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# Digital HF/VHF/UHF Monitoring Direction Finder R&S DDF<sup>®</sup> 0xE

0.3 MHz to 3000 MHz

- ◆ Excellent precision and sensitivity
- ◆ Compact design
- ◆ Outstanding large-signal immunity
- ◆ High adjacent channel suppression
- ◆ HF range: 1 MHz FFT realtime bandwidth, VHF/UHF range: 2 MHz FFT realtime bandwidth
- ◆ Rapid search and scan functions
- ◆ Wide range of antennas from 0.3 MHz to 3000 MHz for stationary and mobile use
- ◆ Direction finding of GSM signals (option)
- ◆ Optimum system compatibility due to
  - effective data compression
  - fast Ethernet and CORBA (common object request broker architecture)

**ROHDE & SCHWARZ**



## General

The Digital HF/VHF/UHF Monitoring Direction Finders R&S DDF®0xE cover the entire frequency range from 0.3 MHz to 3000 MHz to different extents (see table below). The direction finders implement digital signal processing both in filtering (FFT and filters with linear phase response) and in DF value calculation.

Each direction finder consists of three functional units:

- ◆ DF antenna system
- ◆ DF converter with integrated receiver modules
- ◆ Digital signal processing unit

The HF DF Converter R&S EH 110 is designed for the frequency range 0.3 MHz to 30 MHz, while the VHF/UHF DF Converter R&S ET 550 covers the range 20 MHz to 3000 MHz. The Digital Processing Unit R&S EBD 061 has two IF inputs so that both DF converters (R&S EH 110 and R&S ET 550) can be connected to the R&S EBD 061 at the same time (see block diagram on page 3). The software of the digital signal processing unit contains as standard the algorithms for DF evaluation according to the correlative interferometer or the Watson-Watt method.

## Digital DF methods

The type designation R&S DDF®0xE is derived from the term "digital direction finder" to indicate that bearings are determined digitally, i.e. the complex antenna voltages are measured by the high-quality triple DF receiver, which acts like a vector voltmeter, and are subsequently digitized. The bearings are then evaluated on the basis of mathematical algorithms. Evaluation can be performed by means of classic direction finding methods such as Watson-Watt or the modern correlative interferometer method.

The Watson-Watt method is used preferably in the HF range in cases where the space for setting up the DF antenna is limited (e.g. on ships). It also enables maximum scanning speed.

*Table*

Type	Application	Frequency range
R&S DDF®01E	HF	0.3 MHz to 30 MHz
R&S DDF®05E	VHF/UHF	20 MHz to 3000 MHz
R&S DDF®06E	HF/VHF/UHF	0.3 MHz to 3000 MHz

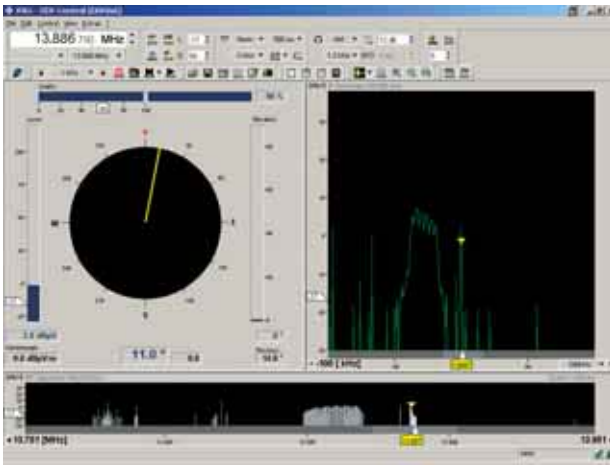
The correlative interferometer has the following advantages over classic methods:

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

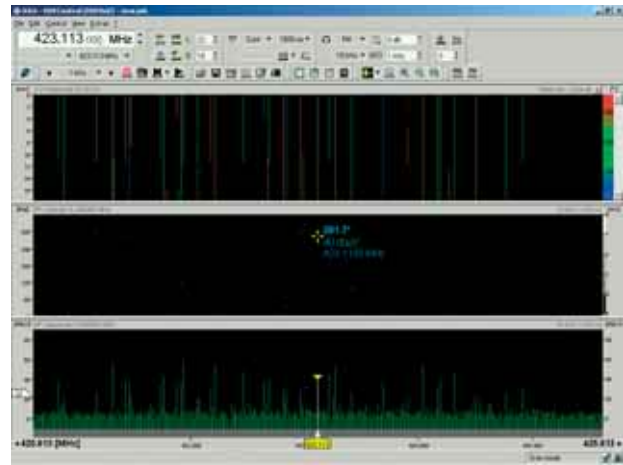
In addition, digital signal processing plus FFT make it possible to quickly scan large frequency ranges for activity. With the R&S DDF®0xE family, the FFT realtime bandwidth is 1 MHz in the HF range and 2 MHz in the VHF/UHF range.

## Operation and displays

The DF converter and the digital processing unit do not have control and display elements as standard. Thus, the direction finder is operated by means of a powerful external PC (with Windows 2000/XP) that is connected to the R&S EBD 061 via fast Ethernet. All direction finders come with a software package that contains the operating/display interface and optional software modules such as single station location (SSL) for the shortwave range and GSM direction finding.



GUI in Fixed Frequency mode



GUI in Scan mode

Three DF modes are supported:

### Fixed Frequency mode (FFM)

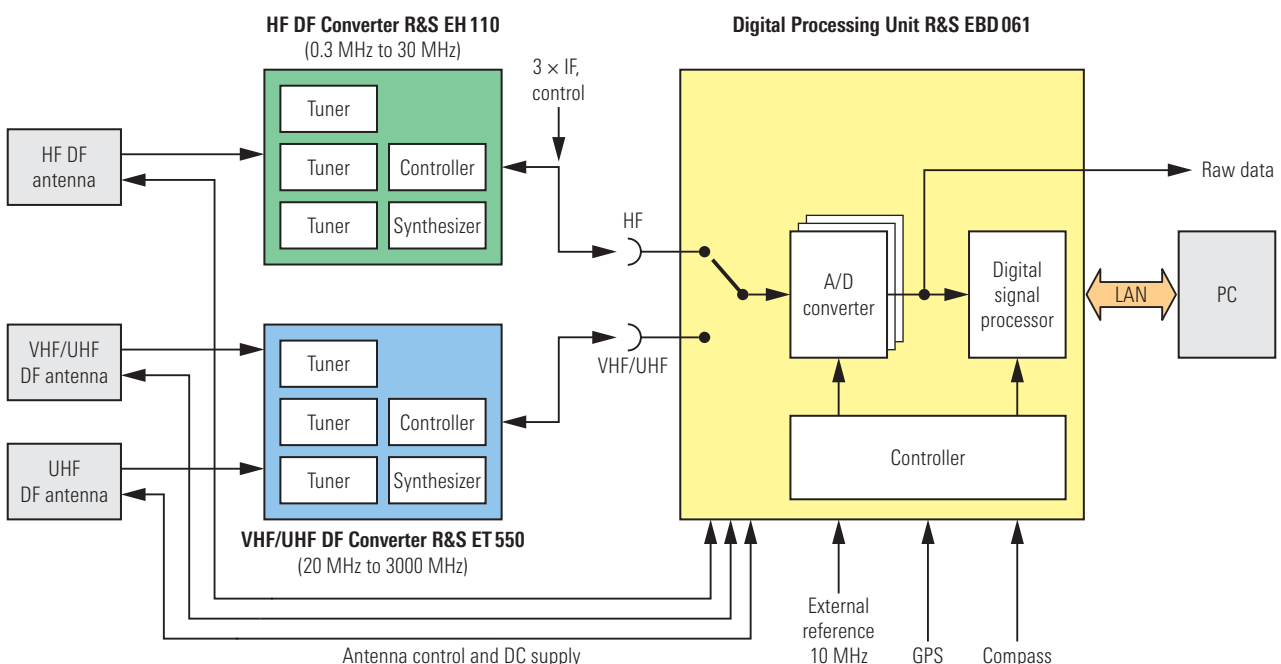
In this mode, the direction finder is operated at a fixed frequency. The bearing is displayed in analog (polar display) and digital format. Alternatively, the bearing can be displayed in histogram/waterfall format. In addition, the receive level and a quality value (0 to 100) are displayed for each bearing. In addition to the bearing, the realtime spectrum is displayed, centered to the receive frequency that has been set. The bandwidths for the DF process and the audio demodulation can be set independently of each other.

### Search mode

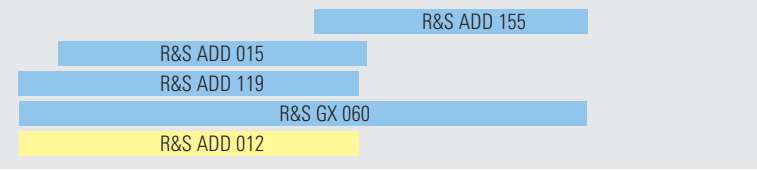
In this mode, either a frequency range (start or stop frequency, step width) or a frequency list (up to 1000 entries) is defined. The direction finder searches this range for activity. If it detects a signal that exceeds a fixed threshold, it dwells on this signal for a previously defined period of time. The bearings are presented in the same way as in the Fixed Frequency mode.

### Scan mode

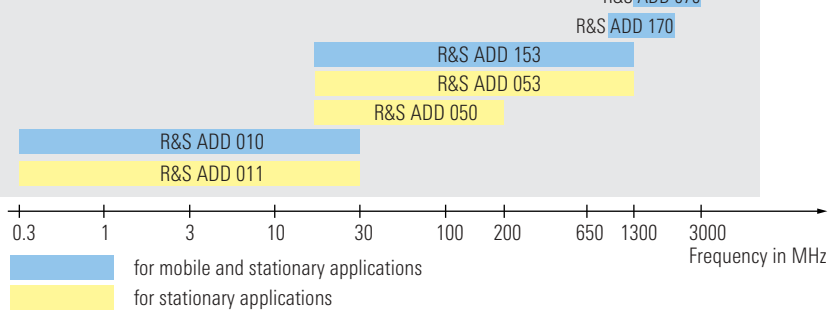
The R&S DDF<sup>®</sup>OxE family of direction finders also offers the capability to scan defined frequency ranges at a selectable step width (frequency scanning) or up to 1000 stored frequency channels (memory scanning) for activity. The DF results can be displayed in different ways: Generally, all signals are displayed as lines in a spectral display named "level versus frequency". The bearings can be colour-coded according to age, level or azimuth.



### Antennas for Watson-Watt method



### Antennas for correlative interferometer



To reduce data, it is also possible to define azimuth sectors or level and elevation ranges.

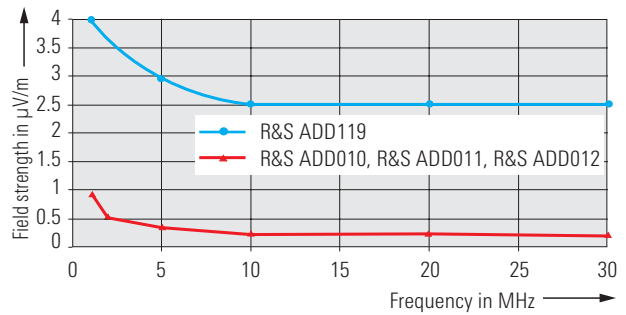
Certain frequencies can be labelled with scales or markers. Simply by clicking the mouse, the user can switch to the FFM menu for a closer analysis of the selected signal.

### DF antennas

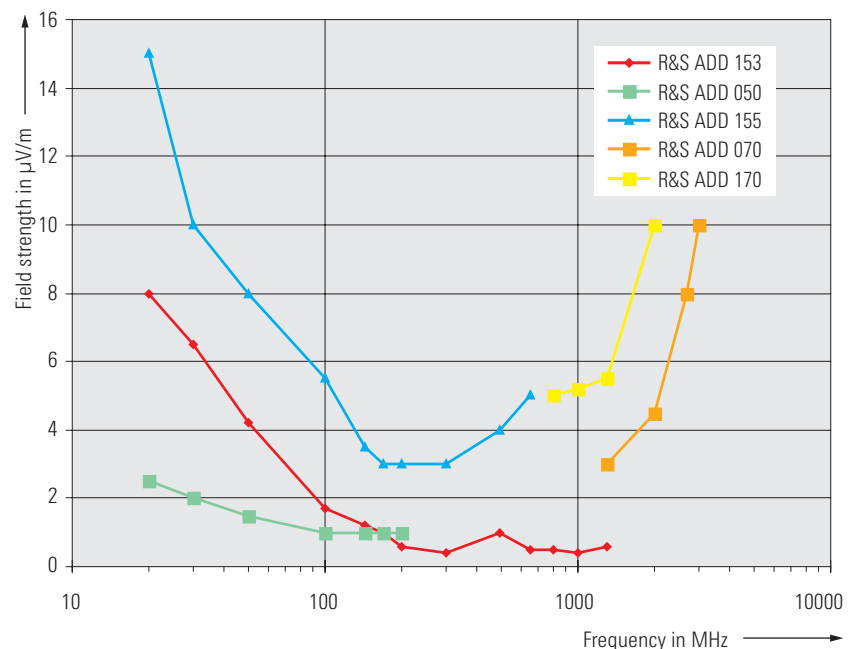
The direction finders of the R&S DDF®0xE family operate with the DF Antennas R&S ADDx, which are also used for the Direction Finders R&S DDF®0xM, R&S DDF®0xS and R&S DDF®0xA.

The DF Antenna R&S ADD 150 has been modified to provide higher sensitivity in the range from 20 MHz to 100 MHz. It is now called R&S ADD 153.

Frequently, existing DF antennas (Adcock, crossed loops) 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; average time 1 s, bearing fluctuation <math>< 2^\circ</math> RMS



## Specifications – HF antennas

Type (Order No.)	R&S ADD119 (4053.6509.02)	R&S ADD010 (4045.0105.03)	R&S ADD011 (4045.0005.13)	R&S ADD012 (4051.1400.03)	R&S ADD012 (4051.1400.13)
Application	mobile, fast scanning for ground waves and sky waves with low elevation angle	semi-mobile and stationary, for signals with elevation angle $\leq 50^\circ$ , SSL possible to a limited extent	stationary, for signals with elevation angle $\leq 85^\circ$ , SSL possible	semi-mobile and stationary, maximum scanning speed	
Frequency range	(0.3) 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 loops	U-Adcock, 1 $\times$ 8 elements + center antenna	U-Adcock, 2 $\times$ 8 elements + center antenna, switchover at 12 MHz
DF method	Watson-Watt	correlation		Watson-Watt	
Polarization	vertical	vertical, horizontal, circular		vertical	
DF accuracy <sup>2)</sup>	2° RMS	1° RMS		1° RMS (1 MHz (1 MHz to 25 MHz)/2° RMS (25 MHz to 30 MHz) when operated in subranges 1 MHz to 12 MHz/12 MHz to 30 MHz)	
Sensitivity	typ. 4 $\mu$ V/m to 2.5 $\mu$ V/m (2° bearing fluctuation, 1 s averaging time)	typ. 1 $\mu$ V/m to 0.2 $\mu$ V/m (2° bearing fluctuation, 1 s averaging time)		typ. 1 $\mu$ V/m to 0.2 $\mu$ V/m when operated in sub-ranges 1 MHz to 12 MHz to 30 MHz (2° bearing fluctuation, 1 s averaging time)	
Max. permissible wind speed	200 km/h without ice, 173 km/h with 30 m radial ice deposit	160 km/h without ice			
Operating temperature range	-40°C to +65°C				
Power supply	from DF equipment for antenna cables <10 m, otherwise Power Supply R&S IN061	from power supply integrated as standard			
Dimensions	1100 mm $\varnothing$ $\times$ 238 mm	antenna circle: 50 m $\varnothing$ , height of rod antenna: approx. 2 m	antenna circle: 50 m $\varnothing$ , height of crossed loop: 3.4 m incl. tripod	antenna circle: 7 m $\varnothing$ for 1 MHz to 30 MHz, 20 m $\varnothing$ for 1 MHz to 12 MHz, height of element: 2 m	antenna circle: 20 m $\varnothing$ , height of element: 2 m
Weight	25 kg	single element: 14 kg, network: 22 kg	single element: 33 kg, network: 22 kg	single element: 14 kg, network: 22 kg	

## Specifications – VHF/UHF antennas

Type (Order No.)	R&S ADD153 (4063.0003.02)	R&S ADD155 (4040.9004.02)	R&S ADD050 (4041.4006.02)	R&S ADD053 (4062.8800.02)	R&S ADD070 (4043.4003.02/.12) <sup>1)</sup>	R&S ADD170 (4055.7502.02)
Application	VHF/UHF, mobile and stationary	VHF/UHF, mobile and stationary, maximum search speed	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	mobile direction finding in GSM bands
Frequency range	20 MHz to 1300 MHz	20 MHz to 500 (650 MHz), above 500 MHz with limited accuracy	20 MHz to 200 MHz	20 MHz to 1300 MHz	1300 MHz to 3000 MHz	800 MHz to 2000 MHz
Antenna type	9 active antenna elements in radome	Adcock, 2 $\times$ active 8-element circular arrays in radome	active 9-element circular array	2 $\times$ active 9-element circular array	8-element circular array	8-element circular array with center antenna
DF method	correlation	Watson-Watt	correlation			
Polarization	vertical					
DF accuracy <sup>2)</sup>	2° RMS (20 MHz to 200 MHz) 1° RMS (200 MHz to 1300 MHz)	3° RMS (20 MHz to 50 MHz) 2° RMS (500 MHz to 500 MHz)	1° RMS		2° RMS	
Sensitivity	typ. 8 $\mu$ V/m to 0.5 $\mu$ V/m (2° bearing fluctuation, 1 s averaging time)	typ. 15 $\mu$ V/m to 5 $\mu$ V/m (2° bearing fluctuation, 1 s averaging time)	typ. 2.5 $\mu$ V/m to 1 $\mu$ V/m (2° bearing fluctuation, 1 s averaging time)	wind load on flange: 2078 Nm at 188 km/h without ice, 2495 Nm at 162 km/h with 30 mm ice deposit	typ. 3 $\mu$ V/m to 10 $\mu$ V/m (2° bearing fluctuation, 1 s averaging time)	typ. 5 $\mu$ V/m (0.8 GHz) typ. 10 $\mu$ V/m (0.2 GHz) (2° bearing fluctuation, 1 s averaging time)
Max. permissible wind speed	200 km/h without ice, 162 km/h with 30 mm radial ice deposit					180 km/h (without ice)
Operating temperature range	-40°C to +65°C					
Power supply	from DF equipment for antenna cables <10 m, otherwise from Power Supply R&S IN061		Power Supply R&S IN061 required		from DF equipment for antenna cables <10 m, otherwise from Power Supply R&S IN061 <sup>3)</sup>	
Dimensions	1100 mm $\varnothing$ $\times$ 238 mm	1100 mm $\varnothing$ $\times$ 238	antenna circle: 3 m $\varnothing$ , height: 1 m, with lightning rod: 3.1 m		340 mm $\varnothing$ $\times$ 1200 mm (.02) 340 mm $\varnothing$ $\times$ 492 mm (.12)	455 mm $\varnothing$ , height: 365 mm
Weight	30 kg		66 kg	110 kg	90 kg (.02), 12 kg (.12)	9 kg

<sup>1)</sup> Model 12: lightweight model for mobile use.

<sup>2)</sup> Measurement in reflection-free environment. The RMS error is calculated from the bearings of an evenly distributed azimuth and frequency sample.

<sup>3)</sup> R&S IN061 required for combination of R&S ADD 153 and R&S ADD 070.

## Specifications

### HF range (R&S DDF<sup>®</sup> 01E and R&S DDF<sup>®</sup> 06E)

Frequency range	0.3 MHz to 30 MHz
DF method	correlative interferometer, correlation and Watson-Watt
Operation	via external PC with Windows 2000/XP
DF accuracy	instrument error 0.5° RMS
System error (in reflection-free environment) with DF Antenna R&S ADD 010 or R&S ADD 011	1° RMS
Display	azimuth/frequency spectrum, polar diagram, histogram, waterfall, realtime IF panorama display (bandwidth 20 kHz or 1 MHz)
DF sensitivity	depending on antenna system (see antenna data on page 5)
Modes of operation	Scan (f-Scan, M-Scan), Search, Fixed Frequency mode (FFM)
Minimum signal duration Correlative interferometer	3.6 ms incl. elevation (10 kHz bandwidth)
Watson-Watt	0.8 ms (10 kHz bandwidth)
Realtime bandwidth	20 kHz or 1 MHz
Scanning speed	5 kHz channel spacing: 200 MHz/s for Watson-Watt 50 MHz/s for correlation with elevation calculation 40 000 channels/s for Watson-Watt, 10 000 channels/s for correlation with elevation calculation
Channel spacing	20/10/5/2/1/0.5/0.2/0.1 kHz
Bandwidths DF	12/6/3/1.2/0.6/0.3/0.12/0.06 kHz
Demodulation	52 Hz to 20 kHz in 70 steps
Adjacent channel suppression	80 dB (FFM)
Modes of reception	CW, AM, FM, SSB
Dynamic range (incl. AGC)	≥120 dB
Linearity Second-order intercept	≥75 dBm
Third-order intercept <sup>1)</sup>	≥32 dBm
Intermodulation-free dynamic range Inband	≥75 dB
Out-of-band	≥90 dB
Phase noise	<-110 dBc (1 Hz) at 1 kHz offset
Impedance	50 Ω
Frequency stability	1×10 <sup>-7</sup> at -10°C to +55°C
Frequency setting accuracy	1 Hz
Image frequency rejection	>90 dB, typ. 110 dB
IF rejection	>90 dB, typ. 110 dB
MTBF (to IEC1709/EN61709) R&S EBD 061	>28 000 h
R&S EH 110	>60 000 h

<sup>1)</sup> Frequency spacing between the intermodulating signals ≥30 kHz.  
Higher values are possible if measurements are performed at larger frequency spacing.

### VHF/UHF range (R&S DDF<sup>®</sup> 05E and R&S DDF<sup>®</sup> 06E)

Frequency range	20 MHz to 3000 MHz
DF method	correlative interferometer, correlation and Watson-Watt
Operation	via external PC with Windows 2000/XP
DF accuracy	instrument error 0.5° RMS
System error (in reflection-free environment) with DF Antenna R&S ADD 053 or DF Antenna R&S ADD 070	1° RMS 2° RMS
Display	azimuth/frequency spectrum, polar diagram, histogram, waterfall, realtime IF panorama display (bandwidth 20 kHz or 1 MHz)
DF sensitivity	depending on antenna system (see antenna data on page 5)
Modes of operation	Scan (f-Scan, M-Scan), Search, Fixed Frequency mode (FFM)
Minimum signal duration Correlative interferometer	0.5 ms (200 kHz bandwidth)
No. of channels for Search and Scan	1000
Realtime bandwidth	2 MHz (Scan) 200 kHz or 1 MHz (FFM)
Scanning speed	250 MHz/s at 25 kHz channel spacing (correlative interferometer)
DF speed	10 000 channels/s (correlative interferometer)
Channel spacing	100/50/25/20/12.5/10/8.33/5/2/1 kHz
Bandwidths DF	60/30/15/12/7.5/6/5/3/1.2/0.6 kHz
Demodulation	120/60/30/15/7.5/5/3/1.2/0.6 kHz
Adjacent channel suppression	80 dB (FFM)
Modes of reception	CW, AM, FM, SSB
Dynamic range (incl. AGC)	≥120 dB
Linearity Second-order intercept	≥50 dBm
Third-order intercept <sup>1)</sup>	≥18 dBm
Intermodulation-free dynamic range Inband	≥75 dB
Out-of-band	≥90 dB
Phase noise	<-120 dBc (1 Hz) at 10 kHz offset
Impedance	50 Ω
Frequency stability	1×10 <sup>-7</sup> at -10°C to +55°C
Frequency setting accuracy	1 Hz
Image frequency rejection	>90 dB, typ. 110 dB
IF rejection	>90 dB, typ. 110 dB
MTBF (to IEC1709/EN61709) R&S EBD 061	>28 000 h
R&S ET 550	>25 000 h

<sup>1)</sup> Frequency spacing between the intermodulating signals ≥2.2 MHz.  
Higher values are possible if measurements are performed at larger frequency spacing.





More information at  
[www.rohde-schwarz.com](http://www.rohde-schwarz.com)  
(search term: DDF0xE)



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