



VIBRATION AND TEMPERATURE SENSOR VTS-3D-M

by PassatInnovations LLC

The vibration and temperature sensor with digital signal processing is designed to monitor the vibration and temperature characteristics of industrial equipment. The sensor can be used both as part of distributed systems for monitoring the state of machines and mechanisms and as an autonomous means of emergency protection.



The vibration and temperature sensor VTS-3D provides:

- measurement and processing of vibration characteristics along **three axes**:
 - RMS vibration acceleration,
 - RMS vibration velocity,
 - RMS vibration displacement,
 - peak-to-peak,
 - peak-factor,
 - frequency with maximum amplitude on spectrum.
- indication of the temperature of the surface on which it is installed;
- measurement of one-third-octave vibration spectra up to 10 kHz;
- the ability to set up custom filters to set the frequency boundaries, select the axis and the controlled parameter;
- raw data transmission (optional).

Digital data interface:

- the industrial RS485 interface allows the sensor to be connected at a distance of up to 1 km;
- when using standard converters of interfaces, local networks, wireless networks and the Internet, the removal of the sensor may not be limited.

Sensor application:

- use of the sensor in a system of minimum configuration using a local connection to a computer via interface converter RS485/USB and free service software;
- connection to existing process control systems (SCADA);
- creation of a distributed, including territorial, (including remote production facilities) system for centralized monitoring of the state of machines and mechanisms.

MODIFICATIONS

Vibration and temperature sensor VTS-3D-M	Digital communication option	
	-	- standard design
R	- transmission of a raw data	

It is possible to organize data transmission via Modbus TCP and ProfiBus

MAIN FEATURES AND DESIGN REQUIREMENTS

№	Parameters and characteristics	Value
1	Supply voltage, V	9 – 36 V
2	Source of power: – power supply type – power isolation – impulse noise protection	DC/DC uninsulated yes
3	Power consumption, no more, W	0.25
4	Sensing element type (SE)	MEMS
5	Number of axes SE	3
6	Measuring range of linear acceleration SE, g ¹⁾	±16



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№	Parameters and characteristics	Value
7	Frequency band ²⁾ SE for vibration acceleration measurements, not worse, Hz	5000
8	Measurement of integral characteristics of vibration in frequency bands ³⁾ , Hz: RMS vibration acceleration RMS vibration velocity RMS vibration displacement	10 – 3000 10 – 1000 10 – 200
9	Measurement range of integral vibration characteristics ⁴⁾ RMS vibration acceleration, m/s ² RMS vibration velocity, mm/s RMS vibration displacement, µm	0 – 111 0 – 222 0 – 441
10	Relative errors in measuring the integral characteristics of vibration (normalized to the actual value), under normal conditions (23 ± 2 °C), not worse, % RMS vibration acceleration RMS vibration velocity RMS vibration displacement	±6.0 ±10.0 ±15.0
11	Additional relative error in case of deviation from normal measurement conditions by 1°C, %, no more	0,02
12	Communication interfaces: – type – maximum transmission rate, bit/s – galvanic isolation – built-in terminal resistor – protection against impulse noise	RS485 115200 no no yes
13	Data transfer protocol	Modbus RTU
14	Data processing cycle time, no more, s	1
15	Number of temperature sensors	1
16	Temperature measuring range, °C	from minus 40 to plus 80
17	Overall dimensions, WxHxD, mm	30x22x30
18	Sensor mount	stud, magnet
19	Connection: - type - number of wire cores - length ⁵⁾ , m - wire termination ⁶⁾	flexible shielded cable 5 2 no
20	The degree of protection against dust and moisture, not worse	IP68
21	Operating conditions: - ambient temperature, °C - relative humidity at 30 °C,%	from minus 40 to plus 80 100
22	Casing design ⁷⁾	general purpose industrial version
23	Casing material	stainless steel
24	Weight, no more, kg	0.15
25	Service life, years, not less	10
26	Mean time between failures at 25 °C, h, not less	93 000

Remarks:

¹⁾ Free fall acceleration is taken equal to $g = 9.81 \text{ m/s}^2$.

²⁾ The frequency bands are given at -3dB, which corresponds to a conversion factor of 0.707 of the nominal value at a calibration frequency of 80 Hz.

³⁾ According to ISO 2954-2014.

⁴⁾ Based on harmonic vibration at 80 Hz calibration frequency.

⁵⁾ This parameter is given for the basic configuration by default, unless otherwise agreed by the Customer and can be specified when ordering.

⁶⁾ Other termination options may be provided upon agreement with the Customer.

⁷⁾ Other versions are possible upon agreement with the Customer.


Typical application:

- using the sensor in a system of minimal configuration using a local connection to a computer via an RS485 / USB interface converter and software of the delivery set;
- connection to existing process control systems (SCADA);
- creation of a distributed, including territorial, (including remote production facilities) system of centralized monitoring of the state of machines and mechanisms.


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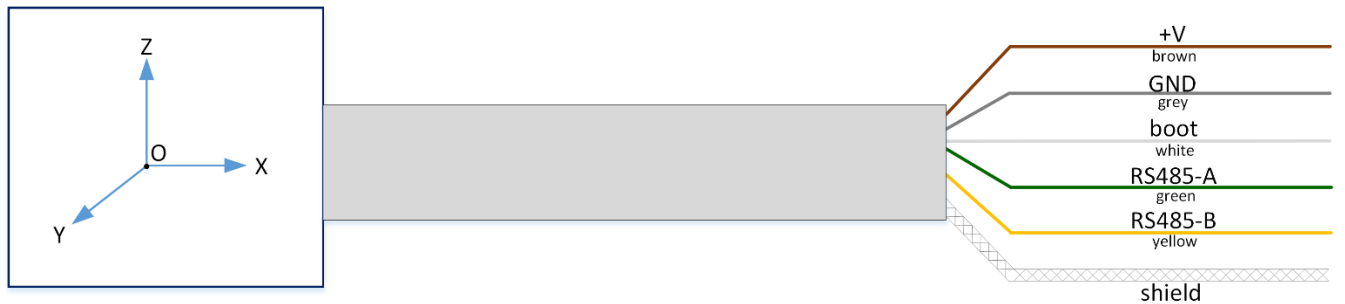

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SENSOR CONNECTIONS

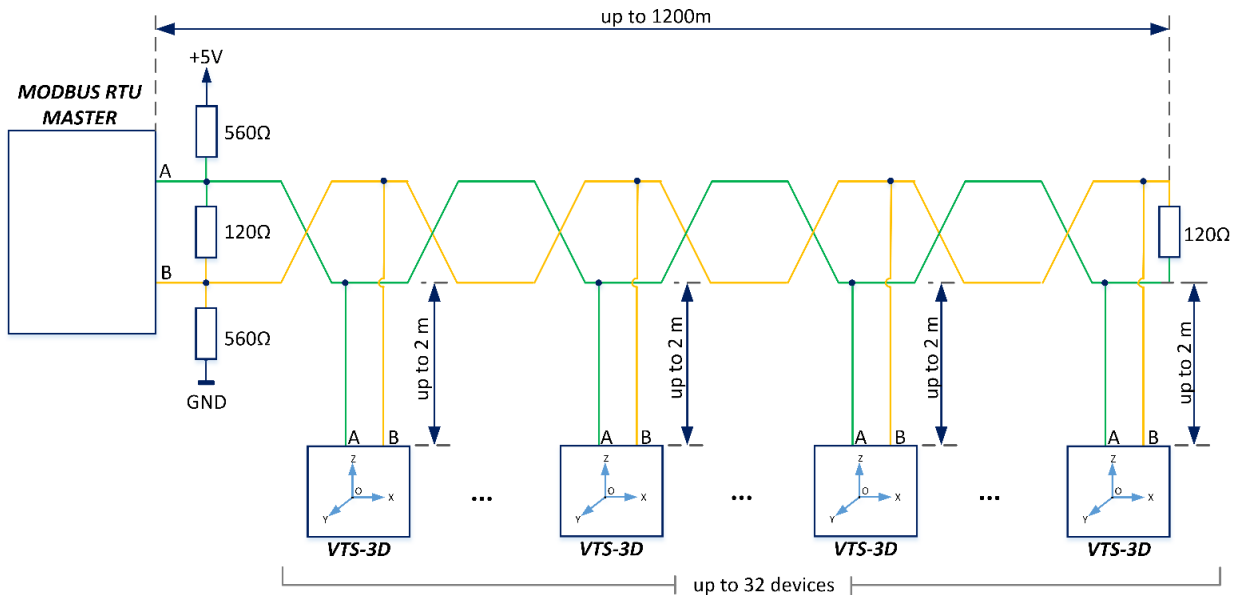


No	Circuit	Colour of the wire	Description
1	+V	brown	«+» power supply 9-36V
2	GND	grey	general
3	RS485-A	green	line A of an interface RS485
4	RS485-B	yellow	line B of an interface RS485
5	boot	white	activating firmware bootloader mode ¹⁾
6	shield	-	cable shield

Remarks:

¹⁾ Leave not connected, to activate the bootloader mode, close to GND and carry out a cold or hot restart.

- To improve the noise immunity of the transmission line, it is recommended to shield the cable by connecting the shield to signal ground.



RELATED DEVICES



USB-RS485 VTS-QC Converter


The VTS-QC converter is a USB (virtual COM) to RS485 serial interface converter with a 12V supply voltage.

Designed to connect the VTS-3D-M vibration and temperature sensor and other devices operating via a two-wire RS485 interface to a computer.


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REGISTERS MAP

Address	Mnemonic notation	Number format	Value	Access ³⁾
40001	MB_REG_STATUS	UINT16	bit 0 - initialization error flag	RO
			bit 1 - sensor malfunction flag	
			bit 2 - memory chip failure flag	
			bit 3 - access to registers allowed (service mode)	
			bit 4 - acceleration out of bounds flag (X-axis)	
			bit 5 - acceleration out of bounds flag (Y-axis)	
			bit 6 - acceleration out of bounds flag (Z-axis)	
			bit 7 - lower temperature sensor malfunction flag	
			bit 8 - upper temperature sensor malfunction flag	
			bit 9 - temperature sensor initialization error flag	
			bit 10..bit15 – reserved	
40002	MB_REG_DEVICE_CODE	UINT16	Device code	RO
40003	MB_REG_DEVICE_ID	UINT16	Device ID	RO
40004	MB_REG_SW_VER	UINT16	Sensor software version	RO
40005	MB_REG_SW_BUILD	UINT16	Software build number	RO
40006	MB_REG_TEMPERATURE_BOTTOM	INT16	Temperature from the sensor 1 (bottom)	RO
40008	MB_REG_ACC_TEMPERATURE	INT16	Temperature from the acceleration sensor	RO
40009	MB_REG_DEVICE_RANGE	UINT16	Current measuring range (2g, 4g, 8g ...) ¹⁾	RO
40010	MB_REG_SAMPLE_FREQ	UINT16	Current measured sampling rate	RO
40011	MB_REG_DATA_UPDATE_COUNTER	UINT16	Data update counter in registers ²⁾	RO
40012	MB_REG_ACCELERATION_RMS_X_LO	FLOAT ⁴⁾	Acceleration RMS x-axis, m/s ²	RO
40013	MB_REG_ACCELERATION_RMS_X_HI			
40014	MB_REG_ACCELERATION_RMS_Y_LO	FLOAT ⁴⁾	Acceleration RMS y-axis, m/s ²	RO
40015	MB_REG_ACCELERATION_RMS_Y_HI			
40016	MB_REG_ACCELERATION_RMS_Z_LO	FLOAT ⁴⁾	Acceleration RMS z-axis, m/s ²	RO
40017	MB_REG_ACCELERATION_RMS_Z_HI			
40018	MB_REG_VELOCITY_RMS_X_LO	FLOAT ⁴⁾	Velocity RMS x-axis, mm/s	RO
40019	MB_REG_VELOCITY_RMS_X_HI			
40020	MB_REG_VELOCITY_RMS_Y_LO	FLOAT ⁴⁾	Velocity RMS y-axis, mm/s	RO
40021	MB_REG_VELOCITY_RMS_Y_HI			
40022	MB_REG_VELOCITY_RMS_Z_LO	FLOAT ⁴⁾	Velocity RMS z-axis, mm/s	RO
40023	MB_REG_VELOCITY_RMS_Z_HI			
40024	MB_REG_DISPLACEMENT_RMS_X_LO	FLOAT ⁴⁾	Displacement RMS x-axis, μm	RO
40025	MB_REG_DISPLACEMENT_RMS_X_HI			
40026	MB_REG_DISPLACEMENT_RMS_Y_LO	FLOAT ⁴⁾	Displacement RMS y-axis, μm	RO
40027	MB_REG_DISPLACEMENT_RMS_Y_HI			
40028	MB_REG_DISPLACEMENT_RMS_Z_LO	FLOAT ⁴⁾	Displacement RMS z-axis, μm	RO
40029	MB_REG_DISPLACEMENT_RMS_Z_HI			
40030	MB_REG_PEAK_TO_PEAK_X_LO	FLOAT ⁴⁾	Peak-to-peak X-axis	RO
40031	MB_REG_PEAK_TO_PEAK_X_HI			
40032	MB_REG_PEAK_TO_PEAK_Y_LO	FLOAT ⁴⁾	Peak-to-peak Y-axis	RO
40033	MB_REG_PEAK_TO_PEAK_Y_HI			
40034	MB_REG_PEAK_TO_PEAK_Z_LO	FLOAT ⁴⁾	Peak-to-peak Z-axis	RO
40035	MB_REG_PEAK_TO_PEAK_Z_HI			
40036	MB_REG_PEAK_FACTOR_X_LO	FLOAT ⁴⁾	X-axis peak factor	RO
40037	MB_REG_PEAK_FACTOR_X_HI			
40038	MB_REG_PEAK_FACTOR_Y_LO	FLOAT ⁴⁾	Y-axis peak factor	RO
40039	MB_REG_PEAK_FACTOR_Y_HI			
40040	MB_REG_PEAK_FACTOR_Z_LO	FLOAT ⁴⁾	Z-axis peak factor	RO
40041	MB_REG_PEAK_FACTOR_Z_HI			
40045	MB_REG_MAX_AMPLITUDE_FREQUENCY_X	UINT16	Frequency with max amplitude on spectrum (X-axis)	RO
40046	MB_REG_MAX_AMPLITUDE_FREQUENCY_Y	UINT16	Frequency with max amplitude on spectrum (Y-axis)	RO
40047	MB_REG_MAX_AMPLITUDE_FREQUENCY_Z	UINT16	Frequency with max amplitude on spectrum (Z-axis)	RO
40201 - 40276			One-third-octave and custom filter registers (see Application Note VTS-3D)	RO
40277 - 40289			Registers with current filter configuration (see Application Note VTS-3D)	RO

Remarks:

¹⁾ Default - 16g, 0 – corresponds to 2g, 1- corresponds to 16g, 2 - corresponds to 4g, 3 - corresponds to 8g

²⁾ The data refresh counter is used as an alternative to the timestamp to indicate the correct operation of the device, it is incremented with each successful data capture.

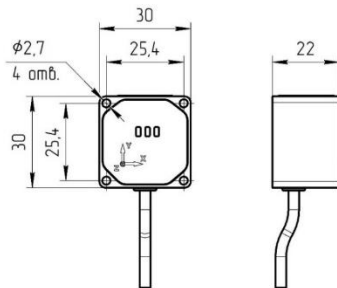
³⁾ RO – read only.

⁴⁾ IEEE 754 Standard Floating Point Number. Default byte order – ABCD. Available upon request: CD AB, BA DC, DC BA.

DESCRIPTION OF LED INDICATION

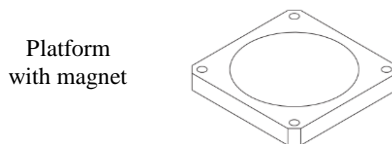
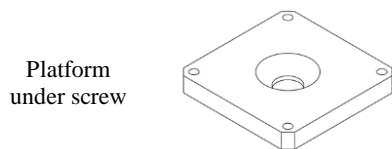
Firmware status	LED State			Description	Action instruction
	Red-Green (Heartbeat)	Yellow (RX)	Blue (TX)		
Start-up	Flashes red for ~ 1s, then flashes green	–	–	Start-up on power-up	Not required
Malfunction	Not lights up	–	–	There is no power supply to the sensor or the sensor is faulty	Check sensor connection
	Blinking red slowly (frequency ~ 1 Hz)	–	–	Power is on, firmware does not start	The sensor is defective. Contact technical support
	Lights up red continuously	–	–	Reset signal activated, firmware does not start	Check the supply voltage, if it is normal, then the sensor is faulty. Contact technical support
Bootloader mode	Blinking green slowly (frequency <10Hz, ~ 4Hz)	–	–	Bootloader mode activated	Install firmware and / or reboot sensor to exit bootloader, check brown wire.
Normal mode	Blinking green quickly (frequency > 10 Hz)	Not lights up	Not lights up	Reception and transmission of data via Modbus RTU is not carried out	Check the connection of the RS485 interface
	--/--	Blink	Not lights up	Receiving requests via Modbus RTU	Check connection of lines A, B and Modbus RTU settings (address, speed, parity)
	--/--	Blink	Blink	Receiving and transmitting data via Modbus RTU	Not required
	--/--	Lights up constantly	Not lights up	Incorrect connection, communication line failure	Check the communication line, the polarity of the A and B lines may be reversed

SENSOR DIMENSIONS



Dimensions are in mm.

SENSOR MOUNTING



Each sensor is supplied with:

- mounting platform for the screw (1 pc.);
- screw for fastening the platform (M6×14 - 1 pc.);
- screws for attaching the sensor to the platform (M2,5×22 - 4 pcs.);
- washer (2,7 - 4 pcs.).

Mounting pad size (L × W × H): 30 × 30 × 4mm.


At the request of the Customer, it is possible to complete the mounting platform with a magnet.

The installation points of the vibration sensor are selected based on the requirements of the relevant standards for a given class of machines and technological equipment. The general requirements for the installation site of the sensor are set out in GOST ISO 10816-1-97, clause 4.2.

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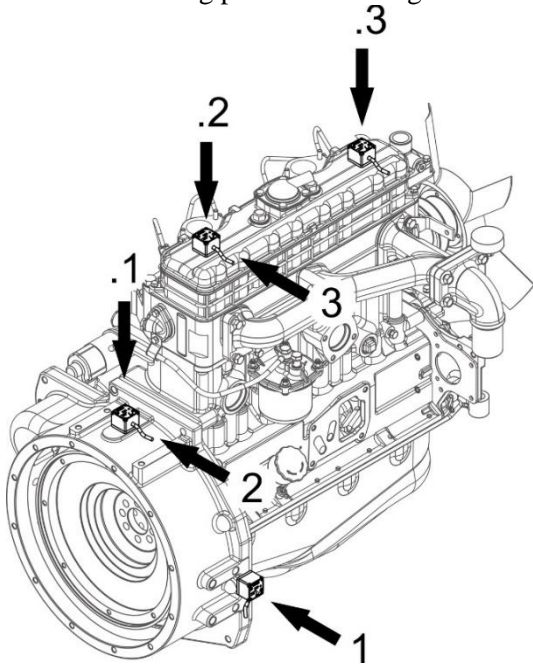
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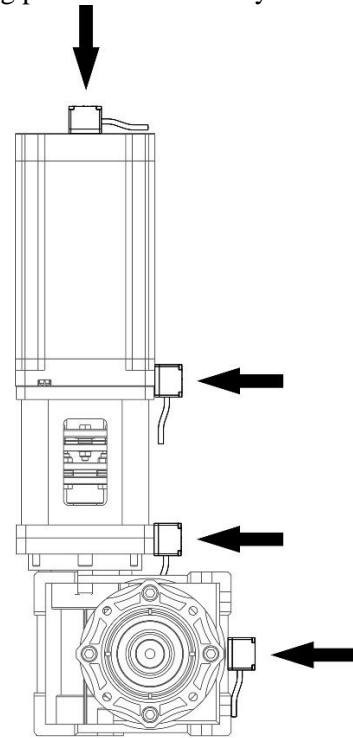
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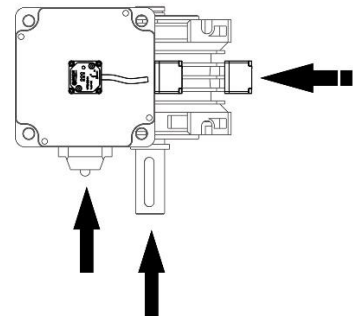
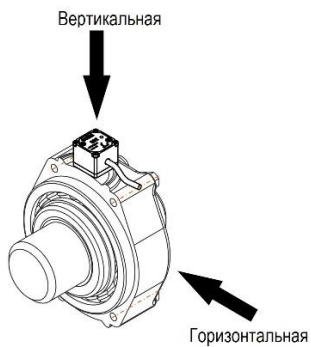
Measuring points on the engine



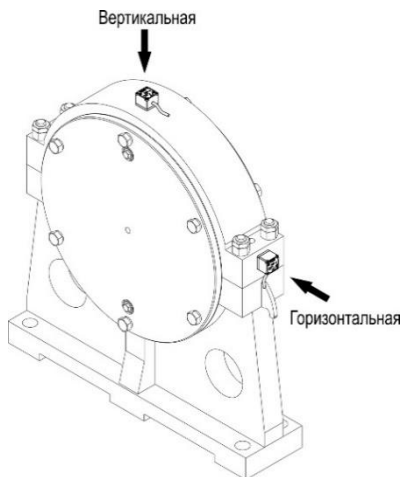
Measuring points on a vertically mounted machine



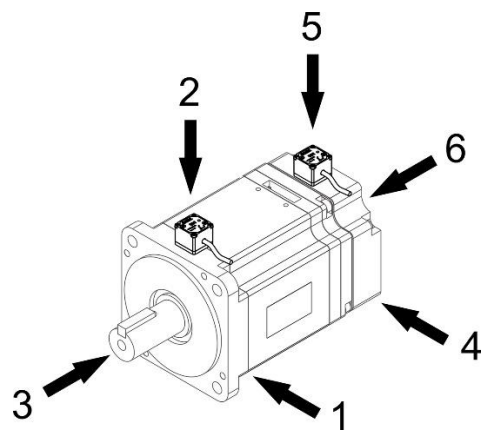
Measuring points on the bearing housing



Measuring points on the bearing pedestal



Measuring points on small electrical machines





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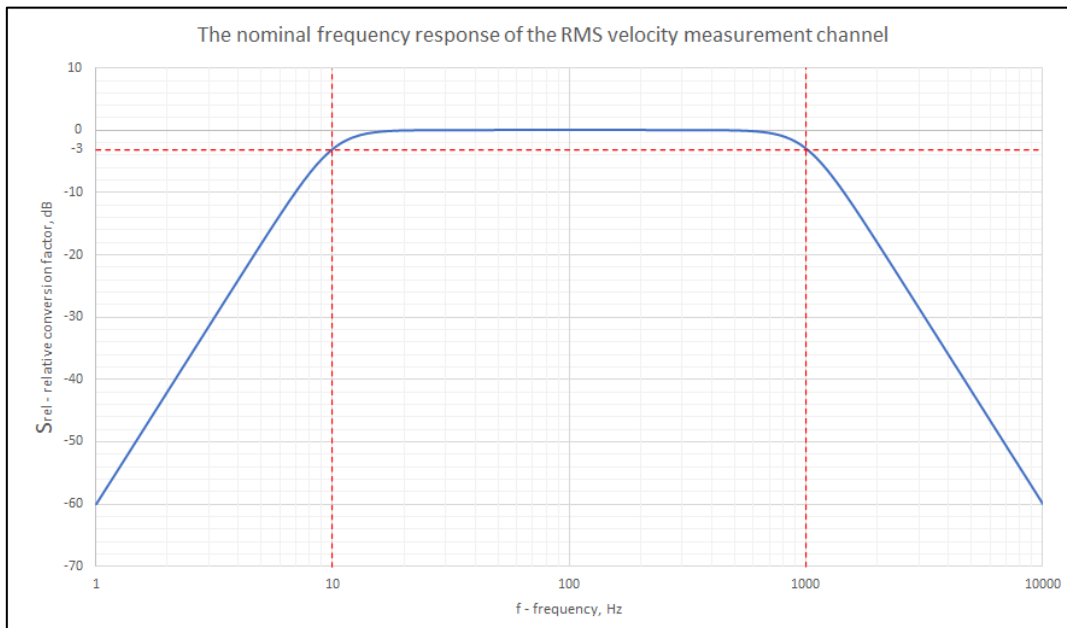
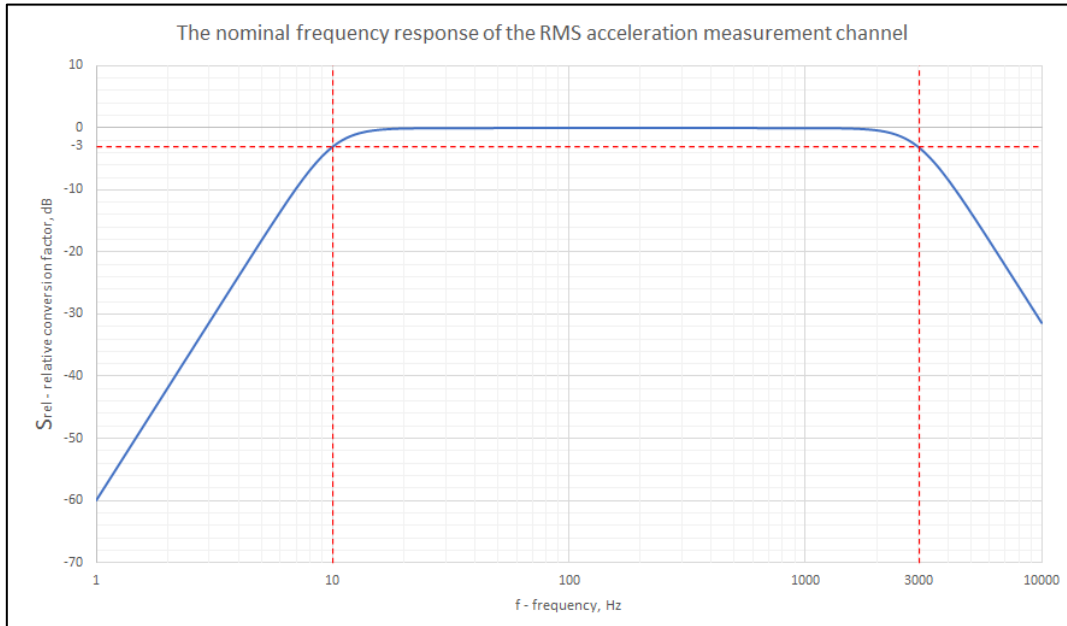
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FREQUENCY CHARACTERISTICS


The digital signal processing algorithm applies frequency filters to the measurement results obtained from the sensitive element, the frequency response of these filters fully complies with the ISO 2954-2014 standard.



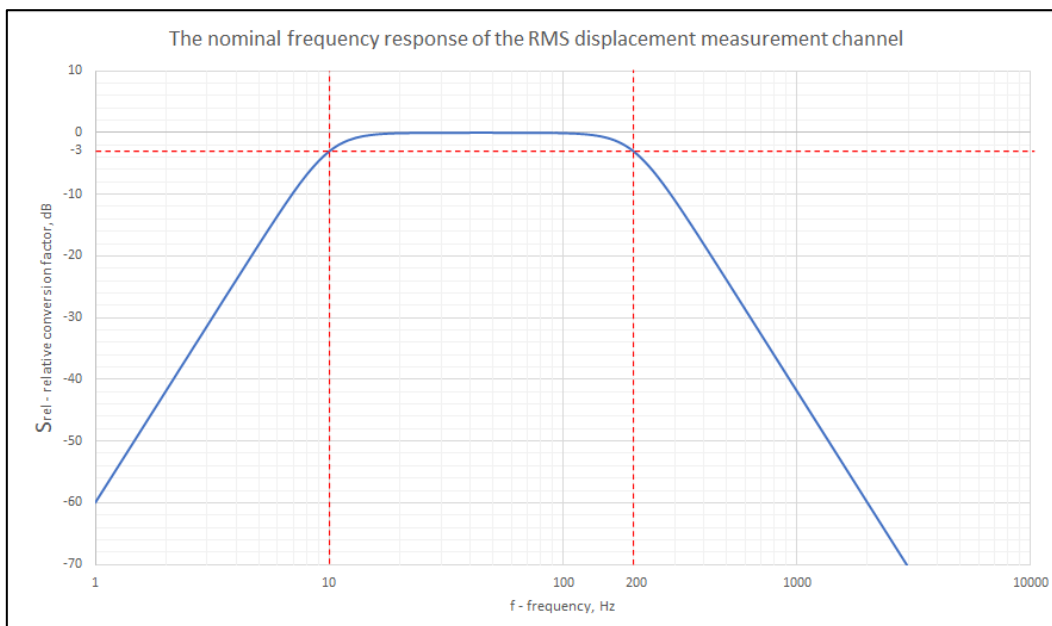

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REVISION HISTORY


Date	Version	Changes
23-Jun-2021	1.0	First public version
11-Aug-2021	2.0	Changed sensor photo
20-Aug-2021	3.0	The registers map has been corrected. Added information about connecting multiple sensors. Made minor changes in the technical description
08-Sep-2021	4.0	Added information about modifications
27-Sep-2021	4.1	Made changes in the technical description
06-Oct-2021	4.2	Replaced data cable
10-Nov-2021	4.3	Added information on additional relative measurement error, service life, mean time between failures. Changed sensor photo
19-Nov-2021	4.4	Changes have been made to the description and connection of the sensor.
23-Dec-2021	4.5	Added information on sensor mounting, changes have been made to the table of sensor technical characteristics, frequency response has been added.
22-Feb-2022	4.6	Changed data processing cycle time. Changes have been made to the cable pinout scheme. Added information to the registers map.
11-Apr-2022	4.7	Added information about possible places for installing the sensor on the object under study. Changes have been made to the table of technical characteristics, the map of registers
26-May-2022	4.8	Added related devices
15-Jul-2022	4.9	Revised main technical specifications and map of registers
16-Nov-2022	4.10	Revised registers map
20-Dec-2022	4.11	Made changes in the technical description

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