Rod Extensometer System
User Manual

Man 270	1.0.0	17/05/21	Philip Day	Gary Pickles	Richard Colegate
Manual No.	**Revision**	**Date**	**Originator**	**Checked**	**Authorised for Issue**

Contents

Section 1 : Introduction

1.01 Important information

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

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

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

Only use the correct battery type as supplied fitted to the digital readout.

Using incorrect battery types may damage the digital display.

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

- This product is designated for 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:

Manual reading system:

- Manual reading Rod Extensometer reference head assembly
- Fibreglass or stainless-steel rod and protective tubes (Fitted to head for continuous system or suppled in lengths for site assembly systems)
- Head plate fixing kit (Expanding or resin fixing)
- Anchors
- Digital readout for manual reading anchors
- Grout and air vent pipe
- Length adjustment rod (Not required for a continuous system)
- Installation tool kit

Remote reading system:

- Remote reading Rod Extensometer reference head assembly
- Fibreglass or stainless-steel rod and protective tubes (Fitted to head for continuous system or suppled in lengths for site assembly systems)
- Head plate fixing kit (Expanding or resin fixing)
- Anchors
- Displacement transducers
- Grout and air vent pipe
- Length adjustment rod (Not required for a continuous system)
- Installation tool kit
- Multicore cable (Not required for single point systems)

1.03 Familiarisation

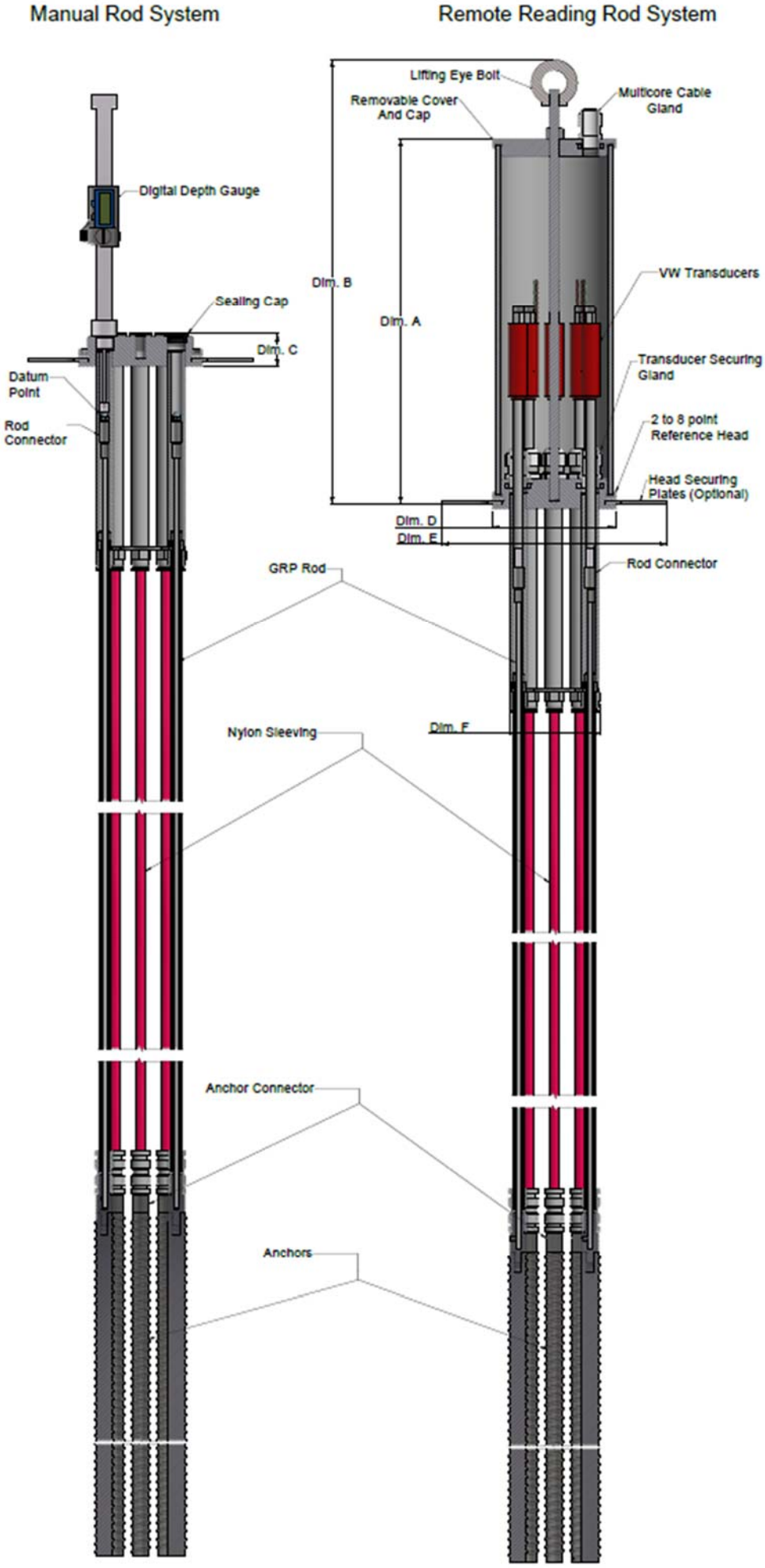
The Rod Extensometer system comprises an anchor unit either groutable or hydraulic to which a length of fibreglass rod (or lengths of stainless steel or fibreglass rod) is attached.

The other end of the fibreglass is attached to a reading point within the reference head assembly.

A Nylon tube (or lengths of tube) covers the fibreglass or stainless-steel rod and connects to both the anchor and the reference head.

The continuous rod assemblies are assembled in the factory to specified lengths as either manual reading or remote reading assemblies and set for a specific transducer range.

Up to 8-rod assemblies can be connected to either a manual reading or remote reading head and are suitable for either up-hole or down-hole installations.


Manual Rod System
Remote Reading Rod System
Digital Depth Gauge
Sealing Cap
Dim. C
Datum Point
Rod Connector
Lifting Eye Bolt
Removable Cover And Cap
Multicore Cable Gland
Dim. B
Dim. A
VW Transducers
Transducer Securing Gland
2 to 8 point Reference Head
Head Securing Plates (Optional)
Dim. D
Dim. E
Rod Connector
GRP Rod
Nylon Sleeving
Dim. F
Anchor Connector
Anchors

All dimensions in mm	Dim.A	Dim.B	Dim.C	Dim.D	Dim.E	Dim.F
Remote Multipoint head 30/50mm transducers	362	439	N/A	120	220	90
Remote Multipoint head 100mm transducers	453	537	N/A	120	220	90
Manual reading Multipoint head	N/A	N/A	35	120	220	90
Remote single point head 30/50mm transducers	376	429	N/A	70	150	20
Remote single point head 100mm transducers	485	538	N/A	70	150	20
Manual reading single point head	35	N/A	N/A	70	150	20

1.04 Required Installation Tools

The following tools are required to perform the installation.
Those marked with # are supplied as part of the installation tool kit.
Unmarked items need to be sourced locally.

- Modified 7mm nut spinner (Soil part number E17-RN-TOOL) manual reading system
- Transducer gland tightening tool (Soil part number E17-G-TOOL)
- Cutting knife#
- Terminal Crimp pliers#
- 5mm A/F ball point hex screwdriver#
- Tape measure#
- Side cutters#
- 5/16” flat blade screwdriver#
- 20mm combination spanner#
- 16mm combination spanner#
- 5/8”AF combination spanner (hydraulic anchor)
- 13mm combination spanner#
- Adhesive tape
- Cable ties
- Marker pen
- Adjustable mole grips (two pairs) #
- Drill and bit for expansion fixings

Additional tools for shortening anchor assemblies

- Flat file
- Junior hacksaw
- 2.5mm A/F hexagon key (Allen key)

Section 2 : Installation Continuous System

This section will describe the basic sequence of operations required to install the Continuous Rod Extensometer.

2.01 Borehole Preparation

The Continuous Multipoint Rod Extensometer is designed for borehole diameters of 100mm and above.

A Single Point Rod Extensometer can be installed in a 50mm borehole.

The top 300mm of the borehole should be opened out to a larger diameter or channels cut to allow for the grout and vent pipes.

The borehole should be free of debris and drilled 600mm deeper than the longest specified anchor position.

If the borehole has been drilled short or the anchors need to be shortened, then see the advanced installation section in this manual.

Anchor locations should be predetermined before ordering the anchor assemblies.

The locations are often dictated by the geology and geometry of the ground to be monitored.

One anchor usually the deepest should be in the stable ground to serve as a reference point for the rest of the anchors in the head.

The reference head should be recessed into the borehole if it is likely to be damaged by blasting or other construction activity.

Alternatively, a protective enclosure can be used in exposed locations.

For down-hole installations, manhole covers can be used to protect the head assemblies.

For down hole installations ensure the recesses and manholes have suitable drain holes to prevent water filling the recess or manhole.

2.02 Uncoiling Method

Ensure suitable gloves and eye protection is worn when uncoiling the Extensometer system.

The Factory assembled continuous system has been coiled up for ease of shipping and handling.

It has been coiled up starting with the longest anchor fixing point and ending with the reference head.

Ideally, the system should be fully uncoiled on-site to allow ease of anchor fitting and insertion into the borehole.

Uncoil the system onto an area that is as flat as possible and close to the borehole.

Where this is not practical the system will need to be uncoiled and anchors fitted before insertion into the borehole (See anchor fixing section below).

Care must be taken to uncoil the system in the reverse of the coiling process by rotating the coil about its central axis. Coils must not be pulled out from the side of the coil at 90 degrees to the coil as this will induce a twist in the rods and protective tube.

When coiled in the factory tie wraps have been used to aid the uncoiling process on site.

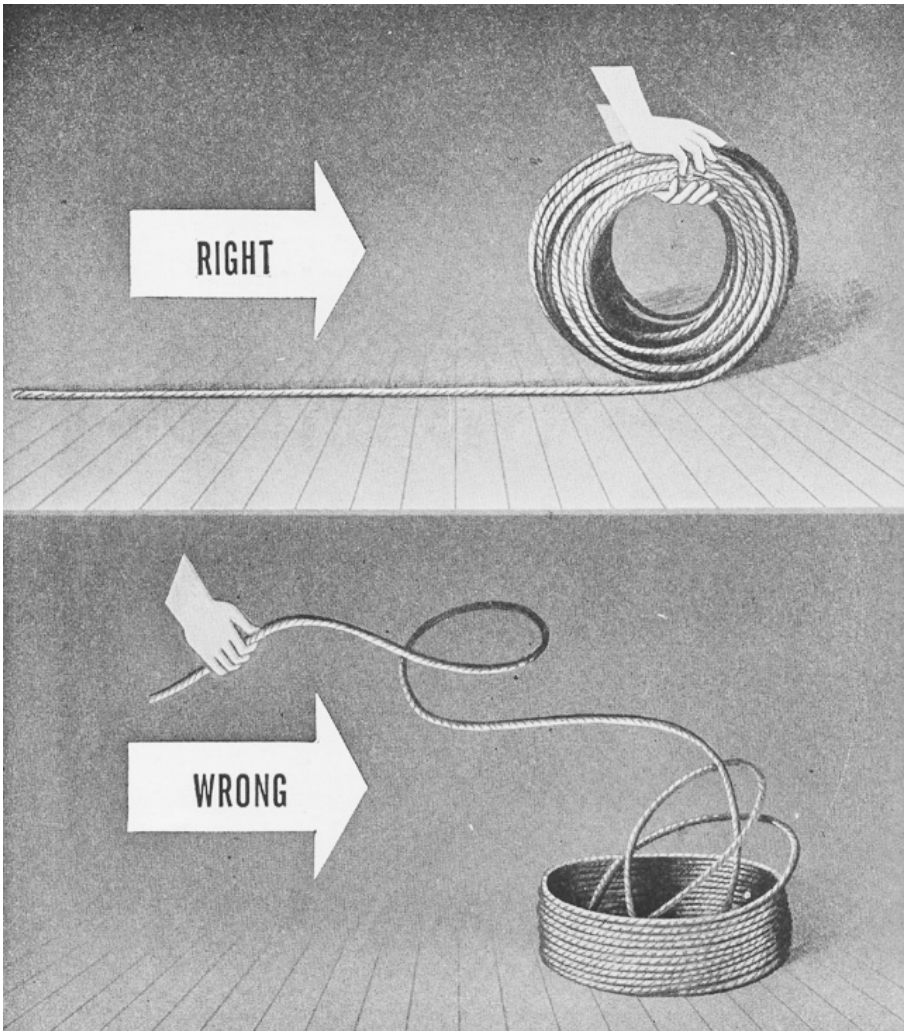
Start uncoiling by Positioning the reference head on the ground and cutting the tie closest to the head, cut the tie and start to uncoil the rods and tubing, cut the other ties as you proceed with the uncoiling either rolling the coil or rotating the coil about its central axis.

Care must be taken to protect the head from physical damage during this process.

Proceed with uncoiling until the system is fully uncoiled.

Care should be taken when releasing the ties that restrain the coil.

Cut the ties one at a time starting at the head end, releasing one coil at a time ensuring that the remaining coils do not release violently.



2.03 Grout Mix

The following mixes are general guides, and you should always consult your site consultant for their recommended mixes and the use of additives.

Grout mixes should be designed to mimic the surrounding soil conditions, however, with rod extensometer systems the borehole may span a range of soil conditions. If this is the case, then it is recommended to consider using a softer mix.

Grout Mix for Hard Soils

Materials	Weight	Ratio by Weight
Portland cement	25kg (1 bag)	1
Water	62.5 Litres	2.5
Bentonite	7.5kg (as required)	0.3

Grout Mix for Medium Soils

Materials	Weight	Ratio by Weight
Portland cement	25kg (1 bag)	1
Water	112.5 Litres	4.5
Bentonite	7.5kg (as required)	0.3

Grout Mix for Soft Soils

Materials	Weight	Ratio by Weight
Portland cement	25kg (1 bag)	1
Water	162.5 Litres	6.5
Bentonite	10kg (as required)	0.4

Additives can be used with the mixes, but these must always be used as specified by your site consultant.

Expanding agents introduce small bubbles into a cement and water mix to prevent it from shrinking during curing, this ensures a good bond between the grout and both the anchor and borehole walls.

Plasticisers can be added to allow the grout to flow more freely through the gout pipes.

Fillers can be added to provide bulk and/or weight to the grout where it is likely to flow through the borehole walls.

For packer anchors, the following mix is recommended.

Materials	Weight	Ratio by Weight
Portland cement	25kg (1 bag)	1
Water	20 Litres	0.8

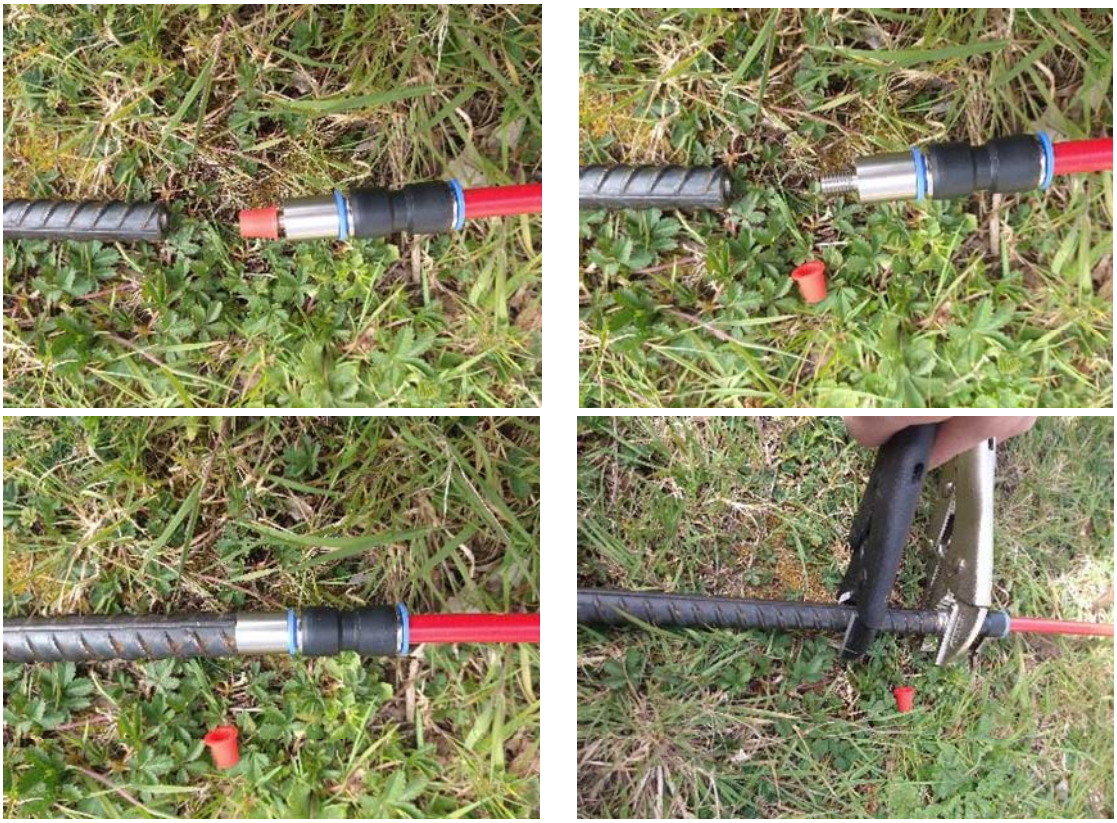
The grout should always be mixed and placed using the appropriate grouting equipment.

2.04 Down Hole Installation Groutable Anchor

Identify the correct reference head and rod assembly for the borehole to be installed.

Uncoil the system as per section 2.02.

Thread the groutable anchor onto the anchor fixing point and tighten using two pairs of mole grips.
Do not allow the anchor fixing point to rotate during the tightening.



Uncoil the grout tube and attach it to the end of the deepest anchor.

Attach using tape or ties sufficiently to hold in place whilst inserting the system into the borehole but not so tight that it cannot be broken free during the grouting process.

The rod and anchor assemblies can now be bundled together and taped or tied for ease of assembly into the borehole.

Lower the assemblies into the borehole being careful not to kink the assemblies in the process.

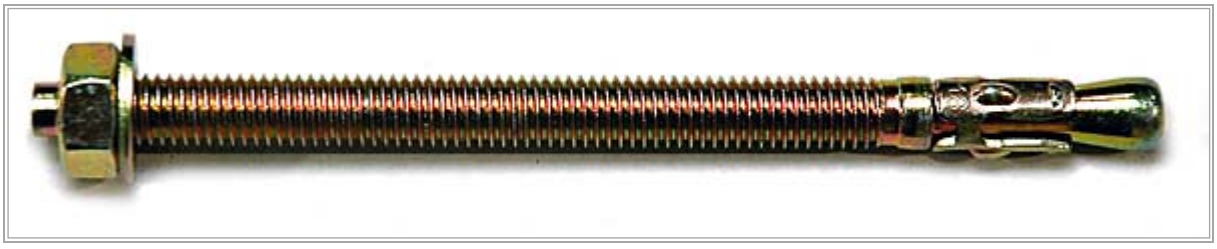
If using the optional reference head securing plates fit these to the location groove in the reference head and secure with cable ties as shown below.

If the head is to be secured to a hard surface of rock or concrete the surface should be flat and perpendicular to the borehole.

Position the head against the surface and mark the position of the four fixing holes through the securing plates.

Drill the holes as required by the fixing type.

If using the expanding fixing kit, ensure the nut and washer are positioned on the fixings as shown below.



Position the securing plate onto the mounting surface over the drilled holes.

Insert the fixings through the securing plates and into the holes and hammer into the hole until the nut and washer contact the fixing plate.

Remove the ties securing the plates to the head.

Tighten the nuts until the plates are secured in position.

If using the resin fixing kit insert the fixing into the holes in the securing plates and secure in place using the nuts and washers.

Apply the resin to the holes and reposition the reference head and the securing plates against the mounting surface whilst inserting the fixings into the resin-filled holes.

When the resin has cured the ties securing the plates to the head can be removed.

Connect the grout tube to the grout pump and pump sufficient water through the grout tube to lubricate it.

Mix up the grout as recommended by your site consultant.

Do not use any sand in the grout mixture.

Pump the grout into the borehole whilst slowly withdrawing the grout pipe.

After completion of the borehole grouting, flush water through the grout tube so that it can be reused on the next borehole.

After the grout has cured fully, remove the lifting eyebolt from the threaded bar then remove the sealing nut from the threaded bar (remote reading systems only).

Remove the head cover cap and the cover (remote reading systems only).

Remove the transducer gland nuts and unscrew the rod setting studs.

If the studs are tight use mole grips to release.

Refit the transducer gland nuts but do not tighten.

For manual reading systems remove the transducer glands from the reference head and fit the blanking plugs

Refer to section 2.08 and 2.09 for transducer installation or section 2.10 for completion of the manual reading installation.

2.05 Up Hole Installation Groutable Anchor

Identify the correct reference head and the rod assembly for the borehole to be installed.

Uncoil the system as per section 2.02.

Thread the groutable anchor onto the anchor fixing point and tighten using two pairs of mole grips.
Do not allow the anchor fixing point to rotate during the tightening.

Uncoil the vent tube and attach it to the deepest anchor so that it protrudes 300mm beyond the end of the anchor.

Attach using tape or ties so that it is securely held in place.

Uncoil the grout tube and attach it to one of the anchor outer tubes at 2 metres from the grout plate.

Attach using tape or ties sufficiently to hold in place during the grouting process.

The anchor and rod assemblies can now be bundled together and taped or tied for ease of assembly into the borehole.

Insert the assemblies into the borehole being careful not to kink the assemblies in the process.

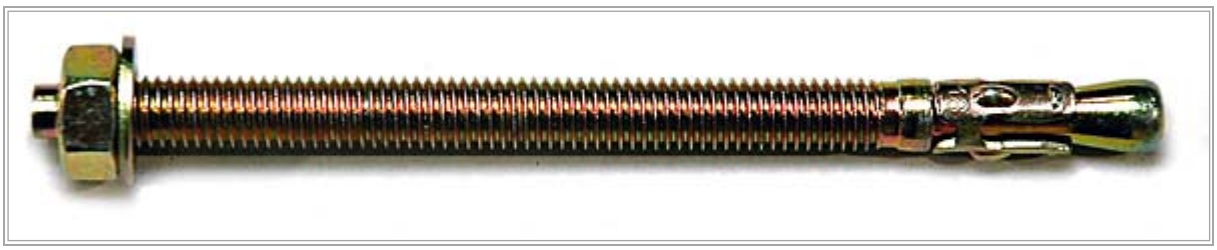
Fit the reference head securing plates to the location groove in the reference head and secure with cable ties as shown below.

If the head is to be secured to a hard surface of rock or concrete the surface should be flat and perpendicular to the borehole.

Position the head against the surface and mark the position of the four fixing holes through the securing plates.

Drill the holes as required by the fixing type.

If using the expanding fixing kit, ensure the nut and washer are positioned on the fixings as shown below.



Position the securing plates onto the mounting surface over the drilled holes.

Insert the fixings through the securing plates and into the holes and hammer into the hole until the nut and washer contact the fixing plate.

Remove the ties securing the plates to the head.

Tighten the nuts until the plates are secured in position.

If using the resin fixing kit insert the fixing into the holes in the securing plates and secure in place using the nuts and washers.

Apply the resin to the holes and reposition the reference head and the securing plates against the mounting surface whilst inserting the fixings into the resin-filled holes.

When the resin has cured the ties securing the plates to the head can be removed.

Due to the high pressures involved in the grouting process, the grouting must be performed in two stages.

The first stage is to create a 1.5-metre grout plug to seal the head of the borehole.

Use the shortest length of grout tube possible and connect the grout tube to the grout pump then pump sufficient water through the grout tube to lubricate it.

Mix up the required amount of grout using Portland cement and water at a ratio of approximately 1:1 by volume.

Do not use any sand in the grout mixture.

Pump the required amount of grout into the borehole to create a 1.5-metre plug.

After completion of the borehole grouting, flush sufficient water through the grout tube so that it can be reused on the next stage of grouting.

Allow the grout to set for a minimum of 24 hours.

After the first stage grouting has cured reconnect the grout pump and continue to grout the borehole using your consultant's recommended grout mix.
Continue grouting until grout exits the vent tube.

Do not use excessive grout pressures as this may blow out the grout plug.

In fractured ground applications, there may be leakage into the fractures causing the top anchor to become un-grouted.

Grouting may need to be continued at intervals until the point at which grout is seen to flow from the vent tube immediately upon recommencing of grouting, at which point the grout column is probably complete and covering the top anchor.
Seal off the grout tube and allow the grout to set.

Cut the grout and vent tubes flush with the securing plate surface.

After the grout has set fully, remove the lifting eyebolt from the threaded bar then remove the sealing nut from the threaded bar (remote reading systems only).

Remove the head cover cap and the cover (remote reading systems only).

Remove the transducer gland nuts and unscrew the rod setting studs.

If the studs are tight use mole grips to release.

Refit the transducer gland nuts but do not tighten.

For manual reading systems remove the transducer glands from the reference head and fit the blanking plugs

Refer to section 2.08 and 2.09 for transducer installation or section 2.10 for completion of the manual reading installation.

2.06 Down Hole Installation Hydraulic Anchor

Identify the correct reference head and rod assembly for the borehole to be installed.

Uncoil the system as per section 2.02.

Thread the hydraulic anchor onto the anchor fixing point and tighten the anchor whilst holding the anchor fixing point with a pair of mole grips.
Do not allow the anchor fixing point to rotate during the tightening.




Measure out the required lengths of ¼” diameter high-pressure nylon hydraulic tubing.

Connect the tubing to the hand pump, keep the pump topped up with oil during the pumping operations to ensure air is not circulated through the tubes.

Pump oil through the hydraulic tube until the tube is filled and free of air, collecting the excess hydraulic oil into a suitable container.

Insert the tubing into the compression fitting and tighten the nut to finger tight, then using a 5/8”AF spanner tighten for another full turn (360 degrees).

Using adhesive tape secure the hydraulic tubing to the anchor protective tube at regular intervals.

Label the end of the hydraulic tube with the anchor depth or position.

Lower the assemblies into the borehole being careful not to kink the assemblies in the process.

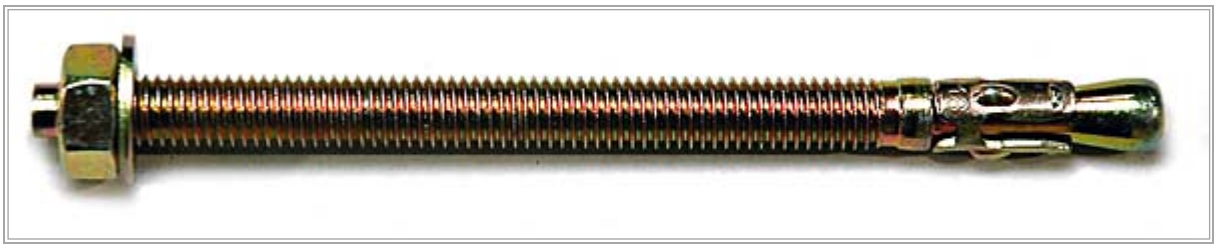
If using the optional reference head securing plates fit these to the location groove in the reference head and secure with cable ties as shown below.

If the head is to be secured to a hard surface of rock or concrete the surface should be flat and perpendicular to the borehole.

Position the head against the surface and mark the position of the four fixing holes through the securing plates.

Drill the holes as required by the fixing type.

If using the expanding fixing kit, ensure the nut and washer are positioned on the fixings as shown below.



Position the securing plates onto the mounting surface over the drilled holes.

Insert the fixings through the securing plates and into the holes and hammer into the hole until the nut and washer contact the fixing plate.

Remove the ties securing the plates to the head.

Tighten the nuts until the plates are secured in position.

If using the resin fixing kit insert the fixing into the holes in the securing plates and secure in place using the nuts and washers.

Apply the resin to the holes and push the reposition the reference head and securing plates against the mounting surface whilst inserting the fixings into the resin-filled holes.

When the resin has cured the ties securing the plates to the head can be removed.

Where securing plates are not being used suspend the head, rod, and anchor assembly in position using the lifting eye bolt.

Deploy the deepest anchor first.

Operate the pump to extend the anchor prongs, pressure will build before the prongs in the anchor begin to extend and then will drop once the prongs start to activate.

The level of oil in the hydraulic reservoir will drop as the prongs continue to extend.

Pressure will build as the prongs push into the soil, the prongs are fully extended when the pressure increases rapidly, and the correct volume of oil has been displaced.

Do not exceed 150 bar pressure.

Single-acting anchors will have an oil displacement of approximately 100ml; double-acting anchors will have twice this volume.

When the anchor has been installed, disconnect the tubing from the pump and seal it off.

The installation of the anchors is now complete, but it is recommended that the anchors and rods are supported by filling the bore hole with cementitious grout.

Where securing plates are not being used the borehole immediately below the head should be backfilled with concrete up to the securing place grooves to provide a secure key for the reference head.

After the anchors have been deployed, remove the lifting eyebolt from the threaded bar then remove the sealing nut from the threaded bar (remote reading systems only).

Remove the head cover cap and the cover (remote reading systems only).

Remove the transducer gland nuts and unscrew the rod setting studs.

If the studs are tight use mole grips to release.

Refit the transducer gland nuts but do not tighten.

For manual reading systems remove the transducer glands from the reference head and fit the blanking plugs.

Refer to section 2.08 and 2.09 for transducer installation or section 2.10 for completion of the manual reading installation.

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2.07 Installation Packer Anchor

Identify the correct reference head and rod assembly for the borehole to be installed.

Uncoil the system as per section 2.02.

Measure out the required lengths of grout pipe.

Packer anchors must be passed over the other longer anchor fixing points before securing to their fixing point.

Fix the anchor to the anchor fixing point with the securing nut.

Do not allow the anchor fixing point to rotate during the tightening.

Fix the grout pipe to the anchor and secure using the retaining clip.

Using adhesive tape secure the grout pipe to the anchor protective tube at regular intervals.

Label the end of the grout pipe with the anchor depth or position.

For vertical installations use a safety wire secured to the anchors to support their weight.

When deploying multipoint rod systems, the mouth of the borehole may need modification to accommodate the additional grout pipes.

Feed the assemblies into the borehole being careful not to kink the assemblies in the process.

Use the safety wires to support the weight of the anchors.

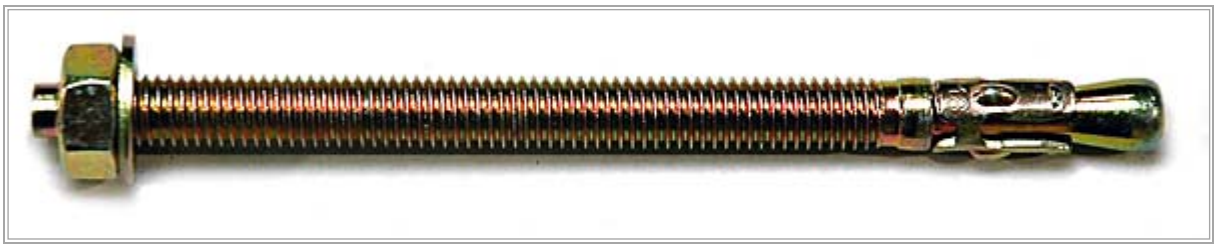
If using the optional reference head securing plates fit these to the location groove in the reference head and secure with cable ties as shown below.

If the head is to be secured to a hard surface of rock or concrete the surface should be flat and perpendicular to the borehole.

Position the head against the surface and mark the position of the four fixing holes through the securing plates.

Drill the holes as required by the fixing type.

If using the expanding fixing kit, ensure the nut and washer are positioned on the fixings as shown below.



Position the securing plates onto the mounting surface over the drilled holes.

Insert the fixings through the securing plates and into the holes and hammer into the hole until the nut and washer contact the fixing plate.

Remove the ties securing the plates to the head.

Tighten the nuts until the plates are secured in position.

If using the resin fixing kit insert the fixing into the holes in the securing plates and secure in place using the nuts and washers.

Apply the resin to the holes and push the reposition the reference head and securing plates against the mounting surface whilst inserting the fixings into the resin-filled holes.

When the resin has cured the ties securing the plates to the head can be removed.

Where securing plates are not being used suspend the head, rod, and anchor assembly in position using the lifting eye bolt.

Deploy the deepest anchor first.

Use a hand grout pump to deploy the anchors.

Pump clean water through the tubing.

Pump the grout until it is hard to pump.

After 1 to 2 minutes pump again to replace grout that has leaked from the packer.

Seal the ends of the grout tubes.

Repeat for the remaining anchors.

Where securing plates are not being used the borehole immediately below the head should be backfilled with concrete up to the securing place grooves to provide a secure key for the reference head.

After the anchors have been deployed, remove the lifting eyebolt from the threaded bar then remove the sealing nut from the threaded bar (remote reading systems only).

Remove the head cover cap and the cover (remote reading systems only).

Remove the transducer gland nuts and unscrew the rod setting studs.

If the studs are tight use mole grips to release.

Refit the transducer gland nuts but do not tighten.

For manual reading systems remove the transducer glands from the reference head and fit the blanking/sealing plugs

Refer to section 2.08 and 2.09 for transducer installation or section 2.10 for completion of the manual reading installation.

2.08 VW Transducer Installation multipoint heads

Before installation of the transducers, it is advised to check the functionality of the transducers to ensure they have not been damaged during transportation or handling.

Connect each transducer to a readout unit and carefully withdraw the transducer rod by approximately 10mm from its transit position, do not rotate the rod during this process.

The gland tightening tool has a recess for location of the rod and pin as shown below.

Hold in position whilst reading.

The readings should be stable, not erratic.

It is only necessary to read the thermistor temperature sensor from one of the installed sensors in each head, so the conductor wires on the other sensors can be cut back as shown below.

This allows for easier installation and wiring.

The reference head has a mark as shown below indicating the number one anchor rod, this is the longest rod.

The other rods decrease in length in a clockwise direction around the head through to number eight, not all the positions will be populated with a securing gland depending on the specific configuration.

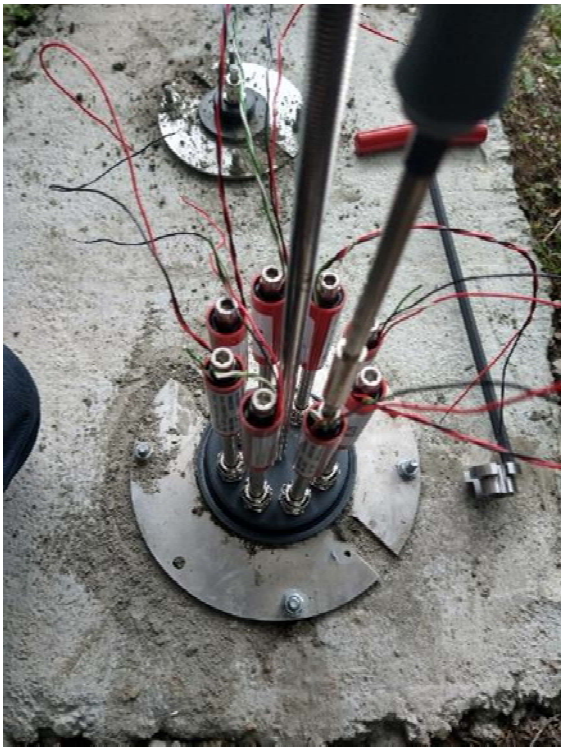
Make a note of the transducer serial number and the gland position it will be installed in.

Slide the transducer through the securing gland until it contacts the rod connector.

The vibrating wire transducer has a pin located within a notch in the stem tube to prevent rotation of the transducer rod.

Rotation of the rod will damage the transducer, do not withdraw the rod from the transducer other than for the pre installation check until the transducer is installed within the head assembly.

Using a 5mm A/F hex drive screwdriver rotate the transducer in a clockwise direction whilst maintaining forward pressure to keep the pin within the notch until the transducer is fully tightened into the rod connector.



Do not over tighten, max 3 Nm

Repeat for remaining transducers.

The transducer start position can be established by reading the transducer and referring to the calibration certificate or by measuring from the top of the securing gland to the mark on the transducer and extending the transducer to the required position.

The zero position for the transducer is 5mm out from the pin in the notch position, so add 5mm to measurements if setting using a ruler.

Using a suitable pen mark the transducer stem at the top of the securing gland.

Carefully extend the transducer to its desired starting position and tighten the securing gland using the gland tightening tool whilst holding the transducer in position, hold tightly to prevent the transducer from rotating whilst tightening.

Tighten sufficiently to secure the transducer.

Set the remaining transducers and record the initial reading from each transducer, noting the serial number of the transducer and the rod position.

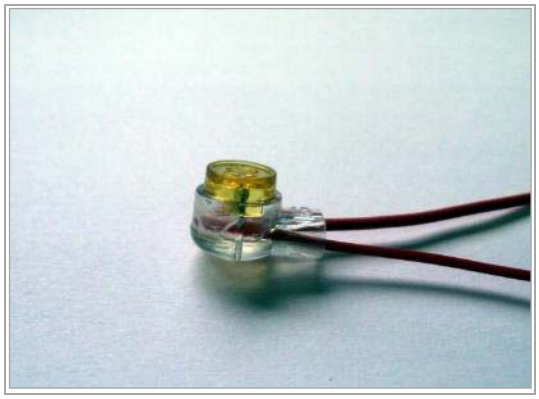
Thread 2 metres of the multicore cable through the cable gland in the head cap and slide the cover over the cable.

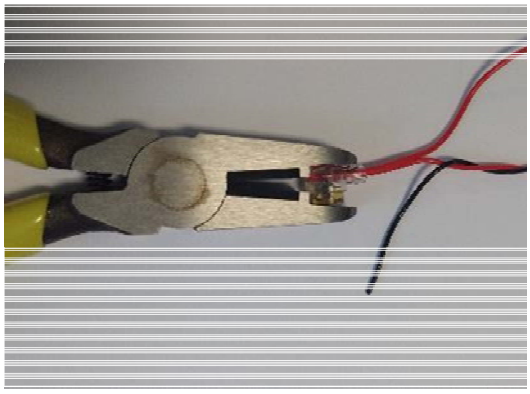
Strip back 100mm of the outer sheath of the cable to expose the internal conductors.

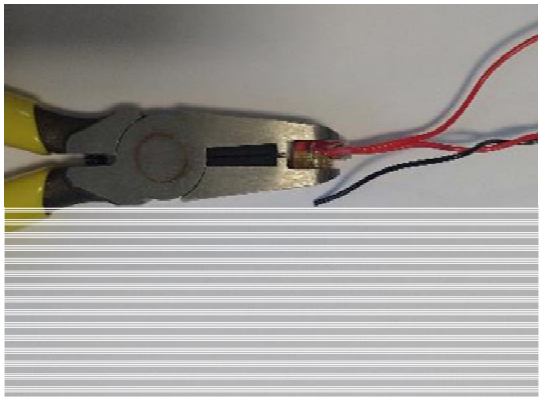
Cut off the ends of the transducer conductor wires so they are clean cut with no exposed copper conductor.

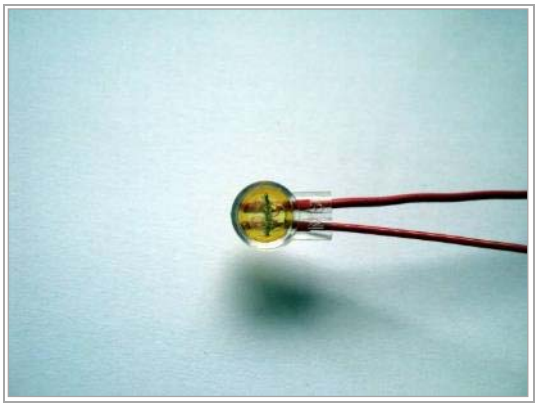
Using the gel-filled crimp connectors supplied connect each transducer to the multicore cable ensuring that the wiring code is recorded.

Insert the two wires to be joined fully into the crimp and then using the crimping tool depress the button.





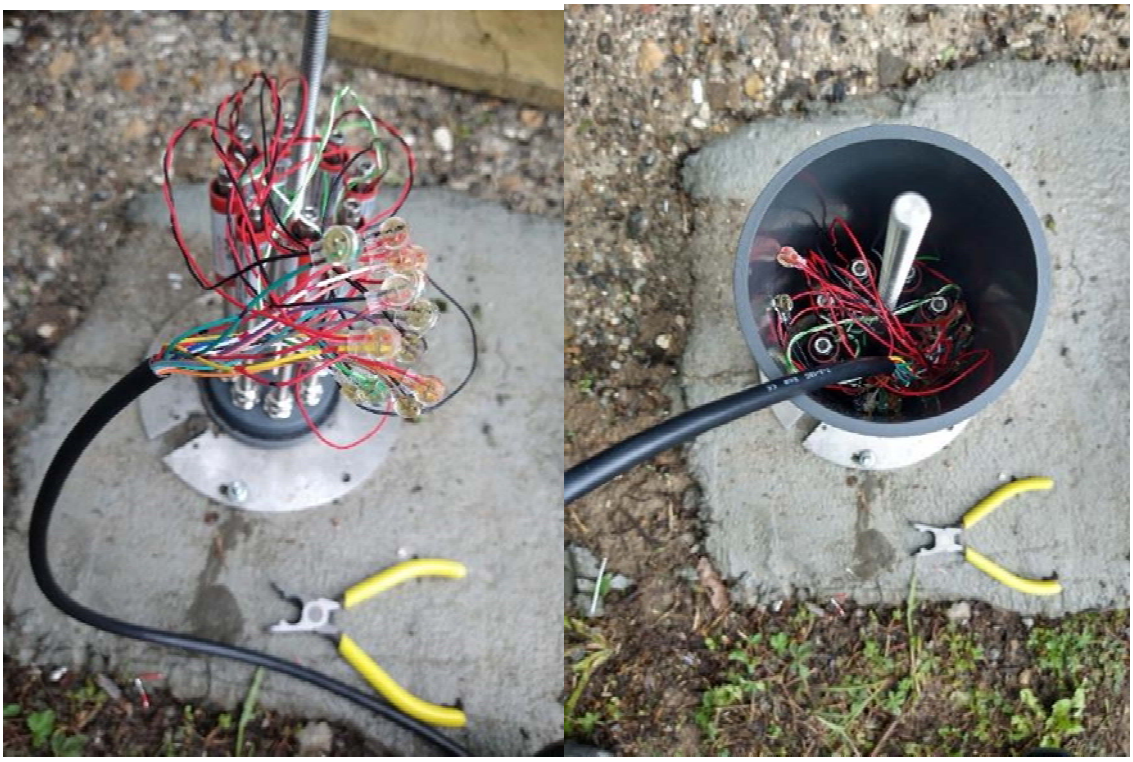




Test all connections after crimping to ensure continuity and security of connections.

When using vibrating wire transducers, it is only necessary to connect the thermistor from one of the transducers to monitor temperature of all the transducers in the head assembly.

Feed all the connections into the void at the centre of the transducer array.



Ensure the Oring and cover location groove are clean and free of debris, remove the Oring and clean as required.

Slide the cover down the multicore cable and into position over the transducers.

Slide the cover cap down the multicore cable back through the cable gland until the stripped end of the outer sheath is level with the internal face of the cover cap.

Tighten the cable gland fully to sufficiently seal the cable.

Position the cap cover over the threaded bar and locate it onto the cover.

Check no wires are trapped between the head, cover, and cap.

Thread the seal nut down the threaded bar with its seal towards the cap.

Ensure the cover is seated into the recesses on both the head and cap, then tighten the nut to a maximum of 8Nm, do not overtighten.

Refit the lifting eyebolt.

Cut the multicore cable to the desired length and re-test the connections.

2.09 VW Transducer Installation single point heads

Before installation of the transducers, it is advised to check the functionality of the transducers to ensure they have not been damaged during transportation or handling.

Connect each transducer to a readout unit and carefully withdraw the transducer rod by approximately 10mm from its transit position, do not rotate the rod during this process.

The gland tightening tool has a recess for the location of the rod and pin as shown below.

Hold in position whilst reading.

The readings should be stable, not erratic.

Make a note of the transducer serial number.

Slide the transducer through the securing gland until it contacts the rod connector.

> The vibrating wire transducer has a pin located within a notch in the stem tube to prevent rotation of the transducer rod.
>
> Rotation of the rod with damage the transducer, do not withdraw the rod from the transducer other than for the pre installation check until the transducer is installed within the head assembly.

Using a 5mm A/F hex drive screwdriver rotate the transducer in a clockwise direction whilst maintaining forward pressure to keep the pin within the notch until the transducer is fully tightened into the rod connector.

Do not over tighten, max 3Nm.

The transducer start position can be established by reading the transducer and referring to the calibration certificate or by measuring from the top of the securing gland to the mark on the transducer and extending the transducer to the required position.

The zero position for the transducer is 5mm out from the pin in the notch position, so add 5mm to measurements if setting using a ruler.

Using a suitable pen mark the transducer stem at the top of the securing gland.

Carefully extend the transducer to its desired starting position and tighten the securing gland using the gland tightening tool whilst holding the transducer in position, hold tightly to prevent the transducer from rotating whilst tightening.

Tighten sufficiently to secure the transducer.

Remove the cable gland from the cover.

Slide the cover down the transducer cover, a drawstring or rod may be required to ease the location of the cable through the threaded gland hole.

Slide the cable gland down the cable.

Fit the cover to the head, refit the gland to the cover and tighten the cable gland nut to seal the cable.

2.10 Manual Reading

Remove the sealing caps from the rod positions to be read.

Insert the manual reading datum into the 7mm modified nut spinner and insert it into the head tube.

For down hole installations a small amount of silicon grease applied to the reading datum will retain it in the nut spinner while inserting it into the head tube.

Tighten the reading datum fully into the rod connector and withdraw the nut spinner.

Repeat for the remaining anchors.

To read the anchors remove the digital readout from the carry case hold the gauge boss against a flat surface.

move the digital display towards the boss until the contact rests on the flat surface.

Check that the display reads 0.00mm.

If the display does not read zero, press and hold the “Origin” button for 3 seconds until the display resets to 0.00mm

The digital display automatically powers up upon movement of the display along the track.
The display will auto power off after 20 minutes of no movement.

Insert the contact and gauge boss into the head and maintain pressure to hold the boss against the face of the head.

Slide the display towards the boss until the contact rests on the reading datum and record the reading that is shown on the display along with the anchor position.

Repeat the reading process for each anchor position and then re-fit the sealing caps.

The checking of the zero setting should be performed before reading each borehole.

3.01 Shortening the Anchor Assemblies

Should the anchor assemblies require shortening this must be performed with the setting studs in place and the system uncoiled and laid out straight on site.

Remove the retaining screw from the anchor connector.

Pull the release ring back on the inline connector where the red nylon tube enters the inline connector.

While the release ring is depressed pull out the red nylon tube separating the anchor connector from the nylon tube and GRP rod.

Cut back the red nylon tube by the required amount using a safety knife.

Ensure a clean parallel cut is achieved.

Cut back the GRP rod by the same amount using a fine blade hacksaw.

use a file chamfer the corner of the fibreglass as shown below.

The GRP should protrude from the red nylon tube by 35mm.

Insert the GRP and red nylon tubing into the anchor connector ensuring the red nylon tubing is fully inserted into the inline connector.

Ensure that the fibreglass is visible through the rod securing hole in the anchor connector and then replace the rod securing screw and tighten to 5Nm to secure the GRP in place.

3.02 Installing Hydraulic Anchors in Cased Boreholes

Where the ground is too weak for a borehole to remain open without being cased the anchor assemblies must be s able to pass through the casing.

Hydraulic anchors are typically supplied with hydraulic tubing that is cut and fitted to the anchors on-site as required.

Prime and fit the hydraulic tubing as per section 2.06

The anchor assemblies can now be bundled together and taped or tied along with the hydraulic tubing for ease of assembly into the borehole.

The head and rod assemblies should be suspended from the drill tower and lowered into their final position ensuring that the head is at its correct level.

As the first section of the casing is withdrawn it is recommended that the deepest anchor should be activated first once clear of the casing.

As each section of the casing is withdrawn disconnect the head from the drill mast, remove the casing section, and then re-secure the head to the drill tower.

The casing is withdrawn until the next anchor is clear of the casing and then this anchor is activated.

The procedure is repeated for all the other anchors.

When the casing has been completely removed from the borehole the borehole can be grouted as required.

As with any monitoring system it is essential that all the factors that could possibly affect the readings are recorded and considered such as atmospheric conditions and construction activities. Because of the nature of the instrument, monitoring during periods of excessive vibration will cause erroneous readings and should be avoided.

Temperature changes have a measurable effect on extensometer systems and therefore ambient and differential temperatures should be recorded. Electronic systems such as readout units are known to be affected by temperature variations.

It should be remembered that rod extensometers are designed to measure relative movements between head and anchor assemblies. Absolute displacements can be obtained if alternative movement monitoring techniques are used in conjunction with rod extensometers.

4.01 Conversion of frequency units into engineering units (mm)

The transducer calibration certificate contains the Gauge Constants required to convert the frequency units into engineering units.

Each Transducer has unique gauge constants.

Calculation using Linear units (Frequency^2/1000).

The following formula is used for readings in 'Linear' units.

E = G (R0 – R1)

Where,

E is the resultant Engineering unit.

G the linear Gauge factor for the units of calibration (from the calibration sheet).

R0 is the Linear base or zero reading.

R1 is the current Linear reading.

If an alternative Engineering-based unit is required other than the units of calibration, then the correct K factor will have to be calculated using the standard relationship between engineering units.

For example, if the units of calculation required were in inches and the calibration units were mm, we can find out that 1 inch is equal to 25.4mm, so we would derive the K factor for inches by dividing the K factor for mm by 25.4.

Linear unit calculation using a Polynomial equation.

Linear units may be applied to the following polynomial equation, for calculation of Engineering units to a higher order of accuracy.

E = AR1^2 + BR1 + C

Where,

E is the resultant Engineering unit.

A, B and C the Polynomial Gauge factors A, B and C, from the instrument's calibration sheet.

R1 is the current Linear reading.

The value C is an offset value and relates to the zero-position experienced by the transducer at the time of calibration. If the transducer is required to read zero engineering units when in its installed position, then C should be re-calculated at the installation time as follows:

$C = - (AR0^2 + BR0)$

Where,

C is the resultant re-calculated Polynomial Gauge factor.

A and B the Polynomial Gauge factors A and B, from the instrument's calibration sheet.

R0 is the Linear 'base' or 'zero' reading.

Please note that the sign of the re-calculated value of C, should be the same as the original value of C, so if the original is negative then the recalculated value should also be negative.

Conversion to engineering units other than the units of calibration, would best be done after conversion, using a factor calculated using the standard relationship between engineering units.

When the above vibrating wire equations are used to analyse subsequent linear readings obtained from the Extensometers the following are true:

Transducer rod movement out = + change in reading in mm.

Transducer rod movement in = - change in reading in mm.

More practically, a + change in reading for the Extensometer will imply that the distance between anchor and reference head is increasing.

4.02 Temperature corrections and coefficients

The Transducers working elements are made primarily of steel and stainless steel and are affected by changing temperature to a certain predictable degree.

In case of large temperature changes application of temperature correction will improve the accuracy of the measurements.

The approximate temperature effect on the gauge is -0.02mm per degree Celsius. Hence for a temperature increase of 10°C a transducer will indicate (-0.02 x 10) 0.2mm to the result indicated by the transducer reading.

A fall in temperature will result in a positive change in linear measurement which can be corrected accordingly.

Physical dimensional changes due to temperature in the transducer and the structure on which it is mounted are of the order of 106m/m/°C and can be neglected.

If you are using the stainless steel rods the formula is:

Length (meters) x E-6 x 17.5 x ºC change

Temperature coefficient 17.5ppm

If you are using fibreglass rods formula is:

Length (meters) x E-6 x 3 x ºC change

Temperature coefficient of 3ppm

Section 5 : Maintenance

5.01 Taking care of your Continuous Rod Extensometer digital readout

Soil Instruments Continuous Rod Extensometer digital readout has been designed for use in harsh environments however certain precautions should be observed to ensure a long reliable product life.

- **Do not drop.**

  The Continuous Rod Extensometer digital readout may malfunction if subjected to strong shocks or vibrations.

- **Do not immerse or expose to water jets.**

  The Continuous Rod Extensometer digital readout has been designed to be used in a dry environment and may malfunction if immersed underwater or used in a wet environment.

- **Keep away from strong magnetic fields.**

  Do not use or store this device in the vicinity of equipment that generates strong electromagnetic radiation or magnetic fields.

- **Avoid extremes of temperature.**

  Do not expose to extreme heat or cold temperatures as this may cause damage to the Continuous Rod Extensometer digital readout.

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5.02 Battery Changing

The low battery indicator will show when the battery needs replacing.

If the Continuous Rod Extensometer digital readout is not to be used for a long time, then it is recommended that the battery should be removed before storage.

5.03 Calibration

Soil Instruments recommends that the Continuous Rod Extensometer digital readout is returned for inspection, cleaning, and Calibration every 12 months.

5.04 Troubleshooting

1. **The digital display will not turn on.**

   Replace the battery.

2. **After replacing the battery, the digital display will still not turn on.**

   Contact technical support, see section 6.02.

3. **The readings are unstable or intermittent.**

   Clean the sliding scale of the digital display.

Section 6 : Help and Support.

6.01 FAQ

How do I know which sweep range I should be using?

The sweep range is determined by the frequency range of the type of instrument you are reading.

Soil Instruments displacement transducers use the sweep range from 1700 to 3400 Hz.

Why are different types of frequency units used?

The measurement of vibrating wire instruments is the frequency of oscillation of the wire.

This is measured by the recorder as the number of oscillations per second or hertz (Hz)

This unit of measurement is not linear in relation to the change in strain of the wire, so the Hz reading is often linearized by squaring and dividing by 1000 to give the unit $F^2/1000$ also called linear or digits.

Another unit for measuring the frequency is Period, this is the length of time taken for one oscillation to occur and is measured in seconds.

Typically for vibrating wire instruments, this value is very small, so it is multiplied by 10^7 to give a four-digit number.

Hz and Period require more complex formulae to convert the frequency readings into engineering units.

Soil Instruments recommends using the $F^2/1000$ units displayed and stored by the VW Note data recorder.

6.02 Support

Contact Soil Instruments support team using the details below:

https://soilinstruments.helpdocs.com
email: support@soilinstruments.com

Scan Me For Support

Appendix A. CE Declaration

EC Declaration of Conformity

Soil Instruments Ltd., located at 34 Bell Lane, Uckfield, East Sussex, TN22, 1QL, United Kingdom.

We hereby declare that the devices described below are in conformity with the directives listed. In the event of unauthorised modification of any devices listed below, this declaration becomes invalid.

Type: Rod Extensometer System

Product Model: E17 series 1021-315, 1021-320, 1021-325, 1021-330, 1021-345 and 1021-400

Relevant EC Directives and Harmonized Standards:

RoHS2: 2011/65/EU
The restriction of the use of certain hazardous substances in electrical and electronic equipment.

2014/30/EU Electromagnetic Compatibility directive, as amended by **EN61326-1:2013**

The product(s) to which this declaration relates is in conformity with the essential protection requirements of **2014/30/EU** Electromagnetic Compatibility directive, as amended by EN61326-1:2013. The products are in conformity with the following standards and/or other normative documents:

EMC: Harmonized Standards: EN 61326-1:2013 Lab Equipment, EMC

IEC61000-6-3:2007 Emission standard for residential, commercial and light-industrial environments
IEC61000-4-2:2008 Electrostatic discharge immunity test
IEC61000-4-3:2006 Radiated, radio-frequency, electromagnetic field immunity test
IEC61000-4-4:2012 Electrical fast transient/burst immunity test
IEC61000-4-5:2005 Surge immunity test
IEC61000-4-6: 2008 Immunity to conducted disturbances, induced by radio-frequency fields
IEC61000-4-11:2004 Voltage dips, short interruptions, and voltage variations immunity tests

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The items comply with all applicable Essential Requirements of the Directives.

Philip Day

Date: 07 June 2021

Mechanical Design Manager,

Issued in: Bell Lane, Uckfield, East Sussex, TN22, 1QL, United Kingdom

Appendix B. UKCA Declaration

UK CA **Declaration of Conformity**

Soil Instruments Ltd., located at 34 Bell Lane, Uckfield, East Sussex, TN22, 1QL, United Kingdom.

We hereby declare that the devices described below are in conformity with the Statutory Instruments listed in accordance with UK Government Guidance. In the event of unauthorised modification of any devices listed below, this declaration becomes invalid.

Type: Rod Extensometer System
Product Model: E17 series 1021-315, 1021-320, 1021-325, 1021-330, 1021-345 and 1021-400

Relevant UK Statutory Instruments and their amendments:

2016 No 1091	The Electromagnetic Compatibility Regulations 2016
2012 No 3032	The Restriction of the Use of Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above Statutory Instruments. The items comply with all applicable Essential Requirements of the Statutory Instruments.

Philip Day

Date: 07 June 2021

Technical Manager,

Issued in: Bell Lane, Uckfield, East Sussex, TN22, 1QL, United Kingdom

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