Specifications Approval Sheet

Product Description: 1.5” COLOR TFT-LCD MODULE			
AU Model Name: A015AN04 V5			
Customer Part No:			
Customer Signature	Date	AUO	2007/09/05
		Approved By: CW Hao	
		Reviewed By: CW Hao	
		Prepared By: Jason Wang	

Please return one copy with your signature and comments for our confirmation.

AU Optronics Corporation

Tel: +886-3-500-8800

Fax: +886-3-564-5785

Doc. Version:	8
Total Pages:	31
Date :	2007.09.05

Product Specifications

1.5″ COLOR TFT-LCD MODULE

MODEL NAME: A015AN04 V5

< ◆ > Preliminary Specification

< > Final Specification

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

Record of Revision

Version	Revise Date	Page	Content
0	2006/06/28		First draft
1	2006/08/23	4	Revise pin assigmnent and description
		5	Modify equivalent circuit of I/O
		6,7	Modify electrical characteristics and LED driving condition
		11	Add charge pump block diagram
		30	Revise the description of Register R2
		31,32	Modify reference application circuit
		33	Revise suggestion power on sequence
2	2006/12/22	8	Modify LED driving conditions
		12	Modify PWM Control state diagram
		30	Revised recommend register table for UPS051 timing
		31	Revised recommend register table for UPS052 timing
2a	*2007/02/15*	6	Update outline drawing by specified pin assignment order on FPC
2b	*2007/03/12*	6	Revised the typical operating conditions of Electrical Specifications
3	*2007/04/09*	5	Midify the note of pin assignment
		7	Modify LED driving conditions
		31	Revised the description of application circuit
		33	Modify power on/off sequence
		34	Add standby on/off sequence
4	*2007/04/23*	7	Modify LED driving conditions
		31,32	Revised reference application circuit
		33,34	Revised power and standby on/off sequence
5	*2007/06/07*	10	Add Input timing AC characteristic
		11~16	Modify AC Timing
6	*2007/06/11*	11~16	Revised AC Timing
		24	Add Panel color Filter Alignment

		26	Revised recommend register table for UPS052 timing
6a	*2007/07/04*	28 32	Modify External LED circuit Add Appendix I: LED lifetime data
6b	*2007/07/25*	9	Modify LED driving conditions.
7	*2007/08/23*	19 28 29 30 31	Update BLU white chromaticity Modify External LED circuit Modify internal LED booster circuit Modify suggestion power on/off sequence Modify suggestion standby on/off sequence
8	*2007/09/05*	9 20 28 29	Modify LED driving conditions. Update white chromaticity Modify internal LED booster circuit Modify external LED circuit

Contents:

A. Physical Specifications

No.	Item	Specification	Remark
1	Display resolution (dot)	280 (W) ×220 (H)	
2	Active area (mm)	29.96 (W) ×22.66 (H)	
3	Screen size (inch)	1.48 (Diagonal)	
4	Dot pitch (mm)	0.107 (W) ×0.103 (H)	
5	Color configuration	R. G. B. delta	
6	Overall dimension (mm)	37.06 (W) ×34 (H) ×3.04 (D)	Note 1
7	Weight (g)	6 Typ	
8	Panel surface treatment	Hard coating (3H)	

Note 1: Refer to Fig. 5

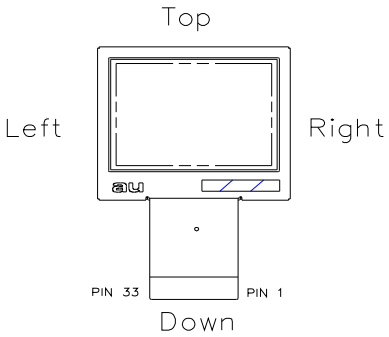
B. Electrical Specifications

1. Pin assignment

Pin no.	Symbol	I/O	Description	Remark
1	VCOM	I	Common electrode driving signal	
2	VGH	C	Positive power for scan driver	
3	V1	C	Power setting capacitor connect pin	
4	V2	C	Power setting capacitor connect pin	
5	Vgoff_H	C	Negative power supply (High) for G1~G240 outputs	
6	Vgoff_L	C	Negative power supply (Low) for G1~G240 outputs	
7	V3	C	Power setting capacitor connect pin	
8	V4	C	Power setting capacitor connect pin	
9	AVDD1	C	FRP level supply	
10	FRP	O	Frame polarity output for panel Vcom	
11	GND	P	Ground pin for digital circuits	
12	DRV	O	Power transistor gate signal for the boost converter	
13	LED Anode	P	LED Anode and power supply for charge pump	
14	FB	I / P	LED cathode and main boost regulator feedback input	
15	VCC	P	Power supply for digital circuits	
16	AGND	P	Ground pin for analog circuits	
17	AVDD	P	Power supply for analog circuits	
18	HSYNC	I	Horizontal sync input. Negative polarity	
19	VSYNC	I	Vertical sync input. Negative polarity	
20	DCLK	I	Clock signal; latch data onto line latches at the rising edge	
21	DD5	I	Data input: MSB	
22	DD4	I	Data input	
23	DD3	I	Data input	
24	DD2	I	Data input	
25	DD1	I	Data input	
26	DD0	I	Data input: LSB	
27	V5	C	Power setting capacitor connect pin	Note2
28	GRB	I	Global reset pin	
29	CS	I	Serial communication chip select	Note3
30	ISDA	I	Serial communication data input	Note3
31	ISCL	I	Serial communication clock input	Note3
32	VCC	P	Power supply for digital circuits	
33	GND	P	Ground pin for digital circuits	

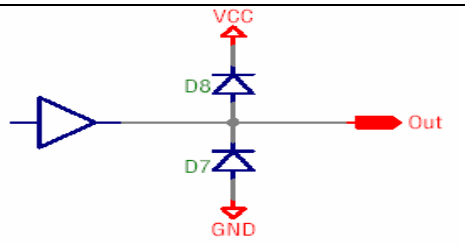
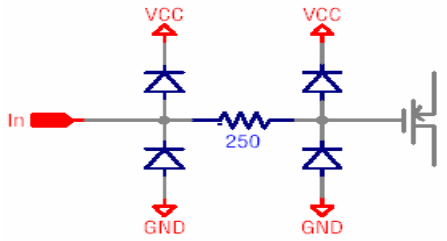
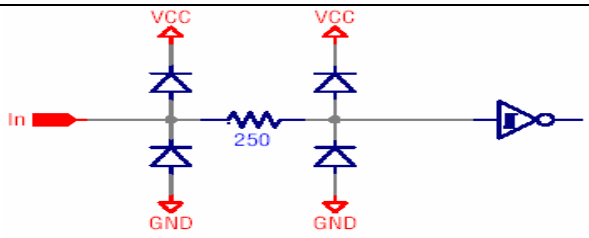
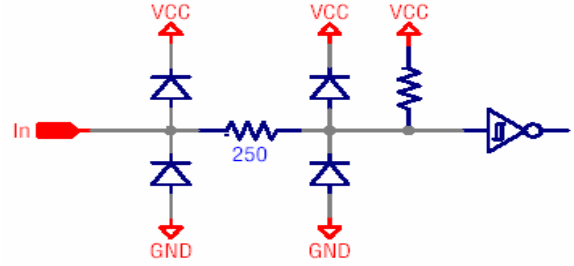
I: input; O: output, P: power

Note 1: For definition of scanning direction, please refer to figure as follows:



Note 2:The capacitor of V5(pin27) will be used for shrinkage IC.
Note 3: Please refer to application note for 3-wire serial communication setting.

2. Equivalent circuit of I/O

Pin no. & Pin name	Schematics
12.DRV	
14.FB	
21.DD5 22.DD4 23.DD3 24.DD2 25.DD1 26.DD0	
28.GRB	

3. Absolute maximum ratings

Item	Symbol	Condition	Min.	Max.	Unit	Remark
Power voltage	V_{CC}	GND=0	-0.5	5.	V	
	AV_{DD}	AV_{SS}=0	-0.5	5.5	V	
Input signal voltage	VCOM		-2.9	5.6	V	
Operating temperature	Topa		0	60	□	Ambient temperature
Storage temperature	Tstg		-25	80	□	Ambient temperature

4. Electrical characteristics

a. Typical operating conditions (GND = AVss = 0V)

Item		Symbol	Min.	Typ.	Max.	Unit	Remark
		V_{CC}	3.0	3.3	3.6	V	
		AV_{DD}	3.0	3.3	3.6	V	
Output Signal voltage	H Level	V_{OH}	Vcc-0.4				
	L Level	V_{OL}	GND		GND+0.4		
Input Signal voltage	H Level	V_{IH}	$0.7V_{CC}$	-	V_{CC}	V	
	L Level	V_{IL}	GND	-	$0.3V_{CC}$	V	
Output current	H Level	IOH		10		uA	
	L Level	IOL		-10		uA	
Analog stand by current		Ist			200	uA	DCLK is stopped
VCOM Voltage		V_{CAC}	4.4	5.6	5.8	V	
		V_{CDC}	0.10	0.14	0.18	V	

b. Recommended Capacitance Values of External Capacitor

The recommended capacitance values of the external capacitor are shown below. These values should be finally determined only after performing sufficient evaluation on the module.

Pin name	Operating value of capacitors (μF)	Withstanding voltage (V)
V5	4.7 to 10	6.3(Note)
VCC	1 to 10	6.3
AVDD	1 to 10	6.3
AVDD1	1 to 10	10
VGH	1 to 10	16
Vgoff_H, Vgoff_L	1 to 10	16
V1, V2	1 to 10	16
V3, V4	1 to 10	16
FRP	10	16
LED_Anode	10	16

Note: The capacitors of V5 (27pin) will be used shrinkage IC.

c. Current consumption (GND = AVss = 0V)

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
	I_{CC}	V_{CC} = 3.3V	-	2	2.5	mA	
	I_{DD}	AV_{DD} = 3.3V	-	1.5	2.0	mA	

d. LED driving conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
LED current	I_{LED}	20	25	25.5	mA	Note1
	$I_{LED\text{-}anode}$	22	25	25.5	mA	Note2
LED voltage	V_L	6.8	7.8	9	*V*	Note3

Note1: Internal LED booster circuit. FB=0.6V

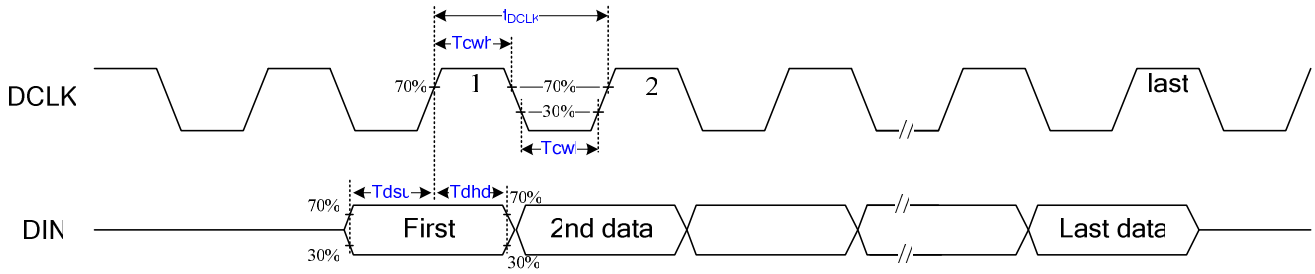
Note2: External LED circuit. FB=0.2V

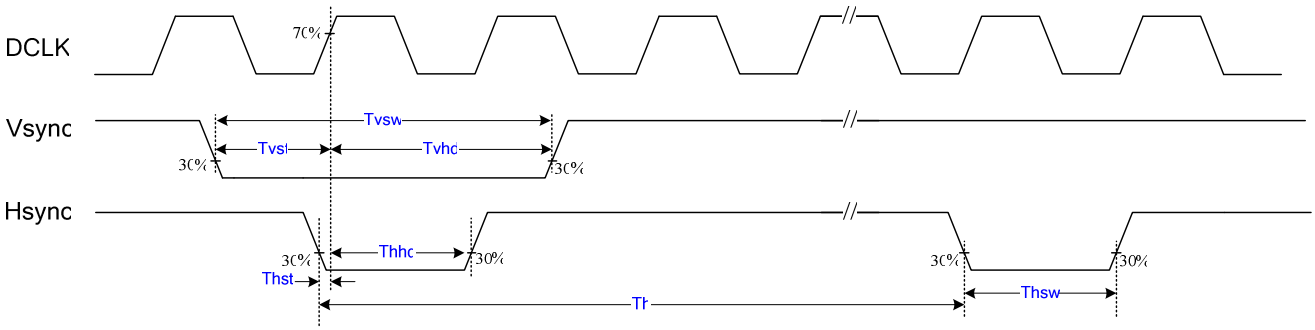
Note3: V_L = LED Anode (PIN 13), LED Max. Voltage: 1pcs/3.6V, LED Min. Voltage: 1pcs/3.0V. @I_{LED}=25mA.

5. Input timing AC characteristic

(VCC=3.3V, AVDD=3.3V, AGND=GND=0V, TA=-25℃~85℃)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
DCLK period time	t_{DCLK}	37	-	-	ns	
HSYNC period time	Th	60	63.56	67	us	
VSYNC setup time	Tvst	12	-	-	ns	
VSYNC hold time	Tvhd	12	-	-	ns	
HSYNC setup time	Thst	12	-	-	ns	
HSYNC hold time	Thhd	12	-	-	ns	
Data setup time	Thst	12	-	-	ns	
Data hold time	Thhd	12	-	-	ns	
HSYNC width	Thsw	1	1	96	t_{DCLK}	
VSYNC width	Tvsw	1 t_{DCLK}	1 t_{DCLK}	6Th		
DCLK duty cycle	Tcwh/Tcwl	40	50	60	%	





6. AC Timing

a. UPS051 Timing conditions

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	5.62	5.67	5.95	MHz	
HSYNC	Period		t_H	360			t_{DCLK}	
	Display period		t_{hd}	280			t_{DCLK}	
	Back porch		t_{hbp}	57	59	60	t_{DCLK}	Note1
	Front porch		t_{hfp}	23	21	20	t_{DCLK}	
	Pulse width		t_{hsw}	1	25	56	t_{DCLK}	
VSYNC	Period	Odd	t_V	256	262.5	264	t_H	
		Even						
	Display period	Odd	t_{vd}	220			t_H	
		Even						
	Back porch	Odd	t_{vb}	23			t_H	
		Even		23.5				
	Front porch	Odd	t_{vf}	13	19.5	21	t_H	
		Even		12.5	19	20.5		
	Pulse width	Odd	t_{vsw}	1 t_{DCLK}	3 t_H	6 t_H	-	
		Even						

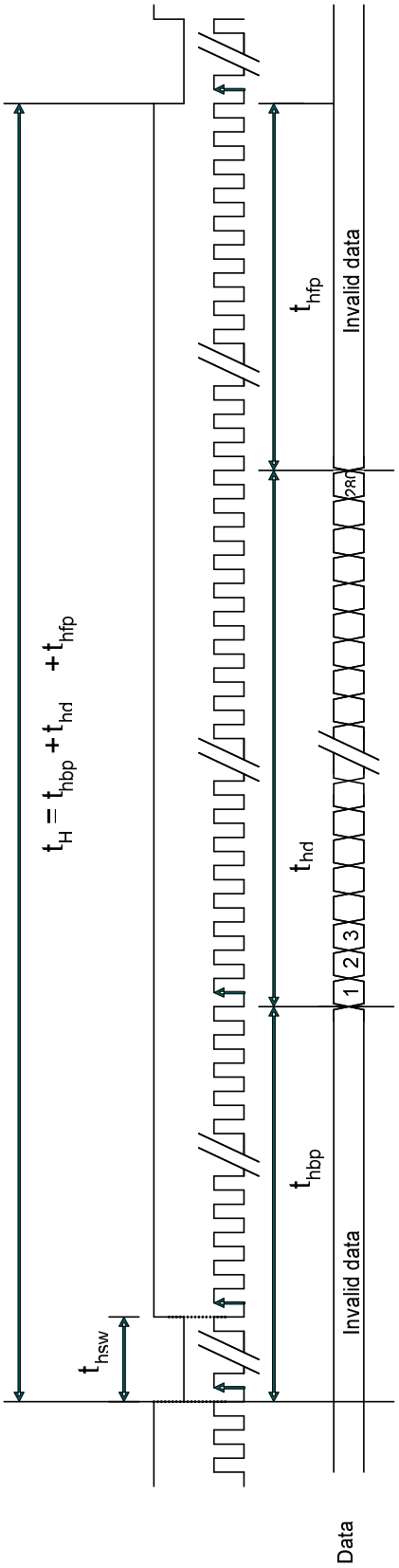
Note1: Horizontal display position:

Available display starts from the data of 60 t_{DCLK} when back porch value (t_{hbp}) set 59.

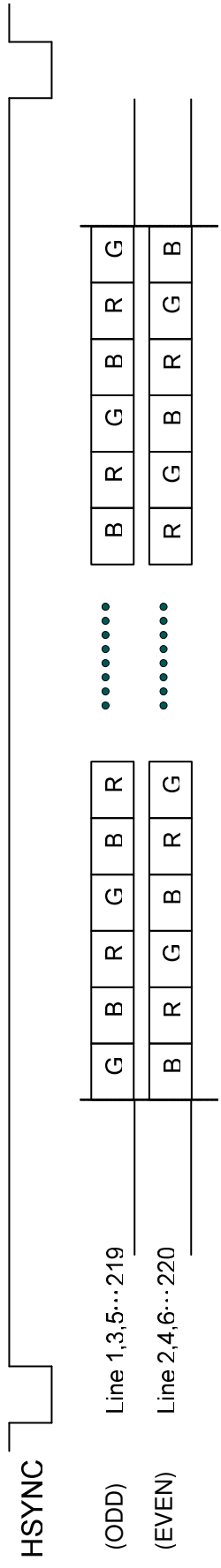
Note2: UPS051 support interlacing input format

Note3: UPS051 support non-interlacing input format. Odd field only or even field only

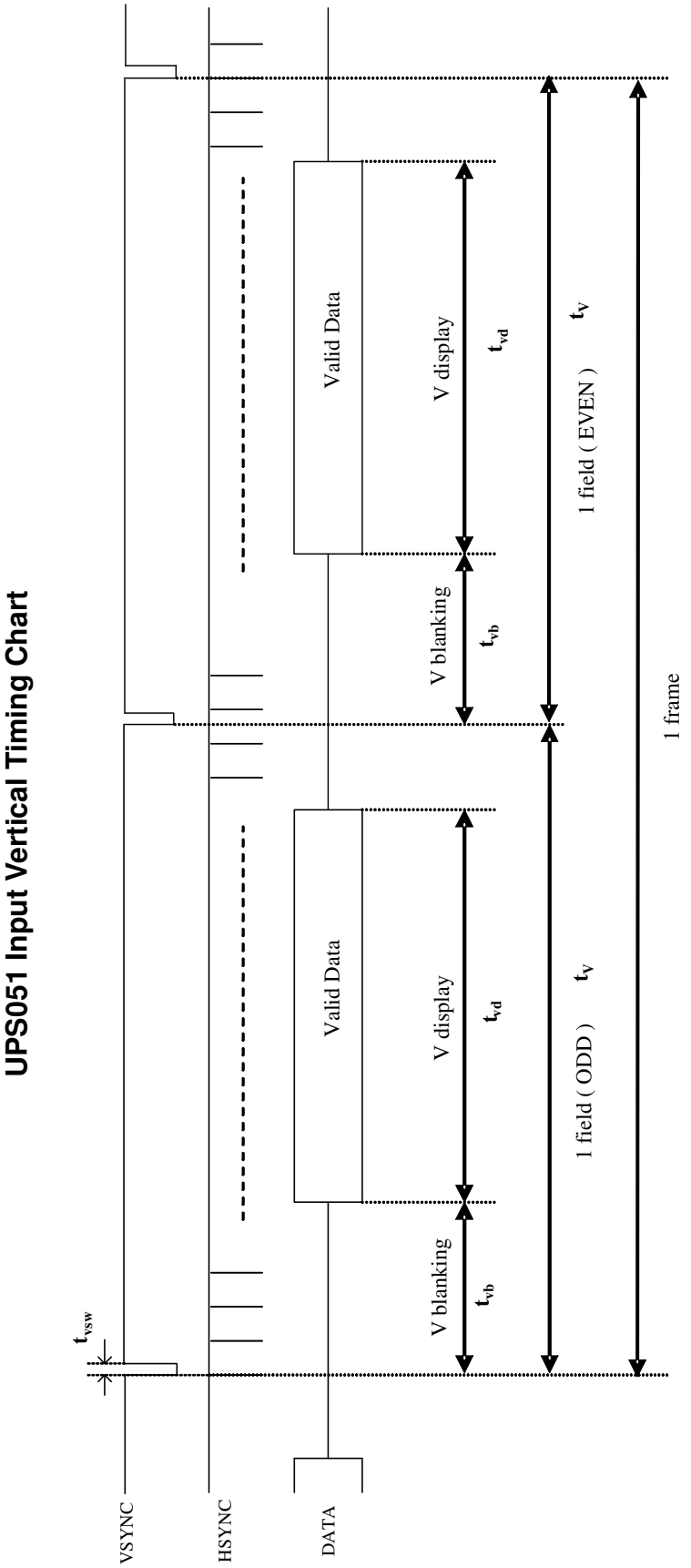
UPS051 Input Horizontal Timing Chart



UPS051 Input Horizontal Data Sequence



UPS051 Input Vertical Timing Chart



b. UPS052 Timing conditions

Parameter			Symbol	Min.	Typ.	Max.	Unit.	Remark
DCLK Frequency			$1/t_{DCLK}$	23.3	24.54	25.7	MHz	
HSYNC	Period		t_H	1560			t_{DCLK}	Note1
	Display period		t_{hdisp}	1280			t_{DCLK}	
	Back porch		t_{hbp}	248	249	251	t_{DCLK}	
	Front porch		t_{hfp}	32	31	29	t_{DCLK}	
	Pulse width		t_{hsw}	1	25	56	t_{DCLK}	
VSYNC	Period	Odd	t_V	256	262.5	264	t_H	
		Even						
	Display period	Odd	t_{vdisp}	220			t_H	
		Even						
	Back porch	Odd	t_{vb}	23			t_H	Note2
		Even		23.5				
	Front porch	Odd	t_{vf}	13	19.5	21	t_H	
		Even		12.5	19	20.5		
	Pulse width	Odd	t_{vsw}	1 t_{DCLK}	3 t_H	6 t_H	-	
		Even						

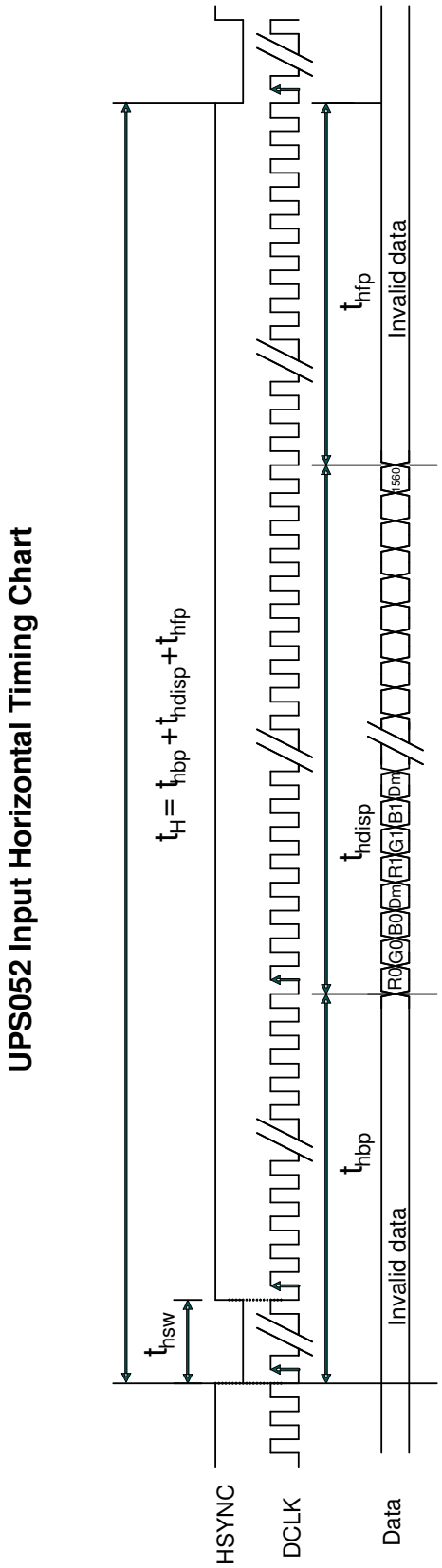
Note1: Horizontal display position:

Available display starts from the data of 266 t_{DCLK} when back porch value (t_{hbp}) set 249.

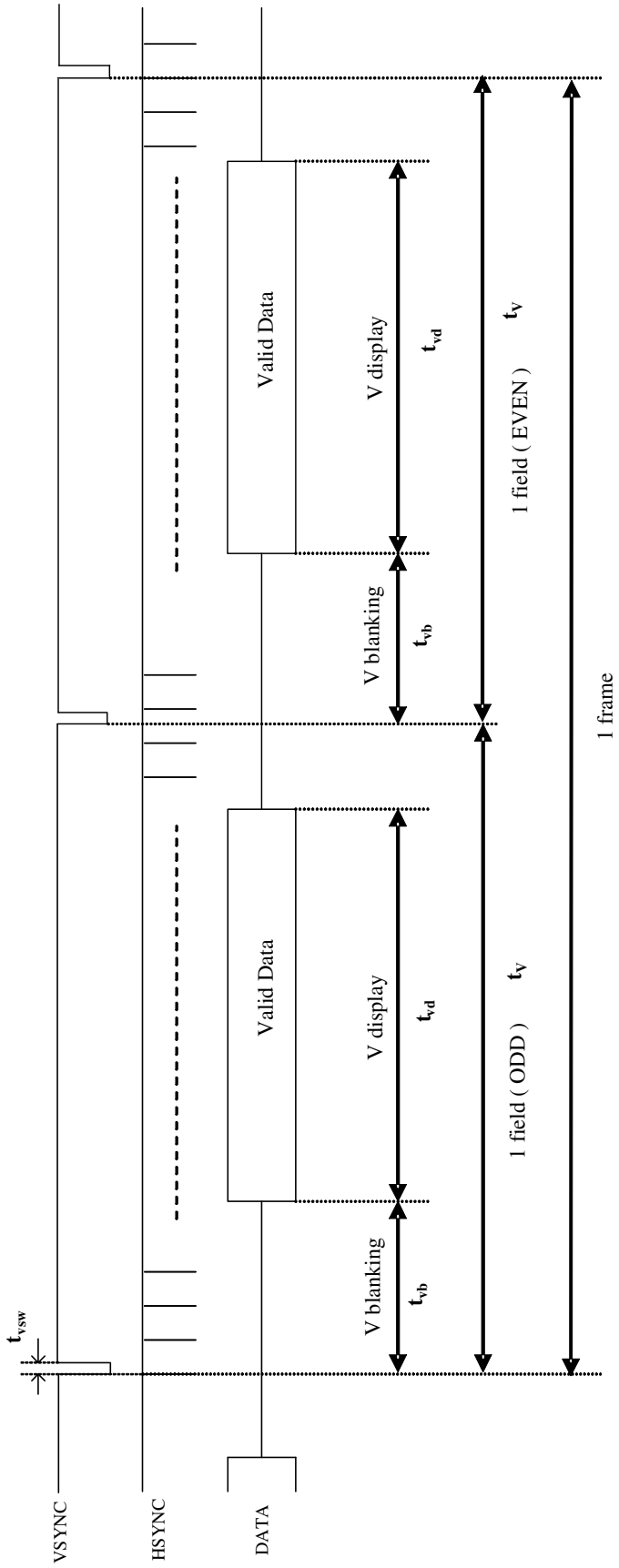
Note2: UPS052 support interlacing input format

Note3: UPS052 support non-interlacing input format. Odd field only or even field only.

UPS052 Input Horizontal Timing Chart



UPS052 Input Vertical Timing Chart



7. 3-wire serial communications

For 3-wire serial communication timing, it is shown in Fig.6. For register setting, please refer to application note.

8. DC-DC Converter Circuit

A015AN04 contains one high-power step-up DC-DC converter, and a backplane drive circuitry for active matrix TFT LCDs. The output voltage of the main boost converter can be set from VCC to 13.5V with external resistors. Also, there are a precision 0.6V reference voltage, a fault detection and a logic shutdown included in A015AN04.

a .Boost Converter

A015AN04 main boost converter uses a boost PWM architecture to produce a positive regulated voltage. Please refer to Fig. 1 for the DC-DC converter block diagram.

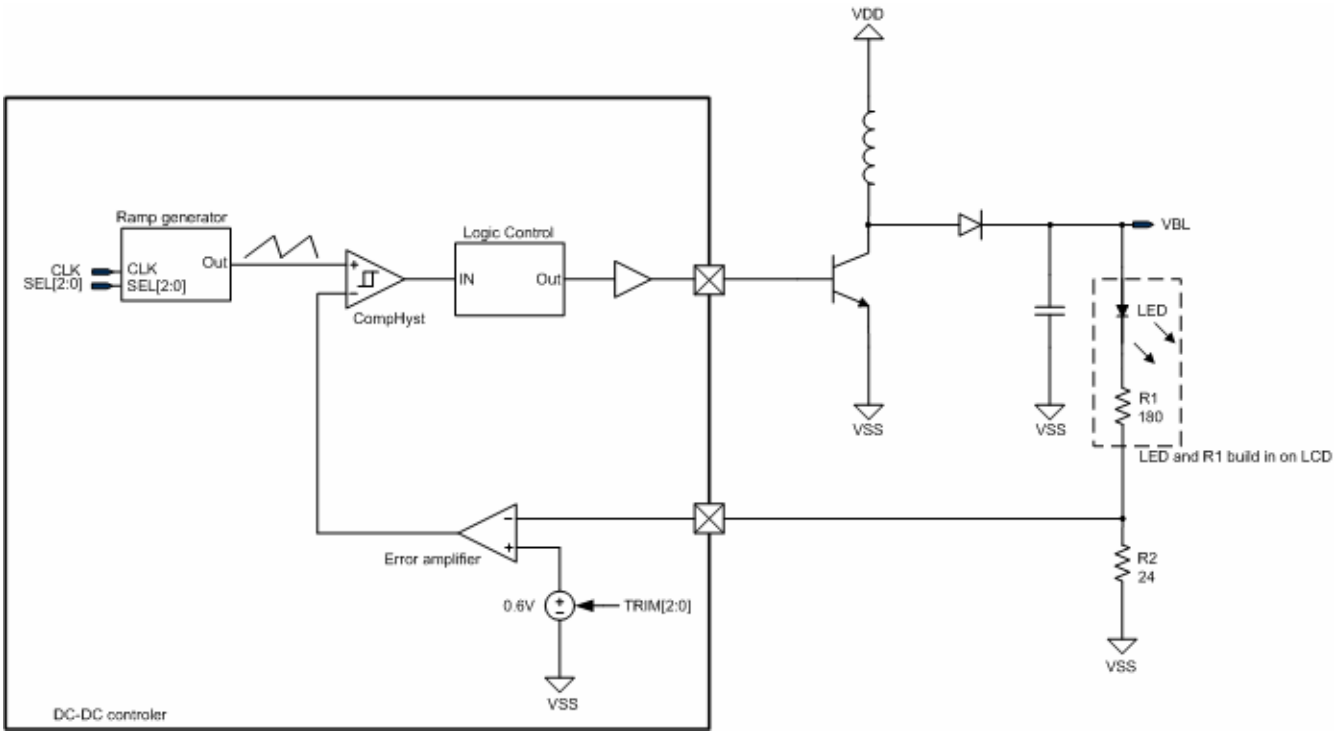


Fig. 1 Dc-Dc converter block diagram

In the internal architecture of DC-DC converter as shown in Fig. 2, the feedback voltage (VFB) will connect to the tri-angle waveform comparator, and generates the output signal (CP0) which determines the duty cycle for (Fdc).

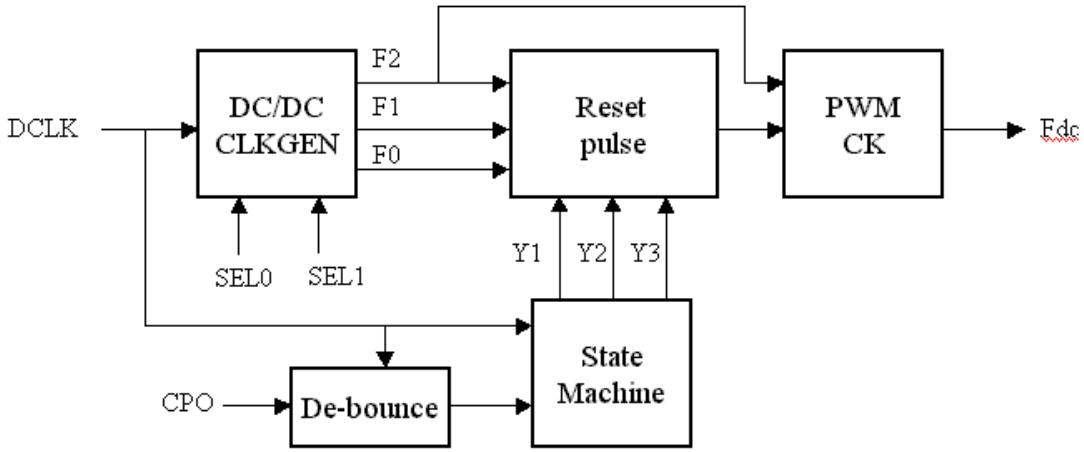


Fig. 2 DC CK block diagram

To reduce the noise affect, CP0 will be processed by De-bounce circuit. State-machine will generate the duty cycle by CP0 signal. To make sure that VFB can reach default VREF quickly, so that State-machine is designed as a discrete step by step function, please refer to Fig. 3. If CP0 is low, the duty cycle will work from 0% to 75%, and the maximum f that is 75%.

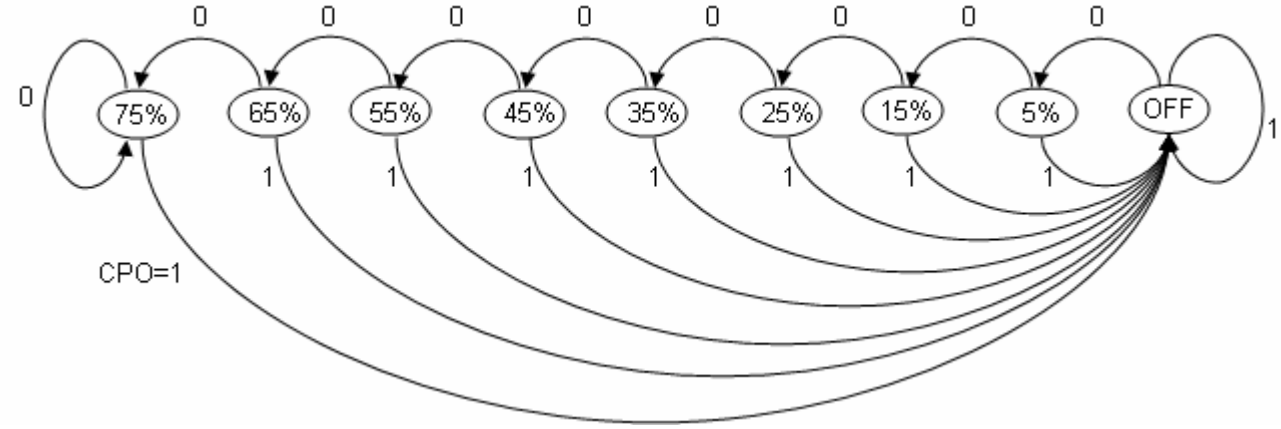


Fig. 3 PWM Control state diagram

b. Charge Pump Block Diagram

The LED_Anode Voltage is used for internal pump circuit to generate VGH/Vgoff_H/ Vgoff_L/Vcac for gate and VCOM used.

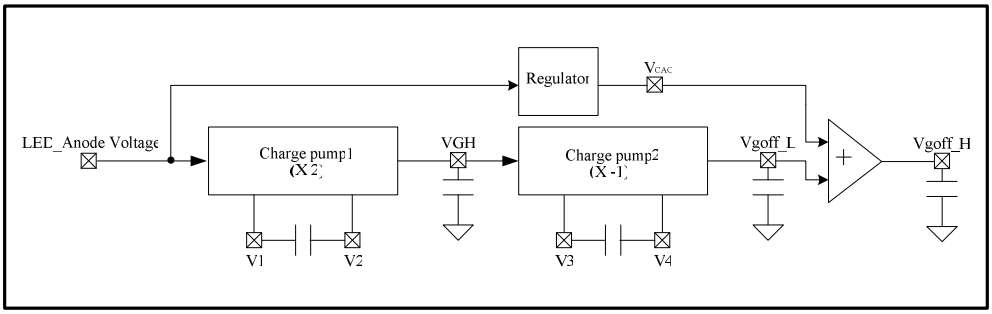


Fig. 4 charge pump diagram

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	60	150	-		Note 5, 6
Viewing angle Top Bottom Left Right		CR□10	 10 30 40 40	 - - - -	 - - - -	deg.	Note 7
Brightness (25mA)	Y_L	θ=0°	130	170	-	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□.

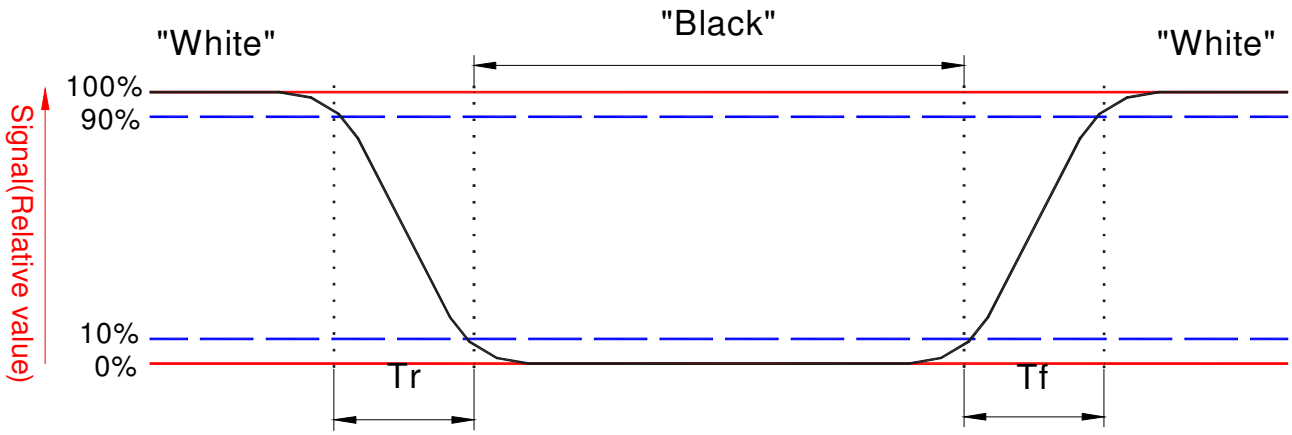
Note 2 Measured in the dark room

Note 3 Measured on the center area of panel with a field angle of 1° by Topcon luminance meter BM-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.

Response time is defined as the time interval between the 10% and 90% of amplitudes. Refer to the figure as follows.

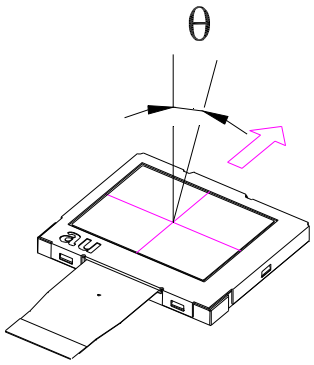


Note 5 Definition of contrast ratio:
Contrast ratio is calculated with the following formula.

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

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.
$V_{i50:}$ The 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 the figure as follows.



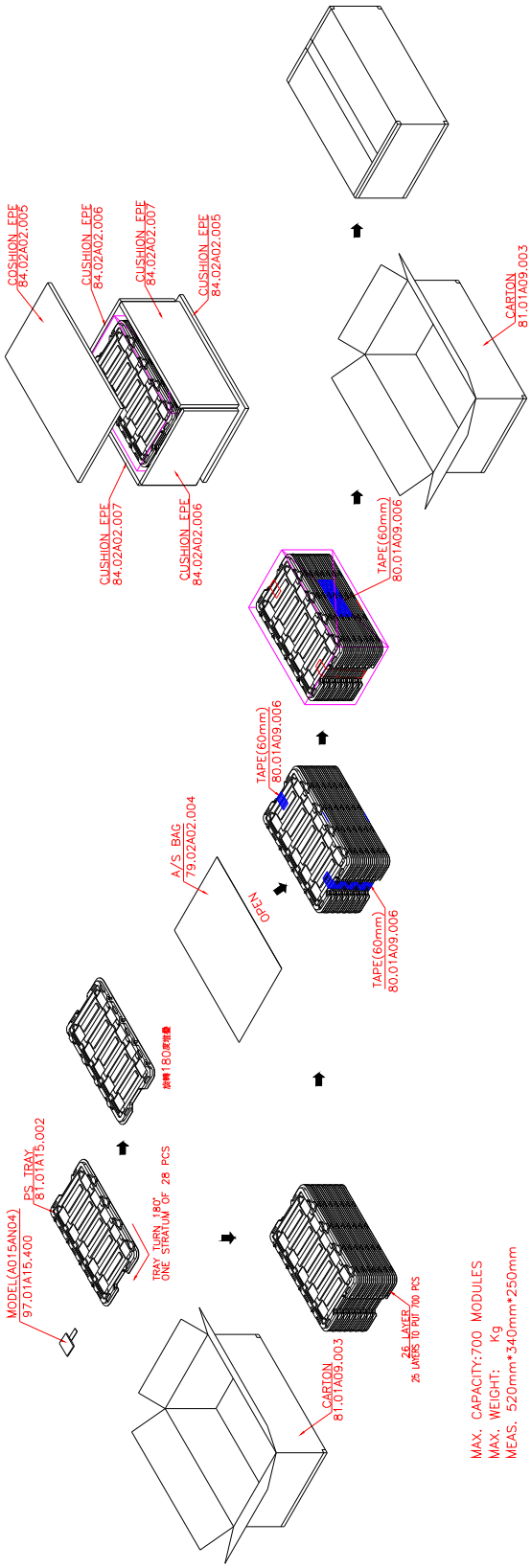
Note 8 Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

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 cycles, 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



F. Outline drawing

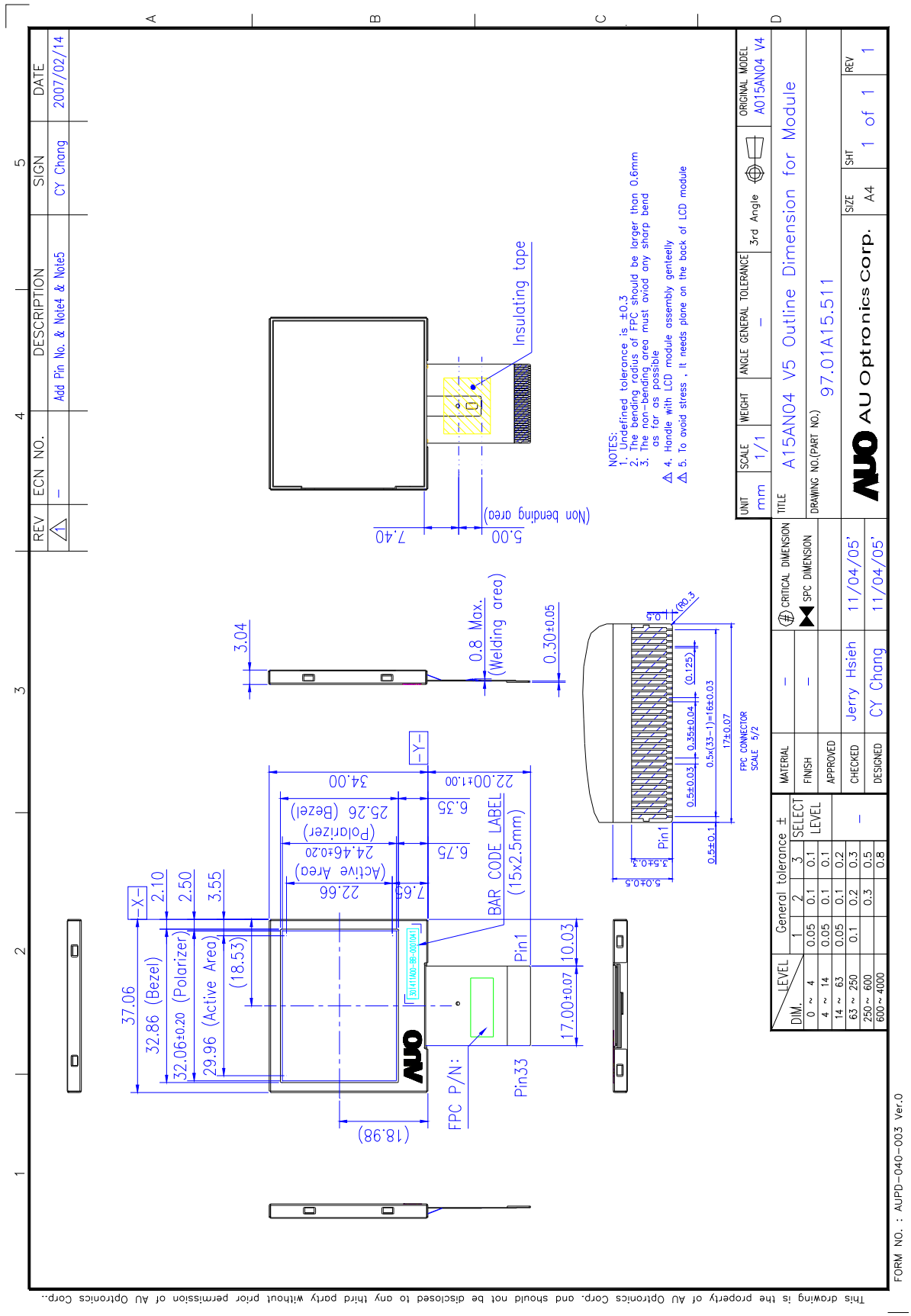


Fig. 5 Outline dimension of TFT-LCD module

G. Appendix

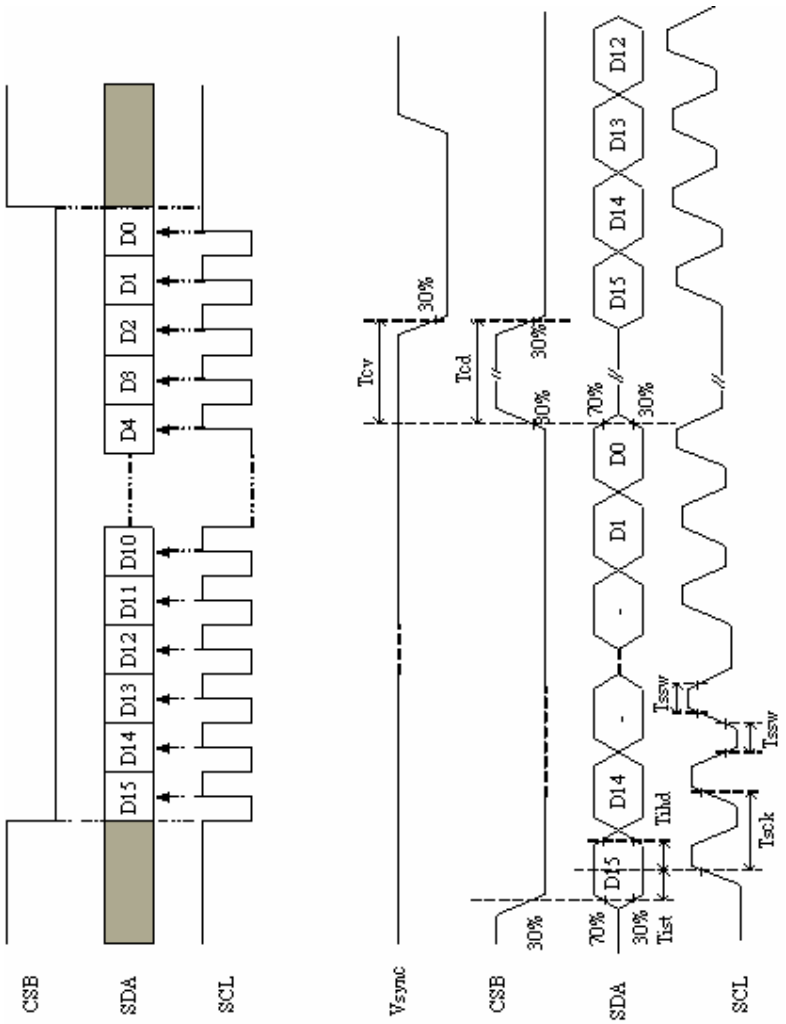


Fig. 6 3-wire programming function timing

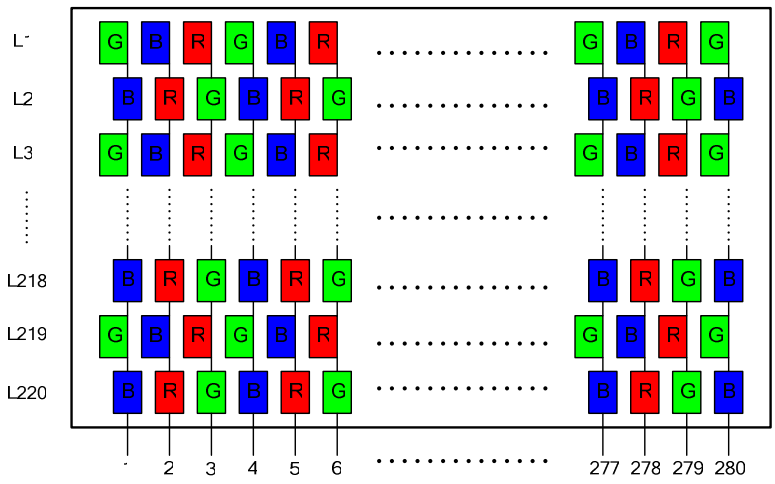


Fig. 8 Panel color Filter Alignment

H. Suggested Application Note

A015AN04 is designed with smart integration advance (SIA) concept for DSC application. This panel integrated not only source driver & gate driver, but also built in power generator and embedded serial communication interface for the function setting.

A015AN04 is supported by two kinds of input timing format: UPS051 and UPS052. Customers can use 3-wire serial port for setting register and select different timing for their own design feature.

In this document, we list essential parameters for configuration. Please follow our recommend setting to achieve the best performance. In the last page, we provide application circuit to drive A015AN04.

For A015AN04 driving circuit design, you just need input one set of power 3.3V, because the charge-pump circuit inside the driver IC produces Vgh & Vgl. The external peripheral is very simple and good for saving BOM cost for customers.

1. 3-wire serial communication AC timing

Parameter	Symbol	Min.	Typ.	Max.	Unit
Serial clock	Tsck	320	-		ns
SCL pulse duty	Tscw	40	50	60	%
Serial data setup time	Tist	120	-	-	ns
Serial data hold time	Tiht	120	-	-	ns
Serial clock high/low	Tssw	120	-	-	ns
Chip select distinguish	Tcd	1	-	-	us
Time that the CSB to Vsync	Tcv	1	-	-	us

2. 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				DATA											

3. Recommend register table for UPS051 timing

		Address															
No.	Description	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R0	Scan direction	0	0	0	0	0	X	X	X	X	X	X	X	X	X	0	1
R1	Data setting	0	0	1	0	0	X	X	X	X	X	X	X	X	X	0	0
R2	Source IC setting	0	1	0	0	0	X	X	X	X	X	X	X	1	1	0	0
R3	Timing select	0	1	1	0	0	X	X	X	X	X	X	X	X	0	0	0
R4	VCAC level setting	1	0	0	0	0	X	X	X	X	X	X	X	X	1	1	0

“X” =>Don’t care

4. Recommend register table for UPS052 timing

		Address															
No.	Description	D15	D14	D13	D12	D11	D10	D9	D8	D7	D6	D5	D4	D3	D2	D1	D0
R0	Scan direction	0	0	0	0	0	X	X	X	X	X	X	X	X	X	0	1
R1	Data setting	0	0	1	0	0	X	X	X	X	X	X	X	X	X	0	1
R2	Source IC setting	0	1	0	0	0	X	X	X	X	X	X	X	1	1	0	0
R3	Timing select	0	1	1	0	0	X	X	X	X	X	X	X	X	0	0	1
R4	VCAC level setting	1	0	0	0	0	X	X	X	X	X	X	X	X	1	1	0

"X"=>Don't care

5. Register detail description

a. Register R0

Bit	Function
D0	Up/down scan direction: "0" => Down to up "1" => Up to down
D1	Left/Right scan direction: "0" => Left to right "1" =>Right to left

b. Register R1

Bit	Function
D0	"0" =>When UPS051 mode selected "1" =>When UPS052 mode selected
D1	Always fixed at "0"

c. Register R2

Bit	Function
D0	Always fixed at "0"
D1	Always fixed at "0"
D2	Standby mode setting: "0" => Turn off driver & DCDC "1" => Normal operating
D3	Global reset setting: "0" =>Driver control register is in reset state, all setting to default value. "1" =>Normal operating;

d. Register R3

Bit	Function
D0	"0" => To select UPS051 timing "1" => To select UPS052 timing
D1	Always fixed at "0"
D2	Always fixed at "0"

e. Register R4 ＊

Bit	Function
D0	Always fixed at "0"
D1	Always fixed at "1"
D2	Always fixed at "1"

＊ Set VCOM AC level = 5.6V (Amplitude)

Reference application circuit

(1) Internal LED booster circuit

The integrated driver IC provides build-in LED booster controller, DC-DC charge pump, and VCOM driver. See Fig. 8 for the application circuit. The recommended capacitance values of the external capacitor please refer to page 7. The capacitors of 411 will be used shrinkage IC.

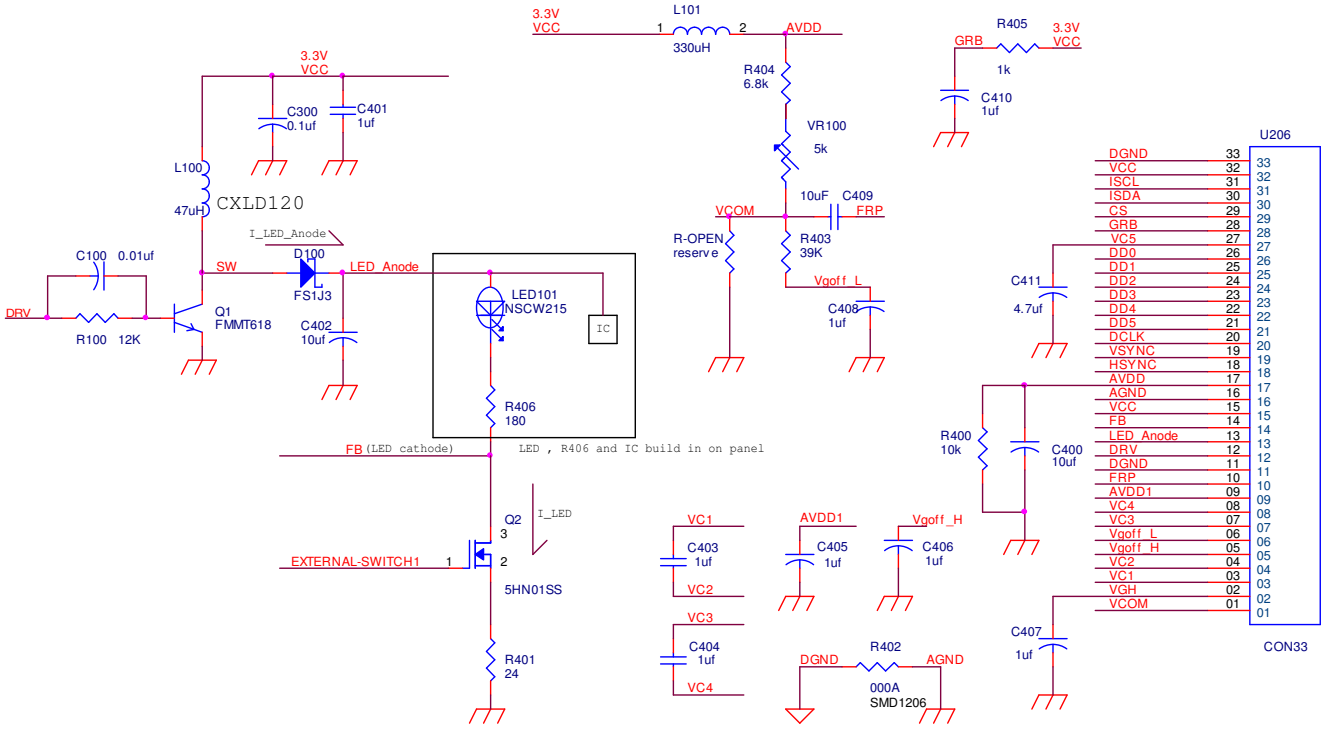


Fig. 8 Typical Application Circuit

Note:

C400 & R400 are new adding external components.

C400 => to stable the AVDD power

R400 => used for discharge AVDD power faster

C411 => used for later shrinkage IC (strongly recommended)

U1 ➔ to control backlight on/off function

EXTERNAL-SWITCH1 “H” ➔ backlight on

EXTERNAL-SWITCH1 “L” ➔ backlight off

Please refer to suggestion power and standby on/off sequence.

(2) External LED circuit

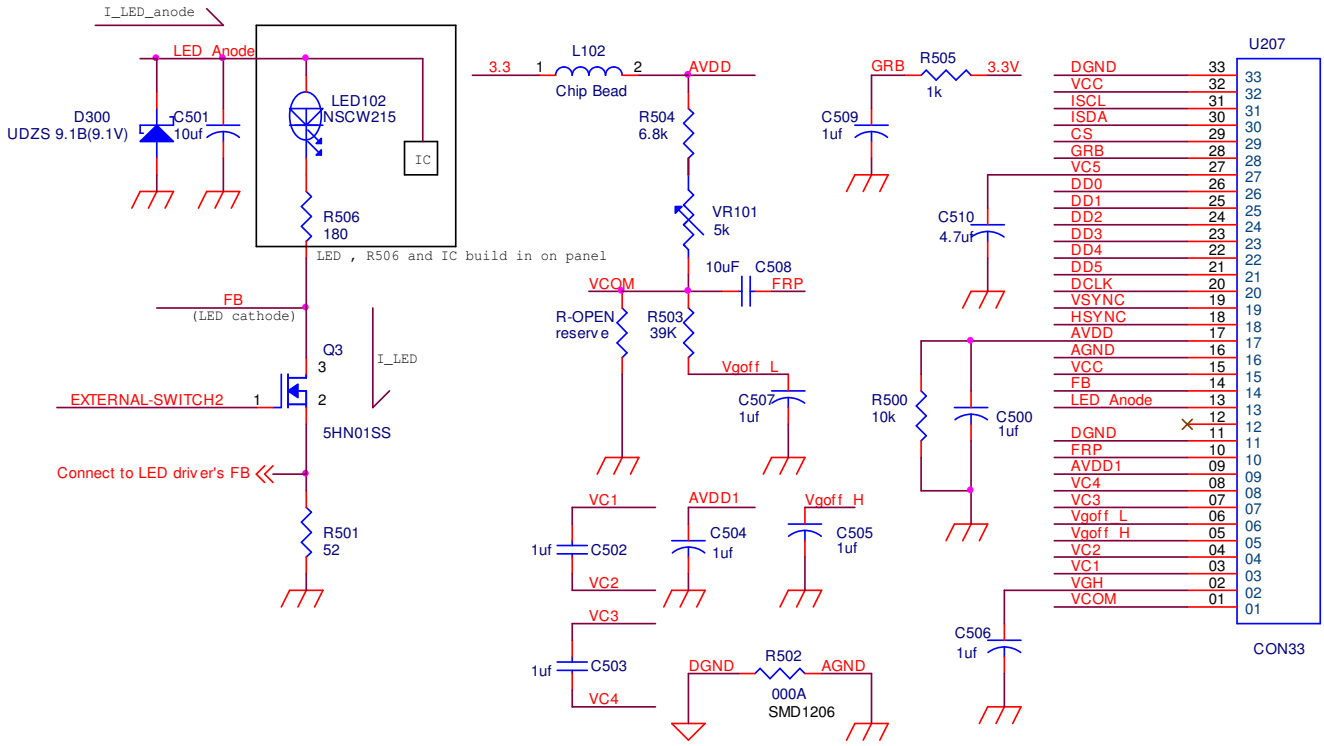


Fig. 9 External LED driver Circuit

Note:

C510 => used for later shrinkage IC (strongly recommended)

U2 ➔ to control backlight on/off function

EXTERNAL-SWITCH2 “H” ➔ backlight on

EXTERNAL-SWITCH2 “L” ➔ backlight off

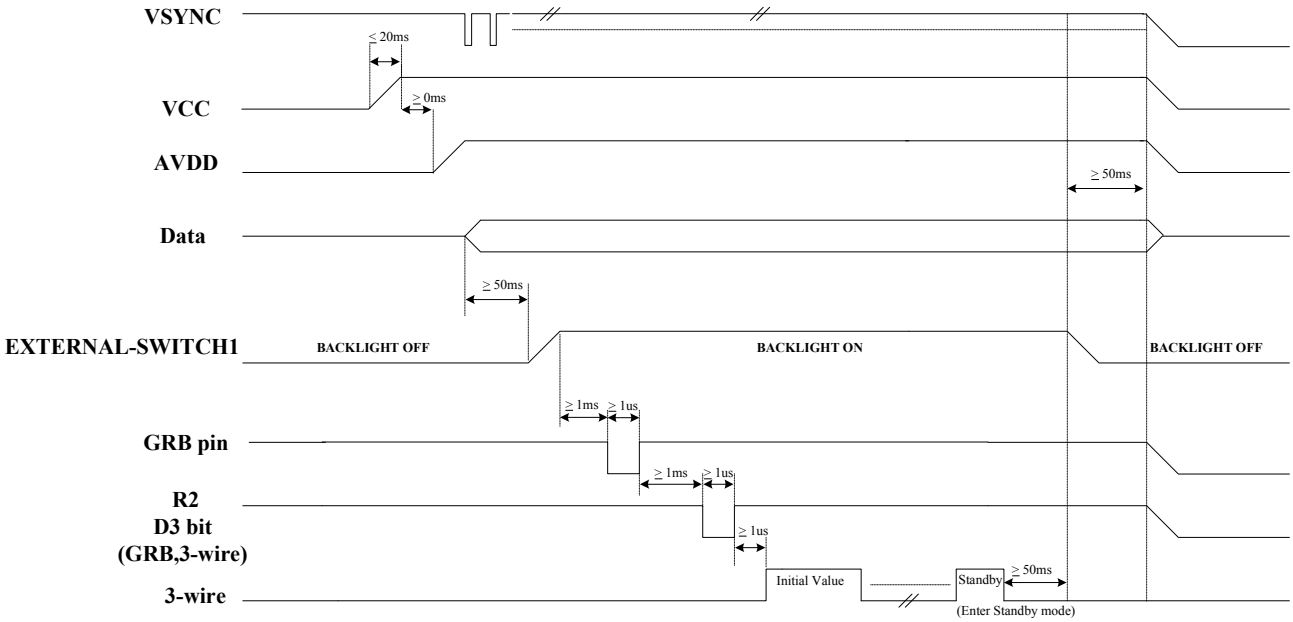
Please refer to suggestion power and standby on/off sequence.

Power supply VCC (typical 3.3V) and AVDD (typical 3.3V) are required to provide driver IC power and generate all necessary voltages for LCD related circuits.

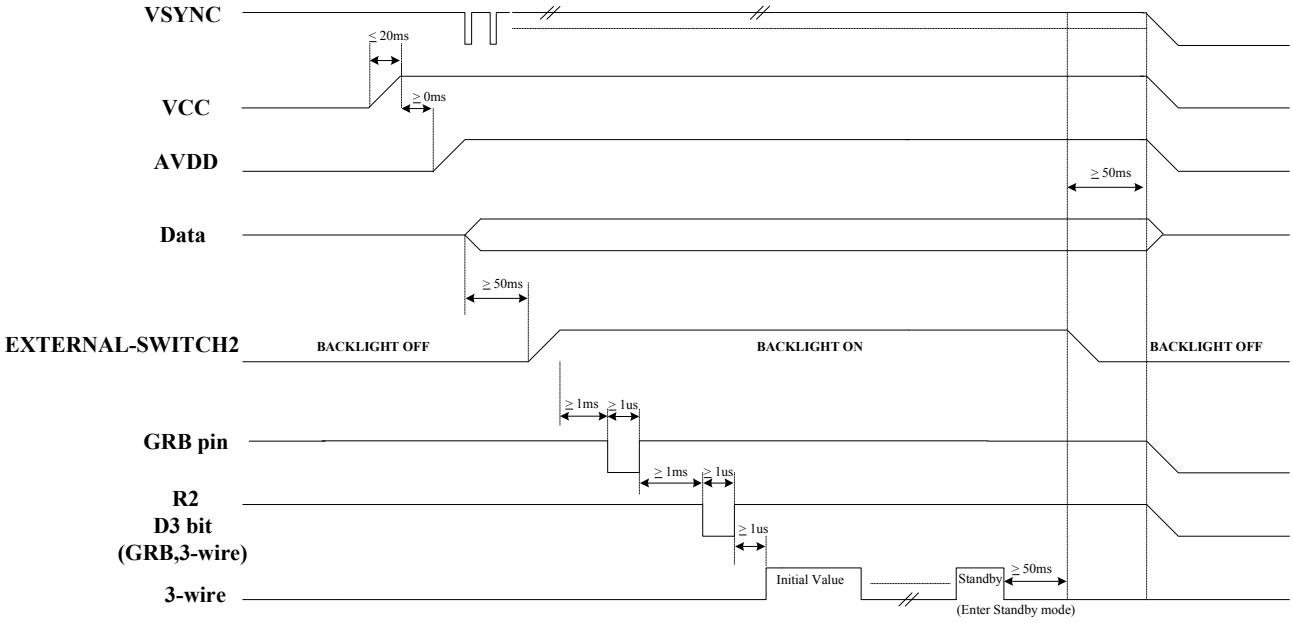
We recommend the external LED driver circuit provide a constant 25mA for LED backlight unit.We suggest the R501 resister value is greater than 30 ohm to turn off DRV signal.The capacitors of C510 will be used shrinkage IC.

Suggestion power on/off sequence

(1) Internal LED booster circuit



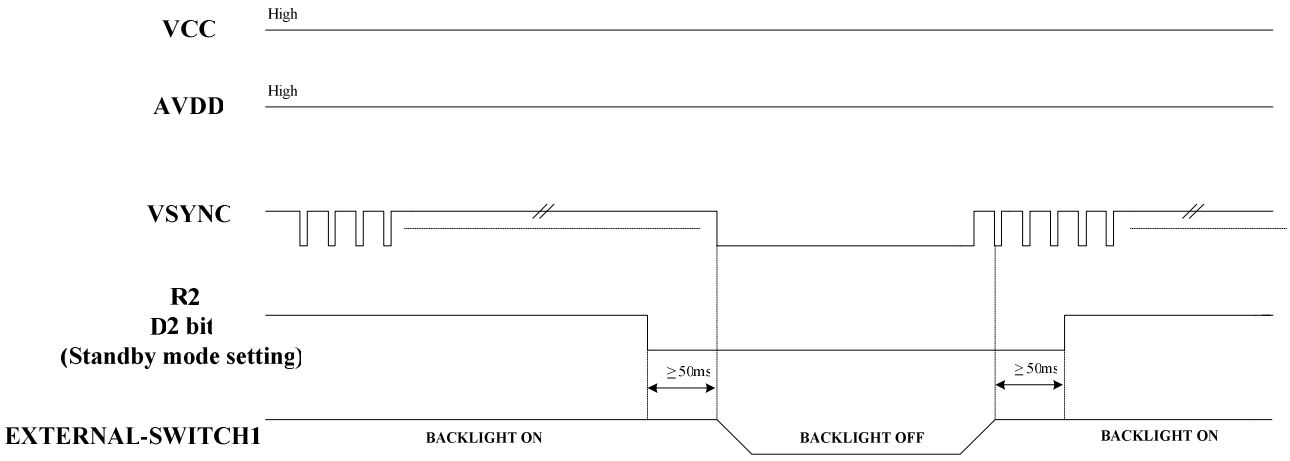
(2) External LED circuit



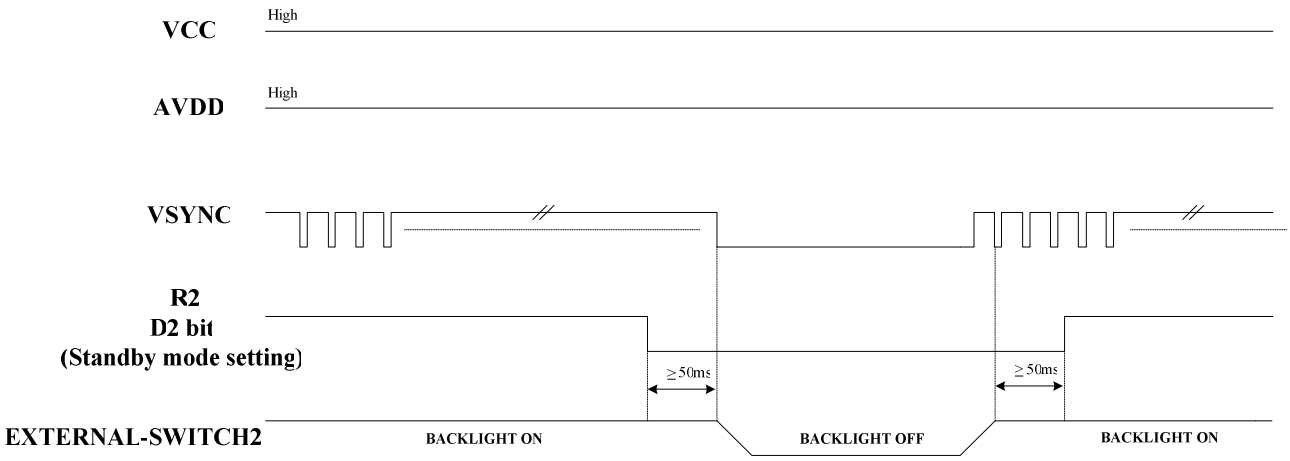
We recommend power on/off sequence that base on differential application circuit to make sure power on/off function can work successfully in every time power on.

Suggestion Standby on/off sequence

(1) Internal LED booster circuit



(2) External LED circuit



We recommend standby on/off sequence that base on differential application circuit to make sure function can work successfully.

I. Appendix – LED life time data

NSSW008C WHITE LED Life Data