{H}	1024	1716	1728	t_{DCLK}	
	Display period	t_{DATA}	960			t_{DCLK}	
	Back porch	t_{HBP}	50	70	255	t_{DCLK}	Note 1
	Front porch	t_{HFP}	14	686	718	t_{DCLK}	
	Pulse width	t_{HSW}	1	1	$t_{\text{HBP}} - 1$	t_{DCLK}	
VSYNC	Period	t_{V}	247.5	262.5	276.5	t_{H}	
	Display period	t_{AL}	240	240	240	t_{H}	
	Back porch	t_{VBP}	6	21	31	t_{H}	Note 2
			6.5	21.5	31.5		
	Front porch	t_{VFP}	1.5	1.5	-	t_{H}	
			1	1	-		
	Pulse width	t_{VSW}	$1t_{\text{DCLK}}$	$1t_{\text{DCLK}}$	$1t_{\text{H}}$		

Note 1: The t_{HBP} time is adjustable by setting register HBLK; requirement of minimum blanking time and minimum front porch time must be satisfied.

Note 2: The t_{VHP} time is adjustable by setting register VBLK.

***Frame rate = DCLK frequency/(t_H * t_V). The condition ($70\text{Hz} \geq \text{Frame rate} \geq 55\text{Hz}$) must be satisfied.**

Table: 8-bit Serial Interface HV Sync. Mode with Dummy Timing Characteristics

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK frequency			1/t _{DotCLK}	20.54	24.535	30	MHz	
HSYNC	Period		t _H	1354	1560	1907	t _{DCLK}	
	Display period		t _{DATA}	1280			t _{DCLK}	
	Back porch		t _{HBP}	50	241	255	t _{DCLK}	
	Front porch		t _{HFP}	24	39	372	t _{DCLK}	
	Pulse width		t _{HSW}	1	1	t _{HBP} - 1	t _{DCLK}	
VSYNC	Period	Odd	t _V	247.5	262.5	276.5	t _H	
		Even						
	Display period	Odd	t _{AL}	240			t _H	
		Even						
	Back porch	Odd	t _{VBP}	6	21	31	t _H	
		Even		6.5	21.5	31.5		
	Front porch	Odd	t _{VFP}	1.5	1.5	-	t _H	
		Even		1	1	-		
	Pulse width	Odd	t _{VSW}	1 t _{DCLK}	1 t _{DCLK}	1t _H		
		Even						

***Frame rate = DCLK frequency/(t_H * t_V). The condition ($70\text{Hz} \geq \text{Frame rate} \geq 55\text{Hz}$) must be satisfied.**

c. YUV Interface

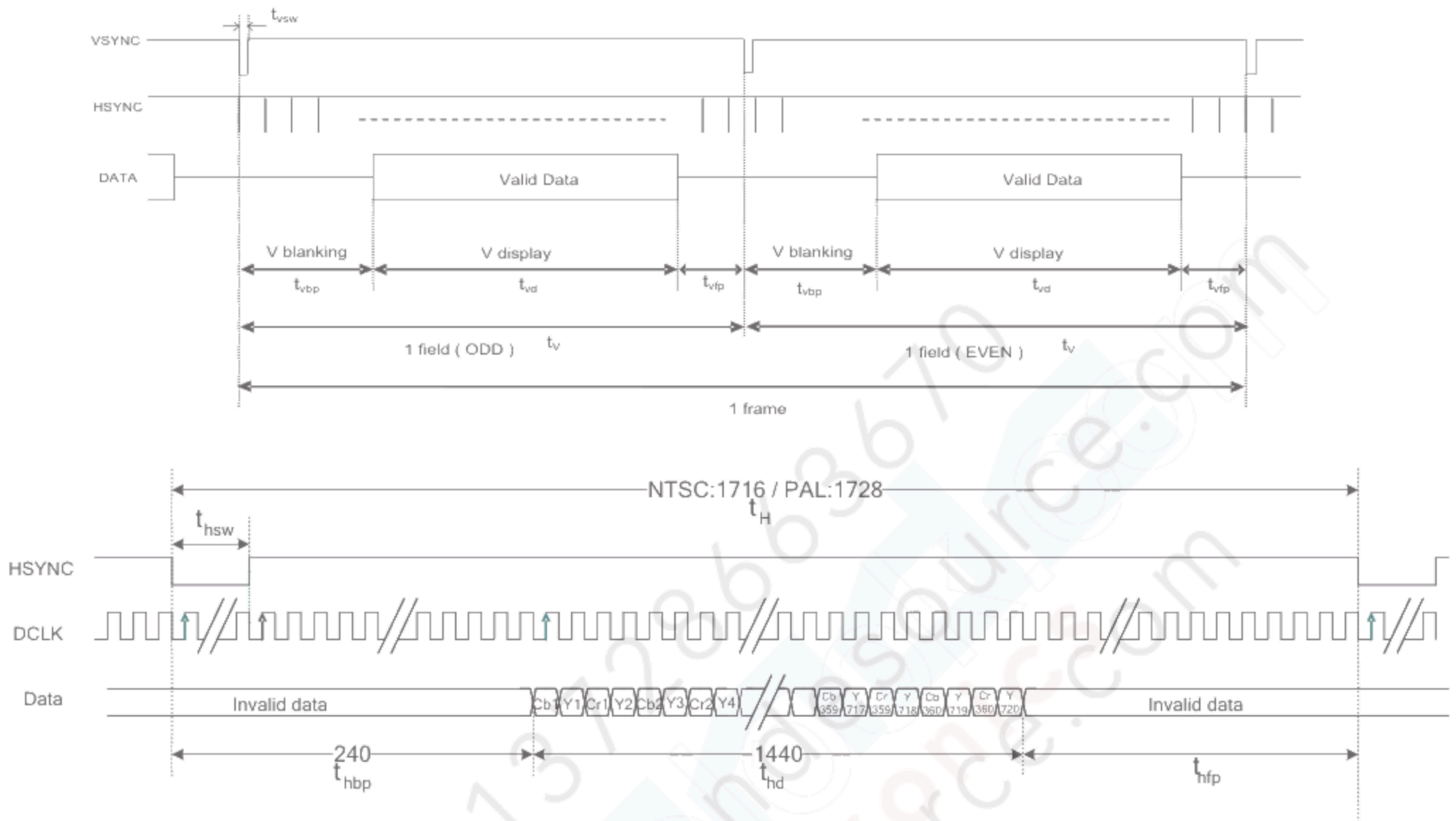


Table: YUV640 Interface HV Sync. Mode Timing Characteristics

Parameter		Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK frequency		$1/t_{DCLK}$	20.65	24.535	30	MHz	
HSYNC	Period	t_H	1362	1560	1907	t_{DCLK}	
	Display period	t_{hd}	1280			t_{DCLK}	
	Back porch	t_{hbp}	50	240	255	t_{DCLK}	
	Front porch	t_{hfp}	32	40	372	t_{DCLK}	
	Pulse width	t_{hsw}	-	1	-	t_{DCLK}	
VSYNC	Period	t_v	247.5	262.5	276.5	t_H	
	Display period	t_{vd}	240			t_H	
	Back porch	t_{vbp}	6	21	31	t_H	
			6.5	21.5	31.5		
	Front porch	t_{vfp}	1.5	1.5	-	t_H	
			1	1	-		
	Pulse width	t_{vsw}	-	1	-	t_{DCLK}	

Table: YUV720 Interface HV Sync. Mode Timing Characteristics

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK frequency			1/t _{DCLK}	23	27	30	MHz	
HSYNC	Period		t _H	1524	1716	1907	t _{DCLK}	
	Display period		t _{hd}	1440			t _{DCLK}	
	Back porch		t _{hbp}	50	240	255	t _{DCLK}	
	Front porch		t _{hfp}	34	36	212	t _{DCLK}	
	Pulse width		t _{hsw}	-	1	-	t _{DCLK}	
VSYNC	Period	Odd	t _V	247.5	262.5	276.5	t _H	
		Even						
	Display period	Odd	t _{vd}	240			t _H	
		Even						
	Back porch	Odd	t _{vbp}	6	21	31	t _H	
		Even		6.5	21.5	31.5		
	Front porch	Odd	t _{vfp}	1.5	1.5	-	t _H	
		Even		1	1	-		
	Pulse width	Odd	t _{vsw}	1 t _{DCLK}	1 t _{DCLK}	1t _H		
		Even						

Note 1: The t_{HBP} time is adjustable by setting register HBLK; requirement of minimum blanking time and minimum front porch time must be satisfied.

Note 2: The t_{VHP} time is adjustable by setting register VBLK.

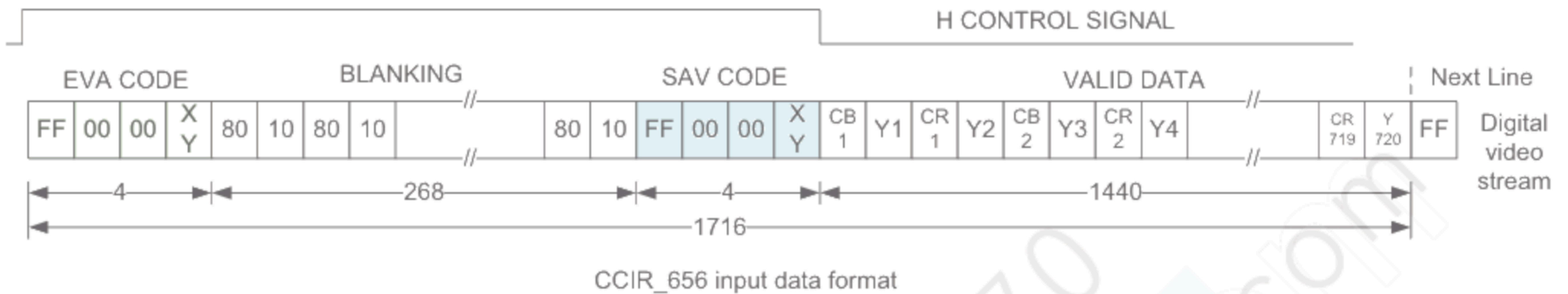
*Frame rate = DCLK frequency/($t_H * t_V$). The condition ($70\text{Hz} \geq \text{Frame rate} \geq 55\text{Hz}$) must be satisfied.

d. CCIR656 Interface

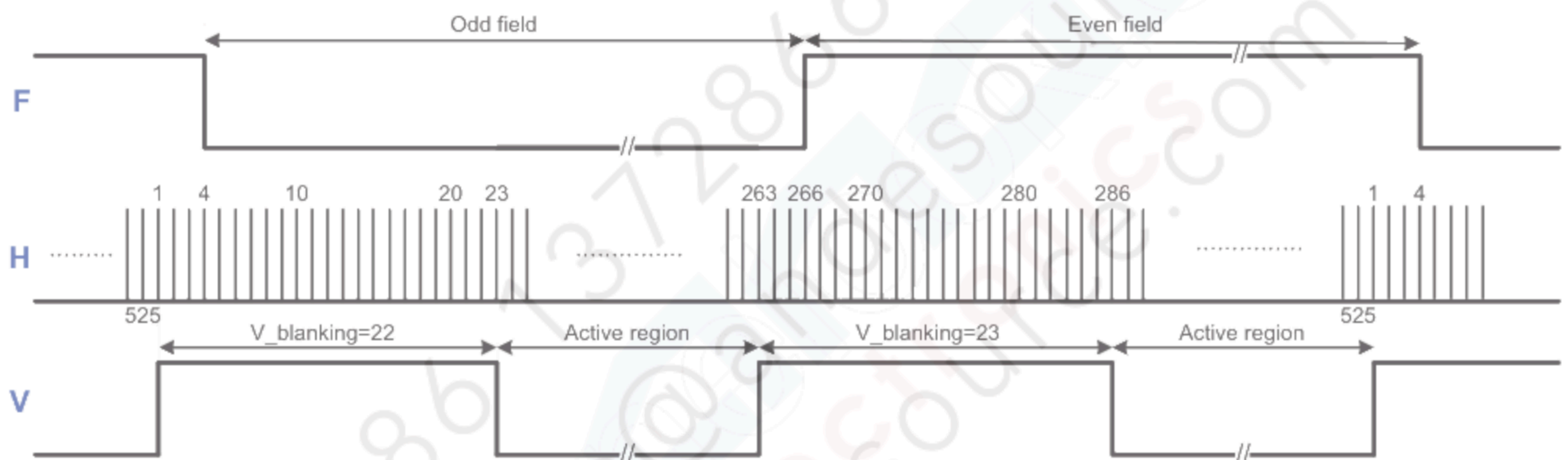
Example:

H control signal =1 at EAV;

H control signal =0 at SAV;(NTSC/PAL)



CCIR656 NTSC Mode Horizontal Timing Format



CCIR656 NTSC Mode Vertical Timing Format

CCIR 656 Decoding

- FF 00 00 < XY > signals are involved with HSYNC, VSYNC and Field

- <XY> encode following bits:

F=field select : F=0 for field 1, F=1 for field 2;

V=1 during vertical blanking

H=0 at SAV , H=1 at EAV ,

P3-P0=protection bits :

$$P3 = V \oplus H \quad P2 = F \oplus H \quad P1 = F \oplus V \quad P0 = F \oplus V \oplus H$$

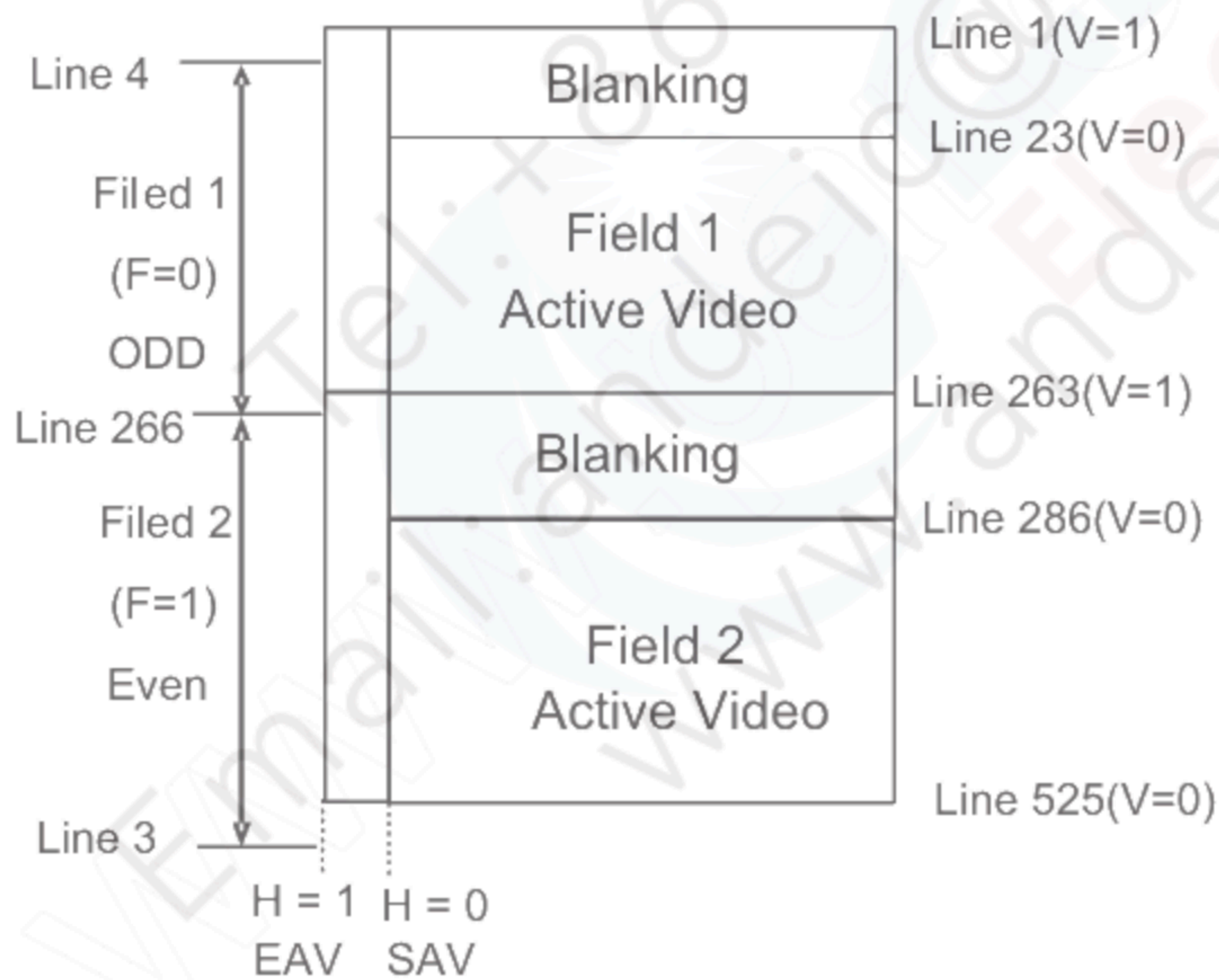
⊕: represents the exclusive-OR function

- Control is provided through “End of Video” (EAV) and “Start of Video” (SAV) timing references.
- Horizontal blanking section consists of repeating pattern 80 10 80 10

XY							
D7(MSB)	D6	D5	D4	D3	D2	D1	D0(LSB)
1	F	V	H	P3	P2	P1	P0

CCIR 656 NTSC Mode

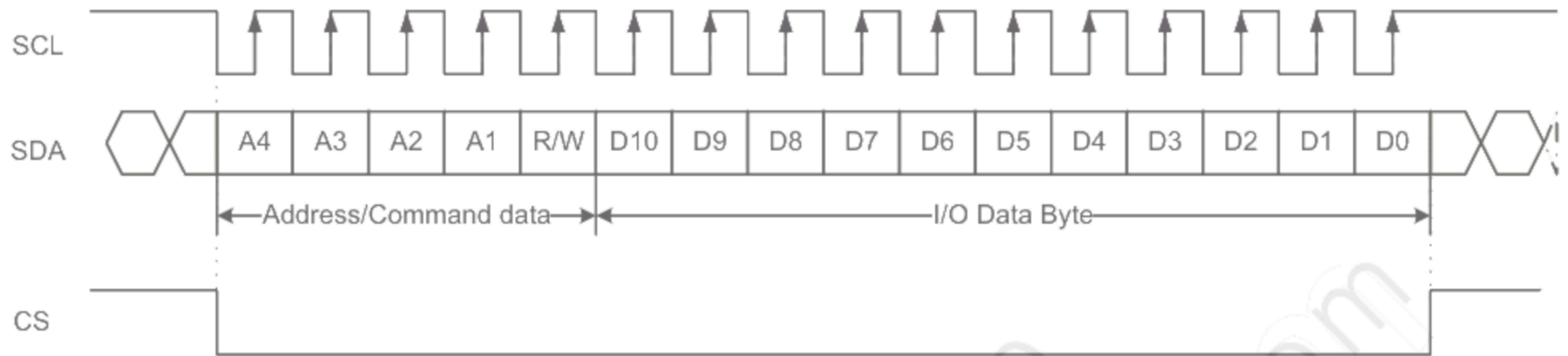
Line Number	F	V	H (EAV)	H (SAV)
1-3	1	1	1	0
4-22	0	1	1	0
23-262	0	0	1	0
263-265	0	1	1	0
266-285	1	1	1	0
286-525	1	0	1	0



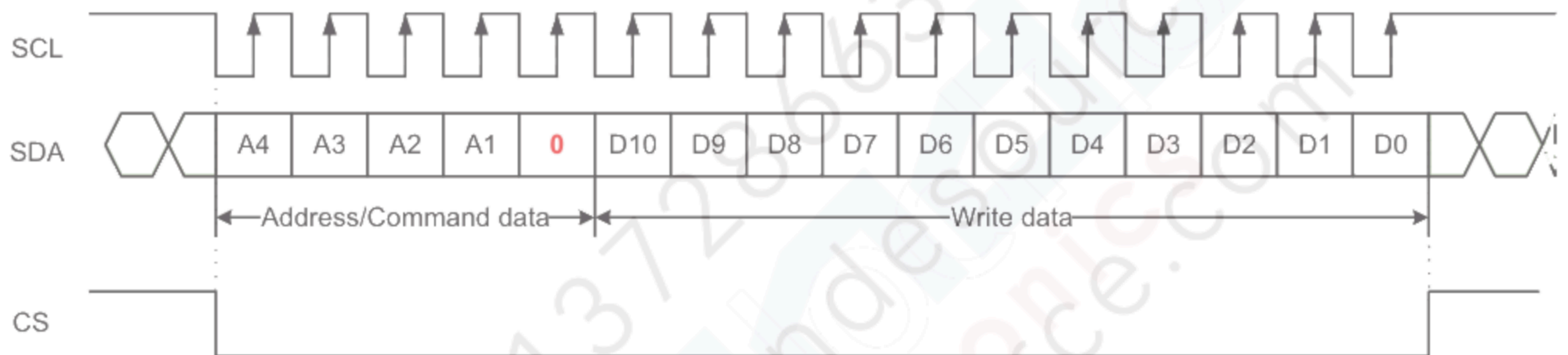
	F	H	V
1	Even Field	EAV	Blanking
0	Odd Field	SAV	Active Video

Parameter			Symbol	Min.	Typ.	Max.	Unit.
DCLK Frequency			$1/t_{DCLK}$	-	27	-	MHz
Horizontal	Period		t_H	-	1716	-	t_{DCLK}
	Display period		t_{Hdisp}	1440			t_{DCLK}
	Blanking (pulse width+back porch)		t_{Hbp}	-	272	-	t_{DCLK}
	Front porch		t_{Hfp}	-	4	-	t_{DCLK}
Vertical	Period	Odd	t_V		262		t_H
		Even			263		
	Display period	Odd	t_{Vdisp}		240		t_H
		Even					
	Blanking (pulse width+back porch)	Odd	t_{Vbp}	-	19	-	t_H
		Even		-	20	-	
	Front porch	Odd	t_{Vfp}	-	3	-	t_H
		Even		-	3	-	

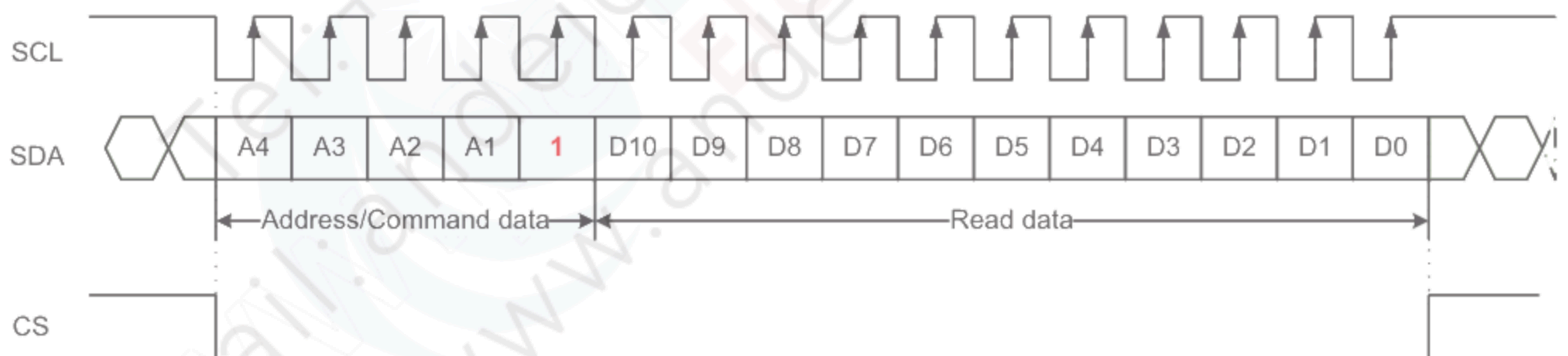
e. SPI Timing Diagram



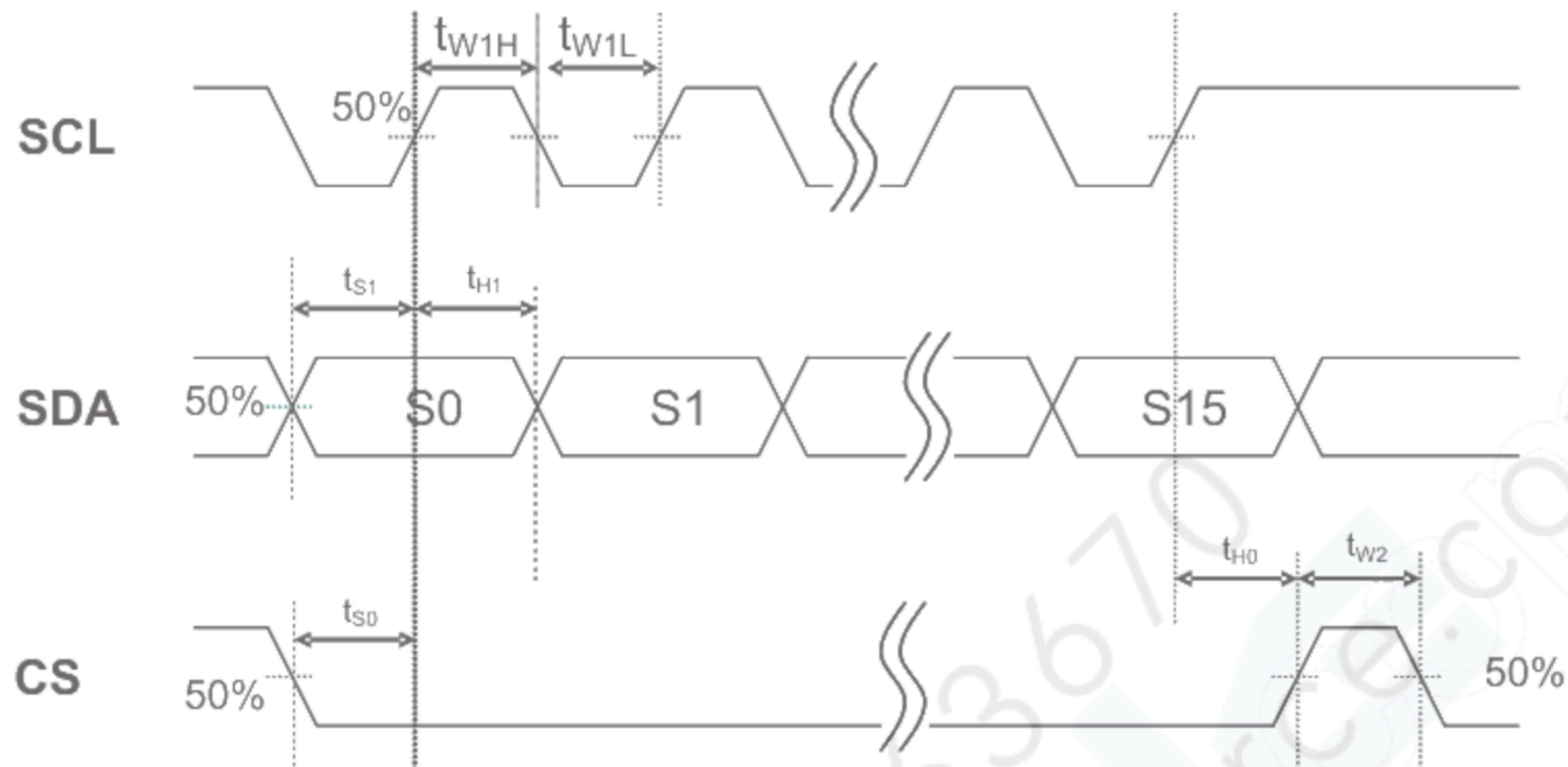
Write Mode:



Read Mode:



f. SPI Timing Specification



Item	Symbol	Min	Typical	Max	Unit
CS input setup Time	t_{S0}	50			ns
CS input hold Time	t_{H0}	50			ns
CS pulse high width	t_{W2}	1			us
Serial data input setup Time	t_{S1}	50			ns
Serial data input hold Time	t_{H1}	50			ns
SCL pulse low width	t_{W1L}	50			ns
SCL pulse high width	t_{W1H}	50			ns

5. Command Register Settings

a. Serial setting map

➤ () is default

No.	Register address					MSB		Register data								LSB			
	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0			
R0	0	0	0	0	R/W	0	0	0	0	0	UD (1)	SHL (1)	GRB (1)	STB (0)	SHDB (0)	SHCB (1)			
R1	0	0	0	1	R/W	x	x	x	Y_CbCr (00)		1	0	1	SEL (000)					
R2	0	0	1	0	R/W	x	x	HBLK_EN (0)	HBLK (01000110)										
R3	0	0	1	1	R/W	x	x	x	x	0	0	VBLK (10101)							
R4	0	1	0	0	R/W	x	1	1	1	1	0	0	1	0	1	AVGY			
R5	0	1	0	1	R/W	x	x	x	x	x	x	x	CONTRAST (1000)						
R6	0	1	1	0	R/W	x	x	x	x	BRIGHTNESS (1000000)									
R7	0	1	1	1	R/W	x	x	x	x	OP (000)			VGL_SEL (10)		VGH_SEL (11)				
R8	1	0	0	0	R/W	x	x	x	1	VCOMH (1000001)									
R9	1	0	0	1	R/W	x	x	x	x	VCOML (1000001)									
R10	1	0	1	0	R/W	x	x	x	PWM_400K (0)	DC_F (1)	CLK_ChP_M (10)		0	1	1	0			
R11	1	0	1	1	R/W	x	GMA_M (1)	GMA_V4 (011)			GMA_V1 (011)			GMA_V0 (011)					
R12	1	1	0	0	R/W	x	x	GMA_V48 (011)			GMA_V36 (011)			GMA_V16 (011)					
R13	1	1	0	1	R/W	x	x	x	x	x	GMA_V59 (011)			GMA_V55 (011)					
R14	1	1	1	0	R/W	x	x	x	x	x	GMA_V63 (011)			GMA_V62 (011)					

NOTE:

1. "X": don't care => Please set to '0'.
2. "0*" and "1*" is for engineering reserved register setting, and please follow the suggested value.
3. Please refer to our recommended register settings section for better performance.

b. Description of serial control data

I. R0 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	R/W	0	0	0	0	0	UD (1)	SHL (1)	GRB (1)	STB (0)	SHDB (0)	SHCB (1)

UD: Vertical shift direction selection

UD	Function
D5	
0	Shift from down to up, Last line = G1←G2...G239←G240 = First line
1	Shift from up to down, First line = G1→G2...G239→G240 = Last line (Default)

SHL: Horizontal shift direction selection

SHL	Function
D4	
0	Shift from right to left, Last data = S1←S2...S959←S960 = First data
1	Shift from left to right, First data = S1→S2...S959→S960 = Last data (Default)

GRB: Global reset

GRB	Function
D3	
0	Reset all registers to default value
1	Normal operation (Default)

STB: Standby mode setting

STB	Function
D2	
0	Standby (Display OFF); timing control, DAC, and DC/DC converter are off, and register data should be kept (Default)
1	Normal operation (Display ON), with power on/off sequence

SHDB: DC-DC converter shutdown setting

SHDB	Function
D1	
0	DC-DC converter is off. (Default)
1	DC-DC converter is on. DC-DC controls by STB and power on/off sequence.

SHCB: Charge Pump shutdown setting

SHCB	Function
D0	
0	Charge Pump converter is off.
1	Charge Pump converter is on. (Default) Charge Pump controls by STB and power on/off sequence.

II. R1 Register

No.	A4	A ₃	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R1	0	0	0	1	R/W	x	x	x	Y_CbCr (00)		1	0	1		SEL (000)	

Y_CbCr: Y & CbCr exchange position (only valid for YUV640 / YUV720)

Y_CbCr	Function
D7~D6	
00	Cb1 Y1 Cr1 Y2 Cb2 Y3 Cr2 Y4 (Default)
01	Cr1 Y1 Cb1 Y2 Cr2 Y3 Cb2 Y4
10	Y1 Cb1 Y2 Cr1 Y3 Cb2 Y4 Cr2
11	Y1 Cr1 Y2 Cb1 Y3 Cr2 Y4 Cb2

SEL: Input data timing format selection

SEL	Function
000	HV mode without dummy. (Default)
001	HV mode with dummy.
100	HV mode with YUV640
101	HV mode with YUV720
110	CCIR656 mode.

III. R2 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R2	0	0	1	0	R/W	x	x	HBLK_EN (0)	HBLK (01000110)							

HBLK: Horizontal blanking setting.

HBLK(D7~D0)	HBLK	Unit	Remark
00110010	50	DCLK(*)	Without dummy
01000110 (Default)	70(Default)		
11111111	255		
00110010	50	DCLK(*)	With dummy
11110001 (Default)	241(Default)		
11111111	255		
00110010	50	DCLK(*)	YUV640 YUV720
11110000 (Default)	240(Default)		
11111111	255		

Note : Disable this function in CCIR656 mode

HBLK_EN: Horizontal blanking enable

HBLK_EN (D8)	Function
0	Disable HBLK setting. (Default)
1	Enable HBLK setting.

IV. R3 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R3	0	0	1	1	R/W	x	x	x	x	00						

VBK
(10101)

VBK: Vertical blanking setting (UPS051 mode)

VBK(D4~D0)	VBK	Unit
00001	1	t _H
10101	21 (Default)	
11111	31	

VBK: Vertical blanking setting (CCIR656 NTSC mode)

VBK(D4~D0)	VBK	Unit
00001	1	t _H
10110	22 (Default)	
11111	31	

Note : In CCIR656 NTSC mode, set the typical value VBK=16h, actually V_{blanking} = 22 lines (Blanking + Front porch)

V. R4 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R4	1	0	0	0	R/W	x	1	1	1	1	0	0	1	0	1	AVGY

AVGY: Average luminance Y setting

AVGY	Function
D0	
0	Only used odd Y sample for YUV to RGB conversion
1	Used odd and even Y sample for YUV to RGB conversion (Default)

Note: This function is only used for YUV640, YUV720.

AVGY='0'

$$R_n = 1.164 * (Y_{2n-1} - 16) + 1.596 * (C_r - 128)$$

$$G_n = 1.164 * (Y_{2n-1} - 16) - 0.813 * (C_r - 128) - 0.392 * (C_b - 128)$$

$$B_n = 1.164 * (Y_{2n-1} - 16) + 2.017 * (C_b - 128)$$

Where Y:16~235 C_r :16~240 C_b :16~240

AVGY='1'

$$R_n = 1.164 * [(Y_{2n-1} + Y_{2n}) / 2 - 16] + 1.596 * (C_r - 128)$$

$$G_n = 1.164 * [(Y_{2n-1} + Y_{2n}) / 2 - 16] - 0.813 * (C_r - 128) - 0.392 * (C_b - 128)$$

$$B_n = 1.164 * [(Y_{2n-1} + Y_{2n}) / 2 - 16] + 2.017 * (C_b - 128)$$

Where Y:16~235 C_r :16~240 C_b :16~240

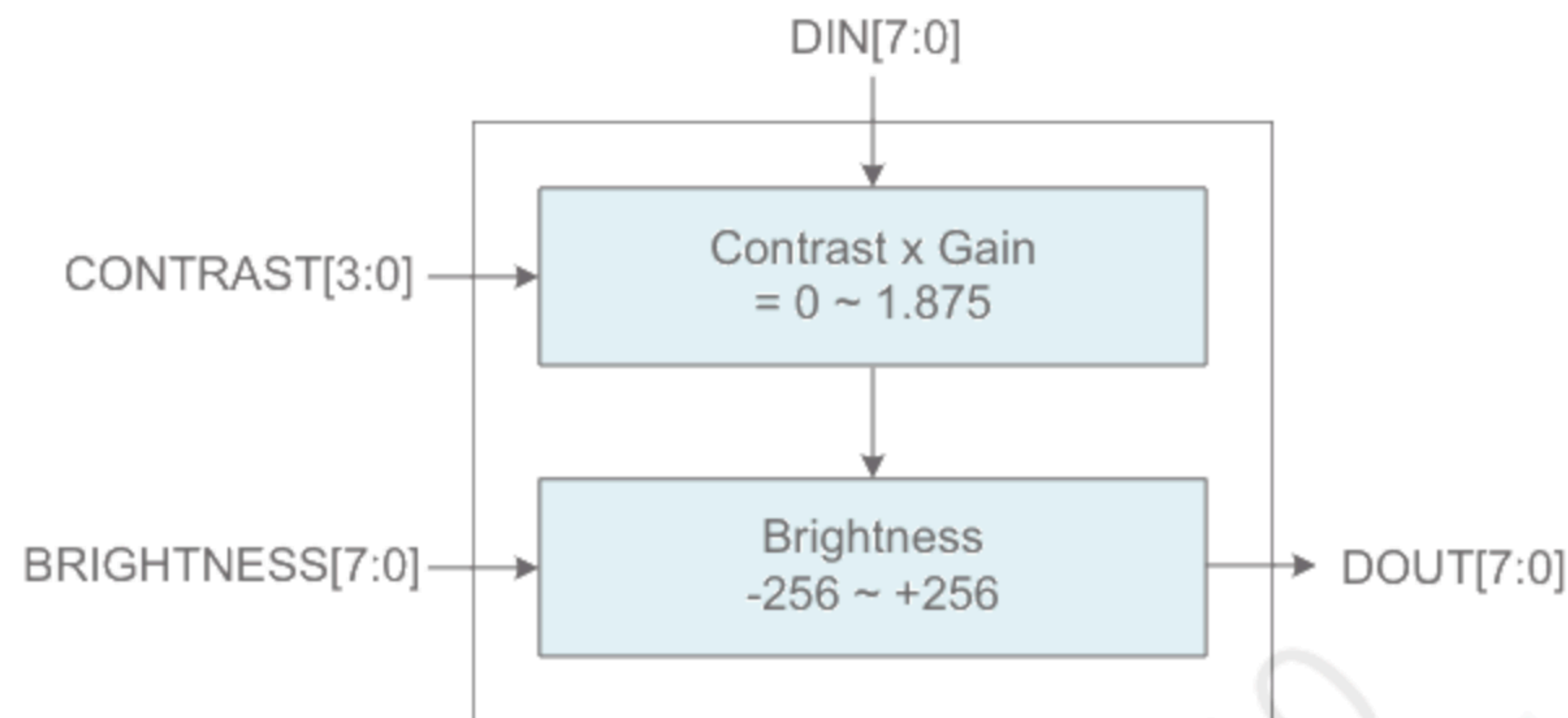
VI. R5 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R5	0	1	0	1	R/W	x	x	x	x	x	x	x	CONTRAST (1000)			

CONTRAST: RGB contrast level adjustment

CONTRAST	Function
D3~D0	
0000	0
1000	1 (Default)
1111	1.875

Note: each step is 0.125/LSB.



8-bit serial setting to control the contrast (gain) for RGB signals

$DOUT[7:0] = DIN[7:0] \times Contrast[0 \text{ to } 1.0 \text{ to } 1.875]$

Note: output value above “255” is clipped

VII. R6 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R6	0	1	1	0	R/W	x	x	x	x	BRIGHTNESS						

BRIGHTNESS: RGB brightness level adjustment

BRIGHTNESS	Function
D6~D0	
00h	-256
40h	0 (Default)
7Fh	+256

Note: each step is 4/LSB.

8-bit serial setting to control the RGB brightness level

$DOUT[7:0] = DIN[7:0] + BRIGHTNESS[-256 \text{ to } 0 \text{ to } +256]$

Note: output value above “255” is clipped

VIII. R7 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R7	0	1	1	1	R/W	x	x	x	x	OP (000)			VGL_SEL (10)		VGH_SEL (11)	

OP: DAC output driving capability selection

OP	Function
D6~D4	
0XX	Controlled by input pin OP0 and OP1(Default)
100	-25%
101	Normal
110	+25%
111	+50%

VGL_SEL:VGL voltage selection

VGL_SEL	Function
D3~D2	
00	-8V
01	-9V
10	-10V (Default)
11	-11V

VGH_SEL:VGH voltage selection

VGH_SEL	Function
D1~D0	
00	12
01	13
10	14
11	15(Default)

IX. R8 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R8	1	0	0	0	R/W	x	x	x	1	VCOMH (1000001)						

VCOMH: VCOMH level adjustment

VCOMH	Voltage(V)	
D6~D0	MVA/TN Normal	TN LV
00h	3.162	1.362
:	:	:
41h	4.332 (Default)	2.532 (Default)
:	:	:
7Fh	5.448	3.648

Note: Step is 18mV/step.

X. R9 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R9	1	0	0	1	R/W	x	x	x	x	VCOML (1000001)						

VCOML: VCOML level adjustment

VCOML	Voltage(V)	
D6~D0	MVA/TN Normal	TN LV
00h	-2.358	-2.628
:	:	:
41h	-1.188 (Default)	-1.458 (Default)
:	:	:
7Fh	-0.072	-0.342

Note: Step is 18mV/step.

XI. R10 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R10	1	0	1	0	R/W	x	x	x	PWM_400K (0)	DC_F (1)	CLK_ChP_M (10)		0	1	1	0

PWM_400K: PWM frequency selection

PWM_400K	Function
D7	
0	Around 200KHz. (Default)
1	Around 400KHz.

DC_F: DCDC frequency selection

DC_F	Function
D6	
0	Operating frequency is base on 13.5MHz.
1	Operating frequency is base on 27MHz. (Default)

CLK_ChP_M: Charge pumping frequency selection

CLK_ChP_M	Function
D5~D4	
00	$F(\text{Chp}) = f(\text{Hsync})/2$
01	$F(\text{Chp}) = f(\text{Hsync})$
10	$F(\text{Chp}) = f(\text{Hsync}) * 2$. (Default)
01	$F(\text{Chp}) = f(\text{Hsync}) * 4$

XII. R11~14 Register

No.	A4	A3	A2	A1	R/W	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R11	1	0	1	1	R/W	x	GMA_M (1)	GMA_V4 (011)			GMA_V1 (011)			GMA_V0 (011)		
R12	1	1	0	0	R/W	x	x	GMA_V48 (011)			GMA_V36 (011)			GMA_V16 (011)		
R13	1	1	0	1	R/W	x	x	x	x	x	GMA_V59 (011)			GMA_V55 (011)		
R14	1	1	1	0	R/W	x	x	x	x	x	GMA_V63 (011)			GMA_V62 (011)		

GMA_M: Gamma adjustment selection

GMA_M	Function
D9	
0	Manual adjust by registers R11~R14.
1	Auto set to gamma 2.2 by LC type. (Default)

C. Optical Specification (Note1, Note 2 and Note 3)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Response Time							
Rise	T_r	$\theta=0^\circ$	--	10	20	ms	Note 4
Fall	T_f	$\theta=0^\circ$	--	15	25	ms	
Contrast ratio	CR	At optimized viewing angle	250	300	--		Note 5
Viewing Angle							
Top	Φ_T	$CR \geq 10$	35	50	--	deg.	Note 6
Bottom	Φ_B		40	55	--		
Left	Φ_L		45	60	--		
Right	Φ_R		45	60	--		
Brightness	Y_L	$\theta=0^\circ$	400	500	--	cd/m ²	Note 7
Chromaticity							
White	X	$\theta=0^\circ$	0.260	0.310	0.360		Note 9
	Y	$\theta=0^\circ$	0.280	0.330	0.380		

Note 1. Ambient temperature =25°C

Note 2. To be measured in the dark room.

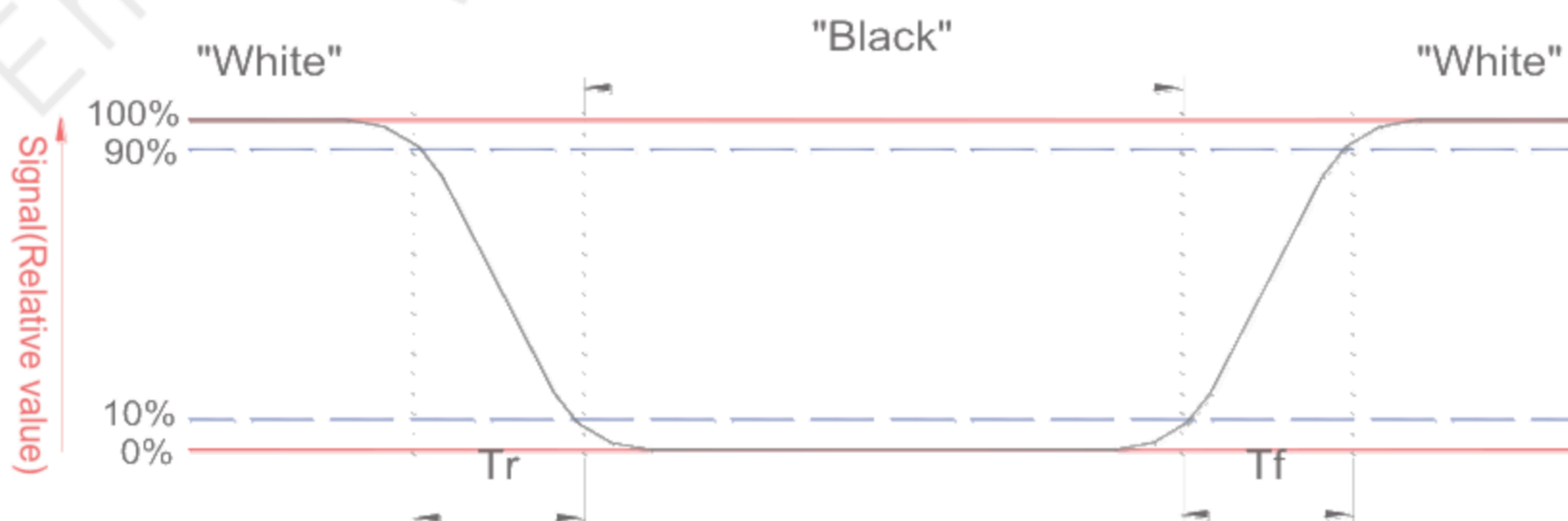
Note 3. To be measured on the center area of panel with a field angle of 1° by Topcon luminance meter BM-5A, after 10 minutes operation.

Note 4. Definition of response time:

The output signals of photo detector are measured when the input signals are changed from "black" to "white"(falling time) and from "white" to "black"(rising time), respectively.

The response time is defined as the time interval between the 10% and 90% of amplitudes.

Refer to figure as below.

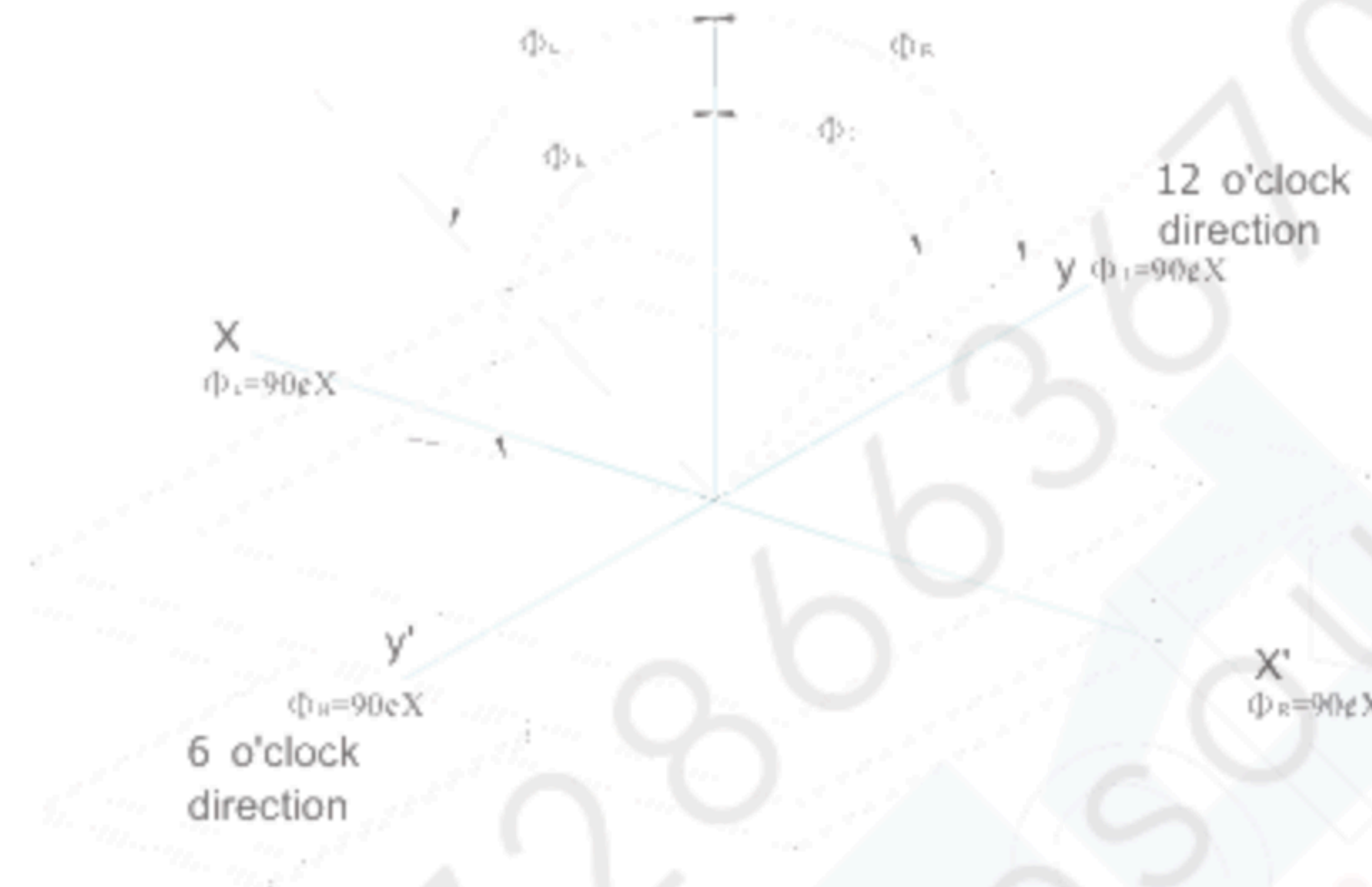


Note 5. Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

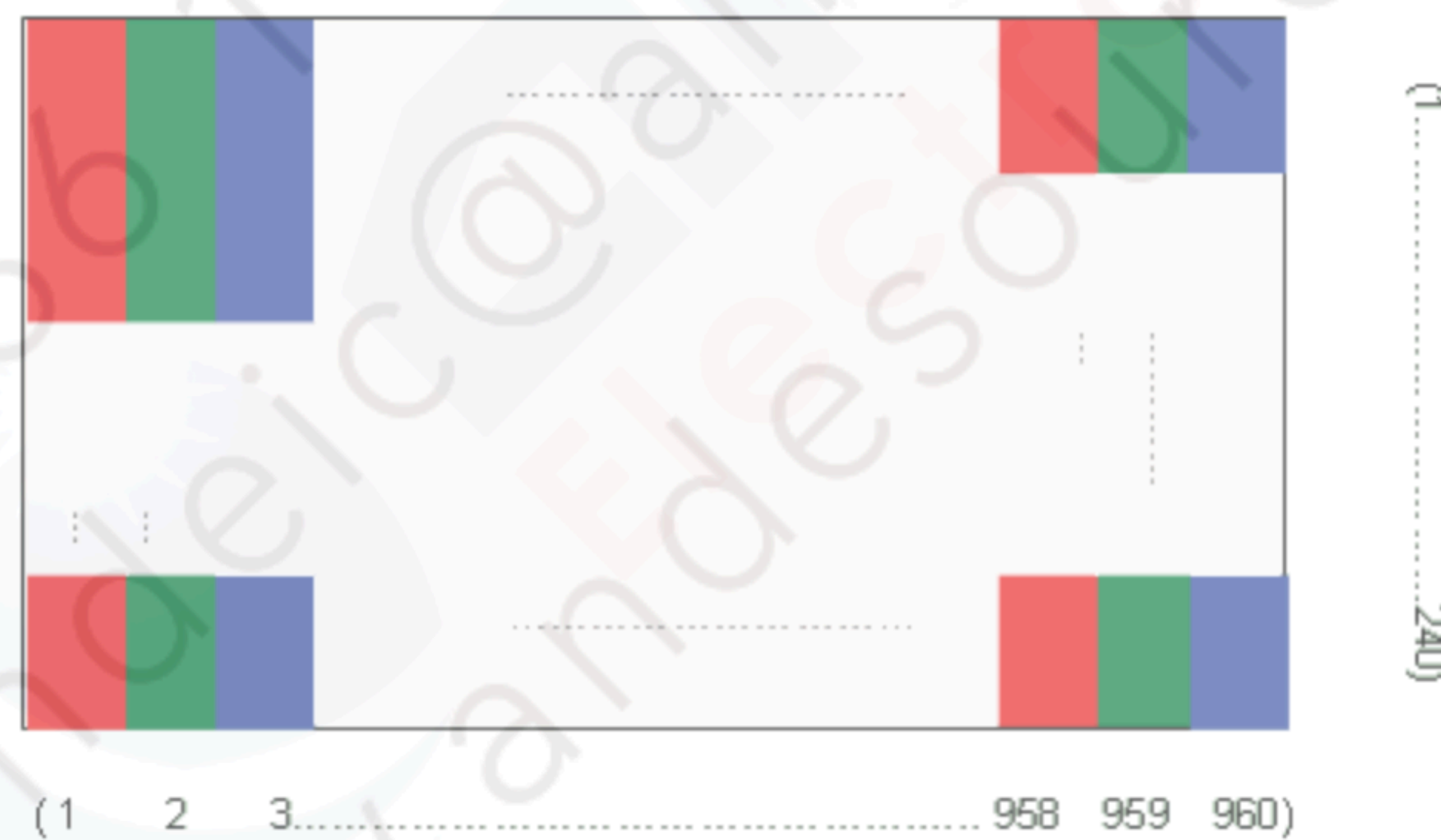
$$\text{Contrast ratio (CR)} = \frac{\text{Photo detector output when LCD is at "White" state}}{\text{Photo detector output when LCD is at "Black" state}}$$

Note 6. Definition of viewing angle, Φ , Refer to figure as below.



Note 7. Measured at the center area of the panel in gray level 255

Note 8. Color Filter Arrangement



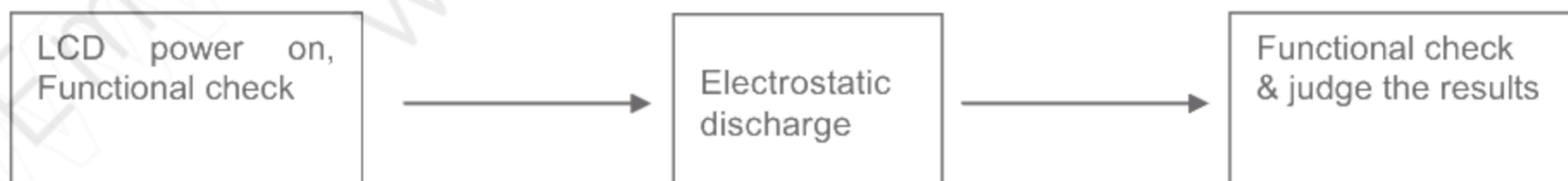
Note9. LED type - Lextar PS06W24V1 (Color Rank_X: D~G/ Y: C~F, excluded BGC)

D. Reliability Test Items

No.	Test items	Conditions	Remark
1	High Temperature Storage	Ta= 80°C 240Hrs	
2	Low Temperature Storage	Ta= -40°C 240Hrs	
3	High Temperature Operation	Tp= 70°C 240Hrs	
4	Low Temperature Operation	Ta= -10°C 240Hrs	
5	High Temperature & High Humidity	Tp= 60°C 90% RH 240Hrs	Operation
6	Heat Shock	-30°C~80°C, 50 cycle, 2Hrs/cycle	Non-operation
7	Electrostatic Discharge	Air-mode : +/- 4kV Contact-mode : +/- 2kV	Note 2,3
8	Vibration	Frequency range : 10~55Hz Stoke : 1.5mm Sweep : 10~55Hz~10Hz 2 hours for each direction of X,Y,Z (6 hours for total)	Non-operation JIS C7021, A-10 condition A
10	Mechanical Shock	100G . 6ms, ±X,±Y,±Z 3 times for each direction	Non-operation JIS C7021, A-7 condition C
11	Vibration (With Carton)	Random vibration: 0.015G ² /Hz from 5~200Hz -6dB/Octave from 200~500Hz	IEC 68-34
12	Drop (With Carton)	Height: 60cm 1 corner, 3 edges, 6 surfaces	

Note 1. Ta: Ambient temperature.

Note 2. ESD Testing Flow as the below,



Note 3. ESD testing method.

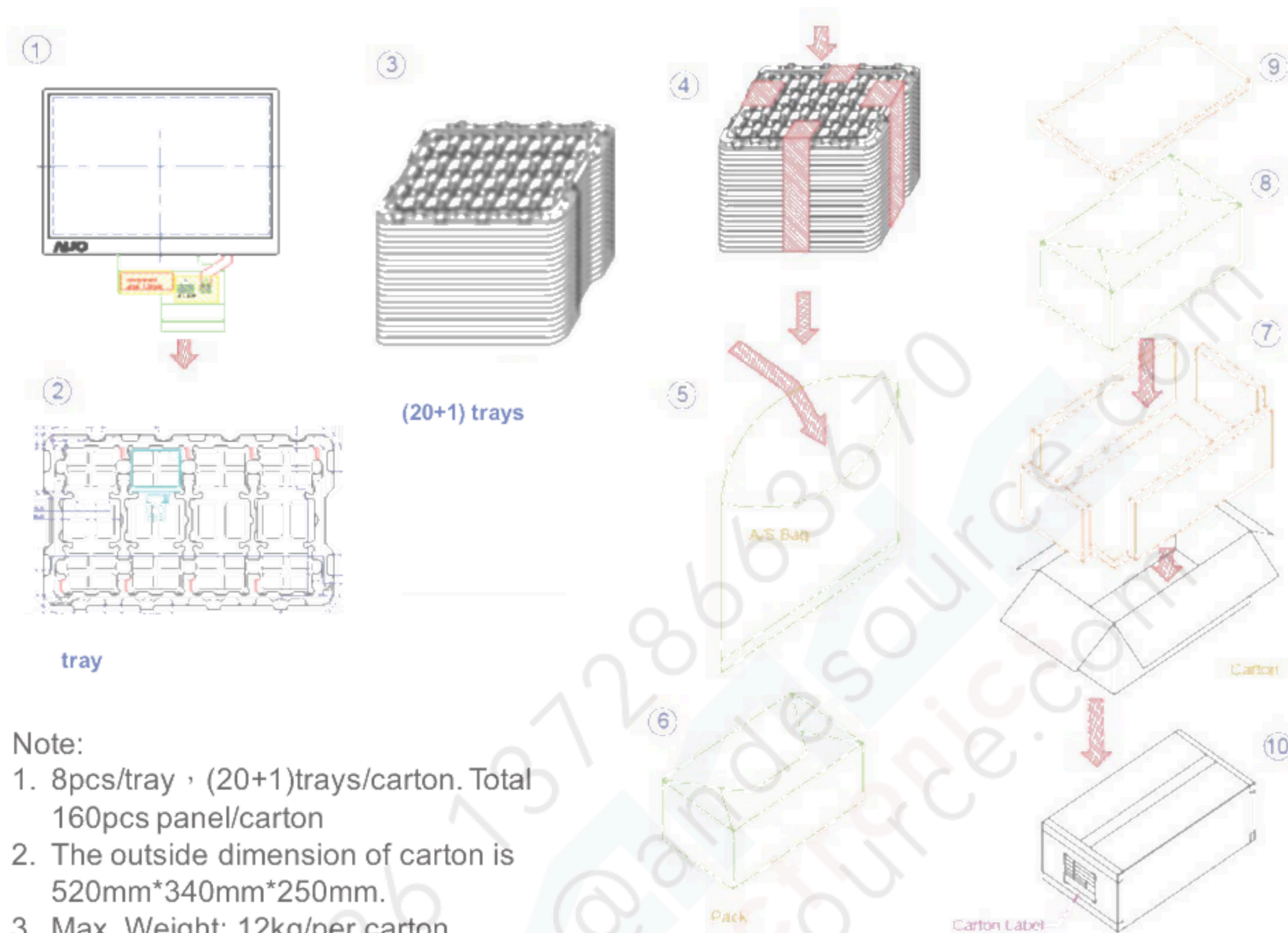
1. Ambient: 24~26°C, 56~65%RH
2. Instruments: Noiseken ESS-2000,
3. Operation System: "CX40FL-B" and adapter "A035QN04 V0T0"
4. Test Mode: Operating mode, test pattern: colorbar+8Gray scale
5. Test Method:
 - a. Contact Discharge: 150pF(330Ω) 1sec, 5 points, 10 times/point
 - b. Air Discharge: 150pF(330Ω) 1sec, 5 points, 10 times/point

6. Test point:

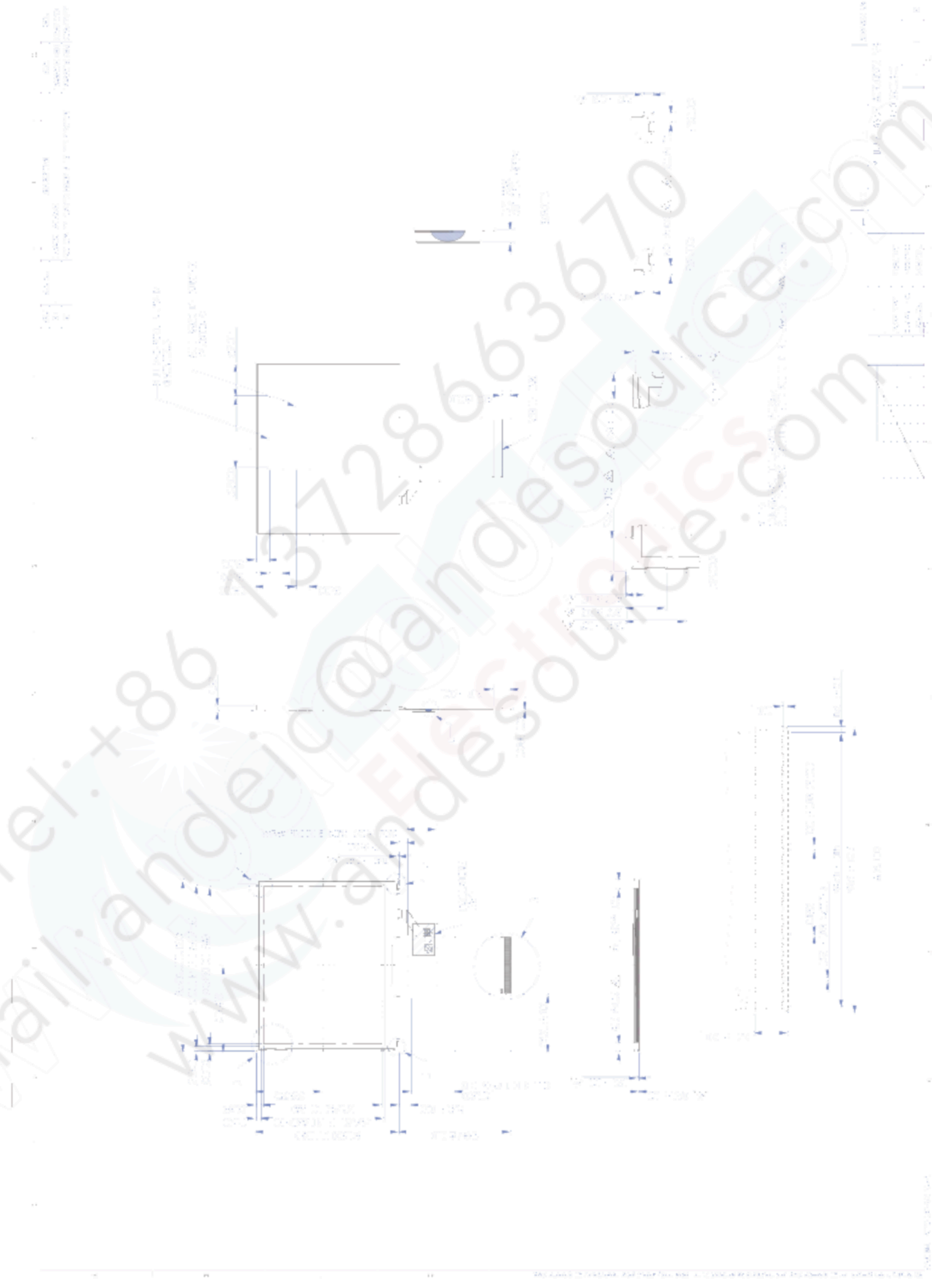


7. The metal casing is connected to power supply ground (0V) at four corners.
8. All register commands are repeating transfer.

E. Packing Form



F. Outline dimension



G. Application note

1.Recommended Register Settings

a. 8-bit Serial Interface HV Sync. Mode without Dummy

Power On

No.	Command		NOTE
	High byte	Low byte	
1	00h	31h	NOTE1
Whait 50 us			
2	00h	39h	
Whait 100 us			
3	10h	38h	NOTE2
4	21h	46h	
5	30h	15h	
6	43h	CBh	
7	50h	08h	
8	60h	40h	
9	70h	0Bh	
10	80h	BBh	
11	90h	3Bh	
12	A0h	66h	
13	B1h	F3h	
14	C1h	77h	
15	D0h	2Dh	
16	E0h	1Ah	
17	00h	3Dh	

Power Off

No.	Command		NOTE
	High byte	Low byte	
1	00h	39h	NOTE3

NOTE 1. Please add these commands if you don't use the HW Reset.

NOTE 2.Please refer to the POWER ON sequence section for register setting timing as power-on.

NOTE 3.Please refer to the POWER OFF sequence section for register setting timing as power-off.

b. 8-bit Serial Interface HV Sync. Mode with Dummy

Power On

No.	Command		NOTE
	High byte	Low byte	
1	00h	31h	NOTE1
Whait 50 us			
2	00h	39h	
Whait 100 us			
3	10h	39h	NOTE2
4	21h	F1h	
5	30h	15h	
6	43h	CBh	
7	50h	08h	
8	60h	40h	
9	70h	0Bh	
10	80h	BBh	
11	90h	3Bh	
12	A0h	66h	
13	B1h	F3h	
14	C1h	77h	
15	D0h	2Dh	
16	E0h	1Ah	
17	00h	3Dh	

Power Off

No.	Command		NOTE
	High byte	Low byte	
1	00h	39h	NOTE3

NOTE 1. Please add these commands if you don't use the HW Reset.

NOTE 2. Please refer to the POWER ON sequence section for register setting timing as power-on.

NOTE 3. Please refer to the POWER OFF sequence section for register setting timing as power-off.

c. YUV640 Mode

Power On

No.	Command		NOTE
	High byte	Low byte	
1	00h	31h	NOTE1
Whait 50 us			
2	00h	39h	
Whait 100 us			
3	10h	3Ch	NOTE2
4	21h	F0h	
5	30h	15h	
6	43h	CBh	
7	50h	08h	
8	60h	40h	
9	70h	0Bh	
10	80h	BBh	
11	90h	3Bh	
12	A0h	66h	
13	B1h	F3h	
14	C1h	77h	
15	D0h	2Dh	
16	E0h	1Ah	
17	00h	3Dh	

Power Off

No.	Command		NOTE
	High byte	Low byte	
1	00h	39h	NOTE3

NOTE 1. Please add these commands if you don't use the HW Reset.

NOTE 2. Please refer to the POWER ON sequence section for register setting timing as power-on.

NOTE 3. Please refer to the POWER OFF sequence section for register setting timing as power-off.

d. YUV720 Mode

Power On

No.	Command		NOTE
	High byte	Low byte	
1	00h	31h	NOTE1
Whait 50 us			
2	00h	39h	
Whait 100 us			
3	10h	3Dh	NOTE2
4	21h	F0h	
5	30h	15h	
6	43h	CBh	
7	50h	08h	
8	60h	40h	
9	70h	0Bh	
10	80h	BBh	
11	90h	3Bh	
12	A0h	66h	
13	B1h	F3h	
14	C1h	77h	
15	D0h	2Dh	
16	E0h	1Ah	
17	00h	3Dh	

Power Off

No.	Command		NOTE
	High byte	Low byte	
1	00h	39h	NOTE3

NOTE 1. Please add these commands if you don't use the HW Reset.

NOTE 2. Please refer to the POWER ON sequence section for register setting timing as power-on.

NOTE 3. Please refer to the POWER OFF sequence section for register setting timing as power-off.

e. CCIR656 Mode Power On

No.	Command		NOTE
	High byte	Low byte	
1	00h	31h	NOTE1
Whait 50 us			
2	00h	39h	
Whait 100 us			
3	10h	2Eh	NOTE2
4	20h	46h	
5	30h	16h	
6	43h	CBh	
7	50h	08h	
8	60h	40h	
9	70h	0Bh	
10	80h	BBh	
11	90h	3Bh	
12	A0h	66h	
13	B1h	F3h	
14	C1h	77h	
15	D0h	2Dh	
16	E0h	1Ah	
17	00h	3Dh	

Power Off

No.	Command		NOTE
	High byte	Low byte	
1	00h	39h	NOTE3

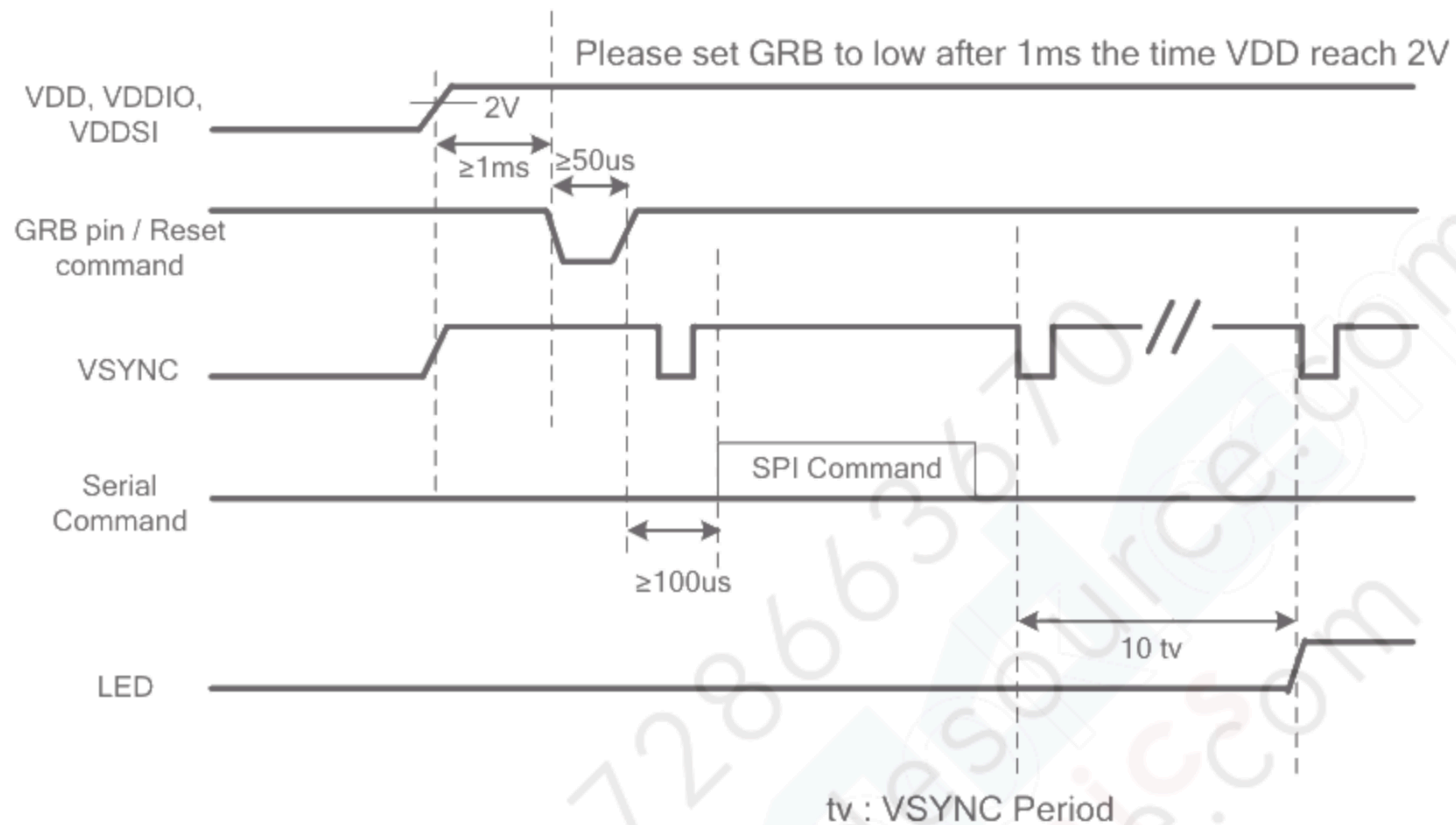
NOTE 1. Please add these commands if you don't use the HW Reset.

NOTE 2. Please refer to the POWER ON sequence section for register setting timing as power-on.

NOTE 3. Please refer to the POWER OFF sequence section for register setting timing as power-off.

2. Power on/off sequence

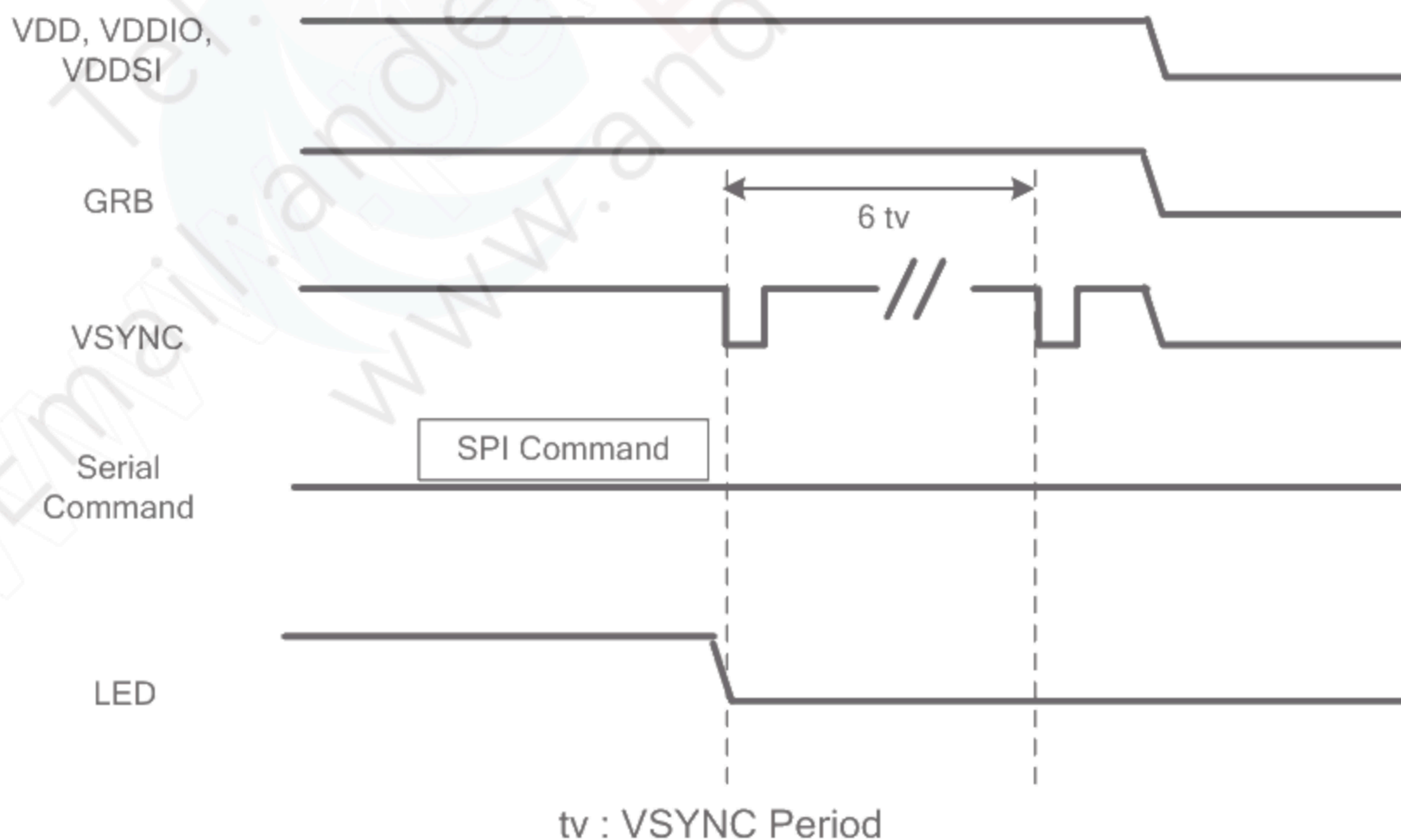
a. Power on (Standby Disabling)



Note

- 1: After Setting Recommended Register, the driver enters into the normal operating mode.
- 2: RESET signal is necessary for power on, Please refer to the POWER ON sequence.
You can use HW GRB PIN or SW Reset command to do this.
- 3: After the driver enters into the normal operating mode, The minimum cycle time of LED ON is 10 frames.

b. Power off (Standby Enabling)



Note

- 1: After Setting Recommended Register, the driver enters into standby mode.
- 2: Please Let LED OFF after the driver enters into the standby mode,
- 3: When enters into standby mode, The minimum cycle time of VDD OFF is 6 frames.

3. Suggested Circuit

The suggested circuit and recommended capacitor specification are both showed as follows. Please refer to the design for better display quality.

Note : (Pin 3~6 is reserved for TP , customer should let it open)

