# Display Elektronik GmbH

## DATA SHEET

## LCD MODULE

# DEM 128064K FGH-PW

**Product Specification**                                   **Ver.: 0**

**13/Nov./2009**

# SPECIFICATION
# FOR
# LCM MODULE

## MODULE NO:
# DEM 128064K FGH-PW

**Customer Approval:**

|  |  |  |
|---|---|---|

|  | SIGNATURE | DATE |
|---|---|---|
| PREPARED BY (RD ENGINEER) |  | Nov-13-2009 |
| PREPARED BY (QA ENGINEER) |  |  |
| CHECKED BY |  |  |
| APPROVED BY |  |  |

## DOCUMENT REVISION HISTORY

| Version | DATE | DESCRIPTION | CHANGED BY |
|---------|------|-------------|------------|
| 0 | Nov-13-2009 | First Issue | MH |

# CONTENTS

# 1. FUNCTIONS & FEATURES
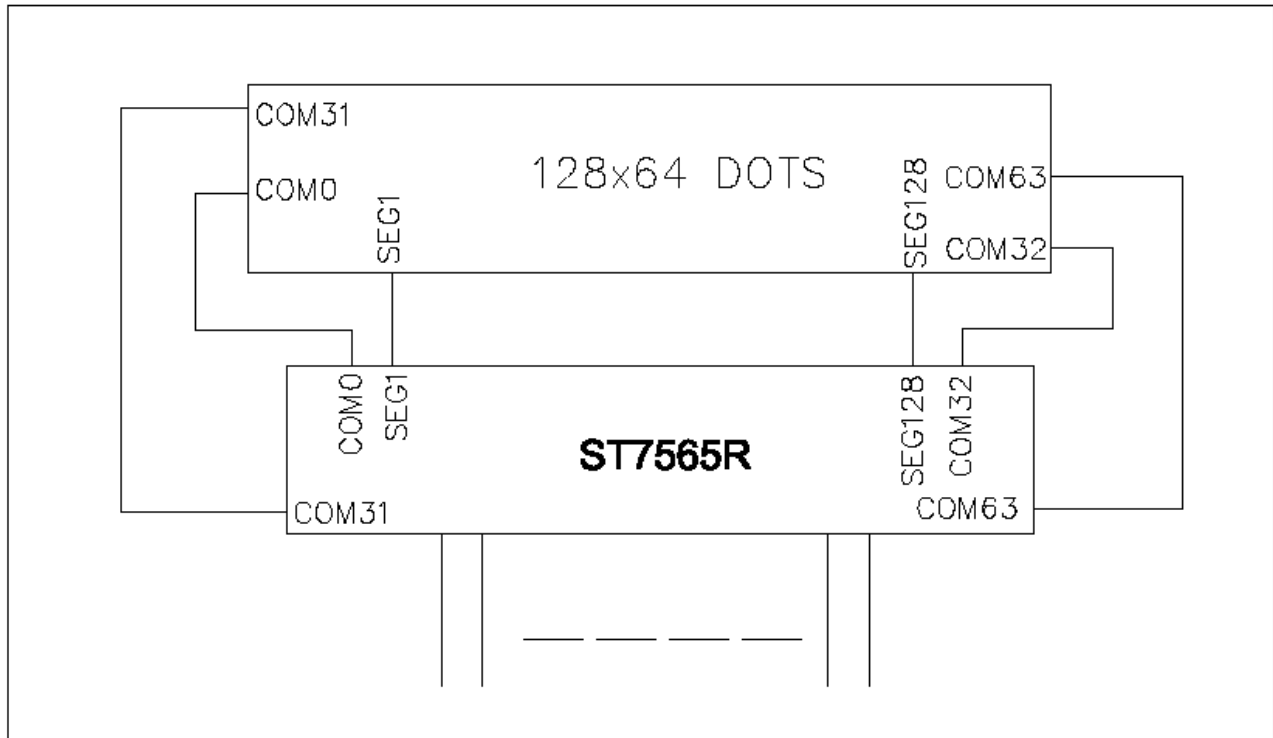
Display Format                               : COG, 128 x 64 Dots
LCD Mode                                     : FSTN / Positive/ Transflective Mode
Viewing Direction                           : 6 o'clock
Driving Scheme                           : 1/65 Duty cycle, 1/9 Bias
Power Supply Voltage ($V_{DD}$)          : 3.3 Volt (typ.)
LCD Driving Voltage ($V_{LCD}$)           : 9.0 Volt (Reference Voltage)
Operation Temperature                  : -20 ~ 70°C
Storage Temperature                    : -30 ~ 80°C
Backlight Color                          : LED, White, Lightguide
RoHS                                          : Compliant.

# 2. MECHANICAL SPECIFICATIONS
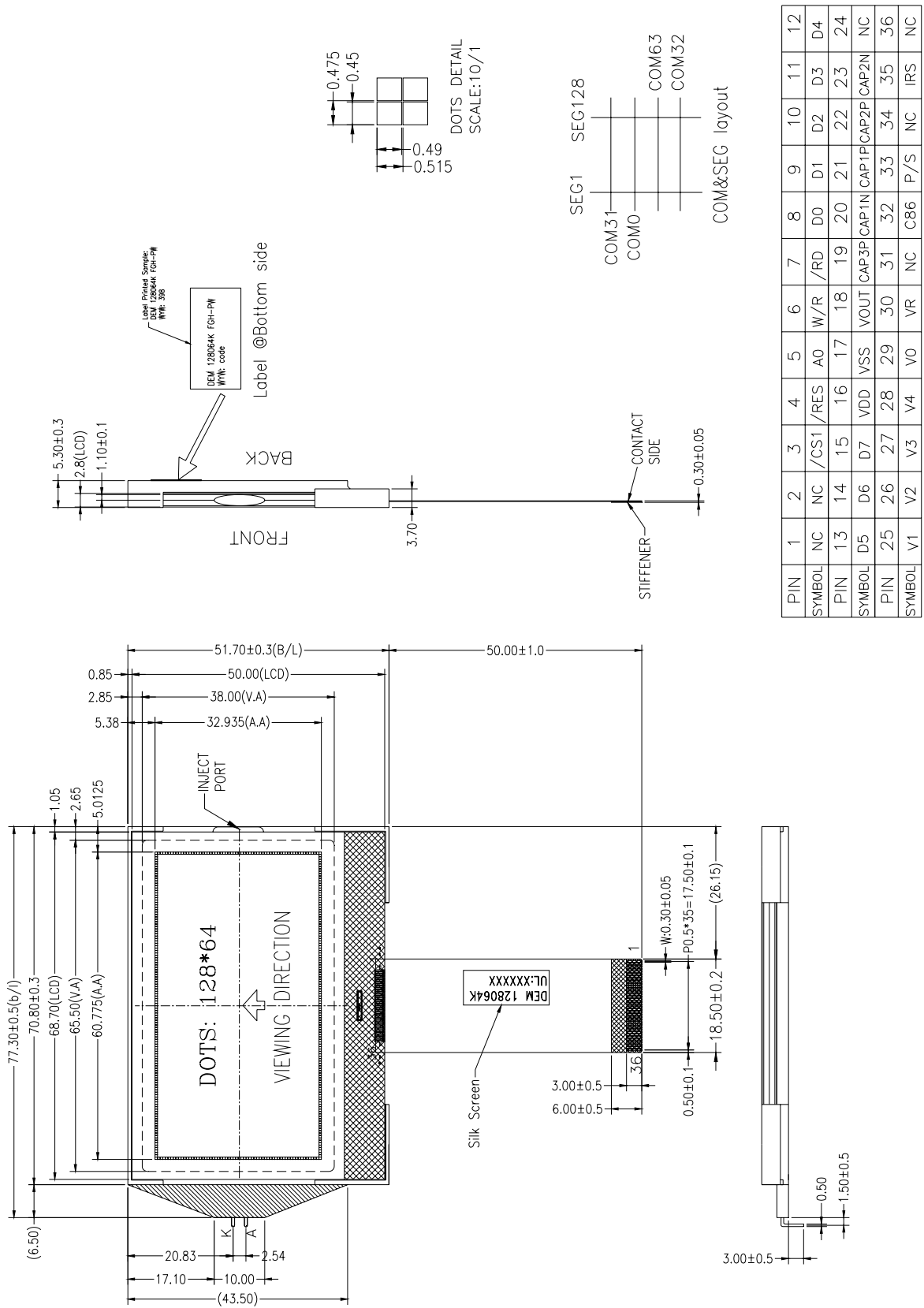
Module Size                                  : 77.30 x 51.70 x 5.30 mm (without FPC)
Viewing Area                               : 65.50 x 38.00 mm
Dot Pitch                                   : 0.475 x 0.515 mm
Dot Size                                     : 0.450 x 0.490 mm

# 3. BLOCK DIAGRAM

# 4. DIMENSIONAL OUTLINE



DOTS DETAIL SCALE:10/1

0.475
0.45
0.49
0.515

COM&SEG layout

SEG1    SEG128

COM31    COM63
COM0     COM32

| PIN | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SYMBOL | NC | NC | /CS1 | /RES | A0 | W/R | /RD | D0 | D1 | D2 | D3 | D4 |
| PIN | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| SYMBOL | D5 | D6 | D7 | VDD | VSS | VOUT | CAP3P | CAP1N | CAP1P | CAP2N | CAP2P | NC |
| PIN | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 |
| SYMBOL | V1 | V2 | V3 | V4 | V0 | VR | NC | C86 | P/S | NC | IRS | NC |

Label Printed Sample:
DEM 128064K FGH-PW
WYW: code

Label @Bottom side

BACK
FRONT

5.30±0.3
2.8(LCD)
1.10±0.1

3.70

CONTACT SIDE
STIFFENER
0.30±0.05

51.70±0.3(B/L)
50.00(LCD)
38.00(V.A)
32.935(A.A)
50.00±1.0

0.85
2.85
5.38

INJECT PORT

1.05
2.65
5.0125

77.30±0.5(b/l)
70.80±0.3
68.70(LCD)
65.50(V.A)
60.775(A.A)

DOTS: 128*64
VIEWING DIRECTION

W:0.30±0.05
P0.5*35=17.50±0.1
(26.15)
18.50±0.2

1
36
0.50±0.1

3.00±0.5
6.00±0.5

Silk Screen
DEM 128064K
UL:XXXXXX

(6.50)

K    A
20.83    2.54
17.10    10.00
(43.50)

0.50
1.50±0.5
3.00±0.5

## 5. LCD Driving voltage generator and bias reference circuit

When the voltage regulator internal resistor is not used.
(Example where $V_{DD2}=V_{DD}$, with 4× step-up)
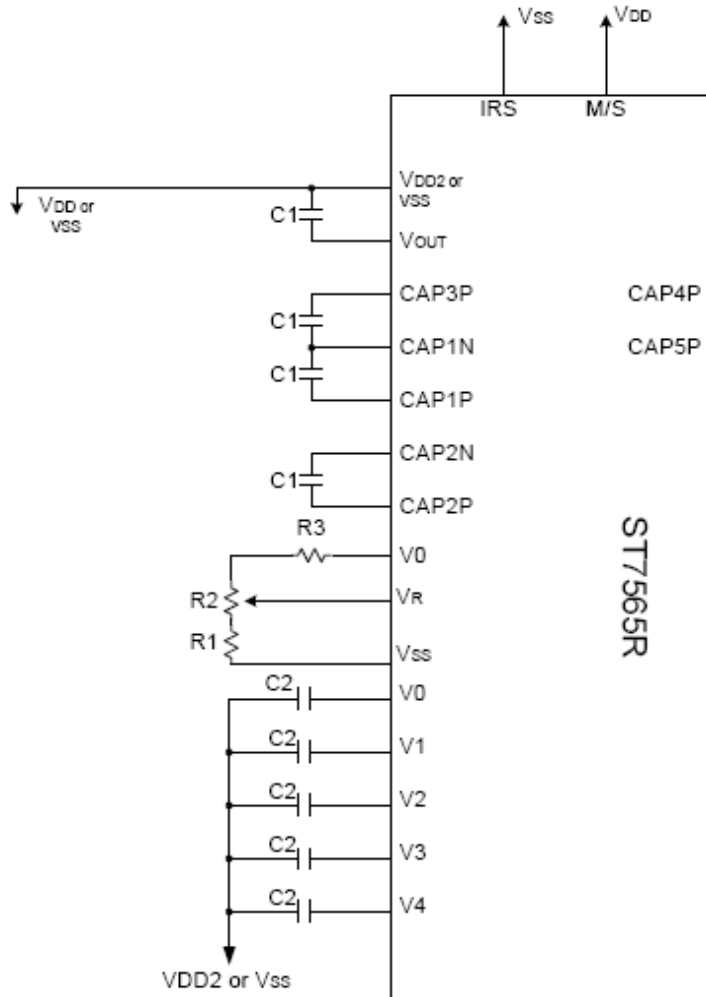


| Item | Set value | units |
|------|-----------|-------|
| c1 | 1.0 to 4.7 | uF |
| c2 | 0.1 to 4.7 | uF |

C1 and C2 are determined by the size of
the LCD being driven

* 1. Because the VR terminal input impedance is high, use short leads and shielded lines.
* 2. C1 and C2 are determined by the size of the LCD being driven. Select a value that will stabilize the liquid crystal drive voltage.

Example of the Process by which to Determine the Settings:
• Turn the voltage regulator circuit and voltage follower circuit ON and supply a voltage to VOUT from the outside.
• Determine C2 by displaying an LCD pattern with a heavy load (such as horizontal stripes) and selecting a C2 that stabilizes the liquid crystal drive voltages (V0 to V4). Note that all C2 capacitors must have the same capacitance value.
• Next turn all the power supplies ON and determine C1.

# 6. PIN DESCRIPTION

| PIN | NAME | FUNCTION |
|---|---|---|
| 1,2 | NC | No connection |
| 3 | /CS1 | This is the chip select signal |
| 4 | /RES | The  RESET signal |
| 5 | A0 | This is connected to the least significant bit of the normal MPU address bus, and it determines whether the data bits are data or a command |
| 6 | W/R | Write signal |
| 7 | /RD | Enable signal |
| 8~15 | D0~D7 | Data bus lines |
| 16 | VDD | Power supply for logic(+3.3V) |
| 17 | VSS | Power  ground |
| 18~23 | VOUT,CAP3P, CAP1N,CAP1P, CAP2P,CAP2N |  DC/DC voltage converter |
| 24 | NC | No connection |
| 25~29 | V1-V0 | LCD driver supplies voltages. |
| 30 | VR | Voltage adjustment pad. Applies voltage between V0 and VSS using a resistive divider. |
| 31 | NC | No connection |
| 32 | C86 | This is the MPU interface switch terminal<br>C86 = "H": 6800 Series MPU interface<br>C86 = "L": 8080 Series MPU interface |
| 33 | P/S | This is the parallel data input/4-line SPI data input switch terminal.<br>P/S = "H": Parallel data input.<br>P/S = "L": 4-line SPI data input. |
| 34 | NC | No connection |
| 35 | IRS | This terminal selects the resistors for the V0 voltage level adjustment.<br>IRS = "H", Use the internal resistors<br>IRS = "L", Do not use the internal resistors |
| 36 | NC | No connection |

# 7. MAXIMUM ABSOUTE LIMIT

## Maximum Ratings (Voltage Reference to VSS valid for the IC)

Unless otherwise noted, $V_{ss}$ = 0V

Table 17

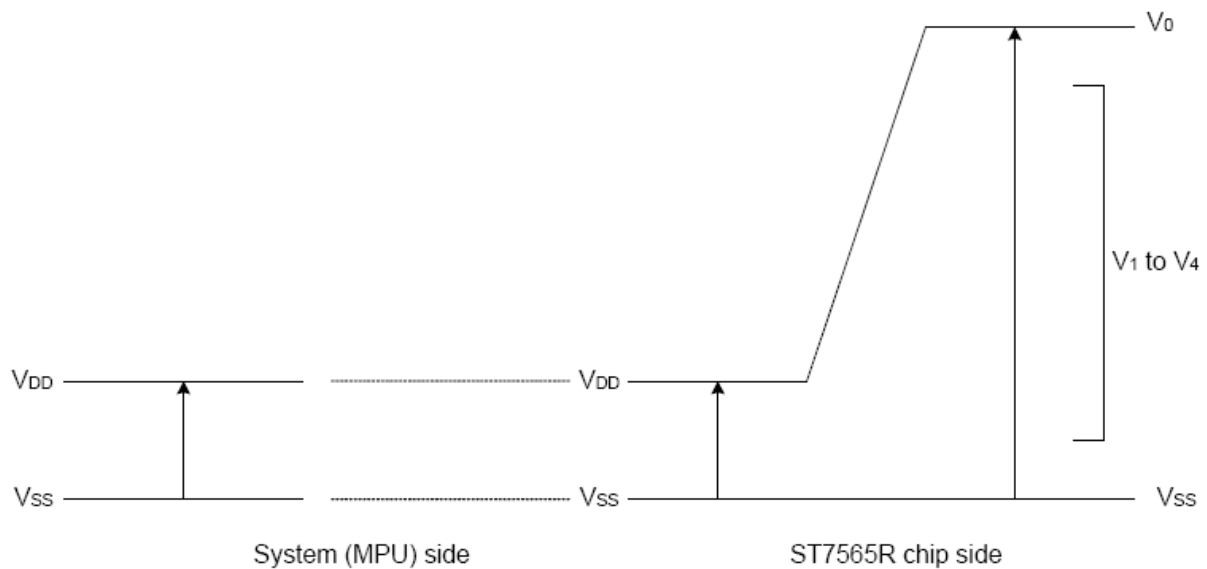| Parameter | | Symbol | Conditions | Unit |
|---|---|---|---|---|
| Power Supply Voltage | | VDD | -0.3 ~ 3.6 | V |
| Power supply voltage (V$_{DD}$ standard) | | VDD2 | -0.3 ~ 3.6 | V |
| Power supply voltage (V$_{DD}$ standard) | | V0, VOUT | -0.3 ~ 13.5 | V |
| Power supply voltage (V$_{DD}$ standard) | | V1, V2, V3, V4 | -0.3 to V0 | V |
| Operating temperature | | TOPR | −30 to +85 | °C |
| Storage temperature | Bare chip | TSTR | −65 to +150 | °C |



Figure 30

Notes and Cautions
1. The $V_{DD2}$, $V_0$ to $V_4$ and $V_{OUT}$ are relative to the $V_{SS}$ = 0V reference.
2. Insure that the voltage levels of $V_1$, $V_2$, $V_3$, and $V_4$ are always such that $V_{OUT} \geq V_0 \geq V_1 \geq V_2 \geq V_3 \geq V_4$.
3. Permanent damage to the LSI may result if the LSI is used outside of the absolute maximum ratings. Moreover, it is recommended that in normal operation the chip be used at the electrical characteristic conditions, and use of the LSI outside of these conditions may not only result in malfunctions of the LSI, but may have a negative impact on the LSI reliability as well.

# 8. ELECTRICAL CHARACTERISTICS

| Item | | Symbol | Condition | | Rating Min. | Rating Typ. | Rating Max. | Units | Applicable Pin |
|---|---|---|---|---|---|---|---|---|---|
| Operating Voltage (1) | | $V_{DD}$ | | | 1.8 | — | 3.3 | V | Vss*1 |
| Operating Voltage (2) | | $V_{DD2}$ | (Relative to Vss) | | 2.4 | — | 3.3 | V | Vss |
| High-level Input Voltage | | $V_{IHC}$ | | | 0.8 x $V_{DD}$ | — | $V_{DD}$ | V | *3 |
| Low-level Input Voltage | | $V_{ILC}$ | | | Vss | — | 0.2 x $V_{DD}$ | V | *3 |
| High-level Output Voltage | | $V_{OHC}$ | $I_{OH}$ = −0.5 mA | | 0.8 x $V_{DD}$ | — | $V_{DD}$ | V | *4 |
| Low-level Output Voltage | | $V_{OLC}$ | $I_{OL}$ = 0.5 mA | | Vss | — | 0.2 x $V_{DD}$ | V | *4 |
| Input leakage current | | $I_{LI}$ | $V_{IN}$ = $V_{DD}$ or Vss | | −1.0 | — | 1.0 | µA | *5 |
| Output leakage current | | $I_{LO}$ | $V_{IN}$ = $V_{DD}$ or Vss | | −3.0 | — | 3.0 | µA | *6 |
| Liquid Crystal Driver ON Resistance | | $R_{ON}$ | Ta = 25°C (Relative To $V_{DD}$) | $V_0$ = 13.0 V | — | 2.0 | 3.5 | KΩ | SEGn COMn *7 |
| | | | | $V_0$ = 8.0 V | — | 3.2 | 5.4 | | |
| Static Consumption Current | | $I_{SSQ}$ | $V_0$ = 13.0 V (Relative To $V_{DD}$) | | — | 0.01 | 2 | µA | $V_{DD}$, $V_{DD2}$ |
| Output Leakage Current | | $I_{5Q}$ | | | — | 0.01 | 10 | µA | V0 |
| Input Terminal Capacitance | | $C_{IN}$ | Ta = 25°C, f = 1 MHz | | — | 5.0 | 8.0 | pF | |
| Oscillator Frequency | Internal Oscillator | $f_{OSC}$ | 1/65 duty 1/33 duty   Ta = 25°C | | 17 | 20 | 24 | kHz | *8 |
| | External Input | $f_{CL}$ | | | 17 | 20 | 24 | kHz | CL |
| | Internal Oscillator | $f_{OSC}$ | 1/49 duty 1/53 duty   Ta = 25°C 1/55 duty | | 25 | 30 | 35 | kHz | *8 |
| | External Input | $f_{CL}$ | | | 25 | 30 | 35 | kHz | CL |

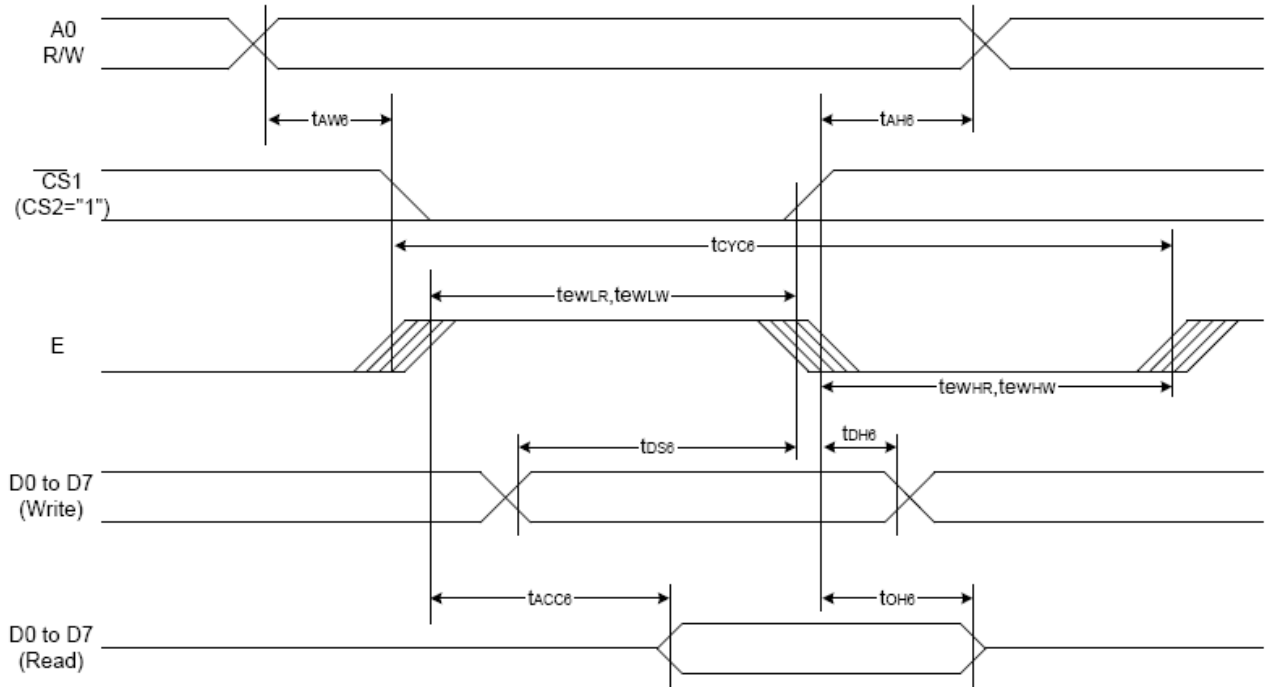| | Item | Symbol | Condition | | Rating Min. | Rating Typ. | Rating Max. | Units | Applicable Pin |
|---|---|---|---|---|---|---|---|---|---|
| Internal Power | Input voltage | $V_{DD2}$ | (Relative To Vss) | | 2.4 | — | 3.3 | V | Vss |
| | Supply Step-up output voltage Circuit | $V_{OUT}$ | (Relative To Vss) | | — | — | 13.5 | V | $V_{OUT}$ |
| | Voltage regulator Circuit Operating Voltage | $V_{OUT}$ | (Relative To Vss) | | 6.0 | — | 13.5 | V | $V_{OUT}$ |
| | Voltage Follower Circuit Operating Voltage | V0 | (Relative To Vss) | | 4.0 | — | 13.5 | V | V0 * 9 |
| | Base Voltage | VRS | Ta = 25°C, (Relative To Vss) −0.05%/°C | | 2.07 | 2.10 | 2.13 | V | *10 |

# 9. TIMING CHARACTERISTICS

System Bus Read/Write Characteristics 1 (For the 8080 Series MPU)
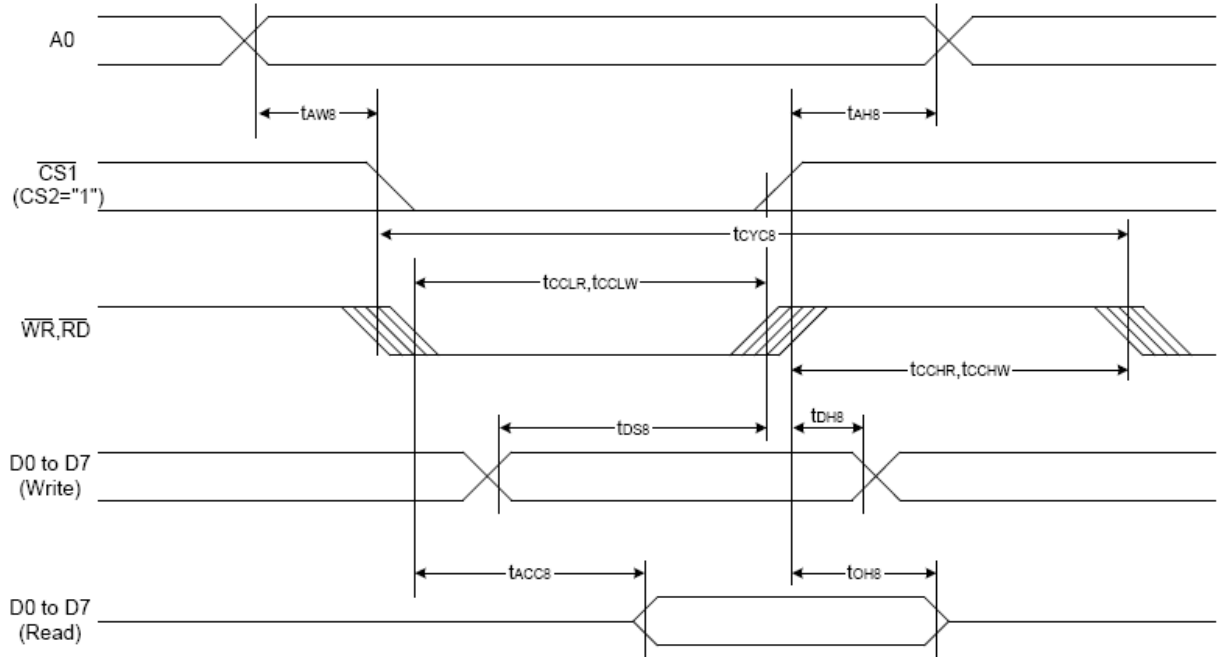


(V$_{DD}$ = 3.3V, Ta = −30 to 85°C)

| Item | Signal | Symbol | Condition | Rating Min. | Rating Max. | Units |
|------|--------|--------|-----------|------|------|-------|
| Address hold time | A0 | t$_{AH8}$ | | 0 | — | |
| Address setup time | A0 | t$_{AW8}$ | | 0 | — | |
| System cycle time | | t$_{CYC8}$ | | 240 | — | |
| Enable L pulse width (WRITE) | WR | t$_{CCLW}$ | | 80 | — | |
| Enable H pulse width (WRITE) | WR | t$_{CCHW}$ | | 80 | — | |
| Enable L pulse width (READ) | RD | t$_{CCLR}$ | | 140 | — | Ns |
| Enable H pulse width (READ) | RD | t$_{CCHR}$ | | 80 | — | |
| WRITE Data setup time | D0 to D7 | t$_{DS8}$ | | 40 | — | |
| WRITE Address hold time | D0 to D7 | t$_{DH8}$ | | 0 | — | |
| READ access time | D0 to D7 | t$_{ACC8}$ | CL = 100 pF | — | 70 | |
| READ Output disable time | D0 to D7 | t$_{OH8}$ | CL = 100 pF | 5 | 50 | |

**System Bus Read/Write Characteristics 2 (For the 6800 Series MPU)**



$(V_{DD} = 3.3V, Ta = -30 \text{ to } 85°C)$

| Item | Signal | Symbol | Condition | Rating Min. | Rating Max. | Units |
|---|---|---|---|---|---|---|
| Address hold time | A0 | $t_{AH6}$ | | 0 | — | ns |
| Address setup time | | $t_{AW6}$ | | 0 | — | |
| System cycle time | | $t_{CYC6}$ | | 240 | — | |
| Enable L pulse width (WRITE) | WR | $t_{EWLW}$ | | 80 | — | |
| Enable H pulse width (WRITE) | | $t_{EWHW}$ | | 80 | — | |
| Enable L pulse width (READ) | RD | $t_{EWLR}$ | | 80 | — | |
| Enable H pulse width (READ) | | $t_{EWHR}$ | | 140 | | |
| WRITE Data setup time | D0 to D7 | $t_{DS6}$ | | 40 | — | |
| WRITE Address hold time | | $t_{DH6}$ | | 0 | — | |
| READ access time | | $t_{ACC6}$ | $C_L = 100 \text{ pF}$ | — | 70 | |
| READ Output disable time | | $t_{OH6}$ | $C_L = 100 \text{ pF}$ | 5 | 50 | |

**The 4-line SPI Interface**
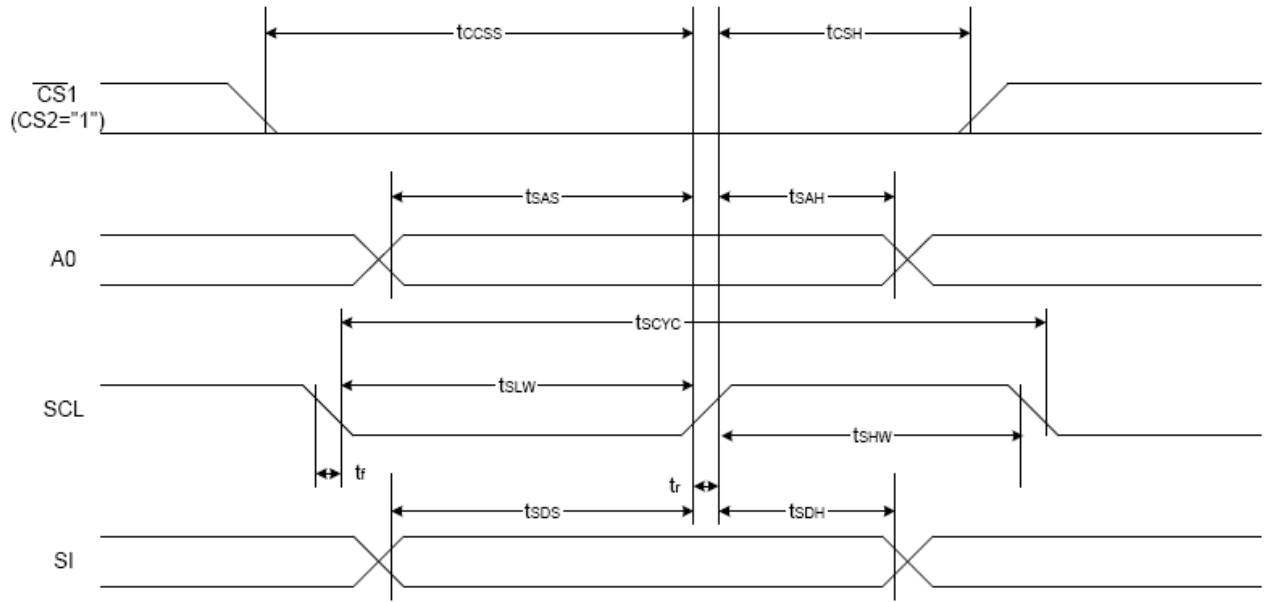


(V<sub>DD</sub> = 3.3V,Ta = −30 to 85°C)

| Item | Signal | Symbol | Condition | Rating Min. | Rating Max. | Units |
|------|--------|--------|-----------|------|------|-------|
| 4-line SPI Clock Period | SCL | T<sub>scyc</sub> | | 50 | — | ns |
| SCL "H" pulse width | | T<sub>shw</sub> | | 25 | — | |
| SCL "L" pulse width | | T<sub>SLW</sub> | | 25 | — | |
| Address setup time | A0 | T<sub>SAS</sub> | | 20 | — | |
| Address hold time | | T<sub>sah</sub> | | 10 | — | |
| Data setup time | SI | T<sub>sds</sub> | | 20 | — | |
| Data hold time | | T<sub>SDH</sub> | | 10 | — | |
| CS-SCL time | CS | T<sub>css</sub> | | 20 | — | |
| CS-SCL time | | T<sub>csh</sub> | | 40 | — | |

# 10. Reset Timing
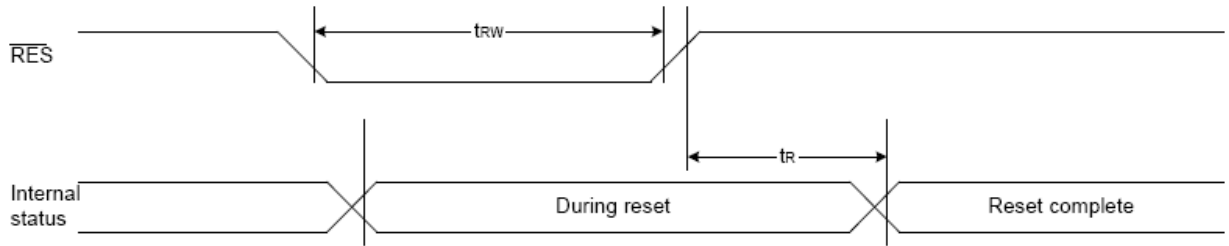


(V<sub>DD</sub> = 3.3V,Ta = −30 to 85°C)

| Item | Signal | Symbol | Condition | Rating Min. | Rating Typ. | Rating Max. | Units |
|------|--------|--------|-----------|------|------|------|-------|
| Reset time | | t<sub>R</sub> | | — | — | 1.0 | us |
| Reset "L" pulse width | /RES | t<sub>RW</sub> | | 1.0 | — | — | us |

# 11. CONTROL AND DISPLAY INSTRUCTION

| Command | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (1) Display ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 / 1 | LCD display ON/OFF 0: OFF, 1: ON |
| (2) Display start line set | 0 | 1 | 0 | 0 | 1 | Display start address | | | | | | Sets the display RAM display start line address |
| (3) Page address set | 0 | 1 | 0 | 1 | 0 | 1 | 1 | Page address | | | | Sets the display RAM page address |
| (4) Column address set upper bit | 0 | 1 | 0 | 0 | 0 | 0 | 1 | Most significant column address | | | | Sets the most significant 4 bits of the display RAM column address. |
| Column address set lower bit | | | | 0 | 0 | 0 | 0 | Least significant column address | | | | Sets the least significant 4 bits of the display RAM column address. |
| (5) Status read | 0 | 0 | 1 | Status | | | | 0 | 0 | 0 | 0 | Reads the status data |
| (6) Display data write | 1 | 1 | 0 | Write data | | | | | | | | Writes to the display RAM |
| (7) Display data read | 1 | 0 | 1 | Read data | | | | | | | | Reads from the display RAM |
| (8) ADC select | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 / 1 | Sets the display RAM address SEG output correspondence 0: normal, 1: reverse |
| (9) Display normal/ reverse | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0 / 1 | Sets the LCD display normal/ reverse 0: normal, 1: reverse |
| (10) Display all points ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0 / 1 | Display all points 0: normal display 1: all points ON |
| (11) LCD bias set | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 0 / 1 | Sets the LCD drive voltage bias ratio 0: 1/9 bias, 1: 1/7 bias (ST7565R) |
| (12) Read/modify/write | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | Column address increment At write: +1 At read: 0 |
| (13) End | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | Clear read/modify/write |
| (14) Reset | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | Internal reset |
| (15) Common output mode select | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 / 1 | * | * | * | Select COM output scan direction 0: normal direction 1: reverse direction |
| (16) Power control set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | Operating mode | | | Select internal power supply operating mode |
| (17) V₀ voltage regulator internal resistor ratio set | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | Resistor ratio | | | Select internal resistor ratio(Rb/Ra) mode |
| (18) Electronic volume mode set | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | Set the V₀ output voltage electronic volume register |
| Electronic volume register set | | | | 0 | 0 | Electronic volume value | | | | | | |
| (19) Static indicator ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 / 1 | 0: OFF, 1: ON |
| Static indicator register set | | | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Mode | Set the flashing mode |
| (20) Booster ratio set | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | select booster ratio 00: 2x,3x,4x 01: 5x 11: 6x |
| | | | | 0 | 0 | 0 | 0 | 0 | 0 | step-up value | | |
| (21) Power save | 0 | 1 | 0 | | | | | | | | | Display OFF and display all points ON compound command |
| (22) NOP | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 1 | Command for non-operation |
| (23) Test | 0 | 1 | 0 | 1 | 1 | 1 | 1 | * | * | * | * | Command for IC test. Do not use this command |

## 12. BACK LIGHT CHARACTERISTICS

LCD Module with Side LED Backlight
**ELECTRICAL   RATINGS**

Ta = 25°C

| Item | Symbol | Condition | Min | Typ | Max | Unit |
|------|--------|-----------|-----|-----|-----|------|
| Forward Voltage | VF | IF=15mA | 2.9 | 3.1 | 3.3 | V |
| Reverse Current | IR | VR=5.0V | --- | 10 | --- | uA |
| Luminance(without LCD) | Lv | IF=15mA | 80 | 110 | --- | cd/m$^2$ |
| Wave length(without LCD) | λp | IF=15mA | X=0.25 Y=0.25 | --- | X=0.29 Y=0.29 | |
| Color | white | | | | | |

Note:
when the temperature exceed 25°C, the approved current decrease rate for Backlight change as the temperature increase is: -0.36mA/°C(below 25°C, the current refer to constant, which would not change with temperature ).

## 13. ELECTRO-OPTICAL CHARACTERISTICS
($V_{DD}$=3.3V,Ta = 25°C)

| Item | Symbol | Condition | Min | Typ | Max | Unit |
|------|--------|-----------|-----|-----|-----|------|
| Operating Voltage for LCD | Vop | Ta =-20°C | 9.2 | 9.5 | 9.8 | V |
| | | Ta = 25°C | 8.7 | 9.0 | 9.3 | |
| | | Ta = 70°C | 8.2 | 8.5 | 8.8 | |
| Response time | Tr | Ta = 25°C | --- | 200 | 400 | ms |
| | Tf | | --- | 250 | 500 | ms |
| Contrast | Cr | Ta = 25°C | --- | 4.0 | --- | --- |
| Viewing angle range | θ | Cr≥ 2 | -40 | --- | +40 | deg |
| | Φ | | -40 | --- | +40 | deg |
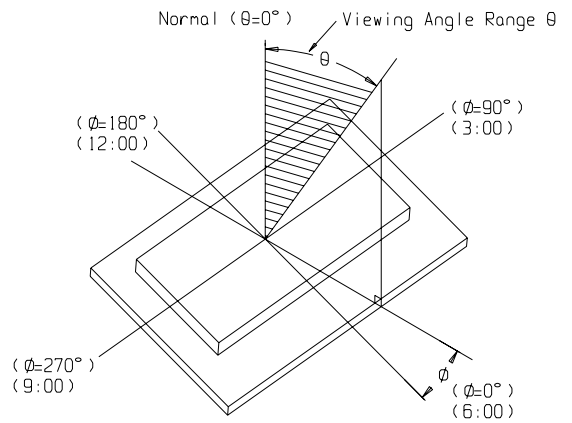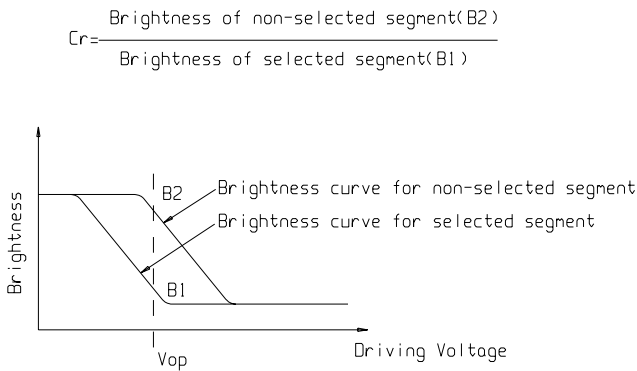
# 14. PRECAUTION  FOR USING LCD/LCM

After reliability test, recovery time should be 24 hours minimum. Moreover, functions, performance and appearance shall be free from remarkable deterioration within 50,000 hours(average) under ordinary operating and storage conditions room temperature ($20\pm8°C$), normal humidity (below 65% RH), and in the area not exposed to direct sun light. Using LCM beyond these conditions will shorten the life time.

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 isoproply alcohol, ethyl alcohol or trichlorotriflorothane, do not use water, ketone or aromatics and never scrub hard.
3.  Do not tamper in any way with the tabs on the metal frame.
4.  Do not made any modification on the PCB without consulting DISPLAY.
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 adheres 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 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.

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:350°C±10°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 Vo.
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°C is required, the relative humidity should be kept below 60%, and avoid direct sunlight.


**Limited Warranty**

DISPLAY LCDs and modules are not consumer products, but may be incorporated by DISPLAY's customers into consumer products or components thereof, DISPLAY does not warrant that its LCDs and components are fit for any such particular purpose.

1. The liability of DISPLAY is limited to repair or replacement on the terms set forth below. DISPLAY will not be responsible for any subsequent or consequential events or injury or damage to any personnel or user including third party personnel and/or user. Unless otherwise agreed in writing between DISPLAY and the customer, DISPLAY will only replace or repair any of its LCD which is found defective electrically or visually when inspected in accordance with DISPLAY general LCD inspection standard . (Copies available on request)
2. No warranty can be granted if any of the precautions state in handling liquid crystal display above has been disregarded. Broken glass, scratches on polarizer mechanical damages as well as defects that are caused accelerated environment tests are excluded from warranty.
3. In returning the LCD/LCM, they must be properly packaged; there should be detailed description of the failures or defect.

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