TOCOS

ANGLE/POSITION SENSORS

CONTACT & NON-CONTACT

TOCOS Angle/Position Sensors

Contact Angle/Position Sensors

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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.

RPA011 Series

TOCOS SENSORS

Low Profile, Single Output, Contact Angle/Position Sensors

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	**Output Guaranteed Range**	96° (0.5V to 4.5V)
Maximum Rated Voltage	16VDC	**Electrical Rotational Angle**	120°
Power Rating	0.05W	**Mechanical Rotational Angle**	130°
Output Characteristics	See *Figure 1*	**Operating Temperature Range**	−40°C to +135°C
Measurement Circuit	See *Figure 2*	**Storage Temperature Range**	−40°C to +140°C
Rotor Stopper Strength	≧0.294N•m (≧3kgf•cm)	**Mounting Hole Pitch**	36mm

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

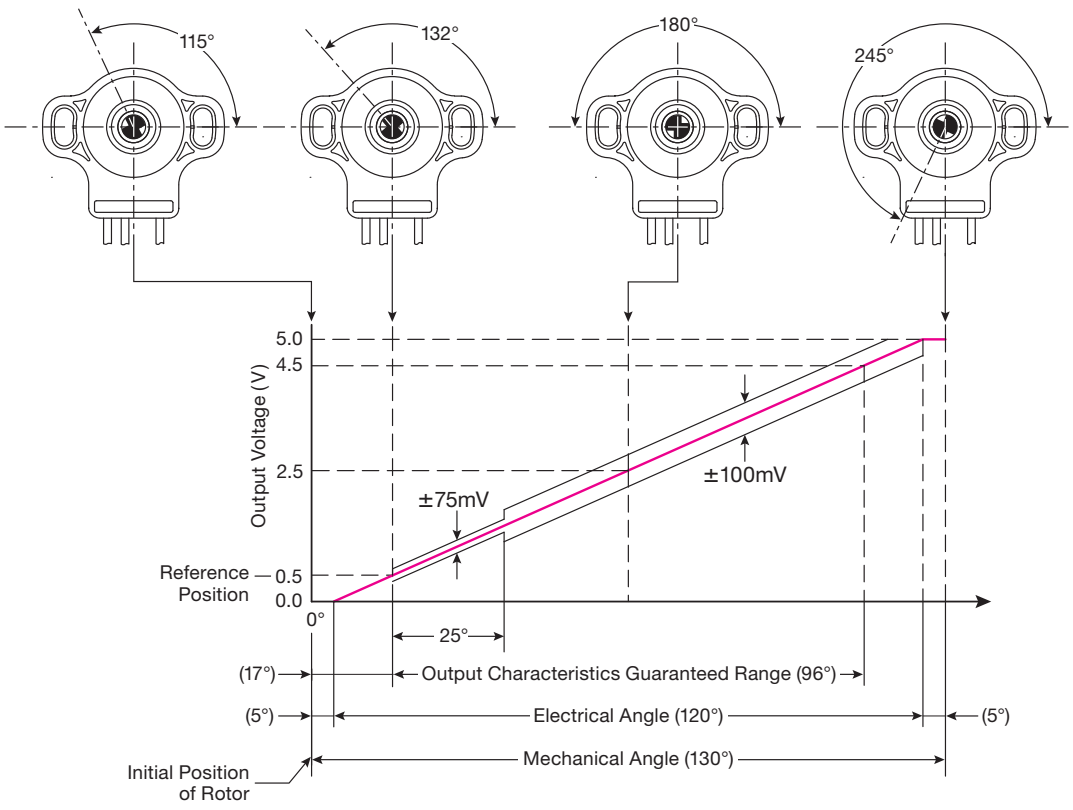
Operating Temperature (°C)	Tested Rotational Cycles	Tested Operating Angle	Output Voltage Range (V)	Frequency Rate (Hz)	Applied Voltage To Vcc Connector Pin
+25	5 million	96° (17° ⇄ 113°)	0.5 to 4.0	4	5V
+100	3 million	96° (17° ⇄ 113°)	0.5 to 4.0	4	5V
−30	2 million	96° (17° ⇄ 113°)	0.5 to 4.0	4	5V
+110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

Constant Vibration	2.5V reference point at +25°C, 10G (O-P), 200 Hz, 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

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.

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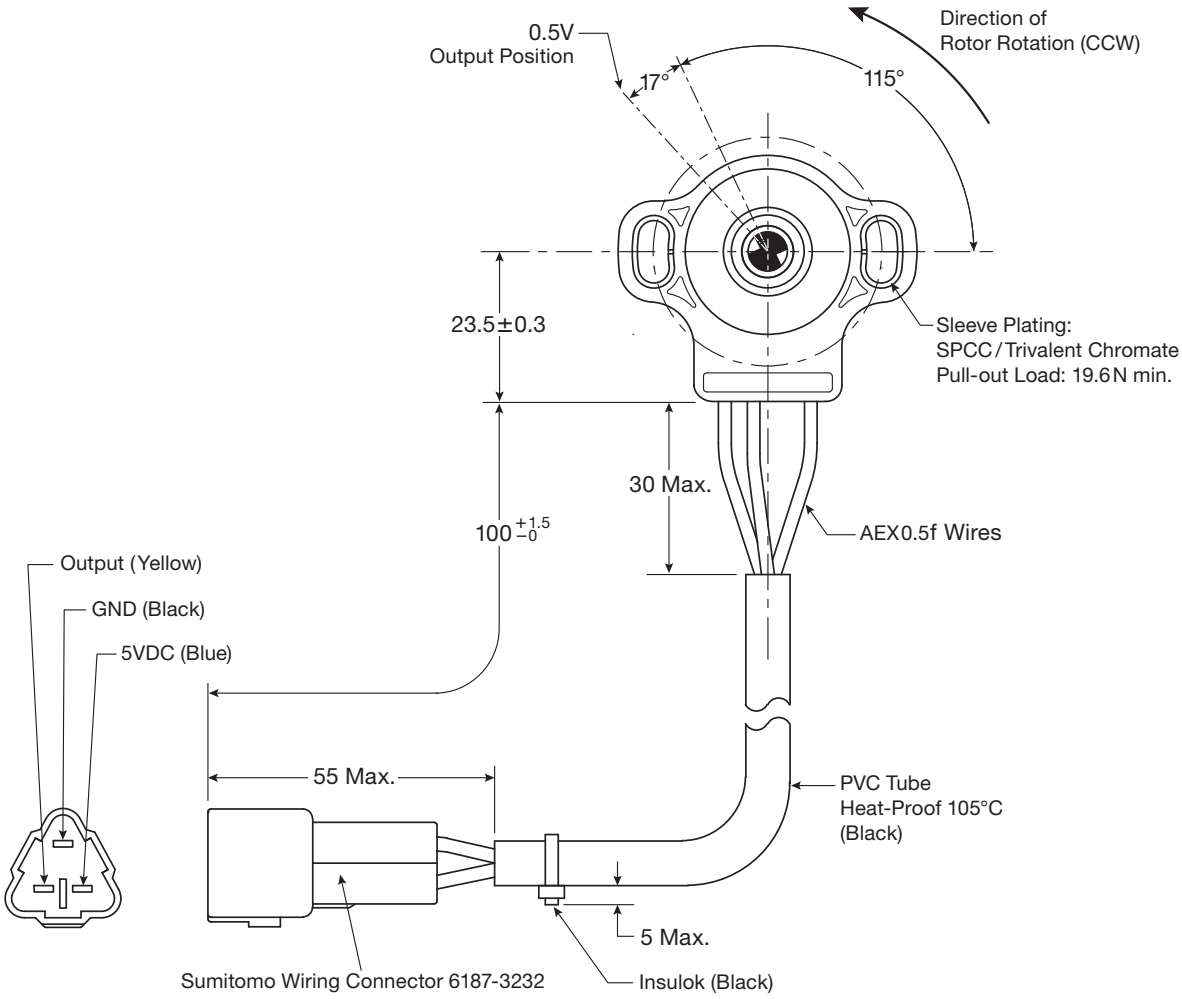
Dimensional Drawings of Front View A with Wire Harness and Connector

Unit: mm



Electrical Schematics

Figure 2: **Evaluation Circuit**

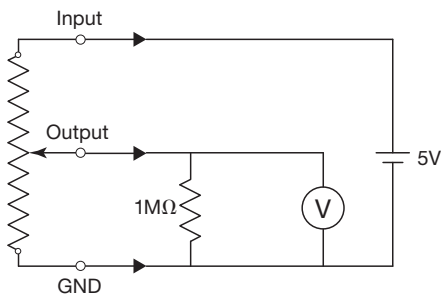
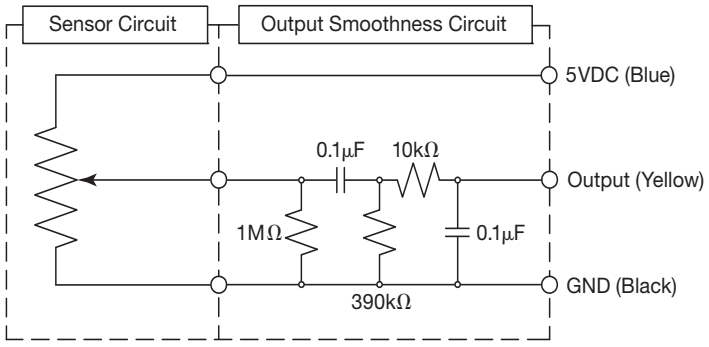
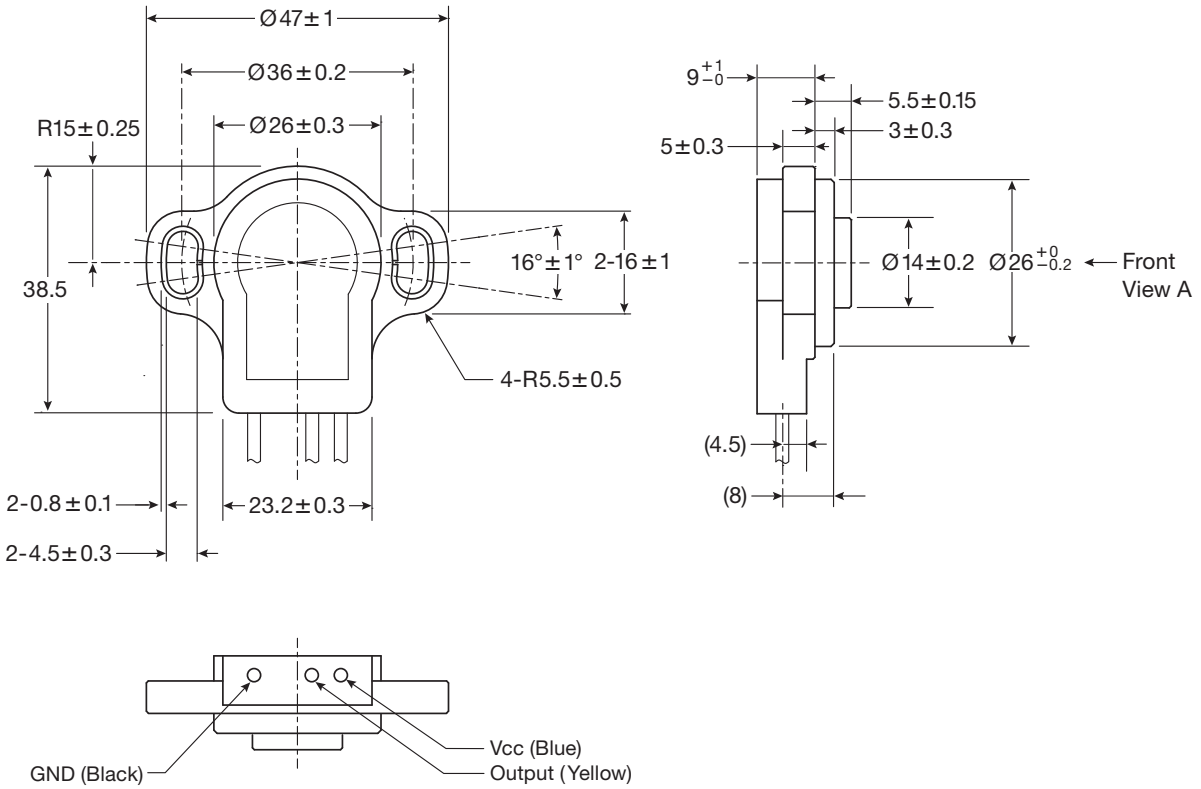


Figure 3: **Output Smoothness Measurement Circuit**



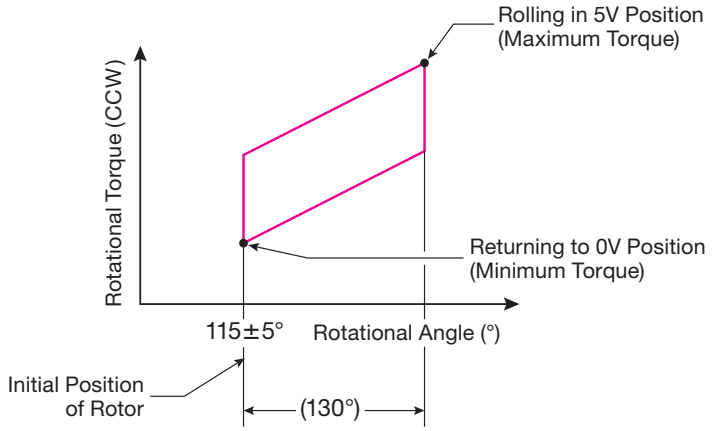
Dimensional Drawings of Back, Side, and Bottom Views

Unit: mm



Rotational Torque

Figure 4: **Operating Torque**



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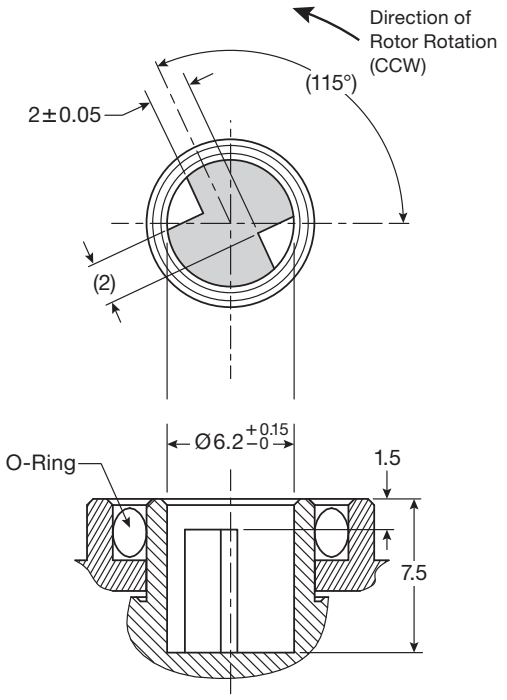
RPA011 Shaft Fitting

Blind Shaft Fitting
Detail from Front View A

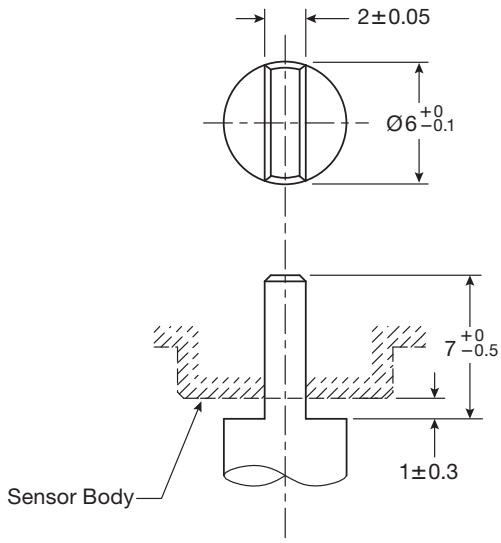
Unit: mm



RPA011 Shaft Style

Recommended Blade Shaped Shaft

Unit: mm



RPAZ052 Series

TOCOS SENSORS

Small, Single Output, Contact Angle/Position Sensors

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

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

Specifications

Basic Characteristics

Rated Voltage	5VDC	**Electrical Rotational Angle**	240°±3°
Maximum Rated Voltage	30VDC	**Mechanical Rotational Angle**	360° (endless)
Power Rating	0.18W	**Operating Temperature Range**	−10°C to +85°C
Total Resistance Value	5kΩ±10%	**Mounting Hole Pitch**	34mm
Waterproof and Dustproof	IP64 rating	**Environmental Load Substances**	RoHS compliant

Significant Characteristics

Output Linearity	±3%	**Operational Life**	5 million cycles
Insulation Resistance	100MΩ at 1,000VDC	**Rotational Torque**	1.96×10^{-2} (200gf•cm) max.
Output Characteristics	See *Figure 1*	**Electrical Schematic**	See *Figure 2*

Specifications Continued

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Environmental Characteristics

Vibration Test	Acceleration 30G, 50-250Hz, X, Y, Z directions, 20 hours; resistance change ΔR/R ≦ 2%
Thermal Shock Test	−40°C for 1 hour ⇄ +120°C for 1 hour, 20 cycles; resistance change ΔR/R ≦ 10%
Low Temperature Exposure	−40°C, 500 hours; resistance change ΔR/R ≦ 5%
High Temperature Exposure	+120°C, 500 hours; resistance change ΔR/R ≦ 10%
Humidity Test	60°C, 90-95%RH, 500 hours; resistance change ΔR/R ≦ 13%
Neutral Salt Spray Test	JIS-C-60068-2-11; test at 35°±2°C in 5±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 ΔR/R ≦ 10%
Oil Test	Coat test sample with light oil (JIS 2 grade), place in an oven at +40°C for 72 hours; resistance change ΔR/R ≦ 2%
Waterproof Test	Water temperature shall be 50°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.

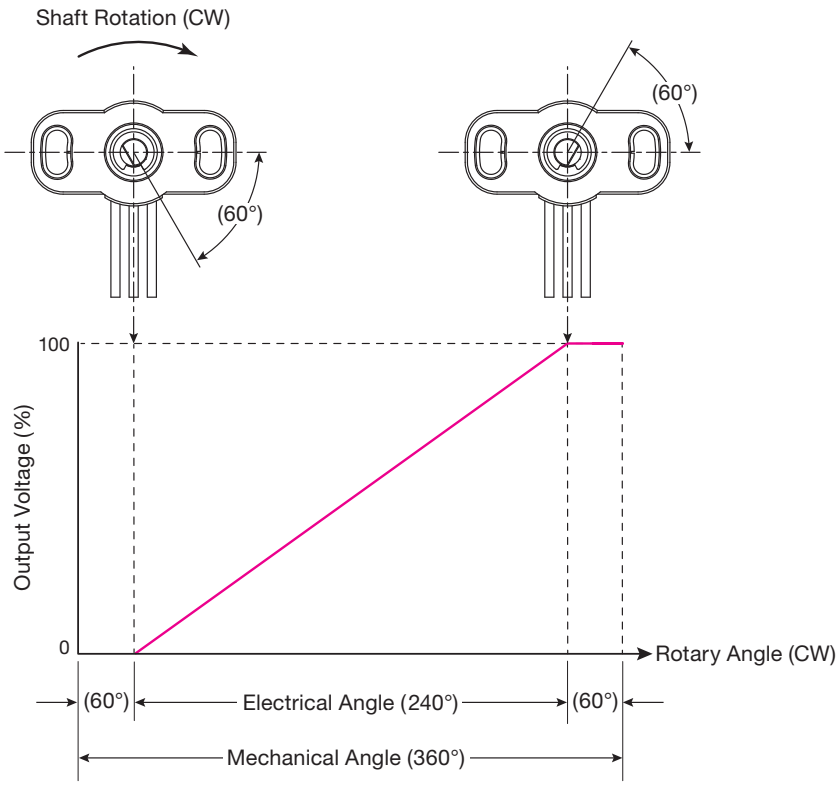
Precautions

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 (1MΩ 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

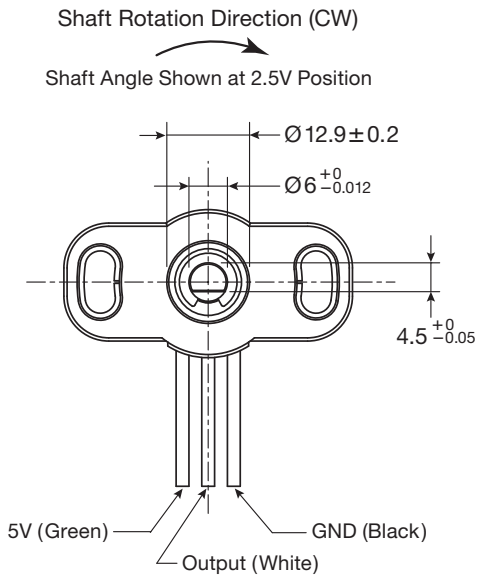
Figure 1: **Output Characteristics**

Unit: mm



Dimensional Drawing of Front View

Unit: mm



Dimensional Drawings of Back, Side, and Bottom Views

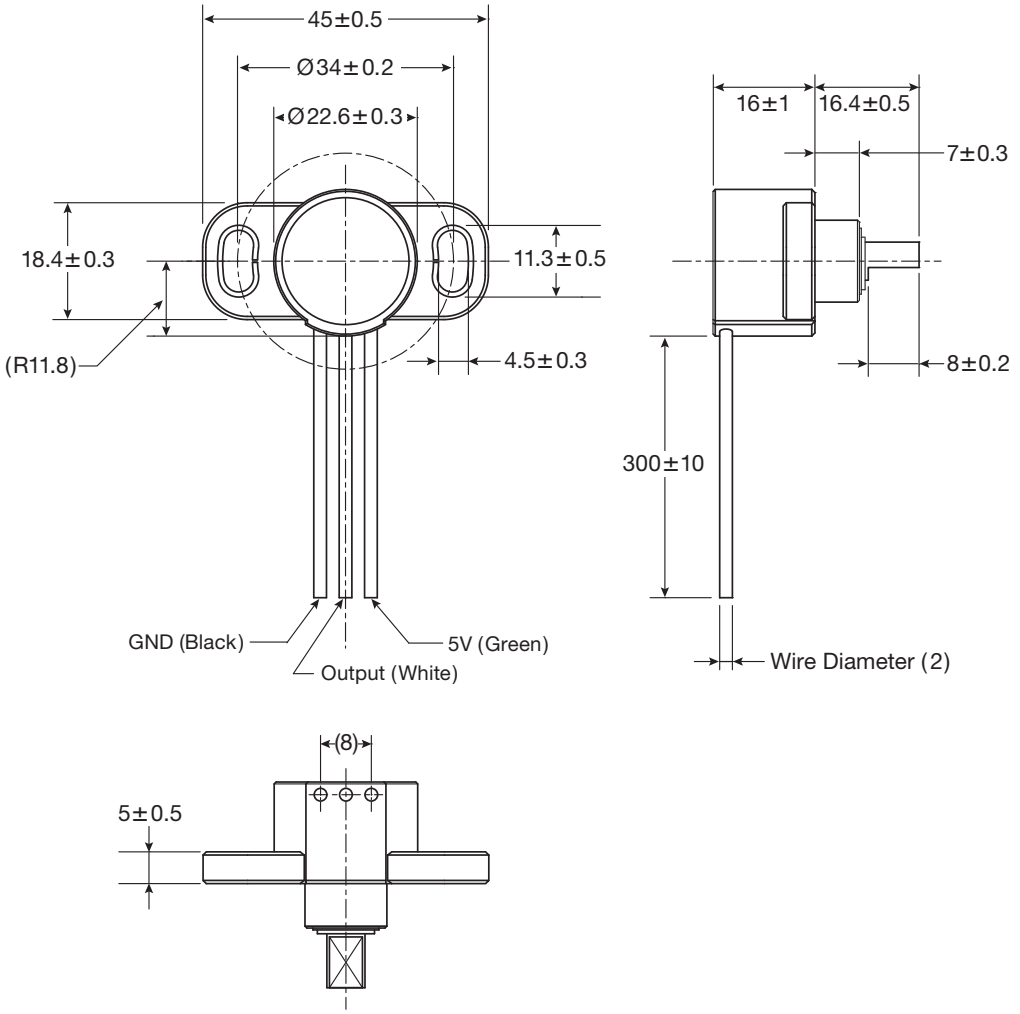


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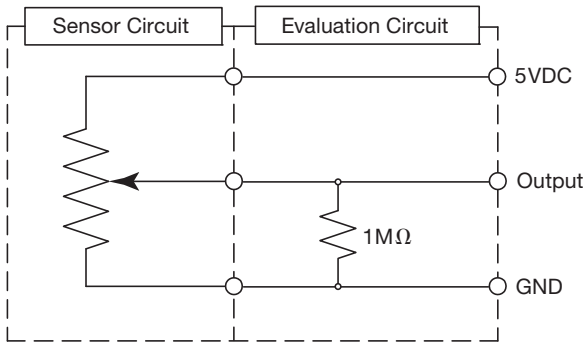
Figure 2: **Circuit Structure and Evaluation Circuit**



RPA112 Series

TOCOS SENSORS

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

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 devises 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

Rated Voltage	5VDC	**Output Guaranteed Range**	90° (0.5V to 4.5V)
Maximum Rated Voltage	16VDC	**Electrical Rotational Angle**	112.5°
Power Rating	0.05W	**Mechanical Rotational Angle**	117°
Measurement Circuit	See *Figure 2*	**Operating Temperature Range**	−30°C to +120°C
Output Characteristics	See *Figure 4*	**Stopper Strength**	98N minimum
Output Inclination	0.044V/degree	**Mounting Hole Pitch**	48mm

Significant Characteristics

Total Resistance	Initial value of 5kΩ±20% before test; 5kΩ±30% after test; when measuring between terminal 1 and 3
Angle at 0.5V	Initial value of 55°±4.5° before test; 55°±7° after test; (see *Figure 4*)
Output Linearity	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*)
Hysteresis	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

Specifications Continued

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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

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

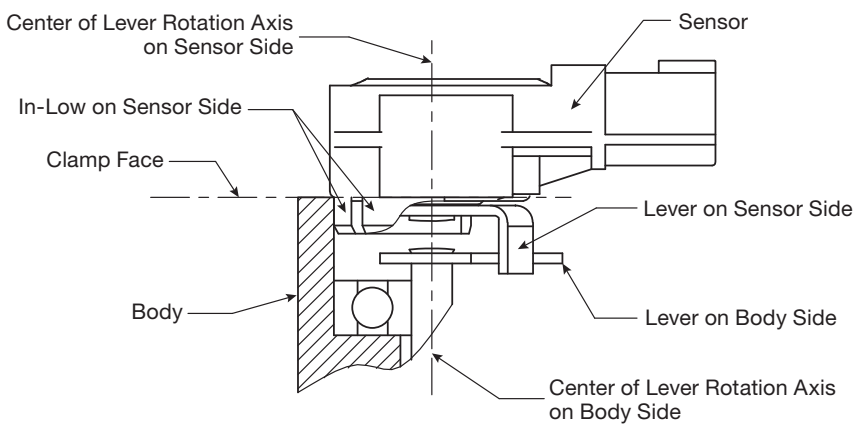
Constant Vibration	2.5V reference point at +25°C, 25G (O-P), 200Hz, 100 hours (applied voltage to Vin connector pin)
Sweep Vibration	2.5V reference point at +25°C, 10G (O-P), 20-130Hz; 20G, 130-200Hz; (20-200Hz, 5 minutes); 100 hours
Temperature Cycle	−30°C for 1 hour ⇄ +120°C for 1 hour, 100 cycles (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*.

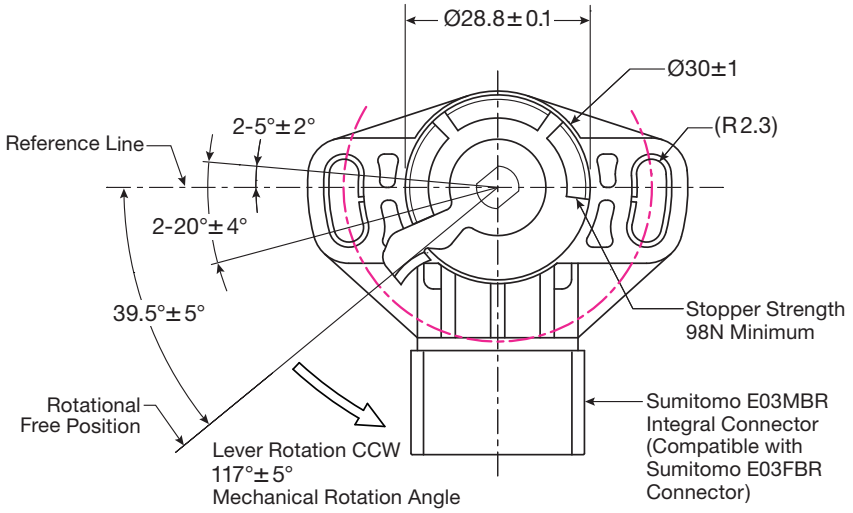
Installation Guidelines

Figure 1: **Cutaway for Installation Conditions**

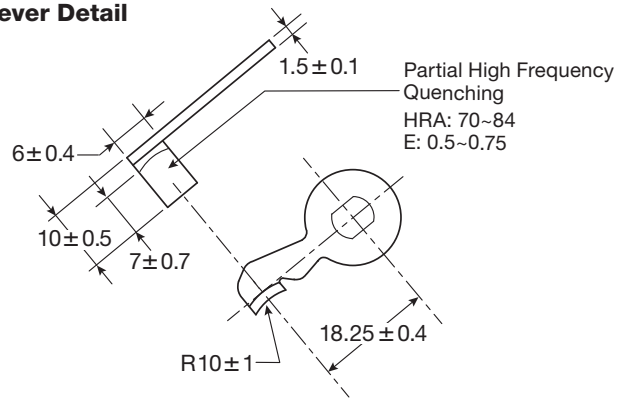


Dimensional Drawings of Front View A and Lever Detail

Unit: mm

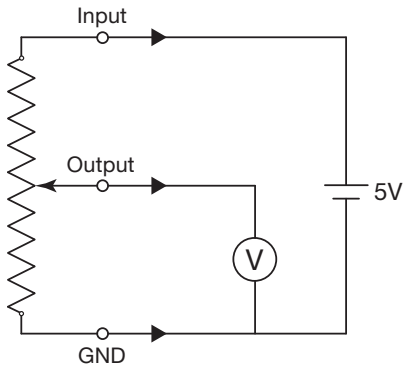


Lever Detail



Electrical Schematic

Figure 2: **Measurement Circuit**



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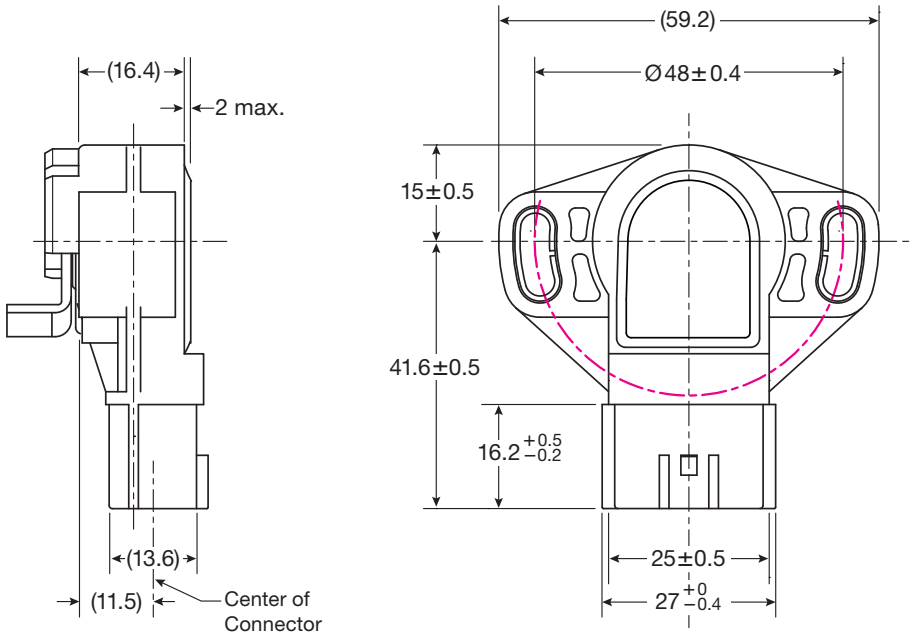
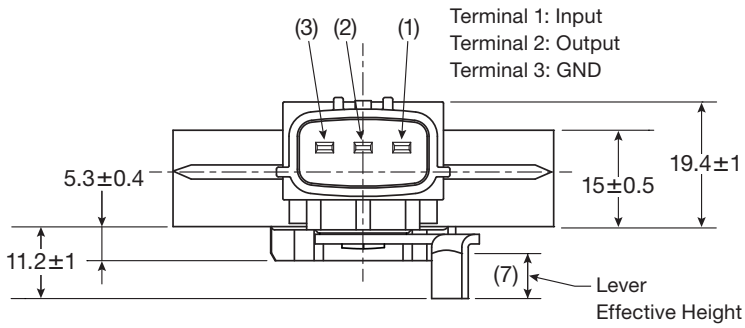
Dimensional Drawings of Back, Side, and Terminal End Views

Unit: mm





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

Rotational Torque

Figure 3: **Operating Torque**

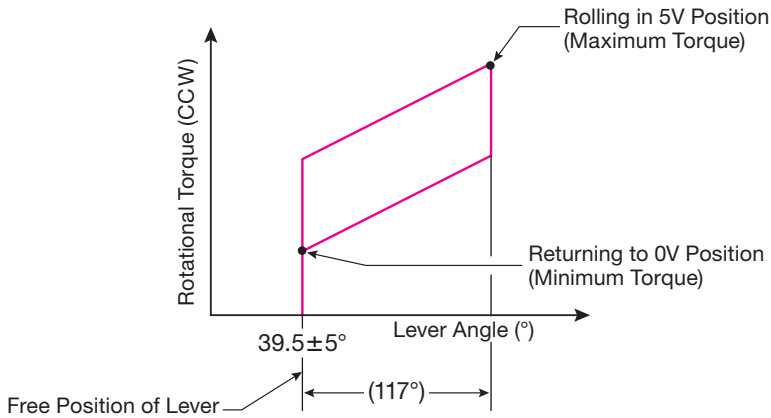
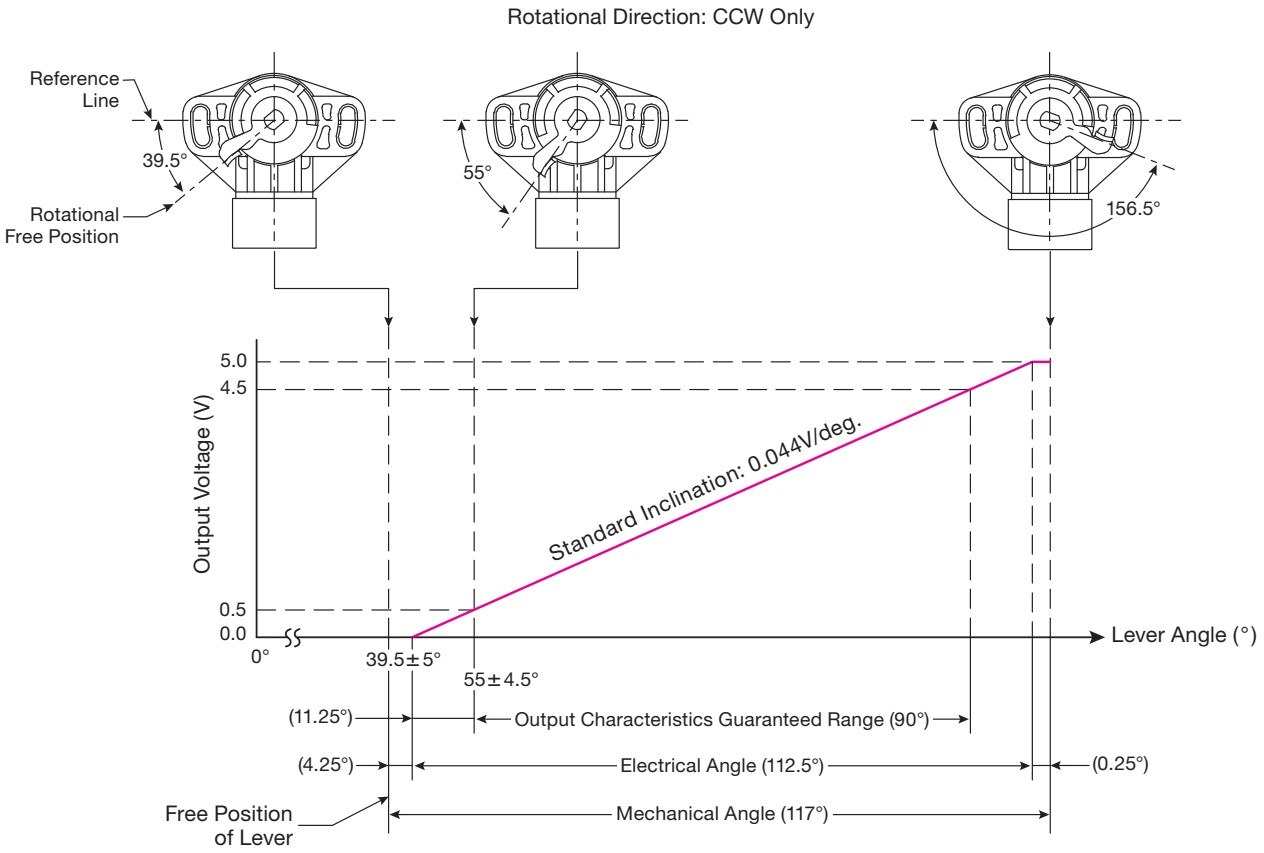


Figure 4: **Output Characteristics**

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.

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RPA132 Series

TOCOS SENSORS

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
- Overall size: 54mm wide including flanges, 58mm long, and 44mm deep from back to end of threaded shaft
- Resistance value of 2kΩ; resistance tolerance of ±30%
- Compatible female F6189-0027 connector recommended to connect with integral male connector
- Operating temperature range of −30°C to +120°C
- 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
- 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

Supply Voltage	5VDC	**Output Guaranteed Range**	±50.6° (0.2V to 4.8V)
Maximum Supply Voltage	16VDC	**Electrical Rotational Angle**	110°±5°
Power Rating	0.12W	**Mechanical Rotational Angle**	150°±5°
Output Characteristics	See *Figure 1*	**Operating Temperature Range**	−30°C to +120°C
Electrical Circuits	See *Figures 3 and 4*	**Mounting Hole Pitch**	41mm

Significant Characteristics

Total Resistance	2kΩ±30% before test; 2kΩ±40% after test; when measuring between input and output terminals
Output Linearity	±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*)
Hysteresis	±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
Insulation Resistance	100MΩ min. before test; 100MΩ min. after test; when 500VDC is applied between the terminals and exposed conducting surfaces (shaft and sleeve)
Rotary Friction Torque	12.8N•cm±20% before test; 12.8N•cm±30% after test

Specifications Continued

Endurance Performance

Operating Endurance

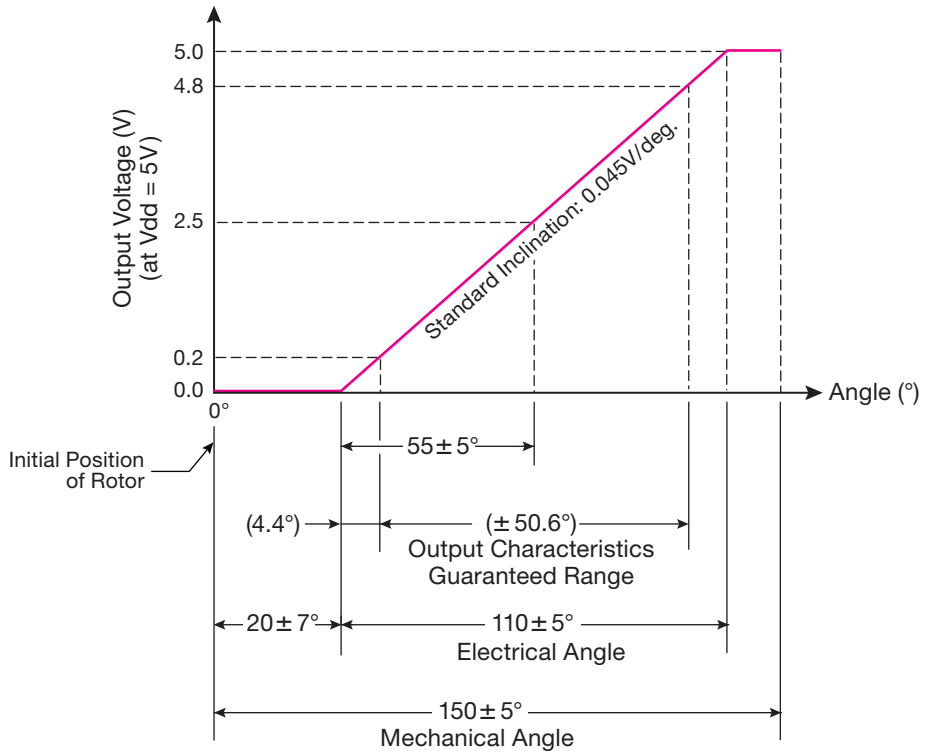
Operating Temperature (°C)	Tested Rotational Cycles	Tested Operating Angle	Output Voltage Range (V)	Frequency Rate (Hz)	Applied Voltage To Vin Terminal Pin
+25	2 million	75°	0.2 to 4.8	3	5V

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**

Unit: mm



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

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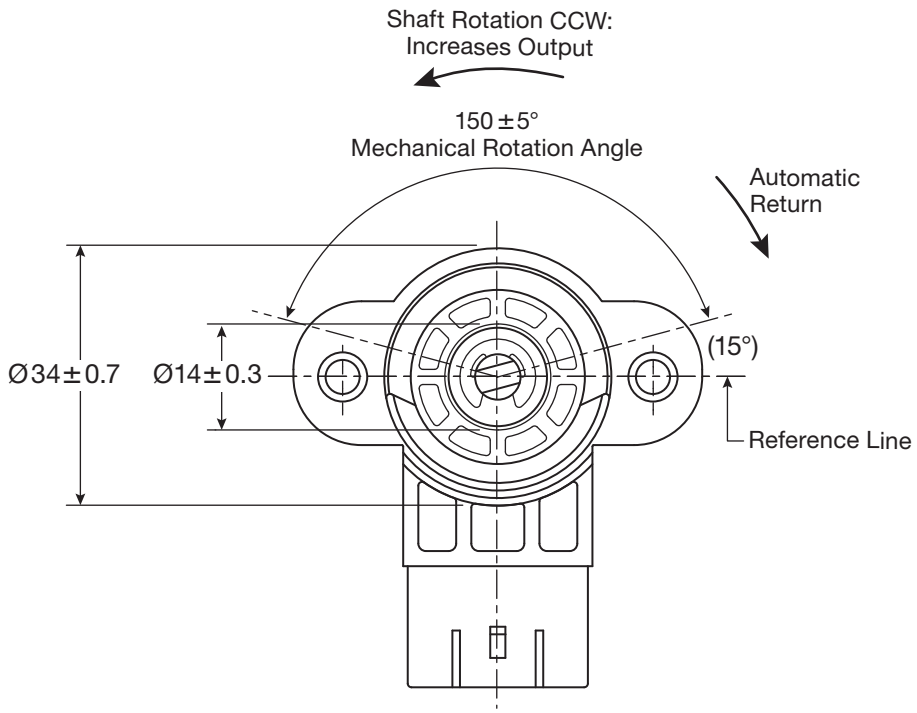
Dimensional Drawing of Front View A with Integral Connector

Unit: mm

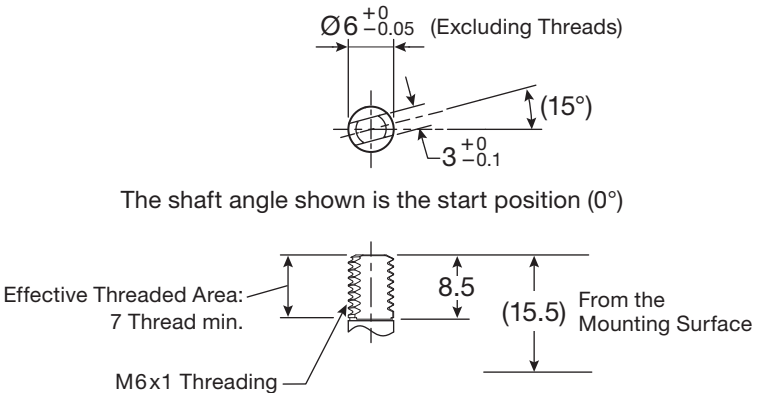


Front View A

Shaft Specifications

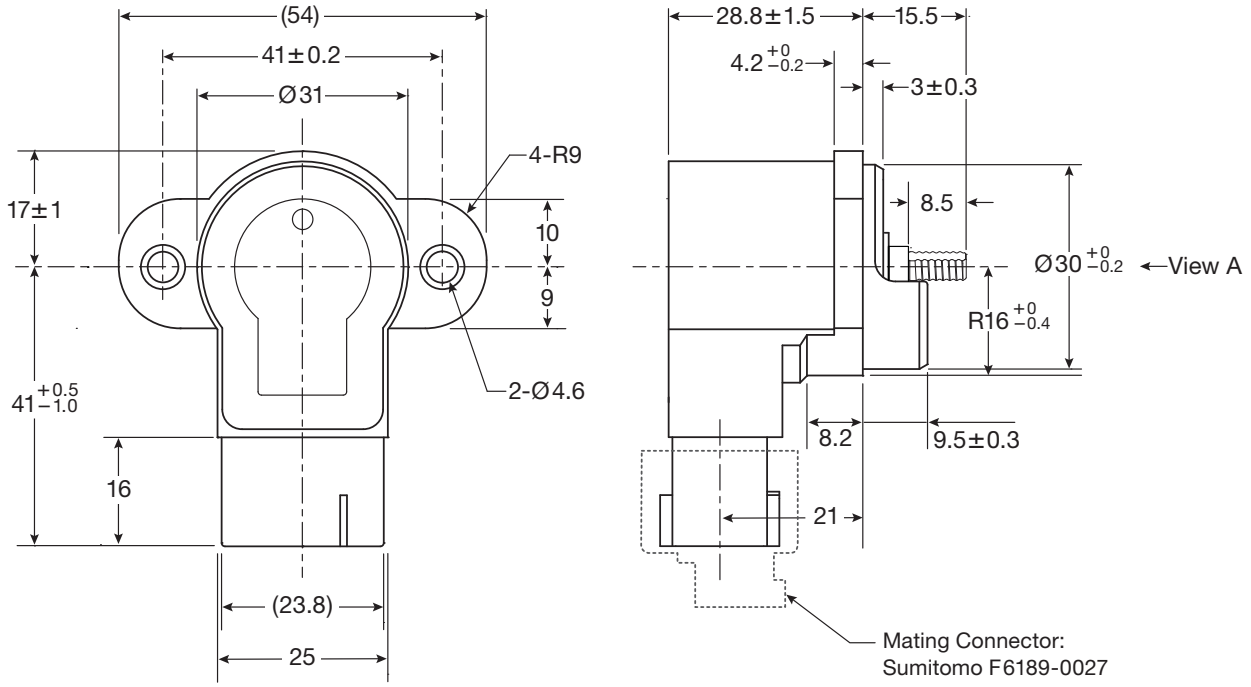
Figure 2: **Detail of Shaft Shape and Threading**

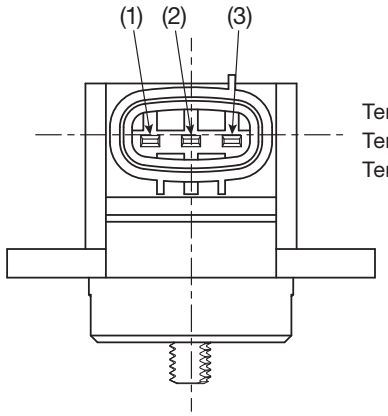
Unit: mm



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)

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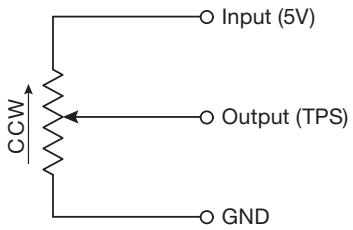
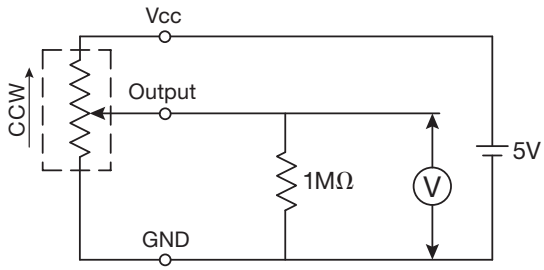
Figure 3: **Circuit Configuration**



Electrical Schematic

Figure 4: **Evaluation Circuit**



RPA211 Series

TOCOS SENSORS

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

Input Voltage	5VDC	**Output Guaranteed Range**	101.2° (0.2V to 4.8V)
Power Rating	0.2W at +70°C	**Electrical Rotational Angle**	110° ± 3°
Output Resolution	∞ (infinite)	**Mechanical Rotational Angle**	120° ± 5°
Output Characteristics	See *Figure 5*	**Operating Temperature Range**	−30°C to +120°C
Output Inclination	0.045V/degree	**Mounting Hole Pitch**	41mm

Significant Characteristics

Total Resistance	2kΩ ± 20% before test; ±20% max. resistance change from initial value after test, when measuring between connector pins Vin and GND
Output Linearity	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*)
Insulation Resistance	1,000MΩ min. before test; 1MΩ min. after test; at 500VDC
Insulation Voltage	750VAC, 1 minute min.
Operating Torque	0.0494N•m minimum at 0V position; 0.137N•m maximum at 5V position (see *Figure 4*)
Lead Wire Pull Strength	Set and hold lead wires at target load of 88.2N for 30 sec. without destruction

Specifications Continued

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Endurance Performance

Operating Endurance

*Satisfies basic characteristics after endurance testing.

Operating Temperature (°C)	Tested Rotational Cycles	Tested Operating Angle	Output Voltage Range (V)	Frequency Rate (Hz)	Applied Voltage To Vin Terminal Pin
+120	2.5 million	88°	0.2 to 4.8	4	5V

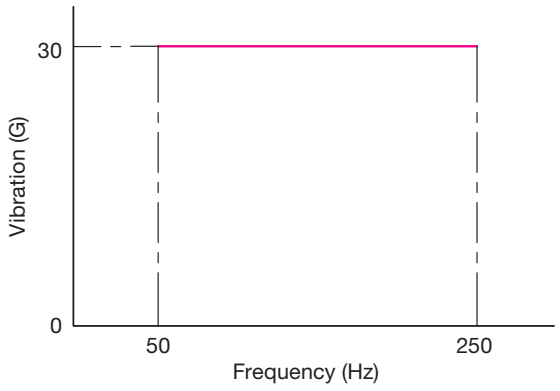
Vibration*	30G, 50-250Hz, X, Y, Z directions, 12 hours (see *Figure 1*)
Temperature Cycle*	−40°C for 1 hour ⇄ +120°C for 1 hour, 20 cycles (see *Figure 2*)
Low Temperature Shelf Life*	−40°C, 96 hours
High Temperature Shelf Life*	+120°C, 96 hours
Humidity*	60°C, 90-95%RH, 500 hours
Salt Water Mist Test*	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.

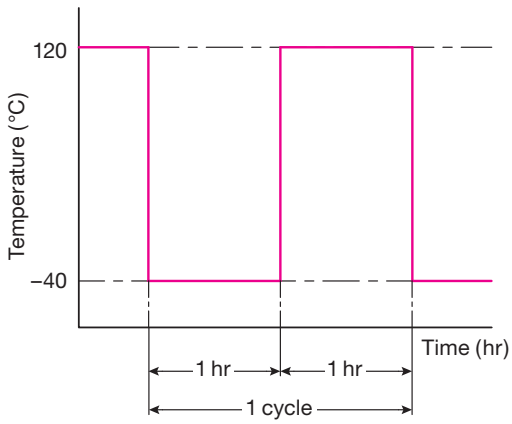
Vibration Test

Figure 1: **Vibration Test Graph**



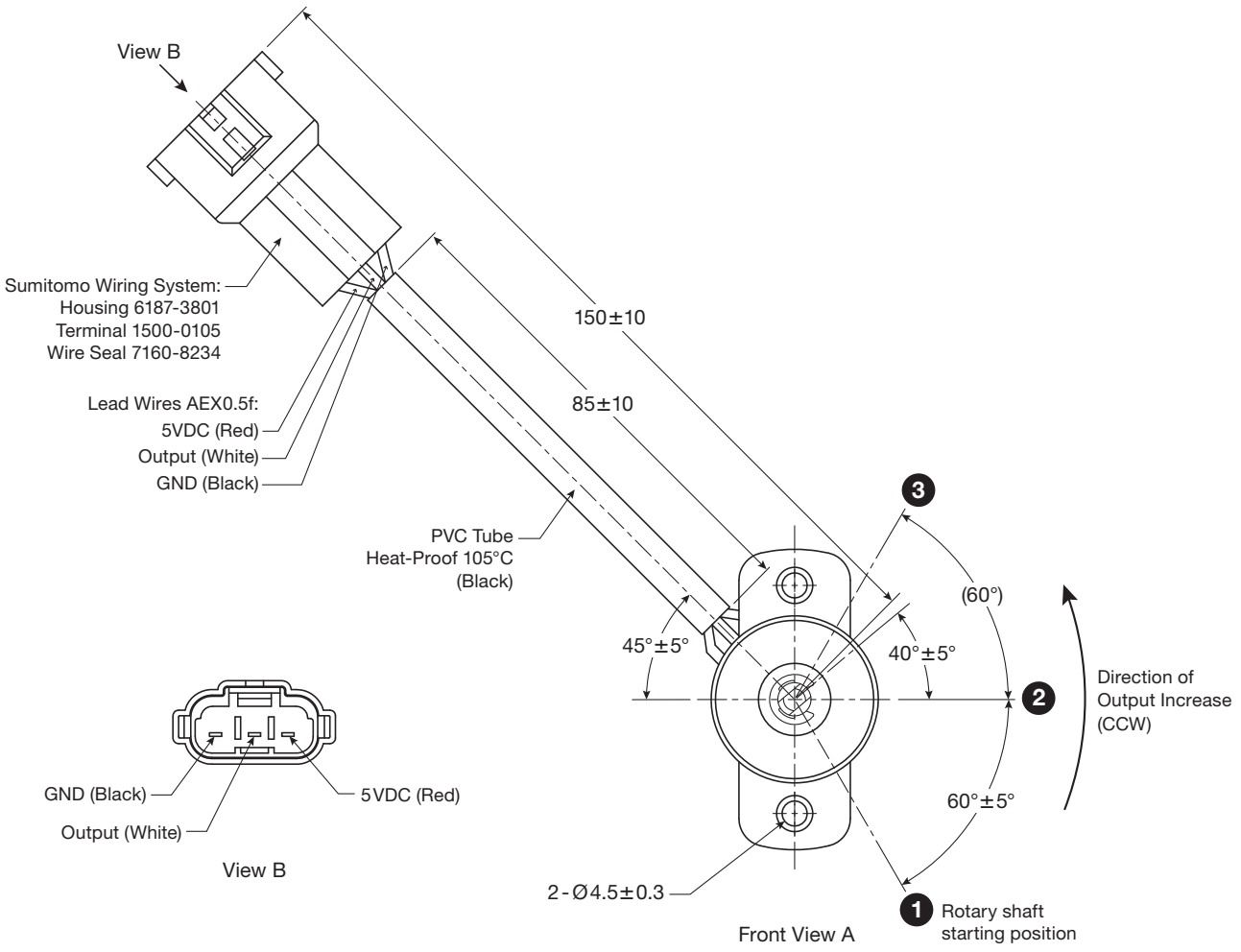
Temperature Test

Figure 2: **Temperature Test Graph**



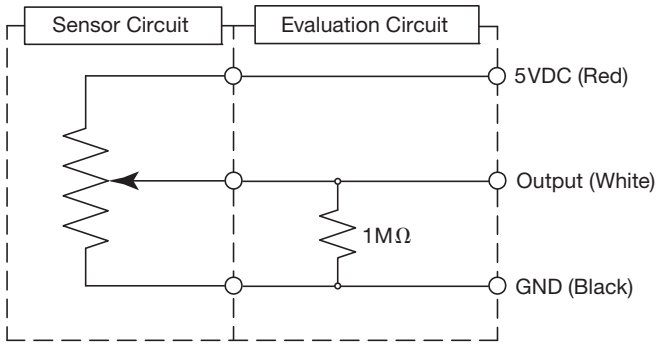
Dimensional Drawings of Front View A with Wire Harness and Connector

Unit: mm



Electrical Schematic

Figure 3: **Measurement-Evaluation Circuit**



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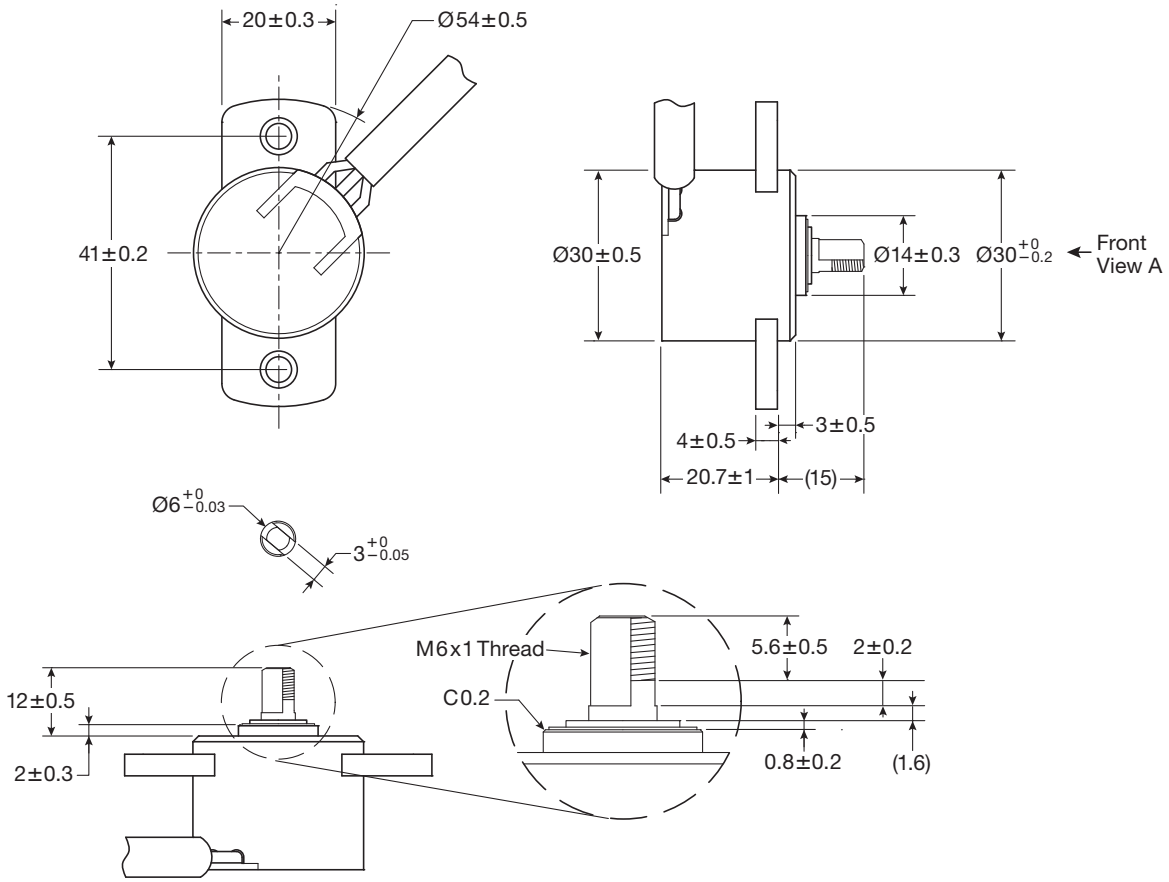
Dimensional Drawings of Back, Side, and Shaft

Unit: mm



Rotational Torque

Figure 4: **Operating Torque**

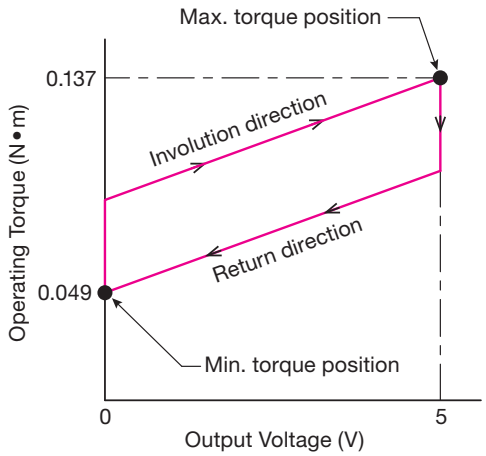
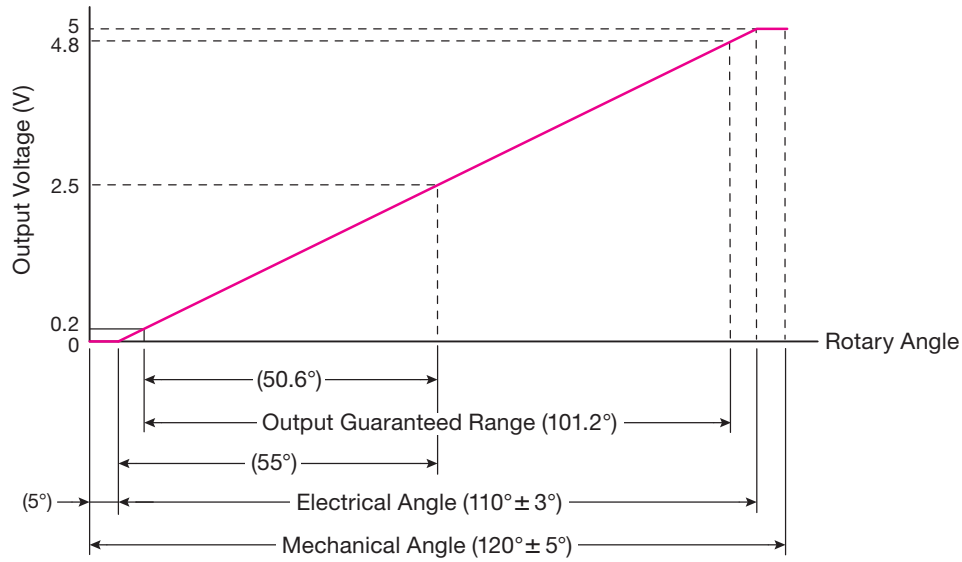


Figure 5: **Output Characteristics**

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.

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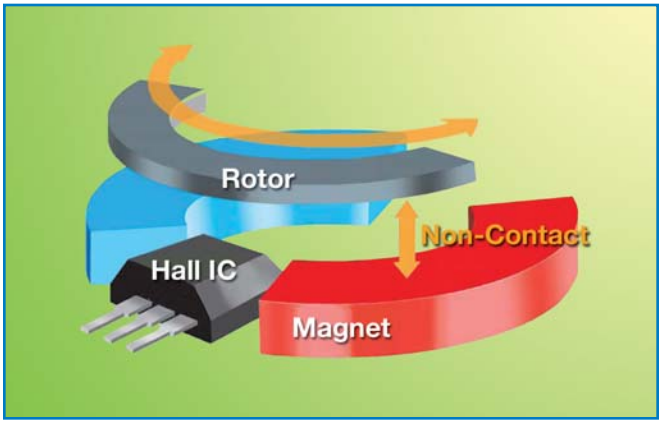
RSM12C Series

TOCOS SENSORS

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

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

Specifications Continued

Specifications Continued

Mechanical Characteristics

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

Environmental Characteristics

*Satisfies electrical specifications after environmental testing.

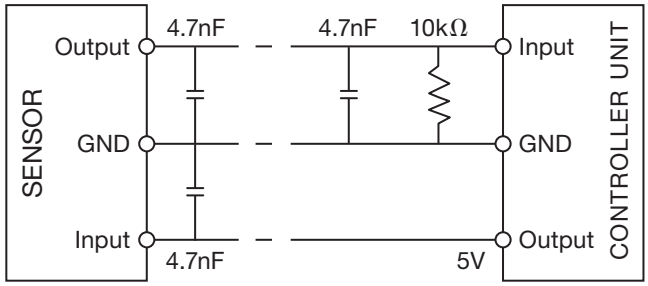
Operating Temperature Range	−40°C to +125°C
Vibration*	10-55Hz (1.5mm amplitude) ⇄ 56-500Hz (196m/s^2), 15 minutes to reciprocate once between frequency ranges, X, Y, Z directions, 2 hours each
Low Temperature Exposure*	−40°C, no load, for 120 hours, (confirm shaft rotation)
Load Life*	+125°C with rated voltage applied (1.5 hours on, 0.5 hours off) for 1,000 hours
Moisture Resistance Load Life*	+40°C, 90-95% RH (no condensation) with rated voltage applied (1.5 hours on, 0.5 hours off) for 1,000 hours
Thermal Shock*	−40°C for 30 minutes ⇄ +125°C for 30 minutes, 100 cycles

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.

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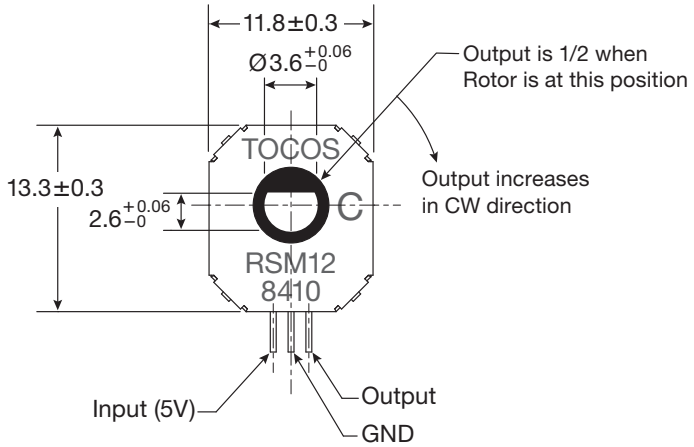
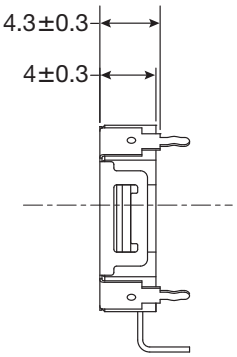
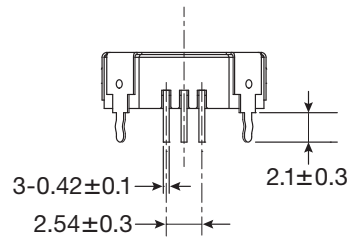
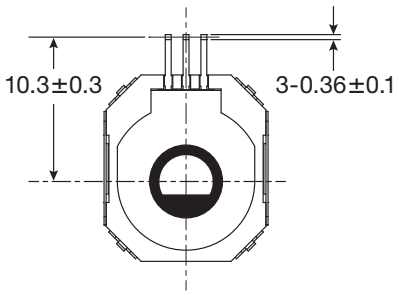
Dimensional Drawings of Top, Side, and Bottom Views

Unit: mm

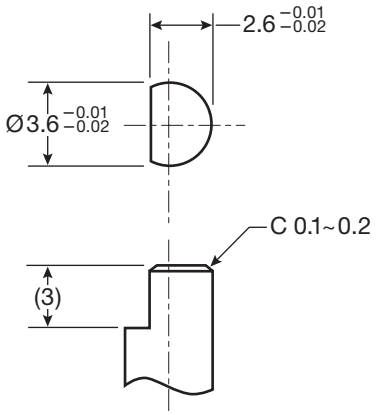








Recommended Shaft Dimensions



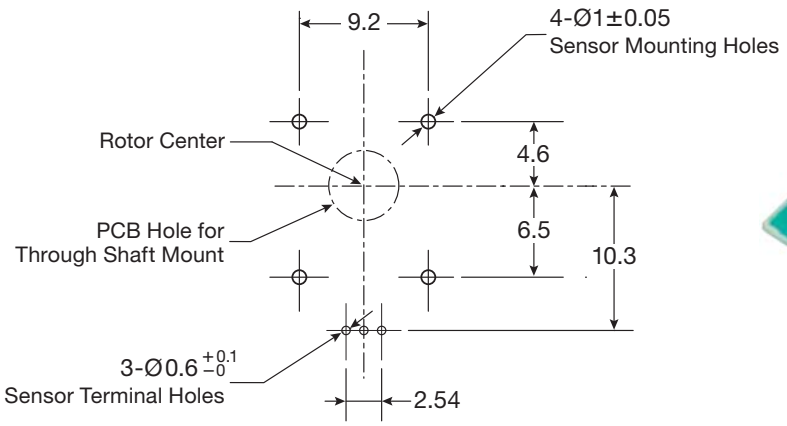
Shaft must be non-magnetic material.

In order to detect the correct angle, it is necessary to properly engage the shaft with the hole of the rotor.

PCB Mounting

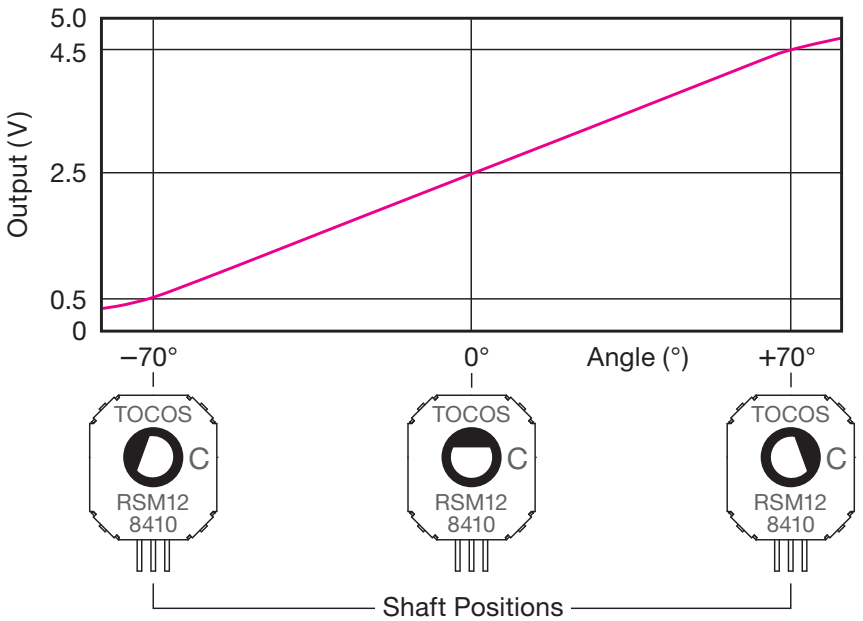
Mounting Hole Dimensions

Unit: mm



Output Voltage at Shaft Positions

Unit: mm



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RSM011 Series

TOCOS SENSORS

Low Profile, Single Output, Non-Contact Angle/Position Sensors

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 devises 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

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

Significant Characteristics

Output Linearity	±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*)
Hysteresis	±0.5° before test; ±0.5° after test; results based on difference of output voltage from hysteresis loop (origin curve and return curve)
Output Noise	±0.2% F.S. before test, ±0.2% F.S. after test
Insulation Resistance	100MΩ min. before test; 10MΩ min. after test; 500VDC, MEGA between each lead and shaft fitting
Operating Torque-Minimum	0.0049N•m min. before test; 0.0010N•m min. after test (see *Figure 3*)
Operating Torque-Maximum	0.0588N•m max. before test; 0.0883N•m max. after test (see *Figure 3*)

Specifications Continued

Endurance Performance

Operating Endurance

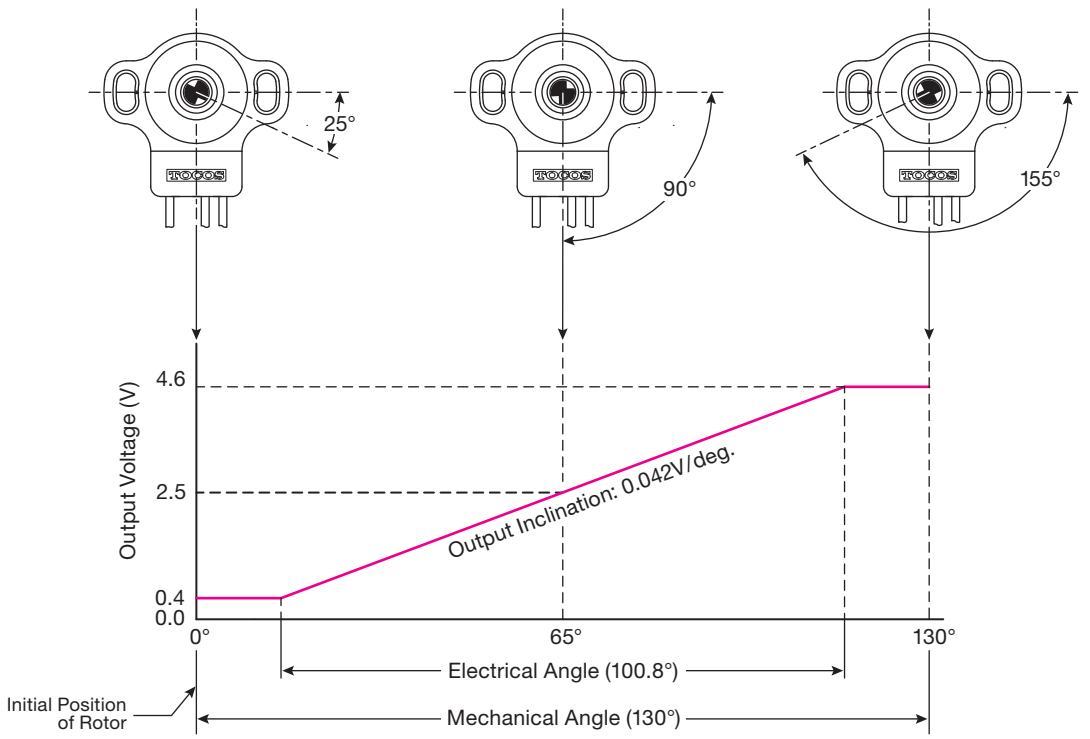
Operating Temperature (°C)	Tested Rotational Cycles	Tested Operating Angle	Output Voltage Range (V)	Frequency Rate (Hz)	Applied Voltage To Vcc Connector Pin
+25	30 million	100.8°	0.4 to 4.6	4	5V
+125	10 million	100.8°	0.4 to 4.6	4	5V
−40	10 million	100.8°	0.4 to 4.6	4	5V
+125	100 million	5°	2.4 to 2.6	30	5V

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**

Unit: mm



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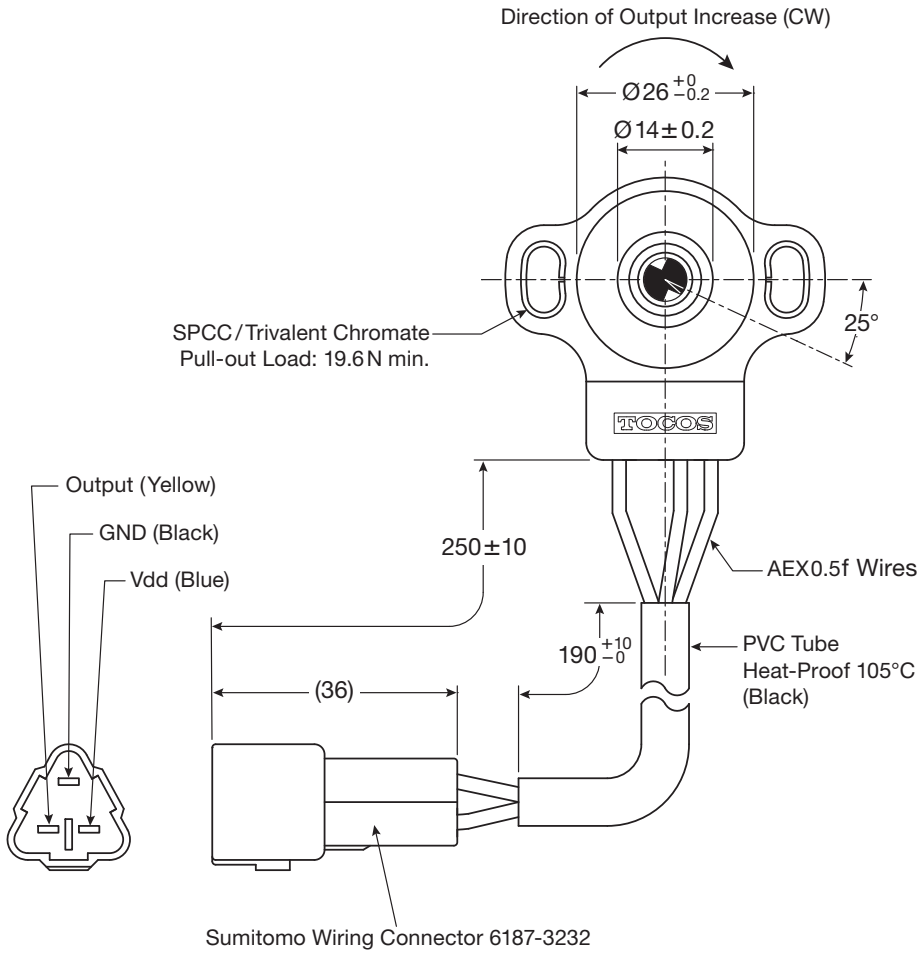
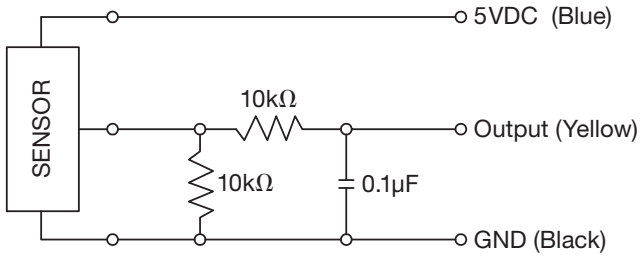
Dimensional Drawings of Front View A with Wire Harness and Connector

Unit: mm



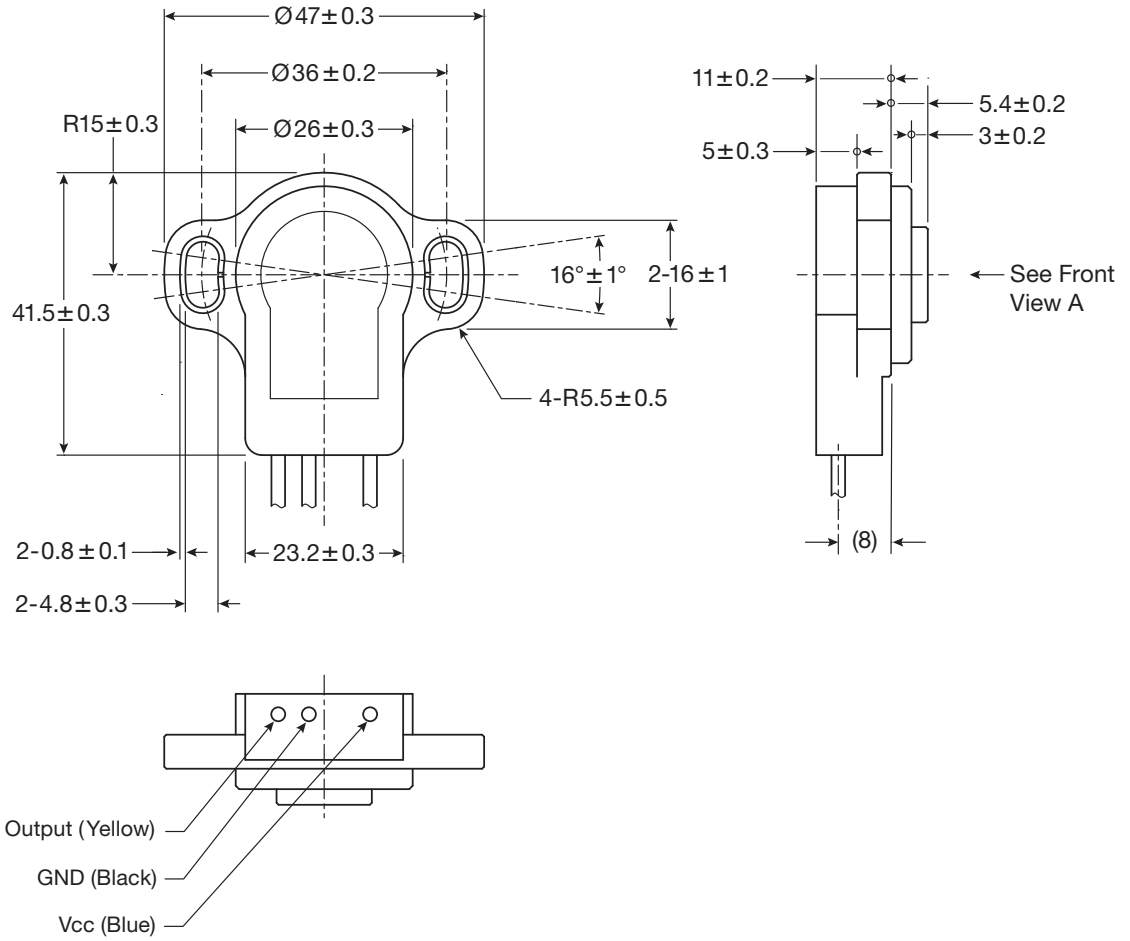
Electrical Schematic

Figure 2: **Measurement Circuit**



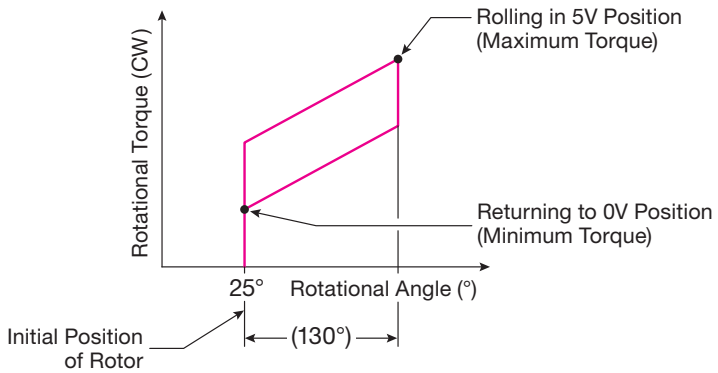
Dimensional Drawings of Back, Side, and Bottom Views

Unit: mm



Rotational Torque

Figure 3: **Operating Torque**



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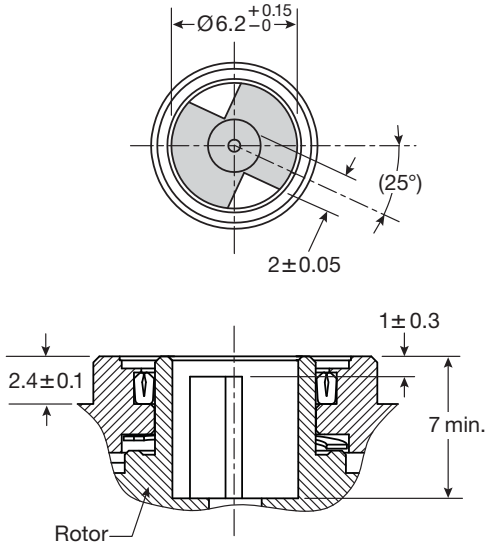
RSM011 Shaft Fitting

Blind Shaft Fitting
Detail from Front View A

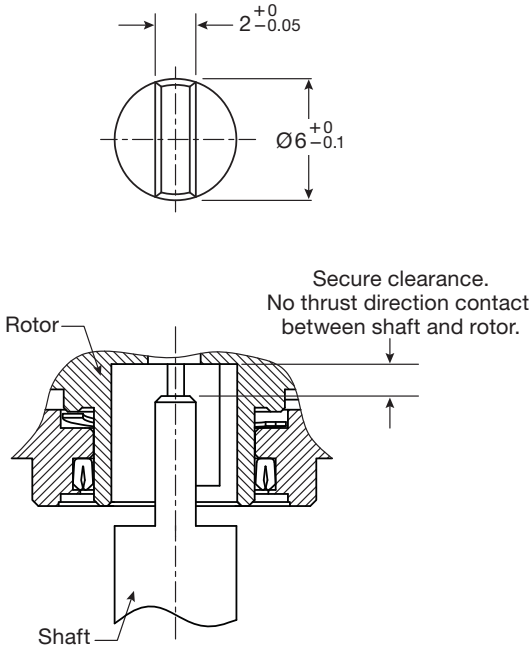
Unit: mm



RSM011 Shaft Style

Recommended Blade Shaped Shaft

Unit: mm



RSM012 Series

TOCOS SENSORS

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

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

Significant Characteristics

Output Linearity	±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*)
Hysteresis	±0.5° before test; ±0.5° after test; results based on difference of output voltage from hysteresis loop (origin curve and return curve)
Relative Deviation	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
Output Noise	±0.2% F.S. before test, ±0.2% F.S. after test
Insulation Resistance	100MΩ min. before test; 10MΩ min. after test; 500VDC, MEGA between each lead and shaft fitting
Operating Torque-Minimum	0.0049N•m min. before test; 0.0010N•m min. after test (see *Figure 3*)
Operating Torque-Maximum	0.0588N•m max. before test; 0.0883N•m max. after test (see *Figure 3*)

Specifications Continued

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Endurance Performance

Operating Endurance

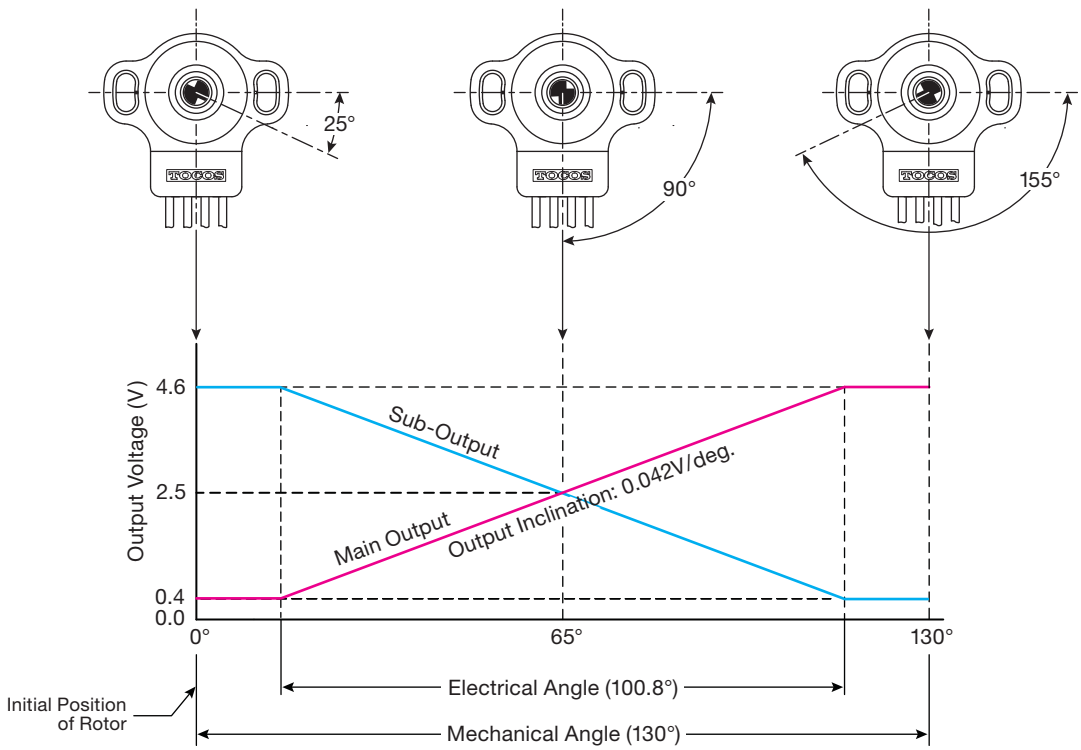
Operating Temperature (°C)	Tested Rotational Cycles	Tested Operating Angle	Output Voltage Range (V)	Frequency Rate (Hz)	Applied Voltage To Vcc Connector Pin
+25	30 million	100.8°	0.4 to 4.6	4	5V
+125	10 million	100.8°	0.4 to 4.6	4	5V
−40	10 million	100.8°	0.4 to 4.6	4	5V
+125	100 million	5°	2.4 to 2.6	30	5V

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

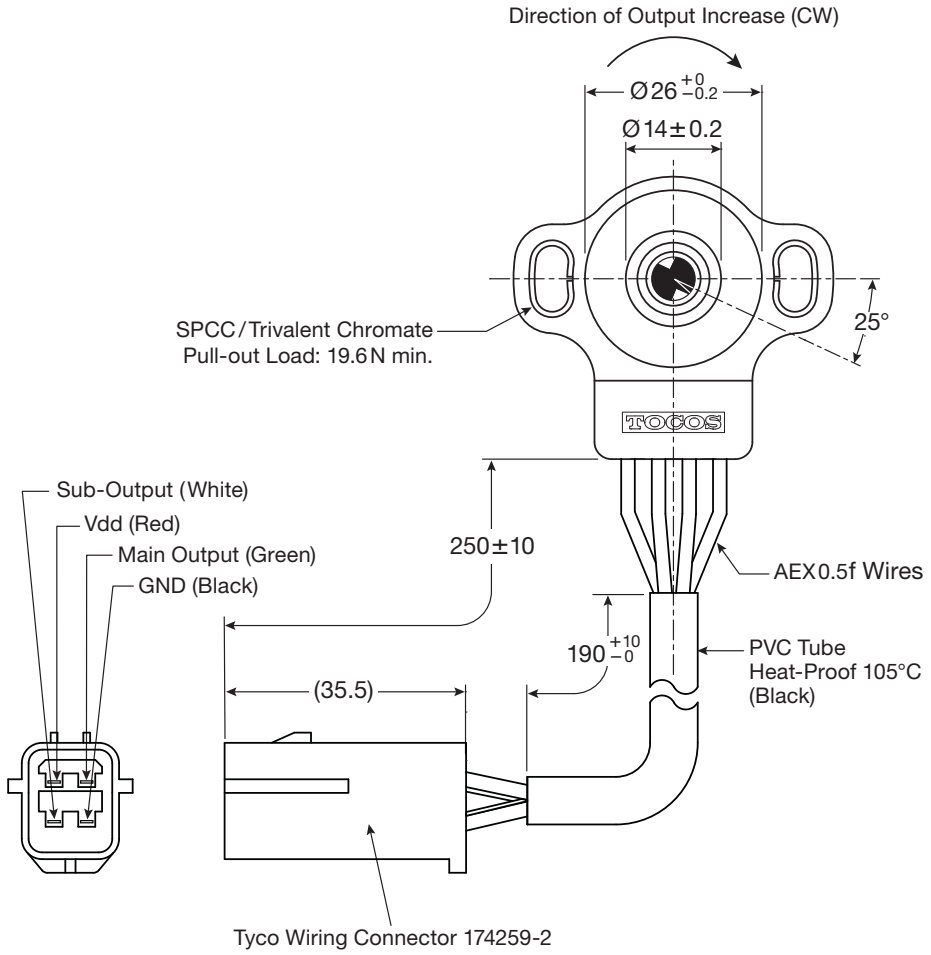
Figure 1: **Output Characteristics**

Unit: mm



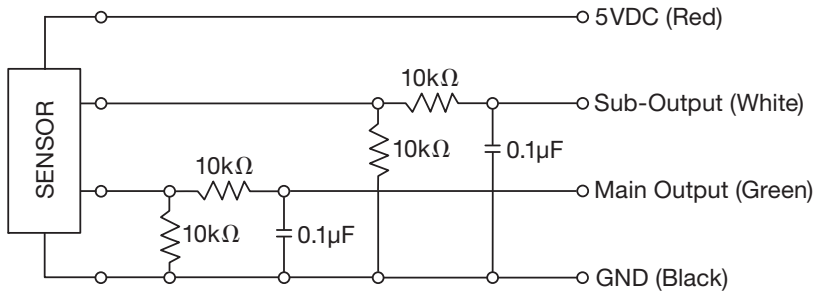
Dimensional Drawings of Front View A with Wire Harness and Connector

Unit: mm



Electrical Schematic

Figure 2: **Measurement Circuit**



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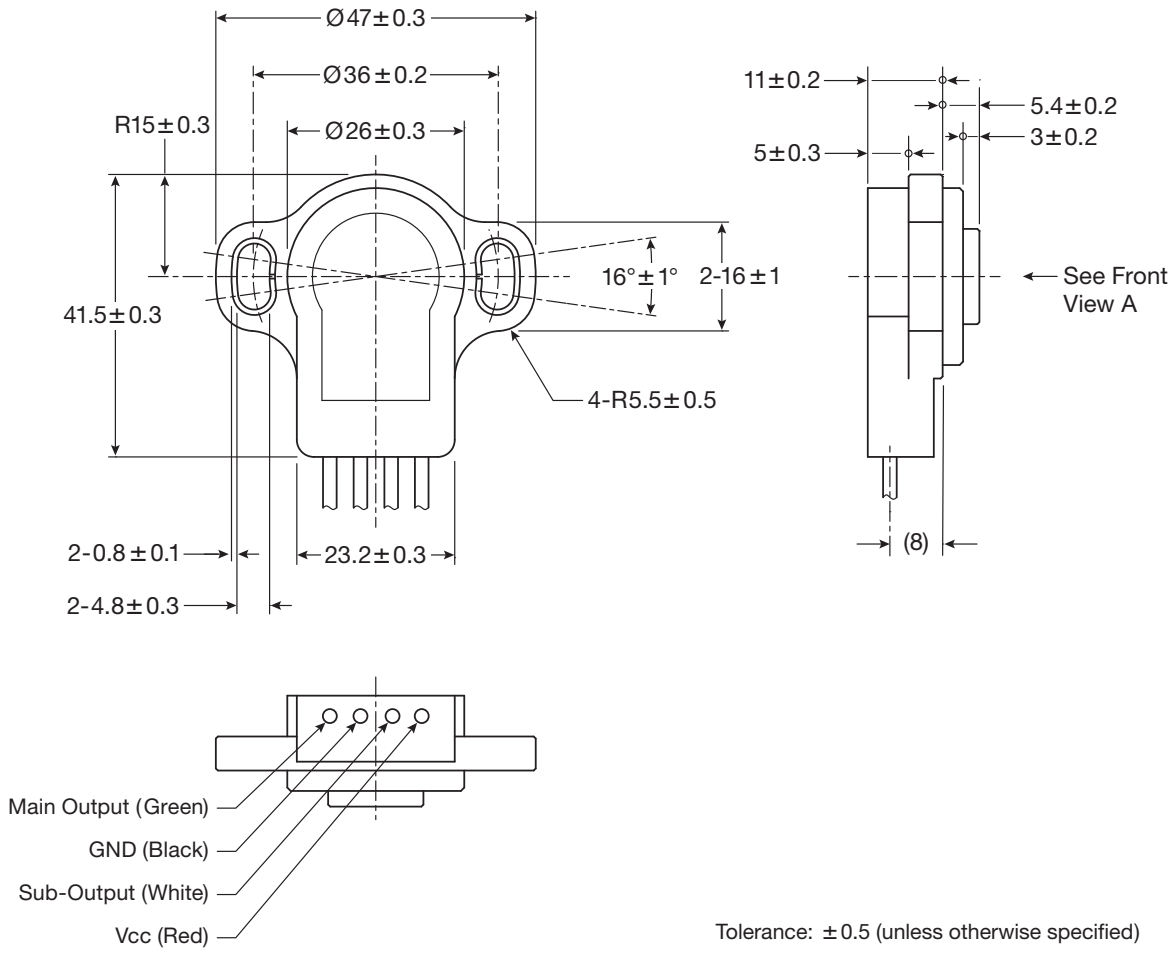
Dimensional Drawings of Back, Side, and Bottom Views

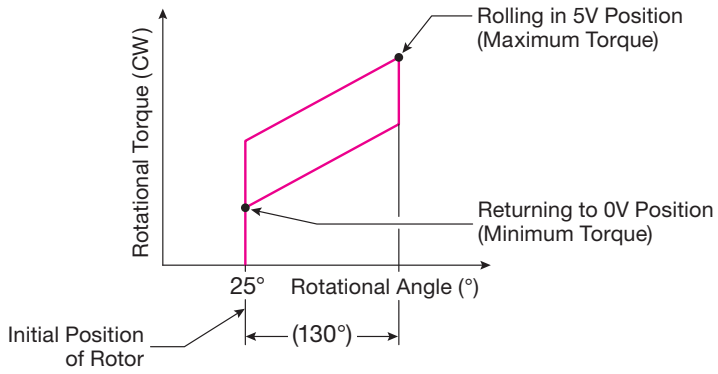
Unit: mm



Tolerance: ±0.5 (unless otherwise specified)

Rotational Torque

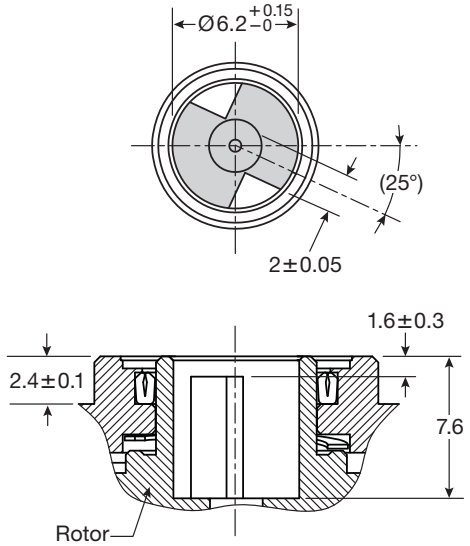
Figure 3: **Operating Torque**



RSM012 Shaft Fitting

Blind Shaft Fitting
Detail from Front View A

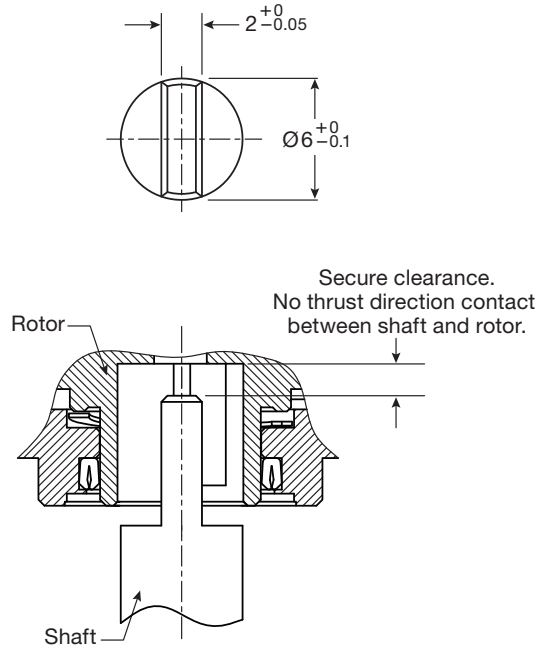
Unit: mm



RSM012 Shaft Style

Recommended Blade Shaped Shaft

Unit: mm



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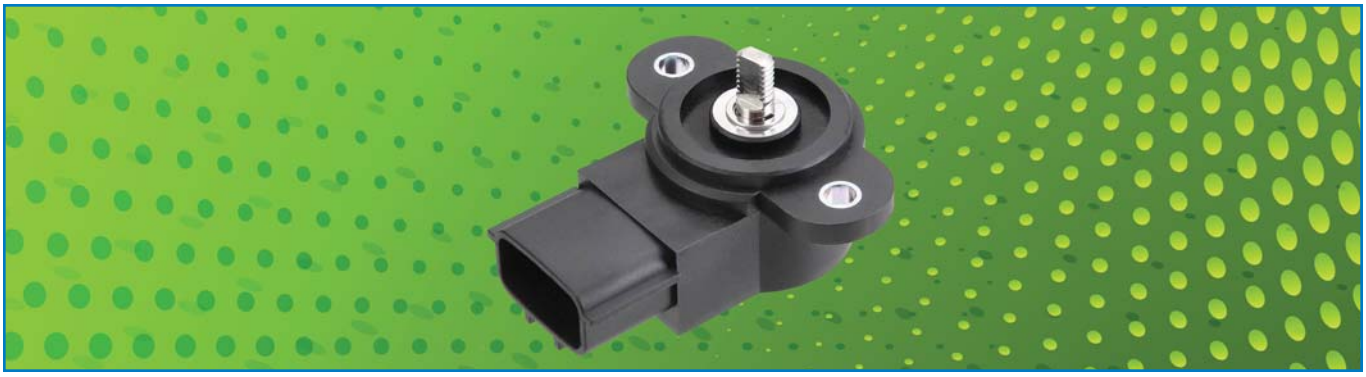
RSM134 Series

TOCOS SENSORS

Single Output, Non-Contact Angle/Position Sensors



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 devises 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

Basic Characteristics

Electrical Angle	50° (Customizable within 20° to 140°)	**Operating Temperature Range**	−30°C to +120°C
Mechanical Angle	150±5°	**Storage Temperature Range**	−40°C to +130°C
Rated Voltage	5±0.5VDC	**Circuit Structure**	See *Figure 1*
Maximum Rated Voltage	12VDC	**Measurement Circuit**	See *Figure 2*
Power Rating	0.07W	**Output Characteristics**	See *Figure 5*
Mounting Hole Pitch	41mm	**Environmental Load Substances**	RoHS compliant

Significant Characteristics

Output Linearity	±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*)
Hysteresis	±1% (±80mV) before test; ±1.5% (±120mV) after test; where output characteristics fall between the guaranteed range of 0.7V to 4.3V
Insulation Resistance	100MΩ min. before test; 100MΩ min. after test; 500VDC, MEGA between each lead and shaft
Operating Torque-Minimum	0.020N•m min. before test; 25% max. change of initial value after test (see (a) in *Figure 4*)
Operating Torque-Maximum	0.094N•m max. before test; 25% max. change of initial value after test (see (b) in *Figure 4*)

Specifications Continued

Endurance Performance

Operating Endurance

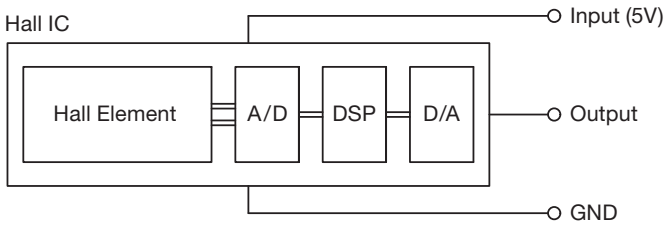
Rotational Life	15 million cycles (guaranteed output voltage range of 0.7V to 4.3V)
Low Temperature Exposure	−40°C, 72 hours
High Temperature Exposure	+130°C, 72 hours
Temperature Cycle	−25°C for 1 hour ⇄ +70°C for 1 hour, 10 cycles
Vibration	JIS D1601 3-B-70
Electromagnetic Susceptibility	200 V/m, 1MHz to 1GHz
Electrostatic Discharge	±8kV contact discharge; ±15kV air discharge; IEC-61000-4-2
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.

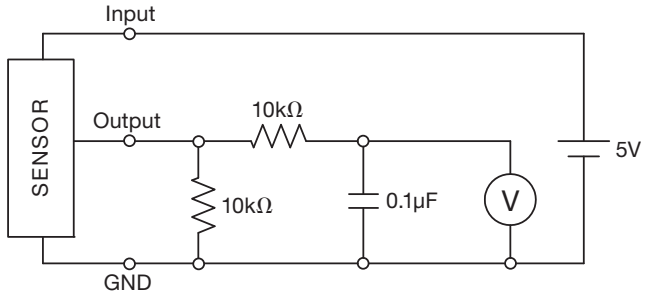
Circuit Structure

Figure 1: **Hall IC Magnetic Circuit**



Electrical Schematic

Figure 2: **Measurement Circuit**



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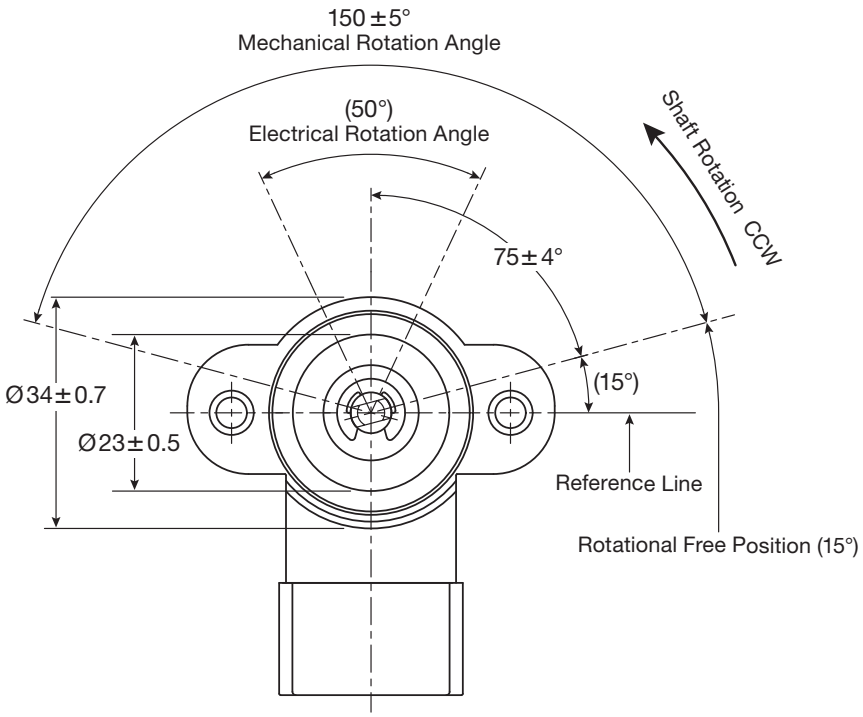
Dimensional Drawing of Front View A

Unit: mm

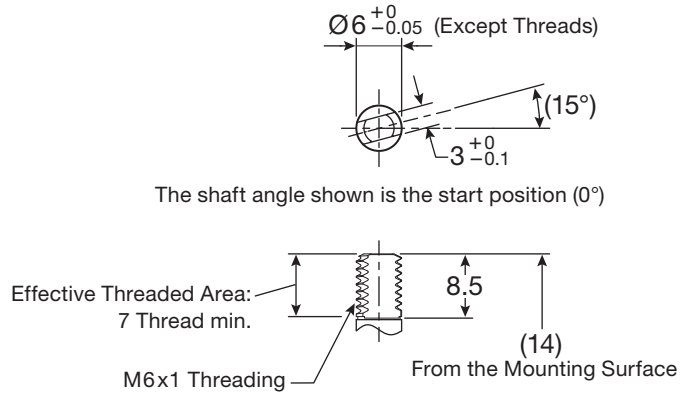


Front View A

Shaft Specifications

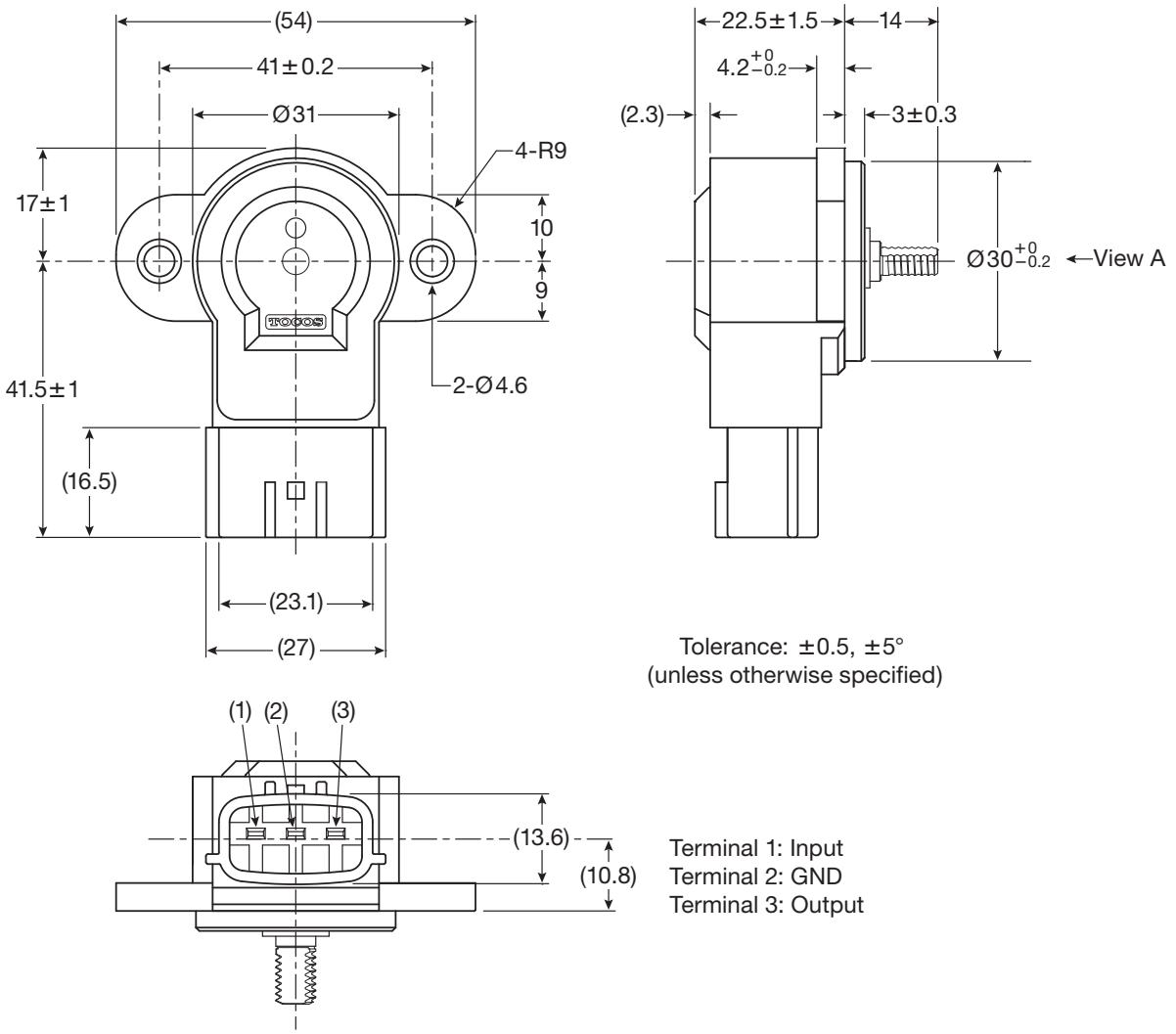
Figure 3: **Detail of Shaft Shape and Threading**

Unit: mm



Dimensional Drawings of Back, Side, and Terminal End Views

Unit: mm



Rotational Torque

Figure 4: **Operating Torque**

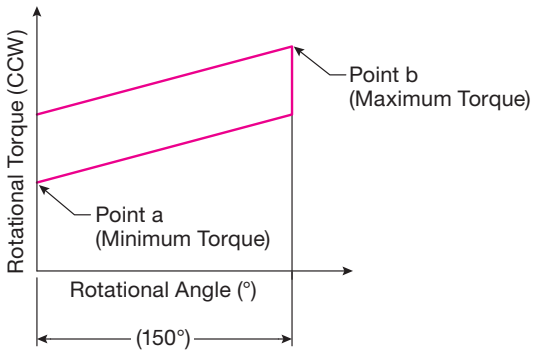


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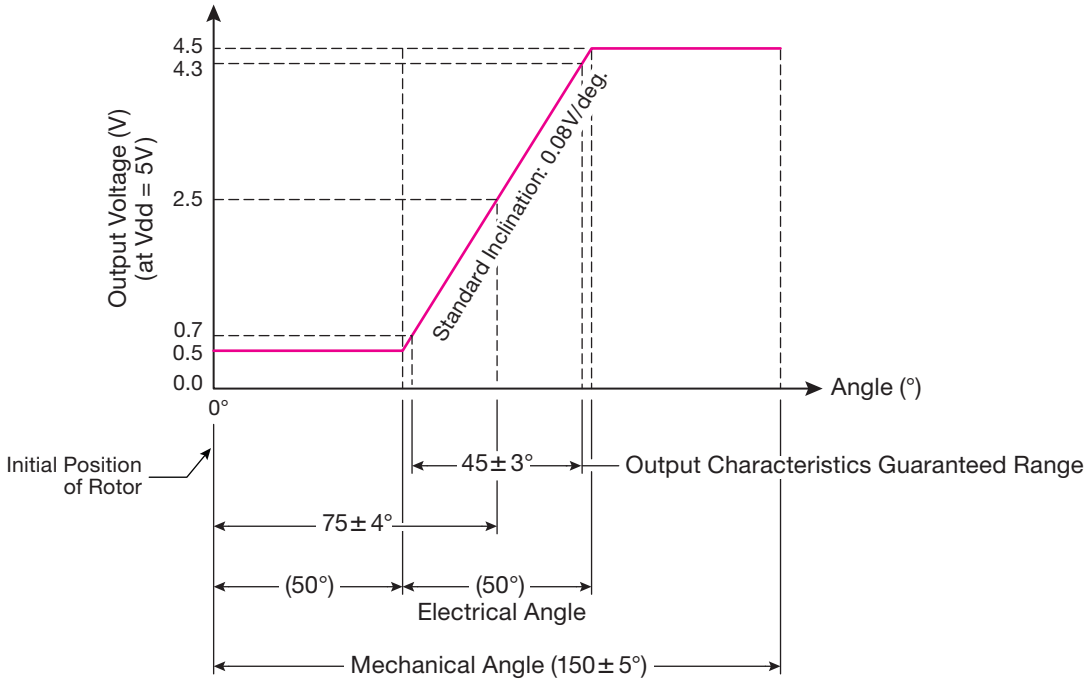
Figure 5: **Output Characteristics (Applied Voltage: 5.0V Constant)**



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

RSM28 Series

TOCOS SENSORS

Panel Mount, Single Output, Non-Contact Angle Sensors

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)

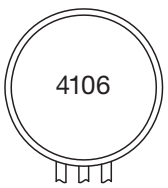
Environmental Characteristics

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 ⇄ +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 . . . . . 100G, 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)



Rear View

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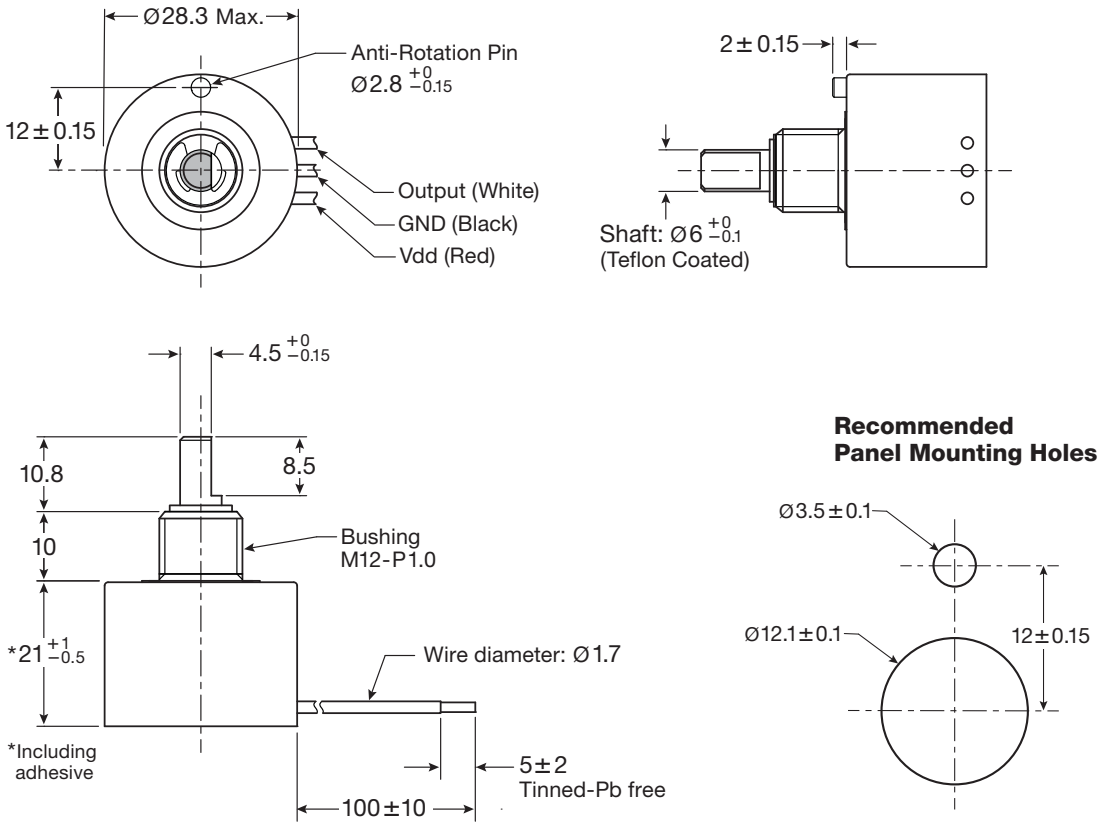
Dimensional Drawings and Tolerances

Unit: mm



Tolerance: ±0.5 (unless otherwise specified)

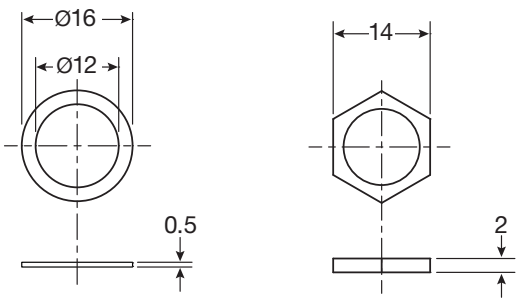
Mounting Hardware

Flat Washer and Hexagonal Nut

Unit: mm

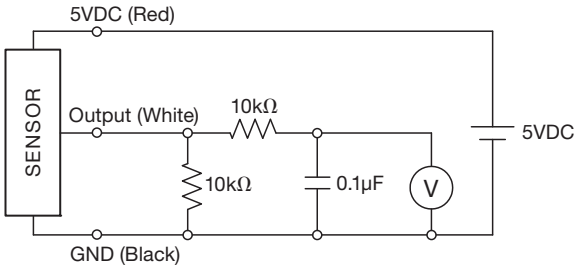
Flat Washer
Material: Cold Rolled Steel,
Ni Plating

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



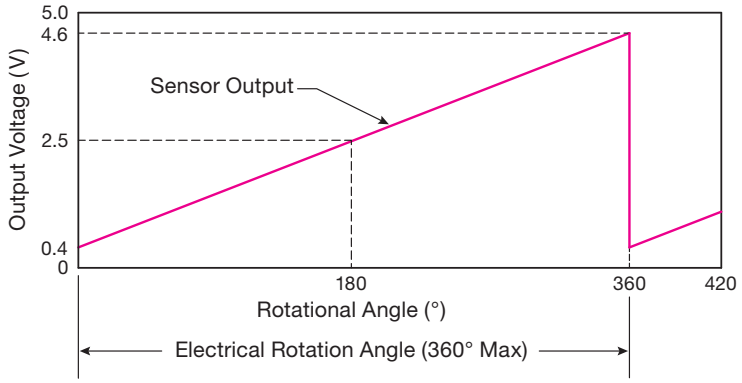
Electrical Schematic

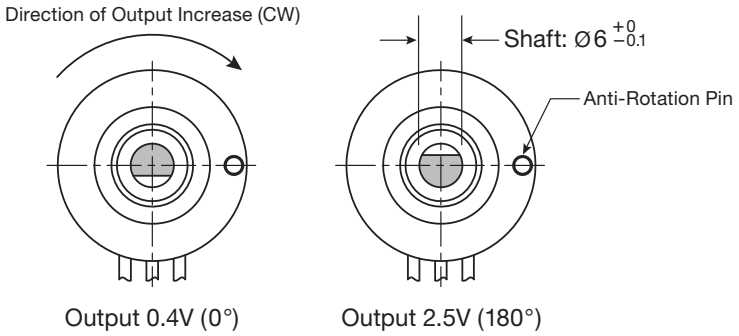
Evaluation Circuit



Output Characteristics

Unit: mm





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