R&S®DDF255 digital direction finder wi

The chief attraction: The R&S®DDF255 is a highly accurate radio direction finder based on the principle of the correlative interferometer. It also offers an extensive range of powerful measurement and analysis functions. It employs a patented

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DF method which, due to the use of special wide-aperture DF antennas, offers a high degree of accuracy and outstanding immunity to reflections. With its compact dimensions and optional DC power supply, the R&S®DDF255 is also an excellent choice for mobile applications.

FIG 1 The R&S®DDF255 digital direction finder offers a high-precision DF method, patented by Rohde&Schwarz, at an excellent price/performance ratio.

Highly accurate direction finding combined with extensive measurement and analysis functions

The R&S®DDF255 (FIG 1) combines the capabilities of the new and extremely powerful R&S®ESMD wideband monitoring receiver* with those of a direction finder based on the correlative interferometer method. This combination yields a highly accurate wideband direction finder featuring a wide range of measurement and analysis functions. With its compact housing and optional DC power supply, it is also an excellent solution for mobile applications. The R&S®DDF255 will replace the tried-and-tested R&S®DDF190/195 direction finders.

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

The R&S®DDF255 is based on the same concept as the successful R&S®DDF190/195 family of direction finders. Both the R&S®DDF190 and the R&S®DDF195, which is an expanded version, enjoy wide market acceptance and are used by 23 regulatory authorities around the world.

Due to the extensive functionality of the R&S®ESMD digital wideband 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, for example, the following capabilities:

- Extremely fast spectrum monitoring with scan speeds of up to 100 GHz/s in the 20 MHz to 3.6 GHz range (optional 9 kHz to 26.5 GHz)
- Wideband direction finding with a realtime bandwidth of up to 20 MHz and selectable channel resolution
- Display and demodulation of signals with extremely large bandwidths of up to 20 MHz
- High-precision direction finding in line with ITU recommendations in the 20 MHz to 3 GHz (optional 300 kHz to 6 GHz) range including map display (optional)
- Signal analysis including the classification, demodulation and decoding of important transmission methods (optional)
- Measurement of technical parameters in line with ITU recommendations (optional)

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. MinHold, MaxHold and average displays are also possible, allowing an even broader scope of applications. All of the R&S®DDF255 functions can be remote-controlled via a 1 Gbit LAN interface, which is also used for data output.

Performance and measurement methods 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 superior to the minimum values recommended by the ITU (higher intercept points, lower phase noise).

As an option, the R&S®DDF255 can be furnished with comprehensive, ITU-compliant measurement methods including:

- Frequency and frequency offset in line with ITU-R SM.377
- Field strength in line with ITU-R SM.378
- Modulation in line with ITU-R SM.328
- Spectrum occupancy in line with ITU-R SM.182/SM.328 (on control PC)
- Bandwidth in line with ITU-R SM.443
- Recognition of mono and stereo transmissions from FM broadcast transmitters

Wideband direction finding with realtime bandwidth of up to 20 MHz

By using high-speed signal processing, the R&S®DDF255 can take 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 such as:

- All channels in the aeronautical or maritime frequency bands can be simultaneously displayed and their bearings taken.
- All FM broadcast channels can be simultaneously displayed and their bearings taken.
- The bearings of signals with large bandwidths such as DAB and DVB-T can be taken with high channel resolution. The bearing is then an average value (histogram) calculated from many individual bearings. This compensates for frequency-dependent bearing fluctuations.

REFERENCE

* R&S®ESMD Wideband Monitoring Receiver – The radiomonitoring specialist: versatile, fast, accurate. News from Rohde&Schwarz (2008) No. 194, pp 62–67.

Direction finding up to 6 GHz

Together with the new R&S®DDF255-SHF option and the R&S®ADD075 DF antenna, the R&S®DDF255 delivers accurate DF results up to 6 GHz. For the first time, bearings can be obtained for signals above 3 GHz, e.g. of WLAN or WiMAX™ transmitters or microwave systems.

Locating the target transmitter previously required the use of rotatable directional antennas, which have disadvantages regarding manageability and measurement speed. The R&S®DDF255 immediately displays the bearing and significantly simplifies direction finding while driving. The high DF accuracy and reflection immunity available in the VHF/UHF range are also achieved in the SHF range.

Fast and reliable radiolocation due to high DF accuracy

In the VHF/UHF range, the R&S®DDF255 uses the correlative interferometer DF method (see page 68). In contrast to simple amplitude comparison methods, the R&S®DDF255 therefore offers significantly higher DF accuracy compliant with class A (highest accuracy class) of the 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.

FIG 2 The R&S®ADD295 DF antenna mounted on the roof of an all-terrain vehicle.

Technical background

Reliable direction finding, even with reflections
Due to multipath propagation, DF antennas often pick up a significant amount of reflection, particularly in urban areas. Compared to most other products on the market, the R&S®DDF255 offers higher immunity to reflections (FIG 3). This is due to the use of DF antennas with a very large number of antenna elements. In the VHF/UHF/SHF range, the R&S®DDF255 uses eight or nine elements. Other products on the market typically have five elements.

The spacing between two adjacent elements of a DF antenna is limited due to the requirement that, for all angles of incidence of incoming waves, at least one pair of elements must have a spacing smaller than half the wavelength at the highest operating frequency. For this reason, the aperture of a DF antenna (diameter referenced to the wavelength) can be significantly increased only if the number of antenna elements is also increased. The aperture of the DF antenna is a major factor contributing to the effectiveness of a direction finder. As the ITU Spectrum Monitoring Handbook 2002 also points out, the DF accuracy, DF sensitivity and immunity to reflections increase in direct proportion to the diameter of the DF antenna aperture.

This advantage comes to light only in an actual operational environment that includes reflections and weak signals. This is not apparent in product specifications, since, for the purpose of comparison, the instrument and system accuracy specified there are valid for ideal, reflection-free DF antenna environments and strong signals.

Reflections can impair DF accuracy. Depending on their design, some DF antennas can handle reflections better than others. The R&S®DDF255 was designed to provide accurate bearings even with a 50 % share of incoming signal reflections. This high immunity to reflections is an advantage gained by the use of many antenna elements. If only five antenna elements are used for instance, a 50 % share of reflections can produce bearing errors in the order of 100°.

Bearing error

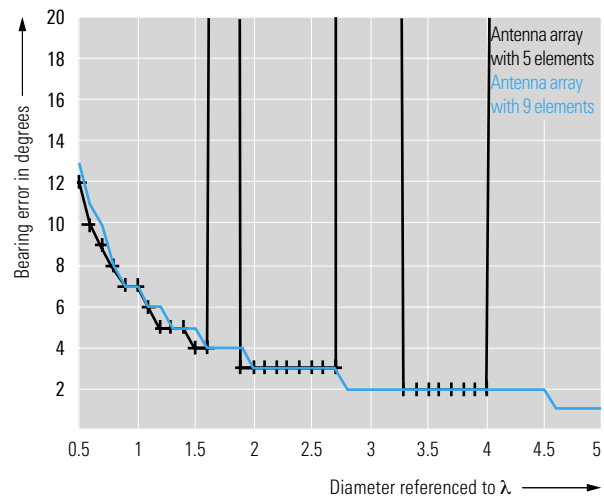

FIG 3 Bearing error of DF antennas with five and nine antenna elements as a function of the antenna diameter (referenced to the wavelength) in a two-wave field.

Single-channel interferometer DF method
The correlative interferometer DF method is based on measuring the phase difference between several antenna 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 (FIG 4). With this method, the phase of one of the signals is shifted in four steps (0°/90°/180°/270°) in the quadrature multiplexer, and the resulting signal is added to the second signal in each case. The receiver measures the amplitude of the sum signal after each phase shift. Placing the four amplitude values (A1/A2/A3/A4) thus obtained in the formula in FIG 4 yields the phase angle between the two signals. The measurement is performed for each antenna element.

Single-channel interferometer DF method

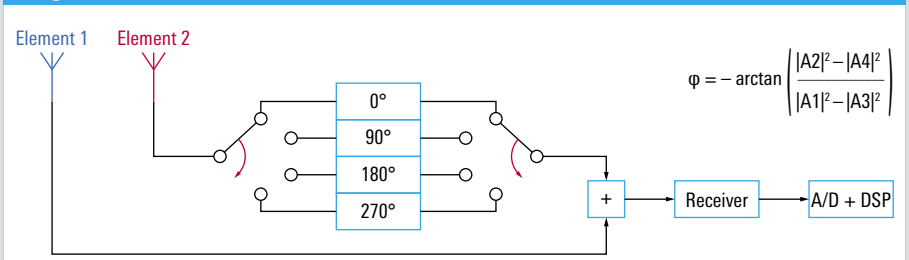

FIG 4 A patented method from Rohde&Schwarz makes it possible to measure the phase angle φ between the signals of two antenna elements by means of a single receiver.

Comprehensive DF antenna program

Rohde & Schwarz offers DF antennas for the R&S®DDF255 to support a variety of applications. The antennas described in the following sections are of particular interest.

For mobile DF applications: R&S®ADD295
(available 1st quarter 2009)
The R&S®ADD295 is a VHF/UHF DF antenna optimized for mobile applications. It covers the entire 20 MHz to 3 GHz frequency range in a compact radome. This is possible through the use of two concentric circles of dipoles.

Previously, two DF antennas were required to cover the entire VHF/UHF range. This caused additional reflections, particularly with systems mounted on vehicle roofs. The new R&S®ADD295 solves this problem and in addition requires only half the space on the vehicle roof. The antenna can be mounted on a vehicle roof by using the R&S®AP502Z1 vehicle adapter (FIG 2). For installation on a mast, the R&S®ADD150A mast adapter is recommended.

For all types of polarization: R&S®ADD197
Rohde & Schwarz is the world's first manufacturer to develop a DF antenna with compact dimensions that contains both vertically and horizontally polarized antenna elements (FIG 6, with lightning protection). In the free space between the nine vertically polarized dipoles, nine horizontally polarized loop antennas have been inserted.

The R&S®ADD197 is suitable for both stationary and mobile applications and covers the 20 MHz to 1.3 GHz frequency range (horizontal polarization: 40 MHz to 1.3 GHz). The R&S®ADD197 can be mounted on a vehicle roof by using the R&S®AP502Z1 vehicle adapter. For installation on a mast, the R&S®ADD150A mast adapter is recommended.

For the SHF range: R&S®ADD075
(available 4th quarter 2008)
With the R&S®ADD075, Rohde & Schwarz offers its first DF antenna for the SHF range. With two circular antenna arrays arranged on top of each other, the R&S®ADD075 covers the 1.3 GHz to 6 GHz frequency range. For mobile applications, the antenna can be flat-mounted on a vehicle roof. For stationary applications, the R&S®ADD196 DF antenna can be mounted above the R&S®ADD075 to create a DF antenna system that covers the 20 MHz to 6 GHz frequency range.

The R&S®ADD119 (FIG 5), a compact DF antenna based on the Watson-Watt DF method, is available **for the HF range**. It can be mounted on a vehicle roof by using the R&S®AP502Z1 vehicle adapter or it can be installed on an R&S®ADD1XTP tripod. Because of its compact dimensions, it can even be camouflaged under an elevated plastic roof.

For stationary and semi-mobile applications in the VHF/UHF range, Rohde & Schwarz offers the **R&S®ADD196** and **R&S®ADD071** DF antennas. They can be mounted above one another on a mast by using the R&S®ADD150A mast adapter and the R&S®ADD071Z antenna adapter.

Application example: mobile radiomonitoring and radiolocation

The R&S®DDF255 is optimally prepared for integration in vehicles:

- High integration density: Its 19" width and its height of only four units make the direction finder extremely compact.
- Flexible power supply: The R&S®DDF255 can be optionally equipped with a DC power supply.
- Front panel control: The R&S®DDF255 can alternatively be controlled from the front panel without using a PC.
- Multiple antenna inputs: Multiple DF and/or monitoring antennas can be connected to the R&S®DDF255.

FIG 5 R&S®ADD119 for the HF range, mounted on an R&S®ADD1XTP tripod.

Application example: stationary radiomonitoring and radiolocation up to 6 GHz

Together with the R&S®ADD197 and R&S®ADD075 DF antennas, the R&S®DDF255 forms an extremely powerful stationary system for radiomonitoring and radiolocation up to 6 GHz. It meets, and in many cases clearly surpasses, ITU recommendations.

With the R&S®ADD197 DF antenna for the VHF/UHF range, direction finding is now also possible for any horizontally polarized transmitters. This means that precise bearings can be taken of all TV and sound broadcast transmitters, for example. The signals from such transmitters can then be used as a reference to align the direction finder to north and check its functionality. The R&S®ADD197 can also take accurate bearings of defective transmitting and receiving systems with horizontally polarized antennas.

Additional monitoring antennas can be directly connected to the R&S®DDF255. The recommendations of ITU can thus be met without using external antenna switches. Together with the R&S®DDF255-ITU option, this yields a radiomonitoring and radiolocation system that delivers reproducible and reliable results in line with ITU recommendations.

Lightning protection

To protect the DF antennas from lightning strikes at high-risk locations, Rohde&Schwarz developed the R&S®ADD-LP lightning protection (FIG 6). This option is recommended for installations higher than 30 meters above ground (masts higher than 30 meters, high buildings, mountain tops). The crossed lightning rods prevent lateral strikes in nearly all cases since the rods project beyond the DF antenna.

Summary

The R&S®DDF255 combines high-precision direction finding with the outstanding performance features of the R&S®ESMD wideband monitoring receiver in a single compact device. The R&S®DDF255 is setting standards both by its extensive functionality and the high quality of the results it delivers. It offers superior performance in terms of accuracy, large-signal immunity and immunity to reflections, characteristics that are especially relevant in practical applications.

An extensive range of DF antennas is available for use with the new R&S®DDF255 digital direction finder. This includes DF antennas for all polarization types and all important frequency ranges as well as for stationary and mobile applications. Featuring front-panel control and an optional DC power supply, the R&S®DDF255 is also an ideal choice for mobile applications.

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FIG 6 R&S®ADD-LP lightning protection (mounted on an R&S®ADD197).