RadioInspector Software News

Contents

2017.01.05

Default folders used by RadioInspectorRC, RadioInspectorRT, RadioInspectorRP, RadioInspectorWiFi, I_MasterDevice, IQ_ProcessPRO programms.

The "RadioInspector" programs save many different files on the disk: settings files, panoramas, recorded phonogram files, recorded IQ, various intermediate and temporary files.

By default, all files are saved in the <RInspector> directory, which is located in the <Computer Name>-<User name> directory. This directory contains the download directories for files, documents, drawings, and other user directories. As a rule, this directory is located on the "C" drive:\<Computer Name><User name>.

The problem is that the RadioInspectorRC/RadioInspectorRT programs can create a great number of large files. This quickly reduces the amount of free space on the "C:\" drive. In this case, it is recommended to move the <RInspector> directory to a separate disk.

To transfer the working directory of the RadioInspector software to a separate disk, you need to specify the name of the new working directory in the file **DefFoldersPath.txt**. For example, *"D:\RadioInspectorData".* File *"D:\RadioInspectorData"* must exist. File **DefFoldersPath.txt** is located in the directory where each of the programs of the RadioInspector project is installed. You will need administrator rights to change this file.

IMPORTANT! Different programs of the RadioInspector project can call each other to analyze IQ files, panorama files, phonogram files, etc. Data is transmitted between programs using temporary files located in the <RInspector> directory. For correct data transfer between programs, you need to change the path to the working directory <RInspector> for ALL programs of the RadioInspector project.

Assignment of individual subdirectories in the <RadioInspector> folder:

<DataBase> - <Range Control> - panorama files (*.pan, *.fcs) received in the "Frequency range (f1-f2) scan and inspection" mode or "Discrete frequencies inspection" mode.

<DataBase> - <Direct Control> - panorama files received in the "RF Signal analysis and performance measurement" mode.

<INIT> and <IWiFiInit> - files of current program settings.

<WAVE> - saved audio files.

<SaveIQ>-<A> - IQ files, when performing a task, if a signal exceeding the threshold is detected.

<SaveIQ>-<H> - IQ files saved during manual recording.

2017.02.20

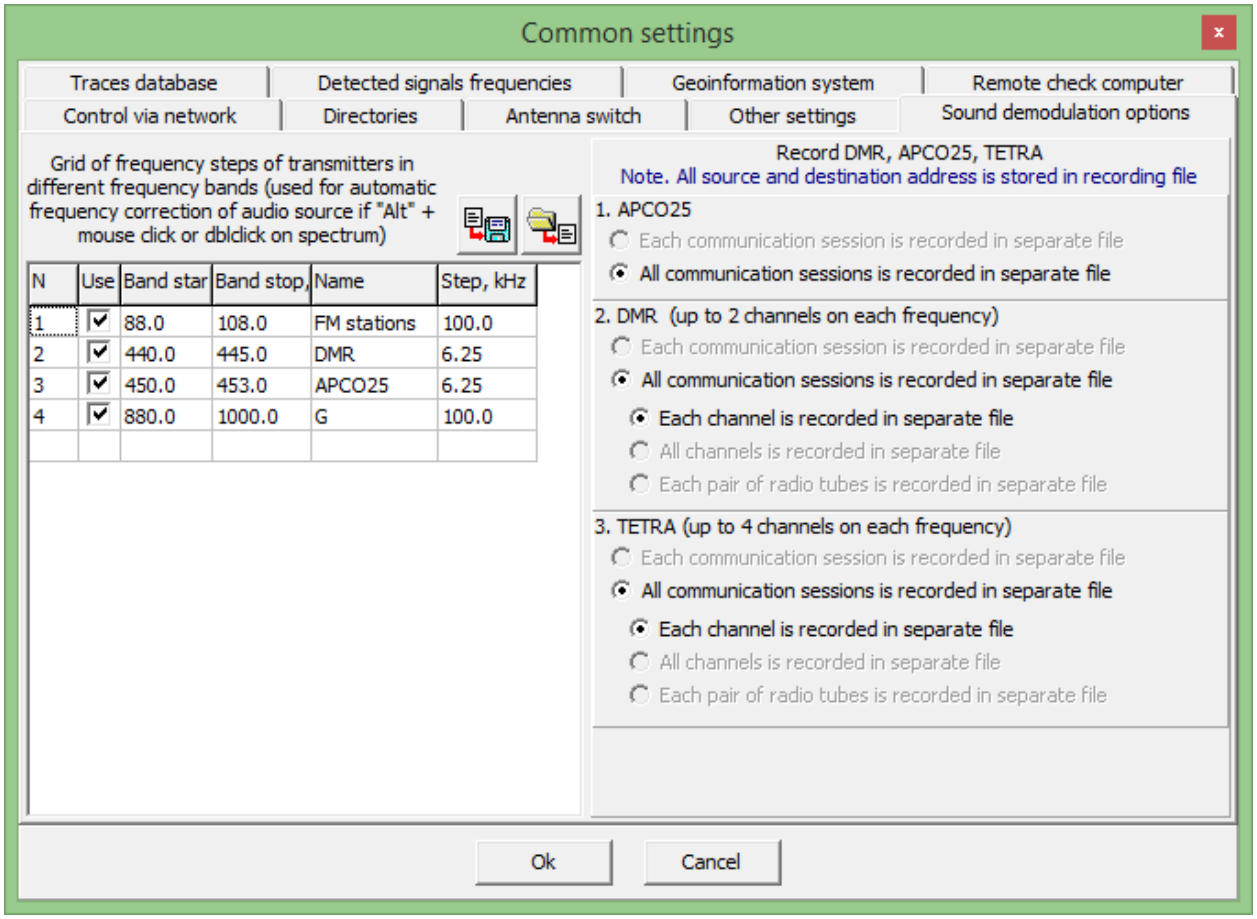
Automatic correction of detected signal frequencies and signal frequencies for demodulation.

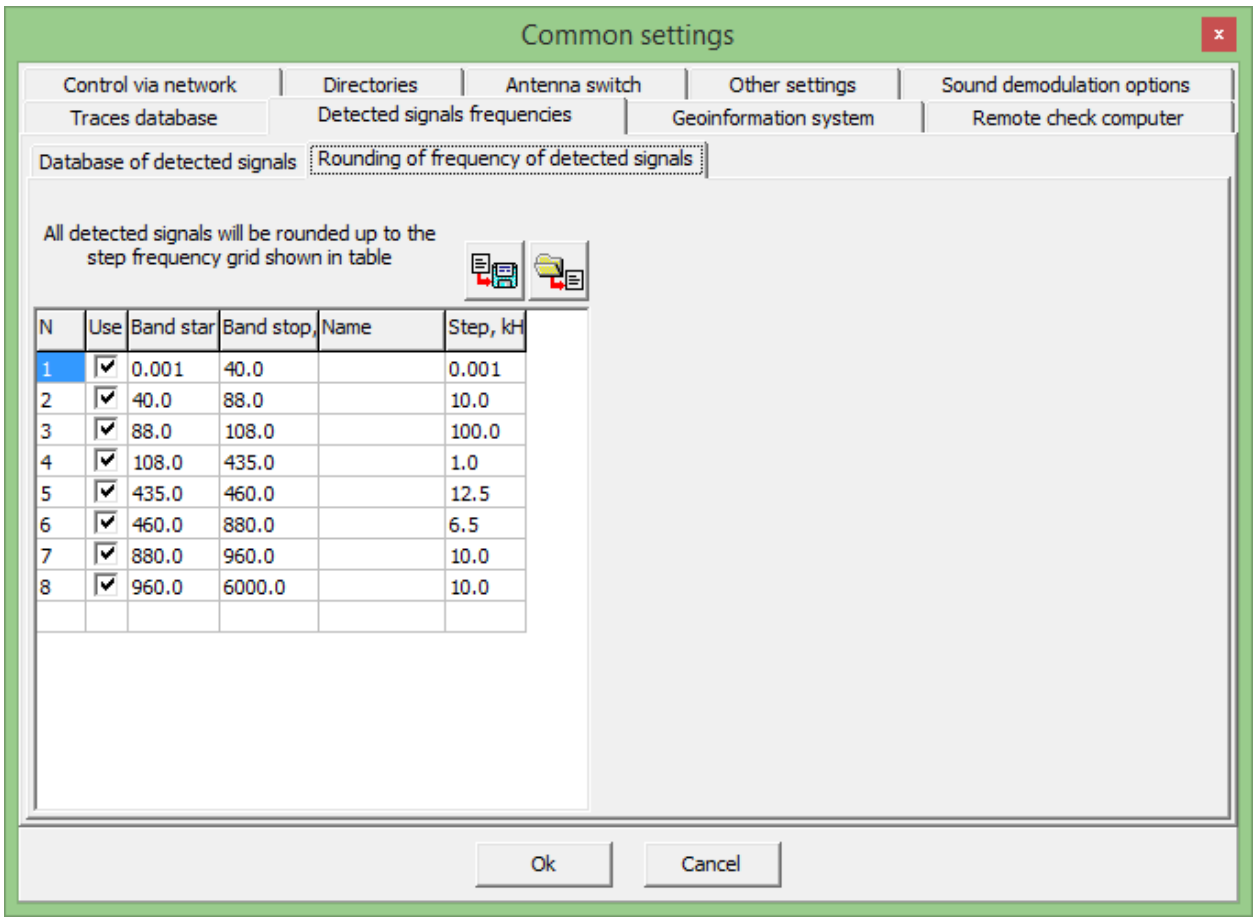
Briefly:
The software now includes automatic correction (rounding up) of detected signals' frequencies and frequency signals for demodulation, depending on the frequency range.

In detail:
In the frequency list of detected signals (signals that exceed the threshold line) the signals are shown with frequencies up to 1 Hz. This may be used when searching for illegal transmitters or interferences (which operate outside of the standard frequency step). However, a large number of neighbouring frequencies with a long number of digits after the decimal point decrease the quality of visual presentation of the information in the table.

A similar situation occurs with a frequency receiver, the source of demodulated audio signal. An inaccurate tunning to the frequency of the detected signal (including the frequency shift, relative to the communication standard's frequency step) leads to deterioration in the quality of signal demodulation.

To resolve these problems in RadioInspectorRC and RadioInspectorRT programs, there are now correction tables included for the detected frequencies and tuning frequencies of the receiver (source of audio demodulation), depending on the frequency range.
These tables are located in common settings window:





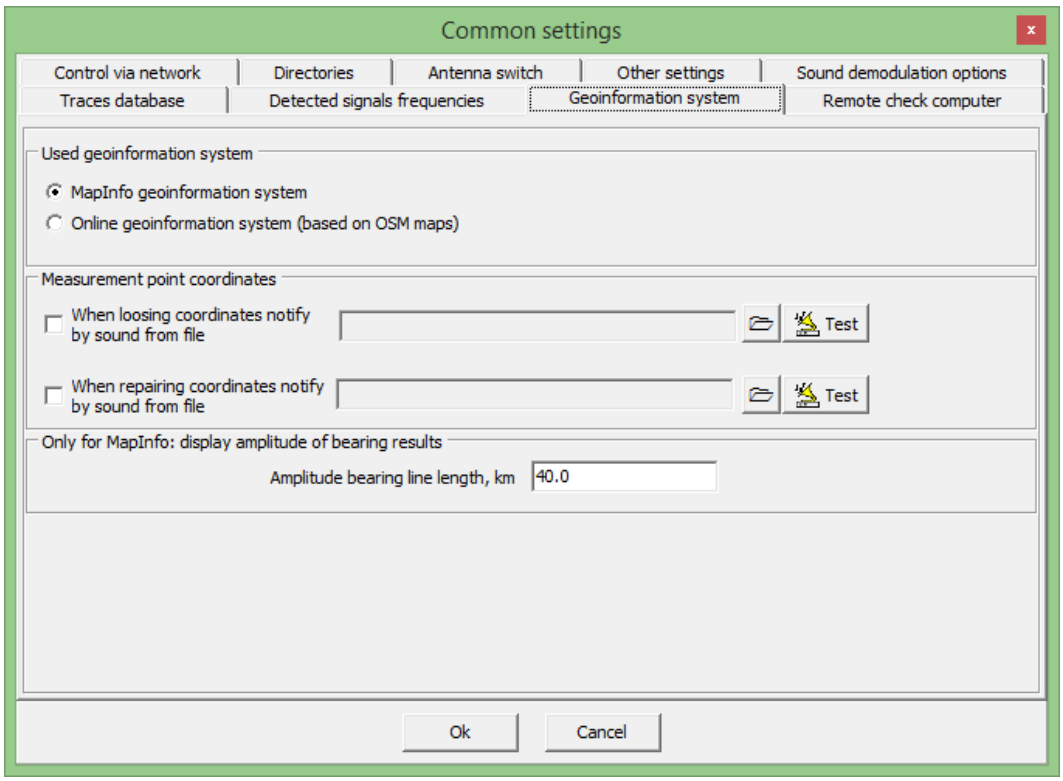
In addition, these tables can be opened by clicking on the button  located above the list of detected frequencies and on the control panel of the receiver, which is the source of the demodulated audio signal.

2017.02.20

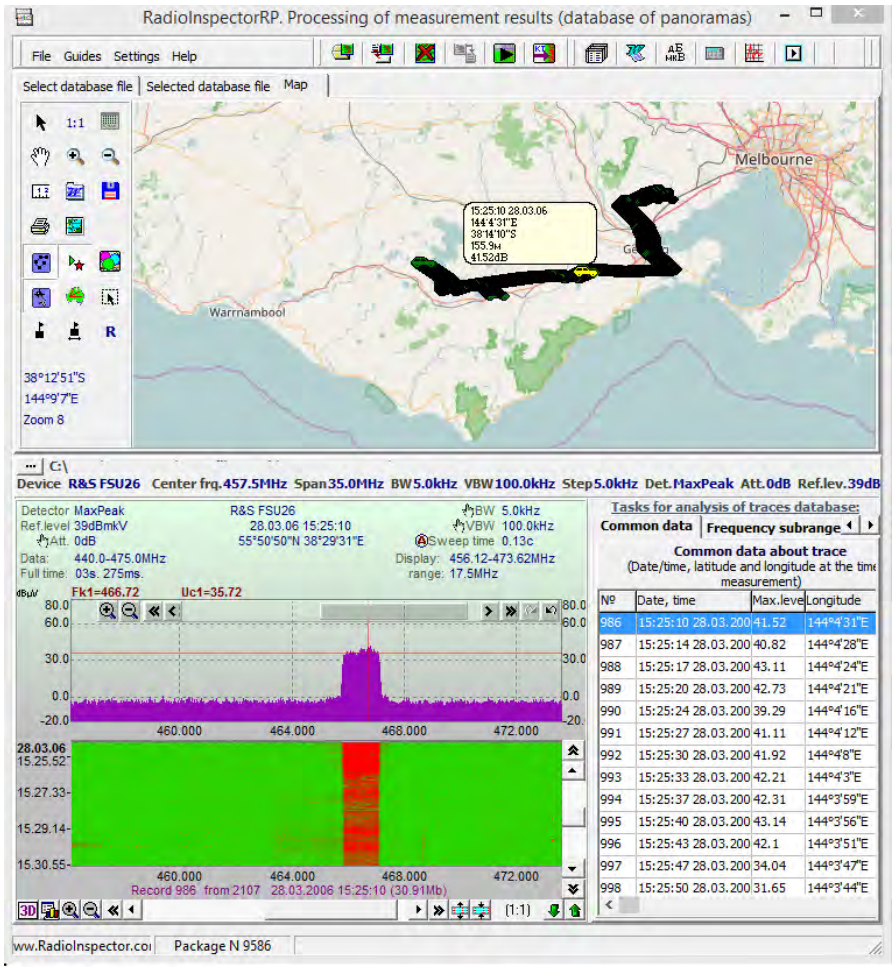
New geographic information system.

Briefly:
New geographic information system has been added to the software, based on the maps of “Open street map”. Separate purchase of “MapInfo” is no longer required, Now the new geographic information is available when purchasing options ‘GEO’ for all programs. The maps for the new system are free and available Online as well as Offline. The price for the ‘Geo’ option remains the same. There will amplitude direction finding available for the new geographic information system available in the future, please stay tuned.

In detail:
In addition to geographic information system ‘MapInfo’, a new geo information server has been developed, based on ‘Open street maps’. The operator can now select the type of geographic information system that they would like to work with.



The new GIS is capable of working both Online and Offline. In order to work in offline mode one session in online mode (Internet connection) will be required to browse the required areas of the map zoomed in. The offline maps will be saved in the cache of the computer used.



2017.03.25

New features in IQ_Process program.

Briefly:
IQ samples processing program has been modified. Now separation of the individual signals from a wide frequency band (digital shift, filtering and decimation) can be done from the files with unlimited size. Previously, files were limited to 100 000 000 IQ pairs.

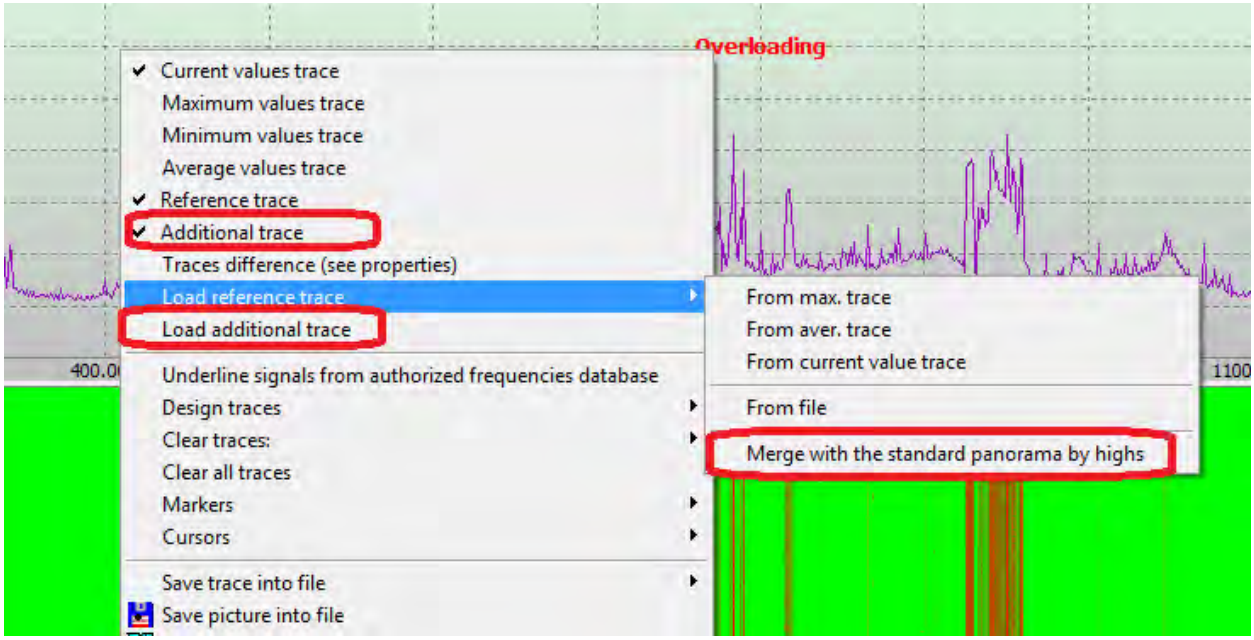
Note. The IQ_Process program is available for free when you purchase the DTest option.

2017.04.13

Advanced features for working with the reference trace

Briefly:
It is now possible to combine several traces (previously saved) into a single trace based on the maximum signal strength values from all panoramas and use it as a graph of reference values.

In detail:
New items have added in the graph management menu in the "Frequency Range Control" mode right click on graphs main window).



These new menu items will allow you to merge previously saved traces by their maximums and use merged traces as a reference trace. Furthermore, RadioInspector can display additional trace, loaded from previously saved trace file. This trace file can be used for control of merging multiple traces with the reference trace.

In order to merge traces you need to:

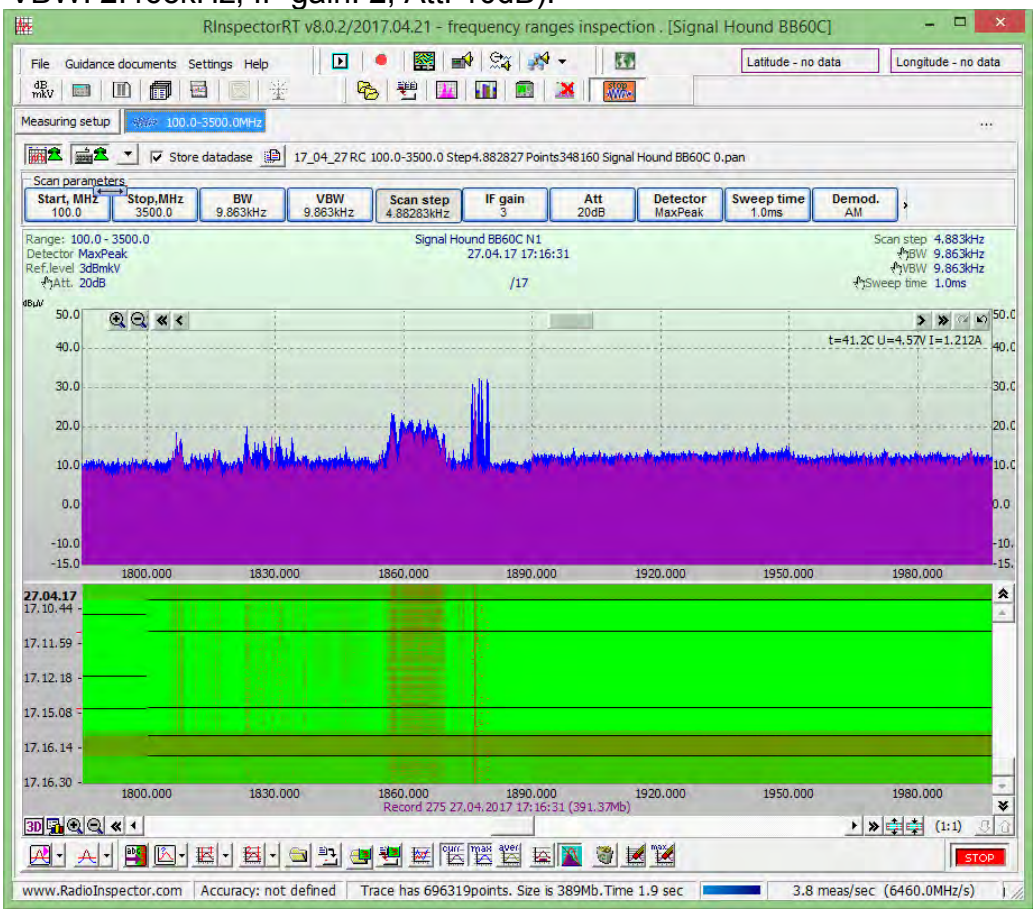
1. Click on «Load additional trace» submenu point (Load additional trace), in order to load previously saved trace file;

2. Click on «Merge with the reference trace by maximums» (Merge with the reference trace by maximums), in order to merge two traces by their maximums.

If the frequency band limits or the frequency scan step in the loaded or merged trace does not match with the current measurements settings, then RadioInspector will interpolate the loaded trace.

Trace merging example:

- Start scanning with parameters shown on image. (Start: 80MHz, End: 500 MHz, BW: 2.465kHz, VBW: 2.465kHz, IF gain: 2, Att: 10dB).



- Save the Maximum values trace to the file 1.trd (Right click on graphs main window and select Maximum values trace. Right click on graphs main window and select Save trace into file -> maximum values. Name file 1.trd)

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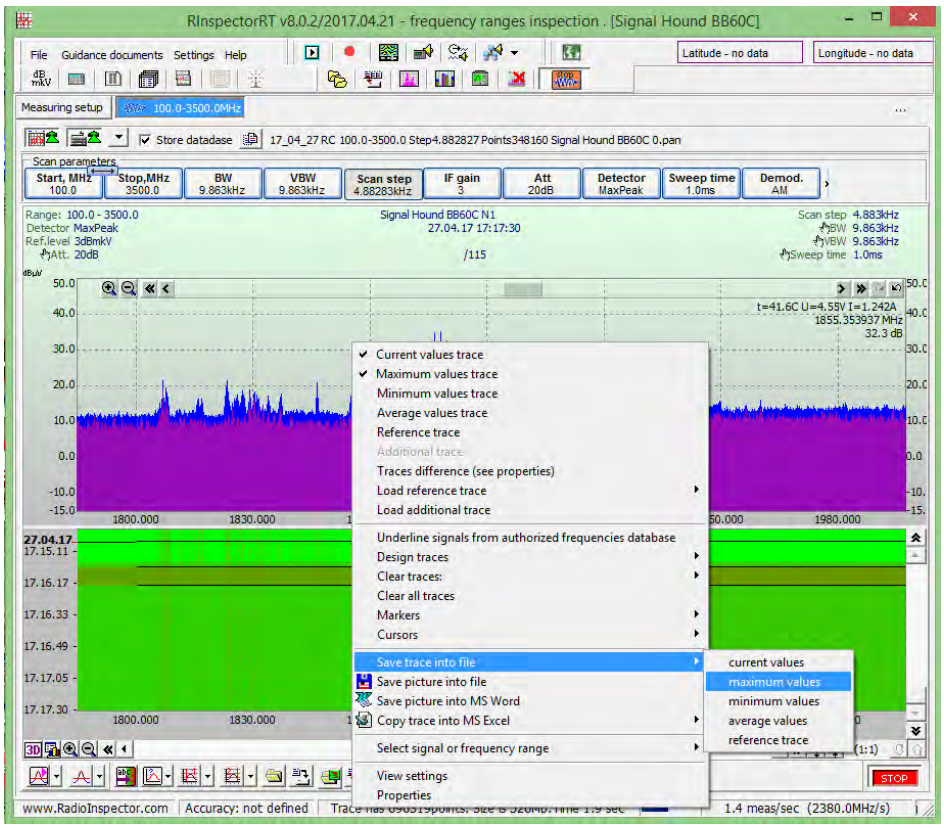

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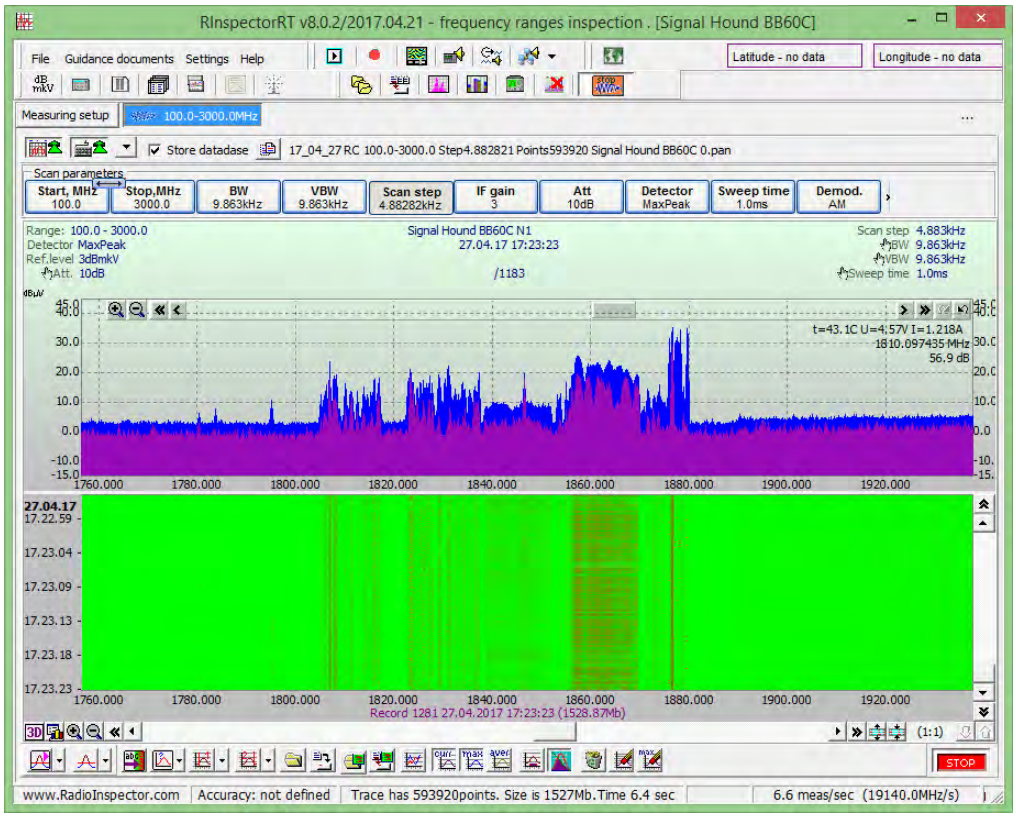
- Start scanning for few minutes. In order to make the experiment more interesting, we change the scanning parameters – we reduce the frequency range to 3000 MHz, we reduce the attenuator to 10 dB so that the noise track becomes lower (Start: 80MHz, End: 700 MHz, BW: 2.465kHz, VBW: 2.465kHz, IF gain: 2, Att: 0dB). Run the scan for a few minutes.



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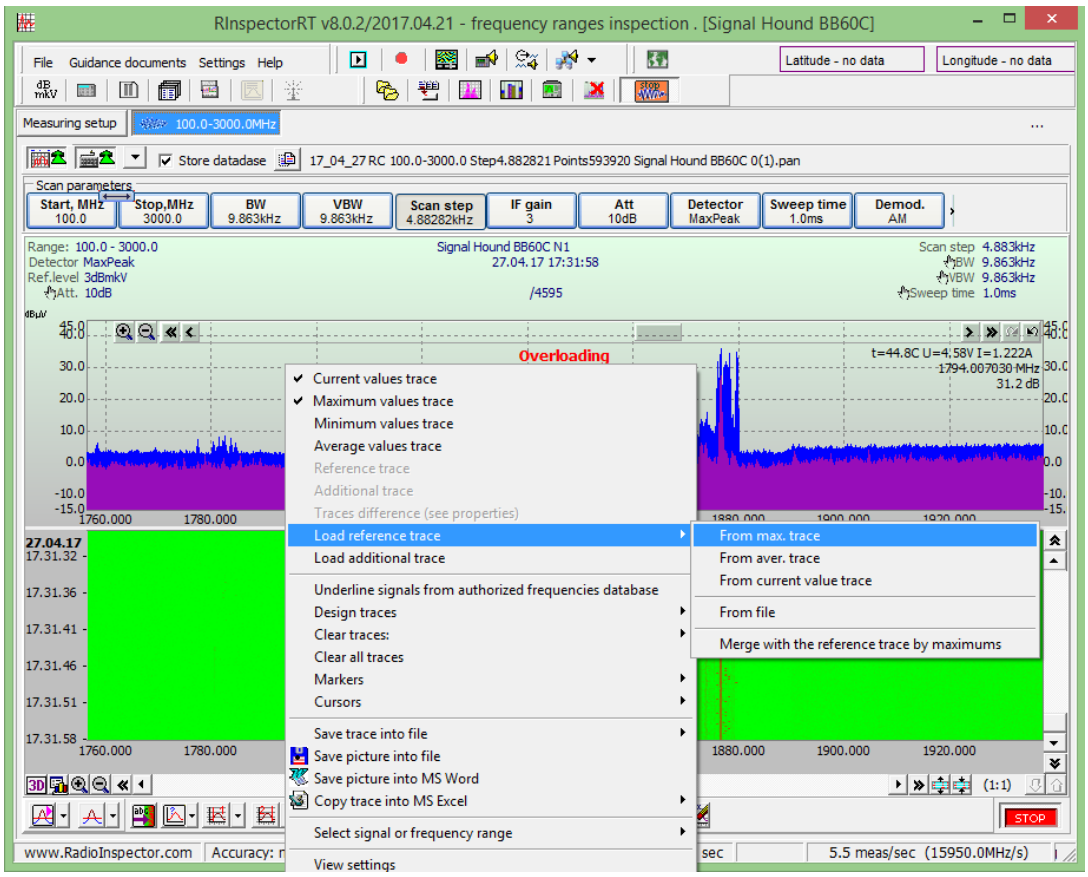
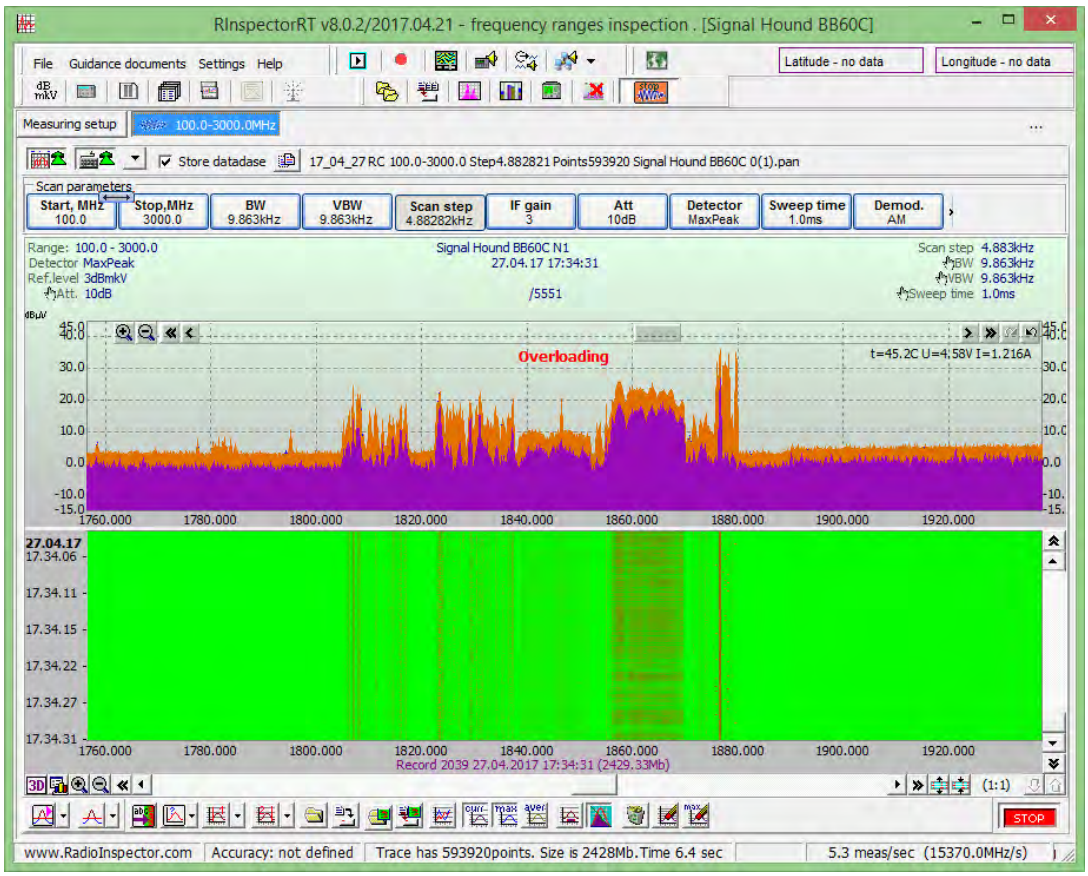
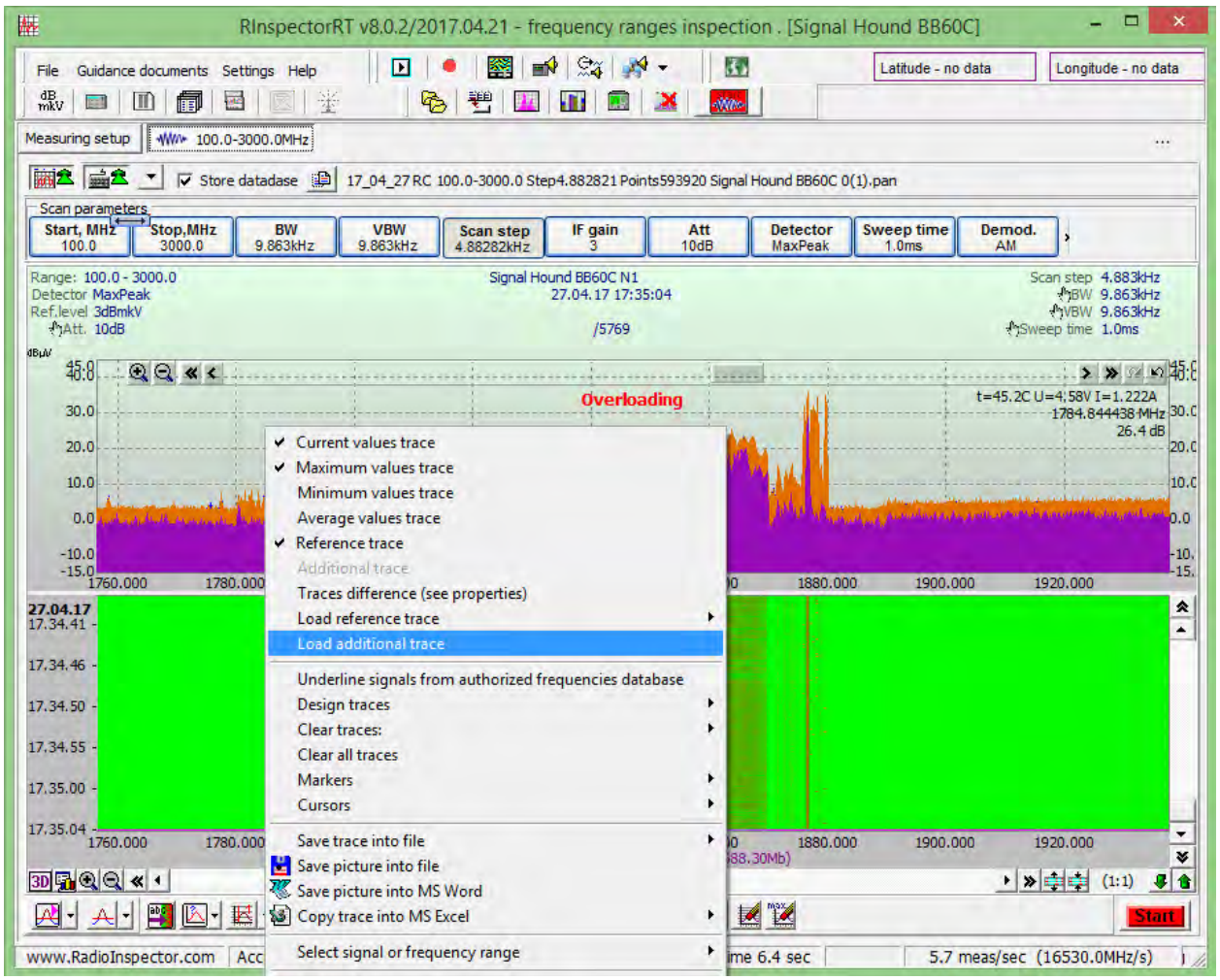
- Now we need to load reference trace from maximum trace by making right click on graphs main window and select Load reference trace -> From max.trace



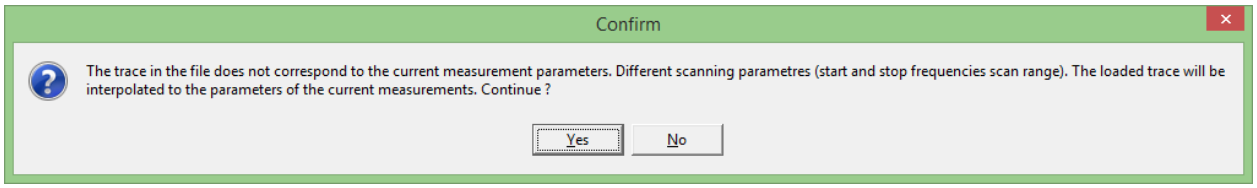
The result:



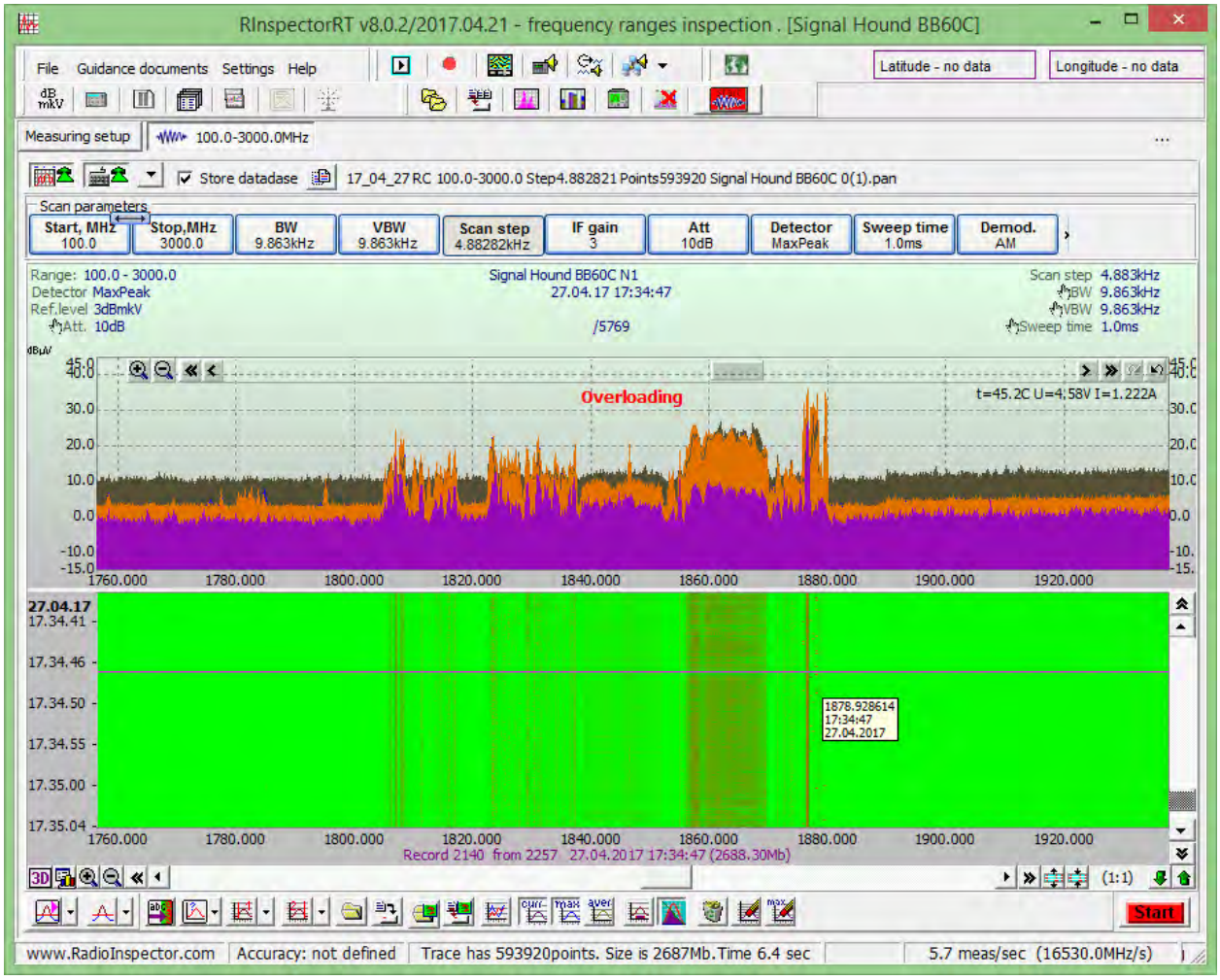
In order to make a visual control of the merging trace we need to load previously saved file 1.trd. Right click on graphs main window and select Load additional trace and click on 1.trd file -> Open



Click on Yes button on the confirmation message.

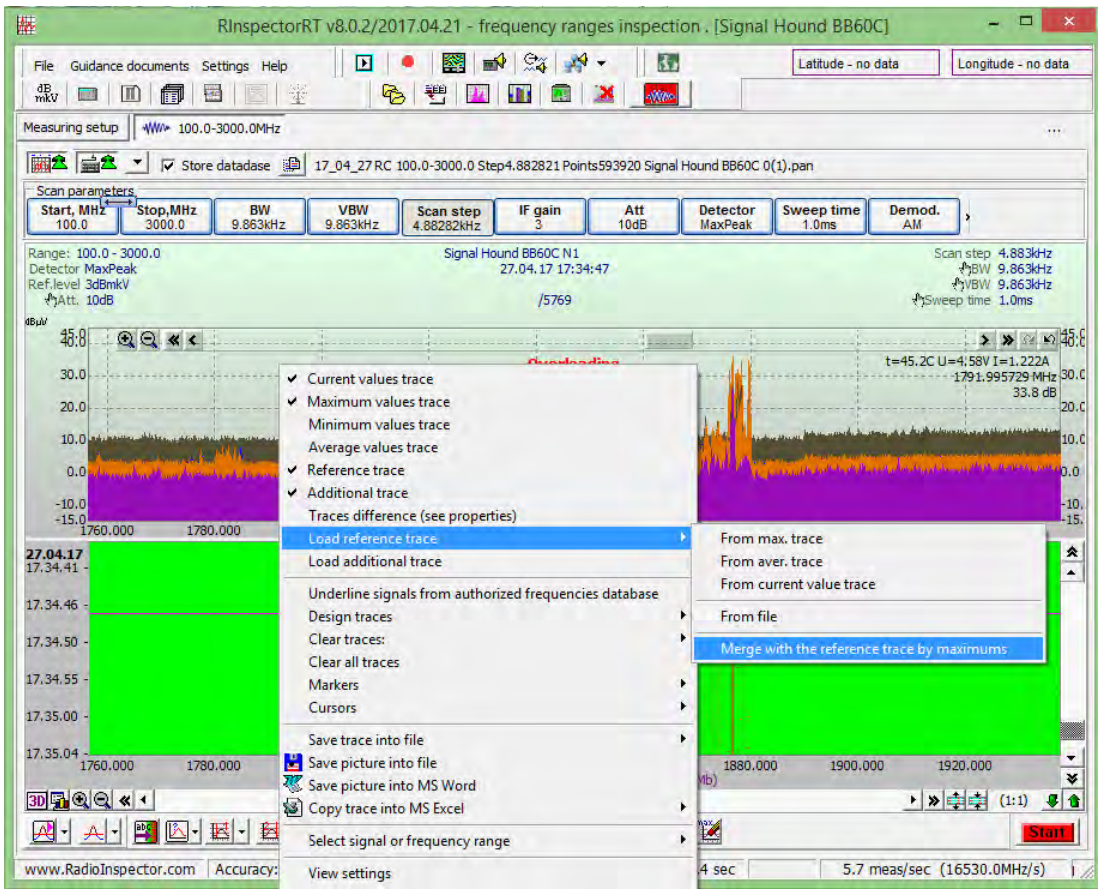


Result will look like this:

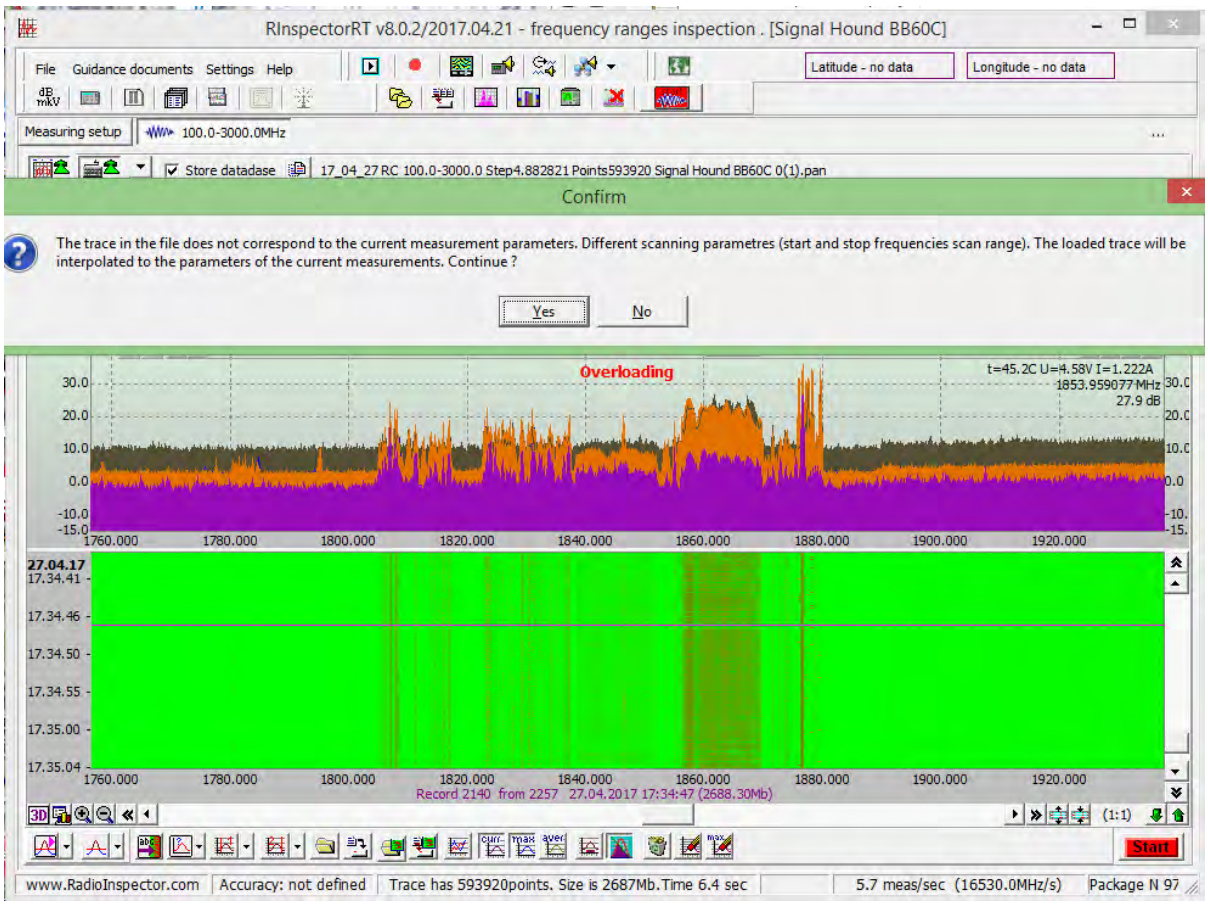


<u>Trace colours:</u>
Purple colour – current values trace;
Orange colour – reference trace;
Blue colour – maximum values trace;
Dark grey-brown – additional trace.

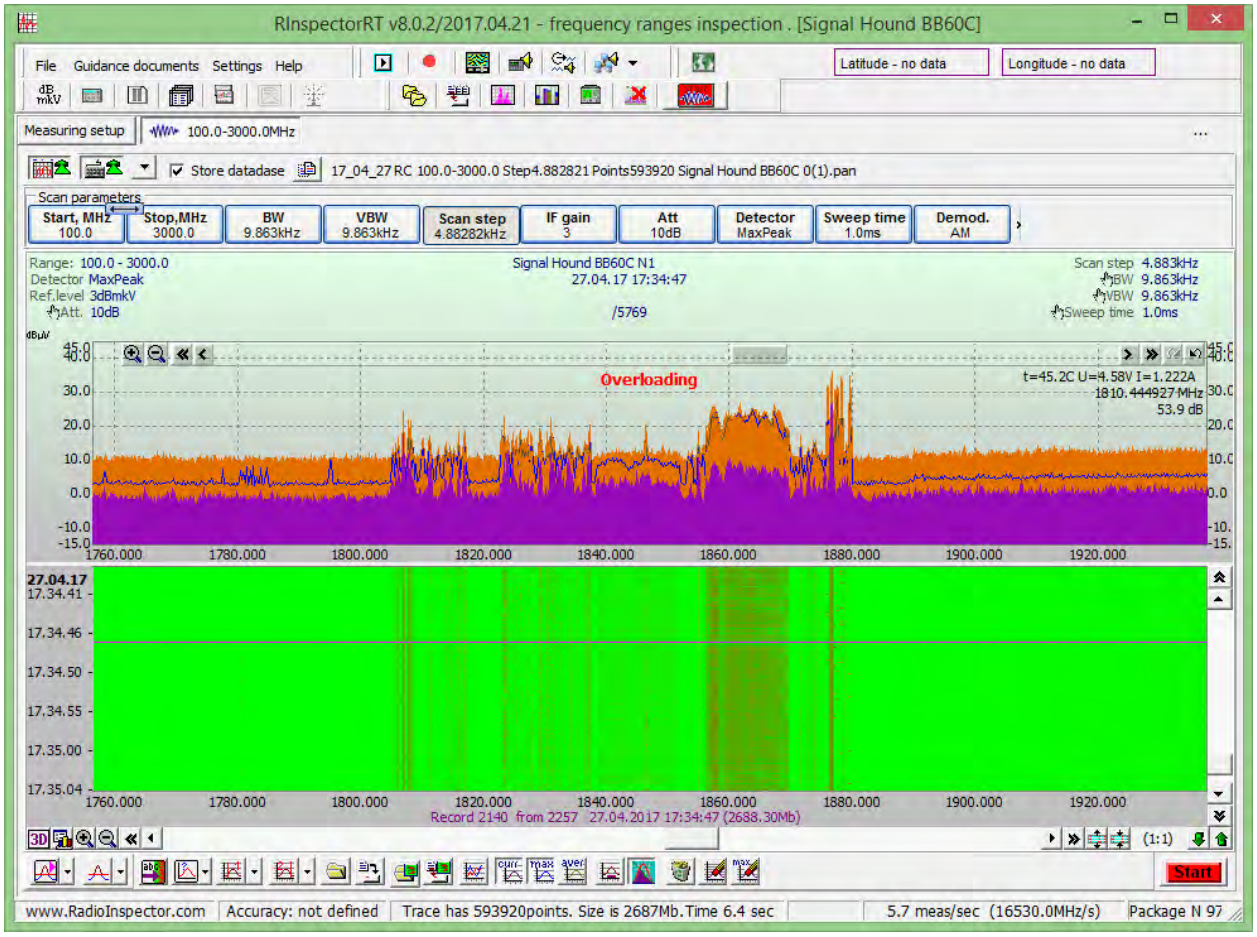
Now we will merge current reference trace with a trace that we previously saved as 1.trd. Right click on graphs main window and select Load reference trace -> Merge with the reference trace by maximums.



Click on Yes button on the confirmation message.



Result will look like this:



The reference value trace merged with the trace from the 1.trd file and "absorbed it". The additional route is no longer visible, since the route of the reference values has become greater than or equal to the additional route at each point.

2017.06.06

Name change and additional options in the RadioInspector software.

For better understanding of the options purpose and software capabilities, we have changed the names of the options and their purpose is given in more detail.

1. The option names «RC-Lan», «RT-Lan» and «Light-Lan» are changed to «RC-RemoteMD», «RT-RemoteMD» and «Light-RemoteMD».

Option description: “RemoteMD” option is used in RadioInspectorRT, RadioInspectorRC and RadioInspectorRT-Light to connect these programs to the I_MasterDevice program, which is installed on the remote computer. I_MasterDevice program controls the measuring instruments. Using I_MasterDevice program you can remotely control measuring instruments connected to another computer via RadioInspectorRC, RadioInspectorRT and RadioInspectorRT-Light programs. Local Area Network (LAN) or the Internet is used to establish communication between RadioInspectorRC, RadioInspectorRT, RadioInspectorRT-

Light programs and I_MasterDevice. You will need to know the IP address or hostname of the computer where I_MasterDevice is installed

Note 1: When you purchase RadioInspectorRC program, I_MasterDevice program comes free of charge and it runs on the same computer where RadioInspectorRC is installed.

Note 2: When you order I_MasterDevice program (including free version), you need to specify name and model of the measuring instrument which will be connected to I_MasterDevice. If I_MasterDevice will be managing 2 or 3 instruments, then you will need to purchase MD2 or MD3 options in addition.

Note 3: RadioInspectorRT program can work with measuring instruments without I_MasterDevice program. RadioInspectorRC works with measuring instruments only via I_MasterDevice program.

2. The name of the "RC DB" option is changed to "RC-MeasDB".Option description: "RC-MeasDB" and "RT-MeasDB" options add measurement results table to the "Advanced" database. This option requires "AdvancedDB" option, "RC-SA" or "RT-SA" option and "RC-Meas" or "RT-Meas" option.

3. "RT-MeasDB" option has been added to RadioInspectorRT program. If RadioInspectorRT program works without I_MasterDevice, field strength measurement will be unavailable in "RT-MeasDB" option, as antenna calibration coefficients are determined in I_MasterDevice program.

4. Two database options "AdvancedDB" and "SimpleDB" were introduced to RadioInspectorRC, RadioInspectorRT and RadioInspectorRP programs. These options determine the complexity level of legal signals databases used in the software. "SimpleDB" database option is a simple database structure (each row in the database defines single measuring instrument, single frequency and one owner). "SimpleDB" database option has a free Converter program, which can add records from a text file (CSV file) to a database format in the software. "AdvancedDB" database option is a complex database, where measuring instrument names, owners, frequencies are stored in different tables. Free Converter program does not work with "AdvancedDB" database. Measurement results table (database) "MeasDB" option only works with "AdvancedDB" database, and links results of the measurements with measuring instruments table and frequency table.

5. The name of the "RC-AN" option has changed to "RC-SA" (RC-Spectrum Analyzer). "RT-SA" option has been added to the RadioInspectorRT program.

Option description: this option allows you to control any spectrum analyzer or receiver directly from the single universal instrument panel. In addition to the control panels of the frequencies range and fixed frequencies, this option introduces expert panel analysis of signals and transmission with which you can control the spectrum analyzator. This panel also controls a spectrum analyzer and measurements of the signal parameters ("MeasDB" option) can be done from here.

List of RadioInspector software options:

RadioInspectorRC (RadioInspectorRT):
RC-RemoteMD – opportunity to connect to I_MD on a remote computer
RC-Sound – (for Light only) record and analyzis of a demodulated audio signal
RC-SList – (for Light only) detection and list of signals that have exceeded the threshold
RC-SoundScaner – additional, connected receivers for demodulating the RC-Geo audio signal – support for the geographic information system
RC-Scanner – additional, connected receivers for spectrum scanning
RC-SA – expert signal analysis (as a gift, without payment)
RC-Meas – performing signal parameter measurements
RC-MeasDB – measurement results database (only if the RC-AdvancedDB option is available)
RC-AdvancedDB – expanded database of legal signals
RC-SimpleDB – a simple database of legal signals
RC-DigitalTest – digital signal analysis (identification and classification of transmitters) standards APCO25, DMR/MOTOTRBO, TETRA, GSM, BlueTooth, Dect, UMTS, DVB, DVB-T2, LTE, 805.15.4 based (ZigBee and others), AnalogTV.

RadioInspectorRP:

RP-Geo – geographic information system support
RP-MeasDB – measurement results database (only if the RC-AdvancedDB option is available)
RP-AdvancedDB – expanded database of legal signals
RP-SimpleDB – a simple database of legal signals

I_MasterDevice:

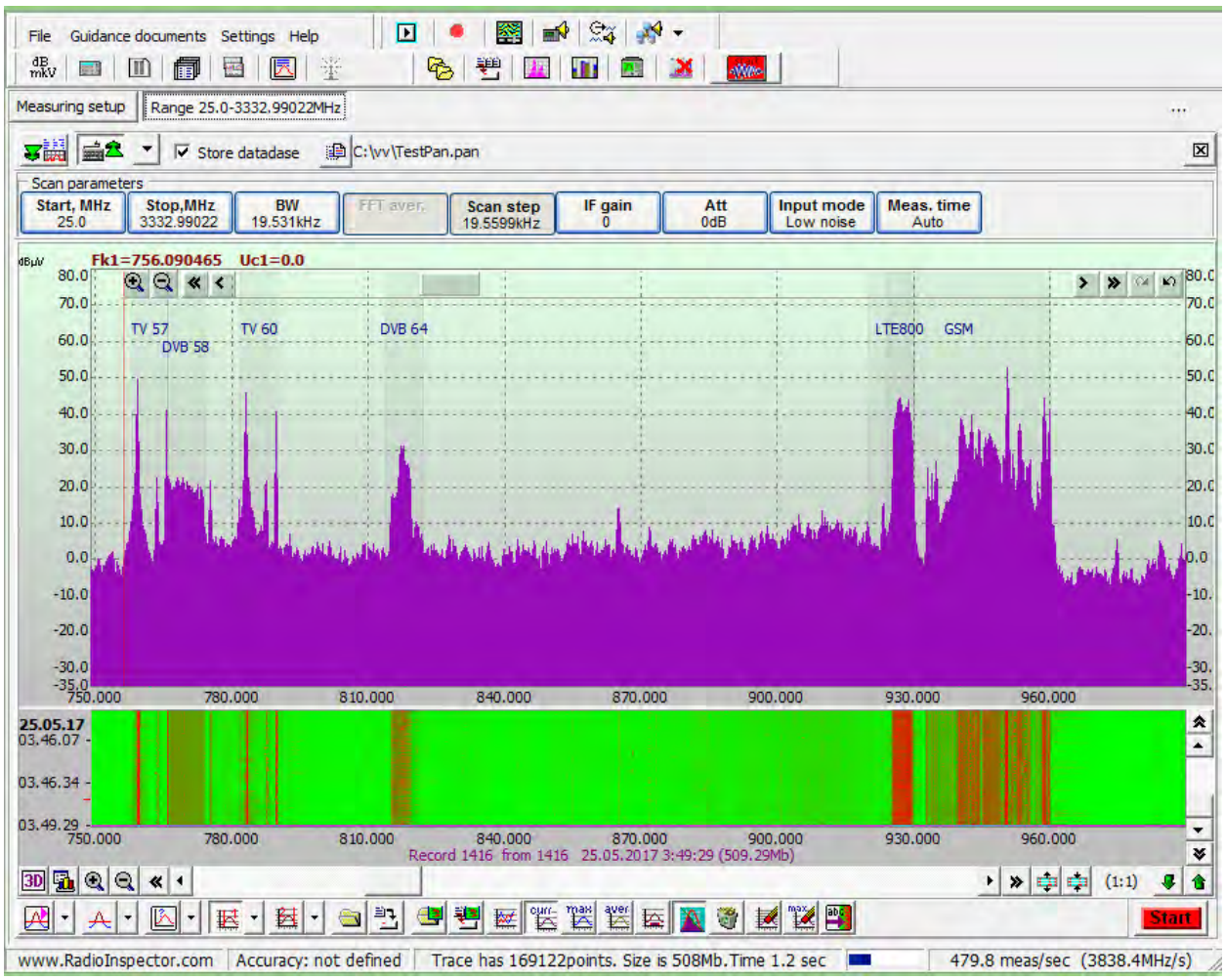
MD-Geo – geographic information system support
MD-2 – support for 2 main devices in the software
MD-3 – support for 3 main devices in the software

2017.06.09

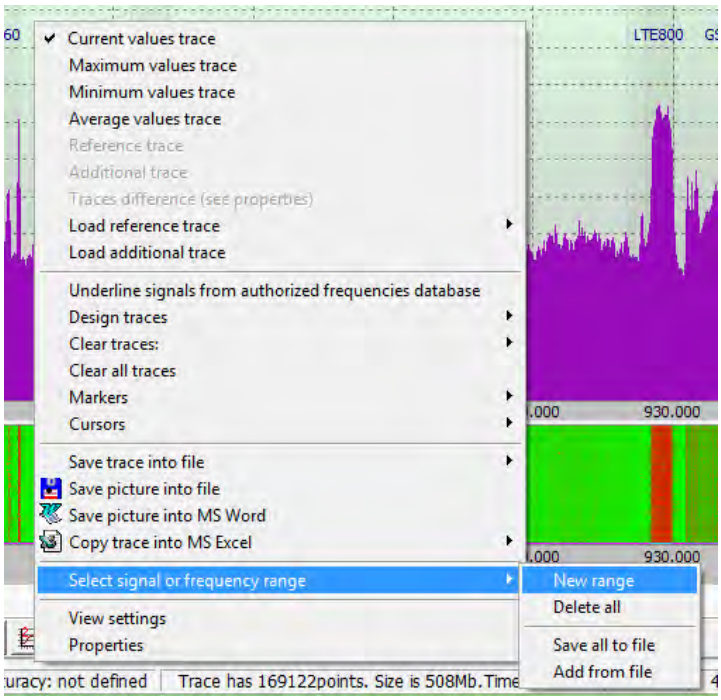
Selection and marking of the standard signal frequency range on signals spectra and frequency range panoramas.

Briefly: Selection and marking of the standard signal frequency range on signals spectra and frequency range panoramas has been added to the RadioInspector software functionality.

In detail: To improve the convenience and quality of the spectrum analysis in the software we have added selection and marking of the standard signal frequency range on signals spectra and frequency range panoramas. This functionality applies to each chart individually, so you can display different information on different charts, depending on the tasks.



To create a new marking of the frequency range right-click on the graph space and select "Select signal or frequency range" and "New range". After that, it is recommended to save selected frequency range to the file.



If there are many separate frequency ranges of standard signals files saved, then you can combine them using "Add from file" menu item to obtain combined allocations list of standard signals. The file with the saved data can be edited, as it is a simple text file.

2017.07.04

Navigation receiver (geodetic coordinates of the measurement point) and electronic antenna compass: algorithm of use.

Briefly:

In RadioInspectorRT, RadioInspectorRC software introduced the possibility of working with an electronic compass showing the azimuth of the direction of the antenna on an electronic map with reference to geodetic coordinates. When rotating the antenna 360 degrees the signal level measuring results are displayed on the map. This will allow you to get the direction to the transmission source or to estimate the antenna pattern. Measurement of several directions to the transmission source from different locations allows determining a signal source by amplitude direction finding method.

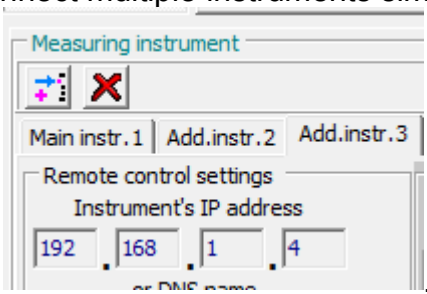
Note. You must use the navigation receiver to display the measurement results on the map

In detail:

Intro

To review the features of using the antenna compass and the navigation receiver in the RadioInspectorRT and RadioInspectorRC software, it is necessary to introduce the concepts of the "Main instrument 1" - "secondary instruments" and "locally controlled instrument " - "remote control instrument".

"Main instrument 1" - "secondary instruments"

You can connect multiple instruments simultaneously in RadioInspectorRT program by pressing button 

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Different scanning pages frequency range monitoring or expert signal analysis can use different instruments to work simultaneously

The first instrument in the list (Main instr.1) will be referred to as the **"Main instrument 1".** It has special privileges:
- Only "Main instrument 1" carries out additional studies of signals that have exceeded a threshold line;
- Only "Main instrument 1" can perform digital signal analysis (DTest option);

- Results of azimuth measuring by the antenna compass only adds to Main instrument 1 measurement results.

RadioInspectorRC program does not have the ability to connect several devices at the same time, so the device with which the program RadioInspectorRC operates will be the "Main instrument 1".

"Locally controlled instrument " - "Remote controlled instrument"

«Remote controlled instrument» - is the device connected to I_MasterDevice. I_MasterDevice program can run on the local computer (on the same computer running RadioInspctorRT or RadioInspctorRC), or on a remote computer. The RadioInspectorRC and RadioInspectorRT programs are connected to the I_MasterDevice program and can manage the devices configured in I_MasterDevice.

Note. RadioInspectorRT program is also able to manage devices without I_MasterDevice.

"Locally controlled instrument" is a device connected in the RadioInspectorRT, without using I_MasterDevice. In RadioInspectorRC, all devices will be called "remote controlled instruments", because the RadioInspectorRC cannot manage the devices themselves, but manages them only through the I_MasterDevice.

Where the data of the antenna compass and the navigation receiver are stored and used.

The data received from the antenna compass and the navigation receiver is saved in the panorama database (in *.pan files) for each scan (for each line in the spectrogram).
This data can be displayed using an electronic map in the RadioInspectorRT, RadioInspectorRC programs in real time or in the RadioInspectorRP program while analyzing saved panorama files.

What instruments should be used to obtain the coordinates of the point measurements and azimuth values of the antenna direction.

To obtain the geodetic coordinates of the measuring point in the software, you can use:

1. Navigation receiver (GPS, GLONASS), which transmits data via USB (USB-COM) port using the NMEA protocol.

2. Measuring receivers and spectrum analyzers with built-in navigation receiver, which together with the measurement results of the signal spectra can transmit the coordinates of the measurement point.

To obtain the azimuth of the antenna direction in the program, the following can be used:

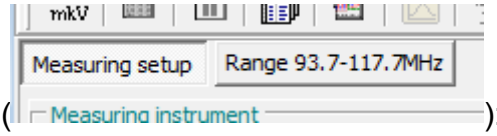
1. An antenna handle, specifically designed for RadioInspector software, equipped with an antenna compass (device named RS CM02). Any directional antennas can be attached to the antenna holder. The compass is connected to the computer via a USB (USB-COM) port. The compass provides the following data: Azimuth, Elevation, Roll.

2. Antennas and measuring receivers of some manufacturers, which can transmit the results of signals spectrum measurements as well as Azimuth, Elevation, Roll.

Note. Rohde&Schwarz PR100 and PR200 devices with the HE400 antenna currently support this mode.

Navigation receiver.

Connecting the navigation receiver.

The navigation receiver can be connected in RadioInspectorRT program on the "Navigation receiver" tab of the "Measuring setup" page (

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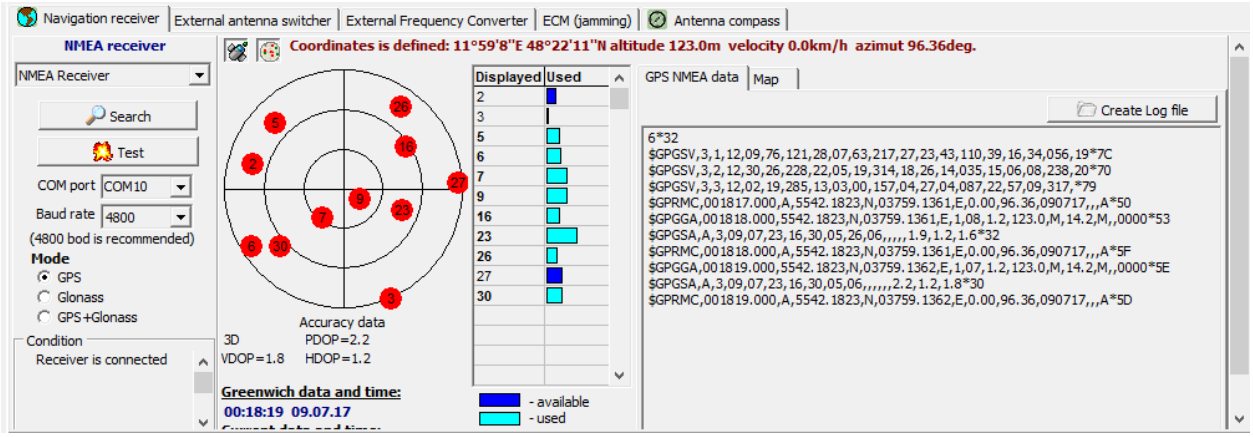
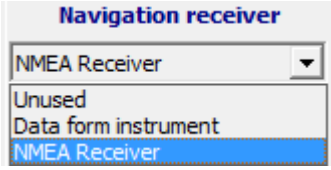


On this page, you need to select:
- type of receiver,
- receiver COM port (receivers are connected via the com port, usually using the built-in USB-COM adapters),
- the speed of data transmission over the COM port,
- the type of satellite navigation system: GPS, GLONASS, GPS+GLONASS or Auto (in Auto mode, the program itself selects the system for obtaining coordinates by analyzing the received data),
- the rate (frequency) of the receiver survey.

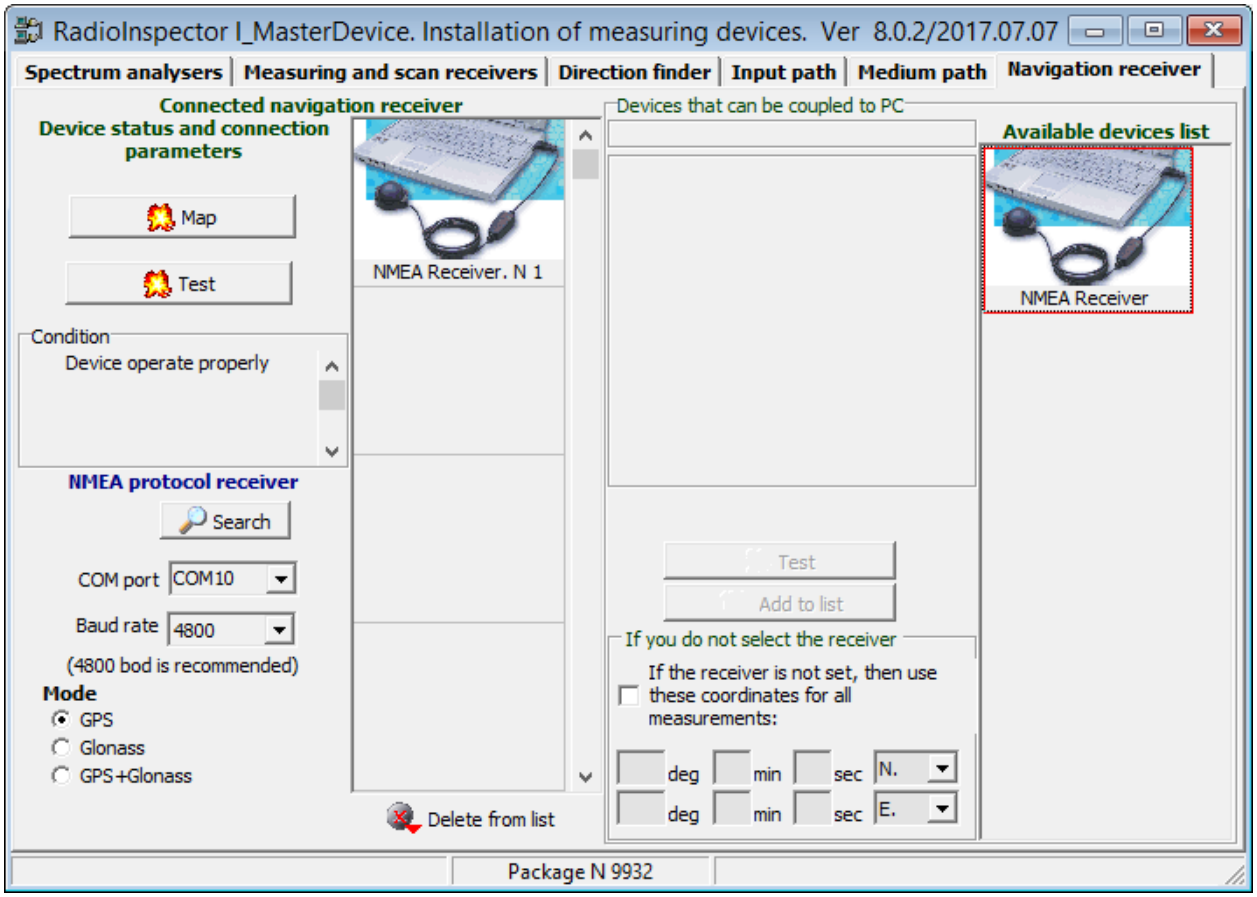
Attention. The program does not control the navigation receiver, but only reads the data that it transmits to the computer and analyzes it. The speed of data transmission over the COM port, the type of satellite navigation system, and the rate (frequency) of coordinate data transmission from the receiver to the computer must be pre-set in the receiver and correspond to those set in the program. To do this, you need to use special programs, which usually can be found on the website of the receiver manufacturer.

The possible selection of navigation receivers in RadioInspectorRT program are determined by a drop box:
- The navigation receiver is not used;
- The data received from the instrument is used;
- Coordinates are obtained from the navigation receiver (NMEA standard), connected to the computer via COM (USB-COM) port.



You cannot connect the navigation receiver in RadioInspectorRC, since it uses I_MasterDevice program (running on a local or remote computer) to receive data from the device.

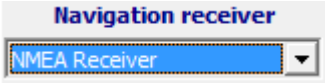
In the I_MasterDevice, the navigation receiver can be connected on the "Navigation receiver" tab.



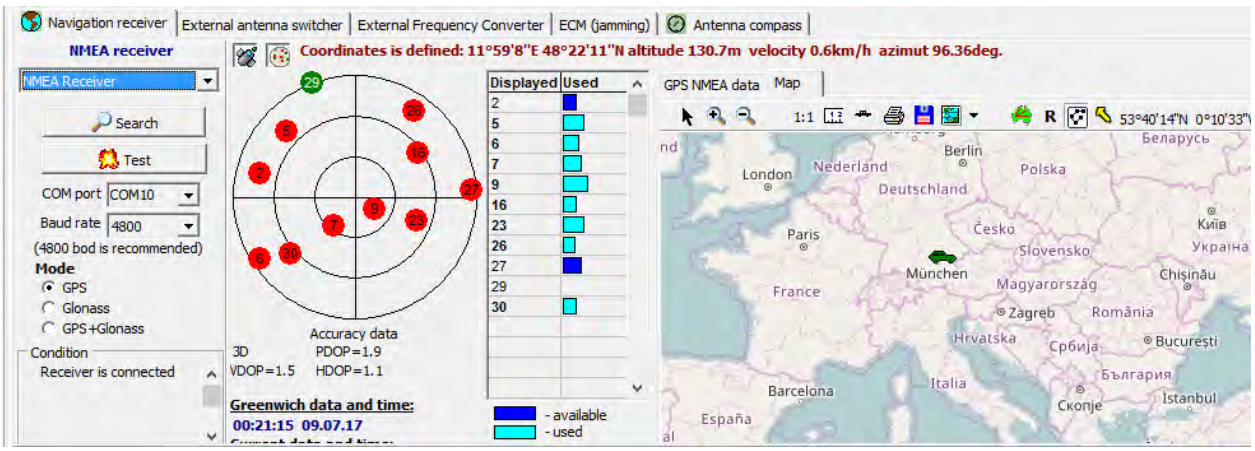
The data from navigation receiver in I_MasterDevice is applied to measurements of all instruments defined in I_MasterDevice. However, if instrument receives data from its built-in navigation receiver, the I_MasterDevice transfers positioning data (obtained by the instrument) along with the measurement results. Positioning data obtained by an external navigation receiver will be discarded.

Displaying current coordinates and point of measurement coordinates.

<u>For RadioInspectorRT program:</u>

- If the condition "use external navigation receiver" 

is chosen for obtaining coordinates, the current coordinates would be displayed on the "Navigation receiver" tab of the "Measuring setup" page:



The coordinates are also displayed in the field 48°22'11"N 11°59'8"E of the main program window. If you click on button above the map in the "Navigation receiver" tab, the points will be displayed according to coordinates received from external navigation receiver (the display interval is approximately 2 seconds).

Note. Do not confuse the result of displaying on this map with displaying the route of measurement results of the signal spectrum by clicking on the similar button on the map of the main program window.

- If the condition "Data from instrument" Navigation receiver Data form instrument is selected for receiving coordinates, the coordinates are displayed only in the field 48°22'11"N 11°59'8"E of the main program window.

For RadioInspectorRC program:

- Coordinates are displayed only in the field 48°22'11"N 11°59'8"E of the main program window.

Conditions for obtaining and using coordinates.

RadioInspectorRC program.

The coordinates are received together with the measurement results from I_MasterDevice, which controls the measuring instruments. In the I_MasterDevice, the coordinates are received either from an external navigation receiver or from instrument's built-in navigation receiver, if available. The coordinates are displayed in 48°22'11"N 11°59'8"E field. The coordinate change occurs only during the scanning process (receiving the measurement results). When the scan is stopped, the last received coordinates are displayed. When you click on button of the main program window, it will display the points in which measurements of spectra and traces of signals were made.

RadioInspectorRT program.

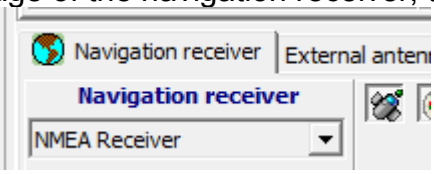
- For all "remote controlled instruments", the coordinates of the measurement points are received together with the measurement results, regardless of the selection condition of the

navigation receiver in the RadioInspectorRT. Coordinates in the measurement results from "remote controlled instruments" may or may not exist. They are not affected in any way by the selection conditions of the navigation receiver in the RadioInspectorRT program.

- If "Main instrument 1" in the list of devices is "remote controlled instrument", the coordinates of the last measurements of this device are displayed in 

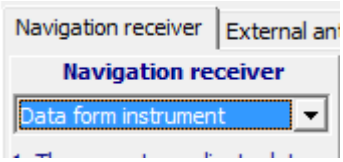
field (regardless of the selection condition of the navigation receiver in the RadioInspectorRT program). When you click on button of the main program window, it will display the points in which the measurements of spectra and the traces of signals were made.

- If "Main instrument 1" in the list of devices is a "locally controlled instrument", then the following options are possible:

- On the selection page of the navigation receiver, the condition is selected - use an external navigation receiver (

).
In this case, the current coordinates are received from the external navigation receiver and are updated on the navigation receiver selection page and in 

field of the main program window. The update rate is approximately once in every 2 seconds regardless of spectrum scanning. If data positioning for any reason is not received for more than 15 seconds, the program will report a missing location coordinates. Coordinates from external navigation receiver will be assigned to the measurement results obtained from "locally controlled instruments" regardless of whether the instrument receives the coordinates from the built-in navigation receiver. The coordinates from the external navigation receiver will always be assigned to the measurement results of all "locally controlled instruments". To the measurement results of "remotely controlled instruments" these coordinates **will not be assigned.**

- On the selection page of the navigation receiver, the condition is chosen - use coordinates data acquired by instruments' build-in navigation receiver (

).
In this case, the current coordinates received from the "Main instrument 1" during spectrum scanning only. To obtain the coordinates, the "Main instrument 1" must be a "locally controlled instrument" (it should not be a "remote controlled instrument"). The current coordinates are updated only in the 

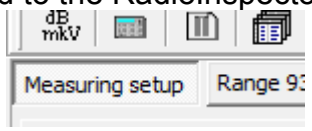
field of the main program window. The rate of updating the coordinates is equal to the scanning rate of the "Main instrument 1".

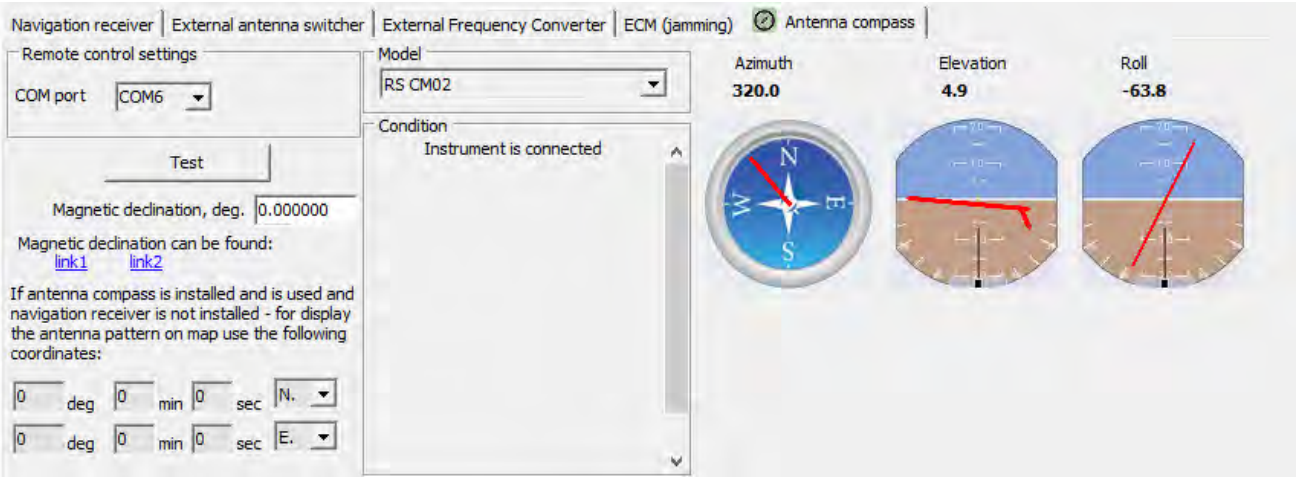
The measurements results obtained from "locally controlled instruments" coordinates received by "Main instrument 1" built-in navigation receiver will be assigned. Regardless of whether the "locally controlled instruments" receives measurement point coordinates from its built-in navigation receiver. To the measurements results of "remotely controlled instruments" these coordinates **will not be assigned.**

If "Main instrument 1" does not perform the spectrum scan task, and the other instruments are running the spectrum scan, then the LAST coordinates of the " Main instrument 1" will be assigned to the measurements results of other "locally controlled instruments".

Antenna compass.

Connecting the antenna compass.

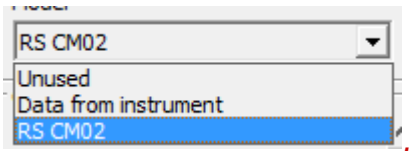
Antenna compass is connected to the RadioInspectorRT program in the "Antenna compass" tab of the "Measuring setup" page 



Possible options for selecting the antenna compass in "RadioInspectorRT" are determined by the drop box:

- Antenna compass is not used,
- The data received from the instrument is used,
- An external antenna compass is connected.

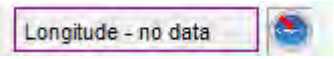
Note. At the time of writing, only one external antenna compass RS CM02 (handle - holder for an external antenna with a built-in electronic antenna compass) can be connected in RadioInspectorRT:



You cannot connect the antenna compass in RadioInspectorRC. RadioInspectorRC uses I_MasterDevice (running on a local or remote computer) to receive data from an instrument. The external antenna compass in I_MasterDevice is not used; since it is not possible to determine which instrument the antenna compass is connected to (the antenna compass can be used only with one instrument and several instruments can be configured in I_MasterDevice). However, if the instrument itself receives data from its antenna compass built into the antenna, I_MasterDevice passes these values along with the measurement results to RadioInspectorRC or RadioInspectorRT.

Where the data of the antenna compass is displayed.

Antenna compass data is displayed:
- In RadioInspectorRT program on the "Antenna compass" tab of the page "Measuring setup" (azimuth, roll and elevation are displayed).

- In RadioInspectorRT and RadioInspectorRC programs in 

field of the main window of the program, to the right of longitude and latitude data (only the azimuth of the antenna is displayed).

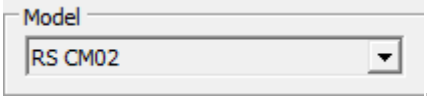
Note. The button  becomes visible only when the program receives azimuth data for the first time.

Conditions for obtaining and using data from the antenna compass.

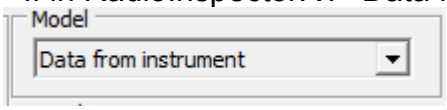
RadioInspectorRC program.

In RadioInspectorRC, you cannot install an external antenna compass. The azimuth data comes along with the measurement results from I_MasterDevice. Installation of external antenna compass is also impossible in I_MasterDevice. The only option for acquiring the azimuth for RadioInspectorRC(RT) programs + I_MasterDevice (using the "remote controlled instrument") is using a device that receives data from its built-in antenna compass and transmits it along with the measurement results.

RadioInspectorRT program.

- In RadioInspectorRT program you can install an external antenna compass on the "Antenna compass" tab of the "Measuring setup" page: 

. When using an external antenna compass, the antenna azimuth is assigned only to "Main instrument 1". To obtain the azimuth, the "Main instrument 1" must be a "locally controlled instrument".

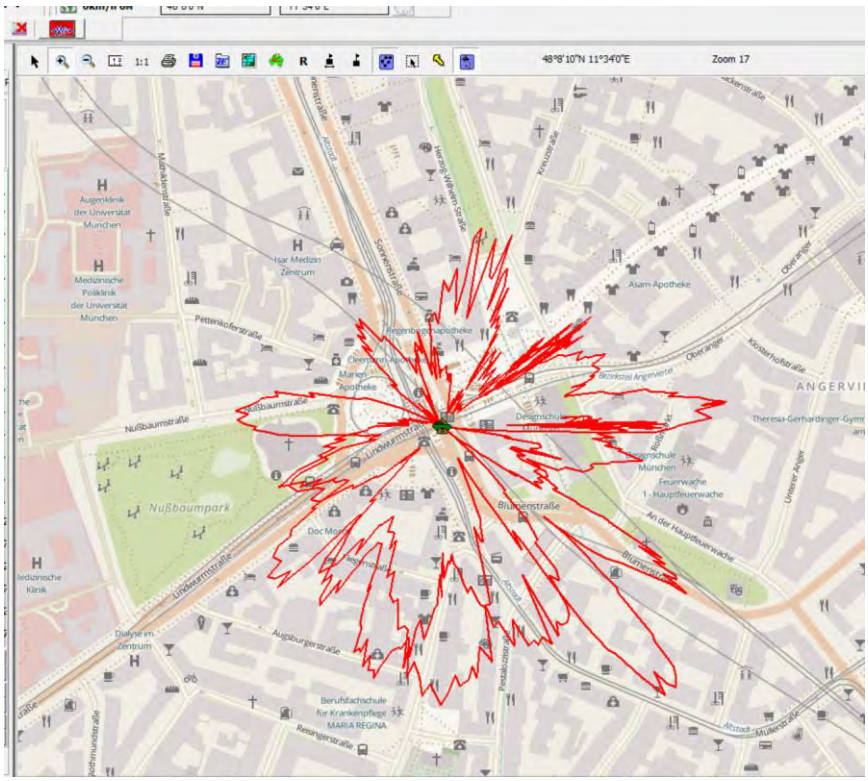
- If in RadioInspectorRT "Data from instrument" is selected to obtain azimuth data 

, then azimuth data is obtained from results of measurements using "Main instrument 1". "Main instrument 1" must have an antenna with a built-in compass and be able to transmit azimuth data along with measurement results.

If for any reason the data from the antenna compass has not been received for more than 15 seconds, the program believes that the latest compass data has lost relevance and stops using it.

Where data from the antenna compass is used.

Data from Antenna compass is used to display the level of the measured signal on an electronic map along with directional antenna position (azimuth). This data can be displayed on an electronic map in RadioInspectorRT, RadioInspectorRC programs in real time or in the RadioInspectorRP program while performing deferring analysis of saved panorama files.



More information on using the antenna compass.

Magnetic declination.

It is known that azimuth obtained from magnetic compass has a deviation from true azimuth due to the fact that magnetic poles of the Earth do not correspond to geographic poles of the Earth. To correct the magnetic azimuth, it is necessary to use magnetic declination. The magnetic declination depends on location in which the measurements are taken. Magnetic declination values slowly change. Magnetic declination values for any location of Earth can be learned from various online services. RadioInspectorRT program contains 2 most popular links. The value of magnetic declination must be entered in Magnetic declination, deg. 0.000000 field to calculate true azimuth.

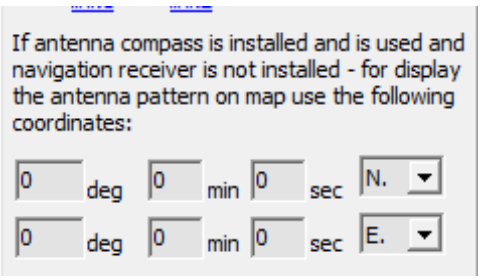
Note. If instrument receives azimuth value and performs the correction of magnetic azimuth by itself, then the value in Magnetic declination, deg. 0.000000 field is not used.

Fixed coordinates.

Sometimes we are asked to measure antenna pattern. To do this task, we need to use a sinusoidal signal generator that emits a signal, and the operator rotates the antenna 360 degrees in the azimuth plane and measures signal level. For this procedure, the coordinates of the measurement point are not needed.

In this case, perform the following actions in RadioInspectorRT:

- Select "Unused" in Navigation Receiver drop box. Navigation receiver Unused



- On the "Antenna compass" tab, fill in fixed coordinates fields.

After this, if the following conditions are met:
- The first device on the list is a "locally controlled instrument"
- The navigation receiver is not used,
- Antenna compass is used,
- Azimuth measurements results are relevant,

Then fixed coordinates determined by the user are used as current coordinates of measurement point.

To use or not to use antenna compass data.

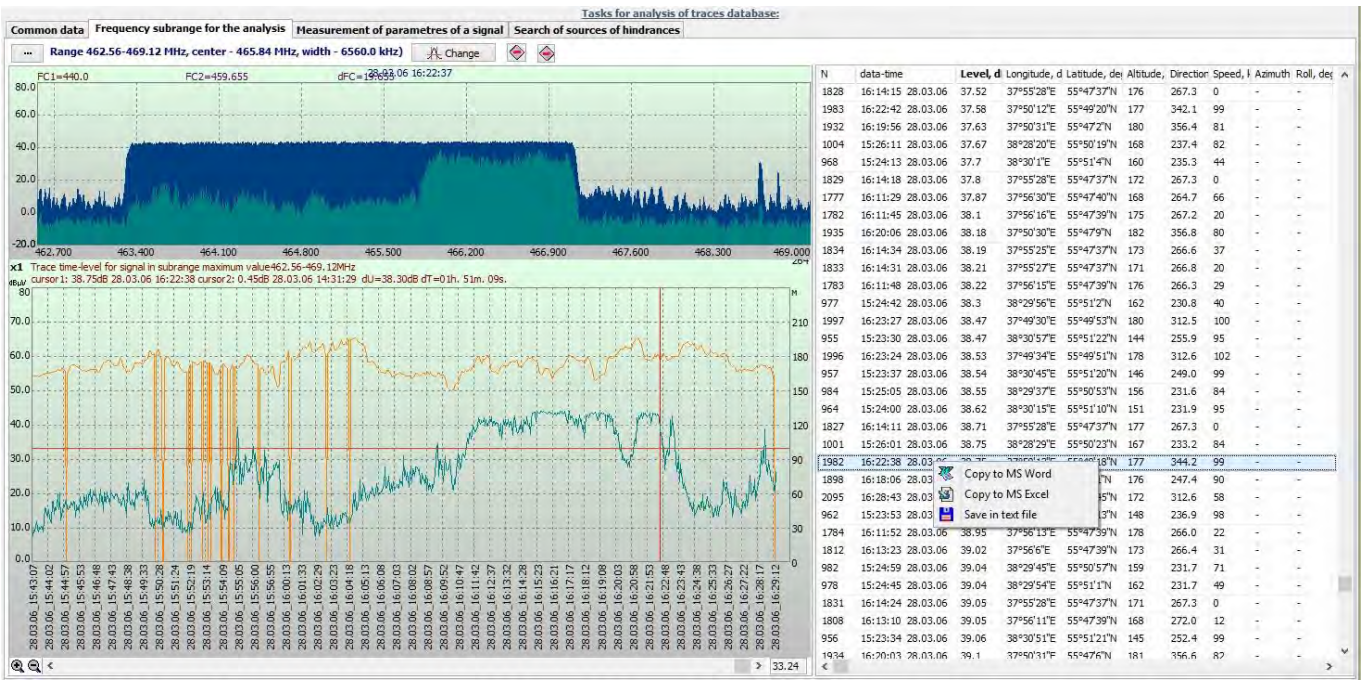
It is not advisable to always use the antenna compass to display measurement directions, but only at stationary points, that the operator chose to search for transmission source direction. Otherwise, a large number of chaotically drawn lines corresponding to all measurement points will be displayed on the map.
In order to enable or disable display of measurement direction data (in fact this means to save or not to save antenna compass data in the *. Pan file) this  button is used.
Pressed button looks like  and means that the current azimuth data will be saved in the *. Pan file and displayed on the map.
Released button looks like  and means that the current azimuth data WILL NOT be stored in the *. Pan file and displayed on the map.

Export of point of measurement coordinates and antenna compass data.

Export of point of measurement coordinates and antenna compass data is available in RadioInspectorRP on the "General data" page or the "Sampling frequency for analysis" page. You can export data to MS Word, MS Excel, or a text file.

Note 1. If there is a large amount of data, it is not recommended to export to Microsoft® Word or Excel. RadioInspectorRP might stop responding.

Note 2. After exporting data to Microsoft® Excel, the cell format will have to be changed from "General" to "Numeric".



2017.09.11

Actions with signals exceeding the amplitude threshold.

<u>Briefly.</u>
Two new actions have been added to the list of actions with detected signals (signals that exceed the amplitude threshold):
- To record and to save file as IQ;
- Store spectrums before and after detection with the specified number of scans, within specified frequency band.

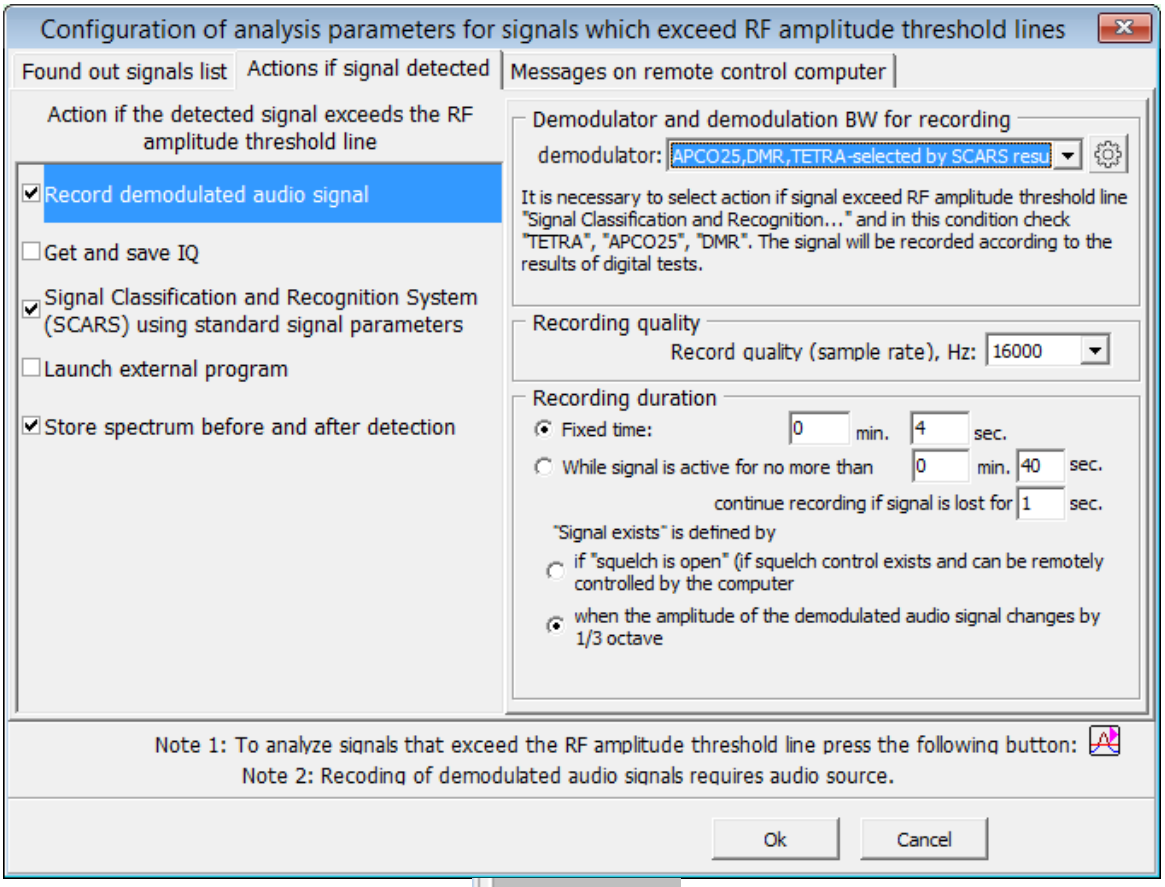
<u>In detail.</u>

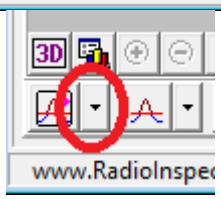
In RadioInspectorRC and RadioInspectorRT programs you can set the amplitude threshold for the new signal detection. Signals exceeding the threshold line fall into the list of detected signals. But detection of the new signals is not the ultimate goal of the radio control operations. You may want to analyze the detected signals for further investigation.

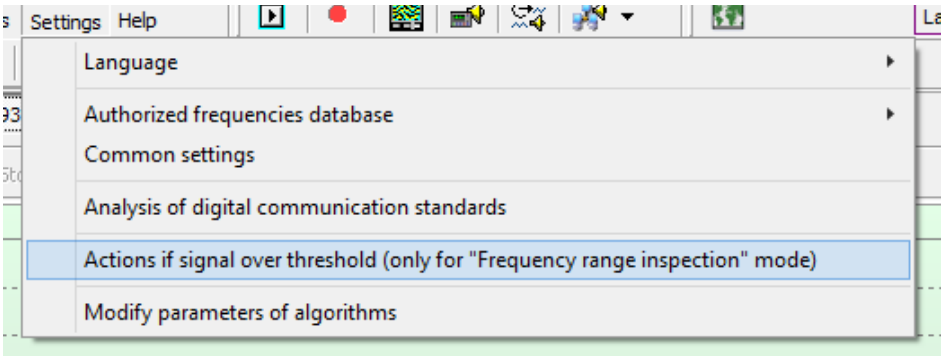
In RadioInspectorRC and RadioInspectorRT you can set the following actions for the signals that exceed the amplitude threshold line in order to analyse them further (actions are performed immediately at the frequency of the detected signal):

1. Record demodulated audio signal;
2. Get and save IQ of the detected signal;
3. Execute Signal Classification and Recognition System (SCARS) using standard signal parameters;
4. Run an external program and pass brief data about the detected signal in the parameter string;
5. Store spectrums before and after detection. Save panorama spectrum of the detected signal into the file before and after detection (with specified frequencies band and number of scans).

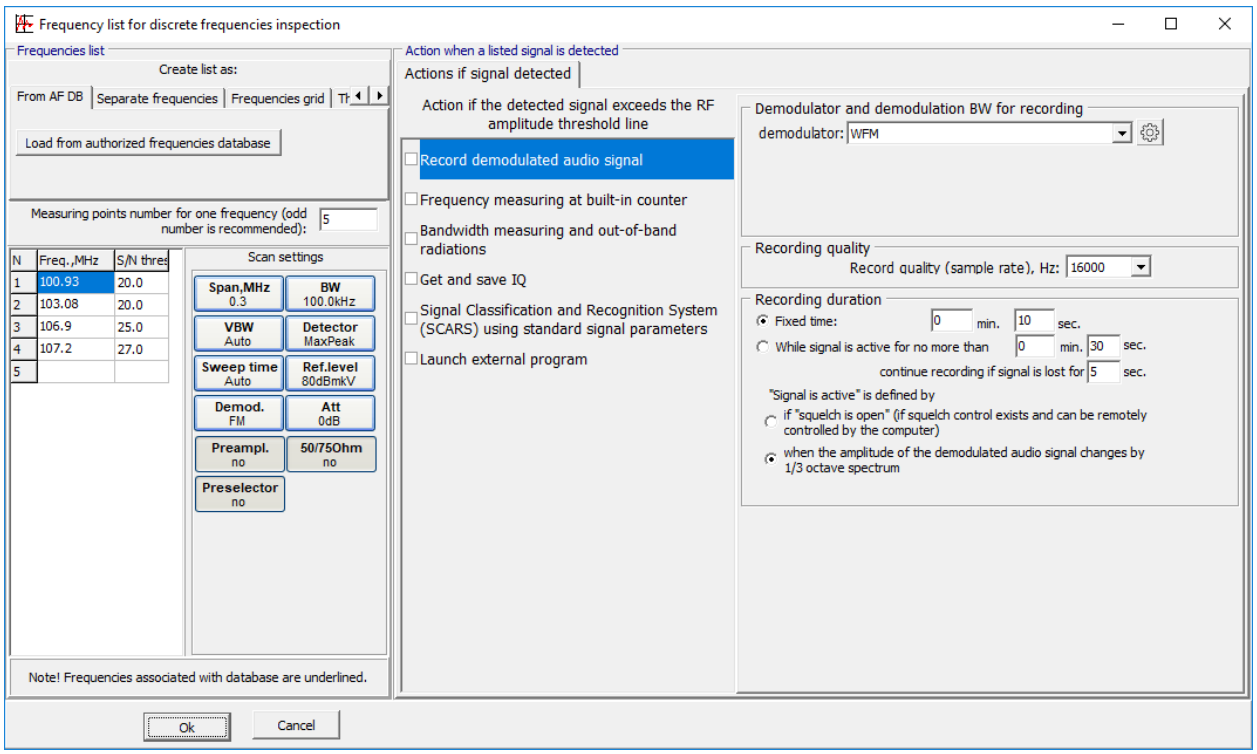
In RadioInspectorRC and RadioInspectorRT in "Frequency range inspection" mode actions for the signals exceeding threshold line can be configured in the window below:



This window appears when you click on  button or when you select the menu item Settings -> Actions if signal over threshold (only for “Frequency range inspection” mode)



RadioInspectorRC program has different actions on signals exceeding the threshold in the "Fixed frequencies inspection" mode from the "Frequency range inspection" mode:



List of actions on the detected signals was increased by following operations:

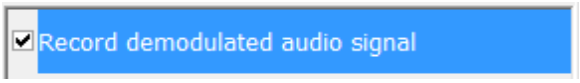
1. Signal frequency measurement by the built-in counter;
2. Signal bandwidth measurement and out-of-band radiation.

These two operations are used by civilian radio frequency services to monitor radiation parameters by legal transmitters. To use these operations you need to have "Advanced DB" and "MeasDB" options. The database of known signals must contain data on controlled transmitters. The frequencies in the controlled frequencies list must be loaded from the database of known signals.

Example of use: You can configure specific schedule to run a task to control legal transmitters. The program automatically performs signal parameters measurements and stores these measurements in the measurement results database, linking records of known transmitters and measurement results.

More about actions on signals that have exceeded the threshold.

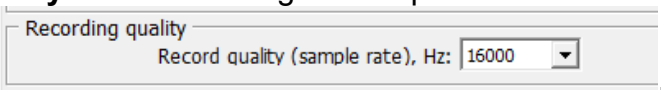
1. Record demodulated audio signal.



To record demodulated audio signal you need to select an audio device – source of demodulated audio signal.

Audio recording parameters:

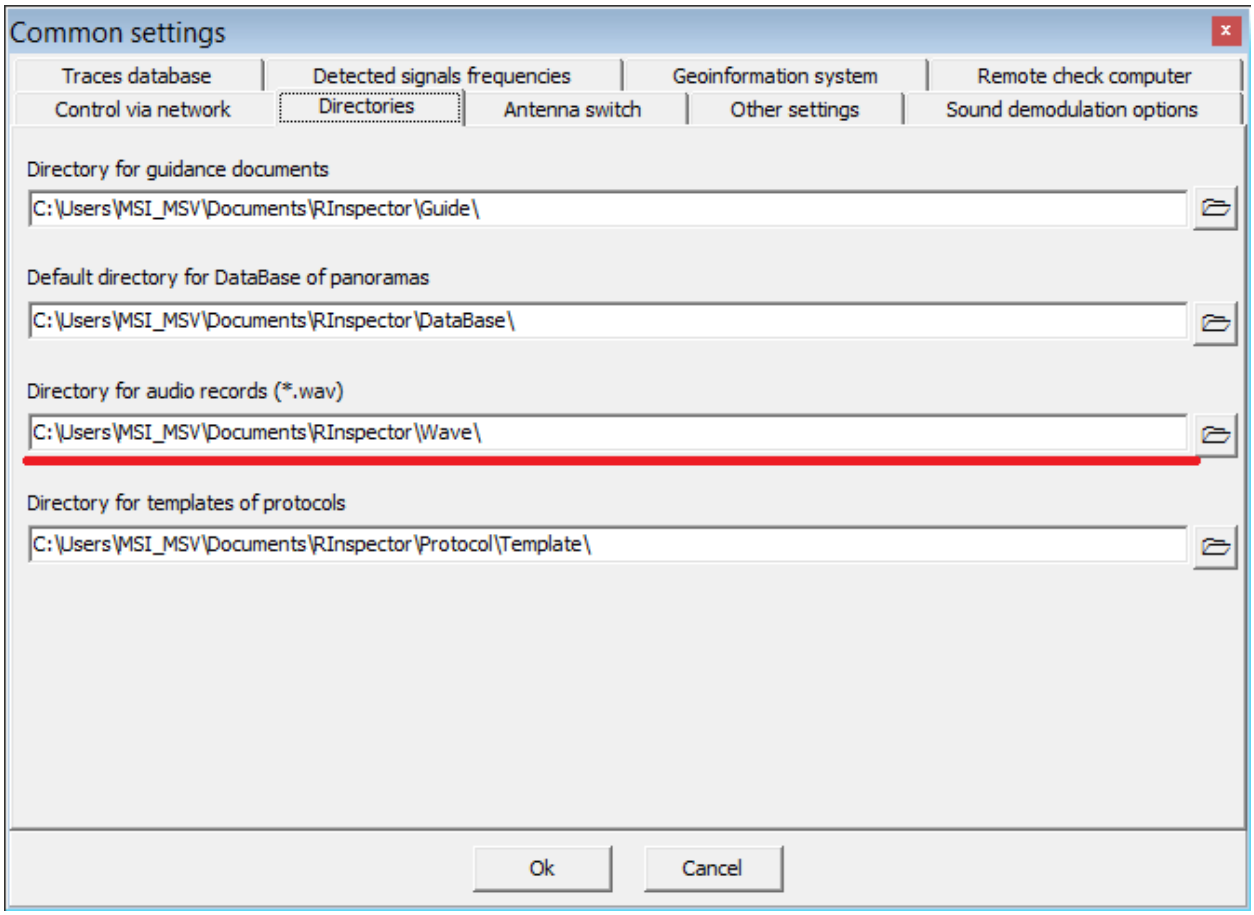
File format: Standard WAV file without compression, mono.

Recording quality: You can configure sample rate in Hz. Available sample rate options are: 8, 16, 32, 48 kHz 

. Available sample rate options are: 8, 16, 32, 48 kHz

File name: is assigned automatically from date, tame and frequency values. This rule is applied to audio files which are recorded manually by pressing button. “a_” characters will be added to the audio file name if audio files are created automatically for the signals exceeding threshold line.

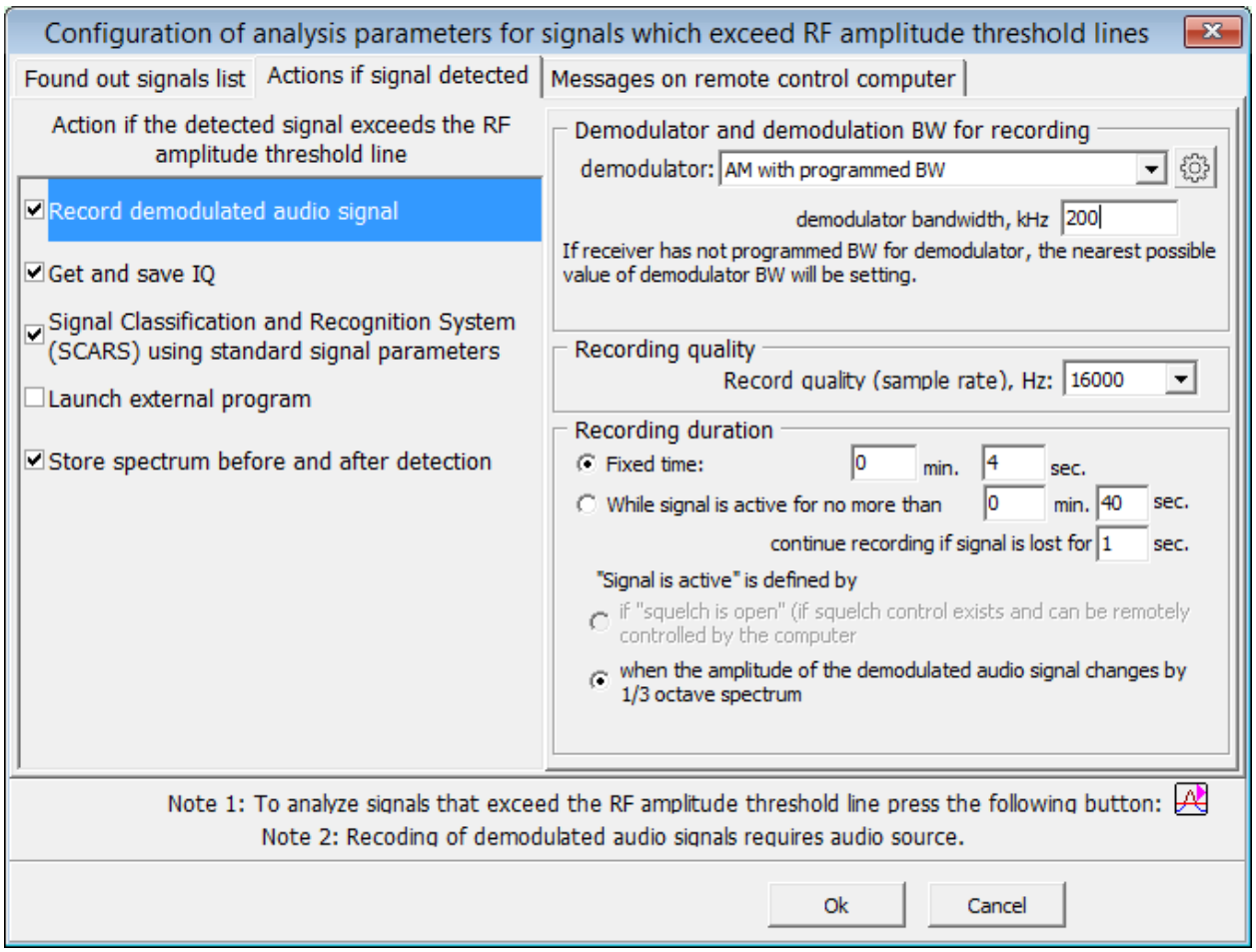
Folder where audio files are saved on your computer: Audio files are stored in the folder configured in common settings -> Directories tab.



If the directory does not exist or not defied, audio files will be saved in “\WAVE\” subfolder in “Documents\RInspector” folder by default. This path can be defined in DefFoldersPath.txt file. There are some differences in "Fixed frequencies inspection" mode. in this mode, If controlled frequency is loaded from legal frequency signals database (extended database, “AdvancedDB” option), then audio files will be saved in “\WAVE\” subfolder in the folder where database files are saved. “\WAVE\” subfolder will be created automatically.

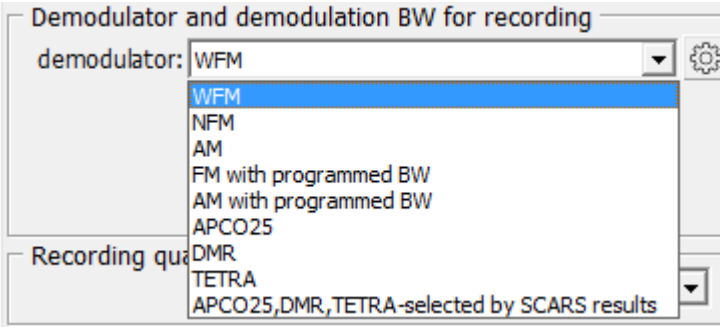
Recording parameters for demodulated audio signal.

Recording parameters can be specified when Record demodulated audio signal is selected in Configuration of analysis parameters for signals which exceed RF amplitude threshold lines.

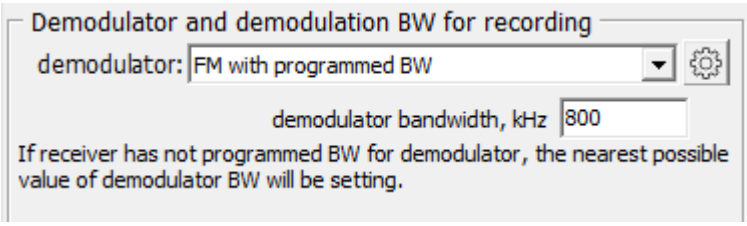


Audio recording demodulation and demodulation bandwidth

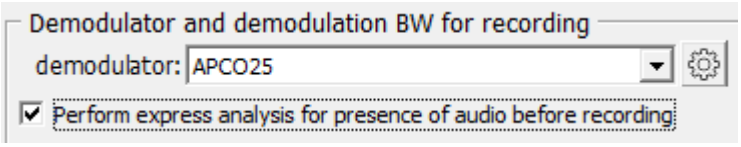
Audio demodulation options:



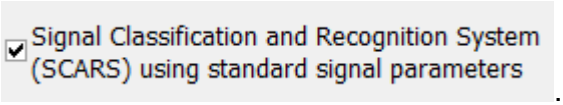
WFM, NFM and AM are standard demodulators widely used in communication receivers. **AM and FM with programmed bandwidth** are demodulators for the receivers capable selecting different bandwidth for AM and FM demodulators. Demodulator bandwidth field appears when you select one of those demodulators:



APCO25, DMR, TETRA are demodulators of the corresponding digital standards. At the time of writing, RadioInspector is using software demodulation from analysing IQ stream received from the instrument. The instrument must be able to transmit an IQ stream to the computer.
In order not to waste time on recording a signal that is not a signal of the selected standard, you can set a condition – Perform an express test for the presence of audio before recording. The program will analyse first parts of received data by the demodulator for audio recording, and if the selected digital standard is not detected in the data, recording of the demodulated audio signal will stop.

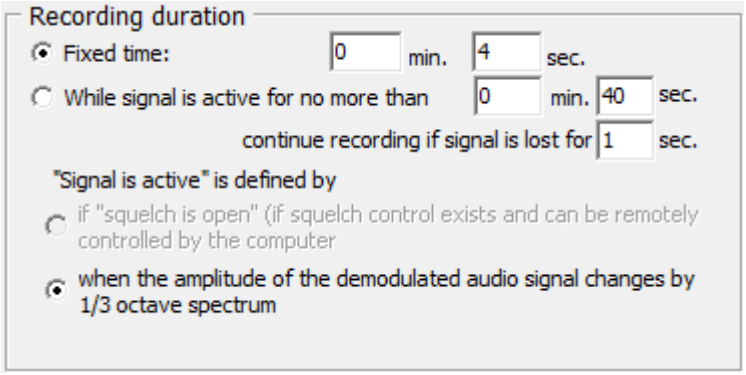


APCO25, DMR, TETRA – automatic selection after SCARS analysis. When this condition is selected, the program analyses the signal for APCO25, DMR, TETRA digital standards first and if one of these standards is confirmed, the demodulated audio signal will be recorded for the detected communication standard.
To select these demodulators, you need to enable Signal Classification and Recognition System (SCARS):



Audio Recording duration

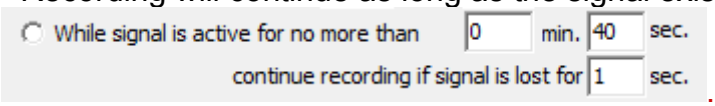
Audio Recording duration is defined in this window:



Possible task option for audio recording duration:

- Recording for a fixed time;

- Recording will continue as long as the signal exists, but no more than the specified time.



Case scenario for this option:

A signal can exist for a long time or permanently. In this case, you can configure maximum recording
time for no more than 0 min. 40 sec. ;
A signal often disappears briefly (for example half-duplex communication channels, short-term noise or signal pausing). This should not be the reason to cancel the recording. This field continue recording if signal is lost for 1 sec. specifies the time during which the audio recording will continuerecording even if the signal is lost.

Parameters of signal detection:

How to know that a signal exists (is active) in the process of recording audio.
In modern receivers there is a "Squelch" control, you can set the threshold level of signal availability. If such a setting exists in the receiver and is available for remote control, the field if "squelch is open" (if squelch control exists and can be remotely controlled by the computer) becomes available and you can select this condition.

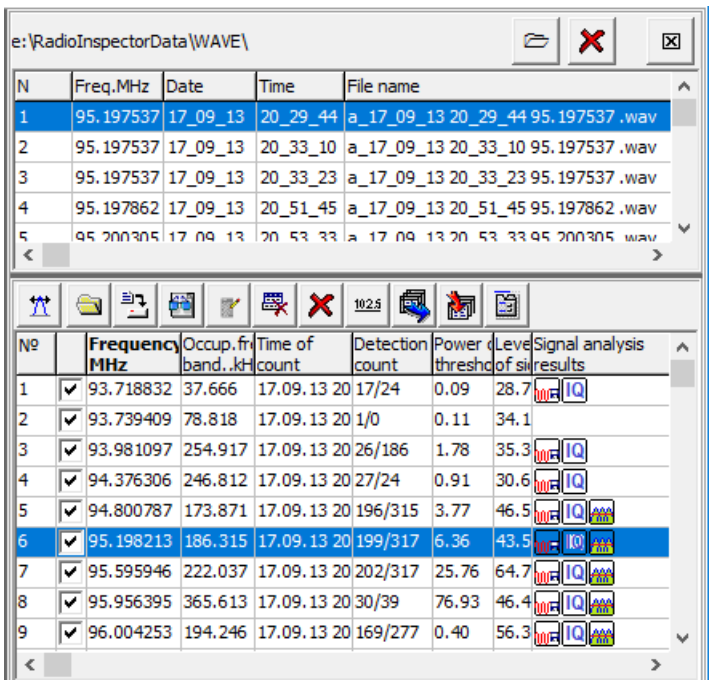
Another method is that the program constantly analyses the 1/3 octave spectrum of the demodulated audio signal. In the absence of significant changes in spectrum energy, program concludes that there is no signal (noise, unlike speech and music, should have constant spectrum energy).
when the amplitude of the demodulated audio signal changes by 1/3 octave spectrum

This method does not always work reliably and strongly. It depends on the quality of the demodulated audio signal (different receivers may have different outcomes).

If you are using digital communication standard demodulators (e.g. APCO25, DMR, TETRA) when there is no signal, there is no noise at the output of the demodulator (only the demodulated audio signal is recorded). Pauses between conversations are not filled with noise. Therefore, it is very difficult to estimate the time of conversations. In playback and analysis mode for demodulated digital signal audio files, a time grid is displayed, allowing you to identify the beginning and end of communication sessions. For automatic recording of phonograms of such signals, it is recommended to use the recording mode, while the signal exists, and select the condition if "squelch is open" (if squelch control exists and can be remotely controlled by the computer).

Where are the results of recorded audio files displayed?

The results of recorded audio files are displayed in the list of detected signals, in the last column (icon).

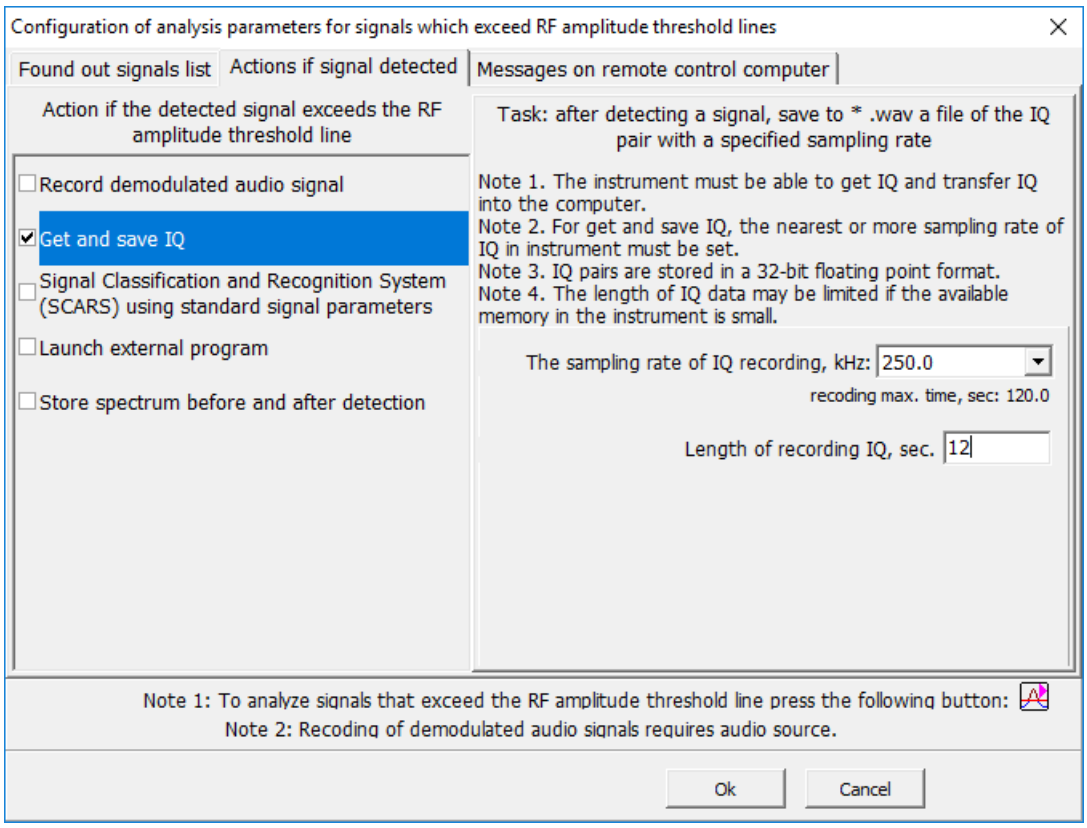


When you click on the stored audio recordings icon (), above the list of detected signals, a table with audio files names opens. Double clicking on audio file name, the audio editor window opens where you can listen and edit the selected audio file.

2. Get and save IQ

Receiver requirements:
To receive and record an IQ, the device must be able to stream or buffer IQ data from its internal memory to the computer. The IQ record length may be limited by device capabilities or computer resources.

Please note that recorded IQ frequency may differ from the true signal frequency. RadioInspector's IQ_Process program may be used for analysis and for frequency correction (digital frequency shift). Get and save IQ options will appear when this feature is activated («Get and save IQ» mode):

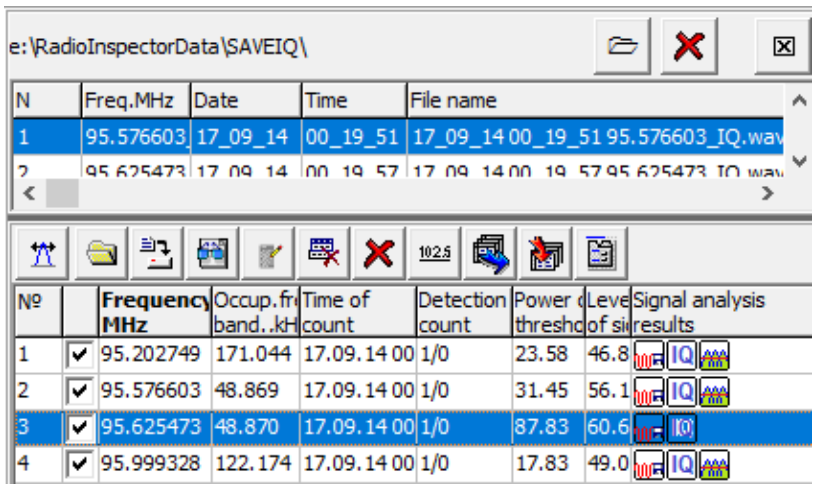


The operator must configure the IQ sampling rate and IQ recording time. The sample rate can be selected from the list. Values are determined by your first connected device. For correct IQ analysis, the sampling rate must be more than 1.25 times of the signal frequency bandwidth. IQ is saved to a standard WAV file in a floating point number format. The program translates absolute values of IQ to the value of "Volt" if it's possible.

Folder location of saved IQ data files on your computer:
WAV files are saved in "\SaveIQ\" subfolder. If this folder does not exist or not defied, audio files will be saved in "\SaveIQ\" subfolder in the "Documents\RInspector" folder by default. This path can be defined in DefFoldersPath.txt file.

File name:
The file name is generated automatically from the date, time, and frequency values.

Where are the results of saved IQ data displayed?
The results of saved IQ data files are displayed in the list of detected signals, in the last column (icon IQ).

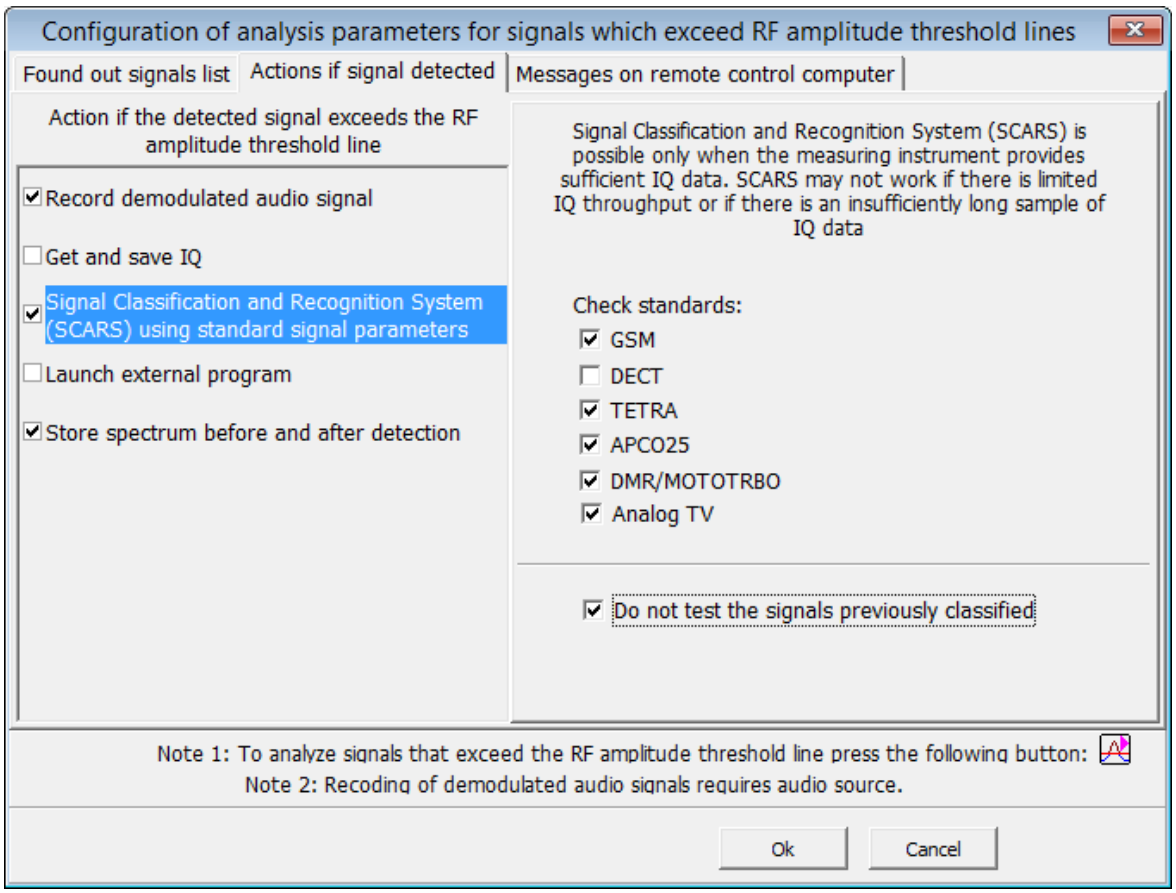


When you click on the stored IQ data icon (IQ), above the list of detected signals, a table with IQ file names opens. Double clicking on IQ file name, IQ_Process program will start.)

3. Signal Classification and Recognition

At present, RadioInspectorRC and RadioInspectorRT has the ability to automatically test radiation of the detected signal to identify following digital data communication standards:
- GSM
- DECT
- TETRA
- APCO25
- DMR/MOTOTRBO
- Analog TV signal PAL / SECAM / NTSC (displays video);
- APCO25 (voice demodulation);
- DRM/MOTOTRBO (voice demodulation);
- IEEE 802.15.4 family standards (ZigBee, ISA100.11a, WirelessHART, MiWi and other protocols)

Signal Classification And Recognition System (SCARS) parameters can be specified when SCARS is selected in Configuration of analysis parameters for signals which exceed RF amplitude threshold lines.



Operation algorithm:
Testing involves obtaining IQ data from the device with specific sampling rate, length and software signal demodulation of the IQ data. If digital headers demodulation of the ID data packets for one of the standards was completed successfully (checksums are matched), then RadioInspector software decides that this signal belongs to a specific digital communication standard.

RadioInspector software requirements:
DTest option is required.

Instrument requirements:
In order to receive and record IQ data stream, the instrument must be able to transmit IQ data to the computer with specified length and sampling rate.

Restrictions:

1. Some devices have a limited capacity of internal memory for IQ data recording and therefore cannot demodulate some communication standards that require a large amount of IQ data.

2. Some instruments have a limited upper frequency IQ sampling, so they can't demodulate some digital communication standards.

3. To demodulate each standard, a recording of IQ data with specific length (duration) and sampling rate is required. The length (time duration) of the IQ data recordings is determined by the period of time of data packets sequence, according to which it is possible to identify specific digital communication standard. The sampling rate depends on the occupied signal frequency bandwidth. It is described in technical documents for digital communication standard. For

example, in order to reliably demodulate DECT standard, it is necessary to record IQ data with a sampling rate of at least 2000 kHz and a 36 minimum recording duration of 200 ms. Amount of memory for IQ data for DECT demodulation should be 0.2 sec * 2000 kHz = 400 kWords of IQ. To demodulate TETRA standard, the sampling rate must be at least 36 kHz and a duration at least 1.1 second. Amount of memory for IQ data should be just 39.6 kWords of IQ.

4. If the user has selected several digital standards for the analysis, then in order to speed up the time of digital signal analysis, the program receives IQ data once from the instrument with the maximum sampling rate and maximum duration of all selected standards. Next, the program performs IQ filtering and decimation for the requirements of each selected demodulator.

This algorithm brings a huge improvements in the analysis speed. However, if the amount of internal memory for recording IQ data with a maximum sampling rate and maximum duration is not enough, then some demodulators will not work. In this case, it is recommended to exclude some of the most broadband standards (primarily DECT) from the automatic analysis.

If the program for demodulation does not have enough sampling rate or IQ recording duration, the program will display the message about this issue.

It is often asked by our clients: Why broadband signals are not enabled for automatic signal identification – BlueTooth, UMTS, 802.15.4 (ZigBee etc.)?

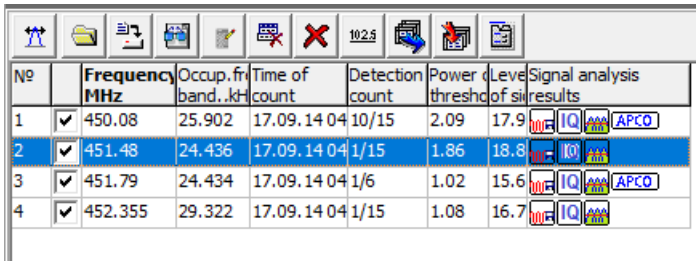
Answer:

1. These digital standards operate at a fixed frequency range, and searching for BlueTooth signal at 100 MHz frequency is unreasonable. It is more logical to assume that the illegal transmitter works under cover of other legal BlueTooth signals in the frequency range intended for BlueTooth digital standard. BlueTooth signal at the other frequencies than specified by BlueTooth standard will be easily detected by spectral analysis.

2. To demodulate any signal, it is necessary to tune precisely to its Central frequency (at least +10% of its centre). In case of automatic detection of broadband signals, it is very difficult to implement this detection, since broadband signals have a low amplitude and their spectrum is severely cut.

3. To identify broadband signals manually, set the cursor to the middle of the signal and press the button .

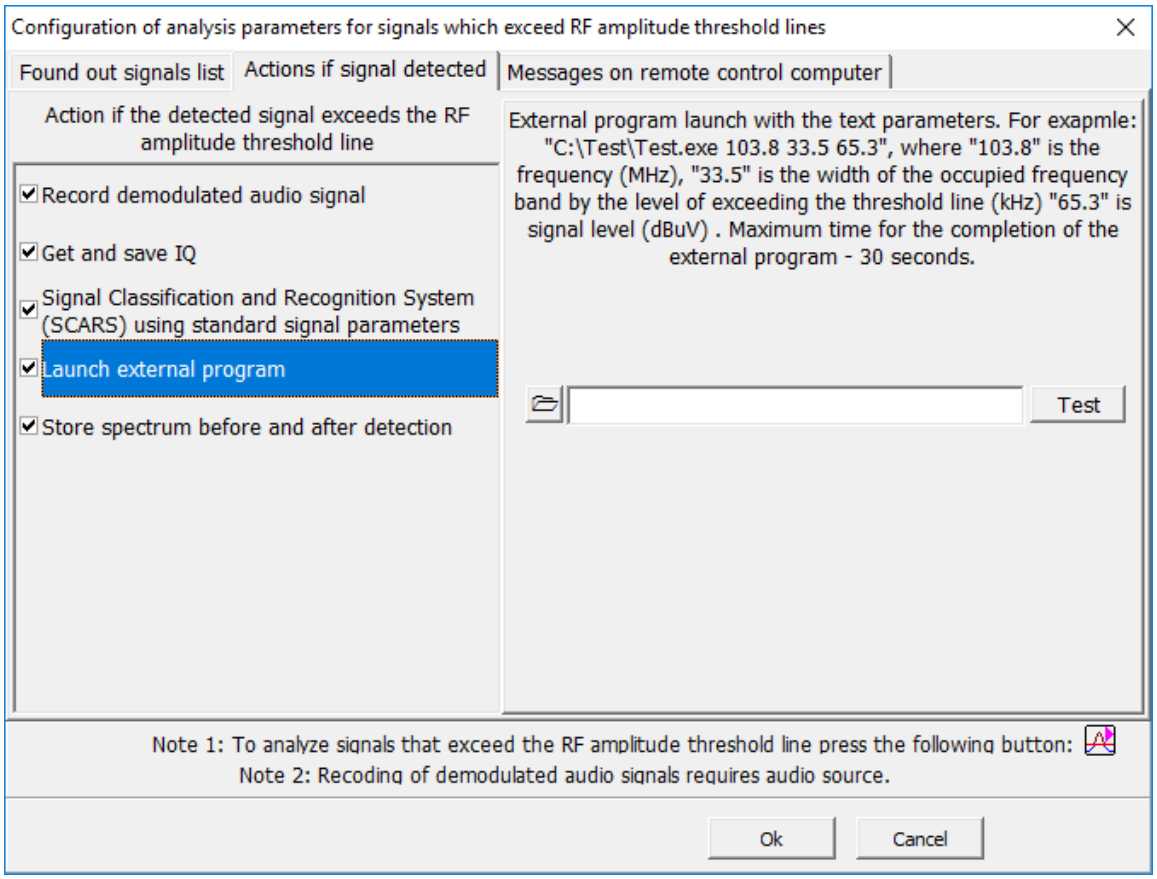
Where the results of Signal Classification and Recognition System are displayed?
The results of Signal Classification and Recognition System are displayed in the list of detected signals, in the last column (icon APCO or other icons, depending on detected digital standard).



4. Launching external program

In some cases, operators are required to execute some unique tasks after signal detection.

For this case we implemented “Launch external program” feature. You can specify any action by configuring third- party program when signal exceeds the threshold line. By selecting “Launch external program” you need to locate configuring third-party program. When this program is started, some information about the breached signal will be sent to the program in the parameter line. The maximum program execution time-out is 30 seconds. After the external program has finished running, or after 30 seconds, RadioinspectorRT(RC) program will continue to run.



5. Storing signal panorama a specified number of times before and after detection in a given frequency band.

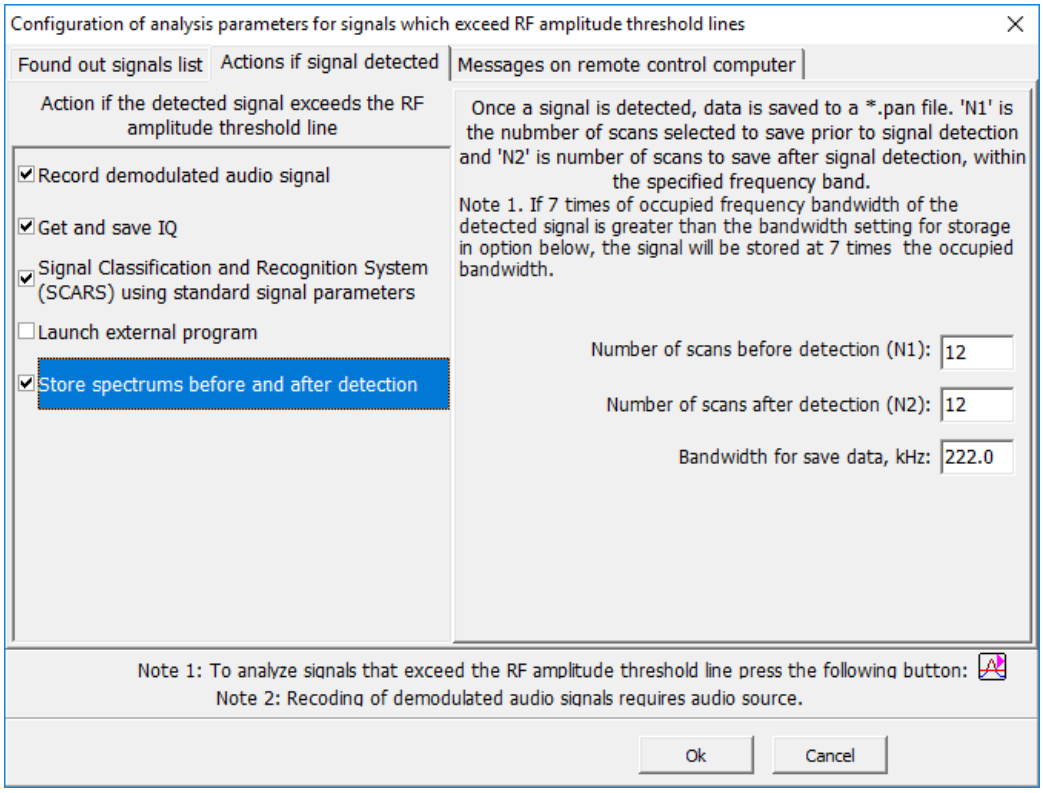
The task of storing signal panorama a specified number of times before and after signal detection in a predefined frequency range in a *.pan file is performed when it is impractical to store the entire panorama file (large *.pan file) for further analysis. However, if you need to keep the history of the signal occurrence for a certain number of scans before its appearance (exceeding the threshold level) and save a certain number of scans after its detection.

Operation algorithm:

“Large *.pan” file is the panoramas file of the entire frequency range.
“Small *.pan” file is the panoramas file, which will be formed when a signal is detected. “Small *.pan” file is limited to the frequency range set by user and number of scans before and after detection.
After signal is detected, RadioInspector starts saving data to a new file from two parts. First part is panorama data is saved, before signal detection from “Large *.pan” file. Second part is at the end of next scan, program appends a part of the last scan panorama data to this file, which

corresponds to the frequency range. The complete files (number of scans after detection corresponds to the specified number) are closed and available for use.

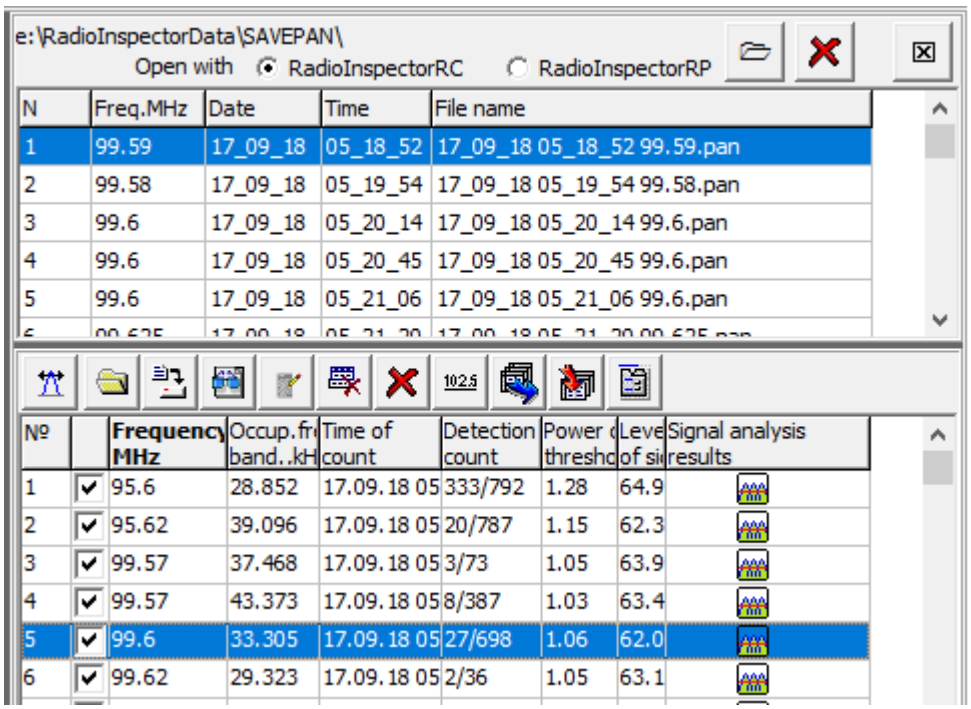
Recording conditions of the signal panorama as a separate file are set on the page that appears when you select the "Store spectrums before and after detection" feature:



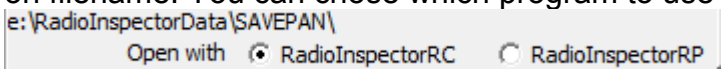
Folder where “Small *.pan” files are saved on your computer:
“Small *.pan” files are saved in “\SavePan\” subfolder. If this folder does not exist or not defied, “Small *.pan” files will be saved in “\SavePan\” subfolder in “Documents\RInspector” folder by default. This path can be defined in DefFoldersPath.txt file.

File name:
The file name is generated automatically from the date, time, and frequency values.

Where are the results of “Small *.pan” files displayed?
The results of saved “Small *.pan” files are displayed in the list of detected signals, in the last column. While the file is not generated, but the recording is already initiated, an icon is displayed . As soon as the “Small *.pan” file is generated, icon is displayed .
When you click on icon, above the list of detected signals, a table with associated with selected frequency “Small *.pan” file names opens. When icon is displayed, “Small *.pan” files are not created at this stage, therefore cannot be displayed in a table above the list of detected signals.



These files can be opened with RadioInspectorRP or RadioInspectorRT(RC) by double clicking on filename. You can chose which program to use to open saved files:



Limitations:

1. Let's denote the bandwidth of the detected signal, which is determined from the points of intersection with threshold line as W1. W2 denotes the bandwidth for saving "Small *.pan" files specified by the user. If W2 < W1 * 7, the new W2 value will be W2 = W1 * 7. That is (for better signal analysis) - 3 frequency bands of the detected signal to the left of the signal, and 3 frequency bands of the detected signal to the right of the signal.

2. If the value of W2 is too large and exceeds the frequency range of the entire scanning frequency range ("Large *.pan" files), the W2 decreases symmetrically, to the right of the signal and to the left of the signal, so that signal frequency is in the centre of the panorama, and W2 does not go beyond "Large *.pan" file.

3. As shown in the figure above, N1 and N2 are numbers of the scans before and after signal detection stored in a " Small *.pan" file. If in the "Large *.pan" file there are not enough scans (less than specified number N1, for example, for the first time recording to the panoramas file) at the time of signal detection, then in "Small *.pan" file gets fewer scans (as many as available).

4. If frequency range scanning is stopped, all "Small *.pan" files are formed with the number of scans after detection, depending on how many of them are performed before scanning has stopped, even if they are less than specified N2 number by user. The same actions are performed if "Large *.pan" file has reached file size limit and a new file is generated instead.
5. If "Small *.pan" file is already being recorded for the detected signal (i.e. at previous scan recording of the "Small *.pan" file was initiated), then no additional action is performed (file is already being saved).

6. Special features of working with audio files, IQ and "small panorama files".

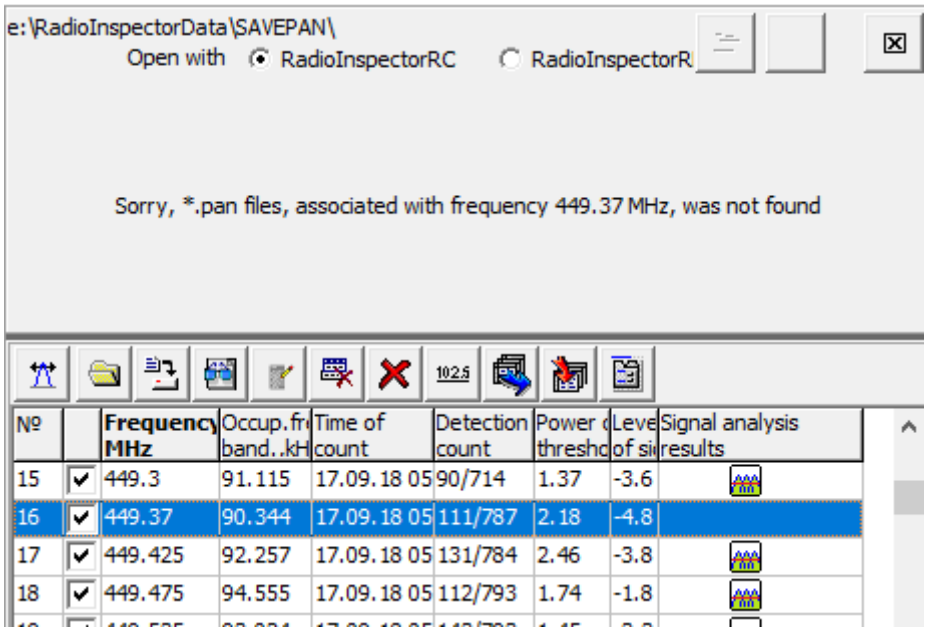
As a result of actions on detected signals exceeding threshold line such as an audio files, IQ recorded data files and "small panorama files", a large number of these files can be created. It may impact computer performance and they can overload file system on the computer. On the other hand, these files should be relevant to the signals in the detected frequencies list.

How these files are associated with frequencies in the list of detected signals.

When you click on , IQ and icons, the searching of corresponding files for signal test result is performed and results are displayed above the list of detected signals. Files are selected according to criterion: frequency of writing to file must fall within range Fc+0.5*BW, where Fc is the frequency of the signal in the list of detected signals, BW is the occupied signal bandwidth in the list of detected signals.

Features working with files – results of automatic testing of signals.

1. It may happen that icons , IQ and exist, but file associated with detected signal does not exist. In this case, after clicking on the icons , IQ and a message displays about the absence of file for a given frequency. Corresponding icon in the list of detected signals will disappear after that.



2. For various reasons, the list of detected signals may contain signals that are close in frequency to the signal, as a result of testing of which the mentioned above files are created. It is logical that the corresponding icons should appear on all lines in the list of detected signals for which file association condition is applied.

3. If you delete individual records from the list of detected signals, files of audio recordings, IQ files and "Small *.pan" files associated with these records will not be deleted. Folders can contain a large number of files that are not associated with list of detected signals. These files are not available for automated analysis and overload the computer's file system.

To solve the above problems in RadioInspectorRT(RC) there is a process of file analysis for audio recordings, IQ files and "Small *.pan" files and checking whether they match the list of detected signals. This procedure deletes files that have no records in the list of detected signals, and adds and icons to the records in list of detected signals for which such files exist. This procedure runs in the background whenever the list of detected signals appears or disappears on the screen. Also, this procedure runs when all entries in the list of detected signals are deleted.

2018.02.08

What is DTest and how to use it.

Briefly.
DTest option is designed for operators who wants to get more information about a signal, not just a shape of it's spectrum. To do this, operator should set 1st cursor to the centre of the signal and press special button. Program will think for a moment and come up with an answer that selected signal belongs to DMR digital standard (or APCO25, TETRA, etc.) Also, RadioInspector will provide with additional information about the signal, such as network address, unique transmitter identifier and other information.

In detail.
The DTest option is a set of software modules (demodulators) that analyze IQ data (we will not tell you what IQ is in this article, there is a WiKi and the Internet, it is enough to say that this is one of the forms of representing the radio signal along with the spectrum). The IQ data is received from a receiver or spectrum analyzer. The result of the analysis is the conclusion that the radiation belongs to a particular communication standard. To confirm a positive conclusion about the presence of radiation of a particular communication standard, the program displays a number of digital radiation parameters (for example, the country code, the operator code, the network address, and other parameters). If it is concluded that this is a known digital signal and the digital parameters of the signal are displayed, then this is a 100% reliable conclusion, since the checksums coincided during the demodulation process. There are also conclusions "similar" to a certain standard. This conclusion is not strict. This means that the internal content of the signal is really "similar" to the standard under study, but something goes wrong. For example, the receiver is not tuned to the center frequency of the signal and therefore the phase-locked frequency does not work well, the signal-to-noise ratio is low and the checksums do not match, or the structure of another signal really repeats the structure of a separate section of the standard under study. In any case, if there is a "similar" output, then this is only a reason to re-test the signal.

In more details.
For each demodulator, there are requirements for the sampling rate (more precisely, the bandwidth, but it is considered common practice that the bandwidth is equal to 80% of the sampling rate) and the duration of the IQ recording. These requirements are defined by the communication standard (the standard defines the periods after which service data is repeated).

For automatic testing of detected signals or manual testing of signals, the operator determines the communication standards demodulators to be used for testing the signals. Before starting digital signal testing, the program calculates the maximum sampling rate and the maximum IQ duration from all the standards selected for testing. After receiving the required IQ array from

the receiver, the program starts the process of demodulating all the communication standards set by the operator and receives a response from the demodulators.

What happens if the receiver has a limited amount of memory for recording IQ or the maximum sampling rate of IQ is limited? In this case, a number of digital standards that fall under the restrictions will not be tested (see the corresponding section below).

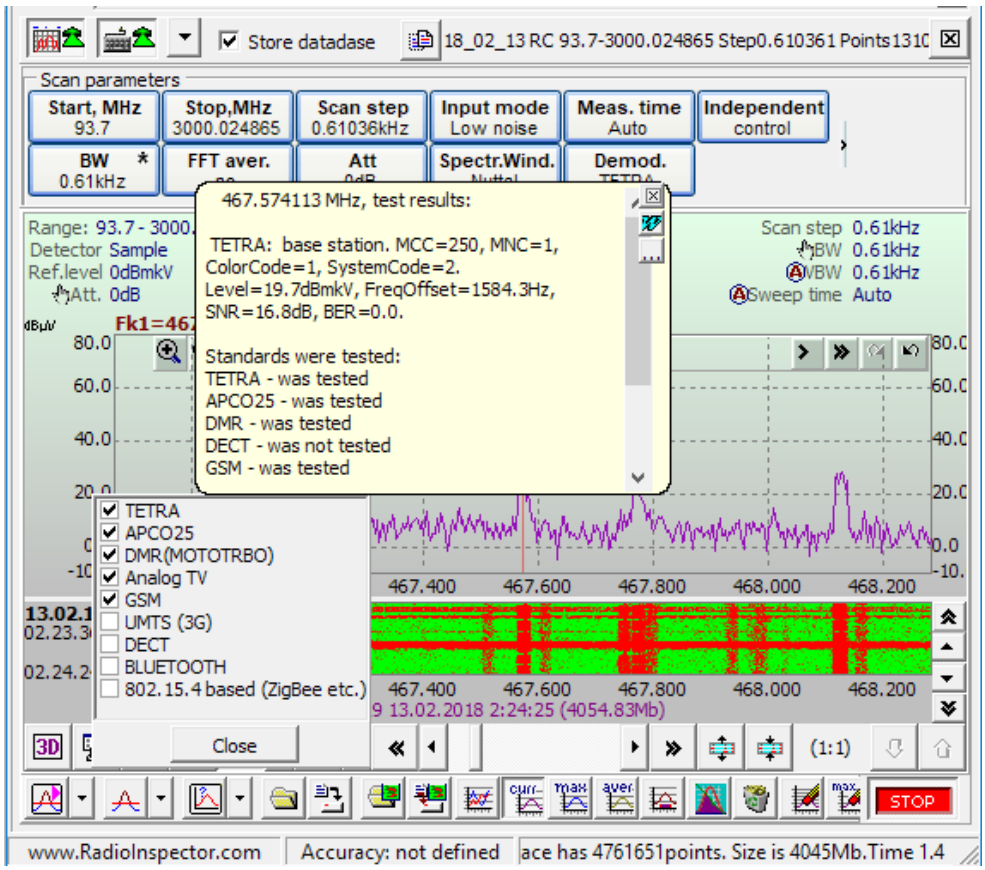
Each data transmission standard has its own software demodulator.
At the time of writing this article, the following types of demodulators are implemented in the RadioInspector software: DRM, APCO25, DMR/MOTOTRBO, TETRA, GSM (2G), Analog Television (PAL/SECAM), Bluetooth, DECT, UMTS (3G), IEEE 802.15.4 (ZigBee, WirelessHART, MiWi, ISA100.11 and others), DVB-T, DVB-T2). The list of digital demodulators that can be used for testing is constantly expanding. Unfortunately, it is not possible to create a universal demodulator of all communication standards.

Why do we make software demodulators? Almost all manufacturers of radio monitoring equipment implement digital demodulators using specialized chips or using purchased cores for FPGA. But in this case, the user will be required to work only on the manufacturer's equipment. We make a universal solution. Our demodulators will work with any receivers that allow you to get IQ.

Digital analysis (using the DTest option) of signals is possible in 4 ways:
- manually;
- automatically when a signal is detected that exceeds the threshold;
- automated, according to a known frequency set (if it exists for the communication standard);
- demodulation of the audio signal of the TETRA, APCO25 and DMR standards (only without encryption), display of video content of analog television.

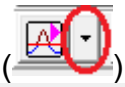
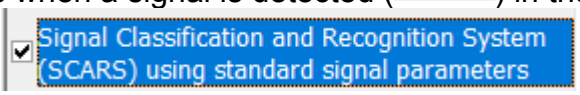
Manual signal analysis.

To perform manual signal analysis, place the 1st cursor on the center of the signal (the 1st cursor is activated when the button  is pressed) and press the button  . First, use the button  to select the digital standards that you want to use for testing.
The test will be displayed on the screen.
The test result can be copied to the clipboard (by clicking the mouse on the first character and c on the last character at the same time as pressing the Shift button) or by copying the results to Microsoft Word (button ).

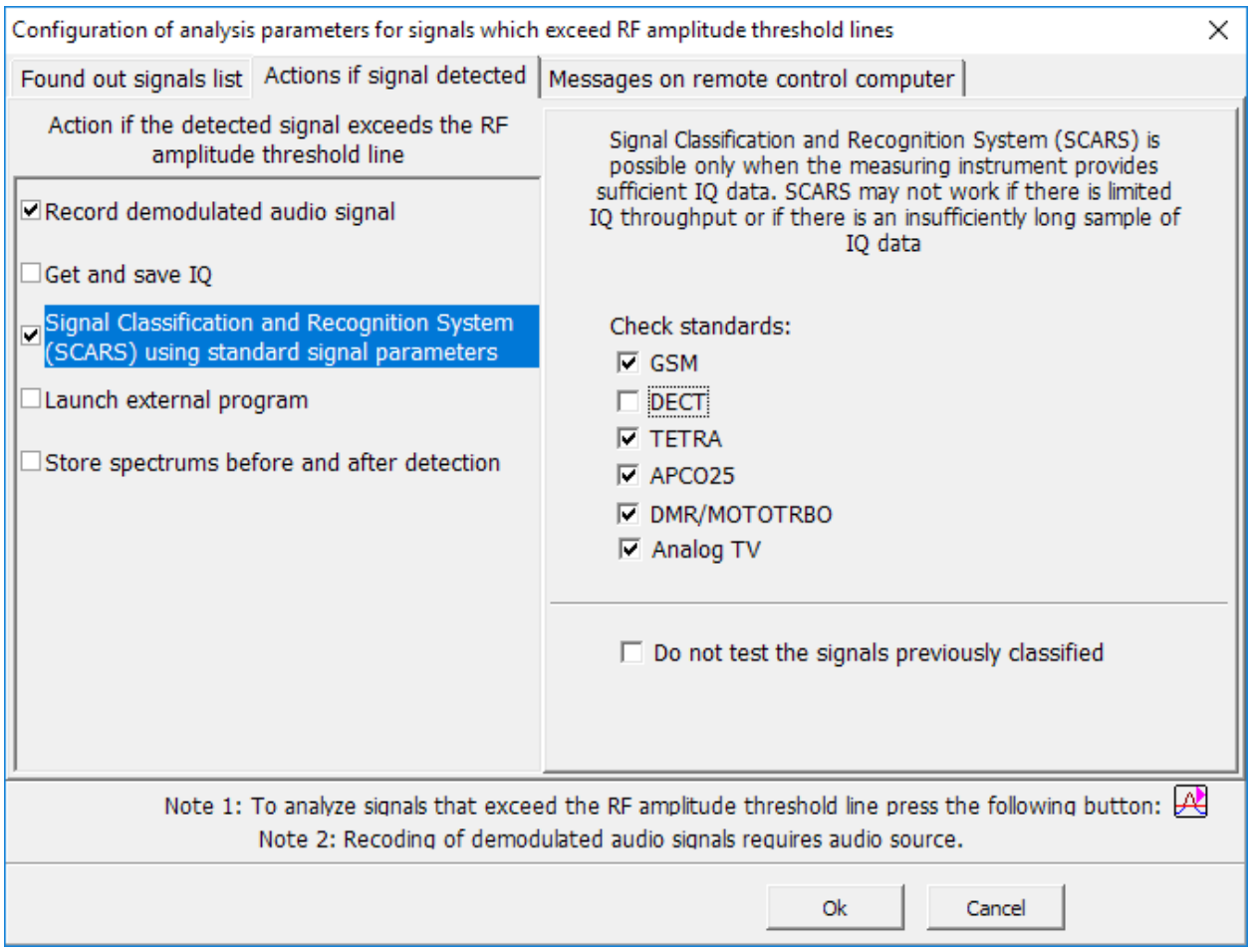


Automatic analysis when a signal is detected that exceeds the threshold.

Automatic analysis of signals that exceed the threshold is possible in the "Frequency range Monitoring" mode. To do this, you must:
- Set a threshold line (you can use a dynamic threshold instead of a threshold line);
- Set the actions to be performed when a signal is detected (button );
- Press the action activation button when a signal is detected  .

When you click on the button for setting actions when a signal is detected () in the window that opens, you need to check the box 

and select the communication standards that you want to use for testing on the right side of the window:

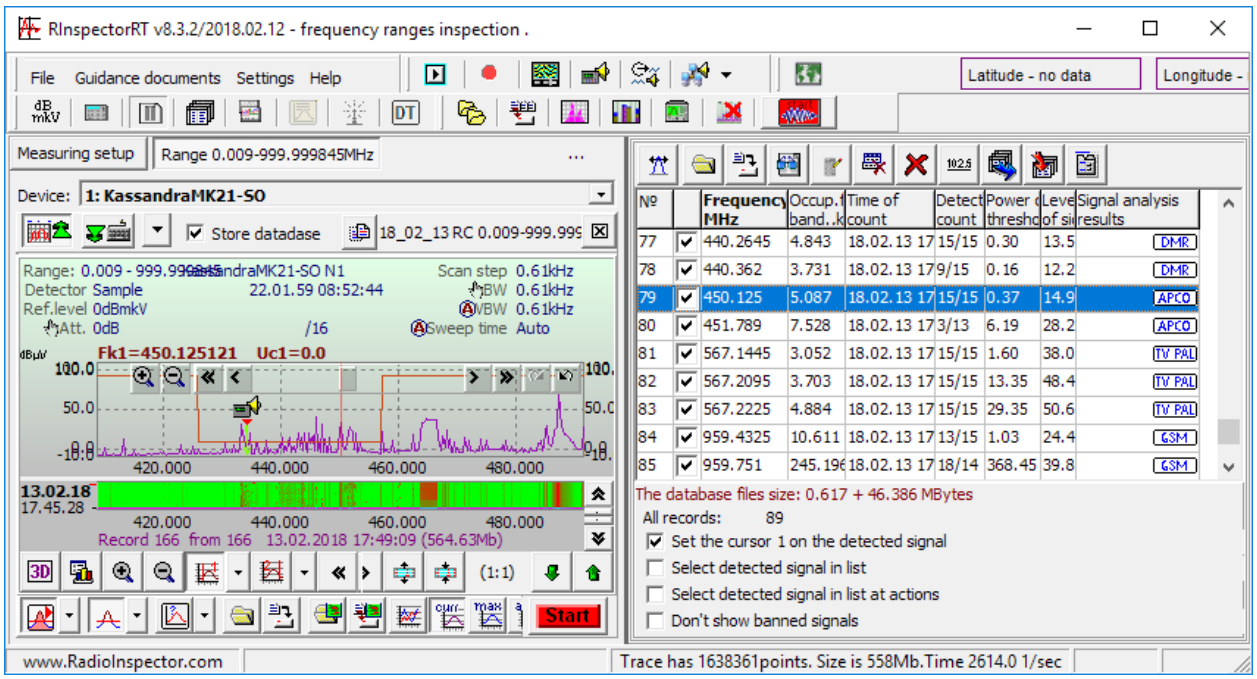


<u>Note.</u> Not all standards available for testing are included in this list. The UMTS, Bluetooth, and 802.15.4 broadband standards are not included in this list for the following reasons:

- The central frequency of broadband signals in automatic mode will be detected with a large error (these signals, as a rule, have a small amplitude, are strongly indented, and cross the threshold line several times), and this leads to incorrect operation of the corresponding demodulator;

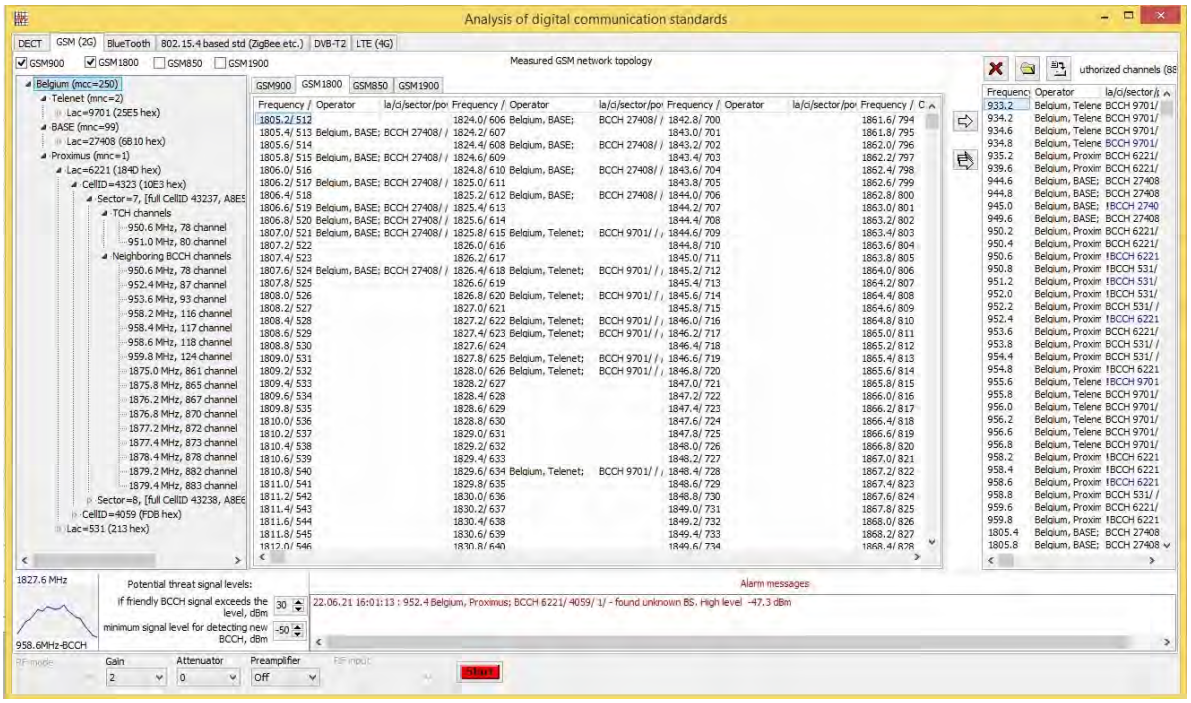
- Broadband signals operate in their own frequency grid and need to be analyzed in a separate window on the digital communication standards analysis page in automated mode.

The test results are displayed in the list of detected signals as pictograms in the last column of the list of detected signals:



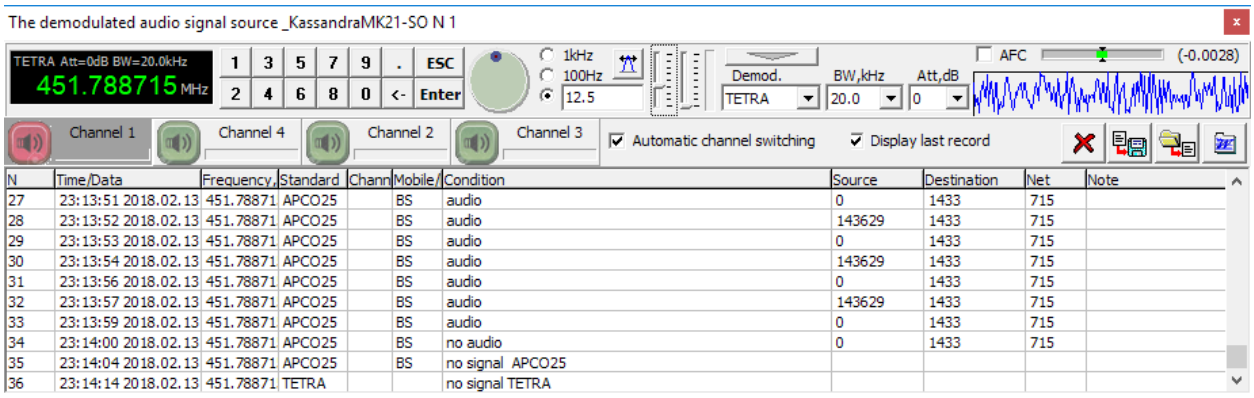
Automated analysis, based on a known frequency set

Automated analysis of digital signals based on a known frequency grid is performed in a separate program window, which is called when the button DT is clicked.
In this window, you can analyze the signals of the GSM, BECT, Bluetooth, 802.15.4 (in the next releases of the program), UMTS (in the next releases of the program) standards.
All of these standards are characterized by the fact that they operate in a standard-defined frequency grid. In this window, you can get the addresses and IDs of all transmitters of the analyzed standards and determine the network topology or identify illegally operating transmitters. The description of the program in this mode is beyond the scope of this article and will be published in a separate article.



Demodulation of the audio signal of the TETRA, APCO25 and DMR standards, display of video content of analog television.

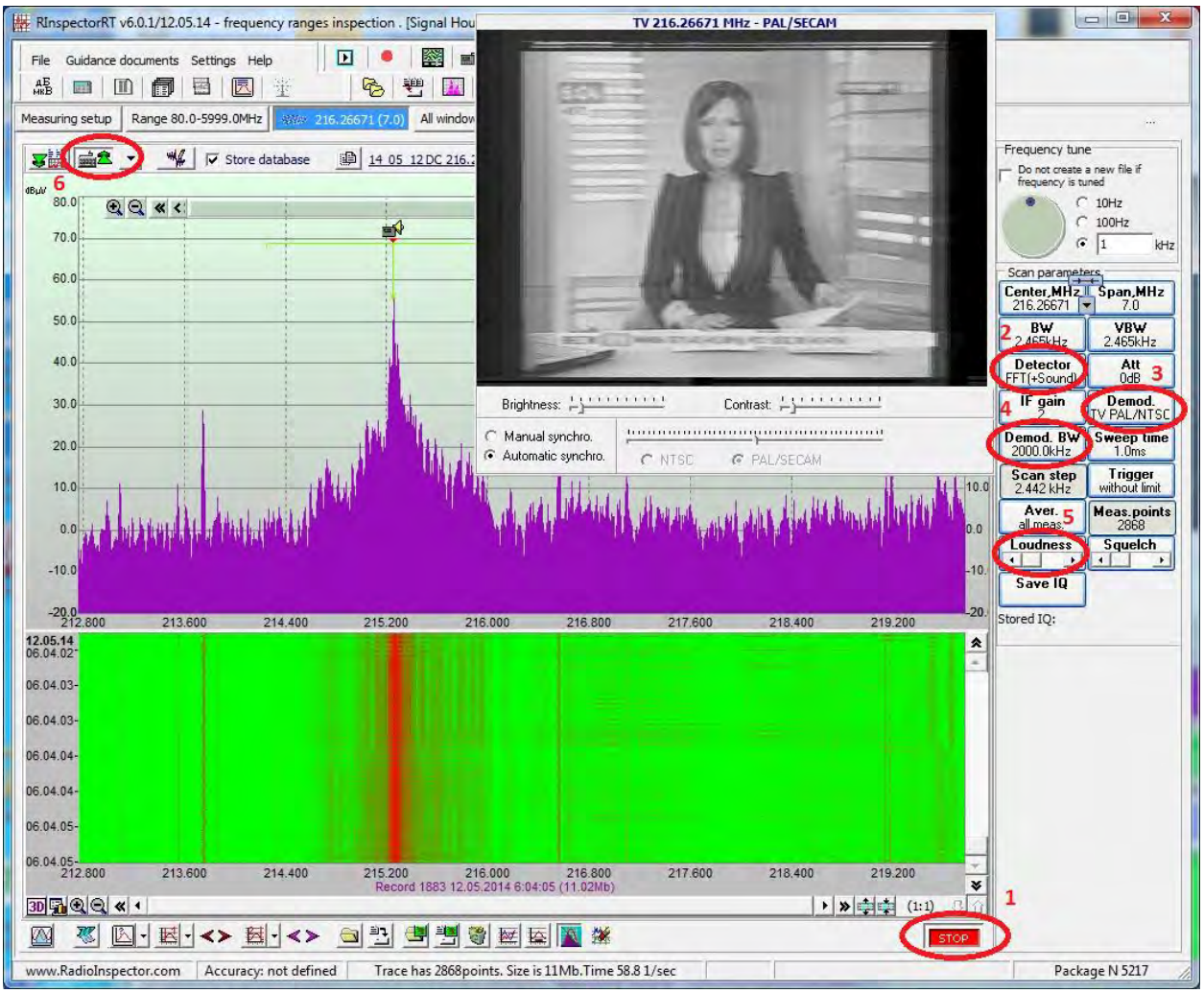
Demodulation of the audio signal of the TETRA, APCO25 and DMR standards, the display of analog TV video content is possible if the receiver outputs an IQ stream. If the DTest option is set, the demodulators of the APCO25, DMR, TETRA, and Analog TV standards appear in the list of demodulators of the source window of the demodulated audio signal.



N	Time/Data	Frequency,	Standard	Chann	Mobile/	Condition	Source	Destination	Net	Note
27	23:13:51 2018.02.13	451.78871	APCO25		BS	audio	0	1433	715	
28	23:13:52 2018.02.13	451.78871	APCO25		BS	audio	143629	1433	715	
29	23:13:53 2018.02.13	451.78871	APCO25		BS	audio	0	1433	715	
30	23:13:54 2018.02.13	451.78871	APCO25		BS	audio	143629	1433	715	
31	23:13:56 2018.02.13	451.78871	APCO25		BS	audio	0	1433	715	
32	23:13:57 2018.02.13	451.78871	APCO25		BS	audio	143629	1433	715	
33	23:13:59 2018.02.13	451.78871	APCO25		BS	audio	0	1433	715	
34	23:14:00 2018.02.13	451.78871	APCO25		BS	no audio	0	1433	715	
35	23:14:04 2018.02.13	451.78871	APCO25		BS	no signal APCO25				
36	23:14:14 2018.02.13	451.78871	TETRA			no signal TETRA				

When digital demodulators are selected, a table appears at the bottom of the demodulated audio source window that displays the documented data or audio transmission sessions by the selected demodulator.

For some receivers, demodulation of the audio signal is possible simultaneously with the display of the spectrum in the "Expert Analysis..." mode.

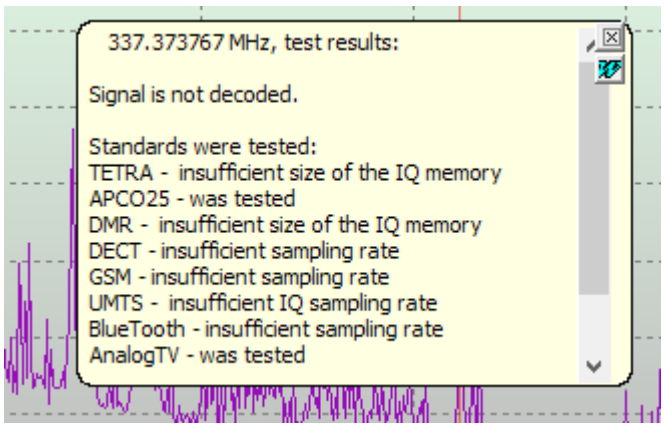


<u>To do this, you must:</u>

- to switch to "expert analysis of signals...." (button ), and then in mode "expert analysis of signals...." press the button (6);
- select a demodulator (3), the bandwidth of the demodulator (4), set the volume (5);
- if the device connected to the remote computer and is controlled by the I_MasterDevice, click on  ;
- select the "FFT+Sound" detector for some devices (2);
- the frequency of the demodulated audio signal can be set by double-clicking the left mouse button on the panorama graph (the central scanning frequency will change) or by pressing the left mouse button once and simultaneously pressing the "Alt " key.

Why sometimes not all specified standards are used in testing

For some devices, after digital testing, the label "insufficient IQ length" or "insufficient sampling rate" is displayed next to some standards



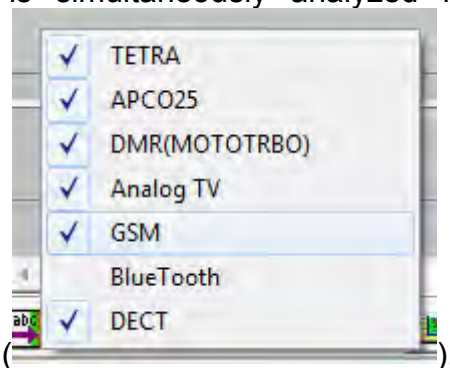
Let's return to the algorithm for recording IQs and their digital analysis.

To analyze digital signals, you need to get an IQ array from the device with the required bandwidth (sampling rate) and the minimum required IQ recording duration. The required bandwidth and the required duration of the IQ recording is determined by the standard of the digital signal being analyzed.

For example, for DECT signals, the minimum required sampling rate is 2000 kHz, and the minimum IQ recording duration is 200 ms. If the device does not have a sampling frequency of 2000 kHz, the program selects the nearest available frequency greater than 2000 kHz and resamples to the required frequency for DECT demodulation. If the device does not allow you to receive an IQ with a frequency of 2000 kHz or higher, then you cannot demodulate the DECT signal (the message "Insufficient sampling rate" is displayed).

Many devices have built-in memory for recording IQ. (*Note:* Some devices do not have built-in memory and can output IQ in a continuous stream. For such devices, the memory limit does not apply). The required minimum sampling rate and minimum recording duration IQ determine the minimum memory requirements:

For example, to analyze a DECT signal, the minimum amount of IQ memory should be 0.2 (s) * 2000 kHz = 400 ksls IQ.

If an unknown signal is simultaneously analyzed for belonging to several digital data transmission standards (

), then to reduce the test time, the IQ data is recorded only once with the maximum sampling rate and the maximum recording time of all the standards selected by the operator. Further, the program itself converts the received IQs for each standard, digital demodulation for all selected standards is performed simultaneously in different threads in a multi-core processor.

Algorithm of the program operation with simultaneous demodulation of several standards:

1. The program selects the maximum value of the required sample rate IQ from all the digital standards to be analyzed (let's call it "Fd"). If for any standard the maximum sampling rate of the device is less than the required one, then this standard cannot be analyzed (the message "insufficient sampling rate" is displayed).
2. The program selects the maximum duration of the IQ record from all the digital standards to be analyzed (let's call it "L").
3. The program checks whether it is possible to record the IQ of the required length based on the available memory of the device. The required memory for writing IQ must be equal to M = Fd * L.
4. If the amount of available memory for writing IQ is less than the value "M", the new value" L1 " = Available / Fd is calculated." L1 " is the maximum time for writing IQ. For those standards for which L1 is less than the minimum required IQ recording time, the analysis is not performed (a message is issued – "insufficient IQ length").

For example, the Rohde&Schwarz FSL spectrum analyzer is used. TETRA, APCO25, DMR, GSM, Bluetooth, and DECT standards were selected for the analysis.

The minimum required sampling rate for simultaneous analysis of all selected standards is Fd=2000 kHz (defined by the DECT standard). The device has this sampling rate. The required time for recording IQ (determined by the GSM standard) is L=1 second. The required amount of memory IQ M=2 000000 Words IQ.

The Rohde&Schwarz FSL spectrum analyzer has only a memory of 523776 IQ words. This memory is enough to record an IQ of length L1=523776/2000000=0.26 seconds with a sampling rate of 2000 kHz.
For the TETRA analysis, an IQ record length of 1.076 seconds is required, the TETRA test will not be performed, and the message "insufficient IQ length"is displayed.
For APCO25 analysis, an IQ record length of 0.8 seconds is required, the APCO25 test will not be performed, and the message "insufficient IQ length" is displayed.
To analyze the DMR, an IQ record length of 0.8 seconds is required, the DMR test will not be performed, and the message "insufficient IQ length" is displayed.
The DECT analysis requires an IQ record length of 0.2 seconds, and the DECT test will be performed.
To analyze AnalogTV, you need an IQ record length of 0.1 seconds, and the AnalogTV test will be performed.
For GSM analysis, an IQ record length of 0.98 seconds is required, the GSM test will not be performed, the message "insufficient IQ length" is displayed.

To find out which standards together can be tested for the device used, as a rule, you can use empirical methods.

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2018.03.13

Graphical user interface (GUI). Displaying additional spectrum traces, panoramas, reference traces and threshold line

Briefly.
New features are available in RadioInsoectorRC, RadioInspectorRT and RadioInspectorRP version 8.3.4:

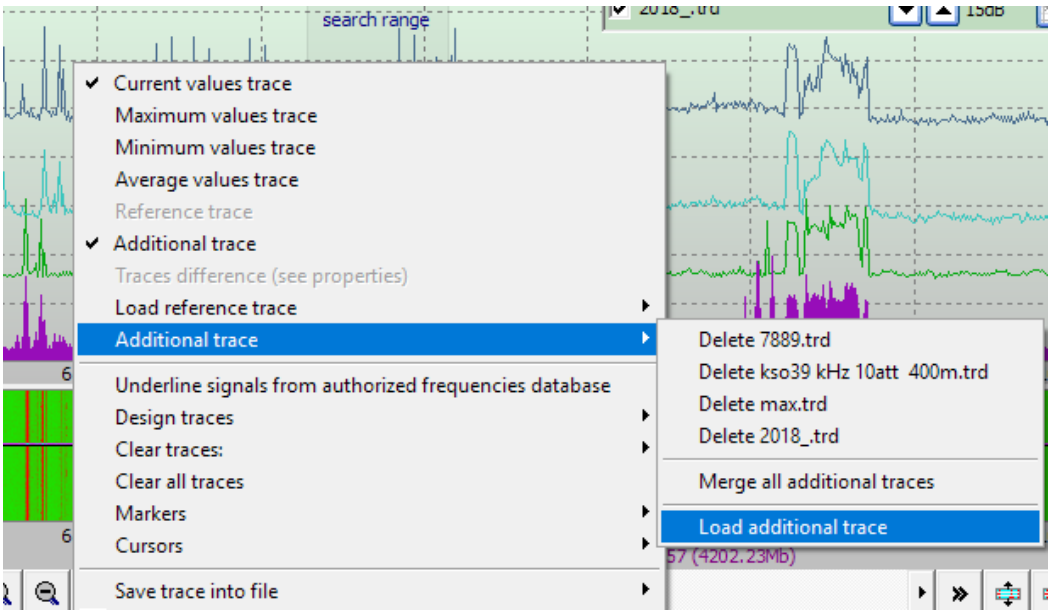
- In addition to existing Graphical User Interface (GUI) features such as current values traces, maximum, minimum and average values, threshold line, reference panorama, traces with panorama difference we have added an ability to display any number of additional traces of the signals spectrum or frequency range panoramas;
- Any of the additional traces can be used as a reference panorama;
- Improved operation algorithm with reference panorama trace (now it does not lose its accuracy when changing the number of points and scan frequencies);
- Added a possibility of visual editing of saved panorama traces;
- Additional traces can be imported from files, from current measurement traces or in a real time (traces data received from other radio monitoring instrument running on a computer connected to a network)

Why do you need additional traces?

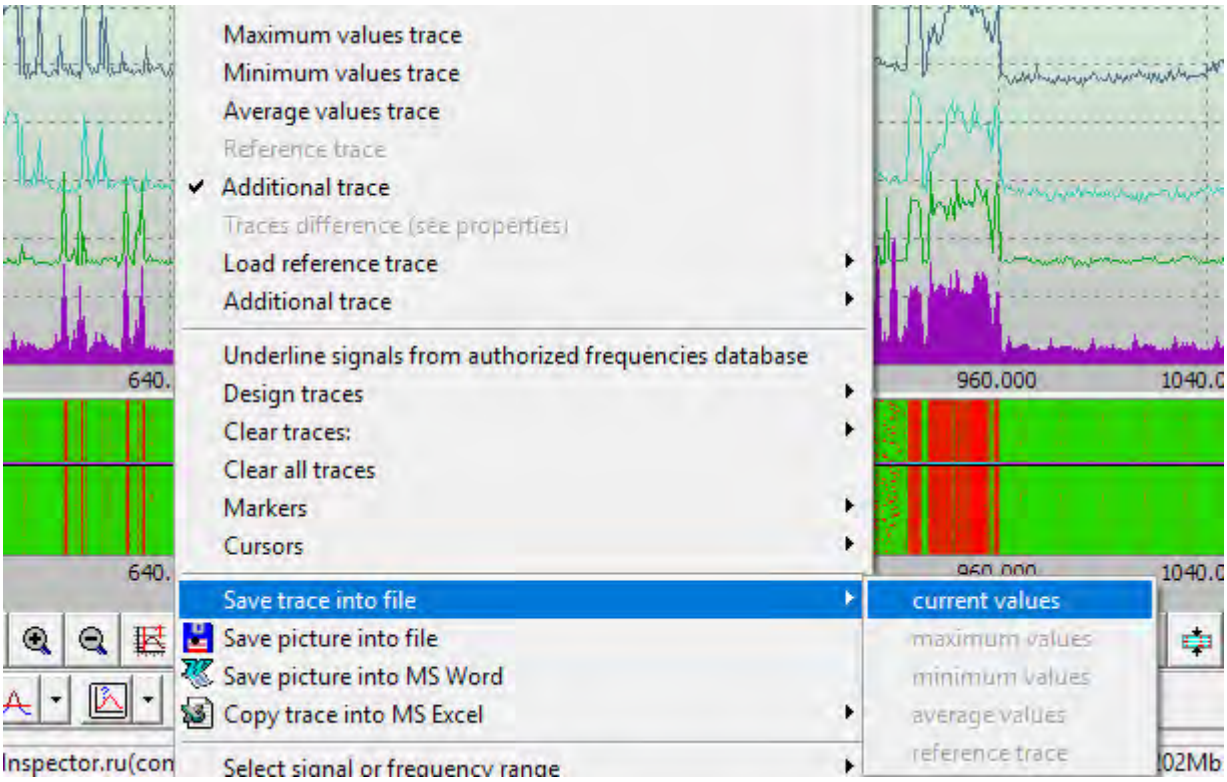
1. For an expert comparison of current panorama with signals recorded at different times or at the same time, but in different location;
2. To use any of the additional traces as a reference trace and automatically create a list of new signals according to the panorama traces difference (current and reference);
3. To combine multiple traces by maximum and get new traces of maximum values. In some cases, the resulting trace can be used as a threshold line or reference panorama;
4. To edit any panorama trace using the threshold line editing tools. After that, the edited panorama trace can be used as a reference trace, where "masks" are set in order to analyze only individual frequency ranges.

Additional traces

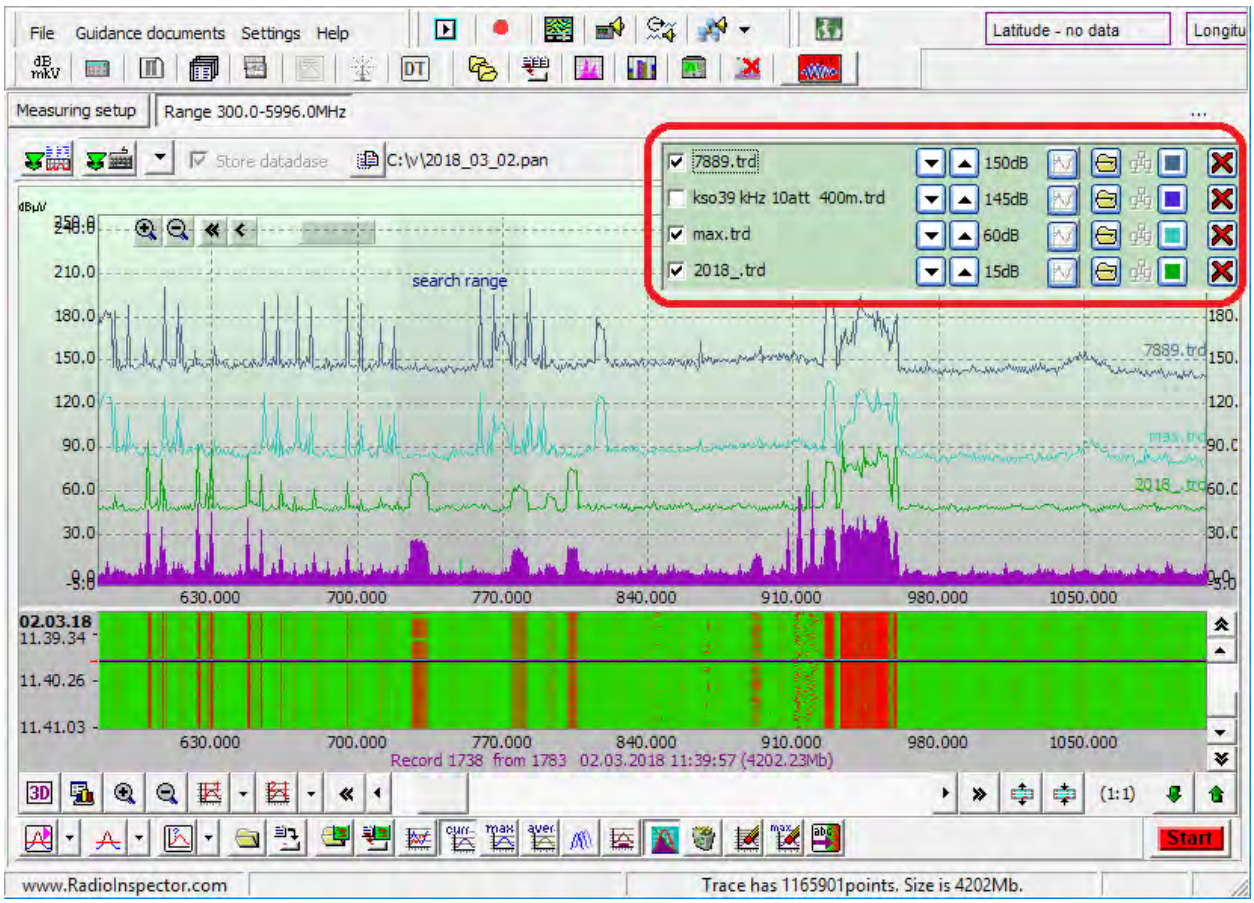
Additional traces are loaded from the file when you click on  button or select “Load additional trace” in “Additional trace” menu:



Note. Any spectrum or panorama trace can be saved to a file using the context menu:



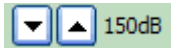
Additional traces control panel appears, right after additional traces has been added.



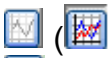
In this panel, a separate line appears for each additional trace

Trace control elements:

- Display or hide additional trace;



- Offset of the additional traces (so that the traces do not overlap);


(when active) - Use this trace as a reference panorama;


- Load a new trace instead of the current one without changing the offset and colour;


- Instead of the current trace, use the latest panorama trace from remote computer with RadioInspector connected to a computer network. This feature will be activated in the next version of RadioInspector (9.1.0).


- Change trace colour;


- Delete trace.

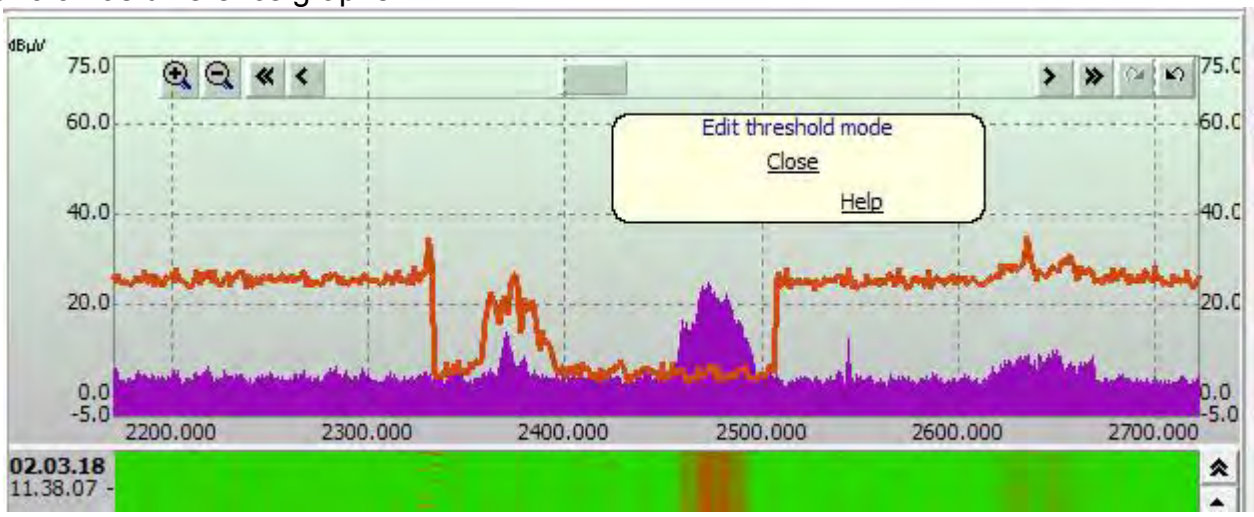
<u>Additional trace features:</u>

- Additional traces are stored in the original form and are not interpolated (adjusted) to the frequency step of the current task;
- Additional traces are using the algorithm to find the maximum of all measurement points that fall into a single point on the screen to display.

Threshold line trace

Starting from version 8.3.4, the threshold line trace is saved to a file and loaded from a file with “*.trd” extension. This format is used to save and load files of individual panoramas and signal spectrum. Using the same format for pan and threshold line trace, you can solve the following problems:

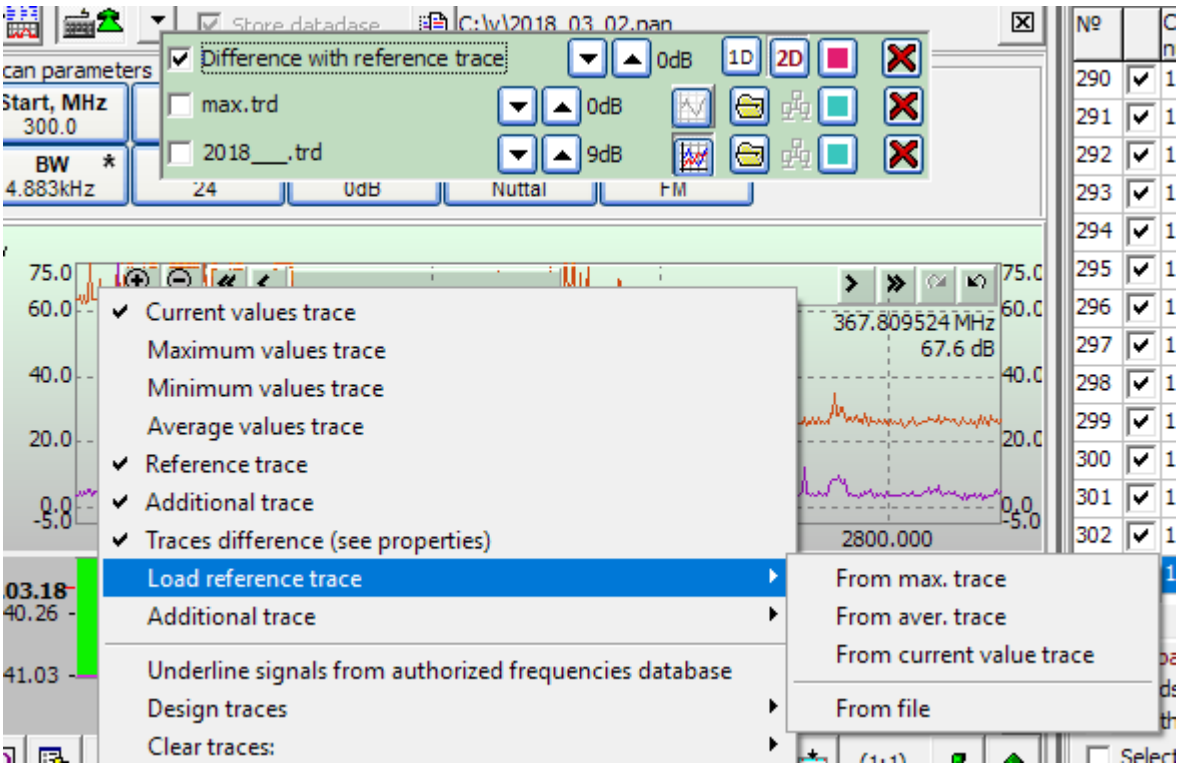
- You can use any previously saved panorama graphs as a threshold line;
- Saved panorama graphs can be loaded as a threshold line trace and this trace can be edited. For example, select the individual frequency ranges that require analysis, and "raise" remaining frequency ranges. Then, saving the resulting trace in the file, you can use it as a reference panorama and to observe new signals only in the selected frequency ranges in panoramas difference graphs:



Reference panorama

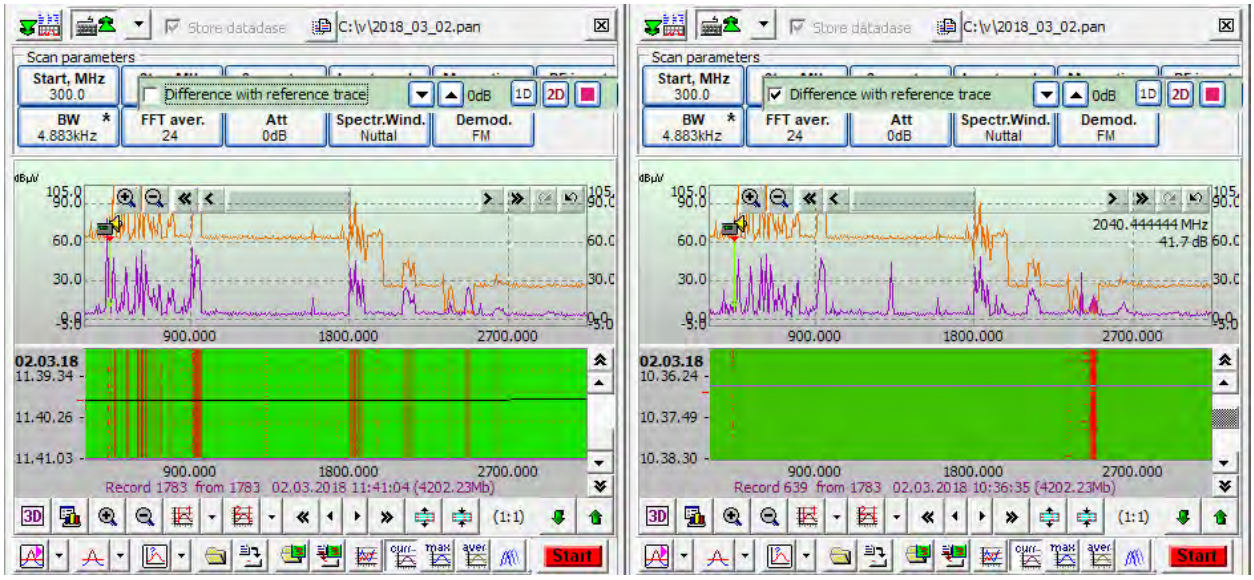
Starting from version 8.3.2, the reference panorama loaded from the file is stored in its original form and is not interpolated (adjusted) to the frequency step of the current job. When you change the frequency range scanning step, the loaded sample of the reference panorama does not change and its distortion does not appear in "cubes" form.
The reference panorama can be loaded:

- From the file (button);
- Using button ( ) from the additional graph;
- From a file or graphs of maximum values, current values graphs or average values graphs using the context menu above the panoramas graphs field:



After loading a reference panorama, you can display panorama difference graph. Difference between current panorama and reference panorama. To display difference of panoramas graph, use the sub-ite ✔ Traces difference (see properties) of the context menu . You can change panorama difference graphs display options in additional graphs control bar:

You can use this control bar to shift the panorama difference graph, change graph view and change colour. Panorama difference graph is very useful to search for a new signals. For example, after applying a "mask" to the reference panorama as described above, the difference graph of panoramas in the 1D and 2D display mode may look as follows:



If you adjust the contrast of the spectrogram display (button), you can achieve the effect when the spectrogram chart displays only new signals that exceed the threshold line. Moreover, by changing the contrast of the display, even the weakest signals exceeding the threshold will be displayed in bright red colour on green background.

2019.05.11

New program – **IQ_ProcessPRO**

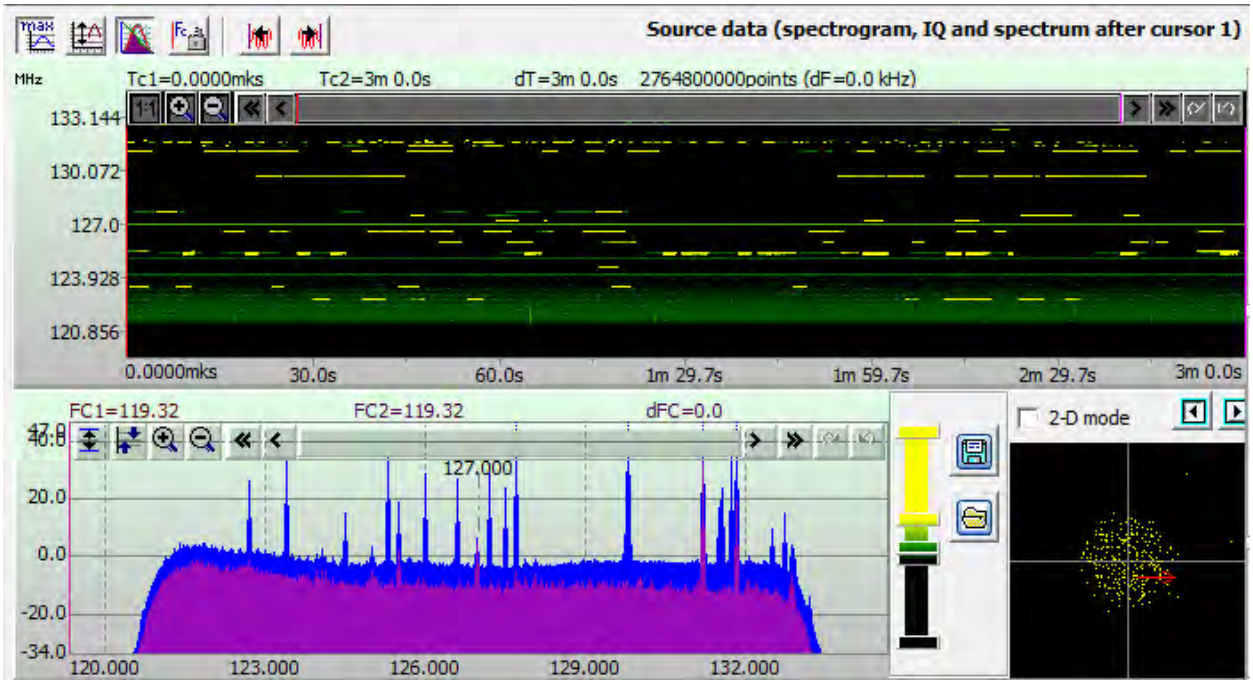
Why do you need the IQ_ProcessPRO program?
IQ_ProcessPRO was developed in accordance with TSCM operators needs in delayed analysis of the collected data.

Let's consider typical tasks in daily work of the TSCM operator:

1. Operator of the radiomonitoring complex has detected a short-term unknown signal that can be potentially dangerous. It is necessary to analyze this signal and understand what danger it can carry.
2. Monitoring of quality of the trunking communication channels, for instance, communications between aircrafts or vessels and dispatchers. It is necessary to have to have effective means quality monitoring and independent documenting.
3. The task is similar to the previous one, but the radio monitoring system recorded an unknown radio signal in automatic mode and recorded its quadrature (IQ) for subsequent analysis by the operator.
4. Tasks mostly the same like described above, but radio monitoring has detected a signal, which it can't demodulate in automated mode and system has saved an IQ file for the postponed analysis.
5. It's necessary to detect and analyse all signals within selected frequency range. The operator has no time to provide an effective analysis or he has no appropriate qualification.

All these tasks and tasks similar to them can be solved by saving an IQ and by consequential analysis of them.
Contemporary systems are able to realise long-lasting IQ records. Most of the up-to-date SDRs and spectrum analyzers can make an uninterruptible record of IQ with the bandwidth 10MHz and broader. An IQ record with the bandwidth 10MHz requires 40 MB per second, 2.4 GB per minute, 144 GB per hour, 3.456 TB per 24 hours. Currently, these requirements are affordable, even conventional hard drive is able to save IQ stream with bandwidth 10 MHz. Our tests confirm that an SSD drive is able to save an IQ stream with bandwidth 60 MHz and more under control of Windows 10.

What can we do with the saved IQ.



This screenshot displays saved IQ (sampling frequency 15 MHz) with duration 3 minutes in time-frequency and amplitude-frequency domains. In the upper-side of the picture a spectrogram of the frequency range 120-134 MHz and duration 3 minute is displayed. Yellow stripes are signals of the transmitters during conversations between aircraft's crews and dispatchers.

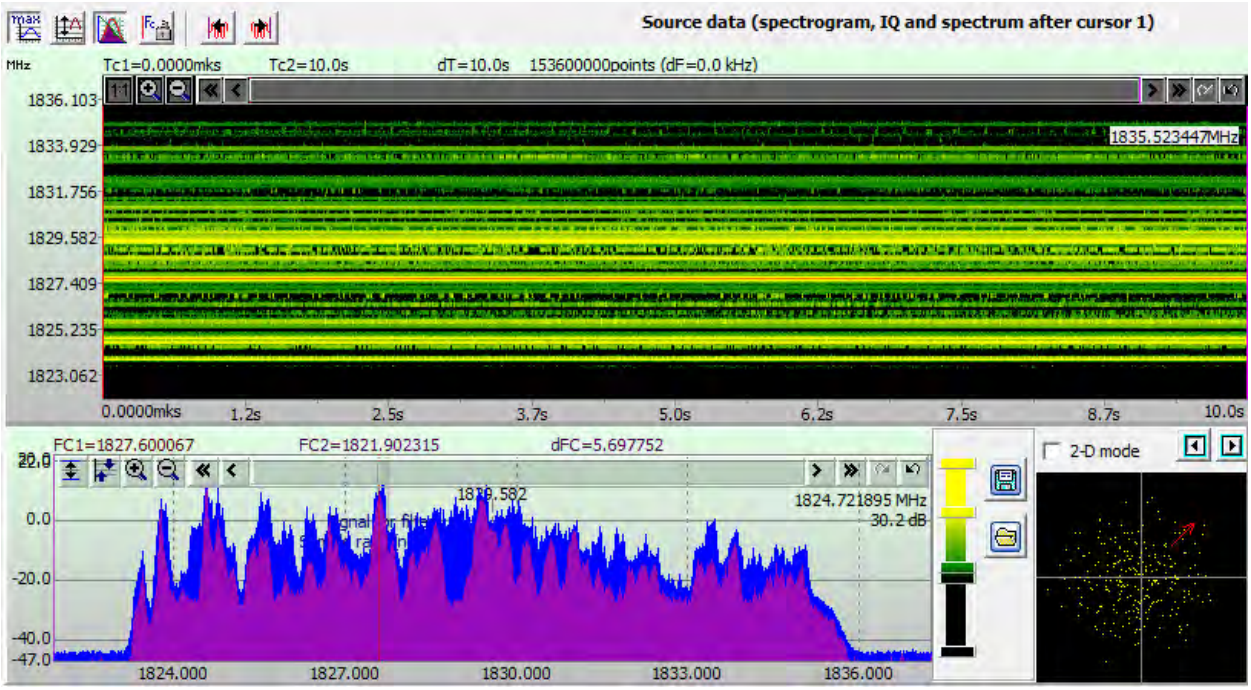
What kind practical tasks might be solved by analysis of this data?
First of all, independent control of radio traffic between dispatchers and aircrafts. The second, this a monitoring of disturbances in communication channels. The third, it is a monitoring of the quality of work of the transmitters.

How can we check one communication session (one yellow stripe)?
It is necessary to "truncate" this session from the entire data and then analyze amplitude, frequency, phase parameters and demodulate this "truncated" signal. The program IQ_ProcessPRO is designed for these tasks.

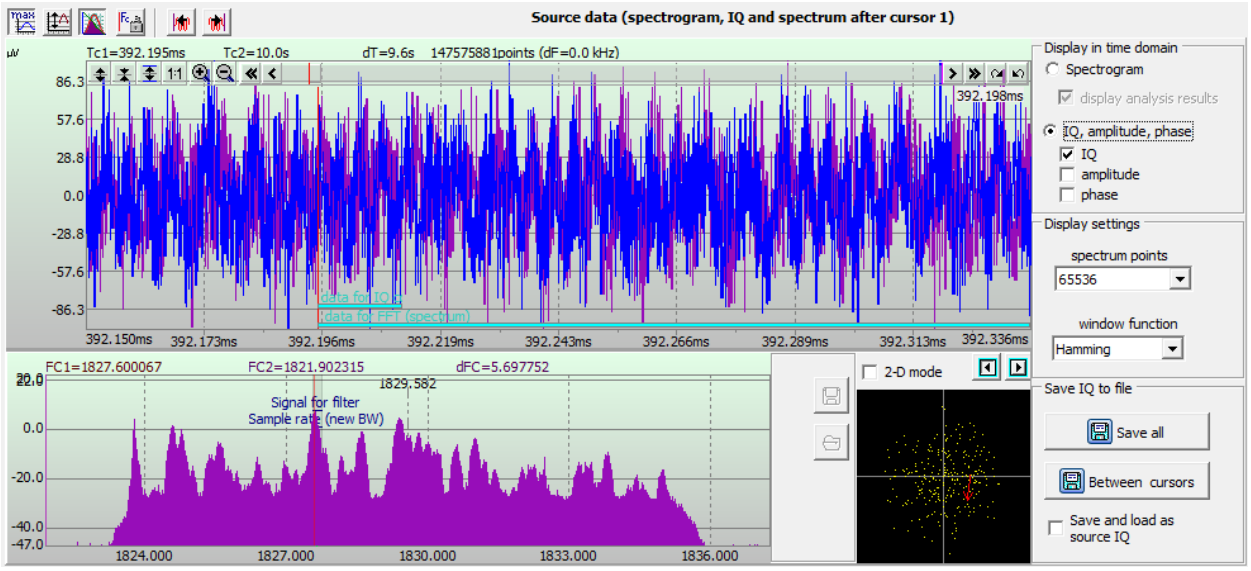
In other words, IQ_ProcessPRO is able to:
- select one signal from the variety of the signals in frequency and time domains;
- demodulate saved signal, listen demodulated audio with AM, FM modulation, digital signals APCO25, DMR, TETRA, watch video information of analog TV (PAL, SECAM, NTSC), DVB-T, DVB-T2;
- determine which standard selected signal belongs to: APCO25, DMR, TETRA, GSM, BlueTooth, DECT, UMTS (WCDMA, 3G), 802.15.4 (Zeeg Be etc.), DVB-T, DVB-T2, LTE and extract meta data for these standards;
- save this signals in format affordable for the expert analysis;
- save IQ of the selected signal.

Let's consider, how can we do it:

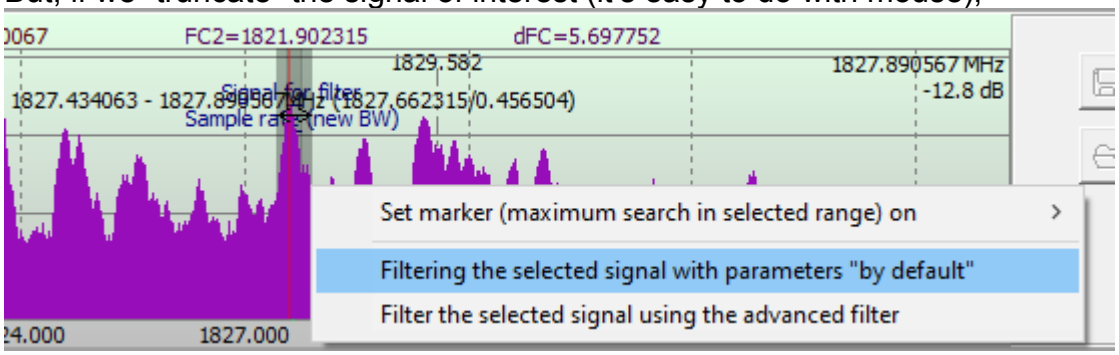
1. Signal analysis



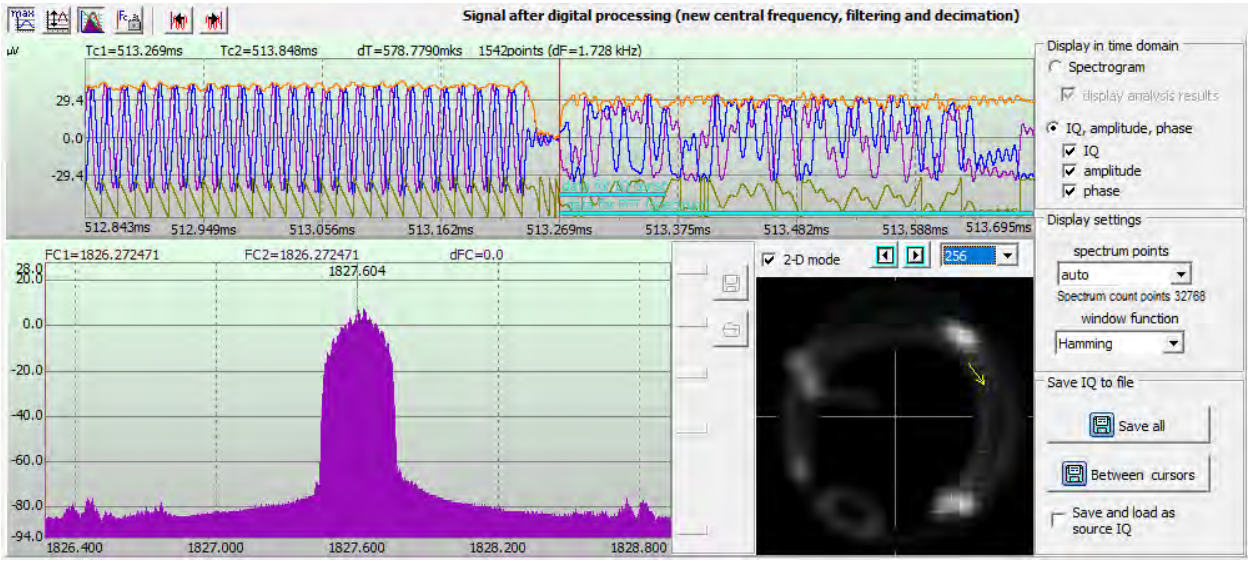
In the screenshot IQ of GSM frequency range are displayed. If we will study IQ for the entire frequency range we'll see the "mix" of all of the signals:



But, if we "truncate" the signal of interest (it's easy to do with mouse),



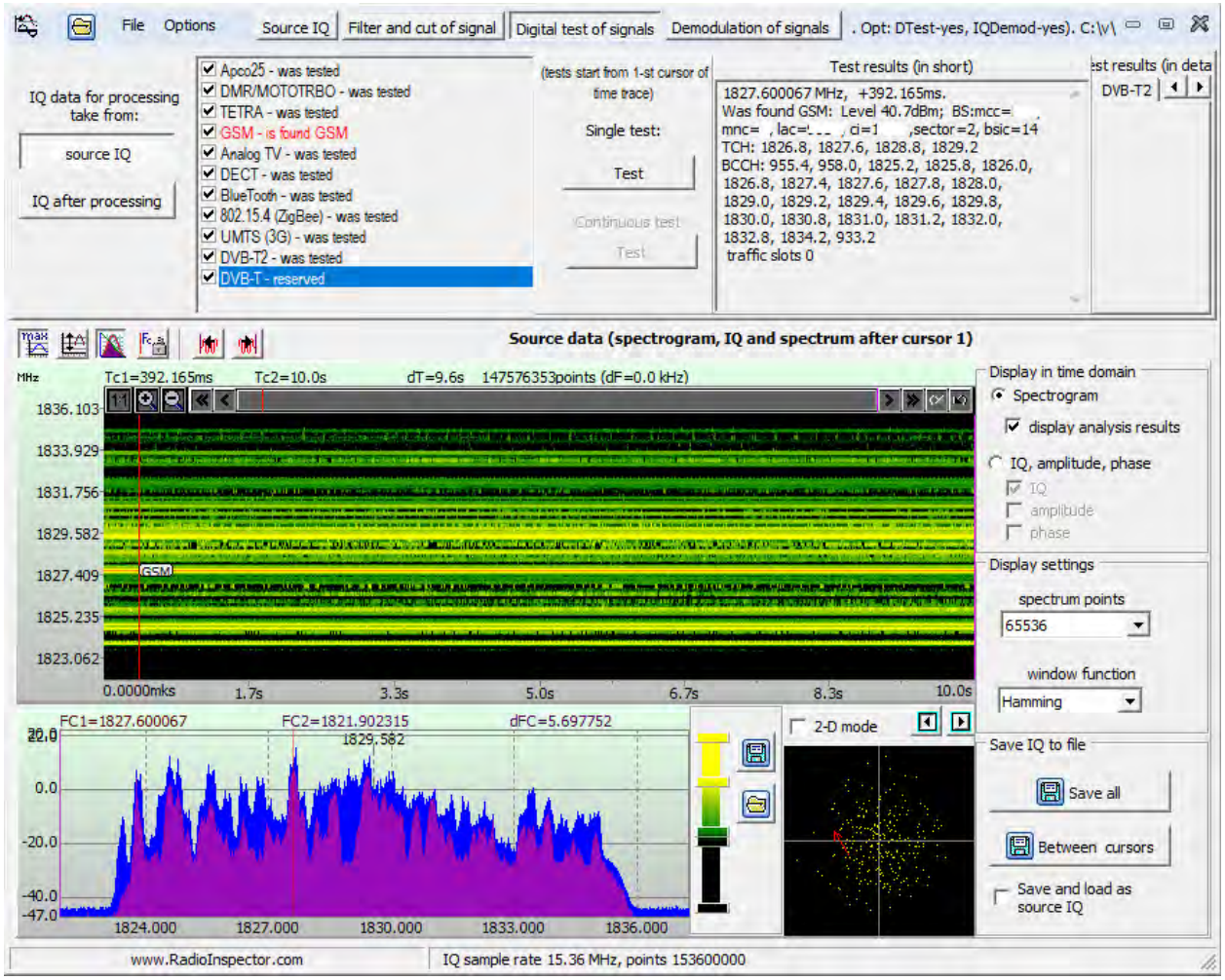
Then we will have another picture very familiar for whose who works with signals:



Further, we can save selected signal, to check if it belongs to one of the known standards, listen or watch the image if it is a video format. By using instruments included to the program, an expert can distinguish type of the modulation, decide if this signal contains information or it's just a spurious emission of the electronic components and evaluate the level of the threat of this signal for current tasks.

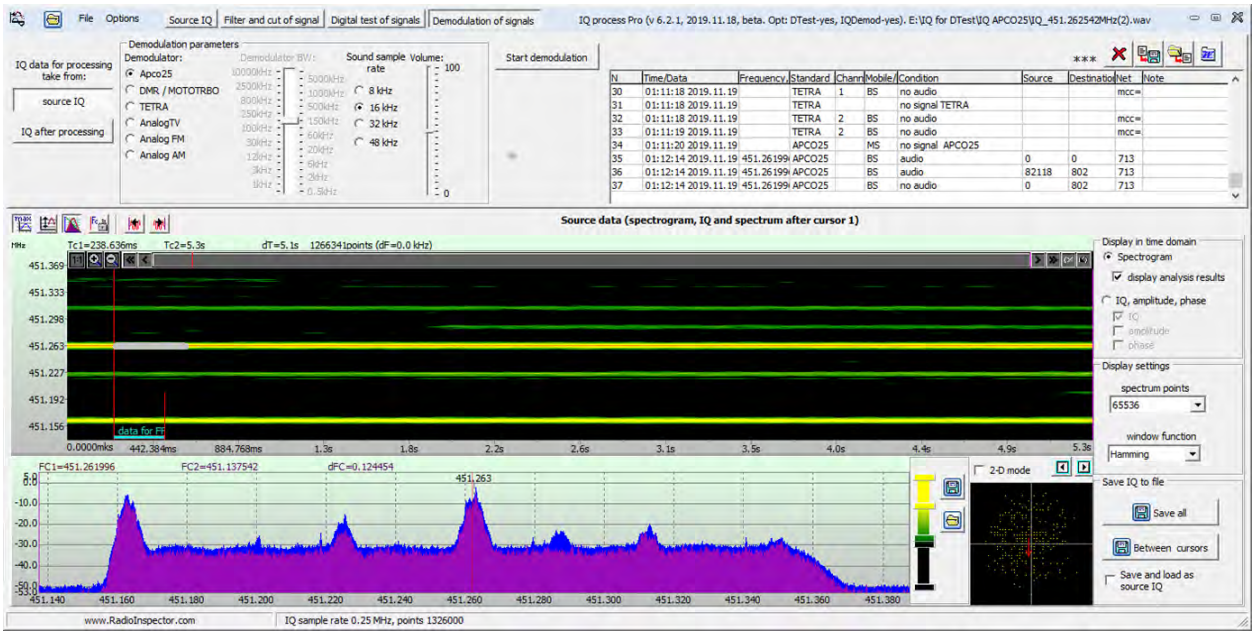
2. Identification of the signal standard

It is easy to check signal of interest on belonging to the known standard. It is just enough to put cursor on the center of the frequency in the frequency domain, select start position in the time domain and press button Test.
Signal analysis and identification affordable for both IQs: "truncated' and initial. The frequency of the signal is determined by the cursor. If the signal source is an initial IQ, then program automatically "extracts" signal from the multiply signals (to be more precise, program selects appropriate bandwidth for each standard) and analyses the signal on belonging to the selected standards.



3. Signal demodulation.

Demodulation can be performed the same way like the identification. . It is just enough to put cursor on the center of the frequency in the frequency domain, select start position in the time domain and press button Start demodulation.



More detailed information about IQ_Process_Pro program presented in the manual for this program.

There are two different versions of IQ_ProcessPRO program:

1. Basic program without demodulation and signal analysis is included for free into RadioInspectorRT(RC) software package.

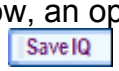
2. Full version of IQ_Process_PRO with the installed demodulators and with support of signal analysis.

Basic version of the software allows an operator to view and analyze IQs including signal “truncation” with variety of digital filters like digital shift of the central frequency, filtration, decimation and signal resampling and storage of the results of signal processing.

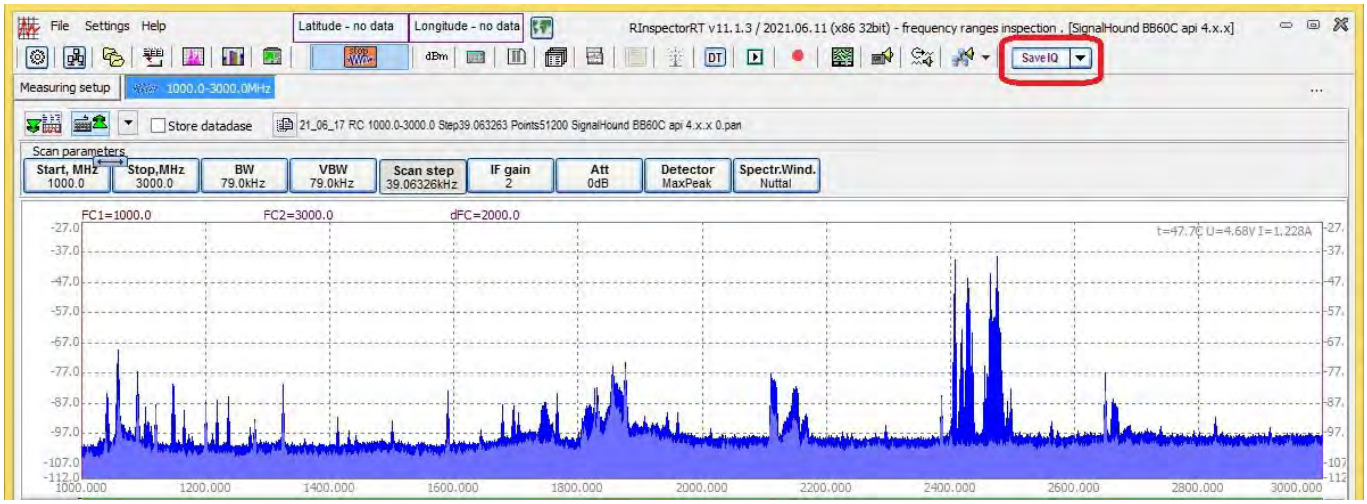
2019.11.15

Fast IQ recording

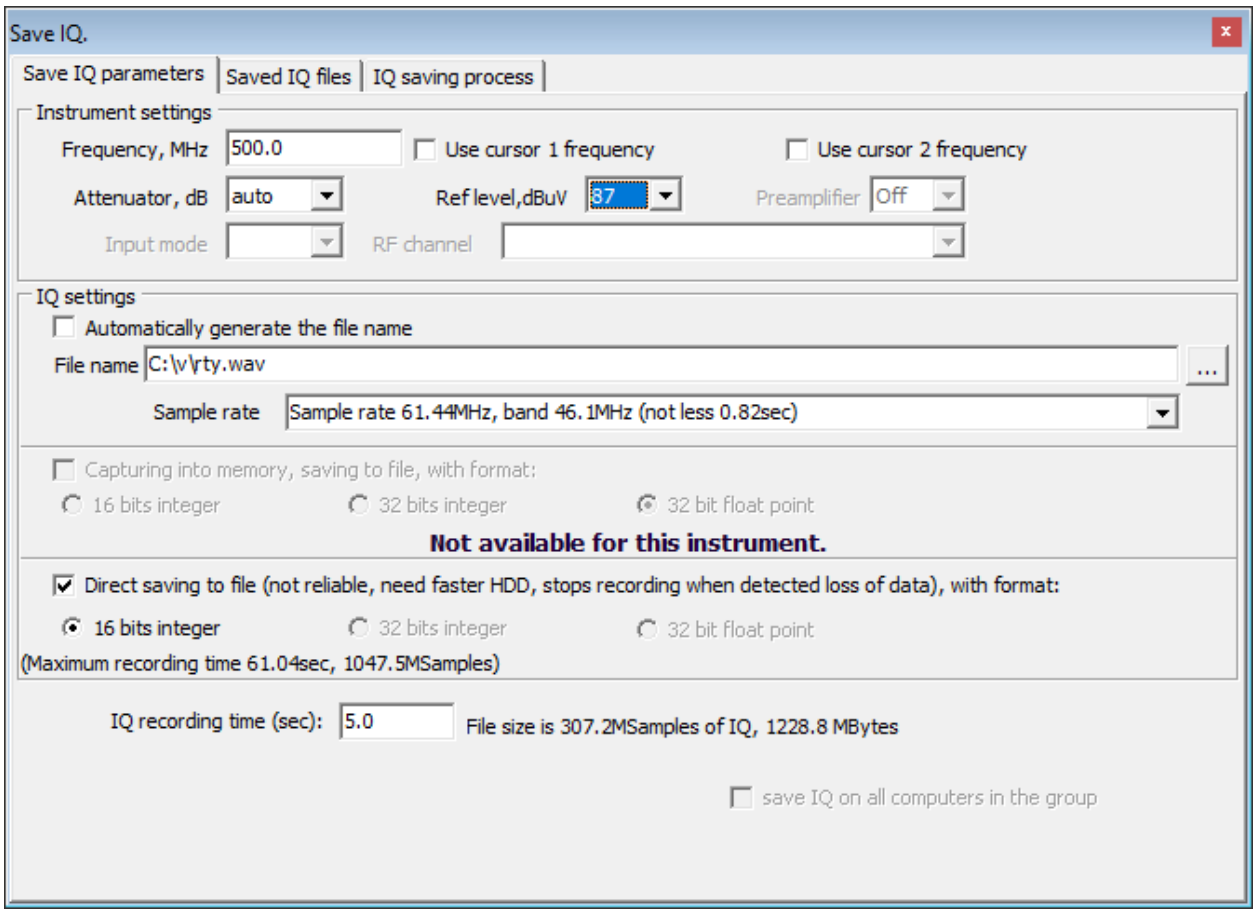
A new function added to the software RadioInspectorRT(RC) – function of the fast IQ recording.

Since now, an operator can activate IQ recording process with the prescribed parameters by pressing 

button. Sampling frequency can be fixed (previously described via settings menu), or can be determined by cursors number 1 and 2. The recoding process starts immediately, it means that all operations, like sweeping or demodulation, will be interrupted or postponed.



The button  opens IQ recording settings menu.



In this window the page Save IQ parameters contains following settings:
- Receiver's parameters during IQ recording Instrument settings.
- Name of the file, IQ sampling frequency and data format (field IQ settings);
- Duration of the IQ record.

If this ☑ Automatically generate the file name setting is selected, then name of the file will be generated automatically and files will be saved to directory: <My computer>\RInspector\SaveIQ\H\.

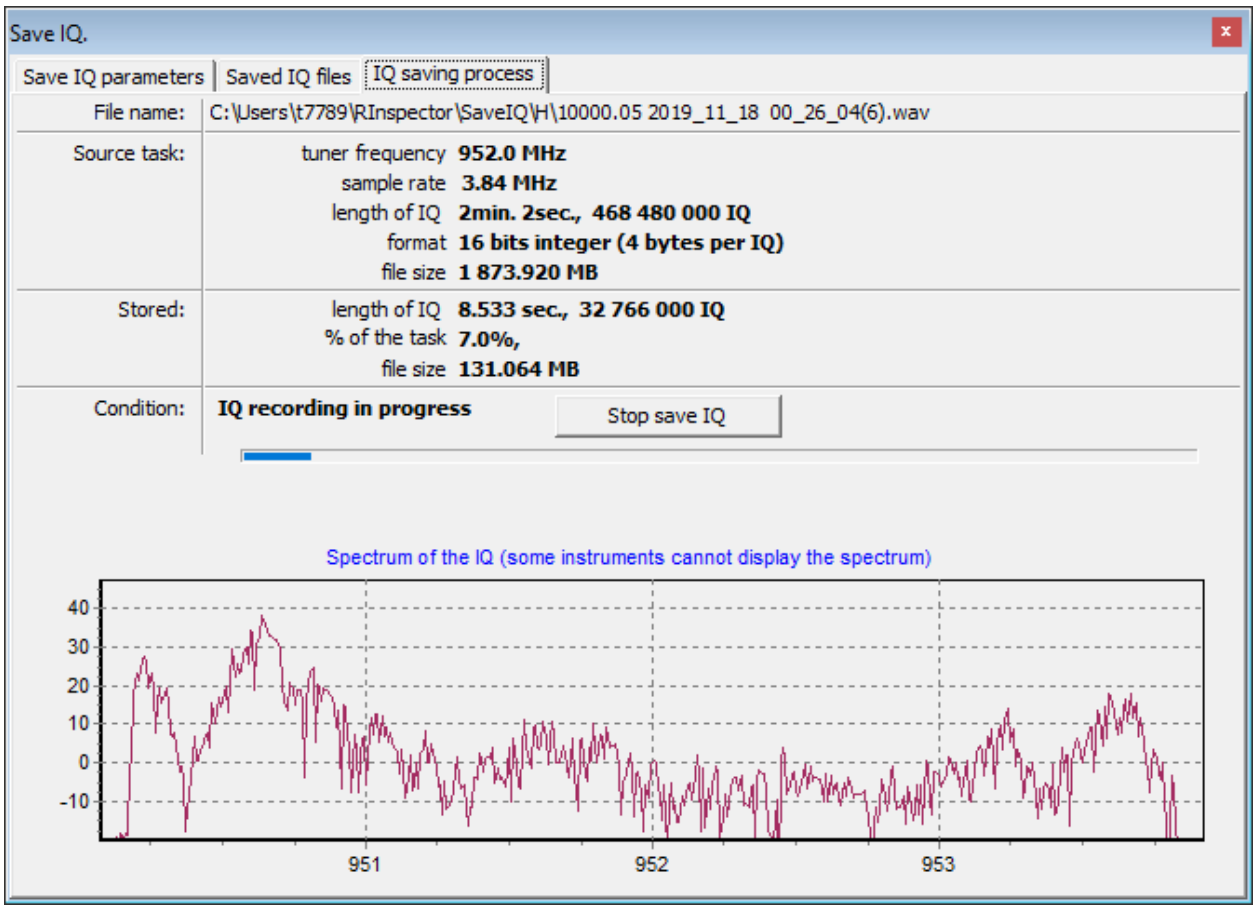
If file's name is chosen, but this filename already taken, to the end of the filename will be added a digit 1, 2, 3, etc.

The duration of the saved IQ might be restricted by parameters of the instrument.
IQ storage process starts immediately after the pressing button Save IQ.

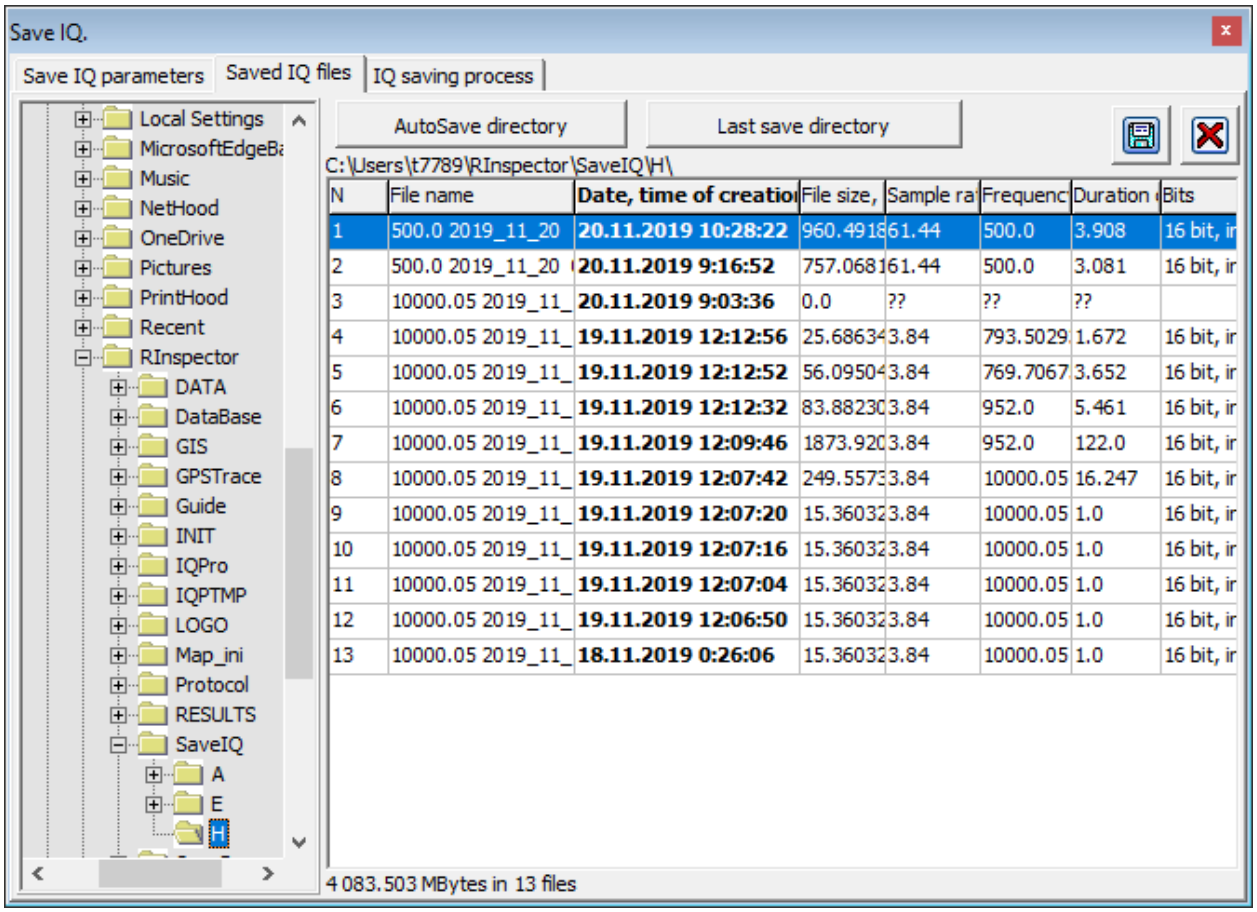
During the recording process IQ saving process is displaying.

This window displays the process of recording IQ in the form of a task and in the form of a dynamic display of the results of recording IQ with the display of the spectrum of recorded IQs.

<u>NOT ALL devices have a dynamic display of the IQ recording process.</u>



Saved IQ files can be found on the page:



This page displays all IQ files saved into directory where the last record was stored.
To sort files in the directory press appropriate row name.

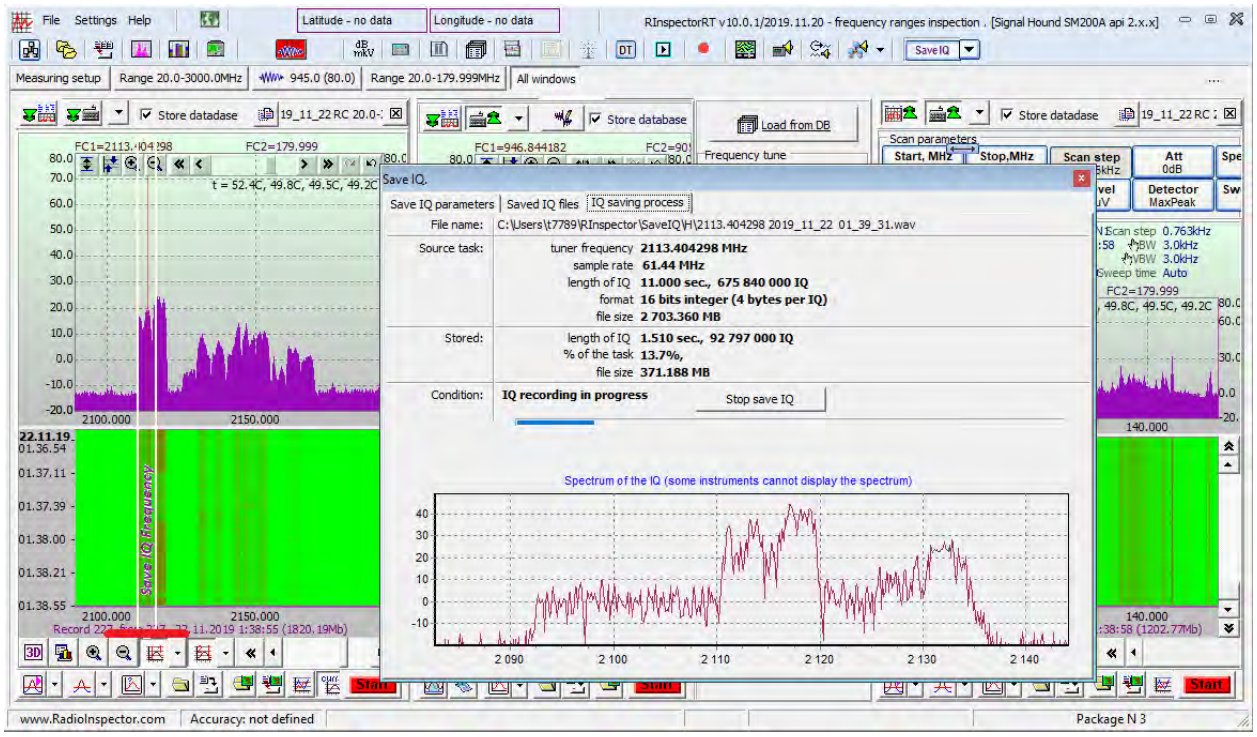
Double click on the selected file opens this record in the IQ_Process_Pro program. If the version with demodulators is installed to the default folder, then starts this version of the software, otherwise basic version of the software that included into RadioInspectorRT/RC.

Frequency of IQ recording.

The frequency of IQ recording can be fixed or determined by the position of the 1st or 2nd cursor:

If the frequency is determined by the cursor.

For multi-window mode, if the frequency is determined by the cursor, this is the frequency of the LAST cursor that was set in multi-window mode. It doesn't matter in which frequency range control window or expert analysis window the cursor was set, as long as it was the "last click" on the spectrum graph field. If the window where the "last click" was performed is deleted, the program considers that there is no cursor for IQ recording and will display a message about the absence of a cursor when trying to record IQ. You need to make a "click" again to determine the new cursor. To indicate the frequency at which IQ is being recorded, the program visually highlights this frequency during recording:



The purpose of the buttons  is intuitive:

 - Opens saving window, where operator can select another name an / or another place where file should be stored.

 - Deletes selected files.

Main changes in the RadioInspector software for 2020.08.10.

1. New devices are intergrated to the software:

Rohde&Schwarz FSV30xx series
Rohde&Schwarz PR200
Rohde&Schwarz EB500
Tektronix RSA607A, RSA 503A, RSA507A, RSA 513A, 518A
USG-9A, USG-30A,
SignalHound SM200B
SignalHound BB60C (API 4.x.x) SM200A (API 2.x.x)

2. The work on converting RadioInspector programs in 64 bit mode has started. Initially, all programs were developed in 32-bit mode. However, the 32-bit mode allows you to work only with 3 GB of memory, which is very small for modern devices.

Today's challenges require analyzing broadband signals (20, 40 or more MHz) or observing wide frequency ranges in real time. Modern devices allow you to do this and transmit IQ streams to the computer with a sampling rate of 40..160 MHz. This means that for a second of IQ analysis, you need to allocate memory from 320 MB to 1.28 GB for IQ storage only. Also, you need memory to process signals in the frequency band of recorded IQS. Therefore, for the analysis of modern signals, the need for computers with a powerful processor, 16 or 32 GB of RAM and a large SSD disk will soon be a normal requirement.

3. Unfortunately, not all devices will be able to work in the 64-bit version of the software. Many drivers for previously connected devices only work in the 32-bit version of the software. Vice versa, some modern devices only work in 64-bit mode. Starting in the fall of 2020, RadioInspector software will be available in 2 versions: 64-bit and 32-bit. The user will decide which version to use, depending on which version the receiver he works with. We will inform users about the possibility of working with different devices with 32-bit or 64-bit versions of the RadioInspector software.

4. At the time of writing this article, I_MasterDevice (remote management of receivers and spectrum analyzers) supports 32-bit and 64-bit versions. The programs RadioInspectorRT, RadioInspectorRC, I_RemoteCheck, RadioInspectorWiFi, IQ_Process, IQ_ProcessPro only work in 32-bit mode. We will inform you about the transfer of these programs to the 64-bit version later.

2020.08.10

Change in the interaction algorithm of the RadioInspectorRT/RC programs and the I_MasterDevice program.

Briefly.
Changed the user interface (GUI) for selecting a measurement tool if the measurement tool is connected to a remote computer and managed over a network. Now the algorithm for selecting remote measuring instruments has become simpler and clearer.

In detail.

Introduction.

This question concerns the interaction algorithm for I_MasterDevice, RadioInspectorRC, and RadioInspectorRT programs. The RadioInspectorRC and RadioInspectorRT programs are designed to perform radio monitoring, search, and signal analysis tasks. This is understandable. So, why do I need the I_MasterDevice program?

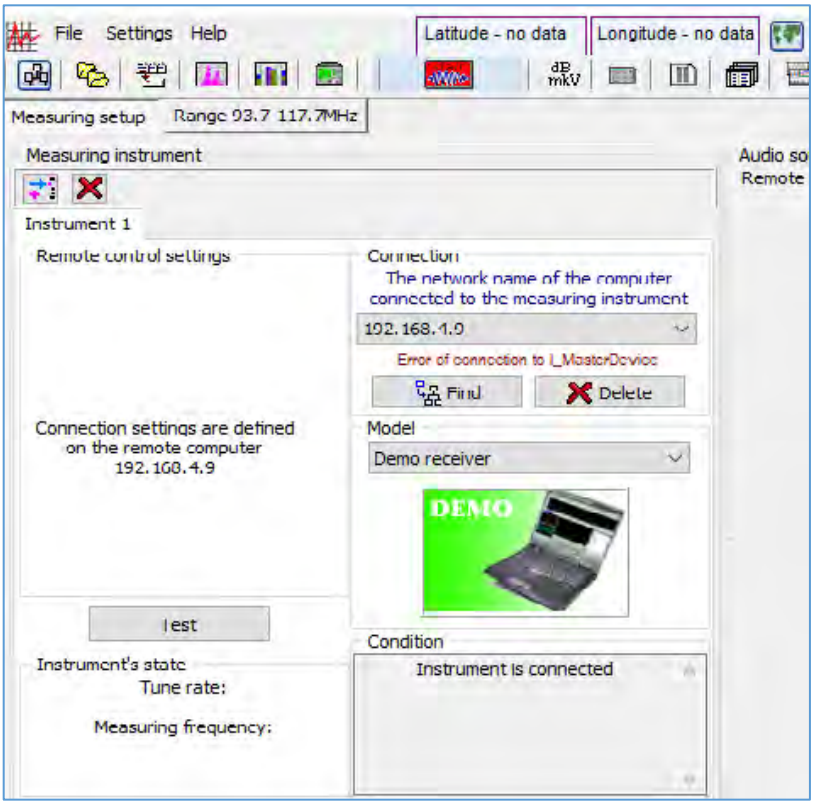
The source data (signal spectra, frequency range panoramas, IQ streams for signal analysis) of the RadioInspectorRC and RadioInspectorRT programs are received from digital receivers and spectrum analyzers. There are no problems if the devices are located next to the computer and connected to the computer. But if the devices are located on the roof/ in another building/ in another city, then there is a problem.

The problem of remote control of measuring instruments is solved by using the I_MasterDevice program. Next to the digital receiver or spectrum analyzer is a computer to which these devices are connected. On this computer, the program I_MasterDevice is running, which on the one hand manages the measurement tools, and, on the other hand, transmits the measurement results over the network to the programs RadioInspectorRC or RadioInspectorRT. Also, to reduce the traffic transmitted over the network, the i_masterdevice program performs pre-processing of data received from the device. This solves the problem of remote control of devices.

Additionally, it should be noted that the I_MasterDevice program can be run on the same computer as the RadioInspectorRC(RT) program. In this case, the I_MasterDevice program is responsible for managing the devices and pre-processing the data received from the device, and removes some of the load from the RadioInspectorRC/RT programs.

When ordering the RadioInspectorRC program, the I_MasterDevice program, which will run on the same computer as RadioInspectorRC, is included in the delivery package for free.

User interface changes.



You can select a computer and device for radio measurements in the RadioInspectorRC and RadioInspectorRT programs on the "Measuring setup" page.
The interface is simple and intuitive. First, you must select the computer to which the measurement tools are connected and on which the I_MasterDevice program is running. After successfully connecting to a remote computer, the operator can select one of the devices connected to the remote computer.

The changes made relate to a situation where an error occurred when connecting to a remote

computer. Previously, when a connection to a remote computer failed, RadioInspectorRC(RT) programs searched for the I_MasterDevice program on the local computer and if they didn't find It, they tried to run it themselves. At the same time, there were many diagnostic messages that confused the operator. The saved settings of the previous successful launch were changed, and when the RadioInspectorRC(RT) programs were restarted, the first connection was made to the local computer.

Now, if the connection to the remote computer is not established, the RadioInspectorRC(RT) programs display a single diagnostic message stating that it is not possible to connect to the remote computer, and install the software emulator of the measurement tool as the current measurement tool. The address of the remote computer saved after the last program launch DOES NOT CHANGE!. After Troubleshooting the network or enabling the remote computer, simply re-select the current address of the remote computer in the list of available remote computers. If the connection is established, you can continue working with the last selected device.

2020.08.06

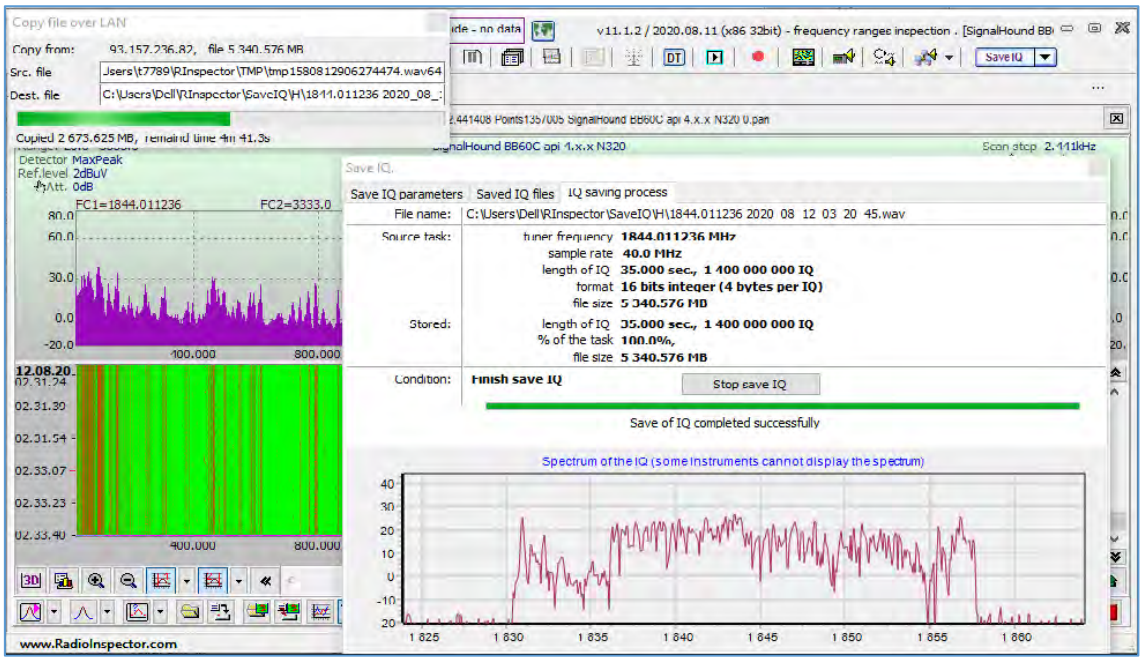
Transfer recorded IQ files in the background.

Briefly.
When you remotely control the measurement tool using the I_MasterDevice program, the recorded IQ files are transmitted in the background and do not interrupt the operation of the radio monitoring system.

In detail.
The problem at first glance is small, but the solution is very effective for the continuous operation of the radio control system.

The need to record IQ for further signal analysis (for example, using the IQ_ProcessPro program) may occur frequently. It is impossible for the operator to deal with a large variety of signals in the loaded frequency ranges in real time. Therefore, we have to record the IQ of large frequency ranges in order to filter and analyze each signal separately. To do this, the IQ data is recorded.

The recorded IQ files can be not just large, but VERY large. For example, the SignalHound BB60C device allows you to record IQ with a frequency of 66 MHz. This means that 66*4=264mbytes will be recorded in 1 second, and 5.28 Gbytes of data will be recorded in 20 seconds. In other words, 5.28 GB of data will be recorded in 20 seconds. Over a 100 Mbit network, 5.28 Gbytes will be transmitted for about 10 minutes (when the network is 100% loaded). Previously, during the transfer of such files, the complex was suspended. Now the recorded IQ data is transmitted in the background. It is clear that the communication channel is divided between the data transmitted by the complex and the file transfer. BUT the work of the radio control complex does not stop!



2020.09.02

Changing the policy for saving work results.

<u>Briefly.</u>
All the results of the work in the program can be documented (graphs of panoramas, signal traces, images of spectra, tables). Previously, the software used the strategy of saving the results of work in Microsoft office Word and Excel products. According to numerous requests from users, the policy for documenting the results of work has now been changed. All the results of the work will be copied to a graphic file or CSV file (a text file whose fields are separated by the "Tab" symbol), as well as to the clipboard, which will allow you to use the "Copy-paste" technology.

2020.09.10

Conversion of the RadioInspector software to 64-bit mode.

Due to the increase in the performance of modern measuring instruments (the expansion of the instantaneous analysis bandwidth, the increase in the IQ clock frequency), the amount of necessary RAM resources requested by programs increases. For 32-bit programs, the maximum limit on the use of RAM in the amount of 3 GB is set. Currently, the RadioInspector software is being migrated to the 64-bit mode of operation and working with UNICODE strings (UNICODE strings will allow you to form file names, notes and comments in the national alphabet, and not just in Latin).

Unfortunately, a large number of devices will remain running in 32-bit mode. The RadioInspector software supports more than 260 types of measuring instruments that have been produced over the past 20 years. All devices were tested in a 32-bit command system, many of them work with their own libraries written in 32-bit mode. It is not possible to switch all devices to 64-bit mode and test their operation. All new connected devices will be connected and tested in 32 and 64-bit software mode. Therefore, to ensure correct operation with different

devices, the RadioInspectorRT and I_MasterDevice software will be delivered to users in 2 versions – 32-bit and 64-bit. Both versions have the same functionality. The choice of the version to use depends on the measuring instruments used.

To facilitate the selection of the software version, a table will be published, which will indicate the devices and the bit depth of the software that supports their operation. If there are no devices in the table, they are only supported by the 32-bit version of the software.

2020.11.08

RS CM03/USB antenna compas is now connected to RadioInspector.

Briefly.
An RS CM03/USB antenna compass is connected to the program. This is an improved modification of the RS CM02 antenna compass. The antenna compass is made in the form of a handle with a button, to which any directional antenna can be attached. The antenna compass is needed to perform manual direction finding of signals. The results of manual direction finding are displayed on the electronic map.

2020.11.12

DVB-T2 demodulator is developed.

Briefly.
A DVB-T2 demodulator has been developed. DVB-T2 demodulator complies with ETSI EN 302 755. DVB-T2 demodulator is included in the DTEST option and can be used in the RadioinspectorRT, RadioinspectorRC, and IQ_ProcessPRO programs. Demodulator allows you to identify DVB-T2 signals and determine their main parameters: the occupied frequency band, the size of the FFT, the value of the protection interval, the number of transport streams in the signal, the modulation of service packets and the modulation of each transport stream. Also, with sufficient quality of IQ it allows you to demodulate transport streams (*. ts files), from which you can get audio and video content.

In detail.
The DVB-T2 demodulator is a software demodulator and is based on the analysis of IQs obtained from any device. The software demodulator can analyze DVB-T2 signals at any frequency.

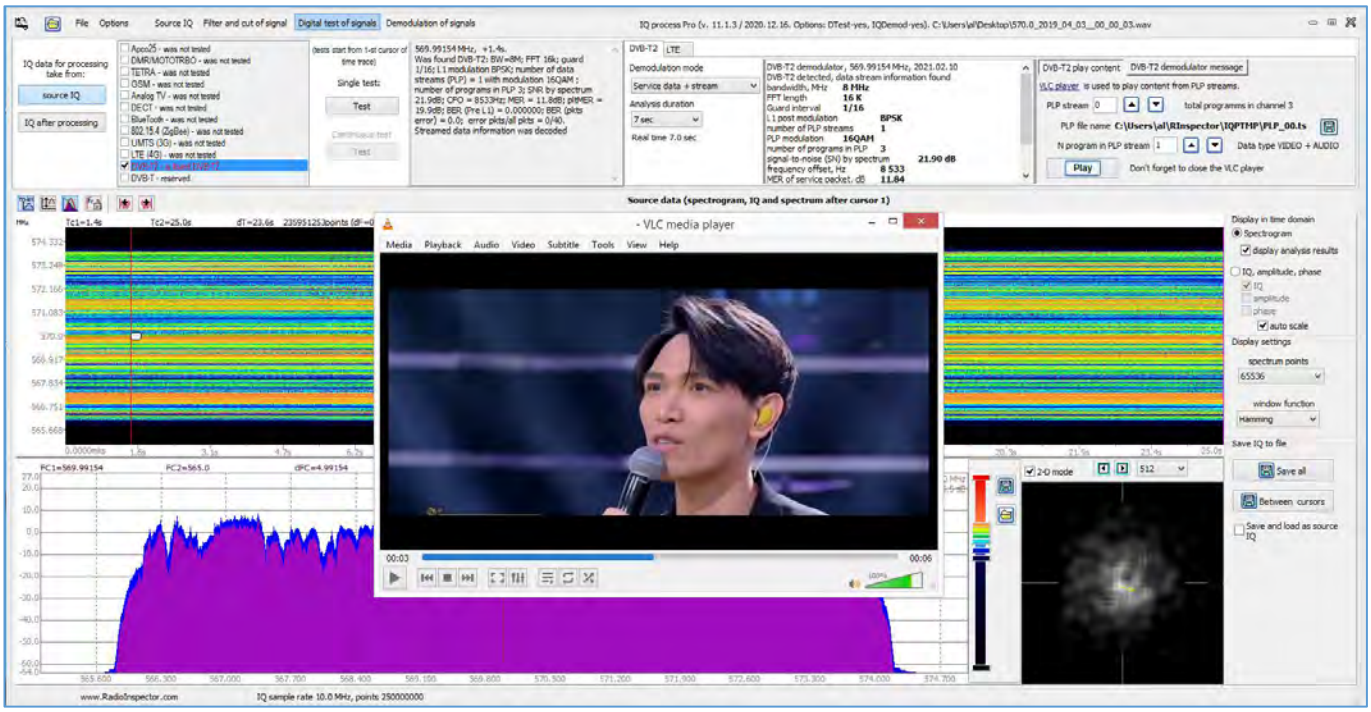
The DVB-T2 standard sets the following requirements for the quality of the IQs received from the device:
- The stability of the sample rate offset of IQ samples must be less than 6 ppm for signal identification and service information demodulation;
- The suppression band of the device filters by 40 dB when receiving IQ - no more than 20% of the sampling frequency;
- The stability of the sample rate offset of IQ samples should be less than 2 ppm of demodulation of transport streams with 64QAM modulation;
- Uneven frequency response in the signal frequency band of no more than 10 dB;
- The error of tuning to the DVB-T2 signal frequency should not exceed 10% of the bandwidth of the occupied signal frequencies;

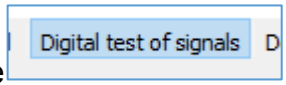
- The signal-to-noise ratio must be at least 20 dB in the entire IQ frequency band (interference refers to noise, out-of-band signals with filter suppression, mirror channel, and any other extraneous signals);
- For demodulation of transport streams with 16QAM modulation, the signal-to-noise ratio in the entire frequency band of the DVB-T2 signal must exceed 30 dB (stability of the reference generator IQ <= 2ppm), 32QAM-36 dB (stability of the reference generator IQ <= 1.5 ppm), 64QAM-42 dB (stability of the reference generator IQ <= 1 ppm), 128QAM-50 dB (stability of the reference generator IQ <= 1ppm);
- Out-of-band legal extraneous signals falling into the IQ sampling frequency band exceeding the DVB-T2 signal frequency band must not exceed the DVB-T2 signal level by 20 ..40 dB (for example, the frequency band of the DVB-T2 signal is 8 MHz, the sampling rate is 12 MHz. To the right and left of the DVB-T2 signal are the 2 MHz frequency bands. It is necessary that the legal signals located in the 2 MHz frequency bands below and above the DVB-T2 signal frequency band do not exceed the analyzed DVB-T2 signal by 20 dB).
- The maximum occupied frequency band of a single DVB-T2 signal is 8 MHz. For such a signal, the required IQ sampling rate must be any, at least 10 MHz (the duration of the IQ recording is at least 3 seconds).

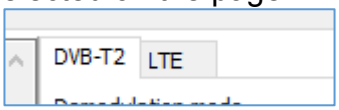
Failure to meet one or more requirements results in the inability to demodulate the DVB-T2 signal or in a decrease in the quality of demodulation.

<u>DVB-T2 demodulation in the IQ_ProcessPRO program.</u>

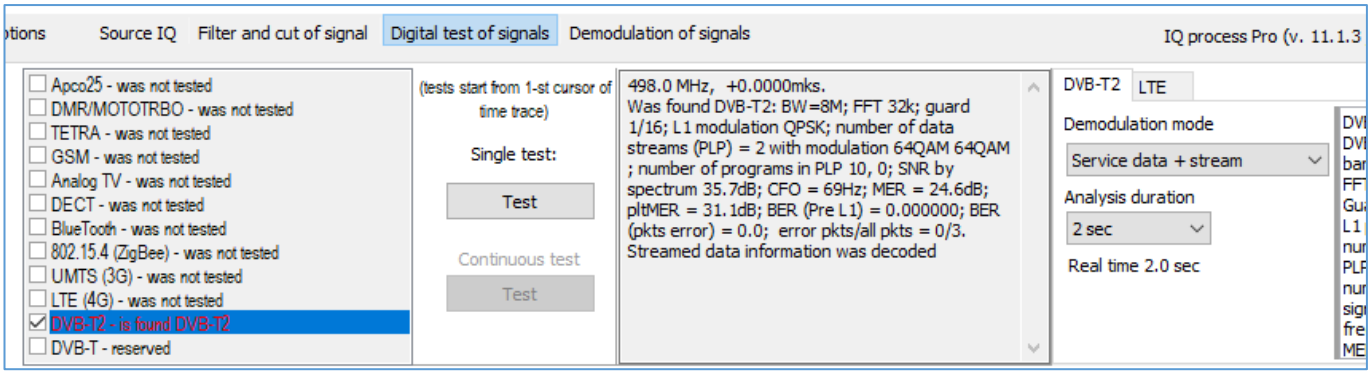
To demodulate the DVB-T2 signal, the DTest option is required in the IQ_ProcessPRO program.



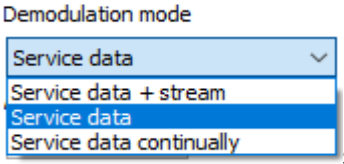
The demodulator is selected on the page 

, , and the demodulator is controlled on the tab 

:



Operation modes of the demodulator.

This field 

sets the demodulator operation mode:

Service data + stream – demodulate service data and PLP data streams (PLP-Physical Layer Pipe, streams that contain video, audio, and other data). This is the most "heavy" mode of operation of the demodulator, in which it demodulates service information and data streams throughout the entire specified length of the IQ.
Service data – as soon as the demodulator receives the entire amount of service data, the demodulator stops working. This is the fastest demodulation mode.
Service data continuously – only service information is demodulated during the entire specified length of the IQ. In this mode, you can correctly estimate the number of errors MER and BER to evaluate the signal quality.

The results of the demodulator.

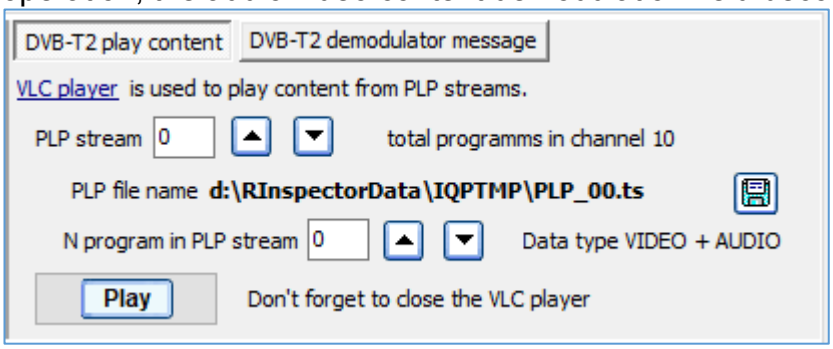
stream information was found	- information data flows (PLP) detected;
bandwidth, MHz 8 MHz	- the bandwidth occupied by the signal;
FFT length 16 K	- FFT length for OFDM modulation;
Guard interval 1/16	- length of the protection interval;
L1 post modulation - BPSK	- L1 post service packet modulation;
number of PLP streams 1	- number of data streams (PLP-Physical Layer Pipe);
PLP modulation 16QAM	- modulating PLP data streams;
number of programs in PLP 2	- number of programs in PLP;
signal-to-noise (SN) by spectrum 24.53 dB	- signal - to-noise ratio over the spectrum;
frequency offset, Hz 52	- offset of the central frequency IQ from the signal frequency;
MER of service packet, dB 13.99	- the number of MER errors when demodulating the L1 pre service package;
MER of pilot signals, dB 22.81	- number of MER errors when identifying pilot signals;
number of received / (with errors) service data packets 88/0	- number of service packets received / number of service packets received with errors

Play audio and video content from PLP streams:
If the **"Service data + stream"** mode of operation of the demodulator is selected, then as a result of its operation, files of the *.ts (transport stream) format will be created, in which information data streams (PLP) are recorded. Each data stream generates its own file in the *.ts. File *format.ts is a container for storing audio, video, and any other content. Each of the decoded PLP streams must have a Program Association Table and an Elementary Stream Table. The detected tables are displayed in the **"number of programs in PLP"** field. The tables contain information about the type of content, the number of programs, and the codecs that the programs are encrypted with. Without detecting these tables, data flow demodulation is

not possible. Program tables are transmitted once every 3-5 seconds. Therefore, to play video content, you need to record IQ with a duration of at least 6-8 seconds.

To play video content, the program uses a standard VLC player. VLC player is one of the most powerful players that supports a large number of codecs and it can work with *. ts files. The VLC player must be installed in the system.

If PLP data streams and programs are detected and demodulated after DVB-T2 demodulator operation, the audio/video content demodulation field becomes available:

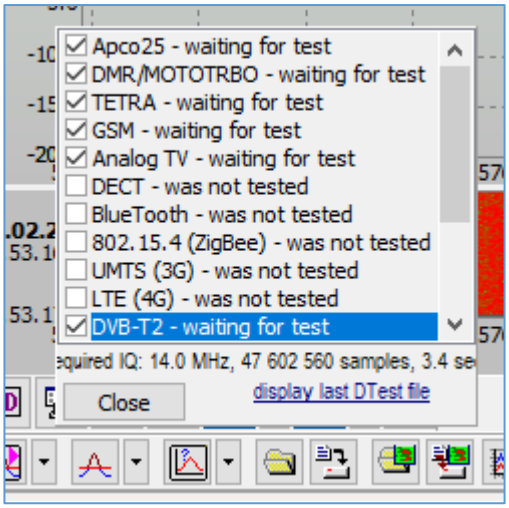


In this field, you must select the PLP stream and the program number in the PLP stream that you want to play. Playback is performed using the VLC player.
If the VLC player cannot play the contents of the PLP (*. ts file), then you can save this *.ts file and try to play it with another player.

<u>DVB-T2 demodulation in the RadioInspectorRT/RadioInspectorRC program.</u>

In the RadioInspectorRT/RadioInspectorRC program, the DVB-T2 demodulator can be activated in 2 places:

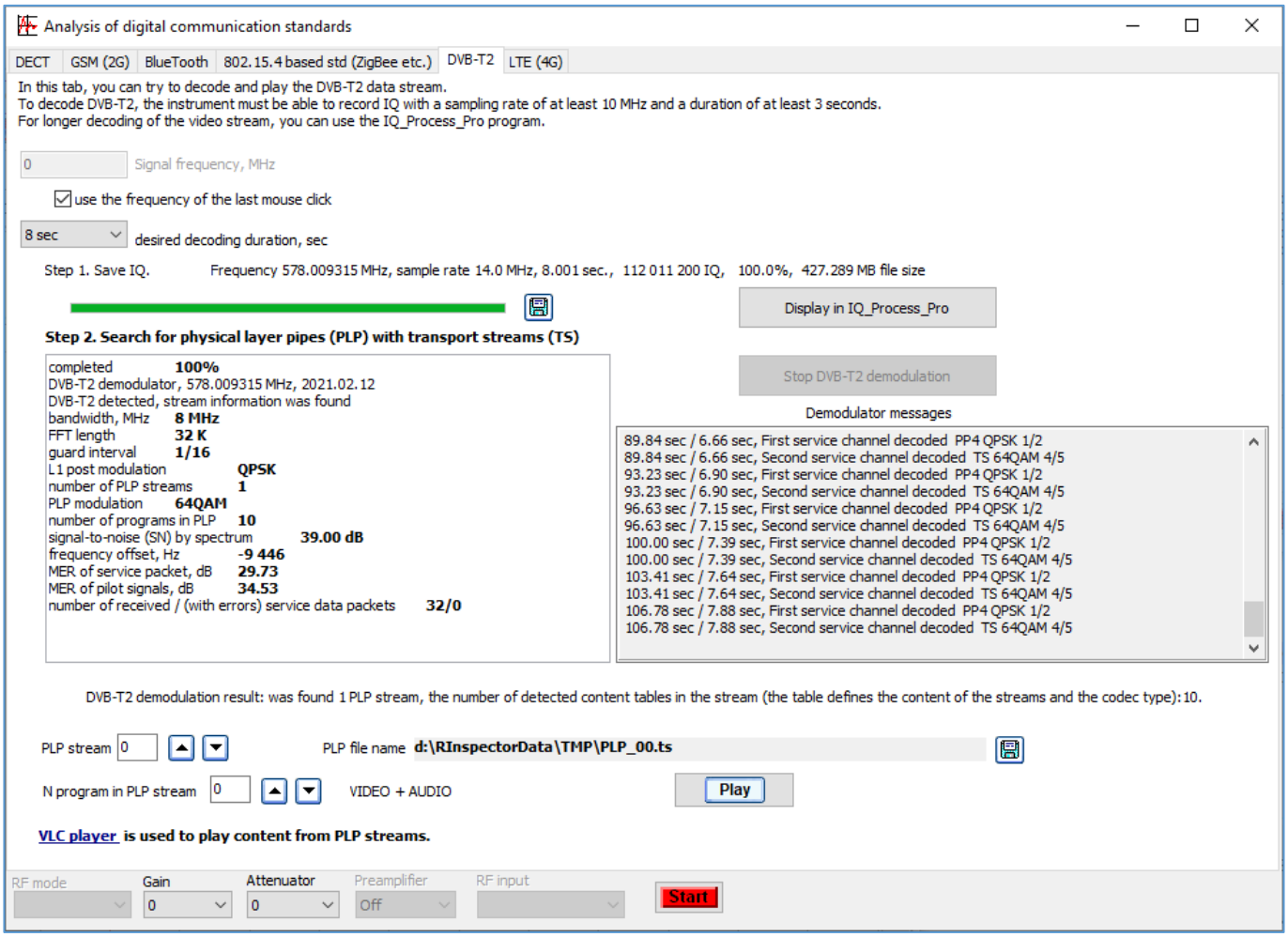
1. Standard, as for all other demodulators when examining the signal that the 1st cursor points to:



At this point, the demodulator works only until the service information is received (analogous to the Service data mode in the IQ_ProcessPRO program).

2. In the Digital analysis window, on the DVB-T2 tab.

On this tab, you can try to display the audio and video content contained in the signal:



The algorithm for analyzing the DVB-T2 signal on this tab:
The program records the IQ of the signal, the frequency of which is fixed or indicated by the last cursor set. After recording the IQ, the signal is demodulated, and when it detects data streams and program tables (codecs), it can be played back using the VLC player. The elements of the DVB-T2 signal analysis interface on this page are identical to the same interface elements in the IQ_ProcessPRO program and should not cause difficulties in operation.

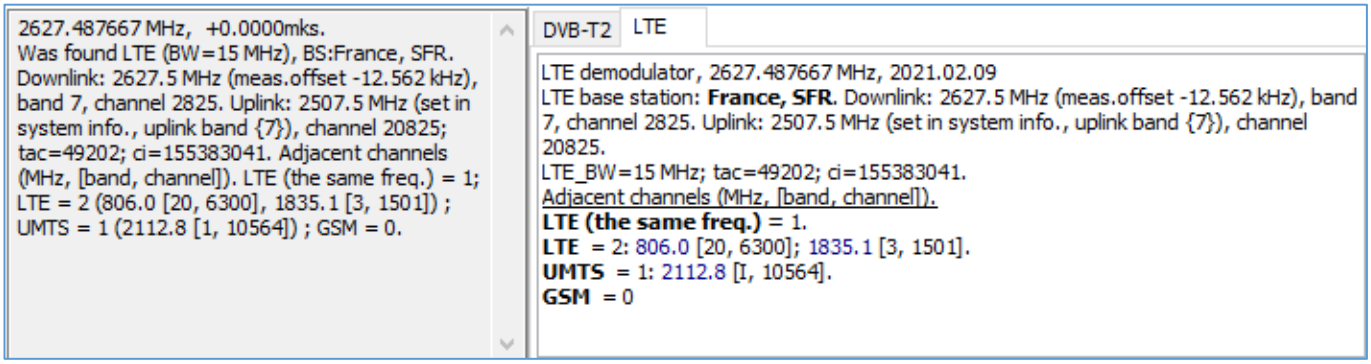
This operation can only be performed in the RadioInspectorRT program. In the RadioInspectorRC program

2020.12.08

LTE (4G) demodulator has been developed.

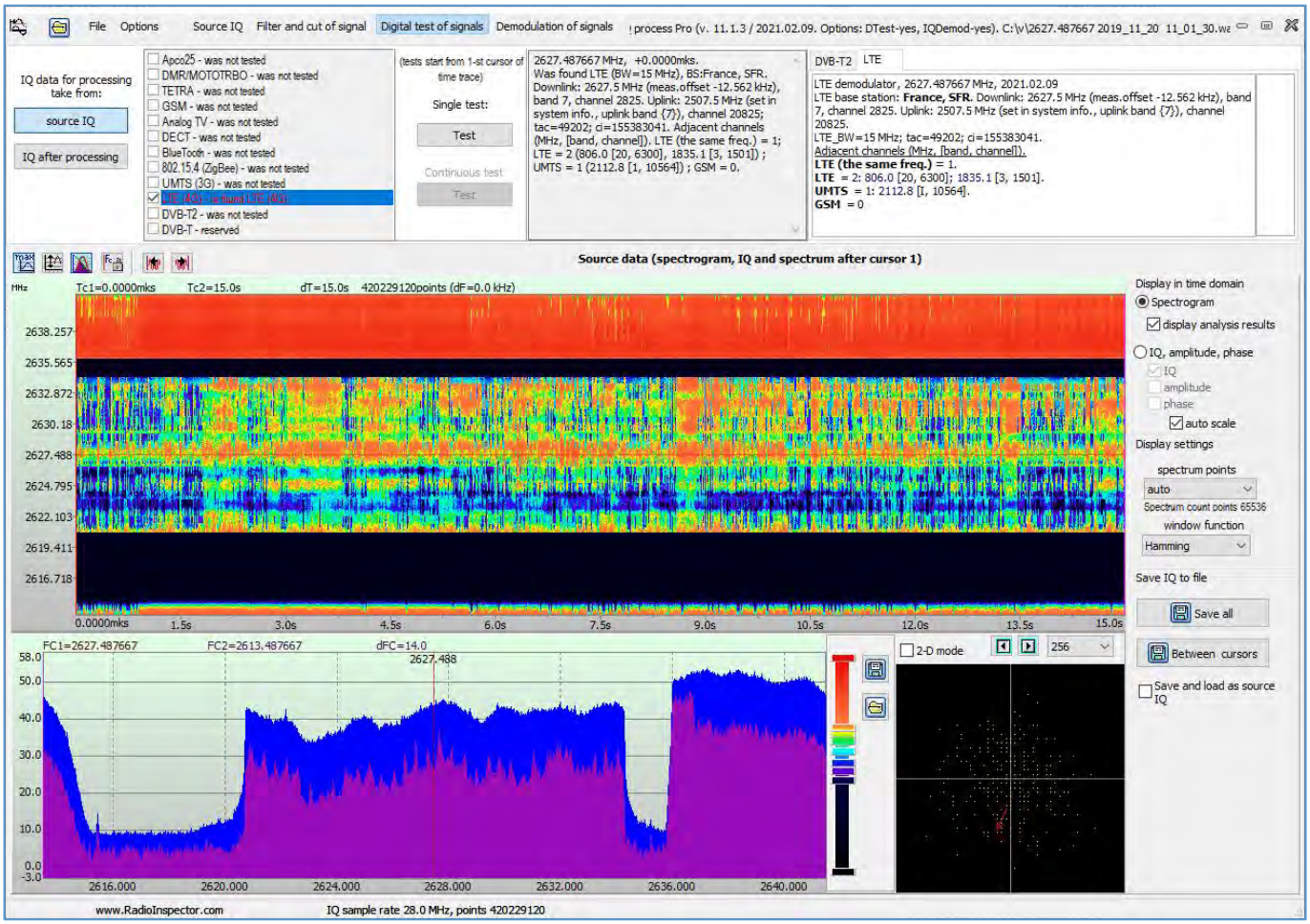
Briefly.
An LTE (4G) demodulator has been developed. The LTE demodulator is included in the DTEST option and can be used in the RadioIInspectorRT, RadioInspectorRC, and IQ_ProcessPRO programs. The LTE demodulator, together with the previously developed GSM(2G) and UMTS (3G) demodulators, allows you to analyze current wireless networks of the 2G, 3G, and 4G generations, including determining the network topology. The demodulator provides basic data

about the LTE signal: country, operator, location area, sector, UpLink frequency, frequencies of neighboring LTE and UMTS (3G) base stations of its network.



<u>In detail.</u>

The LTE demodulator is a software demodulator and is based on the analysis of IQs obtained from <u>any device</u>. The software demodulator can analyze LTE signals at any frequency.



<u>The LTE standard places high demands on the quality of the IQs received from the device:</u>

- the stability of the sample rate offset of IQ should not be worse than 1 ppm;
- the suppression band of the device filters by 40 dB when receiving IQ - no more than 20% of the sampling frequency;
- uneven frequency response in the signal frequency band no more than 5 dB;

- the error of tuning to the LTE signal frequency should not exceed 10% of the bandwidth of the occupied signal frequencies;
- the signal-to-noise ratio must be at least 15 dB in the entire IQ frequency band (interference refers to noise, out-of-band signals with the device filter suppression, mirror channel, and any other extraneous signals in the LTE signal frequency band);
- out-of-band legal extraneous signals falling into the IQ sampling frequency band, located beyond the LTE signal frequency band, must not exceed the LTE signal level by 20 dB (for example, the LTE signal frequency band is 20 MHz, the sampling frequency is 60 MHz. To the right and left of the LTE signal are the 15 MHz frequency bands. It is necessary that the legal signals located in the 15 MHz frequency bands below and above the LTE signal frequency band do not exceed the analyzed LTE signal by 20 dB).

Failure to meet one or more requirements results in the inability to demodulate the LTE signal or in a decrease in the quality of demodulation.

The required sampling rates are IQ.

The maximum occupied frequency band of a single LTE signal is 20 MHz. For such a signal, the required IQ sampling rate must be any, at least 28 MHz (the duration of the IQ recording is at least 1 second). If the maximum sampling rate of the device IQ is less than 28 MHz, the demodulator will determine that the recorded signal is an LTE signal with a bandwidth of 20 MHz, but will not give out detailed data about the signal. Similarly, an LTE signal with a 10 MHz bandwidth requires a sampling rate of at least 14 MHz. If the maximum sampling rate of the device's IQ is less than 14 MHz, the demodulator will determine that the recorded signal is an LTE signal with a bandwidth of 10 or 20 MHz, but will not provide detailed data about the signal. The minimum required sampling rate for LTE signal identification is 5 MHz.

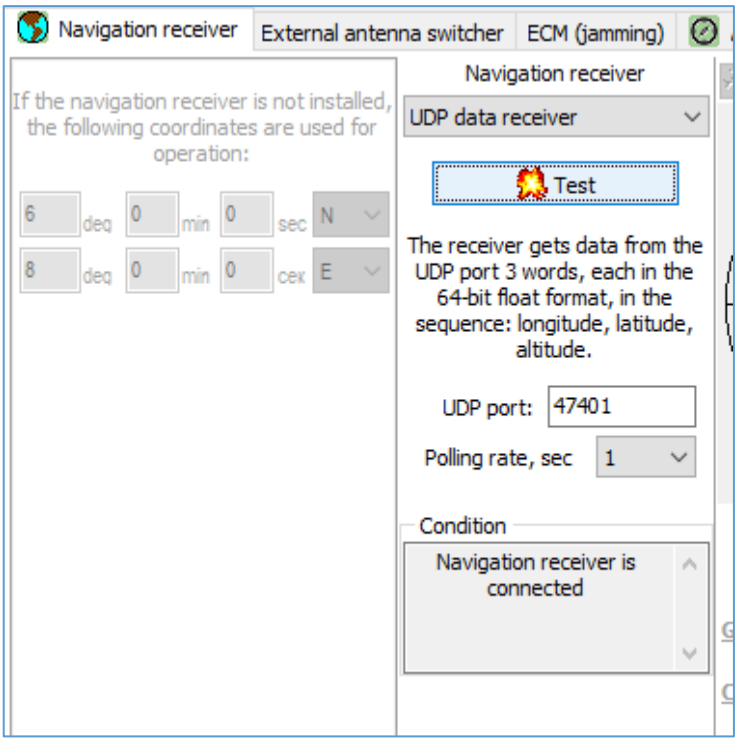
2021.01.08

The ThinkRF R5500 series is connected to the software.

Briefly.
The ThinkRF R5500 series of devices is connected to the software. Traditionally, we do not give the technical and ergonomic characteristics of the device, in order not to compare devices from different manufacturers.
The device allows you to perform digital analysis of all signals included in the DTest option. However, the analysis of broadband signals (DVB-T2, DVB-T, UMTS, LTE) simultaneously with narrowband signals, as well as simultaneous analysis of LTE, DVB-T, DVB-T, UMTS signals is not possible due to the limited size of the IQ memory.
The device can work in 32 and 64 bit versions of the software. The features of connecting this device to a computer and the RadioInspectorRT and I_MasterDevice programs are described in the document "Features of connecting different devices".

2021.06.04

Working with an external compass and navigation receiver

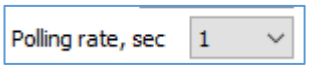


Briefly.
Often, the RadioInspectorRT program works as part of equipment that already has a high-quality compass and navigation receiver. Many users have been assigned the task of using an external compass and a navigation receiver in the RadioInspectorRT program. At the same time, the compass and navigation receiver data can be transmitted from another computer.
To solve this problem, 2 new devices were introduced into the program: "UDP data <navigation>receiver" and "UDP data compass".

In detail.
To use the data from the navigation receiver and compass, which are already working as part of the related equipment, 2 new devices have been developed: "UDP data <navigation>receiver" and "UDP data compass".

The device " UDP data <navigation>receiver "is selected on the tab" Navigation receiver", the device"UDP data receiver".

The device receives data via the UDP protocol from the port specified in the Frequency settings



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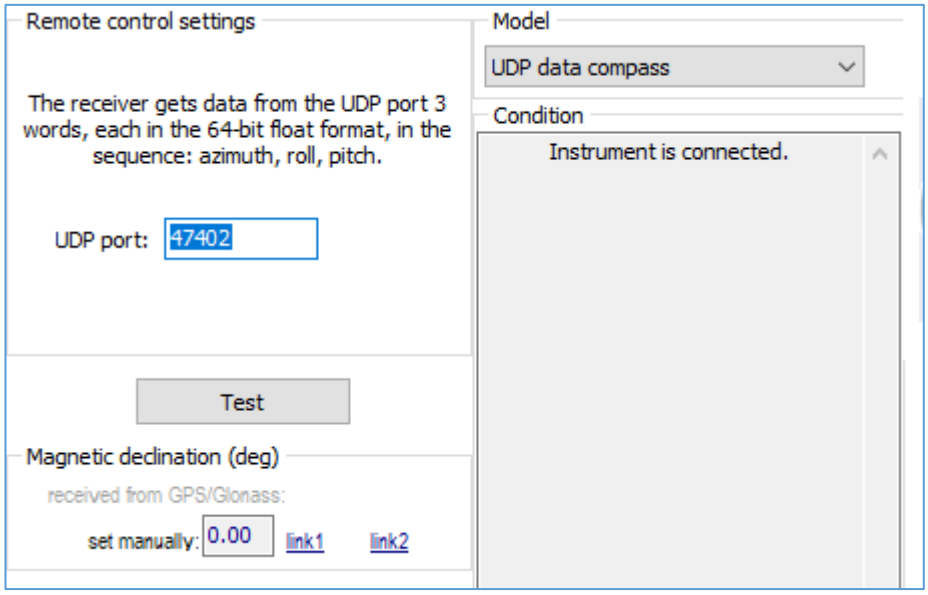
Data about longitude, latitude and altitude are transmitted in the float 64 bit (double) format in the following sequence: 8 bytes-longitude (-180..180 degrees), 8 bytes – latitude (-90..90 deg.), 8 bytes-height (m.). Each UDP packet must contain strictly 24 bytes.



The "UDP data compass" device is selected on the "Antenna Compass" tab, the "UDP data compass" device.

The device receives data via the UDP protocol from the port specified in the settings.

Data about azimuth, roll and pitch is transmitted in the float 24 bit (double) format, in the following sequence: 8 bytes-azimuth (0..360 degrees), 8 bytes-roll (-180..180 degrees), 8 bytes-pitch (-90..90 deg.). Each UDP packet must contain strictly 24 bytes.

For these examples to work, you need to write a small program that generates the necessary UDP packets on the side of external equipment and sends them to pre-defined ports to a computer with the RadioInspectorRT program.

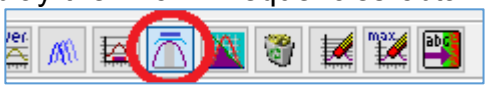
Note. The frequency of transmission of GWZ packets for the device "UDP data <navigation>receiver" should be no more than 1 packet per 100 ms, for "UDP data compass" - no more than 10 ms.

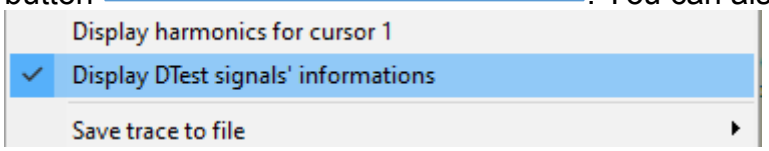
2021.09.01

Display of known signals based on results of digital analysis on panorama graphs

The result of digital signal analysis (DTest option) is the identification and classification of signals. If the signals of 2G, 3G and 4G cellular networks are analyzed, then in addition to the main signal, the frequencies of neighboring signals of base stations are identified. Information about them is transmitted in the service information of the analyzed signal.

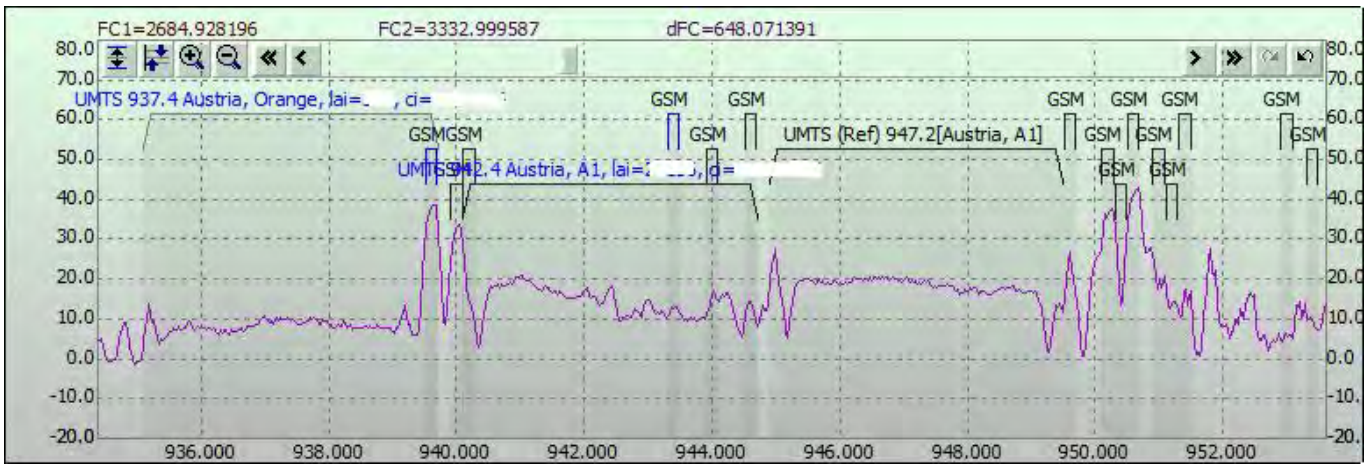
The frequencies of the detected signals can be highlighted on the panorama graph for clarity and identification.

To display the known frequencies obtained from the results of digital signal analysis, there is a button  . You can also use the context menu sub-item



(the right mouse button over the panorama graphs field).

The frequency ranges occupied by known signals are highlighted on the panorama graph:

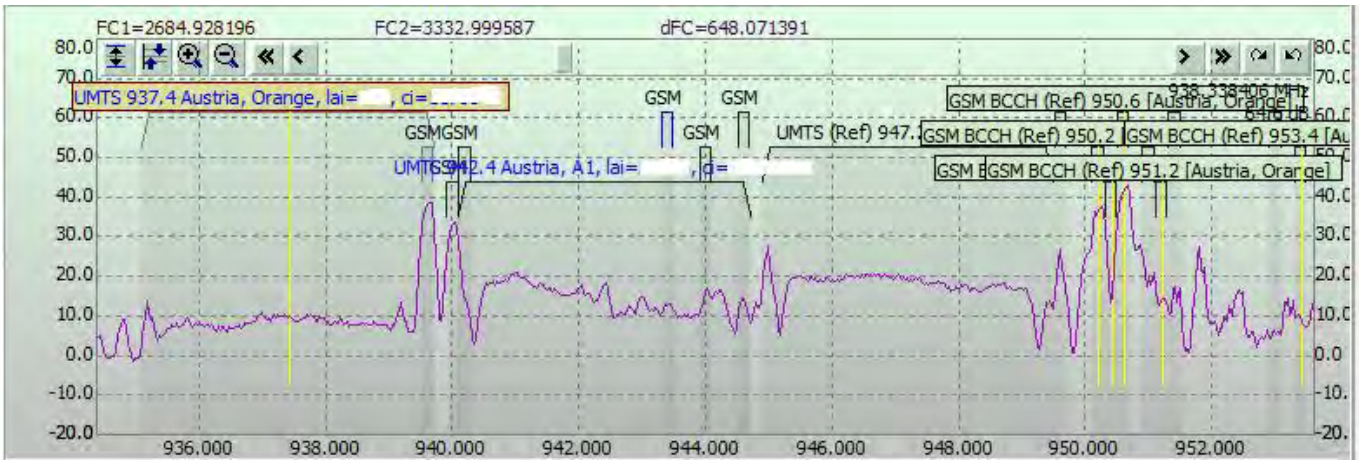


If the bandwidth of the signal allows you to display complete information about the signal, then data about the operator, location area, and base station number is displayed. Otherwise, only the communication standard is signed.

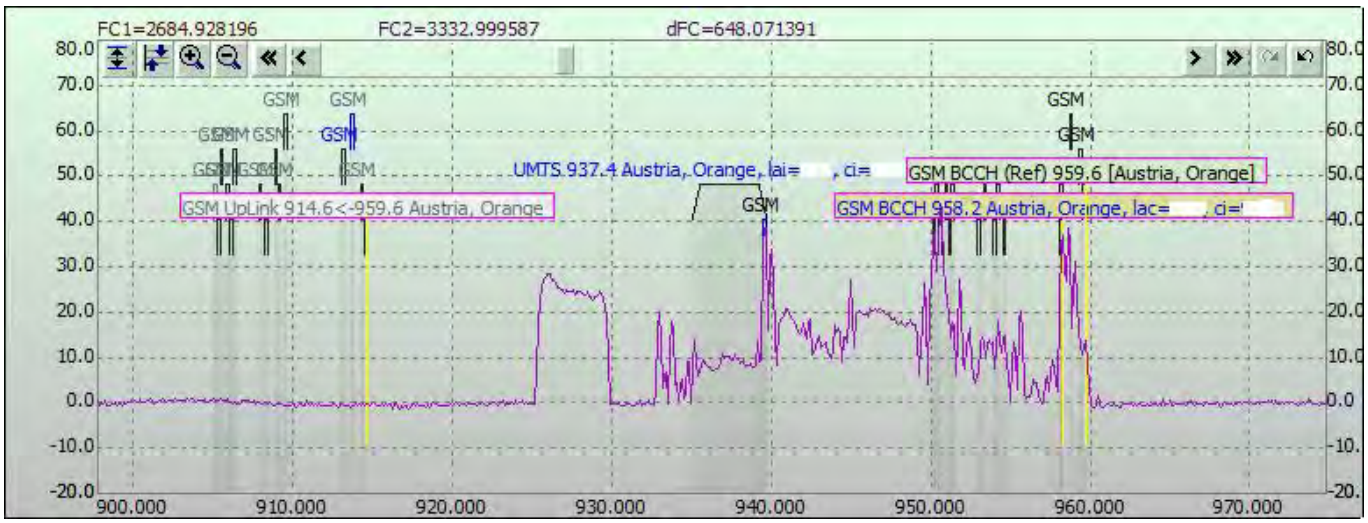
The signals can be signed in blue, black and gray.

- Signals that were directly identified using digital analysis are signed in blue (button );
- The signals that were identified by the links in the service information of the analyzed signals are signed in black. These signals do not have data about the location area, and the number of the base station. In the expanded information, these signals have an inscription "(Ref) – "reference").
- UpLink frequencies (mobile device frequencies) are signed in gray.

"Related" signals (those that have links to each other) can be determined by hovering the mouse pointer over the name of the signal.



In this example, the mouse was pointed at the analyzed 947.2 MHz signal and the program selected 3 associated signals that were referenced in the service information – 944.6, 940.2 MHz-GSM (2G) and 942.4-UMTS (3G).



In this example, the mouse pointer was pointed at the "black" signal of 958.8 MHz and the program displayed 2 associated signals – the "blue" signal of 939.6 MHz (a signal that was analyzed with a reference to 958.8 MHz) and the "gray" signal of 913.8 MHz (the duplex signal of the mobile station for the 958.8 MHz signal).

The selected signals can be "Locked" signals are highlighted with a red border. Such signals remain highlighted after moving the mouse pointer to another location. To block the selection of a signal, you need to click on it with the left or right mouse button. This operation is convenient for searching for related signals when moving the panorama graph to another frequency domain or changing the scale of the panorama graph. "Locked" signals remain visible even if the display of the signal standard, operator or "location area" is canceled.

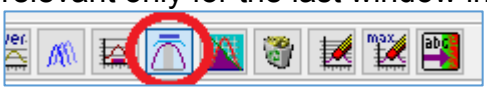
<u>A tree of information about detected signals.</u>

The tree of information about detected signals groups detected signals by common features: communication standard, network operator, location area.

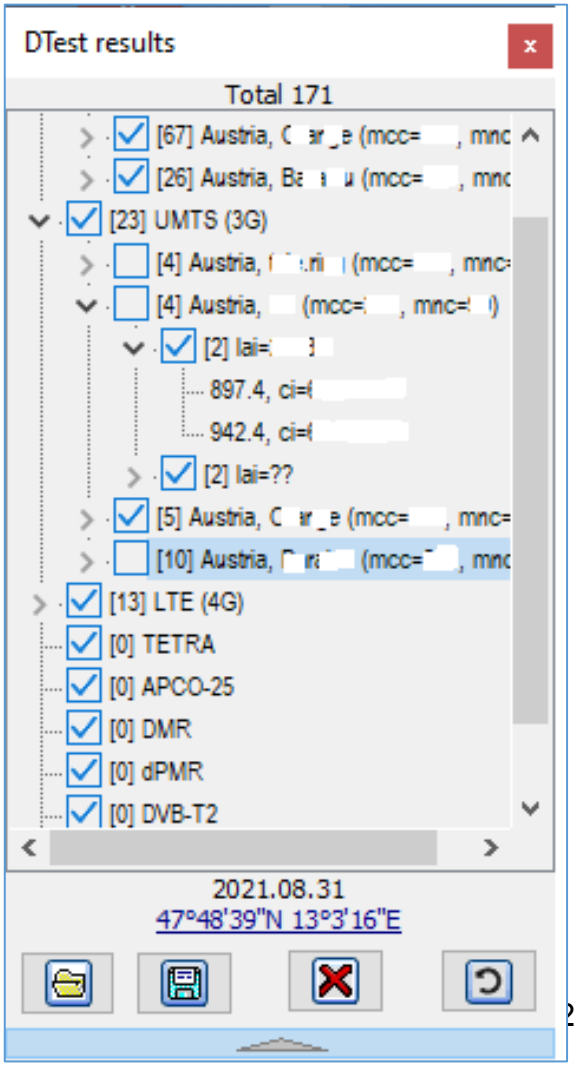
The tree of information about detected signals is displayed simultaneously with the display of known signals based on the results of digital analysis.

In this window, you can disable the display of individual standards or telecom operators. This is convenient in order to remove some of the information from the screen and leave only the necessary data for analysis.

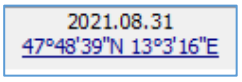
If the program uses several windows of the "frequency range monitoring" task at the same time, the tree of information about detected signals will be relevant only for the last window in which the button



was pressed . This is important for understanding what data is displayed in different windows.



Special attention should be paid to the coordinates of the measurement points. The area of measurement and signal analysis is very important for analysis, since changing the measurement point by a short distance can lead to a different picture of the network topology.

The coordinates (if a navigation receiver is used or fixed coordinates are defined) and the time of the first recorded measurement are displayed in the field 

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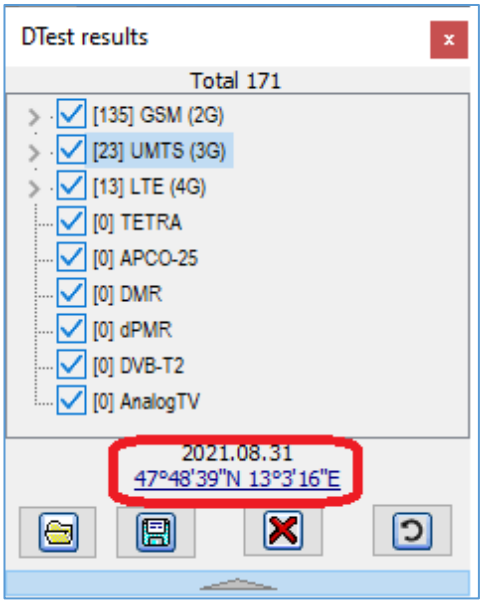
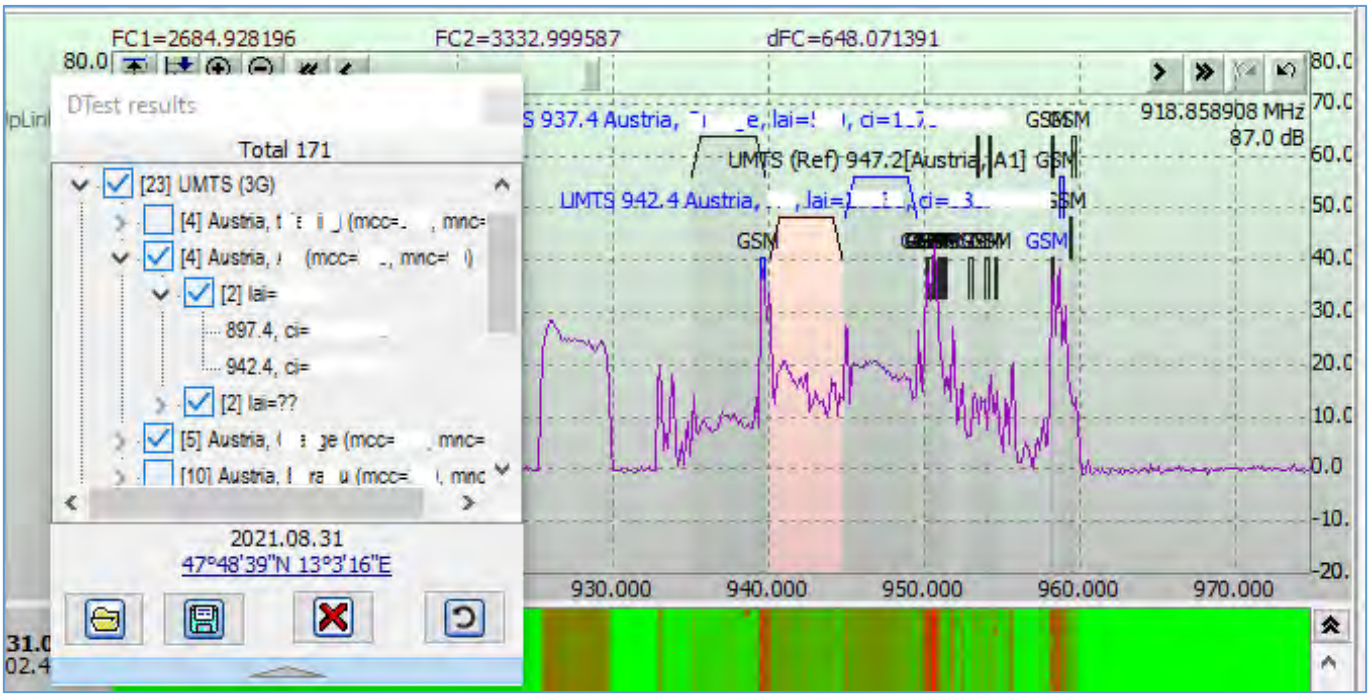
If you click on the coordinates field, the measurement point will be displayed on the map (if the GEO option is set).



If you click on the signal frequency in the window of the information tree about detected signals, the program will highlight this signal in a lighter color:

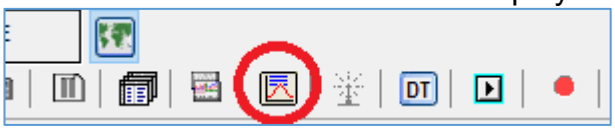


Buttons  are used to load, save, delete and restore information about detected signals that are displayed on the panorama graph.

Note 1. To analyze digital signals in the program, the DTest option is required. The DTest option is not required to display data about detected signals. To display signal data, you can download a file previously saved by the program with the DTest option.
Note 2. It should be noted that for many signals, the location area field is not defined. Location aria is not defined for signals received by links from the analyzed signal, since this data is not included in the service information.

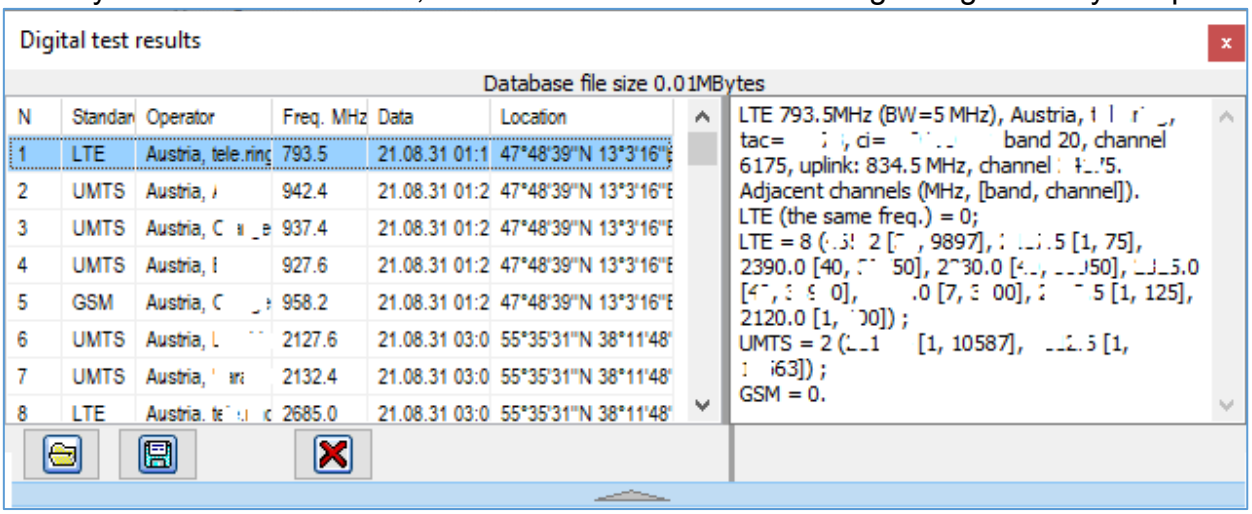
2021.09.01

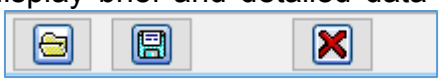
Saving and displaying the history of the results of digital signal analysis.

There is a button to display the data of the digital analysis results 

.

When you click on this button, a window of saved results of digital signal analysis opens.



In this window, the table and the text field display brief and detailed data about the detected signals. Using the buttons located in the field  , you can save the analysis results, load previously saved analysis results or clear the list.

If the map is open (GEO option), then when a line is selected in the list of signals, a measurement column is displayed on the map.

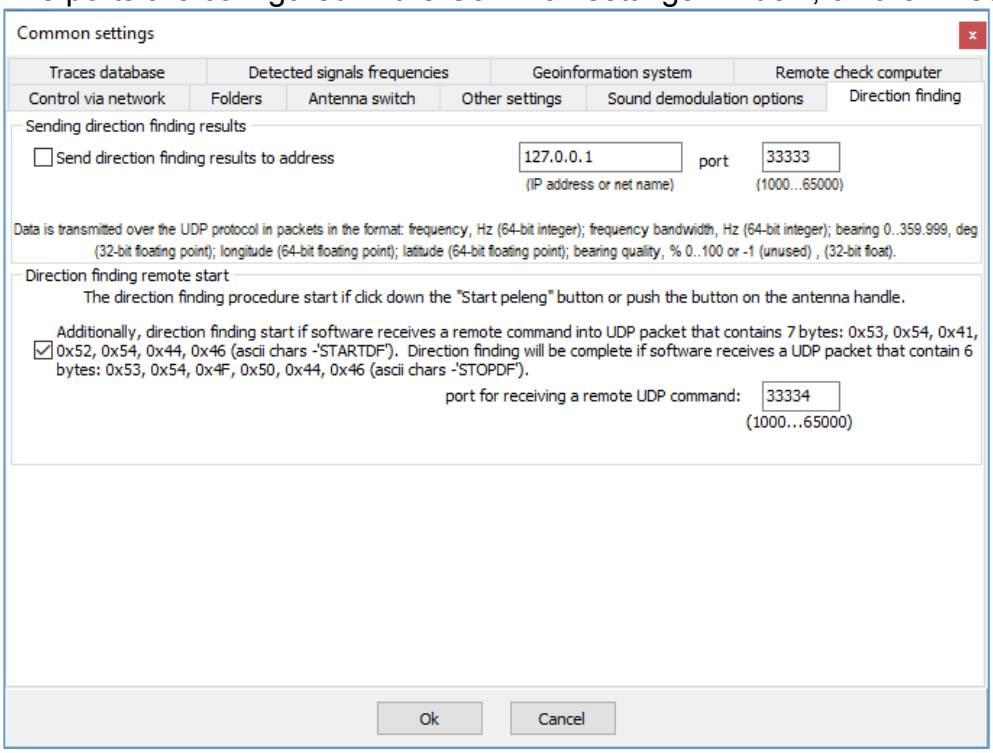
2021.11.26

Remote launch of the direction finding procedure and transmission of direction finding data to a remote computer.

Sometimes there is a need to synchronize the direction finding process with external events. For example, synchronize the beginning and end of the direction finding procedure with the beginning and end of the rotary device operation, or, when the car is moving, turn off direction finding when tunnels are blocked. The direction finding process can be controlled by

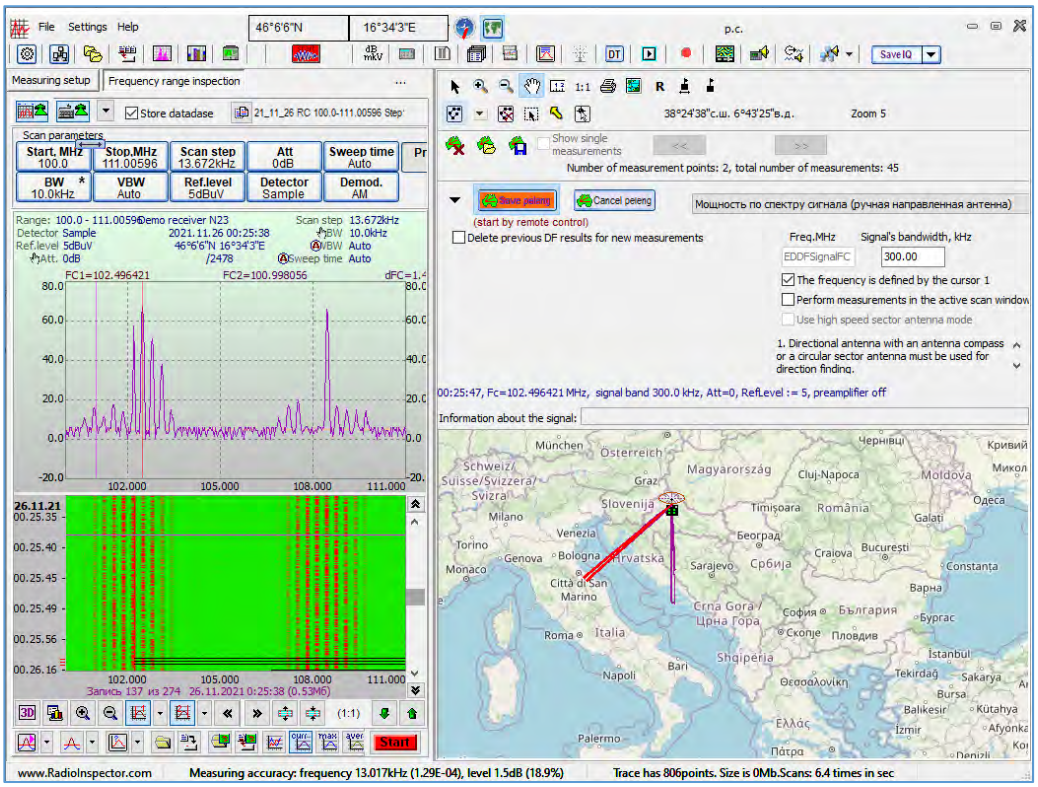
transmitting a special UDP packet to a pre-agreed port of the computer on which the RadioInspectorRT/RC program is running.

The ports are configured in the Common settings window, on the Direction Finding tab.

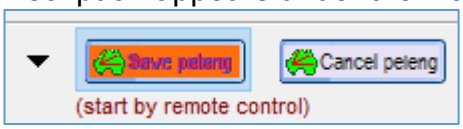


The contents of the UDP packet for starting and stopping the direction finding procedure are displayed on the "Direction finding" tab of the Common settings window.

Also, on this page you can determine the address and port of the remote computer to which the direction finding results will be sent.



If the direction finding procedure is started or stopped by remote control, the corresponding inscription appears under the manual start button of the direction finding start:



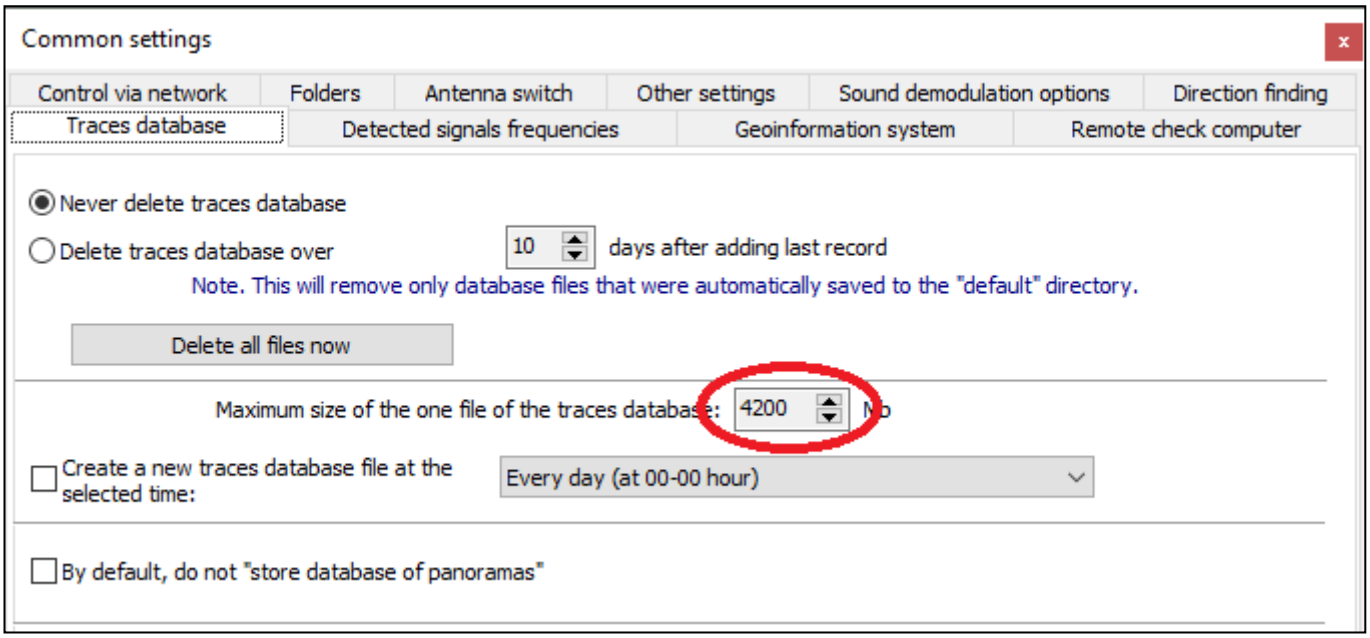
. Using the button  , you can open the general settings window on the required tab.

2021.11.29

Analysis of signals over a long period of observation (sampling of a sub-range of frequencies from many panorama databases).

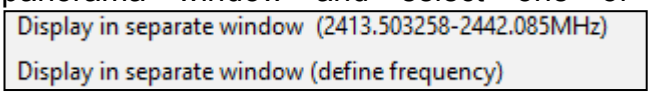
With round-the-clock radio monitoring, the task of analyzing individual rarely repeated signals is often encountered. For example, the signal occurs once a day and lasts 5 minutes. It is visible on the Maximum values trace. It is necessary to analyze the statistics of the appearance of this signal in order to identify it and localize the source of its radiation.

Modern devices used for radio monitoring have a very high scanning speed. Many panorama database files can be created in a day.
When the current panorama database file reaches the size limit set in the general settings window, a new file is created with the same name, but with the index increased by one at the end of the file in parentheses.

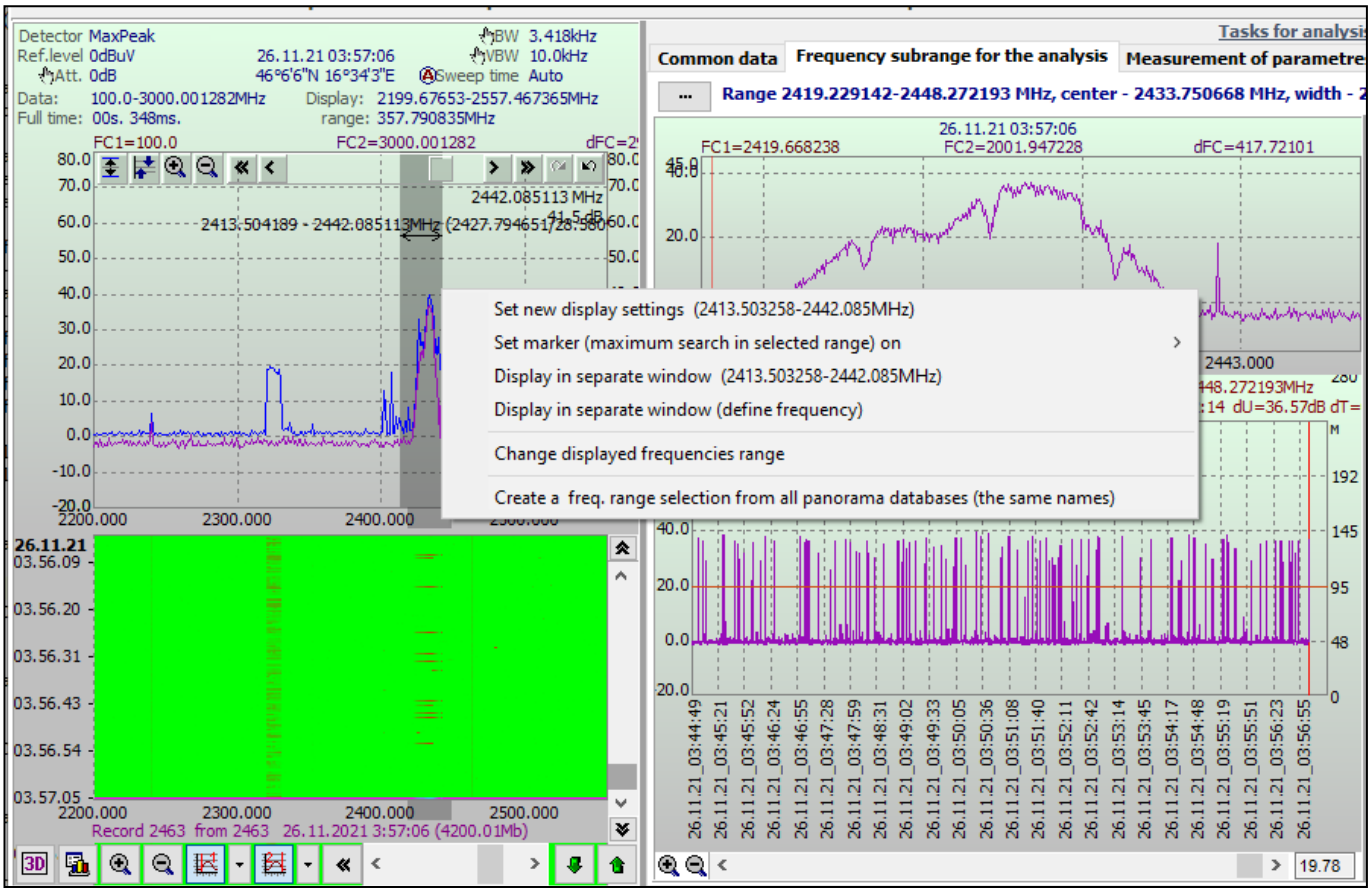


This is necessary in order to be able to copy, open, and analyze each panorama database file in an acceptable time.

The analysis of a single signal in the time domain is performed in the RadioInspectorRP program. To analyze, you need to select a signal using the right mouse button in the signal panorama window and select one of the menu sub-items in the pop-up menu



. The spectrum of the selected signal signal and the time-signal level graph will appear in the additional field.



Previously, this operation could be done with only one panorama database file.

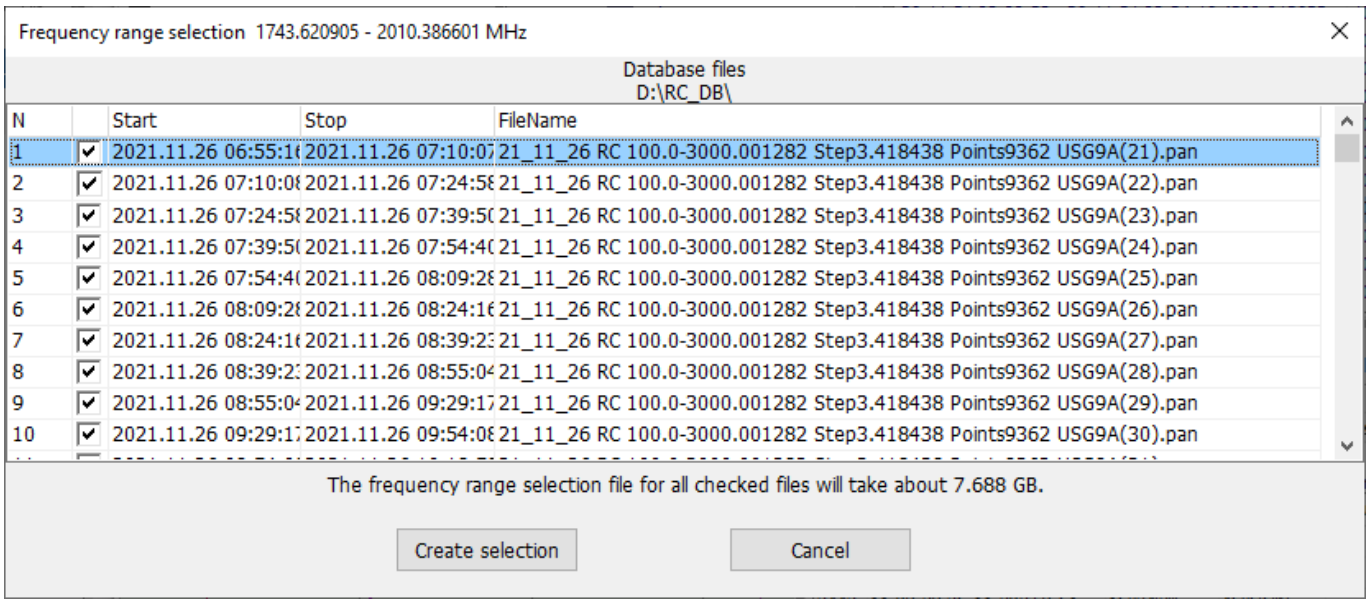
What if the signal occurred once a day and it is necessary to determine when it occurred, and 10 panorama databases were generated during the day? Previously, it was necessary to open all panorama databases sequentially and analyze them sequentially.

Starting with software version 12.1.2, a menu sub-item appeared in the pop-up menu that appears when selecting a sub-band of frequencies with the right mouse button Create a freq. range selection from all panorama databases (the same names).

When you select this menu sub-item, a SINGLE database file is created, which contains only the selected frequency sub-band. The analysis time of the allocated frequency subband will be equal to the entire time of radio monitoring, for which there are panorama database files of the same name.

<u>The algorithm of work.</u>

After selecting the menu item Create a freq. range selection from all panorama databases (the same names), the program searches for all the panorama database files of the same name with different indexes. The search is performed in the same folder where the current analyzed panorama database file is located. Information about files is displayed in a separate window where you can exclude unnecessary files based on the time of their creation.



Also, this window displays the resulting file size of the panorama database of the selected frequency sub-band.

Attention. There are no restrictions on the size of the resulting database of these panoramas. It is necessary to monitor the free amount of disk space.

The database of panoramas of the selected frequency range is formed in the background. A window with information about the progress of the operation is displayed on the screen.

After creating a database of panoramas of the selected frequency sub-band, it can be downloaded as the main database in the RadioInspectorRP program and analyze the amplitude-time characteristics of the signal, as described at the beginning of the article.

In the RadioInspectorRT/RC program, you can also create a selection of a sub-frequency range for all previously created panorama databases. It is also necessary to select the required sub-band of frequencies and click on the sub-item of the pop-up menu Create a freq. range selection from all panorama databases (the same names). As a result of this operation, the RadioInspectorRP program will be launched, in which the current panorama database will open, in which the process of creating a sample of the frequency sub-band according to the algorithm described above will automatically start.

2021.12.20

Analog demodulators of USB and LSB are developed.

Software demodulators of signals of LSB and USB standards have been developed.
When using devices that allow you to receive an IQ stream with a sampling frequency of at least 6 kHz, demodulation of USB, LSB signals is possible.
Demodulators use a filter at the adjacent channel frequency (which is used to restore the full signal) before demodulation, therefore, another signal operating at the adjacent channel frequency does not affect the quality of demodulation of USB and LSB signals.

A list of devices that can perform analysis and demodulation of these standards is given in the section "Capabilities of different devices for digital signal analysis using the DTest option".

2022.01.10

Demodulators of the NXDN and dPMR standards are developed.

Software demodulators of signals of NXDN and dPMR standards have been developed.
When using devices that allow you to receive an IQ stream with a sampling frequency of at least 10 kHz, it is possible to use demodulators of these standards.
The DTest signal analysis option ("digital test") includes the ability to identify and analyze signals of the NXDN, dPMR standards.

A list of devices that can perform analysis and demodulation of these standards is given in the section "Capabilities of different devices for digital signal analysis using the DTest option".

2022.01.20

DVB-T standard demodulators are developed.

A software demodulator of the DVB-T standard has been developed.
Despite the similarity of the names, the DVB-T standard is a completely different data encoding standard compared to the DVB-T2 standard. DVB-T and DVB-T2 standards are an example of maximum flexibility and maximum efficiency of data transmission in a limited frequency range in real radio using OFDM modulation.

Encoding data in a radio signal is very complex. Software demodulation of these signals, even on the most advanced computers, currently takes 5-10 times longer than the duration of the demodulated signal. Nevertheless, the analysis of the radio signal (option "DTest") allows you to identify the signals of DVB-T, DVB-T2 standards and analyze their main characteristics. The built-in demodulation tools in the RInspectorRT/RC program allow you to demodulate audio and video content for a limited time (5-10 seconds), and the IQ_ProcessPro program allows you to demodulate video and audio content for an unlimited time (time is limited by the duration of the recorded file with signal quadratures).

DVB-T and DVB-T2 signals can contain not only audio and video data, but also any binary data stream. If the signal contains audio and video data that use the codecs specified in the specification for them, then software demodulators identify these signals as signals transmitting audio and video information. If codecs other than those specified in the specification are used in the signal, the program signals that data is being transmitted.

In any case, demodulators form files with the extension *.ts, which contain a data stream that is transmitted using a radio signal. A file with the *.ts extension is a standard file that contains a transport stream of data ("transport stream"). This file can be opened by various software tools.

The RadioInspector software makes it possible to play audio and video content from these files using a VLC-Player separately installed by the user. However, this does not limit the ability to analyze the data contained in the *.ts files using other software tools.

For convenience, the DVB-T signal analysis and demodulation interface is made similar to the DVB-T2 signal analysis interface. The DVB-T2 signal analysis and demodulation interface is described in the section "DVB-T2 Demodulator is developed".

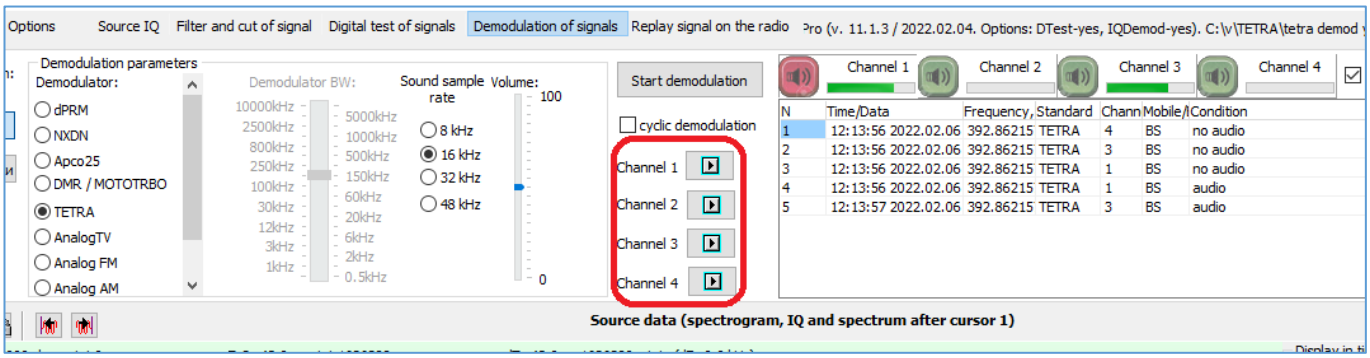
2022.01.30

Instruments for recording demodulated digital and analog radio signals in the IQ_Process Pro program (Demod option) into a standard audio file *.wav and its playback have been developed.

The Demod option in the IQ_ProcessPro program allows you to demodulate analog signals AM, FM, LSB, USB, analog television and digital signals of TETRA, DMR/MOTOTRBO, APCO25, NXDN, dPMR, DVB-T2, DVB-T standards.

The experience of using the Demod option has shown that it is convenient for the operator to save a fragment of the demodulated audio signal in a separate audio file. This is especially true for the DMR/MOTOTRBO and TETRA standards, which can simultaneously transmit voice data on the 2nd or 4th channels, but with demodulation, the operator can listen to only one channel.

The interface of recording and reproducing a demodulated audio signal is extremely simple and does not require separate explanations.



Each time you press the start demodulation button, from one to 4 audio files are generated (depending on the number of channels in the signal), in which the results of demodulation are recorded. After demodulation is complete, these files can be played back and saved to another file in the built-in audio player. It is necessary to understand that when you press the start demodulation button, the previous audio data is deleted.

2020.02.08

Operation of different devices in the 64-bit (x64) and 32-bit versions of the RadioInspector software.

A list of devices supported in the RadioInspector software and the software versions in which they work. The list is not complete. If the device is not in the list, but it is supported by the RadioInspector software, then it only works in the 32-bit version of the software.

The device	32-bit version of software	64-bit version of software	Note
AOR SR2000A	+	-	
• AR 5001D	+	-	
AV4051A, AV4051B, AV4051C, AV4051D, AV4051E, AV4051F, AV4051G, AV4051H	+	?+	In the 64-bit version, the software should work, but it has not been tested
• Advantest R3271, Advantest R3272, Advantest U3772.	+	?+	In the 64-bit version, the software should work, but it has not been tested
• Aeroflex 3251, Aeroflex 3252, Aeroflex 3253, Aeroflex 3254.	+	-	
• Agilent E4411-E4407	+	-	
• Agilent E4440	+	?+	In the 64-bit version, the software should work, but it has not been tested
• Anritsu MS27102A	+	?+	In the 64-bit version, the software should work, but it has not been tested
• Anritsu MS2711E, Anritsu MS2712E, Anritsu MS2713E, Anritsu MS2721A, Anritsu MS2722C, Anritsu MS2723C, Anritsu MS2724C, Anritsu MS2725C, Anritsu MS2726C.	+	-	
• Anritsu MS8911B	+	-	
• HP 8560E-8565E	+	-	
• HP 8590	+	-	
• ICOM PCR1000	+	-	
• ICOM PCR1500	+	-	
• IFR 2394, IFR 2395, IFR 2397, IFR 2399	+	-	
• KEYSIGHT N6841A	+	-	
• KEYSIGHT N9000(13.6GHz),	+	-	

KEYSIGHT N9000(26.5GHz), KEYSIGHT N9000(3GHz), KEYSIGHT N9000(7.5GHz)			
• KEYSIGHT N9010	+	-	
• KEYSIGHT N9020(13.6GHz), KEYSIGHT N9020(26.5GHz), KEYSIGHT N9020(3.6GHz), KEYSIGHT N9020(8.4GHz)	+	-	
• KEYSIGHT N9030	+	-	
• KEYSIGHT N9320	+	-	
• KEYSIGHT N9340	+	-	
• KEYSIGHT N9342C	+	?+	In the 64-bit version, the software should work, but it has not been tested
• KEYSIGHT N9343C	+	?+	In the 64-bit version, the software should work, but it has not been tested
• KEYSIGHT N9344C	+	?+	In the 64-bit version, the software should work, but it has not been tested
• KEYSIGHT N9912A-104, KEYSIGHT N9912A-106	+	?+	In the 64-bit version, the software should work, but it has not been tested
• KEYSIGHT N9913A, KEYSIGHT N9914A, KEYSIGHT N9915A, KEYSIGHT N9916A, KEYSIGHT N9917A, KEYSIGHT N9918A, KEYSIGHT N9935A, KEYSIGHT N9936A, KEYSIGHT N9937A, KEYSIGHT N9938A, KEYSIGHT N9950A, KEYSIGHT N9951A, KEYSIGHT N9952A, KEYSIGHT N9960A, KEYSIGHT N9961A, KEYSIGHT N9962A	+	?+	In the 64-bit version, the software should work, but it has not been tested
• LG SA-930	+	-	
• NARDA NRA IDA3106, NRA3000, NRA6000	+	?+	In the 64-bit version, the software should work, but it has not been tested
• NS 132	+	-	
• NS 265	+	-	
• NS 30	+	-	
• RS-KM series	+	-	
• R&S EB200 D-Scan	+	-	
• R&S EB500	+	-	
• R&S EM100 3.5GHz, R&S	+	?+	In the 64-bit version, the software

EM100 7.5GHz, R&S EM100+HF907			should work, but it has not been tested
• R&S ESCI	+	-	
• R&S ESIB (40)	+	-	
• R&S ESMD	+	?+	In the 64-bit version, the software should work, but it has not been tested
• R&S ESPI3, R&S ESPI7	+	-	
• R&S ESU series	+	-	
• R&S ETL	+	-	
• R&S FS300	+	-	
• R&S FSC series	+	?+	In the 64-bit version, the software should work, but it has not been tested
• R&S FSH3, R&S FSH6, R&S FSH18	+	-	
• R&S FSH4, R&S FSH8, R&S FSH20	+	?+	In the 64-bit version, the software should work, but it has not been tested
• R&S FSL18, R&S FSL3, R&S FSL6	+	-	
• R&S FSP13, R&S FSP3, R&S FSP30, R&S FSP31, R&S FSP40, R&S FSP7	+	-	
• R&S FSQ26, R&S FSQ3, R&S FSQ40, R&S FSQ8 • R&S FSU series	+	-	
• R&S FSV_X series	+	?+	In the 64-bit version, the software should work, but it has not been tested
• R&S FSV3004, R&S FSV3007, R&S FSV3013, R&S FSV3030, R&S FSV3044	+	?+	In the 64-bit version, the software should work, but it has not been tested
• R&S FSW13, R&S FSW26, R&S FSW43, R&S FSW50, R&S FSW67, R&S FSW8, R&S FSW85, R&S PR100	+	-	
• R&S PR100+HF907	+	-	
• R&S PR200	+	+	
• Signal Hound SM200A api 1.x.x	+	-	
• Signal Hound SM200A api 2.x.x	+	+	
• Signal Hound SM200B	+	+	
• SignalHound BB60A	+	-	In the 64-bit version, the software should work, but it has not been tested
• SignalHound BB60C api 2.x.x • SignalHound BB60C api 4.x.x	+	+	

• SignalHound USB-SA124A			
• SignalHound USB-SA124B	+	-	
• SignalHound USB-SA44B	+	-	
• Tektronix H600	**+**	**?+**	In the 64-bit version, the software should work, but it has not been tested
• Tektronix RSA306B			
• Tektronix RSA503A, Tektronix RSA507A, Tektronix RSA513A, Tektronix RSA518A, Tektronix RSA603A, Tektronix RSA607A,	+	+	
• USG-30A, USG-9A	+	+	In the 64-bit version, the software should work, but it has not been tested
• USRP B200	+	-	
• USRP B210	+	-	
• WillTek 9101	+	+	
• ThinkRF R5500	+	+	
•			
• WinRadio 305	+	+	
• AOR-3000A	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR 5000A	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR 5001D Scanner	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR 5000SB8	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR 8600 Mk2	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR 8200	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR 8000	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR SR2200	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR Alpha	+	?+	In the 64-bit version, the software should work, but it has not been tested
• AOR DV1	+	?+	In the 64-bit version, the software should work, but it has not been tested
• ICOM R10	+	?+	In the 64-bit version, the software should work, but it has not been tested
• ICOM R20	+	?+	In the 64-bit version, the software should work, but it has not been

			tested
• ICOM PCR1000 Scanner	+	?+	In the 64-bit version, the software should work, but it has not been tested
• ICOM PCR1500 Scanner	+	?+	In the 64-bit version, the software should work, but it has not been tested
ICOM PCR2500 Scanner	+	?+	In the 64-bit version, the software should work, but it has not been tested
ICOM R8500	+	?+	In the 64-bit version, the software should work, but it has not been tested
ICOM R9500	+	?+	In the 64-bit version, the software should work, but it has not been tested

Capabilities of different devices for digital signal analysis using the DTest option

Table of compliance with the capabilities of devices connected to the RadioInspector software to perform digital signal analysis (identification, service data)

Device, sampling rate (max memory size MSamples/ max recording time, sec), MHz	APCO 25, TETRA, DMR/MOTOTRBO, dPMR, NXDN	UMTS (WCDMA) (3G)	DECT	BlueTooth	GSM	802.15.4 (ZigBee etc.)	Analog TV	DVB-T2	DVB-T	LTE (4G)
R&S FSL[4] 65.8 (0.512/-)	+		+	+	+	+[?]	+	-	-	-
R&S FSV[4] 32, 26, 20, 15, 12.5, 8, 5, 4,2,1 (100/3.125)	+	+	+	+	+	+[?]	+	+	+	+[?,2]
R&S FSV30xx[4] 50,40,32,26,20,15,10,8,5,4,2,1 (100/3.125)	+	+	+	+	+	+[?]	+	+	+	+[?,2]
R&S FSW[4] 12.5, 10, 7, 5, 2, 1 (440/15)	+	+	+	+	+	+[?]	+	+[?]	+[?]	+[?,2]
R&S FSQ //as FSU	+	+[?]	+	+	+	+[?]	+	+[?]	+[?]	-
R&S FSU (ESU) [4] 40, 35, 30, 25, 20, 15, 10, 8, 5, 3, 2 (16/	+	-	+	+	+	+[?]	+	-	-	-
R&S PR100 (EM100) 0.320/(-/18)	+	-	-	-	+	-	+	-	-	-
R&S PR200 12.8, 6.4, 3.2, 1.6, (-/6)	+	+	+	+	+	+	+	+	+	+[?,2]

R&S ESMD (DDF255) 25.6, 19.2, 12.8, 6.4, 3.2, 1.28 (-/3+)	+	+(?)	+	+	+	+	+	+(?)	+(?)	+(?,2)
R&S EB500 12.8, 6.4, 3.2, 1.28, (-/6)	+	+	+	+	+	+	+	+	+	+(?,2)
Narda NRA6000	+	-	-	-	+	-	+	-	-	-
Narda IDA 2	+	-	-	-	+	-	+	-	-	-
SignalHoundBB60A, SignalHoundBB60C 40,20,10,5,2.5,1.25 (-2+)	+	+	+	+	+	+	+	+	+	+
SignalHound SA44B	+	-	-	-	+	-	+	-	-	-
SignalHound SM200A 50, 25, 12.5, 6.25, 3.125, 1.5625 (-/8+) SignalHound SM200A FW4, SignalHound SM200B 61.44, 30.72, 15.36, 7.68, 3.84, 1.92, 0.96, 0.480, 0.24 (-/6.6+)	+	+	+	+	+	+	+	+	+	+
Anritsu MS27102a 25.416667, 19.062500, 9.531250, 3.812500, 1.906250, 9.53125, (-/2.6+)	+	+	+	+	+	+	+	+(?)	+(?)	+(?,2,3)
USRP B200 30, 20, 10, 6, 2, 1, (-/2+) USRP B210 10, 6, 2, 1 (-/6+)	+	+	+	+	+	+	+	+(?)		+(?,2,3)
Tektronix RSA306B 56, 28, 14, 7, 3.5, 1.75 (-/1.1+)	+	+	+	+	+	+	+	+(?)		+

Tektronix RSA500,600 series 56, 28, 14, 7, 3.5, 1.75 (-/1.1+)	+	+	+	+	+	+	+	+		+
USG 9A, USG30A 56, 28, 14, 7, 3.5, 1.75 (9+)	+	+	+	+	+	+	+	+		+
ThinkRF R5500(4) 31.25, 15.625 … (32/1)	+	+	+	+	+	+	+	+		+(?,2,3)

- (?) – Means that the analysis of the standard is possible taking into account the parameters of the device, but the device has not been tested with this standard
- (1) – Low quality
- (2) – This means that the device can identify the LTE standard, but the details may not be defined for signals that use wide occupied frequency bands
- (3) – The quality of demodulation may be low due to insufficient quality filters or the presence of mirror channels. For example, when demodulating broadband signals with a low signal-to-noise ratio, or if other powerful signals are located near the analyzed signal
- (4) – Limited size of internal IQ memory. The instrument can analyze standards individually, but if the condition "analyze multiple standards" is selected in the RadioInspectorRT (RadioInspectorRC) program, then some standards may not be analyzed due to insufficient IQ length. The required memory size for IQ is T*SR, where T is the time to demodulate the longest standard, and SR is the sampling rate of the broadest standard.

Table of matching capabilities of devices connected to the RadioInspector software to perform real-time demodulation of digital and analog signals (stream demodulation)

	APCO 25, TETRA, DMR / MOTOTRBO, NXDN, dPMR - Demodulation (voice)	**Analog TV** Video Display	**DVB-T2** Video Fragment Display	**DVB-T** Video Fragment Display	**Analog FM** with different bandwidths	**Analog AM** with different bandwidths
R&S FSV	-	-	+	+	-	-
R&S FSV30xx	-	-	+	+	-	-
R&S FSW	-	-	+(?)	+(?)	-	-
R&S FSQ	-	-	+(?)	+(?)	-	-
R&S PR100 (EM100)	+	+ (1)	-	-	+	+
R&S PR200	+	+	+	+	+	+
R&S EB500	+	+	+	+	+	+
R&S ESMD (DDF255)	-	-	+(?)	+(?)	-	-
Narda NRA6000	+	+ (1)	-	-	+	+
Narda IDA 2	+	+ (1)	-	-	+	+
SignalHoundBB60A, SignalHoundBB60C	+	+	+	+	+	+
SignalHound SA44B	+	-	-	-	+	+
SignalHound SM200	+	+	+	+	+	+
Anritsu MS27102a	+	+	+(?)	+(?)	+	+
USRP B200, USRP B210	+	+	+(?)	+(?)	+	+
Tektronix 306B	+	+	+(?)	+(?)	+	+
Tektronix RSA500,600 series	+	+	+	+	+	+
USG 9A, USG30A	+	+	+	+	+	+
ThinkRF R5500	+	+	-	-	+	+

- (1) – Low quality
- (?) – Demodulation is possible taking into account the device parameters, but the device has not been tested with this standard