



# PHOENIX DISPLAY INTERNATIONAL, INC.

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## PHOENIX DISPLAY INTERNATIONAL, INC SPECIFICATION FOR LCD MODULE

<b>CUSTOMER</b>	
<b>PART NUMBER</b>	PDI022TC-T01
<b>DESCRIPTION</b>	2.2" TFT 240 x 320
<b>VERSION</b>	
<b>ISSUE DATE</b>	

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## 1 General specifications

Feature		Spec
<b>Display Spec.</b>	Size	2.2 inch
	Resolution	240(RGB) X 320
	Interface	RGB 18 bits+3SPI
	Color Depth	262K
	Technology type	a-si TFT
	Pixel pitch (mm)	0.141x0.141
	Pixel Configuration	R.G.B. Vertical Stripe
	Display Mode	ECB Transflective
	Surface Treatment(Up Polarizer)	Clear type (3H)
	Surface Treatment	Clear type (3H)
Viewing Direction	6 o'clock	
<b>Mechanical Characteristics</b>	DIM. LCM (W x H x D) (mm)	40.6x56.6x2.7
	Active Area(mm)	33.84 x45.12
	With /Without TSP	Without TSP
	IC	ILI9340
	Weight (gram)	12.74
	LED Numbers	4 LEDs (serial)

Note 1 : Requirements on Environmental Protection: Q/S0002

## 2 Input/Output terminals

### 2.1 TFT LCD Panel

Recommended connector: FH23-39S-0.3SHW (HIROSE)

No	Symbol	I/O	Description	Remarks
1	VL1 (LED+)	I	Power supply for LED(High voltage)	
2	VL2 (LED-)	I	Power supply for LED(Low voltage)	
3	GND	P	Ground	
4	VDD	P	Power supply of gate driver(high level)	
5	GND	P	Ground	
6	VSYNC	I	Vertical sync. signal	
7	RESET	I	Reset Enable	
8	GND	P	Ground	
9	CS	I	SPI Chip select	
10	SDO	O	SPI serial Data output	
11	SDI	I	SPI serial Data input	
12	GND	P	Ground	
13	SCL	I	SPI serial interface clock	
14	GND	P	Ground	
15	B5	I	Blue data signal	
16	B4	I	Blue data signal	
17	B3	I	Blue data signal	
18	B2	I	Blue data signal	
19	B1	I	Blue data signal	
20	B0	I	Blue data signal	
21	ENABLE	I	Data enable signal	
22	HSYNC	I	Horizontal sync signal	
23	GND	P	Ground	
24	DCLK	I	Data sampling clock signal	
25	GND	P	Ground	
26	G5	I	Green data signal	
27	G4	I	Green data signal	
28	G3	I	Green data signal	
29	G2	I	Green data signal	
30	G1	I	Green data signal	
31	G0	I	Green data signal	
32	GND	P	Ground	
33	R5	I	Red data signal	
34	R4	I	Red data signal	
35	R3	I	Red data signal	
36	R2	I	Red data signal	
37	R1	I	Red data signal	
38	R0	I	Red data signal	
39	GND	P	Ground	

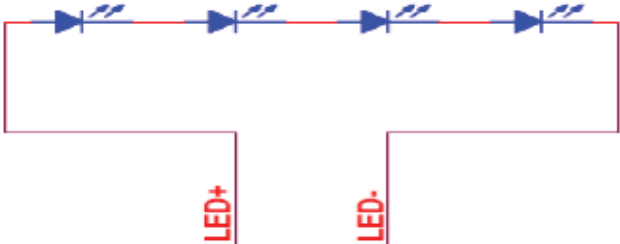
Note2-1: I/O definition:

I----Input

O---Output

P----Power

Note 2-2: The figure below shows the connection of backlight LED.



### 3 Absolute maximum ratings

#### 3.1 Driving TFT LCD Panel

(VSS=0, Ta = 25°C)

Item	Symbol	MIN	MAX	Unit	Remark
Logic Supply Voltage	VDD	-0.3	4.6	V	
Input Signal Voltage	R0~R5,G0~G5,B0~B5, ENABLE,DCLK,HSYNC, VSYNC,/CS,SCL,SDI,SDO/RESET	-0.3	VCC +0.5	V	
Back Light Forward Current	I <sub>LED</sub>	--	25	mA	
Operating Temperature	T <sub>OPR</sub>	-20	70	°C	
Storage Temperature	T <sub>STG</sub>	-30	80	°C	

## 4 Electrical characteristics

### 4.1 Driving TFT LCD Panel

(VSS=0, Ta=25°C)

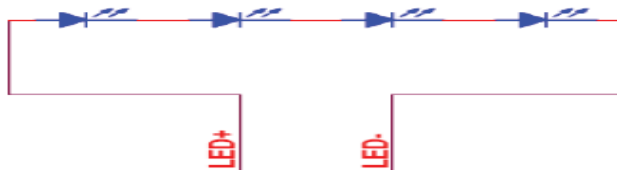
Parameter	Symbol	MIN	TYP	MAX	Unit	Remark
Digital supply Voltage	VDD	2.5	2.8	3.3	V	
Input Signal Voltage	Low Level	VIL	VSS	-	0.2xVDD	R0~R5,G0~G5,B0~B5, ENABLE,DCLK,HSYNC, VSYNC,/CS,SCL,SDI,SDO/RESET
	High Level	VIH	0.8xVDD	-	VDD	
Output Signal Voltage	Low Level	VOL	VSS	-	0.3xVDD	Output Signal Voltage
	High Level	VOH	0.7xVDD	-	VDD	
Current of VDD Power supply	I <sub>CC</sub>	-	10	-	mA	Note 1

Note1: To test the current dissipation, use "all Black Pattern".

### 4.2 Driving Backlight Ta=25°C

Item	Symbol	MIN	TYP	MAX	Unit	Remark
Forward Current	I <sub>F</sub>		20	--	mA	4 LEDs serial
Forward Voltage	V <sub>F</sub>	--	12.8		V	
Power Consumption	W <sub>BL</sub>	--	256	--	mW	
Operating Life Time	-	10000	(20000)	-	Hrs	

Note1: Figure below shows the connection of backlight LED.



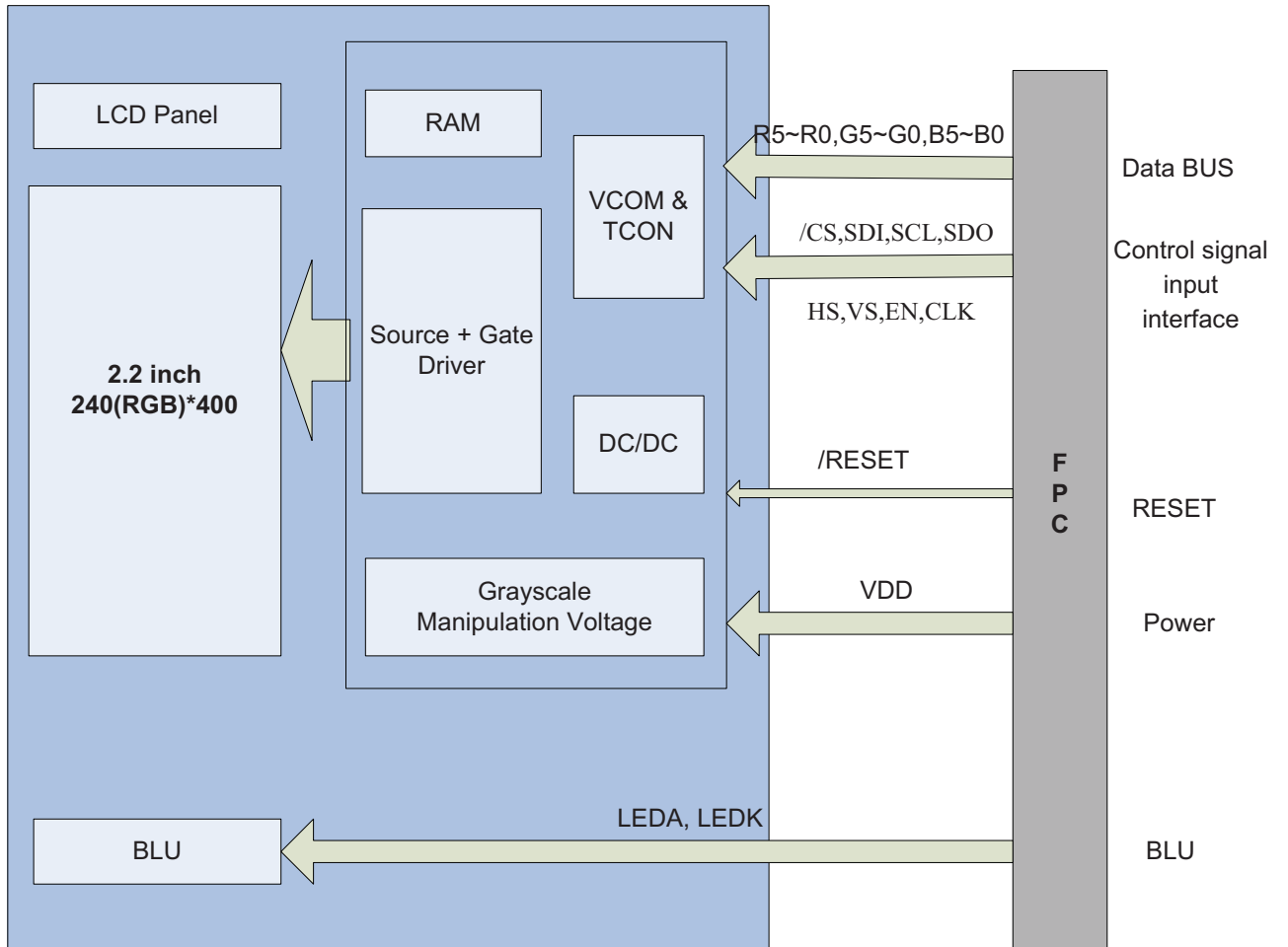
Note 2: One LED: I<sub>F</sub> =20 mA, V<sub>F</sub> =12.8V

Note 3: : I<sub>F</sub> is defined for one channel LED.

Optical performance should be evaluated at Ta=25°C only.

If LED is driven by high current, high ambient temperature & humidity condition. The life time of LED will be reduced. Operating life means brightness goes down to 50% initial brightness. Typical operating life time is estimated data.

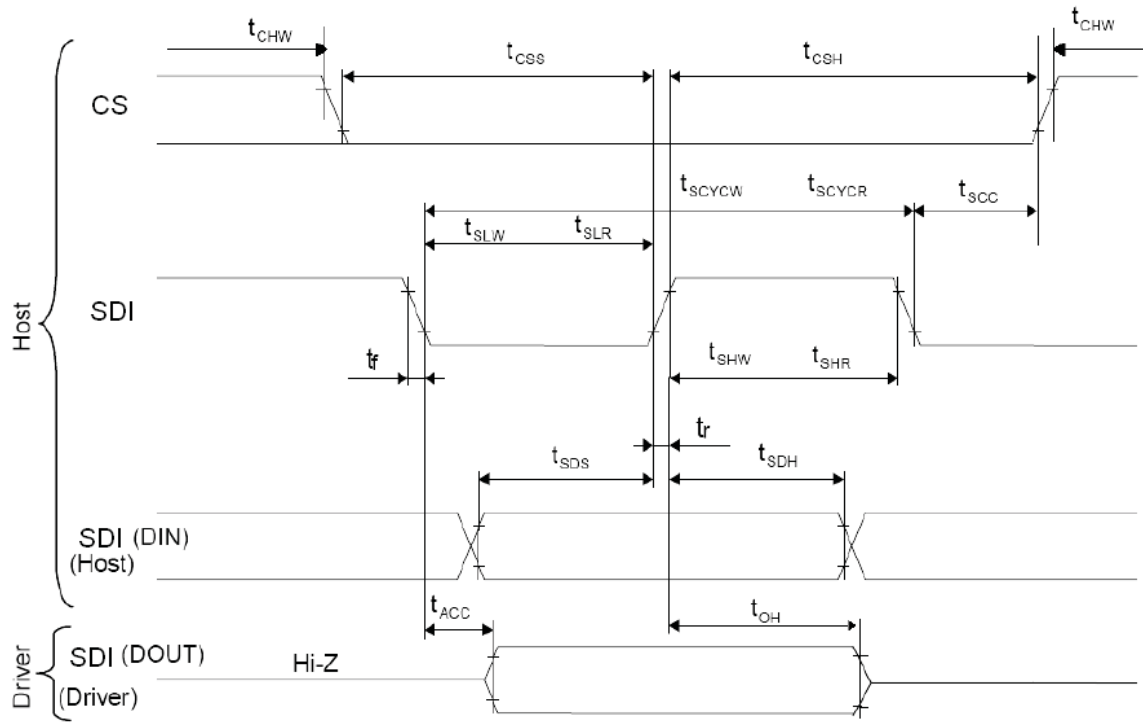
4.3 Block Diagram





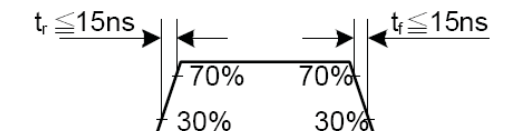
## 5 Timing chart

### 5.1 3wire INTERFACE CHARACTERISTICS

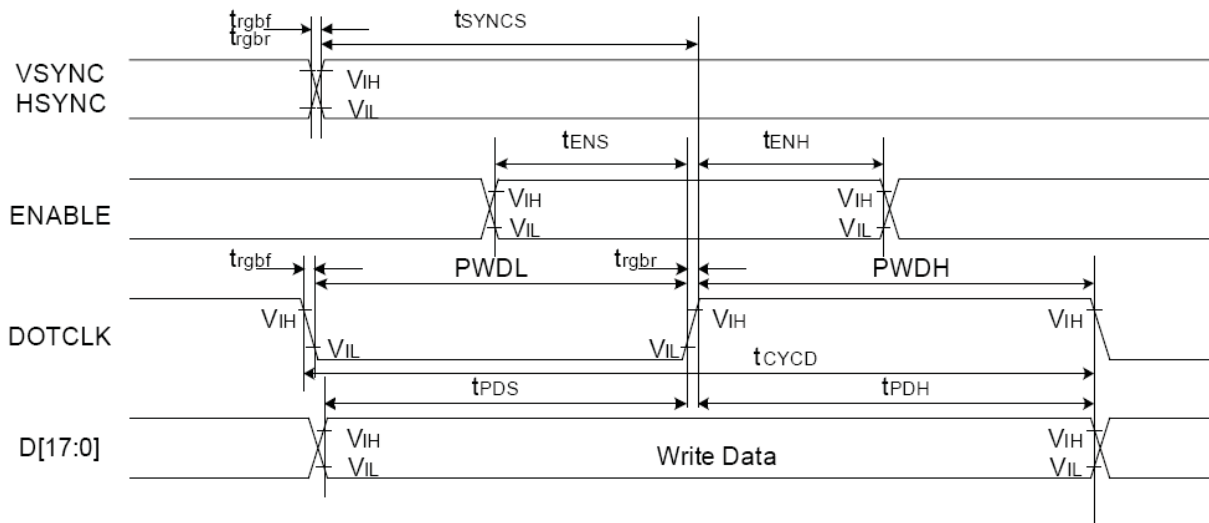


Signal	Symbol	Parameter	min	max	Unit	Description
SCL	tscycw	Serial Clock Cycle (Write)	100	-	ns	
	tshw	SCL "H" Pulse Width (Write)	40	-	ns	
	tslw	SCL "L" Pulse Width (Write)	40	-	ns	
	tscycr	Serial Clock Cycle (Read)	150	-	ns	
	tshr	SCL "H" Pulse Width (Read)	60	-	ns	
	tslr	SCL "L" Pulse Width (Read)	60	-	ns	
SDA / SDI (Input)	tsds	Data setup time (Write)	30	-	ns	
	tsdh	Data hold time (Write)	30	-	ns	
SDA / SDO (Output)	tacc	Access time (Read)	10	-	ns	
	toh	Output disable time (Read)	10	50	ns	
CS	tsc	SCL-CSX	20	-	ns	
	tch	CSX "H" Pulse Width	40	-	ns	
	tcs	CSX-SCL Time	60	-	ns	
	tcs		65	-	ns	

Note:  $T_a = 25\text{ }^\circ\text{C}$ ,  $V_{DDI}=1.65\text{V to }3.3\text{V}$ ,  $V_{CI}=2.5\text{V to }3.3\text{V}$ ,  $AGND=V_{SS}=0\text{V}$

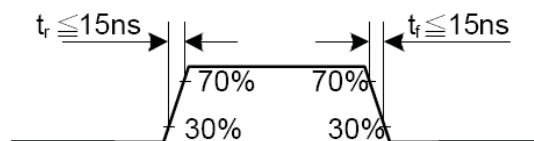


## 5.2 Parallel 18/16/6-bit RGB Interface Timing Characteristics

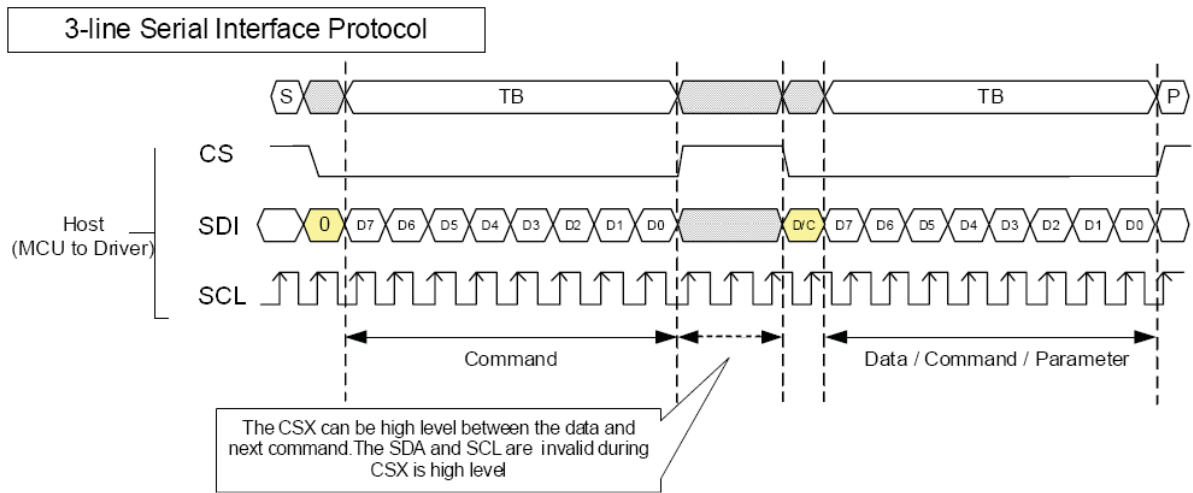


Signal	Symbol	Parameter	min	max	Unit	Description
VSYNC / HSYNC	$t_{SYNCS}$	VSYNC/HSYNC setup time	15	-	ns	18/16-bit bus RGB interface mode
	$t_{SYNCH}$	VSYNC/HSYNC hold time	15	-	ns	
DE	$t_{ENS}$	DE setup time	15	-	ns	
	$t_{ENH}$	DE hold time	15	-	ns	
D[17:0]	$t_{POS}$	Data setup time	15	-	ns	
	$t_{PDH}$	Data hold time	15	-	ns	
DOTCLK	PWDH	DOTCLK high-level period	15	-	ns	
	PWDL	DOTCLK low-level period	15	-	ns	
	$t_{CYCD}$	DOTCLK cycle time	100	-	ns	
	$t_{rgr}, t_{rgbr}$	DOTCLK,HSYNC,VSYNC rise/fall time	-	15	ns	
VSYNC / HSYNC	$t_{SYNCS}$	VSYNC/HSYNC setup time	15	-	ns	6-bit bus RGB interface mode
	$t_{SYNCH}$	VSYNC/HSYNC hold time	15	-	ns	
DE	$t_{ENS}$	DE setup time	15	-	ns	
	$t_{ENH}$	DE hold time	15	-	ns	
D[17:0]	$t_{POS}$	Data setup time	15	-	ns	
	$t_{PDH}$	Data hold time	15	-	ns	
DOTCLK	PWDH	DOTCLK high-level pulse period	15	-	ns	
	PWDL	DOTCLK low-level pulse period	15	-	ns	
	$t_{CYCD}$	DOTCLK cycle time	100	-	ns	
	$t_{rgr}, t_{rgbr}$	DOTCLK,HSYNC,VSYNC rise/fall time	-	15	ns	

Note:  $T_a = -30$  to  $70$  °C,  $V_{DDI}=1.65V$  to  $3.3V$ ,  $V_{CI}=2.5V$  to  $3.3V$ ,  $AGND=V_{SS}=0V$

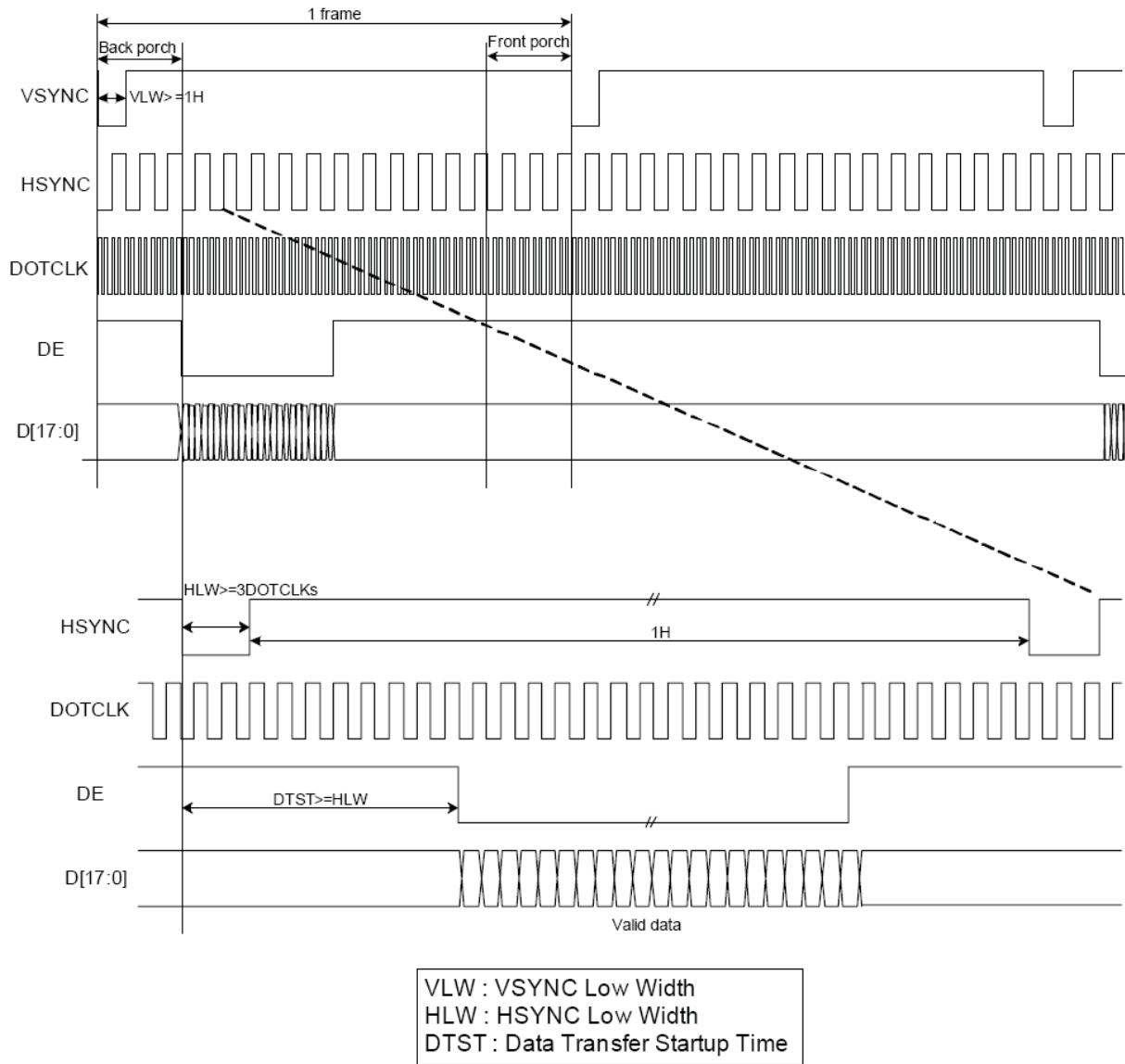


### 5.3 3-line Serial Interface Protocol



## 5.4 RGB Interface Timing

The timing chart of 18-/16-bit RGB interface mode is shown as below

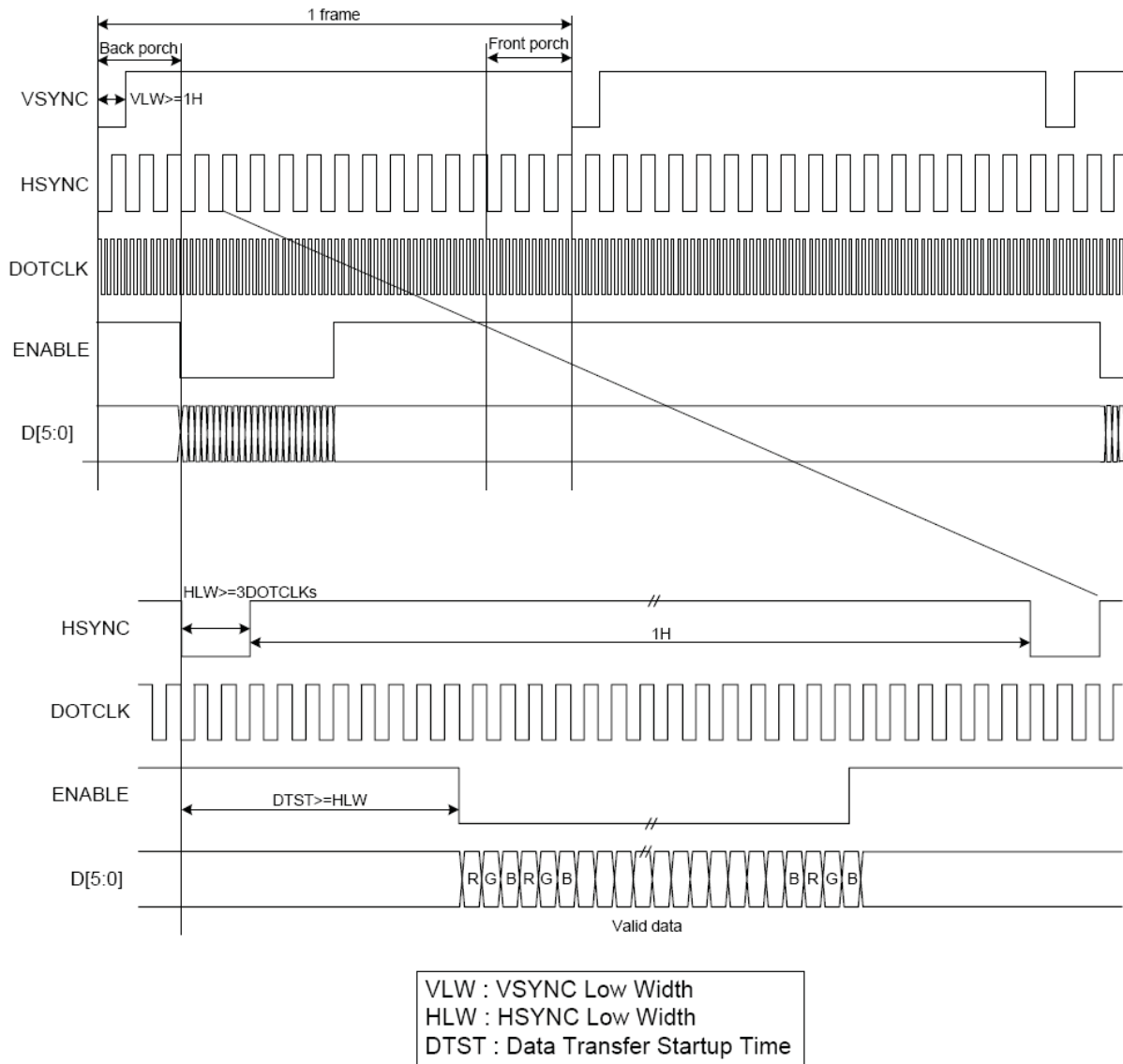


Note 1: The DE signal is not needed when RGB interface SYNC mode is selected.

Note 2: VSPL='0', HSPL='0', DPL='0' and EPL='1' of "Interface Mode Control (B0h)" command.

Fig.5-3 RGB Interface Timing

The timing chart of 6-bit RGB interface mode is shown as below:



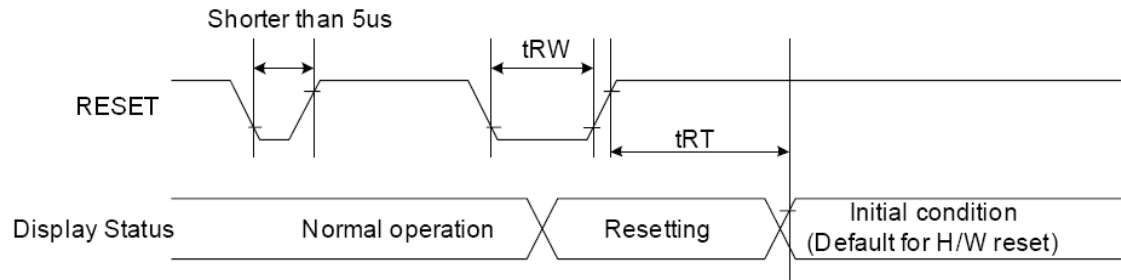
Note 1: The DE signal is not needed when RGB interface SYNC mode is selected.

Note 2: VSPL='0', HSPL='0', DPL='0' and EPL='1' of "Interface Mode Control (B0h)" command.

Note 3: In 6-bit RGB interface mode, each dot of one pixel (R, G and B) is transferred in synchronization with DOTCLK.

Note 4: In 6-bit RGB interface mode, set the cycles of VSYNC, HSYNC and DE to 3 multiples of DOTCLK.

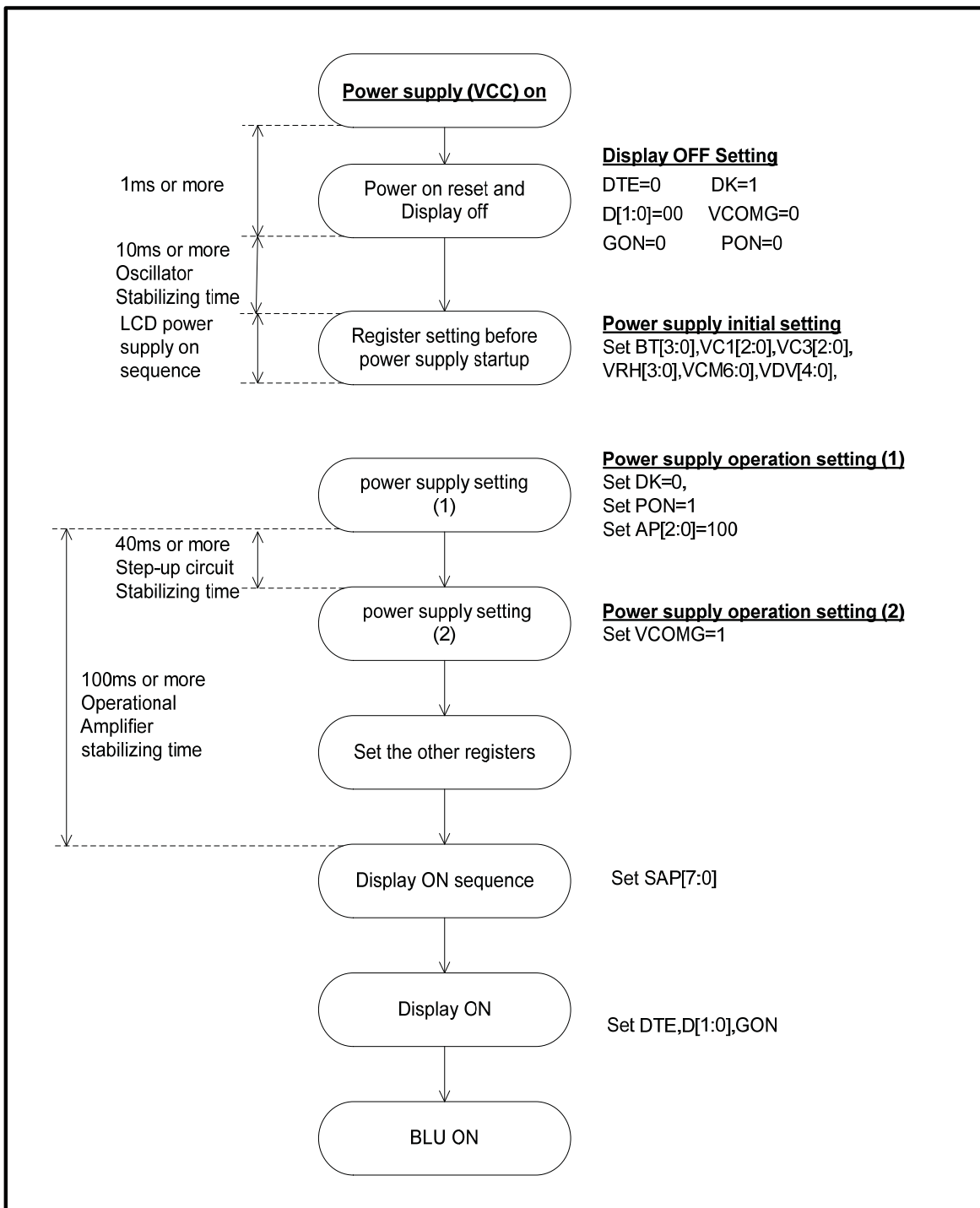
## 5.5 Reset Timing



Signal	Symbol	Parameter	Min	Max	Unit
RESET	$t_{RW}$	Reset pulse duration	10		$\mu\text{S}$
	$t_{RT}$	Reset cancel		5	mS
				120	mS

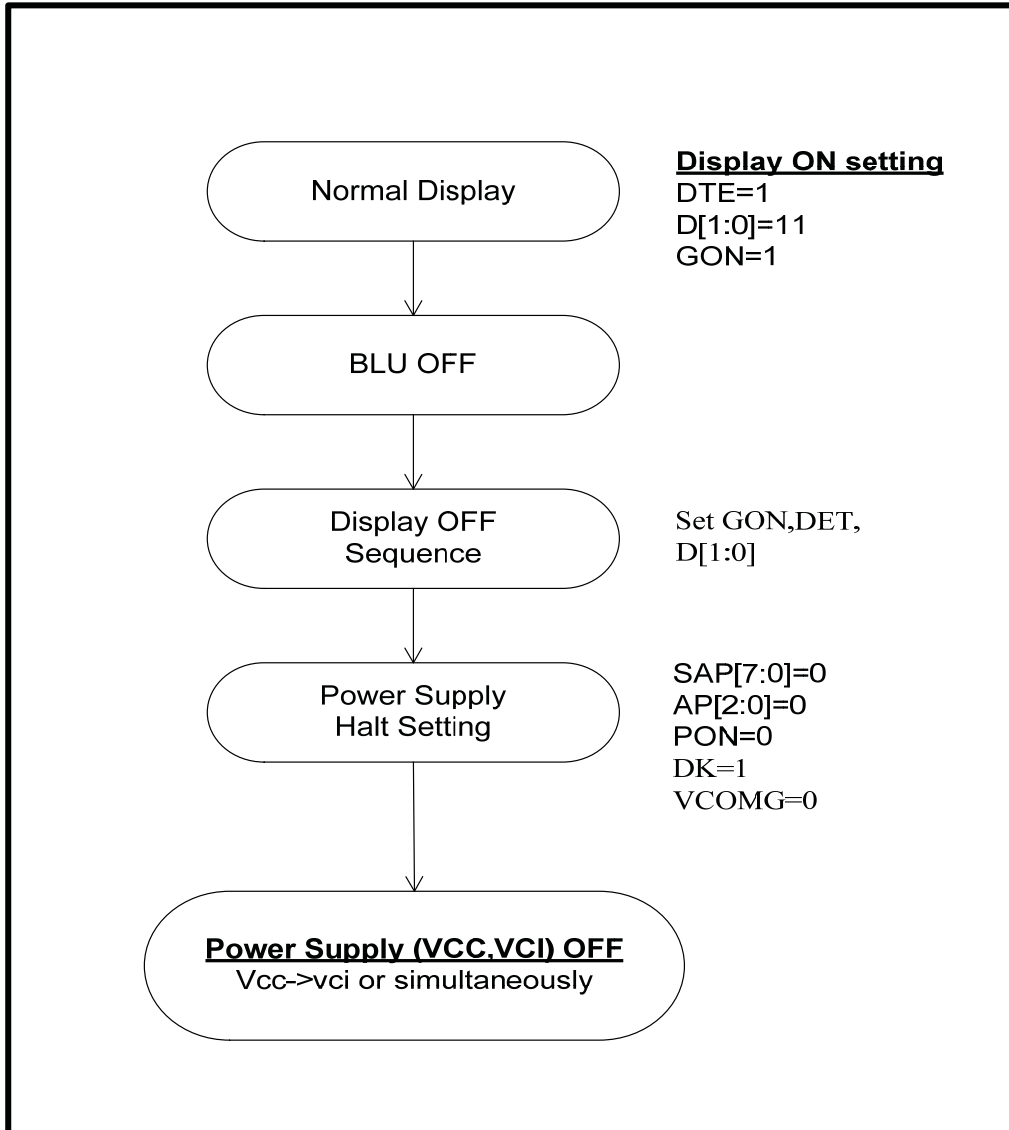
## 5.4 Power on/off Sequence

### 5.4.1 Power on Sequence



Power On Sequence

## 5.4.2 Power off Sequence



Power OFF Sequence



## 6 Optical characteristics

### 6.1 Optical Specification

Ta=25°C

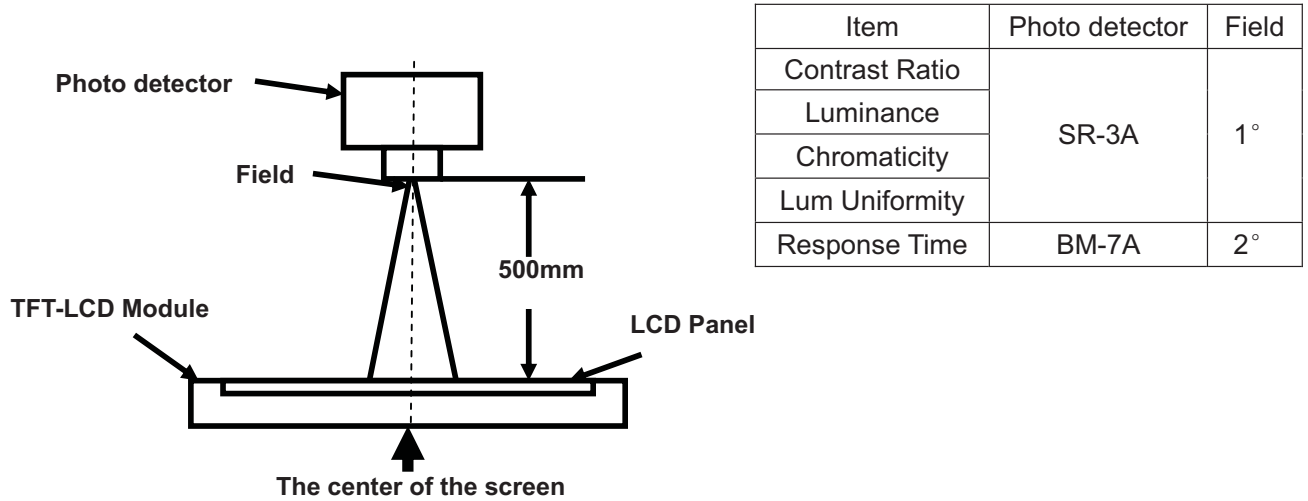
Item	Symbol	Condition	Min	Typ.	Max.	Unit	Remark
View Angles	$\Theta T$	$CR \geq 10$	--	48	53	Degree	Note 2
	$\Theta B$		--	45	50		
	$\Theta L$		--	40	45		
	$\theta R$		--	45	50		
Contrast Ratio	CR	$\theta = 0^\circ$	100	120	-		Note1 Note3
Response Time	Ton	25°C	-	35		ms	Note1 Note4
	Toff						
Chromaticity	White	Brightness is on		0.31			Note5, Note1
				0.30			
Uniformity	U			80	-	%	Note1 Note6
NTSC			-	30	-	%	Note 5
Luminance	L		80	90	-	cd/m <sup>2</sup>	Note1 Note7
Reflectance				6.8		%	Note8

Test Conditions:

1. VDD=2.8V, I<sub>L</sub>=20mA( One LED current), the ambient temperature is 25°C.
2. The test systems refer to Note 1 , Note 2 and Note 8.

Note 1: Definition of optical measurement system.

The optical characteristics should be measured in dark room. After 5 minutes operation, the optical properties are measured at the center point of the LCD screen. All input terminals LCD panel must be ground when measuring the center area of the panel.



Note 2: Definition of viewing angle range and measurement system.

viewing angle is measured at the center point of the LCD by CONOSCOPE(ergo-80).

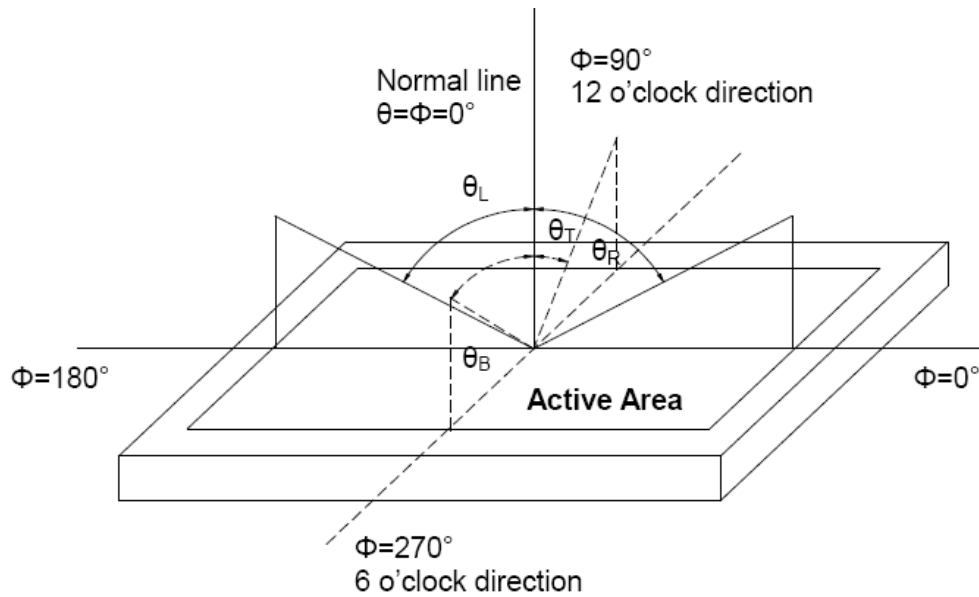


Fig. 1 Definition of viewing angle

### Note 3: Definition of contrast ratio

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance measured when LCD is on the "White" state}}{\text{Luminance measured when LCD is on the "Black" state}}$$

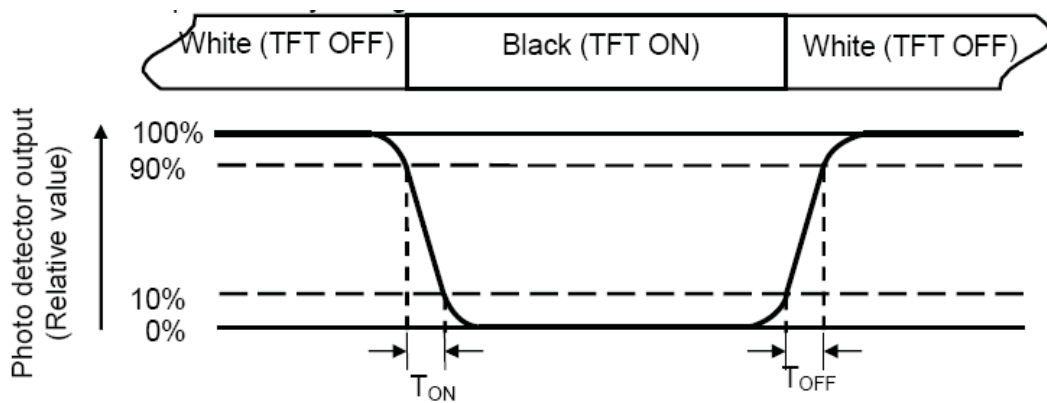
“White state “:The state is that the LCD should driven by  $V_{\text{white}}$ .

“Black state”: The state is that the LCD should driven by  $V_{\text{black}}$ .

$V_{\text{white}}$ : To be determined     $V_{\text{black}}$ : To be determined.

### Note 4: Definition of Response time

The response time is defined as the LCD optical switching time interval between “White” state and “Black” state. Rise time ( $T_{\text{ON}}$ ) is the time between photo detector output intensity changed from 90% to 10%. And fall time ( $T_{\text{OFF}}$ ) is the time between photo detector output intensity changed from 10% to 90%.



### Note 5: Definition of color chromaticity (CIE1931)

Color coordinates measured at center point of LCD.

### Note 6: Definition of Luminance Uniformity

Active area is divided into 9 measuring areas (Refer Fig. 2). Every measuring point is placed at the center of each measuring area.

$$\text{Luminance Uniformity}(U) = L_{\min} / L_{\max}$$

L-----Active area length W----- Active area width

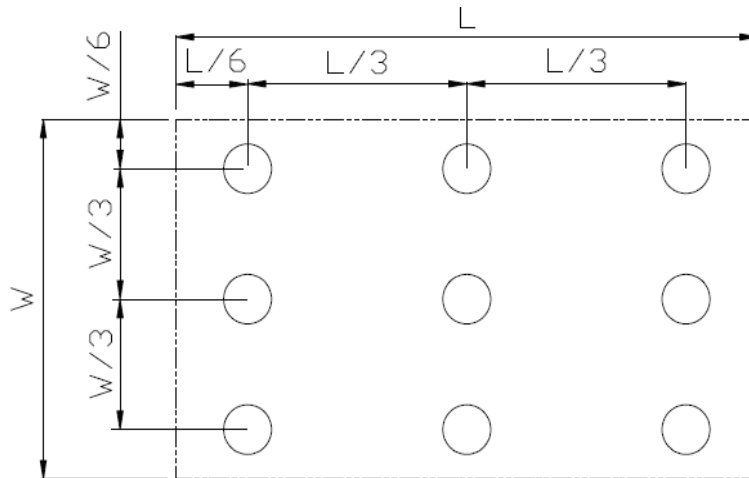


Fig. 2 Definition of uniformity

$L_{\max}$ : The measured maximum luminance of all measurement position.

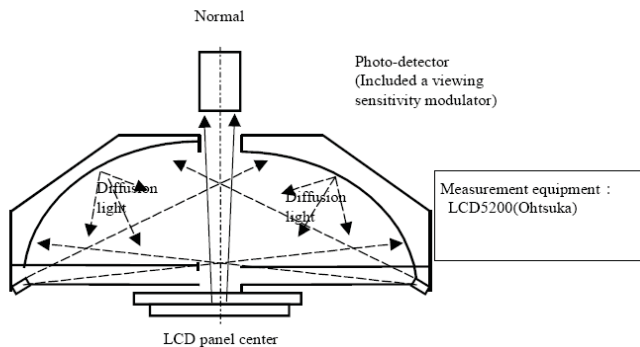
$L_{\min}$ : The measured minimum luminance of all measurement position.

### Note 7: Definition of Luminance :

Measure the luminance of white state at center point.

### Note 8: Definition of Reflectance measurement system

Note 5) Reflectance is defined as follows:



## 7 Environmental / Reliability tests

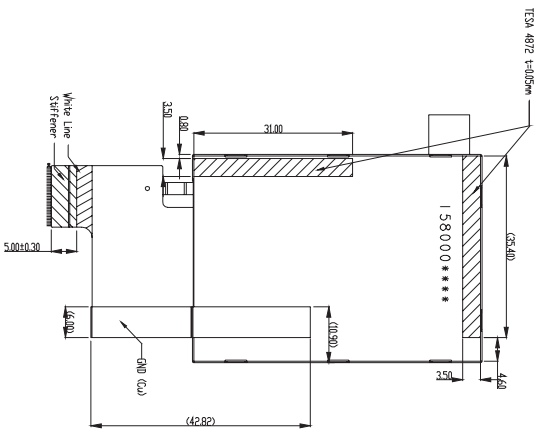
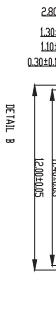
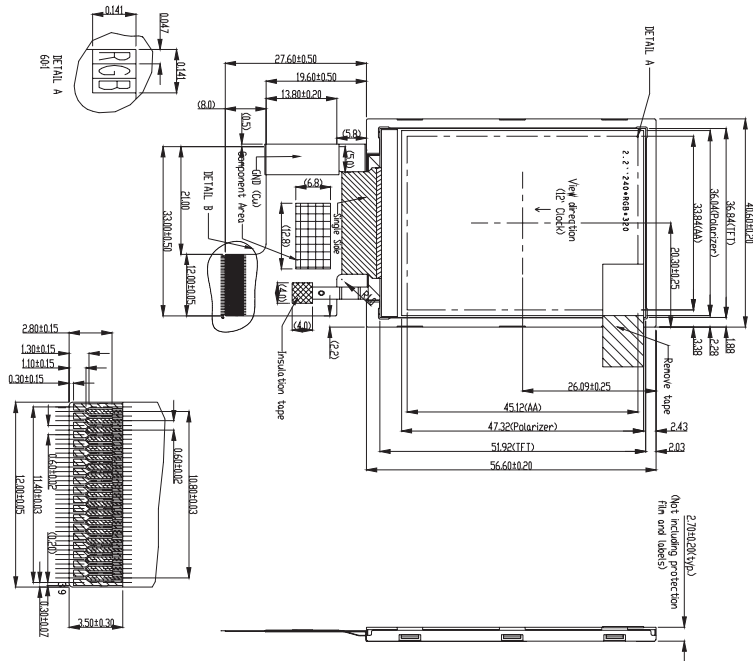
No	Test Item	Condition	Remarks
1	High Temperature Operation	Ts=+70°C, 240hrs	Note1 IEC60068-2-2,GB2423.2—89
2	Low Temperature Operation	Ta=-20°C, 240hrs	IEC60068-2-1 GB2423.1—89
3	High Temperature Storage	Ta=+80°C, 240hrs	IEC60068-2-2, GB2423.2—89
4	Low Temperature Storage	Ta=-30°C, 240hrs	IEC60068-2-1 GB2423.1—89
5	High Temperature & High Humidity Storage	+60°C, 90% RH max,240 hours	Note2 IEC60068-2-3, GB/T2423.3—2006
6	Thermal Shock (Non-operation)	-30°C 30 min~+80°C 30 min, Change time:5min, 20 Cycle	Start with cold temperature, End with high temperature, IEC60068-2-14,GB2423.22—87
7	Electro Static Discharge (Operation)	C=150pF, R=330Ω, 5points/panel Air:± 8KV, 5times; Contact:± 4KV, 5 times; ( Environment: 15°C~35°C, 30%~60%, 86Kpa~106Kpa )	IEC61000-4-2 GB/T17626.2—1998
8	Vibration (Non-operation)	Frequency range:10~55Hz, Stroke:1.5mm Sweep:10Hz~55Hz~10Hz 1 hours for each direction of X.Y.Z.(3 hours for total)	IEC60068-2-6 GB/T2423.10—1995
9	Shock (Non-operation)	60G 6ms, ± X,± Y,± Z 3times for each direction	IEC60068-2-27 GB/T2423.5—1995
10	Package Drop Test	Height:80 cm, 1 corner, 3 edges, 6 surfaces	IEC60068-2-32 GB/T2423.8—1995

Note1: Ts is the temperature of panel's surface.

Note2: Ta is the ambient temperature of sample.

# 8 Mechanical drawing

Pin No	Symbol
1	LED1
2	LED2
3	LED3
4	LED4
5	LED5
6	LED6
7	LED7
8	LED8
9	LED9
10	LED10
11	LED11
12	LED12
13	LED13
14	LED14
15	LED15
16	LED16
17	LED17
18	LED18
19	LED19
20	LED20
21	ENABLE
22	HSYNC
23	GND
24	CLK
25	GND
26	GND
27	GND
28	GND
29	GND
30	GND
31	GND
32	GND
33	GND
34	GND
35	GND
36	GND
37	GND
38	GND
39	GND



- Notes:
- 1. Display Type: a-Si TFT (262K color);
  - 2. Gray Scale Inversion: 6 o'clock;
  - 3. Backlight: 4 LEDs Serials;
  - 4. Mating connector: FH3-39S-0.3SHAW;
  - 5. Operating Temperature: -20°C~+70°C;
  - 6. Storage Temperature: -30°C~+80°C;
  - 7. Turnaround tolerance: R=0.30mm;
  - 8. Requirement on Environment Protection: Q/S0002.

## 9 Packing drawing

No	Item	Model(Material)	Dimensions(mm )	Unit Weight(Kg)	Quantity	Remark
1	LCM module	TST022TC-T01	40.6x56.6x2.7	0.01274	576	
2	Tray	PET ( Transmit )	485x330x11.3	0.162	27	Anti-static
3	Desiccant	EPE	45x35	0.002	6	
4	Anti-static bag	PE	700x545	0.046	1	
5	BOX	CORRUGATED PAPER	520x345x70	0.35	3	
6	EPE	EPE	485x330x5	0.183	3	
7	Carton	CORRUGATED PAPER	544x365x250	1.01	1	
7	Total Weight(Kg)	14.38				

## 10 Precautions for use of LCD modules

### 10.1 Handling Precautions

- 10.1.1 The display panel is made of glass. Do not subject it to a mechanical shock by dropping it from a high place, etc.
- 10.1.2 If the display panel is damaged and the liquid crystal substance inside it leaks out, be sure not to get any in your mouth, if the substance comes into contact with your skin or clothes, promptly wash it off using soap and water.
- 10.1.3 Do not apply excessive force to the display surface or the adjoining areas since this may cause the color tone to vary.
- 10.1.4 The polarizer covering the display surface of the LCD module is soft and easily scratched. Handle this polarizer carefully.
- 10.1.5 If the display surface is contaminated, breathe on the surface and gently wipe it with a soft dry cloth. If still not completely clear, moisten cloth with one of the following solvents:
  - Isopropyl alcohol、
  - Ethyl alcoholSolvents other than those mentioned above may damage the polarizer. Especially, do not use the following:
  - Water
  - Ketone
  - Aromatic solvents
- 10.1.6 Do not attempt to disassemble the LCD Module.
- 10.1.7 If the logic circuit power is off, do not apply the input signals.
- 10.1.8 To prevent destruction of the elements by static electricity, be careful to maintain an optimum work environment.
  - 10.1.8.1 Be sure to ground the body when handling the LCD Modules.
  - 10.1.8.2 Tools required for assembly, such as soldering irons, must be properly ground.
  - 10.1.8.3 To reduce the amount of static electricity generated, do not conduct assembly and other work under dry conditions.
  - 10.1.8.4 The LCD Module is coated with a film to protect the display surface. Be care when peeling off this protective film since static electricity may be generated.

### 10.2 Storage precautions

- 10.2.1 When storing the LCD modules, avoid exposure to direct sunlight or to the light of fluorescent lamps.
- 10.2.2 The LCD modules should be stored under the storage temperature range. If the LCD modules will be stored for a long time, the recommend condition is:

Temperature : 0℃ ~ 40℃      Relatively humidity: ≤80%

- 10.2.3 The LCD modules should be stored in the room without acid, alkali and harmful gas.

### 10.3 Transportation Precautions:

The LCD modules should be no falling and violent shocking during transportation, and also should avoid excessive press, water, damp and sunshine.