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Product Specification

2.0″ COLOR TFT-LCD MODULE

MODEL NAME: A020CN01 V7

< ◆ > Preliminary Specification

< > Final Specification

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

Record of Revision

Version	Revise Date	Page	Content
0	10/May/2006		New create
0.1	24/July/2006	42~54	Update EE part

Contents:

A. Physical specifications

No.	Item	Specification	Remark
1	Display resolution (dot)	480 (W) ×240 (H)	
2	Active area (mm)	39.84 (W) ×29.88 (H)	
3	Screen size (inch)	2 (Diagonal)	
4	Dot pitch (mm)	0.083(W) ×0.1245 (H)	
5	Color configuration	R. G. B. Delta	
6	Overall dimension (mm)	47.54 (W) ×41.08 (H) ×2.5 (D)	Note 1
7	Weight (g)	9	
8	Panel surface treatment	Hard coating (3H)	

Note 1: Refer to Fig. 4

B. Electrical specifications

Pin assignment

Pin No.	Symbol	I/O	Description	Remark
1	VCOM	I	Common electrode driving voltage	
2	VGLC	C	Pins to connect capacitance for negative high power supply	
3	VGL	PO	Negative low power supply for gate driver output: -12.5V	
4	C4P	C	Pins to connect capacitance for power circuitry	
5	C4M	C	Pins to connect capacitance for power circuitry	
6	VGH	PO	Positive power supply for gate driver output: +12.5V	
7	FRP	O	Frame polarity output for VCOM	
8	VCAC	C	Define the amplitude of the VCOM swing	
9	Vint3	P	Intermediate voltage for charge Pump	
10	C3P	C	Pins to connect capacitance for power circuitry	
11	C3M	C	Pins to connect capacitance for power circuitry	
12	Vint2	P	Intermediate voltage for charge Pump	
13	C2P	C	Pins to connect capacitance for power circuitry	
14	C2M	C	Pins to connect capacitance for power circuitry	
15	Vint1	P	Intermediate voltage for charge Pump	
16	C1P	C	Pins to connect capacitance for power circuitry	
17	C1M	C	Pins to connect capacitance for power circuitry	
18	PGND	P	Charge Pump Power GND	
19	PVDD	P	Charge Pump Power VDD	
20	DRV	PO	Gate signal for the power transistor of the boost converter	
21	LED Anode	I	For Led Anode voltage	
22	GND	P	Digital GND	
23	FB	P	Main boost regulator feedback input	
24	AVDD	P	Analog power supply	
25	GND	P	Digital GND	
26	VCC	P	Digital power supply	
27	CS	I	Serial communication chip select	
28	SDA	I/O	Serial communication data input/output	
29	SCL	I	Serial communication clock input	
30	HSYNC	I	Horizontal sync input	
31	VSYNC	I	Vertical sync input	
32	DCLK	I	Clock Input:	
33	D7	I	Data Input: MSB	
34	D6	I	Data Input:	

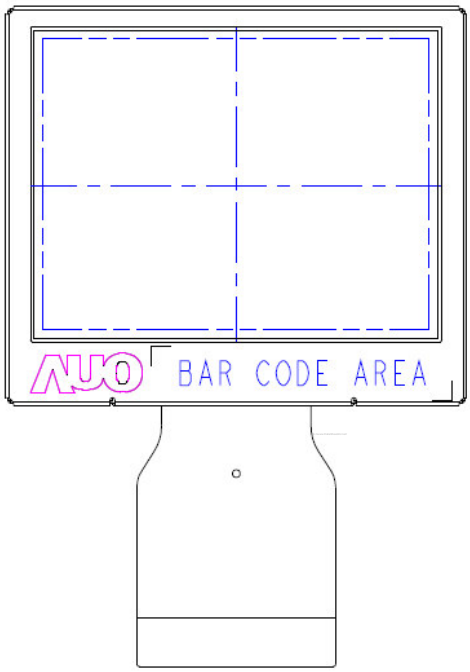
35	D5	I	Data Input:	
36	D4	I	Data Input:	
37	D3	I	Data Input:	
38	D2	I	Data Input:	
39	D1	I	Data Input:	
40	D0	I	Data Input: LSB	

I: Input; O: Output, VI: voltage input, VO: voltage output, P: Power, I/O: input/output

C: capacitor pin, PO: power out.

Note: For definition of scanning direction, refer to the figure as follows

TOP



Absolute maximum ratings

Item	Symbol	Condition	Min.	Max.	Unit	Remark
Power voltage	V_{CC}	GND=0	-0.5	7.0	V	Digital Power Supply
	AV_{DD}	AV_{SS}=0	-0.5	7.0	V	Analog Power Supply
	PV_{DD}	PV_{SS}=0	-0.5	7.0	V	Charge Pump Power Supply
Input signal voltage	Data	-	-0.3	3.6	V	
Input signal voltage	VCOM		-2.9	5.2	V	VCOM DC Voltage
Operating temperature	Topa	-	0	60	℃	Ambient temperature
Storage temperature	Tstg	-	-25	70	℃	Ambient temperature

Electrical characteristics

Typical operating conditions (GND=AVss=0V)

Item		Symbol	Min.	Typ.	Max.	Unit	Remark
Power Voltage		V_{CC}	2.7	3.3	3.6	V	Digital Power Supply
		PV_{DD},AV_D	3.0	3.3	3.6	V	Analog Power Supply
		PV_{DD}	3.0	3.3	3.6	V	Charge Pump Power Supply
Output Signal Voltage	H Level	V_{OH}	Vcc-0.4	-	VCC	V	
	L Level	V_{OL}	GND	-	GND+0.4	V	
Input Signal Voltage	H Level	V_{IH}	0.7xV_{CC}	-	V_{CC}	V	
	L Level	V_{IL}	GND	-	0.3V_{CC}	V	
VCOM Voltage		V_{CAC}	5.4	5.8	6.4	V	V
		V_{CDC}	0.8	1.0	1.2	V	V
DRV output voltage		V_{DRV}		0	-	V_{CC}	V
Analog stand by current		Ist	-	-	100	uA	DCLK is stopped

Note 1: A build-in power on reset circuit for PV_{DD} and V_{CC} is provided within the integrated LCD driver IC. The LCD module is in power saving mode in default, and stand-by releasing is required after V_{CC} power on through serial control. Pleaser refer to the register STB setting for detail.

Current characteristics (GND=AVss=0V)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Input Current for V_{CC}	I_{VCC} (Pin 27)	V_{CC}=3.3V	---	2	4	mA	F_{DCLK}=24.54MHz (UPS052) Other registers are default settings
Input Current for AV_{DD}	I_{AVDD} (Pin 25)	AV_{DD}=3.3V	---	2.5	3	mA	
Input Current for PV_{DD}	I_{PVDD} (Pin 19)	PV_{DD}=3.3V	---	8	10	mA	
Output current	H Level	IOH	---	400	-	uA	
	L Level	IOL	---	-400	-	uA	
Analog stand by current	I_{AST}	AV_{DD}=3.3V	---	50	100	uA	DCLK is stopped
Digital stand by current	I_{DST}	V_{CC}=3.3V	---	---	100	uA	
DRV output current	I_{DRV}	V_{CC} = 3.0V DRV = 0.7V	-	-	10	mA	

LED driving conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
LED current	I_L	-	25	28	mA	
LED voltage	V_L		3.2	3.8	V	Note1
LED Life Time	L_L		TBD-	-	Hr	Note 2,3

Note 1: LED typical voltage 3.8V is base on internal LED driver.
(Please refer to 5. Reference Circuit)

Note 2: Ta. = 25℃, I_L = 25mA

Note 3: Brightness decreased to 50% of the initial value

AC Timing

UPS051 Timing conditions

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	8	9.7	12	MHz	
HSYNC	Period		t_H	580	616	649	DCLK	Note 1
	Display period		t_{hdisp}	480			DCLK	
	Back porch		t_{hbp}	84	100	115	DCLK	
	Front porch		t_{hfp}	0	36	-	DCLK	
	Pulse width		t_{hsw}	1	20	50	DCLK	
VSYNC	Period	Odd	t_V	Note 4	262.5	Note 4	t_H	Note 2, 3, 5, 6
		Even						
	Display period	Odd	t_{vdisp}	240			t_H	
		Even						
	Back porch	Odd	t_{vbp}	11	18	24	t_H	
		Even		10.5	17.5	23.5		
	Front porch	Odd	t_{vfp}	0	4.5	-	t_H	
		Even		0	5	-		
	Pulse width	Odd	t_{vsw}	1	-	-	DCLK	
		Even						
Data set-up time			t_{ds}	12			ns	
Data hold time			t_{dh}	12			ns	

Note 1: UPS051 Horizontal back porch time (t_{hbp}) is adjustable by setting register DDL; requirement of minimum back porch time and minimum front porch time must be satisfied.

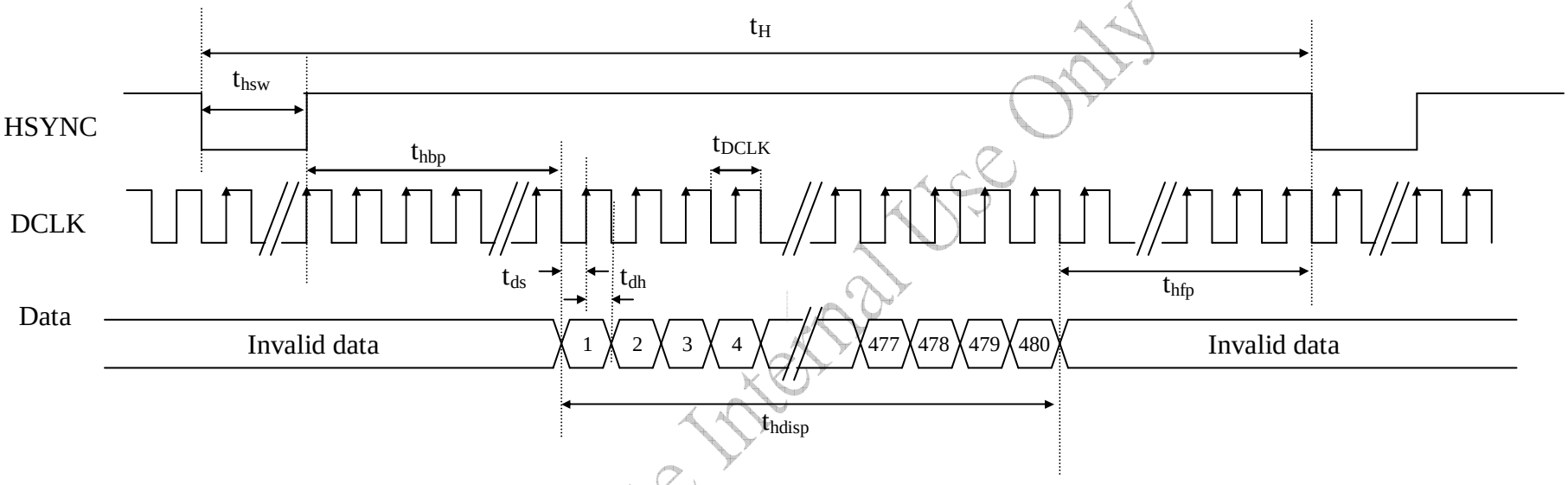
Note 2: UPS051 Vertical back porch time (t_{vbp}) is adjustable by setting register HDL; requirement of minimum back porch time and minimum front porch time must be satisfied.

Note 3: Both interlace and non-interlace mode can be accepted.

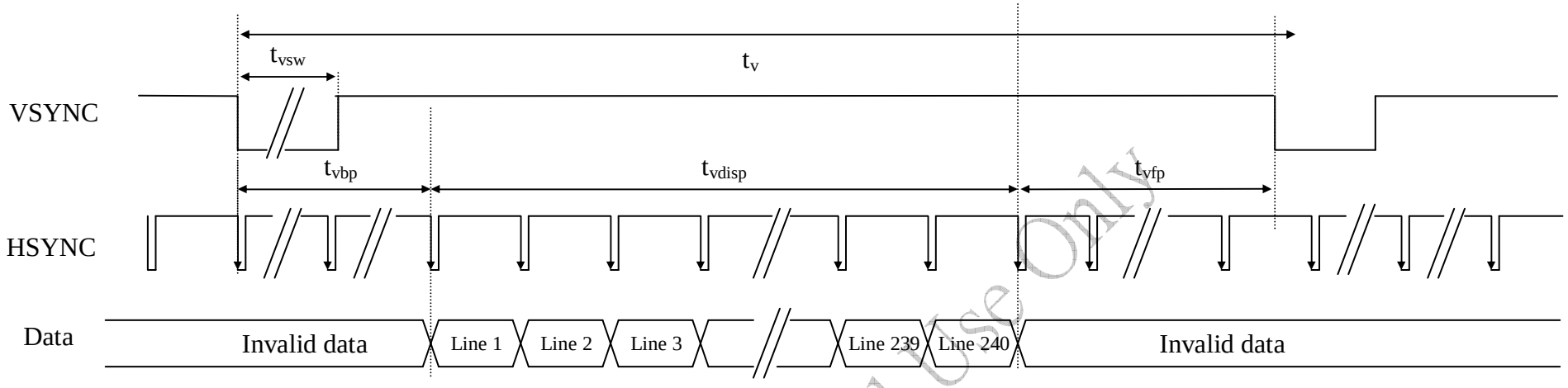
Note 4: Min. and max. value of VSYNC period are related to Hsync period and Vs back porch.

Note 5: This chip supports both interlace & non-interlace mode.

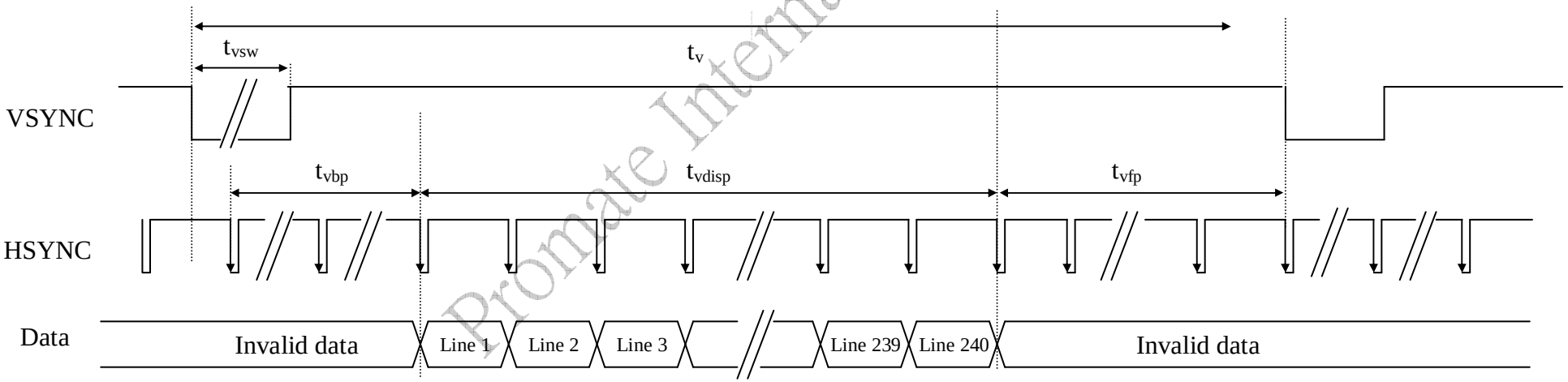
Note 6: Please keep frame over 50 Hz to get the better display quality.



UPS051 Input Horizontal Signal



Odd Field



Even Field

UPS051 Input Vertical Signal

UPS052 Timing conditions

b - 1. UPS052 (320 mode 24.545MHz) timing specifications

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	16	24.55	27	MHz	
HSYNC	Period		t_H	1472	1560	1644	DCLK	
	Display period		t_{hdisp}	1280			DCLK	
	Back porch		t_{hbp}	220	252	283	DCLK	
	Front porch		t_{hfp}	0	-	-	DCLK	
	Pulse width		t_{hsw}	1	-	-	DCLK	
VSYNC	Period	Odd	t_V	Note 1	262.5	Note 1	t_H	Note 2, 3
		Even						
	Display period	Odd	t_{vdisp}	240			t_H	
		Even						
	Back porch	Odd	t_{vbp}	11	18	24	t_H	
		Even		10.5	17.5	23.5		
	Front porch	Odd	t_{vfp}	0	4.5	-	t_H	
		Even		0	5	-		
	Pulse width	Odd	t_{vsw}	1	-	-	DCLK	
		Even						

Note 1: Min and max value of VSYNC period are related to Hsync period and Vs back porch.

Note 2: This chip supports both interlace & non-interlace mode.

Note 3: Please keep frame over 50 Hz to get the better display quality.

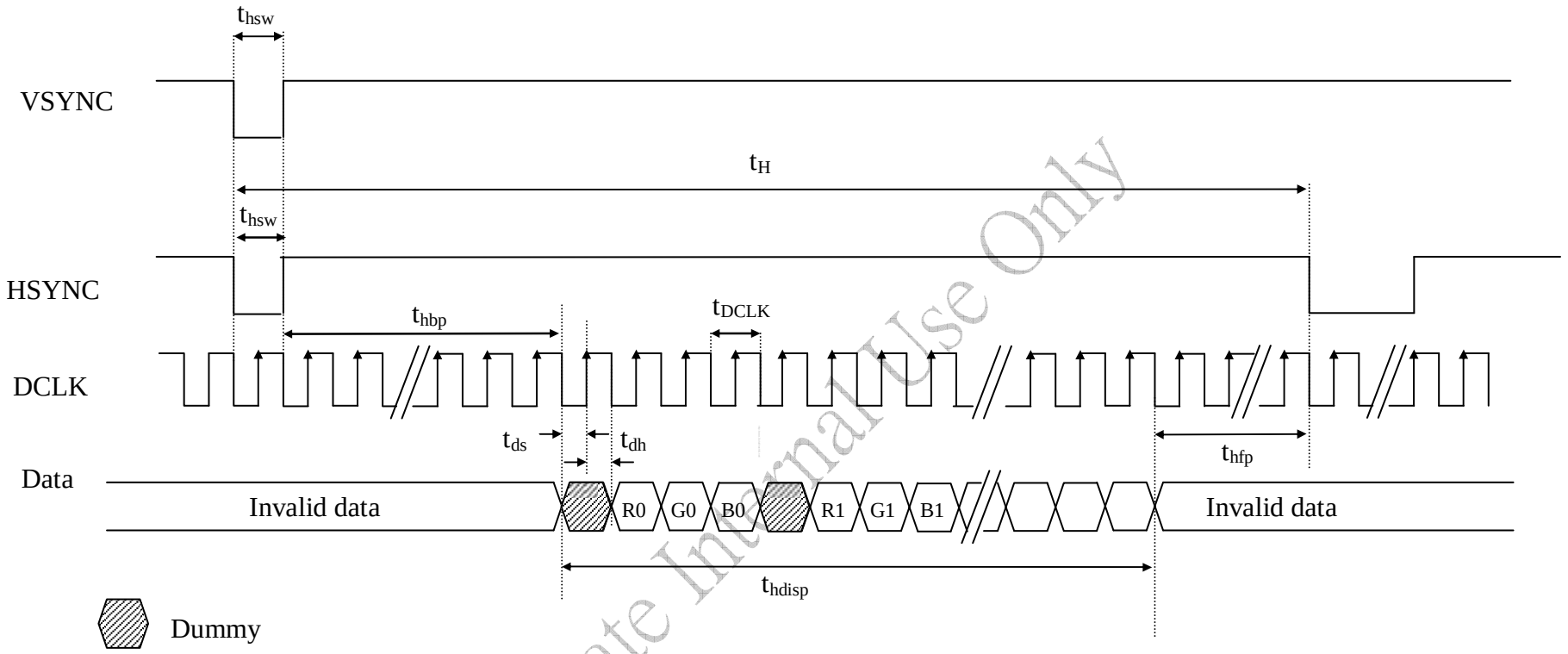
b - 2. UPS052 (360 mode 27MHz) timing specifications

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	16	27	27	MHz	
HSYNC	Period		t_H	1620	1716	1809	DCLK	
	Display period		t_{hdisp}	1440			DCLK	
	Back porch		t_{hbp}	220	252	283	DCLK	
	Front porch		t_{hfp}	0	-	-	DCLK	
	Pulse width		t_{hsw}	1	-	-	DCLK	
VSYNC	Period	Odd	t_V	Note 1	262.5	Note 1	t_H	Note 2, 3
		Even						
	Display period	Odd	t_{vdisp}	240			t_H	
		Even						
	Back porch	Odd	t_{vbp}	11	18	24	t_H	
		Even		10.5	17.5	23.5		
	Front porch	Odd	t_{vfp}	0	4.5	-	t_H	
		Even		0	-	-		
	Pulse width	Odd	t_{vsw}	1	-	-	DCLK	
		Even						

Note 1: Min and max value of VSYNC period are related to Hsync period and Vs back porch.

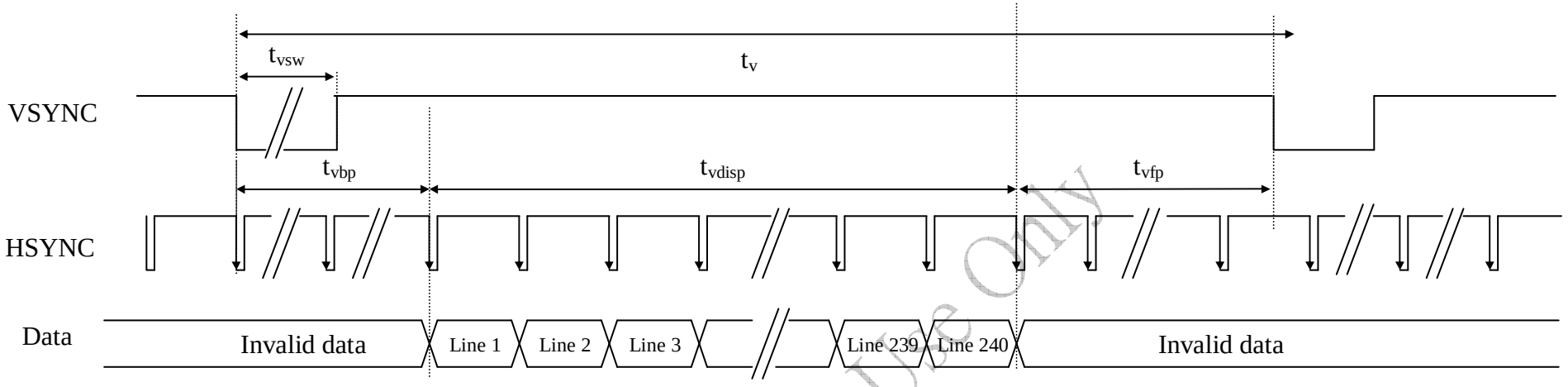
Note 2: This chip supports both interlace & non-interlace mode.

Note 3: Please keep frame over 50 Hz to get the better display quality.

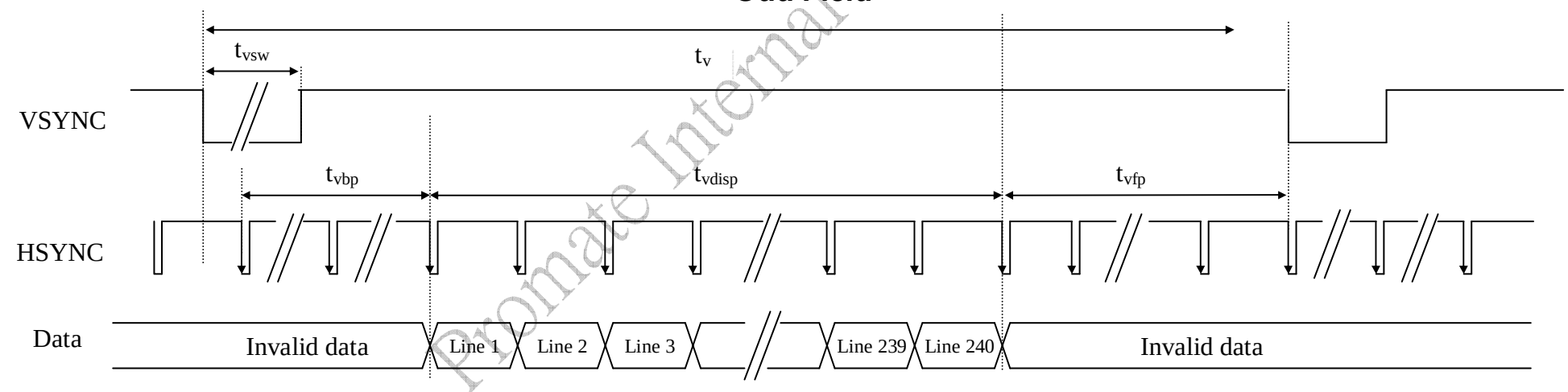


UPS052 Input Horizontal Signal

Note: Please send 00h as blanking data



Odd Field



Even Field

UPS052 Input Vertical Signal

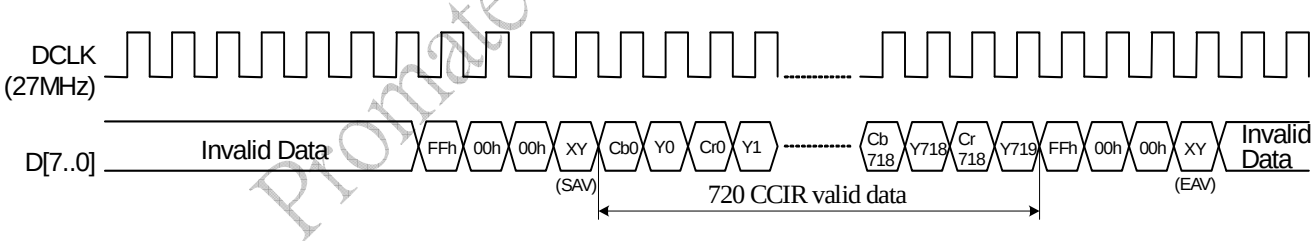
CCIR656 Timing conditions

c - 1. CCIR656 timing specifications:

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	16	27	27	MHz	
HSYNC	Period		t_H	1620	1716	1809	DCLK	
	Display period		t_{hdisp}	1440			DCLK	
	Back porch		t_{hbp}	241	273	304	DCLK	
	Front porch		t_{hfp}	4	4	4	DCLK	
	Pulse width		t_{hsw}	1	-	-	DCLK	
VSYNC	Period	Odd	t_V	Note 1	262.5	Note 1	t_H	Note 2
		Even						
	Display period	Odd	t_{vdisp}	240			t_H	
		Even						
	Back porch	Odd	t_{vbp}	11	18	24	t_H	
		Even		10.5	17.5	23.5		
	Front porch	Odd	t_{vfp}	0	4.5	-	t_H	
		Even		0	5	-		
	Pulse width	Odd	t_{vsw}	1	-	-	DCLK	
		Even						

Note 1: Min and max value of VSYNC period are related to Hsync period and Vs back porch.

Note 2: Please keep frame over 50 Hz to get the better display quality.



CCIR656 Data input format

c- 2. CCIR656 decoding:

FF 00 00 XY signals are involved with HSYNC, VSYNC and Field.

XY encodes following bits:

F = field select

V = indicate vertical blanking

H = 1 if EAV else 0 for SAV

P3-P0 = protection bits

P3 = V⊕H, P2 = F⊕H, P1 = F⊕V, P0 = F⊕V⊕H

⊕ represents the exclusive-OR function.

It is controlled by “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

c- 3. CCIR656 to RGB conversion

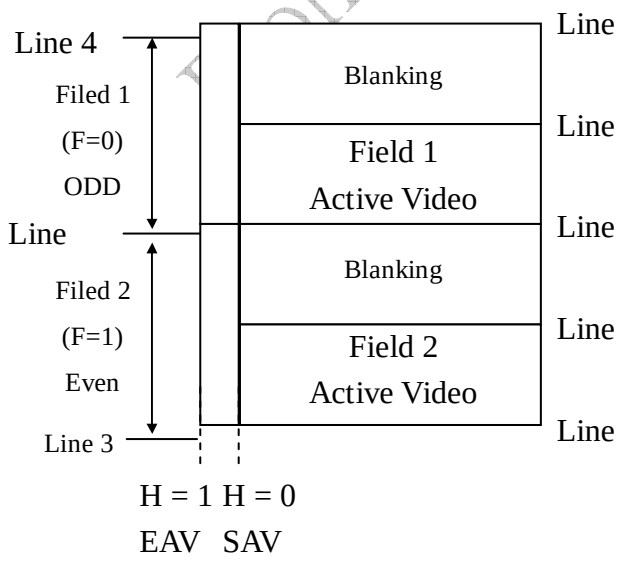
R = 1.164 (Y-16) + 1.596 (Cr-128)

G = 1.164 (Y-16) - 0.813 (Cr-128) - 0.392 (Cb-128)

B = 1.164 (Y-16) + 2.017 (Cb-128)

Where Y: 0~255,Cr: 0~255, Cb: 0~255

c- 4. CCIR656 Vertical Timing Format (NTSC)



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

YUV Timing

d - 1. YUV 640 timing specifications

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	16	24.545	27	MHz	
HSYNC	Period		t_H	1472	1560	1644	DCLK	
	Display period		t_{hdisp}	1280			DCLK	
	Back porch		t_{hbp}	220	252	283	DCLK	
	Front porch		t_{hfp}	0	-	-	DCLK	
	Pulse width		t_{hsw}	1	-	-	DCLK	
VSYNC	Period	Odd	t_V	Note 1	262.5	Note 1	t_H	Note 2
		Even						
	Display period	Odd	t_{vdisp}	240			t_H	
		Even						
	Back porch	Odd	t_{vbp}	11	18	24	t_H	
		Even		10.5	17.5	23.5		
	Front porch	Odd	t_{vfp}	0	4.5	-	t_H	
		Even		0	5	-		
	Pulse width	Odd	t_{vsw}	1	-	-	DCLK	
		Even						

Note 1: Min and max value of VSYNC period are related to Hsync period and Vs back porch.

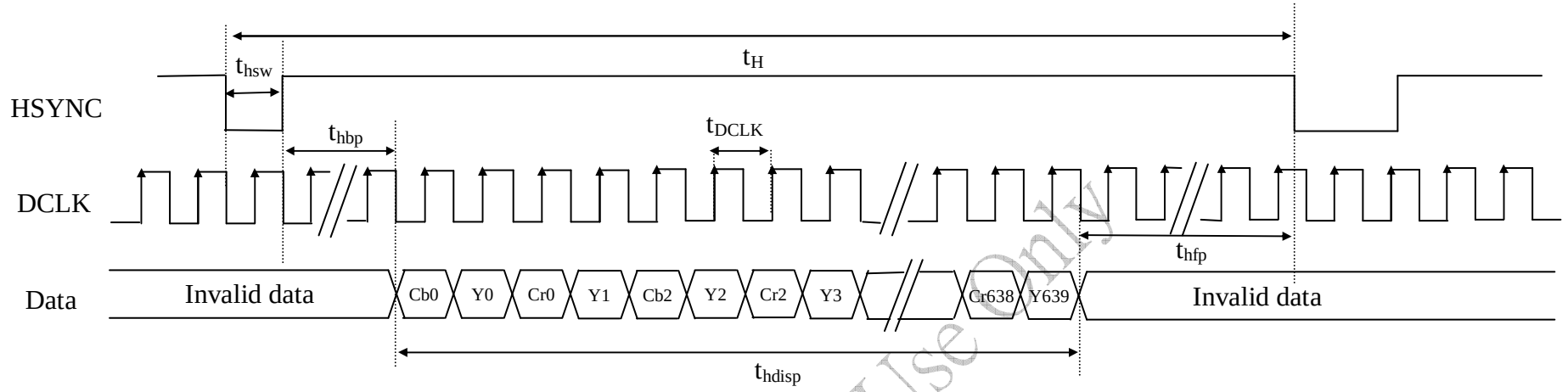
Note 2: Please keep frame over 50 Hz to get the better display quality.

d - 2. YUV 720 timing specifications

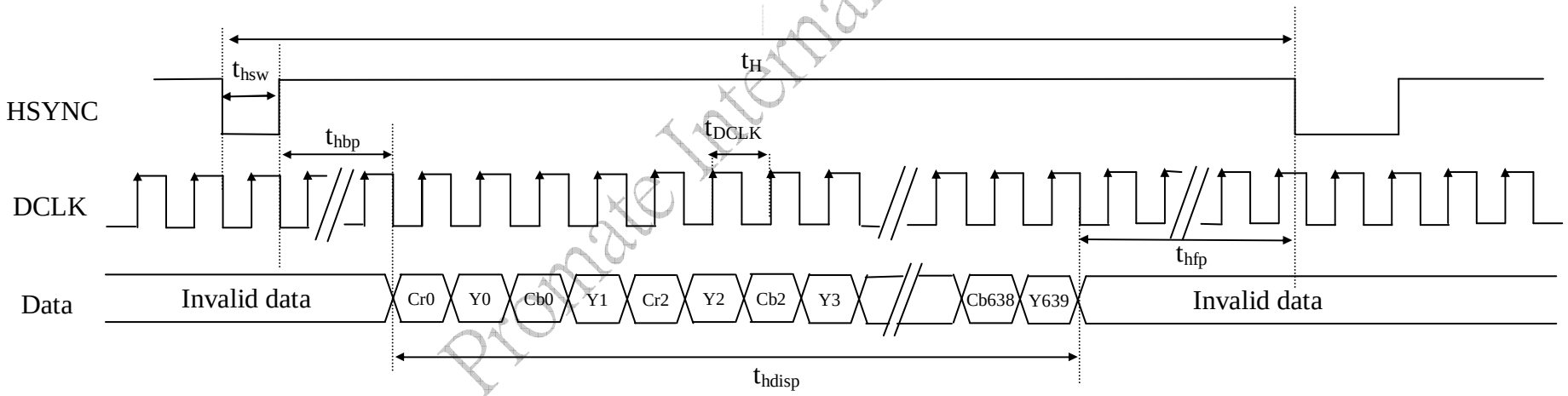
Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	16	27	27	MHz	
HSYNC	Period		t_H	1620	1716	1809	DCLK	
	Display period		t_{hdisp}	1440			DCLK	
	Back porch		t_{hbp}	220	252	283	DCLK	
	Front porch		t_{hfp}	0	24	-	DCLK	
	Pulse width		t_{hsw}	1	20	50	DCLK	
VSYNC	Period	Odd	t_V	Note 1	262.5	Note 1	t_H	Note 2
		Even						
	Display period	Odd	t_{vdisp}	240			t_H	
		Even						
	Back porch	Odd	t_{vbp}	11	18	24	t_H	
		Even		10.5	17.5	23.5		
	Front porch	Odd	t_{vfp}	0	4.5	-	t_H	
		Even		0	5	-		
	Pulse width	Odd	t_{vsw}	1	3	200	DCLK	
		Even						

Note 1: Min and max value of VSYNC period are related to Hsync period and Vs back porch.

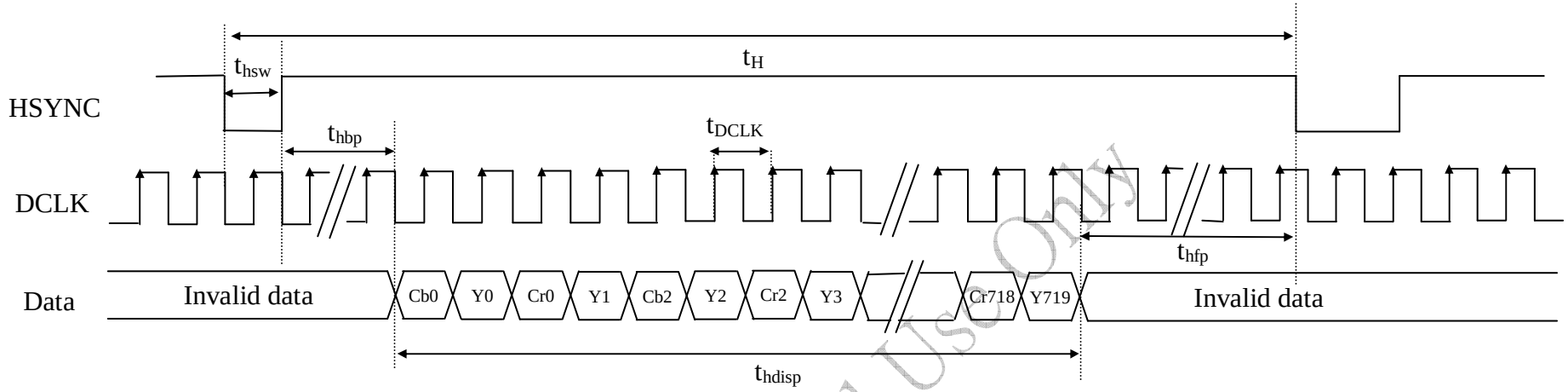
Note 2: Please keep frame over 50 Hz to get the better display quality.



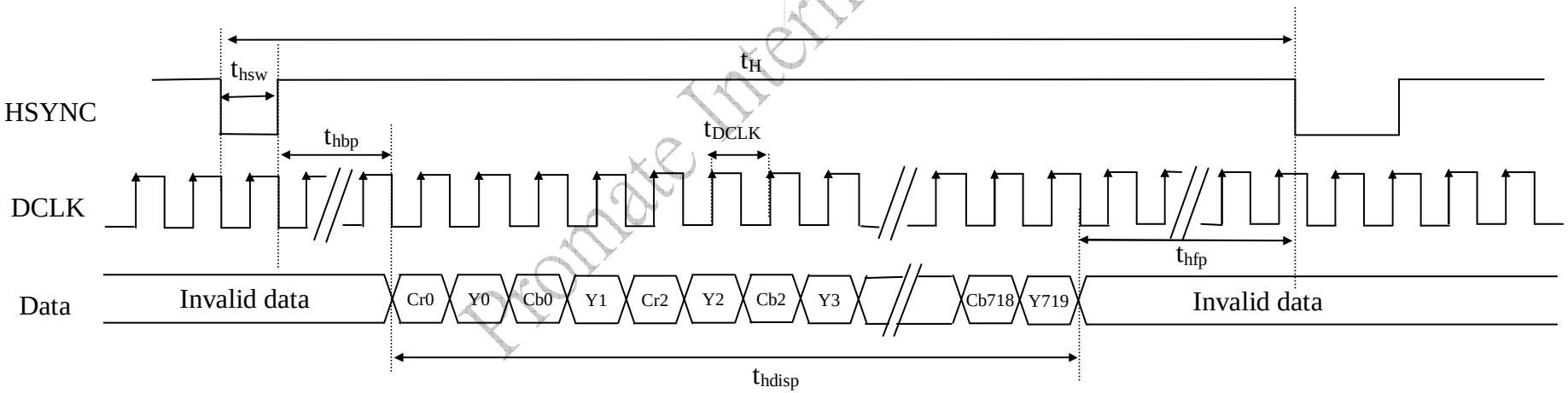
YUV mode A (24.5 MHz) Input Horizontal Signal (SEL = 011)



YUV mode B (24.5 MHz) Input Horizontal Signal (SEL = 101)

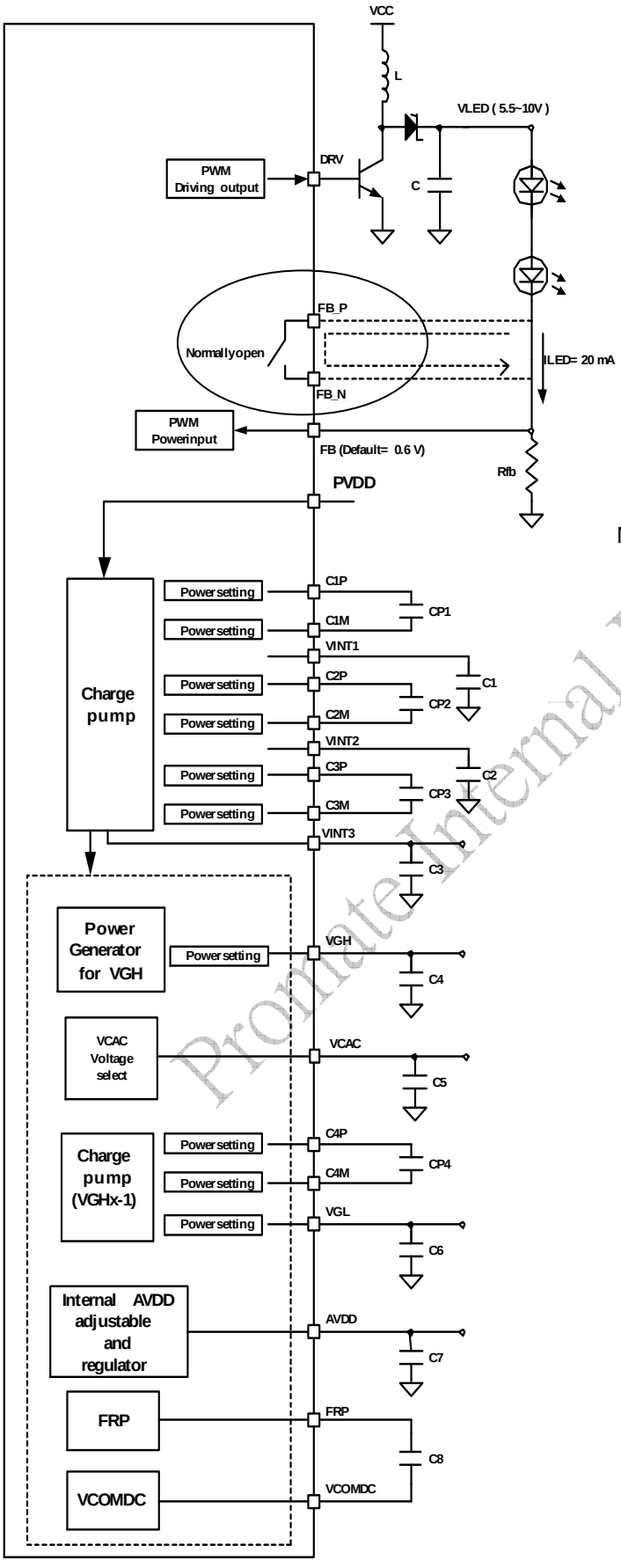


YUV mode A (27 MHz) Input Horizontal Signal (SEL = 100)



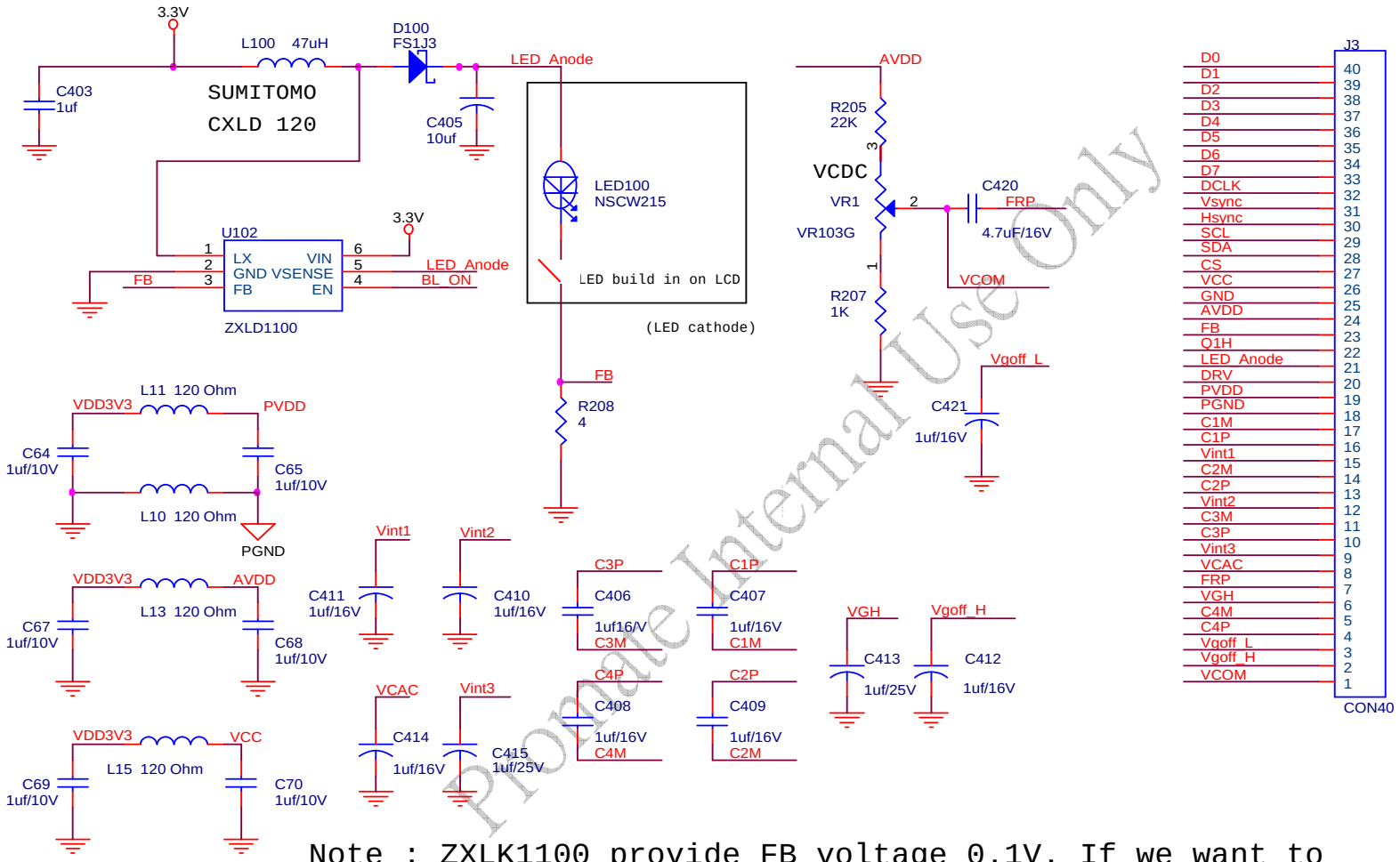
YUV mode B (27MHz) Input Horizontal Signal (SEL = 110)

Charge Pump Structure



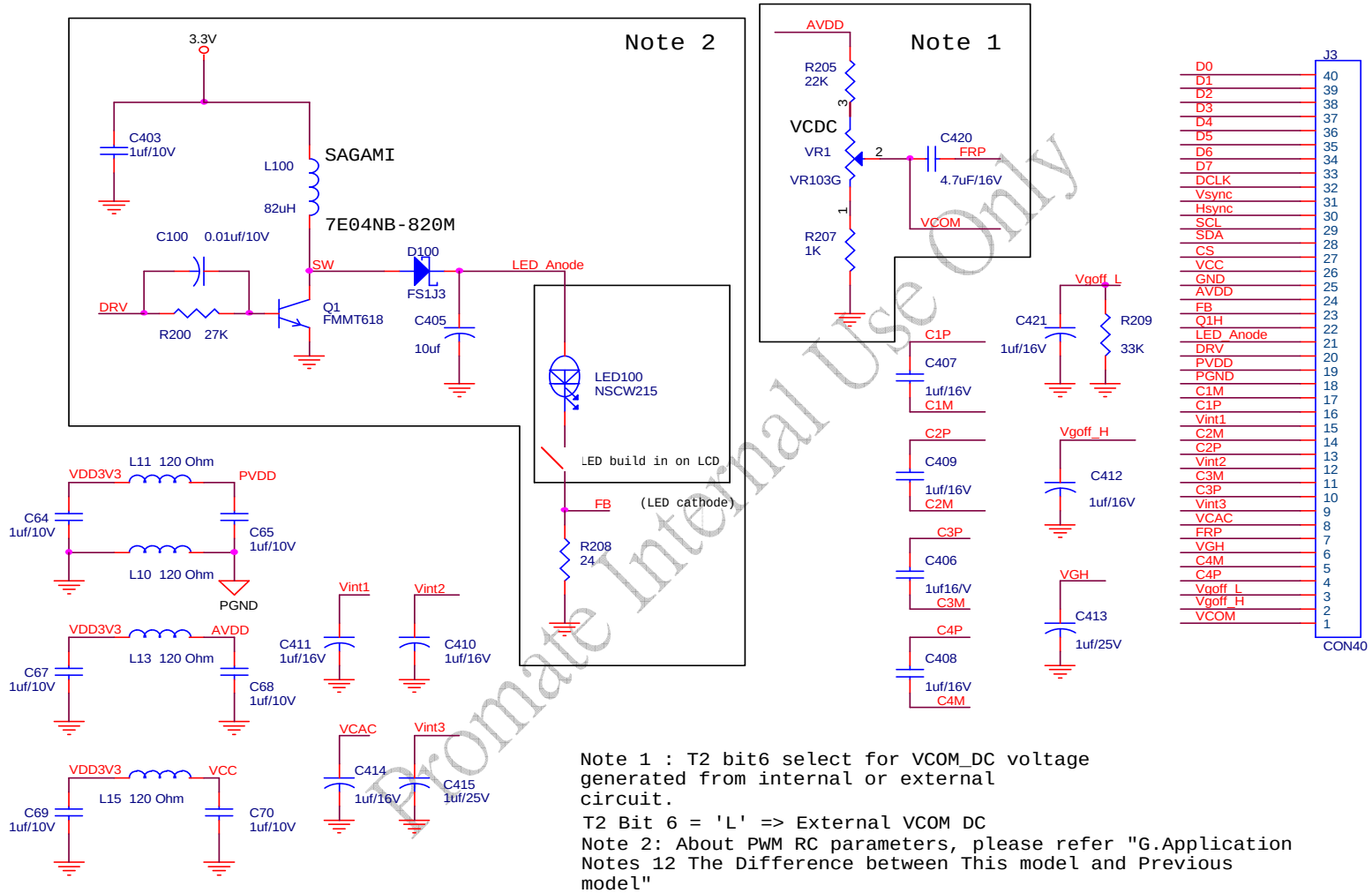
Note: FB_P and FB_N are for one LED solution.

6. Reference Circuit



Note : ZXLK1100 provide FB voltage 0.1V. If we want to keep LED current at 25mA, R208 have to set to 4 ohm.

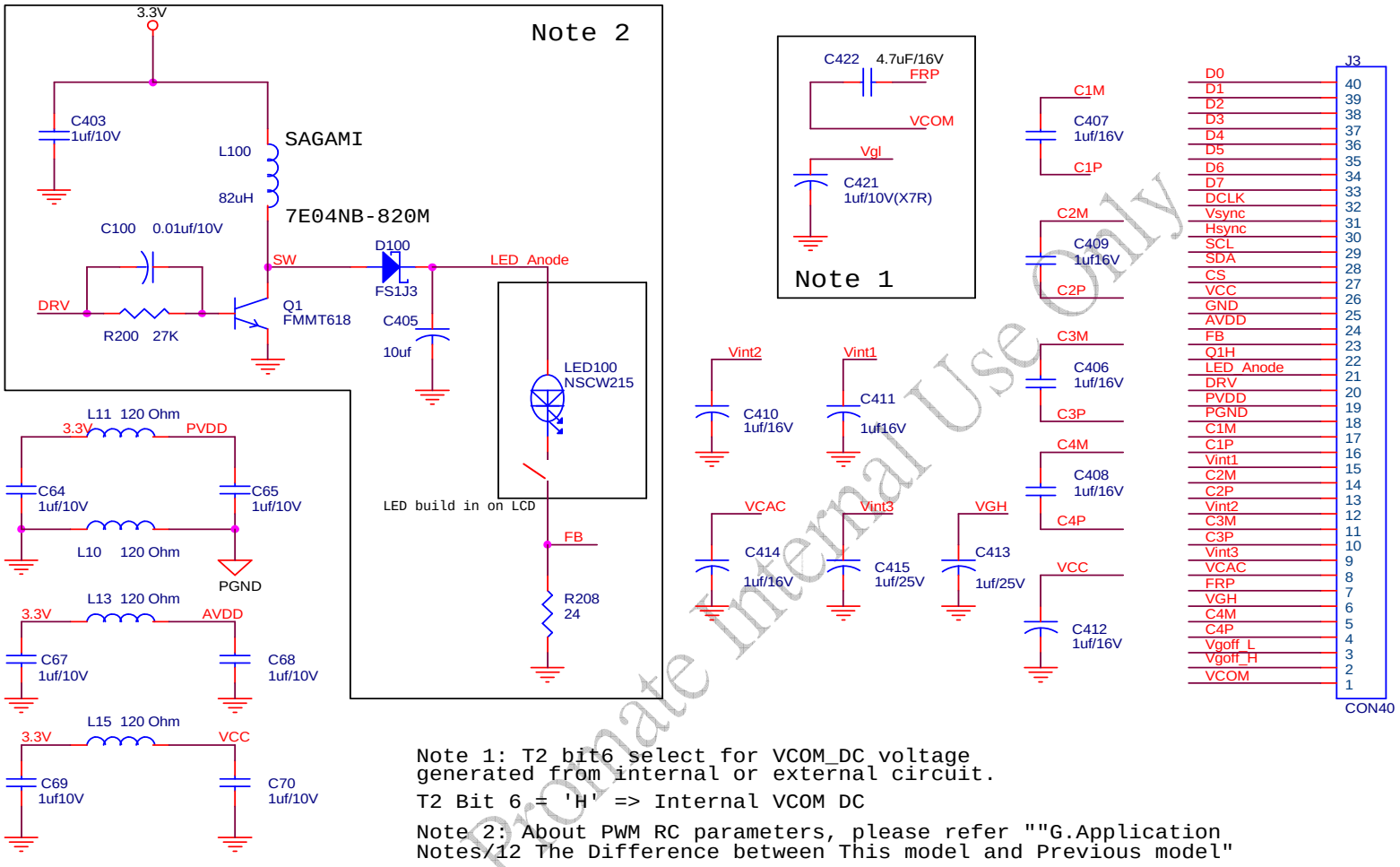
External LED Driver Application Circuit



Note 1 : T2 bit6 select for VCOM_DC voltage generated from internal or external circuit.
T2 Bit 6 = 'L' => External VCOM DC
Note 2: About PWM RC parameters, please refer "G.Application Notes 12 The Difference between This model and Previous model"

Note: PWM R/C/L (R200/C100/L100) parameters and component characteristics will effects efficiency and wave like noise. The application circuit is for reference only. If efficiency is not god or wave like noise is serious, please adjust RCL parameters to get best efficiency and display quality

Internal LED Driver Application Circuit



Note 1: T2 bit6 select for VCOM_DC voltage generated from internal or external circuit.

T2 Bit 6 = 'H' => Internal VCOM DC

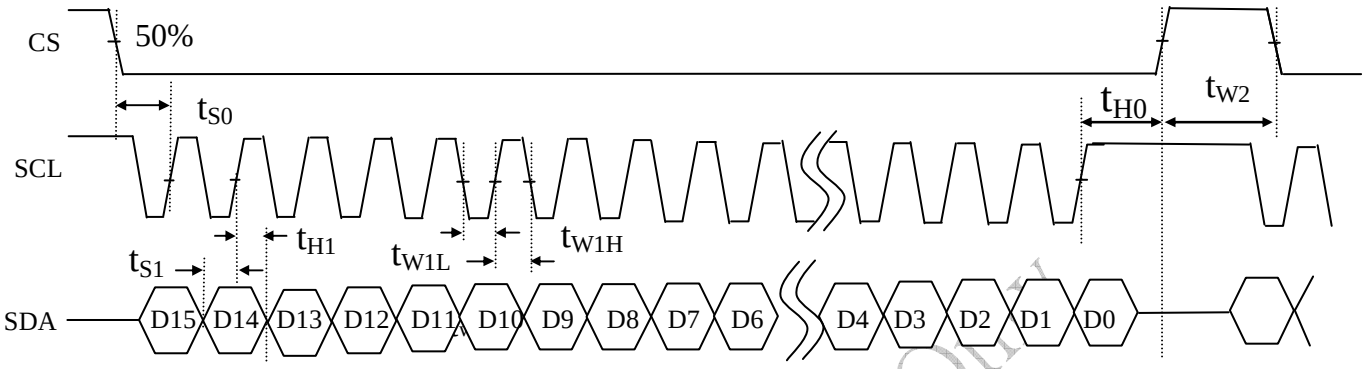
Note 2: About PWM RC parameters, please refer ""G.Application Notes/12 The Difference between This model and Previous model"

Note: PWM R/C/L (R200/C100/L100) parameters and component characteristics will effects efficiency and wave like noise. The application circuit is for reference only. If efficiency is not god or wave like noise is serious, please adjust RCL parameters to get best efficiency and display quality

Internal VCOM DC Application Circuit

7. Serial Interface & Register Table

Serial Interface format



Item	Symbol	Conditions	Min	Typical	Max	Unit
Data Setup Time	t_{S0}	SCL to CS	120			ns
	t_{S1}	SCL to SDA	120			ns
Data Hold Time	t_{H0}	SCL to CS	120			ns
	t_{H1}	SCL to SDA	120			ns
Pulse Width	t_{W1L}	SCL pulse width	120			ns
	t_{W1H}	SCL pulse width	120			ns
	t_{W2}	CS pulse width	1000			ns

The configuration of serial data at SDA terminal is at below

MSB LSB

D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
Register address				R/W	DATA										

Note: R/W = '0' ➔ Write mode R/W = '1' ➔ Read mode

Register parameters

No	ADDRESS				R/W		CONTENT							
	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	GRB	STB	SHDB	SHCB
R1	0	0	1	0	W	x	x	x	SWD			DITB	PFON	D/S
R2	0	1	0	0	W	x	x	x	x	x	FPOL	VSET	U/D	SHL
R3	0	1	1	0	W	x	x	x	x	PALM	PAL	SEL		
R4	1	0	0	0	W	x	x	x	x	DDL				
R5	1	0	1	0	W	x	x	x	OEA		HDL			
R6	1	1	0	0	W	x	x	x	x	x	x	VCSL		
R7	1	1	1	0	W	x	x	x	x	Reserved		VLNC	AVGY	DMDA
T0	0	0	0	1	W	x	Reserved			PDTY		FBV2	FBV1	FBV0
T1	0	0	1	1	W	x	x	AVG	Reserved	T352	CONST			
T2	0	1	0	1	W	x	x	VDCEN	VCOMDC					
T3	0	1	1	1	W	x	x	BRADJ						
T4	1	0	0	1	W	x	x	x	x	x	x	FB_S	VNSEL	
T5	1	0	1	1	W	x	SAT				HUE			
T6	1	1	0	1	R	x	Reserved							

Note 1: Please keep all the Reserved register at ”0” to avoid abnormal display.

Note 2: Register T6 is read only.

c1 - Default register settings

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R1	0	0	1	0	W	x	x	x	0	0	0	0	0	1
R2	0	1	0	0	W	x	x	x	x	x	0	0	1	1
R3	0	1	1	0	W	x	x	x	x	0	0	0	0	1
R4	1	0	0	0	W	x	x	x	x	0	0	0	0	0
R5	1	0	1	0	W	x	x	x	0	0	0	0	0	0
R6	1	1	0	0	W	x	x	x	x	x	x	1	1	0
R7	1	1	1	0	W	x	x	x	x	Reserved		0	1	1
T0	0	0	0	1	W	x	Reserved			0	0	1	0	0
T1	0	0	1	1	W	x	x	0	Reserved	0	1	0	0	0
T2	0	1	0	1	W	x	x	0	1	0	0	0	0	0
T3	0	1	1	1	W	x	x	1	0	0	0	0	0	0
T4	1	0	0	1	W	x	x	x	x	x	x	0	0	0
T5	1	0	1	1	W	x	1	0	0	0	1	0	0	0
T6	1	1	0	1	R	x	Reserved							

“X” => Don’t care

c2 – UPS051 mode Recommand register setting (9.7MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	0	0	0

“X” => Don’t care

c3 - UPS052 320 mode Recommand register setting (24.54MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	0	0	1

“X” => Don’t care.

c4 - UPS052 360 mode Recommand register setting (27MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	0	1	0

“X” => Don’t care.

c5 – YUV 640 mode A Recommand register setting (24.54MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	0	1	1

“X” => Don’t care.

c6 – YUV 720 mode A Recommand register setting (27MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	1	0	0

"X" => Don't care.

c7 – YUV 640 mode B Recommand register setting (24.54MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	1	0	1

"X" => Don't care.

c8 – YUV 720 mode B Recommand register setting (27MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	1	1	0

"X" => Don't care.

c9 – CCIR656 mode Recommand register setting (27MHz)

No	D15	D14	D13	D12	D11	D[10 : 8]	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	W	x	x	x	x	x	1	1	0	1
R3	0	1	1	0	W	x	x	x	x	0	0	1	1	1

"X" => Don't care.

Detail Register Description

d1. Register R0

Address	Bit	Description		Default
0000	[3..0]	Bit3(GRB)	Global reset.	1101b
		Bit2(STB)	Standby mode setting.	
		Bit1(SHDB)	DC-DC converter shutdown setting.	
		Bit0(SHCB)	Charge Pump shutdown setting.	

Bit3	GRB function
0	The controller is resets, the charge pump and DCDC is off. Reset all register to default value.
1	**Normal operation (default)**

Bit2	STB function
0	**T-CON, source driver and DC-DC converter are off. All outputs are High-Z.**
1	**Normal operation (default)**

Bit1	SHDB function
0	DC-DC converter is off. (default)
1	DC-DC converter is on. DC-DC controls by STB and power on/off sequence.

Bit0	SHCB function
0	Charge Pump converter is off.
1	Charge Pump converter is on. (default) Charge Pump controls by STB and power on/off sequence.

d2. Register R1:

Address	Bit	Description		Default
0010	[5..0]	Bit5-3(SWD)	Select type of RGB panel matrix for data alignment	00_0001b
		Bit2(DITB)	Dithering setting	
		Bit1(PFON)	Pre-filter setting.	
		Bit0(D/S)	Select Delta or Stripe mode for Data arrangement.	

Bit5-3	SWD function			
	Output (n=0 to 214)			
	X:3*n+1	Y:3*n+2	Z:3*n+3	
000	G	B	R	Odd Line
	B	R	G	Even Line
001	B	R	G	Odd Line
	R	G	B	Even Line
01X	R	G	B	Odd Line
	G	B	R	Even Line
100	B	R	G	Odd Line
	G	B	R	Even Line
101	R	G	B	Odd Line
	B	R	G	Even Line
11X	G	B	R	Odd Line
	R	G	B	Even Line

Note: To avoid abnormal display, please keep these bits at “000”

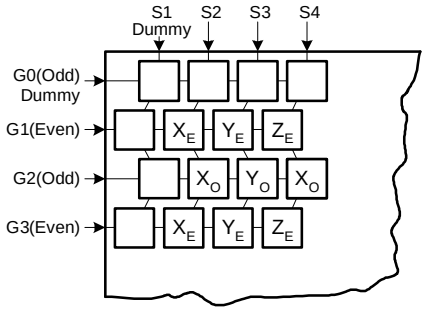


Figure 1: Data alignment position definition

Bit2	Dithering setting
0	Dithering on. 8-bit resolution. (default)
1	**Dithering off. 6-bit resolution (last 2 bits of input data truncated)**

Bit1	Pre-filter setting.
0	Pre-filter off (default)
1	**Pre-filter on**

Bit0	D/S function
0	Stripe mode. Q1H always stays High. Data alignment always be in Odd line.
1	**Delta mode Q1H toggles each line. Data alignment switches between Odd/even lines.** **(default)**

d3. Register R2:

Address	Bit	Description		Default
0100	[3..0]	Bit3(FPOL)	FRP source driver polarity inversion polarity inversion selection.	0011b
		Bit2(VSET)	Selecting internal or external refers to gamma correction. **(For Test only, please keep this bit "L")**	
		Bit1(U/D)	Vertical shift direction selection.	
		Bit0(SHL)	Horizontal shift direction selection.	

Bit3	FPOL function
0	**FRP = 0 in positive polarity** **FRP = 1 in negative polarity (default)**
1	**FRP = 1 in positive polarity** **FRP = 0 in negative polarity**

Bit1	UD function
0	**Scan down: First line = G241 → G239 → … → G2 → Last line = G0.**
1	**Scan up: First line=G0→ G2 →…→ G239 → Last line=G241. (default)**

Bit0	SHL function
0	**Shift left; First data=S640 → S639 → …→ S2 → Last data=S1.**
1	**Shift right: First data=S1→ S2 → …→ S639→ Last data=S640. (default)**

d4. Register R3:

Address	Bit	Description		Default
0110	[4..0]	Bit4(PALM)	PAL 1/6, PAL1/6, 8 selection.	1_0001b
		Bit3(PAL)	PAL/NTSC selection.	
		Bit2-0(SEL)	Input data format selection.	

Bit4	PALM function
0	PAL 1/6, 8 Input format (280 active line).
1	**PAL1/6 Input format (288 active line). (default)**

Bit3	PAL function
0	**NTSC Input format (240 active lines). (default)**
1	**PAL Input format.**

Bit2-0	SEL function

000	UPS051 path, special data format: DDX
001	UPS052 320RGB 24.54MHz data format (default)
010	UPS052 360RGB 27MHz data format
011	YUV mode A 640Y 320CrCb 24.54MHz data format
100	YUV mode A 720Y 360CrCb 27MHz data format
101	YUV mode B 640Y 320CrCb 24.54MHz data format
110	YUV mode B 720Y 360CrCb 27MHz data format
111	CCIR 656 720Y 360CrCb 27MHz data format

d5. Register R4:

Address	Bit	Description		Default
1000	[5..0]	Bit5-0(DDL)	Horizontal Data start delay selection.	10_0000b

Bit4-0	DDL settings
00h	**$T_{HS} = T_{HStyp}$ - 32 CLK period**
20h	**$T_{HS} = T_{HStyp}$ (default)**
3Fh	**$T_{HS} = T_{HStyp}$ + 31 CLK period**

d6. Register R5:

Address	Bit	Description		Default
1010	[5..0]	Bit5-4(OEA)	Odd Even advance selection.	00_0111b
		Bit3-0(HDL)	Vertical delay selection.	

Bit5-4	OEA function
00	Display start @ HDL delay for Odd and Even field (default)
01	Display start @ HDL delay for Odd field and @ HDL+1 for Even field
1X	Display start @ HDL+1 delay for Odd field and @ HDL+1 for Even field

Bit3-0	HDL function
0000	**$T_{STV} = T_{STVtyp}$ - 7 Hsync period**
0111	**$T_{STV} = T_{STVtyp}$ - 0 Hsync period(default)**
1111	$T_{STV} = T_{STVtyp}$ + 8 Hsync period

d7. Register R6:

Address	Bit	Description		Default
1100	[2..0]	Bit2-0(VCOM_AC)	VCAC level adjustment. Step 0.2V/LSB.	100b

VCSL2	VCSL1	VCSL0	VCAC level	Unit
0	0	0	6.2	V
0	0	1	6.4	
0	1	0	5.0	
0	1	1	5.2	
1	0	0	5.4	
1	0	1	5.6	
1	1	0	5.8 (Default)	
1	1	1	6.0	

d8. Register R7:

Address	Bit	Description		Default
1110	[4..0]	Bit4 (Reserved)	Reserved bit	0_0011
		Bit3 (Reserved)	Reserved bit	
		Bit2 (VLNC)	YUV vertical line function	
		Bit1 (AVGY)	Average YUV interface Luminance Y setting	
		Bit0 (DMDA)	Delta data alignment	

Bit2	YUV vertical line function
0	Vertical line are 240 (default)
1	**Vertical line are 234** **NTSC: 240 lines scaling to 234-skip 6 lines (1/40)** **PAL: 288 lines scaling to 234-skip 54 lines (3/16) @ PALM = 'H'** **280 lines scaling to 234-skip 46 lines (1/6) @ PALM = 'L'**

Bit1	Average YUV interface Luminance Y setting
0	**Only use odd Y sample for YUV conversion**
1	**Use odd and even Y sample for YUC conversion (default)**

Bit0	Delta data alignment
0	**Data alignment by default setting.**
1	**Data alignment by referencing to UPS052 timing graph II (default).** **(This function is disabled in UPS051 mode.)**

d9. Register T0:

Address	Bit	Description		Default
0001	[7..0]	Bit5-7(Reserved)	Reserved register	0000_0100b
		Bit3-4(PDTY)	PWM duty control for DC to DC converter	
		Bit2-0(FBV)	FB voltage adjust	

Bit3-4	PWM duty control for DC to DC converter
00	75 % (default)
01	55 %
10	60 %
11	65 %

Bit2-0	FB voltage adjust
000	**0.4V**
001	**0.45V**
010	**0.5V**
011	**0.55V**
100	**0.6V (default)**
101	**0.65V**
110	**0.7V**
111	**0.75V**

d10. Register T1:

Address	Bit	Description		Default
0011	[6..0]	Bit6 (AVG)	Data alignment to scaling down function select	000_1000b
		Bit5 (Reserved)	Reserved register	
		Bit4 (T352)	Select UPS052 path and input data format for 352 RGB	
		Bit3-0 (CONST)	RGB contrast level adjustment	

Bit6	Data alignment to scaling down function select
0	Data alignment by DMDA settling (Default
1	Data alignment with averaged and input data.(R1, (G1+3G2)/4, (3B2+B3)/4…….)

Bit4	Select UPS052 path and input data format for 352 RGB
0	**SEL setting timing (Default)**
1	**SEL setting don’t care, input data for 352 RGB(27MHZ)**

Bit3-0	RGB contrast level adjustment
0x0	**0**
0x8	**1.00 (Default)**
0xF	**1.875**

d11. Register T2:

Address	Bit	Description		Default
0101	[6..0]	Bit6 (VDCEN)	Setting FRP output to add DC level	010_0000b
		Bit5-0 (VCOM DC)	VCOM DC level adjustment (16mV/Bit)	

Bit6	Setting FRP output to add DC level
0	External VCOM DC
1	Internal VCOM DC

Bit5-0	VCOM DC level adjustment
0x00	**0.188V**
0x20	**0.7V (Default)**
0x2C	**1.196V**

d12. Register T3:

Address	Bit	Description		Default
0111	[6..0]	Bit6-0 (BRADJ)	Brightness level adjustment (4/Bit)	100_0000b

Bit6	**Brightness level adjustment**
0x00	-256
0x40	0 (Default)
0x7F	+256

d13. Register T4:

Address	Bit	Description		Default
1001	[2..0]	Bit2 (FB_S)	FB input switch turn ON/OFF settling	000b
		Bit1-0 (WNSEL)	Wide and narrow display select	

Bit6	FB input switch turn ON/OFF settling
0	FB input switch turn OFF (Default)
1	FB input switch turn ON

Bit1-0	Wide and narrow display select
00	**Normal display (Default)**
01	**Narrow display**
10	**Wide display**
11	**Normal display**

d14. Register T5:

Address	Bit	Description		Default
1011	[7..0]	Bit7-4 (SAT)	YUV saturation constant adjustment (0.125/Bit)	1000_1000b
		Bit3-0 (HUE)	YUV Hue adjustment (5Deg/Bit)	

Bit7-4	YUV saturation constant adjustment
0x0	0
0x8	1.00
0xF	1.875

Bit3-0	YUV Hue adjustment (5Deg/Bit)
0x0	**-40θ°**
0x8	**0θ°**
0xF	**35 θ°**

Note: Register T5 is for YUV only.

C. Optical specifications (Note 1,Note 2, Note 3)

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Response time Rise Fall	 Tr Tf	 θ =0°	 - -	 25 30	 50 60	 ms ms	Note 4
Contrast ratio	CR	At optimized viewing angle	120	300	-		Note 5,6
Viewing angle Top Bottom Left Right		CR≧10	 10 30 40 40	 15- 35- 45- 45-	 - - - -	deg.	Note 7
Brightness (25mA)	Y_L	θ =0°	200	250	-	cd/m^2	Note 8
White chromaticity	x	θ =0°	(0.26)	(0.31)	(0.36)		
	y	θ =0°	(0.28)	(0.33)	(0.38)		

Note 1. Ambient temperature = 25℃.

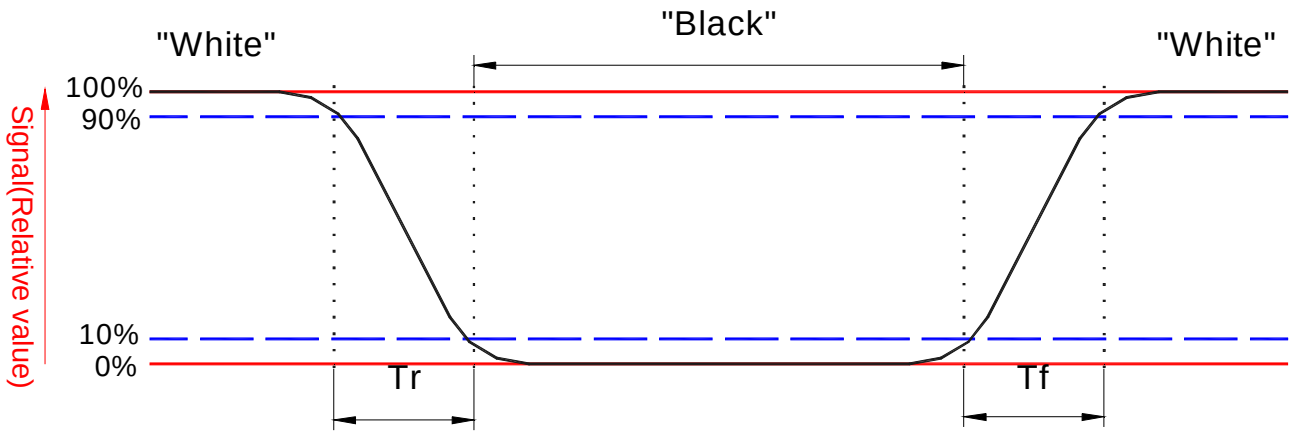
Note 2. To be measured in the dark room.

Note 3.To be measured on the center area of the panel with a field angle of 1° by Topcon luminance meter M-7, after 10 minutes operation.

Note 4. Definition of response time:

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. Refere to figure as follows:



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. White Vi = V_{i50} ∓ 1.5V

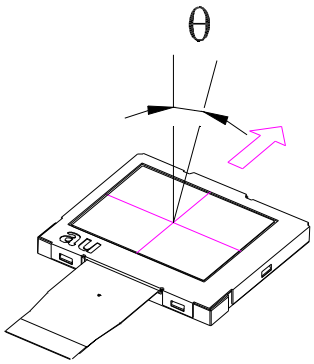
Black Vi = V_{i50} ± 2.0V

“±” means that the analog input signal swings in phase with COM signal.

“ ∓means that the analog input signal swings out of phase with COM signal.

$V_{i50:}$ Analog input voltage when transmission is 50%
100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

Note 7. Definition of viewing angle:
Refer to figure as follows.



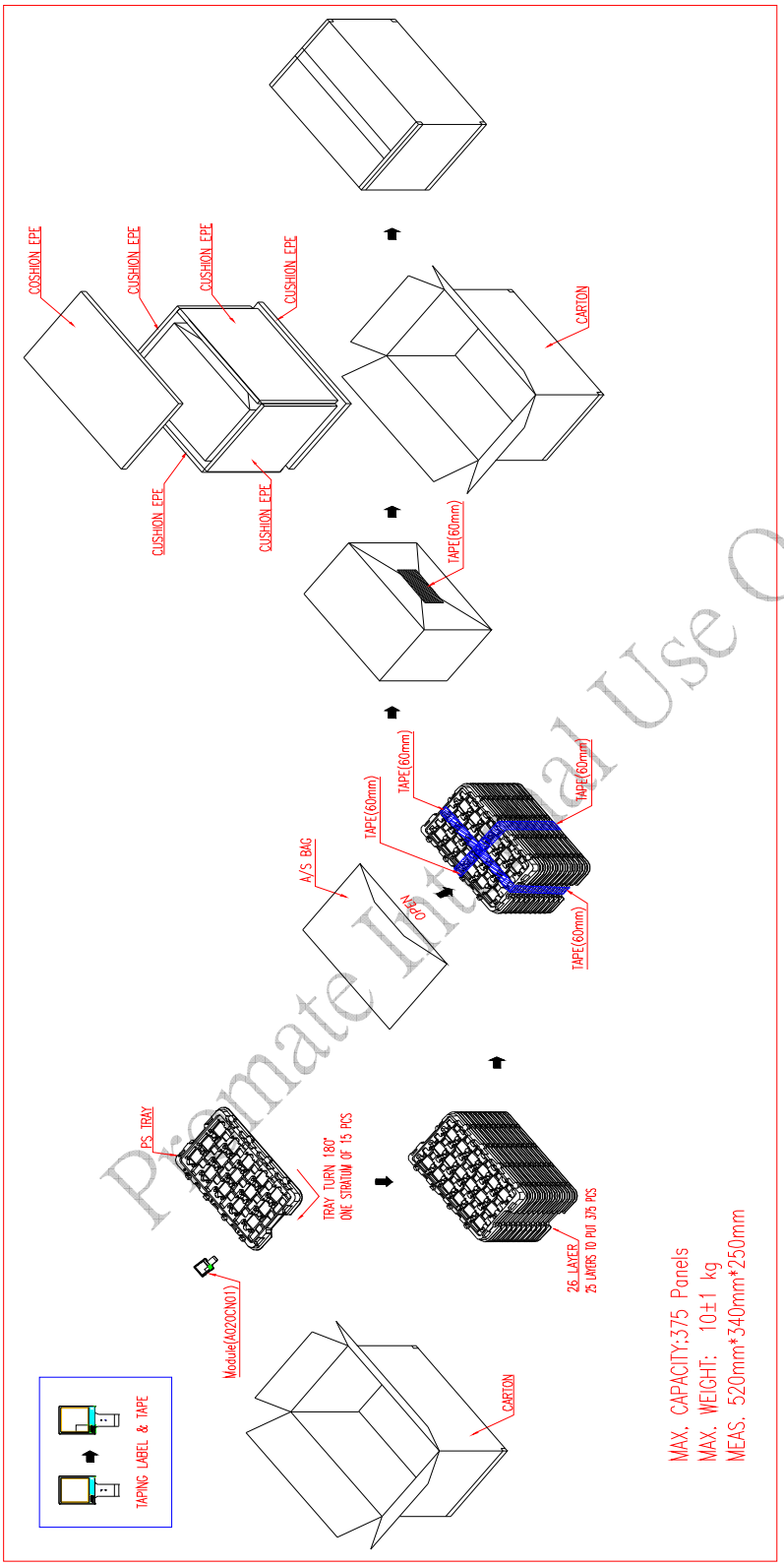
Note 8. Measure at the center area of the panel when all the input terminals of LCD panel are electrically opened.

D. Reliability test items:

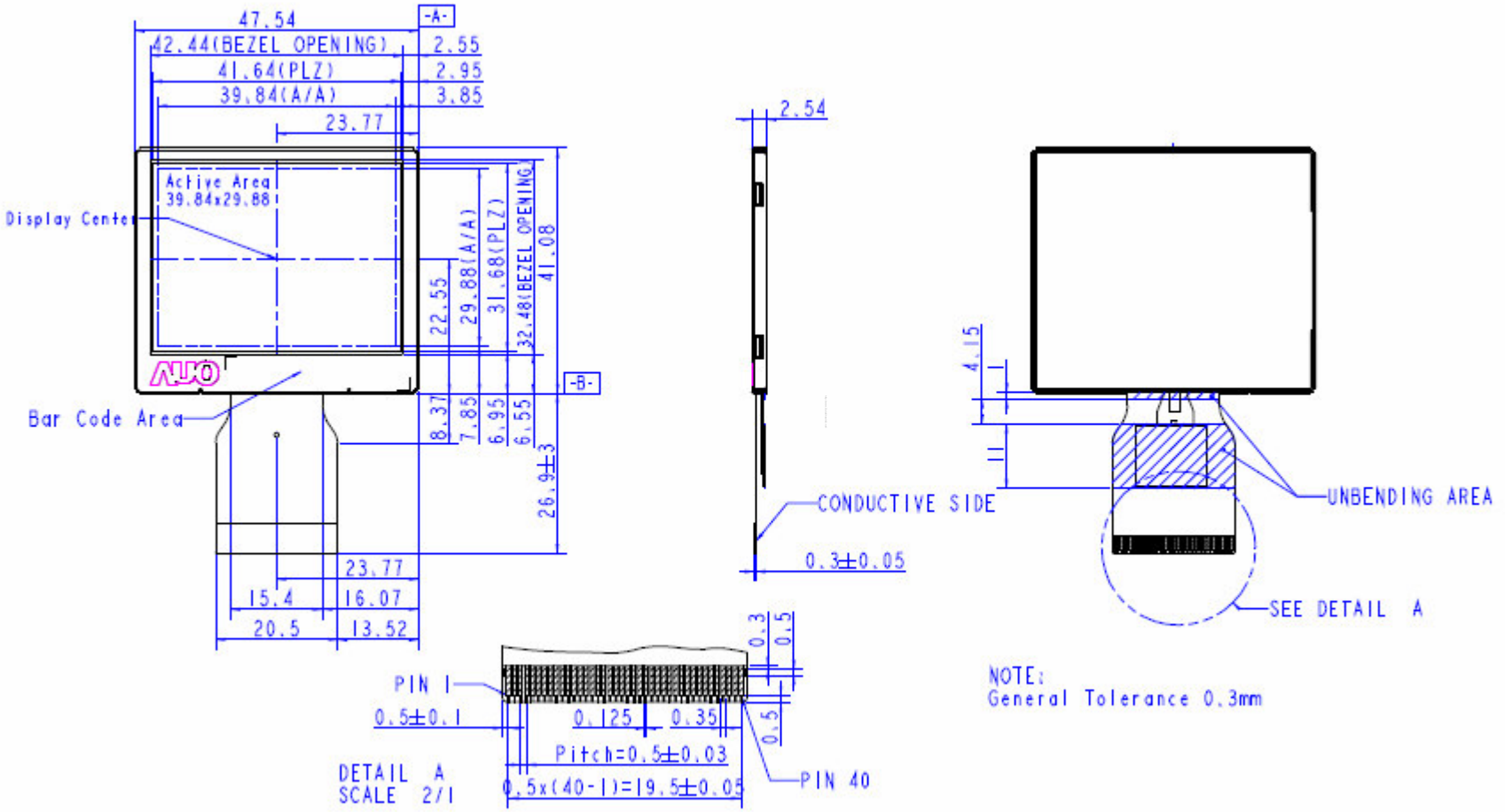
No.	Test items	Conditions	Remark
1	High temperature storage	Ta= 80℃ 240Hrs	
2	Low temperature storage	Ta= -25℃ 240Hrs	
3	High temperature operation	Ta= 60℃ 240Hrs	
4	Low temperature operation	Ta= 0℃ 240Hrs	
5	High temperature and high humidity	Ta= 60℃. 90% RH 240Hrs	Operation
6	Heat shock	-25℃~80℃/50 cycle 2Hrs/cycle	Non-operation
7	Electrostatic discharge	±200V,200pF(0Ω), once for each terminal	Non-operation
8	Vibration (with carton)	Random vibration: 0.015G^2/Hz from 5~200Hz –6dB/Octave from 200~500Hz	IEC 68-34
9	Drop (with carton)	Height: 60cm 1 corner, 3 edges, 6 surfaces	

Note: Ta: Ambient temperature.

E. Packing form



Outline Drawn



F. Application Notes

1. Stand-by timing

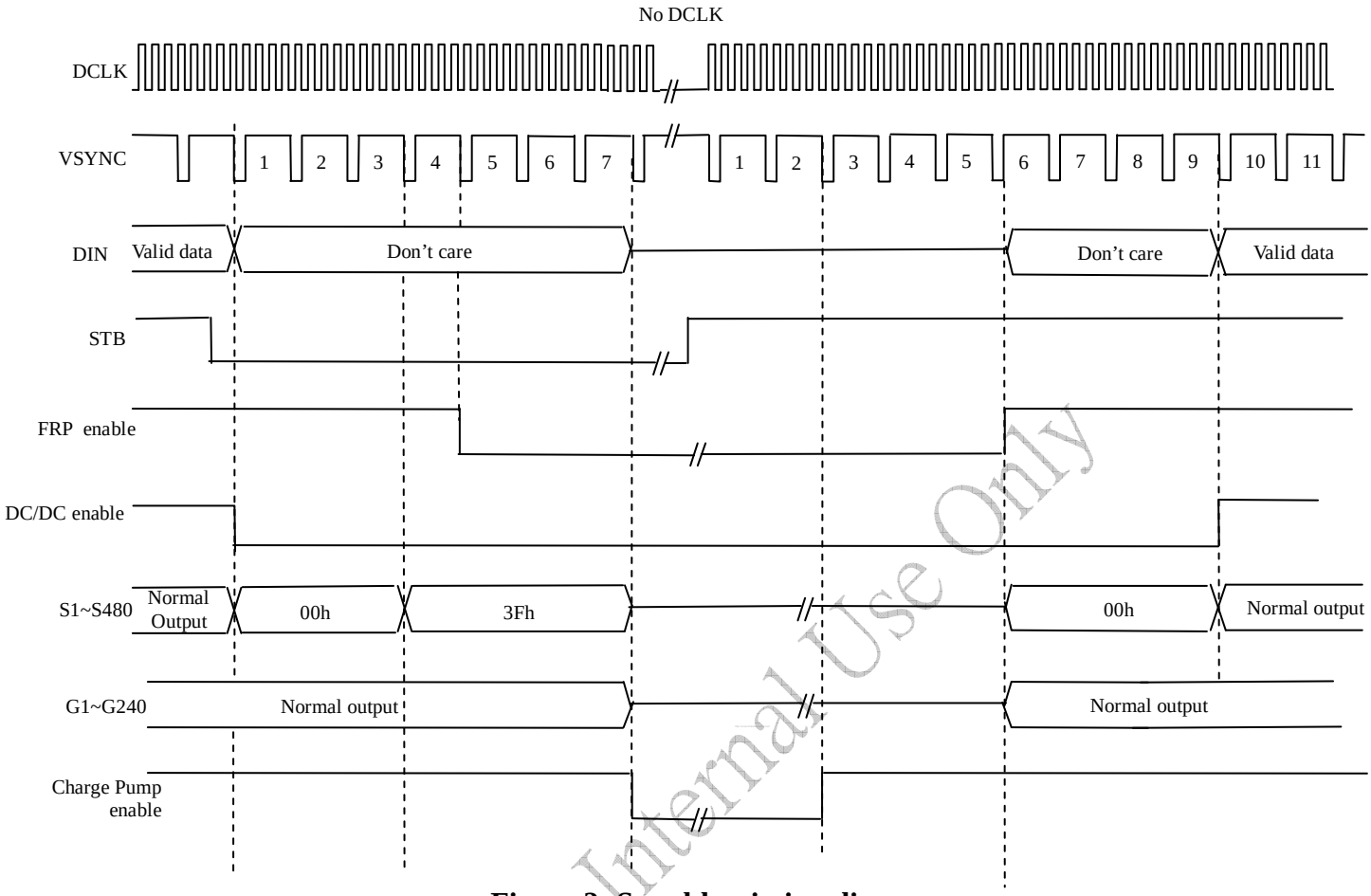
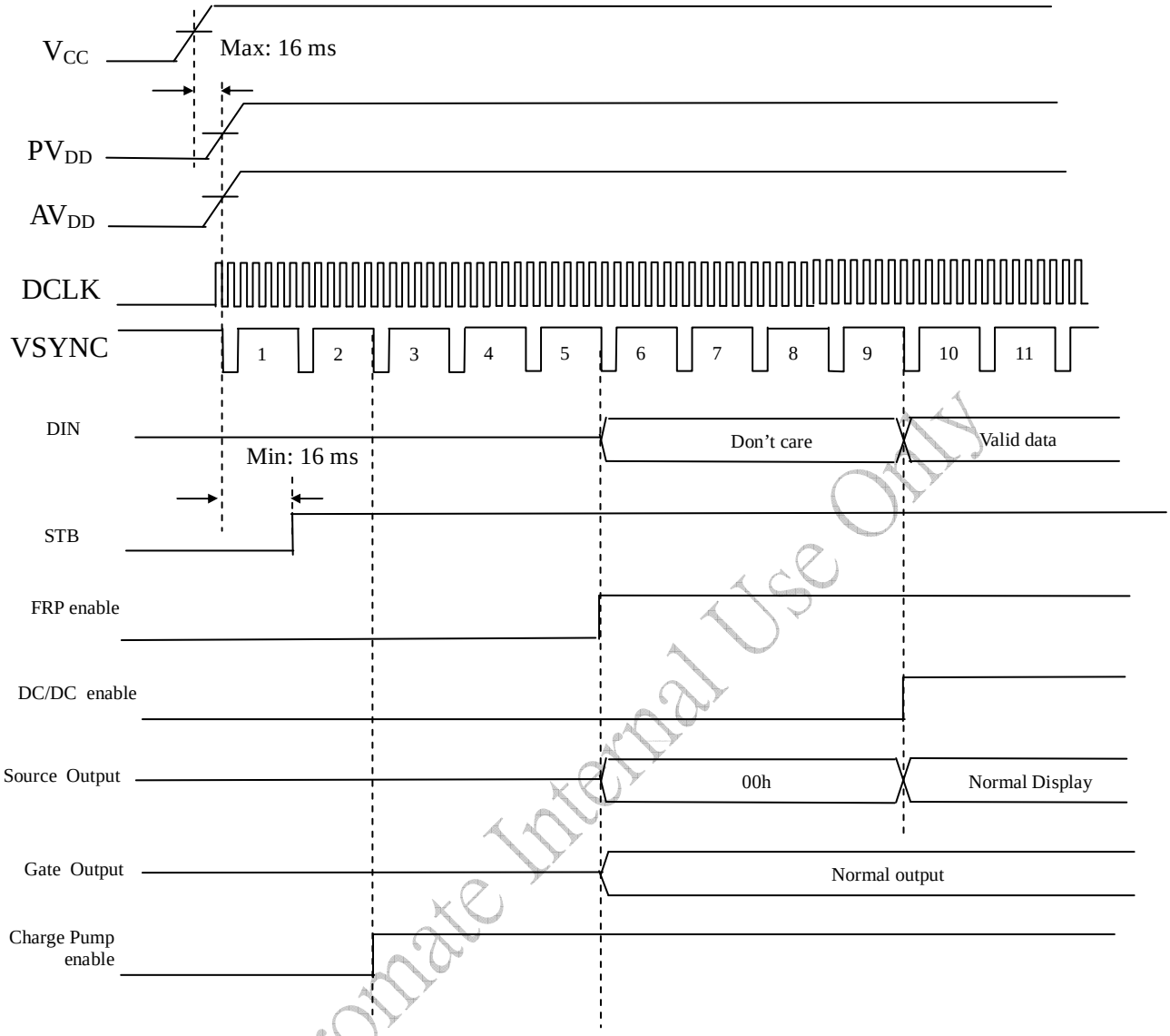


Figure 2: Stand-by timing diagram

Note 1:During No DCLK, HSYNC and VSYNC can be stopped. But in all other cases HSYNC and VSYNC must be active.

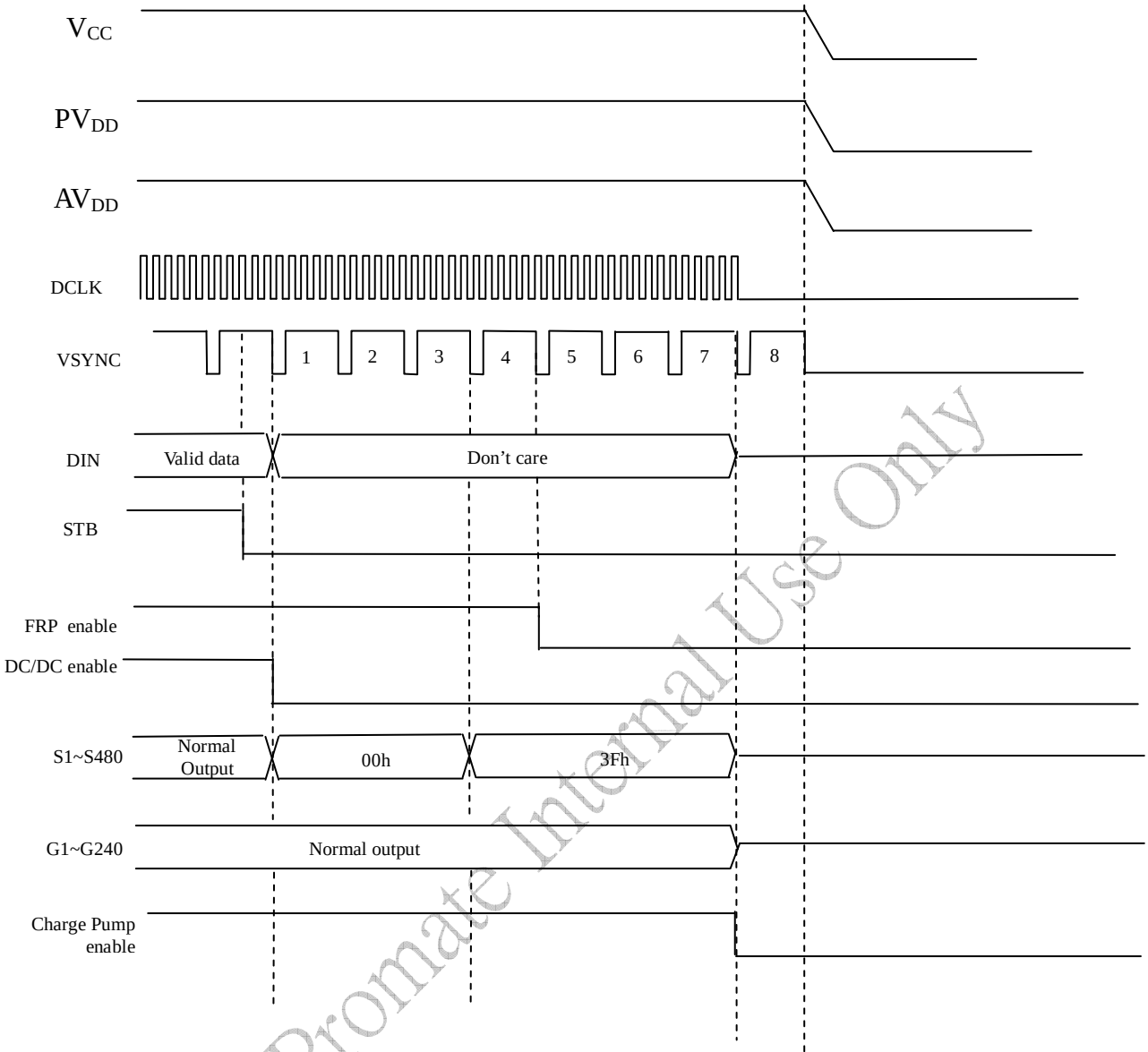
Note 2: External signal: DCLK, VSYNC, DIN (D0 ~ D7), STB (By register)
Internal signal: DC/DC enable S1 ~ S480 (Source Driver output signal), FRP enable G1 ~ G240 (Gate Driver output signal) and Charge Pump enable.

2. Power on sequence



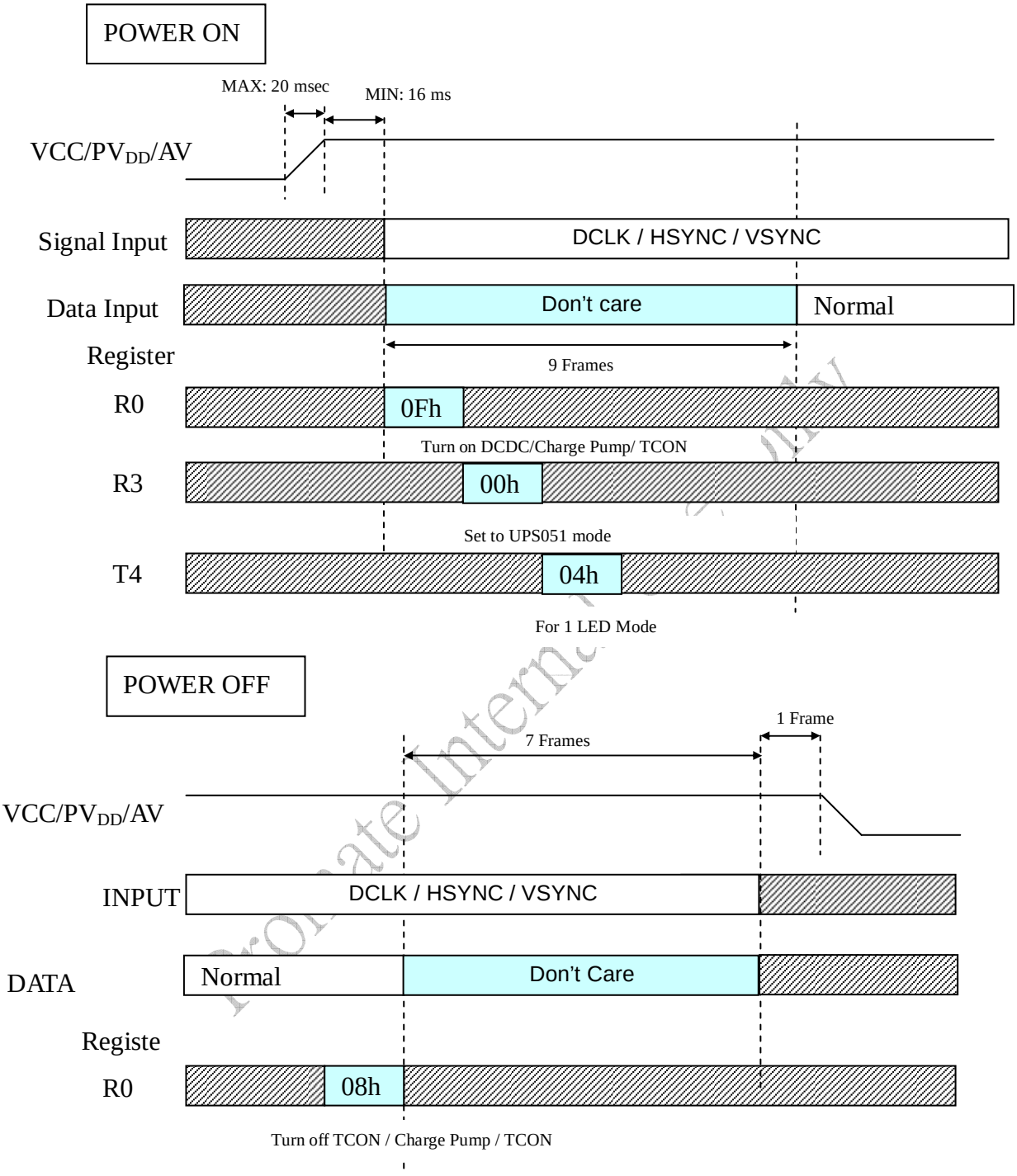
Note 1: External signal: $V_{CC,}$ $PV_{DD,}$ AV_{DD}, DCLK, VSYNC, DIN (D0 ~ D7), STB (By register)
Internal signal: DC/DC enable S1 ~ S480 (Source Driver output signal), FRP enable,
G1 ~ G240 (Gate Driver output signal) and Charge Pump enable.

3. Power off sequence - 1



Note 1: External signal: $V_{CC,}$ $PV_{DD,}$ AV_{DD}, DCLK, VSYNC, DIN (D0 ~ D7), STB (By register)
Internal signal: DC/DC enable S1 ~ S480 (Source Driver output signal), FRP enable, G1 ~ G240 (Gate Driver output signal) and Charge Pump enable.

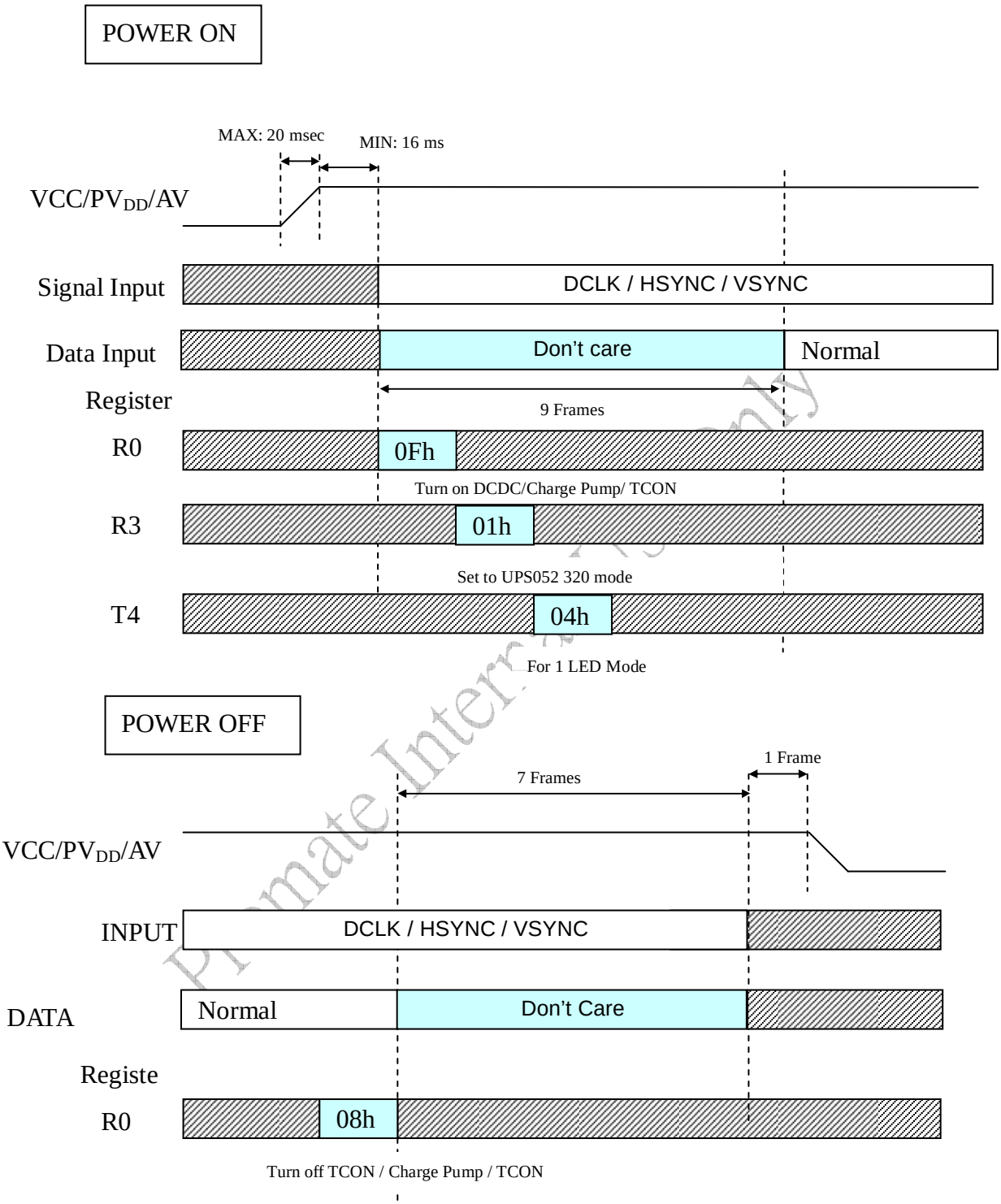
4. Recommend UPS051 (9.7 MHz) power on/off setting



Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

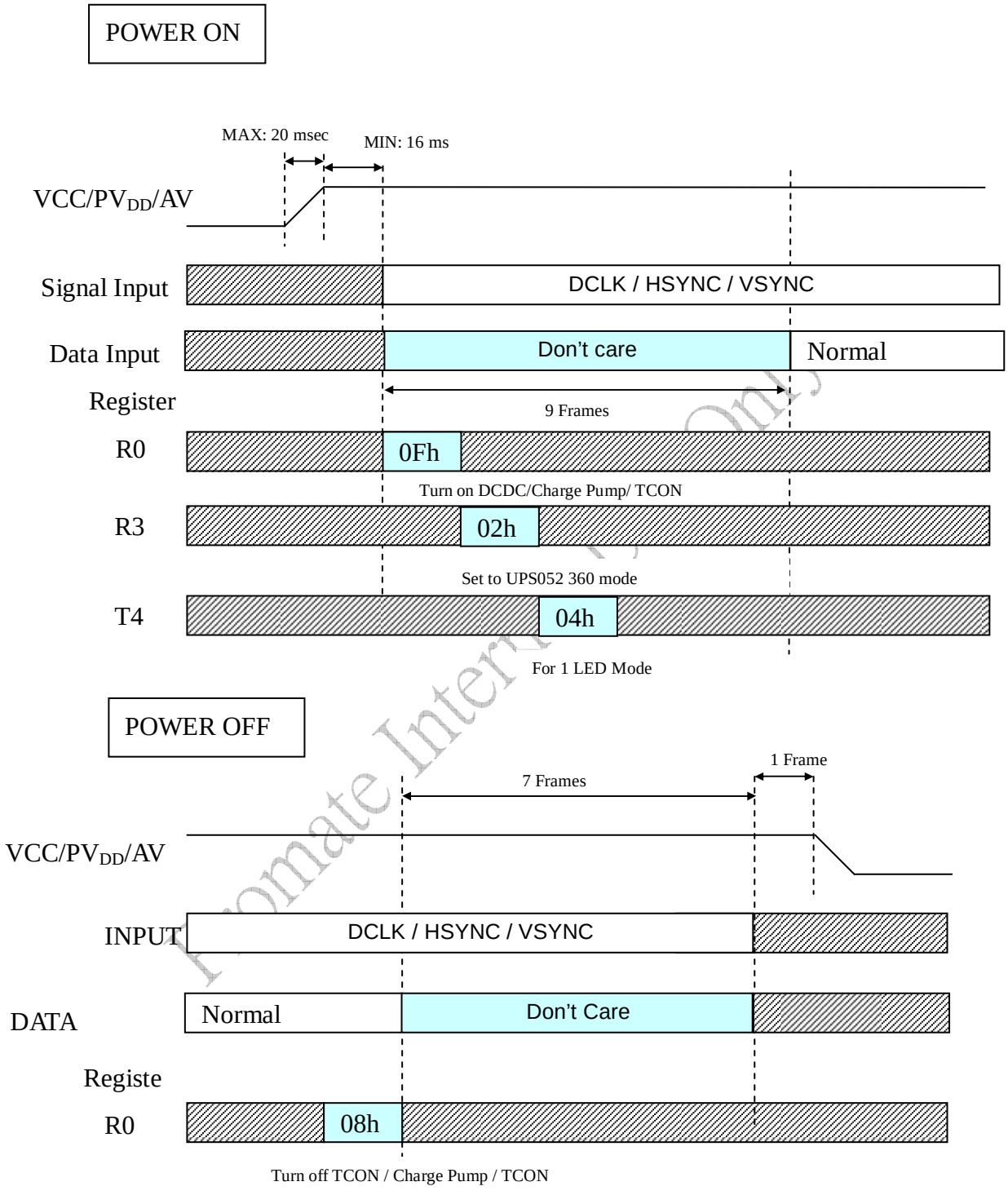
5. Recommend UPS052 320RGB mode (24.54 MHz) power on/off setting



Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

6. Recommend UPS052 360RGB mode (27MHz) power on/off setting

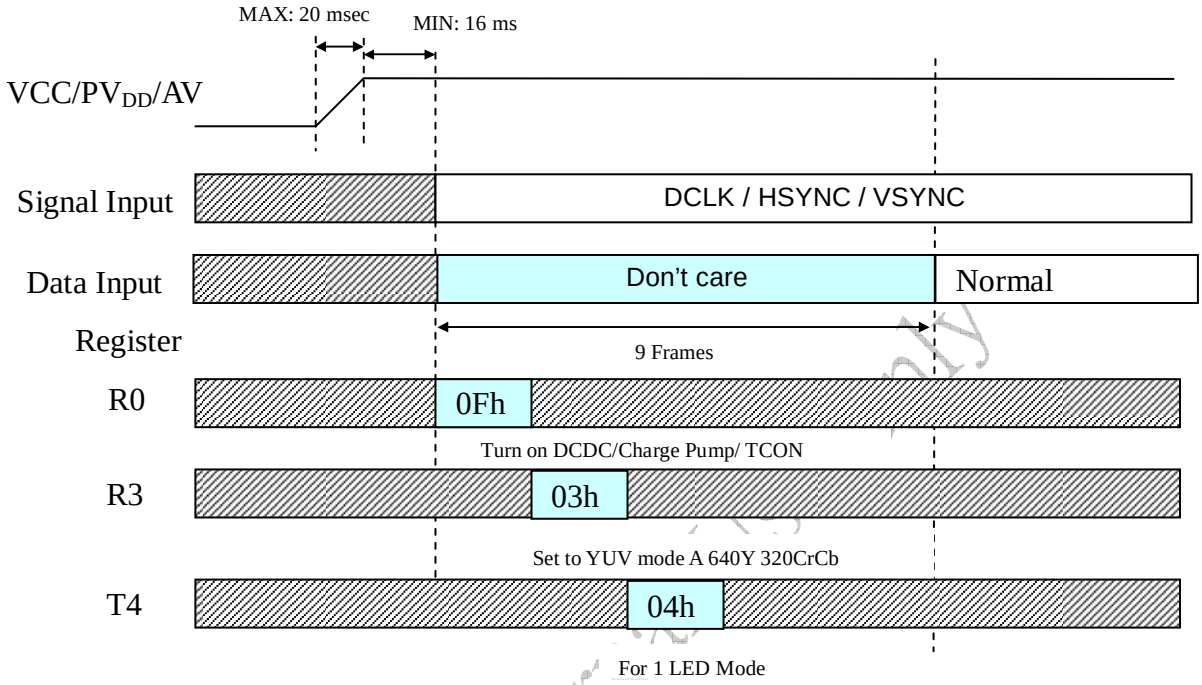


Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

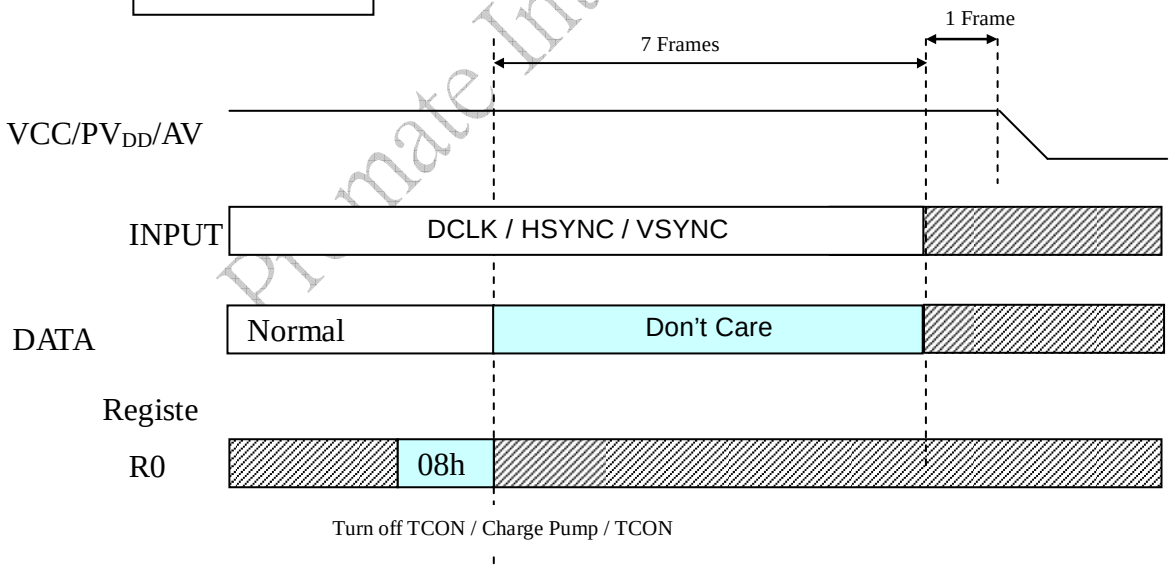
Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

7. Recommend YUV mode A 640Y 320CrCb (24.54 MHz) power on/off setting

POWER ON



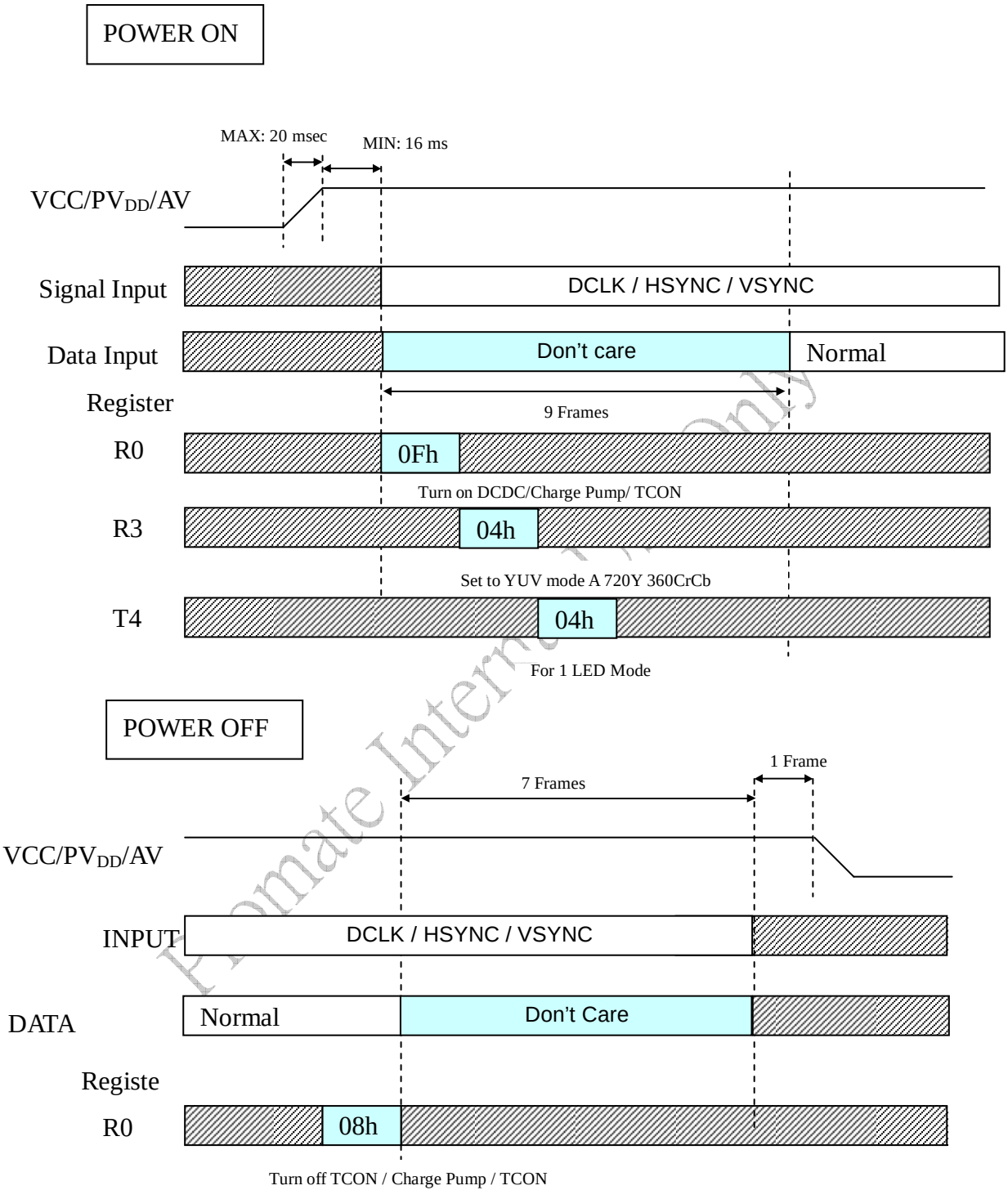
POWER OFF



Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

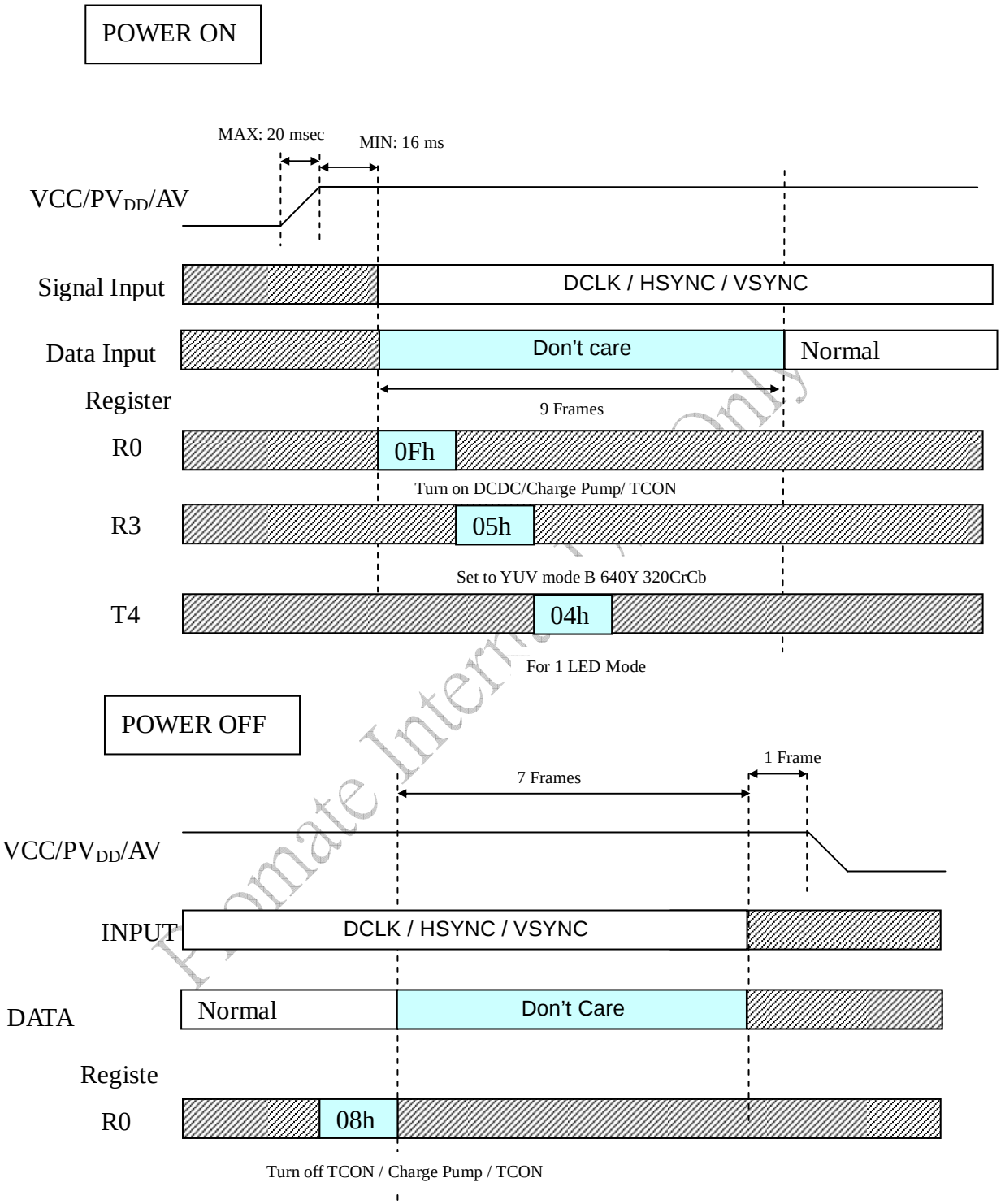
8. Recommend YUV mode A 720Y 360CrCb (27 MHz) power on/off setting



Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

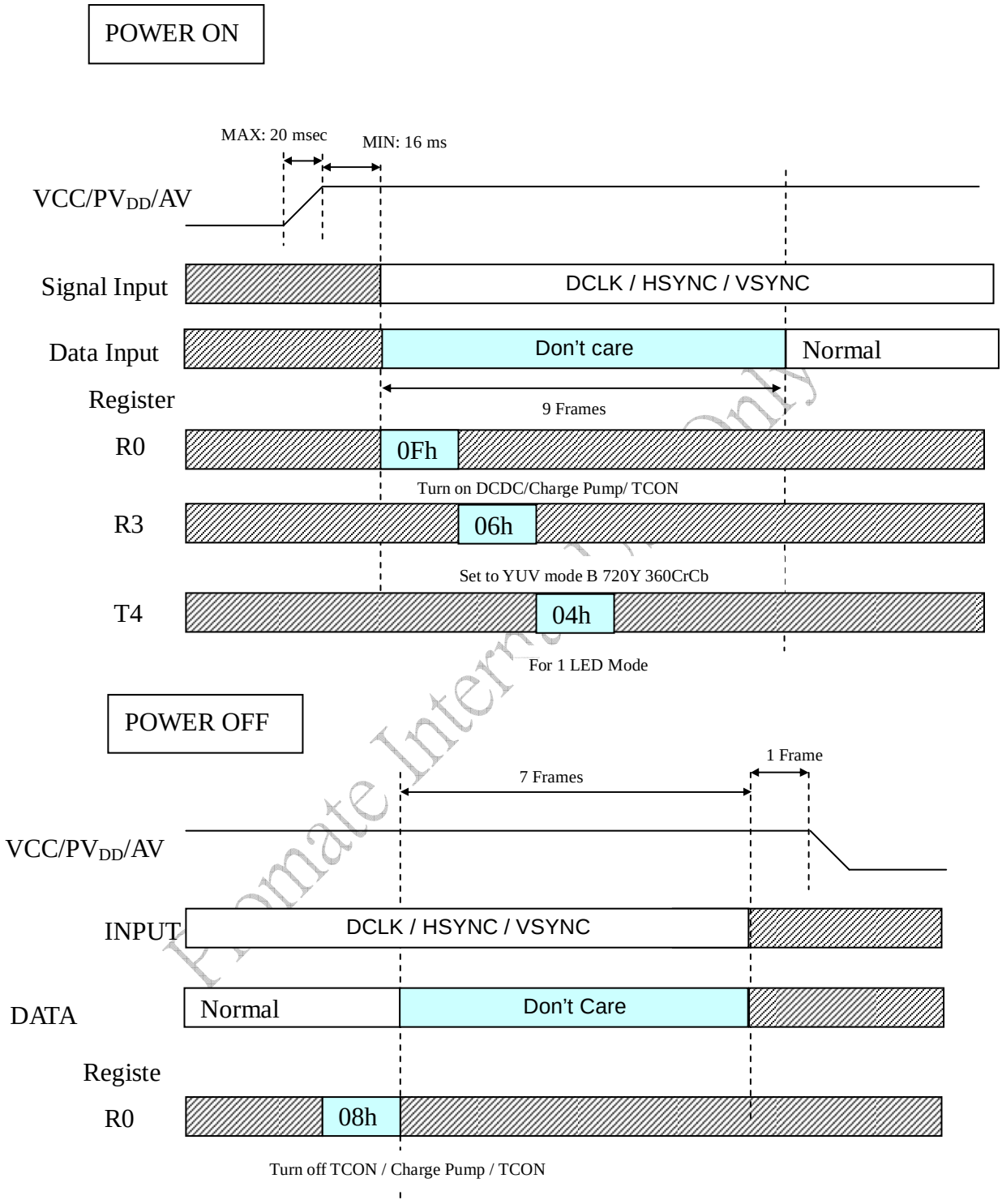
9. Recommend YUV mode B 640Y 320CrCb (24.54 MHz) power on/off setting



Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

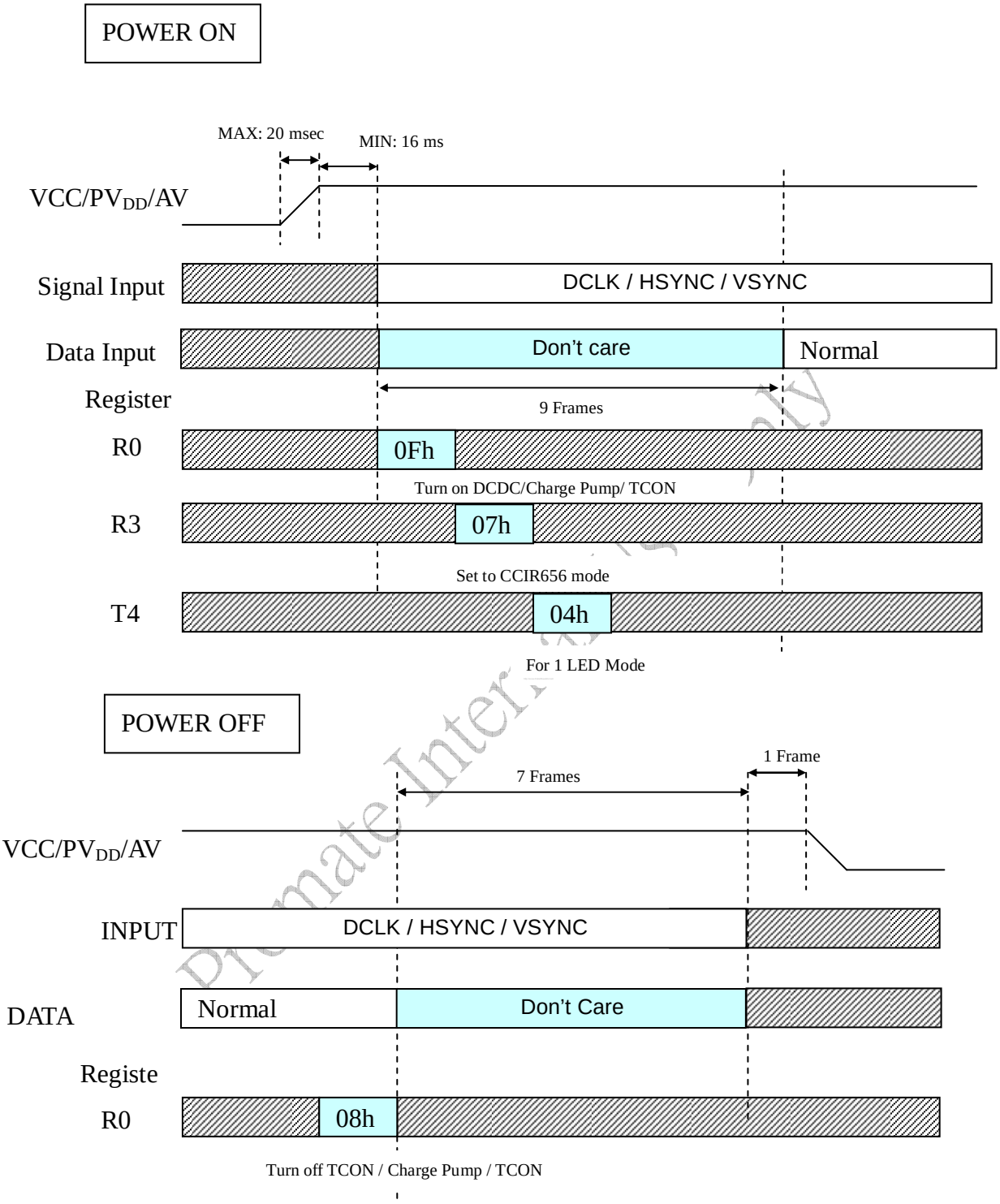
10. Recommend YUV mode B 720Y 320CrCb (27 MHz) power on/off setting



Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

11. Recommend CCIR656 mode (27 MHz) power on/off setting



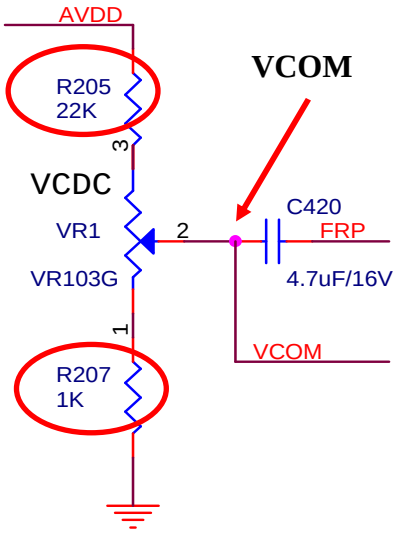
Note 1: Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About PWM structure, please refer B. Electrical specifications 5. Charge Pump Structure.

Note 2: Register FB_S can't be turn on when Register SHDB = 'L'. Please set SHDB = '1' when FB_S = '1'.

12 The Difference between This model and Previous models (A024CN02 V0 ~ V8, VA)

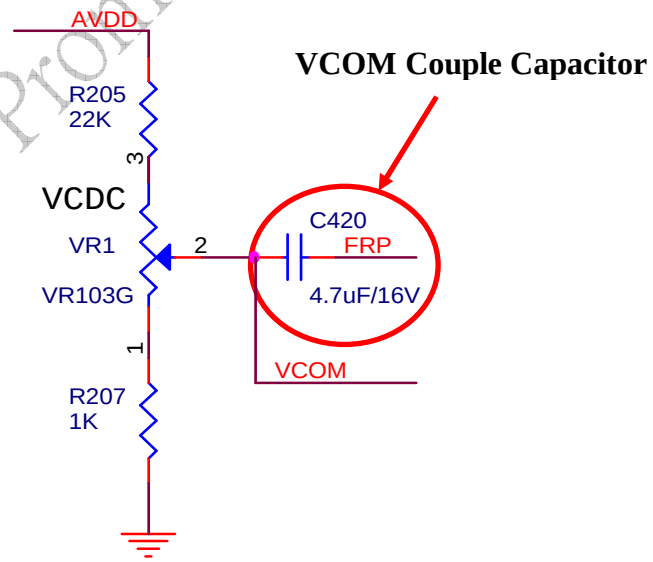
a. VCOM DC setting

Because the structure of ASIC is different between the new model and original model, so AUO suggest customer adjust VCOM DC value from 0.45V±0.2 to 0.7V±0.2 to get best display quality.



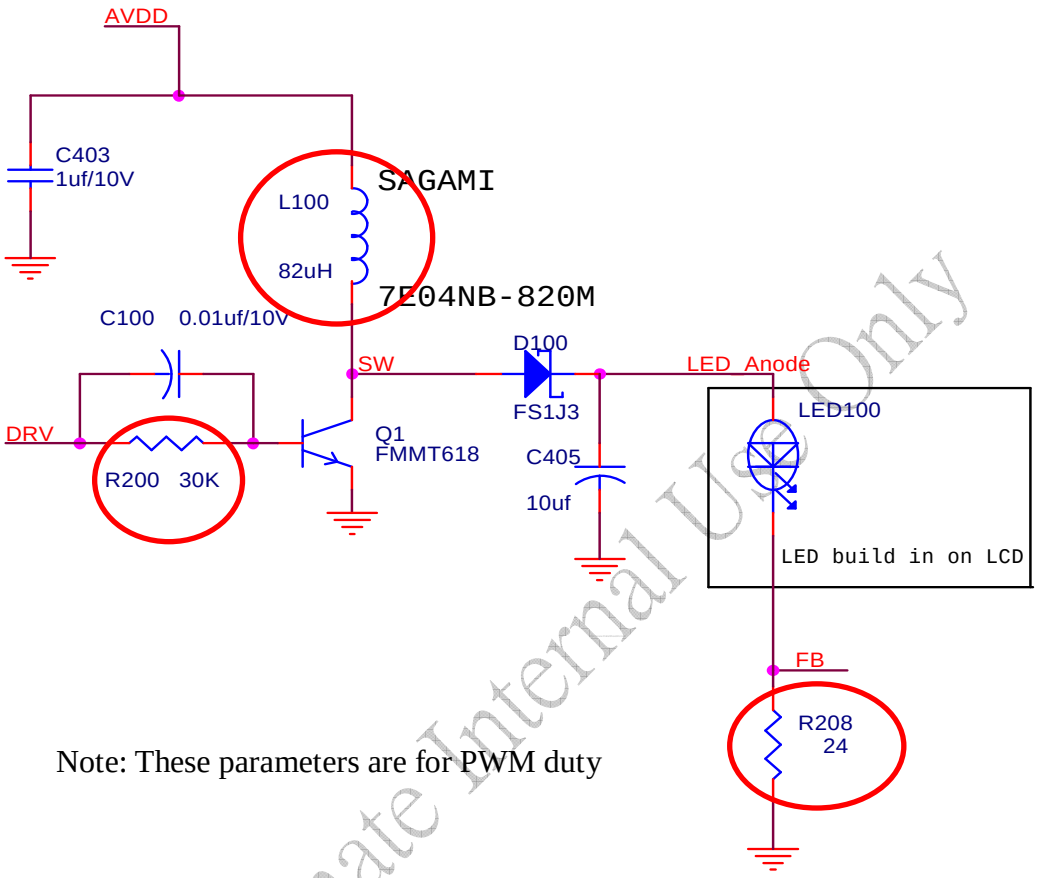
b. VCOM Couple capacitor

The original panel structure is Cst on gate and the new model is Cst on common.
To avoid Horizontal Cross Talk, AUO suggest modify VCOM couple capacitor (C420) from 1uF to 2.2uF.



c. PWM RC Parameters

AUO suggest to fine-tune PWM RC parameters to get best display performance. If wave like noise phenomenon happened, please fine-tune RWM RC Parameters. By the way, please modify R208 from 30 ohm to 24 ohm to get 25 mA LED current. About the recommend RC Parameters, please refer the following figure.



Note: These parameters are for PWM duty

d. ESD Protection

a. AUO suggests always send serial commend to avoid shutdown phenomenon.

b. AUO suggests connect iron shell to system GND to enhance ESD protection ability.

e. 1 LED solution

Because AUO connects FB_N and FB together, please make sure register T4 D2 (FB_S) have already be set to '1'. If FB_S is not '1', LED_Anode will be about 10V and LED will be damaged. About detail registers setting, please refer G. Application Notes 4 – 11 Recommend Register setting.