MOTORSPORT
MEASUREMENT &
CONTROL SENSORS

Innovation In Motion
INNOVATION IN MOTION

For more than 50 years, Penny+Giles has provided creative solutions for position measurement and control. Our success in world markets results from innovative technology, creative design, manufacturing excellence and interactive customer support.

Our experience in providing control and feedback solutions across a wide applications spectrum from aerospace, automotive and motorsport, mining and process control to medical science, broadcasting and recording allows our customers to specify Penny + Giles equipment knowing that it is industry proven in thousands of applications throughout the world.

Penny+Giles sensors are manufactured using state-of-the-art production facilities, which include cell assembly systems, ensuring products are delivered rapidly to meet customers needs.

Custom design
Using the Penny+Giles partnership approach integrates our design and product expertise with your design team, enabling a free flow of ideas to provide the most reliable and cost effective product solution.

Standard build
Specify from our wide range of position measurement and control products - many available from stock.

Motorsport
Success in motor racing depends on hundreds of components working together at peak performance under the most extreme conditions. Position sensors are essential for the control and monitoring systems that supply information to race engineers to help trim precious seconds off the lap times.

Penny+Giles have pioneered developments in motorsport position sensors by using experience gained in aerospace applications, where reliability under extremely hostile conditions are paramount.

Penny+Giles sensors have become a benchmark standard in motor racing and have helped every winning team in the Formula 1 championship since 1986.

Aerospace Products
Penny+Giles design and manufacture position sensors for civil and military applications on fixed and rotary wing aircraft and satellite launch vehicles. These products are sold under the Curtiss-Wright Controls, Integrated Sensing brand.

Industrial products
Penny + Giles industrial products are key components throughout the industrialised world providing control and position feedback in a wide range of applications as diverse as construction vehicles and leisure simulators.

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Linear Potentiometers  page 3
LVDTs  page 13
Rotary Potentiometers  page 18
RVDTs  page 21

EMC
The products detailed on pages 3 to 12 have been tested to the requirements of EN50081-1 (Emissions) and EN50082-2 (Immunity).

Quality Assurance
Penny+Giles are accredited to BS EN ISO9001:2000 Quality is at the heart of all our systems ensuring the reliability of our products from initial design to final despatch.
The Penny+Giles SLS and MLS range of linear potentiometers have been designed with motorsport applications in mind. They utilise established hybrid track technology to provide low electrical noise and high accuracy output over long operating life in the most extreme environments. With a sealing system tested to IP66 and a choice of mountings, these potentiometers have become the benchmark in suspension data acquisition systems for single seat, saloon car, motorcycle and truck racing.

**Features**
- Compact body to stroke length
- Sealing to IP66 and corrosion resistant rod-end bearings
- Integrally moulded rear cable assembly
  - Rotatable shaft
  - Reduced weight
  - Rapid despatch
  - CE approved

**Benefits**
- Reduced installation space
- Can be used in hostile environments
- Excellent cable strain relief with secure sealing
- Easy installation
- Ideal for motorsport applications
- Eliminates customer inventory
- Confidence in EMC performance
SLS095 is designed to provide maximum performance benefits within an extremely compact body diameter of 9.5mm, with stroke lengths from 10 to 100mm. The miniature size of this sensor makes it ideal for applications in robotics, animatronics, medical equipment and motorsport data acquisition.

### Performance

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>75</th>
<th>100</th>
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<tr>
<td>Electrical stroke E</td>
<td>mm</td>
<td>10</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>50</td>
<td>75</td>
<td>100</td>
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<tr>
<td>Resistance ±10%</td>
<td>kΩ</td>
<td>0.4†</td>
<td>0.8</td>
<td>1.2</td>
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<td>3.0</td>
<td>4.0†</td>
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<tr>
<td>Independent linearity ±%</td>
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<td>0.5</td>
<td>0.35</td>
<td>0.25</td>
<td>0.25</td>
<td>0.15</td>
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<tr>
<td>Power dissipation at 20°C W</td>
<td></td>
<td>0.2</td>
<td>0.4</td>
<td>0.6</td>
<td>0.8</td>
<td>1.0</td>
<td>1.5</td>
<td>2.0</td>
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<td>Applied voltage maximum Vdc</td>
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<td>8.9</td>
<td>17.9</td>
<td>26</td>
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<td>Resolution</td>
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<td>Wiper circuit impedance</td>
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<tr>
<td>Life at 250mm per second</td>
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<tr>
<td>Dither life</td>
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<td></td>
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<tr>
<td>Shaft seal life</td>
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<td>Shaft velocity maximum m/s</td>
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<td></td>
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<tr>
<td>Vibration</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Shock</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- 30 to +100
- To MIL-R-39023 grade C 0.1%
- Greater than 100MΩ at 500Vdc
- Voltage divider only - see Circuit Recommendation below
- Minimum of 100 x track resistance or 0.5MΩ (whichever is greater)
- 300 in horizontal plane
- 100 in horizontal plane
- Typically greater than 100 million operations (50 x 10⁶ cycles) at 25mm stroke length
- 200 million operations (100 x 10⁶ cycles) at ±0.5mm, 60Hz
- IP50 standard - IP66 see options
- 20 million operations (10 x 10⁶ cycles)
- 2.5
- RTCA 160D 10Hz to 2kHz (random) @ 4.12g (rms) - all axes
- 40g 6mS half sine

### Circuit Recommendation

Hybrid track potentiometers feature a high wiper contact resistance, therefore operational checks should be carried out only in the voltage divider mode. Hybrid track potentiometers should be used only as voltage dividers, with a minimum wiper circuit impedance of 100 x track resistance or 0.5MΩ (whichever is greater). Operation with wiper circuits of lower impedance will degrade the output smoothness and affect the linearity.

Designed to accept integral shaft seal to give IP66 rating
Can be supplied with self aligning bearings or a plain body for use with body clamps or flange mounting kit.

### Options

- IP 66 sealing
- Mounting

### Accessories

- Mounting kits
- Body clamp kit - SA200841
- Flange kit - SA200842

### Availability

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

### Ordering Codes

- Electrical stroke
- Resistance
- Sealing 50 = IP50, 66 = IP66
- Mounting option R = Self aligning bearing
- P = Plain

**AVAILABILITY**

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

Note: drawings not to scale

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**SELF ALIGNING BEARING MOUNTING**

![Diagram of a self-aligning bearing mounting]

- **D fully retracted ±1 adjustment**
- **Rod end bearing ø2/1.15 mounting hole both ends**
- **Angle of misalignment 12°**

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**PLAIN BODY MOUNTING**

![Diagram of a plain body mounting]

**MOUNTING OPTIONS**

- **Body clamp**
  - **SA200841**
- **Flange mounting**
  - **SA200842**

**Electrical stroke E (mm)**
- 10
- 20
- 30
- 40
- 50
- 75
- 100

**Mechanical stroke M (mm)**
- 12.5
- 22.5
- 32.5
- 42.5
- 52.5
- 77.5
- 102.5

**Body length B (mm)**
- 45.5
- 55.5
- 65.5
- 75.5
- 85.5
- 110.5
- 135.5

**Between centres D (mm)**
- 70
- 80
- 90
- 100
- 110
- 135
- 160

**Weight approximate (mounting option R) (g)**
- 11
- 13
- 14.5
- 16
- 17.5
- 21.5
- 25.5

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**ELECTRICAL CONNECTIONS**

3 core cable: PUR sheathed 0.3m long with PTFE insulated 7/0.125 cores.

![Diagram of electrical connections]

- **Red**
- **Black**
- **Yellow**

**Direction of shaft extension**

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**SA200841**

- 6,5
- 12
- 15
- .5
- 10
- 3

**SA200842**

- M2 SKT cap
- 2 clamps in this kit
The SLS130 range is designed to provide performance benefits within a compact, lightweight package in stroke lengths from 25 to 200mm. With a choice of mounting options and accessories, this sensor is ideally suited to a wide range of industrial applications.

### PERFORMANCE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E mm</td>
<td>25  50  75  100  125  150  175  200</td>
</tr>
<tr>
<td>Resistance ±10% kΩ</td>
<td>1   2   3   4   5   6   7   8</td>
</tr>
<tr>
<td>Independent linearity guaranteed</td>
<td>0.25 0.25 0.15 0.15 0.15 0.15 0.15 0.15</td>
</tr>
<tr>
<td></td>
<td>typical</td>
</tr>
<tr>
<td>Power dissipation at 20°C W</td>
<td>0.5  1.0  1.5  2.0  2.5  3.0  3.5  4.0</td>
</tr>
<tr>
<td>Applied voltage maximum Vdc</td>
<td>22   44   67   74   74   74   74   74</td>
</tr>
<tr>
<td>Electrical output</td>
<td>Minimum of 0.5% to 99.5% applied volts</td>
</tr>
<tr>
<td>Resolution</td>
<td>Virtually infinite</td>
</tr>
<tr>
<td>Hysteresis (repeatability)</td>
<td>Less than 0.01mm</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>-30 to +100 (tested to +130 for 12 hours duration)</td>
</tr>
<tr>
<td>Output smoothness</td>
<td>To MIL-R-39023 grade C 0.1%</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Greater than 100MΩ at 500Vdc</td>
</tr>
<tr>
<td>Operating mode</td>
<td>Voltage divider only - see Circuit Recommendation below</td>
</tr>
<tr>
<td>Wiper circuit impedance</td>
<td>Minimum of 100 x track resistance or 0.5MΩ (whichever is greater)</td>
</tr>
<tr>
<td>Operating force maximum sealed</td>
<td>500 in horizontal plane</td>
</tr>
<tr>
<td></td>
<td>250 in horizontal plane</td>
</tr>
<tr>
<td>Life at 250mm per second</td>
<td>Typically greater than 100 million operations (50 x 10⁶ cycles) at 25mm stroke length</td>
</tr>
<tr>
<td>Dither life</td>
<td>200 million operations (100 x 10⁶ cycles) at ±0.5mm, 60Hz</td>
</tr>
<tr>
<td>Sealing</td>
<td>IP50 standard - IP66 see options</td>
</tr>
<tr>
<td>Shaft seal life</td>
<td>20 million operations (10 x 10⁶ cycles) - replaceable</td>
</tr>
<tr>
<td>Shaft velocity maximum m/s</td>
<td>10</td>
</tr>
<tr>
<td>Vibration</td>
<td>RTCA 160D 10Hz to 2kHz (random) @12.6g (rms) - all axes</td>
</tr>
<tr>
<td>Shock</td>
<td>Less than 0.04% output change @2500g - all axes</td>
</tr>
</tbody>
</table>

### CIRCUIT RECOMMENDATION

Hybrid track potentiometers feature a high wiper contact resistance, therefore operational checks should be carried out only in the voltage divider mode. Hybrid track potentiometers should be used only as voltage dividers, with a minimum wiper circuit impedance of 100 x track resistance or 0.5MΩ (whichever is greater). Operation with wiper circuits of lower impedance will degrade the output smoothness and affect the linearity.

### OPTIONS

- **Compact shaft**
- **Integral shaft seal - IP 66**
- **Extended cable length**
- **Mounting**
- **Protective sleeve**
- **Spring loaded shaft kit**

### ACCESSORIES

- **Mounting kits**
  - Body clamp kit - SA200264, Flange kit - SA200266
  - Quick release balljoint (Heim) - SA200337
- **Protective sleeve**
  - SA202984/...../.....
- **Spring loaded shaft kit**
  - SA200265/stroke (For use with option L/50 units only)

### AVAILABILITY

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

Note: drawings not to scale

SEAF LET AL IN ONG BEARING MOUNTING

PROTECTIVE SLEEVE OPTION - P

SPRING RETURN OPTION †

MOUNTING OPTIONS

SA200264
Body clamp

SA200266
Flange mounting

Quick release
ball joint
SA200337

ORDERING CODES

SLS130/....../....../....../....../......

Electrical stroke
Shaft L = long, C = compact

Protective sleeve N=None, P=Fitted
Cable 1 = 1m, 10 = 10m
Sealing 50 = IP50, 66 = IP66

† Body clamp or flange mounting options should be ordered separately

ELECTRICAL CONNECTIONS

3 core cable: PUR sheathed 1m long with ETFE insulated 19/0.15 cores.

<table>
<thead>
<tr>
<th>Electrical stroke E (mm)</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
<th>175</th>
<th>200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical stroke M (mm)</td>
<td>29</td>
<td>54</td>
<td>79</td>
<td>104</td>
<td>129</td>
<td>154</td>
<td>179</td>
<td>204</td>
</tr>
<tr>
<td>Body length B (mm)</td>
<td>110.5</td>
<td>135.5</td>
<td>160.5</td>
<td>185.5</td>
<td>210.5</td>
<td>235.5</td>
<td>260.5</td>
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<td>Between centres D</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>standard sensor (L)</td>
<td>173.6</td>
<td>198.6</td>
<td>223.6</td>
<td>248.6</td>
<td>273.6</td>
<td>298.6</td>
<td>323.6</td>
<td>348.6</td>
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<tr>
<td>compact shaft sensor (C)</td>
<td>148.6</td>
<td>173.6</td>
<td>198.6</td>
<td>223.6</td>
<td>248.6</td>
<td>273.6</td>
<td>298.6</td>
<td>323.6</td>
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<td>Sleeve length F</td>
<td>102</td>
<td>127</td>
<td>152</td>
<td>177</td>
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<td>227</td>
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<tr>
<td>compact shaft sensor (C)</td>
<td>77</td>
<td>102</td>
<td>127</td>
<td>152</td>
<td>177</td>
<td>202</td>
<td>227</td>
<td>252</td>
</tr>
</tbody>
</table>

Weight approximate

| standard sensor (L) g  | 64   | 71   | 78   | 85   | 92   | 99   | 106  | 113  |
| compact shaft sensor (C) | 80   | 67   | 74   | 81   | 88   | 95   | 102  | 109  |
The MLS130 sealed linear sensor is designed to provide superior performance within a compact, lightweight package in stroke lengths from 25 to 200mm. With a choice of mounting options, including metal rod end bearings, and an optional protective sleeve for extreme environmental conditions, this sensor is ideally suited to motorsport data acquisition applications on suspension and throttle position feedback, where high performance and reliability with competitive pricing and rapid despatch are vital. The sensor is supplied fully sealed to IP66, with an integrally moulded DR25 sheathed multicore cable.

**PERFORMANCE**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E mm</td>
<td>25, 50, 75, 100, 125, 150, 175, 200</td>
</tr>
<tr>
<td>Resistance ±10% kΩ</td>
<td>0.25, 0.25, 0.15, 0.15, 0.15, 0.15, 0.15, 0.15</td>
</tr>
<tr>
<td>Independent linearity guaranteed</td>
<td>±%</td>
</tr>
<tr>
<td>typical</td>
<td>0.15, 0.15, 0.15, 0.10, 0.10, 0.07, 0.07, 0.07</td>
</tr>
<tr>
<td>Power dissipation at 20°C W</td>
<td>0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0</td>
</tr>
<tr>
<td>Applied voltage maximum Vdc</td>
<td>22, 44, 67, 74, 74, 74, 74, 74</td>
</tr>
<tr>
<td>Electrical output</td>
<td>Virtually infinite</td>
</tr>
<tr>
<td>Resolution</td>
<td>Less than 0.01mm</td>
</tr>
<tr>
<td>Hysteresis (repeatability)</td>
<td>-30 to +100 (tested to +130 for 12 hours duration)</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>To MIL-R-39023 grade C 0.1%</td>
</tr>
<tr>
<td>Output smoothness</td>
<td>Greater than 100MΩ at 500Vdc</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Voltage divider only - see Circuit Recommendation below</td>
</tr>
<tr>
<td>Operating mode</td>
<td>Minimum of 100 x track resistance or 0.5MΩ (whichever is greater)</td>
</tr>
<tr>
<td>Wiper circuit impedance</td>
<td>500 in horizontal plane</td>
</tr>
<tr>
<td>Operating force maximum gf</td>
<td>IP66</td>
</tr>
<tr>
<td>Sealing</td>
<td>20 million operations (10 x 10⁶ cycles)</td>
</tr>
<tr>
<td>Shaft seal life (replaceable)</td>
<td>Greater than 100 million operations (50 x 10⁶ cycles) at 25mm stroke length</td>
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<tr>
<td>Sensor track life at 0.25m/s</td>
<td>200 million operations (100 x 10⁶ cycles) at ±0.5mm, 60Hz</td>
</tr>
<tr>
<td>Sensor track dither life</td>
<td>10</td>
</tr>
<tr>
<td>Shaft velocity maximum m/s</td>
<td>RTCA 160D 10Hz to 2kHz (random) @ 12.6g (rms) - all axes</td>
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<tr>
<td>Vibration</td>
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<tr>
<td>Shock</td>
<td></td>
</tr>
</tbody>
</table>

**CIRCUIT RECOMMENDATION**

Hybrid track potentiometers feature a high wiper contact resistance, therefore operational checks should be carried out only in the voltage divider mode. Hybrid track potentiometers should be used only as voltage dividers, with a minimum wiper circuit impedance of 100 x track resistance or 0.5MΩ (whichever is greater). Operation with wiper circuits of lower impedance will degrade the output smoothness and affect the linearity.

**OPTIONS**

- Mounting: Metal rod end bearings, quick release balljoints or plain M4 stud
- Protective sleeve: Available for all stroke lengths

**ACCESSORIES**

- For maximum installation flexibility the following parts are available to purchase separately:
  - Metal rod end (rear) P202605
  - Metal rod end (shaft) P202604
  - Quick release balljoint assembly SA200337
  - Locknut, M4 X63 - 072 - 340
  - Protective sleeve assembly SA202984/stroke/C
  - A suitable stud lock compound should be used to secure the rear rod end or balljoint assembly.
  - Use Loctite™ activator 7471 and Loctite™ 648 on metal rod end.
  - Use Loctite™ 382 on quick release balljoint.

**AVAILABILITY**

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

Electrical stroke E
Mounting G
Q = Quick release balljoints, R = Metal rod end bearings, S = M4 studs
Protective sleeve N = None, P = Fitted

**DIMENSIONS AND MOUNTING OPTIONS**

Note: drawings not to scale

**QUICK RELEASE BALLJOINTS (Q)**

- M4 stud x 6.1 long each end
- Ø13
- ±0.5 adjustment

**METAL ROD END BEARINGS (R)**

- Rod end bearing Ø13 hole ±0.563 both ends
- ±0.5 adjustment

**M4 STUD END (S)**

- M4 stud x 6.1 long each end
- Ø13
- ±0.5 adjustment

**PROTECTIVE SLEEVE (P)**

- Drain plug - Remove if sensor shaft is installed vertically, shaft down

**ELECTRICAL CONNECTIONS**

3 core cable: DR25 sheathed 1m long with ETFT insulated 19/0.15 cores.

- Electrical stroke E mm: 25 50 75 100 125 150 175 200
- Mechanical stroke M mm: 29 54 79 104 129 154 179 204
- Body length B mm: 110.8 135.8 160.8 185.8 210.8 235.8 260.8 285.8
- Between centres D mm: 164.5 189.5 214.5 239.5 264.5 289.5 314.5 339.5
- Between centres G mm: 153.6 178.6 203.6 228.6 253.6 278.6 303.6 328.6
- Sleeve length F mm: 77 102 127 152 177 202 227 252
- Weight approximate g: 80 87 94 101 108 115 122 129
The SLS190 range is designed to provide maximum performance benefits within a compact package in stroke lengths from 25 to 350mm. With a choice of mounting options and accessories, this sensor is ideally suited to a wide range of general purpose industrial applications, for medium stroke linear position sensing.

### PERFORMANCE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E mm</td>
<td>25  50  75  100  125  150  175  200  225  250  275  300  325  350</td>
</tr>
<tr>
<td>Resistance ±10% kΩ</td>
<td>1  2  3  4  5  6  7  8  9  10  11  12  13  14</td>
</tr>
<tr>
<td>Independent linearity guaranteed ±%</td>
<td>0.25  0.25  0.15  0.15  0.15  0.15  0.15  0.15  0.15  0.15  0.15  0.15  0.15</td>
</tr>
<tr>
<td>Typical ±%</td>
<td>0.15  0.15  0.15  0.10  0.10  0.07  0.07  0.07  0.07  0.05  0.05  0.05  0.05</td>
</tr>
<tr>
<td>Power dissipation at 20°C W</td>
<td>0.5  1.0  1.5  2.0  2.5  3.0  3.5  4.0  4.5  5.0  5.5  6.0  6.5  7.0</td>
</tr>
<tr>
<td>Applied voltage maximum Vdc</td>
<td>22  44  67  74  74  74  74  74  74  74  74  74  74  74</td>
</tr>
</tbody>
</table>

**Electrical output**

- Minimum of 0.5% to 99.5% applied volts
- Virtually infinite
- Less than 0.01mm

**Hysteresis (repeatability)**

- From -30 to +100 (tested to +130 for 12 hours duration)
- To MIL-R-39023 grade C 0.1%
- Greater than 100 MΩ at 500 Vdc

**Operational temperature °C**

- -30 to +100 (tested to +130 for 12 hours duration)
- To MIL-R-39023 grade C 0.1%
- Greater than 100 MΩ at 500 Vdc

**Output smoothness**

- Typically greater than 100 million operations (50 x 10⁶ cycles) at 25mm stroke length
- 200 million operations (100 x 10⁶ cycles) at ±0.5mm, 60Hz

**Shaft seal life**

- 20 million operations (10 x 10⁶ cycles) - replaceable

**Shaft velocity maximum m/s**

- 10

**Vibration**

- RTCA 160D 10Hz to 2kHz (random) @ 12.6g (rms) - all axes
- Less than 0.04% output change @ 2500g - all axes

**Shock**

- RTCA 160D 10Hz to 2kHz (random) @ 12.6g (rms) - all axes
- Less than 0.04% output change @ 2500g - all axes

**CIRCUIT RECOMMENDATION**

Hybrid track potentiometers feature a high wiper contact resistance, therefore operational checks should be carried out only in the voltage divider mode. Hybrid track potentiometers should be used only as voltage dividers, with a minimum wiper circuit impedance of 100 x track resistance or 0.5 MΩ (whichever is greater). Operation with wiper circuits of lower impedance will degrade the output smoothness and affect the linearity.

**OPTIONS**

- Compact shaft
- Integral shaft seal - IP 66
- Extended cable length
- Mounting
- Protective sleeve

**ACCESSORIES**

- Compact shaft will reduce dimension D by 25mm
- Designed to accept integral shaft seal to give IP66 rating
- 10m output cable can be specified
- Body clamp or flange mounting kits can be supplied
- For all stroke lengths - self aligning bearings only. See ordering code

**AVAILABILITY**

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

SLS190/...../...../...../.....

Electrical stroke
Shaft L = long, C = compact

Protective sleeve N = None, P = Fitted
Cable 1 = 1m, 10 = 10m
Sealing 50 = IP50, 66 = IP66

DIMENSIONS AND MOUNTING OPTIONS

Note: drawings not to scale

SELF ALIGNING BEARING MOUNTING

PROTECTIVE SLEEVE OPTION - P

MOUNTING OPTIONS

Body clamp
SA59019

Flange mounting
SA59020

ELECTRICAL CONNECTIONS

3 core cable: PUR sheathed 1m long with ETFE insulated 19/0.15 cores.
throttle pedal position

gear select position indication

hydraulic reservoir level

front and rear suspension movement

throttle actuator position

steering angle position

gearbox actuator position

clutch pedal position

clutch actuator position

brake balance measurement

brake pad/disc wear indication
The Penny + Giles high performance ratiometric LVDTs benefit from our extensive experience in fly-by-wire control systems for flight critical aerospace applications. Using high integrity coil, screen and connection assemblies, combined with welded and vacuum brazed stainless steel construction, these LVDTs can be supplied in a range of shaft and body configurations to suit clutch, gearbox, engine and brake applications.

**Features**
- No contact between the sensing elements
- Infinite resolution
- Small transducer body length to stroke ratio
- Welded and vacuum brazed stainless steel construction
- Sealed to IP66
- Temperature range -55 to +200°C
- High integrity coil, screen and connection assemblies
- Screened and sheathed interface cable
- Temperature error less than 35ppm/°C

**Benefits**
- Virtually infinite life and fast dynamic response
- All displacement will be sensed
- Minimal operational footprint and weight
- Maximum reliability in hostile environments
- High performance in electrically noisy environments
- Maximises system accuracy
The AF111 range of high accuracy LVDT displacement transducers have been designed primarily for use in the ratiometric configuration and have a compact size, with stroke lengths from 5mm to 150mm. Suitable for clamp mounting, the AF111 range has a threaded, unguided core assembly to simplify installation. Suited to numerous applications, such as vehicle research, and test rigs.

**PERFORMANCE**

<table>
<thead>
<tr>
<th>Electrical stroke E (mm)</th>
<th>5</th>
<th>15</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>±</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Input voltage and frequency

Operational temperature (°C)

Storage temperature (°C)

Vibration

Environmental protection

Electrical output R proportional to position

Electrical output R at extremes from null ±1% total stroke

Non-linearity ±% total stroke

Secondary coil output voltage

Input impedance

Load resistance (per coil)

Temperature error maximum % total stroke/°C

**OUTPUT SCHEMATIC**

Ratiometric configuration

**DIMENSIONS**

Note: drawings not to scale

<table>
<thead>
<tr>
<th>Electrical stroke E (mm)</th>
<th>5</th>
<th>15</th>
<th>25</th>
<th>50</th>
<th>75</th>
<th>100</th>
<th>125</th>
<th>150</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical stroke M (non captive shaft) (mm)</td>
<td>9</td>
<td>19</td>
<td>29</td>
<td>54</td>
<td>79</td>
<td>104</td>
<td>129</td>
<td>154</td>
</tr>
<tr>
<td>Dimension B (mm)</td>
<td>55</td>
<td>65</td>
<td>80</td>
<td>105</td>
<td>150</td>
<td>175</td>
<td>215</td>
<td>240</td>
</tr>
<tr>
<td>Dimension C (mm)</td>
<td>75</td>
<td>90</td>
<td>110</td>
<td>147.5</td>
<td>205</td>
<td>242.5</td>
<td>295</td>
<td>332.5</td>
</tr>
<tr>
<td>Weight (maximum) (g)</td>
<td>45</td>
<td>50</td>
<td>55</td>
<td>67</td>
<td>90</td>
<td>100</td>
<td>120</td>
<td>140</td>
</tr>
</tbody>
</table>

**AVAILABILITY**

Normally available from stock

**ORDERING CODE**

AF111/.....

Electrical stroke (total) mm

**ELECTRICAL CONNECTIONS**

See AF145 page 15
The AF145 range of high accuracy LVDT displacement transducers have been designed primarily for use in the ratiometric configuration, and have a compact size, with stroke lengths from 5mm to 150mm. The AF145 has self-aligning rod end bearing mounting, with an outer sliding sleeve which protects the movable core whilst enhancing the rigidity of the transducer during operation. Suited to harsh automotive and industrial environments.

**PERFORMANCE**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E mm</td>
<td>5 15 25 50 75 100 125 150</td>
</tr>
<tr>
<td>±</td>
<td>2.5 7.5 12.5 25.0 37.5 50.0 62.5 75.0</td>
</tr>
<tr>
<td>Input voltage and frequency</td>
<td>1 to 10VRMS at 400Hz to 12.5kHz (sinewave)</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Greater than 100MΩ at 500Vdc</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>-35 to +125</td>
</tr>
<tr>
<td>Storage temperature °C</td>
<td>-55 to +135</td>
</tr>
<tr>
<td>Vibration</td>
<td></td>
</tr>
</tbody>
</table>

**Environmental protection**

- Electrical output R proportional to position
  \[ R = \frac{V_a - V_b}{V_a + V_b} \]
- Electrical output R at extremes from null ±1% total stroke
  - 0.3 0.3 0.4 0.4 0.6 0.6 0.6
- Non-linearity ±% total stroke
  - 0.25 0.25 0.25 0.25 0.25 0.125 0.125 0.125
- Secondary coil output voltage
  - 3.3VRMS maximum
- Input impedance
  - Greater than 300Ω
- Load resistance (per coil)
  - Greater than 50kΩ (non reactive)
- Temperature error maximum % total stroke/°C
  - 0.0012 0.0012 0.0012 0.0020 0.0020 0.0030 0.0030 0.0030

**OUTPUT SCHEMATIC**

See AF111 page 14

**DIMENSIONS**

Note: drawings not to scale

<table>
<thead>
<tr>
<th>Dimension C (retracted) mm</th>
<th>100</th>
<th>110</th>
<th>125</th>
<th>150</th>
<th>195</th>
<th>220</th>
<th>260</th>
<th>285</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (maximum) g</td>
<td>65</td>
<td>80</td>
<td>90</td>
<td>115</td>
<td>155</td>
<td>175</td>
<td>200</td>
<td>220</td>
</tr>
</tbody>
</table>

**AVAILABILITY**

Normally available from stock

**ORDERING CODE**

AF145/.....

**ELECTRICAL CONNECTIONS**

5 flying leads 24AWG, screened and sleeved 500mm long

**Phasing notes**

With blue and black leads common, the output on the yellow lead will be in-phase with the red lead (input) as the shaft retracts from the null position.
This specially developed ac LVDT is an example of our capability in producing an extremely compact size (8mm diameter) with a minimal footprint (20mm stroke within a 44mm body length). This LVDT is also suitable for continuous operation at temperatures up to +200°C and is ideally suited for use in clutch position and brake caliper position measurement in the premier classes of motor sport. For optimum performance this LVDT is designed to operate in the ratiometric configuration.

### PERFORMANCE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E mm</td>
<td>±20</td>
</tr>
<tr>
<td>Input voltage and frequency</td>
<td>3VRMS at 5kHz (sinewave)</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Greater than 20MΩ at 500Vdc</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>-55 to +200</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>IP66</td>
</tr>
<tr>
<td>Electrical output R proportional to position</td>
<td>R = (Va - Vb) / (Va + Vb)</td>
</tr>
<tr>
<td>Non-linearity ±% total stroke</td>
<td>0.441</td>
</tr>
<tr>
<td>Summed output voltage (Va+Vb) ±20%</td>
<td>0.7V/V</td>
</tr>
<tr>
<td>Total stroke ratio</td>
<td>0.882</td>
</tr>
<tr>
<td>Input impedance</td>
<td>Greater than 150Ω</td>
</tr>
<tr>
<td>Load resistance (per coil)</td>
<td>Greater than 50kΩ (non reactive)</td>
</tr>
<tr>
<td>Non-linearity ±% total stroke</td>
<td>0.0441</td>
</tr>
<tr>
<td>Temperature error maximum % total stroke/°C</td>
<td>0.0030</td>
</tr>
</tbody>
</table>

### OUTPUT SCHEMATIC

**Ratiometric configuration**

**ac output schematic**

### AVAILABILITY

Please consult our sales office for details.

### ORDERING CODE

Please consult our sales office for details.

### DIMENSIONS

Note: drawings not to scale

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E mm</td>
<td>20</td>
</tr>
<tr>
<td>Mechanical stroke M mm</td>
<td>22</td>
</tr>
<tr>
<td>(non captive shaft)</td>
<td></td>
</tr>
<tr>
<td>Weight (maximum) g</td>
<td>47 (15g for sensor and core only)</td>
</tr>
</tbody>
</table>
This high accuracy LVDT displacement transducer has been designed for use in the ratiometric configuration and has a compact size, with stroke lengths from 25mm to 75mm. This design has self-aligning rod end bearing mounting and features an outer sliding sleeve which protects the movable core whilst enhancing the rigidity of the transducer during operation. Suited to suspension and throttle position feedback applications in premier classes of motorsport.

### PERFORMANCE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke E (mm)</td>
<td>25, 50, 75</td>
</tr>
<tr>
<td>Input voltage and frequency</td>
<td>±12.5, 25.0, 37.5 Vrms at 2.5kHz (sinewave)</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Greater than 20MΩ at 500Vdc</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>-30 to +130</td>
</tr>
<tr>
<td>Storage temperature °C</td>
<td>-55 to +135</td>
</tr>
<tr>
<td>Environmental protection</td>
<td>IP66</td>
</tr>
<tr>
<td>Electrical output R proportional to position</td>
<td>R = ( \frac{V_a - V_b}{V_a + V_b} )</td>
</tr>
<tr>
<td>Electrical output R at extremes from null ±1% total stroke</td>
<td>0.5, 0.5, 0.5</td>
</tr>
<tr>
<td>Non-linearity ±% total stroke</td>
<td>0.5, 0.5, 0.5</td>
</tr>
<tr>
<td>Ratiometric sensitivity per mm</td>
<td>0.04, 0.02, 0.0133</td>
</tr>
<tr>
<td>Summed output voltage (Va+Vb) ±20%</td>
<td>0.641, 0.872, 0.761</td>
</tr>
<tr>
<td>Input impedance</td>
<td>Greater than 200Ω</td>
</tr>
<tr>
<td>Load resistance (per coil)</td>
<td>Greater than 50kΩ (non reactive)</td>
</tr>
<tr>
<td>Temperature error maximum % total stroke/°C</td>
<td>0.0030</td>
</tr>
</tbody>
</table>

### OUTPUT SCHEMATIC

See Ø8mm Special LVDT output schematic, page 16

### AVAILABILITY

Please consult our sales office for details.

### ORDERING CODE

D45371/.....

### DIMENSIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical stroke (total) mm</td>
<td>25, 50, 75</td>
</tr>
<tr>
<td>Mechanical stroke M (mm)</td>
<td>27, 52, 77</td>
</tr>
<tr>
<td>(non captive shaft)</td>
<td></td>
</tr>
<tr>
<td>Dimension C retracted mm</td>
<td>115, 135, 180</td>
</tr>
<tr>
<td>Weight (maximum) g</td>
<td>42, 52, 68</td>
</tr>
</tbody>
</table>

### ELECTRICAL CONNECTIONS

**SPECIAL Ø8mm**

5 flying leads 28AWG, screened and sleeved 1000mm long

**SPECIAL Ø11mm**

5 flying leads 26AWG, screened and sleeved 500mm long

Ratiometric connection configuration

**Phasing notes**

With blue and black leads common, the output on the yellow lead will be in-phase with the red lead (input) as the shaft retracts from the null position.
CONTACTLESS ROTARY POSITION SENSORS
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.
NRH 280 DP

dual output no contact rotary sensor

PERFORMANCE

ELECTRICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</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 Output to GND</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>In 5V regulated mode only</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

Voltage output range

<table>
<thead>
<tr>
<th>Supply</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-30V supply</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</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</td>
<td>0.25 (5%) and 4.75 (95%) nominal (A1)</td>
</tr>
<tr>
<td></td>
<td>0.05 (1%) and 4.95 (99%) nominal (A4)</td>
</tr>
<tr>
<td>Load resistance</td>
<td>10k minimum (resistive to GND)</td>
</tr>
<tr>
<td>Output noise</td>
<td>mVrms</td>
</tr>
<tr>
<td>Input/output delay</td>
<td>mS</td>
</tr>
<tr>
<td></td>
<td>&lt;1</td>
</tr>
<tr>
<td></td>
<td>&lt;2</td>
</tr>
</tbody>
</table>

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

PWM frequency Hz

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

PWM levels 9-30V supply Vdc

<table>
<thead>
<tr>
<th>Value</th>
<th>Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 and 5 nominal (±3%)</td>
<td></td>
</tr>
</tbody>
</table>

PWM levels 5V supply Vdc

<table>
<thead>
<tr>
<th>Value</th>
<th>Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 and Vs (±1%)</td>
<td></td>
</tr>
</tbody>
</table>

Duty cycle %

<table>
<thead>
<tr>
<th>Value</th>
<th>Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 to 90 over measurement range</td>
<td></td>
</tr>
</tbody>
</table>

Monotonic range %

<table>
<thead>
<tr>
<th>Value</th>
<th>Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 and 95 nominal</td>
<td></td>
</tr>
</tbody>
</table>

Load resistance Ω

<table>
<thead>
<tr>
<th>Value</th>
<th>Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>10k minimum (resistive to GND)</td>
<td></td>
</tr>
</tbody>
</table>

Rise/fall time μS

<table>
<thead>
<tr>
<th>Value</th>
<th>Hz</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;15</td>
<td></td>
</tr>
</tbody>
</table>

MECHANICAL

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</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>
ENVIRONMENTAL

Protection class
Life
Dither life
Operational temperature\(^\d\) °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)

\(^\d\) 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

<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>A4 = Analog 0.1-4.9Vdc</td>
</tr>
<tr>
<td></td>
<td>P1 = PWM, 244Hz</td>
</tr>
<tr>
<td></td>
<td>P2 = PWM, 500Hz</td>
</tr>
<tr>
<td></td>
<td>P3 = PWM, 1000Hz</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>Magnet holder</td>
<td>B = Bolt type</td>
</tr>
<tr>
<td></td>
<td>P = Plug type</td>
</tr>
<tr>
<td></td>
<td>M = Magnet only</td>
</tr>
<tr>
<td>Cable length</td>
<td>P5 = 0.5m</td>
</tr>
</tbody>
</table>
**ELECTRICAL CONNECTIONS**

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>O utput 1</td>
</tr>
<tr>
<td>White</td>
<td>O utput 2</td>
</tr>
<tr>
<td>Black</td>
<td>0V Supply (GND)</td>
</tr>
</tbody>
</table>

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.

**MAGNET MISALIGNMENT**

2mm to 7mm Z axis air gap

When any magnet offset or misalignment will increase non-linearity.

**DIMENSIONS**

Note: drawings not to scale.
NRH 285DR Dual Redundant Output
no contact rotary sensor - 5Vdc operation only

**PERFORMANCE**

**ELECTRICAL**

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

* 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 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)
- 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 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
- Maximum rotational speed °/sec: 3600
- Weight g: <55 (with bolt type magnet carrier)
- Mounting
  - 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.
  - 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.

- Phasing
NRH 285 DR

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)
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

ORDERING CODES

NRH285DR/...../...../...../...../...../...../.....

NRH 285 DR

Ordering code

Measurement range
CH1 = angle in °
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
ELECTRICAL CONNECTIONS

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

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

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

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.

MAGNET MISALIGNMENT

Note: any magnet offset or misalignment will increase non-linearity

DIMENSIONS

Note: drawings not to scale

MAGNET HOLDER OPTIONS

Output channel ident (engraved on the mounting plate)

ELECTRICAL ANGLE

Mid point of electrical angle

Ident facing towards cable exit

Plug type

Bolt type

PLUG/MOUNTING PLATE

Bolt type

Plug type

Magnet

Ident facing towards cable exit

Phasing note: sensor is at mid point of electrical angle when magnet ident and cable exit are aligned

IDENT FACING AWAY FROM CABLE EXIT

BEHIND CABLE EXIT

Magnet only

50.00

6.50

3.00

1.00

5.00

8.00

M10x1

ø17.00

32.00

8.00

22.00

20.00

20.00

2.00 X axis max offset

2.00 X axis max offset

2.00 X axis max offset

1.00

3.00

2.00 Y axis max offset

Z axis air gap

2mm to 7mm

Section X-X

Note: any magnet offset or misalignment will increase non-linearity
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;12.5</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>In 5V regulated mode only</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;±50</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

Voltage output range

<table>
<thead>
<tr>
<th>Supply</th>
<th>Vdc</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-30V supply</td>
<td></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</td>
<td></td>
<td>Ratio metric output voltage - 10 to 90% (A1) or 2 to 98% (A4) of Vs over measurement range (±1%)</td>
</tr>
</tbody>
</table>

Monotonic range Vdc 0.25 (5%) and 4.75 (95%) nominal (A1)  
Monotonic range 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 mS <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

<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 - maximum</td>
<td></td>
</tr>
<tr>
<td>sealed shaft IP68 g-cm</td>
<td>120</td>
</tr>
<tr>
<td>unsealed shaft IP50 g-cm</td>
<td>100</td>
</tr>
<tr>
<td>Shaft velocity maximum °/sec</td>
<td>3600</td>
</tr>
<tr>
<td>Weight g</td>
<td>&lt;35</td>
</tr>
</tbody>
</table>

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

Phasing
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.
SRH 280P

ENVIRONMENTAL

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

IP68 (to 2m depth for 1 hour) or IP50
20 million operations (10x10⁶ cycles) of ±75⁰
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.
Contactless - no degradation due to shaft dither
-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
-55 to +140
BS EN 60068-2-64:1995 Sec 8.4 (14gn rms) 20 to 2000Hz Random
3m drop onto concrete
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)
Output
Output direction
Shaft style
Shaft sealing
Cable length m
Custom housing
OEM options

Select from 20° to 360° in 1° increments (factory programmed)
Analog voltage (An) or PWM (Pn)
Clockwise or Anticlockwise shaft rotation with increasing output
D section, sprung shaft (S) or 2.4mm blade shaft (H)
IP50 or IP68
0.2, 0.5 or 2.0
Synchro mount style with ball race bearings - ask our technical sales team for details
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

SRH280P/...../...../...../...../...../.....

Measurement range = 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
1 = Clockwise
2 = Anticlockwise

Shaft style
D = D shaft
S = Sprung shaft
H = 2.4mm blade shaft

Shaft sealing
50 = IP50
68 = IP68

Cable length
P2 = 0.2m
P5 = 0.5m
02 = 2.0m
**SHAFT OPTIONS**

**D shaft**
- Cable exit
- All shafts ø6.000 ±0.007

**S shaft**
- Cable exit
- Shaft ident.
- Ears pre-sprung to 3.10/3.15
- Suggested mating drive for ‘S’ shaft

**H shaft**
- Cable exit
- Shaft ident.
- Flats 2.465 to 2.415
- Suggested mating drive for ‘H’ shaft

**DIMENSIONS**

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ø38.00 PCD</td>
<td>3-core cable 19/0.15</td>
</tr>
<tr>
<td>ø5.10</td>
<td>Stainless steel inserts 0.75 thick</td>
</tr>
<tr>
<td>ø4.50</td>
<td>3.50</td>
</tr>
<tr>
<td>ø3.60</td>
<td>3.00</td>
</tr>
<tr>
<td>ø3.20 flange thickness</td>
<td>14.70</td>
</tr>
<tr>
<td>ø21.00</td>
<td>16.00</td>
</tr>
<tr>
<td>ø10.000</td>
<td>18.35 max</td>
</tr>
<tr>
<td>ø8.50</td>
<td>3.50</td>
</tr>
<tr>
<td>ø5.10</td>
<td>4.50</td>
</tr>
<tr>
<td>ø3.60</td>
<td>3.20 flange thickness</td>
</tr>
<tr>
<td>ø3.10/3.15</td>
<td>14.70</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.
SRH280DP Dual Output
contactless rotary sensor

PERFORMANCE

ELECTRICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</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>Yes</td>
</tr>
<tr>
<td>Output to supply</td>
<td>In 5V regulated mode only</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>Value</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>Ratio metric 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>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>Value</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>

MECHANICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical angle °</td>
<td>360, continuous</td>
</tr>
<tr>
<td>Operating torque - maximum</td>
<td></td>
</tr>
<tr>
<td>sealed shaft IP68 g-cm</td>
<td>120</td>
</tr>
<tr>
<td>unsealed shaft IP50 g-cm</td>
<td>100</td>
</tr>
<tr>
<td>Shaft velocity maximum °/sec</td>
<td>3600</td>
</tr>
<tr>
<td>Weight g</td>
<td>&lt;35</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 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 10⁶ 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
-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
-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**

SRH280DP/....../....../....../....../....../......

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

Shaft style D = D shaft
S = Sprung shaft
H = 2.4mm blade shaft

Shaft sealing 50 = IP50
68 = IP68

Cable length P2 = 0.2m
P5 = 0.5m
**DIMENSIONS**

Note: drawings not to scale.

---

**SHAFT OPTIONS**

- **D shaft**
  - All shafts are ø6.000 / 5.987

- **S shaft**
  - Ears pre-sprung to 3.10/3.15

- **H shaft**
  - Flats 2.400 - 2.390
  - Shaft ident.

---

**ELECTRICAL CONNECTIONS**

200 or 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)

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.

Output increases with CW or ACW rotation viewed on shaft - depending on selected order code.
**TPS 280DP 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>Yes</td>
</tr>
<tr>
<td>Output to GND</td>
<td>In 5V regulated mode only</td>
</tr>
<tr>
<td>Output to supply</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Power-on settlement time S</td>
<td>0.025 of measurement range (12 bit)</td>
</tr>
<tr>
<td>Resolution %</td>
<td>&lt;±0.4</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>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>

#### 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>Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2N.m</td>
</tr>
<tr>
<td>Phasing</td>
<td>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.</td>
</tr>
</tbody>
</table>
**TPS280DP**

**ENVIROMENTAL**

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

- **Operational temperature**
  - -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

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

- **Vibration**
  - BS EN 60068-2-64:1995 Sec 8.4 (31.4gn rms) 20 to 2000Hz Random
  - 3m drop onto concrete and 2500g

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

- **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)**
- **Output**
- **Output direction**
- **Cable length**
- **Connector**
- **OEM 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**
  - 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 ACW
- **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 (2off required)
  - X61-227-202 SOCKET contact (2off required)
**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

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

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

**C1 Connector option**

- Pin 1 = V+ Supply
- Pin 2 = 0V Supply GND
- Pin 3 = CH1 Output
- 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.
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 Vs (±1%) for 5V supply

t = pulse width (Increases with shaft direction code)

D = duty cycle = t/T

T = periodic time = 1/f

Sensor electrical angle (from ordering code)

Actual measured output angle = 1.25 t/T

PWM OUTPUT CHARACTERISTICS

SRH501P/502P - OUTPUT A1
SRH880P - OUTPUT A

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

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

PWM levels = zero volt and 5V (±3%) for 9-30V supply
= zero volt and Vs (±1%) for 5V supply
Penny+Giles high durability potentiometer track technology provides virtually infinite resolution, low electrical noise and high stability under extremes of temperature, humidity, vibration and shock over a long operating life. These potentiometers are ideally suited and race proven in providing data acquisition systems with clean, robust signals for throttle angle, steering angle and gear select position indication.

**Features**
- Corrosion resistant stainless steel shaft
- Duplex shaft bearing support
- Choice of shaft attachments
- Hybrid and conductive plastic tracks
- Electrical angles from $10^\circ$ to $350^\circ$
- Rugged mechanical design
- Sealing to IP68 (SRS280)
- Rapid despatch of any option (SRS280)
- CE Approved (SRS280)

**Benefits**
- Accurate drive location in hostile environments
- Optimum performance under vibration
- Interchangeable with existing installations
- Stable output signal over a long life
- Maximum sensitivity in all applications
- Operation in high shock and vibration environments
- Operation in hostile environments
- Eliminates customer inventory
- Confidence in EMC performance
### PERFORMANCE

#### ELECTRICAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical angle</td>
<td>±2°</td>
</tr>
<tr>
<td>Resistance</td>
<td>±20% Ω</td>
</tr>
<tr>
<td>Hysteresis (repeatability)</td>
<td>±2°</td>
</tr>
<tr>
<td>Accuracy</td>
<td>&lt; 0.03</td>
</tr>
<tr>
<td>Power dissipation at 20°C</td>
<td>0.003 W per angular degree</td>
</tr>
<tr>
<td>Applied voltage maximum Vdc</td>
<td>0.2 per angular degree</td>
</tr>
<tr>
<td>Resolution</td>
<td>Virtually infinite</td>
</tr>
<tr>
<td>Output smoothness</td>
<td>To MIL-R-39023 grade C 0.1%</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Greater than 100MΩ at 500Vdc</td>
</tr>
<tr>
<td>Operating mode</td>
<td>Voltage divider only - see Circuit Recommendation below</td>
</tr>
<tr>
<td>Wiper circuit impedance</td>
<td>Minimum of 100 x track resistance or 0.5MΩ (whichever is greater)</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>Mounting</td>
<td>Use 2 x M4 socket head cap screws and M4 washer - maximum tightening torque 2Nm</td>
</tr>
<tr>
<td>Operating torque maximum unsealed shaft IP50 gm cm</td>
<td>100</td>
</tr>
<tr>
<td>Operating torque maximum sealed shaft IP68 gm cm</td>
<td>120</td>
</tr>
<tr>
<td>Shaft velocity maximum</td>
<td>3000</td>
</tr>
<tr>
<td>Weight</td>
<td>32 (cable option A), 64 (cable option B)</td>
</tr>
<tr>
<td>Phasing</td>
<td>When shaft flat (or shaft ident mark) is facing the cable exit, wiper is at mid travel</td>
</tr>
<tr>
<td>The sensor housing allows for ±10° adjustment via the mounting flange slots</td>
<td></td>
</tr>
</tbody>
</table>

#### ENVIRONMENTAL

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life unsealed shaft IP50</td>
<td>Exceeds 20 million operations (10 x10⁶ cycles) of ±75°</td>
</tr>
<tr>
<td>Life sealed shaft IP68</td>
<td>20 million operations (10 x10⁶ cycles) of ±75°</td>
</tr>
<tr>
<td>Dither life</td>
<td>200 million operations (100 x 10⁶ cycles) of ±3°, 60Hz</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>-40 to +130 (continuous)</td>
</tr>
<tr>
<td>Vibration</td>
<td>RTCA-DO160D, 10Hz to 2000Hz (random), 12.61g rms - all axes</td>
</tr>
<tr>
<td>Shock</td>
<td>Survival to 2500g - all axes</td>
</tr>
</tbody>
</table>

#### CIRCUIT RECOMMENDATION

Hybrid track potentiometers feature a high wiper contact resistance, therefore operational checks should be carried out only in the voltage divider mode. Hybrid track potentiometers should be used only as voltage dividers, with a minimum wiper circuit impedance of 100 x track resistance or 0.5MΩ (whichever is greater). Operation with wiper circuits of lower impedance will degrade the output smoothness and affect the linearity.

### OPTIONS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical angle</td>
<td>Can be supplied from 10° to 350° in 10° increments</td>
</tr>
<tr>
<td>Shaft style</td>
<td>D section, sprung shaft (S) or 2.4mm blade shaft (H)</td>
</tr>
<tr>
<td>Shaft sealing</td>
<td>IP50 or IP68</td>
</tr>
<tr>
<td>Cable length</td>
<td>0.5m or 2m</td>
</tr>
</tbody>
</table>

### AVAILABILITY

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

Electrical angle
Shaft style  
D = D shaft  
S = Sprung shaft  
H = 2.4mm blade shaft

Cable  
A = 0.5m, B = 2m  
Shaft sealing  
50 = IP50  
68 = IP68

**DIMENSIONS**

Note: drawings not to scale

**SHAFT OPTIONS**

D shaft
- Cable exit
- 4.500
- 4.450
- All shafts are ø6.000 ±.007
- Ears pre-sprung to 3.10/3.15
- Shaft ident.
- 7.50
- Suggested mating drive for 'S' shaft

S shaft
- Cable exit
- 3.000
- 3.060
- Flats 2.400
- 2.390
- Shaft ident.
- 7.50
- Suggested mating drive for 'H' shaft

H shaft
- Cable exit
- 2.465
- 2.415
- Flats 2.400
- 2.390
- Shaft ident.
- 7.50
- Suggested mating drive for 'H' shaft

**ELECTRICAL CONNECTIONS**

3 core cable: PUR sheathed, with PTFE insulated 19/0.15 cores.

3 core cable 19/0.15
This specially developed RCP11 has dual electrical output and facilitates low electrical noise and virtually infinite resolution over exceptionally long operating life under extreme operating conditions. This potentiometer is ideally suited and race proven in providing data acquisition systems with clean, robust signals for gear select position indication.

**PERFORMANCE**

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrical angle ±1°</td>
<td>350</td>
</tr>
<tr>
<td>Resistance ±10% kΩ</td>
<td>1</td>
</tr>
<tr>
<td>Independent linearity ±%</td>
<td>0.25</td>
</tr>
<tr>
<td>Power dissipation at 20°C W</td>
<td>1.5</td>
</tr>
<tr>
<td>Dielectric strength Vrms</td>
<td>750</td>
</tr>
<tr>
<td>Applied voltage - maximum Vdc</td>
<td>38</td>
</tr>
<tr>
<td>Resolution</td>
<td>Virtually infinite</td>
</tr>
<tr>
<td>Output smoothness</td>
<td>To MIL-R-39023 grade C 0.1%</td>
</tr>
<tr>
<td>Insulation resistance</td>
<td>Greater than 100MΩ at 500Vdc</td>
</tr>
<tr>
<td>Phasing between tracks ±1°</td>
<td>at 50% applied voltage</td>
</tr>
<tr>
<td>Operating mode</td>
<td>Voltage divider only - see Circuit Recommendation below</td>
</tr>
<tr>
<td>Maximum wiper current mA</td>
<td>10</td>
</tr>
<tr>
<td>Mechanical angle ±°</td>
<td>360 continuous</td>
</tr>
<tr>
<td>Starting torque - maximum gm cm</td>
<td>16</td>
</tr>
<tr>
<td>Shaft run out - TIR mm</td>
<td>0.025</td>
</tr>
<tr>
<td>Lateral run out - TIR mm</td>
<td>0.051</td>
</tr>
<tr>
<td>Pilot run out - TIR mm</td>
<td>0.025</td>
</tr>
<tr>
<td>Shaft end play - maximum mm</td>
<td>0.076</td>
</tr>
<tr>
<td>Weight g</td>
<td>25</td>
</tr>
<tr>
<td>Life</td>
<td>Greater than 50 million rotations</td>
</tr>
<tr>
<td>Operational temperature °C</td>
<td>-65 to +130</td>
</tr>
</tbody>
</table>

**CIRCUIT RECOMMENDATION**

The RCP11 range of potentiometers feature a high wiper contact resistance, therefore operational checks should be carried out only in the voltage divider mode. These potentiometers should be used only as voltage dividers, with a minimum wiper circuit impedance of 100 x track resistance or 0.5MΩ (whichever is greater). Operation with wiper circuits of lower impedance will degrade the output smoothness and affect the linearity.

**OPTIONS**

- Electrical angle
- Resistance
- Single gang output
- Mounting

**AVAILABILITY**

Please consult our sales office for details

**ORDERING CODE**

RCP11/2S D150397

**DIMENSIONS**

Note: drawings not to scale

**ELECTRICAL CONNECTIONS**

SRS280

3 core cable: PUR sheathed, with PTFE insulated 19/0.15 cores

RCP11/2S

6x terminals, gold plated
The Penny+Giles rugged, high integrity RVDT displacement transducer is designed for operation in harsh automotive and motorsport environments. The design elements employed have evolved from the technology and experience gained over 40 successful years in the aerospace/military sensor market, where performance and reliability under extreme operating conditions are paramount.

**High accuracy system performance**

This ac operated RVDT displacement transducer has been designed primarily for use in the ‘difference over sum’ (ratiometric) configuration to provide high system accuracy performance where the output is virtually unaffected by temperature and supply changes. Using high integrity coil and rotor designs, combined with a titanium housing, this RVDT can be supplied with a choice of shaft and mounting flanges to suit high performance, high temperature engine control applications.

### Features

- No contact between the sensing elements
- Precision low torque bearings
  - Infinite resolution
- Temperature range -40° to +180°C
- High integrity coils, screen and connection assemblies
  - Corrosion resistant stainless steel drive shaft
- Rugged mechanical design with titanium housing

### Benefits

- Virtually infinite life and fast dynamic response
- Long trouble free life
- All displacement will be sensed
- Maximum reliability in hostile environments
- Maximum reliability in hostile environments
- Accurate drive location in hostile environments
- Maximum reliability in high shock and vibration environments
**PERFORMANCE**

- **Electrical angle**: ±60° (120 total)
- **Mechanical angle**: 360° continuous
- **Input voltage**: 3
- **Input frequency**: 2 kHz
- **Insulation resistance**: Greater than 50 MΩ at 250 Vdc
- **Resolution**: Virtually infinite
- **Operational temperature**: -40 to +180°C
- **Operating mode**: Ratiometric
- **Electrical output R proportional to position**:
  \[ R = \frac{V_a - V_b}{V_a + V_b} \]
- **Electrical output R at ±60°**: ±0.504
- **Non-linearity (0 to ±50°)**: ±% 1
- **Non-linearity (±50° to ±60°)**: ±% 2
- **Input impedance**: Greater than 150 Ω at 2 kHz
- **Load resistance (per coil)**: Greater than 100 kΩ
- **Phasing**: With black, white and yellow leads common, the output on blue and green leads shall be in anti-phase with the red input for all shaft positions.
- **Temperature error**: ppm/°C
- **Weight (maximum)**: 85 g

**OPTIONS**

- **Mounting**: Custom mounting configurations can be specified

**ORDERING CODE**

RVDT D45600

**DIMENSIONS**

**Note**: drawings not to scale

**ELECTRICAL CONNECTIONS**

- 6 flying leads 26 AWG, sleeved 500 mm long

**OUTPUT SCHEMATICS**

**Suggested driving slot for shaft**

**Individual output voltage schematic**

**Alternative mounting styles**
throttle pedal position

gear select position indication

hydraulic reservoir level

front and rear suspension movement

throttle actuator position

steering angle position

gearbox actuator position

clutch pedal position

clutch actuator position

brake balance measurement

brake pad/disc wear indication
www.pennyandgiles.com

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