KEYNES CONTROLS

Horizontal In-Place-Inclinometer Sensor Range

Models for SDI-12 & RS485 Digital Networks

Horizontal In-place-inclinometer - SDI12 model

Horizontal In-place-inclinometer - RS485 model

- **The horizontal In-place Inclinometer (H-IPI) is ideally suited for near real-time measurement of lateral displacement of rock, soil and man-made structures.**
- **Sensor strings can give a complete profile of horizontal displacements.**
- **Available in uni-axial and bi-axial MEMS sensor versions.**
- **Options for SDI-12 or RS-485 digital networks.**
- **Results directly in engineering units.**

- **Programmable averaging period for noise reduction.**
- **In-built digital conversion to minimise noise.**
- **Ideal for monitoring the stability of natural and cut slopes, tunnels, embankments and structural foundations for large structures.**
- **Models available waterproof to a depth of 80 m.**
- **Optional simple PC interface for local readings**
- **Stainless Steel 315 case**

Wheel Assemblies Fig-3

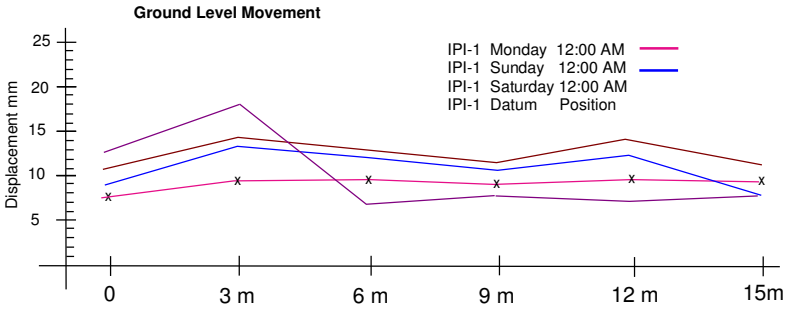
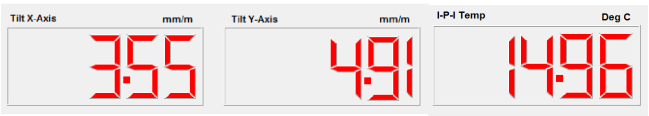


Fig-4



The panel meter display above, is part of the Q-Log data display software, and is available as to show the real-time inclinometer results from a complete I-P-I string. This type of display ideal for testing sensors during installation and maintenance operations.

The Keynes Controls range of horizontal In-place-inclinometers are a range of intelligent sensors that are used to measure local vertical movement such as ground movement.

The horizontal inclinometers are part of the Keynes Control family of tilt sensors, and are as such fully compatible with the companies range of interfaces and media converters.

All of the models of the horizontal I-P-I are supplied with 316 stainless steel body making them safe for long term deployment even in the harshest of environments.

Remote data recording from the I-P-I sensors can be undertaken easily using the Keynes Controls EZi-Log web interface.

Part Number:	Description:
IPI-bar-1m	1 m gauge bar for any H-IPI sensor
IPI-bar-2m	2 m gauge bar for any H-IPI model
IPI-bar-3m	3 m gauge bar for any H-IPI model
H-IPI-case-cap	Cap for I-P-I housing

SDI-12 network:

H-IPI-D-15-SDI12	Dual Axis I-P-I Solid state - +/- 15 deg - SDI-12
H-IPI-D-75-SDI12	Dual Axis I-P-I Solid state - +/- 7.5 deg - SDI-12
H-IPI-D-25-SDI12	Dual Axis I-P-I Solid state - +/- 2.5 deg - SDI-12
H-IPI-S-15-SDI12	Single Axis I-P-I Solid state - +/- 15 deg - SDI-12
H-IPI-S-75-SDI12	Single Axis I-P-I Solid state - +/- 7.5 deg - SDI-12
H-IPI-S-25-SDI12	Single Axis I-P-I Solid state - +/- 2.5 deg - SDI-12

RS-485 network:

H-IPI-D-15-485	Dual Axis I-P-I Solid state - +/- 15 deg - RS-485 comms
H-IPI-D-75-485	Dual Axis I-P-I Solid state - +/- 7.5 deg - RS-485 comms
H-IPI-D-25-485	Dual Axis I-P-I Solid state - +/- 2.5 deg - RS-485 comms
H-IPI-S-15-485	Single Axis I-P-I Solid state - +/- 15 deg - RS-485 comms
H-IPI-S-75-485	Single Axis I-P-I Solid state - +/- 7.5 deg - RS-485 comms
H-H-IPI-S-25-485	Single Axis I-P-I Solid state - +/- 2.5 deg - RS-485 comms

Sensor Connection Diagram:

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

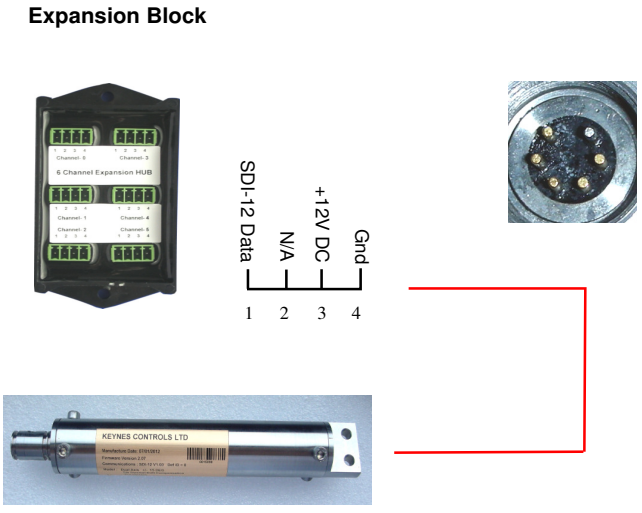


Fig-5

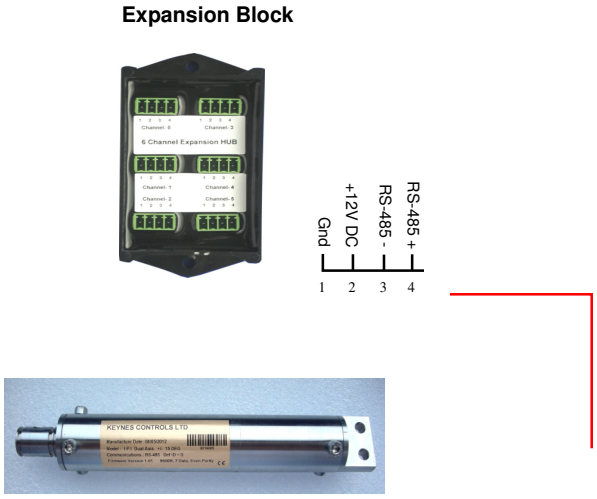
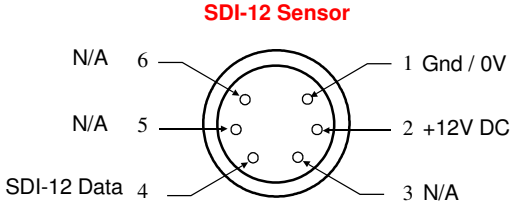
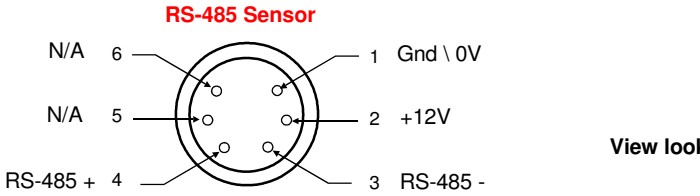
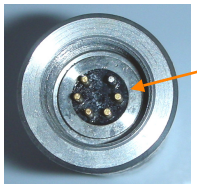


Fig-6





View lool



View looking in cable port

The adjacent image shows the custom designed seals built into the top and bottom of the sensors This seal isolates the signals from the cables to the electronics mounted inside the sensor case.

The pins are gold-plated and so are protected from corrosion.

The seals are manufactured by Keynes Controls. The standard operating depth is 80 m. Higher rated seals can be fitted on demand.

Simple Command Structure:

All of the I-P-I models use the same command structure.

aM! – starts a measurement
aC! – starts a concurrent measurement
aD0! – gets data from the sensor

where a = Instrument ID Number

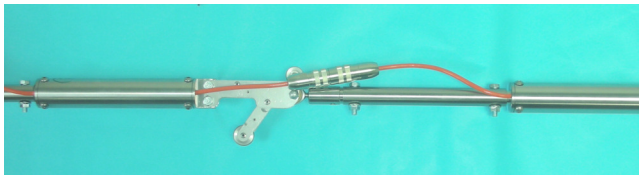
All data is sent digitally across the network. Full details can be found in the product manual.

Optional Connectors - linking the I-P-I sensors together

All of the In-place inclinometers come supplied with IP-68-rated mating interlocking connectors as standard enabling the sensors to be quickly installed and safe for use in non submerged applications in the majority or locations.

Optional waterproof connectors safe for long term deployment in harsh environments can be fitted at the time of order.

Simply lock adjoining sensors together to increase the I-P-I string length.



IP-68-rated mating interlocking connectors for fast installation and maintenance operations.

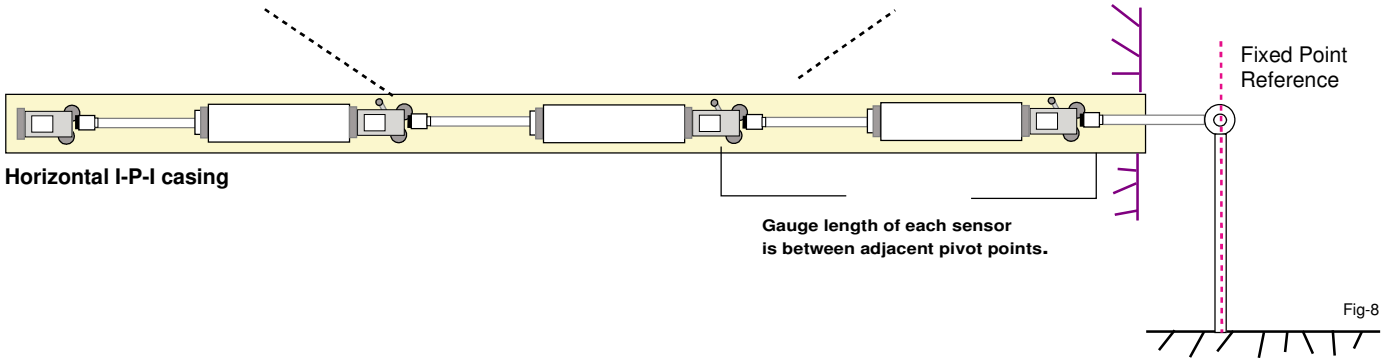


Fig-8

SENSORS		SPECIFICATIONS
Calibrated range		± 15 , ± 7, ± 2.5 deg (0 to 259 mm/m)
Resolution		0.005% full scale
Sensor accuracy		±0.05% full scale
Repeatability		±0.01% full scale (typical values only)
Operating temperature		-20 to +80℃
Repeatability		±0.01% full scale
Digital network type		SDI-12 - 3-wire RS-485 - 4-wire
Minimum casing internal diameter		56 mm
Maximum casing internal diameter		72 mm
Length		230 mm
Power supply @ 12V DC	SDI-12	12 mA dual axis - measurement period 0.3 mA Idle
	RS-485	16 mA dual axis - measurement period 2 mA Idle
Typical values only		
Ingress protection		IP68 -rated 1 m other ranges on request
Housing material		316 stainless steel
Weight		560 g without cable
Signal output		Digital engineering values - Raw data using configuration commands
Addressing mode:		All I-P-I models support standard and enhanced ID address modes. 0..9 A..Z
Range:	SDI-12	0 .. 100m standard
	RS-485	0 .. 1km standard Increased can be achieved depending on signal cable quality.
Firmware		This product has a firmware upgrade facility

Part No: USB-SDI12-Pro

Media Converters:

A range of media converters is available from Keynes Controls, such as the isolated device shown opposite.

The USB-SDI12-Pro and USB-485-Pro model media converters are ideal for fixed installations and directly power from the USB port small numbers of sensors.

The image above SDI-12 Dongle installed in a laptop USB port.

The RS-485 network model is installed in exactly the same way

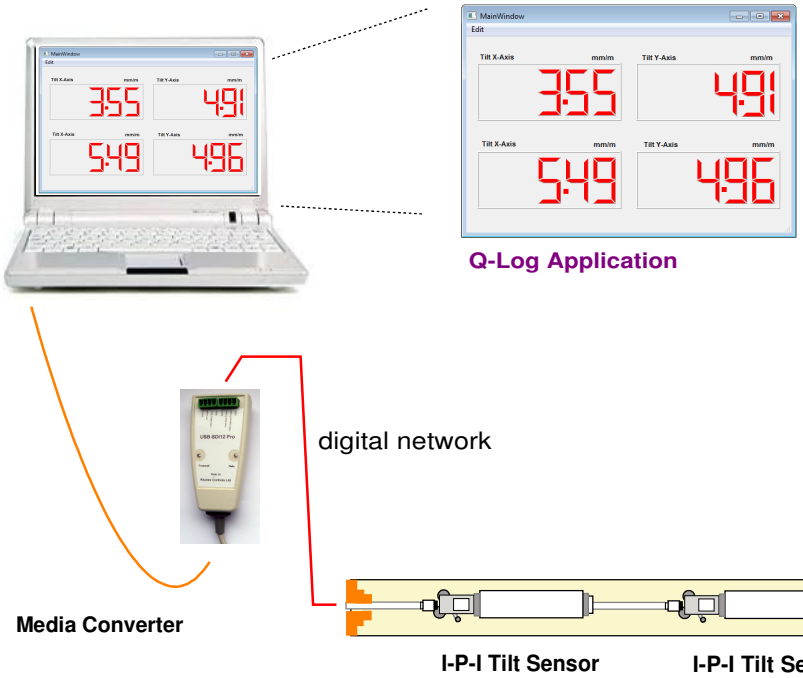
SDI-12 Network

This product supports SDI-12 1.3 operations

Low Cost I-P-I Data Acquisition System

The image below shows how simple a PC / laptop computer data acquisition system can be put together using the Keynes Controls media converter unit and I-P-I range of sensors. All of the current inclinometers connect to a network and send values directly in engineering units into data recorders or PC / laptop data-logging systems.

Tilt values in units of mm/m and temperature values units of Deg C, or Deg F are transmitted digitally across the network. Digital data transmission minimises noise and errors due to cabling losses, and also has the advantage of fast installation and simple maintenance.



Q-Log Application

Fig-11

- **Direct sensor power by the USB port**
- **Automatically loading device drivers**
- **Microsoft accredited device drivers**
- **Free Q-Log applications software**
- **CSV Data file format**
- **Easy to install and operate**
- **Automatic temperature compensated readings**
- **Isolated network connections**
- **Options for SDI12 or RS485 digital networks**

Remote Data Acquisition & Data Display Solutions

The image below shows a basic EZi-LOG remote data logger system. This remote logger solution is all that is required to connect up to 36 In-place-inclinometers to the Internet, and to have the instrumentation to report data automatically to a User.

Data from each sensor is stored into the database and sent automatically to a User in the form of an E-mail attachment. An E-mail alarm system operating on the stored data in the database is used to warn if any measurement conditions have been exceeded.

Q-LOG Data Display & Recording Software

The In-Place-Inclinometers sensors are fully integrated to the free Q-LOG data acquisition & display software.

Additional details can be found at:

http://www.aquabat.net/QLOGFree/qlogv2.html

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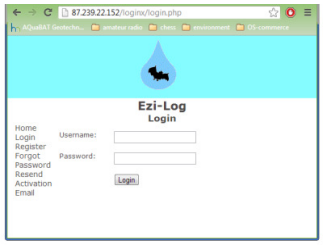
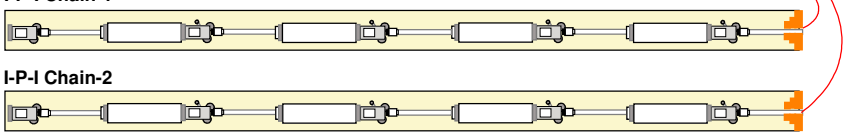


The data from the I-P-I sensors can be accessed from remote sites automatically by using the EZ-LOG data loggers and Web page interface.

Fig-12



Noise Reduction:

All of the I-P-I ranges of sensors have a User-programmable recording period, in steps of 1 ms. This has the effect of removing background vibration and enhancing the correct tilt value. The unwanted noise is averaged out.

Calibration: All sensors are calibrated at the Keynes Controls facility in the UK. The company has a UKAS certified rotary calibrator for use with the companies ranges of In-place-inclinometers.

External calibration can be undertaken upon request.

Fixture Structure - PC Data Acquisition System:

For applications on large structures, such as buildings or bridges, and where different types of sensor are to be used to create a complete monitoring system, then the RS-485 network-type instruments are best used. RS-485 version instruments enable sensor installations up to 1km away for the data recording system to be used. The inclinometers can be mixed with any other

Fully Integrated Applications

Keynes Controls can supply fully integrated solutions combining multiple I-P-I chains to other intelligent sensors to produce complete real-time monitoring systems. Fig 14 opposite shows a typical multiple site display.

The simplest way of integrating a large number of sensors onto a distributed measuring system is to use the RS-485 version instruments connected to a RS485-Ethernet converter attached to a LAN or 3 G modem depending upon the application.

The In-place-inclinometer data can be observed in real-time on a dedicated Window. Sensor data can be accessed individually or as a profile with the movement relative to the starting

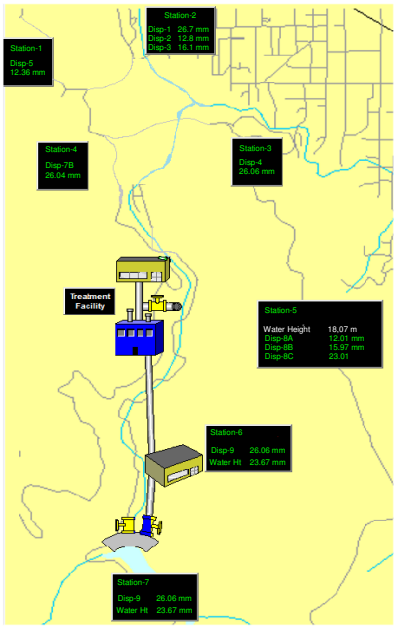
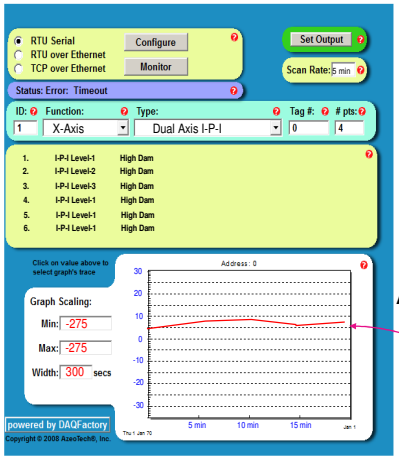


Fig-14 - Multiple Site I-P-I Data Display



Real-time Data Display

Fig VV opposite shows one of the many screens that can be used to display the I-P-I data in the Keynes Controls data display software.

Individual sensors or complete profiles can be accessed at the touch of a button.

All of Keynes Controls applications are created using a range of different software applications.

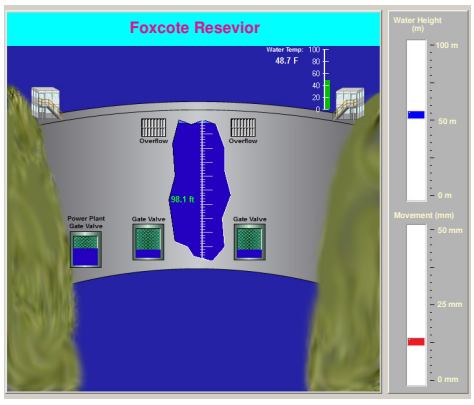


Fig 15 above demonstrates a typical multiple sensor type data display used for a dam.

In this example water height and inclinometer data are combined together to form a simple to understand results screen.

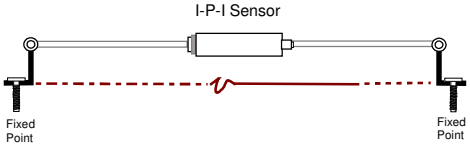


Fig 13 above demonstrates how a fixed sensor is used to monitor the ground movement between 2 fixed points. A real-time plot of the ground movement can be observed on the User screen.