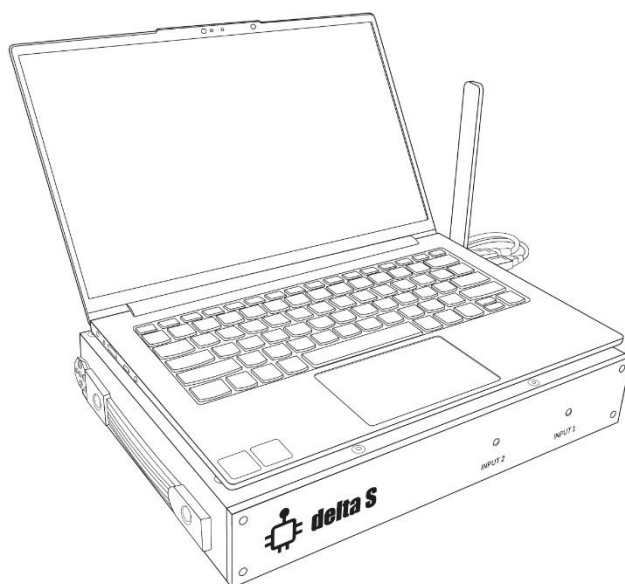# delta S

Countersurveillance sweeping system

User manual
For version of software: 1.0
Edition: July 2022 p.

Content

About the Delta S

General features

- Both easy to learn and a powerful sweeping system
- Quickly and reliably detects all types of RF surveillance devices in the range up to 6 GHz, including analog, digital, working continuously and periodically, transmitting audio or video, with or without encryption
- Finds and identifies covert surveillance devices which use the digital standards GSM, 3G, 4G / LTE, 5G, Bluetooth, Wi-Fi, DECT and others in the range up to 6 GHz
- Analyzes Wi-Fi 2.4 GHz, Wi-Fi 5 GHz, Bluetooth, "Bluetooth LE" and "Bluetooth LE Advertising" channels
- Spectral analysis provides high sensitivity and a long detection distance, exceeding the performance of typical RF detectors and near-field receivers by 10-20 times
- The background masking feature allows you to reject friendly signals such as television, radio, mobile base stations, etc., and focus on finding local signals that pose a danger
- Can be quickly adjusted to the local frequency allocation in the country of use (mobile and wireless bands)
- High-speed spectrum updating and wide real-time bandwidth (RTBW) provide the ability to register short-burst signals
- Search modes include: "All Signals", "Mobile/GPS trackers", "Wireless/ISM" and "Custom", as well as two additional modes for the inspection of suspicious bands or signals
- Two antenna inputs and built-in antenna switch provide maximum sensitivity over the entire frequency range
- Unlimited number of logs, each can contain an unlimited history of events
- "ThreatMark" feature shows dangerous signals on a spectrum graph
- The audio alarm warns the user about the presence of danger with a sound of variable intensity
- The attenuator simplifies location of powerful transmitters
- The "Hold maximum danger" feature automatically displays the most dangerous band or signal
- Demodulation of audio in AM/FM mode
- Works with, and is powered by, a laptop or tablet
- Has convenient magnetic system for attaching the laptop / tablet to the main unit

Specification

Frequency range	57-6000 MHz
Sweeping speed	8 GHz per second
ADC resolution	12 bit
Sensitivity	-85 dB
Dynamic range	80 dB (with attenuator)
Displayed signal level	-90…-10 dB
Real-time bandwidth (RTBW)	27 MHz
Format	Handheld unit
Platform	SDR by Analog Device
Antenna inputs	INPUT 1 – SMA, 57-2000 MHz INPUT 2 – SMA, 2000-6000 MHz
Searching modes and time of update	- All signals (~0.8 s) - Mobile/GPS trackers (~0.2 s)

	• Wireless/ISM (~0.3 s) • Inspect band/signal (~0.1-0.2 s)
Visual elements (panels)	• Level • Spectrum + Waterfall • Alarms
Demodulation	AM and FM with bandwidth 5, 15, 30, 100 and 200 kHz (in the range 70-6000 MHz)
Demands on laptop / tablet	Intel Core i3 / AMD Ryzen 3 or better (recommended Intel Core i5 / AMD Ryzen 5) 2 USB ports, one should be of SuperSpeed type (USB 3.0/3.1/3.2 or USB Type C) RAM 8 Gb or more SSD 128 Gb or more Windows 8,10,11. Screen size 12-14"
Powered	by USB-port of laptop / tablet
Battery resource	1-1.5 hour
Duration of work from AC	Unlimited
Displayed spectrum span	2 - 6000 MHz
Range of working temperature	-5°C…+45°C / 23°F … 113°F
Dimensions of main unit (w/o antennas)	33.5 x 26 x 6 cm / 13.2 x 10.2 x 2.4"
Dimensions of packaging	50 x 40 x 20 см / 19.7 x 15.8 x 7.9"
Weight of main unit with antennas (w/o computer)	3 kg
Weight in packaging	8.5 kg

Functions and features

Search modes
- In the "All signals" mode the system analyzes the spectrum in the full frequency range and detects signals of all types. In addition to mobile and wireless signals, bugging surveillance devices are successfully detected on other frequencies, such as VHF / UHF radio microphones, 900/1200 MHz wireless cameras, and all other RF transmitters up to 6 GHz.
- In the "Mobile/GPS trackers" mode the system detects mobile devices of all standards, including GPS beacons (trackers) that are installed on vehicles and transmit coordinates via mobile networks. Quickly and reliably detects embedded devices (hidden cameras and microphones) that transmit information via mobile GSM, 3G, 4G / LTE and 5G networks (up to 6 GHz).
- In the "Wireless/ISM" mode the Delta S quickly detects Wi-Fi, Bluetooth, ZigBee, DECT, LoRa and other radio frequency devices operating on the ISM bands, such as remote controls, smart home components, wireless sensors, etc.

Bands
- Information about the RF environment is displayed on the bargraphs, each responsible for a separate frequency band
- By default, the frequency range is divided into 3 basic bands, in addition to which a number of mobile and wireless bands are added according to the local frequency allocation
- The table of bands can be easily adjusted to the frequency allocation of the country of use
- It is possible to edit and add new bands, including 4G / LTE and 5G in case of change of frequency allocation
- Each band has an individual threshold which defines the sensitivity and detection distance

- For each band the following information is displayed: name, frequency, current dB level, peak dB level, maximum dB level, threshold, number of dangerous signals and frequency of the most dangerous signal
- The band's bargraph changes color to red when the threshold is exceeded
- The alarm history for each of the bands is stored in the log and displayed on the graph
- The user can inspect separate bands, view the list of signals in it and perform location of the transmitter

Signals
- Signals are automatically recognized in spectral traces, added to the signal list, and then automatically updated
- The list of signals is available in the band's inspection mode
- The frequency, band, channel, current, peak, and maximum recorded level are displayed for each signal
- The alarm history for each signal is stored in the log and can be displayed on the alarms graph
- The user can proceed to the inspection of a single signal

Masking of background
- The "Mask Background" procedure allows the operator to collect and mask external signals, such as TV signals, radio signals, mobile base stations, etc. and thus, focus on identifying only those transmitters that are located in the target area.
- Background signals are ignored with the help of spectral mask, which makes it impossible to hide a bugging device within the TV or radio channel
- This procedure is only required for the "All signals" searching mode
- Signals outside of the mobile and wireless bands are subject to masking only
- The duration of measurement can be selected
- Background masking can be performed at several points around the target zone
- Offset of spectral mask (sensitivity) is set by a threshold

Analysis of Wi-Fi and Bluetooth
- Level of each active Wi-Fi channel is displayed separately when the bands 2.4 GHz and 5 GHz are inspected. Each channel can be studied individually. Interferences of Bluetooth are rejected
- Levels of Bluetooth, Bluetooth LE and Bluetooth LE Advertising are displayed separately. Each type can be inspected separately. Interferences of Wi-Fi are rejected.
- A list of Wi-Fi access points with their attributes and levels can be displayed in the Devices list and on the spectrum

Threshold and warning about alarm
- Each band has an individual threshold which can be defined by user
- The color of the bargraph changes to red when the threshold level is exceeded
- Signals which exceed the threshold are automatically recognized and stored in the log
- The "Audio alarm" feature warns the operator when the threshold is exceeded. The intensity of the alarm increases as the level rises, which facilitates locating the transmitter
- Full alarm history is stored for each band and signal during the search
- Alarm history of a signal or band can be displayed on the graph for any period

Spectrum

- Traces "Live" and "Peak"

- Persistence mode
- Dangerous signals are marked on the spectrum (ThreatMarks feature)
- Waterfall function
- Convenient scrolling and zooming
- Compatibility with touch screens
- Able to zoom in on any part of the spectrum while continuing to search in the entire range
- Buttons for quick selection of the displayed span: "Full" – sets entire range; "Band" – displays the selected band; "Signal" – displays the selected signal.

Supplied set

#	Item	Quantity
1.	Main unit	1
2.	Carry case	1
3.	USB drive with software and user manual	1
4.	Omni-directed wideband antenna ODA-4	1
5.	Microwave antenna MWA-6	1
6.	Microwave antenna LPDA-12	1
7.	Magnetic sticker for laptop or tablet	4
8.	Adapter USB type C – USB type A	2
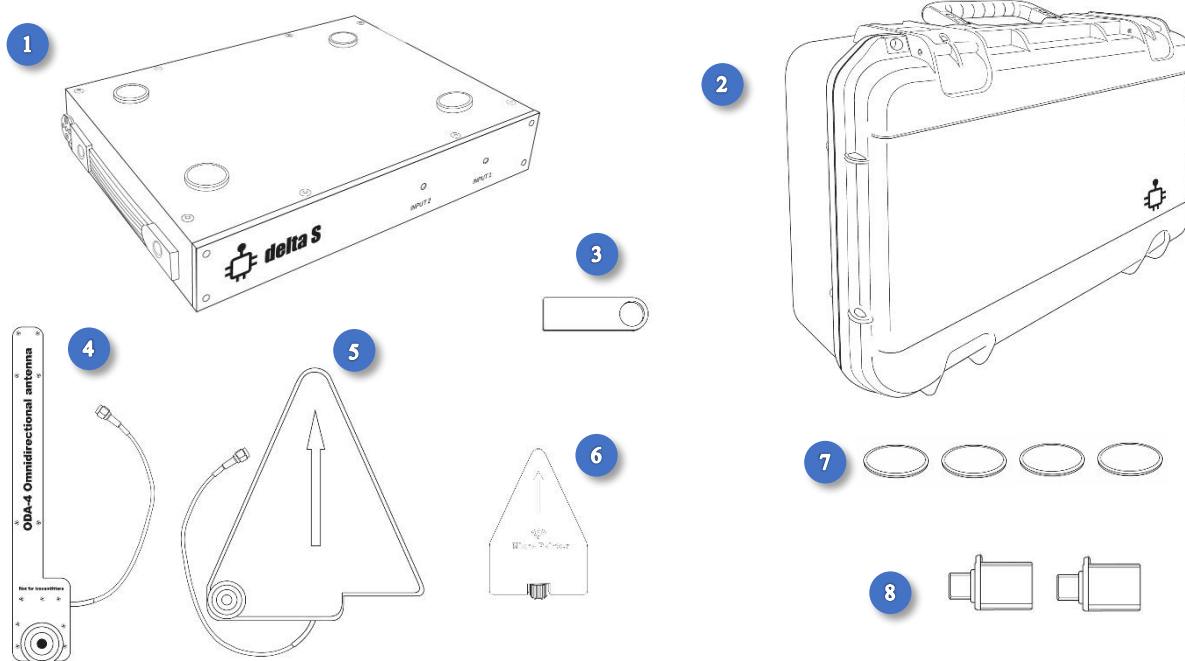
Preparation

Warnings

- Do not apply signals exceeding 0 dBm directly to the inputs of the device
- Avoid operation near strong transmitters such as transceivers or non-linear junction detectors; avoid directing the device's antennas to them.
- Do not direct antennas of powerful transmitters toward the device
- Do not use antennas with non-isolated parts to avoid the electrostatic discharge (ESD)
- Protect input connectors against ESD
- Do not turn on the device immediately after its storage or transporting in a cold environment

Installation

Make sure you are using a computer which corresponds to the specification. Since the system demands significant processing power and performs a high-speed transfer of data, a configuration with a weaker parameter may lead to incorrect work. If possible, deactivate the "USB Suspend" mode in the energy saving settings.

Setup the software from the supplied USB drive. Wait for installation of all components and re-start the computer. Use the start menu or find the shortcut on the desktop to start the software.

Attaching of a laptop or tablet

The Delta S system is designed in the form of a portable unit which holds the laptop or tablet with the help of magnetic holders on its upper side. The counter magnetic stickers are included in the supplied set and must be stuck to the underside of the laptop or tablet before the system is used. Once the stickers are fixed on the bottom side, the laptop or tablet can be attached to or de-attached from the Delta S unit when necessary.

Attaching of magnetic stickers:
1. Clean the bottom side of the laptop/tablet with an anti-grease cleaning wipe
2. Temporarily screw the ODA-4 wide-band antenna to the holder on the right side of the main unit and position it vertically.

Put your laptop or tablet on the Delta S unit, connect the power cable to it, connect the USB cables and adapters as described in section "USB connections" and find the best location for the laptop/tablet, keeping in mind the following suggestions:
- The laptop or tablet should not protrude beyond the edges of the main unit
- Protrusion of the USB cables can be minimized by shifting the laptop/tablet to the opposite side to the USB sockets
- Interference between the cables and antennas can be avoided by shifting the laptop/tablet back-or-forth
- If a tablet is being used make sure the Delta S magnetic holders do not interfere with the tablet's magnetic sensors of "closed cover". If the screen turns off, or a sleep mode is entered suddenly when the tablet is on the holders, it is necessary to change the position of tablet.

- Areas on the laptop's bottom side which touch the magnets must be flat and without any legs or ventilation slots (the stickers will be fixed there). Change the position of laptop if necessary
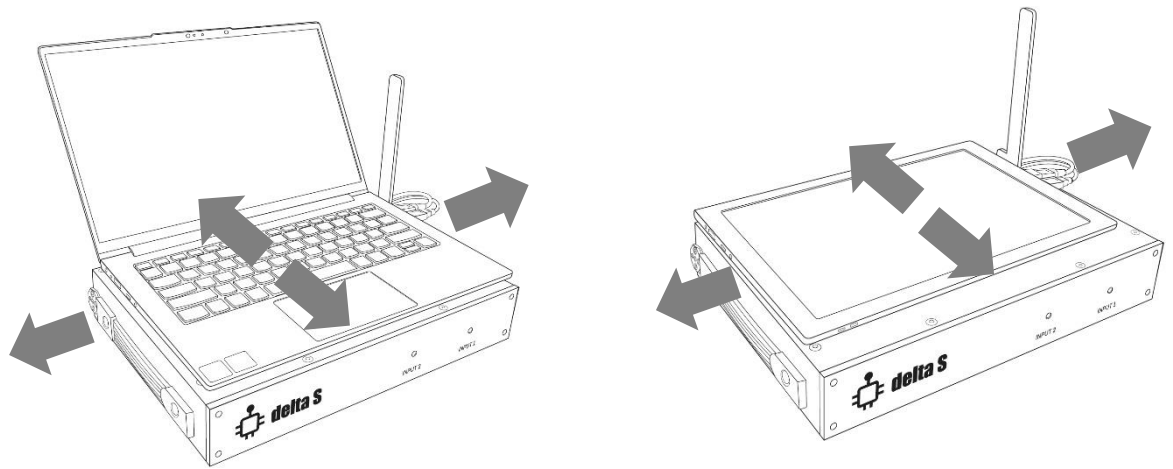
3. Remember the selected location and remove the laptop/tablet
4. Put 4 magnetic stickers on the holders with the adhesive side up and protective film removed. Align the centers
5. Keep the laptop/tablet above the main unit in the desired location, then lower and press it firmly to the stickers. Hold for a minute or two, then lift the laptop by raising its corners in turn. The stickers will be fixed to the bottom side of the laptop/tablet. Allow the glue layer to dry, and avoid multiple mating during the first 24 hours.
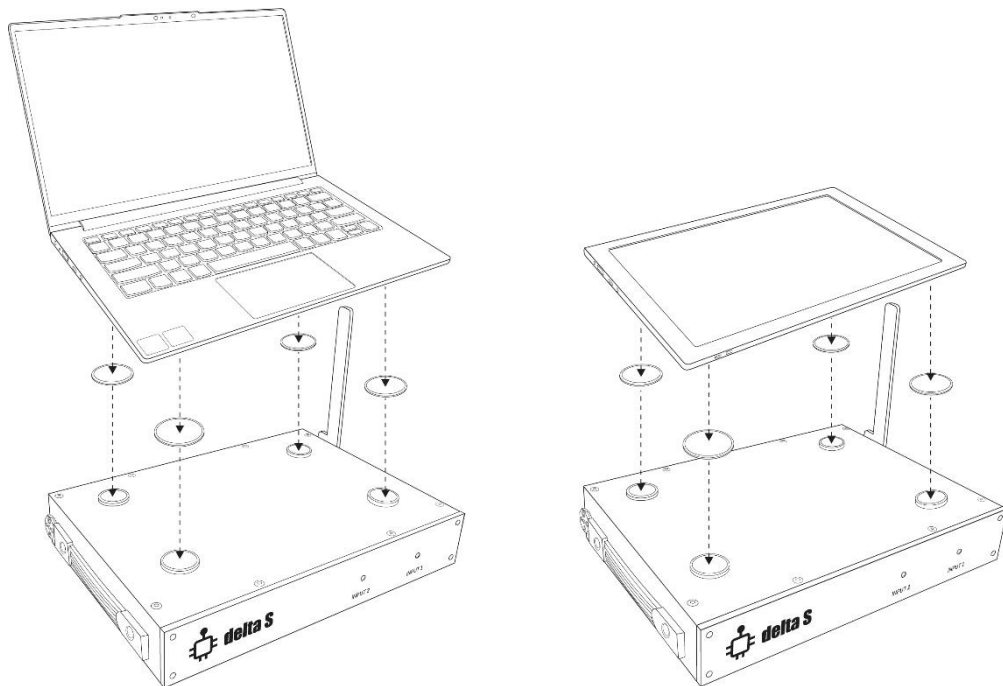
USB connections

The Delta X system has 2 USB cables which should be connected to the USB slots of the laptop or tablet:

- The cable marked "SS" (SuperSpeed) is used for controlling and exchanging data with the receiver. It demands a superspeed port USB 3.0, 3.1 or 3.2 with the similar "SS" label. If such port is absent on your computer, use the Type C port and adapter from the supplied set.
- Another USB cable (without SS marking) can be connected to any USB port directly or via the USB Type C adapter

Superspeed cable Superspeed port

USB Type C port Adapter USB Type C to Type A
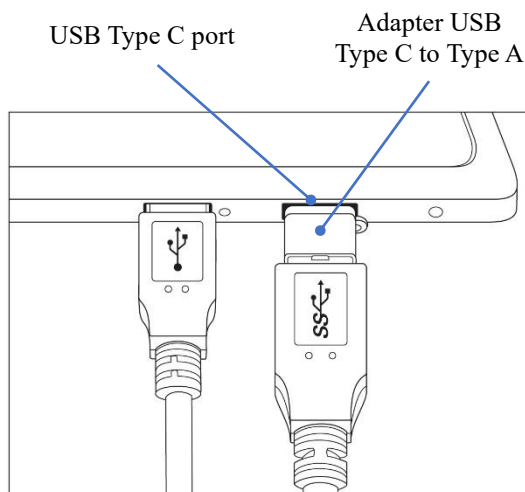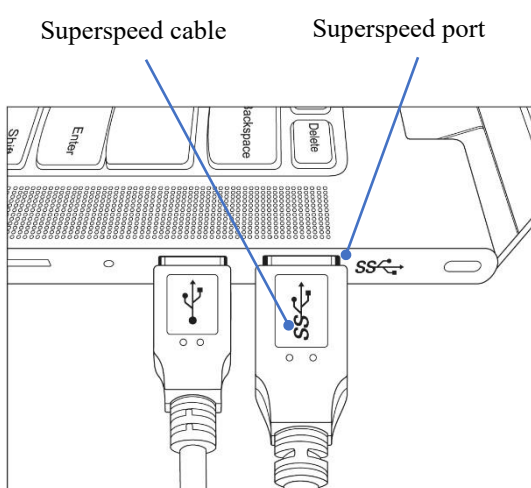
Selecting and connecting of antennas

The Delta S is supplied with 3 antennas:
- ODA-4 – omni-directed wideband antenna (INPUT 1)
- MWA-6 – directed microwave antenna 800 MHz- 6 GHz (INPUT 1)
- LPDA-12 – directed microwave antenna 2-12 GHz (INPUT 2)

The ODA-4 antenna has a wide frequency range and circular sensitivity; therefore, is well suited for all searching modes, including "All signals".

Thanks to its high sensitivity the **MWA-6 antenna** provides longer detection distances of mobile / wireless signals on frequencies above 800 MHz and is therefore well suited for the "Mobile/GPS trackers" mode. An extended detection diagram may be necessary when inspecting a truck or oversized cargo. In addition to the increased sensitivity, the MWA-6 antenna speeds up the locating process in the band/signal inspection mode thanks to the ability to point in the direction of the transmitter.
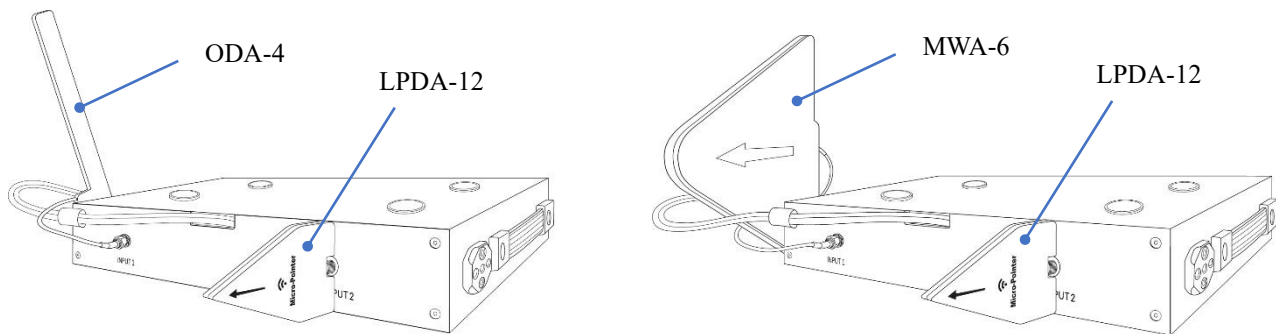
INPUT 1 (frequency range 57-2000 MHz)
The ODA-4 or MWA-6 antenna should be fixed on the right side of the device. Connect its cable to INPUT 1.

INPUT 2 (frequency range 2000-6000 MHz)
Connect the LPDA-12 antenna directly to INPUT 2.

Starting the software

Start the Delta S software using the icon on the desktop or in the Start menu. As the main window opens the software will check the USB ports for the connection of the device. If both USB cables are connected, the program will recognize the device and begin its initialization, displaying a corresponding message in the status bar.

After initialization, all software's functions become available. When the device is not connected, some features of the application remain unavailable.

Problems with the device's recognition can occur because of the following reasons:
- The drivers are not installed
- The computer's battery is low
- The USB cable is not fully inserted, or a poor Type C adapter is being used
- The computer configuration, particularly the processing power and type of port, is insufficient.

The program recognizes the connection of the device during operation.

> *If you have started the software for the first time or have changed the country, it is necessary to adjust the bands table to the frequency allocation of the country of use. To do this, use the menu: Settings | Bands | Country. You can read more about this in section "Settings - Bands".*

Elements and operation

Logs

Logs store the following information:
- Detected signals
- History of alarms (to be displayed on the Alarms graph)
- Masked background

We recommend that you keep a separate log for each search location and reopen it when you work there again.

Go to the "Log file" menu to work with the log.

Open/Create
Opens the "Open/Create log file" window. If you want to create a new file, select the desired folder and enter a name for the new file. You will be prompted to create a new file.

Close
Closes the current log. Features of the software are limited when the log file is closed.

Clear
Fully removes all information from the current log.

Recent
Quick selection of a previous file.

Press the "Back" button to return to the main menu.

Masking background

Masking of the background is a very important action when searching for hidden bugging devices. It allows you to exclude safe background signals existing in the area, such as TV and radio broadcasting, radio communication, mobile base stations, repeaters, etc. Under normal circumstances a significant number of such "friendly" signals would be detected and distract the operator from finding real danger. Thanks to the masking, the Delta S rejects the background and quickly finds only dangerous signals, i.e., those that exist in the target zone.

> *Masking of the background is required before using the "All signals" mode only. It is not required before searching in the "Mobile/GPS trackers" and "Wireless/ISM" modes, as detection is performed by the threshold method in these bands.*

The procedure of masking the background is quick and convenient. Before entering the target room, place the system where external signals will be well received, but not too close to the target room. This can be a window sill of a remote room or corridor, located at a distance of at least 10 meters from the target room. You can also stay outside the building, for example in a car.

Enter the **"Mask background"** menu and confirm the correct placement by setting the checkbox "**Device is at a distance of least 10 m, or more, from target zone**". Then click "**Mask**" and wait for the result.

"**Add mask**" allows you to add a new measurement to the previous one and thus improve masking. You can repeat the masking at several locations by doing "Mask" in the first location and then "Add Mask" in several other locations.

After the procedure, the measurement results are saved in the current log file. Now you can place yourself in the target room and start searching in the "All signals" mode.

"Reset" allows you to erase the results of background masking.

The **"Parameters"** button opens some additional settings for advanced users:
- **"Duration of measurement"** - allows you to increase the measurement time in order to capture more non-constant signals and minimize false alarms
- **"Reset thresholds"** - sets the thresholds of mobile and wireless bands to the default values when masking the background

Searching mode "All signals"

In this mode, the system searches for all types of RF bugging devices in the full frequency range:
- signals of all mobile standards (GSM, CDMA, 3G, 4G/LTE and 5G);
- wireless signals Wi-Fi, Bluetooth, LoRa, DECT, etc.;
- all other transmitters such as radio microphones, wireless video cameras, remote control systems, components of "smart home" systems, wireless sensors, etc. in the range of 57-6000 MHz.

All categories of bands are scanned - "Basic", "Mobile" and "Wireless/ISM".

Signals that exist within the mobile or wireless bands are displayed as mobile or wireless. Transmitters operating on frequencies outside the mobile and wireless bands are displayed in the "Basic" category.

Background masking must be performed before working in the "All Signals" mode. Results of masking are applied to the parts of spectrum which are outside of the mobile and wireless bands only.

The sensitivity and, accordingly, the detection distance can be regulated by thresholds. It is possible to set the threshold for each individual band, for a category of bands or for all bands at once. Thresholds of the basic bands in the presence of background masking work as offsets of masks.

Searching mode "Mobile/GPS trackers"

The use of mobile communication has several advantages for covert surveillance:
1. Broadband channel allows you to transmit audio or video with high quality
2. No need in organizing a control post near the surveillance object. Data is transferred through the Internet. A cloud service can be used
3. Remote control of the surveillance device is possible
4. A convenient way for transmitting the position of the vehicle (GPS trackers)
5. The possibility of accumulating information with fast upload on schedule, or upon request
6. Typical signal of mobile communication attracts less attention during the search

The "Mobile/GPS trackers" mode allows you to search for all types of mobile devices including GSM, CDMA, 3G, 4G/LTE and 5G on frequencies up to 6 GHz. In this mode only the "Mobile" category of bands is being scanned and displayed.

Reducing the measurement interval increases the speed and probability of detecting short-burst signals. Therefore, this mode is well suited and recommended for tasks related to the search of mobile signals. In addition to detection of trackers the mode can be used during sweeping in the building to maximize the probability of detecting specific types of bugging devices.

The sensitivity and, accordingly, the detection distance are set by thresholds. It is possible to set the threshold for each individual band or for the entire category "Mobile".

Searching mode "Wireless/ISM"

Like mobile communications, wireless standards can be used to transmit audio or video information. Their advantages are:
1. Ease of development and creation of a bugging surveillance device - the market is saturated with the necessary components
2. The bandwidth is sufficient to transmit audio or video with high quality
3. Remote control of the surveillance device is possible
4. The possibility of accumulating information with fast upload on schedule or upon request
5. A typical wireless signal attracts less attention during the search

In the "Wireless/ISM" mode, the system scans bands of only one category. Reducing the bandwidth leads to an increase in the probability of detection, which is important for detecting short-burst signals. Therefore, this mode can be used for finding Wi-Fi, Bluetooth, LoRa, DECT and other transmitters of this category as reliably and quickly as possible.

The sensitivity and, accordingly, the detection distance are set by thresholds. It is possible to set the threshold for each individual band or for the entire category "Wireless/ISM".

The "Stop" mode

In this mode the operator can work with the log file, change settings, mask background and review the results of search.

Settings- Bands

For the successful operation of the system, it is very important that the table of bands corresponds to the allocation of mobile and wireless bands that exist in the place of use. Fortunately, the Delta S system includes a data file that carries information about the frequency allocation in many countries and regions.

Country
Allows you to fill the table of bands with the frequency allocation of the place of use. A subpanel with a list of countries will appear at the top of the "Levels" panel.

Leave

Find a country

List of countries with quantity of bands

Adjustment to the selected allocation

Select your country and press Apply. The table of bands will be filled in with the data. Perform this operation during the first starting of the software or after changing the country.

Edit
Allows you to enter the bands editing mode (recommended for advanced users). The sub-panel at the top of the Levels will allow you to edit the bands – change the start and end frequency, name, description and category. The user can add a standard band from the list, create a band manually, or delete a band.

Make sure that mobile and wireless bands do not overlap (overlapping with basic bands is normal). Basic bands are built into the configuration and cannot be edited.

Reset thresholds
Allows you to reset the thresholds of all bands to the default level. This command is usually executed automatically when masking the background.

Settings – Device

Device status – firmware version, temperature and update time. The update time depends on the number of active bands and presence of a high level.

Settings – Other

Split panels
Selection of how the main window is displayed. Splitting the window gives ability to see two panels at the same time. Without splitting, panels occupy a wide area and can show more detailed information.

Toolbar

The toolbar at the top of main window contains a number of features.

Audio alarm
Sound warning for the operator about the presence of danger (exceeding the threshold). The intensity of the clicking sound grows as the danger level increases.

Hold max danger
When this feature is active the Delta S automatically tunes in the most dangerous band or signal and shows its spectrum. The function is convenient when inspecting large areas as it instantly draws the operator's attention to a new event. Among the dangerous bands or signals the system selects the one with the highest 'above-threshold' level. Turn this function off when you want to stop at some particular band or signal, for example when adjusting the threshold.

Attenuator
Use this function to reduce the sensitivity when locating a strong signal. If the signal level reaches -25...-20 dB and the spectrum distortion appears on the adjacent frequencies, temporarily use an attenuator.
The function is only available during inspecting a band or signal and is automatically disabled when exiting the mode.

Demodulation
Allows you to listen to analog signals such as FM radio stations or analog TV audio channels. Digital signals such as mobile or Wi-Fi cannot be heard, although they may have some characteristic sound such as buzzing or crackling (in AM mode). BW is the demodulator bandwidth, selectable from 5 to 200 kHz. Set the cursor to the desired frequency in the spectrum with the mouse or with your finger when on a touch screen.
The function is only available during inspecting a band or signal and is automatically disabled when exiting the mode.

On-screen keyboard (right side)
Is used on touch screens for automatic opening of the on-screen keyboard when a control requiring text input is focused. Set this button to a pressed state on tablets before entering or editing text, for example, naming a band.

Theme (right side)
Selects dark or light interface mode. Dark mode is safer for the eyes and is set by default.

Language (right side)
Choose the desired language.

Panel "Level"

One of the main advantages of the Delta S system is the automatic processing of spectral data. These are recognition of signals, their storage in the log and measurement of level of bands and signals.

The results of spectrum processing are displayed in the Level panel as an easy-to-understand list of bands with level bargraphs. The list allows the operator, without delving into the manual study of the spectrum, to monitor the entire picture as a whole and quickly move to dangerous areas. The bargraph level increases when a new signal appears within the band or the Delta S is moved closer to the transmitter. When the threshold is exceeded, the color of the bargraph changes from green to red.
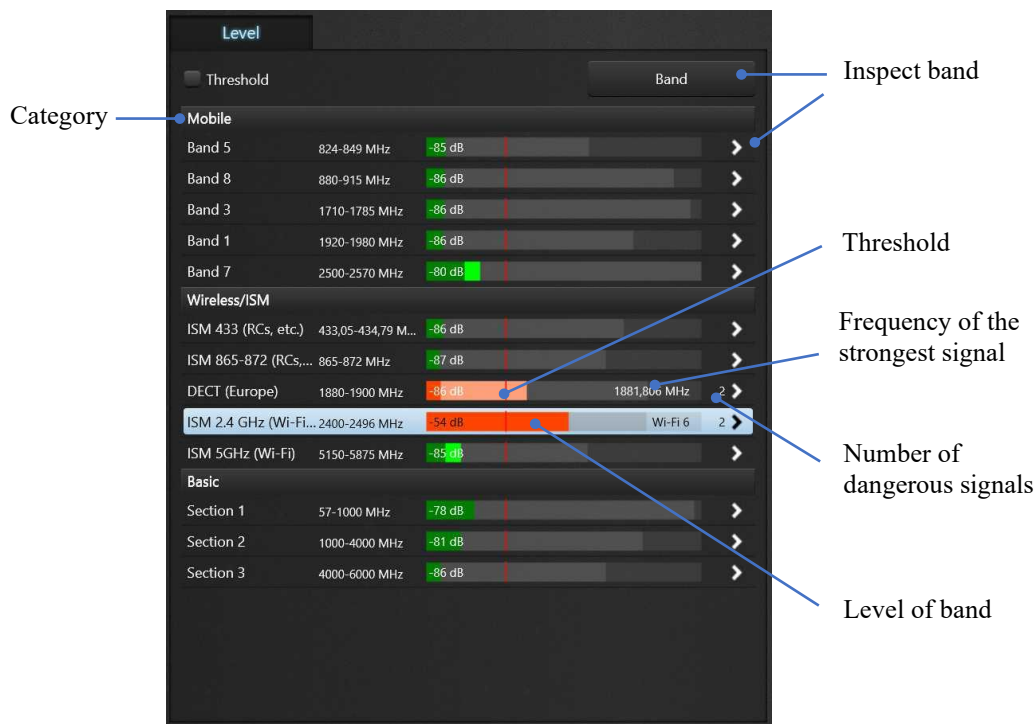
The operator can inspect the dangerous band by pressing the **Band** button or the arrow near the band. When the Level panel is in the band inspection mode, it displays the level of the selected band and a list of signals in the band. A bargraph is displayed for each of the signals. It changes color when the threshold is exceeded. The user can select a dangerous signal and proceed to its inspection.

In this way, the user sees the whole picture at once and can easily switch to individual bands or signals that pose a danger. When switching to a band or signal, the spectrum graph is automatically adjusted to display the corresponding span.

RF level is measured between -90 and -20 dB, where -90 is the weakest signal and -20 is the strongest.

The mobile and wireless bands stand above the basic bands. When the level of the basic band is measured, the spans of mobile and wireless bands are not taken into account. Thus, they do not affect the bargraphs of the basic bands and are only displayed in their own categories "Mobile" and "Wireless/ISM". So, the bargraphs of the basic bands only show signals outside the cellular and wireless bands.

Three kinds of level are displayed for the bands and signals:

- Current (instantaneous rise and instant fall) – bright green or bright red
- Peak (rises instantly, falls slowly) – light green or light red
- Maximum registered (remembers the maximum level) - gray

The band's threshold can be adjusted within -85...-20 dB.

Multi-band measurement
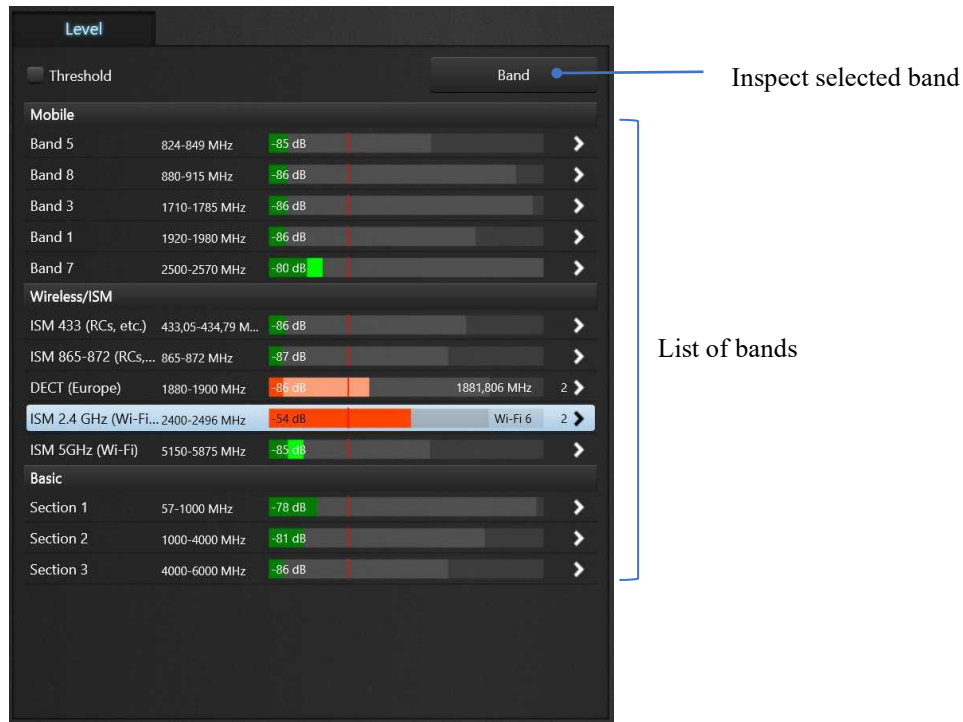
All bands according to the selected mode are scanned and displayed on the panel. The name, description, frequency, level (current, peak, and maximum recorded), as well as the number of dangerous signals and the most dangerous signal are displayed for each band. Bands are grouped by category.

Double-clicking on a band adjusts the spectrum graph to show the band's span.

Mark the **"Threshold"** checkbox to adjust the threshold. The threshold can be set for one band, a category of bands, or all bands at once.

Inspection of band

Select the band you are interested in and **click on the arrow** next to it or press the **"Band"** button. You will enter the band's inspection mode. The "Level" panel will have the following look:

Inspect signal

List of signals in the inspected band

In this mode, only the selected band is scanned, its parameters and the list of signals within the band are displayed. For each of the signals, the frequency, band, channel name, current, peak, and maximum registered level are displayed.

Use this mode to see exactly which signals within the band pose a threat and to select one for a subsequent inspection. You can stay in this mode if you want to locate several signals at once or if the signal changes frequency frequently. Compared to the standard multi-band mode, a smaller part of the spectrum is measured in the band inspection mode, which increases the probability of detecting short-burst signals.

A **single click on a signal** will rewind the spectrum graph to it.
Double-clicking on a signal adjusts the spectrum graph's span and rewinds to it.

Adjust the band's threshold if necessary.

The number of the currently selected signal, total quantity of signals, as well as a button to open an additional menu, is displayed above the list of signals. The following commands are available in this menu:
- **"Delete signal"**
- **"Delete all signals within band"**
- **"Delete all signals"**

Deleting a signal or all signals may be necessary to reset the signal fusion resulting from the operation of the signal recognition algorithm. After removing from the list, all active signals will be automatically recognized and re-added. Be careful not to lose the measurement results of a suspicious signal.

Press the "**Back**" button to exit the mode.

Inspection of signal

Select the signal you are interested in and **click on the arrow next to it** or click the **"Signal"** button to enter the signal inspection mode. The "Level" panel will have the following look:
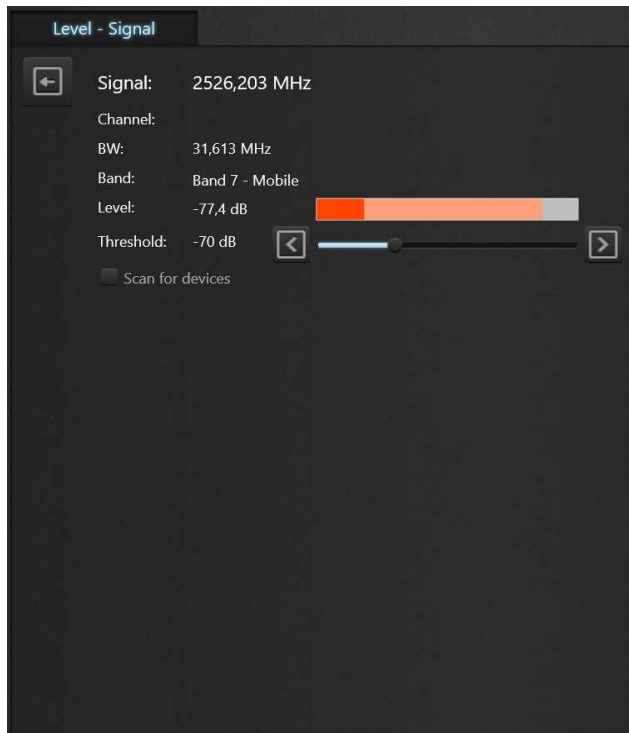
In this mode a separate signal is scanned. Use the signal inspection mode to study and locate the transmitter if it has a fixed frequency.

In this mode, the measured spectral span is minimal and the probability of registering a short-burst signal is maximal. The signal inspection mode is well suited for studying and locating short-burst pulse signals, such as channels of Wi-Fi, 4G/LTE, 5G, etc.

Adjust the band's threshold if necessary.

Press the **"Back"** button to exit the mode.

Scanning for Wi-Fi access points in the signal inspection mode

The **"Scan for devices"** function allows you to scan Wi-Fi access points using the network card of a laptop or tablet.

Active Wi-Fi channels that exceed the threshold level are automatically added to the list of signals in the 2.4 GHz and 5 GHz bands. Decrease the band's threshold to automatically add channels with a lower level. After capturing the active channels, you can proceed to their inspection.

The function is available for signals which are Wi-Fi channels only. The computer should not be in the airplane mode.

Inspected signal must
be a Wi-Fi channel

Blue round icons show the Wi-Fi devices
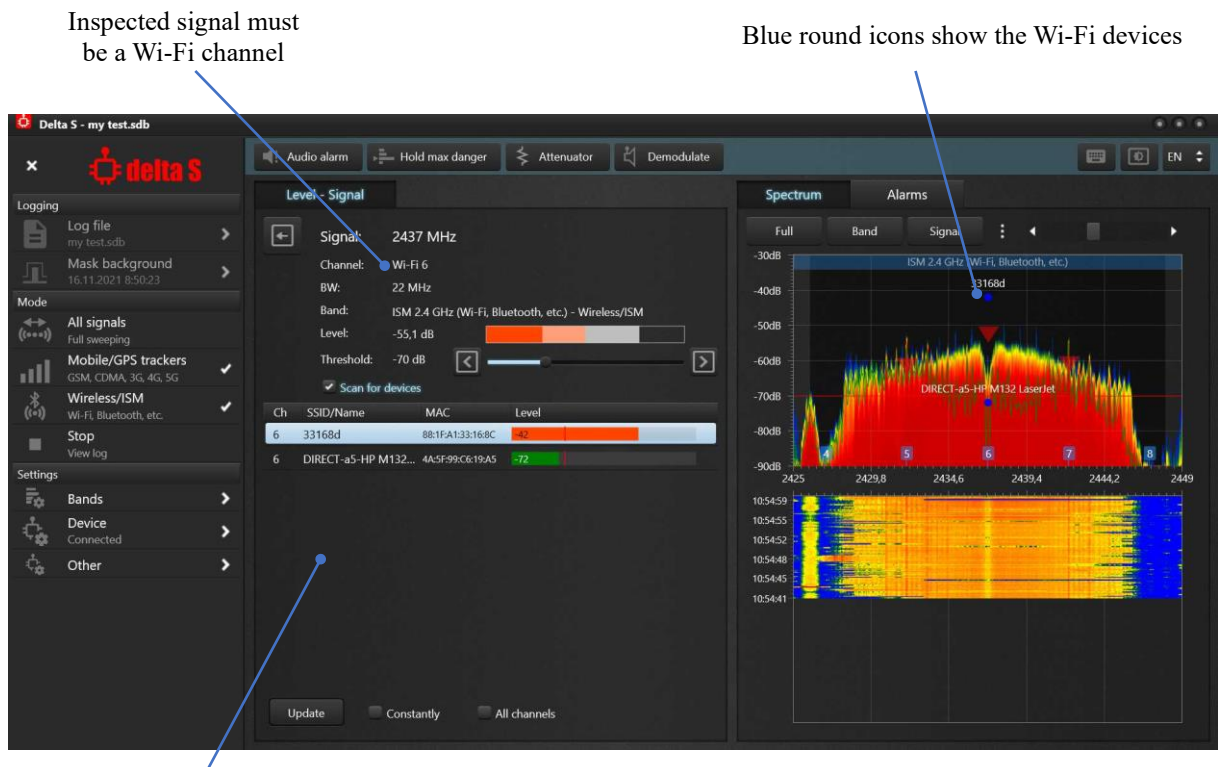
List of devices (access points) which exist
on the channel

When using this feature, a list of access points will be displayed at the bottom of the "Level" panel.

"Update" - rescans access points.

"Constantly" - enables periodic scanning.

"All channels" shows all found access points, without selection by the selected channel.

After exiting the signal inspection mode using the "Back" button, the user can select another Wi-Fi channel and enter it to display the access points on it.

After scanning the devices (access points), they will be displayed on the spectrogram in the form of round blue icons with a caption corresponding to their SSID. The vertical position of the icons will correspond to the device's signal level which was measured by the network card.

The device's level will change when the system is moved. To see this, use the **"Constantly"** function. Comparing the change in the spectral level, which is displayed by the green trace on the spectrum, with the change in the position of the blue icon can provide additional information about the signal. Simultaneous increase of both values will indicate that you are approaching the access point. If only the spectral level increases, and the level of the blue icon decreases or remains unchanged, you might be approaching a device that is a client of a distant access point.

The level measured by the network card (vertical position of the blue icon) may not correspond to the spectral level of the Delta S, as the measurement is made by a separate device. Observe the relative position of both levels.

Adjustment of thresholds

The bands' thresholds determine the sensitivity of detection. When the signal's level exceeds the threshold, an alarm event occurs. At this moment, the bargraph turns red, an audible alarm is generated, and the event is recorded in the log.

The lower the threshold, the weaker signals are detected by the system. With a lower threshold, the detection distance increases, and with a higher threshold the distance drops.

The Delta S system allows the operator to set an individual threshold for each band and thus adjust the detection distance for each type of signals. The allowed values are from -85 dB to -20 dB.
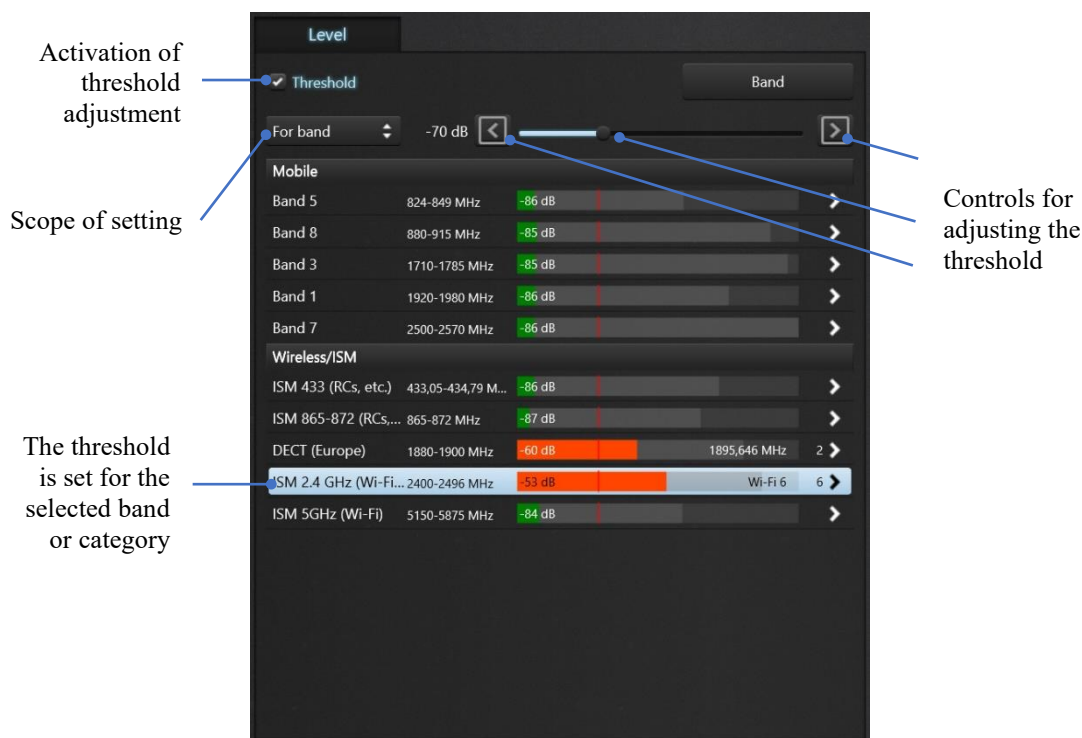
To adjust the threshold:
- When the Level panel is in multi-band measurement, mark the Threshold checkbox in the upper left corner
- Select the desired band
- Change the threshold using the trackbar or arrow buttons
- Select another band and repeat the settings
- You can change the threshold for the entire category or for all bands at once if you select the appropriate scope of setting
- When the system is in the band's or signal's inspection mode, the threshold controls are always available at the top of the panel

You have the option to reset the thresholds of all bands to their default values using the "Reset thresholds" command from the "Settings | Bands" menu. When developing the system, the optimal threshold values were selected as default. They provide normal sensitivity and minimize false alarms from distant transmitters: -75 dB for the basic bands and -70 dB for all other bands.

Recommendations:

- Avoid setting a too low threshold near -85..-80 dB. This may produce an excessive number of alarms from distant transmitters from outside of the area. It is recommended to set a higher threshold in order to limit the detection distance by several meters and minimize false responses. An exception may be made to the "3G 1920-1980 MHz" band often containing signals with a relatively low level. Its threshold can be set to -82..-75 dB
- Do not set a too high threshold at -40...-20 dB. This can cause loss of sensitivity and inability to detect signals

The correspondence of threshold and detection distance can be established experimentally. For this, you can use a mobile phone or a "known" Wi-Fi access point. By gradually changing the distance to the device that is active at the time of the test, you can determine how the signal level changes and determine the threshold required for the distance which you wish to achieve. Make sure the test device is active during testing. A reliable way to keep your mobile phone active is on-hook call mode (voice channel) or a call via a messenger such as WhatsApp (data transfer). When the phone's Wi-Fi is turned on and there is a connection to the access point, the data will go through the Wi-Fi. When Wi-Fi is turned off, data will go through the mobile Internet.

Approximate correspondence between the threshold and detection distance of an average mobile signal or Wi-Fi signal:

Threshold	Approximate detection distance
-80 dB	5-20 m
-70 dB (default)	4-10 m
-60 dB	3-8 m
-50 dB	2-5 m
-40 dB	1-3 m
-30 dB	0.5-1.5 m

Thresholds of the basic bands
Thresholds of the basic bands in the presence of background masking work as the offset for the mask. Increasing the threshold will shift the mask up and accordingly decrease the sensitivity. Decreasing the threshold will increase the sensitivity accordingly.

Panel "Spectrum"

The Spectrum panel displays a spectrum graph and a Waterfall graph. With the help of these graphs, the operator can study the signal and get information about its level, frequency of existence, bandwidth, duration of operation, etc.
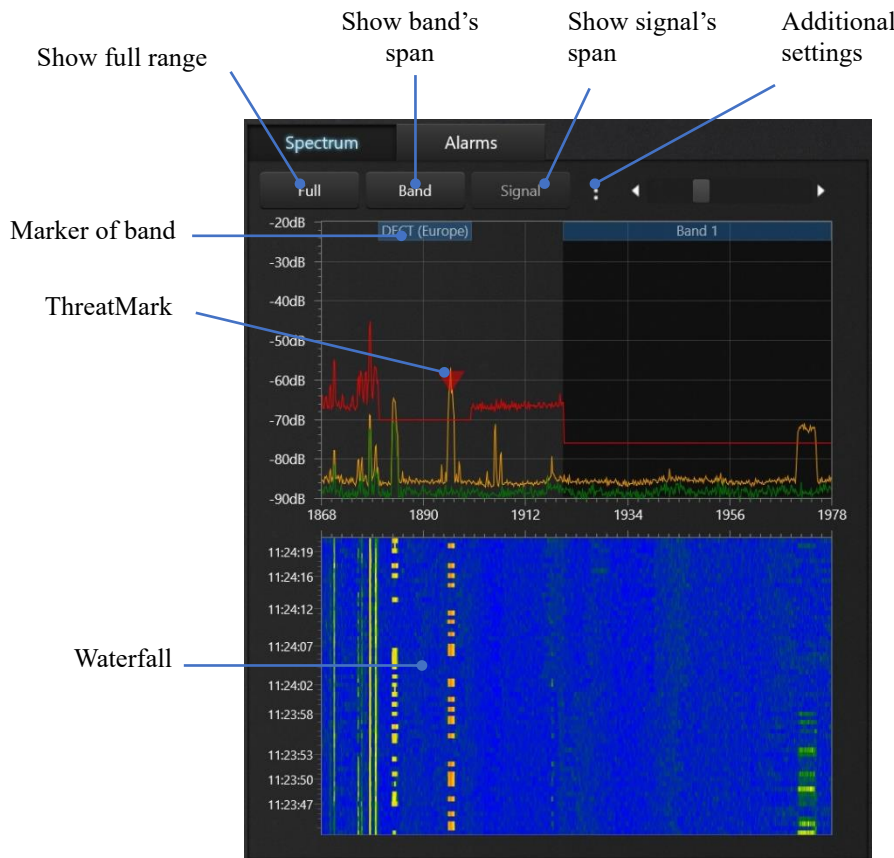
On the spectrum graph, the user can view any area, for example, the entire frequency range covered by the device, a band or a separate signal. Signal levels from -90 to -20 dB are displayed. The spectrum graph will automatically adjust its vertical scale to the maximum level being displayed.

"Full" sets the graph to display the entire frequency range of the system.
"Band" scrolls to and sets the graph to display the span of the currently selected band.
"Signal" scrolls to and displays the span of the currently selected signal (available only in the band/signal inspection mode).

The additional settings button opens the popup menu containing the following commands:

- **"Show peak trace"** - enables drawing of the peak trace (orange color). The peak trace accumulates the maximum level of spectrum and therefore allows you to see non-constant signals
- **"Clear peak trace"**. Use this command to reset and restart data accumulation in the peak trace.
- **"Persistence"**. This feature uses changing colors to display signals with different activity rates. The more often the signal occurs, the warmer the color on the graph is. Single occurrences are displayed in blue, more frequent activities are green, and very frequent or constant signals are yellow or red. Use this mode to study bands where many overlapping signals exist, such as 2.4 GHz ISM band.

- **"Waterfall | Hide sub-threshold values"** - allows you to hide areas of the waterfall that have a low level and thus highlight areas with a high level (above the threshold).

The current (instant) spectrum trace is drawn by green on the graph. The threshold is drawn in red.

The spectrum graph supports **scrolling**. To scroll the graph to another section, press the left mouse button above the graph and drag it to the left or right without releasing the button. The graph will be scrolled to the desired section. The same can be done on touch screen devices - touch the spectrum graph with your finger or stylus and drag it left or right.

The spectrum graph supports convenient **zooming in and out**. To zoom in/out, click on the spectrum with the mouse (or finger) and press the "increase" or "decrease" button.

The **waterfall** displays the spectrum over a period of time. Each horizontal line in it represents one trace of spectrum measurement. The level is displayed by color, where blue is a low level, green is slightly higher, yellow is a medium level, and red is a high signal level. During the measurement, older traces float down, and newer traces are placed at the top. Timestamps are displayed on the left. The operator can use the waterfall to see non-constant signals and track their frequency.

Panel "Alarms"

This panel displays information about the detected danger in real time during the search or in the Stop mode.

Number of dangerous bands and signals

Alarms graph
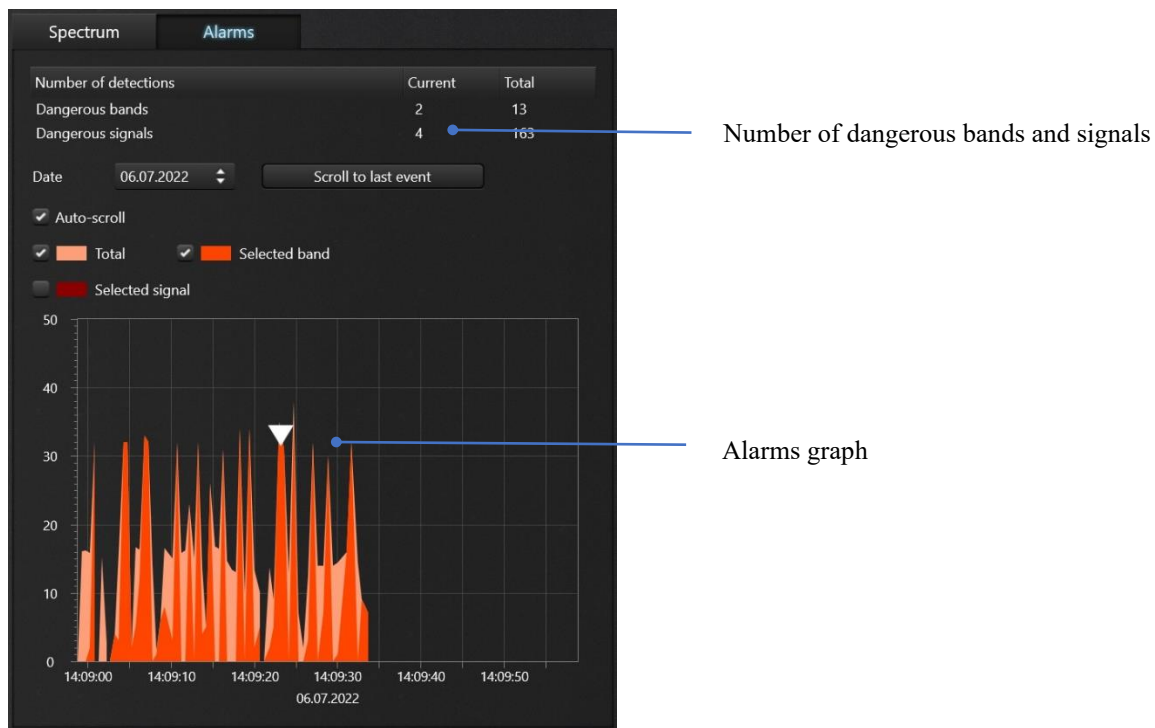
The "Number of detections" table shows the number of dangerous bands and signals at the given moment and for the entire period.

A situation when the band's or signal's level exceeds the threshold during the search is considered as an alarm event which is subject to logging. The number of such events over a long period of time can be significant because of constantly repeating short-time measurements. The alarm graph is the convenient way for displaying these multiple events.

The alarm graph allows you to display the alarm events that were registered in the selected time interval. It is possible to view all events or select them by a certain band or signal. The vertical scale of the graph is the danger level i.e. the above-threshold level of signal in dB. For example, when the signal level is -42 dB, and the threshold is -60 dB, then the danger level on the graph will be 60-42=18 dB.

It is possible to configure what is displayed on the graph:
- **"Total"** – general level of danger on all bands. Is displayed in light red
- **"Selected band"** – level of danger of the selected band. Is displayed in bright red
- **"Selected signal"** – level of danger of the selected signal. Is displayed in dark red.

"Auto-scroll" forces scrolling to the newest measurements during the search.

If auto-scroll is disabled, the alarm graph **can be scrolled** manually to any time. To do this, click the left mouse button on the graph and, without releasing the button, drag the cursor to the left or right. You can do the same with your finger or stylus on a touch screen.

If you want **to increase or decrease the displayed period (zoom in or out)**, click on the graph with the left mouse button and use the "increase" and "decrease" buttons. You can also use the mouse wheel.

In the "Stop" mode the user has access to some additional actions:
- Choose a **date**
- Scroll to the last event in the log using the **"Scroll to last event"** button
- Review the level of bands and signals by **clicking the desired time on the graph**. The "Level" panel will show the level of bands and signals at the selected time. Only dangerous bands and signals can be reviewed.
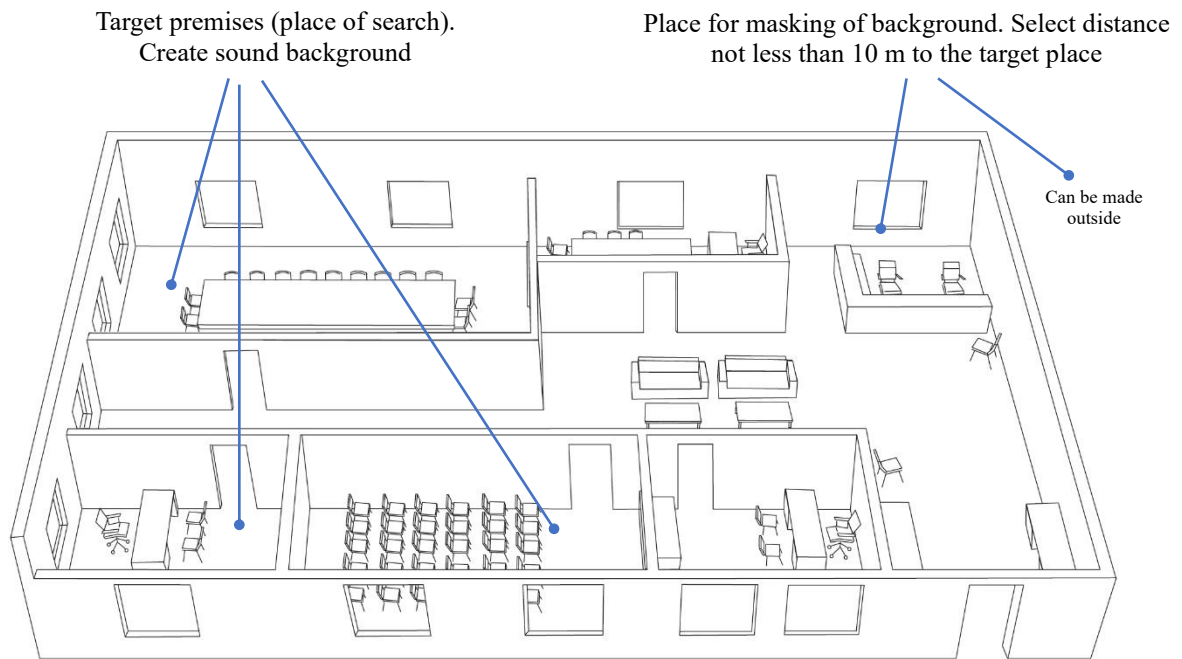
Search recommendations

Preparation

1. Decide what searching mode suits your tasks:
   - **To check the premises for the presence of hidden bugging devices**, use the "All signals" mode

   - **To search for trackers (beacons) on cars**, use the "Mobile/GPS-trackers" mode

   - **For specific tasks**, such as detecting of Wi-Fi devices or wireless devices, use the "Wireless/ISM" mode.

   Use the mode that best suits your task. A slower update rate reduces the probability of detecting short-burst signals, so we recommend avoiding "All Signals" mode for finding GPS trackers or wireless signals.

   The "Mobile/GPS trackers" and "Wireless/ISM" modes can be temporarily used after working in the "All Signals" mode to increase the probability of detecting mobile and wireless signals.

2. Select the antenna for INPUT 1. The ODA-4 is a multi-purpose antenna and suits all detection modes including "All signals". The MWA-6 antenna provides a longer detection distance and simplifies locating thanks to its directivity but has a limited frequency range.

3. Create a separate log file for the planned place of search. You will be able to open the file again to add new data to it when performing a new sweep.

4. The "All signals" mode requires preliminary masking of the background outside the target room. Select a remote place and perform masking. To minimize false alarms, set a longer duration of measurement and repeat masking at several points around the target area (but not inside). The masking of background is not required for the "Mobile/GPS trackers" and "Wireless/ISM" modes.

5. Disable all RF devices which are active in the place of the search, including mobile phones, computers, access points, wireless devices (headset, headphones, watches, etc.), other Bluetooth devices, Wi-Fi, etc. Minimizing false alarms will speed up the search and make its results more reliable.

6. Some listening devices are activated only in the presence of sound. To activate them, create a background sound in the room.

Target premises (place of search).
Create sound background

Place for masking of background. Select distance
not less than 10 m to the target place

Can be made
outside

Search

1. Start the selected searching mode. The "Cellular/GPS trackers" and "Wireless/ISM" modes can be enabled together.

2. Check the threshold settings. Correctly set thresholds allow you to reduce the search time, increase the reliability of detection and speed up the location of a transmitter.

3. Turn on the audio alarm to make it easier to monitor the situation. Use the function "Hold max. danger." to automatically tune in the most dangerous band.

4. Check the premises by parts, for example room by room. Scan each room with a view to the detection distance of the weakest signal that could theoretically exist. For example, if at the current thresholds the minimum guaranteed distance is 1-2 meters, then it is necessary to scan the room dividing it into "strips" of 2 meters width. Move at a speed of no faster than half a meter per second, turning the system in different directions. Watch the Alarms graph, Level panel and listen to the alarm audio.
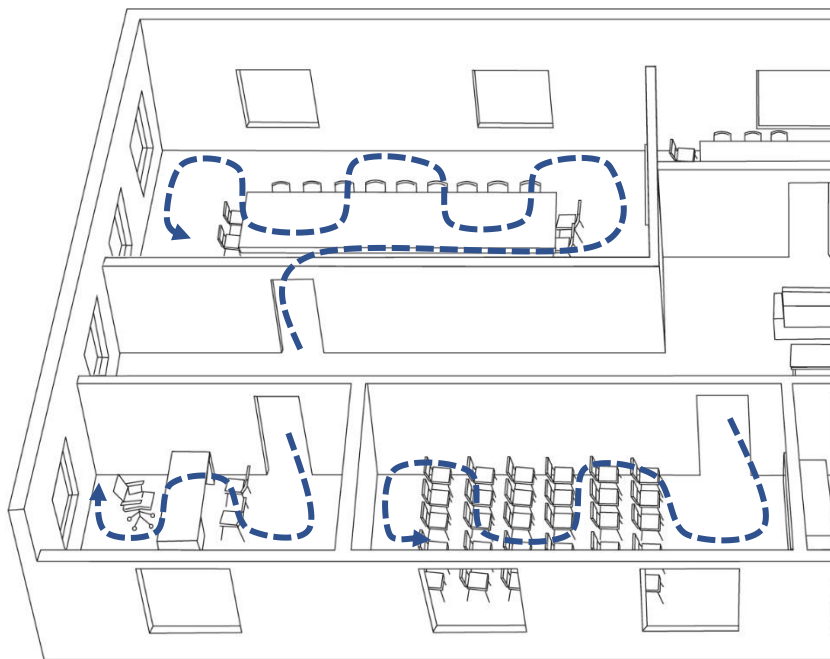
Inspect the entire space
of the room evenly

Finding a transmitter's location

1.   After starting the search, the "Level" panel will be in the multi-band measurement mode. If danger is detected, the operator proceeds to inspecting the dangerous band (enters the band). This narrows the measured part of spectrum, increases the speed and probability of detection which is useful for locating the transmitter. It is also possible to enter a single signal's inspection mode to further narrow the measurement span.

LTE/4G and 5G mobile standards can dynamically change the frequency band. If the level on a band has dropped, return to the multi-band measurement and note where the high level appeared. You can proceed to inspection of a new band or locate the transmitter staying in the multi-band measurement of the "Mobile/GPS Trackers" mode.

2.   Start the search for the location of the transmitter. To do this, move or rotate the system and find the maximum signal level. Watch the level displayed on the bargraph and spectrum and go where the signal is growing. The closer the antenna is to the transmitter, the higher the level will be. LEDs on the front panel will help you determine which antenna is in use. During locating, you can gradually increase the threshold to reduce the search circle (but remember to return to the original value afterwards).

3.   If the signal level reaches -25...-20 dB and spectrum distortion appears at the adjacent frequencies, temporarily use an attenuator.

4.   When you have found a place with the highest signal level, start the physical search of the transmitter.

5.   External signals coming from adjacent areas can cause false alarms. Such disturbances are usually located (have a maximum level) near windows, walls, floor or ceiling and their level decreases in other parts of the room.

6.   After inspecting an individual band or signal, remember to return the Level panel to the multi-band measurement mode.

Long-time monitoring and studying results

The Delta S system can record danger events over a long period of time, such as a day or week. This makes it possible to detect RF bugging devices that do not transmit continuously and upload data by schedule or by a signal from a remote control.

If you wish to study the result of a search, select the "Stop" mode and open the "Alarms" panel and examine the alarm events that have been registered.
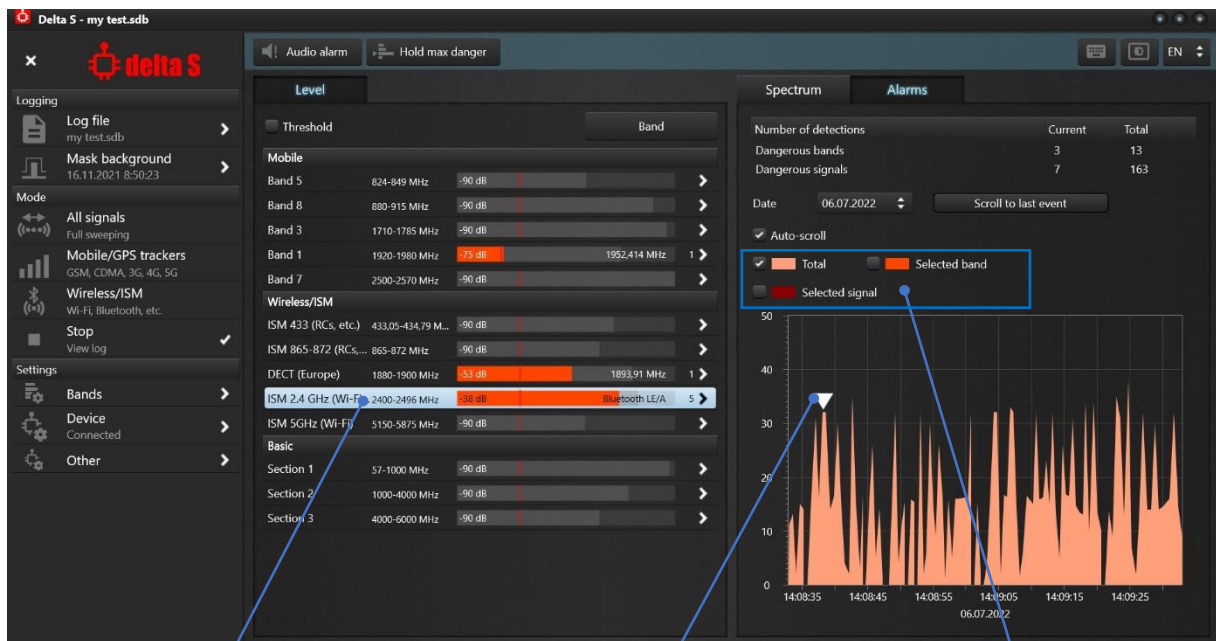
The band which was dangerous at the selected moment   Selected moment   Drawing mode of the graph

1. In the "Alarms" panel, select the desired date. Rewind the time to the beginning of the date, where the first event occurs.

2. If necessary, set a convenient period by zooming in or out (click the mouse, select "increase" or "decrease" several times).

3. Choose the studied moment by clicking on the alarm graph in a place with a high level of danger. The position of the white triangular cursor will show the selected moment. On the "Level" panel, the bands that created danger at the selected moment will have a red bargraph. Just like during the search, the number of dangerous signals and the frequency of the most dangerous signal will be shown next to the bargraph.

4. Select the first dangerous band in the "Level" panel, and then enable drawing of its alarms by setting the "Selected band" checkbox in the "Alarms" panel. On the alarm graph, you will be able to see the level of danger for the selected band in bright red. By analyzing this graph, you can find out how strong the band was and how long the transmission lasted.

5. It is possible to inspect the band in the "Level" panel just like during the search. After pressing the "Band" button you will be able to see a list of signals that existed within the band. Those signals that were dangerous at the selected moment will have a red level bargraph. By selecting a signal with a red bargraph and checking the "Selected signal" in the "Alarms" panel, you can see the alarm graph for the selected signal. By analyzing the alarm graph for a single signal, you can find out how strong it was and how long it lasted.

7. Return to the list of bands in the Level panel and explore other dangerous bands.

8. Repeat clicking on the alarm graph at another time where high danger also existed and explore the dangerous ranges.

9. You can also study the activity of each band in turn by selecting a band and studying its history on the graph (with the "Selected band" checkbox enabled). Don't forget to rewind or zoom the alarm graph to see all events

If you find a suspicious signal that periodically exists in your premises, has a high level and a sufficiently long existence, try to find where it comes from. Study room by room, leaving the system in each room for 24h and analyzing the results. Make sure that this is not a false alarm and that the signal does not come from outside by performing measurements outside the premises.
You can leave the system in the band inspection mode to increase the probability of registering short-burst events.
Find the room with the highest level and try to predict the operating time of the transmitter. Try to locate the transmitter at this moment.

Searching for GPS trackers (beacons)

GPS trackers (beacons) can be divided into three types:
1. Those that accumulate coordinates and do not transmit them
2. Those that accumulate coordinates and transmit them upon request
3. Those which regularly transmit coordinates

Trackers of the second and third type usually use mobile networks to transmit data. To detect these mobile devices, the Delta S system must be in the moving and maneuvering vehicle.

Provide power to the computer if you plan to work for more than one hour. You can use an inverter or powerbank.

1. It is recommended to carry out the sweeping procedure in places with minimal interference from other mobile devices. Urban environments are very saturated with means of mobile communication and makes it impossible to correctly interpret the results. Move to an empty road in the countryside, without settlements and other transport.

2. Place the system in the middle of the vehicle

3. If you want to provide a circular pattern, use an ODA-4 antenna for INPUT 1. If you are testing a long vehicle (such as a long size truck), the MWA-6 antenna at INPUT 1 will provide you with an extended detection distance (the system must be positioned at the edge of the target zone and pointed to it). INPUT 2 always works with the LPDA-12 antenna.

4. Create a log file

5. Start "Mobile/GPS trackers" mode

6. Set the desired bands' thresholds or reset them to the default values

7. Start the engine and start driving. Some tracking devices will periodically transmit information about the coordinates of the vehicle, and some also about engine start/stop and change of direction of movement. Drive for at least half an hour, periodically changing direction, stopping and starting the engine. Keep an eye on the alarm graph, level bargraphs and audio alarm at all times.

8. In the "Mobile/GPS trackers" mode, the system scans all mobile bands and displays the cumulative threat level on the alarm graph. Trackers (beacons) are characterized by short periodic exchanges with the mobile network. The alarm graph makes it possible not to miss

such short-term signals and to catch their periodicity. The presence of signals can inform about a mobile device that is nearby.

9. If a suspicious signal is detected, try to find a connection between its appearance and the behavior of the car - start-stop the engine, start moving, stop, make a turn, etc.

10. If you see a signal, proceed to locating of the transmitter as described earlier. Changing the position of the system and its direction will allow you to find the direction of the signal. The MWA-6 antenna in the INPUT 1 input speeds up the result. Rare periodic signals may require more time to study.