Description

Inverted and Hanging Pendulums are used for accurate, long term monitoring of horizontal movements in large structures.

The Hanging Pendulum comprises a Stainless Steel wire which is anchored at its top to the structure. A weight suspended from the lower end of the wire moves in an oil tank, the oil serving to dampen the oscillations of the wire. Measurements in the X and Y axes are taken along the wire, using a portable optical readout or an automatic CCD (Charge Coupled Device) system.

For both Inverted and Hanging Pendulums, vertical (Z axis) measurements can optionally be taken by using a CCD system in conjunction with a reference mark on the wire.

The Inverted Pendulum uses identical measuring devices but the wire is anchored in stable ground beneath the structure, with a float fixed to the upper end of the wire which floats in a water tank, tensioning the wire and keeping it vertical.

Features

- Greater measuring accuracy than precise geodetic surveying
- Manual or automatic readouts available
- Simple to use
- Long-term reliability

Benefits

- Movements can be observed at frequent intervals without repeated and costly surveys
- Ideal for long-term use
- Can read X, Y and Z movement
**Operation**

**Hanging Pendulum:** The upper end of a Stainless Steel wire is anchored to the structure under observation. A weight suspended from the lower end of the wire keeps it under tension whilst being free to move in an oil tank.

**Inverted Pendulum:** The wire is anchored in stable ground beneath the structure. A float is fixed to the upper end of the wire which is then allowed to float free in a water tank whilst keeping tension in the wire.

Readings for both versions of the pendulum are treated in the same way. Displacements relative to the wire are measured using a portable optical readout or, for remote reading, an automatic CCD system. The reading arrays are corrected for temperature and an external digital display can be connected to the readout unit to display the X and Y (and Z, if used) positions in millimetres.

The readout can be incorporated into almost any data acquisition system.

**Applications**

Hanging and Inverted Pendulum Systems are designed for accurate and long-term measurement of horizontal movements associated with the rotation or tilting of a structure.

Typical applications include:

- Dams and dam foundations
- Abutments
- Bridges and piers
- Towers
- Nuclear power stations
- Tall buildings

**Associated products**

<table>
<thead>
<tr>
<th>For details on:</th>
<th>Catalogue code:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dataloggers</td>
<td>D1</td>
</tr>
<tr>
<td>Automatic Pendulum Readout (CCD System)</td>
<td>C1-5</td>
</tr>
<tr>
<td>Manual Pendulum Readout System</td>
<td>C1-4</td>
</tr>
<tr>
<td>Argus Monitoring Software</td>
<td>D4</td>
</tr>
</tbody>
</table>

View our full product range on [www.soil.co.uk](http://www.soil.co.uk)

**The technical rating for this product:**

**BASIC**

- The installer is trained and experienced in the installation of this type of instrument or systems, and is ideally a specialist Instrumentation and Monitoring contractor.

**ADVANCED**

- The installer already has previous experience and/or training in the installation of this instrument or system.

**INTERMEDIATE**

- As a minimum the installer has read and fully comprehends the manual, and if possible has observed these instruments or systems being installed by others.

**BASIC**

- As the correct installation of any monitoring sensor or system is vital to maximise performance and accuracy, Soil Instruments makes the following recommendations, for the skill level of the installation contractor.

ADDITIONAL SUPPORT

We offer installation and monitoring services to support this system. For more information please email: [sales@soil.co.uk](mailto:sales@soil.co.uk) or call: +44 (0) 1825 765044
### Specifications

#### Hanging Pendulum

<table>
<thead>
<tr>
<th>Component</th>
<th>Anchor</th>
<th>Weight</th>
<th>Oil tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Stainless Steel</td>
<td>Steel</td>
<td>PVC</td>
</tr>
<tr>
<td>Weight</td>
<td>3.5kg</td>
<td>29kg</td>
<td>3kg</td>
</tr>
<tr>
<td>Dimensions</td>
<td>800mm x 50mm x 50mm</td>
<td>Ø252mm x 203mm</td>
<td>Ø680mm x 520mm</td>
</tr>
</tbody>
</table>

#### Inverted Pendulum

<table>
<thead>
<tr>
<th>Component</th>
<th>Float unit</th>
<th>Float tank</th>
<th>Support frame anchor</th>
<th>Anchor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Polypropene</td>
<td>Stainless Steel</td>
<td>Steel</td>
<td>Steel</td>
</tr>
<tr>
<td>Weight</td>
<td>11kg</td>
<td>15.5kg</td>
<td>13kg</td>
<td>8kg</td>
</tr>
<tr>
<td>Dimensions</td>
<td>Ø610mm x 400mm</td>
<td>Ø790mm x 540mm</td>
<td>1040mm x 550mm x 250mm</td>
<td>600mm x Ø500mm</td>
</tr>
</tbody>
</table>

#### Wire

- **Material**: 316 grade Stainless Steel
- **Weight**: 16g/m
- **Dimensions**: Ø1.6mm
- **Wire breaking load**: 280kg

#### Float

- **Float force**: 58kgf

#### Reading Table and Brackets

<table>
<thead>
<tr>
<th>Component</th>
<th>Table</th>
<th>Brackets</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>Stainless Steel</td>
<td>Steel</td>
</tr>
<tr>
<td>Weight</td>
<td>7.5kg</td>
<td>4kg/pair</td>
</tr>
<tr>
<td>Dimensions</td>
<td>450mm x 450mm x 6mm</td>
<td>750mm x 135mm x 40mm</td>
</tr>
</tbody>
</table>

#### Portable Pendulum Readout

<table>
<thead>
<tr>
<th>Range</th>
<th>X = ±75mm, Y = ±75mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye piece</td>
<td>None</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1mm</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±0.1mm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.1mm</td>
</tr>
<tr>
<td>Weight</td>
<td>4kg</td>
</tr>
</tbody>
</table>

#### Automatic Pendulum Readout (CCD)

<table>
<thead>
<tr>
<th>Range</th>
<th>X = ±25mm, Y = ±25mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeatability</td>
<td>±0.1mm</td>
</tr>
<tr>
<td>Accuracy</td>
<td>±0.1mm</td>
</tr>
<tr>
<td>Weight</td>
<td>4kg</td>
</tr>
</tbody>
</table>

Operating humidity: 100% relative humidity non-condensing

Temperature range: -15 to +60°C

Communications: RS485

Analogue output: 4-20mA

Power supply: AC 85V - 220V ±20% 50Hz - 60Hz

Dimensions: 380mm x 380mm x 145mm

(please contact our Sales department for further information)

1 Dependent on operator experience

Soil Instruments Limited has an ongoing policy of design review and reserves the right to amend these specifications without notice.

C1 - Inverted and Hanging Pendulum Systems - DS0914 - Rev1.0.7
## Ordering Information

### Inverted Pendulum Float and Anchor
- **CI-1.1** Float unit with support frame & cover; includes float, tank Ø790mm, tank cover/lid, Stainless Steel frame, wire clamp and wall fixings
- **CI-1.3** Anchor; 600mm long bar x Ø50mm, includes wire clamp
- **CI-1.4** Antifreeze fluid; 5 litres
- **CI-1.5** Verticality Test Spacer; for measurement of lateral deformation of the borehole in rock foundation

### Hanging Pendulum Weight and Anchor
- **CI-2.1** Weight; 29kg, 203mm long, solid steel, supplied complete with damping fins, includes wire clamp
- **CI-2.2** Oil tank; Ø680mm
- **CI-2.3** Anchor unit; Ø16mm - supplied complete with 800mm crossbeam, includes wire clamp
- **CI-2.3** Drip cover

### Wire
- **CI-3.1** Pendulum wire; priced per metre, Ø1.6mm, Stainless Steel wire
- **CI-3.2** Spare wire clamp; for Ø1.6mm wire

### Pendulum Measuring Equipment
- **CI-4.1** Manual reading table; includes support brackets and Stainless Steel measuring plate
- **CI-4.3** Portable pendulum readout; range: X axis = 150mm, Y axis = 150mm
- **CI-4.4** Portable pendulum readout with 45° eyepiece; range: X axis = 150mm, Y axis = 150mm
- **CI-4.5** Portable pendulum readout with 90° eyepiece; range: X axis = 150mm, Y axis = 150mm

### Automatic Pendulum Readout (CCD System)
- **CI-5.1** Automatic pendulum readout; range: 50mm in X and Y axis. RS485 or analogue output. System requires CR800-based datalogger
- **CI-5.4** Automatic pendulum readout; range: 50mm in X and 100mm in Y axis. RS485 or analogue output. System requires CR800-based datalogger
- **CI-5.5** Automatic pendulum readout; range: 50mm in X and 100mm in Y and 50mm in Z axis. RS485 or analogue output. System requires CR800-based datalogger
- **CI-5.3** Display unit for Pendulum Readout Systems CI-5.1 and CI-5.4
- **CI-5.6** Display unit for Pendulum Readout System CI-5.5
- **CI-5.2** Mounting table for automatic pendulum readout

### Manual
- **MAN-73** Inverted Pendulum Wire Equipment
- **MAN-74** Hanging Pendulum Wire Equipment
- **MAN-134** Optical Digital Pendulum Readout

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