Product Specification

1. GENERAL DESCRIPTION

The LH35WS1 is a Color Active Matrix Liquid Crystal Display with Light Emission Diode(LED) backlight system. The matrix employs poly-Si Thin Film Transistor as the active element.
It is transflective type display operating in the normally black mode. This TFT-LCD has 3.54 inch diagonally measured active display area with (640*RGB*960) resolution. Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes.

Block Diagram

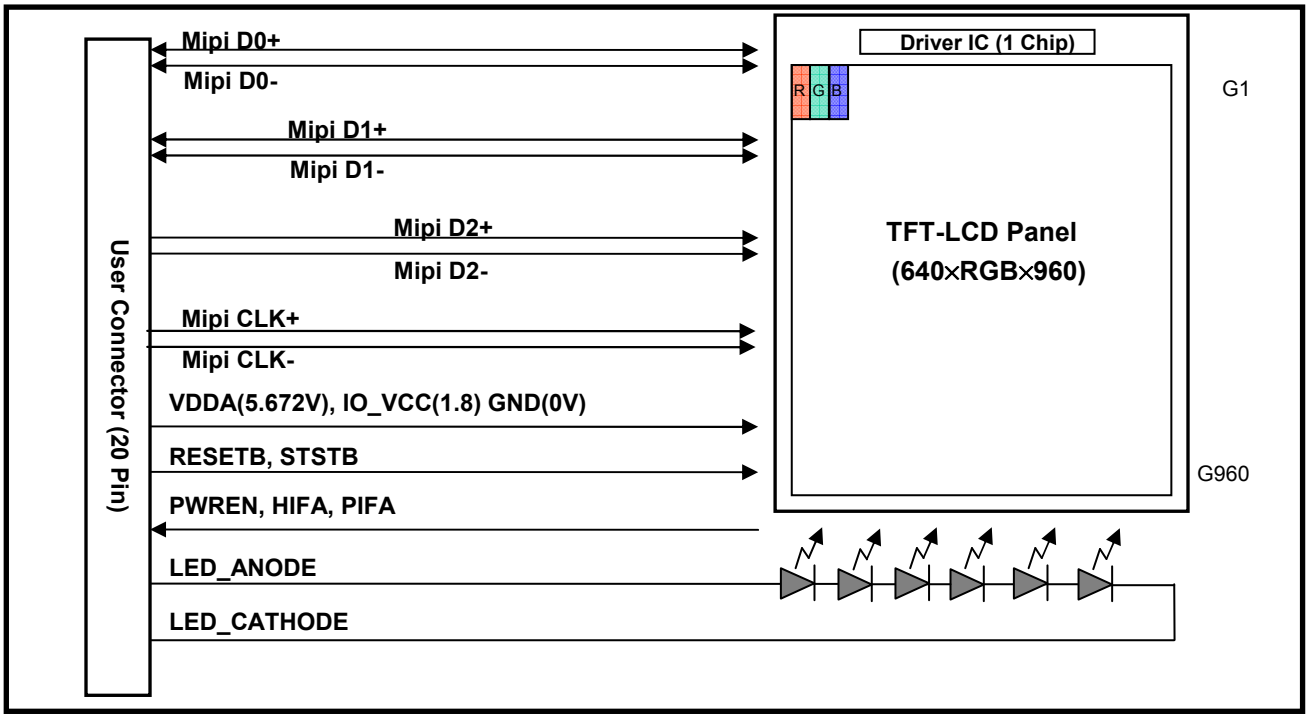


Fig 1.1 Block Diagram of TFT-LCD Module with LED Backlight Unit

General Features

Item	Specification
Active Screen Size	3.54” diagonal
Outline Dimension	54.85(H) x 82.93(V) x 1.44(T)
Pixel Pitch	0.078(H) x 0.078(V)
Pixel Format	640(H) x 960(V) (RGB Stripe)
Color Depth	24-bits (R8, G8, B8)
Interface	MIPI 3-lane
Power Consumption	420mW (Max. B/L),120mW (Max. Panel)
Luminance	500nit(typ.) @20mA
Viewing Direction	6:00 o’clock (Non-inversion)

2. ABSOLUTE MAXIMUM RATINGS

The following are maximum values which, if exceeded, may cause faulty operation or damage to the unit.

Table 2.1 Absolute Maximum Ratings

Parameter	Symbol	Values		Units	Notes
		Min	Max		
Switching Supply Voltage	AVDDH	-0.3	6.4	V	
Logic I/O Voltage	DVDD	-0.3	2.5	V	
Logic Input Voltage	Vin	-0.3	DVDD+0.3	V	1
LED Power Consumption	P_{LED}	-	120	mW	2
LED Current	I_{LED}	-	35	mA	2
Operating Temperature	Top	-20	70	℃	3
Storage Temperature	Tstg	-30	80	℃	3
Humidity	H	5%	95%	RH	3
Maximum Pressure		100		N	4

Notes:
(1) Applies to RESETB, PIFA, HIFA, PWREN, STSTB
(2) Applies for each LED individually
(3) See Section 7 for specific temperature and humidity test conditions.
(4) Test with a 10 mm diameter metal cylinder with 2.5 mm rubber tip moving down at 1mm/minute in the center and top left corner without permanent optical change. See section 7 for additional system-level pressure testing.

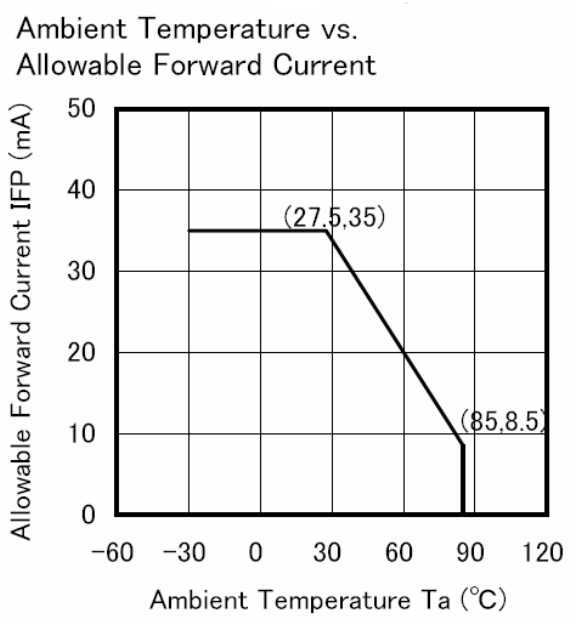


Fig 2.1 Ambient Temperature vs. Allowable Forward Current

3. ELECTRICAL SPECIFICATIONS

3-1. ELECTRICAL CHARACTERISTICS

Table 3.1 Electrical Characteristics Of TFT-LCD Module

Parameter	Symbol	Values			Units	Notes
		Min	Typ	Max		
Input Analog Voltage	AVDDH-Vss	5.468	5.672	5.875	V	
Logic I/O Voltage	DVDD-Vss	1.65	1.8	1.95	V	2
Input Analog Current		-	-	20	mA	1
1.8V Input Current		-	-	8	mA	1
LED Input Current	I_{LED}	-	20	25	mA	
“H” Level Input Voltage	V_{IH}	$0.8V_{EE}$	-	-	V	1,2
“L” Level Input Voltage	V_{IL}	-	-	$0.2V_{EE}$	V	1,2
“H” Level Output Voltage	V_{OH}	$0.8V_{EE}$	-	-	V	1,2
“L” Level Output Voltage	V_{OL}	-	-	$0.2V_{EE}$	V	1,2
Driver Power Supply Stability				250	ms	5
Power, MIPI full refresh	P_{MIPI}	-	-	120	mW	1
Power Consumption, Backlight	P_B	-	384	420	mW	3
Power Consumption, Suspend	P_S	-	-	60	μW	4
COG Resistance	R_{COG}			TBD	Ω	6
FOG Resistance	R_{FOG}			TBD	Ω	7

Notes:
(1) The specified current and power consumption are under the conditions at AVDDH = VDD = 5.672V, DVDD = VEE = 1.8V, T = 25℃, and fv = 60 Hz.
(2) Input mode of RESETB, PIFA, HIFA, PWREN, STSTB.
(3) LED Backlight assumptions: 3.2 Vf, 20 mA, 6 LED’s.
(4) DVDD present only, display off, reset asserted.
(5) Time from AVDDH and DVDD applied until driver power supplies are stable.
(6) Specified for nominal 45 μm x 100 μm bump size
(7) Specified for nominal 70 μm x 800 μm finger size

3. ELECTRICAL SPECIFICATIONS

3-2. BACK LIGHT UNIT

The edge-lighting type of back light unit consists of 6 LEDs which is connected in serial.

Table 3.2 Electrical Characteristics Of Back Light Unit

Parameter	Symbol	Values			Units	Notes
		Min	Typ.	Max		
LED Current	I_{LED}	-	20	25	mA	
LED Forward Voltage	V_{LED}	-	3.2	-	V	

3-3. INTERFACE CONNECTIONS

Interface Connector: AX3E41264 (JAE)

Table 3.3 Module Connector Pin Configuration

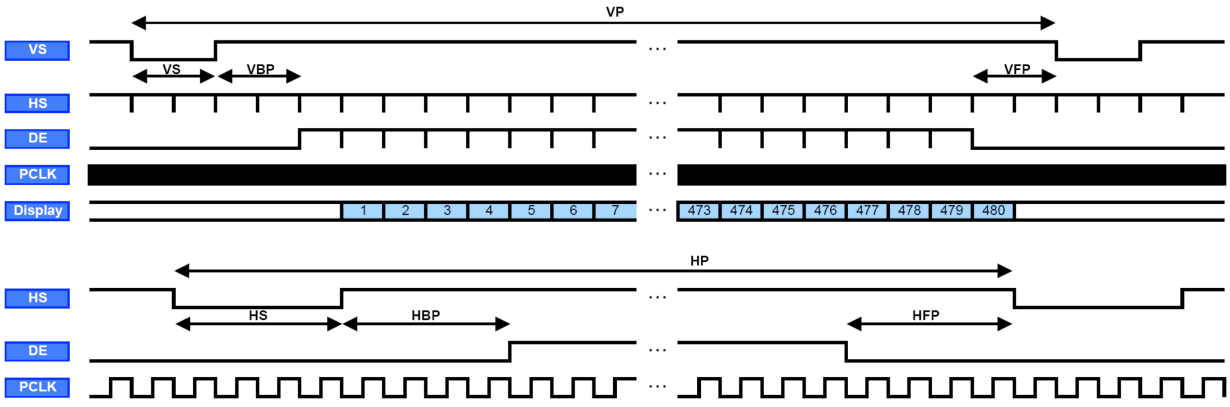
Pin No.	Symbol	I/O	Description
1	GND	-	Ground
2	LED_BL_A	-	LED Anode
3	MIPI_D0P	I/O	MIPI Data
4	LED_BL_C	-	LED Cathode
5	MIPI_D0N	I/O	MIPI Data
6	5V7_AVDDH	-	Switching Power Supply
7	GND	-	Ground
8	1V8_DVDD	-	1.8V LCD Power supply
9	MIPI_D1P	I/O	MIPI Data
10	PWREN	O	System PMU Control
11	MIPI_D1N	I	MIPI Data
12	RESETB	I	Reset (“L” Active)
13	GND	-	Ground
14	HIFA	I/O	Host Interface Access
15	MIPI_CKP	I	MIPI Clock
16	STSTB	I	Set LCD Module Test
17	MIPI_CKN	I	MIPI Clock
18	PIFA	I/O	Panel Interface Access
19	GND	-	Ground
20	GND	-	Ground
21	MIPI_D2P	I/O	MIPI Data
22	MIPI_D3p	I/O	MIPI Data
23	MIPI_D2N	I/O	MIPI Data
24	MIPI_D3N	I/O	MIPI Data
25	GND	-	Ground
26	GND	-	Ground

3-4. SIGNAL TIMING SPECIFICATIONS

Table 3.4 Timing Parameters

Item	Symbol	Timing	Unit	Remarks
Vertical cycle	VP	1000	Line	1
Vertical low pulse width	VS	16	Line	1
Vertical front porch	VFP	12	Line	1
Vertical back porch	VBP	12	Line	1
Vertical display area	VDISP	960	Line	1
Horizontal cycle	HP	684	clk	1
Horizontal low pulse width	HS	16	clk	1
Horizontal front porch	HFP	14	clk	1
Horizontal back porch	HBP	14	clk	1
Horizontal display area	HDISP	640	clk	1,2

Notes:
1: DVDD = VEE = 1.65~1.95V
2: Use 10.80 MHz for Vcom and Gamma Adjustment



3-5. COLOR INPUT DATA REFERENCE

Colors & Gray Scale	Gray Scale Level	Data Signal																							
		R0	R1	R2	R3	R4	R5	R6	R7	G0	G1	G2	G3	G4	G5	G6	G7	B0	B1	B2	B3	B4	B5	B6	B7
Black	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blue	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Green	-	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Cyan	-	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Red	-	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Magenta	-	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Yellow	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
White	-	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
↑ Darker ↑ ↓ Brighter ↓	GS1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GS2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↓	↓								↓								↓							
	GS253	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GS254	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Red	GS255	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
↑ Darker ↑ ↓ Brighter ↓	GS1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GS2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↓	↓								↓								↓							
	GS253	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	GS254	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Green	GS255	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Black	GS0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
↑ Darker ↑ ↓ Brighter ↓	GS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	GS2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
	↓	↓								↓								↓							
	GS253	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	1	1
	GS254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
Blue	GS255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1

3-6. Power On/off Sequence

Power On Sequence

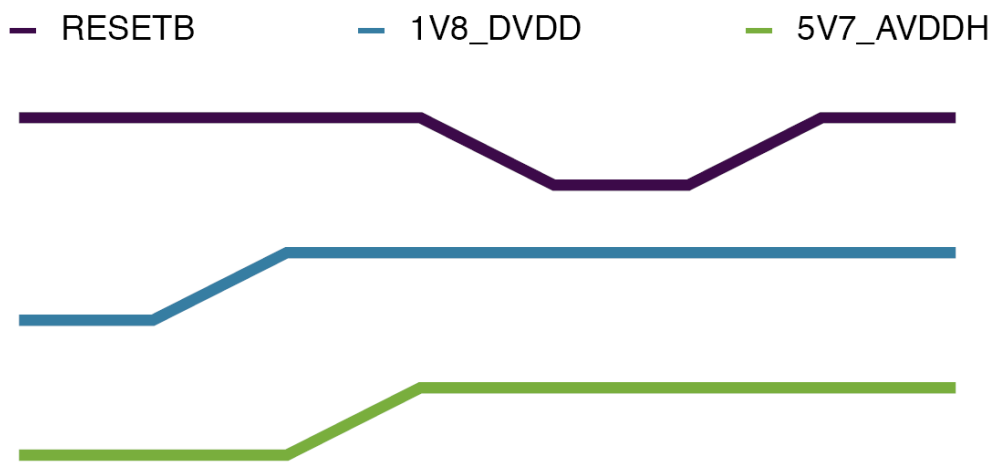


Fig 3.2 Power On Sequence

Power Off Sequence

In a normal power off sequence the commands and/or register settings are followed.

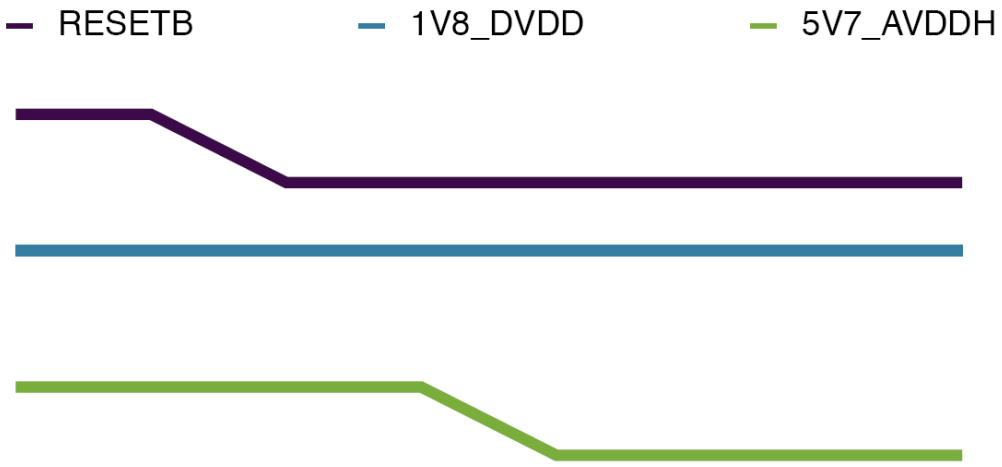


Fig 3.3 Power Off Sequence

3-7. Software Flow

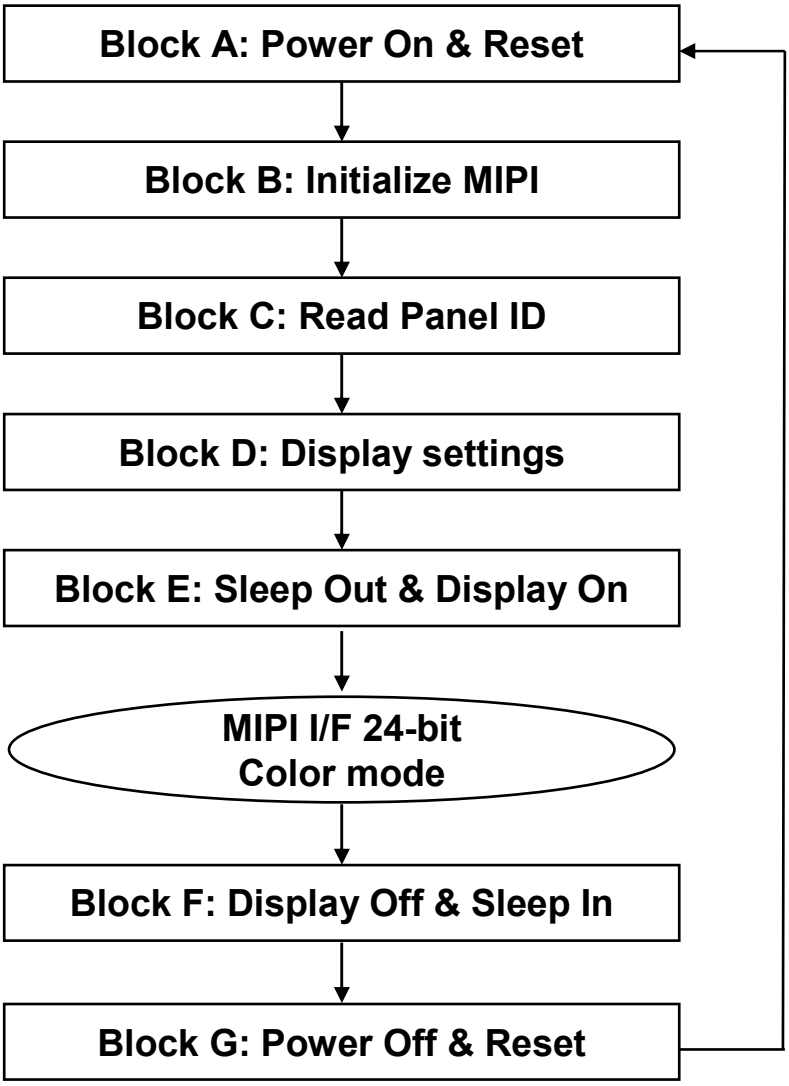


Fig 3.4 Software Flowchart

Table 3-5-1. Block A : Power On & Reset

Step	Operation
1	Apply DVDD
2	Apply AVDDH
3	Toggle Reset

Table 3-5-2. Block B : Initialize MIPI

Step	Register/ Command	Parameter/ Setting	Operation
1			Initialize SOC DSIM
2	0x00		Send MIPI NOP
3			Start MIPI Highspeed Clock

Table 3-5-3. Block C : Read Panel ID

Step	Register/ Command	Parameter/ Setting	Operation
1	**0xB1**	**0x14**	**Read ID**

Table 3-5-4. Block D : Display Settings

Step	Register/ Command	Parameter/ Setting	Operation
1	Optionally override EEPROM settings		

Table 3-5-5. Block E : Sleep Out & Display On

Step	Register/ Command	Parameter/ Setting	Operation
1	0x11		Sleep out
2	0x29		Display On

Table 3-5-6. Block F : Display Off & Sleep In

Step	Register/ Command	Parameter/ Setting	Operation
1	0x28		Display Off
2	0x10		Sleep In

Table 3-5-7. Block G : Power Off & Reset

Step	Register/ Command	Parameter/ Setting	Operation
1	Optionally override EEPROM settings		

4. OPTICAL CHARACTERISTICS

4-1. Optical Characteristics – Backlight Off

Parameter	Symbol	Condition	Min	Typ	Max	Unit	Remarks
Viewing Angle Range	ΘUP	CR ≥10	80	-	-	°(degree)	
	ΘDOWN		80	-	-	°(degree)	
	ΘLEFT		80	-	-	°(degree)	
	ΘRIGHT		80	-	-	°(degree)	
Contrast Ratio	CR	Optimal	600	1000	-		
Brightness	Y	Optimal	400	500	-	Cd/m^2	
Brightness Uniformity	Y	Optimal		85		%	
Response time	τ_f	Θ =0 ° Ta =25 ℃		20	25	ms	
	τ_r			20	25	ms	
Color Gamut	NTSC	-	-	50	-	%	
White Chromaticity	x	CIE 1931		0.309			
	y			0.329			
Red Chromaticity	x	CIE 1931		0.610			
	y			0.345			
Green Chromaticity	x	CIE 1931		0.315			
	y			0.555			
Blue Chromaticity	x	CIE 1931		0.150			
	y			0.120			

1. Optical Test Equipment & Method Refer to Note 1,2,3,4.

[Note 1] Optical Test Equipment Setup

Optical characteristics are determined after the unit has been 'ON' and stable for approximately 30 minutes in a dark environment at 25℃. The values specified are at an approximate distance 50cm from the LCD surface. In case of backlight on, measured on the center area of the panel by PHOTO RESEARCH photometer PR-880&PR650 or Equivalent.

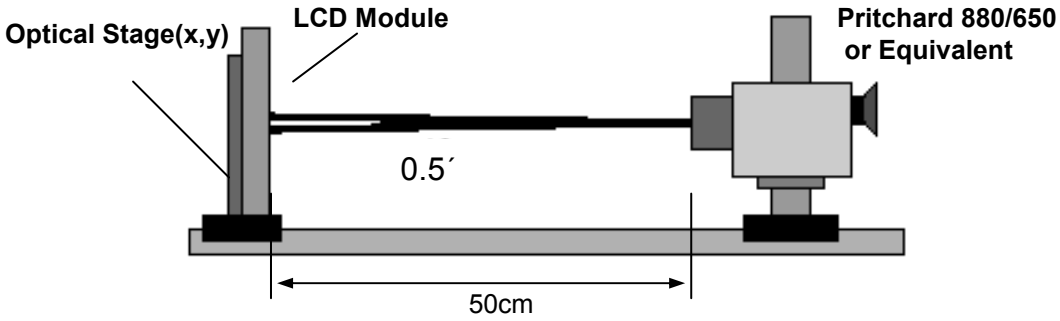


Fig 4.1. Optical Characteristic Measurement Equipment and Method

[Note 2]

Contrast Ratio is defined as follows ;

$$\text{Contrast Ratio(CR)} = \frac{\text{Photo detector output with LCD being “White”}}{\text{Photo detector output with LCD being “Black”}}$$

[Note 3]

Viewing Angle Range is defined as follows;

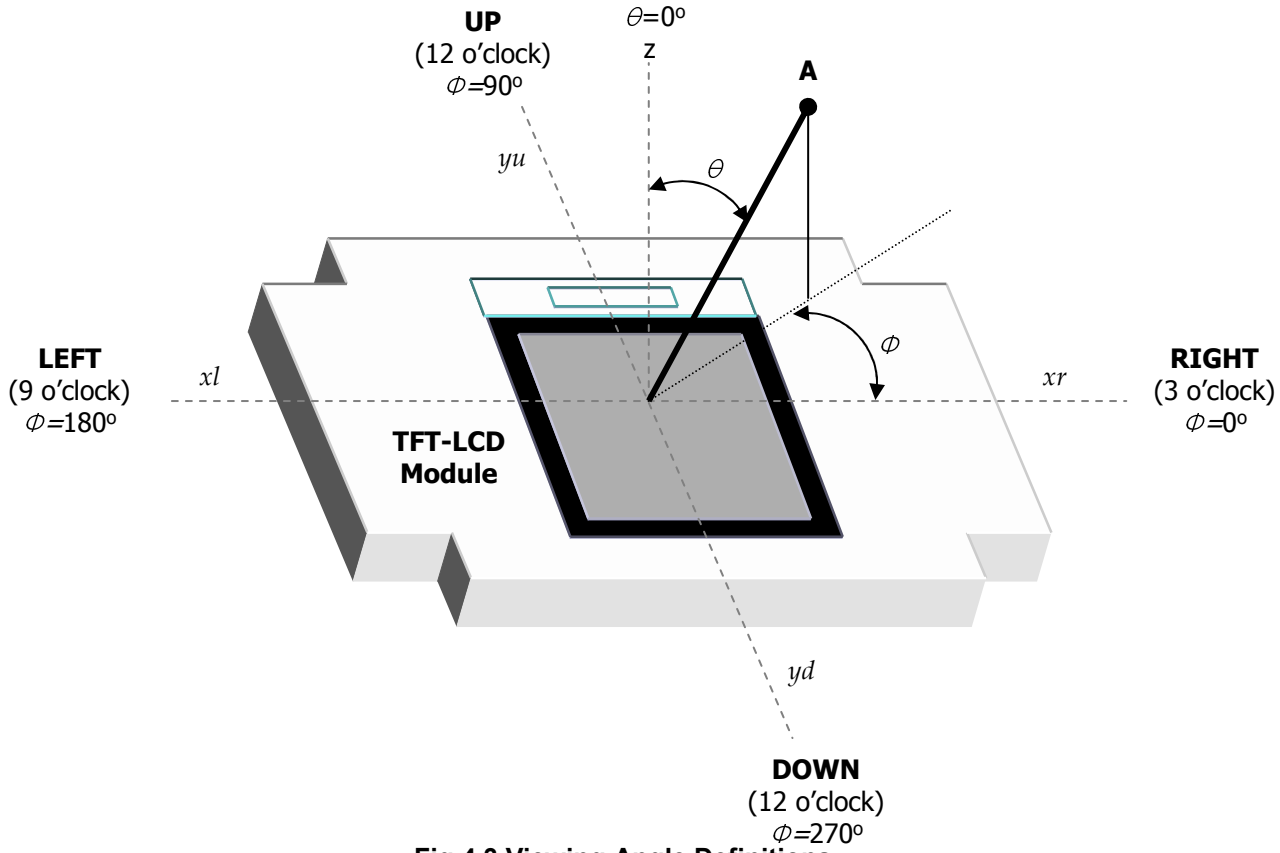


Fig 4.3 Viewing Angle Definitions

[Note 4]

Response time is obtained by measuring the transition time of photo detector output, when input signals are applied so as to make the area “black” to and from “white”.

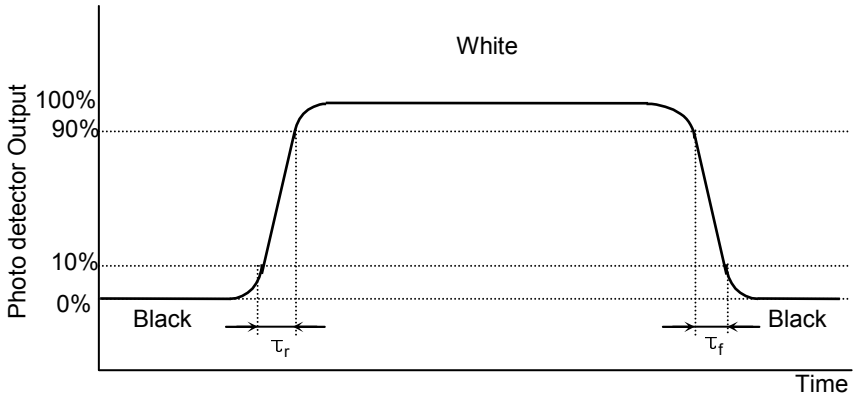


Fig 4.4 Response Time Definition

[Note 5]

The brightness measurement is taken at point B5.

$$\text{Brightness Uniformity} = \frac{\text{Minimum Photo detector output for B1-B9 with all pixels white}}{\text{Maximum Photo detector output for B1-B9 with all pixels white}} \times 100$$

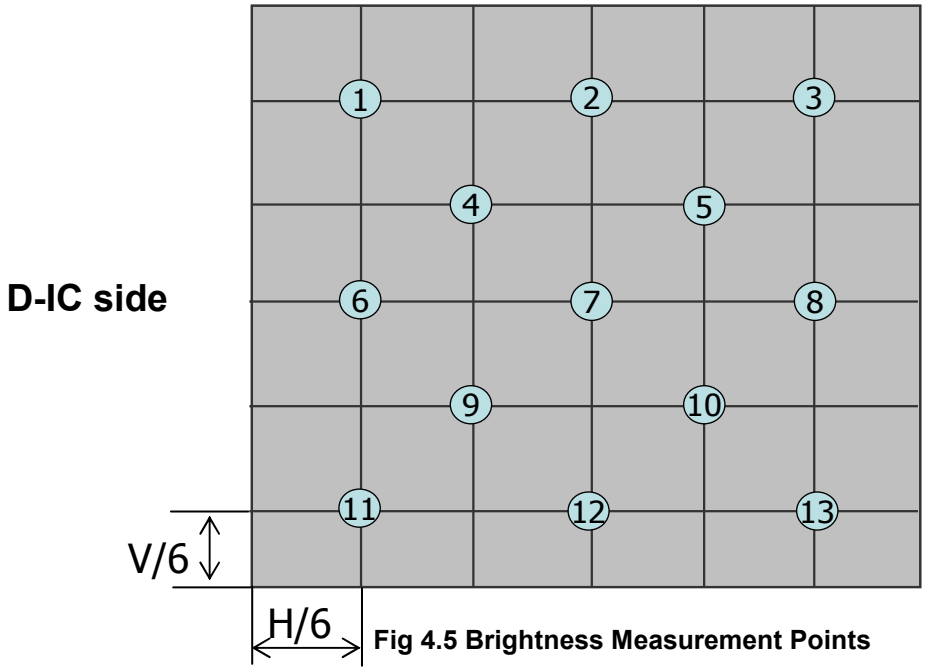


Fig 4.5 Brightness Measurement Points

5. MECHANICAL CHRACTERISTICS

The contents provide general mechanical characteristics for the model.
In addition the figures in the next page are detailed mechanical drawing of the LCD.

DIMENSION	MIN	TYP	MAX	UNIT
HORIZONTAL	54.75	54.85	54.95	mm
VERTICAL	82.83	82.93	83.03	mm
THICKNESS	1.32	1.441	1.520	mm

[Outline Dimension]