# Product Specification

**Part Name:** OEL Display Module  
**Customer Part ID:**  
**Part ID:** QG-2864KSWEG01  
**Ver:** C

<table>
<thead>
<tr>
<th>Customer:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved by</td>
<td></td>
</tr>
</tbody>
</table>

| From: | 成都利惠利特自动化科技有限公司  
Tel: 181 2331 3360  
E-mail: echo@heltec.cn  
www.heltec.cn |  |
## Revised History

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Revision</th>
<th>Revision Content</th>
<th>Revised on</th>
</tr>
</thead>
<tbody>
<tr>
<td>QG-2864KSWEG01</td>
<td>A New</td>
<td></td>
<td>20130225</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>( R_{\text{REF}}=390\text{K} ) 变更为 ( R_{\text{REF}}=910\text{K} )</td>
<td>20130522</td>
</tr>
<tr>
<td></td>
<td></td>
<td>亮度寄存器（0X81）参数 0xCF 变更为 0x66</td>
<td></td>
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<td></td>
<td>C</td>
<td>亮度寄存器（0x81）参数 0x66 变更为 0xCF</td>
<td>20130529</td>
</tr>
<tr>
<td></td>
<td></td>
<td>寄存器（0xD9）的参数 0x1F 变更为 0xF1</td>
<td></td>
</tr>
</tbody>
</table>
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1. Basic Specifications

1.1 Display Specifications

1) Display Mode: Passive Matrix
2) Display Color: Monochrome (White)
3) Drive Duty: 1/64 Duty

1.2 Mechanical Specifications

1) Outline Drawing: According to the annexed outline drawing
2) Number of Pixels: 128 × 64
3) Panel Size: 26.70 × 19.26 × 1.4 (mm)
4) Active Area: 21.744 × 10.864 (mm)
5) Pixel Pitch: 0.17 × 0.17 (mm)
6) Pixel Size: 0.154 × 0.154 (mm)
7) Weight: 1.54 (g)

1.3 Active Area / Memory Mapping & Pixel Construction
1.4 Mechanical Drawing

Notes:
1. Color: White
2. Driver IC: SSD1306
3. FPC Number: QUT1306P01
4. Interface: 8-bit 68XX/80XX Parallel, 3-/4-wire SPI, I2C
5. General Tolerance: ±0.30

Customer Approval
Signature

Title
Date
By
Drawn

Detail "A"
Scale (10:1)

QG-2864KSWEG01 Folding Type OEL Display Module
Pixel Number: 128 x 64, Monochrome, COG Package

±0.3 mm

Unless Otherwise Specified
Unit
Tolerance
Angle
Dimension

Panel / E.E.E.
1:1 Scale
A3 Size

Rev.
Soda Lime / Polyimide

A

HONG

20130222A Original Drawing
P.M.

Remove Tape
t=0.15mm Max
Polarizer
t=0.2mm
3M #1318B
15x8x0.063mm
Contact Side

Pin
cs#
R/W#
E/RD#
Symbol
BS1
2
5
7
6
4
3
1

9
10

18
IREF
RES#
BS2
D0
12
15
17
16
14
13
11

19
20

D1
D2
D3
D4
D5
D6
D7
VCC
VLSS

VCOMH

Segment 0
(Column 128)
Common 1
(Row 64)
Common 63
(Row 2)
Segment 127
(Column 1)
Common 0
(Row 63)
Common 62
(Row 1)

Active Area 0.96" 128 x 64 Pixels

Notes:
1. Color: White
2. Driver IC: SSD1306
3. Interface: 8-bit 68XX/80XX Parallel, 3-/4-wire SPI, I2C
4. General Tolerance ±0.30
### 1.5 Pin Definition

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>I/O</th>
<th>Power Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>VDD</td>
<td>P</td>
<td>Power Supply for Logic</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This is a voltage supply pin. It must be connected to external source.</td>
</tr>
<tr>
<td>8</td>
<td>VSS</td>
<td>P</td>
<td>Ground of Logic Circuit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This is a ground pin. It acts as a reference for the logic pins. It must be connected to external ground.</td>
</tr>
<tr>
<td>28</td>
<td>VCC</td>
<td>P</td>
<td>Power Supply for OEL Panel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This is the most positive voltage supply pin of the chip. A stabilization capacitor should be connected between this pin and VSS when the converter is used. It must be connected to external source when the converter is not used.</td>
</tr>
<tr>
<td>29</td>
<td>VLSS</td>
<td>P</td>
<td>Ground of Analog Circuit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This is an analog ground pin. It should be connected to VSS externally.</td>
</tr>
</tbody>
</table>

#### Driver

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>I/O</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>IREF</td>
<td>I</td>
<td>Current Reference for Brightness Adjustment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This pin is segment current reference pin. A resistor should be connected between this pin and VSS. Set the current at 12.5μA maximum.</td>
</tr>
<tr>
<td>27</td>
<td>VCOMH</td>
<td>O</td>
<td>Voltage Output High Level for COM Signal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This pin is the input pin for the voltage output high level for COM signals. A capacitor should be connected between this pin and VSS.</td>
</tr>
</tbody>
</table>

#### DC/DC Converter

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>I/O</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>VBAT</td>
<td>P</td>
<td>Power Supply for DC/DC Converter Circuit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This is the power supply pin for the internal buffer of the DC/DC voltage converter. It must be connected to external source when the converter is used. It should be connected to VDD when the converter is not used.</td>
</tr>
<tr>
<td>4 / 5</td>
<td>C1P / C1N</td>
<td>I</td>
<td>Positive Terminal of the Flying Inverting Capacitor</td>
</tr>
<tr>
<td>2 / 3</td>
<td>C2P / C2N</td>
<td>I</td>
<td>Negative Terminal of the Flying Boost Capacitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The charge-pump capacitors are required between the terminals. They must be floated when the converter is not used.</td>
</tr>
</tbody>
</table>

#### Interface

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>I/O</th>
<th>Communicating Protocol Select</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>BS0</td>
<td>I</td>
<td>These pins are MCU interface selection input. See the following table:</td>
</tr>
<tr>
<td>11</td>
<td>BS1</td>
<td>I</td>
<td>BS0</td>
</tr>
<tr>
<td>12</td>
<td>BS2</td>
<td>I</td>
<td>1’C</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3-wire SPI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4-wire SPI</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8-bit 68XX Parallel</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>8-bit 80XX Parallel</td>
</tr>
<tr>
<td>14</td>
<td>RES#</td>
<td>I</td>
<td>Power Reset for Controller and Driver</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This pin is reset signal input. When the pin is low, initialization of the chip is executed. Keep this pin pull high during normal operation.</td>
</tr>
<tr>
<td>13</td>
<td>CS#</td>
<td>I</td>
<td>Chip Select</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This pin is the chip select input. The chip is enabled for MCU communication only when CS# is pulled low.</td>
</tr>
<tr>
<td>15</td>
<td>D/C#</td>
<td>I</td>
<td>Data/Command Control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This pin is Data/Command control pin. When the pin is pulled high, the input at D7<del>D0 is treated as display data. When the pin is pulled low, the input at D7</del>D0 will be transferred to the command register. When the pin is pulled high and serial interface mode is selected, the data at SDIN will be interpreted as data. When it is pulled low, the data at SDIN will be transferred to the command register. In 1’C mode, this pin acts as SA0 for slave address selection. For detail relationship to MCU interface signals, please refer to the Timing Characteristics Diagrams.</td>
</tr>
<tr>
<td>17</td>
<td>E/RD#</td>
<td>I</td>
<td>Read/Write Enable or Read</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>This pin is MCU interface input. When interfacing to a 68XX-series microprocessor, this pin will be used as the Enable (E) signal. Read/write operation is initiated when this pin is pulled high and the CS# is pulled low. When connecting to an 80XX-microprocessor, this pin receives the Read (RD#) signal. Data read operation is initiated when this pin is pulled low and CS# is pulled low. When serial or 1’C mode is selected, this pin must be connected to VSS.</td>
</tr>
</tbody>
</table>
### 1.5 Pin Definition (Continued)

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Symbol</th>
<th>I/O</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interface (Continued)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>R/W#</td>
<td>I</td>
<td><strong>Read/Write Select or Write</strong>&lt;br&gt;This pin is MCU interface input. When interfacing to a 68XX-series microprocessor, this pin will be used as Read/Write (R/W#) selection input. Pull this pin to “High” for read mode and pull it to “Low” for write mode. When 80XX interface mode is selected, this pin will be the Write (WR#) input. Data write operation is initiated when this pin is pulled low and the CS# is pulled low. When serial or I²C mode is selected, this pin must be connected to V&lt;sub&gt;SS&lt;/sub&gt;.</td>
</tr>
<tr>
<td>18~25</td>
<td>D0~D7</td>
<td>I/O</td>
<td><strong>Host Data Input/Output Bus</strong>&lt;br&gt;These pins are 8-bit bi-directional data bus to be connected to the microprocessor’s data bus. When serial mode is selected, D1 will be the serial data input SDIN and D0 will be the serial clock input SCLK. When I²C mode is selected, D2 &amp; D1 should be tied together and serve as SDA&lt;sub&gt;out&lt;/sub&gt; and SDA&lt;sub&gt;in&lt;/sub&gt; in application and D0 is the serial clock input SCL. Unused pins must be connected to V&lt;sub&gt;SS&lt;/sub&gt; except for D2 in serial mode.</td>
</tr>
<tr>
<td><strong>Reserve</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>N.C.</td>
<td>-</td>
<td><strong>Reserved Pin</strong>&lt;br&gt;The N.C. pin between function pins are reserved for compatible and flexible design.</td>
</tr>
<tr>
<td>1, 30</td>
<td>N.C. (GND)</td>
<td>-</td>
<td><strong>Reserved Pin (Supporting Pin)</strong>&lt;br&gt;The supporting pins can reduce the influences from stresses on the function pins. These pins must be connected to external ground as the ESD protection circuit.</td>
</tr>
</tbody>
</table>
1.6 Block Diagram

1.6.1 \( V_{CC} \) Supplied Externally

Active Area 0.96"

128 x 64 Pixels

SSD1306

MCU Interface Selection: BS0, BS1 and BS2

Pins connected to MCU interface: CS#, RES#, D/C#, R/W#, E/RD#, and D0~D7

C1, C3: 0.1\( \mu F \)

C2: 4.7\( \mu F \)

C4, C5: 4.7\( \mu F / 16V \) X7R

R1: 910k\( \Omega \), \( R1 = (\text{Voltage at IREF} - VSS) / \text{IREF} \)
1.6.2 $V_{CC}$ Generated by Internal DC/DC Circuit

Active Area 0.96"
128 x 64 Pixels

SSD1306

MCU Interface Selection: BS0, BS1 and BS2
Pins connected to MCU interface: CS#, RES#, D/C#, R/W#, E/RD#, and D0~D7

C1, C2: 1µF
C3: 2.2µF
C4: 4.7µF / 16V X7R
C5, C6: 1µF / 16V X5R
R1: 910kΩ, $R_1 = (\text{Voltage at IREF} - \text{VSS}) / \text{IREF}$
# 2. Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage for Logic</td>
<td>V_{DD}</td>
<td>-0.3</td>
<td>4</td>
<td>V</td>
<td>1, 2</td>
</tr>
<tr>
<td>Supply Voltage for Display</td>
<td>V_{CC}</td>
<td>0</td>
<td>16</td>
<td>V</td>
<td>1, 2</td>
</tr>
<tr>
<td>Supply Voltage for DC/DC</td>
<td>V_{BAT}</td>
<td>-0.3</td>
<td>5</td>
<td>V</td>
<td>1, 2</td>
</tr>
<tr>
<td>Operating Temperature</td>
<td>T_{OP}</td>
<td>-40</td>
<td>85</td>
<td>°C</td>
<td></td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>T_{STG}</td>
<td>-40</td>
<td>85</td>
<td>°C</td>
<td>3</td>
</tr>
<tr>
<td>Life Time (120 cd/m²)</td>
<td></td>
<td>10,000</td>
<td>-</td>
<td>hour</td>
<td>4</td>
</tr>
<tr>
<td>Life Time (80 cd/m²)</td>
<td></td>
<td>30,000</td>
<td>-</td>
<td>hour</td>
<td>4</td>
</tr>
<tr>
<td>Life Time (60 cd/m²)</td>
<td></td>
<td>50,000</td>
<td>-</td>
<td>hour</td>
<td>4</td>
</tr>
</tbody>
</table>

Note 1: All the above voltages are on the basis of “V_{SS} = 0V”.
Note 2: When this module is used beyond the above absolute maximum ratings, permanent breakage of the module may occur. Also, for normal operations, it is desirable to use this module under the conditions according to Section 3. “Optics & Electrical Characteristics”. If this module is used beyond these conditions, malfunctioning of the module can occur and the reliability of the module may deteriorate.
Note 3: The defined temperature ranges do not include the polarizer. The maximum withstood temperature of the polarizer should be 80°C.
Note 4: V_{CC} = 12.0V, T_a = 25°C, 50% Checkerboard.
Software configuration follows Section 4.4 Initialization.
End of lifetime is specified as 50% of initial brightness reached. The average operating lifetime at room temperature is estimated by the accelerated operation at high temperature conditions.
### 3. Optics & Electrical Characteristics

#### 3.1 Optics Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brightness ((V_{CC}) Supplied Externally)</td>
<td>(L_{br})</td>
<td>Note 5</td>
<td>150</td>
<td>-</td>
<td>-</td>
<td>cd/m²</td>
</tr>
<tr>
<td>Brightness ((V_{CC}) Generated by Internal DC/DC)</td>
<td>(L_{br})</td>
<td>Note 6</td>
<td>150</td>
<td>180</td>
<td>-</td>
<td>cd/m²</td>
</tr>
<tr>
<td>C.I.E. (White)</td>
<td>((x)) ((y))</td>
<td>C.I.E. 1931</td>
<td>0.28</td>
<td>0.32</td>
<td>0.36</td>
<td>0.39</td>
</tr>
<tr>
<td>Dark Room Contrast</td>
<td>CR</td>
<td></td>
<td>-</td>
<td>2000:1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Viewing Angle</td>
<td>-</td>
<td>Free</td>
<td>-</td>
<td>degree</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Optical measurement taken at \(V_{DD} = 2.8V, V_{CC} = 12V \) & 7.25V.  
Software configuration follows Section 4.4 Initialization.

#### 3.2 DC Characteristics

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Symbol</th>
<th>Conditions</th>
<th>Min</th>
<th>Typ</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage for Logic</td>
<td>(V_{DD})</td>
<td></td>
<td>1.65</td>
<td>2.8</td>
<td>3.3</td>
<td>V</td>
</tr>
<tr>
<td>Supply Voltage for Display</td>
<td>(V_{CC})</td>
<td>Note 5</td>
<td>11.5</td>
<td>12.0</td>
<td>12.5</td>
<td>V</td>
</tr>
<tr>
<td>Supply Voltage for DC/DC</td>
<td>(V_{BAT})</td>
<td>Internal DC/DC Enable</td>
<td>3.5</td>
<td>-</td>
<td>4.2</td>
<td>V</td>
</tr>
<tr>
<td>Supply Voltage for Display</td>
<td>(V_{CC})</td>
<td>Note 6</td>
<td>7.0</td>
<td>-</td>
<td>7.5</td>
<td>V</td>
</tr>
<tr>
<td>High Level Input</td>
<td>(V_{IH}) (I_{OUT} = 100\mu A, 3.3MHz)</td>
<td>0.8\times V_{DD}</td>
<td>-</td>
<td>V_{DD}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Low Level Input</td>
<td>(V_{IL}) (I_{OUT} = 100\mu A, 3.3MHz)</td>
<td>0</td>
<td>-</td>
<td>0.2\times V_{DD}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>High Level Output</td>
<td>(V_{OH}) (I_{OUT} = 100\mu A, 3.3MHz)</td>
<td>0.9\times V_{DD}</td>
<td>-</td>
<td>V_{DD}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Low Level Output</td>
<td>(V_{OL}) (I_{OUT} = 100\mu A, 3.3MHz)</td>
<td>0</td>
<td>-</td>
<td>0.1\times V_{DD}</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Operating Current for (V_{DD})</td>
<td>(I_{DD})</td>
<td></td>
<td>-</td>
<td>180</td>
<td>300</td>
<td>\mu A</td>
</tr>
<tr>
<td>Operating Current for (V_{CC})</td>
<td>(I_{CC})</td>
<td>Note 7</td>
<td>-</td>
<td>9</td>
<td>15</td>
<td>mA</td>
</tr>
<tr>
<td>Operating Current for (V_{BAT})</td>
<td>(I_{BAT})</td>
<td>Note 8</td>
<td>-</td>
<td>25.6</td>
<td>32.0</td>
<td>mA</td>
</tr>
<tr>
<td>Sleep Mode Current for (V_{DD})</td>
<td>(I_{DD,,SLEEP})</td>
<td></td>
<td>-</td>
<td>1</td>
<td>5</td>
<td>\mu A</td>
</tr>
<tr>
<td>Sleep Mode Current for (V_{CC})</td>
<td>(I_{CC,,SLEEP})</td>
<td></td>
<td>-</td>
<td>2</td>
<td>10</td>
<td>\mu A</td>
</tr>
</tbody>
</table>

Note 5 & 6: Brightness (\(L_{br}\)) and Supply Voltage for Display (\(V_{CC}\)) are subject to the change of the panel characteristics and the customer’s request.

Note 7: \(V_{DD} = 2.8V, V_{CC} = 12V, 100\% \) Display Area Turn on.

Note 8: \(V_{DD} = 2.8V, V_{CC} = 7.25V, 100\% \) Display Area Turn on.

* Software configuration follows Section 4.4 Initialization.
### 3.3 AC Characteristics

3.3.1.1 68XX-Series MPU Parallel Interface Timing Characteristics:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(t_{\text{cycle}})</td>
<td>Clock Cycle Time</td>
<td>300</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{AS}})</td>
<td>Address Setup Time</td>
<td>5</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{AH}})</td>
<td>Address Hold Time</td>
<td>0</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{DSW}})</td>
<td>Write Data Setup Time</td>
<td>40</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{DHW}})</td>
<td>Write Data Hold Time</td>
<td>7</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{DHR}})</td>
<td>Read Data Hold Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{OH}})</td>
<td>Output Disable Time</td>
<td>-</td>
<td>70</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{ACC}})</td>
<td>Access Time</td>
<td>-</td>
<td>140</td>
<td>ns</td>
</tr>
<tr>
<td>(PW_{\text{CSL}})</td>
<td>Chip Select Low Pulse Width (Read)</td>
<td>120</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Chip Select Low Pulse width (Write)</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(PW_{\text{CSH}})</td>
<td>Chip Select High Pulse Width (Read)</td>
<td>60</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Chip Select High Pulse Width (Write)</td>
<td>60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(t_{\text{R}})</td>
<td>Rise Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
<tr>
<td>(t_{\text{F}})</td>
<td>Fall Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
</tbody>
</table>

* \((V_{\text{DD}} - V_{\text{SS}} = 1.65\text{V to 3.3V, } T_{\text{a}} = 25\text{°C})\)*

![Diagram](image-url)
3.3.1.2 68XX-Series MPU Parallel Interface with Internal Charge Pump

**Recommended Components:**
- C1, C2: 1μF / 16V, X5R
- C3: 2.2μF
- C4: 4.7μF / 16V, X7R
- C5, C6: 1μF
- R1: 910kΩ, \( R_1 = \frac{\text{Voltage at IREF} - \text{VSS}}{\text{IREF}} \)
- R2, R3: 47kΩ
- Q1: FDN338P
- Q2: FDN335N

**Notes:**
- **VDD:** 1.65~3.3V, it should be equal to MPU I/O voltage.
- **Vin:** 3.5~4.2V
- * VBAT will be connected to VDD when VCC be connected to external source (12V), R1 should be replaced as **910 kΩ**.
### 3.3.2.1 80XX-Series MPU Parallel Interface Timing Characteristics:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>( t_{\text{cycle}} )</td>
<td>Clock Cycle Time</td>
<td>300</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{AS} )</td>
<td>Address Setup Time</td>
<td>10</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{AH} )</td>
<td>Address Hold Time</td>
<td>0</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{DSW} )</td>
<td>Write Data Setup Time</td>
<td>40</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{DHW} )</td>
<td>Write Data Hold Time</td>
<td>7</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{DHR} )</td>
<td>Read Data Hold Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{OH} )</td>
<td>Output Disable Time</td>
<td>-</td>
<td>70</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{ACC} )</td>
<td>Access Time</td>
<td>-</td>
<td>140</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{PWLR} )</td>
<td>Read Low Time</td>
<td>120</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{PWLW} )</td>
<td>Write Low Time</td>
<td>60</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{PWHR} )</td>
<td>Read High Time</td>
<td>60</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{PWHW} )</td>
<td>Write High Time</td>
<td>60</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{CS} )</td>
<td>Chip Select Setup Time</td>
<td>0</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{CSH} )</td>
<td>Chip Select Hold Time to Read Signal</td>
<td>0</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{CSF} )</td>
<td>Chip Select Hold Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{R} )</td>
<td>Rise Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
<tr>
<td>( t_{F} )</td>
<td>Fall Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
</tbody>
</table>

* \( V_{DD} - V_{SS} = 1.65V \text{ to } 3.3V, T_a = 25°C \)

![Read Timing Diagram]

![Write Timing Diagram]
3.3.2.2 80XX-Series MPU Parallel Interface with Internal Charge Pump

Recommended Components:
- C1, C2: 1μF / 16V, X5R
- C3: 2.2μF
- C4: 4.7μF / 16V, X7R
- C5, C6: 1μF
- R1: 910kΩ, R1 = (Voltage at IREF - VSS) / IREF
- R2, R3: 47kΩ
- Q1: FDN338P
- Q2: FDN335N

Notes:
- VDD: 1.65~3.3V, it should be equal to MPU I/O voltage.
- Vin: 3.5~4.2V

* VBAT will be connected to VDD when VCC be connected to external source (12V), R1 should be replaced as 910 kΩ.
### 3.3.3.1 Serial Interface Timing Characteristics: (4-wire SPI)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{\text{cycle}}$</td>
<td>Clock Cycle Time</td>
<td>100</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{AS}$</td>
<td>Address Setup Time</td>
<td>15</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{AH}$</td>
<td>Address Hold Time</td>
<td>15</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{CSS}$</td>
<td>Chip Select Setup Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{CSH}$</td>
<td>Chip Select Hold Time</td>
<td>10</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{DSW}$</td>
<td>Write Data Setup Time</td>
<td>15</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{DHW}$</td>
<td>Write Data Hold Time</td>
<td>15</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{CLXL}$</td>
<td>Clock Low Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{CLKH}$</td>
<td>Clock High Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{R}$</td>
<td>Rise Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{F}$</td>
<td>Fall Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
</tbody>
</table>

* $(V_{DD} - V_{SS} = 1.65V$ to $3.3V$, $T_a = 25^\circC$)
3.3.3.2 4-wire Serial Interface with Internal Charge Pump

Recommended Components:
C1, C2: 1μF / 16V, X5R
C3: 2.2μF
C4: 4.7μF / 16V, X7R
C5, C6: 1μF
R1: 910kΩ, R1 = (Voltage at IREF - VSS) / IREF
R2, R3: 47kΩ
R4, R5: 4.7kΩ
Q1: FDN338P
Q2: FDN335N

Notes:
VDD: 1.65~3.3V, it should be equal to MPU I/O voltage.
Vin: 3.5~4.2V
* VBAT will be connected to VDD when VCC be connected to external source (12V), R1 should be replaced as **910 kΩ**.
### 3.3.4.1 Serial Interface Timing Characteristics: (3-wire SPI)

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{\text{cycle}}$</td>
<td>Clock Cycle Time</td>
<td>100</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{CSS}}$</td>
<td>Chip Select Setup Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{CSH}}$</td>
<td>Chip Select Hold Time</td>
<td>10</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{DSW}}$</td>
<td>Write Data Setup Time</td>
<td>15</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{DHW}}$</td>
<td>Write Data Hold Time</td>
<td>15</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{CLKL}}$</td>
<td>Clock Low Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{CLKH}}$</td>
<td>Clock High Time</td>
<td>20</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{R}}$</td>
<td>Rise Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
<tr>
<td>$t_{\text{F}}$</td>
<td>Fall Time</td>
<td>-</td>
<td>40</td>
<td>ns</td>
</tr>
</tbody>
</table>

* ($V_{\text{DD}} - V_{\text{SS}} = 1.65V$ to $3.3V, T_{\text{a}} = 25^\circ\text{C}$)
### 3.3.4.2 3-wire Serial Interface with Internal Charge Pump

**Recommended Components:**
- C1, C2: 1μF / 16V, X5R
- C3: 2.2μF/16V
- C4: 4.7μF / 16V, X7R
- C5, C6: 1μF/16V
- R1: 910kΩ, R1 = (Voltage at IREF - VSS) / IREF
- R2, R3: 47kΩ
- R4, R5: 4.7kΩ
- Q1: FDN338P
- Q2: FDN335N

**Notes:**
- VDD: 1.65~3.3V, it should be equal to MPU I/O voltage.
- Vin: 3.5~4.2V
- * VBAT will be connected to VDD when VCC be connected to external source (12V), R1 should be replaced as 910 kΩ.
3.3.5.1 I²C Interface Timing Characteristics:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
<th>Min</th>
<th>Max</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>t&lt;sub&gt;cycle&lt;/sub&gt;</td>
<td>Clock Cycle Time</td>
<td>2.5</td>
<td>-</td>
<td>µs</td>
</tr>
<tr>
<td>t&lt;sub&gt;HSTART&lt;/sub&gt;</td>
<td>Start Condition Hold Time</td>
<td>0.6</td>
<td>-</td>
<td>µs</td>
</tr>
<tr>
<td>t&lt;sub&gt;HD&lt;/sub&gt;</td>
<td>Data Hold Time (for “SDA&lt;sub&gt;OUT&lt;/sub&gt;” Pin)</td>
<td>0</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td></td>
<td>Data Hold Time (for “SDA&lt;sub&gt;IN&lt;/sub&gt;” Pin)</td>
<td>300</td>
<td></td>
<td></td>
</tr>
<tr>
<td>t&lt;sub&gt;SD&lt;/sub&gt;</td>
<td>Data Setup Time</td>
<td>100</td>
<td>-</td>
<td>ns</td>
</tr>
<tr>
<td>t&lt;sub&gt;SSTART&lt;/sub&gt;</td>
<td>Start Condition Setup Time (Only relevant for a repeated Start condition)</td>
<td>0.6</td>
<td>-</td>
<td>µs</td>
</tr>
<tr>
<td>t&lt;sub&gt;STOP&lt;/sub&gt;</td>
<td>Stop Condition Setup Time</td>
<td>0.6</td>
<td>-</td>
<td>µs</td>
</tr>
<tr>
<td>t&lt;sub&gt;R&lt;/sub&gt;</td>
<td>Rise Time for Data and Clock Pin</td>
<td>300</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>t&lt;sub&gt;F&lt;/sub&gt;</td>
<td>Fall Time for Data and Clock Pin</td>
<td>300</td>
<td></td>
<td>ns</td>
</tr>
<tr>
<td>t&lt;sub&gt;Idle&lt;/sub&gt;</td>
<td>Idle Time before a New Transmission can Start</td>
<td>1.3</td>
<td>-</td>
<td>µs</td>
</tr>
</tbody>
</table>

* (V<sub>DD</sub> - V<sub>SS</sub> = 1.65V to 3.3V, T<sub>a</sub> = 25°C)
3.3.5.2 **I²C Interface with Internal Charge Pump**

**Recommended Components:**
- C1, C2: 1μF / 16V, X5R
- C3: 2.2μF
- C4: 4.7μF / 16V, X7R
- C5, C6: 1μF
- R1: 910kΩ, \( R_1 = \frac{\text{Voltage at IREF} - \text{VSS}}{\text{IREF}} \)
- R2, R3: 47kΩ
- R4, R5: 4.7kΩ
- Q1: FDN338P
- Q2: FDN335N

**Notes:**
- VDD: 1.65~3.3V, it should be equal to MPU I/O voltage.
- Vin: 3.5~4.2V
- The I²C slave address is 0111100b’. If the customer ties D/C# (pin 15) to VDD, the I²C slave address will be 0111101b’.
- * VBAT will be connected to VDD when VCC be connected to external source (12V), R1 should be replaced as 910 kΩ.
4. **Functional Specification**

4.1 **Commands**

Refer to the Technical Manual for the SSD1306

4.2 **Power down and Power up Sequence**

To protect OEL panel and extend the panel life time, the driver IC power up/down routine should include a delay period between high voltage and low voltage power sources during turn on/off. It gives the OEL panel enough time to complete the action of charge and discharge before/after the operation.

4.2.1 **Power up Sequence:**

1. Power up \(V_{DD}/V_{BAT}\)
2. Send Display off command
3. Initialization
4. Clear Screen
5. Power up \(V_{CC}\)
6. Delay 100ms
   (When \(V_{CC}\) is stable)
7. Send Display on command

4.2.2 **Power down Sequence:**

1. Send Display off command
2. Power down \(V_{CC}/V_{BAT}\)
3. Delay 100ms
   (When \(V_{CC}/V_{BAT}\) reach 0 and panel is completely discharges)
4. Power down \(V_{DD}\)

**Note:**

1) Since an ESD protection circuit is connected between \(V_{DD}\) and \(V_{CC}\) inside the driver IC, \(V_{CC}\) becomes lower than \(V_{DD}\) whenever \(V_{DD}\) is ON and \(V_{CC}\) is OFF.

2) \(V_{CC}/V_{BAT}\) should be kept float (disable) when it is OFF.

3) Power Pins \((V_{DD}, V_{CC}, V_{BAT})\) can never be pulled to ground under any circumstance.

4) \(V_{DD}\) should not be power down before \(V_{CC}/V_{BAT}\) power down.

4.3 **Reset Circuit**

When RES# input is low, the chip is initialized with the following status:

1. Display is OFF
2. 128x64 Display Mode
3. Normal segment and display data column and row address mapping (SEG0 mapped to column address 00h and COM0 mapped to row address 00h)
4. Shift register data clear in serial interface
5. Display start line is set at display RAM address 0
6. Column address counter is set at 0
7. Normal scan direction of the COM outputs
8. Contrast control register is set at 7Fh
9. Normal display mode (Equivalent to A4h command)
4.4 Actual Application Example
Command usage and explanation of an actual example

4.4.1 $V_{CC}$ Supplied Externally

<Power up Sequence>

If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.
<Power down Sequence>

Normal Operation

Set Display Off 0xAE

Power down V_{CC} (100ms Delay Recommended)

V_{DD}/V_{CC} off State

Power down V_{DD}

<Entering Sleep Mode>

Normal Operation

Power down V_{CC}

Set Display Off 0xAE

Sleep Mode

<Exiting Sleep Mode>

Sleep Mode

Power up V_{CC} & Stabilized (Delay Recommended)

Normal Operation

Set Display On 0xAF

(100ms Delay Recommended)

External setting

{RES=1;
delay(1000);
RES=0;
delay(1000);
RES=1;
delay(1000);
write_i(0xAE); /*display off*/
write_i(0x00); /*set lower column address*/
write_i(0x10); /*set higher column address*/
write_i(0x40); /*set display start line*/
write_i(0xB0); /*set page address*/}
void write_i(unsigned char ins)
{
    DC=0;
    CS=0;
    WR=1;
    P1=ins;  /*inst*/
    WR=0;
    WR=1;
    CS=1;
}

void write_d(unsigned char dat)
{
    DC=1;
}
CS=0;
WR=1;
P1=dat;    /*data*/
WR=0;
WR=1;
CS=1;
}

void delay(unsigned int i)
{
    while(i>0)
    {
        i--;
    }
}
4.4.2 $V_{CC}$ Generated by Internal DC/DC Circuit

*<Power up Sequence>*

- **$V_{DC}/V_{BAT}$ off State**
  - Power up $V_{CC}$ (RES# as Low State)
  - Power Stabilized (Delay Recommended)
  - Power up $V_{DD}$ (100ms Delay Recommended)
  - Set RES# as High (3μs Delay Minimum)
  - Initialized State (Parameters as Default)
  - Set Display Off 0xAE

- **Initial Settings Configuration**
  - Set Display Clock Divide Ratio/Oscillator Frequency 0xD5, 0x80

- **Set Multiplex Ratio**
  - 0xA8, 0x3F

- **Set Display Offset**
  - 0xD3, 0x00

- **Set Display Start Line**
  - 0x40

- **Set Segment Re-Map**
  - 0xA1

- **Set COM Output Scan Direction**
  - 0xC8

- **Set COM Pins Hardware Configuration**
  - 0xDA, 0x12

- **Set Normal/Inverse Display**
  - 0xA6

- **Set Entire Display On/Off**
  - 0xA4

- **Set Charge Pump**
  - 0x8D, 0x14

- **Clear Screen**

- **Set Contrast Control**
  - 0x81, 0xCF

- **Set Pre-Charge Period**
  - 0xD9, 0xF1

- **Set VCOMH Deselect Level**
  - 0xDB, 0x30

- **Display Data Sent**

- **Power Stabilized (100ms Delay Recommended)**

If the noise is accidentally occurred at the displaying window during the operation, please reset the display in order to recover the display function.
<Power down Sequence>

Normal Operation

Set Display Off 0xAE

Set Charge Pump 0x8D, 0x10

Power Stabilized (100ms Delay Recommended)

Power down V_{BAT} (50ms Delay Recommended)

Power down V_{DD}

V_{DD}/V_{BAT} off State

<Entering Sleep Mode>

Normal Operation

Set Display Off 0xAE

Set Charge Pump 0x8D, 0x10

Sleep Mode

Set Display Off 0xAE

Power down V_{BAT}

<Exiting Sleep Mode>

Sleep Mode

Set Charge Pump 0x8D, 0x14

Power up V_{BAT} (100ms Delay Recommended)

Set Display On 0xAF

Normal Operation

Internal setting (Charge pump)

{ 
RES=1;
delay(1000);
RES=0;
delay(1000);
RES=1;
delay(1000);
write_i(0xAE); /*display off*/
write_i(0x00); /*set lower column address*/
write_i(0x10); /*set higher column address*/
}
```c
write_i(0x40);    /*set display start line*/
write_i(0xB0);    /*set page address*/
write_i(0x81);    /*contract control*/
write_i(0xCF);    /*128*/
write_i(0xA1);    /*set segment remap*/
write_i(0xA6);    /*normal / reverse*/
write_i(0xA8);    /*multiplex ratio*/
write_i(0x3F);    /*duty = 1/64*/
write_i(0xC8);    /*Com scan direction*/
write_i(0xD3);    /*set display offset*/
write_i(0x00);
write_i(0xD5);    /*set osc division*/
write_i(0x80);
write_i(0xD9);    /*set pre-charge period*/
write_i(0Xf1);
write_i(0xDA);    /*set COM pins*/
write_i(0x12);
write_i(0xdb);    /*set vcomh*/
write_i(0x30);
write_i(0x8d);    /*set charge pump enable*/
write_i(0x14);
write_i(0xAF);    /*display ON*/
}

void write_i(unsigned char ins)
{
    DC=0;
    CS=0;
    WR=1;
    P1=ins;        /*inst*/
    WR=0;
    WR=1;
    CS=1;
}
void write_d(unsigned char dat)
{
    DC=1;
    CS=0;
    WR=1;
    P1=dat;    /* data */
    WR=0;
    WR=1;
    CS=1;
}

void delay(unsigned int i)
{
    while(i>0)
    {
        i--;
    }
}
5. Reliability

5.1 Contents of Reliability Tests

<table>
<thead>
<tr>
<th>Item</th>
<th>Conditions</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Temperature Operation</td>
<td>70°C, 240 hrs</td>
<td></td>
</tr>
<tr>
<td>Low Temperature Operation</td>
<td>-40°C, 240 hrs</td>
<td></td>
</tr>
<tr>
<td>High Temperature Storage</td>
<td>85°C, 240 hrs</td>
<td>The operational functions work.</td>
</tr>
<tr>
<td>Low Temperature Storage</td>
<td>-40°C, 240 hrs</td>
<td></td>
</tr>
<tr>
<td>High Temperature/Humidity Operation</td>
<td>60°C, 90% RH, 120 hrs</td>
<td></td>
</tr>
<tr>
<td>Thermal Shock</td>
<td>-40°C ⇔ 85°C, 24 cycles</td>
<td></td>
</tr>
<tr>
<td></td>
<td>60 mins dwell</td>
<td></td>
</tr>
</tbody>
</table>

* The samples used for the above tests do not include polarizer.
* No moisture condensation is observed during tests.

5.2 Failure Check Standard

After the completion of the described reliability test, the samples were left at room temperature for 2 hrs prior to conducting the failure test at 23±5°C; 55±15% RH.
6. **Outgoing Quality Control Specifications**

6.1 **Environment Required**
Customer’s test & measurement are required to be conducted under the following conditions:
- Temperature: 23 ± 5°C
- Humidity: 55 ± 15% RH
- Fluorescent Lamp: 30W
- Distance between the Panel & Lamp: ≥ 50cm
- Distance between the Panel & Eyes of the Inspector: ≥ 30cm
- Finger glove (or finger cover) must be worn by the inspector.
- Inspection table or jig must be anti-electrostatic.

6.2 **Sampling Plan**
Level II, Normal Inspection, Single Sampling, MIL-STD-105E

6.3 **Criteria & Acceptable Quality Level**

<table>
<thead>
<tr>
<th>Partition</th>
<th>AQL</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major</td>
<td>0.65</td>
<td>Defects in Pattern Check (Display On)</td>
</tr>
<tr>
<td>Minor</td>
<td>1.0</td>
<td>Defects in Cosmetic Check (Display Off)</td>
</tr>
</tbody>
</table>

6.3.1 **Cosmetic Check (Display Off) in Non-Active Area**

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Classification</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel General Chipping</td>
<td>Minor</td>
<td>X &gt; 6 mm (Along with Edge)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Y &gt; 1 mm (Perpendicular to edge)</td>
</tr>
</tbody>
</table>

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### 6.3.1 Cosmetic Check (Display Off) in Non-Active Area (Continued)

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Classification</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel Crack</td>
<td>Minor</td>
<td>Any crack is not allowable.</td>
</tr>
<tr>
<td>Copper Exposed (Even Pin or Film)</td>
<td>Minor</td>
<td>Not Allowable by Naked Eye Inspection</td>
</tr>
<tr>
<td>Film or Trace Damage</td>
<td>Minor</td>
<td></td>
</tr>
<tr>
<td>Terminal Lead Prober Mark</td>
<td>Acceptable</td>
<td></td>
</tr>
<tr>
<td>Glue or Contamination on Pin (Couldn’t Be Removed by Alcohol)</td>
<td>Minor</td>
<td></td>
</tr>
<tr>
<td>Ink Marking on Back Side of panel (Exclude on Film)</td>
<td>Acceptable</td>
<td>Ignore for Any</td>
</tr>
</tbody>
</table>
6.3.2 Cosmetic Check (Display Off) in Active Area

It is recommended to execute in clear room environment (class 10k) if actual in necessary.

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Classification</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Any Dirt &amp; Scratch on Polarizer's Protective Film</td>
<td>Acceptable</td>
<td>Ignore for not Affect the Polarizer</td>
</tr>
<tr>
<td>Scratches, Fiber, Line-Shape Defect (On Polarizer)</td>
<td>Minor</td>
<td>$W \leq 0.1$ Ignore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$W &gt; 0.1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$L \leq 2$ $n \leq 1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$L &gt; 2$ $n = 0$</td>
</tr>
<tr>
<td>Dirt, Black Spot, Foreign Material, (On Polarizer)</td>
<td>Minor</td>
<td>$\Phi \leq 0.1$ Ignore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.1 &lt; \Phi \leq 0.25$ $n \leq 1$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.25 &lt; \Phi$ $n = 0$</td>
</tr>
<tr>
<td>Dent, Bubbles, White spot (Any Transparent Spot on Polarizer)</td>
<td>Minor</td>
<td>$\Phi \leq 0.5$ Ignore</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.5 &lt; \Phi$</td>
</tr>
<tr>
<td>Fingerprint, Flow Mark (On Polarizer)</td>
<td>Minor</td>
<td>Not Allowable</td>
</tr>
</tbody>
</table>

* Protective film should not be tear off when cosmetic check.
** Definition of $W$ & $L$ & $\Phi$ (Unit: mm): $\Phi = (a + b) / 2$
### 6.3.3 Pattern Check (Display On) in Active Area

<table>
<thead>
<tr>
<th>Check Item</th>
<th>Classification</th>
<th>Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Display</td>
<td>Major</td>
<td><img src="image" alt="No Display" /></td>
</tr>
<tr>
<td>Missing Line</td>
<td>Major</td>
<td><img src="image" alt="Missing Line" /></td>
</tr>
<tr>
<td>Pixel Short</td>
<td>Major</td>
<td><img src="image" alt="Pixel Short" /></td>
</tr>
<tr>
<td>Darker Pixel</td>
<td>Major</td>
<td><img src="image" alt="Darker Pixel" /></td>
</tr>
<tr>
<td>Wrong Display</td>
<td>Major</td>
<td><img src="image" alt="Wrong Display" /></td>
</tr>
<tr>
<td>Un-uniform</td>
<td>Major</td>
<td><img src="image" alt="Un-uniform" /></td>
</tr>
</tbody>
</table>
7. Package Specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module</td>
<td>810 per Primary Box</td>
</tr>
<tr>
<td>Holding Trays (A)</td>
<td>15 per Primary Box</td>
</tr>
<tr>
<td>Total Trays (B)</td>
<td>16 per Primary Box (Including 1 Empty Tray)</td>
</tr>
<tr>
<td>Primary Box (C)</td>
<td>1~4 per Carton (4 as Major / Maximum)</td>
</tr>
</tbody>
</table>

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8. Precautions When Using These OEL Display Modules

8.1 Handling Precautions

1) Since the display panel is being made of glass, do not apply mechanical impacts such as dropping from a high position.
2) If the display panel is broken by some accident and the internal organic substance leaks out, be careful not to inhale nor lick the organic substance.
3) If pressure is applied to the display surface or its neighborhood of the OEL display module, the cell structure may be damaged and be careful not to apply pressure to these sections.
4) The polarizer covering the surface of the OEL display module is soft and easily scratched. Please be careful when handling the OEL display module.
5) When the surface of the polarizer of the OEL display module has soil, clean the surface. It takes advantage of by using following adhesion tape.
   * Scotch Mending Tape No. 810 or an equivalent
   Never try to breathe upon the soiled surface nor wipe the surface using cloth containing solvent such as ethyl alcohol, since the surface of the polarizer will become cloudy.
   Also, pay attention that the following liquid and solvent may spoil the polarizer:
   * Water
   * Ketone
   * Aromatic Solvents
6) Hold OEL display module very carefully when placing OEL display module into the system housing. Do not apply excessive stress or pressure to OEL display module. And, do not over bend the film with electrode pattern layouts. These stresses will influence the display performance. Also, secure sufficient rigidity for the outer cases.

7) Do not apply stress to the driver IC and the surrounding molded sections.
8) Do not disassemble nor modify the OEL display module.
9) Do not apply input signals while the logic power is off.
10) Pay sufficient attention to the working environments when handing OEL display modules to prevent occurrence of element breakage accidents by static electricity.
    * Be sure to make human body grounding when handling OEL display modules.
    * Be sure to ground tools to use or assembly such as soldering irons.
    * To suppress generation of static electricity, avoid carrying out assembly work under dry environments.
    * Protective film is being applied to the surface of the display panel of the OEL display module. Be careful since static electricity may be generated when exfoliating the protective film.
11) Protection film is being applied to the surface of the display panel and removes the protection film before assembling it. At this time, if the OEL display module has been stored for a long period of time, residue adhesive material of the protection film may remain on the surface of the display panel after removed of the film. In such case, remove the residue material by the method introduced in the above Section 5).
12) If electric current is applied when the OEL display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful to avoid the above.
8.2 Storage Precautions

1) When storing OEL display modules, put them in static electricity preventive bags avoiding exposure to direct sunlight nor to lights of fluorescent lamps, and, also, avoiding high temperature and high humidity environment or low temperature (less than 0°C) environments. (We recommend you to store these modules in the packaged state when they were shipped from Allvision technology Inc.) At that time, be careful not to let water drops adhere to the packages or bags nor let dewing occur with them.

2) If electric current is applied when water drops are adhering to the surface of the OEL display module, when the OEL display module is being dewed or when it is placed under high humidity environments, the electrodes may be corroded and be careful about the above.

8.3 Designing Precautions

1) The absolute maximum ratings are the ratings which cannot be exceeded for OEL display module, and if these values are exceeded, panel damage may happen.

2) To prevent occurrence of malfunctioning by noise, pay attention to satisfy the $V_{IL}$ and $V_{IH}$ specifications and, at the same time, to make the signal line cable as short as possible.

3) We recommend you to install excess current preventive unit (fuses, etc.) to the power circuit ($V_{DD}$).
   (Recommend value: 0.5A)

4) Pay sufficient attention to avoid occurrence of mutual noise interference with the neighboring devices.

5) As for EMI, take necessary measures on the equipment side basically.

6) When fastening the OEL display module, fasten the external plastic housing section.

7) If power supply to the OEL display module is forcibly shut down by such errors as taking out the main battery while the OEL display panel is in operation, we cannot guarantee the quality of this OEL display module.

8) The electric potential to be connected to the rear face of the IC chip should be as follows: SSD1306
   * Connection (contact) to any other potential than the above may lead to rupture of the IC.

8.4 Precautions when disposing of the OEL display modules

1) Request the qualified companies to handle industrial wastes when disposing of the OEL display modules. Or, when burning them, be sure to observe the environmental and hygienic laws and regulations.

8.5 Other Precautions

1) When an OEL display module is operated for a long of time with fixed pattern may remain as an after image or slight contrast deviation may occur. Nonetheless, if the operation is interrupted and left unused for a while, normal state can be restored. Also, there will be no problem in the reliability of the module.

2) To protect OEL display modules from performance drops by static electricity rapture, etc., do not touch the following sections whenever possible while handling the OEL display modules.
   * Pins and electrodes
   * Pattern layouts such as the FPC

3) With this OEL display module, the OEL driver is being exposed. Generally speaking, semiconductor elements change their characteristics when light is radiated according to the principle of the solar battery. Consequently, if this OEL driver is exposed to light, malfunctioning may occur.
   * Design the product and installation method so that the OEL driver may be shielded from light in actual usage.
   * Design the product and installation method so that the OEL driver may be shielded from light during the inspection processes.

4) Although this OEL display module stores the operation state data by the commands and the indication data, when excessive external noise, etc. enters into the module, the internal status may
be changed. It therefore is necessary to take appropriate measures to suppress noise generation or to protect from influences of noise on the system design.

5) We recommend you to construct its software to make periodical refreshment of the operation statuses (re-setting of the commands and re-transference of the display data) to cope with catastrophic noise.