Data sheet

Version 02.01

June 2006

Digital HF/VHF/UHF Scanning Direction Finder R&S®DDF 0xA

0.3 MHz to 3000 MHz

- Wide frequency range 0.3 (0.009) MHz to 3000 MHz
- Approx. 10 MHz FFT realtime bandwidth
- High DF scan speed of up to 30 GHz/s (correlative interferometer)
- High processing speed of up to 240 000 channels/s (correlative interferometer)
- Excellent large-signal characteristics
- High adjacent-channel suppression
- Compact design
- Algorithms for correlative interferometer and Watson-Watt as standard
- Automatic squelch setting (switchable)
- Recording of raw data (option)
- Preclassifier (option)
- Wide range of antennas for stationary and mobile applications
- Synchronous direction finding (option)
- Direction finding of GSM signals (option)
- Easy connection to systems via Ethernet and CORBA

Improved minimum signal duration in HF and VHF/UHF

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General

The R&S® DDF 0xA family with its extremely high scan speed is the latest generation of Rohde & Schwarz scanning direction finders. It consists of pure HF (R&S® DDF 01A) and VHF/UHF (R&S® DDF 05A) direction finders as well as the tried-and-tested combined HF/VHF/UHF direction finders (R&S® DDF 06A).

The combination of the R&S® DDF 05A VHF/UHF direction finder and the R&S® DDF A-WB HF wideband option for direct receiving mode results in an extremely compact HF/VHF/UHF full-range direction finder.

All antennas of the R&S® ADDx line plus the Antenna Interface R&S® GX060 can be used.

Digital DF methods

The acronym DDF in the type designation R&S® DDF 0xA stands for digital direction finder, indicating that bearings are determined digitally, i.e. the complex antenna voltages are measured by a high-quality three-channel DF receiver that acts like a vector analyzer and are subsequently digitized. The bearings of all individual signals are evaluated in parallel and independently using mathematical algorithms. Both classic direction finding methods such as Watson-Watt and the modern correlative interferometer can be used.

Correlative interferometer

The correlative interferometer has the following advantages over classic methods:

- Reduction of DF errors caused by reflections and depolarization
- Determination of a reliable DF quality criterion for evaluating and filtering bearings
- Possibility of using wide-aperture DF antennas with a minimum number of antenna elements (preferably a circular array)

The essential features of the Watson-Watt method are:

- Maximum scan/DF speed with three-path evaluation (only one measurement step required)
- Use of small-size antennas in the HF range
- Easy adaptation of existing Adcock antennas (especially in the HF range)

Functions and applications

- Automatic DF and location systems with high probability of intercept
- Interception and direction finding of frequency-hopping and burst signals using automatic evaluation methods
- Internal data reduction to limit results to targets truly of interest (direction-selective scan), thus ensuring optimized use in automatic interception systems
- Segmentation of bearings by means of R&S®DDF-CL emitter preclassifier (option) and assignment of tasks to hand-off receivers
- With correlation-based evaluation, also calculation of elevation in the HF range; implementation of single station location (SSL) systems
- Versatile stationary and mobile applications (vehicle, ship, aircraft) by selecting the appropriate DF algorithms and antenna configurations, especially those with wide-aperture characteristics

Type	Application	Frequency range
R&S®DDF01A	HF	0.3 MHz to 30 MHz
R&S®DDF05A	VHF/UHF	20 MHz to 1300 MHz 20 MHz to 3000 MHz depending on antenna configuration
R&S®DDF06A	HF/VHF/UHF	0.3 MHz to 1300 MHz 0.3 MHz to 3000 MHz depending on antenna configuration
R&S®DDF05A plus R&S®DDF A-WB	HF [1]/VHF/UHF	0.3 MHz to 3000 MHz

1) HF: direct receiving mode.

System configuration

The Digital Scanning Direction Finders R&S®DDF0xA cover the HF/VHF/UHF frequency range from 0.3 MHz to 1300 MHz/3000 MHz with only a few DF antennas.

The direction finders are assigned different type designations for different frequency ranges (see table above).

Each direction finder basically consists of four functional units:

- DF antenna system
- DF converter with integrated three-path DF receiver modules
- Digital signal processing unit
- Control PC and software

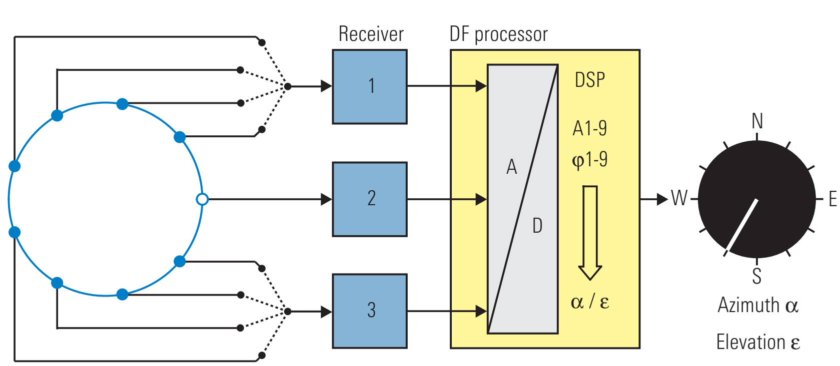
The DF equipment for the HF range consists of the HF DF Converter R&S®EH110 and the Digital Processing Unit R&S®EBD660. For the VHF/UHF range, the VHF/UHF DF Converter R&S®ET550 (20 MHz to 3000 MHz) and the Digital Processing Unit R&S®EBD660 are used. It is also possible to configure a combination that covers the entire frequency range (0.3 MHz to 3000 MHz).

Three DF methods implemented

The software of the digital signal processing unit contains as standard the algorithms for DF evaluation according to the Watson-Watt method, the correlative interferometer and the vector matching method. It is thus possible to use any of the evaluation methods depending on the available antenna system and the operational requirements.

The Digital Scanning Direction Finders R&S®DDF0xA are equipped with built-in test equipment (BITE) by which defects can be localized partly down to module level.

Software updates can be made on the control PC (e.g. via the Internet, and also in remote operation).



Block diagram of the R&S®DDF0xA

Operating and display concept

The direction finders of the R&S®DDF0xA family have no control or display elements. They are controlled from an external PC that is connected to the DF system via data and control interfaces (LAN). Using the standard software that is supplied with each system and runs under Windows XP, you can carry out all control and display functions. The system configuration is to a large extent recognized automatically (antenna type, compass, options).

Four DF modes are available:

Scan mode (fast DF scanning)

In this mode, predefined frequency ranges or frequency lists are scanned for activities at maximum speed. The user enters the scan range (start and stop frequency) or a list of frequencies to be scanned, a lower and, if required, an upper level threshold and the resolution bandwidth. It is also possible to define several scan ranges. Two azimuth sectors and (in the HF range) the elevation range can be defined. In addition, specific frequency bands or discrete frequencies (up to 1000) can be suppressed.

Extremely high scan speed up to 30 GHz/s (see specifications)

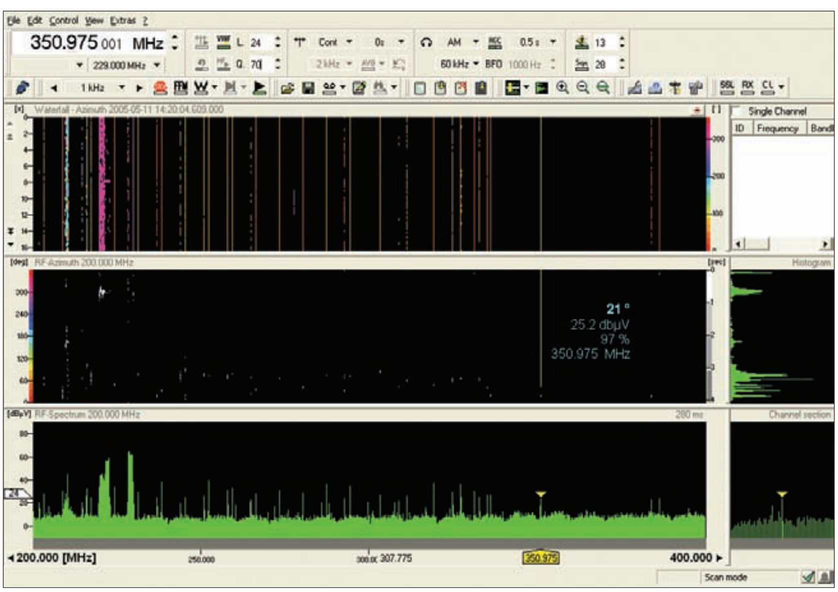
The wide realtime analysis window is shifted step by step at high speed across the defined frequency range. All signals captured in the window are evaluated in parallel, i.e. simultaneously, by means of an FFT with selectable resolution.

DF results can be displayed in several ways:

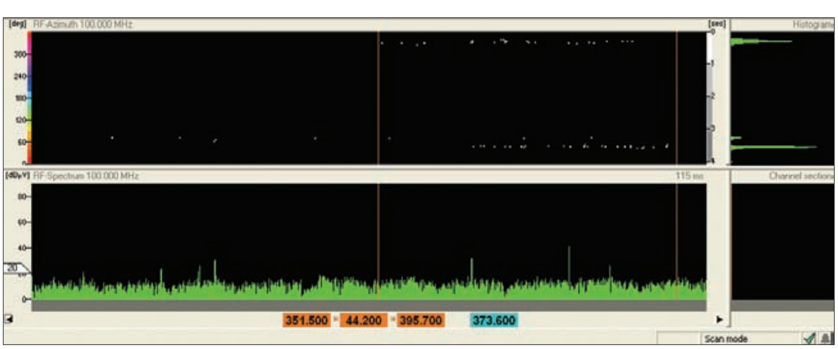
The simplest method is to display DF values as dots in the "bearing versus frequency" mode. The "signal level versus frequency" window below this display shows the current signal occupancy of the selected frequency range or ranges as well as the signal levels (spectrum display).

DF scan speed and channel resolution

The DF scan speed mainly depends on the selected channel resolution. The lower the resolution, the shorter the filter settling time and the higher the DF scan speed. It is therefore important to specify the DF scan speed together with the channel resolution.



Scan mode



Direction finding of two frequency hoppers of the latest generation with 500 hops/s in the same frequency band

It is also possible to show the signals in a waterfall display that reflects the chronological order of their arrival. Results may be color-coded (level or azimuth) to make them easily distinguishable. If required, the evaluation threshold (squelch) can be set such that it automatically orients to the noise level.

A large number of tools can be accessed directly via the screen (icons) to mark frequency, azimuth or level subranges in order to perform measurements or define zoom ranges.

DF scan speed and channel occupancy

The R&S®DDF0xA is one of the very few direction finders available that offers DF scan speed independent of channel occupancy. In other words, the DF scan speed of the direction finder does not vary and is maintained even with 100% channel occupancy. With most of the conventional direction finders, the DF scan speed decreases rapidly as the channel occupancy increases. For this reason, DF scan speed is usually specified for only 10% channel occupancy. This value is quickly exceeded, however, when bearings of weak signals close to the noise floor are taken or of direct sequence spread spectrum (DSSS) signals within the noise floor.

Results can be averaged by forming a histogram, thus providing a stabilized bearing representation.

Frequencies of signals that are identified in the spectrum or bearing display and appear to be of interest can, by clicking a symbol, be assigned to a hand-off receiver for further analysis. Several receivers can be controlled in this way.

Results collected during a specific period of time can be stored on the control PC's hard disk for subsequent analysis.

DF scan speed and channel selectivity

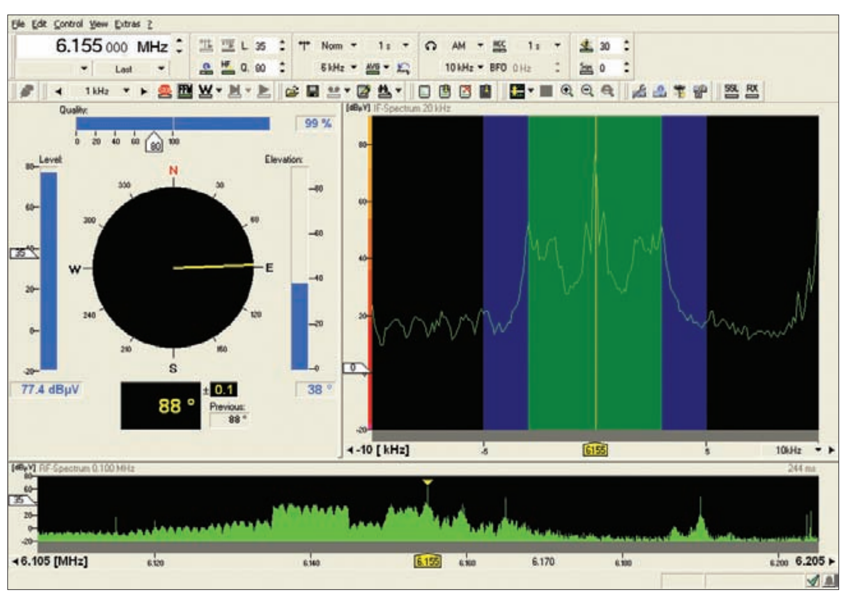
When specifying the DF scan speed, it is essential to indicate the selectivity conditions under which the speed is attained. As a basic rule, the lower the channel selectivity, the higher the speed. With lower selectivity, however, adjacent channel suppression may be insufficient, and adjacent occupied channels may mutually influence the respective bearings that are taken. Selectivity is characterized by the shape factor, which indicates the ratio of the bandwidth at 60 dB suppression to the bandwidth at 3 dB suppression of the unwanted adjacent channel. The R&S®DDF0xA has a shape factor of 3.6 in the scan mode. A quantity connected with the shape factor is the product of the measurement time T and the bandwidth B (B x T or BT). The R&S®DDF0xA has a B x T of 4 to achieve the desired selectivity characteristics.

Fixed frequency mode (FFM)

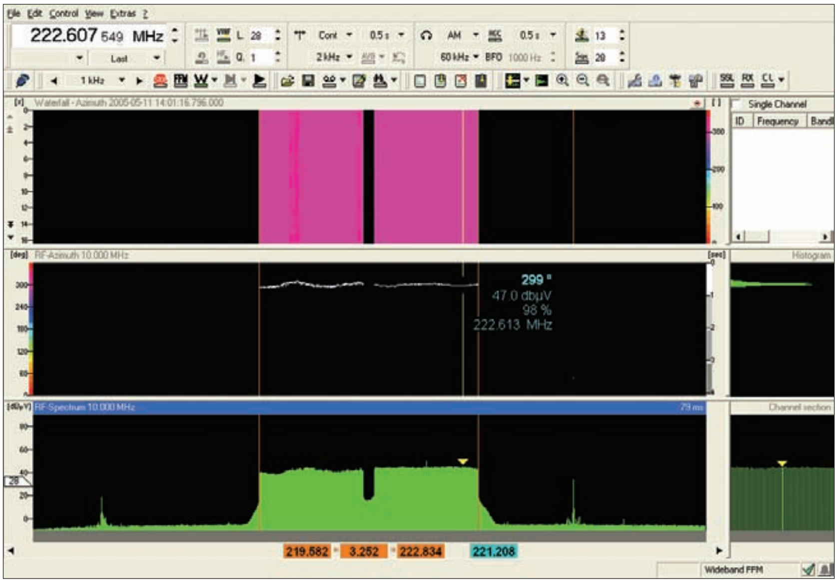
In this mode, the FFT window is locked to the selected center frequency, and it shows the spectrum occupancy in a range of 20 kHz or 1 MHz for the HF and in a range of 100 kHz or 2 MHz for the VHF/UHF range. The bearing obtained for the center frequency is displayed in polar format or as a histogram plus a waterfall. In the FFM mode, the signal of the center frequency can be demodulated. The AF in both analog and digital format is available at the LAN interface for further processing.

Search mode

In this mode, frequency ranges or frequency lists are searched for activities. In contrast to the scan mode, the direction finder dwells for a preselectable time on the frequency of a detected signal that exceeds the level threshold to allow short-time monitoring and averaging of the bearing value before the search is continued. Bearings are presented in the same way as in the fixed frequency mode.



Fixed frequency mode (FFM), search mode



Wideband mode (WFFM)

New: wideband mode

Wideband fixed (WFFM)
In this mode, the direction finder simultaneously takes bearings of all channels that fall within the FFT realtime bandwidth. All relevant parameters such as channel spacing, integration time and DF quality threshold can be directly set.

Results can be displayed in several formats, e.g. spectrum display, bearing versus frequency and waterfall format.

New: parallel averaging of all channels

The WFFM mode in addition offers the innovative feature of parallel averaging of all channels, which significantly enhances the probability of obtaining bearings of weak signals. Even DSSS signals within the noise floor are reliably detected and their bearings taken.

DF accuracy and sensitivity

When the R&S® DDF0xA is tested in a real environment, it is impressive for the stable and accurate bearings it delivers even for weak signals. This fact is due to the direction finder's elaborate design concept, which is described in the following.

Based on the concept of virtual receivers

The direction finder was planned from the start with high accuracy and sensitivity in mind. Consequently, the decision was made in favor of the concept of virtual receivers, which offers significant advantages with respect to the aforementioned prerequisites.

The concept of virtual receivers is characterized by a large number of antenna elements being successively connected to a small number of receivers at very high speed, creating the impression that each antenna element is assigned a receive path of its own. The decisive advantage is that large DF antennas with many antenna elements can be used without requiring a corresponding number of receive paths, which would be very costly, because the larger the size of a DF antenna, the more antenna elements are required.

Number of antenna elements

In principle, DF antennas with a larger number of antenna elements can be designed for larger diameters. But using a larger number of antenna elements offers clear advantages even for DF antennas that have identical diameters.

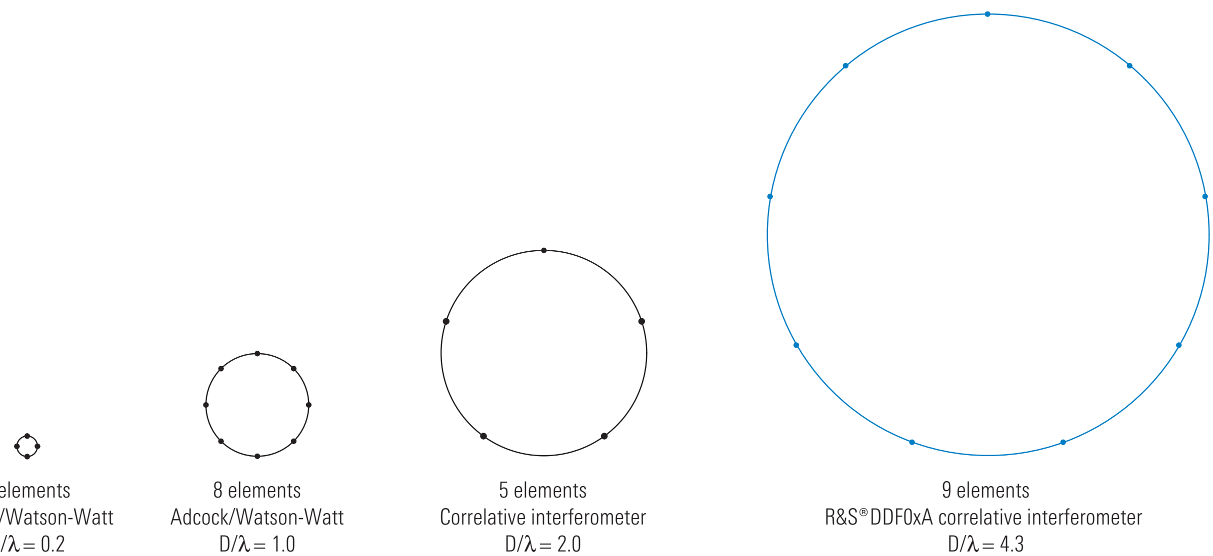
For example, a nine-element DF antenna provides higher accuracy and error tolerance than a five-element antenna due to the fact that it delivers nearly twice as many antenna signals to be averaged.

Larger DF antenna
=
enhanced accuracy and sensitivity

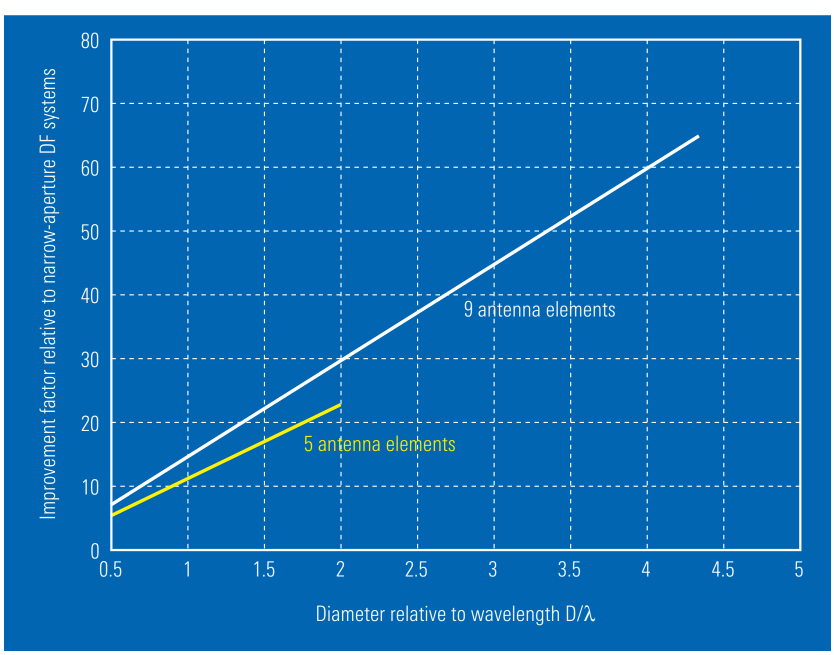
It is generally known that a direction finder's accuracy and sensitivity in a real environment increase with the diameter of the DF antenna. As already mentioned, this advantage comes into its own only in a real operational environment, which involves reflections and weak signals. It is not obvious from specifications, since in data sheets the instrument and system accuracy are specified for ideal, non-reflecting DF antenna environments and strong signals to provide comparability. The figure in the middle shows that the R&S®DDF0xA, featuring a nine-element array and employing the correlative interferometer DF method, offers by far the largest DF antenna and thus higher accuracy and sensitivity.

Immunity to reflections

Reflections may basically impair DF accuracy. Depending on their concept, some DF antennas can handle reflections better than others. The R&S®DDF0xA was designed to provide accurate bearings even with a 50 % share of reflections of the incoming signal. This high immunity to reflections is due to the large number of antenna elements used.



Maximum permissible diameter of the DF antenna relative to the wavelength for unambiguous DF results for up to 50 % of environmental reflections



Improvement factor as a function of the DF antenna aperture for the correlative interferometer

The figure opposite shows the improvement in DF accuracy as a function of the DF antenna aperture. The enhanced accuracy and sensitivity of the R&S®DDF0xA makes it especially suitable for taking bearings

- of weak signals
- of spread spectrum or DSSS signals within the noise floor
- with high accuracy even in non-ideal antenna environments
- in extremely adverse environments, e.g. urban areas

Innovation: averaging in scan mode

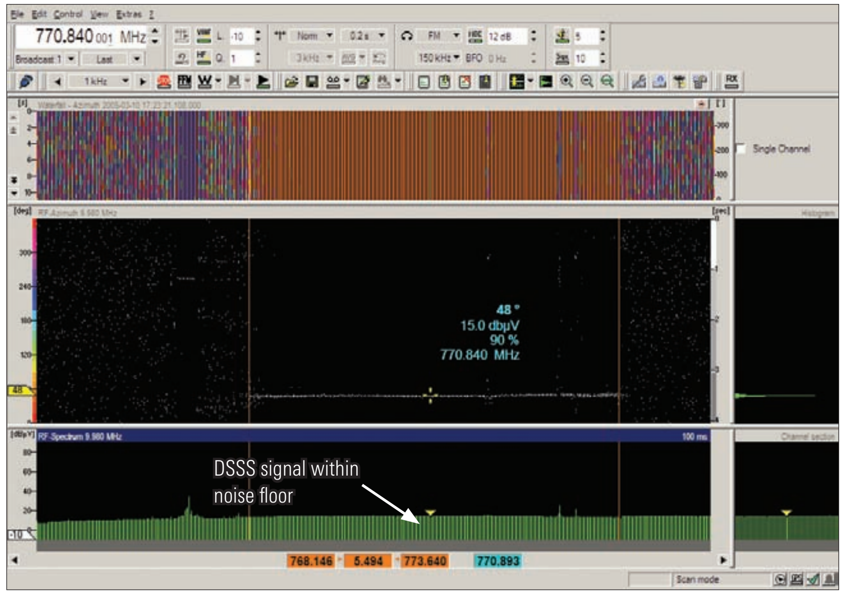
By using averaging during broadband direction finding, a function currently unrivaled, the R&S®DDF0xA reliably detects and takes bearings of signals such as DSSS even if they occur within the noise floor. The R&S®DDF0xA is thus well prepared for this type of data transmission, which is becoming more and more common.

The figure opposite shows a bearing being taken of a DSSS signal within the noise floor (–6 dB), the signal having a width of approx. 5.5 MHz and a nominal bearing value of 48°. The DSSS signal is not recognizable in the spectrum as the signal-to-noise ratio is negative. Another remarkable feature is the very narrow bearing histogram, which indicates very low bearing fluctuation and thus a reliable bearing value.

High sensitivity for maximum range and coverage

The R&S®DDF0xA is also remarkable for its sensitivity: From HF to 1.3 GHz, a low field strength of typically 0.2 µV/m (HF) to 1 µV/m (VHF/UHF) will suffice to obtain a stable bearing. Above 1.3 GHz, no more than 3 µV/m to 10 µV/m is needed.

This makes the R&S®DDF0xA one of the most sensitive direction finders available on the market, which is also due to its large DF antenna.



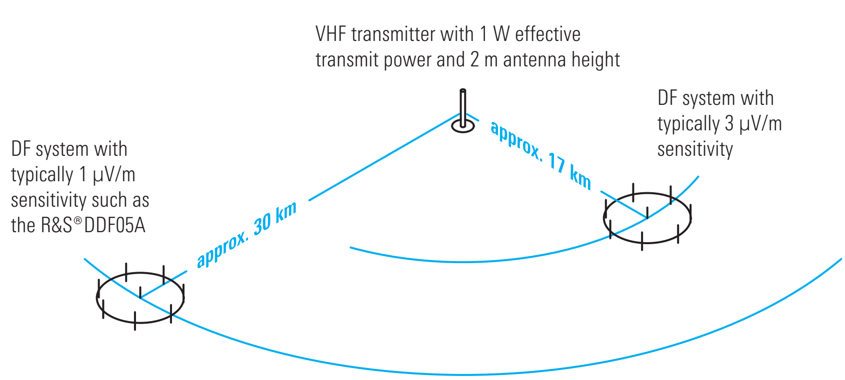
DSSS signal within noise floor (–6 dB)

DF sensitivity

At present, there exists no uniform method of measuring and specifying DF sensitivity. It is therefore of vital importance that precise information be given about the measurement method employed. Specifying DF sensitivity without giving any information about the measurement method by which the specified sensitivity was obtained is meaningless, as different methods will produce significantly different results. For Rohde & Schwarz products, DF sensitivity is defined as the minimum field strength required by the direction finder together with the DF antenna in order to yield accurate bearings (see diagrams on page 19, "Sensitivity of DF antennas").

The higher the sensitivity, the wider the range of a direction finder. This is shown by the figure below, which compares two DF systems of different sensitivity. The comparison is based on the equations for radio propagation in the VHF range recommended by ITU.

According to these equations, the R&S®DDF05A reliably determines the bearing of a 1 W VHF transmitter with a line of sight up to a distance of typically 30 km. For a DF system of lower sensitivity, the distance has to be reduced, and just a few µV/m already mean a significant reduction in DF range.

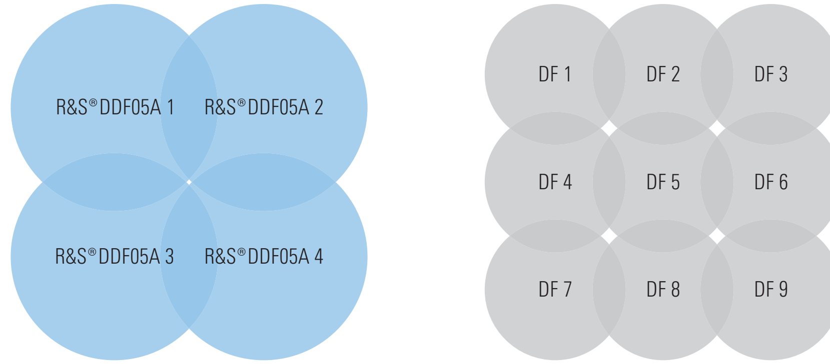


Range comparison of DF systems of different sensitivity for a VHF transmission

High coverage reduces costs

The high sensitivity of the R&S®DDF 0xA provides significantly wider coverage. This means that fewer direction finders are needed for monitoring a specific area than would be in the case of less sensitive DF systems, although sensitivity may differ by just a few µV/m.

This substantially reduces costs, as can be seen from the figure opposite.



Spatial coverage with a typical sensitivity of 1 µV/m as with the R&S®DDF0xA

Spatial coverage with a typical sensitivity of 3 µV/m

Coverage comparison of DF systems of different sensitivity for a VHF transmission

Receiver quality

Whether weak signals can be received at all or whether a direction finder can deliver meaningful results, even when located at an unfavorable site in the vicinity of a strong transmitter, largely depends on the quality of the receivers used.

Enhanced immunity to strong signals because of maximum linearity and minimum phase noise

Linearity, which is defined by the second- and third-order intercept (SOI and TOI) points, describes to what extent intermodulation products in the vicinity of strong transmitters become visible. Unfortunately, standardized procedures for measuring SOI and TOI are not yet available. This makes it difficult to compare the quality of different receivers on the basis of data sheet specifications. Where comparable measurements are available, the R&S®DDF 0xA receivers frequently have significantly higher and thus better values.

The very low phase noise additionally increases immunity to strong signals.

And here another advantage of the virtual receiver concept comes into play: the fact that only a small number of receive paths is required. The DF converter of the R&S®DDF0 xA contains three coherent receive paths. Compared with five-path direction finders, this concept alone reduces costs by 40 %. This in turn makes it possible to use receivers of superior quality.

The vital prerequisite: state-of-the-art receivers

Each R&S®DDF 0xA version is equipped with three receivers that are among the best available on the world market and have been developed and produced by Rohde & Schwarz itself:

- The converter for the HF range contains three receivers nearly identical in design with the R&S®EM010
- The converter for the VHF/UHF range contains three receivers nearly identical in design with the R&S®EM050

Finding a suitable location for a DF antenna is often difficult, in particular in the VHF/UHF range, because strong transmitters, e.g. FM or TV broadcast transmitters, may be located nearby. The R&S®DDF 0xA's high linearity and very low phase noise make it possible to install the direction finder closer to strong transmitters.

High linearity makes finding a suitable DF location easier

Simulations show that, with intermodulation products of equal strength, the R&S®DDF 0xA can be located approx. 30 % closer to a strong transmitter than a direction finder whose intercept points are approx. 10 dB lower. Compared with a direction finder with 18 dB lower intercept points, the R&S®DDF 0xA can be installed at even half the distance. This facilitates finding a suitable DF antenna site.

Typical applications of the R&S®DDF0xA direction finder

Automatic location of LPI transmitters

Several R&S®DDF0xA direction finders can be combined to form a DF network, where the direction finders scan a specific frequency range continuously and synchronously and automatically preclassify and locate transmitters of interest. All located transmitter sites are automatically displayed on an electronic map. The transmitters are color-coded to differentiate between frequency hoppers, chirp, burst and fixed frequency transmitters.

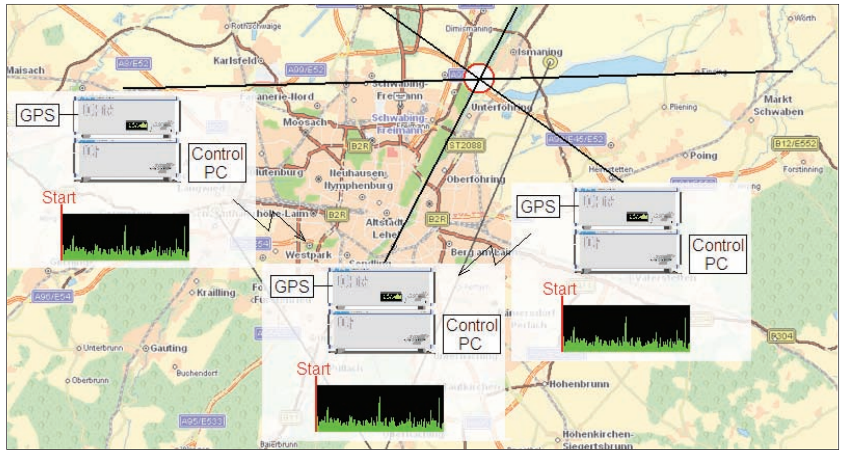
Two DF options are required to ensure reliable automatic direction finding and location:

The R&S®DDF-TS option synchronizes the DF process by means of a GPS signal so that all direction finders of a DF network scan exactly at the same frequency at the same time. This is the only way to ensure that bearings of a short-term emission are taken by **all** direction finders, an essential prerequisite for subsequent location.

Automatic preclassification of LPI signals

The R&S®DDF0xA uses the R&S®DDF-CL option to store all results and compare them to new results. LPI signals with their characteristic patterns are thus automatically detected and classified. The individual results of an emission are summarized to give a condensed result. This means that the overall DF result is compressed to the maximum possible extent, yielding, for example, the information that a frequency hopper is transmitted at such and such a frequency, in such and such a direction and at such and such a time.

The high data reduction also means that requirements on the data rate of the communications link are less stringent. Frequency-agile and crypto radiocommunications equipment can thus easily be used for data transmission.

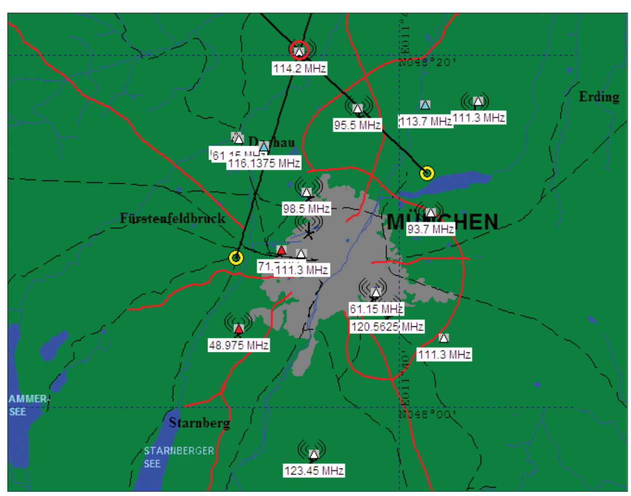


R&S®ScanLoc including three R&S®DDF05A direction finders

Automatic generation and updating of communications order of battle

All radiolocation results are automatically displayed on an electronic map and updated at a settable refresh rate. Different types of signals, e.g. hoppers or bursts, are represented by different symbols. The DF sites are also marked.

The automatic generation and updating of a communications order of battle including tracking is the prerequisite for making fast and reliable decisions.



R&S®ScanLoc DF map

Product	Brief description
R&S®DDF05A	Very fast VHF/UHF scanning direction finder with high accuracy and sensitivity
R&S®ADD050	VHF DF antenna for the frequency range 20 MHz to 200 MHz
R&S®ADD153	VHF/UHF DF antenna for the frequency range 20 MHz to 1300 MHz
R&S®ADD053	DF antenna system for the frequency range 20 MHz to 1300 MHz consisting of the R&S®ADD050 and the R&S®ADD153
R&S®ADD070	DF antenna for the frequency range 1300 MHz to 3000 MHz
R&S®DDF-CL	DF option for the automatic detection and direction finding of LPI signals such as hoppers, chirps and bursts
R&S®DDF-TS	DF option for synchronizing the scan activities of several direction finders in a radiolocation network
R&S®DDFA-MC	DF option for R&S®ScanLoc and multi-user systems; includes the remote-control option

R&S® DDF 05A with R&S® DDF A-WB option

Mobile HF/VHF/UHF direction finder
To provide mobile detection and direction finding throughout the entire frequency range up to 1300 MHz, it takes compact DF equipment, broadband DF antennas and appropriate DF methods.

300 kHz to 1.3 GHz with two compact DF antennas

Rohde & Schwarz offers optimized DF equipment and antennas that provide seamless coverage in the frequency range 300 kHz to 1300 MHz. The complete range is covered by only two DF antennas that deliver very good results despite their small dimensions. Above 200 MHz, the mobile system offers DF accuracy and sensitivity as high as that of the stationary system.

300 kHz to 3 GHz with just eight height units

The R&S® DDF 05A with the R&S® DDF A-WB option is a highly compact HF/VHF/UHF direction finder (eight height units), featuring a wide realtime bandwidth through the entire frequency range. Above 20 MHz, signal processing is carried out in the same way as with the stationary system, i.e. by means of three preselectors and converters. In the HF range, by contrast, the three channels are switched directly to the A/D converters of the DF processor, and the receive paths are implemented in the form of digital software receivers.

The VHF/UHF range is covered by the DF Antenna R&S® ADD153. The antenna consists of nine elements and uses the correlative interferometer. It is preferably installed on a mast, but delivers very good results also when mounted on a vehicle roof.

The DF Antenna R&S® ADD119 was developed for mobile HF direction finding. The antenna consists of a crossed loop and a reference antenna, which combine to form a classic Watson-Watt DF antenna approx. 1 m in diameter. The antenna is designed for ground waves up to 30 MHz and, despite its small dimensions, offers a DF accuracy of 2° RMS as well as high sensitivity. It is preferably installed on a vehicle roof or a tripod.

Error correction on request

With the antenna mounted on a vehicle, the DF accuracy is generally restricted by resonances and reflections, especially in the range below 200 MHz. To minimize impairment of DF quality by such effects, Rohde & Schwarz will on request calibrate your DF vehicle on a turntable. With calibration, the DF accuracy in this range is on average twice as high as without calibration.

Mobile HF/VHF/UHF direction finder from Rohde & Schwarz

Product	Brief description
R&S® DDF 05A	Very fast VHF/UHF scanning direction finder with high accuracy and sensitivity
R&S® DDF A-WB	DF option that extends the VHF/UHF Direction Finder R&S® DDF 05A to include the HF band and increases the FFT realtime bandwidth to 10 MHz
R&S® ADD119	Compact Watson-Watt HF DF antenna
R&S® ADD153	VHF/UHF DF antenna for the frequency range 20 MHz to 1300 MHz
R&S® ADD150A	Adapter for mounting the R&S® ADD153 on a mast
R&S® AP502Z1	Adapter for flat-mounting of the R&S® ADD119 on a vehicle roof

Stationary VHF/UHF radiomonitoring

The R&S®ADD053 antenna system was designed for use in stationary and semimobile VHF/UHF DF systems. This antenna system together with the R&S®DDF05A yields a DF system that offers outstanding characteristics:

- Highly accurate bearings due to the use of large DF antennas with nine elements each: DF accuracy is usually 1° RMS even in real environments due to the high immunity to reflections
- Extremely high sensitivity, which is likewise due to the large antenna diameter: a field strength as low as 1 µV/m suffices at most frequencies to provide accurate bearings (see data sheet on DF Antennas R&S®ADDx)
- High scan speed owing to extensive computing capacity: scan speed as high as 30 GHz/s can be selected

R&S®ADD053 and R&S®ADD070 DF antenna system

The DF Antenna R&S®ADD153 is mounted at the top. This antenna covers the frequency range 200 MHz to 1300 MHz. While the R&S®ADD153 can be used down to 20 MHz, the R&S®ADD050 is employed in this range as it offers better results due to its considerably larger size.

Product	Brief description
R&S®DDF05A	Very fast VHF/UHF scanning direction finder with high accuracy and sensitivity
R&S®ADD053	DF antenna system for the frequency range 20 MHz to 1300 MHz consisting of the R&S®ADD050 and the R&S®ADD153
R&S®ADD070	DF antenna for the frequency range 1300 MHz to 3000 MHz, sturdy version (02), permitting the R&S®ADD053 to be mounted on its top
R&S®KK500	All-weather cabinet for the DF equipment

Maximum accuracy and sensitivity in the tactical VHF range

The R&S®ADD050 with a diameter of 3 m has been optimized for direction finding in the range 20 MHz to 200 MHz. Together with the R&S®ADD153 and a glass-fiber intermediate mast, it forms the R&S®ADD053 antenna system.

Mounting the antenna system takes surprisingly little time, which is also due to the extensive use of lightweight construction material such as aluminum and glass fiber.

In field use, the DF system is impressive for taking extremely accurate bearings of LPI signals such as hoppers and bursts at an extremely high speed, even if such signals are transmitted over large distances and therefore hardly recognizable. If necessary, the DF Antenna R&S®ADD070 can be added to extend the coverage range up to 3 GHz.

Especially when high masts are used or the control PC is spaced some distance away from the DF equipment, it is advisable to accommodate the DF equipment in the All-Weather Cabinet R&S®KK500. This does away with the need for long coaxial cables, which reduce sensitivity at high frequencies and are very costly.

If the Ethernet link is also implemented by means of a glass-fiber cable, the control PC can be installed several hundred meters away from the DF equipment without any impairment to the DF process.

Semimobile HF DF station

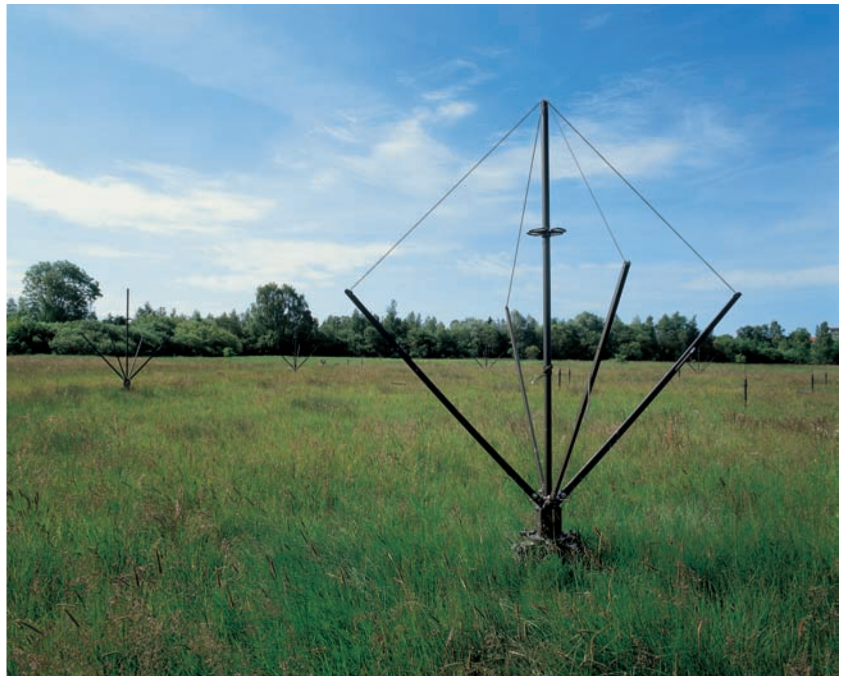
In conjunction with the wide-aperture DF Antenna R&S®ADD011, the Direction Finder R&S®DDF01A forms a DF system for the frequency range 300 kHz to 30 MHz that is remarkable for its high accuracy and sensitivity.

The large nine-element DF antenna of 50 m in diameter combines with the correlative interferometer to make the direction finder less sensitive to reflections encountered in uneven terrain. This greatly facilitates finding a suitable location for the DF antenna.

The use of crossed loops ensures that bearings will still be taken even of signals incident at steep elevation angles of up to 85°. The elevation angle is also calculated, making the DF antenna ideally suited for single station location.

Superior accuracy and sensitivity

The R&S®DDF01A combined with the R&S®ADD011, therefore, offers a typical DF accuracy of 1° RMS and a typical sensitivity of 0.25 µV/m (see specifications) also in real environments that are suitable for direction finding (i.e. not only in an ideal test terrain).



DF Antenna R&S®ADD011

Installation of the R&S®ADD011 is quick and easy. Trained personnel will need no more than half an hour to set up the antenna by using the tools supplied.

In stationary applications, remote control of the DF system by means of the R&S®DDFA-REM option is recommended. This allows the direction finder to be located in a remote area where impairment by man-made noise and reflections is kept to a minimum.

Product	Brief description
R&S®DDF 01A	Very fast HF scanning direction finder with high accuracy and sensitivity
R&S®ADD011	Wide-aperture HF DF antenna with high accuracy and sensitivity
R&S®DDF-SSL	Single station locator DF software option for locating HF transmitters by means of only a single direction finder, based on ionosphere data
R&S®DDFA-REM	DF option for remote control of the direction finder via ISDN, etc
R&S®KK500	All-weather cabinet for the DF equipment

Options

Direction finding of GSM mobile phones

R&S®DDF-GSM option

With this option, the R&S®DDF05A enables quasi-simultaneous direction finding of all mobile phones active in a channel. A bearing is determined for each occupied timeslot. Only in this way is it possible to locate a mobile phone in a densely occupied radio scenario.

Reliable bearings in densely occupied radio scenarios

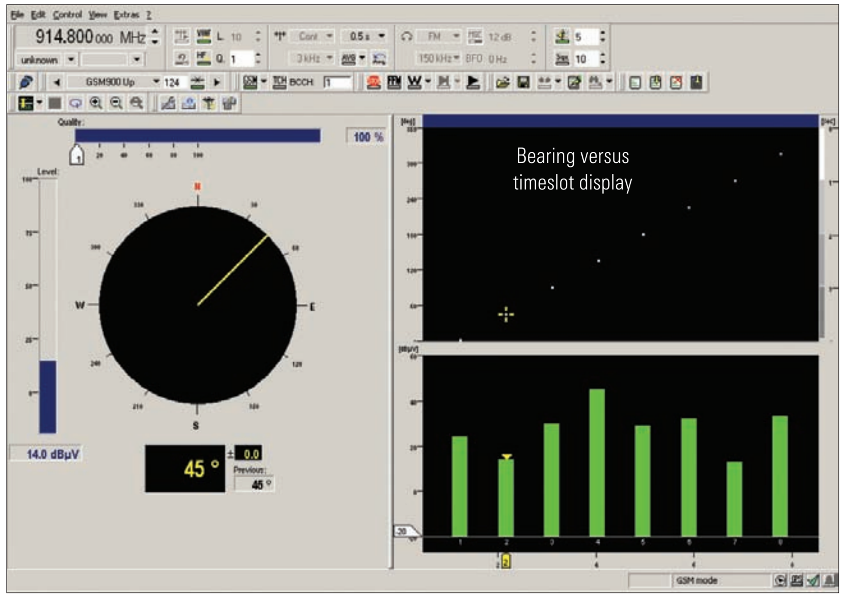
Mobile phones transmit information in short bursts of 577 µs. Requiring a minimum signal duration of only 350 µs, the R&S®DDF05A is able to capture these extremely short-term emissions. The main task of the GSM option is to cause the direction finder to start the measurement exactly when the mobile phone starts transmitting. This can be done in three ways:

- The R&S®DDF05A is synchronized to the base station to which the mobile phone is connected.
- An external trigger signal informs the R&S®DDF05A of the start of an emission (option).
- The R&S®DDF05A is supplied with a highly stable clock signal (e.g. GPS) and synchronized to the base station only once. Depending on the stability of the external clock signal, the direction finder remains synchronized to the base station for many hours.

Automatic preclassifier

R&S®DDF-CL option

Personnel involved in military radiomonitoring in particular has to cope with increasingly complex radio scenarios. The spectrum occupancy is steadily increasing, while the techniques employed to camouflage radio emissions are becoming more and more sophisticated.



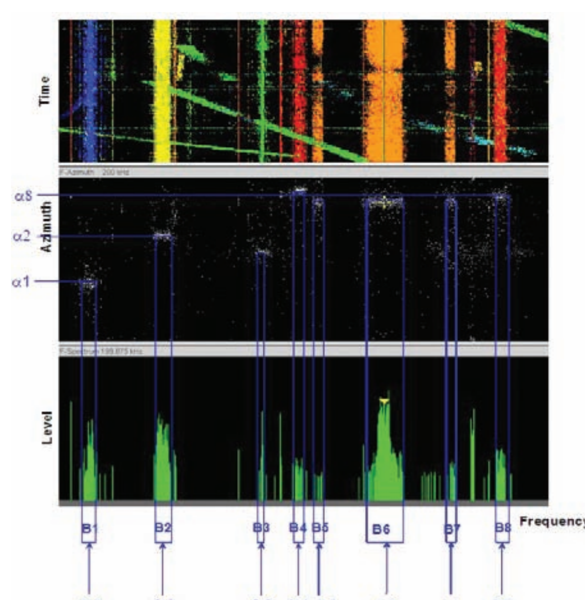
R&S®DDF-GSM option: control software in GSM mode with eight mobile phones

Consequently, the probability increases that, for example, frequency hoppers operating in large bandwidths or short bursts emitted at unknown frequencies will go unnoticed.

The preclassifier ensures that virtually every signal will be detected.

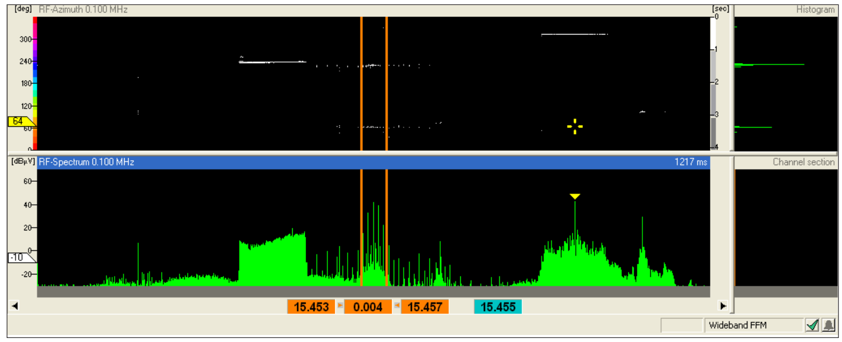
Automatic detection of hoppers, bursts and chirps

After a start and a stop frequency is entered, the frequency range is continuously scanned and results are stored. Any new signals detected are compared with the results previously stored. If a specific pattern is recognized (e.g. several burst emissions from the same direction, indicating a frequency hopper), the signal in question is classified as



R&S®DDF-CL option: principle of preclassification belonging to one of the following categories: fixed frequency, hopper, chirp or burst. Individual results are averaged to form an overall result. The R&S® DDF0xA with the preclassifier option, therefore, provides the basic functionality needed for the automatic location of LPI signals.

This technique not only offers the advantage of being independent of the operator's expertise, but also another important asset, i.e. data reduction.



R&S® DDF-HFR option: direction finding of two emitters in the same frequency range with 20 Hz resolution

Maximum data reduction

Radiolocation networks consisting of several direction finders transfer DF results to a central station. The smaller the amount of data to be transferred, the less conspicuous the data transmission. Preclassification maximally reduces data, leaving only the essential information to be transmitted.

High frequency resolution

R&S® DDF-HFR option

The R&S® DDF0xA offers high frequency resolution as standard, which is sufficient for most applications. Some applications, however, require extremely high resolution, for example:

- Direction finding of co-channel interferers: if two transmitters operate in an overlapping spectrum, the bearing error increases and the bearing may even be invalid.
- Direction finding of hidden signals: the same applies as in the case of co-channel transmitters. The difference is that the signal searched for deliberately conceals itself in the spectrum of an FM or TV broadcast transmitter, for example.

New: extremely high frequency resolution on request

Due to the extremely high frequency resolution achieved with the R&S® DDF-HFR option, the R&S® DDF0xA calculates up to a hundred times more bearings per frequency band. As a result, statistical functions such as the histogram and the sliding averaging function yield more accurate results in considerably less time. Moreover, a greater number of interference-free bearings is obtained since, at the instant a bearing is taken, only one transmitter emits a signal at that specific frequency.

The figure above shows a measurement in the WFFM mode with a resolution of 20 Hz. In the range marked by the two orange lines, a co-channel interferer is superimposed on the signal of interest. Owing to the high resolution, two maxima are clearly discernible in the histogram, and accurate bearings can be taken.

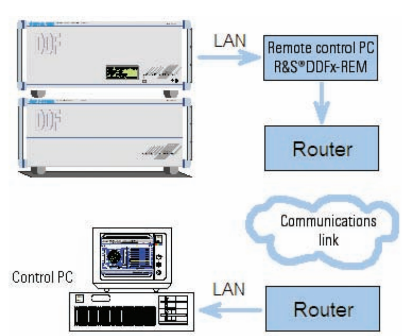
Remote control

R&S® DDF A-REM option

There are two main reasons for operating the R&S® DDF0xA by remote control: improved receive characteristics and simplified control of DF networks.

Remote control via virtually any data link

Improvement of receive characteristics: Man-made noise is particularly high in the shortwave range. Setting up a DF system at a sufficient distance from densely populated areas is therefore crucial when bearings are to be taken of weak signals. To avoid strong reflections, it is further recommended that HF direction finders be set up as far away as possible from buildings, high-tension lines, streets and roads. If the DF operators themselves are not stationed at such remote locations, remote control is the solution.



R&S® DDF A-REM option

Simplification of DF network operation: If several direction finders are connected to form a network, central control is a great advantage as experienced users are needed only at a single station.

The R&S®DDF A-REM remote control software is installed on a commercial PC close to the DF equipment. Data transmission is organized by commercial routers. Any desired communications link can be used:

- ISDN
- GSM/GPRS
- Satellite link
- Radio modems
- Microwave link
- … plus many more

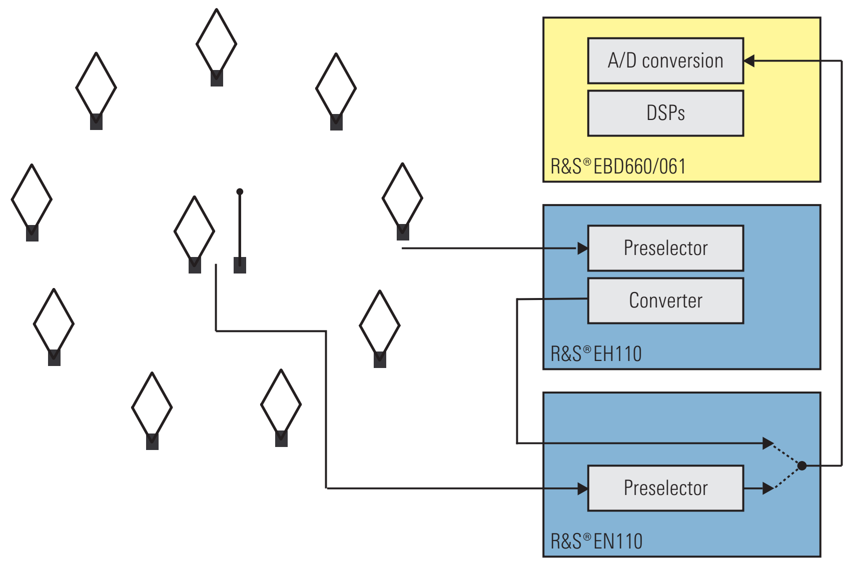
The R&S®DDF A-REM software not only provides remote control, but also performs other tasks:

- Intelligent data reduction to adjust the data volume to be transmitted to the available communications link
- Audio data compression
- Multiple station management

Single station locator
R&S®DDF-SSL option

The shortwave range offers the special opportunity of locating transmitters by means of a single direction finder if their signals are propagated via skywaves. Direction finding makes use of the fact that the shortwave signal is reflected by the ionosphere, and the transmitter location is calculated following the law of angle of incidence being equal to the angle of reflection.

The R&S®DDF 01A calculates the elevation. The DF quality filter and the histogram function are available for data averaging.

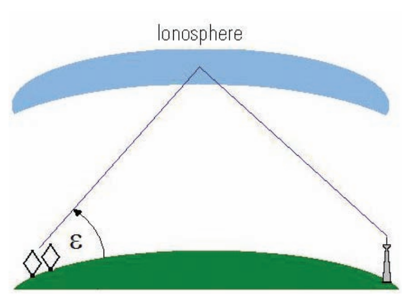


R&S® DDF-LF option

Convenient operation due to integrated ionosphere database

The height of the ionosphere can be conveniently calculated after entering the current smoothed number of sunspots into the DF system. This information is available in a database, which contains the averaged data of many years and is very accurate. All parameters can of course also be user-defined.

The R&S®DDF-SSL option also offers the possibility of calibrating the height of the ionosphere using a transmitter with a known position.



R&S® DDF-SSL option

VLF extension
R&S®DDF-LF option

New: direction finding down to 9 kHz

The R&S®DDF-LF extension expands the R&S®DDF 0xA frequency range down to 9 kHz. The frequency range from 1 MHz to 30 MHz may be covered by the DF Antenna R&S®ADD011, for example. Below 1 MHz, a classic Watson-Watt DF antenna consisting of a crossed-loop antenna and a monopole can be used.

Bearings are determined using either the correlative interferometer or the Watson-Watt method, depending on the frequency, thus making maximum use of the two methods: high bearing accuracy and compact dimensions.

Signal processing also differs for the two ranges. Above 1 MHz, three classic analog receivers with a preselector and a converter are employed. Below this frequency, the receive signals are merely passed through a broadband filter and then applied directly to the A/D converters. Subsequent filtering is performed digitally by means of software receivers.

Synchronous scanning
R&S® DDF-TS option

To locate a transmitter by triangulation, bearings are required of several direction finders. This is ensured for signals with normal transmission duration of a few hundred milliseconds and above.

A key requirement for locating LPI signals

With frequency-agile LPI signals such as hoppers and bursts, the duration of a single transmission is very short. Moreover, the frequency is not known, so that large frequency ranges have to be scanned. It may happen that only one direction finder is operating at the correct frequency at the moment of an emission. Locating the transmitter searched for is then impossible.

Using the R&S® DDF-TS option, the scan activities are synchronized, i.e. each direction finder measures exactly at the same frequency at the same time. A reliable bearing of any detected signal is taken by each direction finder, and the signal is located with maximum accuracy. Synchronization is highly accurate due to the use of GPS. The R&S® DDF-TS option is therefore an important prerequisite for DF networks locating LPI signals.

Tools for maintenance and troubleshooting
R&S® DDF-SK option

The R&S® DDF-SK service kit option considerably cuts the time required for maintenance and troubleshooting of the R&S® DDF 0xA.

Troubleshooting – fast and successful

All tools essential for checking the DF system are conveniently accommodated in a rugged case. An important tool is the

R&S® DDF-TS option

Antenna Simulation R&S® ZT660, which is connected to the direction finder instead of the DF antenna to perform system tests. It can be set to simulate any desired Rohde & Schwarz DF antenna. Using the antenna simulation, it can conveniently be checked whether a fault originates from the DF antenna or the DF equipment. This relieves the operator from having to climb the antenna mast or even dismount the DF antenna unnecessarily. The antenna simulation also allows a signal generator to be connected to the DF system, and to take test bearings of its signals with a predefined direction.

The service kit contains the following test equipment:

- Antenna Simulation R&S® ZT660
- Various cables and adapters
- Various tools for opening housings and enclosures

The following tests can be performed, for example:

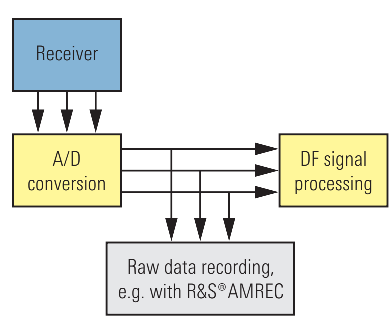
- Localization of faults as originating from the DF equipment or DF antenna
- Testing of the three receive paths
- Taking a test bearing with the aid of a signal generator

Output of digitized raw data
R&S® DDF-DR option

If the R&S® DDF 0xA is used as a data source for an analysis system such as R&S® AMMOS, digitized, unprocessed intermediate-frequency (IF) data has to be output.

New: raw data output for analysis

The R&S® DDF-DR option allows raw data to be output via a standardized FPDP interface. The digitized IF data of the three receive paths are brought out at this interface and can be recorded by means of the R&S® AMREC, for example.



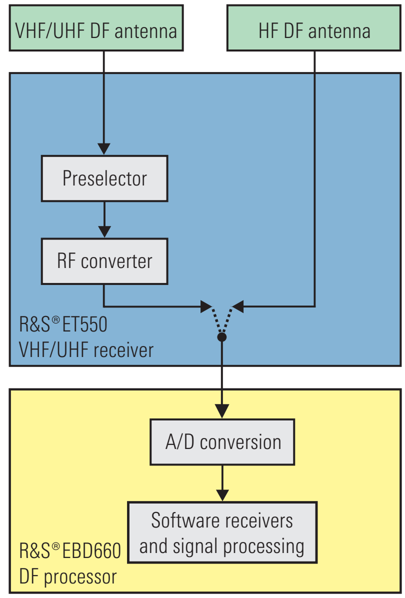
R&S® DDF-DR option

Broadband direction finding and HF extension
R&S®DDF A-WB option

The R&S®DDF A-WB option significantly boosts the already high scan speed in the HF range. It expands the realtime bandwidth from 1 MHz to up to 10 MHz, thus providing a considerably higher probability of intercept for short-term and frequency-agile signals. The complete HF band is searched, at good resolution, in less than 100 ms (see specifications).

When switchover is made to broadband direction finding, the preselectors are bypassed and the antenna signals are applied directly to the A/D converters. Further signal processing is digital.

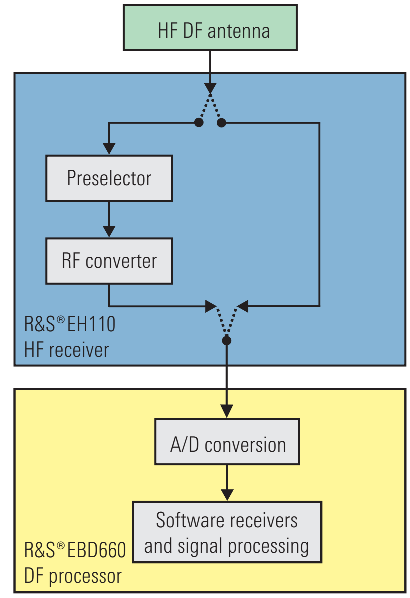
The R&S®DDF A-WB option performs several tasks, depending on the base unit in which it is installed. In the case of the R&S®DDF 01A, the realtime bandwidth is increased to 10 MHz; in the case of the R&S®DDF 05A it additionally extends the frequency range to include the HF band.



R&S®DDF A-WB option to include the HF band for the VHF/UHF Direction Finder R&S®DDF 05A:

Extremely compact full-range direction finder

A compact HF DF antenna, for example the R&S®ADD119, is connected to the DF Converter R&S®ET550. When VHF/UHF is selected, the antenna signals are routed through the preselectors and converters. When HF is selected, the antenna signals are directly applied to the A/D converters of the DF processor. After A/D conversion, the signals are further processed by means of software receivers. Bearings are calculated with 10 MHz realtime bandwidth employing the correlative interferometer or the Watson-Watt method, depending on the DF antenna used.



R&S®DDF A-WB option to expand the realtime bandwidth for the HF Direction Finder R&S®DDF 01A:

Can be switched between maximum scan speed and maximum accuracy as required

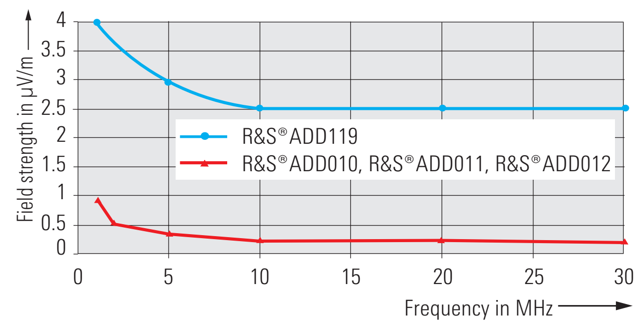
The spectrum can first be scanned at maximum speed with 10 MHz FFT realtime bandwidth. In this mode, the antenna signals are directly applied to the A/D converters; further signal processing is digital.

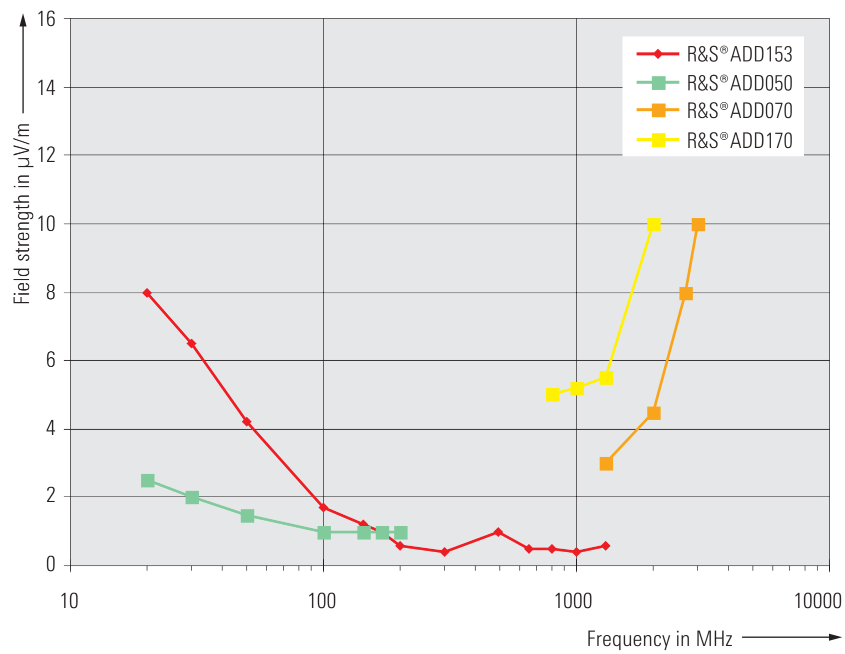
On detecting a transmitter of interest, switchover is made to the normal mode, and the antenna signals are routed through the preselectors and converters. This procedure yields better results especially for weak signals and for locations in the vicinity of strong transmitters.

DF antennas

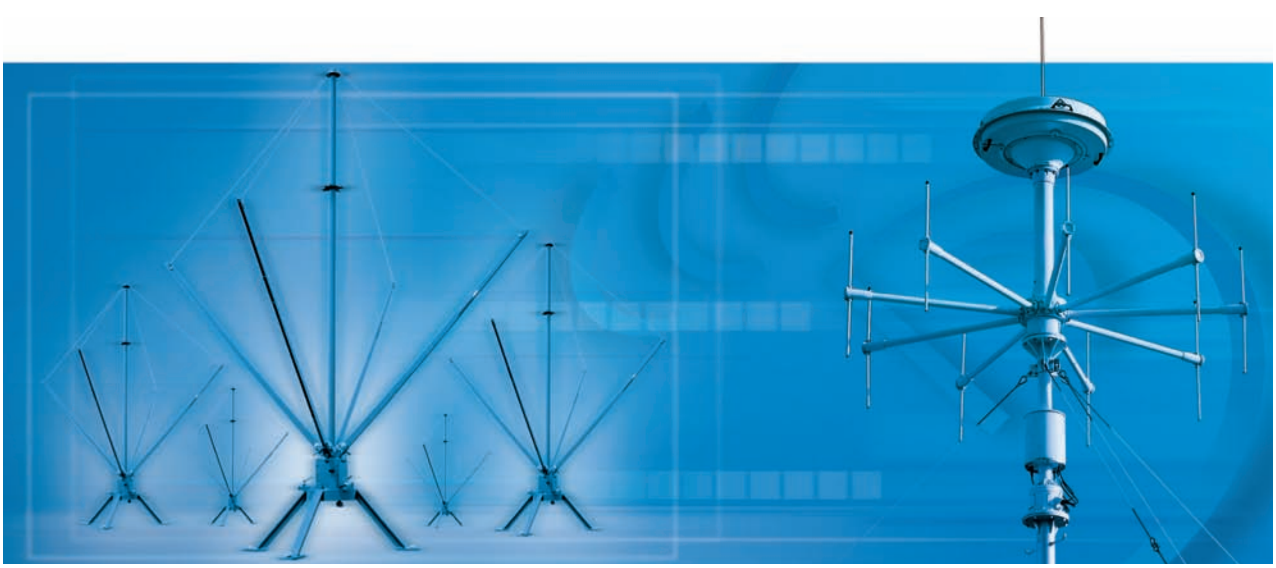
The direction finders of the R&S®DDF0xA family operate with the DF Antennas R&S®ADDx, which are also used for the R&S®DDF0xM, R&S®DDF0xS and R&S®DDF0xE families of direction finders.

In many cases, existing DF antennas (especially HF Adcock antennas) from other manufacturers can be used. In these cases, the Antenna Interface R&S®GX060 is required. The details must be verified from case to case.



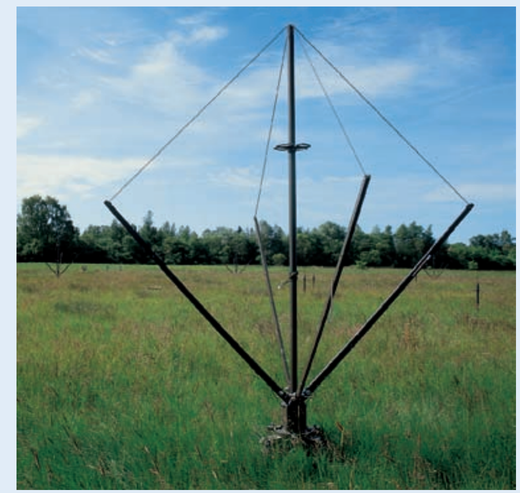


Sensitivity of DF antennas;
averaging time 1 s, bearing fluctuation <2° RMS, bandwidth 1 kHz



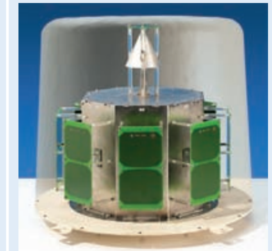
All DF antennas mentioned here are described in detail in the R&S®ADDx DF antenna data sheet

Specifications – HF antennas

Type (Order No.)	R&S®ADD119 (4053.6509.02)	R&S®ADD010 (4045.0105.03)	R&S®ADD011 (4045.0005.13)
		The figure shows an antenna element of the R&S®ADD010, which in total contains nine elements arranged on a circle 50 m in diameter. 	
Application	mobile, fast scanning for ground waves and sky waves with low elevation angle	semimobile and stationary, for signals with elevation angle ≤50°, SSL possible to a limited extent	stationary, for signals with elevation angle ≤85°, SSL possible
Frequency range	(0.3 MHz) 1 MHz to 30 MHz, below 1 MHz with limited sensitivity and accuracy		
Antenna type	1 crossed loop and 1 active dipole	active 9-element circular array of rod antennas	active 9-element circular array of crossed loop antennas
DF method	Watson-Watt	correlation	correlation
Polarization	vertical	vertical	vertical, horizontal, circular
DF accuracy [1]	2° RMS	1° RMS	1° RMS
Sensitivity	typ. 4 μV/m to 2.5 μV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 1 μV/m to 0.2 μV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 1 μV/m to 0.2 μV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)
Power supply	from DF equipment	from power supply built in as standard	from power supply built in as standard
Dimensions (approx.)	1100 mm diameter × 232 mm height	antenna circle: 50 m diameter, height of rod antenna: 2 m	antenna circle: 50 m diameter, height of crossed loop: 3.5 m incl. tripod
Color	RAL 1015	RAL 6014	RAL 6014
Weight (approx.)	25 kg	single element with base plate: 14 kg, network: 22 kg	single element with base plate: 32 kg, network: 22 kg

[1] Measurement in reflection-free environment. The RMS error is calculated from the bearings of an evenly distributed azimuth and frequency sample.

Specifications – VHF/UHF antennas

Type (Order No.)	R&S®ADD153 (4053.0003.02)	R&S®ADD050 (4041.4006.02)	R&S®ADD053 (4062.8800.02)	R&S®ADD070 (4043.4003.02/.12)[2]	R&S®ADD070M (4059.6000.02)	R&S®ADD170 (4055.7502.12)
						
Application	VHF/UHF, mobile and stationary	VHF, stationary, enhanced accuracy especially with multipath propagation	VHF/UHF, stationary, combination of R&S®ADD153 and R&S®ADD050	UHF, stationary, can be mounted below VHF/UHF antennas on same mast	UHF, mobile	optimized for mobile direction finding in GSM bands
Frequency range	20 MHz to 1300 MHz	20 MHz to 200 MHz	20 MHz to 1300 MHz	1300 MHz to 3000 MHz	1300 MHz to 3000 MHz	800 MHz to 2000 MHz
Antenna type	9 active antenna elements in radome	active 9-element circular array	2 × active 9-element circular array	8-element circular array	8-element circular array	8-element circular array with center antenna
DF method	correlation	correlation	correlation	correlation	correlation	correlation
Polarization	vertical	vertical	vertical	vertical	vertical	vertical
DF accuracy[1]	2° RMS (20 MHz to 200 MHz) 1° RMS (200 MHz to 1300 MHz)	1° RMS	1° RMS	2° RMS	2° RMS	2° RMS
Sensitivity	typ. 8 µV/m to 0.5 µV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 2.5 µV/m to 1 µV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 0.5 µV/m to 1 µV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 3 µV/m to 10 µV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 3 µV/m to 10 µV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)	typ. 5 µV/m to 10 µV/m (2° bearing fluctuation, 1 kHz bandwidth, 1 s averaging time)
Wind load/center of wind load						
Without ice deposit	at 188 km/h: 710 N/210 mm	at 188 km/h: 1700 N/380 mm	at 188 km/h: 2700 N/800 mm	at 180 km/h: 200 N/250 mm (model .12) at 200 km/h: 530 N/620 mm (model .02)	at 180 km/h: 199 N/170 mm	at 180 km/h: 350 N/180 mm
With 30 mm ice deposit	at 162 km/h: 770 N/270 mm	at 162 km/h: 2800 N/410 mm	at 162 km/h: 3700 N/690 mm	at 140 km/h: 210 N/260 mm (model .12) at 176 km/h: 530 N/680 mm (model .02)	at 140 km/h: 160 N/180 mm	at 140 km/h: 280 N/200 mm
Power supply	from DF equipment	from DF equipment, Power Supply R&S®IN061 may be required for cables with a length >20 m (details upon request)		from DF equipment	from DF equipment	from DF equipment
Dimensions (approx.)	1100 mm diameter × 297 mm height (height incl. lightning rod: 1327 mm)	antenna circle: 3 m diameter, height: 800 mm, with lightning rod: 3 m	antenna circle: 3 m diameter, height: 800 mm, with lightning rod: 3 m	340 mm diameter × 1200 mm height (model .02) 340 mm diameter × 492 mm height (model .12)	455 mm diameter × 364 mm height	455 mm diameter × 393 mm height
Color	RAL 1015	RAL 1015	RAL 1015	RAL 1015	RAL 1015	RAL 1015
Weight (approx.)	30 kg	70 kg	114 kg	90 kg (model .02), 11 kg (model .12)	11 kg	11 kg

1) Measurement in reflection-free environment. The RMS error is calculated from the bearings of an evenly distributed azimuth and frequency sample.

2) Model .12: lightweight model for mobile use.

Specifications – R&S®DDF01A

Frequency range	0.3 MHz to 30 MHz
DF method	correlative interferometer, Watson-Watt
Operation	via graphical user interface (GUI) on external PC with Windows XP
Instrument DF accuracy	0.5° RMS
System DF accuracy (in test field) with R&S®ADD010 or R&S®ADD011	1° RMS
Display	azimuth versus frequency, level versus frequency, polar diagram, histogram, waterfall, realtime IF panoramic display (bandwidth 20 kHz or 1 MHz)
Display resolution	0.1° or 1° (selectable)
DF sensitivity	typ. 0.2 μV/m to 0.5 μV/m (see diagram for HF DF antennas, page 19)
Operating modes	SCAN (f-SCAN, m-SCAN), SEARCH, fixed frequency mode (FFM), wideband mode (WFFM)
Instantaneous bandwidth	1 MHz 10 MHz/5 MHz/2 MHz with R&S®DDFA-WB option
Frequency span in wideband mode	1 MHz 10 MHz/5 MHz/2 MHz with R&S®DDFA-WB option 0.5 MHz/0.2 MHz/0.1 MHz with R&S®DDF-HFR option
Minimum signal duration [1] (depending on selected FFT realtime bandwidth)	
Correlative interferometer	1 ms
Watson-Watt	0.3 ms
Scan speed with 20 kHz resolution, 100 % channel occupancy, BT = 4	
Correlative interferometer	up to 0.9 GHz/s (incl. calculation of elevation) with R&S®DDFA-WB option: up to 4 GHz/s (incl. calculation of elevation)
Watson-Watt	up to 3.5 GHz/s with R&S®DDFA-WB option: up to 11 GHz/s
Scan speed with 5 kHz resolution, 100 % channel occupancy, BT = 4	
Correlative interferometer	up to 250 MHz/s (incl. calculation of elevation) with R&S®DDFA-WB option: up to 500 MHz/s (incl. calculation of elevation)
Watson-Watt	up to 1 GHz/s with R&S®DDFA-WB option: up to 2 GHz/s
Processing speed	
Correlative interferometer	up to 50 000 channels/s with R&S®DDFA-WB option: up to 200 000 channels/s
Watson-Watt	up to 200 000 channels/s with R&S®DDFA-WB option: up to 400 000 channels/s

Channel spacing (depending on selected FFT realtime bandwidth)	20 kHz/10 kHz/5 kHz/2 kHz/1 kHz/0.5 kHz/0.2 kHz with R&S®DDF-HFR option additionally: 0.1 kHz/0.05 kHz/0.02 kHz
Bandwidths	
Direction finding	12 kHz/6 kHz/3 kHz/1.2 kHz/0.6 kHz/0.3 kHz/0.12 kHz
Demodulation	20 kHz/12 kHz/10 kHz/6 kHz/3.4 kHz/3 kHz/1.2 kHz/0.6 kHz/0.3 kHz/0.12 kHz/0.06 kHz
Adjacent channel suppression ≥10 kHz	80 dB (FFM), 60 dB (SCAN)
Modes of demodulation	CW, AM, FM, SSB
Filter selectivity (shape factor, 60 dB/3 dB)	2.5 (FFM) 3.6 (SCAN)
Dynamic range (incl. AGC)	>120 dB
Linearity	
Second-order intercept (SOI)	≥75 dBm, typ. 85 dBm
Third-order intercept (TOI) [2]	≥32 dBm, typ. 39 dBm
Intermodulation-free dynamic range	typ. 95 dB (in-band, bandwidth of 1.2 kHz)
Phase noise	<–110 dBc (1 Hz) at 1 kHz offset typ. –116 dBc (1 Hz) at 1 kHz offset
Impedance	50 Ω
Frequency stability	1×10^{-7} at –10 °C to +55 °C
Frequency setting accuracy	1 Hz
Image frequency rejection	>95 dB, typ. 110 dB
IF rejection	>95 dB, typ. 110 dB
MTBF	
R&S®EBD660	>24 000 h
R&S®EH110	>60 000 h

1) 100 % probability of intercept for a single burst emission within realtime bandwidth. Lower values are possible for measurements performed with multiple burst emissions and reduced probability of intercept.

2) Frequency separation between intermodulating signals ≥30 kHz. Higher values are possible for measurements performed at larger frequency separation.

Specifications – R&S®DDF 05A

Frequency range	20 MHz to 3000 MHz
DF method	correlative interferometer, Watson-Watt
Operation	via graphical user interface (GUI) on external PC with Windows XP
Instrument DF accuracy	0.5° RMS
System DF accuracy (in test field) With R&S®ADD053 With R&S®ADD070	 1° RMS 2° RMS
Display	azimuth versus frequency, level versus frequency, polar diagram, histogram, waterfall, realtime IF panoramic display (bandwidth 100 kHz or 2 MHz)
Display resolution	0.1° or 1° (selectable)
DF sensitivity 20 MHz to 1300 MHz 1300 MHz to 3000 MHz	 typ. 0.5 µV/m to 1 µV/m typ. 3 µV/m to 10 µV/m (see diagram for VHF/UHF DF antennas, page 19)
Operating modes	SCAN (f-SCAN, m-SCAN), SEARCH, fixed frequency mode (FFM), wideband mode (WFFM)
Instantaneous bandwidth	10 MHz (–6 dB)
Frequency span in wideband mode	10 MHz/5 MHz/2 MHz; with R&S®DDF-HFR option additionally: 1 MHz/0.5 MHz/0.2 MHz/0.1 MHz
Minimum signal duration [1] (depending on selected FFT realtime bandwidth) Correlative interferometer Watson-Watt	 350 µs 150 µs
Scan speed with 200 kHz resolution, 100 % channel occupancy, BT = 4 Correlative interferometer Watson-Watt	 up to 30 GHz/s up to 80 GHz/s
Scan speed with 25 kHz resolution, 100 % channel occupancy, BT = 4 Correlative interferometer Watson-Watt	 up to 6 GHz/s up to 15 GHz/s
Processing speed Correlative interferometer Watson-Watt	 up to 240 000 channels/s up to 600 000 channels/s
Channel spacing (depending on selected FFT realtime bandwidth)	200 kHz/100 kHz/50 kHz/25 kHz/20 kHz/12.5 kHz/10 kHz/8.33 kHz/5 kHz/2 kHz/1 kHz/0.5 kHz/0.2 kHz with R&S®DDF-HFR option additionally: 1 kHz/0.5 kHz/0.2 kHz/0.1 kHz/0.05 kHz/0.02 kHz
Bandwidths Direction finding Demodulation	 60 kHz/30 kHz/15 kHz/12 kHz/7.5 kHz/6 kHz/5 kHz/3 kHz/1.2 kHz/0.6 kHz 150 kHz/60 kHz/30 kHz/15 kHz/12 kHz/7.5 kHz/5 kHz/3 kHz/1.2 kHz/0.6 kHz
Adjacent channel suppression ≥10 kHz	80 dB (FFM), 60 dB (SCAN)
Modes of demodulation	CW, AM, FM, SSB
Filter selectivity (shape factor 60 dB/3 dB)	2.5 (FFM) 3.6 (SCAN)
Dynamic range (incl. AGC)	>120 dB
Linearity Second-order intercept (SOI) Third-order intercept (TOI) [2]	 ≥50 dBm, typ. 63 dBm ≥18 dBm, typ. 28 dBm
Intermodulation-free dynamic range	typ. 85 dB (in-band, bandwidth of 7.5 kHz)
Phase noise	<–116 dBc (1 Hz) at 10 kHz offset typ. –120 dBc (1 Hz) at 10 kHz offset
Impedance	50 Ω
Frequency stability	1 × 10^{-7} at –10 °C to +55 °C
Frequency setting accuracy	1 Hz
Image frequency rejection	>90 dB, typ. 110 dB
IF rejection	>95 dB, typ. 110 dB
MTBF R&S®EBD660 R&S®ET550	 >24 000 h >25 000 h

1) 100 % probability of intercept for a single burst emission within realtime bandwidth. Lower values are possible for measurements performed with multiple burst emissions and reduced probability of intercept.

2) Frequency separation between intermodulating signals ≥2.2 MHz. Higher values are possible for measurements performed at larger frequency separation.

General data

(valid for R&S®DDF01A, R&S®DDF05A and R&S®DDF06A)

	R&S®EBD660	R&S®EH110	R&S®ET550
Operating temperature range	–10 °C to +55 °C, meets EN 60068-2-1, EN 60068-2-2, MIL-STD-810E Meth. 501.3/502.3		
Storage temperature range	–40 °C to +71 °C, meets EN 60068-2-1, EN 60068-2-2, MIL-STD-810E Meth. 501.3/502.3		
Humidity/damp heat	max. 80 % cycl. test at 25 °C/40 °C, meets EN 60068-2-30 max. 95 % rel. humidity, without condensation, meets MIL-STD-810E Meth. 507.3, without cyclic condensation		
Mechanical resistance/shock	30 g, 11 ms semi-sinewave, meets EN 60068-2-27 40 g shock spectrum, 45 Hz to 200 Hz, meets MIL-STD-810E, Meth. 516.4		
Vibration Sinusoidal Random	 5 Hz to 55 Hz, max. 2 g, 55 Hz to 150 Hz, 0.5 g const., 12 min/(3)axis, meets EN 60068-2-6 10 Hz to 500 Hz, 1.9 g (RMS), 30 min/(3)axis, meets EN 60068-2-64		
EMC	30 MHz to 1000 MHz, 30/37 dBμV/m, field strength (emission), meets EN 55022 0.15 MHz to 30 MHz, class B interference voltage on AC power lines, meets EN 55022 0 Hz to 2 kHz interference current on AC power lines, meets EN 61000-3-2 ±8 kV/±4 kV static discharge, meets EN 61000-4-2 80 MHz to 1000 MHz, 10 V/m field strength (immunity), meets EN 61000-4-3 ±2 kV/±1 kV transient burst at AC power/signal connection (immunity), meets EN 61000-4-4 ±2 kV/±1 kV burst (immunity), meets EN 61000-4-5 0.15 MHz to 80 MHz, 10 V unmod./mod. 80 % AM (1 kHz) on lines, meets EN 61000-4-6 10 ms/30 %, 100 ms/60 % voltage reduction, 5 s voltage interruption on AC power lines, meets EN 61000-4-11		
Power supply	100 V to 230 V AC, +10 %/–12 %, 47 Hz to 63 Hz		
Electrical safety (meets EN 61010, VDE 0411)	max. 350 VA, typ. 300 VA	max. 150 VA, typ. 120 VA	max. 200 VA, typ. 180 VA
Dimensions (W × H × D)	436 mm × 192 mm × 460 mm (19" × 4 HU)		
Weight	approx. 15 kg	approx. 16 kg	approx. 18 kg

Ordering information

Order designation	Type	Order No.
Digital HF Scanning Direction Finder	R&S®DDF 01A	4059.9100.02
Digital VHF/UHF Scanning Direction Finder	R&S®DDF 05A	4059.9200.02
Digital HF/VHF/UHF Scanning Direction Finder	R&S®DDF 06A	4059.9300.02
Antennas (see separate data sheet)	R&S®ADDx	see tables on pages 20 and 21
Options		
Master Slave Handover	R&S®RA-MSH	3020.9690.02
LF Extension	R&S®DDF-LF	4060.0348.02
HF Wideband Module	R&S®DDFA-WB	4060.0248.02
GSM Interception	R&S®DDF-GSM	4059.9951.02
Synchronous Scanning	R&S®DDF-TS	4060.0290.02
Raw-Data Recording	R&S®DDF-DR	4060.0390.02
Preclassifier	R&S®DDF-CL	4059.9900.02
Single Station Locator for HF	R&S®DDF-SSL	3020.8864.02
Remote Control Extension	R&S®DDF A-REM	3020.8858.02
High-Frequency Resolution	R&S®DDF-HFR	on request
Service Kit (for maintenance and troubleshooting)	R&S®DDF-SK	4060.0454.02

Certified Quality System
ISO 9001
DQS REG. NO 1954 QM

Certified Environmental System
ISO 14001
DQS REG. NO 1954 UM

More information at
www.rohde-schwarz.com
(search term: DDF0xA)

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