

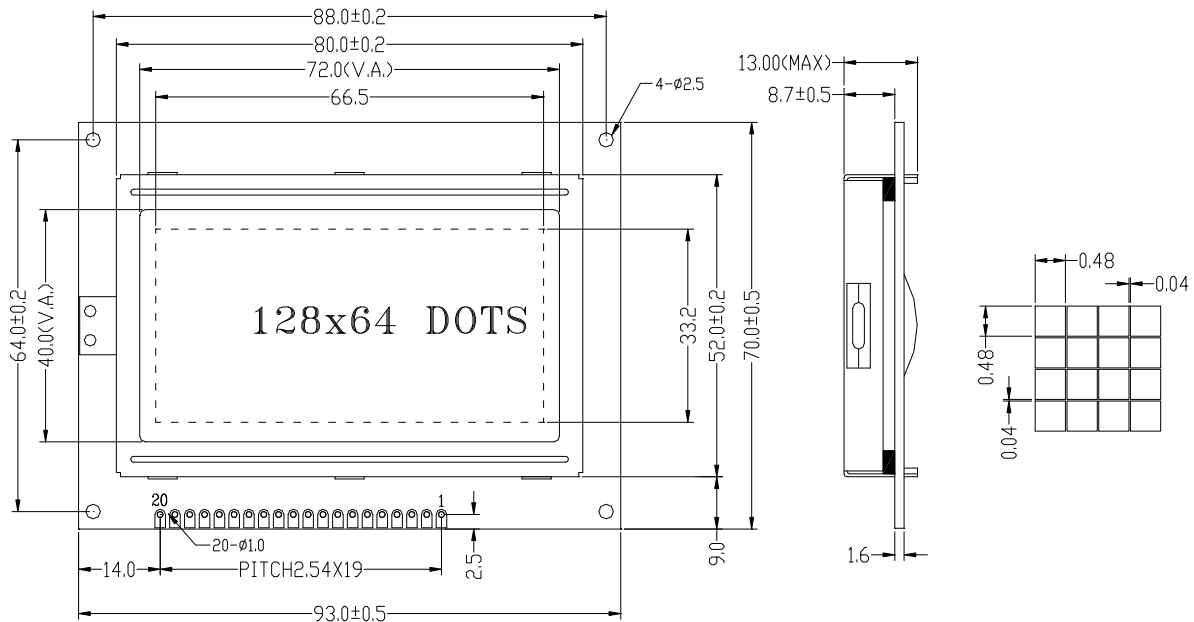
## GDM12864A-FL-YBW

## SPECIFICATIONS OF LCD MODULE

### Features

- 128\*64 dots matrix graphic display
- Controller IC NT7108 or equivalence
- Easy interface with 8-bit MPU
- +5V DC power supply
- STN LCD yellow-green, positive display, transfective type.
- 1/64 duty
- 6 O'clock viewing direction
- Array LED backlight, yellow-green color
- Built-in negative voltage supply -5V V<sub>EE</sub>
- Operating temperature range -20°C to 70°C

### Mechanical Specifications (Unit: mm)



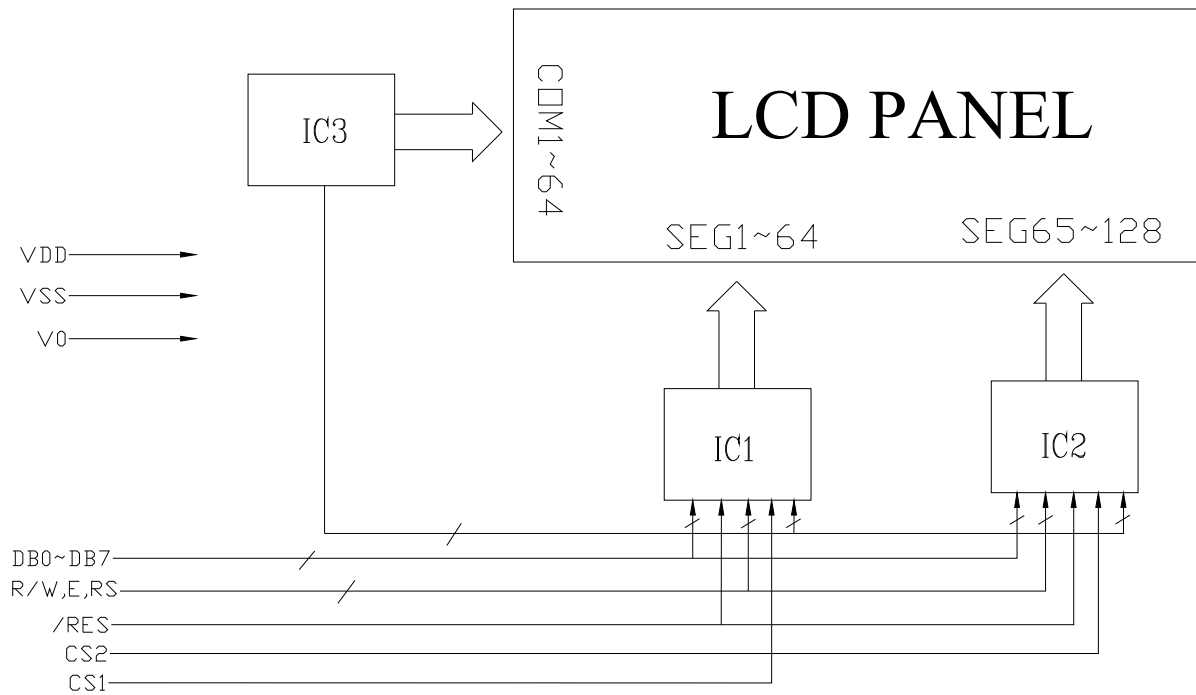
|        |     |     |     |     |     |     |     |     |      |      |
|--------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| PIN    | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9    | 10   |
| SIGNAL | VSS | VDD | V0  | D/I | R/W | E   | DB0 | DB1 | DB2  | DB3  |
| PIN    | 11  | 12  | 13  | 14  | 15  | 16  | 17  | 18  | 19   | 20   |
| SIGNAL | DB4 | DB5 | DB6 | DB7 | CS1 | CS2 | RES | VEE | A(+) | K(-) |

### Temperature Characteristics

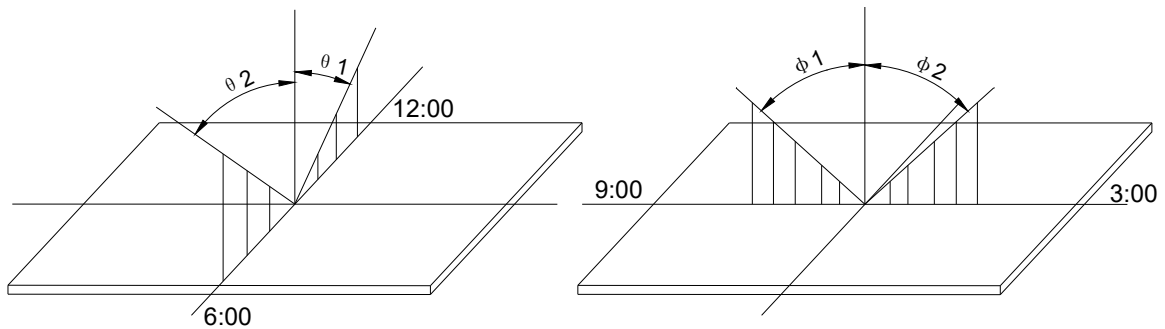
| Parameter             | Symbol          | Rating    | Unit |
|-----------------------|-----------------|-----------|------|
| Operating temperature | T <sub>OP</sub> | -20 ~ +70 | °C   |
| Storage temperature   | T <sub>ST</sub> | -30 ~ +80 | °C   |

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## Block diagram



## Electro-Optical characteristics



STN LCD (Super twisted nematic)

( $T_A=25^\circ\text{C}$ ,  $V_{DD}=5.0\text{V}\pm 0.25\text{V}$ )

| ITEM                 | SYMBOL                             | CONDITION                           | MIN.      | TYP. | MAX. | UNIT |
|----------------------|------------------------------------|-------------------------------------|-----------|------|------|------|
| Viewing Angle        | $\frac{\theta_2 - \theta_1}{\phi}$ | $Cr = 2.0$                          | 70<br>-90 | -    | +90  | deg. |
| Contrast Ratio       | $Cr$                               | $\theta=20^\circ$<br>$\phi=0^\circ$ | -         | 8    | -    | -    |
| Response Time (rise) | $t_R$                              | $\theta=20^\circ$<br>$\phi=0^\circ$ | -         | 200  | 280  | ms   |
| Response Time (fall) | $t_F$                              | $\theta=20^\circ$<br>$\phi=0^\circ$ | -         | 220  | 300  | ms   |

## Backlight Characteristics

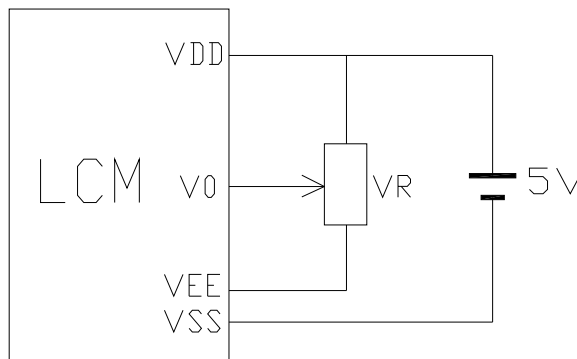
| Parameter                | Symbol | Conditions              | Min. | Typ. | Max. | Unit |
|--------------------------|--------|-------------------------|------|------|------|------|
| Backlight supply voltage | $V_F$  | Input by pin19(+)&20(-) | -    | 4.8  | 5.0  | V    |
| Backlight supply current | $I_F$  | $V_F=5.0\text{V}$       | -    | 120  | 200  | mA   |

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## Interface Pin Connections

| Pin No. | Symbol          | I/O Type | Description   |
|---------|-----------------|----------|---|
| 1       | V <sub>SS</sub> | Supply   | Ground  |
| 2       | V <sub>DD</sub> | Supply   | Power supply  |
| 3       | V <sub>0</sub>  | Supply   | LCD driver supply voltage   |
| 4       | RS              |          | Data or Instruction.<br>RS = H DB<0:7>: Display RAM data<br>RS = L DB<0:7>: Instruction data  |
| 5       | R/W             |          | Read or Write<br><br><b>RW Description</b><br>H Data appears at DB[0:7] and can be read by the CPU while E= H CS1B=L, CS2B=L and CS3=H.<br>L Display data DB[0:7] can be written at falling edge of E when CS1B=L, CS2B=L and CS3=H.  |
| 6       | E               |          | Enable signal<br><br><b>E Description</b><br>H Read data in DB[7:0] appears while E= "High".<br>L Display data DB[7:0] is latched at falling edge of E.   |
| 7~14    | DB0~ DB7        | I/O      | Data bus [0~7]<br>Bi-directional data bus   |
| 15      | CS1             | I        | Chip selection<br>When CS1=L,CS2=H, select IC1<br>When CS1=H,CS2=L, select IC2  |
| 16      | CS2             |          |   |
| 17      | RES             | I        | Reset signal.<br>When RES=L<br><b>【1】</b> ON/OFF register becomes set by 0.(display off)<br><b>【2】</b> display start line register becomes set by 0 (Z-address 0 set, display from line 0)<br><b>【3】</b> After releasing reset , this condition can be changed only by instruction. |
| 18      | V <sub>EE</sub> | Power    | V <sub>EE</sub> is connected by the same voltage.   |
| 19      | A(LED+)         |          | Power for backlight (Anode)   |
| 20      | K(LED-)         |          | Power for backlight (Cathode)   |

### Contrast adjust circuit



V<sub>DD</sub>-V<sub>0</sub>: LCD Driving voltage

VR: 10k~20k

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## Electrical Absolute Maximum Ratings (NT7107)

| Parameter             | Symbol           | Rating                                       | Unit | Note |
|-----------------------|------------------|--|------|------|
| Operating voltage     | V <sub>DD</sub>  | -0.3 ~ +7.0                                  | V    | *1   |
| Supply voltage        | V <sub>EE</sub>  | V <sub>DD</sub> -15.0 ~ V <sub>DD</sub> +0.3 | V    | *4   |
| Driver supply voltage | V <sub>B</sub>   | -0.3 ~ V <sub>DD</sub> +0.3                  | V    | *1,2 |
|                       | V <sub>LCD</sub> | V <sub>EE</sub> -0.3 ~ V <sub>DD</sub> +0.3  | V    | *3,4 |

**\*Notes:**

- \*1. Based on V<sub>SS</sub> = 0V
- \*2. Applies to input terminals and I/O terminals at high impedance. (Except V<sub>0L</sub>, V<sub>1L</sub>, V<sub>4L</sub>, and V<sub>5L</sub>)
- \*3. Applies to V<sub>0L</sub>, V<sub>1L</sub>, V<sub>4L</sub>, and V<sub>5L</sub>.
- \*4. Voltage level: V<sub>DD</sub> ≥ V<sub>0</sub> ≥ V<sub>1</sub> ≥ V<sub>2</sub> ≥ V<sub>3</sub> ≥ V<sub>4</sub> ≥ V<sub>5</sub> ≥ V<sub>EE</sub>

## DC Electrical Characteristics (NT7107)

(V<sub>DD</sub>= 4.5 to 5.5V, V<sub>SS</sub>=0V, V<sub>DD</sub>-V<sub>EE</sub>=8~17V, T<sub>a</sub>= -20 to +70°C)

| Item  | Symbol           | Condition   | Min.                 | Typ. | Max.               | Unit | Note |
|---|------------------|---|----------------------|------|--------------------|------|------|
| Operating voltage                                 | V <sub>DD</sub>  | -   | 4.5                  | -    | 5.5                | V    |      |
| Input voltage                                     | V <sub>IH</sub>  | -   | 0.7V <sub>DD</sub>   | -    | V <sub>DD</sub>    |      | *1   |
|   | V <sub>IL</sub>  | -   | V <sub>SS</sub>      | -    | 0.3V <sub>DD</sub> |      |      |
| output voltage                                    | V <sub>OH</sub>  | I <sub>OH</sub> = -0.4mA                                      | V <sub>DD</sub> -0.4 | -    | -                  |      | *2   |
|   | V <sub>OL</sub>  | I <sub>OL</sub> = 0.4mA                                       | -                    | -    | 0.4                |      |      |
| Input leakage current                             | I <sub>LKG</sub> | V <sub>IN</sub> = V <sub>DD</sub> ~ V <sub>SS</sub>           | -1.0                 | -    | +1.0               | μA   | *1   |
| OSC Frequency                                     | f <sub>osc</sub> | R <sub>f</sub> =47kΩ ± 2%<br>C <sub>f</sub> =20pF ± 5%        | 315                  | 450  | 585                | kHz  |      |
| On Resistance (V <sub>div</sub> -C <sub>i</sub> ) | R <sub>ONS</sub> | V <sub>DD</sub> -V <sub>EE</sub> =17V<br>Load current ± 150μA | -                    | -    | 1.5                | kΩ   |      |
| Operating current                                 | I <sub>DD1</sub> | Master mode<br>1/128 Duty                                     | -                    | -    | 1.0                | mA   | *3   |
|   | I <sub>DD2</sub> | Master mode<br>1/128 Duty                                     | -                    | -    | 0.2                |      | *4   |
| Supply Current                                    | I <sub>EE</sub>  | Master mode<br>1/128 Duty                                     | -                    | -    | 0.1                |      |      |
| Operating Frequency                               | f <sub>op1</sub> | Master mode<br>External Duty                                  | 50                   | -    | 600                | kHz  |      |
| Frequency   | f <sub>op2</sub> | Slave mode  | 0.5                  | -    | 1500               |      |      |

**Notes**

- \*1. Applies to input terminals FS, DS1, DS2, CR, SHL, MS and PCLK2 and I/O terminals DIO1, DIO2, M, and CL2 in the input state.
- \*2. Applies to output terminals CLK1, CLK2 and FRM and I/O terminals DIO1, DIO2, M, and CL2 in the output state.
- \*3. This value is specified about current flowing through V<sub>SS</sub>.  
Internal oscillation circuit: R<sub>f</sub>=47kΩ, C<sub>f</sub>=20pF  
Each terminal of DS1, DS2, FS, SHL, and MS is connected to V<sub>DD</sub> and out is no load.
- \*4. This value is specified about current flowing through V<sub>SS</sub>.  
Each terminal is DS1, DS2, FS, SHL, PCLK2 and CR is connected to V<sub>DD</sub>, MS is connected to V<sub>SS</sub>, and CL2,

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M, DIO1 is external clock.

\*5. This value is specified about current flowing through  $V_{EE}$ , Don't connect to  $V_{LCD}$  ( $V1\sim V5$ ).

## Electrical Absolute Maximum Ratings (NT7108)

| Parameter             | Symbol    | Rating                        | Unit | Note |
|-----------------------|-----------|-------------------------------|------|------|
| Operating voltage     | $V_{DD}$  | -0.3 ~ +7.0                   | V    | *1   |
| Supply voltage        | $V_{EE}$  | $V_{DD}-19.0 \sim V_{DD}+0.3$ | V    | *4   |
| Driver supply voltage | $V_B$     | -0.3 ~ $V_{DD}+0.3$           | V    | *1,3 |
|                       | $V_{LCD}$ | $V_{EE}-0.3 \sim V_{DD}+0.3$  | V    | *2   |

### \*Notes:

- \*1. Based on  $V_{SS} = 0V$
- \*2. Applies the same supply voltage to  $V_{EE}$ .  $V_{LCD}=V_{DD}-V_{EE}$ .
- \*3. Applies to M, FRM, CLK1,CLK2, CL, RESETB, ADC, CS1B, CS2B,CS3, E, R/W, RS and DB0~DB7.
- \*4. Applies  $V0L,V2L,V3L$  and  $V5L$ .

Voltage level:  $V_{DD} \geq V0 \geq V1 \geq V2 \geq V3 \geq V4 \geq V5 \geq V_{EE}$

## DC Electrical Characteristics (NT7108)

( $V_{DD}= 4.5$  to  $5.5V$ ,  $V_{SS}=0V$ ,  $V_{DD}-V_{EE}=8\sim 17V$ ,  $T_a= -20$  to  $+70^\circ C$ )

| Item                            | Symbol    | Condition  | Min.        | Typ. | Max.        | Unit      | Note |
|---------------------------------|-----------|--|-------------|------|-------------|-----------|------|
| Operating voltage               | $V_{DD}$  | -  | 4.5         | -    | 5.5         | V         |      |
| Input High voltage              | $V_{IH1}$ | -  | $0.7V_{DD}$ | -    | $V_{DD}$    |           | *1   |
|                                 | $V_{IH2}$ | -  | 2.0         | -    | $V_{DD}$    |           | *2   |
| Input Low voltage               | $V_{IL1}$ | -  | 0           | -    | $0.3V_{DD}$ |           | *1   |
|                                 | $V_{IL2}$ | -  | 0           | -    | 0.8         |           | *2   |
| Output High Voltage             | $V_{OH}$  | $I_{OH}= -0.2mA$                                   | 2.4         | -    | -           |           | *3   |
| Output Low Voltage              | $V_{OL}$  | $I_{OL}= 1.6mA$                                    | -           | -    | 0.4         | *3        |      |
| Input leakage current           | $I_{LKG}$ | $V_{IN}= V_{SS} \sim V_{DD}$                       | -1.0        | -    | +1.0        | $\mu A$   | *4   |
| Three-state (OFF) Input Current | $I_{TSL}$ | $V_{IN}= V_{SS} \sim V_{DD}$                       | -5.0        | -    | 5.0         |           | *5   |
| Driver Input leakage current    | $I_{DIL}$ | $V_{IN}= V_{EE} \sim V_{DD}$                       | -2.0        |      | 2.0         |           | *6   |
| On Resistance ( $V_{div}-C_i$ ) | $R_{ONS}$ | $V_{DD}-V_{EE}=15V$<br>Load current $\pm 100\mu A$ | -           | -    | 7.5         | $k\Omega$ | *8   |
| Operating current               | $I_{DD1}$ | During Display                                     | -           | -    | 0.1         | mA        | *7   |
|                                 | $I_{DD2}$ | During Access<br>Access Cycle=1MHz                 | -           | -    | 0.5         |           | *7   |

### Notes

- \*1. CL, FRM, M, RSTB, CLK1, CLK2
- \*2. CS1B, CS2B, CS3, E, R/W, RS, DB0~DB7
- \*3. DB0~DB7
- \*4. Except DB0~DB7
- \*5. DB0~DB7 at high impedance
- \*6.  $V0, V1, V3, V4, V5$

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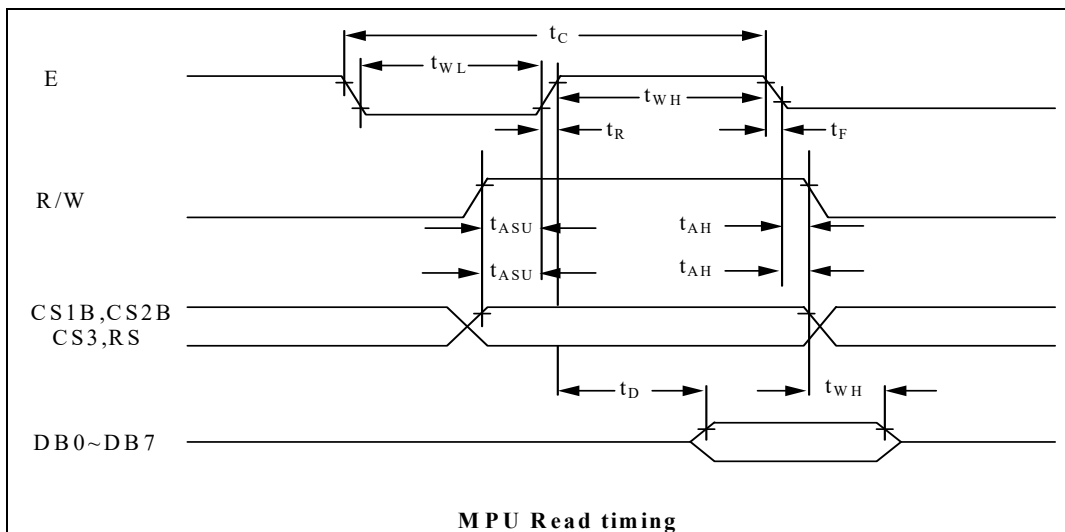
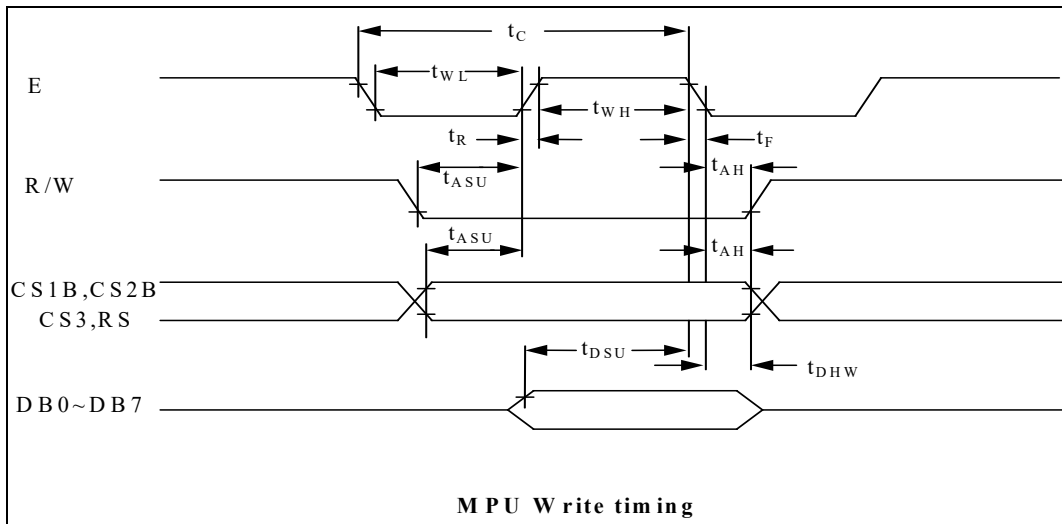
\*7. 1/64 duty , FCLK=250KHZ, Frame Frequency=70HKZ, Output: No Load

\*8.  $V_{DD}-V_{EE}=15.5V$

$$V_{0L} > V_{2L} \geq V_{DD} - 2/7(V_{DD} - V_{EE}) > V_{3L} = V_{EE} + 2/7(V_{DD} - V_{EE}) > V_{5L}$$

## MPU Interface

| Characteristic         | Symbol    | Min  | Typ | Max | Unit |
|------------------------|-----------|------|-----|-----|------|
| E Cycle                | $t_c$     | 1000 | -   | -   | ns   |
| E High Level Width     | $t_{WH}$  | 450  | -   | -   |      |
| E Low Level Width      | $t_{WL}$  | 450  | -   | -   |      |
| E Rise Time            | $t_R$     | -    | -   | 25  |      |
| E Fall Time            | $t_F$     | -    | -   | 25  |      |
| Address Set-Up Time    | $t_{ASU}$ | 140  | -   | -   |      |
| Address Hold Time      | $t_{AH}$  | 10   | -   | -   |      |
| Data Set-Up Time       | $t_{DSU}$ | 200  | -   | -   |      |
| Data Delay Time        | $t_D$     | -    | -   | 320 |      |
| Data Hold Time (Write) | $t_{DHW}$ | 10   | -   | -   |      |
| Data Hold Time (Read)  | $t_{DHR}$ | 20   | -   | -   |      |



## Operating Principles & Methods

### 1. I/O Buffer

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Input buffer controls the status between the enable and disable of chip. Unless the CS1B to CS3 is in active mode, Input or output of data and instruction does not execute. Therefore internal state is not change. But RSTB and ADC can operate regardless CS1B-CS3.

## 2. Input register

Input register is provided to interface with MPU which is different operating frequency. Input register stores the data temporarily before writing it into display RAM.

When CS1B to CS3 are in the active mode, R/W and RS select the input register. The data from MPU is written into input register. Then writing it into display RAM. Data latched for falling of the E signal and write automatically into the display data RAM by internal operation.

## 3. Output register

Output register stores the data temporarily from display data RAM when CS1B, CS2B and CS3 are in active mode and R/W and RS=H, stored data in display data RAM is latched in output register. When CS1B to CS3 is in active mode and R/W=H , RS=L, status data (busy check) can read out.

To read the contents of display data RAM, twice access of read instruction is needed. In first access, data in display data RAM is latched into output register. In second access, MPU can read data which is latched. That is to read the data in display data RAM, it needs dummy read. But status read is not needed dummy read.

| RS | R/W | Function  |
|----|-----|---|
| L  | L   | Instruction   |
|    | H   | Status read (busy check)                              |
| H  | L   | Data write (from input register to display data RAM ) |
|    | H   | Data read (from display data RAM to output register)  |

## 4. Reset

The system can be initialized by setting RSTB terminal at low level when turning power on, receiving instruction from MPU. When RSTB becomes low, following procedure is occurred.

1. Display off

2. Display start line register become set by 0.(Z-address 0)

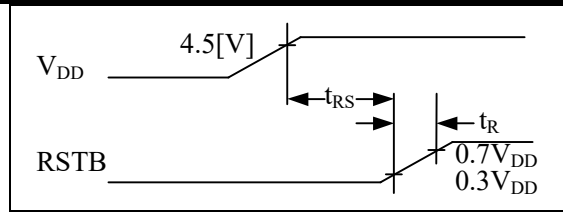
While RSTB is low, No instruction except status read can by accepted. Therefore, execute other instructions after making sure that DB4= (clear RSTB) and DB7=0 (ready) by status read instruction.

The conditions of power supply at initial power up are shown in table 1.

Table 1. Power Supply Initial Conditions

| Item       | Symbol          | Min | Typ | Max | Unit |
|------------|-----------------|-----|-----|-----|------|
| Reset Time | t <sub>RS</sub> | 1.0 | -   | -   | us   |
| Rise Time  | t <sub>R</sub>  | -   | -   | 200 | ns   |

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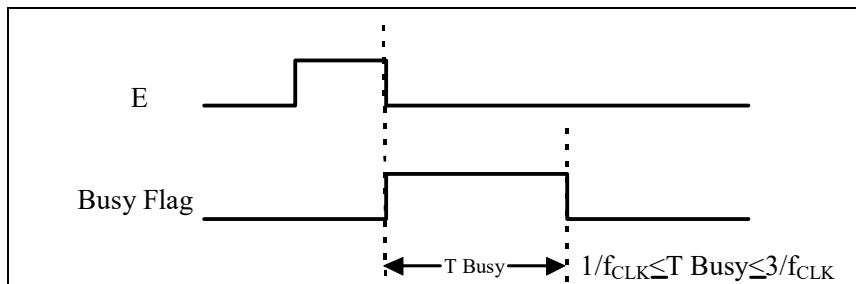


## 5. Busy flag

Busy flag indicates that NT7108 is operating or no operating. When busy flag is high, NT7108 is in internal operating.

When busy flag is low, NT7108 can accept the data or instruction.

DB7 indicates busy flag of the NT7108.



## 6. Display On/Off Flip-Flop

The display on/off flip-flop makes on/off the liquid crystal display. When flip-flop is reset (logical low), selective voltage or non selective voltage appears on segment output terminals. When flip-flop is set (logic high), non selective voltage appears on segment output terminals regardless of display RAM data.

The display on/off flip-flop can changes status by instruction. The display data at all segment disappear while RSTB is low.

The status of the flip-flop is output to DB5 by status read instruction.

The display on/off flip-flop synchronized by CL signal.

## 7. X Page Register

X page register designates pages of the internal display data RAM.

Count function is not available. An address is set by instruction.

## 8. Y address counter

Y address counter designates address of the internal display data RAM. An address is set by instruction and is increased by 1 automatically by read or write operations of display data.

## 9. Display Data RAM

Display data RAM stores a display data for liquid crystal display. To indicate on state dot matrix of liquid crystal display, write data 1. The other way, off state, writes 0.

Display data RAM address and segment output can be controlled by ADC signal.

ADC=H => Y-address 0: S1~Y address 63: S64

ADC=L => Y-address 0: S64~Yaddress 63: S1

ADC terminal connect the V<sub>DD</sub> or V<sub>SS</sub>.

## 10. Display Start Line Register



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The display start line register indicates of display data RAM to display top line of liquid crystal display.

Bit data (DB<0.5>) of the display start line set instruction is latched in display start line register. Latched data is transferred to the Z address counter while FRM is high, presetting the Z address counter.

It is used for scrolling of the liquid crystal display screen.

## Display Control Instruction

The display control instructions control the internal state of the NT7108. Instruction is received from MPU to NT7108 for the display control. The following table shows various instructions.

| Instruction             | RS | RW | DB7        | DB6 | DB5                       | DB4    | DB3 | DB2        | DB1 | DB0 | Function  |
|-------------------------|----|----|------------|-----|---------------------------|--------|-----|------------|-----|-----|---|
| Read Display Date       | 1  | 1  | Read data  |     |                           |        |     |            |     |     | Reads data (DB [7:0]) from display data RAM to the data bus.  |
| Write Display Date      | 1  | 0  | Write data |     |                           |        |     |            |     |     | Writes data (DB [7:0]) into the DDRAM. After writing instruction, Y address is incremented by 1 automatically                                   |
| Status Read             | 0  | 1  | Busy       | 0   | ON/OFF                    | Re-set | 0   | 0          | 0   | 0   | Reads the internal status<br>BUSY<br>0: Ready<br>1: In operation<br>ON/OFF<br>0: Display ON<br>1: Display OFF<br>RESET<br>0: Normal<br>1: Reset |
| Set Address (Y address) | 0  | 0  | 0          | 1   | Y address (0~63)          |        |     |            |     |     | Sets the Y address at the column address counter  |
| Set Display Start Line  | 0  | 0  | 1          | 1   | Display start line (0~63) |        |     |            |     |     | Indicates the Display Data RAM displayed at the top of the screen.  |
| Set Address (X address) | 0  | 0  | 1          | 0   | 1                         | 1      | 1   | Page (0~7) |     |     | Sets the X address at the X address register.   |
| Display On/off          | 0  | 0  | 0          | 0   | 1                         | 1      | 1   | 1          | 1   | 0/1 | Controls the display ON or OFF. The internal status and the DDRAM data is not affected.<br>0: OFF, 1: ON  |

### 1. Display On/Off

The display data appears when D is 1 and disappears when D is 0.

Though the data is not on the screen with D=0, it remains in the display data RAM.

Therefore, you can make it appear by changing D=0 into D=1.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 0   | 1   | 1   | 1   | 1   | 1   | D   |

### 2. Set Address (Y Address)

Y address (AC0~AC5) of the display data RAM is set in the Y address counter.

An address is set by instruction and increased by 1 automatically by read or write operations of display data.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 0   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |

### 3. Set Page (X Address)

X address (AC0~AC2) of the display data RAM is set in the X address register.

Writing or reading to or from MPU is executed in this specified page until the next page is set.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 1   | 0   | 1   | 1   | 1   | AC2 | AC1 | AC0 |

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## 4. Display Start Line (Z Address)

Z address (AC0~AC5) of the display data RAM is set in the display start line register and displayed at the top of the screen.

When the display duty cycle is 1/64 or others (1/32~1/64), the data of total line number of LCD screen, from the line specified by display start line instruction, is displayed.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 0  | 0   | 1   | 1   | AC5 | AC4 | AC3 | AC2 | AC1 | AC0 |

## 5. Status Read

| RS | R/W | DB7  | DB6 | DB5    | DB4   | DB3 | DB2 | DB1 | DB0 |
|----|-----|------|-----|--------|-------|-----|-----|-----|-----|
| 1  | 0   | BUSY | 0   | ON/OFF | RESET | 0   | 0   | 0   | 0   |

- BUSY

When BUSY is 1, the Chip is executing internal operation and no instructions are accepted.

When BUSY is 0, the Chip is ready to accept any instructions.

- ON/OFF

When ON/OFF is 1, the display is on.

When ON/OFF is 0, the display is off.

- RESET

When RESET is 1, the system is being initialized.

In this condition, no instructions except status read can be accepted.

When RESET is 0, initializing has finished and the system is in the usual operation condition.

## 6. Write Display Data

Write data (D0~D7) into the display data RAM.

After writing instruction, Y address is increased by 1 automatically.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1  | 0   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |

## 7. Read Display Data

Reads data (D0~D7) from the display data RAM.

After reading instruction, Y address is increased by 1 automatically.

| RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 1  | 1   | D7  | D6  | D5  | D4  | D3  | D2  | D1  | D0  |

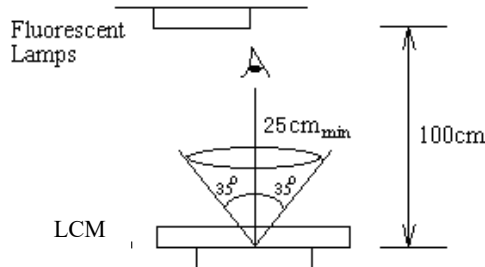
# GDM12864A-FL-YBW

## Quality Specifications

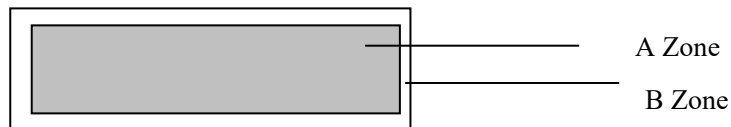
### Cosmetic inspection

The inspection should be performed in using 20W x 2 fluorescent lamps. Distance between LCM and fluorescent lamps should be 100 cm or more. Distance between LCM and inspector eyes should be 25 cm or more.

Viewing direction for inspection is 35° from vertical against LCM.



Definition of zone:



A Zone: Active display area (minimum viewing area).

B Zone: Non-active display area (outside viewing area).

### Specification of quality assurance

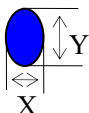
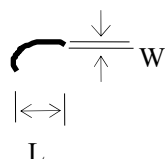
AQL inspection standard

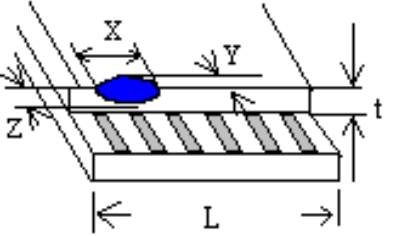
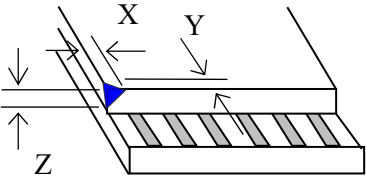
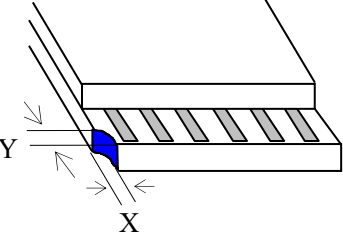
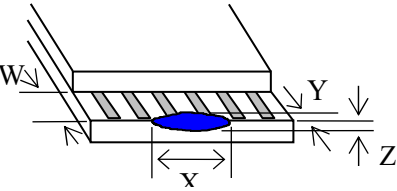
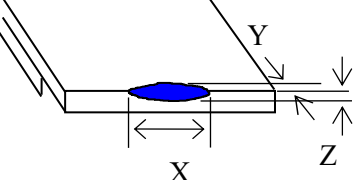
Sampling method: MIL-STD-105E, Level II, single sampling

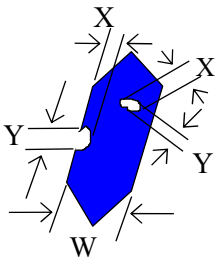
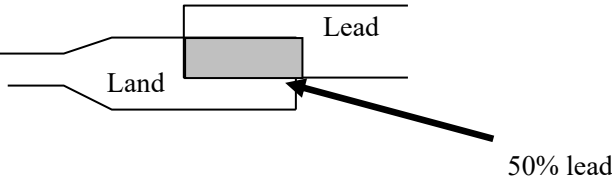
Defect classification

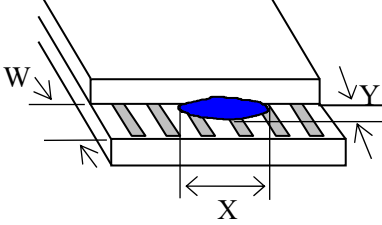
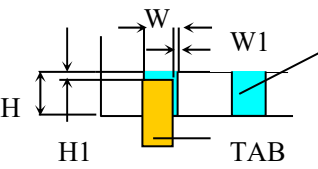
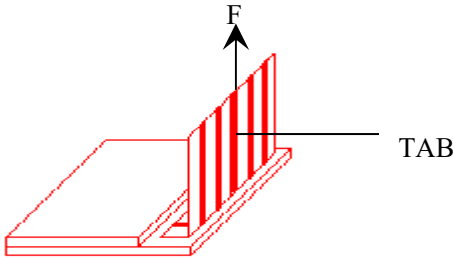
| Classify                   |                             | Item                         | Note      | AQL  |
|----------------------------|-----------------------------|------------------------------|-----------|------|
| Major                      | Display state               | Short or open circuit        | 1         | 0.65 |
|                            |                             | LC leakage                   |           |      |
|                            |                             | Flickering                   |           |      |
|                            |                             | No display                   |           |      |
|                            |                             | Wrong viewing direction      | 2         |      |
|                            |                             | Contrast defect (dim, ghost) |           |      |
|                            |                             | Backlight                    | 1,8       |      |
|                            | Non-display                 | Flat cable or pin reverse    | 10        |      |
| Wrong or missing component |                             | 11                           |           |      |
| Minor                      | Display state               | Background color deviation   | 2         | 1.0  |
|                            |                             | Black spot and dust          | 3         |      |
|                            |                             | Line defect, Scratch         | 4         |      |
|                            |                             | Rainbow                      | 5         |      |
|                            |                             | Chip                         | 6         |      |
|                            |                             | Pin hole                     | 7         |      |
|                            |                             | Polarizer                    | Protruded |      |
|                            | Bubble and foreign material |                              | 3         |      |
|                            | Soldering                   | Poor connection              | 9         |      |
|                            | Wire                        | Poor connection              | 10        |      |
|                            | TAB                         | Position, Bonding strength   | 13        |      |

### Note on defect classification

| No.                     | Item   | Criterion  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|-------------------------|--|--|-----------------|-----------------|------------------|-----------|-------------------------|-----------|-------------------------|------------|---------------|------------------|-----------|---------------------|
| 1                       | Short or open circuit                                      | Not allow  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | LC leakage   |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | Flickering   |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | No display   |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | Wrong viewing direction                                    |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | Wrong Back-light   |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| 2                       | Contrast defect  | Refer to approval sample   |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | Background color deviation                                 |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| 3                       | Point defect,<br>Black spot, dust<br>(including Polarizer) | <div style="display: flex; align-items: center; justify-content: center;">  <table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th>Point Size</th> <th>Acceptable Qty.</th> </tr> </thead> <tbody> <tr> <td><math>\phi \leq 0.10</math></td> <td>Disregard</td> </tr> <tr> <td><math>0.10 &lt; \phi \leq 0.15</math></td> <td>2</td> </tr> <tr> <td><math>0.15 &lt; \phi \leq 0.25</math></td> <td>1</td> </tr> <tr> <td><math>\phi &gt; 0.25</math></td> <td>0</td> </tr> </tbody> </table> </div>   | Point Size      | Acceptable Qty. | $\phi \leq 0.10$ | Disregard | $0.10 < \phi \leq 0.15$ | 2         | $0.15 < \phi \leq 0.25$ | 1          | $\phi > 0.25$ | 0                |           |                     |
|                         | Point Size   |  | Acceptable Qty. |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| $\phi \leq 0.10$        | Disregard  |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| $0.10 < \phi \leq 0.15$ | 2  |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| $0.15 < \phi \leq 0.25$ | 1  |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| $\phi > 0.25$           | 0  |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         | $\phi = (X+Y)/2$   | Unit: mm   |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| 4                       | Line defect,<br>Scratch                                    | <div style="display: flex; align-items: center; justify-content: center;">  <table border="1" style="border-collapse: collapse; text-align: center;"> <thead> <tr> <th colspan="2">Line</th> <th>Acceptable Qty.</th> </tr> <tr> <th>L</th> <th>W</th> <td rowspan="4" style="text-align: center;">Disregard</td> </tr> </thead> <tbody> <tr> <td>---</td> <td><math>0.05 &gt; W</math></td> </tr> <tr> <td><math>3.0 &gt; L</math></td> <td><math>0.1 &gt; W &gt; 0.05</math></td> </tr> <tr> <td><math>2.0 &gt; L</math></td> <td><math>0.15 \geq W &gt; 0.1</math></td> </tr> </tbody> </table> </div> | Line            |                 | Acceptable Qty.  | L         | W                       | Disregard | ---                     | $0.05 > W$ | $3.0 > L$     | $0.1 > W > 0.05$ | $2.0 > L$ | $0.15 \geq W > 0.1$ |
|                         | Line   |  | Acceptable Qty. |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| L                       | W  | Disregard  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| ---                     | $0.05 > W$   |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| $3.0 > L$               | $0.1 > W > 0.05$   |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| $2.0 > L$               | $0.15 \geq W > 0.1$  |  |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
|                         |  | Unit: mm   |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |
| 5                       | Rainbow  | Not more than two color changes across the viewing area.   |                 |                 |                  |           |                         |           |                         |            |               |                  |           |                     |

| No  | Item   | Criterion   |            |   |           |            |            |                        |  |  |
|---|--|---|------------|---|-----------|------------|------------|------------------------|--|--|
| 6<br><br>Remark:<br>X: Length<br>Y: Width<br>Z: Thickness<br>t: Glass thickness<br>W: Terminal width<br>L: Glass length |   | Acceptable criterion<br><table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>&lt; L/8</math></td> <td>0.5mm</td> <td><math>\leq t/2</math></td> </tr> </tbody> </table> | X          | Y | Z         | $< L/8$    | 0.5mm      | $\leq t/2$             |  |  |
|   | X  | Y   | Z          |   |           |            |            |                        |  |  |
|   | $< L/8$  | 0.5mm   | $\leq t/2$ |   |           |            |            |                        |  |  |
|   |   | Acceptable criterion<br><table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 2</math></td> <td>0.5mm</td> <td><math>\leq t</math></td> </tr> </tbody> </table>     | X          | Y | Z         | $\leq 2$   | 0.5mm      | $\leq t$               |  |  |
|   | X  | Y   | Z          |   |           |            |            |                        |  |  |
| $\leq 2$  | 0.5mm  | $\leq t$  |            |   |           |            |            |                        |  |  |
|                                      | Acceptable criterion<br><table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 3</math></td> <td><math>\leq 2</math></td> <td><math>\leq t</math></td> </tr> <tr> <td colspan="2">shall not reach to ITO</td> <td></td> </tr> </tbody> </table> | X   | Y          | Z | $\leq 3$  | $\leq 2$   | $\leq t$   | shall not reach to ITO |  |  |
| X   | Y  | Z   |            |   |           |            |            |                        |  |  |
| $\leq 3$  | $\leq 2$   | $\leq t$  |            |   |           |            |            |                        |  |  |
| shall not reach to ITO  |  |   |            |   |           |            |            |                        |  |  |
|                                      | Acceptable criterion<br><table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td>Disregard</td> <td><math>\leq 0.2</math></td> <td><math>\leq t</math></td> </tr> </tbody> </table>  | X   | Y          | Z | Disregard | $\leq 0.2$ | $\leq t$   |                        |  |  |
| X   | Y  | Z   |            |   |           |            |            |                        |  |  |
| Disregard   | $\leq 0.2$   | $\leq t$  |            |   |           |            |            |                        |  |  |
|                                      | Acceptable criterion<br><table border="1"> <thead> <tr> <th>X</th> <th>Y</th> <th>Z</th> </tr> </thead> <tbody> <tr> <td><math>\leq 5</math></td> <td><math>\leq 2</math></td> <td><math>\leq t/3</math></td> </tr> </tbody> </table>  | X   | Y          | Z | $\leq 5$  | $\leq 2$   | $\leq t/3$ |                        |  |  |
| X   | Y  | Z   |            |   |           |            |            |                        |  |  |
| $\leq 5$  | $\leq 2$   | $\leq t/3$  |            |   |           |            |            |                        |  |  |

| No.                     | Item  | Criterion   |            |                |                  |           |                         |   |               |   |
|-------------------------|---|---|------------|----------------|------------------|-----------|-------------------------|---|---------------|---|
| 7                       | Segment pattern<br>$W = \text{Segment width}$<br>$\phi = (X+Y)/2$ | (1) Pin hole<br>$\phi < 0.10\text{mm}$ is acceptable.<br> <table border="1"> <thead> <tr> <th>Point Size</th> <th>Acceptable Qty</th> </tr> </thead> <tbody> <tr> <td><math>\phi \leq 1/4W</math></td> <td>Disregard</td> </tr> <tr> <td><math>1/4W &lt; \phi \leq 1/2W</math></td> <td>1</td> </tr> <tr> <td><math>\phi &gt; 1/2W</math></td> <td>0</td> </tr> </tbody> </table> <p style="text-align: center;">Unit: mm</p> | Point Size | Acceptable Qty | $\phi \leq 1/4W$ | Disregard | $1/4W < \phi \leq 1/2W$ | 1 | $\phi > 1/2W$ | 0 |
| Point Size              | Acceptable Qty  |   |            |                |                  |           |                         |   |               |   |
| $\phi \leq 1/4W$        | Disregard   |   |            |                |                  |           |                         |   |               |   |
| $1/4W < \phi \leq 1/2W$ | 1   |   |            |                |                  |           |                         |   |               |   |
| $\phi > 1/2W$           | 0   |   |            |                |                  |           |                         |   |               |   |
| 8                       | Back-light  | (1) The color of backlight should be in match with the specification.<br>(2) Not allow flickering   |            |                |                  |           |                         |   |               |   |
| 9                       | Soldering   | (1) Not allow heavy dirty and solder ball on PCB.<br>(The size of dirty refer to point and dust defect)<br>(2) Over 50% of lead should be soldered on Land.<br>   |            |                |                  |           |                         |   |               |   |
| 10                      | Wire  | (1) Copper wire should not be rusted<br>(2) Not allow crack on copper wire connection.<br>(3) Not allow reversing the position of the flat cable.<br>(4) Not allow exposed copper wire inside the flat cable.   |            |                |                  |           |                         |   |               |   |
| 11*                     | PCB   | (1) Not allow screw rust or damage.<br>(2) Not allow missing or wrong putting of component.   |            |                |                  |           |                         |   |               |   |

| No | Item                              | Criterion   |
|----|-----------------------------------|---|
| 12 | Protruded<br>W: Terminal Width    |  <p>Acceptable criteria:<br/> <math>Y \leq 0.4</math></p>  |
| 13 | TAB                               | <p>1. Position</p>  <div style="border: 1px solid black; padding: 5px; display: inline-block;"> <math>W1 \leq 1/3W</math><br/> <math>H1 \leq 1/3H</math> </div> <p>2. TAB bonding strength test</p>  <p> <math>P (=F/TAB \text{ bonding width}) \geq 650\text{gf/cm}</math> ,(speed rate: 1mm/min)<br/>                     5pcs per SOA (shipment)                 </p> |
| 14 | Total no. of acceptable<br>Defect | <p>A. Zone</p> <p>Maximum 2 minor non-conformities per one unit.<br/>                     Defect distance: each point to be separated over 10mm</p> <p>B. Zone</p> <p>It is acceptable when it is no trouble for quality and assembly in customer's end product.</p>  |

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## Reliability test of LCM

Reliability test condition:

| Item                 | Condition                                     | Time (hrs) | Assessment                                   |
|----------------------|---|------------|--|
| High temp. Storage   | 80°C  | 48         | No abnormalities in functions and appearance |
| High temp. Operating | 70°C  | 48         |  |
| Low temp. Storage    | -30°C   | 48         |  |
| Low temp. Operating  | -20°C   | 48         |  |
| Humidity             | 40°C/ 90%RH                                   | 48         |  |
| Temp. Cycle          | 0°C ← 25°C → 50°C<br>(30 min ← 5 min → 30min) | 10cycles   |  |

Recovery time should be 24 hours minimum.

## Precaution for using LCD/LCM

LCD/LCM is assembled and adjusted with a high degree of precision. Do not attempt to make any alteration or modification. The followings should be noted.

### General Precautions:

1. LCD panel is made of glass. Avoid excessive mechanical shock or applying strong pressure onto the surface of display area.
2. The polarizer used on the display surface is easily scratched and damaged. Extreme care should be taken when handling. To clean dust or dirt off the display surface, wipe gently with cotton, or other soft material soaked with isopropyl alcohol or ethyl alcohol, do not use water, ketone or aromatics and never scrub LCD screen hard.
3. Do not tamper in any way with the tabs on the metal frame.
4. Do not make any modification on the PCB without consulting XIAMEM OCULAR
5. When mounting a LCM, make sure that the PCB is not under any stress such as bending or twisting. Elastomer contacts are very delicate and missing pixels could result from slight dislocation of any of the elements.
6. Avoid pressing on the metal bezel, otherwise the elastomer connector could be deformed and lose contact, resulting in missing pixels and also cause rainbow on the display.
7. Be careful not to touch or swallow liquid crystal that might leak from a damaged cell. Any liquid crystal spreads to skin or clothes, wash it off immediately with soap and water.

### Static Electricity Precautions:

1. CMOS-LSI is used for the module circuit; therefore, the operators should be grounded whenever he/she comes into contact with the module.
2. Do not touch any of the conductive parts such as the LSI pads; the copper leads on the PCB and the interface terminals with any parts of the human body.
3. Do not touch the connection terminals of the display with bare hand; it will cause disconnection or defective insulation of terminals.
4. The modules should be kept in anti-static bags or other containers resistant to static for storage.
5. Only properly grounded soldering irons should be used.
6. If an electric screwdriver is used, it should be grounded and shielded to prevent sparks.



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7. The normal static prevention measures should be observed for work clothes and working benches.
8. Since dry air is inductive to static, a relative humidity of 50-60% is recommended.

### **Soldering Precautions:**

1. Soldering should be performed only on the I/O terminals.
2. Use soldering irons with proper grounding and no leakage.
3. Soldering temperature:  $280^{\circ}\text{C}\pm 10^{\circ}\text{C}$
4. Soldering time: 3 to 4 second.
5. Use eutectic solder with resin flux filling.
6. If flux is used, the LCD surface should be protected to avoid spattering flux.
7. Flux residue should be removed.

### **Operation Precautions:**

1. The viewing angle can be adjusted by varying the LCD driving voltage  $V_o$ .
2. Since applied DC voltage causes electro-chemical reactions, which deteriorate the display, the applied pulse waveform should be a symmetric waveform such that no DC component remains. Be sure to use the specified operating voltage.
3. Driving voltage should be kept within specified range; excess voltage will shorten display life.
4. Response time increases with decrease in temperature.
5. Display color may be affected at temperatures above its operational range.
6. Keep the temperature within the specified range usage and storage. Excessive temperature and humidity could cause polarization degradation, polarizer peel-off or generate bubbles.
7. For long-term storage over  $40^{\circ}\text{C}$  is required, the relative humidity should be kept below 60%, and avoid direct sunlight.