R·sensors

6-CHANNEL PROGRAMMABLE SEISMIC DATA LOGGER NDAS-8426N

User Manual

Version 1.0

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

Contents

Addendum

available on demand

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

The following designations are used in this manual:

- important information

- critical information

DUE TO THE CONSTANT TECHNICAL IMPROVEMENTS AND MODERNIZATION, THE CHANGES WHICH ARE NOT EXPRESSED IN THIS USER MANUAL MAY BE INTRODUCED IN DESIGN AND SOFTWARE. PLEASE CONTACT THE MANUFACTURER FOR REFERENCES.

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

1. Introduction

The NDAS-8426N programmable seismic data logger (hereinafter referred to as the 'data logger' or the 'device') is designed for 6-channel digitization of the analog signal, filtration, analysis, storage and transfer of digital seismic information in continuous mode (real time), upon trigger actuation (trigger mode) or upon operator's request (manual mode).

The data logger is used to record and transfer seismic signals using analog acceleration sensors (accelerometers) or velocity sensors (velocimeters, geophones). The data logger is compatible with both passive type sensors (velocimeters, geophones) and active type sensors (velocimeters, accelerometers).

Owing to the available tools of adapting software and hardware to a specific problem, application of flexible response algorithms to a detected event, the data logger may also be applied to a wide range of scientific and industrial applications which cover digitization, accumulation, processing and transfer of the data on slowly changing analog electrical signals generated from physical process sensors including gravimeters, barometers, low-frequency microphones, thermocouples and so on via communication networks or to actuators.

The data logger can be integrated with existing engineering systems such as chains of digital sensors and actuators, in particular, digital accelerometers, fire security and address alarm sensors, actuating industrial controllers using modifications of the RS-485 half-duplex communication protocol (LanDrive, Modbus and others). In addition, the RS-485 half-duplex protocol may be used to connect the external GPS/GLONASS satellite receiver located away from the data logger.

The data logger can be used as part of:

- continuous seismic monitoring systems at stationary and mobile observation points;
- engineering geophysics systems, seismic exploration and seismic microzoning;
- seismic event early warning systems;
- seismometric monitoring systems for building and engineering structures, high-rise buildings, pipelines, tunnels, bridges;
- other engineering and industrial applications.

With highly customizable software based on the open UNIX platform, it is possible to create and install additional software blocks by the user to expand the data logger's capabilities. The open software architecture includes a simple data transfer protocol, access to the device's hardware functions and integration with the data logger's web interface.

The data logger's additional functions are provided through industry-standard Mini PCI-E expansion cards with the USB interface (including SSD drives, Wi-Fi and Bluetooth adapters, 3G modems) as well as external devices with the USB interface (including flash drives, RS-485, CAN, Wi-Fi, Bluetooth adapters, 3G modems and so on).

The data logger utilizes a unified software platform NDAS-RT with a graphical interface for managing software and hardware functions, selecting and configuring operating modes, synchronization modes, translation and saving data, as well as viewing incoming information on the fly. The NDAS-RT software platform allows building combined data acquisition networks both based on analog seismic sensors paired with an NDAS-N recorder, and CME-ND digital seismic sensor paired with an NDAS-RT communication module. The use of the NDAS-RT software platform in different types of devices makes their user interface and software settings the same type, which reduces user training time and simplifies device replacement.

The data logger contains circuits for powering active seismic receivers and similar low power sensors of physical processes (external analog-to-digital converters, velocimeters, accelerometers, temperature, pressure, humidity sensors, string piezometers, crackmeters, etc.).

To register auxiliary information from analog sensors (supply voltage, readings of microbarometer, tilt meter, mass position sensor), the data logger has 4 low-resolution auxiliary ADC channels (environmental channels). The data logger has a generator of analog test signals of an arbitrary shape which is used for applying the testing signals to the connected equipment. The data logger has a software-controlled electromagnetic relay with dry contacts for building alarm and/or emergency shutdown circuits.

The operating modes of the data logger are displayed by means of 5 LED indicators installed on the housing.

Connections via wired USB 2.0 and Ethernet interfaces can be used to transfer the collected information to the consumer as well as to control the data logger and check its operation modes. With installation of commercially available Mini PCI-E adapter modules for the corresponding communication standard, 3G / 4G / LTE, Wi-Fi, Bluetooth, ZigBee wireless interfaces can also be used for this purpose[1].

The data logger contains circuits for measuring the input voltage and the total power consumption for monitoring the operating modes and the power supply status. The operating conditions of the data logger can be controlled by means of an integrated digital temperature and humidity sensor installed inside the housing.

The internal clock of the data logger can be synchronized via the integrated GPS/GLONASS satellite receiver through an Ethernet connection using NTP or PTP protocols or via the remote GPS/GLONASS satellite receiver connecting through the RS-485 protocol.

The collected data can be recorded on the built-in non-volatile media (micro SD card or SSD drive of a Mini PCI-E standard) as well as on external drives connected via USB 2.0. Viewing of seismograms ‘on the fly’ by means of a wired or wireless connection is possible in parallel with registration. The stored data are marked with exact time and coordinates labels for further synchronization during processing. Obtaining information ‘on the fly’ is possible by connecting to the data logger via the SeedLink protocol as a node of the Seiscomp 3 networks. Information stored on the built-in non-volatile media can also be obtained on the Ethernet via the FTP connection or on the SMB protocol as well as via USB connection on the MTP protocol.

The data logger can be powered from a unipolar power supply with the output voltage from 7.5 to 60V of sufficient power. An Ethernet connection using Power over Ethernet (PoE) technology can also be used to power the data logger. The maximum power consumed by the data logger depends on the composition of the periphery equipment and does not exceed 12.95 watts in total. In addition, the limited functionality of the data logger is provided when powered by a USB bus[2].

The data logger is not explosive, toxic and does not serve as a source of environmental pollution.

[1] *Operating with 3G/4G/LTE connection requires installation of a SIM-card and making of contract with a mobile services provider.*

[2] *When the data logger is powered via USB connection, the internal and external USB devices, as well as the external digital and analog sensors are not powered. The functionality of the data logger is also limited by the USB connection load capability.*

2. Delivery set and assignment of connectors

The delivery set includes:

- Programmable seismic data logger **NDAS-8426N** – 1 pc;
- microSD 32Gb drive (installed on the data logger) – 1 pc;
- Power cable with a 7-pin socket connector DH-20-J07PE-03-001 – 1 pc;
- Standard USB A / microB digital cable – 1 pc;
- Cable socket connector DH-20-C12PE-03-001 – 2 pcs;
- Auxiliary cable socket connector DH-24-C19PE-03-001 – 1 pc;
- RJ-45 cable connector plug LP-24-C/RJ45/015/PE-41-001 – 1 pc;
- GPS antenna with 3 or 5 m cable – 1 pc;
- Passport – 1 pc;
- User manual – 1 pc for the batch.

The configuration extension may include[3]:

- *microSD 256 GB card* …… …… ☐
- *microSD 512 Gb card* …… …… ☐
- *industrial temperature range microSD 32 GB card* …… …… ☐
- *SSD drive of PCI-e interface M.2 form factor*…… …… ☐
- *Built-in Wi-Fi controller* …… ☐
- *Wi-Fi controller of PCI-e interface M.2 form factor* …… …… ☐
- *3G/4G/LTE modem of PCI-e interface M.2 form factor* …… ☐
- *RS-485 controller* …… ☐
- *PoE power system* …… ☐

[3] ☒ - installed, ☐ - not installed.

In addition the delivery set may include[4]:

- *Wi-Fi SMA-M antenna for installation on the housing* …… ☐
- *3G/LTE SMA-M antenna for installation on the housing* …… ☐
- *3G/4G/LTE SMA-M external antenna with a 5-meter length cable* … …… ☐
- *SMA-M / RP SMA-M adapter (for connecting antennas with SMA-F connector or the extension cord)* …… ☐
- *SMA-M / SMA-M adapter* …… ☐

The purpose of the cables and connectors in use, pictures of the cables and antennas are given in Appendix 2 to this Manual.

The following connectors and indicators are located on the data logger's housing:

On the FRONT side[4]:

- Connector marked 'USB 1' for connecting digital instruments of YU-USB2-JSX-01-001 type or YU-USB3-JSX-01-001 of USB-A type;
- Data reading connector micro-USB 2.0 IP67;
- Antenna connector GPS/GLONASS, SMA-F socket;
- Data reading connector LP-24-J/RJ45/213/SX-43-401 marked 'LINK', RJ-45 socket;
- Power and RS-485 interface connector marked 'POWER', DH-20-C07SX-03-401 plug;
- Digital instrument activity status orange LED marked 'USB 1';
- Storage activity status green LED marked 'DISK';
- Synchronization status red/green LED marked 'SYNC';
- Connection status greed LED marked 'NET';
- Power status red LED marked 'PWR';
- *Wi-Fi antenna connector, SMA-F socket* …… ☐;
- *3G antenna connector, SMA-F socket* …… ☐.

On the REAR side:

- Auxiliary ADC inputs and relay outputs multifunctional connector marked 'AUX', DH-24-J19SX-03-401 socket;
- 2 analog sensors connectors marked 'CH 1-3' and 'CH 4-6', DH-20-C12SX-03-401 socket.

The connectors layout, LEDs layout and modes of operation are given in Appendix 1 to this Manual.

[4] ☒ - available, ☐ - not available.

3. Connection

A unipolar DC source with a nominal voltage of 12 to 48 volts and an output power of at least 10 watts[5] is used for powering the data logger. The permissible range of supply voltage for the main channel varies from 7.5 to 60 V. The Ethernet connection with the Power over Ethernet (PoE) technology of IEEE 802.3af-2003 and IEEE 802.3at-2009 with a rated voltage of 48 V (permissible range from 36 to 57 V) and direct current of up to 400 mA can also be used as the main power source. When the data logger is powered from the main power source, the supply voltage is supplied to all peripheral devices - both the ones installed inside the data logger and the ones connected externally (provided that the power supply function of external devices is activated in the menu).

As a secondary power source, a connection to the micro-USB port can be used. The load capacity of the USB port should be at least 500 mA. The allowable range of supply voltage for the secondary channel is 4.5…5.5 V. When the data logger is powered only from micro-USB, no power is supplied to all active sensors, external peripheral devices (connected to the USB-A connector or via RS-485), the boards connected to the internal Mini PCI-E[6] connector are not functioning.

Depending on the configuration of the used data logger, it is necessary to install internal peripheral modules before powering up: SD card, internal SSD disks, Wi-Fi/Bluetooth/ZigBee adapter, 3G/4G/LTE modem, SIM card.

Although devices with the Mini PCI-E interface can be connected and disconnected ‘on the fly’ while powered, to ensure stable operation of the system and to avoid accidental damage to the data logger the best practice is to operate inside the housing when the power is off.

If the device uses wireless interfaces, connect the appropriate antennas of the wireless interfaces after installing the internal peripheral modules.

To use external coordinates and synchronize the reference generator via GPS, connect the GPS antenna to the appropriate connector. Active or passive GPS antennas with an SMA-M type connector can be used. An adapter is required to connect an antenna with an SMA-F connector.

To operate wirelessly via Wi-Fi or 3G/4G/LTE, connect the antenna to the appropriate connector. The supplied Wi-Fi antenna connects directly to the connector. An adapter is required for connection of an external antenna with an SMA-F connector.

Turn on the main power supply. When the power is applied, the device displays the main status parameters through LED indicators. From the moment the power is supplied until the processor is loaded, the ‘Power’ indicator displays the presence of the power supply voltage. A complete list of indicators operating modes is given in Appendix 1 to this Manual.

External peripherals connected via USB 2.0 and RS-485 can be connected and disconnected at any time without removing the supply voltage.

[5] The maximum power consumption is determined by the composition of the periphery equipment and does not exceed 12.95 W.
[6] Contact the manufacturer for references.

4. Configuration and operation

To operate the data logger, either a wired (Ethernet) or wireless (Wi-Fi, 3G/4G/LTE) connection is required. The data logger is accessed by the IP address of the device with a proper connection port indicated. To operate in this mode, you can use any device (PC, laptop, tablet PC or mobile phone) with the latest versions of Internet browsers such as Chrome, Safari, Internet Explorer and so on.

Operation and configuration of the device is also possible through the virtual LAN driver (RNDIS) via the USB interface. In this case, a PC-compatible computer or Laptop running Windows, Linux or MacOS is required to operate.

The device terminal can also be accessed through the virtual serial port driver via the USB interface.

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical. The functions and capabilities described in this chapter for NDAS-RT also refer to the data logger.

At an initial connection, the data logger receives an IP address via DHCP from the router. Further access to the device is carried out by typing in the address bar its IP address with indicating port 8000. For example, http://192.168.0.163:8000 where 192.168.0.163 is the address and 8000 is the port number. The automatically assigned IP address can be changed to a fixed one in the settings of the network equipment (Router).

If it is not possible to find out the IP address assigned to the device, use the following algorithm: connect the device simultaneously to the Ethernet network (via wire or Wi-Fi) and to the PC via the micro-USB interface, make sure that your PC has the Ethernet virtual network driver correctly installed. Go to the web interface of the device at 192.168.7.2: 8000 – the IP address of the Ethernet connection will be displayed on the main page in the Networks – Ethernet – details or Networks– Wi-Fi – details sections.

When you access the data logger's web interface, a login and password are requested. At the default settings, the data logger uses the '**ndasrt'** login and the '**ndasrt'** password. Further on, it is recommended changing the password in the settings.

After entering the login and password, you go to the System status page.

4.1. System status page

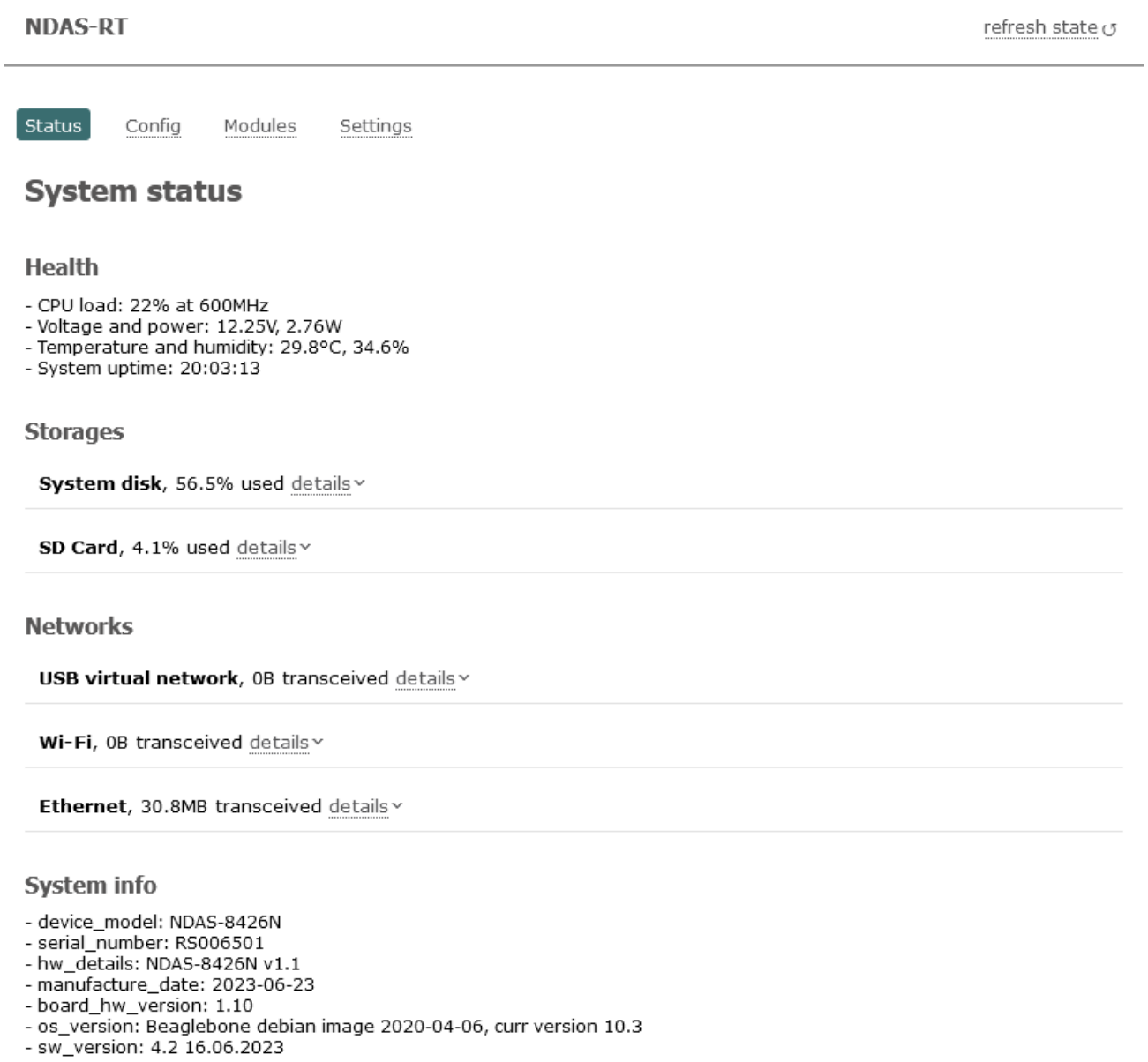

Fig. 4.1. System status page

The System status page displays basic information about the status of the data logger.

The Health section contains information about the current CPU load, power supply voltage and the power consumed by the system, temperature and humidity inside the device and system uptime.

The Storage section contains information about the status of the device drives (SD card, USB drives connected, etc.).

The Networks section contains information about the status of the data logger's current available network connections such as USB, Ethernet, Wi-Fi.

The System Info section contains information about the hardware and software versions.

4.2. Configuration page

The Configuration page lists the data logger's hardware and software functions with their current status displayed.

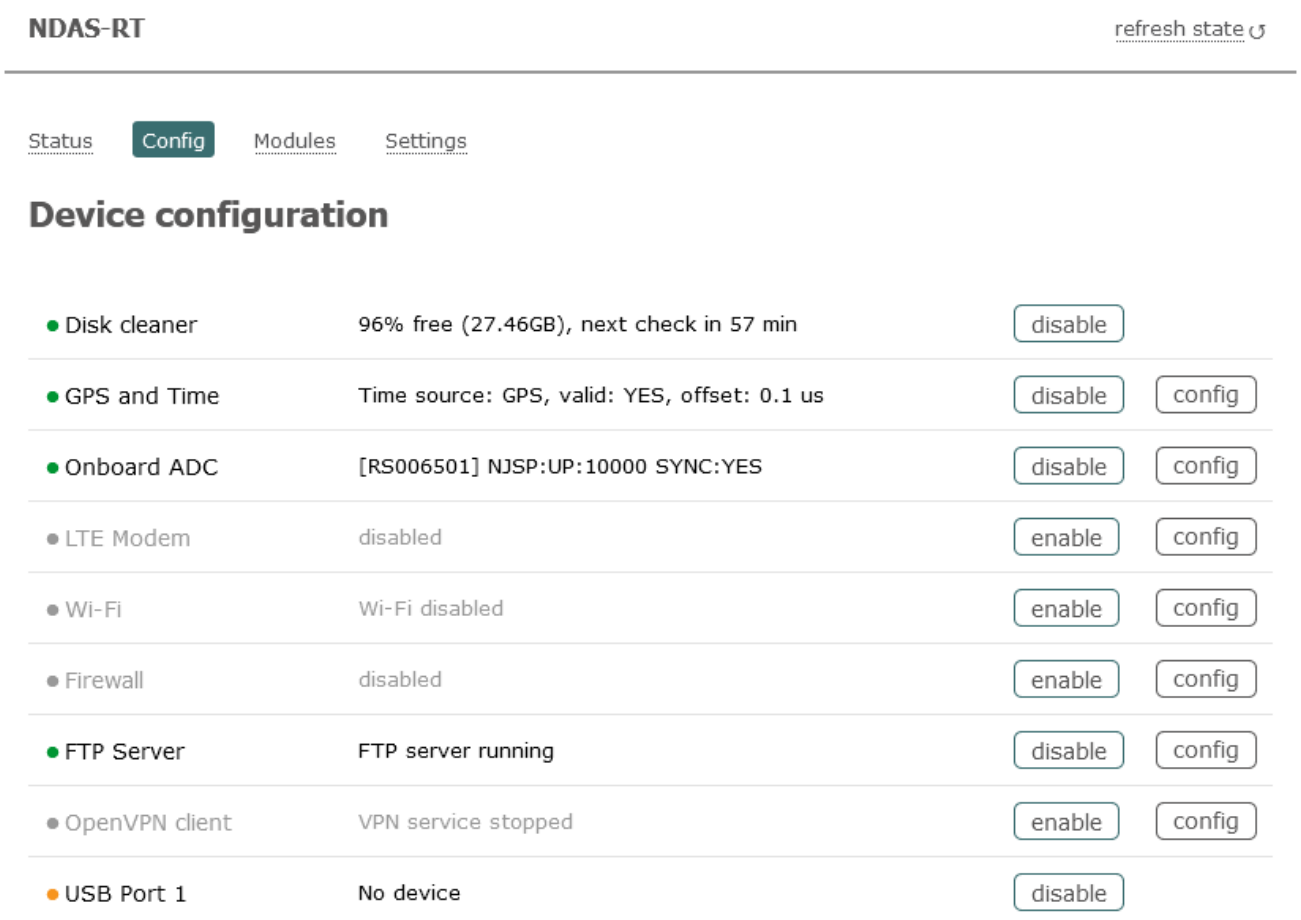

Fig. 4.2. Configuration page

The following functions are currently available for the data logger:

- Enabling and disabling of the Disk Cleanup Service.
- Control of the signal source of precise time. Its state displays a source type, time validity and synchronization offset. A settings submenu is available on the **config** button.
- Control of the main and auxiliary ADC. The **config** button opens a web page of the parameters of the data logger's main and auxiliary ADCs.
- Control of the built-in 3G/LTE modem. The **config** button opens a web page of the current connection and status settings.
- Control of the built-in Wi-Fi network adapter. The **config** button opens a web page of the current connection and status settings.
- Control of the firewall. The **config** button opens a web page of the current connection settings.
- Control of the FTP server. The **config** button opens a web page of the current settings.
- Control of the VPN client. The **config** button opens a web page of the current connection settings.
- Power control of the Mini PCI-E slot inside the device. The ports can be switched on and off physically, and the name of the connected device is displayed.

4.3. Modules page

The Modules page lists the individual software modules installed on NDAS-RT for which their current status is displayed. The **config** button opens the web page of the current settings. The RT viewer also opens the charts display page.

The following software modules are currently available for the data logger:

- NDAS One Manager is a program for receiving a real-time signal from the NDAS devices. For a detailed description of the NDAS One Manager functions, refer to '**NDAS-RT. NDAS One Manager**'.
- RT Viewer is a program for displaying oscillograms of signals in real time. Depending on the settings and established connections, it is possible to display not only information from local ADCs of the current device but also real-time information received from other similar devices over the network. For a detailed description of the functions of the RT Viewer, refer to '**NDAS-RT. RT Viewer**'.
- Raw Data Logger is a program for recording the collected information online on local drives which can be a built-in SD card, an installed flash drive or a USB flash drive connected through a connector. It is possible to record not only information from local ADCs of the current device but also real-time information received from other similar devices over the network. For a detailed description of the Raw Data Logger functions, refer to '**NDAS-RT. Raw Data Logger**'.

- SeedLink Server is a program for implementing the SeedLink server functions. For a detailed description refer to '**NDAS-RT. SeedLink Server**'.

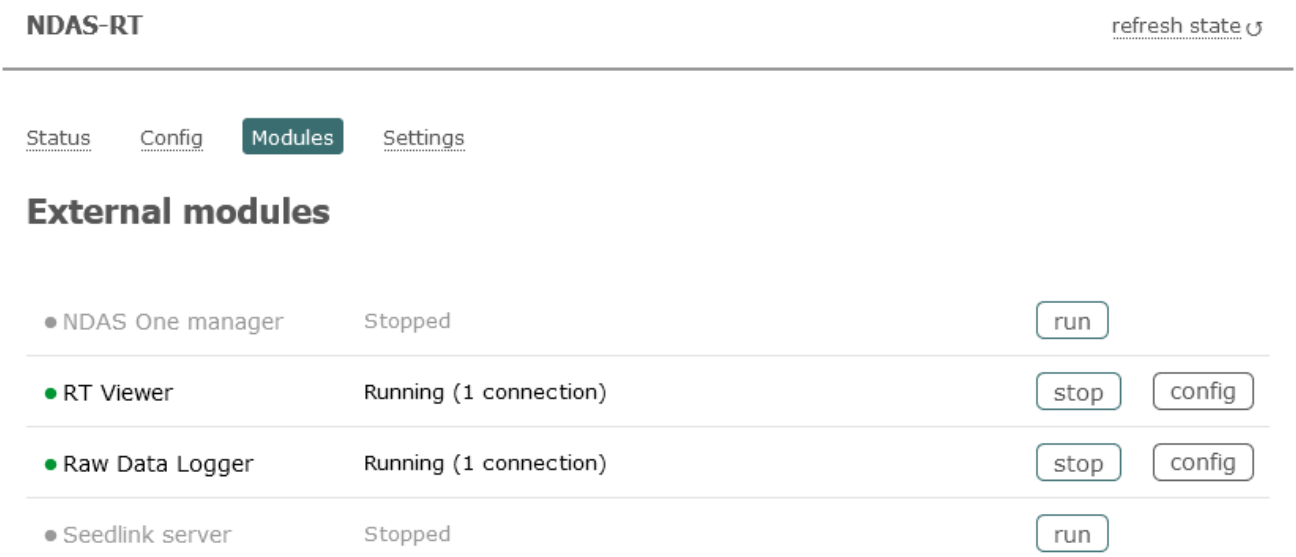

Fig. 4.3. Modules page

4.4. Device settings page

The device settings page contains fields to change the login password of the web interface and the Ethernet connection settings. At the bottom of the screen are the **reload device** button to reload the Module and the **clear sd-card** button to clear SD card.

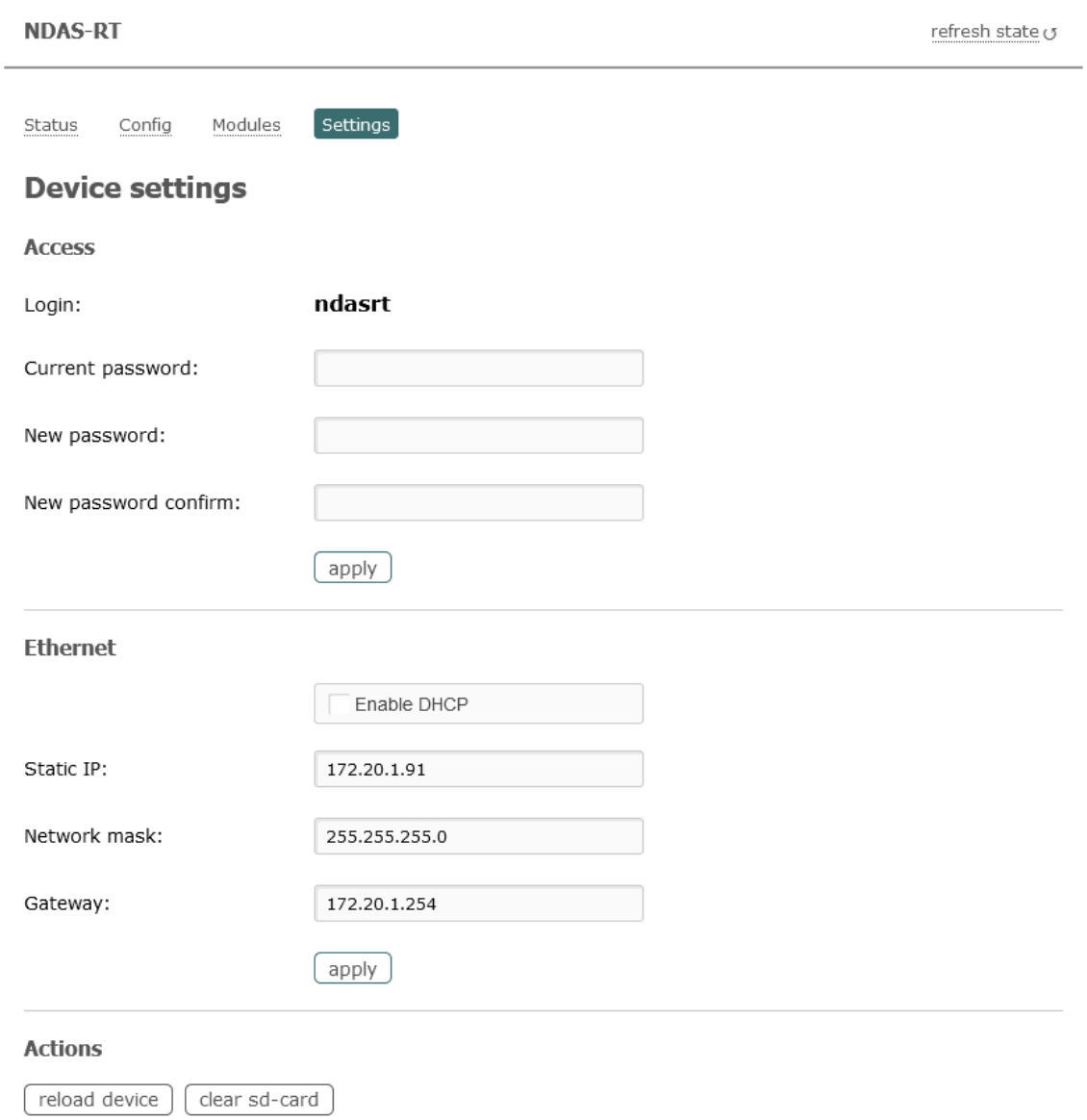

Fig. 4.4. Device settings

4.5. NDAS-RT Network Model

The data exchange with the data logger is based on the NDAS-RT network model. The NDAS-RT network model uses the concept of local network connections when transferring signals between software modules. The signals are transferred in the NJSP all-purpose format so that the user can flexibly adjust the signal route between modules simply by configuring the port numbers.

The NDAS-RT network model is supplied in the following configuration:

The NDAS One Manager module is configured so that signals from the built-in ADCs are output to network port 10000 and the signals from the NDAS device connected to the USB Port 1 connector are output to network port 10001. It is recommended that you follow this port address assignment system for the remaining data logger's connectors. That means you assign port number 10002 to USB Port 2 and send the signals from NDAS devices connected to the NDAS Port 1 and NDAS Port 2 connectors to network ports 10003 and 10004 respectively. The SeedLink server module is configured to connect the ND01 station to port 10001 and the ND02 station to port 10002 and so on. Thus, when the NDAS device is connected to one of the USB or NDAS ports, its real-time signal will be available on the SeedLink server in the appropriate station (the external port for connecting to the SeedLink server is set up separately and has default number 18000). The default configuration is given at Fig. 4.5.

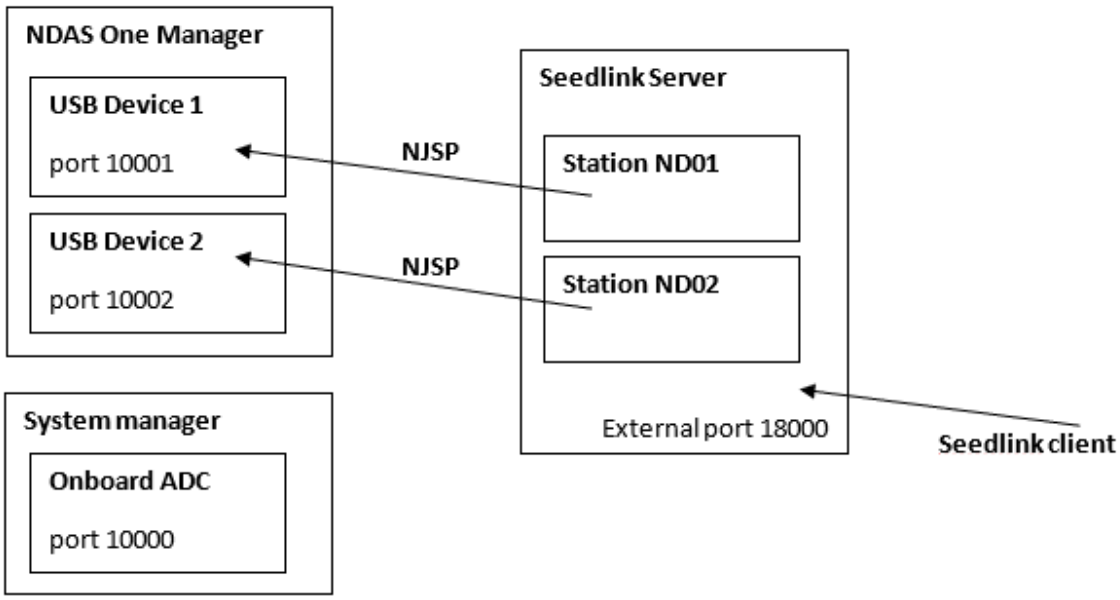

Fig. 4.5. Default network configuration

If the user needs to use signal processing through another module that is a Trigger module, it is required to create a new SeedLink station which will receive a signal after processing by the trigger module and configure the trigger module to connect to the desired device (Fig. 4.6).

Note that multiple 'receivers' can be connected to the same NJSP source at the same time.

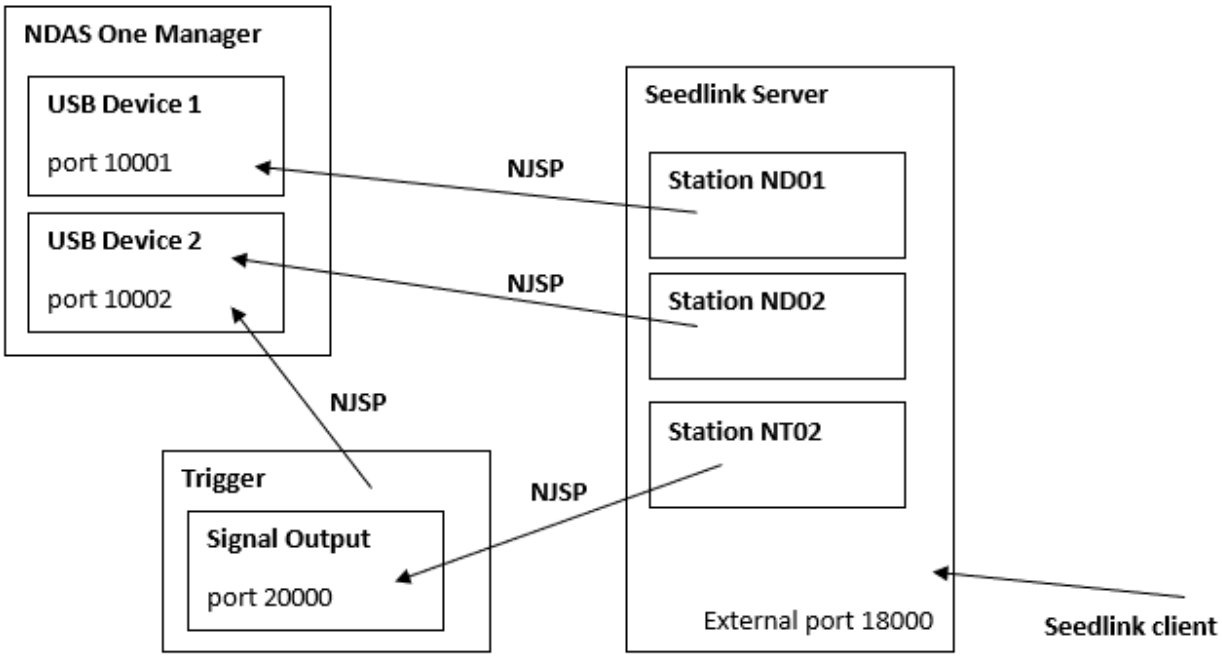

Fig. 4.6. Network configuration with an intermediate module

4.6. Network ports used by default

Port number	Type	Purpose
21	TCP	Standard port for incoming FTP server connections
22	TCP	SSH connections port
3000	TCP	Cloud9 development environment web-interface port
8000	**TCP**	**Web user interface port**
10000	TCP	NJSP port for built-in ADC of NDAS-RT
10001	TCP	NJSP port for NDAS device via the USB 1 connector
10002	TCP	NJSP port for NDAS device via the USB 2 connector
10003	TCP	NJSP port for NDAS device via the NDAS 1 connector
10004	TCP	NJSP port for NDAS device via the NDAS 2 connector
18000	**TCP**	**SeedLink server port**
49152:49168	TCP	Port range for dynamic FTP server connections

5. Onboard ADC program module. ADC configuring

The **Onboard ADC** module is used for viewing status and setting parameters of the data logger's main and auxiliary ADCs.

The module has the following basic functionality:

- Display of the main ADC synchronization status;
- Control of the test signal output;
- Settings of the main ADC parameters;
- Settings of the auxiliary ADC parameters.

5.1. Start of the Module

Click the Config tab on the NDAS-RT main interface. Find the line of the Onboard ADC module, click the **enable** button in this line (see Fig. 5.1).

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

At the initial start the data logger module may display an ADC error message. This message will disappear after any active configuration is set up and saved.

To open the module web interface, click the **config** button in the corresponding line.

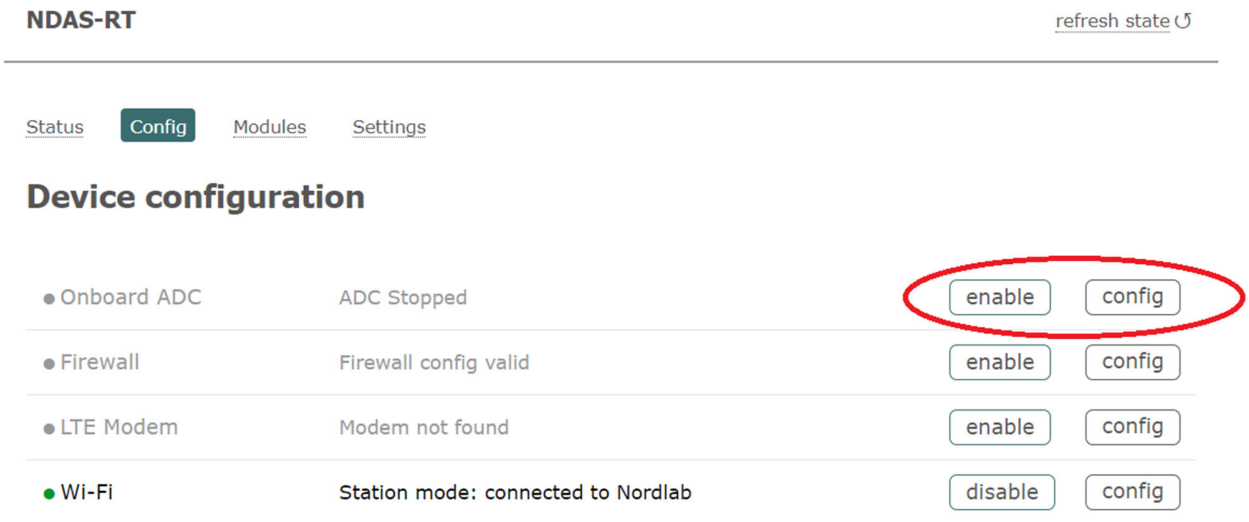

Fig. 5.1. Onboard ADC module. Enabling and configuring

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

5.2. Module interface

The module interface has the following tabs:

- **Status & Manage testing** is a display of the ADC synchronization status and control of the test signal output;
- **Config** is the main tab that allows configuring the operating parameters of the main and auxiliary ADCs.

The Onboard ADC module outputs the data via the NJSP protocol (see NDAS JSON Streaming Protocol). Both other modules located locally and remote signal receivers can be connected to the signal server.

5.3. Status & Manage testing tab

The Status section tab displays the synchronization status of the ADC samplings, namely the presence of synchronization and the current offset and sampling drift. The **Test signal** section has a menu for selecting the test signal to be sent.

The following test signals are currently available:

- Sinusoidal voltages of 1 V amplitude and 1 Hz frequency;
- Sinusoidal voltages of 1 V amplitude and 10 Hz frequency;
- Single rectangular impulse of 1 V amplitude and 1 sec duration;
- Single rectangular impulse of 1 V amplitude and 1 sec duration;
- Periodic rectangular impulses of 1 V amplitude with 1 sec repetition period;
- Periodic rectangular impulses of 1 V amplitude with 1 sec repetition period;
- White noise with the root mean square (RMS) of 1 V.

5.4. Config tab

There are the ADC parameters as a signal source at the top of the **Config** tab. These parameters refer to the both ADCs of the data logger.

- TCP port (10000 by default);
- Restriction to connect only the modules within the device itself (local connections);
- Restriction on the data transfer with the system time valid only.

There is a switch button between the main (main) and auxiliary (env) ADC settings in the middle part of the screen.

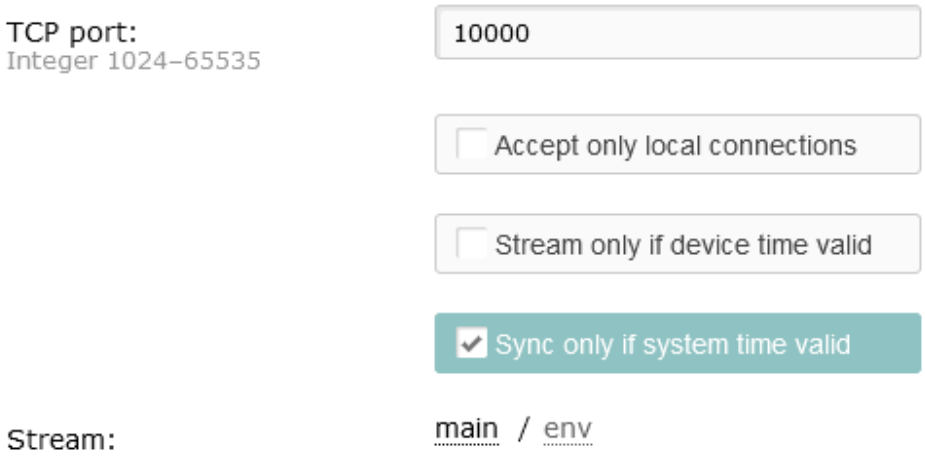

Fig. 5.2. ADC data connection settings field.
Below are settings of the main and auxiliary channels

Next, the number of active channels, sample rates, input gain selection (Gain if any) and input range (Range if any) are selected for each ADC.

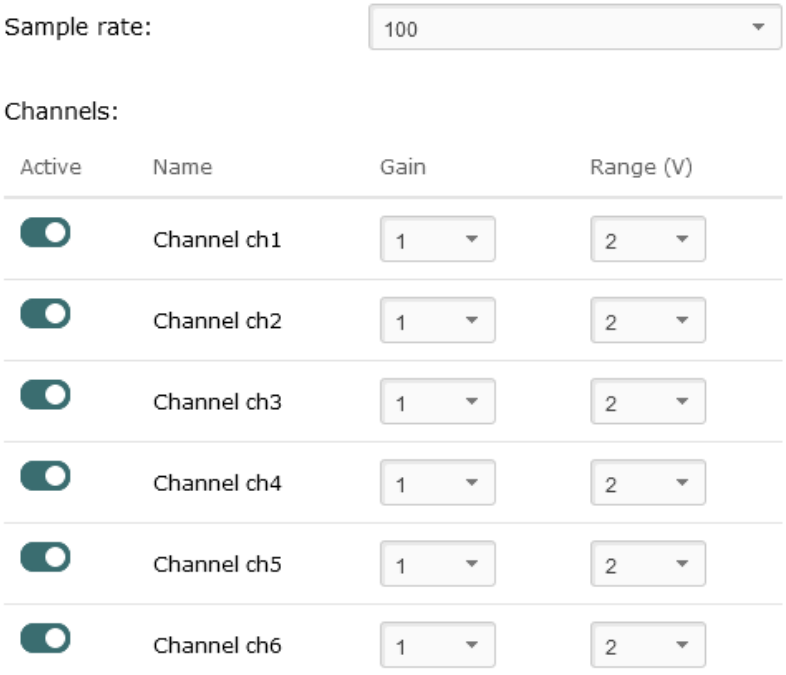

Fig. 5.3. Main ADC settings

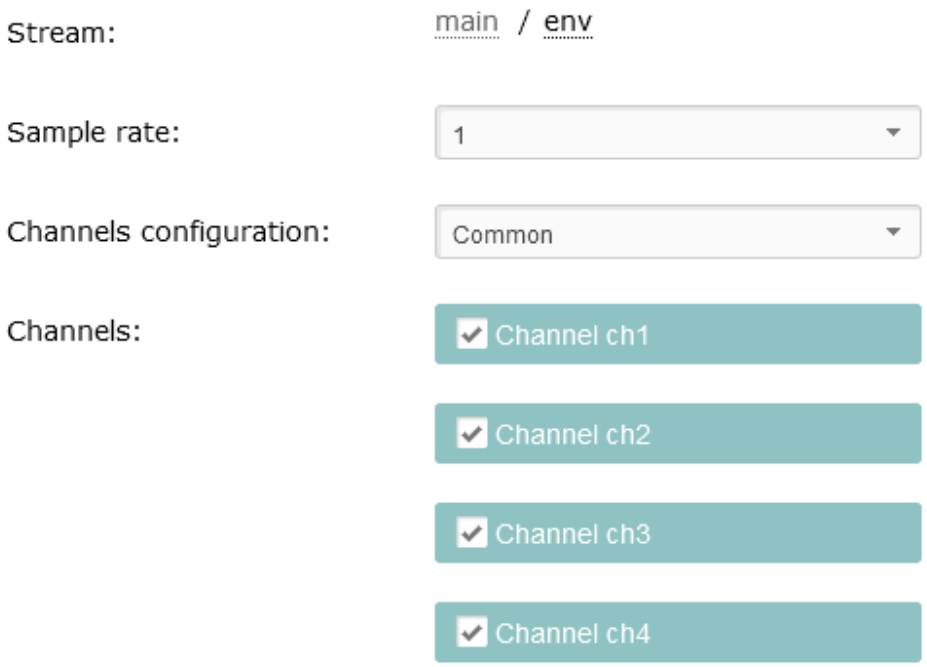

Fig. 5.4. Auxiliary ADC settings

5.5 Main ADC

The main ADC is intended to use for digitalization of seismic signals of the Earth's natural background during carrying out research by means of both passive and active analog output seismic receivers.

A short list of characteristics of the main ADC is given in the table:

Sampling rates	1 – 8000 Hz
Number of channels	6 differential
Input range (switched by the program)	± 4 / 24 V of differential voltage
ADC resolution	24 bit

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

5.6 Auxiliary ADC

The auxiliary ADC is used to measure slowly changing indicators such as temperature, pressure, humidity, wind speed, etc.

A short list of characteristics of the auxiliary ADC is given in the table:

Sampling rate	0.1, 1, 4 Hz
Number of channels (switched by the program)	6 single-ended / 3 differential
Input range	± 18 V single-ended / ± 36 V differential
ADC resolution	12 bit

5.7 Time synchronization and NJSP

The synchronization status information is transferred to the NJSP stream metadata as follows. The timestamp of each package in the stream contains three fields: **Timestamp, Drift, Drift time**.

Timestamp is a timestamp in the sampling system of the quartz ADC generator. At the moment of enabling, the time of the first sample is tied to the system time. The timestamp of each subsequent sample is calculated based on the number of samples since the start. In this time system the data stream is always continuous.

Drift is the last measured time deviation of the ADC samples from the system time. The internal algorithm smoothly corrects the frequency of the quartz generator to compensate for this deviation and maintain synchronization of the ADC with the system time.

Drift time is a drift measurement time.

If the system time is not valid and the **Sync only if time valid** option is active, the ADC time is not synchronized with the system time, and the **Drift** and **Drift time** fields are not updated. In this case, the **Drift** field will contain the last measured drift value at the valid time, and the **Drift time** will contain the last measurement time respectively.

6. RT Viewer program module

The RT Viewer module is designed to view the waveforms and spectra of real-time signals transmitted via the NJSP protocol.

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical. The functions and capabilities described in this chapter for NDAS-RT also refer to the data logger.

The module has the following basic functionality:

- View waveforms, overlay multiple signals in a single window;
- View spectral waveforms, overlay several spectra in a single window;
- View the main text parameters of the signal – minimum, maximum, average, RMS, etc.;
- View the status data transmitted together with signals (GPS, temperature, supply voltage, etc.);
- Save signals to a buffer and upload as a CSV file;
- Save profiles with custom settings;
- Connection to the NJSP servers located on both local NDAS-RT and remote network devices – thus, signals from different sources can be overlaid in a single window.

6.1. Start of the Module

Click the Modules tab on the NDAS-RT main interface. Find the line with the RT Viewer module, click the **run** button in this line.

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

At the initial start the module may display an error message indicating the configuration file was not found. This message will disappear after the required module configuration is set up and saved.

To open the module web interface, click the **config** button in the corresponding line (see Fig. 4.1, 4.3).

6.2. Module interface

The module interface divided into the following tabs:

- Signal is the main tab that contains windows of the displayed charts and tables
- Buffer is a tab that allows configuring the size of the signal buffer and downloading the data stored in the buffer
- Devices is a tab that displays the status information about the connected signal sources
- Connections is a tab that contains a list of addresses to connect to signal sources
- Profiles is a tab that contains a list of profiles of module's user settings

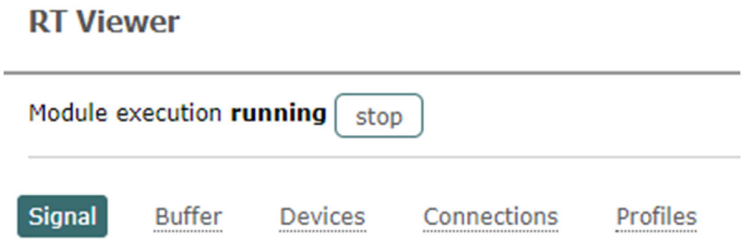

Fig. 6.1. RT Viewer module. Control tabs

6.3. Start of operation

A short sequence of actions to start operating with the module is given below.

- Click the **Connections** tab and add the required connections to the NJSP servers. Make sure the connection is established, the connection status is **Connected**, the name and serial number of the signal source corresponds to the connected device. Detailed information on the status of devices can be found on the **Devices** tab.
- Click the **Signal** tab and add the required number of windows containing waveforms, spectra, and tables.
- Add the required signals to the windows.
- Click the **Buffer** tab and adjust the buffer size to download the saved data if necessary.
- If necessary, go to the **Profiles** tab and save your module settings.

6.4. Connections tab. Connection to the signal source

To add a new NJSP signal source, click the Connections tab, enter the IP address and the NJSP port number. In case of local connection (to a signal source located on the same NDAS-RT device), use IP address 127.0.0.1. Then click the **add connection** button.

A new connection should show up in the connection list below. If the connection to the NJSP server is successful, the connection status changes to Connected and the Device column displays the device's serial number and name.

To remove the connection, click the remove button in the corresponding line.

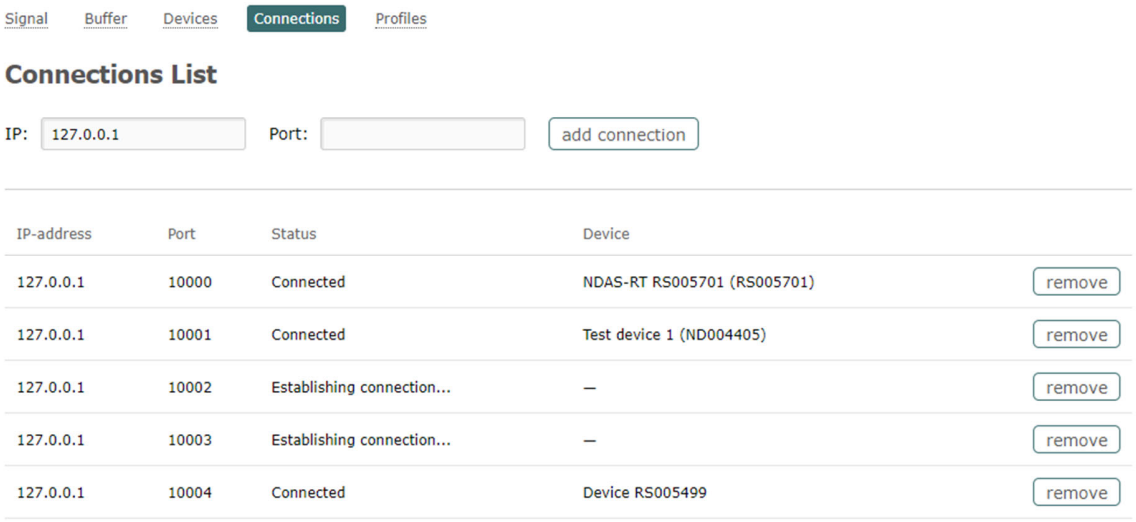

Fig. 6.2. RT Viewer module. Signal source setting

6.5. Devices tab. Device Status view

The Devices tab contains cards of all the devices connected to the module as signal sources. The cards contain information such as the name and serial number of the device, the firmware version, the status of GPS and built-in sensors, sampling rate and channel parameters.

This tab allows setting the color of each channel which will be applied by default when adding this channel to the chart.

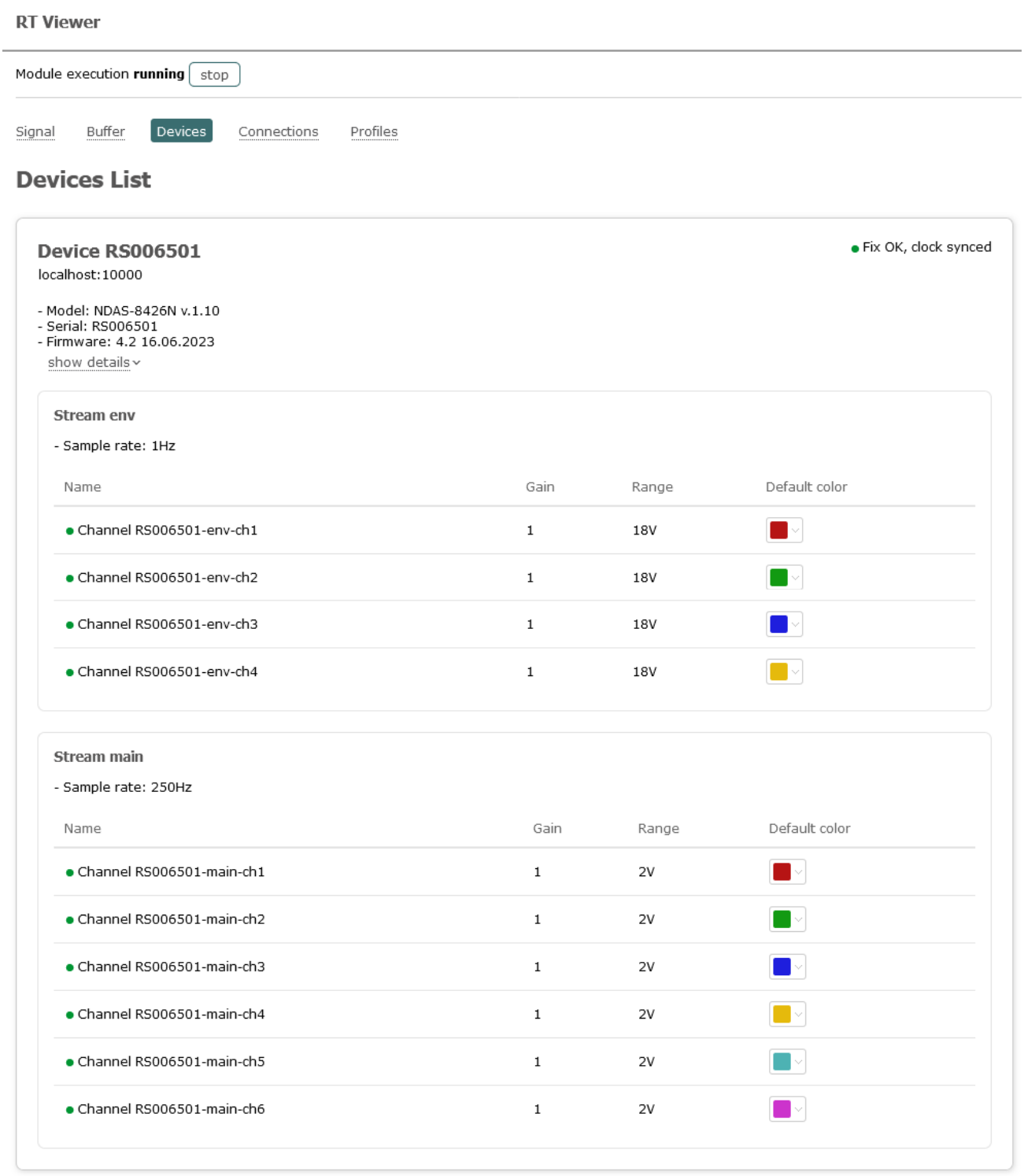

Fig. 6.3. RT Viewer module. List of available devices and status of channel settings

6.6. Buffer tab. Buffering and data downloading

Use this tab to manage the data buffer. The signal received by the application is buffered and stored by the browser for the time specified by the Buffer time parameter.

The data that are currently contained in the buffer can be downloaded using the **Download** button. Either all the data simultaneously or the data for each device can be downloaded.

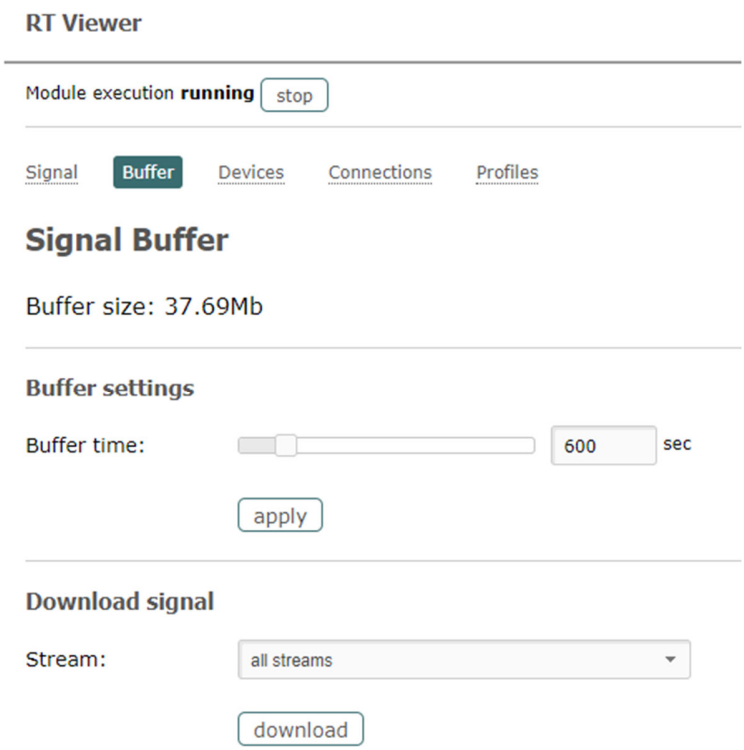

Fig. 6.4. RT Viewer module. Buffering settings

Note that the buffer is used for making charts and tables. For example, to get a signal spectrum containing data for a period of 5 minutes, the Buffer time parameter must exceed this value (e.g., 10 minutes) so that there is enough data in the buffer to make the required chart. At the same time, too much buffer value can lead to unstable operation of the web application due to lack of RAM.

6.7. Signal tab. Adding and removing windows

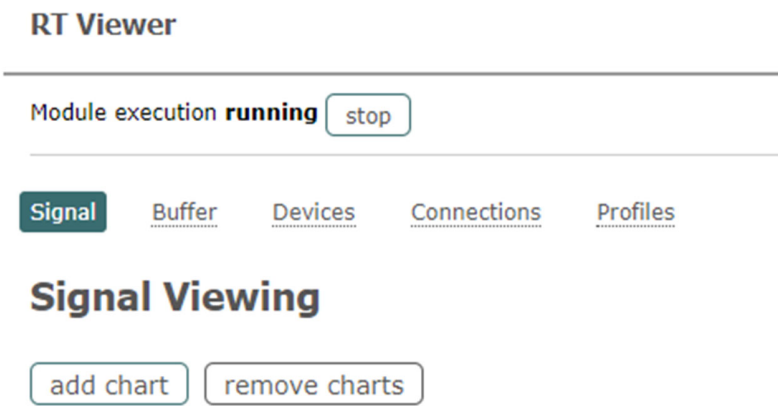

Fig. 6.5. RT Viewer module. Adding a window

To get started, you need to add windows using the **add chart** button. Three types of windows are available such as a waveform, spectral form and table. The window type is selected in the top line of the pop-up window titled a **chart type**.

The following general parameters are set up for all the windows:

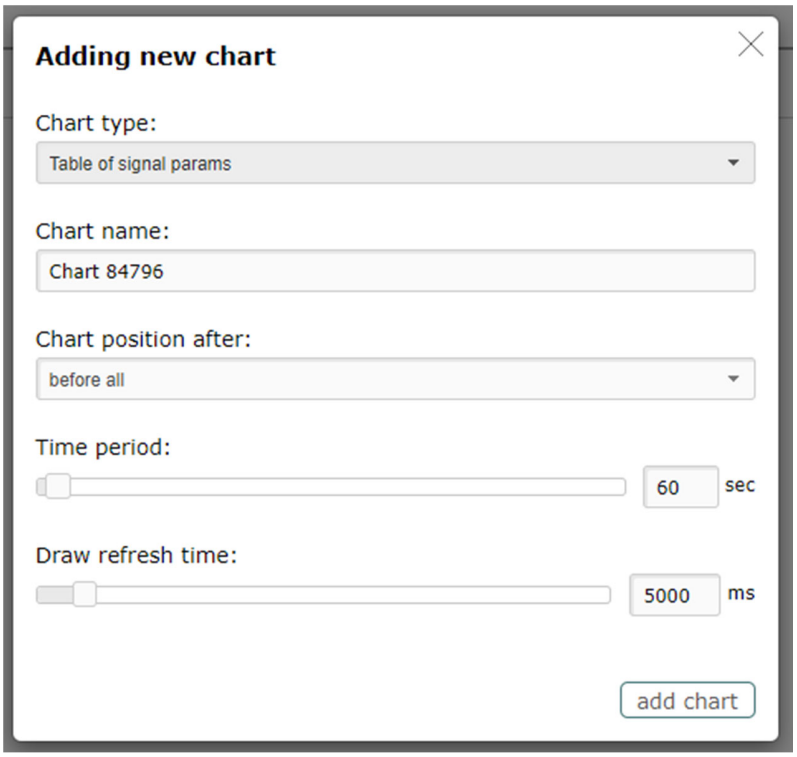

Fig. 6.6. RT Viewer module. Window settings

- Chart name – the window name
- Chart position after – the position of the window in relation to the windows added
- Time period – 'time window' within which the parameters are calculated or the data are displayed
- Draw refresh time – time of refreshing the data in the window

The **Draw refresh time** parameter greatly affects the use of computing resources of your browser. Select the optimal value of this parameter depending on the number of windows, the number of signals in the window and the width of the time window. It is recommended setting the value of 1 sec for waveforms and at least 5-10 sec for spectra and tables.

To remove the window, click on the cross in the upper right corner of the window. Click **remove charts** to remove all the windows.

Additional settings are available for windows of signal and spectrum charts.

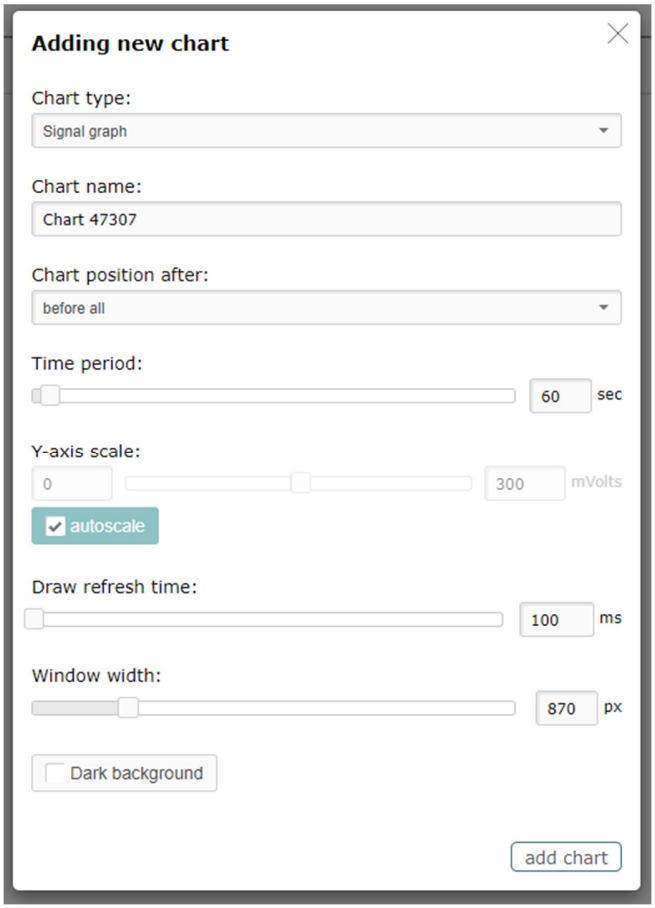

Fig. 6.7. RT Viewer module. Window chart settings for waveforms

In addition to the general parameters when adding a waveform window, you can adjust the Y-axis scale of the chart, the width of the chart, and select the black background of the chart.

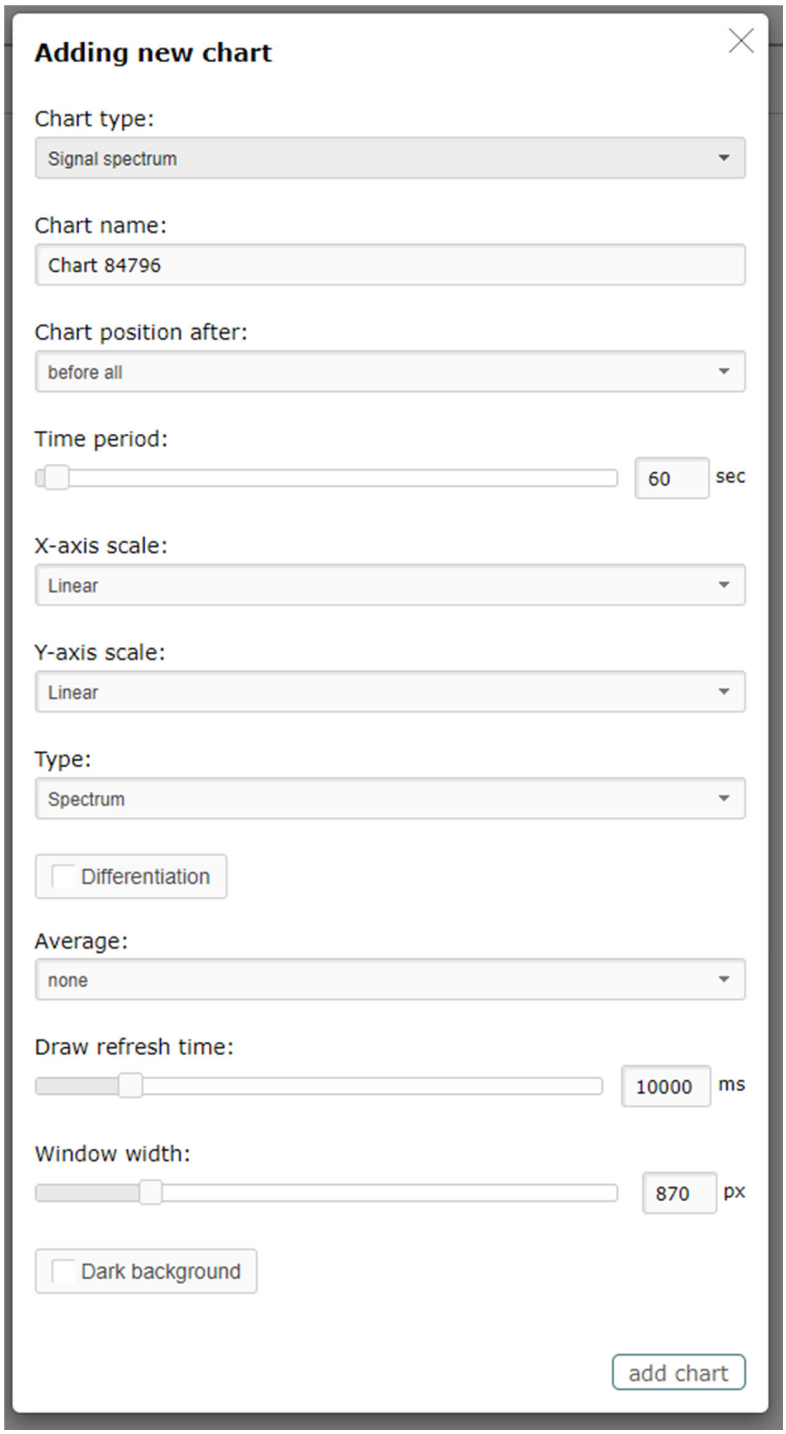

Fig. 6.8. RT Viewer module. Window chart settings for signal spectra

In addition to the general parameters when adding a signal spectrum window, you can set the following parameters:

- X-axis scale – X-axis scale, linear or logarithmic
- Y-axis scale – Y-axis scale is linear, logarithmic or logarithmic in decibels (relative to the 1V level)
- Type – chart type meaning spectrum or power spectral density
- Differentiation – signal differentiation that can be useful while comparing the spectra of seismometers (velocimeters) and accelerometers
- Average – averaging of spectra that means the signal section is divided into N equal sections, for each one the spectrum is calculated, the spectrum generated by averaging all spectra by the points is displayed
- Window width – the width of the window
- Dark background – dark background in the window

6.8. Adding signals to a window

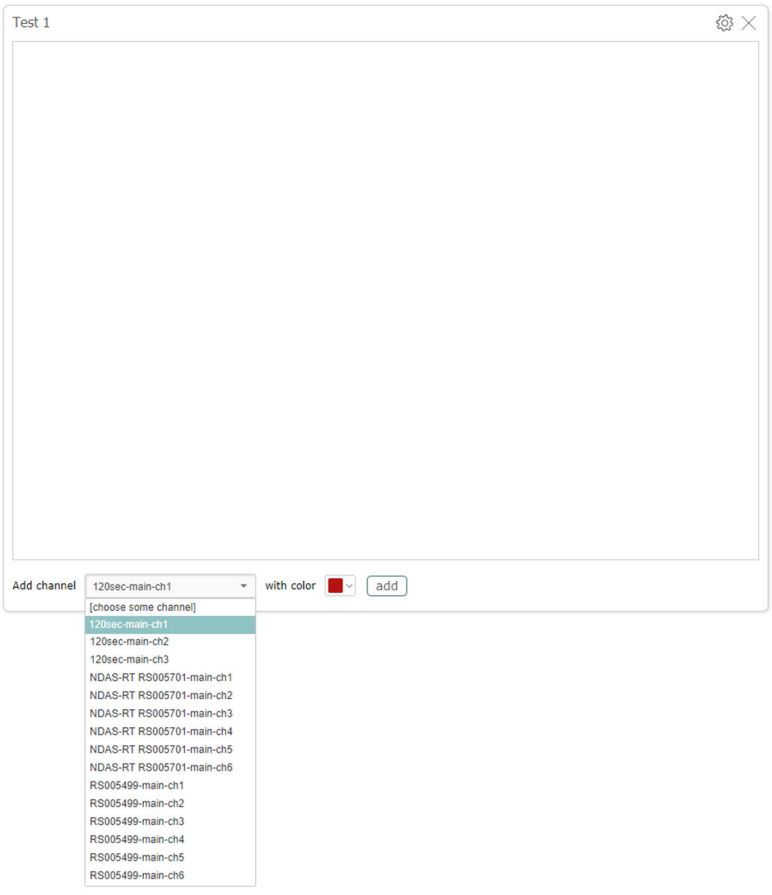

Fig. 6.9. RT Viewer module. Adding a chart to the window

To add a signal at the bottom of the window, select the device and channel, if necessary, change the color of the chart, click the **add** button. To remove the signal, click the cross in the upper right corner of the signal card. The signal card will appear in the lower part of the window:

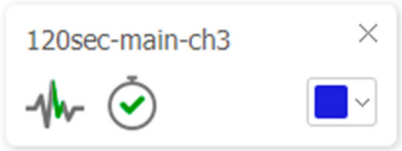

Fig. 6.10. RT Viewer module. Signal card

The signal card contains the following information:

The chart icon displays the presence or absence of the data loss during the 'Time period' specified for this window. If the icon is green, there is no data loss for the selected period, if the color is red, there are breaks in time. Losses will appear as omissions in the waveform chart. It is not possible to make spectra and calculate table values when there is the data loss.

The stopwatch icon displays the clock status of the signal source. If the icon is green, the source clock is synchronized. In this case the timestamps sent with the signal will be used as a time reference. If the icon is red, the source clock is not synchronized, in this case the signal timestamps are ignored and the browser time is used.

There is also a form for choosing the chart color on the right side of the card.

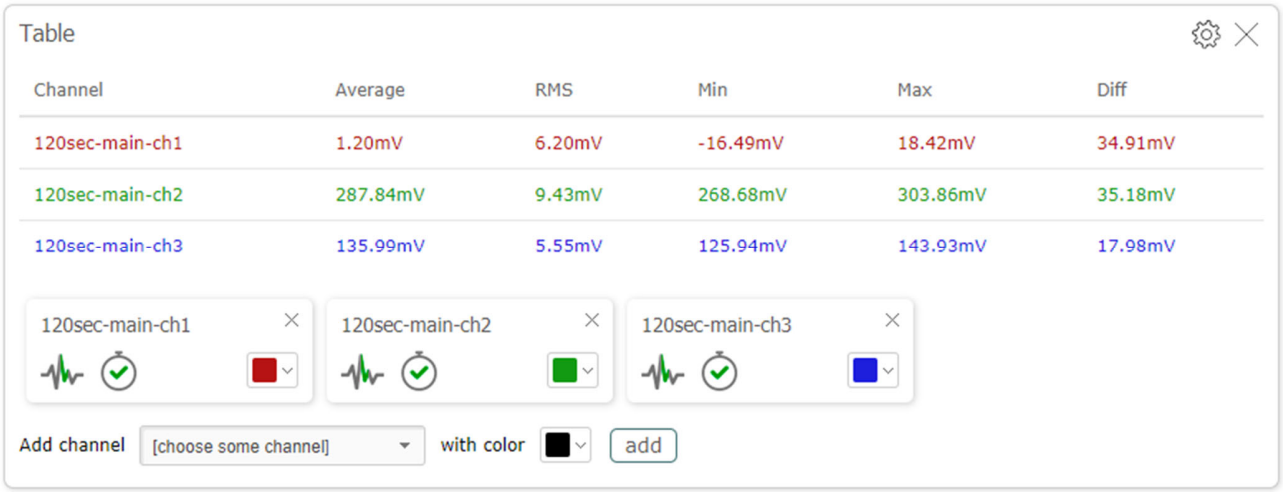

Fig. 6.11. RT Viewer module. Signal text parameters window

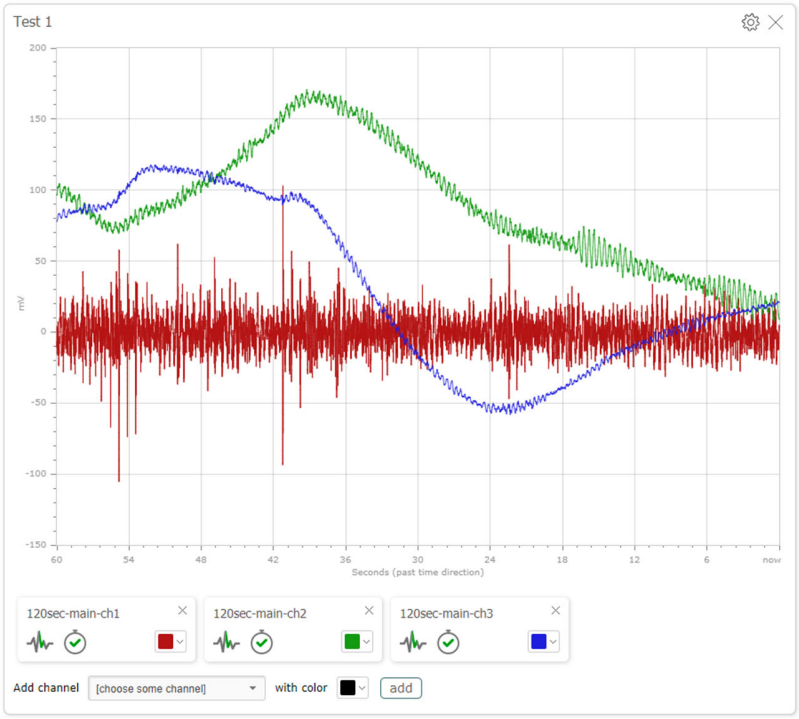

Fig. 6.12. RT Viewer module. Waveform window

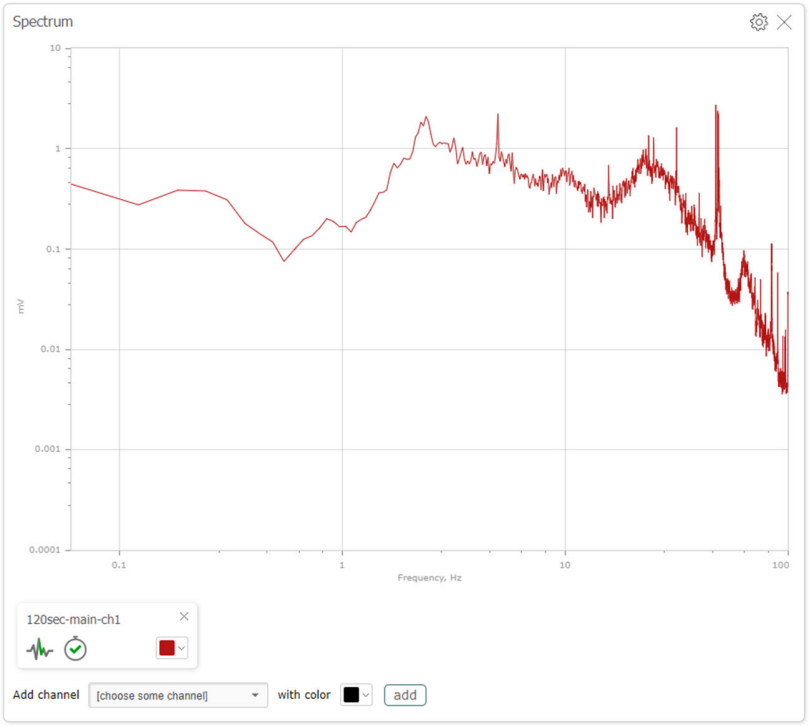

Fig. 6.13. RT Viewer module. Signal spectra window

6.9. Profiles tab

Use the Profiles tab to save and upload the user profiles. The windows created by the user with all the settings, signals and their colors as well as buffering settings are saved to the profile. The saved profiles are stored on NDAS-RT.

The profiles can be useful in the following cases:

- if it is required to move all user settings to another computer or to another browser while opening the module web interface
- if it is desirable to use multiple module settings while working in the same browser

Note that the connections settings (Connections) do not refer to the user profile settings – they are common for the entire module.

7. GPS and Time program module

The GPS and Time module is designed to synchronize the NDAS-RT clock from the GPS, NTP and PTP time sources.

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical. The functions and capabilities described in this chapter for NDAS-RT also refer to the data logger.

The module has the following basic functionality:

- Receive the data from the integrated GPS receiver, synchronizing the clock with the GPS time;
- In the GPS synchronization mode, the module can act as the Stratum 1 NTP server;
- In the GPS synchronization mode, the module can act as the PTP master clock source;
- Clock synchronization with the NTP servers;
- Clock synchronization within the PTP network environment.

The module compares the current evaluation of the timing accuracy to the user-set acceptable threshold. If the timing accuracy exceeds the set threshold, the time of the device is considered valid and this information is sent to the software modules. Thus, in particular, the NDAS One Manager module can synchronize the NDAS One data loggers connected to it if the required accuracy is achieved.

In addition, the information on the time validity as well as on the coordinates of the device (in case of the GPS synchronization) is displayed in the metadata of the NJSP stream of the auxiliary ADC integrated with NDAS-RT.

7.1. Start of the Module

Click the **Config** tab on the NDAS-RT main interface (see Fig. 4.1 and 4.2). Find the line with the **GPS and Time** module, click the **run** button in this line. The module may take some time to start.

When enabling and disabling the module, a password will be requested to get a root access. This is required to start the necessary operating system services.

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

7.2. Module interface

Module interface is divided into the **Status** tab and the **Config** tab.

The **Status** tab contains general information such as the currently selected time source, evaluation of the time offset against the true time, and a logical flag that reports the validity of the clock readings. The same information is duplicated in the module status bar on the NDAS-RT main interface.

In addition, information for each source is displayed:

- The GPS status contains information about the coordinate, time, status of the leap seconds, and number of satellites in view. The NTP service is used to synchronize the system clock with the GPS clock so evaluation of the timing accuracy is available in the next line in the NTP status;
- The NPT status contains information about the current server, time, status of the leap seconds, and evaluation of the clock error against the true time;
- The PTP status contains information about the current operation mode (Master/Slave), id master, evaluation of the timing accuracy.

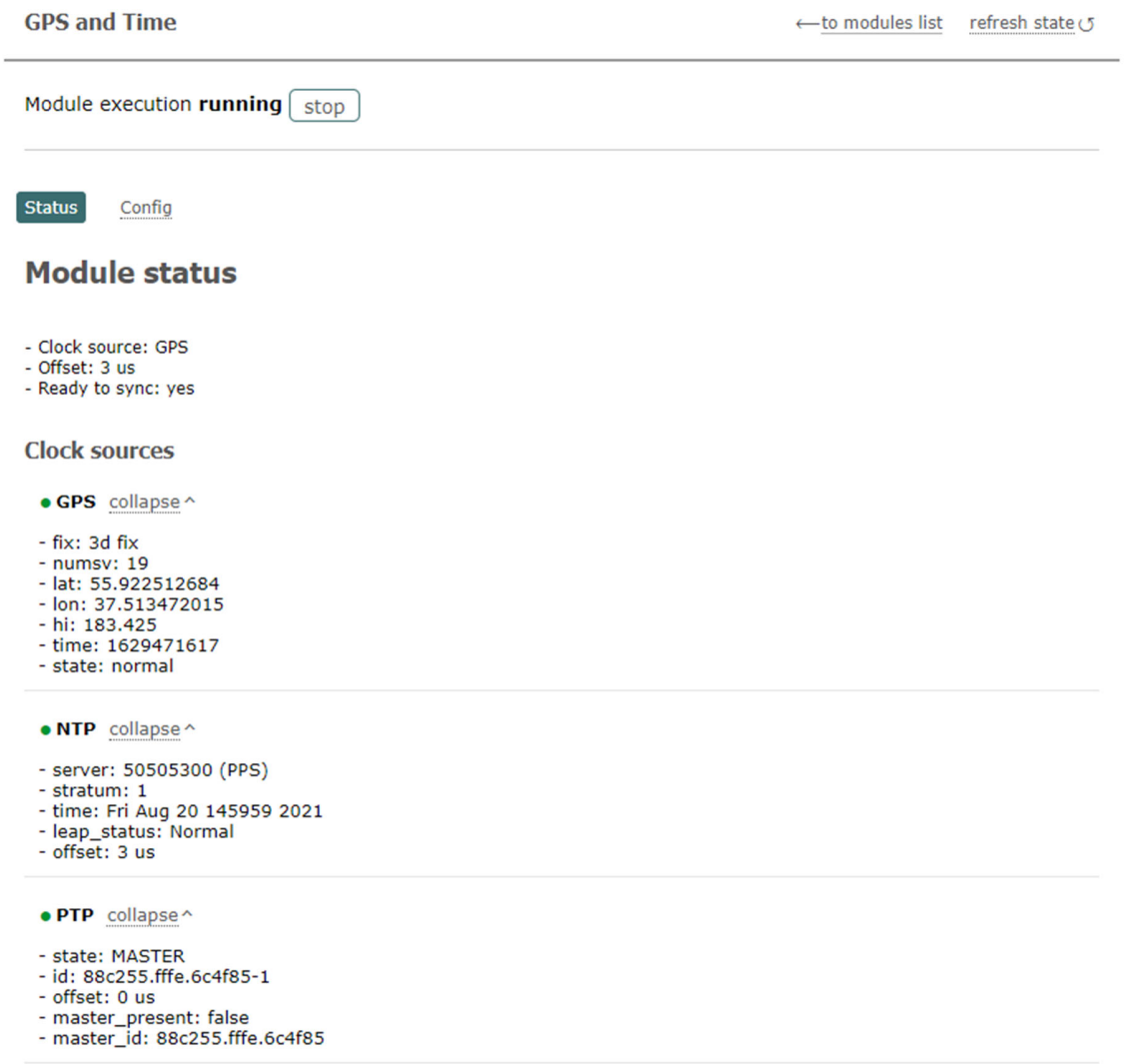

Fig. 7.1. GPS and Time module. Module status

The **Config** tab allows configuring the following parameters:

- Set up the timing accuracy threshold
- Select the time source
- For the GPS synchronization:
  - Use the GPS time as the time source for the NTP server
  - Use the GPS time as the time source for the PTP master
- Servers and server pools can be specified for the NTP time source
- The device can be prevented from taking the master's role for the PTP time source (Slave only mode)

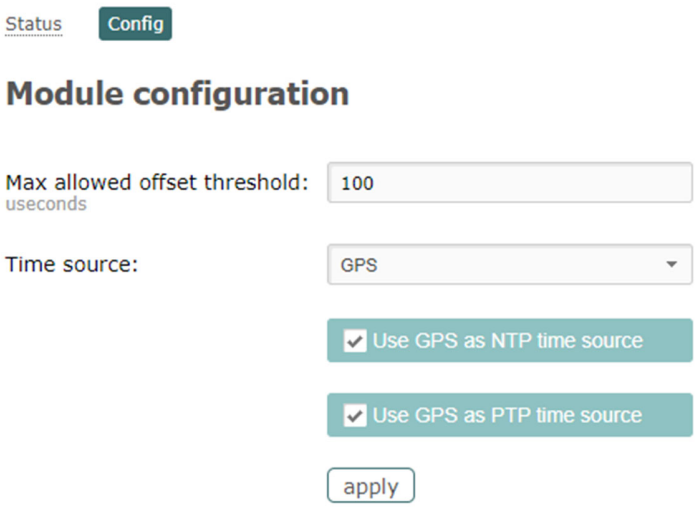

Fig. 7.2. GPS and Time module. Configuration during the GPS synchronization

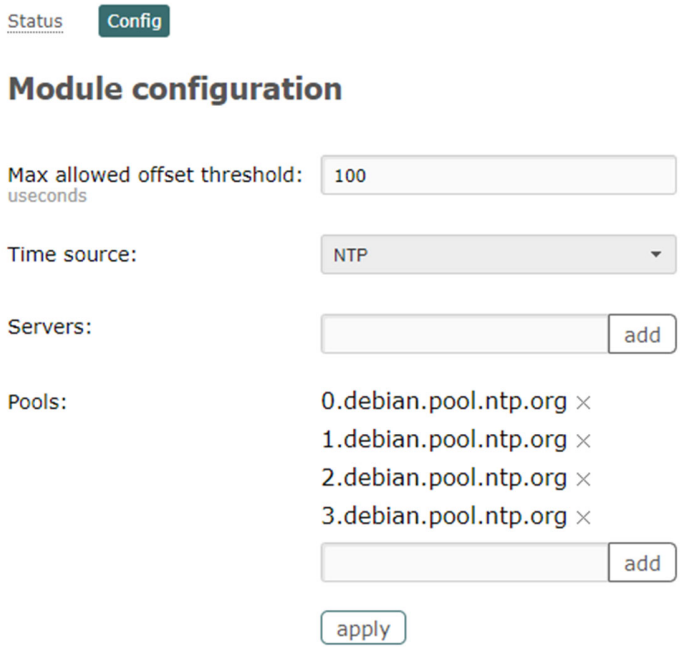

Fig. 7.3. GPS and Time module. Configuration during the NTP synchronization

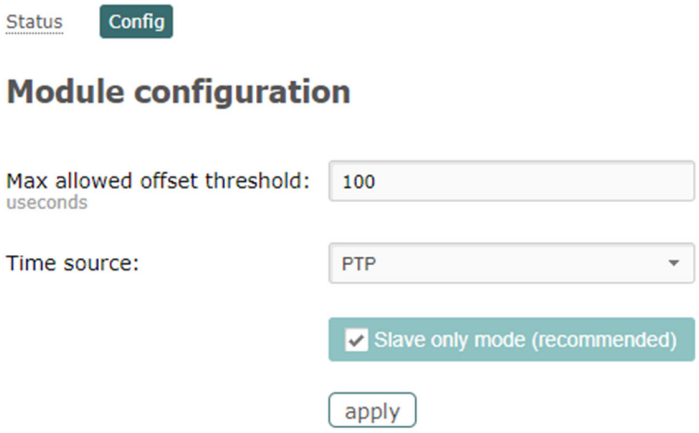

Fig. 7.4. GPS and Time module. Configuration during the PTP synchronization

8. SeedLink server program module

The SeedLink server program module is designed to convert the NJSP streams into the SeedLink protocol as well as to record the data to the internal memory in the miniSEED format. The module is a shell for launching the SeedLink v3.2 (2014.071) and Slarchive 1.7-sc3 programs of the Seiscomp3 package which are distributed under the terms of the GNU General Public License.

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical. The functions and capabilities described in this chapter for NDAS-RT also refer to the data logger.

Each incoming NJSP stream is represented in the SeedLink protocol structure as a separate station. The graphical interface of the module supports basic configuration without the function of filtering and decimation, you will need to go to the development environment and manually edit the file with parameters to set up the complete control and advanced settings.

Before proceeding with the module settings it is recommended reading the official SeedLink documentation provided on the developers' website at
https://docs.gempa.de/seiscomp3/current/apps/seedlink.html

8.1. Start of the Module

Click the **Modules** tab on the NDAS-RT main interface (see Fig. 4.1 and 4.3). Click the **run** button in the appropriate line. If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen after a few seconds.

At the initial start the module may display an error message indicating the configuration file was not found. This message will disappear after the required module configuration is set up and saved.

8.2. Module configuration page

Basic configuration is performed through the module configuration web page. Click the **config** button on the module status bar to open the page. The page consists of a general **Configuration** and a **Stations list**.

The Configuration section configures the following parameters:

- **Organization** is the name of the organization (falls into the **organization** parameter of **seedlink.ini**)
- **Network code** is the code of the network (falls into the **network** parameter of **seedlink.ini**)
- **Seedlink TCP Port** is the SeedLink Server external port (falls into the **port** parameter of **seedlink.ini** displaying **18000** by default)
- **Use custom streams.xml file** is an option controlling **streams.xml**. If this option is disabled, the **streams.xml** file is created on the basis of the stations parameters set up through the web interface. If enabled, the user must manually create a file having the required stream parameters. For details, see **Advanced Settings**
- **Enable archiver** is an option that controls enabling of the **slarchive** program which locally connects to the SeedLink server and saves these files in the miniSEED format
- **Archive path** is a path to the directory to which **slarchive** should save files.

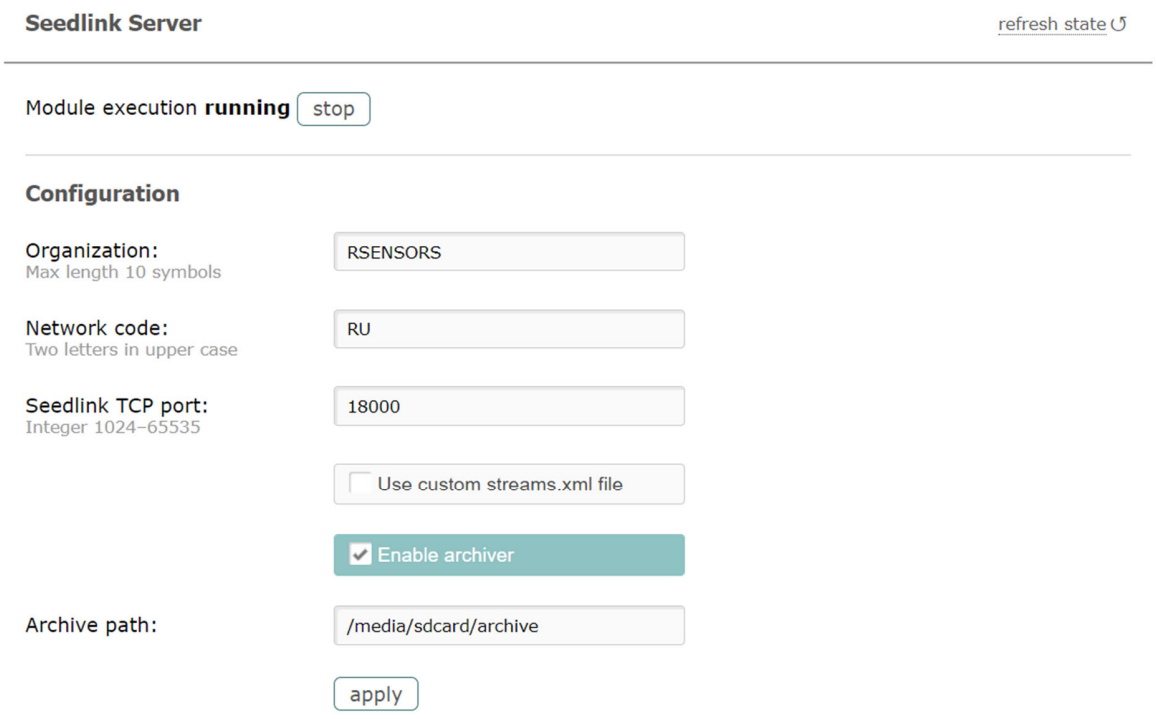

Fig. 8.1. SeedLink server module. Configuration

8.3. Basic configuration of SeedLink stations

The **Stations** section displays a list of stations and a status message for each station. The *Connected* message indicates that the module has successfully connected to the NJSP server and is receiving the data. The *Incorrect sample rate* message indicates that the module has connected to the NJSP server but the sampling rate of the incoming signal is different from the corresponding parameter for the SeedLink stream.

The stations list interface allows adding a station, remove a station from the list, and edit station parameters.

Fig. 8.2. SeedLink server module. Stations list

The station settings include:

- **Station name** is a station user name used only for display in the list of stations
- **Station ID** is a station ID (falls into the **station** parameter of **seedlink.ini** and the corresponding **proc** element of the **streams.xml** tree)
- **Channel's IDs** are channels IDs in the **LL.SSN** format consisting of **location code**, **stream**, **channel** character
- **Sample rate** is a sampling rate of the incoming signal
- **IP address** and **Port** are the NJSP server IP and port to which the station must connect. If a local module connection is used, it is enough to specify the port, the IP field can be left blank.

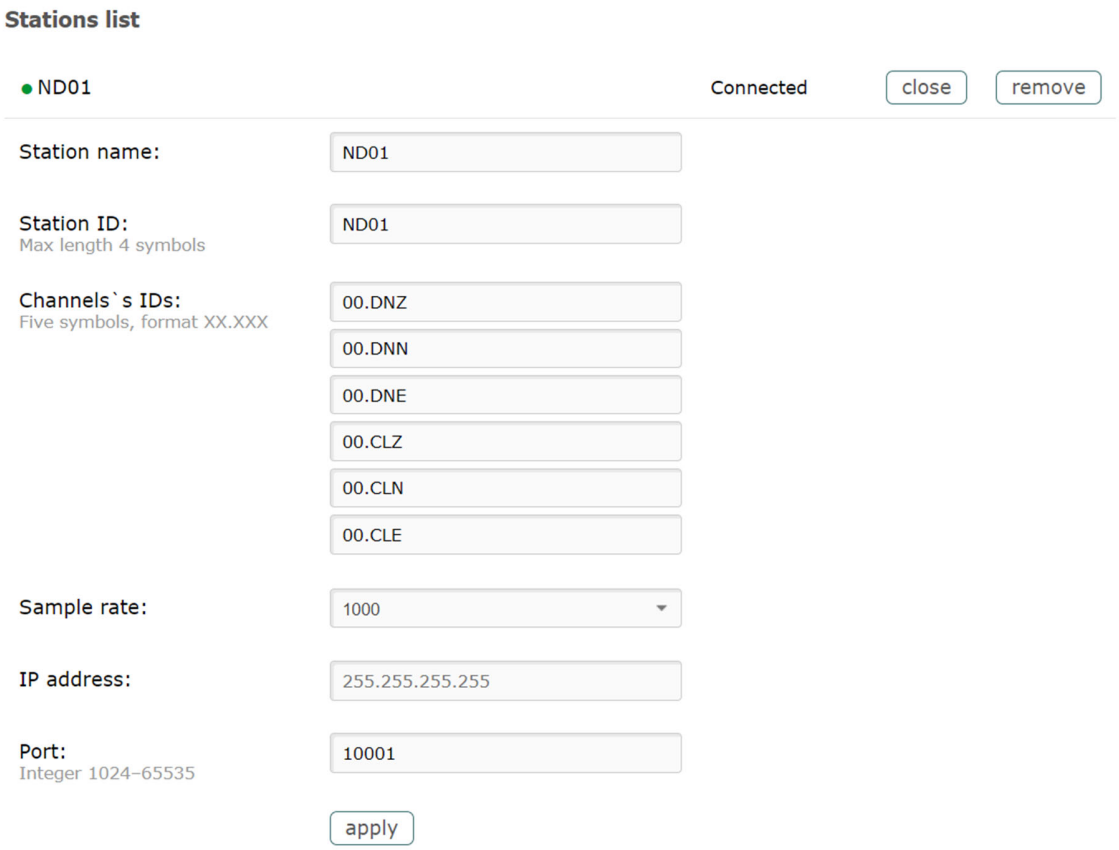

Fig. 8.3. SeedLink server module. Station settings

For example, when entering the data as given in the screenshot, the first channel of the data logger will have the full code in the SeedLink system as **RU.ND01.00.DNZ.D** (where the latter **D** means the Data type).

The sampling rate of the NJSP incoming signal must match the **Sample rate** parameter. That means for correct operation it is necessary to set the same sampling rate in two settings – in the parameters of the signal source (data logger) and in the parameters of the SeedLink module.

8.4. Auxiliary channels

The **NJSP** protocol transmits the auxiliary data such as the data logger coordinates, temperature, supply voltage, and other telemetry data. In the SeedLink Server module this data falls into a separate stream that has an **AU** code as signals with a sampling rate of 1/10 Hz. The **location code** parameter is set by default as **00**.

A complete list of auxiliary channels is given in the table below:

Name	Channel	Description	Units of measure
voltage	A	Supply voltage	mV
temper	B	Temperature of the data logger	1/10°C
pressure	C	Pressure in the data logger housing	Pa
humidity	D	Relative humidity in the data logger housing	%
accel_z	E	Accelerometer readings, Z-axis	mg
accel_x	F	Accelerometer readings, X-axis	mg
accel_y	G	Accelerometer readings, Y-axis	mg
comp_z	H	Accelerometer readings, Z-axis	mGauss
comp_x	I	Accelerometer readings, X-axis	mGauss
comp_y	J	Accelerometer readings, Y-axis	mGauss
latitude	K	Data logger coordinate, latitude	10^{-6} °
longitude	L	Data logger coordinate, longitude	10^{-6} °
height	M	Data logger height above the sea level	m

If it is required to change the **location** code, **stream** code or **channels** code, use the **Use custom streams.xml** file option and manually set the desired codes in the **streams.xml** file. See 'SeedLink Advanced Settings'.

Different data loggers and digital seismic sensors have a different set of built-in sensors. Missing channels will not fall into the SeedLink streams. Refer to the User Manual of the connected device to find out what sensors are available inside of the data logger and what kind of the axes orientation of the built-in compass and accelerometer is if any.

8.5. Log of the data logger

The **NJSP** protocol transfers the log messages from the data logger. In the SeedLink server module, this data falls into the separate **LOG** stream that has the L-type data. The **LOG** stream does not have a **location code** characteristic and will have a full **RU.ND01.LOG.L** type code in the SeedLink system.

8.6. Quality of time data

The **NJSP** protocol contains information on the quality of time data in the following form – in each package a time stamp is transferred marking the time of the first count in the package by the data logger's clock, a drift of the data logger's time against the true time, and a drift measurement time. **SeedLink**, on its part, receives information in the form of conditional quality of time data measured in a percentage rate.

The SeedLink server calculates the quality percentage using the following algorithm. If the last drift measurement was made less than 60 seconds ago, then the quality of the time data is considered to be 100%. Further on, the quality decreases by 1% every minute. If the last drift measurement was made more than 100 minutes ago, the quality of the time data is considered to be 0%.

8.7. Slarchive archiver

The **Slarchive** program connects locally to the SeedLink server and saves the data in the miniSEED format. On the configuration page you can turn this feature on and off as well as configure the directory where the data will be saved.

The program saves the data into the SeisComP Data Structure in the following format **<SDSdir>/Year/NET/STA/CHAN.TYPE/NET.STA.LOC.CHAN.TYPE.YEAR.DAY**.
The details are available in the slarchive program documentation at https://docs.gempa.de/seiscomp3/current/apps/slarchive.html

If it is necessary to change the settings of the archiver (for example, change the data structure, add additional startup parameters or disable the script for cleaning), edit the **slarchive.py** file – the parameters to start the executable file are set in line 21.

8.8. SeedLink advanced settings

The SeedLink program allows reducing the signal sampling rate through a system of stages of digital decimating filters. In this case, several streams with different sampling rates can be created on the basis of the same initial data. This functionality is implemented by building a stream tree in the **streams.xml** file. The decimating filter parameters are specified in **filters.fir**.

Usually, the module generates the **streams.xml** file automatically creating only streams for the source data. Decimation and filtering are not involved. In order to manually edit these parameters, enable the **Use custom streams.xml file** option – in this case, the module will not overwrite the file.

To access the files, open the **Cloud9** development environment web interface available on port **3000**. By default, the login and password is **'ndasrt' / 'ndasrt'**. In the directory tree, uncover the directory *ndas_rt/sw_modules/seedlink_server/seedlink*

Note that the **seedlink.ini** file which contains the basic program settings and file paths is also generated automatically. If it is required to make changes to **seedlink.ini**, it is recommended changing the generation script itself which is contained in the **seedlink_cfg.py** file.

When editing a file manually, follow the following rules:

- The stations names (the **name** attribute of the **proc** element) must match the **Station ID** fields that are specified on the module configuration page in the stations list;
- The sampling rate (the **rate** attribute of the **input** element) must match the actual frequency of the incoming signal. In addition, the frequency specified on the module configuration page must also match the actual frequency of the incoming signal;
- The primary channels names (the **name** attribute of the **input** element) have values of **ch1...ch6**
- The auxiliary channels names are given in the table in the Auxiliary Channels section. The sampling rate of auxiliary channels is always equal to 1/10 Hz.

Below is an example of the **streams.xml** file in which the first three channels of the data logger are transmitted to the DN stream unchanged at a frequency of 1000 Hz, and the second three channels are decimated to a frequency of 100 Hz by the F260 filter and transmitted to the HH stream. This approach is useful when a seismic accelerometer and a broadband seismometer are connected to one 6-channel data logger.

```
<?xml version="1.0" ?>
<streams>
	<proc name="ND01">
		<tree>
			<input channel="Z" location="00" name="ch1" rate="1000"/>
			<input channel="N" location="00" name="ch2" rate="1000"/>
			<input channel="E" location="00" name="ch3" rate="1000"/>
			<node stream="DN"/>
		</tree>
		<tree>
			<input channel="Z" location="00" name="ch4" rate="1000"/>
			<input channel="N" location="00" name="ch5" rate="1000"/>
			<input channel="E" location="00" name="ch6" rate="1000"/>
			<node filter="F260" stream="HH"/>
		</tree>
		<tree>
			<input channel="A" location="00" name="voltage" rate="1/10"/>
			<input channel="B" location="00" name="temper" rate="1/10"/>
			<input channel="C" location="00" name="pressure" rate="1/10"/>
			<input channel="D" location="00" name="humidity" rate="1/10"/>
			<input channel="E" location="00" name="accel_z" rate="1/10"/>
			<input channel="F" location="00" name="accel_x" rate="1/10"/>
```

```
                <input channel="G" location="00" name="accel_y" rate="1/10"/>
                <input channel="H" location="00" name="comp_z" rate="1/10"/>
                <input channel="I" location="00" name="comp_x" rate="1/10"/>
                <input channel="J" location="00" name="comp_y" rate="1/10"/>
                <input channel="K" location="00" name="latitude" rate="1/10"/>
                <input channel="L" location="00" name="longitude" rate="1/10"/>
                <input channel="M" location="00" name="height" rate="1/10"/>
                <node stream="AU"/>
            </tree>
        </proc>
</streams>
```

9. FTP server program module

The **FTP server** module provides access to the NDAS-RT file system using the FTP protocol. Both the anonymous access and the login and password-based access for reading or for reading and recording are supported.

9.1. Start of the Module

Click the **Config** tab on the NDAS-RT main interface. Find the FTP server line, press the **enable** button.

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

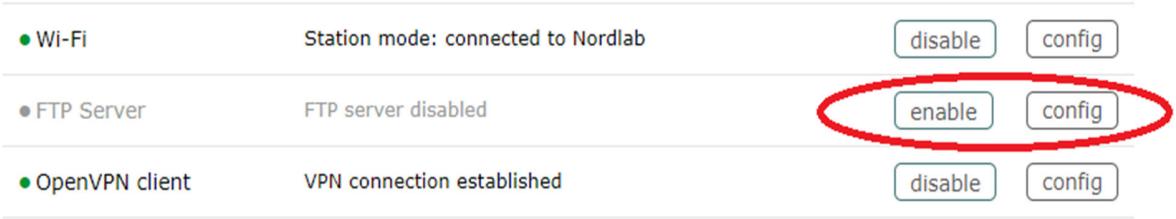

Fig. 9.1. FTP server module. Enabling and configuring

Enabling and disabling the module requires super-user rights so the password to the debian user account will be requested.

9.2. Module configuration page

The **config** button in the line of the FTP server module opens a dedicated page of the access rights configuration.

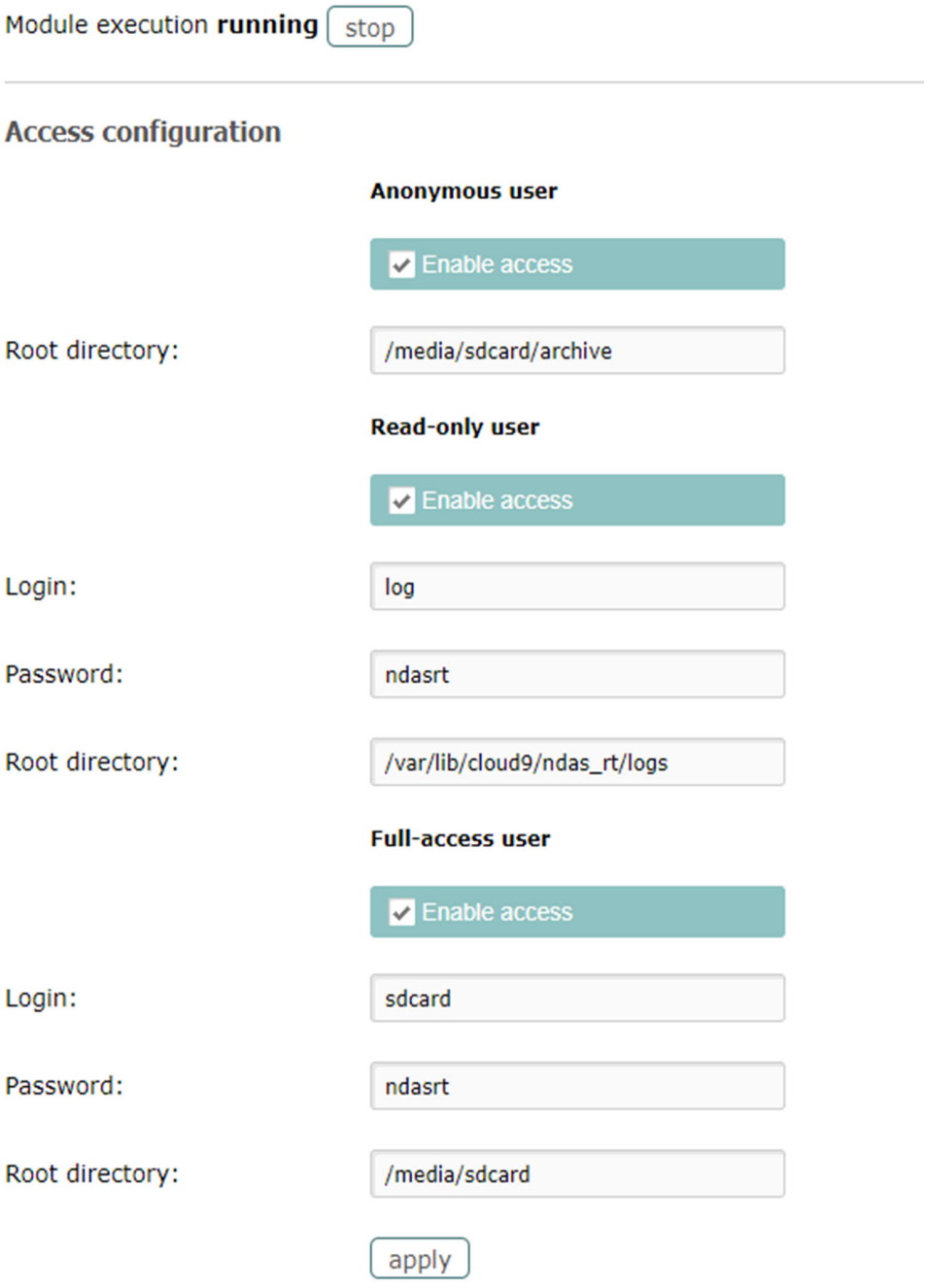

Fig. 9.2. FTP server module. Access rights configuration

The configuration of the module allows configuring three types of access, each of them can be independently enabled or disabled: anonymous read-only access, password-based access for reading, password-based access for reading and recording. Each access type has its own root directory.

The following configuration is given at the screenshot below:

- Anonymous access to the contents of the miniSEED file archive is allowed;
- Reading only access to the log directory for the *log* login is allowed;
- Full access to the memory card contents for the *sdcard* login is allowed.

Changing the FTP server configuration requires super-user rights so the password to the debian user account will be requested.
Logins for the reading only access and the full access must be different.

It is recommended opening the anonymous access only for directories on the device's SD card. Never access the NDAS-RT system directories anonymously. It may grant attackers access to reading files containing critical information such as passwords.

10. Disk Cleaner program module

The **Disk Cleaner** module is an integrated module of the NDAS-RT system and is used to clean the device memory from the oldest files. The module periodically checks the free space of the disk. If the volume of free space is less than the specified threshold, the module sequentially removes the oldest files until the required space volume becomes available. When finished, the module removes empty directories that may remain after removing the files.

The module does not analyze the contents of files, timestamps in the signal, etc. The module sorts the files by the time of the last change according to their attributes in the file system.

10.1 Enabling and disabling the module

Click the **Config** tab on the NDAS-RT main interface. Find the **Disk Cleaner** line, press the **enable/disable** button.

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

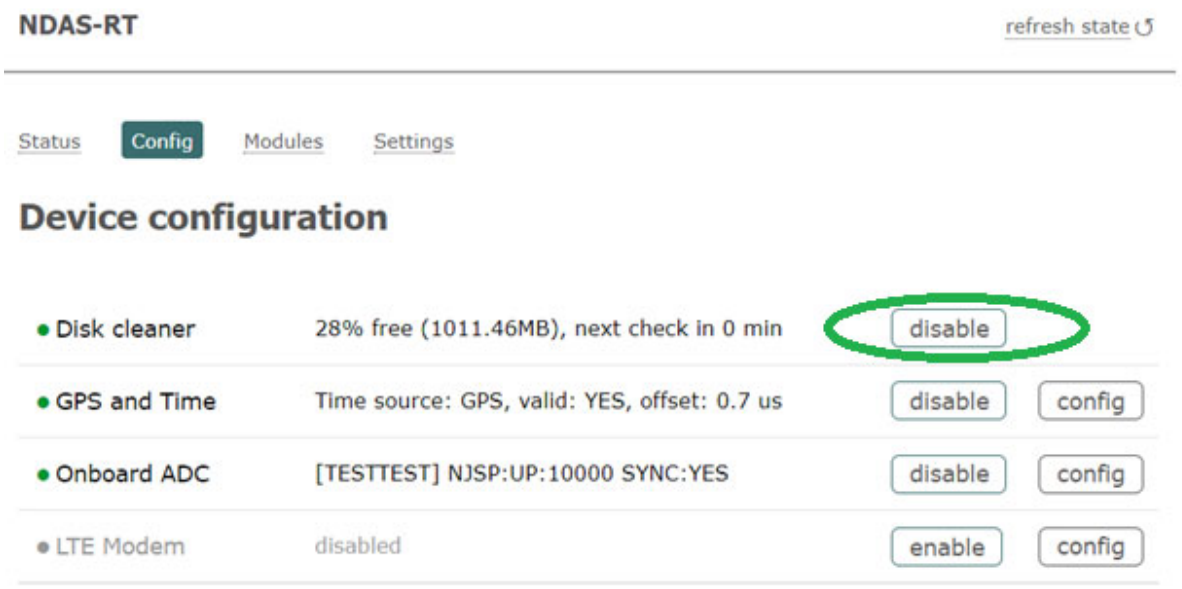

Fig. 10.1. Disk Cleaner module. Enabling and disabling

10.2 Module configuration

The module does not have a graphical interface and in most cases the pre-installed configuration does not need to be changed. If necessary, the module parameters can be changed in the general configuration file named **system_manager_config.json** located in **ndas_rt/settings/**.

Fig. 10.2. Disk Cleaner module. Parameters configuration

The following parameters are available for changing:

- **path** is a path to the directory that is scanned by the module. It is a location of the SD card installation by default;

- **exclude** is a list of subdirectories added to the exceptions. It is a directory of the SeedLink server buffer and a log directory by default;
- **period** is a scanning period, in minutes. 60 minutes are set by default;
- **threshold** is a threshold of free space, in percent. 15% is set by default.

11 Firewall (network screen)

A firewall is required to restrict access to the device when it is connected to an unsafe or public network. First of all, a firewall is required when NDAS-RT is connected to the Internet using an external static IP address.

11.1 Start of the Module

Click the **Config** tab on the NDAS-RT main interface. Press the **enable** button in the **Firewall** line.

Enabling and disabling the module requires super-user rights so the password to the debian user account will be requested.

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

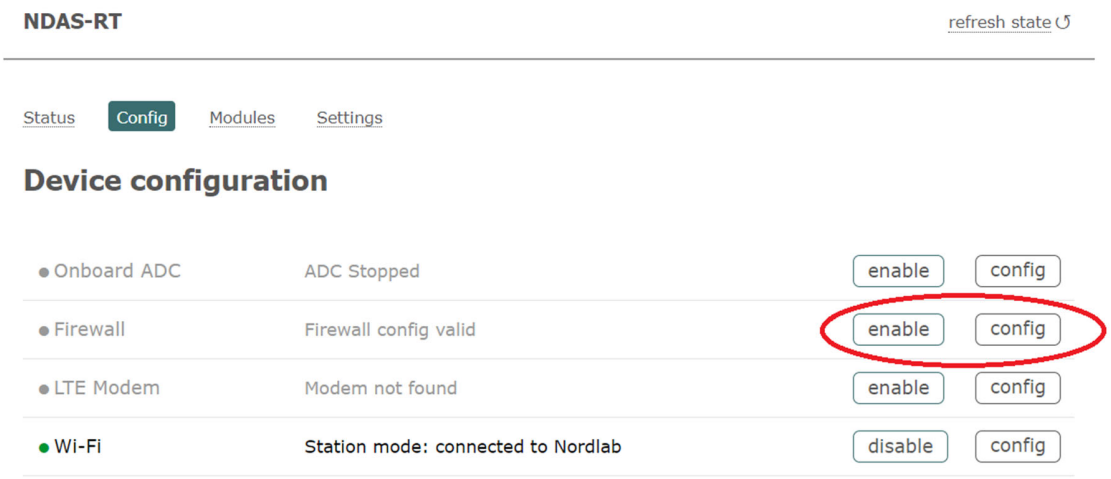

Fig. 11.1. Firewall. Enabling and configuring

11.2 Module configuration page

The **config** button opens a dedicated page of the NDAS-RT firewall configuration.

A set of rules can be configured for each network connection. That is, for example, the firewall to protect an Ethernet connection can be configured and the full access for a USB connection and a VPN tunnel can be left.

The list of network connections is given in the table below.

Table 11.1. NDAS-RT network connections:

Ethernet (eth0)	Ethernet network
Modem connection (ppp0)	3G modem connection
USB virtual network (usb0)	USB virtual network
Wi-Fi station (wlan0)	Wi-Fi connection in the station mode
Wi-Fi access point (tether)	Wi-Fi connection in the access point mode
VPN tunnel (tun0)	VPN tunnel

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical. The functions and capabilities described in this chapter for NDAS-RT also refer to the data logger.

Each rule is based on the principle of whitelisting for incoming connections. In total, there are 3 lists for each connection: the TCP ports list, the UDP ports list, and the IP addresses list. If the whitelist is disabled, all connections of the appropriate type are allowed for the selected network interface. If the whitelist is enabled, only connections of the list will be allowed.

To create a new set of rules, click **add rule**, set the required configuration, and click **apply**.

Only one set of rules must match each interface.
Changing the set of rules requires super-user rights so the password for the debian account will be requested.

For example, in the screenshot below the TCP and UDP ports whitelists are enabled for the ppp0 interface (modem connection). Connections to ports 8000, 3000, 18000, 21, and 22 are allowed for TCP. For UDP the list is empty, that is, all UDP connections are prohibited. Since the whitelist for IP addresses is not enabled, connections from any IP addresses are allowed.

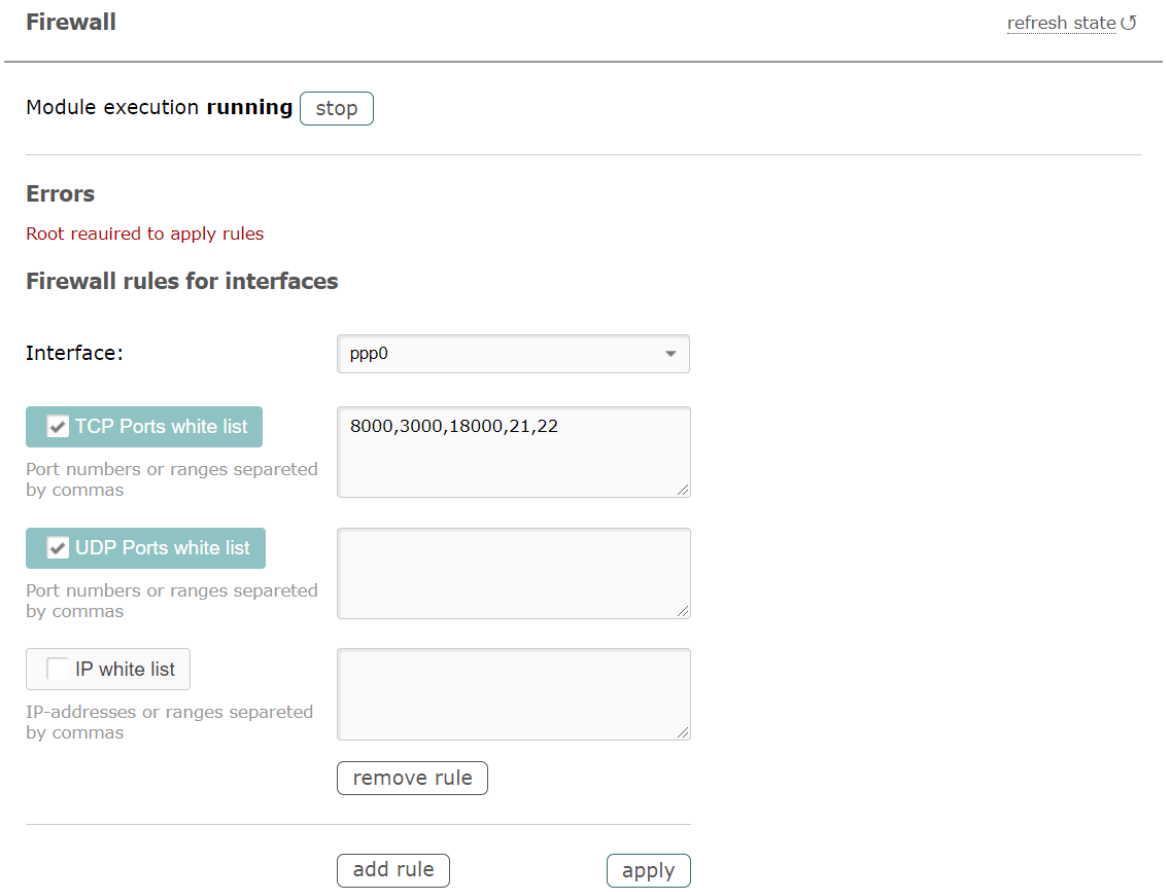

Fig. 11.2. Firewall. Parameters configuring

Refer to section **4.5 NDAS-RT Network Model** of this Manual for details on the port numbers used.

11.3 Firewall. FTP connections

The FTP server uses additional ports to establish connections in a passive mode. For this, a special scenario is provided: if there is the FTP server port (**21**) in the whitelist of ports, then the Firewall module additionally opens the TCP port range of **49152:49168**. The same range is registered in the FTP server configuration by default.

Safety considerations

The NDAS-RT firewall implements only basic rules for restricting access to the device and does not guarantee complete security and protection of the system from hacking and unauthorized access. In particular, Firewall does not provide:

- Blocking of outgoing connections. Any application on the device can send any data to any address;
- Control for which exact application opens and taps the port. For example, if connections to port 18000 are allowed, then a malicious application can open this port for tapping if it has been run earlier than the SeedLink server;
- HTTP connection protection. Traffic between the device's web interface and the web server is transferred over HTTP in an unencrypted form (except for the super-user password which is encrypted by the RSA algorithm). An attacker can intercept the password for authorization in the web interface and gain access. In addition, the web server used in NDAS-RT may have potential vulnerabilities that could be exploited to hack the web interface and run malware.

To ensure the greatest security, it is recommended you follow the recommendations below:

- Use the VPN technology and connect the device inside the VPN network. VPN allows connecting a device with no need to assign a real IP address to it and open ports that makes it impossible to connect to the device from outside;
- If your device has a real IP address, block all incoming connections except SSH (port 22). Be sure to set up a strong password for the debian account to eliminate the possibility of authorizing an attacker via SSH. Use the SSH tunnel technology to access the device.
- If possible, configure the IP addresses whitelist by specifying only the IP addresses which you will use to connect the device.

12. NDAS One Manager module

The NDAS One Manager program module is designed to connect digital seismic sensors and the NDAS One series data loggers (NDAS-8224, NDAS-8226, CME-4x11ND, CME-6x11ND) to the data logger.

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical. The functions and capabilities described in this chapter for NDAS-RT also refer to the data logger.

The module has the following functions:

- Automatically detects devices which are connected to the USB ports and the specialized NDAS ports
- Automatically switches the device into the real-time data mode

- Synchronizes the device clock with the NDAS-RT clock (only for devices connected to the specialized NDAS port).
- Provides access to the device's web interface
- Creates an NJSP server to which other NDAS-RT program modules can connect locally or remotely

Multiple devices can be connected at the same time. Each of such devices is provided as a separate NJSP thread server.

For each hardware port on the NDAS-RT housing, the module matches a specific NJSP network port. As a result:

- The same device connected to different ports on the NDAS-RT housing will have a different NJSP port number.
- Different devices connected to the same port will have the same NJSP port number
- If the device is not directly connected to the data logger but via a USB hub, the device is assigned the NJSP port number out of the free numbers pool

12.1. Start of the Module

Open the **Modules** tab in the data logger's main interface (see Fig. 4.1, 4.3). Find the line with the NDAS One manager module, click the **run** button in this line.

If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

At the initial start the module may display an error message indicating the configuration file was not found. This message will disappear after the required module configuration is set up and saved.

12.2. Connection of devices

There are two ways to connect NDAS-One devices – via USB ports and specialized NDAS ports.

Software for the NDAS-N data logger and the NDAS-RT multifunction module is identical, but the data logger does not have specialized NDAS ports so the connection is possible only through the single USB port. The functions and capabilities described in this chapter refer both to NDAS-RT and NDAS-N, except for restrictions on the availability and number of ports for connecting devices.

Connecting the device via a specialized NDAS port provides additional advantages compared to the USB connection:

- The data logger's clock synchronization with the NDAS-RT clock;
- Connection by a long cable (up to 600 m using a UTP Cat 5 twisted pair cable or up to 40 km using a fiber optic cable);
- Lower power consumption of the system.

Consult the manufacturer for more information on how to connect and use the NDAS-RT-based systems.

Compatible versions of the NDAS-One software:

- At least 5.3 for USB connection
- At least 6.0 for connection via the NDAS port

Early versions of the CME-xxxxND and NDAS-8226 devices have two USB connectors: one for serial connection for the data and command transfer (usually a round RS-10 (PC-10TB) Russian type connector) and a regular USB-B connector for reading data from memory cards in the card reader mode. Connection to NDAS-RT requires the first type of connection that is the one for transferring the data and commands.

Connect the device by the cable to one of the NDAS-RT ports. Make sure that the selected connection port is enabled in the NDAS-RT settings on the Config tab.

The Enable/Disable button in the port configuration line is responsible for supplying power to the port. If the connected device is powered from the port, disabling the port will shut down the device. Thus, a hardware reboot of the connected device can be performed if necessary.

If the connected device is powered by a separate power supply, reboot is recommended (either using the device's web interface or by turning the power off and on again) before connecting.

Within 10-30 seconds NDAS One Manager will start communicating with the device. The LED corresponding to the used port should light up on the housing.

After that on the Config tab an indication should appear in the appropriate line containing short status information about the connected device: the name or serial number, state of the NJSP server, status of the clock synchronization of the device. On the right side of the line the **config** button will show up leading to the web interface of the connected device.

You can click **refresh state** in the upper right corner of the screen to update the information faster.

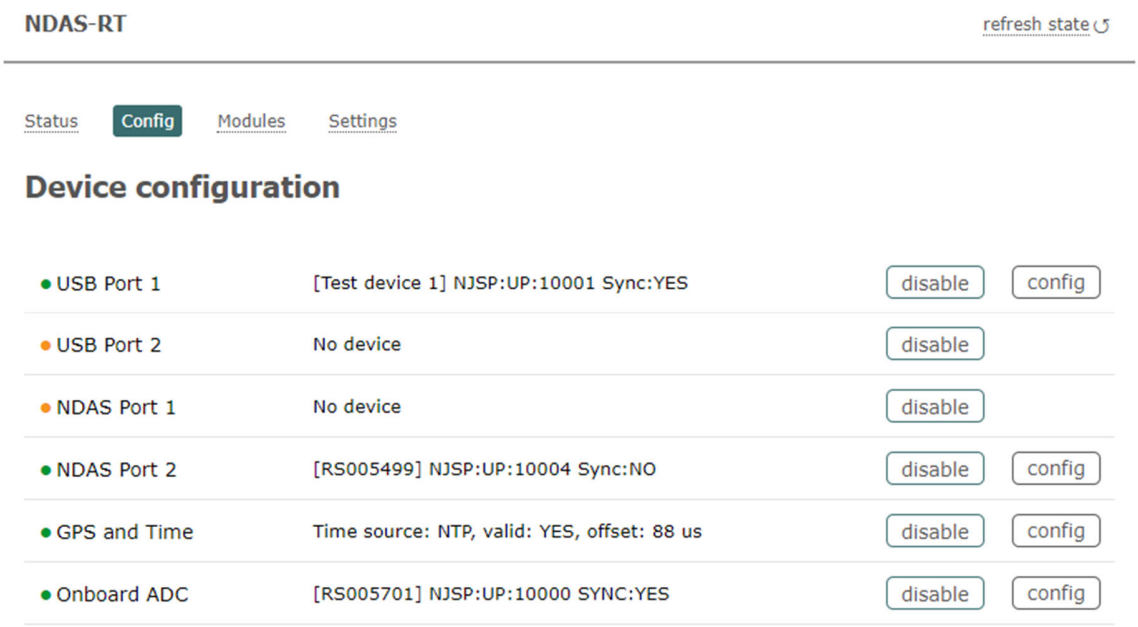

Fig. 12.1 NDAS-RT device configuration

If the connection to the device is successful, the data transfer to the NDAS-RT will automatically start and the LED corresponding to the connection port will start flashing.

Data transfer from the device to NDAS-RT starts automatically and is being done regardless of the data logger's operation mode – recording of the data into the internal memory card on the device itself can be both started and stopped.

If two USB ports on the NDAS-RT housing is not enough, you can connect NDAS-One devices via a USB hub. In this case, connection information will not be displayed on the Device Configuration page but you can view a list of the connected devices and access their web interfaces through the NDAS One Manager configuration page.

Only one NDAS-One device can be connected to each specialized NDAS port, that is, only two devices can be connected to one NDAS-RT through NDAS ports in total.

12.3. NDAS One Manager module configuration page

The module configuration page is divided into three tabs: **Devices, Config, Test**.

Devices tab

The Devices tab displays the status of all connected NDAS-One devices. The main line displays the serial number or device name, data status, and clock synchronization status. On the right side are the **details** and **config** buttons.

With clicking on **details**, you will get the detailed information about the device:

- Device serial number and name (if available)
- NJSP port number associated with that device
- Number of NJSP clients connected
- Synchronization mode
- Hardware port of the device
- Statistics of transmitted and received data

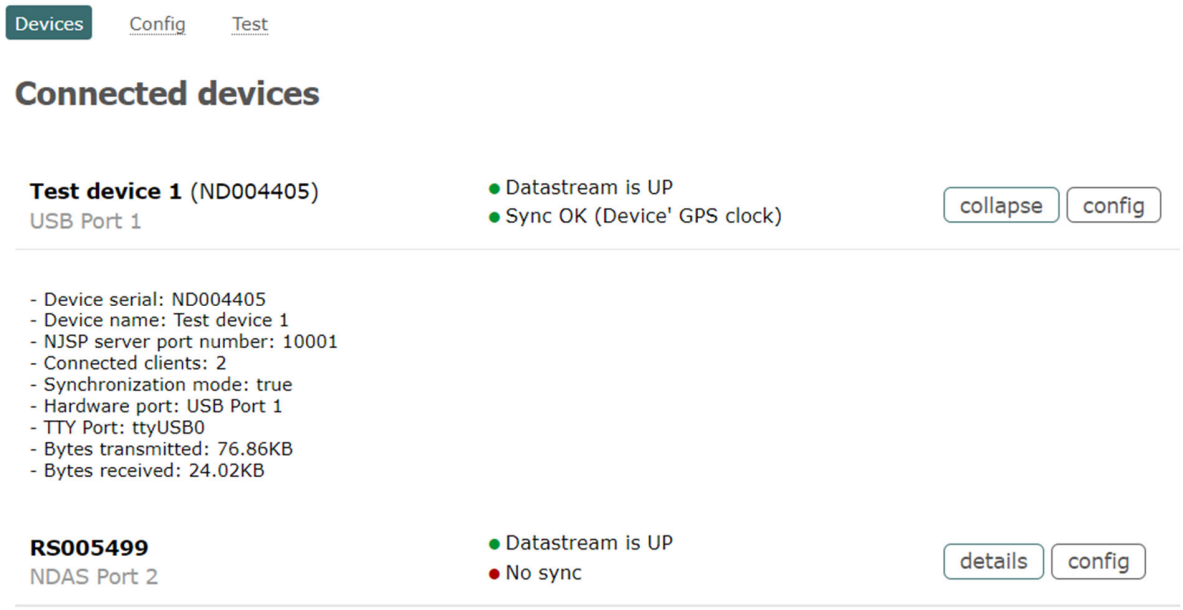

Fig. 12.2. NDAS One Manager module. Devices tab

Clicking on **config** opens the web interface of the device.

Config tab

The Config tab allows setting the configuration of the module.

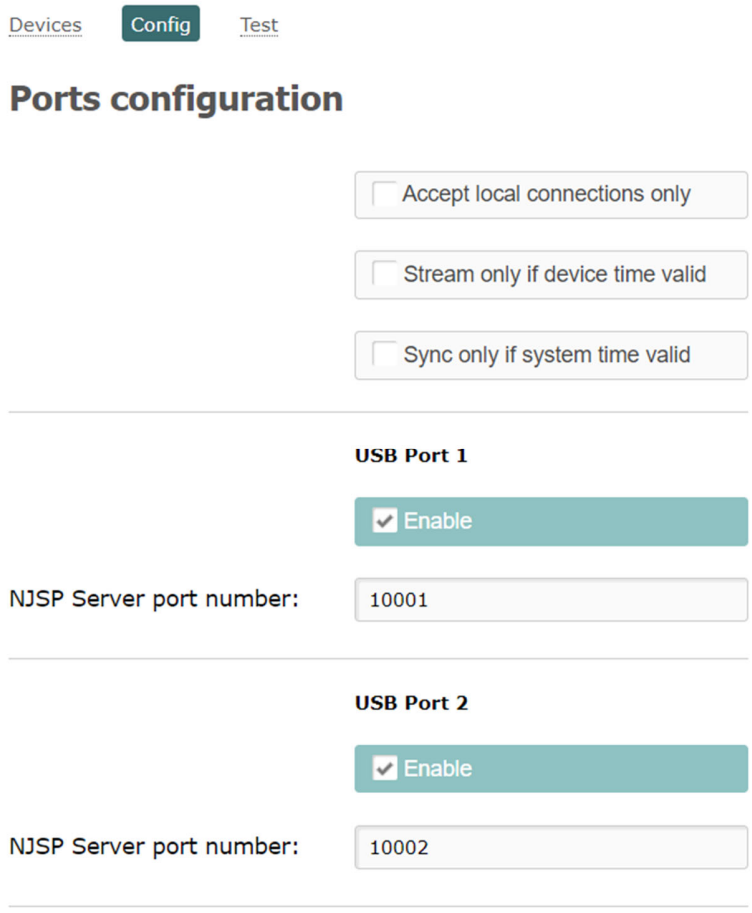

Fig. 12.3. NDAS One Manager module. Config tab

- **Accept local connections only**

This option prevents connections of external network devices to the module. In other words, only programs and program modules of NDAS-RT itself will be able to communicate with the module.

- **Stream only if device time valid**

This option allows streaming the NJSP data only if the clock of the connected NDAS-One device is synchronized.

- **Sync only if system time valid**

This option allows synchronizing the clock of the connected NDAS-One device with the NDAS-RT clock only if the GPS and Time module reports that the time on the NDAS-RT clock is valid.

- **USB Ports**

The following settings are available for USB ports:

- Enable – activating the port.
- NJSP Server port number – NJSP port number associated with that port.

Note that this setting does not control whether the port itself is enabled/disabled – it determines whether the NDAS One Manager module will access this port to locate the NDAS-One device. If you use a port to connect other devices, disable NDAS One Manager through this configuration.

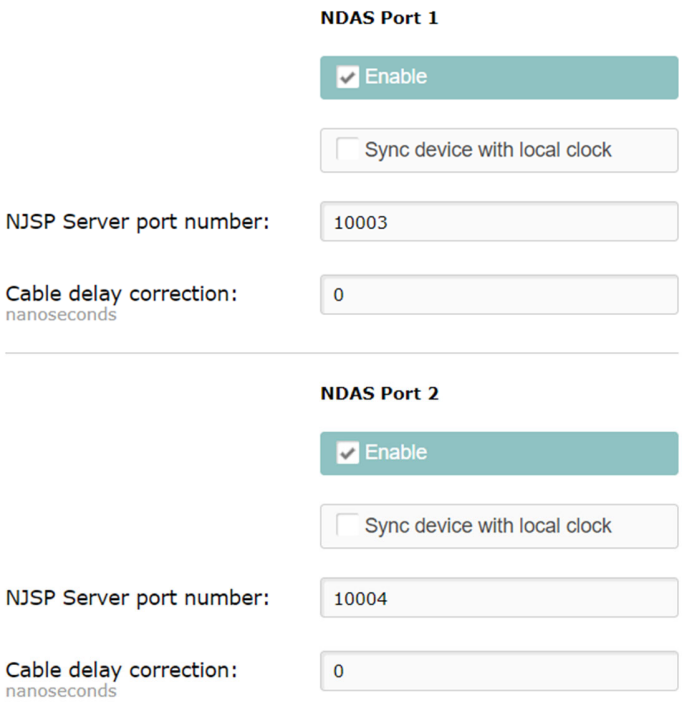

Fig. 12.4. NDAS One Manager module. NDAS ports settings

- **NDAS Ports (if available)**

The following settings are available for NDAS ports:

- Enable – activating the port.
- NJSP Server port number – NJSP port number associated with that port.
- Sync device with local clock is an option enabling synchronization of the connected device from the NDAS-RT clock.

Note: if the device has already been synchronized with its own GPS receiver before connecting to NDAS-RT or before enabling this option in the module settings, then the resynchronization will not be done. In this case you must reboot the device to reset the synchronization.

- Cable delay correction is a correction for a cable length measured in nanoseconds. This correction compensates for the time delay when the NDAS-One device is connected using a long cable.

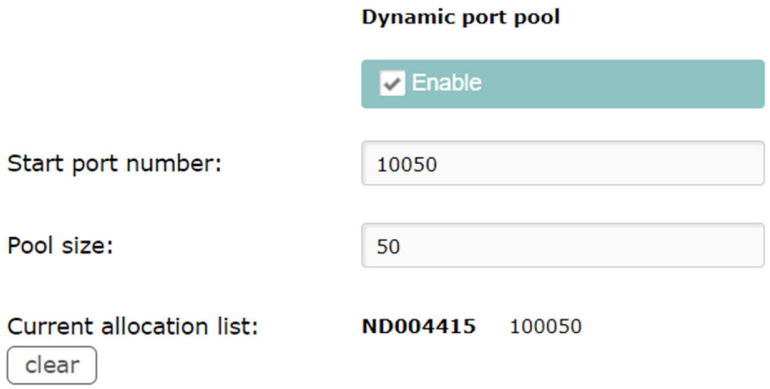

Fig. 12.5. NDAS One Manager module. Setting of dynamically connected ports

Accordance of hardware ports and NJSP ports by default:

USB Port 1	10001
USB Port 2	10002
NDAS Port 1	10003
NDAS Port 2	10004

- **Dynamic port pool**

This option configures the dynamic port pool. When the NDAS-One device is connected via a USB hub, it will be assigned a dynamic NJSP port out of the free port pool. The port number is linked to the serial number of the device so that the same port number will be used when reconnecting.

- Start port number – start port number of the address pool
- Pool size – number of ports in the pool
- Current allocation list – current list of assigned ports
- Clear – the button to clear the current list of assigned ports

Test tab

This tab allows testing the quality of the connection through a specialized NDAS port. This tool is useful for remote installation scenarios using long cables. The system tests operation at the speeds of 460800 Baud and 921600 Baud. Correct operation requires that the both tests be passed successfully.

The test takes about 60 seconds to complete.

Note that during the test the device will be disconnected and the NJSP server operation will be stopped.

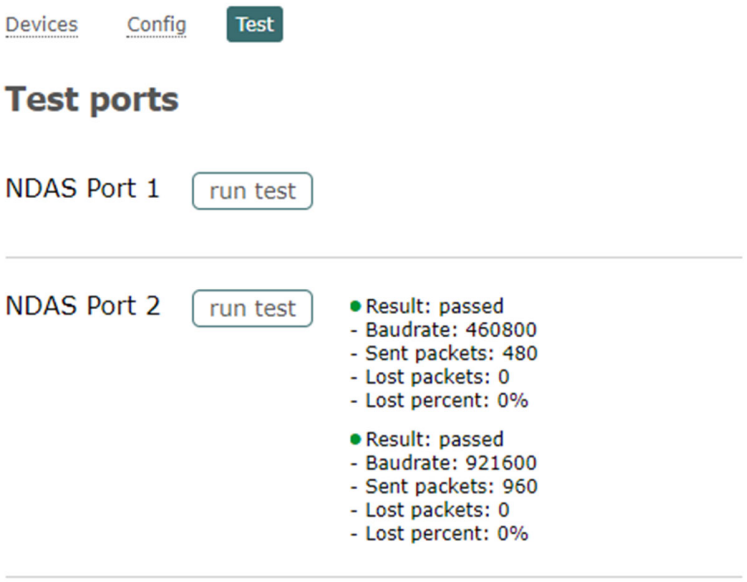

Fig. 12.6. NDAS One Manager module. Test tab

13. Raw Data Logger program module (recording raw data)

The **Raw Data Logger** module is designed to record raw data from the NJSP streams to the disk. The module supports several recording formats, allows configuring recording on the schedule, split files by time and save metadata.

13.1 Enabling and disabling the module

Click the **Modules** tab on the NDAS-RT main interface. Find the **Raw Data Logger** line, press the **run/stop** button. When the module is enabled, the **config** button should appear next to the **stop** button. If the information in the line has not been updated, click the **refresh state** button in the upper right corner of the screen.

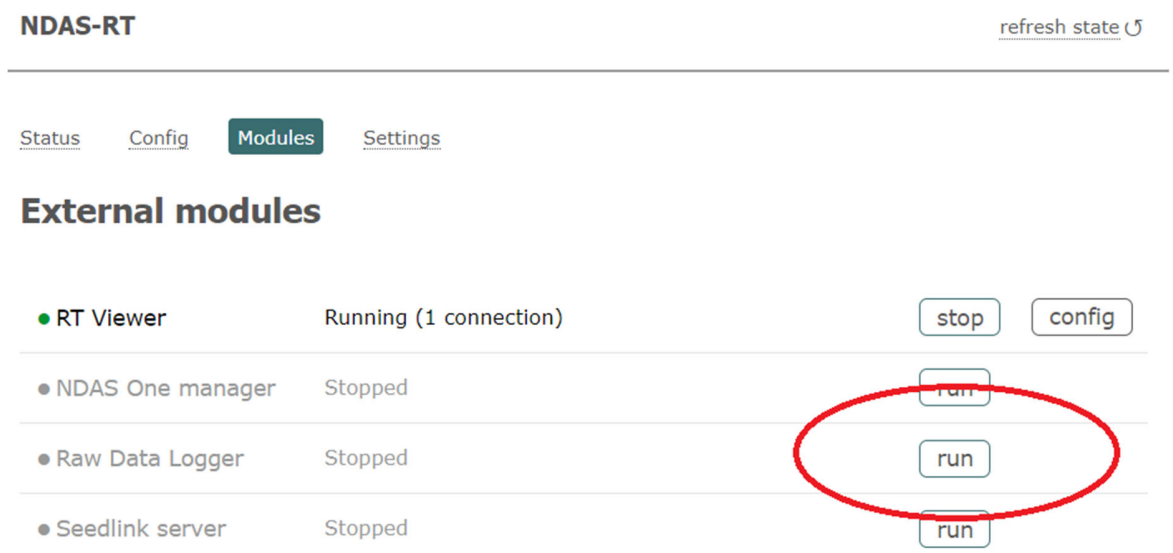

Fig. 13.1. Raw Data Logger module. Enabling and disabling

13.2 Module control

Use the **Manage** tab on the module configuration page to select the operation mode. Four modes are available:

- **Start immediately** – start recording the data immediately after enabling;
- **Start when time valid** – start recording the data after synchronizing.

The module algorithm considers the timestamp valid if the **drift time** field in the metadata package has a value other than 0, that is, synchronization for the stream was set up at least once in the past. That means the data recording will begin after synchronization and will no longer be interrupted even if the exact time source gets unavailable.

- **Start manually** – start and stop recording manually by the user's command;
- **Start by schedule** – start and stop recording on schedule.

To set the required operation mode, select the corresponding line put of the drop-down list, if necessary, set the start and stop time. Then click the **apply** button.

When the **Start manually** mode is selected, control recording using the **start** button.

If the recording is performed into an external USB drive, it is required to press the **Safely remove USB drive** button – this will reset the buffered data to the disk and close all files correctly.

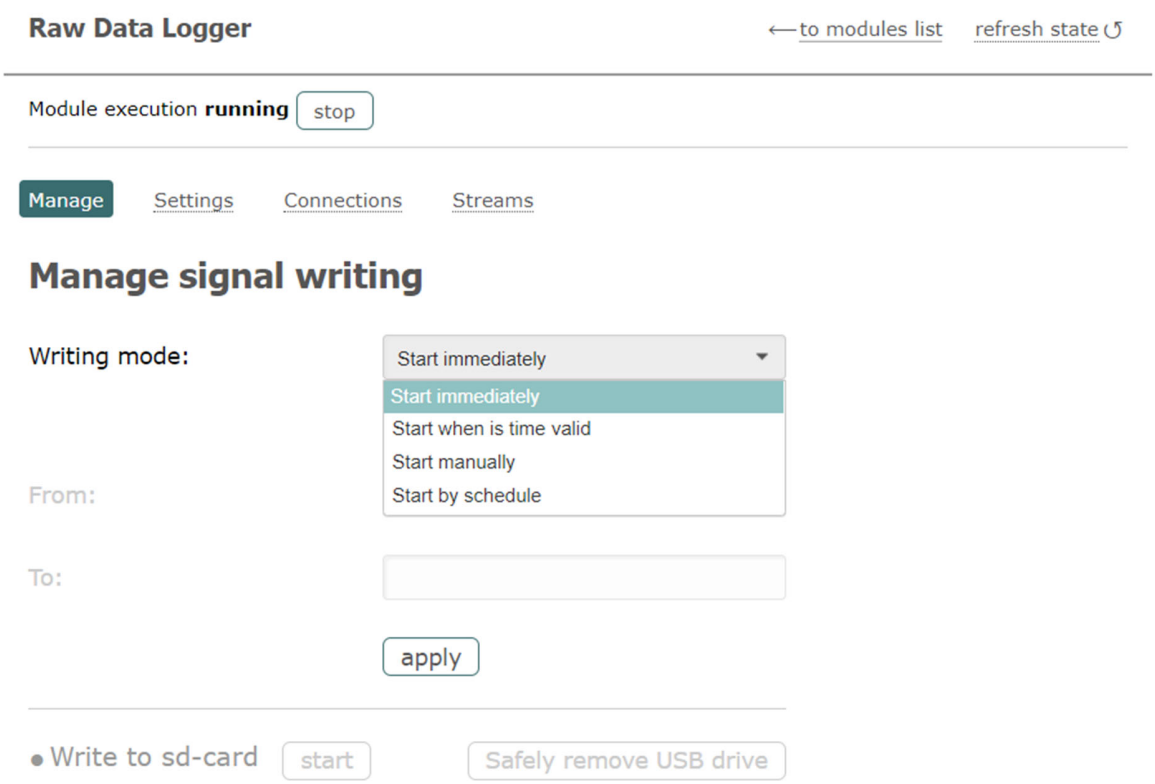

Fig. 13. Raw Data Logger module. Control of recording

13.3 Module settings

The **Settings** tab has the module settings:

- **Write to internal SD card** is a record into the internal memory card;
- **Internal work directory** is a directory on an internal memory card where the data will be recorded into;
- **Write to external USB drive** is a record into an external USB drive;
- **External work directory** is a directory on an external USB drive where the data will be recorded into. When multiple USB drives are connected, recording will be performed on the first device detected by the system;
- **Enable file split** is split the record into files of a preset duration;

File split is performed according to the **File split hour count** setting indicating the duration of the record inside of the file in the whole hours value;

- **Data format** is the data format. The following formats are available:
  - **ASCII, raw ADC samples (integer)** are a text file, integer values, units of measure correspond to the ADC samples;
  - **ASCII, Volts (3-digit precision)** are a text file, units in Volts, 3 decimal digits (1 mV resolution);

- **ASCII, Volts (6-digit precision)** are a text file, units in Volts, 6 decimal digits (1 μV resolution);
- **ASCII, Volts (9-digit precision)** are a text file, units in Volts, 9 decimal digits (1 nV resolution);
- **Binary per channel, 32-bit integer** are binaries channel-by-channel, 32-bit integers, units of measure correspond to the ADC samples;
- **Binary per channel, 32-bit float** are binaries channel-by-channel, numbers of a single precision floating point, units in Volts;
- **Binary per channel, 64-bit double** are binaries channel-by-channel, numbers of a double precision floating point, units in Volts;
- **Binary interleaved, 32-bit integer** is a binary file of interleaved values, 32-bit integers, units of measure correspond to the ADC samples;
- **Binary interleaved, 32-bit float** is a binary file of interleaved values, numbers of a single precision floating point, units in Volts;
- **Binary interleaved, 64-bit double** is a binary file of interleaved values, numbers of a double precision floating point, units in Volts;

- **Status log rate** is a frequency of filling in the table of the status data, minutes.

Click the **apply** button at the bottom of the page to apply the parameters.

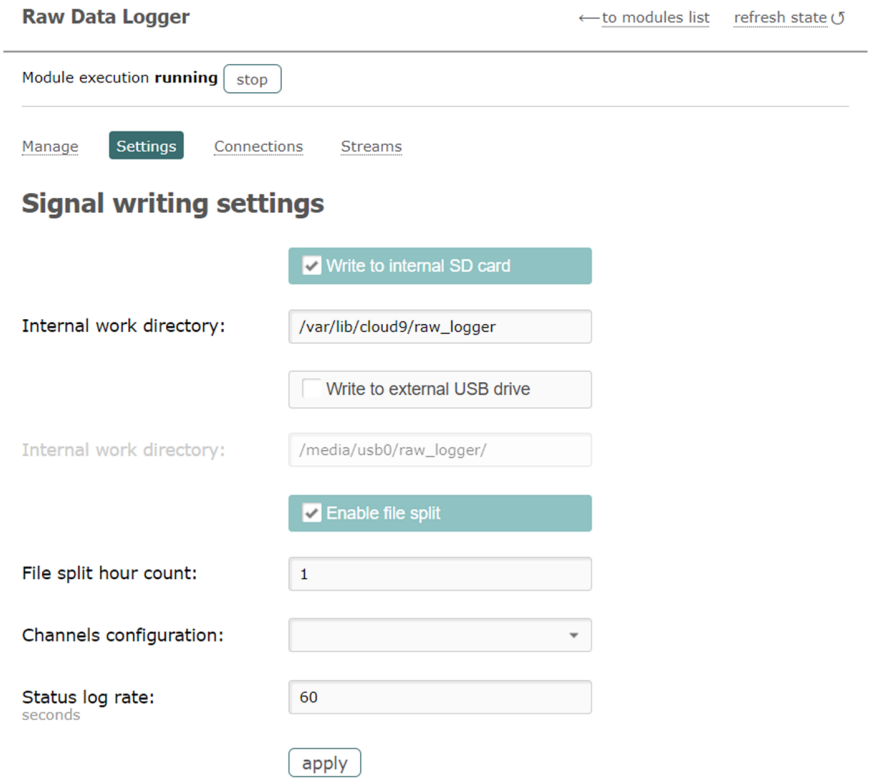

Fig. 13.2. Raw Data Logger module. Setting the record path

13.4 Connections list

The **Connections** tab makes it possible to edit the list of the NJSP servers which the module will attempt to connect to. To add a new NJSP signal source, enter the IP address and the port number of NJSP. If the device is locally connected (to a signal source located on the same device), use IP address of 127.0.0.1. Then click the **add connection** button.

The new connection should appear in the connections list below. If the connection to the NJSP server has been successful, the connection status will change to **Connected** and the Device column will display the serial number and device name.

To remove the connection, click the **remove** button in the corresponding line.

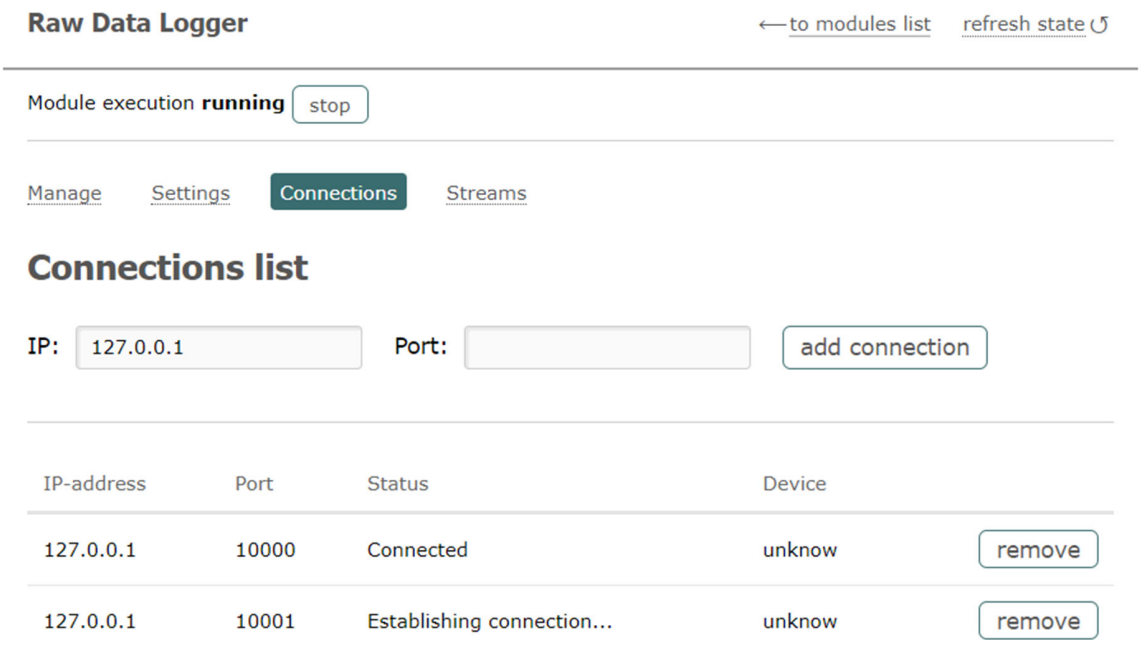

Fig. 13.2. Raw Data Logger module. Connections status and control

13.5 Streams list

The data of every source may contain multiple data streams. The **Streams** tab displays information about the streams that are currently active. The device serial number, network address, stream name, file path, and statistics are also displayed.

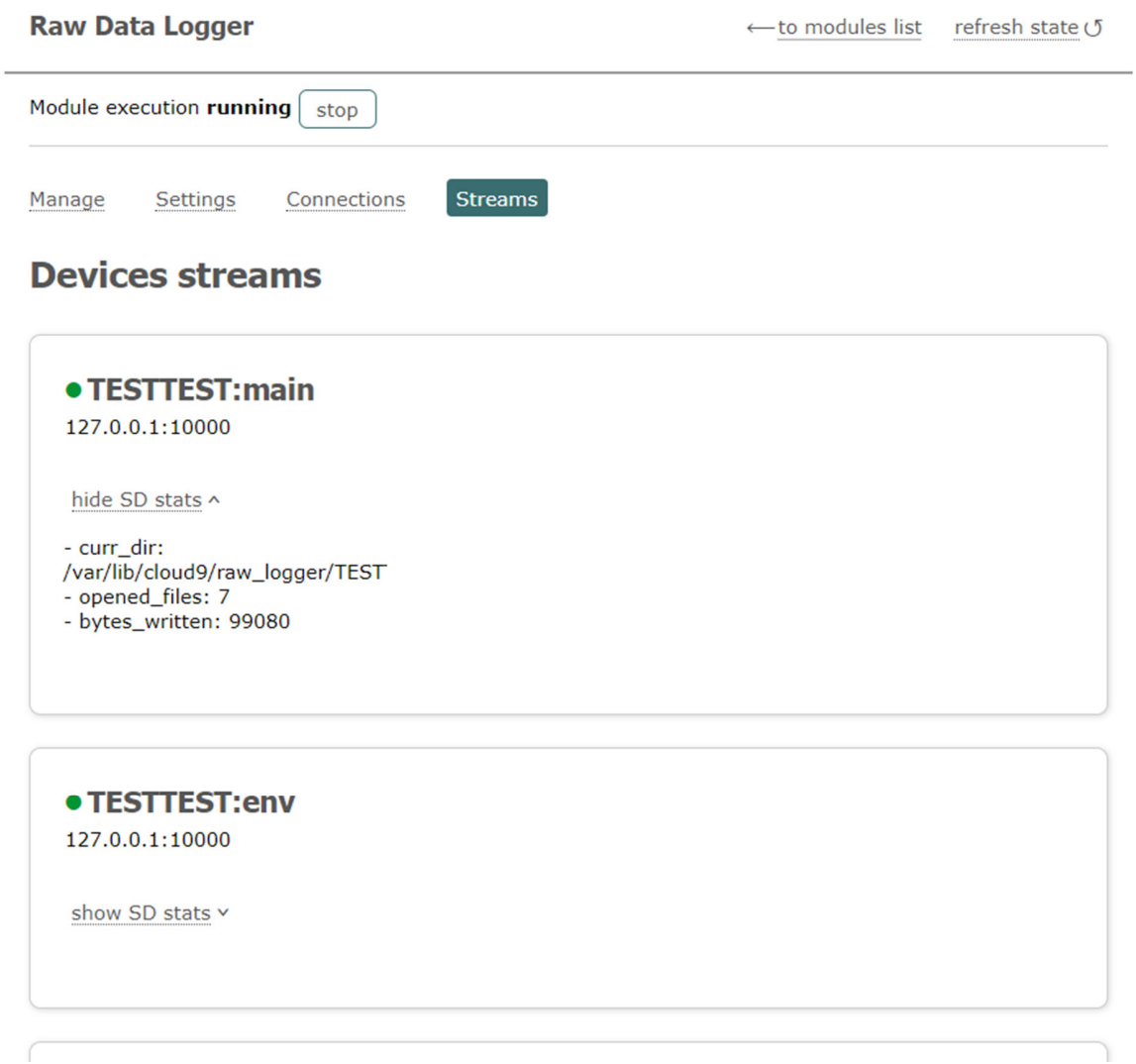

Fig. 13.3. Raw Data Logger module. Data status and streams control

13.6 Directories structure

The module creates directories according to the following structure:

- Operating directory
- Serial number of the device
- Recording start time or ***NO_TIME_XXX***
- Stream name

The file name contains the serial number of the device and the start time of recording. Binaries have the extension of '.**dat**', text files have '.**txt**', status data files have '.**csv**'.

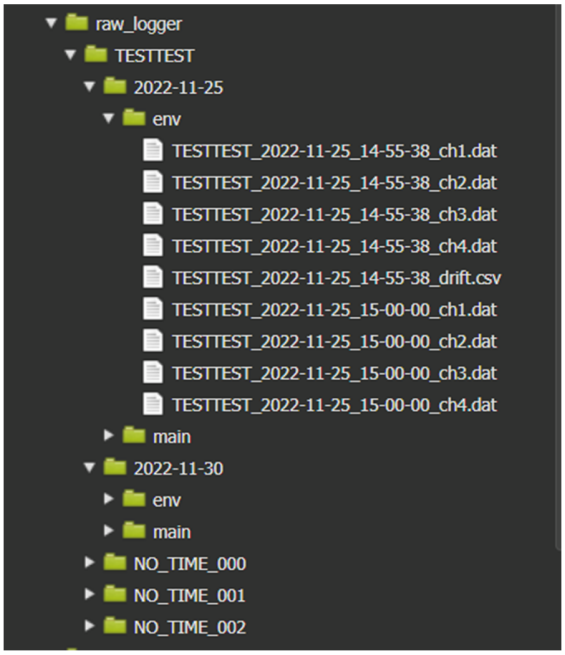

Fig. 13.4. Raw Data Logger module. Directories structure

14. NDAS RT antialiasing filters. Decimation.

To obtain output frequencies from 4000 samples/sec and below, the Recorder's ADC operates at a rate of 8000 samples per second. For an output rate of 8000 samples/sec, the Recorder's ADC samples at a rate of 16000 samples per second.

Table 14.1 shows the decimation coefficients for each of the target sampling rates. For each of the decimation coefficients (10, 8, 4 and 2) a dedicated filter is used. **Table 14.2** shows each filter characteristics. **Table 14.3** shows the resulting characteristics of filter and decimation chains

Table 14.1. Decimation coefficients cascades:

Sample rate \ Stage	1	2	3	4	5	Overall decimation factor
8000 SPS	2	-	-	-	-	2
4000 SPS	2	-	-	-	-	2
2000 SPS	2	-	-	-	-	2
1000 SPS	2	2	-	-	-	4
500 SPS	2	2	2	-	-	8
250 SPS	2	4	2	-	-	16
125 SPS	2	8	2	-	-	32
100 SPS	2	10	2	-	-	40
50 SPS	2	10	2	2	-	80
10 SPS	2	10	10	2	-	400
1 SPS	2	10	10	10	2	4000

Table 14.2. FIR filter characteristics

Parameter \ Filter	2	4	8	10
Number of coefficients	256	384	384	384
Stopband attenuation, dB	-173	-172	-172	-171
Cutoff frequency (normalized, -3dB level)	0.455	0.441	0.384	0.355
Passband ripple, mdB	0.001	0.001	0.001	0.001

Table 14.3. FIR filter characteristics summary

Target sample rate, SPS	Cutoff frequency, Hz	Stopband start, Hz	Passband ripple, mdB	Stopband attenuation, dB
8000	3640	3984	1	-173
4000	1820	1992	1	-173
2000	910	996	1	-173
1000	455	498	2	-173
500	227.5	249	3	-173
250	113.75	124.5	3	-173
125	91	99.6	3	-173
100	45.5	49.8	3	-173
50	9.1	9.96	4	-173
10	0.91	4.98	4	-173
1	0.455	0.498	5	-173

15. Operating conditions

The operating temperature range of the Data Logger is from -40 to + 85°C (-40 to + 185°F). However, it should be taken into account that optionally installed internal and external components can have a narrower temperature range of operating temperatures.

In particular, Industrial Temperature class MicroSD cards have an operating temperature range from –40 to + 85°C while those of Commercial class are operational at the temperatures of –20 to + 85°C. The 3G/LTE modules have an operating temperature range of –35 to + 75°C while SSD drives are operational within +8 to + 70°C and so on[7].

Note that the range of ensured operability of the Data Logger is determined by the component with the narrowest range of operating temperatures.

In accordance with the Ingress Protection Code, the degree of protection of this device is **IP 65** – dust tight protected from powerful water jets (No ingress of dust; complete protection against contact. Water projected by a nozzle (6.3 mm (0.25 in)) against enclosure from any direction shall have no harmful effects).

In accordance with the NEMA 250-2003 standard, the data logger complies with the NEMA TYPE 4 (dust and performance of equipment for indoor and outdoor use).

The data logger must not be immersed in water or installed in flooded areas without additional protection!
To ensure the degree of dust and water tightness, make sure that all unused connectors are covered with protective caps!

16. Carrying and storage

The data logger is durable enough and practically is not subject to damage during transportation. Use the packaging that came with the device or any packaging materials to prevent damage to the connector on the housing cover and scratches on the housing. The storage temperature ranges from –40 to + 85 ° C (-40 to + 185°F).

17. Warranty and service

The warranty period of the product is 18 months. During this period the replacement or repair of the defective product will be made free of charge at the expense of the manufacturer.

After the warranty period the repair and maintenance of the device are carried out for a set fee.

[7] This paragraph shows the characteristic parameter values for device classes. The devices you use may have different parameters. Always consult the documentation of the component manufacturer.

18. Information about the manufacturer

Manufacturer:

R-sensors LLC

Office address: 1/4 Likhachevsky proezd, Dolgoprudny, Moscow region, 141701, Russia
Phone number: +7 (498) 744-69-95
http://r-sensors.ru/

Postal address: 1/4 Likhachevsky proezd, Dolgoprudny, Moscow region, 141701, Russia
Phone number: +7 (498) 744-69-95
r-sensors@mail.ru

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

19. Technical specifications

19.1 Electrical parameters

Supply voltage	12-48 V DC (7.5-60 V permissible)
Power consumption Minimal power consumption [8] Typical average	 No more than 1.5 W 1.6-3,0 W
Maximum consumption[9]	No more than 12.95 W
Supply voltage via USB[10]	4.5-5.5 V

19.2 Mechanical parameters

Connector types	DH-20-C07SX-03-401 is a power and RS-485 interface connector; LP-24-J/RJ45/213/SX-43-401 is the RJ-45 type connector for a wired Ethernet; SMA-F is an antenna connection for GPS/Wi-Fi/3G/LTE – 1 to 3[11] pcs; micro-USB is an input for a wired USB connection and data reading; YU-USB2-JSX is a USB-A input for connecting external USB drives and CME-ND digital sensors; DH-24-J19SX-03-401 are inputs of auxilliary ADC and outputs of signal relay; DH-20-C12SX-03-401 are inputs of the main ADC and outputs for active sensors power – 2 pcs.
Weight	1.5-1.8 kg (3.3-4.0 lbs) depending on the internal modules composition and additional connectors

[8] The average consumption of the Module during self-contained recording with no Ethernet, Wi-Fi, 3G or supply to the sensors activated.
[9] Maximum overall system consumption including peripherals.
[10] Only the digital subsystem is powered, ADC included.
[11] Additional connectors are installed when using Wi-Fi and 3G modem.

Dimensions length x width x height	225 x 160 x 82 (8.86 x 6.3 x 3.2 inch) – housing dimensions
Type, housing material	ADC-10 aluminum alloy of JIS IP-65 according to IEC 529

19.3 Digital subsystem parameters

Platform	Beaglebone 1GHz ARM® CPU, 512MB RAM, 4GB Flash
Operating system	Debian 10.3
Software	SeedLink server Web interface for configuring Additional software on demand
Memory	SDXC memory cards up to 256 GB External USB drives support of any size
Network interface	Ethernet 100 Base-Tx
Time synchronization	Ethernet (NTPv4 RFC 5905, PTP IEEE 1588v2) GPS/GLONASS satellite receiver
Timing accuracy in the presence of the GPS/GLONASS signal	< 10 µS
Operating conditions monitoring	Built-in temperature and humidity sensor, main channel power sensor, power consumption sensor
Status indication	5 LEDs of different colors
Interface for connecting CME-ND sensors	USB 2.0
Interface for connecting external devices	USB 2.0 / mini-PCIe
Data transfer	SeedLink; JSON-based open protocol
Power supply to external devices	5 ±0.1 V, 500 mA maximal for each port (USB, RS485); +12 V ±5%, -12 V ±10%; 200 mA of total power consumption
Number, type of alarm relay	1, electromagnetic with ‘dry’ contacts

Type of alarm relay contacts	SPDT Normally closed / normally open
Maximum voltage at the alarm relay contacts	250 V AC or 220 V DC
Test signal generator: signal waveform and amplitude Calib enable Calib out	 Logic '1' of 3.3 V voltage at the time of the calibration signal sine 1 V peak-peak, 1 Hz, 10 Hz; single pulse 1 V; meander 1 V, noise-like signal 1 V RMS.
Test signal generator: output resistance	100 Ohm

19.4 Analog subsystem parameters, main ADC

ADC type	Sigma delta with the differential input
Number of channels	6 independent ADCs
Sampling frequency	1, 5, 10, 25, 50, 100, 125, 250, 500, 1000, 2000, 4000, 8000 Hz
ADC resolution	24 bit
ADC noise level	21.8 bits noise-free resolution at 100 sps
Bandwidth for 1 – 4000 sps	0.91 of the Nyquist frequency (0,455 of sampling frequency)
Reduction in the noise suppression for 1 – 4000 sps	-173 dB
Dynamic range signal / noise	133 dB at 100 sps
ADC conversion coefficient at the 1:1 divisor and Gain=1	$1{,}144 \cdot 10^{-8} \frac{V}{div}$
Input divisor	1:1, 1:6 switched by the program
Input amplifier	1, 2, 4, 8, 12 switched by the program

Maximum input signal at the 1:1 divisor and Gain=1	±4.096 V peak-peak differential voltage
Input impedance	180 kOhm || 2700 pF

19.5 Analog subsystem parameters, auxiliary ADC

Number of ADC channels[12]	4 single-ended or 2 pseudo-differential
Maximal input signal	±18 V for the single-ended signal; ±36 V for the differential signal
ADC resolution	12 bit
Sampling rate	0.1, 1.0, 4.0 sps
ADC noise level	not determined in the single-ended mode; no more than 10 μV RMS at 100 sps in the differential mode
Input impedance	200 kOhm || 900 pF
ADC input amplifier bandwidth	880 Hz

19.6 Extra Features and Options [13]

Power over Ethernet (PoE)	48 V nominal (36-57 V permissible)
More channels of the main ADC	up to 24 independent channels
Wired interface	RS-485 half-duplex for interfacing with engineering systems or connecting external sensors
Data reading modes	MTP (media transfer protocol), SMB (server message block)
External synchronization	Connection of GPS/GLONASS remote synchronization unit with a cable length of up to 600 m

[12] All ADC channels can simultaneously operate in either differential or non-differential mode.
[13] Available through installing external and internal peripherals. Some features are available only when ordered with the Manufacturer.

Wireless connection	GSM / 3G / LTE modem
Filtration module	creating secondary data streams with a different sampling rate
Test and calibration module	Output of harmonic signals of arbitrary frequency and signals of arbitrary waveform. Automatic measurement of the sensor transfer characteristics
Extra display and control elements	Development of input devices (button, toggle switch) and output devices (LED, logic signal) with arbitrary functionality
Support for extra peripherals	mini-PCIe connector for the USB/I2C supportive modules including a SIM card installation feature
Extra wired interface	RS-485 half-duplex
Extra network options	Wi-Fi , GSM / 3G / LTE, Bluetooth / ZigBee
Highly stable reference generator	TCXO 5 ppb

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

APPENDIX 1. LOCATION OF CONNECTORS AND INDICATION MODES

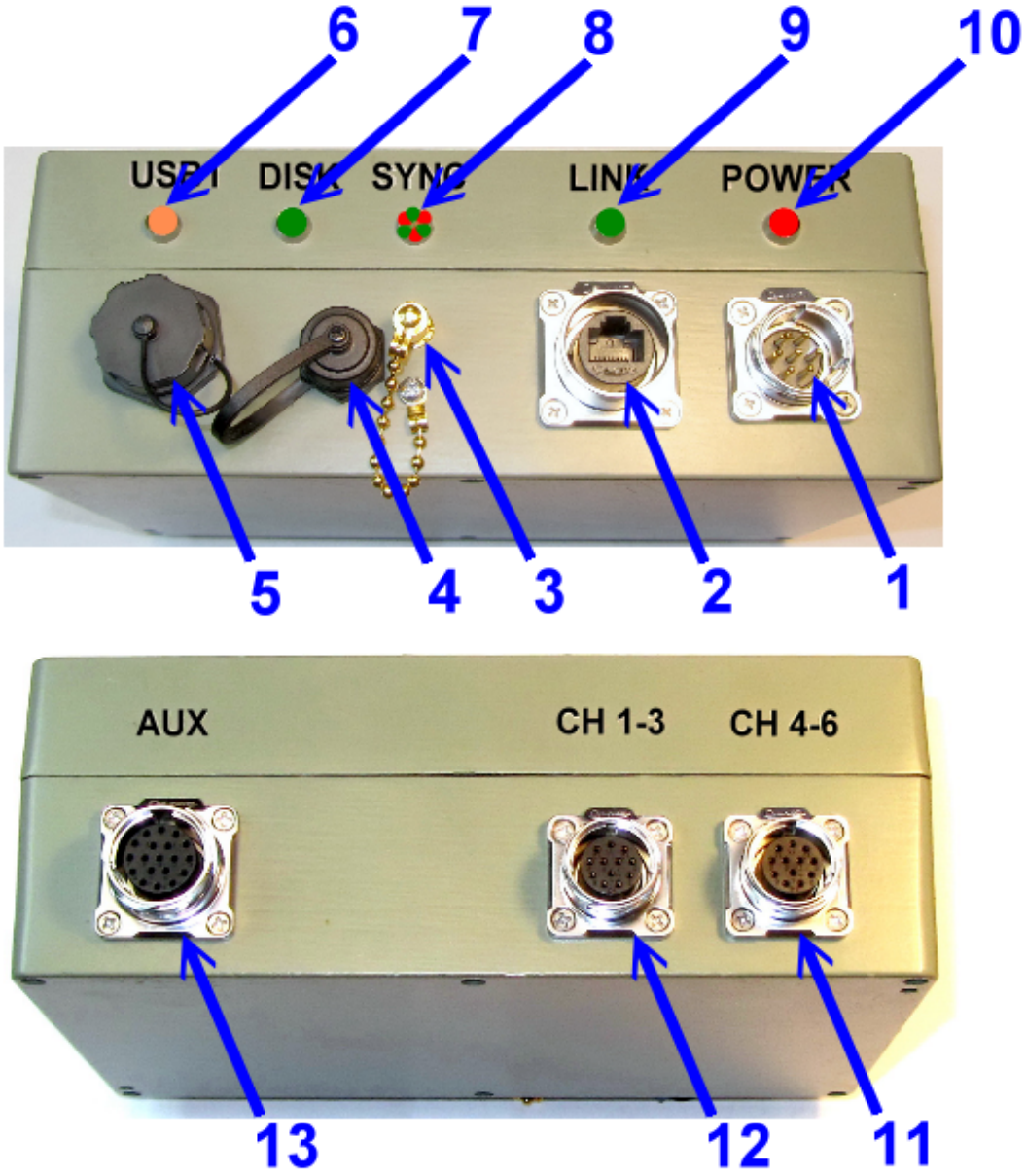

Fig. 1-1. Connectors and indicators

Table 1-1. Designations in fig. 1-1

№	Designation
1	Power and RS-485 connector ‘POWER’ DH-20-C07SX-03-401 type plug
2	RJ-45 type data interchange socket ‘LINK’ LP-24-J/RJ45/213/SX-43-401 type
3	Antenna connector GPS/GLONASS, SMA-F socket[14]
4	micro-USB data interchange connector
5	USB1 or USB-A connector for connecting digital devices YU-USB2-JSX-01-001 или YU-USB3-JSX-01-001 USB-A type
6	USB1 power status orange LED
7	DISK storage activity green LED
8	SYNC synchronization status red/green LED
9	LINK data transfer status green LED
10	POWER status red LED
11	CH 4-6 connector for connecting analog sensors to ADC channels 4-6 using DH-20-C12SX-03-401 type socket
12	CH 1-3 connector for connecting analog sensors to ADC channels 1-3 using DH-20-C12SX-03-401 type socket
13	AUX multifunction connector for auxiliary ADC inputs and relay outputs DH-24-J19SX-03-401 type socket

[14] Depending on the configuration, SMA connectors can be 1 to 3.

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+7 (498) 744-69-95, r-sensors@mail.ru

Table 1-2. LED operation modes

Color	Operation mode
POWER status LED RED	Off – no power, power failure or device malfunctioning. Steady on for the first 2 minutes from the moment when the power supply is on – normal operation, operating system is booting. Steady on after 2 minutes or longer from the moment when the power supply is on – unsuccessful boot, power failure or device malfunctioning. Flashing with the frequency of 1 time per second – normal operation
SYNC synchronization status LED RED GREEN	Steady red – no suitable synchronization source, no synchronization Flashing red/green – synchronizing the time of the data logger Steady green – the data logger has been synchronized
DISK storage activity LED GREEN	Off – no recording into the internal storage Flashing – recording into the internal storage
NET data transfer LED GREEN	Off – the data logger is not connected, no data transfer Flashing – the data logger is connected, the data is transferred
USB1 power status LED ORANGE	Off – no device connected to USB1 Steady on – a device is connected to USB1 Flashing – a CME-ND digital sensor is connected to USB1

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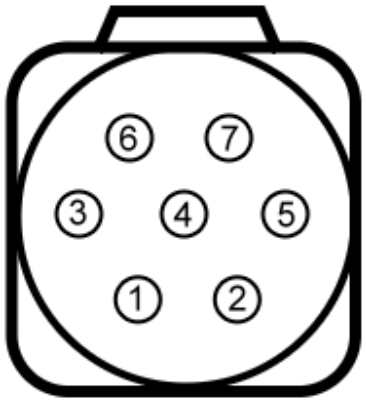
+7 (498) 744-69-95, r-sensors@mail.ru

APPENDIX 2. CONNECTORS, CABLES, ANTENNAS



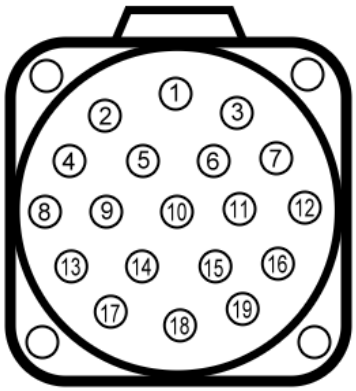
1	+5V PWR	Supply output
2	RS485 B	RS485B
3	RS485A	RS485A
4	PGND	Supply ground
5	N/C	Не исп.
6	PWR In	Main power
7	PGND	Supply ground

DH-20-C07SX-03-401 male connector

Fig. 2-1. Pins for the POWER connector

Table 2-1. Designations at Fig. 2-1

№	Designation
1	**+5V PWR** is power supply for sensors on the RS-485 bus, +5 V ±0.1 V, 500 mA maximum in total with the power consumption of sensors connected to the AUX connector
2	**RS485 B** is a ‘B’ signal wire for bus RS-485
3	**RS485 A** is a ‘A’ signal wire for bus RS-485
4	**PGND** is a common wire for sensors on RS-485, CAN, common wire for the data logger
5	The contact is not used
6	**PWR In** is a ‘+’ for the data logger’s power supply
7	**PGND** is a common wire for the data logger’s power supply



DH-24-J19SX-03-401 female connector
DH-24-J19SX-03-401 гнездо

1	CH1-/CH01	AUX ADC input
2	CH2-/CH02	AUX ADC input
3	CH1+/CH03	AUX ADC input
4	CH2+/CH04	AUX ADC input
5	N/C	
6	N/C	
7	AGND	Analog ground
8	AGND	Analog ground
9	+5V PWR	Supply output
10	N/C	
11	N/C	
12	N/C	
13	R1 NC	Relay 1 NC
14	N/C	
15	R1 NO	Relay 1 NO
16	R1 COM	Relay 1 common
17	N/C	
18	N/C	
19	N/C	

Fig. 2-2. Pins for the AUX connector

Table 2-2. Designations at Fig. 2-2

№	Designation
1	**CH1-/CH01 AUX ADC input** is a '-' input of the first differential channel of the auxiliary ADC or an input of the first single-ended channel of the auxiliary ADC
2	**CH2-/CH02 AUX ADC input** is a '-' input of the second differential channel of the auxiliary ADC or an input of the second single-ended channel of the auxiliary ADC
3	**CH1+/CH03 AUX ADC input** is a '+' input of the first differential channel of the auxiliary ADC or an input of the third single-ended channel of the auxiliary ADC
4	**CH2+/CH04 AUX ADC input** is a '+' input of the second differential channel of the auxiliary ADC or an input of the fourth single-ended channel of the auxiliary ADC
5	The contact is not used
6	The contact is not used
7	**AGND** is an auxiliary ADC common signal wire (analog ground)

8	**AGND** is an auxiliary ADC common signal wire (analog ground)
9	**+5V PWR** is power supply for sensors +5 V ±0.1 V, 500 mA maximum (in total with the power consumption of sensors on RS-485)
10	The contact is not used
11	The contact is not used
12	The contact is not used
13	**R1 NC** is a normally closed contact of relay 1
14	The contact is not used
15	**R1 NO** is a normally open contact of relay 1
16	**R1 COM** is a relay 1 common contact
17	The contact is not used
18	The contact is not used
19	The contact is not used

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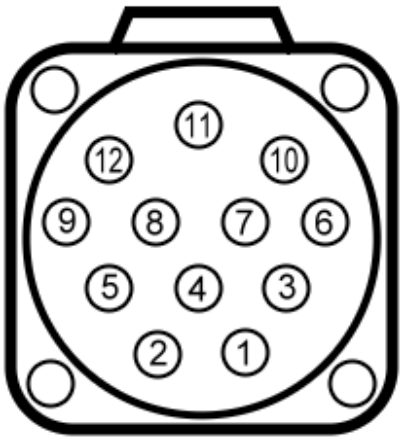


DH-20-J12SX-03-401 female connector
DH-20-J12SX-03-401 гнездо

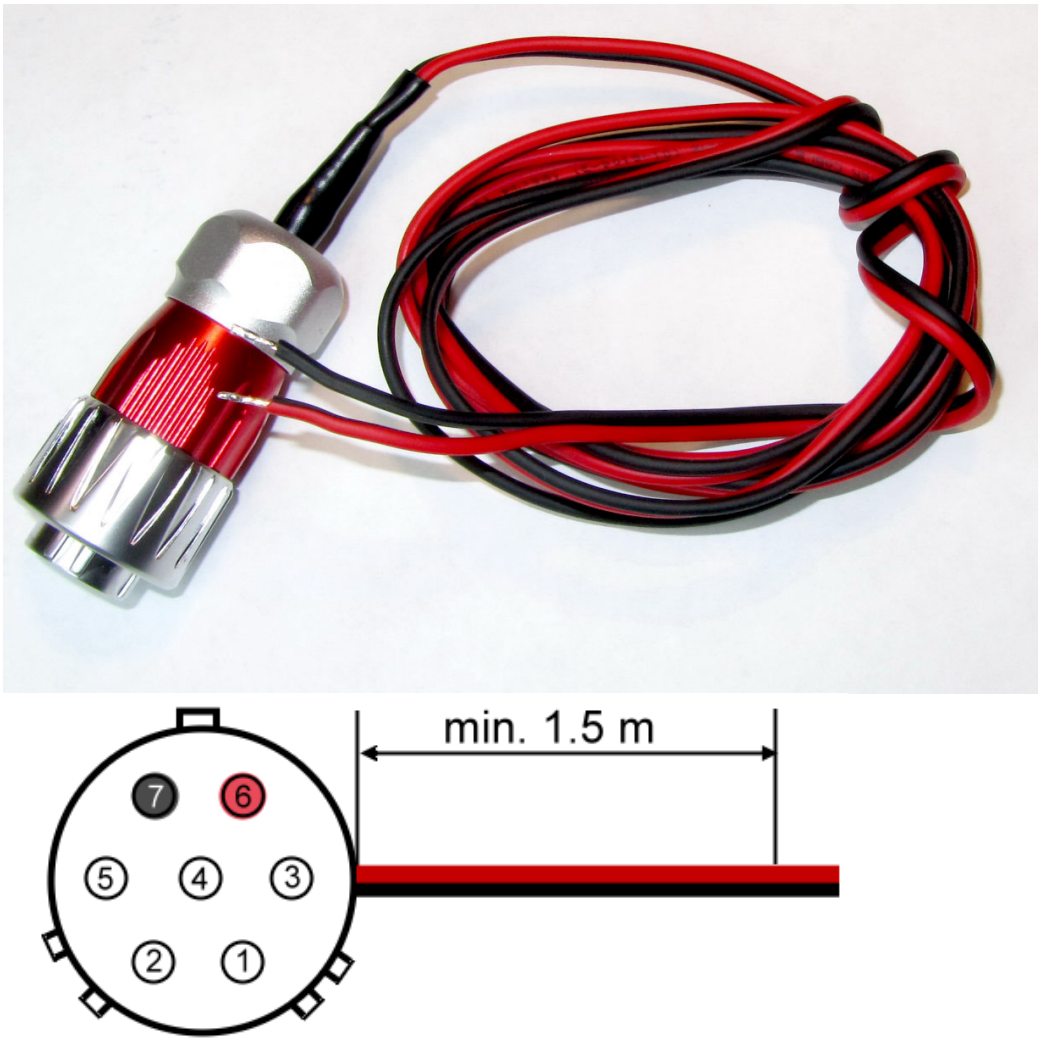
1	CH1- (4-)	Main ADC input
2	CH1+ (4+)	Main ADC input
3	CH2- (5-)	Main ADC input
4	CH2+ (5+)	Main ADC input
5	CH3- (6-)	Main ADC input
6	CH3+ (6+)	Main ADC input
7	AGnd	Analog ground
8	Cal.Enab	Enable calibration
9	Cal.Out	Calibration output
10	+12V	+12V power output
11	-12V	-12V power output
12	PGnd	Power common

Fig. 2-3. Pins for the main ADC connector

Table 2-3. Designations at Fig. 2-3

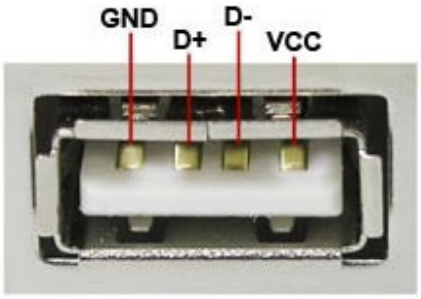
№	Designations
1	**CH1- (4-)** is a '-' input of the first (fourth) channel of the main ADC
2	**CH1+ (4+)** is a '+' input of the first (fourth) channel of the main ADC
3	**CH2- (5-)** is a '-' input of the second (fifth) channel of the main ADC
4	**CH2+ (5+)** is a '+' input of the second (fifth) channel of the main ADC
5	**CH3- (6-)** is a '-' input of the third (sixth) channel of the main ADC
6	**CH3+ (6+)** is a '+' input of the third (sixth) channel of the main ADC
7	**AGnd** – a common signal wire of the main ADC is connected to the PGND line inside of the data logger
8	**Cal.Enab** is a calibration logic output (+ 3.3 V): '1' is on, '0' is off
9	**Cal.out** is a test signal output for calibration

10	**+12V** is a power output of active sensors +12 V ±5%, no more than 200 mA (total with the line is -12 V)
11	**-12V** is a power output of active sensors -12 V ±10%, no more than 200 mA (total with the line is +12 V)
12	**PGnd** is a common power supply contact for active sensors (connected to the AGND line inside of the data logger)



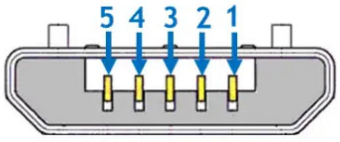
DH-20-J07PE-03-001 female connector
DH-20-J07PE-03-001 розетка

Fig. 2-4. DH-20-J07PE-03-001 type 7-pin power cable



1	VBUS	Red
2	D-	White
3	D+	Green
4	GND	Black
Shell	Shield	Connector Shell

Fig. 2-5. USB-1 connector pin designations



Pinout of Micro B

1 Vcc	Red	+5V
2 D-	White	Data-
3 D+	Green	Data+
4 ID	N/A	USB OTG ID
5 GND	Black	Ground

Fig. 2-6. Micro-USB connector pin designations

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

Fig. 2-7. LP-24-C/RJ45/015 cable connector plug (cable assembly)

Fig. 2-8. USB-A / micro USB-B standard digital cable

R-sensors LLC
Bldg. 1, 4, Likhachevsky proezd, Dolgoprudny, 141701, Russia
+7 (498) 744-69-95, r-sensors@mail.ru

Fig. 2-9. DH-20-C12PE-03-001 type
cable plug to connect sensors

Fig. 2-10. DH-24-C19PE-03-001 type auxiliary cable plug

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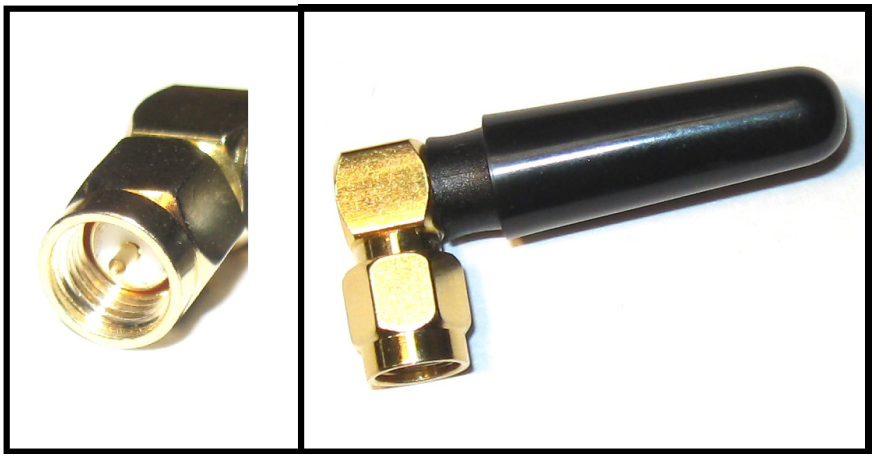

Fig. 2-11. WiFi antenna – connector, appearance
(not included in the standard delivery set)
(the antenna appearance may differ from the one presented)

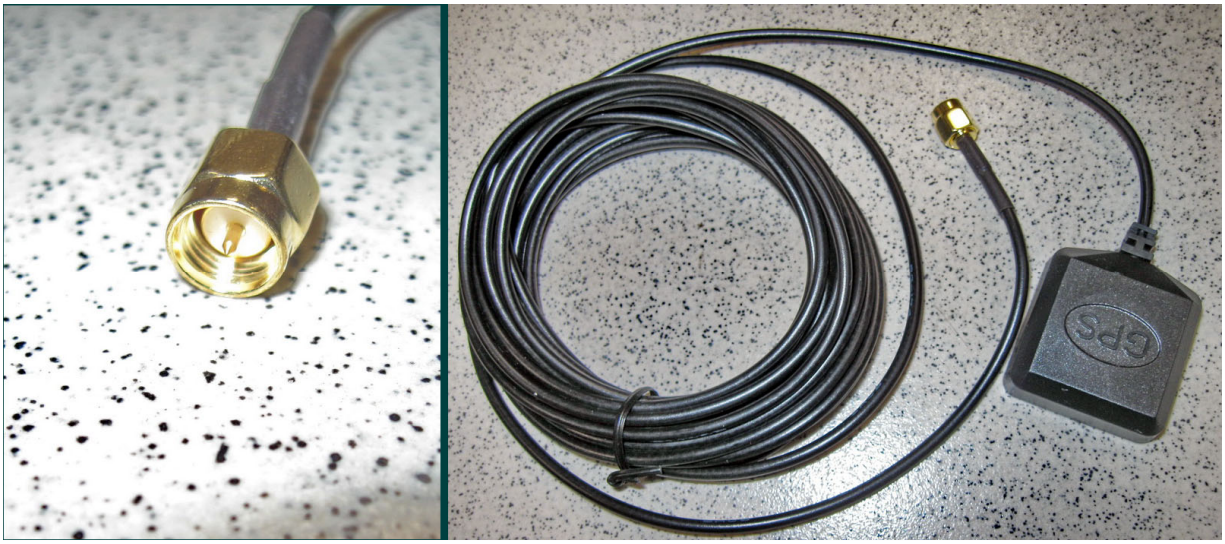

Fig. 2-12. GPS antenna – connector, appearance

Fig. 2-13 *SMA-M / SMA-M adapter*
(not included in the standard delivery set)

Fig. 2-14. *SMA-M / RP SMA-M adapter*
(not included in the standard delivery set)

Fig. 2-15. DH-20-J07PE-03-001 type cable socket power connector
(not included in the standard delivery set)