CONTACTLESS ROTARY POSITION SENSORS

Innovation In Motion
Contactless magnetic rotary sensor IC

The NRH/TPS/SRH series use a high performance, factory programmable 12 bit magnetic rotary sensor IC that includes integrated Hall elements and digital signal processing. The angular position information is provided by a magnet integrated with the sensor’s shaft, or supplied separately. The sensor provides a pulse width modulated signal or an absolute analog voltage signal. Most models are designed to operate from either a 5Vdc regulated or 9-30Vdc unregulated supply, with a high stability circuit and EMC immunity to 100V/m.

Features
- Contactless technology
- Measuring range from 20° to 360° in 1° increments
- Single or Dual outputs
- Temperature error less than 50ppm/°C
- Rugged housing and shaft designs
- Protection up to IP69K
- Choice of shaft attachments and mountings
- Rapid despatch of any option
- CE approved

Benefits
- Long life and impervious to dither vibration
- No loss of position on power down
- Maximum sensitivity in all applications
- Optional redundant output for safety critical applications
- Maximises system accuracy over temperature range
- Suitable for extreme environments
- Operation in hostile environments including pressure washing
- Interchangeable with existing installations
- Eliminates customer inventory
- Confidence in EMC performance

The Penny+Giles contactless rotary position sensors have been specially developed to provide maximum performance under extremes of temperature, humidity, vibration, shock and immersion. Using the latest advances in 12bit Hall effect sensing technology, this expanded range of new generation sensors are factory programmed to provide the user with a wide range of previously unavailable options, including single or dual redundant outputs, clockwise or anticlockwise rotation and measurement angles from 0-20° to 0-360° in 1° increments.

This sensor range is ideally suited to operate in extremely hostile applications that are typical in motorsport, off-road specialist vehicles, military vehicles and heavy industrial machinery.

Design Statement

The design of models SRH501P and SRH502P are subject to Community Registered Design No 000961610-0001.

The majority of our designs include an input protector circuit (Patent number GB2418083).
Innovative, rugged designs - superior protection
All models in our range have been designed to offer the best combination of materials and mounting styles that ensure survivability in the most rugged applications. We use sealing systems and cable connections that offer superior protection against the most hostile of operating conditions.

Impressive environmental capability
Designed with 21st century applications in mind most of our models can withstand operating temperatures from -40°C to +140°C (+170°C for 72 hours with our NRH and TPS models) and have been tested to withstand severe shock and vibration. All sensors have protection to at least IP68 rating, with some models offering protection to IP69K. With an EMC immunity of 100V/m, these position sensors are ready for the harshest applications.

Superior performance
This range of sensors has an impressive performance specification and most can operate from a 5Vdc regulated or 9 – 30Vdc supply. Outputs can be PWM or analog voltage (nominal 0.5 - 4.5Vdc) over the measurement range, with clockwise or anticlockwise shaft rotation. A choice of 341 different electrical angles from 20° to 360° are possible. 12 bit resolution (0.025%) is available over the selected measuring range, with a non-linearity better than ±0.4% and temperature stability better than ±50ppm/°C. The sensor’s analog output option has a very low output noise level of less than 1mV rms.

World leading availability
All models have been 'designed for manufacture' which enables assembly in state-of-the-art manufacturing cells. This means that we can supply any of the configurations possible from the options offered, in a matter of days from ordering. This allows OEMs to reduce or eliminate their inventory, and call on Penny+Giles to supply 'on demand'.

Performance assured*
Penny+Giles product development process includes exhaustive qualification testing to ensure that performance specifications published in our product brochures and technical data sheets are backed by real-life test evidence. This is our assurance to you that our designs have been tested at these parameters.

* The qualification and suitability of these products in any customer specific application is the responsibility of the customer, unless otherwise agreed with Penny+Giles.

Selection Guide
Penny+Giles offers the widest choice of options to suit your unique application. We can also offer a custom design service if one of our standard models does not suit your requirements.

NRH280DP
- Dual output
- 6.5mm deep with metal flange
- Separate magnet assembly
- Sealed to IP69K
- Raychem™ DR25 cable

NRH285DR
- Dual input/dual output version of NRH280DP
- 5Vdc operation only

SRH220DR
- Dual input/dual output
- 28 x 38mm body with crush proof flange
- Sealed to IP68
- Integrated connector

SRH280P
- Single output
- 28mm body with crush proof flange
- Three shaft styles
- Sealed to IP68

SRH280DP
- Dual output
- Raychem™ DR25 cable
- 28mm body with crush proof flange
- Three shaft styles
- Sealed to IP68

TPS280DP
- Dual output
- D drive
- Sealed to IP68
- 25mm body with crush proof flange
- Raychem™ DR25 cable+connector

SRH501P
- Single output
- 87.5mm mounting flange
- Marine grade alloy housing
- Sealed to IP69K

SRH502P
- Dual output
- 87.5mm mounting flange
- Marine grade alloy housing
- Sealed to IP69K

SRH880P
- Single output
- 88 mm body
- Aluminium or stainless steel housing
- Sealed to IP68M
### PERFORMANCE

#### ELECTRICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range °</td>
<td>20 to 360 in 1° increments</td>
</tr>
<tr>
<td>Supply voltage Vdc</td>
<td>9 to 30 (unregulated) and 5 ±0.5 (regulated)</td>
</tr>
<tr>
<td>Over voltage protection Vdc</td>
<td>Up to 40 (-40 to +60°C)</td>
</tr>
<tr>
<td>Maximum supply current mA</td>
<td>&lt;25</td>
</tr>
<tr>
<td>Reverse polarity protection</td>
<td>Yes</td>
</tr>
<tr>
<td>Short circuit protection</td>
<td>In 5V regulated mode only</td>
</tr>
<tr>
<td>Output to GND</td>
<td>Yes</td>
</tr>
<tr>
<td>Power-on settlement time S</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Resolution %</td>
<td>0.025 of measurement range (12 bit)</td>
</tr>
<tr>
<td>Non-linearity* %</td>
<td>&lt;±0.4</td>
</tr>
<tr>
<td>Temperature coefficient ppm/°C</td>
<td>&lt;±30 in 5V supply mode; &lt;±90 in 9-30V supply mode</td>
</tr>
</tbody>
</table>

*Non-linearity is measured using the least-squares method on a computerised calibration system*

#### MECHANICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical angle °</td>
<td>360, continuous</td>
</tr>
<tr>
<td>Maximum rotational speed °/sec</td>
<td>3600</td>
</tr>
<tr>
<td>Weight g</td>
<td>&lt;55 (with bolt type magnet carrier)</td>
</tr>
<tr>
<td>Mounting</td>
<td>Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2N m. Bolt (B) or plug (P) type magnet holders are available for the customer to assemble to their own equipment. We also offer a magnet only (M) option for O E M’s to integrate into their design.</td>
</tr>
<tr>
<td>Phasing</td>
<td>When magnet ident mark is facing toward the sensor and cable exit, output is at mid travel. The sensor housing allows for ±10° adjustment via the mounting flange slots.</td>
</tr>
</tbody>
</table>

#### Analog Output (order code A1, A4) - see graph on page 31

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage output range</td>
<td>Absolute voltage, 0.5 to 4.5 (A1) or 0.1 to 4.9 (A4) over measurement range (±3%)</td>
</tr>
<tr>
<td>9-30V supply Vdc</td>
<td>Ratiometric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)</td>
</tr>
<tr>
<td>5V supply Vdc</td>
<td>0.25 (5%) and 4.75 (95%) nominal (A1)</td>
</tr>
<tr>
<td>Monotonic range Vdc</td>
<td>0.05 (1%) and 4.95 (99%) nominal (A4)</td>
</tr>
<tr>
<td>Load resistance Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Output noise mVrms</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Input/output delay mS</td>
<td>&lt;2</td>
</tr>
</tbody>
</table>

#### PWM Output (order code Pn) - see output characteristics on page 31

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWM frequency Hz</td>
<td>244 (P1); 500 (P2); or 1000 (P3) ±20% over temperature range</td>
</tr>
<tr>
<td>PWM levels 9-30V supply Vdc</td>
<td>0 and 5 nominal (±3%)</td>
</tr>
<tr>
<td>5V supply Vdc</td>
<td>0 and Vs (±1%)</td>
</tr>
<tr>
<td>Duty cycle %</td>
<td>10 to 90 over measurement range</td>
</tr>
<tr>
<td>Monotonic range %</td>
<td>5 and 95 nominal</td>
</tr>
<tr>
<td>Load resistance Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Rise/fall time µS</td>
<td>&lt;15</td>
</tr>
</tbody>
</table>
**ENVIRONMENTAL**

**Protection class**  
IP68 (to 2m depth for 2 hours) and IP69K

**Life**  
This product has no contacting parts.

**Dither life**  
Contactless - no degradation due to shaft dither

**Operational temperature** °C  
-40 to +140 (5V supply) and +170°C for 72 hours
-40 to +135.2 (9V supply option) Derate upper temperature limit by 1.7°C for every 1V increase in supply: e.g. -40 to +100 @30V

**Storage temperature** °C  
-55 to +140

**Vibration**  
BS EN 60068-2-64:1995 Sec 8.4 (31.4gn rms) 20 to 2000Hz Random

**Shock**  
3m drop onto concrete and 2500g

**EMC Immunity level**  
BS EN 61000-4-3:1999, to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

† See Maximum Operating Temperature - derating graph on page 30.  
If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating

**OPTIONS**

**Measurement range (angle)**  
Select from 20° to 360° in 1° increments (factory programmed) for each output channel

**Output**  
Analog voltage (An) or PWM (Pn)

**Output direction**  
Both clockwise, both anticlockwise or one CW, one ACW

**Magnet holder**  
Bolt (B) or plug (P) types, or magnet only (M)

**Cable length** m  
0.5

**OEM options**  
Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages; different output phasing CH1/CH2; faster input/output delay; extended analog range; and output mapping for potentiometer replacements.

**AVAILABILITY**

All standard configurations can be supplied rapidly from the factory - check with your local supplier for more details

**ORDERING CODES**

NRH280DP/...../...../...../...../...../.....

Measurement range CH1 = angle in °
Measurement range CH2 = angle in °

Output  
A1 = Analog 0.5-4.5Vdc
A4 = Analog 0.1-4.9Vdc
P1 = PWM, 244Hz
P2 = PWM, 500Hz
P3 = PWM, 1000Hz

Direction  
3 = Both clockwise
4 = Both anticlockwise
5 = CH1 CW; CH2 ACW

Magnet holder  
B = Bolt type
P = Plug type
M = Magnet only

Cable length  
P5 = 0.5m
**ELECTRICAL CONNECTIONS**

500mm of 4-core cable: FDR-25 sheathed, with 55A spec (24AWG) cores

- **Cable colour** | **Description**
  - Red           | + V Supply
  - Yellow        | Output 1
  - White         | Output 2
  - Black         | 0V Supply (GND)

Output increases with CW or ACW rotation viewed on sensor face - depending on selected order code

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with reverse polarity protection and short circuit protection between outputs (Yellow & White) to GND (Black), but if the outputs (Yellow & White) are connected to the supply this will result in device failure.
**PERFORMANCE**

**ELECTRICAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range °</td>
<td>20 to 360 in 1° increments</td>
</tr>
<tr>
<td>Supply voltage Vdc</td>
<td>5 ± 0.5 (regulated) to each independent sensor channel</td>
</tr>
<tr>
<td>Over voltage protection Vdc</td>
<td>Up to 10 (-40 to +60°C)</td>
</tr>
<tr>
<td>Maximum supply current mA</td>
<td>&lt;12.5 each independent supply (&lt;25 total)</td>
</tr>
<tr>
<td>Reverse polarity protection</td>
<td>Yes</td>
</tr>
<tr>
<td>Short circuit protection</td>
<td></td>
</tr>
<tr>
<td>Output to GND</td>
<td>Yes</td>
</tr>
<tr>
<td>Output to supply</td>
<td>Yes</td>
</tr>
<tr>
<td>Power-on settlement time S</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Resolution %</td>
<td>0.025 of measurement range (12 bit)</td>
</tr>
<tr>
<td>Non-linearity* %</td>
<td>&lt;± 0.4</td>
</tr>
<tr>
<td>Temperature coefficient ppm/°C</td>
<td>&lt;±30</td>
</tr>
</tbody>
</table>

* Non-linearity is measured using the Least-Squares method on a computerised calibration system.

**Analog Output (order code A1, A4) - see graph on page 31**

<table>
<thead>
<tr>
<th>Voltage output range Vdc</th>
<th>Ratiometric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monotonic range Vdc</td>
<td>0.25 (5%) and 4.75 (95%) nominal (A1)</td>
</tr>
<tr>
<td>Load resistance Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Output noise mVrms</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Input/output delay μS</td>
<td>&lt;2</td>
</tr>
</tbody>
</table>

**PWM Output (order code Pn) - see output characteristics on page 31**

| PWM frequency Hz                  | 244 (P1); 500 (P2); or 1000 (P3) ±20% over temperature range                                       |
| PWM levels 5V supply Vdc         | 0 and Vs (±1%)                                                                                    |
| Duty cycle %                      | 10 to 90 over measurement range                                                                  |
| Monotonic range %                 | 5 and 95 nominal                                                                                  |
| Load resistance Ω                 | 10k minimum (resistive to GND)                                                                    |
| Rise/fall time μS                 | <15                                                                                              |

**MECHANICAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical angle °</td>
<td>360, continuous</td>
</tr>
<tr>
<td>Maximum rotational speed °/sec</td>
<td>3600</td>
</tr>
<tr>
<td>Weight g</td>
<td>&lt;55 (with bolt type magnet carrier)</td>
</tr>
<tr>
<td>Mounting</td>
<td>Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2Nm. Bolt (B) or plug (P) type magnet holders are available for the customer to assemble to their own equipment. We also offer a magnet only (M) option for OEM’s to integrate into their design.</td>
</tr>
<tr>
<td>Phasing</td>
<td>When magnet ident mark is facing toward the sensor and cable exit, output is at mid travel. The sensor housing allows for ±10° adjustment via the mounting flange slots.</td>
</tr>
</tbody>
</table>
Measurement range CH1 = angle in °
Measurement range CH2 = angle in °
Output A1 = Analog 0.5-4.5Vdc
A4 = Analog 0.1-4.9Vdc
P1 = PWM, 244 Hz
P2 = PWM, 500 Hz
P3 = PWM, 1000 Hz
Direction 3 = Both clockwise
4 = Both anticlockwise
5 = CH1 CW; CH2 ACW
Magnet holder B = Bolt type
P = Plug type
M = Magnet only
Cable length P5 = 0.5m

ENVIRONMENTAL
Protection class
Life
Dither life
Operational temperature °C
Storage temperature °C
Vibration
Shock
EMC Immunity level

IP68 (to 2m depth for 2 hours) and IP69K
This product has no contacting parts.
Contactless - no degradation due to shaft dither
-40 to +140 and +170°C for 72 hours
-55 to +140
BS EN 60068-2-64:1995 Sec 8.4 (31.4gn rms) 20 to 2000Hz Random
3m drop onto concrete and 2500g
BS EN 61000-4-3:1999, to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

*If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating

OPTIONS
Measurement range (angle)
Output
Output direction
Magnet holder
Cable length m
OEM options

Select from 20° to 360° in 1° increments (factory programmed) for each output channel
Analog voltage (An) or PWM (Pn)
Both clockwise, both anticlockwise or one CW, one ACW
Bolt (B) or plug (P) types, or magnet only (M)
0.5
Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages;
different output phasing CH1/CH2; faster input/output delay; extended analog range; and
output mapping for potentiometer replacements.

AVAILABILITY

All standard configurations can be supplied rapidly from the factory – check with your local supplier for more details

ORDERING CODES

NRH285DR/ ...../ ...../ ...../ ...../ ...../ .....
**ELECTRICAL CONNECTIONS**

2 x 500mm of 3-core cable: FDR-25 sheathed, with 55A spec (24AWG) cores

- **Cable colour**
  - Red: +V Supply
  - Yellow: O utput 1+2
  - Black: 0V Supply (GND)

Output increases with CW or ACW rotation viewed on sensor face - depending on selected order code

Magnet ident facing towards cable exit

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with reverse polarity protection and short circuit protection between outputs (Yellow) to GND (Black) and outputs to supply (Red) on NRH 285DR model only.

*Magnets are identified on the mounting plate: 1 = CH1, 2 = CH2*
PERFORMANCE

Output options

ELECTRICAL

Measurement range °
Supply voltage Vdc
Over voltage protection Vdc
Maximum supply current mA
Reverse polarity protection

SRH 220 DR DUAL REDUNDANT OUTPUT

contactless rotary sensor

<table>
<thead>
<tr>
<th>A1</th>
<th>A4</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
<th>A2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-4.5 or 0.1-4.9 Vdc</td>
<td>PWM</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 to 360 in 1° increments</td>
<td>20 to 360 in 1° increments</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 to 30 (unregulated) and 5 ± 0.5 (regulated)</td>
<td>13.5 to 30 (unregulated)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Up to 40 (-40 to +60°C)</td>
<td>Up to 40 (-40 to +60°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;12.5 each independent supply (&lt;25 total)</td>
<td>&lt;30 (15 each channel)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Output to GND
Output to supply
Power-on settlement time S
Resolution %
Non-linearity* %
Temperature coefficient ppm/°C

<table>
<thead>
<tr>
<th>Output to GND</th>
<th>Output to supply</th>
<th>Power-on settlement time S</th>
<th>Resolution %</th>
<th>Non-linearity* %</th>
<th>Temperature coefficient ppm/°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>Yes</td>
<td>In 5V regulated mode only</td>
<td>&lt;1</td>
<td>&lt;0.4</td>
<td>&lt;±30 (5V supply mode)</td>
</tr>
<tr>
<td>Yes</td>
<td>Yes</td>
<td></td>
<td>&lt;1</td>
<td>&lt;±0.4</td>
<td>&lt;±125</td>
</tr>
</tbody>
</table>

PWM Output (order code Pn) - see output characteristics on page 31

PWM frequency Hz
PWM levels 9-30 V supply Vdc
PWM levels 5 V supply Vdc
Duty cycle %
Monotonic range %
Load resistance Ω
Rise/fall time μS

<table>
<thead>
<tr>
<th>PWM frequency Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>244 (P1); 500 (P2); or 1000 (P3) ±20% over temperature range</td>
</tr>
</tbody>
</table>

*Non-linearity is measured using the least-squares method on a computerised calibration system.
MECHANICAL

**Mechanical angle**
360, continuous

**Operating torque**
g-cm
120

**Maximum rotational speed**
°/sec
3600

**Weight**
g
<51

**Mounting**
Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2Nm

**Phasing**
When shaft drive detail is aligned as shown in Electrical Angle Diagram (page 12) output is at mid travel. The sensor housing allows for ±10° adjustment via the mounting flange slots.

ENVIRONMENTAL

**Protection class**
IP68 - with AMP connector option (when recommended mating part is fully connected)
IP67 - with Deutsch connector option (when recommended mating part is fully connected)

**Life**
20 million operations (10 x 10⁶ cycles) of ±75°; sensing element life is essentially infinite (contactless)

**Dither life**
Contactless - no degradation due to shaft dither

**Operational temperature**

<table>
<thead>
<tr>
<th>Output</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1, A4, P1-3</td>
<td>-40 to +140 (5V supply)</td>
</tr>
<tr>
<td></td>
<td>-40 to +135.7 (9V supply) Derate upper temperature limit by 1.7°C for every 1V increase in supply: e.g. -40 to +100 @30V</td>
</tr>
<tr>
<td>A2</td>
<td>-40 to +115 (13.5V supply) Derate upper temperature limit by 0.91°C for every 1V increase in supply: e.g. -40 to +100 @30V</td>
</tr>
</tbody>
</table>

**Storage temperature**
-55 to +140

**Vibration**
BS EN 60068-2-64:1995 Sec 8.4 (31.4gn rms) 20 to 2000Hz Random

**Shock**
3m drop onto concrete and 2500g

**EMC Immunity level**
BS EN 61000-4-3:1999, to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

1 See Maximum Operating Temperature - Derating graph on page 30. If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating

OPTIONS

**Measurement range (angle)**
Select from 20° to 360° in 1° increments (factory programmed) for each output channel

**Output**
Analog voltage (An) or PWM (Pn)

**Output direction**
Both clockwise, both anticlockwise or one CW, one ACW

**Shaft style**
D section shaft

**Connector**
AMP Superseal 1.5 (A) or Deutsch DT04-6P 6-way integrated connectors

**Operating lever**
An operating lever kit can be supplied separately. See details on page 12

**OEM options**
Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages; different output phasing CH1/CH2; faster input/output delay; extended analog range; and output mapping for potentiometer replacements. We can also supply mating connectors, subject to minimum quantities

AVAILABILITY

All standard configurations can be supplied rapidly from the factory – check with your local supplier for more details

ORDERING CODES

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>CH1 = angle in °</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>CH2 = angle in °</td>
</tr>
<tr>
<td>Output</td>
<td>A1 = Analog 0.5-4.5Vdc</td>
</tr>
<tr>
<td></td>
<td>A2 = Analog 0-10Vdc</td>
</tr>
<tr>
<td></td>
<td>A4 = Analog 0.1-4.9Vdc</td>
</tr>
<tr>
<td></td>
<td>P1 = PWM, 244 Hz</td>
</tr>
<tr>
<td></td>
<td>P2 = PWM, 500 Hz</td>
</tr>
<tr>
<td></td>
<td>P3 = PWM, 1000 Hz</td>
</tr>
<tr>
<td>Direction</td>
<td>3 = Both clockwise</td>
</tr>
<tr>
<td></td>
<td>4 = Both anticlockwise</td>
</tr>
<tr>
<td></td>
<td>5 = CH1 CW; CH2 ACW</td>
</tr>
<tr>
<td></td>
<td>6 = CH1 ACW; CH2 CW</td>
</tr>
<tr>
<td>Shaft style</td>
<td>D = D shaft</td>
</tr>
<tr>
<td>Connector</td>
<td>A = AMP 1.5 Superseal</td>
</tr>
<tr>
<td></td>
<td>D = Deutsch DT04-6P</td>
</tr>
</tbody>
</table>

Accessories (order separately)
Drive lever kit - SA208983 (includes lever and dowel pin)

Recommended Mating Connectors (can be supplied for OEM customers)
AMP Superseal 1.5 Plug – Part 282090-1 (plus 6 x receptacle contacts to match your wire size)
Deutsch DT06 Plug – Part DT06-6S (plus 6 x socket contacts to match your wire size)
**ELECTRICAL CONNECTIONS**

**Option A** - AMP Superseal 1.5 connector
**Option D** - Deutsch DT04-6P connector

Mating connectors are not supplied

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with indefinite reverse polarity protection and short circuit protection between output to GND (Black), but if the outputs are connected to the supply this will result in device failure.

Output increases with CW or ACW rotation viewed on shaft - depending on selected order code.

---

**DIMENSIONS**

Note: drawings not to scale

---

**ELECTRICAL ANGLE**

Output increases for ACW unit when viewed as shown

Output increases for CW unit when viewed as shown

---

**LEVER OPTION**

---

**Connector details for option A or D connector**

---

<table>
<thead>
<tr>
<th>Pin No</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CH1 - 0V Supply (GND)</td>
</tr>
<tr>
<td>2</td>
<td>CH1 - +V supply</td>
</tr>
<tr>
<td>3</td>
<td>CH1 - O output</td>
</tr>
<tr>
<td>4</td>
<td>CH2 - 0V Supply (GND)</td>
</tr>
<tr>
<td>5</td>
<td>CH2 - +V Supply</td>
</tr>
<tr>
<td>6</td>
<td>CH2 - O output</td>
</tr>
</tbody>
</table>
SRH 280P SINGLE OUTPUT
contactless rotary sensor

PERFORMANCE

ELECTRICAL

Measurement range ° 20 to 360 in 1° increments
Supply voltage Vdc 9 to 30 (unregulated) and 5 ± 0.5 (regulated)
Over voltage protection Vdc Up to 40 (-40 to +60°C)
Maximum supply current mA <12.5
Reverse polarity protection Yes
Short circuit protection
  Output to GND Yes
  Output to supply In 5V regulated mode only
Power-on settlement time S <1
Resolution % 0.025 of measurement range (12 bit)
Non-linearity* % <±0.4
Temperature coefficient ppm/°C <±50

*Non-linearity is measured using the least-squares method on a computerised calibration system

Analog Output (order code A1, A4) - see graph on page 31

Voltage output range
  9-30V supply Vdc Absolute voltage, 0.5 to 4.5 (A1) or 0.1 to 4.9 (A4) over measurement range (±3%)
  5V supply Vdc Ratiometric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)
Monotonic range Vdc 0.25 (5%) and 4.75 (95%) nominal (A1)
  Vdc 0.5 (1%) and 4.95 (99%) nominal (A4)
Load resistance Ω 10k minimum (resistive to GND)
Output noise mVrms <1
Input/output delay µS <2

PWM Output (order code P) - See output characteristics on page 31

PWM frequency Hz 244 (P1); 500 (P2); or 1000 (P3) ±20% over temperature range
PWM levels 9-30V supply Vdc 0 and 5 nominal (±3%)
  5V supply Vdc 0 and Vs (±1%)
Duty cycle % 10 to 90 over measurement range
Monotonic range % 5 and 95 nominal
Load resistance Ω 10k minimum (resistive to GND)
Rise/fall time µS <15

MECHANICAL

Mechanical angle ° 360, continuous
Operating torque - maximum
  sealed shaft IP68 g-cm 120
  unsealed shaft IP50 g-cm 100
Shaft velocity maximum °/sec 3600
Weight g <35

Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2Nm
When shaft flat (or shaft ident mark) is facing toward the cable exit, output is at mid travel. The sensor housing allows for ±10° adjustment via the mounting flange slots.
## ENVIRONMENTAL

**Protection class**
- IP68 (to 2m depth for 1 hour) or IP50

**Life**
- 20 million operations (10x10⁶ cycles) of ±75°

Sensing element life is essentially infinite (contactless); the SRH280P life figure refers to the operating shaft seal. Mechanical load (axial and radial) on the shaft should also be considered.

**Dither life**
- Contactless - no degradation due to shaft dither

**Operational temperature**† °C
- -40 to +140 (5V supply)
- -40 to +137 (9V supply)
  Derate upper temperature limit by 0.57°C for every 1V increase in supply:
  e.g. -40 to +125 @30V

**Storage temperature** °C
- -55 to +140

**Vibration**
- BS EN 60068-2-64:1995 Sec 8.4 (14gn rms) 20 to 2000Hz Random

**Shock**
- 3m drop onto concrete

**EMC Immunity level**
- BS EN 61000-4-3:1999, to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

† See Maximum Operating Temperature – Derating graph on page 30

If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating.

## OPTIONS

**Measurement range (angle)**
- Select from 20° to 360° in 1° increments (factory programmed)

**Output**
- Analog voltage (An) or PWM (Pn)

**Output direction**
- Clockwise or Anticlockwise shaft rotation with increasing output

**Shaft style**
- D section, sprung shaft (S) or 2.4mm blade shaft (H)

**Shaft sealing**
- IP50 or IP68

**Cable length**
- 0.2, 0.5 or 2.0 m

**Custom housing**
- Synchro mount style with ball race bearings - ask our technical sales team for details

**OEM options**
- Output can be programmed to provide: non linear law; switch output; clamp voltages; faster input/output delay; extended analog range; and output mapping for potentiometer replacements

## AVAILABILITY

All standard configurations can be supplied rapidly from the factory - check with your local supplier for more details

## ORDERING CODES

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>= angle in °</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output</td>
<td>A1 = Analog 0.5-4.5Vdc</td>
</tr>
<tr>
<td></td>
<td>A4 = Analog 0.1-4.9Vdc</td>
</tr>
<tr>
<td></td>
<td>P1 = PWM, 244 Hz</td>
</tr>
<tr>
<td></td>
<td>P2 = PWM, 500 Hz</td>
</tr>
<tr>
<td></td>
<td>P3 = PWM, 1000 Hz</td>
</tr>
<tr>
<td>Direction</td>
<td>1 = Clockwise</td>
</tr>
<tr>
<td></td>
<td>2 = Anticlockwise</td>
</tr>
<tr>
<td>Shaft style</td>
<td>D = D shaft</td>
</tr>
<tr>
<td></td>
<td>S = Sprung shaft</td>
</tr>
<tr>
<td></td>
<td>H = 2.4mm blade shaft</td>
</tr>
<tr>
<td>Shaft sealing</td>
<td>50 = IP50</td>
</tr>
<tr>
<td></td>
<td>68 = IP68</td>
</tr>
<tr>
<td>Cable length</td>
<td>P2 = 0.2m</td>
</tr>
<tr>
<td></td>
<td>P5 = 0.5m</td>
</tr>
<tr>
<td></td>
<td>02 = 2.0m</td>
</tr>
</tbody>
</table>
**DIMENSIONS**

Note: drawings not to scale

**SHAFT OPTIONS**

<table>
<thead>
<tr>
<th>D shaft</th>
<th>S shaft</th>
<th>H shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cable exit</td>
<td>Cable exit</td>
<td>Shaft ident.</td>
</tr>
<tr>
<td>All shafts are ø6.00 5.997</td>
<td>Ears pre-sprung to 3.10/3.15</td>
<td>≥ø6.00</td>
</tr>
<tr>
<td>≥ø6.00</td>
<td>≥ø6.00</td>
<td>≥ø6.00</td>
</tr>
<tr>
<td>4.500 4.450</td>
<td>3.060 3.000</td>
<td>2.465 2.415</td>
</tr>
<tr>
<td>Suggested mating drive for 'S' shaft</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mid point of electrical angle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRICAL CONNECTIONS**

200, 500 or 2000mm of 3-core cable: PUR sheathed, with PTFE insulated 19/0.15 cores

<table>
<thead>
<tr>
<th>Cable colour</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>+V Supply</td>
</tr>
<tr>
<td>Yellow</td>
<td>Output</td>
</tr>
<tr>
<td>Black</td>
<td>0V Supply (GND)</td>
</tr>
</tbody>
</table>

Output increases with CW or ACW rotation viewed on shaft - depending on selected order code.

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with reverse polarity protection and short circuit protection between output (Yellow) to GND (Black), but if the output (Yellow) is connected to the supply it will result in device failure.
PERFORMANCE

ELECTRICAL

Measurement range ° 20 to 360 in 1° increments
Supply voltage Vdc 9 to 30 (unregulated) and 5 ± 0.5 (regulated)
Over voltage protection Vdc Up to 40 (-40 to +60°C)
Maximum supply current mA < 25
Reverse polarity protection Yes
Short circuit protection
  Output to GND Yes
  Output to supply In 5V regulated mode only
Power-on settlement time S < 1
Resolution % 0.025 of measurement range (12 bit)
Non-linearity* % < ±0.4
Temperature coefficient ppm/°C < ±30 in 5V supply mode; < ±90 in 9-30V supply mode

* Non-linearity is measured using the least-squares method on a computerised calibration system

Analog Output (order code A1, A4) - see graph on page 31

Voltage output range
  9-30V supply Vdc Absolute voltage, 0.5 to 4.5 (A1) or 0.1 to 4.9 (A4) over measurement range (±3%)
  5V supply Vdc Ratiometric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)
Monotonic range Vdc 0.25 (5%) and 4.75 (95%) nominal (A1)
  Vdc 0.05 (1%) and 4.95 (99%) nominal (A4)
Load resistance Ω 10k minimum (resistive to GND)
Output noise mVrms < 1
Input/output delay mS < 2

PWM Output (order code Pn) - see output characteristics on page 31

PWM frequency Hz 244 (P1); 500 (P2); or 1000 (P3) ±20% over temperature range
PWM levels 9-30V supply Vdc 0 and 5 nominal (±3%)
  5V supply Vdc 0 and Vs (±1%)
Duty cycle % 10 to 90 over measurement range
Monotonic range % 5 and 95 nominal
Load resistance Ω 10k minimum (resistive to GND)
Rise/fall time µS < 15

MECHANICAL

Mechanical angle ° 360, continuous
Operating torque - maximum
  sealed shaft IP68 g-cm 120
  unsealed shaft IP50 g-cm 100
Shaft velocity maximum °/sec 3600
Weight g < 35
Mounting
Phasing

Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2Nm
When shaft flat (or shaft ident mark) is facing toward the cable exit, output is at mid travel. The sensor housing allows for ±10° adjustment via the mounting flange slots.
**ENVIRONMENTAL**

Protection class
IP68 (to 2m depth for 1 hour) or IP50

Life
20 million operations (10 x 10^6 cycles) of ±75°
Sensing element life is essentially infinite (contactless); the SRH280DP life figure refers to the operating shaft seal. Mechanical load (axial and radial) on the shaft should also be considered.

Dither life
Contactless - no degradation due to shaft dither

Operational temperature† °C
-40 to +140 (5V supply)
-40 to +135.7 (9V supply) Derate upper temperature limit by 1.7°C for every 1V increase in supply:
  e.g. -40 to +100 @30V

Storage temperature °C
-55 to +140

Vibration
BS EN 60068-2-64:1995 Sec 8.4 (31.4gn rms) 20 to 2000Hz Random

Shock
3m drop onto concrete

EMC Immunity level
BS EN 61000-4-3:1999, to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

† See Maximum Operating Temperature - derating graph on page 30.
If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating.

**OPTIONS**

Measurement range (angle)
Select from 20° to 360° in 1° increments (factory programmed) for each output channel

Output
Analog voltage (An) or PWM (Pn)

Output direction
Both clockwise, both anticlockwise or one CW, one ACW

Shaft style
D section, sprung shaft (S) or 2.4mm blade shaft (H)

Shaft sealing
IP50 or IP68

Cable length m
0.2 or 0.5

Custom housing
Synchro mount style with ball race bearings - ask our technical sales team for details

OEM options
Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages; different output phasing CH1/CH2; faster input/output delay; extended analog range; and output mapping for potentiometer replacements

**AVAILABILITY**

All standard configurations can be supplied rapidly from the factory - check with your local supplier for more details

**ORDERING CODES**

<table>
<thead>
<tr>
<th>Measurement range CH1 = angle in °</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range CH2 = angle in °</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Output</th>
<th>A1 = Analog 0.5-4.5Vdc</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A4 = Analog 0.1-4.9Vdc</td>
</tr>
<tr>
<td></td>
<td>P1 = PWM, 244 Hz</td>
</tr>
<tr>
<td></td>
<td>P2 = PWM, 500 Hz</td>
</tr>
<tr>
<td></td>
<td>P3 = PWM, 1000 Hz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Direction</th>
<th>3 = Both clockwise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4 = Both anticlockwise</td>
</tr>
<tr>
<td></td>
<td>5 = CH1 CW; CH2 ACW</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shaft style</th>
<th>D = D shaft</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>S = Sprung shaft</td>
</tr>
<tr>
<td></td>
<td>H = 2.4mm blade shaft</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shaft sealing</th>
<th>50 = IP50</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>68 = IP68</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cable length</th>
<th>P2 = 0.2m</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P5 = 0.5m</td>
</tr>
</tbody>
</table>
**DIMENSIONS**

Note: drawings not to scale.

**SHAFT OPTIONS**

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with reverse polarity protection and short circuit protection between outputs (Yellow & White) to GND (Black), but if the outputs (Yellow & White) are connected to the supply this will result in device failure.

**ELECTRICAL CONNECTIONS**

200 or 500mm of 4-core cable: FDR-25 sheathed, with 55A spec (24AWG) cores.

<table>
<thead>
<tr>
<th>Cable colour</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>+ V Supply</td>
</tr>
<tr>
<td>Yellow</td>
<td>Output 1</td>
</tr>
<tr>
<td>White</td>
<td>Output 2</td>
</tr>
<tr>
<td>Black</td>
<td>0V Supply (GND)</td>
</tr>
</tbody>
</table>

Output increases with CW or ACW rotation viewed on shaft - depending on selected order code.
TPS 280 DP Dual Output
contactless throttle position/rotary sensor

**PERFORMANCE**

**ELECTRICAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range °</td>
<td>20 to 360 in 1° increments</td>
</tr>
<tr>
<td>Supply voltage Vdc</td>
<td>9 to 30 (unregulated) and 5 ± 0.5 (regulated)</td>
</tr>
<tr>
<td>Over voltage protection Vdc</td>
<td>Up to 40 (-40 to +60°C)</td>
</tr>
<tr>
<td>Maximum supply current mA</td>
<td>&lt; 25</td>
</tr>
<tr>
<td>Reverse polarity protection</td>
<td>Yes</td>
</tr>
<tr>
<td>Short circuit protection</td>
<td></td>
</tr>
<tr>
<td>Output to GND</td>
<td></td>
</tr>
<tr>
<td>Output to supply</td>
<td></td>
</tr>
<tr>
<td>Power-on settlement time S</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Resolution %</td>
<td>0.025 of measurement range (12 bit)</td>
</tr>
<tr>
<td>Non-linearity* %</td>
<td>&lt; ±0.4</td>
</tr>
<tr>
<td>Temperature coefficient ppm/°C</td>
<td>&lt; ±30 in 5V supply mode; &lt; ±90 in 9-30V supply mode</td>
</tr>
</tbody>
</table>

*Non-linearity is measured using the Least-Squares method on a computerised calibration system

Analog Output (order code A1, A4) - see graph on page 31

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage output range</td>
<td></td>
</tr>
<tr>
<td>9-30V supply Vdc</td>
<td>Absolute voltage, 0.5 to 4.5 (A1) or 0.1 to 4.9 (A4) over measurement range (±3%)</td>
</tr>
<tr>
<td>5V supply Vdc</td>
<td>Ratiometric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)</td>
</tr>
<tr>
<td>Monotonic range Vdc</td>
<td>0.25 (5%) and 4.75 (95%) nominal (A1)</td>
</tr>
<tr>
<td>Monotonic range Vdc</td>
<td>0.05 (1%) and 4.95 (99%) nominal (A4)</td>
</tr>
<tr>
<td>Load resistance Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Output noise mVRms</td>
<td>&lt; 1</td>
</tr>
<tr>
<td>Input/output delay μS</td>
<td>&lt; 2</td>
</tr>
</tbody>
</table>

PWM Output (order code Pn) - see output characteristics on page 31

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWM frequency Hz</td>
<td>244 (P1); 500 (P2); or 1000 (P3) ±20% over temperature range</td>
</tr>
<tr>
<td>PWM levels 9-30V supply Vdc</td>
<td>0 and 5 nominal (±3%)</td>
</tr>
<tr>
<td>PWM levels 5V supply Vdc</td>
<td>0 and Vs (±1%)</td>
</tr>
<tr>
<td>Duty cycle %</td>
<td>10 to 90 over measurement range</td>
</tr>
<tr>
<td>Monotonic range %</td>
<td>5 and 95 nominal</td>
</tr>
<tr>
<td>Load resistance Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Rise/fall time μS</td>
<td>&lt; 15</td>
</tr>
</tbody>
</table>

**MECHANICAL**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical angle °</td>
<td>360, continuous</td>
</tr>
<tr>
<td>Operating torque g-cm</td>
<td>10</td>
</tr>
<tr>
<td>Maximum rotational speed °/sec</td>
<td>3600</td>
</tr>
<tr>
<td>Weight g</td>
<td>&lt; 30</td>
</tr>
<tr>
<td>Mounting</td>
<td></td>
</tr>
<tr>
<td>Phasing</td>
<td></td>
</tr>
</tbody>
</table>

Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2N.m
When shaft drive detail is aligned as shown in Electrical Angle Diagram (page 21), output is at mid travel. The sensor housing allows for ±10° adjustment via the mounting flange slots.
**Environmental**

**Protection class**
IP68 (to 2m depth for 1 hour) and IP69K

**Life**
60 million operations (30 x 10^6 cycles) of ±75°; Sensing element life is essentially infinite (contactless)

**Dither life**
-40 to +140 (5V supply) and +170°C for 72 hours
-40 to +135.7 (9V supply option) Derate upper temperature limit by 1.7°C for every 1V increase in supply: e.g. -40 to +100 @ 30V

**Operational temperature**
-55 to +140

**Storage temperature**
-40 to +135.7 (9V supply option) Derate upper temperature limit by 1.7°C for every 1V increase in supply: e.g. -40 to +100 @ 30V

**Vibration**
BS EN 60068-2-64:1995 Sec 8.4 (31.4gn rms) 20 to 2000Hz Random

**Shock**
3m drop onto concrete and 2500g

**EMC Immunity level**
BS EN 61000-4-3:1999, to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

1 See Maximum Operating Temperature – Derating graph on page 30. If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating.

**Options**

**Measurement range (angle)**
Select from 20° to 360° in 1° increments (factory programmed) for each output channel

**Output**
Analog voltage (An) or PWM (Pn)

**Output direction**
Both clockwise, both anticlockwise or one CW, one ACW

**Cable length**
m
0.2 or 0.5

**Connector**
Not fitted (C0) or Mini Sure Seal MSS4R fitted (C1)

**OEM options**
Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages; different output phasing CH1/CH2; faster input/output delay; extended analog range; and output mapping for potentiometer replacements.

**Availability**
All standard configurations can be supplied rapidly from the factory – check with your local supplier for more details.

**Ordering Codes**
TPS280DP/...../...../...../...../...../.....

- Measurement range CH1 = angle in °
- Measurement range CH2 = angle in °
- Output A1 = Analog 0.5-4.5Vdc
  A4 = Analog 0.1-4.9Vdc
  P1 = PWM, 244 Hz
  P2 = PWM, 500 Hz
  P3 = PWM, 1000 Hz
- Direction 3 = Both clockwise
  4 = Both anticlockwise
  5 = CH1 CW, CH2 AC W
- Cable length P2 = 0.2m
  P5 = 0.5m
- Connector C0 = No connector
  C1 = Mini Sure Seal MSS4R

**Accessories** (order all items separately)
- Mating connector – X61-227-002 Mini Sure Seal MSS4P
  X61-227-201 PIN contact (2 off required)
  X61-227-202 SOCKET contact (2 off required)
DIMENSIONS

Note: drawings not to scale

ELECTRICAL CONNECTIONS

Option C0 - 200 or 500mm of 4-core cable: FDR-25 sheathed, with 55A spec (24AWG) cores

Option C1 - Mini sure seal MSS4R fitted to cable

Output increases with CW or ACW rotation viewed on shaft drive - depending on selected order code

Cable colour  Description
Red           + V Supply
Black         0V Supply GND
Yellow        CH1 Output
White         CH2 Output

C1 Connector option
Pin 1 = V+ Supply  Pin 3 = CH1 Output
Pin 2 = 0V Supply GND  Pin 4 = CH2 Output

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with reverse polarity protection and short circuit protection between outputs (Yellow & White) to GND (Black), but if the outputs (Yellow & White) are connected to the supply this will result in device failure.
### PERFORMANCE

**Output options**

<table>
<thead>
<tr>
<th>A1</th>
<th>A4</th>
<th>P1</th>
<th>P2</th>
<th>P3</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5-4.5 or 0.1-4.9Vdc</td>
<td>PWM</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**ELECTRICAL**

<table>
<thead>
<tr>
<th>Measurement range °</th>
<th>20 to 360 in 1° increments</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Supply voltage</th>
<th>Vdc</th>
</tr>
</thead>
<tbody>
<tr>
<td>unregulated</td>
<td>9 to 30</td>
</tr>
<tr>
<td>regulated</td>
<td>5 ±0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Over voltage protection Vdc</th>
<th>Up to 40 (-40 to +60°C)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Maximum supply current mA</th>
<th>&lt;25</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Reverse polarity protection</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Short circuit protection</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Output to GND</th>
<th>Yes</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Output to supply</th>
<th>No</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Power-on settlement time S</th>
<th>&lt; 1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Resolution %</th>
<th>0.025 of measurement range (12 bit)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Non-linearity %</th>
<th>≤ ±0.4</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Temperature coefficient ppm/°C</th>
<th>≤ ±30 in 5V supply mode</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Absolute voltage, 0.5 to 4.5 (A1) or 0.1 to 4.9 (A4) over measurement range (±3%)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Analog Voltage Output - (order code A1, A4) see typical graph on page 31</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Voltage output range Vdc</th>
<th>Absolute voltage, 0.5 to 4.5 (A1) or 0.1 to 4.9 (A4) over measurement range (±3%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-30V supply</td>
<td>Ratiometric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monotonic range Vdc</th>
<th>0.25 (5%) and 4.75 (95%) nominal (A1)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Load resistance Ω</th>
<th>10k minimum (resistive to GND)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Output noise mVRms</th>
<th>&lt;1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Input/output delay mS</th>
<th>&lt;2</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Analog Voltage Output - (order code A2) see typical graph on page 31</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Voltage output range Vdc</th>
<th>Absolute voltage, nominally 0.2 to 9.8 (±0.2V)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Load resistance Ω</th>
<th>10k minimum (resistive to GND)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Output noise mVRms</th>
<th>&lt;1</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Input/output delay mS</th>
<th>3.5</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Analog Current Output - (order code A3) see typical graph on page 31</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Current output range mA</th>
<th>Absolute current, nominally 4 to 20 (±2% span)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Load resistance Ω</th>
<th>400 maximum (resistive to GND)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Output noise μArms</th>
<th>&lt;10</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Input/output delay mS</th>
<th>3.75</th>
</tr>
</thead>
</table>

*Non-linearity is measured using the Least-Squares method on a computerised calibration system

**Temperature compensation possible by using graph shown on page 30**
<table>
<thead>
<tr>
<th>MECHANICAL</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical angle °</td>
<td>360, continuous</td>
<td></td>
</tr>
<tr>
<td>Operating torque - max g-cm</td>
<td>1000</td>
<td>3600</td>
</tr>
<tr>
<td>Shaft velocity maximum °/sec</td>
<td>265 (without cable)</td>
<td></td>
</tr>
<tr>
<td>Weight g</td>
<td>265 (without cable)</td>
<td></td>
</tr>
<tr>
<td>Mounting</td>
<td>Use 3 x M6 threaded holes in front face or 3 x M6 (or 1/4 UNC) clearance holes through the flange – See dimensions for details</td>
<td></td>
</tr>
<tr>
<td>Phasing</td>
<td>When the shaft flat is facing towards the cable exit, sensor output is at mid electrical angle (±5°)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ENVIRONMENTAL</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection class</td>
<td>IP69K with cable codes Bxx and Sxx</td>
</tr>
<tr>
<td>Life</td>
<td>20 million operations (10 x 10^6 cycles) of ±75° Sensing element life is essentially infinite (contactless), and the SRH501P/502P life figures refer to the operating shaft seal. Mechanical load (axial and radial) on the shaft should also be considered.</td>
</tr>
<tr>
<td>Dither life</td>
<td>Contactless - no degradation due to shaft dither</td>
</tr>
<tr>
<td>Shaft side load</td>
<td>2Kg mounted on sensor shaft - tested 3 million cycles</td>
</tr>
<tr>
<td>Operational temperature† °C</td>
<td>-40 to +140 (5V supply) -40 to +135.7 (9V supply) Derate upper temperature limit by 1.7°C for every 1V increase in supply: e.g. -40 to +100 @ 30V</td>
</tr>
<tr>
<td>Storage temperature °C</td>
<td>-55 to +140</td>
</tr>
<tr>
<td>Vibration</td>
<td>BS EN 60068-2-64:1995 Sec 8.4 (14g rms) 20 to 2000Hz Random</td>
</tr>
<tr>
<td>Shock</td>
<td>3m drop onto concrete and 2500g – all axes</td>
</tr>
<tr>
<td>EMC Immunity level</td>
<td>BS EN 61000-4-3:1999, to 100V/m, 80MHz to1GHz and 1.4GHz to 2.7GHz (35V/m 1.4GHz to 2.7GHz for output A3) (2004/108/EC)</td>
</tr>
<tr>
<td>Salt spray</td>
<td>BS EN 60068-2-52: 1996, Test Kb Severity 2 (48hr)</td>
</tr>
<tr>
<td>Humidity</td>
<td>BS EN 60068-2-30: 2005, Severity Db (55°C, 93%RH)</td>
</tr>
</tbody>
</table>

† See Maximum Operating Temperature – Derating graphs on page 30. If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating

<table>
<thead>
<tr>
<th>OPTIONS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range (angle)</td>
<td>Output</td>
</tr>
<tr>
<td>Analogue voltage (A1, A2, A4)</td>
<td>PWM (Pn)</td>
</tr>
<tr>
<td>Analog current (A3)</td>
<td></td>
</tr>
<tr>
<td>coming soon in 2012</td>
<td></td>
</tr>
<tr>
<td>Output direction</td>
<td>Both clockwise, both anticlockwise or one CW, one ACW</td>
</tr>
<tr>
<td>Electrical connections</td>
<td>No cable (A00, S00), 1m, 5m, 10m unscreened (Bxx) or screened (Sxx) cable or M12 receptacle (C01)</td>
</tr>
<tr>
<td>Cabled sockets</td>
<td>1.5, 2, 5 &amp; 10m mating cabled sockets can be ordered separately. See details on page 26</td>
</tr>
<tr>
<td>Operating levers</td>
<td>Operating levers 155 or 230mm long can be ordered separately. See details on page 25</td>
</tr>
<tr>
<td>OEM options</td>
<td>Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages; different output phasing CH1/CH2; faster input/output delay; extended analog range; and output mapping for potentiometer replacements.</td>
</tr>
</tbody>
</table>
SRH 501P AND SRH 502P

AVAILABILITY

ORDERING CODES

NOTE: When selecting output option A3 (4-20mA), cable codes Sxx are the only cable codes allowable.

SINGLE OUTPUT SRH501P

Measurement range = angle in °

Output

A1 = Analog 0.5-4.5 Vdc
A2 = Analog 0-10 Vdc
A3 = Analog 4-20 mA
A4 = Analog 0.1-4.9 Vdc
P1 = PWM, 244 Hz
P2 = PWM, 500 Hz
P3 = PWM, 1000 Hz

Direction

1 = Clockwise
2 = Anticlockwise

Cable code

A00 = No cable, gland fitting
S00 = No cable, screened cable gland (A3 output option – see note)
B01 = 1m 4-core unscreened cable, IP69K
B05 = 5m 4-core unscreened cable, IP69K
B10 = 10m 4-core unscreened cable, IP69K
S01 = 1m 4-core screened cable, IP69K (A3 output options – see note)
S05 = 5m 4-core screened cable, IP69K
S10 = 10m 4-core screened cable, IP69K
C01 = M12 screw locking receptacle

DUAL OUTPUT SRH502P

Measurement range

CH1 = angle in °

Measurement range

CH2 = angle in °

Output

A1 = Analog 0.5-4.5 Vdc
A2 = Analog 0-10 Vdc
A3 = Analog 4-20 mA
A4 = Analog 0.1-4.9 Vdc
P1 = PWM, 244 Hz
P2 = PWM, 500 Hz
P3 = PWM, 1000 Hz

Direction

3 = Both clockwise
4 = Both anticlockwise
5 = CH1 CW; CH2 ACW

Cable code

A00 = No cable, gland fitting
S00 = No cable, screened cable gland (A3 output option – see note)
B01 = 1m 4-core unscreened cable, IP69K
B05 = 5m 4-core unscreened cable, IP69K
B10 = 10m 4-core unscreened cable, IP69K
S01 = 1m 4-core screened cable, IP69K (A3 output options – see note)
S05 = 5m 4-core screened cable, IP69K
S10 = 10m 4-core screened cable, IP69K
C01 = M12 screw locking receptacle

Accessories (order separately)
Drive lever kit – SA202195/MK - see page 25
Mating connectors - see details on page 26
DIMENSIONS
Note: drawings not to scale

Three holes 'b'
M6 x 1 through equi-spaced on 76.0 PCD

Three holes 'a'
ø6.5 through equi-spaced on 76.0 PCD

Three holes 'b'
ø87.5

PHASING OF SHAFT TO HOUSING

Output increases for ACW unit when viewed on shaft
Mid point of electrical angle
Output increases for CW unit when viewed on shaft
Sensor is at mid electrical angle when shaft flat is facing towards the cable exit as shown.
90º
Cable exit
Shaft flat

LEVER OPTIONS (order separately)

Lever SA202195/MK1  L = 155
Lever SA202195/MK2  L = 230
**ELECTRICAL CONNECTIONS**

Option A00 - No cable supplied
Option S00 - No cable supplied
(Fitted gland to suit screened cable)
Option Bxx - Cable supplied (1m, 5m or 10m)
Option Sxx - Screened cable supplied (1m, 5m or 10m)
Option C01 - Series M12 screw locking receptacle to IEC 61076-2-101 (Ed.1) /IEC 60947-5-2 fitted to sensor body.
Mating cabled sockets to be ordered separately.

**CONNECTING CABLE OPTIONS**

Connection details for no cable option A00 S00

Option Bxx - 3-core cable supplied with cable code Bxx SRH501P

Option Sxx - 4-core cable supplied with cable code Bxx SRH502P

Note: Sxx option includes a cable screen required for output option A3

Connection details for option C01 - M12 connector (not available for output A3)

When connecting the sensor, care should be taken with the correct connections. The sensor is provided with indefinite reverse polarity protection and short circuit protection between output to GND, but if the outputs are connected to the supply this will result in device failure.
## PERFORMANCE

### ELECTRICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement range</td>
<td>°</td>
<td>20 to 360 in 1° increments</td>
</tr>
<tr>
<td>Supply voltage</td>
<td>Vdc</td>
<td>9 to 30 (unregulated) and 5 ±0.5 (regulated)</td>
</tr>
<tr>
<td>Over voltage protection</td>
<td>Vdc</td>
<td>Up to 40 (-40 to +60°C)</td>
</tr>
<tr>
<td>Maximum supply current</td>
<td>mA</td>
<td>&lt;12.5</td>
</tr>
<tr>
<td>Reverse polarity protection</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Short circuit protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>output to GND</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>output to supply</td>
<td></td>
<td>In 5V regulated mode only</td>
</tr>
<tr>
<td>Power-on settlement time</td>
<td>S</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Resolution</td>
<td>%</td>
<td>0.025 of measurement range (12 bit)</td>
</tr>
<tr>
<td>Non-linearity*</td>
<td>%</td>
<td>&lt;±0.4</td>
</tr>
<tr>
<td>Temperature coefficient</td>
<td>ppm/°C</td>
<td>&lt;±50</td>
</tr>
</tbody>
</table>

*Non-linearity is measured using the Least-Squares method on a computerised calibration system

### Analog Output (order code A) - see graph on page 31

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage output range</td>
<td>Vdc</td>
<td>Absolute voltage, 0.5 to 4.5 over measurement range (±3%)</td>
</tr>
<tr>
<td>9-30V supply</td>
<td>Vdc</td>
<td>Ratiometric output voltage - 10 to 90% of Vs over measurement range(±1%)</td>
</tr>
<tr>
<td>5V supply</td>
<td>Vdc</td>
<td>0.25 (5%) and 4.75 (95%) nominal</td>
</tr>
<tr>
<td>Monotonic range</td>
<td>Vdc</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Load resistance</td>
<td>Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Output noise</td>
<td>mVrms</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Input/output delay</td>
<td>mS</td>
<td>&lt;2</td>
</tr>
</tbody>
</table>

### PWM Output (order code P) - See output characteristics on page 31

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>PWM frequency</td>
<td>Hz</td>
<td>244 ± 20% over temperature range</td>
</tr>
<tr>
<td>PWM levels</td>
<td>Vdc</td>
<td>0 and 5 nominal (±3%)</td>
</tr>
<tr>
<td>9-30V supply</td>
<td>Vdc</td>
<td>0 and Vs (±1%)</td>
</tr>
<tr>
<td>5V supply</td>
<td>Vdc</td>
<td>0 and Vs (±1%)</td>
</tr>
<tr>
<td>Duty cycle</td>
<td>%</td>
<td>10 to 90 over measurement range</td>
</tr>
<tr>
<td>Monotonic range</td>
<td>%</td>
<td>5 and 95 nominal</td>
</tr>
<tr>
<td>Load resistance</td>
<td>Ω</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Rise/fall time</td>
<td>µS</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>

### MECHANICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical angle</td>
<td>°</td>
<td>360, continuous</td>
</tr>
<tr>
<td>Operating torque - max</td>
<td>g-cm</td>
<td>1000</td>
</tr>
<tr>
<td>Shaft velocity max</td>
<td>%/sec</td>
<td>3600</td>
</tr>
<tr>
<td>Weight</td>
<td>g</td>
<td>500</td>
</tr>
<tr>
<td>Mounting</td>
<td></td>
<td>Use 3 x M6 threaded holes in front face or 3 x M6 clearance holes through the body - see dimensions for details</td>
</tr>
<tr>
<td>Phasing</td>
<td></td>
<td>When the shaft flat is facing the scribed mark on the front face (as shown in the diagram), sensor output is at mid travel (±5°)</td>
</tr>
</tbody>
</table>
**ENVIRONMENTAL**

- Protection class: IP68
- Life: 20 million operations \((10 \times 10^6\) cycles) of \(+75^\circ\)
- Sensing element life is essentially infinite (contactless), but the SRH880P life figures refer to the shaft seal. Mechanical load (axial and radial) on the shaft should also be considered.
- Dither life: Contactless - no degradation due to shaft dither
- Operational temperature: -40 to +120 \(^\circ\)C \((5V and 9V supply)\)
- Storage temperature: -40 to +90 \(^\circ\)C \((30V supply)\)
- Vibration: 10 to 2000Hz Random - 12.6gn rms - all axes
- Shock: Survival to 2500g - all axes
- EMC Immunity level: BS EN 61000-4-3:1999 to 100V/m, 80MHz to 1GHz and 1.4GHz to 2.7GHz (2004/108/EC)

1 If the maximum operating temperature is exceeded, the voltage regulator will shut down to protect the device from overheating

**OPTIONS**

- Measurement range (angle): Select from 20° to 360° in 1° increments (factory programmed) for each output channel.
- Output: Analog voltage (A) or PWM (Pn)
- Output direction: Clockwise or Anticlockwise shaft rotation with increasing output
- Cabled socket: 2m or 5m cabled socket assemblies available
- Body material: Optional anodised aluminium or corrosion resistant stainless steel housing
- Operating levers: Operating levers 155 or 230mm long should be ordered separately. See details page 25
- OEM options: Outputs can be programmed to provide: non linear laws; switch outputs; clamp voltages; alternative PWM frequencies; faster input/output delay; extended analog range; and output mapping for potentiometer replacements.

**AVAILABILITY**

All standard configurations can be supplied rapidly from the factory - check with your local supplier for more details.

**ORDERING CODES**

SRH880P/ ...../ ...../ ...../ ...../ ...../

- Measuring range = angle in °
- Output: A = Analog
  P = PWM
- Direction: 1 = Clockwise
  2 = Anticlockwise
- Cabled socket: 00 = None
  02 = 2m
  05 = 5m
- Body material: AL = Aluminium
  SS = Stainless steel

**Accessories (order separately)**

Drive lever kit - SA202195/MK - see page 25
DIMENSIONS
Note: drawings not to scale

LEVER OPTIONS
See SRH501P page 25

ELECTRICAL CONNECTIONS
Straight cabled socket
E series M12 to IEC 61076-2-101(Ed.1)
/IEC 60947-5-2,
PUR jacket
Conforms to VDE 0472 part 804
Cable temperature range -25 to +90°C

When connecting the sensor, care should be taken with the correct connections.
The sensor is provided with indefinite reverse polarity protection and short circuit protection
between output (Pin 4 - Black) to GND (Pin 1 - Brown), but if the output (Pin 4 - Black) is
connected to the supply this will result in device failure.
TEMPERATURE AND OUTPUT GRAPHS

MAXIMUM OPERATING TEMPERATURE - DERATING GRAPHS

SRH280P

SRH280DP, NRH280DP, TPS280DP, SRH220DR
SRH501P/502P (not A2 & A3 options)

SRH220DR, SRH501P/502P - OUTPUT A2

SRH501P/502P - OUTPUT A3

A3 Typical temperature slope characteristic (can be used for compensation)
PWM levels = zero volt and 5V (±3%) for 9-30V supply
= zero volt and \(V_s\) (±1%) for 5V supply

\(t = \) pulse width
(Increases with shaft direction code)

\(D = \) duty cycle = \(\frac{t}{T}\)

\(T = \) periodic time = \(\frac{1}{f}\)

Sensor electrical angle (from ordering code)

Actual measured output angle = \(1.25 \times \frac{t}{T}\)

---

**SENSOR OUTPUT GRAPH - examples for three different angles**

SRH501P/502P - OUTPUT A1
SRH880P - OUTPUT A

---

**SRH220DR,SRH501P/502P - OUTPUT A2 (0-10Vdc)**

---

**SRH501P/502P - OUTPUT A3 (4-20mA)**

---

**PWM OUTPUT CHARACTERISTICS**

SRH280P, SRH280DP, NRH280DP, NRH285DR, TPS280DP, SRH220DR - OUTPUT P1, P2, P3
SRH501P/502P - OUTPUT P1, P2, P3
SRH880P - OUTPUT P

PWM levels = zero volt and 5V (±3%) for 9-30V supply
= zero volt and \(V_s\) (±1%) for 5V supply
Penny & Giles
Position sensors, joysticks and solenoids for commercial and industrial applications.

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