PRELIMINARY

NEC LCD Technologies, Ltd.

TFT COLOR LCD MODULE

NL2432HC22-41B

8.9cm (3.5 Type)
QVGA

PRELIMINARY DATA SHEET

DOD-PD-1250 (1st edition)

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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.

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1. OUTLINE

1.1 STRUCTURE AND PRINCIPLE

Color LCD module NL2432HC22-41B 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

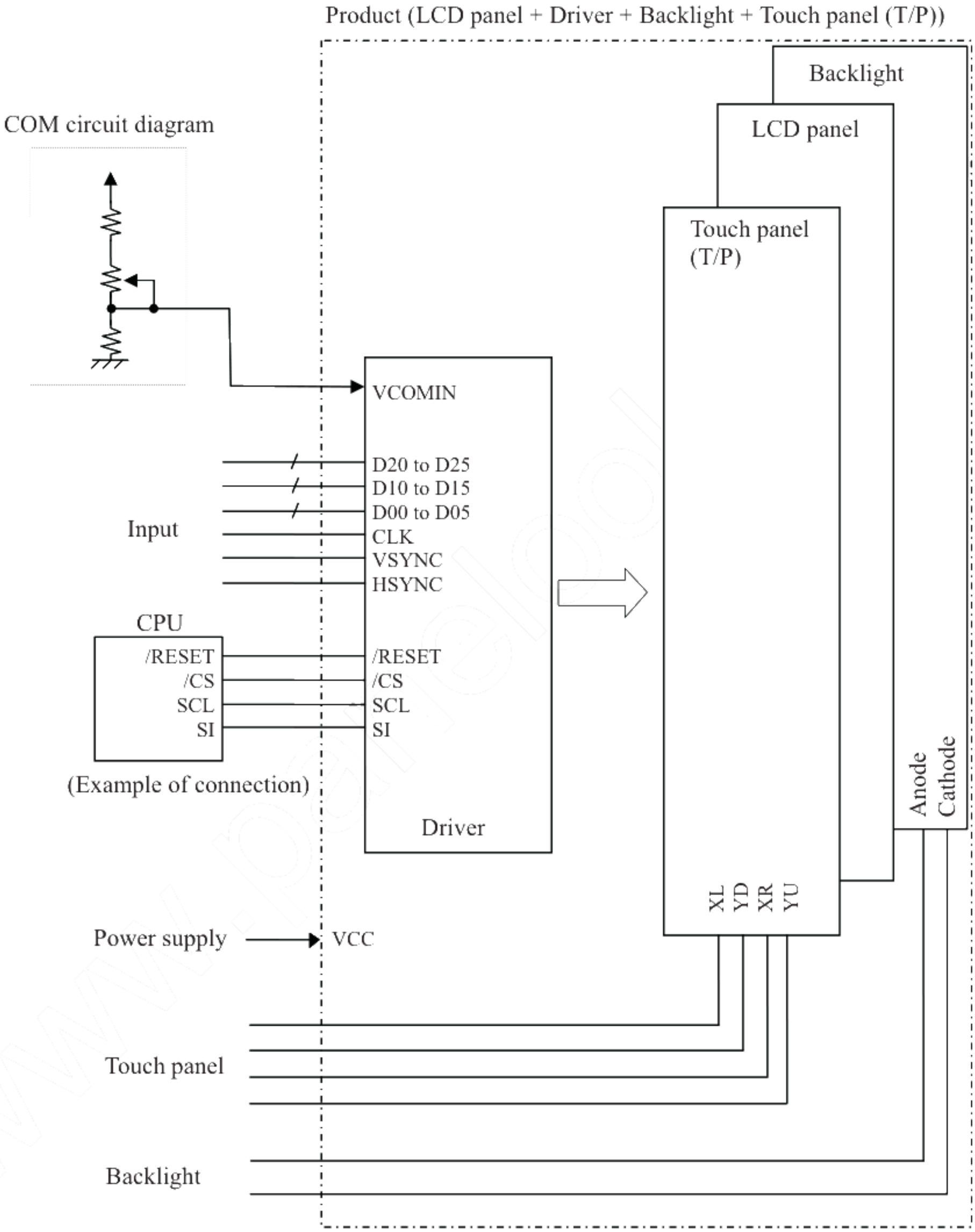
1.3 FEATURES

- Adoption of SR-NLT (Super-Reflective Natural Light TFT) (Transflective type)
- Backlight and touch panel attached
- High luminance
- High contrast
- Including LCD controller and power supply
- 6-bit digital RGB signals

2. GENERAL SPECIFICATIONS

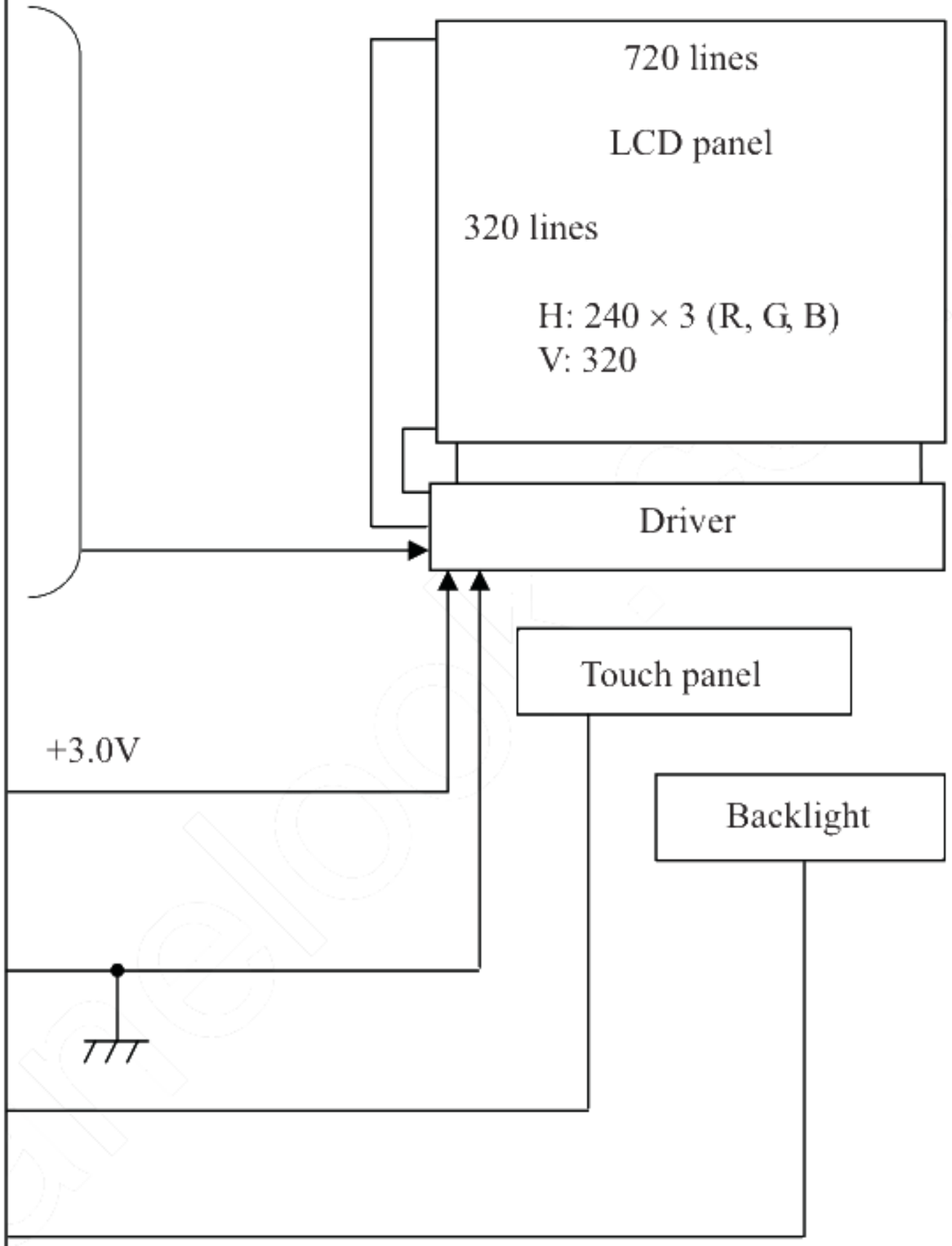
Display area	53.64 (W) × 71.52 (H) mm
Diagonal size of display	8.9 cm (3.5 inches)
Drive system	a-Si TFT active matrix
Display color	262,144 colors
Pixel	240 (H) × 320 (V) pixels
Pixel arrangement	RGB (Red dot, Green dot, Blue dot) vertical stripe
Dot pitch	0.0745 (H) × 0.2235 (V) mm
Pixel pitch	0.2235 (H) × 0.2235 (V) mm
Module size	(63.5) (H) × (85.0) (V) × TBD (D) mm (typ.)
Weight	TBD g (typ.)
Touch panel surface	Antiglare
Touch panel pencil-hardness	(3) H (min.) [by JIS K5400]
Luminance	*At IL= 20mA, with Touch panel* (200)cd/m^2 (typ.)
Reflectance ratio	*With Touch panel* (15)% (typ.)
Contrast ratio	*At transmissive mode, IL= 20mA, with Touch panel* (130:1) (typ.)
	At reflective mode, with Touch panel (3:1) (typ.)
Response time	*Ton+Toff (10%←→ 90%)* TBD 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 (/CS, SCL, SI)
Supply voltage	VCC: 3.0V (typ.)
Power consumption	LCD panel: (50) mW (typ.) Backlight: (384)mW (typ., at IL=20mA)

3. BLOCK DIAGRAM

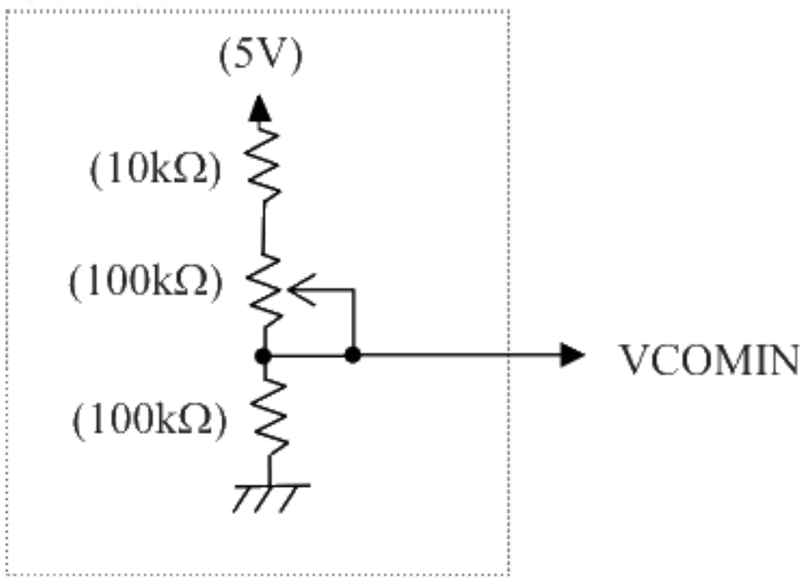


FPC I/F

Pin No.	Symbol
13 to 18	D00 to D05
19 to 24	D10 to D15
25 to 30	D20 to D25
10	VSYNC
9	HSYNC
11	CLK
8	/RESET
35	/CS
32	SCL
33	SI
36	VCOMIN
3, 4, 5, 6	VCC
1, 2, 7, 12, 31, 38, 43	GND
39, 40, 41, 42	XL, YD XR, YU
44	ANODE
45	CATHODE



Reference design of COM circuit



4. DETAILED SPECIFICATIONS

4.1 MECHANICAL SPECIFICATIONS

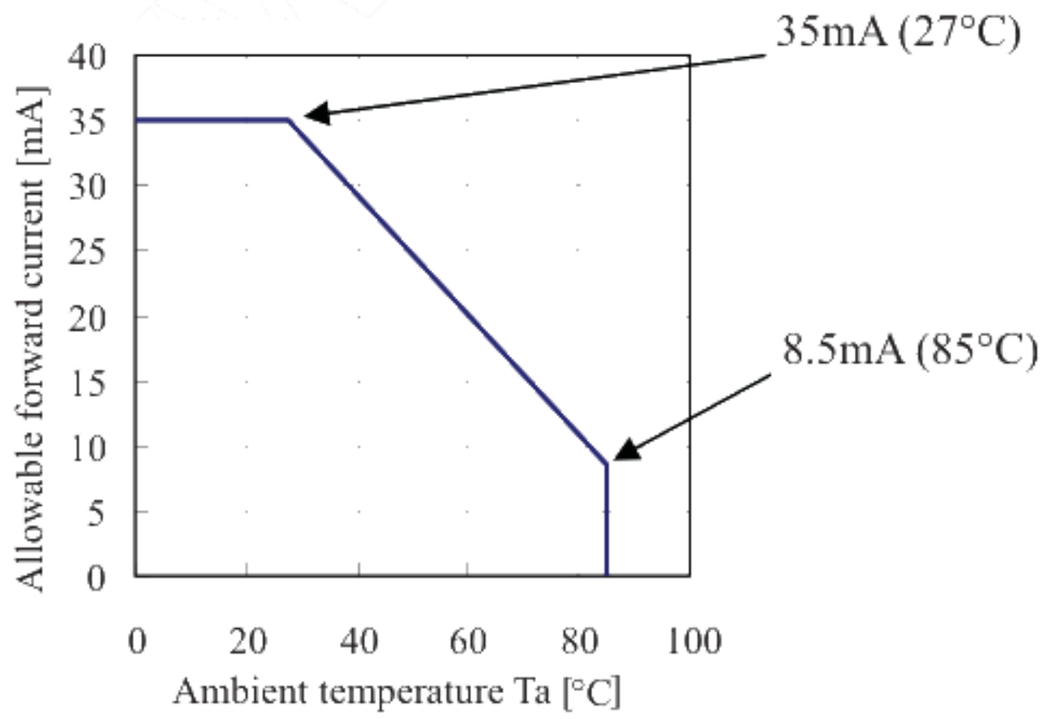
Parameter	Specification		Unit
Module size	(63.5) ± 0.3 (W) × (85.0) ± 0.3 (H) × TBD (D)	Note1	mm
Display area	53.64 (H) × 71.52 (V)	Note1	mm
Weight	TBD (typ.), TBD (max.)		g

Note1: See "**7. 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	(≤ 30)	V	Ta= 25°C
	Power dissipation	PD	(≤ 738)	mW	
	Forward current	IL	Note1	mA	
	Pulse forward current	IFP	(100)	mA	Pulse width ≤ 10ms, Duty ≤ 1/10
Storage temperature		Tst	-20 to +70	°C	-
Operating temperature		Top	-10 to +55		Product surface Note2
Relative humidity Note3		RH	≤ 95	%	Ta≤ 40°C
			≤ 85		40°C <Ta≤ 50°C
			≤ 70		50°C <Ta≤ 55°C
Absolute humidity Note3		AH	≤ 73 Note4	g/m^3	Ta> 55°C
Storage altitude			≤ 13,600	m	-20°C ≤ Ta ≤ 70°C
Operating altitude			≤ 4,850	m	-10°C ≤ Ta ≤ 55°C

Note1: Allowable forward current



Note2: Measured at display area
Note3: No condensation
Note4: Water amount at Ta= 55°C and RH= 70%

4.3 ELECTRICAL CHARACTERISTICS

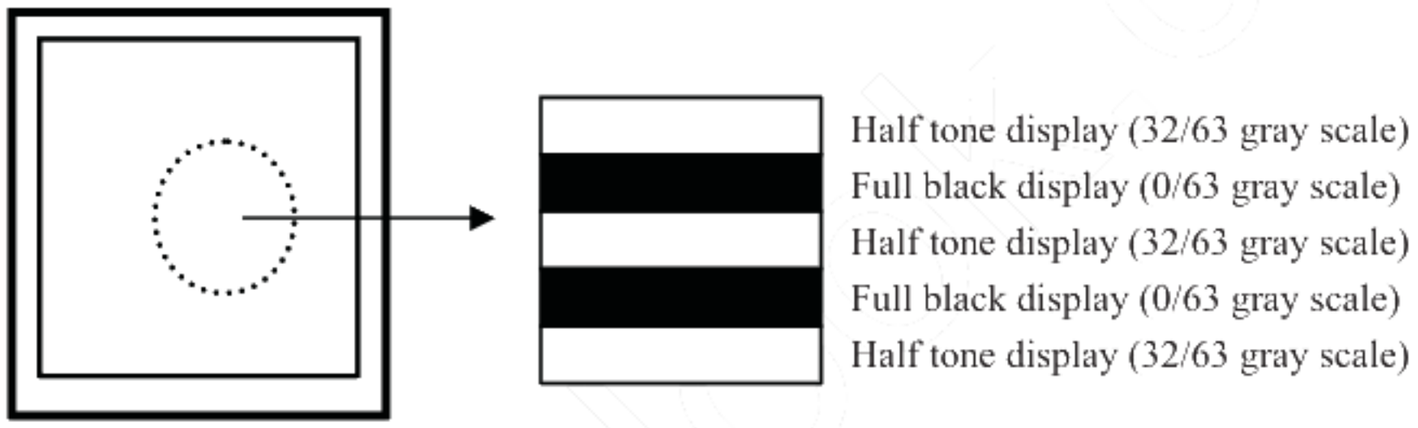
(1) Logic/ LCD driving

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Logic supply voltage	VCC	2.85	3.0	3.15	V	-
Logic input high voltage	VIH	0.8VCC	-	VCC	V	Logic signal
Logic input low voltage	VIL	0	-	0.2VCC	V	
COM high voltage	COM/H	-	(1.8)	-	V	at VCC= 3.0V Note1
VCC supply current	ICC	-	16.5	TBD	mA	at VCC= 3.0V Note2

Note1: The optimum value for COM/H is in the range of TBD V to TBD V.

Recommended adjustment display for COM/H



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

(2) Backlight

(Ta= 25°C)

Parameter	Symbol	min.	typ.	max.	Unit	Remarks
Forward Current	IL	-	(20)	TBD	mA	-
Forward Voltage	VL	-	(19.2)	(21.0)	V	at IL= 20mA

(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	(200)	-	(510)	Ω	-
Resistor between pins(YU-YD)	Ry	(300)	-	(820)	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) (80)	N gf	Note1
Surface hardness	Hs	(3)	-	-	H	Pencil hardness
Point hitting life	Lhr	1,000,000	-	-	times	Silicon rubber: R8mm, Hardness 60° Load: 2.94N(300gf)

Note1: Input method is a Finger.

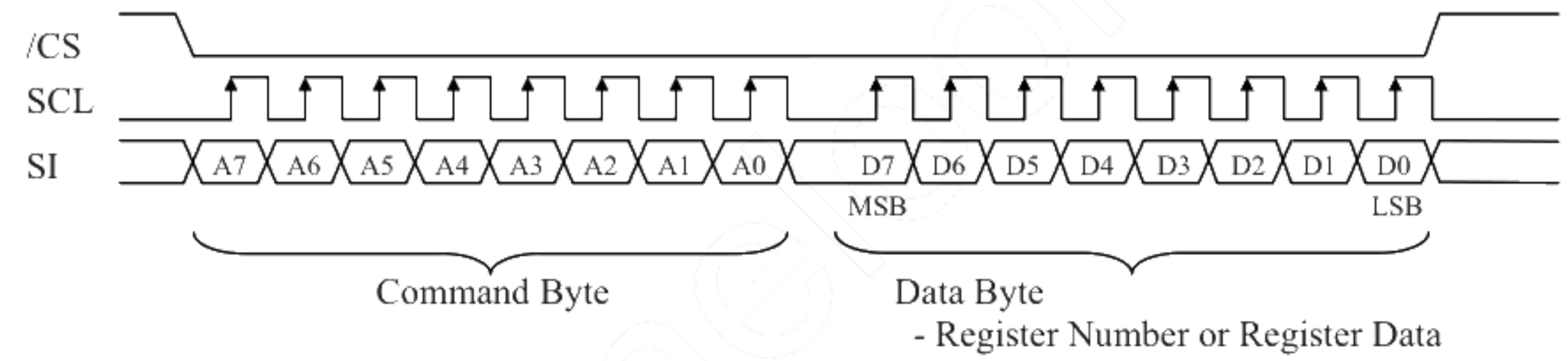
4.4 SETTING OF THE INTERNAL RESISTER

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). The setting method is as follows.

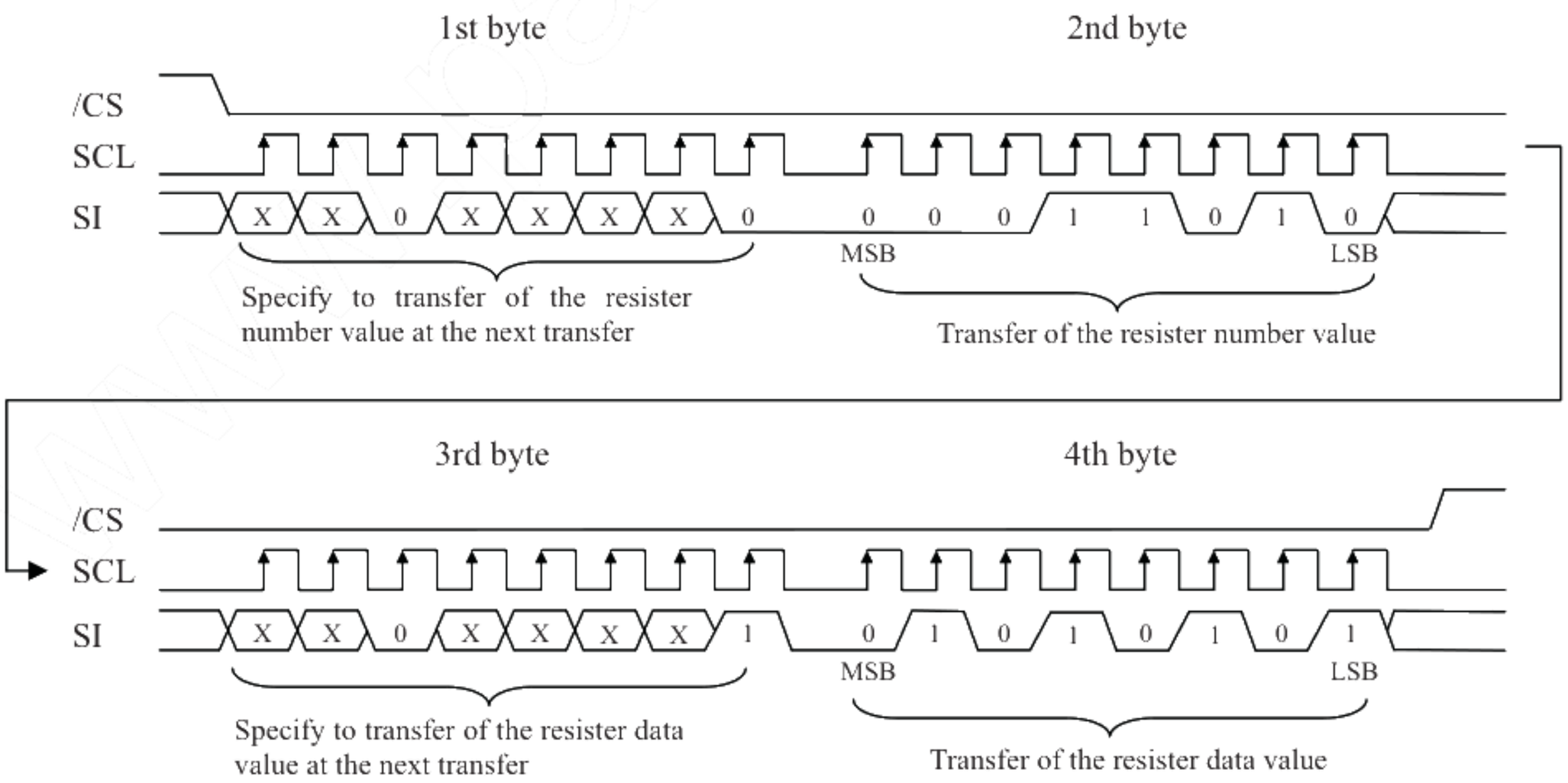
(1) Command Byte Function

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)



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

Sequence	Register Number	Data	Comment	Sequence	Register Number	Data	Comment
1	Power On			27	R77	(01h)	
2	1ms min. wait.			28	R80	(00h)	
3	Reset by the /RESET pin (Pin No. 8).			29	R81	(00h)	-
4	1ms min. wait after /RESET↑.			30	R82	(2Eh)	-
5	R3	(01h)	-	31	R83	(C4h)	-
6	R1	(00h)	-	32	R86	(15h)	-
7	R100	(0Fh)	-	33	R87	(EDh)	-
8	R101	(3Fh)	-	34	R95	(3Fh)	-
9	R102	(3Fh)	-	35	R96	(22h)	-
10	R103	(00h)	-	36	R25	(7Eh)	-
11	R104	(00h)	-	37	R26	(64h)	-
12	R105	(30h)	-	38	R27	(67h)	
13	R106	(04h)	-	39	R28	(60h)	-
14	R107	(37h)	-	40	TBD μs min. wait		
15	R108	(17h)	-	41	R29	(04h)	
16	R109	(00h)	-	42	R30	(1Ch)	-
17	R110	(40h)	-	43	R31	(A9h)	-
18	R111	(30h)	-	44	R32	(00h)	-
19	R112	(04h)	-	45	R33	(20h)	-
20	R113	(37h)	-	46	R24	(77h)	-
21	R114	(17h)	-	47	R51	(00h)	-
22	R115	(00h)	-	48	TBD μs min. wait.		
23	R116	(40h)	-	49	Data input start		
24	R2	(40h)	-	50	R59	(01h)	
25	R75	(04h)	-	51	TBD μs min. wait.		
26	R76	(01h)	-	52	R0	(00h)	49

②Power Off

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

③Standby

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

④Wake Up

Sequence	Register Number	Data	Comment
1	R1	00h	-
2	TBD ms min. wait.		
3	R24	FFh	-
4	TBD μs min. wait.		
5	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.

4.5 INTERFACE PIN CONNECTIONS

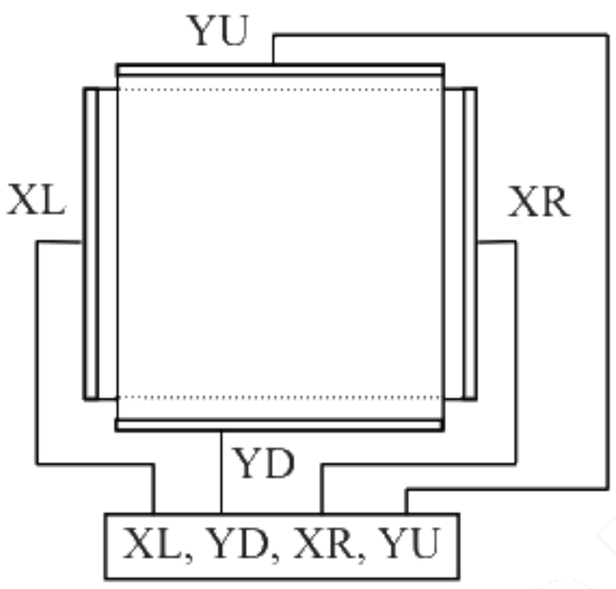
CN1 (FPC)
Adaptable socket: FH23-45S-0.3SHW(05) (Hirose Electric Co., Ltd.(HRS))

Pin No.	Symbols	Functions	Pin No.	Symbols	Functions
1	GND	Ground Note1	25	D20	Red data (LSB)
2	GND	Ground Note1	26	D21	Red data
3	VCC	Power supply Note1	27	D22	Red data
4	VCC		28	D23	Red data
5	VCC		29	D24	Red data
6	VCC		30	D25	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	RSVD	Keep this pin Open.
11	CLK	Dot clock	35	/CS	Chip selection
12	GND	Ground Note1	36	VCOMIN	COM high voltage input
13	D00	Blue data (LSB)	37	N.C.	Keep this pin Open.
14	D01	Blue data	38	GND	Ground Note1
15	D02	Blue data	39	XL	Horizontal terminal (Left side)
16	D03	Blue data	40	YD	Vertical terminal (Down side)
17	D04	Blue data	41	XR	Horizontal terminal (Right side)
18	D05	Blue data (MSB)	42	YU	Vertical terminal (Up side)
19	D10	Green data (LSB)	43	GND	Ground Note1
20	D11	Green data	44	ANODE	LED voltage (Anode)
21	D12	Green data	45	CATHODE	LED voltage (Cathode)
22	D13	Green data			
23	D14	Green data			
24	D15	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.
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**".
YU,XR,YD,XL	Refer to the below "**Circuits of touch panel**".
ANODE, CATHODE	Refer to the below "**Circuits of backlight**".



Circuits of touch panel

Circuits of backlight

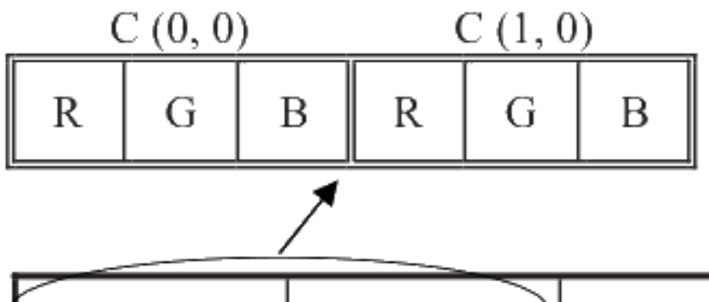
4.6 DISPLAY COLORS AND INPUT DATA SIGNALS

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

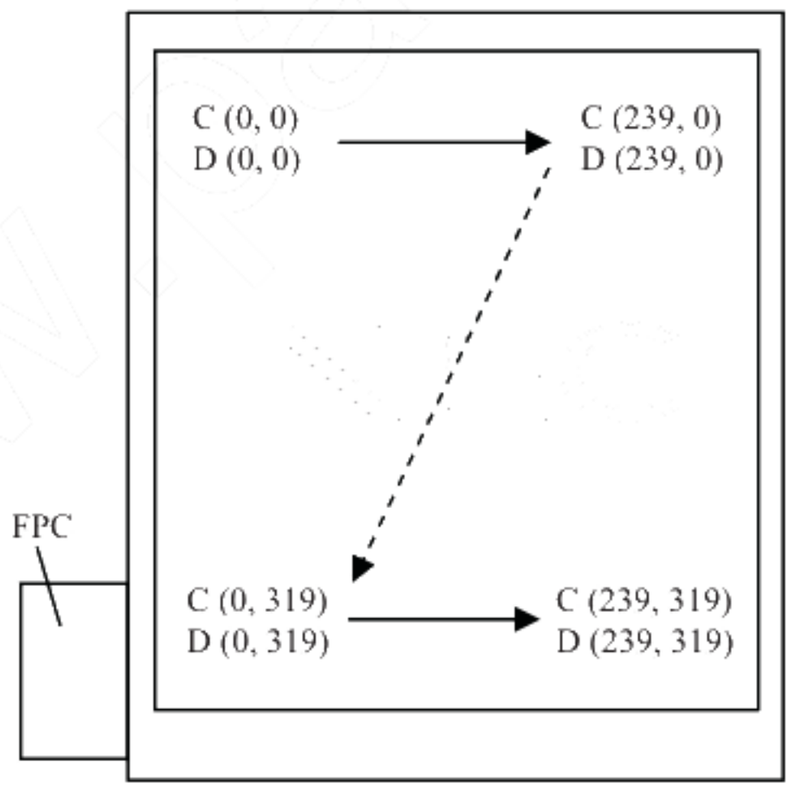
The following table is the coordinates per pixel (See figure of "**4.8 SCANNING DIRECTIONS**".).



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

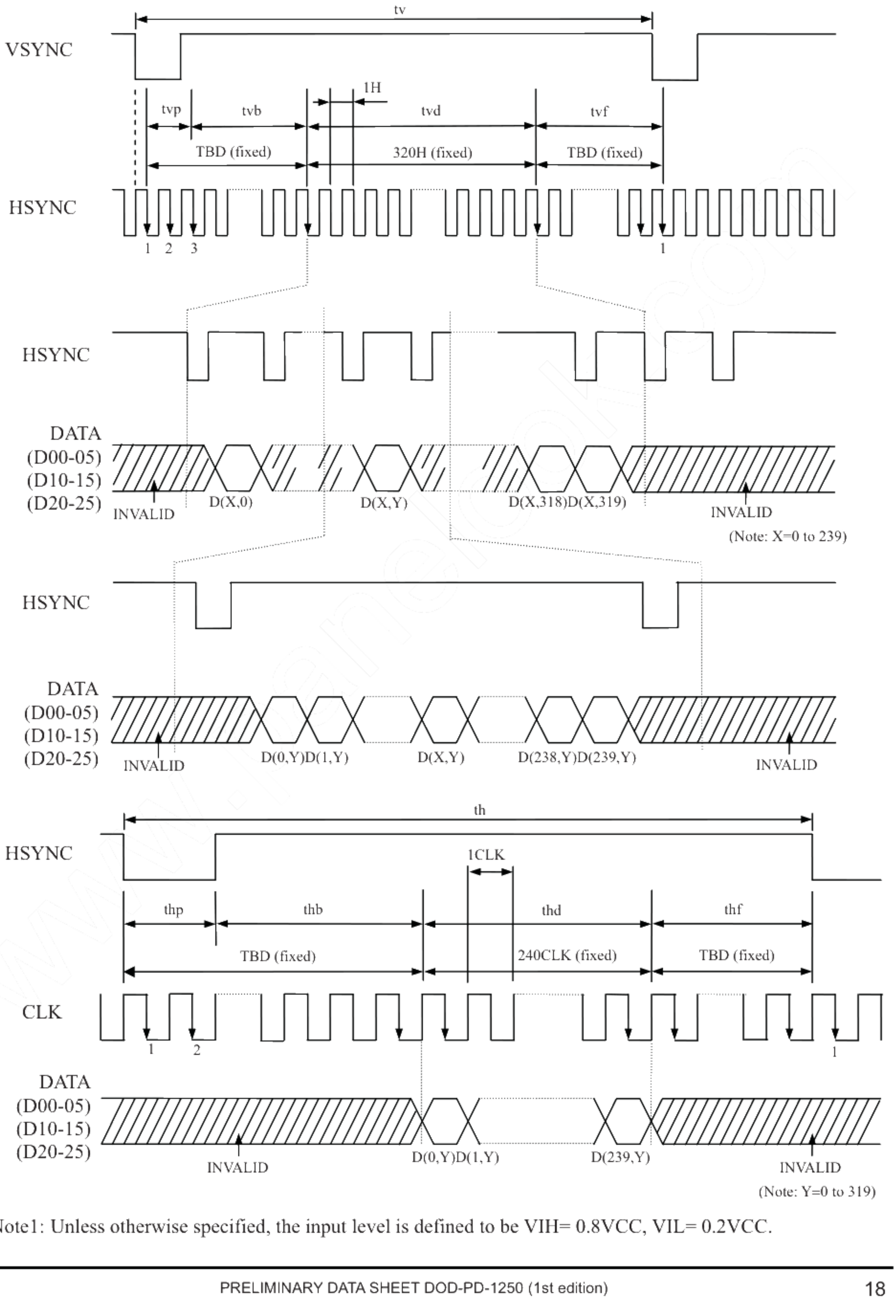
Parameter			Symbol	min.	typ.	max.	Unit	Remarks
CLK	Frequency		1/tc	TBD	(5.0)	TBD	MHz	(200ns) (typ.)
	Duty		tcd	0.4	0.5	0.6	-	-
	Rise time, Fall time		tcrf	-	-	(15)	ns	
DATA (D00-05) (D10-15) (D20-25)	CLK-DATA	Setup time	tds	(15)	-	-	ns	-
		Hold time	tdh	(15)	-	-	ns	
	Rise time, Fall time		tdrf	-	-	(15)	ns	
HSYNC	Cycle		th	TBD	(51.2)	TBD	µs	(19.53kHz) (typ.)
				(256)			CLK	-
	Display period		thd	240			CLK	
	Front-porch		thf	TBD			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	TBD	(16.59)	TBD	ms	(60Hz) (typ.)
				(324)			H	-
	Display period		tvd	320			H	
	Front-porch		tvf	TBD			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.

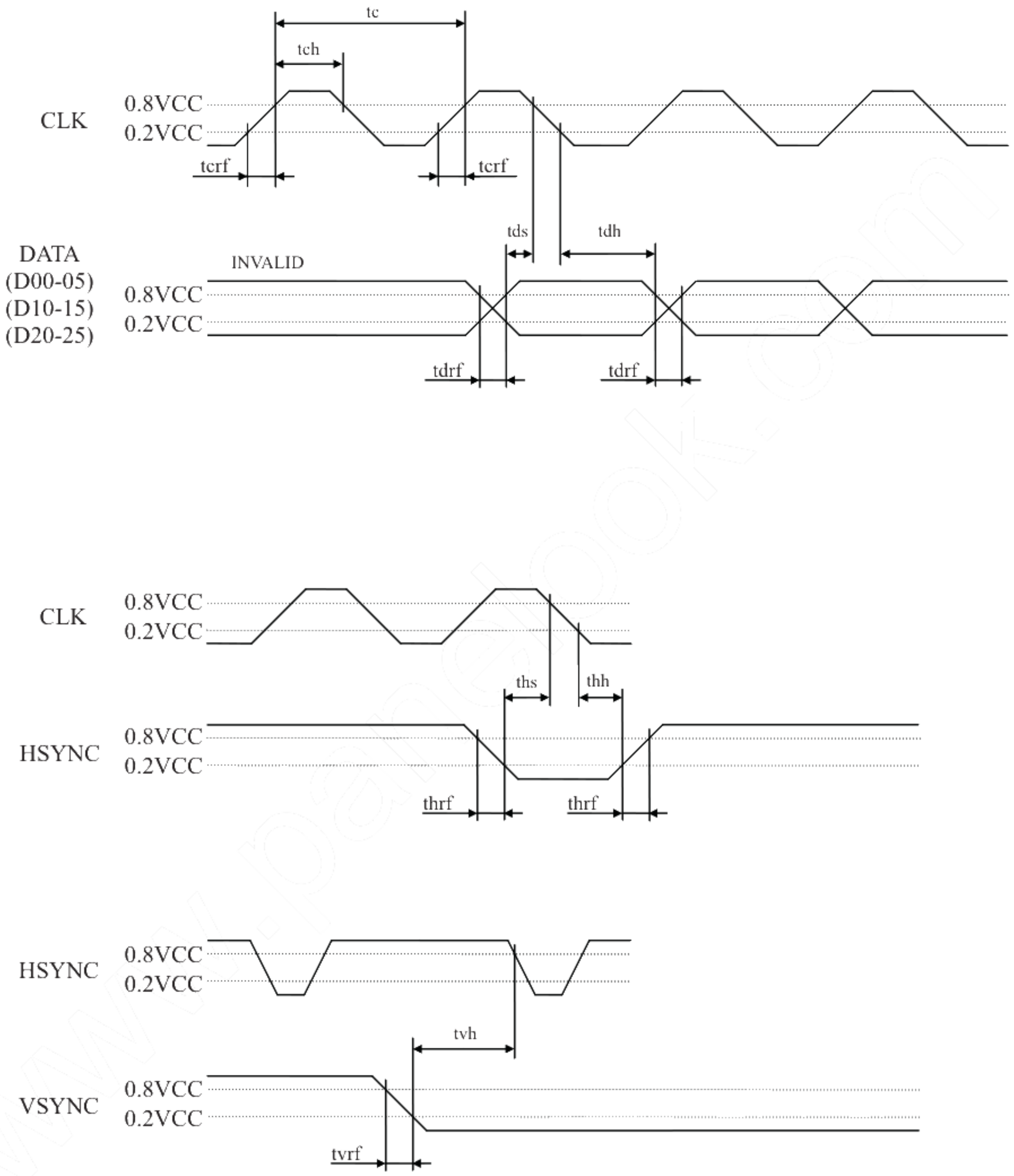
tc= 1CLK, tcd= tch/tc, th= 1H

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.



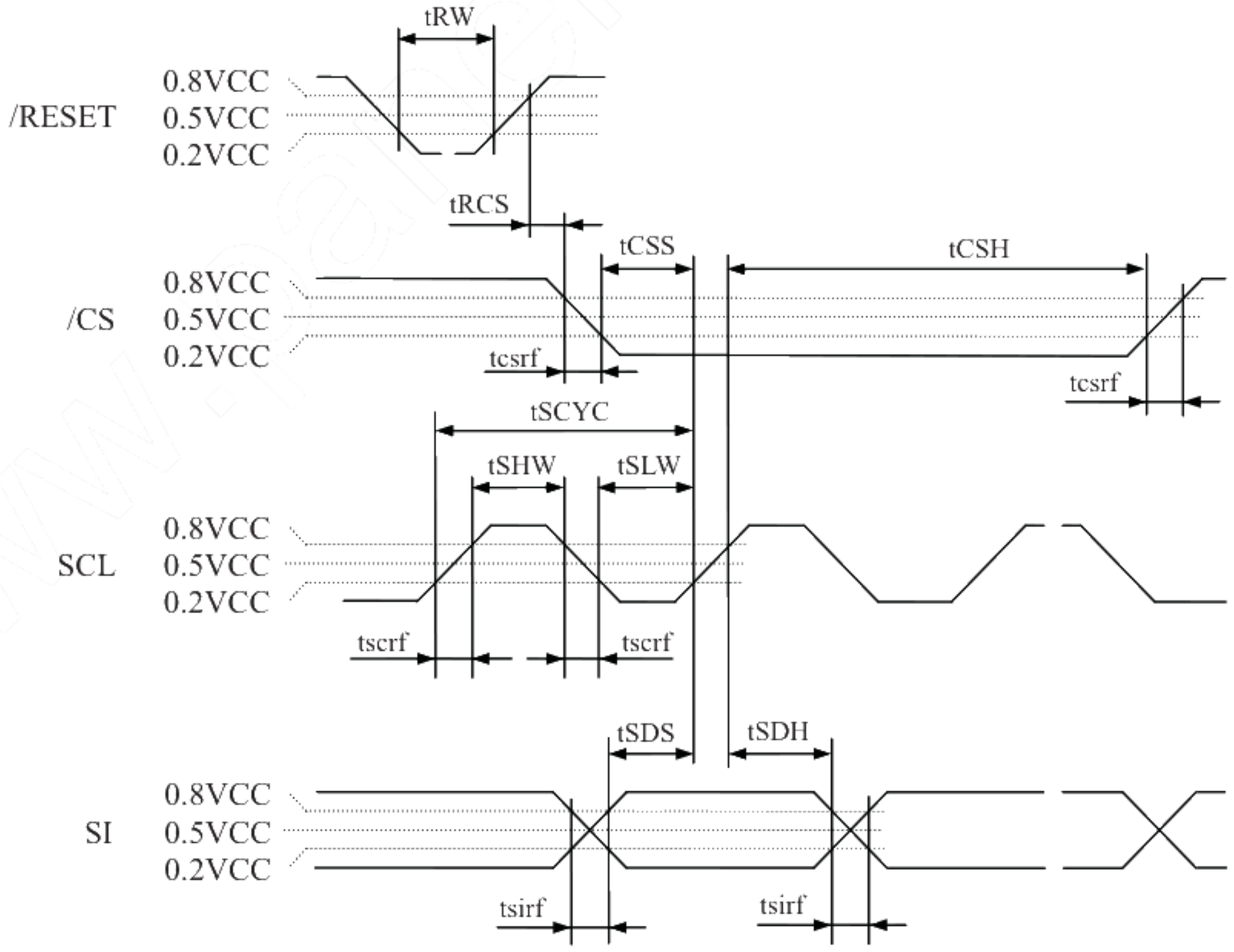
Note1: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.

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	-

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 turning OFF>

(Note1, Note3, Note4)

Parameter	Condition	Symbol	min.	typ.	max.	Unit	Remarks
Reflectance ratio	White, at center	RE	TBD	(15)	-	%	Note6
Contrast ratio	White/Black, at center	CR	TBD	(15)	-	-	Note7

Reference data

(Note1, Note3, Note4)

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

<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	TBD	(200)	-	cd/m^2	-
Contrast ratio	White/Black at center θR= 0°, θL= 0°, θU= 0°, θD= 0°	CR	TBD	(130)	-	-	Note7
Luminance uniformity	White θR= 0°, θL= 0°, θU= 0°, θD= 0° Maximum luminance: 100%	LU	60	70	-	%	Note11

Reference data

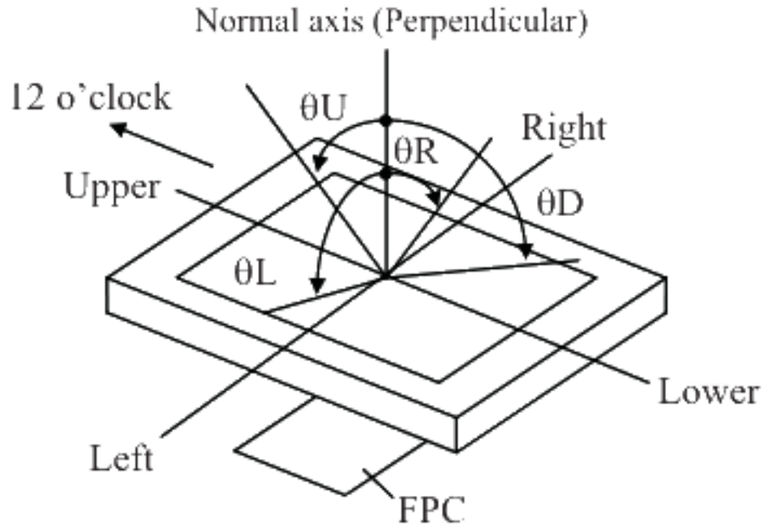
(Note2, Note3, Note5)

Parameter		Condition		Symbol	min.	typ.	max.	Unit	Remarks
Chromaticity coordinates		White		Wx	TBD	TBD	TBD	-	Note8
				Wy	TBD	TBD	TBD	-	
Color gamut		θR= 0°, θL= 0°, θU= 0°, θD= 0° at center, against NTSC color space		C	-	(40)	-	%	
Response time		White to black	90%→ 10%	Ton	-	TBD	TBD	ms	Note9 Note10
		Black to white	10%→ 90%	Toff	-	TBD	TBD		
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	-	35	-	°	
	Down	θR= 0°, θL= 0°, CR≥ 5		θD	-	40	-	°	

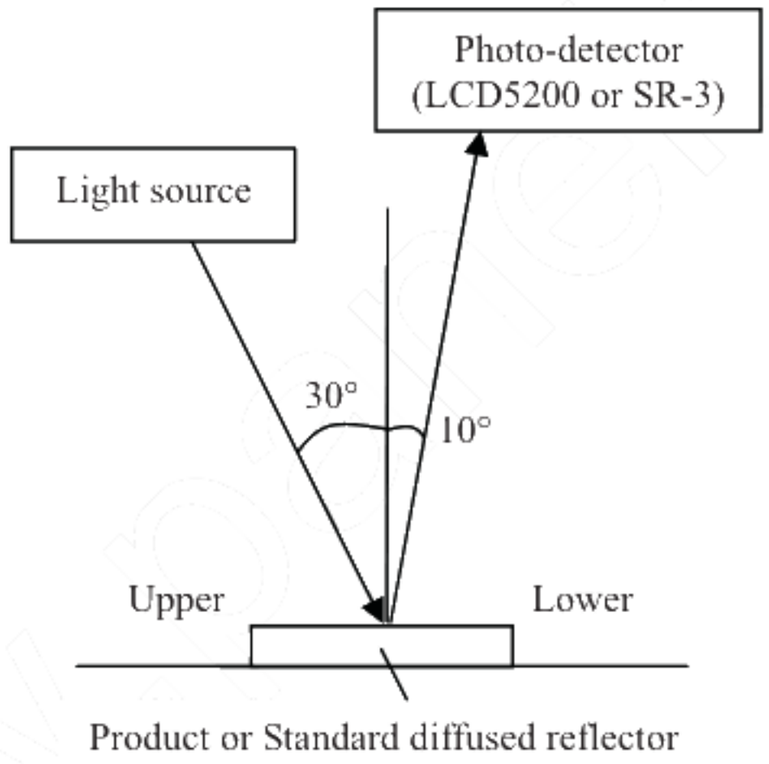
Note1: Measurement conditions are as follows.
Ta= 25 °C, VCC= 3.0V

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

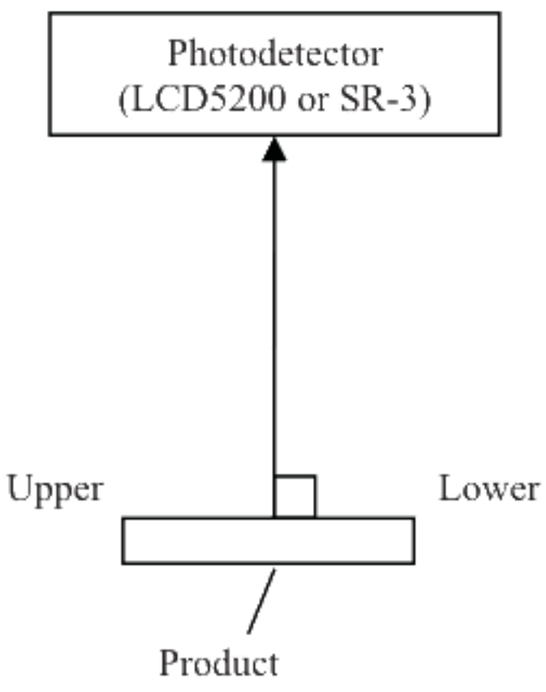
Note3: Definition of viewing angles



Note4: In reflective mode (Backlight turning OFF), Reflectance 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 reflectance ratio

The reflectance ratio is calculated by using the following formula.

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

Note7: Definition of contrast ratio

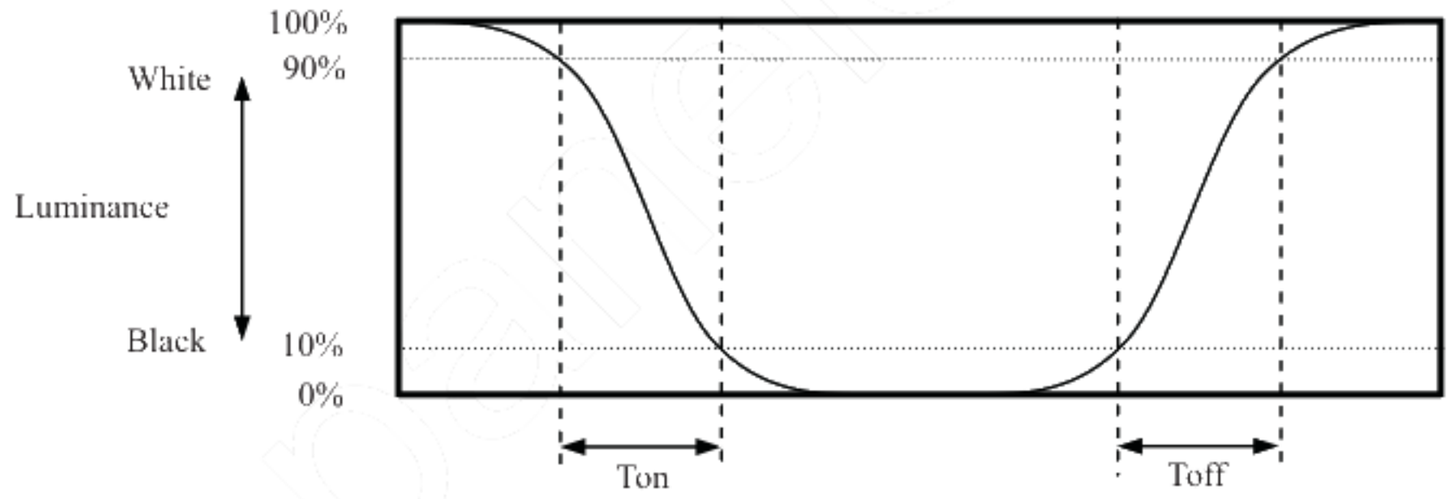
The contrast ratio is calculated by using the following formula.

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

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.).

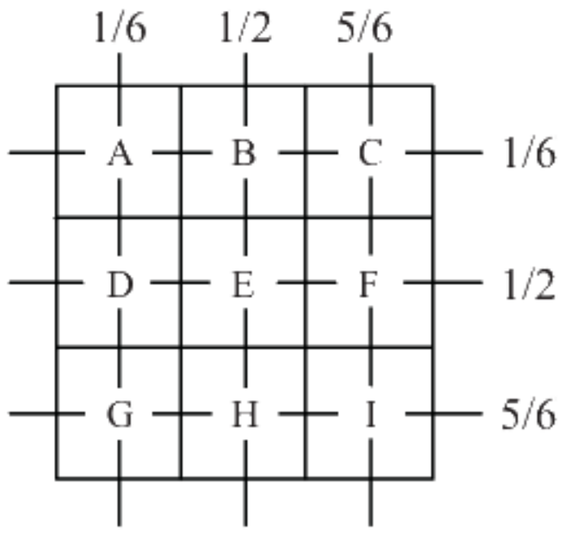


Note10: Product surface temperature: Top= 25°C

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. RELIABILITY TESTS

Test item	Condition	Judgement 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 -10 ± 3°C…1 hour 55 ± 3°C…1 hour ② 50 cycles, 4 hours/cycle ③ Display data is black.	
Thermal shock (Non operation)	① -20 ± 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 -20 ± 3°C…24 hours ③ 70 ± 3°C…24 hours	
Low pressure (Operation)	① 53.3 kPa ② -10 ± 3°C…24 hours ③ 55 ± 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 direction 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 direction ③ 1 times each directions	

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

6. PRECAUTIONS

6.1 MEANING OF CAUTION SIGNS

The following caution signs have very important meaning. **Be sure to read "6.2 CAUTIONS" and "6.3 ATTENTIONS", after understanding these contents!**

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

This sign has the meaning that customer will get an electrical shock, if customer has wrong operations.

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

6.2 CAUTIONS

*** Do not touch the working backlight. There is a danger of an electric shock.**

*** Do not touch the working backlight. There is a danger of burn injury.**
*** 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)**

6.3 ATTENTIONS 

6.3.1 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 without undue stress such as bends or twist. Bends, twist or undue stress to any portion may cause display mura.
⑥ When cleaning the T/P surface, wipe it with a soft dry cloth.
⑦ Do not push nor pull the FPC while the product is working.
⑧ Do not fold the FPC. When folding the FPC, pattern disconnection may be caused. In case of bending FPC, the minimum curvature (R) must be more than 1.0mm.
⑨ When installing the product, do not contact a conductor such as 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.
⑩ When installing the product, apply the waterproof design to avoid going of water into the product.

6.3.2 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.

6.3.3 Characteristics

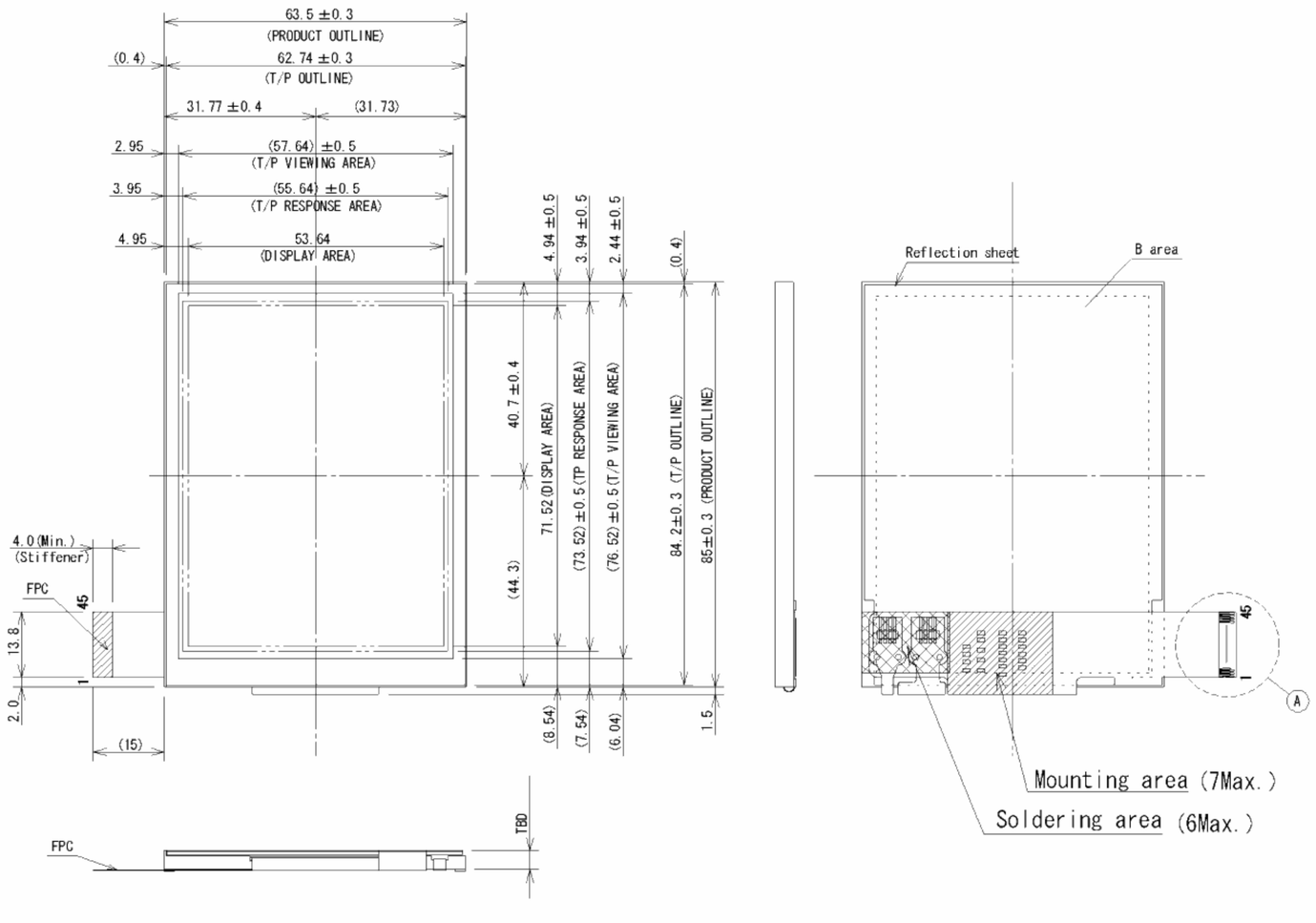
The following items are neither defects nor failures.

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.

6.3.4 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.

7. OUTLINE DRAWINGS



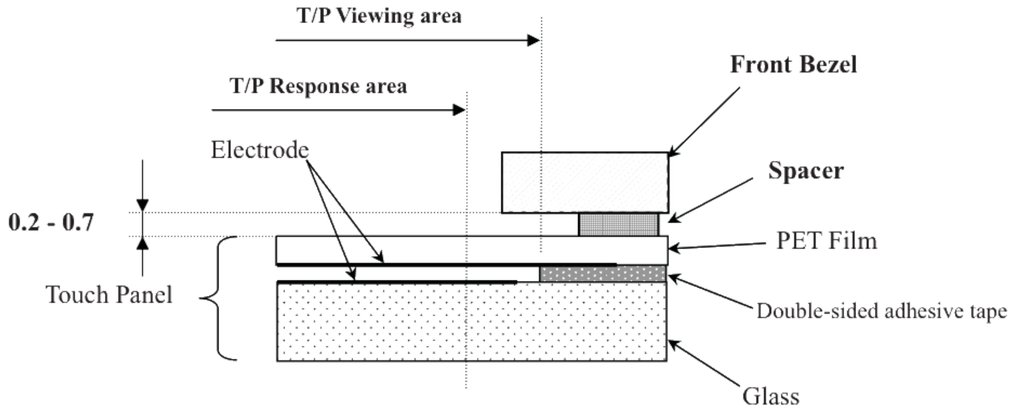
Detail A

Pin No.	Symbols	Pin No.	Symbols
1	GND	25	D20
2	GND	26	D21
3	VCC	27	D22
4	VCC	28	D23
5	VCC	29	D24
6	VCC	30	D25
7	GND	31	GND
8	/RESET	32	SCL
9	HSYNC	33	SI
10	VSYNC	34	RSVD
11	CLK	35	/CS
12	GND	36	VCOMIN
13	D00	37	N.C.
14	D01	38	GND
15	D02	39	XL
16	D03	40	YD
17	D04	41	XR
18	D05	42	YU
19	D10	43	GND
20	D11	44	ANODE
21	D12	45	CATHODE
22	D13		
23	D14		
24	D15		

Note1: The values in parentheses are for reference.
Note2: When installing the product to the customer equipment, do not apply undue stress to the B area, FPC, 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

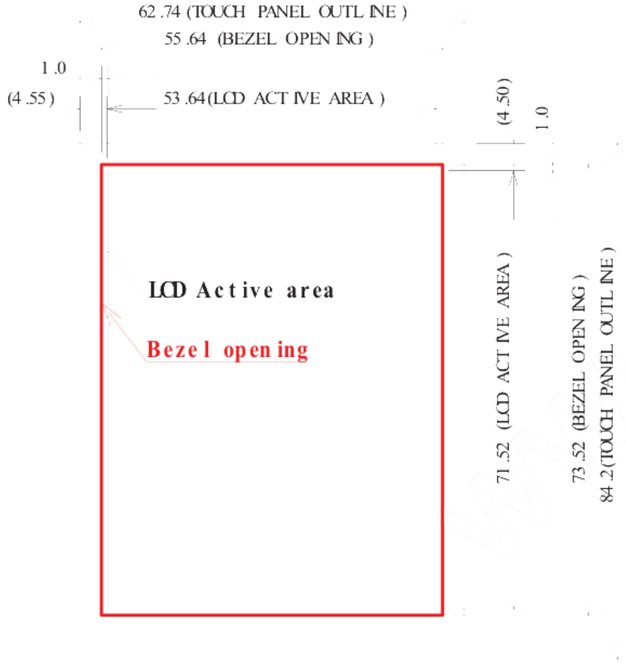
8 RECOMMENDED DESIGN OF FRONT BEZEL



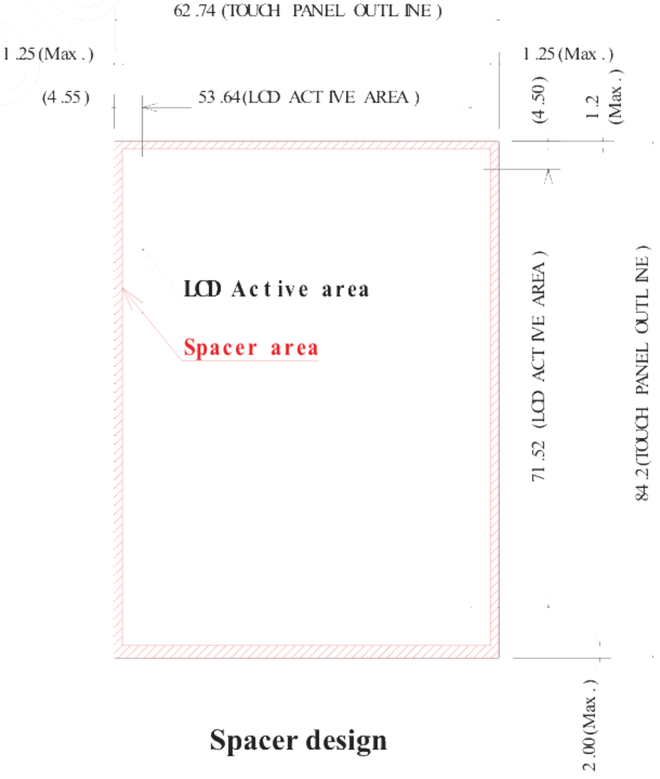
Design guidance for the front bezel and the spacer

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

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-PD-1250	Dec. 14, 2005	**Revision contents** New issue **Signature of writer** *Approved by* / *Checked by* / *Prepared by* T. ITO / / R. KAWASHIMA