| **LCD Module Specification** | First Edition | Approved by | Production Div. |
| | December 3, 1996 | Checked by | Quality Assurance Div. |
| | Final Revision | Checked by | Design Engineering Div. |
| | ******* | | |
| Type No.　ＤＭＦ－５０２６０ＮＦＵ－ＦＷ－８ | | Prepared by | Production Div. |

## Table of Contents

## Revision History

| Rev. | Date | Page | Comment |
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| | | | |

## 1. General Specifications

Operating Temp.      :   min. 0℃ ～ max. 50℃

Storage Temp.      :   min. -20℃ ～ max. 60℃

Dot Pixels      :   640 (W) × 480 (H) dots

Dot Size      :   0.27 (W) × 0.27 (H) mm

Dot Pitch      :   0.30 (W) × 0.30 (H) mm

Viewing Area      :   196.0 (W) × 148.0 (H) mm

Outline Dimensions      :   260.0$^*$ (W) × 174.0 (H) × 8.3 max. (D) mm
         * Without CFL Cable

Weight      :   410g max.

LCD Type      :   NTD-11937
         ( F-STN / Black & White - mode / Transmissive )

Viewing Angle      :   12:00

Data Transfer      :   4-bit parallel data transfer × 2

Backlight      :   Cold Cathode Fluorescent Lamp (CFL) × 1

Additional Spec.      :   High Response Time Type
         High Brightness Type
         Change of Alternate Timing

Drawings      :   Dimensional Outline     UE-21316

## 2. Electrical Specifications

### 2.1. Absolute Maximum Ratings

$V_{SS}=0V$

| Parameter | Symbol | Conditions | Min. | Max. | Units |
|---|---|---|---|---|---|
| Supply Voltage (Logic) | $V_{CC}$-$V_{SS}$ | — | -0.3 | 7.0 | V |
| Supply Voltage (LCD Drive) | $V_{CC}$-$V_{EE}$ | — | 0 | 30.0 | V |
| Input Voltage | $V_I$ | — | -0.3 | $V_{CC}$+0.3 | V |

### 2.2. Electrical Characteristics

$Ta=25℃, V_{SS}=0V$

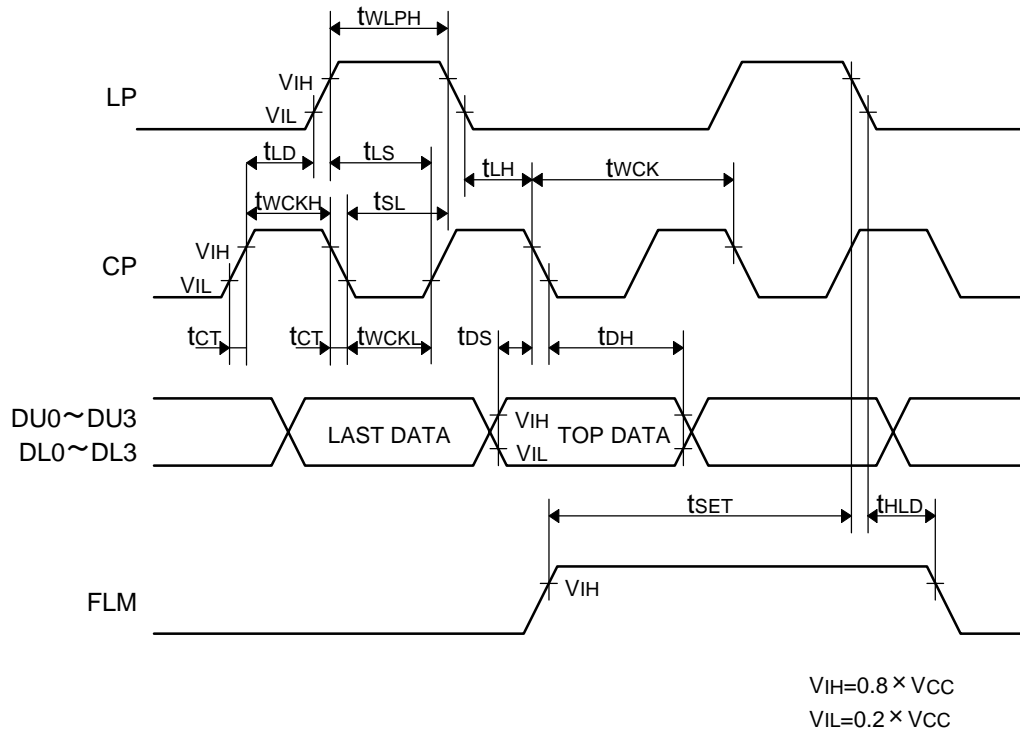| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Supply Voltage (Logic) | $V_{CC}$-$V_{SS}$ | — | 3.0 | — | 5.5 | V |
| Supply Voltage (LCD Drive) | $V_{CC}$-$V_{EE}$ | Shown in 3.1 | | | | V |
| High Level Input Voltage | $V_{IH}$ | $V_{CC}$=3.0～5.5V | $0.8×V_{CC}$ | — | $V_{CC}$ | V |
| Low Level Input Voltage | $V_{IL}$ | $V_{CC}$=3.0～5.5V | 0 | — | $0.2×V_{CC}$ | V |
| Supply Current | $I_{CC}$ | $V_{CC}$-$V_{SS}$=5.0V | — | 15.0 | 25.0 | mA |
| | $I_{EE}$ | $V_{CC}$-$V_{EE}$=22.9V | — | 10.0 | 20.0 | mA |

## 2.3.Timing Characteristics

### 2.3.1.AC Timing Characteristics

$V_{CC}=3.0\sim5.5V$

| Parameter | Symbol | Min. | Max. | Units |
|---|---|---|---|---|
| Shift Clock Frequency | $t_{WCK}$ | 152 | − | ns |
| Clock Width High Level | $t_{WCKH}$ | 65 | − | ns |
| Clock Width Low Level | $t_{WCKL}$ | 65 | − | ns |
| Data Setup Time | $t_{DS}$ | 50 | − | ns |
| Data Hold Time | $t_{DH}$ | 40 | − | ns |
| LP Width High Level | $t_{WLPH}$ | 65 | − | ns |
| CP→LP Rise Time | $t_{LD}$ | 0 | − | ns |
| CP→LP Fall Time | $t_{SL}$ | 65 | − | ns |
| LP→CP Rise Time | $t_{LS}$ | 65 | − | ns |
| LP→CP Fall Time | $t_{LH}$ | 65 | − | ns |
| CP Rise/Fall Time | $t_{CT}$ | − | 50 | ns |
| FLM Hold Time | $t_{HLD}$ | 100 | − | ns |
| FLM Setup Time | $t_{SET}$ | 100 | − | ns |

Please make sure to keep Clock Pulse (CP) in low level during Latch Pulse (LP) level is high.

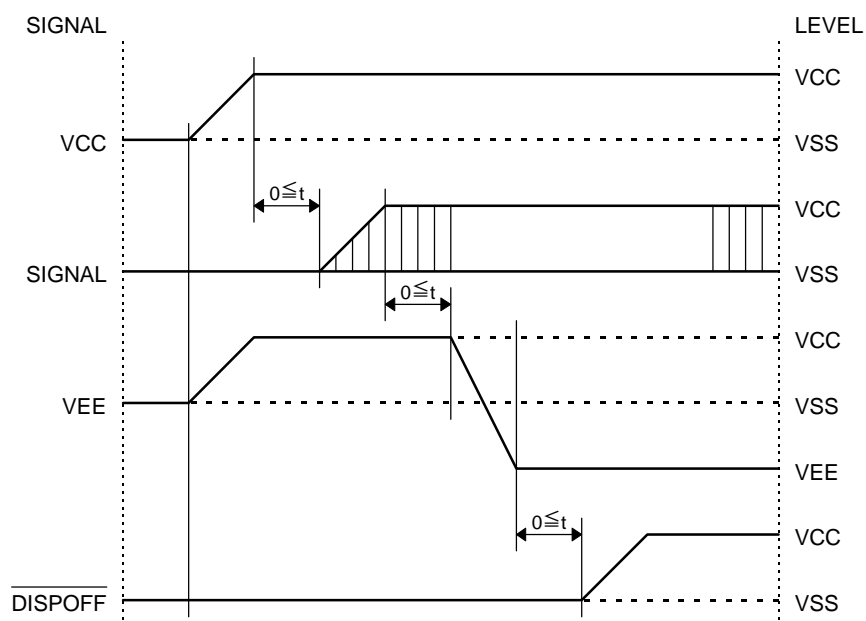$V_{IH}=0.8\times V_{CC}$
$V_{IL}=0.2\times V_{CC}$

## 2.3.2.Timing Chart

| | |
|---|---|
| LP | T=0.0595ms typ. |
| CP | |
| DU0 ∫ DU3 | SEG 633~636 / SEG 637~640 / SEG 1~4 / SEG 5~8 ........ #1 DATA ........ SEG 633~636 / SEG 637~640 / SEG 1~4 / SEG 5~8 |
| DL0 ∫ DL3 | SEG 1273~1276 / SEG 1277~1280 / SEG 641~644 / SEG 645~648 ........ #241 DATA ........ SEG 1273~1276 / SEG 1277~1280 / SEG 641~644 / SEG 645~648 |
| FLM | |
| LP (Reduction) | 240 × T |
| FLM (Reduction) | |
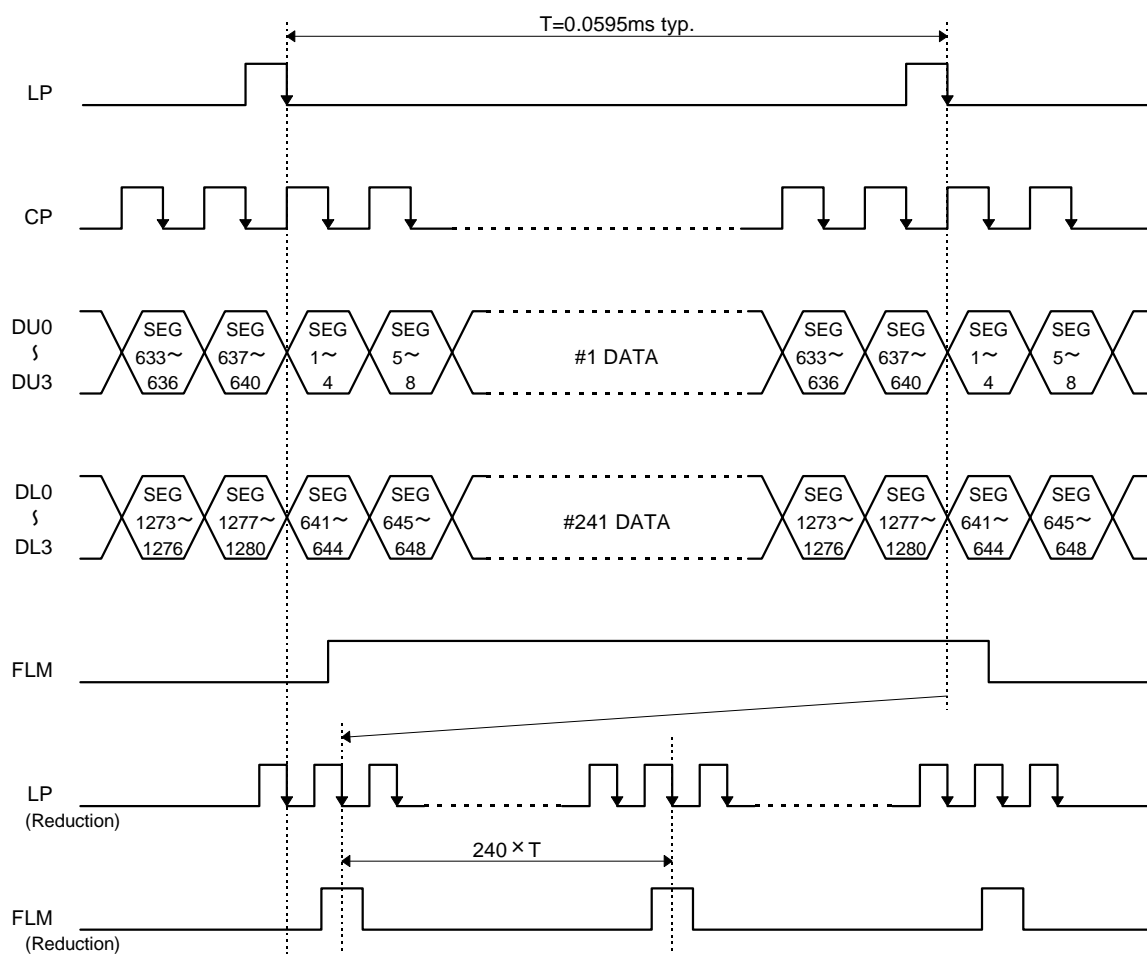
## 2.3.3.Comparison of Display and Data

SEG1 .................................................................... SEG640

| #1 | DU3 | DU2 | DU1 | DU0 | ............................ | DU1 | DU0 |
|---|---|---|---|---|---|---|---|
| ⋮ | | | | | | | |
| #240 | | | UPPER DATA DU0~DU3 | | | | |
| #241 | DL3 | DL2 | DL1 | DL0 | ............................ | DL1 | DL0 |
| ⋮ | | | | | | | |
| #480 | | | LOWER DATA DL0~DL3 | | | | |

SEG641 .................................................................... SEG1280
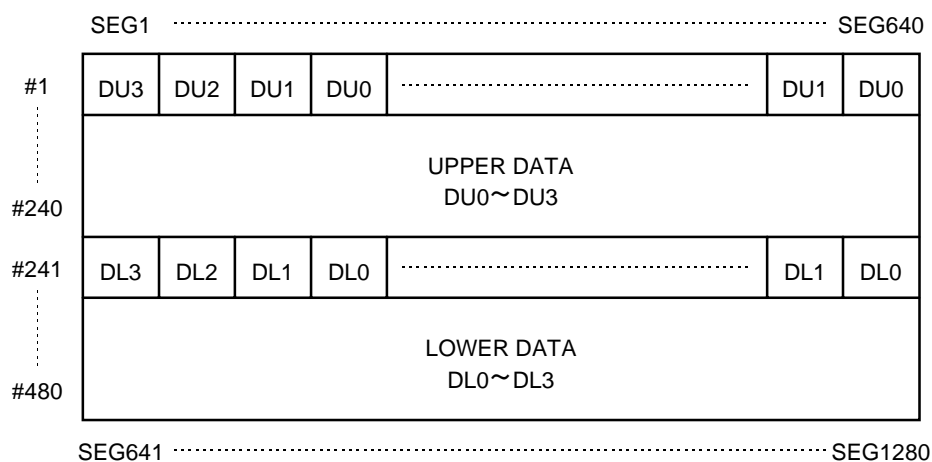
## 2.4.Power Supply ON/OFF Sequence

### 2.4.1.ON Sequence

SIGNAL

LEVEL

VCC

VCC

VSS

$0 \leqq t$

VCC

SIGNAL

VSS

$0 \leqq t$

VCC

VEE

VSS

VEE

$0 \leqq t$

VCC

$\overline{\text{DISPOFF}}$

VSS

### 2.4.2.OFF Sequence

LEVEL

SIGNAL

VCC

VSS

VCC

VCC

VSS

$0 \leqq t$

VCC

SIGNAL

VSS

$0 \leqq t$

VCC

VSS

VEE

VEE

VCC

$0 \leqq t$

VSS
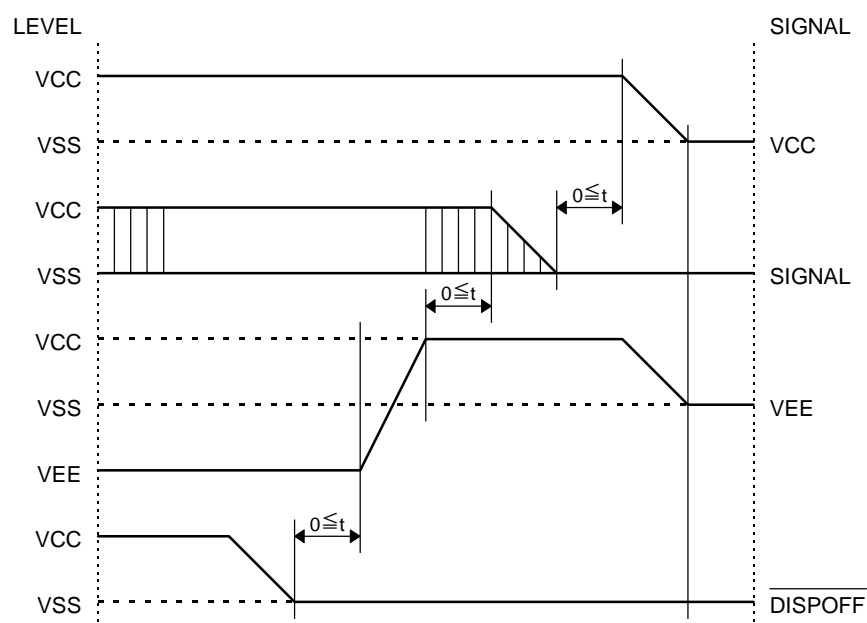
$\overline{\text{DISPOFF}}$

Please maintain the above sequence when turning on and off the power supply of the module. If $\overline{\text{DISPOFF}}$ is supplied to the module while internal alternate signal for LCD driving (M) is unstable, DC component will be supplied to the LCD panel. This may cause damage the LCD module.

### 2.5.Lighting Specification

#### 2.5.1.CFL Specification

Ta=25℃, After 3 minutes power on

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Lamp Voltage | $V_L$ | − | − | 340 | − | Vrms |
| Lamp Current | $I_L$ | − | 5.5 | 6.0 | 6.5 | mArms |
| Starting Voltage | $V_S$ | − | 855 | − | − | Vrms |

#### 2.5.2.Module Surface luminance

Ta=25℃

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Surface Luminance | L | $I_L = 6.0mA$ | 90 | 110 | − | cd/㎡ |
| Average Life | $T_{AL}$ | $I_L = 6.0mA$ | − | 10000 | − | hrs |

#### 2.5.3.CFL Testing Circuit



Measurement Points
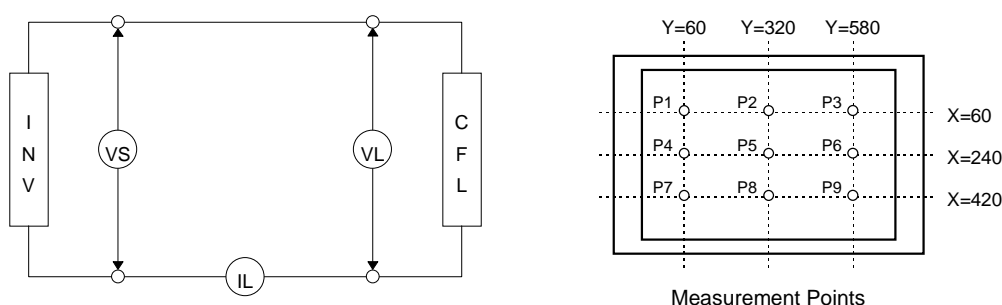
1) Surface Luminance is specified by the average of 9 luminance values measured at each point shown above after 20 minutes power on with the all ON pattern adjusted to maximum contrast and the dimming control of 100% ( maximum brightness).

2) Definition
   a. Average Life ( $T_{AL}$ )
      CFL life is defined as the time for which the initial luminance is attenuated by 50% of the luminance value. Average Life representes the time elapsed at the point of time when the residual ratio becomes below 50% when plural lamps are lighted in comparison with the definition of life mentioned above.

   b. Lamp Voltage ( $V_L$ )
      The voltage ( r.m.s. ) to maintain the electric discharge of the lamp. It is measured after lighting for 3 minutes .

   c. Lamp Current ( $I_L$ )
      The current ( r.m.s. ) to flow through the lamp with the electric discharge. It is measured after lighting for 3 minutes.

   d. Sterting Voltage ( $V_S$ )
      The voltage at starting the electric discharge when the voltage is increased gradually from 0V.

3) Recommended Inverter : S-12562-6M ( Produced by ELEVAM )

### 3. <u>Optical Specifications</u>

#### 3.1. LCD Driving Voltage

| Parameter | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|
| Recommended | | Ta= 0℃ | — | — | 26.6 | V |
| LCD Driving Voltage | $V_{CC}-V_{EE}$ | Ta=25℃ | 21.3 | 22.9 | 24.5 | V |
| Note 1 | | Ta=50℃ | 19.7 | — | — | V |

Note 1 :　　Voltage (Applied actual waveform to LCD Module) for the best contrast. The range of minimum and maximum shows tolerance of the operating voltage. The specified contrast ratio and response time are not guaranteed over the entire range.

#### 3.2. Optical Specifications

Ta=25℃, 1/240 Duty, 1/14 Bias, $V_D$=22.9V (Note 4),　$\theta = 0°$,　$\phi = -°$

| Parameter | | | Symbol | Conditions | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|---|
| Contrast Ratio | | Note 1 | CR | $\theta = 0°$,　$\phi = -°$ | — | 14 | — | |
| Viewing Angle | | | | Shown in 3.3 | | | | |
| Response | Rise | Note 2 | $\tau_r$ | — | — | 210 | 320 | ms |
| Time | Decay | Note 3 | $\tau_d$ | — | — | 120 | 180 | ms |

Note 1 : Contrast ratio is definded as follows.

　　　　　$CR = L_{ON} / L_{OFF}$

　　　　$L_{ON}$ : Luminance of the ON segments

　　　　$L_{OFF}$ : Luminance of the OFF segments

Note 2 : The time that the luminance level reaches 90% of the saturation level from 0% when ON signal is applied.

Note 3 : The time that the luminance level reaches 10% of the saturation level from 100% when OFF signal is applied.

Note 4 : Definition of Driving Voltage $V_D$

　　　　Assuming that the typical driving waveforms shown below are applied to the LCD Panel at 1/A Duty - 1/B Bias ( A : Duty Number, B : Bias Number ). Driving voltage $V_D$ is definded as the voltage $V_{O-P}$ when the contrast ratio ($CR = L_{ON} / L_{OFF}$) is at its maximum.
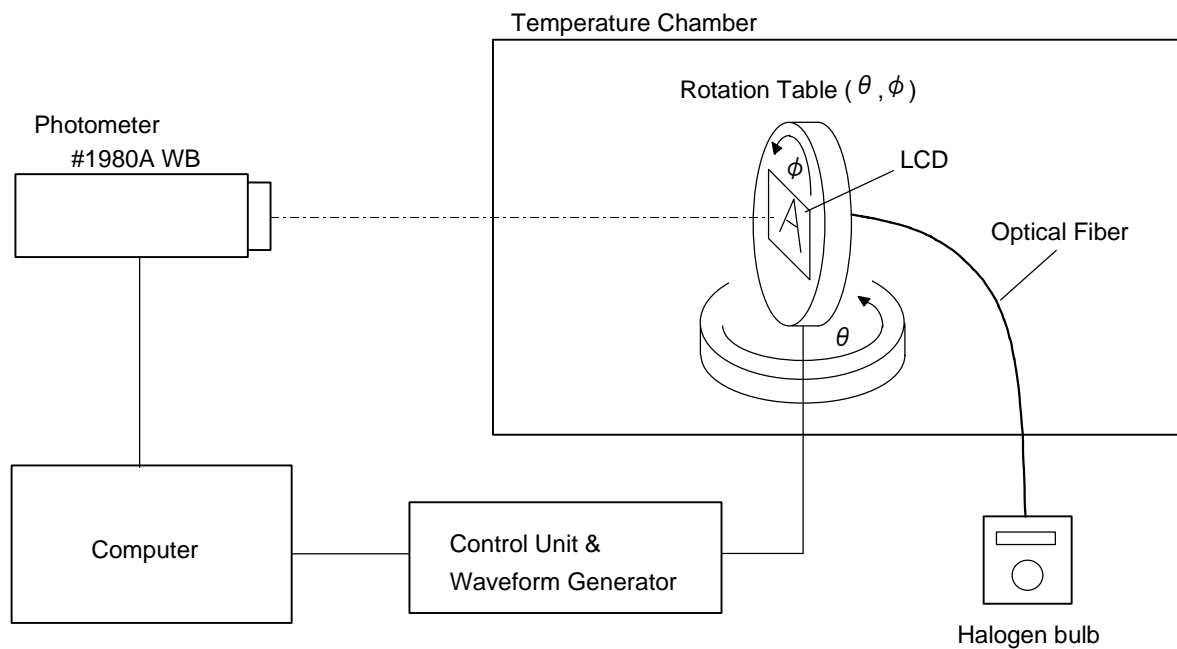


　　$V_{O-P}$　　　　　　　　　　　　　　　　　　　　　　　　　　　　( B-2 ) × $V_{O-P}$ / B

　　1 / ( $f_F$ × A )　　　　　　　　　　　　1 / $f_F$

　　〈ON SIGNAL〉　　　　　　　　　　　〈OFF SIGNAL〉
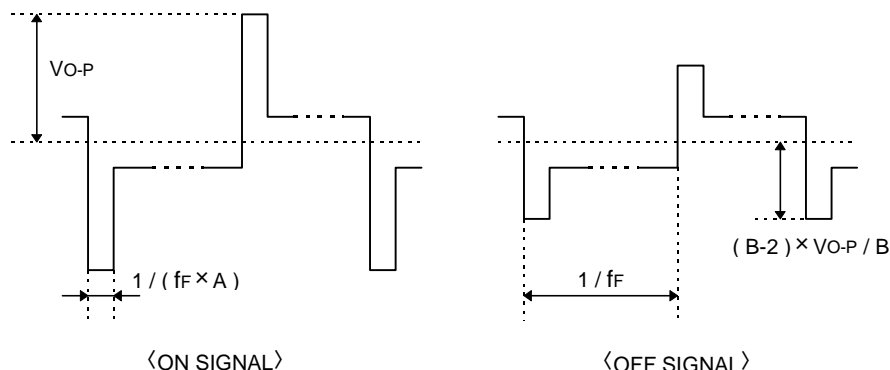
## 3.3.Definition of Viewing Angle and Optimum Viewing Area

・Point ● shows the point where contrast ratio is measured. : $\theta = 0°$ , $\phi = -°$
・Driving condition : 1/240 Duty, 1/14 Bias, $V_D$=22.9V, $f_F$=70Hz



・Area ☐ shows typ. CR≧2
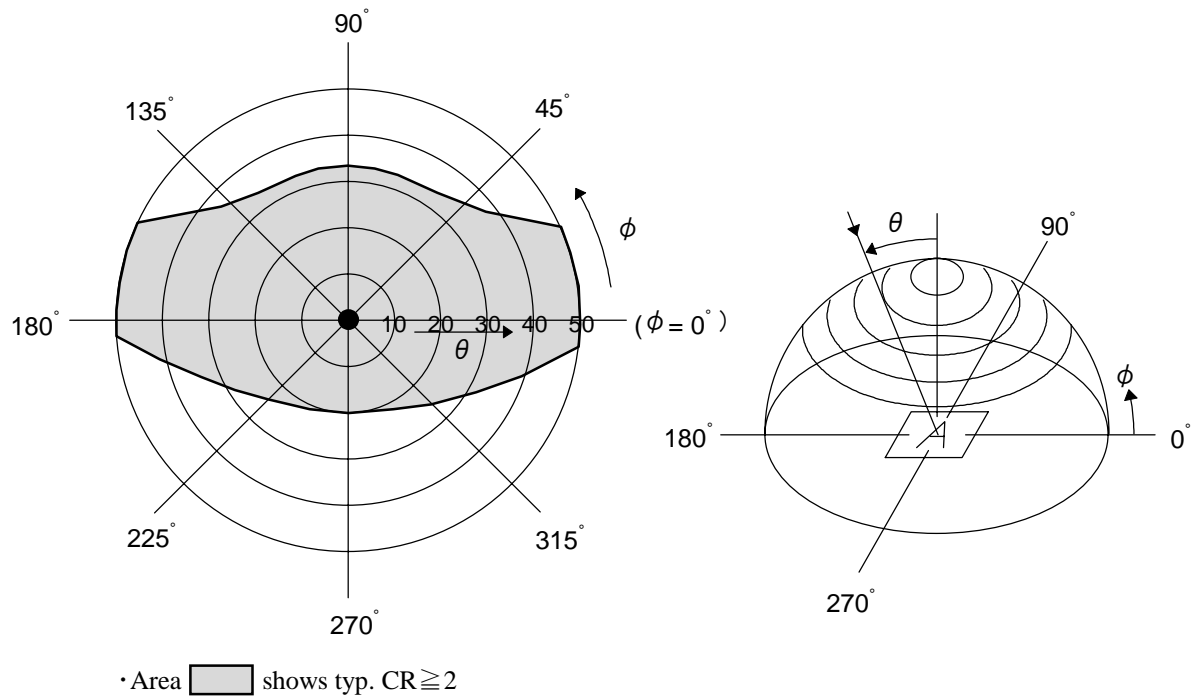
## 3.4.System Block Diagram

## 4.I/O Terminal

### 4.1.Pin Assignment

CN1

| No. | Symbol | Level | Function |
|-----|--------|-------|----------|
| 1 | FLM | H / L | First Line Marker |
| 2 | LP | H→L | Data Latch Signal |
| 3 | CP | H→L | Clock Signal for Shifting Data |
| 4 | $\overline{\text{DISP OFF}}$ | H / L | H : Display on   L : Display off |
| 5 | $V_{CC}$ | — | Power Supply for Logic |
| 6 | $V_{SS}$ | — | Power Supply (0V, GND) |
| 7 | $V_{EE}$ | — | Power Supply for LCD Drive |
| 8 | DU0 | H / L | Display Upper Data |
| 9 | DU1 | H / L | Display Upper Data |
| 10 | DU2 | H / L | Display Upper Data |
| 11 | DU3 | H / L | Display Upper Data |
| 12 | DL0 | H / L | Display Lower Data |
| 13 | DL1 | H / L | Display Lower Data |
| 14 | DL2 | H / L | Display Lower Data |
| 15 | DL3 | H / L | Display Lower Data |

Suitable Connector : 51021-1500 (molex)

CN2

| No. | Symbol | Level | Function |
|-----|--------|-------|----------|
| 1 | CFL OUT1 (HOT) | — | Power Supply for CFL (HOT) |
| 2 | NC | — | Non-connection |
| 3 | NC | — | Non-connection |
| 4 | CFL OUT2 (GND) | — | Power Supply for CFL (GND) |

Suitable Connector : M61M73-04 (MITSUMI)

            M60-04-30-114P Straight Type (MITSUMI)

            M60-04-30-134P Angle Type (MITSUMI)

## 4.2.Example of Power Supply

It is recommended to apply a potentiometer for the contrast adjust due to the tolerance of the driving voltage and its temperature dependence.
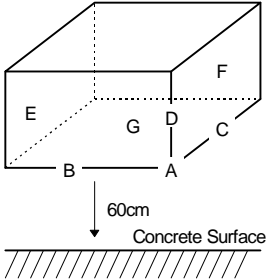
```
           ┌─────────────┐
           │         VCC ├────────────────○ VCC
           │             │
           │         VSS ├──────────┬─────○ 0V
           │             │       Tr │
           │             │         ┌┴┐ R1
           │  MODULE VEE ├───────⟨  ├┤ ├ VR
           │             │         └┬┘ R2
           │             │          │
           │             │          └─────○ VEE
           └─────────────┘
```
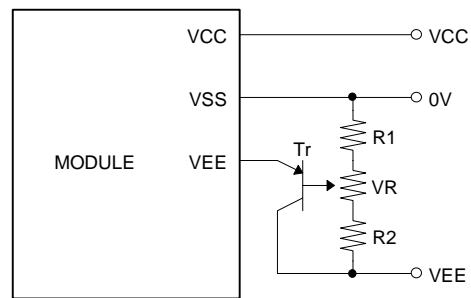
R1+R2+VR=10～20KΩ
Tr=2SA1202 or equivalent

## 4.3.Block Diagram
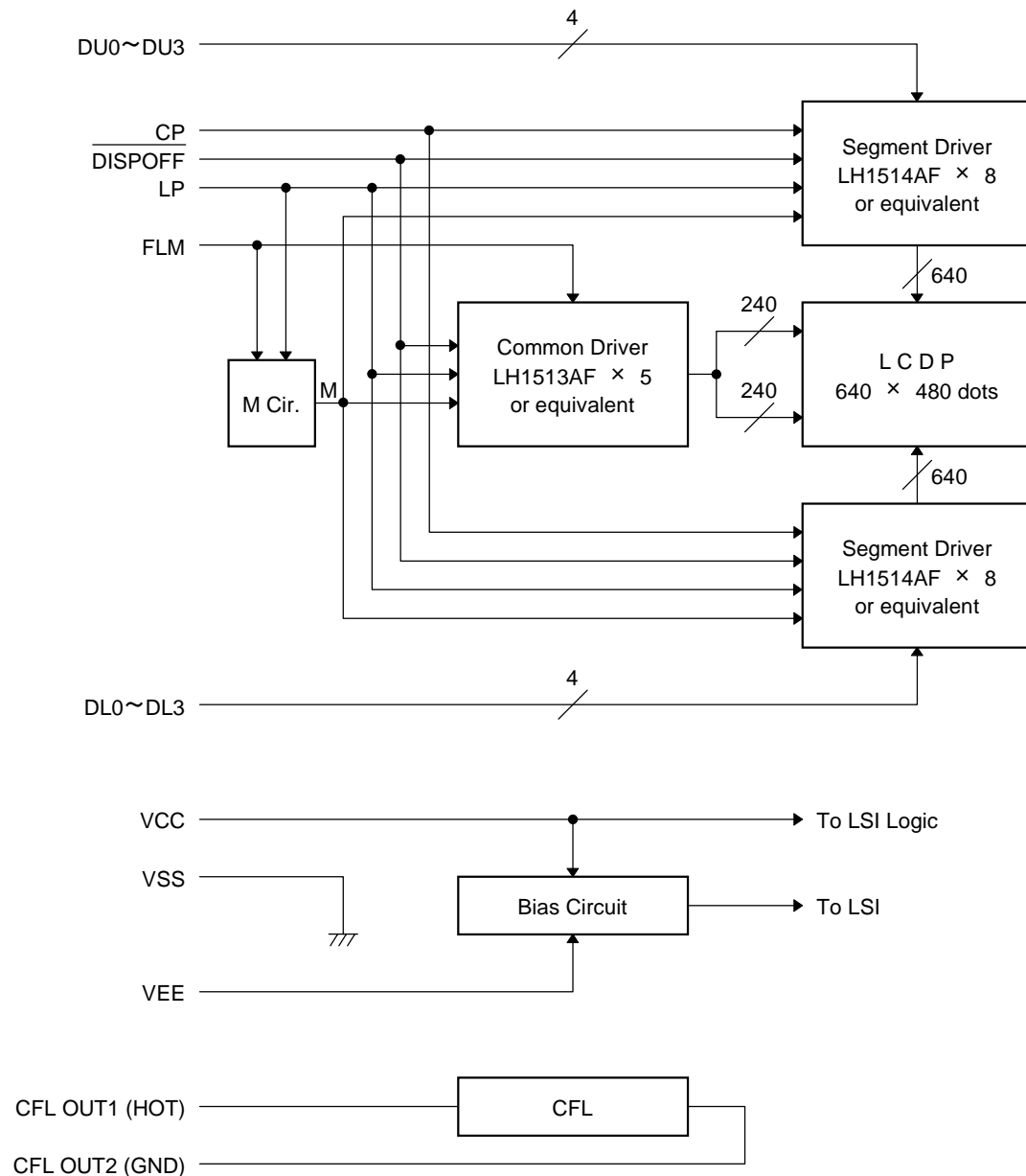
## 5. Test

No change on display and in operation under the following test condition.

| No. | Parameter | Conditions | Notes |
|---|---|---|---|
| 1 | High Temperature Operating | 50℃±2℃, 96hrs (operation state) | |
| 2 | Low Temperature Operating | 0℃±2℃, 96hrs (operation state) | 3 |
| 3 | High Temperature Storage | 60℃±2℃, 96hrs | 4 |
| 4 | Low Temperature Storage | -20℃±2℃, 96hrs | 3, 4 |
| 5 | Damp Proof Test | 40℃±2℃, 90～95%RH, 96hrs | 3, 4 |
| 6 | Vibration Test | Total fixed amplitude : 1.5mm<br>Vibration Frequency : 10～55Hz<br>One cycle 60 seconds to 3 directions of X, Y, Z for each 15 minutes | 5 |
| 7 | Shock Test | To be measured after dropping from 60cm high on the concrete surface in packing state.<br><br>Dropping method corner dropping — A corner : once<br>Edge dropping — B,C,D edge : once<br>Face dropping — E,F,G face : once<br>60cm — Concrete Surface | |

Note 1 : Unless otherwise specified, tests will be conducted under the following condition.
  Temperature : 20±5℃
  Humidity : 65±5%

Note 2 : Unless otherwise specified, tests will be not conducted under functioning state.

Note 3 : No dew condensation to be observed.

Note 4 : The function test shall be conducted after 4 hours storage at the normal temperature and humidity after removed from the test chamber.

Note 5 : Vibration test will be conducted to the product itself without putting it in a container.

## 6. Appearance Standards

### 6.1. Inspection conditions

The LCD shall be inspected under 40W white fluorescent light.
The distance between the eyes and the sample shall be more than 30cm.
All directions for inspecting the sample should be within $45°$ against perpendicular line.
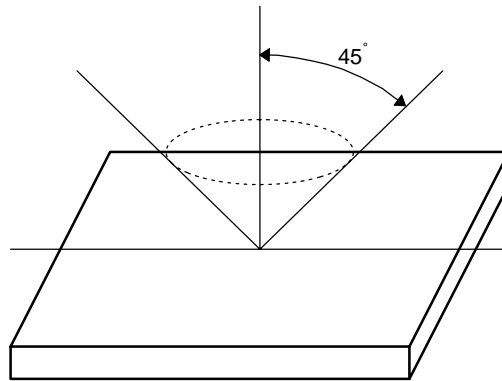


### 6.2. Definition of applicable Zones

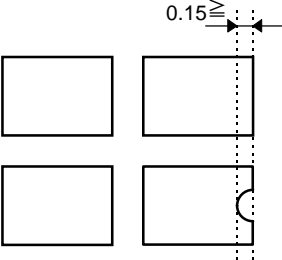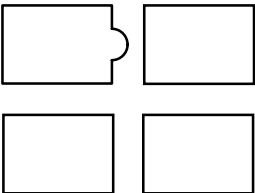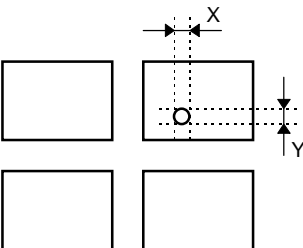

X=196.0mm
Y=148.0mm

Bezel Flame
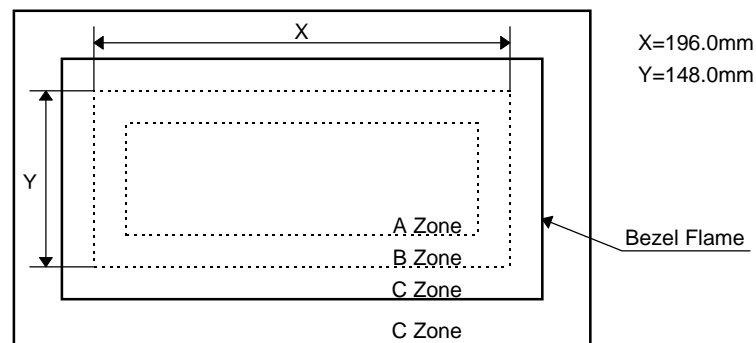
A Zone : Active display area
B Zone : Area from outside of "A Zone" to validity viewing area
C Zone : Rest parts
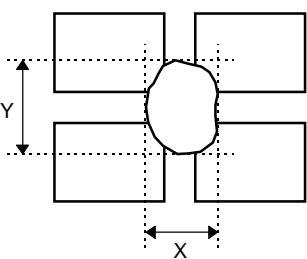
A Zone + B Zone = Validity viewing area

### 6.3. Standards

| No. | Parameter | Criteria |
|---|---|---|
| 1 | Black and White Spots, Foreign Substances | **(1) Round Shape** |
| 2 | Air Bubbles (between glass & polarizer) | |

**No. 1 — Black and White Spots, Foreign Substances**

**(1) Round Shape**

| Dimension (mm) / Zone | A | B | C |
|---|---|---|---|
| $D \leqq 0.1$ | * | * | * |
| $0.1 < D \leqq 0.2$ | 3 | 5 | * |
| $0.2 < D \leqq 0.3$ | 2 | 3 | * |
| $0.3 < D \leqq 0.35$ | 0 | 1 | * |
| $0.35 < D$ | 0 | 0 | * |

$D = ( Long + Short ) / 2$      * : Disregard

**(2) Line Shape**

| X (mm) | Y (mm) | A | B | C |
|---|---|---|---|---|
| − | $0.03 \geqq W$ | * | * | * |
| $2.0 \geqq L$ | $0.05 \geqq W$ | 4 | 4 | * |
| $1.0 \geqq L$ | $0.1 \geqq W$ | 4 | 4 | * |
| − | $0.1 < W$ | In the same way (1) | | |

X : Length    Y : Width     * : Disregard

Total defects shall not exceed 7.

**No. 2 — Air Bubbles (between glass & polarizer)**

| Dimension (mm) / Zone | A | B | C |
|---|---|---|---|
| $D1, D2 \leqq 0.3$ | * | * | * |
| $0.3 < D1, D2 \leqq 0.5$ | 3 | * | * |
| $0.5 < D1 \leqq 0.7$ | 2 | 3 | * |
| $0.5 < D2 \leqq 0.6$ | 2 | 3 | * |
| $0.7 < D1, 0.6 < D2$ | 0 | 0 | * |

D1 : Small foam a gathering    D2 : Single foam      * : Disregard

Total defects shall not exceed 5.

| No. | Parameter | Criteria |
|---|---|---|
| 3 | The Shape of Dot | (1) Dot Shape (with Dent)<br><br>0.15≧<br><br>As per the sketch of left hand.<br><br>(2) Dot Shape (with Projection)<br><br>Should not be connected to next dot.<br><br>(3) Pin Hole<br><br>X<br>Y<br><br>$(X+Y) / 2 \leqq 0.2mm$<br>(Less than 0.1mm is no counted.)<br><br>(4) Deformation<br><br>Y<br>X<br><br>$(X+Y) / 2 \leqq 0.2mm$<br><br>Total acceptable number : 1/dot, 5/cell<br>(Defect number of (4) : 1pc.) |
| 4 | Polarizer Scratches | Refer to the sample. |
| 5 | Polarizer Dirts | If the stains are removed easily from LCDP surface, the module is not defective. |
| 6 | Complex Foreign Substance Defects | Black spots, line shaped foreign substances or air bubbles between glass & polarizer should be 7pcs maximum in total. |
| 7 | Distance between Different Foreign Substance Defects | D≦0.2 : 20mm or more<br>0.2＜D : 40mm or more |

7. <u>Code System of Production Lot</u>

The production lot of module is specified as follows :

☐☐ ☐ ☐ ☐ ☐

Factory Number
Factory Code (Alphabet)
Production Week (1~5)
Production Month (1~9, X, Y, Z)
Production Year (Lower 2 digits)
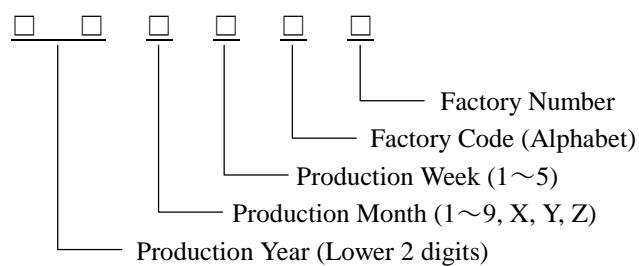
8. <u>Type Number</u>

The type number of module is specified on the back of module as follows :

DMF－5 0 2 6 0 N F U－F W－8

Label
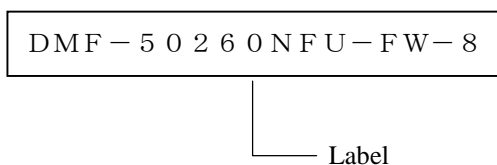
9. <u>Applying Precautions</u>

Please contact us when questions and/or new problems not specified in this specifications arise.

## 10. Handling Precautions

Operex Products are designed for use in ordinary electronic devices such as business machines, telecommunications equipment, measurement devices and etc..
Optrex Products are not designed, intended, or authorized for use in any application in which the failure of the product could result in a situation where personal injury or death may occur. These applications include, but are not limited to, life-sustaining equipment, nuclear control devices, aerospace equipment, devices related to hazardous or flammable materials, etc. (If Buyer intends to purchase or use the Optrex Products for such unintended or unauthorized applications, Buyer must secure prior written consent to such use by a responsible officer of Optrex Corporation.) Should Buyer purchase or use Optrex Products for any such unintended or unauthorized application (without such consent), Buyer shall indemnify and hold Optrex and its officers, employees, subsidiaries, affiliates and distributors harmless against all claims, costs, damages and expenses, and reasonable attorney's fees, arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Optrex was negligent regarding the design or manufacture of the part.

1) LCD may be broken because it is made of glass.

2) Polarizer is a soft material and can easily be scratched.

3) Please avoid static electricity.

　① Please be sure to ground human body and electric appliances during work.
　② It is preferable to use conductive mat on table and wear cotton clothes or conduction processed fiber. Synthetic fiber is not recommended.
　③ Please slowly peel off protective film, because static electricity may be charged.

4) If it is necessary to store LCD modules for a long time, please comply with the following procedures. If storage condition is not satisfactory, display (especially polarizer) may be deteriorated or soldering I/O terminals may become difficult (some oxide is generated at I/O terminals plating).

　① Store as delivered by Optrex
　② If you store as unpacked, put in anti-static bag, seal its opening and store where it is not subjected to direct sunshine nor fluorescent lamp.
　③ Store at temperature 0 to +35℃ and at low humidity. Please refer to our specification sheets for storage temperature range and humidity condition.

5) The module does not contain excess current limiter.
　Please design the limiter to cut excess current in your power supply circuit.

6) The connection between the bezel and $V_{SS}$ (GND) is not specified in the module.
　(Some module do not maintain connection between them.)
　Please consult OPTREX to specify the connection.

7) Liquid crystal may be leaked when display is broken. Never taste it. If your hands or clothes touch it, please immediately wash using soap.

Optrex shall not be responsible for any infringement of industrial property rights of third parties in any country arising out of the application or use of Optrex Products, except which directly concern the structure or production of such products.