R&S® GX430
PC-Based Signal Analysis and Signal Processing
Standalone software solution
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At a glance

R&S® GX430 is a standalone software solution for analysis, classification, demodulation and decoding of digital and analog IF signals. The software provides powerful signal analysis and signal processing functions running on a Windows PC. If connected to modern Rohde & Schwarz monitoring receivers with internal digital downconverters (DDC), e.g. R&S® ESMD, up to four signals can be processed in parallel.

R&S® GX430 provides a signal overview using a high-speed spectrum/waterfall display; it supports both the monitoring of known signals (demodulation and decoding to content level) and surveillance/search operation by automatically detecting signals of interest and performing a classification (recognition of modulation type and transmission system/code).

For complex (very dense, weak or disturbed) signal scenarios, the user can override the automatic signal processing and manually set the classifier or demodulator/decoder to the signal of interest. An additional time domain analysis function makes it possible to manually measure technical signal parameters.

The detect, search and classify application provides a fully automatic mode to monitor a frequency range, detect all signals of interest, classify, demodulate, decode these signals and store the results for later processing.

Signal data (digital IF) can be recorded on the computer hard disk or on external AMREC devices (e.g. R&S® GX460) and replayed for processing.

Key facts
- Automatic interception and monitoring of complete signal scenarios
- Powerful classifier and extensive signal processing library with demodulators and decoders
- Configurable detection of fixed frequency and burst signals with subsequent automatic processing of detected signals (including content recovery depending on signal type)
- Modular scalability from one-channel through four-channel signal processing solution (multichannel capability available if connected to a Rohde & Schwarz monitoring receiver/digital direction finder with internal digital downconverters, e.g. R&S® ESMD/EB510/EB500/DDF255/DDF205)
- Open interface for independent extension of signal processing capabilities by the user
- Manual signal measurement in line with ITU-R SM.1600
- Signal recording and replaying on/from hard disk

Four signals of an 80 MHz signal scenario provided by an R&S® ESMD wideband monitoring receiver are classified, demodulated and decoded in parallel.
R&S® GX430
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Benefits and key features

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- Processing of multiple signals
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Diverse opportunities for user-specific expansion
- Open programming interface for integration of user-specific modules
- Integration of a wide variety of user-programmed module types
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Large variety of sources for signal acquisition

Processing of digital IF data
R&S®GX430 processes digital IF signal data, covering the following:
- Online digital IF data provided by various Rohde & Schwarz receivers/digital direction finders
- Online analog IF data digitized via sound card
- Offline replay of digital IF data (R&S®AMMOS IF format); the signal sample can be an IF file replayed from local hard disk or from an external AMREC recording/replaying device (e.g. R&S®GX460)
- Offline replay of WAV file

Spectrum/waterfall representation of signal data
The frequency range is presented using a realtime waterfall with up to 1000 lines/s. Signal attributes can be measured by using time and frequency axis cursors.

Signal recording and replaying on/from hard disk
By activating the IF recording, a signal sample is stored on the computer hard disk for later IF replay or IF export. Alternatively a connected AMREC recording/replaying device (e.g. R&S®GX460) can be used for data storage.

By using an audio demodulator, (analog) emissions can be listened to and recorded to WAV files on the computer hard disk or on a connected AMREC recording/replaying device.

Processing of multiple signals
If connected to a Rohde & Schwarz monitoring receiver with internal digital downconverters (DDC) such as the R&S®ESMD, R&S®GX430 is able to process up to four downconverted signals in parallel. The center frequency and bandwidth of each DDC can be set independently within the limits of the processable realtime bandwidth of the monitoring receiver or digital direction finder.

1) Depends on monitoring receiver/digital direction finder type.
Quick results with automatic classification

Powerful R&S®AMMOS classification unit
R&S®GX430 contains the powerful R&S®AMMOS classification unit for the HF and VHF/UHF frequency ranges and can recognize the modulation type and transmission system of a huge variety of analog and digital signals. A list of supported modulation types included in the R&S®AMMOS classification unit is provided in the data sheet. This list will be continuously expanded.

The classification algorithm delivers a segmentation and modulation analysis result. The segmentation process determines the accurate center frequency and bandwidth of the signal. The modulation analysis determines the modulation type and all important modulation parameters (symbol rate, frequency shift, etc.).

Comprehensive library of demodulators and decoders
The classifier results are used to automatically parameterize a demodulator from the R&S®AMMOS demodulation library. The resulting symbol/bitstream can be analyzed of transmission system recognition and can be decoded by using the decoders of the R&S®AMMOS decoding library. Depending on the transmission system, the corresponding decoder output will be displayed.

Customer-specific decoders that are developed with the R&S®GX400ID decoder development equipment and installed on R&S®GX430 are also used in the classification process. Symbol/bitstream data can be exported for bitstream analysis with R&S®CA250.
Demodulators and decoders for a wide range of use cases

Manual or automatic demodulation and decoding
Demodulators and decoders can be set manually by the operator or automatically by the R&S®GX430 modulation and transmission system classifier. The symbol viewer is used for visualizing symbol data. For a list of the demodulators and decoders included in R&S®GX430, see the data sheet. This list will be continuously expanded.

Customer-specific decoders and demodulators
Customer-specific decoders (developed with the R&S®GX400ID decoder development equipment) and customer-specific demodulators can be installed on R&S®GX430 to expand the demodulation/decoding capability (see page 17).

Symbol view of multichannel PSK signal.

Meteosat weather fax.

Demodulation and decoding of a Piccolo MK6 signal.
Fast and reliable simultaneous processing of multiple signals

R&S®GX430 has an automatic detector that enables the user to scan or monitor frequency ranges automatically for fixed frequency and burst signals.

**Manual parallel processing of multiple signals**

Frequently, the realtime bandwidth of a monitoring receiver contains multiple signals simultaneously. If R&S®GX430 is connected to a Rohde & Schwarz monitoring receiver/digital direction finder with internal digital downconverters, e.g. R&S®ESMD/EB510/EB500/DDF255/DDF205, the user can downconvert multiple signals and then manually process them in parallel. The individual DDCs can set their center frequencies and bandwidths within the limits of the processable realtime bandwidth of the monitoring receiver. The downconverted signals are processed by the user with audio demodulation, classification, demodulation/decoding and recording.
Automatic detection of fixed frequency and burst signals for fast and dependable results

In addition to its manual mode, R&S®GX430 provides a high level of automation for detecting and monitoring fixed frequency and burst signals. A detection result is generated for every detected signal that meets the predefined selection criteria (signal duration, bandwidth, level, etc.).

The detection results are cyclically compared with the signal scenario from the previous processing cycles. The following events are reported:
- New signal (signal over threshold for first time)
- Change in characteristic of a known signal (activity status, change in level, bandwidth or center frequency)
- Inactive signal (signal level falls below detection threshold)
- End of signal reached

Detected signals are classified automatically.

For content recovery, the user can manually select signals from the list of detected/classified signals and start demodulation/decoding with the measured parameters. The user can also configure a rule-based automated workflow that independently handles the processing of the relevant signals (see page 12).

Detection threshold and ignoring of frequency ranges

The automatically computed detection threshold adapts to the variable noise floor that is typical of a specific frequency range.

In scenarios where certain signals or frequency ranges are of no interest, a list of frequency ranges to ignore can be included in the detector algorithms. The detectors will then stop generating messages for signals in these ranges.

Detection using a scanning receiver

For signal detection, the receiver is operated in scan mode, which means it can cover any frequency range. The automatic detector operates in the scan spectrum and detects signals as described above.

To process (e.g. classify/demodulate/decode) detected signals automatically, the monitoring receivers' internal digital downconverters are used to extract signals if the receiver is in fixed frequency mode.
High-speed spectral shape search

R&S®GX430 excels in detecting and identifying spectral shapes of interest within a wide, densely populated scenario.

Fast recognition of signals by spectral matching

The spectral shape detector is designed to search for known and unknown signals by performing spectral pattern matching. It is very fast and customizable (i.e. it searches for signals of interest as specified by the user). The decisions of the matching algorithm are based on many criteria within a comprehensive decision matrix, which allows the similarities between input signals and shape description sets to be reliably assessed. Owing to this unique algorithm, the spectral shape detector can operate effectively across wide frequency ranges, dense signal scenarios, and even under harsh radio conditions.

Fast recognition of spectral shapes has two other advantages:
- Known shapes of interest can be captured quickly (effective search)
- Known shapes that are not of interest can be ignored (efficient search)

Both capabilities will significantly speed up the work of a surveillance operator and are greatly beneficial for quick search applications.

Thanks to its high speed, the use of predefined shapes and the new search algorithm, the spectral shape detector provides the following features:
- Rapid: It accelerates spectral search by analyzing 1000 spectral shapes in less than 1 s
- Robust: It excels in dealing with varying and complex signal scenarios, by considering noise, fading and shifting sampling rates
- Reliable: It aims to effectively detect signals with distinct spectral shapes (e.g. CW, AM-DSB, multichannel and FSK signals) and also improves the reliability by feeding the recognized spectral shapes to the baseband classifier
- Reconfigurable: It enables users to define the signal categories and configurations that suit their own wishes and needs
Enhancement of detect, search and classify workflows by detection list filtering

The spectral shape detector is especially useful for the following applications and is designed to obtain optimized results:

- Filtering spectral shapes of interest (e.g. identifying only those signals with a spectral shape that matches the shapes of signals of interest) before a baseband classifier/demodulator/decoder optionally starts analyzing and processing them in more detail
- Filtering out known and even unknown spectral shape types that are not of interest and do not need to be analyzed or processed in depth
- Extending the list of recognizable signals based on user-defined categories

The detector is provided with a database of spectral shapes. This is the spectral reference library. The patterns in the database can either be specific user-defined signal types with corresponding parameters, or predefined within the detector as generic signal types (i.e. CW, AM-DSB, multichannel and FSK signals).

To increase the robustness of the detector, several different instances of the same signal category are gathered and processed by the spectral collector. These are used by the spectral detector trainer, which “learns” to recognize and define these shapes in order to develop the spectral reference library. After this “training” phase has been completed, the detector is able to work with the live spectrum (the receiver can be in fixed frequency or scanning mode).

The conventional energy detector is combined with a high-performance spectral shape detector to enhance the signal search and recognition process. The lower screenshot shows the result of matching the library of generic and user-defined signal types by using the spectral shape detector.
Spectral collector and spectral detector trainer
The spectral collector is a fully automatic application for identifying and collecting a reasonable number of signals (based on live or offline spectrum) that are suited for training purposes. Based on an automatic algorithm, it selects and gathers a number of spectral shapes that are representative of the signal of interest. These spectral shapes vary because they have been computed at different times (i.e. within a few seconds of the selection time). The spectral collector also manages the repeated collection of different emissions associated with the same signal category.

The spectral detector trainer is a standalone application for extracting relevant spectral information and identifying certain signal types based on a set of spectral sample data. The extracted spectral features define a specific category of signals. This information is used by the detector to recognize signals with similar spectral characteristics during a spectral shape search.

In order to train the detector, the user decides which signal types are of interest, collects the corresponding sample data and defines the desired signal categories. It is also possible to automatically create a training collection using the spectral detector trainer. Each signal category is represented by a reasonable number of spectral shapes (approx. 30) and defined in the spectral reference library. The training is carried out based on a list of shape-describing features derived from the signals within the spectral reference library. In order to achieve a more reliable detection, the set of reference shapes used for training should include examples of degraded signals. This makes shape detection more robust against negative influences such as noise and fading.

Based on the input data from the spectral reference library, the spectral detector trainer creates a profile for the detector for each signal category. Using an automatic decision algorithm, the detector evaluates how well each detected signal matches the characteristics of the trained categories.
Reduced user workload due to automatic processing of detected signals

R&S®GX430 combines signal detection with configurable, automatic processing (classification, demodulation, decoding, content recovery, recording).

Automatic monitoring of wide frequency ranges
The most impressive benefit of R&S®GX430 is the combination of automatic detection and classification with fully automated processing of signals (demodulation, decoding, recording). This allows R&S®GX430 to independently monitor a wide frequency range and eliminate many routine tasks for the user.

Application example for fully automatic signal processing

The user defines a set of rules. For each signal, these rules are used to automatically and independently perform the following actions:

- Event triggering: The signal's technical parameters are associated with signal types of special interest. An event notification is generated and sent to the user immediately after recognition.
- Recording: A snapshot of the signal (with predefinable length) is to be saved for subsequent processing. The digital IF is saved on a recording/replaying unit. It performs IF recording of the fixed frequency signal as well as wideband IF recording (with defined duration).
- Demodulation or demodulation/decoding: If the demodulators/decoders for the recognized transmission system are found in the library of R&S®GX430, then they are configured with the measured parameters and started. The signal content is recovered and saved. The maximum duration of the content snapshot can be predefined. Automatic processing includes the following:
  - Audio demodulation: performs audio demodulation of the fixed frequency signal and saves the audio data
  - Digital demodulation: performs digital demodulation of the fixed frequency signal and saves the symbol stream data
  - Digital demodulation/decoding: performs digital demodulation/decoding of the fixed frequency signal and saves the content

The user can simultaneously intercept various signal types with R&S®GX430. Example: For detected analog signals, the audio data is recorded (5 s duration). Detected digital PACTOR III signals are decoded until the end of the signal.
Fully automatic signal processing with user-defined rules via script editor

R&S®GX430 performs fully automatic processing using JavaScript scripts to trigger actions that control what is recorded or processed. These scripts make it possible to define conditions or criteria based on the relevant parameters. When these conditions are met, the script triggers the corresponding actions (predefined by the user). The script can also decide when a signal will be skipped and define how long a signal will be recorded if an action is triggered.

R&S®ScriptEditor provides an environment in which such scripts can be written, tested and debugged. This tool has been designed to allow a straightforward approach to script development and to reduce the effort involved in developing the scripts.
Going into detail with manual measurements

Manual measurements of emission characteristics

Manual measurements of emission characteristics (bandwidth, duration, S/N ratio, level) can be performed with measurement cursors in the zoomable spectrum. The filter bandwidth is automatically adapted to filter out all disturbing out-of-band emissions and noise.

Emission analysis

Emissions are analyzed using the time domain analysis functionality of R&S®GX430. Zoomable level, envelope, frequency, phase and spectrum plots make it possible to measure technical parameters such as level range, frequency shift and symbol rate.

Spectrum, time analysis and digital modulation.
Technical parameters of unknown signals
R&S®GX430 covers the measurement methods specified in the ITU-R SM.1600 recommendation. For unknown signals, it offers a variety of representations and tools for analyzing and measuring technical parameters such as bandwidth, symbol rate, number of tones, tone spacing, shift, modulation index, length of guard interval, number of channels, signal duration, symbol valency and modulation type.

Recognition of known or standardized methods
For known or standardized methods (GSM, DECT, CDMA, etc.), correlation and pattern analysis techniques are available. The tools of R&S®GX430 allow quick recognition of preambles, training sequences and synchronization words of known methods.

Analysis of signal scenarios in line with ITU-R SM.1600

QAM16 constellation diagram.

Spectrum and autocorrelation diagram.
Advanced visualization
Time/frequency segmentation including filtering makes multichannel methods, noncontinuous emissions (bursts) and densely occupied signal scenarios easy to handle.

(Coded) orthogonal frequency division multiplex (COFDM) signals and methods using multiple modulation (e.g. AM-FSK, FM-FSK) can be easily measured and analyzed.

I/Q constellation diagrams and eye patterns are available for evaluating the measured parameters and the equalizer settings.
Diverse opportunities for user-specific expansion

R&S®GX430 provides the user with many ways to integrate user-programmed modules for signal processing (receiver driver, classifier, demodulator, decoder). As a result, users can deploy their own expertise in solutions in an independent manner.

Open programming interface for integration of user-specific modules

R&S®GX430 supports various Rohde & Schwarz monitoring receivers/digital direction finders and has a comprehensive library of universal demodulators, decoders and transmission systems. Moreover, the user can program diverse signal processing modules for integration into and use with R&S®GX430.

R&S®GX430 provides a C++ interface for integrating user modules. Internally, user modules can contain components written in other programming languages such as C or MATLAB®.

For example, the user can program and integrate user-specific decoders in C++ (upper screen) and visualize the results (lower screen).
Integration of a wide variety of user-programmed module types

The following types of modules can be integrated:

- **Receiver control:** The user module functions as a receiver driver for a third-party monitoring receiver. It converts the receiver commands from R&S®GX430 into commands for the other receiver and converts the receiver’s digital IF into a format that R&S®GX430 can process.

- **Universal demodulation:** The user module expands the universal demodulator library available with R&S®GX430. Based on the IF data stream for a signal, it performs demodulation and provides a symbol stream for further processing.

- **Decoding:** The user module expands the decoder library available with R&S®GX430. Using a universal demodulator in R&S®GX430, the user module functions as a decoder, i.e. it decodes the demodulated symbol data stream and recovers information content. This is applicable to decoders that have fixed modulation parameters but different encoding types for the content.

- **Transmission system:** The user module expands the transmission system library available with R&S®GX430. It functions as an independent transmission system in order to demodulate/decode the IF data stream from a monitoring receiver and recover the content. This is necessary with signal types for which a solution involving a universal demodulator and decoder is not feasible. This includes adaptive transmission systems (e.g. CLOVER 2000 and PACTOR III) in which certain information in the decoded data stream must result in immediate changes to the demodulator settings, as well as transmission systems that require specific equalization/synchronization.

- **Classification:** Instead of a universal demodulator module, the user can integrate a signal classification module. This user module functions as a modulation type/transmission system recognizer in addition to the Rohde & Schwarz classifier. Limitations: The output of the classifier is used for result visualization only.
### Ordering information

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#### Licensing options

| Licensing of R&S®GX430 with USB Dongle | R&S®GX430-U | 4090.4670.02 |
| Licensing of R&S®GX430 with SD Card Dongle | R&S®GX430-S | 4090.4687.02 |
| Licensing of R&S®GX430 with Mini USB Dongle | R&S®GX430-M | 4090.4693.02 |

#### Options for single-channel processing

| Processing of Digital Signals | R&S®GX430DM | 4071.5746.02 |
| Classification | R&S®GX430CL | 4090.4706.02 |
| Decoder Package One | R&S®GX430DP1 | 4090.4841.02 |
| Decoder Package Two | R&S®GX430DP2 | 4090.4835.02 |
| Decoding of FACTOR II and FACTOR III | R&S®GX430PIII | 4090.4735.02 |
| Decoding of CLOVER | R&S®GX430CV | 4090.4741.02 |
| Decoding of CODAN 3012 | R&S®GX430CO | 4090.4758.02 |
| Decoding of Digital Mobile Communications | R&S®GX430DMC | 4090.4664.02 |

#### Options for multichannel processing

| Multichannel Processing | R&S®GX430MCP | 4090.4793.02 |
| Detection, Search and Classification of Fixed Frequency Signals | R&S®GX430DSC | 4090.4764.02 |
| Spectral Shape Detector | R&S®GX430SDT | 4090.4658.02 |
| Automatic Processing of Detected Signals | R&S®GX430AP | 4090.4787.02 |

#### Options for signal analysis

| Analysis of Signal Scenarios in line with ITU-R SM.1600 | R&S®GX430IS | 4071.5817.02 |

#### Additional options

| Upgrade Package to version ≥ 04.00 (contact Rohde & Schwarz for more information) | R&S®GX430-UP | 4090.4629.02 |

### Note:

Rohde & Schwarz licenses for R&S®GX430 are stored on a USB dongle, USB mini dongle or SD card. If the dongle or SD card is lost, stolen or misplaced, Rohde & Schwarz will not provide a replacement. All licenses stored on the missing device will have to be purchased again at full price. In the unlikely event that a USB dongle, USB mini dongle or SD card is corrupt or broken, it will be replaced by Rohde & Schwarz only if the defective device is returned to Rohde & Schwarz. A moderate fee will be charged for producing and sending the replacement.

All options require the R&S®GX430 base version.

For data sheet, see PD 5213.8321.22 and www.rohde-schwarz.com.
About Rohde & Schwarz
Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment
- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

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PD 5213.8321.12 | Version 08.00 | October 2013 (as/ff)
R&S®GX430
Data without tolerance limits is not binding | Subject to change
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