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# LCD MODULE SPECIFICATION
# FOR CUSTOMER'S APPROVAL

**CUSTOMER : Standard**

**MODULE TYPE : MTG-S12864AFYHSAY**

| APPROVED BY: (FOR CUSTOMER USE ONLY) |
|---|
| |

| Approved By | Checked By | Prepared By | MT File No | Date Issued |
|---|---|---|---|---|
| | | | | |

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# SPECIFICATION FOR

# LIQUID CRYSTAL DISPLAY MODULE

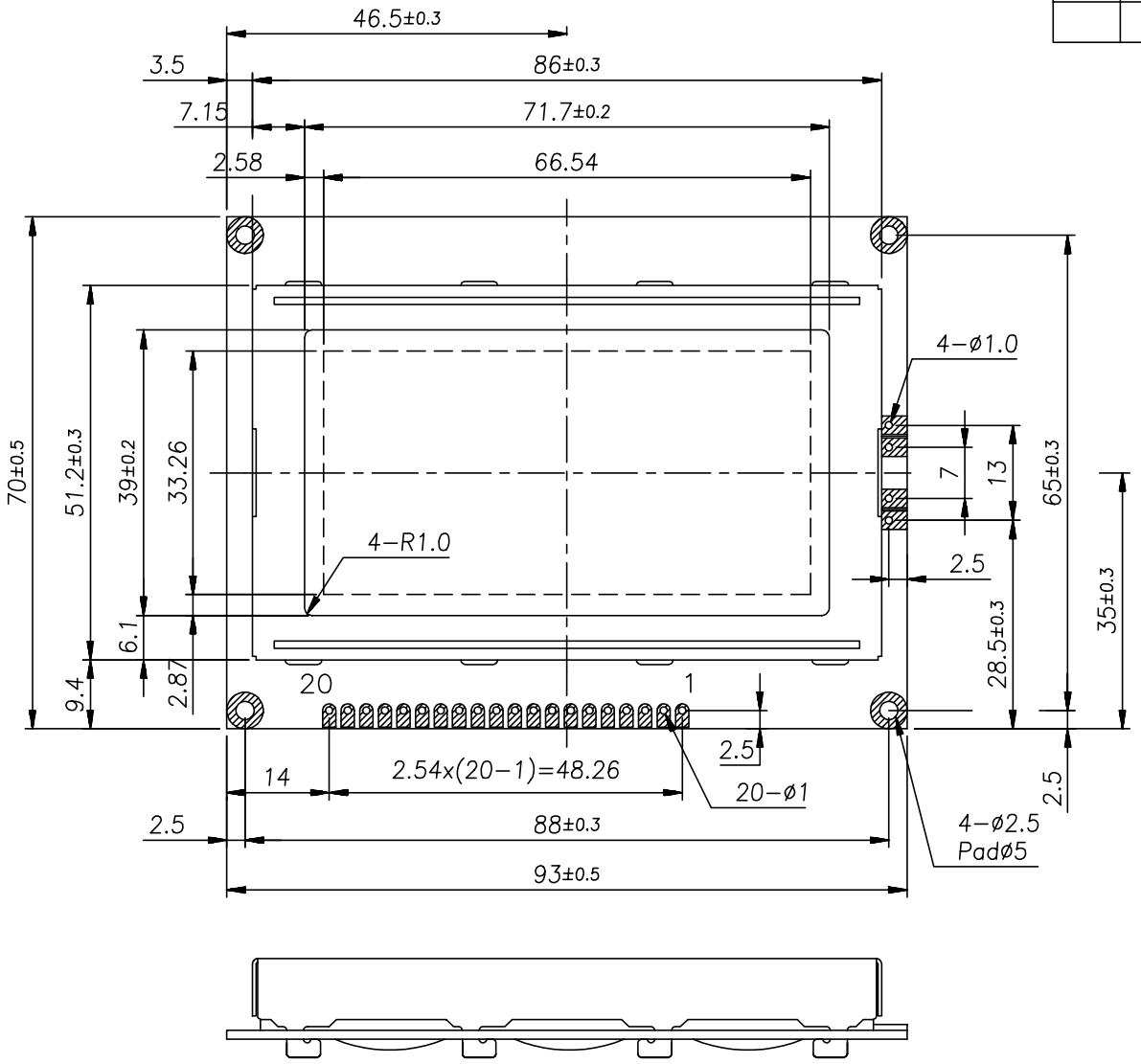
# MODEL NO. : MTG-S12864AFYHSAY

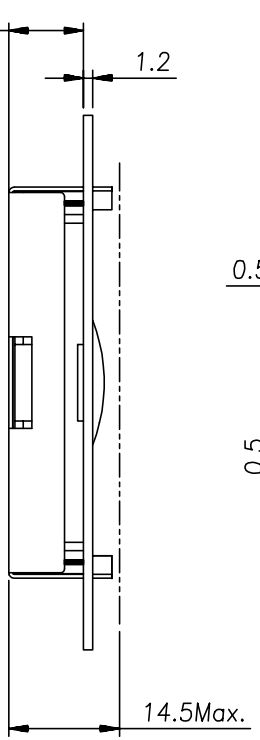
| | | | | |
|---|---|---|---|---|
| View Direction | ☑ 6 O'clock | | ☐12 O'clock | |
| LCD Type | ☐ FSTN Positive | | ☐ FSTN Negative | |
| | ☐ STN Gray | ☑ STN Yellow Green | ☐ STN Blue | |
| Rear Polarizer | ☐ Reflective | ☑ Transflective | ☐ Transmissive | |
| Backlight Type | ☑ LED | ☐ Internal Power | ☐ EL | ☑ 5V input |
| | | ☑ External Power | ☐ CCFL | ☐ 24V input |
| Backlight Color | ☐ White | ☐ Amber | ☐ Blue Green | ☑ Yellow Green ☐ Other |
| Temperature Range | ☐ Normal | ☑ Wide | ☐ Super Wide | |
| EL Driver IC | ☐ Build-in | ☑ Not Build-in | | |
| DC-to-DC | ☐ With | ☑ Without | | |

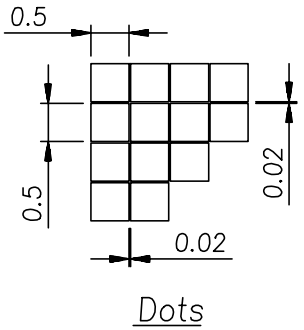
## TO BE VERY CAREFUL !

The LCD driver ICs are made by CMOS process, which are very easy to be damaged by static charge, make sure the user is grounded when handling the LCM.

| REV. | DESCRIPTION | DRAWN | CHECK | APP'D | DATE |
|---|---|---|---|---|---|
| | | | | | |






| PIN ASSIGNMENT | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | VSS | 5. | R/W | 9. | DB2 | 13. | DB6 | 17. | RST |
| 2. | VDD | 6. | E | 10. | DB3 | 14. | DB7 | 18. | VEE |
| 3. | V0 | 7. | DB0 | 11. | DB4 | 15. | CS1 | 19. | BKL1 |
| 4. | D/I | 8. | DB1 | 12. | DB5 | 16. | CS2 | 20. | BKL2 |

| | M-12864AH | --- | 4-28-99' | --- | --- |
|---|---|---|---|---|---|
| NO. | PART NAME | Q'TY | DATE: | MATERIAL | FINISH |

| Microtips Technology | DRAWN | CHECK | APP'D | UNIT: MM | SCALE: 1 /1 | PRODUCT: MTG-12864A(H) |
|---|---|---|---|---|---|---|
| | Henry | Chris | Steele | | UNLESS OTHERWISE SPECIFIED TOLERANCE ON FRACTIONS DECIMALS ANGLES 0.10 0.5° | DWG NO.: G12864A1 |
| | | | | | | FILE: DWG\MTG128\G12864A |
| | | | | | | SHEET 1 / 1 Rev: A |

# GENERAL SPECIFICATION

| Item | Content |
|---|---|
| Display Resolution | 128(W)× 64(H) |
| Dimensional Outline(mm) | 93.0(W)× 70.0(H)× 14.5max(D) |
| Display mode | Transflective Type/ Positive Display |
| Circuit | Common-Driver IC, Segment-driver IC with build-in SRAM |
| Interface | Data (D0～D7), D/I, R/W, E, RST, CS1, CS2, $V_{EE}$, $V_{ADJ}$ |

# ABSOLUTE MAXIMUN RATING

(1) Electrical Absolute Ratings

| Item | Symbol | Min. | Max. | Unit | Note |
|---|---|---|---|---|---|
| Power Supply for Logic | $V_{DD}$-$V_{SS}$ | -0.3 | 6.5 | Volt | |
| Power Supply for LCD | $V_{DD}$-$V_{EE}$ | -0.3 | 19.0 | Volt | |
| Input Voltage | $V_I$ | -0.3 | $V_{DD}$ | Volt | |
| Supply Current for LED backlight | $I_{LED}$ | - | 780 | mA | |

(2) Environmental Absolute Maximum Ratings

| Item | Normal Temperature | | | | Wide Temperature | | | |
|---|---|---|---|---|---|---|---|---|
| | Operating | | Storage | | Operating | | Storage | |
| | Max, | Min. | Max, | Min. | Max, | Min. | Max, | Min. |
| Ambient Temperature | 0℃ | +50℃ | -20℃ | +70℃ | -20℃ | +70℃ | -30℃ | +80℃ |
| Humidity(without condensation) | Note 2,4 | | Note 3,5 | | Note 4,5 | | Note 4,6 | |

Note 2 Ta≦50℃: 80% RH max
Ta>50℃: Absolute humidity must be lower than the humidity of 85%RH at 50℃

Note 3 Ta at -20℃ will be<48hrs at 70℃will be <120hrs when humidity is higher than 75%.

Note 4 Background color changes slightly depending on ambient temperature. This phenomenon is reversible.

Note 5 Ta≦70℃: 75RH max
Ta>70℃: absolute humidity must be lower than the humidity of 75%RH at 70℃

Note 6 Ta at -30℃ will be <48hrs, at 80 ℃ will be <120hrs when humidity is higher than 75%.

# ELECTRICAL CHARACTERISTICS

| Item | Symbol | Condition | Min. | Typ | Max. | Unit | note |
|---|---|---|---|---|---|---|---|
| Power Supply for Logic | $V_{DD}$-$V_{SS}$ | - | 4.5 | 5.0 | 5.5 | Volt | - |
| Input Voltage | $V_{IL}$ | L level | $V_{SS}$ | 0.2 $V_{DD}$ | - | Volt | - |
| | $V_{IH}$ | H level | 0.8 $V_{DD}$ | $V_{DD}$ | - | Volt | - |
| LCM Recommend LCD Module Driving Voltage | $V_{DD}$ –$V_O$ | $T_a$＝-20℃ | 10.1 | 10.7 | 11.3 | Volt | - |
| | | $T_a$＝25℃ | 9.7 | 10.3 | 10.9 | | |
| | | $T_a$＝70℃ | 9.6 | 10.2 | 10.8 | | |
| Power Supply Current for LCM | $I_{DD}$(LED B/L OFF) | $V_{DD}$ =5.0V<br>$T_a$=25℃<br>$V_{DD}$-$V_O$ =10.3V<br>$V_{LED}$=4.2V | - | 1.5 | 1.8 | mA | - |
| | $I_{EE}$ | | - | 0.6 | 1.0 | | |
| | $I_{LED}$ (LED B/L ON) | | - | 390 | 585 | | |
| Power Supply for Backlight | $V_{LED}$ | Ta=25℃ | - | 4.2 | - | V DC | - |
| | $V_{EL}$ | | - | 100VAC /400 Hz | - | VAC | |

# OPTICAL CHARACTERISTICS

| Item | Symbol | Condition | Min. | Typ | Max. | Unit | note |
|---|---|---|---|---|---|---|---|
| Viewing angle range | $\theta_f$(12 o'clock) | When Cr≧2 | - | 35 | - | Degree | 9,10 |
| | $\theta_b$(6 o'clock) | | - | 45 | - | | |
| | $\theta_l$(9 o'clock) | | - | 30 | - | | |
| | $\theta_r$(3 o'clock) | | - | 30 | - | | |
| Rise Time | $T_r$ | $V_{DD}$-$V_O$ =10.3V Ta=25℃ | | 110 | 165 | mS | |
| Fall Time | $T_f$ | | | 250 | 300 | | |
| Contrast | Cr | | - | 5.34 | - | | 7 |

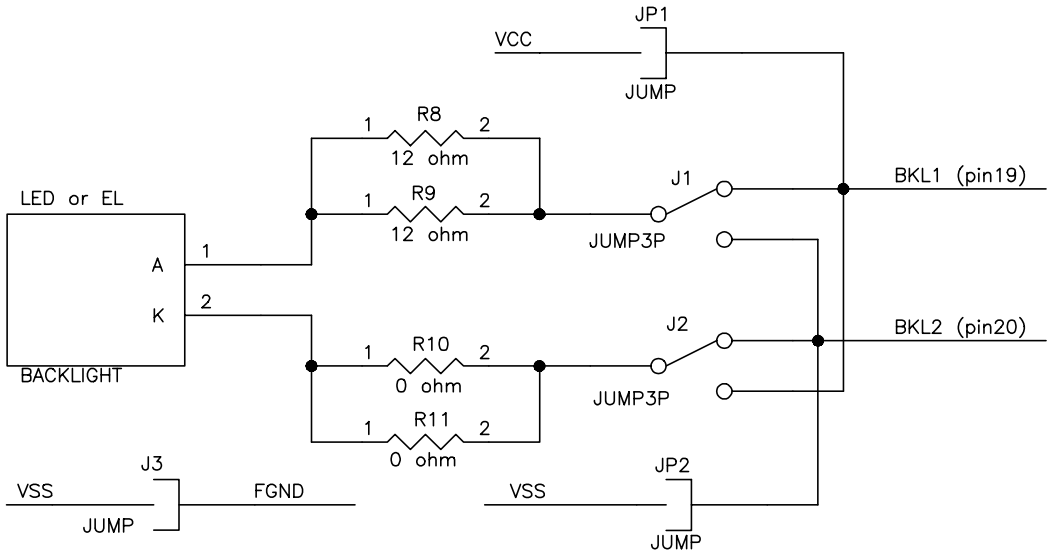
# MECHANICAL SPECIFICATION

| | | |
|---|---|---|
| Product No. | | MTG-S12864AFYHSAY |
| Module Size | | 93.0(W)× 70.0(H)× 14.5max(D) |
| Dot Size | | 0.50(W)mm× 0.50(H)mm |
| Dot Pitch | | 0.52(W)mm× 0.52(H)mm |
| Resolution | | 128(W)× 64(H) Dots Matrix |
| Duty Ratio | | 1/64 Duty |
| LCD Display Mode | STN | ☐Gray Mode ☑Yellow Mode ☐Blue Mode |
| | FSTN | ☐ Black & White(Normally White/Positive Image)<br>☐ Black & White(Normally White/Negative Image) |
| | Rear Polarizer: | ☐ Reflective ☑ Transflective ☐ Transmissive<br>☐ Transflective(High Transmissive) |
| Viewing Direction | | ☑6 O'clock ☐12 O'clock ☐3 O'clock ☐9 O'clock |
| Backlight | | ☐W/O ☐CCFL ☐EL ☑LED |
| Controller | | KS0108 or compatible |
| DC/DC Converter | | Optional |
| EL Driver | | Without |

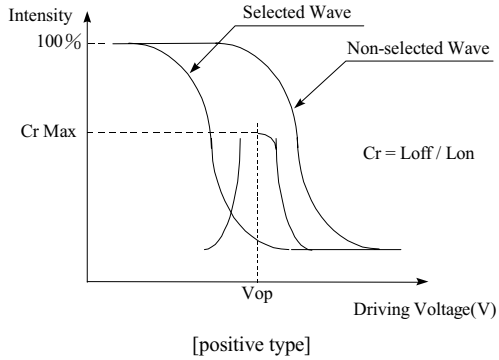
# INTERFACE PIN ASSIGNMENT

| Pin No. | Pin Out | I/O | Description |
|---|---|---|---|
| 1 | $V_{SS}$ | - | GND |
| 2 | $V_{DD}$ | - | Logic supply voltage |
| 3 | $V_O$ | - | Power supply for LCD panel, tuning from $V_{DD}$-$V_{EE}$ |
| 4 | D/I | I | Data/Instruction<br>D/I=high：Indicates that data of DB0~DB7 is display data.<br>D/I=low：Indicates that data of DB0~DB7 is instruction. |
| 5 | R/W | I | Read/Write<br>R/W=high：Data of DB0~DB7 can be read by CPU.<br>R/W=low：Data of DB0~DB7 can be written into LCD driver IC at the falling edge of E when CS1 and CS2 is high. |
| 6 | E | I | Enable<br>When write(R/W=low)：Data of DB0~DB7 is latched at the fall of E<br>When read(R/W=high)：Data is read while E is at high level. |
| 7<br>\|<br>14 | DB0<br>\|<br>DB7 | I/O | Data bus. 3-state I/O common terminal. |
| 15 | CS1 | I | Chip-select for the left half of the display. Active high. |
| 16 | CS2 | I | Chip-select for the right half of the display. Active high. |
| 17 | RES | I | Setting the RES signal to Low level can initialize the following registers.<br>1. ON/OFF register 0 set(Display off)<br>2. Display start line register 0 set(display starts from line 0)<br>After releasing reset, this condition can be changed only by software. |
| 18 | $V_{EE}$ | - | Power supply for LCD driving circuit.<br>Please refer page 11 for DC-to-DC connecting |
| 19 | $BKL_A$ | - | Power supply for backlight.<br>(4.2V/390~585 mA DC for LED backlight, 110V/400Hz AC for EL) |
| 20 | $BKL_K$ | | |

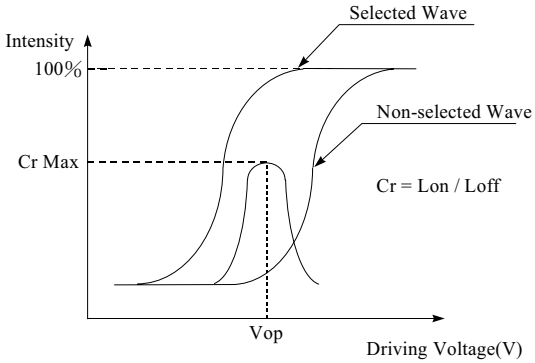
**JUMPER EXPLANATION:**



## [Note 7] Definition of Operation Voltage (Vop)

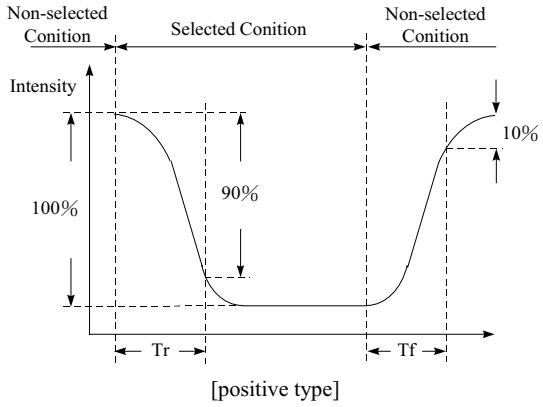



[positive type]

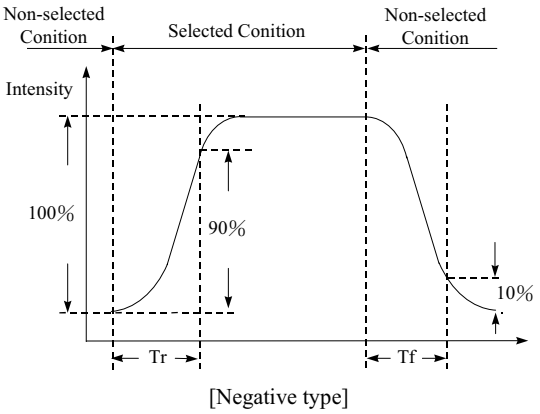



[Negative type]

## [Note 8] Definition of Response Time (Tr, Tf)




[positive type]



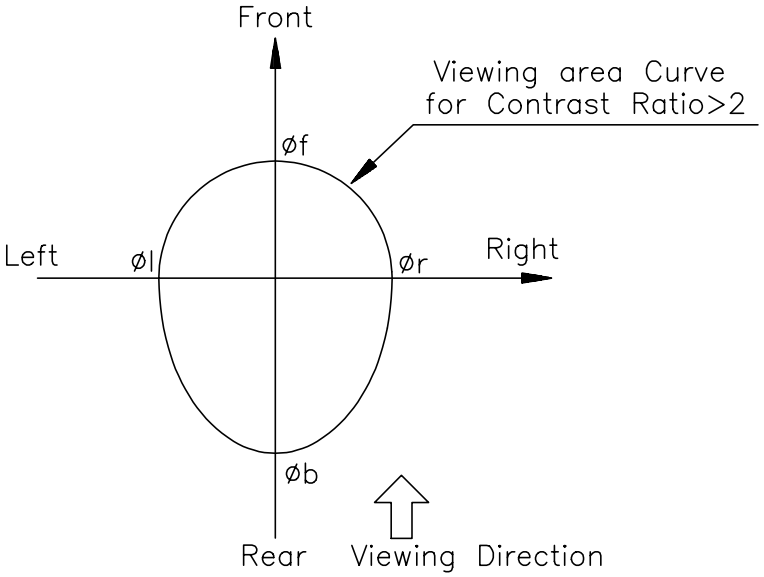

[Negative type]

**Conditions:**

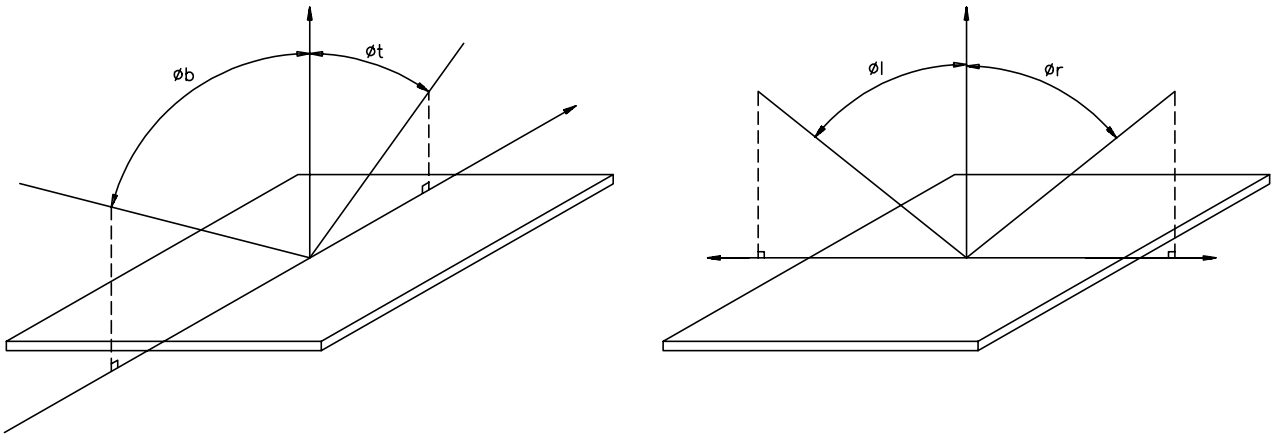
**Operating Voltage : Vop** **Viewing Angle($\theta$, $\varphi$): 0°, 0°**

**Frame Frequency : 64 Hz** **Driving Wave form : 1/N duty, 1/a bias**

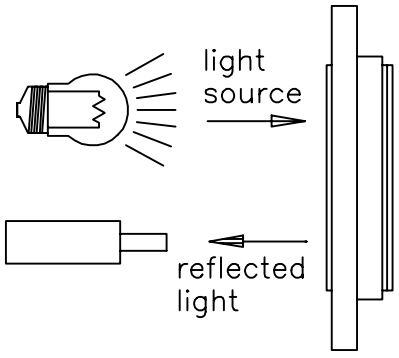
## [Note 9] Definition of Viewing Direction



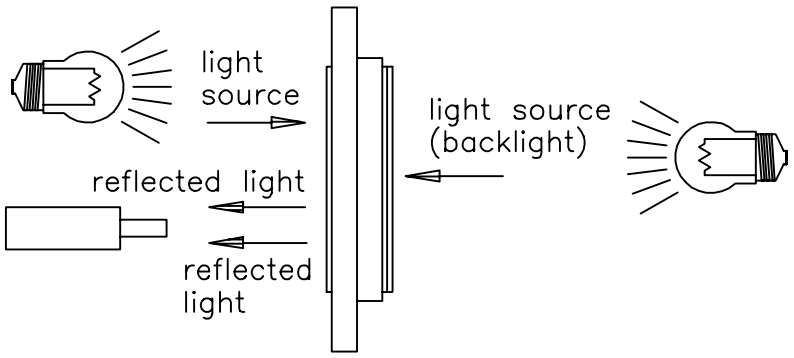
**[Note 10] Definition of viewing angle**




**[Note 11] Description of Measuring Equipment**

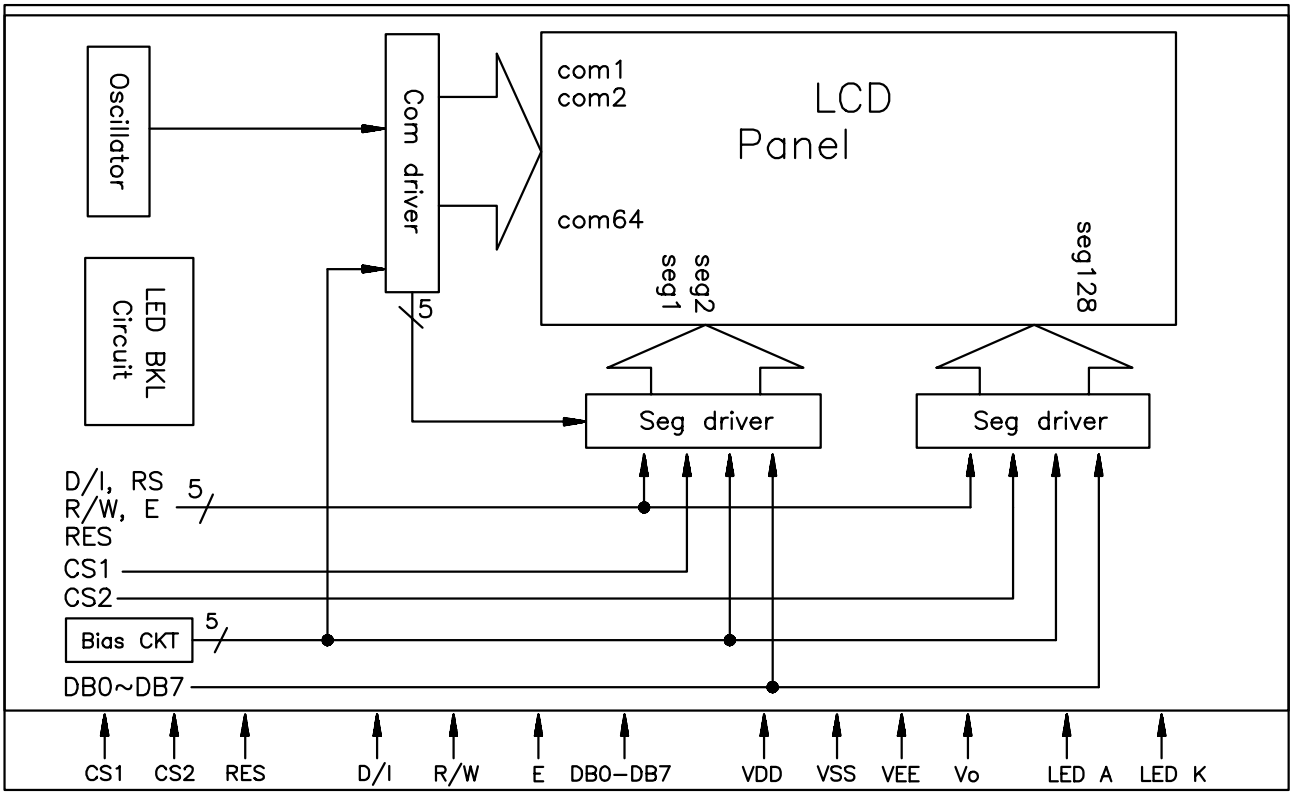



Reflective type

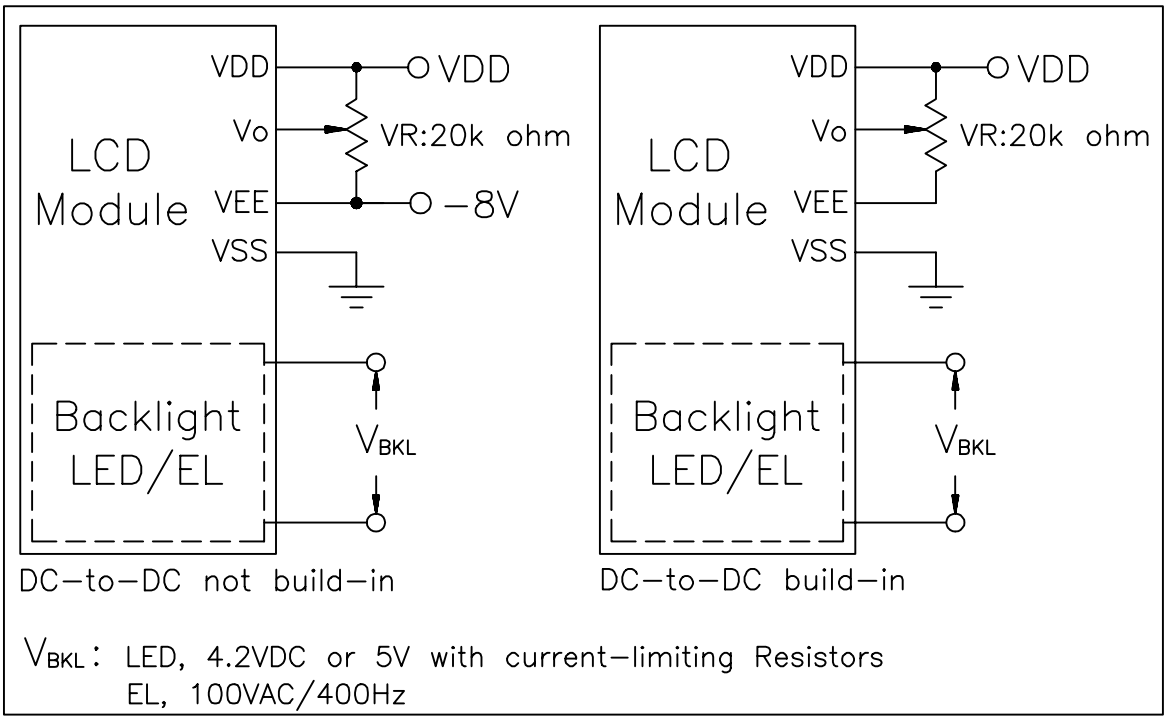



Transflective type

# BLOCK DIAGRAM



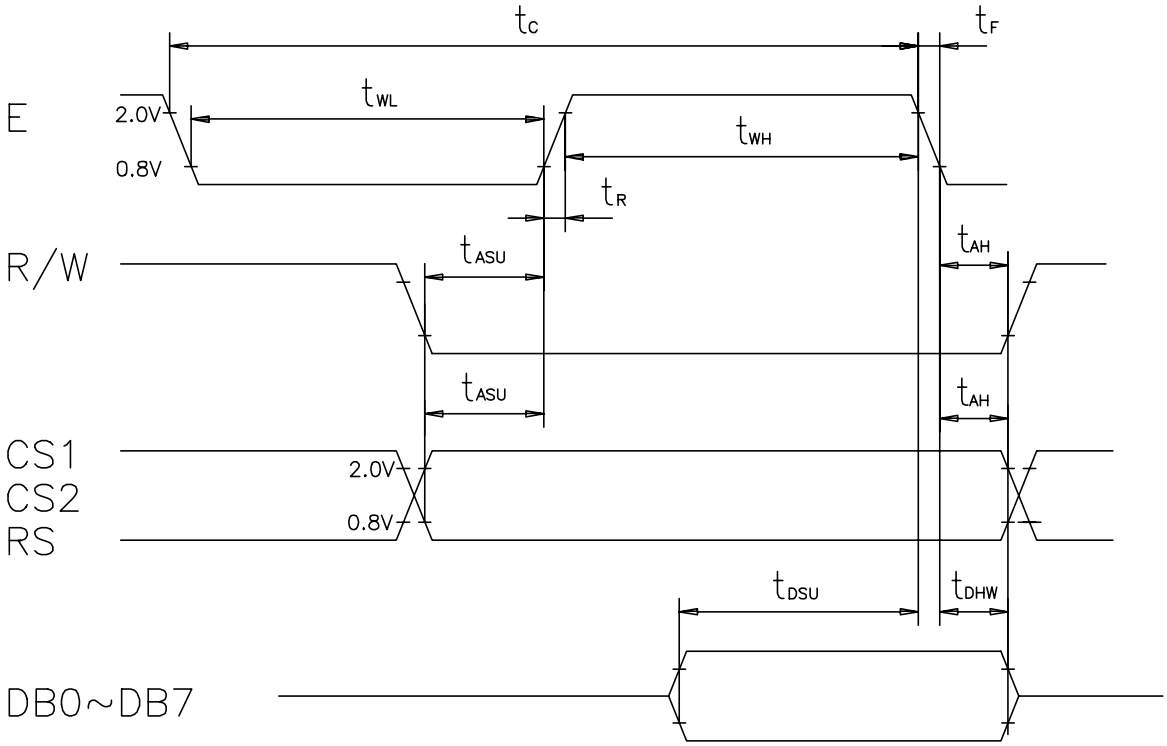

# POWER SUPPLY



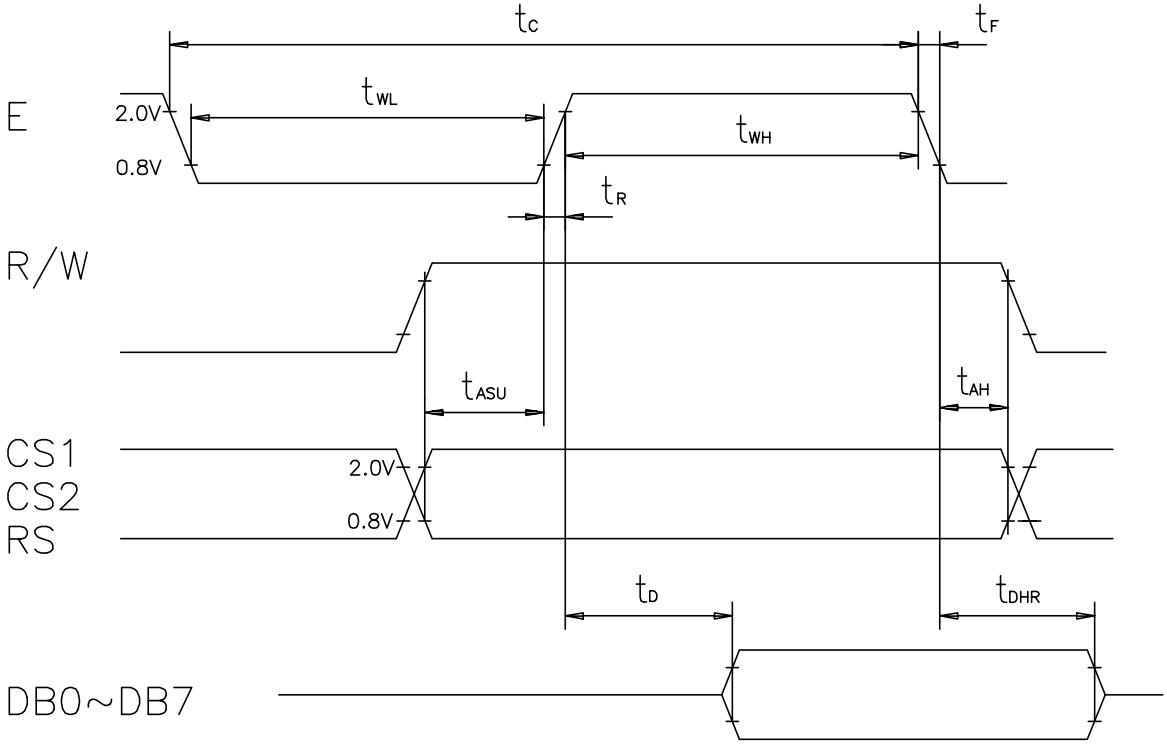
# TIMING CHARACTERISTICS

MPU interface timing: ($V_{SS}$ =0V, $V_{DD}$=4.5V~5.5V, $T_a$=0 to 50℃)

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




MPU Write Timing




MPU Read Timing

# DISPLAY COMMANDS

The display commands shown below control the internal state of the LCD driver ICs. Commands are sent from CPU to LCD module for the display control.

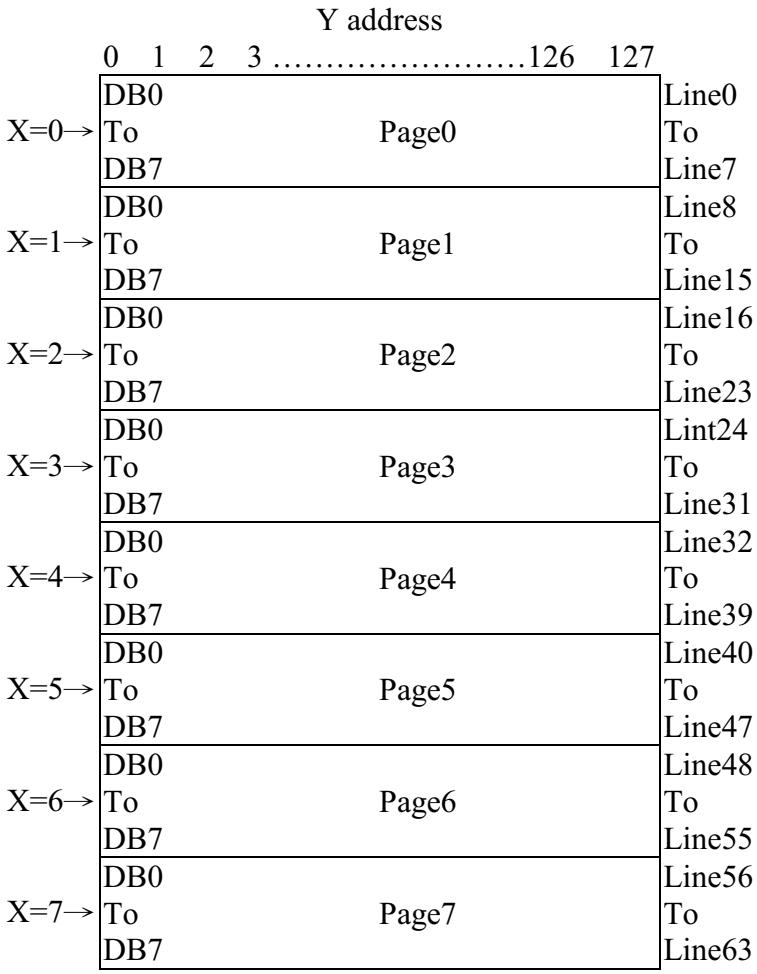
| Command | RS | R/W | DB7 | DB6 | DB5 | DB4 | DB3 | DB2 | DB1 | DB0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Display ON/OFF | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1/0 | To control the display ON or OFF. The internal status and display RAM data are not affected.<br>0:OFF, 1:ON |
| Set address (Y address) | 0 | 0 | 0 | 1 | Y address (0~63) | | | | | | To set the Y address in the Y address counter. |
| Set page (X address) | 0 | 0 | 1 | 0 | 1 | 1 | 1 | Page(0~7) | | | To set the X address at the X address register. |
| Display Start Line | 0 | 0 | 1 | 1 | Display Start Line(0~63) | | | | | | To indicate the display data RAM displayed at the top of the screen. |
| Status Read | 0 | 1 | Busy | 0 | ON/ OFF | Reset | 0 | 0 | 0 | 0 | To read status of the LCD controller IC:<br>Busy<br>0:Ready, 1: In operation<br>ON/OFF:<br>0:Display ON, 1:Display OFF<br>Reset:<br>0:Normal, 1:Reset |
| Write display data | 1 | 0 | Write Data | | | | | | | | To write data into display data RAM. Y address is increased by 1 after this command. |
| Read Display data | 1 | 1 | Read Data | | | | | | | | To read data from display data RAM to the data bus. |

# MEMORY MAPPING

Relationship between RAM data and display

| | | RAM Y address(Y0 ~Y127) | | | | | | | | | | | | | Data |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1st page(X=0) | Line 0→ | 0 | 1 | 1 | 1 | 0 | 0 | ····· | 0 | 0 | 1 | 0 | 0 | 0 | ←DB0(LSB) |
| | Line 1→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 0 | 1 | 1 | 0 | 0 | ←DB1 |
| | Line 2→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 0 | 1 | 0 | 1 | 0 | ←DB2 |
| | Line 3→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 0 | 1 | 0 | 1 | 0 | ←DB3 |
| | ⋮ | 1 | 1 | 1 | 1 | 1 | 0 | ····· | 0 | 0 | 1 | 0 | 0 | 0 | ←DB4 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 1 | 1 | 1 | 0 | 0 | 0 | ←DB5 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 1 | 1 | 1 | 0 | 0 | 0 | ←DB6 |
| | Line 7→ | 0 | 0 | 0 | 0 | 0 | 0 | ····· | 0 | 0 | 0 | 0 | 0 | 0 | ←DB7(MSB) |
| 2nd page(X=1) | Line 8→ | 1 | 1 | 1 | 1 | 0 | 0 | ····· | 0 | 1 | 1 | 1 | 0 | 0 | ←DB0(LSB) |
| | Line 9→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 1 | 0 | 0 | 1 | 0 | ←DB1 |
| | Line 10→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 1 | 0 | 0 | 1 | 0 | ←DB2 |
| | ⋮ | 1 | 1 | 1 | 1 | 0 | 0 | ····· | 1 | 1 | 1 | 0 | 1 | 0 | ←DB3 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 1 | 0 | 0 | 1 | 0 | ←DB4 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 1 | 0 | 0 | 1 | 0 | ←DB5 |
| | ⋮ | 1 | 1 | 1 | 1 | 0 | 0 | ····· | 0 | 1 | 1 | 1 | 0 | 0 | ←DB6 |
| | Line 15→ | 0 | 0 | 0 | 0 | 0 | 0 | ····· | 0 | 0 | 0 | 0 | 0 | 0 | ←DB7(MSB) |
| | ⋮ | | | | | | | ····· | | | | | | | |
| 8th page(X=7) | Line 56→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 0 | 0 | 0 | 0 | 0 | ←DB0(LSB) |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 0 | 0 | 0 | 0 | 0 | ←DB1 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 1 | 0 | 0 | 1 | 0 | ←DB2 |
| | ⋮ | 1 | 1 | 1 | 1 | 1 | 0 | ····· | 1 | 0 | 1 | 0 | 1 | 0 | ←DB3 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 1 | 0 | 0 | 1 | 0 | 0 | ←DB4 |
| | ⋮ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 1 | 0 | 0 | 1 | 0 | 0 | ←DB5 |
| | Line 62→ | 1 | 0 | 0 | 0 | 1 | 0 | ····· | 0 | 1 | 1 | 0 | 1 | 0 | ←DB6 |
| | Line 63→ | 0 | 0 | 0 | 0 | 0 | 0 | ····· | | | | | | | ←DB7(MSB) |

# ADDRESS CONFIGURATION OF DISPLAY DATA RAM




Address configuration of Display Data RAM

# RELIABILITY TEST

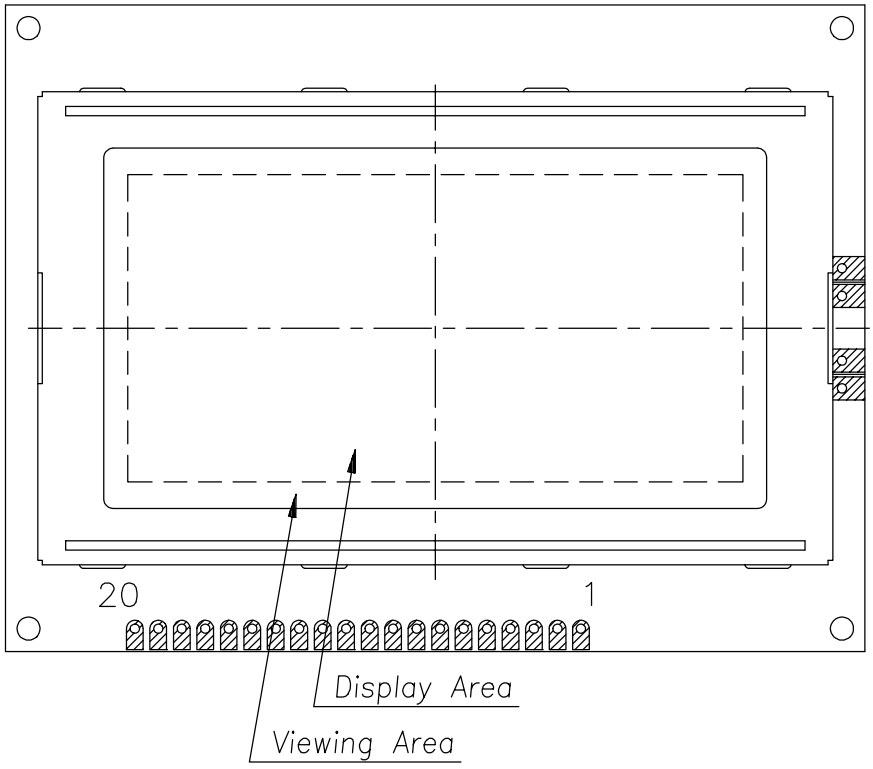
| No | Item | Conditions | | Note |
|---|---|---|---|---|
| 1 | High Temp. Operation | 70℃ | 240 HR | |
| 2 | High Temp. Storage | 80℃ | 240 HR | |
| 3 | Low Temp. Operation | -20℃ | 240 HR | |
| 4 | Low Temp. Storage | -30℃ | 240 HR | |
| 5 | High Temp./Humid Storage | 60℃ 90%RH | 240 HR | |
| 6 | Thermal Shock | 0℃ ,30min<br>+50℃ ,30min | 10 cycles | |
| 7 | Vibration Test<br>( IEC-68-2-6 ) | Frequency : 10~55 Hz<br>Duration : 20 times, 6 min/time<br>Amplitude : 0.75 mm | - | |
| 8 | Shock<br>( IEC 68-2-27) | Duration : 11 mS<br>Acceleration : 100g | - | X, Y, Z direction |

# APPEARANCE CHECK

CONDIITON OF APPEARANCE CHECK:

(1)Specimen shall be checked by eyes in distance of 30cm under 40w-fluorescence lamp.

(2)Checking direction shall be in 45 degree from perpendicular line op specimen surface.



# HANDLING PRECAUTIONS

(1)Treat polarizer very carefully since it is easy to be damaged.

(2)When cleaning the display surface, use soft cloth (e.g. gauss) with a solvent (recommended below) and wipe lightly.

- ◆ ethyl alcohol
- ◆ iso-prcolol

Do not wipe the display surface with dry or hard materials that will damage the polarizer surface.

Do not use the following solvents:

- ◆ water
- ◆ ketone
- ◆ aromatics

(3)Direct current causes electro-chemical reaction with remarkable degradation of the display quality. Give careful consideration to prevent direct current at ON/OFF timing and during operation.

(4)Avoid strong shock and drop from the height.

(5)To prevent LCD panels from degradation, do not operate or store them exposed directly to sunshine or high temperature/humidity.

(6)Give careful consideration to avoid electrical static discharge with causes uneven contrast.

(7)Even a small condensation on the contact pads (terminals) causes electro-chemical reaction which makes missing row and column. Give careful attention to avoid condensation. When assembling with zebra connector, clean the surface of the pads with alcohol and keep the air very clean.

# LCD PRODUCT QUALITY STANDARD

DISPLAY APPEARANCE

| No | Item | Criteria |
|---|---|---|
| 1 | inclusions (black spot, white spot, dust) | (1)round type<br>diameter mm(a*) no of defect*<br>a≦0.20 neglect<br>0.20＜a≦0.35 5max<br>0.35＜a none<br>(2)linear type<br>length mm(l) width mm(W) no. of defect<br>na W≦0.03 neglect<br>l≦3 0.03＜W≦0.08 6<br>3＜l 0.08＜W none |
| 2 | scratch | 1.scratch on protective film is permitted.<br>2.scratch on polarizer shall be as follow:<br>(1)round type<br>diameter mm(a*) no of defect<br>a≦0.15 neglect<br>0.15＜a≦0.20 2 max<br>0.20＜a none<br>(2)linear type<br>be judged bye 1.-(2) linear type |
| 3 | dent | diameter ＜ 1.5mm |
| 4 | bubble | not exceeding 0.5mm average diameter is acceptable between glass and polarizing film |
| 5 | pin hole | (a+b)/2 ≦ 0.15mm<br>maximum number: ignored<br>0.15＜(a+b)/2≦0.20mm<br>maximum number:10 |
| 6 | dot defect | (a+b)/2≦0.20mm<br>maximum number: ignored<br>0.20＜(a+b)/2≦0.30mm<br>maximum number:5<br>x=width |
| 7 | contrast irregularity(spot) | diameter spec no of defect<br>a≦0.50mm neglect<br>0.50＜a≦0.75 5<br>0.75＜a≦1.00 3<br>1.00＜a none |
| 8 | dot width | design width ±15% |
| 9 | color tone and uniformity | obvious uneven color is not permitted |

## REVISION HISTORY

| Revision Content | Page | Date |
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