NEC LCD Technologies, Ltd.

# TFT COLOR LCD MODULE

## NL2432HC22-50K

### 8.9cm (3.5 Type)
### QVGA

## DATA SHEET

**DOD-PP-1235 (1st edition)**

**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: 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 NL2432HC22-50K 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

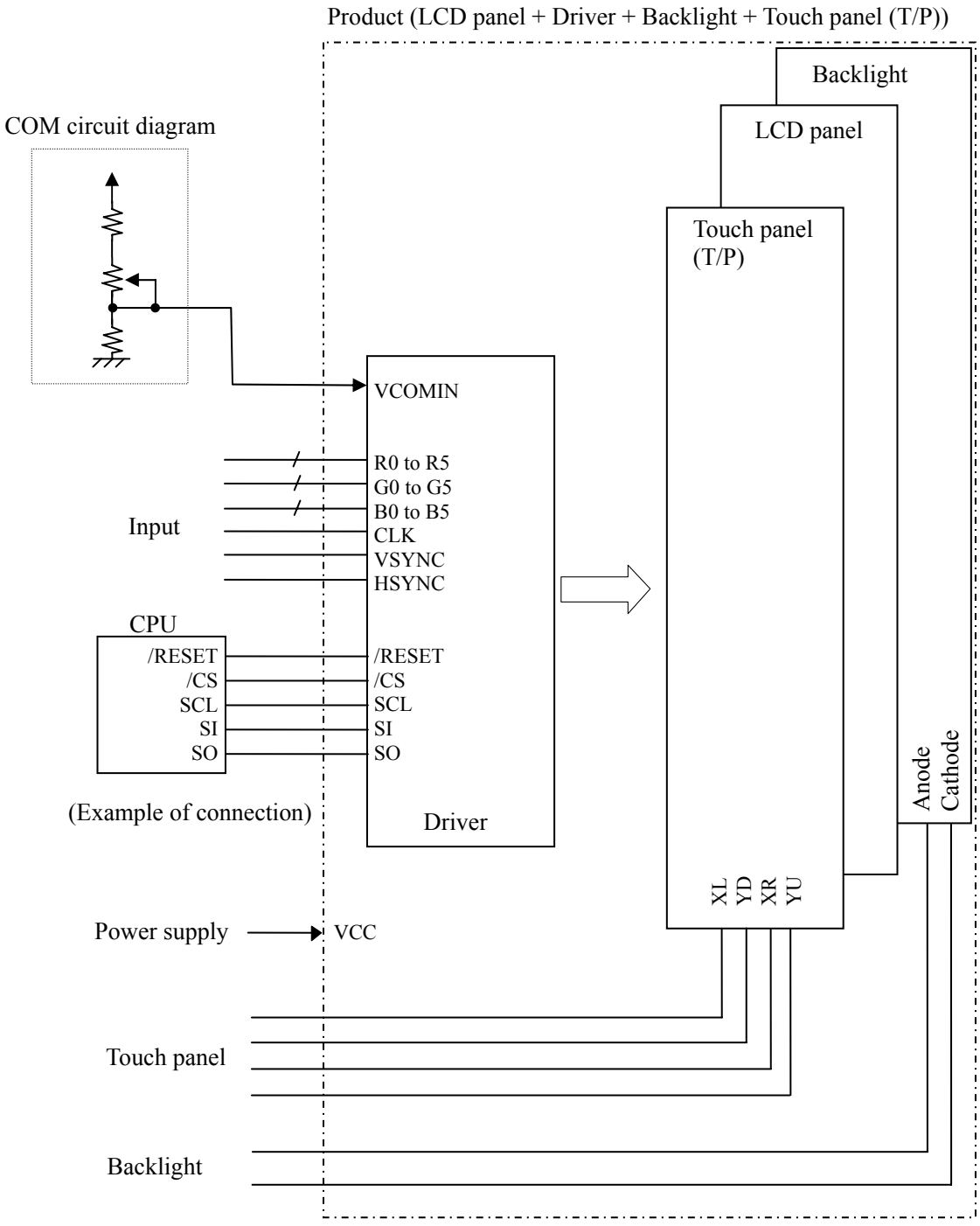
### 1.3 FEATURES

- Adoption of SR-NLT (Super-Reflective Natural Light TFT) (Transflective type)
- Long life Backlight and touch panel 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

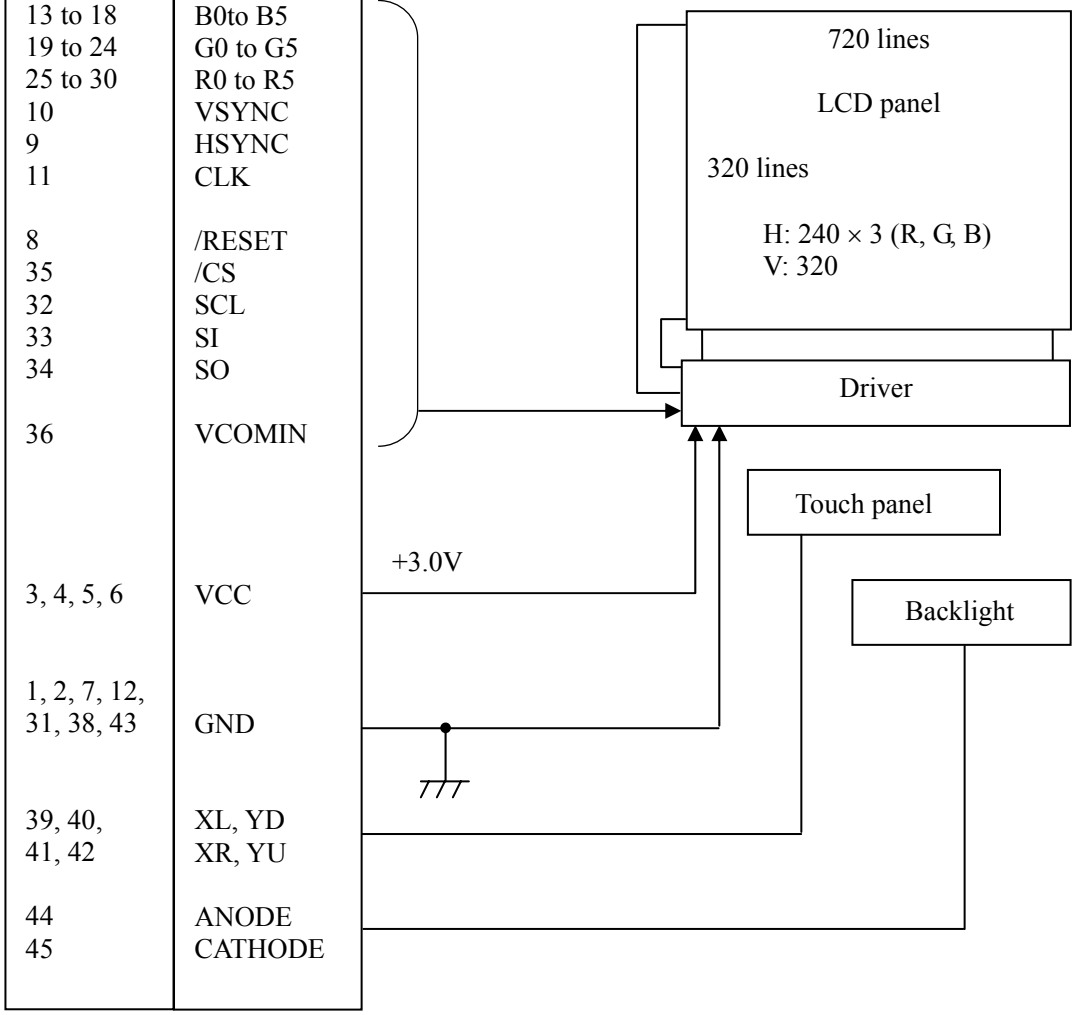
| | |
|---|---|
| ***Display area*** | 53.64 (H) × 71.52 (V) mm |
| ***Diagonal size of display*** | 8.9cm (3.5 inches) |
| ***Drive system*** | a-Si TFT active matrix |
| ***Display color*** | 262,144 colors |
| ***Pixel*** | 240 (H) × 320 (V) pixels |
| ***Pixel arrangement*** | RGB (Red dot, Green 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) × 4.2 (D) mm (typ.) |
| ***Weight*** | 41 g (typ.) |
| ***Touch Polarizer surface*** | Clear |
| ***Touch panel Polarizer pencil-hardness*** | 3H (min.) [by JIS K5600] |
| ***Luminance*** | *At IL= 15mA, with Touch panel*<br>200cd/m$^2$ (typ.) |
| ***Reflection ratio*** | 15% (typ.) (*with Touch panel*) |
| ***Contrast ratio*** | *At transmissive mode, IL= 15mA, with Touch panel*<br>150:1 (typ.) |
| | *At reflective mode, with Touch panel*<br>15:1 (typ.) |
| ***Response time*** | *Ton+Toff (10%←→ 90%)*<br>30 ms (typ., at transmissive mode)<br>16 ms (typ., at reflective mode) |
| ***Designed viewing direction*** | Viewing direction without image reversal: down side (6 o'clock) |
| ***Signal system*** | 6-bit digital signals for data of RGB colors, Dot clock (CLK),<br>Horizontal synchronous signal (HSYNC),<br>Vertical synchronous signal (VSYNC),<br>Serial interface signals (SPI correspondence) (/CS, SCL, SI, SO) |
| ***Supply voltage*** | VCC: 3.0V (typ.) |
| ***Power consumption*** | LCD panel: 50mW (typ.)<br>Backlight: 225mW (typ., at IL= 15mA) |

### 3. BLOCK DIAGRAM

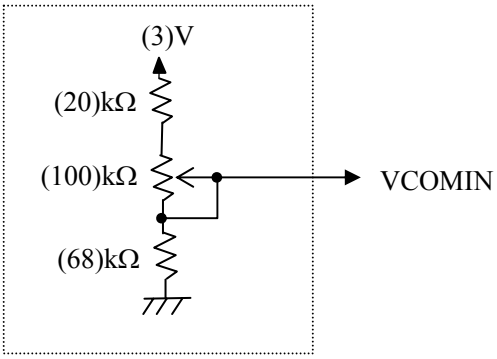


FPC I/F

| Pin No. | Symbol |
|---|---|
| 13 to 18 | B0to B5 |
| 19 to 24 | G0 to G5 |
| 25 to 30 | R0 to R5 |
| 10 | VSYNC |
| 9 | HSYNC |
| 11 | CLK |
| 8 | /RESET |
| 35 | /CS |
| 32 | SCL |
| 33 | SI |
| 34 | SO |
| 36 | VCOMIN |
| 3, 4, 5, 6 | VCC |
| 1, 2, 7, 12, 31, 38, 43 | GND |
| 39, 40, 41, 42 | XL, YD XR, YU |
| 44 | ANODE |
| 45 | CATHODE |




Reference design of COM circuit



## 4. DETAILED SPECIFICATIONS

### 4.1 MECHANICAL SPECIFICATIONS

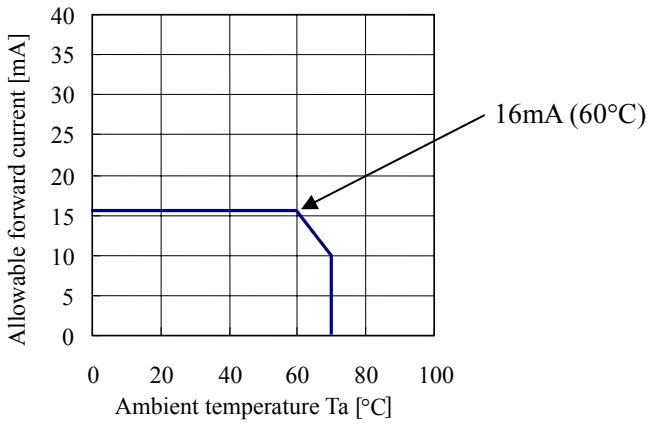
| Parameter | Specification | | Unit |
|---|---|---|---|
| Module size | 63.5 ± 0.3 (W) × 85.0 ± 0.3 (H) × 4.2 ± 0.3 (D) Note1 | Note2 | mm |
| Display area | 53.64 (H) × 71.52 (V) | Note2 | mm |
| Weight | 41 (typ.), 43 (max.) | | g |

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

### 4.2 ABSOLUTE MAXIMUM RATINGS

| Parameter | | Symbol | Rating | Unit | Remarks |
|---|---|---|---|---|---|
| Supply voltage | | VCC | -0.5 to +3.5 | V | Ta= 25°C |
| Logic input voltage | | VI | -0.5 to VCC+0.5 | V | Logic signals |
| Backlight | Reverse voltage | VR | ≤ 25 | V | Ta= 25°C |
| | Power dissipation | PD | ≤ 595 | 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 |
| | | | ≤ 70 | | 50°C <Ta≤ 55°C |
| Absolute humidity Note3 | | AH | ≤ 73 Note4 | g/m$^3$ | Ta> 55°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= 55°C and RH= 70%

4.3 ELECTRICAL CHARACTERISTICS

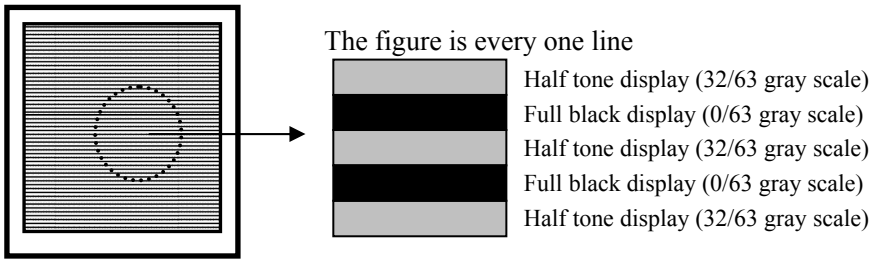
(1) Logic/ LCD driving

(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 | 26 | mA | at VCC= 3.0V Note2 |
| | ICCs | - | 0.2 | 1.0 | | Stand-by mode at VCC= 3.0V Note2 |

Note1: The optimum value for COM/H is in the range of 1.3 V to 2.3 V. The optimum COM/H is different each product.

Recommended adjustment display for COM/H




Note2: CLK= 5.0MHz, HSYNC= 19.53kHz, VSYNC= 60Hz,
Checkered flag pattern (by EIAJ ED-2522)

(2) Backlight

(Ta= 25°C)

| Parameter | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|
| Forward Current | IL | - | 15 | 16 | mA | - |
| Forward Voltage | VL | - | 15 | 16.5 | V | at IL= 15mA |

(3) Touch panel

(Ta= 25°C)

| Parameter | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|
| Touch panel input voltage | Vtp | - | - | 5.5 | V | - |
| Resistor between pins(XL-XR) | Rx | 190 | - | 500 | Ω | - |
| Resistor between pins(YU-YD) | Ry | 140 | - | 540 | 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 | - | - | 0.784 | N | Note1, Note2 |
| | | | | 80 | gf | |
| Surface hardness | Hs | 3 | - | - | H | Pencil hardness [by JIS K5600] |
| Point hitting life | Lhp | 1,000,000 | - | - | times | Polyacetal stylus pen: R0.8mm Load: 2.45N(250gf) |
| | Lhr | 1,000,000 | - | - | times | Silicon rubber: R8mm, Hardness 60° Load: 2.94N(300gf) |
| Line writing life | Lwl | 100,000 | - | - | times / one direction | Polyacetal stylus pen: R0.8mm Load: 2.45N(250gf), 300mm/s, 35mm, 0.5mm inside of Respo -nse area. |

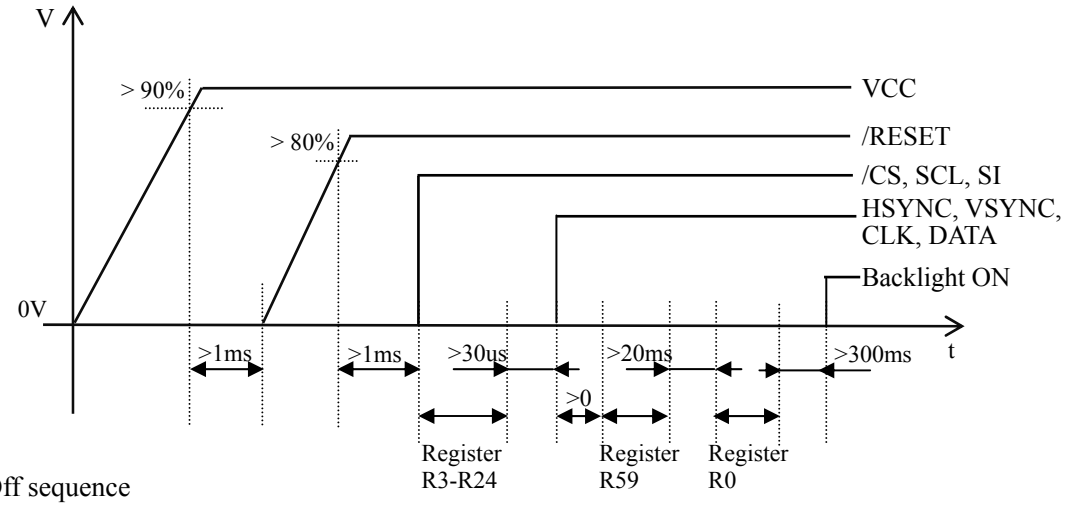
Note1: Input methods are a Finger or R0.8mm Polyacetal Stylus Pen. Input area is Display area.

Note2: Test condition

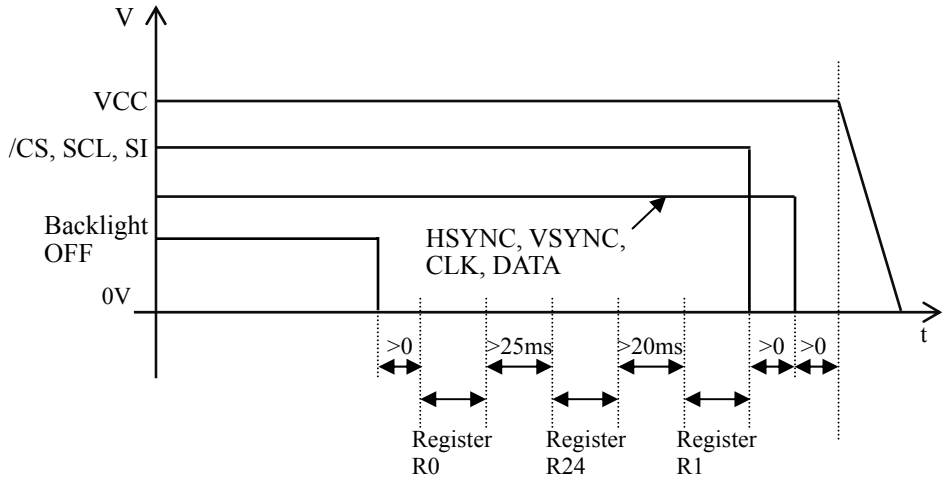
Resistance between X and Y axis must be 2kΩ or less, and the test voltage is 5V DC.

4.4 POWER SUPPLY VOLTAGE SEQUENCE

(1) Power On sequence




(2) Power Off sequence



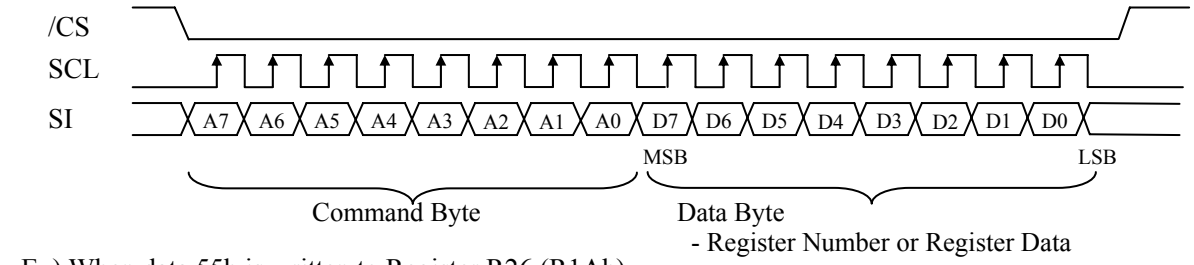

4.5 SETTING OF THE INTERNAL REGISTER

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.

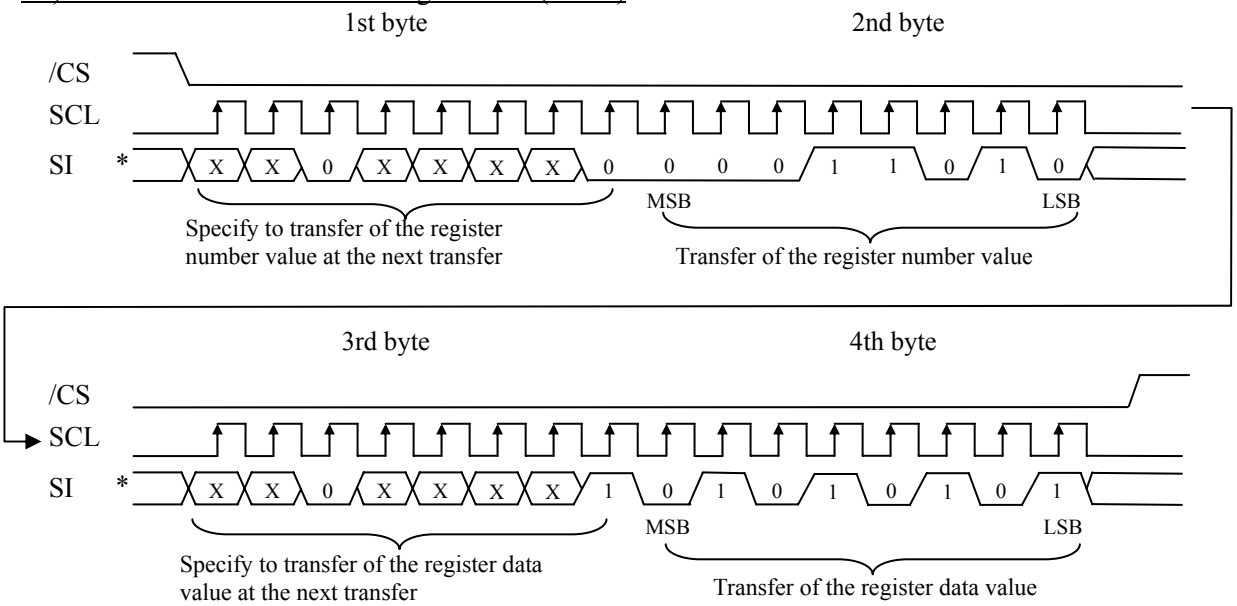
(1) Command Byte Function

| 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

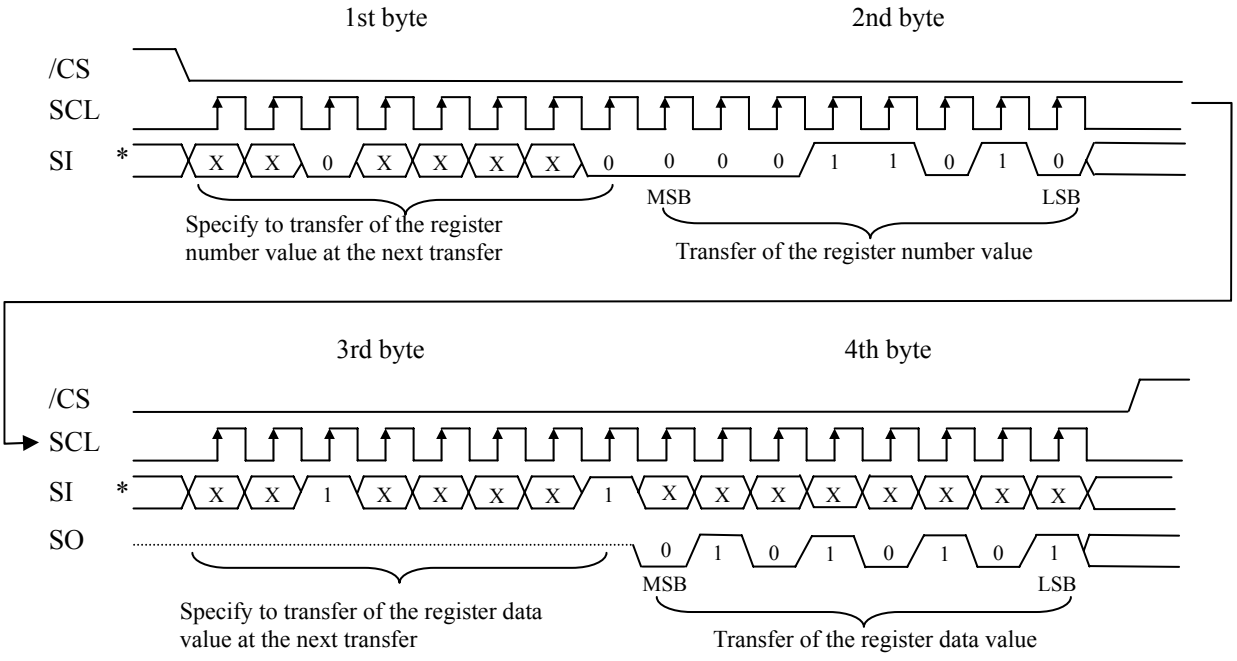



Ex) When data 55h is written to Register R26 (R1Ah)




* "X" value can be set any data.

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




* "X" value can be set any data.

Note1: During 32-bit transfer of the Register Data, /CS pin (Pin No.35) must be maintained active.

(3) Command sequence

① Power On

| Sequence | Register Number | Data | Comment | Sequence | Register Number | Data | Comment |
|---|---|---|---|---|---|---|---|
| 1 | Power On | | | 26 | R76 | 01h | - |
| 2 | 1ms min. wait. | | | 27 | R77 | 01h | - |
| 3 | Reset by the /RESET pin (Pin No. 8). | | | 28 | R80 | 00h | - |
| 4 | 1ms min. wait after /RESET↑. | | | 29 | R81 | 00h | - |
| 5 | R3 | 01h | - | 30 | R82 | 2Eh | - |
| 6 | R1 | 00h | - | 31 | R83 | C4h | - |
| 7 | R100 | 0Fh | - | 32 | R86 | 15h | - |
| 8 | R101 | 3Fh | - | 33 | R87 | EDh | - |
| 9 | R102 | 3Fh | - | 34 | R95 | 3Fh | - |
| 10 | R103 | 00h | - | 35 | R96 | 22h | - |
| 11 | R104 | 00h | - | 36 | R25 | 76h | - |
| 12 | R105 | 30h | - | 37 | R26 | 54h | - |
| 13 | R106 | 04h | - | 38 | R27 | 67h | - |
| 14 | R107 | 37h | - | 39 | R28 | 60h | - |
| 15 | R108 | 17h | - | 40 | R29 | 04h | |
| 16 | R109 | 00h | - | 41 | R30 | 1Ch | - |
| 17 | R110 | 40h | - | 42 | R31 | A9h | - |
| 18 | R111 | 30h | - | 43 | R32 | 00h | - |
| 19 | R112 | 04h | - | 44 | R33 | 20h | - |
| 20 | R113 | 37h | - | 45 | R24 | 77h | - |
| 21 | R114 | 17h | - | 46 | 30 μs min. wait. | | |
| 22 | R115 | 00h | - | 47 | Data input start | | |
| 23 | R116 | 40h | - | 48 | R59 | 01h | - |
| 24 | R2 | 40h | - | 49 | 20 ms min. wait. | | |
| 25 | R75 | 04h | - | 50 | R0 | 00h | - |

② Power Off

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

③ Standby

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

④ Wake Up

| Sequence | Register Number | Data | Comment |
|---|---|---|---|
| 1 | R1 | 00h | - |
| 2 | R24 | 77h | - |
| 3 | 30 μs min. wait. | | |
| 4 | R0 | 00h | - |

Note1: Be sure to perform reset by the /RESET pin (Pin No. 8) every power-on
Note2: Write the Register Data every power-on, because the data are not stored in the product.

4.6 INTERFACE PIN CONNECTIONS

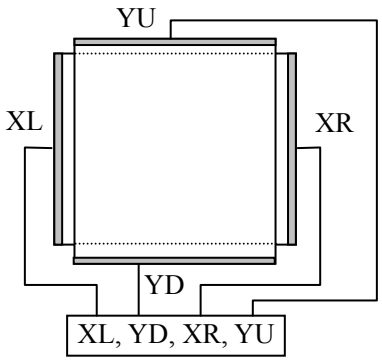
CN1 (FPC)
Adaptable socket: FH23-45S-0.3SHW(05) (Hirose Electric Co., Ltd.(HRS))

| 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 | Power supply Note1 | 27 | R2 | Red data |
| 4 | VCC | | 28 | R3 | Red data |
| 5 | VCC | | 29 | R4 | Red data |
| 6 | VCC | | 30 | R5 | Red data (MSB) |
| 7 | GND | Ground Note1 | 31 | GND | Ground Note1 |
| 8 | /RESET | Reset | 32 | SCL | Serial clock |
| 9 | HSYNC | Horizontal synchronous signal | 33 | SI | Serial input |
| 10 | VSYNC | Vertical synchronous signal | 34 | SO | Serial output |
| 11 | CLK | Dot clock | 35 | /CS | Chip selection |
| 12 | GND | Ground Note1 | 36 | VCOMIN | COM high voltage input |
| 13 | B0 | Blue data (LSB) | 37 | N.C. | Keep this pin Open. |
| 14 | B1 | Blue data | 38 | GND | Ground Note1 |
| 15 | B2 | Blue data | 39 | XL | Horizontal terminal (Left side) |
| 16 | B3 | Blue data | 40 | YD | Vertical terminal (Down side) |
| 17 | B4 | Blue data | 41 | XR | Horizontal terminal (Right side) |
| 18 | B5 | Blue data (MSB) | 42 | YU | Vertical terminal (Up side) |
| 19 | G0 | Green data (LSB) | 43 | GND | Ground Note1 |
| 20 | G1 | Green data | 44 | ANODE | LED voltage (Anode) |
| 21 | G2 | Green data | 45 | CATHODE | LED voltage (Cathode) |
| 22 | G3 | Green data | | | |
| 23 | G4 | Green data | | | |
| 24 | G5 | Green data (MSB) | | | |

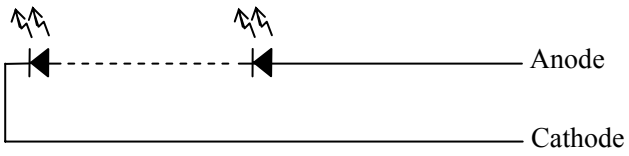
Note1: All GND terminals should be used without any non-connected lines.
Note2: Do not fold the FPC. When folding the FPC, pattern disconnection may occur. In case of bending FPC, the minimum curvature (R) must be more than 1.0 mm.

Description of terminals

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




Circuits of touch panel




Circuits of backlight

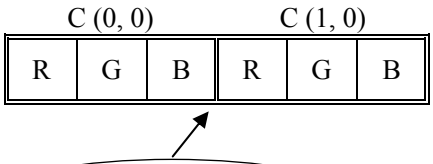
4.7 DISPLAY COLORS AND INPUT DATA SIGNALS

This product can display 262,144 colors with 64 gray scales. Also the relation between display colors and input data signals is as follows.

| 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

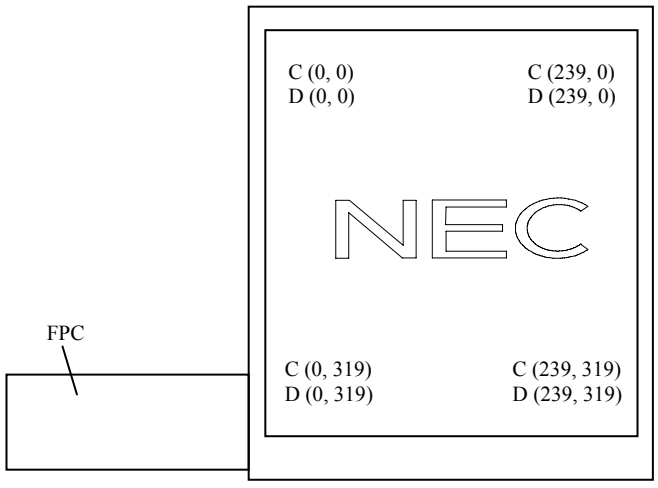
The following table is the coordinates per pixel (See figure of "**4.9 SCANNING DIRECTIONS**".).




| | | | | | | |
|---|---|---|---|---|---|---|
| C( 0, 0) | C( 1, 0) | • • • | 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) |

4.9 SCANNING DIRECTIONS

The following figures are seen from a front view.




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)

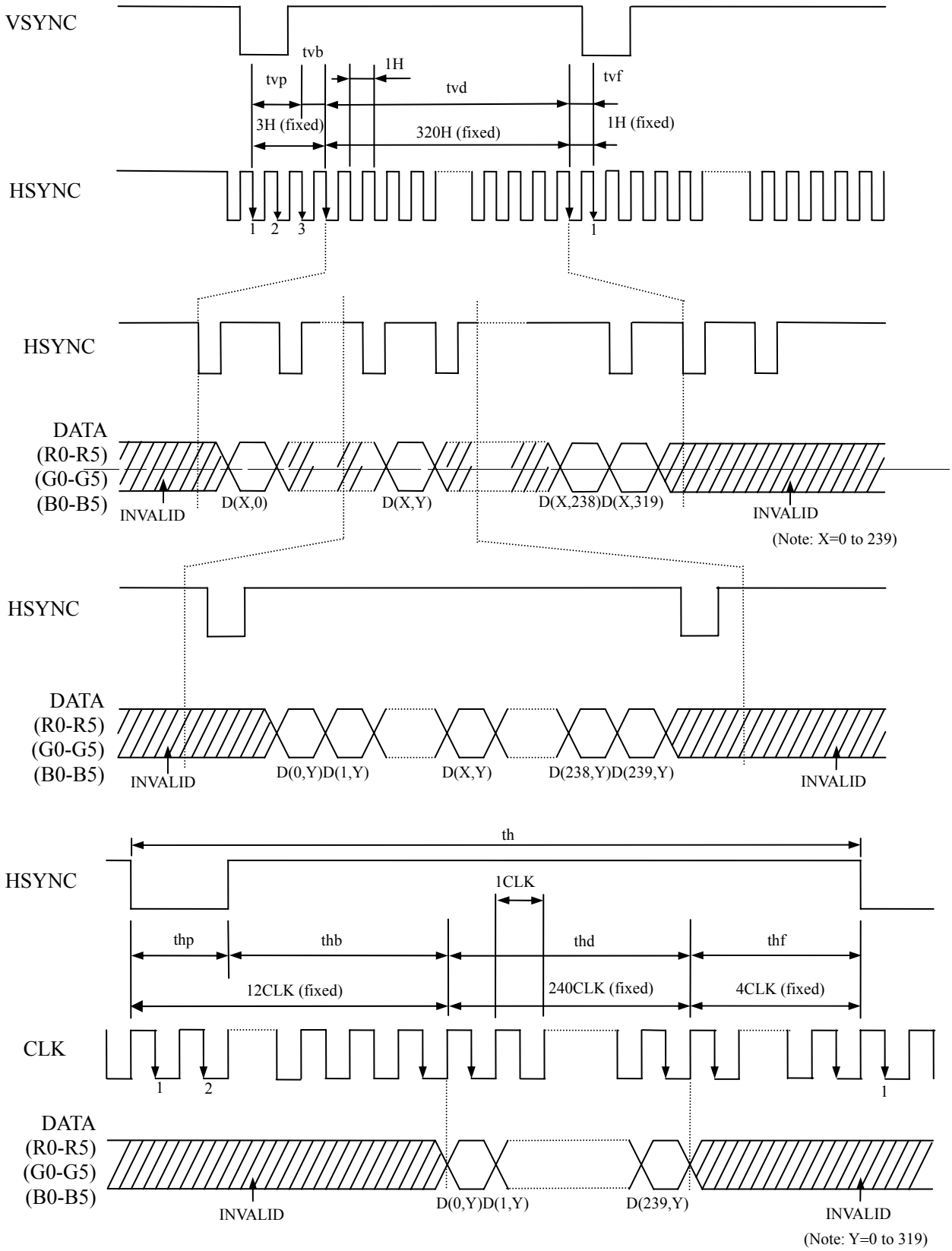
(1) Timing characteristics

| Parameter | | | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|---|
| CLK | Frequency | | 1/tc | 4.81 | 5.0 | 5.12 | MHz | 200ns (typ.) |
| | Duty | | tcd | 0.4 | 0.5 | 0.6 | - | - |
| | Rise time, Fall time | | tcrf | - | - | 15 | ns | |
| DATA (R0-R5) (G0-G5) (B0-B5) | CLK-DATA | Setup time | tds | 15 | - | - | ns | - |
| | | Hold time | tdh | 15 | - | - | ns | |
| | Rise time, Fall time | | tdrf | - | - | 15 | ns | |
| HSYNC | Cycle | | th | 50.0 | 51.2 | 53.2 | µs | 19.53kHz (typ.) |
| | | | | 256 | | | CLK | - |
| | Display period | | thd | 240 | | | CLK | |
| | Front-porch | | thf | 4 | | | CLK | |
| | Pulse width | | thp | 2 | 8 | - | CLK | |
| | Back-porch | | thb | 4 | | | CLK | |
| | CLK-HSYNC | Setup time | ths | 15 | - | - | ns | |
| | | Hold time | thh | 15 | - | - | ns | |
| | Rise time, Fall time | | thrf | - | - | 15 | ns | |
| VSYNC | Cycle | | tv | 16.2 | 16.59 | 17.24 | ms | 60Hz (typ.) |
| | | | | 324 | | | H | - |
| | Display period | | tvd | 320 | | | H | |
| | Front-porch | | tvf | 1 | | | H | |
| | Pulse width | | tvp | 1 | 2 | - | H | |
| | Back-porch | | tvb | 1 | | | H | |
| | VSYNC-HSYNC timing | | tvh | 15 | - | - | ns | |
| | Rise time, Fall time | | tvrf | - | - | 15 | ns | |

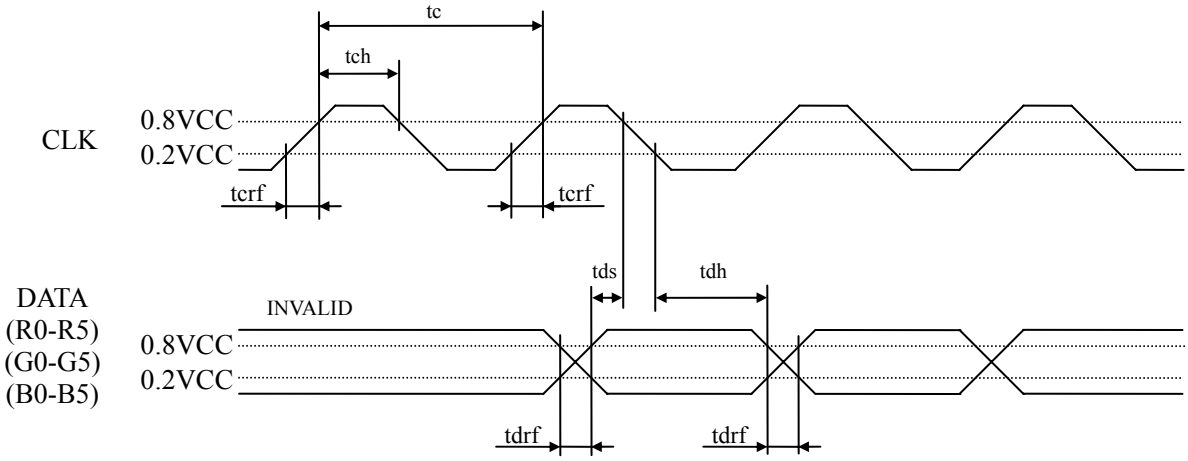
Note1: Definition of parameters is as follows.
tc= 1CLK, tcd= tch/tc, th= 1H

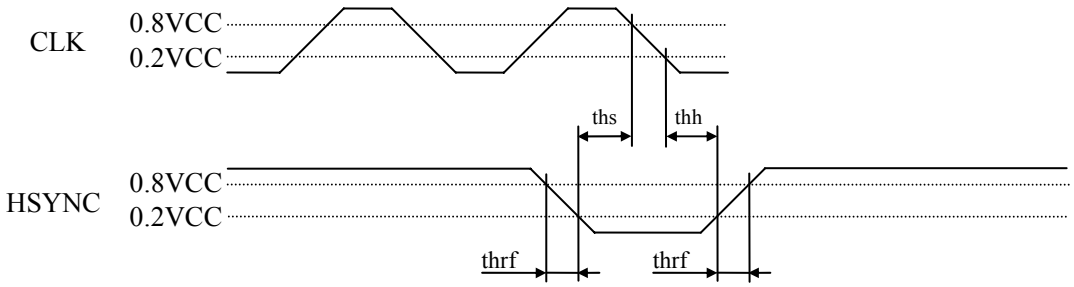
Note2: All parameters should be kept within the specified range.

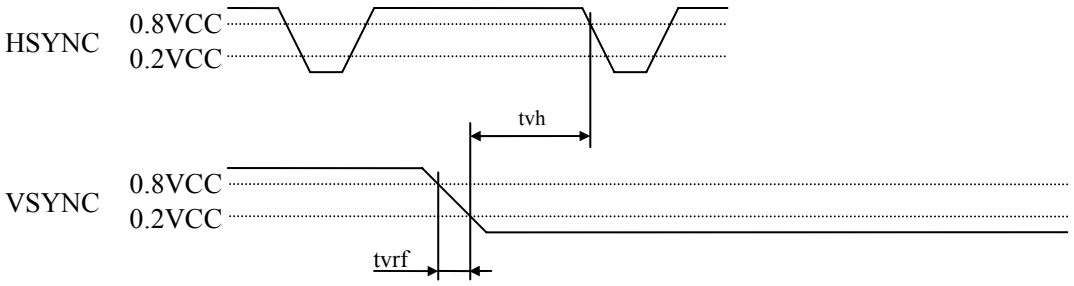
(2) Input signal timing chart




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



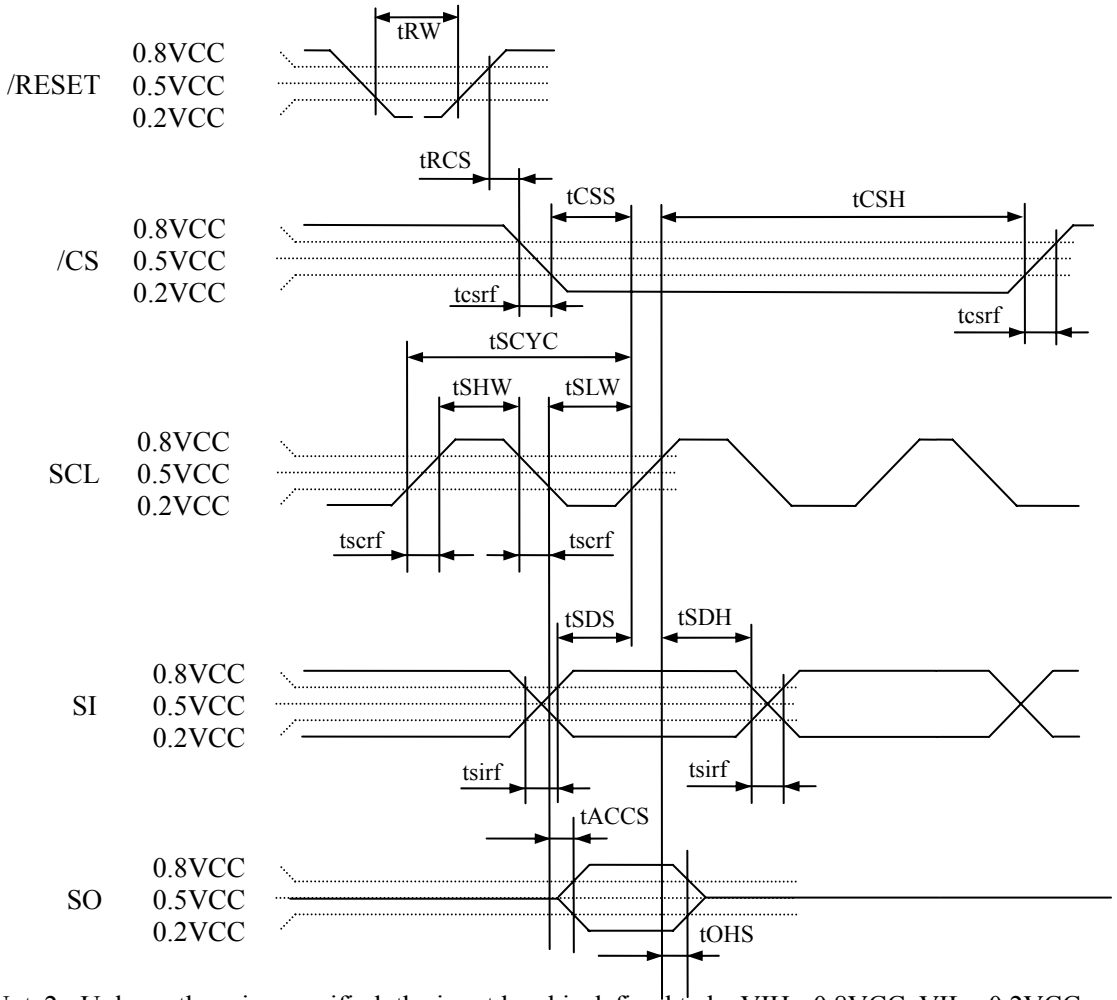

Note1: Unless otherwise specified, the input level is defined to be VIH= 0.8VCC, VIL= 0.2VCC.

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

(1) Timing characteristics

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

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




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

4.11 OPTICAL CHARACTERISTICS

<Backlight turning OFF>

(Note1, Note3, Note4)

| Parameter | Condition | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|
| Reflection ratio | White, at center | RE | 8 | 15 | - | % | Note6 |
| Contrast ratio | White/Black, at center | CR | 10 | 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<br>θR= 0°, θL= 0°, θU= 0°, θD= 0° | L | 150 | 200 | - | $cd/m^2$ | - |
| Contrast ratio | White/Black at center<br>θR= 0°, θL= 0°, θU= 0°, θD= 0° | CR | 75 | 150 | - | - | Note7 |
| Luminance uniformity | White<br>θR= 0°, θL= 0°, θU= 0°, θD= 0°<br>Maximum luminance: 100% | LU | 60 | 70 | - | % | Note11 |

Reference data

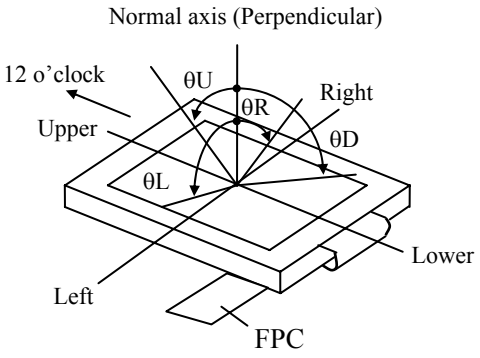
(Note2, Note3, Note5)

| Parameter | | Condition | | Symbol | min. | typ. | max. | Unit | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| Chromaticity coordinates | | White | | Wx | 0.25 | 0.30 | 0.35 | - | Note8 |
| | | | | Wy | 0.27 | 0.32 | 0.37 | - | |
| Color gamut | | θR= 0°, θL= 0°, θU= 0°, θD= 0°<br>at center, against NTSC color space | | C | - | 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 | - | 35 | - | ° | - |
| | Left | θU= 0°, θD= 0°, CR≥ 5 | | θL | - | 35 | - | ° | |
| | Up | θR= 0°, θL= 0°, CR≥ 5 | | θU | - | 35 | - | ° | |
| | Down | θR= 0°, θL= 0°, CR≥ 5 | | θD | - | 35 | - | ° | |

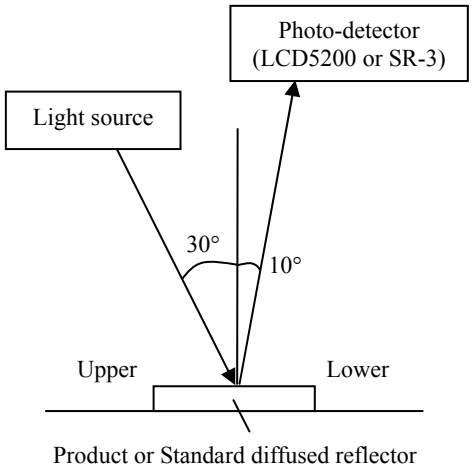
Note1: Measurement conditions are as follows.
Ta= 25 °C, VCC= 3.0V

Note2: Measurement conditions are as follows.
Ta= 25 °C, VCC= 3.0V, IL= 15mA

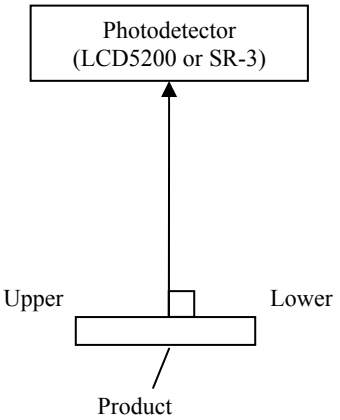
Note3: Definition of viewing angles




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 reflectance 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

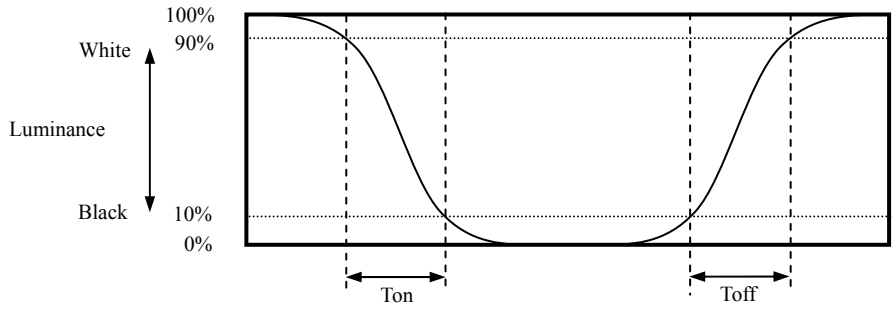
The contrast ratio is calculated by using the following formula.

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

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

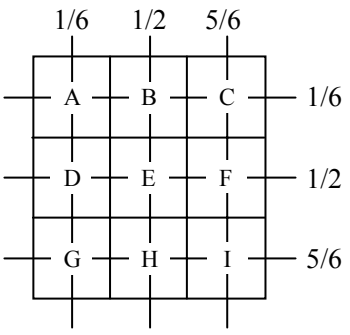



Note10: Product surface temperature: Top= 25°C

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=15mA | 33,000 | h |

Note1: Life time expectancy is mean time to half-luminance.
Note2: Estimated luminance lifetime is not the value for an 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<br>② Display data is black. | No display malfunctions |
| Heat cycle (Operation) | ① -20 ± 3°C…1 hour<br>70 ± 3°C…1 hour<br>② 50 cycles, 4 hours/cycle<br>③ Display data is black. | |
| Thermal shock (Non operation) | ① -30 ± 3°C…30 minutes<br>80 ± 3°C…30 minutes<br>② 100 cycles, 1 hour/cycle<br>③ Temperature transition time is within 5 minutes. | |
| Low pressure (Non operation) | ① 15kPa<br>② -30 ± 3°C…24 hours<br>③ 80 ± 3°C…24 hours | |
| Low pressure (Operation) | ① 53.3 kPa<br>② -20 ± 3°C…24 hours<br>③ 70 ± 3°C…24 hours | |
| ESD (Operation) | ① 150pF, 150Ω, ±10kV<br>② 3 places on a panel surface<br>③ 10 times each places at 1 sec interval | |
| Dust (Operation) | ① Sample dust: No. 15 (by JIS-Z8901)<br>② 15 seconds stir<br>③ 8 times repeat at 1 hour interval | |
| Vibration (Operation) | ① 30 to 100Hz, 19.6m/s$^2$<br>② 30 minutes/cycle<br>③ X, Y, Z directions<br>④ 1 times each directions | No display malfunctions<br>No physical damages |
| Mechanical shock (Non operation) | ① 3,920m/ s$^2$ , 2.5ms<br>② ±X, ±Y, ±Z directions<br>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"!**

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

This sign has the meaning that a customer will be injured if the customer practices wrong operations.

### 7.2 CAUTIONS

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

### 7.3 ATTENTIONS 

#### 7.3.1 Handling of the product

① Take hold of both ends without touching the FPC when the product (LCD module) is picked up from the tray.
② Do not hook nor pull the FPC in order to avoid any damage.
③ When the product is put on the table temporarily, display surface must be placed downward.
④ When handling the product, take the measures of electrostatic discharge with such as earth band, ionic shower and so on, because the product may be damaged by electrostatic.
⑤ The product must be installed and/or handled without any local stress such as bends or twist. Bends, twist or any local stress to any portion may cause display failures. And also do not put heavy or hard materials on the product.
⑥ Do not hit or rub the surface of touch panel with hard materials, because it is easily scratched. (Touch panel pencil-hardness: 3H)
⑦ When cleaning the T/P surface, wipe it with a soft dry cloth.
⑧ Do not push or 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 by any chance, please wash it away with soap and water.

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 occurred by temperature difference, the product packing box must be opened after enough time being left under the environment of an unpacking room. Evaluate the storage time sufficiently because dew condensation is affected by the environmental temperature and humidity. (Recommended leaving time: 6 hours or more with the original packing state after a customer receives the package)
③ Do not operate in high magnetic field. If not, circuit boards may be broken.
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, flickering, vertical streams or tiny spots may be observed depending on display patterns.
③ Do not display the fixed pattern for a long time because it may cause image sticking.
④ Optical characteristics may be changed depending on input signal timings.
⑤ Touch panel film has polarizing characteristic. And the polarizer characteristics differ among products. Therefore, when seeing the displays through the other polarizing material (for example polarizing sunglasses), some displays can not be seen and some displays look different color darker because of polarizer characteristic mismatching between touch panel film and the other polarizing material.

7.3.4 Others

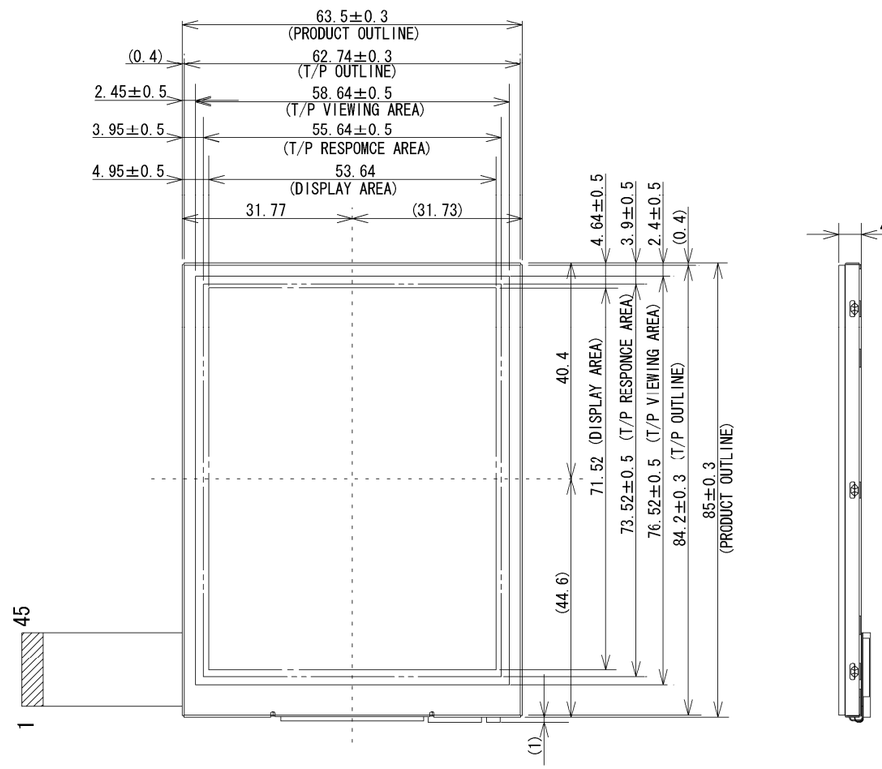
① All GND terminals should be used without any non-connected lines.
② Do not disassemble the product.
③ Pack the product with the original shipping package, in order to avoid any damages during transportation, when returning the product to NEC.
④ When installing the product to the customer equipment, do not apply any local stress to the rear side of the product, FPC, Soldering Area and Component 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.

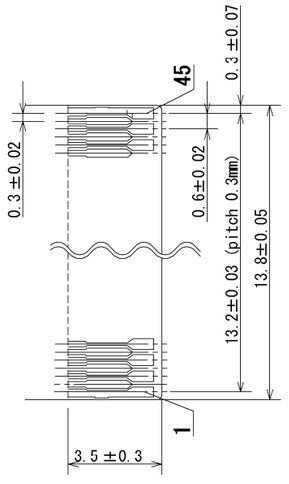
| China RoHS directive six hazardous substances or elements | | | | | |
|---|---|---|---|---|---|
| Lead (Pb) | Mercury (Hg) | Cadmium (Cd) | Hexavalent Chromium (Cr VI) | Polybrominated Biphenys (PBB) | Polybrominated Biphenyl Ethers (PBDE) |
| ○ | ○ | ○ | ○ | ○ | ○ |

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.

## 8. OUTLINE DRAWINGS

Front view

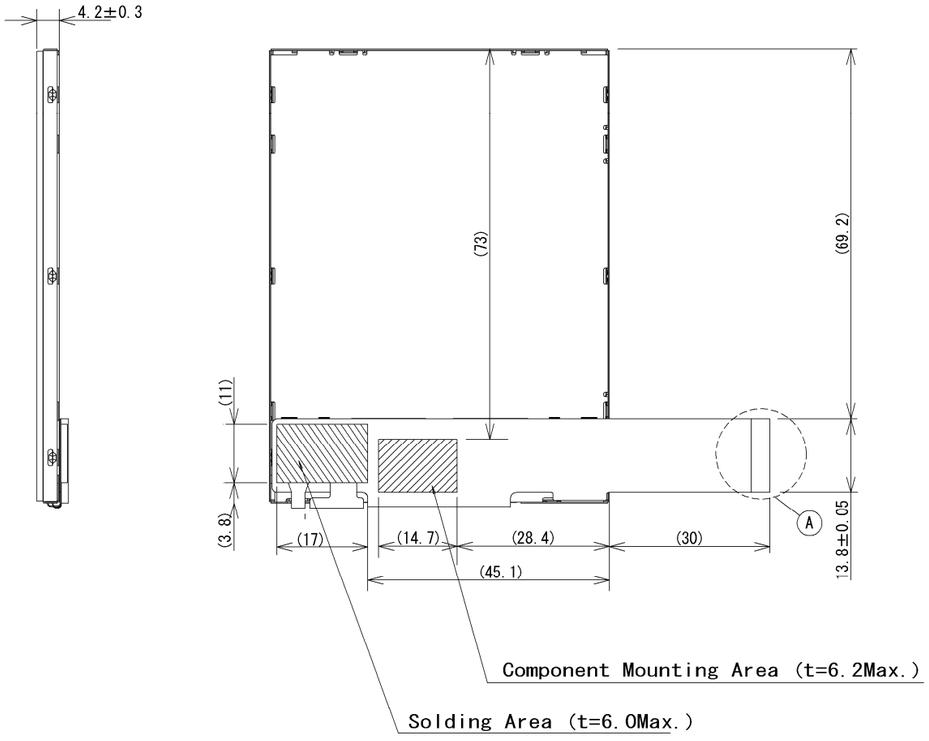



Adaptable sockect : HIROSE FH23-45S-0.3SHW(05)

DETAIL A

Rear view

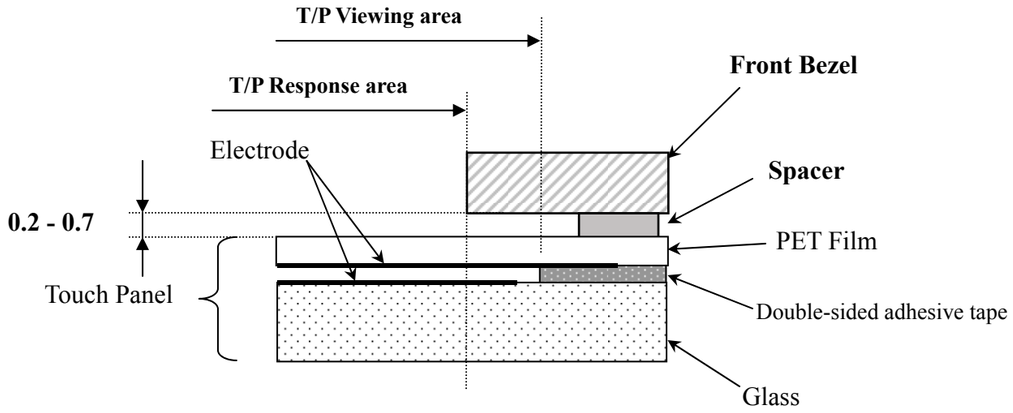



| Pin No. | Symbols | Pin No. | Symbols |
|---|---|---|---|
| 1 | GND | 25 | R0 |
| 2 | GND | 26 | R1 |
| 3 | VCC | 27 | R2 |
| 4 | VCC | 28 | R3 |
| 5 | VCC | 29 | R4 |
| 6 | VCC | 30 | R5 |
| 7 | GND | 31 | GND |
| 8 | /RESET | 32 | SCL |
| 9 | HSYNC | 33 | SI |
| 10 | VSYNC | 34 | SO |
| 11 | CLK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

Note1: The values in parentheses are for reference.
Note2: When installing the product to the customer equipment, do not apply any local stress to the rear side of the product, FPC, Soldering Area and Component 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 Component Mounting Area of the FPC.

Unit: mm

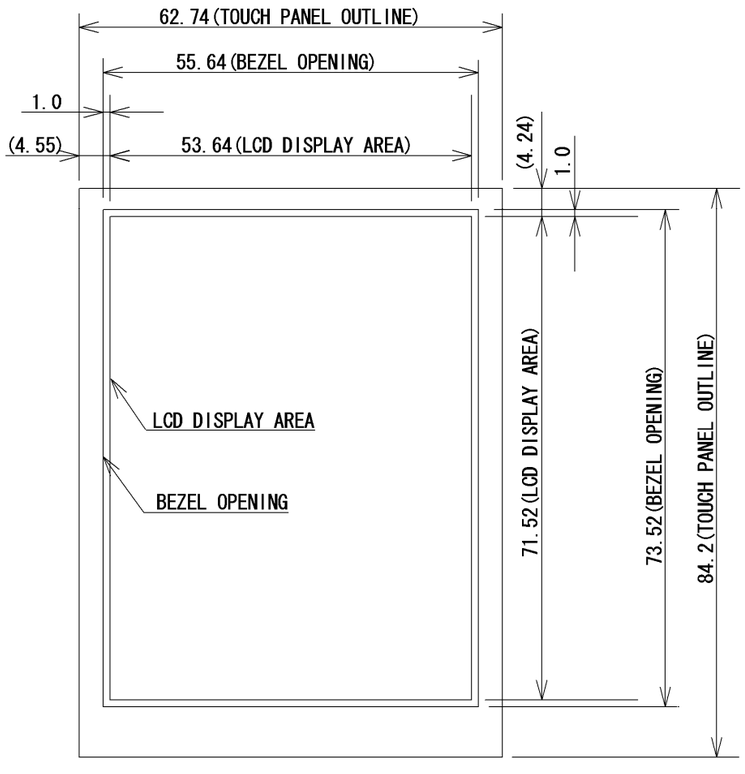
## 9. RECOMMENDED DESIGN OF FRONT BEZEL



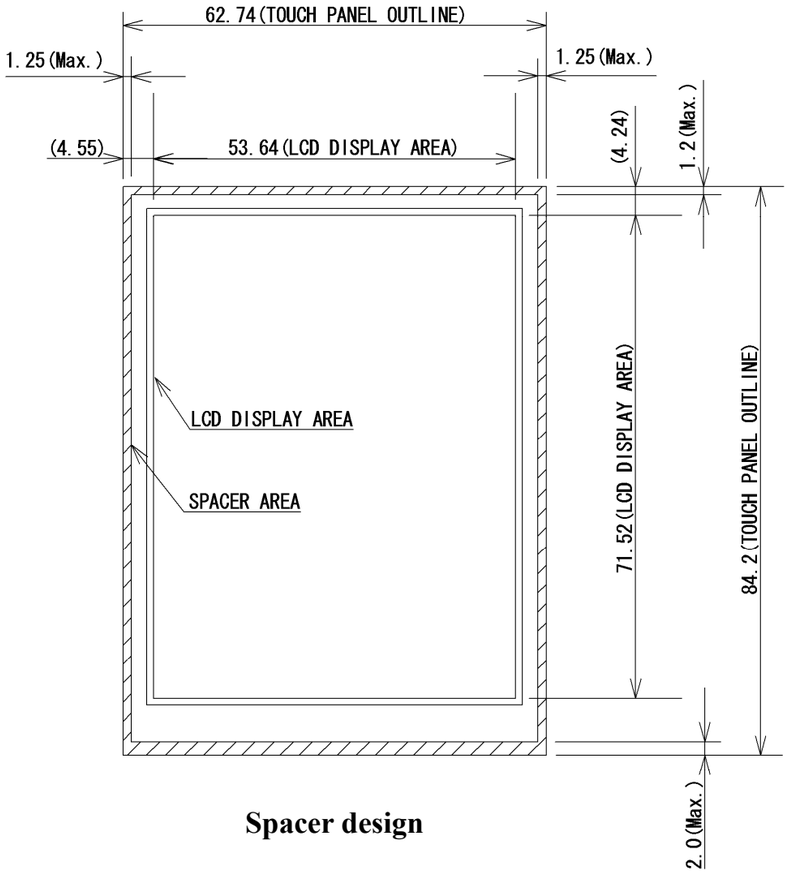

Design guidance for the front bezel and the spacer

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. Any pressures in the area between T/P response area and T/P viewing area are 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**