



Rev 2.2
16.03.2013

Handheld RF Spectrum Analyzer SPECTRAN HF-4040

Affordable Spectrum Analyzer from 100MHz - 4GHz



HF-4040 Rev.3



HF-4040 Rev.3

"Unbeatable price.."

"Particularly Aaronia's very powerful (especially considering their price) SPECTRAN handheld spectrum analysers caused much excitement."
(Markt&Technik 20/2005)

References / examples of proof:

- ◆ BMW, München
- ◆ BASF, Schwarzheide
- ◆ Siemens AG, Nürnberg
- ◆ Vattenfall, Berlin
- ◆ Fedex, USA
- ◆ EnBW, Stuttgart


AARONIA AG
 WWW.AARONIA.DE

Made in Germany



Specifications

SPECTRAN® HF-4040 Rev.3

- ◆ Frequency range: 100MHz to 4GHz*
- ◆ Typ. level range: -90dBm to 0dBm*
- ◆ Lowest possible SampleTime: 100mS
- ◆ Typ. accuracy: +/- 3dB*
- ◆ Filter bandwidth (RBW) Min: 100kHz
- ◆ Filter bandwidth (RBW) Max: 50MHz
- ◆ Vector (I/Q) / True RMS level measurement
- ◆ High performance DSP (Digital Signal Processor)
- ◆ USB 2.0 interface
- ◆ Direct RF spectrum display
- ◆ Frequency and signal strength display
- ◆ Enhanced triple multi-function display
- ◆ Advanced HOLD function
- ◆ Switchable PULS mode
- ◆ Exposure limit calculation according to DIN/VDE 0848
- ◆ AM / FM Demodulation
- ◆ DECT & TimeSlot Analyser
- ◆ Realtime PEAK power detector (option)
- ◆ Internal datalogger (64K)
- ◆ Internet software updates
- ◆ Incl. battery pack and charger
- ◆ Incl. HyperLOG 7040 EMC antenna
- ◆ Incl. aluminum carrycase
- ◆ Dimensions (L/W/D): (260x86x23) mm
- ◆ Weight: 420gr
- ◆ **Warranty: 10 years**



Application examples Spectran® HF-4040 Spectrum Analyzer

Analysis and measurement of:

- ◆ WLAN
- ◆ UMTS
- ◆ WiFi
- ◆ active Radar
- ◆ GSM900
- ◆ GMS1800
- ◆ Bluetooth
- ◆ microwave ovens
- ◆ DECT-phones
- ◆ TETRA
- ◆ 70cm ham radio
- ◆ UWB (FB1-FB4)

Description



Conforming to standards and exact

RF Measurement in this price range has never been this professional. Find radiation sources in your surroundings. Find their respective frequencies and signal strengths, including **direct display of exposure limits**. This used to be impossible in this price category, professional units often costing several thousand euros and being excessively complicated in handling.

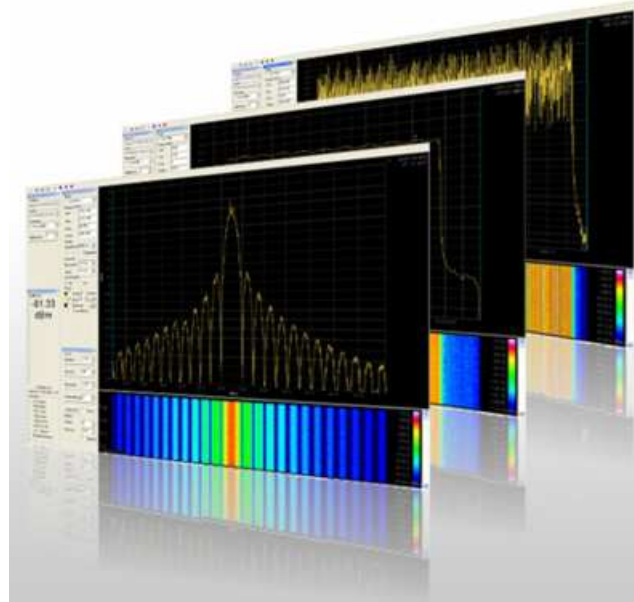
The highly complex calculations in spectrum analysis incl. exposure limit calculation is being performed, unnoticed in the background, by a high-performance DSP (digital signal processor). This ultra-fast processor even allows REAL-TIME display in all EMF (LF) versions of the SPECTRAN® series.

Fast, handy, cost-effective, beautiful exterior and PRECISION - what more could you ask ?

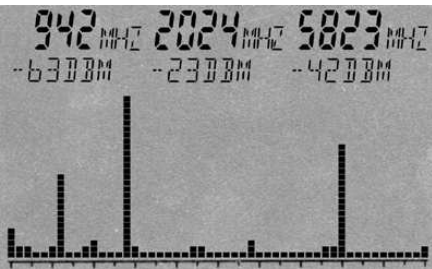
Professional PC analysis software (free download)

The professional PC analysis software demonstrates SPECTRAN's vast capabilities. This software can be used in addition to SPECTRAN and offers an incredible amount of features. All this for FREE. Just download it from our homepage, and your PC turns into a real spectrum analyser with a huge display:

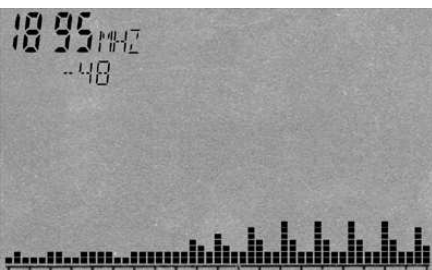
- ◆ **MULTI-device capability!** Remote control of several SPECTRAN units. These can be controlled and their data displayed at once on a single PC.
- ◆ **HIGH-RESOLUTION!**, freely scalable, coloured spectrum display with falloff function..
- ◆ **Display of channel identifiers!** for EXACT identification of providers. Channel numbers etc. freely programmable and extensible!
- ◆ Up to 10! markers with frequency and level display.
- ◆ Intuitive zoom control with very comfortable frequency adjustment.
- ◆ High quality "waterfall"-display with TIMECODE. Colour scale freely configurable. Size freely scalable. Optional display of data DIRECTLY ON TOP OF THE GRAPH by pointing with your mouse and CTRL-clicking!
- ◆ **High-resolution SLOT ANALYSER with 3D display!**
- ◆ **SUPER-LOGGER:** ALL data can be written to disk continuously. File format is readable by spreadsheet applications, for creating custom reports, etc.
- ◆ Freely positionable windows for comfortable entry of frequency, RBW, sweep time etc. etc.
- ◆ **Various pre-defined profiles** for DECT, UMTS, GSM, WLAN etc. etc. for instant recall. Incl. optimal parameters and extensive channel information! Freely programmable and extensible!
- ◆ Independent main display with SIMULTANEOUS display of dBm, dBµV, V/m, W/m² and A/m, each with AUTORANGE. Freely transposable and scalable.
- ◆ **SUPERB exposure limit display** with various profiles (ICNIRP, Salzburg precautionary values, ECOLOG, etc. etc.). Freely programmable with a virtually infinite amount of display options.
- ◆ Functionality to update SPECTRAN measurement device firmwares.
- ◆ Freely programmable key assignments and labels for SPECTRAN measurement devices.
- ◆ Filemanager and COMPILER for creation and management of YOUR OWN PROGRAMS for SPECTRAN measurement devices.
- ◆ "Rename" option for renaming any of your SPECTRAN units (for example, including location) for better identification
- ◆ etc. etc. etc.



AMAZING: The PROFESSIONAL PC software for SPECTRAN. Get to know SPECTRAN's real capabilities!



RF spectrum display and automatic triple multi-marker display on the digital screen of SPECTRAN® (Screenshot)



Well visible: "Frequency hopping" of a DECT portable phone between 1890 and 1900 MHz (Screenshot)

Spectrum ANALYSIS

The perfect analysis:

Professional RF measurement devices use a **frequency dependant measurement approach**, the so-called **spectrum analysis**. In a certain frequency range, the individuals signals and their respective strengths are being broken down, for example into a "bargraph" display (see SPECTRAN® screenshots on the left). The height of the individual bars represents the corresponding signal strength. For the 3 strongest signal sources, SPECTRAN® automatically displays the exact frequency and signal level, thanks to its "Auto Marker" feature. Of course, you can also setup the filter width and the frequency range to be analysed as you like.

In the RF spectrum shown, a frequency range of approx. 100MHz to 7GHz from left to right is being analysed (full sweep). During analysis, the Auto Marker feature has determined - fully automatic - three main signal sources:

Signal#1=942MHz (GSM communications) at -63dBm

Signal#2=2024MHz (UMTS) at -23dBm

Signal#3=5832MHz (802.11a WLAN) at -42dBm

Thanks to its DIRECT frequency display of the individual signal sources, a doubtless mapping of measurement results to the corresponding radiation sources is possible.

Long-term measurement (data logging feature)

SPECTRAN® measurement devices with data logger allow **long-term recordings of measurement results** over a **freely adjustable** period of time. This is particularly indispensable for serious evaluation of exposure by appliances and machinery which have a changing power consumption or radiation strength over time. Examples for these include railroads, power lines and plants, but also home appliances and their respective power cables, and various high-frequency transmission facilities like mobile phone transmission towers, mobile phones, radar etc. Depending on the time of day, considerable variation of exposure can occur (see graphics on the right). Without long-term recordings, massive misinterpretation of total exposure can occur. With long-term data logging using SPECTRAN®, the daily variation of exposure can be recorded and analysed. Thus, the actual total exposure can be evaluated precisely.

With this functionality, you can even discover sporadic EMC problems which would otherwise be very hard to detect. Even though SPECTRAN® units "only" last 2 to 3 (depending on model) hours with one battery charge, the intelligent "Powerdown mode" enables much longer data logging and measurement timespans. Finally, if this is not enough, the external power supply can be used to extend the recording timespan infinitely.



Daily variation of this RF transmitter discloses EXTREME variation in time



The included Transportcase

INCLUDED WITH DELIVERY

- ◆ RF spectrum analyzer SPECTRAN HF-4040
- ◆ HyperLOG 7040 EMC/directional antenna
- ◆ 1300mAh power battery with charger
- ◆ Pistol grip with miniature tripod mode
- ◆ SMA toolset
- ◆ SMA adapter
- ◆ 1m SMA cable
- ◆ Sturdy aluminum-design carrycase (with custom padding!)
- ◆ Exhaustive manual with lots of basic information, hints and exposure limit tables

SPECTRAN® HF (RF) Spectrum Analyser

APPLICATION EXAMPLES: Measurement of (active) radar, mobile communications, mobile phones, UMTS, DECT phones, transmission towers, WLAN, Wifi, Bluetooth, microwaves etc.

	Entrance	Intermediate	Professional			Outdoor
Specifications base unit ⁽¹⁾	HF-2025E	HF-4040	HF-6060V4	HF-6080V4	HF-60100V4	HF-XFR
Frequency Range (min)	700MHz	100MHz	10MHz	10MHz	1MHz	1MHz
Frequency Range (max)	2,5GHz	4GHz	6GHz	8GHz	9,4GHz	9,4GHz
Optional PEAK Power-Detector (Maximum usable frequency) ⁽³⁾	2,5GHz	4GHz	6GHz	8GHz	10GHz	10GHz
DANL (Displayed Average Noise Level) ⁽²⁾	-80dBm	-90dBm	-135dBm(1Hz)	-145dBm(1Hz)	-155dBm(1Hz)	-155dBm(1Hz)
DANL (Displayed Average Noise Level) with Preamp (Option 020) ⁽²⁾	-	-	-150dBm(1Hz)	-160dBm(1Hz)	-170dBm(1Hz)	-170dBm(1Hz)
Max Power at RF input	0dBm	0dBm	+10dBm	+10dBm	+40dBm ⁽²⁾	+40dBm ⁽²⁾
RBW (resolution bandwidth) (min)	1MHz	100kHz	10kHz	3kHz	200Hz ⁽²⁾	200Hz ⁽²⁾
RBW (resolution bandwidth) (max)	50MHz	50MHz	50MHz	50MHz	50MHz	50MHz
EMC-Filter 200Hz, 9kHz, 120kHz, 200kHz, 1,5MHz, 5MHz	-	-	-	-	✓	✓
Demodulator	AM	AM/FM	AM/FM	AM/FM/PM	AM/FM/FM/GSM	AM/FM/FM/GSM
Detector	RMS	RMS	RMS/MinMax	RMS/MinMax	RMS/MinMax	RMS/MinMax
Units dBm, dBµV, V/m, A/m, W/m ² (dBµV/m etc. via PC software)	✓	✓	✓	✓	✓	✓
Internal Datalogger (size). Expandable to 1MB (option 001)	-	64K	64K	64K	64K	harddisk
Lowest SampleTime	100mS	100mS	10mS	10mS	5mS	5mS
Accuracy (typical)	+/-4dB	+/-3dB	+/-2dB	+/-2dB	+/-1dB	+/-1dB
Highlights						
Real-time remote control via USB	✓	✓	✓	✓	✓	internal
Calibration setup (antenna, cable, attenuator etc.)	✓	✓	✓	✓	✓	✓
Exposure limit calculation according to ICNIRP, EN55011, EN55022 etc.	ICNIRP only	ICNIRP only	ICNIRP only	ICNIRP only	✓	✓
Extended full ICNIRP range	-	-	-	-	✓	✓
Suitable for pre-compliance test	-	-	-	-	✓	✓
Realtime limit calculation with simultaneous percentage display	-	✓	✓	✓	✓	Analyzer sw
Time-Domain and fast Zero-Span sweep	-	-	✓	✓	✓	✓
Vector power measurement (I/Q) and True RMS	-	✓	✓	✓	✓	✓
Simultaneously displays frequency and signal strength	✓	✓	✓	✓	✓	Analyzer sw
Up to 3 marker (showing both frequency and field strength)	-	✓	✓	✓	✓	unlimited
Jog Dial controlled manual marker readout	-	✓	✓	✓	✓	key & touchpad
Write, AVG and Hold function	no AVG	no AVG	✓	✓	✓	& Min, Max
DECT and TimeSlot Analyzer	✓	✓	✓	✓	✓	✓
Audio Level Indicator (changes audio frequency vs power level)	-	-	✓	✓	✓	-
Free of charge firmware update (via Internet)	✓	✓	✓	✓	✓	✓
Supports programming of custom P-Code & C++ based custom software	-	✓	✓	✓	✓	✓
14Bit Dual-ADC & DDC Hardware-Filter	-	-	✓	✓	✓	✓
150MIPS high performance DSP (Digital Signal Processor)	-	-	✓	✓	✓	✓
Large high resolution multifunctional LCD (95mm)	✓	✓	✓	✓	✓	14" TFT
Spectrum display (51x25 pixel)	✓	✓	✓	✓	✓	Analyzer sw
High resolution 50 segment bargraph (trend display)	✓	✓	✓	✓	✓	Analyzer sw
Enhanced, much sharper Aaronia LCD display (3d generation)	-	-	✓	✓	✓	14" TFT
Integrated battery charger (supports our optional LiPo battery)	✓	✓	✓	✓	✓	XFR charger
Internal speaker	Piezo	✓	✓	✓	✓	✓

Please continue on next page



HF-2025E



HF-4040



HF-6060 V4



HF-6080 V4



HF-60100 V4



HF-XFR

SPECTRAN® HF (RF) Spectrum Analyser

APPLICATION EXAMPLES: Measurement of (active) radar, mobile communications, mobile phones, UMTS, DECT phones, transmission towers, WLAN, Wifi, Bluetooth, microwaves etc.

	Entrance	Intermediate	Professional			Outdoor
Connectors / Interface	HF-2025E	HF-4040	HF-6060V4	HF-6080V4	HF-60100V4	HF-XFR
USB 1.1/2.0	✓	✓	✓	✓	✓	2x
Audio output (2,5mm jack)	✓	✓	✓	✓	✓	3,5mm jack
Charger plug (max. 12V)	✓	✓	✓	✓	✓	✓
50Ohm SMA input (f)	✓	✓	✓	✓	✓	✓
Jog Dial (easy usage of menu operation and volume control)	-	✓	✓	✓	✓	key & touchpad
1/4" tripod connector	✓	✓	✓	✓	✓	in-Vehicle docking
Included In Delivery						
OmniLOG 90200 Antenna	-	-	-	-	-	✓
HyperLOG EMC directional LogPer antenna (model)	7025	7040	7060	6080	60100	60100 (black)
SPECTRAN 1300mAh rechargeable battery (integrated)	✓	✓	✓	✓	✓	6 cell battery
Battery charger and power supply incl. international adapter sit	✓	✓	✓	✓	✓	no adapter set
Aluminum carrying case with foam protection	✓	✓	✓	✓	✓	-
Detailed English manual (on CD)	✓	✓	✓	✓	✓	installed
Analyzer Software for MAC-OS, Linux and Windows (on CD)	✓	✓	✓	✓	✓	installed
SMA tool	✓	✓	✓	✓	✓	✓
SMA adapter	✓	✓	✓	✓	✓	-
Available Options (extra charge)						
Option 001 (1MB memory expansion)	-	✓	✓	✓	✓	harddisk
Option 002 (high accurate 0,5ppm TCXO timebase)	-	-	-	-	✓	installed
Option 020 (15dB internal low noise preamplifier, switchable)	-	-	✓	✓	✓	installed
Option 20x (Real-time Broadband Peak Power Meter)	✓	✓	✓	✓	✓	✓
Option UBBV1 (40dB external preamplifier 1MHz-1GHz)	-	-	✓	✓	✓	✓
Option UBBV2 (40dB external preamplifier DC-8GHz)	-	-	✓	✓	✓	✓
Optional Accessories						
USB Cable (special EMC screened version)	✓	✓	✓	✓	✓	installed
3000mAh Lithium Polymer (LiPo) Power-Battery	✓	✓	✓	✓	✓	-
Car Power Adapter (operate or charge via cigarette lighter)	✓	✓	✓	✓	✓	-
Outdoor Rubber Protection (perfect for outdoor usage)	✓	✓	✓	✓	✓	-
Pistol Grip / Miniature Tripod	✓	✓	✓	✓	✓	-
Heavy Multifunctional Pistol Grip	✓	✓	✓	✓	✓	-
Aluminum Tripod (big version)	✓	✓	✓	✓	✓	-
DC-Blocker (protects the input against DC voltage)	✓	✓	✓	✓	✓	✓
20dB Attenuator (expands the measurement range by 20dB)	✓	✓	✓	✓	✓	✓
PBS1 Near Field Probe Set (passive)	-	-	-	-	✓	✓
PBS2 Near Field Probe Set (active, incl. UBBV2 preamplifier)	-	-	-	-	✓	✓
ADP1 Active Differential Probe (conductive measurement)	-	-	-	-	✓	✓
5m or 10m low loss SMA Cable	✓	✓	✓	✓	✓	✓
Calibration Resistor (needed for noise floor calibration, SMA)	-	-	✓	✓	✓	✓
Calibration Certificate	✓	✓	✓	✓	✓	✓
Heavy Plastic Carrying Case	✓	✓	✓	✓	✓	-

⁽¹⁾ The new V5 real-time spectrum analyser generation up to 80GHz is already in development. Please contact us for further details!

Preliminary specifications dated 01.03.2013. The V4 and XFR series are available with latest Beta firmware. The Beta firmware is constantly in development. Some functionality may still be limited and not fully to specifications (Beta status). By regularly checking our homepage for updates, you can always keep your measurement device up-to-date. As soon as V1.0 of the firmware is released, all functionality and features will be fully available. Range, sensitivity and accuracy can change depending on frequency, setup, antenna and used parameters. Precision datas are based on Aaronias calibration-reference under specific test conditions. Unless otherwise stated, these specifications are according to the following reference conditions: Ambient temperature 22±3°C, relative air humidity 40% to 60%, continuous wave signal (CW), RMS detection. V4 and XFR DANL @3,6009GHz. Maximum sensitivity of Rev.3 units: -90dBm @2,2GHz.

⁽²⁾ Standard: +20dBm. Only with optional 20dB attenuator +40dBm. Standard: 1kHz. Only with option 002 down to 200Hz.

⁽³⁾ Depending on frequency the option 20x offers a sensitivity down to -50dBm and max. +10dBm, with optional 20dB attenuator +30dBm.



HF-2025E



HF-4040



HF-6060 V4



HF-6080 V4



HF-60100 V4



HF-XFR

Recommended accessories for Aaronia Spectrum Analyzer

Heavy Plastic Carrycase PRO

Shock resistant, heavy version with padding. Offers spaces for 2 SPECTRAN units with all accessories and a HyperLOG 70xx or 60xx antenna. A MUST for the professional user or outdoor usage!

Order/Art.-No.: 243



Calibration Certificate

Available for all SPECTRAN® units. With detailed calibration sheet.

Order/Art.-No.: 784



3000mAh LiPo Power-Battery

Offers a MUCH higher runtime of your SPECTRAN (up to 400%). Strongly recommended for autonomic measurement! The 1300mAh standard-battery will be replaced.

Order/Art.-No.: 254



DC-Blocker (SMA)

It prevents the RF-input of the SPECTRAN to be destroyed by the DC-voltages of f.e. DSL/ISDN lines.

Order/Art.-No.: 778



Pistol grip / miniature tripod

Detachable handle with super-practical miniature tripod mode: this handle is attachable to the backside of the unit and allows optimal handling (esp. for directional measurement) and even fixed installation of the unit. STRONGLY recommended for PC use!

Order/Art.-No.: 280



USB Cable (Special Version)

To connect your Spectran to the PC. Special version with high performance EMC-ferrite. STRONGLY recommended for PC use!

Order/Art.-No.: 774



Car power adapter for mobile use

With power-LED. For charging batteries or operating our units in your car, including special plug.

Order/Art.-No.: 260



Calibration Resistor (DC-18GHz)

This calibration resistor is necessary for the best possible calibration of the noise-floor of each Spectran V4-Analyzer.

Order/Art.-No.: 779



Aluminum tripod

Height adjustable, high stability. STRONGLY recommended for PC use! Max. height: 105cm.

Order/Art.-No.: 281



1m / 5m / 10m SMA-Cable

High quality special SMA cable for connecting any HyperLOG®-Antenna or BicoLOG®-Antenna with our RF Spectrum-Analyzer. Available as 1m, 5m and 10m Cable. All versions: SMA plug (male) / SMA plug (male).



Protection rubber

Protect and personalize your SPECTRAN with a sturdy rubber case and keep it scratch-n-dent free. Allows full access to all functions.

Order/Art.-No.: 290



20dB SMA high-end Attenuator

Expands the measurement range to +40dBm. (ONLY SPECTRAN HF-60100 V4 and HF-XFR).

Order/Art.-No.: 775



Frequency overview Analyzer & Antennas

Frequency Overview SPECTRAN Spectrum Analyzer

1Hz	10Hz	100Hz	1kHz	10kHz	100kHz	1MHz	10MHz	100MHz	1GHz	10GHz	100GHz
	SPECTRAN NF-1010E										
	SPECTRAN NF-3020										
	SPECTRAN NF-5030 (opt. 30MHz)										
	SPECTRAN NF-XFR (opt. 30MHz)										
									SPECTRAN HF-2025E Rev3		
									SPECTRAN HF-4040 Rev3		
								SPECTRAN HF-6060 V4			
								SPECTRAN HF-6080 V4			
							SPECTRAN HF-60100 V4				
							SPECTRAN HF-XFR				

Frequency Overview HyperLOG and BicoLOG Antennas and Probes

1Hz	10Hz	100Hz	1kHz	10kHz	100kHz	1MHz	10MHz	100MHz	1GHz	10GHz	100GHz	
									HyperLOG 7025			
									HyperLOG 7025 X			
									HyperLOG 7040			
									HyperLOG 7040 X			
									HyperLOG 7060			
									HyperLOG 7060 X			
									HyperLOG 6030			
									HyperLOG 6030 X			
									HyperLOG 60100			
									HyperLOG 60180			
									HyperLOG 4025			
									HyperLOG 4025 X			
									HyperLOG 4040			
									HyperLOG 4040 X			
									HyperLOG 4060			
									HyperLOG 4060 X			
									HyperLOG 3080			
									HyperLOG 3080 X			
									HyperLOG 30100			
									HyperLOG 30180			
								HyperLOG 20300 EMI				
								HyperLOG 20600 EMI				
									OmniLOG90200			
								BicoLOG 5070				
								BicoLOG 30100				
								BicoLOG 30100E				
								BicoLOG 20100				
								BicoLOG 20100E				
								BicoLOG 20300				
	Aaronia EMV Probe-Set PBS1 & PBS2											
	Aaronia Active Differential Probe (NF-50xx series)											
	Geophon (Aaronia GEO Series)											
subHz	ELF	SLF	ULF	VLF	LF	MF	HF	VHF	UHF	SHF	EHF	THF

References

User of Aeronia Antennas and Spectrum Analyzers (Examples)

Government, Military, Aeronautic, Astronautic

- ◆ NATO, Belgium
- ◆ Boeing, USA
- ◆ Airbus, Germany
- ◆ Bund (Bundeswehr), Germany
- ◆ Bundeswehr (Technische Aufklärung), Germany
- ◆ Lufthansa, Germany
- ◆ DLR (Deutsches Zentrum für Luft- und Raumfahrt, Germany)
- ◆ Eurocontrol (Flugüberwachung), Belgium
- ◆ Australian Government Department of Defence, Australia
- ◆ EADS (European Aeronautic Defence & Space Company) GmbH, Germany
- ◆ Institut für Luft- und Raumfahrtmedizin, Germany
- ◆ Deutscher Wetterdienst, Germany
- ◆ Polizeipräsidium, Germany
- ◆ Landesamt für Umweltschutz Sachsen-Anhalt, Germany
- ◆ Zentrale Polizeitechnische Dienste, Germany
- ◆ Bundesamt für Verfassungsschutz, Germany
- ◆ BEV (Bundesamt für Eich- und Vermessungswesen)

Research/Development, Science and Universitys

- ◆ Deutsches Forschungszentrum für Künstliche Intelligenz, Germany
- ◆ University Freiburg, Germany
- ◆ Indonesien Institute of Sience, Indonesia
- ◆ Max-Planck-Institut für Polymerforschung, Germany
- ◆ Los Alamos National Labratory, USA
- ◆ University of Bahrain, Bahrain
- ◆ University of Florida, USA
- ◆ University Erlangen, Germany
- ◆ University Hannover, Germany
- ◆ University of Newcastle, United Kingdom
- ◆ University Strasbourg, France
- ◆ Universität Frankfurt, Germany
- ◆ University Munich, Germany
- ◆ Technical University Hamburg, Germany
- ◆ Max-Planck Institut für Radioastronomie, Germany
- ◆ Max-Planck-Institut für Quantenoptik, Germany
- ◆ Max-Planck-Institut für Kernphysik, Germany
- ◆ Max-Planck-Institut für Eisenforschung, Germany
- ◆ Forschungszentrum Karlsruhe, Germany

Industry

- ◆ Shell Oil Company, USA
- ◆ ATI, USA
- ◆ Fedex, USA
- ◆ Walt Disney, Kalifornien, USA
- ◆ Agilent Technologies Co. Ltd., China
- ◆ Motorola, Brazil
- ◆ IBM, Switzerland
- ◆ Audi AG, Germany
- ◆ BMW, Germany
- ◆ Daimler Chrysler AG, Germany
- ◆ BASF, Germany
- ◆ Deutsche Bahn, Germany
- ◆ Deutsche Telekom, Germany
- ◆ Siemens AG, Germany
- ◆ Rohde & Schwarz, Germany
- ◆ Infineon, Austria
- ◆ Philips Technologie GmbH, Germany
- ◆ ThyssenKrupp, Germany
- ◆ EnBW, Germany
- ◆ RTL Television, Germany
- ◆ Pro Sieben – SAT 1, Germany
- ◆ Channel 6, United Kingdom
- ◆ WDR, Germany
- ◆ NDR, Germany
- ◆ SWR, Germany
- ◆ Bayerischer Rundfunk, Germany
- ◆ Carl-Zeiss-Jena GmbH, Germany
- ◆ Anritsu GmbH, Germany
- ◆ Hewlett Packard, Germany
- ◆ Robert Bosch GmbH, Germany
- ◆ Mercedes Benz, Austria
- ◆ EnBW Kernkraftwerk GmbH, Germany
- ◆ AMD, Germany
- ◆ Infineon Technologies, Germany
- ◆ Intel GmbH, Germany
- ◆ Philips Semiconductors, Germany
- ◆ Hyundai Europe, Germany
- ◆ Saarschmiede GmbH, Germany
- ◆ Wilkinson Sword, Germany
- ◆ IBM Deutschland, Germany
- ◆ Vattenfall, Germany
- ◆ Fraport, Germany

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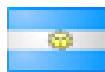
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