

# Hanging & Inverted Pendulum System

## Key Benefits

- The Hanging and Inverted Pendulums are designed for accurate and long term measurement of horizontal movements associated with the rotation or tilting of a structure
- Typical applications include determination of horizontal movements of dams, dam foundations, abutments, bridges, piers, towers, nuclear power stations, and tall buildings. Inverted and hanging pendulums are often installed in the same structure



## Technical Applications

In Hanging Pendulum systems, the upper end of a stainless steel wire is anchored to the structure under observation. A weight suspended from the lower end is free to move in an oil tank, the oil serving to dampen oscillations of the wire. Displacements relative to the wire may be measured using a portable optical readout unit or for remote reading, an automatic X - Y coordinator. Measurements can be made at one or several elevations along the wire, taking readings of two perpendicular components of horizontal movement at each elevation using the reference frames equipped with a vernier microscope. Full utilisation of Hanging or Inverted Pendulii requires that their installation is considered at the design stage of the project.

As the wire remains vertical while the anchor moves with the structure, readings of movement relative to the wire must be corrected for movements of the anchor and for this reason Inverted and Hanging Pendulums are often used in the same structure so that all movements can be related to the Inverted Pendulum anchored at depth in stable ground.

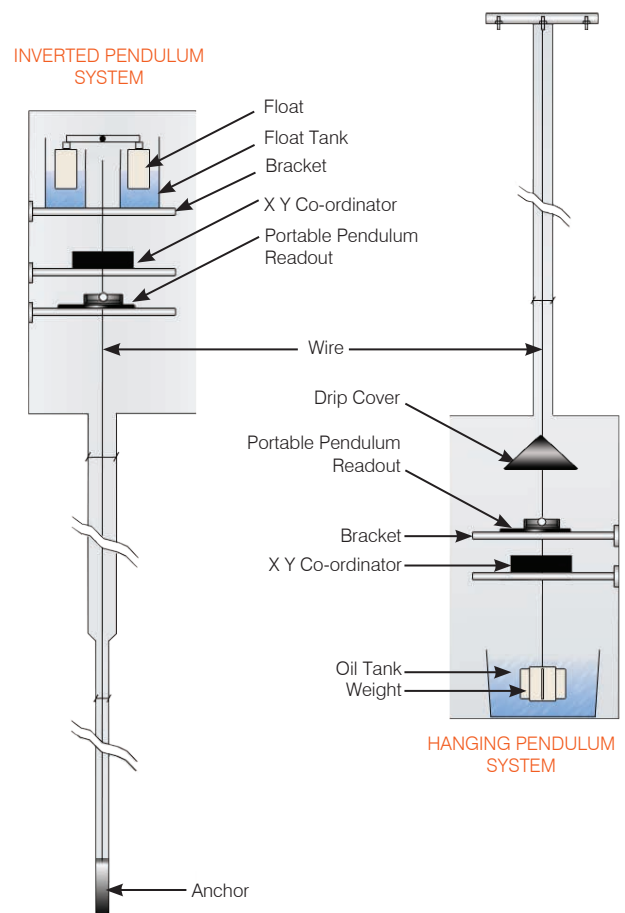
The Inverted Pendulum uses identical measuring devices as the hanging pendulum and consists of a wire, anchored in stable ground beneath the structure, with a float fixed to its upper end. The float, which is free to move in a water tank, tensions the wire and keeps it vertical. If this is intended the reference frame for the Inverted Pendulum is typically placed in the same gallery as the bottom frame for the Hanging Pendulum.

The Soil Instruments Automatic Pendulum Readout uses Charge Coupled Device (CCD) arrays and laser diode emitters to determine the position of a pendulum wire within the central reading aperture. No contact is made with the wire in any way, the measurement being completely contactless. The reading arrays are corrected automatically for temperature and the entire readout can be replaced without the need to move the pendulum wire.

An external digital display can be connected to the readout unit and displays the x & y positions in millimetres, updated 2 times per second. The readout also has an RS485 and an analogue output allowing it to be incorporated into almost any data acquisition system.

## Features

- Measuring accuracy can be greater than that obtained by precise geodetic surveying
- Movements can be observed at frequent intervals without repeated and costly surveys
- Manual or automatic readouts available
- Pendulum instruments are simple and therefore reliable in long-term use



FOR FURTHER INFORMATION PLEASE CONTACT:

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## Specifications

### PORTABLE PENDULUM READOUT

Range	X= ±75mm Y= ±75mm
Resolution	0.1mm
Repeatability <sup>1</sup>	±0.1mm
Accuracy	±0.1mm
Weight	4kg

### XY CO-ORDINATOR (AUTOMATIC PENDULUM READOUT)

Range	X= ±25mm Y= ±25mm or X= ±25mm Y= ±50mm
Resolution	0.01mm
Repeatability	±0.1mm
Accuracy	±0.1mm
Weight	9kg
Operating humidity	100% relative humidity non condensating
Temperature range	-15°C to +60°C
Communications	RS485
Analogue output	4 - 20mA
Power supply	AC 85 - 220V ± 20%, 50Hz - 60Hz or 24VDC, please specify
Dimensions	L x W x H 380 x 330 x 145mm

INVERTED PENDULUM	WEIGHT	DIMENSIONS	MATERIAL
Float unit	11.0kg	610Ø x 400mmH	Polypropelene
Float tank	15.5kg	790Ø x 540mmH	Polypropelene
Support frame anchor	13.0kg	1040 x 550 x 250mm	Stainless steel
Anchor	8.0kg	600 x 50mmØ	Steel

### HANGING PENDULUM

Anchor	3.5kg	800L x 50W x 50Dmm	Stainless steel
Weight	31.5kg	252Ø x 252H	Steel
Oil Tank	3.0kg	700Ø x 520H	PVC

### WIRE

	1.6kg/100m	1.6mmØ	316 stainless steel
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### READING TABLE & BRACKETS

Table	7.5kg	450 x 450 x 6mm	Stainless steel
Brackets	4.0kg (Pair)	750 x 135 x 40mm	Stainless steel

<sup>1</sup>Dependant on operator experience

## Ordering Information

### PART NO. DESCRIPTION

#### INVERTED PENDULUM FLOAT AND ANCHOR

C1-1.1	Float unit with support frame
C1-1.3	Anchor

#### HANGING PENDULUM WEIGHT AND ANCHOR

C1-2.1	Weight
C1-2.2	Oil tank
C1-2.3	Anchor unit

#### WIRE

C1-3.1	Pendulum wire
C1-3.2	Spare wire clamp
C1-3.3	Drip cover

#### MEASURING EQUIPMENT

C1-4.1	Manual reading table with support brackets
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#### AUTOMATIC PENDULUM READOUT

C1-5.1	Automatic Pendulum Readout X= ±25mm Y= ±25mm
C1-5.3	External display

#### PORTABLE PENDULUM READOUT

C1-4.3	Portable pendulum readout
C1-4.4	Portable pendulum readout with 45° eyepiece
C1-4.5	Portable pendulum readout with 90° eyepiece