# LCD Module Technical Specification

First Edition
July 29, 2008

Final Revision
******

Type No. T-55382GD050JU-LW-A-AAN

Customer :

Customer's Product No :

**OPTREX CORPORATION**

| | |
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By _____

Signature :

Date :

Please return this specification within two month with your signature.
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# 1. APPLICATION

This specification applies to color TFT-LCD module, T-55382GD050JU-LW-A-AAN.

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OPTREX classifies the usage of the TFT-LCD module as follows. Please confirm the usage before using the product.

(1) Standard Usage

Computers, office equipment, factory automation equipment, test and measurement equipment, communications, transportation equipment(automobiles, ships, trains, etc.), provided, however, that operation is not influenced by TFT-LCD directly.

(2) Special Usage

Medical equipment, safety equipment, transportation equipment, provided, however, that TFT-LCD is necessary to its operation.

(3) Specific Usage

Cockpit Equipment, military systems, aerospace equipment, nuclear reactor control systems, life support systems and any other equipment. OPTREX should make a contract that stipulate apportionment of responsibilities between OPTREX and our customer.

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OPTREX has been making continuous effort to improve the reliability of its products. Customers should implement sufficient reliability design of their application equipments such as redundant system design, fail-safe functions, anti-failure features.

OPTREX assumes no responsibility for any damage resulting from the use of the product that does not comply with the instructions and the precautions specified in this document.

Please contact and consult OPTREX sales representative for any questions regarding this product.

# 2. OVERVIEW

T-55382GD050JU-LW-A-AAN is 5.0" color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs, control circuit, backlight unit, and touch panel.

By applying 8 bit digital data, 800 × 480, 16.7M-color images are displayed on the 5.0" diagonal screen. Input power voltages are 3.3 V and 5.0 V for LCD driving.
The type of data and control signals are digital and transmitted via CMOS interface per Typ. 33.5 MHz clock cycle.

Driver circuit for LED backlight is not included in this module. General specifications are summarized in the following table:

| ITEM | SPECIFICATION |
|---|---|
| Display Area (mm) | 108.0(H) × 64.8(V)<br>(5.0-inch diagonal) |
| Number of Dots | 800 × 3 (H) × 480 (V) |
| Pixel Pitch (mm) | 0.135(H) × 0.135 (V) |
| Color Pixel Arrangement | RGB vertical stripe |
| Display Mode | Normally White TN |
| Number of Color | 16.7M |
| Luminance (cd/m$^2$) | 350 |
| Wide Viewing Angle Technology | Optical compensation film |
| Viewing Angle (CR ≥ 10) | –65~65° (H)  –45~65° (V) |
| Surface Treatment (Touch panel) | Clear and hard-coating 3H |
| Electrical Interface | CMOS |
| Optimum Viewing Angle (Contrast ratio) | 12 o'clock |
| Module Size (mm) | 118.5(W) × 77.8(H) × 4.7(D) *) |
| Module Mass (g) | 89 |
| Backlight Unit | Edge-light, LED |
| Touch Panel | 4-wire analog resistive |

*) Without FPC

Characteristic value without any note is typical value.

# 3. ABSOLUTE MAXIMUM RATINGS

| ITEM | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| Power Supply Voltage for LCD 1 | VCC | –0.3 | 5.0 | V |
| Power Supply Voltage for LCD 2 | AVDD | –0.3 | 5.5 | V |
| Logic Input Voltage | VI | –0.3 | 5.0 | V |
| Backlight (LED) Current | IF | -- | 30 | mA |
| Touch Panel Voltage | TPV | -- | 7.0 | V |
| Operation Temperature (Touch Panel) Note 1,2) | $T_{op(TouchPanel)}$ | –20 | 70 | °C |
| Operation Temperature (Ambient) Note 2) | $T_{op(Ambient)}$ | –20 | 70 | °C |
| Storage Temperature Note 2) | $T_{stg}$ | –30 | 80 | °C |

[Note]

1) Measured at the center of active area and at the center of panel back surface

2) Top,Tstg ≤ 40°C : 90%RH max. without condensation

Top,Tstg > 40°C : Absolute humidity shall be less than the value of 90%RH at 40°C without condensation.

# 4. ELECTRICAL CHARACTERISTICS

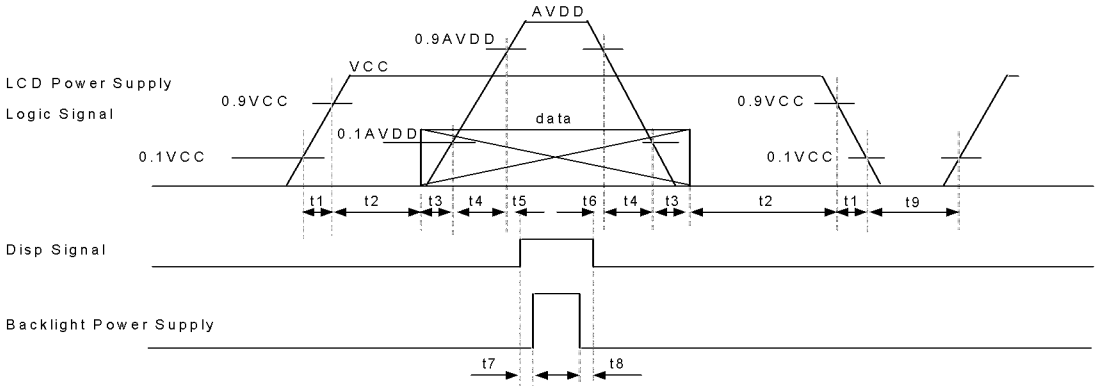
(1) TFT- LCD

Ambient temperature: Ta = 25℃

| ITEM | | SYMBOL | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|---|
| Power Supply Voltage for LCD 1 | | VCC | 3.0 | 3.3 | 3.6 | V | *1) |
| Power Supply Voltage for LCD 2 | | AVDD | 4.8 | 5.0 | 5.2 | V | *1) |
| Power Supply Current for LCD 1 | | ICC | -- | 7.4 | 17.0 | mA | *2) |
| Power Supply Current for LCD 2 | | AIDD | -- | 38.0 | 62.0 | mA | *2) |
| Permissive Input Ripple Voltage | | VRP | -- | -- | 100 | mVp-p | VCC = +3.3V<br>AVDD = +5.0V |
| Logic Input Voltage | High | VIH | 0.7VCC | -- | VCC | V | |
| | Low | VIL | 0 | -- | 0.3VCC | V | |

*1) Power and signals sequence:

| | |
|---|---|
| t1 ≤ 10 ms | 160 ms ≤ t6 |
| 0 < t2 ≤ 50 ms | 160 ms ≤ t7 |
| 0 < t3 ≤ 50 ms | 0 ms ≤ t8 |
| t4 ≤ 10 ms | 1 s ≤ t9 |
| 0 < t5 ≤ 50 ms | |




data: RGB DATA, DCLK, DENA, SC

*2) VCC = + 3.3 V, AVDD=+5.0V, $f_H$=31.5kHz, $f_V$=60Hz, $f_{CLK}$= 33.5MHz
Display image at typical power supply current value is 256-gray-bar pattern (8 bit), 480 line mode.

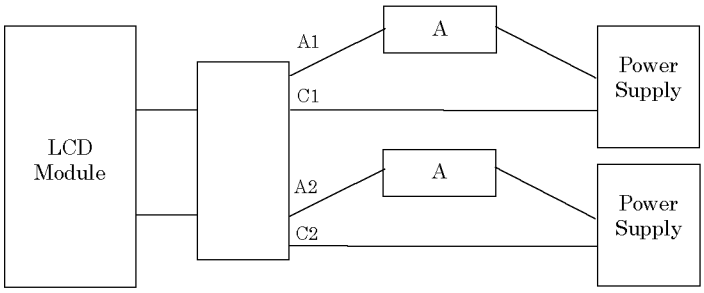
(2) Backlight

| ITEM | SYMBOL | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|
| LED Voltage | VF | (21.0) | -- | 23.1 | V | IF = 20 mA, Ta = 25°C |
| | | -- | -- | 23.8 | V | IF = 20 mA, Ta = 0°C |
| | | -- | -- | 24.5 | V | IF = 20 mA, Ta = –20°C |
| LED Current | IF | -- | 15.0 | 20.0 | mA | *1), *2) |

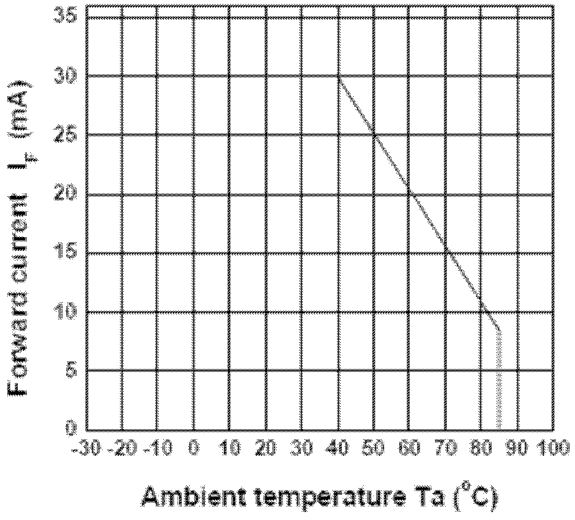
[Note]

*1) Constant Current Drive

*2) LED Current measurement method




Diode IF-Ta CHARACTERISTICS DIAGRAM



(3) Touch Panel

Electrical Characteristics

| ITEM | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|
| Linearity | –1.5 | -- | 1.5 | % | Analog X and Y directions |
| Terminal Resistance | 490 | -- | 1144 | Ω | X |
| | 225 | -- | 526 | Ω | Y |
| Insulation Resistance | 20 | -- | -- | MΩ | DC 25 V |
| Voltage | 3.0 | 5.0 | 7.0 | V | DC |
| Chattering | -- | -- | 10 | ms | |
| Transparency | -- | 80 | -- | % | JIS K 7105, ASTM D 1003 |

*) Do not operate it with a thing except a polyacetal pen (tip R0.8 mm or more) or a finger, especially those with hard or sharp tips such as a ball point pen or a mechanical pencil.

# 5. INTERFACE PIN CONNECTION

(1) FPC1 (Interface Signal)

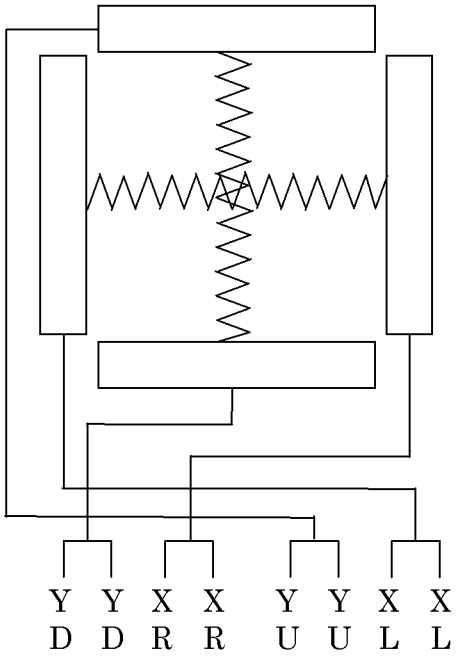
| Pin No. | Symbol | Function |
|---|---|---|
| 1 | GND | |
| 2 | GND | |
| 3 | VCC | 3.3 V Power Supply |
| 4 | VCC | 3.3 V Power Supply |
| 5 | R0 | Red data signal(LSB) |
| 6 | R1 | Red data signal |
| 7 | R2 | Red data signal |
| 8 | R3 | Red data signal |
| 9 | R4 | Red data signal |
| 10 | R5 | Red data signal |
| 11 | R6 | Red data signal |
| 12 | R7 | Red data signal(MSB) |
| 13 | G0 | Green data signal(LSB) |
| 14 | G1 | Green data signal |
| 15 | G2 | Green data signal |
| 16 | G3 | Green data signal |
| 17 | G4 | Green data signal |
| 18 | G5 | Green data signal |
| 19 | G6 | Green data signal |
| 20 | G7 | Green data signal(MSB) |
| 21 | B0 | Blue data signal(LSB) |
| 22 | B1 | Blue data signal |
| 23 | B2 | Blue data signal |
| 24 | B3 | Blue data signal |
| 25 | B4 | Blue data signal |
| 26 | B5 | Blue data signal |
| 27 | B6 | Blue data signal |
| 28 | B7 | Blue data signal(MSB) |
| 29 | GND | |
| 30 | DCLK | Clock signal for sampling catch data signal |
| 31 | DISP | Display on/off (High: on, Low: off) |
| 32 | HD | Horizontal sync signal |
| 33 | VD | Vertical sync signal |
| 34 | DENA | Data enable signal (to settle the viewing area) |
| 35 | AVDD | 5.0 V Analog Power Supply |
| 36 | AVDD | 5.0 V Analog Power Supply |
| 37 | NC | This pin should be open. |
| 38 | NC | This pin should be open. |
| 39 | SC | Scan direction control (Low= Reverse, High= Normal) |
| 40 | GND | |
| 41 | GND | |
| 42 | LED_C1 | LED cathode 1 |
| 43 | LED_A1 | LED anode 1 |
| 44 | LED_C2 | LED cathode 2 |
| 45 | LED_A2 | LED anode 2 |

*) Metal frame is connected to signal GND.

(2) FPC 2 (Touch Panel Interface)

| Pin No. | Symbol |
|---|---|
| 1 | XL |
| 2 | XL |
| 3 | YU |
| 4 | YU |
| 5 | XR |
| 6 | XR |
| 7 | YD |
| 8 | YD |

(3) Touch Panel




Top View

X: Upper electrode

Y: Lower electrode

# 6. INTERFACE TIMING

(1) Timing Specifications

| ITEM | | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|
| DCLK | Frequency | $f_{CLK}$ | -- | 33.5 | 45 | MHz |
| | Period | $t_{CLK}$ | 22.2 | 29.9 | -- | ns |
| | Low Width | $t_{WCL}$ | 40% | -- | -- | $t_{CLK}$ |
| | High Width | $t_{WCH}$ | 40% | -- | -- | $t_{CLK}$ |
| DATA(R,G,B), DENA | Set up time | $t_{DS}$ | 4 | -- | -- | ns |
| | Hold time | $t_{DH}$ | 2 | -- | -- | ns |
| DENA | Horizontal Active Time | $t_{HA}$ | 800 | 800 | 800 | $t_{CLK}$ |
| | Horizontal Blank Time | $t_{HB}$ | 164 | 256 | 348 | $t_{CLK}$ |
| | Horizontal Front Porch | $t_{HFP}$ | 48 | 167 | 343 | $t_{CLK}$ |
| | Horizontal Back Porch | $t_{HBP}$ | 5 | 89 | 116 | $t_{CLK}$ |
| | Vertical Active Time | $t_{VA}$ | 480 | 480 | 480 | $t_H$ |
| | Vertical Blank Time | $t_{VB}$ | 35 | 45 | 55 | $t_H$ |
| | Vertical Front Porch | $t_{VFP}$ | 2 | 12 | 22 | $t_H$ |
| | Vertical Back Porch | $t_{VBP}$ | 33 | 33 | 33 | $t_H$ |
| HD | Frequency | $f_H$ | -- | 31.5 | 35 | kHz |
| | Period | $t_H$ | 28.6 | 31.7 | -- | μs |
| | Low Width | $t_{WHL}$ | 1 | -- | -- | $t_{CLK}$ |
| | Set up time | Thst | 6 | -- | -- | ns |
| | Hold time | Thhd | 6 | -- | -- | ns |
| VD | Frequency | $f_V$ | 55 | 60 | 68 | Hz |
| | Period | $t_V$ | 14.7 | 16.7 | 18.2 | ms |
| | Low Width | $t_{WVL}$ | 1 | -- | -- | $t_H$ |
| | Set up time | Tvst | 6 | -- | -- | ns |
| | Hold time | Tvhd | 6 | -- | -- | ns |

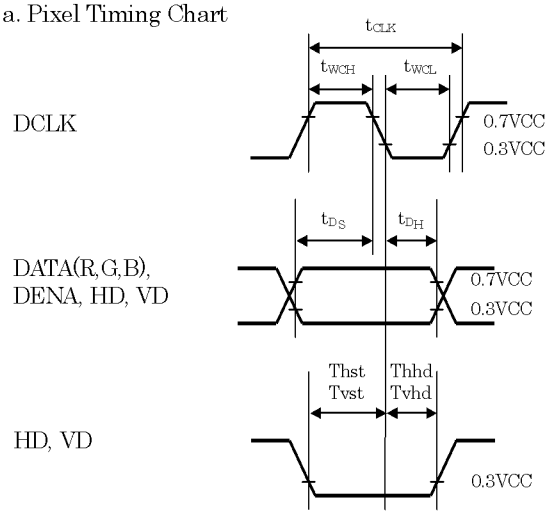
[Note]

1) DATA is latched at fall edge of DCLK in this specification.
2) Polarities of HD and VD are negative in this specification.
3) DENA (Data Enable) should always be positive polarity as shown in the timing specification.
4) DCLK should appear during all invalid period, and HD should appear during invalid period of frame cycle.
5) Please satisfy following condition.

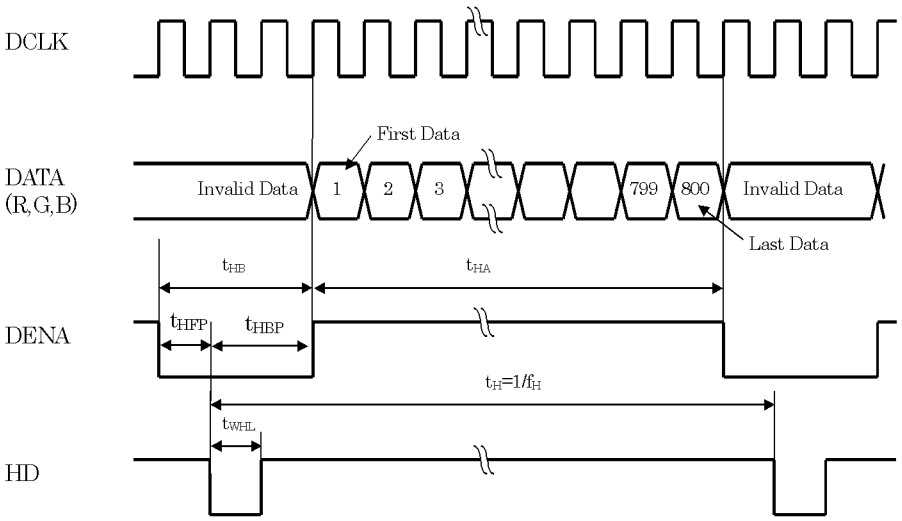
$t_{VBn} = t_{VBn-1}$

## (2) Timing Chart

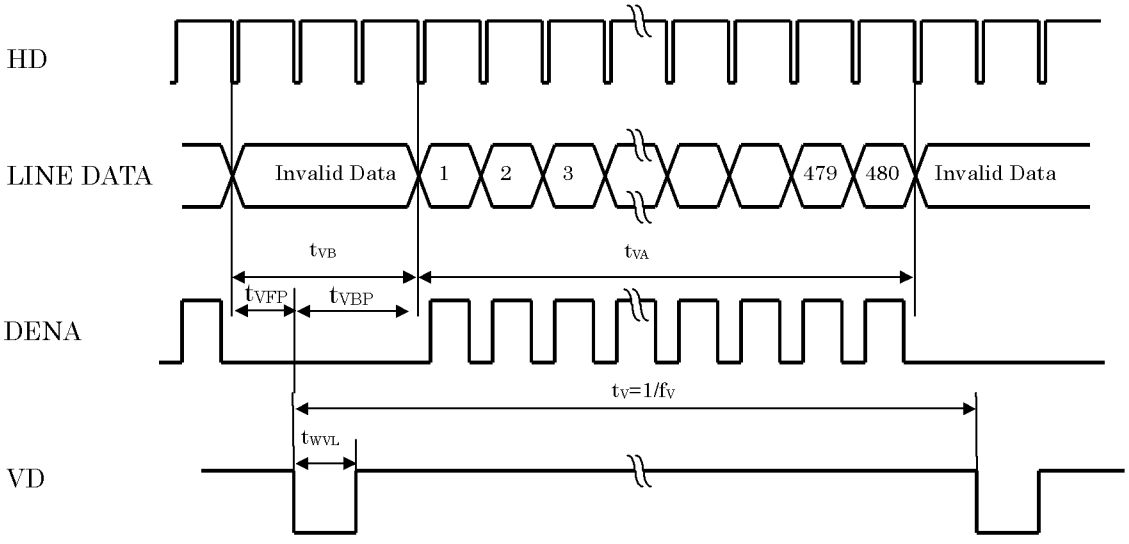
a. Pixel Timing Chart




b. Horizontal Timing Chart




c. Vertical Timing Chart



(3) Color Data Assignment

| COLOR | | INPUT DATA | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | R DATA | | | | | | | | G DATA | | | | | | | | B DATA | | | | | | | |
| | | R7 | R6 | R5 | R4 | R3 | R2 | R1 | R0 | G7 | G6 | G5 | G4 | G3 | G2 | G1 | G0 | B7 | B6 | B5 | B4 | B3 | B2 | B1 | B0 |
| | | MSB | | | | | | | LSB | MSB | | | | | | | LSB | MSB | | | | | | | LSB |
| BASIC COLOR | 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 |
| | RED(255) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN(255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | BLUE(255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | CYAN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | MAGENTA | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | YELLOW | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | WHITE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| RED | RED(1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED(2) | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | RED(255) | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| GREEN | GREEN(1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | GREEN(255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| BLUE | BLUE(1) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| | BLUE(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | BLUE(255) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |

[Note]

1) Definition of gray scale

Color (n) ···n indicates gray scale level.

Higher n means brighter level.

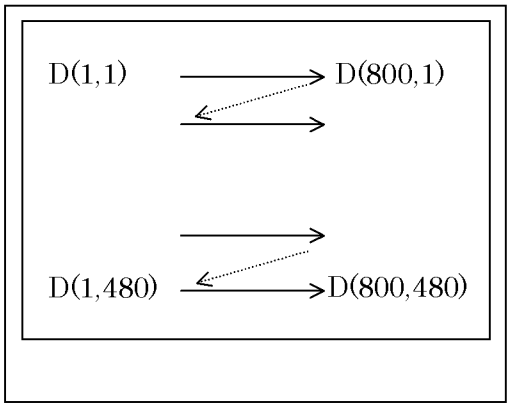
2) Data

1:High, 0: Low

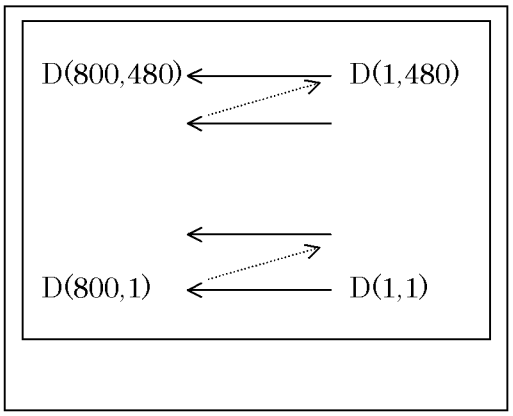
(4) Display Position and Scan Direction

D(X,Y) shows the data number of input signal for LCD panel signal processing PCB.

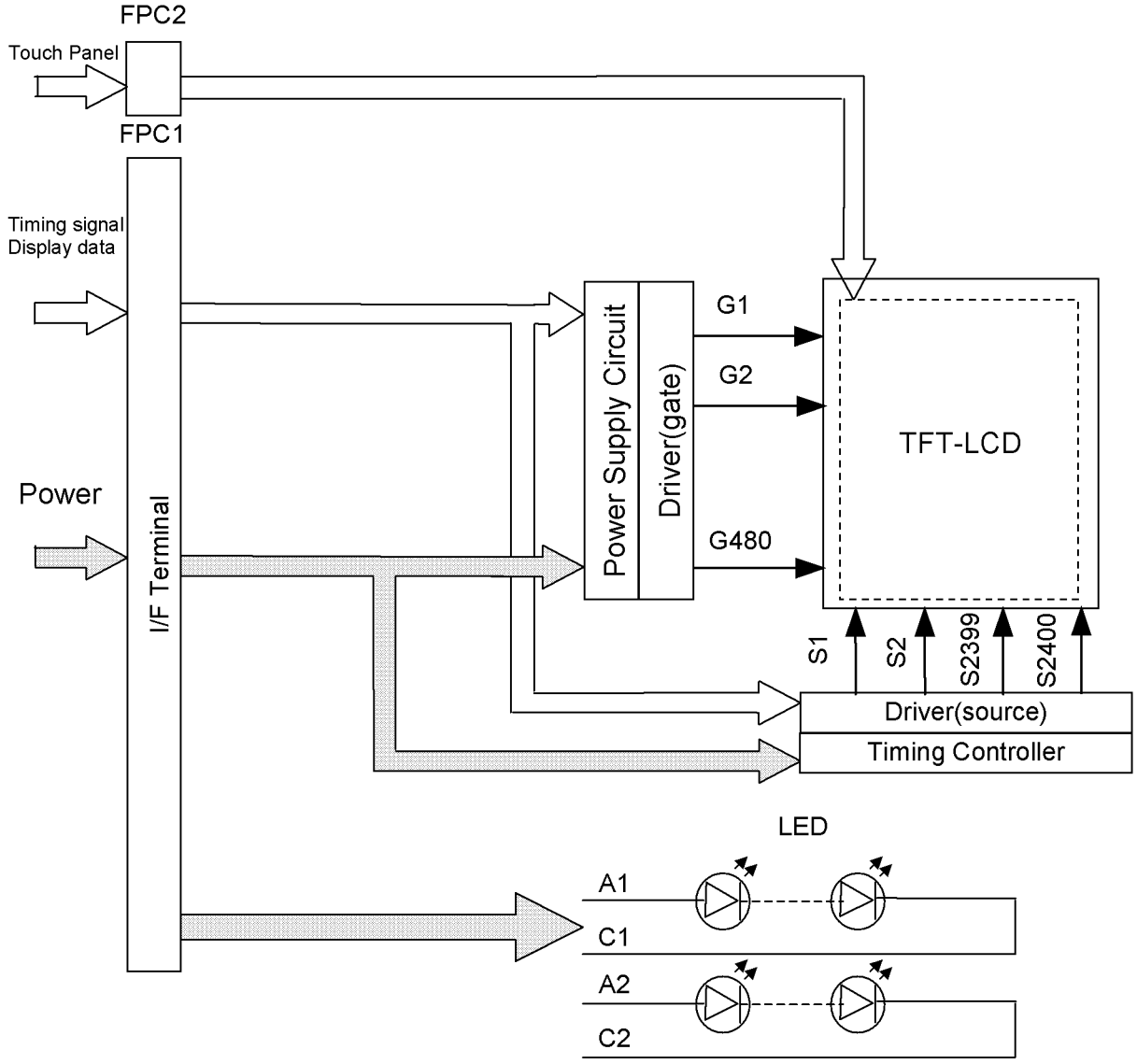
SC: High




SC: Low

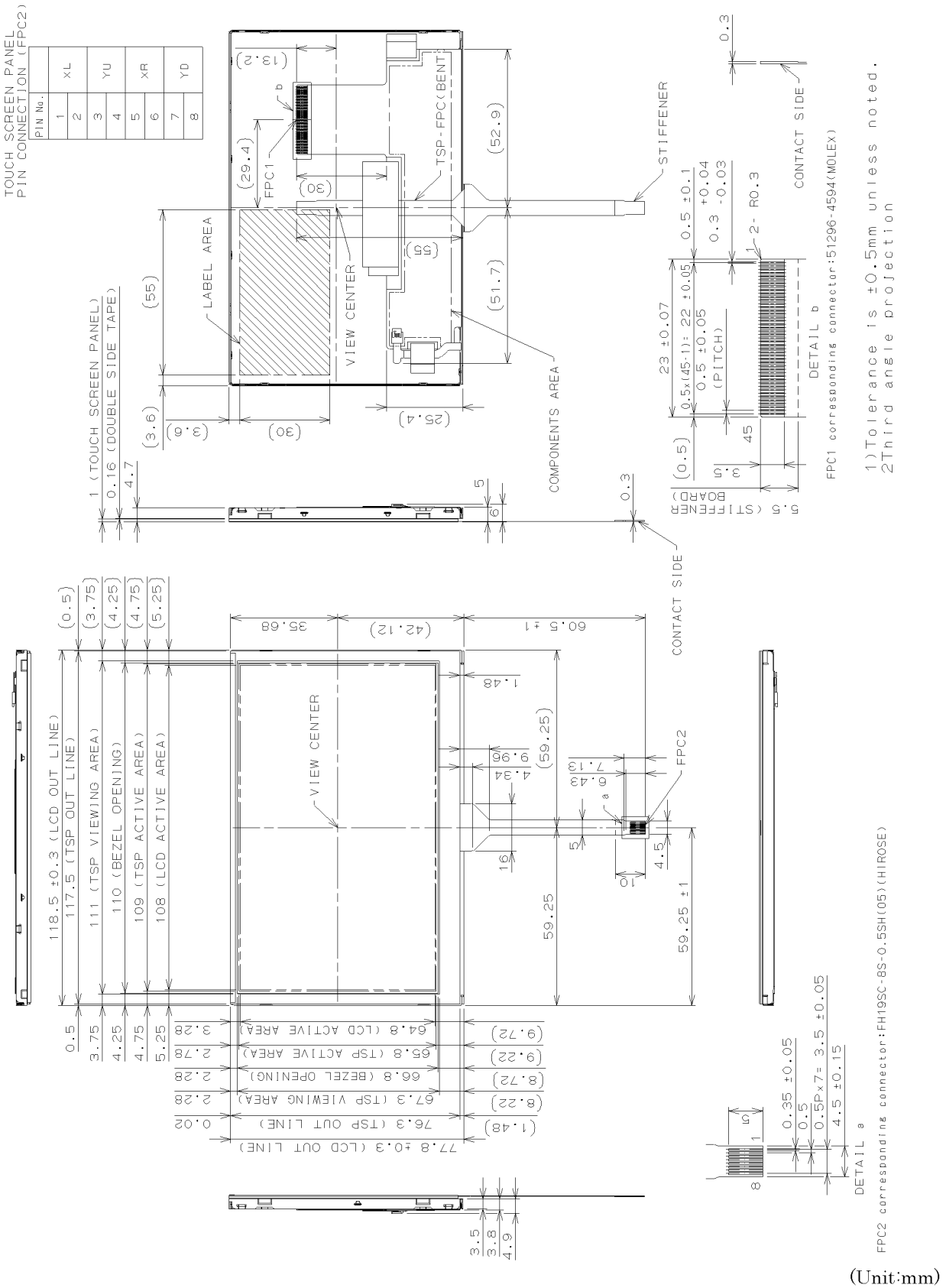


# 7. BLOCK DIAGRAM



# 8. MECHANICAL SPECIFICATIONS

(1) Outline Dimensions




(Unit:mm)

(2) Touch Panel

a. Mechanical & Reliability Characteristics

| ITEM | | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|
| Activation Force | | 0.05 | -- | 0.8 | N | *1) |
| Durability | Surface Scratching | Write 100,000 | -- | -- | characters | *2) |
| | Surface Pitting | 10,000,000 | -- | -- | touches | *3) |
| Surface Hardness | | 3 | -- | -- | H | JIS K5400, ASTM D3363 |

*1) Stylus pen Input: R4.0 mm silicon pen

*2) Measurement for Surface area

-Input size 10 × 10 mm

-Input Character A to Z /minute

-Force: 2.45 N

-Stylus: R0.8 mm polyacetal tip

*3) Pit 10,000,000 hits on the Film with a R4.0 mm silicon pen

-Force: 3 N

-Speed:2 hits/sec

b. Design Guide

-Avoid the design that Front-case overlap and press on the active area of the touch-panel.

-Give enough gap (over 0.5 mm at compressed) between the front case and touch-panel to protect wrong operating.

-Use a buffer material (Gasket) between the touch-panel and Front-case to protect damage and wrong operating.

-Avoid the design that buffer material overlap and press on the inside of touch-panel viewing area.

-The flexible tail section should be designed to avoid stress from the front case and/or avoid any bending stress to root of flexible tail section.

-Please avoid any strong forces, such as pen input in the area between display area and insulated area (distance: >2mm), because it may cause damage to the film.

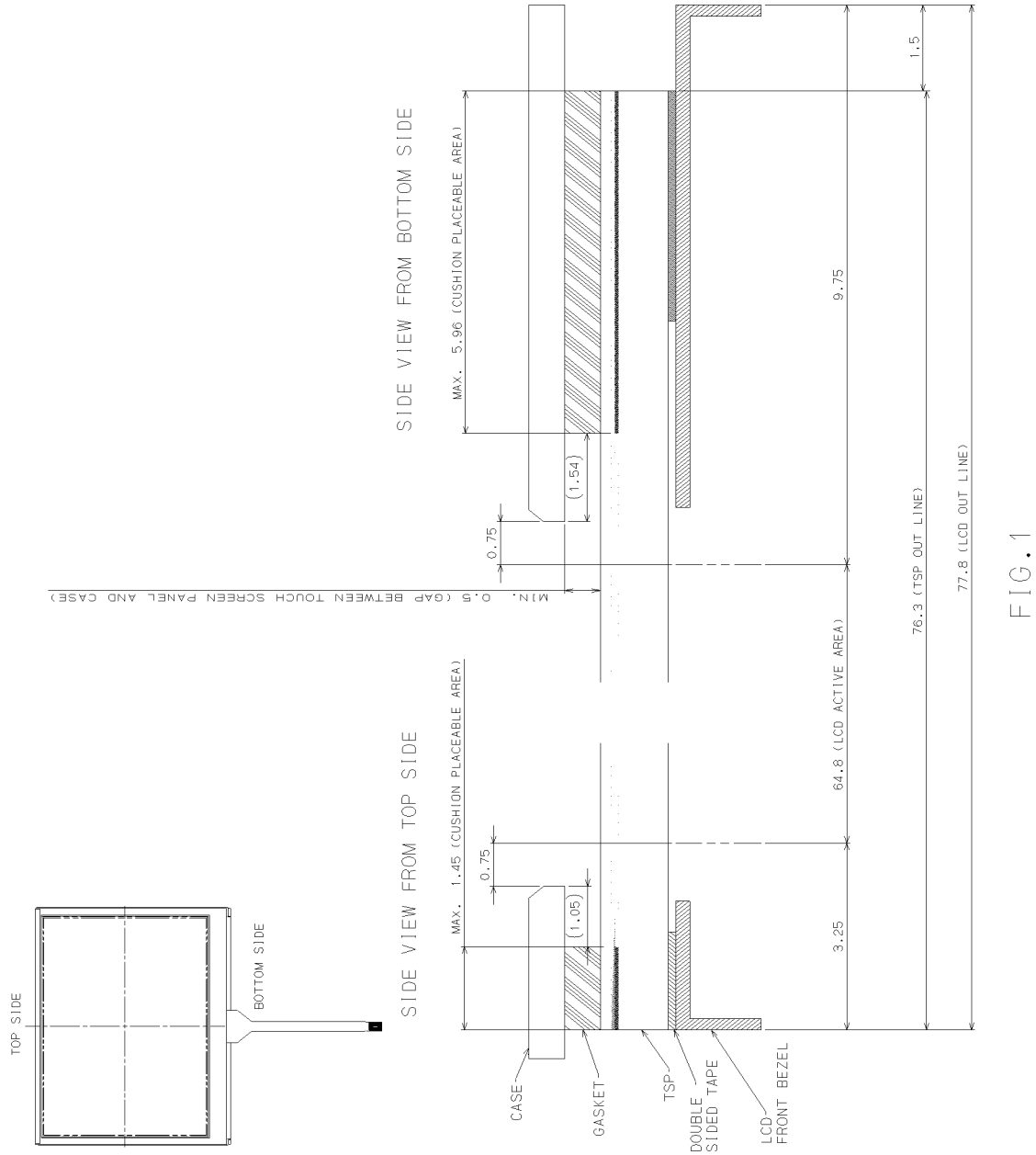



FIG. 1

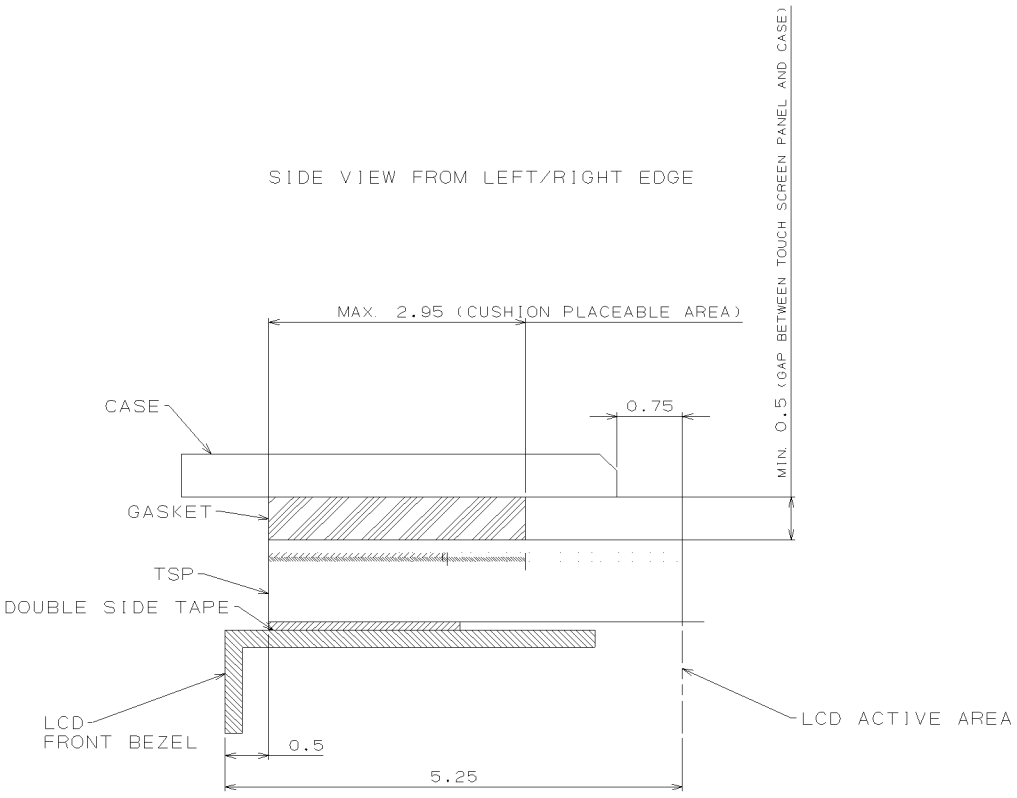

SIDE VIEW FROM LEFT/RIGHT EDGE
MAX. 2.95 (CUSHION PLACEABLE AREA)
MIN. 0.5 (GAP BETWEEN TOUCH SCREEN PANEL AND CASE)
0.75
CASE
GASKET
TSP
DOUBLE SIDE TAPE
LCD
FRONT BEZEL
0.5
5.25
LCD ACTIVE AREA

FIG.2

# 9. OPTICAL CHARACTERISTICS

Ta=25°C, VCC=3.3V, AVDD=5.0V, Input Signals: Typ. Values shown in Section 6

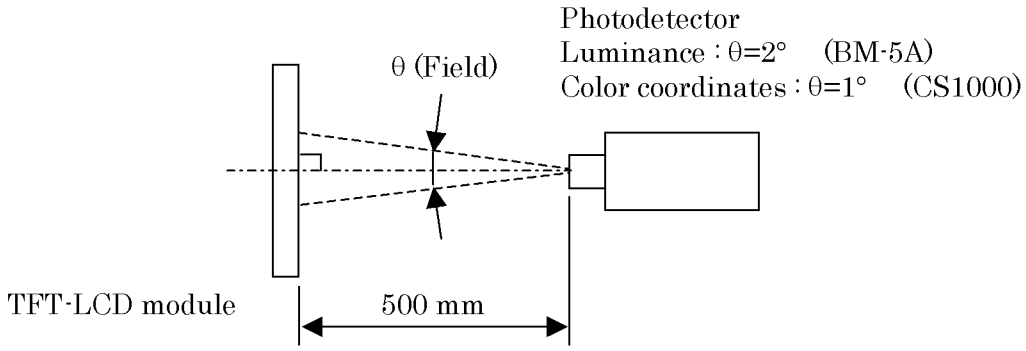
| ITEM | | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|---|---|
| Contrast Ratio | | CR | $\theta_V$=0°, $\theta_H$=0° | 290 | 450 | -- | -- | *1)*2)*5) |
| Luminance | | Lw | $\theta_V$=0°, $\theta_H$=0° | 200 | 350 | -- | cd/m$^2$ | *1)*5) |
| Luminance Uniformity | | ΔLw | $\theta_V$=0°, $\theta_H$=0° | -- | -- | 20 | % | *1)*3)*5) |
| Response Time | | tr | $\theta_V$=0°, $\theta_H$=0° | -- | 5 | -- | ms | *1)*4)*5) |
| | | tf | $\theta_V$=0°, $\theta_H$=0° | -- | 20 | -- | ms | *1)*4)*5) |
| Viewing Angle | Horizontal | $\theta_H$ | CR ≥ 10 | -50~50 | -65~65 | -- | ° | *1)*5) |
| | Vertical | $\theta_V$ | | -30~40 | -45~65 | -- | ° | *1)*5) |
| Image Sticking | | tis | 2 h | -- | -- | 2 | s | *6) |
| Color Coordinates | Red | Rx | $\theta_V$=0°, $\theta_H$=0° | 0.542 | 0.592 | 0.642 | -- | *1)*5) |
| | | Ry | | 0.313 | 0.363 | 0.413 | | |
| | Green | Gx | | 0.291 | 0.341 | 0.391 | | |
| | | Gy | | 0.525 | 0.575 | 0.625 | | |
| | Blue | Bx | | 0.101 | 0.151 | 0.201 | | |
| | | By | | 0.068 | 0.118 | 0.168 | | |
| | White | Wx | | 0.255 | 0.305 | 0.355 | | |
| | | Wy | | 0.280 | 0.330 | 0.380 | | |

[Note]

These items are measured using CS1000(MINOLTA) for color coordinates, EZContrast(ELDIM) for viewing angle and CS1000 or BM-5A(TOPCON) for others under the dark room condition (no ambient light) after more than 30 minutes from turning on the backlight unless noted.

Condition: IF=20 mA(A1), 20 mA(A2)

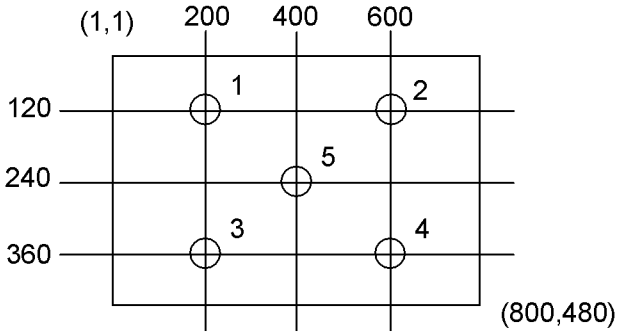
Measurement method for luminance and color coordinates is as follows.




The luminance is measured according to FLAT PANEL DISPLAY MEASUREMENTS STANDARD (VESA Standard).

*1) Measurement Point

Contrast Ratio, Luminance, Response Time, Viewing Angle, Color Coordinates: Display Center
Luminance Uniformity: point 1~5 shown in a figure below



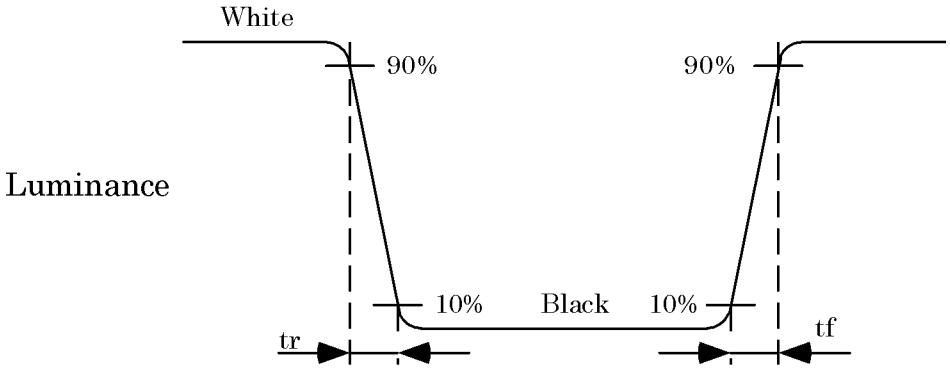

*2) Definition of Contrast Ratio

CR=Luminance with all white pixels / Luminance with all black pixels

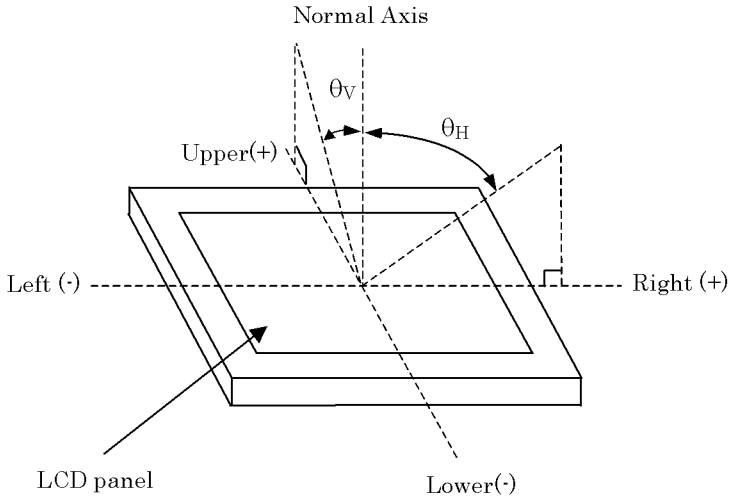
*3) Definition of Luminance Uniformity

$\Delta Lw=[Lw(MAX)/Lw(MIN)-1] \times 100$

*4) Definition of Response Time

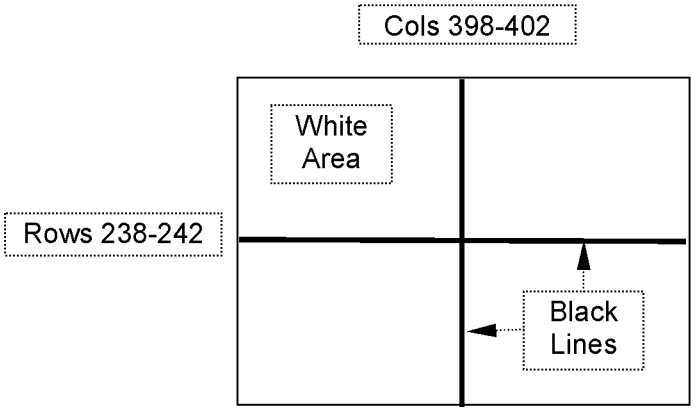



*5) Definition of Viewing Angle ($\theta_V$, $\theta_H$)



*6) Image Sticking

Continuously display the test pattern shown in the figure below for two-hours. Then display a completely white screen. The previous image shall not persist more than two seconds at 25°C.




TEST PATTERN FOR IMAGE STICKING TEST

# 10. RELIABILITY TEST CONDITION

(1) Temperature and Humidity

| ITEM | CONDITIONS |
|---|---|
| HIGH TEMPERATURE<br>HIGH HUMIDITY OPERATION | 40°C, 90%RH, 240 h<br>(No condensation) |
| HIGH TEMPERATURE OPERATION | 70°C, 240 h |
| LOW TEMPERATURE OPERATION | –20°C, 240 h |
| HIGH TEMPERATURE STORAGE | 80°C, 240 h |
| LOW TEMPERATURE STORAGE | –30°C, 240 h |
| THERMAL SHOCK (NON-OPERATION) | BETWEEN –30°C (1h) and 80°C(1h),<br>100 CYCLES |

(2) Shock & Vibration

| ITEM | CONDITIONS |
|---|---|
| SHOCK<br>(NON-OPERATION) | Shock level: 1470m/s$^2$ (150G)<br>Waveform: half sinusoidal wave, 2ms<br>Number of shocks: one shock input in each direction of three mutually perpendicular axis for a total of six shock inputs |
| VIBRATION<br>(NON-OPERATION) | Vibration level: 9.8m/s$^2$ (1.0G)<br>Waveform: sinusoidal<br>Frequency range: 5 to 500Hz<br>Frequency sweep rate: 0.5 octave /min<br>Duration: one sweep from 5 to 500 Hz in each of three mutually perpendicular axis(total 3 hours) |

(3) Judgment standard

The judgment of the above tests should be made as follow:

Pass: Normal display image, no damage of the display function. (ex. no line defect)
Partial transformation of the module parts should be ignored.

Fail: No display image, damage of the display function. (ex. line defect)