R&S®CA120 MULTICHANNEL SIGNAL ANALYSIS SOFTWARE

Automatic multichannel detection, classification, demodulation and decoding of communications signals

Product Brochure
Version 16.00
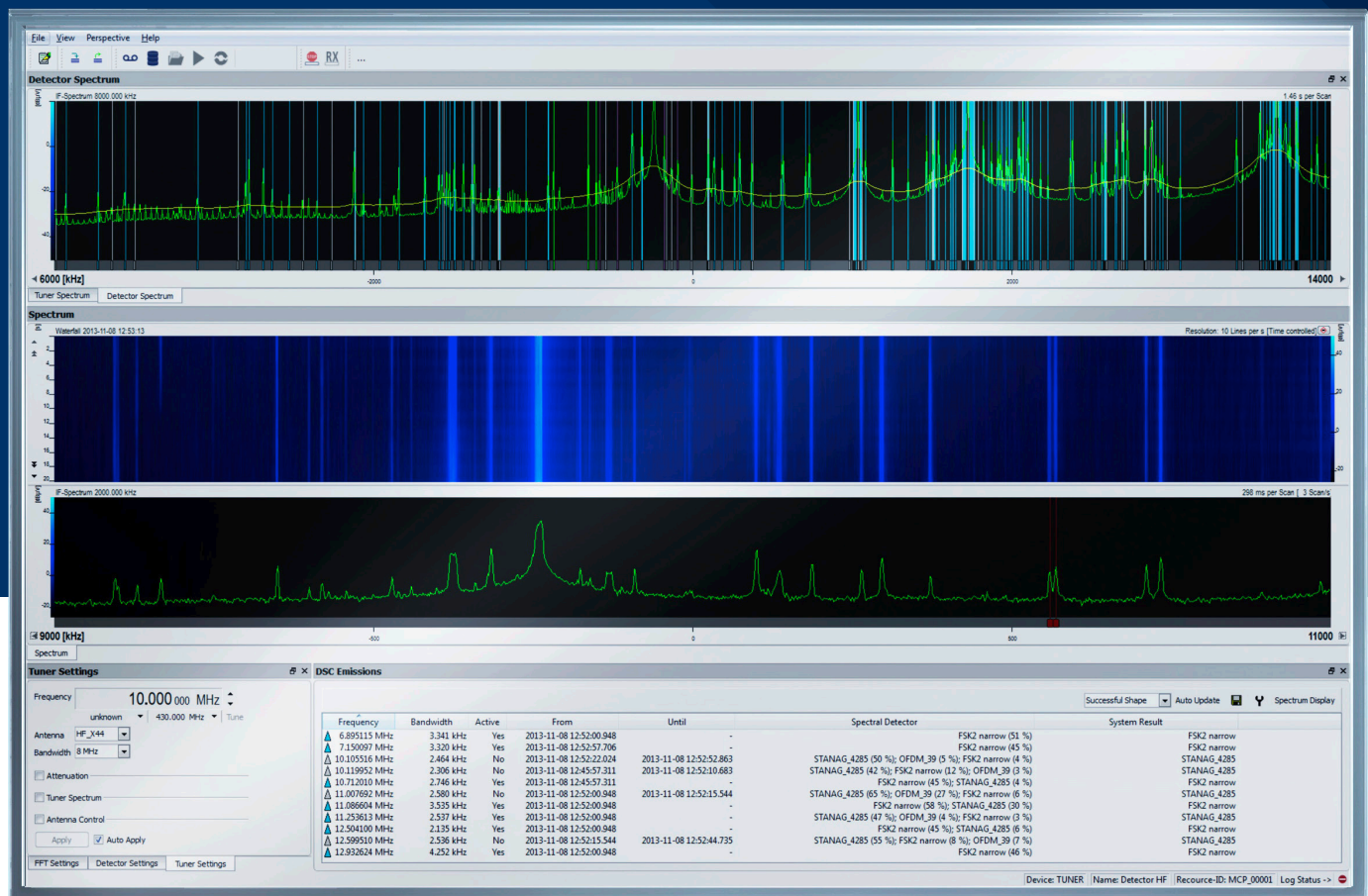
ROHDE & SCHWARZ

Make ideas real

AT A GLANCE

R&S®CA120 is a flexible and automatic multichannel solution for detecting, classifying and processing radiocommunications signals. R&S®CA120 supports a wide spectrum of applications ranging from manual processing and analysis of individual signals to fully automatic signal recognition and processing in wideband signal scenarios.

The R&S®CA120 applications run on a modular, easy-to-maintain signal processing unit architecture that is coupled with advanced Rohde & Schwarz monitoring receivers. The powerful classifier automatically determines the technical signal parameters upon request and delivers the measured parameters to the demodulator/decoder or transmission system. The content is recovered and saved for recognized signal types. Signals that are classified as unknown can be recorded digitally for more in-depth analysis.

A detect, search and classify application supports fully automatic interception and monitoring of fixed frequency and burst signals. Detected signals are measured and classified and can be automatically reported, recorded and demodulated/decoded depending on the signal type.

Multiple signals and wideband signal scenarios can be simultaneously recorded in the form of digital I/Q data and reprocessed during subsequent replay.

For every received signal, R&S®CA120 performs spectrum computation, audio demodulation, I/Q data recording/replay and measurement of fundamental signal parameters. This applies to individual signals and to complete, wideband signal scenarios that are received.

R&S®CA120 processes the following input data:
▶ Digital I/Q data supplied in real time by state-of-the-art Rohde&Schwarz monitoring receivers/direction finders
▶ Digital I/Q data replayed offline from a signal recording

The metadata embedded in the digital I/Q data stream format used by Rohde&Schwarz, such as precise time-stamps and frequency and bandwidth information, is also evaluated during signal processing.

A real-time spectrum is computed for each signal using a fast Fourier transform (FFT). An audio demodulator makes it possible to listen to (analog) signals and save the audio data in digital format.

The manual measurement of signal parameters such as bandwidth, signal duration and S/N ratio is supported. A filter that can be set manually is used to eliminate all inter-fering out-of-band emissions and noise. The data from the time domain analysis (higher-order spectrum, envelope, instantaneous frequency) enables the manual measure-ment of the technical parameters of an emission (e.g. level range, frequency shift, symbol rate). For more in-depth signal analysis, the signal can be recorded and transferred to an offline signal analysis solution (see the R&S®GX410 or R&S®CA210 solutions for technical signal analysis).

KEY FACTS

▶ Support of automatic interception and monitoring of complete signal scenarios

▶ Powerful classifier and extensive signal processing library with demodulators and decoders

▶ Configurable detection of fixed frequency, burst and frequency agile short-time signals with subsequent automatic processing of detected signals (including content recovery depending on signal type)

▶ Processing of wideband signal scenarios
   – HF: up to 20 MHz per receiver
   – VHF/UHF: up to 80 MHz per receiver

▶ Modular scalability from four-channel to n-channel signal processing solution (n > 100)

▶ Open interface for independent extension of signal processing capabilities by the user and integration into existing system solutions

AUTOMATIC CLASSIFICATION TO SUPPORT THE USER

When unknown signals are encountered, R&S®CA120 supports the user by providing a powerful classifier that allows automatic detection and recognition of modulation type and transmission system. During monitoring, the classifier supports recognition of known signal types.

Powerful classifier

R&S®CA120 includes a powerful automatic classifier for determining the modulation type, measuring technical parameters and identifying the transmission system of a wide range of analog and digital signals. For a list of all modulation types and transmission systems that can be recognized, see the R&S®CA120 data sheet (PD 3606.9327.22). Rohde & Schwarz is working continually to expand this transmission system library.

The classification algorithm performs segmentation and modulation analysis. Segmentation determines the signal's exact center frequency and bandwidth. Subsequent automatic modulation analysis determines the modulation type along with relevant modulation parameters such as symbol rate, frequency shift and number of OFDM channels.

After modulation analysis has been performed, automatic transmission system recognition is initiated. Especially with complex classes of signals such as PACTOR III and STANAG 4285, this involves the identification of signal-specific characteristics such as frame structures, bit patterns

and operational modes. Alternatively, pure bitstream classification is performed based on the symbol stream of a universal demodulator that is applied (e.g. FSK2 – Baudot, multitone – Piccolo MK12).

The measured modulation and transmission system parameters can be used to directly set the parameters for the demodulator/decoder so that the content can be recovered and saved. If all that is recognized is the type of modulation, a universal demodulator can be used to recover a symbol stream that is saved for subsequent channel coding analysis (e.g. with R&S®CA250 bitstream analysis).

## User-specific expansion of classification capabilities

Bitstream classification involves the use of user-developed decoders. It is also possible to integrate and employ a user-developed modulation type or transmission system classifier in R&S®CA120 (see page 13).

Wideband classification

The classifier in combination with the wideband snapshot access option (R&S®CA120WSN) – connected, for example, to an R&S®ESME or R&S®ESMD wideband monitoring receiver – uses the receiver's internal wideband snapshot buffer to classify wideband signals (e.g. DVB-T, LTE or WLAN 802.11a/g/n) in up to 80 MHz bandwidth.
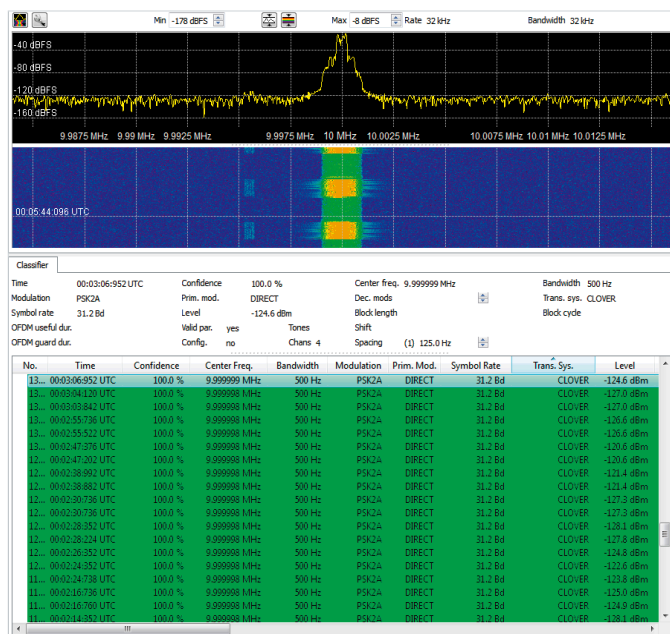
The classifier automatically detects numerous transmission systems
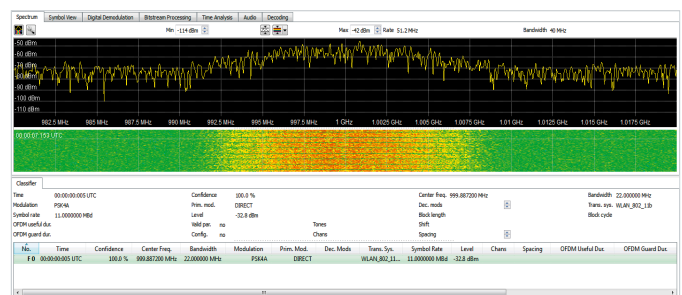
Classification of a WLAN signal with 22 MHz bandwidth

EXTENSIVE TRANSMISSION SYSTEM LIBRARY

R&S®CA120 provides the demodulators and decoders needed to recover the content of numerous signal types.

Manual or automatic demodulation and decoding

The demodulators and decoders or transmission systems are selected manually by the user or automatically by the classifier.

Universal demodulators (e.g. FSK2, PSK4, multitone) provide a bit data stream that can be processed in a selectable decoder or saved in a file for subsequent bitstream analysis (e.g. using R&S®CA250 bitstream analysis).

Depending on the type of encoding (e.g. ASCII, Baudot, Coquelet, fax), the decoder delivers the content data in a format suitable for visual presentation and storage, e.g. plain text, structured text or graphical image data.

Transmission systems even for complex classes of signals

Content recovery from complex classes of signals requires the use of a suitable transmission system (e.g. PACTOR III, CODAN 3012). For a list of all types of demodulators, decoders and transmission systems contained in R&S®CA120, see the R&S®CA120 data sheet (PD 3606.9327.22). Rohde & Schwarz is working continuously to expand this transmission system library.
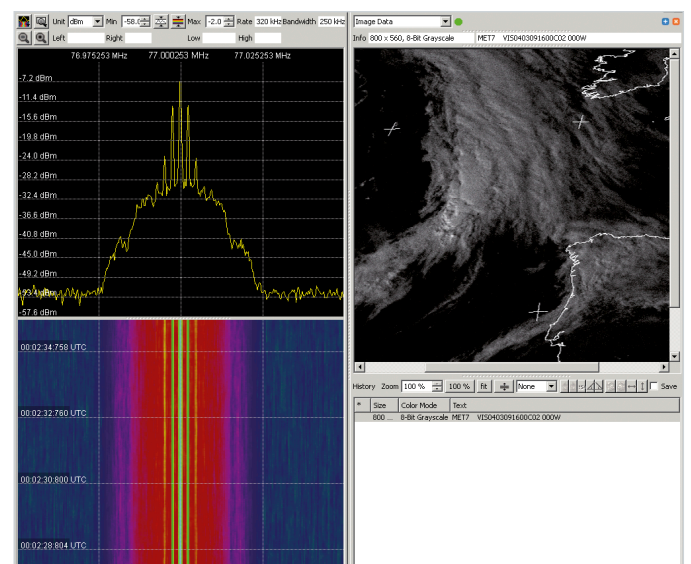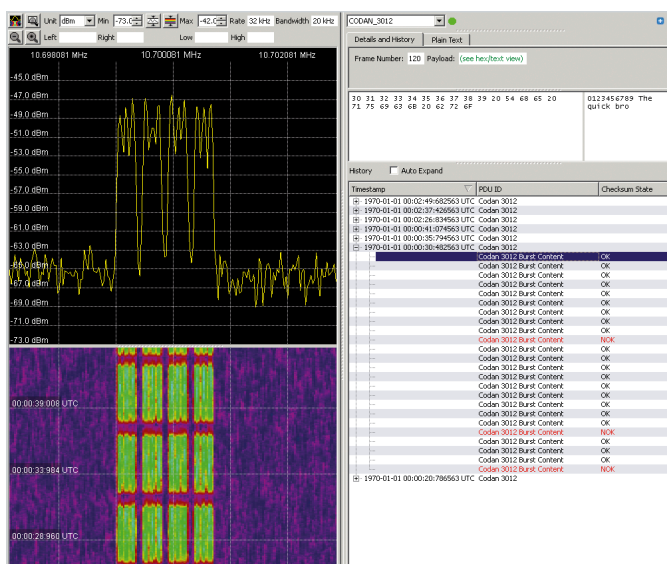
Content recovery from METEOSAT Wefax and CODAN 3012 signals

FAST AND RELIABLE SIMULTANEOUS PROCESSING OF MULTIPLE SIGNALS

R&S®CA120 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, even by several users

Frequently, the real-time bandwidth of a monitoring receiver simultaneously contains multiple signals. If R&S®CA120 obtains the I/Q data for such a scenario from the receiver, the user can downconvert these signals with the aid of DDCs and then manually process them in parallel. The individual DDCs can set their center frequencies and bandwidths within the limits of the processable real-time bandwidth of the monitoring receiver. The downconverted signals are processed by one or more users with the aid of interception processing channels (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®CA120 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 level over threshold for first time)
▶ Change in characteristics of a known signal (activity status, change in level, bandwidth or center frequency)
▶ Inactive signal (signal level falls below detection threshold)
▶ End of signal
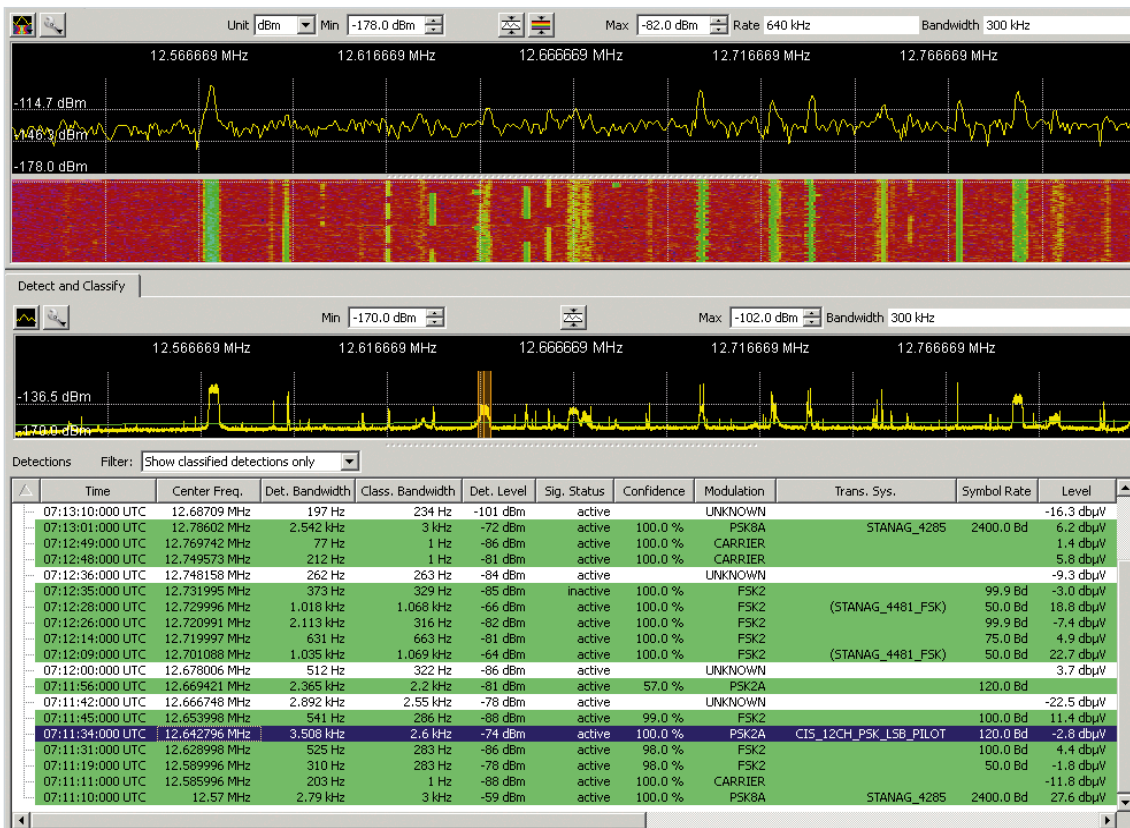
The automatic detection function informs the user about signals and events of potential interest

It is possible to use a multichannel wideband direction finder such as the R&S®DDF550 or R&S®DDF5GTS[1] as a detection sensor. R&S®CA120 will use the directional information to add an azimuth value to the detection results.

Detected signals are classified automatically. Users can select the optimum strategy for a particular scenario from a list of different strategies.

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

High-performance detection of FSK2 signals
The correlative detector optimizes the detection of weak and specific FSK2 signals with very high reliability. Preknowledge of the included bit sequence and user-definable modulation parameters enable the correlative detector to monitor and search for targeted FSK2 signals within a wideband spectrum. The detected signals will be further analyzed to determine the payload, etc. The correlative detector is extremely beneficial for users who want to effectively detect predefined FSK2 signals.[1]

[1] More details about hardware-accelerated multichannel signal processing on page 18.

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 not generate messages for signals in these ranges.

Detection using a scanning receiver
When using a scanning receiver instead of a wideband receiver in fixed frequency mode (as described above), 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) detected signals automatically, digital downconverters are used to extract signals if the receiver is in fixed frequency mode. As this is not possible with a scanning receiver, physical handoff receivers set to the relevant frequencies are used instead of digital down-converters to process the signals of interest.

List of detected and classified signals with additional azimuth information (R&S®RAMON GUI).

AUTOMATIC ANALYSIS OF FREQUENCY AGILE SHORT-TIME SIGNALS IN WIDEBAND SIGNAL SCENARIOS

R&S®CA120 features a powerful detector for short-time signals in the HF and VHF/UHF frequency ranges. The detected short-time signals are automatically analyzed, sorted and matched to transmissions system profiles and can optionally be recombined to a continuous signal.

Detection of frequency agile short-time signals

Frequency agile short-time signals are detected by a short-time signal detector that has been optimized for this task. The short-time emissions are analyzed to determine the relevant technical parameters (e.g. duration, bandwidth, level, modulation) of each individual hop, making it possible to classify the short-time emissions. The results in statistical histograms give the user a full overview of frequency agile communications in a wideband signal scenario. The histograms provide several measurement tools that allow the user to determine the types of active frequency agile transmission systems and the number of active emitters.

Automatic profile separation

Frequency agile short-time signals are separated to determine how many transmitting devices are active. The separator tries to cluster the hops by their measured technical parameters such as duration, modulation type and modulation parameters. Additional parameters such as hop rate (number of bursts per second) and coverage are determined. The user can define profiles of frequency agile transmission systems with their relevant technical parameters. For each cluster of hops, the separator will automatically match the profiles to the estimated hop parameters. This profile recognition and activity analysis of the transmitting devices may be used (outside of R&S®CA120) for network analysis of frequency agile communications. A successful profile separation provides the capability to recombine the hopper signal for further processing.

Frequency agile communications can be detected, analyzed and automatically assigned to an already known transmission system profile. The signal is recombined and demodulated.

Separation and direction finding of hopper transmissions in wideband fixed frequency mode (WFFM) or scan mode

It is possible to use a multichannel wideband direction finder like the R&S®DDF550 or R&S®DDF5GTS [1]) as a sensor to separate frequency agile communications. R&S®CA120 will use the directional information to calculate and add an azimuth value to each detected and separated hopper transmission. This data can be used for network analysis of frequency agile communications outside of R&S®CA120.

In WFFM mode, it is possible to cover a real-time bandwidth of up to 20 MHz in HF and up to 80 MHz in VHF/UHF. In scan mode, the detector runs in the selected scan range. Due to the scan operation, the number of detected hops is reduced compared to the WFFM mode. If the frequency agile signal is hopping in a range larger than 80 MHz, the scan mode should be used.

[1]) More details about hardware-accelerated multichannel signal processing on page 18.

Online recombination of frequency agile short-time signals

Automatic profile separation separates all detected hops coming from one emitter. Using the precisely measured start times of the hops, the frequency agile signal can be recombined to a continuous signal at the I/Q baseband level. These I/Q data streams can be recorded for later analysis or immediately demodulated with analog or digital demodulators. R&S®CA120 contains optimized FSK and PSK demodulators for recombined hopper signals.
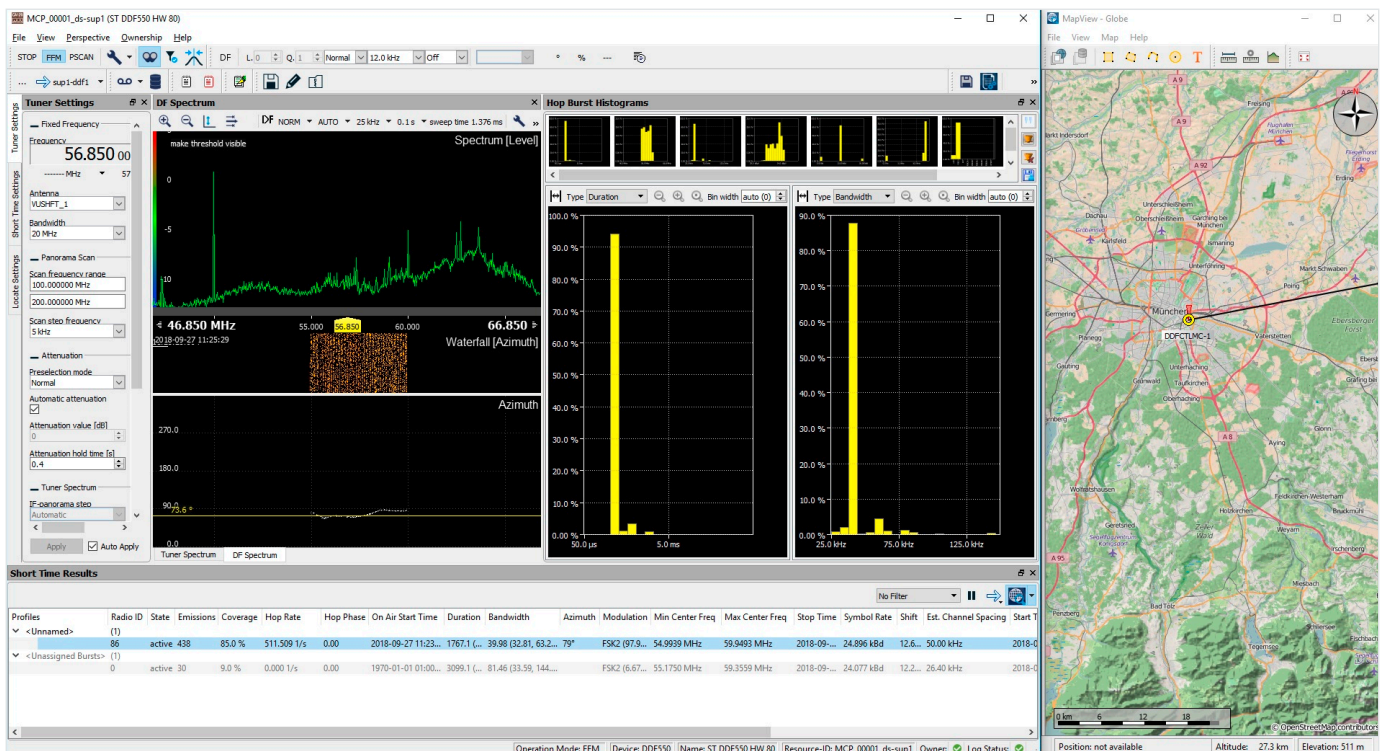
Detecting and measuring a hopper signal, including the hop rate and azimuth (R&S®RAMON GUI).

HIGH SPEED SPECTRAL SHAPE SEARCH (MACHINE LEARNING)

R&S®CA120 excels in detecting and identifying spectral shapes of interest within a wide, densely populated scenario.

Fast recognition of signals using 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 signal categories and configurations that suit their own wishes and needs
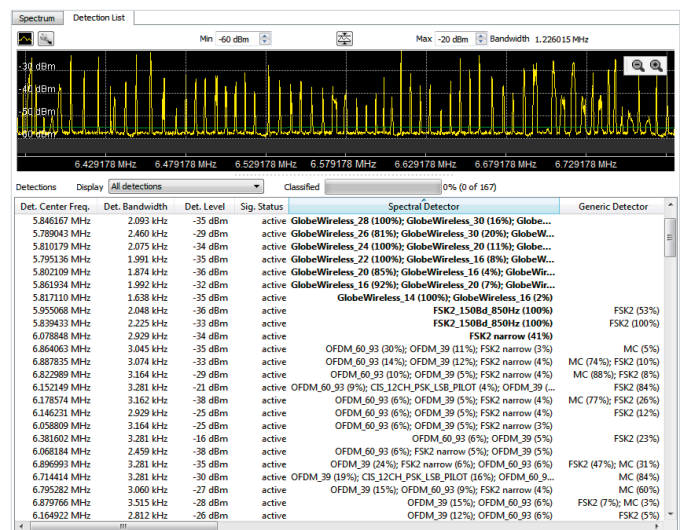
Enhancement of detect, search and classify workflows using detection list filtering

The spectral shape detector is designed to obtain optimized results and is especially useful for the following applications:
▶ 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 shapes 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 includes a database of spectral shapes, the spectral reference library. The patterns in the database can either be specific user-defined signal types with corresponding parameters, or predefined 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 signal search and recognition. The lower part of the screenshot shows the result of matching the library of generic and user-defined signal types using the spectral shape detector.
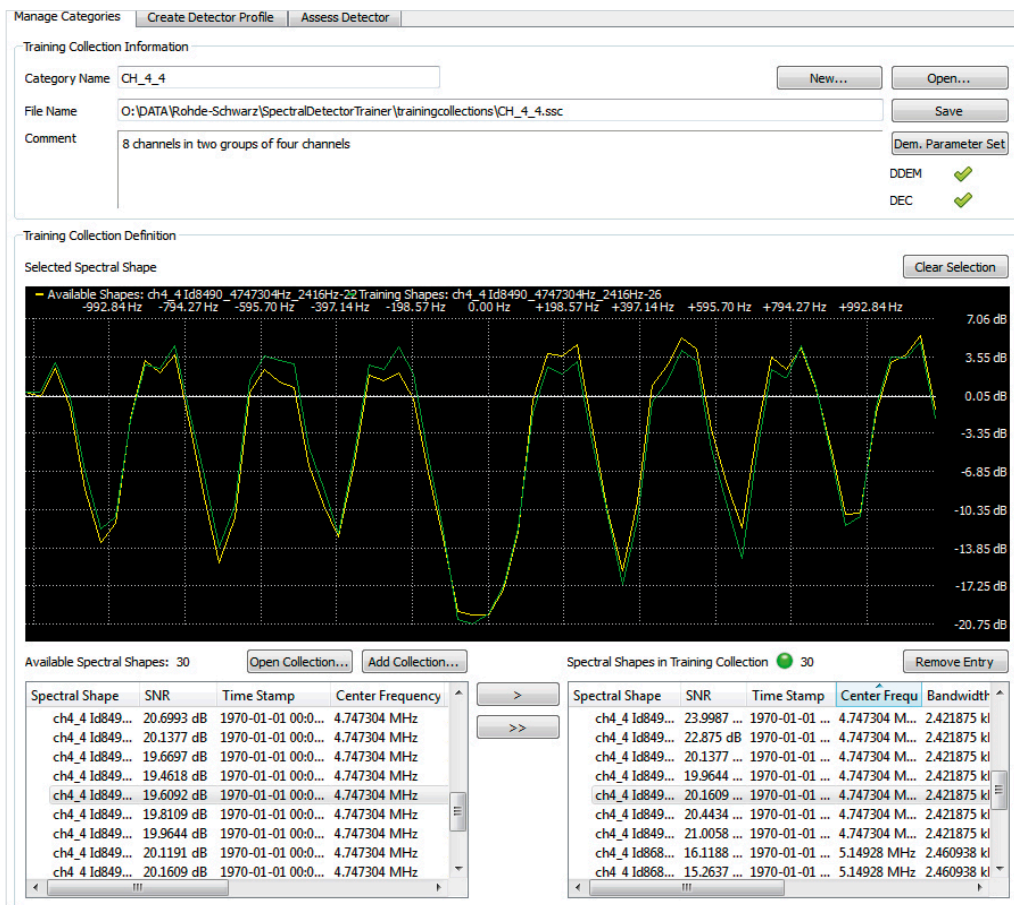
Spectral collector and spectral detector trainer

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 (approximately 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.

Spectral detector trainer.

REDUCED USER WORKLOAD DUE TO AUTOMATIC PROCESSING OF DETECTED SIGNALS

R&S®CA120 combines signal detection with configurable, loss-free automatic processing (classification, demodulation, decoding, content recovery, recording).

Automatic monitoring of wide frequency ranges

The most impressive benefit of R&S®CA120 is the combination of automatic detection and classification with fully automated processing of signals (demodulation, decoding, recording). This allows R&S®CA120 to independently monitor a wide frequency range and eliminate many routine tasks for the user.

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 I/Q data is saved on a recording/replaying unit. It performs I/Q data recording of the fixed frequency signal as well as wideband I/Q data recording (with defined duration)
▶ Demodulation or demodulation/decoding: If the demodulators/decoders for the recognized Rohde & Schwarz transmission system are found in the library of R&S®CA120, 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:
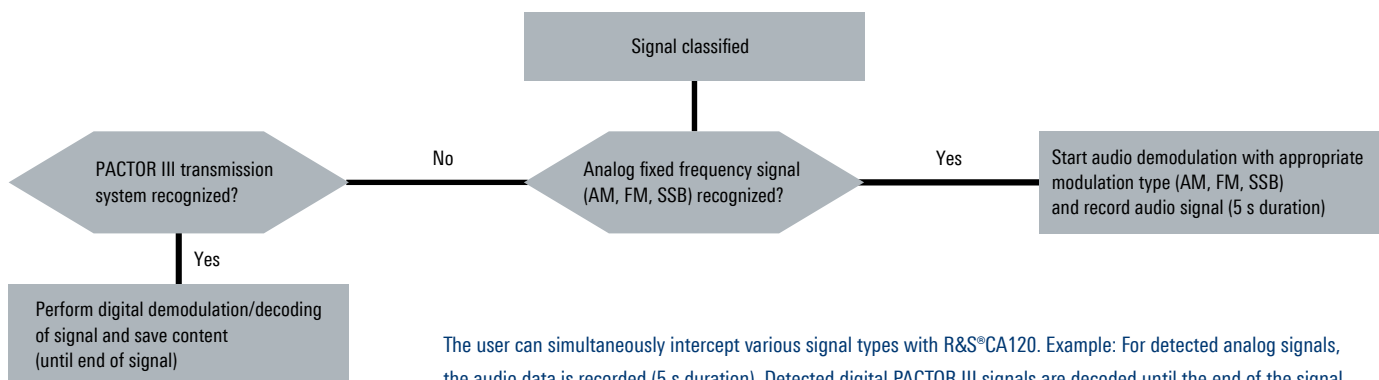– Audio demodulation: performs audio demodulation of the fixed frequency signal and saves the audio data
– Digital demodulation: performs digital demodulation of the fixed frequency signal and saves the symbol stream data
– Digital demodulation/decoding: performs digital demodulation/decoding of the fixed frequency signal and saves the content

Fully automatic signal processing with user-defined rules via script editor

R&S®CA120 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.

Application example of fully automatic signal processing

```
                                    ┌─────────────────┐
                                    │ Signal classified │
                                    └─────────────────┘
                                             │
┌──────────────────┐      No      ┌──────────────────────┐    Yes    ┌─────────────────────────┐
│ PACTOR III        │◄─────────────│ Analog fixed frequency │──────────►│ Start audio demodulation │
│ transmission      │              │ signal (AM, FM, SSB)   │           │ with appropriate         │
│ system recognized?│              │ recognized?            │           │ modulation type          │
└──────────────────┘              └──────────────────────┘           │ (AM, FM, SSB) and record │
         │                                                            │ audio signal (5 s duration)│
        Yes                                                           └─────────────────────────┘
         │
┌──────────────────┐
│ Perform digital   │
│ demodulation/     │
│ decoding of signal│
│ and save content  │
│ (until end of     │
│ signal)           │
└──────────────────┘
```

The user can simultaneously intercept various signal types with R&S®CA120. 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.

DIVERSE OPPORTUNITIES FOR CUSTOMIZED EXPANSION

R&S®CA120 makes it possible to integrate user-programmed modules for signal processing, such as receiver drivers, classifiers, demodulators and decoders. 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®CA120 supports various Rohde & Schwarz monitoring receivers/direction finders and contains 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 the R&S®CA120 multichannel signal analysis system. R&S®CA120 has an open, documented application programming interface (API) for this purpose.

R&S®CA120 provides a C++ interface for integrating user modules. User modules can contain components written in other programming languages such as C or MATLAB®.

```
//! Create and send a "transmission system result" frame (text message)
int dd_send_text_data(typDDParams *ptrTypDDParams,
                                    typOwnParams *ptrTypOwnParams,
                                    ptypBIGTIME bigtimeTime,
                                    void *voidPtrParent)
(
    char strMsgBuf[80];
    unsigned int uMsgLen, uMsgLen32Bit, uFrameSize;
    char *cDest;

    typTRANSMISSION_SYSTEM_RESULT_FRAME *ptrTextDataFrame;


    // ---------------------- Prepare data ----------------------------------
    uMsgLen = sprintf(strMsgBuf, "Configuring. Audio: %s  Decimation step: %3u",
        (ptrTypDDParams->eAudioOnOff == GX_AUDIO_ON) ? "On " : "Off",
        ptrTypDDParams->uDecimation);

    // Length of the text message in bytes after 32-bit alignment
    uMsgLen32Bit = uMsgLen/pdemSIZEOF(ptypUINT);
    if(uMsgLen % pdemSIZEOF(ptypUINT))
        uMsgLen32Bit++;  // there a still less than 4 chars available - you need one more 32 Bit Word
```

The user can program and integrate user-specific decoders in C++ programming language.
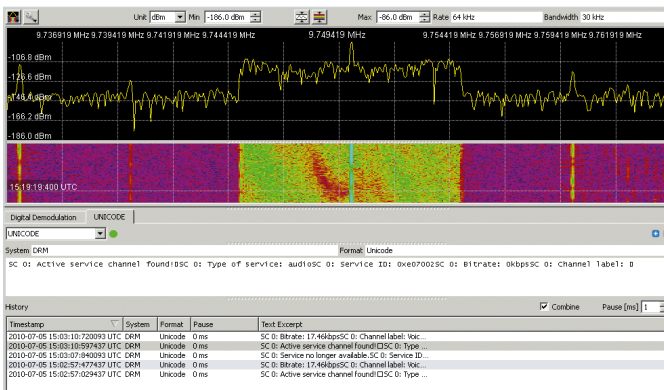
Results delivered by the user-specific modules (here a decoder) are visualized in the graphical user interface.

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®CA120 into commands for the other receiver and converts the receiver's digital I/Q data into a format that R&S®CA120 can process

▶ Universal demodulation: In manual mode the user module expands the universal demodulator library available with R&S®CA120. Based on the I/Q data stream for a signal, it performs demodulation and provides a symbol stream for further processing

▶ Decoding: In manual mode the user module expands the decoder library available with R&S®CA120. Using a universal demodulator in R&S®CA120, 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: In manual mode the user module expands the transmission system library available with R&S®CA120. It functions as an independent transmission system in order to demodulate/decode the I/Q 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: In manual mode, the user can integrate a signal classification module instead of a universal demodulator module. This user module functions as a modulation type/transmission system recognizer in addition to the classifier provided by Rohde & Schwarz

# SIMULTANEOUS RECORDING OR REPLAY OF MULTIPLE SIGNALS

R&S®CA120 opens up additional applications to simultaneously record or replay multiple signals in the form of digital I/Q data.

Enhanced capabilities through postprocessing of recorded signals

Recording and subsequent replay of signal samples considerably expand the processing capabilities. The digital I/Q data arriving from the receivers or interception processing channels can be recorded in a loss-free manner. This enables subsequent processing of signals that cannot be analyzed online (e.g. due to the lack of personnel or resources when a signal of interest occurs). The recorded signals can be exported from R&S®CA120 for processing or archiving using offline analysis tools such as R&S®GX410 or R&S®CA210. The user can replay the recorded signals or signal scenarios in R&S®CA120 and process them as if they were currently online. This includes detection, classification, demodulation, decoding, recording and automatic workflows.

An R&S®CA120REC recording/replay option for digital I/Q data can simultaneously record (or replay) a single signal or multiple signals as a function of the selected recording bandwidth. The modular design of R&S®CA120 makes it possible to operate multiple recording/replay options in parallel. In this manner, the system can be adapted to meet the user's specific requirements for the number of signals to be simultaneously recorded or replayed.

One R&S®CA120REC recording/replay option per monitoring receiver can be used to store and replay signal scenarios with a bandwidth of up to 10 MHz in R&S®CA120. For larger bandwidths (e.g. 20 MHz, 40 MHz or 80 MHz) that can be processed using hardware-accelerated signal processing (see page 18), an external digital wideband storage device such as the R&S®DWR100 or R&S®DWR150 is used in addition.
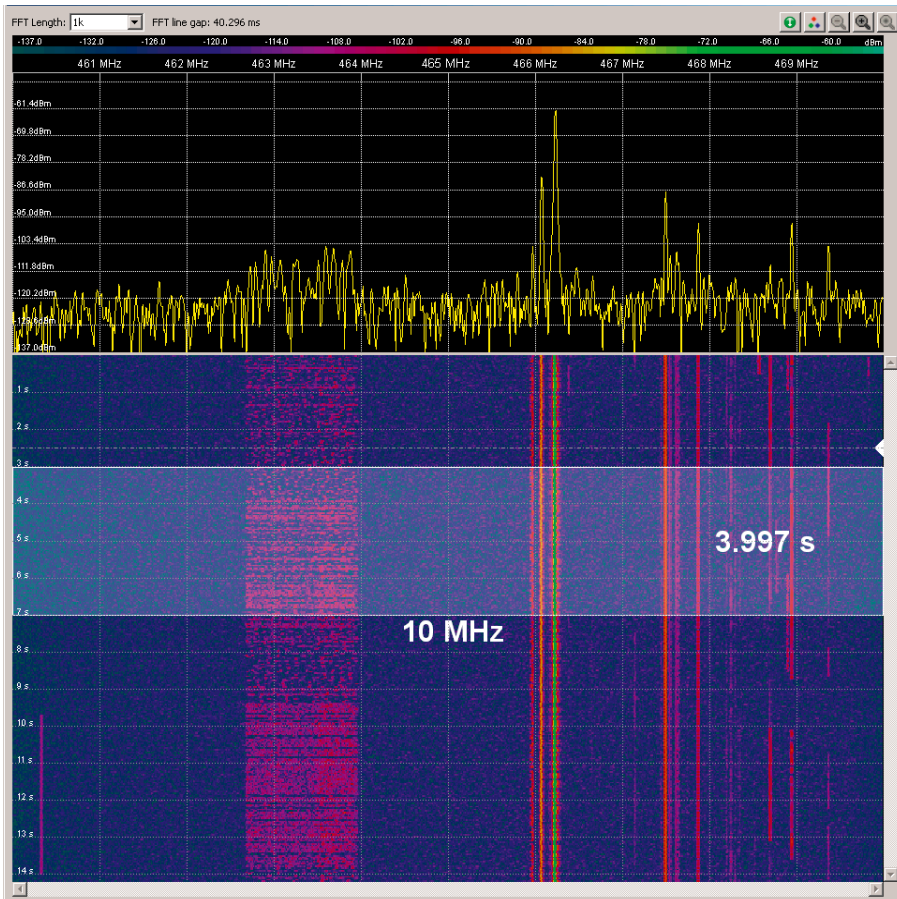
Overview spectrogram: a signal recorded using the R&S®CA120REC option can be replayed for subsequent analysis.

Ring buffer for loss-free recording even with delayed start

All R&S®CA120 interception processing channels have a configurable ring buffer for storing a signal's behavior versus time. When a recording is started, this ring buffer can be included at the start of the recording. As a result, it is possible to begin loss-free recording of any signal in the past. This is necessary, for example, in cases where a user manually triggers recording after recognizing that a signal is important. The response time until recording was started by the user is compensated by reading out the signal from the existing ring buffer. In this manner, the signal can seamlessly be recorded from where it started.

Endless recordings are made by reserving a memory area with predefined size on the recording unit. This memory area is then used as a ring buffer. This ensures that at any instant (depending on the size of the memory that is reserved), the most recent seconds, minutes or hours of a signal are available in the ring buffer without gaps so that the entire signal or a part thereof can be replayed if necessary. The limited size of the ring buffer prevents a single signal recording from using up the entire capacity of the recording system.

Fast, pinpoint navigation within signal recordings

R&S®CA120 offers convenient navigation through long signal recordings:
▶ Bookmarks can be set and comments entered during recording. These bookmarks and comments are then available during replay to facilitate navigation in the signal recording
▶ The ability to compute an overview spectrum (frozen waterfall with time/frequency display) for a signal recording simplifies the user's job. The spectrogram shows the content of the entire signal recording with reduced time resolution. As a result, it is possible to quickly detect the relevant signal activity even in a long signal recording and select only this time-limited section of the signal for subsequent replay or export
▶ The user can set the start and end point for digital replay of a signal. The signal can be replayed once or in an infinite loop as often as desired

Systematic management of recorded signals

Besides its recording and replay functions, R&S®CA120 offers additional functions:
▶ Sortable listing of all recordings
▶ Selection and deletion of recordings
▶ Write protection for important recordings
▶ Status of recording unit (occupied/available memory)
▶ Secure deletion of all recordings (multiple overwriting of deleted data to ensure that no file fragments remain on the hard disk)

SOFTWARE AND HARDWARE ARCHITECTURE

The modular design of R&S®CA120 allows fast determination of the applications and resources needed to handle the current application cases. R&S®CA120 is optimally designed to grow with user requirements, e.g. if a need arises for additional interception processing channels or processing of new signal types.

Modular design

Due to its fully modular and configurable design, R&S®CA120 can be matched precisely to the specific user requirements. The user can select the number of signals to be processed simultaneously and the necessary processing depth (classification, demodulation, decoding).

R&S®CA120 is connected to one or more of the advanced Rohde & Schwarz monitoring receivers/direction finders. Several of these monitoring receivers and direction finders offer hardware-accelerated signal processing. For more details, see page 18. For a list of usable monitoring receivers and direction finders as well as the supported I/Q bandwidths, see the R&S®CA120 data sheet (PD 3606.9327.22).

Expandable resource concept

Each R&S®CA120 multichannel signal analysis system consists of the described components. These components are configured to ensure that the planned tasks can be performed in line with user requirements. When the user has new or enhanced requirements, R&S®CA120 must meet them. Applications (e.g. R&S®CA120FFP interception processing channels, R&S®CA120CL classifiers and R&S®CA120REC recording/replay options) can be retrofitted at any time thanks to the modular design of R&S®CA120.

The R&S®CA120 provides optional hardware components for:
▶ Semimobile applications
  – R&S®CA120PU-S signal processing and storage unit
  – R&S®CA120PU signal processing unit
▶ Server room applications
  – R&S®CA120SPU-S server room signal processing and storage unit
  – R&S®CA120SPU server room signal processing unit

APPLICATIONS AND CONFIGURATION OPTIONS FOR R&S®CA120

Application	Option(s)	Description
Multichannel signal analysis	R&S®CA120 base unit	R&S®CA120 provides the basis for all (optional) signal processing applications and all necessary management functions (resource management, license management, error management, etc.).
Single-channel processing	R&S®CA120FFP	R&S®CA120FFP is configured for single-channel signal processing. A monitoring receiver, direction finder, DDC or recording is used as the signal source. R&S®CA120FFP provides spectrum computation, audio demodulation, time domain analysis and an interface for signal recording/replay. This results in a full-featured solution for the interception of analog signals (e.g. voice signals). The maximum number of signals that can be processed in parallel in R&S®CA120 is determined by the number of available R&S®CA120FFP interception processing channels.
Processing of digital signals	R&S®CA120DM	R&S®CA120DM enables an R&S®CA120FFP interception processing channel to demodulate digital transmission systems using the universal demodulator library.
Classification and wideband classification	R&S®CA120CL, R&S®CA120WSN	R&S®CA120CL enables an R&S®CA120FFP interception processing channel to automatically measure and classify analog and digital signals at the modulation and transmission system levels. R&S®CA120DM is required. R&S®CA120WSN enables R&S®CA120 to classify wideband signals up to 80 MHz bandwidth in online mode. This option allows the classifier to access the wideband snapshot buffer of the R&S®ESME or R&S®ESMD monitoring receiver. R&S®CA120CL is required.
Decoder and transmission system	see R&S®CA120 specifications for further information (PD 3606.9327.22)	A selection of decoder/transmission system packages is available. Each of these packages is an option for R&S®CA120 and enables an R&S®CA120FFP interception processing channel to decode specific transmission systems. R&S®CA120DM is required.
Multichannel processing	R&S®CA120MCP	R&S®CA120MCP allows multichannel parallel processing of a signal scenario. It receives the digital I/Q data from a monitoring receiver, direction finder or a recording, computes the spectrum and provides a maximum of 32 DDCs. The DDCs can be set manually by the user or automatically by the automated applications in order to simultaneously process up to 32 signals from the signal scenario (classification, demodulation, decoding, recording). For this purpose, an R&S®CA120FFP interception processing channel is connected after each DDC.
Signal detector	R&S®CA120DSC	R&S®CA120DSC is operated together with an R&S®CA120MCP and continuously delivers a list of detected signals. Interception processing channels with classifiers can be allocated to it in order to automatically recognize the modulation type and the transmission system of each signal after detection. The higher the number of classifiers that operate simultaneously, the more efficiently the signal scenario will be intercepted and monitored. The maximum number of classifiers that a detector can simultaneously operate is determined by the number of available R&S®CA120FFP interception processing channels.
Automatic processing of detected signals	R&S®CA120AP	R&S®CA120AP enables R&S®CA120DSC to process detected signals fully automatically. For fully automatic operation of R&S®CA120, the user must specify rules for the automatic workflow. A selection of rules (Event → Action) is available to create efficient automatic workflows. All technical parameters obtained through detection and classification (e.g. signal became active; signal was classified as unknown; signal was classified as known) can be used to control the decision-making process for the execution of actions. R&S®CA120AP can perform different actions including event triggering, recording, demodulation or demodulation/decoding. These actions take up one R&S®CA120FFP interception processing channel for the duration of the action.
Detector for frequency agile signals	R&S®CA120ST, R&S®CA120PS, R&S®CA120OR	R&S®CA120ST allows processing of short-time signal scenarios. It provides a snapshot detector for short-time signals. The detector results are combined, statistically evaluated and output. R&S®CA120PS provides the online separation and recognition of already known and unknown short-time signal transmitters. In addition, it is possible to separate equal transmitters that send signals in parallel. R&S®CA120OR allows the online recombination of short-time signal scenarios. The recombined I/Q data stream can be passed on to a R&S®CA120 FFP for further analysis and processing.
Recording/replay channels	R&S®CA120REC	Each R&S®CA120FFP interception processing channel provides an interface for recording/replaying individual signals. Each R&S®CA120MCP provides an interface for the recording/replay of a signal scenario. To record and replay signals, R&S®CA120REC, which simultaneously processes multiple signals, is required. The number of R&S®CA120REC options depends on how many signals and signal scenarios the user wishes to record/replay simultaneously.
Signal processing units	R&S®CA120PU-S, R&S®CA120PU, R&S®CA120SPU-S, R&S®CA120SPU	For semimobile applications depending on the selected options as well as their numbers, the processor configuration of R&S®CA120 is set up using the R&S®CA120PU-S and R&S®CA120PU modules to ensure the necessary computing power and recording capacity. For server room applications, R&S®CA120SPU-S and R&S®CA120SPU are used correspondingly.

HARDWARE-ACCELERATED MULTICHANNEL SIGNAL PROCESSING

## WITH R&S®ESME/ESMD/DDF260/DDF255/DDF550/DDF5GTS

Several Rohde & Schwarz monitoring receivers and direction finders offer hardware-accelerated signal processing functions that provide optional support for R&S®CA120. The result is top-class signal processing with a bandwidth of more than 20 MHz per receiver for simultaneously computing dozens of parallel DDC channels and for detecting/analyzing frequency agile hopper signals.

These capabilities are described below using the R&S®ESME wideband monitoring receiver as an example. The R&S®CA120 data sheet (PD 3606.9327.22) includes a list of all Rohde & Schwarz monitoring receivers and direction finders that feature hardware-accelerated signal processing.

The R&S®ESME wideband monitoring receiver can be equipped with an R&S®ESME-SP signal processing board to enable hardware-accelerated signal processing with R&S®CA120. The board offers up to four high-performance signal processing functions, implemented in field programmable gate array (FPGA) technology.

R&S®ESME with R&S®ESME-SP: support for hardware-accelerated signal processing with R&S®CA120
R&S®ESME-SP signal processing board with options. The results are processed in the R&S®CA120 multichannel signal analysis system.
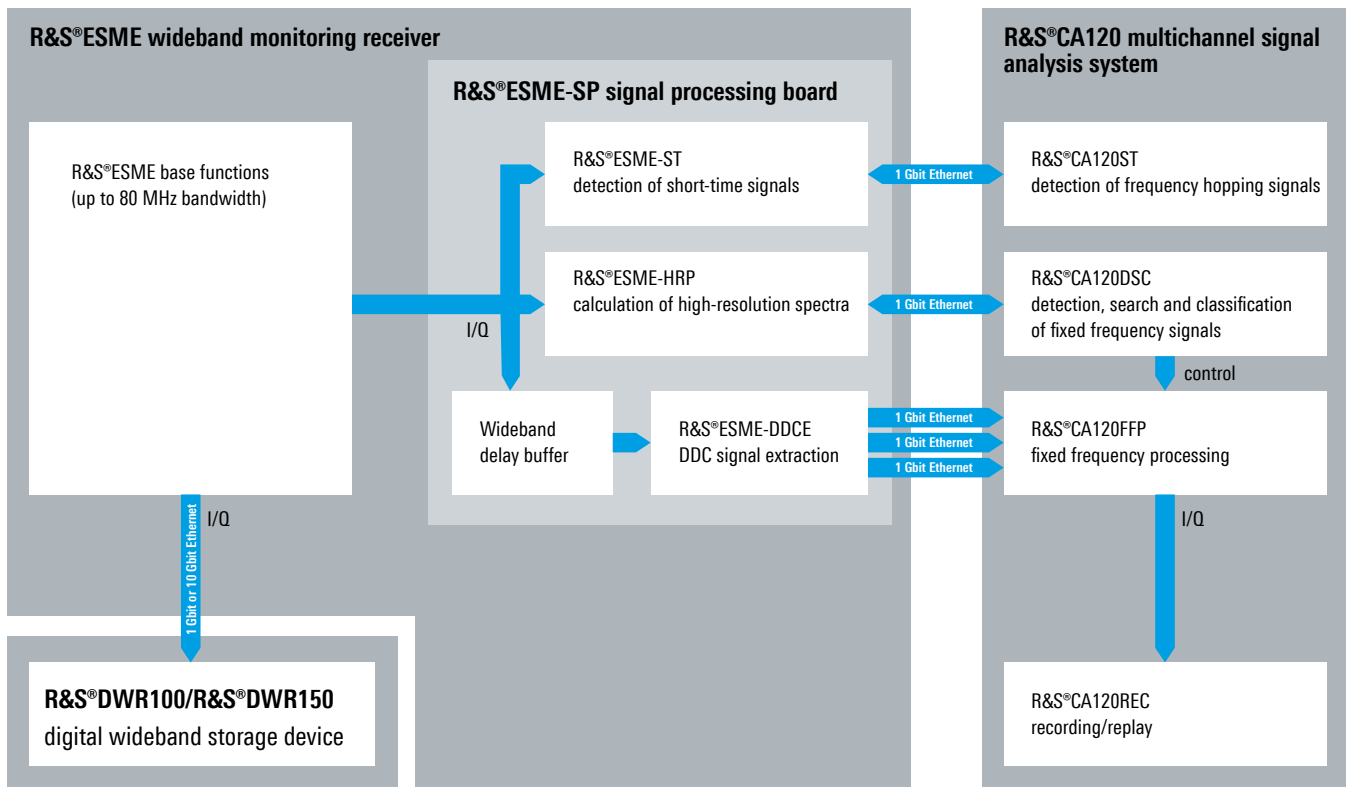
Multichannel digital downconversion (DDC) signal extraction from the R&S®ESME real-time bandwidth with R&S®ESME-DDCE and R&S®CA120FFP

If multiple signals in the real-time bandwidth of the R&S®ESME are active at the same time, users can extract these signals using digital downconverters. The maximum number of DDCs computed in parallel depends on the set DDC bandwidth (for details, see the R&S®CA120 data sheet, PD 3606.9327.22). In a typical HF application scenario with an R&S®ESME real-time bandwidth of up to 20 MHz and a DDC bandwidth of up to 30 kHz, well over 100 signals can simultaneously be extracted and output. The downconverted signals are available as digital I/Q streams at the LAN interface of the R&S®ESME.

R&S®CA120 further processes the extracted signals online (audio demodulation, classification, demodulation/decoding and recording) to provide optimum support for multichannel content recovery from a signal scenario.

Automatic detection of fixed frequency and burst signals with R&S®ESME-HRP and R&S®CA120DSC

The signal detector outputs a detection result for each detected signal that matches user-defined selection criteria in the real-time bandwidth of the R&S®ESME. The automatically computed detection threshold adapts independently to the noise floor characteristic that varies within a frequency range. In scenarios where certain signals or frequency ranges are of no interest, the detector algorithm can be parameterized with a list of frequency ranges that may be ignored. The detector will not generate messages for signals in these ranges.

R&S®CA120 taps the detection spectra at the LAN interface of the R&S®ESME and processes them. R&S®CA120 assigns the results to signals, manages lists of active and inactive signals, and uses digital downconverters (R&S®ESME-DDCE) to automatically process detected signals, thereby providing optimum support for signal search and signal monitoring.

Automatic detection of frequency hopping signals with short-time signal detection

The R&S®ESME-ST option allows automatic detection of frequency hopping signals. It delivers a result for each detected short-time signal that matches user-defined selection criteria. The results are output on the 1 Gbit Ethernet interface for further processing.

By measuring, classifying and sorting the results, the R&S®CA120 multichannel signal analysis system with the R&S®CA120ST and R&S®CA120PS options optimally supports detection and monitoring of frequency hopping signals.

# INTEGRATION INTO EXISTING SYSTEMS WITH MINIMAL EFFORT

R&S®CA120 is available as a programmable sensor subsystem for system integrators. It is used together with other sensor components such as antennas, monitoring receivers and direction finders to support signal interception with R&S®RAMON systems. Future additions will expand performance and the range of applications.

Integration into existing systems with different interfaces

R&S®CA120 has interfaces for connection to a large number of state-of-the-art Rohde & Schwarz monitoring receivers and direction finders. Moreover, R&S®CA120 has an open interface to allow integration of user-specific signal processing components such as receiver drivers, classifiers, demodulators and decoders. For integration into existing system solutions, R&S®CA120 is equipped with a documented interface for the development of a user-specific controller.

Advanced integration and automation together with R&S®RAMON

The R&S®RAMON system family is optimally configured to operate the R&S®CA120 multichannel signal analysis software in systems including antennas, monitoring receivers, direction finders, user workstations and databases, as well as to process the collected data. For more details, see the R&S®RAMON product brochure (PD 5214.3152.12).
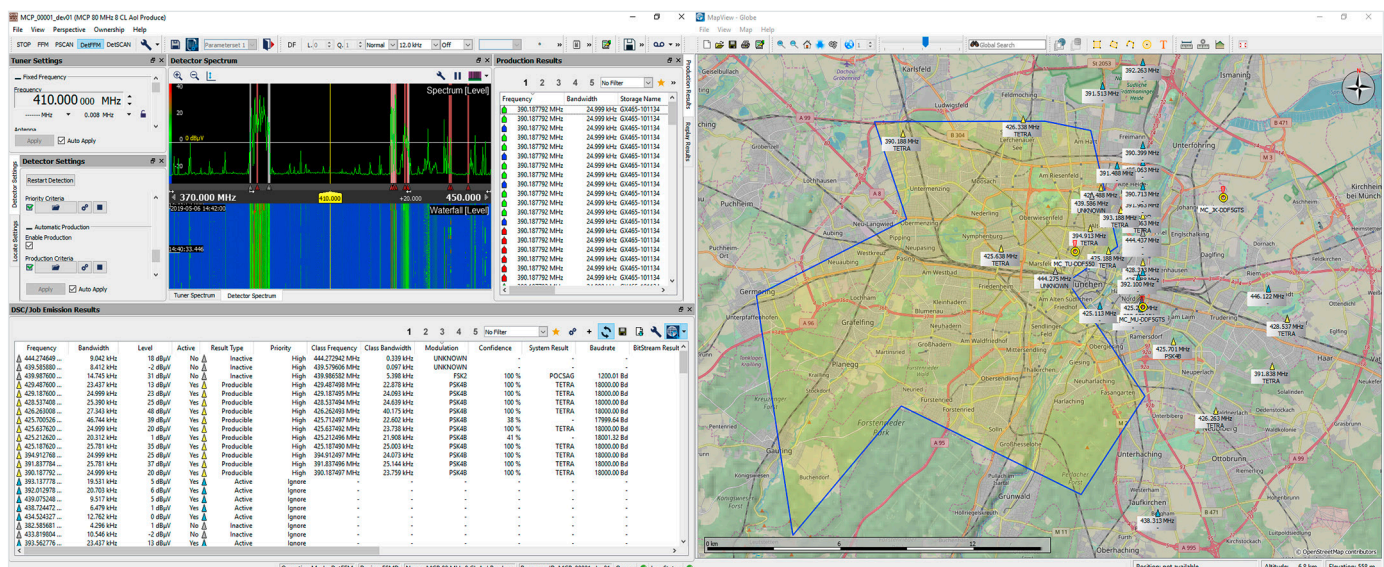
R&S®RAMON graphical user interface.

TRAINING COURSES

The R&S®CA120 training courses offer a combination of classroom based theory lessons and practical exercises. Covering the most important topics, they help operators effectively use R&S®CA120 for signal analysis.

The courses provide participants with the necessary knowledge to understand the workflow concept of R&S®CA120 for analyzing live and recorded signal scenarios. All courses are instructor-led with an interactive approach. The instructor uses a mixture of question and answer sessions, continuous assessment and a final exam to ensure effective knowledge transfer.

COURSE OVERVIEW

Course title	Target audience	Aim	Duration
R&S®CA120-TI, R&S®CA120 introduction	Decision-makers for signal analysis products	Attain basic product familiarity	1 day (5 hours)
R&S®CA120-TO, R&S®CA120 operator training	COMINT users, operators, supervisors, technical analysts	Attain operational familiarity with R&S®CA120	5 days
R&S®CA120-TA, R&S®CA120 operator training application programming interface	COMINT system developers and integrators	Attain confidence in handling the R&S®CA120 API (C++ library and XML) to be able to develop third-party client applications	5 days
R&S®CA1X0-TTU, R&S®CA100/R&S®CA120 developer training for integrating third-party tuners	COMINT signal analysis module developers and integrators	Be able to integrate third-party tuners with R&S®CA100/R&S®CA120	5 days
R&S®CA1X0-TDM, R&S®CA100/R&S®CA120 developer training for integrating third-party demodulators	COMINT signal analysis module developers and integrators	Be able to integrate third-party demodulators with R&S®CA100/R&S®CA120	4 days
R&S®CA1X0-TDC, R&S®CA100/R&S®CA120 developer training for integrating third-party decoders	COMINT signal analysis module developers and integrators	Be able to integrate third-party decoder with R&S®CA100/R&S®CA120	5 days
R&S®CA1X0-SAF, signal analysis fundamentals training	Decision-makers for COMINT solutions, COMINT operators and COMINT technical analysts	Attain basic knowledge about COMINT signal waveforms, signal processing devices (antennas, receivers, direction finders) and signal analysis concepts. Acquire preknowledge for signal analysis product operational training courses	5 days

ORDERING INFORMATION

Designation	Type	Order No.
Base unit		
Multichannel signal analysis software, basic component including system services (hardware is optional)	R&S®CA120	4102.1000.xx [1]
Licensing options		
Licensing of R&S®CA120 with USB dongle	R&S®CA120-U	4102.1846.02
Licensing of R&S®CA120 with mini USB dongle	R&S®CA120-M	4102.1852.02
Licensing of R&S®CA120 with keyring mini USB dongle	R&S®CA120-K	4102.1681.02
Options for single-channel processing		
Fixed frequency processing, interception processing channel; I/Q data input from a receiver or a DDC and processing of a signal with high-resolution spectrum/waterfall, audio demodulation and manual time domain analysis	R&S®CA120FFP	4102.1069.02
Processing of digital signals, processing of digital signals for an R&S®CA120FFP interception processing channel; contains a library with universal demodulators	R&S®CA120DM	4102.1075.02
Classification, automatic classification of modulation type and transmission system for an R&S®CA120FFP interception processing channel; R&S®CA120DM required	R&S®CA120CL	4102.1081.02
Decoder package professional, decoding of HF and VHF/UHF transmission systems for an R&S®CA120FFP interception processing channel; R&S®CA120DM required	R&S®CA120DEC	4102.1098.02
Decoding of PACTOR II and PACTOR III, decoding of PACTOR II and PACTOR III signals for an R&S®CA120FFP interception processing channel; R&S®CA120DM required	R&S®CA120PIII	4102.1117.02
Decoding of CLOVER, decoding of CLOVER 2 and CLOVER 2000 signals for an R&S®CA120FFP interception processing channel; R&S®CA120DM required	R&S®CA120CV	4102.1123.02
Decoding of CODAN 3012, decoding of CODAN 3012 signals for an R&S®CA120FFP interception processing channel; R&S®CA120DM required	R&S®CA120CO	4102.1130.02
Correlative detector, high-performance detection of FSK2 signals; R&S®CA120DM required	R&S®CA120CDT	4102.1223.02
Wideband snapshot access, provides access to the wideband snapshot buffer of the R&S®ESME/ESMD/DDF260/DDF255 for online wideband classification; R&S®CA120CL required; R&S®ESME-RR/ESMD-RR/DDF260-RR/DDF255-RR required	R&S®CA120WSN	4102.1217.02
Options for multichannel processing		
Multichannel processing, I/Q data input from a receiver; computation of data for spectrum/waterfall display and extraction of a maximum of 32 signals with DDCs; processing of extracted signals with R&S®CA120FFP interception processing channels	R&S®CA120MCP	4102.1152.02
Detection, search and classification of fixed frequency signals, automatic detection of fixed frequency signals; required for automatic classification using R&S®CA120CL	R&S®CA120DSC	4102.1169.02
Spectral shape detector, high speed spectral shape search; R&S®CA120DSC required	R&S®CA120SDT	4102.1181.02
Automatic processing of detected signals, option for R&S®CA120DSC; automatic processing (demodulation, decoding, recording) of detected signals	R&S®CA120AP	4102.1175.02
Detection of short-time signals, detection of frequency agile short-time signals; R&S®CA120MCP required	R&S®CA120ST	4102.1198.02
Profile separation, separation of multiple short-time emitters and matching to predefined profiles of frequency agile short-time transmission systems; R&S®CA120ST required	R&S®CA120PS	4098.5224.02
Online recombination, online recombination of frequency agile short-time signals for further processing (for example I/Q recording or demodulation); R&S®CA120PS required	R&S®CA120OR	4098.5218.02
Recording and replay, recording and replay of a frequency range with a max. bandwidth of 10 MHz	R&S®CA120REC	4102.1200.02
Hardware-accelerated signal processing with the R&S®ESME		
DDC signal extraction [2]	R&S®ESME-DDCE	4113.2103.02
High-resolution panorama spectrum [2], supports detection of fixed frequency signals	R&S®ESME-HRP	4113.2126.02
Detection of short-time signals [3], supports detection of frequency agile hopper signals	R&S®ESME-ST	4113.2110.02

Designation	Type	Order No.
Hardware-accelerated signal processing with the R&S®ESMD		
DDC signal extraction [2]	R&S®ESMD-DDCE	4079.7760.02
High-resolution panorama spectrum [2], supports detection of fixed frequency signals	R&S®ESMD-HRP	4079.7902.02
Detection of short-time signals [3], supports detection of frequency agile hopper signals	R&S®ESMD-ST	4079.7883.02
Hardware-accelerated signal processing with the R&S®DDF260		
DDC signal extraction [2]	R&S®DDF260DDCE	4114.0804.02
High-resolution panorama spectrum [2], supports detection of fixed frequency signals	R&S®DDF260-HRP	4114.0827.02
Detection of short-time signals [2, 3], supports detection of frequency agile hopper signals	R&S®DDF260-ST	4114.0810.02
Hardware-accelerated signal processing with the R&S®DDF255		
DDC signal extraction [2]	R&S®DDF255DDCE	4079.7760.03
High-resolution panorama spectrum [2], supports detection of fixed frequency signals	R&S®DDF255-HRP	4079.7902.03
Detection of short-time signals [2, 3], supports detection of frequency agile hopper signals	R&S®DDF255-ST	4079.7883.03
Hardware-accelerated signal processing with the R&S®DDF550		
DDC signal extraction [4]	R&S®DDF550DDCE	4074.0700.02
High-resolution panorama spectrum [4], supports detection of fixed frequency signals	R&S®DDF550-HRP	4074.0745.02
Detection of short-time signals [4, 5], supports detection of frequency agile hopper signals	R&S®DDF550-ST	4074.0722.02
Hardware-accelerated signal processing with the R&S®DDF5GTS		
DDC signal extraction [6]	R&S®DDFGTSDDCE	4074.0716.02
High-resolution panorama spectrum [6], supports detection of fixed frequency signals	R&S®DDFGTS-HRP	4074.0751.02
Detection of short-time signals [6, 7], supports detection of frequency agile hopper signals	R&S®DDFGTS-ST	4074.0739.02
Hardware options		
Signal processing and storage unit	R&S®CA120PU-S	4102.1317.05
Signal processing unit	R&S®CA120PU	4102.1298.05
Server room signal processing and storage unit	R&S®CA120SPU-S	4102.1652.03
Server room signal processing unit	R&S®CA120SPU	4102.1646.03
Service option		
Service package, for R&S®CA120, software update (1 year)	R&S®CA120-SP	3705.8140.02

[1] Model .02 for delivery without hardware options; model .03 for delivery with hardware options.
[2] Corresponding R&S®xx-ADC2 and R&S®xx-SP options required.
[3] Corresponding R&S®xx-DDCE required.
[4] One R&S®DDF550-SP required.
[5] R&S®DDF550DDCE required.
[6] One R&S®DDFGTS-SP required.
[7] R&S®DDFGTSDDCE required.

In addition to the R&S®CA120 multichannel signal analysis software, a complete R&S®RAMON system configuration requires additional components such as antennas, monitoring receivers, interception workstation computers, R&S®RAMON software licenses and central R&S®RAMON IT components. For more details, see the R&S®RAMON product brochure (PD 5214.3152.12).

Note:
Rohde & Schwarz licenses for R&S®CA120 are stored on a USB dongle. In the event of a dongle being 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 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.

Operator training courses		
Designation	**Type**	**Order No.**
R&S®CA120 introduction	R&S®CA120-TI	3637.2524.02
R&S®CA120 operator training	R&S®CA120-TO	3637.3914.02
R&S®CA120 operator training application programming interface	R&S®CA120-TA	3637.4604.02
R&S®CA100/R&S®CA120 developer training for integrating third-party tuners	R&S®CA1X0-TTU	3637.2482.02
R&S®CA100/R&S®CA120 developer training for integrating third-party demodulators	R&S®CA1X0-TDM	3637.2499.02
R&S®CA100/R&S®CA120 developer training for integrating third-party decoders	R&S®CA1X0-TDC	3637.2501.02
Signal analysis fundamentals training	R&S®CA1X0-SAF	3637.4685.02

Rohde & Schwarz

The Rohde & Schwarz technology group is among the trailblazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks & cybersecurity. Founded 90 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

www.rohde-schwarz.com

Sustainable product design

▶ Environmental compatibility and eco-footprint
▶ Energy efficiency and low emissions
▶ Longevity and optimized total cost of ownership

Certified Quality Management	Certified Environmental Management
ISO 9001	ISO 14001

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