TENTATIVE

**All information in this technical data sheet is tentative and subject to change without notice.**

# 4.3”WVGA

## TECHNICAL SPECIFICATION



## AA043MA01

## MITSUBISHI ELECTRIC Corp.

Date: Jan.9,’07

# CONTENTS

# 1. APPLICATION

This specification applies to color TFT-LCD module, AA043MA01.



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(1) Standard Usage

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(2) Special Usage

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## 2. OVERVIEW

AA043MA01 is 4.3” color TFT-LCD (Thin Film Transistor Liquid Crystal Display) module composed of LCD panel, driver ICs, control circuit, and backlight unit.

By applying 6 bit or 8 bit digital data, 800 × 480, 262k-color or 16.7M-color images are displayed on the 4.3” diagonal screen. Input power voltage is 3.3 V for LCD driving.
The type of data and control signals are digital and transmitted via CMOS interface per Typ. 30.4 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) | 93.0(H) × 55.8(V)<br>(4.3-inch diagonal) |
| Number of Dots | 800 × 3 (H) × 480 (V) |
| Pixel Pitch (mm) | 0.116(H) × 0.116(V) |
| Color Pixel Arrangement | RGB vertical stripe |
| Display Mode | Normally white TN |
| Number of Color | 262k(6 bit/color) 16.7M(8 bit/color) |
| Luminance (cd/m$^2$) | 200 |
| Wide Viewing Angle Technology | Optical compensation film |
| Viewing Angle (CR ≥ 10) | –65~65° (H) –65~45° (V) |
| Surface Treatment | Clear and hard-coating 2H |
| Electrical Interface | CMOS (6 bit/8 bit) |
| Optimum Viewing Angle (Contrast ratio) | 6 o’clock |
| Module Size (mm) | 103.0(W) × 67.5(H) × 5.3(D) |
| Module Mass (g) | 58 |
| Backlight Unit | Edge-light, LED |

Characteristic value without any note is typical value.

## 3. ABSOLUTE MAXIMUM RATINGS

| ITEM | SYMBOL | MIN. | MAX. | UNIT |
|---|---|---|---|---|
| Power Supply Voltage for LCD | VCC | –0.3 | 4.0 | V |
| Logic Input Voltage | VI | –0.3 | 6.0 | V |
| Operation Temperature (Panel) Note 1,2) | $T_{op(Panel)}$ | –20 | 70 | °C |
| Operation Temperature (Ambient) Note 2) | $T_{op(Ambient)}$ | –20 | 70 | °C |
| Storage Temperature Note 2) | $T_{stg}$ | –20 | 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℃

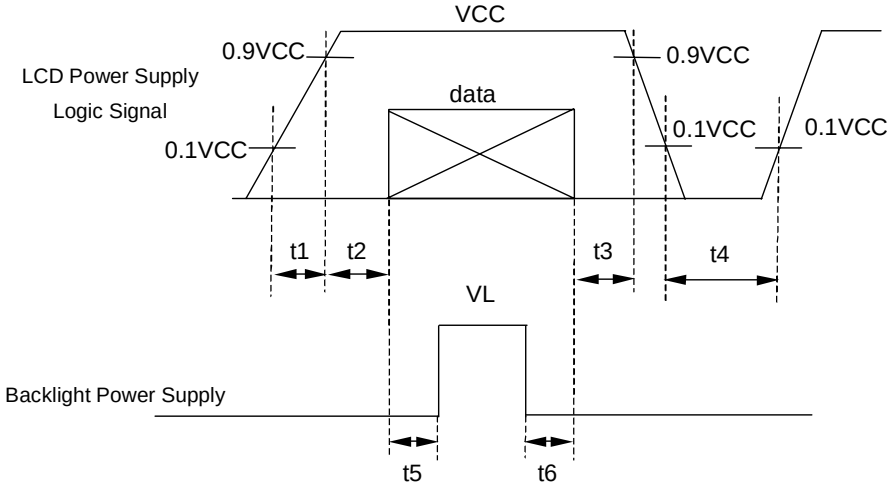
| ITEM | | SYMBOL | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|---|
| Power Supply Voltage for LCD | | VCC | 3.0 | 3.3 | 3.6 | V | *1) |
| Power Supply Current for LCD | | ICC | -- | 140 | 220 | mA | *2) |
| Permissive Input Ripple Voltage | | VRP | -- | -- | 100 | mVp-p | VCC = +3.3V |
| Logic Input Voltage | High | VIH | 2.0 | -- | 5.5 | V | |
| | Low | VIL | 0 | -- | 0.8 | V | |

*1) Power and signals sequence:

t1 ≤ 10 ms  200 ms ≤ t4

0 < t2 ≤ 50 ms  200 ms ≤ t5

0 < t3 ≤ 50 ms  0 ≤ t6



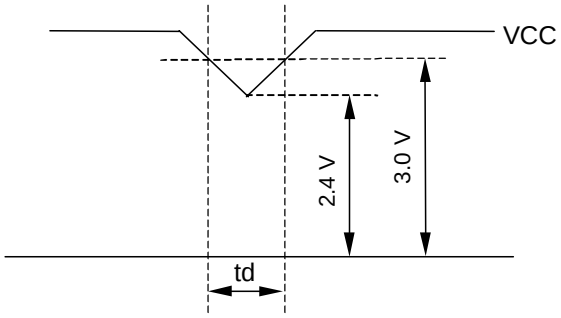

data: RGB DATA, DCLK, DENA, SC

VCC-dip conditions:

1) When 2.4 V ≤ VCC < 3.0 V, td ≤ 10 ms

2) When VCC < 2.4 V

VCC-dip conditions should also follow the power and signals sequence.




*2) Typical current condition:

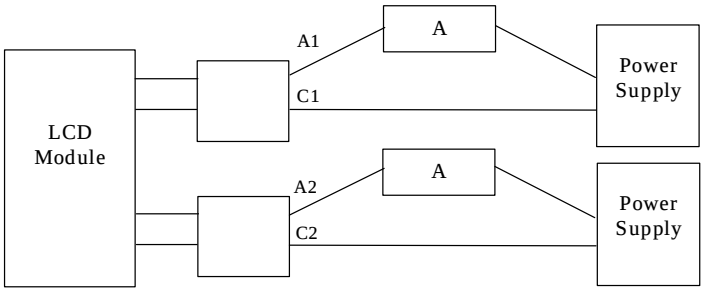
64-gray-bar-pattern(6 bit)
256-gray-bar-pattern(8 bit)
480 line mode
VCC = + 3.3 V, $f_H$=31.6kHz, $f_V$=60Hz, $f_{CLK}$= 30.4MHz

(2) Backlight Ta=25°C

| ITEM | SYMBOL | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|
| Lamp Voltage | VL | -- | (16.0) | (17.5) | V | |
| Lamp Current | IL | -- | 15.0 | 20.0 | mA | *1) |

*1) Constant Current Drive

*2) Lamp Current measurement method



## 5. INTERFACE PIN CONNECTION

CN 1(Interface Signal)

Used connector: FH23-45S-0.3SHW(05) (HIROSE)

| Pin No. | Symbol | Function |
|---|---|---|
| 1 | VCC | 3.3 V Power Supply |
| 2 | VCC | 3.3 V Power Supply |
| 3 | GND | |
| 4 | SC | Scan direction control (Low=Normal, High=Reverse) |
| 5 | DENA | Data enable signal (to settle the viewing area) |
| 6 | GND | |
| 7 | B7 | Blue data signal(MSB) |
| 8 | B6 | Blue data signal |
| 9 | B5 | Blue data signal |
| 10 | B4 | Blue data signal |
| 11 | B3 | Blue data signal |
| 12 | B2 | Blue data signal |
| 13 | B1 | Blue data signal *3) |
| 14 | B0 | Blue data signal(LSB) *3) |
| 15 | GND | |
| 16 | G7 | Green data signal(MSB) |
| 17 | G6 | Green data signal |
| 18 | G5 | Green data signal |
| 19 | G4 | Green data signal |
| 20 | G3 | Green data signal |
| 21 | G2 | Green data signal |
| 22 | G1 | Green data signal *3) |
| 23 | G0 | Green data signal(LSB) *3) |
| 24 | GND | |
| 25 | R7 | Red data signal(MSB) |
| 26 | R6 | Red data signal |
| 27 | R5 | Red data signal |
| 28 | R4 | Red data signal |
| 29 | R3 | Red data signal |
| 30 | R2 | Red data signal |
| 31 | R1 | Red data signal *3) |
| 32 | R0 | Red data signal(LSB) *3) |
| 33 | GND | |
| 34 | VD | Vertical sync signal *1) |
| 35 | HD | Horizontal sync signal *1) |
| 36 | GND | |
| 37 | DCLK | Clock signal for sampling catch data signal |
| 38 | GND | |
| 39 | NC | |
| 40 | NC | |
| 41 | NC | |
| 42 | LED_C1 | LED cathode① |
| 43 | LED_C2 | LED cathode② |
| 44 | LED_A2 | LED anode② |
| 45 | LED_A1 | LED anode① |

*1) HD and VD are not being used for timing control.

*2) The shielding case is connected with GND

*3) In case of 6 bit mode, Input signal should be low.

## 6. INTERFACE TIMING

(1) Timing Specifications

| ITEM | | | SYMBOL | MIN. | TYP. | MAX. | UNIT |
|---|---|---|---|---|---|---|---|
| DCLK | Frequency | | $f_{CLK}$ | -- | 30.4 | 45 | MHz |
| | Period | | $t_{CLK}$ | 22.2 | 32.9 | -- | ns |
| | Low Width | | $t_{WCL}$ | 10 | -- | -- | ns |
| | High Width | | $t_{WCH}$ | 10 | -- | -- | ns |
| DATA(R,G,B), DENA | Set up time | | $t_{DS}$ | 4 | -- | -- | ns |
| | Hold time | | $t_{DH}$ | 4 | -- | -- | ns |
| DENA | Horizontal | Active Time | $t_{HA}$ | 800 | 800 | 800 | $t_{CLK}$ |
| | | Blanking Time | $t_{HB}$ | 20 | 160 | -- | $t_{CLK}$ |
| | | Frequency | $f_H$ | -- | 31.6 | 45 | kHz |
| | | Period | $t_H$ | 22.2 | 31.7 | -- | µs |
| | Vertical | Active Time | $t_{VA}$ | 480 | 480 | 480 | $t_H$ |
| | | Blanking Time | $t_{VB}$ | 3 | 45 | -- | $t_H$ |
| | | Frequency | $f_V$ | 55 | 60 | 75 | Hz |
| | | Period | $t_V$ | 13.3 | 16.7 | 18.2 | ms |

[Note]

1) DATA is latched at fall edge of DCLK in this specification.

2) DENA (Data Enable) should always be positive polarity as shown in the timing specification.

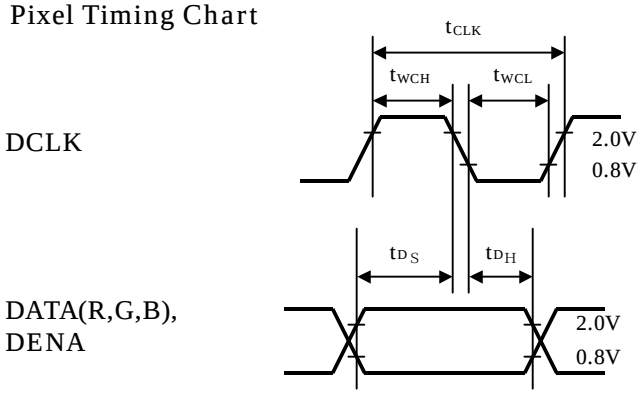
3) DCLK should appear during all invalid period.

4) In case of blanking time fluctuation, please satisfy following condition.

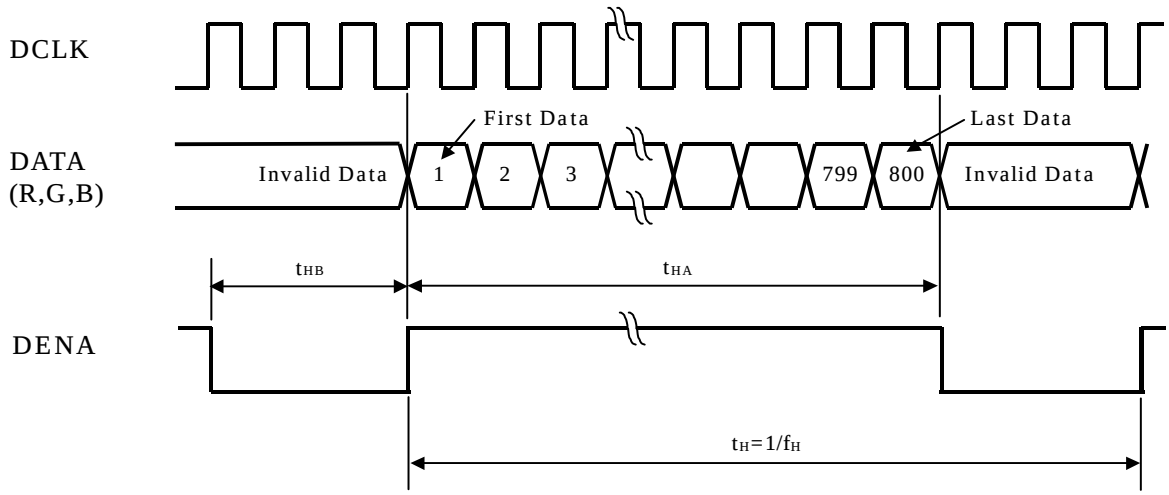
$t_{VBn} > t_{VBn-1} - 3(t_H)$

(2) Timing Chart

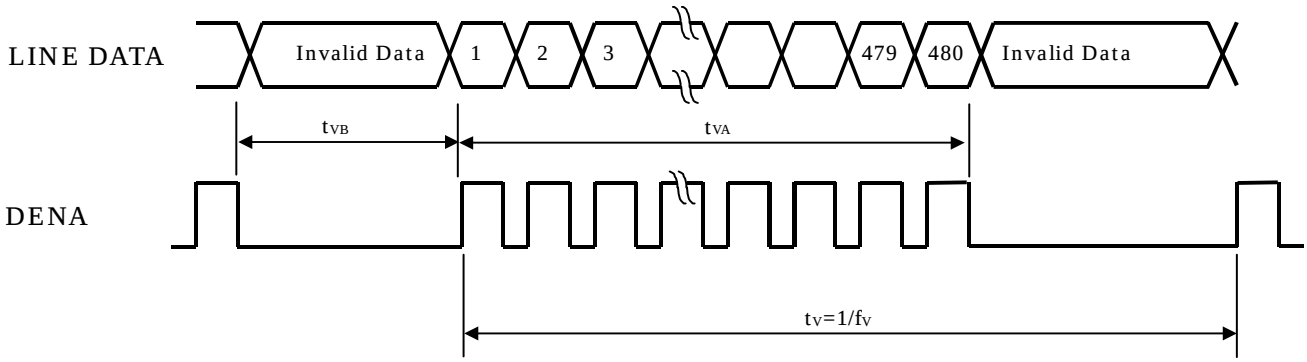
a. Pixel Timing Chart




b. Horizontal Timing Chart




c. Vertical Timing Chart



(3) Color Data Assignment

a. 6 bit input

| 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(63) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN(63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | BLUE(63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| | CYAN | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| | MAGENTA | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| | YELLOW | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | WHITE | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |
| RED | RED(1) | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED(2) | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | RED(62) | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | RED(63) | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 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 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | GREEN(62) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | GREEN(63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 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 | 1 | 0 | 0 |
| | BLUE(2) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| | BLUE(62) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| | BLUE(63) | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 0 |

[Note]

1) Definition of gray scale

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

Higher n means brighter level.

2) Data

1:High, 0: Low

b. 8 bit input

| 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.

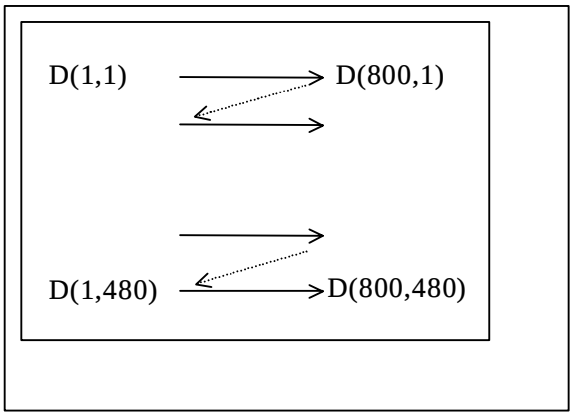
2) Data

1:High, 0: Low

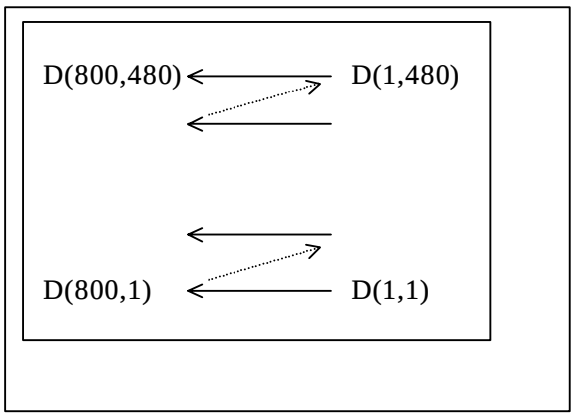
(4) Display Position and Scan Direction

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

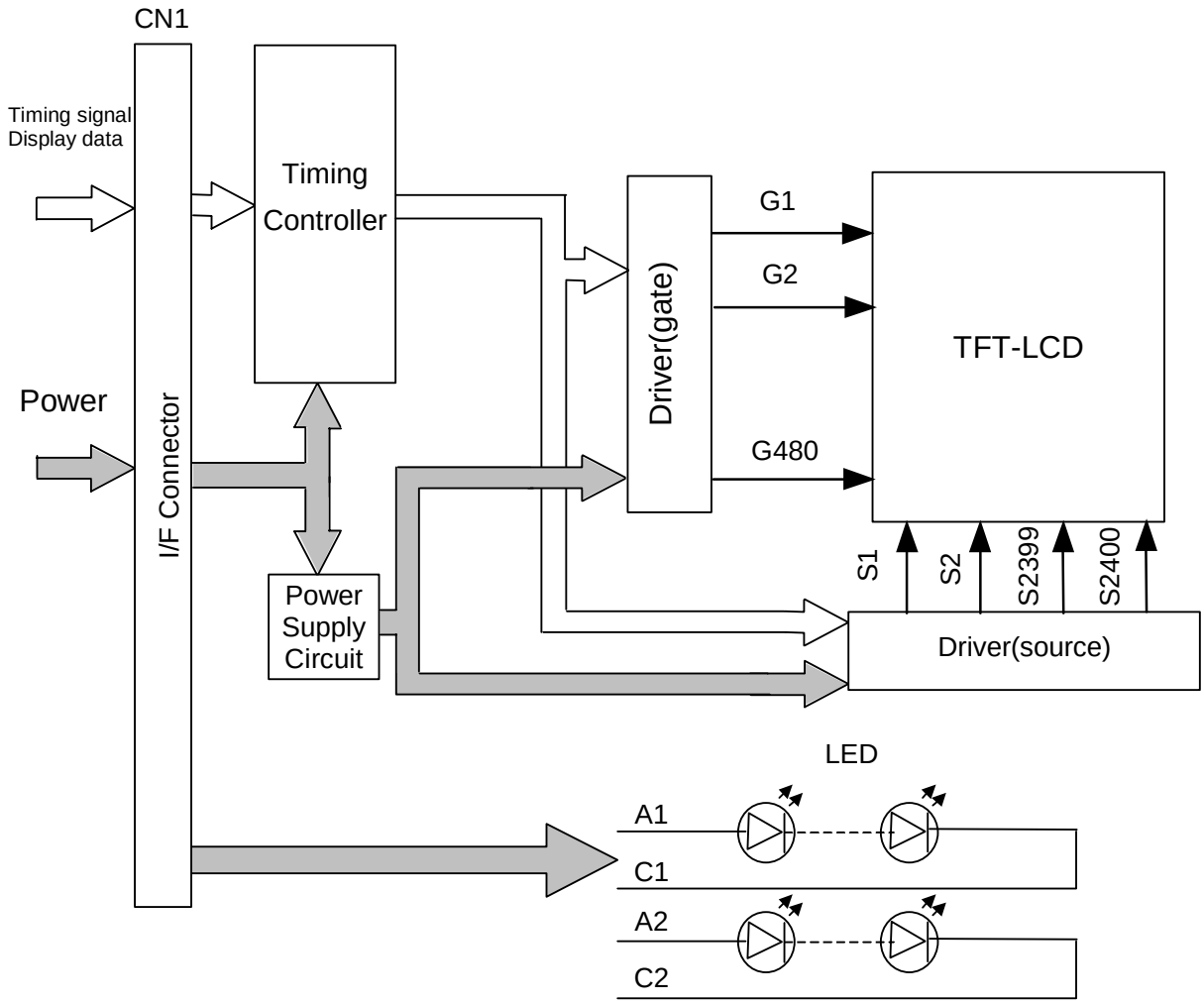
SC: Low




SC: High

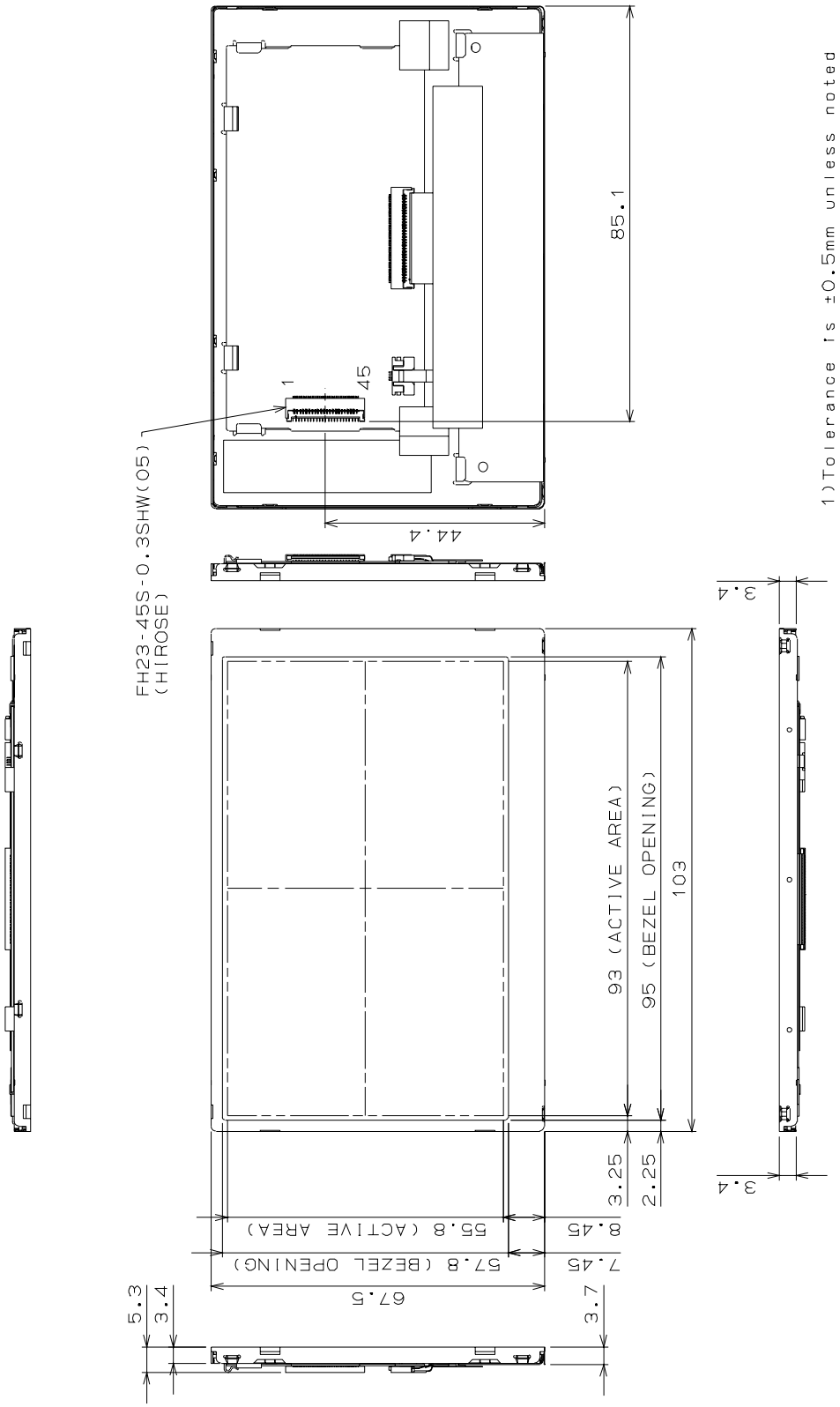


## 7. BLOCK DIAGRAM



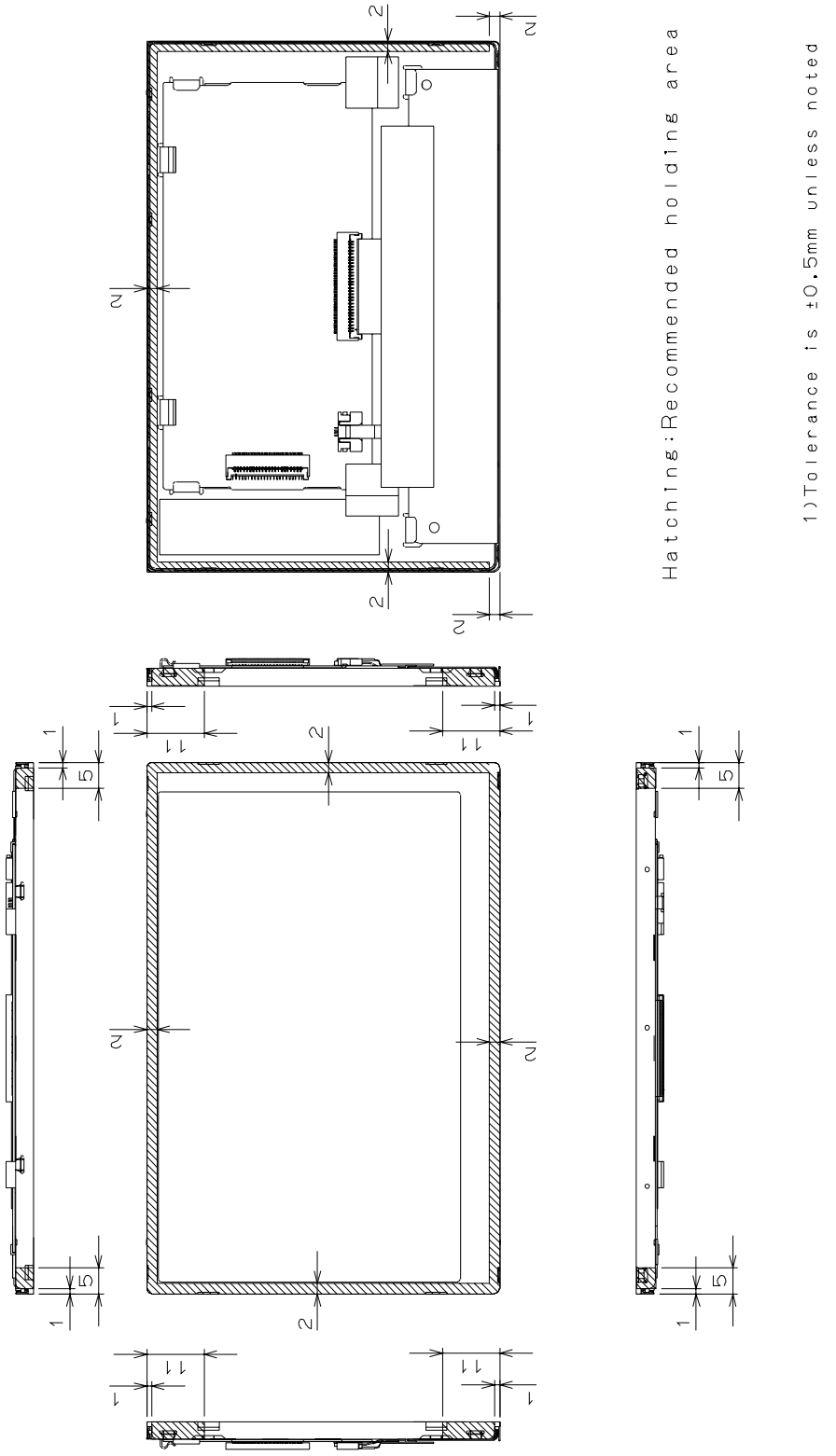
# 8. MECHANICAL SPECIFICATIONS

(1) Outline Dimensions




(Unit:mm)

(2) Recommended Holding Area




(Unit:mm)

## 9. OPTICAL CHARACTERISTICS

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

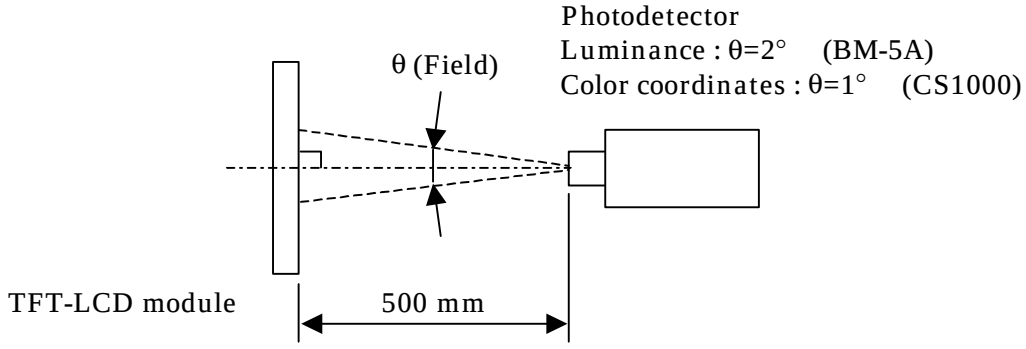
| ITEM | | SYMBOL | CONDITION | MIN. | TYP. | MAX. | UNIT | Remarks |
|---|---|---|---|---|---|---|---|---|
| Contrast Ratio | | CR | $\theta_V$=0°, $\theta_H$=0° | 100 | 400 | -- | -- | *1)*2)*5) |
| Luminance | | Lw | $\theta_V$=0°, $\theta_H$=0° | 100 | 200 | -- | cd/m² | *1)*5) |
| Luminance Uniformity | | ΔLw | $\theta_V$=0°, $\theta_H$=0° | -- | -- | 30 | % | *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 | $\theta_V$ | | –40~30 | –65~45 | -- | ° | *1)*5) |
| | Horizontal | $\theta_H$ | CR ≥ 5 | –65~65 | –80~80 | -- | | *1)*5) |
| | Vertical | $\theta_V$ | | –50~40 | –80~50 | -- | | *1)*5) |
| Image Sticking | | tis | 2 h | -- | -- | 2 | s | *6) |
| Color Coordinates | Red | Rx | $\theta_V$=0°, $\theta_H$=0° | 0.566 | 0.616 | 0.666 | -- | *1)*5) |
| | | Ry | | 0.312 | 0.362 | 0.412 | | |
| | Green | Gx | | 0.293 | 0.343 | 0.393 | | |
| | | Gy | | 0.548 | 0.598 | 0.648 | | |
| | Blue | Bx | | 0.103 | 0.153 | 0.203 | | |
| | | By | | 0.094 | 0.144 | 0.194 | | |
| | White | Wx | | 0.287 | 0.337 | 0.387 | | |
| | | Wy | | 0.316 | 0.366 | 0.416 | | |

[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 lamp unless noted.

Condition: IL=15.0 mA

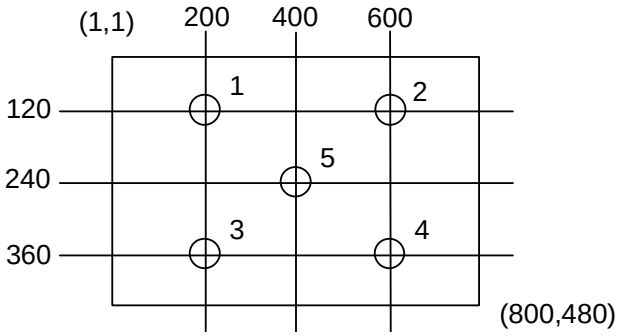
Measurement method for luminance and color coordinates is as follows.




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



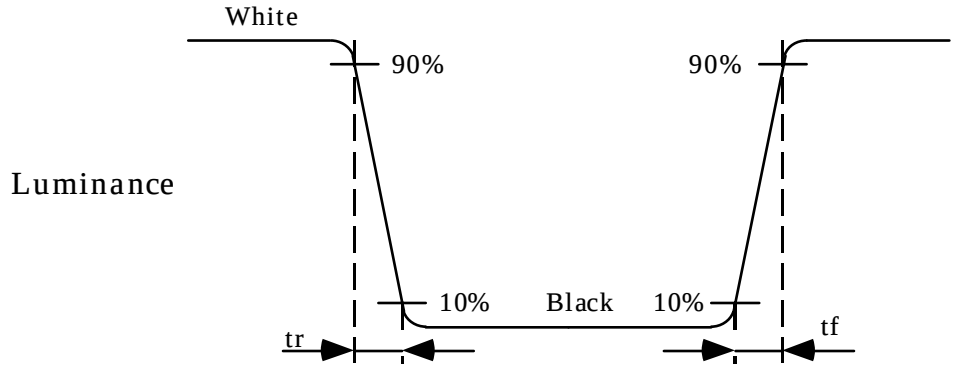

*2) Definition of Contrast Ratio

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

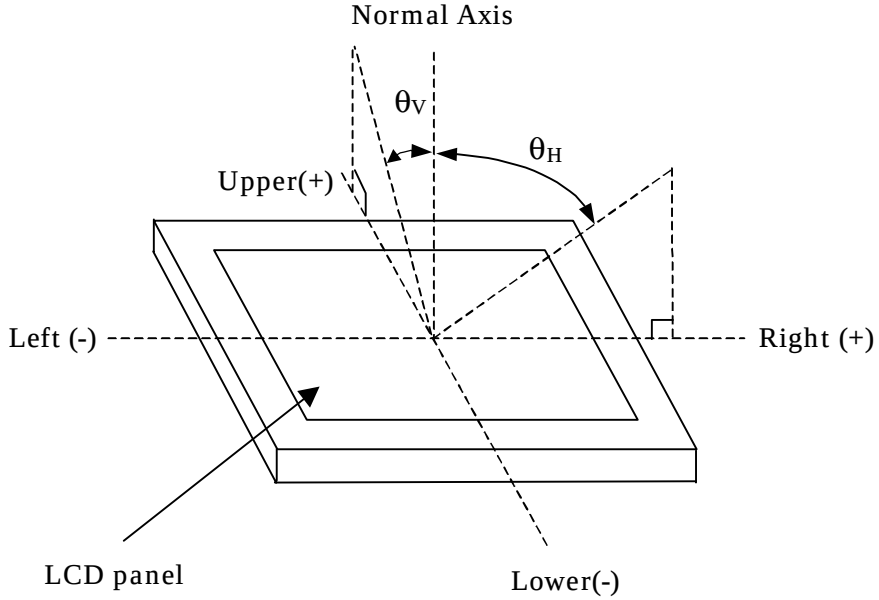
*3) Definition of Luminance Uniformity

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

*4) Definition of Response Time

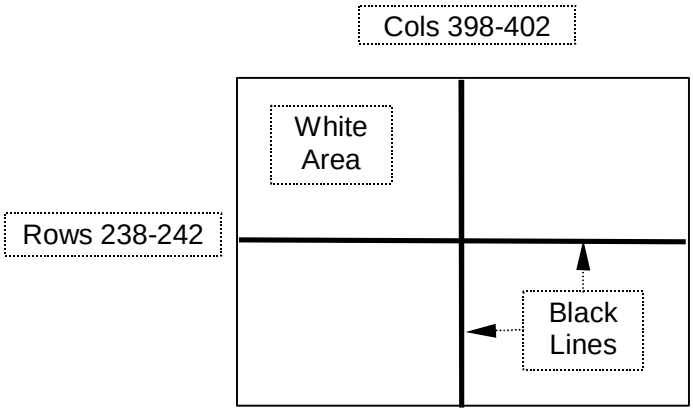



*5) Definition of Viewing Angle ($\theta_V$, $\theta_H$)



*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 | –20°C, 240 h |
| THERMAL SHOCK (NON-OPERATION) | BETWEEN –20°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)

# 11. OTHER FEATURE

This LCD module complies with RoHS*) directive.

*) RoHS: Restriction of the use of certain hazardous substances in electrical and electronic equipment

# 12. HANDLING PRECAUTIONS FOR TFT-LCD MODULE

Please pay attention to the followings in handling TFT-LCD products;

### (1) ASSEMBLY PRECAUTION

a. Please do not bending or wrenching LCD in assembling. And please do not drop, bend or twist LCD module in handling.
b. Please design display housing in accordance with the following guide lines.
   (a) Housing case must be designed carefully so as not to put stresses on LCD all sides and not to wrench module. The stresses may cause non-uniformity even if there is no non-uniformity statically.
   (b) Keep sufficient clearance between LCD module back surface and housing when the LCD module is mounted. Approximately 1.0mm of the clearance in the design is recommended taking into account the tolerance of LCD module thickness and mounting structure height on the housing.
   (c) When some parts, such as, FPC cable and ferrite plate, are installed underneath the LCD module, still sufficient clearance is required, such as 0.5mm. This clearance is, especially, to be reconsidered when the additional parts are implemented for EMI countermeasure.
   (d) Keep sufficient clearance between LCD module and the others parts, such as inverter and speaker so as not to interface the LCD module. Approximately 1.0mm of the clearance in the design is recommended.
   (e) To avoid local elevation/decrease of temperature, considering location of heating element, heat release, thermal design should be done.
c. Please do not push or scratch LCD panel surface with anything hard. And do not soil LCD panel surface by touching with bare hands. (Polarizer film, surface of LCD panel is easy to be flawed.)
d. Please do not press any parts on the rear side such as source TCP, gate TCP, control circuit board and FPCs during handling LCD module. If pressing rear part is unavoidable, handle the LCD module with care not to damage them.
e. Please wipe off LCD panel surface with absorbent cotton or soft cloth in case of it being soiled.
f. Please wipe off drops of adhesives like saliva and water on LCD panel surface immediately. They might damage to cause panel surface variation and color change.
g. Please do not take a LCD module to pieces and reconstruct it. Resolving and reconstructing modules may cause them not to work well.
h. Please do not touch metal frames with bare hands and soiled gloves. A color change of the metal frames can happen during a long preservation of soiled LCD modules.
i. Please handle metal frame carefully because edge of metal frame is very sharp.
j. Please connect the metal frame of LCD module to GND in order to minimize the effect of external noise and EMI.
k. Be sure to connect the cables and the connecters correctly.

### (2) OPERATING PRECAUTIONS

a. Please be sure to turn off the power supply before connecting and disconnecting signal input cable.
b. Please do not change variable resistance settings in LCD module. They are adjusted to the most suitable value. If they are changed, it might happen LCD does not satisfy the characteristics

specification.

c. The interface signal speed is very high. Please pay attention to transmission line design and other high speed signal precautions to satisfy signal specification.
d. A condensation might happen on the surface and inside of LCD module in case of sudden change of ambient temperature.
e. Please pay attention not to display the same pattern for very long time. Image might stick on LCD. Even if image sticking happens, it may disappear as the operation time proceeds.
f. Please obey the same safe instructions as ones being prepared for ordinary electronic products.

### (3) PRECAUTIONS WITH ELECTROSTATICS

a. This LCD module use CMOS-IC on circuit board and TFT-LCD panel, and so it is easy to be affected by electrostatics. Please be careful with electrostatics by the way of your body connecting to the ground and so on.
b. Please remove protection film very slowly from the surface of LCD module to prevent from electrostatics occurrence.

### (4) STORAGE PRECAUTIONS

a. Please do not leave the LCDs in the environment of high humidity and high temperature such as 60°C90%RH.
b. Please do not leave the LCDs in the environment of low temperature; below -20°C.

### (5) SAFETY PRECAUTIONS

a. When you waste damaged or unnecessary LCDs, it is recommended to crush LCDs into pieces and wash them off with solvents such as acetone and ethanol, which should later be burned.
b. If any liquid leaks out of a damaged glass cell and comes in contact with the hands, wash off thoroughly with soap and water.

### (6) OTHERS

a. A strong incident light into LCD panel might cause display characteristics changing inferior because of polarizer film, color filter, and other materials becoming inferior. Please do not expose LCD module direct sunlight and strong UV rays.
b. Please pay attention to a panel side of LCD module not to contact with other materials in preserving it alone.
c. For the packaging box, please pay attention to the followings;
   (a) Packaging box and inner case for LCD are designed to protect the LCDs from the damage or scratching during transportation. Please do not open except picking LCDs up from the box.
   (b) Please do not pile them up more than 7 boxes. (They are not designed so.) And please do not turn over.
   (c) Please handle packaging box with care not to give them sudden shock and vibrations. And also please do not throw them up.
   (d) Packaging box and inner case for LCDs are made of cardboard. So please pay attention not to get them wet. (Such like keeping them in high humidity or wet place can occur getting them wet.)