Product Specification

1. GENERAL DESCRIPTION

The LH154Q01 is a Color Active Matrix Liquid Crystal Display with Light Emission Diode(LED) backlight system. The matrix employs a-Si Thin Film Transistor as the active element.
It is transmissive type display operating in the normally white mode. This TFT-LCD has 1.54 inch diagonally measured active display area with (240*RGB*240) resolution. Each pixel is divided into Red, Green and Blue sub-pixels or dots which are arranged in vertical stripes.

Block Diagram

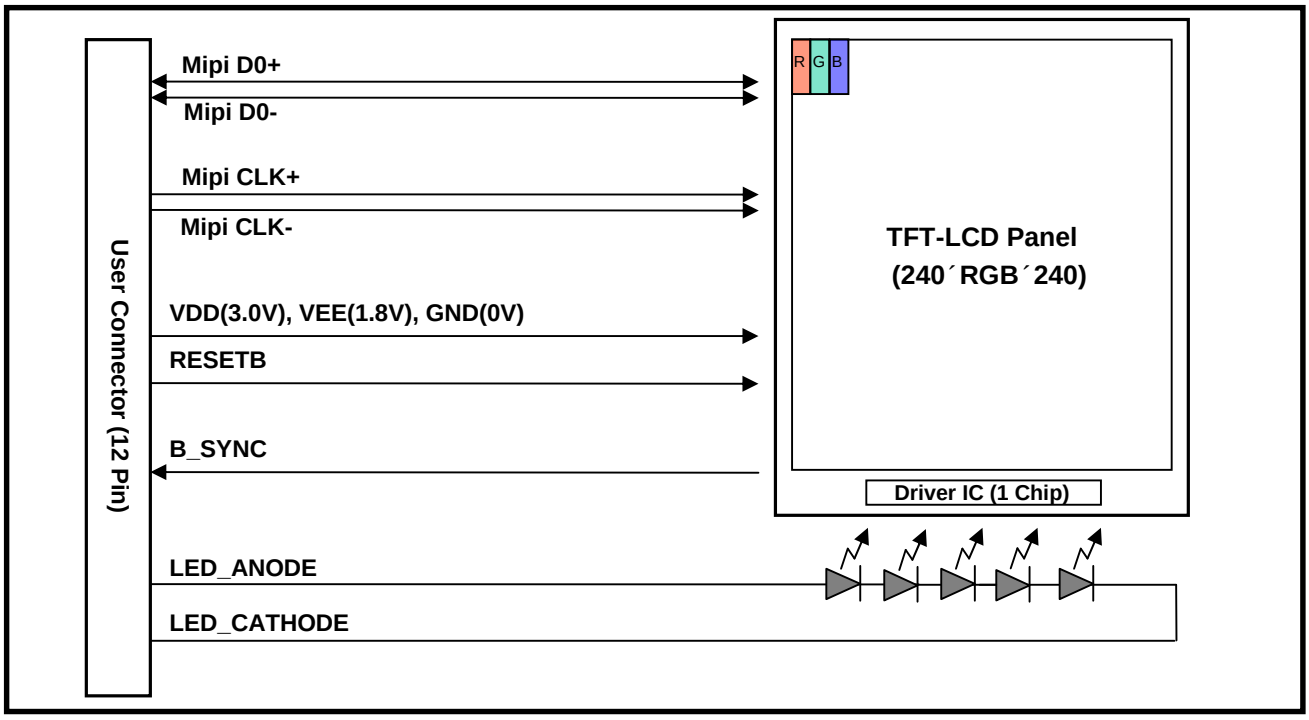


Fig 1.1 Block Diagram of TFT-LCD Module with LED Backlight Unit

General Features

Item	Specification
Active Screen Size	1.54” diagonal
Outline Dimension	31.82 (H) x 33.72 (V) x 1.147 (T) Typ.
Pixel Pitch	0.1155(H) × 0.1155(V)
Pixel Format	240(H) X 240 (V) (RGB Stripe)
Color Depth	18-bits (R6, G6, B6)
Interface	MIPI 1-lane 24-bits (D-PHY version 0.92, DSI version 1.01 r11)
Power Consumption	205mW (max. B/L on @ 11.0mA), 25mW (max. B/L off)
Luminance	450nit(typ.) @ 11.0mA
Viewing Direction	6:30 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		
Power Supply Input	VDD	-0.3	4.0	V	
Power Supply Input	VEE	-0.3	4.0	V	
LED Current	I_{LED}	-	25	mA	1, 2

Notes:
1. Applies to each LED individually.
2. Allowable forward current is refer to Fig 2.1

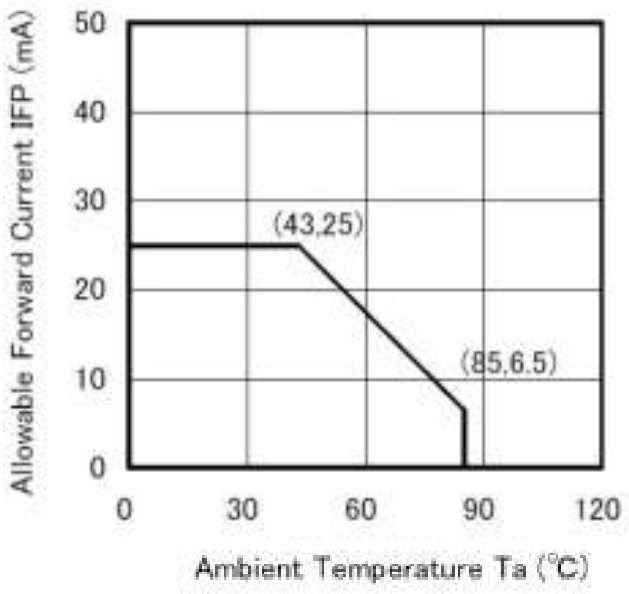


Fig 2.1 Ambient Temperature vs. Allowable Forward Current

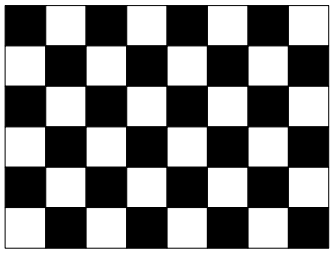
3. ELECTRICAL SPECIFICATIONS

3-1. ELECTRICAL CHARACTERISTICS

Table 3.1 Electrical Characteristics Of TFT-LCD Module

Parameter	Symbol	Values			Units	Notes
		Min	Typ	Max		
Power Supply Input (Analog)	VDD	2.9	3.0	3.1	V	
Power Supply Input (Digital)	VEE	1.7	1.8	1.9	V	
“H”Level Input Voltage	V_{IH}	0.8 V_{EE}	-	-	V	
“L”Level Input Voltage	V_{IL}	-	-	0.2 V_{EE}	V	
Power Consumption, Panel	P_B		20	25	mW	1

Notes:
1. Large black/white checker pattern(20 pixel blocks) at 60Hz



White : 64Gray
Black : 0Gray

3-2. BACK LIGHT UNIT

The edge-lighting type of back light unit consists of 5 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}	-	10.5	25	mA	
LED Forward Voltage	V_{LED}	-	15.5	17.0	V	

3-3. INTERFACE CONNECTIONS

LCD Connector: 503552-1220 (Molex)
System Mating Connector: 503548-1220 (Molex)

Table 3.3 Module Connector Pin Configuration

Pin	Signal	I/O	Description
1	CLKP	I/O	MIPI Clock
2	VDD	-	3.0V Power Supply
3	CLKN	I/O	MIPI Clock
4	VEE	-	1.8V Power Supply
5	GND	-	Ground
6	B_Sync	O	Synchronization Pulse Signal
7	D0P	I/O	MIPI Data
8	Reset	I	Reset (Active Low)
9	D0N	I/O	MIPI Data
10	LED+	O	LED Anode
11	GND	-	Ground
12	LED-	O	LED Cathode

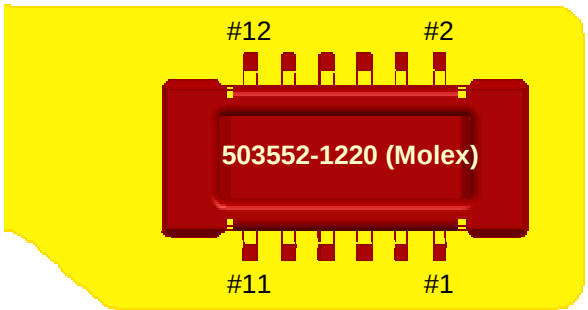


Fig 3.1 Connector Diagram

Note:

1. All GND(ground) pins should be connected together.

Product Specification

3-4. COLOR INPUT DATA REFERENCE

Table 3.4 Color vs. Data

Display Colors		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
Basic Color	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	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1
	Red	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1
	Yellow	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
	White	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1	1
Red Gray Scale	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
	GS1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↕	0	0	•	•	•	•	•	•	0	0	•	•	•	•	•	•	0	0	•	•	•	•	•	•
	Brighter	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	GS62	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green Gray Scale	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
	GS1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
	↕	0	0	•	•	•	•	•	•	0	0	•	•	•	•	•	•	0	0	•	•	•	•	•	•
	Brighter	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	0	0	0	0	0
	GS62	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0	0	0
Blue Gray Scale	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
	GS1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	Darker	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
	↕	0	0	•	•	•	•	•	•	0	0	•	•	•	•	•	•	0	0	•	•	•	•	•	•
	Brighter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1	1
	GS62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

3-5. Power On/Off Sequence

Power On Sequence

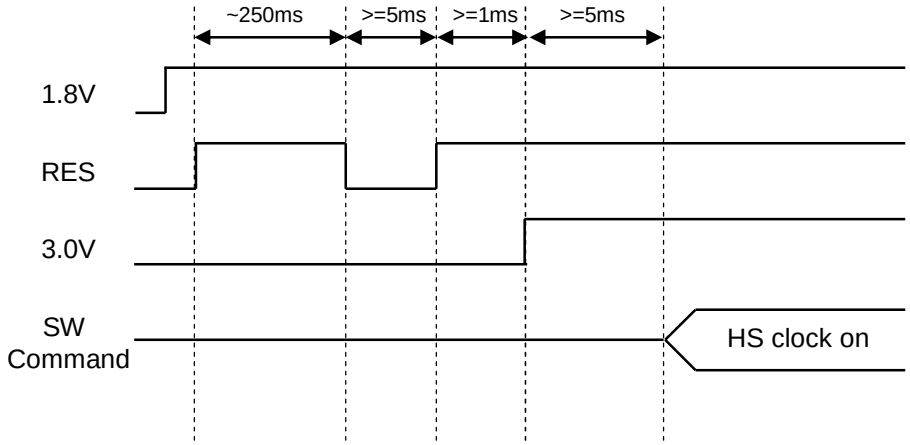


Fig 3.2 Power On Requirements

Power Off Sequence

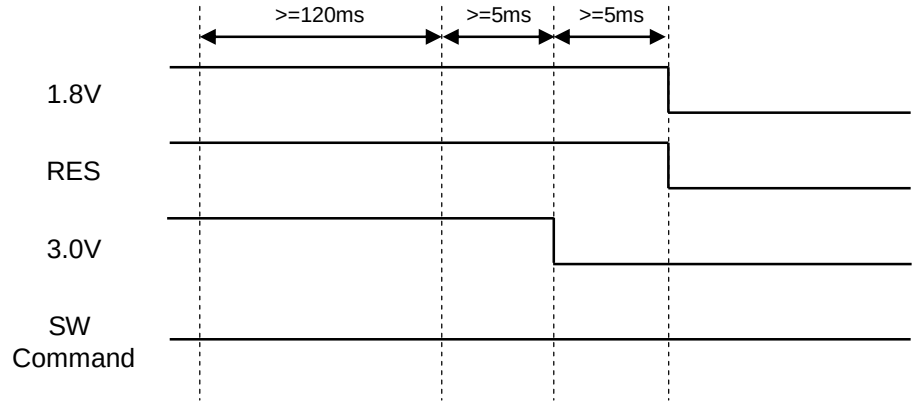


Fig 3.3 Power Off Requirements

3-7. Software Flow

Power on				
Step	**Register**	**Data**	**Delay**	**Command**
1				VEE on (Typ 1.8V)
			10us	
2				H/W reset set to HIGH
			1ms	D-IC Logic power settlement
3				VDD on (Typ 3.0V)
			5ms	OSC stabilization & NVM loading
4				Turn on high-speed clock (HS clock on)
			10us	For settlement
5	0x11			Sleep Out
			120ms	
			40ms	Wait 2 frames
6	0x36	0x08		RGB/BGR order change
7	0x2C	Image		Start to send image data (HS data on)
8	0x29			Displray On
9				Turn on Backlight

Power off				
Step	**Register**	**Data**	**Delay**	**Command**
1				Turn off Backlight
			1ms	
2	0x28			Display off
			5ms	
3	0x10			Sleep In
			120ms	Discharge time
4				Stop to send image data (HS data off)
5				Turn off high-speed clock (HS clock off)
			10us	
6				VDD off (Typ 3.0V)
			5ms	For settlement
7				HW reset set to LOW
			5ms	
8				VEE off (Typ 1.8V)

Table 3.5 Software Flowchart

4. OPTICAL CHARACTERISTICS

4-1. Optical Characteristics – Backlight On

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Viewing Angle Range	ΘUP	CR ≥10	40	50		°(degree)	Note 3
	ΘDOWN		40	50		°(degree)	Note 3
	ΘLEFT		40	50		°(degree)	Note 3
	ΘRIGHT		40	50		°(degree)	Note 3
Contrast Ratio	CR	Optimal	100	150		--	Note 2
Brightness	Y	I_{LED}= 11.0mA	400	450		cd/㎡	Note 1 [PR880]
Brightness Uniformity	Y	I_{LED}=11.0mA	80			%	Note 5 [PR880]
Flicker	F	Optimal			10	%	Note 6
Response Time	$\tau_f + \tau_r$	Θ =0 ° Ta =25 °C		35	50	ms	Note 4
White Chromaticity	Wx	Θ =0 ° Ta =25 °C		0.309			Note 1 [PR650]
	Wy			0.324			
Red Chromaticity	Rx			0.610			
	Ry			0.345			
Green Chromaticity	Gx			0.320			
	Gy			0.555			
Blue Chromaticity	Bx			0.150			
	By			0.120			
Color Gamut	NTSC			50		%	

1. Optical Test Equipment & Method Refer to Note 1,2,3,4,5,6.

[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°C. 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.

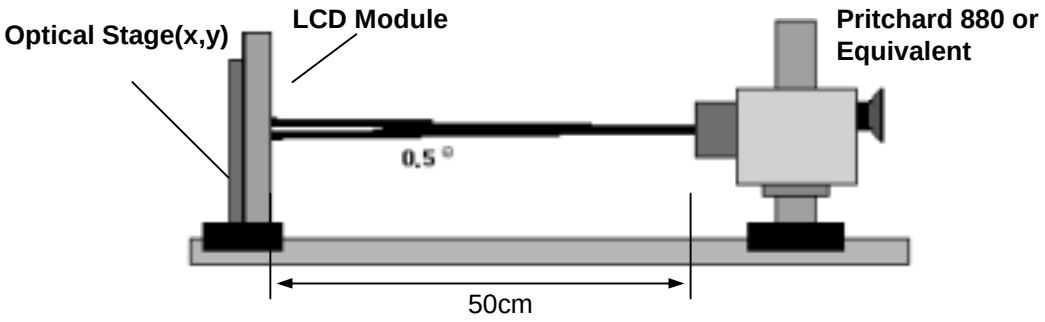


Fig 4.1 Backlight On (Optical Characteristic Measurement Equipment and Method)

[Note 2]

Contrast Ratio is defined as follows ;

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

Product Specification

[Note 3]

Viewing Angle Range is defined as follows;

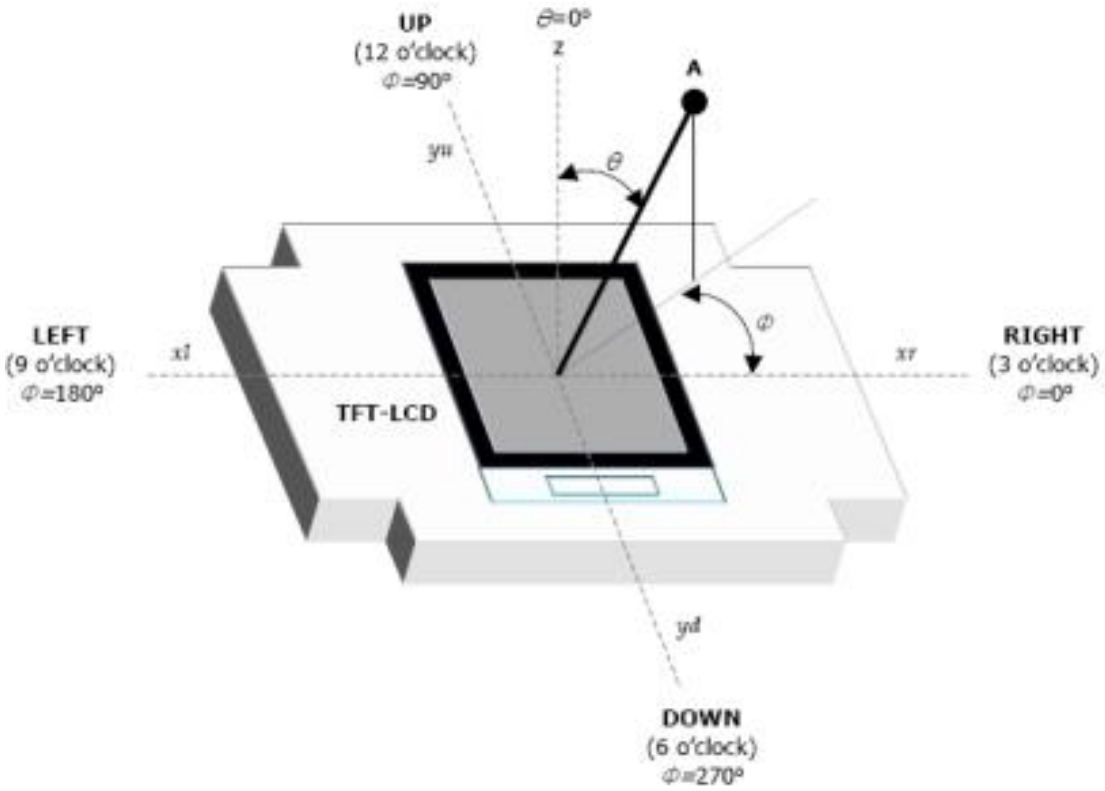


Fig 4.2 Viewing Angle Definitions

[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".

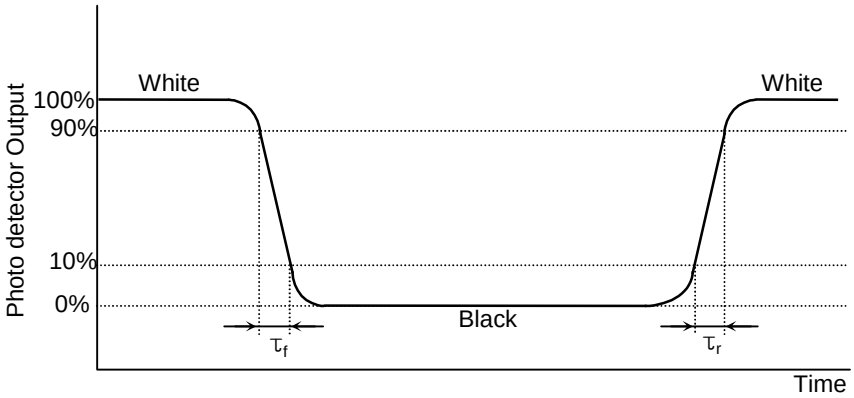


Fig 4.3 Response Time Definition

[Note 5]

The brightness measurement is taken at point B5.

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

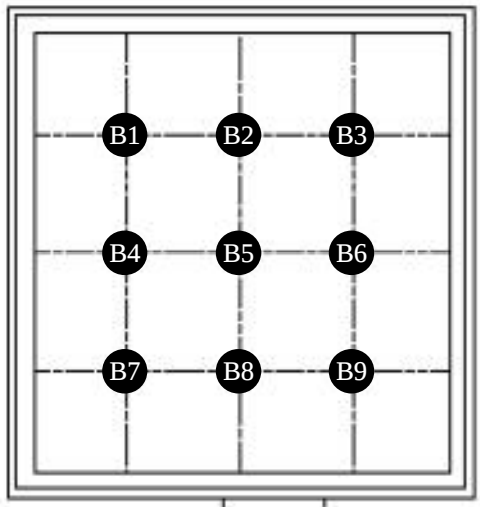
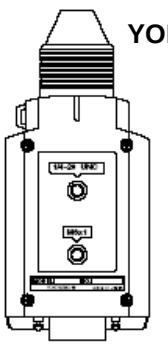


Fig 4.4 Brightness Measurement Points

[Note 6]

The Flicker measurement is taken at center area of the panel (B5).
Measurement equipment is YOKOGAWA 3298.
Measurement patten is Black and Middle gray horizontal.



YOKOGAWA 3298

Fig 4.5 Flicker Measurement Points

5. MECHANICAL CHRACTERISTICS

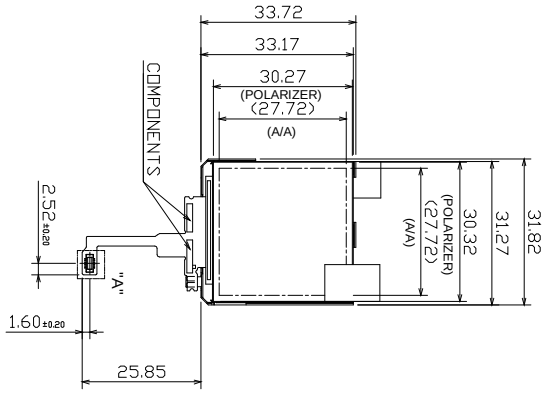
The contents provide general mechanical characteristics for the model.
In addition the figures in the next page are detailed mechanical drawing of the LCD.

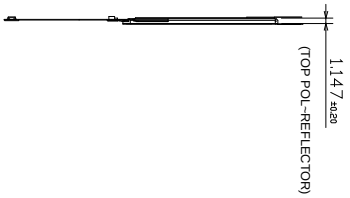
DIMENSION	MIN	TYP	MAX	UNIT
HORIZONTAL	31.52	31.82	32.12	mm
VERTICAL	33.42	33.72	34.02	mm
THICKNESS	0.947	1.147	1.347	mm

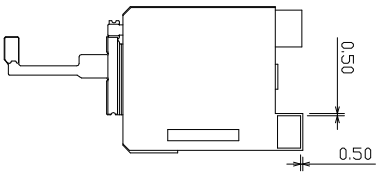
Product Specification

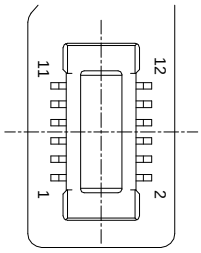
[Outline Dimension]

NOTES
1. Unspecified Dimension Tolerances are ± 0.3mm
2. Weight: 2.5g(Typ.), 3.0g(Max.)
3. Designer's Approval is Required before Mass Production
4. All Material should comply with Halogen free

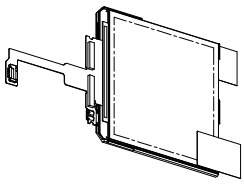








DETAIL "A"
(SCALE 10/1)



6. RELIABLITY TEST

No.	Test Items	Test Condition	Remark
1	Low Temperature Storage	Ta = -30℃ 240hrs	
2	High Temperature Storage	Ta = 70℃ 240hrs	
3	Low Temperature Operation	Ta = -20℃ 240hrs	
4	High Temperature Operation	Ta = 60℃ 240hrs	
5	High Temperature and High Humidity Operation	Ta = 50℃ 90%RH 120hrs	
6	High Temperature and Humidity Storage	Ta = 60℃ 90%RH 120hrs	

{ Result Evaluation Criteria }
TFT-LCD Panel should be at room temperature for 2 hours after the reliability test is over.
There should be no particular change which might affect the practical display function
and the display quality should be conducted under normal operating condition.

7. International Standards

7-1. Safety

a) UL 60950-1, Second Edition, Underwriters Laboratories Inc.
Information Technology Equipment - Safety - Part 1 : General Requirements.

b) CAN/CSA C22.2 No.60950-1-07, Second Edition, Canadian Standards Association.
Information Technology Equipment - Safety - Part 1 : General Requirements.

c) EN 60950-1:2006 + A11:2009, European Committee for Electrotechnical Standardization (CENELEC).
Information Technology Equipment - Safety - Part 1 : General Requirements.

7-2. Environment

a) RoHS, Directive 2002/95/EC of the European Parliament and of the council of 27 January 2003

7-3. EMC

a) ANSI C63.4 “Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electrical Equipment in the Range of 9kHZ to 40GHz. “American National Standards Institute(ANSI), 1992

b) CISPR22 “Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment.“ International Special Committee on Radio Interference.

c) EN 55022 “Limits and Methods of Measurement of Radio Interface Characteristics of Information Technology Equipment.“ European Committee for Electrotechnical Standardization.(CENELEC), 1998
(Including A1: 2000)

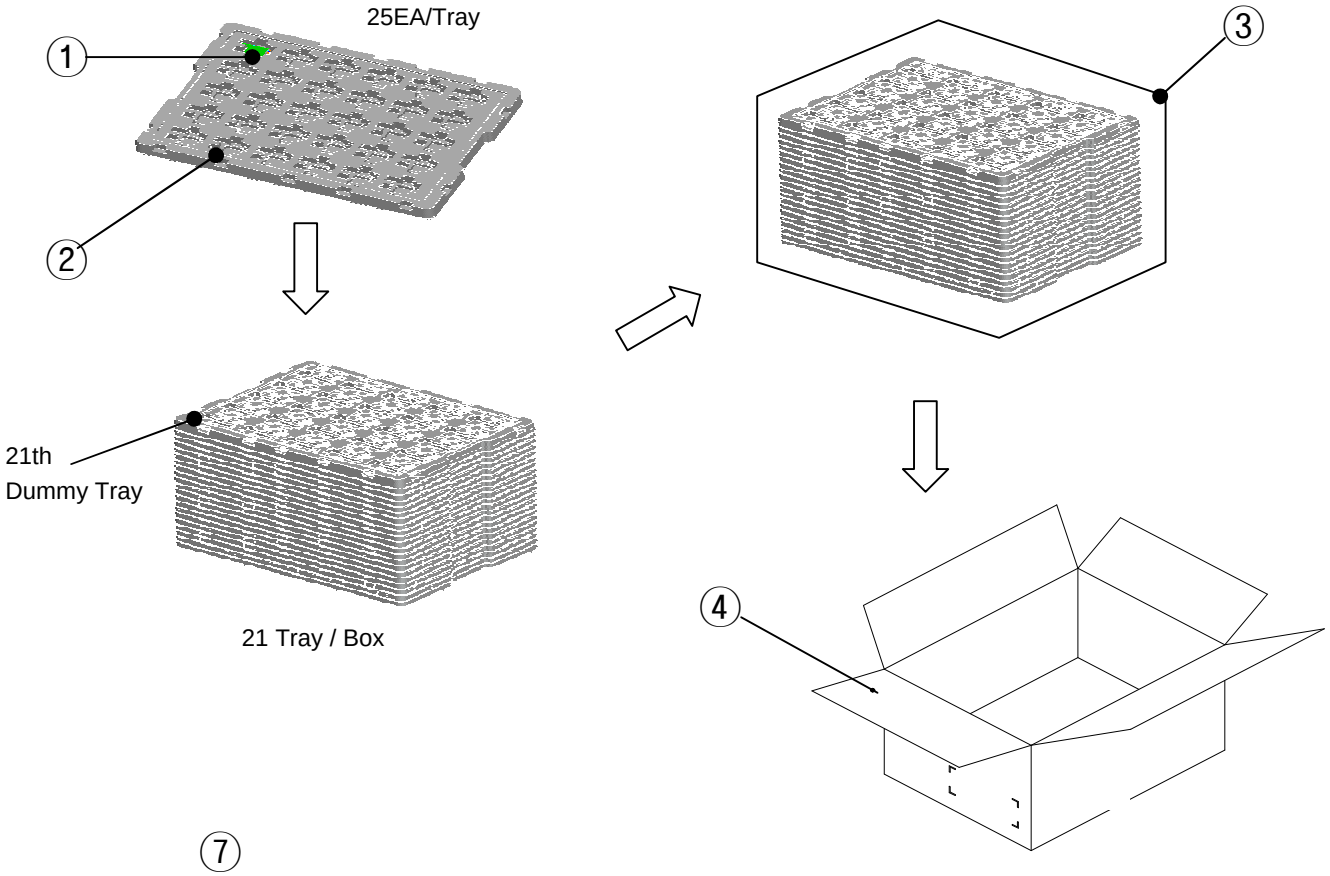
Product Specification

8. PACKING

a) Package Quantity in One Box : 500 pcs

b) Box Size : 475mm X 348mm X 210mm

c) 1Box = 20(Full Tray) + 1(Dummy / Top Tray) = 21 Tray



No.	Description	Material
1	Module	
2	Packing Tray	PET(0.8t)
3	Bag	PE 560x830
4	Box	SWR4
5	Tape	OPP 70MMx300m
6	Label	Art Paper 100x70

9. PRECAUTIONS

Please pay attention to the following when you use this TFT LCD module.

9-1. ASSEMBLY PRECAUTIONS

(1) Please attach a transparent protective plate to the surface in order to protect the polarizer. Transparent protective plate should have sufficient strength in order to the resist external force.
(2) You should adopt radiation structure to satisfy the temperature specification.
(3) Acetic acid type and chlorine type materials for the cover case are not desirable because the former generates corrosive gas of attacking the polarizer at high temperature and the latter causes circuit break by electro-chemical reaction.
(4) Do not touch, push or rub the exposed polarizers with glass, tweezers or anything harder than HB pencil lead. And please do not rub with dust clothes with chemical treatment.
Do not touch the surface of polarizer for bare hand or greasy cloth.(Some cosmetics deteriorate the polarizer.)
(5) When the surface becomes dusty, please wipe gently with absorbent cotton or other soft materials like chamois soaks with petroleum benzine. Normal-hexane is recommended for cleaning the adhesives used to attach front / rear polarizers. Do not use acetone, toluene and alcohol because they cause chemical damage to the polarizer.
(6) Wipe off saliva or water drops as soon as possible. Their long time contact with polarizer causes deformations and color fading.
(7) Do not open the case because inside circuits do not have sufficient strength.
(8) The metal case of a module should be contacted to electrical ground of your system.

9-2. OPERATING PRECAUTIONS

(1) The spike noise causes the mis-operation of circuits. It should be lower than following voltage :
V=±200mV(Over and under shoot voltage)
(2) Response time depends on the temperature.(In lower temperature, it becomes longer.)
(3) Brightness depends on the temperature. (In lower temperature, it becomes lower.)
And in lower temperature, response time(required time that brightness is stable after turned on) becomes longer.
(4) Be careful for condensation at sudden temperature change. Condensation makes damage to polarizer or electrical contacted parts. And after fading condensation, smear or spot will occur.
(5) When fixed patterns are displayed for a long time, remnant image is likely to occur.
(6) Module has high frequency circuits. Sufficient suppression to the electromagnetic interference shall be done by system manufacturers. Grounding and shielding methods may be important to minimized the interference.

9-3. ELECTROSTATIC DISCHARGE CONTROL

Since a module is composed of electronic circuits, it is not strong to electrostatic discharge. Make certain that treatment persons are connected to ground through wrist band etc. And don't touch interface pin directly.

9-4. PRECAUTIONS FOR STRONG LIGHT EXPOSURE

Strong light exposure causes degradation of polarizer and color filter.

9-5. STORAGE

When storing modules as spares for a long time, the following precautions are necessary.
(1) Store them in a dark place. Do not expose the module to sunlight or fluorescent light. Keep the temperature between 5°C and 35°C at normal humidity.
(2) The polarizer surface should not come in contact with any other object.
It is recommended that they be stored in the container in which they were shipped.

9-6. HANDLING PRECAUTIONS FOR PROTECTION FILM

(1) When the protection film is peeled off, static electricity is generated between the film and polarizer. This should be peeled off slowly and carefully by people who are electrically grounded and with well ion-blown equipment or in such a condition, etc.
(2) The protection film is attached to the polarizer with a small amount of glue. If some stress is applied to rub the protection film against the polarizer during the time you peel off the film, the glue is apt to remain on the polarizer.
Please carefully peel off the protection film without rubbing it against the polarizer.
(3) When the module with protection film attached is stored for a long time, sometimes there remains a very small amount of glue still on the polarizer after the protection film is peeled off.
(4) You can remove the glue easily. When the glue remains on the polarizer surface or its vestige is recognized, please wipe them off with absorbent cotton waste or other soft material like chamois soaked with normal-hexane.