# TOCOS®
## Angle/Position Sensors

### Contact Angle/Position Sensors

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### Non-Contact Angle/Position Sensors (Hall Effect)

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<td>34</td>
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<td>RSM134</td>
<td>Screw Mount, Single Output, Threaded Flat Shaft, Integrated Connector</td>
<td>39</td>
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<td>RSM28</td>
<td>Panel Mount, 360° (Endless) Rotational Angle, Wire Harness</td>
<td>44</td>
</tr>
</tbody>
</table>

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### We are TOCOS America, Inc.

TOCOS is a wholly owned subsidiary of Tokyo Cosmos Electric Co., Ltd., a worldwide supplier of quality electronic components. Established in 1957, TOCOS has kept pace with the demands of electronic technology supplying superior quality components at competitive prices around the world. Our wide range of products represents the cutting edge of the electronics industry in major areas such as telecommunications, automotive technology, instrumentation, computer peripherals, and the military.

In 1976, TOCOS started mass production of angle sensors specifically for the automotive industry. Today, the TOCOS Angle/Position Sensor Series, both contact and non-contact designs, are ideal for many applications: automobiles, robotic systems, personal mobility vehicles, construction vehicles, marine vessels, agricultural machinery, and off-road vehicles.

### Design and Manufacturing

Our in-house design and manufacturing of automatic assembly machines and automatic testing and inspection equipment guarantees efficient, quality production. We design and manufacture piece parts such as polymer resistive inks, multi-wire brush contacts, and plastic and metal component housings.

### Research and Development

The continuing technological demand for products with higher accuracy, longer life, and better reliability has led us to utilize the ingenuity of all our employees through an innovative “think and create” philosophy, encouraging company-wide contributions to product research and development.

### Quality Control

Our “total quality control environment” is supported by a start to finish inspection program that begins with the sales person who takes your order and ends with the supplier who must be certified to guarantee just-in-time delivery. Every work station is an inspection point in the manufacturing process and the finished products are always inspected for electrical and mechanical properties as well as environmental reliability.

### Reliability

TOCOS examines the performance of its products long after their sale, through the widely used FIT, or failure rate in the field methodology.

### ISO Certification

TOCOS products are manufactured by our parent company Tokyo Cosmos Electric Co. in ISO 9001, ISO 9002, and ISO 14001 certified facilities.
Features
- Thin 11mm angle/position contact sensor with 3-wire harness and connector offered as a standard assembly
- Detection of objects through direct physical contact resulting in conversion to electrical signals for processing
- Long life of 5 million cycles
- Waterproof as standard with an IP66 rating
- 0.05W power rating
- Spring return function within mechanical rotational angle of 0° to 130°
- Total resistance values of 2kΩ or 5kΩ; resistance tolerance of ±20%
- Blind shaft-fitting design for front insertion of a blade shaft
- Optional customizable angle/position setting within the 60° to 120° range
- Optional CW rotational direction of rotor is available
- Popular screw mount flange with two oval mounting holes (hardware not included)
- RoHS compliant

Applications
- Electric vehicles where speed, steering, orientation, and other movements are controlled by contact sensors
- Agricultural/construction vehicles where contact sensors under harsh conditions control operating functions
- Personal mobility vehicles utilizing contact sensors for maneuvering electric wheelchairs and scooters
- Contact sensors for controlling various operations in off-road vehicles, i.e., golf carts, ATVs, and snowmobiles

Specifications

| Basic Characteristics                  |  |  |
|----------------------------------------|  |  |
| Rated Voltage                          | 5VDC |  |
| Maximum Rated Voltage                  | 16VDC |  |
| Power Rating                           | 0.05W |  |
| Output Guaranteed Range                | 96° (0.5V to 4.5V) |  |
| Electrical Rotational Angle            | 120° |  |
| Mechanical Rotational Angle            | 130° |  |

| Measurement Circuit                    | See Figure 1 |  |
| Operating Temperature Range            | –40°C to +135°C |  |
| Storage Temperature Range              | –40°C to +140°C |  |
| Mounting Hole Pitch                    | 36mm |  |
| Rotor Stopper Strength                 | ≥0.294N•m (≥3kgf•cm) |  |

| Significant Characteristics            |  |  |
|----------------------------------------|  |  |
| Total Resistance                       | 5kΩ ±20% before test; ±20% max. resistance change from initial value after test, when measuring between connector pins Vcc and GND |  |
| Output Linearity                       | Initial value of (1) ±75mV at reference point –25° and (2) ±100mV at +25°-100.8° before test followed by ±50mV voltage change max. from initial value at reference point 100.8° after test; where deviation of output voltage from referenced straight line (inclination) falls between 0.5V to 4.5V guaranteed range (see Figure 1) |  |
| Hysteresis                             | ±30mV before test; ±50mV after test; results based on difference of output voltage from hysteresis loop (origin curve and return curve) between reference point (0.5V) and 100.8° |  |
| Output Smoothness                      | 50mVp-p max. noise component at 5 rpm measurement speed (see Figure 3) |  |
| Operating Torque                       | 4.90-58.8mN•m (50-60gf•cm) before test; 1.00-88.3mN•m (10-900gf•cm) after test; (see Figure 4) |  |
| Insulation Resistance                  | 100MΩ min. before test; 10MΩ min. after test; 500VDC, MEGA between each lead and shaft fitting |  |

Specifications Continued
### Endurance Performance

#### Operating Endurance

<table>
<thead>
<tr>
<th>Operating Temperature (°C)</th>
<th>Tested Rotational Cycles</th>
<th>Tested Operating Angle</th>
<th>Output Voltage Range (V)</th>
<th>Frequency Rate (Hz)</th>
<th>Applied Voltage To Vcc Connector Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25</td>
<td>5 million</td>
<td>96° (17° ± 113°)</td>
<td>0.5 to 4.0</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>+100</td>
<td>3 million</td>
<td>96° (17° ± 113°)</td>
<td>0.5 to 4.0</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>−30</td>
<td>2 million</td>
<td>96° (17° ± 113°)</td>
<td>0.5 to 4.0</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>+110</td>
<td>5 million</td>
<td>6° (62° ± 68°)</td>
<td>2.4 to 2.6</td>
<td>30</td>
<td>5V</td>
</tr>
</tbody>
</table>

**Constant Vibration**: 2.5V reference point at +25°C, 10G (O-P), 200Hz, 100 hours (applied voltage to Vcc connector pin)

**Humidity**: 80±3°C, 95±5%RH, 100 hours

**Temperature Cycle**: −30°C for 1 hour ±120°C for 1 hour, 100 cycles

**Low Temperature Shelf Life**: −30°C, 192 hours

**High Temperature Shelf Life**: +120°C, 192 hours

**Drop Test**: Drop height: 1m, landing area: concrete floor, X, Y, Z directions, 3 times each

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### Output Analysis

**Figure 1: Output Characteristics**

Unit: mm

Note: The electrical rotational angle can be changed as an option (60° to 120°).

The standard CCW rotational direction can be changed to CW as an option.
**Electrical Schematics**

**Figure 2: Evaluation Circuit**

- Input
- Output
- 1MΩ
- 5V
- GND

**Figure 3: Output Smoothness Measurement Circuit**

- Sensor Circuit
- 0.1μF
- 10kΩ
- 1MΩ
- 390kΩ
- 5VDC (Blue)
- Output (Yellow)
- GND (Black)
RPA011 Series  Dimensions

Dimensional Drawings of Back, Side, and Bottom Views

Unit: mm

Rotational Torque

Figure 4: Operating Torque

Rolling in 5V Position (Maximum Torque)
Returning to 0V Position (Minimum Torque)
Initial Position of Rotor
(130°)
115±5° Rotational Angle (°)
Rotational Torque (CCW)
**RPA011 Shaft Fitting**

**Blind Shaft Fitting**

Detail from Front View A  

Unit: mm

- Direction of Rotor Rotation (CCW)
- 2 ± 0.05
- Ø6.2 ± 0.15
- 1.5
- 7.5
- O-Ring

**Recommended Blade Shaped Shaft**

Unit: mm

- 2 ± 0.05
- Ø6 ± 0.1
- 7 ± 0.5
- 1 ± 0.3
- Sensor Body
**RPAZ052 Series**

Small, Single Output, Contact Angle/Position Sensors

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**Features**

- Small angle/position, single output, contact sensor with flatted shaft and tinned 3-wire flying leads
- Detection of objects through direct physical contact resulting in conversion to electrical signals for processing
- 360° (endless) CW mechanical rotational angle
- Potentiometric angle/position contact sensor with a long life of 5 million cycle
- Rated Voltage of 5VDC
- 0.18W power rating
- Operating temperature range of −10°C to +85°C
- Dustproof and waterproof with an IP64 rating
- Overall size: 45mm width of flange, 18.4mm in length, and 32.4mm deep from back to end of flatted shaft
- Electrical rotational angle of 240° ± 3°
- Resistance value of 5kΩ; resistance tolerance of ±10%
- Insulation resistance of 100MΩ at 1,000VDC
- Screw mount flange with two elongated mounting slots for easier mounting and adjustment (hardware not included)
- Output linearity of ±3%
- Very low percentage changes in resistance after subjecting sensors to standardized environmental test procedures
- RoHS compliant

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**Applications**

- Electric vehicles where speed, steering, orientation, and other movements are controlled by contact sensors
- Angle/position detection by contact sensors for controlling movement found in various robotic systems
- Contact sensors for position and movement detection for commercial and recreational marine vessels
- Agricultural/construction vehicles where contact sensors under harsh conditions control operating functions
- Personal mobility vehicles utilizing contact sensors for maneuvering various electric wheelchairs and scooters
- Other applications where small, lightweight single output contact sensors prove cost-effective, reliable control

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**Specifications**

**Basic Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Maximum Rated Voltage</td>
<td>30VDC</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.18W</td>
</tr>
<tr>
<td>Total Resistance Value</td>
<td>5kΩ ± 10%</td>
</tr>
<tr>
<td>Waterproof and Dustproof</td>
<td>IP64 rating</td>
</tr>
<tr>
<td>Environmental Load Substances</td>
<td>RoHS compliant</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical Rotational Angle</td>
<td>240° ± 3°</td>
</tr>
<tr>
<td>Mechanical Rotational Angle</td>
<td>360° (endless)</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>−10°C to +85°C</td>
</tr>
<tr>
<td>Mounting Hole Pitch</td>
<td>34mm</td>
</tr>
<tr>
<td>Rotational Torque</td>
<td>1.96 x 10⁻² (200gf·cm) max.</td>
</tr>
</tbody>
</table>

**Significant Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Linearity</td>
<td>± 3%</td>
</tr>
<tr>
<td>Operational Life</td>
<td>5 million cycles</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>100MΩ at 1,000VDC</td>
</tr>
<tr>
<td>Output Characteristics</td>
<td>See Figure 1</td>
</tr>
<tr>
<td>Electrical Schematic</td>
<td>See Figure 2</td>
</tr>
</tbody>
</table>

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*Specifications Continued*
Environmental Characteristics

**Vibration Test**
Acceleration 30G, 50-250Hz, X, Y, Z directions, 20 hours; resistance change $\Delta R/R \leq 2\%$

**Thermal Shock Test**
$-40^\circ C$ for 1 hour $\rightarrow +120^\circ C$ for 1 hour, 20 cycles; resistance change $\Delta R/R \leq 10\%$

**Low Temperature Exposure**
$-40^\circ C$, 500 hours; resistance change $\Delta R/R \leq 5\%$

**High Temperature Exposure**
$+120^\circ C$, 500 hours; resistance change $\Delta R/R \leq 10\%$

**Humidity Test**
$60^\circ C$, 90 - 95%RH, 500 hours; resistance change $\Delta R/R \leq 13\%$

**Neutral Salt Spray Test**
JIS-C-60068-2-11; test at $35^\circ C \pm 2^\circ C$ in $5 \pm 1\%$ NaCl salt water solution for 96 hours, retain connector during test; after test, wash with water at normal temperature and dry at room temperature before electrical test; resistance change $\Delta R/R \leq 10\%$

**Oil Test**
Coat test sample with light oil (JIS 2 grade), place in an oven at $+40^\circ C$ for 72 hours; resistance change $\Delta R/R \leq 2\%$

**Waterproof Test**
Water temperature shall be $50^\circ C$ higher than that of the test sample. Dip test sample into a water bath at a depth of 100mm for 10 minutes. There shall be no internal water intrusion after test.

**Precautions**

1. In a circuit where resistance undergoes electrical output, set the connecting impedance over 100 times greater than the total resistance value of the sensor (1M$\Omega$ recommended value). See Figure 2 for circuit schematic.
2. All items except the general specifications shall not be covered under warranty.
3. Do not use materials that generate hazardous gas (chloride gas, sulfide gas, etc.) when assembling components in sensor.

Output Analysis

**Figure 1: Output Characteristics**

![Output Characteristics Diagram](image)

- Shaft Rotation (CW)
- Electrical Angle (240°)
- Mechanical Angle (360°)
- Rotary Angle (CW)
- Output Voltage (%)
RPAZ052 Series
Dimensions

Dimensional Drawing of Front View

Shaft Rotation Direction (CW)
Shaft Angle Shown at 2.5V Position

Ø12.9 ± 0.2
Ø6 ± 0.012
4.5 ± 0.05

GND (Black)
5V (Green)
Output (White)

Dimensional Drawings of Back, Side, and Bottom Views

Ø34 ± 0.2
Ø22.6 ± 0.3
11.3 ± 0.5
4.5 ± 0.3
16 ± 1
16.4 ± 0.5
7 ± 0.3
8 ± 0.2
300 ± 10

GND (Black)
5V (Green)
Output (White)

Wire Diameter (2)

5 ± 0.5

(R11.8)
Figure 2: Circuit Structure and Evaluation Circuit

![Circuit Diagram](image-url)
**Features**

- All-in-one housing includes single output angle/position sensor, rotational lever, and integral male connector
- Detection of objects through direct physical contact resulting in conversion to electrical signals for processing
- Potentiometric angle/position sensor with a long life of 2 million cycles
- Resistance value of 5kΩ; resistance tolerance of ±20%
- Rotational function of lever within mechanical rotational angle of 117 degrees
- 0.05W power rating
- Operating temperature range of −30°C to +120°C
- Compatible female E03FBR connector recommended to connect with integral male E03MBR connector of sensor
- Angle/position detection operates in CCW direction only
- Optional customizable angle/position setting within the 60° to 115° range
- Lever metal strength – HRA: 70-84 rating using Rockwell hardness test and elasticity test for an E: 0.5-0.75 rating
- Pulling strength of lever: 98N minimum
- Screw mount flange (approximately 16mm deep) with two oval mounting slots (hardware not included)
- RoHS compliant

**Applications**

- Angle/position detection in electronically controlled devices found in many manufacturing/industrial assembly lines
- Personal mobility vehicles utilizing contact sensors for maneuvering electric wheelchairs and scooters
- Angle/position detection by contact sensors for controlling movement found in various robotic systems
- Contact sensors for controlling various operations in off-road vehicles, i.e. golf carts, ATVs, and snowmobiles

**Specifications**

**Basic Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
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<tbody>
<tr>
<td>Rated Voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Maximum Rated Voltage</td>
<td>16VDC</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.05W</td>
</tr>
<tr>
<td>Measurement Circuit</td>
<td>See Figure 2</td>
</tr>
<tr>
<td>Output Characteristics</td>
<td>See Figure 4</td>
</tr>
<tr>
<td>Output Inclination</td>
<td>0.044V/degree</td>
</tr>
</tbody>
</table>

**Significant Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Resistance</td>
<td>Initial value of 5kΩ ± 20% before test; 5kΩ ± 30% after test; when measuring between terminal 1 and 3</td>
</tr>
<tr>
<td>Angle at 0.5V</td>
<td>Initial value of 55° ± 4.5° before test; 55° ± 7° after test; (see Figure 4)</td>
</tr>
<tr>
<td>Output Linearity</td>
<td>Initial value of ± 0.1V before test; ± 0.2V after test; where deviation of output voltage from referenced straight line (inclination of 0.044V/degree) falls between 0.5V to 4.5V guaranteed range (see Figure 4)</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>Initial value of ± 30mV before test; ± 40mV after test; results based on difference of output voltage from hysteresis loop (origin curve and return curve) between 55° and 90° guaranteed range</td>
</tr>
</tbody>
</table>

Specifications Continued
Specifications Continued

Significant Characteristics Continued

**Insulation Resistance**
Initial value of 100MΩ min. before test; 10MΩ min. after test; 500VDC

**Temperature Characteristic**
±50mV, −30°C to +120°C (reference temperature of +25°C)

**Operating Torque - Minimum at 0V**
Initial value of 0.0049N•m min. before test; 0.0010N•m min. after test (see Figure 3)

**Operating Torque - Maximum at 5V**
Initial value of 0.1471N•m max. before test; 0.1961N•m max. after test (see Figure 3)

**Endurance Performance**

<table>
<thead>
<tr>
<th>Operating Temperature (°C)</th>
<th>Tested Rotational Cycles</th>
<th>Tested Operating Angle</th>
<th>Output Voltage Range (V)</th>
<th>Frequency Rate (Hz)</th>
<th>Applied Voltage To Input Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25</td>
<td>3 million</td>
<td>90°</td>
<td>0.5 to 4.5</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>+100</td>
<td>2 million</td>
<td>90°</td>
<td>0.5 to 4.5</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>−40</td>
<td>1 million</td>
<td>90°</td>
<td>0.5 to 4.5</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>+110</td>
<td>10 million</td>
<td>4.5°</td>
<td>2.4 to 2.6</td>
<td>30</td>
<td>5V</td>
</tr>
</tbody>
</table>

**Constant Vibration**
2.5V reference point at +25°C, 25G (O-P), 200Hz, 100 hours (applied voltage to Vin connector pin)

**Sweep Vibration**
2.5V reference point at +25°C, 10G (O-P), 20-130Hz; 20G, 130-200Hz; (20-200Hz, 5 minutes); 100 hours

**Temperature Cycle**
−30°C for 1 hour +120°C for 1 hour, 100 cycles (with E03FBR connector)

**Low Temperature Shelf Life**
−30°C, 200 hours (with E03FBR connector)

**High Temperature Shelf Life**
+120°C, 200 hours (with E03FBR connector)

**Humidity**
80±3°C, 95±5%RH, 100 hours (with E03FBR connector)

**Salt Water Mist Test**
JIS-Z-2371, 240 hours (with E03FBR connector)

**Moisture, Rain and Spray**
JIS-D-0203-D3, No load

**Drop Test**
Drop height: 1m, landing area: concrete floor, X, Y, Z directions, 3 times each
(Do not allow lever to hit the concrete floor.)

**Installation Notes**
1. Use in-low lever position of sensor when installing to body. See Figure 1.
2. Use center of sensor lever rotation axis to align with lever axis on body. See Figure 1.

**Installation Guidelines**

---

**Figure 1: Cutaway for Installation Conditions**

- Center of Lever Rotation Axis
  - on Sensor Side
- In-Low on Sensor Side
- Clamp Face
- Lever on Sensor Side
- Lever on Body Side
- Center of Lever Rotation Axis
  - on Body Side
- Sensor
- Body

---
**RPA112 Series**

**Dimensions**

**Dimensional Drawings of Front View A and Lever Detail**

Unit: mm

Reference Line

Rotational Free Position

Lever Rotation CCW

117°±5°

Mechanical Rotation Angle

Sumitomo E03MBR Integral Connector
(Compatible with Sumitomo E03FBR Connector)

**Lever Detail**

1.5 ± 0.1

Partial High Frequency Quenching

HRA: 70-84
E: 0.5-0.75

6 ± 0.4

10 ± 0.5

7 ± 0.7

18.25 ± 0.4

R10 ± 1

**Electrical Schematic**

**Figure 2: Measurement Circuit**

```
Input

+-------------------+
|                   |
|                   |
|                   |
|       +---------+ |
|       |         |  
|       |         |  
|       |         |  
|       V         |
|                   |
|                   |
|                   |
|                   |
|                   |
|                   |
|                   |
```

Input

Output

5V

GND

**Stopper Strength**

98N Minimum

**RPA 12 Series**

**Dimensions**

**Dimensional Drawings of Front View A and Lever Detail**

Unit: mm

Reference Line

Rotational Free Position

Lever Rotation CCW

117°±5°

Mechanical Rotation Angle

Sumitomo E03MBR Integral Connector
(Compatible with Sumitomo E03FBR Connector)

**Lever Detail**

1.5 ± 0.1

Partial High Frequency Quenching

HRA: 70-84
E: 0.5-0.75

6 ± 0.4

10 ± 0.5

7 ± 0.7

18.25 ± 0.4

R10 ± 1

**Electrical Schematic**

**Figure 2: Measurement Circuit**

```
Input

+-------------------+
|                   |
|                   |
|                   |
|       +---------+ |
|       |         |  
|       |         |  
|       |         |  
|       V         |
|                   |
|                   |
|                   |
|                   |
|                   |
|                   |
```

Input

Output

5V

GND
Dimensions

**RPA12 Series**

**Dimensions**

**Dimensional Drawings of Back, Side, and Terminal End Views**

Unit: mm

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Center of Connector</td>
<td>(13.6)</td>
</tr>
<tr>
<td>Ø48</td>
<td>±0.5</td>
</tr>
<tr>
<td>0.4</td>
<td>±0.4</td>
</tr>
<tr>
<td>2 max.</td>
<td>15±0.5</td>
</tr>
<tr>
<td>16.2 ± 0.2</td>
<td>41.6±0.5</td>
</tr>
<tr>
<td>0.5</td>
<td>25±0.5</td>
</tr>
<tr>
<td>Ø48</td>
<td>±0.5</td>
</tr>
<tr>
<td>0.4</td>
<td>±0.4</td>
</tr>
<tr>
<td>Ø48</td>
<td>±0.5</td>
</tr>
<tr>
<td>0.4</td>
<td>±0.4</td>
</tr>
<tr>
<td>Terminal 1: Input</td>
<td>16.4</td>
</tr>
<tr>
<td>Terminal 2: Output</td>
<td>15±0.5</td>
</tr>
<tr>
<td>Terminal 3: GND</td>
<td>15±0.5</td>
</tr>
</tbody>
</table>

Tolerance: ±0.5, ±5°
(unless otherwise specified)

**Effective Height**

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lever</td>
<td>19.4±1</td>
</tr>
<tr>
<td>1.0</td>
<td>11.2±1</td>
</tr>
</tbody>
</table>

**Rotational Torque**

**Figure 3: Operating Torque**

- Rotational Torque (CCW)
- Lever Angle (°)
- Rotating in 5V Position (Maximum Torque)
- Returning to 0V Position (Minimum Torque)
- Free Position of Lever (117°)
**Figure 4: Output Characteristics**

Rotational Direction: CCW Only

Reference Line
Rotational Free Position

Output Voltage (V)

Output Characteristics Guaranteed Range (90°)
Electrical Angle (112.5°)
Mechanical Angle (117°)

Standard Inclination: 0.044V/deg.

Note: The electrical rotational angle can be changed as an option (60° to 115°). The rotational direction is counterclockwise only. It cannot be changed.
RPA132 Series

All-in-One, Single Output, Contact Angle/Position Sensors

Features

- All-in-one housing with angle/position sensor, threaded flat shaft, and integral male connector
- Detection of objects through direct physical contact resulting in conversion to electrical signals for processing
- Long life of 2 million cycles
- Flat threaded shaft actuated in the CCW direction for angle/position detection with automatic CW spring return
- 0.12W power rating
- Waterproof and dustproof with an IP65 rating

Applications

- Electric vehicles where speed, steering, orientation, and other movements are controlled by contact sensors
- Contact sensors for controlling various operations in off-road vehicles, i.e. golf carts, ATVs, and snowmobiles
- Angle/position detection by contact sensors for controlling various robotic systems
- Agricultural/construction vehicles where contact sensors control operating functions under harsh conditions

Specifications

Basic Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Maximum Supply Voltage</td>
<td>16VDC</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.12W</td>
</tr>
<tr>
<td>Output Guaranteed Range</td>
<td>±50.6° (0.2V to 4.8V)</td>
</tr>
<tr>
<td>Electrical Rotational Angle</td>
<td>110°±5°</td>
</tr>
<tr>
<td>Mechanical Rotational Angle</td>
<td>150°±5°</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>–30°C to +120°C</td>
</tr>
<tr>
<td>Mounting Hole Pitch</td>
<td>41mm</td>
</tr>
</tbody>
</table>

Significant Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Resistance</td>
<td>2kΩ±30% before test; 2kΩ±40% after test; when measuring between input and output terminals</td>
</tr>
<tr>
<td>Output Linearity</td>
<td>±3% (±150mV) max. before test; ±5% (±250mV) max. after test; where deviation of output voltage from referenced straight line (inclination of 0.045V/degree from 0.2V to 4.8V) falls at reference point 2.5V (see Figure 1)</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>±1° (±45.5mV) before test; ±1.5° (±68.2mV) after test; where output characteristics fall between the guaranteed range of 0.2V to 4.8V</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>100MΩ min. before test; 100MΩ min. after test; when 500VDC is applied between the terminals and exposed conducting surfaces (shaft and sleeve)</td>
</tr>
<tr>
<td>Rotary Friction Torque</td>
<td>12.8N•cm ±20% before test; 12.8N•cm ±30% after test</td>
</tr>
</tbody>
</table>

Specifications Continued
## Endurance Performance

### Operating Endurance

<table>
<thead>
<tr>
<th>Operating Temperature (°C)</th>
<th>Tested Rotational Cycles</th>
<th>Tested Operating Angle</th>
<th>Output Voltage Range (V)</th>
<th>Frequency Rate (Hz)</th>
<th>Applied Voltage To Vin Terminal Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25</td>
<td>2 million</td>
<td>75°</td>
<td>0.2 to 4.8</td>
<td>3</td>
<td>5V</td>
</tr>
</tbody>
</table>

**Vibration**
87.2 m/s acceleration (8.9G), 67Hz, X, Y, Z directions, 8 hours each (see Figure 1)

**Thermal Shock**
-25°C for 1 hour 70°C for 1 hour, 10 cycles

**Low Temperature Shelf Life**
40°C, 72 hours

**High Temperature Shelf Life**
120°C, 72 hours

**Moisture Resistance**
40°C, 90 - 95%RH, 240 hours

**Water Resistance**
Expose sensor to +80°C for 0.5 hour immerse in water at +25°C for 0.5 hour, 10 cycles
Attach compatible female connector F6189-0027 during test.

### Output Analysis

*Figure 1: Output Characteristics*

![Graph of Output Characteristics](image)

- **Initial Position of Rotor**
- **Output Characteristics Guaranteed Range**
- **Electrical Angle**
- **Mechanical Angle**

When the applied voltage changes within the rated voltage range, the output voltage changes at the same rate.
RPA132 Series

Dimensions

Dimensional Drawing of Front View A with Integral Connector

Shaft Rotation CCW: Increases Output

150 ±5°
Mechanical Rotation Angle

Automatic Return

Ø34 ±0.7
Ø14 ±0.3

Reference Line

Front View A

Shaft Specifications

Figure 2: Detail of Shaft Shape and Threading

The shaft angle shown is the start position (0°)

Effective Threaded Area: 7 Thread min.
M6x1 Threading

8.5 (15.5) From the Mounting Surface

Unit: mm

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RPA132 Series

Dimensions

Dimensional Drawings of Back, Side, and Terminal End Views

Unit: mm

Terminal 1: GND
Terminal 2: Output
Terminal 3: Input

Tolerance: ±0.5, ±5°
(unless otherwise specified)

Mating Connector:
Sumitomo F6189-0027
**Figure 3: Circuit Configuration**

```
Input (5V)

 CCW

 Output (TPS)

 GND
```

**Figure 4: Evaluation Circuit**

```
Vcc

 CCW

 Output

 1MΩ

 GND

 5V
```

**RPA132 Series**

**Circuit Configuration**

**Electrical Schematic**
RPA211 Series

Rugged, Single Output, Contact Angle/Position Sensors

Features

- Rugged angle/position contact sensor with 3-wire harness and connector offered as a standard assembly
- Detection of objects through direct physical contact resulting in conversion to electrical signals for processing
- Long life of 2.5 million cycles
- Waterproof and dustproof with an IP67 rating
- 0.2W power rating
- Spring return function within mechanical rotational angle of 0° to 120°
- Body is Ø30mm x 36mm deep including threaded shaft
- Resistance value of 2kΩ; resistance tolerance of ±20%
- Flat threaded shaft actuated in the CCW direction for angle/position detection
- Electrical rotational angle can be changed to 60° to 115° as an option
- Screw mount flange with two round (Ø4.6mm) mounting holes (hardware not included)
- RoHS compliant

Applications

- Electric vehicles where speed, steering, orientation, and other movements are controlled by contact sensors
- Angle/position detection by contact sensors for controlling movement found in various robotic systems
- Agricultural/construction vehicles where contact sensors under harsh conditions control operating functions
- Personal mobility vehicles utilizing contact sensors for maneuvering various electric wheelchairs and scooters

Specifications

Basic Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage</td>
<td>5VDC</td>
</tr>
<tr>
<td>Output Guaranteed Range</td>
<td>101.2° (0.2V to 4.8V)</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.2W at +70°C</td>
</tr>
<tr>
<td>Electrical Rotational Angle</td>
<td>110° ± 3°</td>
</tr>
<tr>
<td>Mechanical Rotational Angle</td>
<td>120° ± 5°</td>
</tr>
<tr>
<td>Output Resolution</td>
<td>∞ (infinite)</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>−30°C to +120°C</td>
</tr>
<tr>
<td>Output Inclination</td>
<td>0.045V/degree</td>
</tr>
<tr>
<td>Mounting Hole Pitch</td>
<td>41mm</td>
</tr>
</tbody>
</table>

Significant Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Resistance</td>
<td>2kΩ ± 20% before test; ±20% max. resistance change from initial value after test, when measuring between connector pins Vin and GND</td>
</tr>
<tr>
<td>Output Linearity</td>
<td>Initial value of ±3% (in percentage of output guaranteed range) before test followed by ±50mV voltage change max. from initial value after test; where deviation of output voltage from referenced straight line (inclination of 0.045V/degree from 0.2V to 4.8V) falls at reference point 2.5V (see Figure 5)</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>1,000MΩ min. before test; 1MΩ min. after test; at 500VDC</td>
</tr>
<tr>
<td>Insulation Voltage</td>
<td>750VAC, 1 minute min.</td>
</tr>
<tr>
<td>Operating Torque</td>
<td>0.0494N•m minimum at 0V position; 0.137N•m maximum at 5V position (see Figure 4)</td>
</tr>
<tr>
<td>Lead Wire Pull Strength</td>
<td>Set and hold lead wires at target load of 88.2N for 30 sec. without destruction</td>
</tr>
</tbody>
</table>

Specifications Continued
RPA211 Series Specifications Continued

Endurance Performance

*Satisfies basic characteristics after endurance testing.

<table>
<thead>
<tr>
<th>Operating Temperature (°C)</th>
<th>Tested Rotational Cycles</th>
<th>Tested Operating Angle</th>
<th>Output Voltage Range (V)</th>
<th>Frequency Rate (Hz)</th>
<th>Applied Voltage To Vin Terminal Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>+120</td>
<td>2.5 million</td>
<td>88°</td>
<td>0.2 to 4.8</td>
<td>4</td>
<td>5V</td>
</tr>
</tbody>
</table>

Vibration* 30G, 50-250Hz, X, Y, Z directions, 12 hours (see Figure 1)

Temperature Cycle* –40°C for 1 hour ≡ +120°C for 1 hour, 20 cycles (see Figure 2)

Low Temperature Shelf Life* –40°C, 96 hours

High Temperature Shelf Life* +120°C, 96 hours

Humidity* 60°C, 90 - 95%RH, 500 hours

Salt Water Mist Test* JIS-Z-2371, 96 hours

Moisture, Rain, and Spray Expose sensor to water at +80°C for 0.5 hour ≡ +20°C for 0.5 hour, 10 cycles No internal water intrusion after test as described in IP67 IEC standard

Oil Test* Completely coat sensor with oil (JIS 2 grade), place in an oven at +40°C, 72 hours

Temperature Coefficient of Resistance 400ppm/°C, based on range of −40°C to +120°C for tests

Drop Test* Drop height: 1m, landing area: concrete floor, X, Y, Z directions, 1 time each

Precautions

1. In a circuit where resistance undergoes electrical output, set the connecting impedance over 100 times greater than the total resistance value of the sensor (1MΩ recommended value). See Figure 3 for evaluation circuit schematic.

2. All items except the basic specifications shall not be covered under warranty.

3. Use the recommended output guaranteed range of 0.2V to 4.8V. See Figure 5.

4. Do not apply excessive load on the internal stopper.

5. Do not use materials that generate hazardous gas (chloride gas, sulfide gas, etc.) when assembling components in sensor.

---

Vibration Test

*Figure 1: Vibration Test Graph*

Temperature Test

*Figure 2: Temperature Test Graph*
**Figure 3: Measurement-Evaluation Circuit**

<table>
<thead>
<tr>
<th>Component</th>
<th>Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor Circuit</td>
<td><img src="image1.png" alt="Sensor Circuit" /></td>
</tr>
<tr>
<td>Evaluation Circuit</td>
<td><img src="image2.png" alt="Evaluation Circuit" /></td>
</tr>
</tbody>
</table>

- **5VDC (Red)**
- **Output (White)**
- **GND (Black)**

---

**Dimensional Drawings of Front View A with Wire Harness and Connector**

*Unit: mm*

- **Sumitomo Wiring System:**
  - Housing 6187-3801
  - Terminal 1500-0105
  - Wire Seal 7160-8234

- **Lead Wires AEX0.5f:**
  - 5VDC (Red)
  - Output (White)
  - GND (Black)

- **PVC Tube**
  - Heat-Proof 105°C (Black)

- **Direction of Output Increase (CCW):**
  - 45° ±5°
  - 40° ±5°
  - 60° ±5°

- **Front View A:**
  - 2-Ø4.5 ±0.3
  - 3

**View B:**

- **Rotary shaft starting position**
  - 1

---

**Notes:**

- Dimensions and connections are depicted for clear understanding.
- The electrical schematic is shown for the circuit evaluation.
- Wire harness and connector details are provided for assembly guidance.

---

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**Dimensions**

**Dimensional Drawings of Back, Side, and Shaft**

Unit: mm

---

**Rotational Torque**

*Figure 4: Operating Torque*

![Graph showing operating torque vs. output voltage](image-url)
**Figure 5: Output Characteristics**

Unit: mm

Note: The electrical rotational angle can be changed as an option (60° to 115°). The rotational direction is counterclockwise only. It cannot be changed.
RSM12C Series

Miniature Board Mount, Single Output, Non-Contact Angle Sensors

Features

- Lightweight board mount, single output, non-contacting angle/position sensors
- Square unit: 11.8 x 13.3mm, low profile: 4.3mm high
- Long life of 20 million cycles
- 360° (endless) mechanical rotational angle
- 140° (± 70°) electrical rotational angle
- Hall IC effect sensor and proprietary magnetic circuit realize high reliability and durability performance
- Through-hole shaft fitting allows shaft insertion from top or bottom of the sensor
- Programmable setting for angle/position detection
- 0.05W power rating
- PCB horizontal through-hole mounting for 3 electrical terminals and 4 offset support pins
- Excellent linearity
- RoHS compliant

Applications

- Personal mobility vehicles utilizing sensors for regulating such operations as speed, braking, and fluid levels
- Actuators where output signals activate control systems for opening/closing valves or conveyor operations
- Factory systems such as robotics, measurement controls, and tooling parameters
- Other applications where PCB miniature Hall effect sensors are ideal devices for angle/position detection

Specifications

Electrical Characteristics

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input Voltage (Vin)</td>
<td>5VDC ± 10%</td>
</tr>
<tr>
<td>Supply Current</td>
<td>11mA max. where Vin = 5VDC, rated voltage applied</td>
</tr>
<tr>
<td>Output Voltage Range</td>
<td>0.5V to 4.5V where Vin = 5VDC, electrical travel range of 140° (± 70°)</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.05W</td>
</tr>
<tr>
<td>Electrical Rotational Angle</td>
<td>140° (± 70°)</td>
</tr>
<tr>
<td>Independent Linearity</td>
<td>± 3% Full Scale max. for electrical travel range of 140° (± 70°) at +25°C</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±1% Full Scale max. initial value; ±4% Full Scale max. after life cycle; at −70°, +70° at +25°C</td>
</tr>
<tr>
<td>Temperature Characteristics</td>
<td>±2% Full Scale max. −60°; 0 (center), +60° −40°C to +125°C (reference +25°C)</td>
</tr>
<tr>
<td>Output Current</td>
<td>±1mA max.</td>
</tr>
<tr>
<td>Load Resistance</td>
<td>4.5kΩ min.</td>
</tr>
<tr>
<td>Load Capacitance</td>
<td>0.33nF to 1µF</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>100MΩ min. at 500VDC ± 50V, 1 minute</td>
</tr>
<tr>
<td>Withstand Voltage</td>
<td>No dielectric insulation breakdown after 500VAC ± 50V, 1 minute</td>
</tr>
</tbody>
</table>

Specifications Continued
## Specifications Continued

### Mechanical Characteristics

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical Rotational Angle</td>
<td>360° (endless)</td>
</tr>
<tr>
<td>Rotational Torque</td>
<td>1.96mN•m (20gf•cm) max.</td>
</tr>
<tr>
<td>Weight</td>
<td>1.5g approximately</td>
</tr>
<tr>
<td>Shaft Strength-Top Adjust</td>
<td>9.8N (1kgf), 10 second max.</td>
</tr>
<tr>
<td>Shaft Strength-Bottom Adjust</td>
<td>4.9N (0.5kgf), 10 second max.</td>
</tr>
<tr>
<td>Rotational Life</td>
<td>20 million cycles min. at 140° rotational angle, 4Hz</td>
</tr>
</tbody>
</table>

### Environmental Characteristics

*Satisfies electrical specifications after environmental testing.*

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature Range</td>
<td>−40°C to +125°C</td>
</tr>
<tr>
<td>Vibration*</td>
<td>10-55Hz (1.5mm amplitude)</td>
</tr>
<tr>
<td>Low Temperature Exposure*</td>
<td>−40°C, no load, for 120 hours, (confirm shaft rotation)</td>
</tr>
<tr>
<td>Load Life*</td>
<td>+125°C with rated voltage applied (1.5 hours on, 0.5 hours off) for 1,000 hours</td>
</tr>
<tr>
<td>Moisture Resistance Load Life*</td>
<td>+40°C, 90-95%RH (no condensation) with rated voltage applied (1.5 hours on, 0.5 hours off) for 1,000 hours</td>
</tr>
<tr>
<td>Thermal Shock*</td>
<td>−40°C for 30 minutes ≠ +125°C for 30 minutes, 100 cycles</td>
</tr>
</tbody>
</table>

### Precautions

1. TOCOS recommends that special attention be paid to the sensor selection and specifications when designing any products requiring high reliability such as transportation equipment (trains, cars, marine vessels, etc.), signal transmission equipment, medical equipment, aerospace equipment, electric and gas appliances, disaster prevention and security equipment. Prior examinations or testing of the finished product are necessary to prevent any product failure. Use of a fail-safe design, fire spread prevention design, and redundant design are recommended.

2. Never attempt to reconfigure or disassemble the sensor. Sensor failure or performance deterioration may result.

3. This sensor product contains a semi-conductor component; please avoid using it in a strong electric field.

4. Do not place magnets near the sensor or expose it to a strong magnetic field because the sensor characteristics will change or fluctuate.

5. It is the customer’s responsibility to verify the appropriate use and installation of the sensor. TOCOS is not responsible for any damages to the customer, third parties, or equipment resulting from use of the sensor.

### Electrical Schematic

**Connection Circuit**

For Sensor: For EMC protection, please connect a 4.7nF ceramic capacitor near the sensor terminals in between sensor output and ground and also in between sensor input and ground.

For Controller Unit: Please connect a 10kΩ resistor and a 4.7nF ceramic capacitor in between controller-unit input and ground for EMC protection also.
The text in the image describes the RSM12C Series sensor. It highlights the dimensional drawings of top, side, and bottom views of the sensor, including output levels and shaft dimensions. It emphasizes the importance of using non-magnetic material for the shaft to ensure accurate angle detection. The PCB mounting section provides dimensions for mounting holes, sensor mounting holes, and rotor center positions.
Output Voltage at Shaft Positions

<table>
<thead>
<tr>
<th>Angle (°)</th>
<th>Output (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2.5</td>
</tr>
<tr>
<td>70°</td>
<td>5.0</td>
</tr>
</tbody>
</table>

Shaft Positions

Unit: mm
**Features**

- Thin 11mm angle/position sensor with 3-wire harness and connector offered as a standard assembly
- Reliable, durable magnetic circuit, Hall IC technology
- Long life of 30 million cycles
- Single output angle/position detection can be set within the F.S. measurement range
- Waterproof as standard with an IP64 rating
- Resistant to dither input, temperature variables, vibration impact and other external environmental factors
- Built-in magnet shield reduces interference from external magnetic field and isolates sensors from magnetic noise found in nearby motors
- 0.08W power rating
- Low impedance allows low load resistance
- Blind shaft-fitting design for front insertion of a blade shaft
- Popular screw mount flange with two oval mounting holes (hardware not included)
- RoHS compliant

**Applications**

- Angle/position detection in electronically controlled devices found in automobiles, construction/agricultural machinery, snowmobiles, and marine vessels
- Various actuators such as valve opening/closing detection
- Angle/position settings for controlling electronic games and various entertainment systems
- Other applications for single output angle/position sensors requiring reliability and very long life

**Specifications**

### Basic Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5 ± 0.5V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>16mV max.</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.08W</td>
</tr>
<tr>
<td>Mechanical Rotational Angle</td>
<td>130°</td>
</tr>
<tr>
<td>Electrical Rotational Angle</td>
<td>100.8° (0.4V to 4.6V)</td>
</tr>
<tr>
<td>Dustproof and Waterproof</td>
<td>IP64 rating</td>
</tr>
<tr>
<td>Output Characteristics</td>
<td>See Figure 1</td>
</tr>
<tr>
<td>Output Inclination</td>
<td>0.042V/degree</td>
</tr>
<tr>
<td>Measurement Circuit</td>
<td>See Figure 2</td>
</tr>
<tr>
<td>Output Resolution</td>
<td>5 /4096V (Vdd /12 bit)</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>–40°C to +125°C</td>
</tr>
<tr>
<td>Mounting Hole Pitch</td>
<td>36mm</td>
</tr>
</tbody>
</table>

### Significant Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Linearity</td>
<td>±1% before test; ±2% after test; (in percentage of F.S. measurement range); deviation of output voltage from referenced straight line (inclination of 0.042V/degree) connecting 0.4V to 4.6V (see Figure 1)</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>±0.5° before test; ±0.5° after test; results based on difference of output voltage from hysteresis loop (origin curve and return curve)</td>
</tr>
<tr>
<td>Output Noise</td>
<td>±0.2% F.S. before test, ±0.2% F.S. after test</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>100MΩ min. before test; 10MΩ min. after test; 500VDC, MEGA between each lead and shaft fitting</td>
</tr>
<tr>
<td>Operating Torque - Minimum</td>
<td>0.0049N•m min. before test; 0.0010N•m min. after test (see Figure 3)</td>
</tr>
<tr>
<td>Operating Torque - Maximum</td>
<td>0.0588N•m max. before test; 0.0883N•m max. after test (see Figure 3)</td>
</tr>
</tbody>
</table>

 Specifications Continued
Endurance Performance

Operating Endurance

<table>
<thead>
<tr>
<th>Operating Temperature (°C)</th>
<th>Tested Rotational Cycles</th>
<th>Tested Operating Angle</th>
<th>Output Voltage Range (V)</th>
<th>Frequency Rate (Hz)</th>
<th>Applied Voltage To Vcc Connector Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25</td>
<td>30 million</td>
<td>100.8°</td>
<td>0.4 to 4.6</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
<td>+125</td>
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<td>−40</td>
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<td>5°</td>
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<td>30</td>
<td>5V</td>
</tr>
</tbody>
</table>

Sweep Vibration 2.5V reference point at +25°C, 30G, 50-250Hz, X, Y, Z direction, 12 hours

Shock 100G, 3 minutes, 18 times

Humidity 80 ± 3°C, 95 ± 5% RH, 1,000 hours

Temperature Cycle −40°C for 1 hour ≠ +125°C for 1 hour, 1,000 cycles

Low Temperature Shelf Life −40°C, 1,000 hours

High Temperature Shelf Life +125°C, 1,000 hours

Moisture, Rain, and Spray JIS-D-0203-D1, temperature of water shall be 10°C lower than temperature of test sample, D1 dip test time: 5 minutes, 10 cycles (installation side of part is sealed using an assembly tool)

Electromagnetic Susceptibility 200 V/m, 1MHz to 1GHz

Electrostatic Discharge ±8kV contact discharge; ±15kV air discharge; IEC-61000-4-2

Output Analysis

Figure 1: Output Characteristics

![Output Characteristics Diagram]
RSM011 Series

Dimensions

Dimensional Drawings of Front View A with Wire Harness and Connector

Unit: mm

Direction of Output Increase (CW)

Ø26 ± 0.2

Ø14 ± 0.2

25°

SPCC/Trivalent Chromate
Pull-out Load: 19.6 N min.

Output (Yellow)
GND (Black)
Vdd (Blue)

250 ± 10

(36)

190 ± 10

PVC Tube
Heat-Proof 105°C
(Black)

AEX0.5f Wires

Sumitomo Wiring Connector 6187-3232

Electrical Schematic

Figure 2: Measurement Circuit

5VDC (Blue)

10kΩ

0.1µF

10kΩ

Output (Yellow)
GND (Black)
**RSM011 Series**

**Dimensions**

**Dimensional Drawings of Back, Side, and Bottom Views**

Unit: mm

![Dimensional Drawings of Back, Side, and Bottom Views](image)

**Rotational Torque**

*Figure 3: Operating Torque*

![Rotational Torque](image)
Blind Shaft Fitting
Detail from Front View A

Unit: mm

Rotor

secured clearance.
No thrust direction contact
between shaft and rotor.

Recommended Blade Shaped Shaft

Unit: mm

Rotor

Shaft
RSM012 Series
Low Profile, Dual Output, Non-Contact Angle/Position Sensors

Features

- Thin 11mm angle/position sensor with 4-wire harness and connector offered as a standard assembly
- Dual output, durable magnetic circuit, Hall IC technology
- Long life of 30 million cycles
- Dual output detection settings configured at factory to meet user's requirements
- Waterproof as standard with an IP64 rating
- Resistant to dither input, temperature variables, vibration impact and other external environmental factors
- Built-in magnet shield reduces interference from external magnetic field and isolates sensors from magnetic noise found in nearby motors
- 0.16W power rating
- Low impedance allows low load resistance
- Blind shaft-fitting design for front insertion of a blade shaft
- Popular screw mount flange with two oval mounting holes (hardware not included)
- RoHS compliant

Applications

- Dual angle/position detection in electronically controlled devises found in automobiles, construction/agricultural machinery, snowmobiles, and marine vessels
- Various actuators such as valve opening/closing detection
- Dual outputs offer flexibility, i.e. redundancy and back-up, clamp voltage range, or indicator/control systems
- Other applications for dual output angle/position sensors requiring reliability and very long life

Specifications

Basic Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply Voltage</td>
<td>5 ± 0.5V</td>
</tr>
<tr>
<td>Supply Current</td>
<td>32mV max.</td>
</tr>
<tr>
<td>Power Rating</td>
<td>0.16W</td>
</tr>
<tr>
<td>Mechanical Rotational Angle</td>
<td>130°</td>
</tr>
<tr>
<td>Electrical Rotational Angle</td>
<td>100.8° (0.4V to 4.6V)</td>
</tr>
<tr>
<td>Dustproof and Waterproof</td>
<td>IP64 rating</td>
</tr>
<tr>
<td>Output Characteristics</td>
<td>See Figure 1</td>
</tr>
<tr>
<td>Output Inclination</td>
<td>0.042V/degree</td>
</tr>
<tr>
<td>Measurement Circuit</td>
<td>See Figure 2</td>
</tr>
<tr>
<td>Output Resolution</td>
<td>5 /4096V (Vdd/12 bit)</td>
</tr>
<tr>
<td>Operating Temperature Range</td>
<td>−40°C to +125°C</td>
</tr>
<tr>
<td>Mounting Hole Pitch</td>
<td>36mm</td>
</tr>
</tbody>
</table>

Significant Characteristics

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output Linearity</td>
<td>±1% before test; ±2% after test; (in percentage of F.S. measurement range); deviation of output voltage from referenced straight line (inclination of 0.042V/degree) connecting 0.4V to 4.6V (see Figure 1)</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>±0.5° before test; ±0.5° after test; results based on difference of output voltage from hysteresis loop (origin curve and return curve)</td>
</tr>
<tr>
<td>Relative Deviation</td>
<td>5 ± 0.08V before test; 5 ± 0.1V after test; to calculate relative deviation use ΔV = V1 + V2 where V1 is main output and V2 is sub-output</td>
</tr>
<tr>
<td>Output Noise</td>
<td>±0.2% F.S. before test, ±0.2% F.S. after test</td>
</tr>
<tr>
<td>Insulation Resistance</td>
<td>100MΩ min. before test; 10MΩ min. after test; 500VDC, MEGA between each lead and shaft fitting</td>
</tr>
<tr>
<td>Operating Torque-Minimum</td>
<td>0.0049N·m min. before test; 0.0010N·m min. after test (see Figure 3)</td>
</tr>
<tr>
<td>Operating Torque-Maximum</td>
<td>0.0588N·m max. before test; 0.0883N·m max. after test (see Figure 3)</td>
</tr>
</tbody>
</table>

Specifications Continued
Endurance Performance

Operating Endurance

<table>
<thead>
<tr>
<th>Operating Temperature (°C)</th>
<th>Tested Rotational Cycles</th>
<th>Tested Operating Angle</th>
<th>Output Voltage Range (V)</th>
<th>Frequency Rate (Hz)</th>
<th>Applied Voltage To Vcc Connector Pin</th>
</tr>
</thead>
<tbody>
<tr>
<td>+25</td>
<td>30 million</td>
<td>100.8°</td>
<td>0.4 to 4.6</td>
<td>4</td>
<td>5V</td>
</tr>
<tr>
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Sweep Vibration 2.5V reference point at +25°C, 30G, 50-250Hz, X, Y, Z direction, 12 hours

Shock 100G, 3 minutes, 18 times

Humidity 80 ± 3°C, 95 ± 5% RH, 1,000 hours

Temperature Cycle −40°C for 1 hour ± +125°C for 1 hour, 1,000 cycles

Low Temperature Shelf Life −40°C, 1,000 hours

High Temperature Shelf Life +125°C, 1,000 hours

Moisture, Rain, and Spray JIS-D0203-D1, temperature of water shall be 10°C lower than temperature of test sample D1 dip test time: 5 minutes, 10 cycles (installation side of part is sealed using an assembly tool)

Electromagnetic Susceptibility 200 V/m, 1MHz to 1GHz

Electrostatic Discharge ±8kV contact discharge; ±15kV air discharge; IEC-61000-4-2

Output Analysis

Figure 1: Output Characteristics

Unit: mm
**RSM012 Series**

**Dimensions**

**Dimensional Drawings of Front View A with Wire Harness and Connector**  
Unit: mm

![Dimensional Drawing Diagram](image)

**Electrical Schematic**

**Figure 2: Measurement Circuit**

![Electrical Schematic Diagram](image)
### Dimensions

**Dimensional Drawings of Back, Side, and Bottom Views**

Unit: mm

![Dimensional Drawings](image)

- **Tolerance:** ±0.5 (unless otherwise specified)

### Rotational Torque

**Figure 3: Operating Torque**

![Rotational Torque Diagram](image)
**RSM012 Shaft Style**

**Recommended Blade Shaped Shaft**

Unit: mm

- Shaft Ø6 +0.1
- 2 ± 0.05

Secure clearance. No thrust direction contact between shaft and rotor.

**RSM012 Shaft Fitting**

**Blind Shaft Fitting**

Detail from Front View A

Unit: mm

- Ø6.2 ± 0.15
- 2 ± 0.05
- 1.6 ± 0.3
- 2.4 ± 0.1
- 7.6

Rotor
### Features
- All-in-one housing with angle/position sensor, threaded flat shaft, and integral female connector
- Reliable, durable magnetic circuit, Hall IC technology
- Long life of 15 million cycles
- Single output angle/position detection customizable within 20° to 140°
- Flat threaded shaft actuated in the CCW direction for angle/position detection and automatic return operation
- Compatible with industry-standard mating connectors
- Built-in magnet shield reduces interference from external magnetic field and isolates sensors from magnetic noise found in nearby motors
- 0.07W power rating
- Waterproof as standard with an IP65 rating
- Operating temperature range of −30°C to +120°C
- Screw mounting flange with two round (Ø4.6mm) mounting holes (hardware not included)
- RoHS compliant

### Applications
- Angle/position detection in electronically controlled devices found in automobiles or construction/agricultural machinery
- Manufacturing control systems, i.e. robotics, conveyors, and tooling
- Sensor settings for steering and speed control for off-road vehicles such as golf carts, ATVs, and snowmobiles
- Wide variety of applications for non-contact, single output angle/position sensors requiring reliability and long life

### Specifications

<table>
<thead>
<tr>
<th>Basic Characteristics</th>
<th>Operating Temperature Range</th>
<th>Storage Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electrical Angle</strong></td>
<td>50° (Customizable within 20° to 140°)</td>
<td>−30°C to +120°C</td>
</tr>
<tr>
<td><strong>Mechanical Angle</strong></td>
<td>150 ± 5°</td>
<td>−40°C to +130°C</td>
</tr>
<tr>
<td><strong>Rated Voltage</strong></td>
<td>5 ± 0.5VDC</td>
<td>Circuit Structure</td>
</tr>
<tr>
<td><strong>Maximum Rated Voltage</strong></td>
<td>12VDC</td>
<td>Measurement Circuit</td>
</tr>
<tr>
<td><strong>Power Rating</strong></td>
<td>0.07W</td>
<td>Output Characteristics</td>
</tr>
<tr>
<td><strong>Mounting Hole Pitch</strong></td>
<td>41mm</td>
<td>Environmental Load Substances</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Significant Characteristics</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output Linearity</strong></td>
<td>±3% (±150mV) before test; ±5% (±250mV) after test; in percentage based on deviation of output voltage from referenced straight line (reference position: 2.5V when applying 5VDC); and within output characteristics guaranteed range of 0.7V to 4.3V (see Figure 5)</td>
</tr>
<tr>
<td><strong>Hysteresis</strong></td>
<td>±1% (±80mV) before test; ±1.5% (±120mV) after test; where output characteristics fall between the guaranteed range of 0.7V to 4.3V</td>
</tr>
<tr>
<td><strong>Insulation Resistance</strong></td>
<td>100MΩ min. before test; 100MΩ min. after test; 500VDC, MEGA between each lead and shaft</td>
</tr>
<tr>
<td><strong>Operating Torque - Minimum</strong></td>
<td>0.020N•m min. before test; 25% max. change of initial value after test (see (a) in Figure 4)</td>
</tr>
<tr>
<td><strong>Operating Torque - Maximum</strong></td>
<td>0.094N•m max. before test; 25% max. change of initial value after test (see (b) in Figure 4)</td>
</tr>
</tbody>
</table>

*Specifications Continued*
Endurance Performance

Operating Endurance

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotational Life</td>
<td>15 million cycles (guaranteed output voltage range of 0.7V to 4.3V)</td>
</tr>
<tr>
<td>Low Temperature Exposure</td>
<td>– 40°C, 72 hours</td>
</tr>
<tr>
<td>High Temperature Exposure</td>
<td>+130°C, 72 hours</td>
</tr>
<tr>
<td>Temperature Cycle</td>
<td>–25°C for 1 hour, +70°C for 1 hour, 10 cycles</td>
</tr>
<tr>
<td>Vibration</td>
<td>JIS D1601 3-B-70</td>
</tr>
<tr>
<td>Electromagnetic Susceptibility</td>
<td>200 V/m, 1MHz to 1GHz</td>
</tr>
<tr>
<td>Electrostatic Discharge</td>
<td>±8kV contact discharge; ±15kV air discharge; IEC-61000-4-2</td>
</tr>
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International Protection

IP65 rating

Precautions

1. Product Handling: If installing a lever to the product, do not apply an operating torque that exceeds 0.49N•m (5kgf•cm) to the internal stopper.
2. About Washing: Do not wash the product as this will adversely affect the components, especially plastics.
3. About Storage: Do not store the product under hot, humid conditions or expose the product to corrosive gases.
4. About Automatic Return Operation: To avoid damaging the internal stopper, do not allow the shaft to travel from fully open position to fully closed position in one motion.
5. About Operating Environment: Do not use materials that generate harmful gases (sulfide gas, chlorine gas, etc.) for components that will be assembled in the product.

Circuit Structure

![Figure 1: Hall IC Magnetic Circuit](image)

Electrical Schematic

![Figure 2: Measurement Circuit](image)
Dimensions

Dimensional Drawing of Front View A

Unit: mm

Shaft Rotation CCW

150 ± 5°
Mechanical Rotation Angle

(50°)
Electrical Rotation Angle

75 ± 4°

References Line

Rotational Free Position (15°)

Front View A

Ø34 ± 0.7

Ø23 ± 0.5

15°

Shaft Rotation CCW

Effective Threaded Area:
7 Thread min. (15°)

M6 x 1 Threading

From the Mounting Surface

Figure 3: Detail of Shaft Shape and Threading

Unit: mm

The shaft angle shown is the start position (0°)

 Ø6 ± 0.05 (Except Threads)

8.5

(14)
### RSM134 Series

#### Dimensions

**Dimensional Drawings of Back, Side, and Terminal End Views**

Unit: mm

![Dimensional Drawings](image)

- **Terminal 1:** Input
- **Terminal 2:** GND
- **Terminal 3:** Output

**Tolerance:** ±0.5, ±5° (unless otherwise specified)

---

#### Rotational Torque

**Figure 4: Operating Torque**

![Operating Torque](image)

- **Point a** (Minimum Torque)
- **Point b** (Maximum Torque)
When the applied voltage changes within the rated voltage range, the output voltage changes at the same rate.
Features

- Long life of 50 million cycles
- Reliable, durable magnetic circuit, Hall IC technology
- Ø28mm panel mount, single output, non-contacting angle sensors
- 360° (endless) rotational angle
- 0.08W power rating
- Clamp voltage range of 0.4V to 4.6V
- Low impedance allows low load resistance
- No sliding electrical contacts, no dither input
- Detection of disconnection and failure in the diagnostic domain at the upper and lower ends of output
- Waterproofing available as an option
- Optional built-in magnet shield to reduce interference from external magnetic field and to isolate sensors from magnetic noise found in nearby motors
- Customizable detection angle and gradient polarity available as an option
- RoHS compliant
- Washer and hexagonal nut mounting hardware included

Applications

- Electric vehicles, i.e. pedal and steering positions, a variety of undercarriage electronically controlled devices
- Construction / Agricultural machinery, i.e. angle detection of rotating parts
- Medical equipment, i.e. electric wheelchairs, precision positioning equipment for patient diagnosis or surgery
- Other applications requiring magnetically operated angle detection, high reliability and very long life

Electrical Characteristics

Supply Voltage ......................... 5 ± 0.5V
Current Consumption .................. ≤ 16mA without load
Power Rating .......................... 0.08W
Electrical Rotational Angle .......... 20° to 360°
Linearity .............................. ±1% Full Scale
Output Voltage ........................ 0.4V to 4.6V at Vdd = 5.0V
Minimum Clamp Voltage ............ 0.4V at Vdd = 5.0V
Maximum Clamp Voltage ............. 4.6V at Vdd = 5.0V
Load Resistance ...................... 10kΩ
Maximum Rated Voltage ............. 12V
Maximum Reverse Voltage .......... 0.3V
Hysteresis ............................. ≤0.2% Full Scale
Resolution ............................ 1.25mV at Vdd = 5.0V

Mechanical Characteristics

Mechanical Rotational Angle .......... 360° (endless)
Rotational Torque .................... ≤5mN•m (≤51gf•cm, 0.708 oz•in)
Push Shaft Strength ................. ≤98N (static load in vertical direction)
Pull Shaft Strength ................... ≤98N (static load in vertical direction)
IP Rating .............................. IP50, IP65 (Option)

Environmental Characteristics

Operating Temperature Range ........ -40°C to +125°C
Storage Temperature Range .......... -40°C to +125°C
Rotational Life ........................ 50 million cycles
Temperature Cycle ................... -40°C to +125°C, 100 cycles
Low Temperature Exposure .......... -40°C, 1,000 hours
High Temperature Exposure ......... +125°C, 1,000 hours
Vibration .............................. 25G, 10-2,000Hz, 12 hours
Shock ................................. 100 G, 3ms, 18 times
Electromagnetic Susceptibility ...... 200 V/m, 1MHz to 1GHz
Electrostatic Discharge .............. ±8kV contact discharge, ±15kV air discharge, IEC-61000-4-2

Marking

Manufacturing Date
4-Digit Code
4 = Last Digit of the Year (one digit)
1 = Month (one digit or letter):
  1 – 9 Jan to Sep
  X = Oct
  Y = Nov
  Z = Dec
06 Day of the Month (two digits)
RSM28 Series

Dimensions

Dimensional Drawings and Tolerances

Unit: mm

Evaluation Circuit

Electrical Schematic

Mounting Hardware

Flat Washer and Hexagonal Nut

Flat Washer
Material: Cold Rolled Steel, Ni Plating

Hexagonal Nut
Material: Carbon Steel Wire
Rods for Cold Heading, Trivalent Chromate Plating

Tolerance: ± 0.5 (unless otherwise specified)
Output Characteristics

**Output Voltage (V)**

- **Direction of Output Increase (CW):**
  - Output 0.4V (0°)
  - Output 2.5V (180°)

**Shaft:** Ø 6 ± 0.1

**Anti-Rotation Pin**

**Sensor Output**

**Rotational Angle (°)**

- 0
- 180
- 360
- 420

**Electrical Rotation Angle (360° Max)**

**Unit: mm**