NEC

NEC Corporation
NEC Electron Devices
Display Device Operations Unit
Color LCD Division
2nd Engineering Department

TFT COLOR LCD MODULE

Type: NL2432DR22-11B
8.9cm (3.5 Type), QVGA

SPECIFICATIONS

(Second Edition, July 10, 2001)

PRELIMINARY

This document is preliminary. All information in this document is subject to change without prior notice.

The devices listed in this document are for use of "Standard" applications as specified below, and are not suitable for use of "Special" or "Specific" applications as specified below. NEC disclaims any responsibility or liability of any kind for any failure of equipment, personal injury or damage to property that may arise from the use of NEC devices for such "Special" applications.
The devices listed in this document should not be used for such "Specific" applications.

Application examples recommended by NEC Corporation.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots.

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support).

Specific: Military systems, aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, or any other equipment for which specifically high standard of quality or reliability is required.

1. DESCRIPTION

The NL2432DR22-11B is a TFT (thin film transistor) active matrix color liquid crystal display (LCD) comprising an amorphous silicon TFT attached to each signal electrode, a driving circuit.
This module is consist of LCD panel, Driver, Front light and Touch panel

The 8.9 cm (3.5 Type) diagonal display area contains 240 × 320 pixels and can display 262,144 colors simultaneously.

2. FEATURES

Front light type with four LEDs (Light Emitting Diodes)
Include Touch panel
Recommended LCD controller: part no. S1L50282F23k100, NEC corp.
High contrast ratio
6-bit digital RGB signals

3. APPLICATIONS

PDA

4. STRUCTURE AND FUNCTION

A reflective TFT (thin film transistor) color LCD module is comprised of a TFT liquid crystal panel structure with LSIs for driving the TFT array. Sandwiching liquid crystal material in the narrow gap between a TFT array glass substrate and a color filter glass substrate creates the TFT panel structure.
RGB (red, green, blue) data signals from a source system are modulated into a form suitable for active-matrix addressing by the onboard signal processor and sent to the driver LSIs, which in turn addresses the individual TFT cells.
Acting as an Electro-optical switch, each TFT cell regulates light from the natural light and so on when activated by the data source. By regulating the amount of light reflection passing through the array of red, green, and blue dots, color images are created with clarity.

5. OUTLINE OF CHARACTERISTICS (at room temperature)

Display area	53.64 (H) × 71.52 (V) mm [Diagonal 8.9 cm]
Drive system	a-Si TFT active matrix
Display colors	262,144 colors
Number of pixels	240 (H) × 320 (V)
Pixel arrangement	RGB vertical stripe
Pixel pitch	0.2235 (H) × 0.2235 (V) mm
Module size	66.2 (Typ., H) × 91.0 (Typ., V) × 4.5 (Typ., D) mm [D: Not include FPC connector]
Weight	52 g (Typ.)
Contrast ratio	10:1 (Typ.:With Front light and Touch panel) Reference: 40:1 (Without Front light and Touch panel)
Response time	32 ms (Typ., Ton + Toff)
Reflection ratio	17 % (Typ. With Front light and Touch panel) Reference: 35%(Without Front light and Touch panel)
Signal system	Controller input (6-bit signals, DCK, DE, POC, OEN) signals Note 1
Supply voltage	VCC 3.0 V (typ. Logic) VDD 5.0 V (typ. ϒ control) VGON 15.0 V (LCD driving) VGOFF –15.0 V (LCD driving)
Power consumption	26 mW (Typ.) Target value Both Gamma and COM circuit in driver are included. Neither Front light nor Touch panel are included.

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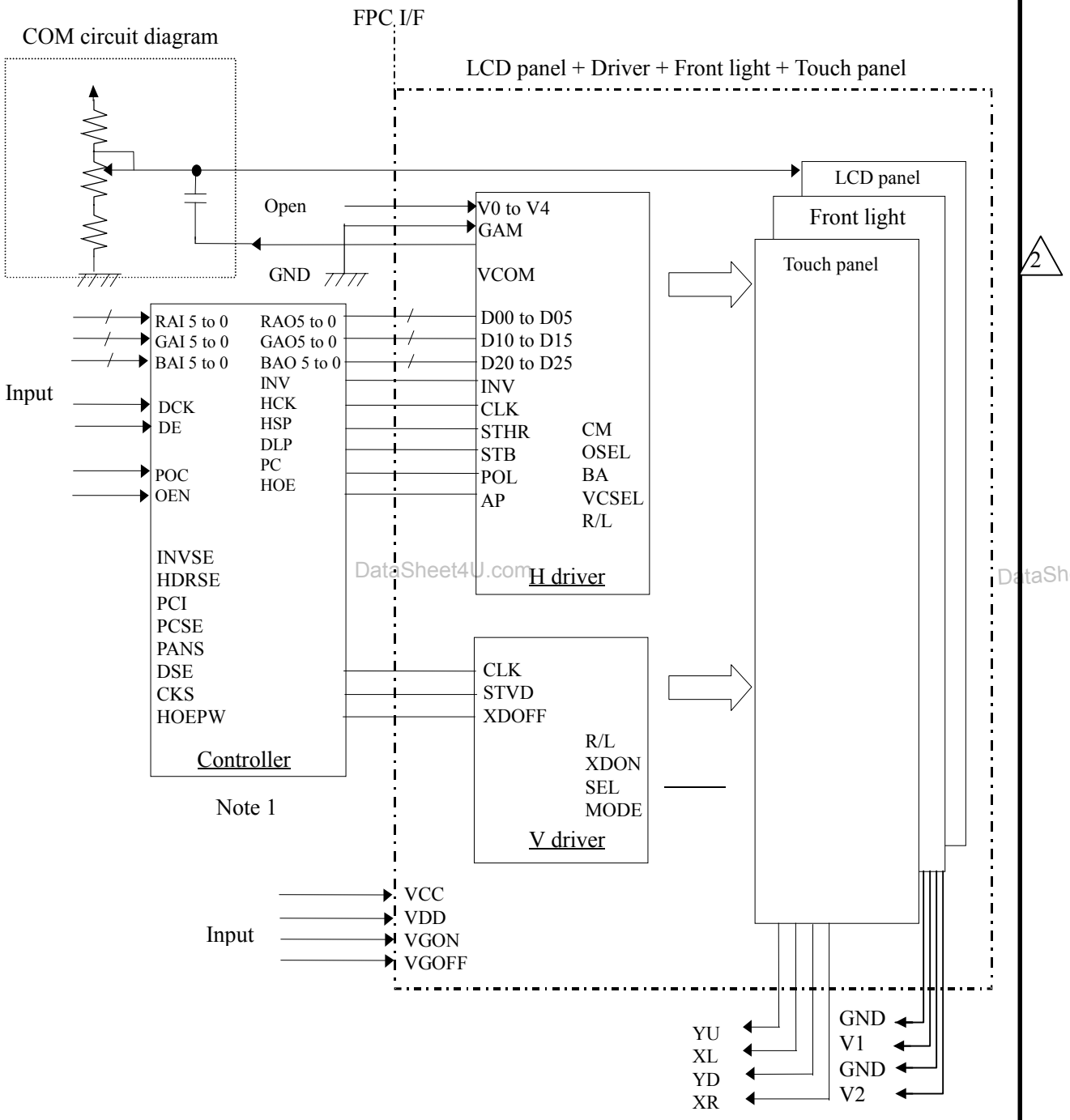
Note 1: Refer to the controller (part no.: S1L50282F23k100) specifications.

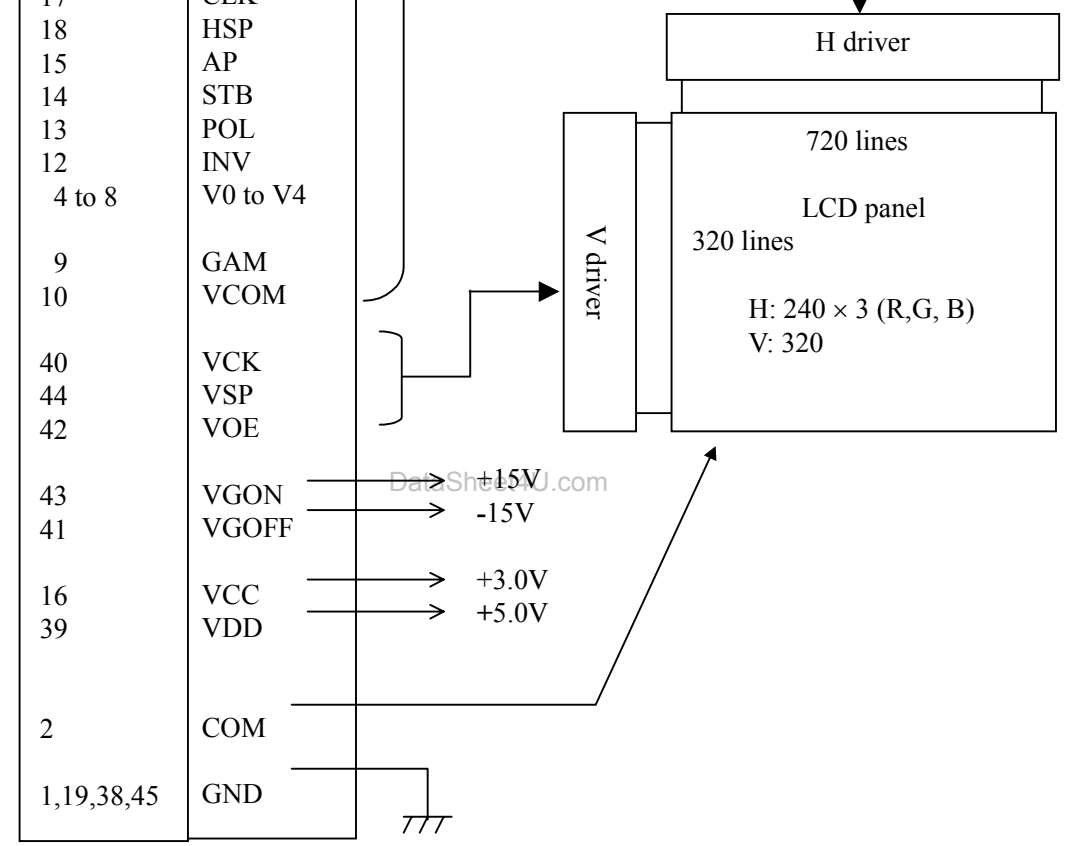
6. BLOCK DIAGRAM



Note 1: Refer to the controller (part no.: S1L50282F23k100) specifications for input timings.

FPC I/F

Terminal No.	Symbol
32 to 37	D00 to D05
26 to 31	D10 to D15
20 to 25	D20 to D25
17	CLK
18	HSP
15	AP
14	STB
13	POL
12	INV
4 to 8	V0 to V4
9	GAM
10	VCOM
40	VCK
44	VSP
42	VOE
43	VGON
41	VGOFF
16	VCC
39	VDD
2	COM
1,19,38,45	GND



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7. GENERAL SPECIFICATIONS

Items	Specifications	Units
Module size	66.2 ± TBD(H) ×91.8 ± TBD (V) × 5.0 ± TBD (D)	mm
Display area	53.64 (H) × 71.52 (V) [Diagonal display area: 8.9 cm (Type 3.52)]	mm
Number of pixels	240 (H) × 320 (V)	pixel
Dot pitch	0.0745 (H) × 0.2235 (V)	mm
Pixel pitch	0.2235 (H) × 0.2235 (V)	mm
Pixel arrangement	RGB (Red, Green, Blue) vertical stripe	-
Display colors	262,144	color
Weight	52 (typ.)	g

8. ABSOLUTE MAXIMUM RATINGS

Parameters	Symbols	Ratings	Units	Remarks
Supply voltage	VCC	-0.3 to +4.0	V	Ta = 25 °C
	VDD	-0.3 to +6.0	V	Ta = 25 °C
	VGON	-0.3 to +44.0		
	VGOFF	VGON – 44.0 to +0.3		
Logic input voltage	VI	-0.3 to VCC+0.3	V	Logic signals
γ control voltage	V0 to V4	-0.3 to VDD+0.3	V	-
Storage temperature	Tst	-20 to +70	℃	-
Operating temperature	Top1	0 to +50		Module surface Note: 1
Relative humidity (RH) Note 2		≤ 95	%	Ta≤ 40°C
		≤ 90		40°C <Ta≤ 50°C
Absolute humidity Note 2		Absolute humidity shall not exceed Ta = 50°C, RH = 90%.	g/m^3	Ta>50°C
Storage altitude		≤ TBD	m	-20°C ≤ Ta ≤ 70°C
Operating altitude		≤ TBD	m	0°C ≤ Ta ≤ 50°C

Note 1: Measure at the display area

Note 2: No condensation

9. ELECTRICAL CHARACTERISTICS

(1) Logic/ LCD driving (Ta = 25°C)

Parameters	Symbols	Min.	Typ.	Max.	Units	Remarks
Logic supply voltage	VCC	2.6	3.0	3.6	V	-
H driver supply voltage	VDD	4.8	5.0	5.5	V	-
V driver(+) supply voltage	VGON	14.0	15.0	16.0	V	-
V driver(-) supply voltage	VGOFF	-16.0	-15.0	-14.0	V	-
Logic input high voltage	VIH	0.7×VCC	-	VCC	V	Logic signal
Logic input low voltage	VIL	0	-	0.3×VCC	V	
γ control supply voltage	V0 to V4	GND +0.1	-	VDD-0.1	V	
COM voltage input range	COM	VDD	-	-	Vp-p	
COM center voltage note 1	COM/C	1.3	1.8	2.3	V	At (V0-V4)/2=2.5V
VCC supply current	ICC	-	0.2	TBD	mA	VCC= 3.0 V Not include the controller
VDD supply current	IDD	-	5.2	TBD	mA	VDD= 5.0 V
VGON supply current	IGON	-	0.04	TBD	mA	VGON=15.0 V
VGOFF supply current	IGOFF	-	0.04	TBD	mA	VGOFF= -15.0 V

Note 1: An optimal value for COM/C is in the range of 1.3 to 2.3.

(2) Front light (Ta = 25°C)

Parameters	Symbols	Min.	Typ.	Max.	Units	Remarks
Forward Voltage	VL	-	TBD	TBD	V	At IL = 18mA
Reverse current	IL	-	50	-	μA	At VR = 5V

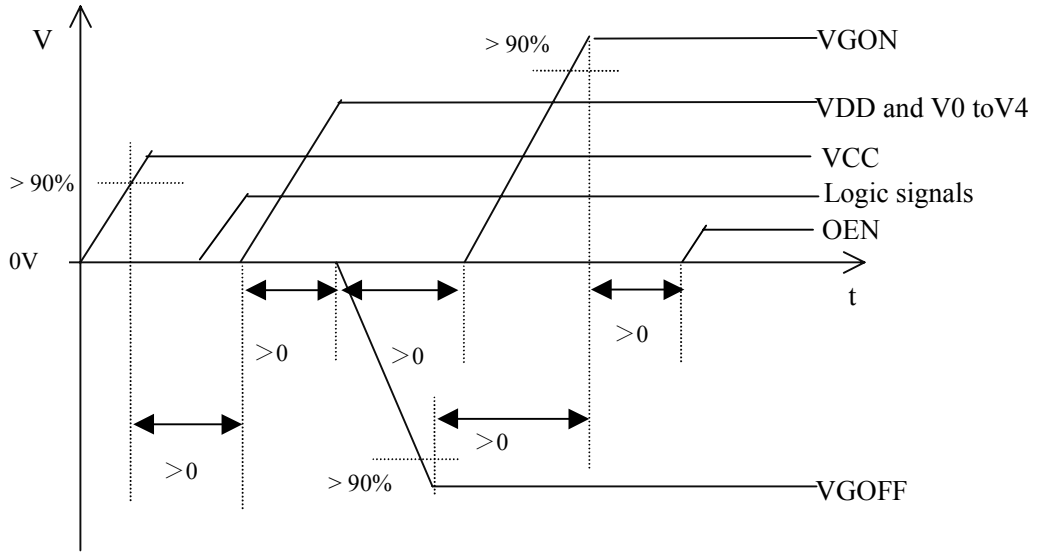
Remark 1: The front light has four LEDs.

(2) Touch panel (Ta = 25°C)

Parameters	Symbols	Min.	Typ.	Max.	Units	Remarks
Touch panel input voltage	TBD	3.0	5.0	5.5	V	-
Insulation resistance	TBD	10	-	-	MΩ	At DC 25 V

Remark 1: Refer to TBD.

10. SUPPLY VOLTAGE SEQUENCE



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Remark1: Supply voltages must keep above timings or input at the same time. And when supply voltages are blocked, these must be opposite timings.

Remark2: The "OEN" signal of the controller should be "H" after VGON.

Remark3: The signal should not be down during operation. Even if signal could recover, LCD module can not be operated correctly, the display may be un-uniformity. In case signal is down, VCC should be turned off, and then turn VCC and signal on as above sequence.

11. INTERFACE PIN CONNECTIONS

(1) Interface connector for signals and power

CN1

Adaptable socket: FH12-45S-0.5SH (lower terminal type) or FH12A-45S-0.5SH (upper terminal type)

Supplier: Japan Aviation Electronics Industry, Limited.

Pin No.	Symbols	Functions	Pin No.	Symbols	Functions
1	GND	Ground	24	D24	Blue data
2	COM	Signal for common electrode	25	D25	Blue data(MSB)
3	N.C.	Non-connection	26	D10	Green data(LSB)
4	V0	γ control	27	D11	Green data
5	V1		28	D12	Green data
6	V2		29	D13	Green data
7	V3		30	D14	Green data
8	V4		31	D15	Green data (MSB)
9	GAM	External γ signal select	32	D00	Red data(LSB)
10	VCOM	Driver output signal	33	D01	Red data
11	N.C.	Non-connection	34	D02	Red data
12	INV	Data reversal signal	35	D03	Red data
13	POL	Polarity reversal signal	36	D04	Red data
14	STB	H driver latch signal	37	D05	Red data(MSB)
15	AP	H driver inhibition signal	38	GND	Ground
16	VCC	Logic voltage	39	VDD	H driver voltage
17	HCK	H driver shift clock	40	VCK	V driver shift clock
18	HSP	H driver start pulse	41	VGOFF	V driver OFF voltage
19	GND	Ground	42	VOE	V driver output enable (“L” output)
20	D20	Blue data(LSB)	43	VGON	V driver ON voltage
21	D21	Blue data	44	VSP	V driver start pulse
22	D22	Blue data	45	GND	Ground
23	D23	Blue data			

(2) Interface connector for front light

CN2

Adaptable socket: 04FH-SM1-TB

Supplier: J.S.T. TRADING COMPANY LTD.)

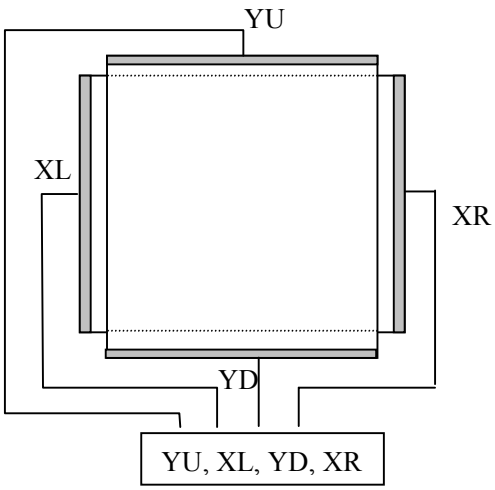
Pin No.	Symbols	Functions
1	GND	Ground (left cathode)
2	V1	LED 1 Voltage (left anode)
3	GND	Ground (right cathode)
4	V2	LED 2 Voltage (right anode)

(3) Interface connector for touch panel

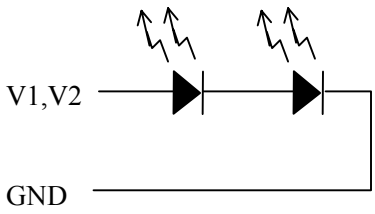
CN3 socket: SLW4R-5STE1

Adaptable plug: FCI Japan

Pin No.	Symbols	Functions
1	XR	Horizontal terminal (Right side)
2	YD	Vertical terminal (Down side)
3	XL	Horizontal terminal (left side)
4	YU	Vertical terminal (Up side)



Circuits of touch panel



Circuits of front light

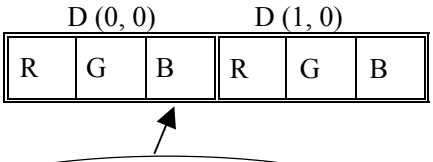
12. DISPLAY COLORS vs. DISPLAY POSITIONS

(1) Display colors

Display colors		Data signal(0: Low level, 1: High level)																	
		R5	R4	R3	R2	R1	R0	G5	G4	G3	G2	G1	G0	B5	B4	B3	B2	B1	B0
Basic colors	Black	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	1	1	1	1	1	1
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
	Magenta	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1	1	1	1
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
	Cyan	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1
	Yellow	1	1	1	1	1	1	1	1	1	1	1	1	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
Red grayscale	Black	0	0	0	0	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	0	0
	dark	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑				:						:						:		
	↓				:						:						:		
	bright	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
Green grayscale	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	0	0	0	0	0	1	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	↑				:						:						:		
	↓				:						:						:		
	bright	0	0	0	0	0	0	1	1	1	1	0	1	0	0	0	0	0	0
		0	0	0	0	0	0	1	1	1	1	1	0	0	0	0	0	0	0
	Green	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	0	0	0
Blue grayscale	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	0	0	0	0	0	0	0	0	0	0	0	1
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	↑				:						:						:		
	↓				:						:						:		
	bright	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0
	Blue	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1

Remark 1: Colors are developed in combination with 6-bit signals (64 steps in grayscale) of each primary red, green, and blue color. This process can result in up to 262,144 (64×64×64) colors.

(2) Display positions of input data



D(0, 0)	D(1,0)	•••	D(239,0)
D(0,1)	D(1, 1)	•••	D(239,1)
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
•	•	•	•
D(0, 319)	D(1, 319)	•••	D(239,319)

13. OPTICAL CHARACTERISTICS

< Front light turning off > Note 1

Parameters	Symbols	Conditions	Min.	Typ.	Max.	Units	Remarks
Contrast ratio	CR	-	TBD	10:1	-	-	Note 2,3
Reflection ratio	RE	-	TBD	17	-	%	Note 3
Chromaticity Coordinates	W	White (x, y)	-	0.30, 0.31	-	-	Note 4

< Front light turning on > Note 1

Parameters	Symbols	Conditions	Min.	Typ.	Max.	Units	Remarks
Contrast ratio	CR	-	TBD	8:1	-	-	Note 2,5
Chromaticity Coordinates	W	White (x, y)	-	TBD	-	-	Note 5
Luminance	Lu	IL= 18mA	-	15	-	cd/m^2	Note 5

Reference data

Note 1

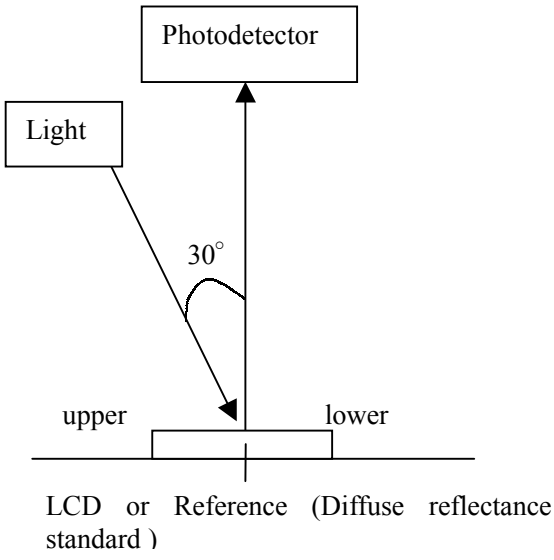
Parameters	Symbols	Conditions		Min.	Typ.	Max.	Units	Remarks
Response time (Module front surface temperature = TBD°C)	Ton	White to black	90%→10%	-	15	TBD	ms	Note 6
	Toff	Black to white	10%→ 90%	-	17	TBD		

Note 1: Ta = 25 °C, VCC= 3.0V, Include front light and Touch panel

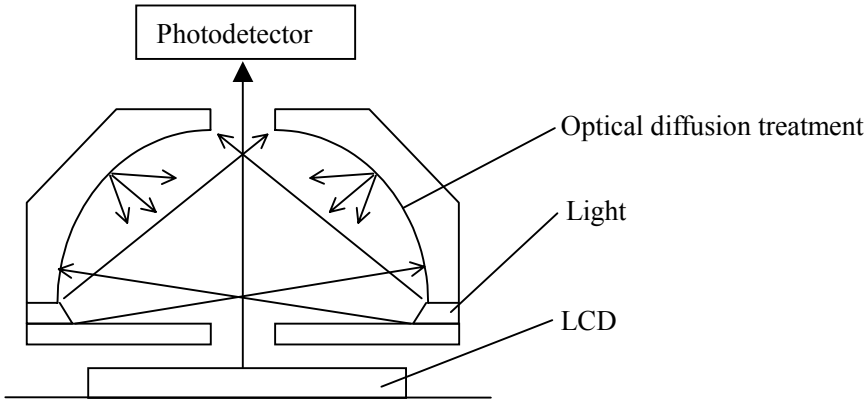
Note 2: The contrast ratio is calculated by using the following formula.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance with all pixels in "white"}}{\text{Luminance with all pixels in "black"}}$$

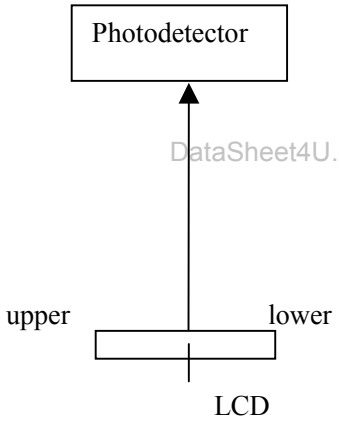
Note 3: Contrast ratio and reflection ratio are measured as follows.



Note 4: White chromaticity coordinate is measured as follows.

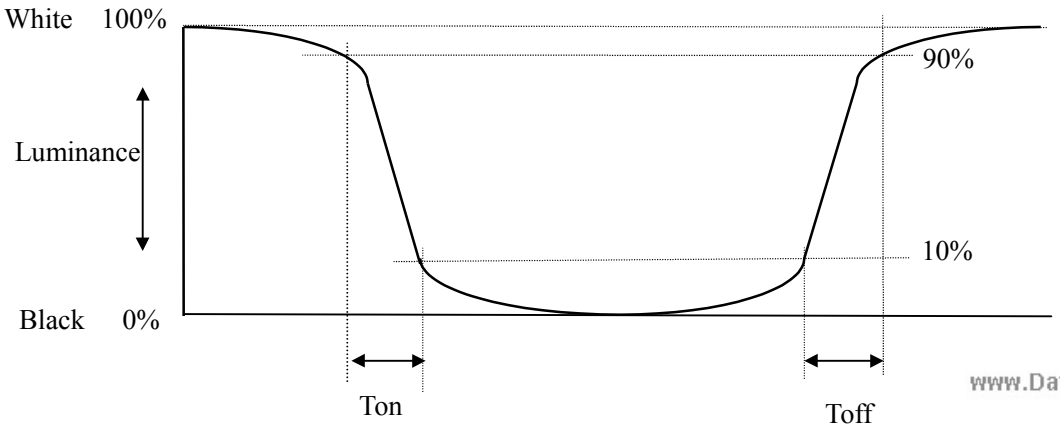


Note 5: Contrast ratio, Chromaticity Coordinates and Luminance are measured as follows.



Note 6: Definitions of response time is as follows.

Photo-detector output signal is measured when the luminance changes "white" to "black" or "black" to "white".



14. TOUCH PANEL CHARACTERISTICS

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<Electrical characteristics>

Parameters	Min.	Typ.	Max.	Units	Remarks
Input voltage	(3.0)	-	5.5	V	-
Resistor between terminals(XL-XR)	-	(270)	-	Ω	
Resistor between terminals(YU-YD)	-	(630)	-	Ω	-
Line linearity(X direction)	-	-	1.5	%	
Line linearity(Y direction)	-	-	1.5	%	
Insulation resistance	10	-	-	MΩ	At DC 25V

<Mechanical characteristics>

Parameters	Min.	Typ.	Max.	Units	Remarks
Operation starting force	10	-	80	g	-
Surface hardness	3	-	-	H	Pencil hardness

Remark 1: Input method is Finger or R0.8mm Polyacetal stylus pen

14. GENERAL CAUTIONS

Because the following statements are very important, please be sure you understand their contents completely.

⚠ **CAUTION**	This figure is a warning that you will get hurt and/or the module will be damaged if you make a mistake in operation.

This figure is a warning that you will get hurt if you make a mistake in operation.

⚠ CAUTIONS

(1) Caution when taking out the module

① Pick up the pouch only, when removing the module from a carrier box.

(2) Cautions for handling the module

① As the electrostatic discharges may break the LCD module, handle the LCD module with care against electrostatic discharges. Peel protection sheet out from the LCD panel surface as slowly as possible.

②  As the LCD panel and front light element are made from fragile glass material, impulse and pressure to the LCD module should be avoided.

③ As the surface of polarizer is very soft and easily scratched, use a soft dry cloth without chemicals for cleaning.

④ Do not pull the interface connectors in or out while the LCD module is operating.

⑤ Put the module display side down on a flat horizontal plane.

⑥ Handle connectors and cables with care.

⑦ When the module is operating, do not lose logic signals. If any one or more of these signals is lost, the LCD panel would be damaged.

⑧ Don't push or rub the surface of LCD module please. If you do, the scratches or the marks like rubbing marks may be left on the surface of the module.

⑨ The LCD module should be mounted in strong body such as magnesium alloy. If the press or twist are added to the module, the display may have un-uniformity image. When the module is mounted to customer chassis, please evaluate the display condition carefully.

(3) Cautions regarding atmosphere

① Dew-drop atmosphere must be avoided.

② Do not store and/or operate the LCD module in a high-temperature and/or high-humidity atmosphere. Storage in an anti-static pouch and under the room temperature atmosphere is recommended.

③ Do not operate the LCD module in high magnetic field.

(4) Cautions about the module characteristics

① Do not apply any fixed pattern data for a long time to the LCD module. It may cause image sticking.

(5) Other cautions

① Do not disassemble and/or reassemble the LCD module.

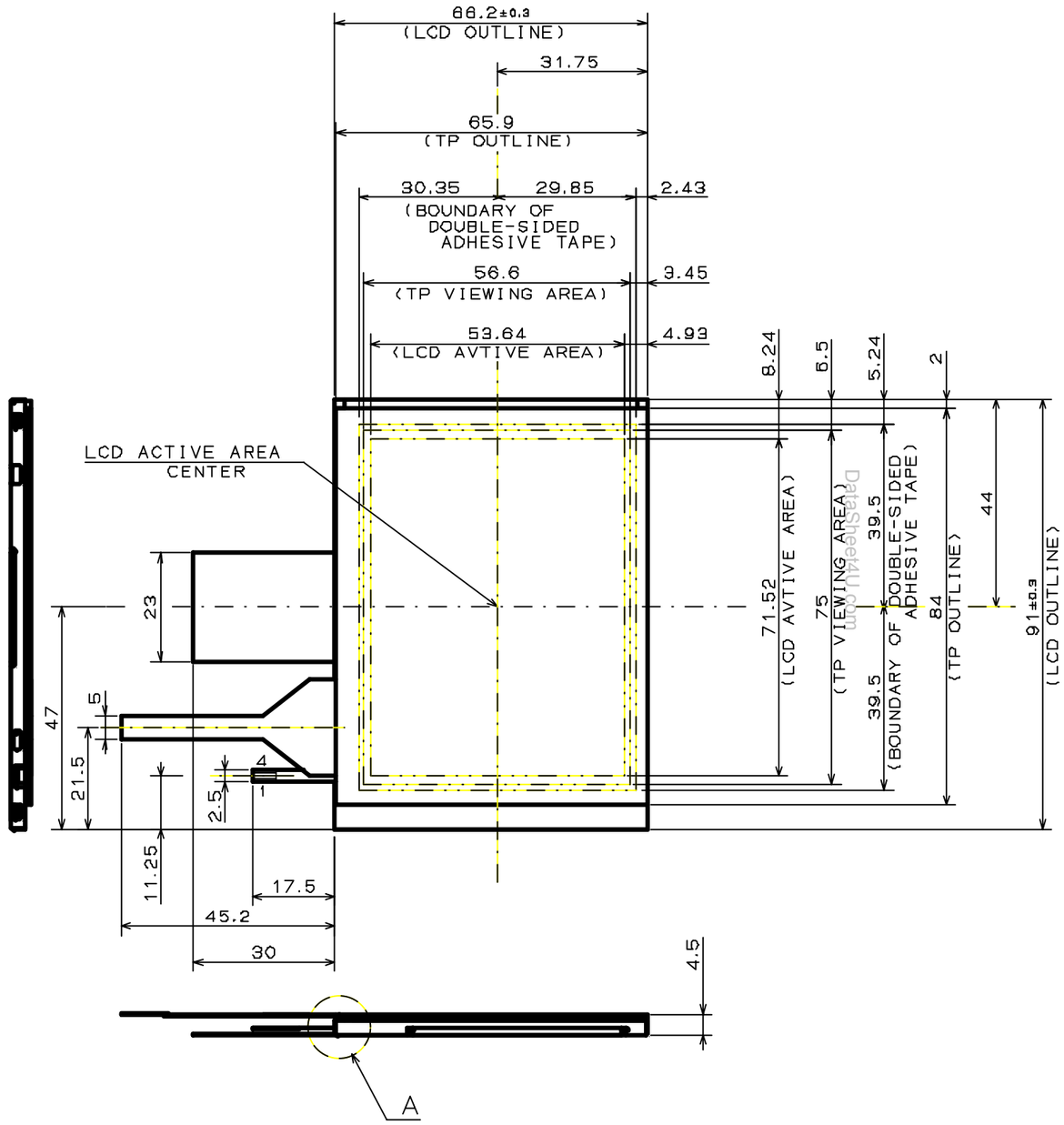
② When returning the module for repair, etc., please pack the module properly to avoid any damages. NEC recommends using original shipping packages.

The liquid crystal display has the following specific characteristics. These are not defects or malfunctions.

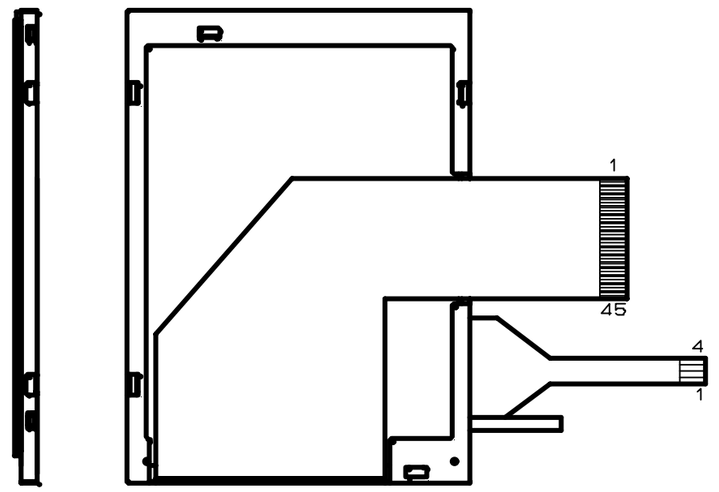
The ambient temperature may affect the optical characteristics of this module.

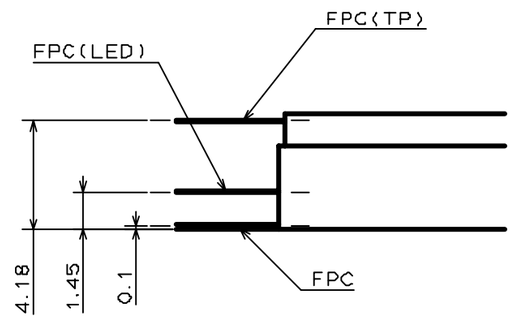
Uneven brightness and/or small spots may be observed depending on different display patterns.

15. OUTLINE DRAWING



3222R-11B OUTLINE Ver.2 2001.7.9





DETAIL A

NEC Corporation

Revision History				DOD-N-0249		20/20
Rev.	Prepared Date	Revision contents	Approved	Checked	Prepared	Issued Date
1	June 15, 2001	DOD-N-0206	H.Moriyama	-	T. Kusanagi	-
2	July 10, 2001	DOD-N-0249 P4, 7 Weight: 45→52g typ. P5 BLOCK DIAGRAM is revised. GAM connected with GND P6 VDD voltage: VDD=-5.0 → VDD=+5.0 P8 γ control supply voltage: Min.;VDD+0.1 → GND+0.1 P8 Front light: 18.0mA → 50μA typ. 20.0mA typ. → - P8 Touch panel input voltage(Min) is added. P9 OEN signal is added P16 Touch Panel Characteristics is added. P19 Outline Drawing is revised.	山浦 (T. Yamaura)	-	T. Kusanagi (T. Kusanagi)	