In-Place-Inclinometer

Single & Dual Axis Sensors

Updated Aug 2023

Advantages

- **The In-Place-Inclinometer (I-P-I) is ideally suited for near real-time measurement of lateral rock displacement of rock, soil and man-made structures, natural and cut slopes, tunnels, embankments.**
- **Sensor Strings can be deployed for vertical, horizontal and fixed angle applications**
- **Available in Uni-axis and Bi-axial Models.**
- **Options for SDI-12 / RS-485 / Modbus over RS-485 Digital Communications.**
- **Programmable averaging period for Vibration Noise Reduction .**
- **Automatic temperature compensated readings.**
- **Stainless Steel 316 Body Parts - Corrosion Resistant.**
- **Free issue Device Configuration Software - Configure , make test measurements, Display Results**
- **Optional USB Media converter SDI12, RS485 - LAN and Wi-Fi 3rd Party Interfaces**

In-Place-Inclinometer Range of Intelligent Sensors

The Keynes Controls range of In-Place-Inclinometers are solid state intelligent devices that support SDI12, RS485 and Modbus over RS485 digital communications. The sensors use advanced power management techniques and are suitable for use in stand-alone recording systems or larger network applications.

A range of accessories are available in order to simplify installations such as USB media converters, Multi-channel sensor connection PCBs, Casing caps and Free applications software.

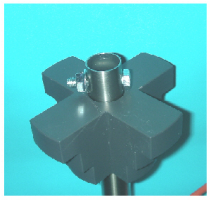
Vibration Reduction

All of the I-P-I ranges of sensors have a User programmable recording period that can be used to remove or reduce background vibration effects.

Engineering Units

The sensors can return measurements in mm/m or Degrees for displacement and Celsius for temperature.

Part Number:	Description: (Other lengths on request)
IPI-bar-1m	1m gauge bar for any IPI sensor
IPI-bar-2m	2m gauge bar for any IPI model
IPI-bar-3m	3m gauge bar for any IPI model
IPI-case-cap	Cap for I-P-I housing
SDI-12 network:	Vertical Sensors
IPI-D-15-SDI12	Dual Axis I-P-I Solid state - +/- 15 deg - SDI-12 Connunication
IPI-S-15-SDI12	Single Axis I-P-I Solid state - +/- 15 deg - SDI-12 Communication
RS-485 network:	
IPI-D-15-485	Dual Axis I-P-I Solid state - +/- 15 deg - RS-485 Communication
IPI-S-15-485	Single Axis I-P-I Solid state - +/- 15 deg - RS-485 Communication
IPI-S-H-15-SDI12	Single Axis Horizontal Sensor +/- 15 deg - SDI-12 Connunication
IPI-S-H-15-486	Single Axis Horizontal Sensor +/- 15 deg - RS485 Connunication
	Modbus Version Instruments same as 485
IPI-D-15-4Mod	Dual Axis I-P-I Solid state - +/- 15 deg - RS-485 comm's
IPI-S-15-4Mod	Single Axis I-P-I Solid state - +/- 15 deg - RS-485 comm's
Q-LOG	Free issue Application Software
SEN-PCB-8	8 Channel Sensor Interconnect PCB and base



Features

High Resolution Small Movement Option

Large Angle Models

Fixed Angular Offset Sensors

Advanced Power Management.

Lightning Protection as Standard

In-line coupling for signal cable installation. Simplifies installation and maintenance.

Programmable Sample Period.

Waterproof to 100 m Standard - Other ranges on request.

Stainless Steel Body Parts.

Steel Wire - Spacer Wire Option

Optional USB Media Converter

Full Range of Installation Accessories

Free Test and Configuration Software

Option for Fixed Angle Offset - 30 45 60 Degree

Updated Aug 2023

Sensor Connection Diagram:

The images below show the sensor connection details for both the SDI-12 and RS-485 model sensors:

Dimensions

Dimensions

1 = 230 mm
2 = 32.5 mm
3 = 100 mm
4 = 73 mm - no spring compression
5 = 17 mm
6 = 35 mm
7 = 28.5 mm

Dimensions

The I-P-I Wheel Assembly can be adjusted upon request.

Sensor Spacer Bars

The In-place inclinometers can be supplied with a range of fixed length spacer bars. The spare bars enable the sensor positions to be accurately placed from the datum point. Common sizes are 0.5, 1 and 2 meters. Longer bars can be supplied upon request.

ISpacer Bar

Sensor Connections

The In-place-Inclinometers are suitable for connection to the SDI12 and RS485 digital networks. A version of the sensor is available for connection to the for connection to the Modbus over RS485 network.

RS485 /' Modbus Model Sensor Connection

	Cable Colour	Signal
1	Green	- RS485
2	White	+ RS585
3	Red	+12 V DC
4	Black	0 V / Gnd

SDI12 Model Sensor Connection

	Cable Colour	Signal
1	Green	Not Used
2	White	SDI12 Data
3	Red	+12 V DC
4	Black	0 V / Gnd

Standard Colour Code for all Keynes Sensors.

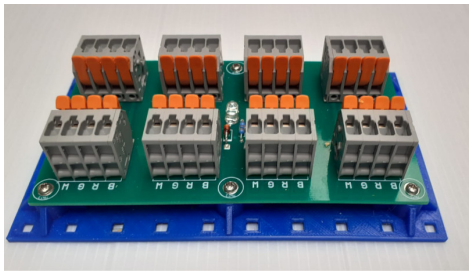
Modbus

The Modbus version inclinometers can be connected to any device supporting Modbus over a RS-485 digital network and act as a slave device. The instruments continually update the Modbus data registers so long as power is applied. A Modbus master device polls the sensors for new readings.. Modbus communications enable the sensors to be integrated quickly into many different 3rd party SCADA systems.

In-Place-Inclinometer

Single & Dual Axis Sensors

Updated Aug 2023



Part Number SEN-PCB-8

Sensor Installation PCB - 8 Channel

The image opposite shows the 8 channel sensor connection block available from Keynes Controls.

The SEN-PCB-8 board can be used to terminate 8 intelligent devices together, and used as a building block for larger systems.

The connectors are spring loaded clamps to grip the sensor cables without any screw connections. Simply press the clamp down and insert the cable.

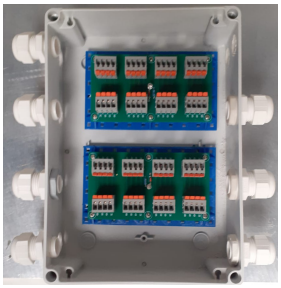
The SEN-PCB-8 PCB is available with or without the mounting plate.

Sensor Junction BOX

Keynes Controls can supply complete junction boxes ready for installation

The junction boxes are used to simplify the installation of sensor chains when the sensor cables are terminated at the surface. Space is available on the printed circuit boards to place customised labels.

Please contact Keynes Controls for more details.



Optional Media Converters

Model: USB-485-Pro

Model : USB-SDI12-Post

Model: USB-SDI12-Pro

Keynes Controls manufactures a range of media converters that can be used to connect the In-Place-Inclinometers to a Windows PC. The media converter can power sensors directly from a computer USB port.

Media Converter Specifications

Description	
1 x USB Type B	User assigned cable length
1 x Network Port	SDI12 or RS485 Port
1 x External Power Port	9.5 to 16 V DC - 1 Amp (Excludes USB-SDI12-Post model)
1 x Power Indicator LED	USB Supply Level exceeds 9.5 V DC / Short circuit detection
Direct Connection Power	Maximum current 150 mA without external source
External Power	1 x External supply 9.5 - 16 V DC
Short Circuit Protection	Automatic reset - network + 12 V DC to Gnd
Opto-isolation	1000 V DC SDI-12 Data to Gnd
Connector	2 x 4 way - 3.5 mm pitch screw lock.
Chip Set	FTDI - uses Windows 10 Microsoft Accredited Driver

USB type B extension cable for media converter connection.

In order to simplify configuration operations and to test the sensors prior to installation then the In-Place-Inclinometers can be supplied with an optional USB media converter and free issue Windows applications software Q-LOG

In-Place-Inclinometer

Single & Dual Axis Sensors

Updated Aug 2023

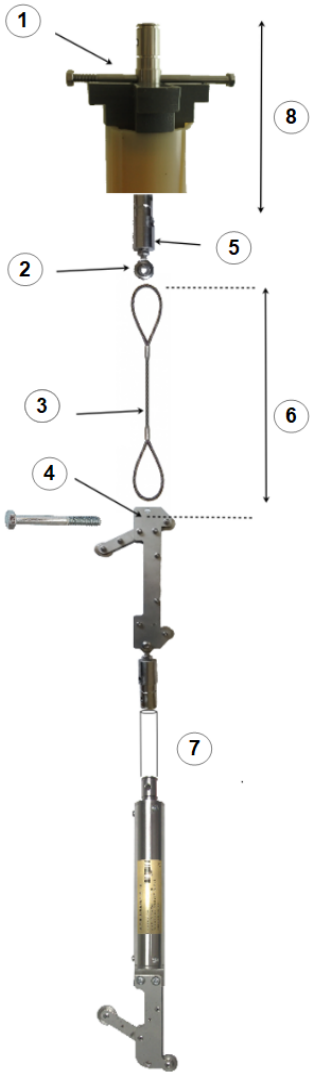
Technical Specifications

SENSORS

Calibrated range	± 12 ° , 20 mm/m) High Resolution - +/- 30 Degree Large Angle
Resolution	± 2 arcsec / ±0.0006 ° / ±0.01 mm/m
Sensor accuracy	± 0.05 % F.S.
Repeatability	± 0.012 % F.S. (typical values only)
Non-linearity	± 0.012 % F.S (typical values only)
Operating temperature	-25 to +75°C / -13 to 167 °F
Sensor	MEMS Accelerometer - Uniaxial or Biaxial.
Digital network type	SDI-12 - 3-wire RS-485 - 4-wire/ 1200 / 9600 Baud Modbus over RS-485 9600 Baud
Minimum casing internal diameter	56 mm
Maximum casing external diameter	72 mm - other ranges upon request
Length	230 mm
Power supply at 12V DC SDI-12	14 mA Dual Axis (Typical during measurement) 14 mA Dual Axis (Typical during measurement)
Standby Current	2.2 mA Low Power Standby.

Typical values only

Ingress protection	Rated to 100 m submergence other ranges on request
Housing material	316 stainless steel
Weight	560 g without cable
Signal output	mm/m , Degrees, Temperature Degrees Celsius
Addressing mode:	All I-P-I models support standard and enhanced ID address modes. 0..9 - a., A..Q
Range: SDI-12	0 .. 100 m standard
RS-485/Modbus	0 .. 1 km standard
Identifier	13KEYNESCOIPINV2005



Double Wheel Assembly Accessory

1	Top Cap	2	Rod end bearing
3	Steel Sling	4	Wheel Assembly Mounting
5	Bar plug	6	Spacing Reference Point
7	Spacer bar 0.5 to 3m		

Configuration Video

https://youtu.be/vwEfple5FCM

Demonstration for configuring the sensor using Q-LOG software.

Steel Wire Sensor Suspension Solutions

The sensor chain can be deployed from a steel wire at User defined depth. This gives the User the ability to mechanically split the chain into several groups of sensors and maintain the network communications.

Q-LOG

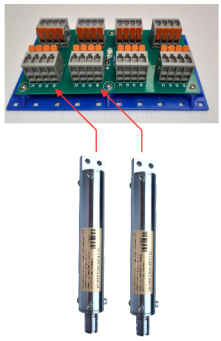
Q-LOG is the Keynes Controls application software used to configure, test and display results from the different models of the sensors.The Q-LOG software supports SDI12 and RS485 Communications and offers a Vitual COM port facility for optional WiFi and LAN connected instruments. It is ideal for making on-site test measurements, network modifications and displaying real-time data.

The Q-LOG software can be downloaded for free at:

http://keynes-controls.com/Download/QLogSetup50_21may2020.zip

Windows PC – QLOG Software

RS485 – Wi-Fi Gateway

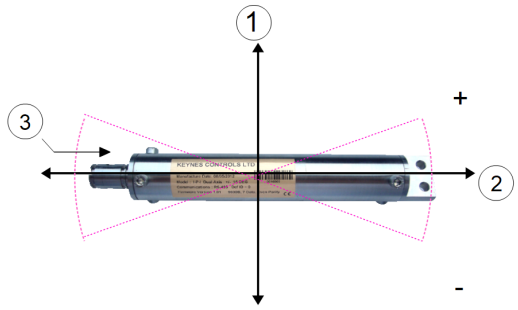


In-Place-Inclinometer

Single & Dual Axis Sensors

Updated Aug 2023

Horizontal Axis Measurements - High Resolution



Reference Axis

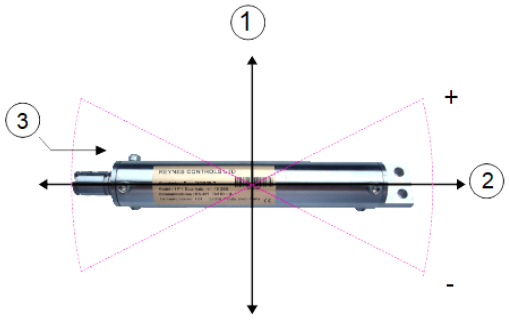
1 = Vertical Axis
2 = Horizontal Axis
3 = Angle measured from the horizontal axis in mm/m

Maximum Range = +/- 15 Degree from the reference axis
= 25 mm / m .

The horizontal I-P-I sensors are normally measured +/- 15 Degree from the horizontal axis.

Fixed offset angle can be supplied upon request

Horizontal Measurement - Large Angle - Sensor



Reference Axis

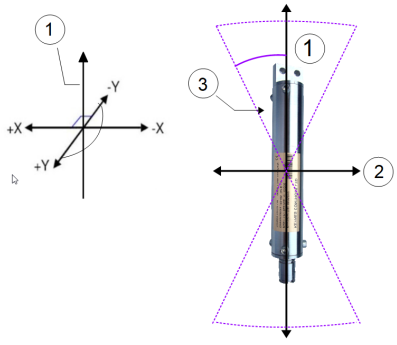
1 = Vertical Axis
2 = Horizontal Axis
3 = Angle measured from the horizontal axis in mm/m or Degree

Maximum Range = +/- 30 Degree from the reference axis
= 50 mm/m

This sensor can be used at a wide range of offset angles without any mechanical changes to the sensor. The disadvantage of this sensor is a slightly higher noise on the measurements compared to a fixed offset high resolution device.

These sensors should be calibrated on a yearly basis to correct the offset error.

Vertical Measurement High Resolution Inclinometer



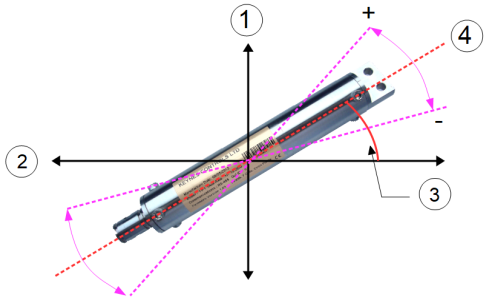
Reference Axis

1 = Vertical Reference Axis
2 = HorizontalReference Axis
3 = Angle measured from the horizontal axis in mm/m or Degree

Measurement Range = +/- 15 Degree from the reference axis
= 25 mm/m

This sensor is available in single or dual axis models. Each axis is capable of being measured over the range of 25 mm/m.

Fixed Offset Angle Sensors - High Resolution



Reference Axis

1 = Vertical Axis. **2** = Horizontal Axis.
3 = Fixed Offset Angle. **4** = Measurement Reference Axis.

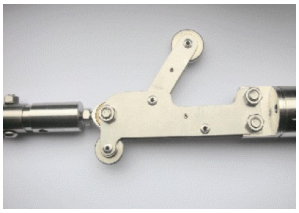
Measurement Range = +/- 15 Degree from the reference axis
= 25 mm/m .

The fixed offset angle sensors are single axis only.

Sensors manufactured on request.

Updated Aug 2023

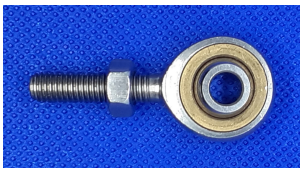
Standard I-P-I Parts



Complete Wheel Assembly

The spring loaded wheel assembly fits onto the bottom of the sensor and is used to secure the sensor inside a casing. The standard size wheel assembly is for casing diameters 58 - 62 mm.
Other sizes can be supplied upon request.

Part Number:



Rod End Bearing

The rod end bearing fits inside the bar block and enables the sensor to move in two degrees of freedom inside the casing.

Part Number:

Bar Plug Assembly

The bar plug assembly shows how the rod end bearing is attached to a sensor spacer bar. The bar plug secures the bearing to the space bars. The spacer bars can be supplied in various sizes with the most common being 1 and 2 meter lengths.

Part Number:

Double Wheel Assembly

Part Number:

Double Wheel Assembly for Steel Sling Deployment

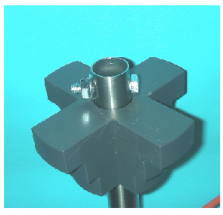
For applications when multiple sensor chains are to be deployed into a single casing, or when a sensor chain has to be deployed a substantial depth below the top-cap then a double wheel assembly can be supplied. A steel wire sling can be used to suspend a sensor chain.

The double wheel assembly provides a secure fastening between a sensor and a steel wire sling. It also ensures that the sensor is centralised into the casing upon deployment. The spring arrangement ensures there is adequate flexibility in the design for the measurement operations.

Full details on its use in the Deployment Guide.

Casing Top-Cap

The top-cap is used to suspend the inclinometer chain from the top of the sensor casing. A hole in the center of the cap allows for the fitting of a spacer bar so the initial position of the top most sensor can be accurately assigned,



Part Number: IPI-Top-Cap

Sensor on Mounting Bracket