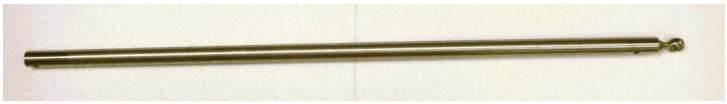
Smart In-Place-Inclinometer Sensor Range

Advantages:

- **The In-place Inclinometer (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 vertical or horizontal displacements.**
- **Available in Uni-Axial and Bi-Axial MEMS sensor versions.**
- **Low-power SDI-12 or RS-485 digital communications. Compatible with the NP-Isolator network modules**
- **Programmable averaging period for signal enhancement and noise reduction. Data values in engineering units**
- **Digital data communication to remove noise and to simplify installation.**
- **Ideal for monitoring the stability of natural and cut slopes, tunnels, embankments and structural foundations for large structures.**
- **Waterproof to 200 m**
- **Automatic temperature compensated readings**

Wheel Assemblies



Extension Rods

Features

Advanced rugged sensor technology utilising power management.

Lightning protects as standard

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

Six Point Calibration Curve - Optimised for MEMS sensor operation

Programmable sample period : removes unwanted vibration

Waterproof to 200 depth

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

Digital data communications to minimise noise

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-15-SDI12	Dual Axis I-P-I Solid state - +/- 15 deg - SDI-12 comms - sealed to 30 m
IPI-D-75-SDI12	Dual Axis I-P-I Solid state - +/- 7.5 deg - SDI-12 comms - sealed to 30 m
IPI-D-25-SDI12	Dual Axis I-P-I Solid state - +/- 2.5 deg - SDI-12 comms- sealed to 30 m
IPI-S-15-SDI12	Single Axis I-P-I Solid state - +/- 15 deg - SDI-12 comms - sealed 30 m
IPI-S-75-SDI12	Single Axis I-P-I Solid state - +/- 7.5 deg - SDI-12 comms - sealed 30 m
IPI-S-25-SDI12	Single Axis I-P-I Solid state - +/- 2.5 deg - SDI-12 comms - sealed 30 m

RS-485 network:

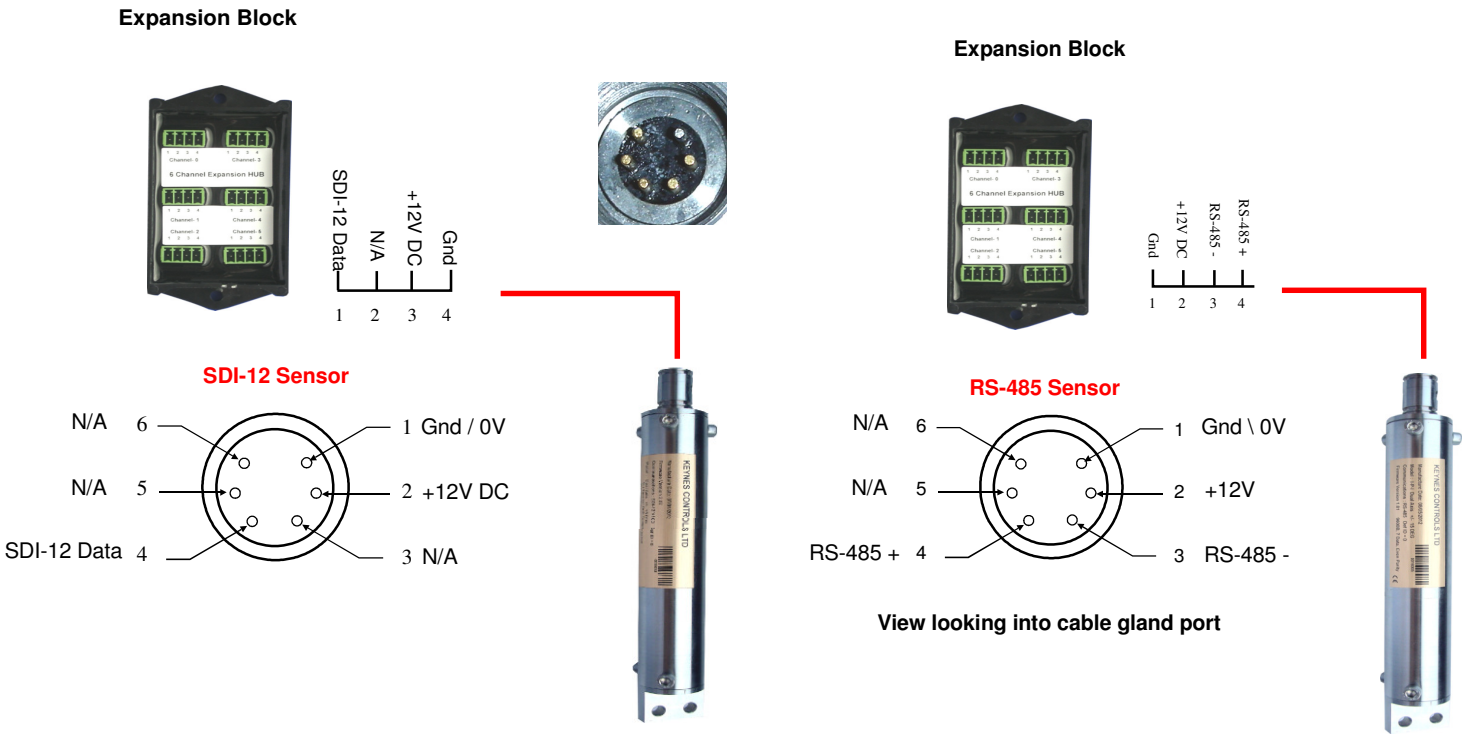
IPI-D-15-485	Dual Axis I-P-I Solid state - +/- 15 deg - RS-485 comms - sealed 80 m
IPI-D-75-485	Dual Axis I-P-I Solid state - +/- 7.5 deg - RS-485 comms - sealed 80 m
IPI-D-25-485	Dual Axis I-P-I Solid state - +/- 2.5 deg - RS-485 comms - sealed 80 m
IPI-S-15-485	Single Axis I-P-I Solid state - +/- 15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

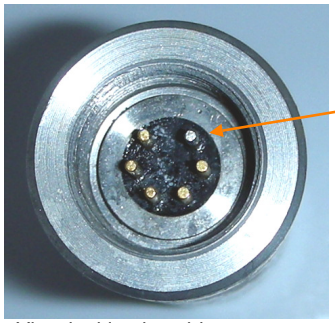
Full systems detail & prices can be found at:

http://www.aquabat.net

Sensor Connection Diagram:

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





View looking in cable port

The adjacent image shows the PTFE seal 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 PTFE seal is rated to 20 bar pressure

Simple Command Structure:

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

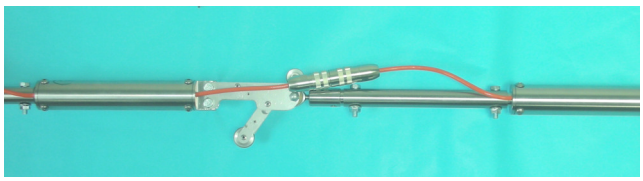
aM! – starts a measurement
aC! – starts a concurrent measurement
aD0! – gets data from the sensor

where a = Instrument ID Number

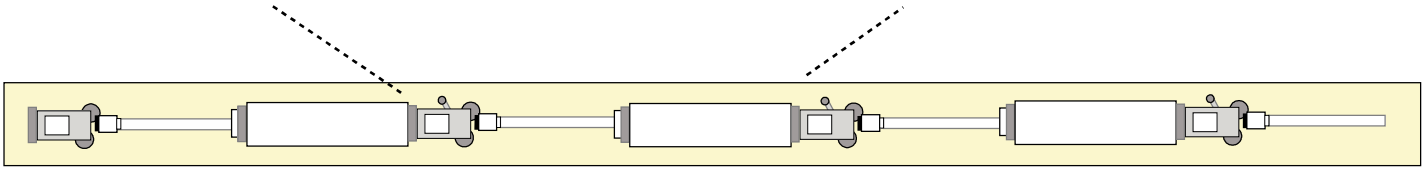
All data is sent digitally across the network. Full details can be found in the product manual.

Connecting In-Place-Inclinometer Sensors Together:

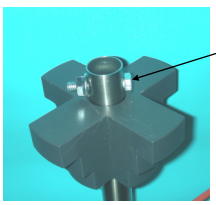
All of the In-place inclinometers come supplied with IP-68-rated mating interlocking connectors enabling the sensors to be quickly installed. Simply lock adjoining connectors together to increase the I-P-I string length. A multi-core plastic-sheathed cable is used for signal transmission, with any spare 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.



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.

I-P-I with gauge tube wheel assembly

SENSORS		
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 +75℃
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		Rated 100 m submergence 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.

SDI-12 Network

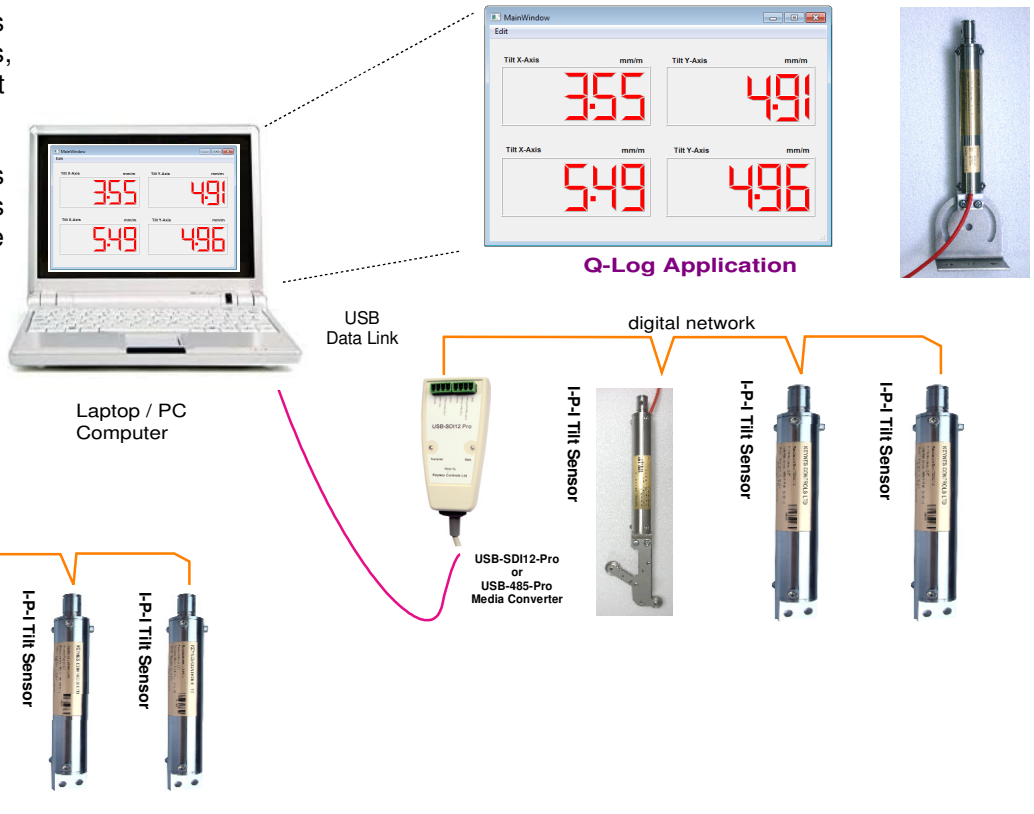
This product supports SDI-12 1.3 operations

PC based In-Place-Inclinomter Data Acquisition System

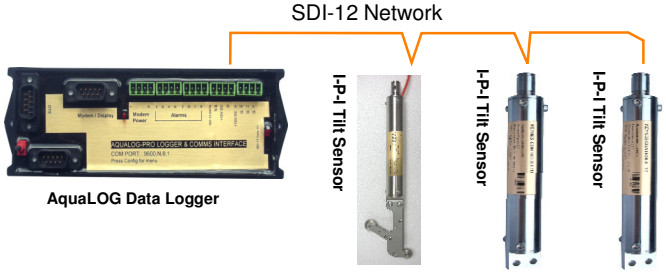
The image below shows how simple a PC / laptop computer data acquisition system can be put together using the Keynes Controls media converter unit and I-P-I range of sensors. All of the current inclinometers connect to a network and send values directly in engineering units into data recorders or PC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

The 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.



Data Logger Solution



For stand-alone operations the I-P-I sensors can be connected to a data logger unit supporting a suitable digital communications network.

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.

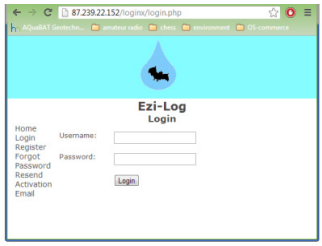
Data from each sensor is stored into the database and sent automatically to a User in the form of an E-mail attachment. An E-mail alarm system operating on the stored data in the database is used to warn if any measurement conditions have been exceeded.

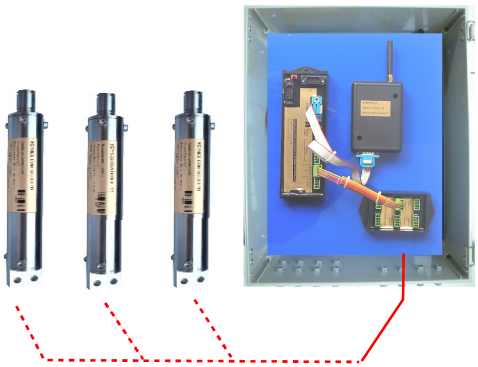
Q-LOG Data Display & Recording Software

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





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.

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.

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.

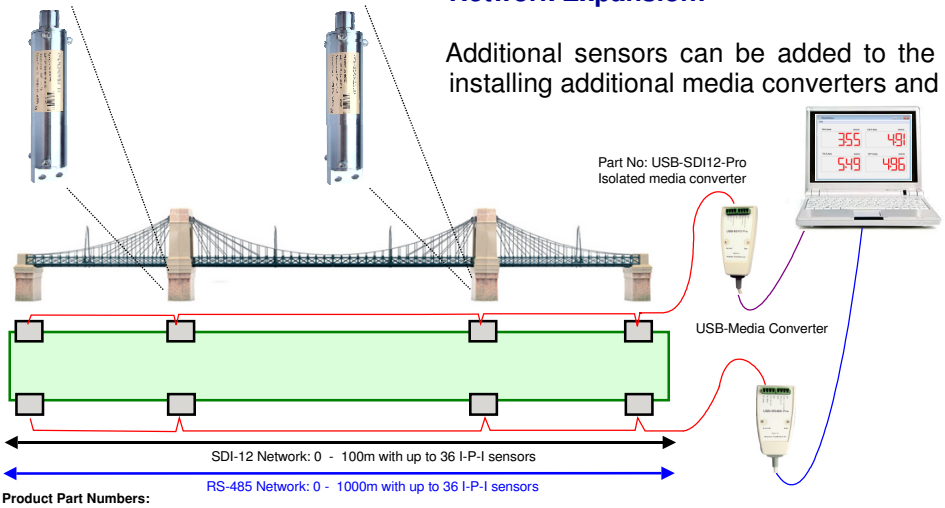
Calibration: All sensors are calibrated at the Keynes Controls facility in the UK. External calibration can be undertaken upon request.

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 1km 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

Network Expansion:

Additional sensors can be added to the PC / laptop data-acquisition system by simply installing additional media converters and wiring the sensors to the network.



Product Part Numbers:

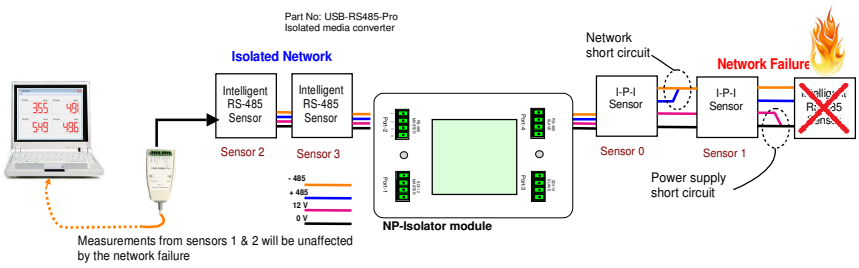
Submerged Sensor Operations

For I-P-I sensors deployed for operation under water and where the sensors will be located into difficult to access locations, then Keynes Controls recommend that the digital network used by the sensors be broken down into small groups, with each group of sensors being protected by an isolator module.

In case a sensor should a sensor fail, cabling become damaged, then only data from the sensors up to the NP_Isolator module will be effected. The NP_Isolator module prevents a digital network from failing in the case of a fault on a sensor and maintains data integrity.

Further details can be found at

http://www.aquabat.net/downloads/NP-isolatorv1.pdf



Description	Part Number
Isolated SDI-12 USB dongle	USB-SDI12-Pro
Isolated RS485 USB Dongle	USB-RS485-Pro
EZ-LOG Web Logger	EZ-LOG
AquaLOG data-logger	Aqualog
I-P-I Mounting bracket	IPI-Bracket

Lightning Protection:

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