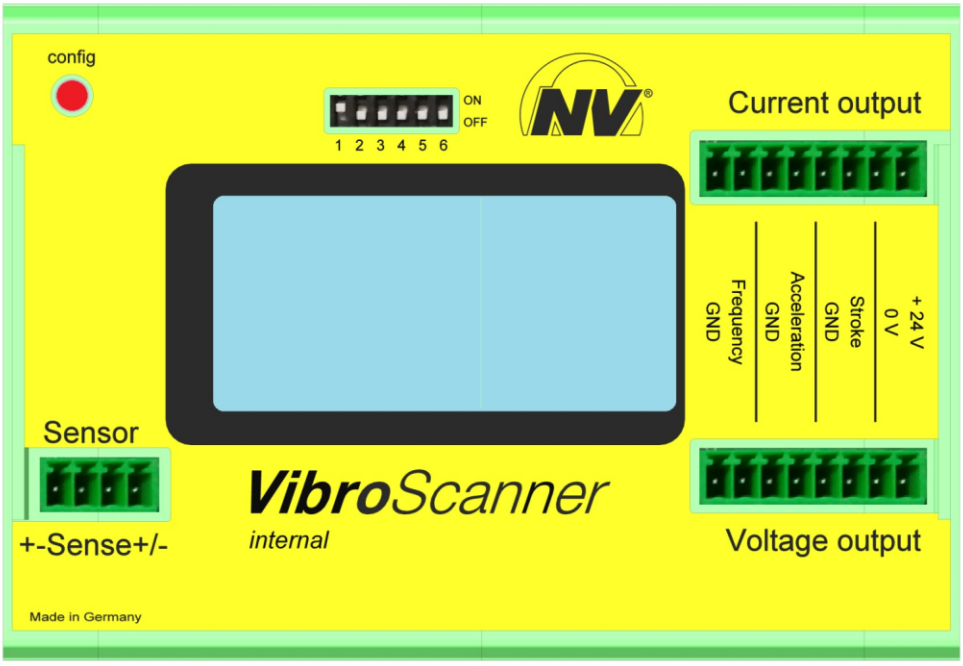
Operating instructions for vibration measuring systems *Vibro*Scanner VSI

These operating instructions apply to: vibration measuring systems series ***Vibro***Scanner VSI



Contents

Scope of delivery

Please refer to the delivery note for the scope of delivery.
Check the packaging for possible transport damage. In the event of damage to the packaging, check the contents for completeness and possible damage. Inform the carrier in the case of damage.

Designation

The vibration measuring systems series VibroScanner VSI are hereafter referred to as "VSI".

Version of document

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1 General information

Use and storage

Before installing the VSI read these instructions carefully. It is the basis for any action when dealing with the VSI, and may be used for training purposes. The instructions should be subsequently stored at the operation site.

Target group

The target group for these instructions is technical staff, who have basic knowledge in mechanics and electrics.

Only complying technical staff may work on the VSI.

The VSI may only be installed, put into operation, maintained, troubleshot and disassembled by persons authorised by the operator.

Copyright

Limitation of liability

All technical information, data and instructions for installation, operation and maintenance in these instructions are based on the latest information available at the time of printing and take our past experience to the best of our knowledge into account.

No claims can be derived from the information, illustrations and descriptions in these operating instructions.

The manufacturer does not assume liability for damages resulting from:

- failure to observe the instructions,
- improper use,
- unauthorised repairs,
- technical modifications,
- use of non-permissible spare parts.

Translations are made to the best of our knowledge.

Netter*Vibration* does not assume liability for translation errors, even if the translation was made by us or on our behalf. Only the original German text remains binding.

Directives / standards observed

The vibration measuring systems series VibroScanner VSI are build according to the following standards and directives:

- 2014/35/EU low voltage directive
- 2014/30/EU electromagnetic compatibility directive
- DIN EN 60204-1
- DIN EN 61010-1
- DIN EN 61326-1

The rules and regulations of the local associations for electrical engineering apply (e. g. IEC, VDE, OEVE, SEV, etc.).

Instruction and warning symbols

The following instruction and warning symbols are used in these instructions:

Personal injuries

⚠ DANGER	
	indicates an immediate danger. Disregard of this notice will result in death or severe personal injuries.

⚠ WARNING	
	indicates a potential danger. Disregard of this notice can result in death or severe personal injuries.

⚠ CAUTION	
	indicates a potentially dangerous situation. Disregard of this notice can result in minor or moderate personal injuries.

Material damages

NOTICE
indicates potential material damage. Disregard of this notice can result in material damage.

Notes

IMPORTANT
indicates actions, methods or notes that are not relative to safety, e.g. useful information and tips.

	**Environmentally safe disposal** indicates the obligation of environmentally safe disposal.

2 Safety

Intended use

VSI controllers are intended for assembly in switch cabinets and control cabinets. VSI sensors are intended for installation in vibration systems.

VSI are used to measure the acceleration and dominant frequency of mechanical vibrations by means of an acceleration sensor.
Possible applications are the measurement of the operational parameters of vibration systems, e. g. frequencies and effective accelerations in vibration feeders and conveyors, vibration compactors or vibration test systems.

Any other use is considered improper.

Qualification of qualified personnel

Installation, commissioning, maintenance and troubleshooting of the VSI may only be performed by authorised qualified personnel.

All handling of the VSI is the responsibility of the operator.

High voltage

⚠ DANGER	
	**Risk of electric shock due to high voltage** Live parts can cause severe injuries or even death. ➢ The electrical installation may only be carried out by authorized qualified personnel. ➢ Control cabinet doors must not be opened during operation. ➢ All work on the system may only be carried out in a volt-free state. ➢ Observe the permissible protection class and protective grounding. The VSI may only be operated with the correct connection of the protective conductor. ➢ Perform all work only with insulated tools suitable for the application.

Safety rules

⚠ DANGER

Electric shock

An electric shock will result in serious injury or even death. The VSI must be free of voltage during assembly, start-up, maintenance and troubleshooting.

Observe the following five safety rules:

1. Disconnect the VSI from the mains supply.
2. Secure the VSI against re-activation.
3. Establish that the VSI has no voltage.
4. Earth and short-circuit the power supply of the VSI.
5. Cover adjacent live parts or fence them off.

Electric shock

⚠ DANGER

Danger of electric shock due to high voltage

Live parts can cause severe injuries or even death.

- ➢ Lay electrical cables carefully. Make sure that electrical cables are not worn through vibrating parts or sharp edges.
- ➢ Check the perfect condition of the electric cables regularly. Detected errors must be eliminated immediately.

Maximum screw-in depth

NOTICE

When fastening the sensor of the VSI using the fastening thread, the maximum screw-in depth (10 mm) must be observed, otherwise the sensor can be damaged

3 Technical data

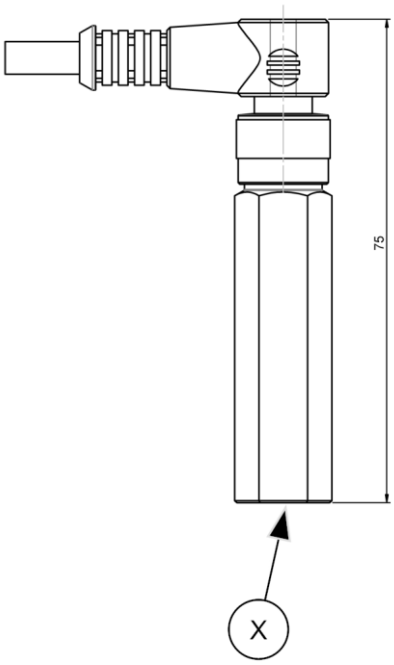
Permissible operating conditions

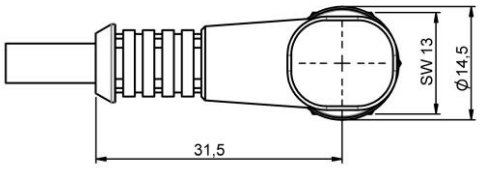
Controller (measuring unit)	
Series	Netter VSI
Operating voltage	24 V DC (+/- 10 %), residual ripple < 0,1 V
Ambient temperature	0 °C to 40 °C
Humidity	The relative humidity should not exceed 60%
Degree of protection	IP 20
Sensor with cable	
Ambient temperature	0 °C to 40 °C
Degree of protection	IP 65
Cable length between sensor and controller	max. 3 m (unscreened) max. 10 m (screened)
Shock acceleration	max. 10.000 g

Parameters controller

Parameters Controller	
Current output	8-pin connection terminal
Voltage output	8-pin connection terminal
Connection for sensor	4-pin connection terminal
Dimensions [mm]:	w: 114 / h: 76 / d: 31
Mounting	On mounting rail according to DIN EN 50022 (DIN EN 60715) or for direct wall mounting
Acceleration measurement	
Display: a_{rms}	Root mean square (RMS) displayed as a multiple of the acceleration due to gravity (1 g = 9,81 m/s²)
Measuring range	0 to 12 g (depending on the default setting)
Resolution (in the measuring range 35 Hz)	2 g: +/- 0,002 g / 4 g: +/- 0,004 g / 8 g: +/- 0,008 g / 12 g: +/- 0,0012 g
Frequency measurement	
Display: F	Hz
Measuring range	0 to 300 Hz (depending on the default setting)
Resolution	+/- 0,001 Hz

Dimensions sensor

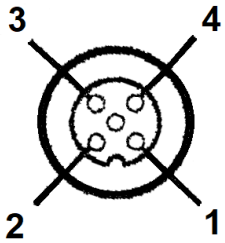
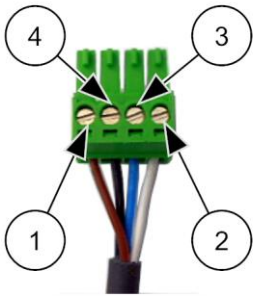




Parameters sensor

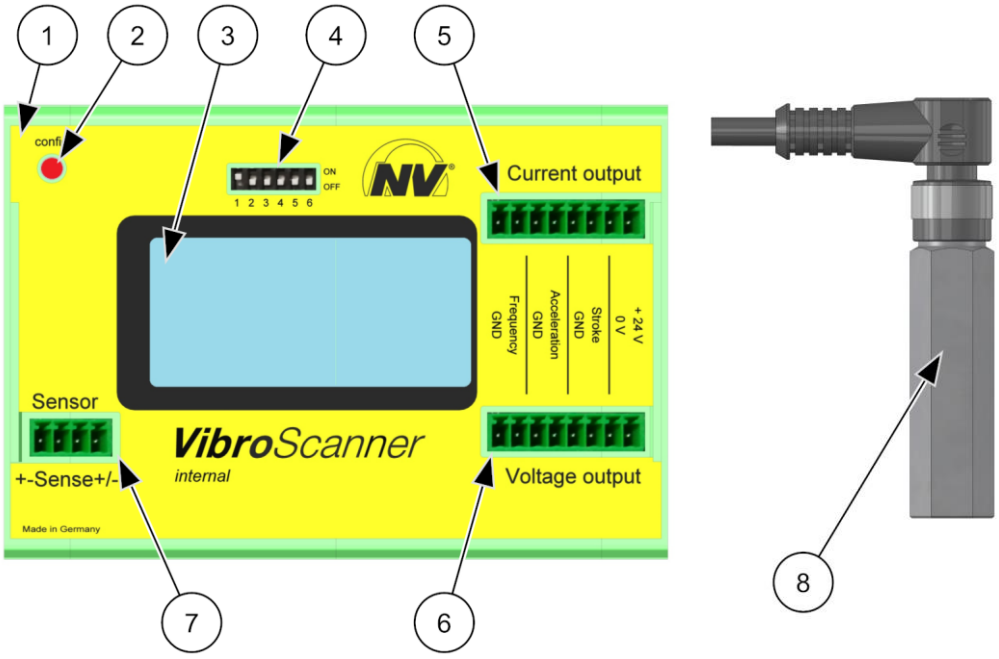
Parameters sensor	
Design type	MEMS-sensor
Connection	4-pin via round connector M12 x 1 (preferably with union screw and integrated screw lock)
Dimensions [mm]:	Ø 14,5 mm / SW13; height sensor with plug = 75 mm
X	Fastening thread M6 Maximum screw-in depth 10 mm

PIN assignment sensor cable

PIN assignment sensor cable	Connector VSI
	
1	brown
2	white
3	blue
4	black

4 Design and function

Design



No.	Element	Function
1	Controller/measuring unit	Contains the electronic components, the connections and the display.
2	Button: configuration	Setting the values shown on the display.
3	Display	Shows measured values.
4	DIP-switch	Configure controller.
5	Connection terminal: current output and power supply	Connect current output and power supply.
6	Connection terminal: Voltage output and power supply	Connect voltage output and power supply.
7	Connection terminal: sensor	Connect sensor with the controller.
8	Sensor with sensor cable	Acquires values for acceleration and frequency on vibration systems. Is connected to the controller via the sensor cable.

Function

The VSI consists of an acceleration sensor and a controller, via which both the voltage supply of the sensor and the signal evaluation takes place. The VSI are used to measure the acceleration, the dominant frequency and the vibration amplitude of mechanical vibration using a capacitive, micromechanical (MEMS) sensor.

The VSI enables continuous quantitative process control and can therefore contribute significantly to the long-term successful operation of a vibration system.

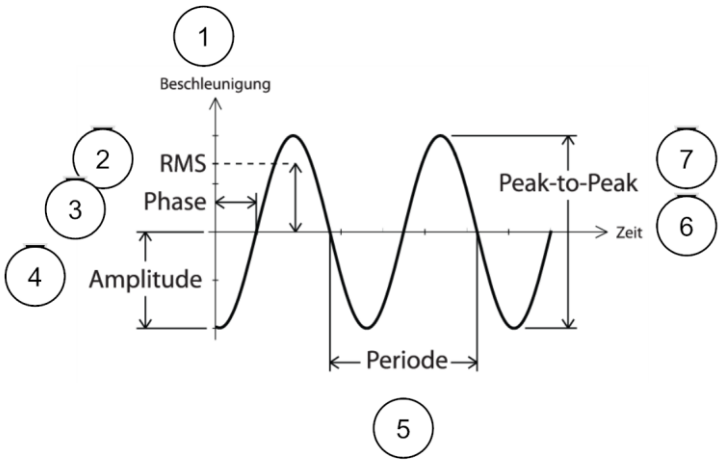
Basics of vibration measurement

A vibration is the periodic variation of a parameter (e. g. displacement of a plate) caused by the fact that a system is displaced from its stable equilibrium due to a disturbance and forced back towards its original state by a restoring force. A well-known example from everyday life is a pendulum which after displacement by an external force is drawn back into the equilibrium position by gravity.
A harmonic vibration, where displacement, velocity and acceleration in relation to time show the shape of a sinusoidal wave, represents an idealized special case. In this case only few parameters are needed to describe the shape of the vibration and mathematical principles can be derived very easily.
In practice, the acceleration in relation to time in vibration systems mostly deviates from this ideal sinusoidal wave; either because the vibration drive itself does not generate a harmonic vibration (e. g. special pneumatic linear vibrators) or because interfering factors like vibrating or hitting components or natural vibrations of an excited product overlay the excited vibration.

Harmonic vibrations

To describe a harmonic vibration, three parameters are needed: Frequency (unit of measurement: 1 Hz = 1/s), amplitude and phase. The frequency determines how many vibration cycles per second occur, the amplitude determines the maximum value of the vibration and the phase indicates in how far the zero position of the vibration is shifted in relation to the zero point on the time scale. The time required for one cycle of vibration (reciprocal of the frequency) is called period.

Figure: Acceleration of a harmonic (sinusoidal) vibration



1 Acceleration (y-axis)
2 RMS (Root Mean Square)
3 Phase
4 Amplitude
5 Period
6 Time (x-axis)
7 Peak-to-Peak value (vibration amplitude)

Peak-to-Peak value

As the zero position and thus the amplitude often are difficult to access for measuring purposes, sometimes the difference between maximum and minimum value, the so called peak-to-peak value, is indicated instead. The peak-to-peak value of the displacement is also called stroke.

Root Mean Square RMS

A further important parameter is the Root Mean Square (RMS) or effective value. The RMS value of a time-dependent parameter a (t) in a time interval T is defined as the root of the sum of the squared measured values which has been divided by the time interval before:

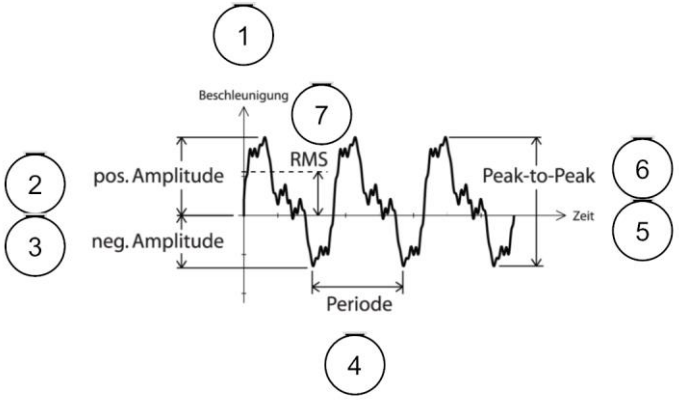
$$a_{RMS} = \sqrt{\frac{1}{T}\int_0^T a(t)^2 \cdot dt}$$

In case of a harmonic vibration the RMS is about 71% of the amplitude (exactly $1/\sqrt{2}$). The advantage as compared to amplitude or peak-to-peak value is that small variations of the minimum or maximum acceleration have only little effect on the RMS, as an average value is ascertained over a time interval instead of only considering peak values at a time. This is the reason why it is better suited to ascertain the actual effect a vibration is having on a machine part or product over a longer period of time.

Random vibrations

Random vibration wave forms can be described mathematically as superposition of several harmonic vibrations varying in frequency, amplitude and phase. The more complex and “sharp-edged“ the shape of a vibration is, the more harmonic vibration components are needed to describe it with sufficient accuracy. Usually random vibrations are characterized by means of the frequency spectrum which indicates the portion each harmonic vibration component with fixed frequency contributes to the overall vibration.

Figure: Acceleration of a non-sinusoidal periodic vibration



1 Acceleration (y-axis)
2 Positive amplitude
3 Negative amplitude
4 Period
5 Time (x-axis)
6 Peak-to-Peak value (vibration amplitude)
7 RMS (Root mean square)

Figure:
Spectrum of a sinusoidal vibration with a frequency of 10 Hz.

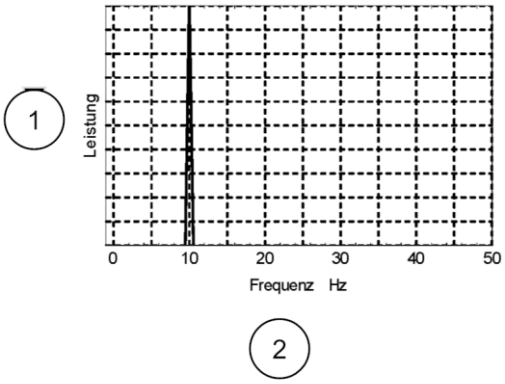
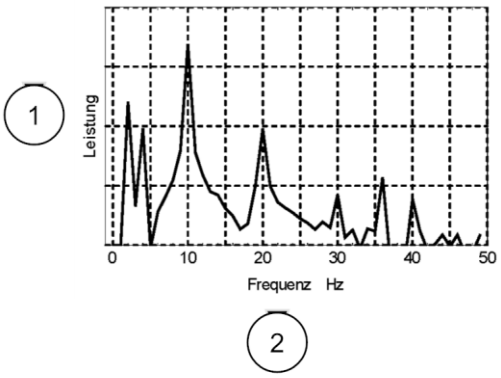


Figure:
Spectrum of a random vibration with a dominant frequency of 10 Hz



1 Power

2 Frequency (Hz)

Also for more complex types of vibration it is common use in vibration technology to indicate only one frequency which dominates the system to be measured. The relevant period is ascertained between two points of time in a row where the value of the oscillating quantity reaches its maximum (or minimum).

The VSI show the frequency which contributes at least 50% to the power of the overall vibration. Thus it is possible, for instance, to read out the exact value of the excitation frequency of a vibration drive without any affect on the measurement by low or high frequency interference.

5 Transport and storage

Transport conditions

Special conditions of transport are not required.

Packaging

The VSI are packed ready for installation.

The packaging protects the VSI from transport damage. The packaging material has been selected from an environmentally safe and technically disposable point of view and is therefore recyclable.

The return of packaging to the material cycle conserves raw materials and reduces the amount of waste.

Storage

- Store the VSI in a dry and clean environment.
- The permissible storage temperature is between 0 °C and +40 °C.
- The permissible relative humidity is max. 60 %.
- Do not store the VSI outdoors. The electrical components are not protected against corrosion.

6 Installation

Observe the safety instructions in Ch. Safety, from page 5 on.

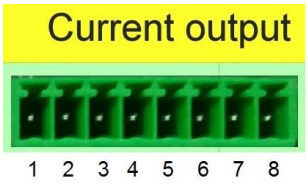
Mount the controller

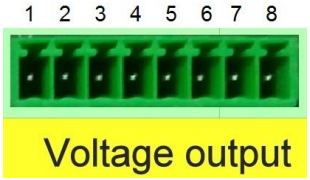
Mount the controller on a standard mounting rail in a suitable control cabinet (Degree of protection IP 65).

Connect the controller

Controller of the VSI requires an operating voltage of 24V DC.

Depending on the configuration of the DIP switches, the connection is made via the current outputs or voltage outputs.

Pin assignment of the current output		
	PIN 1: GND	Ground frequency
	PIN 2: Frequency	Frequency
	PIN 3: GND	Ground acceleration
	PIN 4: Acceleration	Acceleration
	PIN 5: GND	Ground stroke (vibration amplitude)
	PIN 6: Stroke	Stroke (vibration amplitude)
	PIN 7: 0 V	Ground power supply
	PIN 8: +24V	Power supply

Pin assignment of the voltage output		
	PIN 1: GND	Ground frequency
	PIN 2: Frequency	frequency
	PIN 3: GND	Ground acceleration
	PIN 4: Acceleration	Acceleration
	PIN 5: GND	Ground stroke (vibration amplitude)
	PIN 6: Stroke	Stroke (vibration amplitude)
	PIN 7: 0 V	Ground power supply
	PIN 8: +24V	Power supply

Mount the sensor

The sensors are attached directly to the vibrating application part via the fastening thread (M6, max. screw-in depth 10 mm) or with a plastic clamp bracket or a rubberized pipe clamp. Make sure that in case of linear vibrations the longitudinal axis of the sensor is to be aligned parallel to the direction of vibration.

Connect the sensor

Connect the sensor cable with the sensor. The plug is protected against polarity reversal. Tighten the union screw hand-tight. Do not use a tool.

Insert the plug of the sensor cable into the 4-pin connection terminal on the controller.

7 Start-up and operation

Observe the safety instructions in Ch. Safety, from page 5 on.

Permissible operating conditions

Please refer to Ch. Technical data, page 7 for permissible operating conditions.

Regulations

Installation work as well as operation of the system are to be carried out taking the valid accident prevention regulations into account.

The operator is responsible for the proper condition of the system.

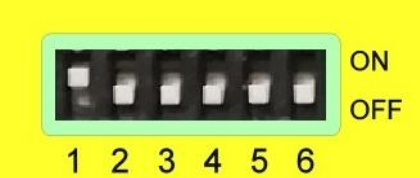
Measures

Carry out the following measures before start-up:

1. Check the mains voltage and the grid feed-in.
2. Check that the system is in perfect electrical condition.
3. Check that all protective measures on the system have been observed.
4. Check that the cables are undamaged and laid according to the known regulations and standards.
5. Eliminate possible errors.

Configure the controller

The VSI can be supplied with voltage via the two connection terminals. The connection of the power supply and the definition of measuring ranges depends on the configuration of the DIP switches on the controller.



Configuration of the DIP switches		
Switch 1	OFF = voltage outputs	ON = current outputs
Switch 2	OFF = measuring range vibration amplitude up to 49 mm	ON = measuring range vibration amplitude up to 99 mm
Switch 3 + 4 binary coded	Measuring range acceleration: 00 = 2 g 01 = 4 g 10 = 8 g 11 = 12 g	
Switch 5 + 6 binary coded	Measuring range frequency: 00 = 35 Hz 01 = 75 Hz 10 = 150 Hz 11 = 300 Hz	

Indications on the display

Indicated values / symbols	Description
F	Frequency [Hz]
	Harmonic (sinusoidal) vibration
	Non-harmonic (sinusoidal) vibration
a_{rms}	Acceleration RMS [g] (root mean square)
S_{pp}	Stroke (vibration amplitude) [mm] (peak to peak)

The indications on the display can be changed by pressing the "configuration" button. The preset values are displayed.

Indicated values	Description
Active Output I/V	Active output I or V
F	Set measuring range of the frequency [Hz]
a_{rms}	Set measuring range of the acceleration RMS [g]
S_{pp}	Set measuring range of the vibration amplitude [mm] (peak to peak)

8 Maintenance and servicing

Observe the safety instructions in Ch. Safety, from page 5 on.

Maintenance plan

Maintenance of the VSI must be carried out as follows:

Interval	Action
Monthly	Check cables.
Every 6 month	Check proper condition of connecting cables and plugs.
At least every 4 years	Check proper condition of electrical systems and stationary electrical equipment.

9 Troubleshooting

Observe the safety instructions in Ch. Safety, from page 5 on.

Expertise and regulations

Electrical faults may only be processed by a qualified electrician. Work on the VSI may only be carried out by authorised persons.

In the case of unauthorised intervention in the VSI there is no longer any warranty claim. Interventions of any kind are to be agreed upon with ***Netter****Vibration*.

Malfunctions and causes

In the case of malfunctions of the VSI proceed as follows:

Malfunction	Possible causes	Corrective action
The measured frequency changes continuously between two or more values which differ considerably (more than 10%) from each other.	The measured vibration is composed of two or more harmonic vibrations which contribute nearly equally to the overall vibration.	If only the lowest frequency of a system with several excitation/resonance frequencies is to be measured, a mechanical dampening (e. g. a rubber pad placed below the sensor) can be used in order to hide higher frequencies during the measurement (mechanical low pass filter).
	The sensor is not firmly fixed to the system to be measured or detaches repeatedly from the measuring surface during the measurement.	Fasten the sensor correctly. The sensor must be firmly attached to the measuring surface.
The measured stroke differs distinctively from a reference value which has been ascertained through a different measuring method.	The vibration deviates considerably from a sinusoidal wave.	The measurement of the vibration amplitude will only be reliable if the measured acceleration is sinusoidal.
	The sensor is not aligned parallel to the vibration direction.	The longitudinal axis of the sensor must be aligned parallel to the vibration direction or radially in case of circular vibrations.
The acceleration displayed is always zero, although the sensor is attached to a vibrating system.	The sensor is aligned at a 90-degree angle to the vibration direction.	The longitudinal axis of the sensor must be aligned parallel to the vibration direction or radially in case of circular vibrations.
	The sensor is defective or the measuring unit is defective.	Send the measuring unit (controller) including sensor and connecting cable to ***Netter****Vibration* for checking and repair.

10 Spare parts and accessories

Ordering of spare parts

Please provide the following details when ordering spare parts:

- required amount
- description and position of spare part
- type of VSI

Spare part list

A list of the parts used can be found in the spare part list of the VSI.

Requirements for exchange

Spare parts of the VSI and of the electrical installation must be installed by an authorised electrician. This specialist must be familiar with the protective measures.

Defective parts must be replaced by parts of the same type. If you need to replace components of the VSI, then contact ***Netter****Vibration*.

Prices

All parts of the VSI must be properly disposed of according to the material specifications. The valid disposal prices of the VSI are available on request.