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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.
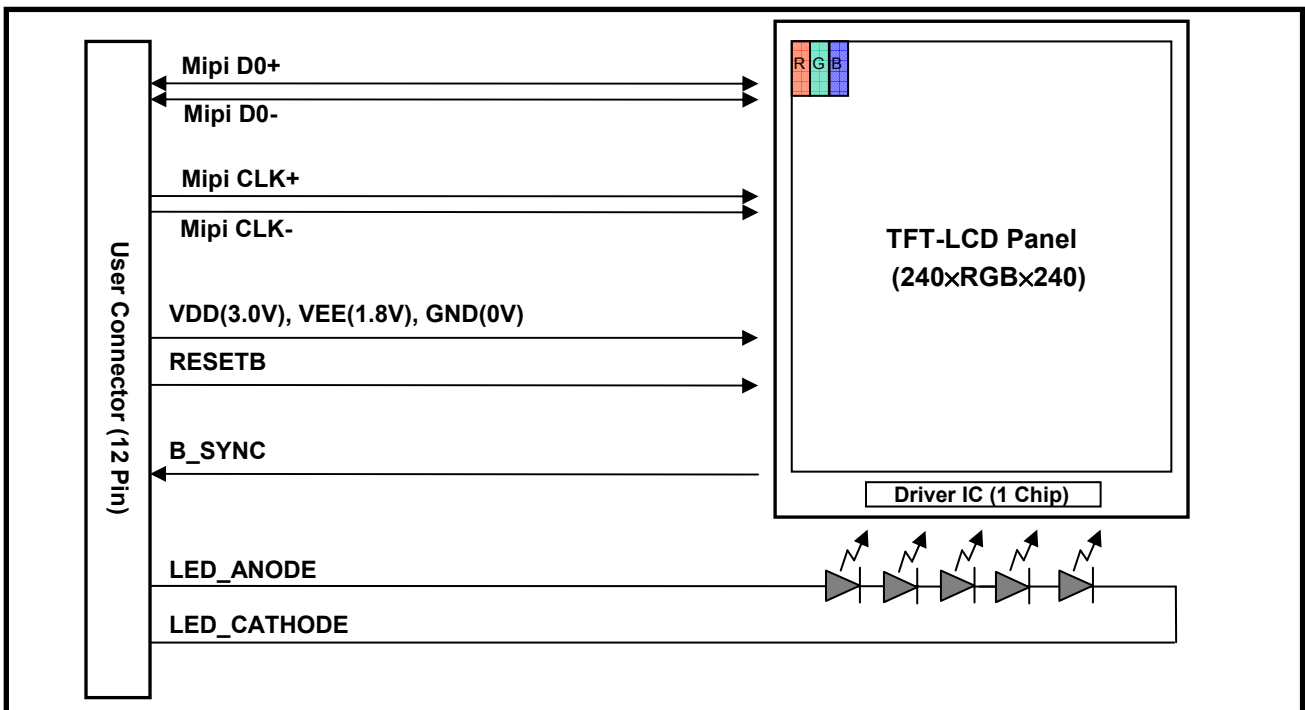
Block Diagram

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 @ 10.5mA), 25mW (max. B/L off)
Luminance	450nit(typ.) @ 10.5mA
Viewing Direction	6:30 o'clock (Non-inversion)

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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.
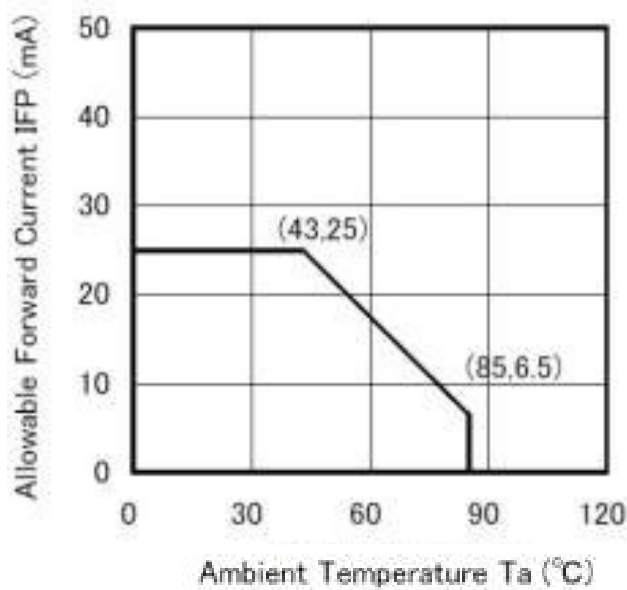 2. Allowable forward current is refer to Fig 2.1

Fig 2.1 Ambient Temperature vs. Allowable Forward Current
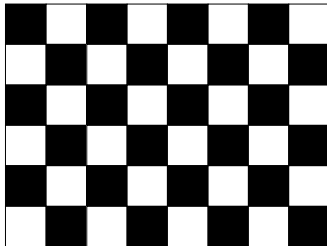
Product Specification

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	

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3-3. INTERFACE CONNECTIONS

LCD Connector: 503552-1220 (Molex)

System Mating Connector: 503548-1220 (Molex)

Table 3.3 Module Connector Pin Configuration

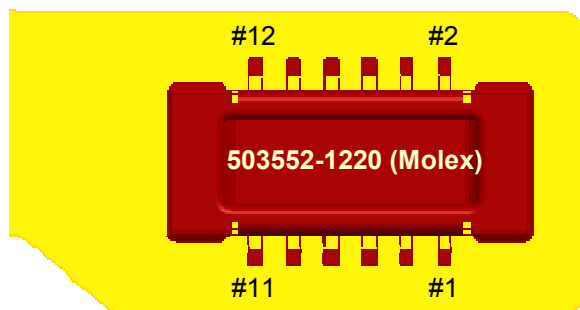| Pin	Signal	I/O	Description
1	CLKP	I/O	MIPI Clock
2	VDD	-	3.0V Power Supply
3	CLKN	I/O	MIPI Clock
4	VEE	-	1.8V Power Supply
5	GND	-	Ground
6	B_Sync	O	Synchronization Pulse Signal
7	D0P	I/O	MIPI Data
8	Reset	I	Reset (Active Low)
9	D0N	I/O	MIPI Data
10	LED+	O	LED Anode
11	GND	-	Ground
12	LED-	O	LED Cathode

Fig 3.1 Connector Diagram

Note:

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

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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

| ~250ms | >=5ms | >=1ms | >=5ms |

1.8V

RES

3.0V

SW Command — HS clock on
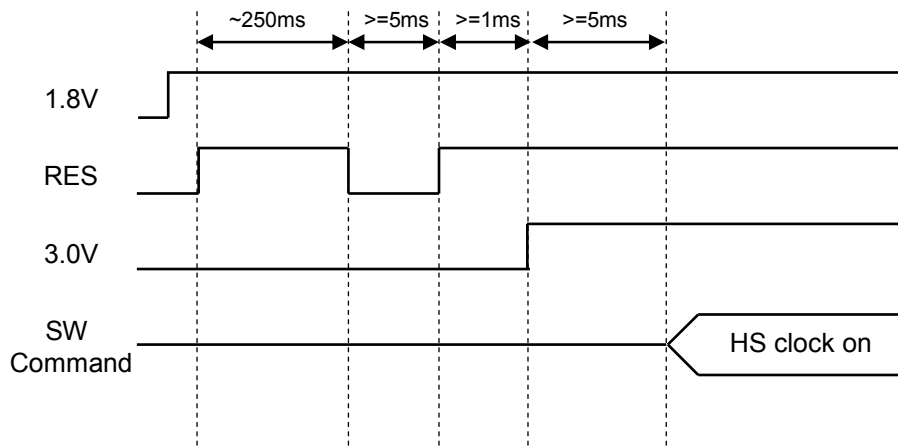
Fig 3.2 Power On Requirements

Power Off Sequence

| >=120ms | >=5ms | >=5ms |

1.8V

RES

3.0V
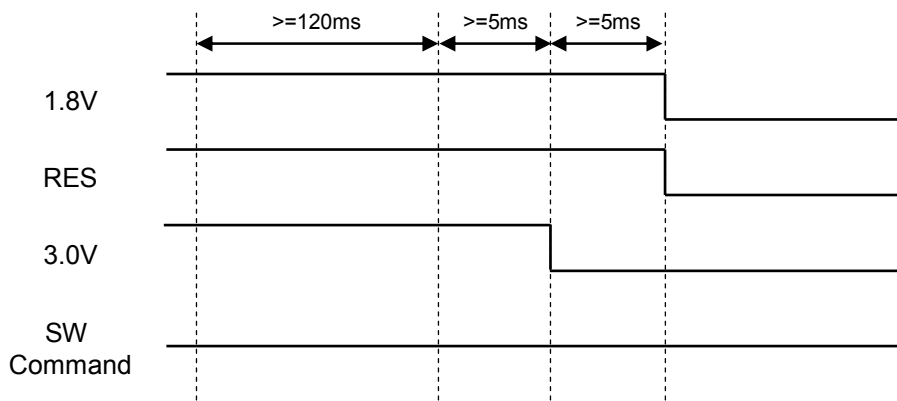
SW Command

Fig 3.3 Power Off Requirements

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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

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4. OPTICAL CHARACTERISTICS

4-1. Optical Characteristics – Backlight On

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit	Remarks
Viewing Angle Range	$\ominus$UP	CR $\geq$10	40	50		°(degree)	Note 3
	$\ominus$DOWN		40	50		°(degree)	Note 3
	$\ominus$LEFT		40	50		°(degree)	Note 3
	$\ominus$RIGHT		40	50		°(degree)	Note 3
Contrast Ratio	CR	Optimal	100	150		--	Note 2
Brightness	Y	I_{LED}= 10.5mA	400	450		cd/㎡	Note 1 [PR880]
Brightness Uniformity	Y	I_{LED}=10.5mA	80			%	Note 5 [PR880]
Flicker	F	Optimal			10	%	Note 6
Response Time	$\tau_f + \tau_r$	$\ominus$ =0 ° Ta =25 ℃		35	50	ms	Note 4
White Chromaticity	Wx	$\ominus$ =0 ° Ta =25 ℃		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.

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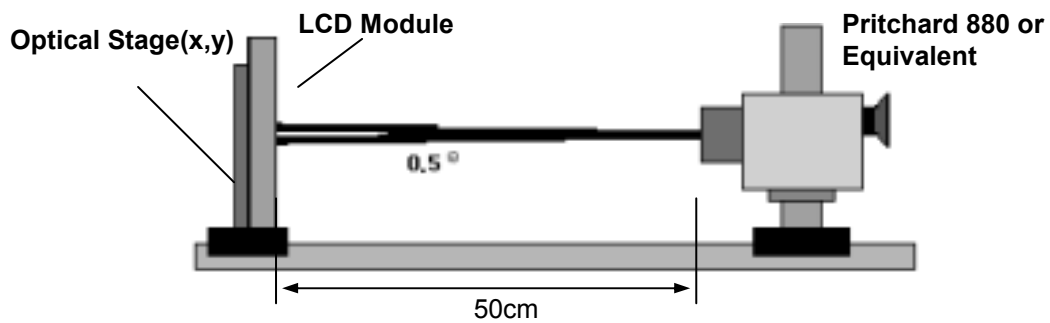
Fig 4.1 Backlight On (Optical Characteristic Measurement Equipment and Method)

[Note 2]

Contrast Ratio is defined as follows ;

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

[Note 3]

Viewing Angle Range is defined as follows;
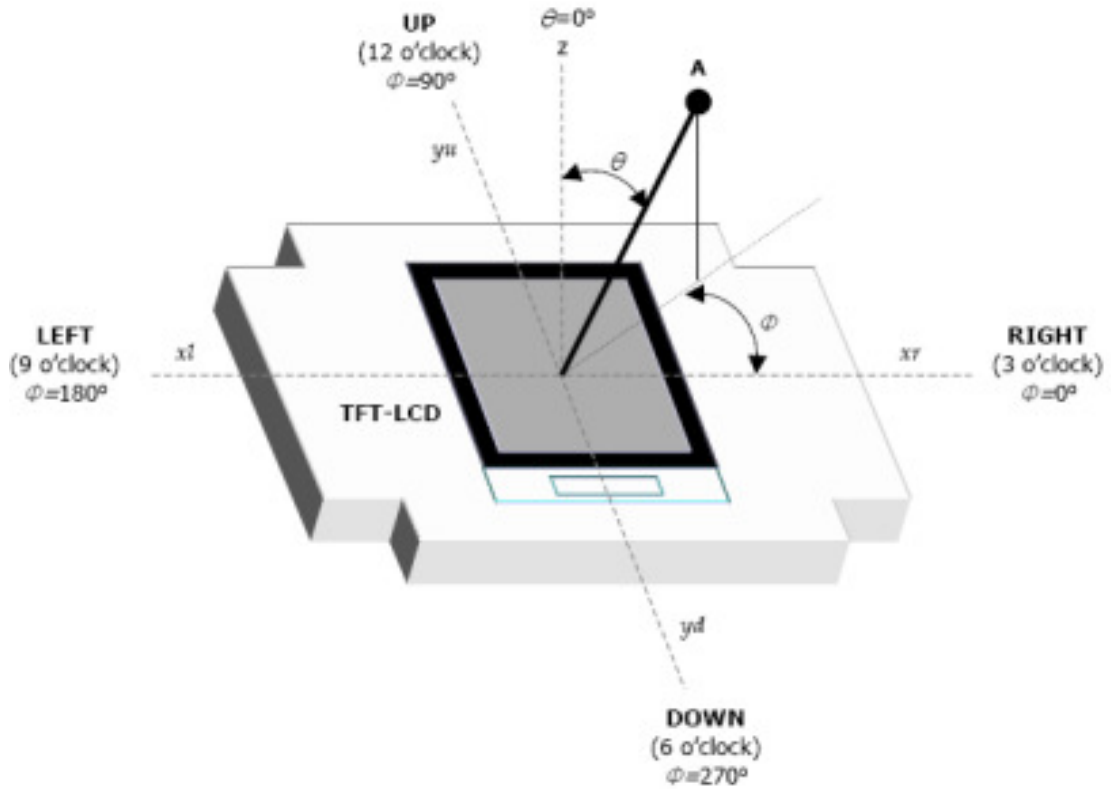
Fig 4.2 Viewing Angle Definitions

[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".
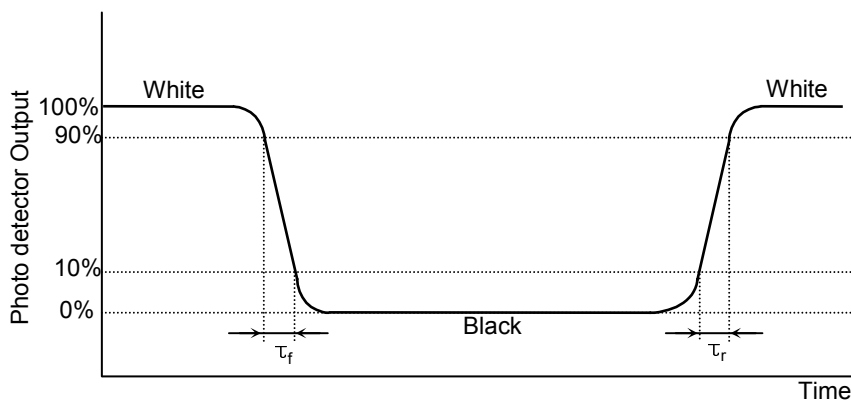
Fig 4.3 Response Time Definition

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[Note 5]

The brightness measurement is taken at point B5.

$$\text{Brightness Uniformity} = \frac{\text{Minimum photo detector output for B1-B9 with all pixels white}}{\text{Maximum photo detector output for B1-B9 with all pixels white}} \times 100$$
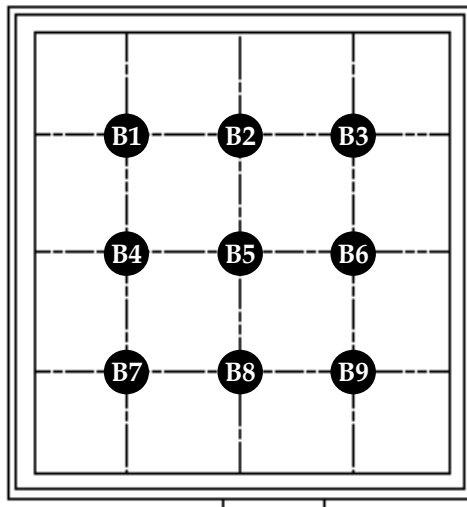
Fig 4.4 Brightness Measurement Points

[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.
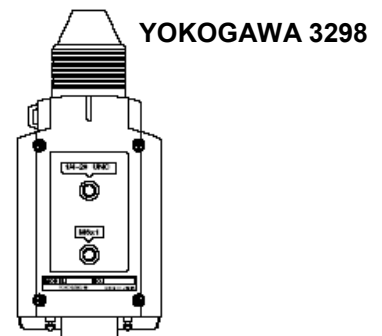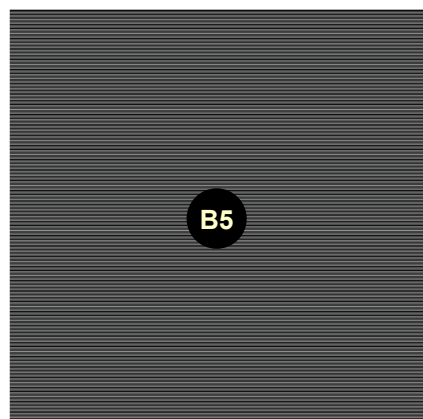
Fig 4.5 Flicker Measurement Points

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

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[Outline Dimension]