NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL2432HC17-10B

6.8cm (2.7 Type)
QVGA

DATA SHEET

DOD-PP-0893 (1st edition)

All information is subject to change without notice. Please confirm the sales representative before starting to design your system.

INTRODUCTION

NEC does and will not assume any liability for infringement of patents, copyrights or other intellectual property rights of any third party arising out of or in connection with application of the products described herein except for that directly attributable to mechanisms and workmanship thereof. No license, express or implied, is granted under any patent, copyright or other intellectual property right of NEC.

Some electronic parts/components would fail or malfunction at a certain rate. In spite of every effort to enhance reliability of products by NEC, the possibility of failures and malfunction might not be avoided entirely. To prevent the risks of damage to death, human bodily injury or other property arising out thereof or in connection therewith, each customer is required to take sufficient measures in its safety designs and plans including, but not limited to, redundant system, fire-containment and anti-failure.

The products are classified into three quality grades: **"Standard"**, **"Special"**, and **"Specific"** of the highest grade of a quality assurance program at the choice of a customer. Each quality grade is designed for applications described below. Any customer who intends to use a product for application other than that of Standard quality grade is required to contact an NEC sales representative in advance.

The **Standard** quality grade applies to the products developed, designed and manufactured in accordance with the NEC standard quality assurance program, which are designed for such application as any failure or malfunction of the products (sets) or parts/components incorporated therein a customer uses are, directly or indirectly, free of any damage to death, human bodily injury or other property, like general electronic devices.

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

The **Special** quality grade applies to the products developed, designed and manufactured in accordance with an NEC quality assurance program stricter than the standard one, which are designed for such application as any failure or malfunction of the products (sets) or parts/components incorporated therein a customer uses might directly cause any damage to death, human bodily injury or other property, or such application under more severe condition than that defined in the Standard quality grade without such direct damage.

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

The **Specific** quality grade applies to the products developed, designed and manufactured in accordance with the standards or quality assurance program designated by a customer who requires an extremely higher level of reliability and quality for such products.

Examples: Military systems, aircraft control equipment, aerospace equipment, nuclear reactor control systems, medical equipment/devices/systems for life support, etc.

The quality grade of this product is the **"Standard"** unless otherwise specified in this document.

CONTENTS

1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL2432HC17-10B is composed of the amorphous silicon thin film transistor liquid crystal display (a-Si TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array, touch panel (T/P) and a backlight.

The a-Si TFT LCD panel structure is injected liquid crystal material into a narrow gap between the TFT array glass substrate and a color-filter glass substrate.

Color (Red, Green, Blue) data signals from a host system (e.g. signal generator, etc.) are modulated into best form for active matrix system by a controller, and sent to the driver LSIs which drive the individual TFT arrays.

The TFT array as an electro-optical switch regulates the amount of transmitted light from the backlight assembly, when it is controlled by data signals. Color images are created by regulating the amount of transmitted light through the TFT array of red, green and blue dots.

1.2 APPLICATION

- PDAs
- Handy terminal

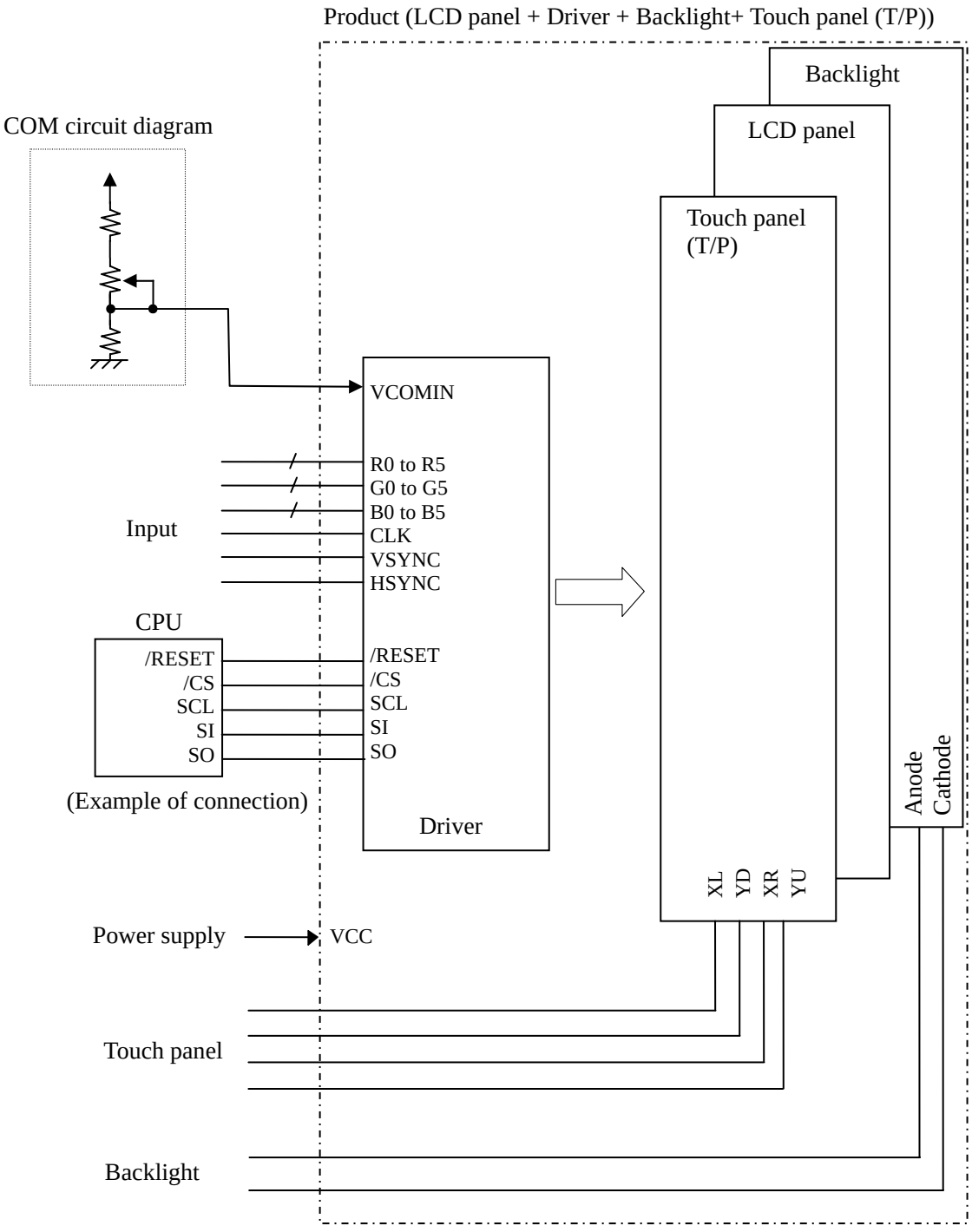
1.3 FEATURES

- Transmissive type
- Backlight and touch panel attached
- High luminance
- Small footprint and light weight
- Including LCD controller and power supply
- 6-bit digital RGB signals
- Compliance with the European RoHS directive (2002/95/EC)

2. GENERAL SPECIFICATIONS

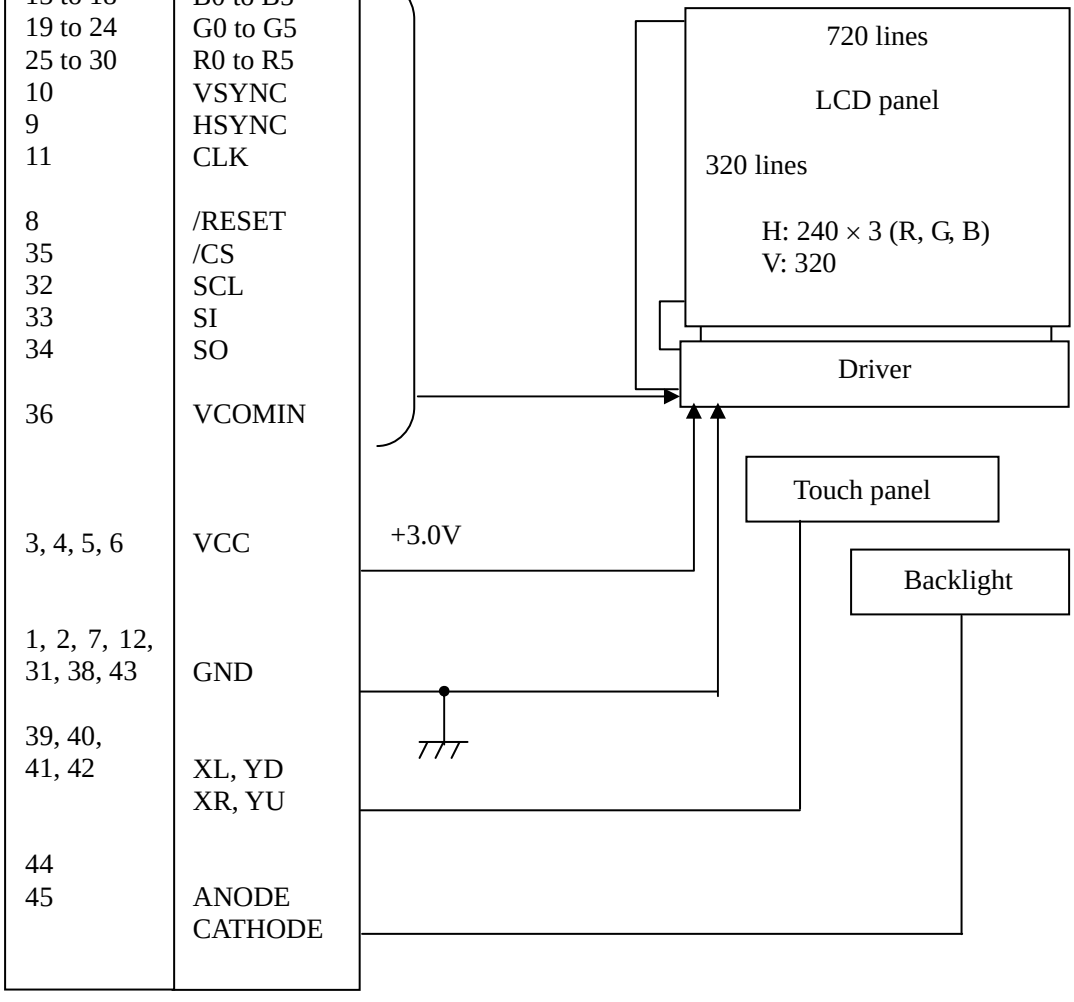
Display area	41.04 (H) × 54.72 (V) mm
Diagonal size of display	6.8cm (2.7 inches)
Drive system	a-Si TFT active matrix
Display color	262,144 colors
Pixel	240 (H) × 320 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.057 (H) × 0.171 (V) mm
Pixel pitch	0.171 (H) × 0.171 (V) mm
Module size	50.54 (H) × 68.62 (V) × 3.55 (D) mm (typ.)
Weight	25g (typ.)
Touch panel surface	Clear
Touch panel pencil-hardness	3 H (min.) [by JIS K5400]
Luminance	*At IL= 18mA,With Touch panel* 500cd/m^2 (typ.)
Contrast ratio	*At IL= 18mA With Touch panel* 400:1 (typ.)
Designed viewing direction	• Viewing direction without image reversal: lower side (6 o'clock) • Viewing direction with contrast peak: upper side (12 o'clock)
Response time	*Ton+Toff (10%←→ 90%)* 23 ms (typ.)
Signal system	6-bit digital signals for data of RGB colors, Dot clock (CLK), Horizontal synchronous signal (HSYNC), Vertical synchronous signal (VSYNC) Serial interface (SPI correspondence) (/CS, SCL, SI, SO)
Supply voltage	VCC: 3.0V (typ.)
consumption	LCD panel: 36mW (typ.) Backlight: 288mW (typ., at IL= 18mA)

3. BLOCK DIAGRAM

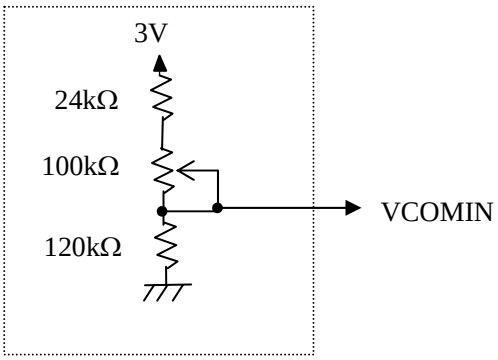


FPC I/F

Pin No.	Symbol
13 to 18	B0 to B5
19 to 24	G0 to G5
25 to 30	R0 to R5
10	VSYNC
9	HSYNC
11	CLK
8	/RESET
35	/CS
32	SCL
33	SI
34	SO
36	VCOMIN
3, 4, 5, 6	VCC
1, 2, 7, 12, 31, 38, 43	GND
39, 40, 41, 42	XL, YD XR, YU
44	
45	ANODE
	CATHODE



Reference design of COM circuit



4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

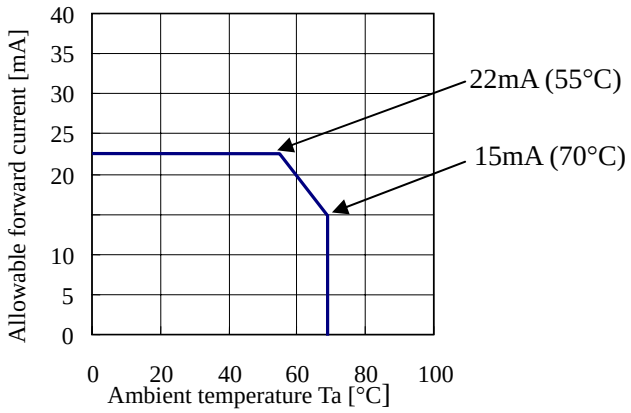
Parameter	Specification	Unit
Module size	50.54 ± 0.2 (W) × 68.62 ± 0.2 (H) × 3.55 ± 0.2 (D) Note1 Note2	mm
Display area	41.04 (H) × 54.72 (V) Note2	mm
Weight	25 (typ.), 27 (max.)	g

Note1: Excluding FPC
Note2: See "**8. OUTLINE DRAWINGS**".

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Supply voltage		VCC	-0.5 to +6.0	V	Ta = 25°C
Logic input voltage		VI	-0.5 to VCC+0.5	V	Logic signals
Backlight	Reverse voltage	VR	≤ 25	V	Ta = 25°C
	Power dissipation	PD	≤ 615	mW	
	Forward current	IL	Note1	mA	
	Pulse forward current	IFP	100	mA	Pulse width ≤ 10ms, Duty ≤ 1/10
Storage temperature		Tst	-30 to +80	°C	-
Operating temperature		Top	-20 to +70		Product surface Note2
Relative humidity Note3		RH	≤ 95	%	Ta ≤ 40°C
			≤ 85		40°C < Ta ≤ 50°C
			≤ 55		50°C < Ta ≤ 60°C
			≤ 36		60°C < Ta ≤ 70°C
Absolute humidity Note3		AH	≤ 70 Note4	g/m^3	Ta > 70°C
Storage altitude			≤ 13,600	m	-30°C ≤ Ta ≤ 80°C
Operating altitude			≤ 4,850	m	-20°C ≤ Ta ≤ 70°C

Note1: Allowable forward current



Note2: Measured at display area
Note3: No condensation
Note4: Water amount at Ta= 70°C and RH= 36%

4.3 ELECTRICAL CHARACTERISTICS

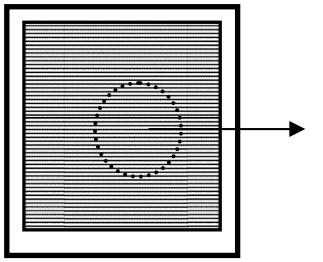
(1) Logic/ LCD driving

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Logic supply voltage	VCC	2.85	3.0	3.45	V	-
Logic input high voltage	VIH	0.8VCC	-	VCC	V	Logic signal
Logic input low voltage	VIL	0	-	0.2VCC	V	
VCOMIN voltage	VCOMIN	-	2.0	-	V	at VCC= 3.0V Note1
VCC supply current	ICC	-	12	-	mA	Normal mode at VCC= 3.0V Note2
	ICCs	-	0.2	-		Stand-by mode at VCC= 3.0V Note2

Note1: The optimum value for VCOMIN is in the range of 1.5 V to 2.5 V.

Recommended adjustment display for VCOMIN



Half tone display (32/63 gray scale)
Full black display (0/63 gray scale)
Half tone display (32/63 gray scale)
Full black display (0/63 gray scale)
Half tone display (32/63 gray scale)

Note2: PPCLK= 5.0MHz, PPHSYNC= 19.53 Hz, PPVSYNC= 60Hz,
Checkered flag pattern (by EIAJ ED-2522)

(2) Backlight

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Forward Current	IL	-	18	22	mA	-
Forward Voltage	VL	-	16	17.5	V	at IL= 18mA

(3) Touch panel

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Touch panel input voltage	Vtp	-	-	5.5	V	-
Resistor between pins(XL-XR)	Rx	190	-	490	Ω	-
Resistor between pins(YU-YD)	Ry	140	-	530	Ω	-
Line linearity (X direction)	Xlin	-	-	1.5	%	Note1
Line linearity (Y direction)	Ylin	-	-	1.5	%	Note1
Insulation resistance	Rins	20	-	-	MΩ	at DC 25V
Static Capacitance	Ctp	-	-	100	nF	-
Chattering	Chat	-	-	10	ms	Note1
Operation starting force	Ost	-	-	0.78	N	Note1, Note2
				80	gf	
Surface hardness	Hs	3	-	-	H	Pencil hardness
Point hitting life	Lhp	1,000,000	-	-	times	Polyacetal stylus pen: R0.8mm Load: 2.45N(250gf)
	Lhr	1,000,000	-	-	times	Silicon rubber: R8mm, Hardness 60° Load: 2.94N(300gf)
Line writing life	Lwl	50,000	-	-	times	Polyacetal stylus pen: R0.8mm Load: 2.45N(250gf), 35mm

Note1: Input method is Finger or Polyacetal stylus pen (R0.8mm).

Note2: Test condition

Resistance between X and Y axis must be 2kΩ or less, and the test voltage is 5V DC.

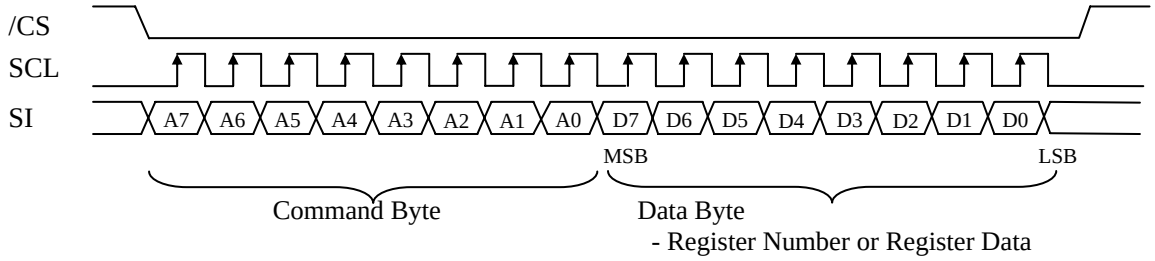
4.4 SETTING OF THE INTERNAL RESISTER

Initial setting of the internal Resister is undefined data. So the Resister Data must be written in the Resister, after initialization by the /RESET pin. The Resister Data can be written from serial interface pins (/CS, SCL and SI) and can be read from serial interface pins (SO). This serial interface corresponds to SPI. The setting method is as follows.

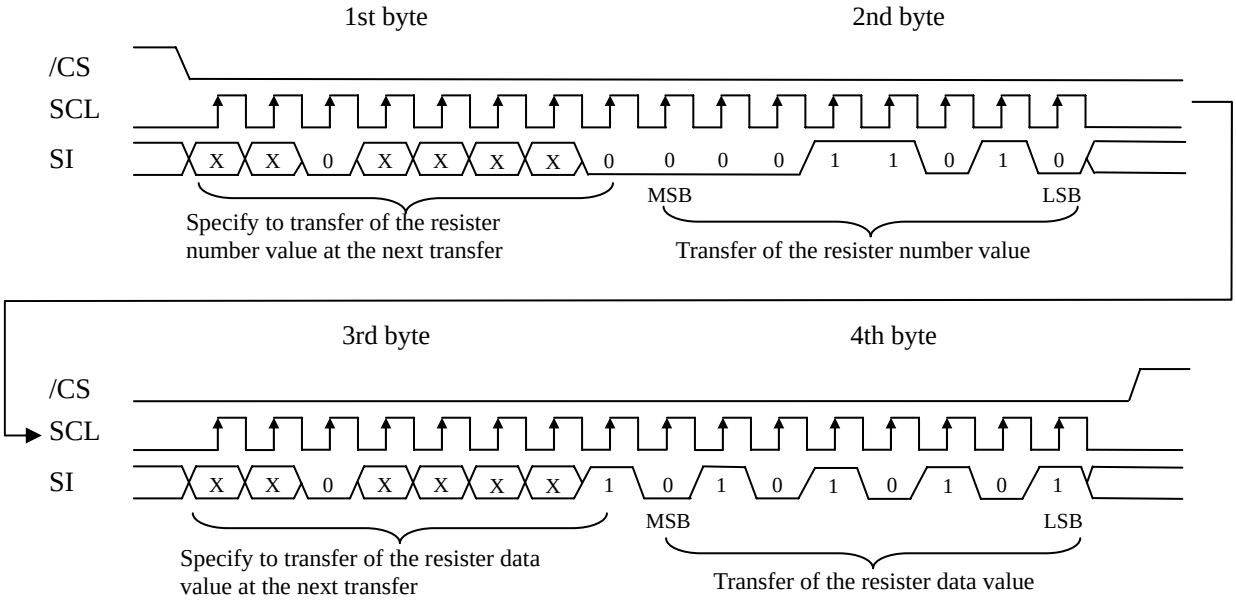
(1) Command Byte Function

Bits	Functions	Discription
A7	-	-
A6	-	-
A5	Read / Write	0:Write 1:Read
A4	-	-
A3	-	-
A2	-	-
A1	-	-
A0	Register Number / Data	0:Register Number 1:Register Data

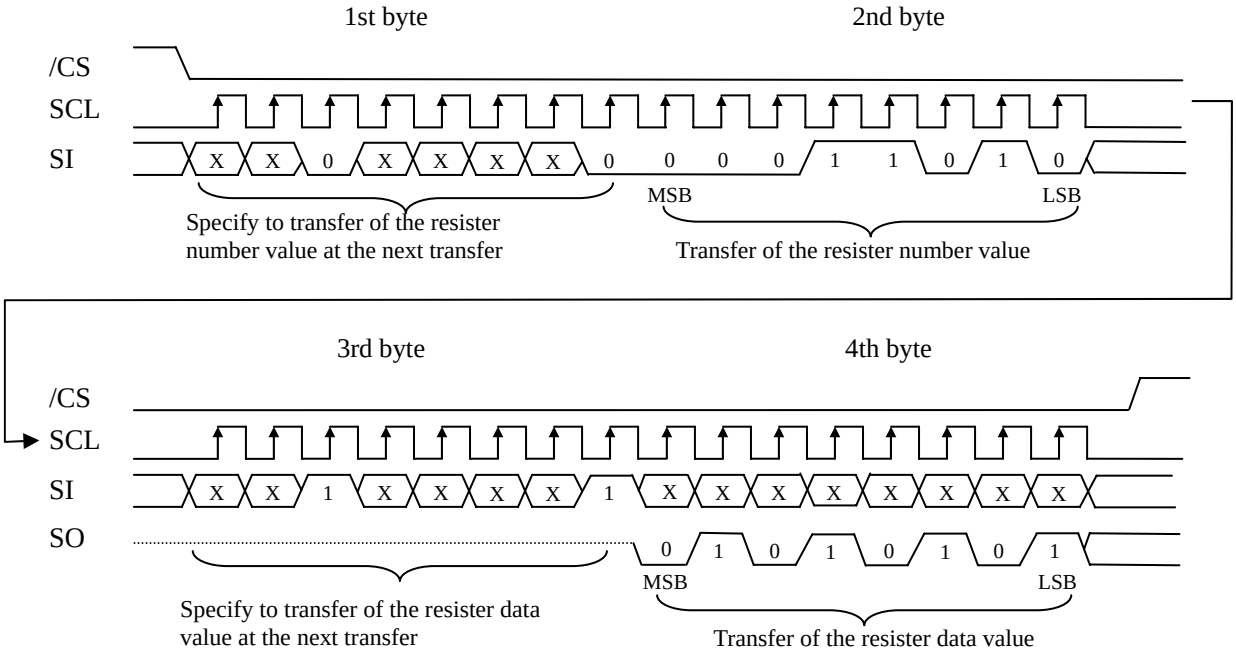
(2) Timing chart



Ex) When data 55h is written to Register R26 (R1Ah)



Ex) When data 55h is read to Register R26 (R1Ah)



Note1: During 32-bit transfer of the Resister Data, /CS pin (Pin No.35) must be maintained active.
Note2: "X" is set in accordance with the usage conditions.

(3) Command sequence

①Power On (At VCC=3.0±0.15V)

Sequence	Register Number	Data	Comment	Sequence	Register Number	Data	Comment
1	Power On			26	R76	01h	-
2	1ms min. wait.			27	R77	01h	-
3	Reset by the /RESET pin (Pin No. 8).			28	R80	00h	-
4	1ms min. wait after /RESET↑.			29	R81	00h	-
5	R3	01h	-	30	R82	24h	-
6	R1	00h	-	31	R83	A1h	-
7	R100	0Fh	-	32	R86	15h	-
8	R101	37h	-	33	R87	F0h	-
9	R102	3Dh	-	34	R95	3Fh	-
10	R103	04h	-	35	R96	22h	-
11	R104	00h	-	36	R25	76h	-
12	R105	30h	-	37	R26	54h	-
13	R106	84h	-	38	R27	6Bh	-
14	R107	05h	-	39	R28	60h	-
15	R108	17h	-	40	R29	04h	
16	R109	62h	-	41	R30	1Ch	-
17	R110	50h	-	42	R31	A1h	-
18	R111	30h	-	43	R32	00h	-
19	R112	73h	-	44	R33	20h	-
20	R113	07h	-	45	R24	77h	-
21	R114	66h	-	46	30 μs min. wait.		
22	R115	51h	-	47	Data input start		
23	R116	50h	-	48	R59	01h	-
24	R2	40h	-	49	20 ms min. wait.		
25	R75	04h	-	50	R0	00h	-

①Power On (At VCC=3.15±0.15V)

Sequence	Register Number	Data	Comment	Sequence	Register Number	Data	Comment
1	Power On			26	R76	01h	-
2	1ms min. wait.			27	R77	01h	-
3	Reset by the /RESET pin (Pin No.8)			28	R80	00h	-
4	1ms min. wait after /RESET↑			29	R81	00h	-
5	R3	01h	-	30	R82	24h	-
6	R1	00h	-	31	R83	EBh	-
7	R100	0Fh	-	32	R86	15h	-
8	R101	37h	-	33	R87	F0h	-
9	R102	3Dh	-	34	R95	3Fh	-
10	R103	04h	-	35	R96	3Fh	-
11	R104	00h	-	36	R25	76h	-
12	R105	30h	-	37	R26	54h	-
13	R106	84h	-	38	R27	6Bh	-
14	R107	05h	-	39	R28	60h	-
15	R108	17h	-	40	R29	04h	
16	R109	62h	-	41	R30	1Ch	-
17	R110	50h	-	42	R31	A1h	-
18	R111	30h	-	43	R32	00h	-
19	R112	73h	-	44	R33	20h	-
20	R113	07h	-	45	R24	77h	-
21	R114	66h	-	46	30 μs min. wait.		
22	R115	51h	-	47	Data input start		
23	R116	50h	-	48	R59	01h	-
24	R2	40h	-	49	20 ms min. wait.		
25	R75	04h	-	50	R0	00h	-

①Power On (At VCC=3.3±0.15V)

Sequence	Register Number	Data	Comment	Sequence	Register Number	Data	Comment
1	Power On			26	R76	01h	-
2	1ms min. wait.			27	R77	01h	-
3	Reset by the /RESET pin (Pin No. 8).			28	R80	00h	-
4	1ms min. wait after /RESET↑.			29	R81	00h	-
5	R3	01h	-	30	R82	24h	-
6	R1	00h	-	31	R83	EBh	-
7	R100	0Fh	-	32	R86	15h	-
8	R101	37h	-	33	R87	F0h	-
9	R102	3Dh	-	34	R95	3Fh	-
10	R103	04h	-	35	R96	22h	-
11	R104	00h	-	36	R25	76h	-
12	R105	30h	-	37	R26	54h	-
13	R106	84h	-	38	R27	6Bh	-
14	R107	05h	-	39	R28	60h	-
15	R108	17h	-	40	R29	04h	
16	R109	62h	-	41	R30	3Ch	-
17	R110	50h	-	42	R31	A1h	-
18	R111	30h	-	43	R32	00h	-
19	R112	73h	-	44	R33	20h	-
20	R113	07h	-	45	R24	77h	-
21	R114	66h	-	46	30 μs min. wait.		
22	R115	51h	-	47	Data input start		
23	R116	50h	-	48	R59	01h	-
24	R2	40h	-	49	20 ms min. wait.		
25	R75	04h	-	50	R0	00h	-

②Power Off

Sequence	Register Number	Data	Comment
1	R0	08h	-
2	25 ms min. wait.		
3	R24	00h	-
4	20 ms min. wait.		
5	R1	08h	-
6	Data Off		
7	Power Off		

③Standby

Sequence	Register Number	Data	Comment
1	R0	08h	-
2	25 ms min. wait.		
3	R24	00h	-
4	20 ms min. wait.		
5	R1	08h	-

④Wake Up

Sequence	Register Number	Data	Comment
1	R1	00h	-
2	R24	FFh	-
3	30 μs min. wait.		
4	R0	00h	-

Note1: Be sure to perform reset by the /RESET pin (Pin No. 8) every power-on
Note2: Write the Resister Data every power-on, because the data are not stored in the product.
Note3: Due to influence such as static electricity from the outside, data in the register may transform. Data is recommended to be written in the register regularly.

4.5 INTERFACE PIN CONNECTIONS

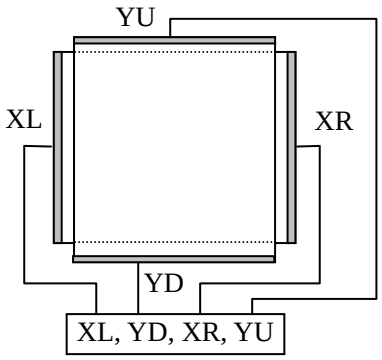
CN1 (FPC)
Adaptable socket: FH23-45S-0.3SHW (05) (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbols	Functions	Pin No.	Symbols	Functions
1	GND	Ground Note1	25	R0	Red data (LSB)
2	GND	Ground Note1	26	R1	Red data
3	VCC	Power supply Note1	27	R2	Red data
4	VCC		28	R3	Red data
5	VCC		29	R4	Red data
6	VCC		30	R5	Red data (MSB)
7	GND	Ground Note1	31	GND	Ground Note1
8	/RESET	Reset	32	SCL	Serial clock
9	HSYNC	Horizontal synchronous signal	33	SI	Serial input
10	VSYNC	Vertical synchronous signal	34	SO	Serial output
11	CLK	Dot clock	35	/CS	Chip selection
12	GND	Ground Note1	36	VCOMIN	COM high voltage input
13	B0	Blue data (LSB)	37	N.C.	Keep this pin Open.
14	B1	Blue data	38	GND	Ground Note1
15	B2	Blue data	39	XL	Horizontal terminal (Left side)
16	B3	Blue data	40	YD	Vertical terminal (Down side)
17	B4	Blue data	41	XR	Horizontal terminal (Right side)
18	B5	Blue data (MSB)	42	YU	Vertical terminal (Up side)
19	G0	Green data (LSB)	43	GND	Ground Note1
20	G1	Green data	44	ANODE	LED voltage (Anode)
21	G2	Green data	45	CATHODE	LED voltage (Cathode)
22	G3	Green data			
23	G4	Green data			
24	G5	Green data (MSB)			

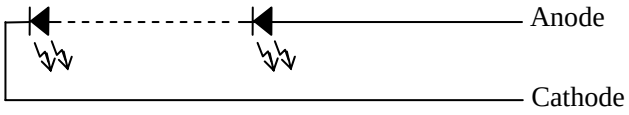
Note1: All GND terminals should be used without any non-connected lines.
Note2: Do not fold the FPC. When folding the FPC, pattern disconnection may occur. In case of bending FPC, the minimum curvature (R) must be more than 1.0 mm.

Description of terminals

Terminals	Description
/RESET	When /RESET is L, an internal reset is performed. The reset operation is executed at the /RESET signal level. Be sure to perform reset via this pin at power application.
/CS	This pin is used for chip select signals. When /CS= L, the chip is active and can perform data I/O operations including command and data I/O.
SCL	This pin is clock input of serial interface.
SI	This pin is data input of serial interface.
SO	This pin is data output of serial interface.
VCOMIN	This pin is the Common high voltage. The voltage needs to be adjusted. The details are explained the above. See "**3 BLOCK DIAGRAM - Reference design of COM circuit**".
XL,YD,XR,YU	Refer to the below "**Circuits of touch panel**".
ANODE, CATHODE	Refer to the below "**Circuits of backlight**".



Circuits of touch panel



Circuits of backlight

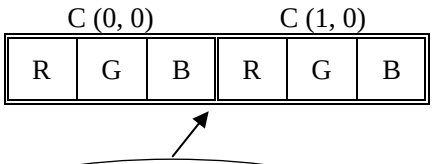
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 262,144 colors in 64 gray scales. Also the relation between display colors and input data signals is as the following table.

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 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	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 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	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 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	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

4.7 DISPLAY POSITIONS

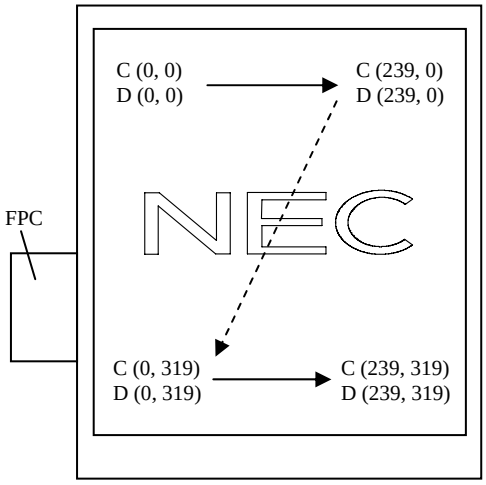
The following table is the coordinates per pixel (See figure of "**4.8 SCANNING DIRECTIONS**".).



C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(238, 0)	C(239, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(238, 1)	C(239, 1)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(238, Y)	C(239, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, 318)	C(1, 318)	• • •	C(X, 318)	• • •	C(238, 318)	C(239, 318)
C(0, 319)	C(1, 319)	• • •	C(X, 319)	• • •	C(238, 319)	C(239, 319)

4.8 SCANNING DIRECTIONS

The following figures are seen from a front view. Also the arrow shows the direction of scan.



Note1: Meaning of C (X, Y) and D (X, Y)
C (X, Y): The coordinates of the display position (See "**4.7 DISPLAY POSITIONS**".)
D (X, Y): The data number of input signal for LCD panel

4.9 INPUT SIGNAL TIMINGS

4.9.1 RGB interface (Ta= 25°C, VCC= 3.0V)

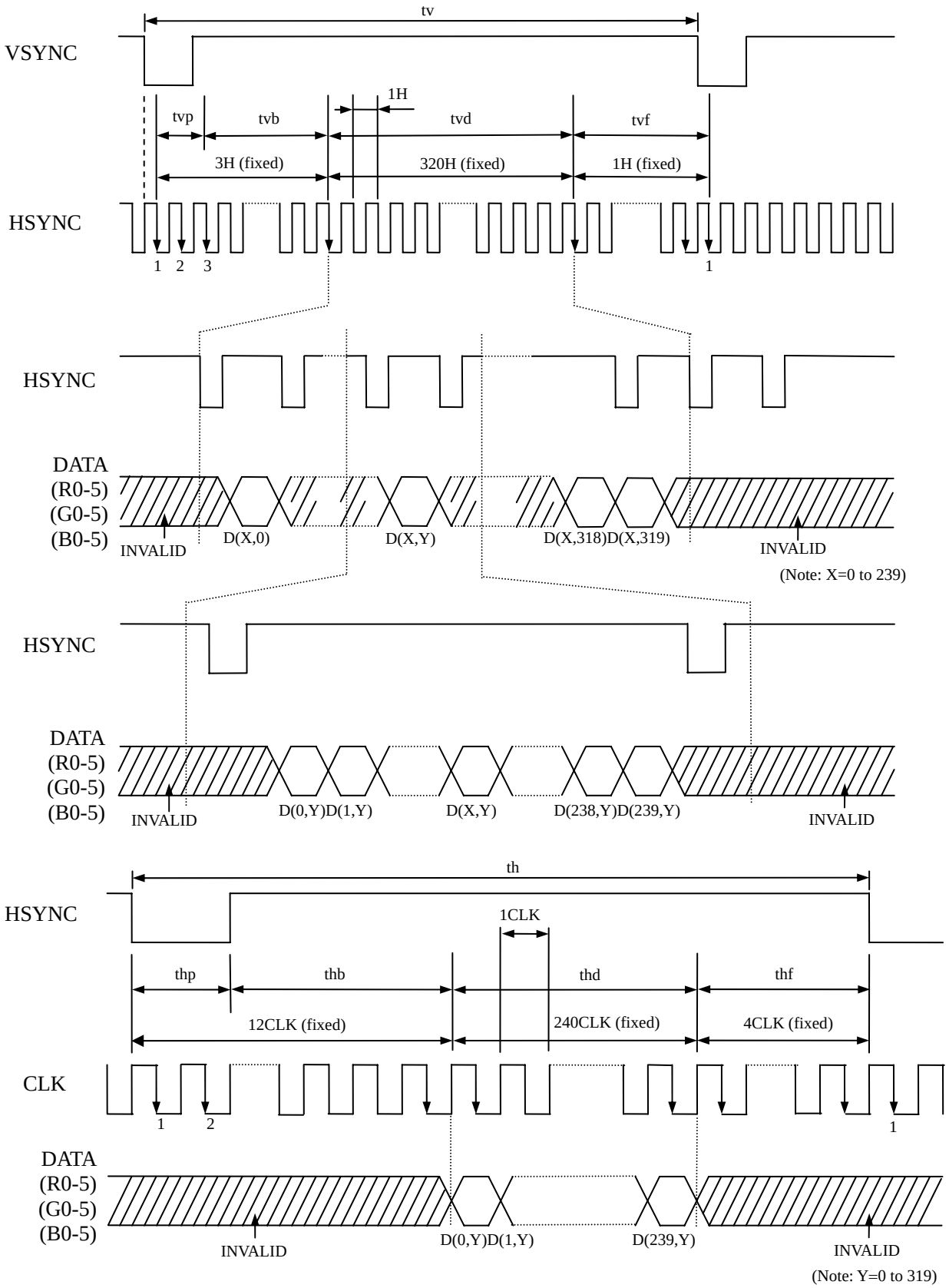
(1) Timing characteristics

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	4.81	5.0	5.12	MHz	200ns (typ.)
	Duty		tcd	0.4	0.5	0.6	-	-
	Rise time, Fall time		tcrf	-	-	15	ns	
DATA (G0-5) (B0-5) (R0-5)	CLK-DATA	Setup time	tds	15	-	-	ns	-
		Hold time	tdh	15	-	-	ns	
	Rise time, Fall time		tdrf	-	-	15	ns	
HSYNC	Cycle		th	50.0	51.2	53.2	μs	19.53kHz (typ.)
				256			CLK	-
	Display period		thd	240			CLK	
	Front-porch		thf	4			CLK	
	Pulse width		thp	2	8	-	CLK	
	Back-porch		thb	4			CLK	
	CLK-HSYNC	Setup time	ths	15	-	-	ns	
		Hold time	thh	15	-	-	ns	
	Rise time, Fall time		thrf	-	-	15	ns	
VSYNC	Cycle		tv	16.2	16.59	17.24	ms	60Hz (typ.)
				324			H	-
	Display period		tvd	320			H	
	Front-porch		tvf	1			H	
	Pulse width		tvp	1	2	-	H	
	Back-porch		tvb	1			H	
	VSYNC-HSYNC timing		tvh	15	-	-	ns	
	Rise time, Fall time		tvrf	-	-	15	ns	

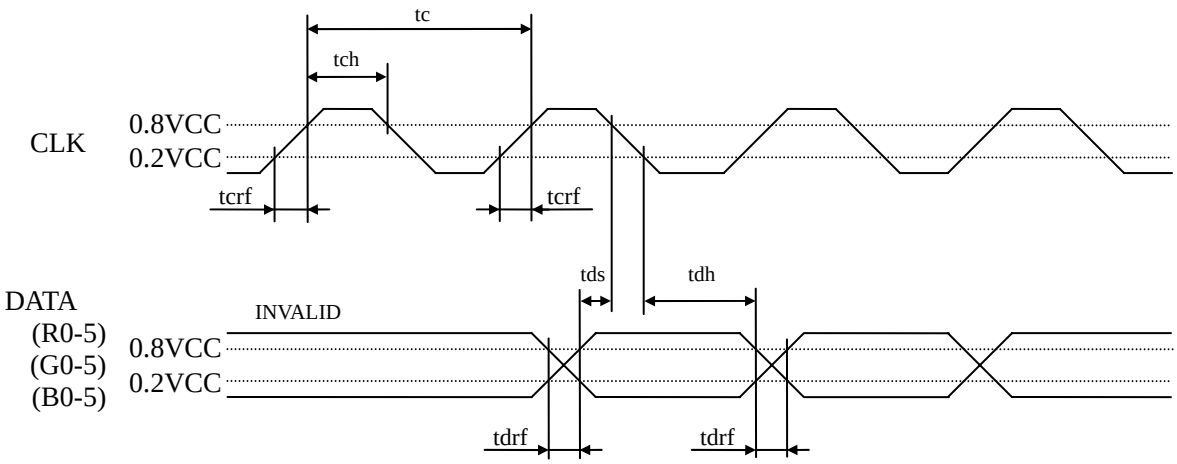
Note1: Definition of parameters is as follows.
tc= 1CLK, tcd= tch/tc, th= 1H

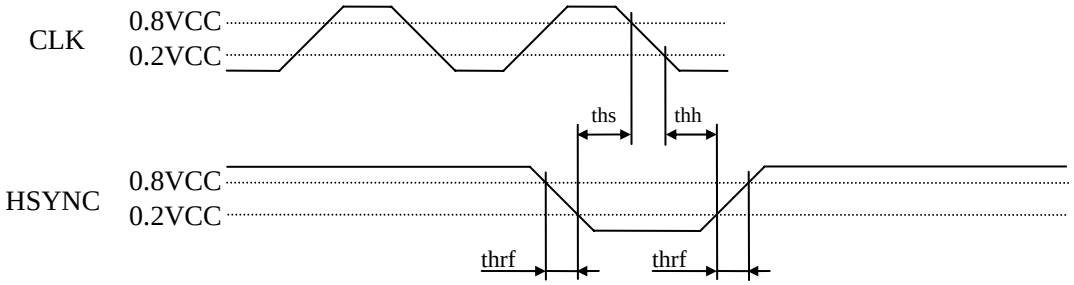
Note2: All parameters should be kept within the specified range.

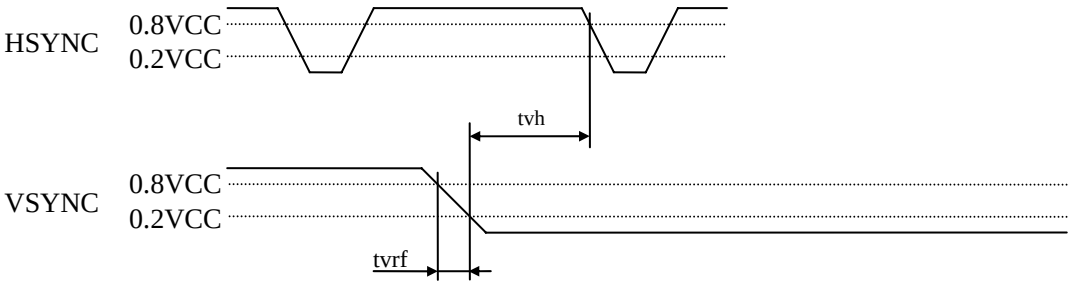
(2) Input signal timing chart



Note1: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.







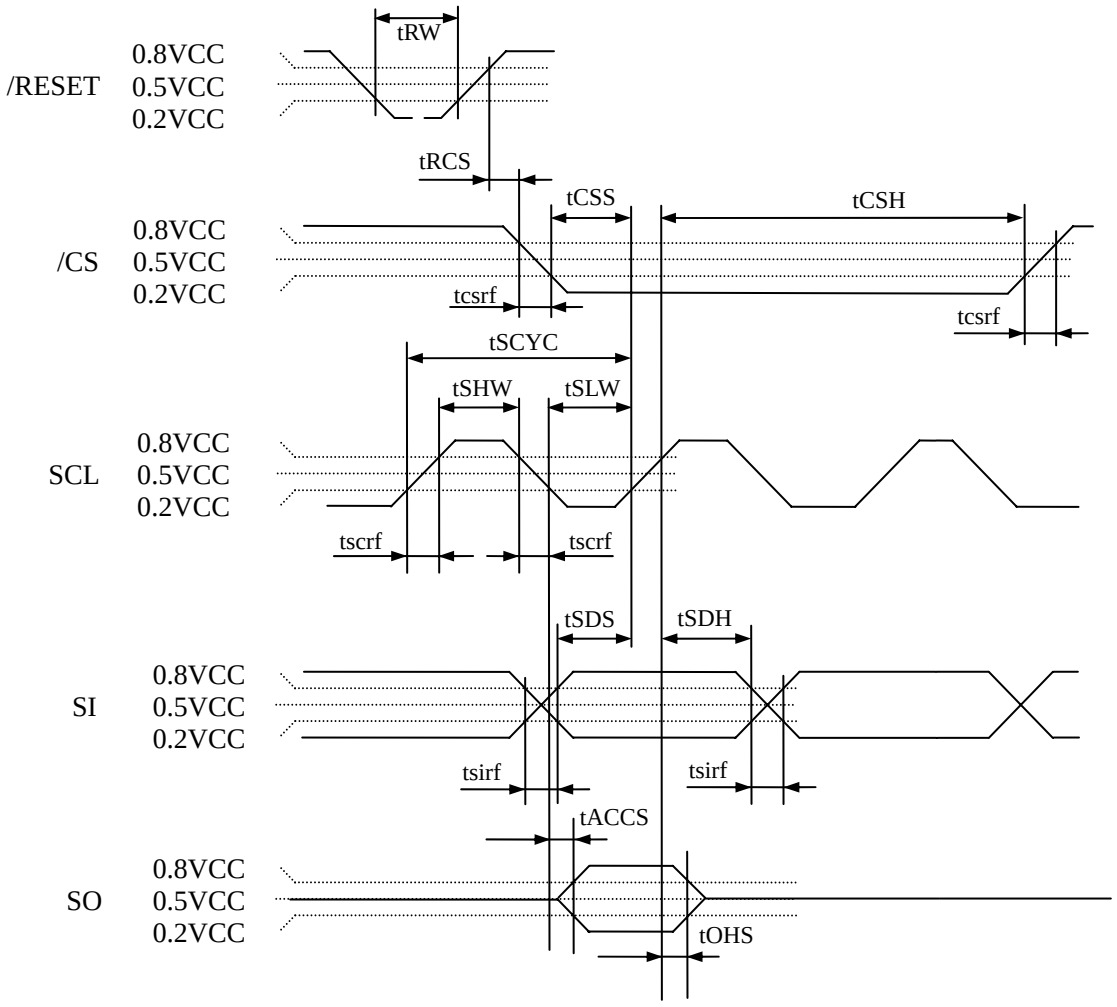
Note1: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.

4.9.2 Serial interface (Ta= 25°C, VCC= 3.0V)

(1) Timing characteristics

Parameter	Symbol	Condition	min.	typ.	max.	Unit	Remarks
Serial clock cycle	tSCYC	READ	450	-	-	ns	-
		WRITE	100	-	-	ns	-
SCL high level pulse width	tSHW	READ	210	-	-	ns	-
		WRITE	40	-	-	ns	-
SCL low level pulse width	tSLW	READ	210	-	-	ns	-
		WRITE	40	-	-	ns	-
/CS rise time, fall time	tcsrf	/CS	-	-	15	ns	-
SCL rise time, fall time	tscrf	SCL	-	-	15	ns	-
SI rise time, fall time	tsirf	SI	-	-	15	ns	-
/CS setup time	tCSS	/CS	50	-	-	ns	-
/CS hold time	tCSH	/CS	30	-	-	ns	-
Data setup time	tSDS	SI	30	-	-	ns	-
Data hold time	tSDH	SI	15	-	-	ns	-
Reset pulse width	tRW	/RESET	2	-	-	μs	-
/RESET↑ to /CS time	tRCS	/RESET↑ to /CS	1	-	-	ms	-
Access time	tACCS	SO	-	-	180	ns	-
Output disable time	tOHS	SO	-	-	100	ns	-

Note1: All parameters should be kept within the specified range.



Note2: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.

4.10 OPTICAL CHARACTERISTICS

<Backlight turned ON>

(Note1, Note2, Note3)

Parameter	Condition	Symbol	min.	typ.	max.	Unit	Remarks
Luminance	White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	350	500	-	cd/m^2	-
Contrast ratio	White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	150	400	-	-	Note4
Luminance uniformity	White θR= 0°, θL= 0°, θU= 0°, θD= 0° Maximum luminance: 100%	LU	70	85	-	%	Note8

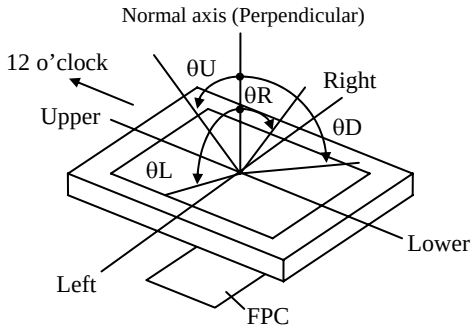
Reference data

(Note1, Note2, Note3)

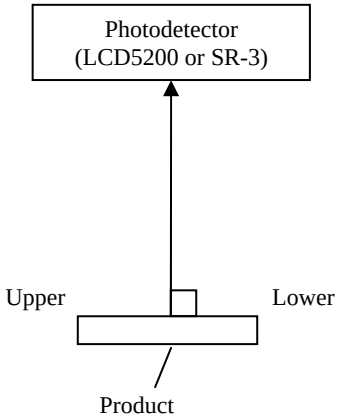
Parameter		Condition		Symbol	min.	typ.	max.	Unit	Remarks
Chromaticity coordinates		White		Wx	0.27	0.32	0.37	-	Note5
				Wy	0.29	0.34	0.39	-	
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space		C	-	50	-	%	
Response time		White to black	90%→ 10%	Ton	-	8	16	ms	Note6 Note7
		Black to white	10%→ 90%	Toff	-	15	30		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 5		θR	-	50	-	°	
	Left	θU= 0°, θD= 0°, CR≥ 5		θL	-	50	-	°	
	Up	θR= 0°, θL= 0°, CR≥ 5		θU	-	60	-	°	
	Down	θR= 0°, θL= 0°, CR≥ 5		θD	-	30	-	°	

Note1: Measurement conditions are as follows.
Ta= 25 °C, VCC= 3.0V, IL=18mA

Note2: Definition of viewing angles



Note3: Luminance, Contrast ratio, Chromaticity coordinates and Color gamut are measured as follows.



Note4: Definition of contrast ratio

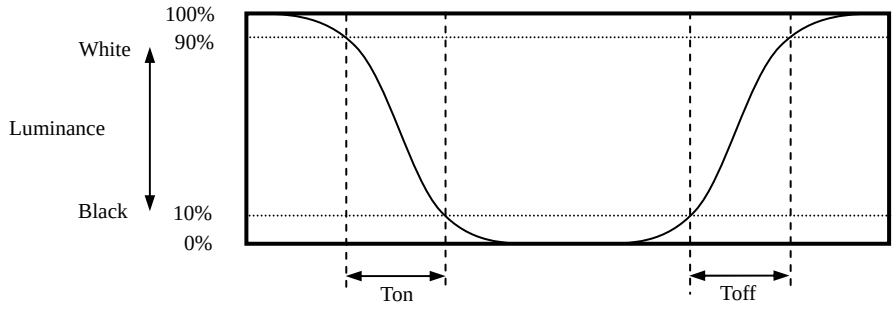
The contrast ratio is calculated by using the following formula.

$$\text{Contrast ratio (CR)} = \frac{\text{Luminance of white screen}}{\text{Luminance of black screen}}$$

Note5: The White chromaticity coordinates are deviated by the LED deviation in addition to color filter deviation.

Note6: Definition of response times

Response time is measured, the luminance changes from "white" to "black", or "black" to "white" on the same screen point, by photo-detector. Ton is the time it takes the luminance change from 90% down to 10%. Also Toff is the time it takes the luminance change from 10% up to 90% (See the following diagram.).

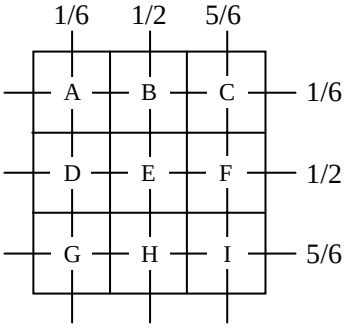


Note7: Product surface temperature: Top= 25°C

Note8: Definition of luminance uniformity

Luminance uniformity is calculated by using the following formula.

$$\text{Luminance uniformity (LU)} = \frac{\text{Minimum luminance from A to I}}{\text{Maximum luminance from A to I}} \times 100$$



5. ESTIMATED LUMINANCE LIFETIME

The luminance lifetime is the time from initial luminance to half-luminance.

This lifetime is the estimated value, and is not guarantee value.

Condition		Luminance lifetime (MTTF) Note1, Note2	Unit
Module	25°C (Ambient temperature of the product) Continuous operation, IL= 18 mA	3,900	h

Note1: MTTF is mean time to half-luminance.
Note2: By ambient temperature, the lifetime changes particularly. Especially, in case the product works under high temperature environment, the lifetime becomes short.

6. RELIABILITY TESTS

Test item	Condition	Judgment Note1
High temperature and humidity (Operation)	① 55 ± 2°C, RH = 85%, 240 hours ② Display data is black.	No display malfunctions
Heat cycle (Operation)	① -20 ± 3°C…1 hour 70 ± 3°C…1 hour ② 50 cycles, 4 hours/cycle ③ Display data is black.	
Thermal shock (Non operation)	① -30 ± 3°C…30 minutes 80 ± 3°C…30 minutes ② 100 cycles, 1 hour/cycle ③ Temperature transition time is within 5 minutes.	
Low pressure (Non operation)	① 15kPa ② -30 ± 3°C…24 hours ③ 80 ± 3°C…24 hours	
Low pressure (Operation)	① 53.3 kPa ② -20 ± 3°C…24 hours ③ 70 ± 3°C…24 hours	
ESD (Operation)	① 150pF, 150Ω, ±10kV ② 3 places on a panel surface ③ 10 times each places at 1 sec interval	
Dust (Operation)	① Sample dust: No. 15 (by JIS-Z8901) ② 15 seconds stir ③ 8 times repeat at 1 hour interval	
Vibration (Operation)	① 30 to 100Hz, 19.6m/s^2 ② 30 minutes/cycle ③ X, Y, Z directions ④ 1 times each directions	No display malfunctions No physical damages
Mechanical shock (Non operation)	① 3,920m/ s^2 , 2.5ms ② ±X, ±Y, ±Z directions ③ 1 times each directions	

Note1: Display and appearance are checked under environmental conditions equivalent to the inspection conditions of defect specifications.

7. PRECAUTIONS

7.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "7.2 CAUTIONS" and "7.3 ATTENTIONS", after understanding these contents!**

This sign has the meaning that customer will be injured by personnel or the product will sustain a damage, if customer has wrong operations.

This sign has the meaning that customer will be injured by personnel, if customer has wrong operations.

7.2 CAUTIONS

∗ **Do not shock and press the LCD panel and the backlight! There is a danger of breaking, because they are made of glass. (Shock: Equal to or no greater than 3,920m/s^2 and equal to or no greater than 2.5ms)**

7.3 ATTENTIONS

7.3.1 Handling of the product

① Take hold of both ends without touching the FPC when the product (LCD module) is picked up from the tray.
② Do not hook nor pull the FPC in order to avoid any damage.
③ When the product is put on the table temporarily, display surface must be placed downward.
④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
⑤ The product must be installed and/or handled without any local stress such as bends or twist. Bends, twist or any local stress to any portion may cause display failures. And also do not put heavy or hard materials on the product.
⑥ Do not hit or rub the surface of touch panel with hard materials, because it is easily scratched. (Touch panel pencil-hardness: 3H)
⑦ When cleaning the T/P surface, wipe it with a soft dry cloth.
⑧ Do not push nor pull the FPC while the product is working.
⑨ Do not fold the FPC. When folding the FPC, pattern disconnection may occur. In case of bending FPC, the minimum curvature (R) must be more than 1.0 mm.
⑩ When installing the product, do not contact a conductor such as a metal to the FPC excluding the terminal area. There is a risk of short circuit which is caused by breakage of insulation layer of the FPC.
⑪ When installing the product, apply the waterproof design to avoid going of water into the product.
⑫ Usually liquid crystals don't leak through the breakage of glasses because of the surface tension of thin layer and the construction of LCD panel. But, if you contact with liquid crystal for the worst, please wash it out with soap.

7.3.2 Environment

① Do not operate or store in high temperature, high humidity, dewdrop atmosphere or corrosive gases. Keep the product in packing box with antistatic pouch in room temperature to avoid for dusts and sunlight, when storing the product.
② In order to prevent dew condensation occurring by temperature difference, the product packing box should be opened after enough time being left under the environment of an unpacking room. Evaluate the leaving time sufficiently because a situation of dew condensation occurring is changed by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with packing state)
③ Do not operate in high magnetic field. Circuits may be broken down by it.
④ This product is not designed as radiation hardened.

7.3.3 Characteristics

The following items are neither defects nor failures.

① Response time, luminance and color may be changed by ambient temperature.
② Display mura, flicker, vertical seam or small spot may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking.
④ Optical characteristics may be changed depending on input signal timings.
⑤ Touch panel film has polarizing characteristic. And the polarizer characteristics differ among products. Therefore, when seeing the displays through the other polarizing material (for example polarizing sunglasses), some displays can not be seen and some displays look different color darker because of polarizer characteristic mismatching between touch panel film and the other polarizing material.

7.3.4 Other

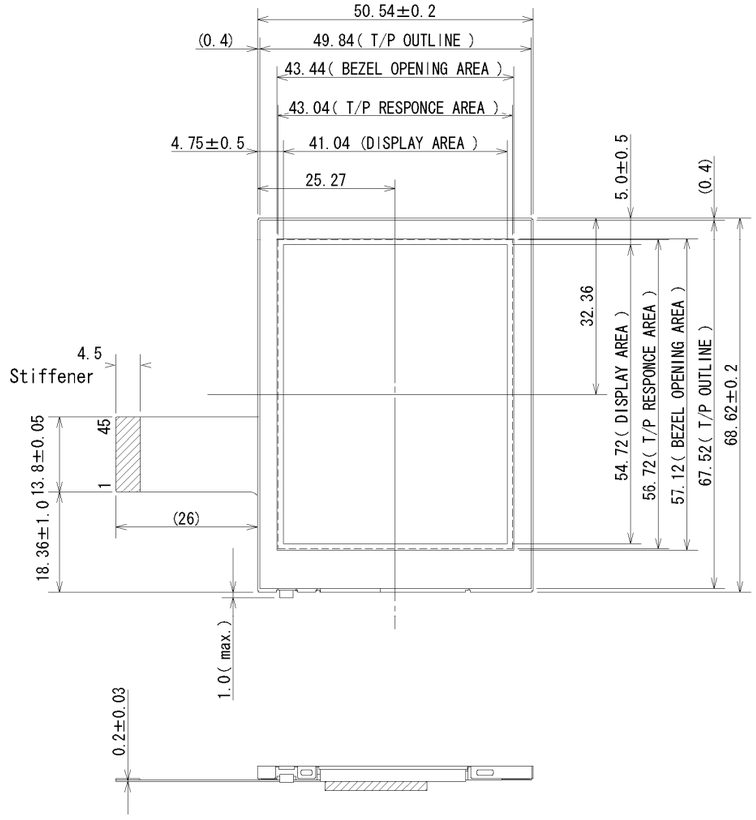
① All GND terminals should be used without any non-connected lines.
② Do not disassemble the product.
③ Pack the product with original shipping package, in order to avoid any damages during transportation, when returning the product to NEC.
④ When installing the product to customer equipment, do not apply any stress to the rear side of the product, FPC, A area, Soldering Area and Mounting Area. If not, it may cause display un-uniformity or LCD panel separation or break down of the product.
⑤ The information of China RoHS directive six hazardous substances or elements in this product is as follows.

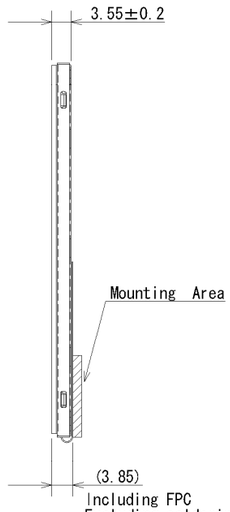
China RoHS directive six hazardous substances or elements					
Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr VI)	Polybrominated Biphenys (PBB)	Polybrominated Biphenyl Ethers (PBDE)
○	○	○	○	○	○

Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of SJ/T11363-2006 standard regulation.
×: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above the limitation level of SJ/T11363-2006 standard regulation.

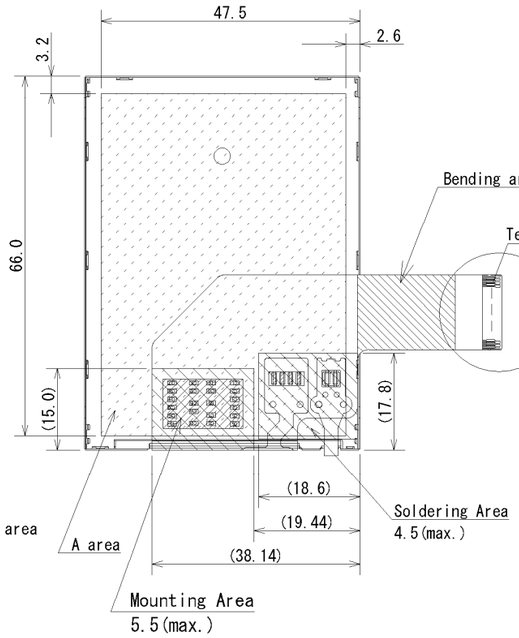
8. OUTLINE DRAWINGS

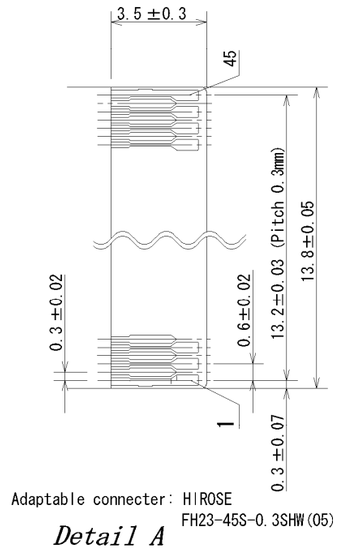
Front view





Rear view





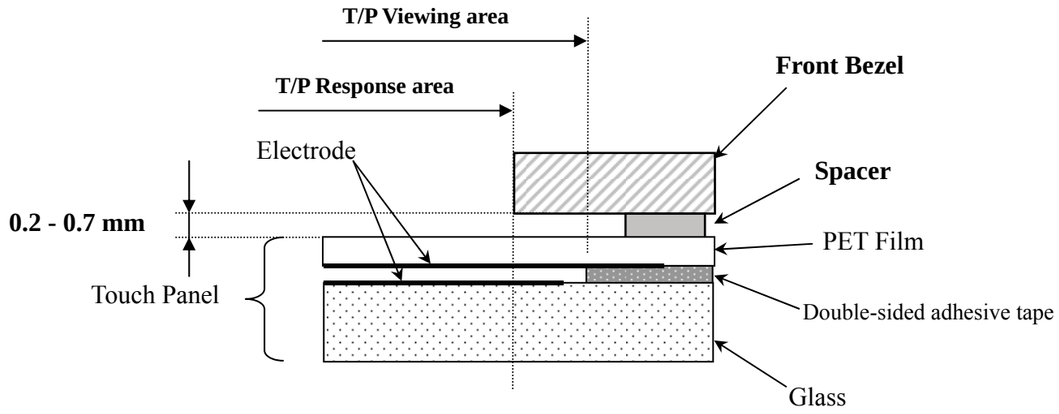
Detail A

Pin No.	Symbols	Pin No.	Symbols
1	GND	25	R0
2	GND	26	R1
3	VCC	27	R2
4	VCC	28	R3
5	VCC	29	R4
6	VCC	30	R5
7	GND	31	GND
8	/RESET	32	SCL
9	HSYNC	33	SI
10	VSYNC	34	SO
11	CLK	35	/CS
12	GND	36	VCOMIN
13	B0	37	N.C.
14	B1	38	GND
15	B2	39	XL
16	B3	40	YD
17	B4	41	XR
18	B5	42	YU
19	G0	43	GND
20	G1	44	ANODE
21	G2	45	CATHODE
22	G3		
23	G4		
24	G5		

Note1: The values in parentheses are for reference.
Note2: When installing the product to customer equipment, do not apply any local stress to the rear side of the product, FPC, A area, Soldering Area and Mounting Area.
If not, it may cause display un-uniformity or LCD panel separation or break down of the product.
Note3: While the product is working, do not contact a conductor such as a metal to the Soldering Area and Mounting Area of the FPC.

Unit: mm

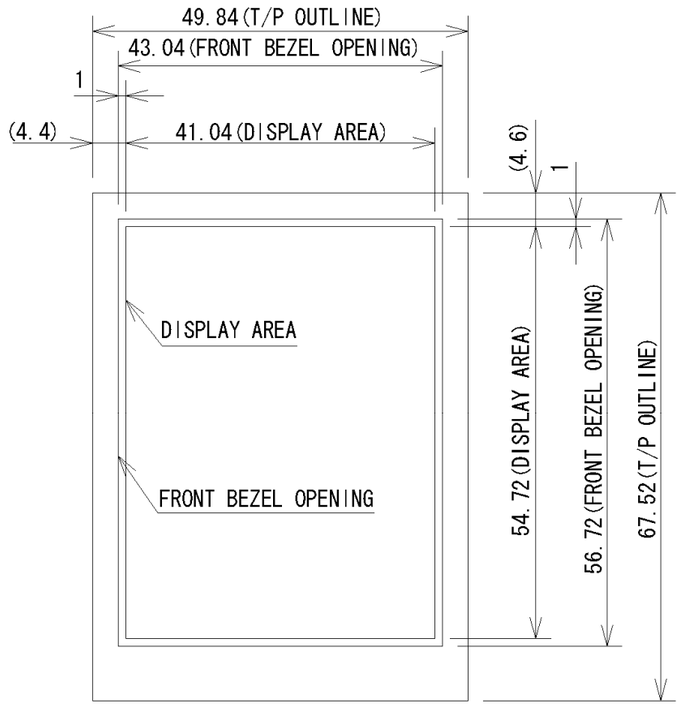
9. RECOMMENDATION DESIGN OF FRONT BEZEL



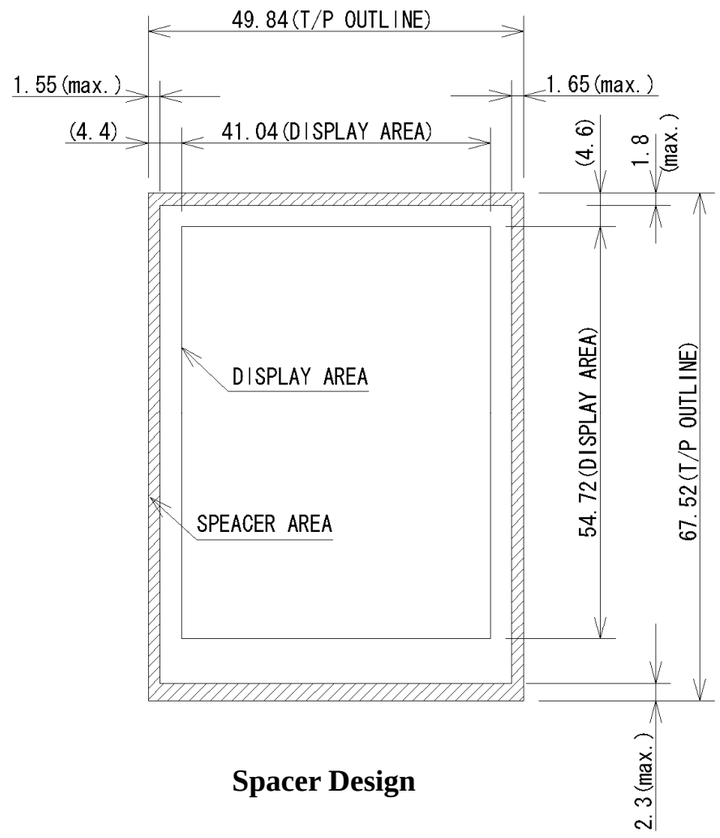
Design guidance for the front bezel and the spacer

1. Front Bezel opening design
   a. Please place the front bezel opening to maintain the operation by a stylus pen inside the T/P response area.
   b. The any pressures in the area between T/P response area and T/P viewing area is prohibited.
      Please use the appropriate material as the front bezel.

2. Spacer design
   a. Please put the spacer, a cushion, on the front bezel. Do not use a double-sided adhesive tape because it adheres on the touch panel surface.
   b. Please position the spacer over the Spacer area to avoid a “short”.



Front Bezel Opening Design



Spacer Design