



Pro In-Place Inclinometer (IPI) System

User Manual



Man 269	1.0.0	17/05/21	Philip Day	Gary Pickles	Richard Colegate
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Section 1 : Introduction

1.01 Important information

Thank you for choosing the Soil Instruments Pro IPI system. This manual has been written to help you install the Pro IPI System. Please read this manual thoroughly before use and keep it handy when installing the Pro IPI System.

The following symbols are used throughout the manual:



This Symbol indicates a warning.

Failure to observe the warning may result in injury, product malfunction, unexpected readings or damage to the product that may invalidate its warranty.



This symbol indicates a tip.

Additional information that may be helpful when installing the Pro IPI system

Soil Instruments has an ongoing policy of design review and reserves the right to amend the design of the Pro IPI System and this instruction manual without notice.

Please refer to our terms and conditions of sale for warranty information.



Products marked with the symbol are subject to the following disposal rules in the UK and European countries.

- This product is designated for a separate collection at an appropriate collection point.
- Do not dispose of as household waste.
- For more information, contact Soil Instruments Ltd or the local authorities in charge of waste management.

1.02 System components

Depending upon system configuration you should have the following system components:

Per Borehole

- One terminating Pro IPI sensor
- Up to 99 Pro IPI sensors
- One top support assembly
- One Junction box (Not required if your datalogger is within 2m of the borehole)
- Data and power Buss cable (Not required if your datalogger is within 2m of the borehole)
- Safety support wire
- Data logger, Hub or wireless node

1.03 Familiarisation

The Pro IPI System comprises of many Pro IPI sensors coupled together to form a linked chain of sensors suspended from the top of installed sections of inclinometer casing.

The chain starts with a terminating sensor to which the PRO IPI sensors are coupled, as each sensor is added to the chain is lowered down the casing.

The chain is completed by coupling a top support assembly to the last Pro IPI sensor and adjusting the top support assembly to position the chain relative to the ground level.

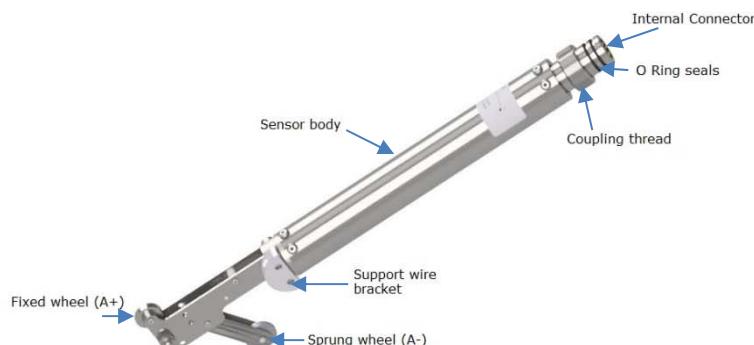
A safety wire is attached to the terminating sensor which provides a method of retrieval should the chain be dropped down the casing during installation.

The casing should have been installed with the keyway orientated in line with the expected direction of movement or aligned to the structure being monitored.

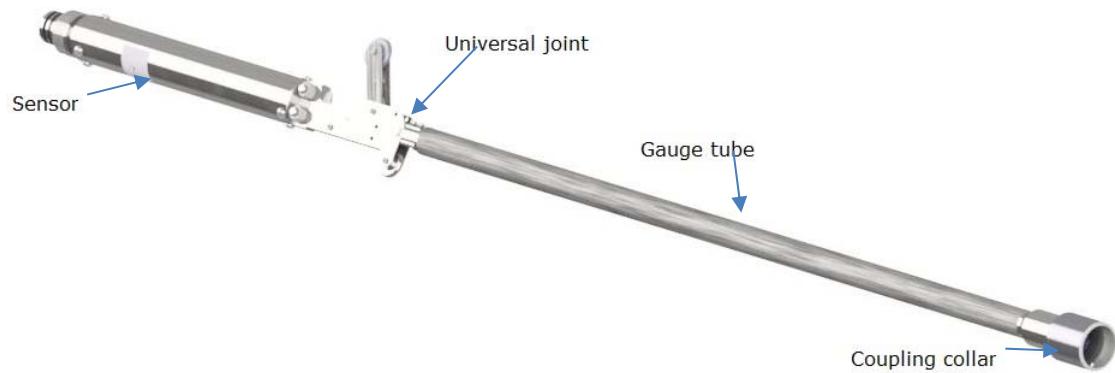
The fixed wheel on the sensor wheel bracket should be installed in the keyway where the positive direction on movement is expected.

All the sensors should be oriented in the same direction.

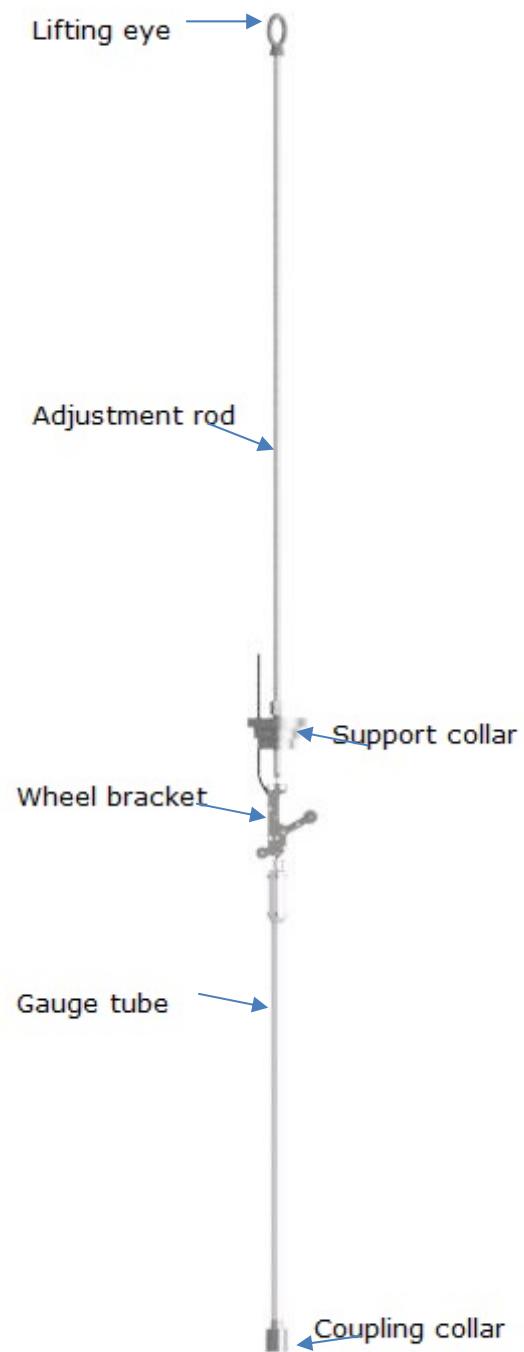
Terminating Sensor



Pro-IPI Sensor



Top Support Assembly



1.04 Required Installation Tools

The following tools are required to perform the installation.

- Installation support bracket (Soil part number C12-PRO-ISB)
- Lifting tool (Soil part number C12-PRO-ISBL) Required for long chains
- Cable strippers (If using junction box)
- 5mm A/F hex key (Allen key)
- Cable ties
- Side cutters (If using junction box)
- 2.5mm flat blade screwdriver
- 2 x 19mm combination spanner
- 10mm combination spanner
- 5.5mm combination spanner

Section 2 : Installation Pro-IPI system

2.01 Prerequisites

This manual assumes that you have already installed a quality inclinometer casing. For details of the suitable casing, please see Soil Instruments datasheets C9, C9-4 and C18.



If you are fitting the Smart IPIs into recently installed casing, you must take care to ensure that any hydration heat has dissipated before you install the Smart IPI Sensors.

2.02 Preparation

Layout the components in the order in which they will be installed, starting with the terminal sensor, and ending with the top support assembly.



Record the IPI serial numbers and the order in which they will be installed. See appendix A



It is recommended to use an anti-galling compound on the threads of the IPI couplings.

Couple the terminating sensor with the first IPI sensor by aligning the keyways and inserting the connector of the terminating sensor into the coupling of the IPI gauge tube.

Screw the coupling collar onto the coupling thread and fully tighten it by hand.



Join the Terminating Sensor to the first Smart IPI Sensor before you attempt to lower the sensors down the borehole.

Pass the support wire through the support wire bracket and secure using one wire grip, retain the second grip for securing the wire to the Top Support assembly.

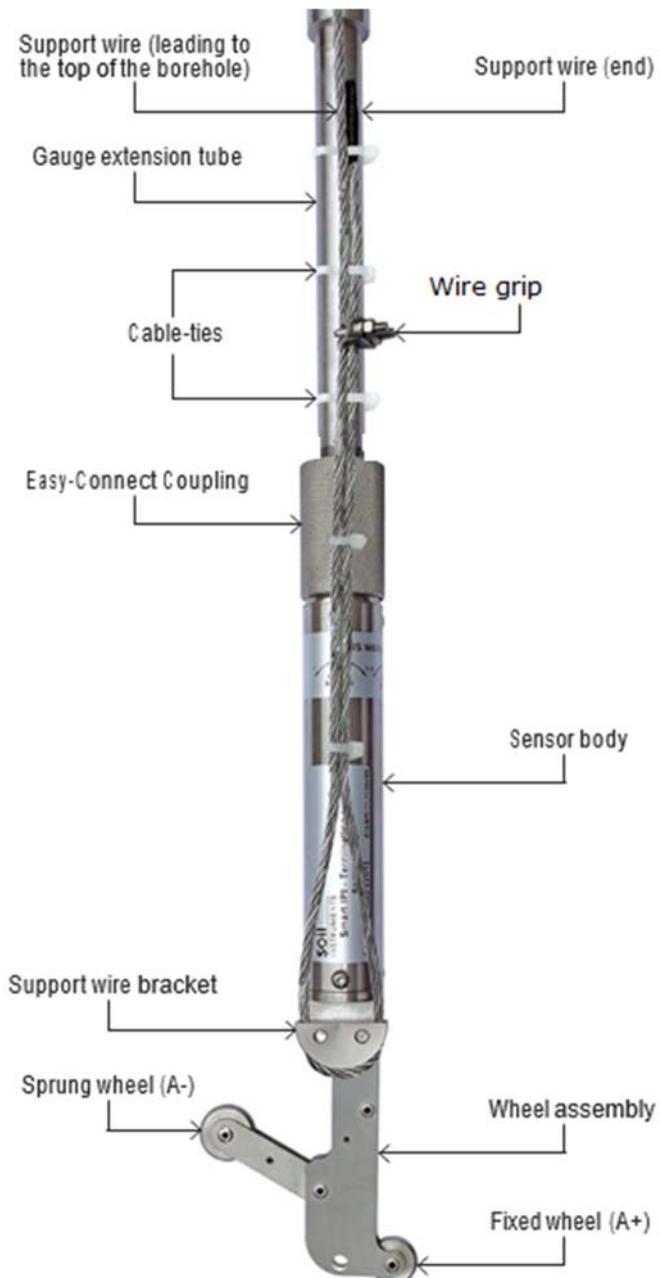


Right Way of Applying Bulldog Grips



Wrong Way of Applying Bulldog Grips

Ensure the return end of the wire is on the correct side of the grip and fit the additional Nyloc nuts to the wire grip.



Assemble the top support range adjustment unit to the top support gauge tube using the two M6 socket cap screws and the Nyloc nuts

2.03 Installation of sensors in the casing



Ensure suitable gloves are used when installing the IPIs

Locate the A+ direction of the Terminating Sensor; the fixed wheel should be facing towards the expected direction of movement and the sprung wheel away from the direction of movement.

Whilst holding the Terminating Sensor with one hand, gently guide the wheel assembly (bottom wheel first) into the borehole with the fixed wheel facing towards the A+ direction. Make sure that both wheels are correctly aligned in the keyways of the casing.

Guide the wheel assembly of the second IPI sensor into the borehole in the same manner as before and place the Installation Support Tool in the available slot directly underneath the second IPI Sensor coupling thread.

The Installation Support Tool spans the inclinometer casing, preventing the sensor from falling into the borehole, allowing you to fit subsequent sensors with ease.

The IPI Sensor can now rest safely in place on the Installation Support Tool.



Take care to ensure that the wheels remain in the keyways of the casing and that they are not snagged by the support wire which should be free to move within the borehole.

Pick up the next IPI Sensor and align the key slot on the sensor end with the key on the gauge tube end. Gently push together and tighten using the coupling collar as before, lift the sensor chain and remove the support tool, then lower into the borehole, making sure that both wheels are correctly aligned in the keyways of the casing.



For long chains of sensors, it is advisable to use the lifting tool and lifting equipment to support the weight of the sensor chain.

Repeat this process until all sensors are installed, remembering to check and record the serial number, chain position and depth for each sensor as you go.

2.04 Installation of the top support assembly

Typically, the fixed wheel on the top support assembly is positioned down the borehole to align with the ground level.

Measure the distance from the top of the casing to where the ground level is.

The Top support casing collar has multiple seating faces depending on the diameter of the casing used.

Adjust the position of the two M12 nuts until the Top Support casing collar seating face is in the correct position relative to the fixed wheel.

Connect the top support assembly to the last IPI sensor, gently push together and tighten using the coupling collar as before, lift the sensor chain and remove the support tool, then lower into the borehole, making sure that both wheels are correctly aligned in the keyways of the casing and the top support casing collar locates correctly into the casing.

Lift and support using the lifting eye on the top support adjustment rod if required.



Ensure the cable and support wire are not trapped between the casing and the casing collar.



Make any final adjustments to the length of the IPI chain if needed before securely tightening the M12 locking nut.

Excess threaded rod can be removed as required.

Refit the lifting eye and secure the support wire to the eye using the second wire grip.



Section 3 : Logger connection

3.01 Gteclink digital node

Typically, a Gteclink digital node is connected directly to the cable of the Top support assembly.

The Digital node can power and read 30 Pro IPI sensors with the standard configuration.

The Digital node with external power can power and read 50 Pro IPI sensors.

Wiring is indicated in the RS485 port of the data logger.

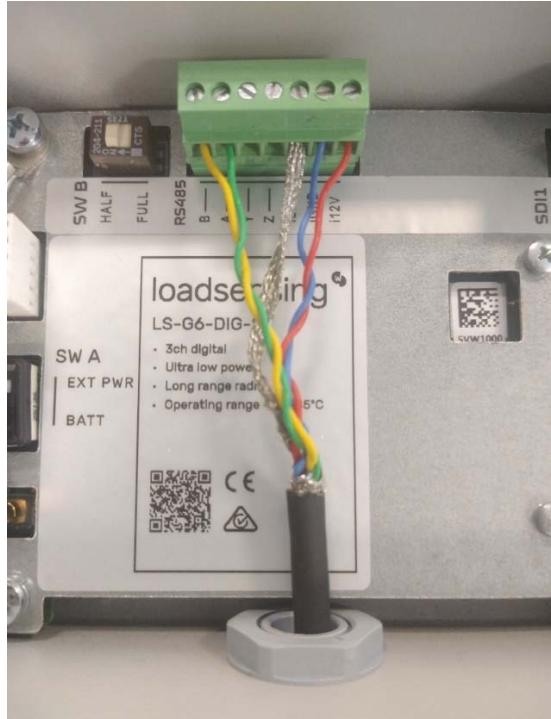
The data logger must be placed at HALF to read the Pro IPIs.

Note: Always remove plastic protection from the Half/Full switch as it can cause erratic behaviour on the node.

Ensure the power is off before wiring the sensor chain.

Wire the Top Support cable to the node as shown below:

Top Support cable wire	Digital Node RS485 terminal
Red ve+	12V
Black ve-	GND
Yellow B+	B
Green A-	A
Screen	SHLD



View of the inside of the Digital node connected to a Pro IPI chain

Refer to the Gteclink manual for node configuration details.

3.02 Campbell based data logger

The Campbell based data logger can power and read up to 100 Pro IPI sensors.

The sensor chain can be wired directly to the data logger or for longer distances via a Data & Power cable using the junction box.

Ensure the power is off before wiring the sensor chain.

Wiring details as shown below:

Top Support cable wire	Soil Instruments Data & Power cable	Data logger terminals
Red ve+	Red	12V
Black ve-	Black	GND
Yellow B+	White	White
Green A-	Blue	Blue
Screen	Screen	SHLD

Repower the data logger and the logger will read the sensor chain as per its reading schedule.

Refer to the datalogger manual for configuring the reading schedule and data retrieval.

3.03 Sencieve hub

The Sencieve hub can power and read up to 50 Pro IPI sensors.

The Chain needs to be wired to a multipole connector that plugs into the hub.

The sensor chain can be wired to the hub or for longer distances via a Data & Power cable using the junction box.

Ensure the power is off before wiring the sensor chain.

Wiring details as shown below:

Top Support cable wire	Soil Instruments Data & Power cable	Multipole plug pin numbers
Red ve+	Red	1
Black ve-	Black	12
Yellow B+	White	3
Green A-	Blue	2
Screen	Screen	

Repower the hub and the hub will read the sensor chain as per its reading schedule.

Refer to the hub manual for configuring the reading schedule and data retrieval.

3.04 Junction box

When the data logger or wireless node is more than 2m from the top of the borehole the Top support cable will need to be extended using Soil Instruments Data & Power cable and the junction box.

When connecting to the junction box with the top support assembly cable and the Data & Power cable, the cables must be grounded between the screening and the EMC cable gland at both Glands. This protects from potential EMC effect from both external and internal sources.

Strip back the outer sheath of your cables, providing enough length to connect to the terminal connections.

Cut back the outer screen braid of the cable to approximately 20mm in length.

Insert the cable into the EMC gland and loosely tighten down the head.

Check that the internal fingers of the EMC gland are in full contact with the braiding and the head of the gland is tightening down on the outer sheathing of the cable.

Tighten down the head of the EMC cable gland when satisfied that the steps above have been met.

Remove the foil protruding from the cable and terminate the wires into the terminal strip as listed below.

Top Support cable wire	Soil Instruments Data & Power cable
Red ve+	Red
Black ve-	Black
Yellow B+	White
Green A-	Blue

The junction box is supplied with a clip-on ferrite filter, this must be clipped over the conductor wires of the Top support cable within the junction box.



EMC protection can only be completed if both ends of the cable are terminated as stated in the steps above and the ferrite filter is fitted.

Refit the junction box cover ensuring it is securely tightened.

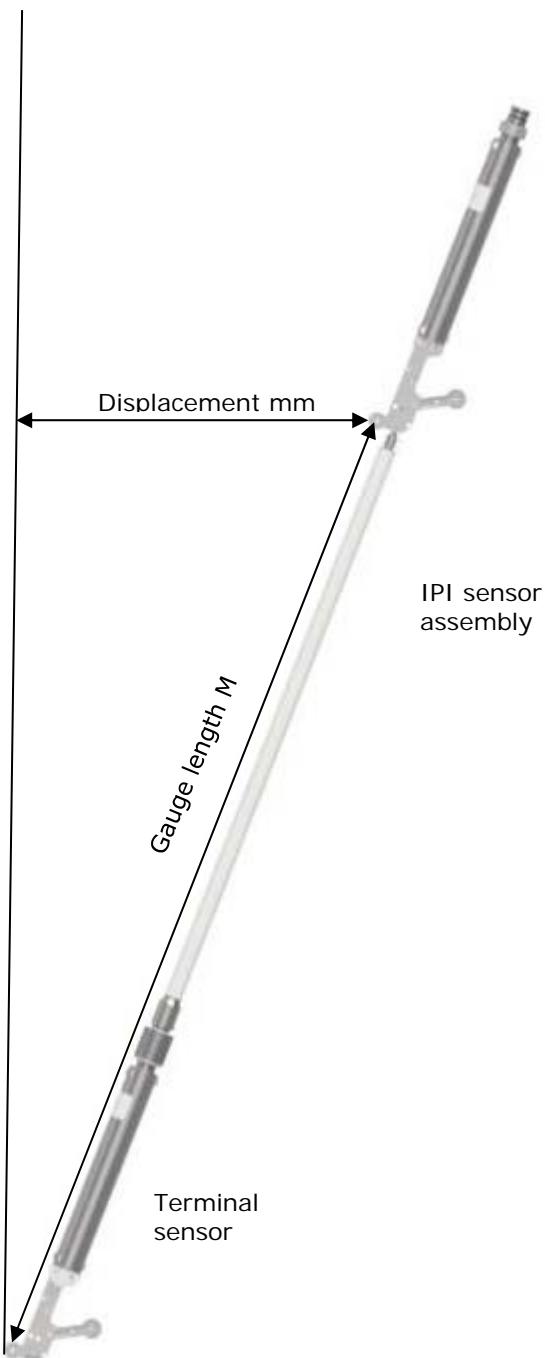
Section 4 : Data Reduction

4.01 Displacement calculation

The Pro IPI sensors output their readings in mm/M.

This needs to be multiplied by the gauge length of the sensor to calculate the horizontal displacement in mm.

The horizontal displacement is the displacement of the fixed wheel above the sensor and gauge tube relative to the fixed wheel below the sensor.



4.02 Conversion of sensor displacement into profile change

Immediately after installation, the sensor chain will go through a process of mechanically settling into the casing.

Typically, this settling only lasts 48 hours after which any movement seen is that of the casing moving due to ground movement.

A datum set of reading needs to be established and we recommend that this is established after the settling period.

Select a set of readings taken from the chain of sensors all at the same time and date, this is called the datum set.

Subsequent sets of readings can be processed to produce a profile change plot to show the horizontal ground movement of the borehole over time.

Typically, IPI boreholes are drilled to a depth where the bottom of the IPI chain within the casing is located within the stable ground, beyond the zone of influence where movement is anticipated.

Therefore, profile change plots are shown with all the data sets starting at zero change at the maximum installed depth where the fixed wheel of the terminal sensor is in contact with the casing.

The angular change for the terminal sensor is used to calculate the horizontal displacement of the next fix wheel above it i.e., the fixed wheel of the next sensor in the chain.

To calculate the change for each sensor, use the following equation:

$$SC = C - D$$

Where:

SC is the sensor change in mm for the current reading.

C is the current reading horizontal displacement.

D is the Datum reading horizontal displacement.

Once calculated for each sensor in the chain an Incremental or Accumulated profile plot can be created.

Section 5 : Help and Support.

5.01 Support

Contact Soil Instruments support team using the details below:

<https://soilinstruments.helpdocs.com>

email: support@soilinstruments.com



Scan Me For Support

Appendix A. Installation Sheet example

Document Title	Pro In-Place Inclinometer (IPI) Installation Record Sheet		
Date: 31/10/2013	Installer: John Smith	Site: Site Identifier	Borehole ID: BH01
Borehole Depth: 26m	No. of Sensors: 25	A+ Direction: North	Casing Size: 70mm
Sensor Depth	Sensor Position	Serial Number	Gauge Length
25m	25: Terminating sensor	41226	1m
24m	24	41227	1m
23m	23	41228	1m
22m	22	41229	1m
21m	21	41230	1m
20m	20	41231	1m
19m	19	41232	1m
18m	18	41233	1m
17m	17	41234	1m
16m	16	41235	1m
15m	15	41236	1m
14m	14	41237	1m
13m	13	41238	1m
12m	12	41239	1m
11m	11	41240	1m
10m	10	41241	1m
09m	09	41242	1m
08m	08	41243	1m
07m	07	41244	1m
06m	06	41245	1m
05m	05	41246	1m
04m	04	41247	1m
03m	03	41248	1m
02m	02	41249	1m
01m	01	41250	1m

NOTES:
A+ direction towards excavation, IPIs installed to depth (25m).
Installation assisted by Alan Jones, installation records completed by John Smith.
No issues occurred during installation.
Pro-IPI's Installed in ascending serial number order

Appendix B. Installation Sheet Blank



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