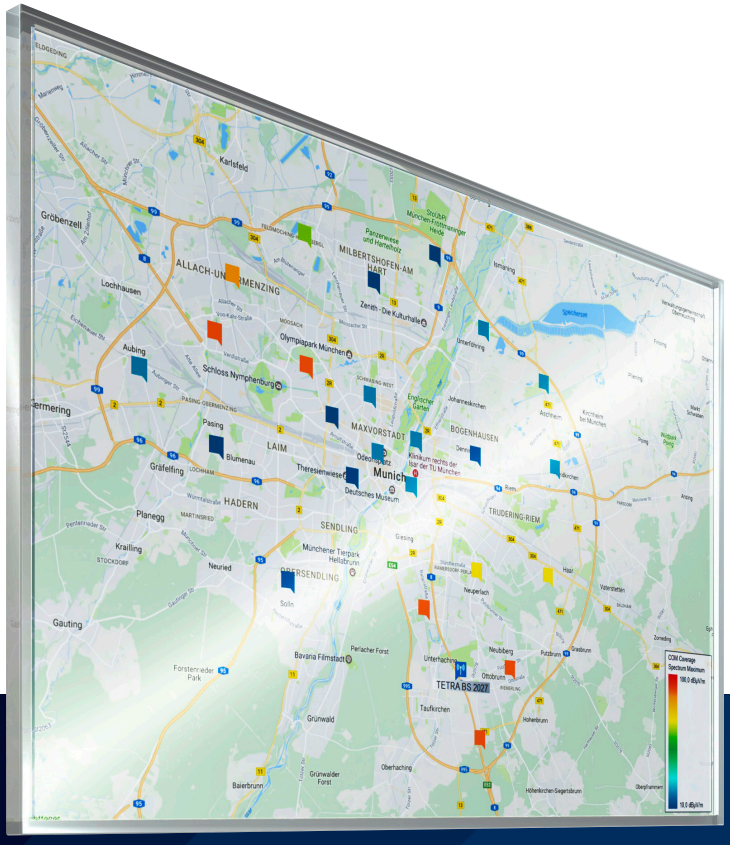
R&S®ARGUS 6.1
SPECTRUM MONITORING SOFTWARE

For monitoring solutions in line with ITU recommendations



Product Brochure
Version 10.00

ROHDE&SCHWARZ
Make ideas real

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 30 years. R&S®ARGUS measures, analyzes and evaluates. The measurement modes, reflecting typical workflows, support operators in their daily work. Numerous statistics analyze data in depth and create informative and concise reports. R&S®ARGUS 6.1, the latest development step, focuses on complete workflows and operability to ensure that you get the job done – faster and better than ever.

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 interactive, quick response operation to fully automatic procedures, and from standalone devices to nationwide monitoring networks. New features such as continuous monitoring and a central database are excellent solutions for the latest challenges in spectrum monitoring.

R&S®ARGUS combines powerful spectrum monitoring tools with easy and efficient operation. 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 demanding tasks quickly and reliably.

Electronic maps show a detailed overview of the system's operational status and usage. Map-based operation, such as the definition and triggering of monitoring and location missions for multiple remote stations, provides a more pleasant working experience and improves efficiency.

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

R&S®ARGUS has been consistently and systematically expanded and improved to ensure excellent solutions for ever-changing challenges. Thanks to a wide range of specialized equipment, numerous open interfaces and unrivaled monitoring capabilities, R&S®ARGUS is well-suited for applications far beyond the scope of ITU-compliant monitoring.

KEY FACTS

- Measurements and analysis in line with the ITU spectrum monitoring handbook and ITU recommendations
- Geolocation of emitters via angle of arrival (AOA), time difference of arrival (TDOA) and hybrid (combination of AOA and TDOA) as well as mobile locator (ML) technology
- Extended capabilities for continuous monitoring and automatic evaluation in large-scale networks
- Map-based operation and system status display
- Open interface to exchange data with spectrum management applications
- Simple scalability due to modular software architecture
- Strong focus on user support
- Guided measurements

BENEFITS

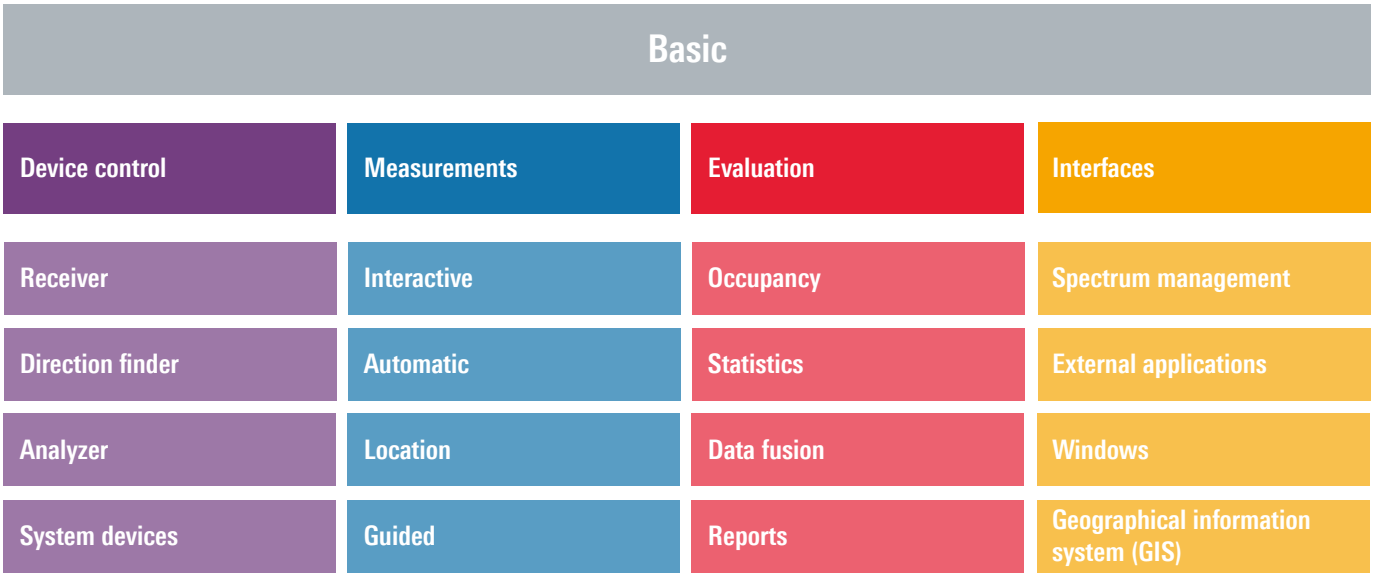
THE MODULAR STRUCTURE

One of the advantages of the R&S®ARGUS software is its modular structure. The enormous wealth of features and functionality is organized in several software options. Each option is separately licensed. With this customer-friendly concept users individually configure a system that perfectly matches their own requirements.

Often a very small subset of the R&S®ARGUS options is sufficient to satisfy initial requirements. With growing demands, further functionality is easily added. Since the entire user interface follows a systematic structure and style guide, operators immediately benefit from new capabilities with only minimal training.

The same organic growth applies to individual stations and to an entire monitoring network. When adding another remotely controlled station, simply use the built-in wizard to set up the connection.

Modular structure of R&S®ARGUS to flexibly and economically configure systems perfectly matching individual requirements



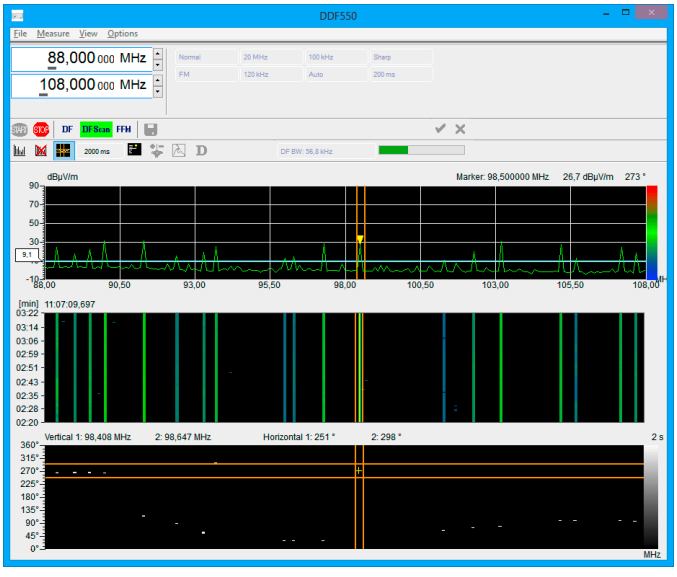
THE RIGHT INSTRUMENT FOR EVERY TASK

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 line with ITU recommendations.

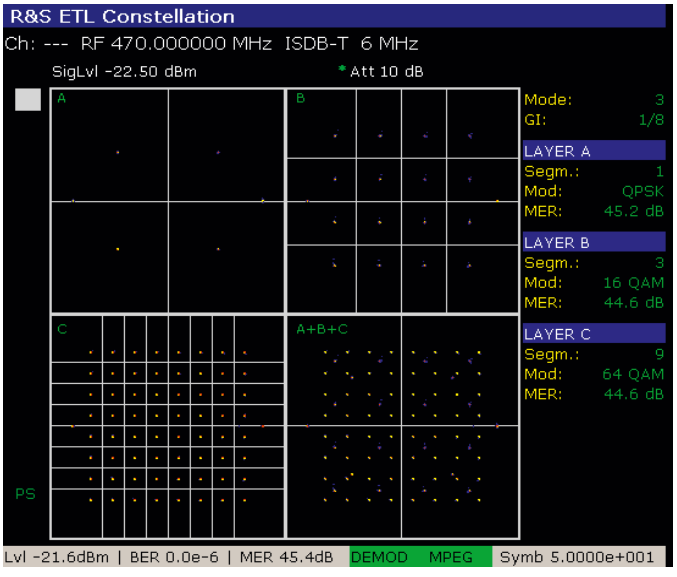
Receivers and direction finders are the classical workhorses for providing fundamental technical data and the true location of the transmitters. Spectrum analyzers and TV test receivers for analog and digital TV and broadcast transmissions analyze these important types of emissions. Special decoders analyze the data in depth and classify and identify the signals. System devices such as antenna switches, controllers for positioning directional antennas, compasses and GPS equipment supplement the other setup to create a fully automatic system. This list of instruments is rounded out by individually selectable filters, amplifiers and attenuators.

To find unwanted emissions in buildings and areas not accessible with vehicles, portable devices are mandatory to successfully accomplish the mission. Devices of different performance classes for different signal scenarios are needed for economical solutions.

These dedicated devices are fully integrated into the R&S®ARGUS control software. The standardized user interface maximizes ease of operation for the user and minimizes the training effort required for system expansions involving new instruments.



A scanning direction finder determines the direction towards each transmitter in the selected frequency band.



Typical constellation diagram of an ISDB-T transmitter.

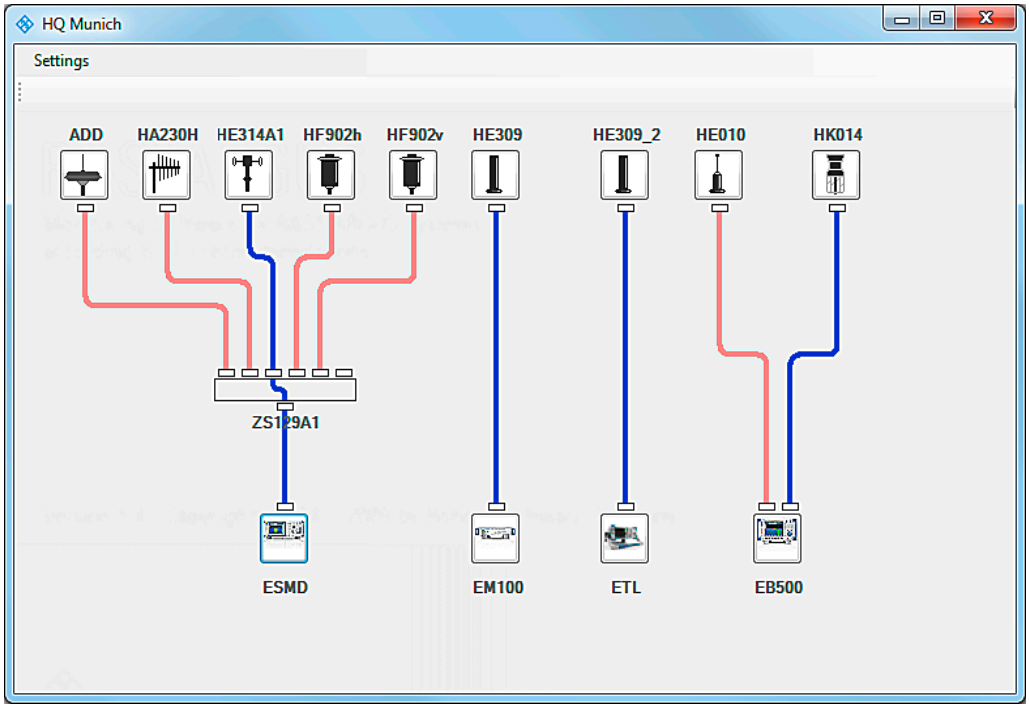
THE DIRECT DEVICE CONTROL FOR MAXIMUM FLEXIBILITY

The direct device control directly controls the measurement equipment via virtual front panels. This mode enables the operator to monitor, measure, locate and identify emissions fast.

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 with a single mouse click.

A mouse click on a device icon opens the interface from which the user controls the device and performs the measurements. This interface includes all the functions and the settings of the device.

Depending on the device, 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.



The visualizer illustrates the monitoring hardware available at the selected station.

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 keep operation as simple as possible and make work efficient and error-free, the individual workflows are implemented using software modules known as measurement modes.

The guided measurement modes are a unique feature. Depending on the task selected by the operator, R&S®ARGUS suggests appropriate devices and even device settings.

The suggestions are based on fundamental physics, ITU recommendations and customer-specific definitions. This way even less experienced operators can efficiently perform ambitious monitoring tasks in line with national and international regulations.

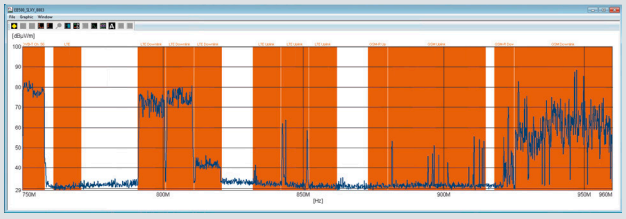
The following measurement modes are available:

- Interactive measurement mode (IMM)
- Location measurement mode (LMM)
- Automatic measurement mode (AMM)
- Guided measurement mode (GMM)
- Digital measurement mode (DM)
- Coverage measurement mode (CMM)
- Classification measurement mode (CLMM)

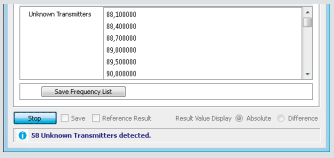
Results of a coverage measurement.

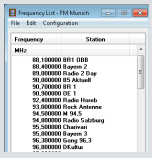
INTERACTIVE MEASUREMENT MODE (IMM)

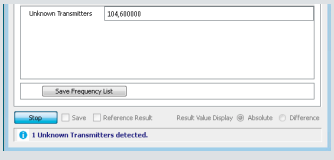
Spectrum
The spectrum mode gives a quick overview of a frequency spectrum.



Violation detection
The violation detection mode is very efficient for detecting new or unknown transmitters.





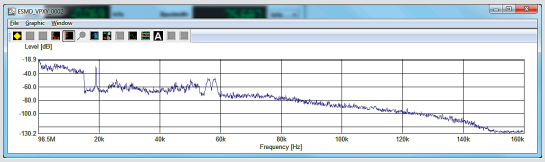


Intera
measu
mode

Coverage
The coverage mode explores the true coverage of a certain radio service.

The interactive measurement mode gives an overview of a spectrum, analyzes and identifies electromagnetic emissions, delivers results when an antenna is moved, analyzes intermodulation, performs coverage measurements and automatically detects unknown signals.

Signal analysis
The signal analysis mode analyzes and identifies electromagnetic emissions.



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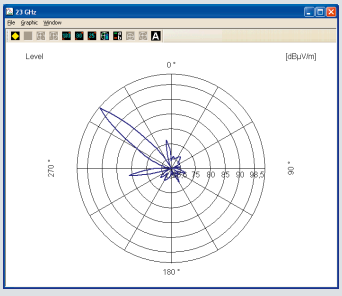
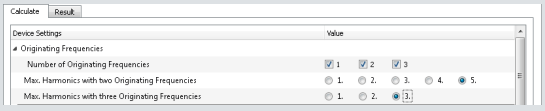
Antenna analysis
The antenna analysis mode measures while the azimuth, elevation or height of a directional antenna is varied.



Intermodulation analysis
The intermodulation mode tracks emissions producing an intermodulated signal.



LOCATION MEASUREMENT MODE (LMM)

The location measurement mode offers different techniques to precisely locate a transmitter. The traditional angle of arrival (AOA) principle combines lines of bearings from direction finders. The time difference of arrival (TDOA) method correlates I/Q data from several suitable devices. The hybrid approach of combining AOA and TDOA benefits from the advantages of the two location techniques. Mobile locator is a new technology for locating transmitters using a single direction finder in a vehicle.

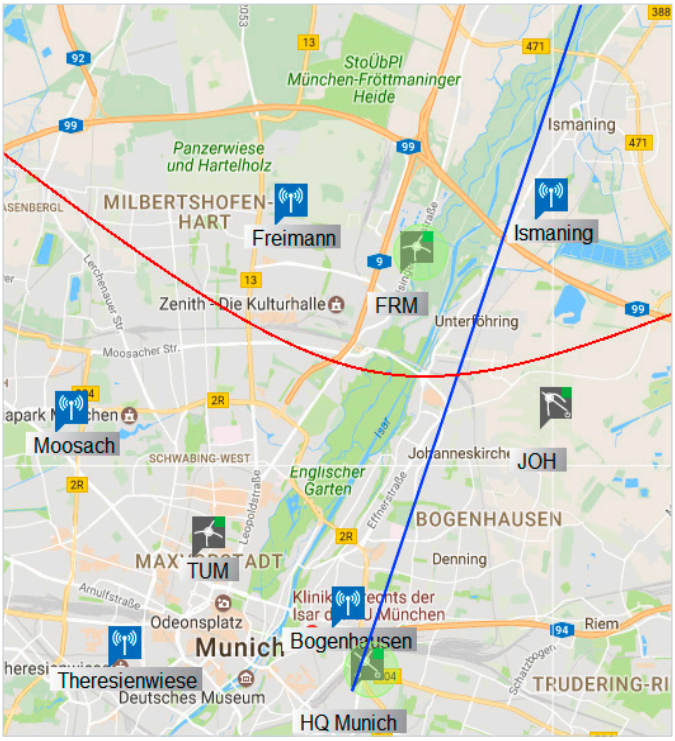
Additionally, the LMM includes the functionality of the parallel mode of previous R&S®ARGUS generations. It efficiently controls multiple remote sites from a single control station for simultaneous measurements.

With the LMM options the user selects appropriate devices and remote stations for the location tasks and defines device settings and specific parameters. The stations involved are selected from a map via R&S®MapView geographic information software or via the list in the LMM configuration window. Digital maps within the R&S®MapView show the DF stations, bearing lines, hyperbolas and locations. Additional information such as the position of licensed stations is superimposed. This way, the user can immediately see whether the measured location coincides with a known transmitter.

Location via AOA

Equipped with the LMM-DF option, R&S®ARGUS controls up to four direction finders simultaneously. Directional antennas on azimuth rotators are supported too. This allows direction finding at frequencies well above the upper limit of currently available direction finders.

In addition to the live mode, it is also possible to combine previously recorded DF results. This is useful if only one mobile DF is available. By combining individual DF results taken at different locations, a precise geolocation (running fix) is possible.



Result of a hybrid TDOA – AOA location. Combined with data from spectrum management, it shows that the measured location of the interferer does not coincide with a licensed transmitter.

Location via TDOA

The time difference of arrival method uses synchronized snapshots (I/Q data) of a transmitter signal taken by multiple TDOA receivers. Since the receivers are at different locations and distances from the transmitter, the same signal reaches them at slightly different times. Correlating the individual I/Q data delivers the transmitter's location.

Similar to classic DF, the results from several stations are necessary to calculate the location of the transmitter. The principle of TDOA requires data from at least three receivers. The TDOA server processes location requests from the local LMM and communicates with the defined remote stations. Once these stations have delivered their I/Q data, the server calculates the correlation. The transmitter's derived location is forwarded to the requesting LMM and displayed on R&S®MapView.

Hybrid (AOA and TDOA) location

Both techniques, AOA and TDOA, have their advantages and drawbacks. Depending on e.g. transmitter characteristics, signal scenario and location, the one or the other method delivers better results.

R&S®ARGUS provides the extremely beneficial possibility to combine both methods. For each mission, the user decides whether to utilize the DF, the TDOA functionality or a combination of the two.

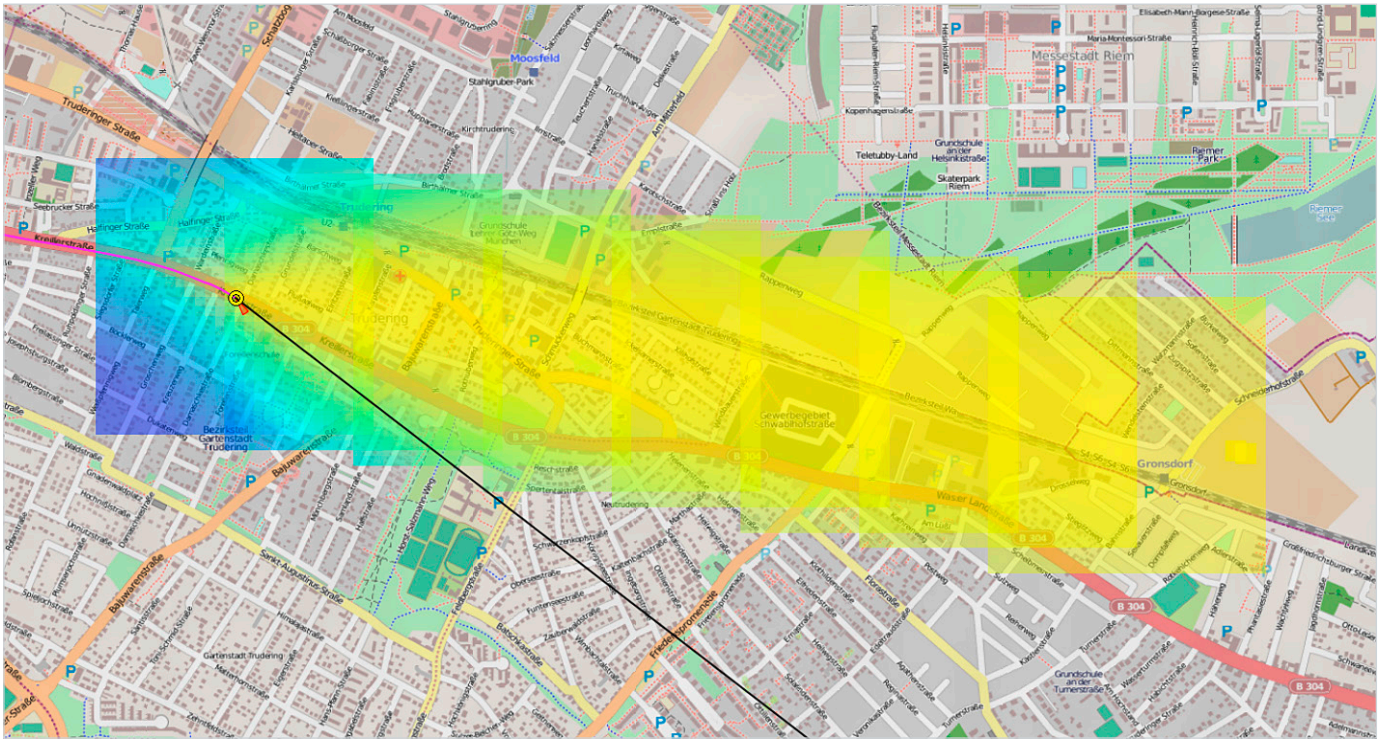
It is even possible to have quasi-simultaneous DF and TDOA capability within the same device. A DF records an I/Q snapshot for TDOA and immediately takes a line of bearing. Thus, one direction finder and one additional TDOA receiver provide high-quality location information by sophisticatedly merging DF and TDOA capabilities into a powerful hybrid location system.

Location via mobile locator (ML)

The mobile locator technique was developed for automatic location of fixed frequency signals using a single DF in a vehicle. The mobile locator algorithm filters the bearings – in contrast to classic methods such as homing or running fixes where all bearing results are displayed. When the vehicle is parked or waiting at a red traffic light, for example, the bearings generally become unreliable because of reflection or multipath propagation. These values are discarded.

Statistical analysis is applied to the remaining relevant bearings, and the most probable signal direction and location are determined. The results are displayed on an electronic map as a probability cloud. Every new relevant bearing updates the result and the display. These results enable the driver to plan and adjust the route until the precise location of the transmitter is found.

Focusing only on the important data makes this concept much more efficient and reliable. Thus, it is ideal for interference hunting in urban areas.



Line of bearing points toward the southeast. However, the mobile locator probability cloud (result of analysis of many lines of bearings) indicates that the transmitter is in the east.

AUTOMATIC MEASUREMENT MODE (AMM)

The automatic measurement mode serves three main purposes:

- Relieve the operator from routine tasks
- Perform measurements in line with a specific time schedule
- Automatically detect whether a live result is outside a user-defined value range and respond as defined by the user

Many tasks in spectrum monitoring follow a certain routine or have to be repeated over and over again. Examples are long-term campaigns to verify license-compliant operation or occupancy measurements. Performing these tasks fully automatically relieves operators from routine work so that they can focus on sophisticated interactive challenges. Even though the routine tasks run in the background, any abnormal activity such as the sudden appearance of an interferer is detected and analyzed, and the operator will be notified.

Setting up the mission

For every measurement, the user defines what (frequencies, parameters) has to be measured, and where (selection of monitoring sites) and how (device selection and settings) it is to be performed. All supported devices such as receiver, direction finder, spectrum analyzer and TV test receiver are available for automatic procedures. Rotators and masts can also be controlled so that the measurements are performed at certain azimuths, elevations, polarizations and heights. This is especially beneficial when monitoring certain digital transmitters. Here, various standards recommend performing the measurements while a directional antenna is moved 360° in azimuth and repeating this for different antenna heights. Another example is monitoring of TV transmitters. The ITU recommends using a directional antenna pointed toward the transmitter. Precisely positioning the antenna in azimuth and polarization is done fully automatically.

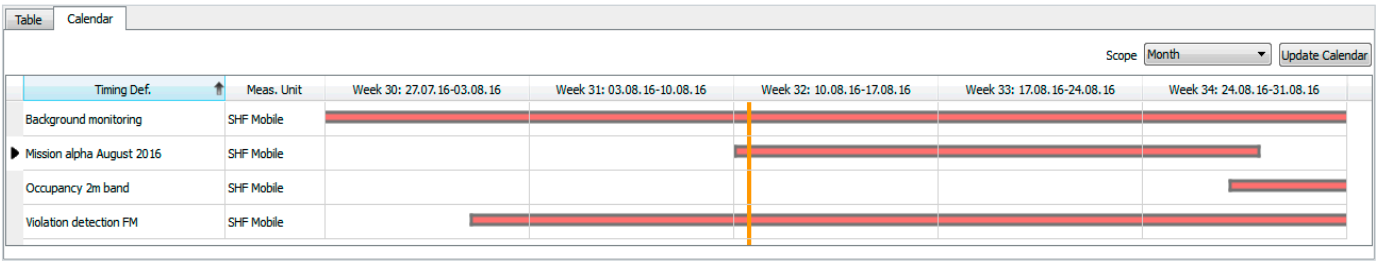
For each frequency band and measurement parameter, individual devices can be selected, e.g. antennas with the respective polarization. After this, settings of these devices are defined, e.g. scan step width matching the channel spacing, IF bandwidths according to the expected signal bandwidth.

Setting up the same task for multiple monitoring sites is extremely efficient. During measurement definition, all involved stations can be selected from a list or by using electronic maps. This definition has to be done only once (often by a senior monitoring expert to ensure full ITU compliance).

To repeat the same task, the respective saved settings can be selected from a list and immediately started. Thus, even less experienced operators perform sophisticated tasks in line with national and international guidelines. To compare all results and to get a complete record of the transmitter, all measurements are performed with exactly the same device settings.

With the AMM wizard, the user sets up an AMM procedure quickly and easily. This wizard guides the user through the appropriate dialog windows to enter required settings. The wizard then generates the necessary definition files.

Once the setup is complete, 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 after it has been accomplished.



The calendar view with an overview of all scheduled tasks.

Defining flexible time schedules

With the AMM an individual time schedule can be set up for each measurement. Possible timeslots range from simple start/stop times to fragmented measurements, e.g. to perform a task starting at every full hour for five minutes on Tuesdays, Fridays and Saturdays. A frequently used application is system check measurements. Running the same measurement, e.g. every first Monday in a month, verifies that the entire system is still working as expected.

Powerful alarms

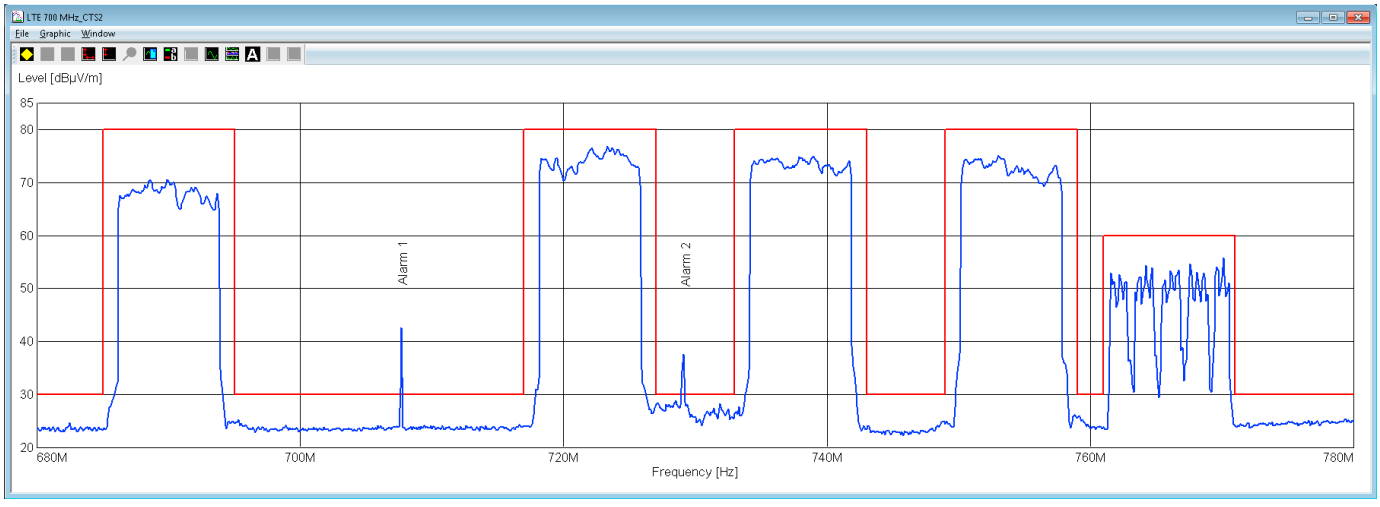
For each frequency and parameter, an upper and/or lower limit can be defined. The AMM compares live results in realtime with the expected values. If one of these limits has been exceeded, several options are available:

- Alarm: displayed on the screen of an attended station or the central station (if the alarm is at an unattended station)
- SMS: sent to the person in charge
- Written information: written to a file in a predefined Windows folder to be read and processed by third-party applications
- Start of a new measurement: to examine in detail all frequencies that triggered the alarm (e.g. to perform various modulation measurements; record audio data or integrate additional measurement stations with DF equipment in order to determine the emitter location)

The alarm measurement duration can be a fixed or a flexible value, e.g. as long as the alarm condition is given. After that the main measurement continues.

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. When the remote site detects an alarm, it will briefly connect to the headquarters, to deliver the alarm information.

A further application is automated background monitoring. Low-priority background measurements run whenever a certain device is not used. If the device is needed for another task, background monitoring immediately interrupts so that the equipment is always available. Once the more important task is completed, background monitoring automatically resumes. The valuable system is utilized to the maximum extent, and important data is collected.



The realtime comparison of the live result (blue trace) with a reference spectrum mask (red trace) reveals the presence of two unexpected signals at 707.7 MHz and 729.1 MHz. An automatic subsequent in-depth analysis of these frequencies reveals technical parameters, identity and location of the interferers.

GUIDED MEASUREMENT MODE (GMM) – THE ULTIMATE USER SUPPORT

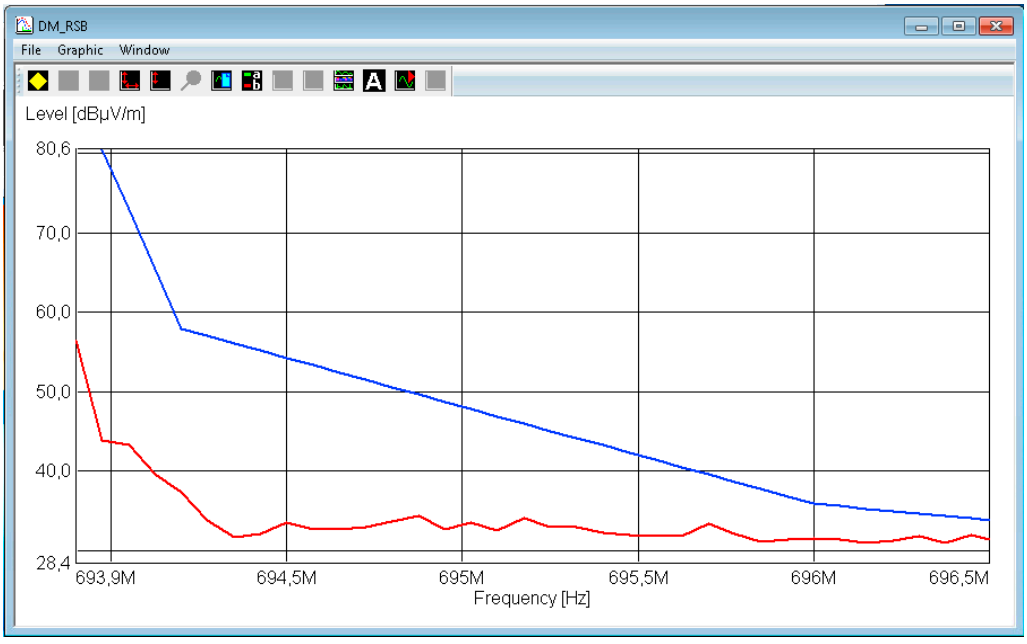
Guided measurements are available for three application areas, each with their own features:

- Guided measurement mode for analog signals (GMM)
- Guided measurement mode for digitally modulated signals (DM)
- Guided measurement mode for coverage measurements (CMM)

R&S®ARGUS strongly focuses on usability and optimum user support to enable straightforward, efficient and goal-oriented working. For example, error messages contain information on solving and avoiding problems. Accidental deletion or loss of data is virtually impossible.

Ultimate user support means that the user selects the frequencies of interest along with the measurement parameters, e.g. level, offset, bandwidth and band occupancy. Using an internal knowledge database, R&S®ARGUS then automatically proposes suitable instruments and device settings, e.g. IF bandwidth, detector and measurement time. Thus, even less experienced users measure quickly and reliably in line with ITU.

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 user can modify these automatically set values, because they are suggestions. Values that do not conform to the recommendations are highlighted in red. 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.



Result of a vestigial sideband measurement. The guided digital measurement mode automatically positions the spectrum mask over the signal of interest.

Guided measurement mode for analog signals (GMM)

After choosing the frequency range, R&S®ARGUS selects the appropriate instrument and the corresponding parameter settings. Single frequency, frequency lists and scan ranges are supported. Measurement parameters include level, frequency, offset, bandwidths, modulation and occupancy.

Guided measurement mode for digitally modulated signals (DM)

Due to the technical characteristics of these signals, the modulation standard is selected prior to entering the frequency or frequencies.

The vestigial sideband measurement is of particular interest. Unlike analog signals, which tend to be Gaussian, digital signals typically have rectangular spectra. They frequently consist of a large number of individual carriers. 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.

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 is operating within the allocated bandwidth or has violated the terms of its license.

Guided measurement mode for coverage measurements (CMM)

Coverage measurements depict the availability of a radio service in a geographic area. They are created while the user drives the monitoring vehicle through the area of interest. 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 given as measurement parameters. Level, bit error rate (BER, for DVB-T) and channel impulse response (CIR, for DVB-T) are provided for digital signals. A connected GPS adds high-precision geocoordinates to each measurement point.

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

Electronic maps display the results using the R&S®MapView geographic information software, where different colors represent different, user-definable value ranges.

HIGH-RESOLUTION SPECTRUM MONITORING NETWORKS

The use of low-power short-range transmitters is steadily increasing. They are often outside the reach of existing monitoring stations. The monitoring capacities need to be increased to keep pace with the number of transmitters and their capabilities. These additional monitoring sites should be set up at strategic locations such as airports, train stations, commercial and industrial zones, where there is a higher density of transmitters. In addition, interferences and operation of illegal transmitters at such locations have more negative impacts on crucial communications. For this reason, more monitoring resources should be concentrated around these hotspots, and the equipment should have excellent sensitivity, linearity and dynamic range in order to handle the complex signal scenario. For maximum efficiency, the sites should form a network, operated from a single control station. In fully automatic mode, they can continuously monitor critical frequency bands 24/7 and deliver data with high time and space resolution.

Based on the detailed occupancy calculation, a frequency can be licensed for several short-range transmitters in different parts of the city instead of granting a citywide license to only one transmitter. This reduces the need for spectrum.

Continuous monitoring (COM)

In this mode, the selected monitoring stations continuously measure the level of all frequencies within the user-defined bands.

An extended database supplies information for multiple tasks and purposes. Comparison of the results with reference data, e.g. from spectrum management, detects illegal or unlicensed transmitters. Calculating the occupancy provides information on the spectrum usage and potential frequency candidates for additional transmitters. Displaying the data on maps delivers coverage information without the need for permanent test drives. Furthermore, long-term trends and developments are visualized. Comparing the level of a transmitter measured at multiple monitoring stations even allows basic geolocation.

COM measurements run whenever the devices are not used for other tasks. Thus, the equipment is utilized to the maximum extent.

Since nonstop measurements lead to a huge amount of data, COM results are automatically compressed. For each frequency, each compressed result comprises a date/timestamp, the minimum, maximum and average value of all data during the compression interval, as well as the occupancy.

Several compression intervals can be defined, depending on the age of the data. Depending on the compression stages, a maximum age of the data can be defined so that data that exceeds the maximum age is deleted automatically.

Implemented as an AMM with low priority, COM measurements might be interrupted by tasks with higher priorities. Upon completion of these tasks, the COM measurements continue automatically.

For easier comprehension and more efficient work, the COM measurement results can also be displayed on electronic maps.

Compression interval examples

Age	Compression interval
Raw data	every 5 minutes
Data that is one week old	1 hour
Data that is one month old	1 day

Automatic data transfer (ADT)

The ADT functionality makes it possible to move data from the remote monitoring stations to predefined destinations. All information from the R&S®ARGUS database can be manually or automatically exported in the internal backup format to a predefined folder. The folder content is sent to a configurable destination, typically a regional/national control center or a central database, where it is automatically read and processed.

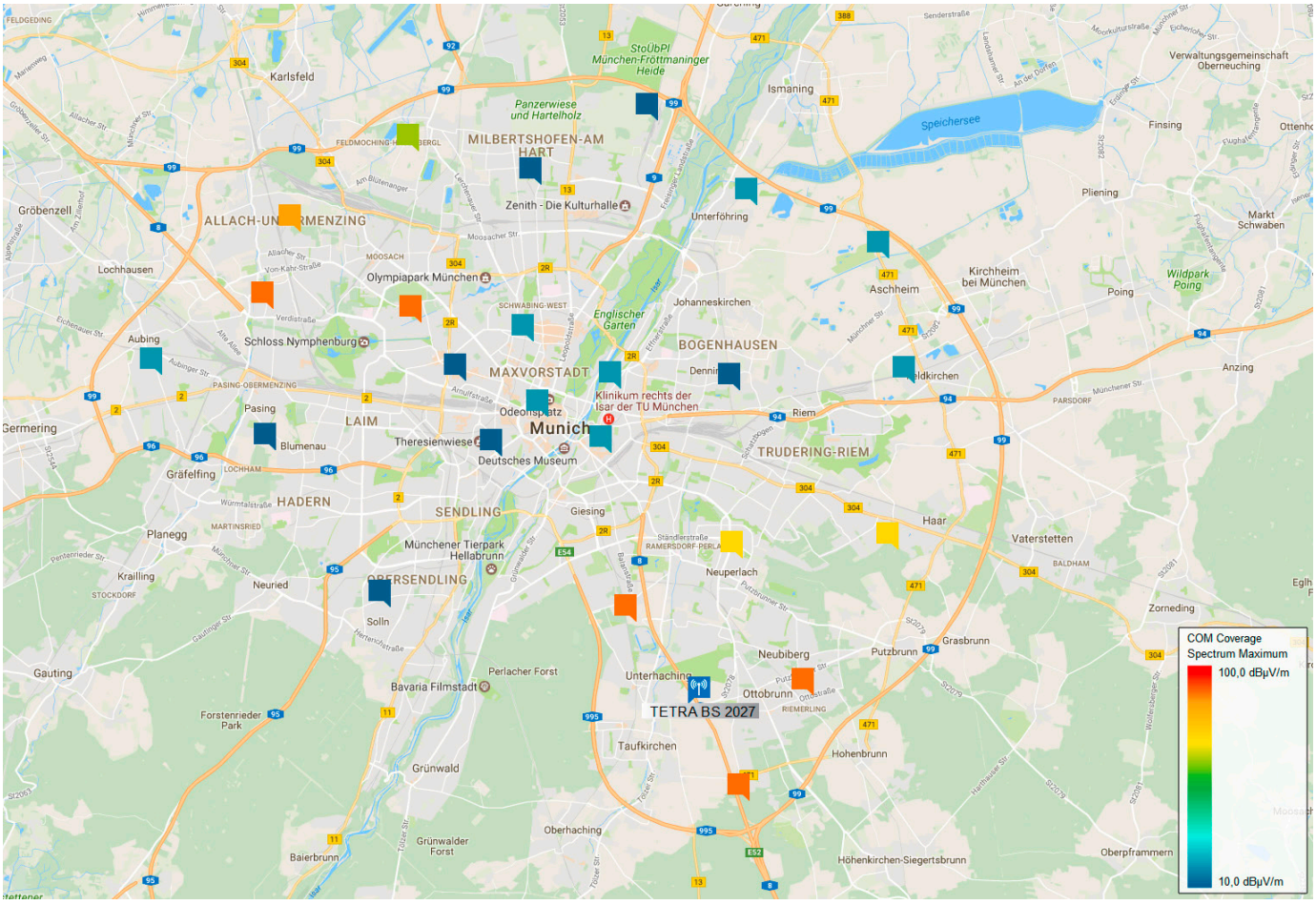
Automatic evaluation and analysis (AAA)

The evaluation option automatically detects unknown and irregular transmitters. An unknown transmitter is an active signal that cannot be associated with a known or licensed transmitter. An irregular transmitter is an active signal that is known according to the license database but does not comply with license conditions.

Whereas standard evaluation is based on measurement results from a single monitoring station, this procedure uses data from multiple sites.

The list of unknown transmitters includes the frequency, name and coordinates of the monitoring station that received the signal with the highest level.

The list of irregular transmitters includes all the information from the standard transmitter list, e.g. frequency, name, service type, location and technical limits. This data is supplemented by measured level, offset, bandwidth and modulation values. These values originate from the monitoring station that received the signal with the highest level. The name and coordinates of that monitoring station are also included. Comparing the license limits with the measured results immediately reveals the license violation.



Results and analysis of COM measurements displayed with high information density on an electronic map. The field strength values for the selected frequency are color-coded and displayed at the location where they were measured. The map reveals that two transmitters are present, a strong one in the southeast and another one in the northwest. Superimposing data from spectrum management shows that the high values in the southeast originate from a licensed transmitter. The transmitter in the northwest has not been licensed, which means that an illegal transmitter site has been detected.

CLASSIFICATION MEASUREMENT MODE (CLMM)

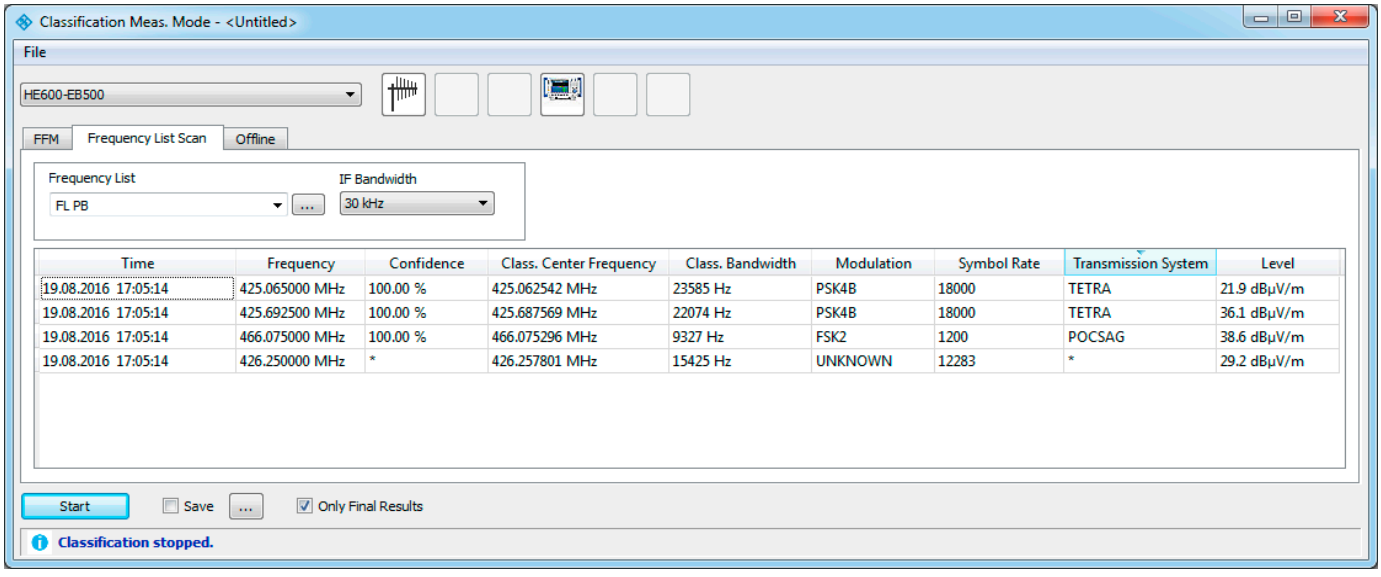
The classification measurement mode automatically identifies and classifies transmitters. Based on I/Q data, characteristic parameters such as modulation, signal type and properties are determined. Due to the increasing number of transmitters using digital modulation, this task is rapidly becoming important.

The procedures work online and offline, interactively and automatically, locally and remotely controlled.

In online mode, the live data stream is analyzed in realtime: Classification results and respective spectra are displayed and are permanently updated. In offline mode, previously recorded I/Q data files are analyzed. This is useful when currently no human resources are available for this task or at a dedicated evaluation workspace data from many sites and sources is combined and analyzed.

In addition to these interactive workflows, fully automatic operation is supported. Classification can be part of an automatic measurement (AMM). Similar to level, bearing and other technical parameters, classification data is deter-mined for multiple frequencies, each with individual, specific device settings at predefined timeslots. Classification can be an alarm activity. When the AMM detects the presence of unexpected transmitters, each one can be classified. In combination with simultaneously recorded audio, technical data and location results, the interferers are reliably identified.

Classification results can be combined with other monitoring and DF results. All relevant information is then condensed into a single comprehensive result file or report.



Dialog window of the classification measurement mode.

OPEN INTERFACES – THE KEY TO INTEGRATED SPECTRUM MONITORING AND MANAGEMENT

For various monitoring tasks monitoring data with supplemented information from other sources are mandatory. R&S®ARGUS has several open interfaces to flexibly and efficiently integrate R&S®ARGUS into the customer's existing infrastructure. When other applications have to be replaced or added, these open interfaces ensure seamless collaboration.

To optimally utilize the frequency spectrum as a limited resource, it is important to allow spectrum monitoring and spectrum management systems to exchange data with each other. R&S®ARGUS has an open interface that allows integration of any spectrum management system.

The main activities involved in spectrum management include planning new transmitters and issuing 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.

SMDI

With the spectrum management database interface (SMDI) option, the user searches for relevant information in license databases. In the R&S®ARGUS dialog window, the user defines the parameters for the database query. The created 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 further measurements and analysis.

ORM

With the order report module (ORM) option, spectrum management applications define orders for R&S®ARGUS. The desired measurements are performed interactively or fully automatically by R&S®ARGUS. The results are then forwarded to the spectrum management system for further processing and analysis. All data can be transferred as an XML file or a realtime data stream.

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

Successful reference projects have been underway for many years with the leading spectrum management companies LStelcom 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.

FROM COMPREHENSIVE ANALYSIS TO INFORMATIVE REPORTS

Concise, informative reports are generated in four steps:
- Filtering of raw data
- Analysis and evaluations in line with ITU guidelines and recommendations
- Data fusion, combination of different information from multiple sources to obtain a complete and correct result
- Compilation of concise, informative reports

Filtering of raw data

Advanced Rohde&Schwarz monitoring instruments generate huge amounts of data in a very short period of time. Measurement results can grow to a size of several gigabytes within a few minutes. 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. Any measurement parameter (e.g. bandwidth, modulation, offset, bearing) can be 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 result file. For a complete report, transmitter lists and band occupancy statistics can be appended additionally.

Analysis and evaluations in line 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:
- Occupancy
- Transmission statistics
- Measurement value statistics
- Subaudio tone occupancy statistics
- Violation detection

Occupancy

The most frequently used statistic is the occupancy calculation – for a single frequency (frequency channel occupancy) or a whole frequency range (frequency band occupancy). This gives detailed information about how a frequency is actually used.

Transmission statistics

The transmission statistics reveal how often and how long a channel has been used for transmission. This is an important supplement to the occupancy statistic. While occupancy primarily provides a mathematical value (frequency used × % of the time), the transmission statistics add information about the practical availability.

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 provide information about the variance of measured values, the stability of measured values, the environmental noise component as well as cross-modulation and intermodulation effects. It also reveals the presence of multiple transmitters on the same frequency.

Subaudio tone occupancy statistics

Subaudio tone (or CTCSS) occupancy statistics enable the user to ascertain how often and how long transmissions have been made using a certain subaudio tone. One application is to distinguish multiple users on the same frequency.

Violation detection

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

Similar to the procedure in the interactive measurement mode (IMM), active, but unknown or unlicensed transmitters can be determined fully automatically. In contrast to the IMM, this analysis is performed offline in the evaluation module after the measurement.

Data fusion

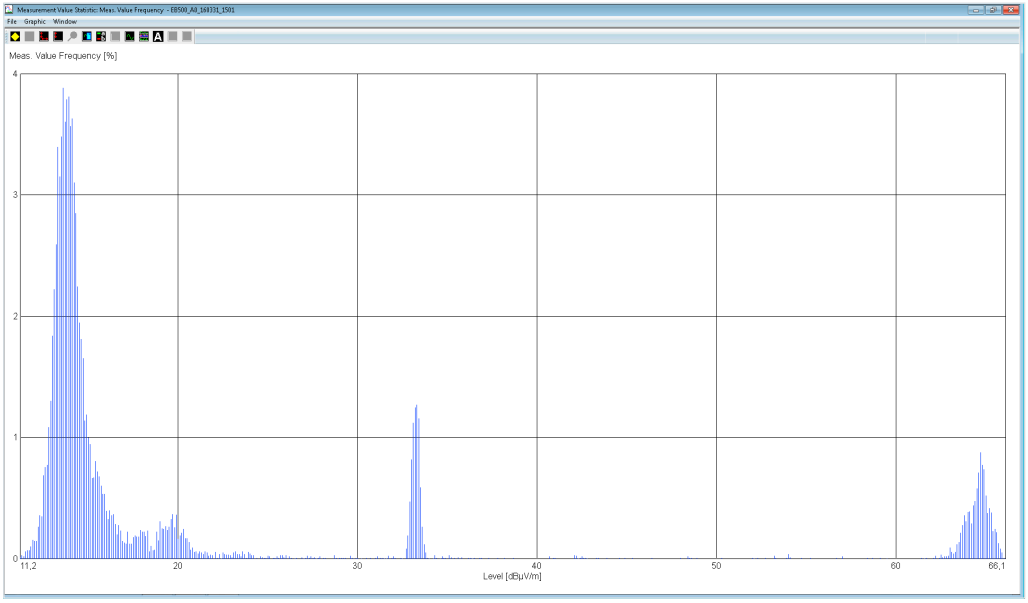
To get a complete and correct overview of the electromagnetic environment, it is often necessary to combine the measurement results (raw data) with additional information. Data from spectrum management is used to verify license-compliant operation or to distinguish pirate stations from legitimate users. Combining location results with the coordinates of known transmitters show the true identity of a transmitter. Comparing measured coverage data with results from calculations reveals the accuracy and reliability of the theoretical approach.

Compilation of concise, informative reports

At the end of a measurement, a report is typically generated.

The R&S®ARGUS evaluation module includes comprehensive documentation options. Measurement results and definitions and statistical evaluations (as graphs or tables) can be compiled and configured by the user. The reports can be printed out or saved as a file.

With the integrated RTF editor, users modify the design of the report in line with their own preferences or corporate identity. Multiple customer-specific report templates can easily be created.



The measurement value statistic reveals the presence of multiple emitters on the same frequency.

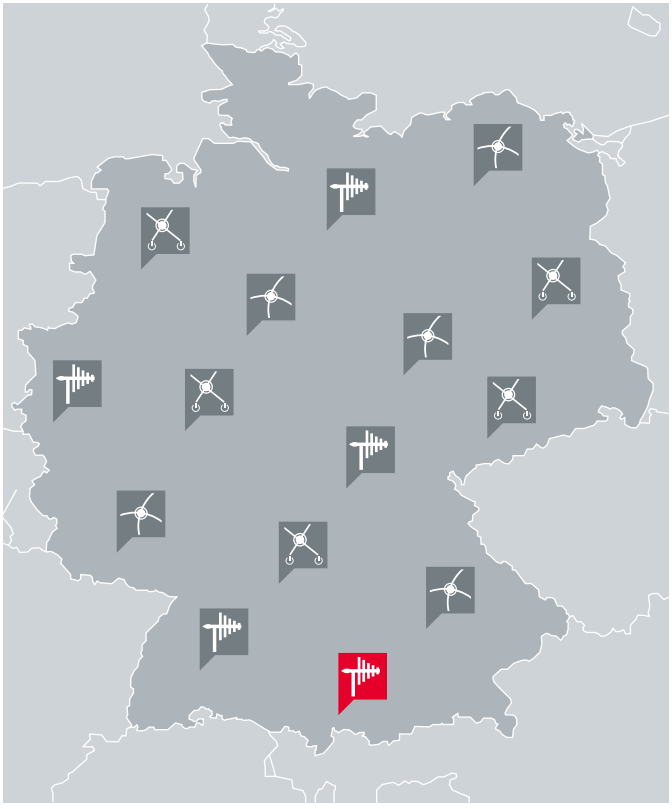
MAP-BASED DISPLAY AND OPERATION

R&S®ARGUS displays all data as numerical values (e.g. table) and in different types of graphics. For easier comprehension, sometimes the display on geographical maps is preferred. Lines of bearing or, for TDOA, hyperbolas and heatmaps show the origin of a signal much more clearly than the numerical values of latitude and longitude. The simultaneous display of known transmitters reveals immediately whether the signal coincides with a licensed station.

Another application is to plot the results from propagation calculations and superimpose measured coverage data to verify the expected coverage area.

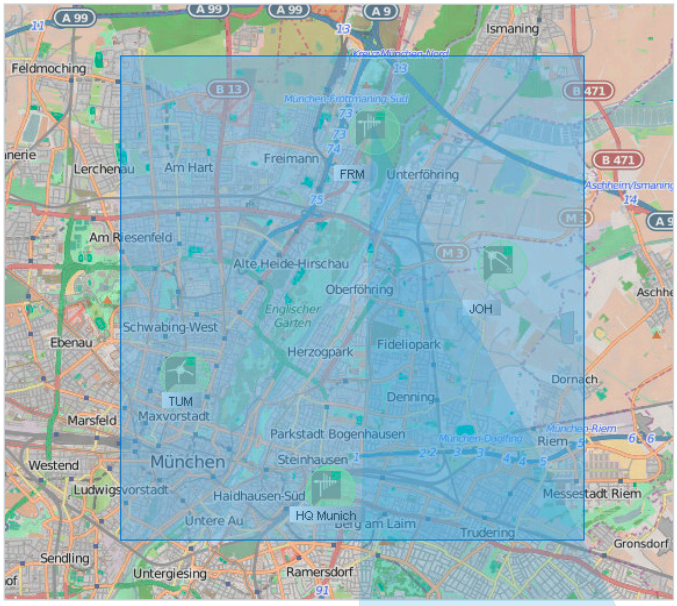
Map-based result display provides support when a lot of data has to be displayed. With respect to the upcoming Internet of Things, regulators all over the world are increasing the density of monitoring sites in important and critical areas. Displaying the results from many stations on a map reveals problems much faster than checking endless tables.

Overview of status, location and capability of all monitoring sites

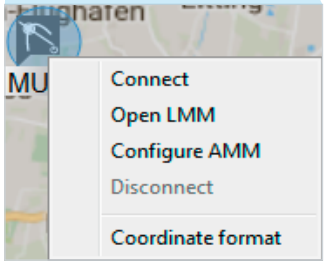


Especially in larger networks it is crucial to maintain an overview of status, usage and availability of all monitoring assets. The R&S®ARGUS station information system (SIS) provides up-to-date, realtime system status data. Information about capabilities (monitoring, DF, TDOA, hybrid), usage (devices idle or occupied) and station health (connectivity, device warnings, measurement errors) are displayed. Various sensors, e.g. for temperature, smoke and door contacts, allow detailed site surveillance. Different symbols and colors provide a clear overview. The tooltip of the station's icon on the map shows all details.

In addition to displaying monitoring results, spectrum management data and system status, the map also operates the monitoring systems. Clicking a station's icon on the map immediately establishes a connection to remotely control that site. Selecting multiple stations configures an automatic measurement procedure or a synchronized geolocation task for all sites.



Selection of multiple stations via R&S®MapView ...



... to setup a location measurement task.

FURTHER FEATURES

R&S®ARGUS can be operated locally and remotely with the identical user interface. All dialog windows have the same structure and follow a Rohde&Schwarz internal style guide. This ensures a short learning curve.

The sophisticated client/server architecture minimizes the demand for communications infrastructure. In case the equipment produces more data than can be sent over the network, smart data reduction and compression algorithms ensure the best use of the available network. All R&S®ARGUS communications are based on the TCP/IP protocol to use standard commercial network components and existing network infrastructures. Communications can also be encrypted as required.

For efficiency and security, all data created within R&S®ARGUS is saved in an SQL-type database. In case of larger networks, this can be several local (distributed) databases or a central database, depending on the customer's preference. Local databases store the data at the monitoring site that started the measurement. In contrast, a central database automatically stores all data from all R&S®ARGUS stations in one location, irrespective of who has initiated the task and where it was performed. For occupancy calculations, verification of license-compliant operation or detection of illegal transmitters, for example, the data can be immediately evaluated for an entire country, without the need to collect individual data from all stations. Administration and backup of all monitoring information is much easier and more efficient, since everything is already in a central database.

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 to standard Microsoft formats such as XLS, CSV, TXT, XML, JPG, BMP, WAV and MP3. Various ITU-defined exchange formats are implemented. The open database access (ODA) interface provides direct, SQL-based read access to the R&S®ARGUS database.

The security concept comprises password-protected login, individual assignment of access rights and efficient user management. R&S®ARGUS runs on Windows 7, 8, and 10 operating systems. Currently supported languages include Chinese, English, French, German, Russian and Spanish.

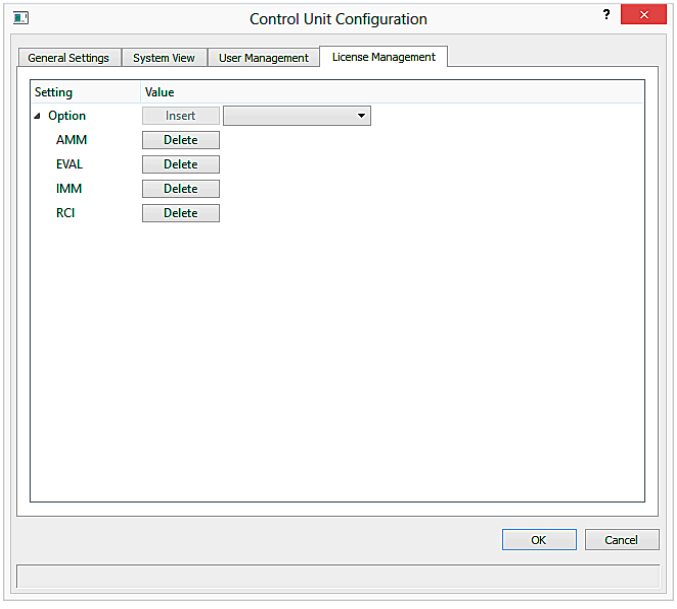
CUSTOMER-FRIENDLY LICENSING CONCEPT

Modular structure for individual demands

All features reflect typical monitoring tasks and workflows. They are separate software modules and individually licensed. The customer selects only those modules that match current needs. 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 with a different one, no change in licensing is necessary.

License management server

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 loaded from the pool via the license management server. Upon completion of the mission, the license is returned to the pool, where it is available to other operators.



Additional features can temporarily be activated via the license server.

ORDERING INFORMATION

Designation	Type	Order No.
Base module	R&S®ARGUS	3056.8706.02
Automatic measurement mode (AMM)	R&S®ARGUS	3056.8706.10
Location measurement mode (LMM-DF)	R&S®ARGUS	3056.8706.11
Location measurement mode (LMM-ML)	R&S®ARGUS	3056.8706.39
Location measurement mode (LMM-TDOA) [1]	R&S®ARGUS	3056.8706.35
Location measurement mode (LMM-TDOAS)	R&S®ARGUS	3056.8706.38
Location measurement mode (TDOA-SRVL)	R&S®ARGUS	3056.8706.36
Coverage measurement mode (CMM)	R&S®ARGUS	3056.8706.12
Digital measurement mode (DM)	R&S®ARGUS	3056.8706.13
Guided measurement mode (GMM)	R&S®ARGUS	3056.8706.14
Interactive measurement mode (IMM)	R&S®ARGUS	3056.8706.15
Synchronous measurement mode (SYNC)	R&S®ARGUS	3056.8706.18
Classification measurement mode (CLMM)	R&S®ARGUS	3056.8706.19
Classification measurement mode (CLMM-ASM)	R&S®ARGUS	3056.8706.21
Evaluation module (EVAL)	R&S®ARGUS	3056.8706.25
Audio recording & replay (ARR)	R&S®ARGUS	3056.8706.30
Station information system (SIS)	R&S®ARGUS	3056.8706.31
Flexible remote access, 5 concurrent users (FRA5)	R&S®ARGUS	3056.8706.32
Flexible remote access, 10 concurrent users (FRA10)	R&S®ARGUS	3056.8706.33
Extended system functionality (ESF)	R&S®ARGUS	3056.8706.34
Remote control interface (RCI)	R&S®ARGUS	3056.8706.40
Data exchange interface (DEI)	R&S®ARGUS	3056.8706.41
Spectrum management database interface (SMDI)	R&S®ARGUS	3056.8706.42
Order report module (ORM)	R&S®ARGUS	3056.8706.43
Device control interface (DCI standard)	R&S®ARGUS	3056.8706.44
Device control interface (DCI advanced)	R&S®ARGUS	3056.8706.45
Device driver for receiver class (ARGUS-RX) [2]	R&S®ARGUS	3056.8706.50
Device driver for direction finder class (ARGUS-DF) [3]	R&S®ARGUS	3056.8706.60
Device driver for analyzer class (ARGUS-ANALYZER) [4]	R&S®ARGUS	3056.8706.70
Device driver for system devices class (ARGUS-SYSDEV) [5]	R&S®ARGUS	3056.8706.80
Device driver for legacy devices class (ARGUS-LD) [6]	R&S®ARGUS	3056.8706.85
Open database access (ODA)	R&S®ARGUS	3056.8706.90
Macro recorder (MACRO)	R&S®ARGUS	3056.8706.92
Automatic evaluation and analysis (AAA)	R&S®ARGUS	3056.8706.93
Automatic data transfer (ADT)	R&S®ARGUS	3056.8706.94
Central database server (CDS)	R&S®ARGUS	3056.8706.95
Continuous monitoring (COM)	R&S®ARGUS	3056.8706.96
Multistation operation (MSO)	R&S®ARGUS	3056.8706.97

[1] The LMM-TDOA option is not to be made, used, sold or offered for sale in the USA or imported into the USA.

[2] The receiver class includes the following devices: R&S®EM100, R&S®EM200, R&S®ESMD, R&S®ESME, R&S®PR100, R&S®PR200, R&S®EB500, R&S®EB510 and RX extension of R&S®DDF205, R&S®DDF255 and R&S®DDF260.

[3] The direction finder class includes the following devices: R&S®DDF255, R&S®DDF260, R&S®DDF205, R&S®DDF007, R&S®DDF550, R&S®DDF5GTS, R&S®DDF19x, R&S®DDF0xAE, R&S®DDF39x and DF extensions of R&S®ESMD, R&S®ESME and R&S®EB500.

[4] 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.

[5] 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, R&S®MSD and R&S®OCB600.

[6] The legacy devices class enables temporary support of discontinued devices. List of supported devices on request.

Options for license server

Designation	Type	Order No.
Base module (BASIC SL)	R&S®ARGUS	3056.8712.02
Automatic measurement mode (AMM SL)	R&S®ARGUS	3056.8712.10
Location measurement mode (LMM-DF SL)	R&S®ARGUS	3056.8712.11
Location measurement mode (LMM-TDOA SL) [1]	R&S®ARGUS	3056.8712.35
Location measurement mode (LMM-TDOAS SL)	R&S®ARGUS	3056.8712.38
Digital measurement mode (DM SL)	R&S®ARGUS	3056.8712.13
Guided measurement mode (GMM SL)	R&S®ARGUS	3056.8712.14
Interactive measurement mode (IMM SL)	R&S®ARGUS	3056.8712.15
Evaluation module (EVAL SL)	R&S®ARGUS	3056.8712.25
Audio recording & replay (ARR SL)	R&S®ARGUS	3056.8712.30
Extended system functionality (ESF SL)	R&S®ARGUS	3056.8712.34
Remote control interface (RCI SL)	R&S®ARGUS	3056.8712.40
Data exchange interface (DEI SL)	R&S®ARGUS	3056.8712.41
Order report module (ORM SL)	R&S®ARGUS	3056.8712.43
Macro recorder (MACRO SL)	R&S®ARGUS	3056.8712.92

[1] The LMM-TDOA option is not to be made, used, sold or offered for sale in the USA or imported into the USA.

Your local Rohde & Schwarz expert will help you determine the optimum solution for your requirements.
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PD 3607.1013.12 | Version 10.00 | June 2020 (sk)
R&S®ARGUS 6.1 Spectrum Monitoring Software
Data without tolerance limits is not binding | Subject to change

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