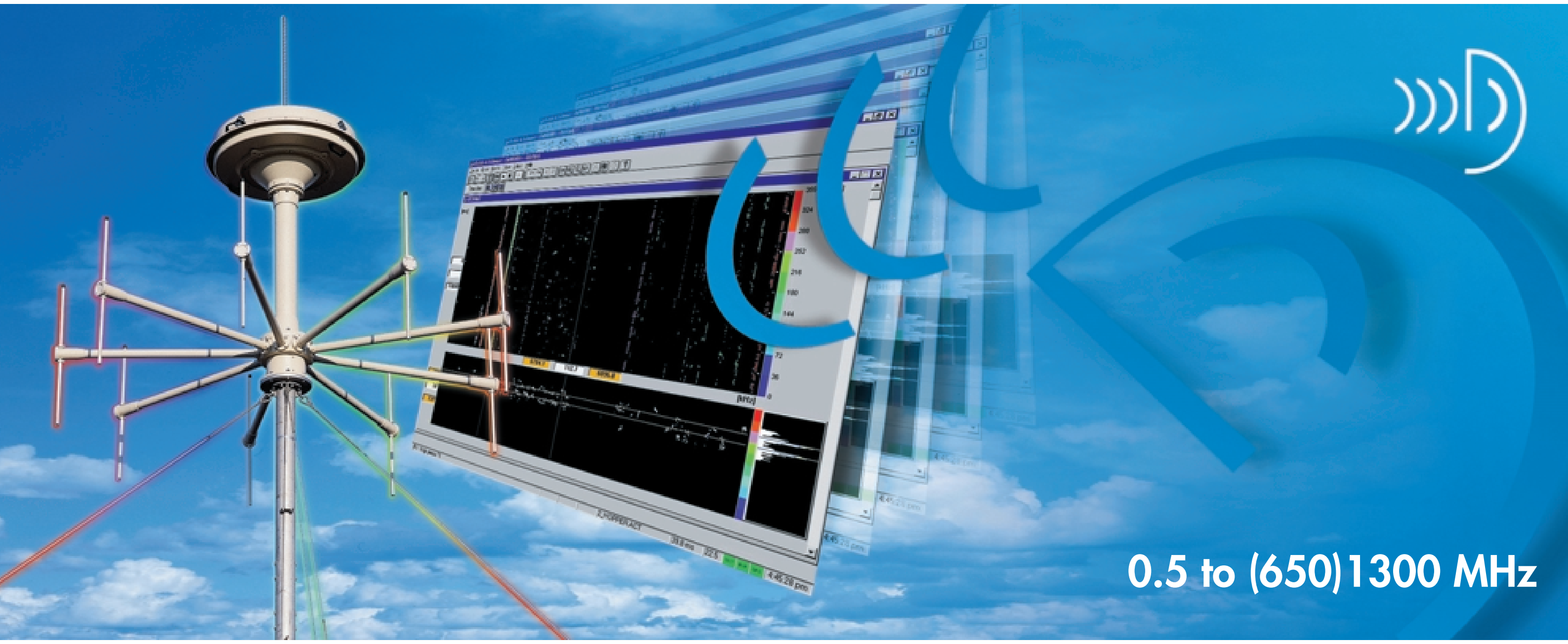

Digital Scanning Direction Finders DDF0xS

Fast and reliable interception of complex signals

- High scanning speed: 200 MHz/s for 8 kHz resolution (6 dB bandwidth) and 200 kHz FFT realtime bandwidth
- High selectivity
- Convenient user interface
- Excellent system compatibility through
  - effective data compression
  - integrated controller for hand-off receivers
  - system integration via all common data interfaces
- Wide range of antennas for stationary and mobile use from 0.5 to 1300 MHz
- Algorithms for correlative interferometer and Watson-Watt method as standard

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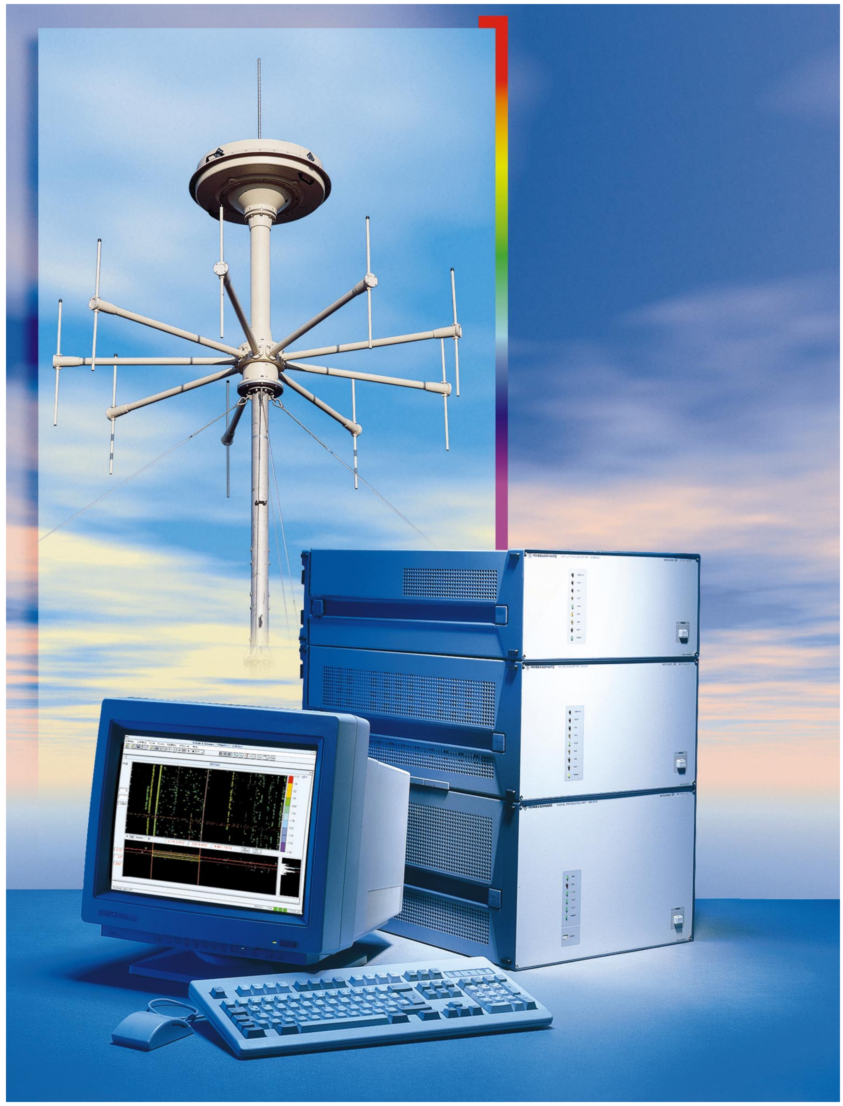
- Use in automatic radiolocation systems with high probability of intercept
- Direction finding of frequency-hopping, burst and broadband signals
- Data reduction can be optimized according to frequency-, time- and direction-selective criteria
- For HF direction finding using the correlation method, the elevation can also be determined, which allows single-station location (SSL) systems to be implemented
- Versatile stationary and mobile applications (vehicle, ship, aircraft) through the use of different DF algorithms and antenna configurations, especially wide-aperture arrays



System overview

The DDF0xS family of scanning direction finders covers the frequency range 0.5 MHz to (650) 1300 MHz. The type designations are:

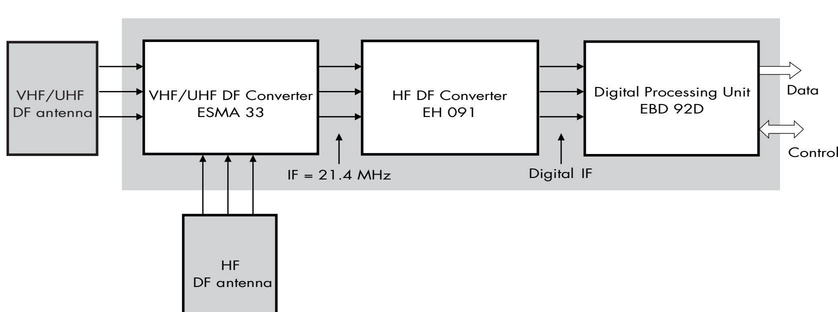
HF:
DDF01S 0.5 MHz to 30 MHz
HF/VHF/UHF:
DDF06S 0.5 MHz to (650) 1300 MHz

Each direction finder comprises three functional groups: a DF antenna system, a DF converter including three DF receiver modules, and a digital signal processing unit.

The HF direction finder consists of HF DF Converter EH091 and Digital Processing Unit EBD92D. The same equipment is used for the VHF/UHF range, but with VHF/UHF DF Converter ESMA33 connected ahead of the direction finder. ESMA33 converts the received signals to the IF (21.4 MHz) and routes them to HF DF Converter EH091.

The DF system is operated via an external computer that also displays the results.

The software of the digital processing unit contains as a standard the algorithms for DF evaluation according to the correlative interferometer or the Watson-Watt method, so that either of the methods can be used depending on available antenna system and operational requirements.



Digital DF methods

Scenarios with rapidly changing situations, for example as a result of frequency-hopping transmitters or burst transmissions, become more and more frequent and require new concepts for reconnaissance systems.

If signal detection and direction finding/locating are performed using separate units, it is not uncommon that a newly discovered frequency activity cannot be passed on to the DF system because of its short duration and so the signal remains undetected. State-of-the-art systems should therefore be capable of determining frequency, level and bearing of such signals simultaneously.

Concepts of this kind have so far been implemented by analog systems. The scanning speed of such systems is however limited due to the time required for synthesizer switching and filter settling.

The DDF0xS generation of direction finders makes use of fast Fourier transform (FFT), which allows several signals to be analyzed simultaneously within a wide frequency band and a selectable resolution bandwidth.

The complex antenna voltages are measured by a high-grade triple DF receiver that acts like a vector voltmeter. The measured values are digitized. The results are evaluated on the basis of mathematical algorithms simultaneously and separately for each signal. Evaluation can be performed using classic DF methods such as Watson-Watt or interferometer or, preferably, state-of-the-art correlation methods (correlative interferometer).

The **correlation principle** offers the following advantages over the classic methods:

- Reduction of DF errors caused by reflection and depolarization
- Use of wide-aperture DF antennas with a minimum number of antenna elements (also arranged in circular arrays)
- The elements forming the DF antenna system can basically be arranged in any configuration
- In mobile use highly effective reduction of bearing errors caused by platform (vehicle, ship, aircraft) through correction

The essential features of the **Watson-Watt** method are:

- Maximum scanning/DF speed since only one measurement step is required per FFT window
- Adcock antennas, especially those for the HF range, can easily be adapted

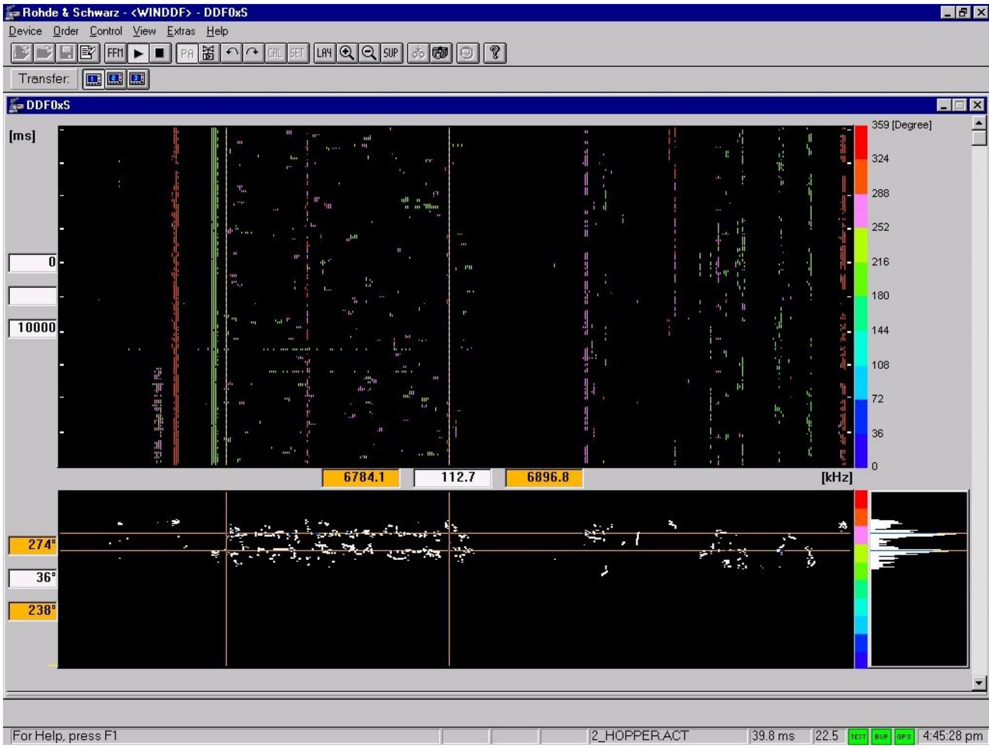
Bearing correction and synchronization

To ensure highly precise bearings in environments with very strong interference, eg onboard vehicles, ships or aircraft, a **bearing correction** option (EBD92AK) is available for DDF0xS. It allows correction of bearings throughout the frequency range 0.5 MHz to 1300 MHz over an azimuth range of 360°.

Position finding – especially of frequency-agile signals – makes maximum demands on the **synchronization** of the direction finders **within a location system** during scanning. To meet the requirements direction finders can be equipped with a GPS receiver (option EBD92GP) that delivers a highly precise sync pulse as well as the time stamp (1 µs resolution) necessary for position finding.

Operation and displays

All operating and display functions are performed via a PC by means of the software supplied as standard. Signal activities and bearings are displayed on the screen which is divided into several windows. The user can select and arrange the windows according to his operational requirements. The following display modes are available: Amplitude versus frequency (spectrum display), bearing versus frequency, bearing or level versus frequency and time (waterfall), elevation versus frequency. Most parameters can also be displayed in the form of histograms. Colour scales can be activated in the windows to visualize the magnitude of bearing and level. The DF values measured at the individual frequencies can be displayed numerically at a keystroke. The associated frequency and level values are also shown as numerals. The user can select whether instantaneous values or results obtained by histogram averaging are displayed. Actions are triggered by clicking icons on the user interface or pressing hardkeys. Only those control



User interface with typical scenario of broadband emitters in HF band. Waterfall display (top) reveals frequency-agile emitters; histogram (bottom right) allows unambiguous identification of weak frequency-hopped signals from overlapping frequency bands of same azimuth sector.

elements that are constantly needed are permanently displayed.

The direction finder basically operates in two modes: the scan mode and the fixed-frequency mode (FFM).

Scan mode

In the scan mode, which is probably the most important operating mode, the FFT window with a width of 200 kHz is shifted stepwise at high speed within one or several scan ranges. Each scan range is defined by the start and stop frequency as well as by the resolution of the scan. If an activity is detected that is confined to a specific subrange, the user can define and activate a zoom range using the mouse. The defined range will then be scanned at high speed, which increases the probability of intercept. As all results of the preceding 60 seconds are permanently stored in the background, the parameters of FH or burst signals encountered unexpectedly can be evaluated later on with the aid of the memory. It is furthermore possible to record data over an extended period of time, although the duration of recording depends on the space available on the hard disk. For data compression a maximum of two azimuth ranges of interest can be selected when defining the scan range. All results outside these ranges will be suppressed. In addition, the user can enter maximum/minimum values for signal duration and period as well as elevation limits (HF, correlative interferometer).

Fixed-frequency mode (FFM)

The only difference between FFM and scan mode is that the 200 kHz analysis window is not shifted but stays fixed at a frequency. This center frequency is selected and marked in the scan mode using the frequency cursor. The maximum probability of intercept is guaranteed for this narrow range.

As the direction finders of the DDF0xS family are not provided with an integrated demodulator because they are mainly used in the scan mode, the frequency information may be sent to hand-off receivers for further processing. If the user detects a

Scanning speeds

	Scanning range >200 kHz (SCAN)				Scanning range 200 kHz (FFM)			
Resolution	**Time for 200 kHz (in ms)**		**Scanning speed (in MHz/s)**		**Time for 200 kHz (in ms)**		**Scanning speed (in MHz/s)**	
HF range	Watson-Watt	Correlation	Watson-Watt	Correlation	Watson-Watt	Correlation	Watson-Watt	Correlation
125 Hz	69	363	3	0.6	66	384	3	0.5
250 Hz	37	184	5	1.1	34	194	6	1.0
500 Hz	21	93	10	2.2	17	96	12	2.0
1 kHz	13	49	15	4.1	9	51	22	3.9
2 kHz	9	25	22	8.0	5	26	40	7.7
V/UHF range								
4 kHz	1.6	5.0	125	40	1.6	5.0	125	40
8 kHz	1.0	4.0	200	50	1.0	4.0	200	50
16 kHz	1.0	4.0	200	50	1.0	4.0	200	50
32 kHz	1.0	4.0	200	50	1.0	4.0	200	50

frequency of interest in the scan mode or FFM, he places the cursor on this frequency and activates one of the receiver symbols in the transfer bar. The selected receiver allows the signal in question to be intercepted, recorded or analyzed. The operating parameters for the receivers (demodulation mode, bandwidth, level threshold) can already be defined when determining the scan range. To obtain a bearing the direction finder can also be set to the desired frequency by means of an external receiver.

CertifiedQualitySystem
ISO 9001
DQSREG.NO1954-04

Specifications

HF range (DDF01S and DDF06S)

Frequency range	0.5 MHz to 30 MHz
DF method	Watson-Watt, correlative interferometer
DF accuracy	
Instrumental	0.5° rms (Watson-Watt)
With antenna ADD011	1° rms
Sensitivity (2° rms bearing fluctuation)	depending on antenna system: see diagram on page 6
Operating modes	– SCAN with 3 modes for data reduction (azimuth selection, time filter, threshold and frequency suppression function) – FFM (fixed-frequency mode)
FFT realtime bandwidth	200 kHz
Resolution (corresp. to 6 dB BW)	0.125/0.25/0.5/1/2 kHz
Filter characteristics	shape factor 2 to 3
Resolution of A/D converter	16 bits
Scanning speed	see table on page 4
Screen display and analysis	
Display modes	azimuth versus frequency, waterfall, spectrogram, bearing and level histogram
Monitor resolution	min. 1024 x 768 pixels
Frequency channel width	1 pixel
Cursor functions	1 x threshold, 2 x frequency, 2 x time, 2 x marker
Zoom functions	graphical and physical zoom
Recording capacity	recording on 2 Gbyte hard disk: approx. 10 h
Offline analysis	available
Dynamic range	typ. 120 dB
Nominal impedance	50 Ω
Frequency stability	3 x 10^{-7} for T = 0°C to +40°C
Image frequency rejection	>90 dB, typ. 110 dB
IF rejection	>90 dB, typ. 110 dB

VHF/UHF range (DDF06S)

Frequency range	20 MHz to (650)1300 MHz
DF method	Watson-Watt, correlative interferometer
DF accuracy	
Instrumental	0.7° rms (Watson-Watt)
With antenna ADD051	1° rms
Sensitivity (2° rms bearing fluctuation)	depending on antenna system: see diagram on page 6
Polarization	vertical
Operating modes	– SCAN with 3 modes for data reduction(azimuth selection, time filter, threshold and frequency suppression function) – FFM (fixed-frequency mode)
FFT realtime bandwidth	200 kHz
Resolution (corresp. to 6 dB BW)	4/8/16/32 kHz
Filter characteristics	shape factor approx. 4
Resolution of A/D converter	16 bits
Scanning speed	see table on page 4
Screen display and analysis	
Display modes	azimuth versus frequency, waterfall, spectrogram, bearing and level histogram
Monitor resolution	min. 1024 x 768 pixels
Cursor functions	1 x threshold, 2 x frequency, 2 x time, 2 x marker
Zoom functions	graphical and physical zoom
Recording capacity	recording on 2 Gbyte hard disk: approx. 10 h
Offline analysis	available
Dynamic range	typ. 120 dB
Nominal impedance	50 Ω
Frequency stability	2 x 10^{-8} for T = 0°C to +40°C
Image frequency rejection	>90 dB, typ. 110 dB
IF rejection	>90 dB, typ. 110 dB

General data

Analog outputs	IF = 1280 ± 100 kHz
Tracking generator	0.5 MHz to (650) 1300 MHz
Audiomonitoring channel	separate receiver at IF output or hand-off receiver with its own antenna
BITE	integrated
Power supply	115/230 V +10%/–12%, 47 Hz to 440 Hz, max. 750 VA
Dimensions, weight	
EBD92D	19", 6 HU; 33 kg
EH091	19", 5 HU; 32 kg
ESMA33	19", 4 HU; 27 kg
Operating temperature range	0°C to +40°C
Storage temperature range	–40°C to +70°C
Relative humidity	to DIN IEC 68-2-30, 95% at +40 °C
Vibration, sinewave	to DIN IEC 68-2-6 (MIL-T28800D), 5 Hz to 50 Hz, 0.15 mm amplitude
Vibration, random	to DIN IEC 68-2-36, 10 Hz to 300 Hz, 1.2 g rms
Shock	to DIN IEC 68-2-27 (MIL-STD-810D, MIL-T28800D), 40 g shock spectrum
EMC	EN50081-1, EN50082-1

Ordering information

Digital Scanning Direction Finders	DDF0xS	
0.5 to 30 MHz, consisting of: EBD92D + EH091	DDF01S	4044.8754.02
0.5 to 650 MHz, consisting of: EBD92D + EH091 + ESMA33	DDF06S	4044.9009.02
0.5 to 1300 MHz, consisting of: EBD92D + EH091 + ESMA33 with ESMA-T2	DDF06S	4044.9009.03
Options		
GPS for accurate time stamp:	EBD92GP	4033.0070.02
Antenna Correction	EBD92AK	4033.0086.02
Recommended extras		
Antenna Interface	GX060	4050.8500.02
Multicoupler	VE010	4050.8000.02

DF antennas

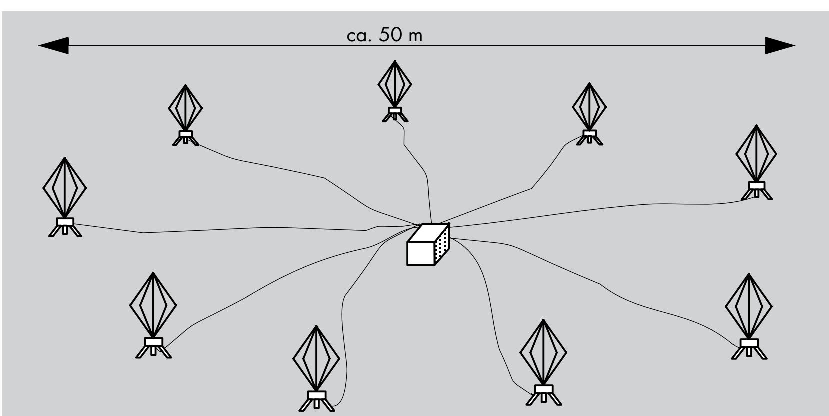
A variety of DF antennas is available to match different applications. The antennas available include Adcock, circular or crossed-loop arrays. For details of antennas see table on page 7.

All these antennas feature a coding function that informs the connected DF system about the algorithm (correlation or Watson-Watt) to which the direction finder is to be set. Optionally, the antennas for mobile use can be equipped with an electronic compass by which the bearings are automatically referred to magnetic north.

Adapters are available for installing the mobile DF antennas on vehicles or masts, eg on ships.

In many cases, existing installations of non-R&S antennas (Adcock) can be used with the direction finders provided that Antenna Interface GX060 (0.3 MHz to 650 MHz) is used as well. Details have to be checked in each individual case.

HF DF Antenna ADD011



Multicoupler VE010

Multicoupler VE010 makes it possible to operate simultaneously up to six Direction Finders DDF01S or DDF01M (see data sheet PD 757.1854) from one HF DF Antenna ADD010 or ADD011. With VE010, Direction Finders DDF01M/DDF01S can be connected to the HF DF antenna in any combination and operated completely independently of each other.

Antenna cables

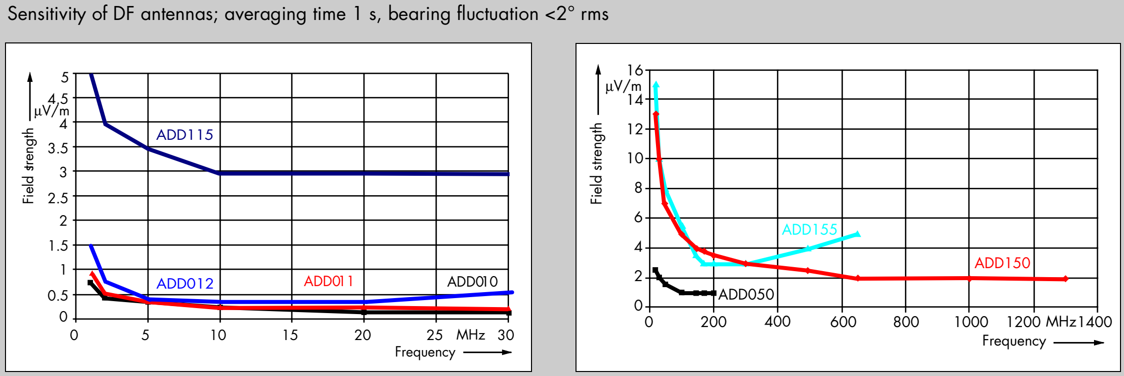
HF Antenna Cable ADD01xZ is required for connecting the HF DF antenna to the DF equipment. The cable is available in various lengths to suit the application.

Antenna Cable ADD05xZ is used for the VHF/UHF range. For cable lengths exceeding 10 m, Power Supply IN061 is supplied with the cable.

Effective lightning protection

The cable inputs and outputs of the DF antennas are overvoltage-protected as standard. In the case of VHF/UHF DF Antennas ADD150, ADD050 and ADD051, a lightning rod is supplied to protect the equipment against direct lightning strokes.

Sensitivity of DF antennas; averaging time 1 s, bearing fluctuation <2° rms



Overview of available antennas – specifications

	HF antennas					VHF/UHF antennas			
Type Order No.	**ADD115** 4040.5009.02	**ADD010** 4045.0105.03	**ADD011** 4045.0005.02	**ADD012** 4051.1400.02	**ADD012** 4051.1400.12	**ADD150** 4041.1007.02	**ADD155** 4040.9004.02	**ADD050** 4041.4006.02	**ADD051** 4041.7005.02
Application	HF, mobile use; ideal for fast scanning of ground waves and sky waves with low angle of incidence	HF, semimobile and stationary use, for signals with angle of incidence ≤50°, SSL possible with restrictions	HF, stationary use, for signals with angle of incidence ≤85°, SSL possible	HF, semimobile and stationary use, maximum scanning speed		VHF/UHF, mobile and stationary	VHF/UHF, mobile and stationary, maximum scanning speed	VHF, stationary use; enhanced accuracy especially with co-channel propagation	VHF/UHF, stationary use; combination of ADD150 and ADD050 (see photo on page 4)
Frequency range	0.3 (1) to 30 MHz below 1 MHz with limited sensitivity and accuracy			1 (0,3)... 12 (30) MHz, below 1 MHz with limited sensitivity	1 (0.3) to 30 MHz	20 to 1300 MHz	20... 500 (650) MHz, above 500 MHz with limited accuracy	20 to 200 MHz	20 to 1300 MHz
Type of antenna	1 crossed loop + 1 active dipole	active 9-element circular array of rod antennas	active 9-element circular array of crossed loops	U-Adcock 1 x 8 elements	U-Adcock 2 x 8 elements, switchover at 12 MHz	9 active antenna elements in radome	Adcock, 2 active 8-element circular arrays in radome	active 9-element circular array	2 active 9-element circular arrays
DF method	Watson-Watt	Correlation		Watson-Watt		Correlation	Watson-Watt	Correlation	
Polarization	vertical	vertical	circular	vertical	vertical	vertical	vertical	vertical	vertical
DF accuracy (in reflection-free environment)	2° rms	1° rms		1° rms (1 to 25 MHz), 2° rms (25 to 30 MHz) with operation in subranges 1 to 12 and 12 to 30 MHz		20 to 200 MHz: 2° rms 200 to 1300 MHz 1° rms	20 to 50 MHz: 3° rms 50 to 500 MHz: 2° rms	1° rms	1° rms
Sensitivity (2° bearing fluctuation, 1 s averaging time)	5...3 µV/m typ.	1...0,2 µV/m typ.	1...0,3 µV/m typ.	1...0,2 µV/m typ. (BW = 1 kHz) when operated in subranges 1 to 12 MHz and 12 to 30 MHz	1...0,2 µV/m typ. (BW = 1 kHz)	13...2 µV/m typ.	15... 5 µV/m typ.	2,5... 1 µV/m typ.	wind load on flange: 2078 Nm at 188 km/h without icing, 2495 Nm at 162 km/h with 30 mm icing
Dimensions (mm)	1100 (dia) x 238	antenna circle approx. 50 m in dia, height of rod antennas approx. 2 m	antenna circle approx. 50 m in dia, height of crossed loops: 3.4 m incl. tripod	Diameter: 7 m for 1 to 30 MHz 20 m for 1 to 12 MHz Element height: 2 m	Diameter 20 m Element height 2 m	1100 (dia) x 238	1100 (dia) x 238	Antenna circle 3 m in dia, height 1 m, with lightning rod: 3.1 m	
Weight	25 kg	250 kg	400 kg	Single element approx. 4.5 kg Network approx. 6 kg		30 kg		66 kg	110 kg
Maximum permissible wind speed	200 km/h without icing, 173 km/h with 30 mm radial icing	160 km/h, without icing				200 km/h, without icing 173 km/h with 30 mm radial icing			
Operating temperature range	-40 to +65°C					-40 to +65°C			
Power supply	from DF set if antenna cables <10 m, otherwise from Power Supply IN061	via power supply built in as standard				from DF set if antenna cables <10 m, otherwise from Power Supply IN061		Power Supply IN061 required	
Power Supply IN061	115/230 V AC ±15%, 47 to 63 Hz; 20 to 32 V DC, max. 4.5 A (terminal strip) Dimensions, weight: 345 mm x 255 mm x 155 mm, 10 kg, operating temperature range: -40 to +65 °C						Electronic Compass GH150 (Order No. 4041.8501.02) for integration into Antennas ADD115, ADD150 and ADD155		

Fax Reply (Digital Scanning Direction Finders DDF0xS)

- ❑ **Please send me an offer**
- ❑ **I would like a demo**
- ❑ **Please call me**
- ❑ **I would like to receive your free-of-charge CD-ROM catalog** (Test and Measurement Products)

Others: ______________________________
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Name: ______________________________
Company/Department: ______________________________
Position: ______________________________
Address: ______________________________
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ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München
P.O.B. 80 14 69 · D-81614 München · Telephone +49 89 41 29-0 · Fax +49 89 41 29-32 47 · Internet: http://www.rsd.de