In-Place-Inclinometer Sensor Range

Options for Built-in-Offset

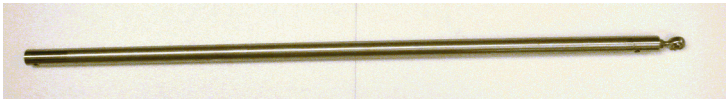
Advantages:

- The In-place Inclinometer (IPI) is ideally suited for near real-time measurement of lateral displacement of rock, soil and man-made structures.

  Automatic temperature compensated readings.

- Available in Uni-axial and Bi-axial sensor versions.
- Low-power SDI-12 or RS-485 digital communications. IP 68 rated in-line network connection for fast installation and maintenance.
- Programmable averaging period for signal enhancement and noise reduction
- Digital data communication to simplify measurements & installation.
- Ideal for monitoring the stability of natural and cut slopes, tunnels, embankments and structural foundations for large structures.
- 30 / 45 / 60 Deg fixed angle offset options

Wheel Assemblies



Extension Rods

Features:

Advanced rugged sensor technology utilising power management.

Lightning protection as standard

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

Calibrated range ±15 ±10 ±5 deg (to 259 mm/m)

Programmable sample period : removes unwanted vibration

Immersion to 80 m depth (Standard) - additional depth on request.

Sensor strings can provide a complete profile of vertical and horizontal displacements.

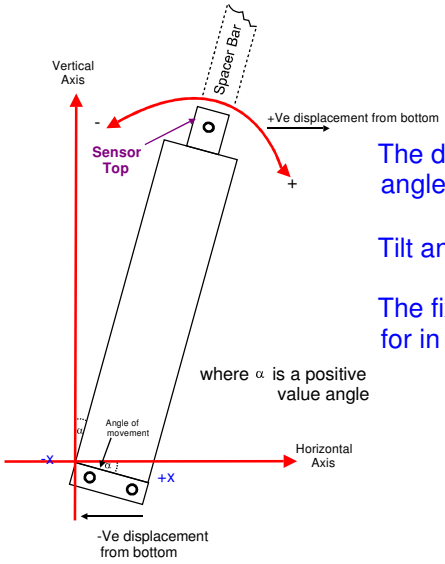
Digital data communications to simplify installation and measurement operations

Part Number:	Description:
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:	
IPI-D-30-SDI12-15	Dual Axis I-P-I Solid state 30 Deg Offset +/- 15 deg range SDI-12 comms
IPI-D-45-SDI12-15	Dual Axis I-P-I Solid state 45 Deg Offset +/- 15 deg range SDI-12 comms
IPI-D-60-SDI12-15	Dual Axis I-P-I Solid state 60 Deg Offset +/- 15 deg range SDI-12 comms
IPI-S-30-SDI12-15	Single Axis I-P-I Solid state 30 Deg Offset +/- 15 deg range SDI-12 comms
IPI-S-45-SDI12-15	Single Axis I-P-I Solid state 45 Deg Offset +/- 15 deg range SDI-12 comms
IPI-S-60-SDI12-15	Single Axis I-P-I Solid state 60 Deg Offset +/- 15 deg range SDI-12 comms
RS-485 network:	
IPI-D-30-RS485-15	Dual Axis I-P-I Solid state 30 Deg Offset +/- 15 deg range RS485 comms
IPI-D-45-RS485-15	Dual Axis I-P-I Solid state 45 Deg Offset +/- 15 deg range RS485 comms
IPI-D-60-RS485-15	Dual Axis I-P-I Solid state 60 Deg Offset +/- 15 deg range RS485 comms
IPI-S-30-RS485-15	Single Axis I-P-I Solid state 30 Deg Offset +/- 15 deg range RS485 comms
IPI-S-45-RS485-15	Single Axis I-P-I Solid state 45 Deg Offset +/- 15 deg range RS485 comms
IPI-S-60-RS485-15	Single Axis I-P-I Solid state 60 Deg Offset +/- 15 deg range RS485 comms
	Horizontal I-P-I Sensor Range
IPI-HD-SDI12-15	Dual Axis I-P-I Solid state Horizontal +/- 15 deg range SDI-12 comms
IPI-HD-SDI12-75	Dual Axis I-P-I Solid state Horizontal +/- 7.5 deg range SDI-12 comms
IPI-HD-SDI12-25	Dual Axis I-P-I Solid state Horizontal +/- 2.5 deg range SDI-12 comms
IPI-HS-SDI12-15	Dual Axis I-P-I Solid state Horizontal +/- 15 deg range SDI-12 comms
IPI-HS-SDI12-75	Dual Axis I-P-I Solid state Horizontal +/- 7.5 deg range SDI-12 comms
IPI-HS-SDI12-25	Dual Axis I-P-I Solid state Horizontal +/- 2.5 deg range SDI-12 comms

RS-485 network:

IPI-D-15-485	Dual Axis I-P-I Solid state - +/- 15 deg - RS-485 comms - sealed 80 m
IPI-D-75-485	Dual Axis I-P-I Solid state - +/- 7.5 deg - RS-485 comms - sealed 80 m
IPI-D-25-485	Dual Axis I-P-I Solid state - +/- 2.5 deg - RS-485 comms - sealed 80 m
IPI-S-15-485	Single Axis I-P-I Solid state - +/- 15 deg - RS-485 comms - sealed 80 m
IPI-S-75-485	Single Axis I-P-I Solid state - +/- 7.5 deg - RS-485 comms - sealed 80 m
IPI-S-25-485	Single Axis I-P-I Solid state - +/- 2.5 deg - RS-485 comms - sealed 80 m

Offset Angel

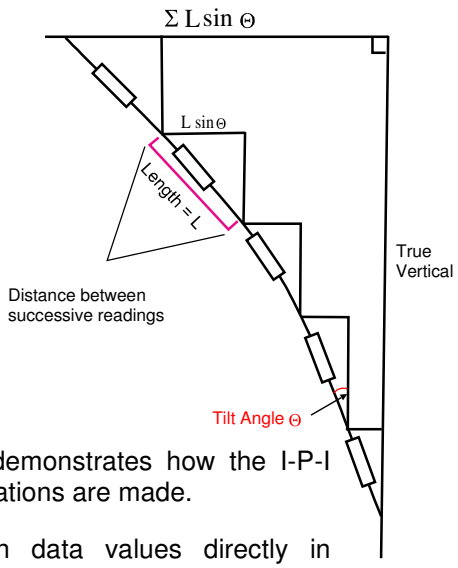


The diagram opposite shows how the tilt angle is determined for the I-P-I.

Tilt angle = α (Radians)

The fixed offset value is automatically allowed for in the operation of the sensor.

I-P-I Chain with Fixed Offset

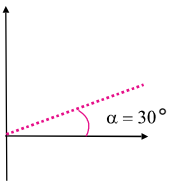


The image above demonstrates how the I-P-I displacement calculations are made.

The sensors return data values directly in engineering units.

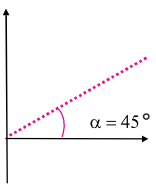
Standard Angular Offsets

The following standard fixed offset angles are available with the Keynes Controls In-Place-Inclinometers.



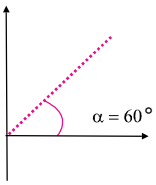
Output = 30 Deg Offset ± 15 Deg

Part No. IPI-D-30-SDI12-15
IPI-S-30-SDI12-15
IPI-D-30-RS485-15
IPI-S-30-RS485-15



Output = 45 Deg Offset ± 15 Deg

Part No. IPI-D-45-SDI12-15
IPI-S-45-SDI12-15
IPI-D-45-RS485-15
IPI-S-45-RS485-15



Output = 60 Deg Offset ± 15 Deg

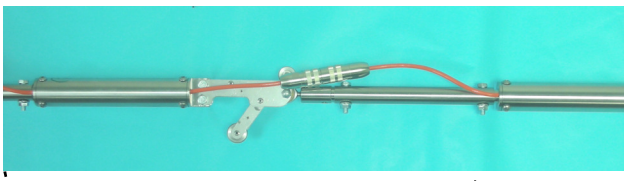
Part No. IPI-D-60-SDI12-15
IPI-S-60-SDI12-15
IPI-D-60-RS485-15
IPI-S-60-RS485-15

Connecting In-Place-Inclinometer Sensors Together:

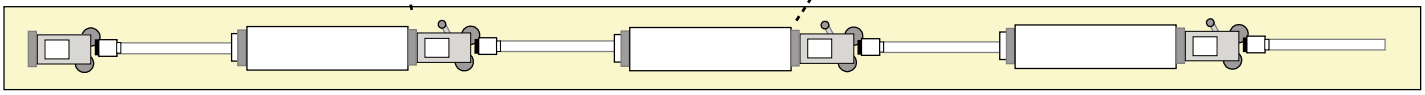
All of the In-place inclinometers come supplied with IP-68-rated mating interlocking connectors enabling the sensors to be quickly installed. Simply lock adjoining connectors together to increase the I-P-I string length. A multi-core plastic-sheathed cable is used for signal transmission, with any spare cores acting as the local earth to reduce voltage losses for long network length operations. The signal cables are terminated to the glass-metal seals fitted into the sensor to maintain water integrity.

Digital Sensor Communications

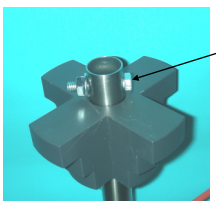
The image opposite shows how the I-P-I local area network is connected between the different sensors on the chain.



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

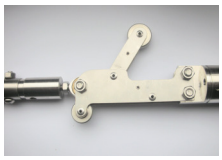


Gauge length of each sensor is between adjacent pivot points.



The image opposite shows the I-P-I casing top mounting bracket with a sensor secured into place with a bolt.

Keynes Controls wheel assemblies can be supplied to fit any casing,



I-P-I Wheel Assembly

SENSORS		SPECIFICATIONS
Calibrated range		± 15 , ± 7, ± 2.5 deg (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		56mm
Maximum casing internal diameter		72mm
Length		230mm
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		560g 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

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.

SDI-12 Dongle installed in a Laptop.

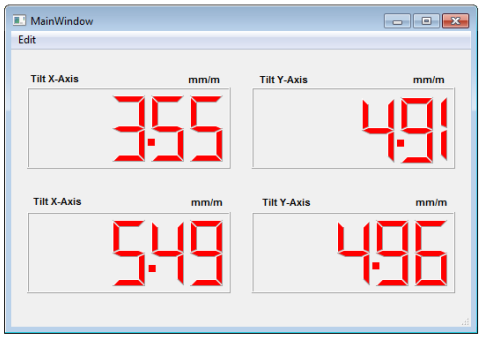
Media Converters

This product supports SDI-12 1.3 operations

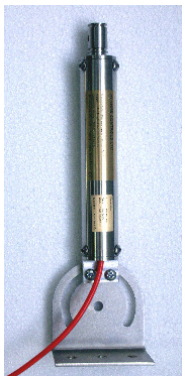
In-place Inclinomter Data Acquisition System:

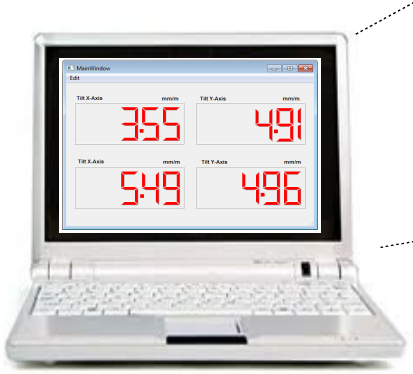
The image below shows how simple a PC / laptop computer data acquisition system can be put together using the Keynes Controls media converter unit and I-P-I range of sensors. All of the current inclinometers connect to a network and send values directly in engineering units into data recorders or PC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

Adding new sensors to a network is simplified as no new calibration factors have to be added to, or changed, inside the software.



Q-Log Application





Laptop / PC Computer

USB Data Link

digital network

SDI12-HB Media Converter

I-P-I Tilt Sensor

I-P-I Tilt Sensor

All of the inclinometer range of sensors are fully integrated into the Q-Log data recording and display software.

Remote Data Acquisition & Data Display Solutions

The image below shows a basic EZ-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.

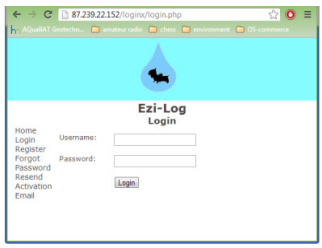
Data from each sensor is stored into the database and sent automatically to a User in the form of an E-mail attachment. An E-mail alarm system operating on the stored data in the database is used to warn if any measurement conditions have been exceeded.

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:

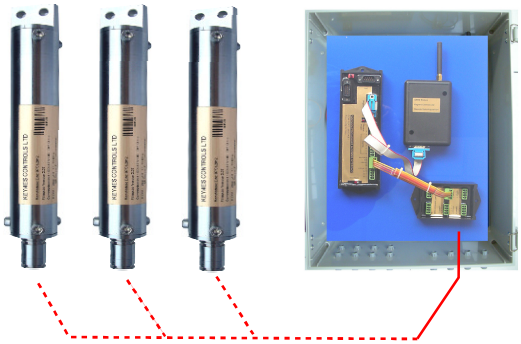
http://www.aquabat.net/QLOGFree/qlogv2.html



Expansion Options:

The AquaLOG data recorder shown opposite can be expanded to accept up to a maximum of I-P-I sensors or other intelligent SDI-12-based devices.

Any suitable sensor from third-party suppliers can be used so long as it supports the correct digital network.



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

Data is sent out across the mobile phone GPRS network and stored into a database.

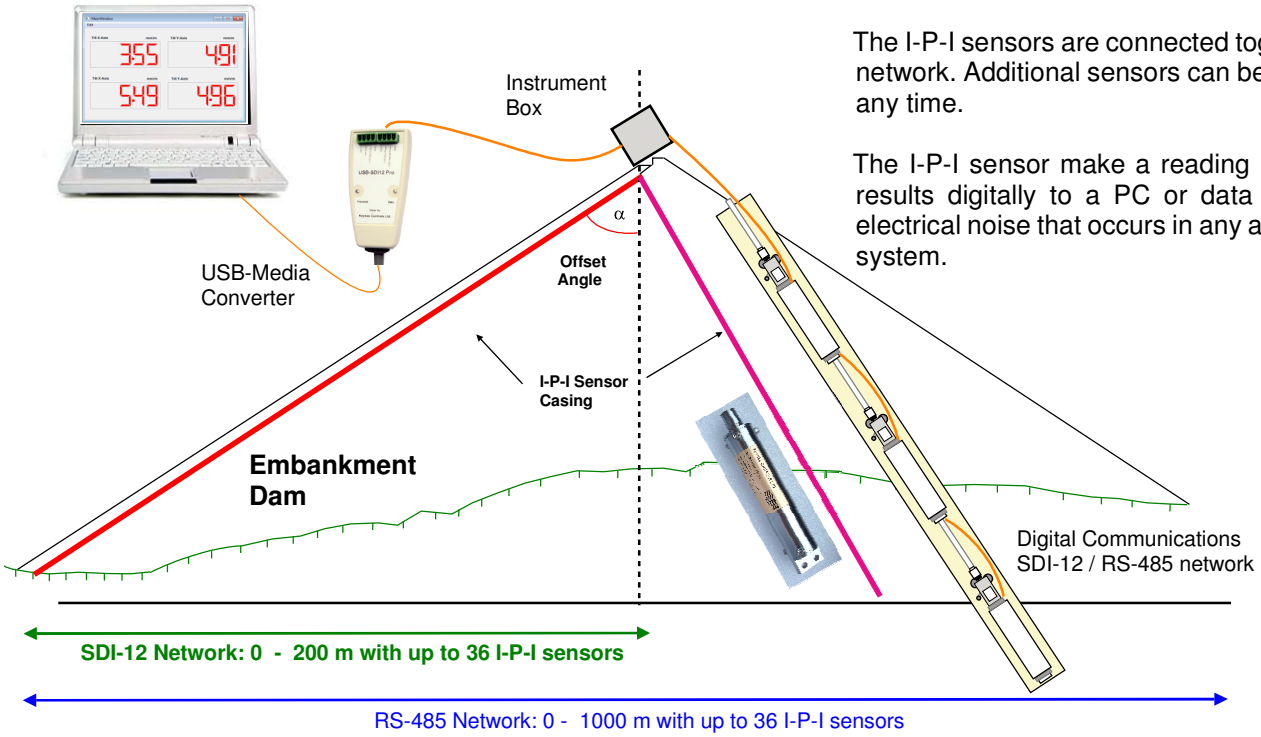
Noise Reduction:

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. Any unwanted vibration noise is averaged out of the measurement.

Calibration: All sensors are calibrated at the Keynes Controls facility in the UK. 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 1 km away for the data recording system to be used. The inclinometers can be mixed with any other suitable sensor along the network string. Up to a maximum of 36 sensors can be deployed



Digital Communications

The I-P-I sensors are connected together on a local digital network. Additional sensors can be added to a network at any time.

The I-P-I sensor make a reading internally and transmit results digitally to a PC or data logger. This removes electrical noise that occurs in any analogue measurement system.

Addtional Part Numbers:

Description	Part Number
Isolated SDI-12 USB media converter	USB-SDI12-Pro
Isolated RS-485 USB media converter	USB-RS485-Pro
EZ-LOG Web Logger	EZ-LOG
AquaLOG data-logger	Aqualog
I-P-I Mounting backet	IPI-Bracket-S

Lightning Protection:

All of the I-P-I ranges of sensors have lightning protection fitted on the power and data lines.