



3-COMPONENT BROADBAND
MOLECULAR-ELECTRONIC DIGITAL SEISMOMETER
CME-4211ND

USER MANUAL



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1. Overview

CME-4211ND, a 3-component broadband molecular-electronic seismometer (hereinafter referred to as 'seismometer' or 'instrument') is designed for recording the Earth's surface vibrations in 3 orthogonal directions. The instrument can be used both for permanent seismic stations and for portable field installations.

This seismometer contains 3 high-sensitive molecular-electronic sensors - transducers (1 vertical and 2 horizontal), with their sensitivity axes oriented along the 3 orthogonal axes, an amplifier's electronic board and an autonomous wireless data logger's board which are fixed on a single base and held into a protecting external case.

Being exposed to an external mechanical force due to the seismic motion of the ground, the working fluid inside the transducers (a concentrated electrolyte solution) is moved between the electrodes of the sensing cells, bringing to or drawing away from them ions of the dissolved substance. Convective flow of charged ions causes an electrical response at the electrodes.

The electrical response is amplified and converted into an electrical signal (voltage) by the amplifier board with the amplitude proportional to the speed of an external action (vibrations of the ground surface). The voltage generated this way is converted into a stream of 32-bit samples which are later stored on the instrument's memory card or transmitted further via communication channels.

The following hardware interfaces are exploited to operate the seismometer:

- A Low-speed connection - USB Full Speed (v1.1) for configuring and set up;
- A High-speed connection - USB High Speed (v2.0) for reading of the acquired data;
- A Wireless connection - Wi-Fi IEEE 802.11b/g/n type for configuring, set up and reading of the acquired data.

The seismometer is not explosive or toxic and does not cause any pollution to the environment.



DUE TO A PERMANENT TECHNICAL IMPROVEMENT AND MODERNIZATION OF THE PRODUCTS, CHANGES WHICH ARE NOT DESCRIBED IN THIS USER MANUAL AND WHICH DO NOT AFFECT THE CONDITIONS OF INSTALLATION, OPERATION AND TECHNICAL CHARACTERISTICS CAN BE INTRODUCED IN THE DESIGN.

2. Delivery set and connectors function

The delivery set includes:

- The CME-4211ND seismometer in a package;
- Leveling foot – 3 sets;
- A 1.5 meter 10-pin connector power cable with pig tails;
- A 1.5 meter 10-pin/USB-A connectors digital cable;
- A Standard digital USB A/B cable;
- A Wi-Fi SMA-M antenna for installation on the case;
- A 5-meter cable length GPS antenna;
- A technical passport.

The following items can be additionally supplied:

- A User Manual with appendices – 1 copy per batch;
- A Software CD - 1 copy per batch;
- A PC-10TB connector;
- An SMA-M / RP SMA-M adapter (to connect a Wi-Fi antenna with a SMA-F connector);
- SMA-M / SMA-M adapter.

The cables' wire assignment and connectors' pinout as well as the pictures of cables and antennas are supplied in Appendix 2 to this Manual.

The following connectors and indicators are located on the top cover of the instrument:

- A PC-10TB multifunctional connector;
- A USBBF7 (a standard USB-B) connector for data reading;
- An SMA-F connector for Wi-Fi antenna;
- An SMA-F connector for GPS antenna;
- A Green LED for time synchronization status;
- A Yellow LED for operating mode status.

Location of the connectors, description of the operating modes and location of the indicators are given in Appendix 1 to this Manual.

3. Connection

A unipolar DC power supply with a nominal voltage of 12 or 24 volts should be used to power the seismometer. The permissible voltage range for the main power supply is 9...36 V. When powered from a 12V voltage, the average current consumed by the seismometer is about 60 mA and depends on the input action. At the moment of turning on or whenever a strong input signal is applied, the current can increase up to 180 mA for the duration of the action and for several minutes after the strong signal ceased. It is desirable to use a linear voltage regulated power supply or an accumulator unit.

The power pins are located on the multifunctional connector.

A USB port connection can be used as a backup power source. The load capacity of the USB port must be at least 500 mA. The permissible voltage range for the backup channel is 4.5...5.5 V.



Be careful when applying power to the multifunctional connector! Applying a voltage over 5.5 volts to the backup power pins will damage the instrument.

Different configurations of power supply are given in Appendix 3 to this manual.

Connect a GPS antenna to the corresponding connector to operate with external coordinates and GPS synchronization. Active or passive GPS antennas can be used.

For wireless connection mode, connect a Wi-Fi antenna to the corresponding connector. The supplied Wi-Fi antenna can be connected directly to the Wi-Fi connector. An adapter (not included in the delivery set) is required to connect an extension cord or an antenna with an SMA-F connector.

4. Installation and Operation

Unlike traditional broadband electromechanical instruments, molecular-electronic seismometers are extremely durable and therefore not equipped with locks and other special devices for carrying, packaging, unpacking and transportation. The seismometer does not need a mass centering and hence does not have the output of the mass position sensor and the input signal for mass centering. The seismometer does not require a level adjustment and operates correctly at installation tilts up to 15°.

Place the seismometer on a firm horizontal surface so that the arrow "↑" on the upper plane of the case is oriented to North (Fig.1). Then the pointers in the lower part of the case will be directed along the axis from North to South. Use the pointers to set the azimuth of the instrument precisely (Fig. 2).

The sensor has three leveling feet (Fig. 3) and a bubble level. Use the leveling feet to adjust the sensor horizontally. To inspect the tilt angle, use the bubble level on the top cover of the sensor. After the bubble is in the center of the bubble level, fix the legs by means of the knurled nuts (Fig. 4).

Apply power from the multifunctional connector or from the USB connector.



Fig. 1. North direction arrow

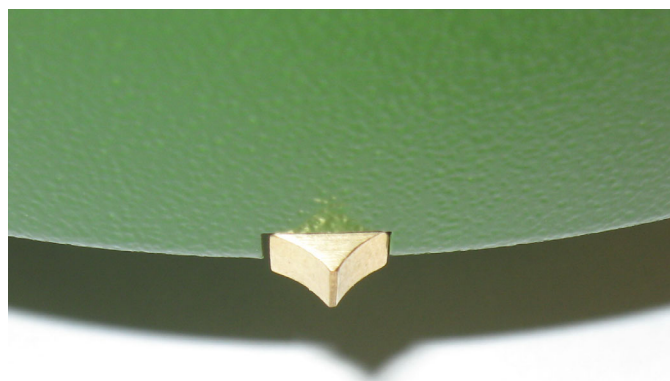


Fig. 2. The pointer in the bottom



Fig. 3. The leveling foot, a set

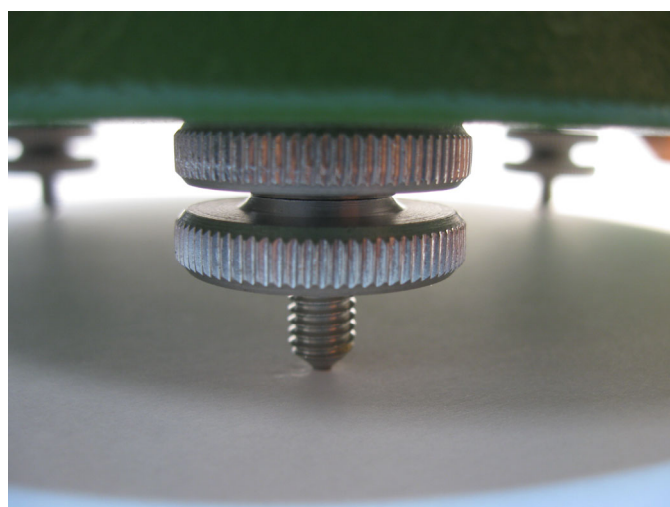


Fig. 4. The leveling foot's set-up

Operating modes of the digital subsystem of the seismometer:

- Main – the instrument is in the standby mode or the data is being logged;
- Card reader – SD card of the seismometer becomes accessible to external devices, logging is impossible.

4.1. Software installation and Initial settings

4.1.1. Software installation

The NDAS and drivers software are stored on the CD if it is supplied with the instrument. In addition, the distributive of the latest version of the software is available on the FTP server at

<ftp://download.r-sensors.ru/NDAS/NDAS%20App/>

Installation of the NDAS software requires a computer running under Windows OS. Before installing a new version of the software, we recommend that you close and uninstall the old version, then restart the computer. A user guide for installing and operating the software is given in Appendix 4 to this Manual.



Pay attention to the compatibility of the downloaded software version and the firmware of the instrument. Compatible versions of the firmware are specified in the 'Release notes' document in the software distributive folder.

While accessing the instrument via a low-speed USB channel with a 10-pin connector for the first time, an installation of an FTDI virtual COM-port driver may be required.

The drivers are available to download from the FTP server at

<ftp://download.r-sensors.ru/NDAS/Miscellaneous/NDAS%20One%20FTDI%20Drivers/>

or from the manufacturer's website at

<http://www.ftdichip.com/Drivers/VCP.htm>

4.1.2. Initial wireless settings

By default settings the seismometer operates in the 'station' mode and uses the following wireless network parameters for connection:

- SSID - 'NDAS';
- Network Password - 'NDAS12345678';
- Security type - WPA2;
- IP address, network mask and Gateway are set up by DHCP.

If your network parameters differ from the specified, you will need to connect the seismometer via the low-speed USB channel using a digital cable and to use the NDAS software to set the required wireless connection parameters.

4.1.3. Wireless connection modes

The device can be configured to operate in the following modes:

- ‘Station’ mode – connection to network via a Wi-Fi router;
- ‘Access point’ mode – connection directly to the instrument.

In the ‘access point’ mode, the instrument creates its own Wi-Fi network, with the name consisting of the specified SSID of the network defined from the settings, and the serial number. For example, if you specify ‘NDAS’ in the SSID parameters, the seismometers will create a networks with the names of NDAS_RS003601, NDAS_ND003501 and so on.



In the ‘access point’ mode, the network password must have at least 8 characters length.

Static IP settings are required to operate in networks without a DHCP server. This option is only available in the ‘station’ mode. In the ‘access point’ mode, the instrument has its own running DHCP server which always assigns the IP address 192.168.0.1 to the seismometer.



Do not use static IP settings in the networks where a DHCP server is running as this will result in a conflict of IP addresses. If you need to assign the specified IP address to the instrument, use the IP address reservation settings of the DHCP server.

4.2. Operation in the Main Mode

The NDAS software should be used to manage and configure the instrument via a low-speed USB channel.

The control and configuration of the seismometer connected to a Wi-Fi network can be carried out both with the NDAS software and via the instrument’s web interface.

4.2.1. NDAS software

The NDAS software can provide the following:

- View the current status of the seismometer (voltage, free space on the memory card, presence of Wi-Fi and GPS signals, time synchronization status, other available parameters);
- Setting the parameters of SSID wireless network, password, safety modes;
- Changing of configuration parameters (sampling rate, setting the scheduled records, setting the input gain of the channels);
- Manual start and stop of registration;
- Preview of the received data on the fly;
- Operations with the built-in SD card (clear, start registration, switch to the data reading mode);
- Emitting of testing signals.

4.2.2. Web Interface

The web interface is designed for convenient configuring NDAS instruments on smartphones and tablets. Access to the web interface can be made through a browser of any device connected to the same network as the seismometer does. The web interface allows you to perform the same operations as the NDAS software, but for editing the schedule recording table as only the first row of the table will be available for editing.

The access to the web page with the settings can be performed by entering the local domain name of the instrument represented as <serial>.local (for example, RS003601.local) or directly via the instrument's IP address.

A detailed user guide for the web interface is provided in Appendix 5 to this Manual.

4.2.3. FTP server

An FTP server can be used to access files on the memory card of the instrument over the network. You can use any modern browser (Chrome, Firefox, IE, Safari), Windows Explorer as well as specialized programs such as Total Commander or FileZilla to view the file system and files download.

To access the FTP root directory, type with the prefix “FTP” the IP address of the instrument or the local domain name (in case the Bonjour service is available) in the address bar, for example, "ftp://192.168.0.100" or "ftp: //rs003601.local". The server accepts any username and password.

A detailed user guide for handling the FTP server is provided in Appendix 6 to this Manual.



The FTP server is unavailable whenever the instrument is set in card reader mode.



If the data is being registered, the FTP server allows you to download all files except for the files that are currently open for writing – the current SIVY file as well as the current 1-Hz record file.

4.2.4. Safe modes of FTP and Web-servers

Safe modes are designed to prevent data loss for cases in which access to the interface and file system is open to a wide range of users. In the safe mode of the web interface, the instrument parameters can't be changed and start and stop commands are blocked. Only reading of the instrument's parameters and preview of the acquired data are available. The safe mode of the FTP server restricts access to the file system with the ‘read only’ mode. The safe mode settings can only be changed through the NDAS software only.

4.2.5. Serial port and Log display

All major events of the instrument firmware come along with corresponding log messages which are translated to the serial port of a low-speed USB connection and can be displayed by programs for operating with the terminal. In the Windows environment, such programs include ‘Tera term’, ‘DockLight’, ‘Terminal by Bray’ and so on. Specify the following values to configure the serial port:

- Baud Rate – 115200;
- Data bits – 8;
- Stop bits – 1;
- Parity bits – 0;

Use a digital cable with a 10-pin connector and a USB-A connector to handle the serial port. The cable is to be connected to the multifunctional connector.



When using a wired connection, the NDAS software also communicates with the instrument through the serial port so in this case you should disconnect all terminal programs which can block access to the port. And vice versa: the NDAS software will block access to the serial port for other programs.

The NDAS software communicates with the instrument through the serial port by means of an internal communication protocol. Upon the receipt of the first package which has a corresponding format header, the instrument switches to the protocol communication mode. In this case, all messages of the log file are also packed into the NDAS package format but, if necessary, the message body can still be read by any terminal program.

4.2.6. File System

The main directory of the instrument is a folder named 'RS_XXXXXXXX' where 'XXXXXXXX' is a serial number of the seismometer. Inside the main directory the instrument creates subdirectories, which are called 'working directories' with signal records as well as the 'LOGS' directory in which working logs are being stored.

The system sets up a working directory at the time of creation of the first record file. If there are valid data on the current time at the time of creation of the directory, the name of the working directory will be formed according to the principle of 'YYYY-MM-DD' that is year-month-day. If there is no time information, then the name will include 'NO_TIME_xxx' where 'xxx' is the next number in the order.

The working directory remains unchanged during the time of the instrument's continuous operation except for the following two cases:

If the working directory was created in the absence of time data, then after the synchronization procedure is completed, the working directory will be changed and all subsequent data will be written to the directory with the correct name.

After switching the instrument from the card reader mode back to the main mode, the file system is initialized that results in updating the working directory.

Inside of the working directory, the instrument creates recording files with a name of 'YYYY-MM-DD HH-MM-SS' that is 'year-month-hour hour-minute-second' corresponding to the actual start time rounded off to a second. Recording files have an extension of '* .siv'.

When you turn on an option of registering an additional 1-Hz signal in the working directory, a subdirectory with a name of '1Hz' is being created which holds additional files being recorded.

The 'LOGS' folder contains text files of the system log with a format name of 'LOG_xxx' where 'xxx' is a file sequential number. The contents of files duplicate text messages which are transmitted to the serial port by the instrument. The maximum size of a log file is limited to 1 Mb, as soon as the size is exceeded, a new file with the next sequence number is created. The data are written consecutively and in case of a reset, the recording continues to the latest file.

4.2.7. Time Synchronization

This instrument automatically associates the recorded data with the exact time received by the GPS/GLONASS receiver. The process of synchronizing the system clock with the exact time can take from a few seconds up to 30 minutes – it depends on temperature conditions, the time which has passed from of the latest synchronization and conditions for receiving the satellite signal at the installation place. The synchronization process goes through several stages:

- After connecting the GPS/GLONASS antenna, the receiver searches for satellite signals and, in case of a steady signal, provides a solution to a navigation task – it determines coordinates and time. At this point, the 'GPS' flag lights up in the NDAS software window and the 'GPS' LED on the case starts blinking slowly;
- The clock generator is being adjusted - till a fine-tune to the clock;
- After the adjustment is completed, the system clock is corrected with an accuracy better than 1μs. At this point, the 'SYNC' flag lights up in the software window and the 'SYNC' LED on the case starts blinking regularly.
- After the synchronization is completed, you can turn off the GPS antenna – this will not affect the instrument's normal operation.

- However, if a GPS signal is present during the recording, the instrument will continue to adjust smoothly a frequency of the clock as well as to put time stamps each minute and measure the current drift of the clock. This will significantly improve a time accuracy of recording and will improve the correlation of recording of two devices operating independently.



The time synchronization is retained until the instrument is being reset. In most cases changing of parameters of the instrument results in its reset and loss of synchronization as a result.

To correctly convert the GPS time into UTC, the system maintains up-to-date information on coordination seconds, also known as leap seconds. Updating the number of seconds of coordination may occur once in six months just before January 1 and July 1. Changing the number of seconds of coordination may require updating the instrument's firmware. Recalculating the seconds of coordination may take up to 15 minutes and the time synchronization can be performed only after the process of recalculation is over.



In order maintain the integrity of the record whenever at the zero time of January 1 or July 1 the data logging is running, the time will not be corrected even in case the amount of leap seconds were changed until the next stop of the recording.

4.2.8. Registration Module Modes

There are 4 modes of the registration module:

- Manual mode – registration is started and stopped manually through the NDAS software or WEB-interface;
- Immediate start – registration starts automatically when the instrument is turned on;
- Synchronous start – registration starts automatically after the synchronization is done;
- Operation by the schedule – registration starts and stops automatically at a set time.

The GPS synchronization is not necessary in the manual and immediate start modes. In case the signal recording started before synchronization, the files header will miss data of the exact time and the files will be placed in a folder of 'NO_TIME_XXX' where 'XXX' is a sequence number.

If during the registration that was started before the synchronization, a GPS signal will appear – the instrument will start a synchronization procedure without interrupting the recording. In this case,

once the procedure is completed, a new working folder with a correct name will be created and the next data block will be written to a new file that has the correct timing data.

While in the synchronous start mode, the instrument starts recording from the beginning of the next whole minute after the synchronization procedure is completed.

While in operation by the schedule, the signal recording starts automatically at a set time with an accuracy of up to one count. Registration in this mode always starts after synchronization being done, but after the instrument is synchronized, the presence of a GPS signal is not necessary until the moment the power is turned off or the instrument is reset.

The instrument finds the time-nearest row in the table and waits for the start time. If the acquired current time is within one of the intervals set up by the table, the recording starts immediately from the next whole minute. In any case the registration will stop at the end of the current table interval. Then the instrument proceeds to the next row of the table.

When the end of the table is reached, the instrument switches to the manual mode. If the ‘shutdown after finish’ option is set – the instrument goes into a hibernation mode which results in a reduced power consumption. The return from the hibernation mode can be done via switching the power supply.

In case of a power failure while the scheduled recording is being performed, it will resume only after the synchronization with a GPS signal is restored. The presence of a GPS signal in this case is necessary to resume a schedule recording.

4.2.9. Cyclic Recording Option

If the option of a cyclic data recording is enabled and there is not enough space on the SD card, the software starts deleting the oldest files to free more space. While using this option, you have to pay attention to the following:

- Scanning of files occurs only inside of the logger’s main directory – meaning the directory named ‘RS_xxxxxxx’ where ‘xxxxxxx’ is the serial number of the seismometer. All other directories are ignored;

- Scanning occurs only among files with the extension of ‘.siv’. All other files are ignored;
- If after the cleaning procedure no files remain in the directory, then such a directory is also deleted;
- A time attribute of the file modification is used as an evaluation criterion.



Be careful when using the cyclic recording option if there is no time synchronization. When you turn on the instrument, the clock starts from the same moment – on January 1, 2017, so the files will be deleted in the sequence which differs from the one the files were actually written.



Avoid configurations in which a large number of small files will be created on the instrument – this can lead to a slower operation of the file scanning function and also may lead to a data loss.

4.2.10. Option to record an additional signal of a 1-Hz frequency

When you turn on the option of recording an additional signal, in addition to the main data the instrument starts recording additional files with a 1-Hz sample rate. The files get into a subdirectory called ‘1Hz’ and are named by the same principle as the main files except for the ‘1Hz’ suffix.

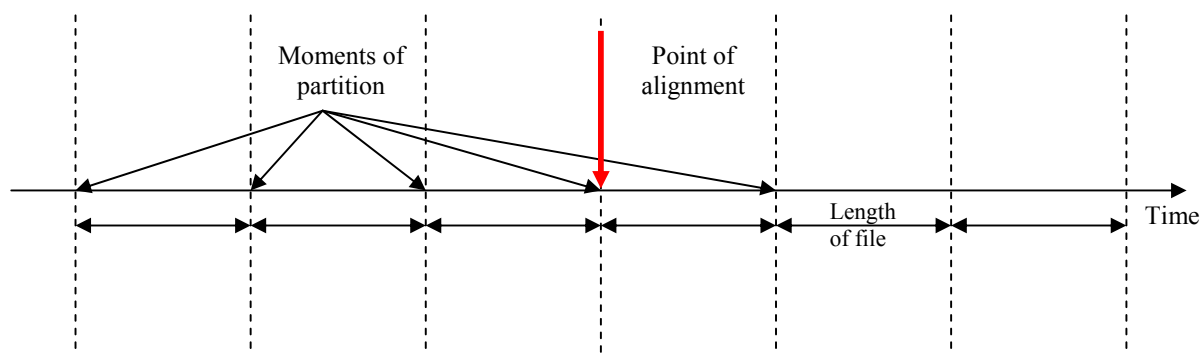
In general, main and additional files are created synchronously (at an accuracy of 1 count) and have the same name but there are possible situations in which they will be desynchronized:

- If the SD card was removed during recording and then inserted back;
- If, in the schedule recording mode, the memory card was installed after the synchronization had been performed and the start time had been skipped;
- If the working directory of the software has been changed during a time synchronization process.

In all the above-mentioned cases, the registration module firmware will create new files on the memory card with the earliest data stored in the buffer being the beginning of these files. Since the buffer size and the amount of data in the buffer for different signals and at different times are different, the start time of the files will also differ.

4.2.11. Option to align the beginning of files to a certain time

An option to align the beginning of files to a certain time affects the moment at which the partition is made and a new file is opened. This option is useful in a case when it is necessary to get records of the same time intervals from several instruments that are not started synchronously (not in the table mode). The moments of 'partition' are counted from the alignment time through intervals that are multiples of the specified length of the files. The algorithm is shown in the figure below.



Example 1.

A length of a file is 3 hours, a point of alignment is 17 July 2018, 16:00:00.

The record starts on 17 July at 11:45.

A new file will be created at 13:00, then at 16:00, at 19:00 and then every 3 hours.

Example 2.

A length of a file is 1 hour, a point of alignment is 01 January 2017, 00:30:00.

The record starts on 17 July 2018 at 12:43.

A new file will be created at 13:30, then at 14:30 and then in the middle of each next hour.

Example 3.

A length of a file is 24 hours, a point of alignment is 01 January 2017, 18:00:00.

The record starts on 17 July 2018 at 13:30.

A new file will be created at 18:00 and will continue to be created every day at the same time.

4.2.12. Data Filtering

The instrument's analog-to-digital converter generates a signal with a sampling rate of 1000 Hz. Output signals with frequencies below 1000 Hz are generated by a decimation going along with an anti-alias filtering of high frequencies.

FIR (finite impulse response) filter cascades with a linear phase response are used as filters. Contact the manufacturer to learn more about the filtering algorithms.

General characteristics of the filters are presented in the table below:

Finite impulse response, Hz	Delay*, msec	Edge of passband, Hz	Edge of stopband, Hz	Unevenness of frequency response, mdB	Coefficient of suppression, dB
500	63,5	200	250	0,7	-177
250	95,5	90	120	0,7	-175
125	349,5	50	62,5	1,4	-177
100	413	40	50	1,5	-177
50	573	18	24	1,5	-175
25	2483	10	12,5	2,2	-177
10	2960,5	3,6	4,8	2,3	-175
5	4679,5	1,625	2,425	2,6	-174
1	23779,5	0,325	0,485	3,4	-174

* Delay of a cascade of anti-aliasing filters presented without consideration of an additional signal delay caused by the ADC inner circuits which is 4.5 msec.

4.3. Operation in the Card Reader Mode

The Card Reader mode is used to transfer quickly the recorded information from the SD-card of a seismometer to a PC for further processing. To use the seismometer in the card reader mode, connect it to a PC using a USB A/B standard digital cable.

Switch the seismometer to the card reader mode using the 'card reader' command of the NDAS software or the web interface. The seismometer in this mode can be powered via either of USB ports or via the main power channel.



To give the command to switch to the data reading mode, the NDAS software must have either a wireless connection or a low-speed USB connection with a seismometer.

In the card reader mode, the seismometer's SD-card looks like an ordinary external flash drive with all operations – read / write / format - which are similar to a standard USB drive under a PC operating system.

The instrument automatically escapes of the data reading mode when the USB-B cable for files transfer is disconnected as well as after a reset. In addition, the mode can be switched off by means of the NDAS software or the web interface.



The FTP server can be used to read data over the network (see section 4.2.6).
If the instrument is in the card reader mode, the FTP server becomes unavailable.

4.4. Firmware Upgrade

NDAS series instruments manufactured after 2018 have a built-in bootloader which allows to perform a secure update of the firmware, the license file and the web interface pages.

Each time the instrument is powered on or reboots, the loader checks the root directory of the memory card for the presence of the following files, and, if any, updates them:

- ndas_firmware.bin – a firmware file;
- ndas_bootloader.bin – a bootloader file (**unsafe – see the note below**);
- ndas_license.dat – a license file;
- ndas_webserver – a folder containing html-pages of the web interface.

To update, place the file or folder into the root of the instrument's memory card in any available way, you have to be sure that the name is correct, reset the instrument and wait until the update process is completed. The process goes along with alternating frequent flashing of the LEDs, after this process is successfully completed, the LEDs go into a normal mode.

If necessary, during the time of updating you can watch the messages display in the log file by means of one of the terminal programs (see section 4.2.5). All messages also get into BOOT_LOG.txt which is created in the main directory of the memory card.

Make sure the firmware version has been changed through the NDAS software, the web interface or the contents of the log file.

The files for download and the latest information about the changes and compatibility are available on the FTP server at <ftp://download.r-sensors.ru>.



If the firmware update is interrupted or failed, the instrument will boot in a safe mode using the default firmware. In this case you need to retry the update.

The version of the latest boot can be checked through the NDAS software, the web interface or through the log file on the memory card.



The bootloader updating procedure ('ndas_bootloader.bin') is unsafe. In case of an error or a power failure, the instrument will stop operating during the update process. To restore the functionality, it will be necessary to repair it at the manufacturer's facility, therefore it is not recommended that you update the loader without a strong necessity.

5. Conditions of operation

The seismometer is protected from fluctuations of temperature and atmospheric pressure, however, to reduce a level of undesirable set up effects caused by temperature changes and air convection, it is recommended covering it with a casing of porous heat-insulating material (foam, polyurethane foam and the like).

After unpacking, installing and connecting, the instrument will be operational within 10-15 min. Within first 24-72 hours, depending on the ambient conditions, the noise level will be little higher and sparse spikes may occur in the output signal. This is normal for settling.

In accordance with the international standard of a dust and water protection, the seismometer's degree of protection is IP 54 that is partial dust protection (it does not penetrate in the amount which can interfere with the operation), protection against water splashes in any direction.



The instrument must not be immersed in water or be installed in water-flooded areas without an additional protection!

6. Calibration

Analog circuits of the seismometer have a flat-speed response in the entire bandwidth with a -3 dB slope at the edges of passband. The analog circuits are calibrated and adjusted with a ± 1 dB precision.

The seismometer is capable to self-test for a vertical channel by giving reference signals of a sinusoidal and rectangular shape. Horizontal channels do not have a capability to self-test due to absence of feedback circuits.

The procedure for handling test signals is given in Appendix 4 to this Manual.

7. Carrying and Storage

The seismometer is quite strong and practically is not subject to damage during transportation. Use packages provided with the seismometer or any packaging materials to prevent damage to the connectors and scratches on the case. A temperature range for storage is from -15 to +70°C (low temperature version -40...+70°C).



It is not recommended to turn the device upside down or keep it in lateral position during transportation. The transportation in these positions will result in longer settling period with higher noise level.

8. Warranty and Service

The warranty period of the product is 18 months. Within this period the instrument which proves defective should be returned to the manufacturer for free repair or replacement.

This warranty shall remain valid provided there are no signs of opening and/or external damage to the housing resulting from abnormal use of the device.

After this period the regular repairing charges will apply.

9. Manufacturer Information

Manufacturer:

R-sensors LLC

8A Zhukovskogo street, Dolgoprudny, Moscow region, 141701, Russia

Tel.: +7 (498) 744-69-95

E-mail: r-sensors@mail.ru

10. Specifications

10.1 Electrical Specifications

Supply voltage main source	12/24 V DC nominal (9 – 36 V permissible range)
Supply voltage auxiliary source (USB)	5 V DC nominal (4.5 – 5.5 V permissible range)
Power consumption from the main source during stand-alone recording	< 800 mW, depending on the input signal's intensity
Power consumption from the auxiliary source Nominal / peak	140 mA / 350 mA

10.2 Mechanical Specifications

Connector types	PC10-TB 10-pin multipurpose male connector (Russian made) SMA-M for an active/passive GPS antenna SMA-M for a Wi-Fi antenna USB-B – a high-speed USB port
Weight	5.0 kg
Dimensions	Diameter: 180 mm Height without a handle: 160 mm Height with a handle: 195 mm
Case material	Aluminum

10.3 Sensor Specifications

Sensor type	Molecular-electronic seismic sensor
Axes	3 orthogonal sensitivity axes – Up, North, East
Standard gain	2000 V/(m/sec)
Output signal type	analog, differential
Clip level	± 10 V (or ± 5 mm/sec)
Bandwidth	30 sec (0.033 Hz) – 50 Hz
Maximum installation tilt	$\pm 15^\circ$
Temperature range	- 12..+55°C - 40..+55°C (low temperature)
Output impedance	1000 Ohm
Self noise at 1 Hz	8.9 nm/sec (17.8 μ V)
Integral noise in the band	
0.0167 (60 sec) – 50 Hz	76 nm/sec (152 μ V)
0.1 (10 sec) – 20 Hz	28.4 nm/sec (57.8 μ V)
Dynamic range at 1 Hz	112 dB
Cross-axis coupling	-60 dB

10.4 Digitizer Specifications

ADC type	Sigma-delta
Number of channels	3 (main)
ADC sampling rate	1, 10, 50, 100, 250, 500, 1000 Hz
ADC resolution	24 bit
ADC noise performance	22 bits noise-free resolution at 100 sps
Data recording format	Internal, binary, miniSeed, SEG converter
GNSS receiver	GPS / GLONASS
GNSS timing accuracy	< 1 μ S
Reference clock stability	± 0.5 ppm
Data recording mode	Manual, schedule, autorun on power-up, autorun on GPS synchronization
Data storage	32 Gb micro SD flash storage (class 10)
Data transfer protocols	Full-speed USB 1.1 (configuration) High-speed USB 2.0 (data reading) Wi-Fi IEEE 802.11b/g/n (wireless)
Temperature range	-25...+85°C - Standard Temperature microSD -45...+85°C - Industrial Temperature microSD
Inbuilt sensors for instrument's health monitoring	Voltage supply, temperature sensor

APPENDIX 1. LOCATION OF CONNECTORS AND MODES OF INDICATION

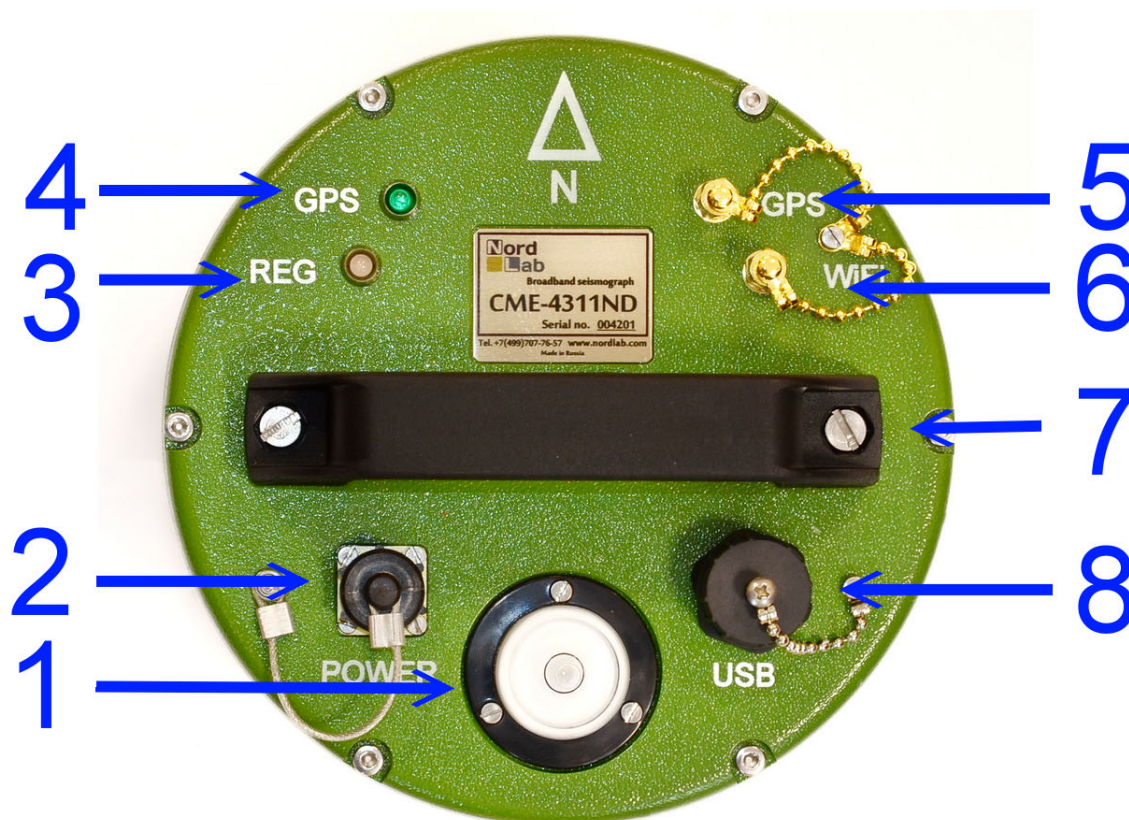


Fig. 1. Connectors and Indicators

Table 1.

Notes on the figure

№	Purpose
1	Bubble level
2	Multifunctional connector
3	Yellow LED for REG (mode of operation)
4	Green LED for GPS (synchronization status)
5	GPS antenna connector
6	Wi-Fi antenna connector
7	Handle
8	USBBF7 data reader connector

Table 2. Modes of LED Operation*

*After powering or reboot while the firmware is being loaded, the LEDs flash ‘frequently’ for 4-8 seconds, then go out.

Color	Mode of Operation
Yellow – mode of operation	<p>2% on / 98% off – no recording, no schedule set up</p> <p>10% on / 90% off – waiting to start on the schedule</p> <p>50% on / 50% off – signal recording</p> <p>Frequent flashing - incorrect parameters or error</p>
Green – synchronization status	<p>100% off – no satellite signal, no synchronization</p> <p>10% on / 90% off – there is a satellite signal, no synchronization</p> <p>90% on / 10% off – no satellite signal but there is synchronization</p> <p>50% on / 50% off – there is a satellite signal and synchronization</p>

APPENDIX 2. CONNECTORS, CABLES, ANTENNAS

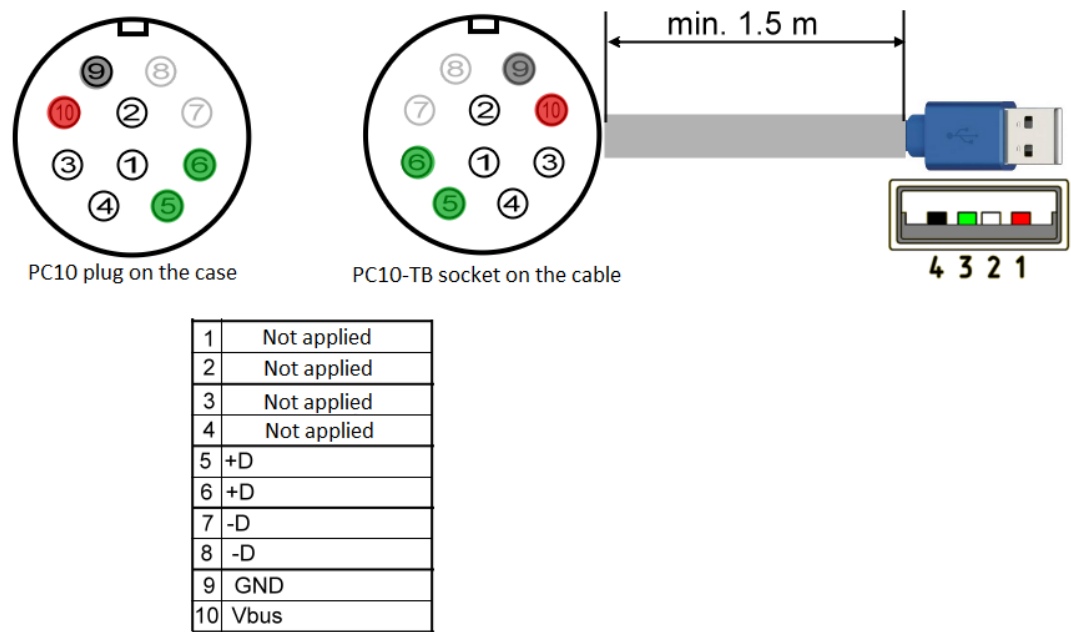


Fig. 1. Multifunctional connector, digital cable

Supply cord, 1.5 meter

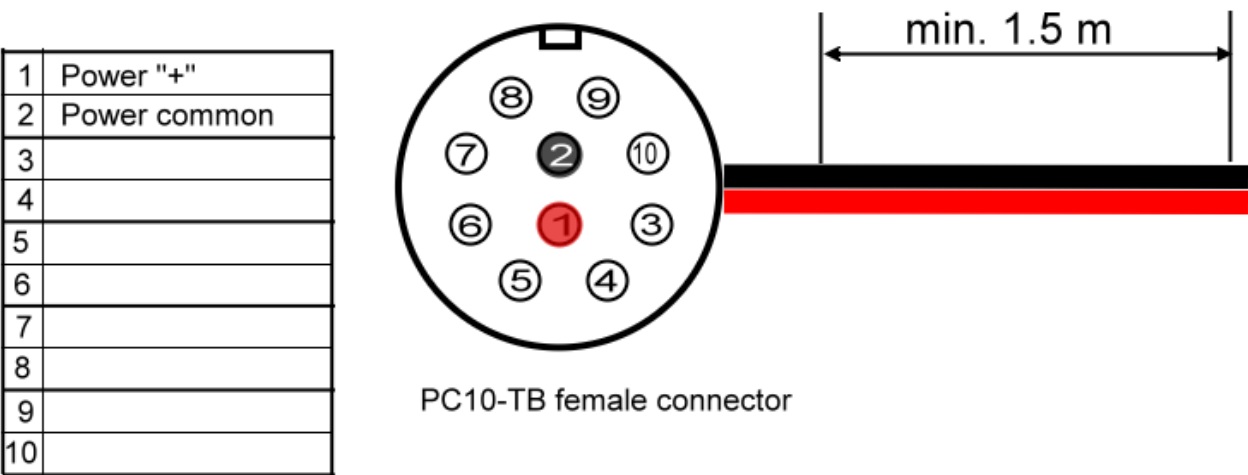


Fig. 2. Multifunctional connector, power cable



Fig. 3. Digital cable



Fig. 4. Power cable



Fig. 5. USB A/B standard digital cable



Fig. 6. Wi-Fi antenna – connector view

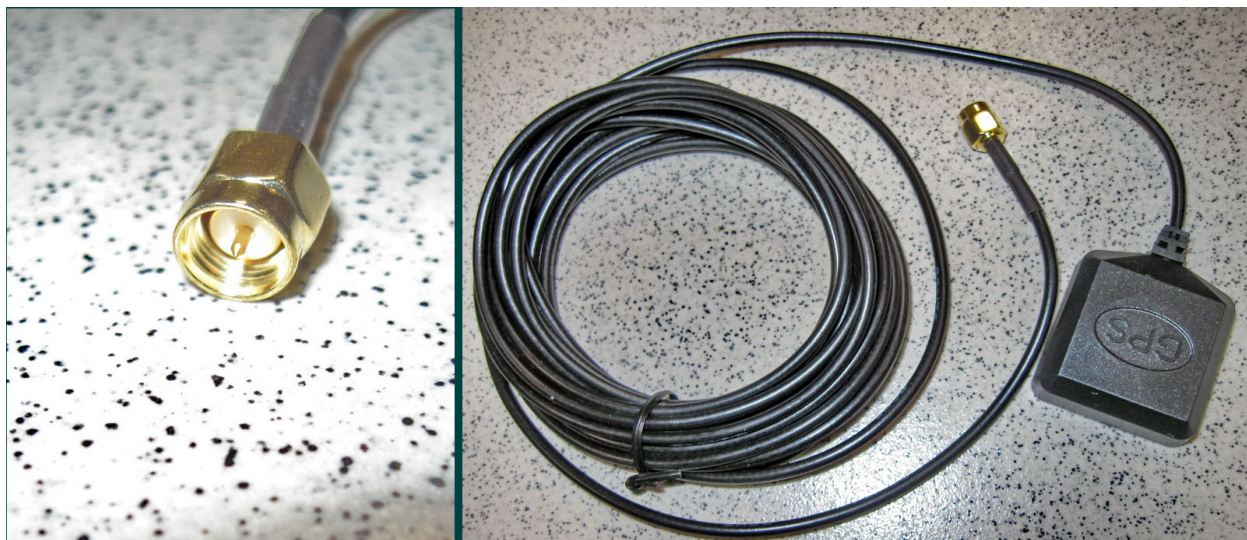


Fig. 7. GPS antenna – connector view



Fig. 8. *SMA-M / RP SMA-M adapter*



Fig. 9. *SMA-M / SMA-M adapter*

APPENDIX 3. THE WAYS OF CONNECTION IN DIFFERENT MODES

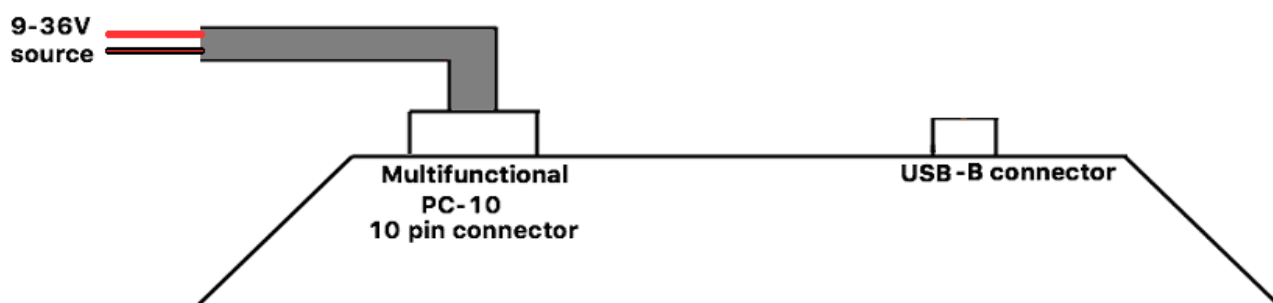


Fig. 10. Power supply through a power cable (main mode of operation)

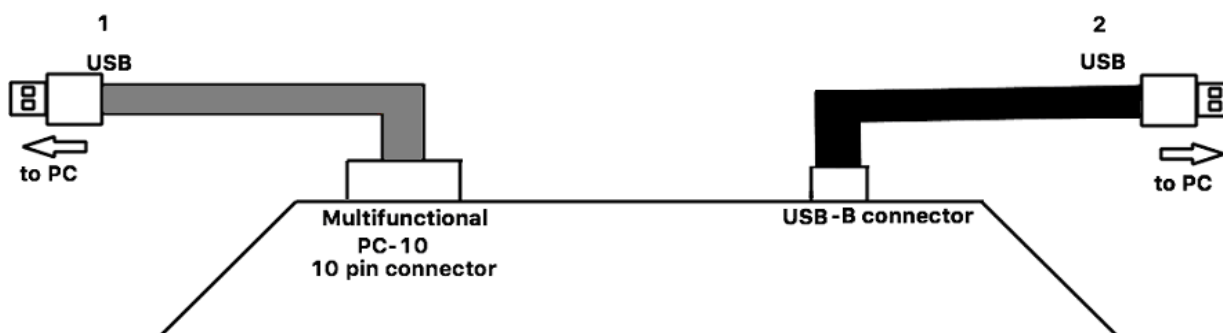


Fig. 11. Power supply via USB (options 1 or 2)

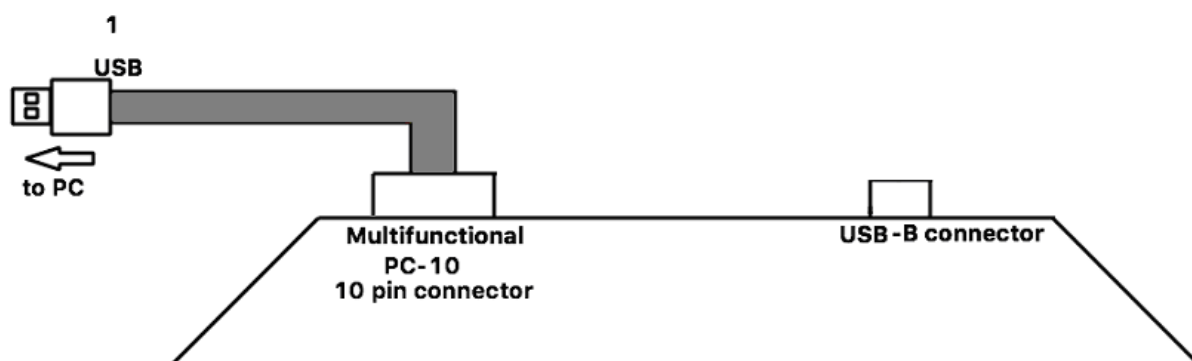


Fig. 12. Initial settings and configuration via USB

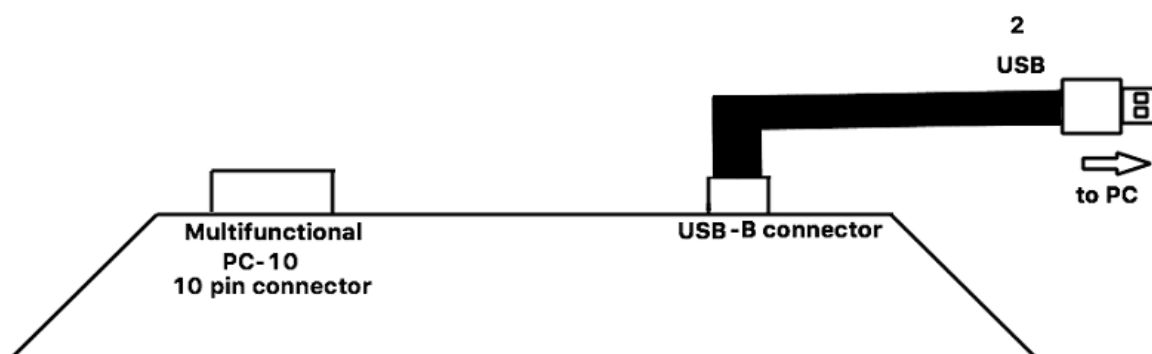


Fig. 13. Connections in the card reader mode