

R&S® DDF255

Digital Direction Finder

Accurate direction finding with measurement and analysis capabilities in a single unit



R&S® DDF255 Digital Direction Finder At a glance

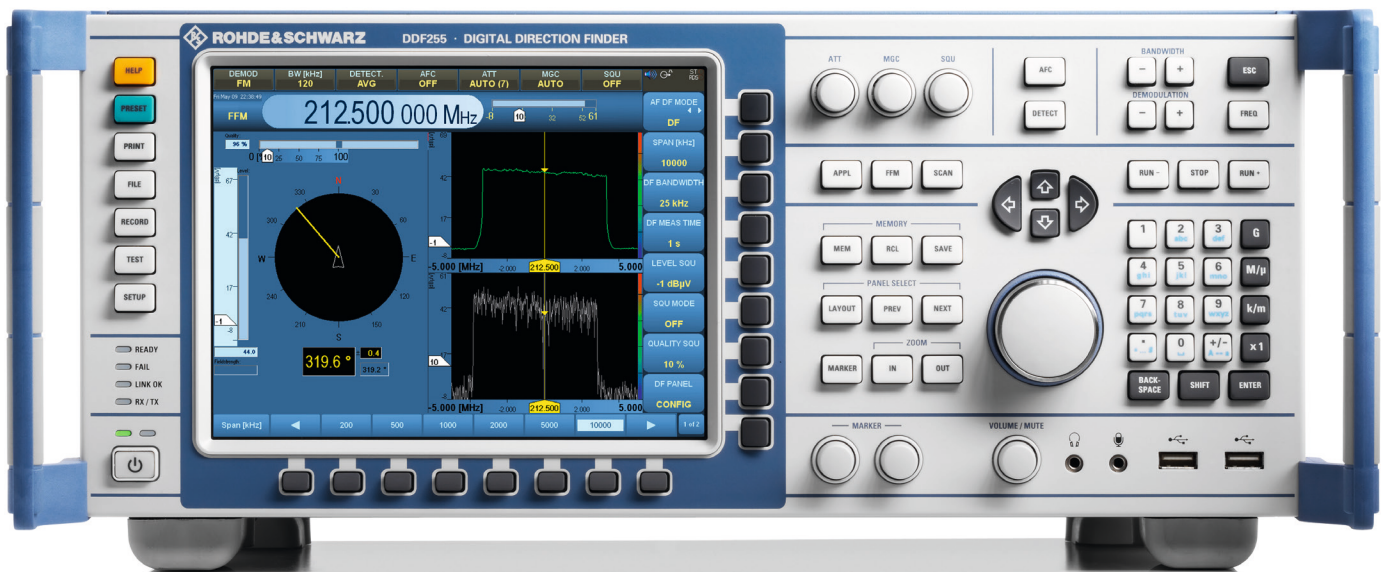
The R&S® DDF255 combines the extremely powerful R&S® ESMD wideband monitoring receiver with the accurate correlative interferometer DF method. This combination yields a high-precision wideband direction finder featuring extensive measurement and analysis functions. With its high integration density and optional DC power supply, the R&S® DDF255 is also ideal for mobile applications.

Due to the use of wide-aperture DF antennas and a very large number of antenna elements, the correlative interferometer DF method offers a high degree of accuracy and outstanding immunity to reflections at an excellent price/performance ratio.

In addition, the direction finder offers a wide scope of measurement and analysis capabilities such as the optional measurement of radio signals in line with ITU recommendations.

Key facts

- ▮ Tried and tested DF method used by 24 regulatory authorities worldwide
- ▮ High-precision DF method at an excellent price/performance ratio (patented method)
- ▮ Reliable DF results even in difficult environments (e.g. in urban areas with up to 50% reflection)
- ▮ Direction finding of signals in the frequency range up to 8.2 GHz
- ▮ Detection of extremely short emissions at unknown frequencies due to high-speed panorama scan (optional)
- ▮ Measurement methods in line with ITU recommendations (optional)
- ▮ Realtime event capture (REC) for I/Q recordings and realtime replay (optional)



R&S®DDF255

Digital Direction Finder

Benefits and key features

Extended applications

- Fast direction finding and spectrum monitoring, analysis and demodulation of wideband signals
- Parallel monitoring and demodulation of one plus four signals within realtime bandwidth
- Time domain analysis up to 20 MHz bandwidth with R&S®DDF255-ZS zero span option

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Effective measurements in line with ITU recommendations

The R&S®DDF255 fulfills all ITU recommendations for monitoring direction finders and receivers.

- Option for ITU-compliant measurements on signal parameters for AM, FM and PM-modulated signals (e.g. modulation index, occupied bandwidth and phase deviation)
- Offline measurements on digitally modulated signals using the R&S®CA100IS software and suitable options (in line with ITU recommendation SM1600)

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Wideband direction finding with realtime bandwidth of up to 20 MHz

- Parallel determination of bearings of all transmitters within the realtime bandwidth

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Fast and reliable radiolocation due to high DF accuracy

- High-precision correlative interferometer DF method using multi-element DF antennas (VHF/UHF/SHF)

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High-resolution IF spectrum

- All details visible in DF mode

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Direction finding up to 8.2 GHz

- Fast, effective interference detection

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Recording and replaying of up to 80 MHz wide I/Q data

- Never miss an event: activation of recordings with flexible realtime event capture (REC)
- Signals as received from an antenna: all receiver functions available when replaying I/Q data
- Detailed display: replay of I/Q data with increased time resolution
- Realtime replay of recorded data

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Map display with GNSS position

- Map display of current direction finder location
- Selectable display of recorded results (e.g. spectra) relative to a position
- Map material based on OpenStreetMap (OSM)
- For receivers with front panel operation or for external R&S®DDF255 GUI software

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Hardware-accelerated multichannel signal processing

- Multichannel signal detection and analysis in a networked system
- Parallel multichannel output of more than 100 channels
- Multichannel digital downconversion (DDC) signal extraction from the R&S®DDF255 realtime bandwidth with R&S®DDF255DDCE and R&S®CA120FFP
- Automatic detection of fixed frequency and burst signals with R&S®DDF255-HRP and R&S®CA120DSC
- Automatic detection of frequency agile short-time signals with R&S®DDF255-ST

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TDOA ready with high-accuracy timestamps and GNSS synchronization of frequency and time

- Synchronization of receiver frequency and time using the R&S®DDF255IGT2 internal GNSS module
- High-accuracy timestamps in I/Q baseband data stream for use in TDOA systems

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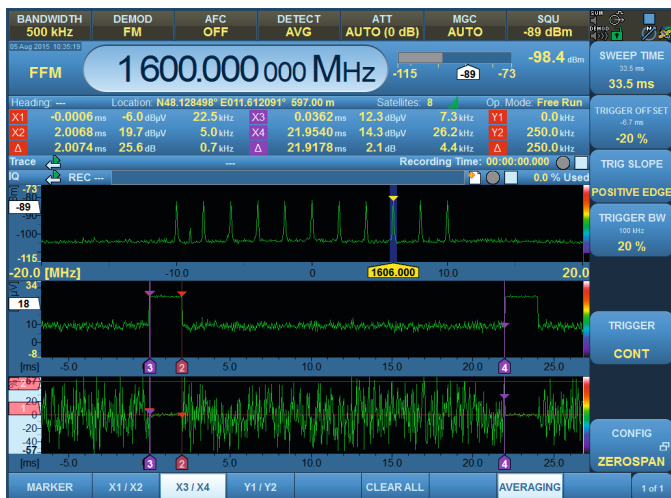
Extended applications

Fast direction finding and spectrum monitoring, analysis and demodulation of wideband signals

Due to the extensive functionality of the R&S®ESMD digital wideband monitoring receiver, the R&S®DDF255 offers more standard features than a conventional direction finder. With the appropriate options, the R&S®DDF255 transforms into a complete, integrated solution for radiomonitoring and radiolocation. When controlled through a PC or laptop, the R&S®DDF255 offers the following capabilities, for example:

- Extremely fast spectrum monitoring with scan speeds of up to 100 GHz/s in the 20 MHz to 3.6 GHz frequency range (optionally 8 kHz to 26.5 GHz)
- Wideband direction finding with a realtime bandwidth of up to 20 MHz and selectable channel resolution, for example for simultaneously taking the bearings of all broadcast, aeronautical or maritime radio signals
- Display and demodulation of signals with very large bandwidths of up to 20 MHz
- Highly accurate direction finding in line with ITU recommendations in the 20 MHz to 3 GHz (optionally 300 kHz to 6 GHz) range including map display (optional)
- Signal analysis including the classification, demodulation and decoding of important communications standards (optional)

Measurement of a frequency hopping signal. The blue markers can also be used to measure intervals (center) and the instantaneous frequency (bottom).



To enable more in-depth analysis of the signal spectrum and the signal environment, the R&S®DDF255 features an IF panorama. The current receive frequency is positioned in the center of the spectrum display. The display width can be set between 1 kHz and 20 MHz for optimal adaptation to the task at hand. Min. hold, max. hold and average displays are also possible, allowing an even broader scope of applications.

Quick identification of signals is often critical especially in complex signal scenarios with many wireless transmissions. The direction finder's polychrome spectrum is very useful for this signal separation. The direction finder analyzes the frequency of occurrence of each individual signal and displays the results versus frequency in a color-coded diagram. This allows signals to be differentiated and identified more quickly.

Parallel monitoring and demodulation of one plus four signals within realtime bandwidth

When the direction finder is equipped with the R&S®DDF255-DDC and R&S®DDF255-ADC2 options, up to five signals can be monitored and demodulated in parallel within a realtime bandwidth of 20 MHz. This provides a great speed advantage for verifying the signal and its content. The demodulated information of all five channels is processed as separate data streams via the LAN interface, e.g. as a *.wav data stream for audio data or as I/Q baseband data for analysis purposes. Additionally, when using the direction finder with R&S®DDF25-CTL software for control, the user can select whether to display DF results or listen in to demodulated audio content for all five channels in parallel.

Time domain analysis up to 20 MHz bandwidth

The direction finder can also be optionally equipped with the R&S®DDF255-ZS zero span option to provide a realtime display of signals up to 20 MHz bandwidth in the time domain to facilitate analysis of time division multiple access (TDMA) signals such as TETRA, GSM and DECT. Since two separate paths are used in the direction finder for processing, it allows continuous monitoring and analysis and measurement of any occurrence, e.g. detection of frequency agile signals, concurrently. This allows users to investigate the detected emissions in greater detail while keeping an eye on the overall signal environment.

Effective measurements in line with ITU recommendations

The R&S®DDF255 meets, and in many cases clearly surpasses, the ITU recommendations for monitoring direction finders and receivers. For example, the R&S®DDF255 receiver offers large-signal immunity clearly better than the minimum values recommended by ITU (higher intercept points, lower phase noise).

Option for ITU-compliant measurements on signal parameters for AM, FM and PM-modulated signals

The R&S®DDF255-IM option can be used to perform ITU-compliant measurements on signal parameters for AM, FM and PM-modulated signals. The modulation index, occupied bandwidth and phase deviation can be determined. The minimum, maximum and average values over a user-defined measurement period are displayed. The R&S®DDF255-IM option covers the following ITU recommendations:

- ITU-R SM.377¹⁾ (frequency and frequency offset measurements)
- ITU-R SM.378 (field strength measurements)
- ITU-R SM.328 (determination of modulation modes)
- ITU-R SM.443 (bandwidth measurements)
- ITU-R SM.1880 (determination of spectral occupancy, with remote control PC and R&S®ARGUS software package)

For offline measurements on digitally modulated signals in line with ITU-R SM.1600, the R&S®CA100IS option can be added to the R&S®CA100 software solution (requires additional PC).

The R&S®DDF255 fulfills the following ITU hardware recommendations:

- ITU-R SM.1836 (measurements of IF filter edge steepness)
- ITU-R SM.1837 (IP3 measurements)
- ITU-R SM.1838 (noise figure measurements)
- ITU-R SM.1840 (sensitivity measurements)

Modulation and bandwidth measurement results at a glance.



¹⁾ Depending on the application, an external reference frequency with higher accuracy may be required, e.g. as provided by the R&S®DDF255IGT2 internal GNSS module and external GPS antenna.

Wideband direction finding with realtime bandwidth of up to 20 MHz

Parallel determination of bearings of all transmitters within the realtime bandwidth

By using high-speed signal processing, the R&S®DDF255 can take the bearings of all signals in a wide frequency range of up to 20 MHz with selectable resolution. For all signals above the level threshold, bearings are calculated in parallel and displayed.

Wideband direction finding offers a variety of applications and benefits:

- All channels in the aeronautical or maritime frequency bands can be displayed and their bearings taken in parallel (800 aeronautical channels or 88 maritime channels)
- All FM broadcast channels can be displayed and their bearings taken in parallel
- The bearings of signals with large bandwidths such as DAB and DVB-T can be taken with high channel resolution. The bearing is an average value (histogram) calculated from many individual bearings. This compensates for frequency-dependent bearing fluctuations
- The bearings of frequency agile transmitters (frequency hopping and chirp transmitters) with up to 100 hops/s are reliably determined

R&S®DDF255 graphical user interface displaying 20 MHz realtime bandwidth.



Fast and reliable radiolocation due to high DF accuracy

High-precision correlative interferometer DF method using multi-element DF antennas (VHF/UHF/SHF)

In the VHF/UHF/SHF range, the R&S®DDF255 uses the correlative interferometer DF method (see page 16). In contrast to other direction finders using simple amplitude comparison methods, the R&S®DDF255 offers significantly higher DF accuracy up to class A in line with ITU recommendations.

This high DF accuracy relies on the precise measurement of the phase angles between the reference antenna element and the other elements. Measuring the phase difference between two signals normally requires two coherent receive paths. For this reason, most interferometer direction finders on the market use at least two receivers. With the R&S®DDF255, the two receive paths are coherently linked in the DF antenna using a patented method from Rohde & Schwarz.

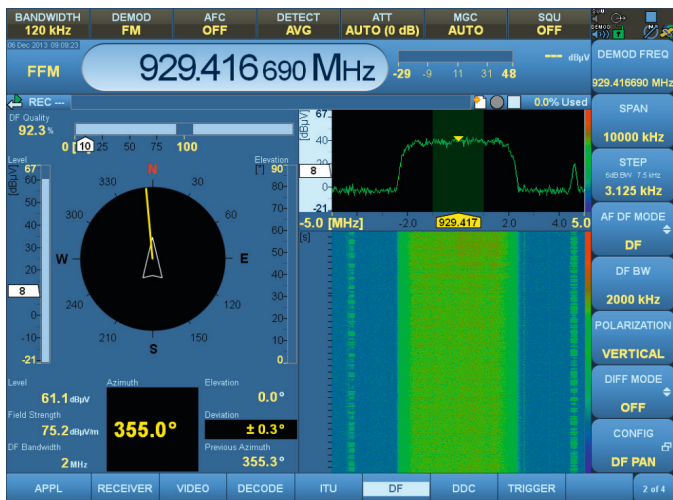
In the HF range, the Watson-Watt DF method is used. The special advantage of this method is that small DF antennas can be deployed. This makes the R&S®DDF255 also suitable for mobile direction finding in this frequency range.

High-resolution IF spectrum

All details visible in DF mode

In order to get stable and accurate DF results, a sufficiently wide DF bandwidth is required, i.e. the DF bandwidth should be similar to the signal bandwidth. Typically, this results in a coarse spectrum resolution. In many applications, a much finer channel resolution in the IF spectrum is required in order to see details in the spectrum that are not visible otherwise. Now the R&S®DDF255 offers both in parallel: an IF spectrum with fine resolution for spectrum display and a DF spectrum with coarse resolution for direction finding (see screenshot). Both resolutions can be set independently.

WCDMA signal measured with a DF bandwidth of 2 MHz and displayed at high resolution.



Direction finding up to 8.2 GHz

Fast, effective interference detection

Together with the R&S®DDF255-SHF option and the R&S®ADD075 DF antenna, the R&S®DDF255 delivers precise DF results up to 8.2 GHz. Until now, this has been possible only up to 3 GHz. For the first time, bearings can now be taken on transmitters up to 8.2 GHz, for example in the frequency bands of the following services:

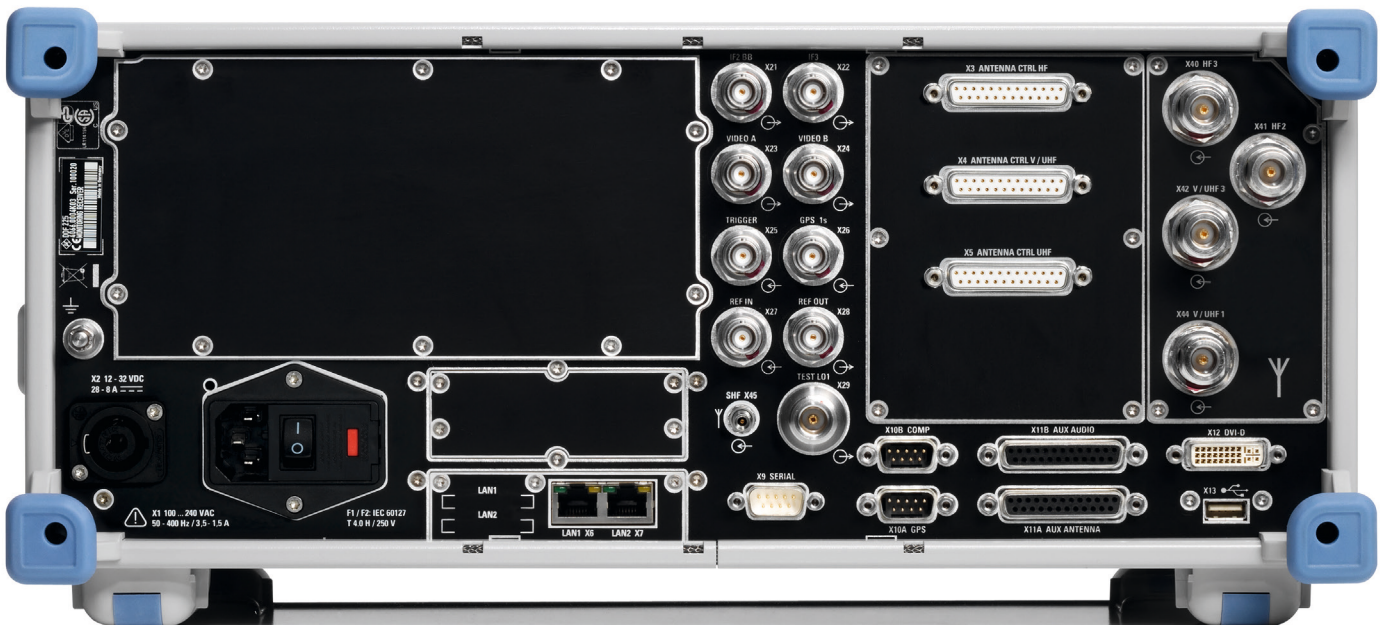
- WLAN
- WiMAX™
- Microwave systems

The R&S®DDF255 effectively detects interference in the corresponding frequency bands.

Locating target transmitters previously required the use of rotatable directional antennas, which have disadvantages regarding manageability and measurement speed. The R&S®DDF255 immediately displays the bearing, significantly simplifying direction finding during test drives. The high DF accuracy and immunity to reflections in the VHF/UHF range are also achieved in the SHF range.

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R&S®DDF255 rear view.

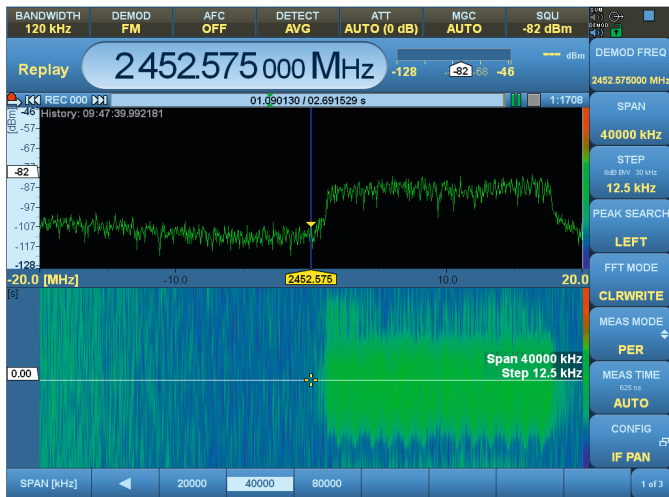


Recording and replaying of up to 80 MHz wide I/Q data

The realtime event capture (REC) can be easily edited in the live spectrum.



Waterfall diagram of WLAN pulse with a resolution of 625 nanoseconds per line.



Never miss an event: activation of recordings with flexible realtime event capture (REC)

Rare, short-time signals are difficult to record and analyze. Yet these signals are of significant interest. The R&S®DDF255-RR option includes a configurable realtime event capture (REC) that can be used to activate I/Q data recording. The R&S®DDF255 records only events defined as relevant by the user. The user decides how the defined mask is used – either the trigger is activated when a signal enters or leaves the predefined mask, or the trigger remains active as long as a signal is within the mask. As a result, even events in the nanosecond range can be reliably detected using the R&S®DDF255.

Signals as received from an antenna: all receiver functions available when replaying I/Q data

Equipped with the R&S®DDF255-RR option, the R&S®DDF255 records I/Q data up to the full 80 MHz bandwidth and stores it in the internal memory. The recorded data is played from memory directly on the instrument. All receiver functions are available when replaying I/Q data (demodulation of analog modulated signals, setting of DDCs and ITU-compliant measurements)¹⁾. The user sets all parameters as if in live mode. All changes are immediately adopted without additional calculation time, as if the signal was directly received from an antenna. I/Q data replay is limited only by the recording bandwidth and time limits. The recorded I/Q data can be stored on external storage media (e.g. USB flash drive) and later loaded into an R&S®DDF255 for analysis.

Detailed display: replay of I/Q data with increased time resolution

When analyzing digital signals, radar pulses and short-time emissions, users are interested in the time behavior of the signal. When replaying I/Q data, the time resolution in the waterfall diagram can be increased as far as the nanosecond range per line. The R&S®DDF255 is therefore able to display even very short events with high resolution and provide a detailed overview of the spectral signal characteristics.

Realtime replay of recorded data

Recorded data is replayed in realtime in the receiver. No wait or delay time is required for redisplaying recorded signals, e.g. after parameter changes – for maximum user convenience.

¹⁾ Exception: direction finding mode.

Maximum recording capacity of the internal memory

Span	Max. record length
2 MHz	approx. 2.5 min
10 MHz	approx. 42 s
40 MHz	approx. 10 s
80 MHz	approx. 5 s

Map display with GNSS position

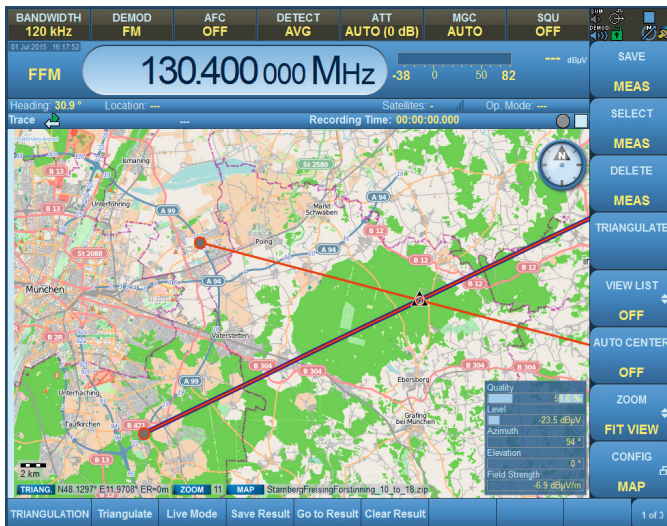
If the receiver is operated in nonstationary mode (e.g. vehicular operation) or in temporary transportable setups, a map display is useful for showing the current direction finder position (R&S®DDF255-Map option).

The digital map (e.g. based on OpenStreetMap (OSM) maps) shows, for example, the points where values were measured, direction information (if bearings are available) and the current position of the direction finder.

The recorded measured values are displayed after selecting a specific point, e.g. the spectrum recorded at a certain intersection in an urban area. This function helps to identify interference so that the source of the problem can be promptly eliminated.

The R&S®DDF255-Map option is available for direction finders with front panel operation (model .03) or for external R&S®DDF255 GUI software.

The positions recorded during a drive test (including the bearing, if applicable) are shown on a map.



Hardware-accelerated multichannel signal processing

The R&S®DDF255 digital direction finder optionally provides hardware-accelerated signal processing for the R&S®CA120 multichannel signal analysis system (see also product brochure, PD 3606.9327.12 or data sheet, PD 3606.9327.22). For this purpose, the R&S®DDF255 needs to be equipped with the R&S®DDF255-SP signal processing board. The board supports up to four different high-performance signal processing functions implemented in field programmable gate array (FPGA) technology.

Multichannel signal detection and analysis in a networked system

Equipped with the R&S®DDF255-SP hardware-accelerated signal processing option, the R&S®DDF255 supports parallel multichannel signal detection and analysis. The following high-performance signal processing functions are implemented in field programmable gate array (FPGA) technology:

- Multichannel signal extraction: R&S®DDF255DDCE
- Calculation of high-resolution spectra: R&S®DDF255-HRP

The R&S®CA120 multichannel signal analysis system ideally complements the R&S®DDF255 when equipped with the following options:

- Multichannel signal processing: R&S®CA120MCP, R&S®CA120FFP
- Detection of fixed frequency and burst signals: R&S®CA120DSC

Thanks to the detailed interface description, system integrators can directly access the receiver data streams for processing in their own external systems.

Parallel multichannel output of more than 100 channels

Within the direction finder's realtime bandwidth, more than 100 channels (manually set by the user) with a maximum bandwidth of 30 kHz each or 32 channels with a maximum bandwidth of 300 kHz each can be simultaneously output over the 1 Gbit Ethernet interface. As a result, a large number of signals are available as an I/Q baseband data stream that can be processed in external systems (R&S®DDF255DDCE option).

Equipped with the R&S®CA120MCP and R&S®CA120FFP options, the R&S®CA120 multichannel signal analysis system processes the extracted signals online and supports multichannel content recovery in a signal scenario with many signals through audio demodulation, classification, demodulation/decoding and recording.

Multichannel digital downconversion (DDC) signal extraction from the R&S®DDF255 realtime bandwidth with R&S®DDF255DDCE and R&S®CA120FFP

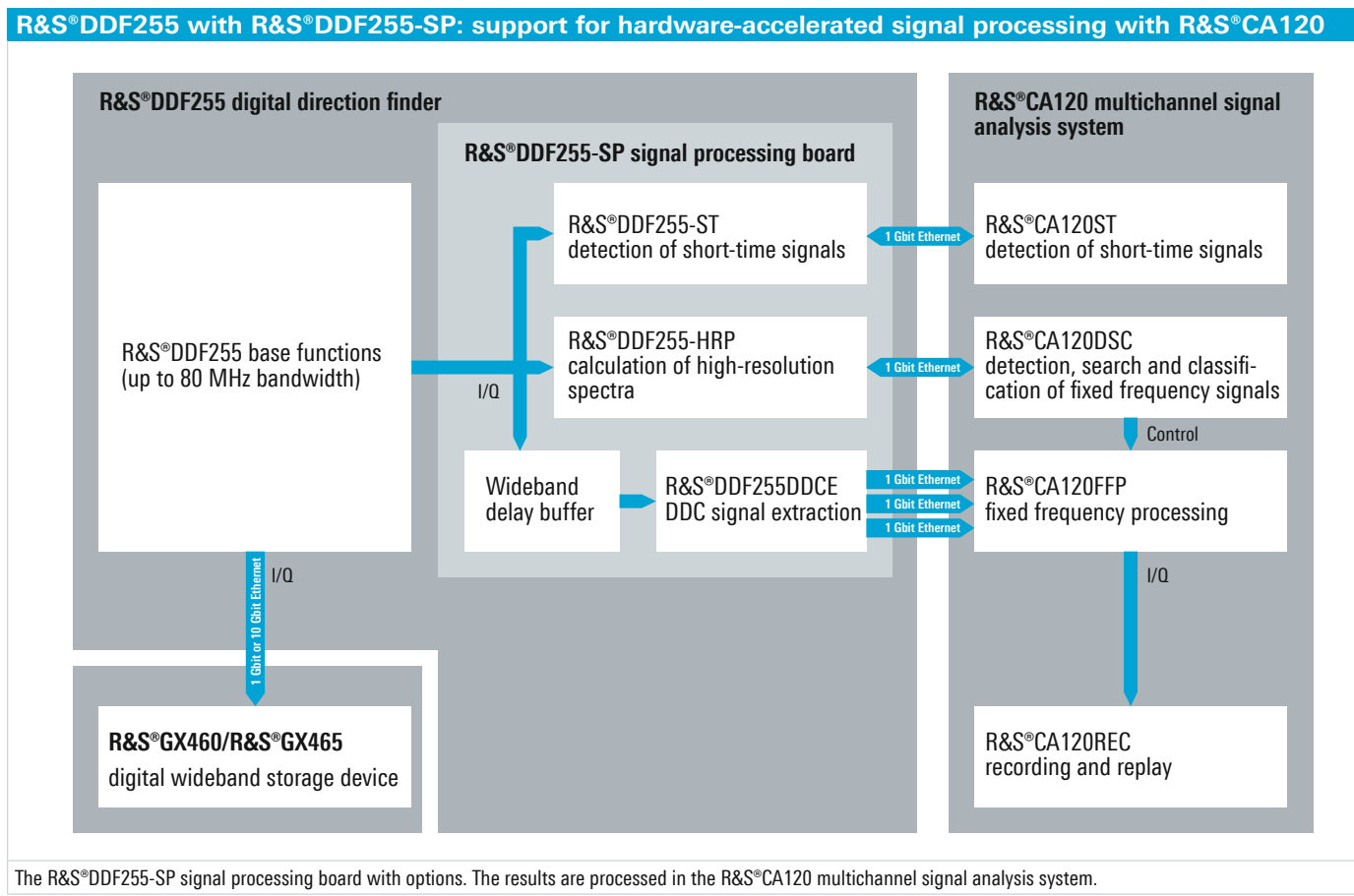
If multiple signals in the R&S®DDF255 realtime bandwidth are active at the same time, users can extract these signals by means of digital downconverters. The maximum number of DDCs computed in parallel depends on the set DDC bandwidth (for details, see the R&S®CA120 data sheet, PD 3606.9327.22). In a typical HF application with an R&S®DDF255 realtime bandwidth of up to 20 MHz and a DDC bandwidth of up to 30 kHz, well over 100 signals can be extracted and output simultaneously. The downconverted signals are available as digital I/Q streams on one of the R&S®DDF255 LAN interfaces.

The R&S®CA120 multichannel signal analysis system 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®DDF255-HRP and R&S®CA120DSC

The signal detector provides a detection result for each detected signal matching user-defined selection criteria in the realtime bandwidth of the R&S®DDF255. 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 generate no messages for signals in these ranges.

The R&S®CA120 taps the detection spectra at the LAN interface of the R&S®DDF255 and processes them. The R&S®CA120 assigns the results to signals, manages lists of active and inactive signals and uses digital downconverters (R&S®DDF255DDCE) to automatically process detected signals, thereby providing optimum support for signal search and signal monitoring.



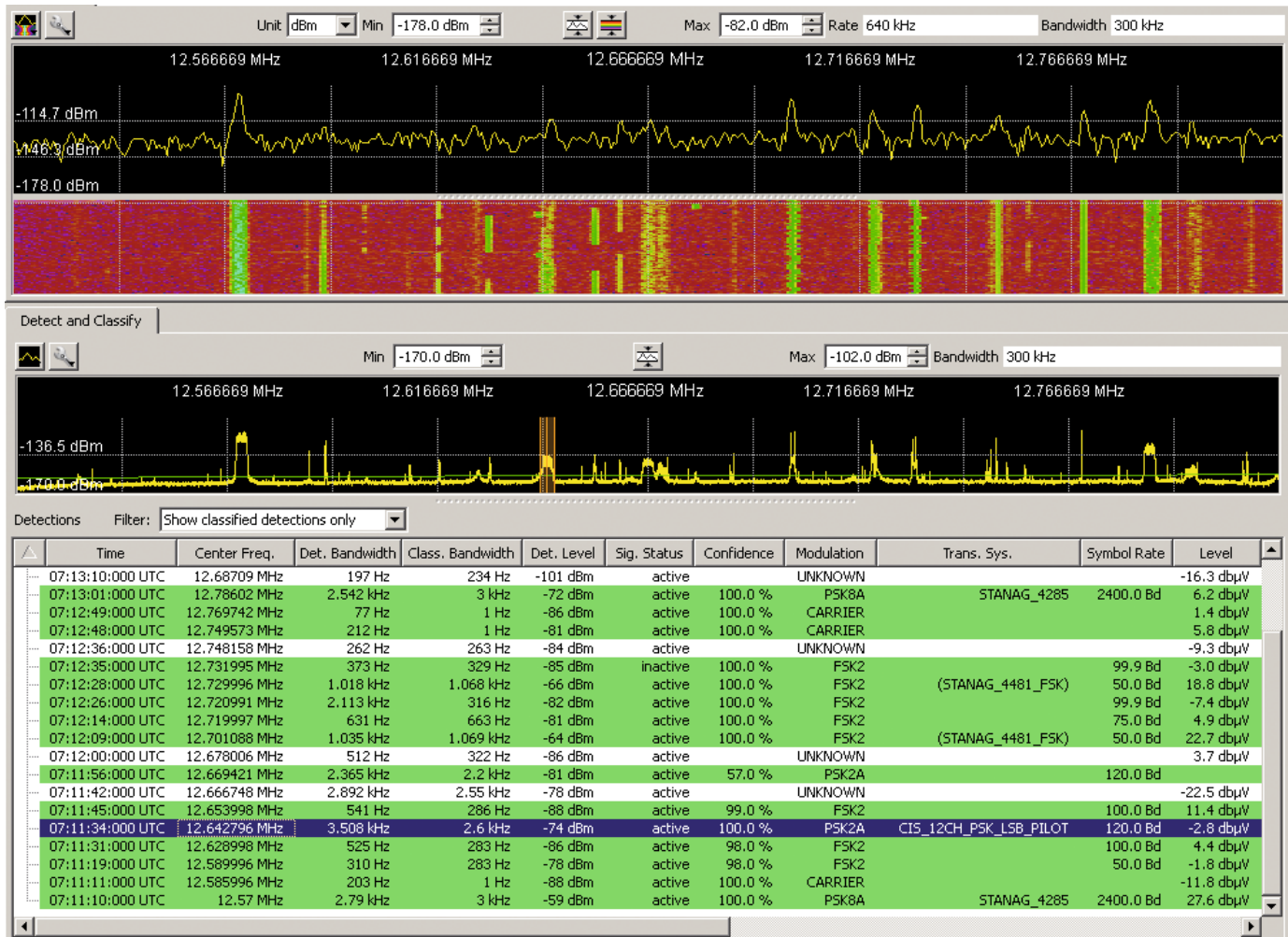
Automatic detection of frequency agile short-time signals with R&S®DDF255-ST

When used with R&S®CA120, the R&S®DDF255-ST option delivers a result for each short-time signal that is detected within the realtime bandwidth of the R&S®DDF255 and 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 the detection and monitoring of frequency agile short-time signals.

With its automatic profile separation and online recombination capabilities, R&S®CA120 provides the enhanced online dehopping solution.

With its automatic detection and classification capability, R&S®CA120 can monitor complete signal scenarios and informs the user about any signals or events of interest.



TDOA ready with high-accuracy timestamps and GNSS synchronization of frequency and time

Synchronization of receiver frequency and time using the R&S®DDF255IGT2 internal GNSS module

The R&S®DDF255 system time is set via an internal or external GNSS module's NMEA protocol and distributed. GNSS information, e.g. position and date, is additionally distributed via LAN.

The internal R&S®DDF255 10 MHz reference frequency is synchronized using a pulse per second (PPS) signal from the GNSS module. Depending on the GNSS module used, the accuracy of the internal reference frequency can be significantly improved to fulfill all ITU frequency accuracy requirements ($\leq 1 \times 10^{-9}$) for radiomonitoring receivers:

- Typ. 1×10^{-10} (with external GPS module, standard quality)
- Typ. 1×10^{-12} (with internal GNSS module, R&S®DDF255IGT2 option)

High-accuracy timestamps in I/Q baseband data stream for use in TDOA systems

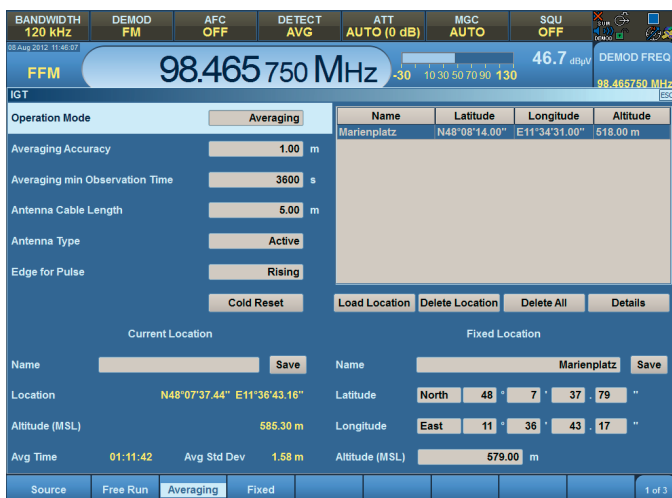
The direction finder's high-accuracy timestamp in the I/Q output data stream is also derived from the information in the GNSS module. The accuracy of the timestamp is typically in the microsecond range (with external GPS module) or in the nanosecond range (with internal GNSS module, R&S®DDF255IGT2 option).

The timestamps in the I/Q baseband data stream of the R&S®DDF255 permit TDOA¹⁾ applications via LAN. The R&S®DDF255 can be switched over to function as a receiving node in the sensor network. Time accuracy is related to the antenna input and is independent of the direction finder's settings, which significantly simplifies the setup of correction tables for a TDOA system. The tables only need to contain system parts such as antennas, cable lengths and signal distribution, and not all receiver settings. This greatly simplifies the TDOA system integrator's job.

The time accuracy in the baseband data stream (when using the internal GNSS module) leads to extremely reliable radiolocation results in the TDOA network.

¹⁾ TDOA: time difference of arrival.

Detailed display of GPS data and GPS operating mode.



Technical background

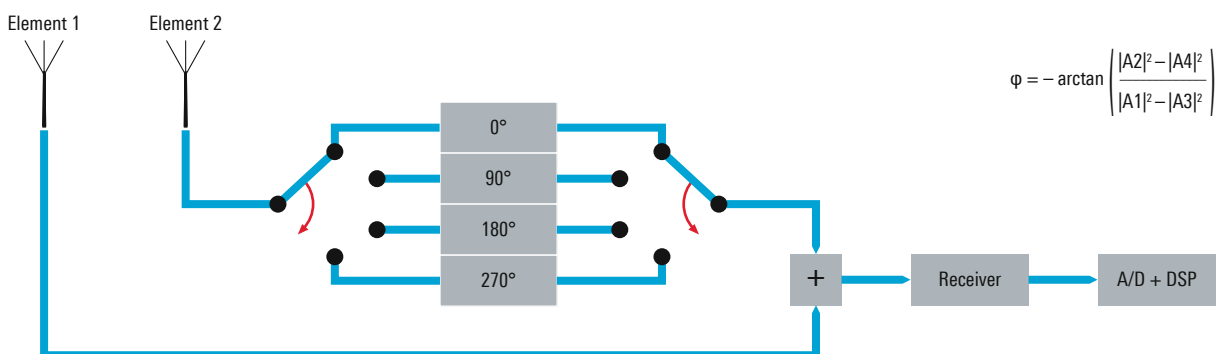
Single-channel interferometer DF method

The correlative interferometer DF method is based on measuring the phase differences between the reference antenna element and the other elements of a DF antenna. To measure the phase angle φ between the signals of two antenna elements by means of a single receiver, a patented method from Rohde&Schwarz is used. With this method, the phase of one of the two signals is shifted in four steps ($0^\circ/90^\circ/180^\circ/270^\circ$) in a quadrature multiplexer, and the two signals are added in each case. The receiver measures the amplitude of the sum signal after each phase shift. Inserting the four amplitude values obtained ($A1/A2/A3/A4$) into the formula (see diagram) yields the phase angle φ between the two signals. This measurement is performed for each antenna element.

Most interferometer direction finders on the market use at least two receivers. The two receive paths must be in phase and calibrated accordingly, since otherwise the measurement time will be significantly extended. Moreover, the local oscillator signals need to be multiplied and distributed in phase. This means that more hardware is necessary than with a single-channel interferometer direction finder: an additional receive path, hardware for in-phase multiplication and distribution of the local oscillator signals, a calibration signal generator, calibration signal distribution and an additional cable to the DF antenna for the calibration signal.

With the R&S®DDF255, the two receive paths are coherently linked in the DF antenna using a patented method from Rohde&Schwarz. As a result, the single-channel interferometer DF method provides the same DF accuracy and immunity to reflections as delivered by direction finders with two or more receive paths – without requiring additional hardware.

Single-channel interferometer DF method



Multi-element DF antennas

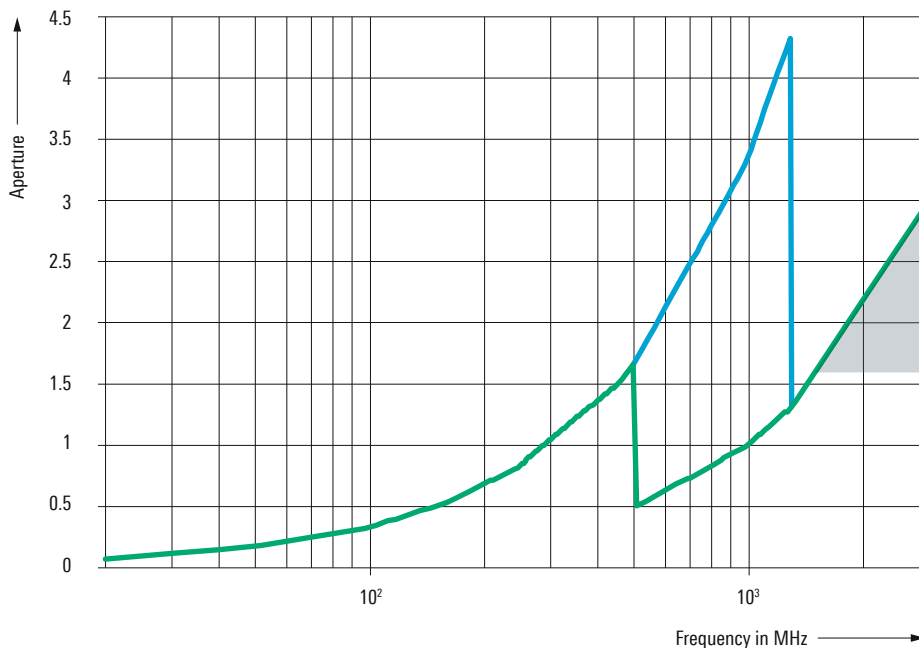
Due to multipath propagation (especially in urban areas), not only the direct wave but also reflections arrive at the DF antenna. Immunity to reflections is influenced to a large extent by the number of antenna elements in a DF antenna. Virtually all R&S®ADDx DF antennas comprise nine antenna elements for the VHF/UHF range, or eight for the UHF/SHF range. These DF antennas were designed to provide stable bearings even with a 50% share of reflections. If only five antenna elements are used (as is the case with typical commercially available antennas), substantial DF errors can be expected in certain frequency ranges (see gray area in diagram).

The aperture of a DF antenna (diameter/wavelength) can be considerably enlarged by increasing the number of antenna elements. The distance between two adjacent antenna elements of a DF antenna is to be selected such that unambiguous phase differences are obtained between the antenna elements at the highest operating frequency and for all possible combinations of direct and reflected waves. Commercially available five-element DF antennas therefore have a much smaller aperture than DF antennas with nine elements across wide frequency ranges.

The aperture of a DF antenna is crucial to the efficiency of a direction finder. The wider the DF antenna's aperture, the higher the DF accuracy and sensitivity as well as the immunity to reflections (see ITU SMH 2002, section 4.7.1.1.3).

This advantage is not apparent from the specifications. For the purpose of comparison, data sheets always specify instrument and system accuracy based on ideal, reflection-free DF antenna environments and strong signals.

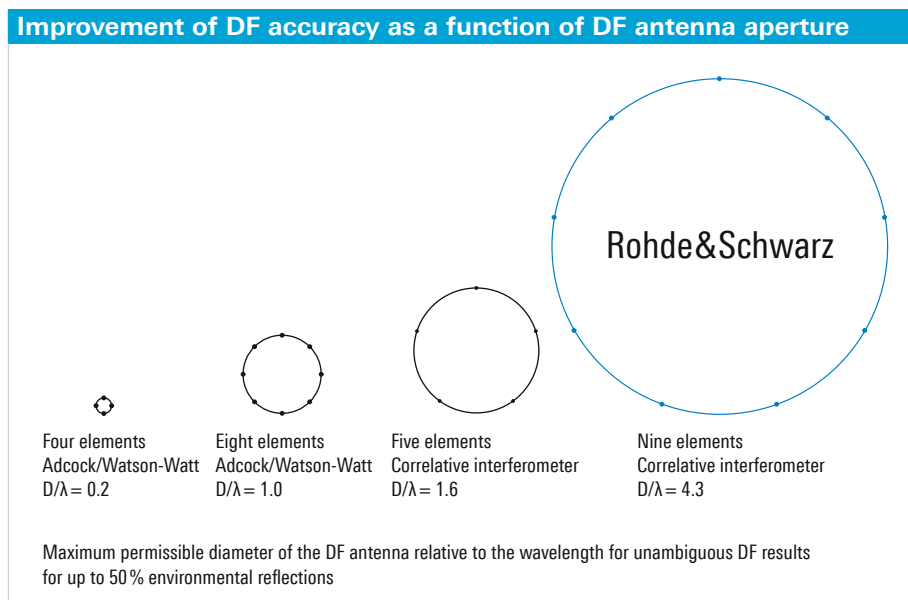
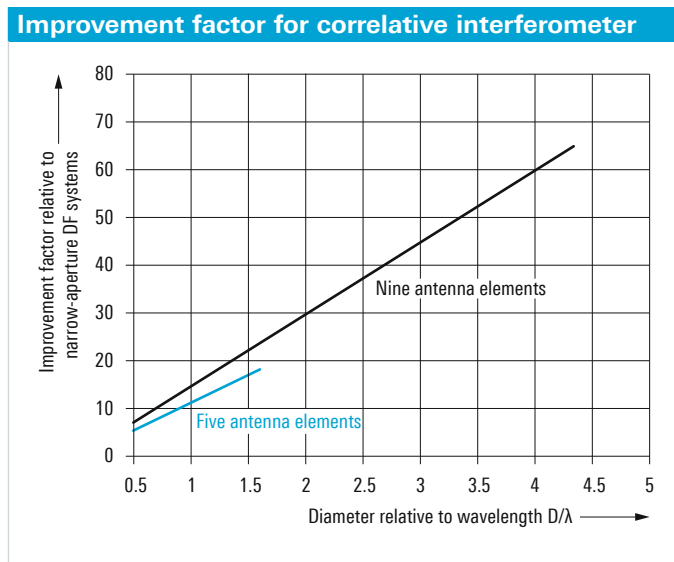
Comparison of aperture of commercially available five-element DF antennas (green) with that of Rohde & Schwarz DF antennas (blue)



DF antennas using nine elements and the correlative interferometer DF method offer by far the widest aperture and therefore enhanced accuracy and sensitivity (see top figure). As a result, they have a considerably greater improvement factor (compared with small-base DF antennas) than antennas containing only five elements, for example.

The considerably higher immunity to reflections offered by DF antennas with nine elements (compared with five-element DF antennas) can be mathematically proven by simulating the DF antennas in a two-wave field (direct wave and reflected wave). First, the DF values that a DF antenna in a two-wave field would produce are calculated one after the other, the field strength of the direct wave being twice as high as that of the reflected wave. Since the DF error depends on the frequency, the angle of incidence and the phase angle of the reflected wave, all possible combinations of these parameters are simulated. Then the RMS value is determined from the individual DF errors.

The table below shows that DF antennas with nine elements provide considerably higher DF accuracy than commercially available five-element DF antennas. It is assumed that the five-element DF antennas exhibit a system DF accuracy of 1° RMS in a reflection-free environment. Since the Rohde&Schwarz DF antennas use eight elements for direction finding in the frequency range above 1.3 GHz, an eight-element DF antenna is simulated in this frequency range.



Average DF error of different DF antennas in a two-wave field			
	Frequency ranges	DF antenna diameter	DF accuracy in two-wave field (approx.)
Rohde&Schwarz DF antennas	20 MHz to 1.3 GHz	1 m	1.7° RMS
	1.3 GHz to 3 GHz	0.3 m	2.2° RMS
Commercially available five-element DF antennas	20 MHz to 500 MHz	1 m	6.1° RMS
	500 MHz to 3 GHz	0.3 m	10° RMS

Active/passive switchover with just a mouse click

The number of radio services and transmitters is continuously growing, resulting in an increasing cumulative load on the antenna input and the receiver input. Especially digital broadcasting services such as DVB-T and DAB with their high bandwidths represent a growing challenge to the linearity of antennas and receivers. The problem may intensify if the DF antenna is in the vicinity of strong transmitters – which, particularly in urban areas, can hardly be avoided.

If the number of strong signals becomes too high, intermodulation products may become visible in the spectrum. In the worst case, they would mask signals of interest and make it impossible to take bearings.

Most Rohde&Schwarz DF antennas are equipped with active antenna elements, which provide significantly higher sensitivity than passive elements – and also have compact dimensions. Although extremely linear, active antenna circuitry with top-quality components is used, very strong signals may cause intermodulation.

Passive antennas provide significantly higher linearity and therefore generate virtually no intermodulation products; however, they are either less sensitive or considerably larger than active antennas. In applications where only compact antennas can be used, passive DF antennas are substantially less sensitive in the VHF and the lower UHF range than active models.

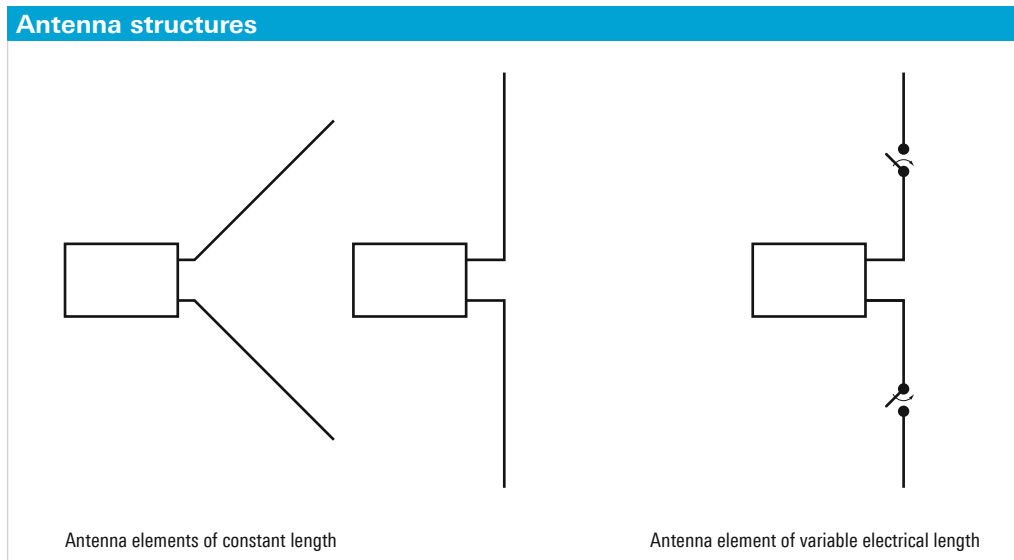
Up until now, users have had to decide what is more important to them: the higher sensitivity offered by active DF antennas or the higher immunity to strong signals provided by passive DF antennas.

The R&S®ADD196/197/295 for the first time make it possible to bypass the active circuitry of the antenna elements. The user can switch the active elements to passive mode by a simple mouse click. These DF antennas offer the advantages of both methods.

Exceptionally high DF sensitivity

For DF antenna elements to exhibit good receive characteristics, adaptation to the subsequent stage must be optimized and coupling to the adjacent elements minimized. These requirements can best be met over a wide frequency range by using configurable antenna structures:

- At low frequencies, configuration of antenna element for maximum electrical length
- At high frequencies, selection of the most effective antenna length to achieve the best possible compromise between decoupled receive power and impact on the directional pattern due to mutual coupling



Optimal results are achieved using electric switches that connect or disconnect parts of the antenna element (see figure, right).

The antenna elements of the R&S®ADD196, R&S®ADD197 (vertical polarization) and R&S®ADD295 DF antennas are equipped with PIN diodes, allowing the electrically active structure to change very quickly in the VHF/UHF range. As a result, these elements are always optimally adapted to the receive frequency and offer exceptionally high sensitivity.

Commercially available DF antennas that cover a very wide frequency range with antenna elements of constant length (see figure, left) are usually optimized for the UHF range and are considerably less sensitive in the VHF range than the Rohde&Schwarz models with variable electrical length.

Integrated, extendible lightning protection

DF antennas for the VHF/UHF/SHF range are usually positioned as high as possible in order to achieve wide coverage. The higher a DF antenna is located, the more likely it will be struck by lightning. This applies especially to areas with frequent thunderstorms.

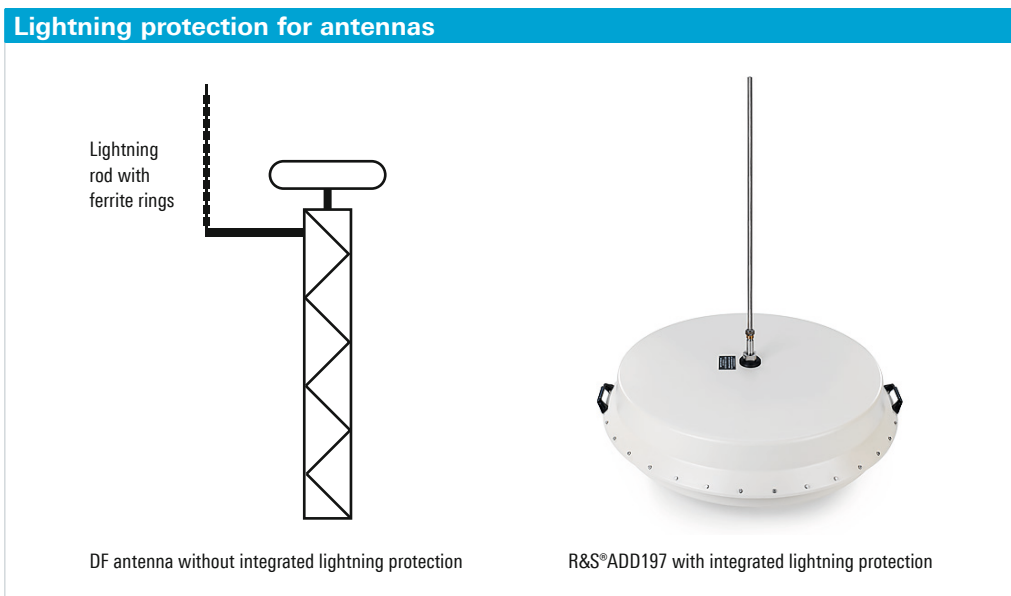
All installed Rohde&Schwarz DF antennas that are at risk of being struck by lightning feature built-in, effective lightning protection up to an installation height of 20 m:

- Lightning rod that prevents lightning from striking the DF antenna from the side
- Massive metal core inside the DF antenna to divert the lightning current to the mast so that the current flows off via the ground
- Gas arresters at all critical spots to prevent voltage peaks (caused by lightning bolts) from destroying the DF antenna circuitry

This lightning protection concept was taken into account in development right from the start and does not impair DF accuracy. As a result, the DF accuracy specified in the data sheets is attained even with the lightning rod.

Commercially available DF antennas without integrated lightning protection have a lightning rod that is mounted next to the DF antenna, which leads to considerable DF errors (especially in the VHF range). Even if this type of lightning rod is lined with ferrite rings and is positioned two meters away from the DF antenna, DF accuracy is considerably poorer than that specified in the data sheet for a reflection-free environment (see table). At certain frequencies where the lightning rod is in resonance, considerable DF errors of more than 20° can occur. It is not possible to predict precisely how high the DF errors will be.

If the spacing between the DF antenna and the lightning rod next to it is less than two meters, or if the rod is not thoroughly ferritized, significantly higher DF errors are to be expected.



The additional DF errors due to the separate lightning rod can be reduced by calibration, which is, however, very complicated and can correct only part of the DF errors. But even after calibration, additional DF errors can occur at any time in the VHF range.

For the R&S®ADD196, R&S®ADD197 and R&S®ADD295 DF antennas, the R&S®ADD-LP extended lightning protection is available as an option. It is recommended for installation heights of more than 20 m above ground (e.g. masts > 20 m, tall buildings, mountaintops). The figure shows the extended lightning protection, which consists of two crossed lightning rods that protrude laterally beyond the DF antenna to provide an especially high level of protection against lightning striking from the side.

R&S®ADD197 with R&S®ADD-LP.



Easy replacement of DF antennas

Unlike other commercially available antennas, DF antennas from Rohde&Schwarz do not need to be individually calibrated. The precisely manufactured R&S®ADDx DF antennas behave exactly as predicted in theory. They provide the high DF accuracy specified in the data sheet without subsequent correction by means of individual factory calibration.

Rohde&Schwarz strives to avoid individual calibration of DF antennas in the development stage by implementing the following:

- High decoupling from interference (e.g. from cables)
- High common mode rejection
- Minimal mutual coupling between antenna elements

A Rohde&Schwarz DF antenna can be replaced with the same model without having to manage new calibration data and store it in the direction finder.

Comparison of specifications of DF antennas with and without integrated lightning protection		
	DF antennas without integrated lightning protection ¹⁾	Rohde & Schwarz DF antennas with integrated lightning protection (example: R&S®ADD196)
Average DF accuracy according to data sheet specifications (reflection-free environment)	1° RMS	1° RMS (2° RMS for f < 80 MHz)
Average DF accuracy with lightning protection, 20 MHz to 200 MHz	5° RMS	1° RMS (2° RMS for f < 80 MHz)
Average DF accuracy with lightning protection, > 200 MHz	2° RMS	1° RMS
Additional DF error due to lightning protection	depends on frequency, up to 20°	no additional DF error

¹⁾ Measurement with separate lightning rod, lined with ferrite rings, 2 m away from antenna.

System components

DF antennas for the R&S®DDF255

The R&S®DDF255 can be operated with all R&S®ADDx single-channel DF antennas (see table). For details, see the R&S®ADDx single-channel DF antennas product brochure (PD 3606.8295.12) and data sheet (PD 3606.8295.22).

R&S®RAMON and R&S®ARGUS control and system software

In addition to front panel control, the R&S®DDF255 can also be controlled via the R&S®RAMON and R&S®ARGUS system software. This permits integration of the direction finder into systems.

The R&S®DDF255 comes with appropriate R&S®RAMON control software for operating the R&S®DDF255 from a standard PC. The control interface is accessible to users, which allows operation of the R&S®DDF255 using customer-specific software.

System requirements

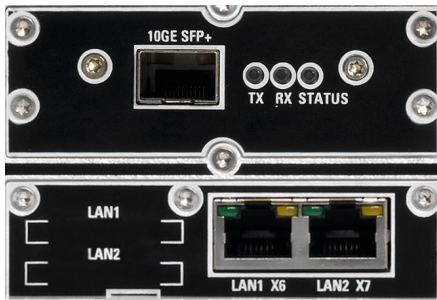
If the R&S®DDF255 is ordered without front panel control, a standard PC is required to control the direction finder.

Ethernet interfaces for remote control and data transmission

The base unit is equipped with two 1 Gbit LAN interfaces to control the R&S®DDF255 from a remote operator workstation and to output measurement results. System and analysis software packages from Rohde&Schwarz, such as R&S®ARGUS, R&S®RAMON and R&S®CA100, access this interface to utilize all receiver functions.

The open interface description for remote control commands (in line with the SCPI standard) and the output data formats enable external system integrators to incorporate the R&S®DDF255 into third-party software solutions.

LAN interfaces for remote control and/or data transmission



Two 1 Gbit LAN interfaces and an optional 10 Gbit LAN interface for remote control and/or data transmission on the direction finder's rear panel

DF antenna	Frequency range	Application
R&S®ADD119	300 kHz to 30 MHz	mobile
R&S®ADD107	20 MHz to 1.3 GHz	mobile and portable
R&S®ADD207	690 MHz to 6 GHz	mobile and portable
R&S®ADD307	20 MHz to 690 MHz	portable
R&S®ADD196	20 MHz to 1.3 GHz	mobile and stationary
R&S®ADD197	20 MHz to 1.3 GHz	mobile and stationary
R&S®ADD071	1.3 GHz to 3 GHz	mobile and stationary
R&S®ADD075	1.3 GHz to 8.2 GHz	mobile and stationary
R&S®ADD295	20 MHz to 3 GHz	mobile and stationary
R&S®ADD175	690 MHz to 2.7 GHz	mobile and portable
Discontinued antennas		
R&S®ADD190	20 MHz to 1.3 GHz	mobile and stationary
R&S®ADD195	20 MHz to 1.3 GHz	mobile and stationary

Interfaces for up to 80 MHz wide I/Q data streaming

The R&S®DDF255-DIQ option is an extremely powerful FPGA board. This board comes standard with the R&S®Digital I/Q Interface, which permits I/Q streaming in Rohde&Schwarz recording instruments (e.g. R&S®IQR) or vector signal generators (e.g. R&S®SMW). Using the R&S®Digital I/Q Interface, the R&S®DDF255 transmits I/Q data up to its full bandwidth of 80 MHz. The R&S®DDF255 detects compatible Rohde&Schwarz instruments connected to the R&S®Digital I/Q Interface.

Via the 10 Gbit LAN interface (R&S®DDF-10G option), the R&S®DDF255 can transmit I/Q baseband data from the instrument and also replay it in realtime from a storage device¹. The R&S®DDF255 operates as in normal receive mode even though it uses recorded data. All measurement and analysis functions provided by the R&S®DDF255 in fixed frequency mode remain available². This means that the center frequency and demodulation bandwidth of the receiver can be moved freely within the boundaries of the replayed recording. Copper or fiber-optic cables can be used to connect the 10 Gbit LAN interface to the external storage device (e.g. R&S®GX460 with a maximum I/Q bandwidth of 40 MHz or R&S®GX465 with a maximum I/Q bandwidth of 80 MHz). When connected to an R&S®GX465, the R&S®DDF255 controls the storage device. The user controls the recording and replay of I/Q data via the user interface of the R&S®DDF255, while the R&S®DDF255 controls the storage device in the background.

¹ In conjunction with the R&S®DDF255-DIQ option.

² Exceptions: recording and replay of GNSS data and in DF mode.

Status report for an R&S®IQR100 connected to the R&S®Digital I/Q Interface.



An R&S®DDF255 with R&S®DDF255-DIQ and R&S®DDF-10G options controls an R&S®GX465, both for recording and for realtime replay of I/Q data.



DC operation (e.g. on vehicle battery)

The R&S®DDF255 receives its power directly from a DC power source, such as a vehicle battery. Thanks to its wide input voltage range, the direction finder can be operated on both car and truck batteries, even with all options installed. The R&S®DDF255-DC option is installed directly in the direction finder, eliminating the need for additional space in vehicles.

System time synchronization using NTP server

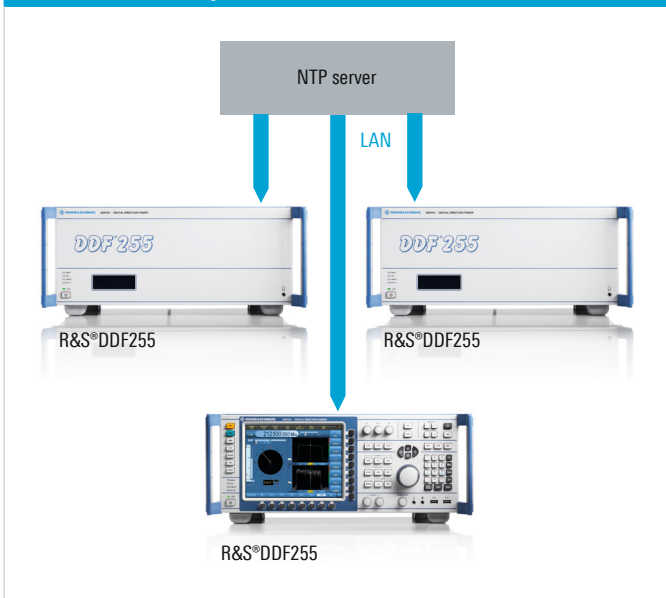
An NTP server distributes the system time to all devices in the networked system. Synchronization takes place automatically every time the R&S®DDF255 starts up, or can be manually triggered by an SCPI command issued by the user or a software application running on the network. The internal device time and date are synchronized to the received NTP time. The accuracy depends on the quality of the NTP server and LAN infrastructure and is typically in the millisecond range. Cyclic synchronization of device time and date prevents drifting differences in the internal time references of multiple devices in the network.

The synchronized timebase makes it easier to compare measurement results received by different stations (e.g. spectrum, audio). As a result, it is possible to identify and assign results with identical timestamps. It is also possible to document when a specific signal, e.g. an interfering signal, was received.

DC port for connecting the R&S®DDF255 to the vehicle's on-board power supply



An NTP server distributes time and date to the devices in the system via a network connection



Application examples

Mobile radiomonitoring and radiolocation

The R&S®DDF255 is optimally suited for integration into vehicles:

- High integration density: compact dimensions of only four height units and 19" width
- Flexible power supply: powering from AC source or optionally from DC source
- Front panel control: operation via front panel without using a PC
- Multiple antenna inputs: In the VHF/UHF range, up to three DF and/or monitoring antennas can be connected without an external switch being required

The DF and monitoring antennas connected to the R&S®DDF255 have a decisive impact on its performance. In this area, Rohde&Schwarz offers solutions that meet the specific requirements of mobile radiomonitoring and radiolocation.

R&S®ADD295 VHF/UHF wideband DF antenna

Previously, two DF antennas were required in order to cover the entire VHF/UHF range. This resulted in additional reflection, particularly with systems mounted on vehicle roofs. The R&S®ADD295 solves the problem. It covers the entire VHF/UHF frequency range with two antennas in the form of concentric dipole circles nested in one another. This solution takes up only half the space on the vehicle roof.

R&S®ADD295.



Stationary radiomonitoring and radiolocation up to 8.2 GHz

The R&S®DDF255 together with the R&S®ADD197 and R&S®ADD075 DF antennas form an extremely powerful stationary DF system for radiomonitoring and radiolocation up to 8.2 GHz. It meets, and in many cases clearly surpasses, ITU recommendations.

The R&S®ADD197 DF antenna for the VHF/UHF range now makes it possible to take accurate bearings also on all horizontally polarized transmitters. This solves a number of problems, and also opens up new applications:

- Illegal TV and audio broadcast transmitters equipped with horizontally polarized antennas on masts are in operation in some countries. Locating such transmitters using vertically polarized DF antennas and triangulation is not possible
- Defective transmit and receive systems using horizontally polarized antennas can be located with significantly higher reliability
- Public TV and audio broadcast transmitters can be used to align the direction finder to north and check its functionality. These transmitters are ideal for this purpose as they permanently broadcast a powerful and undisturbed signal from a known location. DF accuracy and north alignment can be conveniently checked

Several DF and monitoring antennas can be directly connected to the R&S®DDF255. The ITU recommendations can therefore be met without using an external antenna switch.

Together with the R&S®DDF255-IM option, a radiomonitoring and radiolocation system is created that delivers reproducible and reliable results in line with ITU recommendations.

Options

R&S®DDF255-DC DC power supply

The R&S®DDF255 can optionally be equipped with a DC power supply. This option provides a wide voltage range to cover nearly any type of application. For instance, the R&S®DDF255 can be directly connected to a vehicle's power supply system when equipped with the R&S®DDF255-DC option.

R&S®DDF255-HF HF frequency range extension

The R&S®DDF255-HF option extends the frequency range of the R&S®DDF255 downward. The resulting lower frequency limit depends on the operating mode:

- DF mode: 300 kHz
- Receive mode: 8 kHz

To use this option, suitable DF and/or receiving antennas are additionally required.

R&S®DDF255-SHF SHF frequency range extension

The R&S®DDF255-SHF option extends the frequency range of the R&S®DDF255 upward. The resulting upper frequency limit depends on the operating mode:

- DF mode: 6 GHz
- Receive mode: 26.5 GHz

To use this option, suitable DF and/or receiving antennas are additionally required.

R&S®DDF255-IM ITU measurement software

The R&S®DDF255-IM option adds a comprehensive range of ITU-compliant measurement methods. These include:

- ITU-R SM.377¹⁾ (frequency and frequency offset measurements)
- ITU-R SM.378 (field strength measurements)
- ITU-R SM.328 (determination of modulation modes)
- ITU-R SM.443 (bandwidth measurements)
- ITU-R SM.1880 (determination of spectral occupancy, with remote control PC and R&S®ARGUS software package)

To use this option in line with ITU recommendations, we recommend that suitable receiving antennas be provided.

¹⁾ Depending on the application, an external reference frequency with higher accuracy may be required, e.g. as provided by the R&S®DDF255IGT2 internal GNSS module and external GPS antenna.

R&S®DDF255-SL selective call analysis

The R&S®DDF255-SL option allows the decoding of diverse selective call methods and the demodulation of pagers.

The following selective call methods are supported: CCIR1, CCIR7, CCITT, EEA, EIA, EURO, DCS, DTMF, CTCSS, NATEL, VDEW, ZVEI1, ZVEI2. Other methods are available on request.

Results are shown on the display of the direction finder or on the external control PC.

R&S®DDF255-PS panorama scan

When equipped with the R&S®DDF255-PS option, the R&S®DDF255 traverses a user-defined frequency range at maximum speed (without direction finding). This provides the user with a quick overview of the spectrum occupancy. Any changes caused by illegal radio services, interference sources, temporary emissions, etc., can be recognized immediately. The marker function can be used to take a bearing of the target signal and demodulate and analyze it.

The resolution for the FFT computation can be set to match the channel spacing used by various radio services. This FFT scan provides fast scan rates at narrow resolution bandwidths and consequently high sensitivity.

R&S®DDF255-COR DF error correction

The R&S®DDF255-COR option enables the R&S®DDF255 to correct errors through the use of comparison tables.

Especially in mobile DF applications, DF accuracy may be degraded due to vehicle reflections. DF accuracy can be significantly improved by applying appropriate DF error correction. For this purpose, the DF vehicle is exposed to test signals applied in 10° steps from all directions across the entire frequency range. With the resulting DF values, correction tables are generated and loaded into the R&S®DDF255 memory. By using this approach, many DF errors are rectified. The option does not include the measurement of the vehicle.

R&S®DDF255-ADC2 multifunction board

The R&S®DDF255-ADC2 option increases the signal processing power of the R&S®DDF255 and is a prerequisite for the use of the R&S®DDF255-DDC and R&S®DDF255-WB options. The two options can be used individually or in parallel on an R&S®DDF255-ADC2 multifunction board.

R&S®DDF255-DDC digital downconverter

The R&S®DDF255-DDC option transforms the R&S®DDF255 digital direction finder into a multichannel receiver with a total of five demodulation channels, which can be allocated to any frequencies within the realtime bandwidth. The demodulation channels can be parameterized independently of each other (demodulation mode, level squelch, etc.). Demodulated data can be stored and replayed internally, and is also available at the Ethernet interface.

R&S®DDF255-WB bandwidth extension to 80 MHz

The R&S®DDF255-WB option expands the R&S®DDF255 realtime bandwidth to 80 MHz. This permits the demodulation (I/Q) of signals up to this bandwidth, improves the detection of short-time signals and increases the scan speed to 850 GHz/s (in-band).

The R&S®DDF255-WB option has no impact on the DF functionality of the R&S®DDF255.

R&S®DDF-10G 10 Gbit Ethernet interface

The R&S®DDF255 is equipped as standard with two 1 Gbit LAN interfaces. These support the transmission of I/Q data with a bandwidth of up to 20 MHz. The optional 10 Gbit Ethernet interface supports I/Q data transmission up to the R&S®DDF255 maximum realtime bandwidth of 80 MHz. No transceiver module is supplied with this option, because a transceiver module is included with the R&S®GX460 digital wideband storage device. Transceiver modules can be ordered separately if required.

R&S®DDF255-SP signal processing board

When equipped with this hardware-accelerated signal processing option, the R&S®DDF255 supports the R&S®CA120 multichannel signal analysis system. The R&S®DDF255-SP signal processing board provides an execution platform for the R&S®DDF255DDCE and R&S®DDF255-HRP options.

R&S®DDF255DDCE DDC signal extraction

The R&S®DDF255DDCE option uses digital downconversion (DDC) to extract signals from the R&S®DDF255 realtime bandwidth. Depending on the bandwidth set on the R&S®DDF255 and the desired DDC bandwidth, well over 100 signals can be extracted simultaneously. The option runs on the R&S®DDF255-SP signal processing board.

R&S®DDF255-HRP high-resolution panorama spectrum

The R&S®DDF255-HRP option supports the R&S®CA120 multichannel signal analysis system with the automatic detection of fixed frequency and burst signals within the R&S®DDF255 realtime bandwidth, thereby enabling automatic signal detection/monitoring and processing (with R&S®DDF255DDCE). A high-resolution spectrum is calculated within the realtime bandwidth, and the spectra are output on the 1 Gbit Ethernet interface to be further processed by the R&S®CA120DSC option. The option runs on the R&S®DDF255-SP signal processing board.

R&S®DDF255-ST detection of short-time signals

The R&S®DDF255-ST option supports the R&S®CA120 multichannel signal analysis system with the automatic detection of frequency agile short-time signals, thereby enabling the automatic detection/monitoring and online dechopping of frequency agile signals. The option runs on the R&S®DDF255-SP signal processing board.

R&S®DDF255IGT2 internal GNSS module and external GPS antenna

The internal GNSS module's NMEA protocol sets the system time. The R&S®DDF255 direction finder's internal 10 MHz reference frequency can be synchronized over the extra input using the GNSS module's PPS signal. This increases the accuracy of the internal reference to typ. 10^{-12} (or better). In addition, the receiver's output data stream is given a high-precision timestamp. The accuracy of the timestamp is typically in the nanosecond range.

This option can also be used to determine the location of the direction finder, e.g. in mobile DF applications where the results are presented on a map.

R&S®DDF255-ZS zero span

The zero span option offers time domain analysis, allowing the direction finder to measure e.g. power level, intervals and frequency hops.

R&S®DDF255-DIQ broadband I/O data streaming board

The R&S®DDF255-DIQ enables the direction finder to stream I/Q data up to the full bandwidth via the standard R&S®Digital I/Q interface to compatible Rohde&Schwarz instruments. It is the hardware requirement for wideband I/Q streaming via the 10 Gigabit Ethernet interface.

Specifications in brief

Specifications in brief		
Frequency range, receive mode	base unit	20 MHz to 3.6 GHz
	with R&S®DDF255-SHF option	20 MHz to 26.5 GHz
	with R&S®DDF255-HF option	8 kHz to 3.6 GHz
Frequency range, DF mode	base unit	20 MHz to 3 GHz
	with R&S®DDF255-SHF option	20 MHz to 8.2 GHz ¹⁾
	with R&S®DDF255-HF option	300 kHz to 3 GHz
DF mode		
DF method	VHF/UHF/SHF	correlative interferometer
	HF	Watson-Watt
Instrument DF accuracy		0.5° RMS
System DF accuracy ²⁾	depends on DF antenna (i.e. R&S®ADD119, R&S®ADD196 and R&S®ADD075), in reflection-free environment, with lightning protection, in line with report ITU-R SM.2125 (limited to one modulation type) and recommendation ITU-R SM.854	
	300 kHz to 30 MHz	≤ 2° RMS
	20 MHz to 80 MHz	typ. 1° RMS
	80 MHz to 1.3 GHz	typ. 0.5° RMS
	1.3 GHz to 8.2 GHz	typ. 1° RMS
System DF sensitivity	depends on DF antenna (i.e. R&S®ADD119, R&S®ADD196 and R&S®ADD075), for 5° RMS DF fluctuation, 5 s integration time and 250 Hz (HF)/600 Hz (VHF/UHF/SHF) DF bandwidth, in line with report ITU-R SM.2125	
	300 kHz to 80 MHz	typ. 14 µV/m to 4 µV/m
	80 MHz to 1.3 GHz	typ. 1 µV/m
	1.3 GHz to 6 GHz	typ. 2 µV/m
	6 GHz to 8.2 GHz	typ. 3 µV/m to 14 µV/m
Realtime bandwidth for wideband direction finding		up to 20 MHz
Minimum signal duration	for a single burst signal, in line with report ITU-R SM.2125	
	VHF/UHF/SHF	1 ms
	HF	2 ms
Receive mode		
Realtime bandwidth for analysis/demodulation	base unit	up to 20 MHz
	with R&S®DDF255-ADC2 and R&S®DDF255-WB options	additionally 40 MHz and 80 MHz
Scan speed	with R&S®DDF255-PS option	up to 270 GHz/s (in-band)
	with R&S®DDF255-ADC2, R&S®DDF255-WB and R&S®DDF255-PS options	up to 850 GHz/s (in-band)

¹⁾ Depends on DF antenna.

²⁾ Measurement in reflection-free environment. The RMS error is calculated from the bearings of evenly distributed samples versus azimuth and frequency.

For data sheet with options for hardware-accelerated signal processing, see PD 3606.9327.22 (R&S®CA120)

For data sheet with accessories for 10 Gbit interface, see PD 5214.5461.22 (R&S®GX460)

For R&S®ADDx single-channel DF antennas product brochure and data sheet, see PD 3606.8295.12 and PD 3606.8295.22 and www.rohde-schwarz.com

This product includes software developed by the University of California, Berkeley and its contributors.

This product includes software developed by the Kungliga Tekniska Högskolan and its contributors.

This product includes software developed by Yen Yen Lim and North Dakota State University.

This product includes software developed by the OpenSSL Project for use in the OpenSSL toolkit. (<http://www.openssl.org/>)

This product includes cryptographic software written by Eric Young (eay@cryptsoft.com) and software written by Tim Hudson (tjh@cryptsoft.com).

This product contains information from OpenStreetMap (<http://www.openstreetmap.org/>) which is made available here under the

Open Database License, ODbL (<http://opendatacommons.org/licenses/odbl/1.0/>).

Ordering information

Designation	Type	Order No.
Base unit (including accessories supplied such as power cable, operating manual)		
Digital Direction Finder, without front panel control	R&S®DDF255	4067.9240.02
Digital Direction Finder, with front panel control	R&S®DDF255	4067.9240.03
Documentation of Calibration Values	R&S®DDF255-DCV	4066.4780.03
Hardware options		
DC Power Supply	R&S®DDF255-DC	4066.4000.13
SHF Frequency Range Extension ¹⁾	R&S®DDF255-SHF	4066.4200.03
HF Frequency Range Extension	R&S®DDF255-HF	4066.4100.03
Software options		
ITU Measurement Software	R&S®DDF255-IM	4066.4400.03
Internal Recording	R&S®DDF255-IR	4079.7960.03
Map Display	R&S®DDF255-Map	4079.7977.03
Panorama Scan	R&S®DDF255-PS	4066.4500.03
Selective Call Analysis	R&S®DDF255-SL	4066.4600.03
DF Error Correction	R&S®DDF255-COR	4066.4745.03
Multifunction Board	R&S®DDF255-ADC2	4079.7925.03
Digital Downconverter ²⁾	R&S®DDF255-DDC	4066.4545.03
Bandwidth Extension (80 MHz) ²⁾	R&S®DDF255-WB	4066.4645.03
Zero Span	R&S®DDF255-ZS	4079.7983.03
Wideband I/O Data Streaming Board ²⁾	R&S®DDF255-DIQ	4079.8109.03
10 Gbit Ethernet Interface (without transceiver module) ³⁾	R&S®DDF-10G	4074.7604.05
40 Gbit I/Q Interface	R&S®DDF-40G	4093.2404.03
Internal GNSS Module (GPS, Glonass, BeiDou)	R&S®DDF255IGT2	4079.8209.03
Record and Replay ²⁾	R&S®DDF255-RR	4079.7954.03
Options for hardware-accelerated signal processing (in combination with R&S®CA120)		
Signal Processing Board	R&S®DDF255-SP	4066.4268.03
DDC Signal Extraction ⁴⁾	R&S®DDF255DDCE	4079.7760.03
High-Resolution Panorama Spectrum ⁴⁾	R&S®DDF255-HRP	4079.7902.03
Detection of Short-Time Signals ^{4), 5)}	R&S®DDF255-ST	4079.7883.03
DF system accessories		
Compact VHF/UHF DF Antenna	R&S®ADD107	4090.7005.02
Compact UHF/SHF DF Antenna	R&S®ADD207	4096.0002.02
Collapsible VHF/UHF DF Antenna	R&S®ADD307	4098.2002.07
HF DF Antenna	R&S®ADD119	4053.6509.02
VHF/UHF DF Antenna	R&S®ADD196	4077.3000.12
Dual Polarized VHF/UHF DF Antenna	R&S®ADD197	4068.1450.12
VHF/UHF Wideband DF Antenna	R&S®ADD295	4070.9002.12
UHF DF Antenna	R&S®ADD071	4043.6006.02
UHF/SHF DF Antenna	R&S®ADD075	4069.6603.12
UHF DF Antenna	R&S®ADD175	4079.4003.02
DF Antenna Cable Set for single-channel direction finders, frequency range 0.3 MHz to 1.3 GHz	R&S®DDF1C-1	4077.6009.xx ⁶⁾
DF Antenna Cable Set for single-channel direction finders, frequency range 0.3 MHz to 3 GHz	R&S®DDF1C-5	4077.7005.xx ⁶⁾
DF Antenna Cable Set for single-channel direction finders, frequency range 0.3 MHz to 6 GHz	R&S®DDF1C-7	4077.8001.xx ⁶⁾
Interconnection Cable Set for R&S®ADD075	R&S®DDF1CX	4077.8801.10
Interconnection Cable Set for R&S®ADD071	R&S®DDF1CX	4077.8801.15
Extended Lightning Protection	R&S®ADD-LP	4069.6010.02
Mast Adapter for compact DF antennas; color: light ivory	R&S®ADD150A	4041.2655.02
Antenna Adapter for R&S®ADD071, R&S®ADD190, R&S®ADD195, with cable outlet	R&S®ADD071Z	4043.7002.02
Antenna Adapter for R&S®ADD071, R&S®ADD190, R&S®ADD195, without cable inlet/flange	R&S®ADD071Z	4043.7002.03

Designation	Type	Order No.
Tripod with adapter for R&S®ADD195, R&S®ADD153, R&S®ADD119	R&S®ADD1XTP	4063.4409.02
Mast Adapter for R&S®ADD175	R&S®ADD17XZ2	4079.5000.02
Vehicle Adapter with Magnet Mount	R&S®ADD17XZ3	4090.8801.02
Antenna Cable Set without Converter, length: 5 m, for R&S®ADD107, R&S®ADD207 and R&S®ADD175	R&S®ADD17XZ4	4090.8730.02
Wooden Tripod	R&S®ADD17XZ6	4090.8860.02
Tripod Bag for R&S®ADD17XZ6	R&S®ADD17XZ7	4096.1450.02
Mast Adapter for R&S®ADD075	R&S®ADD07XZB	4069.7300.02
Antenna Adapter for R&S®ADD075	R&S®ADD07XZT	4069.7200.02
Vehicle Adapter for portable DF antennas; color: light ivory	R&S®AP502Z1	0515.1419.02
Electronic Compass	R&S®GH150	4041.8501.02
GPS Navigator/GPS Receiver with integrated inertial navigation (with GPS antenna)	R&S®GINA	4055.6906.04
Recommended extras		
Optical Cable, for 10 Gbit, incl. two optical transceivers, length: 20 m	R&S®GX460-OCG	4094.8641.02
Copper Cable, for 10 Gbit, incl. two optical transceivers, length: 5 m	R&S®GX460-CCG	4094.8635.02
19" Rack Adapter	R&S®ZZA411	1096.3283.00

¹⁾ Upgrade must be performed in factory.

²⁾ Only one R&S®DDF255-ADC2 is required.

³⁾ Only one R&S®DDF255-DIQ is required.

⁴⁾ One R&S®DDF255-ADC2 and one R&S®DDF255-SP are required.

⁵⁾ R&S®DDF255DDCE is required.

⁶⁾ The DF antenna cable sets are available in various lengths, designated by the last two digits of the order number.

Service options		
Extended Warranty, one year	R&S®WE1	Please contact your local Rohde & Schwarz sales office.
Extended Warranty, two years	R&S®WE2	
Extended Warranty, three years	R&S®WE3	
Extended Warranty, four years	R&S®WE4	
Extended Warranty with Calibration Coverage, one year	R&S®CW1	
Extended Warranty with Calibration Coverage, two years	R&S®CW2	
Extended Warranty with Calibration Coverage, three years	R&S®CW3	
Extended Warranty with Calibration Coverage, four years	R&S®CW4	

Extended warranty with a term of one to four years (WE1 to WE4)

Repairs carried out during the contract term are free of charge¹⁾. Necessary calibration and adjustments carried out during repairs are also covered.

Extended warranty with calibration (CW1 to CW4)

Enhance your extended warranty by adding calibration coverage at a package price. This package ensures that your Rohde & Schwarz product is regularly calibrated, inspected and maintained during the term of the contract. It includes all repairs¹⁾ and calibration at the recommended intervals as well as any calibration carried out during repairs or option upgrades.

Your local Rohde & Schwarz expert will help you determine the optimum solution for your requirements.

To find your nearest Rohde & Schwarz representative, visit

www.sales.rohde-schwarz.com

¹⁾ Excluding defects caused by incorrect operation or handling and force majeure. Wear-and-tear parts are not included.

Service that adds value

- ▮ Worldwide
- ▮ Local and personalized
- ▮ Customized and flexible
- ▮ Uncompromising quality
- ▮ Long-term dependability

Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

Sustainable product design

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

Certified Quality Management

ISO 9001

Certified Environmental Management

ISO 14001

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R&S®DDF255 Digital Direction Finder

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