User Manual
VE-53 Short-Period Seismometer

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Level:	Product
Distribution:	GeoSIG Ltd, Customers

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DOCUMENT REVISION

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5		Orientation axis			
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7		Mounting section updated			
8		Housing photos updated			
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13	21.09.2023	Updated photos and comments about test pulse	ALV	ALB	VAG
14	31.01.2024	Removed installation instructions for downhole, which has its own manual	KEC	ALM	ALB

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Warnings and Safety

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 is a short period seismometer (2 x 500 V/m/s, 1 to 50 Hz bandwidth, high dynamic range), standard version.

Separately, there is also VE-53-DH, a down-hole sensor that has its own operating manual.

This document applies to the VE-53 short period seismometer surface sensor.

Figure 1, VE-5X surface sensor

2. Basic specifications

Sensor Series	**VE-53**
Input range	Velocity, ±12.5 mm/s full scale, with a clip level at 75 mg (0.74 m/s^2)
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)
Bandwidth	SP version: 0.9 Hz (1.1 sec) to 89 Hz, flat response BB version: 0.125 Hz (8 sec) to 160 Hz, flat response
Frequency range	1 Hz to 50 Hz
Protections	All connector pins are protected by Transzorb diodes, and a VDR (30 V_{rms}) is implemented between electronic ground and case.
Power supply	9.5 – 18 VDC
Current drain	Typical 75 mA @ 15 VDC

INSTALLATION

3. Electrical Connector

VE-5x velocity sensors are supplied with a 2 m connection cable as standard. Based on the intended use, the 12-pin metallic-style connectors will be supplied in one of the following options: Binder Serie 623 or Binder Serie 423.

3.1. Binder Serie 623

GeoSIG	P/N #J_CIR.012.002.F
Binder Serie 623	P/N 99 4606 00 12

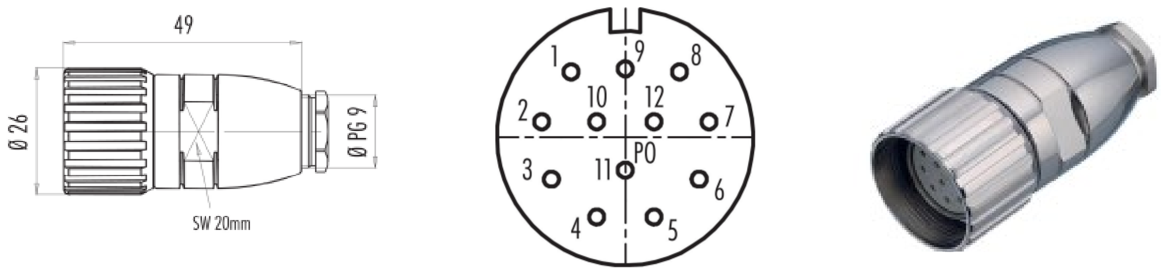

Figure 3, Binder Serie 623 Connector

The cable gland nut is determined according to the cable's external diameter and must be ordered separately. It must also provide the cable shield connection to connector case.

3.2. Binder Serie 423

GeoSIG	P/N #J_CIR.012.010.M
Binder Serie 423	P/N 99 5629 00 12

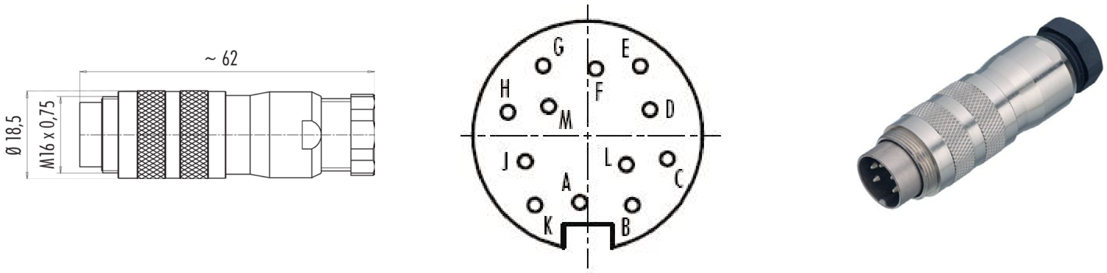

Figure 4, Binder Serie 423 connector

The cable gland nut is determined according to the cable's external diameter and must be ordered separately. It must also provide the cable shield connection to connector case.

3.3. Connector Pin Description

The connector pin assignment and cable colour code can be observed in the table below:

Binder Connector		SIGNAL	Comment	Colour	
Serie 623	Serie 423				
Pinout	Pinout				
1	A	OUTPUT X (+)	0 V ± 10 V voltage output, 50 Ω output impedance	White	
2	B	OUTPUT X (-)	0 V ± 10 V voltage output inverted, 50 Ω output impedance	Brown	
3	C	OUTPUT Y (+)	0 V ± 10 V voltage output, 50 Ω output impedance	Green	
4	D	OUTPUT Y (-)	0 V ± 10 V voltage output inverted, 50 Ω output impedance	Yellow	
5	E	OUTPUT Z (+)	0 V ± 10 V voltage output, 50 Ω output impedance	Grey	
6	F	OUTPUT Z (-)	0 V ± 10 V voltage output inverted, 50 Ω output impedance	Pink	
7	G	TEST INPUT	Test input, output will result in a sensor step response	Blue	
8	H	GND	Connected to Recorder's GND	Red	
9	J	+12 VDC power	Power input, +9.5 to +18 VDC range, 75 mA @ +15 VDC	Black	
10	K	GROUND	Ground, not connected to mechanical ground	Violet	
11	L	AUX	Sensor Mode Signal	Grey/Pink	
12	M	GROUND	Ground, not connected to mechanical ground	Red/Blue	

Table 1. VE-5x Connector Pin Assignment and Cable Colour Code

3.4. Internal PCB Pin Description

Pin No.	Signal	Description	12 Lead Cable Colour	
1	OUTPUT X (+)	X-Signal high	**white**	
2	OUTPUT X (-)	X-Signal low	**brown**	
3	OUTPUT Y (+)	Y-Signal high	**green**	
4	OUTPUT Y (-)	Y-Signal high	**yellow**	
5	OUTPUT Z (+)	Z-Signal high	**grey**	
6	OUTPUT Z (-)	Z-Signal low	**pink**	
7	TEST INPUT	Sensor Test Signal	**blue**	
8	GND	Analog Ground	**red**	
9	+12 VDC power	External Voltage (12VDC)	**black**	
10	GROUND	Analog Ground	**violet**	
11	AUX	Sensor Mode Signal	**grey-pink**	
12	GROUND	Analog Ground	**red-blue**	

Table 2. VE-5x Internal PCB Pin Assignment

3.5. Sensor Housing Pin Assignment

Binder Connector		Signal	Description	12 Lead Cable Colour	
Serie 623	Serie 423				
Pinout					
1	A	OUTPUT X (+)	X-Signal high	**white**	
2	B	OUTPUT X (-)	X-Signal low	**brown**	
3	C	OUTPUT Y (+)	Y-Signal high	**green**	
4	D	OUTPUT Y (-)	Y-Signal high	**yellow**	
5	E	OUTPUT Z (+)	Z-Signal high	**grey**	
6	F	OUTPUT Z (-)	Z-Signal low	**pink**	
7	G	TEST INPUT	Sensor Test Signal	**blue**	
8	H	GND	Analog Ground	**red**	
9	J	+12 VDC power	External Voltage (12VDC)	**black**	
10	K	GROUND	Analog Ground	**violet**	
11	L	AUX	Sensor Mode Signal	**grey-pink**	
12	M	GROUND	Analog Ground	**red-blue**	

Table 3. VE-5x Sensor Housing Pin Assignment

4. Electrical Configuration

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

5. 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.

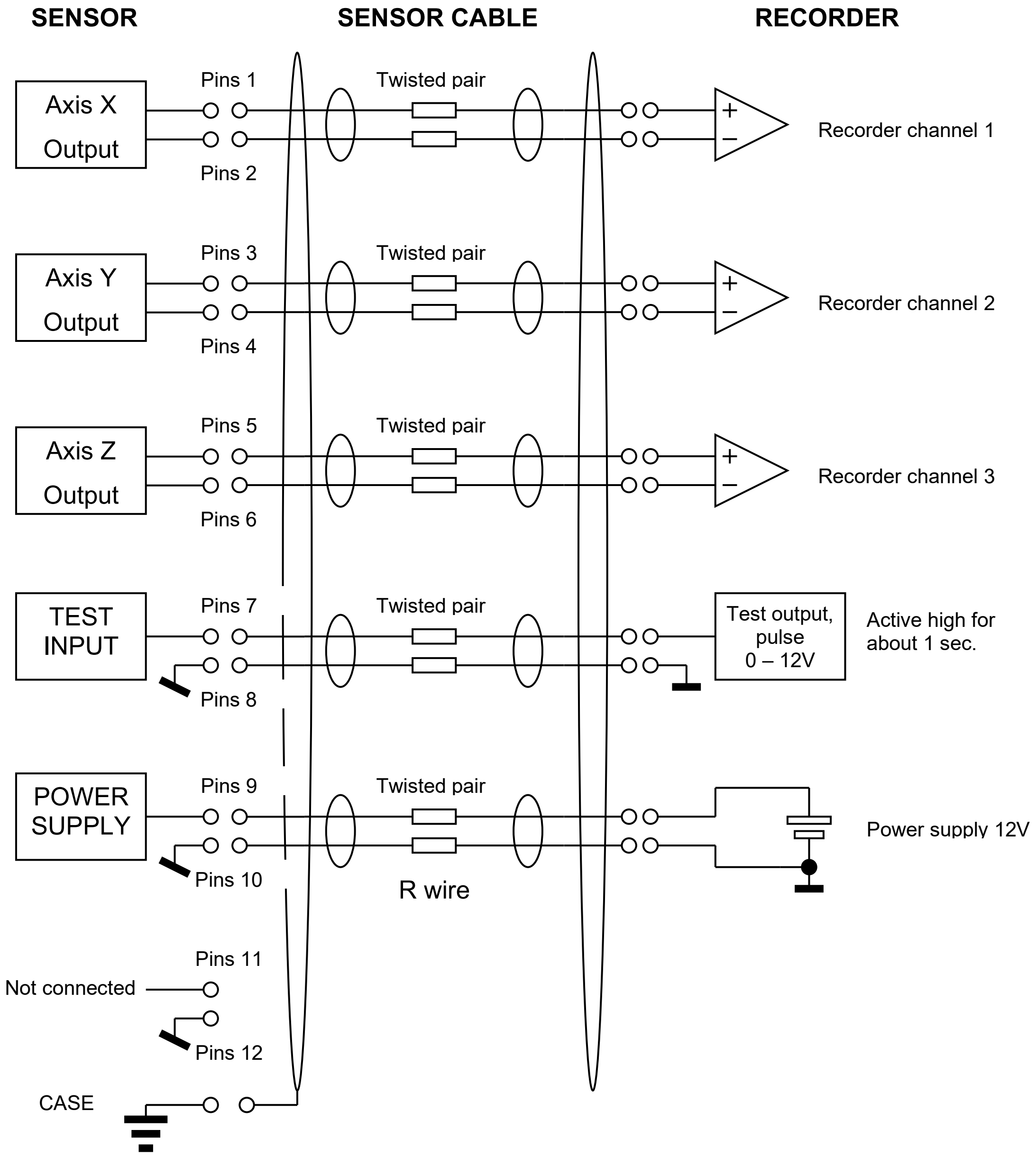

Figure 5 – Interfacing Schematic

5.1. Output signals

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

Table 4 – Output Signals

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	+500 uV	-500 uV	+1000 uV
-1 um/s	-500 uV	+500 uV	-1000 uV

Note:

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

5.2. 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 than 8 volts to activate the test circuit. The sensor test pulse can display one or the other depending on jumper settings

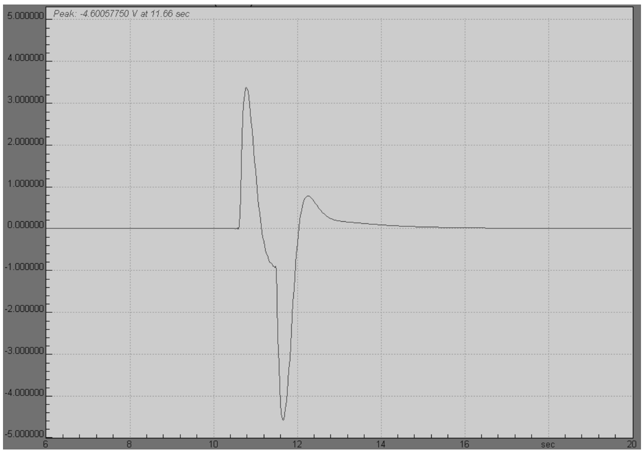

Figure 6, sensor test pulse with Amplification (peak about 4-5 mm/s)

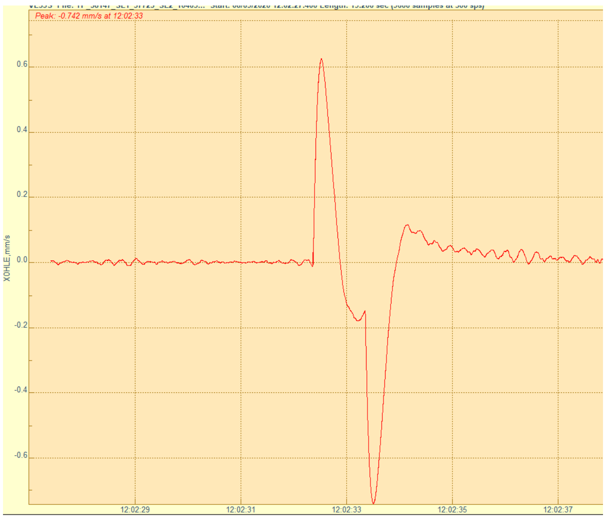

Figure 7, sensor test pulse without amplification (peak about 0.6-0.7 mm/s)

5.3. Cable length

One of the most limiting parameters 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**
mm2	**mA**	**Volts**	**ohms**	**meters**
0.25 one pair	50		13.9	100
0.25 two pairs	50	1.5	13.9	175
0.75 one pair	50	1.5	13.9	400

Table 5 - Cable length

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

6. Mounting of the surface sensor

Figure 8, VE-5X housing

Small size and single bolt attachment allow the VE-5X to be easily installed saving installation time. Levelling is accomplished via three-point levelling screws.

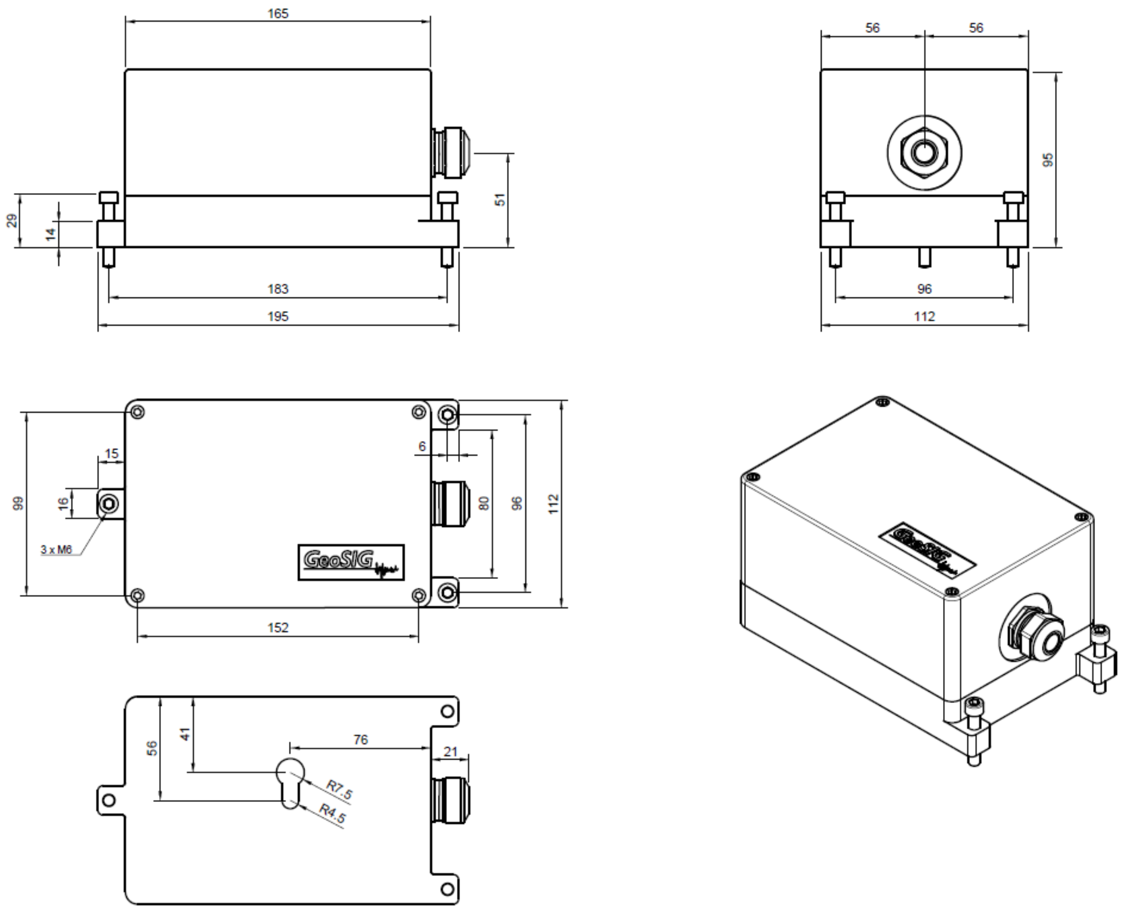

Figure 9, Sensor housing dimensions

The sensor must be firmly mounted to a surface and levelled, 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.

THEORY OF OPERATION

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.

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 and completely tested.

7.2. Principle

The accelerometer is based on a geophone mass-spring system with electronic correction. This type of sensor 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.

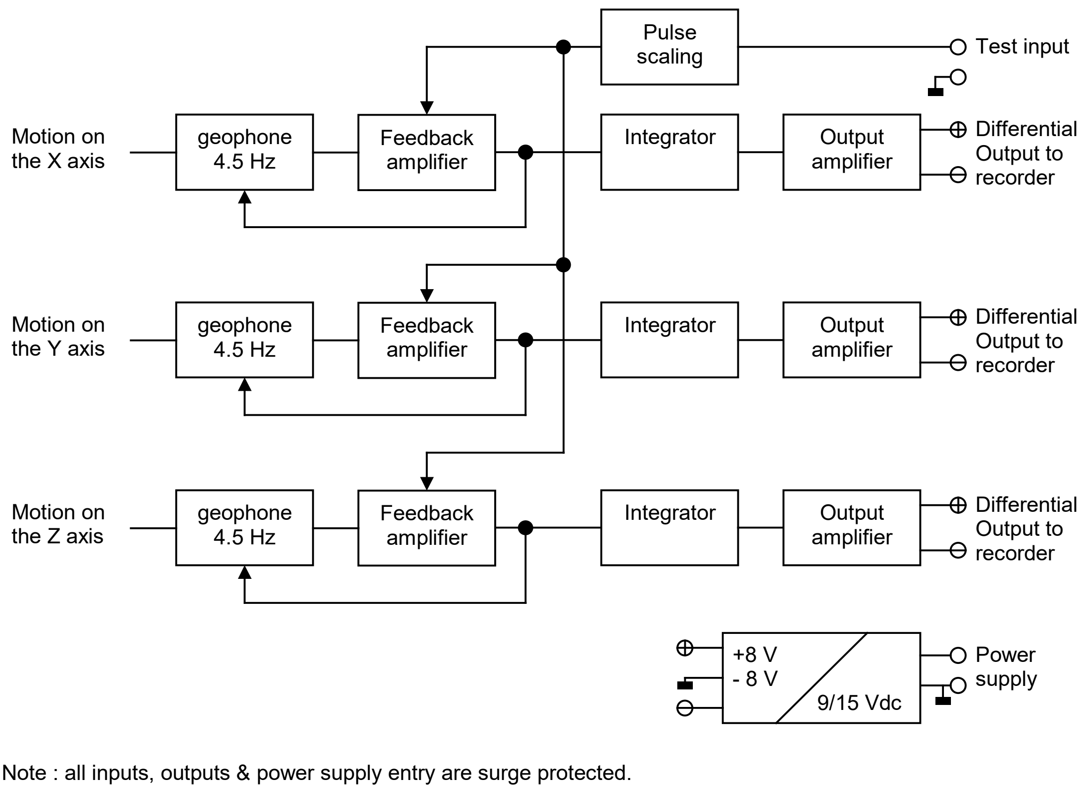

Figure 10 VE-53 Sensor block diagram

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.

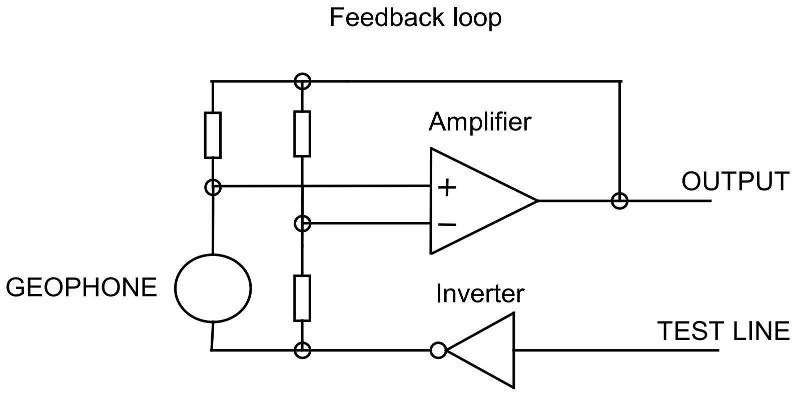

Figure 11 TEST INPUT configuration