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Competence in Test and Measurement, Radiocommunications and Broadcasting

From our principles

We are an independent manufacturer of electronic equipment and systems. Our name is synonymous with innovation, precision and quality. A leading position on the European market and worldwide presence are the solid basis to our success.

Who we are and what we do

Rohde&Schwarz is an internationally active company in the fields of radiocommunications and test and measurement. For more than 60 years the company group has been developing, producing and marketing a wide range of electronic products for the capital goods sector. The company is headquartered in Munich. With 4500 employees worldwide and subsidiaries and representatives in over 70 countries around the world, the Rohde&Schwarz group achieves an annual turnover in excess of 1.3 billion DM. The company is highly export-oriented: More than 70% of the total turnover is achieved outside Germany. Due to the comprehensive know-how and the innovative strength of its employees, Rohde&Schwarz is among the technological leaders in all of its business fields.

Today the Rohde&Schwarz group of companies is active in the following fields:

- Test and measurement
- Radiocommunications systems
- Mobile radio
- Broadcasting
- Radiomonitoring and radiolocation
- IT security
- Services

Quality management

The quality and environmental management system of Rohde&Schwarz has been certified to DIN EN ISO 9001 and 14001 and complies with the standards of AQAP 110 and 150. The company has approval for the development, production, installation and servicing of avionic communication equipment and is the first German transmitter manufacturer authorized to carry out BZT (Federal Approvals Office for Telecommunications) approval testing for radio transmitter systems.

Radiomonitoring and radiolocation

Listen, locate, analyze

No matter how elusive the source, it will not remain concealed with modern radiomonitoring and radiolocation equipment. Because with the instruments and systems from Rohde&Schwarz, you can locate and analyze practically any type of radio signal. We offer complete solutions, enabling you to monitor frequency management systems and master the intricate tasks involved in the arena of security irrespective of whether the threat is from within or from the outside.

Backed by more than six decades of experience, Rohde&Schwarz offers a complete range of products and has implemented a large number of key projects in these fields: with equipment ranging from single workstations to nationwide, customized networks. Rohde&Schwarz has got what it takes to provide competent solutions even for the most unusual radiomonitoring and radiolocation problems.

Radiomonitoring and spectrum management solutions

From stand-alone systems to completely automated nationwide networks

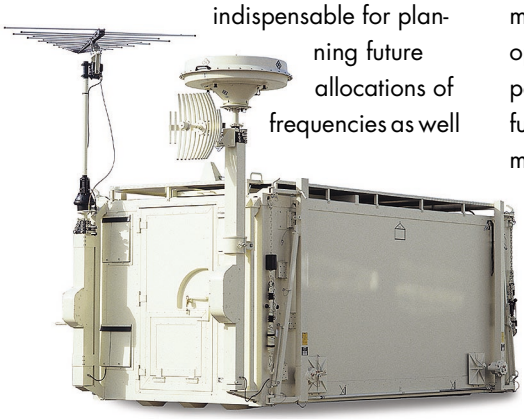
Industrial nations rely on an efficient telecommunication infrastructure. An increasing number of radio service users pay high license fees and demand freedom from interference in return. National monitoring authorities have the task of policing stringent national and international legislation on the use of radio frequencies.

But the task is immense: pagers, cordless phones and radio telephones, radio modems, air traffic control and train radio, professional mobile radio – the list of radiocommunication services gets longer each year. And as the radio spectrum gets more and more crowded, national regulatory bodies face the increasingly complex problem of monitoring and managing spectrum usage.

Competence in Test and Measurement, Radiocommunications and Broadcasting

Rohde & Schwarz provides flexible solutions for your radiomonitoring and spectrum management tasks – from stand-alone systems to completely automated nationwide networks, as recommended and specified by the International Telecommunications Union (ITU).

Spectrum management requires radiomonitoring as an essential element. Measuring the spectrum occupancy is indispensable for planning future allocations of frequencies as well as monitoring all kinds of emissions, measuring of their technical characteristics and locating their sources by using direction finders.



Monitoring the entire frequency band from 100 Hz to 40 GHz around the clock and nationwide is obviously a huge and complex task. Rohde & Schwarz provides a modular solution that can be adapted to meet all national radiomonitoring requirements.

Rohde & Schwarz offers a complete range of ITU compliant equipment for the measurement of frequency, modulation and field strength. The Rohde & Schwarz direction finders permit the remote-controlled, fast and effective position finding of all kinds of signal sources.

Integrating spectrum management and radiomonitoring is a crucial task. Rohde & Schwarz systems provide optimum efficiency by combining up-to-date radio-monitoring equipment with powerful and optimum spectrum management software.

Being an ITU member, Rohde & Schwarz is always well informed on current developments and plays an active role in preparing new recommendations. Considering future developments, Rohde & Schwarz is prepared to work out solutions that will fully meet the customers' future requirements.

Signal intelligence and electronic warfare

Solutions for interception, identification and electronic countermeasures

Military forces, the police and government agencies with security-relevant tasks can only be successful if their technical equipment is up to the latest state of the art.

Survival in the digital battlefield is only possible through the use of flexible technology. You simply have to be the fastest and smartest to intercept and evaluate the multitude of signals and information to be successful in the age of information warfare.

"SIGINT goes digital" is the trend. All instruments and systems from Rohde & Schwarz are completely in line with this trend through the massive use of extremely fast data and signal processors for digital signal processing and the use of intelligent modular hardware and software.

We assist you in solving your complex tasks by providing all-inclusive solutions for searching, detecting, analyzing and jamming all communication signals from HF to SHF as well as non-com signals. And that for any type of modulation and transmission method. Whether voice, fax or data, analog or digital signals, encryption or LPI methods such as frequency hopping or spread spectrum technique – we have the optimum solution for you in store. Rohde & Schwarz has specialized in designing and manufacturing equipment and systems for COMINT and ELINT applications and provides complete turnkey SIGINT and EW solutions, such as

- antennas from 1 kHz to 40 GHz,
- receivers for all communication bands for stationary, mobile and even portable use,
- direction finders fully digitally for landbased, shipborne or airborne operation,
- signal analyzers and classifiers in particular for data communications signal processing.

On request, tactical monitoring systems for special applications can be supplied.

Competence in Test and Measurement, Radiocommunications and Broadcasting

Rohde & Schwarz does not only provide a wide product line for SIGINT and EW applications but its strength is to design and deliver complete even turnkey systems based on its modular hardware and software:

- Amongst other examples there is an integrated shipborne early warning (COM ESM) System for automatic detection and direction finding of threat signals in the HF band. The system is also suitable against short burst transmissions
- Based on very fast intercepting digital direction finders the ScanLoc System allows to intercept locate and analyze military frequency hopping networks
- The V/UHF wideband mobile/portable networked DF system NetTrap is designed for tactical applications even under severe environmental conditions.

All Rohde & Schwarz systems for SIGINT application are run by the specifically designed modular software RAMON which allows an extremely flexible configuration of systems.

Radiomonitoring and Radiolocation for Security Organizations

Security Organizations like Police, Border or Coast Guard, Intelligence, e.t.c., make also use of the equipment and systems designed for Signal Intelligence and Electronic Warfare. They are adapted, however, according to their respective requirements. In addition Rohde & Schwarz offers on request, mobile monitoring systems for special applications.

IT security

The Rohde&Schwarz subsidiary SIT Gesellschaft für Systeme der Informationstechnik satisfies customers' demands for secure and reliable utilization of information and communications technology. Key activities are the development of crypto products and systems for the protection of information in modern data processing and communication systems as well as consulting and IT security analyses for industry and government authorities.

- Hardware and software crypto products
- Development of customer-specific crypto systems
- Consulting and IT security analyses

Services

Rohde&Schwarz maintains at its Cologne Plant one of Europe's largest service centers for T&M and communications equipment.

Our training centers in Cologne and Munich offer a comprehensive choice of courses on T&M and communications topics, which on request can also be held at the customer's.

- Calibration, service and maintenance
- Planning, development, system integration
- Seminars and training courses
- Development of customer-specific systems
- Technical documentation and logistics
- Electronic information systems, multimedia applications

Technical milestones

1938 World's first portable crystal clock

1948 Europe's first VHF sound broadcast transmitter

1964 Europe's first air-traffic-noise monitoring system

1967 Europe's first automatic IC test system

1974 First microprocessor-controlled radio measurement system

1975 World's first quality monitoring system for TV signals

1980 Europe's first stereo/dual-sound TV transmission system

1984 First processor for automatic setup of shortwave links

1986 Introduction of radio data system RDS for sound broadcasting in Germany

1990 First compact test set for GSM transmitters and receivers

1992 Exclusive supplier of reference test equipment for type-approval testing of GSM mobile phones

1992 World's fastest digital radiomonitoring system

1995 Technical equipment for world's largest pilot project for digital audio broadcasting (DAB)

1996 First integrated HF voice/data radio for use in commercial aircraft for fully automatic worldwide transmission of flight data

Competence in Test and Measurement, Radiocommunications and Broadcasting

1997 Reference test equipment for first mobile radio standard for satellite- and ground-based communications

1997 Order for nationwide DVB-T transmitter network in Great Britain (largest DVB project worldwide)

1999 World's first operational universal software radios for use on military platforms

Plants

Munich

Company headquarters in Munich house the R&D departments, systems engineering and assembly, training and service center, central divisions and administration.

ROHDE&SCHWARZ GmbH & Co. KG
Mühldorfstraße 15 · 81671 München
P.O.B. 80 14 69 · 81614 München
Phone +49 89 41 29-0
Fax +49 89 41 29-121 64

Memmingen

The plant in Memmingen is responsible for the final production and delivery of all Rohde& Schwarz equipment.

ROHDE&SCHWARZ Meßgerätebau GmbH
Riedbachstraße 58 · 87700 Memmingen
P.O.B. 16 52 · 87686 Memmingen
Phone +49 8331 1 08-0
Fax +49 83 31 1 081-124

Teisnach

The Rohde&Schwarz plant in northern Bavaria produces the mechanical and electrical parts for the equipment production in Memmingen.

ROHDE&SCHWARZ GmbH & Co. KG
Kaikenrieder Straße 27 · 94244 Teisnach
P.O.B. 11 49 · 94240 Teisnach
Phone +49 9923 8 57-0
Fax +49 9923 8 571-174

Cologne

Rohde&Schwarz Cologne Plant is one of Europe's largest service centers for electronic T&M and communications equipment. Services include maintenance and repair, training, technical documentation and logistics (also in conjunction with multimedia applications), system integration and adaptation as well as services for information and communications technology projects.

Factory for PCBs in Memmingen (Photo 36770)

The Cologne Plant is an accredited calibration laboratory of the German Calibration Service.

ROHDE&SCHWARZ GmbH & Co. KG
Graf-Zeppelin-Straße 18 · 51147 Köln
P.O.B. 98 02 60 · 51130 Köln
Phone +49 2203 49-0
Fax +49 2203 49-51 308

Subsidiaries

ROHDE&SCHWARZ Vertriebs-GmbH (RSV)

Founded in Berlin in 1946 and relocated to Munich in 1961, RSV is responsible for domestic sales of Rohde&Schwarz products as well as products of other make marketed on behalf of RSE. RSV has a marketing network throughout Germany.

Rohde&Schwarz Vertriebs-GmbH
Mühldorfstraße 15 · 81671 München
P.O.B. 80 14 69 · 81614 München
Phone +49 89 41 29-20 07
Fax +49 89 41 29-35 67

ROHDE&SCHWARZ International GmbH (RUSIS)

Since the end of 1993, RUSIS has been responsible for sales of Rohde & Schwarz products outside Europe. The company coordinates agencies, representatives and other business partners in the Asia-Pacific region, Middle East, Africa, North and Latin America.

ROHDE&SCHWARZ International GmbH
Mühldorfstraße 15 · 81671 München
P.O.B. 80 14 60 · 81614 München
Phone +49 89 4129-20 05
Fax +49 89 41 29-35 97

Competence in Test and Measurement, Radiocommunications and Broadcasting

ROHDE&SCHWARZ Engineering and Sales GmbH (RSE)
Founded as a subsidiary in 1972 and headquartered in Munich, RSE is primarily involved in marketing complementary products from other manufacturers. The objective of RSE is a vertical completion of the Rohde & Schwarz product line in close cooperation with headquarters and the representatives abroad. The numerous companies represented by RSE include renowned manufacturers such as the Rohde&Schwarz cooperation partner Advantest.

ROHDE&SCHWARZ Engineering and Sales GmbH
Mühldorfstraße 15 · 81671 München
P.O.B. 80 14 29 · 81614 München
Phone +49 89 4129-137 11
Fax +49 89 41 29-137 23

R & S BICK Mobilfunk GmbH
R&S BICK Mobilfunk GmbH with headquarters in Bad Münder specializes in the development and implementation of professional mobile radio systems. In particular, the company supplies system infrastructure and applications for trunked radio.

R&S BICK Mobilfunk GmbH
Im Landerfeld 7 · 31848 Bad Münder
P.O.B. 20 62 · 31844 Bad Münder
Phone +49 50 42 9 98-0
Fax +49 50 42 9 98-105

ROHDE & SCHWARZ FTK GmbH
ROHDE&SCHWARZ FTK GmbH with headquarters in Berlin has developed from the former broadcast transmitter manufacturing activities of Funkwerk Köpenick. The company develops and supplies products and systems in the field of VHF sound broadcasting as well as solutions for the transmission of ancillary data via digital broadcast channels. Services offered by Rohde&Schwarz FTK include software development.

ROHDE&SCHWARZ FTK GmbH
Wendenschloßstraße 168, Haus 28
12557 Berlin
Phone +49 30 6 58 91-122
Fax +49 30 65 55 0-221

SIT Gesellschaft für Systeme der Informationstechnik mbH
SIT provides solutions for security in information technology. Key activities are the development of crypto products and systems for the protection of information in modern data processing and communication systems as well as consulting and IT security analyses for industry and government authorities.

SIT Gesellschaft für Systeme der Informationstechnik mbH
Wendenschloßstr. 168, Haus 28
12557 Berlin
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Fax +49 30 6 58 84-183

Our partners

To secure a complete market presence in the technological key regions North America and Japan, we are cooperating with successful local partners who guarantee customer-oriented consultation and competent servicing – Tektronix in North America and Advantest in Japan.

Tektronix
The company was founded in 1946 and with its headquarters in Beaverton/Oregon is now fully devoted to test and measurement products after selling its line of printers and video/network equipment in 1999. With 3600 employees worldwide, Tektronix achieved a turnover of US$ 845 million in the fiscal year 1999 with its test and measurement products. In North America, the Tektronix product range is enhanced by almost the full range of T&M products from Rohde&Schwarz. The two companies also cooperate in the development of test and measurement instruments for special applications.

Advantest
Advantest, a Tokyo-based company founded in 1954, is the world's leading supplier of semiconductor test systems. The second most important business field is test and measurement equipment. In the fiscal year 1998, Advantest had a total turnover of Yen 141.7 billion. Advantest and Rohde&Schwarz have concluded a mutual sales agreement for T&M products: Advantest sells Rohde&Schwarz equipment in Japan and Rohde&Schwarz markets Advantest test and measurement instruments in Europe, the Middle East, in Brazil, Australia, South Africa and other countries. The two companies also cooperate in the development of T&M equipment for the Japanese market.

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Antennas

Receiving signals from 100 Hz to 40 GHz

The Rohde & Schwarz product line encompasses a wide range of highly sensitive active and passive antennas for mobile and stationary use, providing complete coverage of the 100 Hz to 40 GHz frequency range. Especially in radiomonitoring and radiolocation our broadband antennas minimize the number of antennas needed. Our monitoring antennas can be easily arranged on a single mast using both directional and/or omnidirectional elements providing optimum reception for any polarized signal. All antennas are fit for use under extreme weather conditions.

Our antenna systems can be controlled easily and efficiently with a commercial PC and our software running under Windows NT. For the microwave range Rohde & Schwarz offers an extensive line of equipment:

- Antenna reflectors of different sizes with optimized feeds
- Log-periodic feeds with high polarization decoupling even at 18 GHz
- Integrated preamplifiers for system optimization
- Complete antenna systems for full coverage from 1 GHz to 40 GHz

For more antennas see the HF-VHF-UHF-SHF Antennas Catalog (PD 756.9800.54)

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General

Tera – Atto

					Prefixes
T	Tera	10^{12}	c	Centi	10^{-2}
G	Giga	10^{9}	m	Milli	10^{-3}
M	Mega	10^{6}	µ	Micro	10^{-6}
k	Kilo	10^{3}	n	Nano	10^{-9}
h	Hecto	10^{2}	p	Pico	10^{-12}
da	Deca	10^{1}	f	Femto	10^{-15}
d	Deci	10^{-1}	a	Atto	10^{-18}

Measures of length

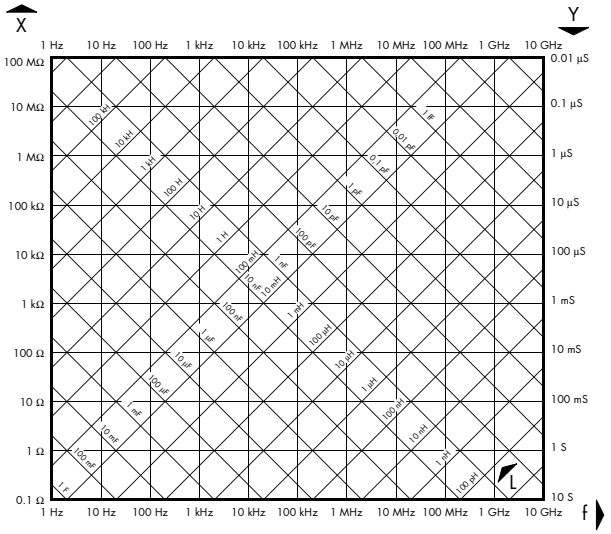
1 meter (m) = 100 centimeters (cm) = 1000 millimeters (mm) = 1 000 000 micrometers (µm).
1 m = 10 decimeters (dm).
1 kilometer (km) = 1000 m.
1 sea mile = 10 cable lengths = 1852 m.
1 English statute mile = 1760 yards = 1609 m.
1 yard = 3 English feet = 36 English inches (") = 91.44 cm.
1 English inch = 25.4 mm (accurately 25.399956 mm).

Inch in mm

inch	$\frac{1}{64}$	$\frac{1}{32}$	$\frac{1}{16}$	$\frac{1}{8}$	$\frac{3}{16}$	$\frac{1}{4}$
mm	0.397	0.794	1.587	3.175	4.762	6.350
inch	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{4}$	$\frac{7}{8}$	1
mm	9.525	12.700	15.875	19.050	22.225	25.400

Reactance chart

$$f = \frac{1}{2\pi\sqrt{LC}}$$

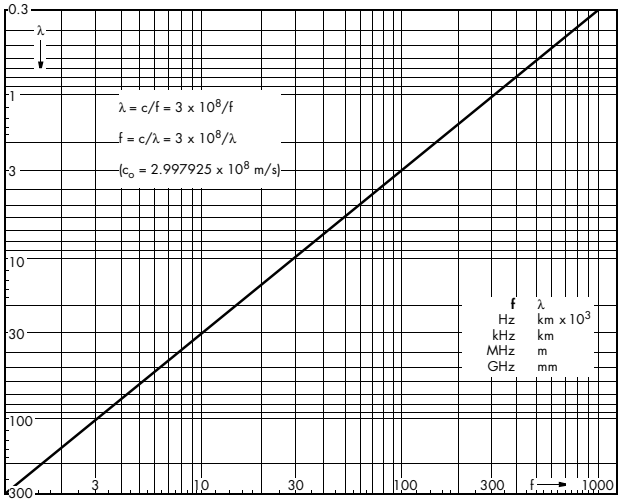


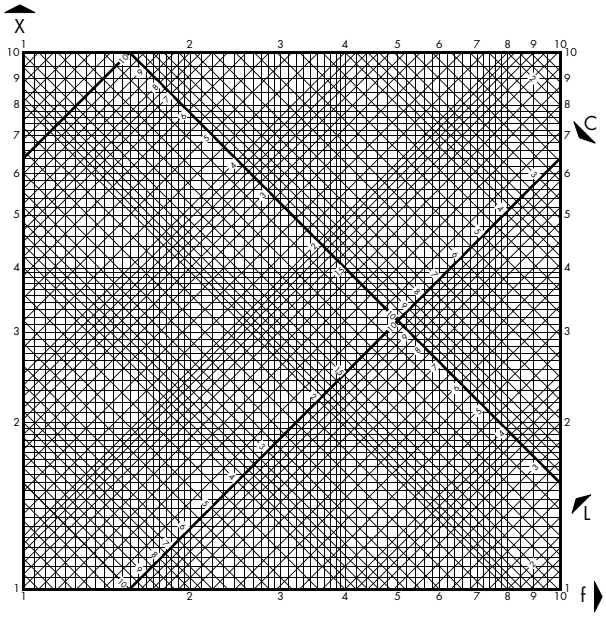
Frequency

Range		Classification	Band
VLF	3 kHz to 30 kHz 100 km to 10 km	Very low frequency	4
LF	30 kHz to 300 kHz 10 km to 1 km	Low frequency	5
MF	300 kHz to 1650 (3000) kHz 1000 m to 182 (100) m	Medium frequency	6
HF	3 MHz to 30 MHz 100 m to 10 m	High frequency	7
VHF	30 MHz to 300 MHz 10 m to 1 m	Very high frequency	8
UHF	300 MHz to 3000 MHz 1 m to 0.1 m	Ultra high frequency	9
SHF	3 GHz to 30 GHz 10 cm to 1 cm	Super high frequency	10
EHF	30 GHz to 300 GHz 10 mm to 1 mm	Extremely high frequency	11

Conversion

f / λ ↔ λ / f





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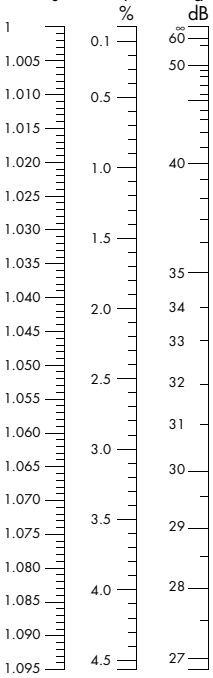
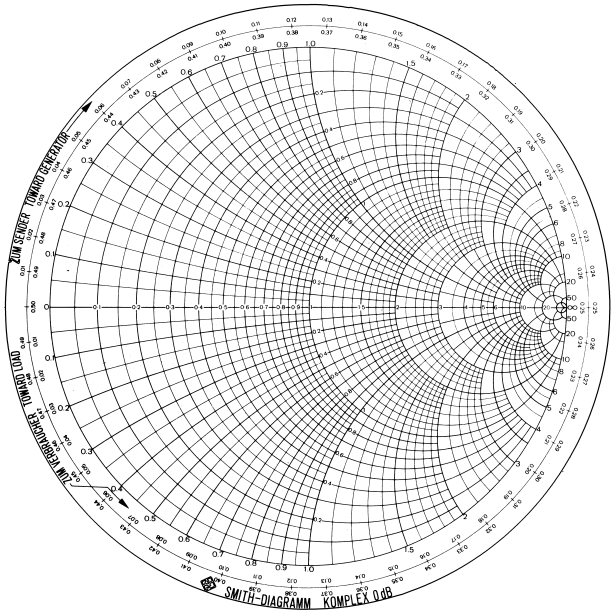
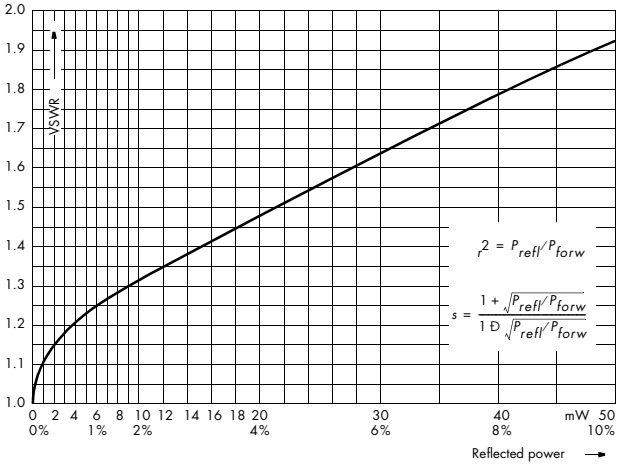
Reflection, matching

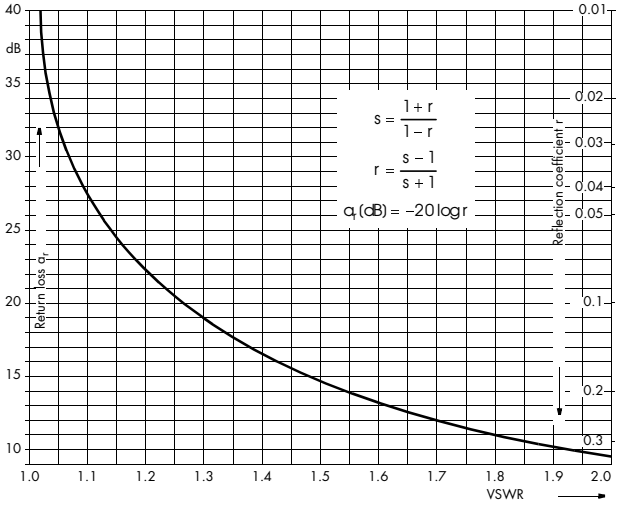
s VSWR r Reflection a Return loss	s(VSWR) $\frac{U_{max}}{U_{min}}$	r % $\frac{U\leftarrow}{U\rightarrow}$	P_{refl} %	a dB $20\lg\frac{U\rightarrow}{U\leftarrow}$
	1.01	0.50		46.1
	1.02	0.99	0.01	40.1
	1.03	1.48	0.02	36.6
	1.04	1.96	0.04	34.2
	1.05	2.44	0.06	32.3
	1.06	2.91	0.08	30.7
	1.07	3.38	0.11	29.4
	10.8	3.85	0.15	28.3
	1.09	4.31	0.19	27.3
	1.10	4.76	0.23	26.4
	1.11	5.21	0.27	25.6
	1.12	5.66	0.32	24.9
	1.13	6.10	0.37	24.3
	1.14	6.54	0.43	23.7
	1.15	6.98	0.49	23.1
	1.16	7.41	0.55	22.6
	1.17	7.83	0.61	22.1
	1.18	8.26	0.68	21.7
	1.19	8.68	0.75	21.2
	1.20	9.09	0.83	20.8
	1.30	13.0	1.70	17.7
	1.40	16.7	2.78	15.6
	1.50	20.0	4.00	14.0
	1.60	23.1	5.33	12.7
	1.70	25.9	6.72	11.7
	1.80	28.6	8.16	10.9
	1.90	31.0	9.63	10.2
	2.00	33.3	11.10	9.5
	2.20	37.5	14.1	8.5
	2.40	41.2	17.0	7.7
	2.60	44.4	19.8	7.0
	2.80	47.4	22.4	6.5
	3.00	50.0	25.0	6.0
	3.50	55.6	30.9	5.1
	4.00	60.0	36.0	4.4
	5.00	66.7	44.4	3.5
	6.00	71.4	51.0	2.9
	7.00	75.0	56.2	2.5
	8.00	77.8	60.5	2.2
	10.0	81.8	66.9	1.7
	20.0	90.5	81.9	0.9
	50.0	96.1	92.3	0.3



$s = \frac{1+r}{1-r} = \frac{10^{0.05a}+1}{10^{0.05a}-1}$ $r = \frac{s-1}{s+1}$ $a = 20\lg\frac{s+1}{s-1}$







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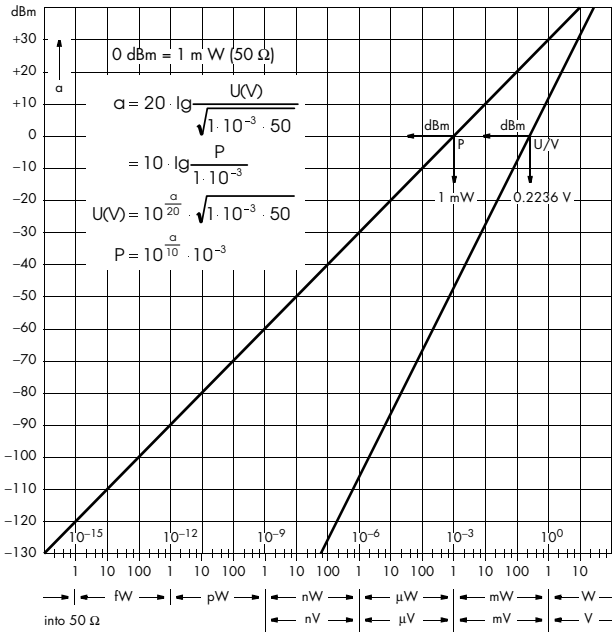
Voltage and power ratio

Levels

Type of level	Definition	Unit	Abbrev.
Absolute power level	$10\lg\left(\frac{P}{1\ mW}\right)$	dB(mW)	dBm
	$10\lg\left(\frac{P}{1\ W}\right)$	dB(W)	dBW
Absolute voltage level	$20\lg\left(\frac{\lvert U/V\rvert}{755\ mV}\right)$	dB(775 mV)[1]	dB
	$20\lg\left(\frac{\lvert U/V\rvert}{1\ V}\right)$	dB(V)	dBV
Power density level referred to frequency	$10\lg\left(\frac{P/\Delta f}{1\ W/Hz}\right)$	dB(W/Hz)	–
Power density level referred to antenna surface	$10\lg\left(\frac{P/A}{1\ W/m^2}\right)$	dB(W/m²)	–
Field strength level	$20\lg\left(\frac{\lvert E\rvert}{1\ \mu V/m}\right)$	dB(µV/m)	–
Relative level[2]	$10\lg\left(\frac{P}{P_0}\right)$	–	dBr
Absolute power level reduced to 0 dB point		dB(mW, 0)	dBm 0
Absolute noise power level reduced to 0 dB point and with psophometric weighting		dB(mW, 0, p)	dBm 0 p

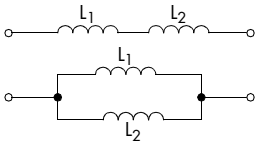
1) $R_i = R_a = 600\ \Omega$
2) Level P_s referred to site = power at 0 dB point (in mW0 or pW0).

Power, voltage Level



Inductance, capacitance

Cylindrical coil



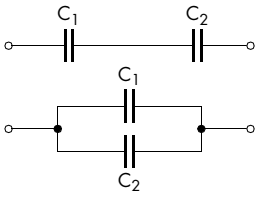
$$L = \mu_0\ \mu_r\ N^2\ \frac{A}{l}$$

$$L_{total} = L_1 + L_2$$

$$L_{total} = \left(\frac{1}{L_1} + \frac{1}{L_2}\right)^{D1}$$

$$\mu_0 = 4\pi \cdot 10^{-7}\ \frac{V_s}{A_m}$$

Plate capacitor



$$C = \varepsilon_0\ \varepsilon_r\ \frac{A}{d}$$

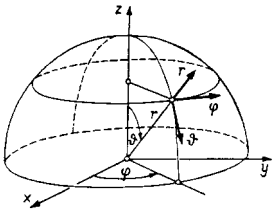
$$C_{total} = \left(\frac{1}{C_1} + \frac{1}{C_2}\right)^{D1}$$

$$C_{total} = C_1 + C_2$$

$$\varepsilon_0 = 8.8541 \cdot 10^{-12}\ \frac{F}{m}\left[\frac{F}{m} = \frac{A_s}{V_m}\right]$$

Characteristic impedance of free space

$$Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}} = 120 \cdot \pi i\Omega = 377\ \Omega$$



φ = Azimuth
90° – ϑ = Elevation

Maximum receive power

$$P_E = P_S \cdot G_S \cdot G_E \cdot \left(\frac{\lambda}{4\pi r}\right)^2$$

$$P_{rec} = P_{trans} \cdot G_{trans} \cdot G_{rec} \cdot \left(\frac{\lambda}{4\pi r}\right)^2$$

$$g = 10 \cdot \lg G\ dB$$

λ: Wavelength

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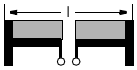
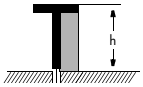
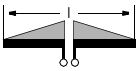
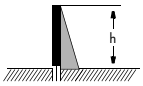
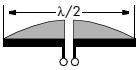
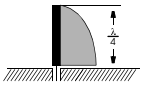
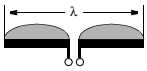
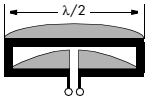
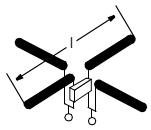
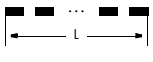
Parameters of selected antenna types

Type of antenna	Current distribution	Directivity factor D[1]	Effective antenna length l_w l_e	Radiation resistance R in Ω	Field strength in direction of maximum radiation[4] in mV/m	
					r in km P in W	r in km P in kW
Isotropic radiator		1 ≙ 0 dB			$\sqrt{30} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$173 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Hertz dipole with end capacitance[3]		1.5 ≙ 1.8 dB	l	$80\pi^2\left(\frac{l}{\lambda}\right)^2$	$3 \cdot \sqrt{5} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$212 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Short antenna on infinitely conducting ground with top capacitance[2]		3 ≙ 4.8 dB	h	$160\pi^2\left(\frac{h}{\lambda}\right)^2$	$3 \cdot \sqrt{10} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$300 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Short dipole without end capacitance[3]		1.5 ≙ 1.8 dB	$\frac{l}{2}$	$20\pi^2\left(\frac{l}{\lambda}\right)^2$	$3 \cdot \sqrt{5} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$212 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Short antenna on infinitely conducting ground without top capacitance[2]		3.0 ≙ 4.8 dB	$\frac{h}{2}$	$40\pi^2\left(\frac{h}{\lambda}\right)^2$	$3 \cdot \sqrt{10} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$300 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Halfwave dipole		1.64 ≙ 2.15 dB	$\frac{\lambda}{\pi}$	73.2	$7 \cdot \frac{\sqrt{P/W}}{(r/km)}$	$221 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Quarter-wave antenna on infinitely conducting ground		3.28 ≙ 5.2 dB	$\frac{\lambda}{2\pi}$	36.6	$10 \cdot \frac{\sqrt{P/W}}{(r/km)}$	$316 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Small single-turn loop in free space	Loop surface S any shape	1.5 ≙ 1.8 dB	$\frac{2\pi F}{\lambda}$	$80\pi^2\frac{4\pi^2F^2}{\lambda^4}$	$3 \cdot \sqrt{5} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$212 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Full-wave dipole		2.4 ≙ 3.8 dB			$6 \cdot \sqrt{2} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$268 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Folded halfwave dipole		1.64 ≙ 2.15 dB	$\frac{2\lambda}{\pi}$	$4 \cdot 73.2 \cong 280$	$7 \cdot \frac{\sqrt{P/W}}{(r/km)}$	$221 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Turnstile antenna (Hertz dipole) radiating in horizontal plane		0.75 ≙ –1.2 dB	l	$40\pi^2\left(\frac{l}{\lambda}\right)^2$	$\frac{3}{2} \cdot \sqrt{10} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$150 \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Broadside array (Hertz dipoles) (L >> λ)		$4 \cdot \frac{L}{\lambda}$			$2 \cdot \sqrt{30} \cdot \sqrt{\frac{l}{\lambda}} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$346 \cdot \sqrt{\frac{l}{\lambda}} \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Collinear array (Hertz dipoles) (L >> λ)		$2 \cdot \frac{L}{\lambda}$			$2 \cdot \sqrt{15} \cdot \sqrt{\frac{l}{\lambda}} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$245 \cdot \sqrt{\frac{l}{\lambda}} \cdot \frac{\sqrt{P/kW}}{(r/km)}$
Antenna with directivity D		D			$\sqrt{30} \cdot \sqrt{D} \cdot \frac{\sqrt{P/W}}{(r/km)}$	$173 \cdot \sqrt{D} \cdot \frac{\sqrt{P/kW}}{(r/km)}$

1) Corresponds to gain with loss-free antenna.

2) $h < 0.1\,\lambda$.

3) $l < 0.2\,\lambda$.

4) Antenna and surroundings loss-free.

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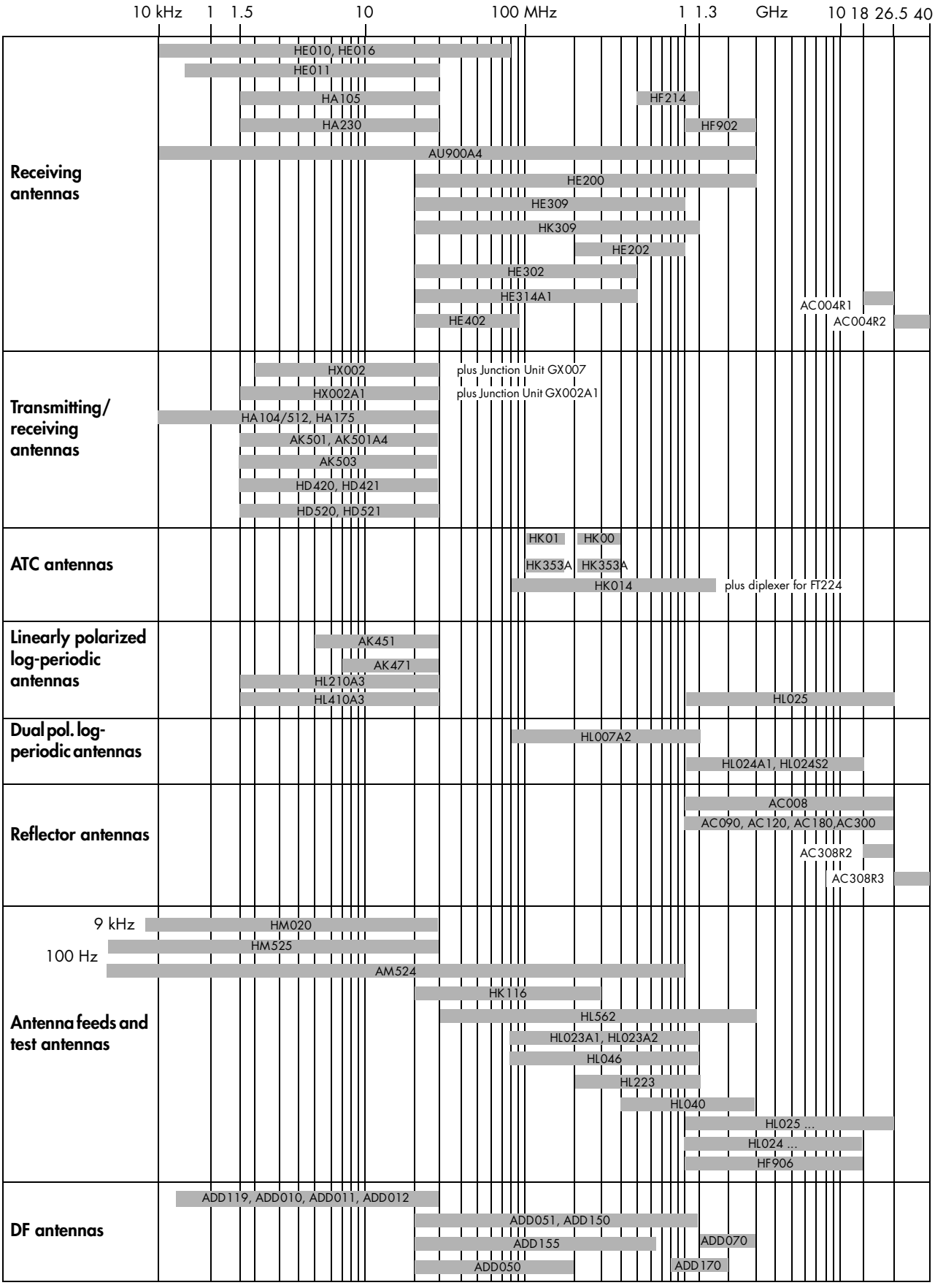

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Active Rod Antenna HE010

10 kHz to 80 MHz

Excellent characteristics of active receiving antenna

Photo 29050

Brief description

The excellent characteristics of active receiving antennas are a result of carefully matching the passive antenna structure to the active circuitry.

Special features

- Wide frequency range 10 kHz to 80 MHz
- Optimized for maximum dynamic range (high sensitivity, excellent large-signal characteristics)
- Short length (1 m only)
- High immunity to nearby lightning strikes

Specifications

Frequency range	10 kHz to 80 (120) MHz
Polarization	vertical
Nominal impedance	50 Ω
VSWR	
50 kHz to 120 MHz	<2
10 kHz to 50 kHz	<3
Antenna factor (mounted on conductive plane)	17 dB
Intercept point	
2nd order	≥50 dBm (typ. 60 dBm)
3rd order	≥30 dBm
Crossmodulation limit	12 V/m up to 30 MHz 6 V/m, 30 MHz to 80 MHz
Power supply	via RF cable, 21 V to 26 V DC (170 mA)
Connector	N female
Operating temperature	–40 °C to +65 °C
Max. wind speed	188 km/h (without ice deposit)
Dimensions	
Length	1000 mm
Max. diameter	120 mm
Weight	0.9 kg

Ordering information

Active Rod Antenna (connector 1× N female)	HE010	0523.1414.13
Extras		
Power Supply Unit	IN110	4040.8508.02
Power Supply Unit	IN115	4004.1707.02

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Active Rod Antenna HE011

50 kHz to 30 MHz

Careful matching of passive antenna structure to active circuitry

Brief description

The excellent characteristics of active receiving antennas are a result of carefully matching the passive antenna structure to the active circuitry.

Special features

- Wide frequency range 50 kHz to 30 MHz (operational up to 200 MHz)
- Optimized for maximum dynamic range (high sensitivity, excellent large-signal characteristics)
- Short length
- High immunity to nearby lightning strikes
- Adjustable length of radiator

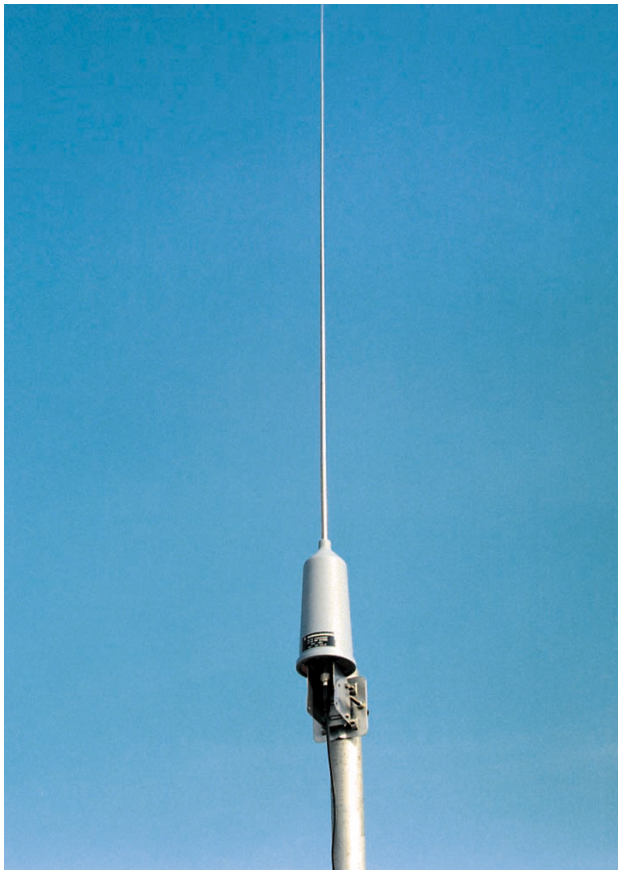

Photo 40323

Specifications

Frequency range	50 kHz to 30 MHz (up to 200 MHz w/o specification)
Polarization	vertical
VSWR	<2
Antenna factor	13 dB
Intercept point	
2nd order	≥50 dBm (typ. 60 dBm)
3rd order	≥30 dBm
Crossmodulation limit	≥10 V/m
Power supply	via RF cable; 24 V DC ±15 % (190 mA)
Connector	N female
Operating temperature	–25 °C to +55 °C
Max. wind speed	130 km/h (without ice deposit)
Dimensions	
Max. length with radiator	1700 mm
Max. diameter	90 mm
Weight	0.9 kg

Ordering information

Active Rod Antenna (with power supply unit)	HE011	4031.7654.03

For use under extreme environmental conditions as well as on board vehicles and ships, the proven Active Rod Antenna HE010 with Power Supply IN115 is available (see page 13).

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Active Antenna System HE016

10 kHz to 80 MHz (vertical)
600 kHz to 40 MHz (horizontal)
Omnidirectional reception also for horizontally polarized waves

Photo 43060

Brief description

This antenna system is a combination of Active HF Rod Antenna HE010 and two crossed HF dipole antennas. The two horizontal dipole antennas are combined via a 90° coupler to produce an omnidirectional antenna pattern for the reception of horizontally polarized signals.

Special features

- Extremely small dimensions
- High sensitivity – same system sensitivity as comparable passive antennas with more than three times the size
- High linearity
- High immunity to nearby lightning strikes
- Optimum results under any receiving conditions with minimum space requirement
- Omnidirectional reception of horizontally and vertically polarized signals

Specifications

Frequency range	
Vertical polarization	10 kHz to 80 (120) MHz
Horizontal polarization	600 kHz to 40 MHz
Nominal impedance	50 Ω
VSWR	<2 (10 kHz to 20 kHz: <3)
Intercept point	
2nd order	≥50 dBm up to 30 MHz
3rd order	≥30 dBm up to 30 MHz
Power supply	21 V to 26 V DC (460 mA)
Connector	2 x N female
Operating temperature	–40°C to +65°C
Max. wind speed	188 km/h (without ice deposit)
Dimensions (dia. × H)	3 m × 1.4 m
Weight	3 kg

Ordering information

Active Antenna System	HE016	4051.8504.02
Extras		
Power Supply Unit	IN115	4004.1707.02
6 m Plug-in Mast	KM011	0273.9116.02

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HF Receiving Antenna HA105

1.5 MHz to 30 MHz

For use in mobile stations and on ships

Photo 3757

Brief description

Due to its small size and low weight, the HF Receiving Antenna HA105 is particularly suitable for use in mobile stations and on ships. The V-shaped arrangement of the radiators enables this antenna to be used for the reception of both horizontally and vertically polarized signals.

Special features

- Wide frequency range
- Small size
- Omnidirectional horizontal pattern when receiving high-angle signals (NVIS)
- Proven in mobile and stationary use

Specifications

Frequency range	1.5 MHz to 30 MHz
Polarization	horizontal and vertical
Nominal impedance	50 Ω
Connector	
HA105/1/50	N female
HA105/11/50	4/10 female
Length of radiators	
HA105/1/50	3.5 m
HA105/11/50	3.8 m
Weight	
HA105/1/50	14 kg (with stand)
HA105/11/50	5 kg

Ordering information

HF V-Dipole, mobile	HA105/1/50	0111.5816.11
HF V-Dipole, stationary	HA105/11/50	0101.3262.50

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HF Receiving Antenna HA230

1.5 MHz to 30 MHz

For polarization-diversity reception

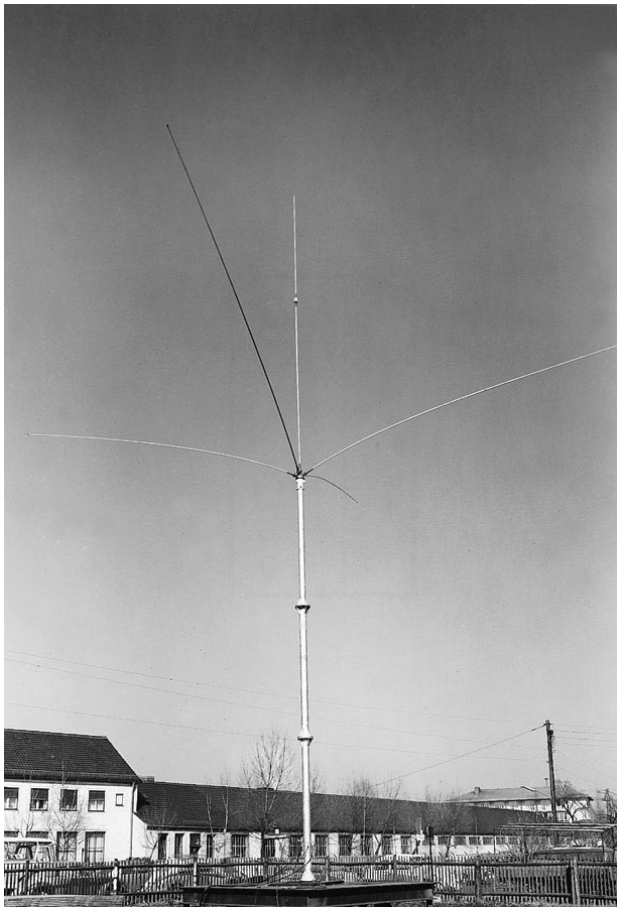

Photo 13141

Brief description

The HF Receiving Antenna HA230 is a versatile shortwave antenna for both horizontally and vertically polarized waves. Made up of electrically isolated and decoupled individual elements, this antenna is particularly suitable for polarization-diversity reception.

Special features

- Individual radiators for horizontal and vertical polarization
- Suitable for polarization-diversity reception
- For mobile and stationary use

Specifications

Frequency range	1.5 MHz to 30 MHz
Polarization	horizontal and vertical
Nominal impedance	50 Ω
Connectors	3 × N female
Preferred application	
HA230/401	mobile use
HA230/403	stationary use
Dimensions	
Length of radiators	
HA230/401	5.7 m
HA230/403	5 m
Height	
HA230/401	11.7 m
HA230/403	11 m
Weight	
HA230/401	35 kg
HA230/403	85 kg

Ordering information

Polarization Diversity Antenna		
mobile	HA230/401	0101.1160.02
stationary	HA230/403	0101.1176.02

Rotatable Log-Periodic Antenna System AK451

5 MHz to 30 MHz

For transmission and reception of horizontally polarized waves over medium to long distances

Photo 36608-1

Brief description

The compact Rotatable Log-Periodic Antenna System AK451 is used for the transmission and reception of horizontally polarized waves. Due to a transmission frequency range from 5 MHz to 30 MHz, the antenna system is particularly suitable for operation over medium to long distances despite its extremely small size. Reception is possible from 2 MHz thus covering all distances.

Special features

- Extremely small dimensions (size of loaded log-periodic antenna for 6.2 MHz to 30 MHz)
- Transmission from 5 MHz, reception from 2 MHz
- Unrestricted halfwave elements leading to high antenna gain
- Easy and quick assembly
- Little maintenance required

Specifications

Frequency range	5 MHz to 30 MHz (reception 2 MHz to 30 MHz)
Polarization	horizontal
Nominal impedance	50 Ω
VSWR	≤2
Max. input power	1 kW
Gain	6 dBi to 12.5 dBi
Radius of rotation	8.3 m
Range of rotation	±(n × 360°)
Max. wind speed	180 km/h (without ice deposit)
MTBF	>100,000 h
Dimensions	
Length of antenna	15 m
Width of antenna	16 m
Weight of antenna	260 kg

Ordering information

Log-Periodic HF Antenna	HL451	0733.8507.02
Lattice Mast		
15 m (standard)	KM451B2	4028.3400.02
10 m (for roof top mounting)	KM451B1	4028.3351.02
30 m (for long-range communications)	KM451B3	4028.3451.02
Antenna Rotator	RD008	0720.6300.02
Adaption Set/Rotary Joint	RD008Z1	0720.6400.02
Control Unit (manual)	RB040	4003.2100.02
Control Unit (remotely/computer-controlled)	BG030	0749.8501.02

Other configurations on request.

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Rotatable Log-Periodic Antenna System AK471

7 MHz to 30 MHz

For transmission and reception of horizontally polarized waves especially over long distances

Photo 37391-3

Brief description

The compact Rotatable Log-Periodic Antenna System AK471 is used for the transmission and reception of horizontally polarized waves. Due to its transmission frequency range from 7 MHz to 30 MHz it is used especially over long distances. Reception is possible from 3 MHz to 30 MHz leading to coverage of almost all distances. Its low weight and small size make the antenna system ideal for installation on roofs.

Special features

- Extremely small dimensions
- Low weight
- Easy and quick assembly
- Little maintenance required

Specifications

Frequency range	7 MHz to 30 MHz (reception 3 MHz to 30 MHz)
Polarization	horizontal
Nominal impedance	50 Ω
VSWR	≤2
Max. input power	1 kW
Gain (with 15 m mast)	
7 MHz to 8 MHz	0 dBi to 6 dBi
8 MHz to 30 MHz	6 dBi to 12.5 dBi
Radius of rotation	5 m
Range of rotation	±(n × 360°)
Max. wind speed	180 km/h (without ice deposit)
MTBF	>100,000 h
Dimensions	
Length of antenna	8.8 m
Width of antenna	11 m
Weight of antenna	100 kg

Ordering information

Log-Periodic HF Antenna	HL471	0755.3008.02
Lattice Mast		
15 m (standard)	KM451B2	4028.3400.02
10 m (for roof top mounting)	KM451B1	4028.3351.02
30 m (for long-range communications)	KM451B3	4028.3451.02
Antenna Rotator	RD008	0720.6300.02
Adaption Set/Rotary Joint	RD008Z1	0720.6400.02
Control Unit (manual)	RB040	4003.2100.02
Control Unit (remotely/computer-controlled)	BG030	0749.8501.02

Other configurations on request.

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Antenna Rotator RD008

For azimuth positioning of antennas and antenna systems

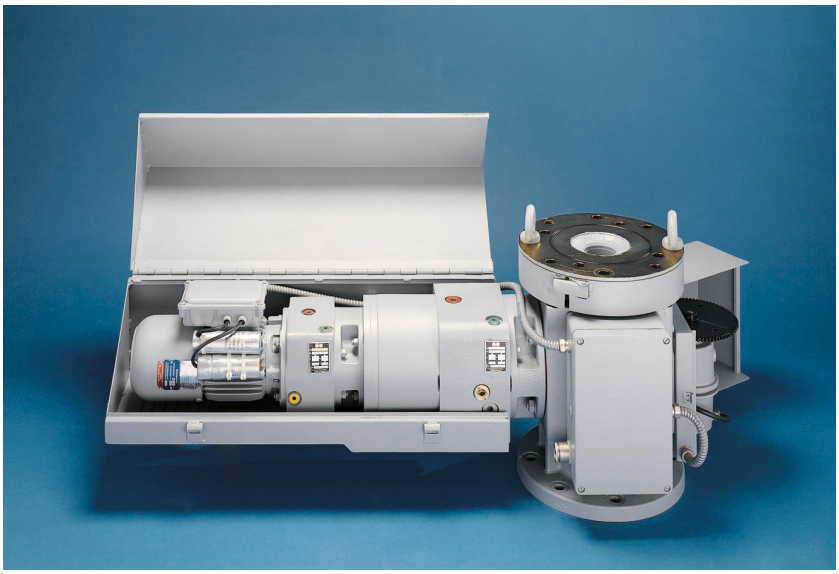

Photo 36007

Brief description

The Antenna Rotator RD008 is used for azimuth positioning of antennas and antenna systems. It features a positioning accuracy of ±1°. A manual control unit (RB040) or computer-controlled model (BG030) is available for the rotators.

Special features

- Smooth start-up thanks to starting clutch
- Overload protection thanks to slip-friction clutch
- Easy to service
- High MTBF

Specifications

Range of rotation	±(n × 360°)
Max. vertical load	3000 N
Max. bending moment referred to upper edge of drive flange	4250 Nm
Max. radial force on upper bearing	23,500 N
Max. bending moment referred to lower edge of base flange	6750 Nm
Drive speed	0.5 rpm
Power supply	220 V AC ±5%, 50 Hz, 2.2 A
Operating temperature	–25°C to +70°C
Weight	110 kg

Ordering information

Antenna Rotator	RD008	0720.6300.02
Extras		
Control Unit	RB040	4003.2100.02
Control Unit	BG030	0749.8501.02
Adaption Set/RF Rotary Joint	RD008Z1	0720.6400.02
Adaption Set/ RF Rotary Joint and 4 Slip Rings	RD008Z3	4042.4200.02

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Control Unit BG030

For controlling Antenna Rotator RD008

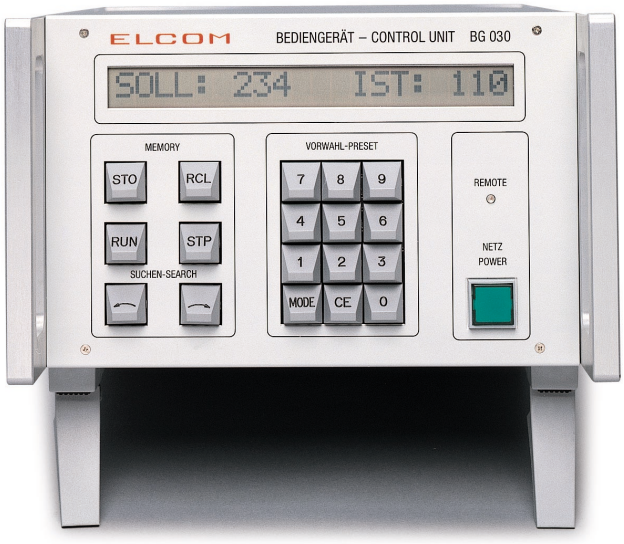

Photo 36208-1

Brief description

The Control Unit BG030 is used for controlling the Antenna Rotator RD008 in local mode or in computer-controlled remote mode. Optional the BG030 is available with an IEC-625/IEEE-488 interface or a serial RS-232-C and RS-485 interface.

Specifications

Operation	local or computer control
Display accuracy	±1°
Power supply	220 V AC +10/–15%, 47 Hz to 63 Hz (45 VA, without rotator)
Operating temperature	0 to +50°C
Dimensions (W × H × D)	220 mm × 133 mm × 312 mm
Weight	6 kg

Ordering information

Control Unit	BG030	0749.8501.02
Extras		
Serial Interface	BG030-Z1	0749.8547.02
IEC/IEEE Bus Interface	BG030-Z2	0749.8582.02

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Control Unit RB040

For manual control of Antenna Rotator RD008 and antenna positioning

Photo 37795

Brief description

The Control Unit RB040 for the Antenna Rotator RD008 is used for positioning antennas, eg log-periodic antennas, preferably in radiomonitoring and radiolocation systems. The RB040 is available as a desktop unit or as a 19" rack-mount.

Specifications

Operation	manual control with three-position switch for CW and CCW rotation and standstill
Display accuracy	±2°
Power supply	220 V AC +10/–15 %, 47 Hz to 63 Hz (max. 7.5 A, with rotator)
MTBF	>100,000 h
Operating temperature	0 to +50 °C
Dimensions (W × H × D)	220 mm × 145 mm × 360 mm (½ × 19", 3 height units)
Weight	5.8 kg

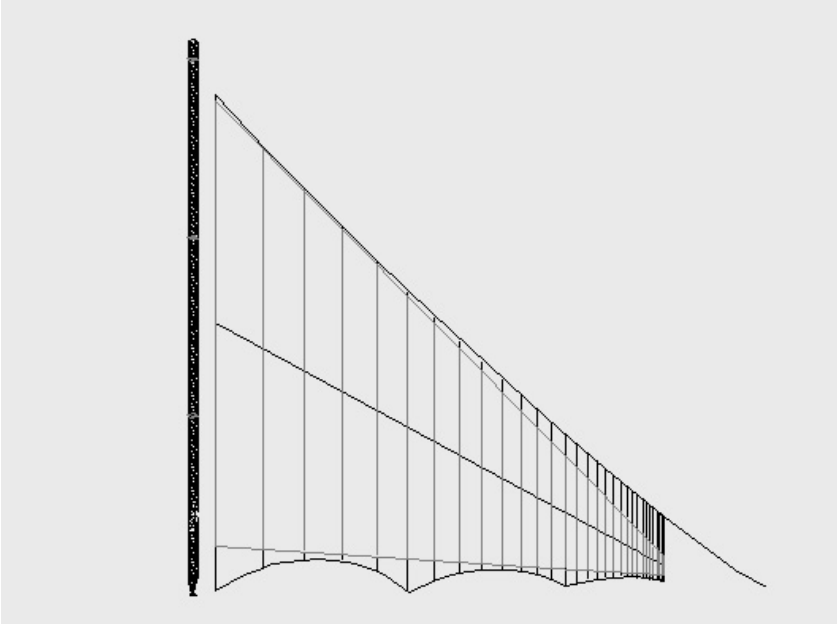
Ordering information

Control Unit	RB040	4003.2100.02

Log-Periodic HF Antenna HL210A3

1.5 MHz to 30 MHz

For high-sensitivity radiomonitoring through reception of ground waves and vertically polarized sky waves



Brief description

The Log-Periodic HF Antenna HL210A3 is suitable for the reception of ground waves as well as vertically polarized sky waves and allows even very weak signals to be detected. According to the physical characteristics of vertically polarized waves, maximum sensitivity is obtained at low and medium elevation angles. For additional reception of horizontally polarized waves and predominantly horizontally polarized high-angle radiation the antenna can be combined with the horizontal Log-Periodic Antenna HL410A3. The azimuth range of the HL210A3 of about 120° can be enhanced up to 360° cost-effectively by adding further antennas.

Special features

- Reception of even very weak signals
- Very high efficiency through dipole structure
- Extremely large frequency range
- No ground net required
- Small antenna size for 1.5 MHz to 30 MHz range and high directivity
- Little maintenance required

Specifications

Frequency range	1.5 MHz to 30 MHz
Polarization	vertical
Nominal impedance	50 Ω
VSWR	
1.5 MHz to 2 MHz	<6
2 MHz to 30 MHz	<2.5 (typ. <2)
Directivity	
1.5 MHz to 2 MHz	8 dB to 10.5 dB
2 MHz to 30 MHz	10.5 dB to 12 dB
Efficiency	>90%
Connector	N female
Max. wind speed	170 km/h for survival 145 km/h to DIN 4131
with ice deposit	135 km/h to DIN 4131
MTBF	≥100,000 h
Dimensions	
Length of antenna array	approx. 97 m
Height of supporting mast	approx. 90 m

Ordering information

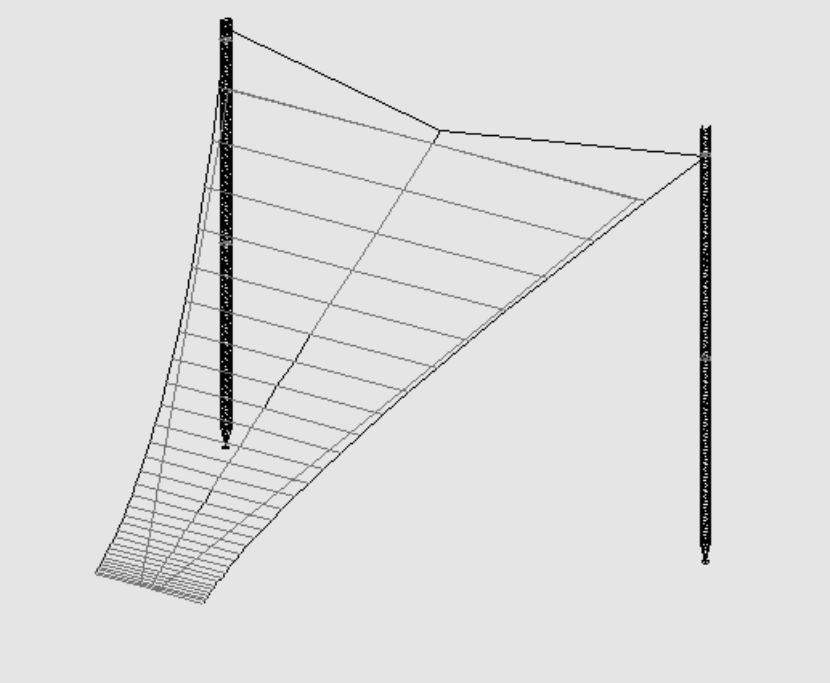
Log-Periodic HF Antenna	HL210A3	4045.9002.xx

Further information on request.

Log-Periodic HF Antenna HL410A3

1.5 MHz to 30 MHz

For radiomonitoring over short, medium and global distances with extremely high sensitivity



Brief description

The Log-Periodic HF Antenna HL410A3 is suitable for the reception of horizontally polarized waves and allows even very weak signals to be detected. The vertical patterns are shaped taking into account the transmission characteristics in the ionosphere. In conjunction with the extremely large frequency range from 1.5 MHz to 30 MHz the antenna thus allows reception of signals over short, medium and global distances. The azimuth range of about 70° can be enhanced up to 360° in a cost-saving way by adding further antennas. For the reception of vertically polarized waves the antenna can be combined with the vertical Log-Periodic Antenna HL210A3.

Special features

- Reception of even very weak signals
- No skip zone
- Extremely large frequency range
- Small antenna size for 1.5 MHz to 30 MHz range
- Star-shaped arrangement possible
- Little maintenance required

Specifications

Frequency range	1.5 MHz to 30 MHz
Polarization	horizontal
Nominal impedance	50 Ω
VSWR	
1.5 MHz to 2 MHz	<6
2 MHz to 30 MHz	<2.5 (typ. <2)
Directivity	
1.5 MHz	7.5 dB
1.6 MHz to 30 MHz	8 dB to 12 dB
Efficiency	>90%
Connector	N female
Max. wind speed	170 km/h for survival
	145 km/h to DIN 4131
with ice deposit	135 km/h to DIN 4131
MTBF	≥100,000 h
Dimensions	
Length of antenna array	approx. 94 m
Width of antenna array	approx. 88 m
Height of supporting masts	approx. 66 m

Ordering information

Log-Periodic HF Antenna	HL410A3	4049.8000.xx

Further information on request.

Receiving Antenna System AU900A4

10 kHz to 3 GHz

Omnidirectional and directional reception of vertically and horizontally polarized waves

Photo 42146-1

Brief description

The rotatable Antenna System AU900A4 is designed for the reception of linearly polarized electromagnetic waves in the frequency range 10 kHz to 3 GHz. Featuring a wide frequency range and omnidirectional and directional reception of signals with vertical and horizontal polarization, Antenna System AU900A4 is particularly suitable for radiomonitoring. The compact size of the antenna designed for extreme environmental conditions makes for reduced space requirements, simple installation and thus low infrastructure costs.

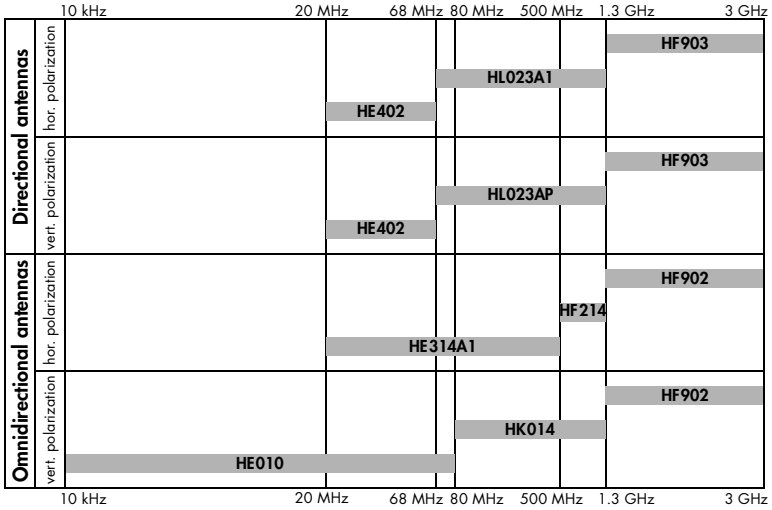
Specifications

Frequency range	10 kHz to 3 GHz
Polarization	horizontal and vertical
Nominal impedance	50 Ω
Number and type of outputs	according to antennas used
Operating temperature	–40 °C to +50 °C
Max. wind speed	180 km/h (without ice deposit)[1]
Wind load (at 180 km/h)	13,500 N[1]
MTBF	≥15,000 h
Range of rotation	0 to 400°
Dimensions	
Height	6.5 m
Radius of rotation	2.4 m
Weight	approx. 350 kg[1]

Ordering information

Receiving Antenna System	AU900A4	4045.0205.02

1) For maximum configuration.

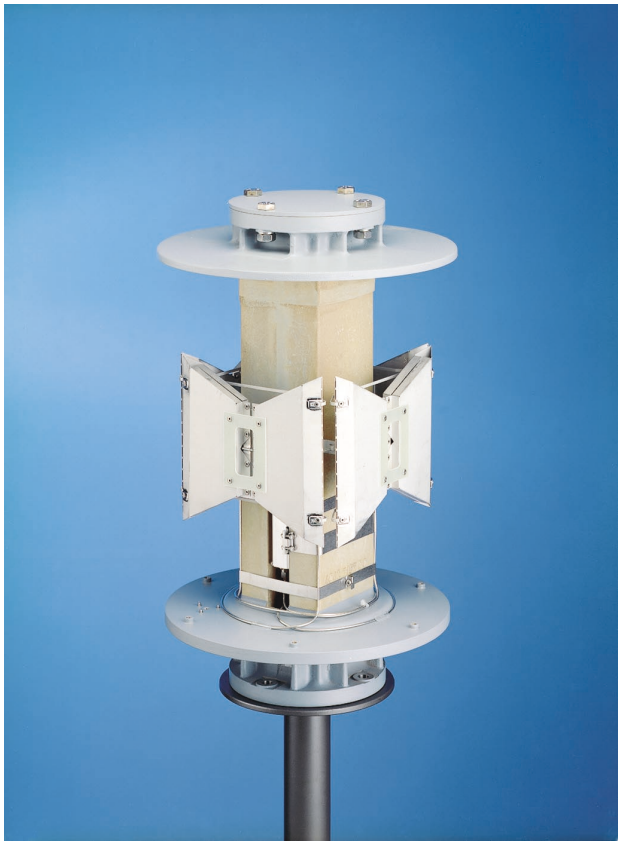


The Antenna System AU900A4 is of modular design and consists of standard antennas. Based on the maximum possible configuration, the antenna system can be adapted to specific applications by omitting individual antennas.

Omnidirectional Antenna HF214

500 MHz to 1300 MHz

For reception of horizontally polarized waves



HF214 without radome (photo 42314)

Brief description

The Omnidirectional Antenna HF214 is designed for the reception of horizontally polarized waves. It is ideal for broadband detection and monitoring of RF signals in the frequency range 500 MHz to 1300 MHz.

The compact broadband antenna is suitable for applications where the available space is limited. With a maximum diameter of 0.31 m and a height of 0.49 m it is ideal for use in mobile systems.

A compact omnidirectional receiving system for horizontally and vertically polarized electromagnetic waves in the frequency range 20 MHz to 3000 MHz is obtained by combining HF214 with Antennas HE309, HE314A1 and HF902.

Special features

- Small size
- Rugged design
- Mobile use
- Easy integration into extremely broadband antenna systems

Specifications

Frequency range	500 MHz to 1300 MHz
Polarization	horizontal
Impedance	50 Ω
VSWR	<3
Gain	0 dB (typ.)
Departure from circularity	±3 dB
Connector	N female
Operating temperature	–40 °C to +65 °C
Max. wind speed	188 km/h
with 30 mm radial ice deposit	130 km/h
Dimensions	
Diameter	310 mm
Height	492 mm
Weight	approx. 8 kg

Ordering information

Omnidirectional Antenna	HF214	4042.7009.02

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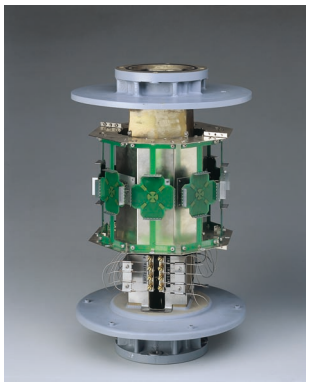
Omnidirectional Antenna HF902

1 GHz to 3 GHz

For simultaneous reception of horizontally and vertically polarized waves



HF902 without radome (photo 42313-2)

HF902 with radome (photo 42313-1)

Brief description

The Omnidirectional Antenna HF902 is designed for simultaneous reception of horizontally and vertically polarized waves. It is ideal for broadband detection and monitoring of RF signals.

The compact broadband antenna is suitable for applications where the available space is limited. With a maximum diameter of 0.31 m and a height of 0.49 m it is ideal for use in mobile systems.

A compact omnidirectional receiving system for horizontally and vertically polarized electromagnetic waves in the frequency range 20 MHz to 3000 MHz is obtained by combining HF902 with Antennas HE309, HE314A1 and HF214.

Special features

- Small size
- Rugged design
- Mobile use
- Easy integration into extremely broadband antenna systems

Specifications

Frequency range	1.3 GHz to 3 GHz (from 1 GHz with reduced data)
Polarization	horizontal and vertical
Impedance	50 Ω
VSWR	<3 (typ.)
Gain	0 dB (typ.)
Connector	2 x N female
Operating temperature	–40 °C to +65 °C
Max. wind speed	188 km/h
with 30 mm radial ice deposit	130 km/h
Dimensions	
Diameter	310 mm
Height	492 mm
Weight	approx. 8 kg

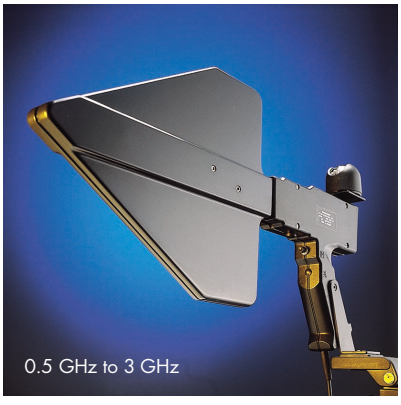
Ordering information

Omnidirectional Antenna	HF902	4042.8005.02


HE200HF: 10 kHz to 20 MHz


20 MHz to 200 MHz


200 MHz to 500 MHz


0.5 GHz to 3 GHz

Active Directional Antenna HE200

Brief description

Due to its small size and low weight, the Active Directional Antenna HE200 in conjunction with a compact, portable minireceiver (eg EB200) is ideal for tracing signal sources and interfering sources. The direction is found by pointing the antenna towards the direction of maximum signal voltage. The overall frequency range from 20 MHz to 3000 MHz is covered by three exchangeable antenna modules, which handle both vertically and horizontally polarized signals and have almost identical cardioid patterns in both planes.

Special features

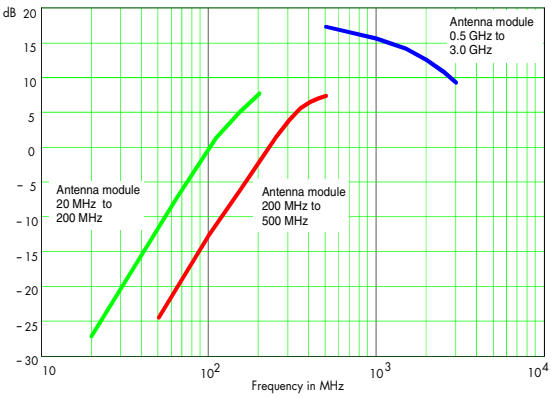
- Distinct, unambiguous directional pattern
- Wide frequency range
- For horizontal and vertical polarization
- Handy size, low weight
- Wide dynamic range

Specifications

Frequency range	20 MHz to 3000 MHz
RF modules	20 MHz to 200 MHz 200 MHz to 500 MHz 500 MHz to 3000 MHz
Nominal impedance	50 Ω
Radiation patterns in H and E plane	cardioid
Power supply	four 1.5 V R6 dry cells
Connector	N male
Operating temperature	–30 °C to +60 °C
Dimensions (in transit case)	470 mm × 360 mm × 180 mm (L × W × H)
Length of connecting cable	1000 mm
Weight of antenna	1 kg max.
with case	5 kg

Ordering information

Active Directional Antenna	HE200	4050.3509.02
Extras		
Loop Antenna 0.01 MHz to 20 MHz	HE200HF	4051.4009.02



Gain, active mode

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Active Vertical Dipole HE309

20 MHz to 1300 MHz

Large bandwidth, wide dynamic range and high sensitivity

Photo 41241

Brief description

Extremely large bandwidth, wide dynamic range and high sensitivity make the HE309 ideal for all receiving tasks in radiocommunication, detection and monitoring in which small size, minimum amount of distribution and switching units and high S/N ratio are at a premium.

The broadband characteristic of the Active Vertical Dipole HE309 is obtained through the combination of the active antenna principle with a special design of the radiator.

Special features

- Extremely wide frequency range
- Small dimensions – only 1.2 m in length
- High sensitivity
- Just one active antenna replaces several passive antennas
- High immunity to nonlinear distortion
- High immunity to nearby lightning strikes
- Low weight

Specifications

Frequency range	20 MHz to 1000 MHz (up to 1300 MHz with reduced sensitivity)
Polarization	vertical
Nominal impedance	50 Ω
Horizontal pattern	omnidirectional
Noise figure (frequency-dependent, referred to external noise)	22 dB (typ.) at 20 MHz 10 dB (typ.) at 100 MHz 7 dB (typ.) at 1000 MHz
Intercept point	
2nd order	55 dBm (typ.)
3rd order	32 dBm (typ.)
Power supply	via RF cable; 21 V to 28 V DC, 150 mA
Connector	N female
Operating temperature	–40 °C to +70 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions	
Length	1210 mm
Diameter	100 mm
Weight	approx. 3 kg

Ordering information

Active Vertical Dipole	HE309	4027.5009.02
Extras		
Power Supply Unit	IN110	4040.8508.02
Power Supply Unit	IN115	4004.1707.02
Mast Adapter	HE202Z1	0649.7510.02
RF Cable	HE202Z2	0649.7785.02
Active Omnidirectional Antenna	HE314A1	4027.6505.02

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Passive Broadband Receiving Dipole HK309

20 MHz to 1300 MHz

Large bandwidth

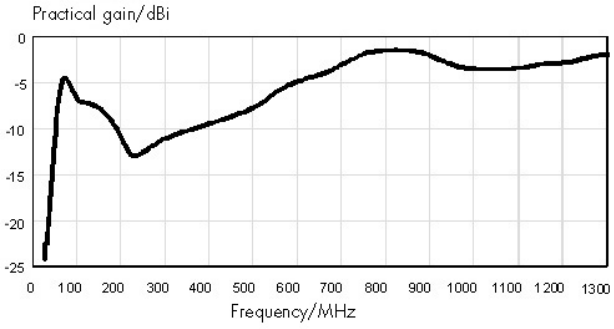
Suitable for high field strengths and mobile use

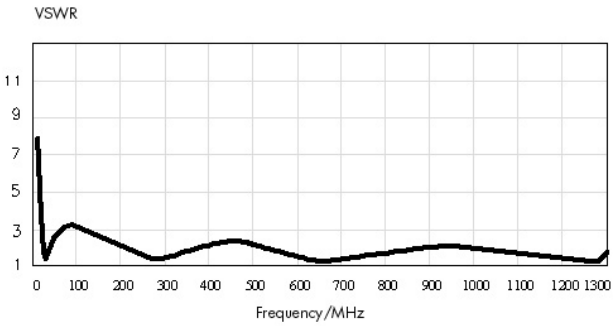
Photo 43312-2

Brief description

Extremely large bandwidth and high sensitivity make the HK309 ideal for all receiving tasks in radiocommunication, detection and measurement in which small size, minimum number of distribution and switching units and high S/N ratio are at a premium.

The broadband characteristic of the Receiving Dipole HE309 is obtained through eight impedance elements which generate travelling waves with the antenna and prevent nulls in the radiation pattern.





Special features

- Extremely wide frequency range
- Small dimensions – only 1.7 m in length
- High sensitivity
- Large-signal immunity
- High immunity to nearby lightning strikes
- Low weight

Specifications

Frequency range	20 MHz to 1300 MHz
Polarization	vertical or horizontal (depending on mounting)
Nominal impedance	50 Ω
VSWR	see diagram
Practical gain	see diagram
Connector	N female
Operating temperature	–40 °C to +70 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions	
Length	1710 mm
Diameter	100 mm
Weight	approx. 4 kg

Ordering information

Passive Broadband Receiving Dipole	HK309	4054.2007.02
Extras		
Mast Adapter	HE202Z1	0649.7510.02
RF Cable	HE202Z2	0649.7785.02

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Active Receiving Dipole HE202

200 MHz to 1000 MHz

Careful matching of passive antenna structure to active circuitry

Photo 435718

Brief description

The excellent characteristics of active receiving antennas are a result of carefully matching the passive antenna structure to the active circuitry.

Special features

- Extremely small dimensions
- High sensitivity despite small size
- Wide frequency range
- Just one active antenna instead of several passive antennas
- High immunity to nonlinear distortion (same as passive antenna with high-grade preamplifier)
- High immunity to nearby lightning strikes
- Low weight
- Shock- and vibration-resistant (MIL-STD-810C)

Specifications

Frequency range	200 MHz to 1000 MHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	<2.5 (typ.)
Electronic gain	5 dB to 9 dB
Practical gain	7 dBi to 11 dBi
Directivity	2 dB average
Antenna factor	10 dB to 22 dB
Noise figure	
200 MHz	6 dB
1000 MHz	7 dB
Field sensitivity (Δf = 1 kHz)	
200 MHz	–17 dB(µV/m)
1000 MHz	–2 dB(µV/m)
Intercept point	
2nd order	>55 dBm
3rd order	>30 dBm
Power supply	via RF cable; 18 V to 30 V DC (200 mA)
Connector	N female
Operating temperature	–40 °C to +70 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (L × H)	512 mm × 238 mm
Weight	2.1 kg

Ordering information

Active Receiving Dipole	HE202	0630.0310.02
Extras		
Power Supply Unit	IN110	4040.8508.02
Power Supply Unit	IN115	4004.1707.02
Mast Adapter	HE202Z1	0649.7510.02
RF Cable	HE202Z2	0649.7785.02

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Active Receiving Dipole HE302

20 MHz to 500 MHz

Careful matching of passive antenna structure to active circuitry

Photo 43519

Brief description

The excellent characteristics of active receiving antennas are a result of carefully matching the passive antenna structure to the active circuitry.

Special features

- Extremely small dimensions
- High sensitivity despite small size
- Wide frequency range
- Just one active antenna instead of several passive antennas
- High immunity to nonlinear distortion (same as passive antenna with high-grade preamplifier)
- High immunity to nearby lightning strikes
- Low weight
- Shock- and vibration-resistant (MIL-STD-810C)

Specifications

Frequency range	20 MHz to 500 MHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	<2.5
Electronic gain	–11 dB to +8 dB
Practical gain	–9 dBi to +10 dBi
Directivity	2 dB average
Antenna factor	0 dB to 14 dB
Noise figure	
20 MHz	28 dB
500 MHz	9 dB
Field sensitivity (Δf = 1 kHz)	
20 MHz	–15 dB(µV/m)
500 MHz	–6 dB(µV/m)
Intercept point	
2nd order	>60 dBm
3rd order	>30 dBm
Power supply	via RF cable; 18 V to 30 V DC (170 mA)
Connector	N female
Operating temperature	–40 °C to +70 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (L × H)	1000 mm × 240 mm
Weight	2.5 kg

Ordering information

Active Receiving Dipole	HE302	0644.1114.02
Extras		
Power Supply Unit	IN110	4040.8508.02
Power Supply Unit	IN115	4004.1707.02
Mast Adapter	HE202Z1	0649.7510.02
RF Cable	HE202Z2	0649.7785.02

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Active Omnidirectional Antenna HE314A1

20 MHz to 500 MHz

For reception of horizontally polarized signals

Photo 40707-1

Brief description

The Active Omnidirectional Antenna HE314A1 is a turnstile antenna consisting of two Active Receiving Dipoles HE302 which are connected via a 90° hybrid coupler. It is used for the reception of horizontally polarized signals. Its horizontal radiation pattern is omnidirectional.

The Antenna HE314A1 can be extended for omnidirectional reception of vertically polarized waves using the Active Vertical Dipole HE309 mounted on top.

Special features

- Small dimensions
- Ideal for mobile or semi-mobile receiving systems
- High sensitivity
- Wide frequency range

Specifications

Frequency range	20 MHz to 500 MHz
Polarization	horizontal
Nominal impedance	50 Ω
VSWR	<2.5
Electronic gain	–15 dB to +8 dB
Practical gain	–14 dBi to +5 dBi
Directivity	1 dB average
Antenna factor	2 dB to 20 dB
Noise figure	
20 MHz	<29 dB
500 MHz	<10 dB
Field sensitivity (Δf = 1 kHz)	
20 MHz	–12 dB(µV/m)
500 MHz	–3 dB(µV/m)
Intercept point	
2nd order	>60 dBm
3rd order	>30 dBm
Power supply	via RF cable; 18 V to 30 V DC (340 mA)
Connector	N female
Operating temperature	–40 °C to +70 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (L × W × H)	1000 mm × 1000 mm × 327 mm
Weight	8 kg

Ordering information

Active Omnidirectional Antenna	HE314A1	4027.6505.02
Extras		
Power Supply Unit	IN115	4004.1707.02
Mast Adapter	HE202Z1	0649.7510.02
RF Cable	HE202Z2	0649.7785.02
Active Vertical Dipole	HE309	4027.5009.02

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Active Directional Antenna HE402

20 MHz to 87 MHz

Cardioid-shaped horizontal pattern

Brief description

The Active Directional Antenna HE402 consists of two Active Receiving Dipoles HE302, a combining network and the mechanical fixing elements. The antenna normally receives vertically polarized signals; it can, however, also be used for horizontally polarized signals by mounting the dipoles by 90° from the vertical. The horizontal radiation pattern is cardioid-shaped.

Special features

- Small size (approx. 1 m × 1 m)
- Ideal for use in mobile or semi-mobile receiving systems

Photo 33907

Specifications

Frequency range	20 MHz to 87 MHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	<2.5
Electronic gain	–19 dB to +5 dB
Practical gain	–14 dBi to +10 dBi
Directivity	5 dB average
Noise figure	
20 MHz	34 dB
87 MHz	11 dB
Field sensitivity (Δf = 1 kHz)	
20 MHz	–12 dB(µV/m)
87 MHz	–22 dB(µV/m)
Horizontal pattern	cardioid
Intercept point	
2nd order	>60 dBm
3rd order	>30 dBm
Power supply	via RF cable; 18 V to 30 V DC (340 mA)
Connector	N female
Operating temperature	–40 °C to +75 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (L × W × H)	990 mm × 170 mm × 1099 mm
Weight	12 kg

Ordering information

Active Directional Antenna	HE402	0684.2011.02
Extras		
Power Supply Unit	IN115	4004.1707.02

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Power Supply Unit IN110

Powering of active receiving antennas via coaxial cable

100 V to 240 V AC

10 V to 32 V DC

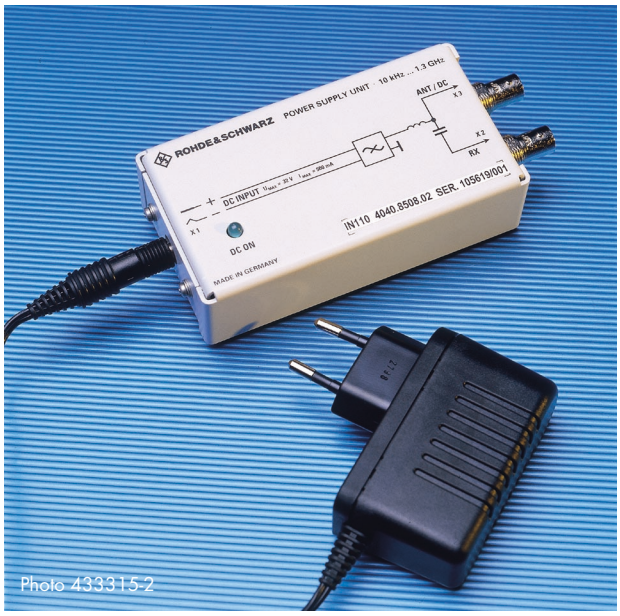

Photo 433315-2

Brief description

The Power Supply Unit IN110 is used for powering active receiving antennas via the inner conductor of a coaxial cable.

The DC feed is operated from an external AC supply unit or battery via a low-voltage connector to DIN 45323. After the two-stage DC filter and the DC RF feed circuit the voltage is available at a BNC connector; the second connector is without voltage. A LED indicates the operating state (ON).

Special features

- AC supply or battery operation
- Short-circuit-proof (polyswitch fuse making again after elimination of short circuit)
- Small size and favourable price

Specifications

Frequency range	10 kHz to 1.3 GHz
Nominal impedance	50 Ω
VSWR	<2.5 typ.
Insertion loss	<1.5 dB typ.
AC supply	100 V to 240 V (47 Hz to 63 Hz)
Battery supply	10 V to 32 V
Switch-on monitor	LED
Output voltage with AC operation	24 V
Max. load current	350 mA
RF connectors	BNC female
DC connector	low-voltage connector to DIN 45323
Operating temperature	0 °C to +40 °C
Dimensions (L × W × H)	140 mm × 60 mm × 40 mm
Weight	approx. 250 g (without AC/DC adapter)

Ordering information

Power Supply Unit	IN110	4040.8508.02

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Power Supply Unit IN115

115/125/220/235 V AC

Supply of active receiving antennas via coaxial cable

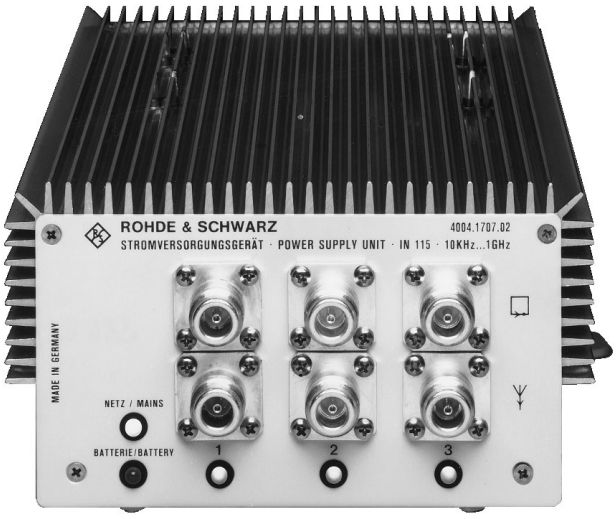

Photo 38691-1

Brief description

The Power Supply Unit IN115 supplies the following active receiving antennas via coaxial cable: HE010, HE016, HE309, HE202, HE302, HE314A1 and HE402.

Special features

- AC supply or battery operation
- Short-circuit-proof
- Three DC feed sections for up to three active antennas

Specifications

AC supply	115/125/220/235 V AC ±10 %
Power consumption	50 VA max.
DC supply	24 V +35/–20 %
Switch-on monitor	pilot light
Output voltage	
with AC operation	3 × 24 V ±5 %
with battery operation	3 × 18 V ±5 %
Max. load current	500 mA per output
Short-circuit current	200 mA
RF frequency range of DC feed sections	10 kHz to 1.3 GHz
Connectors	N female
Operating temperature	–25 °C to +55 °C
Dimensions (W × H × D)	170 mm × 125 mm × 350 mm
Weight	5.5 kg

Ordering information

Power Supply Unit	IN115	4004.1707.02

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Log-Periodic Antenna HL023A1

80 MHz to 1300 MHz

Particularly suitable for radiomonitoring and measurements

Photo 29358-1

Brief description

Due to its broadband characteristics, the Log-Periodic Antenna HL023A1 is particularly suitable for radiomonitoring and measurements.

Special features

- Only one antenna required to cover wide frequency range
- Selectable polarization plane
- Radiation pattern virtually independent of frequency
- Sturdy construction
- Suitable for mobile use
- Long dipoles can be removed for transportation
- Individual calibration

Specifications

Frequency range	80 MHz to 1300 MHz
Polarization	depending on plane of antenna (linear)
Nominal impedance	50 Ω
VSWR	≤2.5
Max. input power	460 W to 150 W + 100% AM
Gain	6.5 dBi
Connector	N female
Max. wind speed	150 km/h (without ice deposit)
Dimensions (L x W)	1670 mm x 1960 mm
Weight	5 kg

Ordering information

Log-Periodic Antenna	HL023A1	0577.8017.02

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Log-Periodic Antenna HL023A2

80 MHz to 1300 MHz

Particularly suitable for radiomonitoring and measurements

Photo 29601-1

Brief description

Due to its broadband characteristics, the Log-Periodic Antenna HL023A2 is particularly suitable for radiomonitoring and measurements.

Special features

- Only one antenna required to cover wide frequency range
- Selectable polarization plane
- Radiation pattern virtually independent of frequency
- Sturdy construction
- Suitable for mobile use
- Center bracket

Specifications

Frequency range	80 MHz to 1300 MHz
Polarization	depending on plane of antenna (linear)
Nominal impedance	50 Ω
VSWR	≤2.5
Max. input power	300 W to 100 W + 100% AM
Gain	6.5 dBi
Connector	N female
Max. wind speed	150 km/h (without ice deposit)
Dimensions (L × W)	1670 mm × 1960 mm
Weight	5 kg

Ordering information

Log-Periodic Antenna with center bracket	HL023A2	0624.2815.02

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Log-Periodic Antenna HL223

200 MHz to 1300 MHz

Particularly suitable for radiomonitoring and measurements

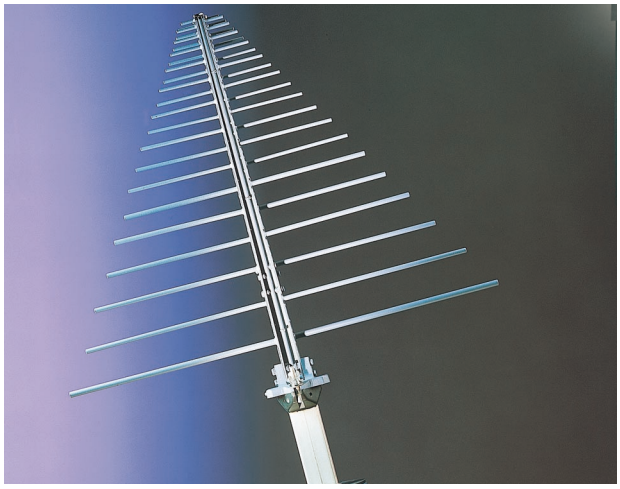

Photo 40423

Brief description

Thanks to its broadband characteristics, the Log-Periodic Antenna HL223 is particularly suitable for radiomonitoring and measurements.

Special features

- Only one antenna required to cover wide frequency range
- Selectable polarization plane
- Radiation patterns virtually independent of frequency
- Sturdy construction
- Suitable for mobile use
- Individual calibration to ANSI C63.5/DIN45003 and ARP958

Specifications

Frequency range	200 MHz to 1300 MHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	≤2, typ. 1.6
Max. input power	1500 W to 600 W CW
Gain	>6 dBi
Connector	N female
Max. wind speed	200 km/h (without ice deposit)
Dimensions (L × W)	710 mm × 765 mm
Weight	2 kg

Ordering information

Log-Periodic Antenna	HL223	4001.5501.02
Extras		
Antenna Case	HL223Z1	4001.6189.02

Log-Periodic Dipole Antenna HL040

400 MHz to 3000 MHz

Broadband transmission and reception, for use in labs and open-field applications

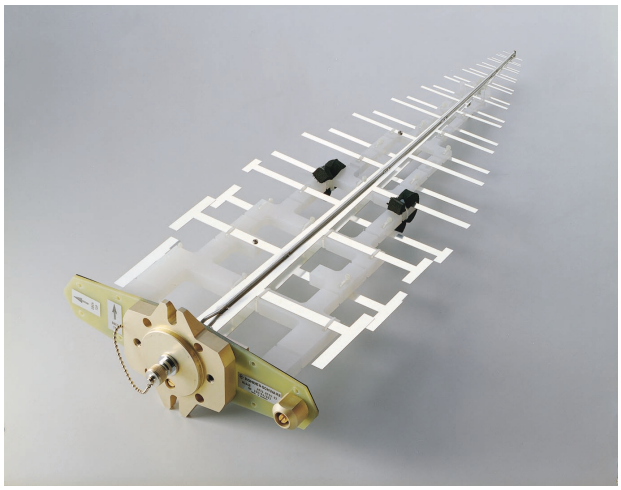

Photo 42038-1

Brief description

The linearly polarized Log-Periodic Dipole Antenna HL040 provides broadband transmission and reception in the frequency range 400 MHz to 3000 MHz and can be used in the lab as well as for open-field applications.

Special features

- Suitable for field-strength and EMI measurements thanks to high precision
- Individual calibration to ANSI C63.5/DIN45003
- Suitable for mobile radio measurements
- High symmetry of radiation patterns
- Very low frequency dependence
- Compact and sturdy design

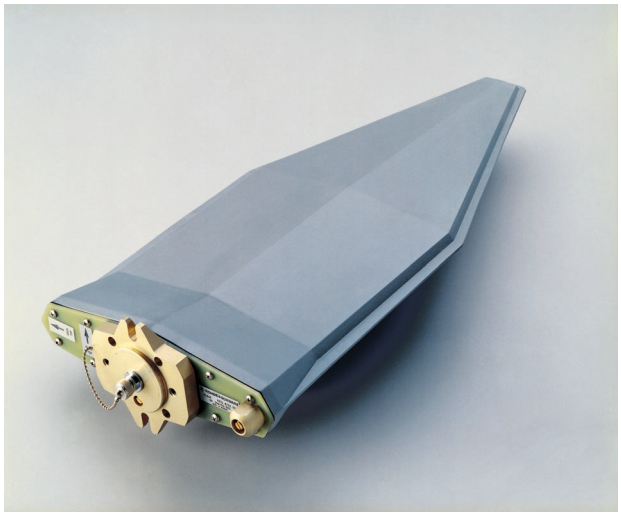

Photo 42038-2

Specifications

Frequency range	400 MHz to 3000 MHz
Polarization	linear
Impedance	50 Ω
VSWR	<2.5, typ. <2.0
Max. input power	150 W to 50 W CW
Gain	5 dBi to 7 dBi
Front-to-back ratio	>10 dB (400 MHz to 450 MHz) >15 dB (450 MHz to 3000 MHz)
Polarization isolation	>20 dB
Connector	N female
Operating temperature	–20 °C to +70 °C
Max. wind speed	
without ice deposit	200 km/h
with ¼" radial ice deposit	118 km/h
Dimensions (H × W × L)	130 mm × 302 mm × 680 mm
Weight	2.8 kg

Ordering information

Log-Periodic Dipole Antenna	HL040	4035.8755.02

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Crossed Log-Periodic Antenna HL007A2

80 MHz to 1300 MHz

Particularly suitable for measurement and monitoring of RF signals

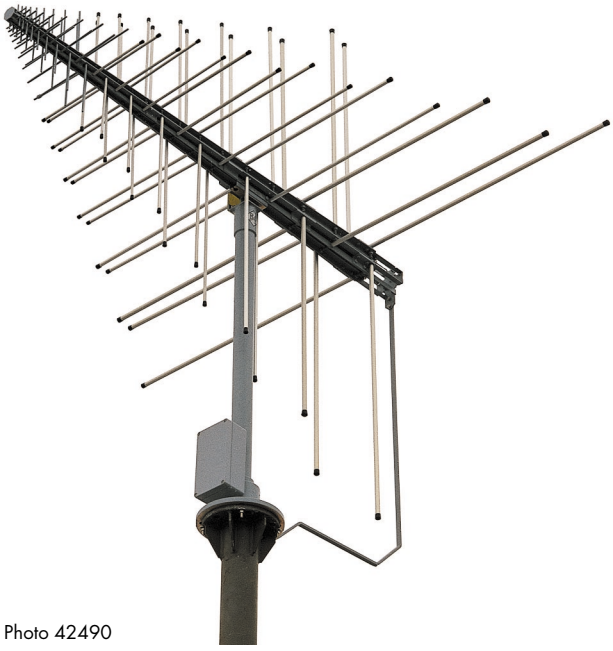

Photo 42490

Brief description

The Log-Periodic Antenna HL007A2 with crossed elements is particularly suitable for measurement and monitoring of RF signals.

Special features

- Polarization horizontal, vertical or +45°/–45°, selectable with option ZS107
- Remote-controlled polarization switchover with GB016
- Wide frequency range with virtually frequency-independent radiation pattern

Specifications

Frequency range	80 MHz to 1300 MHz
Polarization (remotely selectable)	horizontal, vertical, +45°/–45°
Nominal impedance	50 Ω
VSWR	≤2.5
Gain	6 dBi typ.
Connector	2 x N female
with ZS107	2 x SMA female
Operating temperature	–40 °C to +50 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (L x W x H)	1.7 m x 2 m x 2.2 m
Weight	15 kg

Ordering information

Crossed Log-Periodic Antenna	HL007A2	4025.8700.03
Extras		
Polarization Network Switch for hor./vert./+45°/–45°polarization	ZS107	0428.2853.02
Polarization Network Switch for hor./vert. polarization	ZS107	0428.2853.04
Control Unit (computer-controllable)	GB016	4056.7006.02

Control Unit GB016

Designed for local control,

used for polarization switchover of antennas

Brief description

Control Unit GB 016 is used for controlling the polarization network, amplifiers and bypass switchover of Antenna Feeds HL 025 S7, HL 024 S7, HL 024 S8, HL 024 S9 and Log-Periodic Antenna HL 024 S2 using negative logic and Antenna Feed ZS xxx.xx using positive logic. Polarization, amplifier and bypass settings can be selected manually using four keys S1, S2, S3 and S4 or remote-controlled via a serial RS232 interface.

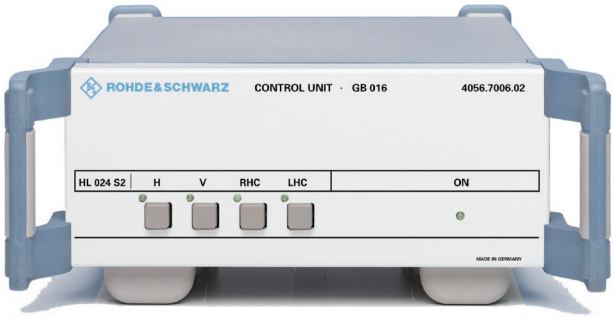

Photo 43551

Specifications

Operation	local or remote control
Selectable functions (depending on controlled unit)	
Polarization	horizontal/vertical left-/right-handed circular or +45°/–45°
Amplifier	on or bypass
Power supply	
Voltage	85 V AC to 264 V AC, 50 Hz to 400 Hz (80 VA) or 100 V DC to 375 V DC
Current	3 A_p
Operating temperature	–10°C to +55°C
Dimensions (W x H x D)	23 cm x 12 cm x 30 cm (approx.)
Weight	approx. 3.5 kg

Ordering information

Control Unit	GB016	4056.7006.02

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VHF/UHF Coaxial Dipole HK014

100 MHz to 1300 MHz/80 MHz to 1600 MHz

Extremely broadband omnidirectional antenna with vertical polarization featuring high suppression of skin currents

Photo 39646

Brief description

The VHF/UHF Coaxial Dipole HK014 is an omnidirectional antenna with vertical polarization featuring high suppression of skin currents. Due to its sturdy design it is also suitable for mobile use, in particular on board ships.

Special features

- Wide frequency range
- Low weight
- Minimal wind load
- Sturdy design
- High suppression of skin currents
- Protected against lightning
- Vertical pattern with null fill-in

Specifications

Frequency range	
Model 02	100 MHz to 1300 MHz
Model 12	80 MHz to 1600 MHz
Polarization	vertical
Nominal impedance	50 Ω
VSWR	≤2
Max. input power	
Model 02	
up to 150 MHz	800 W + 100% AM
up to 400 MHz	430 W + 100% AM
up to 1000 MHz	270 W + 100% AM
up to 1300 MHz	240 W + 100% AM
Model 12	20 W CW
Gain	2 dBi typ.
Horizontal pattern	omnidirectional
Connector	N female
Operating temperature	–40 °C to +85 °C
Max. wind speed	160 km/h (without ice deposit)
Dimensions (dia. × H)	
Model 02	308 mm × 1100 mm
Model 12	308 mm × 1252 mm
Weight	5 kg

Ordering information

VHF/UHF Coaxial Dipole	HK014	
100 MHz to 1300 MHz		0644.1514.02
80 MHz to 1600 MHz		0644.1514.12
Extras		
Diplexer for frequency ranges 100 MHz to 162 MHz and 225 MHz to 400 MHz	FT224	0525.5117.03
6 m Plug-in Mast	KM011	0273.9116.02
Mast Adapter	KM011Z2	4022.3608.02

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Log-Periodic Antennas HL025, HL025S1

1 GHz to 26.5 GHz

Extremely broadband directional antennas with rotationally symmetrical radiation pattern

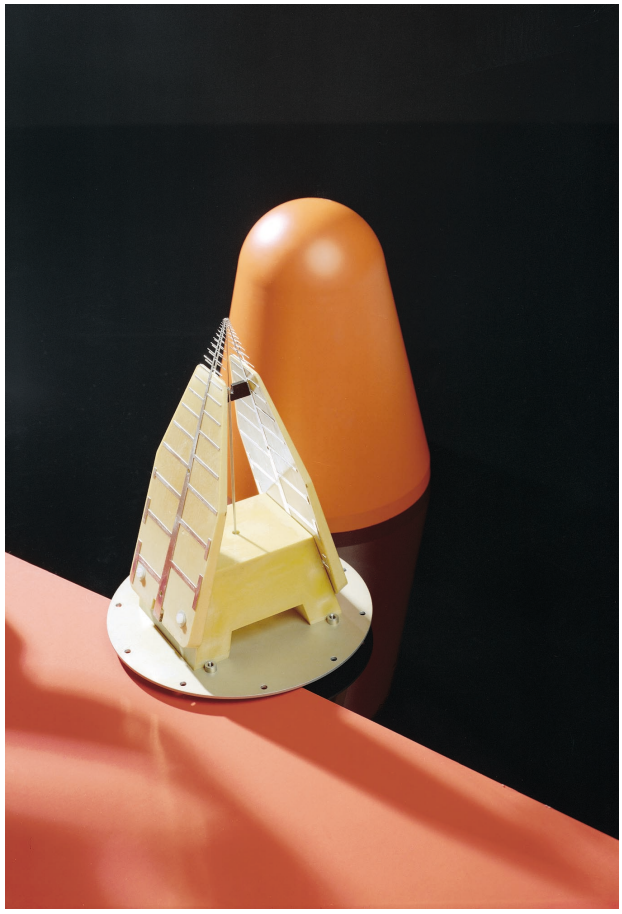

Photo 33011

Brief description

Due to their broadband characteristics, the Log-Periodic Antennas HL025 and HL025S1 are particularly suitable for measurement and monitoring of RF signals. Their almost rotationally symmetrical radiation patterns ensure optimum secondary radiation patterns when used as a feed in reflector antennas.

HL025 serves as a stand-alone antenna and as a feed for the Microwave Directional Antenna AC008.

HL025S1 has been designed as a feed for the SHF Directional Antenna Systems AC090 to AC300.

Special features

- Extremely wide frequency range
- Constant and almost rotational symmetrical radiation patterns
- High gain due to V-shaped arrangement
- Ideal for use as a feed for reflector antennas

Specifications

Frequency range	1 GHz to 26.5 GHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	≤2
Max. input power	10 W to 5 W CW
Gain	8 dBi typ.
Connector	SMA female
Operating temperature	–40 °C to +55 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (dia. × L) with radome	210 mm × 300 mm
Weight	0.7 kg

Ordering information

Log-Periodic Antenna	HL025	0671.5317.02
	HL02551	4053.3000.02

Extras
(not required if used as a feed in systems AC090 to AC300)

Microwave Cable, 10 m	AC008W2	0751.6931.03
Mast Adapter	HL025-Z	0661.9910.02
Wooden Tripod	HZ-1	0837.2310.02
Adapter for HZ-1	HL025Z1	4053.4006.02

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Active Antenna Feed HL025S7

1 GHz to 26.5 GHz

Consisting of HL025 and broadband preamplifier

Brief description

The Active Antenna Feed HL025S7 for microwaves is primarily used in reflector antennas, eg AC090, AC120, AC180 and AC300 systems, where the signal is picked up by the Log-Periodic Antenna HL025 and taken to the amplifier unit incorporated in the active antenna feed. The unit is designed with a low-noise amplifier.

Special features

- Extremely wide frequency range 1 GHz to 26.5 GHz
- Constant and rotationally symmetrical radiation pattern
- Maximum system sensivity due to integrated preamplifier

Specifications

Antenna	
Frequency range	1 GHz to 26.5 GHz
Polarization	linear
Nominal impedance	50 Ω
VSWR	≤2
Gain	8 dBi
Connector	SMA female
Control connector	10-contact male round connector
Weight	1 kg
Amplifier	
Noise figure	≤3.6 dB
Amplifier gain	27 dB ± 2 dB
1 dB compression point	≥+5 dBm
Power supply	+15 V DC (0.25 A) +12 V DC (0.75 A)

Ordering information

Active Antenna Feed	HL025S7	4051.4250.02

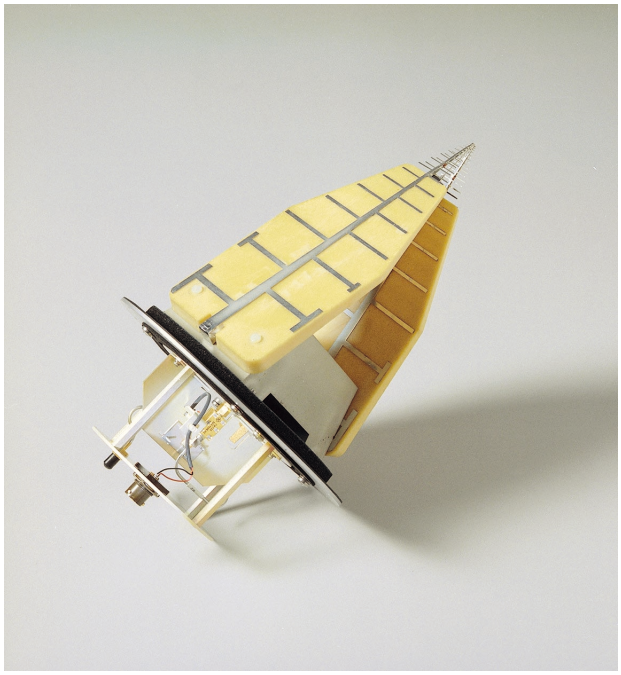

Photo 38864-2

Photo 38864-1

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Crossed Log-Periodic Antennas HL024A1, HL024S1

1 GHz to 18 GHz

For simultaneous reception of horizontally and vertically polarized waves

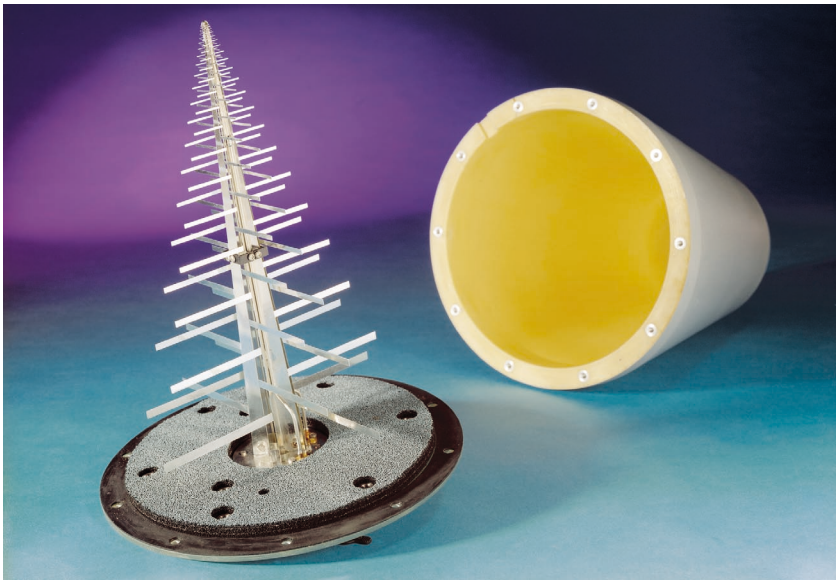

Photo 32994-2

Brief description

The Log-Periodic Antennas HL024A1 and HL024S1 with crossed antenna elements are suitable for simultaneous reception of horizontally and vertically polarized waves. Furthermore they can be used as transmitting antennas for low power. The HL024A1 can also be used as a feed in the Microwave Directional Antenna AC008. The HL024S1 has been designed as a feed in the SHF Directional Antenna Systems AC090 to AC300.

Special features

- Horizontal and vertical polarization
- Wide frequency range with virtually frequency-independent radiation patterns
- Ideal for use as a feed for reflector antennas

Specifications

Frequency range	1 GHz to 18 GHz
Polarization	horizontal and vertical
Nominal impedance	50 Ω
VSWR	≤2.5
Max. input power	10 W to 3 W CW
Gain	7 dBi
Connector	2 × SMA female
Operating temperature	–40 °C to +55 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (dia. × L) with radome	210 mm × 300 mm
Weight	0.7 kg

Ordering information

Crossed Log-Periodic Antenna	HL024A1	0650.7510.03
	HL024S1	4055.1256.02

Extras
(not required if used as a feed in systems AC090 to AC300)

Microwave Cable	AC008W2	0751.6931.03
Mast Adapter	HL025-Z	0661.9910.02
Wooden Tripod	HZ-1	0837.2310.02
Adapter for HZ-1	HL025Z1	4053.4006.02

Crossed Log-Periodic Antenna HL024S2

1 GHz to 18 GHz

Consisting of HL024A1 and polarization switching network

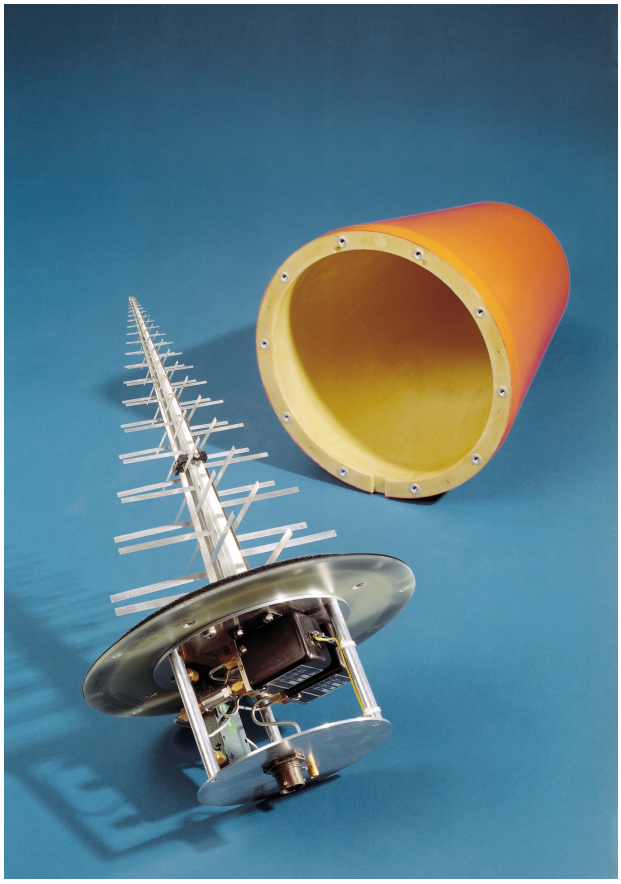

Photo 34203

Brief description

The HL024S2 consists of the HL024A1 and a polarization switching network. Four types of polarization can be selected by remote control. The HL024S2, just like the HL024A1, can be used as a feed for reflector antennas, eg the Microwave Directional Antennas AC008 to AC300.

Special features

- Horizontal, vertical, circular left-hand and circular right-hand polarization
- Remotely controlled polarization selection with Control Unit GB016
- Wide frequency range
- Ideal for use as a feed for reflector antennas

Specifications

Frequency range	1 GHz to 18 GHz
Polarization	horizontal, vertical, circular left-hand, circular right-hand
Nominal impedance	50 Ω
VSWR	
1 GHz to 12 GHz	≤2.5
12 GHz to 18 GHz	≤3
Gain (with polarization switching network)	4 dBi to 6 dBi
Connector	SMA female
Control connector	10-contact male round connector
Operating temperature	–40 °C to +55 °C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (dia. × L) with radome	210 mm × 353 mm
Weight	1 kg

Ordering information

Crossed Log-Periodic Antenna	HL024S2	4052.1003.02

Extras
(not required if used as a feed in systems AC090 to AC300)

Control Unit	GB016	4056.7006.02
Control Cable		
5 m	HL024W1	4052.1203.02
10 m	HL024W1	4052.1203.03
Microwave Cable		
5 m	AC008W2	0751.6931.02
10 m	AC008W2	0751.6931.03

Active Antenna Feed HL024S5

1 GHz to 18 GHz (passive)/

2 GHz to 18 GHz (active)

Consisting of HL024A1, polarization switching network, and four subband amplifiers

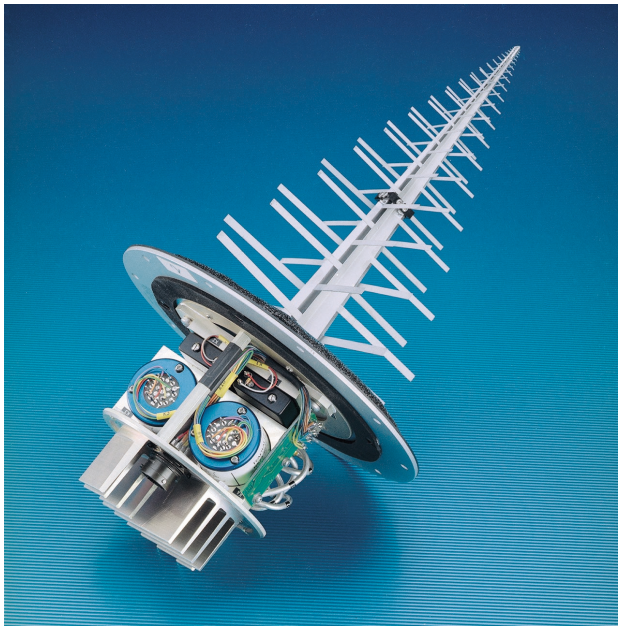

Photo 43031-1

Brief description

The feed consists of the Crossed Log-Periodic Antenna HL024A1 with polarization switching network, four preamplifiers and an RF switch for choosing the different frequency bands. An additional switchable bypass which bridges the preamplifiers is also integrated. The coverage of the frequency range 2 GHz to 18 GHz by four amplifiers, each approximately one octave wide, provides the advantage that the noise figures thus obtained are better than for a broadband amplifier; moreover, intermodulation products of the second order are avoided. The Active Antenna Feed HL024S5 is mainly used in reflector antennas, eg AC090, AC120, AC180 and AC300.

Special features

- High sensitivity due to low-noise amplifiers
- Wide frequency range (2 GHz to 18 GHz), four subbands
- Remotely switchable polarization
- Remotely switchable bypass
- BITE

Specifications

Antenna

Frequency range	2 GHz to 18 GHz (active) 1 GHz to 18 GHz (passive)
Polarization	horizontal /vertical
Nominal impedance	50 Ω
VSWR	<2.5
Gain	7 dBi
Power supply	+12 V DC (1.3 A)
Connectors	2 x SMA female
Control connector	10-contact male round connector
Operating temperature	–30°C to +55°C
Max. wind speed	180 km/h (without ice deposit)

Amplifiers

Frequency range (GHz)	2 to 4	4 to 8	8 to 12	12 to 18
Gain (dB)	26 ± 2	30 ± 2	33 ± 2	38 ± 2
Noise figure (dB)	≤2.5	≤3.5	≤4	≤4.5
1 dB compression point (dBm)	≥+15	≥+15	≥+15	≥+15
VSWR in/out	≤2	≤2	≤2	≤2
DC supply +15 V DC	0.2 A	0.3 A	0.3 A	0.3 A

Ordering information

Active Antenna Feed	HL024S5	4047.7507.02

Extras
(not required if used as a feed in systems AC090 to AC300)

Control Unit	GB016	4056.7006.02
Control Cable		
5 m	HL024W1	4052.1203.02
10 m	HL024W1	4052.1203.03
Microwave Cable		
5 m	AC008W2	0751.6931.02
10 m	AC008W2	0751.6931.03

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Active Antenna Feeds HL024S7, HL024S8, HL024S9

1 GHz to 18 GHz

Consisting of HL024A1 or HL024S2 and broadband preamplifier

Brief description

The Active Antenna Feeds HL024S... consist of the Crossed Log-Periodic Antenna HL024A1 with a broadband preamplifier unit and a polarization switching network (HL024S9 only). The antenna feeds are optimally matched to the SHF Directional Antenna Systems AC090 to AC300.

Special features

- Wide frequency range, ie no change of feed required
- Remotely selectable polarization
- HL024S7 and HL024S8 with remotely switchable bypass
- High system sensitivity due to low-noise amplifier at antenna output

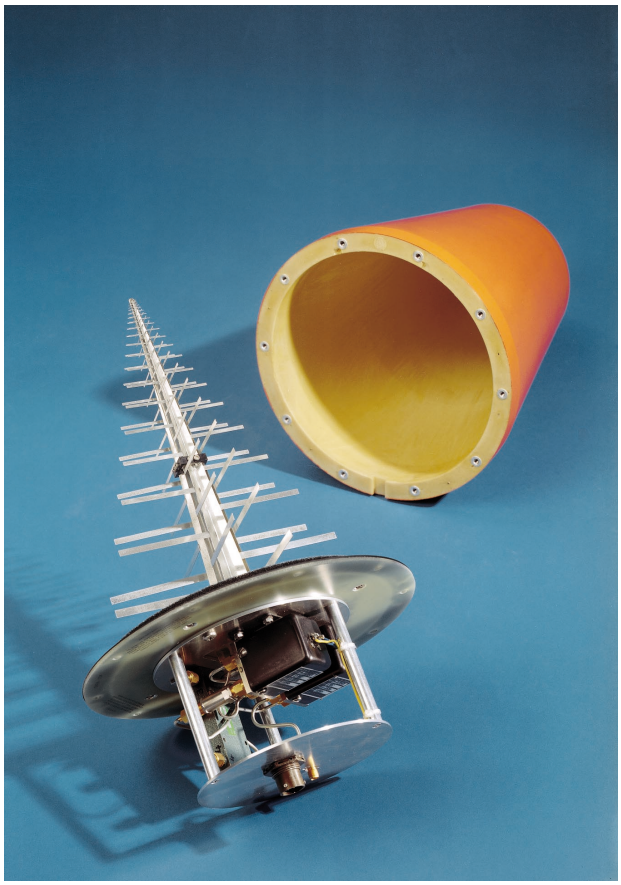

Photo 34203

Specifications

Frequency range	1 GHz to 18 GHz
Polarization	
HL024S7	horizontal or vertical
HL024S8	horizontal and vertical
HL024S9	horizontal or vertical left- or right-hand circular
Nominal impedance	50 Ω
VSWR	<2
Gain (HL024A1 only)	>6 dBi
Noise figure	≤3 dB
Amplifier gain (active netw.)	26 dB ± 2 dB
Amplifier gain (HL024S9)	>22 dB ± 2 dB (circular only)
1 dB compression point	approx. +8 dBm
Power supply	
HL024S7	+15 V DC (0.3 A)
HL024S8	+15 V DC (0.7 A)
HL024S9	+15 V DC (0.5 A)
HL024S...	+12 V DC (1.5 A)
Connector	SMA female
Control connector	10-contact male round connector
Weight	
HL024S7, HL024S8	1 kg
HL024S9	1.2 kg

Ordering information

Active Antenna Feed	HL024S7	4042.8505.02
	HL024S8	4042.7509.02
	HL024S9	4047.6252.02

Extras
(not required if used as a feed in systems AC090 to AC300)

Control Unit	GB016	4056.7006.02
Control Cable		
5 m	HL024W1	4052.1203.02
10 m	HL024W1	4052.1203.03
Microwave Cable		
5 m	AC008W2	0751.6931.02
10 m	AC008W2	0751.6931.03

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Microwave Directional Antenna AC008

1 GHz to 26.5 GHz/1 GHz to 18 GHz

Manually steerable directional antenna for detection of RF signals and field-strength measurements

Photo 34271-1

Brief description

The AC008 is a manually steerable directional antenna (reflector diameter 0.9 m) for the detection of RF signals and field-strength measurements in the range from 1 GHz to 18 GHz or from 1 GHz to 26.5 GHz (depending on feed used). It can also be directed towards geostationary satellites. Different feeds are available to allow reception of signals with any type of polarization.

Special features

- Wide frequency range
- Linear, dual-linear and circular polarization, depending on feed used
- Collapsible design (including feed) for easy transport

Specifications

Frequency range		1 GHz to 26.5 GHz (model 03) 1 GHz to 18 GHz (models 02/04)
Polarization		
with feed	HL025	linear (model 03)
	HL024A1	dual-linear (model 02)
	HL024S2	linear and circular (model 04)
Nominal impedance		50 Ω
VSWR		≤2.5
Gain		15 dBi to 40 dBi
Half-power beam width		20° to 1.5°
Positioning range		
Azimuth		±360°
Elevation		–6° to +44°
Connector		SMA female
Reflector diameter		0.9 m
Weight		12 kg

Ordering information

Microwave Directional Antenna	AC008	0671.5017.02 0671.5017.03 0671.5017.04
Extras		
Tripod	AC008-Z	0671.5117.02
Control Unit for Feed HL024S2	GB016	4056.7006.02
Control Cable		
5 m	HL024W1	4052.1203.02
10 m	HL024W1	4052.1203.03
Microwave Cable		
5 m	AC008W2	0751.6931.02
10 m	AC008W2	0751.6931.03
Telescope	AC008F1	0751.6919.02

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SHF Directional Antenna System AC090

1 GHz to 26.5 GHz/1 GHz to 18 GHz

Extremely broadband steerable 0.9 m directional antenna for radiomonitoring

Photo 43168

Brief description

The AC090 is a directional antenna adjustable in azimuth and elevation with a reflector diameter of 90 cm. It is suitable for general radiomonitoring tasks in the frequency range 1 GHz to 26.5 GHz or 1 GHz to 18 GHz depending on the feed used. The frequency range can be enhanced to 40 GHz by flange-connected options.

Special features

- 0.9 m reflector diameter
- Extremely wide frequency range using the same feed
- Adjustable in azimuth and elevation
- System control (rotator, antenna and polarization selection) via PC interface (Windows NT4.0)

Specifications

Frequency range (depending on feed)		1 GHz to 26.5 GHz/ 1 GHz to 18 GHz
Gain		15 dBi to 40 dBi
Half-power beam width		20° to 1.5°
Minimum field strength with HL024S9		13 dB(µV/m) (Δf = 1MHz)
Range of rotation	Azimuth	±180°
	Elevation	–5° to 95°
Connector		RPC3.5 female
Operating temperature		–30°C to +55°C
Max. wind speed		180 km/h (without ice deposit)
Reflector diameter		0.9 m
Weight		165 kg

Ordering information

SHF Directional Antenna System	AC090	4051.4509.00

The following antenna feeds are available

		Frequency range	Polarization	Page
HL025S1	Log-Periodic Antenna	1 GHz to 26.5 GHz	linear	44
HL025S7	HL025 with preamplifier	1 GHz to 26.5 GHz	linear	45
HL024S1	Crossed Log-Periodic Antenna	1 GHz to 18 GHz	H and V	46
HL024S2	HL024A1 with passive polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	48
HL024S5	HL024A1 with four subband preamplifiers	2 GHz to 18 GHz	H or V	48
HL024S7	HL024A1 with preamplifier	1 GHz to 18 GHz	H or V	49
HL024S8	HL024A1 with two preamplifiers	1 GHz to 18 GHz	H and V	49
HL024S9	HL024A1 with active polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	49
Options (retrofittable):				
AC308R2	250 mm Reflector Antenna, 29 dBi to 33 dBi	18 GHz to 26.5 GHz	H, V or 45°	55
AC308R3	250 mm Reflector Antenna, 33 dBi to 36 dBi	26.5 GHz to 40 GHz	H, V or 45°	55

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SHF Directional Antenna System AC120

1 GHz to 26.5 GHz/1 GHz to 18 GHz

Extremely broadband steerable 1.2 m directional antenna for radiomonitoring

Photo 43316

Brief description

The AC120 is a directional antenna adjustable in azimuth and elevation with a reflector diameter of 120 cm. It is suitable for general radiomonitoring tasks in the frequency range 1 GHz to 26.5 GHz or 1 GHz to 18 GHz depending on the feed used. The frequency range can be enhanced to 40 GHz by flange-connected options.

Special features

- 1.2 m reflector diameter
- Extremely wide frequency range using the same feed
- System control (rotator, antenna and polarization selection) via PC interface (Windows NT4.0)
- Adjustable in azimuth and elevation

Specifications

Frequency range (depending on feed)		1 GHz to 26.5 GHz/ 1 GHz to 18 GHz
Gain		18 dBi to 42 dBi
Half-power beam width		15° to 1°
Minimum field strength with HL024S9		10 dB(µV/m) (Δf = 1MHz)
Range of rotation	Azimuth	±180°
	Elevation	–5° to 95°
Connector		RPC3.5 female
Operating temperature		–30°C to +55°C
Max. wind speed		180 km/h (without ice deposit)
Reflector diameter		1.2 m
Weight		170 kg

Ordering information

SHF Directional Antenna System	AC120	4051.5005.00

The following antenna feeds are available

		Frequency range	Polarization	Page
HL025 S1	Log-Periodic Antenna	1 GHz to 26.5 GHz	linear	44
HL025S7	HL025 with preamplifier	1 GHz to 26.5 GHz	linear	45
HL024S1	Crossed Log-Periodic Antenna	1 GHz to 18 GHz	H and V	46
HL024S2	HL024A1 with passive polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	48
HL024S5	HL024A1 with four subband preamplifiers	2 GHz to 18 GHz	H or V	49
HL024S7	HL024A1 with preamplifier	1 GHz to 18 GHz	H or V	49
HL024S8	HL024A1 with two preamplifiers	1 GHz to 18 GHz	H and V	49
HL024S9	HL024A1 with active polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	49
Options (retrofittable):				
AC308R2	250 mm Reflector Antenna, 29 dBi to 33 dBi	18 GHz to 26.5 GHz	H, V or 45°	55
AC308R3	250 mm Reflector Antenna, 33 dBi to 36 dBi	26.5 GHz to 40 GHz	H, V or 45°	55

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SHF Directional Antenna System AC180

1 GHz to 26.5 GHz/1 GHz to 18 GHz

Extremely broadband steerable 1.8 m directional antenna for radiomonitoring

AC180 with options AC308R2 and AC308R3 (photo 42845-3)

Brief description

The AC180 is a directional antenna adjustable in azimuth and elevation with a reflector diameter of 180 cm. It is suitable for general radiomonitoring tasks in the frequency range 1 GHz to 26.5 GHz or 1 GHz to 18 GHz depending on the feed used. The frequency range can be enhanced to 40 GHz by flange-connected options.

Special features

- 1.8 m reflector diameter
- Extremely wide frequency range using the same feed
- Enhanced antenna gain
- Adjustable in azimuth and elevation
- System control (rotator, antenna and polarization selection) via PC interface (Windows NT4.0)

Specifications

Frequency range (depending on feed)		1 GHz to 26.5 GHz/ 1 GHz to 18 GHz
Gain		22 dBi to 46 dBi
Half-power beam width		12° to 0.7°
Minimum field strength with HL024S9		6 dB(µV/m) (Δf = 1MHz)
Range of rotation	Azimuth	±180°
	Elevation	–5° to 95°
Connector		RPC3.5 female
Operating temperature		–30°C to +55°C
Max. wind speed		160 km/h (without ice deposit)
Reflector diameter		1.8 m
Weight		420 kg

Ordering information

SHF Directional Antenna System	AC180	4051.5505.00

The following antenna feeds are available

		Frequency range	Polarization	Page
HL025S1	Log-Periodic Antenna	1 GHz to 26.5 GHz	linear	44
HL025S7	HL025 with preamplifier	1 GHz to 26.5 GHz	linear	45
HL024S1	Crossed Log-Periodic Antenna	1 GHz to 18 GHz	H and V	46
HL024S2	HL024A1 with passive polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	48
HL024S5	HL024A1 with four subband preamplifiers	2 GHz to 18 GHz	H or V	49
HL024S7	HL024A1 with preamplifier	1 GHz to 18 GHz	H or V	49
HL024S8	HL024A1 with two preamplifiers	1 GHz to 18 GHz	H and V	49
HL024S9	HL024A1 with active polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	49
Options (retrofittable):				
AC308R2	250 mm Reflector Antenna, 29 dBi to 33 dBi	18 GHz to 26.5 GHz	H, V or 45°	55
AC308R3	250 mm Reflector Antenna, 33 dBi to 36 dBi	26.5 GHz to 40 GHz	H, V or 45°	55

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SHF Directional Antenna System AC300

1 GHz to 26.5 GHz/1 GHz to 18 GHz

Extremely broadband steerable 3 m directional antenna for monitoring even weak signals

Photo 42844

Brief description

The AC300 is a directional antenna adjustable in azimuth and elevation with a reflector diameter of 300 cm. It is suitable for general radiomonitoring tasks in the frequency range 1 GHz to 26.5 GHz or 1 GHz to 18 GHz depending on the feed used. The frequency range can be enhanced to 40 GHz by flange-connected options.

Special features

- 3 m reflector diameter
- Extremely wide frequency range using the same feed
- High antenna gain
- Adjustable in azimuth and elevation
- System control (rotator, antenna and polarization selection) via PC interface (Windows NT4.0)

Specifications

Frequency range (depending on feed)		1 GHz to 26.5 GHz/ 1 GHz to 18 GHz
Gain		26 dBi to 51 dBi
Half-power beam width		6° to 0.35°
Minimum field strength with HL024S9		2 dB(µV/m) (Δf = 1MHz)
Range of rotation	Azimuth	±180°
	Elevation	–1° to 91°
Connector		RPC3.5 female
Operating temperature		–30°C to +55°C
Max. wind speed		160 km/h (without ice deposit)
Reflector diameter		3 m
Weight		1460 kg

Ordering information

SHF Directional Antenna System	AC3004051.6546.00

The following antenna feeds are available

		Frequency range	Polarization	Page
HL025S1	Log-Periodic Antenna	1 GHz to 26.5 GHz	linear	44
HL025S7	HL025 with preamplifier	1 GHz to 26.5 GHz	linear	45
HL024S1	Crossed Log-Periodic Antenna	1 GHz to 18 GHz	H and V	46
HL024S2	HL024A1 with passive polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	48
HL024S5	HL024A1 with four subband preamplifiers	2 GHz to 18 GHz	H or V	49
HL024S7	HL024A1 with preamplifier	1 GHz to 18 GHz	H or V	49
HL024S8	HL024A1 with two preamplifiers	1 GHz to 18 GHz	H and V	49
HL024S9	HL024A1 with active polarization switching network	1 GHz to 18 GHz	H, V, RHC or LHC	49
Options (retrofittable):				
AC308R2	250 mm Reflector Antenna, 29 dBi to 33 dBi	18 GHz to 26.5 GHz	H, V or 45°	55
AC308R3	250 mm Reflector Antenna, 33 dBi to 36 dBi	26.5 GHz to 40 GHz	H, V or 45°	55

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SHF/EHF Directional Antennas AC308R2, AC308R3

18 GHz to 26.5 GHz/26.5 GHz to 40 GHz

Broadband directional antennas for radio-monitoring

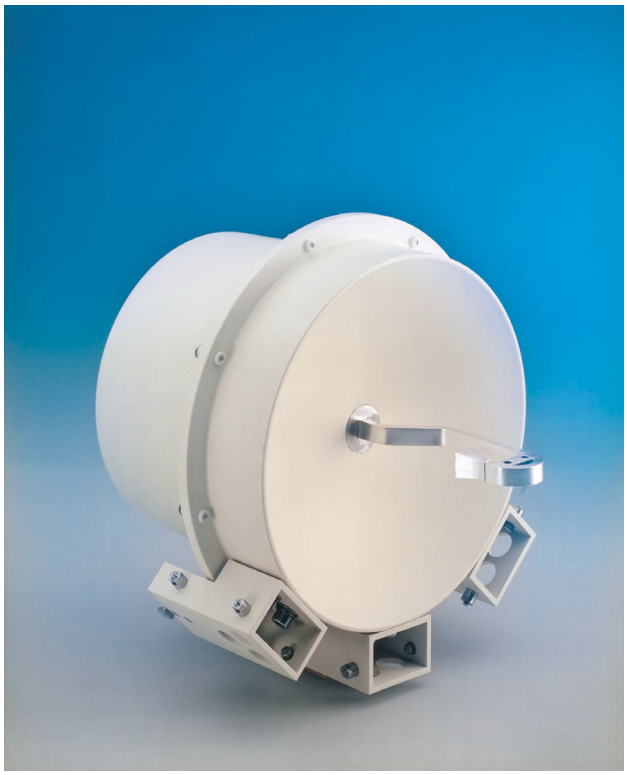


Photo 42612-1

Brief description

The Directional Antennas AC308R2 for the K band (18 GHz to 26.5 GHz) and AC308R3 for the Ka band (26.5 GHz to 40 GHz) have a reflector diameter of 25 cm. They are especially suitable for extending the frequency range of the Directional Antenna Systems AC090 to AC300.

The antennas come in two models:

- With integrated preamplifier (model 02)
- With downconverter and integrated reference crystal (model 03)

Special features

- Fast and simple installation
- Rugged design
- Integrated into operational concept of AC090 to AC300

Specifications

	AC308R2	AC308R3
Antennas		
Frequency range	18 to 26.5 GHz	26.5 to 40 GHz
Polarization	H, V or 45°	H, V or 45°
Nominal impedance	50 Ω	50 Ω
VSWR	<2	<2
Gain	29 dBi to 33 dBi	33 dBi to 36 dBi
Half-power beam width	4.5° to 3°	3° to 2°
Reflector diameter	250 mm	250 mm
Weight approx.	2.5 kg	2.5 kg
Preamplifier		
Amplifier gain	28 dB ± 2 dB	28 dB ± 2 dB
1 dB compression point	≥+8 dBm	≥+8 dBm
Noise figure	<3 dB	<4 dB
Power consumption	+15 V/0.2 A	+15 V/0.2 A
RF connector	RPC3.5	K
Downconverter		
PLL frequency	27.5 GHz	41 GHz
Frequency stability	3 kHz/°C	3 kHz/°C
IF frequency	9.5 GHz to 1 GHz	14.5 GHz to 1 GHz
Noise figure	<5 dB	<6 dB
Gain	>34 dB	>30 dB
1 dB compression point	1 dBm (typ.)	–3 dBm (typ.)
Power consumption	+15 V/3 A	+15 V/3 A
RF connector	SMA female	SMA female

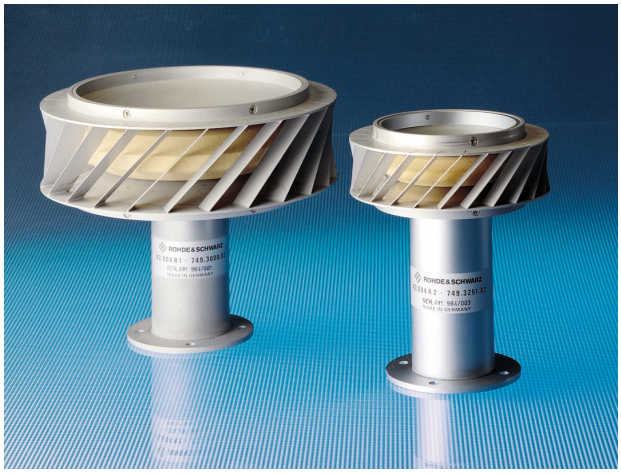
Ordering information

SHF Directional Antenna		
with amplifier	AC308R2	4051.6001.02
with downconverter	AC308R2	4051.6001.03
SHF/EHF Directional Antenna		
with amplifier	AC308R3	4051.6253.02
with downconverter	AC308R3	4051.6253.03

Omnidirectional Antennas AC004R1, AC004R2

18 GHz to 26.5 GHz/26.5 GHz to 40 GHz

Broadband reception of circular, horizontal and vertical polarization



AC004R1 and AC004R2 without radome (photo 36600-1)

Brief description

The Antennas AC004R1 and AC004R2 are designed for omnidirectional reception in the frequency range 18 GHz to 26.5 GHz and 26.5 GHz to 40 GHz. Both antennas are circularly polarized, so that signals with horizontal and vertical polarization can be received, too. Due to their mechanical design the antennas are suitable for use under extreme environmental conditions, eg in mobile applications.

Special features

- Omnidirectional reception
- Wide frequency range
- Circular polarization

Specifications

Frequency range	
AC004R1	18 GHz to 26.5 GHz
AC004R2	26.5 GHz to 40 GHz
Polarization	circular
Nominal impedance	50 Ω
VSWR	<2.5
Gain	2 dBi
Departure from circularity of azimuth pattern	±2 dB
Connector	RPC2.92(K) female
Operating temperature	–35°C to +65°C
Max. wind speed	180 km/h (without ice deposit)
Dimensions (H × dia.), with radome	
AC004R1	150 mm × 155 mm
AC004R2	170 mm × 150 mm
Weight	
AC004R1	1.4 kg
AC004R2	1.8 kg

Ordering information

Omnidirectional Antenna		
18 GHz to 26.5 GHz	AC004R1	0749.3000.03
26.5 GHz to 40 GHz	AC004R2	0749.3251.03

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Contents of Chapter 2

Receivers

Searching/intercepting even the weakest of signals

Whatever kind of receiver you need, we can offer it:

- Stationary as well as mobile
- From HF, VHF/UHF and SHF through to 18 GHz
- Extremely sensitive even in a congested signal environment
- Incorporating state-of-the-art DSP technology
- Featuring intelligent search routines
- With networking and remote control capability via software
- Providing all features for measuring field strength, type of modulation, etc, as required by ITU

Our receivers search at extremely high speeds of several GHz/s. This makes them ideal for intercepting frequency-agile emissions and LPI signals.

Miniport Receiver EB200 with active handheld directional antenna for portable radiolocation in frequency range 10 kHz to 3 GHz

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Monitoring Receiver ESMB

ITU-compliant measurements from 9 kHz to 3 GHz

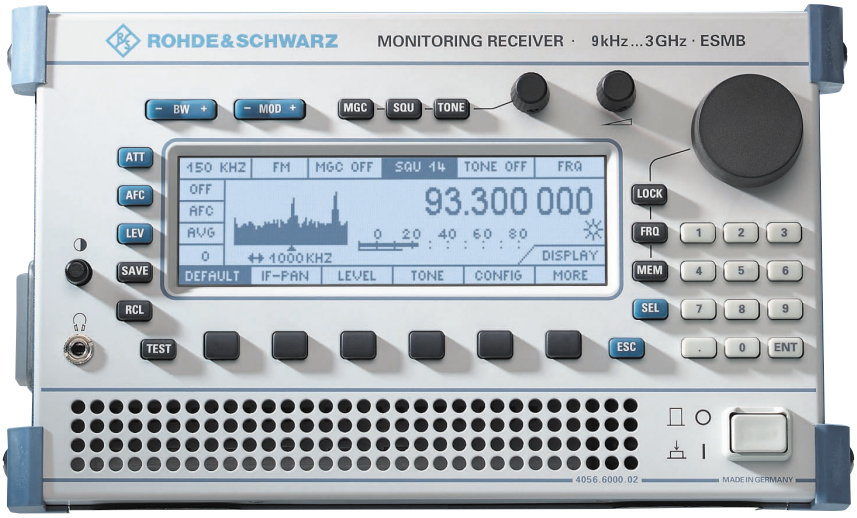


Photo 43406-1

Brief description

Monitoring Receiver ESMB is a test and monitoring receiver for all radiomonitoring tasks according to ITU-R and for radio investigation services. The compact and sturdy design combined with low weight makes ESMB a versatile and universal unit for stationary and mobile use.

ESMB covers the wide frequency range from 9 kHz to 3 GHz. Processing the various signals available with optimum signal-to-noise ratio requires a large number of IF bandwidths. This problem cannot be solved with analog filters, as space is limited. The solution is a digital IF section in which a wide variety of different filters can be realized on relatively small space with the aid of DSP. ESMB is provided with 18 IF bandwidths between 150 Hz and 300 kHz and up to 1 MHz in the IF panorama mode. Bandwidths above 300 kHz are for level, deviation and bandwidth measurement. Demodulation is not possible.

Main features

With ESMB the following measurements in line with ITU-R specifications can be performed:

- Frequency and frequency offset to ITU-R SM 377
- Field strength to ITU-R SM 378
- Modulation to ITU-R SM 328
- Spectrum occupancy and identification with external PC to ITU-R SM 182
- Bandwidth to ITU-R SM 328

For radio investigation services the following tasks can be performed:

- Frequency scan with predefined frequency ranges
- Memory scan of up to 1000 memory channels
- RF frequency spectrum (option)
- Audio monitoring of CW, AM, SSB and FM transmissions
- Identification
- Storage of measured values for later download to PC

Monitoring Receiver ESMB is a ½ 19" rack-mountable unit. The basic elements of ESMB are:

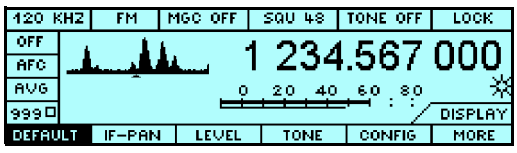
- Band and tracking preselection
- RF frontends to convert the antenna signal into an IF of 10.7 MHz
- Fast synthesizer
- A/D and DSP module with digital IF filters, digital demodulators for CW, AM, LSB, USB, PULSE, FM, PM, IQ and ISB, parameter measurements and FFT processing of IF panoramic display
- Processor system
- Display and control unit
- Remote interface
- Power supply unit

Scan modes

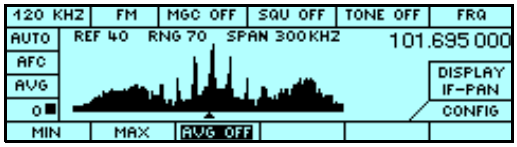
- Frequency scan
- Memory scan
- Frequency spectrum

Optimized view for current task

Overview

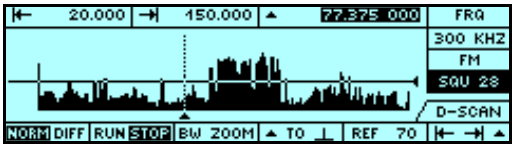


IF panorama

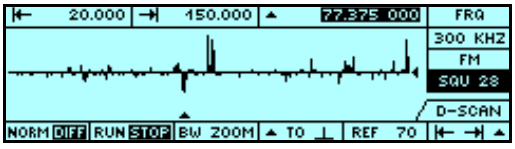


Monitoring Receiver ESMB

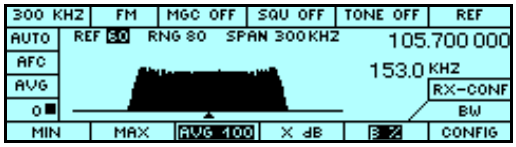
DIGI-Scan listen mode



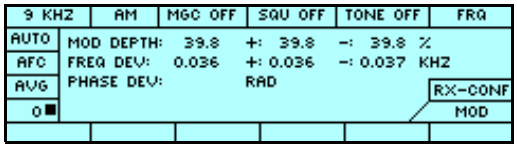
DIGI-Scan differential mode

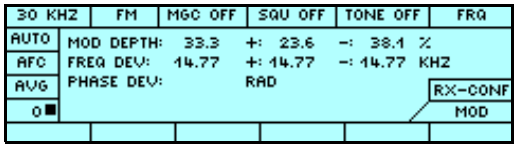


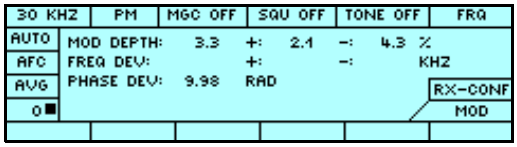
Bandwidth measurement



Modulation measurement







ESMB in measurement mode

Use in computer-controlled systems

For use in computer-controlled systems Rohde & Schwarz offers the system monitoring software ARGUS and RAMON.

Full use of the measurement features of the receiver is possible only in the remote mode via LAN using a powerful PC in connection with the Rohde& Schwarz Spectrum Monitoring Software ARGUS or RAMON, for example.

RAMON, used in the military field, is for fast frequency detection and transfer to support monitoring receivers, while ARGUS is intended for civil applications, eg for authorities with frequency management tasks such as long-term monitoring of specific frequency bands.

To simplify entry into ARGUS, the software ARGUS MON is offered – a version reduced in functionality and consequently price – for remote control of one ESMB. This version allows remote control of all settings, measurement and scan functions and saving of measured data such as frequency, level, offset, date and time. The basic ARGUS MON software can be extended to ARGUS for use in systems of any size. Operation of ARGUS MON is user-friendly and clear. ESMB together with ARGUS MON is a low-cost minisystem that fulfils all the recommendations according to ITU.

Specifications

Frequency range	
Basic unit	20 MHz to 3 GHz
Basic unit with optional HF Unit EB200HF	9 kHz to 3 GHz
Frequency setting via keypad or rollkey	1 kHz, 100 Hz, 10 Hz, 1 Hz; or in selectable increments
Frequency accuracy	≤1 x 10^{-6} (0 °C to +45 °C)
Input for external reference	10 MHz
Synthesizer setting time	≤3 ms
Oscillator phase noise	≤–120 dBc/Hz at 10 kHz offset (HF range) ≤–100 dBc/Hz at 10 kHz offset (V/UHF range)
Antenna inputs	N socket, 50 Ω
VSWR	≤3, typ. 2
Oscillator reradiation	≤–107 dBm
Input selection	
9 kHz to 30 MHz	5 bandpass filters
20 (30) MHz to 1500 MHz	tracking preselection
1500 MHz to 3000 MHz	highpass, lowpass
Interference rejection, nonlinearities – HF range (only with optional HF Unit EB200HF)	
Image frequency rejection	≥90 dB, typ. 100 dB
IF rejection	≥90 dB, typ. 100 dB
2nd order intercept point	≥40 dBm, typ. 55 dBm (ATT off)
3rd order intercept point	≥20 dBm, typ. 25 dBm (ATT off)
Internal spurious signals	≤–107 dBm
Interference rejection, nonlinearities – VHF-UHF range	
Image frequency rejection	≥90 dB, typ. 100 dB
IF rejection	≥90 dB, typ. 100 dB
2nd order intercept point	≥30 dBm, typ. 40 dBm (f = 20 (30) MHz to 2700 MHz, low distortion mode)
3rd order intercept point	≥10 dBm, typ. 18 dBm (f = 20 (30) MHz to 2700 MHz, low distortion mode)
Internal spurious signals	≤–107 dBm

Monitoring Receiver ESMB

Sensitivity – HF range
(only with optional HF Unit EB200HF)

Overall noise figure (including AF section)	≤14 dB, typ. 12 dB (f ≥50 kHz, ATT off)
Signal-to-noise ratio (f = 0.1 MHz to 30 MHz)	
CW, bandwidth 300 Hz, V = 0.6 µV	
SSB, bandwidth 2.5 kHz, V = 1 µV	
AM, bandwidth 9 kHz, f_{mod} =1 kHz, m = 0.5, V =1 µV	≥10 dB, measurement with telephone filter

Sensitivity – VHF-UHF range

Overall noise figure (including AF section)	≤12 dB, typ. 10.5 dB (f = 20 (30) MHz to 2700 MHz, low noise mode)
Signal-to-noise ratio	measurement with telephone filter
AM, bandwidth 9 kHz, f_{mod} = 1kHz, m = 0.5	
20 (30) MHz to 2700 MHz, V = 1 µV	
2.7 GHz to 3 GHz, V = 1.3 µV	≥10 dB (low noise mode)
FM, bandwidth 15 kHz, f_{mod} = 1 kHz, deviation = 5 kHz	
20 (30) MHz to 2700 MHz, V = 1 µV	
2.7 GHz to 3 GHz, V = 1.3 µV	≥25 dB (low noise mode)
Detection modes	AM, FM, PM, USB, LSB, CW, ISB, PULSE, IQ
IF bandwidths for level detection and offset measurement	23 filters (150 Hz to 1 MHz)
IF bandwidths with standard demodulation (–6 dB bandwidth)	0.15, 0.3, 0.6, 1, 1.5, 2.4, 3, 4, 6, 8, 9, 15, 30, 100, 120, 150, 250, 300 kHz (reduced IF bandwidth in HF range: ±5 kHz)
Squelch, signal-controlled	–10 dBµV to 110 dBµV
Gain control	AGC, MGC (120 dB)
AFC	digital retuning for unstable signals

Modulation measurement

AM (f_{max} = 100 kHz)	m = 1 % to 99 % (resolution 0.1 %)
Indication error	<5% for m=50%, S/N >40 dB, AF=1 kHz
FM (f_{max} = 100 kHz)	deviation max. 125 kHz less modulation frequency (resolution 0.001 kHz)
Indication error	
Narrow BW (≤15 kHz)	100 Hz plus 3 % of reading
Broad BW (≤250 kHz)	2 kHz plus 3 % of reading for S/N >40 dB, AF=1 kHz
PM (f = 0.3 to 5 kHz)	Δφ = 0 to 4π, Δφ = 0 to 12.5 rad (resolution 0.01 rad)
Indication error	<0.1 rad plus 5 % of reading for S/N >40 dB, AF=1 kHz

Level and offset measurement

Offset indication	graphically with tuning label or numerically
Signal level indication	–10 dBµV to 110 dBµV (dBµV/m) numerical 3 digits resolution 0.1 dB (error max. ±2 dB for V = 20 dBµV to 100 dBµV, AVG, 0°C to +45°C) or graphical as level line acoustic indication by level tone
IF panorama display	internal module
Span range	0.15 kHz to 1000 kHz (23 steps)

Scan characteristics

Automatic memory scan	1000 definable memory locations
Frequency scan	start/stop/step and 100 suppress ranges
DIGI-Scan (option)	RF spectrum 9 kHz to 3 GHz or smaller on display

Inputs / outputs

Bidirectional reference frequency connector	10 MHz, SMA
IF 10.7 MHz, wideband	±1 MHz, VHF-UHF range ±5 kHz, HF range uncontrolled for external panorama display, SMA
AF output (digital)	AF signal, 2 x 16 bit
AF output, symmetrical	600 Ω, 0 dBm
Loudspeaker output	4 Ω, 500 mW
Headphone output	via volume control
BITE	monitoring of test signals by means of loop test
Data interface	LAN (ETHERNET 10Base-T) or 9-pin RS232C, PPP

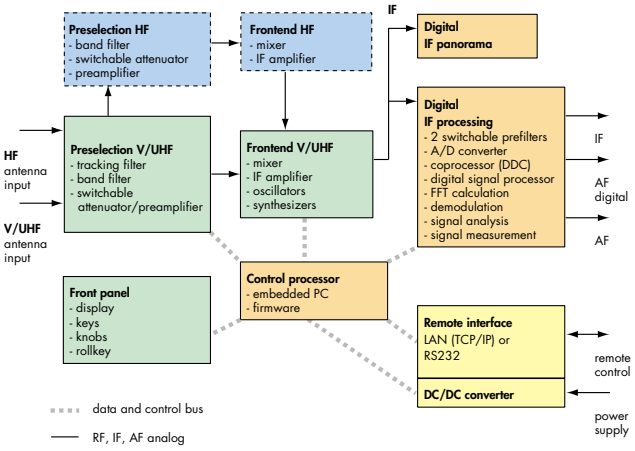
General data

Operating temperature	0 °C to +50 °C
Power	10 V to 32 V DC (max. 40 W) or via external AC/DC supply
Dimensions (W x H x D)	227 mm x 153 mm x 474 mm
Rack model (1/2 19" x 3 HU)	210 mm x 132 mm x 460 mm
Weight	8 kg

Ordering information

Monitoring Receiver		
with external power supply	ESMB	4056.6000.02
Tuner for 9 kHz to 30 MHz	EB200HF	4055.3107.02
RF Spectrum DIGI-Scan	EB200DS	4052.9604.02
Software ARGUS		4049.9859.02
ARGUS driver for ESMB		4049.9859.35

Block diagram of Monitoring Receiver ESMB



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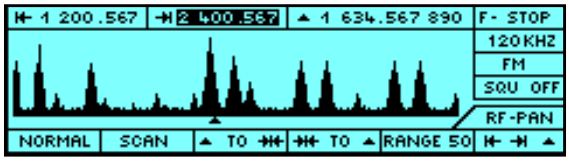
Brief description

Miniport Receiver EB200 is a miniaturized portable professional receiver for the HF-VHF-UHF range. The EB200 is characterized by high input sensitivity and frequency setting accuracy throughout the frequency range from 10 kHz to 3 GHz.

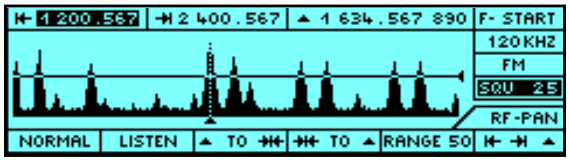
Its small dimensions – ½19" in size corresponds to two height units – and low weight as well as a sturdy, pickup-proof die-cast aluminium housing with well-protected integrated operating elements make the EB200 ideal for use in places which cannot be reached with a vehicle. Its low power consumption permits battery operation typically of six hours. The EB200 battery pack is easily accessible and can be exchanged quickly. In case of power supply interruption, all the data are stored. Operation can thus be resumed immediately after the power supply is restored.

EB200 fulfils the following tasks:

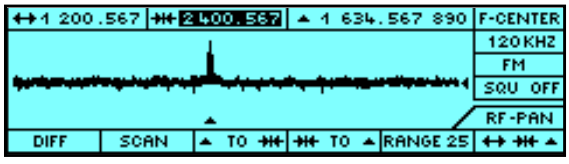
- Monitoring of given frequencies, eg storage of 1 to 1000 frequencies, squelch setting, constant monitoring of one frequency or cyclical scanning of several frequencies
- Searching in a frequency range with freely selectable start and stop frequency and step widths of 1 kHz to 9.999 MHz
- Location of close-range to medium-range targets with the aid of Hand-held Directional Antenna HE200
- Detection of undesired emissions including pulsed emissions
- Detection of unlicensed transmitters communicating illegally or interfering with licensed transmission
- Protection against tapping by detecting miniature spy transmitters (bugs)
- Monitoring of one's own radio exercises in a service band
- Monitoring of selected transmissions
- Remote-controlled operation via modem and PC in coverage measurement and monitoring systems



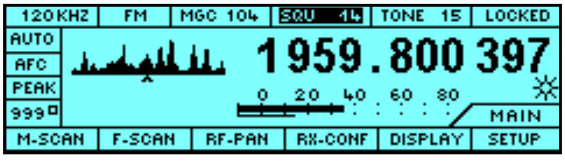
Scan mode



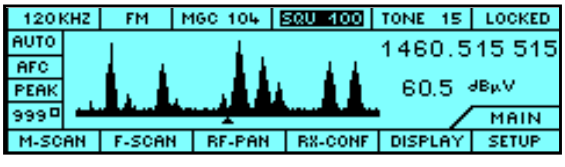
Listen mode



Differential mode



Overview



IF panorama

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Use in computer-controlled systems

For use in computer-controlled systems Rohde&Schwarz offers the system monitoring software ARGUS and RAMON.

RAMON, used in the military field, is for fast frequency detection and transfer to support monitoring receivers, while ARGUS is intended for civil applications, eg for authorities with frequency management tasks such as long-term monitoring of specific frequency bands.

Main features

- Ergonomic design for on-body operation
- Continuous frequency range 10 kHz to 3 GHz
- Digital IF section with 12 bandwidths (150 Hz to 150 kHz)
- Fast, accurate level indication across 110 dB dynamic range
- Scanning modes
  - Frequency scan
  - Memory scan
  - Frequency spectrum
- Remote-controllable via RS232 PPP or LAN (Ethernet 10 Base-T, option)

Directional antenna

see chapter “Antennas” on page 28

Specifications in brief

Frequency range	10 kHz to 3 GHz
Frequency setting via keypad or rollkey	1 kHz, 100 Hz, 10 Hz, 1 Hz or in selectable increments
Frequency accuracy	≤1.5 x 10^{-6} (–10 °C to + 55 °C)
Aging	≤0.5 x 10^{-6} /year
Synthesizer setting time	≤3 ms
Oscillator phase noise	≤–100 dBc/Hz at 10 kHz offset
Antenna input	N female, 50 Ω, VSWR ≤3, SMA connector on rear panel for rack mounting
Oscillator reradiation	≤–107 dBm
Input attenuation	manual or automatic
Input selection	
100 kHz to 20 MHz	highpass/lowpass
20 MHz to 1.5 GHz	tracking preselection
1.5 GHz to 3 GHz	highpass/lowpass
Interference rejection, nonlinearities	
Image frequency rejection	≥70 dB, typ. 80 dB
IF rejection	≥70 dB, typ. 80 dB
2nd order intercept point	typ. 40 dBm
3rd order intercept point	typ. 2 dBm
Internal spurious signals	≤–107 dBm
Sensitivity	
Overall noise figure	typ. 12 dB
Demodulation	AM, FM, USB, LSB, CW
IF bandwidths	12 (150/300/600 Hz/1.5/2.5/6/9/15/30/50/120/150 kHz)
IF bandwidths for level and deviation indication	15 (150 Hz to 1 MHz) only with IF Panoramic Unit EB200SU
Squelch	signal-controlled, can be set from –10 dBµV to 100 dBµV
Gain control	AGC, MGC
AFC	digital retuning for frequency-unstable signals
Deviation indication	graphical with tuning label
Signal level indication	graphical as level line or numerical from –10 dBµV to 100 dBµV, acoustic indication by level tone
IF panorama (option SU)	internal module, ranges 25, 50, 100, 200, 500, 1000 kHz
Scan characteristics	
Automatic memory scan	1000 definable memory locations to each of which a complete data set can be allocated
Frequency scan	START/STOP/STEP definition with receiving data set
Inputs/outputs	
Digital IF output	serial data (clock, data, frame) up to 256 ksps
I/Q output (digital) IF 10.7 MHz, wideband	AF signal, 16 bit ±5 MHz uncontrolled for external panoramic display
AF output, balanced	600 Ω, 0 dBm
Loudspeaker output	8 Ω, 500 mW
Headphones output	via volume control
Output, log. signal level	0 V to +4.5 V
BITE	monitoring of test signals by means of loop test
Data interface	RS232C 9-pin, PPP
Option	LAN (Ethernet 10 Base-T)
General data	
Operating temperature	–10 °C to +55 °C
Rated temperature	0 °C to +50 °C
Storage temperature	–40 °C to +70 °C
Power supply	AC 110/230 V, 50/60 Hz battery pack (typ. 4 h operation) or DC 10 V to 30 V (max. 22 W)
Dimensions (W x H x D)	210 mm x 88 mm x 270 mm; ½19" x 2 HU
Weight (without battery pack)	4 kg
Battery pack	1.5 kg

Brief specifications of HE200

Frequency range	20 MHz to 3000 MHz with 3 RF modules
HF module	10 kHz to 20 MHz as an option
RF connector	N, male, 50 Ω
Length of connecting cable	0.9 m
General data	
Operating temperature	–10 °C to +55 °C
Rated temperature	0 °C to +50 °C
Storage temperature	–30 °C to +60 °C
Power supply	in handle, 4 x 1.5 V mignon cell R6
Dimensions (W x H x D)	470 mm x 360 mm x 180 mm (in transit case)
Weight (without battery)	4.5 kg including transit case

Ordering information

Miniport Receiver	EB200	4052.2000.02
Extras		
Carrying Case (telescopic antenna, headset, belt and space for EB200 and battery pack)	EB200SC	4052.9304.02
Battery Pack	EB200BP	4052.4102.02
Internal IF Panoramic Unit	EB200SU	4052.3206.02
RF Spectrum DIGI-Scan	EB200DS	4052.9604.02
LAN (Ethernet 10 Base-T) Interface	EB200R4	4052.9156.02
Handheld Directional Antenna including carrying case	HE200	4050.3509.02
HF Module 10 kHz to 20 MHz	HE200HF	4051.4009.02

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Compact Receiver ESMC

Lightweight – compact – user-friendly: optimized radiomonitoring from 0.5 MHz to 3000 MHz

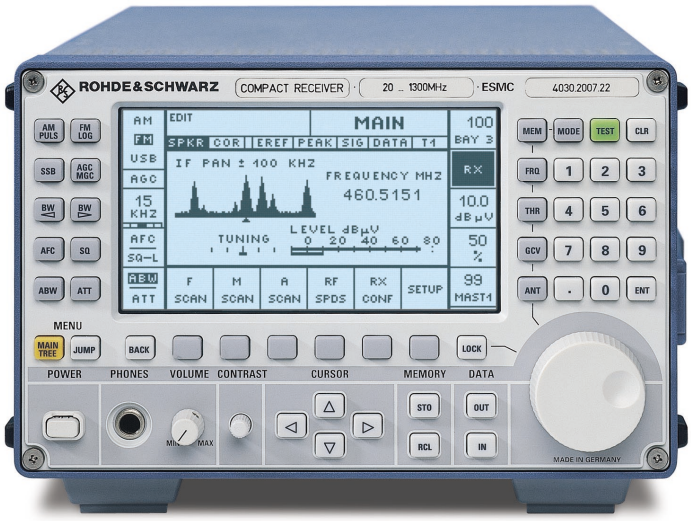


Photo 43150-3

Brief description

With the Compact Receiver ESMC, a universal and multipurpose receiver for radiomonitoring applications has been produced in a compact size that was thought not possible up to now.

The new receiver is only half the size of customary 19" multipurpose receivers of 3 height units but its technical data are even superior to those of such units.

Applications

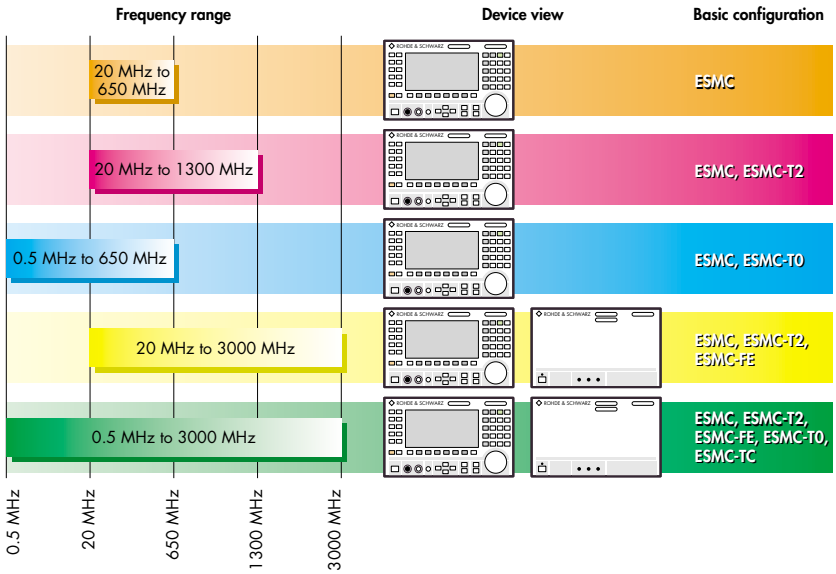
- Signal reception
  - aural monitoring
  - radiomonitoring
  - recording
- Searching and scanning
  - continuous manual tuning
  - at any channel spacing
  - 5 start/stop frequency ranges
  - spectrum display with a speed of up to 13 GHz/s
  - within 1000 memory locations
- Measurement of
  - frequency occupancy
  - level and frequency
  - coverage

Main features

- Custom-specific frequency extension from HF to UHF (see diagram)
- Detection of frequency-agile emissions with analog sweep
- Compact design and low weight
- Simple operation via LC display
- Wide dynamic range and high overload capacity
- 1 Hz frequency resolution
- RF and IF spectrum display
- Low phase noise
- Master/slave operation without a PC
- Accurate measurement of signal level
- Offset display for channel frequency
- Remote control unit for mobile use
- AC/DC supply without changing the power supply unit

Operation

The operating concept meets all the demands made on a state-of-the-art radiomonitoring receiver, ie all main functions such as type of demodulation, bandwidth, etc, can be set directly via labelled keys. A hotkey permits returning to the main menu from any submenu. Menu control is organized in priority levels so that signal processing is not interrupted by menu changes and the user never loses sight of what is going on.



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Compact Receiver ESMC

Search facilities

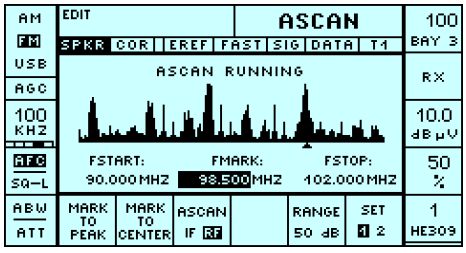
The ESMC uses highly advanced search routines. Fast synthesizer settling and short level measurement times guarantee highly effective search operations.

Frequency scan
Five start/stop frequency ranges (5 jobs) may be defined and a complete data set allocated to each range. In addition to receiver settings, the following scan parameters may be included in the data set:

- Step width
- Signal threshold (dBµV)
- Dwell time (s)
- Hold time (ms) plus the time required for external devices, if any
- Number of scan repetitions
- Signal-controlled continuation (on/off)
- Suppression (individual frequencies or ranges)

Memory scan
ESMC uses 1000 memory locations, each holding a complete receiver setting, such as frequency, type of modulation, bandwidth, etc. The content of the memory can be modified manually or overwritten by results of a scan operation. User-definable code names, group ID and scan enable flags may also be defined for each location. Finally the whole memory can be sorted according to increasing frequency values. The content of any memory location can be transferred to the receiver manually, by using the RCL key, by turning the tuning knob or automatically by activating the memory scan.

Analog scan – full-speed detection of bursts and hoppers
The advantage of analog sweep is the extremely high speed. This allows detection of burst signals and frequency-agile transmissions. With the option ESMC-AS and an external PC a program under Windows™ is provided, which enables panoramic and waterfall displays. Start and stop frequency are freely selectable within any tuner range. Depending on the performance of the controlling PC, a scanning speed of up to 13 GHz/s can be achieved. With the aid of a printer, measurement results may be documented as a frequency-versus-time plot.



With option ESMC-AS fast hopping frequencies can be detected

Option overview

Several "plug&play" options allow the user to tailor the ESMC to his special needs. All these options can be added to the basic version of the ESMC without any software reconfiguration; whenever a module is changed or added, a recalibration process is started automatically after power-up.

Description	Type	Order No
Frequency extension from 0.5 MHz to 30 MHz instead of ESMC-T2 [1]	ESMC-T0	4039.9004.03
Frequency extension up to 1.3 GHz [1]	ESMC-T2	4037.5201.02
Separate $^1/_2$19" unit for frequency extension from 1.3 GHz to 3 GHz or 0.5 MHz to 3 GHz	ESMC-FE	4042.6002.02
Antenna splitter for one antenna input, 20 MHz to 3 GHz (only with ESMC-FE) [2]	ESMC-AN	4042.6702.02
10 MHz OCXO reference (error ≤0.1 x 10^{-6})	ESMC-OR	4042.6902.02
Reception of LSB/USB and A1	ESMC-S3	4037.5501.02
Low-cost panoramic adapter using the receiver's LCD	ESMC-SU	4037.5553.02
Analog scan function and software	ESMC-AS	4042.0404.02
Remote control via IEC 625-2/IEEE 488 (instead of ESMC-R2) [3]	ESMC-R1	4037.5401.02
Remote control via RS232, RS422 and RS485 bus (instead of ESMC-R1) [3]	ESMC-R2	4037.5453.02
Remote control unit (operator front panel) for controlling ESMC model .02 or 03 via serial link especially for mobile applications	ESMC-GB	4039.8508.02
IF section with special bandwidth (see ordering information on page 66)	ESMC-Z1	4037.5253.xx

1) Only one of these options to be fitted.
2) Slot in option ESMC-FE available, otherwise in ESMC basic unit instead of option ESMC-SU.
3) Only one of these options to be fitted.

Compact Receiver ESMC

Click & listen
For fixed frequency monitoring a spectrum line can be selected by mouse click or by frequency marker.

Use in computer-controlled systems

For use in computer-controlled systems Rohde&Schwarz offers the system monitoring software ARGUS and RAMON.

RAMON, used in the military field, is for fast frequency detection and transfer to support monitoring receivers, while ARGUS is intended for civil applications, eg for authorities with frequency management tasks such as long-term monitoring of specific frequency bands.

Specifications

Frequency range

Basic unit (with tuner 1)	20 MHz to 650 MHz
Tuner 2	650 MHz to 1300 MHz (optional)
Tuner 0	0.5 MHz to 30 MHz (optional)
Frequency setting	1 kHz, 100 Hz, 10 Hz, 1 Hz
Frequency error	≤±1.5 x 10^{-6} (–10 °C to +55 °C)
Frequency aging	≤±0.5 x 10^{-6} per year
Oscillator phase noise	≤–110 dBc (10 kHz)
for tuner 0	≤–138 dBc (10 kHz)
Synthesizer settling time	≤1 ms

Antenna input

N connector, 50 Ω, VSWR ≤2.5, overload-protected

Oscillator reradiation	≤–107 dBm
Tuner 0	≤–127 dBm
Input selectivity	tuned filters
Tuner 0	4 switched bandpass filters

Immunity to interference, nonlinearities

Image frequency rejection	typ. 110 dB, ≥90 dB
IF rejection	typ. 110 dB, ≥90 dB
IP2	typ. 50 dBm, ≥40 dBm
Tuner 0	typ. 70 dBm, ≥55 dBm
IP3	typ. 11 dBm, ≥ 8 dBm
Tuner 2	typ. 9 dBm, ≥6 dBm
Tuner 0	typ. 35 dBm, ≥28 dBm
Spurious	≤–107 dBm
Tuner 0	≤–113 dBm

Sensitivity

Total noise figure (incl. AF section)
≤13.5 dB, typ. 10 dB (20 MHz to 650 MHz)
≤14.5 dB, typ. 11 dB (650 MHz to 1300 MHz)

(S+N)/N ratio (measurement using telephone filter to CCITT)

	Tuner 1 20 to 650 MHz	**Tuner 2 650 to 1300 MHz**
AM, IF bandwidth = 8 kHz, f_{mod}=1 kHz, m= 0.5	V_{in}=–107 dBm (1 µV) ≥10 dB	V_{in}=–103.5 dBm (1.5 µV) ≥10 dB V_{in}=–47 dBm (1 mV) ≥47 dB
FM, IF bandwidth =15 kHz, f_{mod} =1 kHz, deviation = 5 kHz	V_{in}=–107 dBm (1 µV) ≥25 dB	V_{in}=–103.5 dBm (1.5 µV) ≥25 dB V_{in}=–47 dBm (1 mV) ≥70 dB
USB/LSB, IF bandwidth=2.5 kHz, Δf =1 kHz	V_{in}=–117 dBm (0.3 µV) ≥10 dB	V_{in}=–47 dBm (1 mV) ≥50 dB

Tuner 0	**0.5 to 20 MHz**	**20 to 30 MHz**
USB/LSB, IF bandwidth 500 Hz, Δf = 500 Hz	V_{in}= 0.4 µV ≥10 dB	V_{in}= 0.5 µV ≥10 dB
USB/LSB, IF bandwidth 2.5 kHz, Δf = 1 kHz	V_{in}= 0.6 µV ≥10 dB	V_{in}= 0.7 µV ≥10 dB V_{in} = 100 µV ≥46 dB
AM, IF bandwidth 2.5 kHz, f_{mod} =1 kHz, m=0.5	V_{in}= 1 µV ≥10 dB	V_{in}= 1.2 µV ≥10 dB

Large signal behaviour for tuner 0
Crossmodulation: interfering signal 2.5 V (+21 dBm), Δf ≥ 30 kHz; m = 0.3; f = 1 kHz, signal level 5 mV (–33 dBm)
Modulation transfer ≤10 %

Blocking: interfering signal 3.15 V (+ 23 dBm), Δf ≥ 30 kHz, signal level 500 µV (–53 dBm), m = 0.3, f = 1 kHz
Signal attenuation ≤1 dB

Desensitization: interfering signal 150 mV (–3.5 dBm), Δf ≥ 30 kHz, signal level 15 µV (–83.5 dBm), IF bandwidth 2.5 kHz
SINAD ≥20 dB

Other receiving characteristics

Demodulation	AM, FM , LOG, PULSE; SSB and CW optional
Squelch	signal-controlled, adjustable –10 dBµV to 80 dBµV (max. 110 dBµV, 120 dBµV with tuner 0)
AGC range	90 dB; 1 µV to 10 mV makes ≤4 dB difference in AF level
RF attenuator	30 dB (40 dB with tuner 0) selectable or signal-controlled

AGC speed for 90 dB range

	Attack	Decay
AM/B=15 kHz	<15 ms	15 ms
Pulse/B=100 kHz	<0.1 ms	3 s, corr. to 3 dB/100 ms
SSB/B=2.5 kHz	<1 ms	

Range of MGC (manual gain control)	90 dB
EGC (external gain control) by analog voltage	90 dB
COR	
Decay	adjustable 1 s to 10 s
Attack	≤25 ms
AFC	digital tuning for signals of unstable frequency
Offset indication	graphical using tuning markers, numeric in 50 Hz steps (B ≤100 kHz)
Signal-level indication	graphical as level line or numerical from –10 dBµV to 80 dBµV (110 dBµV), with tuner 0 120 dBµV
Resolution	graphical 1 dB, numerical 0.1 dB
Error	≤±3 dB, ≤±2 dB for level ≥ 0 dBµV

Compact Receiver ESMC

Automatic memory scan	1000 definable memory locations, each location may be allocated a complete set of receive data
Frequency scan	five definable start/stop frequency spans with separate receive data sets (5 jobs)
Analog sweep (option)	full receive range (max. 650 MHz) or any expanded section
Frequency marker	added for receiver tuning
Sweep time	approx. 47 ms
Resolution filter	IF filters of receiver
Built-in test (BIT)	
Continuous test	module monitoring, test points of modules can be shown on display, fault signalling with error code + text
Loop test	key-triggered, automatic test of complete receive section incl. AF section
Real-time display on Spectrum Display EPZ 513[1])	
IF	±3.5 MHz, ±1 MHz, ±100 kHz or zoom
RF	full receive range (max. 650 MHz) or any expanded section
Inputs and outputs	
IF 21.4 MHz, controlled output	500 Hz to 8 MHz[2]), BNC, 50 Ω, –10 dBm
IF 21.4 MHz, uncontrolled output	500 Hz to 8 MHz[2]), BNC, 50 Ω, V_{in} + 12 dB
21.4 MHz, wideband output	±4 MHz uncontrolled, BNC, 50 Ω, V_{in} +9 dB, for external spectrum display
Video output, AM/FM/LOG	1/2 IF bandwidth, DC-coupled, BNC, 50 Ω, 2 V (pp); for log 1 V
AF output, balanced	600 Ω, 0 dBm
AF output, filtered, unbalanced	0.3 kHz to 3.4 kHz, fixed, 1 V (rms)
AF output, unbalanced	1 V (rms)
AF loudspeaker output (AF filter 0.3 kHz to 3.4 kHz may be switched to any AF output)	4 Ω, 500 mW
Output, log signal level	0 V to +5 V, Z_{out} = 1 kΩ
Output, channel offset	–5 V to +5 V, Z_{out} = 1 kΩ
Input, ext. MGC voltage	0 V to 2 V, Z_{in} = 10 kΩ
Output, 1st LO	50 Ω, SMA, –10 dBm
Output, 2nd LO	50 Ω, SMA, –15 dBm
Bidirectional reference-frequency connector	10 MHz, BNC in: 0.1 V to 2 V, Z_{in}= 500 Ω out: 3 dBm, Z_{out} = 50 Ω
Special function ports	configurable for muting, ext. scan stop, etc
Output for controlling antenna selectors	BCD, TTL level (for frequency information)
Data interfaces	IEC 625-2 (IEEE 488) (standard) or RS232C/RS422/RS485 (option)

General data		
Operating temperature		–10 °C to +55 °C
Nominal temperature		0 °C to +50 °C
Power supply	AC	100/120/230/240 V, –12%/+10%, 47 Hz to 440 Hz, overvoltage protection to VDE 160
	DC	10 V to 32 V, reversed polarity protection
Power consumption	AC	≤100 VA
	DC	≤75 W
Dimensions (W x H x D)		219 mm x 147 mm x 460 mm ($^1/_2$ 19", 3 height units)
Weight		
Model .02/.03		11.5 kg
Model .22/.23		12 kg

Ordering information

VHF/UHF Compact Receiver ESMC		
Basic units including IEC625 (IEEE488) interface and IF section (filters 2.5 kHz/ 8 kHz/15 kHz/100 kHz/2 MHz)		
with front-panel control		4030.2007.22
without front-panel control		4030.2007.02
Basic units without IEC625 (IEEE488) interface and IF section		
with front-panel control		4030.2007.23
without front-panel control		4030.2007.03
Options	**see table on page 64**	
Tuner 0 for 0.5 MHz to 30 MHz	ESMC-T0[3])	4039.9004.03
Tuner 2 for 650 MHz to 1300 MHz (combination of tuner 0 and tuner 2 in one ESMC not possible)	ESMC-T2[3])	4037.5201.02
SSB Unit	ESMC-S3	4037.5501.02
IF Spectrum Unit	ESMC-SU	4037.5553.02
Analog Scan (software)	ESMC-AS	4042.0404.02
IEC625 (IEEE488) Interface	ESMC-R1[4])	4037.5401.02
Serial Interface (RS232/422/485)	ESMC-R2[4])	4037.5453.02
Remote Control Unit for model .02/.03	ESMC-GB	4039.8508.02
Frequency Extension 1.3 GHz to 3 GHz (separate $^1/_2$19"unit)	ESMC-FE	4042.6002.02
OCXO Reference	ESMC-OR	4042.6902.02
Antenna Splitter	ESMC-AN[5])	4042.6702.02
Extras		
Spectrum Display (data sheet PD756.9451)	EPZ513	4011.9500.04
19 " Adapter	ZZA-98	0827.4533.00

1) External unit.
2) Depending on selected bandwidth (see table on this page).
3) Only one of these options to be fitted.
4) Only one of these options to be fitted.
5) Slot in option ESMC-FE available, otherwise in ESMC basic unit instead of option ESMC-SU.

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Compact Receiver ESMC

Option for model .23/.03
IF Section (special bandwidths) ESMC-Z1 4037.5253.XX

500 Hz	2.5 kHz	8 kHz	15 kHz	30 kHz	50 kHz	100 kHz	200 kHz	500 kHz	1 MHz	2 MHz	4 MHz	8 MHz	Model
	•	•	•			•				•			.02
•	•		•			•				•			.03
	•		•	•		•	•						.04
		•	•	•	•	•							.05
	•	•	•			•	•						.06
			•		•	•	•			•			.07
•	•	•		•		•							.08
		•	•	•		•				•			.09
	•	•	•	•		•							.10
		•	•			•				•		•	.11
		•	•	•			•					•	.12
	•	•	•	•		•							.13
	•				•			•	•		•		.15
	•	•				•				•		•	.16
			•			•	•	•				•	.17
		•	•	•		•						•	.18
		•	•	•				•		•			.19
•	•					•					•	•	.20
		•		•		•		•	•				.21
	•	•				•					•	•	.22
						•	•	•	•	•			.23
		•			•		•	•		•			.24
		•		•		•			•	•			.25
		•		•				•	•		•		.26
			•			•		•	•			•	.27
		•		•	•			•		•			.29
						•	•		•		•	•	.30
						•	•		•	•		•	.31
	•	•	•	•			•						.32
						•	•	•	•			•	.33
•	•		•				•				•		.34
		•				•				•	•	•	.35

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VHF-UHF Search Receiver ESMA

Fast radiomonitoring from

20 MHz to 3000 MHz

Photo 42192

Brief description

The Rohde & Schwarz VHF-UHF Search Receiver ESMA is the perfect central unit of a processor-controlled system for fast and efficient radiomonitoring.

Scanning

- Scan rate up to 5 GHz/s
- Signal verification processing
- User-definable threshold pattern variable over frequency axis for up to 10,000 channels
- Suppress function for single frequencies or subranges
- Scan based on frequency range or frequency list supporting up to 500 entries
- Multiple range operation

Interception and identification

- Aural monitoring
- Frequency
- Frequency offset
- Level
- Modulation
- Bandwidth

Occupancy monitoring

- On-line display for state of occupancy for frequency ranges and channel groups by means of panoramic and waterfall diagrams

Off-line functions (optional)

- Scan replay
- Statistical evaluation

Main features

Designed as a search receiver for fast radiomonitoring in the VHF/UHF range, the ESMA is setting standards :

- Wide frequency range, 20 MHz to 3000 MHz (with option ESMA-T2 and ESMA-FE)
- Wide dynamic range
- Accurate measurement of signal level
- Measurement of frequency offset
- Detection of short-term signals due to high scan rate
- High-speed data link between front-end and process controller
- User support by means of sophisticated control panel and on-line help
- Man-machine interface running on standard IBM-compatible PC featuring flexible system upgrade (LAN, printer, data backup, etc)
- Built-in test equipment (BITE) down to submodule level
- Mains and battery operation

Applications

National organizations and authorities in charge of radiomonitoring and radio reconnaissance, such as radiomonitoring services, police, customs, security services, as well as military customers require equipment providing fast and efficient radiomonitoring with a minimum of accessories and staff.

Consequently, the ESMA has been designed as a fast search receiver which forms the key component of an advanced radiomonitoring system.

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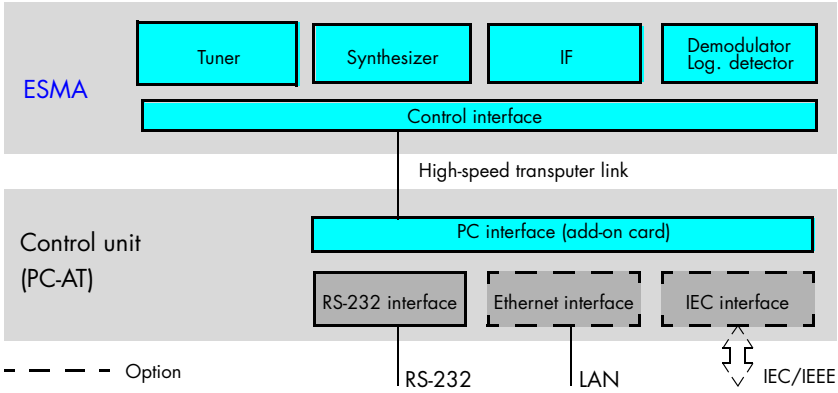
VHF-UHF Search Receiver ESMA

The versatile concept allows both stationary and mobile use in land vehicles, vessels and airplanes. The scope of ESMA applications ranges from statistical channel monitoring and dialog-based searching and identifying to continuous scenario monitoring of frequency bands. The monitoring of frequency-agile systems or burst transmissions is also possible. Thanks to the wide dynamic range and the low-noise synthesizer the ESMA is perfectly suited for use as a frontend for digital postprocessing.



Block diagram of ESMA connected to PC via high-speed transputer link

Scan features

- Scan rate up to 5 GHz/s
- Predefinable sequence of up to nine frequency ranges and one frequency list for multiple range operation
- Overview mode for continuous monitoring
- Search mode for identification purposes
- Alarm threshold variable over frequency axis for monitoring of complex scenarios
- Suppress function for single channels and subranges via temporary and permanent suppress lists

Receive features

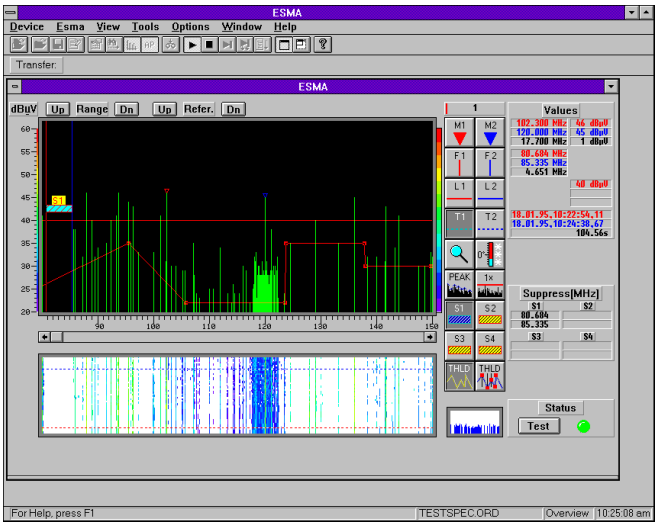
- Tracking preselection
- High sensitivity
- Wide dynamic range
- Low oscillator reradiation
- May be equipped with up to 5 IF bandwidths from 8 kHz to 8 MHz
- Synthesizer switching time better than 150 µs
- Low oscillator phase noise even close to carrier
- Thermostat-controlled reference crystal featuring an extremely high frequency accuracy

Operation

A standard stand-alone configuration consists of Search Receiver ESMA including control software and IBM-compatible PC, which is operated via keyboard, mouse and VGA monitor. The PC communicates with the receiver via a high-speed transputer link and a link adapter which is to be installed in the PC (see diagram).

The control software operates under MS-Windows 3.x/95/98/NT and features:

- Setting of all receiver and scanning parameters for overview and search mode including a global threshold level or polygonal threshold pattern which may be adapted to the current scenario during scanning
- On-line display of event data gained, multiple ways of representation (panoramic, waterfall) in overview mode
- Interactive panel for identification of channel and station in search mode
- Transfer of receiver setting to slave receiver and direction finder
- Recording function for overview mode (optional)
- Off-line statistics (optional)
- Scan replay (optional)



User interface for overview mode allows interactive definition of a polygonal threshold pattern even during scan operation

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VHF-UHF Search Receiver ESMA

Moreover, the stand-alone configuration can be upgraded to a standard monitoring system including:

- Extracting tools for off-line analysis
- Linking of several standard systems to form a multi-position system

The menu gives a complete overview of all operating modes. Even in time-relevant situations the user is effectively supported by the graphical user interface. A convenient on-line help is also part of the standard software.

Specifications

Frequency range	20 MHz to 3000 MHz
Basic unit	20MHz to 650 MHz
Tuner 2	650 MHz to 1300 MHz (optional)
Tuner FE	1300 MHz to 3000 MHz
Frequency resolution	100 Hz
Stability	like reference frequency
Reference frequency	10 MHz
Temperature stability	≤1.5 x 10^{-8}(–10 °C to +55 °C)
Aging	≤5 x 10^{-10}/day
After warm-up time	≤3 x 10^{-8}/5 min
Antenna input	50 Ω, N socket, protected against overvoltage, VSWR ≤2.5
Oscillator reradiation	≤–107 dBm
Input selectivity	tuned filters
Oscillator phase noise	≤–115 dBc (10 kHz), typ. –120 dBc (10 kHz)
Synthesizer switching time	≤150 µs
Immunity to interference, nonlinearities	
Image frequency rejection	typ. 110 dB, ≥90 dB
IF rejection	typ. 110 dB, ≥90 dB
2nd order intercept point	typ. 50 dBm, ≥40 dBm
3rd order intercept point	
20 MHz to 650 MHz	typ. 11 dBm, ≥8 dBm
650 MHz to 1300 MHz	typ. 9 dBm, ≥6 dBm
Spurious	≤–107 dBm
Sensitivity	
Total noise figure (incl. AF section)	
20 MHz to 650 MHz	typ. 10 dB, ≤13.5 dB
650 MHz to 1300 MHz	typ. 11 dB, ≤14.5 dB
(S+N)/N ratio (CCITT)	
AM (m=0.5)	≥10 dB, for V_{in} = 1.5 µV, IF bandwidth 15 kHz
FM (deviation=5 kHz)	≥25 dB, for V_{in} = 1.5 µV, IF bandwidth 15 kHz
Signal level indication	graphical as vertical level line in panoramic display, numerical in static and search mode
IF bandwidths	8/15/30/100 kHz/2 MHz (standard), max. 8 MHz possible
Demodulation	AM, FM, LOG
Squelch	signal-controlled
Control	
Automatic AGC	90 dB signal variation for ≤ 4 dB AF variation
Manual MGC	IF control 90 dB
Attenuator	30 dB selectable
Built-in test equipment (BITE)	
Continuous test	module monitoring, fault signalling
Loop test	automatic test of complete receive section including signal evaluation section
Status indication	LEDs on front panel
Outputs	
IF outputs	
21.4 MHz, controlled	8 kHz to 8 MHz [1]), –10 dBm, BNC, 50 Ω
21.4 MHz, uncontrolled	±4 MHz wideband output, V_{in} + 11 dB, BNC, 50 Ω
AF outputs	AF filter 0.3 kHz to 3.4 kHz, may be switched to any AF output
Balanced	0 dBm, 600 Ω
Unbalanced	0.5 V (rms), R_i=600 Ω
AF loudspeaker output	500 mW, 4 Ω
Headphone output	1 V (rms), R_i=5 Ω, jack socket, 6.35 mm, controllable
AM, FM, LOG video output	1/2 IF bandwidth, DC-coupled, BNC, 50 Ω, 2 V (pp) (for LOG 1 V)
Reference frequency output	10 MHz, BNC, 50 Ω, 5 dBm
Special function ports	2 ports, configurable outputs: frequency information, control signals for antennas, log signal level, frequency offset input: IF analog voltage for external gain control
Control interface	transputer link (RS422)

General data

Operating temperature	–10 °C to +55 °C
Nominal temperature	0 °C to +50 °C
Power supply	
AC	100/120/230/240 V, –12/+10%, 47 Hz to 440 Hz, overvoltage protection to VDE 160
DC	20 V to 32 V (reversed polarity protection)
Power consumption (without PC)	
AC	≤150 VA
DC	≤120 W
Dimensions (W x H x D)	436 mm x 192 mm x 460 mm
Weight	20 kg

Ordering information

VHF-UHF Search Receiver	ESMA	4024.5008.02
Accessories supplied	Transputer Card ESMA-TK (ISA-16), standard software, control cable ESMA–PC, operating manual, power cable	
Recommended controller	IBM-compatible PC-AT486, at least 66 MHz, including SVGA adapter (800 x 600 pixels, 256 colours); one free ISA slot for ESMA-TK	
Options		
Tuner 2 for frequency range extension 650 MHz to 1300 MHz	ESMA-T2	4034.4256.02
Data Evaluation Package	ESMA-EV	4047.3060.01

[1]) Depending on selected IF bandwidth.

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Digital VLF-HF Receivers EK895, EK896 – Overview

EK895 and EK896 (Photo 41623)

10 kHz to 30 kHz

Compact DSP-based receivers for radiomonitoring and detection, radiocommunication, search operation, DF systems and as front-end for HF intelligence tasks

Brief description

The compact and modular VLF-HF receivers are ideal for use in stationary, mobile and remote receiving systems. Thanks to the modern and flexible concept, the receivers can be used as communication receivers in communication networks and for fast search, scanning, radio detection and radiomonitoring tasks. Moreover, the units are optimally suitable as high-performance front-end units (eg for special post-processing applications (COMINT) as well as for frequency-synchronous receiving or DF systems.

Digital VLF-HF Receivers EK895/896 resort to the use of digital signal processing (DSP) for the IF, demodulation and AF. The DSP, equipped with a very powerful microprocessor, offers a variety of additional features to the user such as automatic signal processing, signal optimization and high operating convenience. All this significantly improves the attainable reception quality.

The very compact ½ 19" single receivers or 19" (rackable) single or dual receivers allow any type of system combinations in the form of operator positions or handoff receivers (master-slave operation). Handoff or remote receiving operation over any distance is possible without any constraints using master (EK896)/slave (EK895) concepts (see page 77).

Moreover, Remote Control Unit GB899 or serial computer interfaces (also bus-compatible) for PC-controlled operation of single receivers or up to 99 handoff receivers (addressable) are available in the system.

Features and benefits

All the well-proven features of the EK890 family such as RF characteristics, operating and remote-control concept, applications, high immunity to spurious emission as well as high reliability (especially in the RF field and under environmental stress) can be found in these two receivers.

Well-proven system concept

- 2 different models:
  - Half-rack receiver EK895
  - Search receiver EK896 (19")
- Receiving range throughout with 1 Hz resolution
- 13 or 128 bandwidths
- Excellent large-signal behaviour
- Very short frequency change time (typ. 10 ms)
- High rejection of strong interfering signals
- BIT (built-In-test) integrated down to module level
- MIL-STD-810D and MIL-STD-461B
- Digital signal processing (DSP) for convenient and versatile operation
- Excellent radio signal analysis application with Digital Spectrum Display EP090

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Digital VLF-HF Receivers EK895, EK896 – Overview

Operational features

- Easy to operate via terminal, computer, remote control unit or front panel
  - Menu-guided settings
- Remote control of all settings – over any distance when using modems
  - Real-time remote control or master/slave mode
  - Master/slave and system operation
  - Fully BUS-controllable (RS-232-C, RS-485, 2/4-wire)
  - Available with operator front panel or remote-control-only front panel
- 1000 programmable channel memory locations
- Scan mode for programmable frequency ranges and any desired channel sequences
- Ideal handoff receivers in stationary, mobile and remote receiving systems

Customer benefits

- Extremely reliable operation under harsh environmental and EMC conditions (MTBF >14000 hours)
- High availability thanks to long MTBF and short MTTR
- Easy to adapt to special requirements by means of optional plug-in modules and standardized interfaces
- Excellent price/performance ratio
- Powerful microprocessor for bus interfacing, menus and user programs
- Free slots for retrofitting of options
- Integrated self-test down to module level with plain-text result display
- Low power consumption <25 VA (basic model EK895), therefore little self-heating
- Highly compact, width ½ 19" (EK895) or 19" (EK896)
- Dual receiver as 19" bench or rack models

Overview of EK890 models

Type	Model	Use (typ.)	Special features	Size	Bandwidths	Local & remote control	Remote control	Available internal opt.	Page
EK895	02	Slave, comm., monitoring	DSP + additional features	½ 19"	13	–	•	7	73
	07	Special communication	LINK11 reception/demodul.	½ 19"	13	–	•	7	73
	12	Gen.-purpose, comm., monitoring	DSP + additional features	½ 19"	13	•		6	73
	14	Gen.-purpose, monitoring, comm.	DSP, OCXO, opt. 128 BW	½ 19"	13	•		7	73
	17	LINK11 reception	With internal OCXO	½ 19"	13	•		7	73
	37	LINK11 reception	For use with external frequency standard	½ 19"	13	•		7	73
	63	1.44 IF	Additional IF output	½ 19"	13	•		7	73
EK896	12	Master, gen.-purpose, monitoring	DSP, fast and easy op., opt. 128 BW	19"	128	•		7	75
	14	Gen.-purpose, master, monitoring	DSP, fast and easy op., OCXO, monitoring RX	19"	128	•		8	75
	17	LINK11 reception	With internal OCXO	19"	128	•		8	75
	37	LINK11 reception	For use with external frequency standard	19"	128	•		8	75

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Digital VLF-HF Receiver EK895

Compact ½19" DSP-based high-end receiver for radiocommunication, radiomonitoring and detection, search operation, DF systems and as front-end for HF intelligence tasks

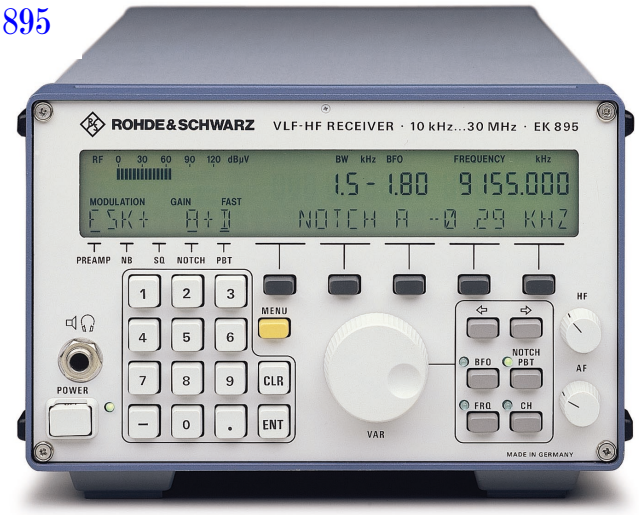

Photo 41636

Features and benefits

- Digital signal processing (DSP) for convenient and versatile operation
- Clear-cut front panel for simple, menu-guided operation
- Real-time remote control or master-slave mode
- Well-proven system concept
- Excellent price/performance ratio
- Extremely reliable operation under harsh environmental and EMC conditions
- Application-specific options and accessories available

Applications

Due to the excellent RF characteristics and the uncomplicated and full remote-control capability EK895 is suitable for all civil, administrative and military shortwave applications. Receiver EK895 is an ideal choice for receiving systems which have to fulfill extremely high reliability requirements, in particular under harsh environmental and EMC conditions.

Characteristics

With EK895, Rohde&Schwarz has a powerful VLF-HF receiver which is a top-end product benefiting from many years of experience in this field. Due to the advantages of digital signal processing, embedded in Receiver EK895 a number of additional features and operator convenience have been added. The operational features additionally incorporated into EK895, such as preamplifier (PREAMP), noise blanker (NB), squelch (SQ), notch filter (NOTCH) and passband tuning (PBT), are selected in submenus using softkeys. If one of these features is active, a bargraph appears on the display above the relevant inscription (PREAMP, NB, SQ, NOTCH, PBT).

A clearly organized, menu-guided selection and programming of the receiving settings ensure excellent processing and handling of the received signal content. Thanks to its full system compatibility, the receiver provides the basis for extremely economical customer-specific solutions.

EK895 thus fulfills the requirements for versatile use in voice receiving and any kind of data communication systems as well as for all radiomonitoring, radio detection and radio intelligence (COMINT) applications.

Operation

The built-in memory has capacity for nonvolatile storage of 1000 complete channel settings so that channel management and control by an external computer are not required but nevertheless additionally possible.

Receivers with remote-control panel

The receivers can be remote-controlled by ASCII command sequences via a multistandard interface (RS-232-C, RS-485, RS-422/423, 2/4-wire). In the simplest case, a terminal can be used as the control unit. For more convenience a computer can be used to handle complex tasks and to create special user interfaces. A demo program for generating a virtual front panel is available if desired.

A remote control unit (GB899) permits full remote control via the serial interface, and with external line modems, over any distance.

Two wired and bus-integrated slots for plug-in modules are provided in EK895 for extensions.

The comprehensive sequence control can be used for all demanding short-

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wave reception tasks. Due to flexible programming of the processor, the following operating modes are possible:

- Manual operation
- Remote control or master-slave operation
- Channel scanning, sequential and programmable
- Frequency scan
- Channel reception
- Password-protected channel reception

Special features

- Excellent large-signal behaviour, very good intercept points
- High resolution of tuning frequency down to 1 Hz
- Fast and low-noise synthesizer
- Demodulators for AM, CW, LSB, USB, ISB, FM, FSK, AFSK and FAX included in basic configuration
- 13 bandwidths from 150 Hz to 8 kHz (128 BW as option)
- LINK11 reception (models 07, 17, 37)
- RF preamplifier, switchable (noise figure 8 kT_0)
- Double notch filter
- Noise blanker
- Passband tuning
- Syllabic squelch
- Special RTTY (FSK/AFSK) mark and space filters, matched to the selected shift
- Digital data output (Data, Clock, Frame)
- Maximum input voltage protection up to 100 V EMF
- Control interface fully complying with international standards
- Low power consumption <25 VA (basic model EK895), therefore little self-heating
- Powerful microprocessor for bus interfacing, menus and user programs
- Dual receiver as 19" bench or rack models
- Free slots for retrofitting of options
- Integrated self-test down to module level with plain-text result display
- Available with operator front panel or remote-control-only front panel
- Highly compact, width $^1/_2$ 19"

Specifications

Frequency range	10 kHz to 30 MHz	
Resolution	1 Hz	
Frequency drift	−10 to +45 °C	aging/year
Frequency standard (TCXO)	5×10^{-7}	1×10^{-6}
Option: OCXO	1×10^{-7}	1×10^{-7}
External frequency standard	1/5/10 MHz, 0.2 to 1 V RMS	
Antenna input	BNC connector, 50 Ω	
Max. input voltage (≤30 MHz)	100 V_{EMF}	
Demodulation modes	CW/MCW (A1A, A1B, A2A, A2B) FAX1 (F1C) AM/AME (A3E, H2A, H2B, H2E) USB/LSB (R2A, R3E, J2A, J3E) ISB (B8E) FSK/AFSK (F1A, F1B), F6 (F7B) FAX2 (F3C), FM (F3E) DATA LINK to MIL-STD-188-203-1A (on request)	
IF bandwidth (standard values)	13, selectable between 150 Hz and 8 kHz	
Quasicontinuous bandwidth selection	128 steps, between 100 Hz and 9 kHz (with option EK895S7)	
Sensitivity (for S/N=10 dB, f=0.1 to 30 MHz)		
A1A (CW)	0.4 µV EMF (−121 dBm), BW=300 Hz	
J3E (SSB), J7B	1.0 µV EMF (−113 dBm), BW=2.7 kHz	
H3E (AME), 1 kHz, m=60%	2.7 µV EMF (−104 dBm), BW=6 kHz	
with preamplifier, f=0.2 to 30 MHz		
A1A (CW)	0.2 µV EMF (−127 dBm), BW=300 Hz	
J3E (SSB), J7B	0.4 µV EMF (−121 dBm), BW=2.7 kHz	
H3E (AME), 1 kHz, m=60%	1.0 µV EMF (−113 dBm), BW=6 kHz	

Immunity to interference, non-linearities	
Intermodulation (1.5 to 30 MHz)	
IP_2	>60 dBm (typ. 70 dBm)
IP_3	>30 dBm (typ. 35 dBm)
Gain control	automatic (AGC), manual (MGC) or remote (DGC)
AGC error	≤3 dB (1 µV to 1 V EMF)
Time response constants	
Attack time	<10 ms
Decay time	25/150/500 ms, 1 s, 3 s
DGC range	0 to 120 dBµV EMF in 1 dB steps
AFSK/FSK demodulator	transfer rate (50 to 600 baud) and deviation range (±42.5 to ±425 Hz) adjustable; V.28 interface and audible tone circuit
Diplex telegraphy demodulator (F7B)	2 x V.28 interface
Channel memory	for 1000 channels, nonvolatile, storage of complete receiver setup for each channel
Data interface	RS-232-C, RS-485 (bus-compatible)
Transfer rate	50 to 38 400 baud

General data

Environmental conditions	to MIL-STD-810 D
Rated temperature range	−10 to +45 °C
Operating temperature range	−25 to +55 °C
Storage temperature range	−40 to +80 °C
Humidity (non-condensing)	max. 95% at +40 °C
Vibration test	10 to 55 Hz; 0.4 mm double amplitude
Shock test	30 g, 11 ms
EMC	to MIL-STD-461/462
MTBF	>14 000 h
Power supply	100/120/230/240 V −15/+10%, 47 to 420 Hz (approx. 25 to 75 VA, depending on model)
Dimensions (W x H x D), weight	211 mm x 132 mm x 460 mm, approx. 8 kg

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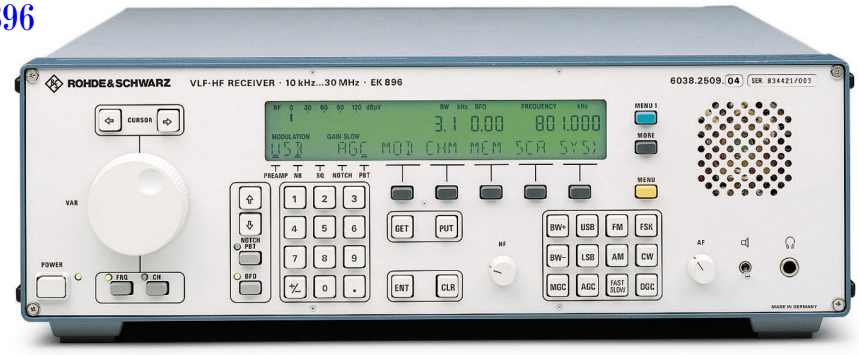
Ordering information EK895

VLF-HF Receiver		
with control panel for local/remote control		
Standard Receiver (with TCXO)	EK895	6057.8996.12
with oven-controlled frequency standard (OCXO)	EK895	6057.8996.14
with front panel for remote control		
Standard Receiver (with TCXO)	EK895	6057.8996.02
for LINK11 reception		
Standard Receiver (with TCXO)	EK895	6057.8996.07
for LINK11 reception, with oven-controlled frequency standard (OCXO)	EK895	6057.8996.17
for LINK11 reception, for use with external frequency standard	EK895	6057.8996.37
with 1.44 MHz additional IF output	EK895	6057.8996.63
Accessories supplied	manual	

Recommended extras		
Control Panel	GB890	6007.7709.03
Remote Control Unit	GB899	6037.3501.03
19" Adapter Kit	ZZA98	0827.4533.00
19" Adapter Kit for 2 EK895	KA890L1	6041.6699.03
Service manual	EK895	6045.6712.62
Line Current Source	GH890	6007.6054.02
Plug-in modules		
Input Filter Unit	FK890H1	6007.7750.02
BCD Interface	GC890	6007.7809.02
Broadband Output (module)	GM893	6051.8494.03
IF Converter (submodule of IF/AF processor)	UX895	6077.0261.02
Quasicontinuous IF Bandwidth Control (128 BW)	EK895S7	6077.0510.02
Remote Control Software	EK890S2	6077.7051.03

Digital VLF-HF Receiver EK896

19" DSP-based receiver for radiomonitoring and detection, radiocommunication, master receiver for radio workstations



Search Receiver EK896 with front panel for local/remote control (Photo 41639)

Features and benefits

- Digital signal processing (DSP) for convenient and versatile operation
- Digital RF selection (optional)
- Real-time remote control or master-slave mode
- Well-proven system concept
- Excellent price/performance ratio
- Extremely reliable operation under harsh environmental and EMC conditions
- Application-specific options/accessories available

Applications

EK896 has been designed with a particular view to complex tasks of radio detection and search reception, its operating principle and configuration matching perfectly the relevant requirements. As standard it is fitted with panel controls and LC display for local and remote-control operation since with radiomonitoring manual optimization of receive parameters is practically always necessary.

High-speed and reliable radiomonitoring is supported by temporary storage of a complete receiver setup and its transfer to or readout from the connected slave. EK896 is the optimal operator's position in modern radiomonitoring systems. In the usual master-slave mode, a master receiver can control up to 99 slave receivers via additional line drivers to handle simultaneous radiomonitoring or specific radio detection tasks. Due to its outstanding characteristics, EK896 is also ideal for use as a stand-alone receiver. All EK895 options can be fitted.

Characteristics

EK896 is based on the basic model EK895, see page 73.

Special operations

- Master-slave operation
- Complete erasure of channel memory

In addition, the following functions can be selected on the front panel:

- Display of interface configuration
- Fast channel storage
- Channel buffer storage
- Default settings on/off
- Password for channel service
- Local/remote mode
- Knob increments

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Special features

- Excellent large-signal behaviour, very good intercept points
- High resolution of tuning frequency down to 1 Hz
- Fast and low-noise synthesizer
- Demodulators for AM, CW, LSB, USB, ISB, FM, FSK, AFSK and FAX included in basic configuration
- 128 bandwidths from 100 Hz to 9 kHz
- RF preamplifier, switchable (noise figure 8 kT_0)
- Double notch filter
- Noise blanker
- Passband tuning
- Syllabic squelch
- Special RTTY (FSK/AFSK) mark and space filters, matched to the selected shift
- Direct, fast access key panels
- Digital data output
- Maximum input voltage protection up to 100 V EMF (up to 200 V EMF, see option)
- Control interface fully complying with international standards
- Digital selection (optional)
- Built-in speaker, switchable
- Large tuning knob
- Low power consumption <25 VA (basic model EK896), therefore little self-heating
- Powerful microprocessor for bus interfacing, menus and user programs
- Receiver as 19" bench or rack models
- Free slots for retrofitting of options
- Integrated self-test down to module level with plain-text result display

Specifications

Frequency range	10 kHz to 30 MHz	
Resolution	1 Hz	
Frequency drift	–10 to +45°C	aging/year
Frequency standard (TCXO)	5×10^{-7}	1×10^{-6}
Option: OCXO	1×10^{-7}	1×10^{-7}
External frequency standard	1/5/10 MHz, 0.2 to 1 V RMS	
Antenna input	BNC connector, 50 Ω	
Max. input voltage (≤30 MHz)	100 V EMF, opt. 200 V EMF	
Demodulation modes	CW/MCW (A1A, A1B, A2A, A2B) FAX1 (F1C) AM/AME (A3E, H2A, H2B, H2E) USB/LSB (R2A, R3E, J2A, J3E) ISB (B8E) FSK/AFSK (F1A, F1B), F6 (F7B) FAX2 (F3C), FM (F3E) DATA LINK to MIL-STD-188-203-1A (on request)	
IF bandwith	13, selectable between 150 Hz and 8 kHz and 128 steps, between 100 Hz and 9 kHz	
Sensitivity	(for S/N=10 dB, f=0.1 to 30 MHz)	
A1A (CW)	0.4 µV EMF (–121 dBm), BW=300 Hz	
J3E (SSB), J7B	1.0 µV EMF (–113 dBm), BW=2.7 kHz	
H3E (AME), 1 kHz, m=60%	2.7 µV EMF (–104 dBm), BW=6 kHz	
with preamplifier, f=0.2 to 30 MHz		
A1A (CW)	0.2 µV EMF (–127 dBm), BW=300 Hz	
J3E (SSB), J7B	0.4 µV EMF (–121 dBm), BW=2.7 kHz	
H3E (AME), 1 kHz, m=60%	1.0 µV EMF (–113 dBm), BW=6 kHz	
IP2 and IP3	same as EK895	
Gain control	automatic (AGC), manual (MGC) or remote (DGC)	
AGC error	≤3 dB (1 µV to 1 V EMF)	
Time response constants		
Attack time	<10 ms	
Decay time	25/150/500 ms, 1 s, 3 s	
DGC range	0 to 120 dBµV EMF in 1 dB steps	
AFSK/FSK demodulator	transfer rate (50 to 600 baud) and deviation range (±42.5 to ±425 Hz) adjustable; V.28 interface and audible tone circuit	
Diplex telegraphy demodulator	2 x V.28 interface	
Channel memory	for 1000 channels, nonvolatile, storage of complete receiver setup for each channel	
Data interface	RS-232-C, RS-485 (bus-compatible)	
Transfer rate	50 to 38 400 baud	
General data		
Environmental conditions	to MIL-STD-810 D	
Rated temperature range	–10 to +45°C	
Operating temperature range	–25 to +55°C	
Storage temperature range	–40 to +80°C	
Humidity (non-condensing)	max. 95% at +40°C	
Vibration test	10 to 55 Hz; 0.4 mm double amplitude	
Shock test	30 g, 11 ms	
EMC	to MIL-STD-461/462	
MTBF	>14 000 h	
Power supply	100/120/230/240 V –15/+10%, 47 to 420 Hz (approx. 25 to 75 VA, depending on model)	
Dimensions (W x H x D), weight	426 mm x 132 mm x 460 mm, approx. 11 kg	

Ordering information

VLF-HF Receiver		
with control panel		
Standard Receiver with TCXO	EK896	6038.2509.12
with oven-controlled frequency standard (OCXO)	EK896	6038.2509.14
for LINK11 reception (int. OCXO)	EK896	6038.2509.17
for LINK11 reception (for use with external frequency standard)	EK896	6038.2509.37
Accessories supplied	manual	
Recommended extras		
Remote Control Unit	GB899	6037.3501.03
Service manual	EK896	6045.7783.62
Line Current Source	GH890	6007.6054.02
Plug-in modules		
Input Filter Unit	FK890H1	6007.7750.02
BCD Interface	GC890	6007.7809.02
Broadband Output (module)	GM893	6051.8494.03
IF Converter (submodule of IF/AF processor)	UX895	6077.0261.02
Quasicontinuous Digital Selection	FK896	6077.2264.02
Remote Control Software	EK890S2	6077.2264.03
HF Unit with 1.44 MHz IF output, unregulated	(EK890)	6007.4400.03

Control Concepts of VLF-HF Receivers EK895/896

Remote control

... via PC or ASCII terminal

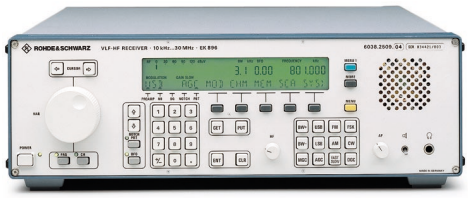
EK895 with front panel for remote control (Photo 40376)

... via Remote Control Unit GB899, model 03 (Photo 41978)

RS-485 bus

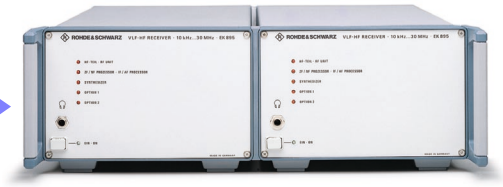
Local control

EK895 with control panel as a stand-alone unit or as a master receiver in systems (Photo 41637)



Search Receiver EK896 (Photo 40439)

Master-slave operation



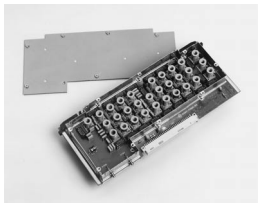
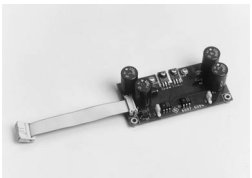
Slave receivers, max. 99 addressable (Photo 41625)

Internal Options for EK895/EK896 – Overview

	Control Panel GB890, 03	IF Conv. UX895	Input Filter FK890H1	Broadband Output GM893 model 03	BCD Interf. GC890	Line Curr. Source GH890	Digital Selection FK896	IF Bandw. Contr.(128) EK895S7	Remarks
EK895 (model 02 to 14)	o	o	o	o	o	o	—	o	**max. 2/ set**
EK896 (model 12, 14)	—	o	o	o	o	o	o	o	max. 2/ set

— not available
• standard
o optional

Internal Options for VLF-HF Receivers EK895/896

Designation	Description	Features and benefits Specifications	Ordering information
Control Panel GB890 	Control Panel GB890, also called operator front panel for local control, is part of Receivers EK895 and EK896, models ≥12. GB890 can be easily retrofitted – also during operation – into receivers, which makes them particularly suitable for the field of servicing. In addition to the controls and displays, GB890 also contains an AF amplifier for headphones or for an external loudspeaker.	Easily exchangeable front panel with control, setting and display elements as well as AF amplifier (max. 1 W into 8 Ω) at headphone jack plug.	**Blank Panel** GX890 6007.5506.02 **Control Panel** GB890 6057.9140.02
IF Converter UX895	IF Converter UX895 is a submodule for the IF/AF (DSP) processor. Instead of the analog IF output (0 to 40 kHz) IF Converter UX895 performs a linear conversion of the set receive parameters into the IF of 455 kHz (100 kHz output frequency on request). This option allows connection of external signal processing units/ analyzers operating with an input frequency of 455 kHz.	Level 0 dBm Connector BNC Impedance 50 Ω	**IF Converter** UX895 6077.0261.02
Input Filter Unit FK890H1 	The input filter module comprises a lowpass filter, a bandpass filter and eight suboctave filters which are automatically selected with the receive frequency. It is also equipped with a signal input protection up to 30 V EMF (for the HF bands). The input filter unit has a very low insertion loss (<1dB) and an excellent large-signal behaviour matching with the receiver (no inherent distortion/hysteresis). The input filter unit is recommended for use to ensure unimpaired reception in an environment subject to RF interference (collocation). In this case, unwanted (interfering) frequency ranges are strongly suppressed.	Lowpass filter 0 to 0.5 MHz Bandpass filter 0.5 to 1.5 MHz Suboctave filters (8x) 1.5 to 30 MHz Insertion loss <1 dB Input voltage protection ≥30 V EMF Design plug-in module	**Input Filter Unit** FK890H1 6007.7750.02
BCD Interface GC890	The BCD interface provides the current receive frequency information – with a resolution of 100 Hz to a parallel BCD output. This frequency information can be used to control external frequency-dependent add-on units such as tuned Selection FK101 or tuned active Antenna System AK001. This option needs an additional output connector at the rear of the receiver (BCD interface).	Frequency information 22 bit parallel, CMOS, 5 V Design plug-in board	**BCD Interface** GC890 6007.7809.02
TTY Line Current Source GH890 	This option supplies the line current (40 mA at 60 V, or ±20 mA at ±30 V) required for direct connection of teletype units provided that a FSK/AFSK demodulation (eg with GM890) – standard for EK895/896 – is given. This option is recommended for the connection of older teletype units which still need line current. It is not required for modern teletype units that are operated under V.28 or TTL control.	Line current 40 mA/60 V Double current (can be selected) ±20mA/±30 V Design printed circuit	**TTY Line Current Source** GH890 6007.6054.02

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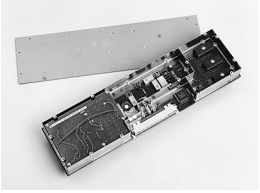
Internal Options for VLF-HF Receivers EK895/896

Designation	Description	Features and benefits Specifications	Ordering information
Digital Selection FK896 (for EK896 only) 	This option comprises Digital Selection FK2010 which, together with Control Interface GS896, is integrated into EK896. The automatically tuned, tracking selection circuit incorporates the following functions: The digital selection is recommended for use in environments with strong RF interference (ie collocation problems). It improves input selection by automatic tracking of the receive frequency and increases the input voltage protection (overload protection) of the receiver. Design: filter unit (FK2010) plus plug-in board (GS896).	• 7-circuit lowpass (0 to approx. 30 MHz) • 5-circuit lowpass (0 to approx. 1.5 MHz) for rejection of strong shortwave interfering signals • Tracking single-circuit filter 1.5 to 30 MHz with stopband attenuation of >20 dB at 10% spacing • Power on/off by remote control (can be bypassed) • Input voltage protection to 200 V EMF	**Digital Selection** FK896 6077.2264.02
DATA LINK demodulator	This software option is used for the demodulation of DATA LINK emissions according to MIL-STD-188-203-1.	Further information supplied on request.	
Quasicontinuous IF Bandwidth Control EK895S7	This software option allows the fine selection of the IF bandwidth between 100 Hz and 9 kHz in 128 steps and thus permits optimization of the required bandwidth for the different types of modulation or of the adjacent-channel suppression. This option offers a choice of operation with either 13 (standard) or 128 bandwidths. The advantage lies – especially important for radiodetection and analyzing receiving equipment – in the optimum S/N ratio setting for the signal received and demodulated. The optimum bandwidth can be stored with DEF OFF and is then automatically set again depending on the modulation type. This option has to be indicated when ordering the relevant receiver (factory installation).	BW steps: 128 steps between 100 Hz and 9000 Hz, displayed, variable by means of knob Shape factor (max. at 3 dB): 1.2 to 1.5	**Quasicontinuous IF Bandwidth Control** EK895S7 6077.7051.02 **Note:** This option is standard in Receiver EK896.
Broadband Output GM893	The optional broadband output (plug-in module) supplies an approx. 1 MHz broad signal at the first IF of 41.44 MHz (at the receive frequency ±500 kHz). To avoid impairment of the receiver sensitivity of the main (information) channel, the path to the broadband channel is decoupled by ≈10 dB. For broadband spectrum analysis, Spectrum Display EPZ513 can be connected to this broadband output.	Output frequency: 41.44 MHz Bandwidth: >1 MHz (at 3 dB) Min. gain: –10 dB, related to antenna input Impedance: 50 Ω	**Broadband Output** GM893 6051.8494.03
Oven-controlled crystal oscillator (OCXO)	To obtain a higher frequency stability of the receiver an OCXO module can be incorporated into the synthesizer instead of a standard crystal oscillator (TCXO). This option has to be indicated when ordering the relevant receiver (factory installation).	Stability short-term: <1 x 10^{-9}/day long-term: <1 x 10^{-7}/year Drift versus temperature: <5 x 10^{-7} (–10 to +45°C)	**Oven-controlled crystal oscillator** (OCXO) for EK895 6057.8996.14 for EK896 6038.2909.14

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External Options for VLF-HF Receivers EK895/896

Designation	Description	Features and benefits Specifications	Ordering information
Remote Control Unit GB899, (models 02, 03) 	Remote Control Unit GB899 can be used to remote-control one or several receivers of the EK890 family via the serial and bus-compatible interface. The receivers can be selected and operated via addresses 01 to 99. GB899 has the same appearance and dimensions as EK895.	Interface RS-232, RS-485 (bus) Data transfer 50 to 19200 Bd For distances of more than 100 m the use of standard line modems is recommended.	**Remote Control Unit** GB899 6037.3501.03
Shockmount KS890 for EK895 	Two types are available, one for MIL-specified uses, one for non-specified use.	KS890M1: random vibration and shock according to MIL-STD-810D Test Procedure 514.3 or 416.3, proc. 1. KS890C1: for highly qualified applications, using silicon elastomer absorbers.	**Shockmount** KS890M1 6043.4941.xx **Shockmount** KS890C1 6043.4941.xx

Service Kit KA890C1

Service kit for EK895/896. This service kit is packed in a small hard-foam-lined case, with the following contents:

List of contents

No.	Quantity	Designation	Order No.	Used for
1	1	Adapter Card	6030.9104.02	Motherboard to: • Synthesizer • RF Unit • IF Section • IF Unit/Demodulator • IF/AF Processor For optional modules: • Preselection Unit • IF Signal Processor • IF Converter • BCD Interface • Control Unit 2
2	1	Adapter 96 pin	6007.7680.02	Control Processor
3	4	Coaxial Cable	699.4196	
4	1	BNC-SMB Adapter	FJ 080.2270	

Ordering information

Service Kit	KA890C1	6030.9004.02

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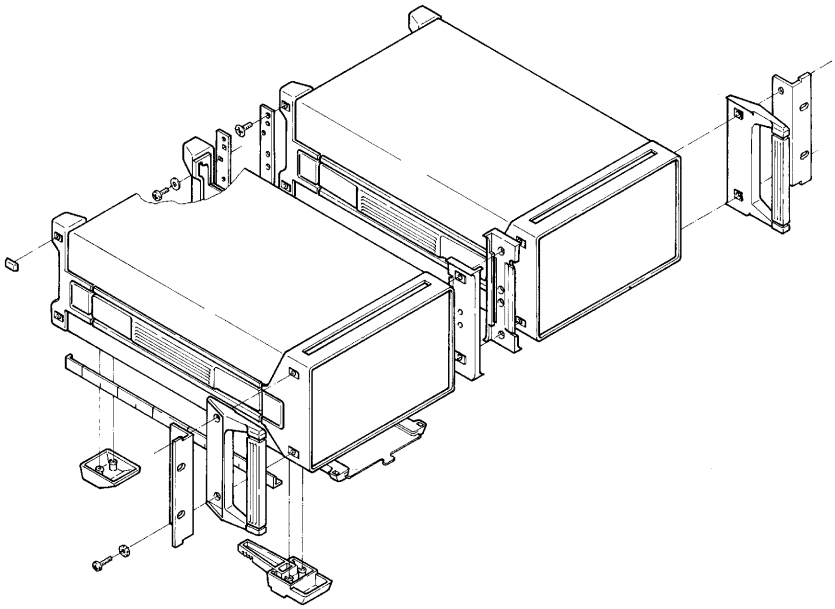
19" Rackmount Kits

Rackmount Kit KA890L1

For side-by-side mounting of 2 EK895 receivers in one 19" unit,

- as desktop model: KA890L1, model 02
- as rackmount set: KA890L1, model 03 of 6041.6699.xx

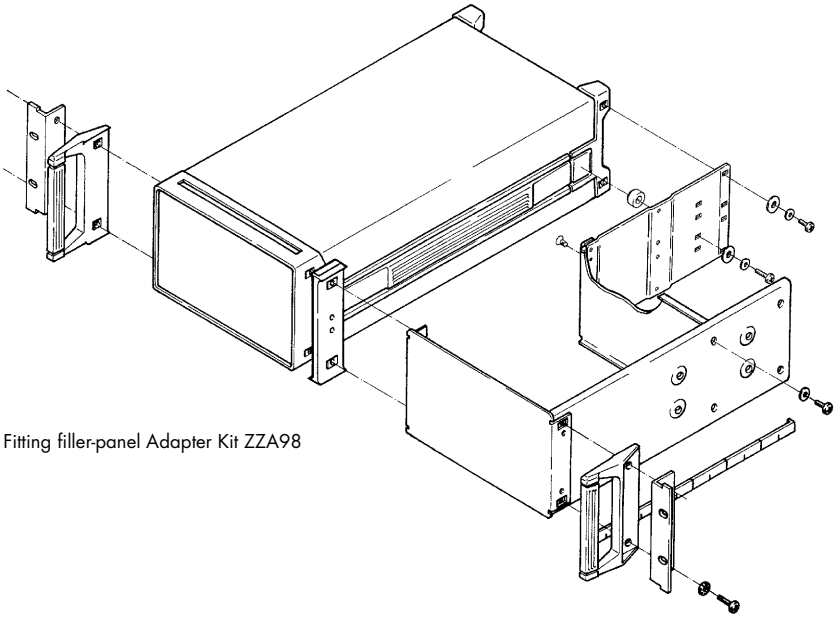


Fitting 19" rackmount kit to a combination of two 3 HU ½ W units with the same depth

Adapter Kit ZZA98

For assembling one EK895 receiver together with a blank panel in a 19" rackmount unit.
(3 HU, ½ width, depth 460 mm)

(Order No. 0827.4591)

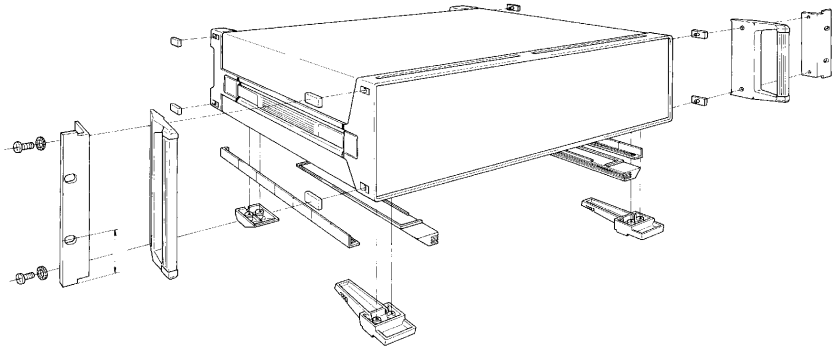


Fitting filler-panel Adapter Kit ZZA98

Adapter Kit ZZA93

For EK896 to obtain a 19" rackmount receiver (3 HU).

(Order No. 0396.4892)



19" adapter, from desktop model to rackmount

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VXI Monitoring Receiver EM010

Efficient and versatile solution for radiomonitoring systems

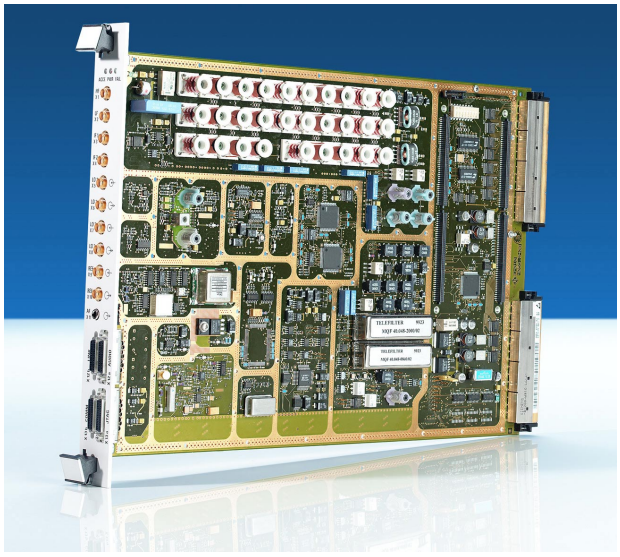


Photo 43430-2

Brief description

EM010 is a VXI receiver of advanced design based on DSPs and covers the frequency range 10 kHz to 30 MHz (plus 300 Hz to 20 kHz with option EM010LF).

Excellent RF characteristics paired with powerful signal processors create the prerequisites for optimum system solutions.

Shielding covers ensure excellent electromagnetic compatibility even in critical environments.

Main features

- System compatibility on a variety of platforms
- Only one single C-size module for covering the total frequency range
- Suitable for all common monitoring methods
- Frequency and memory scan
- Excellent price/performance ratio

Characteristics

VXI Monitoring Receiver EM010 is based on the long-standing experience of Rohde&Schwarz in the design of high-grade shortwave receivers. With the VXI interface the prerequisites are created for powerful, compact and versatile system solutions. The use of modern signal processors allows filtering, demodulation as well as a variety of data formats to be tailored to the signal scenario.

The receiver is controlled via the VXI interface as standard and is configured for binary control based on the OSI Common Management Information Service Element (CMISE) Standard.

As an alternative to the control via the VXI interface, commands can be entered via a C40 Comm Port or a SHARC Link Port. The baseband data can be output equally via VXI, SHARC Link Port or C40 Comm Port.

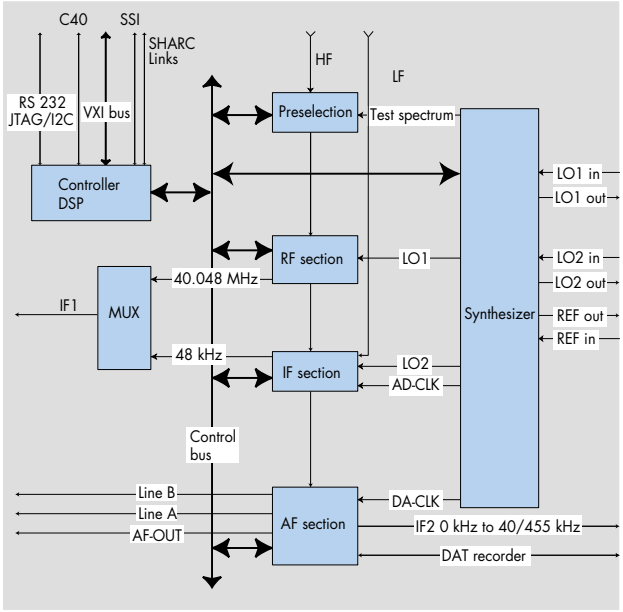
The receiver operates in the following modes:

- Fixed frequency mode (FFM)
- Memory scan mode
- Frequency scan mode
- Replay (IF/AF)
- Test

Data output is possible in the following formats:

- Baseband signal (I and Q) in digital form, maximum bandwidth 20 kHz
- IF 1 wideband analog 40.048 MHz ±2 MHz[1)]
- IF 2 analog 455 kHz or 0 to 40 kHz
- AES/EBU for recording and replay of IF data
- AF digital
- AF analog (600 Ω line and headphones)

[1)] If the IF 1 wideband output is activated, demodulation is not possible and the complete digital IF section is inactive



Block diagramm of VXI Monitoring Receiver EM010

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Specifications

Frequency

Frequency range	10 kHz to 30 MHz 300 Hz to 20 kHz (via separate input with option EM010LF)
Frequency spacing	1 Hz
Frequency stability (int. reference)	$1x10^{-7}$
Phase noise	–110 dBc/Hz (1 kHz offset)
External frequency locking	10 MHz

Tuning

Tuning time	<10 ms (bandwidth 20 kHz) <25 ms (delay of AF at 3 kHz IF bandwidth)
Synthesizer setting time	<5 ms

Antenna input

Nominal impedance	50 Ω
VSWR	<2 (1.5 MHz to 30 MHz)
Overvoltage protection	<100 V EMF (Z_{in} = 50 Ω)
Preselection	lowpass and bandpass plus 10 switchable suboctave filters
Noise figure	9 dB (preamplifier on)
Input protection	100 W max. (with automatic reset)

Linearity

2nd order intercept point	75 dBm (f > 1.5 MHz)
3rd order intercept point	40 dBm (f > 1.5 MHz)
Crossmodulation	30% AM-modulated signal of 10 dBm produces less than 10% crossmodulation for an unmodulated signal of –60 dBm (frequency offset 100 kHz)
Blocking	a useful signal of –60 dBm is attenuated by less than 3 dB by an unmodulated signal of 10 dBm (frequency offset 100 kHz)

Dynamic range of A/D converter >90 dB

Interference rejection

Image frequency rejection	>90 dB
IF rejection	>100 dB
Oscillator reradiation at antenna input	<–107 dBm
Spurious responses	<–110 dBm

Gain control AGC or MGC

RF control

AGC range	>30 dB
AGC time constants	
Attack time	<2 ms (20 dB step)
Hold time (incl. decay)	10/20/50/100/200 ms for 20 dB rolloff
MGC range	>30 dB in 1 dB steps

Overall control

(RF and analog narrowband IF)

AGC range	>120 dB
AGC time constants	
Attack time	<2 ms, 10 ms (60 dB step)
Hold time (incl. decay)	25/150/500 ms/1/5/9 s for 60 dB rolloff
MGC range	120 dB in 1 dB steps

Squelch syllabic or level squelch selectable, –20 dbµV to +100 dBµV

Filters

Baseband filter	
3 dB bandwidth	20 kHz and 8 kHz
Inband ripple	<1 dB (BW = 8 kHz)
IF filter	
3 dB bandwidths	52 Hz to 20 kHz in 70 steps
Stopband attenuation	>90 dB
Shape factor (60 dB/6 dB)	<1.5 (from bandwidth of 300 Hz and above)
Inband ripple	0.5 dB typ. (without ripple of baseband filter)
Notch filter	max. 2; separately adjustable
Stopband (3 dB)	50 Hz to 500 Hz, adjustable in 1 Hz steps
Stopband attenuation	>40 dB with 80 Hz stopband

Demodulation

Demodulation modes	AM, FM (all bandwidths) USB, LSB, CW (bandwidths <6 kHz) ISB (2.8 kHz per sideband)

Sensitivity

AM (m = 50%, f_{mod} = 1000 Hz, bandwidth 6 kHz)	–103 dBm for (S+N)/N = 10 dB
FM (5 kHz deviation, f_{mod} = 400 Hz, bandwidth 15 kHz)	–95 dBm for (S+N)/N = 20 dB
CW (bandwidth 300 Hz)	–120 dBm for (S+N)/N = 10 dB
SSB (bandwidth 2.7 kHz)	–113 dBm for (S+N)/N = 10 dB

BFO ±10 kHz, adjustable in 1 Hz steps

Scan functions

Memory scan	1000 programmable channels
Frequency scan (sweep)	start frequency – stop frequency, step size according to IF filter

Power supply (DC)	+24 V/20 mA +12 V/1500 mA –12 V/240 mA +5 V/2500 mA
Total power consumption	34 W typ.

Inputs/outputs

Inputs	RF 10 kHz to 30 MHz, impedance 50 Ω (SMA) LF 300 Hz to 20 kHz, impedance 600 Ω (SMA) 1st LO 40.096 MHz to 70.048 MHz (SMA) 2nd LO 40 MHz (SMA) 10 MHz reference (SMA)
Outputs	IF0 (software-configurable, SMA): baseband digital I and Q (VXI, C40 Link and SHARC Link); bandwidth 52 Hz to 20 kHz or AF digital (VXI, C40 Link and SHARC Link); IF1 wideband analog 40.048 MHz, bandwidth 4 MHz max.[1)] IF2 analog 455 kHz regulated (15 kHz bandwidth) or 0 Hz to 40 kHz 1st LO 40.096 MHz to 70.048 MHz (SMA) 2nd LO 40 MHz (SMA) 10 MHz reference (SMA) AF analog 600 Ω balanced (AMPLIMITE .050 series 26-pin) AF phone (3.5 mm jack)
Control data interfaces	VXI (96-pin VG connector) AUDIO/COMM//LINK/JTAG (each 26-pin AMPLIMITE .050 series)

General data

Operating temperature	0°C to 50°C
Storage temperature	–40°C to 75°C
Dimensions (W x H x L)	302 mm x 233 mm x 343 mm
with front panel	302 mm x 262 mm x 343 mm

Ordering information

VXI Monitoring Receiver	EM010	4055.0008.03

1) If the IF1 wideband output is activated, demodulation is not possible and the complete digital IF section is inactive.

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Contents of Chapter 3

Direction finders

Locating emissions in a few microseconds

Using state-of-the-art digital technology, direction finders from Rohde & Schwarz detect super-fast any signal from 300 kHz to 3 GHz. Even extremely brief emissions of only 500 µs (eg GSM) will be located. Having various DF methods implemented, the direction finders can be optimally matched to any scenario.

We offer a complete program:

- For land-based, airborne or shipboard use
- Portable sets as well as fast stationary search DF systems
- SSL (single station location) DF systems for the HF range

When it comes to locating frequency hopping networks, our fast digital search direction finders and receivers featuring synchronous scanning stand every test.

Example of digital direction finder family 20 MHz to 1300 MHz

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Introduction into Theory of Direction Finding

1 Introduction

1.1 Radio direction finding applications

While radio direction finding for navigation purposes (cooperative direction finding) is losing in importance due to the availability of satellite navigation systems, the requirement for determining the location of emitters increases with the mobility of the communication equipment:

- In radiomonitoring in line with ITU-guidelines:
  - Searching for interference sources
  - Localization of non-authorized transmitters
- In security services:
  - Fighting organized crime
- In military intelligence [1]:
  - Detecting activities of potential enemies
  - Gaining information on enemy's order of battle (signal intelligence)
- In intelligent communications systems:
  - **S**pace **D**ivision **M**ultiple **A**ccess requiring knowledge of the direction of incident waves [2]
- In research:
  - Radioastronomy
  - Earth remote sensing

Another reason for the importance of radio direction finding lies in the fact that frequency-spreading techniques are increasingly used for wireless communications: this means that the spectral components can only be associated with a certain emitter if the direction is known. Direction finding therefore is an indispensable first step in radiodetection, the more as reading the contents of such emissions is usually impossible.

The localization of emitters is often a multi-stage process. Direction finders spread across a country allow the transmitter to be located to a few kilometers by means of triangulation (typically 1% to 3% of the DF distances). The emitter location can more precisely be determined with the aid of direction finders installed in vehicles. Portable direction finders moreover allow searching within the last 100 meters, for instance in buildings.

1.2 Historical development

The DF technique has existed for as long as electromagnetic waves have been known. It was Heinrich Hertz who in 1888 found out about the directivity of antennas when he made his investigations in the decimetric wave range. An application of this for determining the direction of incidence of electromagnetic waves was proposed in 1906 in a patent of Scheller on a homing DF method.

The initial DF units were polarization direction finders. They consisted of a rotatable electric or magnetic dipole whose axis is brought to coincidence with the direction of the electric or magnetic field. The knowledge about the polarization direction then led to the direction of incidence. The rotating-loop direction finder is one of the best known direction finders of this type. In 1907 Bellini and Tosi discovered the DF principle that was named after them: a combination of two crossed directional antennas (eg loop antennas) with a rotatable coil goniometer for determining the direction Despite this invention, rotating-loop direction finders were mostly used in the First World War (Fig. 1).

The invention of Adcock meant a great step in the improvement of the DF accuracy of skywaves in the short-wave range. The pharmacist by profession realized in 1917 that with the aid of vertical linear antennas (rod antennas or dipoles) directional characteristics can be generated that correspond to that of loop antennas but do not pick up any interfering horizontally polarized field components (G. Eckard proved in 1972 that this does not hold true without any restrictions [3]). It was not until 1931 that Adcock antennas were first employed in practical applications in Great Britain and Germany.

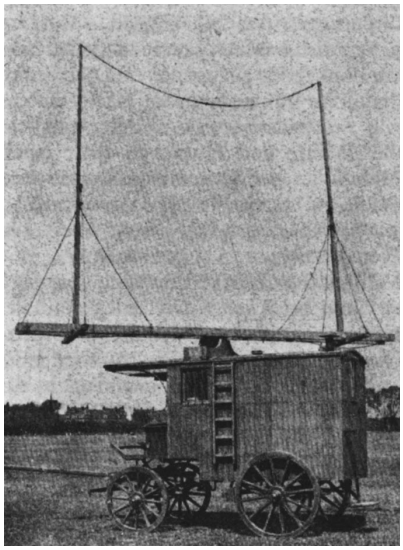

Fig. 1: Mobile rotating-loop direction finder for military use (about 1918)

Sir Watson-Watt made in the years 1925/26 the step from the mechanically moved goniometer direction

finder to the electronic visual direction finder. As from 1943 British naval vessels were equipped with crossed loops and three-channel Watson-Watt direction finders for the shortwave range ("huff-duff" for detecting German submarines).

As from 1931 camouflaged direction finders were available for use in vehicles and as portable direction finders for detecting spies.

The first shortwave direction finder operating on the Doppler principle was built in 1941. The rapid progress in the development of radar in Great Britain made it necessary to cover higher frequency ranges: in 1943 the first direction finders for "radar observation" at around 3000 MHz were delivered.

As from 1943 wide-aperture circular-array direction finders (Wullenweber) were built for use as remote direction finders. Since the 50s, airports all over the world have been quipped with VHF/HF Doppler direction finding systems for air-traffic control.

In the early 70s, digital technique made its way into direction finding and radiolocation; digital bearing evaluation and digital remote control are the main outcomes of this development.

As from 1980 digital signal processing has been increasingly used in direction finding. It permits the implementation of the interferometer direction finder and initial approaches towards the realization of multiwave direction finders ("super resolution").

The first theoretical considerations were made much earlier, eg in [4].

Another important impulse for the development came from the requirement for direction finding of frequency-agile emissions such as frequency-hopping and spread-spectrum signals. The main result of this development was the broadband direction finder which is able to simultaneously carry out the search and DF process on the basis of digital filter banks (usually with the aid of **F**ast **F**ourier **T**ransform) [5].

1.3 Tasks of radio direction finding

The task of a radio direction finder is to estimate the direction of an emitter by measuring and evaluating electromagnetic field parameters.

Usually the **azimuth** α is sufficient to determine the direction; measurement of the **elevation** ε is of interest for emitters installed in flying platforms and especially for direction finding of shortwave signals (Fig. 2).

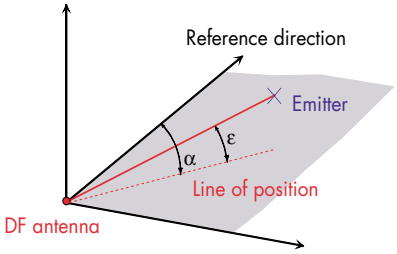

Fig. 2: Definition of emitter direction

Only in the case of undisturbed wave propagation is the direction of the emitter identical with the direction of incidence of the radio waves. Usually there is a large number of partial waves arriving from different directions and making up a more or less scattered field. The direction finder takes from this wavefront spatial and temporal samples and supplies in the ideal case the estimated values $\hat{\alpha}$ and $\hat{\varepsilon}$ for the most probable direction of the emitter observed.

The bearing can be referred to the following reference directions (Fig. 3) (see also DIN 13312 [6]):

- True north (true radio bearing)
- Magnetic north
- Vehicle axis or relative radio bearing

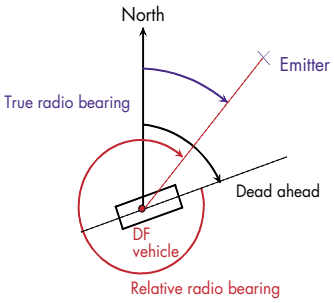

Fig. 3: Reference directions

2 DF Principles

2.1 Generation and characteristics of electromagnetic waves

Electromagnetic waves are caused by charging and discharging processes on electrical conductors in the form of AC currents [7], [8].

The first assumption is based on an undisturbed propagation of a harmonic wave of the wavelength λ. At a sufficiently large distance the radial field components are largely decayed so that limited to a small area the wave can be considered to be plane: electric and magnetic field compo-

Introduction into Theory of Direction Finding

nents are orthogonal and in-phase to each other and perpendicular to the propagation direction which is defined by the **radiation density vector (Poynting vector)** $\vec{S}$

$$\vec{S} = \vec{E} \times \vec{H} = \vec{e}_0 \frac{|E|^2}{Z_0}$$

where E = effective value of electric field strength
Z_0 = characteristic impedance of free space; $Z_0 \cong 120\pi\Omega$

or by the **wave number vector** $\vec{k}$

(Fig. 4). $\vec{k} = \vec{e}_0 \frac{2\pi}{\lambda}$

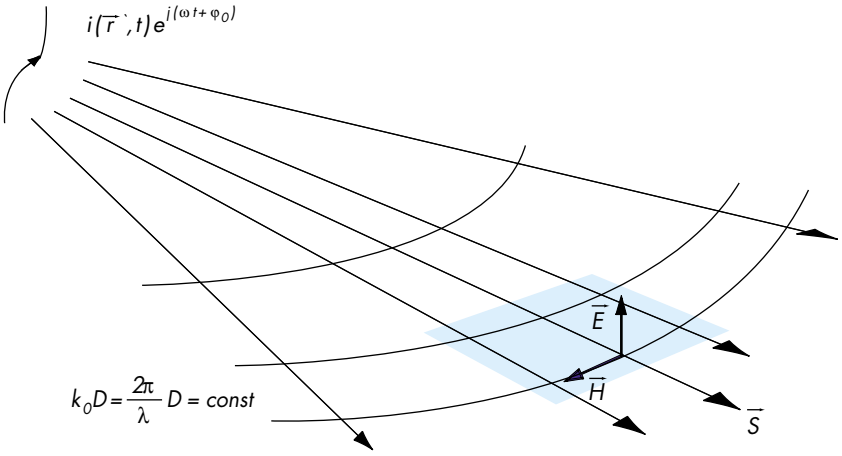

Fig. 4: Propagation of space waves

Wave characteristic	Transversality	Phase surfaces ⊥ Direction of probagation		
DF principle	Polarizations direction finder	Phase direction finder		
Examples		Direction finding with directional patterns	Aperture sampling	
		Conversion phase –> amplitude	Direct evaluation	Sensor array processing
	- Rotating loop - Dipole - Loaded loop - Crossed loop with Watson-Watt evaluation	- Directional antenna Maximum signal direction finder Minimum signal direction finder - Adcock with Watson-Watt evaluation	- Interferometer - Rotating field direction finder - Doppler direction finder	- Correlation direction finder - Adaptive beam former - MUSIC - ESPRIT

Table: DF principles

2.2 Overview of the main DF principles

The basic characteristics of electromagnetic waves, ie

- transversality (field vectors are perpendicular to direction of propagation) and
- orthogonality of phase surfaces and direction of propagation

form the foundation of radio direction finding. Any DF process can be traced back to one of the following two methods (see Table):

- Method A: measuring the direction of electric and/or magnetic filed vectors (polarization direction finders)
- Method B: measuring the orientation of surfaces of equal phase (or lines of equal phase if the elevation is not of interest) (phase direction finder)

Polarization direction finders are implemented by means of dipole and loop antennas. The classical rotating-loop direction finder belongs to this category (rotation of loop to minimum received signal → direction of wave incidence perpendicular to loop). Nowadays polarization direction finders are used in situations where there is sufficient space only for small antennas, eg in vehicles and on board ships for direction finding in the HF band. Evaluation is usually made according to the Watson-Watt principle (Chapter 3).

Phase direction finders obtain the directional information from the spatial position of the lines or surfaces of equal phase. There are two basic methods:

Introduction into Theory of Direction Finding

- **Direction finding with directional characteristics:**
  With this method partial waves are coupled out at various points of the antenna system and combined at one point to form a sum signal. The maximum of this sum signal occurs at that antenna angle at which the phase differences between the partial waves is at a minimum. The sum signal is thus always orthogonal to the phase surfaces of the incident wave (maximum-signal direction finding). For minimum-signal direction finding the partial waves are combined so that the phase differences in the direction of the wave incidence become maximal and there is a distinct minimum of the received signal
- **Direction finding by means of aperture sampling:**
  With this method, samples are taken at various points of the field and applied to sequential or parallel evaluation circuits which determine the bearing by subjecting the samples to predominantly mathematical operations

Interferometers, rotating-field direction finders and Doppler direction finders are typical examples.

The DF methods mentioned so far are suitable to a limited extent only for determining the directions of incidence of several overlapping waves in the frequency domain.

With the progress made in digital signal processing the methods known from the theory of spectral estimation have been applied to the analysis of wavefronts and further developed. The term "sensor array processing" describes the technique of gaining information about the parameters of the incident waves from the element signals of sensor arrays (antenna arrays in radio direction finding, hydrophone arrays for sonar).

There are basically two different methods:

- Beamforming methods, eg correlation direction finder, spatial Fourier analysis, adaptive antenna
- Subspace methods, eg MUSIC, ESPRIT

2.3 Requirements on DF systems

The main requirements are:

- Great accuracy
- High sensitivity
- Sufficient large-signal immunity
- Immunity to field distortion caused by multipath propagation
- Immunity to polarization errors
- Determination of elevation in short-wave range
- Stable response in case of non-coherent co-channel interferers
- Signals of short duration
- Scanning direction finders: high scanning speed and probability of intercept (POI)

2.4 Components of a DF system

A DF system (Fig. 5) consists of the following components:

- antenna system
- DF converter
- evaluation unit and
- display unit

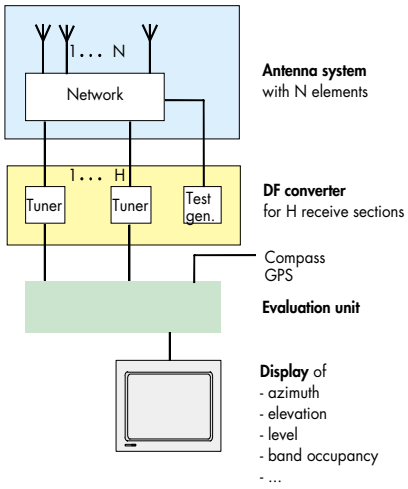

Fig. 5: DF system components

Depending on the configuration, systems for determining the DF's own coordinates/orientation (GPS, compass), remote-control units (LAN, WAN), antenna control units, etc, can be added.

The achievable DF speed is mainly depends on the number H of receive sections which determines the number of antenna outputs measured in parallel.

To achieve maximum speed it must be possible to obtain the bearing in one time step, ie from one set of samples (monopulse direction finding). For unambiguous direction finding over the total azimuth range at least three antenna outputs are required. If there are also three receive sections, multiplexing of the measurement channel is not required.

Typical examples of monopulse DF antennas are:

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- Multimode antenna for amplitude comparison direction finders (eg Adcock antenna)
- Interferometer and rotating-field direction finder

For high DF accuracy (eg 1°) and large bandwidth (eg 1 MHz to 30 MHz or 20 MHz to 1000 MHz) five to nine aperture probes are usually required. Since monopulse solutions would then be very complex, one fixed and two sequentially switched receive sections are frequently used.

The DF converter converts the carrier-frequency antenna signals to a fixed IF. Since this conversion must be made with equal phase and amplitude in all receive sections, the use of a common synthesizer is indispensable. Moreover, with most multipath direction finders the receive sections are calibrated with the aid of a test generator prior to the DF operation proper in order to ensure equal amplitude and phase.

The evaluation unit determines the bearing from the amplitudes and/or phases of the IF signals.

3 Classical DF methods

3.1 Using directional antennas

Evaluating the receive voltage of a mechanically rotated directional antenna with reference to the direction is the simplest way of direction finding. With this method the bearing is derived from the characteristic of the receive voltage as a function of the antenna rotation angle: when a wave arrives, the receive voltage yields the directional pattern of the antenna. The pattern position relative to the antenna rotation angle is the measured bearing.

This type of direction finder is by nature a phase direction finder since the directivity of its receiving antenna is achieved by superimposing partial waves whose phase differences depend on the angle of incidence. In the simplest case, the rotation of the antenna and the bearing determination are carried out by the operator. The antenna is rotated until the receiver output voltage assumes an extreme value. The antenna direction thus found is read from a scale and the bearing determined therefrom. If the directional antenna (with maximum or minimum pattern) is permanently rotated with the aid of a motor and the receive voltage displayed graphically as a function of the angle of rotation, a socalled rotating direction finder is obtained (Fig. 6). With suitable automatic evaluation, eg using a maximum detector, a fully automatic direction finder is obtained.

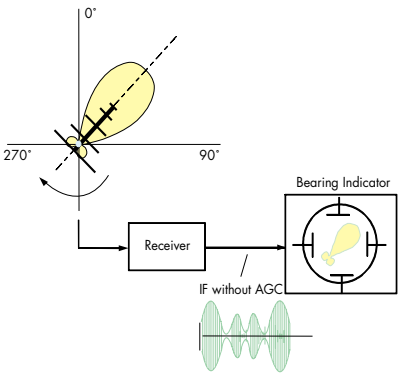

Fig. 6: Direction finding using directional antenna

The following benefits are common to all variations of this DF method:

- High sensitivity due to the directivity of the antenna
- Simple and inexpensive realization (only one receiver required, single-channel principle)
- Resolution of multi-wavefronts possible (prerequisite: different angles of incidence and high-directivity antenna system)
- Same antenna can be used for direction finding and monitoring

The drawbacks of this method result from the detection range that is inevitably restricted due to the directivity and mainly from the rotating speed of the antenna that is limited by the mechanical antenna rotor:

- Probability of intercept is reciprocal of the directivity
- Method fails in case of short-duration signals, ie signal dwell times that are short compared to the period duration of the antenna movement

Despite these drawbacks DF methods using mechanically rotated directional antennas are still in use today since the advantages of other methods can be achieved partly only with a considerably higher outlay. Especially in the microwave range the mechanical DF method often is the only justifiable compromise between gain, low noise and outlay.

If in addition to the directional pattern with maximum in the direction of wave incidence a directional pattern with minimum is used, a monopulse direction finger is obtained which even with a slowly rotating or fixed antenna furnishes bearing as long as the waves

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arrive within the main receiving direction of the antenna. Fig. 7 shows the implementation with log-periodic dipole antennas connected with the aid of a 0°/180° hybrid. The directional patterns shown in the picture on the right are thus obtained.

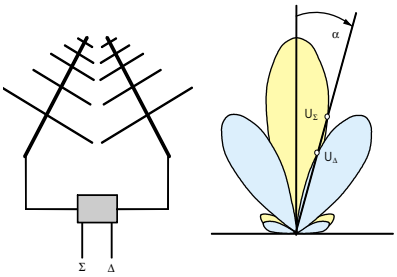

Fig. 7: Direction finding using sum-difference method: typical realization on the right, directional characteristics for sum(Σ) and difference (Δ) outputs on the left

The quotient between the difference and the sum signal yields a dimensionless time-independent function, ie the DF function

$$PF(\alpha) = \frac{U_\Delta(\alpha)}{U_\Sigma(\alpha)} .$$

After forming the quotient of the two test voltages, the DF function immediately produces the bearing α.

3.2 Watson-Watt principle

If the boosted and filtered signals of a receiving antenna with outputs for the sine- and cosine-shaped directional characteristics are applied to the x and y deflection of a cathode ray tube, a line Lissajous figure is obtained in the ideal case, whose inclination corresponds to the wave angle but has a 180° ambiguity. The indicated angle is obtained from the ratio of the two signals

$$\hat{\alpha} = \arctan \frac{U_x}{U_y}$$

An unambiguous bearing indication is obtained (Fig. 7) if a blanking signal, derived from an omnidirectional receiving antenna with unambiguous phase relationship is added to this DF principle implemented the first time in 1926 by Watson-Watt.

If the two voltages U_x and U_y exhibit a phase shift δ due to ambient interference (eg reflections), the displayed figure is an ellipse. The position of the main axis yields the bearing which is calculated from the voltages of the equation [9], [10].

$$\hat{\alpha} = \frac{1}{2} \arctan \frac{2|U_x||U_y|\cos\delta}{|U_y|^2 - |U_x|^2}$$

The main benefit of this method is the undelayed bearing indication and the monopulse capability over the full azimuth range.

Suitable antennas with sine- or cosine-shaped directions patterns are in particular

- loop antennas (or ferrite antennas) and
- Adcock antennas (monopole or dipole arrays)

Crossed-loop antennas with Watson-Watt evaluation (Fig. 8) are mainly suitable for mobile applications due to their compact size. They feature the following benefits and drawbacks:

- Benefits: minimum signal duration is sufficient, simple implementation, little space required
- Drawbacks: small-aperture system ($D/\lambda < 0.2$) leading to errors in case of multipath propagation, large DF errors in case of skywaves with steep elevation angles

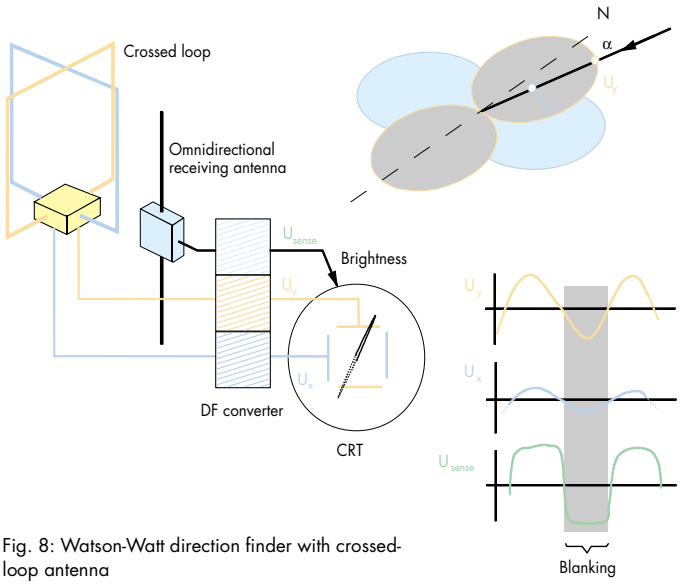

Fig. 8: Watson-Watt direction finder with crossed-loop antenna

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Adcock antennas (Fig. 9) feature the following advantages over crossed-loop antennas:

- improved error tolerances for sky-wave reception
- implementation of wider apertures to avoid errors in case of multipath reception
  (eg D/λ<1 for 8-fold Adcock)

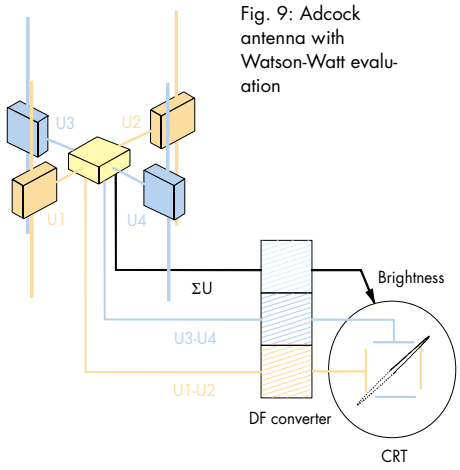

Fig. 9: Adcock antenna with Watson-Watt evaluation

The main selectivity is effected with the aid of digital filters; the bearings are calculated numerically, eg from the last equation above and displayed on a computer with graphical user interface (workstation, PC).

A number of disadvantages of analog direction finders can be avoided in this way:

- Synchronization of channels also on filter edges
- Simple method of considering correction values for antenna networks, cables, etc
- No temperature drift in digital section
- Bearings are available in numeric form for further evaluation, in particular for easy transmission to remote evaluation stations

Fig. 11: Digital direction finder (above) and Adcock DF antenna (below)

Modern direction finders no longer display the IF voltages of the antenna signals on a CRT, but digitally process the signals to form a relatively wide IF band (Fig. 10).

Fig. 11 shows a direction finder using digital signal processing which evaluates the signals of the Adcock antenna shown below according to the Watson-Watt principle.

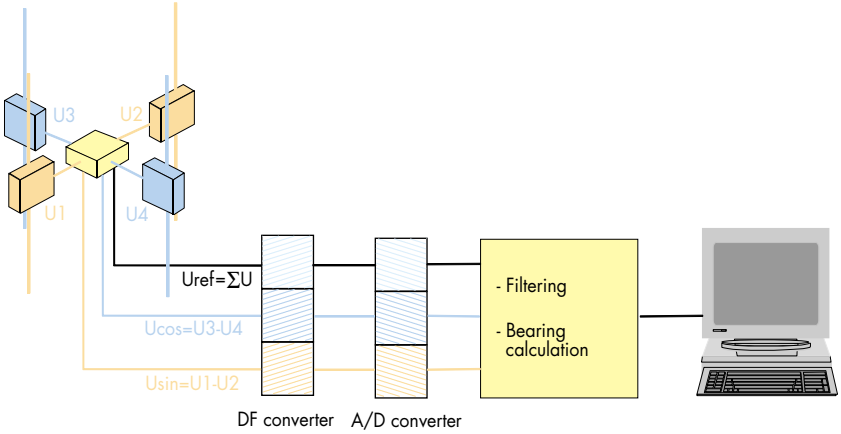

Fig. 10: Configuration of a modern direction finder according to the Watson-Watt principle

3.3 Doppler direction finder

If an antenna element rotates on a circle with the radius R, the received signal with the frequency ω_0 is frequency-modulated with the rotating frequency ω_r of the antenna due to the Doppler effect: if the antenna moves towards the radiation source, the frequency is increased; if the antenna moves away from the radiation source, the receive frequency is reduced.

From the instantaneous amplitude

$$u(t) = a\cos\left(\omega_0 t + \frac{2\pi R}{\lambda_0}\cos(\omega_r t - \alpha) + \varphi\right)$$

the instantaneous frequency is derived by differentiation

$$\omega(t) = \frac{d\phi(t)}{dt} = \omega_0 - \frac{2\pi R}{\lambda_0}\omega_r \sin(\omega_r t - \alpha) \quad .$$

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After filtering out the DC component ω_0, the demodulated Doppler signal is obtained as

$$S_D = \frac{2\pi R}{\lambda_0}\,\omega_r \sin(\omega_r t - \alpha) \cdot$$

The phase of the demodulated signal compared to a reference signal of equal center frequency derived from the antenna rotation yields

$$S_r = -\sin\omega_r t$$

the bearing α.

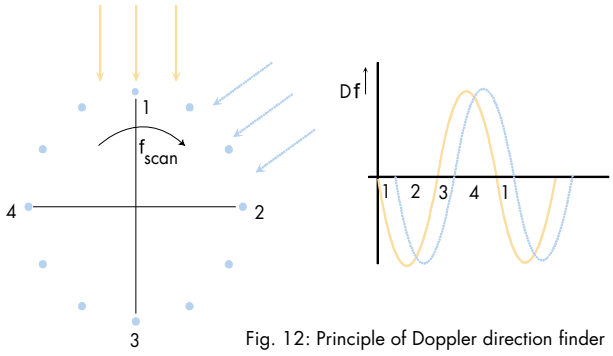


Fig. 12: Principle of Doppler direction finder

Since mechanical rotation of an antenna element is in practice neither possible nor recommendable, several elements (dipoles, monopoles, crossed loops) are arranged on a circle (Fig. 12) and electronically scanned with the aid of diode switches.

To obtain unambiguous DF results, the spacing between the individual antenna elements must be smaller than half the operating wavelength; in practice a distance of about one third of the minimum operating wavelength is usually selected. Fig. 13 shows an example of a Doppler direction finder for portable use in the frequency range 20 MHz to 1000 MHz.

If this rule is adhered to, Doppler DF antennas of any size can be made so that wide-aperture systems featuring

- high immunity to multipath reception and
- high sensitivity

can be implemented in a simple way.

A disadvantage of the Doppler method is the time required, since at least one antenna scanning cycle is needed to obtain a bearing. With a typical rotating frequency of 170 Hz in the VHF/UHF band one cycle takes about 6 ms.

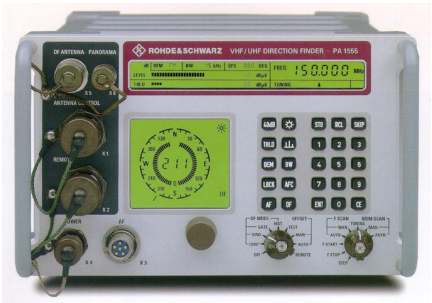


Fig. 13: Doppler direction finder for portable use in frequency range 20 MHz to 1000 MHz

3.4 Interferometer

The interferometer direction finder determines the angle of incidence of a wave by directly measuring the phase difference between the signals picked up at different points on the received wavefront by the elements of the antenna array (Fig. 14).

Unambiguous determination of the azimuth and elevation with the aid of three antenna elements is only possible if the spacing a between the antennas is not greater than half a wavelength. If Φ_1, Φ_2, Φ_3 are the phases measured at the antenna element outputs, the azimuth is calculated as

$$\hat{\alpha} = \arctan\frac{\Phi_2 - \Phi_1}{\Phi_3 - \Phi_1} \cdot$$

The elevation angle is obtained as

$$\hat{\varepsilon} = \arccos\frac{\sqrt{(\Phi_2 - \Phi_1)^2 + (\Phi_3 - \Phi_1)^2}}{2\pi a/\lambda} \cdot$$

In practice, the 3-antenna configuration is usually enhanced by further antenna elements so that the antenna spacings can be optimally adapted to the operating frequency range and antenna spacings of $a > \lambda/2$ be used

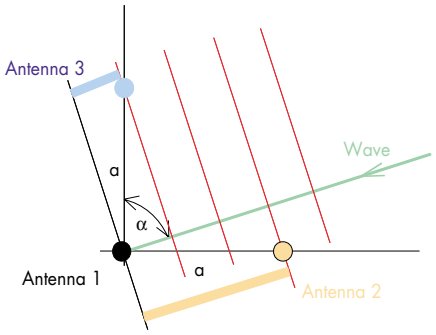
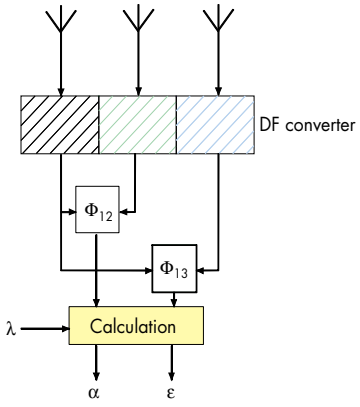


Fig. 14: 3-element interferometer



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to increase the accuracy of small-aperture DF systems. Frequently used antenna arrangements include the right-angled isoceles triangle and the circular array (Fig. 15).

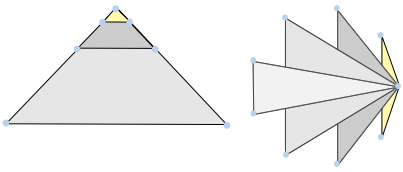

Fig. 15: 3-element interferometer enhanced to form a multi-element interferometer

Triangular arrays are usually restricted to frequencies below 30 MHz. At higher frequencies it is recommended to use circular arrays since these

- ensure equal radiation coupling between the antenna elements as well as
- minimum coupling with the antenna supporting mast and
- due to the symmetry about the center point favour direction-independent characteristics at different positions.

Special considerations are to be given to avoiding ambiguities that result from the fact that unambiguous measurement of the phase is only possible in the range of ±180°. As already mentioned before, the spacing between the elements of a 3-element (small-aperture) interferometer is therefore limited to half the minimum operating wavelength. For multi-element interferometers there are the following possibilities:

- **Use of "filled" antenna groups:** phase differences between neighbouring elements are always smaller than 180°; ambiguities can thus be avoided
- **Use of "thinned out" antenna groups:** at least one neighbouring pair of elements with a phase difference >180°

There are the following approaches to resolve ambiguities:

- Coarse direction finding suing a small-aperture system ($\alpha<\lambda/2$)
- Use of circular arrays with at least one antenna pair having a phase difference of less than 180°

Fig. 16: Direction Finder DDF06M (photo 42136) operating on the principle of a correlative interferometer for the frequency range 20 MHz to 3000 MHz. Nine antenna elements are used for each of the three frequency subranges (photo 43073_2)

A very effective means of eliminating the ambiguities of thinned out circular arrays is the correlation method.

Fig. 16 shows a direction finder designed according to the correlation principle. The antenna array covers the frequency range 20 MHz to 3000 MHz.

The basic principle of the **correlative interferometer** entails a comparison of the measured phase differences with those obtained for a DF antenna system of known configuration at a given wave angle. The comparison is made by calculating the quadratic error or forming the correlation coefficient of the two data sets. If different azimuth values of the comparison data set are used, the bearing is obtained from the data for which the correlation coefficient is at a maximum.

This is illustrated by the example of a 5-element antenna as shown in Fig. 17: each column of the lower data matrix corresponds to a wave angle α and forms a comparison vector. The elements of the comparison vectors represent the expected phase differences between the antenna elements for this direction of incidence. The upper 5x1 data matrix contains the currently measured phase differences (measurement vector).

To determine the unknown direction of incidence each column of the lower reference matrix is correlated with the measurement vector by multiplying and adding the vectors element by element. The result is the correlation function $K(\alpha)$, which reaches its maximum with the optimum coincidence of com-

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parison vector and measurement vector. The angle associated with the comparison vector is the wanted bearing.

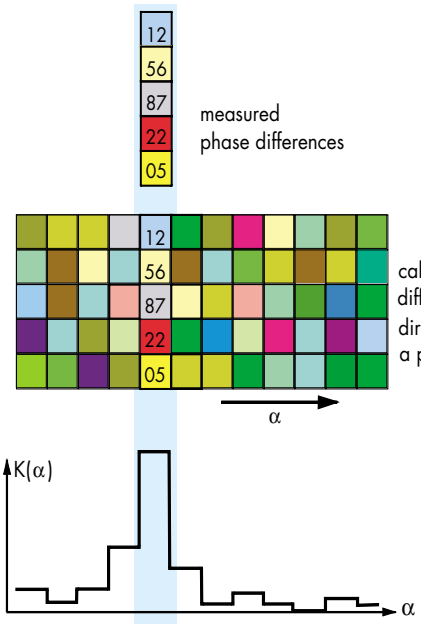

Fig. 17: Principle of correlation evaluation

This method is a special form of a beamforming algorithm [11], which is described in detail in the following section on direction finding using sensor array processing.

4 Direction Finding Using Sensor Array Processing

4.1 General

The development of the classical DF methods was aimed at designing antenna configurations and circuits that allowed bearing determinations to be as simple as possible. It was important to establish a simple mathematical relationship between the antenna signals and the direction of wave incidence largely independent of frequency, polarization and environment.

With the development of digital signal processing new approaches have now become possible:

- With high-speed signal processing chips being available, the requirement for a simple and frequency-independent relationship between the antenna signals and the bearing no longer applies. Even highly complex mathematical relationships can be evaluated in a reasonably short time for determining the bearing or handled fast and economically with the aid of search routines
- Numeric methods allow the separation of several waves arriving from different directions even with limited antenna apertures (high-resolution method, super resolution, multi-wave resolution)

4.2 Basic design

A typical hardware configuration of a PC-based direction finder is shown below.

The outputs of the individual antenna elements are usually taken first to a network which contains for instance

- test signal inputs and
- multiplexers if the number N of antenna outputs to be measured is greater than the number H of the receiver sections (tuner and A/D converter).

The signals are then converted to an intermediate frequency that is appropriate for the selected sampling rate of the A/D converter and digitized. To reduce the volume of data, the digital data are down-converted into the baseband. The complex samples of the baseband signal $x_i(t)$ (i=1, 2, ... N) are filtered for the desired evaluation bandwidth and applied to the bearing evaluation section.

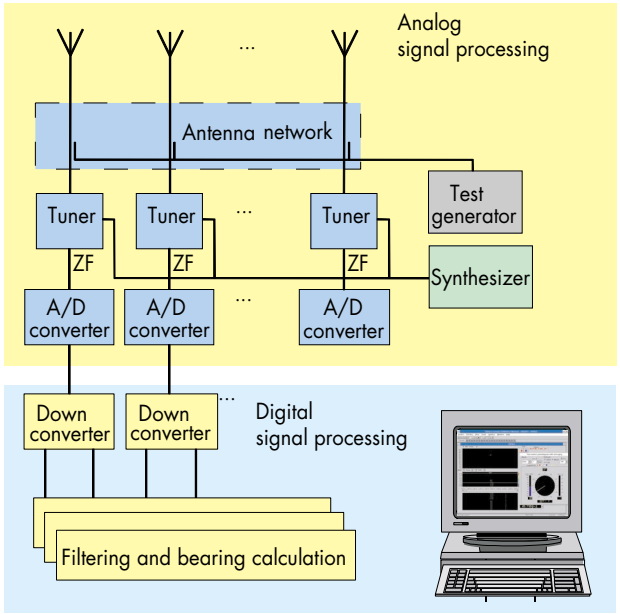

Fig. 18: Typical configuration of a PC-based direction finder

4.3 Beamforming methods[1)]

If analogously to the conventional antenna arrays the element signals x_i are multiplied by complex weighting factors w_i and added (Fig. 19), a sum signal is obtained which according to the resulting directional characteristic depends on the direction of wave incidence.

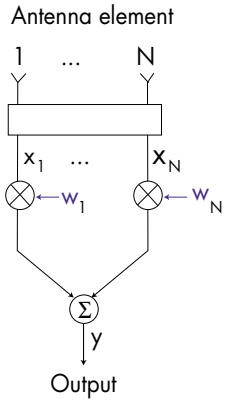

Fig. 19: Beamforming by weighting the outputs of an antenna array

The response of the output signal y to the change in the weighting factors w_i cannot be used for direction finding the same as with the classical rotating or goniometer direction finder. The difference is that with numeric beamforming the DF speed is only limited by the computing speed.

With **conventional beamforming algorithm** the phases of the weighting factors are chosen so that the weighted element signals are added in phase and thus yield a maximum sum signal if the wave arrives from the given direction α_r.

Fig. 20 shows the sequence of the direction finding process.

[1)]The beamforming, correlation and Fourier methods are equivalent in their system theory: they all use generalized FIR filters with wave incidence angles as "sky frequencies"

Fig. 21 shows the response of a linear array with five elements spaced 0.45λ apart to the variation of the direction with a wave arriving at an angle of 60°.

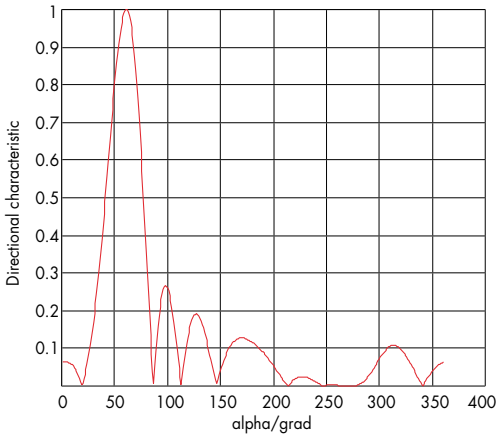

Fig. 21: Response of linear 5-element array to variation of direction (elements have cardioid directional characteristic)

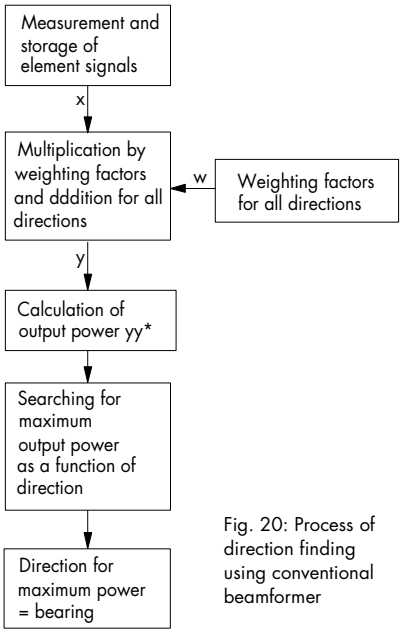

Fig. 20: Process of direction finding using conventional beamformer

If antenna arrays with largely the same elements and an array geometry describable by analytical means are used, the weighting factors can in the most cases directly be calculated from the array geometry.

If multiport antennas are used (Fig. 22, see next page), the port voltages u_i are as a rule measured as a function of the wave angle. The weighting is then given by

$$w_i(\alpha) = \frac{u_i^*(\alpha)}{u_0(\alpha)} = x_i^*(\alpha)$$

where u_0 is a suitable reference voltage and (.)* means complex conjugate. Since beamforming using general multiport antennas often does not produce a distinct directivity of the (synthetic) antenna diagram, the terms

- correlation method and
- vector matching

are used in this case too.

This is explained by the following: if the measured complex antenna voltages N are considered to be the coordinates of a vector in an N-dimensional space (measurement vector) and the N weighting factors the components of the weighting factor in the same space, beamforming is equivalent to the forming of a scalar product between these two vectors. If a normalization to the absolute values is made, the scalar product corresponds to the direction cosine between the two vectors. The direction cosine reaches its maximum if the directions agree (the vectors are matched); the Euclidean distance reaches its minimum.

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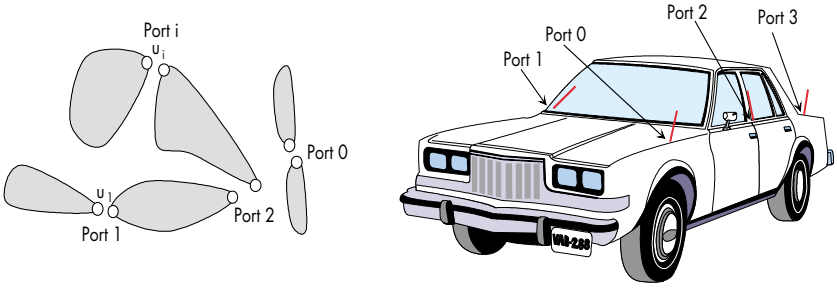

Fig. 22: General multiport antenna with application example

Adaptive antennas are antenna arrays with beamformers allowing automatic spatial suppression of interference waves [13], [14], [15]. In communication systems, optimization of the signal-to-noise ratio is the primary aim; in radio direction finding the weighting determined for signal suppression is used to determine the directions of wave incidence.

The direction cosine between two N-dimensional vectors corresponds to the correlation coefficient between two data streams with N elements. The distance square corresponds to the error square between two data streams to be matched.

4.4 High-resolution DF methods (super resolution)

If in the frequency channel of interest unwanted waves are received in addition to the wanted wave, conventional beamforming may lead to bearing errors as a function of the antenna geometry. There are two approaches to solve this problem:

- If the power of the interference wave component is smaller than that of the wanted wave component, the direction finder can be designed to minimize the bearing errors especially by choosing a sufficiently wide antenna aperture (see 5.1)
- If the interference wave component is greater or equal to the wanted wave component, the interference waves too have to be determined in order to be able to eliminate them. When using conventional beamforming algorithms, this means that the secondary maxima in the DF function have to be evaluated too.

The limits are reached

– if the ratio between primary maximum and secondary maxima of the directional characteristic becomes too small or
– the angle difference between wanted and interference wave is smaller than the width of the main lobe

By optimizing the weighting factors, the level of the secondary maxima can be reduced but at the same time the width of the primary maximum is increased. The aim of the super-resolution (SR) DF method is to resolve this problem.

Minimum-signal direction finders are so to speak the grandfathers of the SR direction finders. In the early days of direction finding, the bearing of co-channel signals was taken by alternately suppressing the waves involved with the aid of a rotating loop. It is noteworthy that signals are separated by the acoustic monitoring of the modulation. To determine the loop null a correlation process with acoustic patterns is therefore required.

To this end the weighting of the beamformer is selected so that under certain auxiliary conditions the output power is minimized. In the case of the Capon beamformer [22] the auxiliary condition for setting the weighting is defined with the antenna gain remaining constant for a given direction α_r. If the incident waves are uncorrelated, the beamformer is adjusted for nulls to occur in all signal directions except for the direction α_r (Fig. 23).

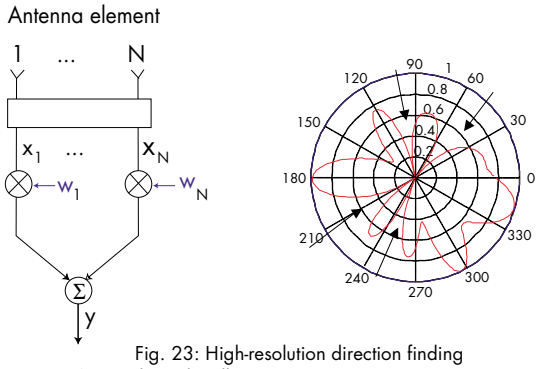

Fig. 23: High-resolution direction finding through nulling

If the direction of an incident wave coincides with the given direction α_r, there is a distinct maximum in the output power. Fig. 24 shows an example of the angular spectrum of a Capon beamformer with a 9-element circular array (D/λ=1.4) and five uncorrelated waves [23].

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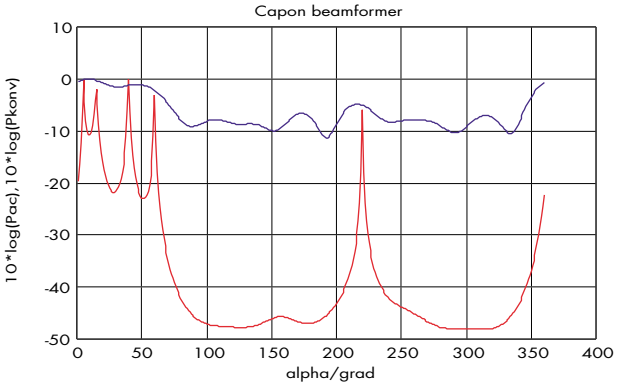

Fig. 24: DF function of Capon beamformers compared to conventional beamformer (S/N=100). Wave angle: 5°, 15°, 40°, 60°, 220°

Similar to a minimum-signal direction finder, the resolution strongly depends on the signal-to-noise ratio. Fig. 25 shows the same receiving scenario with noise increased by a factor of 10. The resolution of waves arriving at an angle of 5°and 10° is no longer possible.

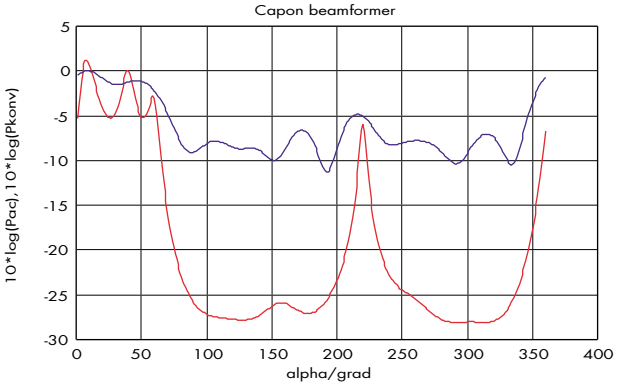

Fig. 25: DF function of Capon beamformer compared to conventional beamformer (S/N=10)

The socalled **subspace methods** are aimed at eliminating the effect of noise. This can be done by splitting up the N-dimensional space opened up by the element outputs into subspaces. The known MUSIC algorithm (**Mu**ltiple **Si**gnal **C**lassification) uses the fact that the signals lie perpendicular to the noise subspace. If the direction vectors are now projected to the noise subspace, nulls are obtained in the presence of signals that are independent of the noise level [16], [17], [24]. The reciprocal value is usually used as the DF function so that distinct peaks occur in the signal directions (Fig. 26).

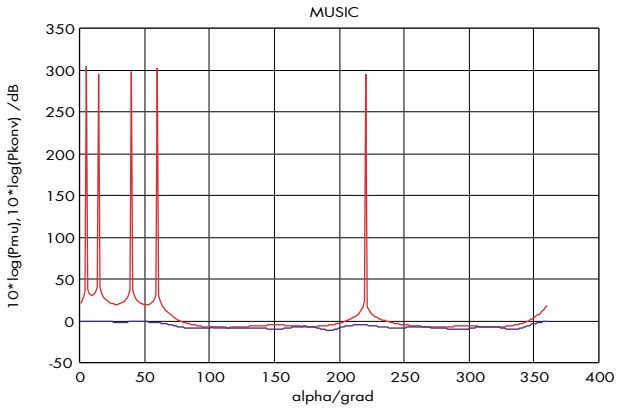

Fig. 26: DF function when using MUSIC algorithm (S/N=10)

5 Display of Bearings

The display of the DF results is of great importance as an interface to the operator. Basically, distinction is to be made whether the display is the DF result of a single channel or of a multichannel direction finder. In a single-channel display, the following parameters are usually indicated:

- Numeric DF value
- Azimuth in polar coordinates
- Elevation as bargraph or polar diagram (combined with azimuth display)
- DF quality
- Level
- Histogram of DF values
- DF values versus time (waterfall)

Fig. 27 shows a choice of possible displays.

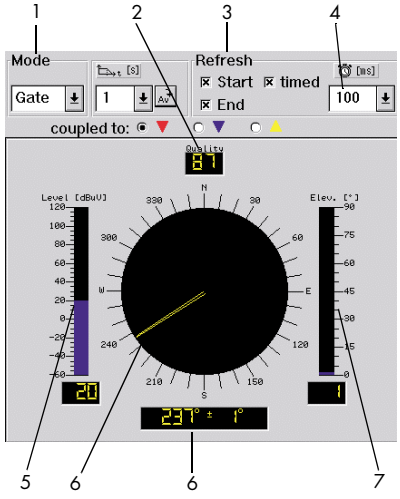

Fig. 27: Display of DF values with single-channel direction finding

1 = Averaging mode
2 = DF quality
3 = Output mode
4 = Averaging time
5 = Level
6 = Azimuth
7 = Elevation

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In addition to the usual receiver settings such as frequency and bandwidth, the following settings and displays are made for direction finders:

- Averaging mode (if the signal level drops below the preset level threshold, averaging - depending on the averaging mode - is either stopped and restarted upon the next exceeding of the threshold or continued)
- Averaging time
- Output mode (refresh rate of display; output as a function of exceeding the signal threshold)

Multichannel direction finders are implemented with the aid of digital filter banks (FFT and polyphase filters). Depending on the outlay, these direction finders allow quasi simultaneous direction finding in a frequency range from some 100 kHz up to a few MHz. Scan mode is additionally provided to cover larger frequency ranges (Fig. 28).

With a multichannel direction finder it is essential that the individual events can quickly be recognized and the activities taking place in different channels correctly assigned. Usually the following display modes are therefore provided:

- DF values versus frequency
- DF values versus frequency and time (eg by using different colours for the DF values)
- Level versus frequency (power spectrum)
- Level versus time and frequency (using different colours for level values)
- Histograms

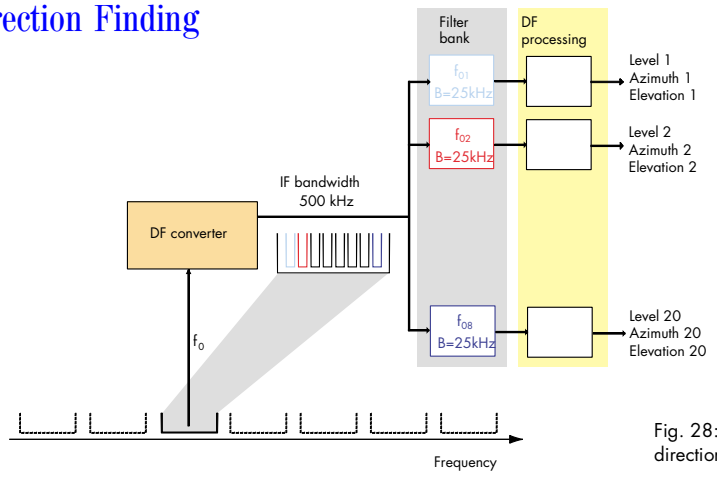

Fig. 28: Multichannel direction finder

6 Error Sources

The DF accuracy is affected by a number of influences:

- Wave propagation (usually disturbed by obstacles)
- Signals radiated by the emitters are modulated, limited in time and their carrier frequency is often unknown
- Received field is additionally superimposed by noise, co-channel interferers
- Tolerances and noise in the DF system

6.1 Multiwave-related problems

As already mentioned in the introduction, the simple case of a plane wave occurs seldom in practice. In a real environment, further waves have usually to be taken into account which result

- from other emitters in the same frequency channel (incoherent interference) or
- from secondary waves (caused by reflection, refraction, diffraction - see Fig. 30) (coherent in-channel interference)[1)]

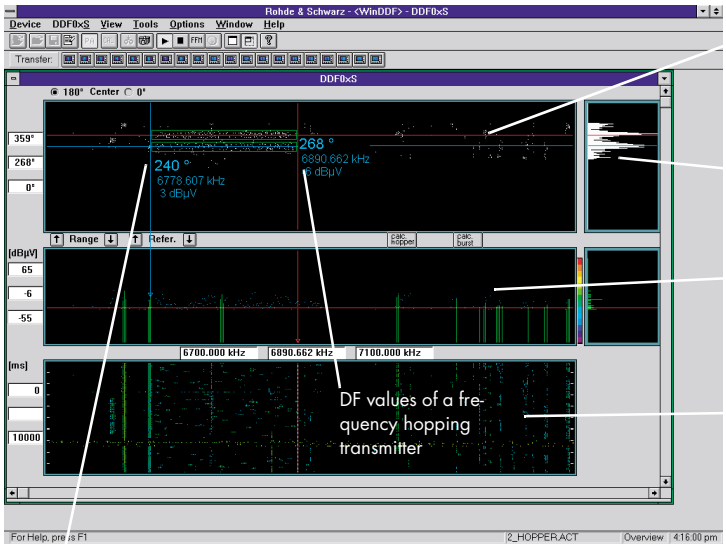

Fig. 29: Multichannel (broadband) display

[1)] A prerequisite is that the detours are small relative to the coherence lengths defined by the bandwidth B (see also 5.3)

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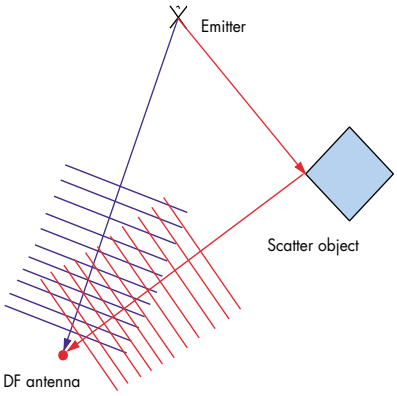

Fig. 30: Coherent secondary waves caused by reflection

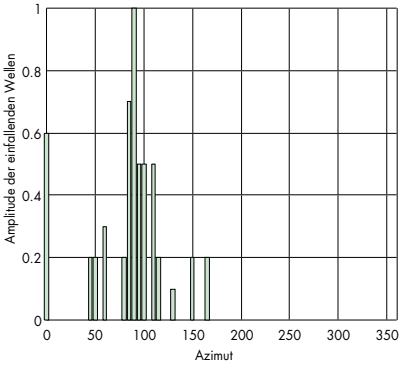

Fig. 31: Azimuth distribution of waves radiated by an emitter in built-up area

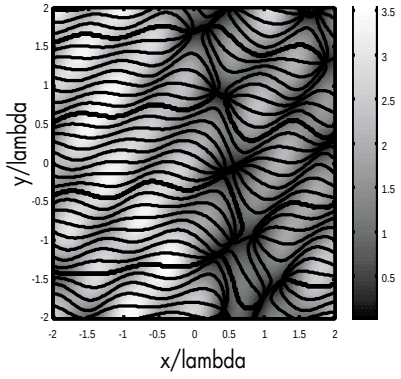

Fig. 32: Resulting field within a range of 4 x 4 wavelengths (the amplitudes are grey-level-coded, the lines represent isophases with π/4 spacing)

A large number of waves is involved [18]; Fig. 31 shows for example the azimuth distribution of the waves generated by a mobile transmitter in a built-up area. The direct wave component with the amplitude 1 arrives from an angle of 90°. Fig. 32 shows the resulting wavefront in form of a contour display for phase and amplitude [11].

If the majority of waves arrives from the direction of the emitter, the DF error can be sufficiently reduced by increasing the aperture of the antenna system. This effect is shown in Fig. 33 for an interferometer direction finder.

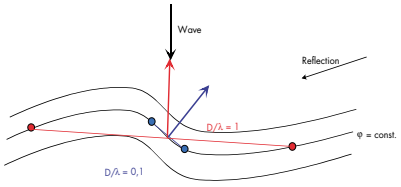

Fig. 33: Reducing bearing error of interferometer direction finder by increasing antenna aperture

6.2 Synchronization tolerances

Different gain and phase in the receive sections cause DF errors that are the greater the smaller the antenna aperture referred to the wavelength. This is illustrated in Fig. 34 for a 2-element interferometer.

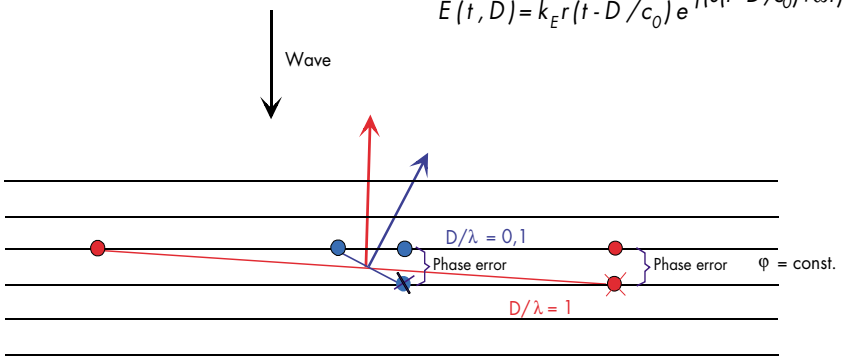

Fig. 34: Effects of phase synchronization tolerances on the bearing error when using different antenna apertures

As already mentioned, the receive sections of most multipath direction finders are calibrated for synchronism with the aid of a test generator prior to the DF operation. The transmission parameters are measured in magnitude and phase and the level and phase differences are stored. In the DF process the measured values are corrected by the stored difference values before the bearing is calculated.

Special attention is to be given to the frequency response of the filters since synchronism is not only to be ensured in the middle of the filter passband but also at the band limits. Digital filters have the decisive advantage that they can be implemented with absolutely identical transmission characteristics.

6.3 Modulation

Usually the carrier signal (angular frequency ω) of the emitter to be DFed is modulated with the complex modulation function

$$m(t) = r(t)\, e^{js(t)}$$

(complex envelope).

The electric field strength at the spacing D is

$$E(t, D) = k_E r(t - D/c_0)\, e^{j(s(t - D/c_0)+\omega t)}$$

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The modulation can affect the DF result in several aspects:

- Different envelope delay distortion in the DF channels (see 3.2)
- With sequential antenna scanning: modulation function is not sufficiently stationary for the duration of the measurement or cannot be compensated by other measures prior to DF evaluation
- Possible decorrelation between the antenna elements if the spacing between the elements is greater than the coherence length $L_k = B/c_0$, where B is the bandwidth of the signal. The instantaneous values of the amplitudes and the phase differences between the elements are then no longer independent of the scanning point in time.
  Typical coherence length:
  B= 100 kHzL_k=3000 m
  B= 10 MHzL_k=30 m

6.4 Noise

Leaving aside intermodulation distortion, interference caused by noise has a limiting effect on the sensitivity of a DF system.

Sensitivity is to be understood as the field strength at which the bearing fluctuation remains below a certain standard deviation.

Noise can be in the form of

- external noise (atmospheric, galactic, industrial noise)
- internal noise produced in the system (antenna amplifier, DF converter, A/D converter)

The following considerations refer to the internal noise. The 2-element interferometer is used again as a mode, the same as in the examination of multiwave problems; for the complex case of a 3-element interferometer see [19].

Uncorrelated noise in the two receive sections causes statistically independent phase variations of the two test voltages according to the signal-to-noise ratio (Fig. 35).

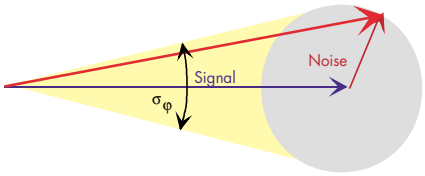

Fig. 35: Effect of noise on phase variation of measured voltages

In narrowband systems the noise voltage becomes approximately sine-shaped with slowly varying amplitude and phase so that - assuming large signal-to-noise ratios - the phase variation is given by the following equation [20]

$$\sigma^2_\varphi = \frac{1}{2S/N}$$

Mapping of the phase variation to virtual variations of the DF antenna positions (Fig. 36) yields for the bearing error.

$$\sigma_\alpha = 2 \arcsin \frac{\sigma_\varphi}{4\pi} \frac{\lambda}{D}$$

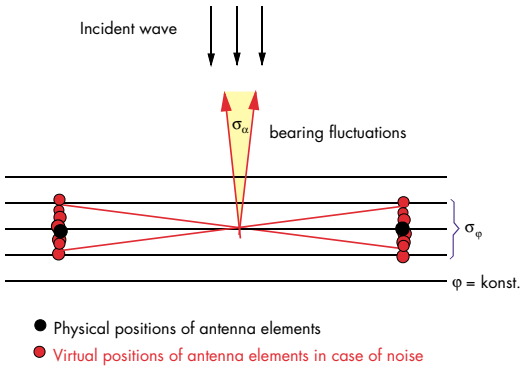

Fig. 36: Effect of phase noise on bearing error

This shows again the importance of the relative antenna aperture D/λ to be as large as possible.

Given a sufficiently long observation time, the variations caused by noise can be reduced by averaging. If the data used for averaging are uncorrelated, the variation is improved through averaging over K values in accordance with [21].

$$\sigma^2_{\alpha v} = \frac{\sigma^2}{K}$$

In Fig. 37 the two effects are combined. The shown curves of the signal-to-noise ratio in dB achieve a bearing fluctuation of 1° (standard deviation).

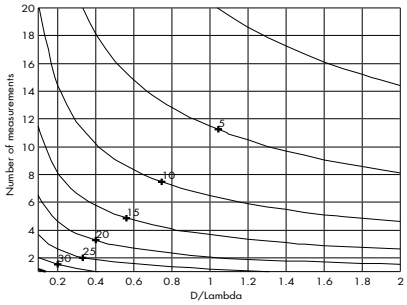

Fig. 37: Effect of antenna aperture and number of measurements on signal-to-noise ratio (in dB) required for a bearing fluctuation of 1° (standard deviation)

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7 References

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Digital Scanning Direction Finders DDF0xS

Fast and reliable interception of complex signals

Brief description

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.


Photo 43123-2

Main features

- 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 MHz to 1300 MHz
- Algorithms for correlative interferometer and Watson-Watt method as standard
- Use in automatic radiolocation systems with high probability of intercept
- Direction finding of frequency-hopping, burst and broadband signals

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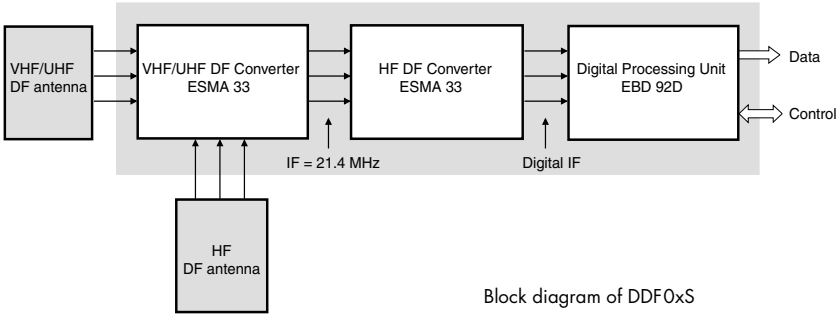
Digital Scanning Direction Finders DDF0xS

- 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

Bearing correction and synchronization

To ensure highly precise bearings in environments with very strong interference, eg on board 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.



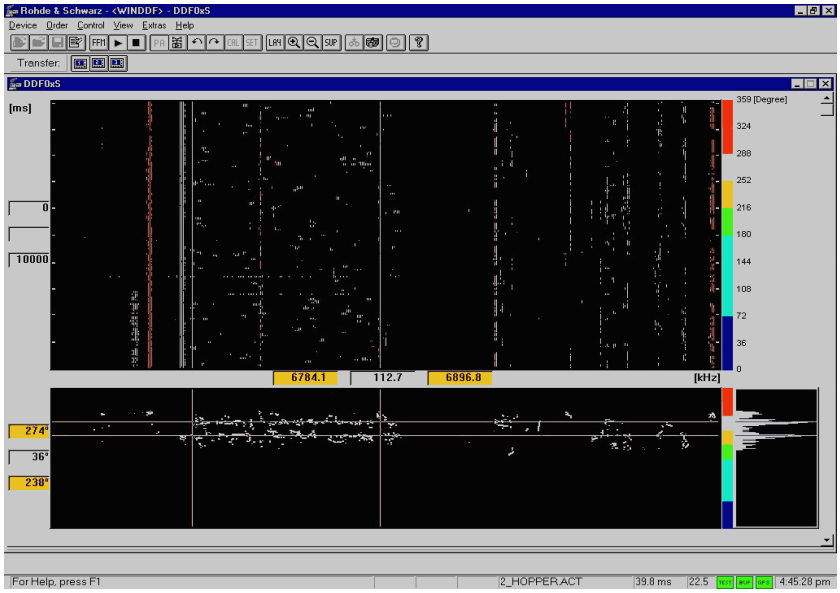
Block diagram of DDF0xS

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 in 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

The direction finder basically operates in the scan mode and the fixed-frequency mode (FFM). 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. Actions are triggered by clicking icons on the user interface or pressing hardkeys. Only those control elements that are constantly needed are permanently displayed.



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

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

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 110
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 above
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

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 111
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 above
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 kHz ± 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
Operating temperature range	0°C to +40°C
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

Ordering information

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

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Digital Monitoring Direction Finders DDF0xM

Fast and reliable interception of complex signals from 0.3 MHz to 3000 MHz

Photo 42136

Brief description

The HF/VHF/UHF Monitoring Direction Finders DDF0xM make intensive use of digital signal processing, in particular in the field of filtering, bearing calculation and signal demodulation.

In this way the high scanning and DF speeds can be achieved that are required for the most common radio transmission methods using bursts and frequency hopping.

Digital Monitoring Direction Finders DDF0xM come in three models:

- **HF: DDF01M**
  (0.3 MHz to 30 MHz)
- **VHF/UHF: DDF05M**
  (20 MHz to 1300/3000 MHz)
- **HF/VHF/UHF: DDF06M**
  (0.3 MHz to 1300/3000 MHz)

Each direction finder is made up of a DF converter (HF or VHF/UHF) and a digital processing unit. Moreover, one or several DF antennas are required.

HF DF Converter EH010 is designed for the frequency range 0.3 MHz to 30 MHz, VHF/UHF DF Converter ET050 for 20 MHz to 1300 MHz. Converter ET070 (1.3 GHz to 3 GHz), which is connected ahead of ET050, extends the frequency range up to 3 GHz. Digital Processing Unit EBD060 has two IF inputs, allowing two DF converters (EH010 and ET050) to be connected simultaneously. The algorithms for the correlative interferometer and for the Watson-Watt DF method are implemented as standard in the software of the digital processing unit.

Main features

- Maximum accuracy, sensitivity and flexibility
- Correlative interferometer
- Monopulse processing (Watson-Watt)
- Optional direction finding of GSM signals
- Wide range of antennas for stationary and mobile use
- User-friendly operation
- Integration into Rohde&Schwarz radiolocation systems

Digital DF methods

For bearing determination, the complex antenna voltages are measured by a high-grade triple DF receiver which acts like a vector voltmeter. The measured values are digitized.

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Digital Monitoring Direction Finders DDF0xM

As various algorithms are used for bearing determination, existing DF antennas (eg Adcock HF antennas) that are in good operational condition can be connected to the state-of-the-art direction finders.

With the DDFGSM option bearings can be determined for the individual timeslots of a GSM channel.

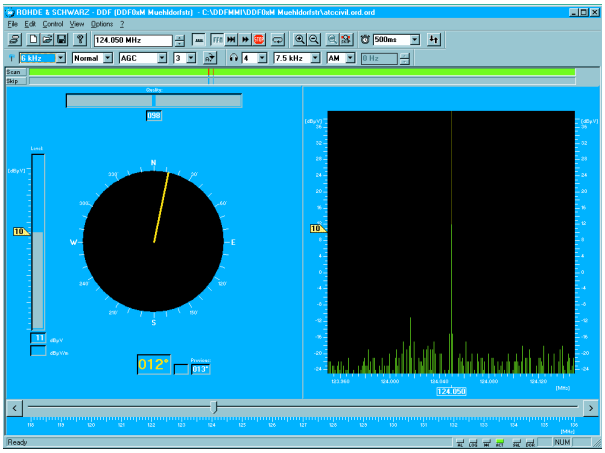
Operation via PC

The DF converters and the digital processing unit have as standard no control or display elements so that the direction finder is operated via a PC, which is connected to or integrated in EBD060.

Each direction finder comes with a software package (DDFMMI) which generates a user interface (MMI) under the Windows NT operating system. The interface features windowing technique for easy setting of operating parameters by means of a mouse and pop-up menus. The following display modes are supported:

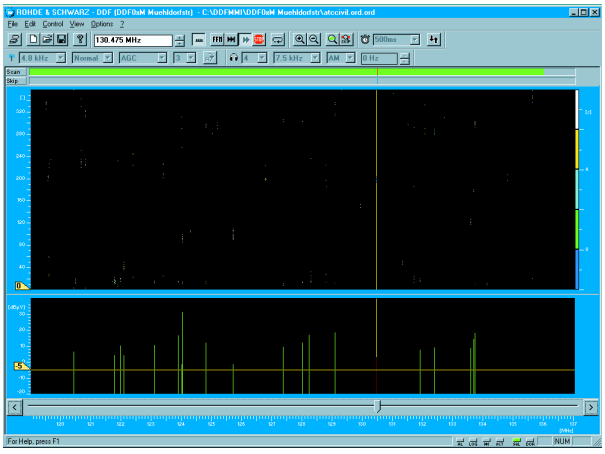
In fixed frequency mode:

- Bearing in polar diagram, additionally DF ellipse if Watson-Watt analysis is employed
- Level (input voltage or field strength), elevation and DF quality as bargraphs with numerical values
- Level versus frequency in the range ±100 kHz (HF: ±12.5 kHz) about receive frequency (IF spectrum)
- Bearings versus time (histogram and waterfall display)



The interface using windowing technique offers a user-configurable toolbar and object-dependent pop-up menus for maximum operating convenience

Fixed frequency mode (FFM)



Scan mode

In scan mode:

- Amplitudes and bearings versus frequency
- Aging of bearings indicated by colours
- Frequency versus time (waterfall display)

The direction finders are further enhanced by zoom functions, recording and replay functions, the support of libraries with defined scanning ranges, as well as a number of options for remote control of DF units, control of hand-off receivers and Single Station Location Manager.

Digital Processing Unit EBD 060 is optionally available with a built-in PC and colour LCD with 640 x 480 pixels. For EMC, the PC is optimally screened to prevent radiated electromagnetic interference. This is especially important for direction finders installed in a vehicle or shelter as in this case the DF antennas are usually located close to the DF equipment.

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Digital Monitoring Direction Finders DDF0xM

Display Unit EBD060A

The additional Display Unit EBD060A is available for use of the DDF0xM in a vehicle with the DF equipment accommodated in the boot, for example. The relevant DF information is shown on an LCD display, and the audio content of the DF'd signal can be monitored via the built-in loudspeaker.

DF antennas

A variety of DF antennas is available to match different applications. The antennas offered include Adcock, crossed-loop and circular arrays (see page 109).

Use in computer-controlled systems

For use in computer-controlled systems Rohde&Schwarz offers the system monitoring software ARGUS and RAMON.

RAMON, used in the military field, is for fast frequency detection and transfer to support monitoring receivers, while ARGUS is intended for civil applications, eg for authorities with frequency management tasks such as long-term monitoring of specific frequency bands.

Rohde&Schwarz also offers a solution for triangulation systems. Two or more direction finders can be combined with the software MONLOC to build a radiolocation network. The position of the direction finders, the bearing lines and the location of the signal source are displayed on a digital map.

Specifications

DDF01M and DDF06M (HF section)

Frequency range	0.3 MHz to 30 MHz
DF method	correlative interferometer and Watson-Watt method
Inherent DF error	0.5° RMS
DF accuracy (in reflection-free environment)	1° RMS with Antenna ADD 010
Sensitivity (2° RMS bearing fluctuation)	depending on antenna system (see diagram on page 110)
Operating modes	fixed frequency mode (FFM), scan mode, search mode
DF modes (FFM)	Normal, Gate, Continuous
Display	azimuth/frequency spectrum, polar diagram, histogram, waterfall, real-time IF panoramic display (25 kHz bandwidth)
Resolution of display	1° or 0.1°
Bearing information	numerical and graphical display of azimuth and elevation, bearing quality and signal level
FFT realtime bandwidth	25 kHz
Minimum signal duration for DF	5 ms (down to 0.5 ms with Watson-Watt method)
Scanning speed	0.5 MHz/s for 1 kHz resolution
Channel spacing	0.125/0.25/0.5/1/2.5/5/25 kHz
Selectivity for DF (1 dB bandwidth)	0.075/0.15/0.3/0.6/1.5/3/15/25 kHz
Selectivity for audio monitoring (1 dB bandwidth)	0.15/0.3/0.6/1.5/3/15/25 kHz
Reception modes	CW, AM, FM, SSB
Linearity	
IP2	50 dBm typ.
IP3 (inband)	8 dBm typ.
IP3 (signal spacing >0.1 MHz)	25 dBm typ.
Dynamic range	120 dB typ.
Impedance	50 Ω
Frequency stability	2×10^{-6} at –10°C to +55°C
Image frequency rejection	>90 dB, 110 dB typ.
IF rejection	>90 dB, 110 dB typ.
Power supply	
AC	115/230 V AC + 10%/–12%, 47 Hz to 440 Hz, max. 300 VA
Battery	20 V to 32 V DC, max. 250 W
Built-in test	module monitoring, fault signalling
Remote control	RS-232-C; ISDN or Ethernet with suitable PC configuration

DDF05M and DDF06M (VHF/UHF section)

Frequency range	20 MHz to 1300 MHz (up to 3000 MHz with Converter ET 070)
DF method	correlative interferometer and Watson-Watt method
Inherent DF error	0.5° RMS
DF accuracy*) (in reflection-free environment)	1° RMS with Antenna ADD 051 (stationary) 2° RMS (20 MHz to 200 MHz with ADD 150) 1° RMS (200 MHz to 1300 MHz with ADD 150)
Sensitivity (2° RMS bearing fluctuation)	depending on antenna system (see diagram on page 111)
Operating modes	fixed frequency mode (FFM), scan mode, search mode
DF modes (FFM)	Normal, Gate, Continuous

*) For slim masts with a height between 4 m and 8 m, the specified values may be exceeded in the frequency range between 20 MHz and 40 MHz (by 1° to 2°, depending on the mast symmetry and the ground connections at the mast base) because of the self-resonance of the mast that may occur.

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Digital Monitoring Direction Finders DDF0xM

Display	azimuth/frequency spectrum, polar diagram, histogram, waterfall, real-time IF panoramic display (200 kHz bandwidth)
Resolution of display	1° or 0.1°
Bearing information	numerical and graphical display of azimuth, bearing quality and signal level
FFT realtime bandwidth	200 kHz
Minimum signal duration for DF	500 µs (down to 10 µs with Watson-Watt method)
Scanning speed	1800 channels/s, 45 MHz/s for 25 kHz resolution
Channel spacing	1/2/4/8/10/12.5/20/25/50/100/200 kHz
Selectivity for DF (1 dB bandwidth)	0.6/1.2/2.4/4.8/6/7.5/12/15/30/120/200 kHz
Selectivity for audio monitoring (1 dB bandwidth)	0.6/1.2/2.4/4.8/6/7.5/12/15/30/200 kHz
Reception modes	CW, AM, FM, SSB
Linearity	
IP2	50 dBm typ.
IP3 (inband)	12 dBm typ.
Dynamic range	120 dB typ.
Impedance	50 Ω
Frequency stability	2×10^{-6} at –10°C to 55°C
Image frequency rejection	>90 dB, 110 dB typ.
IF rejection	>90 dB, 110 dB typ.
Power supply	
AC	115/230 V AC + 10%/–12%, 47 Hz to 440 Hz, max. 300 VA
Battery	20 V to 32 V DC, max. 250 W
Built-in test	module monitoring, fault signalling
Remote control	RS-232-C, ISDN (see HF)

Integrated PC (option)

Type	Pentium
Display	colour TFT display, 640 x 480 pixels
RAM	32 Mbyte
Hard disk	3.5", >3 Gbyte
Floppy disk drive	3.5", 1.44 Mbyte
Serial interfaces	COM 1, COM 2, LAN
Parallel interfaces	LPT 1
CD-ROM drive	external

General data

Operating temperature	
EH010/ET050/ET070	–10°C to +55°C
EBD060	without PC: 0°C to +50°C with PC: +5°C to +45°C
Dimensions (W x H x D)	
EBD060	436 mm x 192 mm x 460 mm
EH010/ET050/ET070	436 mm x 148 mm x 460 mm
Weight	
EBD060	24 kg
EH010/ET050/ET070	22 kg

Ordering information

Digital Monitoring Direction Finders		
0.3 MHz to 30 MHz	DDF01M	4044.8002.02
20 MHz to 1300 MHz	DDF05M	4044.8254.02
20 MHz to 3000 MHz	DDF05M	4044.8254.03
0.3 MHz to 1300 MHz	DDF06M	4044.8502.02
0.3 MHz to 3000 MHz	DDF06M	4044.8502.03
Models with integrated PC		xxxxxxxxxx.1x
Accessories supplied	transputer board (ISA-16, Order No. 4039.5950.02), cables between DF converter and digital processing unit, standard software (MMI)	
DF Antennas	see page 109	
Accessories		
GSM DF Unit	DDFGSM	4050.4257.03
Remote-Control Software	DDFREM	4050.4105.02
Various adapters for mast and vehicle installation	on request	

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DF Antennas ADDx

0.3 MHz to 3 GHz


VHF/UHF
DF antenna system

DF antennas

A variety of DF antennas is available for Direction Finders DDF0xM and DDF0xS to match different applications. They cover the frequency ranges from 0.3 MHz to 3 GHz. The antennas offered include Adcock, crossed-loop and circular arrays (see data sheets PD 757.1854.23/PD 757.2173.22). All the antennas offered feature a coding function to inform the DF system of the algorithm (Watson-Watt or correlation) 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. The cable inputs and outputs of the DF antennas are overvoltage-protected as standard. For VHF/UHF DF Antennas ADD150, ADD050 and ADD051, a lightning rod is supplied to protect the equipment against direct strokes.

In many cases, non-Rohde&Schwarz antennas (Adcock) already installed can be used with the direction finders. For this, **Antenna Interface GX060** (0.3 MHz to 650 MHz) is required.

The add-on **Electronic Compass GH150** can be fixed to the antennas ADD119, ADD150, ADD155 and ADD170 for automatic direction finding referred to north.

Multicoupler VE010 makes it possible to operate up to six Direction Finders DDF01M or DDF01S (data sheet PD 757.2173) from one HF DF Antenna ADD010 or ADD011. With VE010, the Direction Finders DDF0xM/DDF0xS can be connected to the HF DF antenna in any combination and operated completely independently of one another.

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.

For the VHF/UHF range, Antenna Cable ADD05xZ or ADD07xZ is used.

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

Specifications

IN061

Power Supply	115/230 V AC ±15%, 47 Hz to 63 Hz; 20 V to 32 V DC, max. 4.5 A
Operating temperature range	–40°C to +65°C
Dimensions (W x H x D)	345 mm x 255 mm x 155 mm
Weight	10 kg

Ordering information

HF Antennas		
(0.3) 1 MHz to 30 MHz	ADD119	4053.6509.02
(0.3) 1 MHz to 30 MHz	ADD010	4045.0105.03
(0.3) 1 MHz to 30 MHz	ADD011	4045.0005.03
(0.3) 1 MHz to 30 MHz	ADD012	4051.1400.03
(0.3) 1 MHz to 30 MHz	ADD012	4051.1400.13
VHF/UHF Antennas		
20 MHz to 1300 MHz	ADD150	4041.1007.02
20 MHz to 500 (650) MHz	ADD155	4040.9004.02
20 MHz to 200 MHz	ADD050	4041.4006.02
20 MHz to 1300 MHz	ADD051	4041.7005.02
1300 MHz to 3000 MHz	ADD070	4043.4003.02/.12 *)
800 MHz to 2000 MHz	ADD170	4055.7502.02
Accessories		
Antenna cable	on request	
Electronic Compass	GH150	4041.8501.02
Extras		
Antenna Interface	GX060	4050.8500.02
Multicoupler	VE010	4050.8000.02

*) Model 12: lightweight model for mobile use

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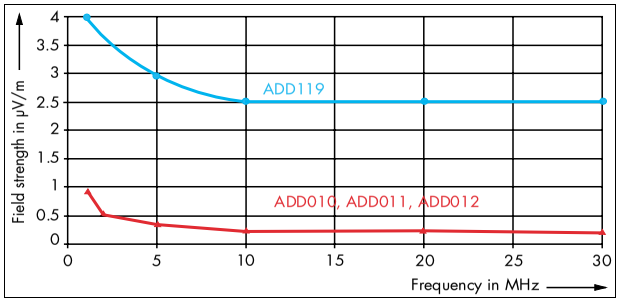
Specifications – HF Antennas

Type	ADD119	ADD010	ADD011	ADD012	ADD012
Application	mobile, fast scanning for ground waves and sky waves with low elevation angle	semi-mobile and stationary, for signals with elevation angle ≤50°, SSL possible to a limited extent	stationary, for signals with elevation angle ≤85°, 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 x 8 elements + center antenna	U-Adcock, 2 x 8 elements + center antenna, switchover at 12 MHz
DF method	Watson-Watt	correlation		Watson-Watt	
Polarization	vertical		vertical, horizontal, circular	vertical	
DF accuracy (in reflection-free environment)	2° RMS	1° RMS		1° RMS (1 MHz to 25 MHz)/2° RMS (25 MHz to 30 MHz) with operation in subranges 1 MHz to 12 MHz/12 MHz to 30 MHz	
Sensitivity	4 µV/m to 2.5 µV/m typ. (2° bearing fluctuation, 1 s averaging time)	1 µV/m to 0.2 µV/m typ. (2° bearing fluctuation, 1 s averaging time)		1 µV/m to 0.2 µV/m typ. with operation in subranges 1 MHz to12 MHz or 12 MHz to 30 MHz (2° bearing fluctuation, 1 s averaging time)	1 µV/m to 0.2 µV/m typ. (2° bearing fluctuation, 1 s averaging time)
Dimensions	1100 mm dia x 238 mm	antenna circle: 50 m dia, height of rod antenna: approx. 2 m	antenna circle: 50 m dia, height of crossed loop: 3.4 m incl. tripod	antenna circle: 7 m dia (for 1 MHz to 30 MHz) or 20 m dia (for 1 MHz to 12 MHz), height of element: 2 m	antenna circle: 20 m dia, 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	
Maximum wind speed	200 km/h without ice, 173 km/h with 30 mm radial ice deposit	160 km/h without ice			
Operating temperature	–40°C to +65°C				
Power supply	from DF equipment for antenna cables <10 m, otherwise Power Supply IN061	from power supply integrated as standard			

ADD011 (Photo 42342_2)



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

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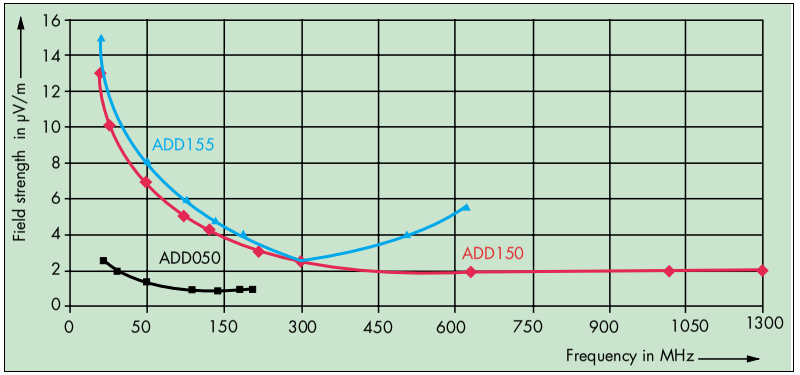
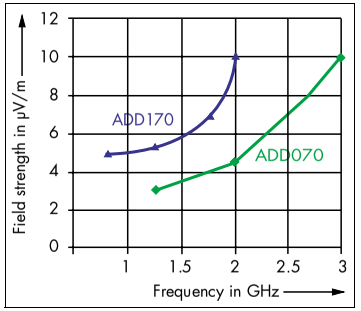
Specifications – VHF/UHF Antennas

Type	ADD150	ADD155	ADD050	ADD051	ADD070	ADD170
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 ADD150 and ADD05	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 x active 8-element circular arrays in radome	active 9-element circular array	2 x active 9-element circular array	8-element circular array	8-element circular array with center antenna
DF method	correlation	Watson-Watt	correlation		correlation	
Polarization	vertical					
DF accuracy (in reflection-free environment)	2° RMS (20 MHz to 200 MHz) 1° RMS (200 MHz to 1300 MHz)	3° RMS (20 MHz to 50 MHz) 2° RMS (50 MHz to 500 MHz)	1° RMS		2° RMS	
Sensitivity	13 µV/m to 2 µV/m typ. (2° bearing fluctuation, 1 s averaging time)	15 µV/m to 5 µV/m typ. (2° bearing fluctuation, 1 s averaging time)	2.5 µV/m to 1 µV/m typ. (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	3 µV/m to 10 µV/m typ. (2° bearing fluctuation, 1 s averaging time)	5 µV/m typ. (0.8 GHz) 10 µV/m typ. (2 GHz) (2° bearing fluctuation, 1 s averaging time)
Dimensions	1100 mm dia x 238 mm	1100 mm dia x 238 mm	antenna circle: 3 m dia, height: 1 m, with lightning rod: 3.1 m		340 mm dia x 1200 mm (.02) 340 mm dia x 492 mm (.12)	455 mm dia, height: 365 mm
Weight	30 kg		66 kg	110 kg	90 kg (.02), 12 kg (.12)	9 kg
Maximum wind speed	200 km/h without ice, 162 km/h with 30 mm radial ice deposit					180 km/h (without ice)
Operating temperature	–40 °C to +65 °C					
Power supply	from DF equipment for antenna cables <10 m, otherwise from Power Supply IN061		Power Supply IN061 required		from DF equipment for antenna cables <10 m, otherwise from Power Supply IN061**)	

**) IN061 always required for combination of ADD150 and ADD070





Sensitivity of VHF/UHF DF antennas; averaging time 1 s, bearing fluctuation <2° RMS

DF Remote-Control Software DDFREMM

For Direction Finders DDF0xM

Brief description

With DDFREMM, one Digital Monitoring Direction Finder DDF0xM can be remotely controlled. Using the MapView option, the bearing results can be displayed on a digital map.

System concept
The DDFREMM software permits to display the graphical user interface (man-machine interface MMI) of the Digital Direction Finder DDF0xM detached from the direction finder and connected via common communication link (see diagram). The demodulated audio signal is also transmitted via this link.

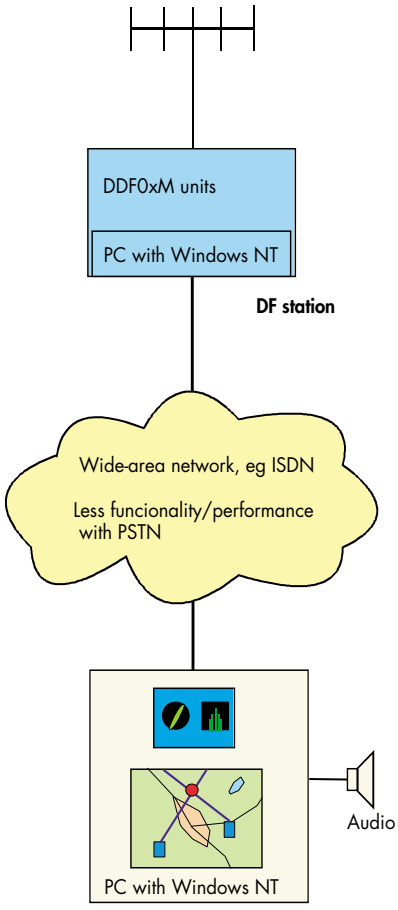
Since one or several direction finders can be remote-controlled from different operator positions, full-area direction finding can be performed with very few personnel. Such a DF System is called MONLOC .

Main features

The operator at the control station activates the remote direction finder via an automatic dial-up procedure for the wide-area network (eg ISDN) connection.

On the local PC monitor the user interface of the remote DDF is displayed. The DDF is controlled in the same way as in local mode.

The AF (audio) of the direction finder is also transferred to the operator position for clear identification of the wanted signal.



Remote-controlled DDF with option MapView

System data

Operating system	Windows NT	For further specifications see	
Transmitting lines	wide-area network (WAN), eg ISDN; other lines on request	Direction Finder DDF0xM	see page 105; DF antennas see page 109
		MapView/MapEdit	see page 148
Recommended minimum PC configuration	Pentium 166 MHz, 64 MByte RAM (depending on number of connected DF stations)	MONLOC	see page 144

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GSM Controller DDFGSM

For Direction Finders DDF05M and DDF06M

Brief description

GSM Controller DDFGSM is used for locating mobile telephone signals according to the GSM900 and GSM1800/GSM1900 standard. Direction Finders DDF05M and DDF06M fulfil the following conditions:

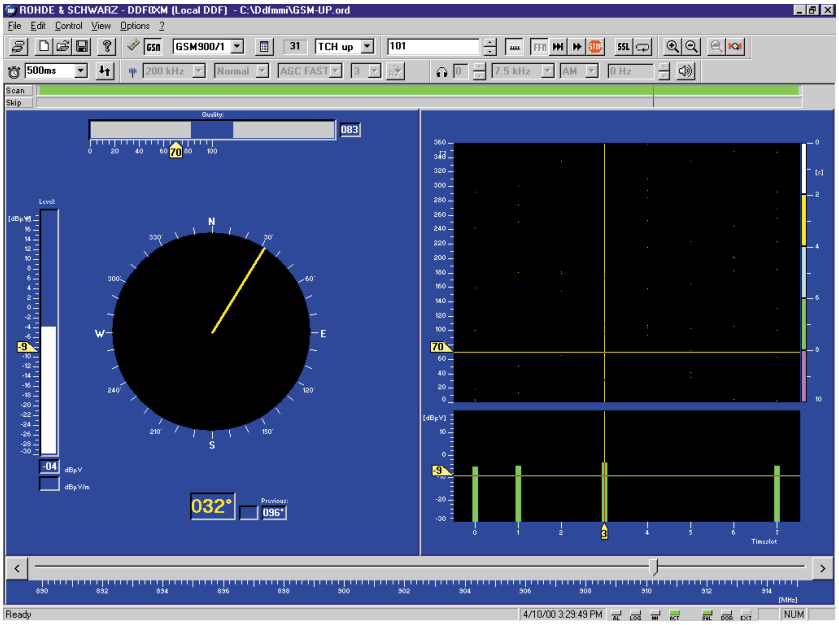
- Measuring time <577 µs
- Bandwidth 200 kHz
- Possibility to synchronize to the selected timeslot
- Averaging of the bearings produced cyclically

Another important feature for taking bearings of mobile telephone signals is the immunity against multipath propagation. The Digital Direction Finders DDF0xM (page 105) operate according to the correlative interferometer method using wide-aperture DF antennas in the mobile telephone ranges, which provides high accuracy even in situations of strong coherent interference.

Functions

Optional GSM Controller DDFGSM offers internal or external synchronization to selected timeslots of the GSM signal and contains:

- Module control processor with high-accuracy clock generators which can be synchronised



Direction finding of GSM signals in Fixed Frequency Mode: The FFM display is split into two sections: The left part contains the polar display with level and bearing quality as usual. The occupancy and the bearings of the 8 time slots are shown in the right section

- Pulse shaping unit with cable for external synchronization by CMDxx
- Software package with extended MMI (under WindowsNT) and extended direction finder software.

External synchronization

The RS422 input GSM-STRB of X15 of the DF Processor EBD060 is used to synchronize within the multiframe raster (26 TDMA frames). The DF process is triggered by the rising edge of the synchronization pulse and will be repeated within the TDMA frame (every 4.6 ms).

Internal synchronization

The frequency correction burst (FCB) of the broadcast control channel (BCCH) of a base station is used. First the downlink frequencies of the selected net will be analyzed in the background for possible base stations to be able to select the base station. The five strongest signals are presented to the user together with channel number, level, and bearing. After the selection the direction finder changes to the fixed frequency mode (FFM) and synchronizes.

Operation

After successful synchronization the following modes may be used as with the standard direction finder: fixed frequency mode (FFM), scan mode and search mode. In the scan mode the results of the 8 timeslots of each channel are presented in parallel where timeslot 0 of each channel is highlighted. After switching to FFM selection of channel and timeslot is still possible.

Specifications

Frequency range	like DF system
Channel spacing/width	200 kHz/200 kHz
Minimum burst duration	500 µs
DF accuracy (condition of test ground) with Antenna ADD170	<2° RMS (800 MHz to 2000 MHz)
DF sensitivity (1 s signal duration)	5 µV/m typ. (GSM 900) 10 µV/m typ. (GSM1800/ GSM1900 band)
Modes of operation	fixed frequency/scan/search mode
Synchronization selectable	external or internal

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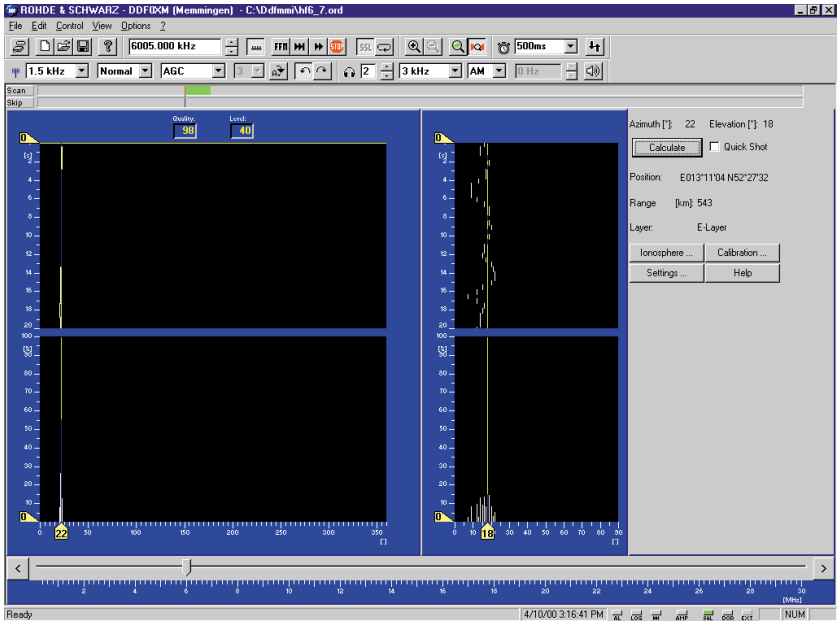
Single Station Locator Software DDFSSLM

For HF Digital Monitoring Direction Finder DDF01M



SSL display

Brief description

Single station location (SSL) is a method to determine the location of an HF transmitter with only one HF direction finder. This method will always be used if only one direction finder is available.

SSL is based on the fact that an HF signal which was reflected in the ionosphere arrives at the DF site at the same angle of elevation as it was emitted by the HF transmitter towards the ionosphere. Using the azimuth and elevation parameters processed by the HF direction finder and the necessary ionospheric data the origin of an HF transmission can be calculated.

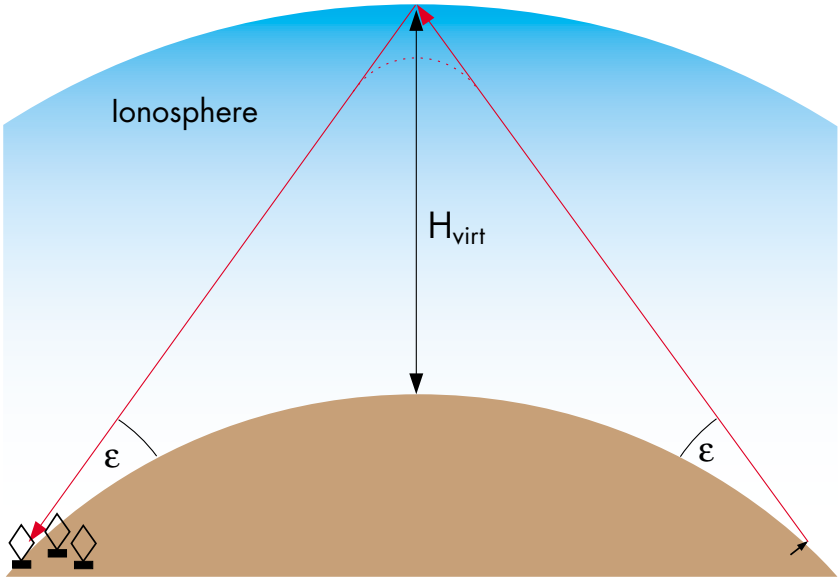
SSL accuracy is about 5% to 10% with respect to the distance to the target.

The Rohde&Schwarz SSL software

The SSL software is an extension (option) of the DDFMMI man-machine interface for Digital Monitoring Direction Finders DDF0xM (see page 105) and allows location of an HF transmitter by means of one direction finder combining bearing and elevation. The result is the position of the transmitter and the range (distance between DF and transmitter).

In the setup mode initial information such as position data of the DF station, selection of coordinates in geographical degrees north/south and east/west or UTM grid values, distances to be indicated in kilometers or miles etc can be defined.

The necessary ionospheric data can be obtained from an internal data base and ionospheric model.



HF propagation via ionosphere

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Automatic Remote Control DDFARCM

Brief description

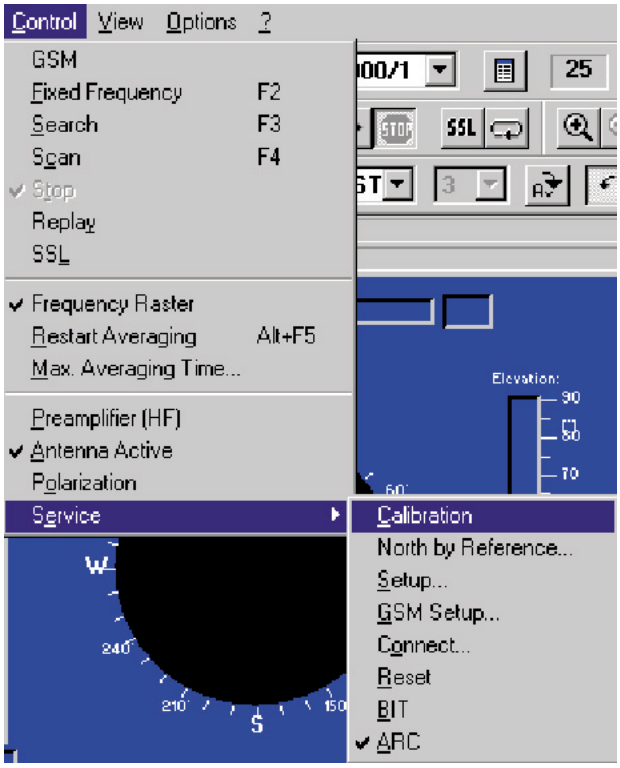
ARC stands for automatic remote control. With ARC it is possible to request a DDFMMI for DF values via TCP/IP from a detached system. The DDFMMI then returns the requested DF values.

Activation

Option ARC has to be enabled by means of an option code. The option code is only valid for the direction finder it was purchased for. The code can be entered during the DDFMMI setup or at a later time by means of the supplied program OPTIONS.EXE.

ARC menu

With Control-Service-ARC selected (see Fig.), the ARC can be switched on or off.



Digital Direction Finder DDF190

0.5 MHz to 3 GHz

Brief description

Digital Direction Finder DDF190 may comprise the following elements:

- HF DF Antenna ADD119 (0.5 MHz to 30 MHz)
- VHF/UHF DF Antenna ADD190 (20 MHz to 1300 MHz)
- UHF DF Antenna ADD071 (1.3 GHz to 3 GHz)
- DF Unit EBD190
- Cable Set DDF190Z

Photo 43456

Moreover, a monitoring receiver with unregulated IF output of 10.7 MHz or 21.4 MHz (eg EB200, ESMB, ESMC or ESN) is required.

Digital Direction Finder DDF190 can be operated in accordance with two DF methods using digital signal processing: the proven Watson-Watt method (HF band) and the advanced correlative interferometer method (VHF/UHF band). The system allows direction finding of signals with any modulation.

Three operating modes can be selected on the DF unit:

- **NORMAL** (In this mode, which is preferably used for monitoring radio networks, the DF process is started and stopped by the squelch of the DF unit. The bearing display follows the various directions of incidence of the signals without any delay.)
- **GATE** (This mode is used for direction finding of transmitters whose emissions may be interrupted briefly by modulation (eg keyed transmitters) if the transmitter on-the-air time is too short for NORMAL mode.)
- **CONT** (In this mode, direction finding is performed continuously so that a bearing may be obtained even for specially modulated or very weak signals for which the DF process is not triggered by the squelch.)

In each of these modes, bearings can also be displayed in a **histogram**, which is of advantage in the analysis of communication networks. Histograms display the current bearing in digital form (three-digit number), and all values obtained since the activation of this display mode are shown as radial beams indicating the direction of incidence. The lengths of the beams are a measure of frequency occurrence of the bearings.

The display mode can also be switched to QDM (heading with reference to magnetic north). Results can be output as lists.

Main features

- Direction finding of signals with any modulation
- Wide-aperture behaviour above 300 MHz
- AC supply or battery operation
- Simultaneous operation of all DF antennas (HF and VHF/UHF)
- Complies with ITU class A (in HF band) and B (in VHF/UHF band)

Digital Direction Finder DDF190

HF extension

To cover the HF range, two new features have to be implemented:

- Connection of HF DF Antenna ADD119 to receiver and to DF unit
- Installation of current firmware (version 2.0 or higher)[1] with evaluation algorithm for Watson-Watt method in DF unit

If DDF190 is operated only in the HF range, the connections between DF Antenna ADD119 and the DF unit are straightforward. Where DF Antenna ADD190 and/or DF Antenna ADD071 are to be used in addition, Connection Board GX190 is needed. The connection board performs frequency-dependent, automatic switchover to the required DF antenna and allows up to three communication receiving antennas to be connected to the receiver input.

Where it is not possible to mount all DF antennas at the top of the mast, DF Antenna ADD119 is to be fitted on a bracket on the side of the mast. This asymmetrical installation leads to bearing errors, which can however be kept low by fitting a second ADD119 on the opposite side of the mast. The signals from the two antennas are taken to Combiner GX119 and then to the DF equipment.

[1] The new firmware is available on the Internet (Rohde & Schwarz homepage) for updating.

DF antennas

For DDF190 there are three DF antennas for mobile and stationary applications covering the frequency ranges 0.5 MHz to 30 MHz (ADD 119), 20 MHz to 1300 MHz (ADD190) and 1.3 GHz to 3 GHz (ADD071) (see data sheet PD 757.1460.24).

Extras

For operation of DDF190 with ESMC in the VHF/UHF range in a vehicle with the DF unit accommodated in the boot of the car for instance, the additional Display Unit EBD190A is available. It shows the relevant DF information on an LCD display.


Photo 41949

Use in computer-controlled systems

For use in computer-controlled systems Rohde&Schwarz offers the system monitoring software ARGUS and RAMON.

RAMON, used in the military field, is for fast frequency detection and transfer to support monitoring receivers, while ARGUS is intended for civil applications, eg for authorities with frequency management tasks such as long-term monitoring of specific frequency bands.

Rohde&Schwarz also offers a solution for triangulation systems. Two or more direction finders can be combined with the software MONLOC to build a radiolocation network. The position of the direction finders, the bearing lines and the location of the signal source are displayed on a digital map.

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Digital Direction Finder DDF190

Specifications

DF method	Watson-Watt or correlative interferometer
Frequency range (depending on receiver/DF antenna)	
HF	0.5 MHz to 30 MHz
VHF/UHF	20 MHz to 1300 MHz
UHF	1.3 GHz to 3 GHz
DF accuracy in reflection-free environment*)	2° RMS (0.5 MHz to 30 MHz) 3° RMS (20 MHz to 30 MHz) 2° RMS (30 MHz to 80 MHz) 1° RMS (80 MHz to 1300 MHz) 2° RMS (1.3 GHz to 3 GHz)
Resolution of A/D converter	16 bit
Minimum signal duration	50 ms
DF sensitivity (≤5° RMS fluctuation, 5 s averaging time, 8 kHz bandwidth Rohde&Schwarz receiver)	
HF	15 µV/m to 4 µV/m (frequency-dependent)
VHF/UHF	1 µV/m to 10 µV/m (frequency-dependent)
UHF	3 µV/m to 10 µV/m
Bandwidths (internal)	1 kHz, 2.5 kHz, 8 kHz, 25 kHz, 100 kHz
Averaging time	100 ms to 5 s
Squelch	internal or external
IF input	10.7 MHz or 21.4 MHz, 50 Ω, level <0 dBm unregulated (ie without AGC), broadband or narrowband
DF display	graphical LCD on front panel; three-digit display with additional indication of direction on compass rose
Data interface	RS-232-C for remote control of system, 2nd serial interface and parallel interface for receiver control

General data EBD190

Operating temperature	–10°C to +55°C
Power supply	AC: 100/120/230/240 V, –12/+10%, 47 Hz to 440 Hz, overvoltage-protected to VDE160, ≤40 VA; DC: 10 V to 32 V, ≤20 W
Dimensions (W x H x D)	219 mm x 147 mm x 460 mm
Weight	approx. 10 kg

Ordering information

Digital Direction Finder	DDF190	
20 MHz to 1300 MHz		4046.4004.02
20 MHz to 3000 MHz		4046.4004.03
Extras		
HF DF Antenna	ADD119	4053.6509.02
Connection Board	GX190	4032.1508.02
Combiner	GX119	4032.1008.02
Display Unit	EBD190A	4041.6009.02
Remote-control software		on request
Antenna cables		on request

*) For slim masts with a height between 4 m and 8 m, the specified values may be exceeded in the frequency range between 20 MHz and 40 MHz (by 1° to 2°, depending on the mast symmetry and the ground connections at the mast base) because of the self-resonance of the mast that may occur.

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VHF-UHF Direction Finder PA1555

Mobile compact system for use in adverse environments

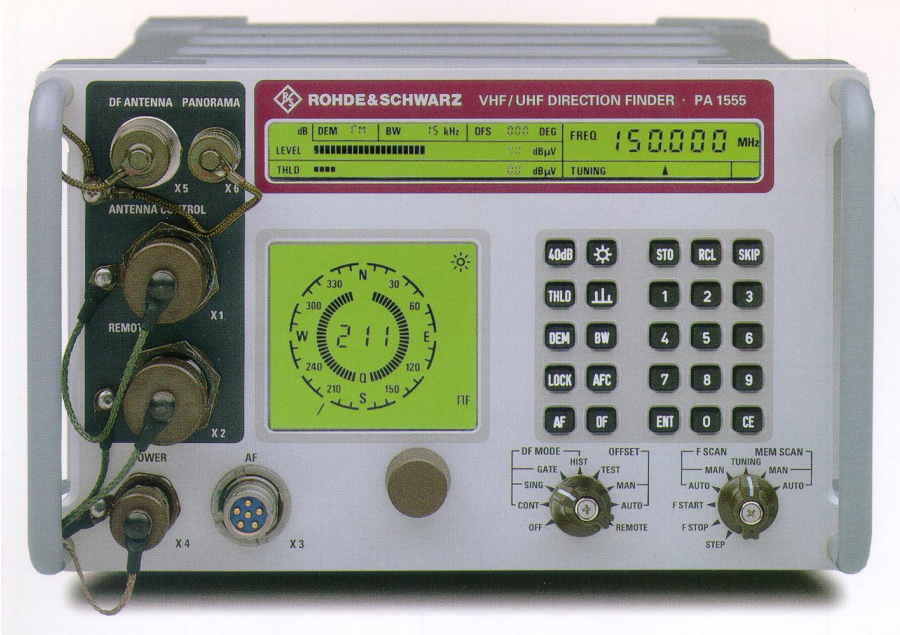

Photo 41952

Brief description

PA1555 from Rohde & Schwarz is a weatherproof, compact VHF-UHF direction finder featuring a foldable antenna system. It has been designed specially for use in adverse environments and at hard-to-get-at sites. Its high flexibility is enhanced by a low-drain DC supply. An RS-232-C interface allows the system to be integrated into computer-controlled radiolocation networks.

Main features

- Frequency range 20 MHz to 1000 MHz
- Lightweight, compact design
- Ideal for temporary applications and when frequently changing locations
- Can be integrated into radiolocation networks
- All functions of the DF unit can be remotely controlled and queried
- Connector for IF panoramic display
- Self-test by means of internal test signal

Characteristics and operation

All operating states and results of the DF unit are clearly arranged on backlit LC displays. DF results are indicated on a three-digit numerical display, supported by a ring-shaped 72-segment coarse direction indicator (each segment 5°) and a fan-shaped DF quality indicator. The front panel further shows the set frequency, level and level threshold (analog and digital), the demodulation type, bandwidth, and the selected north adjustment value.

The frequency can be entered via the numerical keypad or using the rotary knob. Tuning is facilitated by arrow markers in the Rx display field which indicate the frequency offset. Up to 100 frequencies together with the receiver settings can be stored and recalled. The DF unit cannot only be tuned to individual frequencies, but it is also possible to trigger frequency scans either using a preset start/stop frequency and stepwidth or via the channels stored in the memory. In the auto mode, the system is made to dwell for about 3 seconds on each signal that exceeds a preselected level threshold. The user can select individual channels to be skipped in the memory scan.

Antenna AP 1555 M was specially devised for use in vehicles and is of compact design. It covers the entire frequency range from 20 MHz to 1000 MHz

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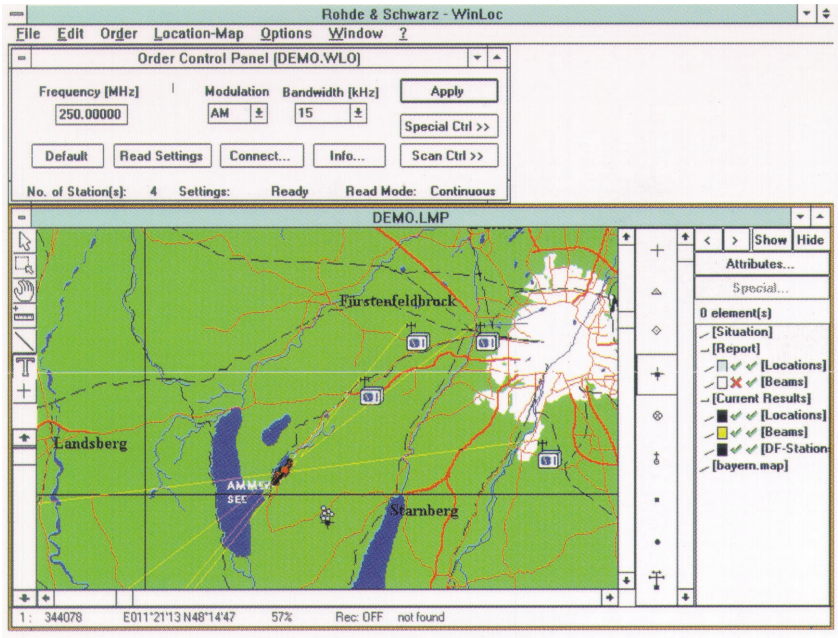
VHF-UHF Direction Finder PA1555

For north adjustment of PA1555, a correction value is entered via the numerical keypad. Alternatively, a bearing can be taken of a transmitter with a known azimuth value and the nominal value for the transmitter entered. North adjustment will then be performed automatically.

PA1555 allows the audio signal to be monitored also without any interference from the noise generated during antenna scanning. To this end, direction finding can be stopped.

DF operating modes

- **CONT**
  Direction finding of CW signals. The maximum integration time is 2.5 s.
- **SING**
  Squelch-controlled direction finding of individual signals with medium integration time – especially of simplex voice communication with a medium signal duration. The DF result is cleared at the end of signal transmission.
- **GATE**
  Squelch-controlled direction finding of intermittent signals originating from the same source. The DF information remains stored during the intervals when no signal is received.
- **HIST**
  Squelch-controlled direction finding of signals of identical frequency but from different angles of incidence (eg simplex voice communication). Averaging in this mode is performed by means of histograms that discriminate up to ten angles of incidence.



Via its RS-232-C interface, PA1555 can be integrated into radiolocation systems using the WinLoc software (see data sheet PD 757.1483). The WinLoc software contains a driver addressing PA1555.

PA1555 can be conveniently operated also in vehicles, using detachable Display Unit GB1555

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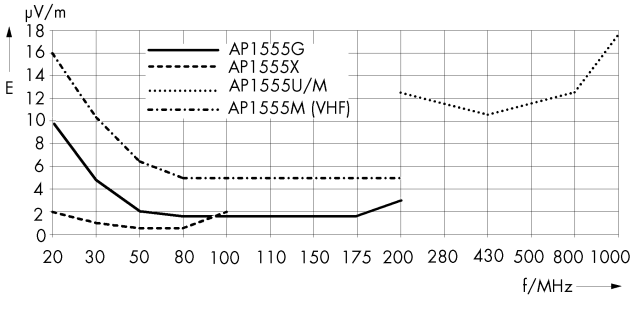
VHF-UHF Direction Finder PA1555

VHF-UHF DF Antenna AP1555T

DF Antenna AP 1555T covers the frequency range from 20 MHz to 1000 MHz. It is made up of two antennas – AP 1555G (20 MHz to 200 MHz) and AP 1555U (200 MHz to 1000 MHz) – which can also be operated separately. AP 1555G can be folded for transport. UHF DF Antenna AP 1555U can be disconnected from AP 1555G mechanically and electrically to facilitate transport.

VHF-UHF Compact Antenna AP1555M

Compact Antenna AP 1555M covers the frequency range 20 MHz through 1000 MHz. It was specially devised for use in vehicles.



DF sensitivity with Antennas AP1555G/U, AP1555M and AP1555X (±2° display fluctuation, 1 s signal duration)

Photo 42405

Specifications

Frequency range	20 MHz to 200/1000 MHz
DF accuracy	2° rms (DF antenna mounted on mast; siting effects not taken into account; averaging over azimuth and frequency)
Sensitivity	dependent on frequency and antenna used (see diagram)
Minimum required signal duration	approx. 50 ms, depending on modulation
Modulation	AM, FM, CW; selectable bandwidth 7.5/15/150 kHz
Data interface	V.24 (RS-232-C); baud rate: 50 bd to 9600 bd (internally selectable)
DF antennas	
AP 1555G (20 MHz to 200 MHz)	6-dipole Doppler antenna, lightweight construction, 1 m in diameter, weight approx. 6.5 kg
AP 1555U (200 MHz to 1000 MHz)	6-dipole Doppler antenna in weatherproof radome, weight approx. 4.5 kg
AP 1555T (20 MHzto 1000 MHz)	(= AP 1555G + AP 1555U), max. wind speed 100 km/h
AP 1555X (20 MHz to 100 MHz)	6-dipole Doppler antenna, lightweight construction, 2 m in diameter
AP 1555M (20 MHz to 1000 MHz)	compact antenna in radome, 1.1 m in diameter, weight approx. 25 kg
DF unit	accommodated in weatherproof, impact-resistant case; digital and analog DF-value and status indications on LC displays (with backlighting)
Dimensions (W x H x D)	254 mm x 152.4 mm x 268 mm
Weight	approx. 7.5 kg
Power supply	10 V to 30 V DC, power consumption approx. 10 W
Nominal temperature	
DF antenna	–40°C to +55°C
DF base equipment	–25°C to +55°C
Shock	to MIL-STD-810 D
Vibration	to MIL-STD-810 C
Class of protection	IP 65
EMC	to MIL-STD-461 D, CE 102, CS 101, RE 102

Ordering information

VHF-UHF Direction Finder	PA 1555	
20 MHz to 200 MHz		4036.9555.40
200 MHz to 1000 MHz		4036.9555.41
20 MHz to 1000 MHz		4036.9555.42
20 MHz to 1000 MHz, compact design		4036.9555.43
Options		
Display Unit	GB1555	4031.7202.02
Plug-in Mast, including guy ropes, compass and mounting tools, for DF Antennas AP1555G/U/T	KM1555T	4036.9003.02
Mast Adapter for DF Antenna AP1555U	KM1555U	4036.8259.02
Vehicle Adapter for DF Antenna AP1555M	AP502Z1	0515.1419.02
Mast Adapter for DF Antenna AP1555M	AP502Z5	4015.2151.04
Cable Drum	PA1555D	4036.9255.02
Headphones	PA1555H	4036.9355.02
Loudspeaker	PA1555L	4036.9561.02
Battery (rechargeable, 7.2 Ah)	PP1555B	4037.0251.02
Transport Bags for DF unit and antenna	PA1555T	4036.9755.02

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Contents of Chapter 4

Analyzing and decoding practically any type of radio signals

For these applications, Rohde & Schwarz has a wide range of equipment:

- Units for the visualization of radio traffic
- Demodulation of analog and digital waveforms
- Decoding of a wide range of codes
- Automatic classification of waveforms, codes and transmission characteristics
- Automatic Morse decoders to provide messages even of hand-keyed signals
- Recognition of emissions
- Analyzers evaluating signals transmitted via modern digital HF modems
- Evaluation of extremely short HF burst signals
- High-speed detection, classification and demodulation of FSK and PSK signals
- Verification of 12-tone parallel PSK2/4 signals
- Satellite radiocommunication monitoring (voice, fax, data)
- Mobile radiocommunication monitoring
- Microwave link radiomonitoring up to 40 GHz

Rohde & Schwarz is the only manufacturer to supply systems for the search, classification and demodulation of PSK signals (PSK2/4/8) emitted via serially modulated HF modems. Even PSK8B with 9600 bit/s can be realized without any problems. Elaborate equalizers ensure signal detection also without using the training sequence.

The use of modern DSP technology allows a modular design of analyzing equipment capable of responding very flexibly and consistently to any change of communication codes or procedures.

Morse Decoder GM094

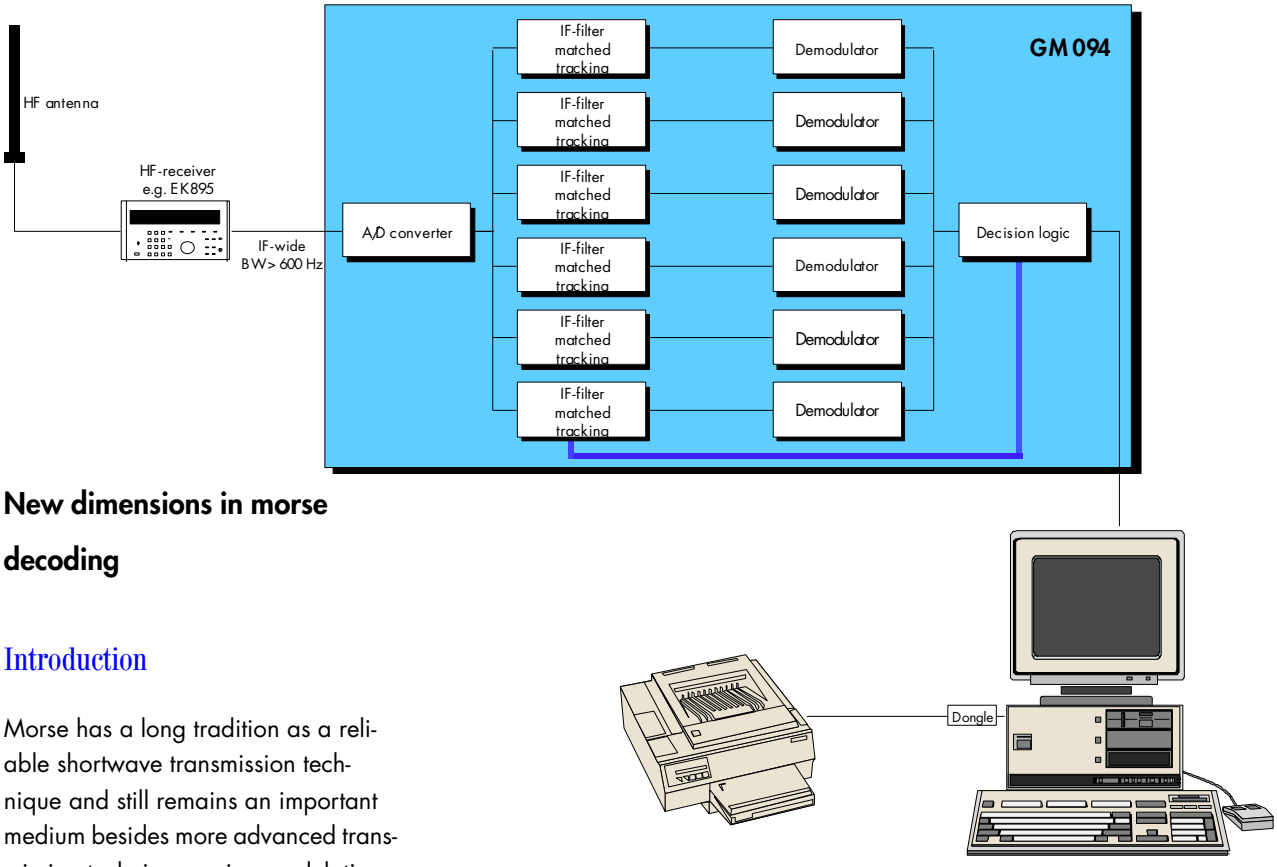

Fig. 1: Functional block diagram of GM094 (single-channel version)

New dimensions in morse decoding

Introduction

Morse has a long tradition as a reliable shortwave transmission technique and still remains an important medium besides more advanced transmission techniques using modulation such as FSK and PSK. This is primarily due to two factors:

- Compared to other transmission techniques, Morse signals using the robust amplitude modulation (A1A) are subjected to relatively little distortion caused by the various types of interference present on the RF transmission channel
- Neither transmitter nor receiver are operated automatically but by radio operators who have undergone training over several weeks or even months. Routine and experience enable these operators to compensate for interference on the transmission channel as well as for any imperfection on the part of the sender.

Morse uses a length-optimized transmission code. It also makes use of the fact that a human operator is able to react to the diverse transmission errors occurring in a message and to cope with error-tolerant transmissions.

These are the reasons why Morse signals continue to be an important target of radio reconnaissance. The nature of this technique, however, makes Morse reconnaissance highly labor-intensive. Morse Decoder GM094 is aimed in particular at cutting down on personnel capacity especially for routine tasks and at extending the range of channels covered, even in unmanned operations.

Decoders that have been developed so far produce acceptable results only under conditions that do not usually occur in practice:

- Ideal keying, ie a constant touch-break ratio is assumed
- The keying and radio equipment are assumed to be perfect, ie featuring no frequency instabilities, AM/FM conversion, delay distortion, chirp effects, etc
- Between signals an interference-free transmission channel is assumed
- The active Morse signal is not disturbed by interference on the transmission channel

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Morse Decoder GM094

The first prerequisite (correct Morse coding) could only be provided by using fully automatic keying equipment. Semiautomatic or manual keying always results in more or less marked decoding errors. In severe cases the text generated turns out to be illegible.

The second prerequisite (no frequency instabilities) is unrealistic, in particular with obsolete equipment. To meet this prerequisite, the Morse decoder will have to capture several frequencies at a time.

The third prerequisite (no false alarms) is fulfilled rarely. Usually one can assume that the receive level of the Morse signal is only slightly stronger than the permanent interference level. This means that between Morse signals the decoder is confronted with a strong interfering signal. This signal does not have the structure of white noise, but is a man-made noise consisting of several superimposed communication signals. The decoder attempts to interpret these signals as Morse signals. As a consequence, an enormous amount of irrelevant information is produced by the decoder, which makes evaluation of the message more difficult.

The fourth prerequisite (probability of detection) is particularly problematic when dealing with shortwave, as here fading, delay and Doppler shift as well as ambient noise (see above) are particularly blatant. Common pulse interference must not be interpreted as Morse signals (eg e, i, t, m). Permanent interference such as humming and speech signals must not cover up the wanted signal.

In difficult cases the result produced by conventional Morse decoders was often a decoded text that was virtually impossible to interpret even for an experienced radio operator with a good measure of patience at the receive end. Few users are willing to accept equipment with the described functionality.

The points outlined above were fully taken into account in the development of Morse Decoder GM094, which fulfills all the prerequisites described.

GM094 sets new standards

Decoder GM094 has been designed to tolerate different types of keying. Varying dot-dash ratios for each letter or fluctuations in the keying speed are accepted. Frequency and level fluctuations are compensated for by a discrete IF receive unit (Fig. 1) with matched filters.

The real achievement of this new development is the capability of GM094 to run a continuous classification process during reception, which classifies the Morse signal as a certain type of signal that can be distinguished from other signals.

This capability is essential for the professional use of the decoder.

This is made possible through the use of a modern digital signal processor which allows the use of signal processing algorithms, a technique that could only be realized with traditional analog technology at a high expenditure.

With GM094, the potential of digital signal processing is fully utilized with the aid of modern signal processors. These processors helped to implement characteristics which were not available previously and are combined in the decoder in a unique way. Particularly noteworthy are:

- Automatic signal search with adjustable capture range
- Frequency-accurate display of the signal offset from the receiver center frequency
- Adjustable signal hold time
- Decoding of signals produced by both manual and automatic keying
- Decoding of short-time signals, ie down to one letter
- Decoding of duplex traffic

It should be added that the decoding of duplex traffic is performed in real two-channel operation with only one log being printed. Yet the temporal sequence of the radio traffic is represented correctly.

GM094 has been equipped with several other characteristics which proved to be useful during numerous trials performed by various users.

Among these are:

- Registration of receive time
- Editable and selectable Morse code
- Editable and selectable radio traffic abbreviations
- Structuring of Morse text
- Marking of call sequences and call signals
- Automatic saving of Morse text
- Fast and easy-to-use text editor

These features allow optimal adaptation of the decoder to various communication types as well as easy and straightforward processing of the decoded text if this should become necessary.

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Morse Decoder GM094

Technical description

Configuration
The Morse decoder has been realized in the form of a software module that can be run on the DSP card GM091, so GM094 can be easily integrated into a commercial IBM-compatible PC at the customer's.

The equipment supplied with the simplex version (Fig. 2) consists of a PC plug-in card GM091 and GM094 with dongle, software on floppy disk (3.5") with user-prompting in English as well as a manual in English. A complete turnkey system already integrated in a PC can be delivered at customer's request.

The equipment supplied with the duplex version (Fig. 3) is made up of two simplex versions. Up to 6 Morse decoder channels may be integrated into one PC.

Decoder functions
Settings are entered by means of mouse or keyboard via menus. The decoder can be operated with or without receiver control.

Logging
The decoded text is stored on the hard disk in text format (*.txt) with date and time information. The text can then be processed using standard editors.

Setting parameters
The following parameters can be set via the user interface of the decoder.

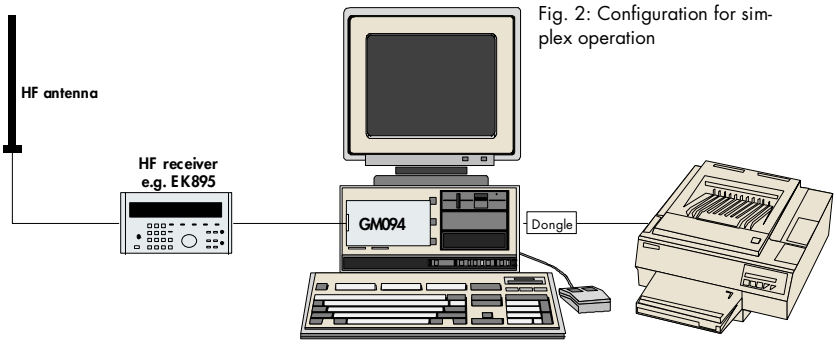

Fig. 2: Configuration for simplex operation

Receiver
Decoder GM091/GM094 can be connected to almost any HF receiver provided it has a suitable IF output. Some receivers can also be supplied with a frequency control. At present the following HF receivers can be connected.

- EK890/893/895/896 via RS-232-C
- E1800 via RS-232-C

Further receivers and interfaces can be used if required.

IF center frequency
Decoder GM091/GM094 is connected to the IF output of the HF receiver.

- Frequency range A
  2 kHz to 18 kHz (adjustable)
- Frequency range B
  22 kHz to 38 kHz (adjustable)

This also enables direct connection to a tape recorder.

RS232 control
The receiver is controlled via COM1 and/or COM2 of the PC. If more channels are to be used, additional interfaces have to be fitted. The RS232 interface can be defined in terms of parameters.

Receive frequency
The receive frequency is set via GM094 or the receiver. GM094 allows stepwidths of 1 Hz or 10 Hz.

Capture range
The capture range is adjustable:
±5 Hz, ±10 Hz, ±25 Hz, ±50 Hz, ±100 Hz, ±250 Hz, ±500 Hz

A certain frequency range to be set via the user interface is defined as capture range. Within this frequency range the decoder searches periodically (see also under hold time) for the signal with the strongest level at intervals of 0.8 s. If this signal turns out to be a Morse signal, it is decoded.

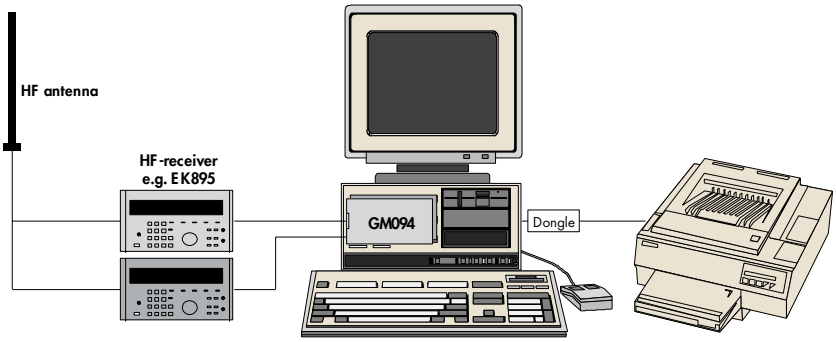

Fig. 3: Configuration for duplex operation

Morse Decoder GM094

Hold time
The hold time is adjustable:
0 s, 3 s, 10 s, 60 s, infinite

A certain timespan to be set via the user interface is defined as hold time. When the decoder detects a Morse signal, it remains at the detected frequency in the pauses between two signals for the hold time selected.

- If the hold time is 0 s, the decoder starts searching for the strongest signal within the capture range after 0.8 s at the most
- If, however, the hold time set is infinite, the decoder remains at a Morse signal that has been detected

Morse code
The Morse code to be used can be freely selected by the user with the help of the editor supplied.

Radio traffic abbreviations
Radio traffic abbreviations can be defined by the user with the help of the editor supplied (Fig. 4).

Signal quality
The decoder can be optimized to receive distorted signals such as signals with superimposed FM (chirp signals).

Format
The format function of the log can be switched on and off.

Spectrum display
The signal spectrum received can be displayed to allow checking of receiver settings and signal quality.

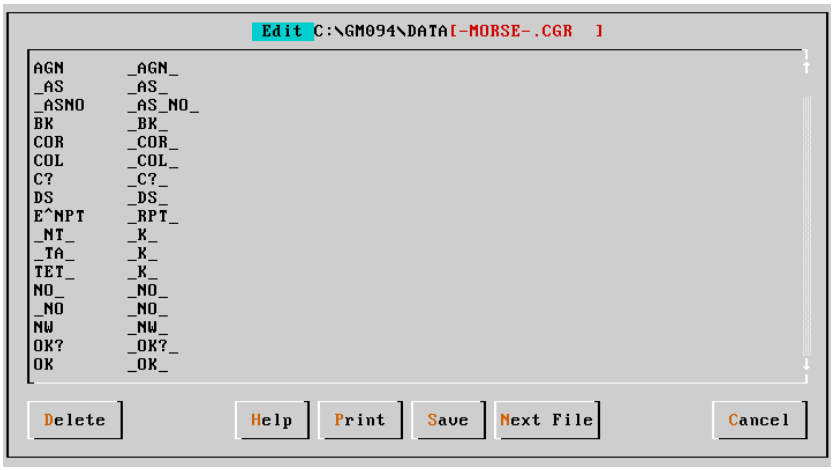

Fig. 4: Editor for radio traffic abbreviations

Characteristics

Error rate
The maximum error rate is typically below 0.5 % of the characters transmitted at an S/N ratio of 6 dB, receiver bandwidth of 300 Hz and keying speed of 20 Bd.

Maximum keying speed
The maximum baud rate is approx. 60 Bd, which represents approx. 150 characters per minute.

Permissible signal drift
If the RF frequency changes by <10 Hz/s, the signal is tracked within the set capture range. Keying speeds may vary from one letter to the next by the factor 3 or 1/3. The dot-dash ratio may vary from one letter to the next within the range 1:2 to 1:5. The signal level within one letter may vary by more than 20 dB.

Decoded text
If the decoder stops, the decoded text is saved on the hard disk as a text file. A special text editor is available to process, print or delete all saved text files. Signals that cannot be decoded are logged as dot-dash combinations.

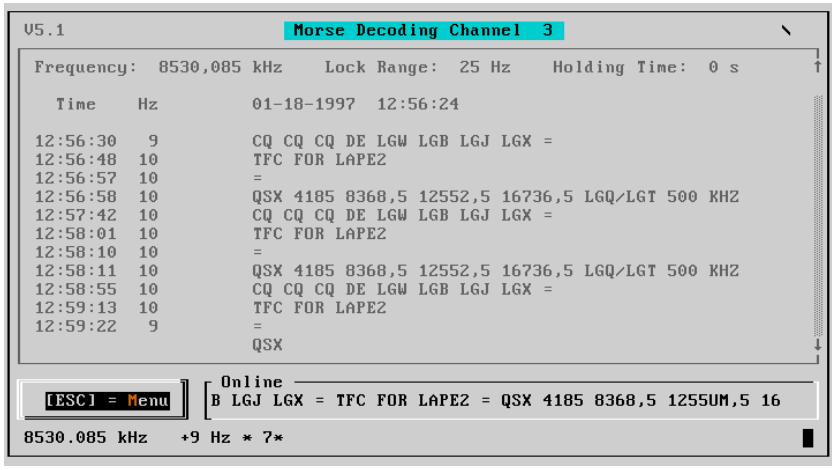

Fig. 5: Display of decoded text in simplex operation during reception

Morse Decoder GM094

Running text
The text being decoded is displayed as unstructured text in a single line (Fig. 5).

Structured text
The structured text is displayed in 18 lines on the screen (Fig. 5) with time and signal offset from the IF center frequency given in each line.

Call sequence
Identified call sequences are marked by the symbol ADDR in each line (Fig. 6).

Call signal
Single call signals are marked by the symbol R in each line (these call signals must be identified beforehand in call sequences).

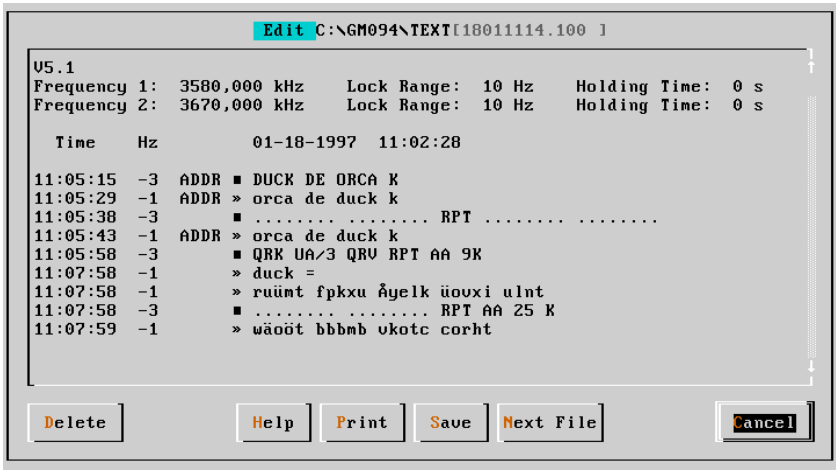

Fig. 6: Display of decoded text in duplex operation at two frequencies during subsequent evaluation

Duplex traffic
For decoding duplex traffic, two DSP cards need to be installed in the PC system. Logging is in the form of a special printout format.

The decoded texts of the two transmitting ends are allocated to different lines and identified by upper- and lower-case letters. In addition, a symbol before each line indicates which transmitter was the origin of that line.

Specifications

Signal Processor Card GM091

Plug-in card	AT (long)
A/D converter	16 bit
Sampling frequency	80 kHz
Input impedance	1 kΩ
Max. input voltage	±2.5 V
Power consumption	<12 W from 5 V

Interface to HF receiver

Decoder input	receiver IF
Receiver setting	RS232

Hardware requirements
GM094/GM091 can be integrated into simple PC systems as shown in the following example of simplex and duplex operation.

Operating system	MS-DOS from version 5.0 onwards
CPU	80486 SX/25 MHz as minimum
Hard disk drive	>30 MByte
Disk drive	3.5", 1.44 MByte
Receiver control	
Simplex operation	1 serial interface (COM1 or COM2)
Duplex operation	2 serial interfaces (COM1 and COM2)
Number of channels	6 at maximum
Printer port	Centronics
Operation	keyboard and mouse
RAM	≥8 MByte

If several channels are to be covered, an appropriate number of receiver interfaces and slots at the rear of the PC have to be made available. The decoder may also be operated without receiver control.

On special demand the Morse decoder can also be supplied as a turnkey solution installed in a PC.

Ordering information

Demodulator hardware	GM091	4051.2506.02
Morse Decoder software	GM094	4051.2606.02
PC integration	on demand	
Software driver for specific receivers	on demand	

PSK Demodulator GM097

Detecting signals that hardly differ from noise

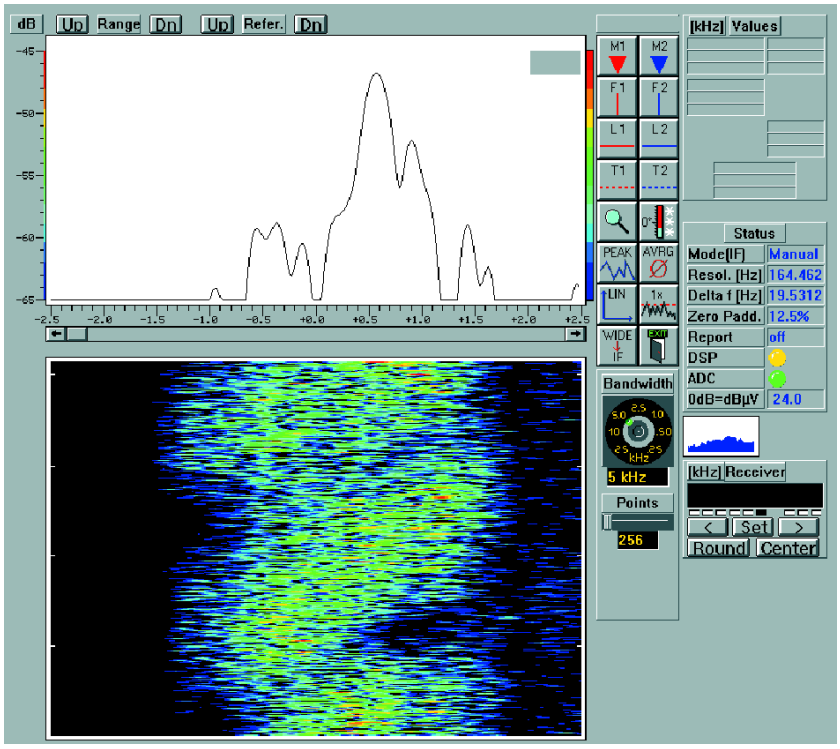

Fig. 1: Spectrum and waterfall display of serial PSK signal

Brief description

Modern digital HF modems handle many different types of modulation. Radio detection is therefore confronted with a variety of signals, a number of which can hardly be distinguished from noise. PSK Demodulator GM097 is able to reliably detect signals where conventional instruments are just fumbling in the dark.

PSK Demodulator GM097 is based on a processor board with DSPs and appropriate software. This module – which is also used by Morse Decoder GM094 (see page 123) – allows all entries to be made for the receiver IF. Up to six modules with different demodulator programs can be used in one controller. Operation of several demodulators in parallel allows the time required for searching and verification to be reduced considerably.

Main features

Radiomonitoring faces new challenges

Rapid advances in digital radiocommunication equipment created a need for a new generation of monitoring equipment. The architecture of this type of equipment and its functionality differ very much from that of analog systems. Classic radiomonitoring functions such as searching, localizing and classifying can no longer be seen as sequential operations. Instead processes will work simultaneously for the most part or will overlap. The basic functions of state-of-the-art demodulators and their system performance are therefore not specified too tightly.

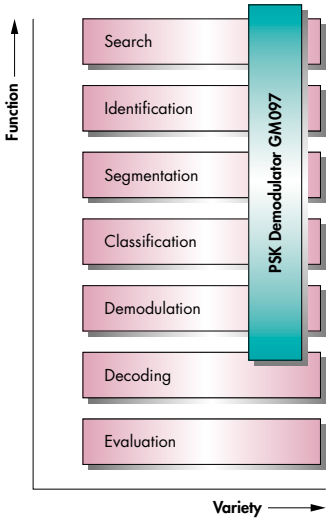

Fig. 2: PSK Demodulator GM097 performs many tasks simultaneously

Although it is not a universal unit, PSK Demodulator GM097 from Rohde&Schwarz performs all activities from searching through to demodulation (Fig. 2).

Conventional instruments fail on serial PSK modulation

Many modern HF modems use serial PSK modulation for fast digital transmission. Transfer rates of up to 2400 Bd can be achieved depending on the quality of the transmission link. Such emissions often prove to be an insurmountable barrier for conventional monitoring equipment. As early as while searching, the operator comes up against signals that look and sound like noise (Fig. 1).

The plait-like structure in the lower half of Fig. 1 (sonogram) is produced by frequency-selective fading, which is

PSK Demodulator GM097

typical of HF transmission and not signal-specific. The spectrum in the upper window shows a snapshot. Averaging over an extended period of time produces envelopes that theoretically and in favourable practical cases approach a sinx/x function.

However, the spectrum of a PSK8A signal illustrates the harsh reality of the HF detection scenario (Fig. 3). It shows the spectral characteristic of HF modems that resembles noise and is familiar from DSSS (direct sequence spread spectrum) signals. Automatic classifiers or search receivers using only the power density spectrum are confronted with the same almost irresolvable problem.

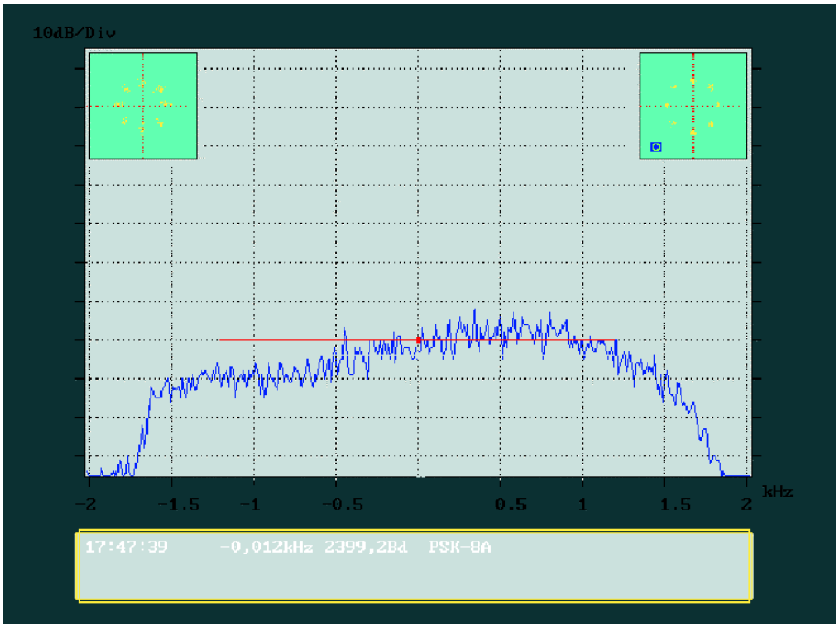

Fig. 3: Spectrum and phase constellation diagram of PSK8A signal

Operation

PSK Demodulator GM097 offers a solution for demodulating PSK signals. The demodulator identifies the modulation form (Fig. 3) while searching and determines the exact carrier frequency through continuous classification. The horizontal line marks the bandwidth used for transmission and the baud rate is automatically displayed (here 2400 symbols/s). During demodulation the operator can simultaneously view the phase constellation diagram (top right of Fig. 3).

GM097 also displays a new type of graph showing a differential phase constellation diagram that helps to identify modulation such as PSK4A, PSK2B, OQPSK. Functions like enlarging and smoothing of points are measures of demodulation quality. Classification is no longer possible in unfavourable conditions for transmission however. In such cases the effective and non-cooperative equalizer supplied with the demodulator is switched into circuit.

If the operator is sufficiently familiar with the operation of the instrument, he may correct demodulation parameters or specify them more tightly. A signal decoding function was deliberately omitted in GM097. But customers' decoders can be connected to the outputs for clock and data. The bit stream is stored on hard disk, so it can also be subsequently evaluated.

Specifications

Functions	search, monitoring, classification, demodulation
Types of modulation	PSK2A, PSK2B, PSK4A, PSK4B, PSK8A, PSK8B, OQPSK
Baud rate	PSK: 50 to 2500 symbols/s OQPSK: 25 to 1250 symbols/s
Bit error rate (with white noise)	PSK2A, PSK2B: <0.1% (S/N = 12 dB) PSK4A, PSK4B: <0.1% (S/N = 15 dB) PSK8A, PSK8B: <0.1% (S/N = 18 dB) OQPSK: <0.1% (S/N = 15 dB)
Frequency centering	AFC
Spectrum display	FFT, bandwidth 8/4 kHz
Resolution	20/10 Hz for search/demodulation
Search ranges	max. 3
Output	1 clock channel, 1 data channel

Ordering information

PSK Demodulator	GM097	xxxx.xxxx.xx

HF Signal Analyzer System GX202

Even the shortest of emissions firmly under control

Photo 43190-1

Brief description

Modern digital data transmission techniques are increasingly gaining in importance for use in the HF band. By resorting to special coding schemes, brief emissions (burst) or sudden variation of the baud rate such signals remain undetected to the customary techniques of interception. To be able to monitor today's complex signal scenarios, the user needs comprehensive support in terms of partial automation of detection and evaluation.

Compact monitoring system
HF Signal Analyzer System GX202 together with VLF/HF Receiver EK895/896 forms a compact system that exhibits all the attributes of large monitoring systems.

- Detection with
  - Search
  - Signal detection
  - Modulation parameter determination
- Demodulation
- Code determination
- Decoding
- Recognition of coding systems
- Automatic storage of detected signals using a relational database
- Statistical evaluation of received signals
- Reporting on received signals in user-defined formats

System compatibility
GX200 is functionally ready to be incorporated into a large monitoring system where more than one unit can be operated. It then manages for example the dwell time at a specific frequency and thus relieves the workload of the system controller.

Main features

- Designed for interception of burst signals
- Recognition of predefined signals (warning receiver)
- Search for signals whose parameter sets lie within specified limits
- Automatic recognition and alarm if variations of the baud rate are detected
- Recognition of bit patterns, codes and in-parallel decoding
- User-definable code structures
- Automatic detection and demodulation of F1B (FSK) and (optional) G1DB (PSK2A) and G1DD (PSK2B/PSK4A) signals
- Fast evaluation of signal parameters
- Continuous reconstruction of bit stream
- Options
  - Codes of variable length
  - Codes with shift registers
  - PSK demodulator
  - FFT spectrum analysis of transient signals

Monitoring functions

Detection
As part of GX202 software GX200Control controls the receiver along with Analyzer GX200. Receiver EK895 with its fast digital filters and suitable level control offers the optimal

prerequisites for the detection of brief signals. If, for example, the frequency is set on the receiver, the settings are taken over by GX200Control.

Moreover GX200Control initiates searches covering specific frequencies or frequency ranges.

Signal detection
The method of signal detection is matched to the modulation classes of FSK and PSK. Signals are subsequently processed without the loss of data through the use of a signal buffer memory.

Modulation parameter determination
The modulation types F1B (FSK-2) and G1DB (PSK-2) and G1DD (PSK-4) signals are detected. Differentiation between PSK2B/PSK4A is also implemented.

Modulation parameters are assessed accurately and rapidly to enable fast signal recognition. Subsequently modulation parameters such as center frequency, baud rate, shift and other parameters are determined with high precision. Reports are given of only those emissions that lie within the parameter intervals of the activated waveforms.

Code detection
In addition to fixed codes user-defined codes and bit masks can be specified by the job definitions entered by GX200Control. It is possible to search simultaneously for several coding systems. The detection can be parametrized using confidence thresholds.

Decoding
During subsequent decoding detection and mask recognition too are in the background. A host of codes can optionally be subjected to asynchronous or synchronous processing.

Method identification
This detection includes not only the modulation parameters but also the codes and bit masks. Due to spectral features identification is possible together with the use of the FFT option.

Evaluation
A bit stream editor, an autocorrelation function and a signal duration histogram, for example, are available for the evaluation of the detected and saved events in the database.

Spectrum analysis
The detected signals can be evaluated by means of high-resolution frequency spectra with settable averaging factor. For the purpose of signal recognition, automatic spectrum evaluation can be initiated. The characteristic spectrum parameters can be saved in the database.

Operation

The IF signal coming from the receiver is digitized and converted to a complex baseband signal. Demodulation, synchronization and bit stream analysis form the central functional units. Ring buffers are provided between the functional units to avoid loss of data. Thus realtime processing is ensured on the alteration of operational parameters (change of baud rate and code specifications).

Besides automatic detection demodulation and synchronization include the determination of parameters such as baud rate, shift and center frequency. The synchronized bit stream is analyzed by means of special signal identification algorithms. Depending on the presets, bit-pattern recognition based on fast reference pattern correlation and at the same time a search for specific elements according to stipulated coding standard can be carried out. A warning can be generated if the search returns a positive result and the decoded contents (text) or the bit stream can be output. Simultaneous search in line with several methods or bit patterns is possible even for complex code standards.

Options

PSK option
The PSK option enables a parallel search for PSK and FSK emissions. This option incorporates a modulation recognition module which differentiates between PSK and FSK emissions on the basis of their characteristics. The signal paths from this module are taken to the functional units for further processing. In addition, a differentiation between the different PSK variants is made.

FFT option
An optional FFT processor is available for Signal Analyzer GX200. It performs a maximum of 1000 spectral transforms and calculates the arithmetic average of the spectra on the basis of the arrays.

HF Signal Analyzer System GX202

The calculated average is transferred as a data packet to a system computer and can be compared with stored sample spectra. Furthermore, the analyzer can calculate specific parameters from the average of the spectra which are then available to the system controller as characteristic parameters. This allows additional features of the source to be recognized and classified.

System control with Software GX200Control

HF Signal Analyzer System GX202 is controlled by an industrial computer PC/AT.

GX200Control performs the following tasks:

- Supports the operator in defining decoding methods by using editors for alphabet, frame structure, code structure and alarm patterns
- Fully automatic scanning of frequency lists or ranges defined by the scan editor without user interaction and storage of results in a database
- On-line display of monitoring results including signal parameters, bit patterns, decoded text and averaged spectrum
- Supports off-line evaluation and reporting of database results with the help of report generator, bitstream editor and spectrum editor

GX200Control offers six different editors for GX200 and EK895/896 parameters:

- Job definition: analyzer setting, defined by one or more methods, codes, masks together with a set of parameters to control the system actions
- Alphabet editor: a translation table (alphabet) defines the translation of the information bits of a code into the 8 bit ASCII code. Translation tables are always bound to a code either in the method or in the code definition. If a code does not have a translation bound to it, there will be no message text for emissions with this code. There are some predefined translation tables in the system
- Code editor: the code defines periodic frames in the transmission which may consist of start, stop and parity bits and information bits. There are some predefined codes in the HF Signal Analyzer GX200 which are also available in the system. These are commonly used codes like BAUDOT, ARQ1A, etc
- Mask editor: defines the bit masks which are characteristic for the transmission (these can be start sequences or other characteristic bit patterns in the signal)
- Method editor: defines the parameter ranges which are relevant for the baud rate, shift etc, and, if known for this kind of signal, also defines the code, translation table and start and stop mask
- Scan editor: defines settings for the EK895/896 VLF/HF receiver

Evaluation with GX200Control

The database management tool provides a report writer where reports can be designed, generated, modified, viewed and printed. Some reports are predefined in GX200Control. But the user has also the possibility to design his own reports or to modify the predefined reports.

Reports together with the relational database allow flexible evaluation and statistics on the received data, for example:

- Selecting data by time (TOA) baud rate or any other parameters
- Sorting data (F, T, baud rate etc)
- Printing lists and graphics

Specifications

Modulation analysis and demodulation

Detectable modulation types	F1B (FSK2), G1DB (PSK2, PSK2A) and G1DD (QPSK, PSK2B, PSK4) optional
Demodulation	digital
Modulation rate (S/N=15 dB, white noise referred to receiver bandwidth)	10 Bd to 1200 Bd
Error	±0.1 % to 100 Bd, ±1 % >100 Bd
Reaction time	30 symbol changes (depending on information contents)
Frequency shift (F1B)	
Range	50 Hz to 2000 Hz
Accuracy	typ. 1 Hz to 400 Bd, 1% for >400 Bd
Permissible center frequency offset	
F1B	±300 Hz
Accuracy	typ. 1 Hz <400 Bd, 1% >400 Bd
G1DB, G1DD	±100 Hz
Accuracy	typ. 1 Hz
Analyzed bandwidth	receiver bandwidth, max. 10 kHz

Code analysis and decoding

Code library	max. 100 codes, 10 of them are part of the firmware (standard codes)

HF Signal Analyzer System GX202

User-defined input of code structures within predefined classes of codes

Bit pattern library	max. 100 patterns
Length of bit patterns	1024 bit
Confidence threshold	50% to 99%, adjustable
Standard codes	alphabet
Baudot	CCITT2
ASCII	CCITT5
ARQ	CCITT3 (frame with 28, 35 or 56 bit)
ARQ-1A	CCITT2 (frame with 28 or 56 bit)
SITOR	Sitor-7-bit (CCIR 476-3A)
SIFEC	Sitor-7-bit (CCIR 476-3B)
BAUER 10	CCITT2
SPREAD	CCITT2 (frame with 21 or 51 bit)
PARITY 14	
Idle	frame with 2, 7, 8, 14, 28, 56 bit
Detection of code change	by threshold decision and follow-up algorithm
Number of simultaneously checked codes	depending on baud rate and complexity, automatic adaptation

On-line decoding

Description of predefined alphabets	by assignment tables (256 entries)

On-line pattern comparison with reference bit patterns (masks)

Mask library	100 masks
Max. length of mask	1024 bits
Confidence level of detection	selectable, 50% to 100%
Number of simultaneously checked masks	depending on baud rate and complexity, automatic adaptation
Bit stream	output of all bits between start and stop of emission
Text	if code is recognized, the information contents are presented as blocks of ASCII units (8 bit)
Search tasks	
Definition of target signal	by predefined windows for baud rate and shift as well as start and end of transmitted signals (masks), code

General data GX200

IF input	
Frequency, bandwidth	12.5 kHz, 10 kHz
Level, connector	0 dBm for max. output at 600 Ω, BNC
Serial interface	RS-232-C
Data rate (selectable)	2400, 4800, 9600, 19200 Bd
Connector	9-pin male (Cannon)
Handshake	software only (XON/XOFF)
Remote control interface, connector	IEEE 488-2, 24-pin male
Operating temperature	0° to +40 °C
Storage temperature	–40° to +70°C
Power supply	100/120/220/240 V ±10%, 47 to 63 Hz, approx. 150 VA
Dimensions	427 mm x 177 mm x 460 mm
Weight	approx. 20 kg

Options

FFT Processor GA101F1	calculation of averaged and scaled spectrum with logarithmic presentation
Instantaneous bandwidth	3 kHz with input frequency as center frequency
Resolution	0.6 Hz
Averaging	<1000, selectable
Start	automatic by recognition of targeted signal or by function command
PSK Demodulator GA101P1	demodulator for G1DB or G1DD signals operating in parallel to F1B demodulator of basic unit
Modulation classes	PSK2A (BPSK, G1DB), PSK2B/4A (QPSK, G1DD)
Baud rate range	10 Bd to 1200 Bd
Baud rate accuracy	±0.1% to 100 Bd, ±1% to 100 Bd, (S/N=15 dB, white noise according to receiver bandwidth)
Lock-on range	±100 Hz
Frequency accuracy	typ. 1 Hz
Predetection filter	sin(x)/x filter, (will be controlled automatically according to the signal bandwidth)
Extension: Variable Code Length	GA101VL, detection algorithms for a class of codes of variable length (eg Morse)
Extension: Binary Shift Register	GA101SR, detection algorithms for a class of codes using binary, linear and feedback shift registers for error control

Ordering information

HF Signal Analyzer System consists of:	GX202	3019.4998.02
Signal Analyzer	GX200	4053.2003.03
Control Software	GX200S1	
	GX200Control	3019.5142.02
Accessories supplied	operating manual, spare fuses	
Options		
FFT Option	GA101F1	4019.4107.02
PSK Demodulator	GA101P1	4019.4194.02
Variable Code Length	GA101VL	4028.5490.02
Binary Shift Register	GA101SR	4028.5431.02
Extras		
19" Rack Adapter	ZZA-94	0396.4905.00
Service manual		4028.5983.2401
Operational training	5 days	on request
Maintenance training	5 days	on request
VLF/HF Receiver	EK895	6057.8996.12
or		
VLF/HF Receiver	EK0896	6038.2509.14

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Contents of Chapter 5

Complex automatic systems – even nationwide

Rohde & Schwarz has decades of experience in the design and implementation of complex radiomonitoring, radiolocation and spectrum management systems:

- Stand-alone or multi-user systems
- Remote-controlled, networked, nationwide configurations using LANs/WANs
- Short-term delivery even of custom-tailored systems due to modular hardware/software design
- Full integration of the spectrum management and radiomonitoring tasks based on relational databases
- Training and logistics from a single source

When it comes to monitoring and locating frequency hopping networks, our fast digital search direction finders and receivers featuring synchronous scanning come into their own.

ARGUS – software for spectrummonitoring applications
Rohde & Schwarz developed a very modular software for spectrummonitoring applications called ARGUS. Due to its modular design ARGUS can be adapted to specific customer requirements. It enables not only the accomplishment of all measurement tasks according to ITU regulations but provides also an optimum interface to the spectrum management software.

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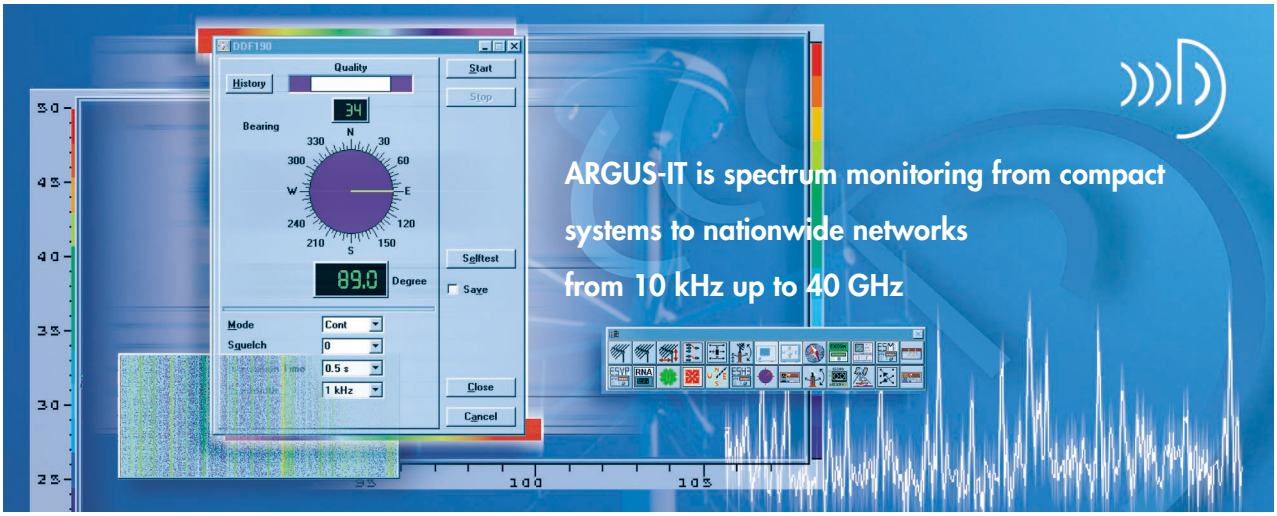
Spectrum Monitoring System ARGUS-IT



Brief description

The radio spectrum is a natural resource which cannot be enlarged. Being part of our environment it has to be maintained to provide the most effective use for communication. The major factors which determine the quality of the spectrum are:

- Interference from licensed and non-licensed users (national and international)
- Man-made interference

To maintain the quality of the spectrum, it is necessary to detect and avoid the described interference technically and by means of administrative measures. The International Telecommunication Union (ITU), Geneva, lays down the relevant rules and recommendations for spectrum monitoring and spectrum management. These rules and recommendations allow governmental authorities to do both:

- Serve their clients best
- Secure the license revenues

Spectrum monitoring permits the acquisition of information required for spectrum management.

The Rohde & Schwarz spectrum monitoring system ARGUS-IT concept is modular, extendable and upgradable. Therefore the operator can compose a basic set according to his budget, beginning with the core set of equipment for a modest amount of money. Step by step a nationwide system can be formed by adding additional hardware and software modules according to the availability of funds. In other words: A better service for clients yields more license revenues which pay for the whole system when reinvested.

Main features

- Reliability and modularity
- Compact system design
- Easy operation by intuitive graphical user interface
- Attractive price
- Automated measurement procedures
- Processing and evaluation of measurement results
- Interference analysis
- Storage of all measurement activities including results
- Interface to spectrum management database

Why use ARGUS?

The ARGUS software concept satisfies all requirements of a state-of-the-art monitoring and measurement system in a highly modular way. Four packages cover all the needs of modern operators:

- ArgusMon for all measurement and monitoring tasks
- ArgusEval for statistical evaluation and archiving of measurement results
- MapView for direction finder triangulation and geographical display on maps
- Link to frequency management database (IMPORT/EXPORT function)

Spectrum Monitoring System ARGUS-IT

Networking

The ARGUS system can be used as a single-station system, as a local network system (LAN) or as large, multi-station network (WAN).

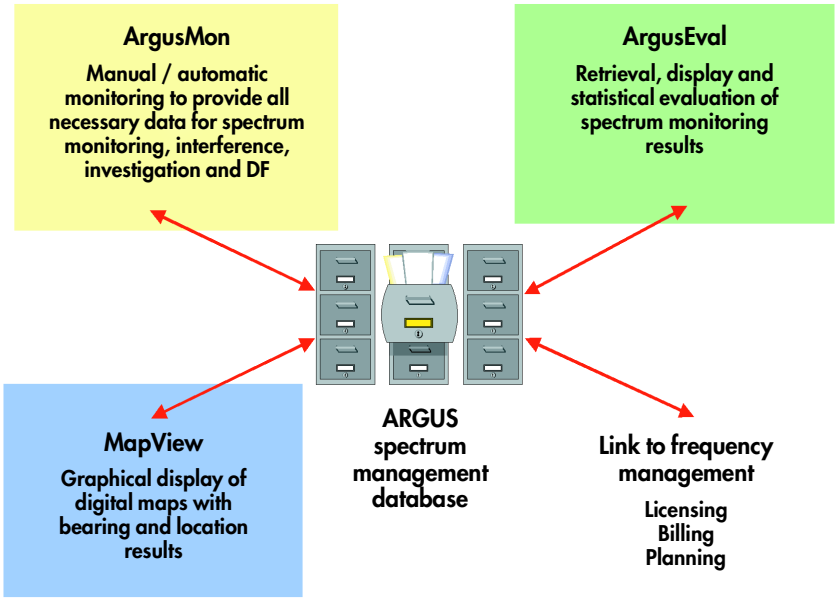
The software allows full client-server operation, with or without permanent connection. The protocol used is TCP/IP which has become a quasi-standard in worldwide communications. A large variety of different communication media allows a most flexible configuration:

- PSTN lines (dialled or leased, up to 57600 bit/s)
- GSM communication (9.6 kbit/s to14.4 kbit/s, with RLP)
- ISDN (64 kbit/s to 1500 kbit/s)
- Microwave links (19.2 kbit/s to 8000 kbit/s)
- Ethernet (10 Mbit/s to 100 Mbit/s)
- Dedicated digital lines (up to 2000 kbit/s)

The operation is totally transparent thanks to TCP/IP. Handling and control of the communication link are done by modern communication servers (routers).

Mobile applications

One core requirement for an efficient spectrum monitoring system is mobility. In many cases, eg remote areas of a country, urban environments or poor infrastructure, fixed monitoring stations need a mobile component to cover all necessary aspects of their duty.



ARGUS-IT modules

Due to the flexibility of ARGUS-IT, mobile or transportable systems are equipped with the same software as fixed stations. Moreover, the simple addition of compass, GPS and mobile communication (eg GSM or AMPS) adds significant value to a monitoring network and makes the mobile system a fully integrated monitoring station, inclusive of simultaneous transfer of audio and data.

We have the right device driver for all Rohde & Schwarz analyzers, receivers, direction finders and accessories for use in monitoring.

Of course, should it be necessary, Rohde & Schwarz will develop device drivers for other models and manufacturers as well. The main criterion is always that the devices have standard interfaces (eg RS232, IEEE 488.2, Ethernet).

Radiomonitoring vehicle

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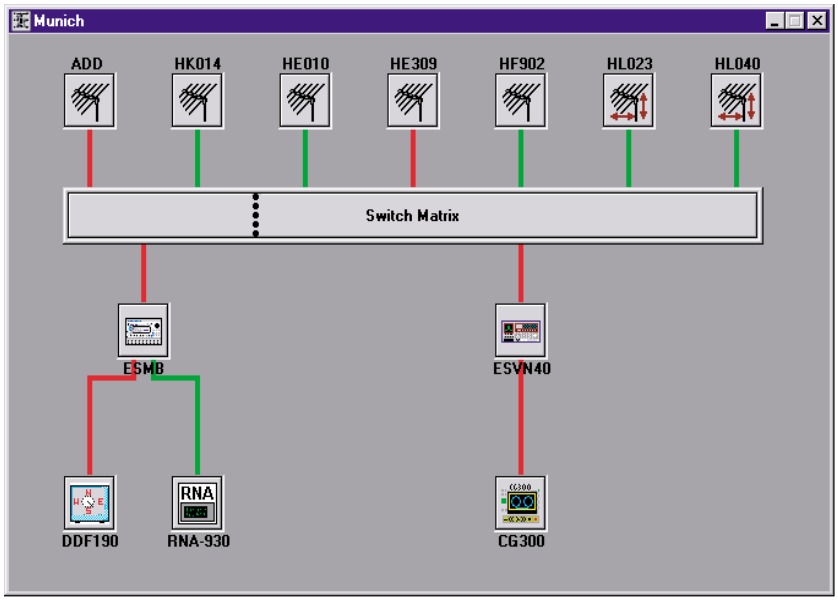
Spectrum Monitoring System ARGUS-IT

Data interfaces

The ARGUS software modules allow many ways of exchanging data between the modules themselves and other applications. These are:

- Dynamic data exchange (DDE) – transfer of ArgusMon data to other applications like MS Excel, MS Access, MS Word
- Open database connectivity (ODBC) – transfer and reception between ArgusMon database and other databases like MS Access, ORACLE, spectrum management software
- Data access object (DAO) – transfer and reception between ArgusMon database and other databases using files like Excel files, dBase files
- Rohde & Schwarz internal formats – data exchange between all ARGUS modules



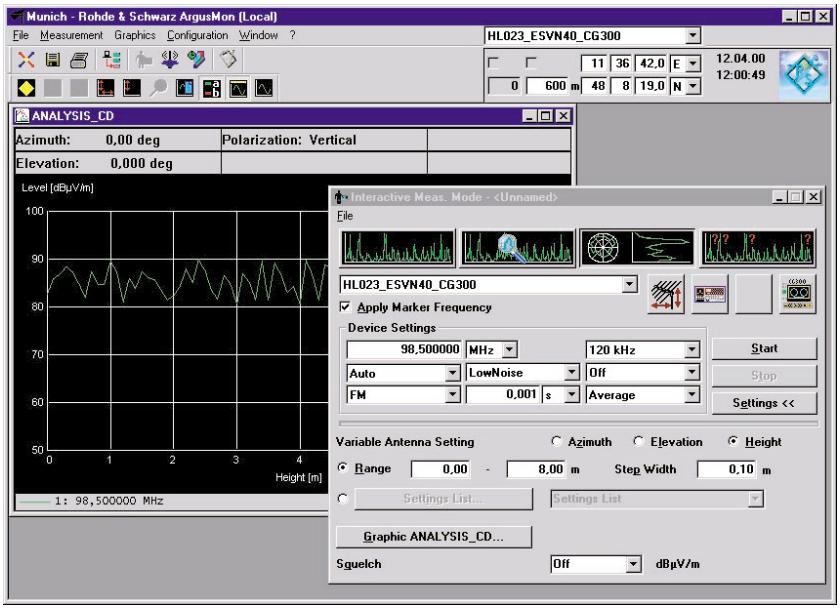
System Visualizer

Spectrum Monitoring

The following most important applications have been worked out by Rohde & Schwarz together with different national regulatory bodies on the basis of their daily work as well as of all measurements described in the ITU Spectrum Monitoring Handbook.

- Interference due to co-channel emissions identifies an emission at a known frequency
- Interference due to adjacent channel emissions determines an emission at a known frequency and identifies an emission at an unknown frequency
- Interference due to intermodulation determines sources of intermodulation
- Monitoring of the technical parameters of transmitters measures the relevant parameters of an emission at known frequencies
- Coverage measurements at fixed stations reveal the exact field strength of a known transmitter at a fixed location
- Identification of unlicensed transmitters exposes unlicensed emissions at a known frequency
- Deviation measurements of FM broadcast transmitters determine the peak deviation of one or several FM transmitters under operating conditions

Interactive measurement mode



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- Long-term monitoring of transmitters involves the determination of relevant transmitter parameters over a long period and their statistical evaluation
- Frequency occupancy measurements determine the occupancy of one or several known channels

ArgusMon measurement modes

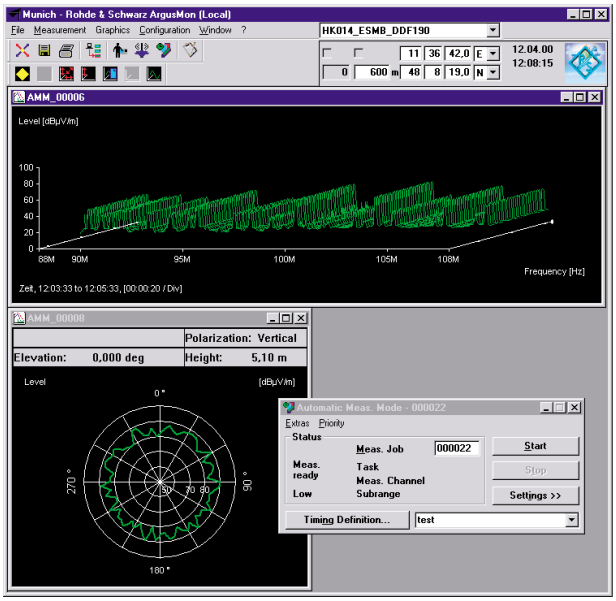
ArgusMon handles all spectrum monitoring tasks in four measurement modes which are briefly outlined below:

- The **direct measurement mode** is used to control the devices directly
- The **interactive measurement mode** is used for fast finding and identification of electromagnetic emissions within the frequency band being measured, for quick identification of interfering signals in the frequency spectrum, for identification of unlicensed stations and to trace possible source signals of an intermodulated signal. Intermodulations with up to three source signals are taken into account
- The **automatic measurement mode** is used primarily for the surveillance and observation of the parameters bandwidth, field strength, frequency and modulation
- The **bearing measurement mode** controls up to four direction finders simultaneously. The controlled devices can be located in various monitoring stations

Security concept

The security concept of ArgusEval comprises three areas:

- Security through user groups as owners of the files
- User class concept with grading of access rights
- Password protection



Automatic measurement mode

Evaluation Software ArgusEval

Evaluation Software ArgusEval enables a comprehensive statistical evaluation of measurement results in accordance with the standards and recommendations of ITU-R. Measurement results, their definitions and statistical evaluations can also be documented.

Histograms and distribution can be determined and documented on the basis of the channels. These calculations can be used for providing information about the following quantities:

- Variation bandwidth of measured values
- Stability of measured values
- Ambient noise component
- Cross-modulation and intermodulations effects

Service during whole life cycle

Rohde & Schwarz provides service during the whole life cycle of any ARGUS-IT system. This service includes support during the requirement analysis and system configuration as well as training, hot line and maintenance of hardware and software during operation.

Available ARGUS device drivers for

- Receivers and Analyzers: ESxN, ESH3, ESVP, FAM, FSx, ESxI, ESM, ESMC, VSA, ESxx, EB200, EK89x, FSEFSIQESI, FMx, EFA, ESMB
- Direction Finders: PA025, PAx55, PA1555, DDF190, DDF0xM
- Decoders and Recoders: RNA-930, DEF, DMC01, CG300, TELEVOX, SWS80, PCM-7010, OPTOTRAKKER
- Accessories: RSU, RSU_S, HSRG, BG030, ORBIT, BG016, COMPASS, GPS, GX300, XL-DC

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Basic Spectrum Monitoring System ARGUS-IT Basic

According to ITU Recommendations

Photo 43456-1

Brief description

Spectrum monitoring becomes transparent with solutions from Rohde&Schwarz. The well balanced combination of hardware and software allows:

- Display of frequency spectrum
- Monitoring of specific frequencies
- Measurement of technical parameters
- Direction finding
- Graphical and numerical evaluation of measurement results

The ARGUS-IT Basic system is the core of our spectrum monitoring systems. It is designed for fixed and mobile applications, is extendable and can be networked. So it is the first step to a nationwide spectrum monitoring system.

The system is of compact design. All measurement and DF equipment including PC, TFT display, antenna switch unit and printer are installed into transport housings. The system is also equipped with the necessary accessories like cables, antennas for monitoring/direction finding, and antenna masts.

With the support of the ARGUS software (see page 135), which is installed on the PC, the measurement and bearing results can be stored, evaluated and printed out. It is also possible to program a set of measurements, which are then performed automatically for unmanned operation.

The system covers the frequency range from 9 kHz to 3 GHz with the Monitoring Receiver ESMB for signal reception, measurement, identification and audio monitoring. With its digital IF section, the ESMB can provide 17 different bandwidths. With the DIGI-Scan option, any frequency range of interest is scanned with digital control and displayed as a spectrum.

Main features

The ARGUS software provides the following functions:

- Spectrum occupancy measurement
- Signal parameter measurement
- Signal direction finding
- Signal identification
- Signal evaluation and statistics
- Report creation

Acknowledgements

With ARGUS-IT Basic it is possible to accomplish all important measurement tasks in spectrum monitoring:

- Frequency and frequency offset measurement: ITU R SM 377
- Field strength measurement: ITU R SM 378
- Measurement of occupied bandwidth: ITU R SM 328
- Modulation depth and frequency deviation measurement: ITU R SM 328
- Occupancy measurements and spectrum analysis: ITU R SM 182
- Visual spectrum monitoring with IF analysis: ITU R SM 328
- IF analysis with audio check of received signal (identification) using AM, FM, CW and SSB demodulators with selectable AF bandwiths and AF squelch: ITU R SM 328
- Direction finding: ITU class A for HF, ITU class B for VHF/UHF

Planning Support and Monitoring System for FM and TV transmitters ARGUS-FMTV

Interior of ARGUS-FMTV test vehicle

Brief description

Planning and monitoring of FM and TV transmitters

Telecommunication organizations together with broadcasting corporations are responsible for the frequency planning for FM and TV transmitters. The transmitter parameters and sites must be coordinated with broadcasting corporations at home and with relevant telecommunication authorities abroad. Transmitter parameters must be monitored during operation.

Planning Support and Monitoring System for FM and TV transmitters ARGUS-FMTV from Rohde & Schwarz is a cost-effective solution to support these tasks.

Normally, the organization to perform these tasks has a frequency planning service and a monitoring service. Based on certain computation models, the frequency planning service makes theoretical calculations regarding the coverage of the region by a given or planned transmitter. Measurements are planned and prepared to check these calculations. To this effect, different frequency ranges are defined as well as lists of transmitter frequencies to be measured and test sites required for the measurements.

The monitoring service then carries out the measurements with a test vehicle. The quality of the measurements can be assessed from initial evaluations carried out on ARGUS-FMTV. This evaluation is based on selectable guidelines. These guidelines, which are defined by international and national bodies, stipulate the assessment and mathematical evaluation of interfering transmitters, for example. The measurements may be repeated as required.

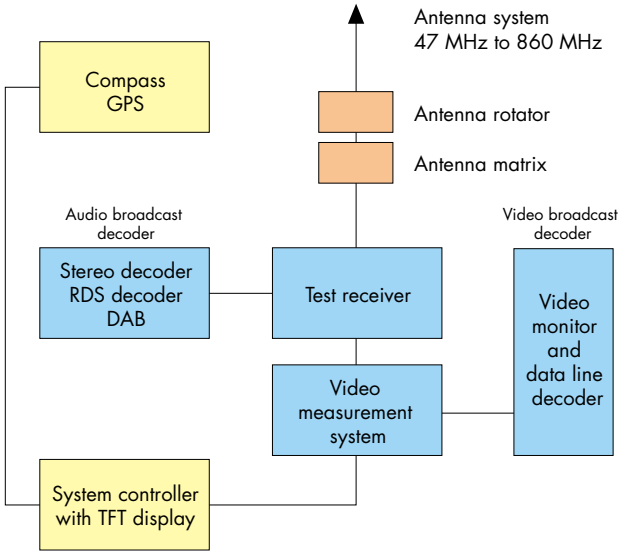
Final evaluation of the test results is performed by the frequency planning service.

The ARGUS-FMTV system is installed in a vehicle and comprises the Monitoring Software ARGUSMon and a test receiver for measuring field strength, modulation, frequency offset and reflection at FM band, an RDS decoder for decoding transmitter information at FM band, an RDS codec for decoding transmitter information in

Planning Support and Monitoring System for FM and TV transmitters ARGUS-FMTV

the TV band, a video measurement system for measuring reflections in the TV band, and a process controller. An antenna system covering the frequency range from 47 MHz to 860 MHz is used for reception. The antenna is mounted with an azimuth and a polarization rotator. The individual antennas of the system are selected by means of an antenna selector.

The ARGUS-FMTV system thus offers a reliable support in the frequency planning of FM and TV transmitters as well as monitoring of transmitter parameters. With its ultramodern technology it enables the responsible telecommunication organizations to efficiently perform their tasks.



ARGUS-FMTV block diagram

ARGUS-FMTV vehicle

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Modular Radiomonitoring System RAMON

We have the spectrum covered: nothing goes unnoticed from 10 kHz up to 40 GHz

Brief description

Times call for flexibility
The challenges for radiomonitoring are growing rapidly: political structures have changed, technology has improved, time moves faster. This is the time for compact, flexible and modular radiomonitoring systems, which can quickly be adapted to the actual demands.

With RAMON always up-to-date
RAMON is the name of a Rohde&Schwarz radiomonitoring system. A unique concept based on a set of products to cover customers' needs. The advantage of the RAMON concept is its modularity – providing the full scale from portable receivers to complete systems for radiomonitoring, location and analysis. Custom-tailored solutions are implemented by connecting standard hardware components and off-the-shelf, tested software modules.

RAMON can easily be upgraded, so that a compact system can be expanded step by step to form a complex monitoring system.

RAMON modules

RAMON Search scans frequency bands for known and new signals – a good starting set for radiomonitoring. Together with a high-speed Search Receiver or direction finder, which is the core of RAMON Search, the frequency range can be scrutinized. Signal parameters can be stored on digital disk for later evaluation and statistics.

RAMON Monitor observes interesting signals. The set can be configured with different receivers to cover the whole frequency range from HF to SHF.

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Modular Radiomonitoring System RAMON

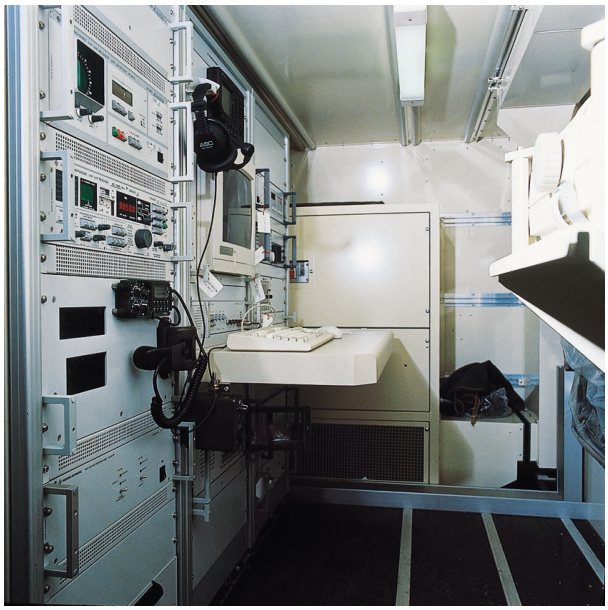
Signal parameters and tactical information are stored in operational reports, and signal contents can be recorded on DAT tapes or multitrack recording systems.

RAMON Locate identifies the location of radio transmitters by triangulation. Three different types of powerful direction finders are available for the frequency range from 0.5 kHz to 3000 kHz. The bearings and locations are displayed on digital maps using MapView.

RAMON Supervise manages the operation of one or more of the above-described modules. So several RAMON modules can be combined to form a versatile monitoring system.

RAMON Evaluate allows to store, sort and analyze all information gathered with RAMON. Operational and tactical reports can be created. Post data evaluation provides statistical information like channel activity or waterfall displays.

RAMON Compact is the combination of the Search, Monitor, Locate and Evaluate modules – ideal if the available space is limited as in shelters, ships or aircraft. With this combination set, sophisticated monitoring tasks are performed with a single system.



RAMON operating philosophy

RAMON operation is based on an order report structure. The orders contain information for the operators to perform their task. Receivers and direction finders are set automatically to the data contained in the order. For fast operation, the operator can transfer device settings from one receiver to another only by pressing one button. The search, monitoring and direction finding results are translated into reports, which are attached to each order. Bearings and locations are additionally displayed on a digital map. All reports are stored in a database and provide the basis for tactical and operational reports. For further processing, RAMON provides an interface to standard software and other computers.

RAMON key features

RAMON orders are search orders, monitoring orders and direction finding orders. Search orders can contain:
– up to 9 frequency scan ranges
– up to 500 single frequencies
– up to 50 suppress frequency ranges

RAMON reports contain information on:
– receiver settings
– technical signal parameters
– signal contents
– direction/location

RAMON evaluation provides radio-network-oriented information such as:
– network structure information
– network station
– network members
– network call signs
– network frequency list
– operational and tactical reports
– data export possible (CSV-format)

RAMON statistics provide graphic diagrams on:
– channel occupancy
– frequency/level
– frequency/time activity
– RAMON

Device drivers for
– HF Receivers EK893, EK895, EK896
– V/UHF Receiver ESMC, EB200
– Automatic Scan Receiver ESMA
– SHF Receiver Gigatune
– Digital Direction Finders (HF, V/UHF) DDF0xM, DDF0xS, DDF190
– EP127 spectrum display software
– All Audio Digital Recording System
– Antenna Rotor HSRG
Other drivers on request

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DF/Location System Software MONLOC

Combines two or more Digital Monitoring Direction Finders DDF0xM or DDF190 to a DF and location network

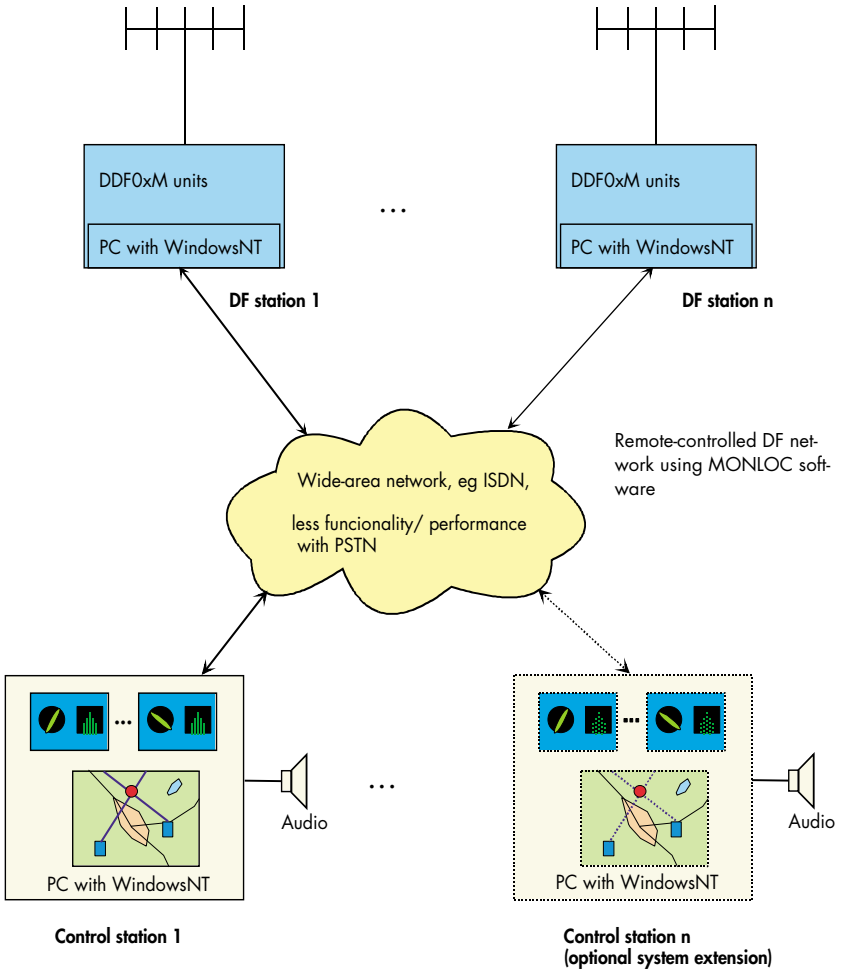
Brief description

MONLOC allows direction finding of conventional signals (DDF190) as well as of very short and wideband emissions (DDF0xM). Depending on the antennas and DF converters used, a frequency range from 0.3 MHz (DDF190: 0.5 MHz) to 3000 MHz can be covered in the fixed-frequency, search or scan mode. With MONLOC, two or more Digital Monitoring Direction Finders DDF0xM or DDF190 can be combined to a DF and location network. The DF and location results are displayed on a digital map.

System concept

The MONLOC software permits to display the graphical user interface (man-machine interface MMI) of the digital direction finder on a remote PC when connected to the detached direction finder via common communication links (see illustration). The demodulated audio signal can also be transmitted via these links.

The available transmission bandwidth is optimally used so that even at low data rates full system operation and almost constant probability of interception (POI) is achieved. Since one or several direction finders can be remote-controlled from different operator positions, full-area direction finding can be performed with very few personnel.



Main features

The operator – at one of the freely selectable control stations – selects the required direction finders from a list within the area of interest to activate the automatic dial-up procedure for the wide-area network connection (eg ISDN). For reliable triangulation results the combination of at least three direction finders is recommended.

On the monitor of the local PC the user interfaces of the selected direction finders are simultaneously displayed. The positions of the selected direction finders and the actual bearing lines are displayed on the digital map.

The DDFs are controlled in the same way as in local mode. By selecting one of the DDFs, the AF (audio) of that direction finder can be transferred to the operator's position for clear identification of the actual signal. MONLOC provides three operational modes:

- Fixed-frequency mode
- Search mode
- Scan mode (DDF0xM)

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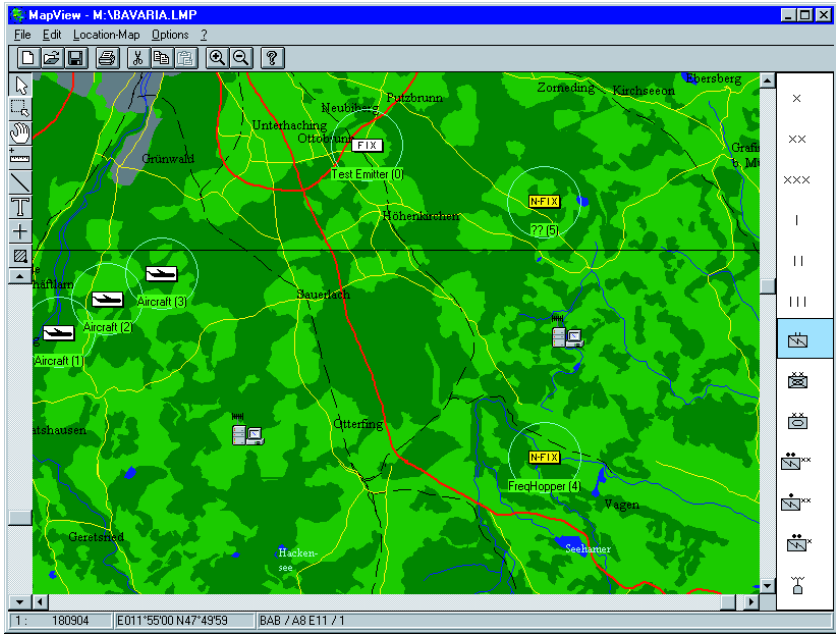
DF/Location System Software MONLOC

Networking of digital direction finders
To improve the efficiency of radiomonitoring and direction finding with quick determination of the location of an emitting source by triangulation, networking of several digital direction finders is essential. MONLOC provides as basic configuration the control of two DDFs (one local and one remote). Further remote direction finders can be connected optionally. For each additional direction finder, an additional remote control software license is needed.

Map display
MONLOC displays a digital map. This is achieved with the integrated MapView software module. MapView supports digitized vector maps as well as pixel maps.



Display of digital map with location results

Location results
On the digital map, the position of the transmitter is displayed as a yellow dot. The position is calculated from the bearings of the selected detached stations.

Offline evaluation option
With this software option, averaged location results with date/time of activity and additional information can be stored in a database. Results can be selected from the database and displayed offline on the corresponding map for later evaluation. The positions of mobile emitters can be displayed, showing the track of the mobile.

System data

Operating system	Windows NT
Transmitting lines	wide-area network (WAN), eg ISDN; other lines on request
Further specifications	Direction Finder DDF0XM (page 105), Direction Finder DDF190 (page 116) and associated ADD antennas (page 109) MapView/MapEdit (page 148)

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Scanning Radiolocation System SCANLOC

Location finding of frequency-agile and short-time emissions

Brief description

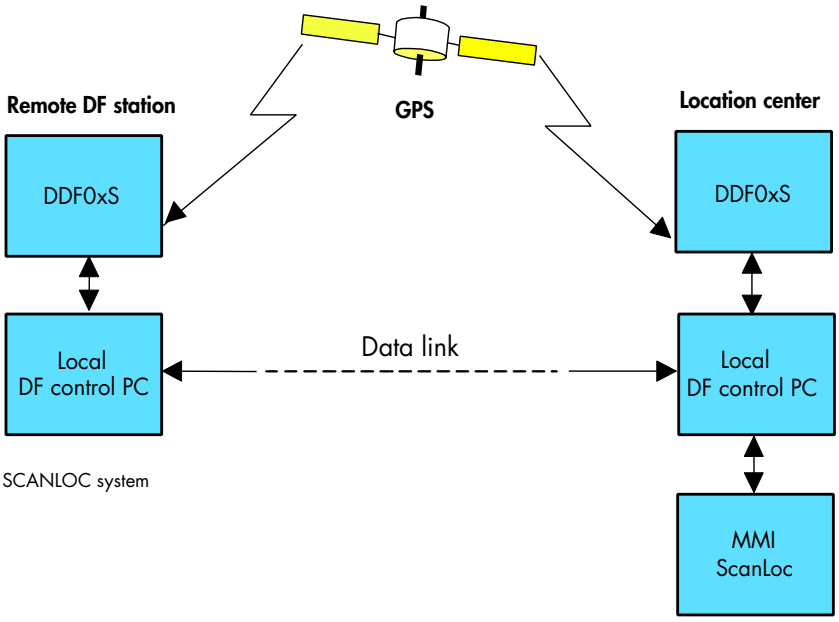
SCANLOC is a radiolocation system for

- short-time radio emissions,
- frequency-agile radio emissions (eg frequency hoppers),
- intermittent radio emissions,
- using direction finders in synchronized scanning mode.

The heart of the system is the Digital Scanning Direction Finder DDF0xS with its high scanning speed of up to 200 MHz/s. Up to four direction finders can be integrated into the SCANLOC system.

Main features

- One location center with up to four direction finders
- Location calculation (spherical) performed in the location center
- Message handling integrated for operator mails between location center and remote stations
- Only 30 minutes setup time with two trained people (depends on DF antennas used)
- Instantaneous signal interception, direction finding and radiolocation
- Automatic recognition of emission type:
  - fixed-frequency radio emissions,
  - frequency-agile radio emissions
  - intermittent radio emissions
- Tracking of mobile radio emitters
- Storage of location results in a database



SCANLOC system

SCANLOC system concept

Up to four direction finders DDF0xS can be linked to a scanning location system. The whole system is controlled via the location center. The direction finders at the individual DF sites are synchronized via GPS and scan the same frequency range. All bearing results together with the associated frequency and time tags are buffered on the local subsystems. The system provides an internal data reduction so that it can operate with low capacity data links ≥19.2 kbit/s.

Operational modes

Two main operational modes are available:

- Continuous surveillance of a scenario
- Focussed snapshot of a scenario

In both modes, the recognition function can be activated.

Continuous surveillance of a scenario
This is the automatic operating mode of the system. It provides an overview of all signal activities in the selected scan range together with their locations.

The system scans the frequency ranges of interest and produces location results.

Focussed snapshot of a scenario
This manual operating mode interrupts the continuous surveillance mode. It enables the operator to concentrate on a single event, which may even be not active anymore. The operator can focus on a special part of frequency range, azimut range and time range

This mode is especially designed for a quick examination of specific emissions in highly dense signal scenarios.

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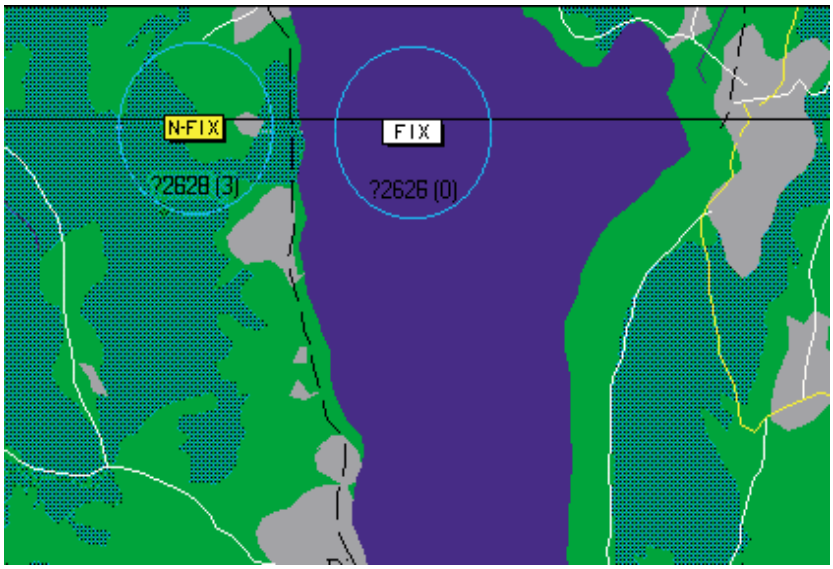
Scanning Radiolocation System SCANLOC

Signal library

The operator can store all signals of interest in a signal library. The following parameters are stored:

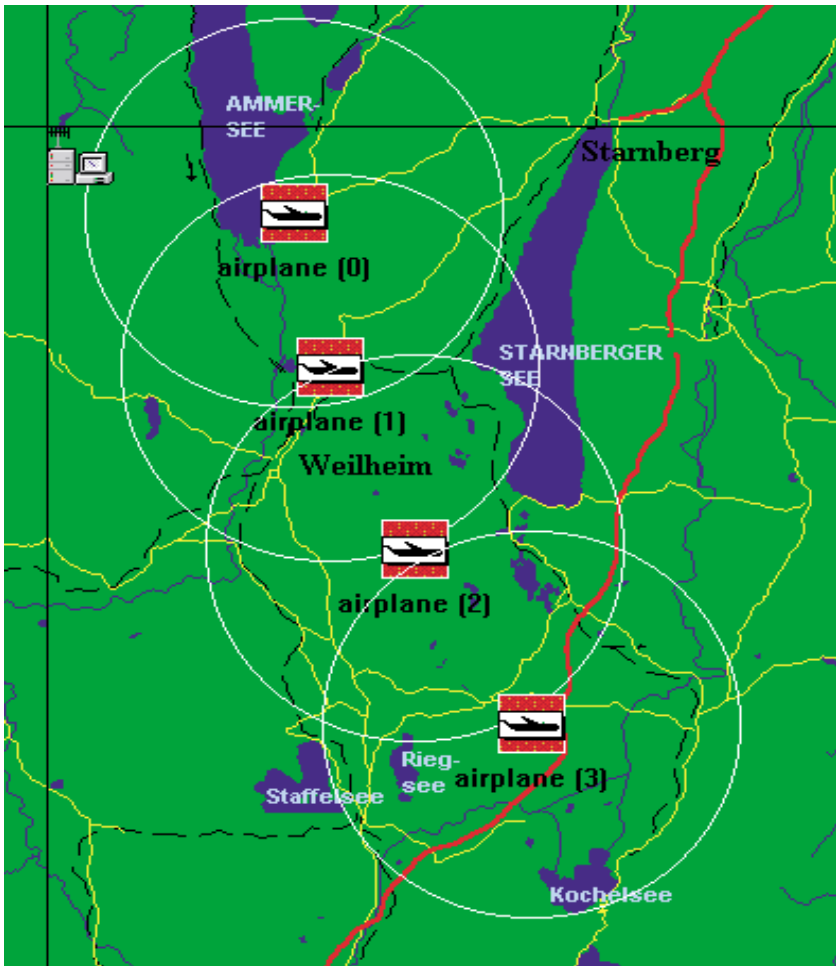
- Frequency/list of frequencies for FH
- Signal ID
- Emitter name
- Net code
- Type of signal
- Bandwidth
- Comments
- Start/stop time
- Position



Recognition function: When the recognition function is selected, the activities are pre-classified. Location results of the same position (with tolerance) or same frequency are combined and displayed as a circle, denoting the type of signal. This provides further data reduction for the operator

System extensions

- SCANLOC can be integrated into a radiomonitoring system based on RAMON. This allows use of the RAMON order/report concept
- Further Hand-off/Monitoring Receivers ESMC, EB200 or EK895 can be connected
- All stations (center and remote) can be integrated into shelters for semi-mobile operation



SCANLOC database

With the aid of the SCANLOC database, the operator can also display historical results of locations and look for the path on which a mobile emitter has moved.

Also the entries of the signal library can be transferred into the SCANLOC database

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Software MapView/MapEdit

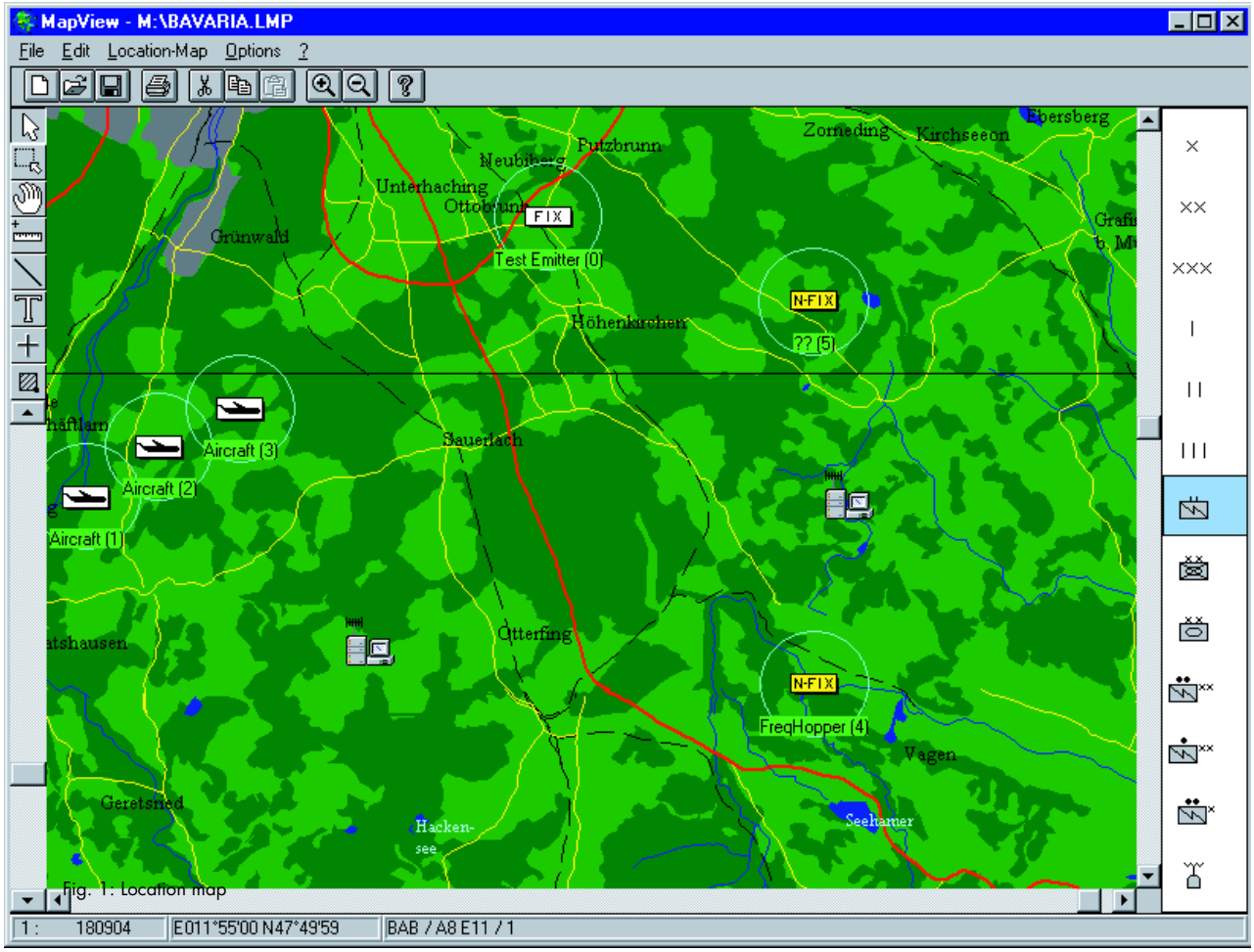

Fig. 1: Location map

Digital map display for direction finding and radiolocation systems

Brief description

MapView and MapEdit from Rohde&Schwarz are two powerful, network-compatible software packages for radiolocation applications. They are operated under a Windows user interface and therefore easy to handle.

Main features

MapView

- Fast online display of results on digitized map
- Offline display of results (from databases)
- Simple graphical display of scenario
- Integral part of location systems MONLOC, SCANLOC and DDFLOC
- Option for RAMON and ARGUS radiomonitoring systems
- Calculation of positions with the aid of spherical trigonometry

MapEdit

- Adding information to the map
- Using maps from geographical information systems
- Adapting maps to specific applications

MapView

System functions

MapView is used for the display and evaluation of direction finding and radiolocation results. The control software for the direction finders is included in the Rohde&Schwarz radiolocation and radiomonitoring systems.

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Software MapView/MapEdit

MapView receives the location data of the individual direction finders and the associated DF results for a target transmitter via a Windows system interface. The data may result from current measurements or come from the database of an evaluation center. With the aid of the DF results and the direction finder locations the location of the target transmitter is calculated using spherical trigonometry. This is followed by the graphic display of the DF and location results. Hidden details of the graphic display can be revealed in a window by double-clicking on the desired location point:

- alphanumeric location result (in UTM or GEO coordinates),
- frequency,
- quality level,
- number of DF operations,
- time/date,
- remarks.

The location results obtained for a transmitter can be averaged and compiled in plots. A plot contains several location results of a transmitter at one or several frequencies (frequency hopper). Should the transmitter be moving, this is automatically detected and displayed, ie the plot moves on the map correspondingly.

The location results can be provided with a name and icon and stored in a signal library. If the transmitter becomes active again, it is automatically displayed with its name and icon.

Optional postevaluation
This option is used for online storage of the averaged location results (plots) in a database. In a postevaluation process specific location results can be searched for and displayed on the map. The digital map required for MapView is generated or converted with the aid of MapEdit and adapted, if necessary.

MapEdit

Generating digital maps
Digitized maps can be generated with the aid of Windows software MapEdit. This software allows bit or vector maps to be imported or generated and edited with the aid of a scanner, digitizer or mouse. It is possible to

- adapt available maps to user-specific needs,
- add information to a map (eg icons),
- use maps from geographical information systems.

The maps may be printed in any scale. Windows provides a large variety of drivers for printers and plotters.

Convenient display
A map is made up of several superimposed layers which may contain text, points, lines/areas, scanned maps or icons. The layer technique allows representations to scale with variable information depth (layers can be inserted or cut). The use of different colours and icons makes for versatile ways of representation. Any map section can be displayed by entering the coordinates. A zoom function allows continuous zooming of a specific section.

Hardware and software requirements

MapView
Pentium PC with 32 Mbyte RAM, 256-colour graphics card, Windows 95 or WindowsNT

MapEdit
Pentium PC with 32 Mbyte RAM, 256-colour graphics card, Windows 95 or WindowsNT

The following hardware/software is recommended for generating user-specific maps:
Scanner for bit maps, eg HPScanJet DIN A4 with Aldus Photostyler software
Digitizer for vector maps: Summagrid V from Summagraphics

Ordering information

DF and Radiolocation Software	MapView	4046.1205.02
Map Editor	MapEdit	4046.1170.02
Extras		
Optional postevaluation		on request
Material supplied		software including manual and dongle
Demo disks		on request

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Radiolocation System NetTrap ML 501

Mobile, portable Location System

Brief description

NetTrap ML 501 from Rohde&Schwarz is a compact radiolocation system using the map-based Software MapView/MapEdit (page 148) in combination with the portable Direction Finder PA1555 (page 119).

The system includes full-duplex radio links for data transmission and voice communication between central station and each remote station, which makes the system ideal for use in areas without any infrastructure.

The radio links are normally used for data transmission in order to control the remote direction finders and for getting the bearing results back to the central station simultaneously. Alternatively they support full-duplex voice communication which makes establishing the radio links even more easy.

The system is operated from a single operator position in the central station with MapView/MapEdit. This graphical user interface provides easy control of the direction finders and display of the DF and location results on a digitized map on the computer screen.

Main features

- Complete location system comprising
  – 1 central DF station and
  – up to 3 remote DF stations
- Mobile use
- Compact design
- Frequency range 20 MHz to 1000 MHz
- Radiolocation Software WinLoc integrated
- Built-in full-duplex data/voice radio units for control of remote stations and voice communication
- Each site operated from a single +12 V DC supply, eg car battery
- Easy setup without infrastructure
- Easily portable due to small size and low weight
- Ideal for temporary missions and rapid changes of sites
- Integration into vehicles possible

System description

The task of the triangulation system is to provide radiolocation service in a defined area of interest independently of the local infrastructure.

Due to the system concept two or more location cells can be used within overlapping areas independently from each other.

Each station requires only a single +12 V DC supply voltage, eg a car battery.

The central station comprises a rugged laptop computer with integrated TFT colour display, the central radio unit with four radios and the local direction finder.

Up to three remote stations, each consisting of a direction finder and a remote radio unit with two radios, can be controlled from the central station.

The radio units contain a transmitter, a receiver and an antenna signal distribution as well as data interface components necessary for transmitter control , synchronization to incoming data signals and data integrity.

Each radio unit contains a GPS receiver and provides a single connector for the RF signal from and to the communication antenna and RS-232 serial ports for connection to the computer or direction finder.

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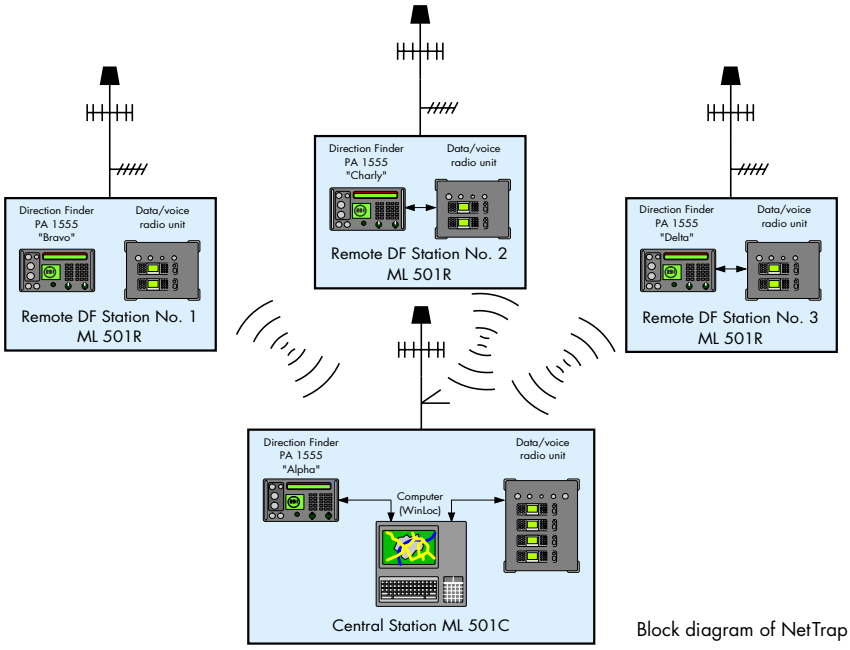
Radiolocation System NetTrap ML 501



Block diagram of NetTrap ML 501

An electronic compass may be connected to the radio unit.

The radio links are transparent to the user, so that the radios have simply to be set to the desired channels. During voice communication the data transmission will be interrupted and automatically continued when the voice communication is finished.

Specifications

DF components

DF frequency range	20 MHz to 200/1000 MHz
Direction Finder	PA 1555
DF Antennas	AP 1555 G AP 1555 T (AP 1555 G + AP 1555 U)

For more information please refer to PA 1555 (page 119)

Graphical user interface	Radiolocation Software WinLoc
Response time	triangulation results available after approx. 2 s
Result update rate	<1 second intervals between consecutive DF results, simultaneously from all direction finders

For more information please refer to Software MapEdit (page 148)

Computer

Rugged laptop	Pentium, 133 MHz, 32 Mbyte RAM, TFT colour display 640 x 480 pixels
Power supply	10.8 V to 14.5 V
Current drain	2.5 A
Dimensions (W x H x D)	420 mm x 95 mm x 390 mm
Weight	6.8 kg

Communication components

Frequency	
Remote to central	480 MHz to 493 MHz
Central to remote	507 MHz to 520 MHz
Other frequency ranges	on request
Number of channels	99
Modulation	FM
Output power	1/4/7 W
Data transmission rate	2400 bit/s, full duplex
Dimensions (W x H x D)	
Central station unit	approx. 400 mm x 320 mm x 300 mm
Remote station unit	approx. 300 mm x 320 mm x 250 mm
Weight	
Central station unit	16.7 kg
Remote station unit	9.9 kg
Power supply	10.8 V DC to 15.8 V DC
Current drain (radio unit)	
Central station (reception/ transmission/average[1])	1.6 A/5 A (peak)/2 A
Remote station (reception/ transmission/average[1])	0.8 A/3.5 A (peak)/1.5 A
Communication antenna	
Central station	horizontally polarized V dipole
Remote station	horizontally polarized dipole or Yagi antenna

Ordering information

NetTrap Center	ML 501C	3015.6009.02
NetTrap Remote	ML 501R	3015.6496.02
Accessories		
Plug-In Mast	KM 1555T	4036.9003.02
Transport Bags	PA 1555T	4036.9755.02
Cable Drum	PA 1555D	4036.9255.02
Headphones	PA 1555H	4036.9355.02
Loudspeaker	PA 1555L	4036.9561.02
Battery 26 Ah	ML 501B	3013.1297.26
Battery 40 Ah	ML 501B	3013.1297.40
Solar Panel 40 W	ML 501SP	3015.7740.40

[1] Under typical operating conditions.

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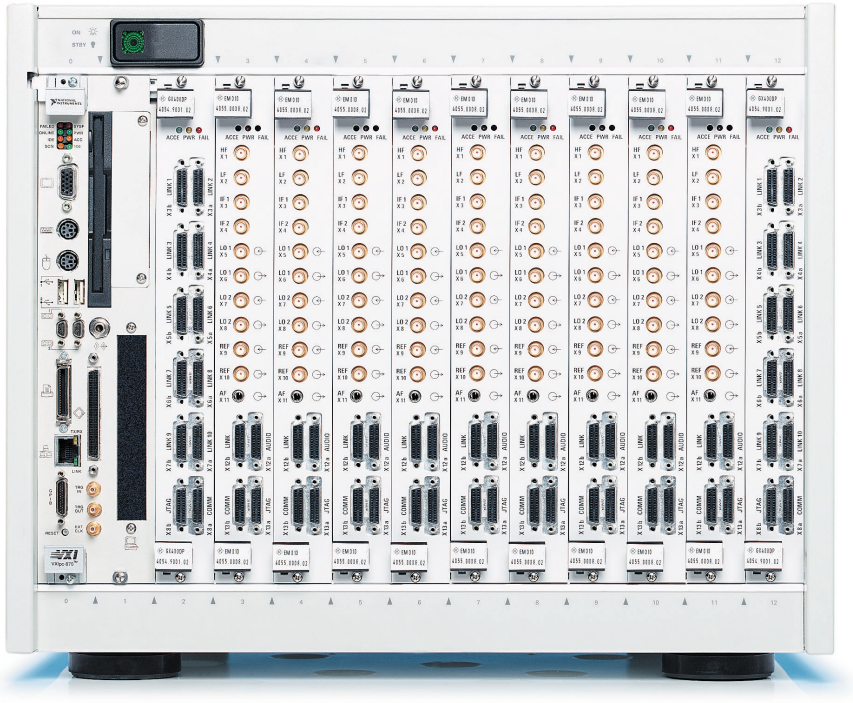
Automatic Modular Monitoring System AMMOS

Brief description

Digital RF links become transparent by automatic interception, classification, demodulation and decoding of signals using VXI receivers and digital signal processors developed by Rohde&Schwarz.

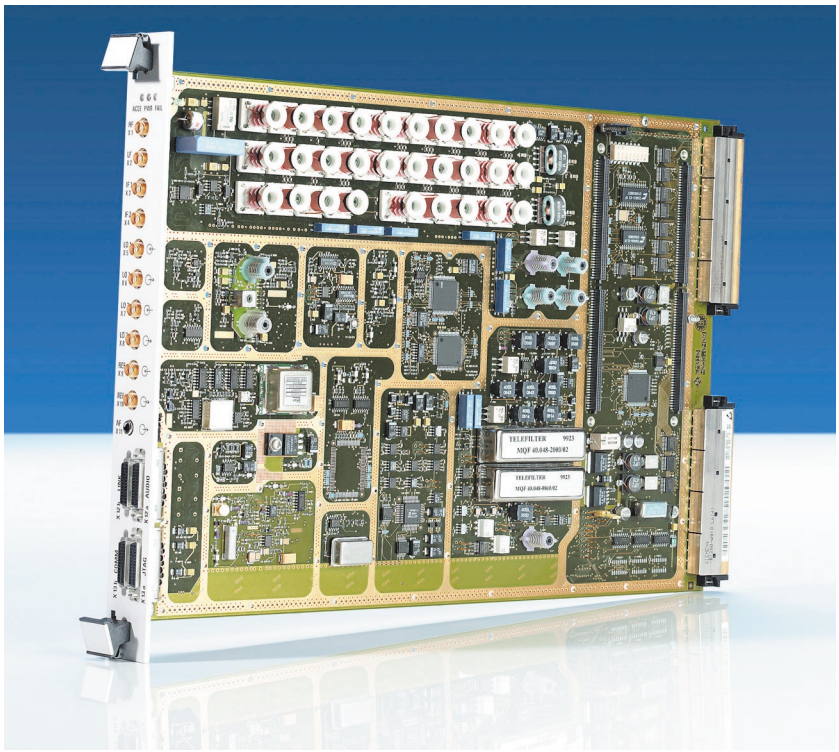
Classic monitoring system solutions consist of a number of special boxes with each box having dedicated and limited functions of its own. The customer-tailored system software controls these boxes. The advanced Rohde&Schwarz AMMOS solution provides flexible functions by using standard hardware boards. A set of standard software modules performs the specific tasks of interception, analysis, demodulation, decoding and visualization of signals.



AMMOS system (photo 43430-1)

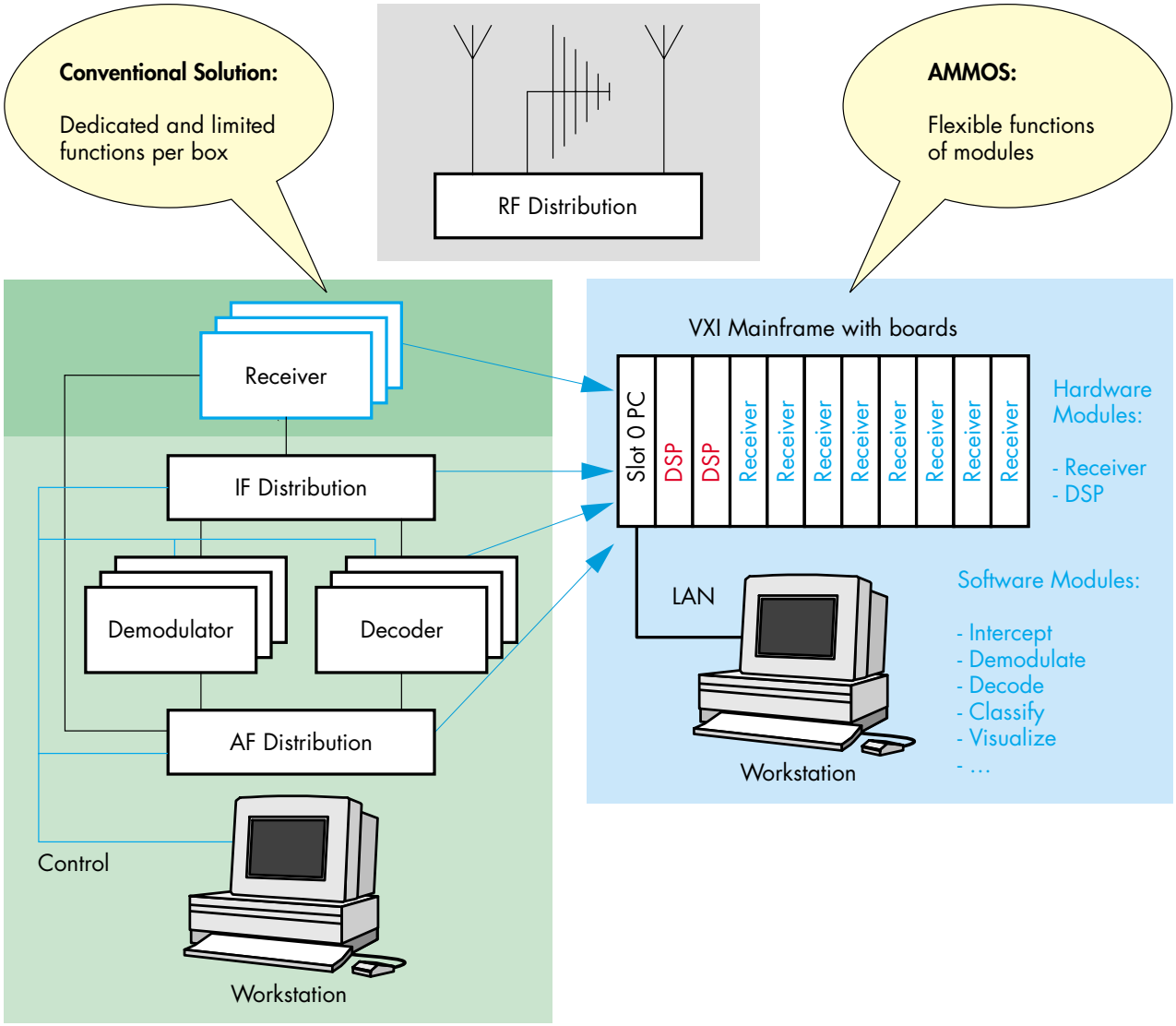
The AMMOS system can be configured according to the particular system requirements by selecting the necessary number of receivers, DSP boards, and VXI mainframes plus the required software modules. The VXI mainframes are connected to the operator workstations via LAN interface. The key features of this solution are:

- Enhanced flexibility due to multi-functionality
- Compact equipment size
- Support of programming/processing of customer-specific classified signal patterns
- Easy future extension capability
- Simplified logistics



Inner view of VXI receiving module (Photo 43430-2)

Automatic Modular Monitoring System AMMOS



Key components of AMMOS

VXI Receiver EM010 + EM050

- Frequency range
  300 Hz to 30 MHz (HF)
  20 MHz to 3.5 GHz (V/UHF)
- IF bandwidth 20 kHz/4 MHz (HF)
  250 kHz/20 MHz (V/UHF)
- Demodulation modes AM, FM, USB, LSB, ISB, CW
- Operational modes:
  fixed frequency, memory scan, frequency scan, replay, test

VXI Digital Signal Processor GX400DP

- Computing power >2 Gflops
- Memory 256 MB SDRAM
- Support of VXI bus and Shark link
- Easy handling of digital data streams
- Realtime data processing
- Digital IF distribution via LAN, no IF matrices required
- IF storage for replay by using buffer memory and recording server

Software library with

- Spectrum/sonogram display/eye pattern, phase pattern
- Digital signal buffer
- Modulation classificator/recognizer
- Digital demodulator
- Digital decoder
- Bit stream display
- Voice recognizer

Signal intelligence at sea with ERICA

Systems with integrated direction finder for ship-based communications intelligence

Brief description

ERICA[1)], the ship-based electronic reconnaissance system from Rohde & Schwarz, is ideal for diverse COMINT and COM-ESM tasks. It detects, receives, analyzes and classifies all communications signals in conjunction with electronic systems for the reconnaissance of radar and navigational signals. The main strength of the system lies in the detection of modern digital signals in the frequency range from 500 kHz to 3 GHz, and especially in the interception of very short emissions in the HF band.

Operation is largely automatic and permits extremely fast searching with the aid of the digital scanning direction finder as well as accurate setting of receivers and analyzers for identifying and classifying results. The systems are of compact design and thanks to their flexible interfaces they can be easily integrated in existing concepts and structures.

Fully automatic, order-controlled direction finding

The COMINT System ERICA from Rohde & Schwarz is fully automatic and order-controlled. An order defines the frequencies and azimuth ranges to be monitored by the direction finder. For fast monitoring, the high-performance direction finder with search speeds of up to 200 MHz/s (VHF/UHF) and 20 MHz/s (HF) is coupled to separate, matched signal receive paths. After signal analysis and classification, the parameters are saved with a time stamp in a database and are thus available for comparison and further evaluation.

Analysis, decoding and classification of signals

Digital HF receivers and fast data signal analyzers from Rohde & Schwarz are incorporated in the signal reception and classification paths. The analyzers with integrated digital signal classification and synchronized decoding also assume early-warning functions, ie an alarm is triggered when parameters of a signal are detected which has been defined as a threat.

Classification algorithms and demodulators are available for complex and fast FSK and PSK signals in addition to decoders for digital transmission methods. Using simple and easy-to-follow paradigms stored in a database, the system software allows the entry of additional signal descriptions.

---

1) (Electronic reconnaissance in combat application)

Signal intelligence at sea with ERICA

Characteristics

Clear result display
Results are presented on colour displays (FIG 1). The detected signals are shown in different windows on the user interface of the fast scanning direction finder, which ensures clear presentation of results to suit specific tasks (FIGs 2 to 4).

Security first
The system has a user management system with password-protected log-on procedure, loadable user profiles with different privileges, protection against unauthorized access during pauses and interruption-free operation on change of users.

Flexible system concept
Flexibility and upward compatibility are guaranteed features. The order-specific software modules with customized configuration and the instruments provided in the system are continually adapted to new requirements, eg for detecting new types of signals in the future. Parameters such as priority assignment, decision criteria and, if required, the steps for manual processing are saved in operational profiles. The latter can be rapidly activated as required by the signal scenario or the task to be performed. Frequency subranges with different operational profiles can also be processed in parallel or one after the other.

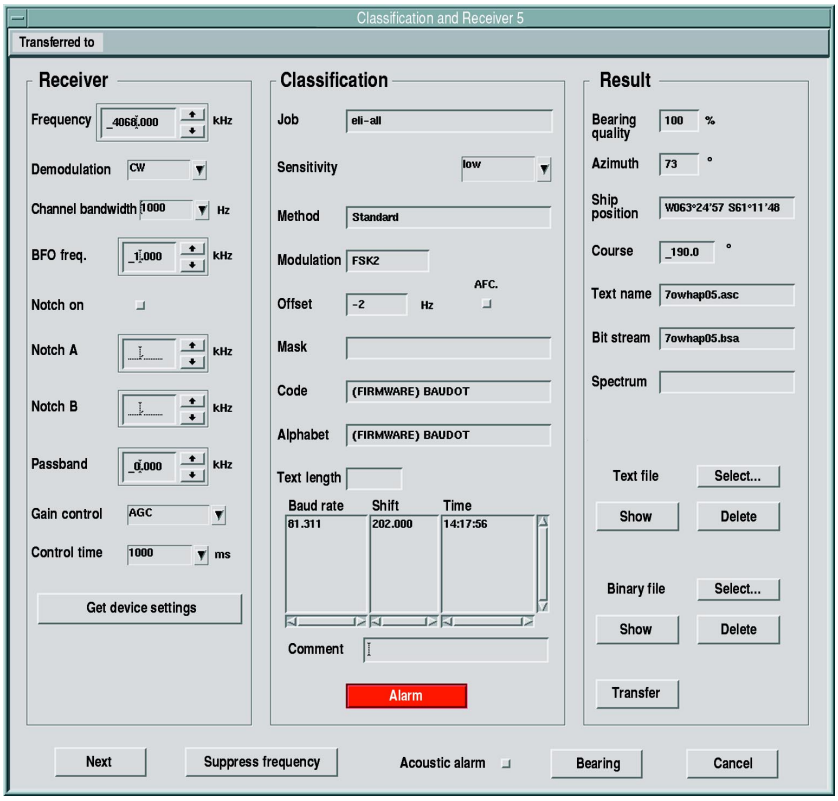


FIG 1: Easy-to-read display of each reception path in a result window: classification results, signal parameters and receiver settings

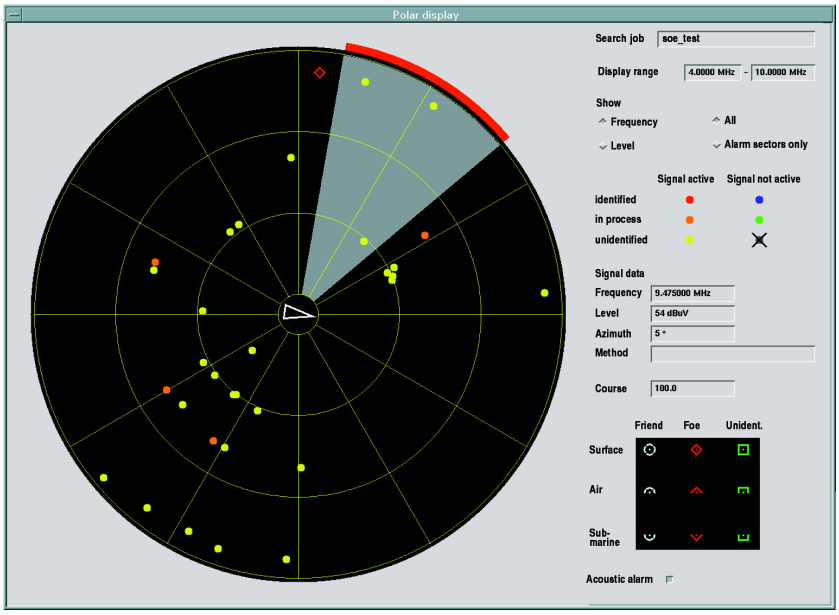


FIG 2: Polar display for north- or ship-referenced presentation of scenarios

Signal intelligence at sea with ERICA

Integration of the equipment into large ship-based reconnaissance systems, operation in other frequency ranges or adaptation to customer requirements are just as feasible as the incorporation in different ship platforms or the installation in shelters or shore-based stations. All system functions can of course be remote-controlled, eg from a detached operating center. Installation, training and logistic support are performed in the well-tried Rohde & Schwarz way and all this for customized systems too.

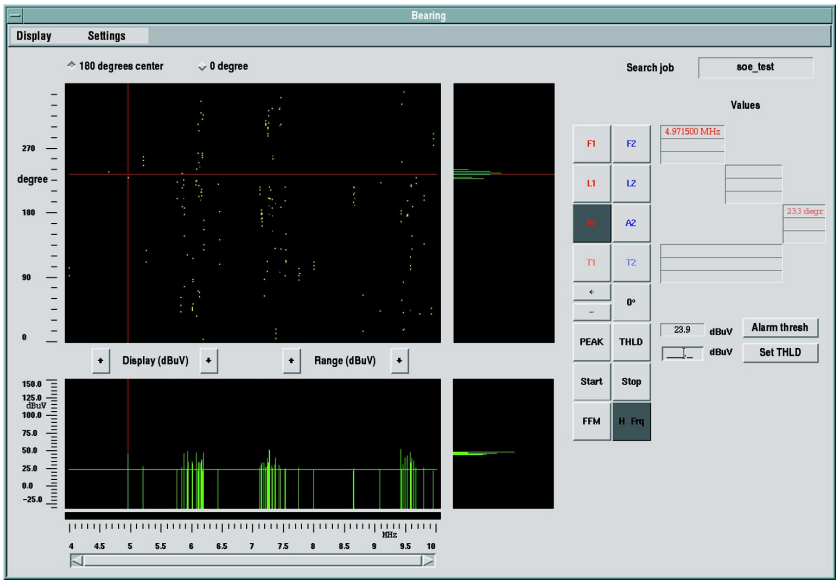


FIG 3: Display of histogram window for evaluation of azimuth and frequency or of groups of frequencies for the detection of radio networks

Other features

- Search speed independent of spectrum occupancy and simultaneously running direction finding
- Digital direction finding allows various DF methods to be used in the whole frequency range from 0.5 MHz to 3 GHz (reduces the effects of the ship structure on the bearing accuracy)
- In addition to automatic routines, a convenient Windows® software supports manual operation of system functions
- Accurate time synchronization by means of GPS
- Detection, direction finding and location (in networked operation) also of frequency hopping or TDMA signals

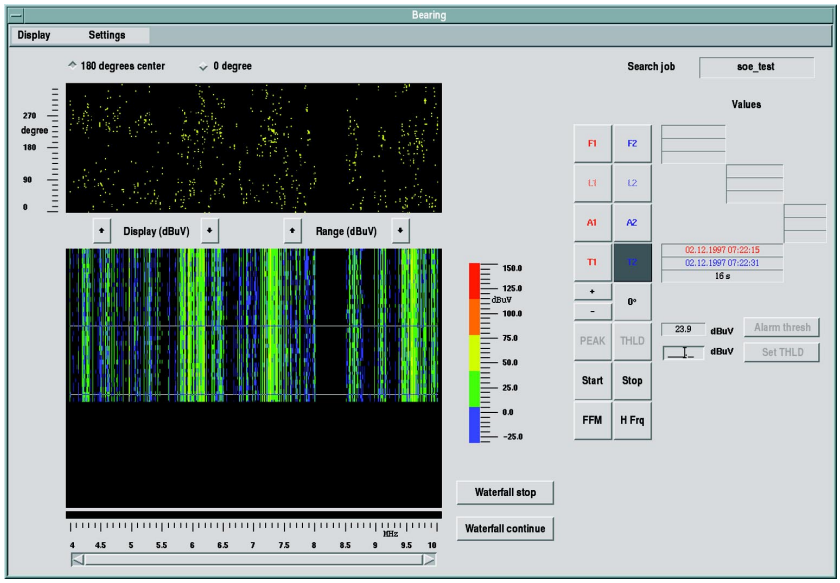


FIG 4: Waterfall display revealing time sequence of signal activities

Example of configuration

Fast digital scanning direction finder

- Well-proven antenna systems for shipboard use
- Computer-controlled matrix for distributing the antenna signals to the receive and classification paths
- Workstation with large screen as a platform for system software and database (Unix, Windows NT®)
- PCs that can be enhanced with commercial or customized decoder modules
- Interfaces to the onboard systems (position computer, GPS, compass, intercom, LAN)

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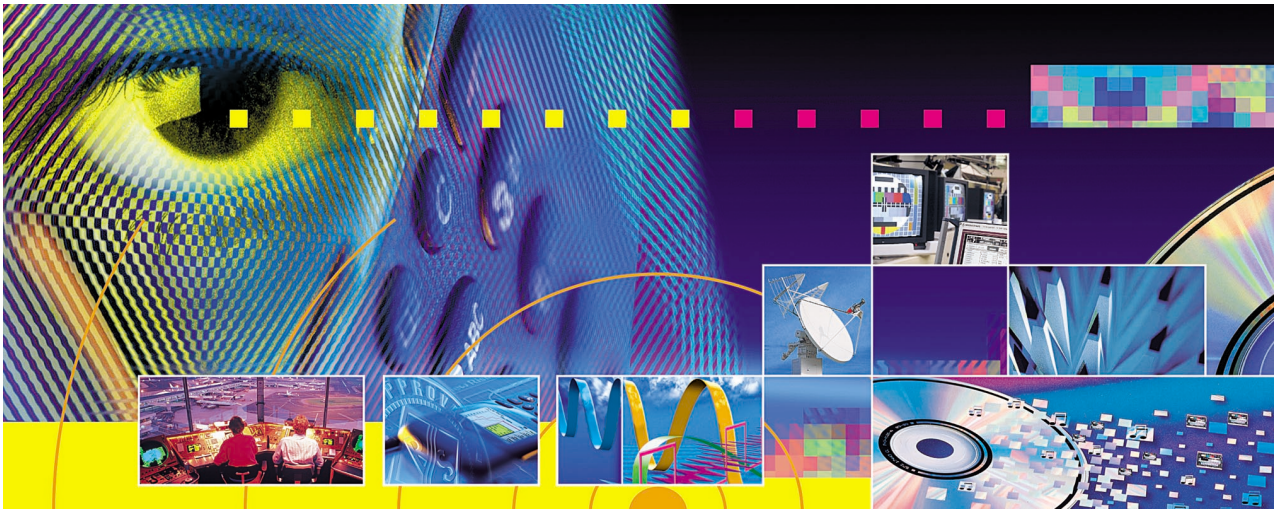
Rohde & Schwarz Customer Service



Contents of Annex

Documentation – medium between man and technology

Technical documentation from Rohde&Schwarz prepared to customer's order - also for non-R&S products

- Review and appraisal of existing documentation for compliance with standards and guidelines
- Operating instructions and user's guides
- Maintenance instructions
- Service and calibration instructions
- Repair instructions
- Fault diagnosis instructions
- Leaflets
- Brochures
- Data sheets
- Materials management concepts
- Technical manuals
- Design drawings with 2D and 3D illustrations
- Spare parts catalogs and illustrated spare parts lists
- Program-controlled input and print-out of modular documents
- Training documentation

Keeping pace with new requirements

Laws, standards and directives place high demands on technical documentation. We guarantee that the documentation prepared by us conforms to all relevant standards, directives, regulations and laws, including for instance

- EU directives for
  - machinery
  - low voltage
  - EMC

- medical products law
- EN, ISO and VDI specifications
- DIN specifications
- product liability law
- product safety law
- multimedia law

New tools for your technical documentation

Your documentation will be tailored to your specific needs. We undertake the complete project handling through to the finished data medium.

More than just a translation

Our translations cover all fields of activity of our company. Technical documentation is translated into any desired language mainly by native speakers. The texts are translated technically correctly and edited. The result is a comprehensible, reliable and accurate match of your original documentation.

Drawing on qualified sources

Our staff at the Cologne Plant has a solid background of experience and know-how. This is the result of close cooperation with headquarters ranking among the market leaders worldwide in the fields of communications and test and measurement, as well as of numerous projects handled for other branches of industry. Benefits are also gained from the broad range of services provided by the Cologne Plant, including maintenance and repair, calibration, generation of special software, training and over 30 years of experience in documentation. We are always technically up to date. This is ensured by our participation in standardization bodies and joint ventures with leading international companies, by our intensive R&D work as well as by holding or attending lectures at universities and institutes of technology.

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Documentation – medium between man and technology

This up-to-date technical know-how is of course also a benefit for product documentation where our staff can provide valuable information and recommendations.

Documentation just in time

Market success is also determined by the "time to market". This means: if development and documentation take place simultaneously, time to market can be reduced substantially. Therefore we can make available on request an expert or whole team to support you on site in generating optimized documentation just in time in close cooperation with your specialists.

Documentation as you like it

You choose the hardware and software to be used for generating, storing and duplicating your documentation. The technical documentation furnished by us can easily be revised or completed – of course also by your staff. The documentation you receive is your individual solution: a manual, an illustrated catalog, detailed operating instructions – as a hardcopy, disk, tape, microfiche or CD-ROM.

Further support provided by Rohde&Schwarz

- Logistics concepts
- Material maintenance concepts
- Repair concepts
- Spare parts stockkeeping concepts
- Equipment layout diagrams
- Integrated logistics support
- Illustrated spare parts catalog (complying with B007, C-1-4, SPEC 2000, ATA DMKL, NATO guidelines)
- Electronic spare parts management, spare parts catalogs, materials lists
- Electronic information systems
- 3D illustrations, exploded views
- Generation of circuit diagrams, block diagrams to standard
- Design drawings to DIN
- Generation of home pages for Internet
- Generation of documentation in SMGL or HTML format
- Online documentation
- Database programming and design
- Multimedia productions eg for maintenance, service, marketing and sales
- Multimedia product presentations including trainer or simulator
- Storage on CD-ROMs

Get in touch with us

Call us and put our competence to the test. We shall be glad to provide you with any further information.

Rohde&Schwarz Cologne Plant
Telephone: +492203 49-51 246
Telefax: +492203 49-51 364

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Training

Committed cultivation of market and customer as well as the continuous training of your staff will ensure competitiveness of your company in the present and in the future

Photo 40829-1

Welcome to our training courses

Electronics as a basic technology calls for highly qualified staff. Rohde&Schwarz offers basic training, seminars, retraining, and training on instruments and systems in line with customer's requirements.

We provide our customers with what will be increasingly important in the future: practical training, transfer of know-how, helping you to help yourself. Our seminars are constantly being adapted to meet these objectives and to offer up-to-date solutions to your problems.

Small groups for optimum results
The number of participants is limited for all seminars. This makes for enhanced receptivity and allows an intensive dialog between the trainees and the trainer. Thus, knowledge can be passed on at greater depth, and individual problems can be dealt with in greater detail. In most seminars, the emphasis is on practical exercises performed on modern test equipment, since this is the most efficient way of learning.

Photo 40829-3

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Training

Our training staff
Our communications, electrical and software engineers and physicists provide you with the knowledge you actually require. Having the latest know-how and many years of experience is one thing, being able to pass this on in an interesting and comprehensible way is another.

We therefore attach utmost importance to the qualified didactic training of our engineers picked to be your lecturers and trainers. Where appropriate and necessary, we call in lecturers from universities, authorities and from among users. We want to make sure that our customers have the best trainer available.

Training courses kept up to date
All seminars are constantly reviewed and improved and new knowledge and relevant changes taken into account immediately. This guarantees that the technical know-how as well as the regulations and standard specifications presented to you are always up to date.

Rohde&Schwarz standard seminars
In our seminars your measurement problems, and not the Rohde&Schwarz test assemblies, are given top priority. Our training programs are structured so that both newcomers and specialists will find a seminar suiting their requirements.

Customer-specific seminars
We offer customized seminars for training tasks to be performed at your company. This starts with an analysis of the learning objectives and target group in the conceptual phase, which is followed by a proven methodical approach. This ensures an optimum benefit/cost ratio and avoids burdening the courses with unnecessary information. Within the framework of these seminars, we also offer special user and application courses for Rohde&Schwarz instruments to allow an even more time-saving and efficient use.

Training sites

Training courses are held at Rohde&Schwarz headquarters in Munich, at the Cologne Plant, our branch offices and representatives and at the customer's.

Training at Rohde&Schwarz
Highly qualified personnel and a complete range of measuring instruments and teaching aids make each seminar a success. Here you can get acquainted with state-of-the-art measurement and communications technology from Rohde&Schwarz.

Seminars at the customer's
You want to train several staff members at a time? To put learnt matter into practice immediately? To solve specific problems within your own organization? To leave travelling to us? In this case we hold seminars at your company. These may be standard Rohde&Schwarz or customized seminars.

Ask for information on our seminars

Training Center Munich
Our brochure provides detailed information on the contents, dates, prices and other terms of our seminars.
Telephone: +4989 4129-13051
Telefax: +4989 4129-13335

Training Center Cologne
Our training brochure gives you an overview of the seminars held at the Cologne Plant.
Telephone: +492203 49-51 271
Telefax: +492203 49-51 285

For information on seminars held in other cities or at the customer's or seminars held in English please contact our sales offices (see address list on page 172).

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Repair

We check, overhaul and repair electronic equipment from Rohde&Schwarz and other manufacturers

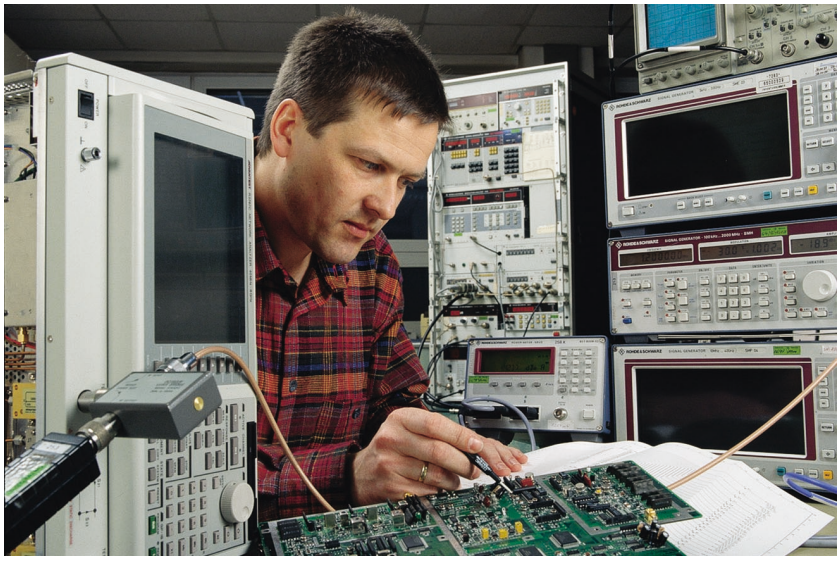


Photo 39001

Service centers of international standard

Maintenance and repair are central to our integrated support

- Our service labs are equipped with state-of-the-art computerized test stations
- All instruments can be tested under simulated environmental conditions of extreme temperatures and humidity
- The mobile service from Rohde&Schwarz provides rapid, reliable on-site support

With its testing labs, workshops and maintenance vehicles worldwide, Rohde&Schwarz is perfectly equipped to provide comprehensive, short-term and reliable service. This covers measuring instruments and systems, automatic test systems, data processing systems, communications engineering, radiomonitoring/radiolocation, sound and TV broadcasting, avionics, telemetry and radar and sonar equipment testing.

Customer-oriented service

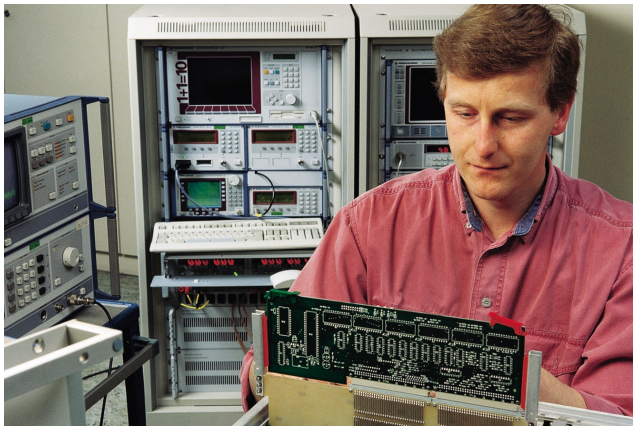
Where appropriate, we have set up independent service centers, for example the Rohde&Schwarz Emirates LLC in Abu Dhabi. Already shortly after its foundation, this service center developed into a strong partner of regional customers as well as European manufacturers, providing an on-site service base for the latter.

Spare parts procurement also for older components and PCBs

We work out reasonably priced alternatives if the original components or assemblies you need are no longer available. Our technical documentation is constantly updated to comply with current developments. Documentation is modified in accordance with requirements and supplied with the equipment. A well-thought out logistics concept guarantees availability of PCBs and assemblies produced by Rohde&Schwarz even after many years.

Our range of services

- Worldwide service
- Service at the operational facilities of our customers
- Mobile calibration/repair labs
- Express service
- Repair of measuring and communications equipment from Rohde&Schwarz, OEM (**o**riginal **e**quipment **m**anufacturer) products and equipment of other make
- Service training
- Spare parts procurement



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Calibration

Rohde&Schwarz has been calibrating measuring equipment and systems from domestic and foreign manufacturers since the 60s. In 1977, our Cologne Plant was appointed the first accredited calibration center of the German Calibration Service (DKD) for electrical parameters

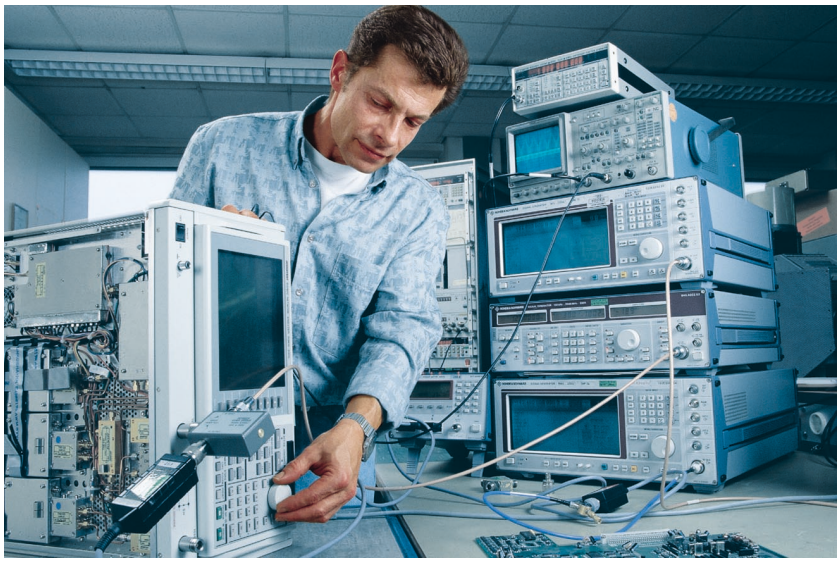

Photo 39002

Definitions

Calibration

- Upon calibration, the deviation of measured values from rated specifications of the device under test (DUT) is determined (difference between nominal and actual value or nominal and actual reading)
- Each calibration is based on relevant test instructions
- Results are recorded in a test report
- The measurement uncertainty of the calibration equipment must be known
- No technical modifications are made on the DUT

Official calibration

- Same scope of services as for calibration
- Testing by calibration authority in line with calibration standards
- Stamped label affixed to DUT
- Measuring instruments subject to official calibration and those exempt from official calibration are governed by legal provisions

Testing

- Same scope of services as for calibration, but without test report
- Verification of compliance with predefined conditions (eg specifications)

Adjustment (alignment)

Adjustment involves manipulation, which usually results in a permanent modification of the DUT. The DUT is adjusted to ensure minimum departure from rated specifications or departure that is so low that the DUT fully complies with specifications (measurement uncertainty to be taken into account!). The adjustment is made with the aid of variable components or via computer control (eg new correction factors in EEPROM or RAM).

Product calibration certificate

More and more companies are endeavouring to obtain certification or already have a certification to ISO 9000. Calibration must be traceable for instruments intended for use in quality-related processes, eg R&D, incoming goods inspection, testing, final inspection, quality control, etc. We offer a special factory calibration package for you to furnish evidence that your equipment has been calibrated by Rohde&Schwarz. You can order the factory calibration package against a small charge when buying an instrument. This package provides you with a qualified, written evidence that the instrument has undergone calibration. This evidence includes a calibration certificate, a label affixed to the instrument and a test report.

Calibration in service

This type of service is becoming more and more important in view of the obligation to furnish evidence under product liability but also with respect to increasing demands being made on precision in all fields of electronics. Rohde&Schwarz provides high-precision calibration for the electrical instruments and fields of measurement approved by the Federal German Bureau of Standards (PTB), which is the national metrological institute of the Federal Republic of Germany.

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Calibration

The test antennas from Rohde&Schwarz are calibrated in compliance with relevant standards, eg ANSI, C63.5, SAE, ARP958, DIN45003 and IEC597-2. Prior to the calibration of loop antennas, a patented attenuation measurement is performed.

Calibration to DIN ISO9000

- Inspection and documentation of status of DUT upon receipt, if DUT data are out of specified tolerances (ISO 9001 4.11g)
- Remark on cover sheet of test report/calibration certificate
- Testing and recording of results according to performance test/ calibration instructions
- Readjustments
- Minor repairs
- Detailed test report
- Calibration certificate
- Calibration label affixed to DUT
- Archiving of results for 5 years
- Electrical safety inspection (VBG 4)

DKD calibration (at Rohde&Schwarz Cologne Plant only)

- Measurement of basic parameters accredited by PTB Braunschweig
- Measurements at specific points
- Scope of measurements to be specified by customer
- Recording of nominal and actual values
- Verification of measurement uncertainty
- With a sufficient number of measurement points, a certificate of conformity with manufacturer's specifications can be issued
- DKD label on DUT
- Calibration certificate and test report

DEUTSCHER KALIBRIERDIENST (DKD)

Kalibrierlaboratorium für Meßgeräte der Nachrichtentechnik
Calibration laboratory for measuring instruments of telecommunication engineering

AKKREDITIERT DURCH DIE PHYSIKALISCH-TECHNISCHE BUNDESANSTALT (PTB)

ROHDE&SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG
Werk Köln

Kalibrierschein
Calibration Certificate

Kalibrierzeichen / *Calibration mark*: 2913 | DKD-K-00201 | 97-05

Gegenstand / *Object*	Dig. Radiocommunication Tester
Hersteller / *Manufacturer*	Rohde & Schwarz GmbH & Co.KG
Typ / *Type*	CMD 57 Id. No: 1050.9008.57
Fabrikat/Serien-Nr. / *Serial number*	838770/016
Auftraggeber / *Customer*	Rohde & Schwarz Vertriebs-GmbH Zweigniederlassung Köln Graf-Zeppelin-Straße 18 D-51147 Köln
Auftragsnummer / *Order No.*	971914
Anzahl der Seiten des Kalibrierscheines / *Number of pages of the certificate*	6. und Test Report 32 Seiten
Ort und Datum der Kalibrierung / *Place and Date of calibration*	Köln, den 15.05.1997

Der Deutsche Kalibrierdienst ist Unterzeichner des multilateralen Übereinkommens der Western European Calibration Cooperation (WECC) zur gegenseitigen Anerkennung der Kalibrierscheine.
Die Kalibrierung erfolgt auf der Grundlage des zwischen der Physikalisch-Technischen Bundesanstalt und dem Träger abgeschlossenen Vertrages.
Dieser Kalibrierschein dokumentiert die Rückführbarkeit auf nationale Normale zur Darstellung der physikalischen Einheiten in Übereinstimmung mit dem Internationalen Einheitensystem (SI).
Für die Einhaltung einer angemessenen Frist zur Wiederholung der Kalibrierung ist der Benutzer verantwortlich.

The Deutscher Kalibrierdienst is signatory to the Multilateral agreement of the Western European Calibration Cooperation (WECC) for the mutual recognition of calibration certificates.
The calibration is performed according to the stipulations of the contract between the Physikalisch-Technische Bundesanstalt and the holder of the calibration laboratory.
This calibration certificate documents the traceability to national standards, which realize the physical units of measurement according to the International System of Units (SI).
The user is obliged to have the object recalibrated at appropriate intervals.

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge oder Änderungen bedürfen der Genehmigung sowohl der Physikalisch-Technischen Bundesanstalt als auch des ausstellenden Kalibrierlaboratoriums.
Kalibrierscheine ohne Unterschrift und Stempel haben keine Gültigkeit.

This calibration certificate may not be reproduced other than in full except with the permission of both the Physikalisch-Technische Bundesanstalt and the issuing laboratory.
Calibration certificates without signature and seal are not valid.

Stempel / *Seal*: Deutscher Kalibrierdienst DKD-K-00201
Datum / *Date*: 15.05.1997
Leiter des Kalibrierlaboratoriums / *Head of the calibration laboratory*: Bremmekamp
Bearbeiter / *Person responsible*: Schneider

ROHDE&SCHWARZ GmbH & Co. KG Werk Köln · Graf-Zeppelin-Straße 18 · D-51147 Köln
Postfachadresse: Postfach 980260 · D-51130 Köln
Telefon: (02203) 49 - 0
Durchwahl: 49 - 240

Our air-conditioned calibration labs are equipped with state-of-the art technology allowing a wide variety of electrical parameters to be measured over wide frequency ranges. If a measuring instrument is found defective or out of tolerance in calibration, and the defect or deviation cannot be eliminated by adjustment, the instrument can be repaired right in the lab.

Calibration interval

The calibration interval is the maximum period of time between two calibrations. It is proposed by the manufacturer or by the calibration center. Recalibration is performed by the Rohde&Schwarz Central Service Department in Munich.

The calibration interval proposed by Rohde&Schwarz for new types of equipment is 12 to 36 months unless otherwise specified in the data sheet. In the case of harsh environmental conditions, stringent requirements placed on safety (eg in medicine or air traffic control) or great financial loss in the event of erroneous measurements, the calibration interval should be shortened. The interval can be prolonged however where for instance the requirements placed on measurement accuracy are less stringent than specifications or if the financial losses resulting from erroneous measurements would be minimal.

Tolerance analysis

Tolerance analysis is an integral part of any test instructions. It is used to determine the measurement uncertainties of a test setup/measuring system and to take into account errors that cannot be specified in the data sheet. Such errors may for instance occur in power measurements if both the power meter and the source are mismatched and may become as large as the specified errors.

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A correct error specification must contain two aspects:

- Error limits
- Confidence level, ie how many results from a large number of measurements do not exceed the error limits

For the maximum error the confidence level is 100%. In practice the maximum error occurs very rarely only. If the total error is made up of a large variety of individual errors resulting from independent sources (which is typical of individual errors) it is according to the laws of statistics very rarely encountered that in a single measurement all individual errors do occur with their maximum value and the same polarity.

In measurements it has therefore become expedient to specify the practice-oriented RSS error (RSS = root sum of squares), which is the square root of the sum of the squares of the individual RSS errors. The RSS error of a sum of individual errors is an error that will not be exceeded in 95% of all measurement results.

Traceability

According to the quality system DIN ISO 9001 (4.11.b), test equipment must be calibrated against certified equipment having a known valid relationship to nationally recognized standards. This relationship is defined in a calibration pyramid (see below).

Parameters that are not included in the list of accredited measured quantities (voltage, current, attenuation, mechanical length, etc) such as amplitude and frequency modulation can be traced to the basic parameters via approved measurement and computational methods. For example, FM can be traced to the mathematical Bessel function, which in turn can be described in terms of amplitude and frequency.

How do we do it?

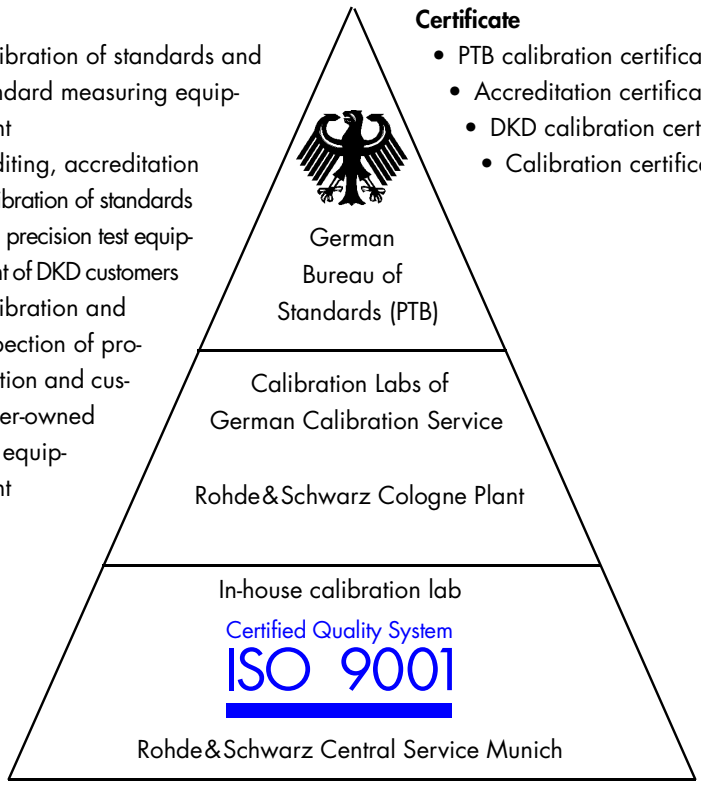
Our technical competence is the result of more than six decades of experience in developing and producing electronic measuring instruments and communications equipment and providing customized solutions for a wide variety of applications. Rohde&Schwarz stands for uncompromising quality and competence in the industry, as well as among authorities and institutions. Our certified quality management system meets the requirements of the international DIN ISO 9001 standard – "Quality systems - Model for quality assurance in design/development, production, installation and servicing". The confirmation system for the measuring equipment used meets the requirements of DIN ISO 10012 Part 1 – "Quality assurance requirements for measuring equipment".

Task

- Calibration of standards and standard measuring equipment
- Auditing, accreditation
- Calibration of standards and precision test equipment of DKD customers
- Calibration and inspection of production and customer-owned test equipment

Certificate

- PTB calibration certificate
- Accreditation certificate
- DKD calibration certificate
- Calibration certificate



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Repair, Calibration

Hotline

Your contact partner for servicing is your nearest Rohde&Schwarz agency, which as a rule has a service lab of its own. This guarantees fast availability of equipment. For addresses, telephone and fax information please refer to our list of addresses on page 172.

Central Service Munich, Spare Parts:
Telephone: +4989 4129-12 860
or 12 465
Telefax: +4989 4129-13 306

Service Hotline, T&M Equipment
Telephone: +4989 4129-13 774
Telefax: +4989 4129-13 777

Technical Inquiries
Telefax: +4989 41 29-13 275

Rohde&Schwarz Cologne Plant
Telephone: +492203 49-51 205
Telefax: +492203 49-51 308

Integrated customer support at Rohde&Schwarz

Financing

Rohde&Schwarz offers a variety of financing schemes based on rental and leasing contracts that allow the acquisition of test & measurement equipment at the time it is needed. Required T&M products are thus available fast and easily without any strain being placed on your liquidity.

Rental agreement with purchase option
You need an instrument only temporarily? Or you are not sure if an instrument is to be purchased at a later date? Or you have to bridge a momentary financial bottleneck? In such cases a rental agreement with purchase option is an ideal solution: you can rent an instrument for a period between six and 36 months, and buy the instrument after min. three and max. 30 months after the beginning of the rental agreement. If you buy the instrument, 75% of the paid rent will be credited against the price.

Leasing
Leasing is common practice in today's business transactions especially as far as medium-term investments are concerned. The lease of instruments expands your financial scope for implementing other, long-term investments, for instance a planned extension of your plant.

We are cooperating with well-established companies and can offer you a broad spectrum of leasing schemes. You can profit from state-of-the-art measuring equipment and systems from Rohde&Schwarz without binding your finances. This makes it possible to realize necessary investments immediately if budgets are tight and acquisitions would normally have to be postponed to the next fiscal period.

And, another important point: leasing is an interesting alternative also in terms of taxation since leasing payments are immediately and fully tax-deductible for example in Germany.

Service contracts

Repair service contract
Admittedly, not even equipment from Rohde&Schwarz is completely safe from failure. We therefore offer a repair service contract which you can conclude already at the time of purchasing your instrument so as to profit from this Rohde&Schwarz service right from the start and on the most favourable terms. The repair service contract extends the standard warranty period to three years. The contract price covers all services necessary to restore the instrument to proper operating condition.

Calibration and maintenance contract
In addition to the repair service contract for new equipment, Rohde &Schwarz offers a calibration and maintenance contract for the most common instruments and test antennas. Please direct your inquiry to:

Central Service Munich
Telefax: +4989 4129-3275

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Application notes

Free-of-charge publications
Measuring instruments from Rohde&Schwarz are small, highly complex systems in themselves. They can be used for a variety of applications. The data sheets only cover a small selection of possible applications. Our application engineers are constantly working out solutions to new measurement problems and describing them in application notes. These notes are available to you free of charge. For some applications, we also offer a special software at a small nominal charge. Please contact your local Rohde&Schwarz representative.

Demo units

Rohde&Schwarz offers demo units at very favourable prices. These units have been in use very little, if at all, and are in an excellent condition. As a matter of course, the instruments are checked through before leaving our factory, and Rohde&Schwarz gives full warranty. Your local Rohde&Schwarz representative will be glad to inform you of available instruments.

Support center

Whatever your problem, our support center is there to help you. Your question will be dealt with fast and in detail, or a competent partner will be found for your problem. The staff of our support center is optimally trained to assist you in solving your problems.

- You are looking for a special type of instrument?
- You need competent support in the implementation of remote control concepts for test equipment for use in production?

Our hotline team (Photo 43448)

- You have a question regarding the operation of equipment?
- Or you just want to find your local sales partner in order to take a look at our equipment?
- And so on ...

Just call our support center, and we will be glad to assist you. You can get in touch with us in the following ways:

Telephone
+49180 512 4242

Fax
+4989 4129-13777

E-mail
CustomerSupport@rohde-schwarz.com

The support center can work out a solution together with you for any aspect relating to the operation, programming and also applications of T&M equipment from Rohde&Schwarz or Advantest. You can rely on the technical expertise of our personnel.

In cases where an immediate answer is not possible, your time will not be wasted with unnecessary calls but the support center will record your problem and find a competent partner to get back to you.

Try us
Our support center can certainly help you. It is your hotline.

+49180 512 4242

Your local partner remains
If you are already in contact with Rohde&Schwarz, your local sales office will of course remain the first partner to get in touch with as it is more familiarized with your specific requirements and applications than the support center, and will know right away how to give you the fastest support.

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Cabinets, designs

Dimensions

The dimensions of Rohde&Schwarz instruments are specified as follows:

Overall width x height x depth in mm, looking onto the front panel (this also holds for pocket-size instruments). Dimensions generally refer to desktop models.

Cabinet designs

Cabinet design must meet all the criteria that mature electronic packaging has to fulfill. Changing requirements regarding technology and environment call for new cabinet designs and systems.

Rohde&Schwarz uses the following two design forms for its products:

- Design 2000 (BW2000)
- Compact design 90 (KB90)

Rackmounting

Rohde&Schwarz instruments in the above cabinet design can be mounted into 19" racks with the aid of appropriate adapters. It may be necessary to retrofit the racks accordingly.

Design 2000 (BW2000)

Design 2000 is a standardized cabinet system suitable for desktop models, for mobile use and for mounting in 19" racks. With only a few basic elements, a variety of cabinets can be implemented from one to five height units and in different widths and depths.

Design 2000 (Photo 42980-3)

With the

- iF Product Design Award 1998

and

- iF Ecology Design Award 1998

DESIGN AWARD WINNER 1 9 9 8
INDUSTRIE FORUM DESIGN HANNOVER

received from Industrie Forum Design Hanover, design 2000 has been attested excellent design that takes account of all environmental and recycling criteria for products.

Construction

The sturdy construction of design 2000 essentially consists of a chassis, an enclosure, feet and front handles.

The chassis is made up of an aluminium-cast front frame and a sheet-metal module support including rear panel. To enclose the instrument, the enclosure is slid over the chassis from the rear and fixed by means of rear-panel feet with elastic pads. The bottom feet with antislide protection are screwed to the enclosure and serve at the same time as a locking device for stacking units.

Compared to previous designs, design 2000 features further improved shielding. The few interfaces between the cabinet parts can be sealed with braided cords and spring strips where required.

Options

The cabinets can optionally be fitted with side handles for use with carrying strap and tilt feet. Special shock-absorbing parts for the front and rear panel as well as a swivel carrying handle that can also be used as a stand are available for mobile use.

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Cabinets, designs

19" adapters for rackmounting design 2000

Cabinet (all depths)	19" adapter	
	Type	Order No.
4HU 7/8	ZZA-478	1096.3248.00
1HU 1/1	ZZA-111	1096.3254.00
2HU 1/1	ZZA-211	1096.3260.00
3HU 1/1	ZZA-311	1096.3277.00
4HU 1/1	ZZA-411	1096.3283.00
5HU 1/1	ZZA-511	1096.3290.00

Adapters for mounting on telescopic rails (only in conjunction with19" adapter of design 2000)

Cabinet		Adapters for telescopic rails	
Height	Depth	Type	Order number
1HU	350	ZZA-T13	1109.3739.00
	450	ZZA-T14	1109.3745.00
2HU to 5HU	250	ZZA-T25	1109.3751.00
	350	ZZA-T35	1109.3768.00
	450	ZZA-T45	1109.3774.00
	550	ZZA-T55	1109.3780.00

Accessories

A wide range of accessories enhances the versatile applications of design 2000. Suitable adapters are available for all cabinet sizes for mounting in 19" racks. Cabinets of 4 height units can be equipped with a special swivel keyboard. Sturdy transit cases can be supplied for all cabinet sizes to ensure safe transport. Padded carrying bags with an accessory pocket make for greater convenience in mobile measurements.

Compact design 90 (KB 90)

Construction

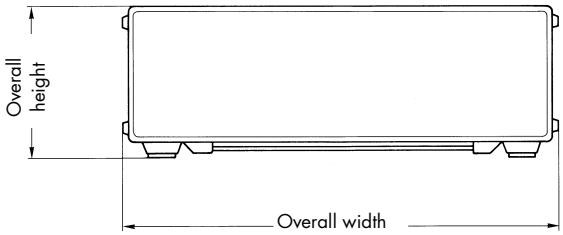
The design 90 cabinet consists of a self-supporting aluminium-cast frame with front and rear panels and top and bottom covers which make up the panelling.

The panelling is fixed and the instrument thus enclosed by screwing two feet (4 screws) to the rear panel. The cabinet is completed by attaching feet at the bottom and on the sides. Depending on the type of equipment, one or two carrying straps fixed on the sides make for portability of the instruments.

Compact design 90 meets shielding requirements that are becoming more and more stringent. By laying braided cords into special grooves, the instruments can be adapted to specific shielding requirements.

The compact cabinets of design 90 can be stacked not only with one another but also with19" cabinets of preceding cabinet designs (Photo 35053-4)

Front view of compact design 90



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Cabinets, designs

The tilt stands at the bottom allow the instrument to be set up in a position for convenient operation. The tilt stands on the rear panel enable the instrument to be operated in an upright position (except instruments of one or two height units). Desktop models can be provided with additional front handles.

System compatibility

The compact units of design 90 can be stacked with each other as well as with 19" units of previous designs. The bottom feet serve for stacking the units to form a system.

For mounting into 19" racks to DIN41494 all that is required is to remove the side and bottom feet and to fix the 19" adapter brackets including front handles.

The 19" adapter comes with mounting instructions and two self-adhesive slides for protecting the underside when sliding the unit in or out of the rack. Adapters are also available for mounting on telescopic rails.

Cabinet dimensions, rackmounting accessories (compact design 90)

Dimensions in mm					Rackmounting						
					19" adapters		DIN adapters	Adapters for mounting on telescopic rails (only in conjunction with 19" adapter)			
Width in 19" system	overall (mm)	Height in units	Height overall (mm)/rackmount	Depth overall (without controls) (mm)	Type	Order No.	Order No.	Height (in units)	Depth	Type	Order No.
1/2	219	2	103/87.6	240/350/460	ZZA-97[1])	0827.4527.00	–	1	350	ZZA-913	0396.5430.00
		3	147/132.1	350/460	ZZA-98[1])	0827.4533.00	–		460	ZZA-914	0396.5460.00
3/4	327	4	192/176.5	350 460	ZZA-99	0839.5775.00	– –	2 to 6	350	ZZA-923	0396.5476.00
1/1	435	1	59/43.2	350 460	ZZA-91	0396.4870.00	0396.8569.00		460	ZZA-924	0396.5482.00
		2	103/87.6	350 460/570	ZZA-92	0396.4886.00	0396.8575.00		570	ZZA-925	0396.5499.00
		3	147/132.1	350 460 570	ZZA-93	0396.4892.00	0396.8581.00				
		4	192/176.5	350 460 570	ZZA-94	0396.4905.00	0396.8598.00				
		5	236/221	350 460 570	ZZA-95	0396.4911.00	0396.8600.00				
		6	280/265.4	350/460/570	ZZA-96	0396.4928.00	–				

[1]) The 19" adapters for half-width 19" instruments are suitable for mounting 1 or 2 units. For two units of half width and different height (2HU und 3HU) use 19" adapter ZZA-98.

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Transit Cases ZZK-9x

Transit cases made of an aluminium composite material are available for all cabinet sizes. Reinforced rounded corners and edges ensure high stability and protection against knocks. Locks and handles are recessed for safety. The cases are dust-proof and splash-proof to DIN 40050 with IP54 type of protection.

Their suitability for airfreight and express freight has been proven in free-fall tests from a height of 80 cm with a 30 kg instrument inside.

The interior is lined with anthracite-grey foam mats. Foam inserts adhered to the corners ensure tight fit and protection of the instruments. The protective covers supplied with the instruments must be used for packing. A protective cover supplied with the cases allows the instruments to be transported with front handles mounted.

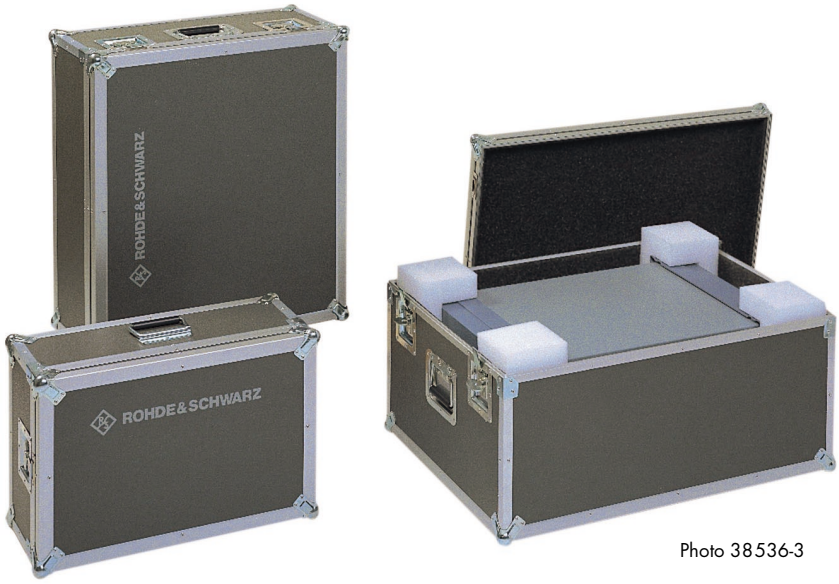

Photo 38536-3

Dimensions, ordering information

Instrument size (H, W, D)	Inner dimensions of case (mm) Height	Width	Depth	Weight (kg)	Type	Order No.
2HU, 1/2, 350	211	329	507	7.3	ZZK-973	1013.9143.00
2HU, 1/2, 460	211	329	619	8.5	ZZK-974	1013.9150.00
3HU, 1/2, 350	256	329	507	8.0	ZZK-983	1013.9172.00
3HU, 1/2, 460	256	329	619	9.3	ZZK-984	1013.9189.00
4HU, 3/4, 350	300	438	507	10.0	ZZK-993	1013.9237.00
4HU, 3/4, 460	300	438	619	11.6	ZZK-994	1013.9243.00
1HU, 1/1, 350	166	546	507	8.5	ZZK-913	1013.9266.00
1HU, 1/1, 460	166	546	619	9.8	ZZK-914	1013.9272.00
2HU, 1/1, 350	211	546	507	9.2	ZZK-923	1013.9295.00
2HU, 1/1, 460	211	546	619	10.7	ZZK-924	1013.9308.00
2HU, 1/1, 570	211	546	731	12.0	ZZK-925	1013.9314.00
3HU, 1/1, 350	255	546	507	10.0	ZZK-933	1013.9320.00
3HU, 1/1, 460	255	546	619	12.0	ZZK-934	1013.9337.00
3HU, 1/1, 570	255	546	731	13.0	ZZK-935	1013.9343.00
4HU, 1/1, 350	299	549	507	10.8	ZZK-943	1013.9350.00
4HU, 1/1, 460	299	549	619	12.4	ZZK-944	1013.9366.00
4HU, 1/1, 570	299	549	731	14.0	ZZK-945	1013.9372.00
5HU, 1/1, 350	343	549	507	11.6	ZZK-953	1013.9389.00
5HU, 1/1, 460	343	549	619	13.3	ZZK-954	1013.9395.00
5HU, 1/1, 570	343	549	731	14.5	ZZK-955	1013.9408.00
6HU, 1/1, 350	392	558	507	12.4	ZZK-963	1013.8682.00
6HU, 1/1, 460	392	558	619	14.2	ZZK-964	1013.8682.00
6HU, 1/1, 570	392	558	731	15.5	ZZK-965	1013.8682.00

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