| REVISIONS | | | |
|---|---|---|---|
| REV. | DESCRIPTION | DATE | APPROVED |
| | | | |

1. **Specification subject to change without notice.**
2. **All dimensions and specifications apply to standard modules. This information may vary for modules with optional features.**
3. **All dimensions are in millimetres.**
4. **Precautions: These precautions apply equally to modules from all makers, not just Densitron. Violation of these guidelines may void the warranty and can cause problems ranging from erratic operation to catastrophic display failure.**

*Handling precautions:*

- This device is susceptible to Electro-Static Discharge (ESD) damage. Observe Anti-Static precautions.

*Power supply precautions:*

- Identify and, at all times, observe absolute maximum ratings for both logic and LC drivers. Note that there is some variance between models.
- Prevent the application of reverse polarity to VDD and VSS, however briefly.
- Use a clean power source free from transients. Power up conditions are occasionally "jolting" and may exceed the maximum ratings of the module.
- The +5V power of the module should also supply the power to all devices that may access the display. Don't allow the data bus to be driven when the logic supply to the module is turned off.
- DO NOT install a capacitor between the VO (contrast) pin and ground. VDD must, at all times, exceed the VO voltage level. The capacitor combines with the contrast potentiometer to form an R-C network which "holds-up" VO, at power-down, possibly damaging the module.

*Operating precautions:*

- DO NOT plug or unplug the module when the system is powered up.
- Minimise the cable length between the module and host MPU. (Recommended max. length 30 cm).
- For models with EL backlights, do not disable the backlight by interrupting the HV line. Unloaded inverters produce voltage extremes that may arc within a cable or at the display.
- Operate the module within the limits of the modules temperature specifications.

*Mechanical / Environmental precautions:*

- Improper soldering is the major cause of module difficulty. Use of flux cleaner is not recommended as they may seep under the elastomeric connection and cause display failure. Densitron recommends the use of Kester "245" no-clean solder.
- Mount the module so that it is free from torque and mechanical stress.
- Surface of LCD panel should not be touched or scratched. The display front surface is an easily scratched, plastic polariser. Avoid contact and clean only when necessary with soft, absorbent cotton dampened with petroleum benzene.
- ALWAYS employ anti-static procedure while handling the module.
- Prevent moisture build-up upon the module and observe the environmental constraints for storage temperature and humidity.
- DO NOT store in direct sunlight.
- If leakage of the liquid crystal material should occur, avoid contact with this material, particularly ingestion. If the body or clothing becomes contaminated by the liquid crystal material, wash thoroughly with water and soap.

**Notes:** (unless otherwise specified)

| Unless otherwise specified: Dimensions are mm Tolerances are: X = ± 3, 0.X = ± 0.5, 0.XX = ± 0.05 | APPROVALS | DATE | DENSITRON EUROPE LTD<br>BIGGIN HILL, ENGLAND | |
|---|---|---|---|---|
| | DRAWN | | | |
| | CHECKED | | 100 X 64 PIXEL MINI-GRAPHIC ARRAY WITH EDGELIT LED BACKLIGHT | |
| | ISSUED | | DWG.NO. **LM4064** | SHEET 1 of 10 |

# 1.0 DESCRIPTION

Graphic matrix display module consisting of a Liquid Crystal Display, CMOS driver and controller LSI, printed circuit board and edgelit Light Emitting Diode (LED) backlight.

Available LC fluid types are STN (supertwisted nematic) yellow. Available backlight colour: yellow-green.

Features include on-board DC/DC, on-board temperature compensation, software contrast control, serial or 8-bit parallel interface.

# 2.0 MECHANICAL CHARACTERISTICS

| Item | Specifications | Unit |
|---|---|---|
| Package Dimensions | 52(W) x 47.5(H) x 7.5(D) | mm |
| Display format | 100 x 64 | - |
| Character font format | defined by on-board controller (SED1560) | dots |
| Driving method | 1/64 duty, 1/9 bias | duty |
| Dot size | 0.35 x 0.40 | mm |
| Dot pitch | 0.38 x 0.43 | mm |
| Character Size | 1.9 x 2.98 | mm |
| Active display area | 38.0 x 27.5 | mm |
| Viewing area | 48.0 x 32.0 | mm |
| Weight | 15 approx | g |

**Notes:** W-Width; H-Height; D-Depth.

# 3.0 ABSOLUTE MAXIMUM RATINGS

$V_{SS}$=0V;$T_a$=25°C

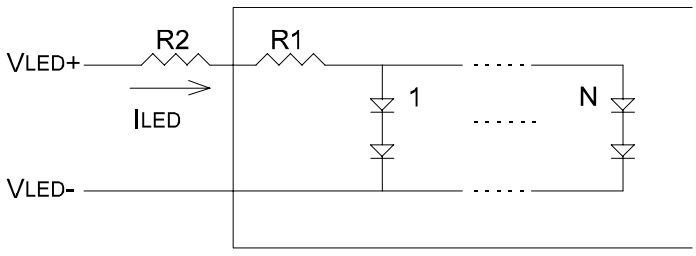
| Item | Symbol | STN | | Unit |
|---|---|---|---|---|
| | | Min | Max | |
| Logic supply voltage | $V_{DD}$-$V_{SS}$ | 0 | 7 | V |
| LC driver supply voltage | $V_{DD}$-$V_O$ | 0 | 6 | V |
| Operating temperature | $T_{OP}$ | 0 | +60 | °C |
| Storage temperature (Note 1) | $T_{ST}$ | -20 | +70 | |
| Humidity: Operating (@40°C) | - | - | 85% | RH (Note 2) |
| Non-operating (@40°C) | - | - | 95% | RH (Note 2) |

**Notes:** 1: Tested to 100 hrs.
2: Refers to non-condensing conditions.
3. With backlight switched off.

# 4.0 BACKLIGHT SPECIFICATIONS:

$T_a$=20°C,60%RH,Darkroom.

| Item | Symbol | Typ. | Max. | Unit |
|---|---|---|---|---|
| LED forward bias voltage | $V_{FB}$ | 4.1 | 4.3 | Vrms |
| Nominal LED current | $I_F$ | 60 | - | mA |
| LED peak current | $I_P$ | - | 90 | mA |
| Average luminous intensity | $I_V$ | 25 | - | $Cd/m^2$ |
| Peak emission wavelength | $\lambda_P$ | 572 | - | nm |
| Spectral line half-width | $\Delta\lambda$ | 30 | - | nm |
| | | n/a | | Ω |
| Life to half initial brightness | - | 10 | | Ω |
| Recommended backlight inverter | - | 4 | | - |



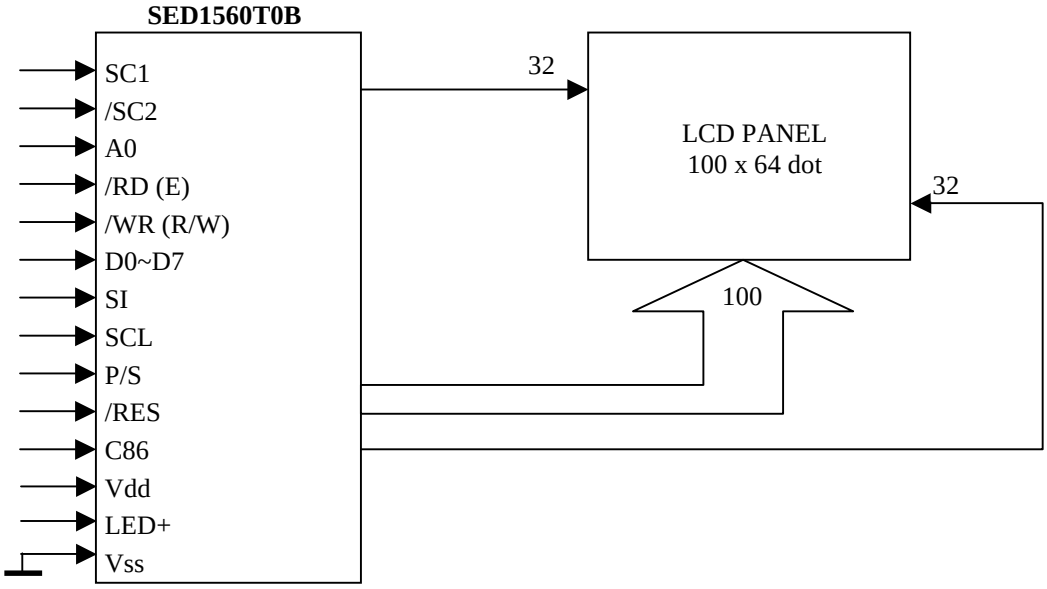
# 5.0 ELECTRICAL CHARACTERISTICS

| Item | Symbol | Condition | Specification value | | | Unit |
|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | |
| Operating voltage | $V_{DD}$ | | 4.5 | 5.0 | 5.5 | V |
| High level input voltage<br>Low level input voltage | $V_{IHC}$<br>$V_{ILC}$ | | 0.8×$V_{DD}$<br>$V_{SS}$ | —<br>— | $V_{DD}$<br>0.2×$V_{DD}$ | |
| High level output voltage<br>Low level output voltage | $V_{OHC}$<br>$V_{OLC}$ | | 0.8×$V_{DD}$<br>$V_{SS}$ | —<br>— | $V_{DD}$<br>0.2×$V_{DD}$ | |
| Input leakage current<br>Output leakage current | $I_{LI}$<br>$I_{LO}$ | $V_{IN}$=$V_{DD}$ or $V_{SS}$ | –1.0<br>–3.0 | —<br>— | 1.0<br>3.0 | µA |
| Static current consumption (with backlight switched off) | $I_{SSQ}$ | | — | 0.01 | 5 | µA |
| Dynamic current consumption (with backlight switched off) | $I_{DD}$ | $V_{DD}$ = 5V, Ta=25°C | — | 200 | 350 | µA |
| Input pin capacitance | $C_{IN}$ | Ta=25°C, f=1MHz | — | 5.0 | 8.0 | pF |

# 6.0 INTERFACE DESCRIPTION

<table>
<tr><th>Pin No.</th><th>Symbol</th><th>I/O</th><th>Function</th></tr>
<tr><td>1</td><td>$V_{SS}$</td><td>-</td><td>Ground (0V)</td></tr>
<tr><td>2</td><td>$V_{DD}$</td><td>-</td><td>Logic Supply Voltage (+3/+5V)</td></tr>
<tr><td>3</td><td>D7</td><td>I/O</td><td rowspan="8">Bi-directional data bus</td></tr>
<tr><td>4</td><td>D6</td><td>I/O</td></tr>
<tr><td>5</td><td>D5</td><td>I/O</td></tr>
<tr><td>6</td><td>D4</td><td>I/O</td></tr>
<tr><td>7</td><td>D3</td><td>I/O</td></tr>
<tr><td>8</td><td>D2</td><td>I/O</td></tr>
<tr><td>9</td><td>D1</td><td>I/O</td></tr>
<tr><td>10</td><td>D0</td><td>I/O</td></tr>
<tr><td>11</td><td>/CS1</td><td>I</td><td rowspan="2">Chip Select input. Data input/output is enabled when CS1 is LOW and CS2 is HIGH</td></tr>
<tr><td>12</td><td>CS2</td><td>I</td></tr>
<tr><td>13</td><td>A0</td><td>I/O</td><td>Control/Display data flag input. This is connected to the LSB of the microprocessor address bus.<br>• When LOW, data on D0 to D7 is command data<br>• When HIGH, data on D0 to D7 is display data</td></tr>
<tr><td>14</td><td>RD</td><td>I/O</td><td>Read</td></tr>
<tr><td>15</td><td>/WR</td><td>I/O</td><td>Write</td></tr>
<tr><td>16</td><td>SI</td><td>I</td><td>Serial data input</td></tr>
<tr><td>17</td><td>SCL</td><td>I</td><td>Serial Clock input. Data is read on the rising edge of CSL and converted to 8-bit parallel data</td></tr>
<tr><td>18</td><td>P/S</td><td>I</td><td>Parallel/Serial input select<br><br>
<table>
<tr><th>P/S</th><th>Operating Mode</th><th>Chip Select</th><th>Data/Command</th><th>Data I/O</th><th>Read/Write</th><th>Serial Clock</th></tr>
<tr><td>HIGH</td><td>Parallel</td><td>/CS1, CS2</td><td>A0</td><td>D0 ~ D7</td><td>RD, WR</td><td>-</td></tr>
<tr><td>LOW</td><td>Serial</td><td>/CS1, CS2</td><td>A0</td><td>SI</td><td>WR only</td><td>SCL</td></tr>
</table>
<br>In serial mode, data can not be read from the RAM, and D0 to D7, RD and WR must be HIGH or LOW. In parallel mode, SI and SCL must be HIGH or LOW</td></tr>
<tr><td>19</td><td>RES</td><td>I</td><td>Reset input. Setting this LOW initialises the LCM</td></tr>
<tr><td>20</td><td>C86</td><td>I</td><td>Microprocessor interface select input<br>• LOW when interfacing to 8080-series<br>• HIGH when interfacing to 6800-series</td></tr>
<tr><td>21</td><td>LED_A</td><td>-</td><td>Power supply for LED backlight (anode)</td></tr>
<tr><td>22</td><td>N/C</td><td>-</td><td>Not connected</td></tr>
</table>

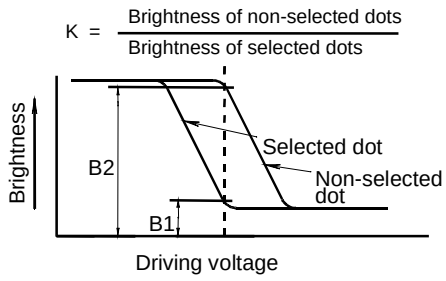
## 7.0 BLOCK DIAGRAM



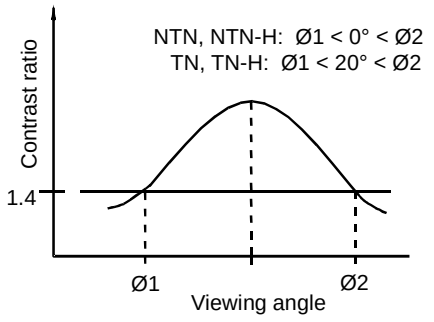

## 8.0 ELECTRO-OPTICAL CHARACTERISTICS

| Item | | Symbol | Test Condition | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|---|
| Contrast ratio TN, TN-H | | K | Ø=20° θ=0° | 3 | - | - | - |
| Contrast ratio STN | | K | Ø=20° θ=0° | 4 | - | - | - |
| Contrast ratio NTN-H | | K | Ø=20° θ=0° | 5 | - | - | - |
| Viewing angle | TN, TN-H | Ø2-Ø1 | θ=0° K≥1.4 | 20 | - | - | Deg. |
| | | θ | Ø=20° K=1.4 | ±30 | - | - | Deg. |
| Viewing angle | STN | Ø2-Ø1 | θ=0° K≥1.4 | 40 | - | - | Deg. |
| | | θ | Ø=20° K=1.4 | ±30 | - | - | Deg. |
| Viewing angle | NTN-H | Ø2-Ø1 | θ=0° K≥1.4 | 40 | - | - | Deg. |
| | | θ | Ø=20° K=1.4 | ±40 | - | - | Deg. |
| Response time | Rise | $t_r$ | Ø=20° θ=0° | - | 150 | 240 | mS |
| | Fall | $t_f$ | Ø=20° θ=0° | - | 350 | 560 | mS |

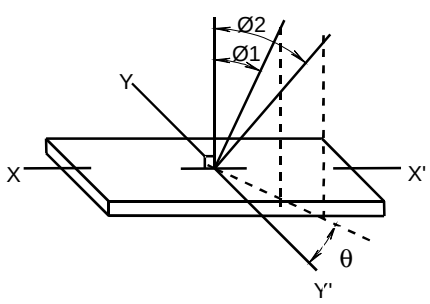
DEFINITION OF CONTRAST RATIO (K)



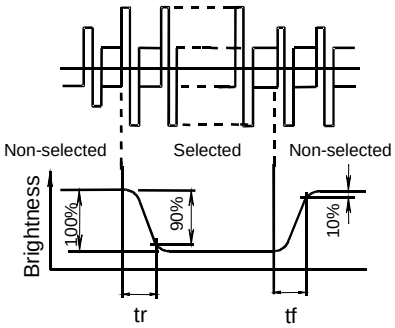

CONTRAST VERSUS VIEWING ANGLE




DEFINITION OF ANGLES Ø AND θ

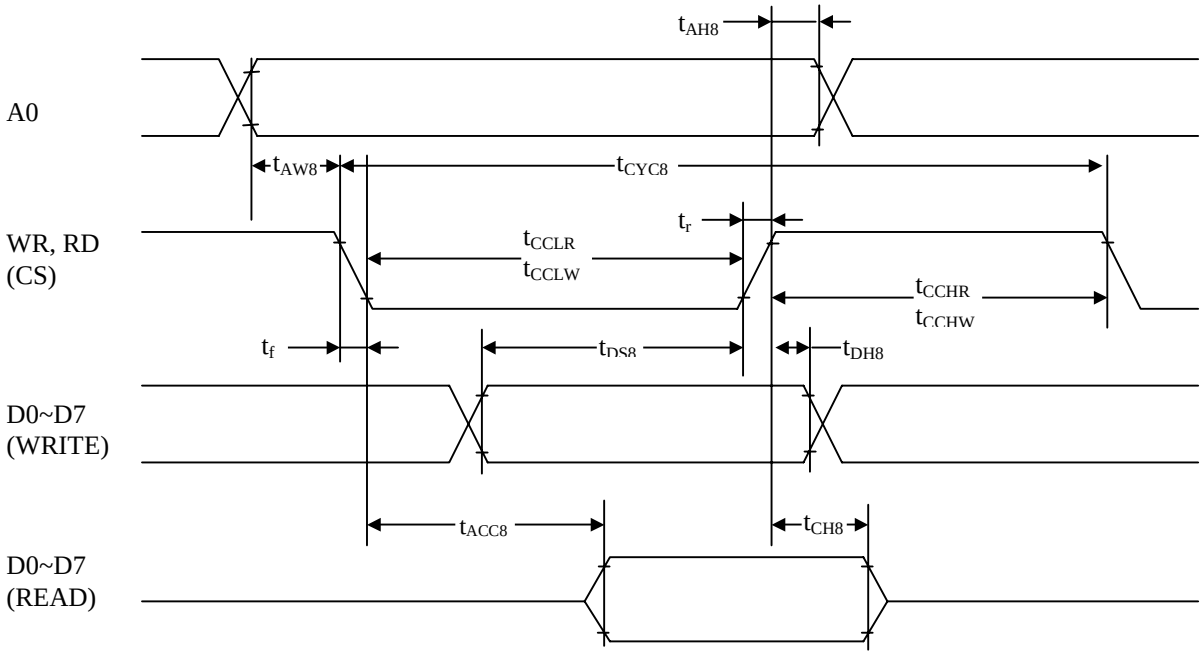



DEFINITION OF OPTICAL RESPONSE



# 9.0 INTERFACE TIMING CHARACTERISTICS

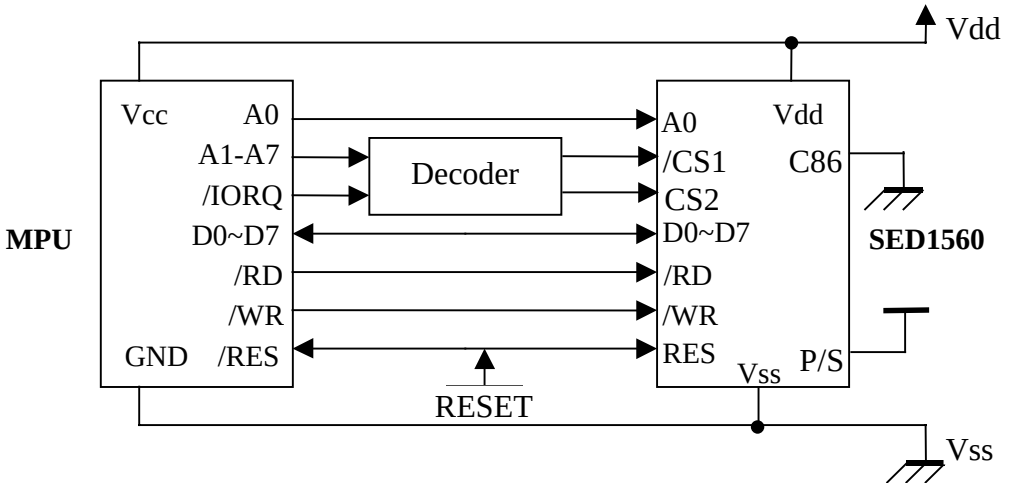
## 9.1 8080-SERIES MPU



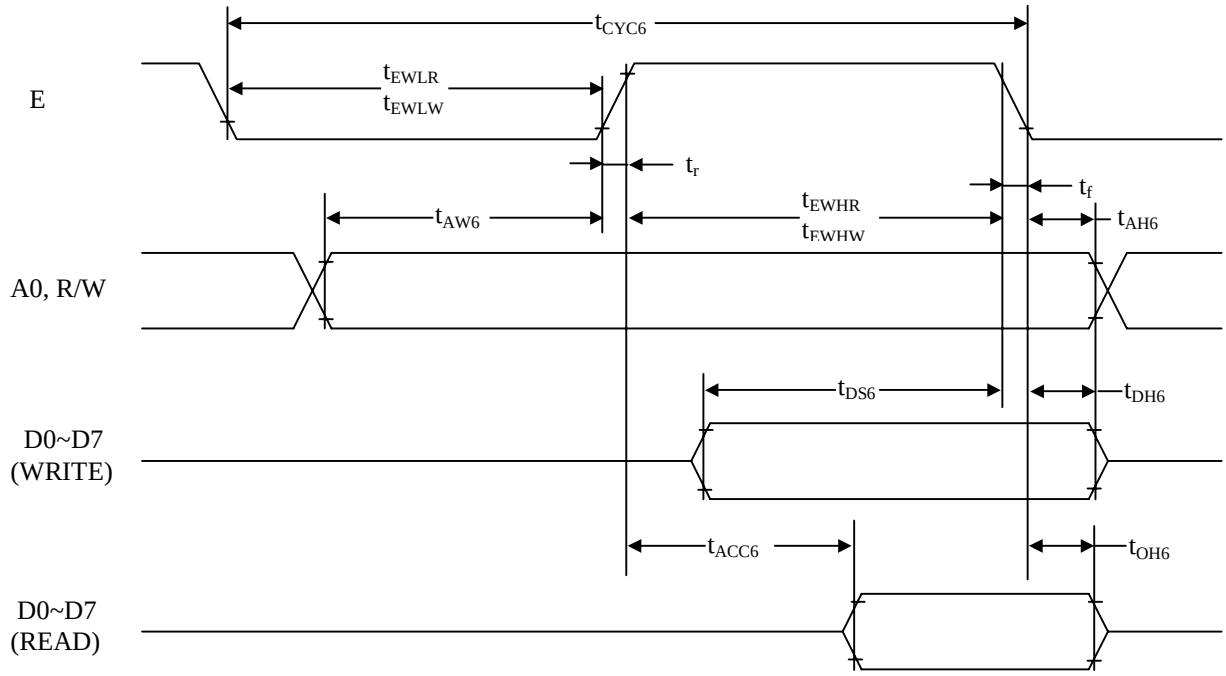

$V_{DD}$ =5V±10%, Ta= 0 °C ~ +60 °C

| Item | Signal | Symbol | Condition | Specification value | | Unit |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Address hold time | A0, CS | $t_{AH8}$ | | 10 | | nS |
| Address set-up time | | $t_{AW8}$ | | 10 | | |
| System cycle time | | $t_{CYC8}$ | | 200 | | |
| Control L pulse width (WR) | /WR | $t_{CCLW}$ | | 22 | | |
| Control L pulse width (RD) | /RD | $t_{CCLR}$ | | 77 | | |
| Control H pulse width (WR) | /WR | $t_{CCHW}$ | | 172 | | |
| Control H pulse width (RD) | /RD | $t_{CCHR}$ | | 117 | | |
| Data set-up time | | $t_{DS8}$ | | 20 | | |
| Data hold time | | $t_{DH8}$ | | 10 | | |
| /RD access time | D0~D7 | $t_{ACC8}$ | $C_L$ =100pF | | 70 | |
| Output disable time | | $t_{CH8}$ | | 10 | 50 | |
| Input signal change time | | $t_r$, $t_f$ | | | 15 | |

Notes: 1. $t_r + t_f \le (t_{CYC8} - t_{CCLW} - t_{CCHW})$ or $t_r + t_f \le (t_{CYC8} - t_{CCLR} - t_{CCHR})$ at all times.
2. For timing purposes, LOW=20% Vdd, HIGH=80%Vdd.
3. READ/WRITE operation is performed while CS (/CS1 and CS2) is active and RD (WR) signal is LOW.



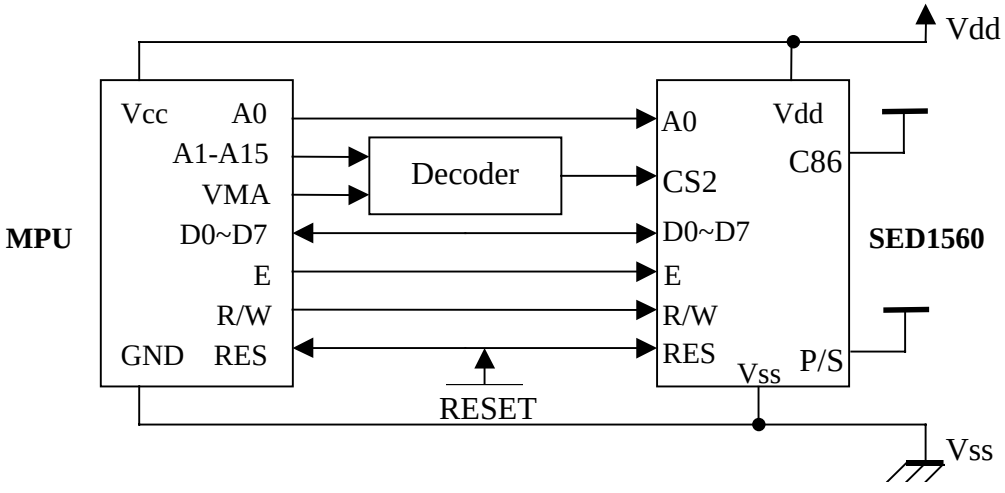
## 9.2 68-SERIES MPU



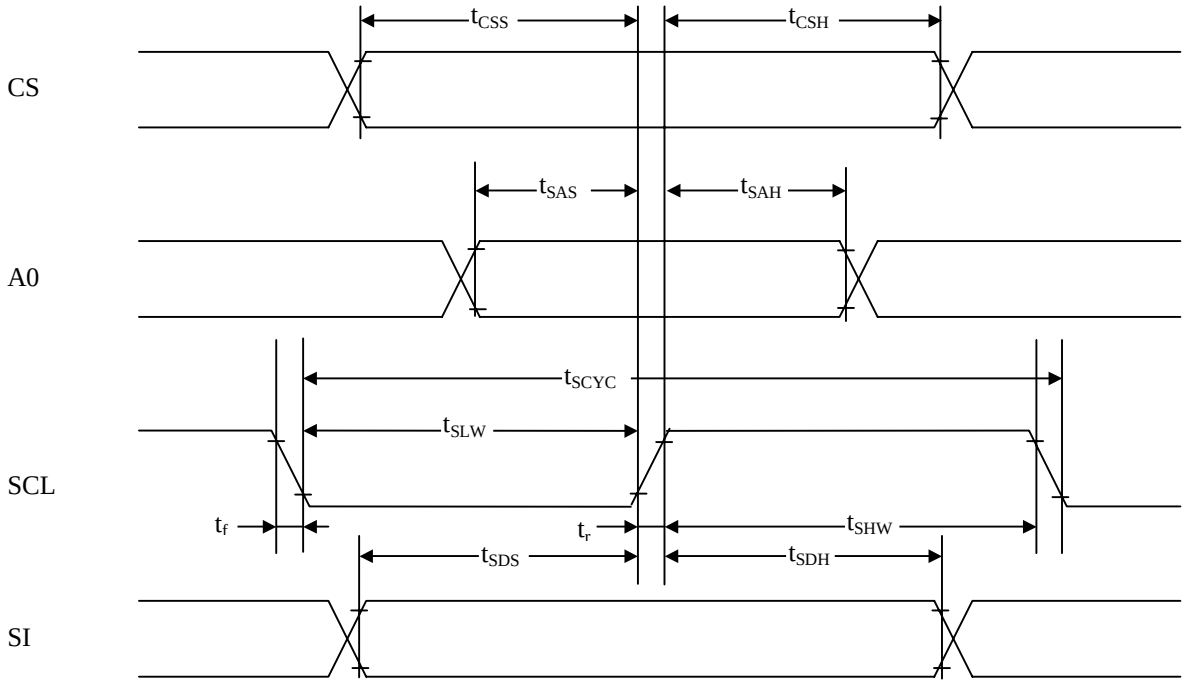

$V_{DD}$ =5V±10%, Ta= 0 °C ~ +60 °C

| Item | | Signal | Symbol | Condition | Specification value | | Unit |
|---|---|---|---|---|---|---|---|
| | | | | | Min. | Max. | |
| Address hold time | | A0 | tAH6 | | 0 | - | nS |
| Address set-up time | | | tAW6 | | 0 | - | |
| System cycle time | | | tCYC6 | | 800 | - | |
| Data set-up time | | D0 to D7 | tDS6 | | 80 | - | |
| Data hold time | | | tDH6 | | 30 | - | |
| Access time | | | tACC6 | CL=100pF | - | 280 | |
| Output disable time | | | tOH6 | | 10 | 200 | |
| Enable H pulse width | READ | E | tEWHR | | 240 | - | |
| | WRITE | | tEWHW | | 120 | - | |
| Enable L pulse width | READ | E | tEWLR | | 120 | - | |
| | WRITE | | tEWLW | | 120 | - | |
| Input signal change time | | | | | | | |

Notes: 1. $t_r + t_f \le (t_{CYC6} - t_{EWLW} - t_{EWHW})$ or $t_r + t_f \le (t_{CYC6} - t_{EWLR} - t_{EWHR})$ at all times.
2. For timing purposes, LOW=20% Vdd, HIGH=80%Vdd.

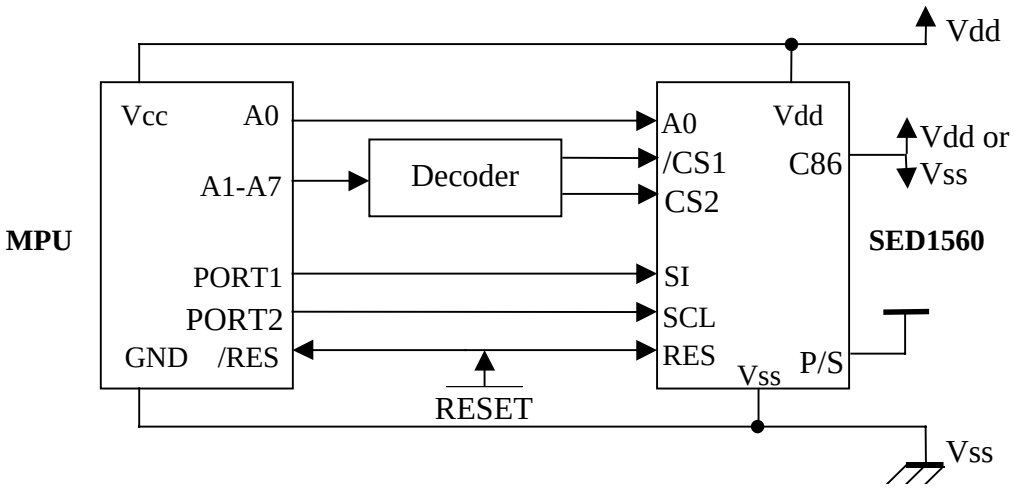


## 9.3 SERIAL INTERFACE




$V_{DD}$ =5V±10%, Ta= 0 °C ~ +60 °C

| Item | Signal | Symbol | Condition | Specification value | | Unit |
|---|---|---|---|---|---|---|
| | | | | Min. | Max. | |
| Serial clock cycle | SCL | $t_{SCYC}$ | | 250 | | nS |
| SCL High pulse width | | $t_{SHW}$ | | 75 | | |
| SCL Low pulse width | | $t_{SLW}$ | | 75 | | |
| Address set-up time | A0 | $t_{SAS}$ | | 50 | | |
| Address hold time | | $t_{SAH}$ | | 200 | | |
| Data set-up time | SI | $t_{SDS}$ | | 50 | | |
| Data hold time | | $t_{SDH}$ | | 30 | | |
| CS-SCL time | CS | $t_{CSS}$ | | 30 | | |
| | | $t_{CSH}$ | | 400 | | |
| Input signal change time | | $t_r$, $t_f$ | | | 50 | |



# 10.0 DISPLAY COMMAND SET (8080-series MPU example)

| Command | Code | | | | | | | | | | | Function |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A0 | /RD | /WR | D7 | D6 | D5 | D4 | D3 | D2 | D1 | D0 | |
| Display ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | Turns the LCD display ON and OFF<br>0: OFF<br>1: ON |
| Display START line set | 0 | 1 | 0 | 0 | 1 | Display start address | | | | | | Load RAM line address of start display line (COM 0) into start line register |
| Page address set | 0 | 1 | 0 | 1 | 0 | 1 | 1 | Page address | | | | Load page RAM page address into page address register |
| Column address set: higher-order 4 bits | 0 | 1 | 0 | 0 | 0 | 0 | 1 | High-order column address | | | | Load 4 higher-order bits of RAM column address into column address register |
| Column address set: lower- order 4 bits | 0 | 1 | 0 | 0 | 0 | 0 | 0 | Low-order column address | | | | Load 4 lower-order bits of RAM column address into column address register |
| Status read | 0 | 0 | 1 | Status bits | | | | 0 | 0 | 0 | 0 | Read LCD controller status |
| Display data write | 1 | 1 | 0 | Write data | | | | | | | | Write data to display RAM location specified by column address and page address registers |
| Display data read | 1 | 0 | 1 | Read data | | | | | | | | Reads data from display RAM |
| ADC select | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0<br>1 | Set column scan direction<br>0: normal 1: reversed |
| Normal/reverse display | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 0<br>1 | Set normal/inverted display mode<br>0: normal 1: reversed |
| All segments ON/OFF | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 1 | 0 | 0<br>1 | Toggle between normal display operation and ALL SEGMENTS ON<br>0: Normal display<br>1: All ON |
| Duty select | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0<br>1 | Sets LCD drive duty (1)<br>0: 1/48 1: 1/64 |
| Duty + 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0<br>1 | Sets LCD drive duty (2)<br>0: Normal 1: Duty + 1 |
| n-line reverse register set | 0 | 1 | 0 | 0 | 0 | 1 | 1 | No. of reversed n-lines | | | | Sets the period for inverting LCD drive waveform in terms of a number of lines (2-16). |
| n-line reverse register release | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | Restore normal 2-frame inversion period |
| Read Modify write | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | Change data read mode: column address no longer incremented automatically by Read Display Data command |
| End | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 0 | Cancel Read Modify write mode |
| Reset | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 0 | 0 | 1 | 0 | Internal reset |
| Output status register set | 0 | 1 | 0 | 1 | 1 | 0 | 0 | Output status | | | | Sets COM/SEG function of dual outputs |
| Built-in DC/DC generator ON/OFF | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 0<br>1 | 0: DC generator OFF<br>1: DC generator ON |
| Power-on completion | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | Complete the turn -on sequence |
| Software contrast control register set | 0 | 1 | 0 | 1 | 0 | 0 | Contrast control value | | | | | Sets output voltage for contrast control in contrast control register |
| Power save | | | | | | | | | | | | A complex command to turn off the display while preserving display content |

**Note**: RESET signal

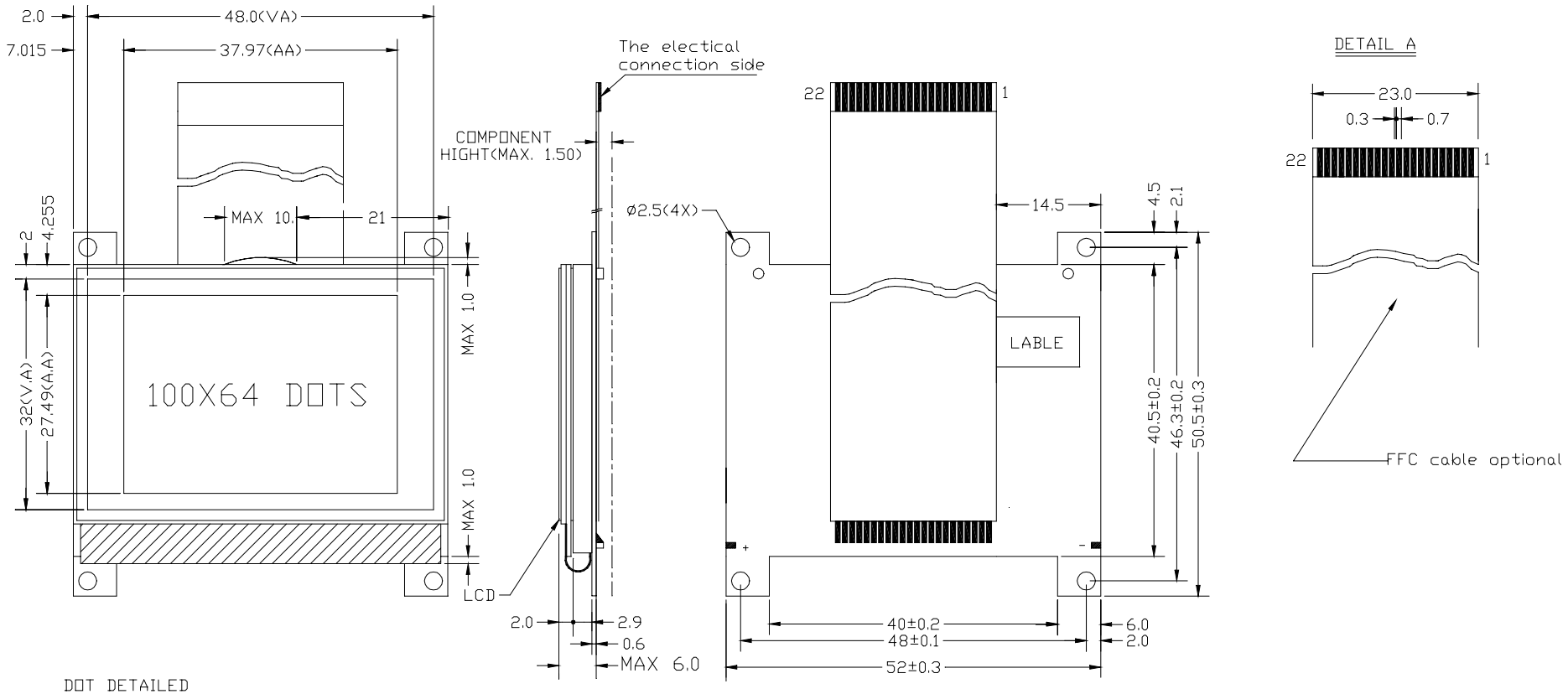
When power is turned ON, the display is initialised on the rising edge of /RES. Initial settings are as follows:

Display : OFF
Display mode : Normal
n-line inversion : OFF
Duty cycle : 1/64
ADC select : Normal (D0 = L)
Read/write modify : OFF
Internal power supply : OFF
Serial interface register data: Cleared
Display initial line register : Line 1
Column address counter : 0
Page address register : Page 0
Output selection circuit : Case 6
n-line inversion register : 16
Contrast control register : 0

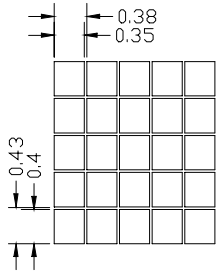
/RES must be LOW for at least 1 μS to reset the controller correctly. Normal operation starts 1 μS after the rising edge of /RES.

**Note**: for detailed description of system functions refer to Seiko-Epson operation manual for SED1560 LSI.

## 11.0 DRAWING (note: FFC cable is an optional extra and is not supplied as standard)



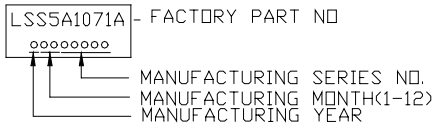

DOT DETAILED




NOTE:

1. LCD DISPLAY MODE:STN/YELLOW-GREEN/TRANSFLECTIVE TYPE.
2. VIEWING ANGLE: 12 O'CLOCK.
3. OPERATING TEMP:0 TO 50 DEGREE.
4. STORAGE TEMP:-20 TO 60 DEGREE.
5. THE LCD DRIVING CONDITION IS:1/64D,1/9B,Vop=8.8V.

MANUFACTURE LABEL




| DWG.NO. | LM4064 | SHEET 9 of 10 | REV. |
|---|---|---|---|

## 12.0 ENVIRONMENTAL TESTING

The test criteria for LM4064 LCM require that the module operate normally after application of the following conditions:

- High temperature operation, under normal humidity (less than 30% RH) at 50 °C for 120 hours.
- Low temperature operation, under normal humidity (less than 60% RH) at 0 °C for 120 hours (no dew).
- High temperature storage, under normal humidity (less than 30% RH) at 60 °C for 120 hours.
- Low temperature storage, under normal humidity (less than 60% RH) at –20 °C for 120 hours.
- High temperature and high humidity storage, under condition of 90% RH at 40 °C for 120 hours (no dew).
- Vibration, under the following conditions:

  | | |
  |---|---|
  | Frequency | : 10-55 Hz |
  | Max. acceleration | : 5G |
  | 1 cycle time | : 1 min |
  | Duration: | : 15 mins |

- Drop impact test, 0.7 m drop to concrete floor (inside packaging).

Expected lifetime of LM4064 module is more than 50,000 hours (under normal operating conditions).

## 13.0 PART NUMBER DESCRIPTION FOR AVAILABLE OPTIONS

# LM4064①②64G100③④⑤/X

**①** **Poliriser type**
B = transflective positive (light background, with backlight)

**②** **LED Backlight Colour**
G = yellow-green

**③** **Operating Temperature Range And Power Supply**
S = standard temperature range (0 to +50 ºC) single-rail 3V or 5V with on-board DC/DC

**④** **Fluid Type And Temperature Compensation**
C = STN with on-board temperature compensation

**⑤** **Background Colour**
G = Grey background
Y = Yellow-Green background

**X** **Operating Voltage**
Blank = 5VDC operation
3V = 3VDC operation