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SPECIFICATION

DEVICE SPECIFICATION for
TFT LCD Module

Model No.

LS029B3SX06

Draft Version

BUSINESS UNIT VII
BU III
DISPLAY DEVICE COMPANY
SHARP CORPORATION

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[For handling and system design]

(1) Do not scratch the surface of the polarizer film as it is easily damaged.

(2) If the cleaning of the surface of the LCD panel is necessary, wipe it swiftly with cotton or other soft cloth. Do not use organic solvent as it damages polarizer.

(3) Water droplets on polarizer must be wiped off immediately as they may cause color changes, or other defects if remained for a long time.

(4) Since this LCD panel is made of glass, dropping the module or banging it against hard objects may cause cracks or fragmentation.

(5) Certain materials such as epoxy resin (amine's hardener) or silicone adhesive agent (de-alcohol or de-oxym) emits gas to which polarizer reacts (color change). Check carefully that gas from materials used in system housing or packaging do not hart polarizer.

(6) Liquid crystal material will freeze below specified storage temperature range and it will not get back to normal quality even after temperature comes back within specified temperature range. Liquid crystal material will become isotropic above specified temperature range and may not get back to normal quality. Keep the LCD module always within specified temperature range.

(7) Do not expose LCD module to the direct sunlight or to strong ultraviolet light for long time.

(8) If the LCD driver IC (COG) is exposed to light, normal operation may be impeded. It is necessary to design so that the light is shut off when the LCD module is mounted.

(9) Do not disassemble the LCD module as it may cause permanent damage.

(10) As this LCD module contains components sensitive to electrostatic discharge, be sure to follow the instructions in below.

1. Operators
   Operators must wear anti-static wears to prevent electrostatic charge up to and discharge from human body.
2. Equipment and containers
   Process equipment such as conveyer, soldering iron, working bench and containers may possibly generate electrostatic charge up and discharge. Equipment must be grounded through 100Mohms resistance. Use ion blower.
3. Floor
   Floor is an important part to leak static electricity which is generated from human body or equipment.
   There is a possibility that the static electricity is charged to them without leakage in case of insulating floor, so the counter measure (electrostatic earth:$1\times10^{8}\Omega$) should be made.
4. Humidity
   Proper humidity of working room may reduce the risk of electrostatic charge up and discharge. Humidity should be kept over 50% all the time.
5. Transportation/storage
   Storage materials must be anti-static to prevent causing electrostatic discharge.
6. Others
   Protective film is attached on the surface of LCD panel to prevent scratches or other damages. When removing this protective film, remove it slowly under proper anti-ESD control such as ion blower.

(11) Hold LCD very carefully when placing LCD module into the system housing. Do not apply excessive stress or pressure to LCD module. Do not to use chloroprene rubber as it may affect on the reliability of the electrical interconnection.

(12) Do not hold or touch LCD panel to flex interconnection area as it may be damaged.

(13) As the binding material between LCD panel and flex connector mentioned in 12) contains an organic material, any type of organic solvents are not allowed to be used. Direct contact by fingers is also prohibited.

(14) When carrying the LCD module, place it on the tray to protect from mechanical damage. It is recommended to use the conductive trays to protect the CMOS components from electrostatic discharge. When holding the module, hold the Plastic Frame of LCD module so that the panel, COG and other electric parts are not damaged.

(15) Do not touch the COG's patterning area. Otherwise the circuit may be damaged.

(16) Do not touch LSI chips as it may cause a trouble in the inner lead connection.

(17) Place a protective cover on the LCD module to protect the glass panel from mechanical damages.

(18) LCD panel is susceptible to mechanical stress and even the slightest stress will cause a color change in background. So make sure the LCD panel is placed on flat plane without any continuous twisting, bending or pushing stress.

(19) Protective film is placed onto the surface of LCD panel when it is shipped from factory. Make sure to peel it off before assembling the LCD module into the system. Be very careful not to damage LCD module by electrostatic discharge when peeling off this protective film. Ion blower and ground strap are recommended.

(20) Make sure the mechanical design of the system in which the LCD module will be assembled matches specified viewing angle of this LCD module.

(21) This LCD module does not contain nor use any ODS (1,1,1-Trichloroethane, CCL4) in all materials used, in all production processes.

(22) Reflection sheet is exposed in the rear side of LCD module in order to make this module thinner and lighter.
Please do not laminate something on reflection sheet and push reflection sheet.
If do so, mura or blem could be occurred due to deflection of reflection sheet or breakage inside of LCD module.

[For Operating LCD Module]

(1) Do not operate or store the LCD module under outside of specified environmental conditions.

(2) At the shipment, adjust the contrast of each LCD module with electric volume. LCD contrast may vary from panel to panel depending on variation of LCD power voltage from system.

(3) As opt-electrical characteristics of LCD will be changed, dependent on the temperature, the confirmation of display quality and characteristics has to be done after temperature is set at 25 °C and it becomes stable.

[Precautions for Storage]

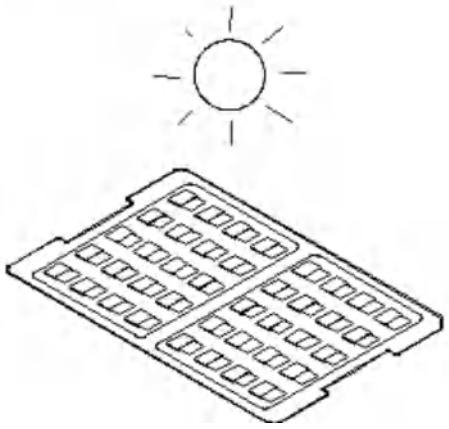
(1) Do not expose the LCD module to direct sunlight or strong ultraviolet light for long periods. Store in a dark place.

(2) The liquid crystal material will solidify if stored below the rated storage temperature and will become an isotropic liquid if stored above the rated storage temperature, and may not retain its original properties. Only store the module at normal temperature and humidity (25±5°C, 60±10%RH) in order to avoid exposing the front polarizer to chronic humidity.

(3) Keeping Method

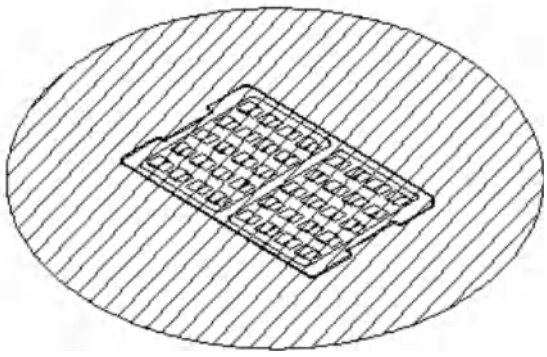
a. Don't keeping under the direct sunlight.

DON'T



b. Keeping in the tray under the dark place.

DO



(4) Do not operate or store the LCD module under outside of specified environmental conditions.

(5) Be sure to prevent light striking the chip surface.

[Other Notice]

(1) Do not operate or store the LCD module under outside of specified environmental conditions.

(2) As electrical impedance of power supply lines (VDDI-GND) are low when LCD module is working, place the de-coupling capacitor nearby LCD module as close as possible.

(3) Reset signal must be sent after power on to initialize LSI. LSI does not function properly until initialize it by reset signal.

(4) Generally, at power on, in order not to apply DC charge directly to LCD panel, supply logic voltage first and initialize LSI logic function including polarity alternation. Then supply voltage for LCD bias. At power off, in order not to apply DC charge directly to LCD panel, execute Power OFF sequence and Discharge command.

(5) Don't touch to FPC surface, exposed IC chip, electric parts and other parts, to any electric, metallic materials.

(6) No bromide specific fire-retardant material is used in this module.

(7) Do not display still picture on the display over 2 hours as this will damage the liquid crystal.

(8) U/V glue (Liquid OCA) should not be attached on upper polarizer edge, when customer laminate cover glass and touch panel on LCD.

[Precautions for Discarding Liquid Crystal Modules]

COG: After removing the LSI from the liquid crystal panel, dispose of it in a similar way to circuit boards from electronic devices.

LCD panel: Dispose of as glass waste. This LCD module contains no harmful substances. The liquid crystal panel contains no dangerous or harmful substances. The liquid crystal panel only contains an extremely small amount of liquid crystal (approx.100mg) and therefore it will not leak even if the panel should break.
Its median lethal dose (LD50) is greater than 2,000 mg/kg and a mutagenic (Aims test: negative) material is employed.

FPC: Dispose of as similar way to circuit board from electric device.

1. Application

This data sheet is to introduce the specification of active matrix 16,777,216 color LCD module.
Main color LCD module is controlled by Driver IC (Synaptics R63455).
If any problem occurs concerning the items not stated in this specification, it must be solved sincerely by both parties after deliberation.
As to basic specification of driver IC refer to the IC specification and handbook.

2. Construction and Outline

This module is a color transmissive, high contrast, wide viewing angle and active matrix LCD module.
Construction: LCD panel, Driver (COG), FPC with electric components, LEDs, prism sheet, diffuser, light guide, reflector and plastic frame to fix them mechanically.

3. Mechanical Specification

Table 1

Item	Specifications	Unit	Remarks
Screen size (Diagonal)	73.406 (2.89inch)	mm	
Active area	51.84(H) x 51.84(V)	mm	
Pixel format	2160(H) x 2160(V)	Pixel	
	1 Pixel =R+G+B dots	-	
Pixel pitch	0.008(H) x 0.024(V)	mm	
Pixel configuration	R,G,B Vertical Stripes	-	
Display mode	Normally Black	-	
Number of colors	16,777,216	Colors	24 bits
Outline dimensions	54.24(W) x 59.32(H) x 1.365(D)	mm	Note 3-1
Mass	TBD	g	

Note 3-1) The above-mentioned table indicates module sizes without some projections and FPC

4. Input Terminal Names and Functions

Pin No	Signal	Function	I / O
1	VSN	Power supply to the analog circuit (-5.8V)	I
2	VSN	Power supply to the analog circuit (-5.8V)	I
3	VDDIO	Power supply to the logic circuit (1.8V)	I
4	VDDIO	Power supply to the logic circuit (1.8V)	I
5	VSP	Power supply to the analog circuit (5.8V)	I
6	VSP	Power supply to the analog circuit (5.8V)	I
7	GND	GND=0V	I
8	BCKLIGHT	Control signal for LED backlight (refer to next page)	O
9	TE-2	Tearing effect output pin2	O
10	TE-1	Tearing effect output pin1	O
11	PNSLV	Selects the master port ("H"=port B, "L"=port A)	I
12	PN2PTX	Selects the number of DSI-2 ports ("H"=1 port, "L"=2 port)	I
13	RESET	Reset pin (Low active)	I
14	GND	GND=0V	I
15	Data 2P_B	Mipi data2 positive signal of MIPI Port B	I
16	Data 2N_B	Mipi data2 negative signal of MIPI Port B	I
17	GND	GND=0V	I
18	Data 1P_B	Mipi data1 positive signal of MIPI Port B	I
19	Data 1N_B	Mipi data1 negative signal of MIPI Port B	I
20	GND	GND=0V	I
21	CLK P_B	Mipi clock positive signal of MIPI Port B	I
22	CLK N_B	Mipi clock negative signal of MIPI Port B	I
23	GND	GND=0V	I
24	Data 0P_B	Mipi data0 positive signal of MIPI Port B	I / O
25	Data 0N_B	Mipi data0 negative signal of MIPI Port B	I / O

26	GND	GND=0V	I
27	Data 3P_B	Mipi data3 positive signal of MIPI Port B	I
28	Data 3N_B	Mipi data3 negative signal of MIPI Port B	I
29	GND	GND=0V	I
30	Data 3N_A	Mipi data3 negative signal of MIPI Port A	I
31	Data 3P_A	Mipi data3 positive signal of MIPI Port A	I
32	GND	GND=0V	I
33	Data 0N_A	Mipi data0 negative signal of MIPI Port A	I / O
34	Data 0P_A	Mipi data0 positive signal of MIPI Port A	I / O
35	GND	GND=0V	I
36	CLK N_A	Mipi clock negative signal of MIPI Port A	I
37	CLK P_A	Mipi clock positive signal of MIPI Port A	I
38	GND	GND=0V	I
39	Data 1N_A	Mipi data1 negative signal of MIPI Port A	I
40	Data 1P_A	Mipi data1 positive signal of MIPI Port A	I
41	GND	GND=0V	I
42	Data 2N_A	Mipi data2 negative signal of MIPI Port A	I
43	Data 2P_A	Mipi data2 positive signal of MIPI Port A	I
44	GND	GND=0V	I
45	GND	GND=0V	I
46	LED-C3	LED cathode 3	I
47	LED-A3	LED-anode 3	I
48	LED-C2	LED cathode 2	I
49	LED-A2	LED-anode 2	I
50	LED-C1	LED cathode 1	I
51	LED-A1	LED-anode 1	I

Matching Connector : FH35C-51S-0.3SHW (HIROSE)

5. Absolute Maximum Ratings

Table2 GND=0V

Parameter	Symbol	Conditions	Rated Value	Unit	Remarks
Driver IC (Positive Analog) Power Supply Voltage	AVDD	Ta=+25°C	-0.3 to +6.5	V	Note5-1
Driver IC (Negative Analog) Power Supply Voltage	AVEE	Ta=+25°C	+0.3 to -6.5	V	Note5-1
Driver IC (Digital) Power Supply Voltage	VDDI	Ta=+25°C	-0.3 to +5.5	V	Note5-1
Temperature for storage	T_{stg}	-	-20 to +70	°C	Note5-2
Temperature for operation	T_{opr}	-	-10 to +60	°C	Note5-2
LED Input electric current	ILED	Ta=+25°C	0 to 100 (Duty 10%)	mA	Note5-3

Note5-1) Voltage applied to GND pins. GND pin conditions are based on all the same voltage (0V). Always connect all GND externally and use at the same voltage.

Note5-2) Humidity: 95%RH Max.(at T*a*≤40°C). Maximum wet-bulb temperature is less than 39°C (at T*a*>40°C). Condensation of dew must be avoided.

Note5-3) Ambient temperature and the maximum input are fulfilling the following operating conditions.

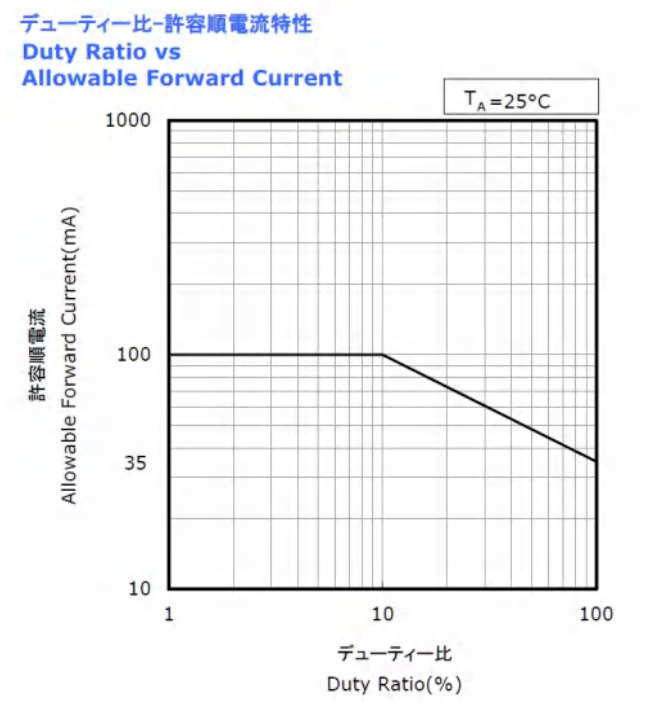


Fig. 1

6. Electrical Specifications

6-1. TFT-LCD Panel Driving Section

Ta=+25°C, GND=0V

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
Driver IC(Digital) Power Supply Voltage	VDDI		1.80		V	
Driver IC(Positive Analog) Power Supply Voltage	AVDD		5.5		V	
Driver IC(Negative Analog) Power Supply Voltage	AVEE		-5.5		V	
Current consumption	I_{VDDIO}	-	117.5		mA	Note6-1
	I_{VSP}	-	23.64		mA	
	I_{VSN}		-19.65	-	mA	
Power consumption			449.6		mW	

Note6-1) 90Hz / white pattern / C-phy 6Trio / without DSC

6-2. Back Light Driving Section

Table3

Ta=+25°C, GND=0V

Parameter	Symbol	Min.	Typ.	Max.	Unit	Remarks
LED Voltage	V_{LED}	-	6.15	-	V	per unit
LED Current	I_{LED}	-	40	-	mA	Duty 10%
Power Consumption	W_{LED}	-	295.2	-	mW	Time average
LED Quantity			12		pcs	

7. Timing characteristics of input signals

7-1. MIPI DC/AC Characteristics

TBD

7-2. Reset Timing Characteristics

TBD

7-3. Display Timing

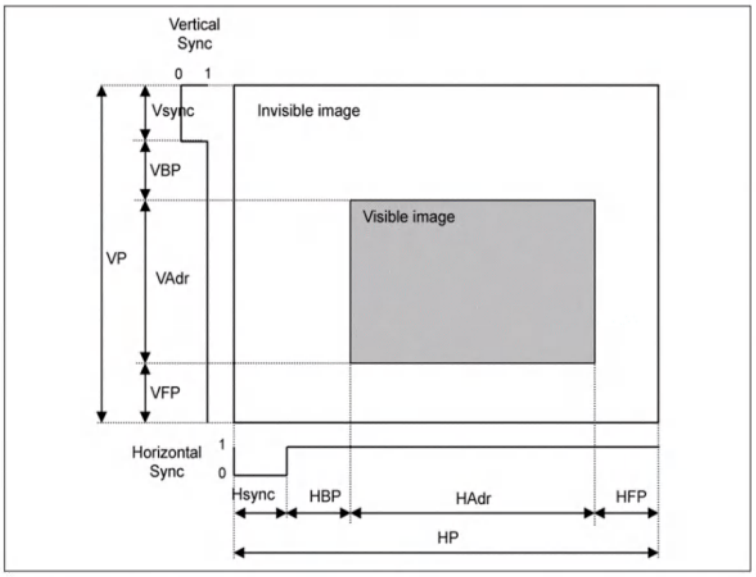


Fig. 2

< Interface Display timing (90Hz frame / 6ms scanning driving) >

Table4 I/F: MIPI C-phy 6Trio, Dots Size: 2160xRGBx2160

Item	Min.	Typ.	Max.	Unit
Horizontal data start point(HS+HBP)		TBD		Pixel
Horizontal active area (HAdr)		2160		Pixel
Horizontal front porch(HFP)		TBD		Pixel
Vertical low pulse width(VS)		TBD		H
Vertical front porch(VFP)		TBD		H
Vertical back porch(VBP)		TBD		H
Vertical active area (VAdr)		2160		H
Frame Frequency	-	TBD	-	Hz
1H Time	-	TBD	-	us
DSI DATA rate	-	TBD	-	Mbps/Lane

< B/L Impulse Driving timing (90Hz frame / 6ms scanning driving) >

TBD

8. Power Sequence

8-1. Power ON Sequence

TBD

8-2. Power OFF Sequence

TBD

9. Input Signals, Basic Display Colors and Gray Scale of Each Color

Table5 0: Low level voltage, 1: High level voltage

	Colors & Gray Scale	Gray Scale	Data signals Signal																							
			R0 LSB	R1	R2	R3	R4	R5	R6	R7 MSB	G0 LSB	G1	G2	G3	G4	G5	G6	G7 MSB	B0 LSB	B1	B2	B3	B4	B5	B6	B7 MSB
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	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
Gray Scale of Red	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
	⇧	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
	Darker	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
	⇧	↓					↓								↓							↓				
	⇩	↓					↓								↓							↓				
	Brighter	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
Gray Scale of Green	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
	⇧	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
	Darker	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
	⇧	↓					↓								↓							↓				
	⇩	↓					↓								↓							↓				
	Brighter	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	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
Gray Scale of Blue	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
	⇧	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
	Darker	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
	⇧	↓					↓								↓							↓				
	⇩	↓					↓								↓							↓				
	Brighter	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

Each basic color can be displayed in 256 gray scales from 8 bit data signals. According to the combination of total 24 bit data signals, the 16,777,216-color display can be achieved on the screen.

10. Optical Characteristic

TARGET

Table6 VDDI=1.8V, AVDD=5.5V, AVEE=-5.5V, Frame Frequency = 90fps, ILED=40mA@10%Duty, Ta = 25℃

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remark
Contrast Ratio	CR	θ=0°	600	800	-	-	Note10-1,2
Response Time	τ	θ=0°	-	3.0	-	ms	Black to White Note10-3
			-	4.0	-	ms	Gray to Gray Note10-3
White Chromaticity	x	θ=0°	0.287	0.313	0.343	-	
	y		0.299	0.329	0.359	-	
Red Chromaticity	x		-	0.64	-	-	
	y		-	0.33	-	-	
Green Chromaticity	x		-	0.3	-	-	
	y		-	0.6	-	-	
Blue Chromaticity	x		-	0.15	-	-	
	y		-	0.06	-	-	
Brightness	L	θ=0°	80	100	-	cd/m²	
Uniformity	U	θ=0°	-	-	-	%	Note10-4
NTSC Ratio	S	θ=0°	-	72	-	%	
Gamma	γ	θ=0°	-	2.2	-	-	
Flicker	F	θ=0°	-	-	TBD	dB	Note10-5
Crosstalk	CT	θ=0°	-	-	TBD	%	

*The measuring method of the optical characteristics is shown by the following figure.
*A measurement device is TOPCON luminance meter SR-3. (Measurement angle 1°)

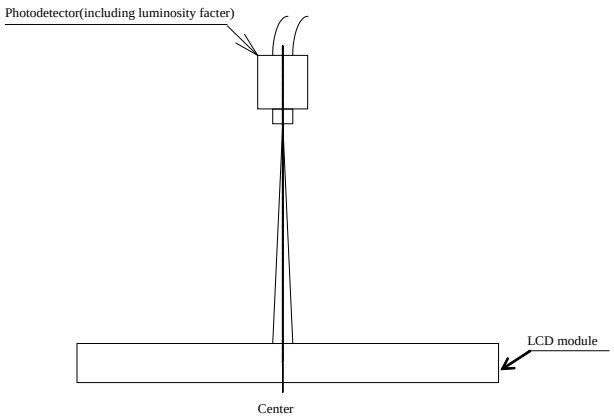


Fig. 3

Note 10-1) Contrast / NTSC / GAMMA viewing angle is defined as follows.

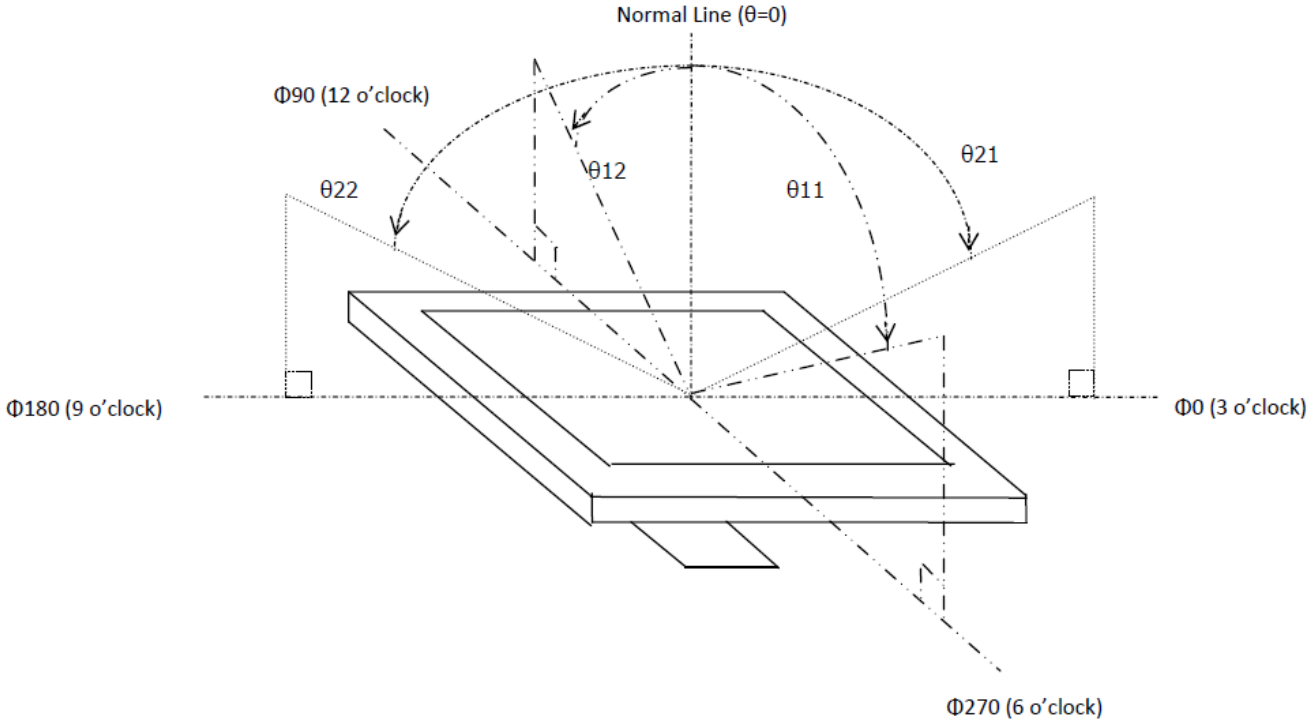


Fig. 4

Note 10-2) Definition of contrast ratio:

The contrast ratio is defined as the follows:

$$\text{Contrast Ratio (CR)} = \frac{Luminance(brightness)\ with\ all\ pixels\ white}{Luminance(brightness) with\ all\ pixels\ black}$$

Note 10-3) Definition of response time:

The response time is defined as the following figure and shall be measured by switching the input signal for "black" and "white"

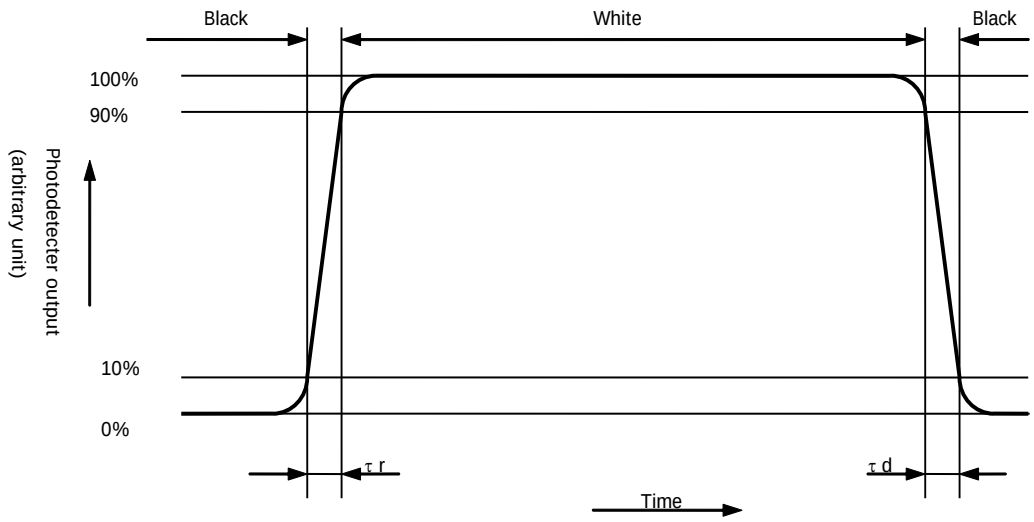


Fig. 5

Note 10-4) Uniformity is defined as follows:

$$\text{Uniformity} = \frac{Minimum\ Luminance\ (brightness) in\ 9\ points}{Maximum\ Luminance\ (brightness)\ in\ 9\ points}$$

Note 10-5) Measuring systems: Konica-Minolta CA-310

- Temperature = 25°C (±3°C), Frame Frequency = T.B.D. Hz, LED back-light: ILED= T.B.D. mA/Duty 100%, Environment brightness < 150 lx
- Measured sample : New sample before a long term aging.
- Flicker ratio is very sensitive to measuring condition.
- Measuring pattern Please refer to figure below.

11. Reliability

Table 7

No.	Test item	Conditions
1	High temperature storage test	Ta = +70°C, 200h
2	Low temperature storage test	Ta = -20°C, 200h
3	High temperature operation test	Ta = +60°C, 120h
4	Low temperature operation test	Ta = -10°C, 120h
5	High temperature and high humidity operation test	Ta = +40°C95%RH, 120h (No condensation)
6	Heat shock test	Ta = -20℃(30min) ~ 70°C(30min), 10 cycle
7	Electro static discharge test	±200V, 200pF(0Ω) to Terminals(Contact) 1 time for each terminals, None operation

Note 11-1) Ta = Ambient temperature

Note 11-2) Check items for other Test

In the standard condition, there shall be no practical problems that may affect the display function.

Outline dimension