amc VIBRO

WIRELESS VIBRATION SENSOR AVS 2000R

USER MANUAL

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1. Introduction

In order to ensure quick and proper installation and commissioning of the system described in this manual, user absolutely must read and comply with the recommendations contained therein.

1.1. Copyright

Due to the continuous development of AVS 2000R devices, AMC VIBRO Sp. z o.o. reserves the right to modify this manual.

1.2. Configuration and handling

Installation, commissioning and operation should be entrusted to a person skilled in matters of electronics, industrial automation and measuring technology or specially trained for this purpose. The manufacturer is not liable for any damage to the AVS equipment as a result of improper use, non-use instructions described in this manual or maintenance and operation by unauthorized persons.

1.3. Symbols

NOTE!

Information marked with this sign are of particular importance to the safety of the system.

1.4. Important recommendations

System components are not resistant to aggressive cleaning agents, aerosols, alcohols and solvents. If necessary, dust can be removed with a dry brush, and larger dirt with a damp cloth.

2. AV SENSOR family

2.1. System description

The **AV SENSOR** is a wireless sensor system specially designed for measuring vibrations in industrial conditions. The entire system is configured and monitored by AVM GATEWAY device. Through the protocols implemented on the GATEWAY it is possible to connect the system with existing infrastructure. The AVS 2000R module is used to measure temperature and vibration in two axes. Moreover, it process parameters and calculate estimates.

AVM GATEWAY is responsible for coordinating the wireless network created by the AVS modules. The main task of AVM GATEWAY is to manage the sensor network and collect the data from the devices.

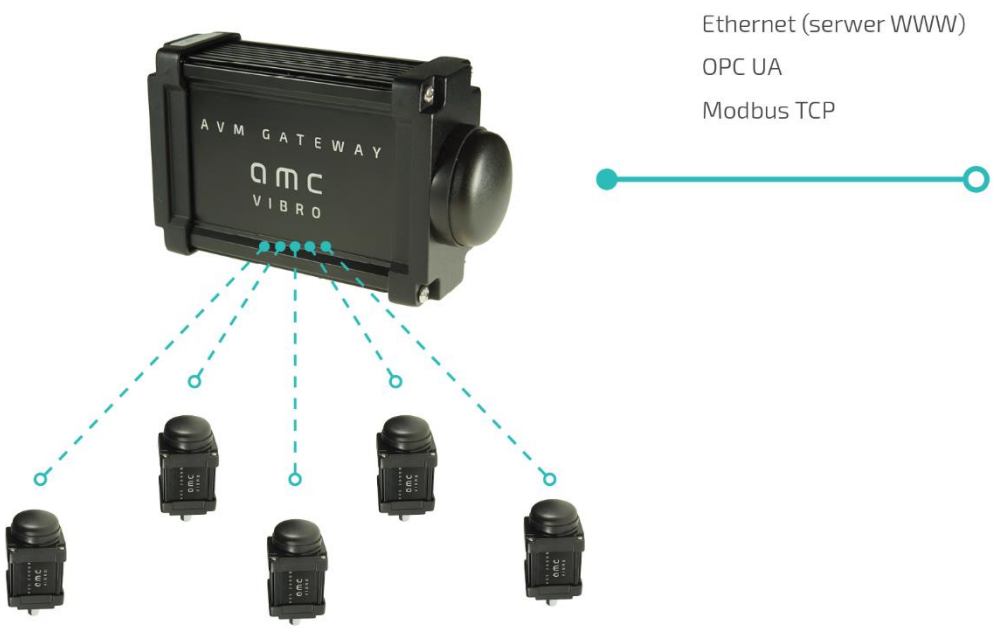


Figure 1. The AV SENSOR system architecture

GATEWAY has an OPC UA and Modbus TCP communication protocol for integration with supervisory system. The module has implemented website where the user can configure the system, view and download gathered data.

When the above devices work together they form the AV SENSOR system. The wireless technology spares the hassle of wire routing to the machine, the costs of laying cable routes and unforeseen repairs.

The main advantages of the system are simple and quick assembly / disassembly and scalability. The AV SENSOR wireless diagnostic system provides the user with early detection of a malfunction, thereby avoiding unpredictable stops and losses.

2.2. Devices

- **AVS 2000R** – Vibration sensor
- **AVM GATEWAY** – GATEWAY module

3. Operation of AVS 2000R device

Figure 2. AVS 2000R

3.1. Method of operation

AVS 2000R is a wireless dual-channel fully configurable unit for continuous monitoring and machine diagnostics. The module allows you to send information about the status of the machines via the radio network to the system where they are processed further. The AV SENSOR modules work in ISM 868 MHz band. Measurement data are collected periodically according to the configured interval. During the transmission with the GATEWAY the Vibration sensor LED blinks approximately once per second. In case of communication measurement problems data is stored in the internal memory of the device and transmitted at the time of re-connection so the continuity of measurement is maintained. The device can report alert states and adapt their own operating mode to them. The module performs warning or alarm function for each of the channel by setting thresholds for each measured estimate. This way the module can provide the monitoring function.

3.2. Technical specification of AVS 2000R

Table 1. Technical parameters of the AVS 2000R

Parameter	Description
Axes	2
Sensing element	Piezo-ceramic sensor
Measurement range	±20 g Peak
Frequency response	1 – 10 000 Hz for x and y axis (3 dB response)
Transverse sensitivity	0.05
Temperature measurement range	-40°C to 85°C
Sampling frequency	40 kHz
Sampling resolution	16 bit
Number of points - time waveform	4000 samples
Maximal recording duration	1000 ms with minimum 5 minutes interval
Acquisition modes	Periodic, warning-based, alarm-based
Vibration limit/ Shock limit	5000 g Peak
Hazardous environment	non
Operating temperature	From -40°C to 85°C
Network standard	Star / Mesh topology
Radio standard	ISM 868 MHz (Europe) / 915 MHz (USA)
Wireless range	Up to 150 meters in a typical industrial conditions
Battery	7.2 V, 2 x AA-cell lithium-thionyl chloride ($Li\text{-}SOCl_2$)
Battery lifetime	Up to 8 years 6400 measurements (2x per day)
Dimensions	65 x 140 x 65 mm
Weight	530 g
IP rating	IP65
Built-in analysis	Measured value is vibration acceleration. Calculated estimates: • RMS & 0-Peak vibration acceleration [m/s^2] • Acceleration kurtosis [-] • Acceleration envelope RMS and Peak-Peak [m/s^2] • RMS & 0-Peak vibration velocity [mm/s] • ISO RMS velocity [mm/s] • Analysis in 8 defined bands (BEC) acceleration or velocity

Parameter	Description
Internal data buffer	Flash memory 8096 measurement packets
Calibration	Acceleration – sensor signal, temperature, battery level

3.3. Calculated estimates

The method of measuring the vibration acceleration signal is based on collecting samples by a 16-bit ADC converter with a sampling rate of 40 kSps with 1 second data buffer. The vibration measurement range is up to ± 20 g. The calculated estimates are:

- acceleration 0-Peak and RMS
- velocity 0-Peak and RMS
- acceleration Kurtosis
- envelope of acceleration Peak-Peak and RMS
- velocity 0-Peak and RMS and RMS according to ISO 10816
- RMS value of acceleration or velocity in eight defined bands (BEC)

For permanent storage of data the device has a flash memory and it can store the results of up to 8096 measurement cycles in it.

3.4. Work modes

Basically, we can distinguish two modes: active and inactive - storage mode. In storage mode, the device is turned off. The active mode can be divided into:

- normal operation mode
- operating mode in the warning state
- operation mode in the alarm state

To set the device in the storage mode, you can hold the magnet in the same place as in the figure 3 for about 5 seconds until the LED light starts to blink quickly. Then just put the magnet away. Then LED light will stop blinking and the device will be in storage mode. The second way to change active state is unchecking the *active* field on the configuring website (figure 4). To exit the storage mode, an operator must hold the magnet for a second in the same place as before (figure 3) until the LED lights up.

Figure 3. Wake up the vibration sensor

In active mode you can choose the interval in which the sensor will wake up. For example, with a selected interval of 2 hours, the Vibration sensor will wake up every day at 0 a.m., 2 a.m., 4 a.m. and so on (UTC time zone). This applies to field *General Configuration* area in *Configuration* website tab.

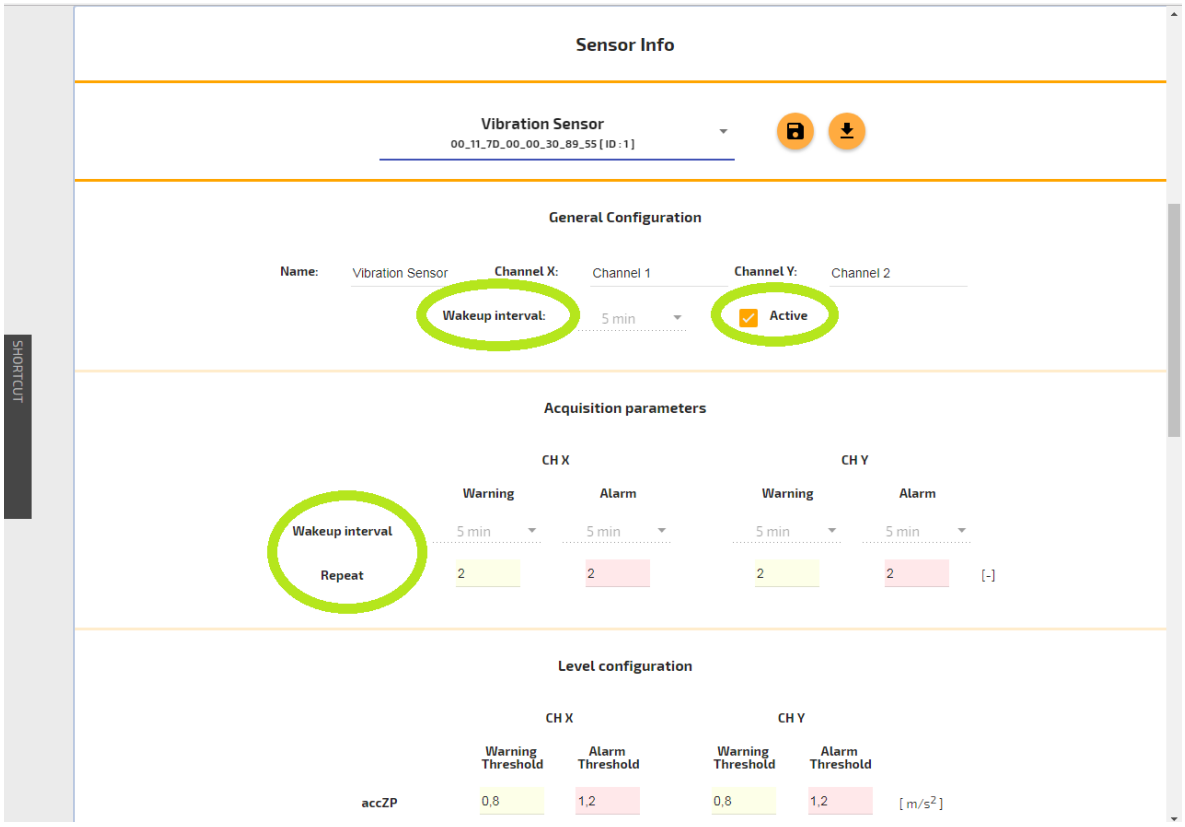


Figure 4. Active state and wake-up intervals

Only when the alarm or warning threshold is detected number of times specified by the *repeat* parameter such data is noted and reported. This is made to avoid triggering accidental alerts. Similarly, in order to remove the alarm / warning status, the value of a source of the alert must not exceed the threshold for the number of times specified in the *repeat* field. This applies to field *Acquisition parameters* area in *Configuration* website tab. For example, an alarm will be reported at the *Repeat* parameter equal to 2 during the third threshold violation (1 occurrence + 2 repetitions).

4. Operation of AVM GATEWAY

Figure 5. AVM GATEWAY

4.1. Method of operation

AVM GATEWAY is the coordinator of wireless sensor network. It is used for configuration or collecting measurements and reports from all sensors. It also stores all data in non-volatile memory and presents them to users via web interface. Module can be integrated with other system via Ethernet, Modbus TCP and OPC UA protocol. The alarms and warnings are reported through the GATEWAY device.

4.2. Technical specification

Table 2. Technical parameters of the AVM GATEWAY

Parameter	Description
Power supply	24 VDC (range 12-36 VDC 4 W, peak power on max 24 W)
Size	106 x 187 x 56 mm
Weight	735 g
IP rating	IP65
Temperature range	From -25°C to +85 °C
Ethernet channel	M8 4-pin connector RJ45 for 10/100 Base-T Ethernet
IT and networks	TCP/IP (HTTP, OPC UA, Modbus TCP)
Maximal number of transmitters	Up to 32 pcs. AVS 2000R SENSOR
Radio	ISM 868 MHz (Europe) / 915 MHz (USA)
SENSOR network configuration	GATEWAY Website

5. Mechanical installation

This section presents the dimensions and method of mechanical installation of the AVS 2000R and the AVM GATEWAY modules.

5.1. AVS 2000R housing

1. Choose a mounting position on the machine housing.
    a. Choose what type of mount you should use. Refer to the machine warranty information.
    b. Provide enough space to install the sensor.
    c. Define a place for optimal radio frequency connectivity.
2. Prepare the mounting position.
    a. Prepare a clean surface. Use a steel brush to remove dirt or paint / corrosion protection lareys from the mounting surface.
    b. Prepare the mounting site.
3. Set the axis of the sensor as intended to the axis of the acceleration being monitored.
4. The maximal dimensions of the AVS 2000R module are 65 x 137 x 65 mm. The housing has a M8 screw 30 mm long, which is used to screw the sensor to the target object. The screw should be screwed to a depth of 9 mm and then tightened to the hole with two attached nuts.

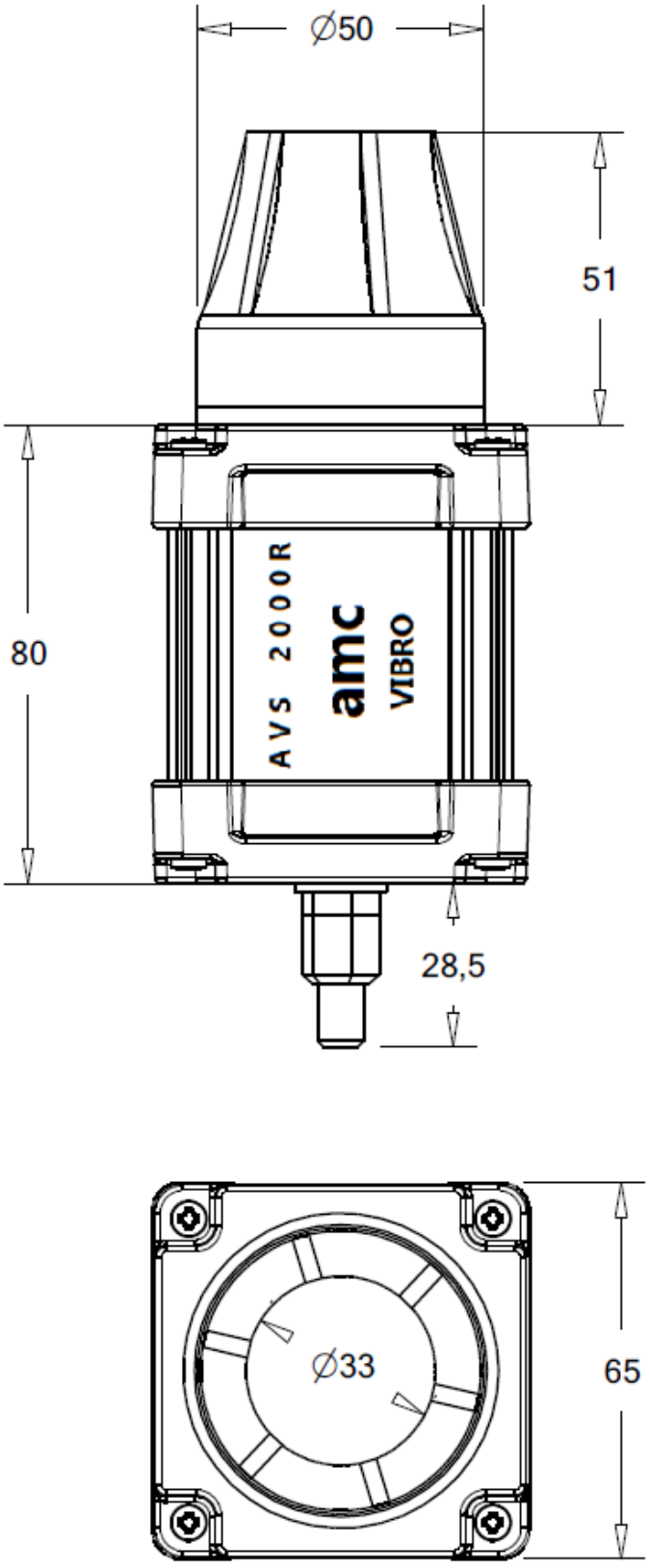


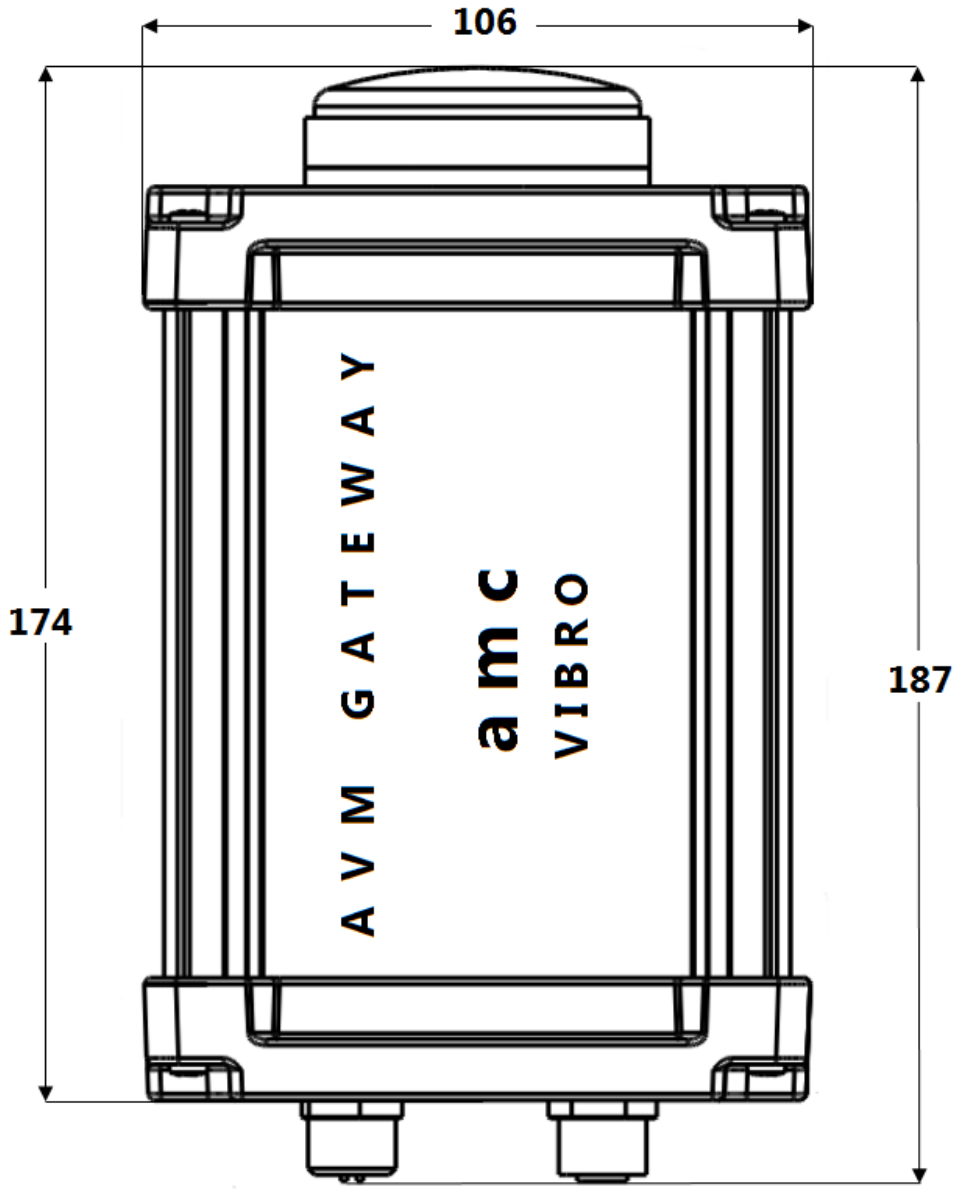
Figure 6. AVS 2000R dimensions in millimeters

Table 3. AVS 2000 housing

Parameter	Value
Case material	Aluminum + stainless steel M8 screw
Width	65 mm
Height	137 mm
Length	65 mm

5.2. AVM GATEWAY housing

The maximal dimensions of the AVM GATEWAY module are 106 x 187 x 56 mm. The GATEWAY housing does not have mounting holes or screws.



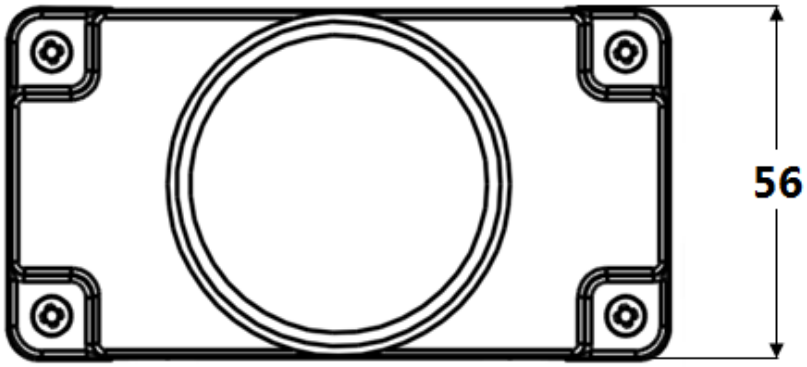


Figure 7. AVM GATEWAY dimensions in millimeters

Table 4. AVM GATEWAY housing

Parameter	Value
Case material	Aluminum
Width	106 mm
Height	187 mm
Length	56 mm

6. Sensors network configuring

Configuration of sensors and network is made via website that is implemented in the GATEWAY. Settings can be done in the *Configuration* tab on the website. The changes must be confirmed with the *Save Changes* button. The changes are approved separately for GATEWAY and for Vibration sensor. The changes on the GATEWAY are updated immediately after they are saved. Changes made for Vibration sensors are updated during next radio connection. The re-configuration status is visible in the detail view of Vibration sensors in the *Status* tab.

6.1. Connection parameters

NOTE!

In order to enter the GATEWAY website it is necessary to set the network card IP address of computer / tablet in accordance with the Ethernet network settings present on the GATEWAY. By default this is the IP address 192.168.0.10. The recommended web browser is Google Chrome.

Table 5. Connection parameters

Parameter	Value
Default IP	192.168.0.10
Modbus TCP Port (fixed)	502
OPC Port (fixed)	16664
Default user name	admin
Default password	admin

GATEWAY settings that can be configured are in table 6. The area for entering these settings is presented in the figure 8.

Table 6. GATEWAY settings

Number	Parameter to set
1.	User name and password
2.	GATEWAY name
3.	IP address
4.	Modbus activation
5.	OPC activation

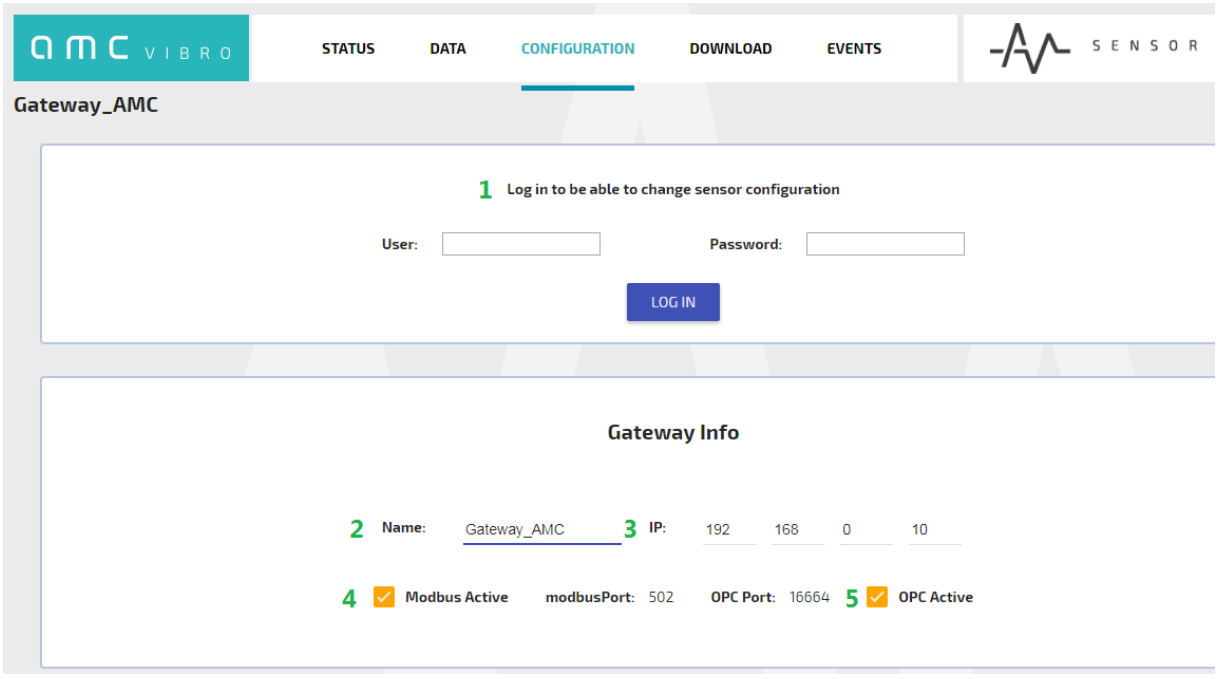


Figure 8. Administrator panel

6.2. AVS 2000R set-up

Vibration sensor settings that can be configured are present in table 7. The area for entering these settings is presented in the figures 9 and 10.

Table 7. AV SENSOR settings

Number	Parameter to set	Comment
1.	Name of the saved configuration	The configuration can be saved on the AVM GATEWAY with the name and location you wish
2.	Sensor name	You can give any name to your AVS 2000R
3.	Channel X & Y name	The X and Y channels may have other names
4.	Wakeup interval	During normal operation the AVS 2000R wake up every time specified by this parameter
5.	State activation	If you uncheck this box and send configuration the AVS 2000R will go into the inactive- storage mode
6.	Wakeup interval for Warning & Alarms for Channel X & Y	During operation when warnings or alarms occurred the AVS 2000R wake up every time specified by this parameter
7.	Repeat for Warning & Alarms for Channel X & Y	In order to some event reported it must be repeated this number of times
8.	Warning & Alarm thresholds for all estimates	The level of an estimate to report the warning or alarm
9.	Bands name & type (acceleration / velocity) for 8 bands	You can name all bands and choose their type - that is whether the acceleration or velocity will be calculated in these bands
10.	Frequency range of bands	It is possible to select the frequency ranges for 8 bands per channel

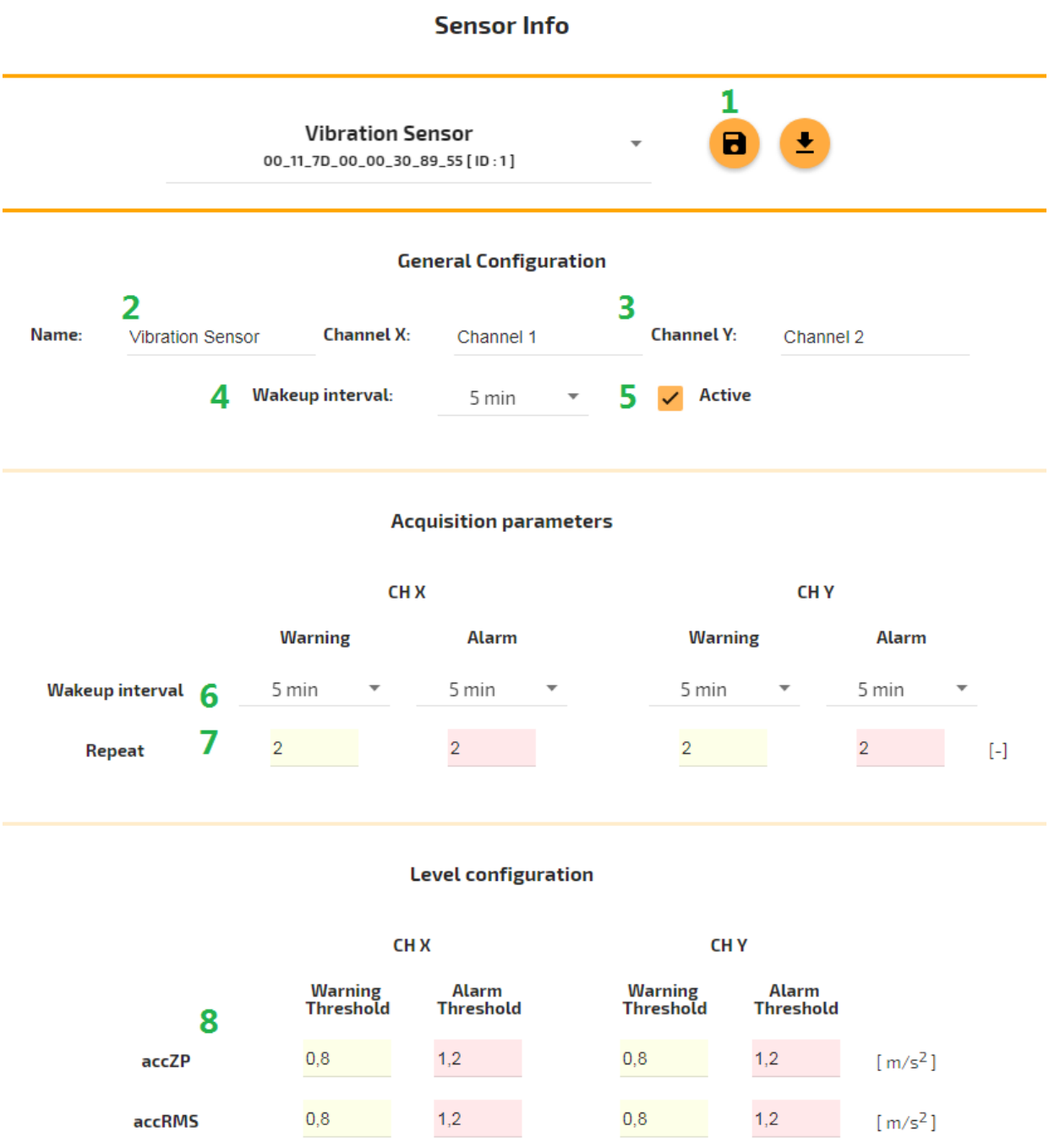


Figure 9. Sensor configuration part 1

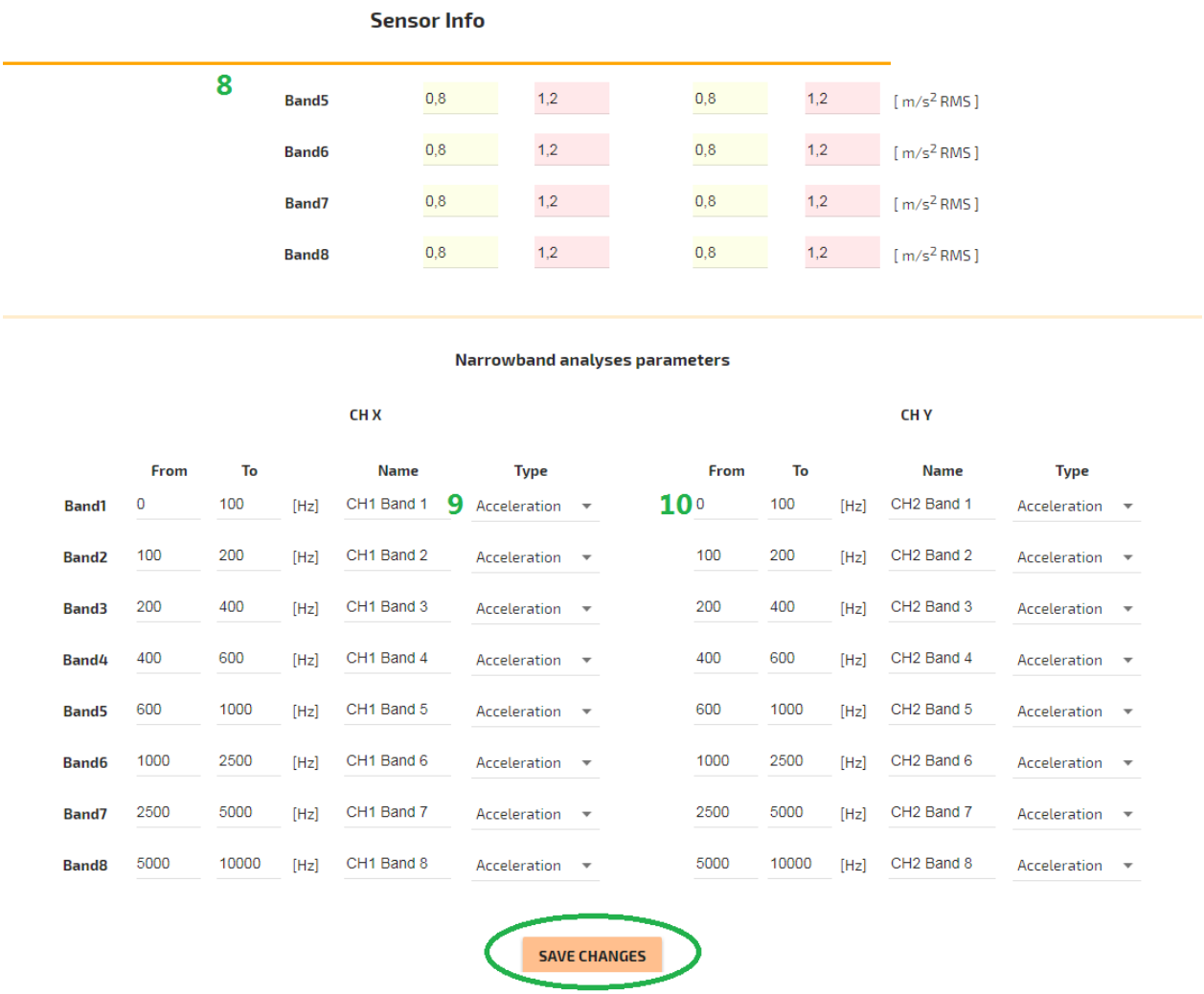


Figure 10. Sensor configuration part 2

There are other ways to make configuration changes. The first one is to choose the *Multiple* configuration- it will work for many sensors at once. Just select the method from the drop-down list and select the sensors to which you want to send the new configuration. You can also enter a *Default* configuration to any new sensor in the network.

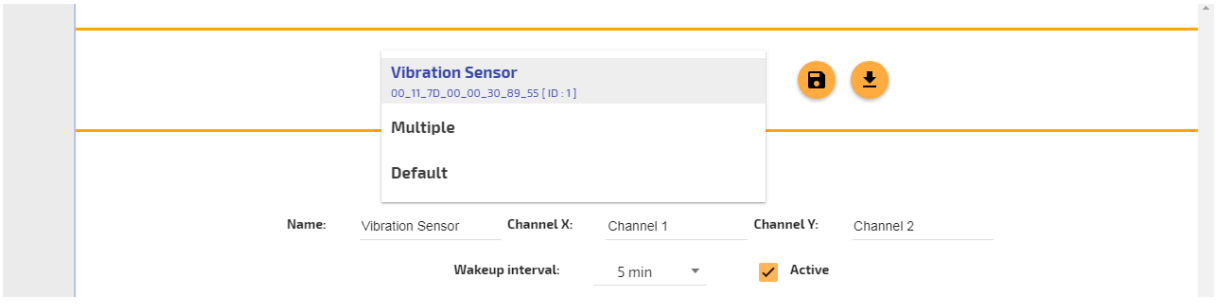


Figure 11. Multiple and default configuration

Another way to make changes is to use the Shortcut bar on the left side and drag the previously saved configurations. This can be used for example to drag a configuration of Vibration sensor ID 1 to the ID 2 module.

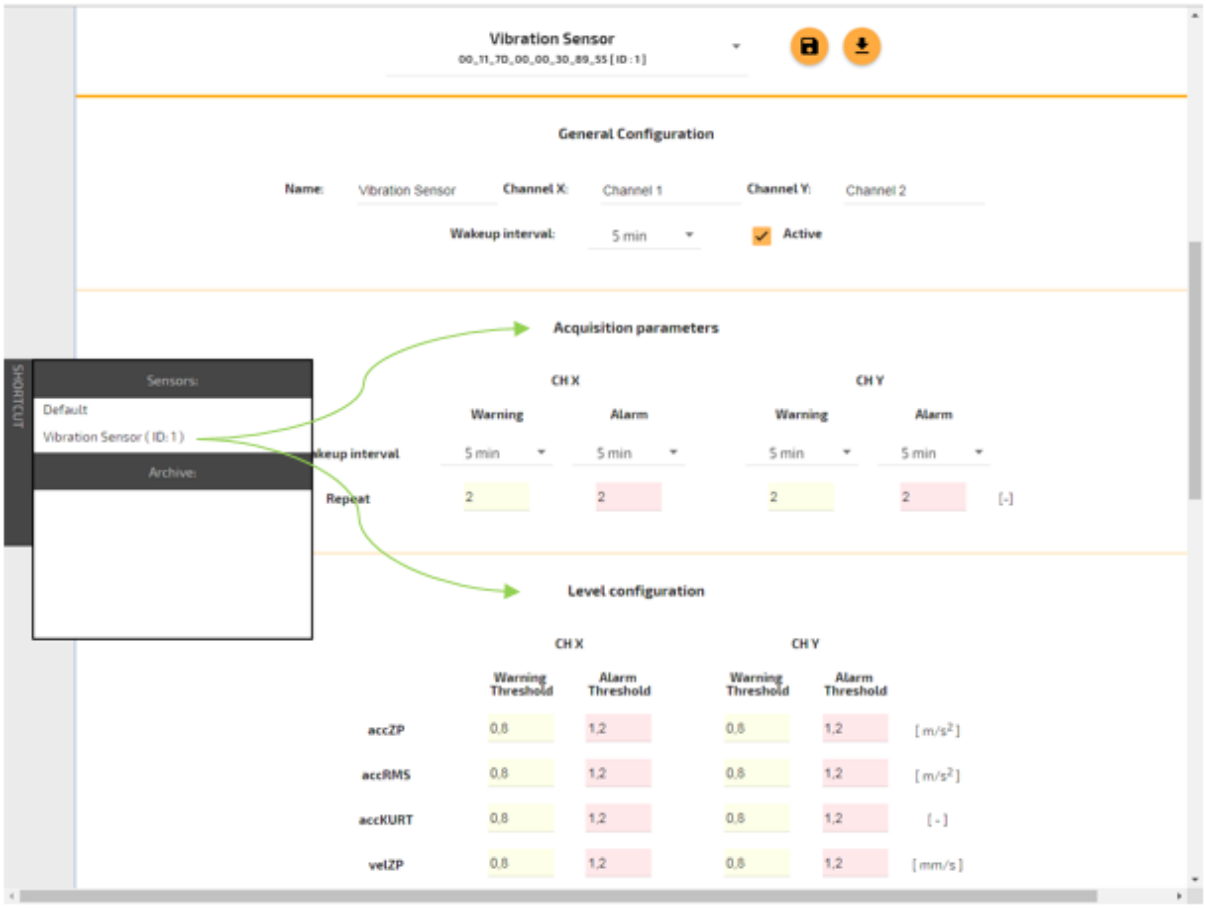


Figure 12. Quick configuration

You can also save the configuration of the currently selected sensor:

Select this button to save the configuration on a hard disk of your device.

Select this button to save the configuration on the GATEWAY in the folder of your choice.

7. Data storage and presentation

7.1. General information

When it comes to presenting the layout of the network the first tab which appears immediately after entering the website is the most important one. After entering the website you go to the *Status* tab (on the banner at the top) and to the *Overview* field (in the bar on the left). You find there a graphical representation of the state of sensors, their name, MAC address and battery status. All modules present in the network assigned to the GATEWAY are visible in the *Overview* field. To remove them from the network click on the *X* mark in the upper right corner of the rectangle representing the AVS device or on the left side in the screen.

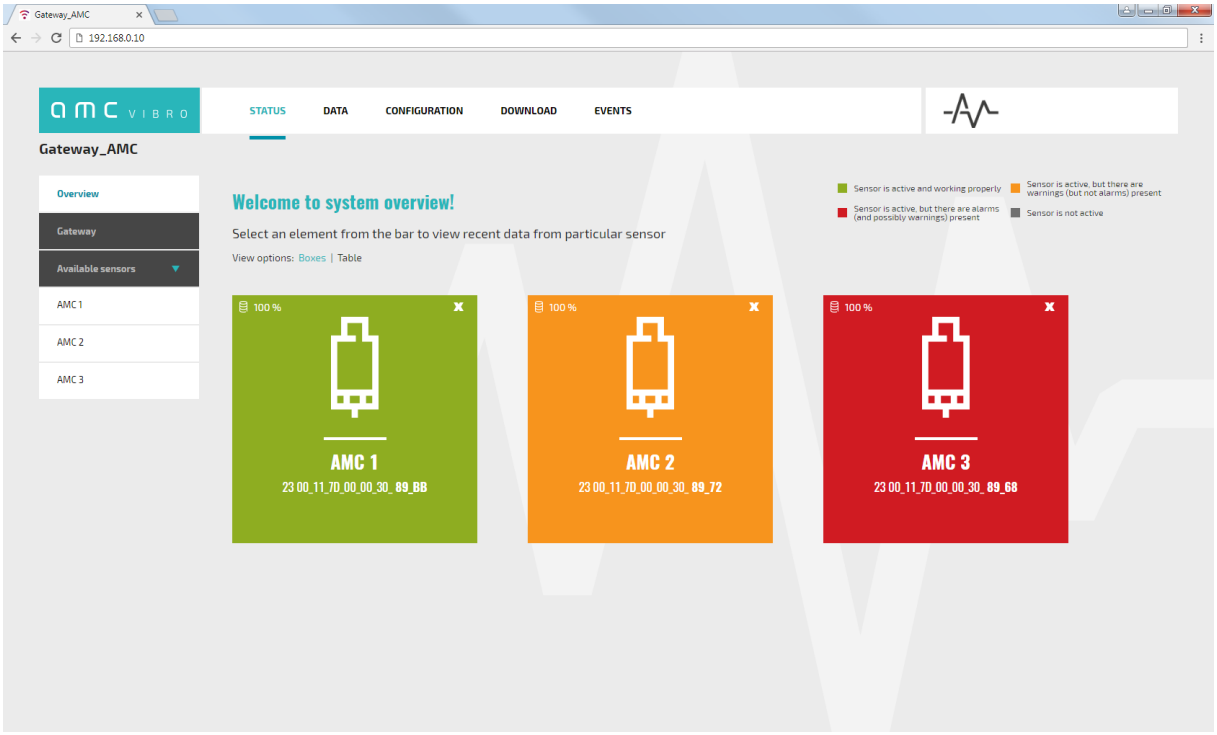


Figure 13. Front page of GATEWAY – Boxes view

7.2. Status

The condition of the sensors is explained in the legend in the upper right corner. Meaning of colors:

- green - none of the estimates exceeds the set thresholds
- yellow - there is at least one warning
- red - there is at least one alarm
- grey – sensor is not active

Figure 14. Legend - the meaning of graphic markings

You can choose an overview: *Boxes* (figure 13) or *Table* (figure 15). In the table view you will additionally see the amount of free memory and the number of reported errors in the form: number of reported errors from channel 1 / number of reported errors from channel 2. Similar information will be seen after hovering the cursor over the rectangle representing the sensor.

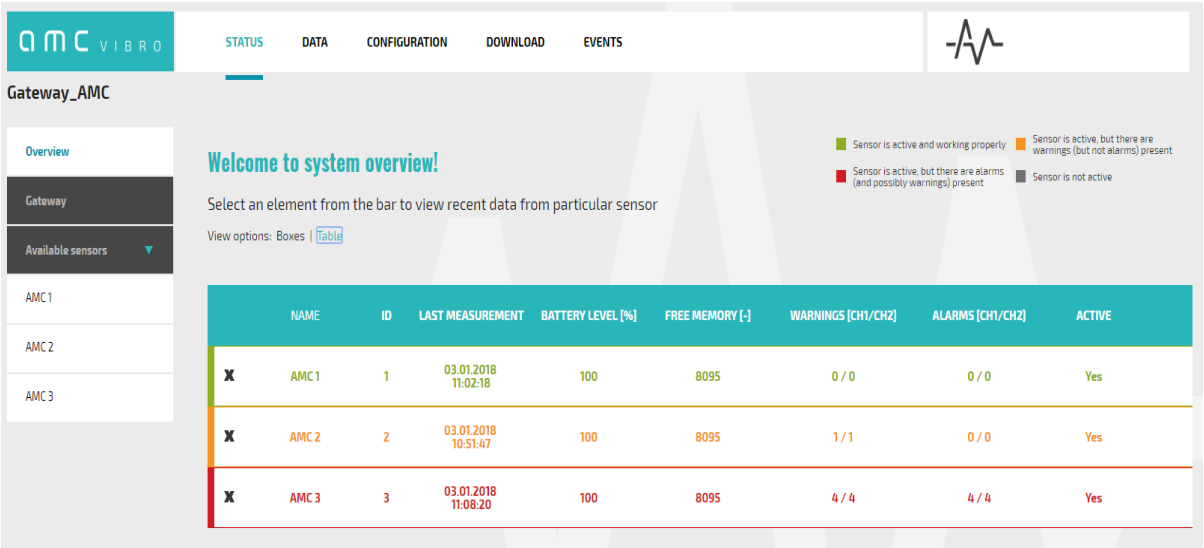


Figure 15. Front page of GATEWAY – table view

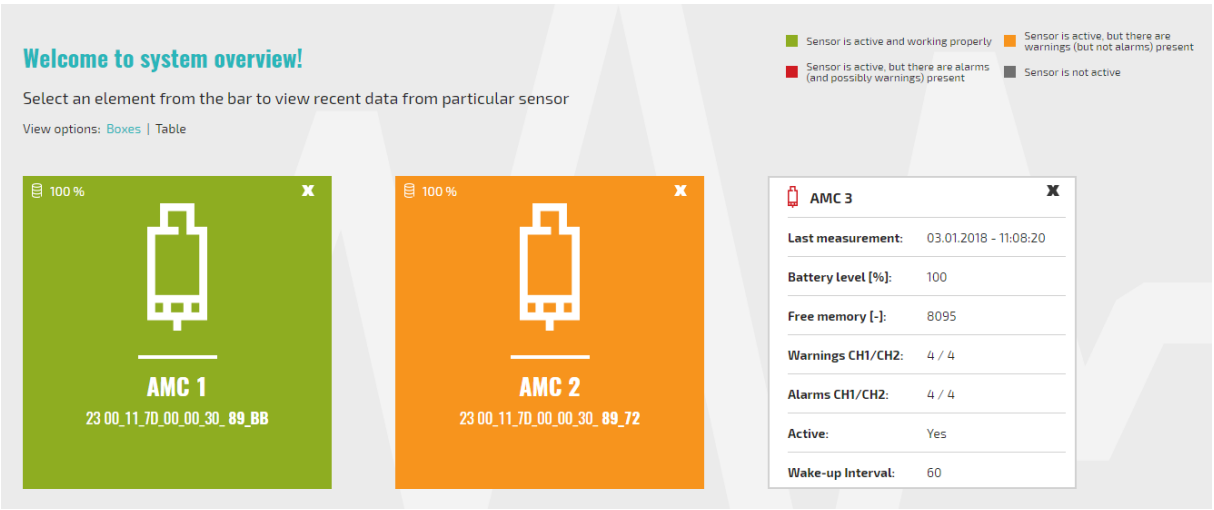


Figure 16. Detailed view of the sensor

In the *Status* tab on the *GATEWAY* field (in the bar on the left) there are information about the GATEWAY device. There you can also read and set the time on the GATEWAY device. You have to remember that the GATEWAY time is sent to the Vibration sensors and they save this date and this is operation time for them.

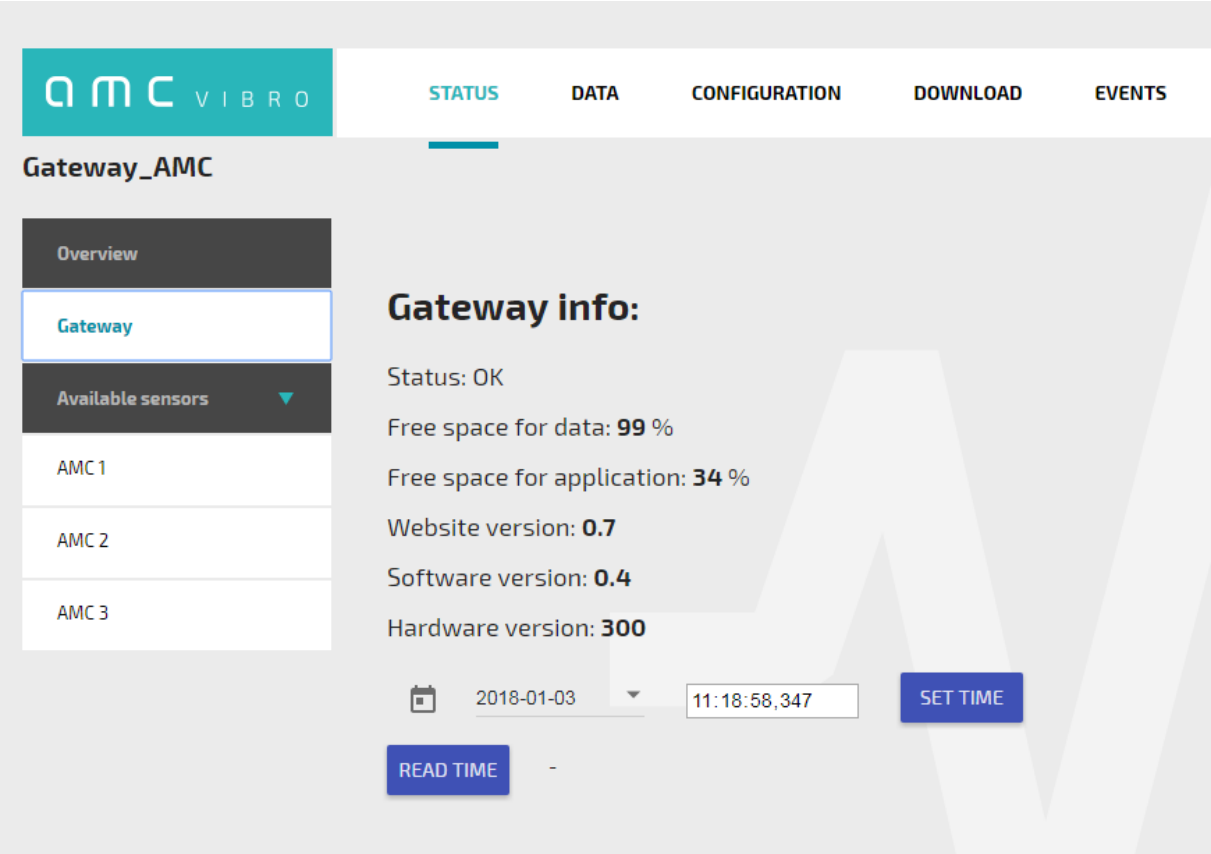


Figure 17. The AVM GATEWAY information

In the detailed view of any sensor (choice in the bar on the left side) you can see its detailed status. These are the elements described in table 8. Also in this case for the user's convenience the level of the estimate is color-coded in the same manner as before- described in figure 14.

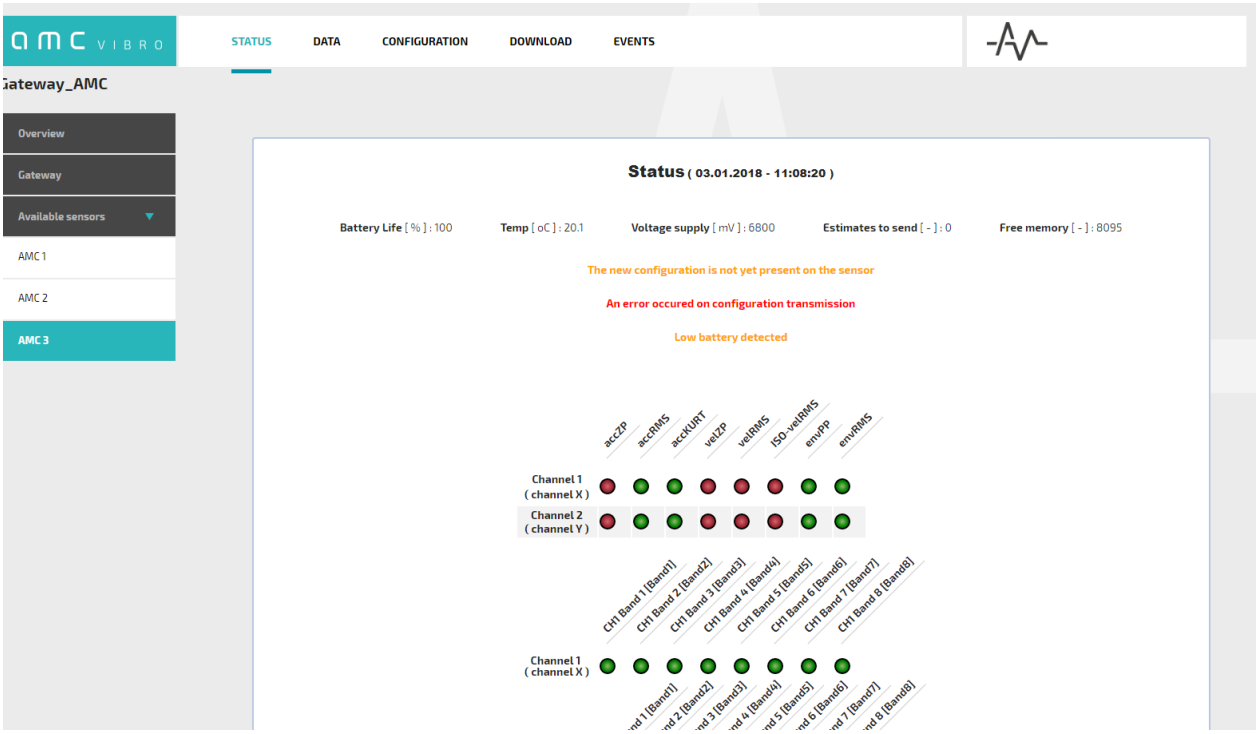


Figure 18. Detailed information from AVS 2000R. Part I

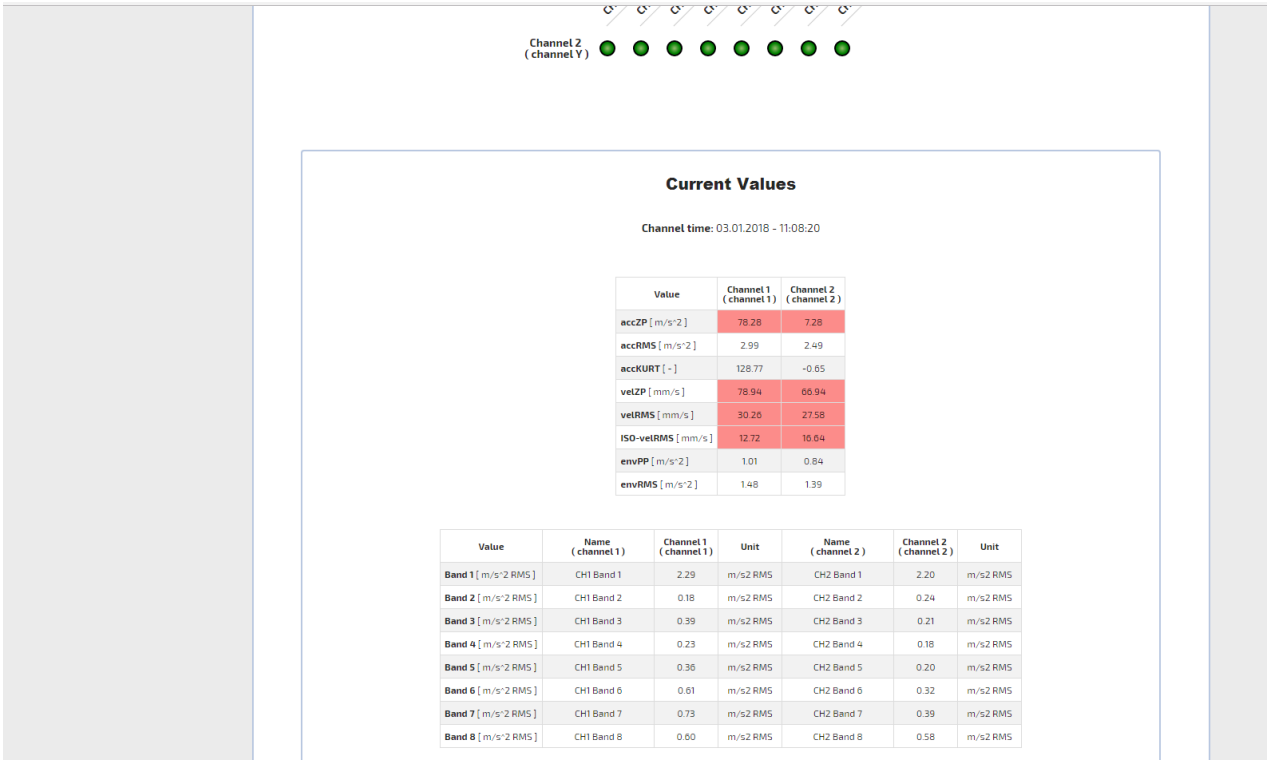


Figure 19. Detailed information from AVS 2000R. Part II

Table 8. Status of the AVS 2000R

Parameter	Information
Date of the status	This is the date when the sensor device collected the measurements and judged its status, which is now visible on the site
Battery Life	The battery level which is expressed as percentage
Temperature	Temperature in Celsius degrees
Voltage supply	Battery voltage given in millivolts
Estimates to send	The number of statuses – packets of estimates that are waiting for sending to the GATEWAY
Free memory	Free place in the flash memory for the statuses - packets of estimates. It is equal: 8095 - Estimates to send
New configuration status	If the newly sent configuration from AVM GATEWAY is not yet saved by AVS 2000R, the following message appears: *The new configuration is not yet present on the sensor*
Status of configuration transmission	If there is an error when sending the configuration, a message is displayed: *An error occurred on configuration transmission*
Battery alert	If the battery has run out, an message *Low battery detected* will appear and then the System administrator is obliged to report this event to AMC VIBRO to exchange the battery.
Values of estimates	The measured estimates are: » 0-Peak & RMS vibration acceleration [m/s2] » acceleration kurtosis [-] » 0-Peak & RMS vibration velocity [mm/s] » ISO RMS velocity [mm/s] » acceleration envelope RMS and Peak-Peak [m/s2] » acceleration or velocity in 8 defined bands (BEC)

7.3. Data

Viewing all measurement data is possible in the *Data* tab. Measurements are visible in the table and you can also put them on the chart by pressing the name of the column with the estimate to be drawn. First you need to decide which sensor data you choose to view. Each sensor is uniquely identified by the MAC address. The sensor can assume different names over its lifetime. Then data from periods when the sensor had different names can be viewed in the *Data Archive* tab. There you should choose the name assigned to the sensor at given time and the file with the date of saving measurements which you want to analyze.

In the *Current Values* tab you can view the current data - assigned to the sensor with the current name.

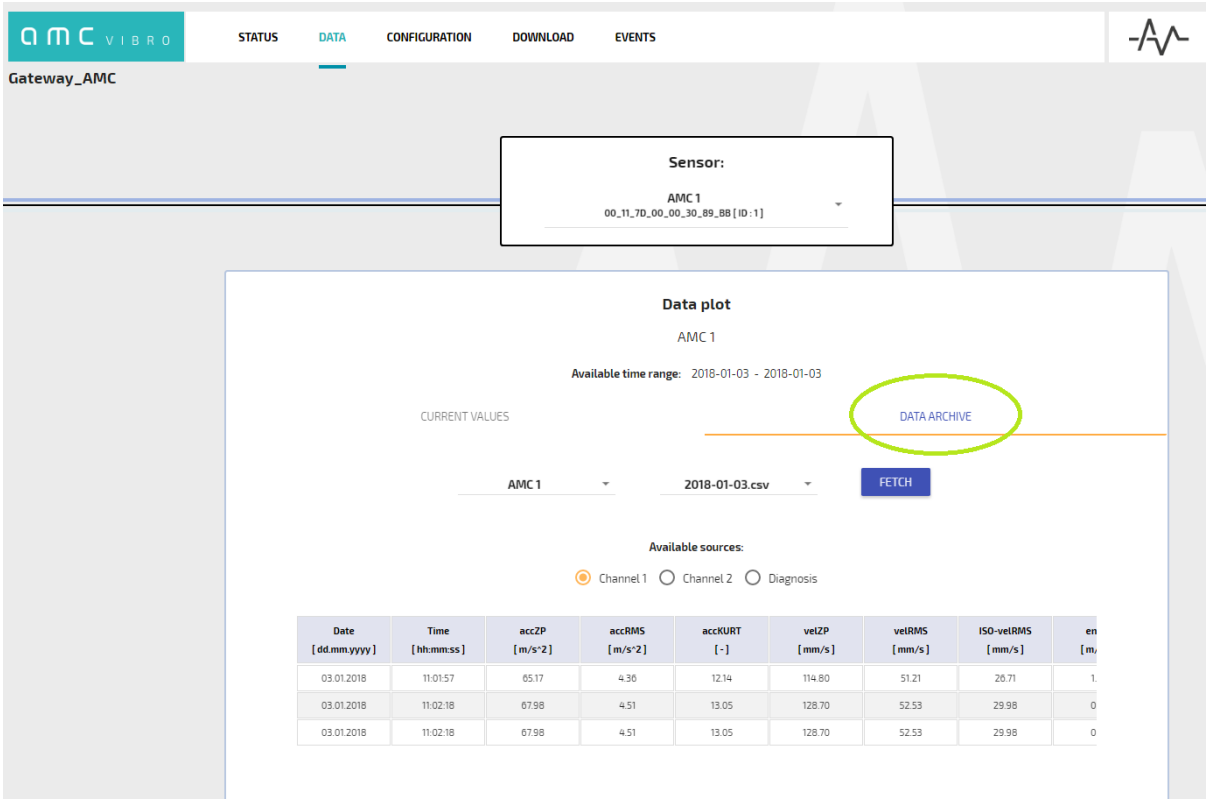


Figure 20. Data tab – Data Archive

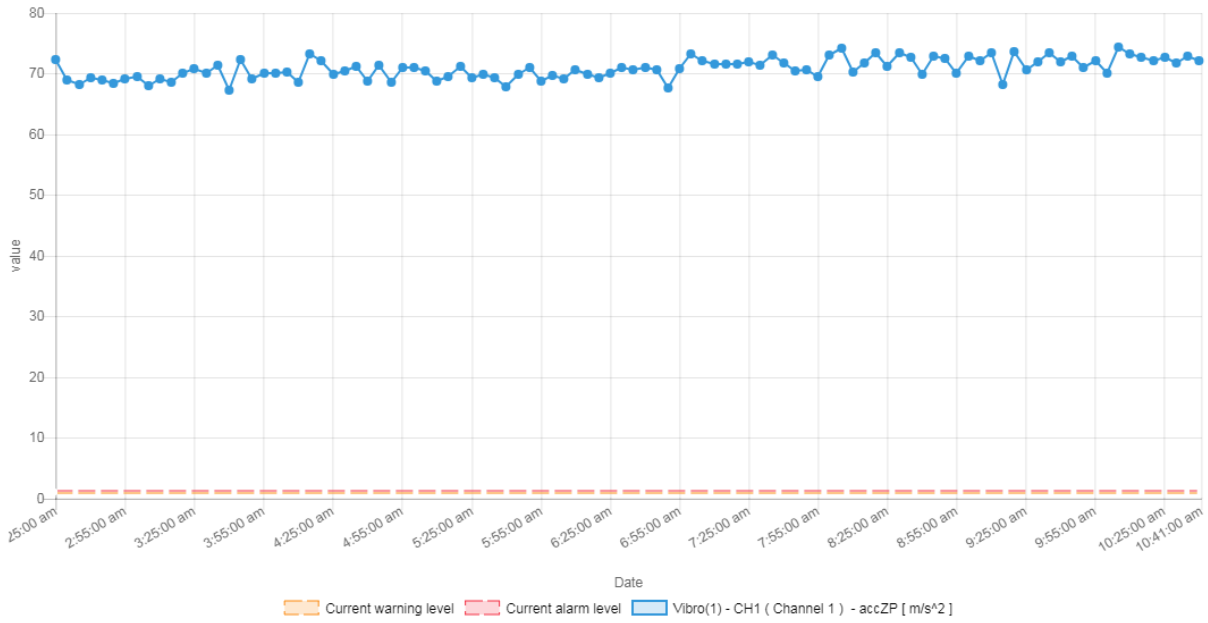


Figure 21. Data plot

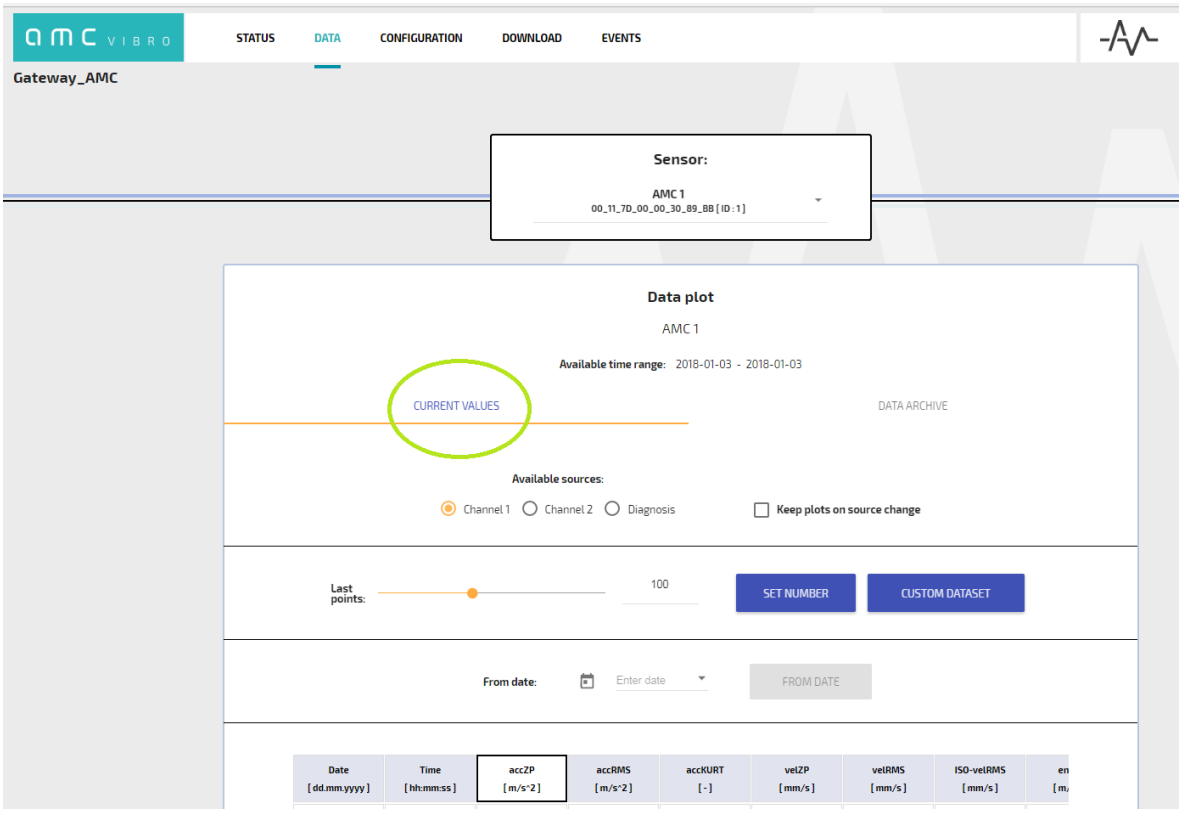


Figure 22. Data tab – Current Values

When selecting *Current Values*, you have the following display options to choose:

- *Available sources* - measurements from channel X or Y or diagnostic data
- *Keep plots on source change* - if you want to keep already drawn charts from one of the above sources in the chart field when you want to draw new graphs from another source along with them- check this option
- *Set Number* - the number of last measurements to be displayed
- *Custom Dataset* - advanced graph drawing options in which you can choose to draw any estimate from any sensors at once and clean all graphs at once with *clear plot* button
- *From Date* - allows you to draw a chart from the selected date
- Title of column - to draw a graph, click on the selected column title

Selected curves and chart legend are visible in the area of the graph.

7.4. Data download from the system

The Measurements are stored in CSV format and can be exported via the website in the *Download* tab. Both the tab and the content of the sample file are presented in the figures below. After clicking the *Download* button the file archive is downloaded. It is a directory called *vibrosensor_MAC_address* along with directories inside with the names that this sensor had. In the folder with the name of the sensor there are files in the CSV format which have the date of saving the measurements as a title. If you want to narrow down the period from which you will download files, you have to check the *From* or *To* fields and select the chosen date. Otherwise, all files assigned to the sensor name will be downloaded.

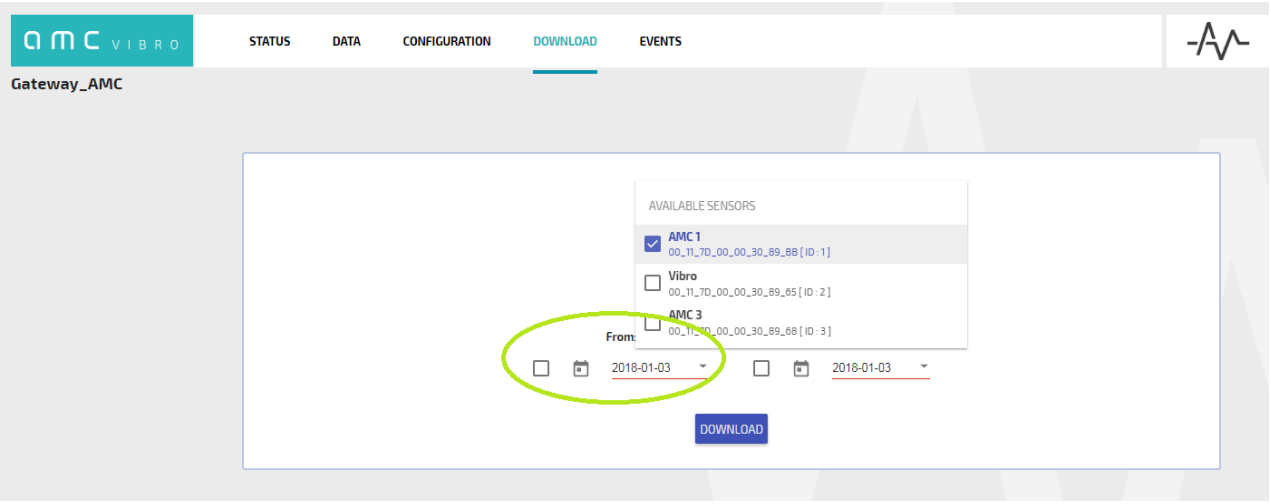


Figure 23. Download tab

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Name sensor	AMC 1												
2	MAC	00:11:7D:00:00:30:5F:9A												
3	Sensor ID	1												
4	Ch1 Name	Channel 1												
5	Ch2 Name	Channel 2												
6														
7	Date[yyyy-mm-dd]	Time[hh:mm:ss]	Status	Battery Life	Temp[C]	Voltage supply[mv]	Sensor Status	RF Status	Left Estimates	Free memory	CH 1	Warning	Alarm	accZP [m/s^2]
8	2017-07-31	06:48:59	0	70	39.8	6181	1	0	0	8095		0	0	0.046402
9	2017-07-31	07:49:16	0	70	39.9	6161	1	0	0	8095		0	0	0.051529
10	2017-07-31	08:49:16	0	70	40	6223	1	0	1	8094		0	0	0.045761
11	2017-07-31	09:49:16	0	70	40.1	6192	1	0	0	8095		0	0	0.503693
12	2017-07-31	10:49:16	0	70	40	6212	1	0	0	8095		0	0	0.858719
13	2017-07-31	11:19:16	0	70	40	6216	1	0	0	8095		1001	1000	0.548676
14	2017-07-31	11:49:16	0	70	40	6223	1	0	0	8095		1001	1000	0.466797
15	2017-07-31	12:19:16	0	70	40	6226	1	0	0	8095		1001	1000	0.449722
16	2017-07-31	12:49:16	0	70	40	6229	1	0	0	8095		0	0	0.40625
17	2017-07-31	13:19:16	0	70	40	6233	1	0	0	8095		0	0	0.429733
18	2017-07-31	13:49:16	0	70	40	6236	1	0	0	8095		0	0	0.609589
19	2017-07-31	14:19:16	0	70	40	6247	1	0	0	8095		1000	0	0.431137
20	2017-07-31	14:49:16	0	70	39.9	6243	1	0	0	8095		1000	0	0.575363
21	2017-07-31	15:19:16	0	70	39.9	6247	1	0	0	8095		1000	0	0.596954
22	2017-07-31	15:49:16	0	70	39.9	6247	1	0	0	8095		1000	0	0.476181
23	2017-07-31	16:19:16	0	69	41	6250	1	0	0	8095		1000	0	0.514664
24	2017-07-31	16:49:16	0	69	41	6253	1	0	0	8095		1000	0	0.433563
25	2017-07-31	17:19:16	0	69	41	6257	1	0	0	8095		1000	0	0.638748
26	2017-07-31	17:49:16	0	69	41	6253	1	0	0	8095		1000	0	0.534866
27	2017-07-31	18:19:16	0	69	41	6253	1	0	0	8095		1000	0	0.42334
28	2017-07-31	18:49:16	0	69	41	6233	1	0	0	8095		0	0	0.411926
29	2017-07-31	19:19:16	0	69	41	6212	1	0	0	8095		0	0	0.528152
30	2017-07-31	19:49:16	0	69	42	6202	1	0	0	8095		1000	0	0.42363
31	2017-07-31	20:19:16	0	69	42.1	6181	1	0	0	8095		1000	0	0.509369
32	2017-07-31	20:49:16	0	69	42.2	6192	1	0	0	8095		1000	0	0.551651
33	2017-07-31	21:19:16	0	69	42.3	6175	1	0	0	8095		1000	0	0.700623
34	2017-07-31	21:49:16	0	69	42.4	6178	1	0	0	8095		1000	0	0.641891
35	2017-07-31	22:19:16	0	69	42.5	6195	1	0	0	8095		1000	0	0.502487
36	2017-07-31	22:49:16	0	69	42.6	6205	1	0	0	8095		1000	0	0.676468
37	2017-07-31	23:19:16	0	69	42.7	6178	1	0	0	8095		1000	0	0.554535
38	2017-07-31	23:49:16	0	69	42.7	6178	1	0	0	8095		1000	0	0.363251

Figure 24. Data file

Important notice- data format is made in a way to provide marking of warnings and alarms as well as self-diagnostic status. Note that *Time* parameter is provided in UTC time zone. The method of marking is as follows:

- Warnings and Alarms – the value in the the warning and alarm field has a 16-bit binary format. Value of 1 indicates the presence of a warning or alarm and value of 0 means that they are not present. The LSB (in a file the first bit visible on the far right side) means the alarm of the first estimate, that is acceleration 0-Peak from channel X. The second bit from the left means that the source of occurrence is acceleration RMS from channel Y and so on
- Sensor Status – bit coding is as follows, counting out from LSB (that is from the right side). The value of 1 means the presence of the mentioned state:
  1. Active mode
  2. Temperature measurement failed
  3. RTC chip error
  4. Flash memory error
  5. RAM memory error
  6. Analog process failed
  7. Not used
  8. Reconfiguration not received yet
  9. Reconfiguration error
- RF Status – bit coding is as follows, counting out from LSB (that is from the right side). The value of 1 means the presence of the mentioned state:
  1. RF module error

7.5. Events

As mentioned- the GATEWAY monitors all network devices and occurrences by them reported. It reacts to exceeding measured values above the thresholds of warnings and alarms. These occurrences are listed in the Events tab. You can choose a sensors to view alerts. There are the following options to choose:

- *From Date* – allows you to choose a date since you will be viewing events. Otherwise all possible will be displayed
- *Source* – the source of occurrence: All, Channel X or Channel Y
- *State* – All - if all alerts are displayed - past and present or Current – if only still ongoing alerts are displayed
- *Type* – Warnings or Alarms or All
- *Estimate* – a kind of estimate which is the source of occurrence / alert

Start date parameter informs when the occurrence began and the *End date* parameter informs when the occurrence was stopped.

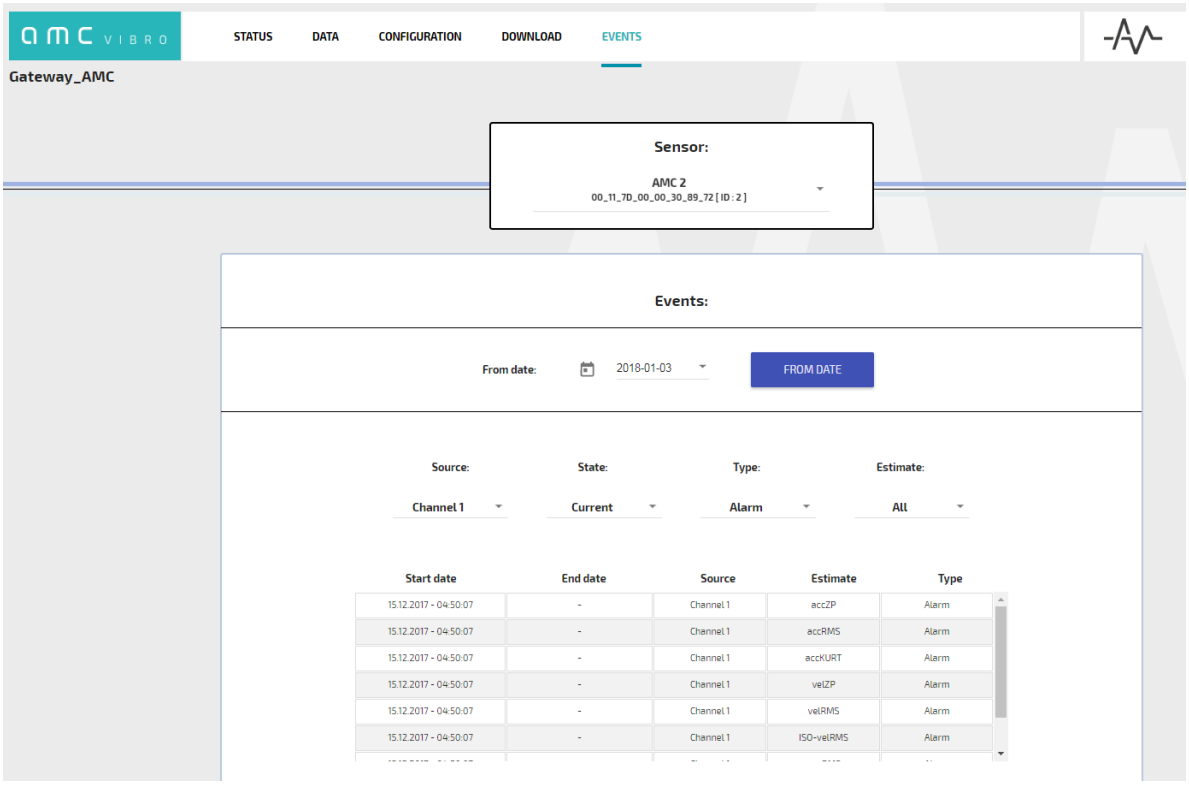


Figure 25. Events tab

7.6. Modbus TCP and OPC protocols

Due to AVM GATEWAY functionality measurement data can be readed in various ways. For example they can be applications to Modbus TCP client or OPC UA client.

By using the GATEWAY you can have access to all current data via Modbus TCP - port 502, function 03 Read Holding Registers. Table 9 shows the Modbus registers of the AVS 2000R, ID number = 1.

The registers available for reading via the GATEWAY for subsequent IDs are shifted by a number equal to:

2025 + 58 * (ID of AVS 2000R - 1)

AMC VIBRO provides a spreadsheet for determining register addresses. System operator only needs to enter the ID number of AVS 2000R device. Then addresses of registers assigned to the sensor with the given ID are automatically displayed. The figure 26 shows example date read using the Modbus TCP client.

Table 9. Modbus registers

AVM 2000R ID 1		Register	Address	Type	Size [B]	Unit / Range
	Status	OPC Status	2000	uint16_t	2	boolean
		Modbus Status	2001	uint16_t	2	boolean
		WWW status	2002	uint16_t	2	boolean
		-	2003 - 2024	uint16_t	2	reserved
AVS 2000R	**Time Stamp**	Day	2025	uint16_t	2	1-31
		Month	2026	uint16_t	2	1-12
		Year	2027	uint16_t	2	number
		Hour	2028	uint16_t	2	0-23
		Minute	2029	uint16_t	2	0-59
		Second	2030	uint16_t	2	0-59
	Status	RF MAC	2031	8 x uint16_t	16	ASCII
		Id	2039	uint16_t	2	number
		Battery Life	2040	uint16_t	2	%
		Temperature	2041	uint16_t	2	x0.1 °C
		Voltage supply	2042	uint16_t	2	mV
		SENSOR Status	2043	uint16_t	2	binary
		RF Status	2044	uint16_t	2	binary
		Left Estimates	2045	uint16_t	2	binary
		Free memory	2046	uint16_t	2	number
	Estimates CH1	Warning	2047	uint16_t	2	binary
		Alarm	2048	uint16_t	2	binary
		acceleration 0-Peak	2049	uint16_t	2	x0.1 m/s2
		acceleration RMS	2050	uint16_t	2	x0.1 m/s2
		acceleration Kurtosis	2051	uint16_t	2	x0.1 [-]
		velocity 0-Peak	2052	uint16_t	2	x0.1 mm/s
		velocity RMS	2053	uint16_t	2	x0.1 mm/s
		ISO-velocity RMS	2054	uint16_t	2	x0.1 mm/s
		envelope Peak-Peak	2055	uint16_t	2	x0.1 m/s2
		envelope RMS	2056	uint16_t	2	x0.1 m/s2

AVM 2000R ID 1		Register	Address	Type	Size [B]	Unit / Range
		Band[8]	2057	8x uint16_t	16	x0.1 m/s2 or x0.1 mm/s*
	Estimates CH2	Warning	2065	uint16_t	2	binary
		Alarm	2066	uint16_t	2	binary
		acceleration 0-Peak	2067	uint16_t	2	x0.1 m/s2
		acceleration RMS	2068	uint16_t	2	x0.1 m/s2
		acceleration Kurtosis	2069	uint16_t	2	x0.1 [-]
		velocity 0-Peak	2070	uint16_t	2	x0.1 mm/s
		velocity RMS	2071	uint16_t	2	x0.1 mm/s
		ISO-velocity RMS	2072	uint16_t	2	x0.1 mm/s
		envelope Peak-Peak	2073	uint16_t	2	x0.1 m/s2
		envelope RMS	2074	uint16_t	2	x0.1 m/s2
		Band[8]	2075	8x uint16_t	16	x0.1 m/s2 or x0.1 mm/s*
						*acceleration or velocity

	02025
2025	3
2026	1
2027	2018
2028	10
2029	2
2030	18

Figure 26. Date reading from the Vibration sensor ID 1

Similarly, the namespace that lists the contents of fields for OPC UA communication is listed in the table 10. The port used is 16664. The identifier of each field is of the string type. It starts with the type of sensor followed by the id number followed by the group and field name (see table). Figure 27 shows the OPC field structure for the Vibration sensor.

Table 10. OPC fields

Device type	Field name	ID
Vibration SENSOR	TimeStamp	vs{x}.TimeStamp
	Configuration – Active	vs{x}.conf.active
	Configruration – Wakeup interval	vs{x}.conf.wakeup
	Diagnostic – Batery life	vs{x}.diag.battLife

Device type	Field name	ID
	Diagnostic – Free memory	vs{x}.diag.freeMem
	Diagnostic – Id	vs{x}.diag.id
	Diagnostic – MAC	vs{x}.diag.mac
	Diagnostic – RF Status	vs{x}.diag.rfStatus
	Diagnostic – Status	vs{x}.diag.status
	Diagnostic – Temperature	vs{x}.diag.temp
	Diagnostic – Voltage supply	vs{x}.diag.voltSupply
	Estimate Ch{n} - Band	vs{x}.est.ch{n}.band
	Estimate Ch{n} – ISOvelRMS	vs{x}.est.ch{n}.ISOvelRMS
	Estimate Ch{n} – accKURT	vs{x}.est.ch{n}.accKURT
	Estimate Ch{n} – accRMS	vs{x}.est.ch{n}.accRMS
	Estimate Ch{n} – accZP	vs{x}.est.ch{n}.accZP
	Estimate Ch{n} – envPP	vs{x}.est.ch{n}.envPP
	Estimate Ch{n} – envRMS	vs{x}.est.ch{n}.envRMS
	Estimate Ch{n} – velRMS	vs{x}.est.ch{n}.velRMS
	Estimate Ch{n} – velZP	vs{x}.est.ch{n}.velZP
	Event Ch{n} – Alarm	vs{x}.event.ch{n}.alarm
	Event Ch{n} – Warning	vs{x}.event.ch{n}.warning

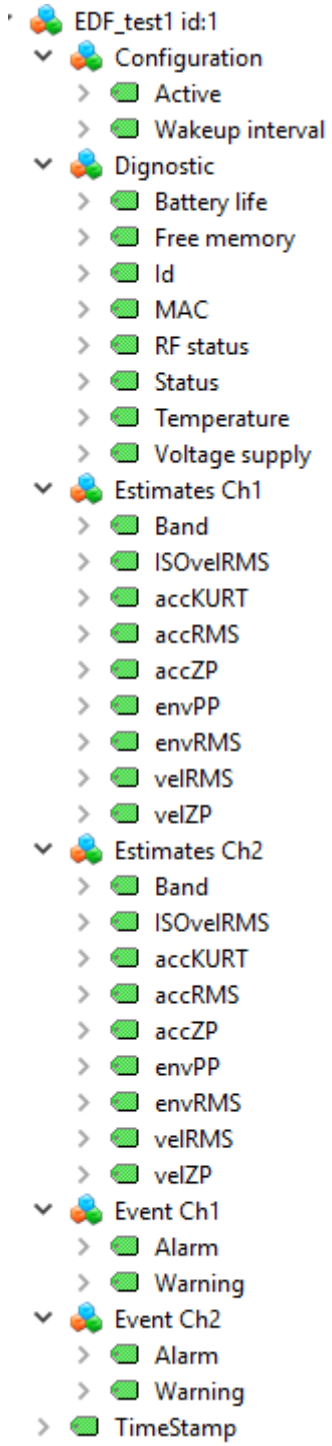


Figure 27. The OPC structure for the vibration sensor

7.7. Conection via Modbus TCP and OPC UA protocols

To correctly display data from a specyfic sensor using the Modbus TCP protocol, you need to know the ID number of a choosen sensor. In the AVM Gateway software, go to the DATA tab and select the sensor. The ID number is located in the area marked as below.

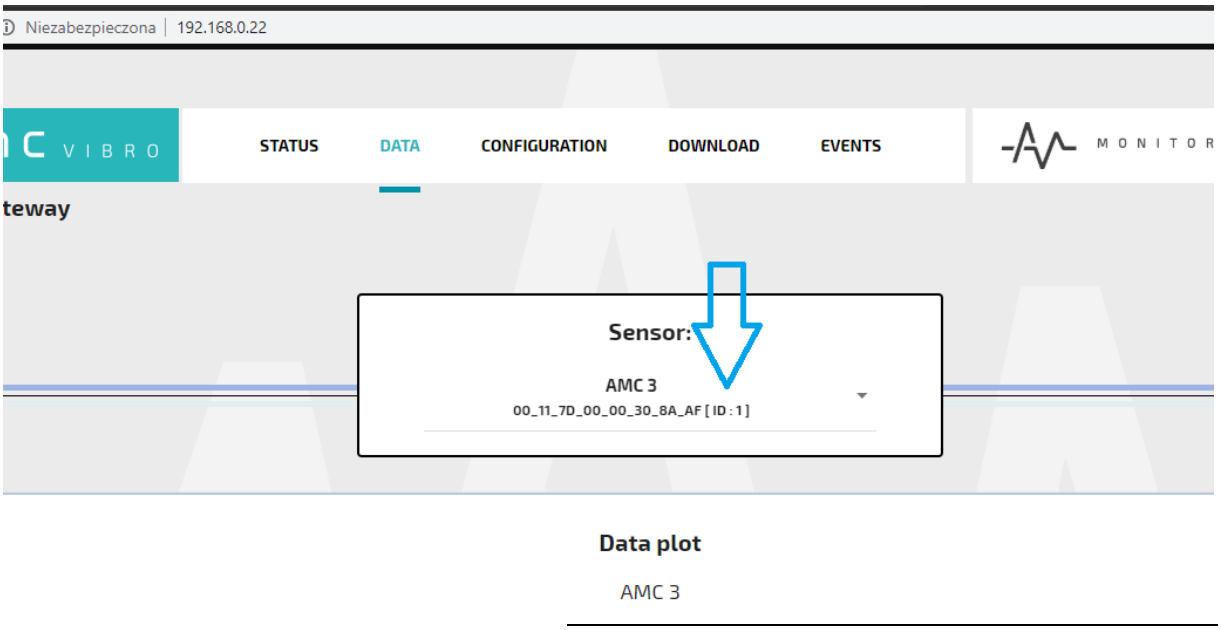


Figure 28. Checking ID of specific sensor

To read data using communication protocols, follow the steps below.

Modbus:

1. Start the program to read by protocol - Modbus TCP client (example Modbus Master)
2. Select Modbus TCP from the Options list
3. Enter the IP address of the given Gateway (visible on the AMV GATEWAY website or on the nameplate on the GATEWAY enclosure)
4. Enter the port number: 502
5. Select Modbus Mode: TCP
6. In the Function Code field, select: Read holding Registers 03
7. Determine the starting address of the read range of registers: Start Address according to the equation: **2025 + 58 * (Device ID AVS 2000R - 1)**
8. Define the number of registers displayed in the Number of Registers
9. Click Connect
10. Click Scan

Below is a step by step illustration.

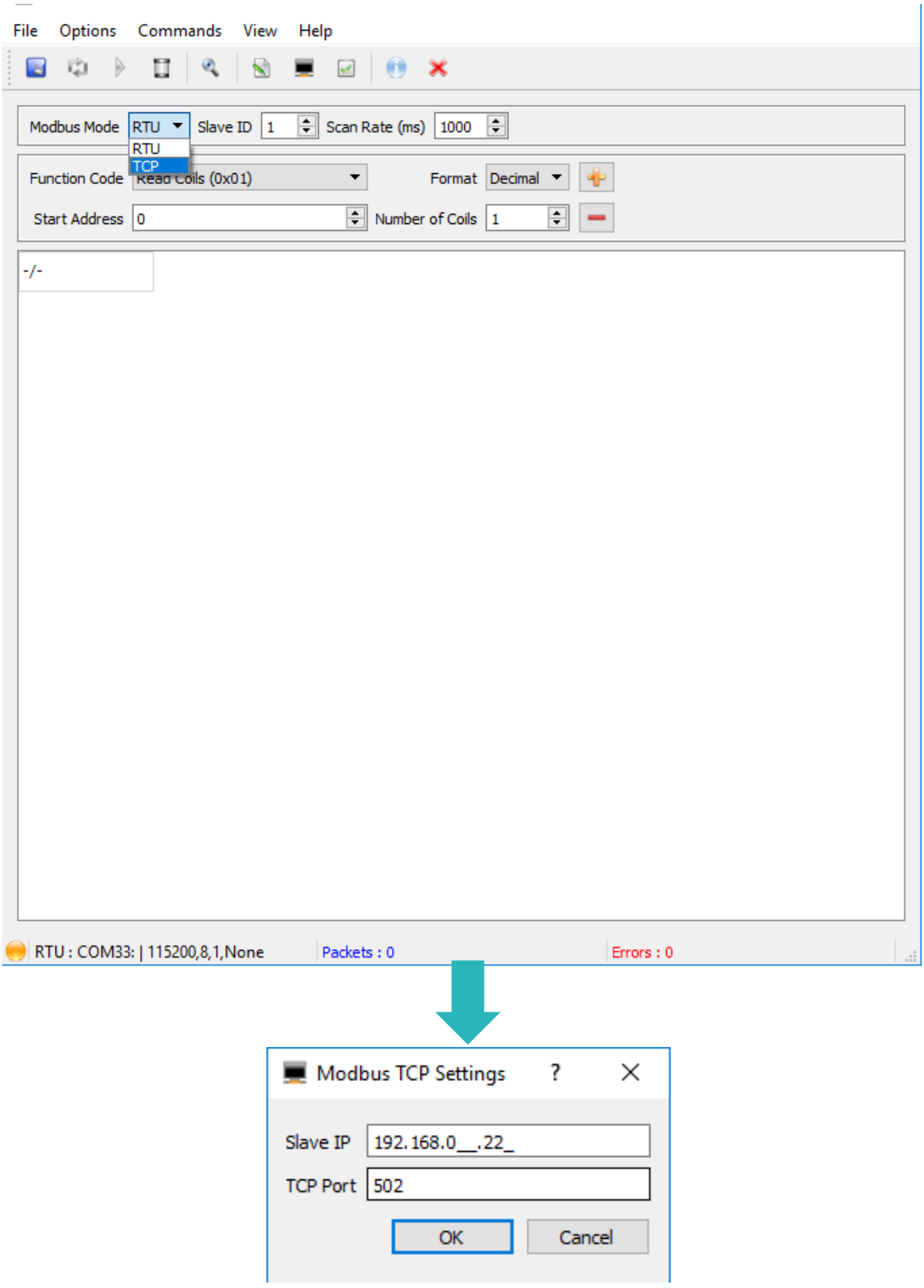


Figure 29. Defining IP and port for Modbus TCP

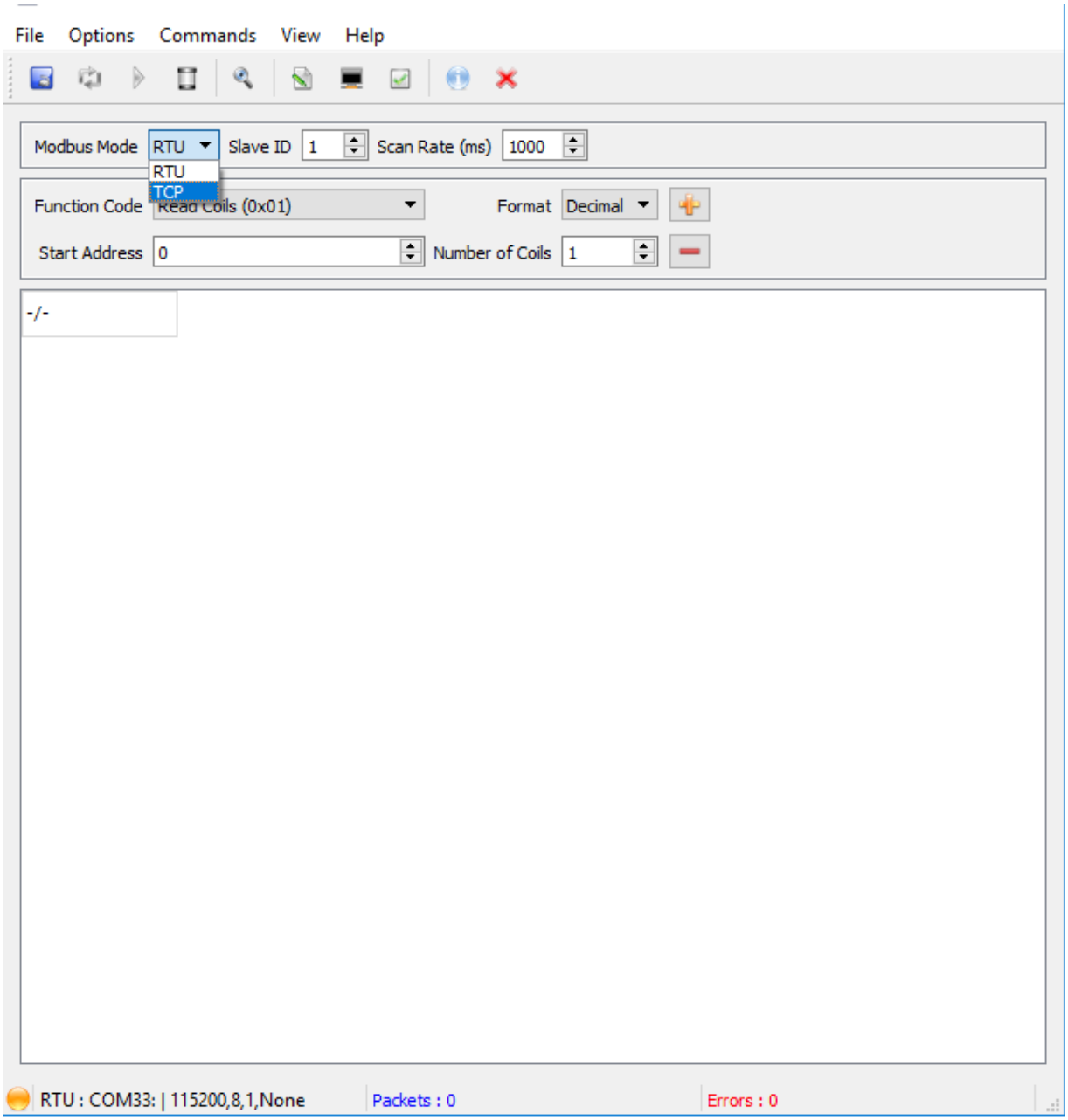


Figure 30. Setting TCP mode

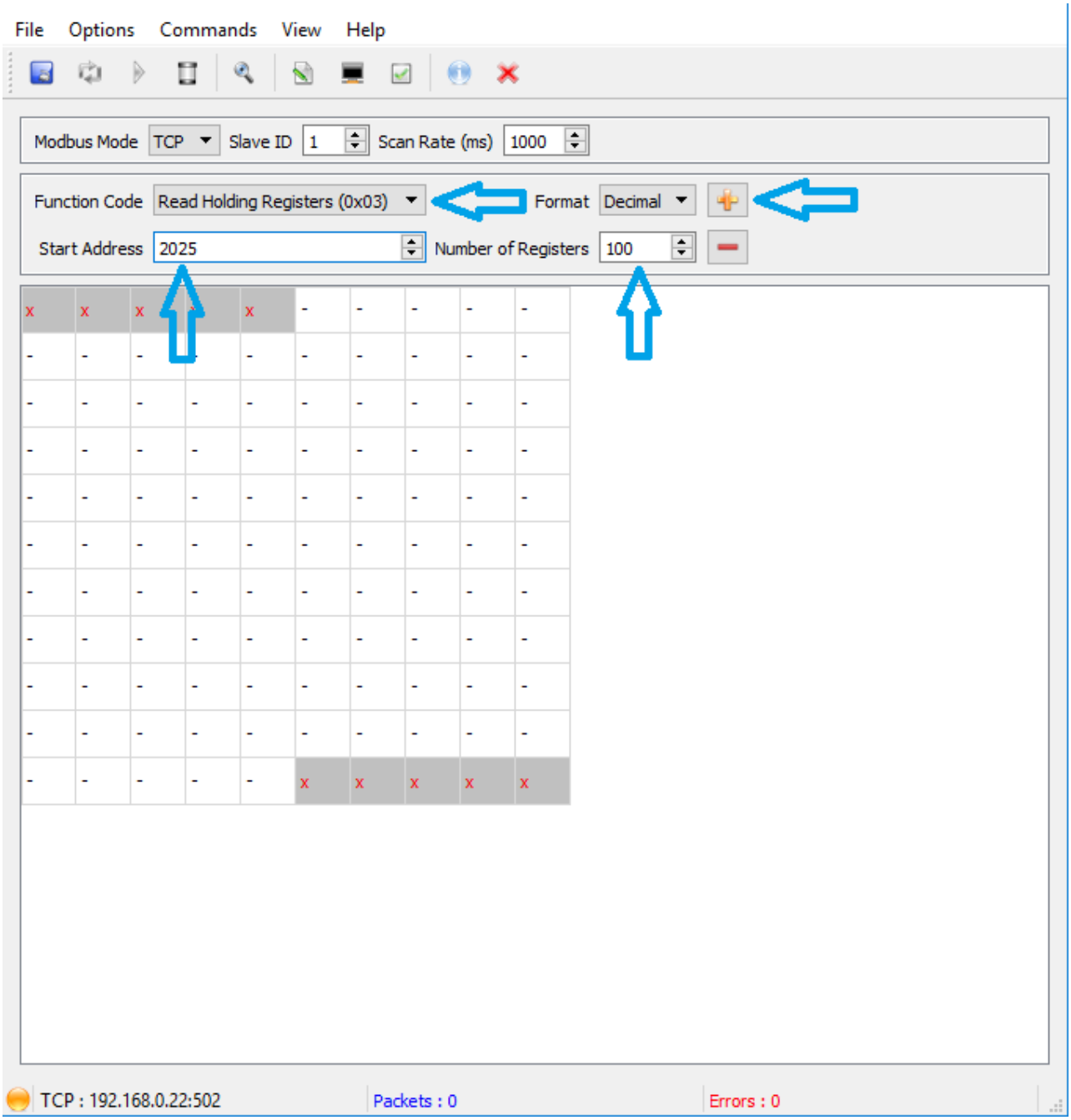
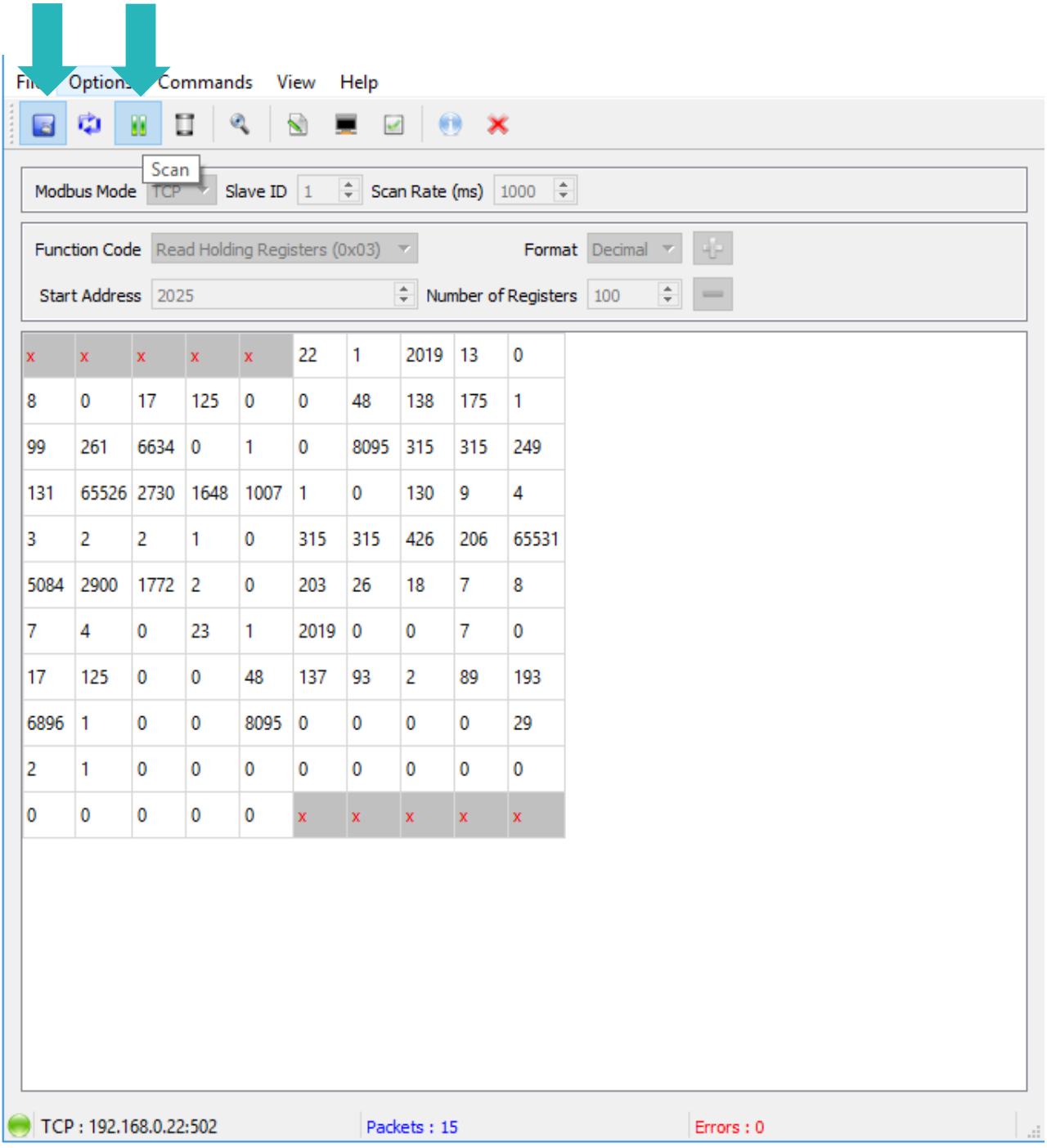


Figure 31. Function settings, start address, number of registers



x	x	x	x	x	22	1	2019	13	0
8	0	17	125	0	0	48	138	175	1
99	261	6634	0	1	0	8095	315	315	249
131	65526	2730	1648	1007	1	0	130	9	4
3	2	2	1	0	315	315	426	206	65531
5084	2900	1772	2	0	203	26	18	7	8
7	4	0	23	1	2019	0	0	7	0
17	125	0	0	48	137	93	2	89	193
6896	1	0	0	8095	0	0	0	0	29
2	1	0	0	0	0	0	0	0	0
0	0	0	0	0	x	x	x	x	x

Figure 32. The values read by the Modbus TCP protocol

OPC UA:

1. Start the program to read by protocol - OPC client (example UAExpert)
2. Select Add Server
3. Make a double click on 'Double click to Add Server'
3. Enter the IP address of the given Gateway and port 16664
    3.1. For example, opc.tcp: //192.168.0.22: 16664 where 192.168.0.22 is the IP address
4. After approval, perform a double-click on the new server and confirm the message
5. Expand the server list and select new → double click
6. In the upper left corner, our server will appear → use the right mouse button and Connect
7. After successfully connecting to OPC UA we have access to readings

Below is a step by step illustration.

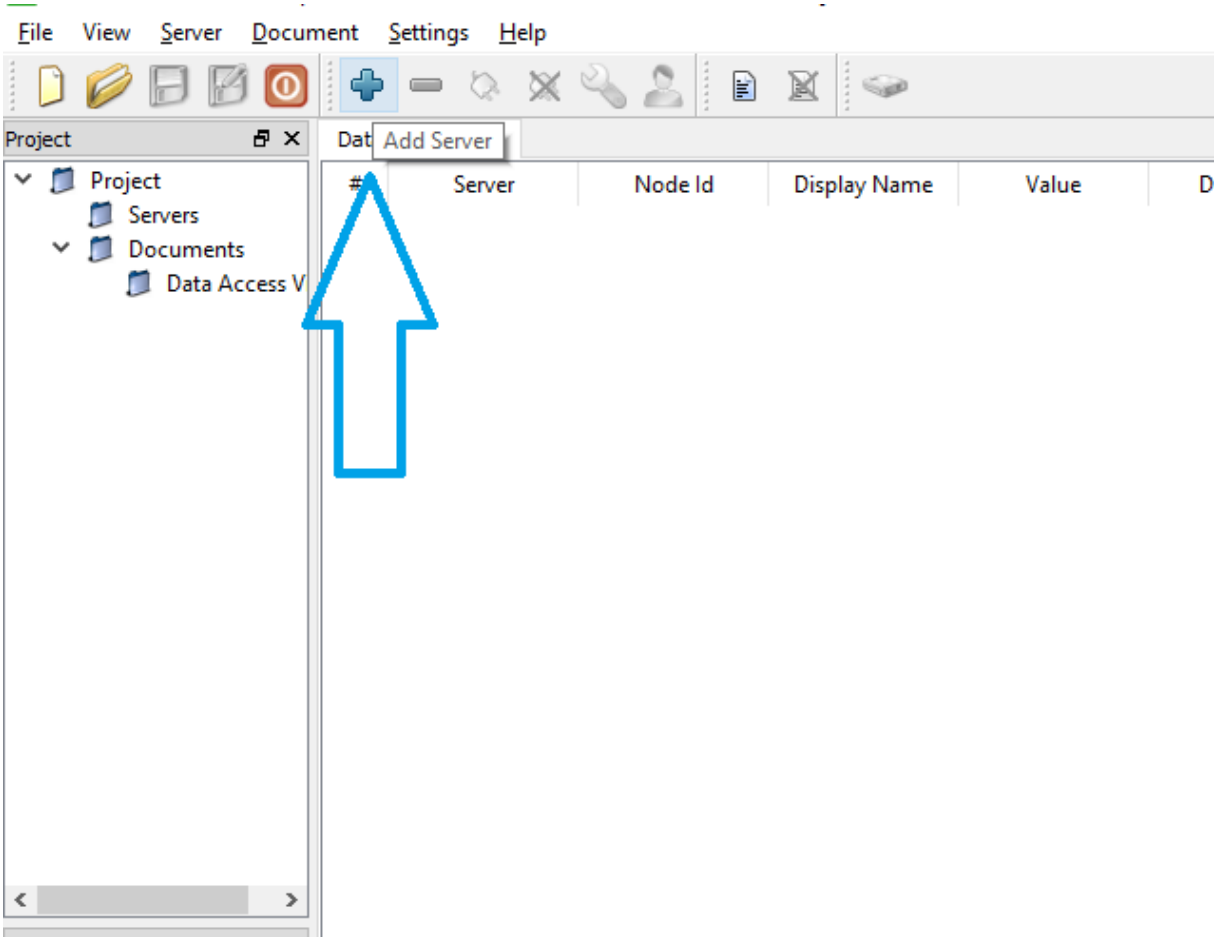


Figure 33. Adding OPC UA server

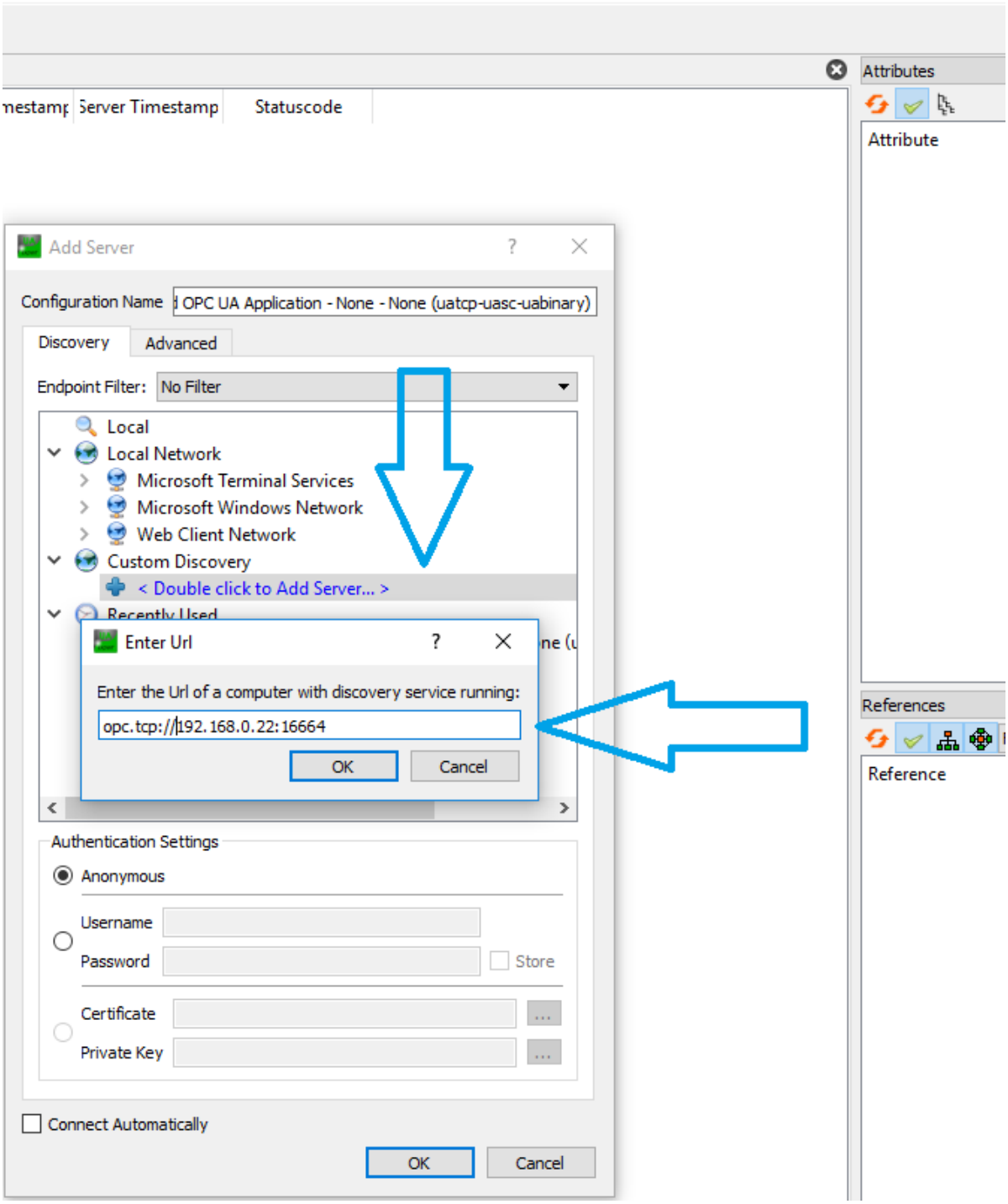


Figure 34. Url configuration

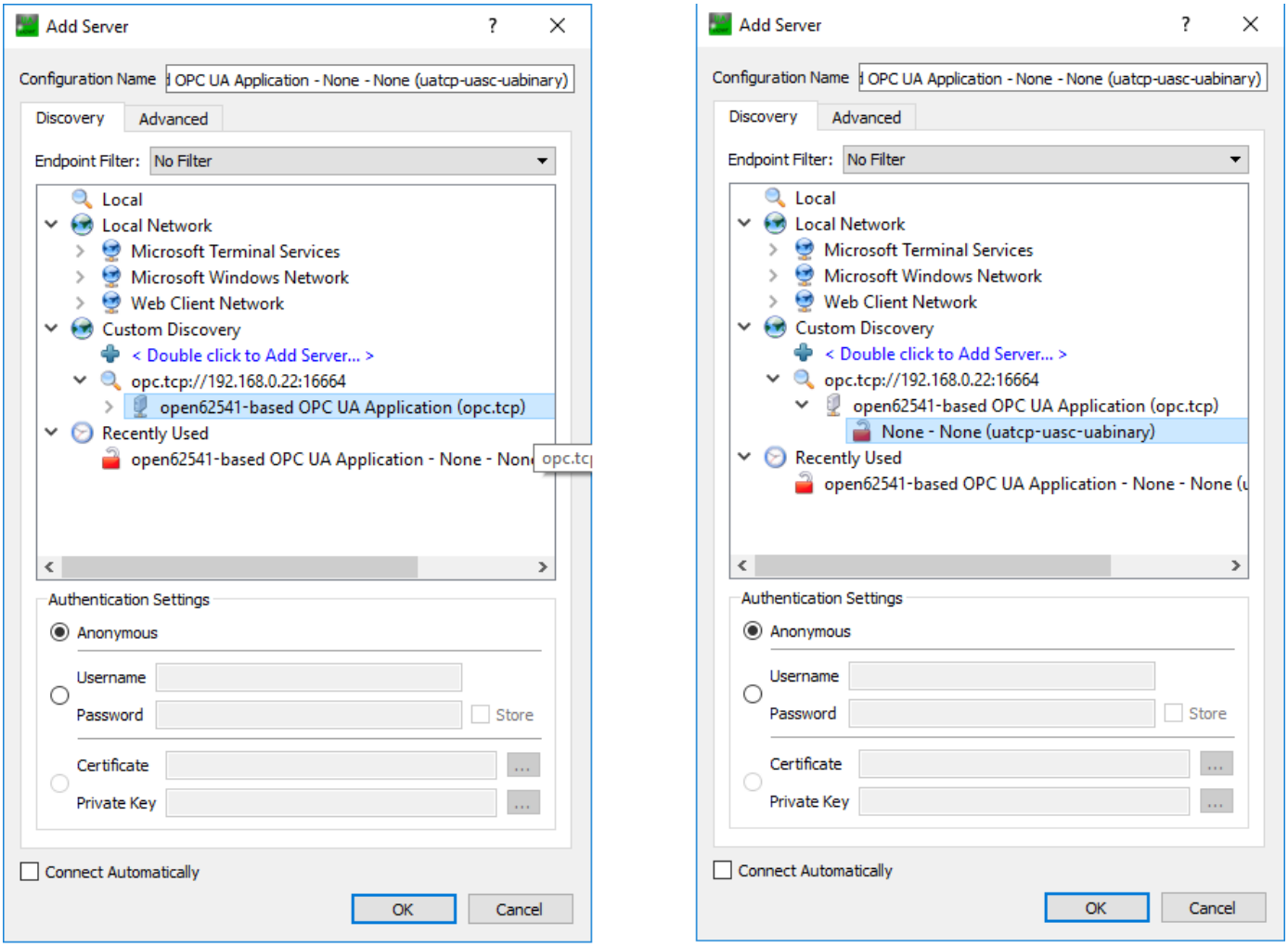


Figure 35. Choosing new server

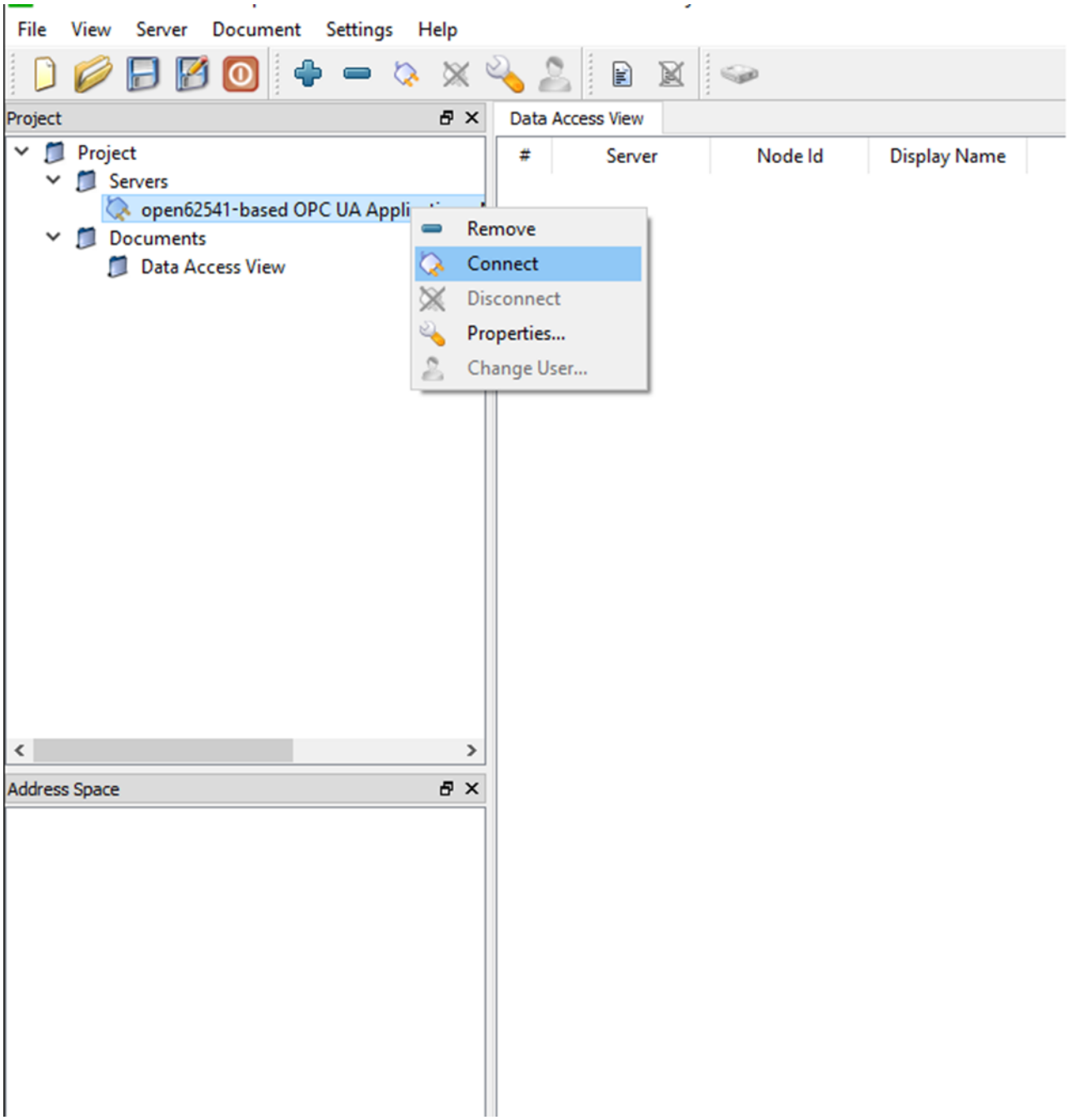


Figure 36. Connecting to new server

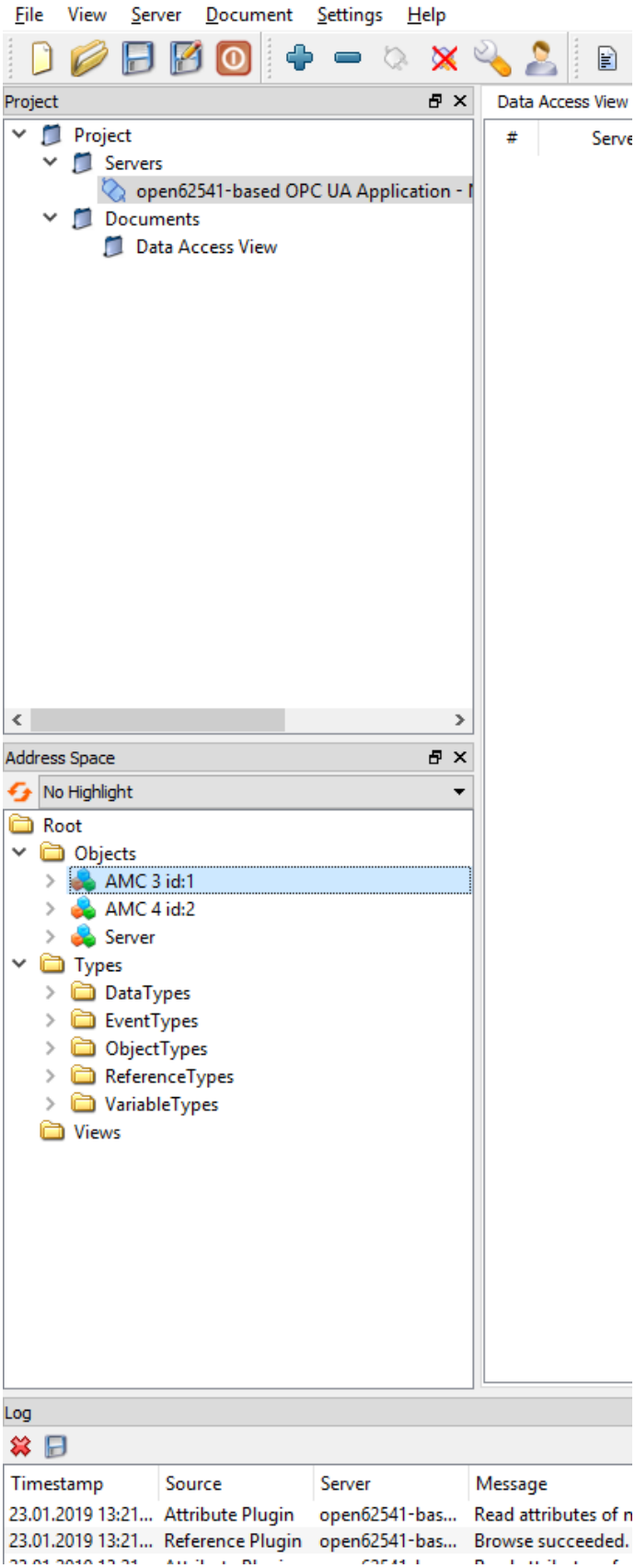


Figure 37. Ready OPC UA structure

8. Quick start

In order to start the AVS 2000R system follow the instructions below.

8.1. Mechanical part

1. Install the AV SENSOR System from AMC VIBRO on your object as described in chapter 5.

8.2. AVM GATEWAY

2. Connect the AVM GATEWAY to the power supply as shown in figure 38. After connecting the module to the power supply it will automatically start. After two minutes it will be ready to work and the website will respond.

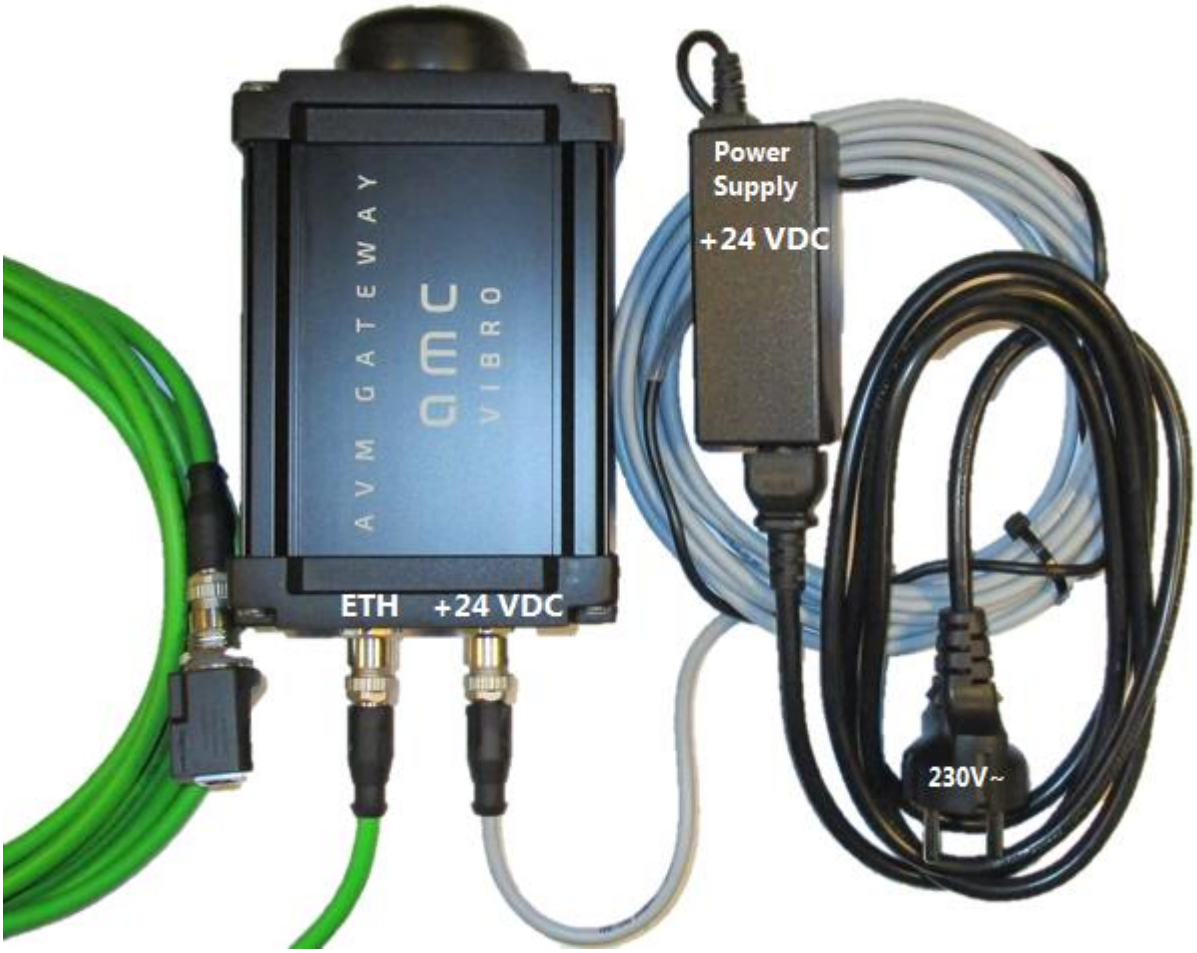


Figure 38. AVM GATEWAY description of connectors

3. Connect the AVM GATEWAY to the your computer using an Ethernet network cable.

4. Now set the network adapter of your device for example a laptop or PC computer from which you will connect to the AVM GATEWAY. For the first use set your computer IP address to 192.168.0.2 and the subnet mask 255.255.255.0. You do not need to fill other fields. The illustrations below show how to do it in the Windows 7 operating system.

» Left-click on the *Start* button and open *Control Panel*

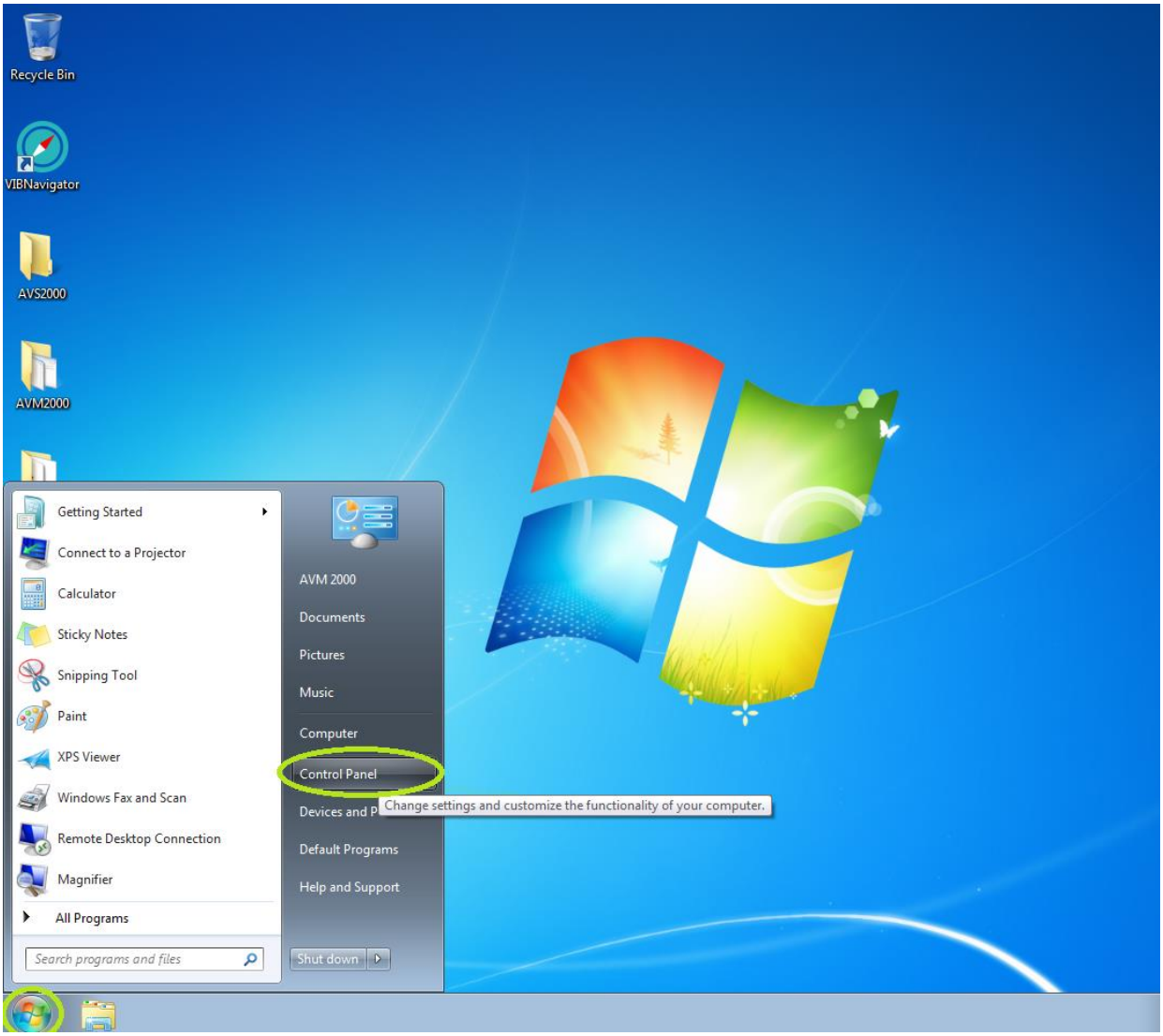


Figure 39. OS Control Panel

» Left-click on *View network status and tasks* option

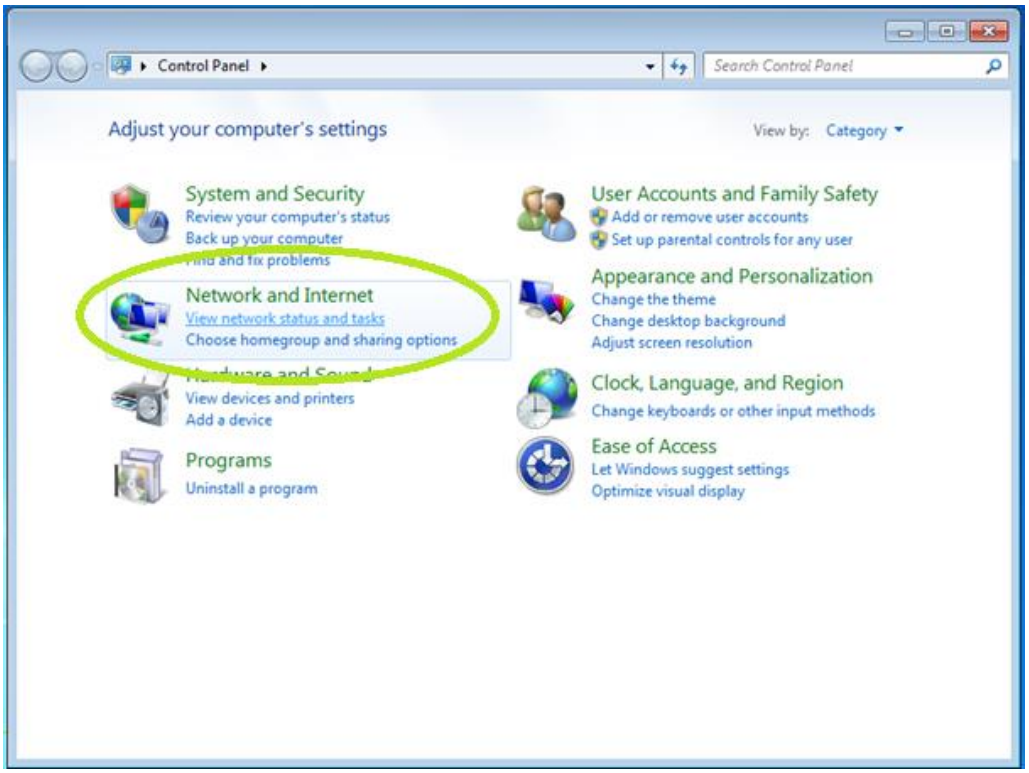


Figure 40. OS Network settings

» Left-click on *Change adapter settings* option

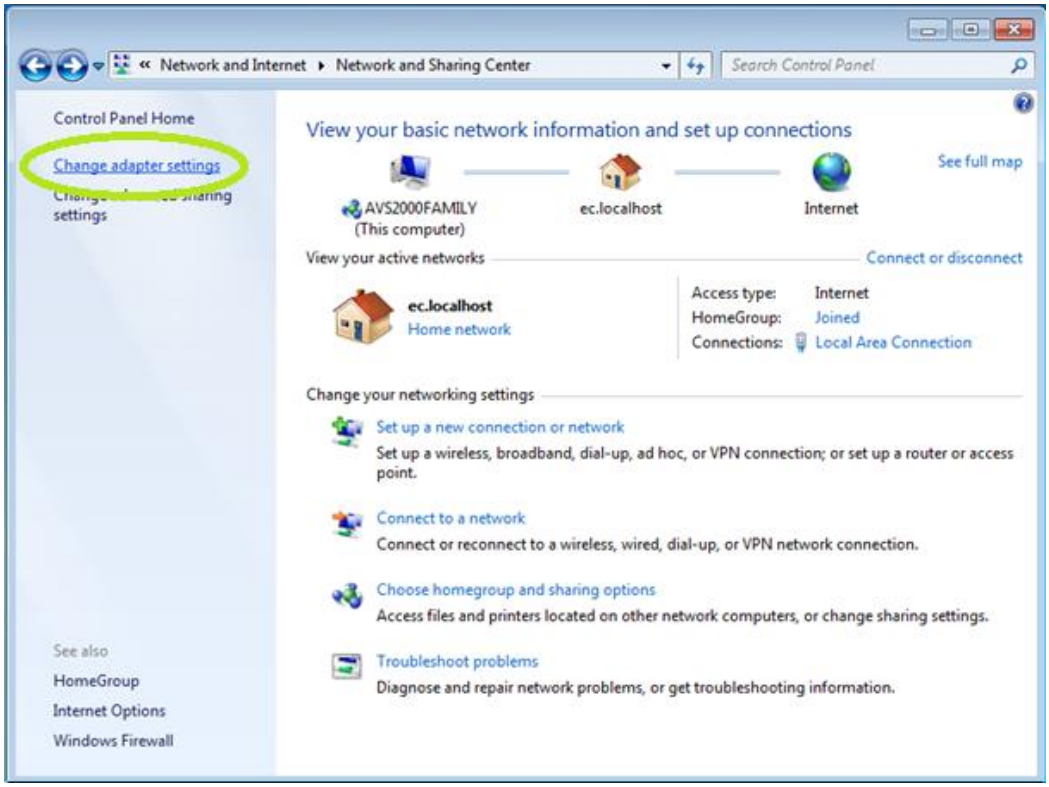


Figure 41. OS Network and Sharing Center

» Right-click on your network adapter and open its *Properties*

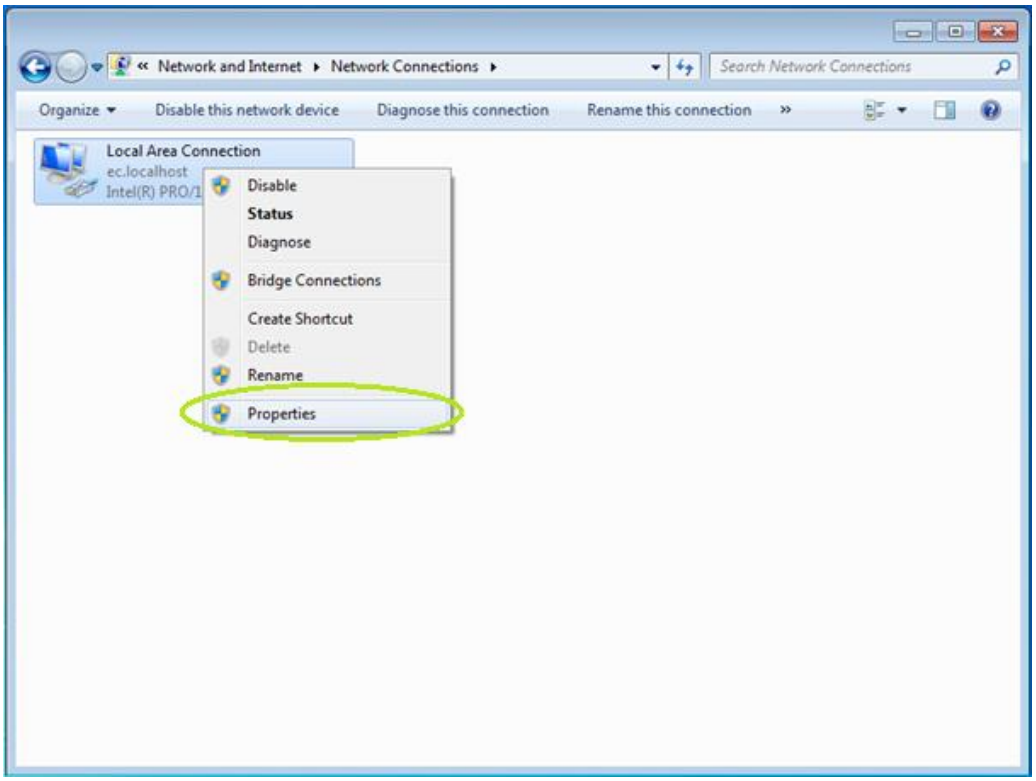


Figure 42. OS Network adapter properties

» Double-click on *Internet Protocol Version 4 (TCP/IPv4)* field

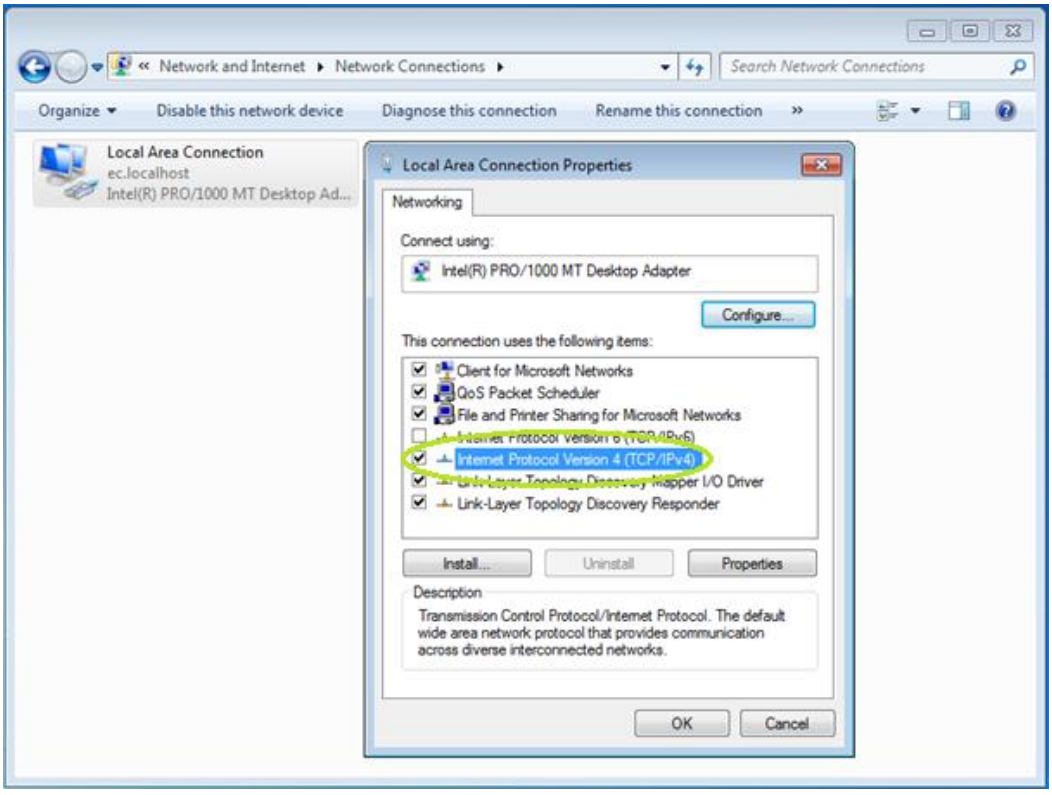


Figure 43. OS Network adapter change settings

» Select the *Use the following IP address* option and type *IP address:* 192.168.0.2 and *Subnet mask:* 255.255.255.0. Then confirm your changes by clicking *OK* in the open windows (*Internet Protocol Version 4 (TCP / IPv4) Properties* and *Your Network Adapter Properties*)

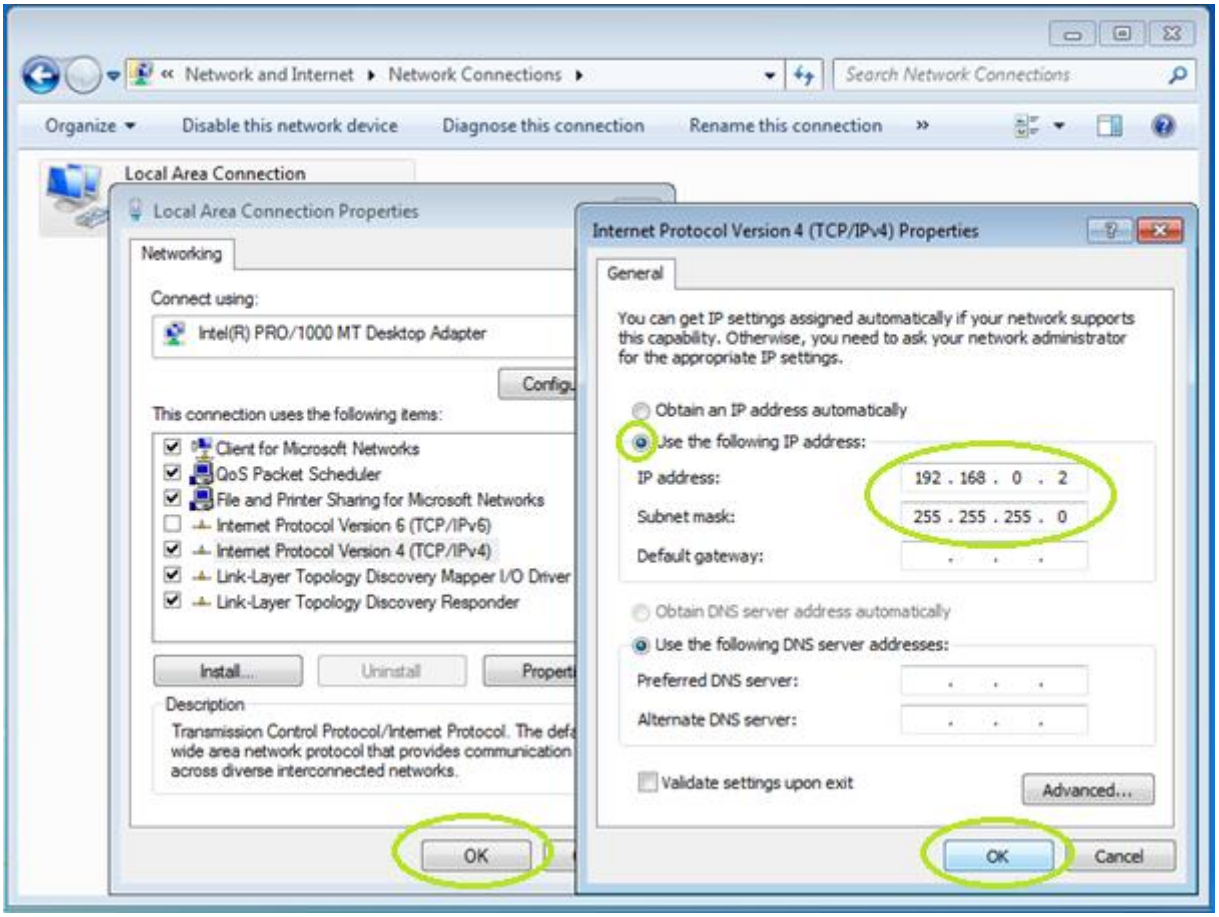


Figure 44. Computer IP address

5. After this steps you should be able to browse the website on the AVM GATEWAY. You will also be able to set the AVM GATEWAY module to the IP address of your wish.

8.3. AVS 2000R

6. Now you should wake up all of the AVS devices by applying a neodymium magnet to a device until LED blinks. After waking up the sensors will take measurements and register in the radio network map. They will be visible on the website (*Status* tab, *Overview* field). They will work according to the default configuration. The default and target settings for each sensor can be modified by user via the website in the *Configuration* tab. After receiving the target configuration the sensor will automatically wake up according to the settings.

Figure 45. Wake up the Vibration sensor

7. All modules present in the network assigned to the GATEWAY are visible in the *Overview* field. To set the device in the storage mode, you can hold the magnet in the same place as in the figure 45 for about 5 seconds until the LED light starts to blink quickly. Then just put the magnet away. Then LED light will stop blinking and the device will be in storage mode. To exit the storage mode, an operator must hold the magnet for a second in the same place as before (figure 45) until the LED lights up.
8. To remove SENSOR from network operator can use the 'x' mark as on picture below. To bring it back to network operator should wake up SENSOR 2x in a row.

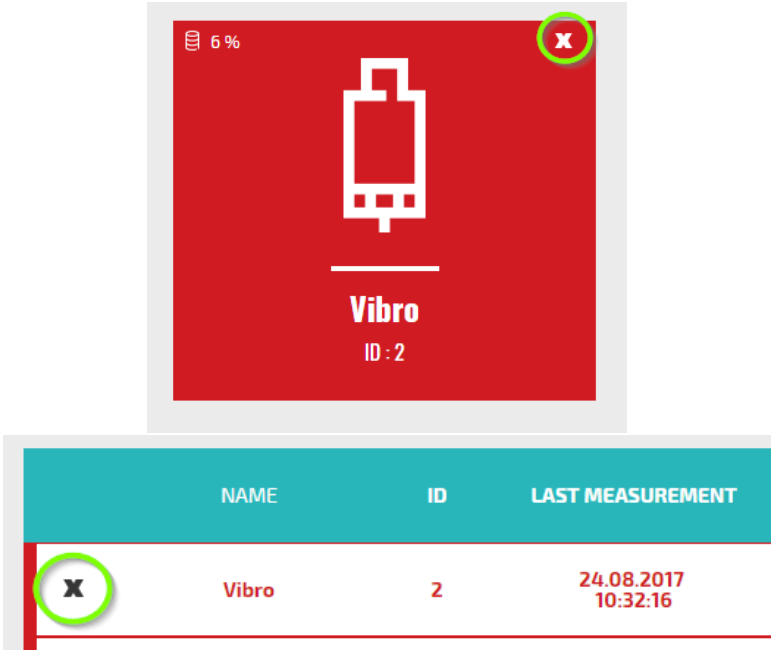


Figure 46. Removal of the AVS 2000R from the network

9. To enter any other network configuration follow the instructions in chapter 6. To view the data follow the instructions in chapter 7.

9. Battery safety and recycle

The AVS 2000R wireless sensor uses 3.6 V lithium AA batteries. Lithium batteries are volatile. When handling and storing lithium metal batteries, follow below precautions:

- Store and handle lithium metal batteries in the way to avoid contact with other lithium batteries.
- Don't place lithium metal batteries on hot and/ or metal surfaces.
- If you store an inactive Vibration sensor- remember to remove the battery.

The lithium batteries in AVS 2000R will typically last up to eight years.

9.1. Hazardous Materials

AVS 2000R system does not use any hazardous materials outlined by RoHS. These regulations confirm that lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls, polybrominated diphenyl ether, or other battery related materials are limited to no more than trace amounts.

9.2. Recycling Facilities

When decommissioning out of use devices, minimize the impact of the waste created. Refer to local waste removal administration for current information on proper material collection and recycling.