NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL9654HL06-01J

6.8cm (2.7 Type)
QHD

DATA SHEET

DOD-PP-0818 (1st edition)

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INTRODUCTION

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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.

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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.

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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 NL9654HL06-01J is composed of the low temperature poly silicon thin film transistor liquid crystal display (LTPS TFT LCD) panel structure with driver LSIs for driving the TFT (Thin Film Transistor) array and a backlight.

The LTPS 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 the driver LSIs.

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

- View finder

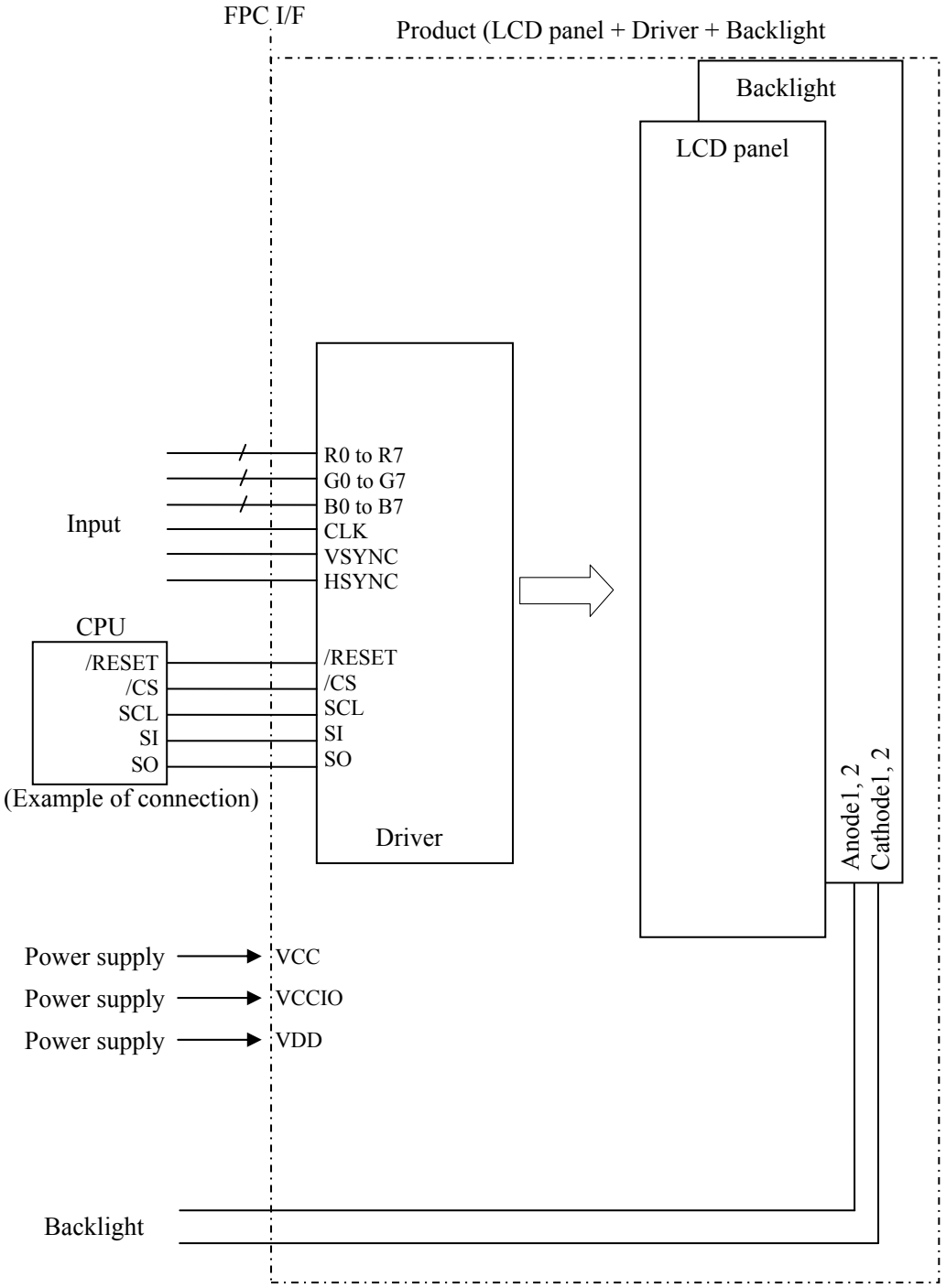
1.3 FEATURES

- Adoption of VIT (Value integrated TFT) (Transmissive type)
- High resolution
- High luminance
- High contrast
- Including LCD controller and power supply
- 8-bit digital RGB signals
- Compliance with the European RoHS directive (2002/95/EC)

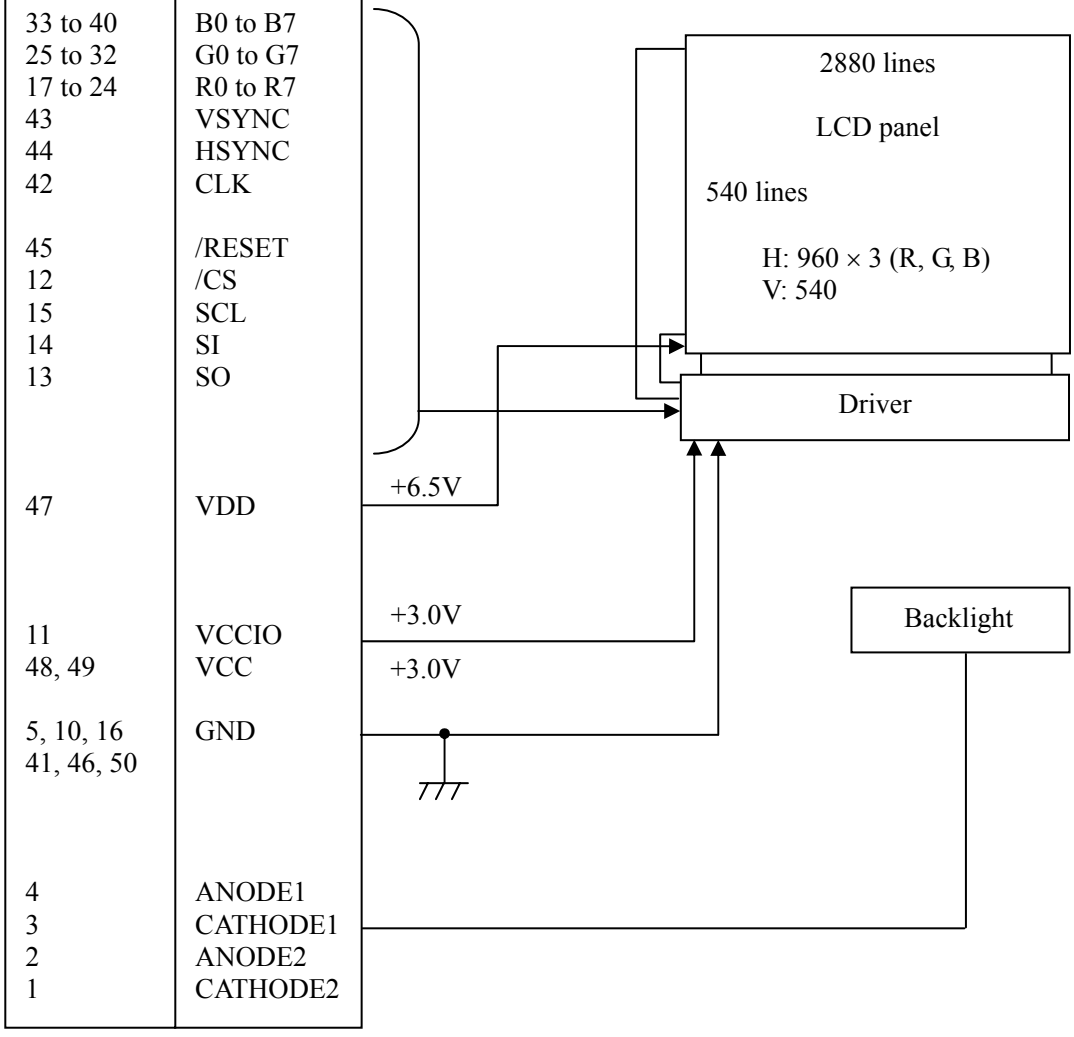
2. GENERAL SPECIFICATIONS

Display area	59.04 (H) × 33.21 (V) mm
Diagonal size of display	6.8 cm (2.7 inches)
Drive system	LTPS TFT active matrix
Display color	16,777,216 colors
Pixel	960 (H) × 540 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.0205 (H) × 0.0615 (V) mm
Pixel pitch	0.0615 (H) × 0.0615 (V) mm
Module size	69.0 (H) × 50.8 (V) × 3.6 (D) mm (typ.) [Excluding FPC]
Weight	26 g (typ.)
Polarizer surface	Clear
Polarizer pencil-hardness	3 H (min.) [by JIS K5400]
Designed viewing direction	• Viewing direction without image reversal: lower side (6 o'clock) • Viewing direction with contrast peak: up side (12 o'clock)
Luminance	*At IL= 14 mA/LED* 300cd/m^2 (typ.)
Contrast ratio	*At IL= 14 mA/LED* 500:1 (typ.)
Response time	*Ton + Toff (10% ←→ 90%)* 14.5 ms (typ.)
Signal system	8-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	VCCIO: 3.0V (typ.) VCC: 3.0V (typ.) VDD: 6.5V (typ.)
Power consumption	LCD panel + Driver: 256 mW (typ.) Backlight: 518 mW (typ., at IL= 14 mA/LED)

3. BLOCK DIAGRAM



Pin No.	Symbol
33 to 40	B0 to B7
25 to 32	G0 to G7
17 to 24	R0 to R7
43	VSYNC
44	HSYNC
42	CLK
45	/RESET
12	/CS
15	SCL
14	SI
13	SO
47	VDD
11	VCCIO
48, 49	VCC
5, 10, 16 41, 46, 50	GND
4	ANODE1
3	CATHODE1
2	ANODE2
1	CATHODE2



4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

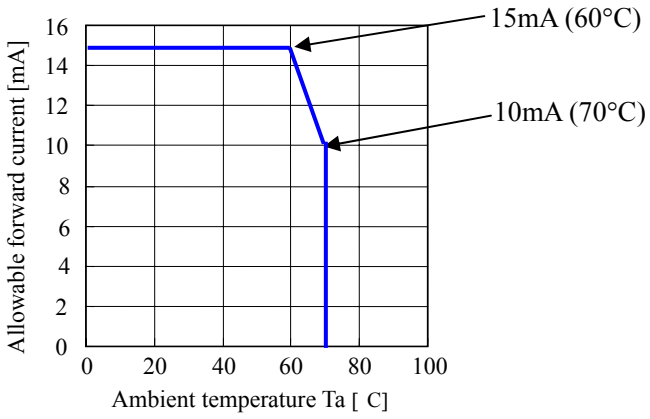
Parameter	Specification	Unit
Module size	69.0 ± 0.3 (W) × 50.8 ± 0.3 (H) × 3.6 ± 0.2 (D) Note1 Note2	mm
Display area	59.04 (H) × 33.21 (V) Note2	mm
Weight	26 (typ.), 28 (max.)	g

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

4.2 ABSOLUTE MAXIMUM RATINGS

Parameter		Symbol	Rating	Unit	Remarks
Supply voltage (DC/DC)		VCC	-0.3 to + 3.7	V	Ta= 25°C
Supply voltage (Logic)		VCCIO	-0.3 to + 6.0	V	Ta= 25°C
Supply voltage (LCD)		VDD	9.0	V	Ta= 25°C
Logic input voltage		VI	-0.3 to VCCIO + 0.3	V	Logic signals
Backlight	Reverse voltage	VR	≤ 30	V	Ta= 25°C
	Power dissipation	PD	612	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
Supply voltage (DC/DC)	VCC	2.7	3.0	3.3	V	-
Supply voltage (Logic)	VCCIO	2.3	3.0	3.3	V	-
Supply voltage (LCD)	VDD	6.4	6.5	6.6	V	-
Permissible ripple voltage	VRP	-	-	100	mVp-p	for VCC,VCCIO,VDD
Logic input high voltage	VIH	0.8VCCIO	-	VCCIO	V	Logic signal
Logic input low voltage	VIL	0	-	0.2VCCIO	V	
VCC supply current	ICC	-	70	100	mA	at VCC= 3.0V Note1
VCCIO supply current	ICCIO	-	0.1	2	mA	at VCCIO= 3.0V Note1
VDD supply current	IDD	-	7	10	mA	at VDD= 6.5V Note1
VCC standby current	ICCs	-	1	2	mA	Standby mode at VCC=3.0V Note2
VCCIO standby current	ISBIO	-	0.06	0.1	mA	Standby mode at VCCIO=3.0V Note2

Note1: CLK= 32.08 MHz, HSYNC= 32.94 kHz, VSYNC= 60 Hz
Checkered flag pattern (by EIAJ ED-2522)
Note2: CLK, control signals: inactive

(2) Backlight

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Forward Current	IL	-	14	15	mA	-
Forward Voltage	VL	-	18.5	20.4	V	at IL= 14 mA

(3) Power supply voltage ripple

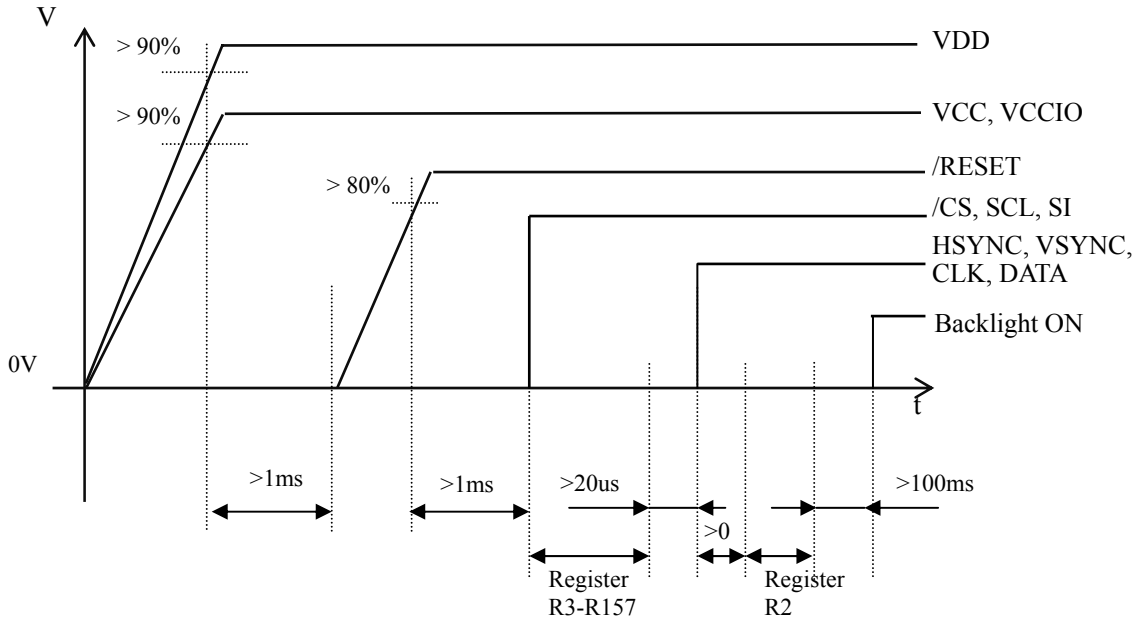
This product works, even if the ripple voltage levels are beyond the permissible values as following the table, but there might be noise on the display image.

Power supply voltage		Ripple voltage Note1 (Measure at input terminal of power supply)	Unit
VCC	3.0V	≤ 100	mVp-p
VCCIO	3.0V	≤ 100	mVp-p
VDD	6.5V	≤ 100	mVp-p

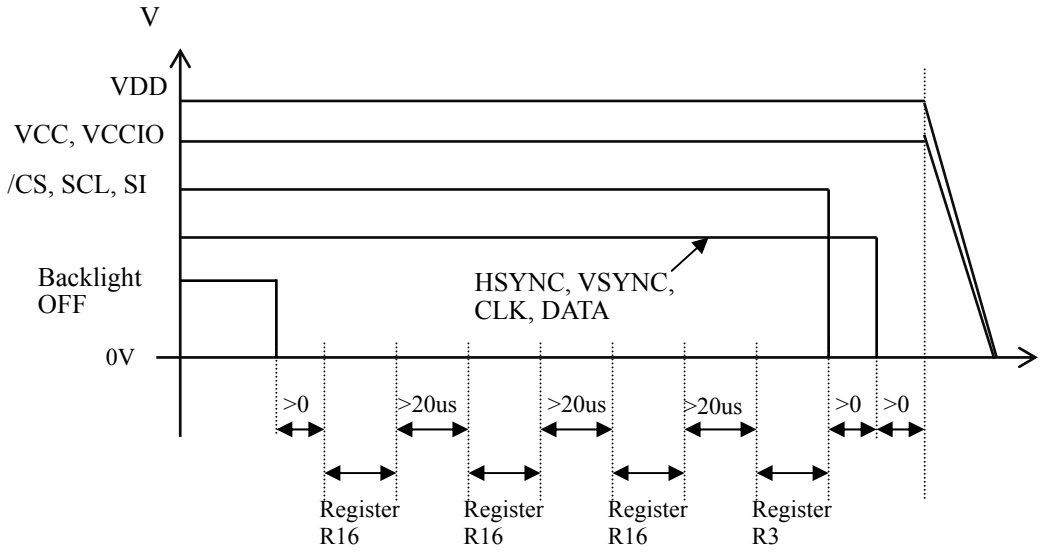
Note1: The permissible ripple voltage includes spike noise.

4.4 POWER SUPPLY VOLTAGE SEQUENCE

(1) Power ON



(2) Power OFF



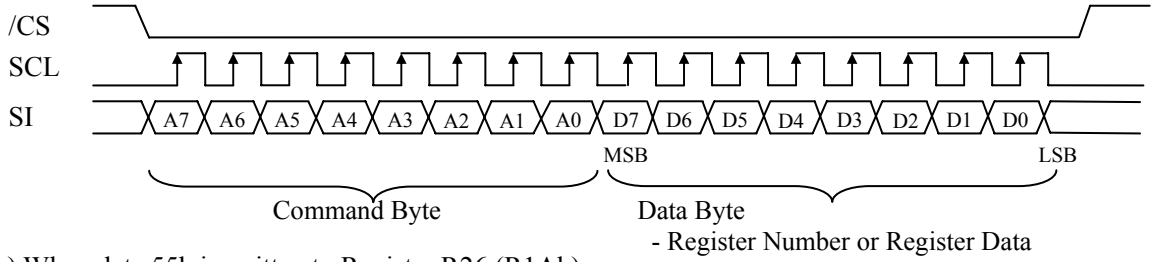
4.5 SETTING OF THE INTERNAL REGISTER

Initially, the internal register of driver is undefined. Therefore, the following procedure is required. After initialization is done by the /REST pin, the register must be written using /CS, SCL and SI pins. To check or confirm the written register data, you can read it using SO pin. The setting method is as follows.

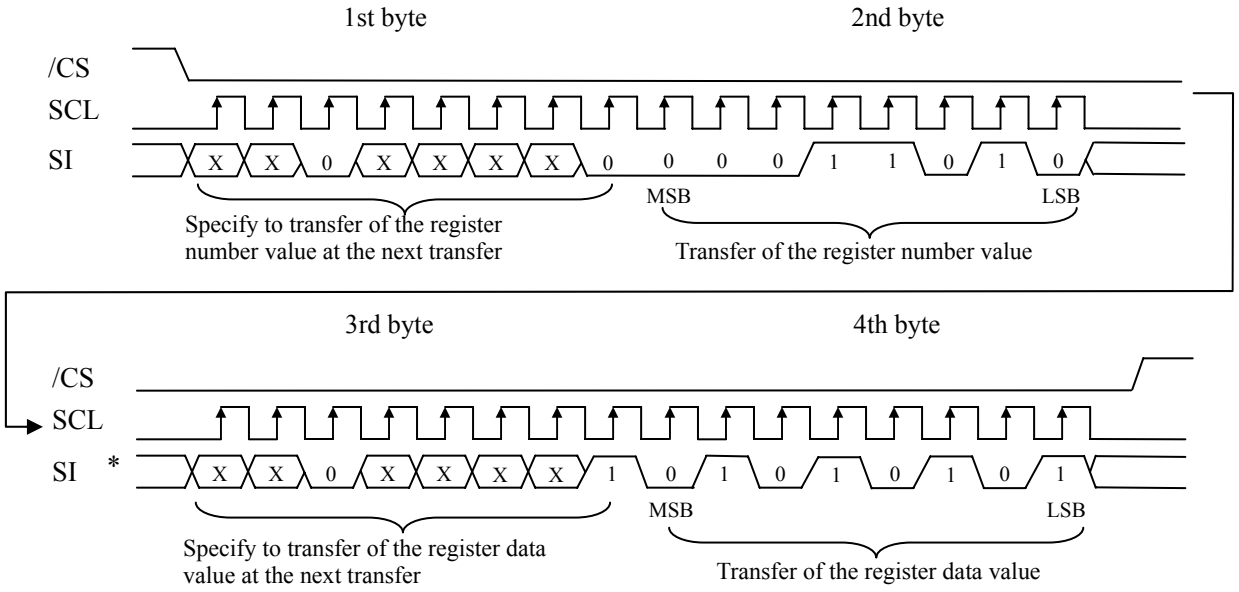
(1) Command Byte Function

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

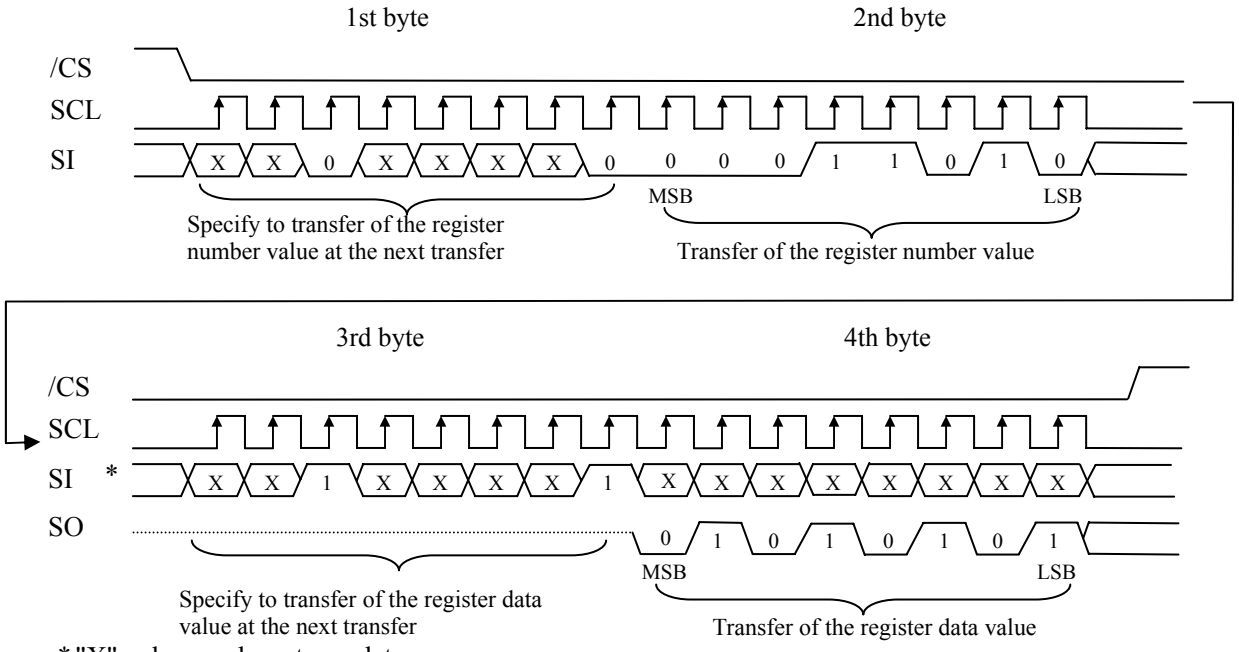


Ex) When data 55h is written to Register R26 (R1Ah)



* "X" value can be set any data.

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



* "X" value can be set any data.

Note1: During 32-bit transfer of the Register Data, /CS pin (Pin No.12) must be maintained active.
Note2: Data transfer should be performed every 32 bit.

(3) Command sequence

① Power On

Sequence	Register Number	Data	Comment	Sequence	Register Number	Data	Comment
1	Power On			46	R83	40h	-
2	1ms min. wait.			47	R84	42h	-
3	Reset by the /RESET pin(PIN No.45)			48	R85	41h	
4	1ms min. wait after /RESET↑			49	R86	2Ch	
5	R3	01h	-	50	R89	8Ah	-
6	R0	00h	-	51	R90	01h	-
7	R1	01h	-	52	R91	00h	-
8	R4	00h	-	53	R92	1Eh	-
9	R5	14h	-	54	R93	0Ah	-
10	R6	24h	-	55	R94	32h	-
11	R16	D7h	-	56	R95	30h	-
12	R17	02h	-	57	R98	70h	-
13	R18	00h	-	58	R99	30h	-
14	R19	55h	-	59	R102	AEh	-
15	R20	01h	-	60	R103	30h	-
16	R21	70h	-	61	R112	04h	-
17	R22	1Fh	-	62	R113	04h	-
18	R23	0Fh	-	63	R114	02h	-
19	R24	0Fh	-	64	R115	18h	-
20	R25	02h	-	65	R118	00h	-
21	R26	02h	-	66	R121	30h	-
22	R27	A0h	-	67	R130	01h	-
23	R32	20h	-	68	R131	00h	-
24	R33	05h	-	69	R132	FCh	-
25	R34	10h	-	70	R134	10h	-
26	R35	12h	-	71	R136	10h	-
27	R36	12h	-	72	R138	04h	-
28	R37	0Dh	-	73	R139	10h	-
29	R38	0Bh	-	74	R140	00h	-
30	R39	10h	-	75	R141	FCh	-
31	R40	02h	-	76	R143	00h	-
32	R41	02h	-	77	R145	00h	-
33	R42	02h	-	78	R147	00h	-
34	R43	00h	-	79	R148	00h	-
35	R44	05h	-	80	R149	00h	-
36	R45	10h	-	81	R150	FCh	-
37	R46	12h	-	82	R152	00h	-
38	R47	12h	-	83	R154	00h	-
39	R48	0Dh	-	84	R156	00h	-
40	R49	0Bh	-	85	R157	00h	-
41	R50	10h	-	86	20μs min. wait		
42	R51	02h	-	87	Data input start		
43	R52	02h	-	88	R2	00h	
44	R53	02h	-				
45	R80	0Ah	-				

②Power Off

Sequence	Register Number	Data	Comment
1	R16	05h	-
2	20 μs min. wait.		
3	R16	01h	-
4	20 μs min. wait.		
5	R16	00h	
6	20 μs min. wait.		
7	R3	01h	-
8	Data Off		
9	Power Off		

③Stand-by

Sequence	Register Number	Data	Comment
1	R2	01h	-
2	40ms min. wait		

④Wakeup

Sequence	Register Number	Data	Comment
1	R2	00h	-

⑤Reverse Mode

Sequence	Register Number	Data	Comment
Horizontal	R1	01h	Normal
		03h	Reverse
Vertical	R121	30h	Normal
		10h	Reverse

Note1: Be sure to perform reset by the /RESET pin (Pin No. 45) every power-on
Note2: Write the Register 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.

4.6 INTERFACE PIN CONNECTIONS

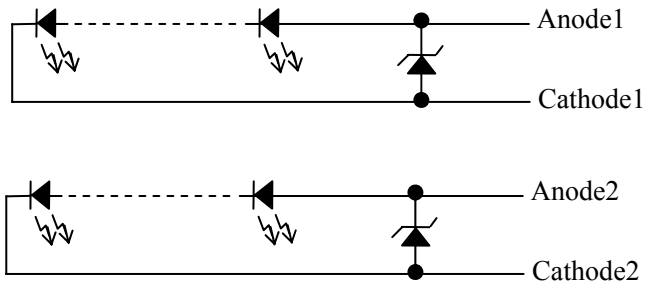
CN1 (FPC)
Adaptable socket: FH12-50S-0.5SHW (05) (Hirose Electric Co., Ltd. (HRS))

Pin No.	Symbols	Functions	Pin No.	Symbols	Functions
1	CATHODE2	LED2 voltage (Cathode)	26	G6	Green data
2	ANODE2	LED2 voltage (Anode)	27	G5	Green data
3	CATHODE1	LED1 voltage (Cathode)	28	G4	Green data
4	ANODE1	LED1 voltage (Anode)	29	G3	Green data
5	GND	Ground Note1	30	G2	Green data
6	RSVD	Keep this pin Open.	31	G1	Green data
7	RSVD	Keep this pin Open.	32	G0	Green data (LSB)
8	RSVD	Keep this pin Open.	33	B7	Blue data (MSB)
9	RSVD	Keep this pin Open.	34	B6	Blue data
10	GND	Ground Note1	35	B5	Blue data
11	VCCIO	Power supply (Logic)	36	B4	Blue data
12	/CS	Chip selection	37	B3	Blue data
13	SO	Serial output	38	B2	Blue data
14	SI	Serial input	39	B1	Blue data
15	SCL	Serial clock	40	B0	Blue data (LSB)
16	GND	Ground Note1	41	GND	Ground Note1
17	R7	Red data (MSB)	42	CLK	Dot clock
18	R6	Red data	43	VSYNC	Vertical synchronous signal
19	R5	Red data	44	HSYNC	Horizontal synchronous signal
20	R4	Red data	45	/RESET	Reset
21	R3	Red data	46	GND	Ground Note1
22	R2	Red data	47	VDD	Power supply
23	R1	Red data	48	VCC	Power supply
24	R0	Red data (LSB)	49	VCC	Power supply
25	G7	Green data (MSB)	50	GND	Ground Note1

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.
ANODE1,2 CATHODE1,2	Refer to the below "**Circuits of backlight**".



Circuits of backlight

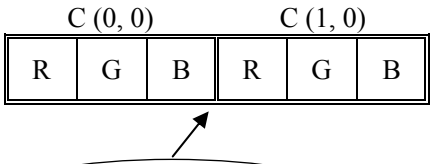
4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 16,777,216 colors in 256 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)																							
		R7	R6	R5	R4	R3	R2	R1	R0	G7	G6	G5	G4	G3	G2	G1	G0	B7	B6	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	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
	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
	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
	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
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
		0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	↑					:								:							:				
	↓					:								:							:				
	bright	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	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
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	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	dark	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	↑					:								:							:				
	↓					:								:							:				
	bright	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
		0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
	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
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	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	0	0	0	0	0	0	1	0
	↑					:								:							:				
	↓					:								:							:				
	bright	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	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

4.8 DISPLAY POSITIONS

The following table is the coordinates per pixel (See figure of "**4.9 SCANNING DIRECTIONS**".).



C(0, 0)	C(1, 0)	•••	C(X, 0)	•••	C(958, 0)	C(959, 0)
C(0, 1)	C(1, 1)	•••	C(X, 1)	•••	C(958, 1)	C(959, 1)
• • •	• • •	• ••• •	• • •	• ••• •	• • •	• ••• •
C(0, Y)	C(1, Y)	•••	C(X, Y)	•••	C(958, Y)	C(959, Y)
• • •	• • •	• ••• •	• • •	• ••• •	• • •	• • •
C(0, 538)	C(1, 538)	•••	C(X, 538)	•••	C(958, 538)	C(959, 538)
C(0, 539)	C(1, 539)	•••	C(X, 539)	•••	C(958, 539)	C(959, 539)

4.9 SCANNING DIRECTIONS

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

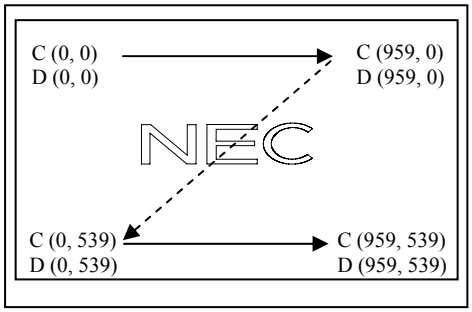


Figure1. Normal scan
(R1:01h, R121:30h)

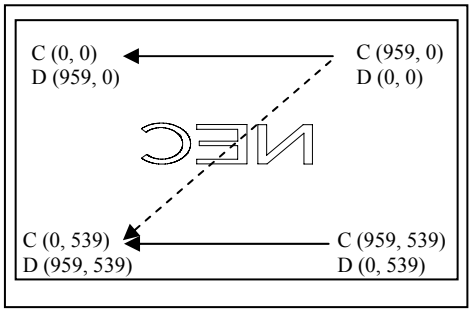


Figure2. Horizontal Reverse scan
(R1:03h, R121:30h)

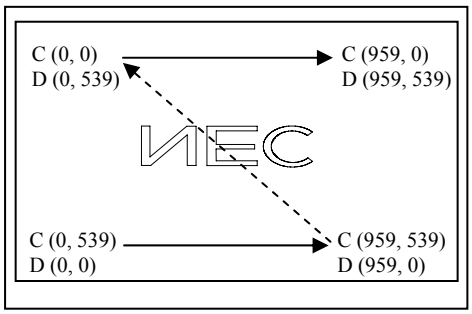


Figure3. Vertical Reverse scan
(R1:01h, R121:10h)

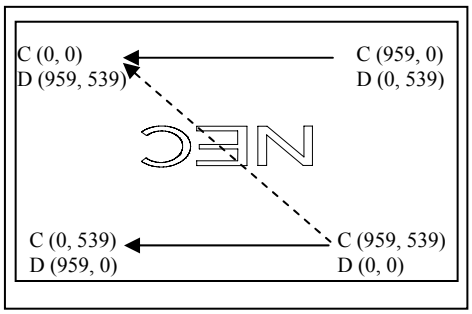


Figure4. Horizontal and Vertical Reverse scan
(R1:03h, R121:10h)

Note1: Meaning of C (X, Y) and D (X, Y)
C (X, Y): The coordinates of the display position (See "**4.8 DISPLAY POSITIONS**".)
D (X, Y): The data number of input signal for LCD panel

4.10 INPUT SIGNAL TIMINGS

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

(1) Timing characteristics

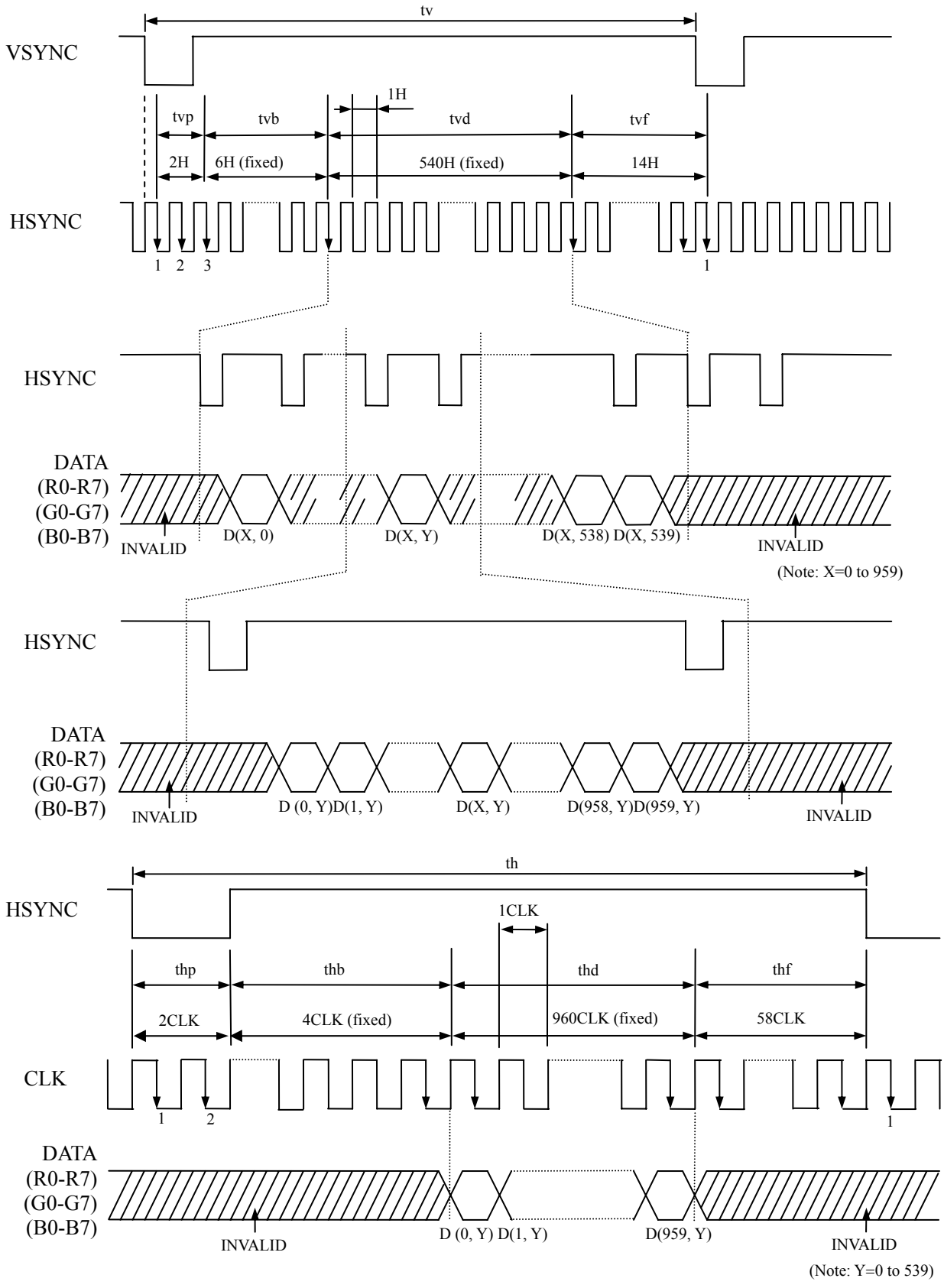
Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	29.27	34.53	37.0	MHz	29ns (typ.)
	Duty		tcd	0.4	0.5	0.6	-	-
	Rise time, Fall time		tcrf	-	-	2	ns	
DATA (R0-R7) (G0-G7) (B0-B7)	CLK-DATA	Setup time	tds	13	-	-	ns	-
		Hold time	tdh	13	-	-	ns	
	Rise time, Fall time		tdrf	-	-	2	ns	
HSYNC	Cycle		th	-	29.66	-	µs	33.72 kHz (typ.)
				971	1024	1120	CLK	-
	Display period		thd	960			CLK	
	Front-porch		thf	6	58	A	CLK	
	Pulse width		thp	2	2	B	CLK	
	Back-porch		thb	4			CLK	
	CLK-HSYNC	Setup time	ths	13	-	-	ns	
		Hold time	thh	13	-	-	ns	
	Rise time, Fall time		thrf	-	-	2	ns	
VSYNC	Cycle		tv	-	16.67	-	ms	60Hz (typ.)
				548	562	640	H	-
	Display period		tvd	540			H	
	Front-porch		tvf	1	14	C	H	
	Pulse width		tvp	1	2	D	H	
	Back-porch		tvb	6			H	
	CLK-VSYNC	Setup time	tvs	13	-	-	ns	
		Hold time	tvh	13	-	-	ns	
	CLK-VSYNC	Setup time	tvhs	0	-	-	ns	
		Hold time	tvhh	0	-	-	ns	
	Rise time, Fall time		tvrf	-	-	2	ns	

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

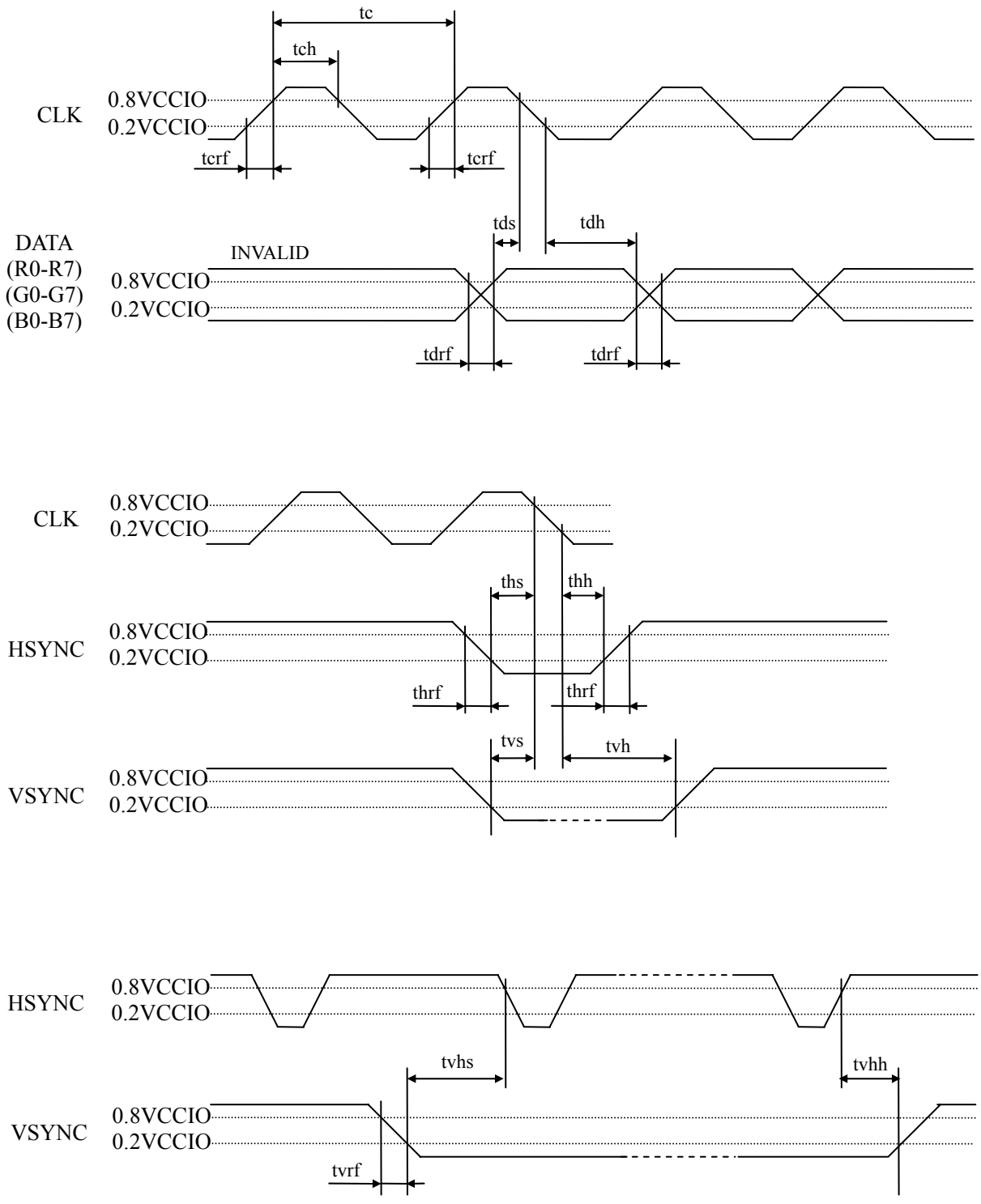
Note2: All parameters should be kept within the specified range.

Note3: A+B ≤ 156CLK, C+D ≤ 94H

(2) Input signal timing chart



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



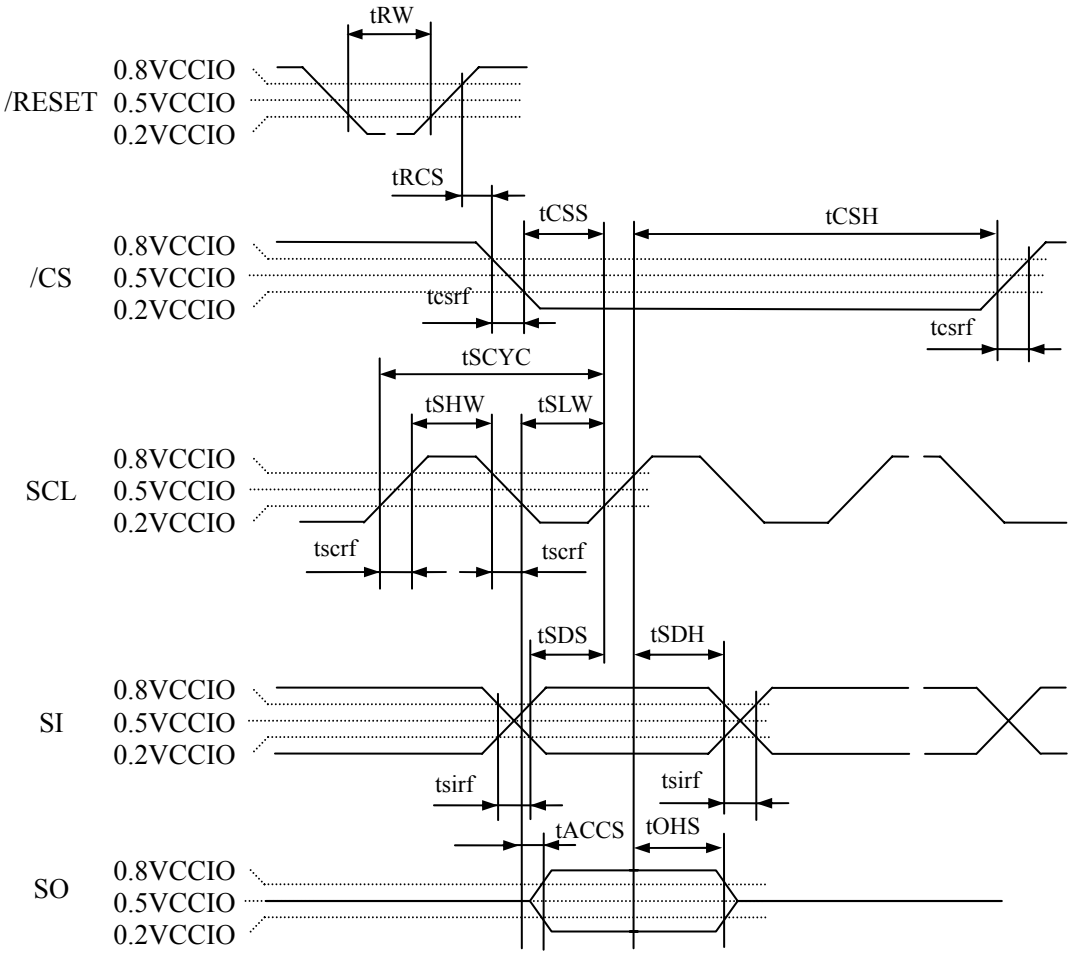
Note1: Unless otherwise specified, the input level is defined to be VIH= 0.8VCCIO, VIL= 0.2VCCIO.

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

(1) Timing characteristics

Parameter	Symbol	Condition	min.	typ.	max.	Unit	Remarks
Serial clock cycle	tSCYC	SCL	100	-	-	ns	-
SCL high level pulse width	tSHW	SCL	50	-	-	ns	-
SCL low level pulse width	tSLW	SCL	50	-	-	ns	-
/CS rise time, fall time	tcsrf	/CS	-	-	2	ns	-
SCL rise time, fall time	tscrf	SCL	-	-	2	ns	-
SI rise time, fall time	tsirf	SI	-	-	2	ns	-
/CS setup time	tCSS	/CS	50	-	-	ns	-
/CS hold time	tCSH	/CS	50	-	-	ns	-
Data setup time	tSDS	SI	50	-	-	ns	-
Data hold time	tSDH	SI	50	-	-	ns	-
Reset pulse width	tRW	/RESET	10	-	-	µs	-
/RESET↑ to /CS time	tRCS	/RESET↑ to /CS	10	-	-	µs	-
Access time	tACCS	SO	-	-	150	ns	
Output disable time	tOHS	SO	-	-	20	ns	-

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



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

4.11 OPTICAL CHARACTERISTICS

(Note1, Note2)

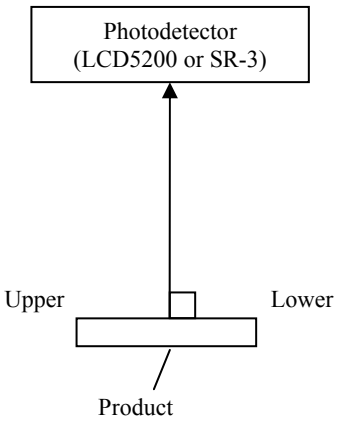
Parameter	Condition	Symbol	min.	typ.	max.	Unit	Remarks
Luminance	White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	150	300	-	cd/m^2	-
Contrast ratio	White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	200	500	-	-	Note3
Luminance uniformity	White θR= 0°, θL= 0°, θU= 0°, θD= 0° Maximum luminance: 100%	LU	75	85	-	%	Note4

Reference data

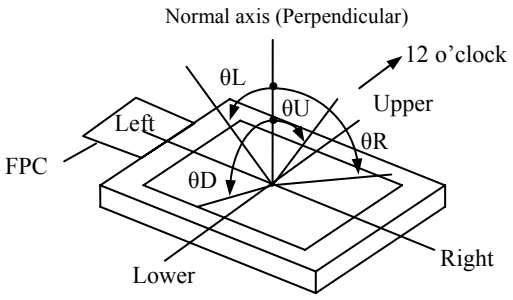
(Note1, Note2)

Parameter		Condition		Symbol	min.	typ.	max.	Unit	Remarks
Chromaticity coordinates		White		Wx	0.26	0.30	0.34	-	Note5
				Wy	0.27	0.31	0.35	-	
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space		C	60	70	-	%	
Response time		White to black	90%→ 10%	Ton	-	3.5	5.0	ms	Note6 Note7
		Black to white	10%→ 90%	Toff	-	11.0	16.0		
Viewing angle	Right	θR		θR	-	80	-	°	-
	Left	θL		θL	-	80	-	°	
	Up	θU		θU	-	60	-	°	
	Down	θD		θD	-	60	-	°	

Note1: Measurement conditions are as follows.
Ta= 25°C, VCC= 3.0V, VCCIO= 3.0V, IL= 14 mA



Note2: Definition of viewing angles



Note3: Definition of contrast ratio

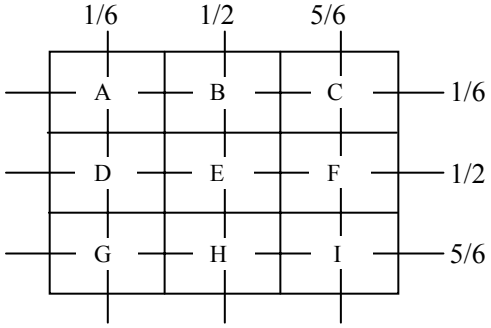
The contrast ratio is calculated by using the following formula.

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

Note4: Definition of luminance uniformity

Luminance uniformity is calculated by using the following formula.

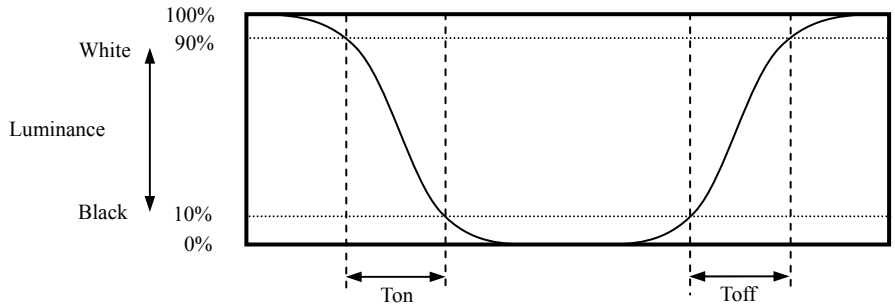
$$\text{Luminance uniformity (LU)} = \frac{\text{Minimum luminance from A to I}}{\text{Maximum luminance from A to I}} \times 100$$



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

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		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of LED) Continuous operation, IL=14mA	20,000	h

Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for LCD module but the value for LED elementary substance.
Note3: 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: To be not greater 3,920m/s^2 and to be not greater 2.5ms)**

7.3 ATTENTIONS

7.3.1 Handling of the product

① Pull out the product from side without FPC and take hold of side with out FPC, when the product (LCD module) is picked up from the tray. Do not touch the FPC.
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 without any stress such as bends or twist. Bends, twist or any stress to any portion may cause display mura.
⑥ Do not hit or rub the surface of panel with hard materials, because it is easily scratched. (Polarizer pencil-hardness: 3H)
⑦ When cleaning the panel 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 Do not adjust the variable resistor which is mounted on the FPC.
⑫ When installing the product, apply the waterproof design to avoid going of water into the product.
⑬ 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 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.

7.3.4 Other

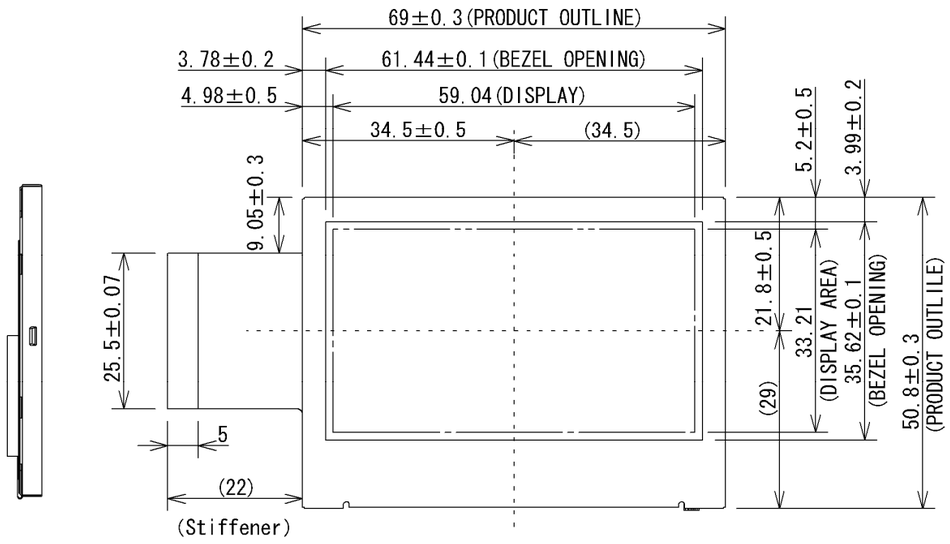
① All GND terminals should be used without any non-connected lines.
② Do not disassemble the product.
③ Pack the product with original shipping package, in order to avoid any damages during transportation, when returning the product to NEC.
④ When installing the product to the customer equipment, do not apply any stress to the A area, FPC, Soldering Area and Mounting Area. If not, it may cause display un-uniformity 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)
×	○	○	○	○	○

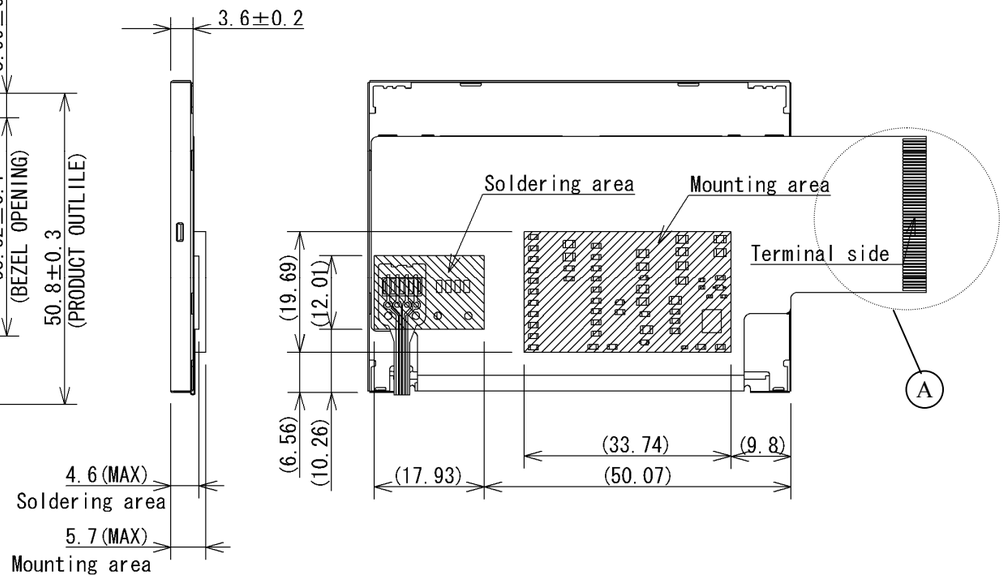
Note1: ○: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is equal or below the limitation level of SJ/T11363-2006 standard regulation.
×: This indicates that the poisonous or harmful material in all the homogeneous materials for this part is above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

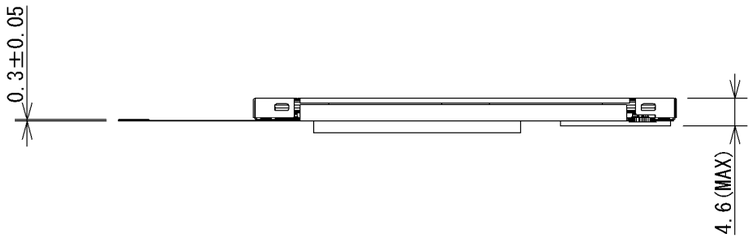
8. OUTLINE DRAWINGS

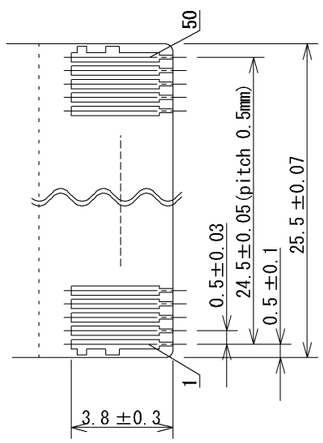
Front view



Rear view







Detail A

Adaptable connecter: FH12-50S-0.5SH(05) (HIROSE)

Pin No.	Symbols	Pin No.	Symbols
1	CATHODE2	26	G6
2	ANODE2	27	G5
3	CATHODE1	28	G4
4	ANODE1	29	G3
5	GND	30	G2
6	RSVD	31	G1
7	RSVD	32	G0
8	RSVD	33	B7
9	RSVD	34	B6
10	GND	35	B5
11	VCCIO	36	B4
12	/CS	37	B3
13	SO	38	B2
14	SI	39	B1
15	SCL	40	B0
16	GND	41	GND
17	R7	42	CLK
18	R6	43	VSYNC
19	R5	44	HSYNC
20	R4	45	/RESET
21	R3	46	GND
22	R2	47	VDD
23	R1	48	VCC
24	R0	49	VCC
25	G7	50	GND

Note1: The values in parentheses are for reference.
Note2: 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.
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.
Note4: Do not adjust the variable resistor.

Unit: mm