INSTRUCTION MANUAL

SELF-ALIGNING PLASTIC INCLINOMETER CASING IN BOREHOLES

Model GEO-LOK

CE

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This product should be installed and operated only by qualified personnel. Its misuse is potentially dangerous. The Company makes no warranty as to the information furnished in this manual and assumes no liability for damages resulting from the installation or use of this product. The information herein is subject to change without notification.

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1 PRODUCT

1.1 DESCRIPTION

The inclinometer casing model GEO-LOK consists of 1.5 or 3 meters length of ABS pipe with 4 internal grooves spaced 90 degrees apart and running along the entire casing length. Adjoining casing sections are assembled using GEO-LOK's tightening system: a mating key located within the coupling ensures precise alignment of the casing grooves as succeeding casing lengths are assembled by simply rotating the coupling ring. The casing comes in two diameter sizes: 85 mm and 70 mm OD (3.34"and 2.75").

1.2 APPLICATIONS

The GEO-LOK inclinometer casing is designed to be used in conjunction with the PROFIL inclinometer probe manufactured by Roctest. Inclinometer probes from other manufacturers can also be used in the GEO-LOK casing (please confirm with Roctest for compatibility).

The casing, whether installed within boreholes or fastened to the surface of a structure, responds to any deflection or deformation of the surrounding material or structure. An inclinometer probe, fixed or wheel-mounted and oriented by the internal grooves, measures the tilt angle of the casing from the vertical. Changes in the tilt angle caused by casing deflection or deformation are converted to displacements normal to the casing axis and are incrementally summed to provide profiles of total displacement versus depth.

The casing can also be fitted with magnetic anchors and be used as a settlement extensometer in which a reed switch probe is inserted using a graduated cable in order to locate the anchors.

FIGURE 1: Typical casing applications

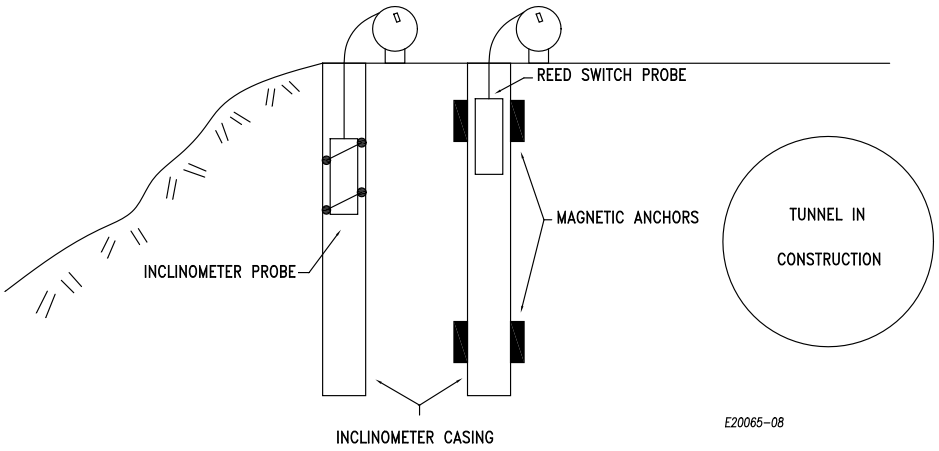


FIGURE 2: GEO-LOK casing

1.3 MAIN SPECIFICATIONS

CASING		
Nominal diameter:	70 mm OD x 59 mm ID	85 mm OD x 72 mm ID
Length:	1.572 m / 3.096 m	
Material:	ABS	
Weight: (1.5 m / 3 m)	1.79 kg / 3.42 kg	2.25 kg / 4.81 kg
Maximum compression/ extension of casing length	1% of casing length	

COUPLING RING		
Diameter:	72 mm OD	87 mm OD

TELESCOPIC SECTION		
Diameter:	73 mm OD x 59 mm ID	89 mm OD x 72 mm ID
Length fully extended:	791.2 mm	
Length fully compressed:	638.8 mm	
Weight:	0.76 kg	1.04 kg

TOP CAP		
Diameter:	69.9 m OD	84.8 mm OD
Weight:	0.033 kg	0.048 kg

BOTTOM CAP		
Diameter:	69.9 m OD	84.8 mm OD
Weight:	0.11 kg	0.15 kg

TABLE 1: Main Specifications

2 INSTALLATION

2.1 GENERAL

2.1.1 BORING

Borehole diameter and the method of accomplishing the boring depend upon the type of materials encountered, the depth of the hole, and the equipment available.

If the ground is firm, the borehole will remain open without steel casing. Either a dry borehole (drilled with a continuous-flight auger) or a water-filled hole (drilled with a chopping or a rotary bit and water to flush out the cuttings) is satisfactory. If the hole is likely to cave in, drilling mud may be used and left in the hole upon completion of the boring.

Percussion drilling also may be used for the boring and the steel casing pulled after the casing has been installed. A careful check must be made before pulling the steel casing to insure that backfill material has not filled the annular space between the casing and the lower portion of the steel casing. Backfill material can lock the inclinometer casing to the steel casing and will cause it to be pulled from the boring with the steel casing. In extremely difficult cases, steel casing may be left in place upon completion of the boring. However, steel casing tends to thicken zones of movement.

2.1.2 SELECTION OF CASING AND BOREHOLE SIZE

Proper casing installation can make the difference between a successful measurement program and an unsuccessful one. The procedure is simple and should be followed rigorously.

1. The first step is to select the size of casing to be used. The casing size has no effect upon overall system accuracy, but care should be exercised to match the casing size to the type of deformation expected. The reason for this is that as the casing size increases, the probe will pass through a smaller radius of curvature without becoming wedged in the casing.

2. The second step is to select a standard or telescopic casing assembly. If no significant settlement is expected, the casing ends should butt together within the coupling. If significant settlement is expected, then telescopic casings should be used. The standard casing will accept axial deformations of 1%, while each telescopic casing will allow an additional 152 mm of axial deformation. In installations where the expected axial compression is to exceed approximately 1%, compliance of the casing with the host material is ensured by using the appropriate type, quantity and location of telescopic sections. Be aware that settlement may not be uniform along the borehole; in that case, more telescopic sections must be installed in zones where important settlement is expected.

3. The third step is to select the hole size to be drilled, based upon the maximum OD of the casing chosen, the material to be drilled and the type of equipment available. In soft or sandy material, it will be necessary to case the hole to keep it open while installing the casing. The clearance should include space for the tape and the grout tube. Minimum clearance around the casing in an uncased hole should be at least 5 mm. In cased holes, the OD clearance can be as little as 1.25 mm. This clearance must be increased to allow the passage of the grout tubing.

2.2 CASING ASSEMBLY

Before starting casing installation, be sure to have all tools, equipment and materials needed, namely: adequate casing, end plugs (top and bottom), grout, tubing and pump, plus, of course, the drill rig and associated equipment. Always have a spare length of casing and spare end caps before going into the field.

While drilling the boreholes for the casing, pre-assemble the casings into 6 meter lengths if possible. The casing at the bottom of the hole is fitted with a bottom cap to prevent entry of material into the casing.

2.2.1 GEO-LOK COUPLINGS

GEO-LOK casings do not require rivets or glue to be joined. Ensure that a lubricated O-ring is well placed on the male end of the casing. (Figure 3) Line up the buttons of the female end with the alignment slots of the male end and push together. (Figure 4) Turn the coupling ring clockwise (relative to female end) until joint is tight. (Figure 5) Simply reverse the process to undo the joint.

2.2.2 TELESCOPING SECTIONS

The telescopic sections are attached to standard couplings exactly the same way standard casings are.

Nylon screws are provided for maintaining the telescopic sections open during the installation. These will shear around 30 kg of compressive forces allowing the telescopic section to close during any future settlement of the ground.

NOTE: BE SURE TO INSTALL TELESCOPIC CASINGS IN OPEN POSITION. TELESCOPIC CASINGS MUST BE FULLY OR PARTIALLY EXTENDED DEPENDING ON THE ANTICIPATED MOVEMENT. FOR EXAMPLE, IF A HIGH SETTLEMENT IS ANTICIPATED, THEY SHOULD BE INSTALLED FULLY EXTENDED.

For preventing any grout ingress into the telescopic sections when these are installed in a borehole, it is suggested to apply some duct tape as shown below.

Two layers of duct tape will increase resistance to compression by about 20 kg.

2.3 CASING INSTALLATION

2.3.1 STANDARD INSTALLATION

2.3.1.1 WITH THE USE OF A GROUTING TUBE

a) After the hole(s) is prepared, attach the grouting tube to the first section of casing with PVC or duct tape, running longitudinally along the casing. To prevent the end of the grout tube from getting plugged up, cut a few lateral openings within the first meter of the end of the tube. (Figure 6) This tube will be extended to the surface, so it must be at least 6 meters longer than the hole depth, or long enough to reach the grout pump.

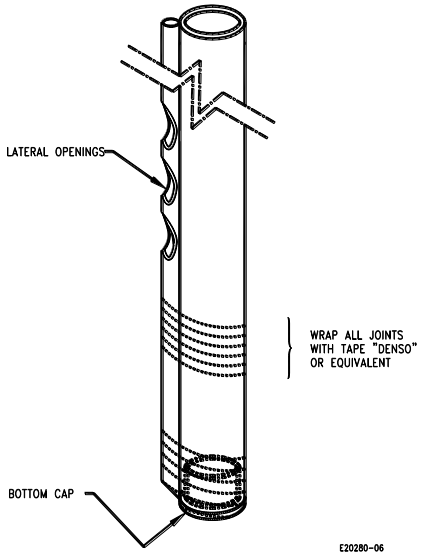


FIGURE 6: Grouting tube assembly

When using telescopic sections do not force the casing down the hole or allow it to sit on the bottom of the borehole. The force or weight of the casing can cause it to collapse longitudinally and preventing the further extension or shortening of the casing with the potential for buckling.

The first section of casing has the bottom cap tightened in place. The cap must be securely fastened to the bottom section of the casing, otherwise there is a risk that an accidental abrupt contact of the probe with the end cap bottom will cause the wheel assemblies of the probe to travel beyond the casing and become stuck.

When installing casing lengths greater than 30 m in dry holes, a lowering wire should be tied to the lower end cap. The lowering wire supports the weight of the casing with the potential for buckling.

b) Lower the first 6-meter section of pre-assembled casing into the hole, stopping at a depth which will permit about 0.6 meter of casing to extend above the top of the hole. Clamp the casing in place with the casing clamp in the kit, using it to prevent the casing from dropping into the hole (in deep installations, use a second clamp).

The casing should be filled with water only to overcome buoyancy if any exists and, later on, the ingress of grout.

In deep boreholes buoyancy can become important. Spring anchors can then be used for holding the casing in place. However note that these may not be very effective in rock.

c) Place the second 6 meters of pre-assembled casing section in place on top of the first section, joining sections by aligning the coupling key with the slot in the coupling. Tighten the couplings together and lower the section into the hole. Stop the casing when about 1/3 meter of casing extends above the top of the hole. Feed the grout tube down the hole during the lowering process.

d) Repeat step c) as often as needed to reach the bottom of the hole. If there is water in the hole, it will be necessary to add water in the casing to compensate the buoyancy. As the grout fills the borehole, it will apply even greater buoyancy on the casing. Therefore, if the

grout is particularly dense, a steel pipe inside the casing or another weight outside the casing may be installed at the bottom.

e) Rotate the inclinometer casing to orient the casing grooves as required by the monitoring program.

f) If an intermediate casing has been used to hold the hole open, withdraw this casing, being careful not to sever the grout tube or change the groove orientation.

g) Mix a thin slurry of grout and pump it down the hole, filling it from the bottom. The grout is usually a bentonite – sand cement mixture with strength comparable to that of the surrounding soil or rock. The proportion of the mix we suggest is the one described by Mikkelsen (*Geotechnical News December 2002 p. 38–42*)

h) Remove the grout tube. The section of the grout tube has been weakened; it should be possible by pulling up on the grout tube to free it from the casing when the grouting is completed (or leave it in place and cut it off at the top of the hole).

i) Place a top cap on the top end of the casing. A steel standpipe with lock and hasp is then cemented in place over the protruding end of the casing. The standpipe is anchored either in concrete placed in the upper meter of the borehole or by anchoring it in a concrete pad cast at the collar of the borehole.

j) Allow the grout to cure and proceed with initial measurement.

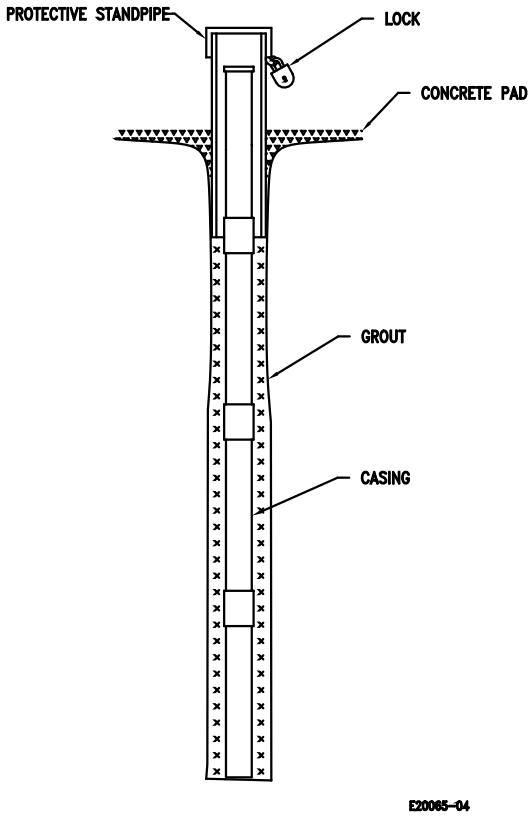


FIGURE 7: Typical final installation

2.3.1.2 WITH THE USE OF A GROUTING PLUG

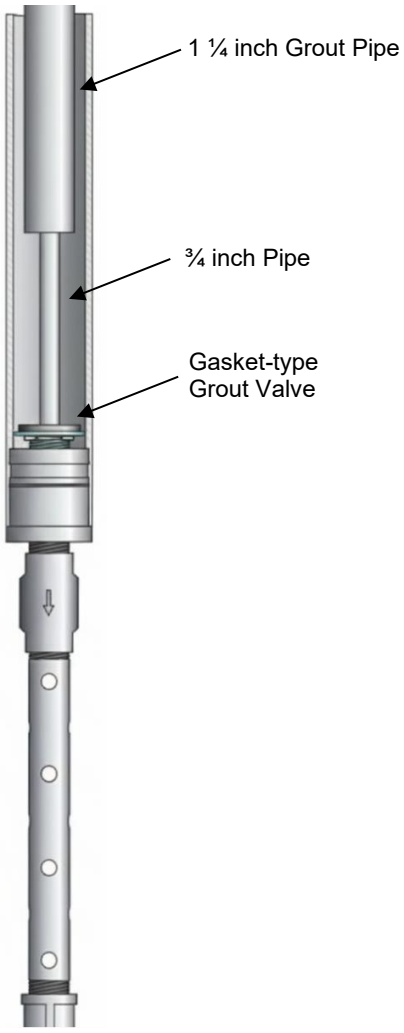
The grouting can also be performed with a grout plug instead of using an external grouting tube. The grout valve is a one-way valve installed at the bottom of the casing. A grout pipe is then lowered inside the casing to inject grout through the grout plug.

A grout plug will add about 60 cm below the last casing. The borehole should be 60 cm deeper to compensate.

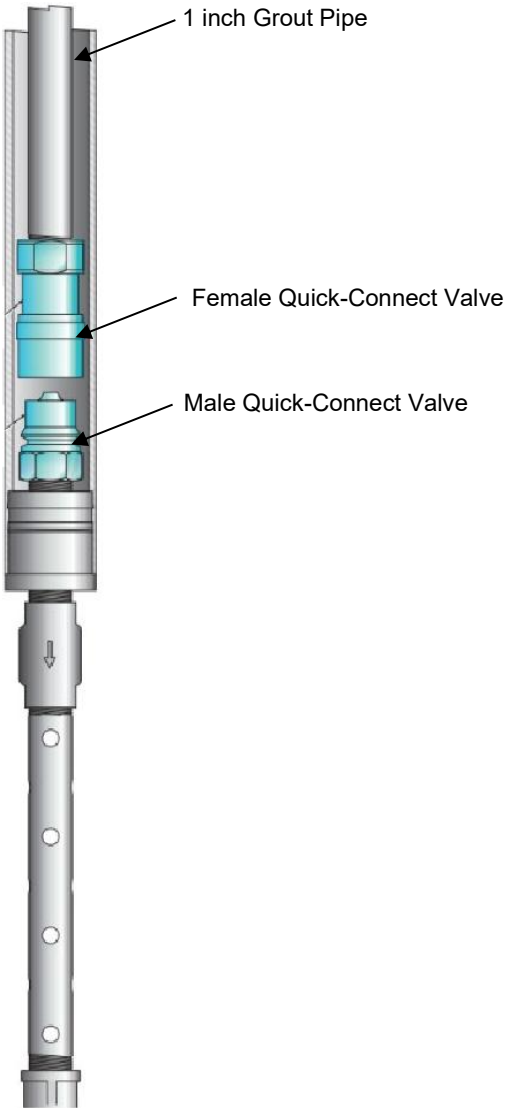
2.3.1.2.1 Types of Grouting Plugs

There are two types of grouting plugs.

The gasket-type grouting plug has a rubber gasket at its base. The grout pipe is lowered in the casing and seals against the rubber gasket to prevent grout from entering the casing. When the grout pipe is withdrawn, grout will spill into the casing and must be flushed with water.



The quick-connect grouting plug has a male quick-connect fitting. A female quick-connect fitting is installed on the grout pipe. When the grout pipe is withdrawn, very little grout spills into the casing.



2.3.1.2.2 Using a Grouting Plug

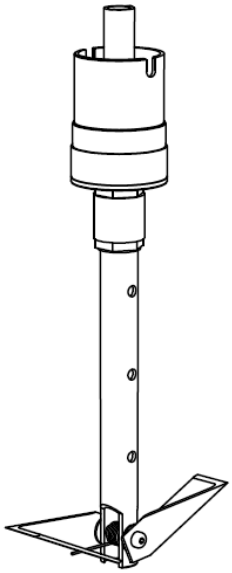
1) The grouting plug must be securely tightened to the bottom section of casing. Then install the casing at the required depth.
2) Lower the grout pipe into the casing until it contacts the grouting plug. Successful coupling can be tested by injecting water into the grout pipe. If the water level in the casing rises, reposition the grout pipe and test again.
3) Inject grout until it spills out at the surface. The weight of the grout pipe will keep the casing from floating. If the casing was installed dry, water needs to be pumped in the casing as the grout level rises.
4) When the grout pipe is retrieved, the casing will float upwards. Be ready to hold it down. Follow either of the two procedures below:

a) Gasket-type grouting plug: Raise the grout pipe well above the grouting plug and inject water into the casing to flush out the grout. When clear water spills out at the surface, gradually lower the pipe and continue to flush until you have flushed grout from the bottom of the casing. Then disconnect the pipe at the surface and leave it in the casing to counteract buoyancy. After the grout is set, withdraw the pipe.

b) Quick-connect grouting plug: Retrieve the grout pipe and flush it with water. Then lower the pipe to counteract buoyancy. Make sure you are not pushing on the quick-connect valve because it can open easily. After the grout is set, withdraw the pipe.

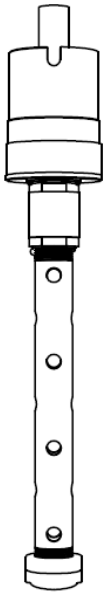
5) Top off the borehole with grout and install a protective cover.

2.3.1.3 ANCHORS OR GROUT PLUGS (OPTIONNAL ITEMS)



ANCHOR GROUT VALVE WITH GASKET
ANCRAGE ET VALVE DE COULIS AVEC JOINT D'ÉTANCHÉITÉ

FR-1280050600D ↔ 70mm (2.75")
FR-1280A50600D ↔ 85mm (3.34")



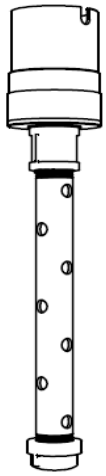
PLUG GROUT VALVE WITH GASKET
BOUCHON ET VALVE DE COULIS AVEC JOINT D'ÉTANCHÉITÉ

FR-1280050600A ↔ 70mm (2.75")
FR-1280A50600A ↔ 85mm (3.34")

HYDRAULIC COUPLING
SOCKET, #B8HP36

COUPLEUR HYDRAULIQUE
FEMELLE, #B8HP36

05-R01LA8H36



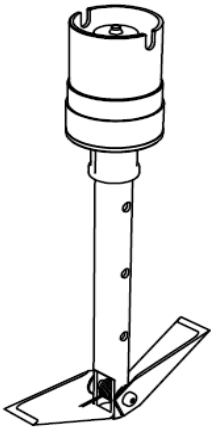
PLUG GROUT VALVE WITH QUICK CONNECT
BOUCHON ET VALVE DE COULIS AVEC RACCORD RAPIDE

FR-1280050600B ↔ 70mm (2.75")
FR-1280A50600B ↔ 85mm (3.34")

HYDRAULIC COUPLING
SOCKET, #B8HP36

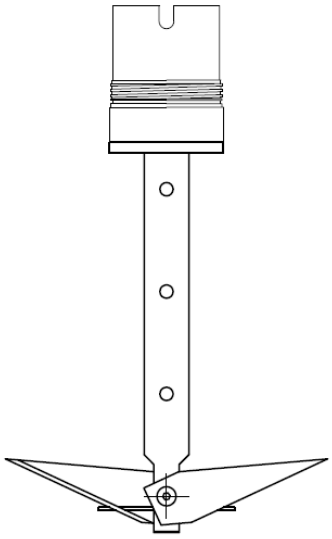
COUPLEUR HYDRAULIQUE
FEMELLE, #B8HP36

05-R01LA8H36



ANCHOR GROUT VALVE WITH QUICK CONNECT
ANCRAGE AVEC RACCORD RAPIDE

FR-1280050600E ↔ 70mm (2.75")
FR-1280A50600E ↔ 85mm (3.34")



ANCHOR
ANCRAGE

FR-1280050600C ↔ 70mm (2.75")
FR-1280A50600C ↔ 85mm (3.34")

2.3.2 MISCELLANEOUS INSTALLATION PROCEDURES

If grout is not available, an alternate method may be used, replacing step g) of section 2.3.1.1 above by the following. Clean sand or fine gravel may be used in place of grout, pouring it into the hole around the casing and compacting using a mechanical vibrator. This alternate method is less desirable than grouting, since there is a chance of having voids in the sand.

Installations in rock or earth fill must be protected from damage during the compaction while ensuring that the fill material around the casing is as well compacted as elsewhere in the embankment. Small portable compaction tools or equipment are generally preferred to conduct compaction around the casing.

Casing lengths are added one at a time to keep pace with the fill operation. An end cap is fitted at each stage to prevent entry of dirt. In rock fill particularly, it may be necessary to protect the casing by surrounding it with sand or with a secondary compatible protective tubing that will follow the deformation of the fill.

When installing a telescopic casing in an embankment, the casing should be supported in its extended position to maintain a gap of 152 mm for future telescoping; otherwise the casing can collapse prematurely.

For installations in concrete, the pre-assembled casing is tied to the reinforcing steel before the concrete is poured.

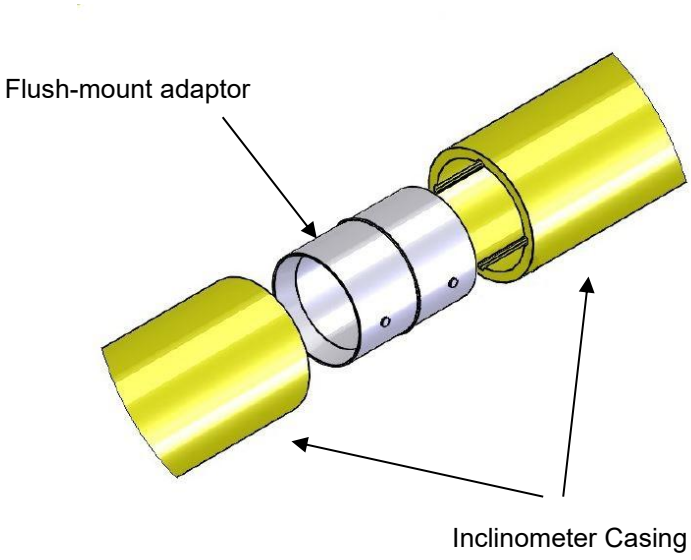
The casing may be also fixed to a surface with mounting clamps grouted or mechanically anchored in short boreholes.

3 MISCELLANEOUS

3.1 SPLICING THE CASING

It is possible to splice two sections of casing using a flush-mount adaptor provided by the Roctest. In order to do so, the procedure below must be followed.

- Cut the two ends of the two inclinometer sections you wish to splice. Cut the sections clean & straight.
- Put some ABS-PVC transition glue on one end of the PVC adaptor and install this one on the casing. Make sure to align the pins on the adaptor with the grooves in the casing.
- Put some ABS-PVC transition glue on the other end of the PVC splicing part and install the other casing on it. Make sure to align the pins on the adaptor with the grooves in the casing.
- In each case, do not put too much glue, which could block the way to the inclinometer probe.
- Wait for the glue to cure.



3.2 CONVERSION FACTORS

	To Convert From	To	Multiply By
LENGTH	Microns Millimeters Meters	Inches Inches Feet	3.94E-05 0.0394 3.2808
AREA	Square millimeters Square meters	Square inches Square feet	0.0016 10.7643
VOLUME	Cubic centimeters Cubic meters Liters Liters	Cubic inches Cubic feet U.S. gallon Imperial gallon	0.06101 35.3357 0.26420 0.21997
MASS	Kilograms Kilograms Kilograms	Pounds Short tons Long tons	2.20459 0.00110 0.00098
FORCE	Newtons Newtons Newtons	Pounds-force Kilograms-force Kips	0.22482 0.10197 0.00023
PRESSURE AND STRESS	Kilopascals Kilopascals Kilopascals Kilopascals Pascals Bars Inches head of water* Inches head of Hg	Psi Atmospheres Bars Meters head of water* Newtons / square meter Psi Psi Psi	0.14503 0.00987 0.01 0.10199 1 14.4928 0.03606 0.49116
TEMPERATURE	Temp. in °F = (1.8 x Temp. in °C) + 32 Temp. in °C = (Temp. in °F – 32) / 1.8		

* at 4 °C

E6TabConv-990505

TABLE 2: Conversion factors

EC Declaration of Conformity

Roctest Limited, located at 680 Birch, Saintt-Lambert, QC, Canada J4P 2N3

Declares under its sole responsibility, that the following product:

- **GEO-LOK, INCLINOMETRIC CASING MODEL 85 mm OD**
- **GEO-LOK, INCLINOMETRIC CASING MODEL 70 mm OD**

To which this declaration relates, is in conformity with the following standards:

- **EN 61326-1:2006 Lab Equipment, EMC**

In accordance with the provisions of the following Council Directives:

- **2004/108/EC (Electromagnetic Compatibility directive, as amended by EN61326-1, ed2)**
- **2006/42/EC (Machinery directive)**

Year of CE Marking: **2013**

I, the undersigned, hereby declare that the equipment specified above conforms to the listed directives and standards.

François Juneau

François Juneau, Eng.
Engineering Manager

Issued in: Saint-Lambert, QC, Canada **Date:** August 20, 2013