VE-53 Sensor Uniaxial / Triaxial
Surface and Downhole Velocity Sensor

Operation Manual

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DOCUMENT REVISION

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3	Updated for the new housing and design improvement
4	Added cable color code table 28.11.2005
5	Orientation axis
6	New logo and updated address 12.06.2014
7	Mounting section updated
8	Housing photos updated

TABLE OF CONTENTS

WARNING

The sensor housing provides no protection against explosive atmosphere. It must not be directly operated in area where explosive gases are present.

1. Introduction

This document describes the principle of operation and installation instructions of the VE-53 sensor family. The VE-53 is a high dynamic short period seismometer.

The VE-53 exist in 2 basic version:

- **VE-53**, short period seismometer (2 x 400 V/m/s, or 2 x 500 V/m/s, 1 to 50 Hz bandwidth, high dynamic range), standard version.
- **VE-53-DH**, down-hole version (optional).

This document applies to both the VE-53 short period seismometer surface sensor and the down-hole version.

Figure 1, VE-5X surface sensor

Figure 2, VE-5X-DH downhole sensor

INSTALLATION

2. Electrical Connection

2.1. Main Connector Pin Assignment

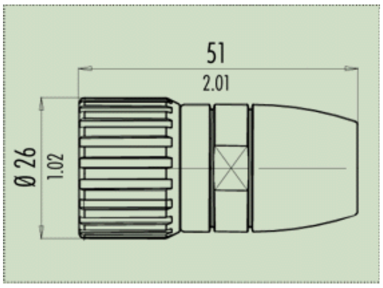
All the AC-2X accelerometers use the same 12 pins male metallic style connector as the AC-33 and AC-63. The connector pins standard assignments are as follows:

Pin	SIGNAL	Comment
1	OUTPUT X (+)	0 V ± 5 V voltage output, 47 Ω output impedance
2	OUTPUT X (-)	0 V ± 5 V voltage output inverted, 47 Ω output impedance
3	OUTPUT Y (+)	0 V ± 5 V voltage output, 47 Ω output impedance
4	OUTPUT Y (-)	0 V ± 5 V voltage output inverted, 47 Ω output impedance
5	OUTPUT Z (+)	0 V ± 5 V voltage output, 47 Ω output impedance
6	OUTPUT Z (-)	0 V ± 5 V voltage output inverted, 47 Ω output impedance
7	TEST INPUT	Test input, output will result in a sensor step response
8	GROUND	Ground, not connected to mechanical ground
9	+12 VDC power	Power input, +10 to +15 VDC range, 50 mA @ +12 VDC
10	GROUND	Ground, not connected to mechanical ground
11	AUX	Auxiliary input (reserved)
12	GROUND	Ground, not connected to mechanical ground

Table 1 VE-5X Connector Pin Assignment

2.2. Mating connector

GeoSIG	P/N #J_CIR.012.002.F
CONINVERS	P/N RC 12 S 1 N 12L 300
Binder Serie 623	P/N 99 4622 00 12



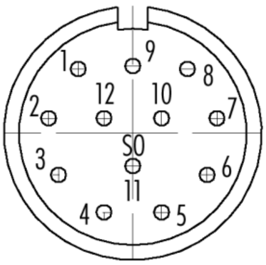


Figure 3, Mating connector

Cable gland nut has to be determined as per cable external diameter and must be separately ordered. It has also to provide the cable shield connection to connector case.

Table 2. VE Internal PCB Pin Assignment

12 Pin	Name	12 Lead Cable Colour	Description
1	Sens_X_HI	white	X-Signal high
2	Sens_X_LO	brown	X-Signal low
3	Sens_Y_HI	green	Y-Signal high
4	Sens_Y_LO	yellow	Y-Signal high
5	Sens_Z_HI	grey	Z-Signal high
6	Sens_Z_LO	pink	Z-Signal low
7	S_Test	blue	Sensor Test Signal
8	AGND	red	Analog Ground
9	V_EXT	black	External Voltage (12VDC)
10	AGND	violet	Analog Ground
11	S_MODE	grey-pink	Sensor Mode Signal
12	AGND	red-blue	Analog Ground

Table 3. VE Sensor Housing Pin Assignment

12 Pin	Name	12 Lead Cable Colour	Description
1	Sens_X_HI	white	X-Signal high
2	Sens_X_LO	brown	X-Signal low
3	Sens_Y_HI	green	Y-Signal high
4	Sens_Y_LO	yellow	Y-Signal high
5	Sens_Z_HI	grey	Z-Signal high
6	Sens_Z_LO	pink	Z-Signal low
7	S_Test	blue	Sensor Test Signal
8	AGND	red	Analog Ground
9	V_EXT	black	External Voltage (12VDC)
10	AGND	violet	Analog Ground
11	S_MODE	grey-pink	Sensor Mode Signal
12	AGND	red-blue	Analog Ground

Table 4. VE Sensor Cable Pin Assignment

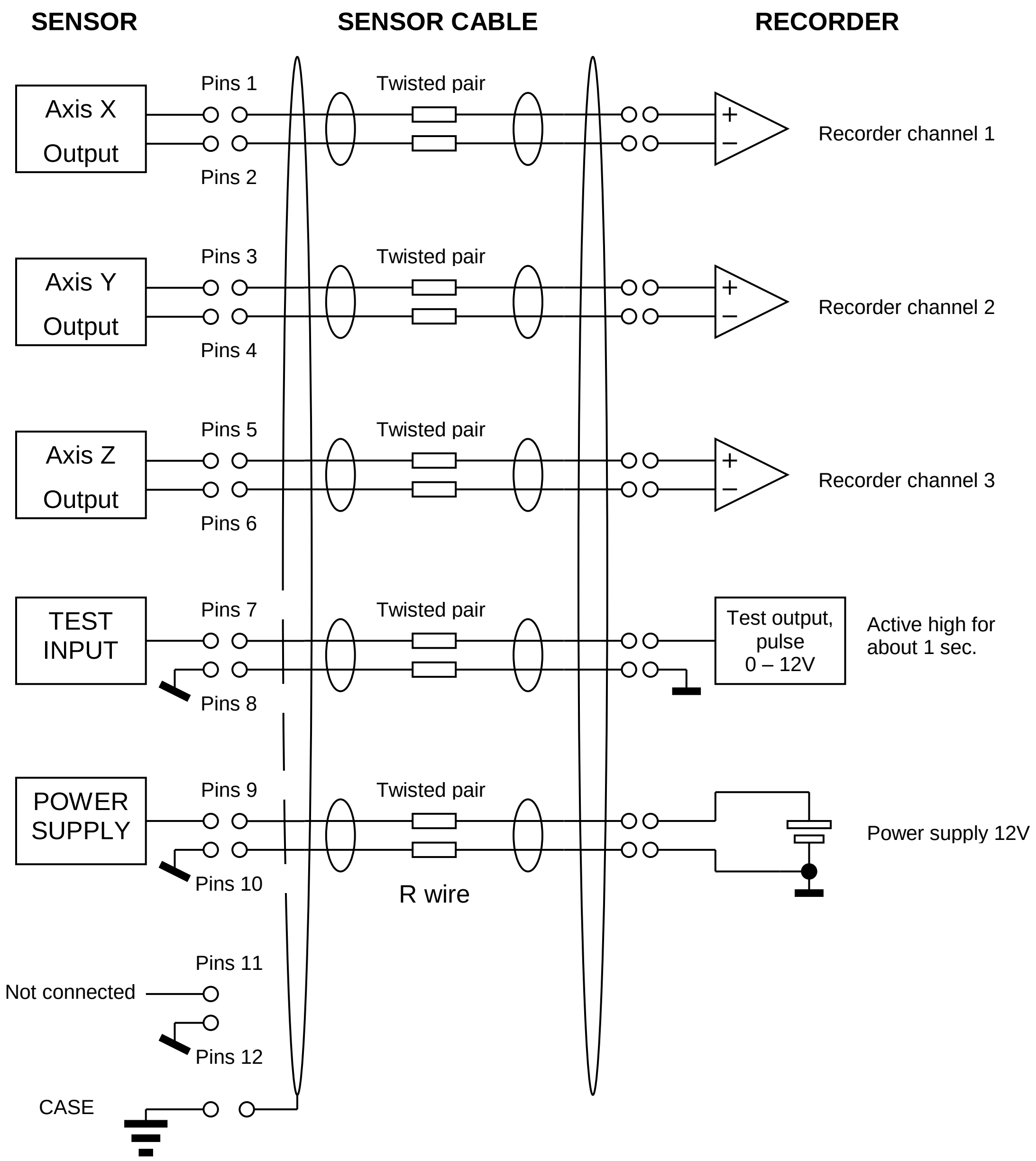
12 Pin	Name	12 Lead Cable Colour	Description
1	Sens_X_HI	white	X-Signal high
2	Sens_X_LO	brown	X-Signal low
3	Sens_Y_HI	green	Y-Signal high
4	Sens_Y_LO	yellow	Y-Signal high
5	Sens_Z_HI	grey	Z-Signal high
6	Sens_Z_LO	pink	Z-Signal low
7	S_Test	blue	Sensor Test Signal
8	AGND	red	Analog Ground
9	V_EXT	black	External Voltage (12VDC)
10	AGND	violet	Analog Ground
11	S_MODE	grey-pink	Sensor Mode Signal
12	AGND	red-blue	Analog Ground

3. Electrical configuration

The seismometer is adjusted at factory for a sensitivity of 2 x 400 V/m/s (optionally 2 x 500 V/m/s). There is no configuration required on site and no damping to be set.

4. Interfacing

The sensor must be connected to a recorder with differential inputs to achieve high dynamic. Single ended connection can be used only for testing.



4.1. Output signals

The output signals are differential. One pin (+) provide a 400 V/m/s (500 V/m/s) output signal and the pin (-) provide also a 400 V/m/s (500 V/m/s) signal, but with inverted signal. When measuring the difference between the 2 pins provide a differential signal of 2 x 400 = 800 V/m/s (2 X 500 = 1000 V/m/s):

Velocity	**Pin (+) voltage**	**Pin (-) voltage**	**Differential signal**
[m/s]	**[V to ground]**	**[V to ground]**	**[V]**
0	0.00	0.00	0.00
+0.0125	+5.00	-5.00	+10.0
-0.0125	-5.00	+5.00	-10.0
+1 um/s	+400 uV (+500 uV)	-400 uV (-500 uV)	+800 uV (+1000 uV)
-1 um/s	-400 uV (-500 uV)	+400 uV (+500 uV)	-800 uV (-1000 uV)

Note:

- Pin (+) apply to pins 1, 3 and 5, pin (-) apply to pins 2, 4 and 6.

4.2. Test input

The next figure shows the response of the sensor to a 1 second test pulse. The test pulse should be at least greater for 8 volts to activate the test circuit.

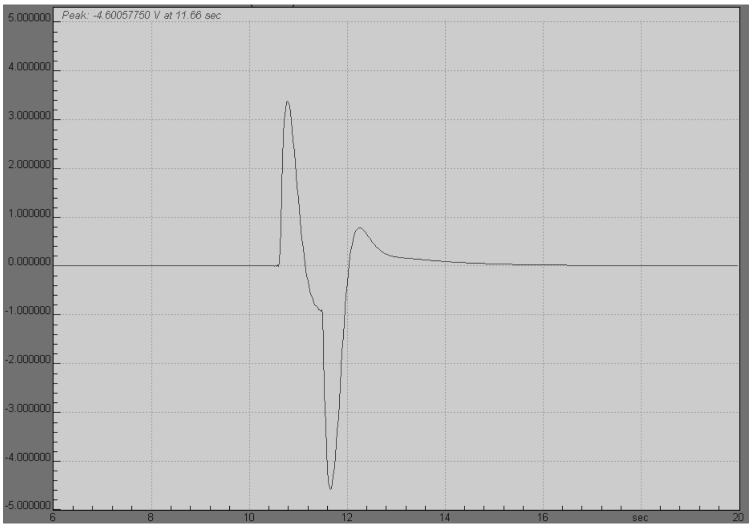


Figure 4, sensor test pulse

4.3. Cable length

One of the most limiting parameter of the cable length is the voltage drop in the power supply lines.

Wire size	**Max. current in wire at 11.5 V supply**	**Maximum total supply drop @ 40 °C**	**Maximum one wire resistance @ 20°C**	**Maximum cable length**	**Practical value**
mm2	**mA**	**Volts**	**ohms**	**meters**	**meters**
0.25	50	1.5	13.9	198	**200**
0.5	50	1.5	13.9	397	**400**
0.75	50	1.5	13.9	595	**600**

In case the sensor is supplied from the recorder with a voltage different from 11.5 V, the maximum length must be reevaluated: Max_length = New_section/0.25 mm2 * 200 meters * (New_supply-10) / 1.5.

5. Mounting (surface sensor)

Figure 5, VE-5X housing

Small size and single bolt attachment allow the AC-2X to be easily installed saving installation time. Leveling is accomplished via three-point leveling screws.

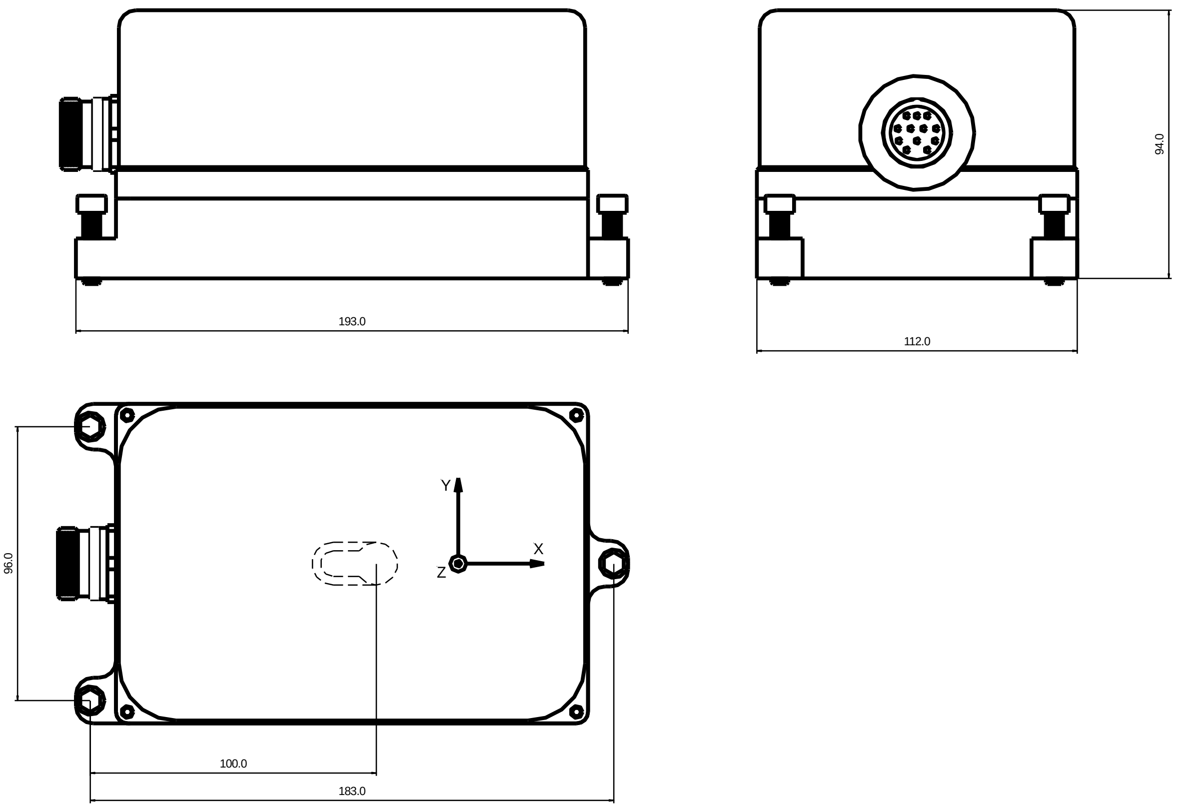


Figure 6, Sensor housing dimensions

The sensor must be firmly mounted to a surface and leveled, as the application requires. Check to be sure that the sensor is aligned to produce the desired output signals. Displacement in the direction indicated on the case will produce a positive output signal. The orientation definitions as shipped are: **X=East**, **Y=North** and **Z=Vertical (Up)**.

The sensor has single-bolt, 3-feet-levelling mechanism.

The surface should have a scribed north/south orientation line accurately surveyed from reliable markers. The X-axis of the sensor has to be pointed to East or to any other main direction of the structure to monitor.

One M8 expanding nut rock anchor must be used for the sensor fixation.

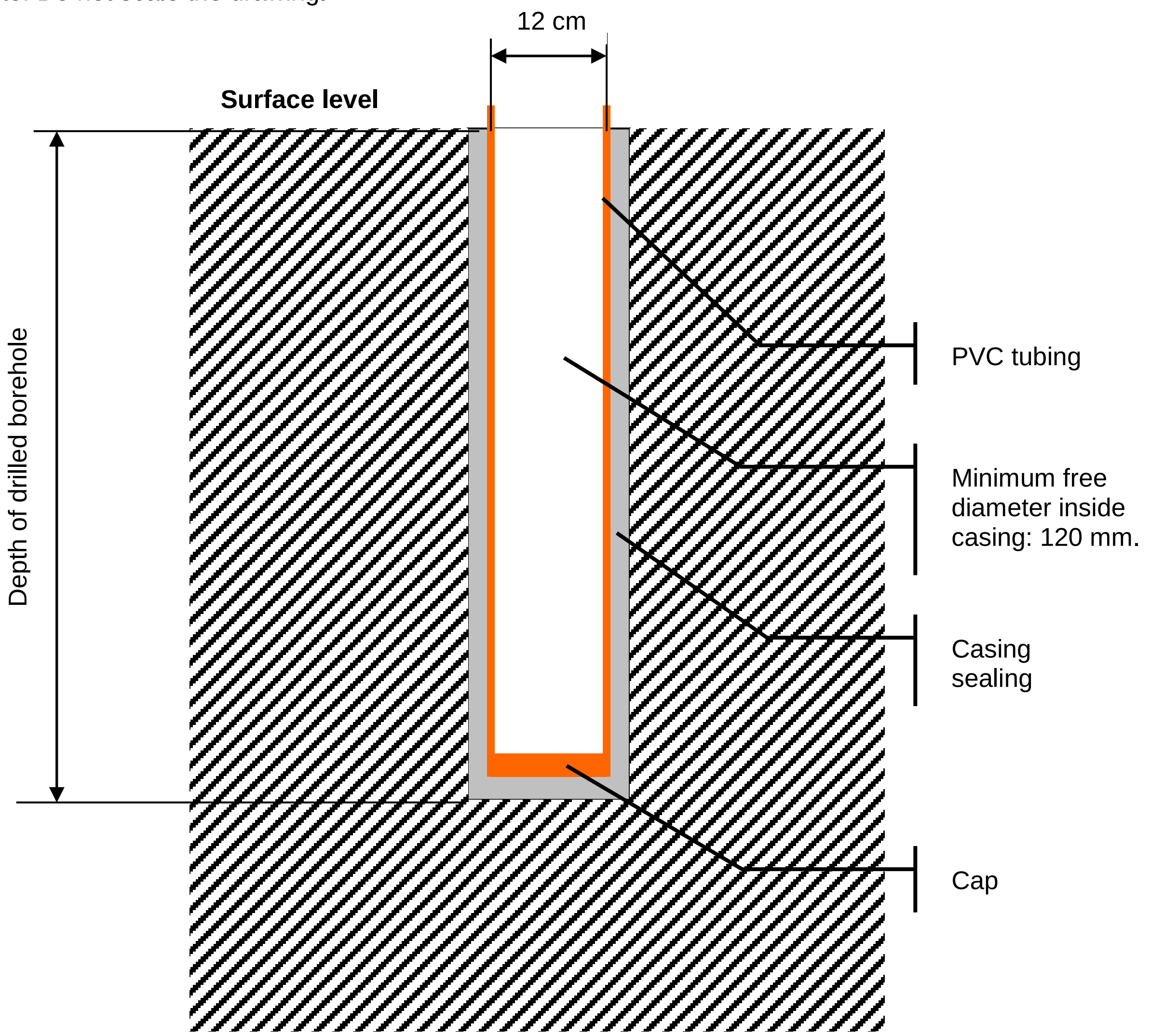
Do not overtighten the three-point levelling mechanism. This may damage the sensor.

6. Mounting (downhole sensor)

The sensor must be installed in a 3-inch inclinometer tube. At least a 100 mm borehole must be drilled. Depending on the soil condition, it could be required to drill a higher dimension hole and to implement a 120 mm PVC casing to insure a free path when the inclinometer tube is inserted in the borehole.

6.1. Borehole preparation

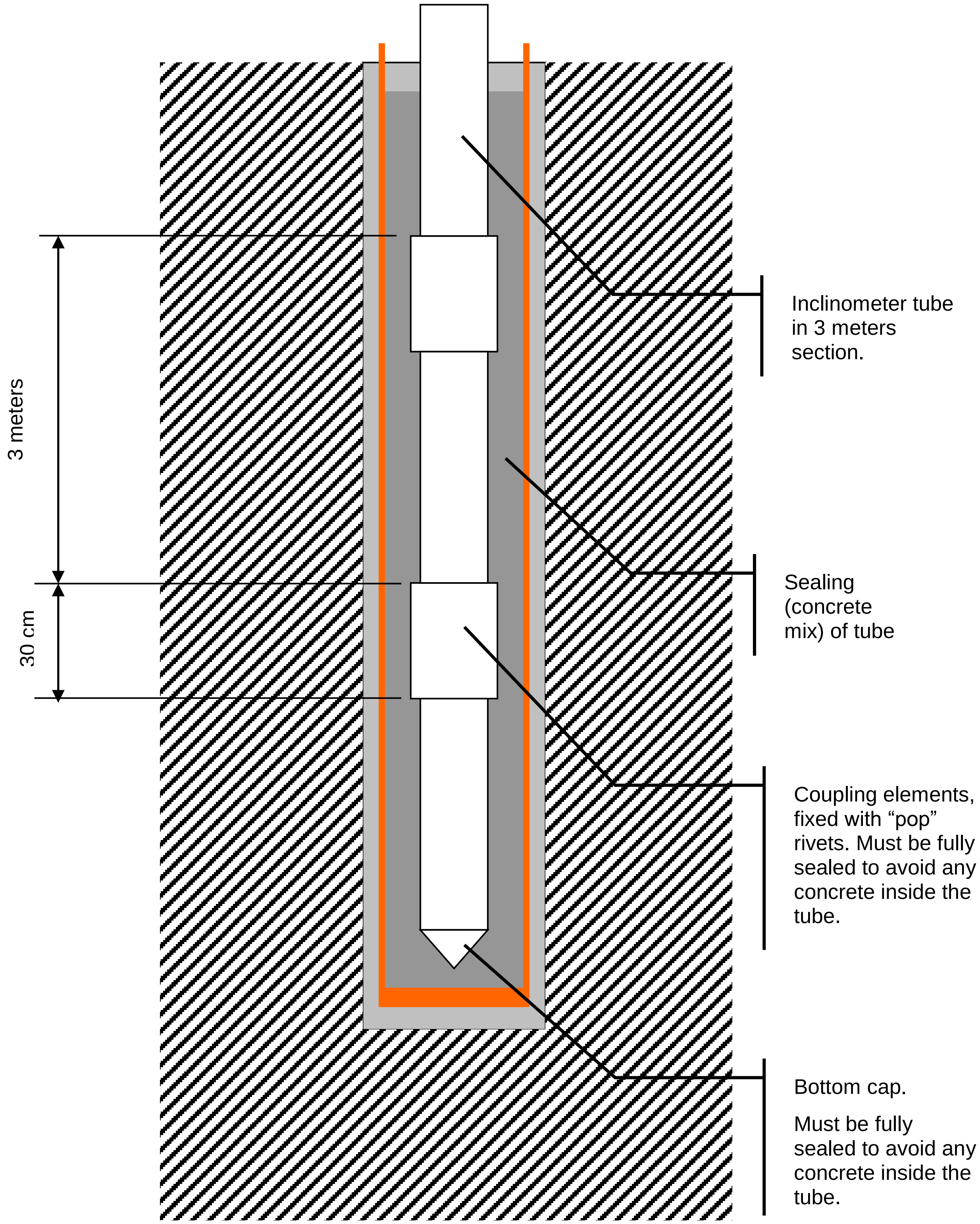
Note: Do not scale the drawing.



Do not allow concrete mix from casing sealing to enter the casing.

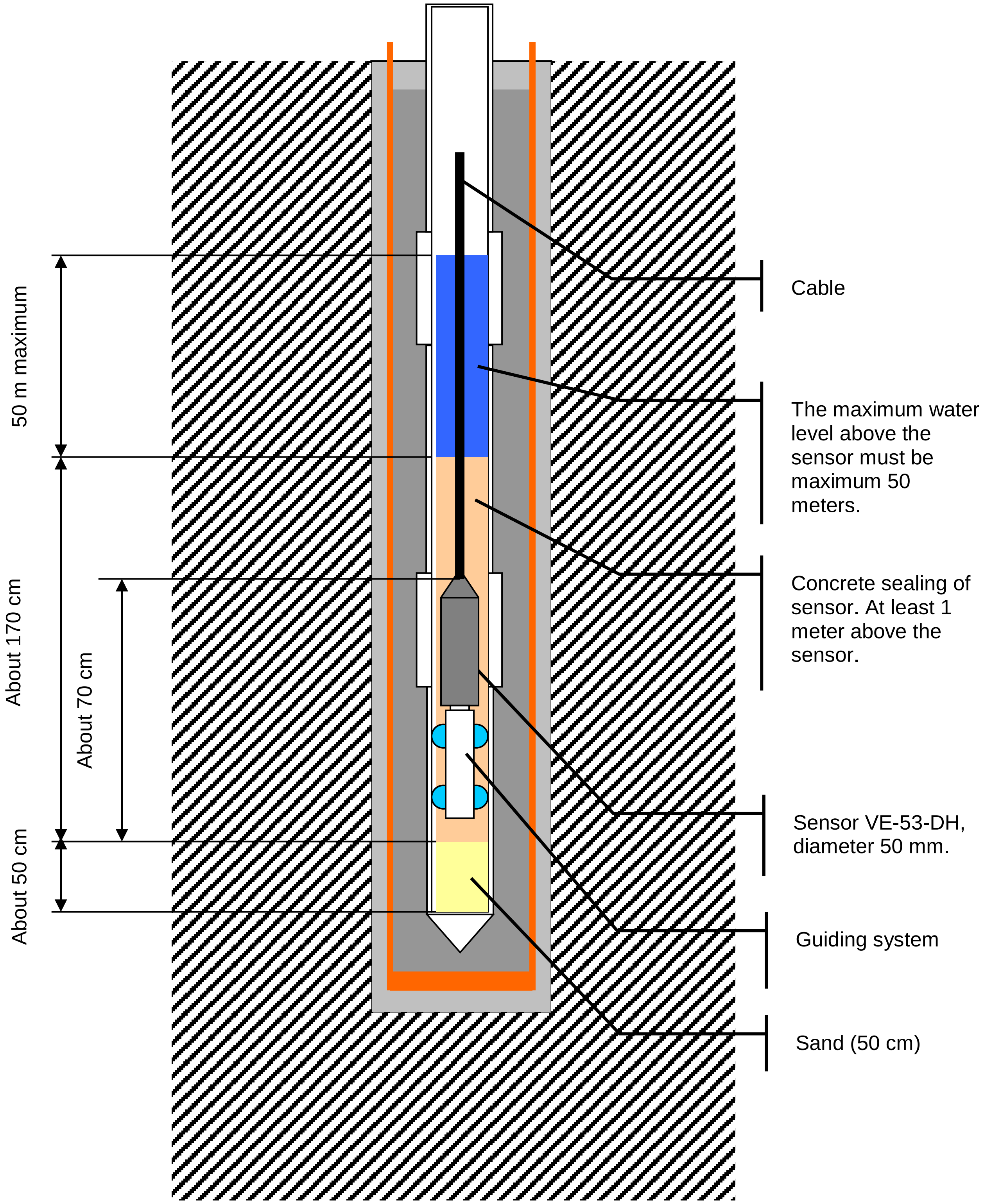
6.2. Inclinometer tube installation

Note: Do not scale the drawing. The number of section is only an example.



6.3. Sensor installation

Note: Do not scale the drawing. The number of section is only an example.



6.4. Inclinometer casing assembly

The borehole must have a casing or the soil must insure that a free path for the inclinometer tube is warranted. It is recommended to insert the inclinometer tube as soon the borehole is ready.

The free path for the inclinometer tube should be 10 to 15 cm, 12 cm typically.

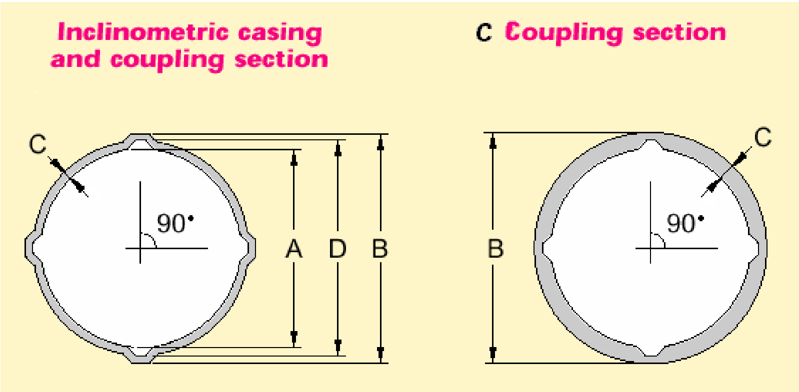
It could be required to insert some water in the casing to sustain the water pressure at the bottom of the borehole.

The inclinometer tube should be mounted with a maximum deviation of ±1° / 3 meters and with a maximum deviation from vertical at sensor location of ±3°. The functional limit for the sensor is ±9°.

The water level in the inclinometer tube should be maximum 50 meters, including fast elevation due to heavy rain.

It is recommended to use the optional assembly kit that GeoSIG can provide (optional) with the inclinometer tube. It will insure a perfect sealing of the tube elements and would avoid concrete mix to enter the tube.

The dimensions of the inclinometer tube are:



INCLINOMETRIC CASING (3 m section)			COUPLING ELEMENT		
A	Inner diameter	76.1 mm	**A**	Inner diameter	81.0 mm
B	Groove outer diameter	86.4 mm	**B**	Outer diameter	92.0 mm
C	Thickness	2.2 ±0.1 mm	**C**	Thickness	2.2 mm
D	Groove inner diameter	82.0 mm	**D**	Groove inner diameter	87.6 mm
	Length	3 meters		Length	300 mm
	Weight	1.4 Kg/m		Weight	0.5 kg
	Borehole diameter	> 100 mm			

The following elements will be inserted in the borehole.

Figure 7		Torpedo (the sensor)
Figure 8		Guiding system
Figure 9		Inclinometer tube

6.5. Axis orientation

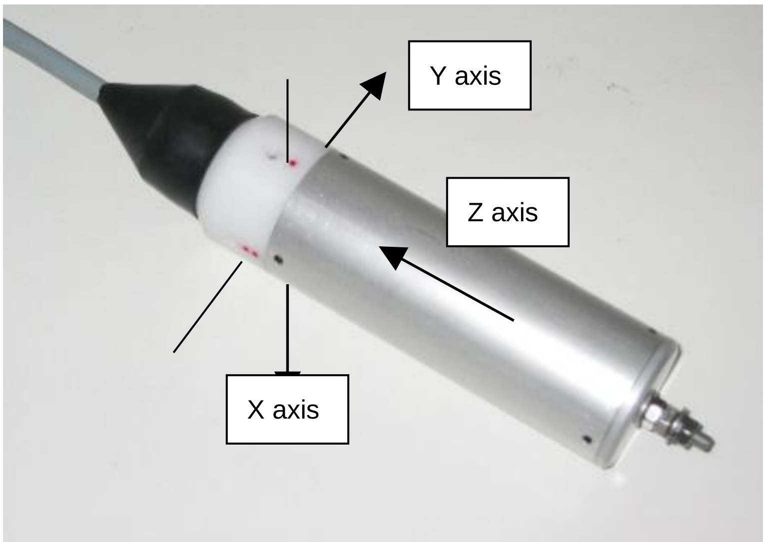


Figure 10, Down hole axis orientation

Before the sensor is inserted in the inclinometer tube, the guiding system must be mounted bellow it. The guiding system must be orientated before the insertion.

7. INSTALLATION VERIFICATION

Please note that temperature compensation device is mounted for each axis inside the sensor and that the temperature in the sensor has to stabilize before accurate measurement can be done. Allow at least half an hour for temperature stabilization.

THEORY OF OPERATION

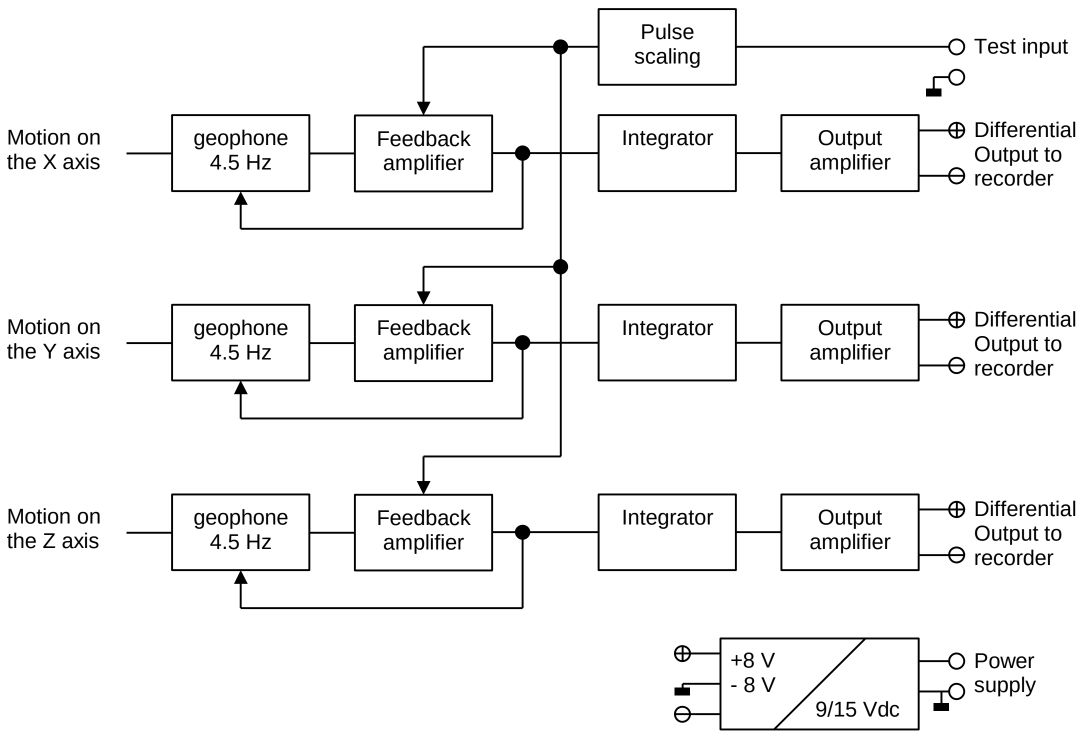
7.1. Introduction

The **VE-53** sensor package is a triaxial seismometer designed for free field applications regarding earthquake monitoring. This sensor is well suited for applications where a high sensitivity is required.

With the help of the **TEST LINE,** the complete sensor can be very easily completely tested.

7.2. Principle

The accelerometer is based on a geophone mass-spring system with electronic correction. This type of sensors gives a very good stability in temperature and aging because of the very simple principle. It uses a damped mass spring oscillator called "Geophone" to convert seismic movement into electrical value proportional to the velocity. In a graphic with constant acceleration, the geophone response will present a maximum at the frequency called "Natural Frequency" which is the resonant frequency of the mass-spring oscillator. Above and below this point, the response will decay with one pole slope (±20 dB / decade). The feedback amplifier will over-damp the geophone by applying a voltage with opposite polarity over the geophone and the output response will be flat and proportional to the acceleration in this frequency band. Before the output stage, an integrator is implemented to convert the acceleration signal to a velocity signal.



Note : all inputs, outputs & power supply entry are surge protected.

Figure 11 VE-53 Sensor block diagram

The geophone is connected in a resistor bridge, driven by the low noise feedback amplifier, which applies the amplified bridge differential signal as an opposite polarity current. The bridge is zero balanced during calibration.

The test-line shifts the voltage at one side of the bridge, which produces a current flow in the geophone. This current flowing in the Geophone will move the seismic mass. The movement of the mass generates a voltage across the Geophone, which is detected by the differential amplifier and induces an output signal.

The test pulse must be 0 / 12 V signal, an internal circuit scale the internal pulse to a constant value.

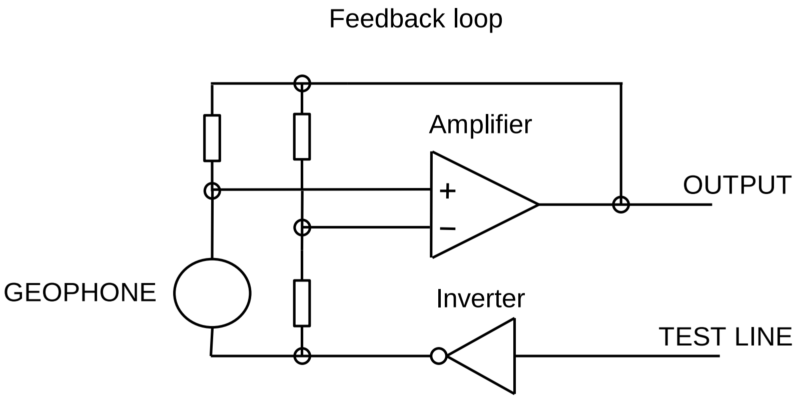


Figure 12 TEST INPUT configuration

8. Basic specifications

Detailed specifications	**VE-53**
Input range	Velocity, ±12.5 mm/s full scale, with a clip level at 75 mg (0.74 m/s²)
Output range	±10 Volt differential output or 0 ± 5 Volt single ended output
Sensitivity	When differential output is used, ±10 V signal with a sensitivity of 2 x 400 = 800 V/m/s Or When single ended output is used, ±5V signal with a sensitivity of 400 V/m/s (optionally 500 V/m/s)
Frequency range	1 Hz to 50 Hz
Protections	All connectors pins protected by Transzorb diodes and a VDR (30 V_{rms}) is implemented between electronic ground and case.
Power supply	10 – 15 VDC
Current drain	Typical 45 mA @ 12 VDC