Wafer Mapping Sensor
M-DW1

The safe LED beam reflective type wafer mapping sensor

Safe LEDs adopted
Conventional laser mapping sensor that adopts laser beam has been dangerous because an operator is exposed directly to laser beam, which comes out of the load port through FOUP. We have succeeded in developing LED to adopt as light source for M-DW1. Therefore an operator’s safety is ensured.

Sensing of nitride-coated wafers possible
Nitride-coated wafers absorb light at certain wavelengths depending on the coating thickness. If the sensor uses the laser beam having a single wavelength, the beam may be absorbed completely, resulting in wafer detection error. The M-DW1 uses a LED light source with a wide wavelength band that allows to detect nitride-coated wafers successfully.

High-speed response time: 0.5 ms
The sensor responds in 0.5 ms, meeting the requirements of both high speed and high accuracy in wafer detection.

Glass wafers are also detectable
The M-DW1, which detects wafers not by the light amount but by the light position, can detect the glass wafers regardless of the light amount.

Precise position detection by 2-segment receiving element
Wafer detection by the amount of reflected light may sometimes fail depending on the wafer edge shape. The M-DW1 uses 2-segment receiving element in the beam-receiving part, and detects wafers by the reflected light position instead of the amount of reflected light. Thus, the sensor is less affected by wafer thickness or the amount of reflected light.

Compact and lightweight design with built-in amplifier
The sensor measures W80.6 mm × H18.3 mm × D50 mm W3.173 in × H0.720 in × D1.969 in, and weighs only 75 g approx.
**ORDER GUIDE**

<table>
<thead>
<tr>
<th>Appearance</th>
<th>Center sensing distance</th>
<th>Sensing object</th>
<th>Model No.</th>
<th>Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wafer Mapping Sensor M-DW1</td>
<td>45 mm</td>
<td>1.772 in</td>
<td>3 inch or larger semiconductor wafer</td>
<td>M-DW1</td>
</tr>
</tbody>
</table>

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Item</th>
<th>Model No.</th>
<th>LED beam reflective type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>M-DW1</td>
<td></td>
</tr>
<tr>
<td>Center sensing distance</td>
<td>45 mm</td>
<td>1.772 in</td>
</tr>
<tr>
<td>Sensing object</td>
<td>3 inch or larger semiconductor wafer (Note 2)</td>
<td></td>
</tr>
<tr>
<td>Detectable surface</td>
<td>Surface having a side edge which reflects light in the light receiving direction (Note 3)</td>
<td></td>
</tr>
<tr>
<td>Sensing angle</td>
<td>12.5 ± 5° (Note 4)</td>
<td></td>
</tr>
<tr>
<td>Wafer pitch</td>
<td>Separate sensing is possible at normal sensitivity for 3 mm 0.118 in pitch or more (Note 5)</td>
<td></td>
</tr>
<tr>
<td>Suitable cassette</td>
<td>SEMI standard FOPU cassette / open cassette</td>
<td></td>
</tr>
<tr>
<td>Supply voltage</td>
<td>12 to 24 V DC ±10 % Ripple P-P 10 % or less</td>
<td></td>
</tr>
<tr>
<td>Current consumption</td>
<td>65 mA or less</td>
<td></td>
</tr>
</tbody>
</table>

**Output**

- NPN output / PNP output, selectable with output selection switch
  - **<NPN output>**
    - NPN open-collector transistor
    - Maximum sink current: 100 mA
    - Applied voltage: 30 V DC or less (between output and 0 V)
    - Residual voltage: 1 V or less (at 100 mA sink current)
    - 0.4 V or less (at 16 mA sink current)
  - **<PNP output>**
    - PNP open-collector transistor
    - Maximum source current: 100 mA
    - Applied voltage: 30 V DC or less (between output and +V)
    - Residual voltage: 1 V or less (at 100 mA source current)
    - 0.4 V or less (at 16 mA source current)

**Utilization category**

- DC-12 or DC-13

**Output operation**

- Light-ON / Dark-ON, selectable by switch

**Short-circuit protection**

- Incorporated (restored automatically)

**Response time**

- 500 µs or less

**Operation indicator**

- Orange LED (lights up when the output is ON)

**Stability indicator**

- Green LED (lights up under stable light receiving condition or stable dark condition)

**Timer function**

- Approx. 2 ms fixed OFF-delay timer, switchable either effective or ineffective

**Test input (emission halt input)**

- Signal condition
  - Emission Halt: Open, or 4 to 8 V
  - Emission: 0 to 3 V, or 9 V to +V (26.4 V max.)

**Sensitivity selection input**

- Signal condition
  - Input OFF: Open, or 4 to 8 V
  - Input ON: 0 to 3 V, or 9 V to +V (26.4 V max.)

**Sensitivity setting**

- Back surface teaching: effectuated with sensor's sensitivity setting button
- Detection sensitivity selection: 4 levels with sensor's Z bit switch or 2 levels with external input selectable

**Pollution degree**

- 3 (Industrial environment)

**Protection**

- IP20 (IEC)

**Ambient temperature**

- 0 to +55 °C +32 to +131 °F

**Ambient humidity**

- 35 to 85 % RH, Storage: 35 to 85 % RH

**Ambient illuminance**

- Incandescent light: 3,000 lx at the light-receiving face, Fluorescent light: 1,500 lx at the light-receiving face

**EMC**

- EN 60947-5-2

**Voltage withstandability**

- 1,000 V AC for one min. between all supply terminals connected together and enclosure

**Insulation resistance**

- 20 MΩ, or more, with 250 V DC megger between all supply terminals connected together and enclosure

**Vibration resistance**

- 10 to 500 Hz frequency, 3 mm 0.118 in amplitude in X, Y and Z directions for two hours each

**Shock resistance**

- 98 m/s² acceleration (10 G approx) in X, Y and Z directions for five times each

**Emitting element**

- LED (modulated)

**Material**

- Enclosure: ABS and Stainless steel (SUS301), Lens: Acrylic

**Cable**

- 0.15 mm² 5-core cable tyre, 300 mm 11.811 in long

**Cable extension**

- Extension up to total 10 m 32.808 ft is possible with 0.15 mm², or more, cable.

**Weight**

- Net weight: 75 g approx.

Notes:
1. Where measurement conditions have not been specified precisely, the conditions used were an ambient temperature of +20 °C ±6 °F.
2. In case of 8 inch or less wafers, the wafer pitch, the orientation flat or surface condition may affect the sensing.
3. Polished wafers, etc., which have a sharp edge cannot be detected since they do not reflect the light in the light receiving direction.
4. Since the position of the orientation flat may vary by ±20° due to its rotation, refer to "Detecting wafer having orientation flat (p.890)" for detection of a wafer having an orientation flat.
5. This is the pitch of an 8 inch wafer near its center region when it is inserted in an inclined fashion. When detecting a wafer having an orientation flat, the wafer pitch becomes smaller when sensing at positions which avoid the orientation flat. In this case, the sensing signal cannot be resolved and it becomes a continuous, broad signal. For details, refer to "Sensing signal (p.891)".

**ORDER GUIDE**

<table>
<thead>
<tr>
<th>Type</th>
<th>LED beam reflective type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item</td>
<td>Model No.</td>
</tr>
</tbody>
</table>

**Output**

- NPN output / PNP output, selectable with output selection switch
  - **<NPN output>**
    - NPN open-collector transistor
    - Maximum sink current: 100 mA
    - Applied voltage: 30 V DC or less (between output and 0 V)
    - Residual voltage: 1 V or less (at 100 mA sink current)
    - 0.4 V or less (at 16 mA sink current)
  - **<PNP output>**
    - PNP open-collector transistor
    - Maximum source current: 100 mA
    - Applied voltage: 30 V DC or less (between output and +V)
    - Residual voltage: 1 V or less (at 100 mA source current)
    - 0.4 V or less (at 16 mA source current)

**Utilization category**

- DC-12 or DC-13

**Output operation**

- Light-ON / Dark-ON, selectable by switch

**Short-circuit protection**

- Incorporated (restored automatically)

**Response time**

- 500 µs or less

**Operation indicator**

- Orange LED (lights up when the output is ON)

**Stability indicator**

- Green LED (lights up under stable light receiving condition or stable dark condition)

**Timer function**

- Approx. 2 ms fixed OFF-delay timer, switchable either effective or ineffective

**Test input (emission halt input)**

- Signal condition
  - Emission Halt: Open, or 4 to 8 V
  - Emission: 0 to 3 V, or 9 V to +V (26.4 V max.)

**Sensitivity selection input**

- Signal condition
  - Input OFF: Open, or 4 to 8 V
  - Input ON: 0 to 3 V, or 9 V to +V (26.4 V max.)

**Sensitivity setting**

- Back surface teaching: effectuated with sensor’s sensitivity setting button
- Detection sensitivity selection: 4 levels with sensor’s Z bit switch or 2 levels with external input selectable

**Pollution degree**

- 3 (Industrial environment)

**Protection**

- IP20 (IEC)

**Ambient temperature**

- 0 to +55 °C +32 to +131 °F (No dew condensation), Storage: –10 to +70 °C

**Ambient humidity**

- 35 to 85 % RH, Storage: 35 to 85 % RH

**Ambient illuminance**

- Incandescent light: 3,000 lx at the light-receiving face, Fluorescent light: 1,500 lx at the light-receiving face

**EMC**

- EN 60947-5-2

**Voltage withstandability**

- 1,000 V AC for one min. between all supply terminals connected together and enclosure

**Insulation resistance**

- 20 MΩ, or more, with 250 V DC megger between all supply terminals connected together and enclosure

**Vibration resistance**

- 10 to 500 Hz frequency, 3 mm 0.118 in amplitude in X, Y and Z directions for two hours each

**Shock resistance**

- 98 m/s² acceleration (10 G approx) in X, Y and Z directions for five times each

**Emitting element**

- LED (modulated)

**Material**

- Enclosure: ABS and Stainless steel (SUS301), Lens: Acrylic

**Cable**

- 0.15 mm² 5-core cable tyre, 300 mm 11.811 in long

**Cable extension**

- Extension up to total 10 m 32.808 ft is possible with 0.15 mm², or more, cable.

**Weight**

- Net weight: 75 g approx.
### I/O CIRCUIT DIAGRAMS

#### NPN output

**I/O circuit diagram**

```
+-----------+    +-----------+
|           |    |           |
|   D       |    |   D       |
|           |    |           |
| Zd1       |    | Zd2       |
|           |    |           |
| Tr1       |    | Tr2       |
|           |    |           |
|           |    |           |
| 12 to 24 V DC | 4 ±10% |
|            |    |            |
| Load       |    | Load       |
|           |    |           |
| (Brown) +  |    | (Brown) +  |
| V         |    | V         |
| (Blue) 0 V |    | (Blue) 0 V |
| (Green) 0 V|    | (Green) 0 V|
|           |    |           |
| Users' circuit |   | Users' circuit |
```

**Color code**

- Brown (+V)
- Green (0 V)
- Black (Output)
- Blue (0 V)
- Pink (Ext. test input)
- Violet (Ext. sensitivity selection input)

**Symbols**

- D: Reverse supply polarity protection diode
- Zd1, Zd2: Surge absorption zener diode
- Tr1: NPN output transistor
- Tr2: PNP output transistor

#### PNP output

**I/O circuit diagram**

```
+-----------+    +-----------+
|           |    |           |
|   D       |    |   D       |
|           |    |           |
| Zd1       |    | Zd2       |
|           |    |           |
| Tr1       |    | Tr2       |
|           |    |           |
|           |    |           |
| 12 to 24 V DC | 4 ±10% |
|            |    |            |
| Load       |    | Load       |
|           |    |           |
| (Brown) +  |    | (Brown) +  |
| V         |    | V         |
| (Blue) 0 V |    | (Blue) 0 V |
| (Green) 0 V|    | (Green) 0 V|
|           |    |           |
| Users' circuit |   | Users' circuit |
```

**Color code**

- Brown (+V)
- Green (0 V)
- Black (Output)
- Blue (0 V)
- Pink (Ext. test input)
- Violet (Ext. sensitivity selection input)

**Symbols**

- D: Reverse supply polarity protection diode
- Zd1, Zd2: Surge absorption zener diode
- Tr1: NPN output transistor
- Tr2: PNP output transistor

**Wiring diagram**

- Non-voltage contact or PNP open-collector transistor
  - External test input (emission halt input)
    - 0 to 3 V, or 9 V to +V (26.4 V max.): Emission halt Open, or 4 to 8 V: Emission
  - External sensitivity selection input
    - 0 to 3 V, or 9 V to +V (26.4 V max.): Input ON Open, or 4 to 8 V: Input OFF

---

**I/O Circuit Diagrams**

**NPN output**

**I/O circuit diagram**

```
+-----------+    +-----------+
|           |    |           |
|   D       |    |   D       |
|           |    |           |
| Zd1       |    | Zd2       |
|           |    |           |
| Tr1       |    | Tr2       |
|           |    |           |
|           |    |           |
| 12 to 24 V DC | 4 ±10% |
|            |    |            |
| Load       |    | Load       |
|           |    |           |
| (Brown) +  |    | (Brown) +  |
| V         |    | V         |
| (Blue) 0 V |    | (Blue) 0 V |
| (Green) 0 V|    | (Green) 0 V|
|           |    |           |
| Users' circuit |   | Users' circuit |
```

**Color code**

- Brown (+V)
- Green (0 V)
- Black (Output)
- Blue (0 V)
- Pink (Ext. test input)
- Violet (Ext. sensitivity selection input)

**Symbols**

- D: Reverse supply polarity protection diode
- Zd1, Zd2: Surge absorption zener diode
- Tr1: NPN output transistor
- Tr2: PNP output transistor

**Wiring diagram**

- Non-voltage contact or PNP open-collector transistor
  - External test input (emission halt input)
    - 0 to 3 V, or 9 V to +V (26.4 V max.): Emission halt Open, or 4 to 8 V: Emission
  - External sensitivity selection input
    - 0 to 3 V, or 9 V to +V (26.4 V max.): Input ON Open, or 4 to 8 V: Input OFF

---

**I/O Circuit Diagrams**

**PNP output**

**I/O circuit diagram**

```
+-----------+    +-----------+
|           |    |           |
|   D       |    |   D       |
|           |    |           |
| Zd1       |    | Zd2       |
|           |    |           |
| Tr1       |    | Tr2       |
|           |    |           |
|           |    |           |
| 12 to 24 V DC | 4 ±10% |
|            |    |            |
| Load       |    | Load       |
|           |    |           |
| (Brown) +  |    | (Brown) +  |
| V         |    | V         |
| (Blue) 0 V |    | (Blue) 0 V |
| (Green) 0 V|    | (Green) 0 V|
|           |    |           |
| Users' circuit |   | Users' circuit |
```

**Color code**

- Brown (+V)
- Green (0 V)
- Black (Output)
- Blue (0 V)
- Pink (Ext. test input)
- Violet (Ext. sensitivity selection input)

**Symbols**

- D: Reverse supply polarity protection diode
- Zd1, Zd2: Surge absorption zener diode
- Tr1: NPN output transistor
- Tr2: PNP output transistor

**Wiring diagram**

- Non-voltage contact or PNP open-collector transistor
  - External test input (emission halt input)
    - 0 to 3 V, or 9 V to +V (26.4 V max.): Emission halt Open, or 4 to 8 V: Emission
  - External sensitivity selection input
    - 0 to 3 V, or 9 V to +V (26.4 V max.): Input ON Open, or 4 to 8 V: Input OFF
PRECAUTIONS FOR PROPER USE

• Never use this product as a sensing device for personnel protection.
• In case of using sensing devices for personnel protection, use products which meet laws and standards, such as OSHA, ANSI or IEC etc., for personnel protection applicable in each region or country.

Mounting
• Set the distance between the sensor detection surface and the wafer edge to be 45 mm 1.772 in and mount the sensor so that sensing is done at an angle of 12.5° with respect to the wafer. Mount using M4 (length 16 mm 0.630 in) screws. The tightening torque should be 1.2 N·m or less. Further, although the sensing distance may change due to variation in the wafer position (wafer protrusion, orientation flat position, etc.), if it is within 5 mm 0.197 in, stable sensing is possible.

Wiring
• Make sure that the power supply is off while wiring.
• Take care that wrong wiring will damage the product.
• Verify that the supply voltage variation is within the rating.
• If power is supplied from a commercial switching regulator, ensure that the frame ground (F.G.) terminal of the equipment is connected to an actual ground.
• In case noise generating equipment (switching regulator, inverter motor, etc.) is used in the vicinity of this product, connect the frame ground (F.G.) terminal of the equipment to an actual ground.
• Do not run the wires together with high-voltage lines or power lines or put them in the same raceway. This can cause malfunction due to induction.
• Extension up to total 10 m 32.808 ft, or less, is possible with 0.15 mm², or more, cable. However, in order to reduce noise, make the wiring as short as possible.
• Make sure to use an isolation transformer for the DC power supply. If an autotransformer (single winding transformer) is used, this product or the power supply may get damaged.
• In case a surge is generated in the used power supply, connect a surge absorber to the supply and absorb the surge.

Others
• Do not use during the initial transient time (0.5 sec.) after the power supply is switched on.
• Take care that the sensor is not directly exposed to fluorescent lamp from a rapid-starter lamp, a high frequency lighting device or sunlight etc., as it may affect the sensing performance.
• Avoid dust, dirt, and steam.
• Take care that the product does not come in contact with water, oil, grease or organic solvents, such as, thinner, etc.
• Do not allow any water, oil, fingerprints, etc., which may refract light, or dust, dirt, etc., which may block light, to stick to the sensing surfaces of the sensor. In case they are present, wipe them with a clean, dust-free soft cloth or lens paper.

Detecting wafer having orientation flat
• When detecting a wafer having an orientation flat, mount the sensor so that a portion other than the orientation flat is detected. Further, arrange to detect the wafer from two different angles by moving the robot arm, etc., and OR the signal so obtained.

Sensitivity selection setting
• Sensitivity can be selected from four levels by appropriate setting of the sensitivity selection switch (2 bits).

Notes:
1) In case of 8 inch or less wafers, the wafer pitch, orientation flat or the surface condition may affect the sensing.
2) Polished wafers, etc., which have a sharp edge cannot be detected since they do not reflect the light in the light receiving direction.
The sensing signal has a width larger than the thickness of the wafer. If the sensitivity is selected with the external sensitivity selection input, set the sensitivity selection switch as shown in the table below.

<table>
<thead>
<tr>
<th>Sensitivity selection switch</th>
<th>Ext. sensitivity selection input</th>
<th>Sensitivity</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Image" /></td>
<td>0 to 3 V, or 9 V to +V (26.4 V max.)</td>
<td>ON</td>
</tr>
<tr>
<td><img src="image" alt="Image" /></td>
<td>Open, or 4 to 8 V</td>
<td>OFF</td>
</tr>
<tr>
<td><img src="image" alt="Image" /></td>
<td>0 to 3 V or 9 V to +V (26.4 V max.)</td>
<td>ON</td>
</tr>
<tr>
<td><img src="image" alt="Image" /></td>
<td>Open, or 4 to 8 V</td>
<td>OFF</td>
</tr>
</tbody>
</table>

Sensitivity setting

- Although this sensor has an optical system which makes it difficult for the background to affect the detection, the background may have an effect when detecting small diameter wafers. Hence, if the background gets detected, or the stability indicator (green) lights off when the cassette has no wafers, sensitivity setting should be done so that the background does not have an effect. However, the sensitivity reduces when sensitivity setting is done.
- Since the sensitivity is stored in an EEPROM when the sensitivity setting button is pressed, the setting need not be repeated when the power is switched on again. However, note that the EEPROM has a lifetime and its guaranteed life is 100,000 write operation cycles.

Light emission control function

- Light emission is halted when the external light emission control input (pink) is connected to 0 to 3 V, or 9 V to +V (26.4 V max.). In this case, the output turns to the dark state.

Timer function

- Using the timer operation mode switch, it is possible to select an approx. 2 ms fixed OFF-delay timer. Since the output is extended by a fixed period, it is useful when the connected device has a slow response time.

**Sensing signal**

- The sensing signal which is output from the sensor is as follows:
  1. The signal width also varies with the reflectivity of the sensing edge. High reflectivity (polish, aluminum evaporated, etc.): Large signal width
  2. Low reflectivity (nitride or oxide film processed): Small signal width

**Example:**
- **Wafer thickness**
  - **Signal width**
    - T = 0.6 mm 0.024 in
    - Signal width
    - 1.5 mm 0.059 in approx.
  - Low reflectivity (nitride or oxide film processed): Small signal width
  - **Example:**
    - **Wafer thickness**
      - **Signal width**
        - T = 0.6 mm 0.024 in
        - Signal width
        - 1.1 mm 0.043 in approx.
  - **High reflectivity**
    - **Signal width**
      - T = 0.6 mm 0.024 in
      - Signal width
      - 1.1 mm 0.043 in approx.

**Time chart**

- From the above, for determining the position of the wafer from the sensing signal, calculate the center position of the signal’s ON region, while taking into consideration the response time.
### PRECAUTIONS FOR PROPER USE

**Narrow pitch sensing signal width**

- In case of "Detecting wafer having orientation flat (p.890)", when the sensor is mounted at positions which avoid the wafer orientation flat, the pitch of a cross-condition wafer changes as shown in the figure below.

- The calculated pitch based on the wafer size is given in the table below.

<table>
<thead>
<tr>
<th>Wafer size</th>
<th>Normal pitch (narrow)</th>
<th>Orientation flat length</th>
<th>Wafer thickness</th>
<th>Cross pitch (narrow)</th>
<th>Cross pitch (wide)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 inch (75 mm 2.953 in)</td>
<td>4.75 mm 0.187 in</td>
<td>22.2 mm 0.874 in</td>
<td>0.380 mm 0.015 in</td>
<td>1.58 mm 0.062 in</td>
<td>3.17 mm 0.125 in</td>
</tr>
<tr>
<td>4 inch (100 mm 3.937 in)</td>
<td>4.75 mm 0.187 in</td>
<td>32.5 mm 1.280 in</td>
<td>0.625 mm 0.025 in</td>
<td>1.54 mm 0.061 in</td>
<td>3.21 mm 0.126 in</td>
</tr>
<tr>
<td>5 inch (125 mm 4.921 in)</td>
<td>4.75 mm 0.187 in</td>
<td>42.5 mm 1.673 in</td>
<td>0.625 mm 0.025 in</td>
<td>1.52 mm 0.060 in</td>
<td>3.23 mm 0.127 in</td>
</tr>
<tr>
<td>6 inch (150 mm 5.906 in)</td>
<td>4.75 mm 0.187 in</td>
<td>57.5 mm 2.264 in</td>
<td>0.675 mm 0.027 in</td>
<td>1.43 mm 0.056 in</td>
<td>3.33 mm 0.131 in</td>
</tr>
<tr>
<td>8 inch (200 mm 7.874 in)</td>
<td>6.35 mm 0.250 in</td>
<td>59.3 mm 2.335 in</td>
<td>0.725 mm 0.029 in</td>
<td>2.19 mm 0.086 in</td>
<td>4.16 mm 0.164 in</td>
</tr>
</tbody>
</table>

- From the above, it is seen that, since the pitch of the cross-condition wafer reduces, the pitch resolution required for high reflectivity wafers becomes more stringent than the specified resolution of 3 mm 0.118 in. Hence, the sensing signal from two wafers may not be resolved and may become a continuous signal.

- Further, the sensing signal may also change due to the sensitivity setting, the relectivity of the wafer, and the sensing conditions (sensing distance or sensing angle). For the above reasons, in case of wafers which have been cross-inserted, since the small cross-pitch side is similar to overlapping wafers, the sensing signal of two wafers may become a continuous signal or may get resolved.

- If the orientation flat happens to get in the position of sensing, sensing is not possible in one of the two sensing positions. Therefore, if the wafer is cross-inserted, a resolved signal may not be output, and in this case, the information on the wafer position calculated from the sensing signal will be erroneous.

### DIMENSIONS (Unit: mm in)

The CAD data in the dimensions can be downloaded from our website.