# PRODUCT PREVIEW

**Product Part#:**    **LPST096096A00-T3**

**Product Name:**    **65K color OLED Module**

**Revision:**    **0.0**

**Date:**    **Sep'2004**

# REVISION RECORD

| Revision | Description of Revision | Revision date | Remark |
|:---:|:---|:---:|:---:|
| 0.0 | Initial release | 17-Sep-04 | -- |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# TABLE OF CONTENTS

# 1. FUNCTIONS & FEATURES

1.1. Format           : 96(RGB)*96 dots
1.2. Display mode        : Passive Matrix
1.3. Display color         : 65k color
1.4. Duty            : 1/96

# 2. MECHANICAL SPECIFICATIONS

2.1. Module size         : 27.70mm(W)*39.51mm(H)
2.2. Panel size          : 27.70mm(W)*27.10mm(H)
2.3. Viewing area        : 20.872mm(W)*20.872mm(H)
2.4. Active area         : 19.847mm(W)*19.852mm(H)
2.5. Dot pitch          : 0.207mm(W)*0.207mm(H)
2.6. Dot size          : 0.182mm(W)*0.187mm(H)
2.7. Thickness(with polarizer)  : 1.70mm
2.8. Weight           : TBD
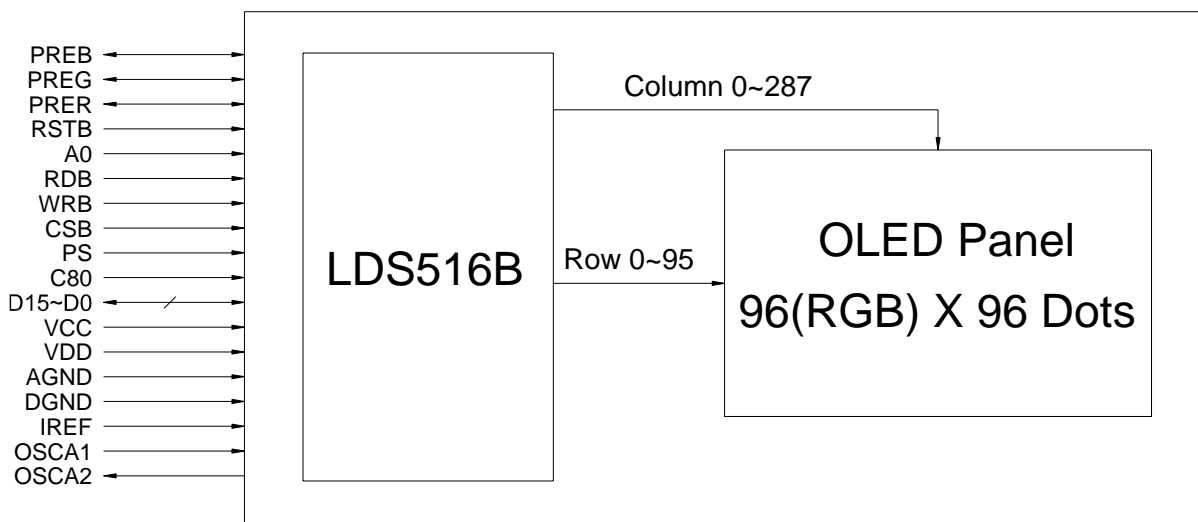
# 3. BLOCK DIAGRAM
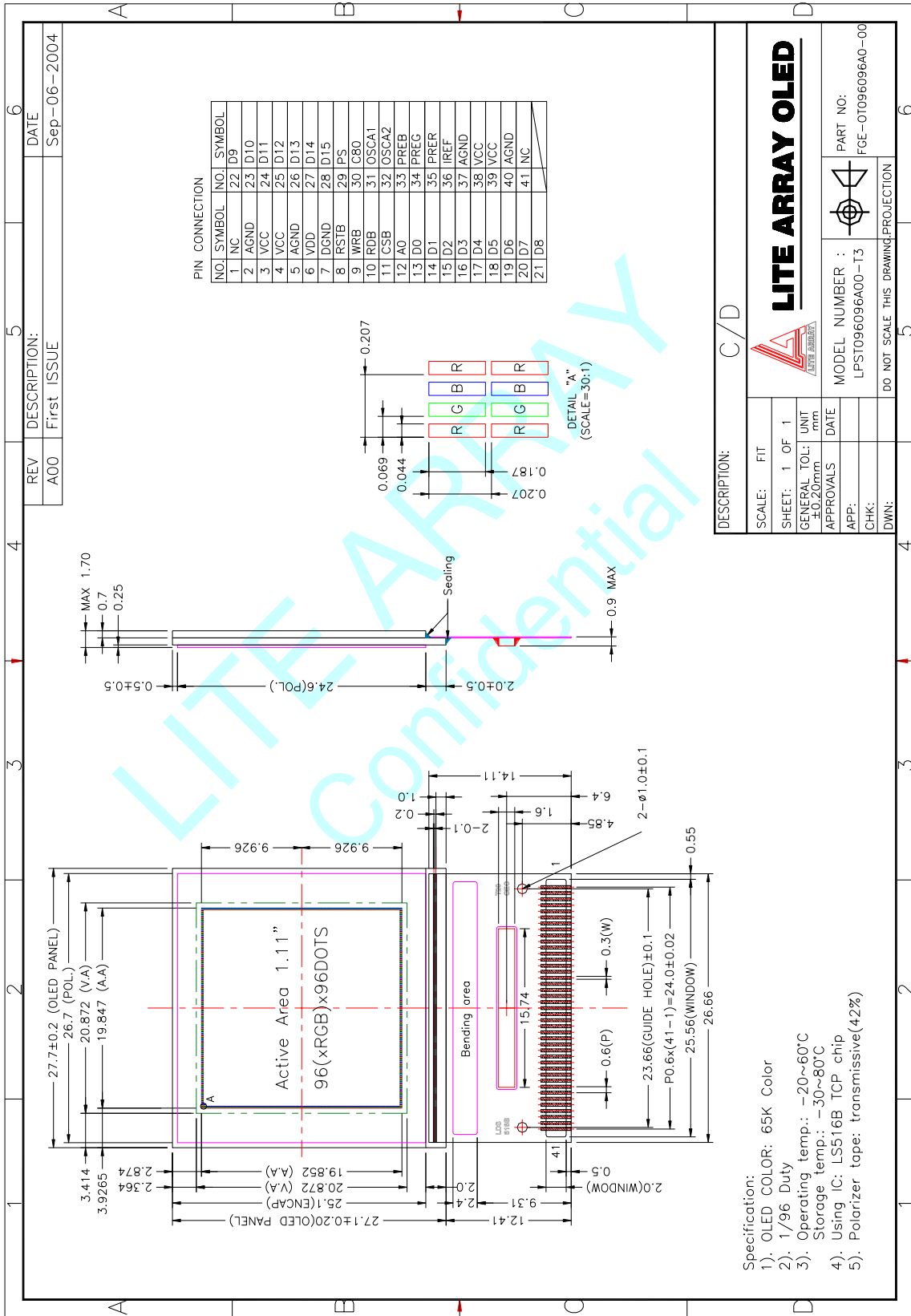


**Figure 1: Block diagram**

# 4. DIMENSIONAL OUTLINE



**Figure 2: Dimensional outline**

# 5. PIN DESCRIPTION

| Pin no. | Symbol | Function |
|---------|--------|----------|
| 1,41 | NC | No connection |
| 2,5,37,40 | AGND | Analog (Driver) GND |
| 3,4,38,39 | VCC | OLED Dot Matrix Power Supply |
| 6 | VDD | Logic Power Supply |
| 7 | DGND | Logic GND |
| 8 | RSTB | Reset (Active Low) |
| 9 | WRB | Write (Active Low, 80 interface)<br>H: Read L: Write (68 interface) |
| 10 | RDB | Read (Active Low, 80 interface)<br>Enable (68 interface) |
| 11 | CSB | Chip Select (Active Low) |
| 12 | A0 | Address (L: command, H: Parameter) |
| 13~28 | D0~D15 | Data Bus<br>In serial mode: D1 is Serial Data, D0 is Serial Clock |
| 29 | PS | H: Parallel L: Serial |
| 30 | C80 | H: 68CPU L: 80CPU |
| 31 | OSCA1 | Aspirator for Dot Matrix |
| 32 | OSCA2 | There is an on-chip oscillator in the OLED driver.    The frequency is controlled by an external resistor value between OSCA1 and OSCA2. Frame frequency is adjusted by "DFRAME" command. |
| 33 | PREB | Pre-Charge Voltage for Blue<br>A Zener diode should be connected between PREB pin and VSS. |
| 34 | PREG | Pre-Charge Voltage for Green<br>A Zener diode should be connected between PREG pin and VSS. |
| 35 | PRER | Pre-Charge Voltage for Red<br>A Zener diode should be connected between PRER pin and VSS. |
| 36 | IREF | Current Setting, current adjustable range is ± 30%.<br>A resistor should be connected between IREF pin and VSS. |

**Table1: Pin Description**

# 6. ABSOLUTE MAXIMUM RATINGS

## 6.1 Absolute Maximum Ratings

| Parameter | Symbol | Min | Max | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | -0.3 | 4.0 | V |
| | $V_{CC}$ | -0.3 | 23.0 | V |
| Input voltage | $V_{IN}$ | -0.3 | $V_{DD}+0.3$ | V |
| Out voltage range | $V_{OUT}$ | -0.3 | $V_{DD}+0.3$ | V |
| Operating Temperature | $T_{OP}$ | -20 | 60 | $^{o}C$ |
| Storage Temperature | $T_{STG}$ | -30 | 80 | $^{o}C$ |

**Table2: Absolute Maximum Ratings**

Note 1: $V_{DD}$ and $V_{CC}$ are on the basis of "VSS = 0.0V"

Note 2: Voltage relationship VCC>VDD>VSS must always be satisfied.

Note 3: When this module is used beyond above absolute maximum ratings, permanent damage of the module may occur. For normal operation, it is desirable to use this module under the conditions according to the section of "Electrical Characteristics". If this module is used beyond these conditions, malfunctioning of the module will occur and the reliability of the module may deteriorate.

# 7. OPTICS & ELECTRICAL CHARACTERISTICS

| Characteristics | Symbol | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| Brightness(White) | $L_{br}$ | Display average (With polarizer) | 30 | 50 | 70 | $Cd/m^2$ |
| CIE (Blue) | X | | 0.11 | 0.16 | 0.21 | -- |
| | Y | | 0.11 | 0.16 | 0.21 | -- |
| CIE (Green) | X | | 0.25 | 0.30 | 0.35 | -- |
| | Y | | 0.58 | 0.63 | 0.68 | -- |
| CIE (Red) | X | With polarizer | 0.58 | 0.63 | 0.68 | -- |
| | Y | | 0.32 | 0.37 | 0.42 | |
| CIE (White) | X | | 0.24 | 0.29 | 0.34 | -- |
| | Y | | 0.27 | 0.32 | 0.37 | -- |
| Dark Room Contrast | CR | | 200 | -- | -- | -- |
| View Angle | A | -- | >160 | -- | -- | degree |

**Table 3: Optics & electrical characteristics**

# 8. ELECTRICAL CHARACTERISTICS

## 8.1 DC Characteristics

| Symbol | Parameter | Test Condition | Min | Typ | Max | Unit |
|--------|-----------|----------------|-----|-----|-----|------|
| $V_{DD}$ | Supply voltage for logic at $V_{DD}$ | - | 2.25 | 2.8 | 3.3 | V |
| $V_{CC}$ | Operating voltage for OLED at $V_{CC}$ | - | 10.0 | 18.0 | 21.0 | V |
| $V_{IH}$ | High level input voltage at PS, C80, RSTB, WRB, RDB and D15~D0 | - | $0.7V_{DD}$ | - | $V_{DD}$ | V |
| $V_{IL}$ | Low level input voltage at PS, C80, RSTB, WRB, RDB and D15~D0 | - | $V_{SS}$ | - | $0.3V_{DD}$ | V |
| $V_{OH}$ | High level output voltage at D15~D0 | $I_{OH}$=-0.1mA | $0.85V_{DD}$ | - | $V_{DD}$ | V |
| $V_{OL}$ | Low level output voltage at D15~D0 | $I_{OL}$=0.1mA | $V_{SS}$ | - | $0.15V_{DD}$ | V |
| $I_{IL}$ | Input leakage voltage at PS, C80, RSTB, WRB, RDB and D15~D0 | $V_{IN}$ =$V_{DD}$ or $V_{SS}$ | -1.0 | - | +1.0 | μA |
| $F_{OSC1}$ | Oscillator frequency | $V_{DD}$=2.8V | 2.7 | 3.0 | 3.3 | MHz |
| $I_{fc}$ | Forward current | All pixels on | - | 14.0 | - | mA |
| $P_{wr}$ | Power consumption | 30% ON, 50cd/m$^2$ | - | <100 | - | mW |

**Table 4: DC characteristics**

## 8.2 AC Characteristics

### 8.2.1 Write characteristics
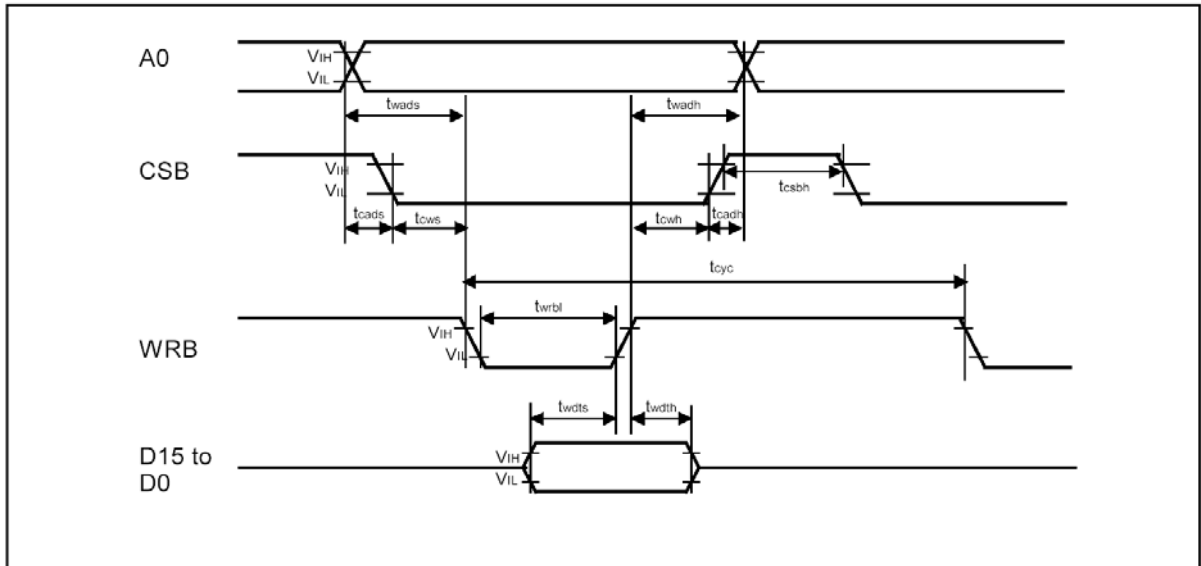


(V<sub>DD</sub> = 2.8V, Ta = 25 °C)

| Symbol | Parameter | Conditions | Related Pins | MIN | TYP | MAX | Unit |
|--------|-----------|------------|--------------|-----|-----|-----|------|
| $t_{cyc}$ | Write cycle time | - | WRB | 100 | - | - | ns |
| $t_{cads}$ $t_{cadh}$ | Address and Select setup time Address and Select hold time | - | CSB,A0 | 0 0 | - - | - - | ns |
| $t_{wads}$ $t_{wadh}$ | Address setup time Address hold time | - | A0 | 50 20 | - - | - - | ns |
| $t_{cws}$ $t_{cwh}$ | Select setup time Select hold time | - | CSB | 10 10 | - - | - - | ns |
| $t_{wrbl}$ | Write Low pulse width | - | WRB | 30 | - | - | ns |
| $t_{csbh}$ | Select High pulse width | - | CSB | 10 | - | - | ns |
| $t_{wdts}$ $t_{wdth}$ | Data setup time Data hold time | - | D15 to D0 | 10 20 | - - | - - | ns |

**Figure 3: Timing diagram for Write characteristics**

### 8.2.2 Read characteristics
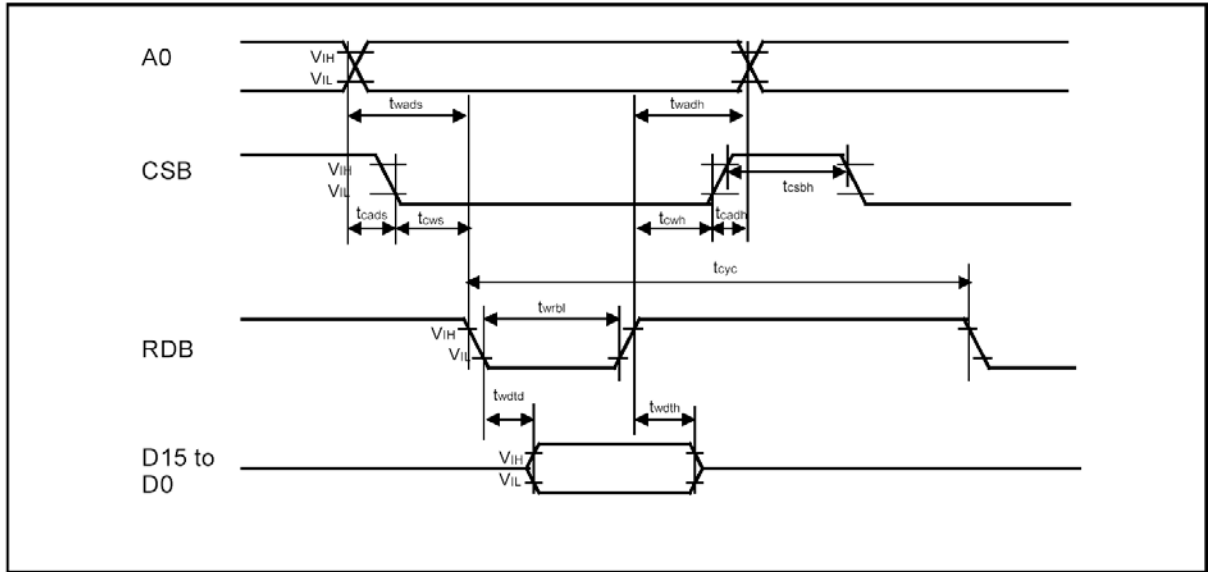


(V$_{DD}$ = 2.8V, Ta = 25 °C)

| Symbol | Parameter | Conditions | Related Pins | MIN | TYP | MAX | Unit |
|---|---|---|---|---|---|---|---|
| t$_{cyc}$ | Read cycle time | - | RDB | 500 | - | - | ns |
| t$_{cads}$ | Address and Select setup time | - | CSB,A0 | 0 | - | - | ns |
| t$_{cadh}$ | Address and Select hold time | | | 0 | - | - | |
| t$_{rads}$ | Address setup time | - | A0 | 50 | - | - | ns |
| t$_{radh}$ | Address hold time | | | 20 | - | - | |
| t$_{crs}$ | Select setup time | - | CSB | 10 | - | - | ns |
| t$_{crh}$ | Select hold time | | | 10 | - | - | |
| t$_{rdbl}$ | Read Low pulse width | - | RDB | 250 | - | - | ns |
| t$_{csbh}$ | Select High pulse width | - | CSB | 10 | - | - | ns |
| t$_{rdtd}$ | Data output delay time | CL = 100pF | D15 to D0 | - | - | 200 | ns |
| t$_{rdth}$ | Data output hold time | | | 5 | - | - | |

**Figure 4: Timing diagram for Read characteristics**

## 8.2.3 Parallel interface characteristics (6800-series MPU)
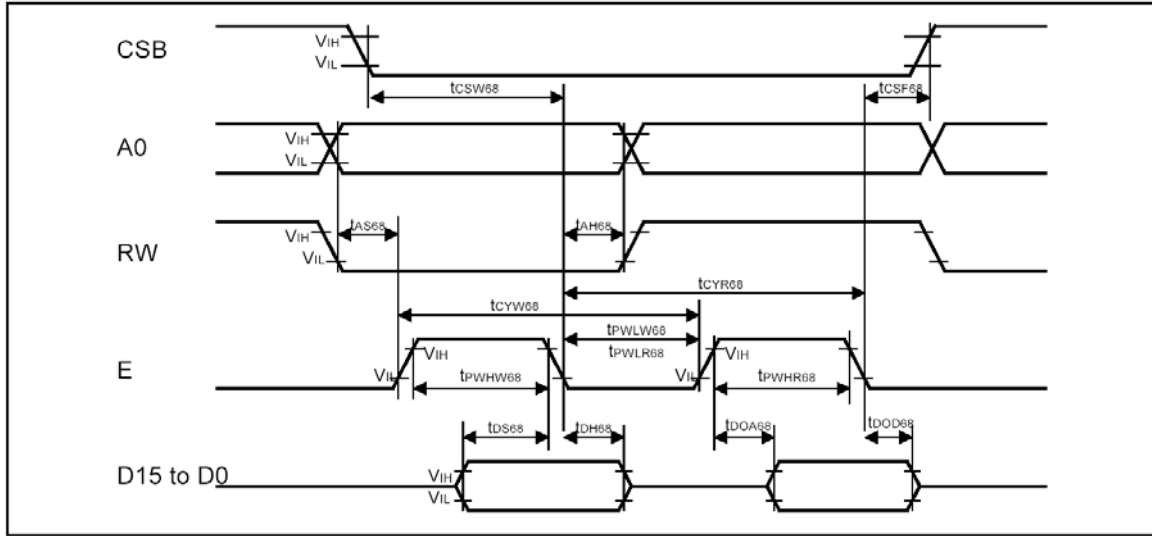


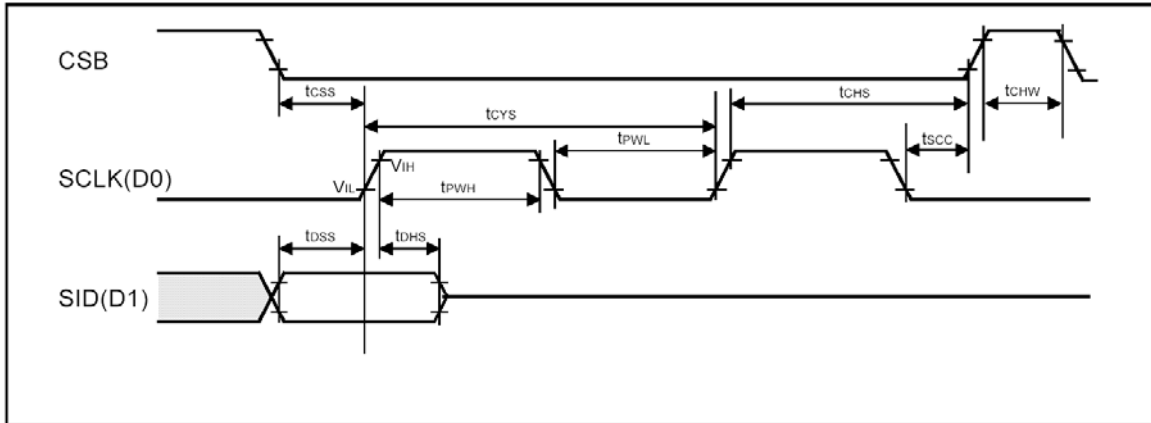(Vss=0V, VDD=2.8V,Ta = 25°C)

| Symbol | Parameter | Conditions | Related Pins | MIN | TYP | MAX | Unit |
|---|---|---|---|---|---|---|---|
| $t_{CSW68}$<br>$t_{CSF68}$ | Chip select setup time<br>Chip select hold time | - | CSB | 10<br>10 | -<br>- | -<br>- | ns |
| $t_{AS68}$<br>$t_{AH68}$ | Address setup time<br>Address hold time | - | A0<br>RW | 50<br>20 | -<br>- | -<br>- | ns |
| $t_{CYW68}$<br>$t_{PWHW68}$<br>$t_{PWLW68}$ | Write cycle time<br>Write High Time<br>Write Low Time | - | E | 160<br>40<br>90 | - | - | ns |
| $t_{CYR68}$<br>$t_{PWHR68}$<br>$t_{PWLR68}$ | Read cycle time (Parameter read)<br>Read High (Parameter read)<br>Read Low (Parameter read) | - | E | 160<br>40<br>90 | - | - | ns |
| $t_{CYR68}$<br>$t_{PWHR68}$<br>$t_{PWLR68}$ | Read cycle time (Data read)<br>Read High (Data read)<br>Read Low (Data read) | - | E | 450<br>355<br>90 | - | - | ns |
| $t_{DS68}$<br>$t_{DH68}$ | Data setup time<br>Data hold time | - | D15 to D0 | 10<br>20 | -<br>- | -<br>- | ns |
| $t_{DOA68}$<br>$t_{DOD68}$ | Data output access time<br>Data output disable time | CL = 30pF | | -<br>40 | -<br>- | 40<br>80 | ns |

**Figure 5: Timing diagram for 6800-series MPU**

## 8.2.4 Serial interface characteristics



(Vss=0V, VDD=2.8V,Ta = 25°C)

| Symbol | Parameter | Conditions | Related Pins | MIN | TYP | MAX | Unit |
|--------|-----------|------------|--------------|-----|-----|-----|------|
| $t_{CYS}$ | Serial clock cycle | | | 160 | - | - | |
| $t_{WHS}$ | High pulse width | - | SCLK | 60 | - | - | ns |
| $t_{WLS}$ | Low pulse width | | | 60 | - | - | |
| $t_{DSS}$ | Data setup time | | SID (D1) | 60 | - | - | ns |
| $t_{DHS}$ | Data hold time | | | 60 | - | - | |
| $t_{CSS}$ | Chip select setup time | | | 60 | - | - | |
| $t_{CHS}$ | Chip select hold time | - | CSB | 65 | - | - | ns |
| $t_{CHW}$ | Chip select high pulse width | | | 45 | - | - | |
| $t_{SCC}$ | SCLK to Chip select | - | SCLK, CSB | 20 | - | - | ns |

## Figure 6: Timing diagram for serial interface

# 9. CONTROL AND DISPLAY COMMAND

## 9.1 Main Command

"-": Don't care

| Instruction | W/R | A0 | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function | Default |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Software Reset** | | | | | | | | | | | | | | | | | | | | |
| SOFTRES | W | L | | | | | | | | | | | 01h | | | | | | Display Off | - |
| **Dot Matrix Display On/Off Control** | | | | | | | | | | | | | | | | | | | | |
| DDISPON/OFF | W | L | | | | | | | | | | | 02h | | | | | | Dot Matrix Display ON/OFF | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | - | D0 | D0=0:Display Off, D0=1:Display On | 00h |
| **Dot Matrix Stand-By On/Off Control** | | | | | | | | | | | | | | | | | | | | |
| DSTBYON/OFF | W | L | | | | | | | | | | | 14h | | | | | | Dot Matrix Stand-By ON/OFF | **-** |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | - | D0 | D0=0:OSCA start, D0=1:Run DDISPOFF,OSCA stop | 01h |
| **Dot Matrix Frame Frequency Control** | | | | | | | | | | | | | | | | | | | | |
| DFRAME | W | L | | | | | | | | | | | 1Ah | | | | | | Dot Matrix Frame frequency set | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | F2 | F1 | F0 | 60 ~ 150 Hz | 02h |
| **Data Write Direction Control** | | | | | | | | | | | | | | | | | | | | |
| WRDIR | W | L | | | | | | | | | | | 1Dh | | | | | | Dot Matrix Frame frequency set | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | VH | D1 | D0 | VH=0;Horizontal, VH=1:Vertical | 00h |
| **Display Direction Control** | | | | | | | | | | | | | | | | | | | | |
| DISPDIR | W | L | | | | | | | | | | | 09h | | | | | | Display Direction Control | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | D1 | D0 | Display direction | 00h |
| **Display Size Set** | | | | | | | | | | | | | | | | | | | | |
| DISPSIZEX | W | L | | | | | | | | | | | 30h | | | | | | Display size X | **-** |
| 1'st parameter | W | H | | | | | | | | | - | FX6 | FX5 | FX4 | FX3 | FX2 | FX1 | FX0 | Display size X From | 00h |
| 2nd parameter | W | H | | | | | | | | | - | TX6 | TX5 | TX4 | TX3 | TX2 | TX1 | TX0 | Display size X to | 5fh |
| DISPSIZEY | W | L | | | | | | | | | | | 32h | | | | | | Display size Y | **-** |
| 1'st parameter | W | H | | | | | | | | | - | FY6 | FY5 | FY4 | FY3 | FY2 | FY1 | FY0 | Display size Y From | 00h |
| 2nd parameter | W | H | | | | | | | | | - | TY6 | TY5 | TY4 | TY3 | TY2 | TY1 | TY0 | Display size Y to | 5fh |
| **8/16Bit Interface Select** | | | | | | | | | | | | | | | | | | | | |
| Interface8/16 | W | L | | | | | | | | | | | 0Dh | | | | | | 8/16Bit Interface Select | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | - | D0 | D0=0:to 8Bit, D0=1:to 16bit | 00h |
| **Data Reverse & Color Masking** | | | | | | | | | | | | | | | | | | | | |
| Data_MASK | W | L | | | | | | | | | | | 1Eh | | | | | | Data Reverse & Color Masking | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RV=0:Origin, RV=1:Reverse | 07h |
| **Data Read/Writing Box Set** | | | | | | | | | | | | | | | | | | | | |
| XBoxStart | W | L | | | | | | | | | | | 34h | | | | | | R/W Box Column Start Set | - |
| 1'st parameter | W | H | | | | | | | | | - | XS6 | XS5 | XS4 | XS3 | XS2 | XS1 | XS0 | R/W Box Column Start Address | 00h |
| XBoxEnd | W | L | | | | | | | | | | | 35h | | | | | | R/W Box Column End Set | **-** |
| 1'st parameter | W | H | | | | | | | | | - | XE6 | XE5 | XE4 | XE3 | XE2 | XE1 | XE0 | R/W Box Column End Address | 5fh |
| YBoxStart | W | L | | | | | | | | | | | 36h | | | | | | R/W Box Row Start Set | - |
| 1'st parameter | W | H | | | | | | | | | - | YS6 | YS5 | YS4 | YS3 | YS2 | YS1 | YS0 | R/W Box Row Start Address | 00h |
| YBoxEnd | W | L | | | | | | | | | | | 37h | | | | | | R/W Box Row End Set | - |
| 1'st parameter | W | H | | | | | | | | | - | YE6 | YE5 | YE4 | YE3 | YE2 | YE1 | YE0 | R/W Box Row End Address | 5fh |

### Memory Read Start Address Set

| Name | W/R | H/L | Data / Bits | Function | Default |
|---|---|---|---|---|---|
| XDispStart | W | L | 38h | Memory Read Column Start Set | - |
| 1'st parameter | W | H | - XS6 XS5 XS4 XS3 XS2 XS1 XS0 | Memory Read Column Start Address | 00h |
| YDispStart | W | L | 39h | Memory Read Row Start Set | - |
| 1'st parameter | W | H | - YS6 YS5 YS4 YS3 YS2 YS1 YS0 | Memory Read Row Start Address | 00h |

### Data Write

| Name | W/R | H/L | Data / Bits | Function | Default |
|---|---|---|---|---|---|
| DATAWRITE | W | L | 08h | Dot Matrix Data Write | |
| 16Bit Mode 1'st | W | H | R4 R3 R2 R1 R0 G5 G4 G3 G2 G1 G0 B4 B3 B2 B1 B0 | 1'st Data | |
| : | : | : | : | | |
| 16Bit Mode N'th | W | H | R4 R3 R2 R1 R0 G5 G4 G3 G2 G1 G0 B4 B3 B2 B1 B0 | N'th Data | |
| 8Bit Mode 1'st | W | H | R4 R3 R2 R1 R0 G5 G4 G3 | 1'st Data | |
| | W | H | G2 G1 G0 B4 B3 B2 B1 B0 | | |
| : | : | : | : | | |
| 8Bit Mode N'th | W | H | R4 R3 R2 R1 R0 G5 G4 G3 | N'th Data | |
| | W | H | G2 G1 G0 B4 B3 B2 B1 B0 | | |

### Data Read

| Name | W/R | H/L | Data / Bits | Function | Default |
|---|---|---|---|---|---|
| DATAREAD | W | L | 08h | Dot Matrix Data Read | |
| 16bit dummy | R | H | X X X X X X X X X X X X X X X X | dummy | |
| 16Bit Mode 1'st | R | H | R4 R3 R2 R1 R0 G5 G4 G3 G2 G1 G0 B4 B3 B2 B1 B0 | 1'st Data | |
| : | : | : | : | | |
| 16Bit Mode N'th | R | H | R4 R3 R2 R1 R0 G5 G4 G3 G2 G1 G0 B4 B3 B2 B1 B0 | N'th Data | |
| 8bit dummy | R | H | X X X X X X X X | dummy | |
| 8Bit Mode 1'st | R | H | R4 R3 R2 R1 R0 G5 G4 G3 | 1'st Data | |
| | R | H | G2 G1 G0 B4 B3 B2 B1 B0 | | |
| : | : | : | : | | |
| 8Bit Mode N'th | R | H | R4 R3 R2 R1 R0 G5 G4 G3 | N'th Data | |
| | R | H | G2 G1 G0 B4 B3 B2 B1 B0 | | |

### Register Read

| Name | W/R | H/L | Data / Bits | Function | Default |
|---|---|---|---|---|---|
| READREG | W | L | 20h | Register Read | |
| 1'st parameter | R | H | D7 D6 D5 D4 D3 D2 D1 D0 | 1'st parameter | |
| : | R | H | : | | |
| N'th parameter | R | H | D7 D6 D5 D4 D3 D2 D1 D0 | N'th parameter | |

### Peak Pulse Width Set

| Name | W/R | H/L | Data / Bits | Function | Default |
|---|---|---|---|---|---|
| PeakWidthR | W | L | 3Ah | Red Peak Pulse Width Set | - |
| 1'st parameter | W | H | - - - W4 W3 W2 W1 W0 | Width = 0 ~ 31us | 05h |
| PeakWidthG | W | L | 3Bh | Green Peak Pulse Width Set | - |
| 1'st parameter | W | H | - - - W4 W3 W2 W1 W0 | Width = 0 ~ 31us | 05h |
| PeakWidthB | W | L | 3Ch | Blue Peak Pulse Width Set | - |
| 1'st parameter | W | H | - - - W4 W3 W2 W1 W0 | Width = 0 ~ 31us | 05h |

### Peak Pulse Delay Set

| Name | W/R | H/L | Data / Bits | Function | Default |
|---|---|---|---|---|---|
| PeakDelay | W | L | 16h | Peak Pulse Delay Set | - |
| 1'st parameter | W | H | - - - W4 W3 W2 W1 W0 | Delay = 0 ~ 15us | 05h |

**Dot Current Set**

| | | | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DotCurrentR | W | L | | | | 40h | | | | | Red Dot Current Set | | - |
| 1'st parameter | W | H | I7 | I6 | I5 | I4 | I3 | I2 | I1 | I0 | Level = 0 ~ 255uA | | 00h |
| DotCurrentG | W | L | | | | 41h | | | | | Green Dot Current Set | | - |
| 1'st parameter | W | H | I7 | I6 | I5 | I4 | I3 | I2 | I1 | I0 | Level = 0 ~ 255uA | | 00h |
| DotCurrentB | W | L | | | | 42h | | | | | Blue Dot Current Set | | - |
| 1'st parameter | W | H | I7 | I6 | I5 | I4 | I3 | I2 | I1 | I0 | Level = 0 ~ 255uA | | 00h |

**Pre-Charge Pulse Width Set**

| | | | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PreC_Width | W | L | | | | 18h | | | | | Pre-Charge Width Set | | - |
| 1'st parameter | W | H | T7 | T6 | T5 | T4 | T3 | T2 | T1 | T0 | Width = 0 ~ 255us | | 08h |

**Pre-Charge Mode Set**

| | | | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PreC_Select | W | L | | | | 44h | | | | | Pre-Charge Mode Set | | - |
| 1'st parameter | W | H | - | - | - | - | - | - | D1 | D0 | | | 01h |
| Compare_BitR | W | L | | | | 45h | | | | | Red Compare Bit | | - |
| 1'st parameter | W | H | - | - | R5 | R4 | R3 | R2 | R1 | R0 | | | 00h |
| Compare_BitG | W | L | | | | 46h | | | | | Green Compare Bit | | - |
| 1'st parameter | W | H | - | G6 | G5 | G4 | G3 | G2 | G1 | G0 | | | 00h |
| Compare_BitG | W | L | | | | 47h | | | | | Blue Compare Bit | | - |
| 1'st parameter | W | H | - | - | B5 | B4 | B3 | B2 | B1 | B0 | | | 00h |

**Row Overlap Timing Set**

| | | | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Row_Overlap | W | L | | | | 48h | | | | | Row Overlap Timing Set | | - |
| 1'st parameter | W | H | - | - | - | - | - | - | RO1 | RO0 | | | 00h |

**Row Scan Mode Set**

| | | | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Row_Scan | W | L | | | | 17h | | | | | Row Scan Mode Set | | - |
| 1'st parameter | W | H | - | - | - | - | - | - | - | D0 | | | 00h |

**Row Scan Sequence Set**

| | | | b7 | b6 | b5 | b4 | b3 | b2 | b1 | b0 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ScanMode | W | L | | | | 13h | | | | | Row Scan Sequence Set | | - |
| 1'st parameter | W | H | - | - | - | - | - | - | D1 | D0 | | | 00h |

**Table 5: Main Command Table**

## 9.2 Screen Saver Command

SS : Screen Saver ,"-": Don't care

| Instruction | W/R | A0 | D15 | D14 | D13 | D12 | D11 | D10 | D9 | D8 | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | Function | Default |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Screen Saver Sleep Timer Set** | | | | | | | | | | | | | | | | | | | | |
| S_SleepTimer | W | L | | | | | | | | | | | C0h | | | | | | SS Sleep Timer Set | - |
| 1'st parameter | W | H | | | | | | | | | T7 | T6 | T5 | T4 | T3 | T2 | T1 | T0 | Timer = 0 ~ 255us | 00h |
| **Screen Saver Sleep Start Set** | | | | | | | | | | | | | | | | | | | | |
| S_SleepStart | W | L | | | | | | | | | | | C2h | | | | | | SS Auto Sleep Timer Start | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | - | D0 | | 00h |
| **Screen Saver Step Timer Set** | | | | | | | | | | | | | | | | | | | | |
| S_StepTimer | W | L | | | | | | | | | | | C3h | | | | | | SS Step Timer Set | - |
| 1'st parameter | W | H | | | | | | | | | T7 | T6 | T5 | T4 | T3 | T2 | T1 | T0 | Timer = 0 ~ 255us | 00h |
| **Screen Saver Step Unit Set** | | | | | | | | | | | | | | | | | | | | |
| S_StepUnit | W | L | | | | | | | | | | | C4h | | | | | | SS Step Timer Unit Set | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | S1 | S0 | | 00h |
| **Screen Saver Box Area Set** | | | | | | | | | | | | | | | | | | | | |
| SBoxStartX | W | L | | | | | | | | | | | C6h | | | | | | SS Box Column Start Set | - |
| 1'st parameter | W | H | | | | | | | | | - | SX6 | SX5 | SX4 | SX3 | SX2 | SX1 | SX0 | SS Box Column Start Address | 00h |
| SBoxEndX | W | L | | | | | | | | | | | C8h | | | | | | SS Box Column End Set | - |
| 1'st parameter | W | H | | | | | | | | | - | EX6 | EX5 | EX4 | EX3 | EX2 | EX1 | EX0 | SS Box Column End Address | 5fh |
| SBoxStartY | W | L | | | | | | | | | | | C7h | | | | | | SS Box Row Start Set | - |
| 1'st parameter | W | H | | | | | | | | | - | SY6 | SY5 | SY4 | SY3 | SY2 | SY1 | SY0 | SS Box Row Start Address | 00h |
| SBoxEndY | W | L | | | | | | | | | | | C9h | | | | | | SS Box Row End Set | - |
| 1'st parameter | W | H | | | | | | | | | - | EY6 | EY5 | EY4 | EY3 | EY2 | EY1 | EY0 | SS Box Row End Address | 5fh |
| **Screen Saver Changing or Moving Step Set** | | | | | | | | | | | | | | | | | | | | |
| SStepX | W | L | | | | | | | | | | | CAh | | | | | | SS Changing or Moving X Step | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | SX3 | SX2 | SX1 | SX0 | | 01h |
| SStepY | W | L | | | | | | | | | | | CBh | | | | | | SS Changing or Moving Y Step | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | SY3 | SY2 | SY1 | SY0 | | 01h |
| **Screen Saver Condition Set** | | | | | | | | | | | | | | | | | | | | |
| S_Condition | W | L | | | | | | | | | | | CCh | | | | | | SS Condition Set | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | LO | U | D | R | L | | 00h |
| **Screen Saver Start/Stop** | | | | | | | | | | | | | | | | | | | | |
| S_Start/Stop | W | L | | | | | | | | | | | CDh | | | | | | SS Start/Stop | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | - | - | - | SS | | 00h |
| **Screen Saver Select** | | | | | | | | | | | | | | | | | | | | |
| S_Select | W | L | | | | | | | | | | | CEh | | | | | | SS Select Common Command | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | - | SS3 | SS2 | SS1 | SS0 | SS 0=ZIGZAG<br>SS 1=RANDOM<br>SS 2=MultiScroll<br>SS 3=BlockMove<br>SS 4=FadeInOut<br>SS 5=FadeBox<br>SS 6=FadeMask<br>SS 7=FadeScroll<br>SS 8=AutoColor | 00h |
| **Screen Saver Color Stage and Pallet Set** | | | | | | | | | | | | | | | | | | | | |
| S_ColorStage | W | L | | | | | | | | | | | CFh | | | | | | SS Color Stage Set | - |
| 1'st parameter | W | H | | | | | | | | | 0 | - | - | - | - | S2 | S1 | S0 | | 00h |
| S_ColorPallet | W | L | | | | | | | | | | | D0h | | | | | | SS Pallet Set | - |
| 1'st parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet0 | 07h |
| 2nd parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet1 | 06h |
| 3rd parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet2 | 05h |
| 4th parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet3 | 04h |
| 5th parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet4 | 03h |
| 6th parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet5 | 02h |
| 7th parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet6 | 01h |
| 8th parameter | W | H | | | | | | | | | - | - | - | RV | - | R | G | B | RGB pallet data for pallet7 | 00h |

**Table 6: Screen Saver Command Table**

# 10. REFERENCE APPLICATION CIRCUIT

This is an example for the application circuit for using LT1930 DC/DC converter.  Users can choose their own DC/DC voltage converter.
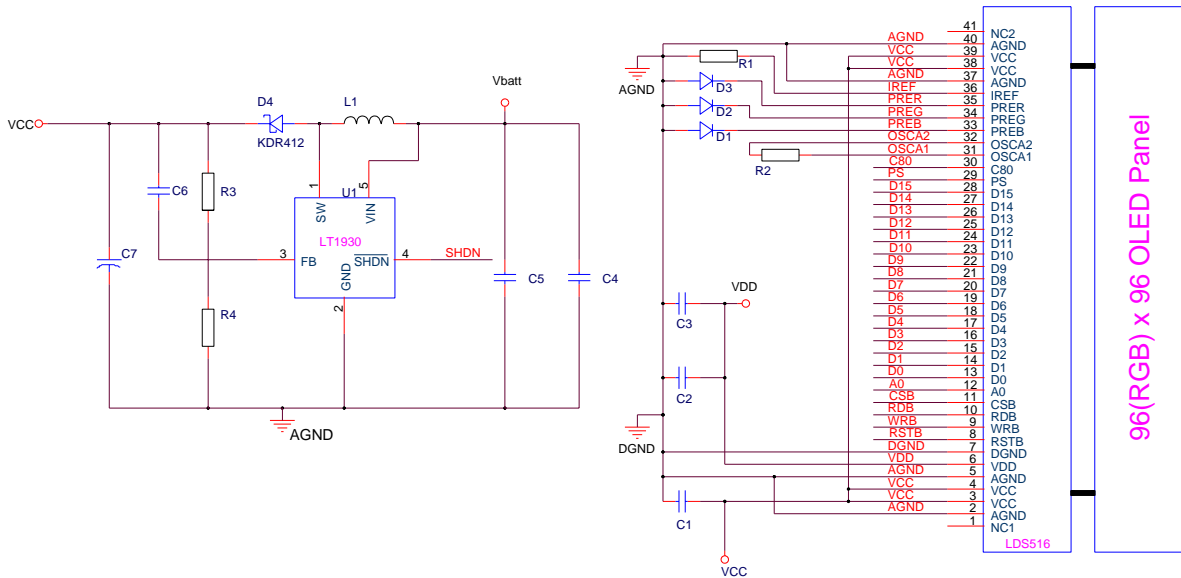


**Figure 7: Reference Application Circuit**

Notes:

- MPU interface: 68 /80 series parallel interface or Serial interface.  It is pin selectable by PS and C80.

|  | 68 series parallel interface | 80 series parallel interface | Serial interface |
|---|---|---|---|
| **PS** | 1 | 1 | 0 |
| **C80** | 1 | 0 | 0 |

- U1: LT1930 DC/DC Converter

- SHDN can be connected to MCU or VDD for alternative solution.

Below table is the component list for the application circuit.

| Item | Description |
|---|---|
| LDS516 | OLED Driver IC (*Leadis*) |
| U1 | DC/DC Converter – LT1930 Step-up(*Linear*) |
| L1 | Inductor – 10µH, 520mA |
| D1 | Zener Diode – 2.4V |
| D2,D3 | Zener Diode – 2.2V |
| D4 | Schottky Diode – 20V, 0.5A |
| R1 | Resistor – 39kΩ |
| R2 | Resistor – 68kΩ |
| R3 | Resistor – 110kΩ |
| R4 | Resistor – 8.2kΩ |
| C1,C3,C4 | Capacitor – 0.1µF, 25V |
| C2,C5,C7 | Capacitor – 4.7µF, 25V |
| C6 | Capacitor – 10pF, 25V |

**Table 7: Component list for the reference application circuit**

# 11. QUALITY SPECIFICATIONS

## 11.1 Quality guaranty of Zone
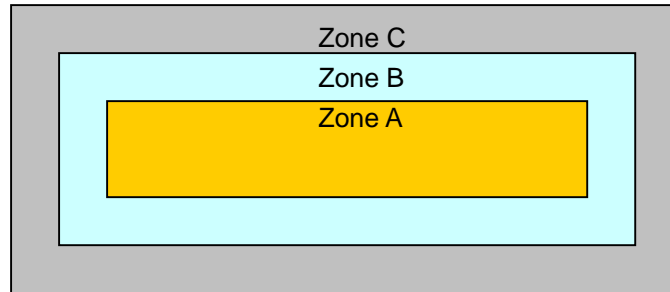
Zone C
Zone B
Zone A

Zone A: Active Area
Zone B: Viewing Area
Zone C: Appearance or other module organization of Zone B

## 11.2 Inspection Condition

Temperature: 20~30℃
Humidity: 40~70%RH
Pressure: 86~106kPa

Functional and Appearance tests shall be performed when the module is turned ON and OFF respectively, allowing a distance of 30cm or more. The viewing angle for a visual check shall not exceed 45 degrees from the vertical in each direction: forward, backward, right and left (See the sketch below). A sample shall be subject to visual observations under the fluorescent lamp of 40watts.

45 degree
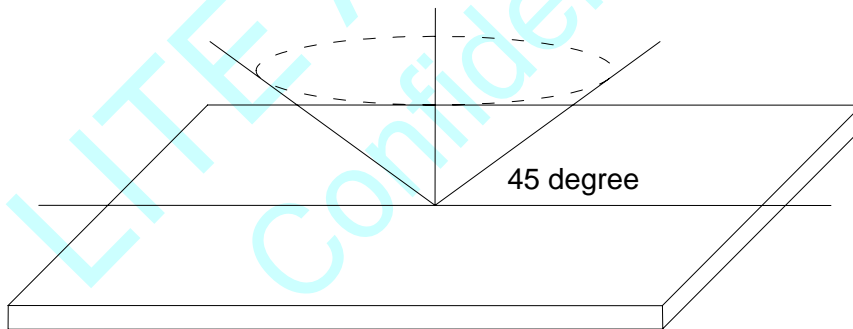
## 11.3 AQL

| Defect type | Sampling procedures | AQL |
|---|---|---|
| Major | MIL-STD-105D Inspection level I normal inspection single sample inspection | 0.65 |
| Minor | MIL-STD-105D Inspection level I normal inspection single sample inspection | 1.5 |

**\*Major defect**
A major defect refers to the defect, which is considered to substantial degradation to the usability for product application.

**\*Minor defect**
A minor defect refers to the defect, which is not considered to be substantial degradation for product application, or the defect, which deviate from the existing standards, and it is almost unrelated to the effective use of the product or its operation.

## 11.4 Inspection standards
The size of foreign object or black spot shall be defined as follows
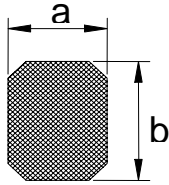
D (mm) = (a + b) / 2 [When changing square, length of a side]

### 1) Major

| Zone | Item | Judgment |
|---|---|---|
| A. B (turn on) | Non display | No non display is allowed |
| | Irregular operating | No irregular operation is allowed |
| | Short | No shorts are allowed |
| | Open | Any segments or common patterns that don't active are rejected. |

### 2) Minor
**2-1) Alien substance, Blemish**

| Zone | D size (mm) | Judgment |
|---|---|---|
| A.B (turn on) | D ≤ 0.10 | Pass |
| | 0.10 < D ≤ 0.15 | 2 |
| | 0.15 < D ≤ 0.20 | 1 |
| | 0.20 < D | 0 |

**2-2) Scratch on Polarizer**

| Zone | Width (W, mm) | Length (L, mm) | Judgment |
|---|---|---|---|
| A.B (turn on) | W≤0.03 | Pass | Pass |
| | 0.03<W≤0.05 | L≤2.0 | Pass |
| | | L>2.0 | 1 |
| | 0.05<W≤0.08 | L>1.0 | 1 |
| | | L≤1.0 | Pass |
| | 0.08<W | (*) | (*) |

**2-3) Polarizer Bubble**

| Zone | D size (diameter, mm) | Judgment |
|---|---|---|
| A.B (turn on) | D ≤ 0.20 | PASS |
| | 0.20 < D ≤ 0.50 | 3 |
| | 0.50 < D ≤ 0.80 | 2 |
| | 0.80 < D | FAIL |

**2-4) White/Dark Spot (Spot/Line type)**

| Zone | D size (mm) | Judgment |
|---|---|---|
| A.B (turn on) | D ≤ 0.15 | PASS |
| | 0.15 < D ≤ 0.20 | 3 |
| | 0.20 < D ≤ 0.30 | 2 |
| | 0.30 < D | FAIL |

| Zone | Width (W, mm) | Length (L, mm) | Judgment |
|---|---|---|---|
| A.B (turn on) | 0.03<W ≤ 0.04 | 10<L | 5 |
| | 0.04<W ≤ 0.06 | 5.0<L ≤ 10 | 3 |
| | 0.06<W ≤ 0.07 | 1.0<L ≤ 5.0 | 2 |
| | 0.07<W ≤ 0.09 | L ≤ 1.0 | 1 |

## 3) CRACKS

### ① General crack(unit : mm)
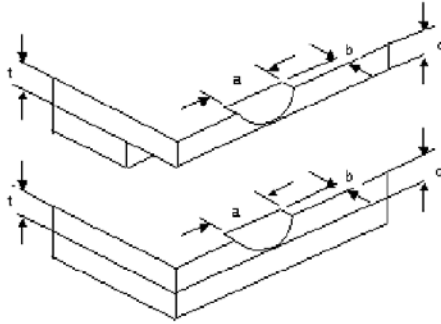


| a ≤ 1/6 panel length |
|---|
| b ≤ 1 |
| c ≤ t |

### ② Corner crack(unit :mm)
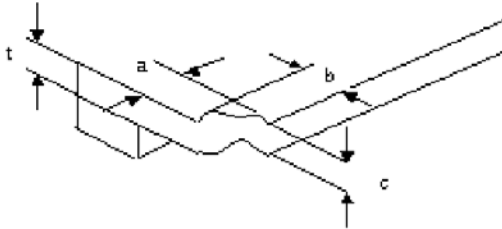


| a ≤ 2.5 | NO EXPOSURE ANY CONDUCTIVE MATERAL |
|---|---|
| b ≤ 2.5 | |
| c ≤ t | |



| a ≤ 0.7 | NO EXPOSURE ANY CONDUCTIVE MATERAL |
|---|---|
| b ≤ 0.7 | |
| c ≤ t | |



| a ≤ 1.3 | a ' ≤ a |
|---|---|
| b ≤ 1.3 | b ' ≤ b |
| c ≤ t | |
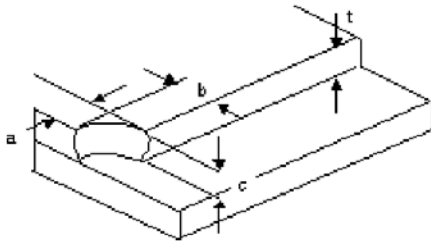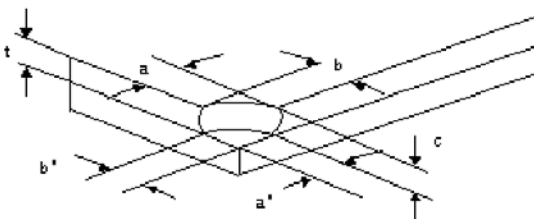
③Electrode pad crack (unit : mm )
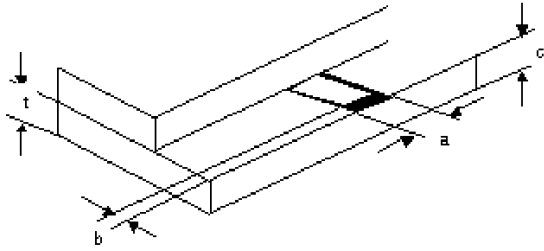


| | |
|---|---|
| a ≤ 1/6 panel length | |
| b ≤ 1/6 pad length | |
| c ≤ t | |

④Glass chip remain (unit : mm)
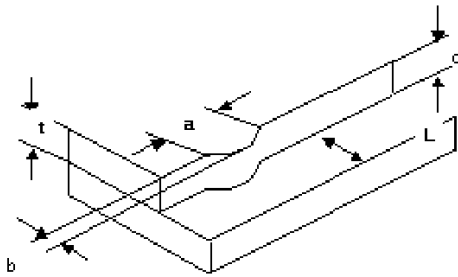


| | |
|---|---|
| a ≤ 1/6 panel length | |
| b ≤ 1/10 pad length | |
| c ≤ t | |

⑤Future crack (unit: mm)



NO TOLERATION ANY PROGRESSING CRACK

## 11.5 Reliability test condition

Operating life time (30% ON, 50cd/ m2) : Longer than 10,000 hours
Reliability characteristics shall meet following requirements

| No. | ITEM | CONDITION | TEST TIME | CRITERION |
|---|---|---|---|---|
| 1 | High Humidity Storage | 60±2℃,90±5%RH | 96 Hrs | Brightness: over 50% of initial value.<br>Color coordination: within ±0.05 of initial value. |
| 2 | High Humidity Operation | 60±2℃,90±5%RH | 96 Hrs | |
| 3 | High Temperature Storage | 80±2℃ | 96 Hrs | |
| 4 | High Temperature Operation | 60±2℃ | 96 Hrs | |
| 5 | Low Temperature Storage | -30±2℃ | 96 Hrs | |
| 6 | Low Temperature Operation | -20±2℃ | 96Hrs | |
| 7 | Thermal shock | -30℃(30min) →80℃(30min) 5Cycles,<br>Transient time = 10 min (Turn off)<br>-20℃(30min) → 70℃(30min) 5 Cycles<br>Transient time = 10 min (Turn on) | | Appearance or E/T inspection: follows working specification. |
| 8 | Vibration test<br>(Packaging state) | 1.Operating time: 2hrs exposure in each direction (X, Y, Z)<br>2. Frequency (1min): 10 to 55Hz<br>3. Amplitude: 2mm | | There isn't crack and broken on soldering part. |
| 9 | Drop test<br>(Packaging state) | 1.Direction: 1 corner, 3 edges, 6 faces, drop once for each direction<br>2. 3 times height 1.8m or 5 times height 1.5m from concrete surface | | There isn't crack and broken on soldering part. |
| 10 | ESD | 150Pf, 330 ,±8kV 10times, air discharge | | After testing, cosmetic and electrical defects should not happen.<br>Total current consumption should be double of initial value. |