Doc. Version	0.1
Total Pages	29
Date	2006/11/06

Product Specification

4.0” COLOR TFT-LCD MODULE

MODEL NAME: A040FL01 V2

<◆>Preliminary Specification

< >Final Specification

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

Record of Revision

Version	Revise Date	Page	Content
0	02/Sep/2006		First draft.
0.1	06/Nov/2006	14 17 20 23	Update TBD value of 3.4.2.1 Timing Parameter. Add “3.5.3 Low-voltadge set”. Uodate D5, D6 setting of R0. Update contrast ratio and brightness spec.

Contents

General Description

A040FL01 V2 is a color TFT (Thin Film Transistor) LCD (Liquid crystal Display). This model is composed of TFT-LCD, drive IC, FPC (flexible printed circuit), backlight unit, and Touch Panel.

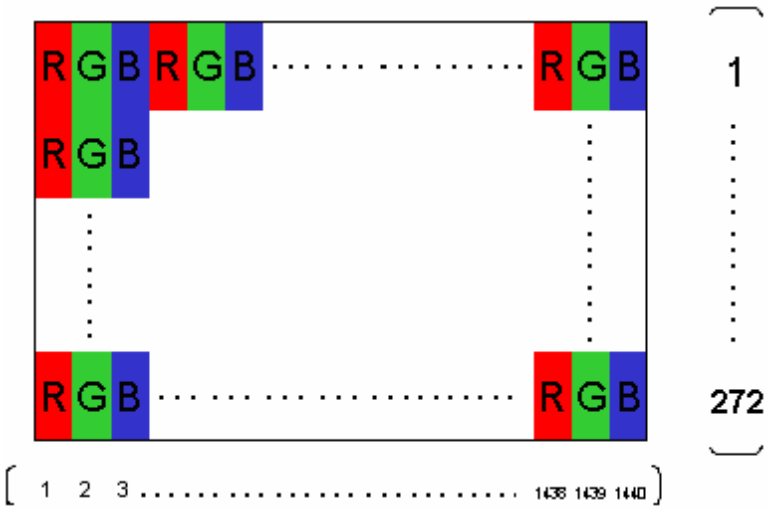
Features

- 4-inch display size
- QQHDTV resolution and wide aspect ratio
- 16.7M colors
- System Integration
  - Timing controller
  - Charge pump for VGH, VGL
  - 2-in-1 FPC
- SYNC + DE input mode
- Parallel digital 8-bit data interface
- ATR-MVA (**A**dvanced **TR**ansflective – **M**ulti-domain **V**ertical **A**lignment)
  - Wide view angle
  - No Gray Scale Inverison
  - High contrast ratio
- Touch Screen. Surface coating: **anti-fingerprint , anti-glare**, hardcoating
- VCOM, brightness, contrast control by SPI register
- Green design

1. General Information

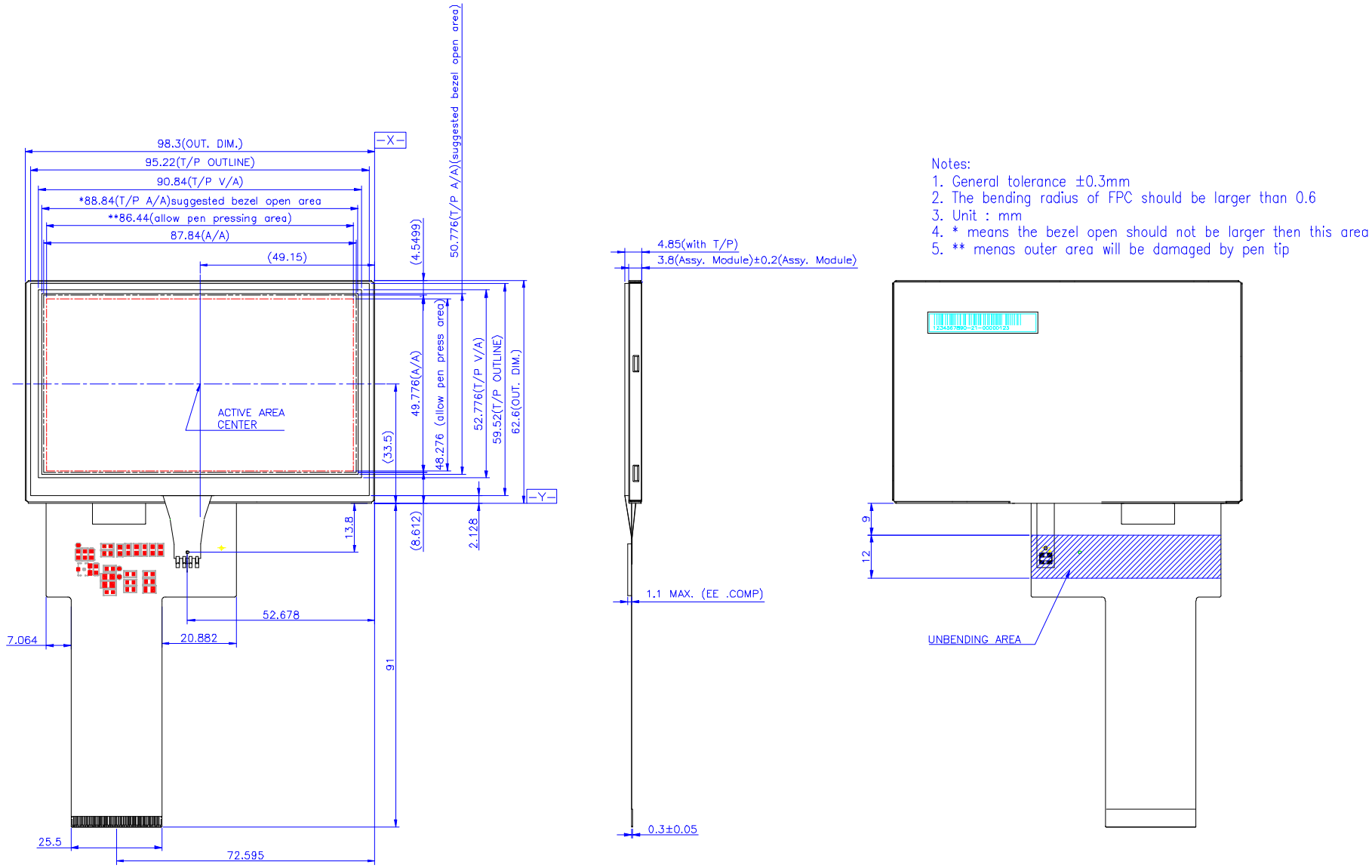
NO.	Item	Unit	Specification	Remark
1	Display Resolution	dot	480RGB(H)×272(V)	
2	Active Area	mm	87.84(H)×49.776(V)	
3	Screen Size	inch	4.0” (Diagonal)	
4	Dot Pitch	mm	0.061(H)×0.183(V)	
5	Color Configuration	--	R. G. B. Stripe	Note 1
6	Color Depth	--	16.7M Colors	Note 2
7	Overall Dimension	mm	98.3(H) × 62.6(V) × 4.85(T)	Note 3
8	Weight	g	50 (Typical)	
9	Touch Panel surface treatment	--	Hard Coating 3H Anti-Glare, Anti-fingerprint	
10	Display Mode	--	Normally Black	

Note 1: Below figure shows dot stripe arrangement.



Note 2: The full color display depends on 8-bit data signal (pin5~28).

Note 3: Not include FPC. Refer next page to get further information.



Outline Dimension of A040FL01 V2 Module

2. Electrical Specifications

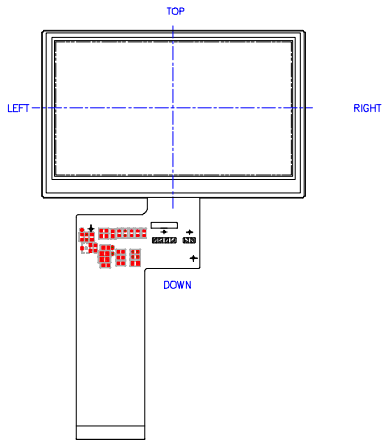
2.1 FPC Pin Assignment

Pin no	Symbol	Type	Description	Remark
1	GND	P	Ground	
2	GND	P	Ground	
3	VDD	P	Power supply for charge pump	
4	VDDIO	P	Power supply for digital interface	
5	R0	I	Red data (LSB)	
6	R1	I	Red data	
7	R2	I	Red data	
8	R3	I	Red data	
9	R4	I	Red data	
10	R5	I	Red data	
11	R6	I	Red data	
12	R7	I	Red data (MSB)	
13	G0	I	Green data (LSB)	
14	G1	I	Green data	
15	G2	I	Green data	
16	G3	I	Green data	
17	G4	I	Green data	
18	G5	I	Green data	
19	G6	I	Green data	
20	G7	I	Green data (MSB)	
21	B0	I	Blue data (LSB)	
22	B1	I	Blue data	
23	B2	I	Blue data	
24	B3	I	Blue data	
25	B4	I	Blue data	

Pin no	Symbol	Type	Description	Remark
26	B5	I	Blue data	
27	B6	I	Blue data	
28	B7	I	Blue data (MSB)	
29	GND	P	Ground	
30	DCLK	I	Pixel clock	
31	DISP	I	DISP : 'L' Display OFF DISP : 'H' Display ON	
32	HSYNC	I	Horizontal Sync Signal	
33	VSYNC	I	Vertical Sync Signal	
34	DE	I	Data Enable	
35	NC		None Connect	
36	NC		None Connect	
37	GND	P	Ground	
38	GND	P	Ground	
39	TP_R	O	Touch Panel Right Signal	
40	TP_B	O	Touch Panel Bottom Signal	
41	TP_L	O	Touch Panel Left Signal	
42	TP_U	O	Touch Panel Up Signal	
43	SCL	I	Serial communication clock input	
44	SDA	I/O	Serial communication data input and output	
45	CS	I	Serial communication chip select	
46	VLED-	P	LED cathode	
47	VLED+	P	LED anode	
48	GND	P	Ground	
49	GND	P	Ground	
50	GND	P	Ground	

Note 1: I: Input; O: Output; P: Power.

Note 2: Customer can also connect pin 43-45 to GND and bypass serial communication setting.



2.2 Absolute Maximum Ratings

Item	Symbol	Condition	Min.	Max.	Unit	Remark
Power voltage	VDD	GND=0	-0.3	4.5	V	Note 1
	VDDIO	GND=0	-0.3	4.5	V	Note 1
Operating temperature	Topa	—	0	60	℃	Ambient temperature
Storage temperature	Tstg	—	-25	80	℃	Ambient temperature

Note 1: Functional operation should be restricted under normal ambient temperature.

3. Electrical Characteristics

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

3.1 TFT- LCD Typical Operation Condition

Item	Symbol	Min.	Typ.	Max.	Unit	Remark
Power supply	VDD	3.1	3.3	3.5	V	
	VDDIO	1.65	3.3	3.5	V	
Vsync Frequency	f_V		60		Hz	

Hsync Frequency	f_H		17.28		kHz	
Main Frequency	f_{DCLK}		9.0	10.0	MHz	

Note 1: Above every operation range is based on stable operation from suggested application circuit 3.3.1.

Note 2: A built-in power-on reset circuit for VDD and VDDIO is provided within the integrated LCD driver IC. The LCD module is in default in power save mode, and a standby releasing is required after VDDIO power on through DISP pin. Please refer to the pin description for detail.

Note 3: The power supply of digital interface, VDDIO, is for the 1.8V digital interface requirement in the future. These digital signals are DCLK, HSYNC, VSYNC, R7~R0, G7~G0, B7~B0, DE. If the digital interface is in the level of 3.3V, please short the power pin, VDD and VDDIO, to 3.3V. In other words, no matter the voltage level of VDDIO is 1.65V or 3.5V, the voltage level of VDD needs to be kept around 3.3V.

3.2 Backlight Driving Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remark
LED Current	I_L	---	20	25	mA	single seral
LED Voltage	V_L	---	25.6	---	V	single seral
LED Life Time	L_L	10,000	---	---	Hr	Note 2, 3

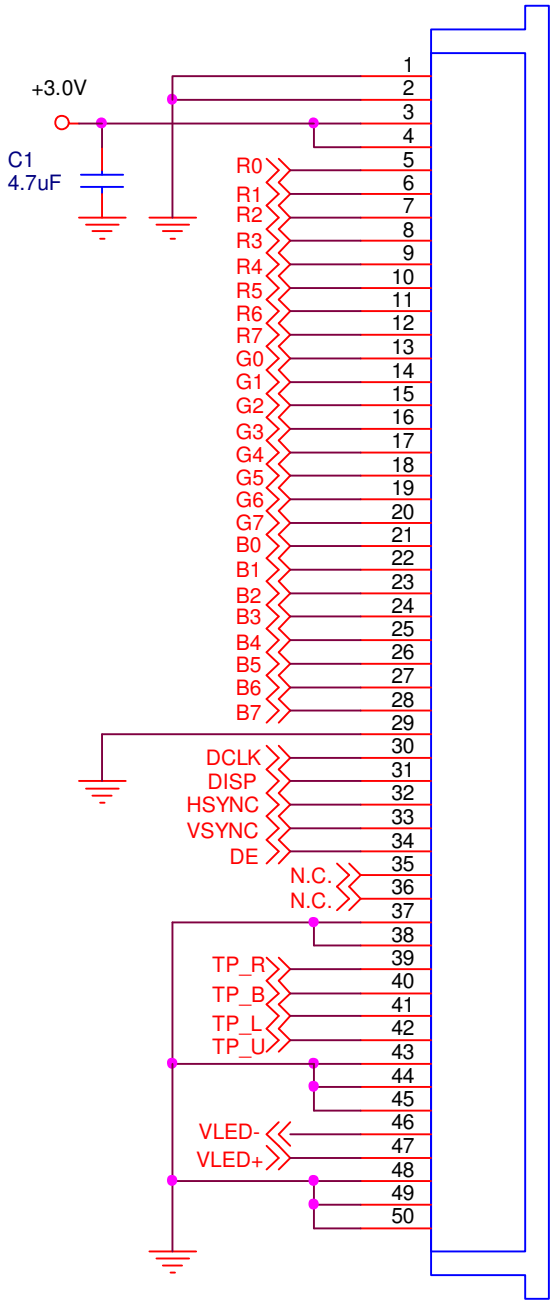
Note 1: LED backlight is eight LEDs serial type.

Note 2 :Define “LED Lifetime”: brightness is decreased to 50% of the initial value. LED Lifetime is restricted under normal condition, ambient temperature = 25℃ and LED current = 20mA.

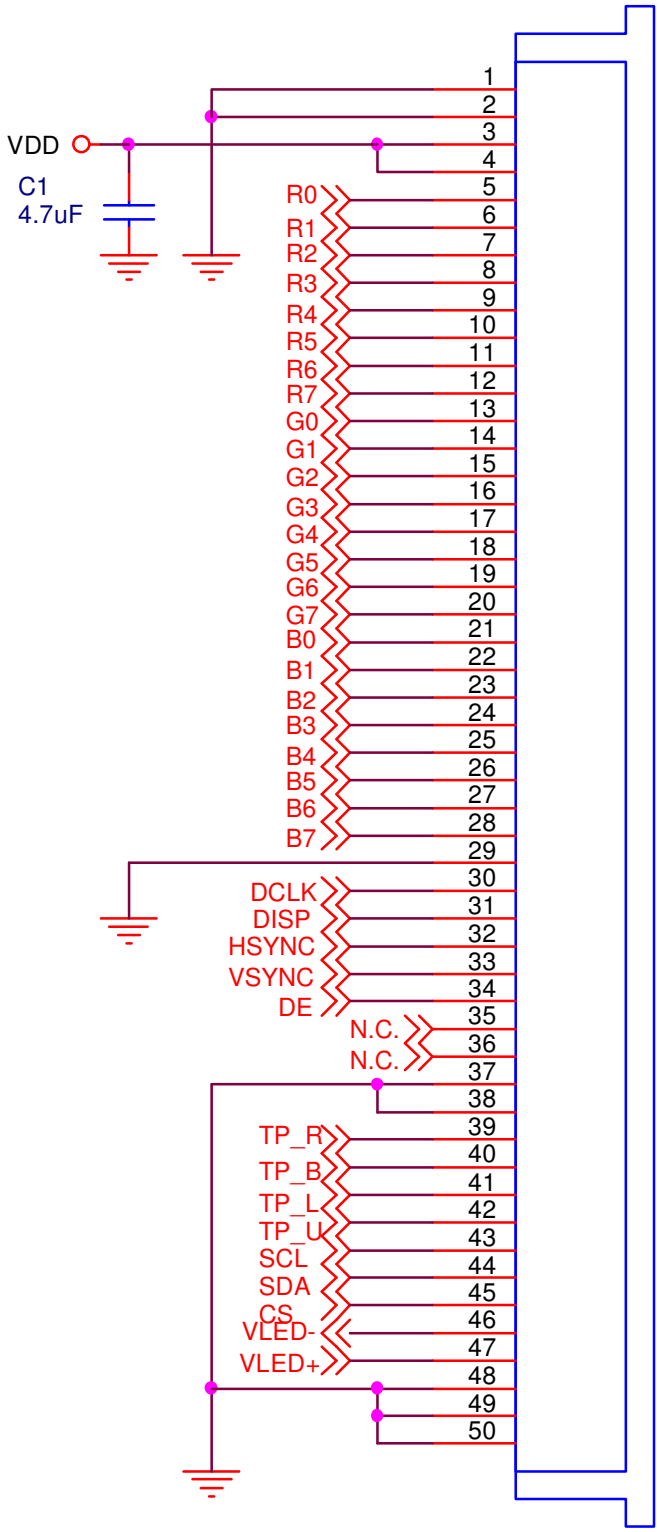
Note 3: If it uses larger LED current I_L more than 20mA, it maybe decreases the LED lifetime.

3.3 Suggested Application Circuit

3.3.1 Suggested Application Circuit (not use SPI control)



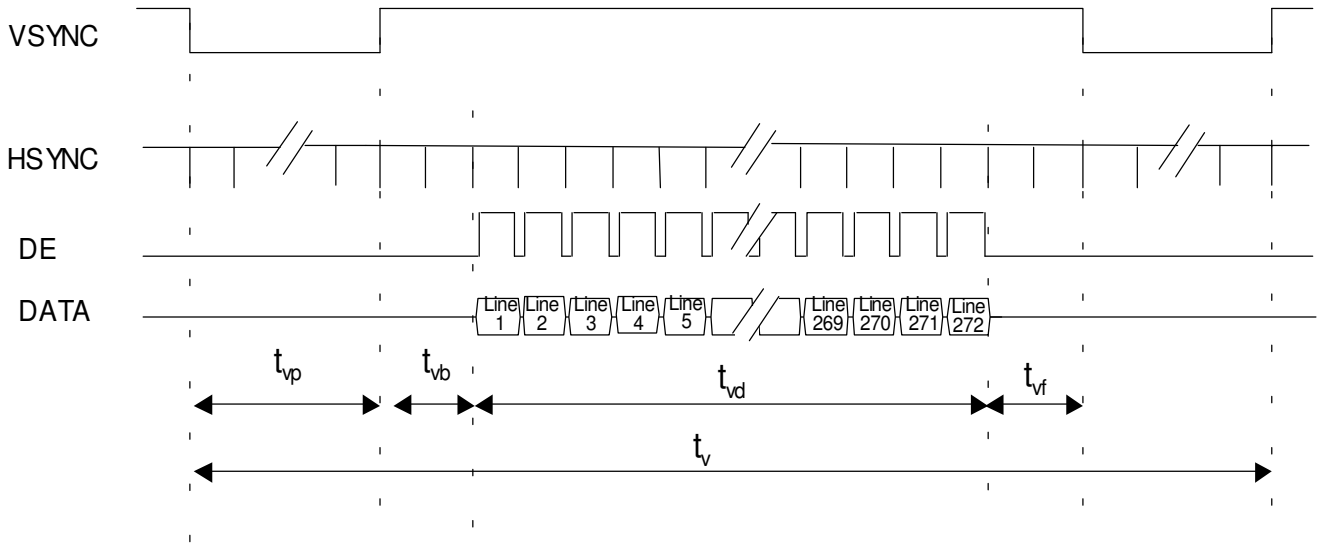
3.3.2 Suggested Application Circuit (use SPI control)



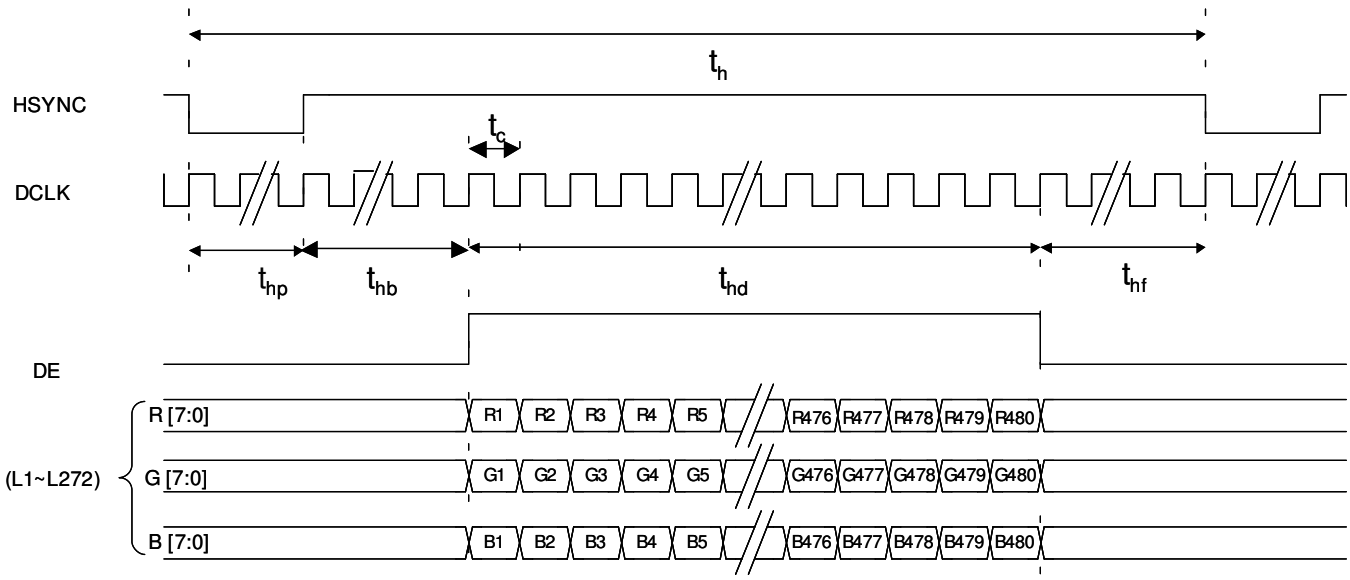
3.4 AC Timing

3.4.1 Timing Diagram

3.4.1.1 Vertical Timing of Input



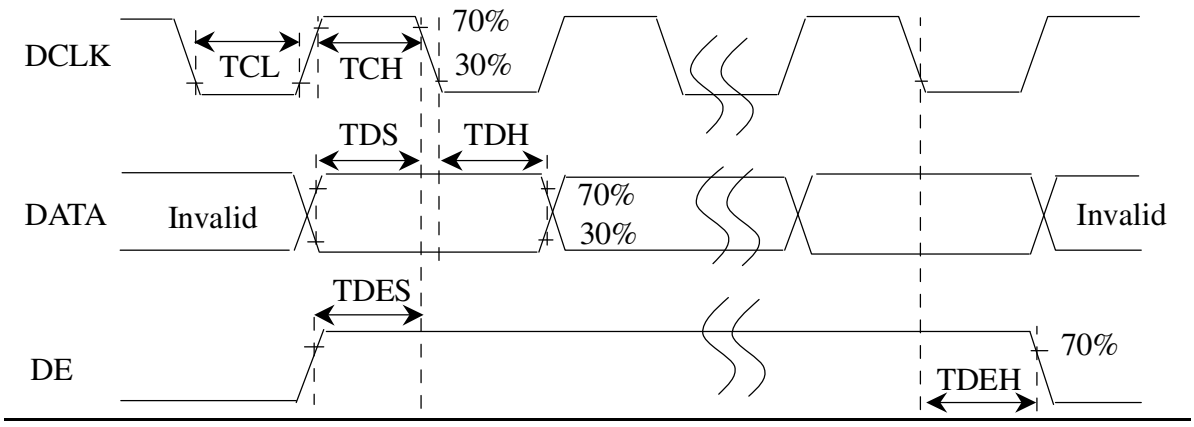
3.4.1.2 Horizontal Timing of Input



3.4.2 Timing Condition

3.4.2.1. Timing Parameters

Parameter		Symbol	Min.	Typ.	Max.	Unit.	Remark
Clock	Frequency	1/Tc	--	9.2	10	MHz	
	High Time	TCH	40	--	--	ns	
	Low Time	TCL	40	--	--	ns	
Data	Setup Time	TDS	10	--	--	ns	
	Hold Time	TDH	3	--	--	ns	
DE	Setup Time	TDES	10	--	--	ns	
	Hold Time	TDEH	3	--	--	ns	
Frame Frequency	Cycle	tv	--	16.7	--	ms	
1 Frame Scanning Time	Cycle	tv	--	288	--	H	
	Display Period	tvd	272			H	
	Front porch	tvf	2	4	--	H	
	Pulse width	tvp	1	10	--	H	
	Back porch	tvb	2	2	--	H	
1 Line Scanning Time	Cycle	th	490	533	545	DCLK	
	Display Period	thd	480			DCLK	
	Front porch	thf	2	8	--	DCLK	
	Pulse width	thp	1	41	--	DCLK	
	Back porch	thb	2	4	--	DCLK	

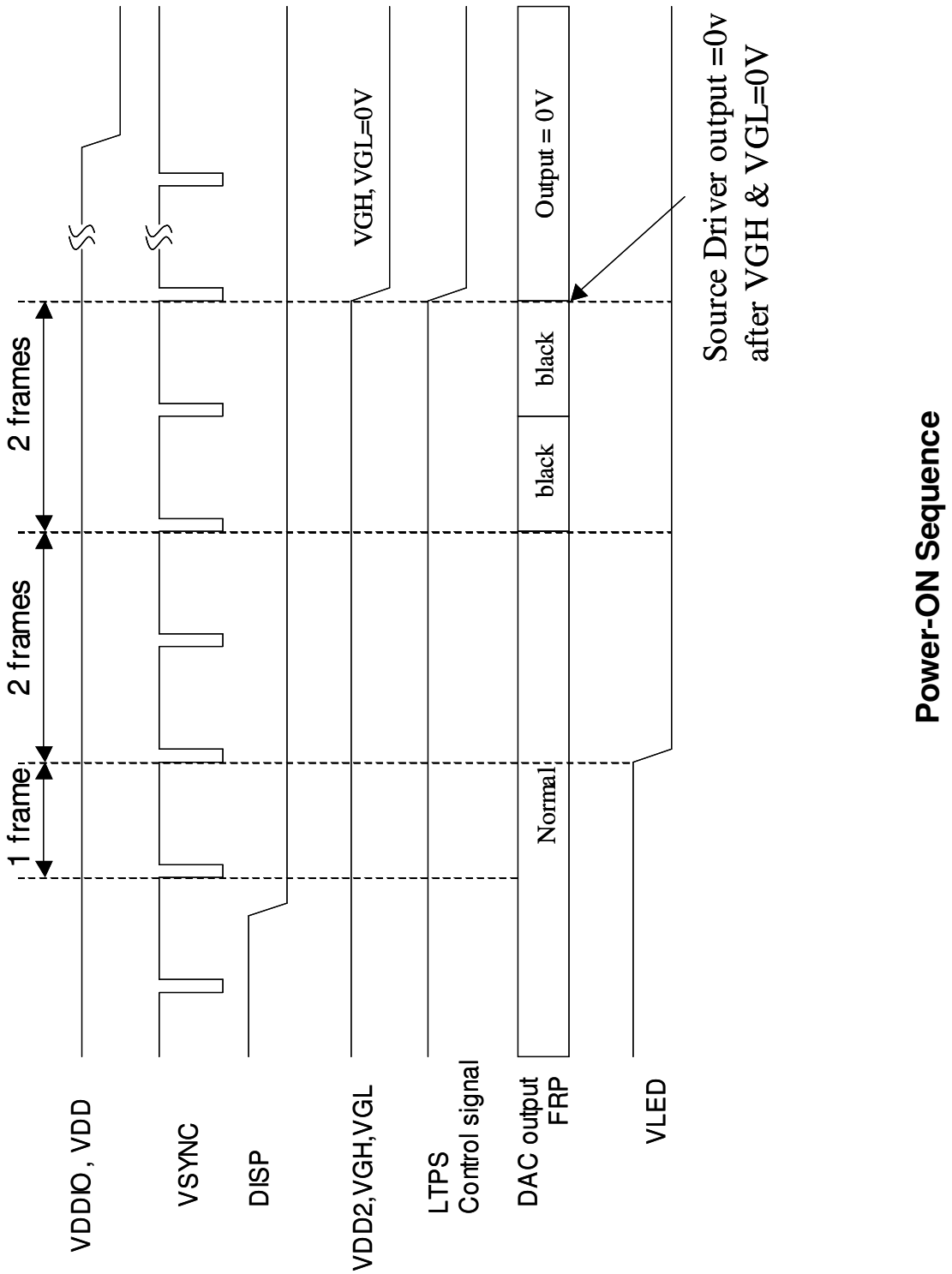


3.5 Power On/Off Sequence

The pin DISP setting of standby mode disabling / enabling is used to control the build-in power on / off sequence.

3.5.1 Power-On (Display ON; Standby Disabling)

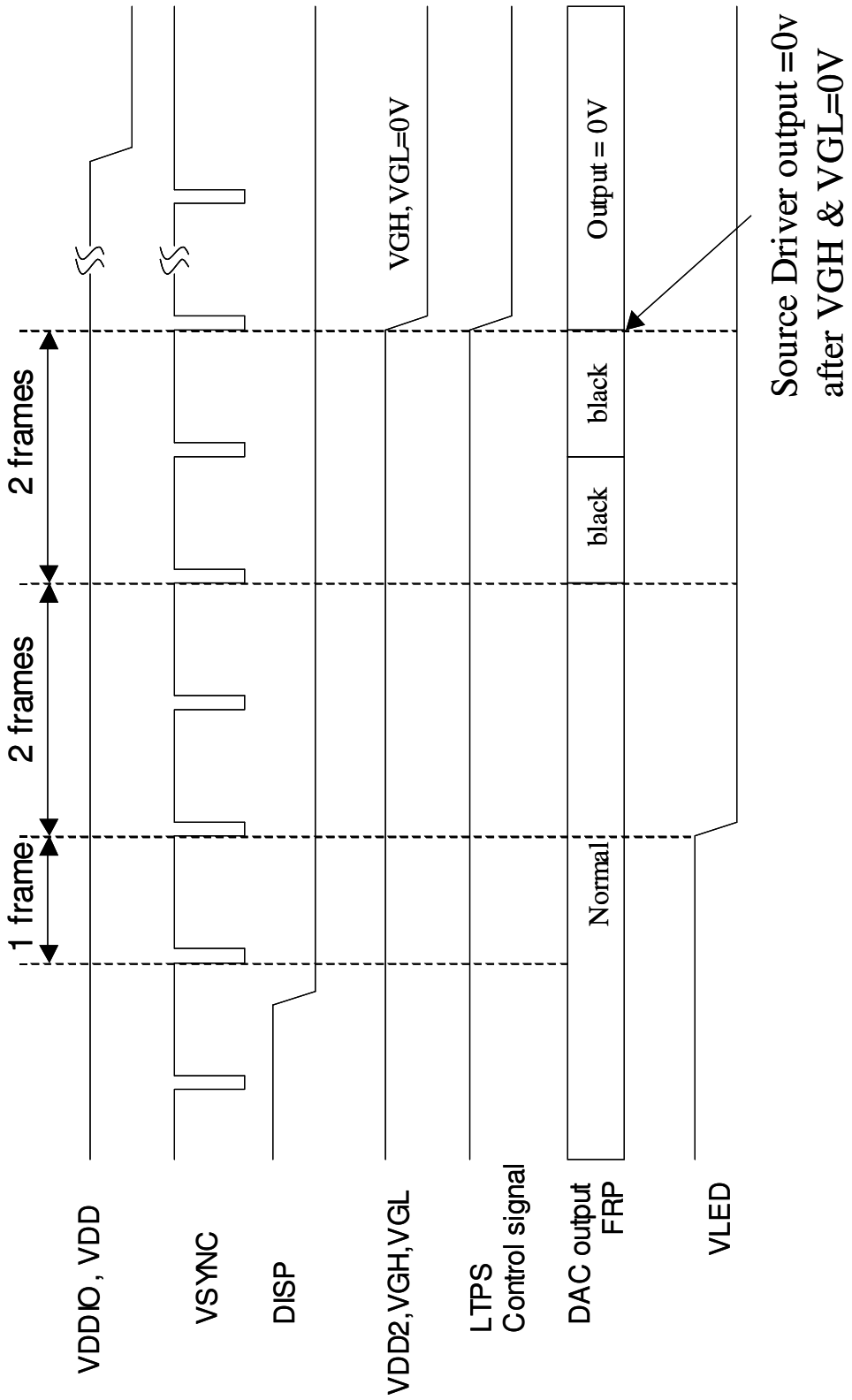
The LCD driver is in default standby mode after VDD/VDDIO power-on, and set the pin DISP to high to disable the standby mode is required for normal operation. When the standby mode is disabled, a build-in power on sequence is started. The driver IC analog power VDD2 is turned on first, and then the LCD positive and negative power supplies VGH/VGL are pumped, and followed by the LED power. Since we recommend using external LED driver, the backlight power should be provided at this time. Please refer to power on sequence for the detail timing.



Power-ON Sequence

3.5.2 Power-Off (Display Off; Standby Enabling)

When DISP is set to low to enable standby mode, a build-in power off sequence is started. Please also refer to the power off sequence for the detail timing.



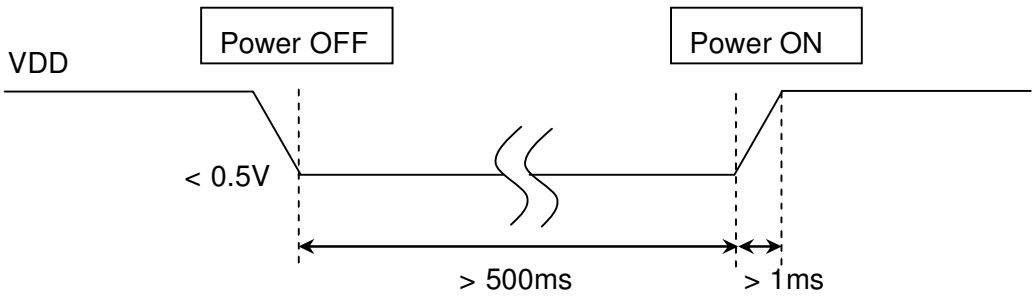
Power-OFF Sequence

3.5.3 Low-voltage reset

Following figure suggests for low voltage reset function on power on sequence. When low voltage reset function enable, all the registers are loaded to default setting.

A. The rising time (10%-90%) of VDD nedds larger than 1ms.

B. After power off, VDD needs to be keep under 0.5V more than 500ms, then it can be power on again.



3.6 Serial Control Setting

3.6.1 Input timing specifications (refer to Fig. 1)

Parameter	Symbol	Min.	Typ.	Max.	Unit.	Remark
Serial load input setup time	t_{s0}	50			ns	
Serial load input hold time	t_{h0}	50			ns	
Serial data input setup time	t_{s1}	50			ns	
Serial data input hold time	t_{h1}	50			ns	
SCL pulse width	t_{WL1}	50			ns	
	t_{WH1}	50			ns	
CS pulse width	t_{W2}	400			ns	

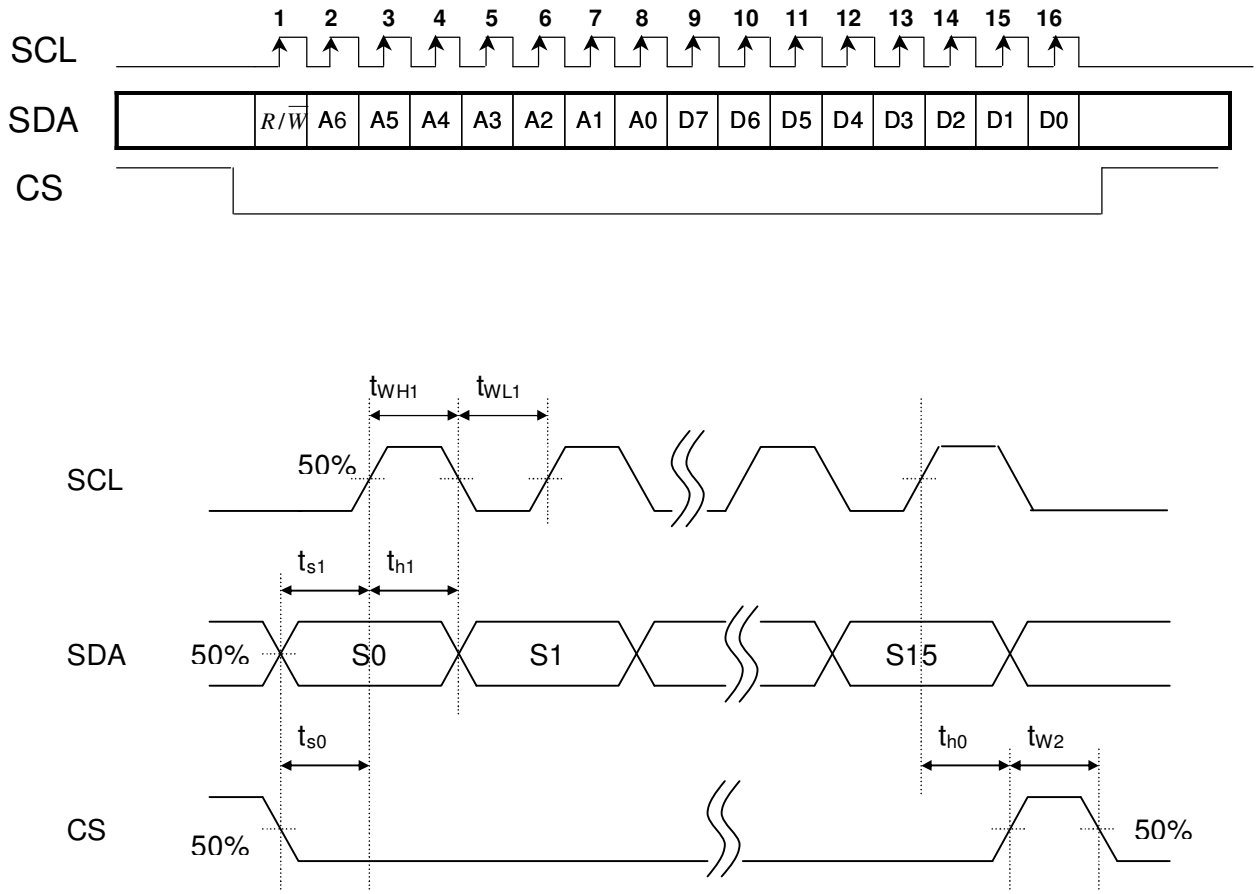


Fig.1 Serial Interface Control Timing

3.6.2 Serial setting table

No	Register Address								Register Data (Default Setting)							
	$R/\overline{W}$	A6	A5	A4	A3	A2	A1	A0	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	0	0	0	0	0	0	0	X	VDIR(1)	HDIR(1)	0	VCOM_AC(0110)			
R1	0	0	0	0	0	0	0	1	0	VCOM_DC(40h)						
R2	0	0	0	0	0	0	1	0	CONTRAST(40h)							
R3	0	0	0	0	0	0	1	1	X	SUB-CONTRAST_R(40h)						
R4	0	0	0	0	0	1	0	0	X	SUB-CONTRAST_B(40h)						
R5	0	0	0	0	0	1	0	1	BRIGHTNESS(40h)							
R6	0	0	0	0	0	1	1	0	X	SUB-BRIGHTNESS_R(40h)						
R7	0	0	0	0	0	1	1	1	X	SUB-BRIGHTNESS_B(40h)						

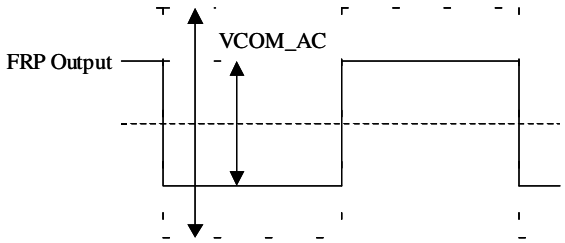
Note: X is “don’t care”. “ ” could be registered by customer.

Register R0

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	00h	X	VDIR	HDIR	0	VCOM_AC			

VCOM_AC : Common voltage AC level selection (deviation ±0.1V)

VCOM_AC				Voltage (V)
D3	D2	D1	D0	
0	0	0	0	5.8
0	0	0	1	5.9
0	0	1	0	6.0
0	0	1	1	6.1
0	1	0	0	6.2
0	1	0	1	6.3
0	1	1	0	6.4 (Default)
0	1	1	1	6.5
1	0	0	0	6.6
1	0	0	1	6.7
1	0	1	0	6.8
1	0	1	1	6.9
1	1	X	X	7.0



Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R0	0	00h	X	VDIR	HDIR	0	VCOM_AC			

HDIR : Horizontal scan direction setting

HDIR	Description
0	Right to left
1	Left to right (Default)

VDIR : Vertical scan direction setting

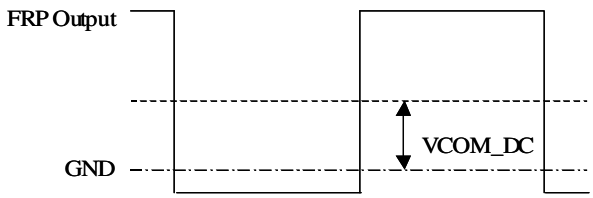
VDIR	Description
0	Down to up
1	Up to down (Default)

Register R1

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R1	0	01h	0	VCOM_DC						

VCOM_DC : Common voltage DC level selection

VCOM_DC D6~D0	Voltage (V)
00h	2
:	:
40h	2.605 (Default)
:	:
7Fh	3.2



Register R2, R3, R4, R5, R6, R7

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R2	0	02h	CONTRAST							

CONTRAST : RGB contrast level setting, the gain changes (1/64) / bit

CONTRAST	Gain
D7~D0	
00h	0
40h	1 (Default)
FFh	3.984

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R3	0	03h	X	SUB-CONTRAST_R						

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R4	0	04h	X	SUB-CONTRAST_B						

SUB-CONTRAST_RB : RB sub-contrast level setting, the gain changes (1/256) / bit

SUB-CONTRAST	Gain
D6~D0	
00h	0.75
40h	1 (Default)
7Fh	1.246

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R5	0	05h	BRIGHTNESS							

BRIGHTNESS : RGB bright level setting, setting accuracy : 1 step / bit

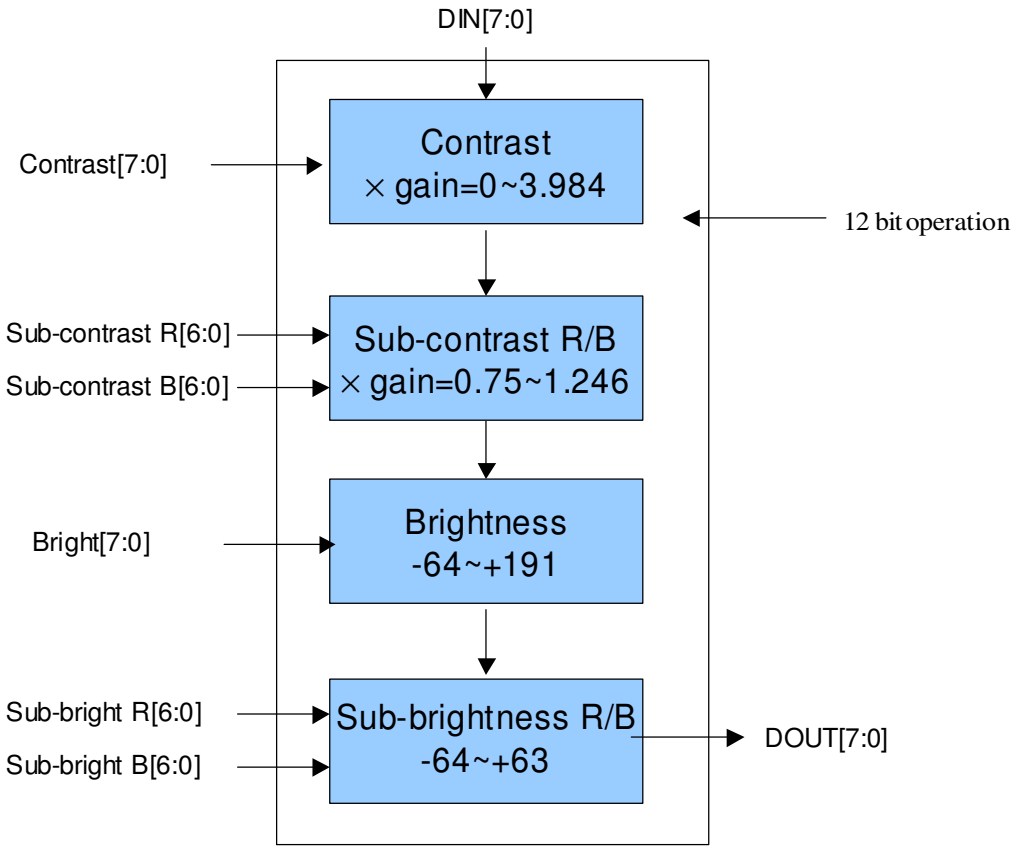
BRIGHTNESS	Setting
D7~D0	
00h	Dark (-64)
40h	Center (0) (Default)
FFh	Bright (+191)

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R6	0	06h	X	SUB-BRIGHTNESS_R						

Register	$R/\overline{W}$	Address	D7	D6	D5	D4	D3	D2	D1	D0
R7	0	07h	X	SUB-BRIGHTNESS_B						

SUB-BRIGHTNESS_RB : RB sub-brightness level setting, setting accuracy : 1 step / bit

SUB-BRIGHTNESS	Setting
D6~D0	
00h	Dark (-64)
40h	Center (0) (Default)
7Fh	Bright (+63)



4. Optical specification

Item	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Response Time							
Rise	Tr	$\theta=0^\circ$	-	20	40	ms	Note 4
Fall	Tf		-	20	40	ms	
Contrast ratio	CR	At optimized viewing	-	500	-		Note 6, 7
Viewing Angle							
Top			70	80	-		
Bottom		CR≧10	70	80	-	deg.	Note 8
Left			70	80	-		
Right			70	80			
Brightness	Y_L	$\theta=0^\circ$	190	300	-	cd/m^2	Note 9
White Chromaticity	X	$\theta=0^\circ$	0.26	0.31	0.36		
	y	$\theta=0^\circ$	0.29	0.34	0.39		

Note 1: Measurement is in the dark room, optical ambient temperature =25℃, and backlight current I_L=20 mA

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-7, 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.

Note 5. From liquid crystal characteristics, response time will become slower and the color of panel will become darker when ambient temperature is below 25℃.

Note 6. Definition of contrast ratio:

Contrast ratio is calculated with the following formula.

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

Note 7. White $Vi=V_{i50} \overline{+} 1.5V$

Black $Vi=V_{i50} \pm 2.0V$

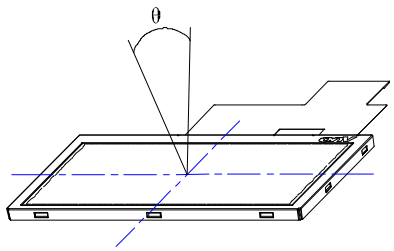
“±” means that the analog input signal swings in phase with COM signal.

“$\overline{+}$” means that the analog input signal swings out of phase with COM signal.

V_{i50} : The analog input voltage when transmission is 50%

The 100% transmission is defined as the transmission of LCD panel when all the input terminals of module are electrically opened.

Note 8. Definition of viewing angle: refer to figure as below. Measure viewing angle by machine Eldim.



Note 9. Measured at the center area of the panel when all the input terminals of LCD panel are electrically opened.

5. Touch Screen Panel Specifications

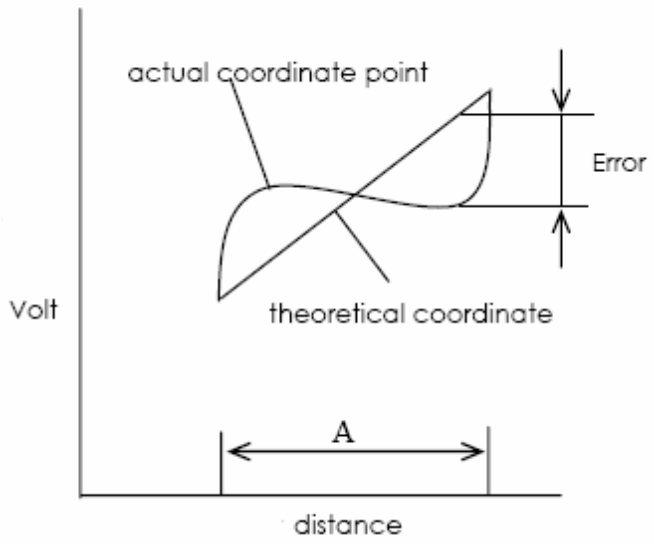
5.1 FPC Pin Assignment

Pin No.	Symbol	I/O
1	TP_R	O
2	TP_B	O
3	TP_L	O
4	TP_U	O

5.2 Electrical Characteristics

Item		Min.	Max.	Unit	Remark
Rate DC Voltage			7	V	
Resistance	X (Film)	500	1500	Ω	At connector
	Y (Glass)	200	900		
Linearity		-1.5%	1.5%	--	Note 1
Response Time			20	ms	
Insulation Resistance		20		MΩ	DC 25V

Note 1: Measurement condition of Linearity: difference between actual voltage & theoretical voltage is an error at any points. Linearity is the value max. error voltage divided by voltage difference on active area.

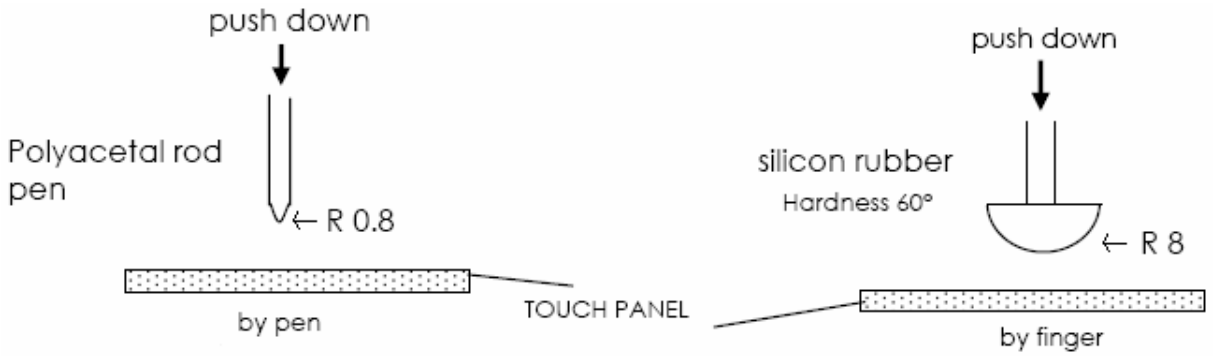


5.3 Mechanical Characteristics

Item	Min.	Max.	Unit	Remark
Hardness of Surface	3	--	H	JIS K-5400
Operation Force (Pen or Finger)	--	100	gf	Note 1, 2

Note 1: Within ”guaranteed active area”, but not on the edge and dot-spacer.

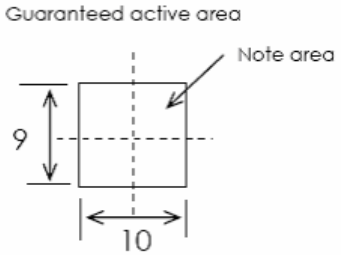
Note 2: Measurement condition of Operation Force: Within ”guaranteed active area”. Resistance, Insulation resistance, and operation force should be under **5.2** & **5.3** condition. When user pushes down on the film, resistance between X & Y axis must be equal or lower than 2kΩ. Below is test figure.



5.4 Life test Condition

Item	Min.	Max.	Unit	Remark
Notes Life	10^5	--	words	Note 1, 2
Input Life	10^6	--	times	Note 1, 3

Note 2: Notes Life test condition (by pen): Notes area for pen notes life test is 10×9 mm. Size of word is 7.5×6.75mm. Word is any A.B.C….. letter. Writing speed is 60mm/s. Center of each word is changed at random in notes area.

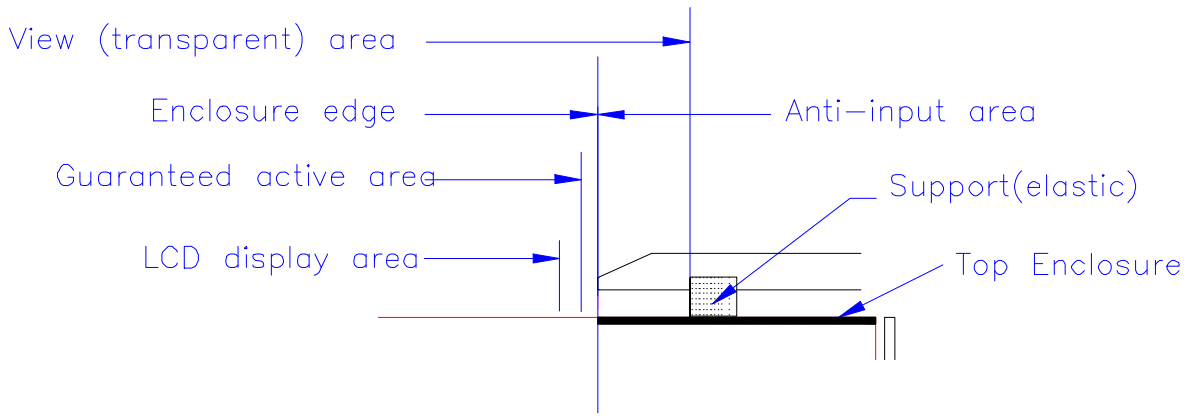


Note 3: Input Life test condition(by finger): By silicone rubber tapping at same point. Tapping Load is 200g, and tapping frequency is 5Hz.

5.5 Attention

Please pay attention for below matters at mounting design of touch panel of LCD module.

1) Do not design enclosure pressing the view area to prevent from miss input.
2) Enclosure support must not touch with view area.
3) Use elastic or non-conductive material to enclosure touch panel.
4) Do not bond film of touch panel with enclosure.
5) The touch panel edge is conductive. Do not touch it with any conductive part after mounting.
6) If user wants to cleaning touch panel by air gun, pressure 2kg/cm^2 below is suggested. Not to blow glass from FPC site to prevent FPC peeled off.



7) Do not put a heavy shock or stress on touch panel and film surface. Ex. Don't lift the panel by film face with vacuum.
8) Do not lift LCD module by FPC.
9) Please use dry cloth or soft cloth with neutral detergent (after wring dry) or one with ethanol at cleaning. Do not use any organic solvent, acid or alkali liquor.
10) Do not pile touch panel. Do not put heavy goods on touch panel.

6. Absolute Ratings of Ambient Environment

No.	Test items	Conditions	Remark
1	High Temperature Storage	Ta= 80℃ 240Hrs	
2	Low Temperature Storage	Ta= -25℃ 240Hrs	
3	High Ttemperature Operation	Ta= 70℃ 240Hrs	
4	Low Temperature Operation	Ta= -10℃ 240Hrs	
5	High Temperature & High	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	Non-operation
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
9	Mechanical Shock	100G . 6ms, ±X,±Y,±Z 3 times for each direction	Non-operation JIS C7021, A-7 condition C
10	Vibration (With Carton)	Random vibration: $0.015G^2$/Hz from 5~200Hz –6dB/Octave from 200~500Hz	IEC 68-34
11	Drop (With Carton)	Height: 60cm 1 corner, 3 edges, 6 surfaces	

Note 1 : Ta: Ambient Temperature.

Note 2: In the standard condition, there is not display function NG issue occurred. All the cosmetic specification is judged before the reliability stress.

7. Packing Form

TBD