NEC NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL4864HL11-02A

8.9cm (3.5 Type)
VGA

DATA SHEET
DOD-PP-0763 (1st edition)

This DATA SHEET is updated document from PRELIMINARY DATA SHEET DOD-PP-0564(2).

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

INTRODUCTION

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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.

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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 NL4864HL11-02A 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 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
- PNDs

1.3 FEATURES

- Adoption of VIT (Value Integrated TFT) (Transflective type)
- Multi resolution (VGA or QVGA)
- Backlight attached
- High luminance
- High contrast
- 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	53.28 (H) × 71.04 (V) mm
Diagonal size of display	8.9cm (3.5 inches)
Drive system	LTPS TFT active matrix
Display color	262,144 colors
Pixel	480 (H) × 640 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.037 (H) × 0.111 (V) mm
Pixel pitch	0.111 (H) × 0.111 (V) mm
Module size	63.5 (H) × 85.0 (V) × 3.0 (D) mm (typ.)
Weight	25g (typ.) ☆
Polarizer surface	Clear
Polarizer pencil-hardness	3H (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= 20mA* 220cd/m^2 (typ.) ☆
Reflection ratio	7% (typ.) ☆

Contrast ratio	*At transmissive mode, IL= 20mA/LED*
	  180:1 (typ.)
	At reflective mode
	  15:1 (typ.)

Response time	*Ton+Toff (10%←→90%)*
	  30 ms (typ., at transmissive mode)
	  16 ms (typ., at reflective mode)

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.) VCCIO: 3.0V (typ.)
Power consumption	LCD panel + Driver: 120mW (typ.) Backlight: 512mW (typ., at IL= 20mA/LED)

3. BLOCK DIAGRAM

FPC I/F

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

1440 lines

LCD panel

640 lines

H: 480 × 3 (R, G, B)
V: 640

Driver

+3.0V

+3.0V

Backlight

Reference design of COM circuit

3.0V

47KΩ

100KΩ

VCOMIN
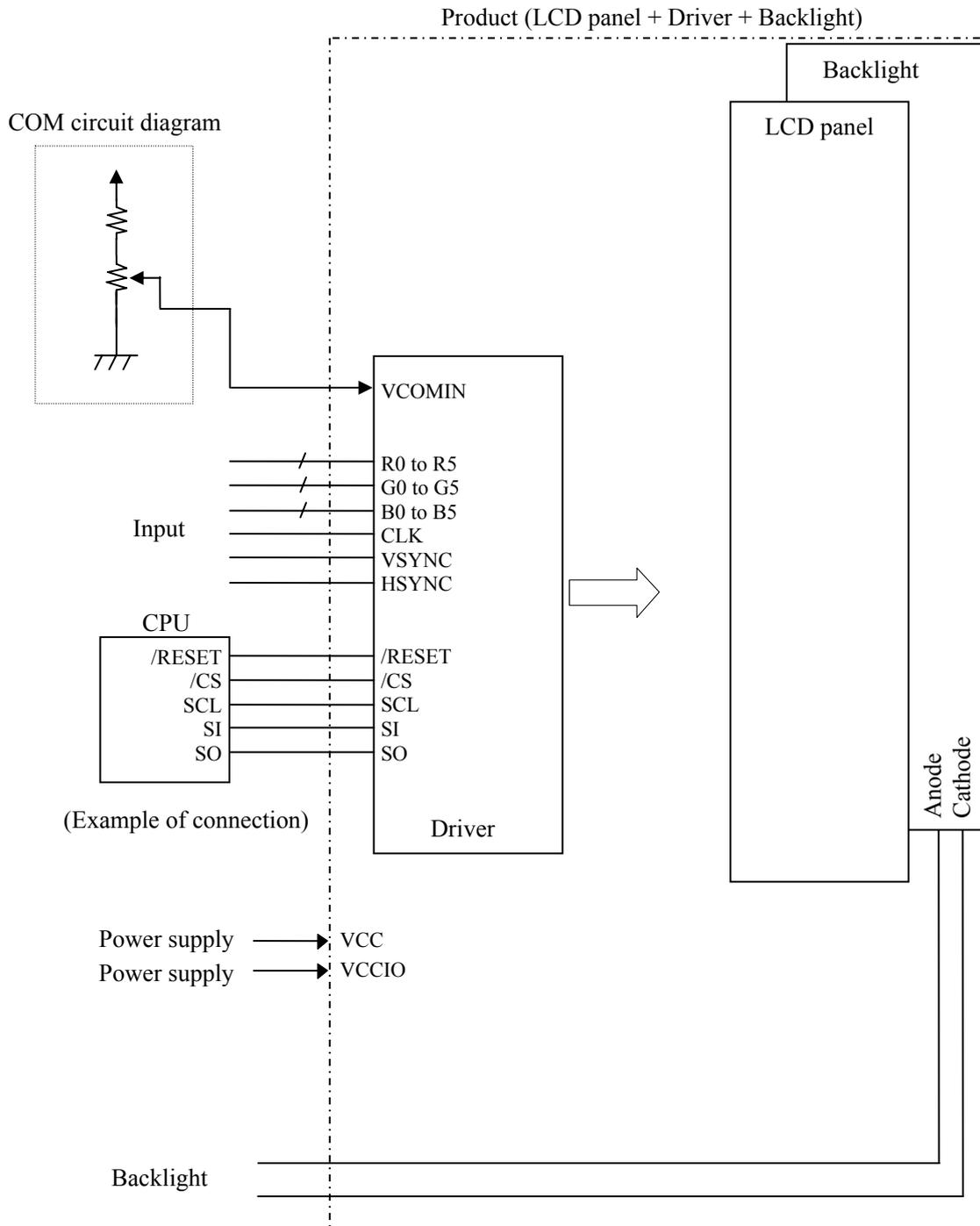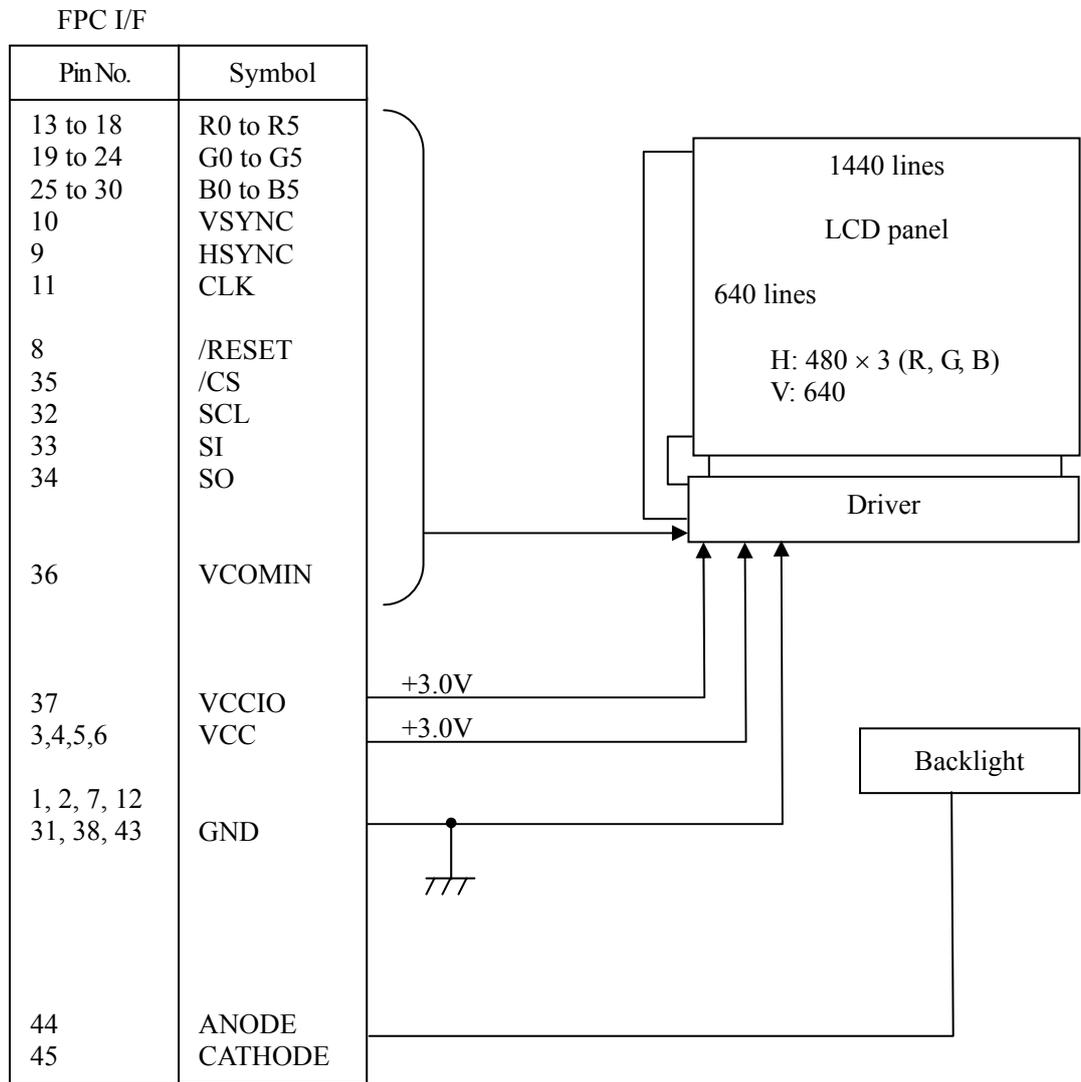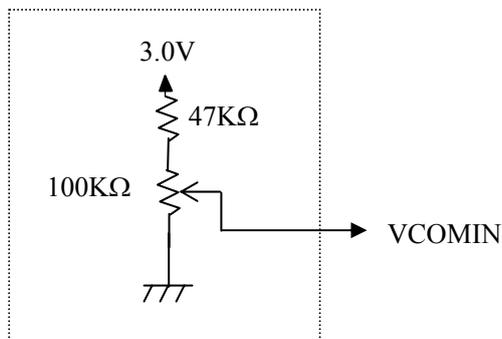
4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

Parameter	Specification		Unit
Module size	63.5 ± 0.3 (W) $\times$ 85.0 ± 0.3 (H) $\times$ 3.0 ± 0.2 (D) Note1	Note2	mm
Display area	53.28 (H) $\times$ 71.04 (V)	Note2	mm
Weight	25 (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	
Logic input voltage		VI	-0.3 to VCCIO + 0.3	V	Logic signals
Backlight	Reverse voltage	VR	≤ 40	V	Ta= 25°C
	Power dissipation	PD	≤ 984	mW	
	Forward current	IL	Note1	mA	-
	Pulse forward current	IFP	100	mA	Pulse width $\leq$ 10ms, Duty $\leq$ 1/10
Storage temperature		Tst	-30 to +70	°C	-
Operating temperature		Top	-20 to +70		Product surface Note2
Relative humidity Note3		RH	≤ 95	%	Ta$\leq$ 40°C
			≤ 85		40°C <Ta$\leq$ 50°C
			≤ 55		50°C <Ta$\leq$ 60°C
Absolute humidity Note3		AH	≤ 71 Note4	g/m³	Ta> 60°C
Storage altitude			$\leq 13,600$	m	-30°C $\leq$ Ta $\leq$ 80°C
Operating altitude			$\leq 4,850$	m	-20°C $\leq$ Ta $\leq$ 70°C

Note1: Allowable forward current

22mA (45°C)
12mA (70°C)
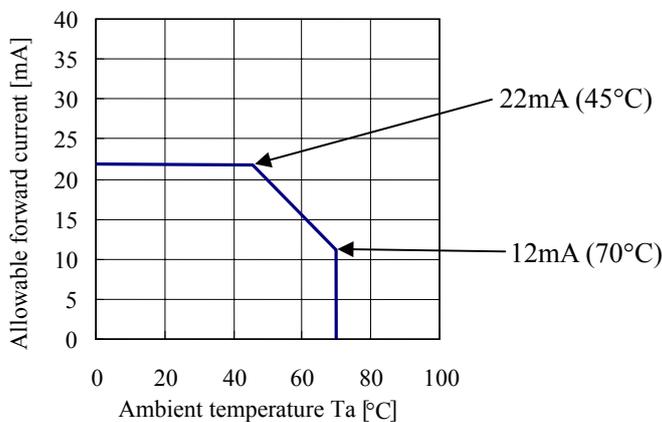
Note2: Measured at display area
Note3: No condensation
Note4: Water amount at Ta= 60°C and RH= 55%

NL4864HL11-02A

4.3 ELECTRICAL CHARACTERISTICS

(1) Logic/ LCD driving

(Ta= 25°C)

| Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Supply voltage (DC/DC)	VCC	2.85	3.0	3.15	V	-
Supply voltage (Logic)	VCCIO	1.65	3.0	3.3	V	-
Logic input high voltage	VIH	0.8VCCIO	-	VCCIO	V	Logic signal
Logic input low voltage	VIL	0	-	0.2VCCIO	V	Logic signal
VCOM input voltage	VCOMIN	-	0.2	-	V	at VCC= 3.0V Note1
VCC supply current	ICC	-	40	60	mA	Normal mode at VCC= 3.0V Note2
VCCIO supply current	ICCIO	-	0.03	0.2	mA	Normal mode at VCCIO= 3.0V Note2
VCC standby current	ICCs	-	1.0	2.0	mA	Standby mode at VCC= 3.0V Note3
VCCIO standby current	ISBIO	-	0.025	0.04	mA	Standby mode at VCCIO= 3.0V Note3

Note1: The optimum value for VCOMIN is in the range of 0 V to 0.5 V. The optimum value VCOMIN is different each product.

Note2: PPCLK= 19.6MHz, PPHSYNC= 38.88kHz, PPVSYNC= 60Hz,
Checkered flag pattern (by EIAJ ED-2522)

Recommended adjustment display for VCOMIN

The figure is every one line

← Half tone display (32/63 gray scale)
← Full black display (0/63 gray scale)
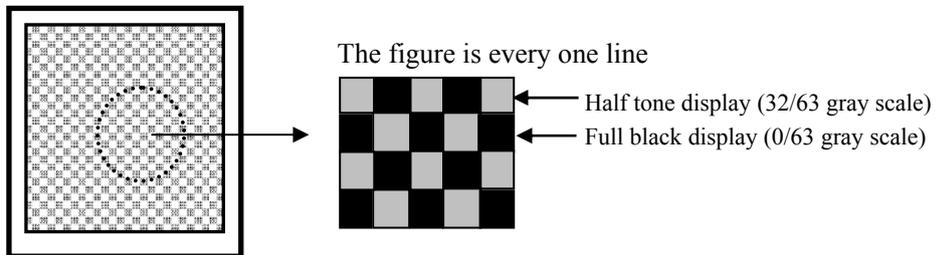
Note3: CLK, control signals: inactive.

(2) Backlight

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Forward Current	IL	-	20	22	mA	-
Forward Voltage	VL	-	25.6	28.0	V	at IL= 20mA

4.4 POWER SUPPLY VOLTAGE SEQUENCE   ☆

(1) Power ON
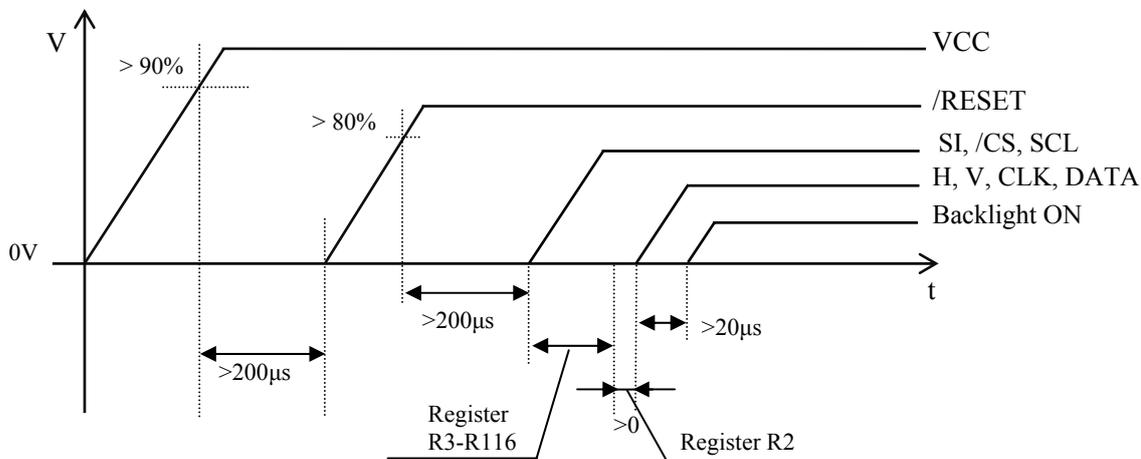
(2) Power OFF
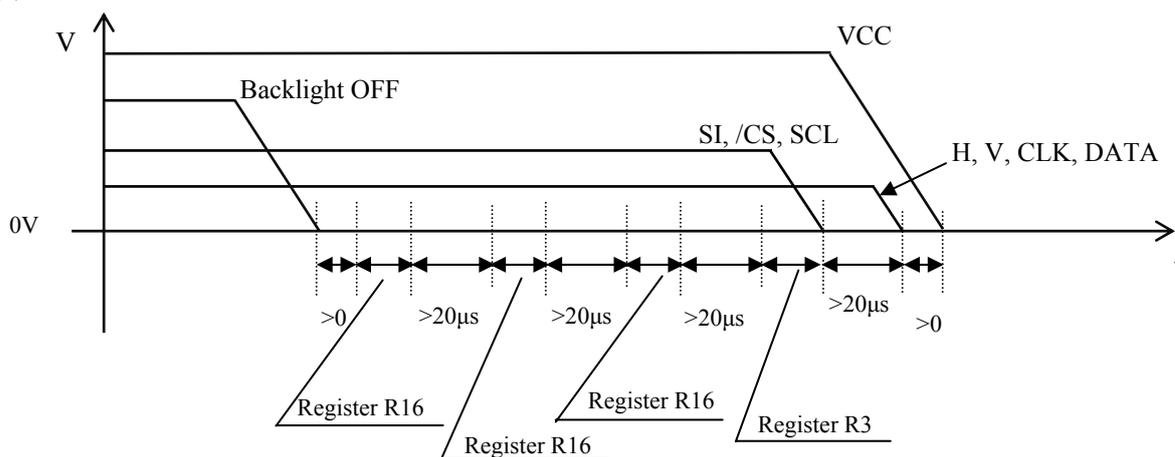
4.5 SETTING OF THE INTERNAL REGISTER

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

| Command Byte |
| Data Byte - Register Number or Register Data |
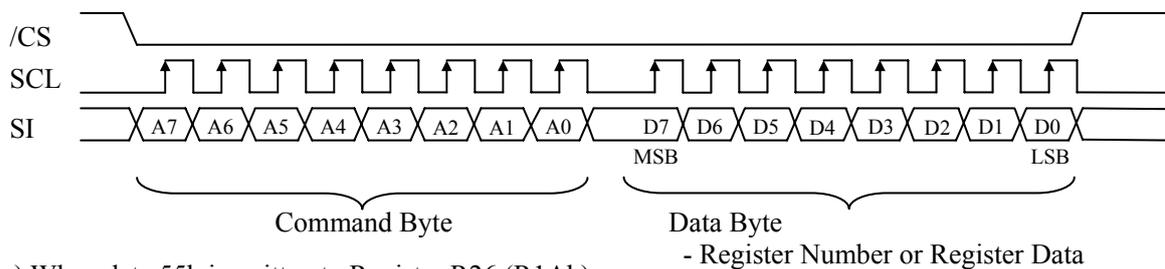
Ex) When data 55h is written to Register R26 (R1Ah)

1st byte / 2nd byte

Specify the data write of register number by next byte

Transfer the register number

3rd byte / 4th byte

Specify the data write of register data by next byte

Transfer of the register data

* "X" value can be set any data.
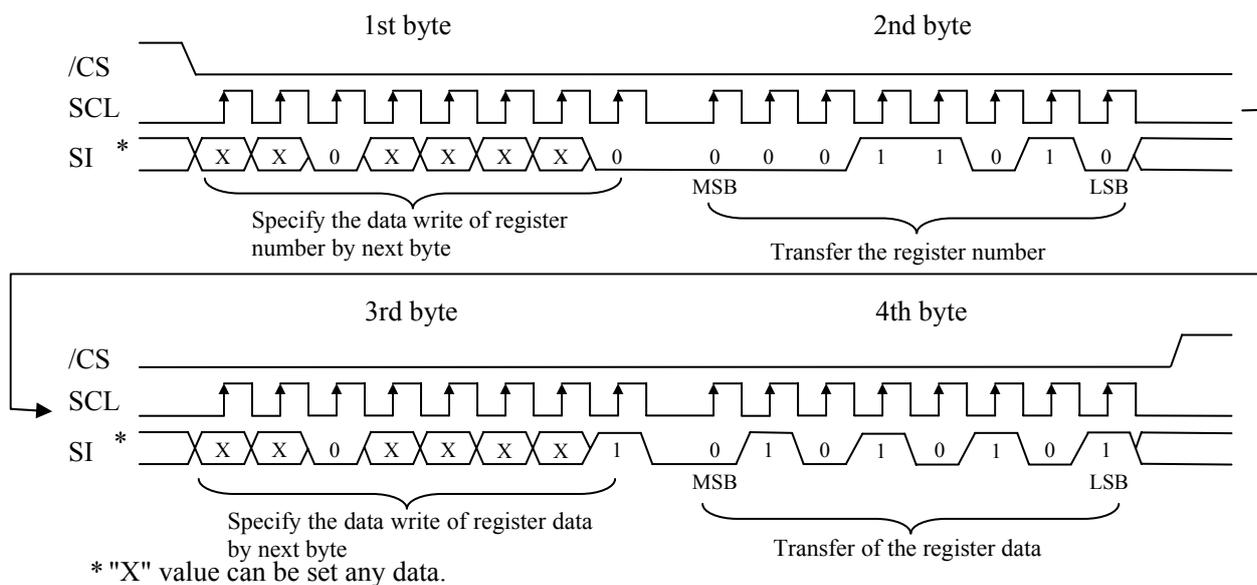
Ex) When data 55h is read from Register R26 (R1Ah)

1st byte / 2nd byte

Specify the data write of register number by next byte

Transfer of the register number

3rd byte / 4th byte

Specify the data read of register data by next byte

Transfer of the register data

* "X" value can be set any data.
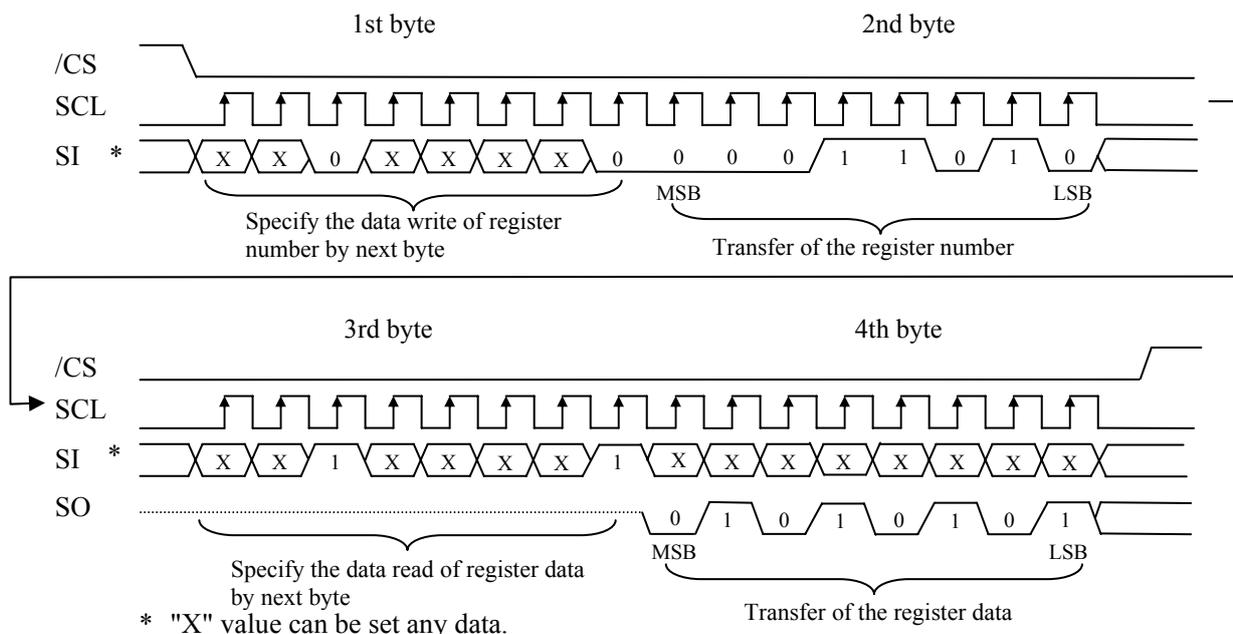
Note1: During 32 bits data transfer of the Register , /CS pin (Pin No.35) must be maintained active.
Note2: Please transfer the data every 32 bits.

(3) Command sequence

① Power On

Sequence	Register Number	Data	Comment	Sequence	Register Number	Data	Comment
1	Power On			35	R44	05h	-
2	200us min. wait.			36	R45	0Eh	-
3	Reset by the /RESET pin (Pin No.8).			37	R46	16h	-
4	200us min. wait.			38	R47	0Bh	-
5	R3	01h	-	39	R48	0Ah	-
6	R0	00h	-	40	R49	19h	-
7	R1	09h	-	41	R50	03h	-
8	R4	07h	-	42	R51	02h	-
9	R5	14h	-	43	R52	02h	-
10	R6	24h	-	44	R53	02h	-
11	R16	D7h	-	45	R55	04h	-
12	R17	03h	-	46	R58	04h	-
13	R18	00h	-	47	R80	02h	-
14	R19	55h	-	48	R83	42h	-
15	R20	01h	-	49	R84	42h	-
16	R21	70h	-	50	R85	4Fh	-
17	R22	0Ch	-	51	R86	1Eh	-
18	R23	2Fh	-	52	R89	08h	-
19	R24	2Fh	-	53	R90	01h	-
20	R25	FFh	-	54	R91	00h	-
21	R26	02h	-	55	R92	0Fh	-
22	R27	80h	-	56	R93	0Ah	-
23	R32	2Bh	-	57	R94	57h	-
24	R33	05h	-	58	R95	18h	-
25	R34	0Eh	-	59	R98	3Bh	-
26	R35	16h	-	60	R99	18h	-
27	R36	0Bh	-	61	R102	1Fh	-
28	R37	0Ah	-	62	R103	18h	-
29	R38	19h	-	63	R106	02h	-
30	R39	03h	-	64	R116	0Bh	-
31	R40	02h	-	65	20us min. wait		
32	R41	02h	-	66	Data input start		
33	R42	02h		67	R2	00h	-
34	R43	0Bh	-				

② Power Off

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

③Standby

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

④Wake Up

Sequence	Register Number	Data	Comment
1	R2	00h	-

⑤QVGA mode

Sequence	Register Number	Data	Comment
1	R1	29h	VGA mode at 09h

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.

4.6 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			27	R2	Red data
4	VCC	Power supply	Note1	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	VCCIO	Power supply (Logic)
14	B1	Blue data		38	GND	Ground	Note1
15	B2	Blue data		39	N.C.	Keep this pin Open.
16	B3	Blue data		40	N.C.	Keep this pin Open.
17	B4	Blue data		41	N.C.	Keep this pin Open.
18	B5	Blue data (MSB)		42	N.C.	Keep this pin Open.
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 input voltage. The voltage needs to be adjusted. The details are explained the above. See "**3 BLOCK DIAGRAM - Reference design of COM circuit**".
ANODE, CATHODE	Refer to the below "**Circuits of backlight**".
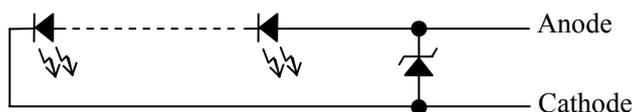
Circuits of backlight

4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display in equivalent to 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

4.8 DISPLAY POSITIONS

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

C (0, 0)   C (1, 0)

R	G	B	R	G	B

C(0, 0)	C(1, 0)	• • •	C(X, 0)	• • •	C(478, 0)	C(479, 0)
C(0, 1)	C(1, 1)	• • •	C(X, 1)	• • •	C(478, 1)	C(479, 1)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, Y)	C(1, Y)	• • •	C(X, Y)	• • •	C(478, Y)	C(479, Y)
• • •	• • •	• • •	• • •	• • •	• • •	• • •
C(0, 638)	C(1, 638)	• • •	C(X, 638)	• • •	C(478, 638)	C(479, 638)
C(0, 639)	C(1, 639)	• • •	C(X, 639)	• • •	C(478, 639)	C(479, 639)
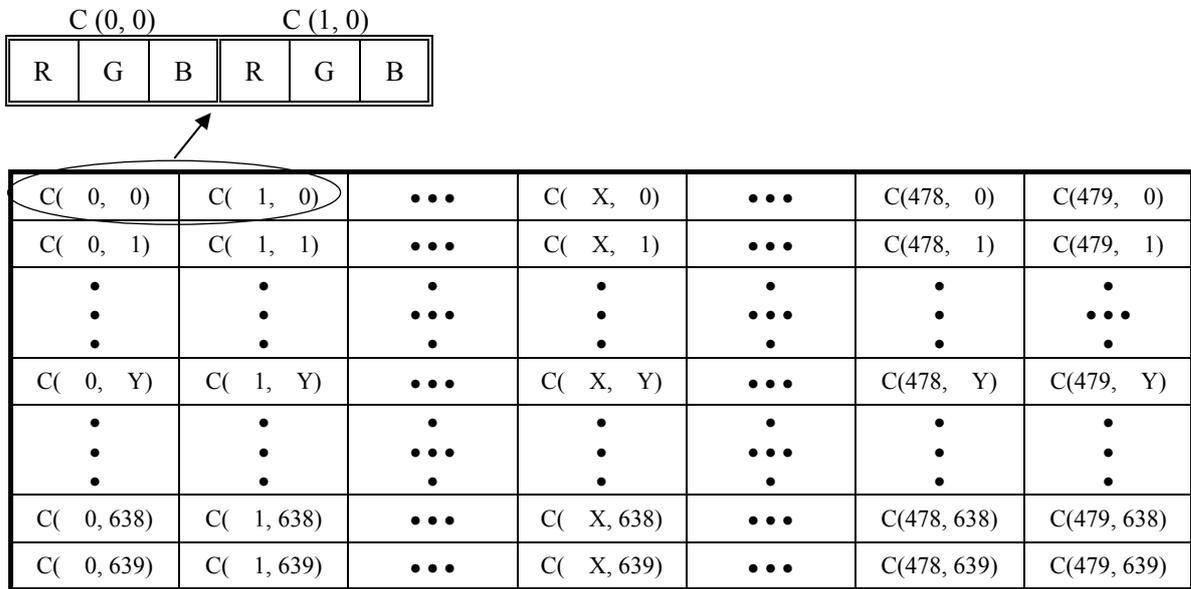
4.9 SCANNING DIRECTIONS

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

C (0, 0)   C (m, 0)
D (0, 0)   D (m, 0)

VGA mode:
  m=479, n=639

QVGA mode:
  m=239, n=319

FPC

C (0, n)   C (m, n)
D (0, n)   D (m, n)
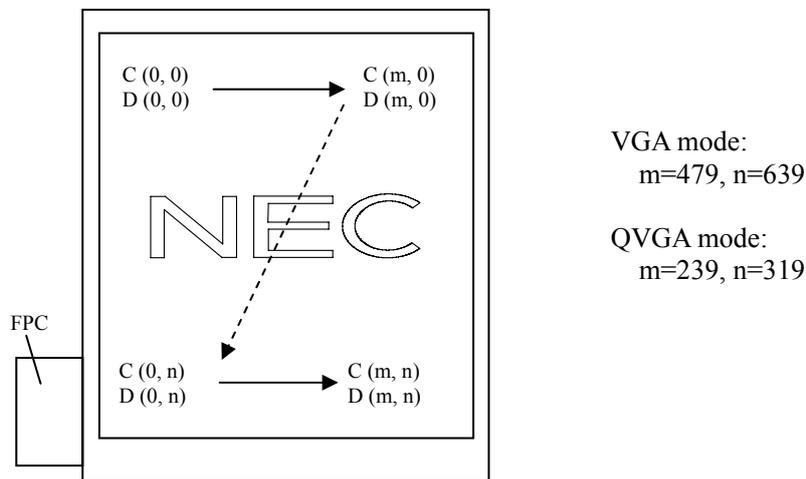
Note1: Meaning of C (X, Y) and D (X, Y)
        C (X, Y): The coordinates of the display position (See "**4.8 DISPLAY POSITIONS**".)
        D (X, Y): The data number of input signal for LCD panel

4.10 INPUT SIGNAL TIMINGS

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

(1) Timing characteristics (VGA mode)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	18.0	19.6	21.3	MHz	51ns (typ.)
	Duty		tcd	0.4	0.5	0.6	-	-
	Rise time, Fall time		tcrf	-	-	2	ns	
DATA (R0 - 5) (G0 - 5) (B0 - 5)	CLK-DATA	Setup time	tds	14	-	-	ns	-
		Hold time	tdh	14	-	-	ns	
	Rise time, Fall time		tdrf	-	-	2	ns	
HSYNC	Cycle		th	23.77	25.71	28.0	μs	38.88kHz (typ.)
					504		CLK	-
	Display period		thd		480		CLK	
	Front-porch		thf		6		CLK	
	Pulse width		thp		14		CLK	
	Back-porch		thb		4		CLK	
	CLK-HSYNC	Setup time	ths	14	-	-	ns	
		Hold time	thh	14	-	-	ns	
	Rise time, Fall time		thrf	-	-	2	ns	
VSYNC	Cycle		tv	15.41	16.67	18.14	ms	60Hz (typ.)
					648		H	-
	Display period		tvd		640		H	
	Front-porch		tvf		1		H	
	Pulse width		tvp		1		H	
	Back-porch		tvb		6		H	
	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.

(2) Input signal timing chart (VGA mode)
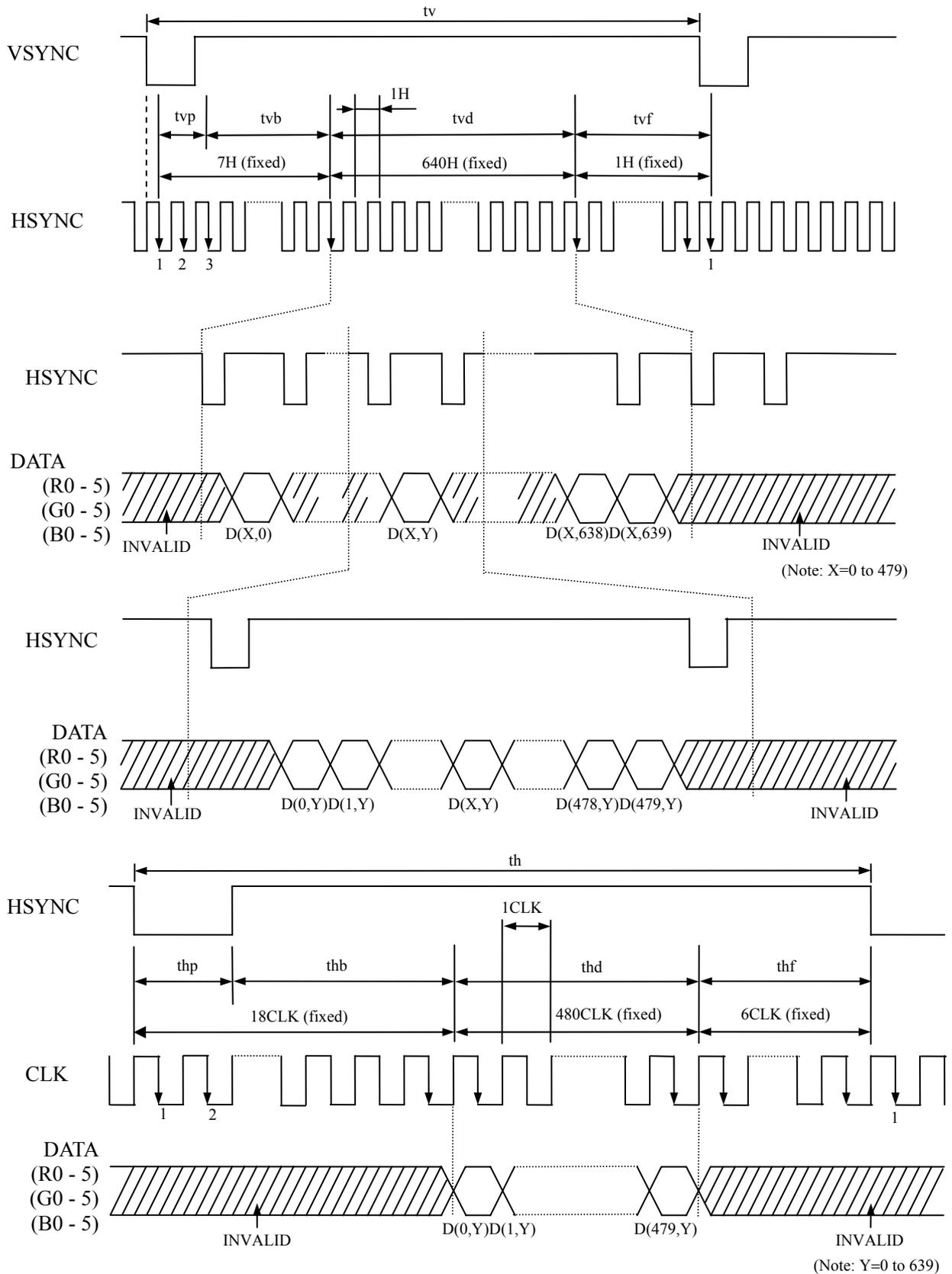
(Note: X=0 to 479)

(Note: Y=0 to 639)

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

CLK

0.8VCCIO
0.2VCCIO

tc

tch

tcrf

tcrf

DATA
(R0 - 5)
(G0 - 5)
(B0 - 5)

0.8VCCIO
0.2VCCIO

INVALID

tds

tdh

tdrf

tdrf

CLK

0.8VCCIO
0.2VCCIO

HSYNC

0.8VCCIO
0.2VCCIO

ths

thh

thrf

thrf

VSYNC

0.8VCCIO
0.2VCCIO

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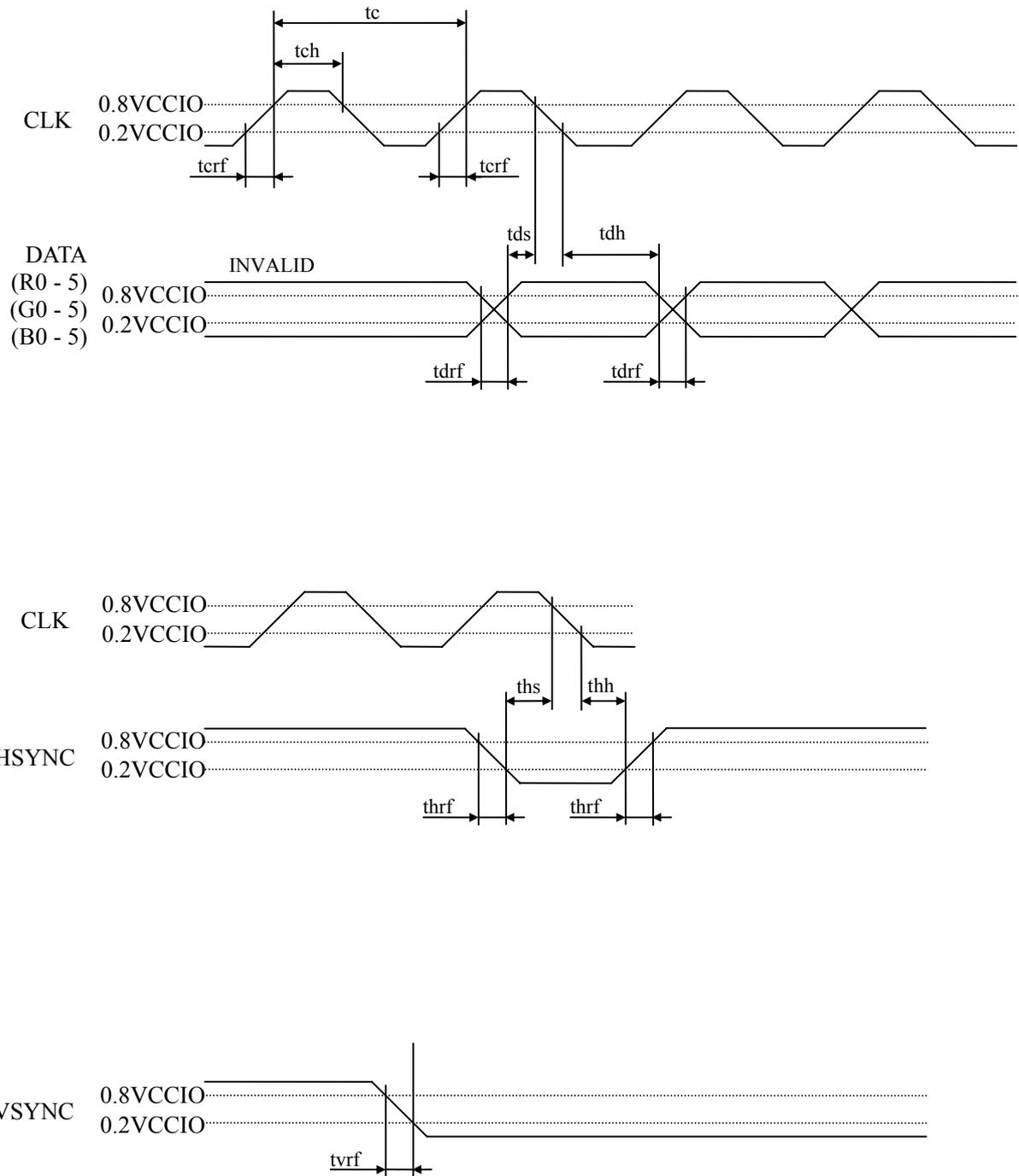
Note1: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.

(3) Timing characteristics (QVGA mode)

Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	4.59	5.0	5.42	MHz	200ns (typ.)
	Duty		tcd	0.4	0.5	0.6	-	-
	Rise time, Fall time		tcrf	-	-	2	ns	
DATA (R0 - 5) (G0 - 5) (B0 - 5)	CLK-DATA	Setup time	tds	60	-	-	ns	-
		Hold time	tdh	60	-	-	ns	
	Rise time, Fall time		tdrf	-	-	2	ns	
HSYNC	Cycle		th	46.5	50.4	54.9	μs	19.84kHz (typ.)
					252		CLK	-
	Display period		thd		240		CLK	
	Front-porch		thf	2	5	-	CLK	
	Pulse width		thp		3		CLK	
	Back-porch		thb		4		CLK	
	CLK-HSYNC	Setup time	ths	60	-	-	ns	
		Hold time	thh	60	-	-	ns	
	Rise time, Fall time		thrf	-	-	2	ns	
VSYNC	Cycle		tv	15.39	16.68	18.17	ms	60Hz (typ.)
					331		H	-
	Display period		tvd		320		H	
	Front-porch		tvf		5		H	
	Pulse width		tvp		1		H	
	Back-porch		tvb		5		H	
	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.

(4) Input signal timing chart (QVGA mode)

(Note: X=0 to 239)

(Note: Y=0 to 319)
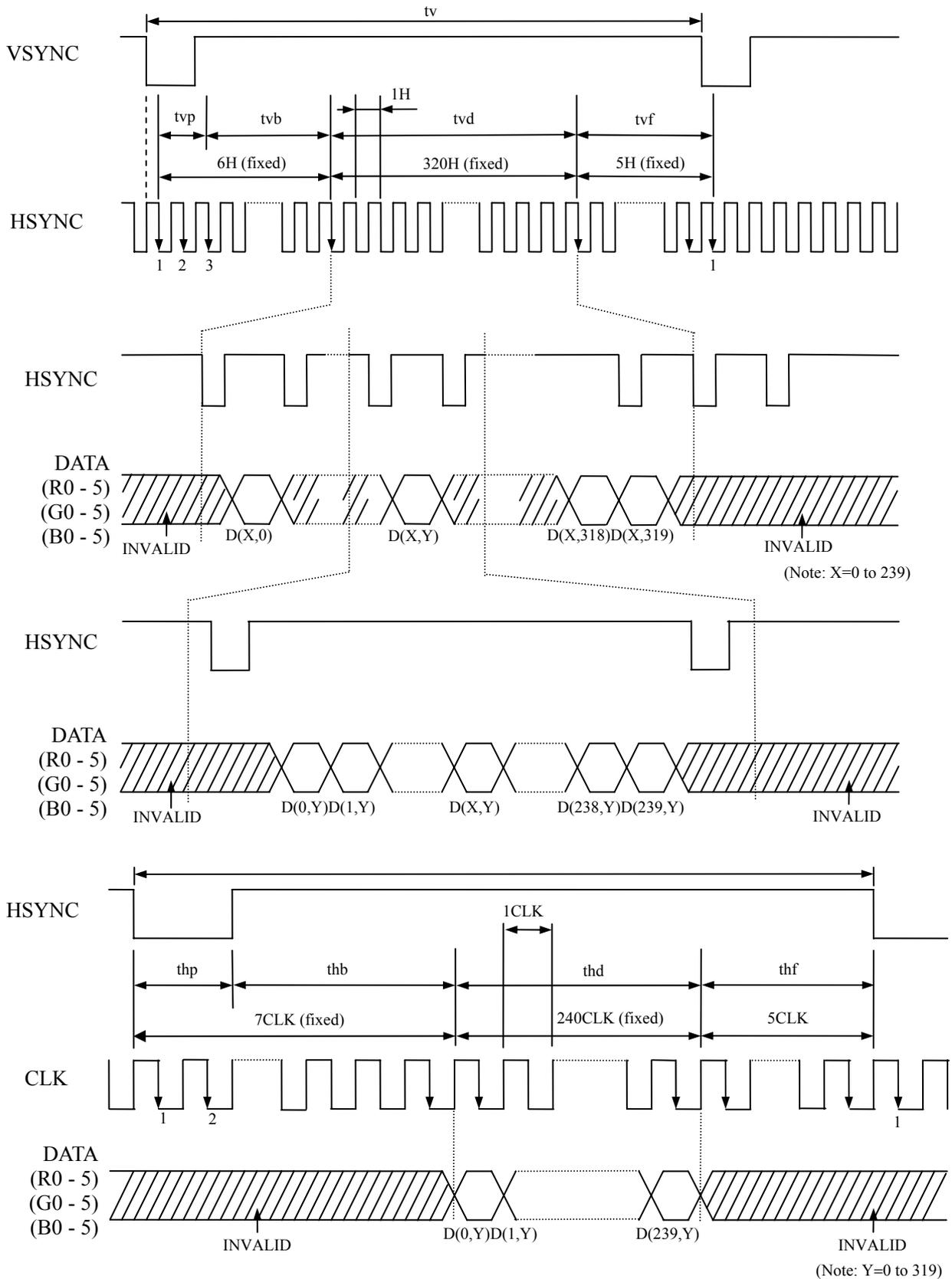
4.10.2 Serial interface (Ta= 25°C, VCC= 3.0V)

(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	-	-	360	ns	-
Output disable time	tOHS	SO	-	-	300	ns	-

☆ ☆

Note1: All parameters should be kept within the specified range.
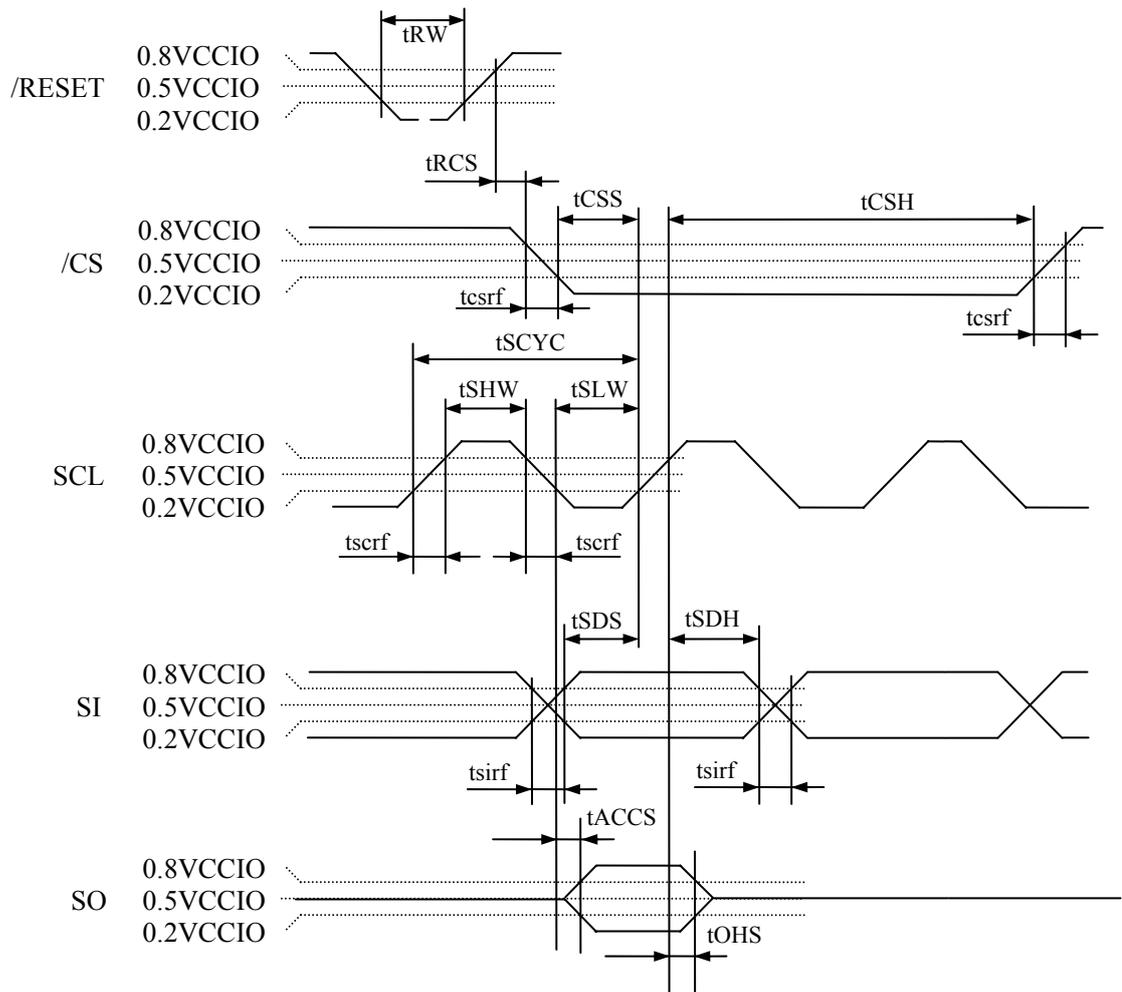
Note2: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.

4.11 OPTICAL CHARACTERISTICS

<Backlight turning OFF>

(Note1, Note3, Note4)

Parameter	Condition	Symbol	min.	typ.	max.	Unit	Remarks
Reflection ratio	White, at center	RE	3	7	-	%	Note6
Contrast ratio	White/Black, at center	CR	7	15	-	-	Note7

☆
☆

Reference data

(Note1, Note3, Note4)

Parameter	Condition		Symbol	min.	typ.	max.	Unit	Remarks
Chromaticity coordinates	White		Wx	-	0.32	-	-	Note8
			Wy	-	0.34	-	-	
Color gamut	at center, against NTSC color space		C	-	5	-	%	
Response time	White to black	90%→10%	Ton	-	7	14	ms	Note9 Note10
	Black to white	10%→90%	Toff	-	9	18		

<Backlight turning ON>

(Note2, Note3, Note5)

Parameter	Condition	Symbol	min.	typ.	max.	Unit	Remarks
Luminance	White at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	L	130	220	-	cd/m^2	-
Contrast ratio	White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	110	180	-	-	Note7
Luminance uniformity	White θR= 0°, θL= 0°, θU= 0°, θD= 0° Maximum luminance: 100%	LU	60	70	-	%	Note11

☆

Reference data

(Note2, Note3, Note5)

Parameter		Condition		Symbol	min.	typ.	max.	Unit	Remarks
Chromaticity coordinates		White		Wx	0.25	0.30	0.35	-	Note8
				Wy	0.26	0.31	0.36	-	
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space		C	30	40	-	%	
Response time		White to black	90%→10%	Ton	-	7	14	ms	Note9 Note10
		Black to white	10%→90%	Toff	-	23	46		
Viewing angle	Right	θU= 0°, θD= 0°, CR≥ 5		θR	-	30	-	°	-
	Left	θU= 0°, θD= 0°, CR≥ 5		θL	-	30	-	°	
	Up	θR= 0°, θL= 0°, CR≥ 5		θU	-	30	-	°	
	Down	θR= 0°, θL= 0°, CR≥ 5		θD	-	35	-	°	

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

Note2: Measurement conditions are as follows.
Ta= 25°C, VCC= 3.0V, IL= 20mA

Note3: Definition of viewing angles
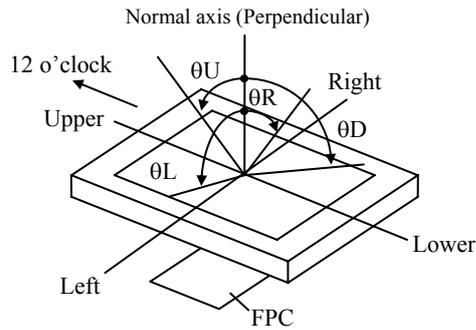
Note4: In reflective mode (Backlight turning OFF), Reflection ratio, Contrast ratio, Chromaticity coordinates and Color gamut are measured as follows.
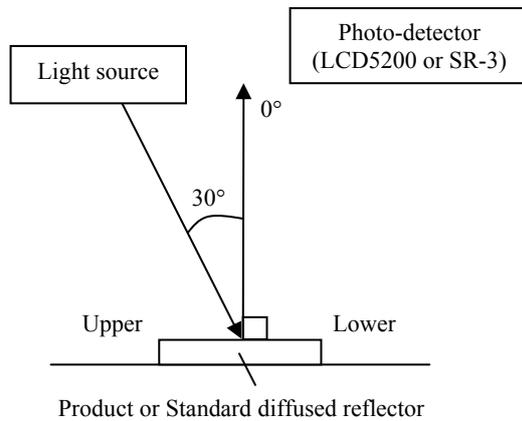
Note5: In transmissive mode (Backlight turning ON), Luminance, Contrast ratio, Chromaticity coordinates and Color gamut are measured as follows.
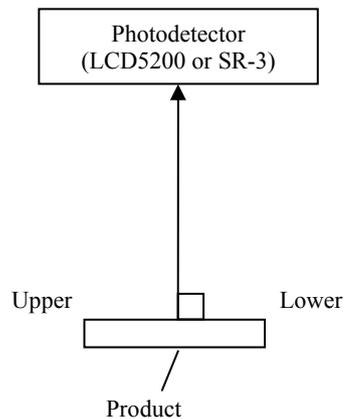
Note6: Definitions of reflection ratio

The reflection ratio is calculated by using the following formula.

$$\text{Reflection (RE)} = \frac{\text{Luminance of reflected light at white screen}}{\text{Luminance of standard diffused reflector}} \times 100$$

Note7: Definition of contrast ratio

The contrast ratio is calculated by using the following formula.

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

Note8: The White chromaticity coordinates are deviated by the LED deviation in addition to color filter deviation.

Note9: 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.).
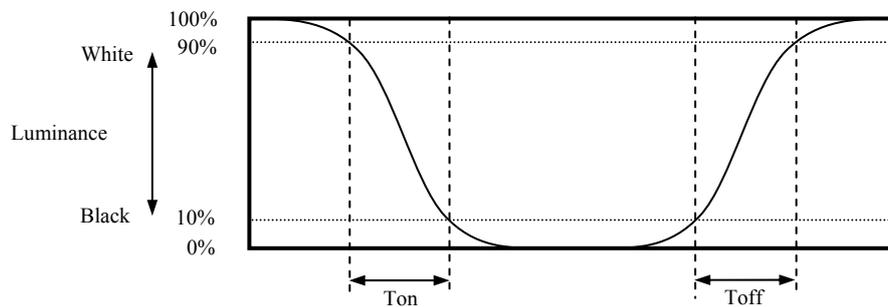
Note10: Product surface temperature: Top= 25°C

Note11: Definition of luminance uniformity

Luminance uniformity is calculated by using the following formula.

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

☆
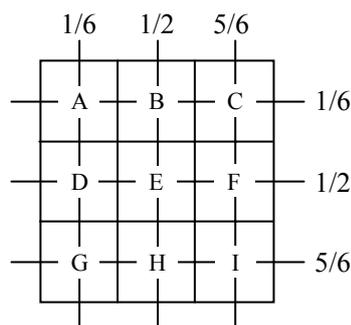
5. ESTIMATED LUMINANCE LIFETIME

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

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

Condition		Estimated luminance lifetime (Life time expectancy) Note1, Note2, Note3	Unit
LED elementary substance	25°C (Ambient temperature of LED) Continuous operation, IL= 20mA	12,000	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 is change. 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 70 ± 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 70 ± 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/s² and to be not greater 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 stress such as bends or twist. Bends, twist or any 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 panel with hard materials, because it is easily scratched.(Panel 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 the FPC is folded, pattern disconnection may be caused. 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.

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, B 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.

8. OUTLINE DRAWINGS
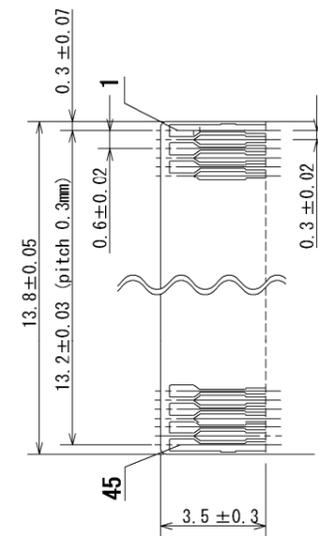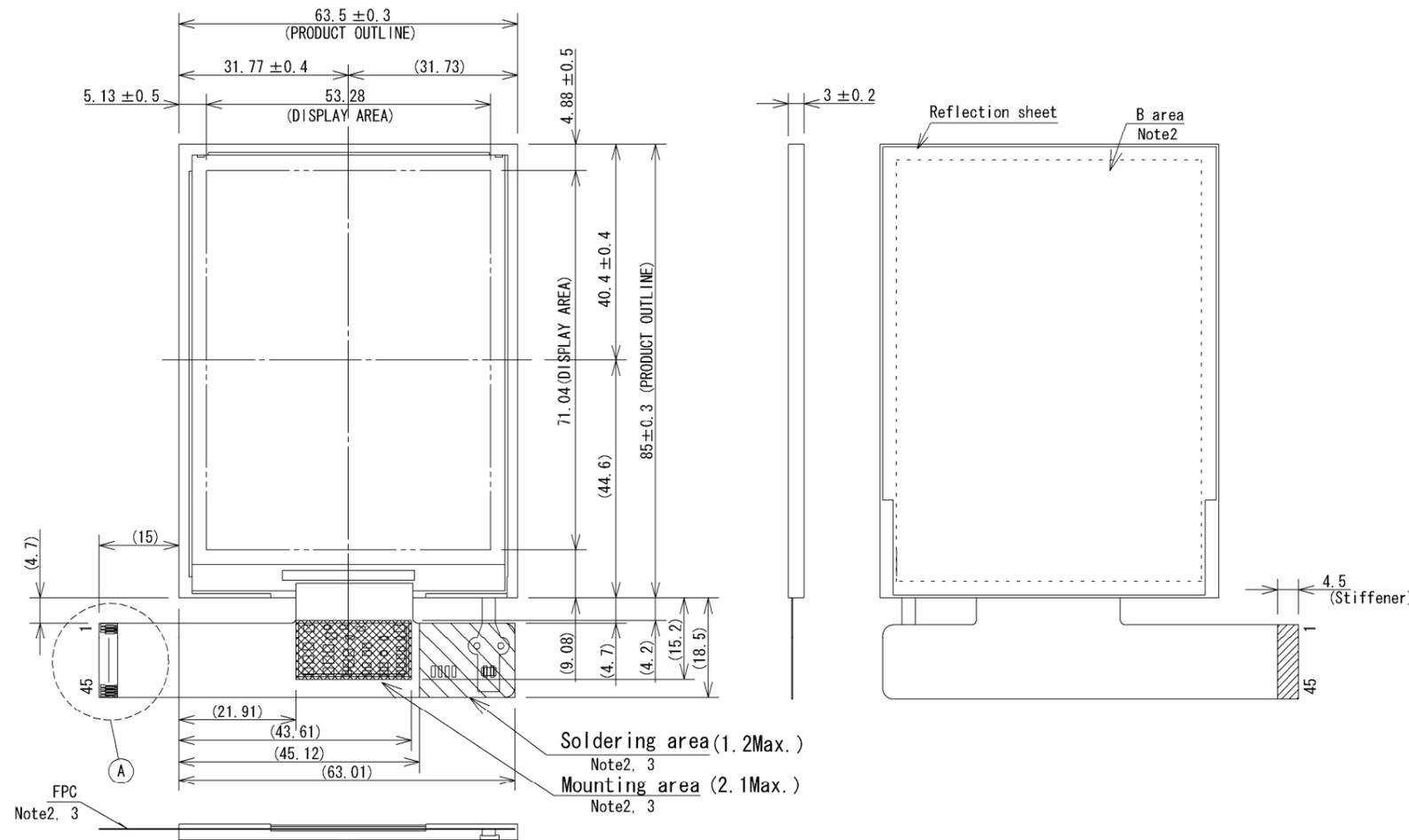
Detail A

Adaptable connecter：FH23-45S-0.3SHW(05)　(HRS)

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	VCCIO
14	B1	38	GND
15	B2	39	N.C.
16	B3	40	N.C.
17	B4	41	N.C.
18	B5	42	N.C.
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 stress to the rear side of the product, FPC, B area, Soldering Area and Mounting Area.
    If not, it may cause display un-uniformity 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.
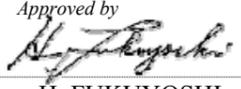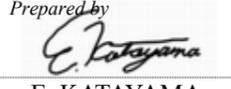
Unit: mm

REVISION HISTORY

The inside of latest specifications is revised to the clerical error and the major improvement of previous edition. Only a changed part such as functions, characteristic value and so on that may affect a design of customers, are described especially below.

Edition	Document number	Prepared date	Revision contents and signature
1st edition	DOD-PP-0763	Mar. 31 2009	**Revision contents** Preliminary Data Sheet DOD-PP-0654(2) → Data Sheet DOD-PP-0763(1) P4 Features • Compliance with the European RoHS directive (2002/95/EC) (addition) P5 General specifications • Weight: (25) g (typ.) → 25 g (typ.) (change) • Luminance: (220) cd/m^2 (typ.) → 220 cd/m^2 (typ.) (change) • Reflection ratio: (7) % (typ.) → 7 % (typ.) (change) P9 Mechanical specifications • Weight: (25) g (typ.), (28) g (max.) → 25 g (typ.), 28 g (max.) (change) P8 Electrical characteristics • Note1 (change) P10 Power voltage sequence (addition) P10-11 Setting of the internal register (correction) • Note2 → * "X" value can be set any data. (change) • Note3 → Note2 (change) P14 Interface pin connections, P30 Outline drawing • D00-D05, D11-D15, D20-D21 B1-5, G1-5, R1-5 (correction) P23 Serial interface (Ta= 25 C, VCC= 3.0V) • Access time: TBD → 360 ns (change) • Output disable time: 200 → 300 ns (change) P24 Optical characteristics <Backlight turning OFF> • Reflection ratio: TBD % (min.), (7) % (typ.) → 3 % (min.), 7 % (typ.) (change) • Contrast ratio: TBD (min.), (15) (typ.) → 7(min.), 15 (typ.) (change) <Backlight turning ON> • Luminance: TBD cd/m^2 (min.), (220) cd/m^2 (typ.) → 130 cd/m^2 (min.), 220 cd/m^2 (typ.) (change) P27 Estimated luminance lifetime (addition) P28 Cautions • Do not touch the working backlight. There is a danger of burn injury. (elimination) P29 Attentions - Other • ⑤ (addition) **Signature of writer** Approved by Checked by Prepared by ___H. FUKUYOSHI___ _____ ___E. KATAYAMA___