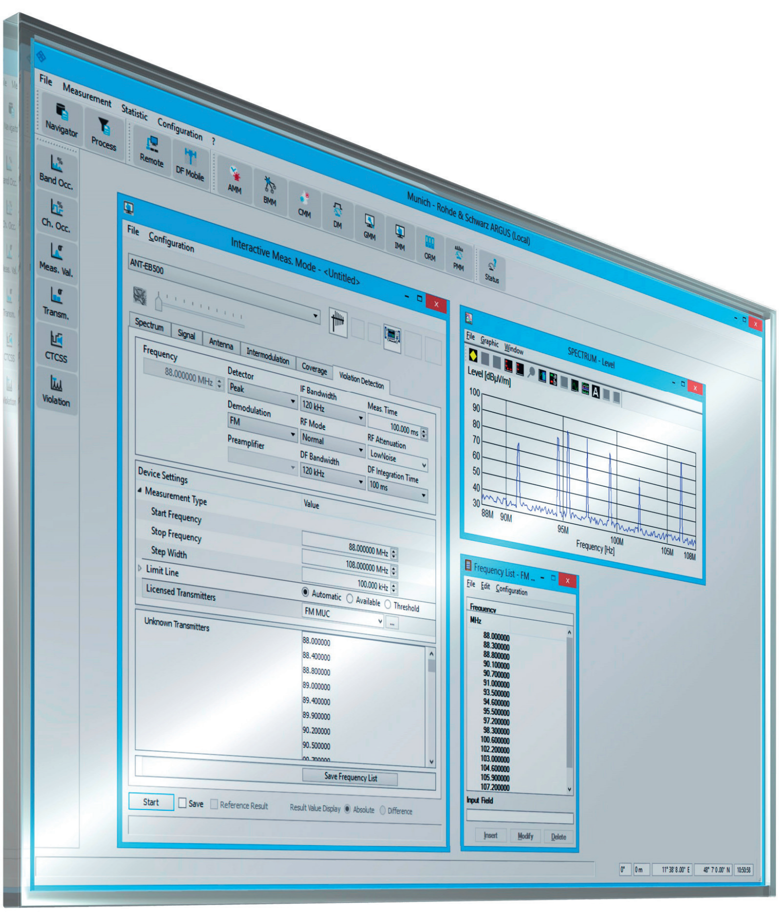
R&S®ARGUS Monitoring Software

For R&S®ARGUS systems in accordance with ITU recommendations

Radiomonitoring & Radiolocation

Product Brochure | 02.00



ROHDE&SCHWARZ

R&S®ARGUS Monitoring Software
At a glance

When it comes to ITU-compliant measurements and evaluations, R&S®ARGUS has been the preferred choice for regulators from more than 100 countries for more than 25 years. R&S®ARGUS controls dedicated devices and analysis tools. The measurement modes, reflecting typical workflows, are designed to support operators in their daily work. Numerous statistics allow for an in-depth analysis and the creation of informative and concise reports. R&S®ARGUS 6, the latest development step, focuses on complete workflows and operability to ensure that you get the job done – faster and better than ever.

The R&S®ARGUS approach combines powerful spectrum monitoring tools with easy and efficient operation. The user interface defines new standards for monitoring software. Dialog windows, menus and control elements have been completely redesigned, following the latest findings in usability and ergonomics. Toolbars that can be flexibly positioned and displayed, favorite icons for faster access to the most important remote stations, display filters to focus only on the really important information, and tags that allow to immediately find all data pertaining to a certain mission – this are just some of the many innovations. Every operator can adjust the user interface to match individual preferences. This does not only provide a more pleasant working experience, it also improves efficiency.

Tried and tested features such as reasonable default values and the unique guided measurement modes are provided in an improved version. As a result, even less experienced operators can perform challenging tasks, quickly and reliably.

At the same time, a broad scope of monitoring and evaluation functionality is available, ranging from simple level measurements to sophisticated intermodulation analysis and vestigial sideband emission investigation, from standalone devices to nationwide monitoring networks, from interactive, quick response operation to fully automatic procedures.

The modular structure makes it possible to configure a system that perfectly matches customer requirements. Various open interfaces allow flexible adaptation to practically any customer demand. Any subsequent expansions are easily implemented, regardless of number of instruments, enhanced measurement capabilities or additional monitoring stations.

Throughout the last quarter of a century R&S®ARGUS has been consistently and systematically expanded and improved, always ensuring excellent solutions for ever-changing challenges. This long and successful tradition is continuing. Thanks to a wide range of specialized equipment, the numerous open interfaces and unrivaled monitoring capabilities, R&S®ARGUS provides unique features that make it very well-suited for applications far beyond the scope of ITU-compliant monitoring.

Key facts

- Measurement and analysis in accordance with ITU handbook and recommendations
- Monitoring and direction finding from 20 Hz to 256 GHz
- First monitoring software to integrate the ITU SMS4DC spectrum management application
- Simple scalability due to modular software architecture
- Ergonomic design, based on latest findings in usability combined with 25 years of market experience
- Strong focus on user support
  - Guided measurements
  - Helpful default values
  - Informative status and error messages
- Running under Windows 7 and 8
- Support of IPv6 protocol

R&S®ARGUS Monitoring Software Benefits and key features

The right instrument for every task

ITU-compliant spectrum monitoring involves a number of highly diverse measurement tasks. A wide range of specialized instruments is required to perform these measurements in accordance with ITU recommendations: receivers, direction finders, spectrum analyzers, antenna switches, controllers for positioning directional antennas, compasses and GPS equipment. Special decoders are used for in-depth analysis and identification of signals. This list of instruments is rounded out by individually selectable filters, amplifiers and attenuators. Due to the standardized user interface, ease of operation is maximized for the user while the training effort required when system expansions involve new instruments is minimized.

For maximum flexibility – the direct measurement mode

The direct measurement mode (DMM) is used to control the measurement equipment directly via virtual front panels. This mode provides the operator with a fast way to monitor, measure, locate and identify emissions.

The system visualizer in R&S®ARGUS produces the schematic of a selected radiomonitoring station: Antennas, receivers, analyzers, decoders and recording equipment with all their connections are shown in a graphical representation. The required connections between antennas and receivers can be selected and switched by a single mouse click.

A mouse click on a device icon opens the interface from which the user can control the device and perform the measurements. This interface simulates all the functions and the settings of the device.

Depending on the device driver, it contains several tabs. Each tab corresponds to a measurement type that the device in question can perform. Depending on the measurement type, the measurement results are shown using different types of graphics, tables or a numeric display. The measurement results can be saved for further analysis or for printing out.

Structured measurement sequences for successful monitoring

Spectrum monitoring involves many activities including searching for interference sources, detection and identification of new, unknown transmitters, localization of emitters, and long-term monitoring of emissions to verify compliance with the applicable license. Each of these activities has its own characteristic workflow. To make operation as simple as possible for the user and ensure efficient, error-free working, the individual workflows are implemented using software modules known as measurement modes.

The following measurement modes are available:

- Interactive measurement mode (IMM)
- Bearing measurement mode (BMM)
- Automatic measurement mode (AMM)
- Guided measurement modes (GMM)
- Digital measurement mode (DM)
- Coverage measurement mode (CMM)
- Pulse measurement mode (PMM)

Interactive measurement mode (IMM)

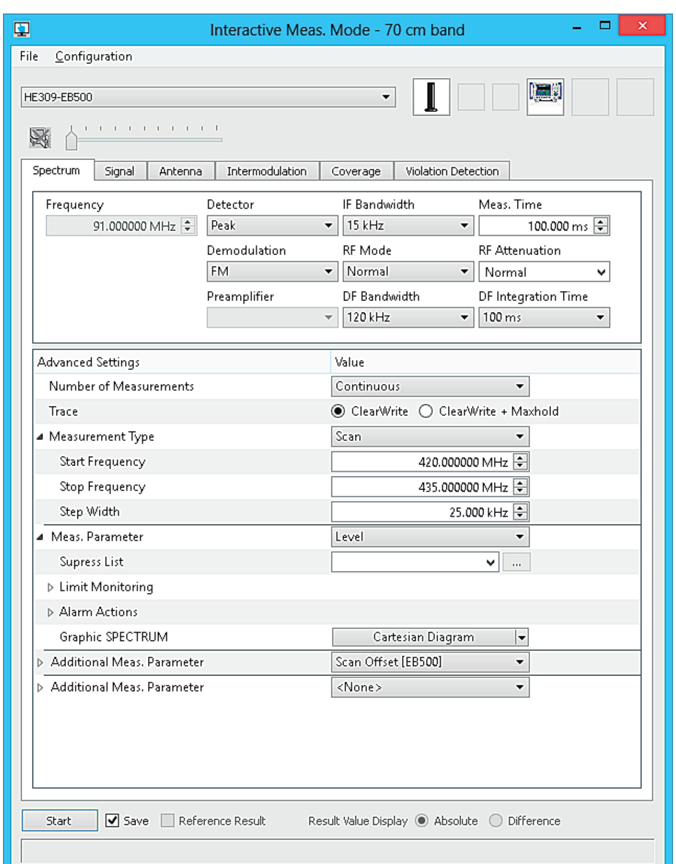
The interactive measurement mode is used for obtaining an overview of a spectrum, for analyzing and identifying electromagnetic emissions, for obtaining results when an antenna is moved, for analyzing intermodulation, for performing coverage measurements and for automatic detection of unknown signals.

The following IMM modes provide direct access to various activities:

- Spectrum
- Signal analysis
- Antenna analysis
- Intermodulation analysis
- Coverage measurement
- Violation detection

The dialog window is split into two sections. The upper section has the same settings for all modes. It contains the parameters for the selection of the mode and the devices, the most important device settings and the Start, Stop and Settings >> buttons. For selecting special device settings, the user can open the device interfaces. The Settings >> button allows the dialog window to be enlarged. The enlarged section contains the settings for the selected mode. The measurement results can be saved for further evaluation or printed out. A report can be printed out directly from the IMM.

Interactive measurement mode.



The **spectrum mode** gives the user a quick overview of a frequency spectrum.

This mode offers scan (scanning from start frequency to stop frequency using frequency increments), frequency list scan (scanning using frequencies from a frequency list) or transmitter list scan (scanning using frequencies from a transmitter list). Additional measurements (e.g. frequency offset or modulation) on all signals within the frequency band can also be made if the receiver has the necessary capability. Frequencies that are not of interest to the user can be suppressed for any measurement. If limits for a measurement parameter are defined, signal analysis can be started automatically if the value goes above or below the limit, e.g. to identify the appropriate transmission.

The measurement results are displayed using a Cartesian diagram (measurement value versus frequency) or 2D/3D waterfall diagrams.

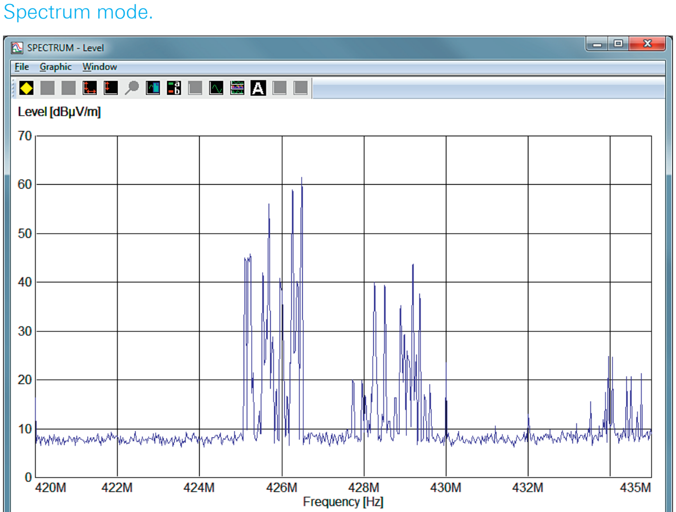
In the **signal analysis mode**, electromagnetic emissions can be analyzed and identified.

The user can select the frequency and the measurement parameters (e.g. level, frequency offset, bandwidth, modulation or location), depending on the capability of the selected devices.

The measurement results are displayed using a y-t plot (measurement value versus time).

A very convenient way of changing the frequency during the measurement is to use the graphic from the spectrum mode. Simply position the marker on the frequency of interest. The receiver is then automatically set to that frequency. The use of this method means that the measured spectrum can be analyzed very easily and quickly.

Spectrum mode.

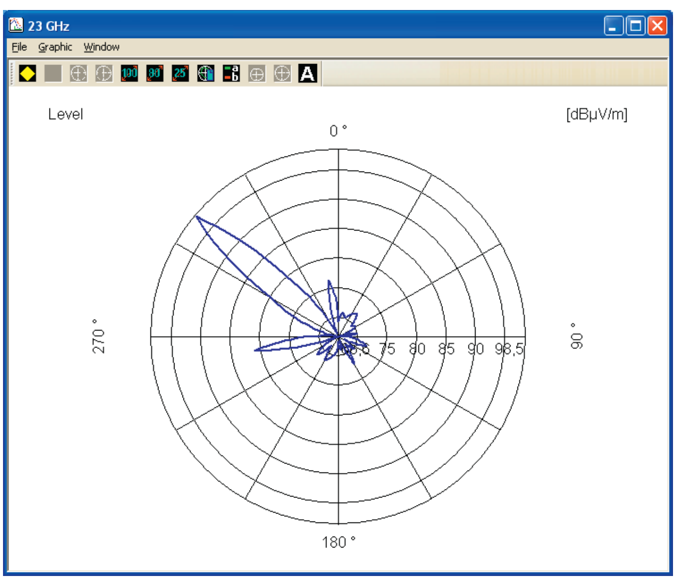


In the **antenna analysis mode**, level measurements are performed on a frequency while the azimuth, elevation or height of a directional antenna is varied. This mode is only activated for steerable antennas.

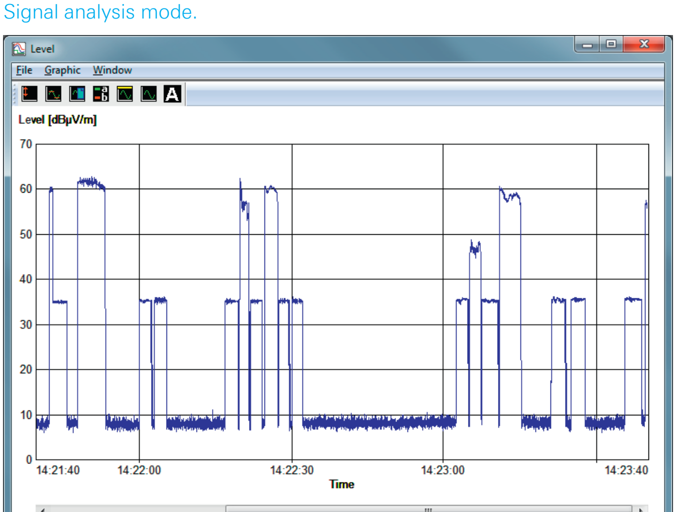
Users can define the antenna settings in two ways: They can either select a range for the antenna and the antenna covers this range using the selected step width. Or they can select a settings list. Users can enter individual antenna settings in this list.

The measurement results are shown as a polar diagram (azimuth and elevation) or as a Cartesian diagram (height).

Moving a directional antenna by 360° and displaying the level versus the azimuth immediately gives the direction of maximum intensity, i.e. the direction toward the transmitter. For this reason, this mode can also be used for direction finding. This is especially important for frequencies above 3 GHz, which is the upper limit of most conventional direction finders.



Antenna analysis mode.



Signal analysis mode.

The **intermodulation analysis mode** is used to track the emission producing an intermodulated signal. Intermodulations with up to three source signals are taken into account.

Intermodulation analysis is performed in four steps:

First, the spectrum associated with the frequency range to be investigated is measured in the spectrum mode.

Second, the number of frequency values can be restricted to a reasonable number by setting a threshold. Only frequencies with levels above the threshold are used. It is assumed that only sufficiently strong transmitters cause intermodulation.

Third, the possible originating frequencies are calculated, based on the fact that any given frequency can only cause intermodulation at certain discrete frequencies. This further reduces the number of potential sources for the observed intermodulation.

All frequencies determined in steps one and two are possible originating frequencies. The user can add or delete frequencies from this list.

Intermodulation is calculated as follows:

$$I = \pm X \cdot A \ \pm Y \cdot B \ \pm Z \cdot C$$

where I is the frequency on which the intermodulation is observed; A, B and C are the originating frequencies; the coefficients X, Y and Z represent the harmonics. The number of originating frequencies, the maximum harmonics with two originating frequencies and the maximum harmonics with three originating frequencies are entered by the user.

In the final step, the intermodulation products calculated in this way can now be investigated by clicking the Start button in the IMM dialog window. All frequencies that can theoretically cause intermodulation are acoustically compared with the observed intermodulation using the receiver's built-in demodulator.

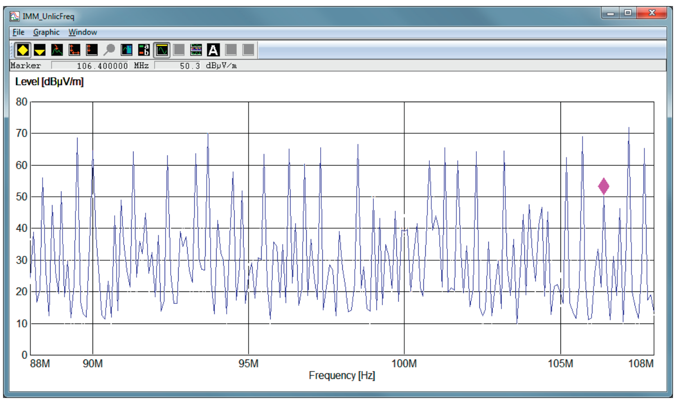
The results are stored in an IMA result file, sorted in the order of decreasing probability. The most probable results are those with the fewest number of original frequencies and the lowest order. The calculation results can be saved to an IMA result file and reloaded later.

In the **coverage measurement mode**, level measurements are performed while driving. This mode is only activated if a GPS receiver is available.

Measurements can be performed with fixed frequency mode (measurement using one frequency) and frequency list scan (scanning using frequencies from a frequency list).

The results are displayed on electronic maps using the R&S®MapView geographic information software.

Automatically detected active frequencies.



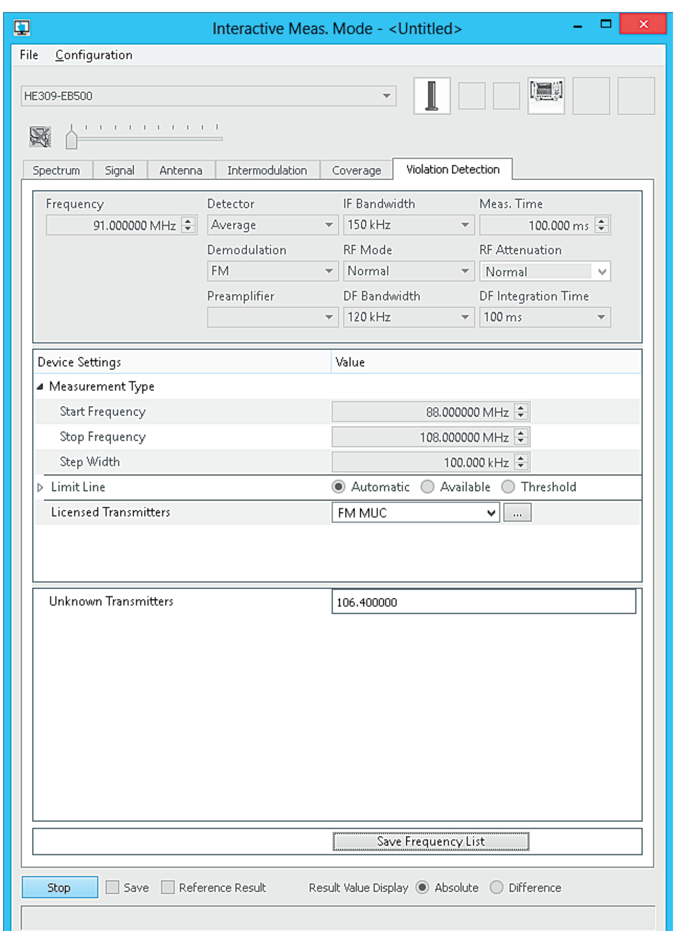
Using the frequency list scan, the results of a single frequency are displayed. After the measurement the results of the other frequencies can be displayed one by one.

The user can set the time interval parameter that defines the time interval between two measurements.

The **violation detection mode** provides a very efficient way to automatically detect new, unknown transmitters.

As a first step, a user-defined frequency range is scanned. Then, R&S®ARGUS will determine the frequencies on which there is an emission. This is done fully automatically (mathematically speaking, R&S®ARGUS will calculate local maxima in the spectrum). Additionally, the criterion for distinguishing noise from transmitters can be a user-defined threshold or limit line. For fine tuning, e.g. to select weak signals from strong noise, a level offset can be applied. The result will be a list of occupied frequencies.

Violation detection mode: Of all the automatically detected frequencies in the upper graphic, only one is unknown.



A reference list of known or licensed transmitters can be selected in order to easily detect new, unknown emissions. These frequencies will not be included in the final list. The final result will be a list of occupied frequencies that are not known or licensed. This list can be saved for further evaluation and identification.

Bearing measurement mode (BMM)

The bearing measurement mode combines the functionality of the bearing and parallel modes of previous R&S®ARGUS generations to yield one powerful multistation operating mode. In the initial step, users select whether they want to perform location determination or standard monitoring measurements. Depending on this selection, the corresponding user interface is displayed.

In case of location determination, up to four direction finders can be controlled simultaneously. The DF stations, bearings and locations can be displayed on digital maps within the R&S®MapView geographic information software.

The following three BMM modes handle the activities in question:

- Bearing mode
- Replay mode
- Combine mode

The dialog window is split into two sections. The upper section has all settings for the selected mode. The lower section contains the bearing results from every station involved, together with level, bearing, quality and recording time of the bearing. In addition, it shows the longitude and latitude if there are at least two stations, or a single station location (SSL) station and the error radius of the target location (if there are at least three stations). The >> button allows the dialog window to be enlarged.

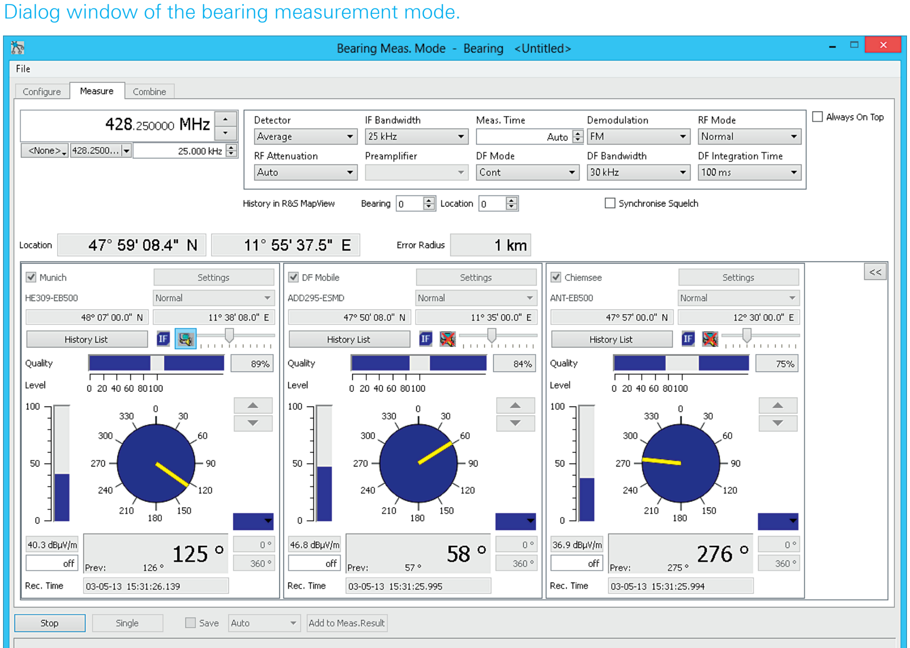
In the **bearing mode**, single-shot or continuous bearing measurements are performed on all emissions at a selected frequency within a range of 360° or within a sector defined by the operator. Up to four measurement stations can be used simultaneously.

The devices controlled can be direction finders or directional antennas on azimuth rotators. The directional antenna is rotated step-by-step through the angle range and the level is measured. The measurements are displayed as a polar diagram. The results are evaluated after all azimuth steps have been performed.

The angle with the maximum or minimum level (depending on the antenna) is displayed as a bearing result. This method allows direction finding at frequencies way above 6 GHz, which is the upper limit for most currently available direction finders. By using appropriate antennas and downconverters, R&S®ARGUS can perform direction finding up to 256 GHz.

The results are then automatically transferred to R&S®MapView where the bearing results are displayed on a digital map. A result history is provided in the BMM dialog window and in R&S®MapView to determine the best transmitter bearing. Using an appropriate transmitter list, the position of known transmitters can also be displayed on the map. In this way, the origin of a transmission can be determined very easily.

Dialog window of the bearing measurement mode.



If, for any reason, it is not possible to set up a connection to a measurement station, the results can be transmitted verbally from the remote station and entered manually in the system by the user.

In order to identify the emission or to make sure that all direction finders track the same signal, it is possible to listen to the audio signal of all stations involved. Furthermore, the IF spectra can be displayed.

The bearing results can be saved for further evaluation, replayed, combined or printed.

A specialty of the R&S®ARGUS bearing measurement mode is that all DF results are taken simultaneously. This is the only way to locate a fast moving transmitter.

In the **replay mode**, previously recorded bearing results are displayed in the BMM dialog window and/or in R&S®MapView.

After the bearing result and the time period have been selected, the bearing results can be displayed step-by-step or continuously.

The **combine mode** is used to combine previously recorded bearing results. This mode supports users without any direct connection to the DF stations. The bearing measurements can be performed in each station. Later, the bearing results can be combined somewhere else and the location of the transmitter can be calculated.

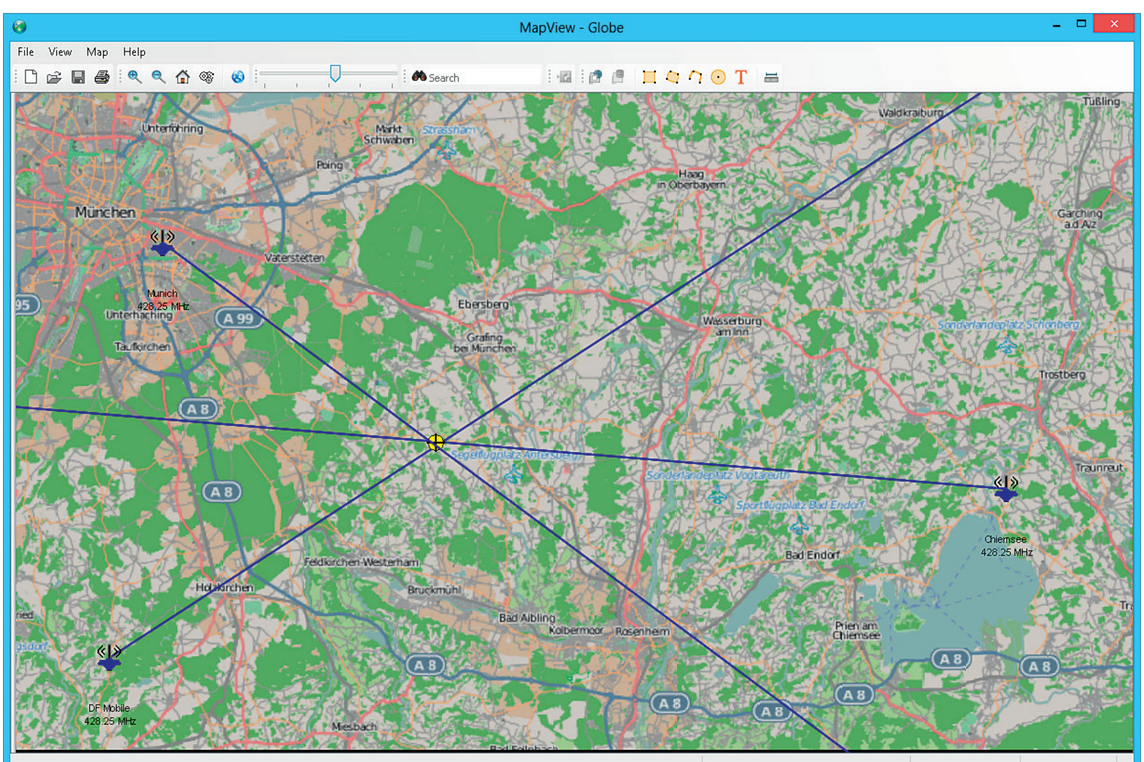
This mode is also useful if a user has only one vehicle. First, the vehicle must move to the initial DF point. The bearing is taken. Then, the vehicle must move to the next DF point where the bearing is taken again. The two bearings are then used to determine the location of the transmitter (running fix). If necessary, additional bearings can be taken and combined.

After the bearing results, the frequency and, if required, the level and quality threshold have been selected, the bearing results can be combined.

The results can be displayed in the bearing result dialog window and/or in R&S®MapView using the replay mode.

When the user has initially selected **standard monitoring**, synchronized measurements of a parameter using up to four different measurement units are performed. All results are combined into a single file and saved. It is also possible to listen to the audio signal of all devices involved. This makes it easy to confirm that all stations really monitor the same transmitter.

Example illustrating the bearing measurement mode (three stations connected) with results shown in R&S®MapView.



Automatic measurement mode (AMM)

The automatic measurement mode serves two main purposes:

- Perform measurement tasks in line with a specific time schedule
- Automatically detect if a live result is outside a user-defined value range (i.e. an alarm occurred) and react as defined by the operator

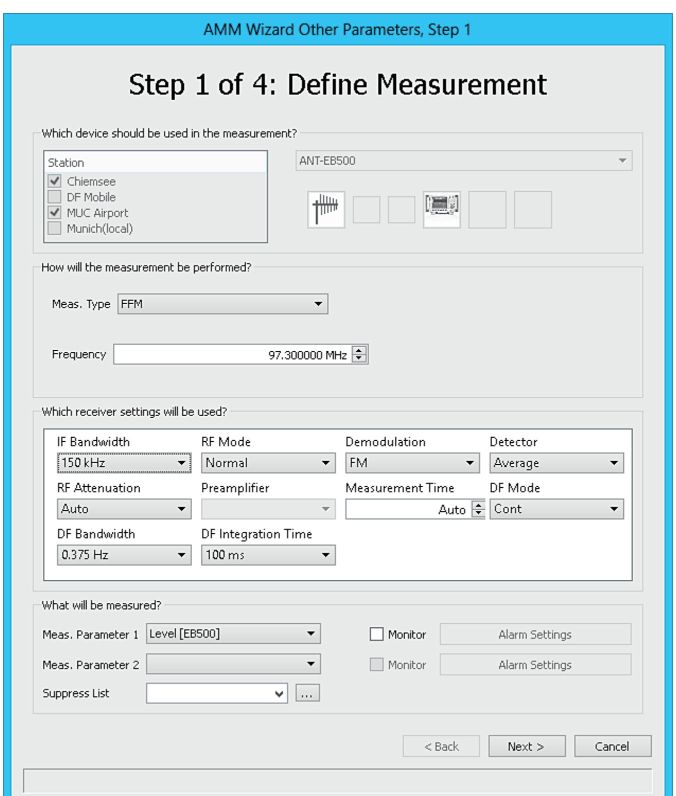
The automatic measurement mode is used to automatically perform measurements in line with a schedule. The user defines the measurement tasks and starts them. The measurements will be performed automatically, exactly as defined by the user. The measurement results can be evaluated while the task is being performed or when it has been completed. Cyclic measurements can be performed at certain times of the day and over a period of days, months or even years.

For each frequency and parameter, an upper and/or lower limit can be defined. If one of these limits has been exceeded during a measurement, several options are available. The alarms can be displayed on the screen at an attended station or passed to the central station if the alarm is at an unattended station. An SMS or e-mail can be sent to the person in charge. Furthermore, a new measurement can be started for a detailed examination of the frequency that triggered the alarm. It is possible, for example, to perform various modulation measurements; the audio data can be recorded or additional measurement stations with DF equipment can be integrated in order to determine the emitter location.

Rotators and masts can also be controlled so that the measurements are also performed at certain azimuths, elevations, polarizations and heights.

If the measurements are defined by a regional or national headquarters but run on a remote monitoring station, **no permanent connection is required during the measurement, which drastically minimizes network costs**. Simply define the measurement tasks and select the remote sites at which these tasks are to be performed. R&S®ARGUS will automatically connect, transfer the monitoring requests and disconnect. At the remote sites, the measurement tasks will be performed as predefined. When the remote site detects an alarm, it will briefly connect to the headquarters, just to deliver the alarm information. The measurement will continue and the results will be saved in the measurement unit. When the control unit and the measurement unit are connected again, the measurement results can be transferred. Alternatively, the result files can be moved to the headquarters fully automatically.

AMM wizard.

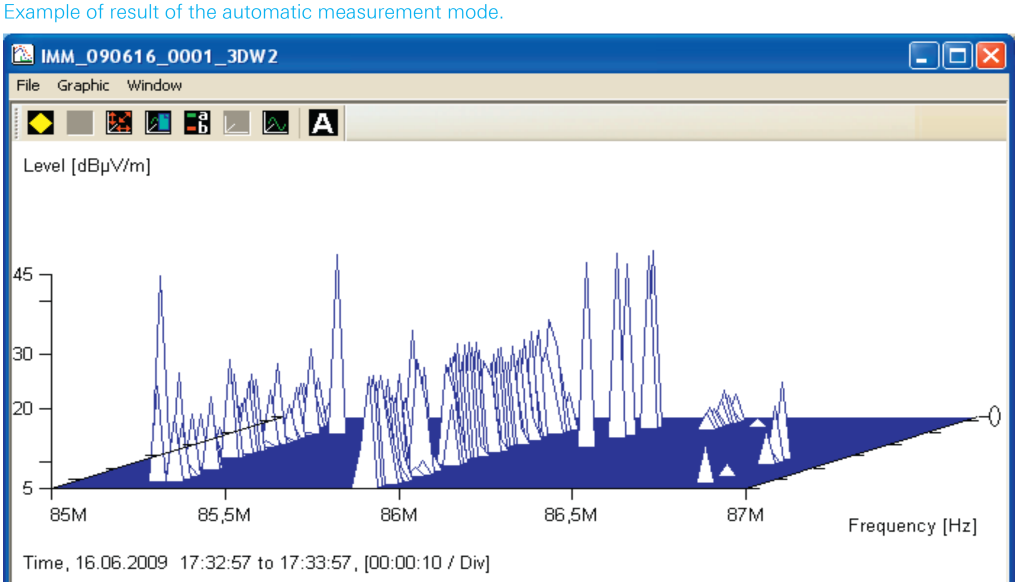


The measurement results can be saved in different formats:

- Measurement result:
  All measurement results are saved
- Max. hold:
  Only one data record with the max. hold value for each frequency is saved
- Compressed measurement result:
  The mean, maximum and minimum value as well as the standard deviation during a user-defined period are saved for each frequency
- Measurement result during an alarm:
  Measurement results are only saved if an alarm criterion is fulfilled, i.e. a measurement value exceeds the upper or lower limit
- Beginning and end of an alarm:
  For each frequency where an alarm condition is fulfilled, date, time, measurement value and status (high, low, ok) are saved
- Measurement result during an alarm and compressed measurement result outside an alarm:
  If no alarm condition is active: The mean, maximum and minimum value as well as the standard deviation during a user-defined period are saved for each frequency. If an alarm condition is active: All measurement results are saved

The user can set up an AMM procedure quickly and easily using the AMM wizard. The AMM wizard guides the user through the appropriate dialog windows where the entries necessary for setting up the AMM can be made. The wizard then generates the necessary definition files.

Example of result of the automatic measurement mode.



Difference measurement module (DIFF)

The difference measurement module is an addition to the automatic measurement mode (AMM). Its main purpose is to detect clandestine transmitters such as electronic bugs or other hidden devices.

This module makes it possible to perform simultaneous measurements with two receivers or analyzers of the same type. One measurement is made in the room to be checked (e.g. conference room), while the second measurement is made at the same time in a room close by, providing a reference spectrum in time and location. After each scan the difference of the two measurements is calculated. In this way, signals present in both rooms are eliminated and the weak emission from the electronic bug only detected in the conference room, for example, is clearly visible.

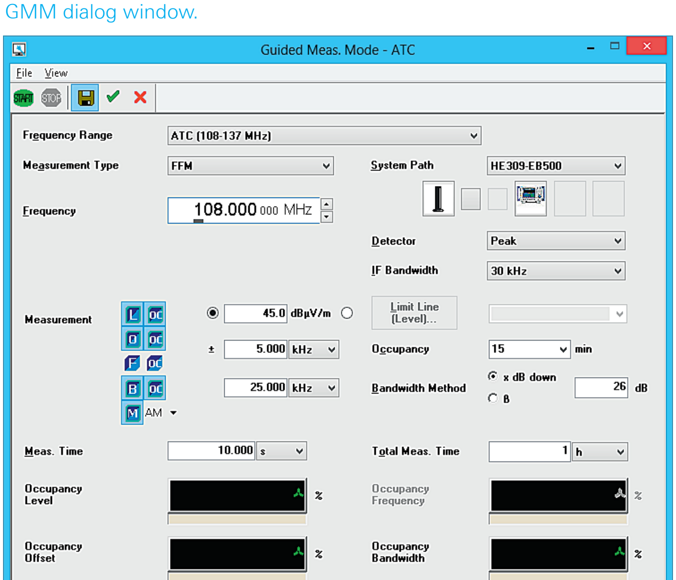
This feature can be used with scans and frequency list scans.

The frequency spectrum of both devices and the difference can be displayed graphically. To eliminate noise, a threshold can be defined by the user. Afterwards the difference is calculated and displayed. The difference results are saved using special criteria for each frequency. These criteria can be a limit value, a limit line or both. The date and time, frequency, field strengths of both receivers and the difference will be saved. All standard receivers and spectrum analyzers can be used. As a result, the frequency range from 20 Hz to 256 GHz is covered.

The upper graphic shows the result of the reference receiver, taken in a nearby "clean" room.
The graphic in the center shows the result of the monitoring receiver, taken at the same time in the room to be checked.
The lower graphic displays the difference of the two spectra.

Guided measurements – for the ultimate in user support

GMM dialog window.



As the ultimate form of user support, guided measurements include the following monitoring capabilities:

- Guided measurement mode for analog signals (GMM)
- Guided measurement mode for digital signals (DM)
- Guided measurement mode for pulsed signals (PMM)
- Guided measurement mode for coverage measurements (CMM)

The main objective of the R&S®ARGUS approach is to provide optimum support for the user and enable straightforward, efficient and goal-oriented working. For example, selection options that are temporarily illogical or unavailable are deactivated. Informative error messages are also implemented that provide information on solving and avoiding problems. Accidental deletion or loss of data is practically impossible.

However, R&S®ARGUS goes one step further since it is the only product of its kind to offer guided measurement modes, providing the ultimate in user support. The user only needs to select the frequency or frequencies of interest along with the measurement parameters, e.g. level, offset, bandwidth and band occupancy. Using an internal knowledge database, R&S®ARGUS automatically proposes suitable instruments and device settings, e.g. IF bandwidth, detector and measurement time. This enables even less experienced users to immediately perform ITU-compliant measurements quickly and reliably.

The settings from the knowledge database are based on the corresponding ITU recommendations and guidelines. Authorized users can edit the database and create custom extensions, for example.

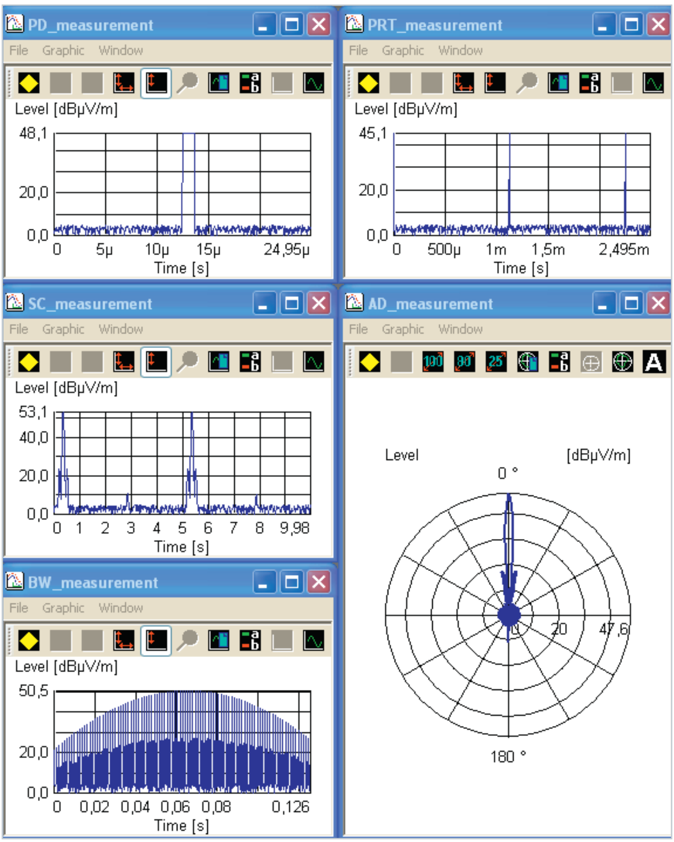
The values that are set automatically are suggestions. The user can, of course, modify the settings. Any values that do not conform to the recommendations are highlighted in red, and a suitable warning is generated at the start of the measurements. If the user decides to override the warning and proceed with the settings, an appropriate entry will be included in the header of the result file.

Guided measurements are available for four application areas with their own special features.

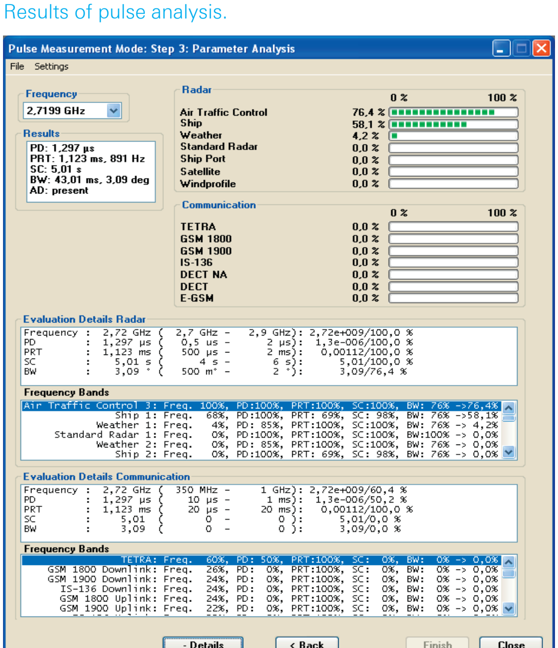
Guided measurement mode for analog signals (GMM)

After the selection of the frequency range, R&S®ARGUS selects the appropriate instrument and the corresponding parameter settings.

Measurements of characteristic parameters for pulsed signals.



Results of pulse analysis.



Guided measurement mode for digital signals (DM)

This mode enables guided measurements on digitally modulated signals. Due to the technical characteristics of these signals, the modulation standard is selected prior to the entry of the frequency or frequencies.

The vestigial sideband measurement is of particular interest here. Digital signals typically have rectangular spectra, unlike analog signals which tend to be Gaussian. They also consist of a large number of individual carriers. This means that a significant portion of the transmit power can be very close to the edge of the signal. In order to avoid interference to adjacent channels, the permissible bandwidth must not be exceeded. For this purpose, the ITU has defined spectrum masks for diverse standards that characterize the level relative to the center frequency. The user must position this mask so that it lies exactly over the signal to be examined. The digital measurement mode provided by R&S®ARGUS accomplishes this complicated task simply and reliably.

After the user has selected the modulation standard and the approximate center frequency of the signal of interest, R&S®ARGUS determines the bandwidth and the exact center frequency. As a result, the mask can be positioned in the frequency range. Next, the maximum level of the signal is measured by using the parameter values found in the knowledge database. In this manner, the position of the mask in the level range is known. Finally, the signal is scanned again. The display then shows the measured signal with the associated mask precisely superimposed at the proper location. This reveals at a glance whether the transmitter operates within the allocated bandwidth or has violated the terms of its license.

Using these guided measurements, even inexperienced users can perform the challenging analysis of digital signals quickly and reliably.

Guided measurement mode for pulsed signals (PMM)

First, the frequency range of interest is scanned and a list of all active frequencies is generated fully automatically from the scan results. Here too, the user can select a predefined frequency range. R&S®ARGUS then selects the appropriate settings.

For the signals that have been detected, characteristic parameters such as pulse duration, pulse repetition rate, scan cycle and beam width are determined (also based on values from the knowledge database). Finally, the measured values are compared with data from a reference database, which allows the signal to be identified.

Guided measurement mode for coverage measurements (CMM)

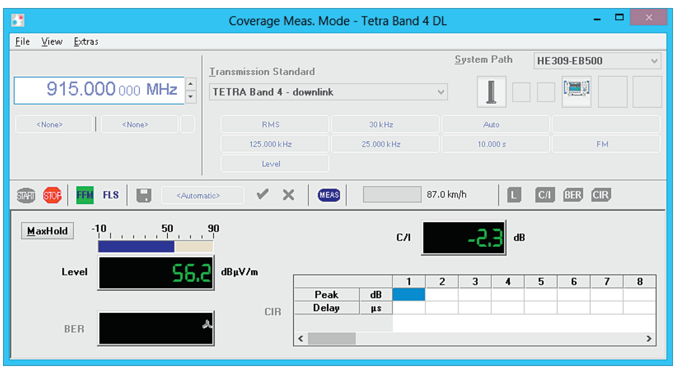
Coverage measurements are performed at changing locations and frequently also in the monitoring vehicle while driving. One objective of these measurements is the on-site verification of the coverage calculated by the spectrum management system.

For analog signals, level and adjacent channel interference (carrier to interference ratio) are provided as measurement parameters. Level, bit error rate (BER, for DVB-T) and channel impulse response (CIR, for DVB-T) are provided for digital signals. All parameters can be measured while driving. A connected GPS adds high-precision geocoordinates to each measurement point.

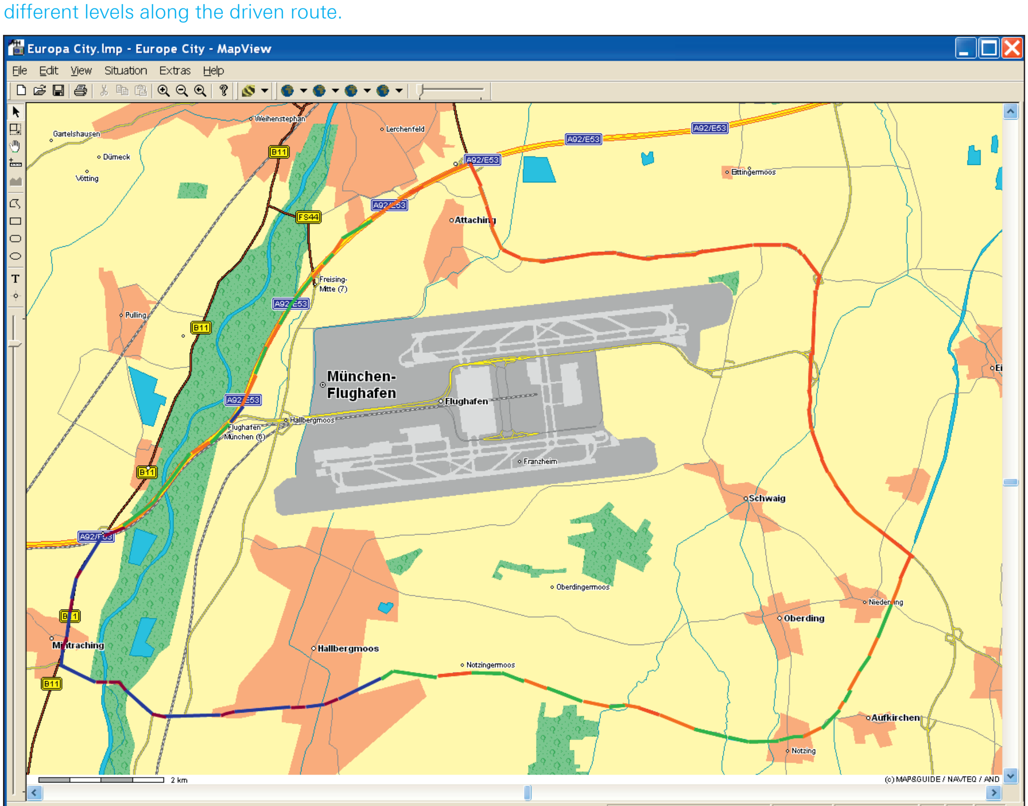
Measurements can be performed either on a single frequency or on multiple frequencies defined in a frequency list. The integrated view mode enables the operator to quickly scan the spectrum and detect emissions on adjacent channels. To further enhance usability and operator support, the maximum recommended vehicle speed is displayed (ITU recommends to perform 50 individual measurements within a distance of 40 times the wavelength).

The results are displayed on electronic maps using the R&S®MapView geographic information software, where different colors represent different, user-definable value ranges.

Coverage measurement mode.



Example illustrating a result of a coverage measurement displayed in R&S®MapView. Different colors represent different levels along the driven route.



Detection and identification of new transmitters

- Automatic detection of new transmitters
- Diverse analysis capabilities for clear identification

One of the main objectives of this application is to detect and identify new transmitters. New transmitters can be unlicensed stations or unwanted signals such as interference or intermodulation, for example. As the number of transmitters continues to grow, searching for unknown transmitters is increasingly like "looking for a needle in a haystack". However, R&S®ARGUS provides ways to look through this "haystack" and find transmitters simply and reliably.

As the first step, the frequency range of interest is scanned and a list of all active frequencies is generated fully automatically from the scan results. This list is then compared with a reference list. The user can compile this reference list as required and edit it. It is also possible to import data from the frequency management system. The measured values are compared with the reference data in realtime, i.e. during the measurement. This makes it possible to identify exclusively the emissions that are unknown.

Alternatively, this analysis can also be performed in offline mode. Instead of the realtime measurement results, a file containing previously saved measured values is analyzed.

If an unknown transmitter is detected, it must be identified.

First, technical parameters such as frequency, bandwidth and modulation are measured. Using direction finders, the exact location can be determined. Listening to the demodulated audio signal is also effective.

If the technical parameters listed above, in combination with listening, are not adequate to identify the emission (e.g. when dealing with data transmission or a digitally modulated signal), identification must be performed based on the decoded content of the emission. For this purpose, many devices allow the recording of I/Q data. This data is subsequently analyzed with the dedicated R&S®GX430 signal analysis software. Results are then combined with the monitoring results to create one comprehensive report.

Efficient solutions for the digital world

- Digital television
- Digital radio
- Digitally modulated signals

There is currently a worldwide transition underway from analog to digital transmission. In the area of telephony, standards such as ISDN, DECT, UMTS and LTE are in use around the world. This change in technology is especially apparent in the areas of sound and TV broadcasting. In many regions, analog television broadcasts via antennas have been shut down and replaced with digital techniques. R&S®ARGUS also provides its users with optimal tools for handling the new, challenging measurements that are now required.

Digital television

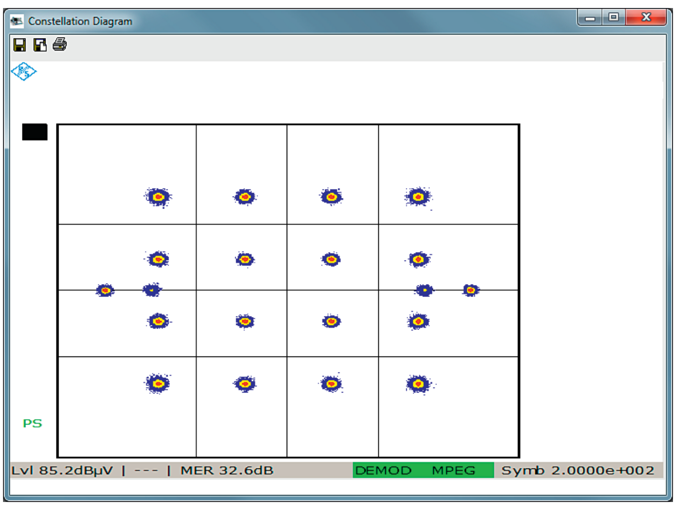
An analog television signal can be properly characterized by its frequency, level and bandwidth. With digital television, however, the situation is significantly more complex. The level is measured, but it is less important. Parameters such as data rates, modulation error rates, bit error rates and error correction are much more critical.

While in analog television each frequency is associated with only one transmitter, multiple digital television signals can be transmitted per frequency in digital television (depending on the transmission standard, typically four to six transmitters). This means that new techniques are required for signal identification, e.g. transport stream analysis.

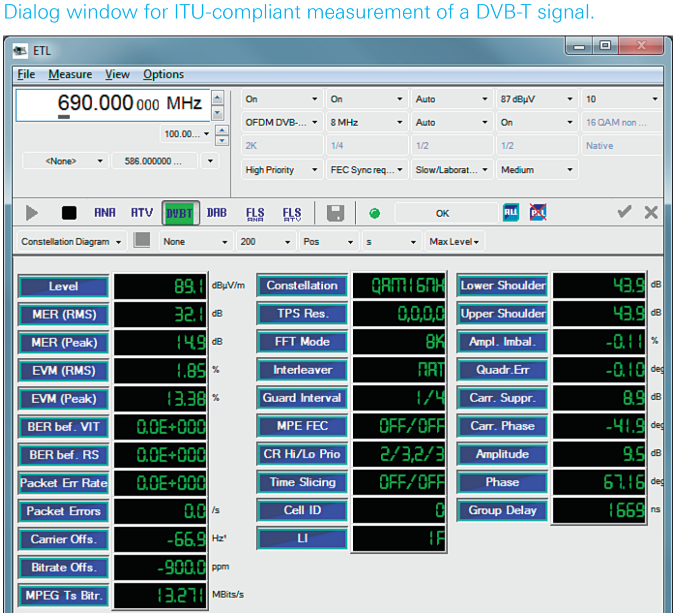
Rohde & Schwarz has developed special TV test receivers for this application. The bottom figure shows a selection of the measurement parameters that characterize a digital TV signal.

Measurement of vestigial sidebands is a very important but also difficult measurement. Solving this problem with R&S®ARGUS is described in the section on "Guided measurements" (see page 14).

Typical constellation diagram of a DVB-T transmitter.



Dialog window for ITU-compliant measurement of a DVB-T signal.



Digital radio

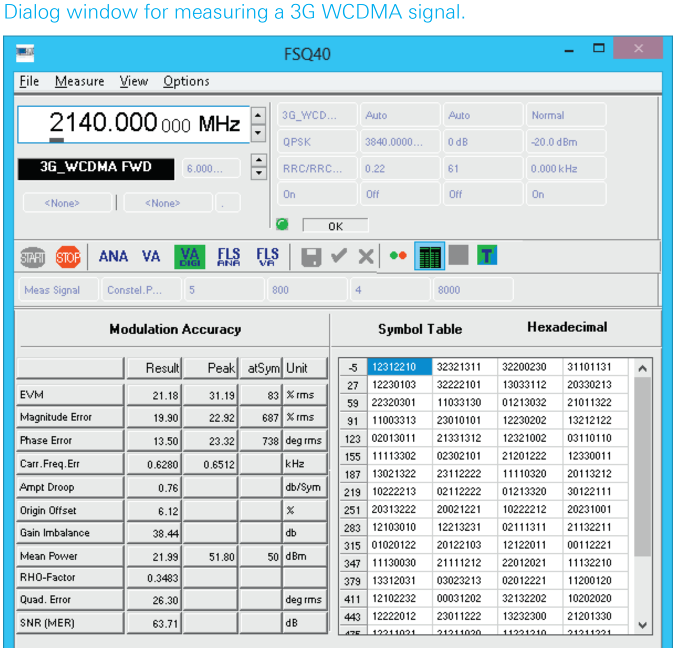
There are also multiple digital transmission methods used in sound broadcasting. One standard of particular interest is digital audio broadcasting (DAB) and its advanced version, DAB+. Using the R&S®ETL TV analyzer all important technical parameters of these emissions can be monitored. This analyzer, such as all other devices, is fully integrated into R&S®ARGUS and provides all monitoring capabilities on either an interactive or fully automatic basis.

Digitally modulated signals

For measuring and analyzing digital communications signals, various spectrum analyzers are integrated into R&S®ARGUS. Transmission standards such as GSM, CDMA, CDMA2000®, UMTS, EDGE, DECT or TETRA can be monitored in detail.

Proper measurement parameter settings are even more critical with digital signals than with analog signals. To provide maximum support to the user, the values for demodulation, symbol rate and filter, for example, are preset when a standard is selected. This is the best approach in order to allow execution of ITU-compliant measurements even by inexperienced users or in situations where time is critical.

Dialog window for measuring a 3G WCDMA signal.



CDMA2000® is a registered trademark of the Telecommunications Industry Association (TIA-USA).

Clear presentation of measurement and statistical results

Measured values are presented as follows:
- Presentation using various specially adapted graphic types
- Replay of recorded audio signals
- Presentation on maps (geographic information systems)

Presentation using various specially adapted graphic types

All measurement and evaluation results can be presented in tabular format. Special graphics are also available to provide a better overview and make it easier to monitor complex signal scenarios.

If only a single frequency is examined, the y-t plot is useful since it presents the values for a specific measurement parameter versus time.

If measured values for multiple frequencies are to be visualized, however, a Cartesian diagram is preferable since the measured value can be shown versus frequency.

If the behavior versus time also needs to be documented simultaneously, waterfall diagrams can be used. A 2D waterfall shows time versus frequency, and user-definable thresholds and associated colored symbols can be used to clearly depict the distribution of the measured values. A 3D waterfall includes axes for frequency, measured value and time. Both types of graphics are ideal for presenting a wide frequency range while simultaneously allowing tracking of changes in signals versus time.

In addition to these standard graphics, there are also special formats. A polar diagram depicts the measured value as a function of the antenna orientation (azimuth or polarization). Especially with digitally modulated signals, the spectrum can be measured using different antenna heights. The graphic then shows the measured value versus height. Many of the parameters that characterize a digital signal cannot be adequately represented using conventional graphics. Instead, specially optimized graphics such as the eye diagram or constellation diagram are used for this purpose.

All these graphic types include numerous options for customizing the layout. The colors of the traces and background can be individually selected and the axes can be scaled as required. Using the zoom and marker functions, a region of interest in the graphic can be expanded for more precise exploration. Another very useful feature is the option to enter a comment at any desired location. This makes it possible to clearly mark a signal of special interest within a spectrum. Of course, graphics can be printed, saved and copied to other applications using the clipboard.

Replay of recorded audio signals

The demodulated audio signal can provide extremely useful information. Besides realtime audio monitoring, R&S®ARGUS allows such signals to be saved, e.g. for documentation purposes. Especially in cases where measurement results from R&S®ARGUS are to be used as legal evidence in a court of law, it is very impressive if the technical data proving that a license violation occurred, for example, is supported by the audio signal.

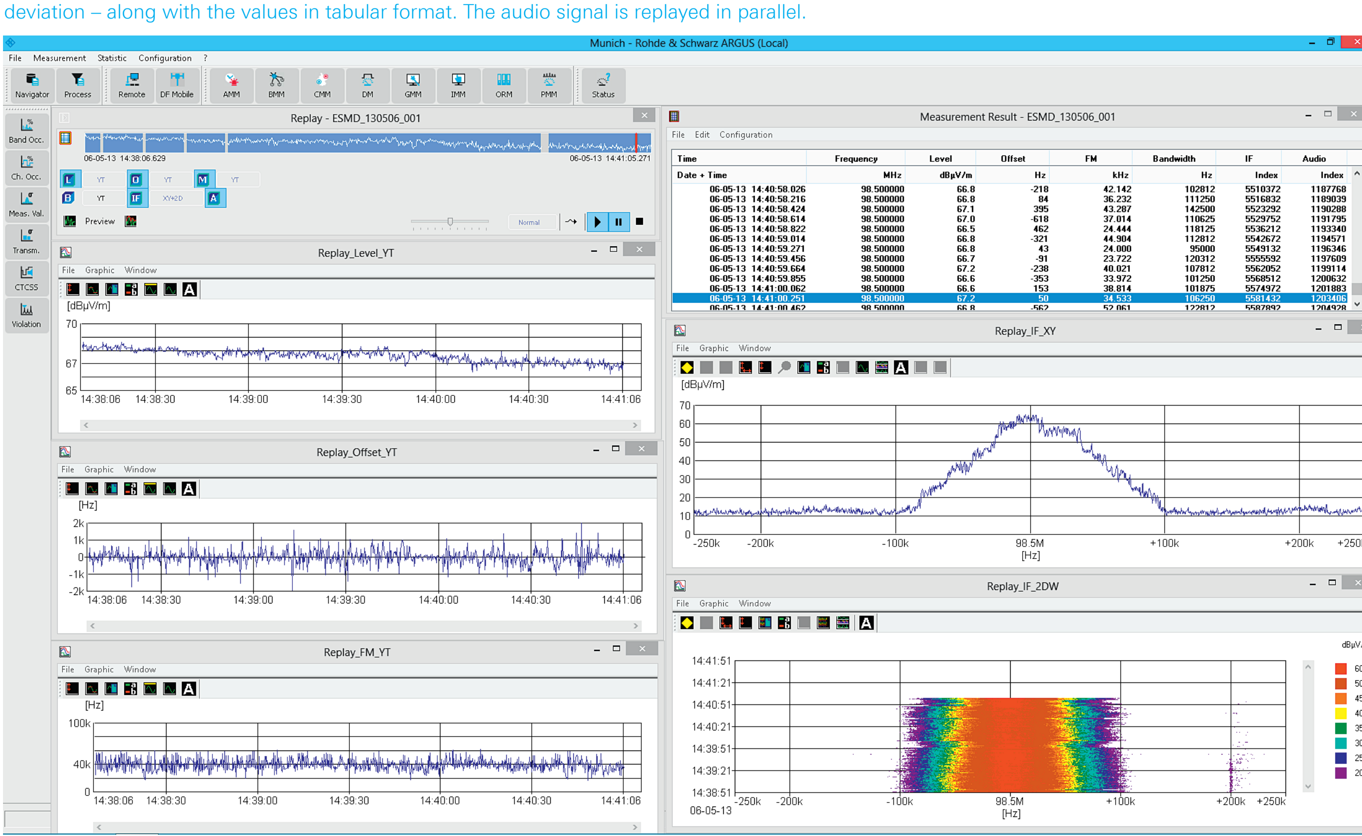
One notable feature of R&S®ARGUS is the fact that the audio signal is saved in a file along with all other measured values. This allows absolutely time-synchronous replay even over an extended period of time. Especially for bidirectional communications involving walkie-talkies or aeronautical radio, for example, this feature ensures that the correct bearing is output for the currently heard audio signal. In applications where measured values and audio data are stored in separate files, the critical synchronicity is lost.

Presentation on maps (geographic information systems)

For certain measurement parameters, fast and reliable analysis is possible only if these parameters are visualized on an electronic map. This includes above all bearing and location results. The direction finder locations and the associated bearings are displayed on a map along with the precisely computed transmitter location. The locations of licensed transmitters can also be shown simultaneously. The map immediately reveals whether the transmitter of interest is known or unknown.

Another example of map-based presentation occurs with coverage measurements in which the measured values are recorded at different geographic locations, most commonly during drives. The measured values are color-coded on the map to show at a glance the areas where a transmitter can be received with adequate quality and where coverage gaps might exist.

Example of time-synchronous reproduction of a measurement result. The graphics show the IF spectrum, the history of the IF spectrum, level, offset and deviation – along with the values in tabular format. The audio signal is replayed in parallel.



From comprehensive analyses to informative reports

Concise, informative reports are generated in three steps:
- Filtering of raw data
- Analyses and evaluations in accordance with ITU guidelines and recommendations
- Compilation of concise, informative reports

Filtering of raw data

Advanced monitoring instruments from Rohde & Schwarz can generate huge amounts of data in a very short period of time. Measurement results can grow to a size of several gigabytes in only an hour. Normally, the measurement definition is tailored to reduce the amount of data generated during the measurement. If this is not possible, the data is typically filtered at the start of the evaluation process. Most commonly, a level threshold is defined for distinguishing active signals from frequencies that contain only noise. Generally, however, any measurement parameter (e.g. bandwidth, modulation, offset, bearing) can be used as a filter criterion. Moreover, the date/time of day, frequency and even the antenna setting can be used for filtering if, for example, only signals with horizontal polarization are to be analyzed.

If necessary, several sets of partial results can be combined to produce a comprehensive measurement result file. For a complete report, transmitter lists and band occupancy statistics can be appended additionally.

Analyses and evaluations in accordance with ITU guidelines and recommendations

The ITU recommends which measurements to make, how to make them and how to evaluate the measurement results.

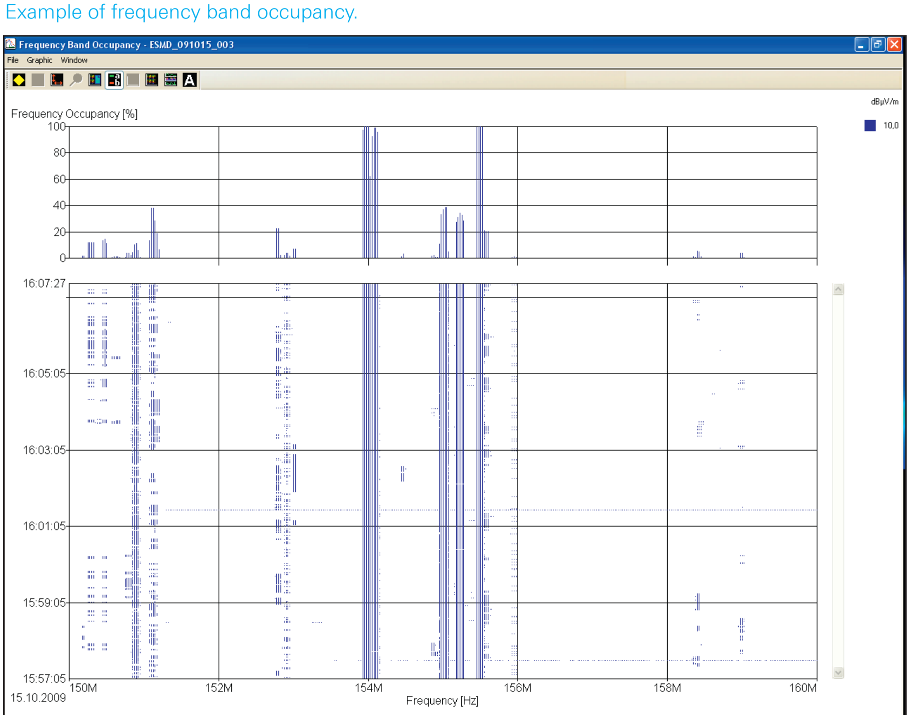
The following ITU-compliant analyses are implemented:
- Frequency band occupancy
- Frequency channel occupancy
- Measurement value statistics
- Transmission statistics
- Subaudio tone occupancy statistics
- Violation detection

Frequency band occupancy

Frequency band occupancy involves the calculation of the occupancy for the entire measured frequency band. Two graphics are opened:

The 2D waterfall diagram shows frequency along the x-axis and time along the y-axis. A symbol represents the measurement values that exceed a user-defined threshold.

Example of frequency band occupancy.



The frequency occupancy diagram shows frequency along the x-axis and frequency occupancy values in [%] along the y-axis. The frequency occupancy is calculated for every frequency as follows:

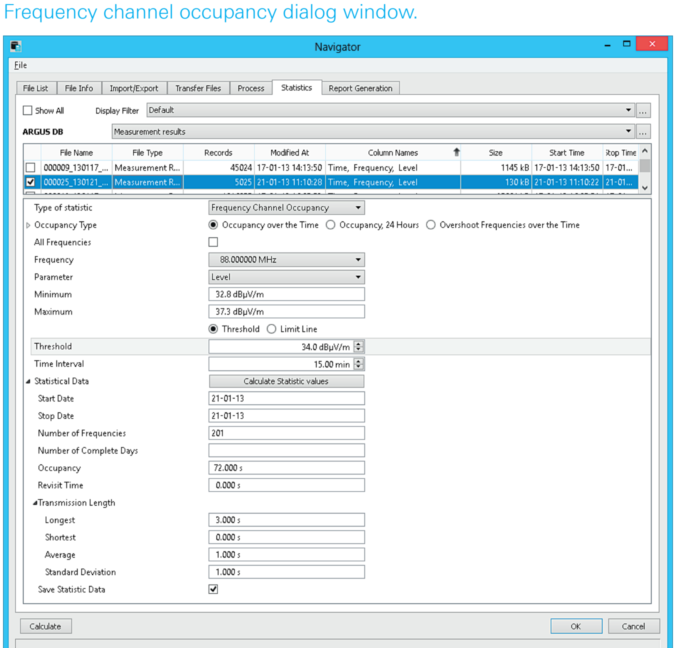
$$\frac{\text{Number of measured values} \geq \text{threshold}}{\text{Total number of measured values}} \times 100$$

Frequency channel occupancy

Three types are available for this kind of statistics:

- Occupancy over time:
  Frequency occupancy is displayed in [%] along the time axis. The time axis begins with the start date and time of the measurement and ends with the stop date and time of the measurement.
- Occupancy, 24 hours:
  This option is only available if the measurement took longer than 24 hours. The maximum, mean and minimum occupancy is calculated and displayed for each interval from 00:00 h to 24:00 h. Only the selected days of the week are considered
- Overshoot frequencies over time:
  The overshoot frequencies 0/10/50/90 % and 100 % of the measured values are displayed along the time axis. The graph consists of bars whose width represents the interval. The overshoot frequencies 0 % (maximum value), 10/50/90 % and 100 % (minimum value) are shown as lines within the bar at the corresponding measured value

Frequency channel occupancy dialog window.



The occupancy is calculated for every interval as follows:

$$\frac{\text{Number of measured values} \geq \text{threshold}}{\text{Total number of measured values}} \times 100$$

The overshoot frequency is calculated for every measurement value as follows:

$$\frac{\text{Number of measured values} \geq \text{measured value}}{\text{Total number of measured values}} \times 100$$

An overshoot frequency of 100 % means that all measured values are greater than or equal to a particular measured value. As a consequence, this is the lowest measured value.

An overshoot frequency of 0 % means that no measured value is greater than or equal to a particular measured value. This value is the largest measured value plus a value corresponding to the smallest step width of the measured value unit. The overshoot frequencies 0/10/50/90 % and 100 % are important representative values.

In addition to the graphical statistics, various statistical data can be calculated in the frequency channel occupancy dialog window:

- Revisit time:
  The revisit time is directly dependent on the measurement time, the number of channels (in case of a frequency list scan), and any waiting time between the individual measurements: revisit time = (measurement time per channel + waiting time per channel) × (number of channels)
- Transmission length:
  The transmission length is the duration of a transmission data burst that is above the specified threshold level. The accuracy of the transmission length determination depends highly on the revisit time
- Busy hour:
  A busy hour is defined as the moment on the sliding hour average line where the occupancy is at the highest within a 24 h interval from 00:00 h to 24:00 h. For example, with an interval of 15 min the sliding hour average is determined in two steps: First, samples of 15 min are averaged, resulting in 96 samples per day. Second, each 15 min average value is then used to form a sliding one-hour average. This means that four pieces of 15 min samples are averaged 96 times a day (beginning at each quarter of an hour)

Measurement value statistics

The measurement value statistics indicate how often each measured value occurs and how often each measured value has been exceeded. These calculations can be used to provide information about the variance of measured values, the stability of measured values, the environmental noise component as well as crossmodulation and intermodulation effects. Two graphics are opened:

- The measured value frequency graph has the measurement value along the x-axis and the frequency in [%] along the y-axis. The measured value frequency is calculated for every measurement value as follows:

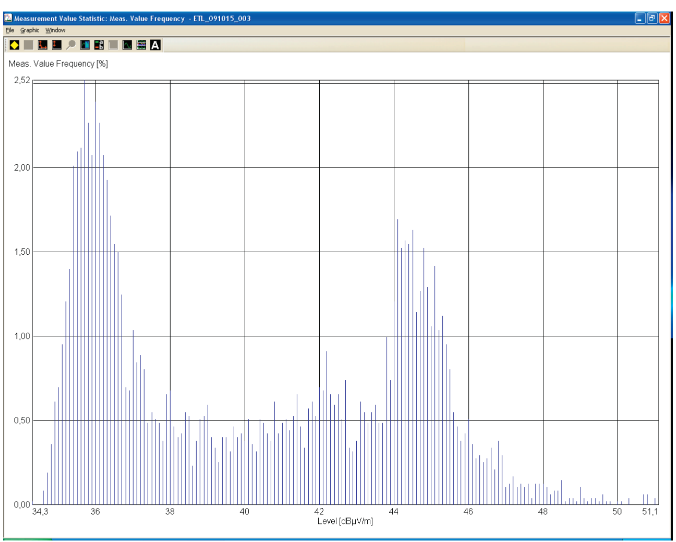
$$\frac{\text{Number of measured values for a measured value}}{\text{Total number of measured values}} \times 100$$

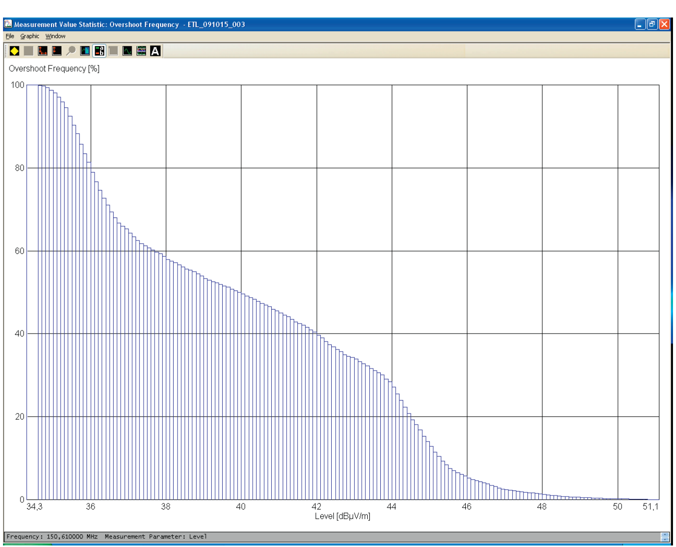
- The overshoot frequency graph has the measured value along the x-axis and the overshoot frequency in [%] along the y-axis. The overshoot frequency is calculated for every measurement value as follows:

$$\frac{\text{Number of measured values} \geq \text{measured value}}{\text{Total number of measured values}} \times 100$$

An overshoot frequency of 100 % means that all measured values are greater than or equal to a particular measured value. As a consequence, this is the lowest measured value. An overshoot frequency of 0 % means that no measured value is greater than or equal to a particular measured value. This value is the largest measured value plus a value corresponding to the smallest step width of the measured value unit. The overshoot frequencies 0/10/50/90 % and 100 % are important representative values.

Example of measurement value statistics.





Transmission statistics

Transmission statistics enable the user to determine how often and how long a channel has been used for transmission. The threshold for these statistics is settable. The following definitions apply:

$t_{(tot)}$: total observation time ($t_{(on)}$ + $t_{(off)}$)

$t_{(on)}$: sum of all times during which the measured value is above the threshold

$t_{(off)}$: sum of all times during which the measured value is below the threshold

$t_{(trans)}$: sum of all times during which the measured value is above the threshold. Only times at which the value exceeds the threshold and then drops below it again are counted. $t_{(trans)}$ can only be calculated if the threshold is exceeded twice within $t_{(tot)}$

$t_{(gap)}$: sum of all times during which the measurement value is below the threshold. Only times at which the value drops below the threshold and then exceeds it again are counted. $t_{(gap)}$ can only be calculated if the threshold is overshot or undershot twice within $t_{(tot)}$

Two graphics are opened:

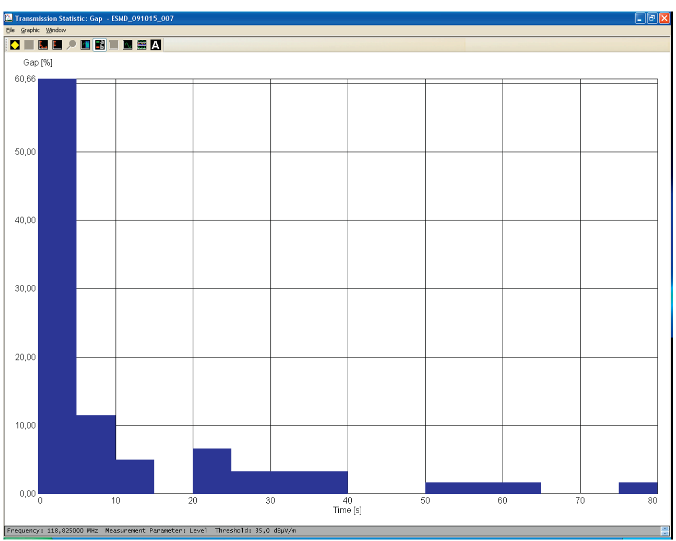
- The transmission graph shows the transmission time along the x-axis and transmission in [%] along the y-axis. The transmission times are displayed using 1 s grids. The graph is not displayed if the threshold is not exceeded twice within the entire measurement time

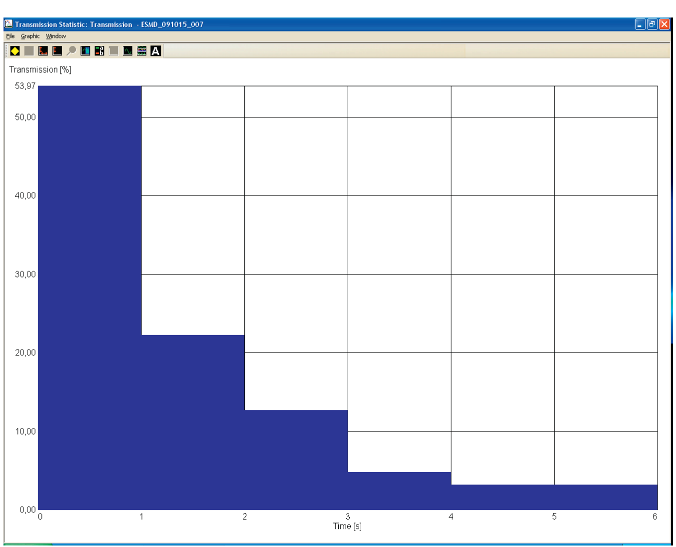
$$\frac{\text{Number of transmission times within a second}}{\text{Total number of transmission times}} \times 100$$

- The gap graph shows the pause time along the x-axis and the gap in [%] along the y-axis. The pause times are displayed over 5 s grids. The graph is not displayed if the threshold is not undershot twice within the entire measurement time

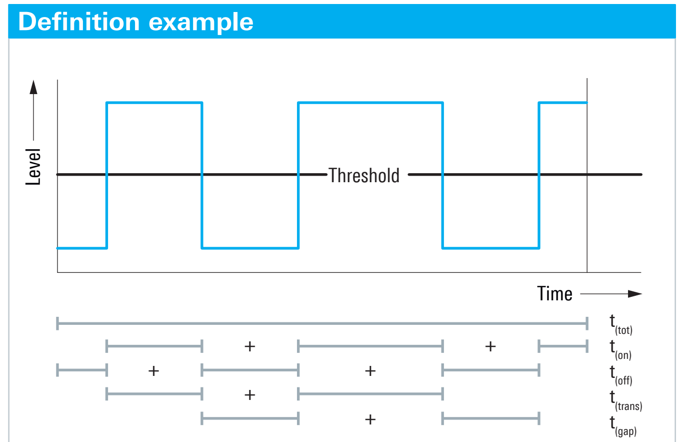
$$\frac{\text{Number of pause times within five seconds}}{\text{Total number of pause times}} \times 100$$

Example of transmission statistics.





Definition example



Subaudio tone occupancy statistics

Subaudio tone occupancy statistics enable the user to ascertain how often and how long transmissions have been made using a certain subaudio tone.

The result is shown as a table. The entire transmission time (column $t_{(on)}$) is given for every subaudio tone (theoretical subaudio tone column). The table also specifies how often the tone has been measured (number column).

Violation detection

Saved scan measurement results can be used to automatically detect new or unknown transmitters.

Similar to the procedure in the interactive measurement mode (IMM), occupied frequencies can be determined fully automatically or via limit lines and thresholds. A reference list of known transmitters can be utilized to eliminate licensed stations. The result is a list of occupied frequencies which have not been characterized as known or good.

Here, this analysis is performed offline in the evaluation module after the measurement. In the IMM, the analysis is performed live while the measurement is still running.

Compilation of concise, informative reports

A report is typically generated at the end of a measurement.

The R&S®ARGUS evaluation module offers the user comprehensive documentation options. Measurement results, measurement definitions and statistical evaluations in the form of graphs or tables can be compiled and configured by the user for reports. These reports can be printed out and saved as a file.

The integrated RTF editor enables users to modify the look and feel of the report in line with their own preferences or corporate identity.

The navigator – main area for all file operations

As a general rule, all data gathered in R&S®ARGUS such as measured values, statistics, graphics and frequency lists can be saved in an internal database. This has clear benefits:

- Security:
  Only authorized personnel has access to the data
- Performance:
  The latest generation of instruments can produce several gigabytes of data – per hour

Data can be conveniently accessed via a central dialog window known as the navigator. The different file types and selection of the data source (i.e. the monitoring station that is the source of the result) allow an ergonomic and systematic approach to the work at hand. Defined user authorizations and groups are helpful for precisely controlling who can see what data (see the "Security concept" section, page 33). Depending on the data type, special editors are available for the table view. Measurement and statistical results can also be presented using different types of graphics.

All files and file types can be reliably distributed in the R&S®ARGUS network using the integrated backup mechanism.

Moreover, data can be exported using different Windows formats such as XLS, CSV, TXT, DBF, MDB and XML. The ITU has stipulated different data exchange formats for international monitoring campaigns, e.g. ECC-REC-0203 or ITU-R SM1809. These formats are also implemented. Users can also define their own export formats as required.

The navigator reflects the workflow of typical spectrum monitoring tasks. First, measurement results are collected, either from local measurements or from remote monitoring stations. Next, files pertaining to a certain monitoring campaign are combined; irrelevant data is filtered out. After data reduction, evaluations are made and statistics are calculated. Finally, informative and concise reports are created. All these steps are performed in one dialog window in various tabs of the navigator, making work extremely efficient.

Open interface for integration of spectrum management applications

To enable optimum utilization of the frequency spectrum as a limited resource, it is very important to allow the spectrum monitoring and spectrum management systems to exchange data with each other. R&S®ARGUS provides an open interface that in principle allows integration of any spectrum management system.

The main activities involved in spectrum management include planning of new transmitters and issuing of licenses. Planning is based primarily on different theoretical models that compute signal propagation, spatial coverage and potential interference to or by other transmitters. These computed values are verified using on-site measurements.

When a license is granted, the transmitters are assigned limits for technical parameters that may not be violated during transmission, e.g. maximum level, frequency offset, modulation depth and bandwidth. Using regular long-term measurements, spectrum monitoring verifies that the license requirements are fulfilled and that interference to other radio users is avoided.

In both cases, the spectrum monitoring and spectrum management systems must be capable of exchanging information with one another. Accordingly, R&S®ARGUS provides two open interfaces.

Using the spectrum management database interface (SMDI) option, it is possible to search license databases for relevant information. In the R&S®ARGUS dialog window, the user defines the parameters for the database query. This information as an XML file is read in by the spectrum management system and processed. The results are sent back to R&S®ARGUS where they are available for measurements and analyses.

Using the order report module (ORM) option, spectrum management applications can define measurement orders for R&S®ARGUS. The desired measurements are performed fully automatically by R&S®ARGUS, and the results are forwarded to the spectrum management system for further processing and analysis.

Depending on the customer-specific organizational procedures, evaluation is handled either by spectrum management or spectrum monitoring. Here too, R&S®ARGUS sets the standard with its flexibility and adaptability to project-specific requirements.

Using ORM, the data can be transferred either as an XML file or as a realtime data stream.

For this mechanism to work properly, a small application is required to convert the R&S®ARGUS format into the specific format used by the database. Successful reference projects have been underway for many years with the leading spectrum management companies LStelcom (including Spectrocan and CTS) and ATDI. The ITU SMS4DC application is also fully integrated. R&S®ARGUS was the first spectrum monitoring software capable of exchanging data with the SMS4DC application. Due to the open architecture of R&S®ARGUS, integration of additional customer-specific database applications is straightforward, regardless of the operating system or database. The smooth data exchange possible with a program from the Bilkent company is just one good example.

Data exchange – simple and efficient

As measurement software, R&S®ARGUS focuses on collecting data that is written to a dedicated database. R&S®ARGUS itself provides several options for evaluating and analyzing this data, but the data must also be distributed to other applications. This can be done in multiple ways. Via the navigator, data is exported to the Microsoft world in standard file formats such as XLS, CSV, TXT or XML. Spectrum management requests information, usually via the ORM open interface.

The R&S®ARGUS open database access (ODA) option provides an alternative. ODA directly accesses information in the R&S®ARGUS database, without involving R&S®ARGUS users. Authorized persons have read access to the database. Applying appropriate SQL statements they can retrieve exactly that subset of information they are looking for. Subsequently, the data can be used for any suitable third-party application, such as spectrum management, MATLAB® or customer-specific tools. Relevant information is available to authorized persons, while the R&S®ARGUS operators can focus on their monitoring tasks.

Flexible operating concepts

Users can operate instruments and applications in different ways:

- Local control
- Remote control via R&S®ARGUS
- Remote control via Internet
- Remote control via the ORM open interface

Local control

Normally, operation is local, i.e. the user controls the instruments available on site via the control PC.

Remote control via R&S®ARGUS

From an R&S®ARGUS workstation, any other R&S®ARGUS measurement station can be remotely operated, provided that it is properly configured and accessible via the communications network. For efficient operation, the user interface (e.g. menus, dialog windows, graphics) is virtually identical in local and remote operation. Only the available instruments vary depending on the equipment in place at the individual monitoring stations. The connection to a remote station is established via a list of available stations, via favorite icons in the toolbar or by clicking the respective icon in the map software.

Remote control via Internet

For maximum flexibility, it is also possible to access the R&S®ARGUS network via a web browser. No R&S®ARGUS specific software or license needs to be installed on the control computer. All that is required is a web browser plus the Java Runtime Environment.

Remote control via the ORM open interface

Another remote control option is provided by the order report module (ORM) open interface that can be used to define measurement orders by means of any external application. The measurements are performed by R&S®ARGUS (either fully automatically or interactively). The results (reports) are then made available to the application that requested them.

Remote operation made easy

Remote operation is backed by the following features:
- Sophisticated client/server architecture
- Data reduction and compression
- Easy integration through use of standard network components

Sophisticated client/server architecture

Networking and remote operation capabilities are critical for monitoring systems. Its sophisticated client/server architecture makes R&S®ARGUS ideal for monitoring applications. After a connection has been established, only the description of the measurement task is transmitted from the central station to the remote monitoring station via the network, i.e. the selection of instruments, the settings, the frequencies and the measurement parameters. During the measurement, a realtime data stream is transmitted from the monitoring station to the central station containing only a precise timestamp, the frequency (or frequencies) and the measured values. All dialog windows, graphics and analyses are executed on the computer in the central station and are not transmitted via the network. This makes R&S®ARGUS especially well-suited for use with communications infrastructures that are limited to relatively low data rates.

Data reduction and compression

If the volume of results nevertheless exceeds the available transmission bandwidth, R&S®ARGUS has intelligent mechanisms for reducing and compressing the data. This makes it possible to perform even extremely data-intensive measurements such as high-speed scans, audio signals or IF data streams via a narrowband GSM connection.

Easy integration through use of standard network components

All R&S®ARGUS communications is based on the TCP/IP protocol, making it possible to use standard commercial network components and existing network infrastructure. Communications can also be encrypted as required. Accordingly, nationwide monitoring systems can easily be networked.

Station information system (SIS)

What is the current status of the monitoring stations and the equipment installed there? How are the current availability and utilization? Such information is critical for management purposes and can be monitored with the R&S®ARGUS station information system (SIS) option. The SIS provides always up-to-date information about all monitoring stations in the network. The status of the stations as well as of the respective equipment is displayed on an electronic map.

The following data is provided for each station:
- Name
- Location (latitude, longitude)
- Type (fixed, mobile)
- Maximum data transfer rate
- Current connection status
- Users logged in
- Measurements running
- Status of all devices (physical/virtual)

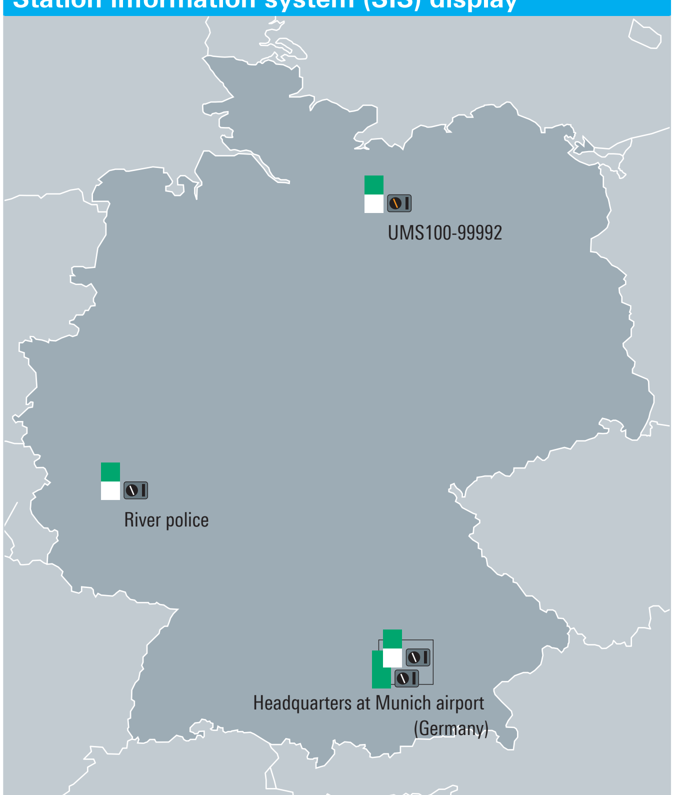
Furthermore, the following data is provided for each station that is equipped with the R&S®SA129 station monitoring unit[1]:
- Temperature
- Humidity
- Smoke
- Fire
- Open doors/windows
- Power supply
- Uninterruptible power supply (UPS)

The R&S®ARGUS system can automatically poll all configured stations in a user-definable time interval. The update can also be triggered manually. The collection of data is performed in the background and does not impact the running or scheduled measurement tasks. Alarm information is saved in a log file. Regular analysis of this log file provides an excellent overview of the system's performance.

Default maps for all countries are provided. However, customers can also create their own maps. SIS provides map tools that can georeference and integrate standard maps in JPG format. Of course, the R&S®MapView geographic information software can be used as well. The map can not only display the distribution and current status of the entire monitoring network, but also the location of known transmitters. One quick look at the map shows immediately which station is best suited to monitor a certain transmitter.

All it takes to establish a connection to that site or to select stations for the bearing measurement mode (BMM) is a single click on the respective station's icon.

Station information system (SIS) display



An example map showing a number of monitoring stations and their current status (indicated by different colors).

[1] Depending on selected sensors.

Security concept

Besides the password protection already implemented in Windows, the security concept of R&S®ARGUS comprises three areas:

- Password-protected login
- Individual assignment of access rights
- Efficient user management

R&S®ARGUS has a security concept that authenticates users via a user name and password in different security areas when they log in. This concept ensures that data cannot be edited or deleted by every user.

Users generally have different measurement and evaluation interests. It is assumed that users with similar interests are grouped together in a user group.

User groups are the current owners of R&S®ARGUS files. Every user is assigned to one user group. All files are stored with the user group name of the user. They are invisible to members of other groups. In a self-generated file, the user can set the user group to "public". This allows users in other user groups to read and edit this file.

The software recognizes two user classes with different access rights: administrator and user. Every user must be assigned to exactly one user class. The users of the administrator class can access all the software. Those in the user class can access all the software except for the configuration part.

Customer-friendly licensing concept

Modular structure for individual demands

R&S®ARGUS follows a modular approach. The various features, designed to reflect typical monitoring tasks and workflows, are separate software modules that are individually licensed. The customer selects only those modules that match current demands. If additional tasks arise, the existing functionality can be easily extended by adding options. Licenses for devices are bundled into license classes, e.g. for a receiver or direction finder. If, for example, the receiver in a station has to be replaced by a different one, no change in licensing is necessary.

License management server

The license management server goes even one step further. If a certain functionality is not required all the time, it can be part of a customer-specific pool of licenses. When required, the respective license can be "borrowed" from the pool via the license management server. Upon completion of the mission, the license is returned to the pool where it is available for other operators.

Example

A direction finder vehicle is typically tasked by the headquarters to be part of a location finding procedure. If during a certain mission this vehicle is the temporary headquarters, additional R&S®ARGUS BMM and RCI options are required. These options are temporarily (i.e. for the time of the mission) retrieved from the license management server.

Ordering information

Designation	Type	Order No.
Base Module	R&S®ARGUS	3046.8603.02
Automatic Measurement Mode (AMM)	R&S®ARGUS	3046.8603.10
Bearing Measurement Mode (BMM)	R&S®ARGUS	3046.8603.11
Coverage Measurement Mode (CMM)	R&S®ARGUS	3046.8603.12
Digital Measurement Mode (DM)	R&S®ARGUS	3046.8603.13
Guided Measurement Mode (GMM)	R&S®ARGUS	3046.8603.14
Interactive Measurement Mode (IMM)	R&S®ARGUS	3046.8603.15
Pulse Measurement Mode (PMM)	R&S®ARGUS	3046.8603.17
Synchronous Measurement Mode (SYNC)	R&S®ARGUS	3046.8603.18
Evaluation Module (EVAL)	R&S®ARGUS	3046.8603.25
Difference Measurement Module (DIFF) [1]	R&S®ARGUS	3046.8603.26
Audio Recording & Replay (ARR)	R&S®ARGUS	3046.8603.30
Station Information System (SIS)	R&S®ARGUS	3046.8603.31
Extended System Functionality	R&S®ARGUS	3046.8603.34
Remote Control Interface (RCI)	R&S®ARGUS	3046.8603.40
Data Exchange Interface (DEI)	R&S®ARGUS	3046.8603.41
Spectrum Management Database Interface (SMDI)	R&S®ARGUS	3046.8603.42
Order Report Module (ORM)	R&S®ARGUS	3046.8603.43
Device Control Interface (DCI Standard)	R&S®ARGUS	3046.8603.44
Device Control Interface (DCI Advanced)	R&S®ARGUS	3046.8603.45
Web Interface (WEB-05)	R&S®ARGUS	3046.8603.46
Web Interface (WEB-10)	R&S®ARGUS	3046.8603.47
Web Interface (WEB-20)	R&S®ARGUS	3046.8603.48
Web Interface (WEB-MTT)	R&S®ARGUS	3046.8603.49
Device Driver for Receiver Class (ARGUS-RX) [2]	R&S®ARGUS	3046.8603.50
Device Driver for Direction Finder Class (ARGUS-DF)	R&S®ARGUS	3046.8603.60
Device Driver for Analyzer Class (ARGUS-ANALYZER) [3]	R&S®ARGUS	3046.8603.70
Device Driver for System Devices Class (ARGUS-SYSDEV) [4]	R&S®ARGUS	3046.8603.80
Device Driver for Legacy Devices Class [5]	R&S®ARGUS	3046.8603.85
Open Database Access (ODA)	R&S®ARGUS	3046.8603.90
License Management Server	R&S®ARGUS	3046.8603.91

1) Requires AMM option.
2) The receiver class includes the following devices: R&S®EM100, R&S®ESMD, R&S®PR100, R&S®EB500 and RX extension of R&S®DD205 and R&S®DDF255.
3) The analyzer class includes the following devices: R&S®ETL, R&S®FSH3/6/18, R&S®FSIQ3/7/26, R&S®FSP3/7/13/30/40, R&S®FSQ3/8/26/40, R&S®FSV and R&S®ESU.
4) The system devices class includes the following devices: COMPASS, GPS, MIXER, R&S®FU129, R&S®GB127M, R&S®GB127MU, R&S®GB127S, R&S®HSRG, R&S®RD127, R&S®RSU, R&S®ZS125/126/127/128/129, R&S®GX300, ePS and R&S®MSD.
5) The legacy devices class enables temporary support of discontinued devices. List of supported devices on request.

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