

# High-power amplifiers

from

# Rohde & Schwarz





# Amplifiers from Rohde & Schwarz

Sophisticated technology based on decades of experience

Rohde & Schwarz has a longstanding history in high-power amplifier design – both air-cooled and liquid-cooled. Backed by decades of experience in the transmitter business, the company constantly pushes the technological limits when designing its high-power amplifiers.

Rohde & Schwarz amplifier systems are extremely well-engineered, manufactured in an award-winning factory and come with field-proven reliability that is second-to-none in the industry.

Rohde & Schwarz built Europe's first FM transmitter, which went into operation in 1949. In 1956, TV transmitters were added to the product portfolio. Rohde & Schwarz products always were and still are at the technological forefront and

in tune with the times. The first broadcast amplifiers were based on tubes. Transistor amplifiers followed in the 1980s – initially air-cooled. In 1999, Rohde & Schwarz was the first manufacturer to introduce liquid cooling for its high-power broadcast amplifiers. As a result, the company could offer amplifiers that were more efficient and more compact in size and did not need all the additional space for the air ducts and air mixing chamber.

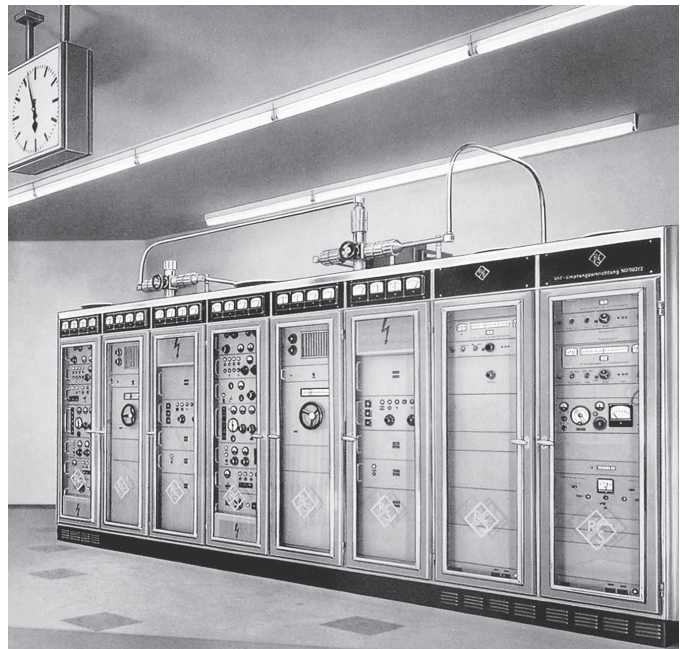
Today's Rohde & Schwarz solid-state TV and sound broadcast transmitters deliver more than 100 kW RF power on average. Several thousand units have been delivered over the years, many of them liquid-cooled. Rohde & Schwarz is undoubtedly the market leader in this field of application. In 2010, Rohde & Schwarz started its successful line of broadband amplifiers, which now covers frequency bands from 9 kHz to 6 GHz.

All amplifiers are manufactured in Rohde & Schwarz plants, which have superior manufacturing depth: from precision mechanical engineering and machining to printed board production and final assembly.

With more than 70 subsidiaries and local representatives worldwide, Rohde & Schwarz has built up long-lasting relationships with customers, the global research community and industry partners. Driven by our own curiosity for technical innovation and research development, we are constantly expanding this relationship network – offering our expertise and cutting-edge solutions to our partners. With its broadband and high-power amplifiers, Rohde & Schwarz constantly pushes the technological limits.



1949: Europe's first FM transmitter by Rohde & Schwarz side-by-side with today's generation



1963: VHF radio transmitter with 2x 5 kW







# Amplifiers: fields of application

The comprehensive portfolio of amplifiers addresses a wide range of applications. Rohde&Schwarz also offers an integrated global support network with a good understanding of air-cooled and liquid-cooled high-power amplifiers for broadcasting, EMC, physics and engineering applications. The company offers a broad range of products, including narrowband and broadband solid-state amplifiers for the frequency range from 9 kHz to 6 GHz, delivering more than 100 kW of CW power. Find out more about the different fields of application where Rohde&Schwarz high-power amplifiers are a valuable partner:

## ■ EMC

■ Design and product verification  
and validation testing

■ Industrial and scientific  
applications



R&S®BBA130



R&S®BBL200



## Design and product verification and validation testing



R&S®BBA150

## EMC



## Industrial and scientific applications



© Roger Eriksson / ESS



R&S®THx9



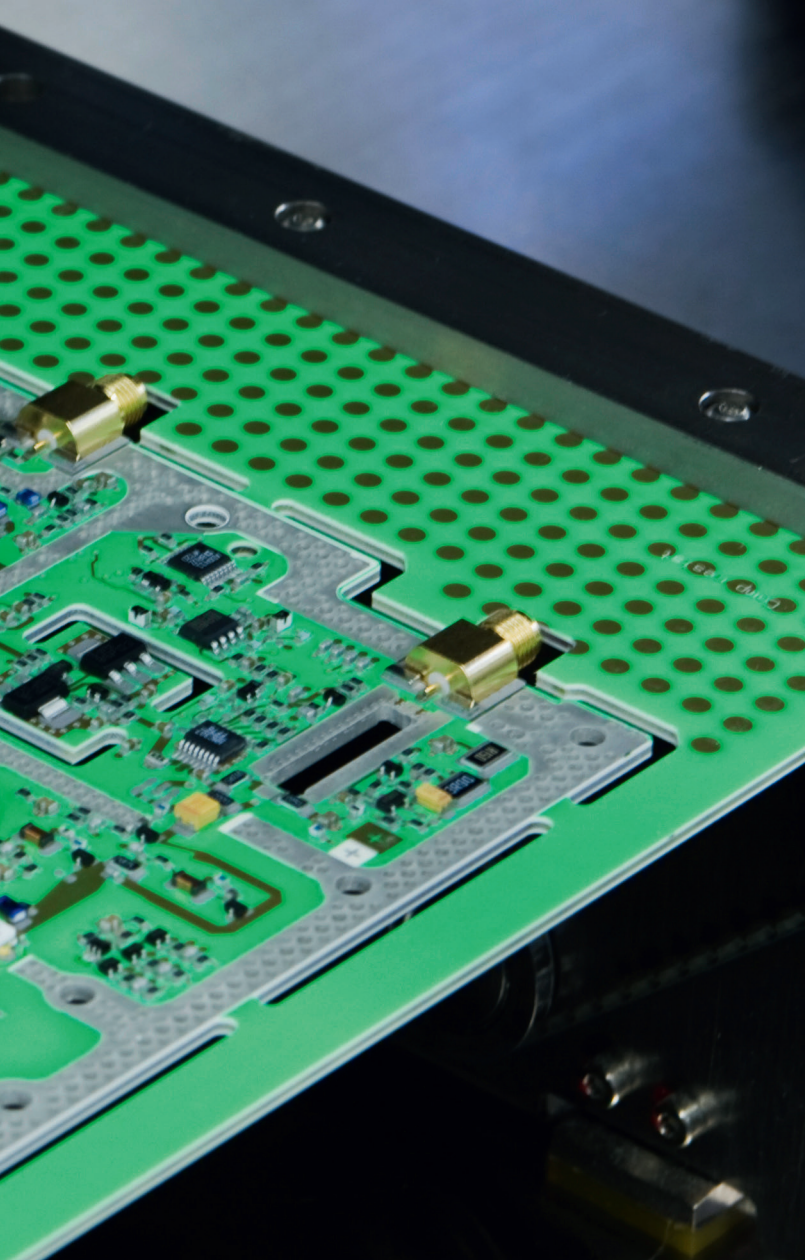


## Design and product verification and validation testing: when versatility matters

During development in the lab, in production or for Q&A purposes, amplifiers are often needed for tests. Two different tests are often performed during the development cycle. Verification tests confirm that the product meets the specified requirements, regulations or imposed conditions. This procedure ensures that the specified item has been correctly built and fulfills its data sheet values. Validation tests confirm that the correct item has been built. The product is fit for its intended use. A successful design and product validation process can improve product quality and lower warranty costs. Prototype costs will decrease as well. Design cycle times can also be compressed, which is in the interest of the manufacturers.

Typical tests include intermodulation, multitone and peak-to-average-ratio tests as well as robustness, aging and slam tests. Quite often a subset of these tests is also performed during production as part of the quality assurance process.

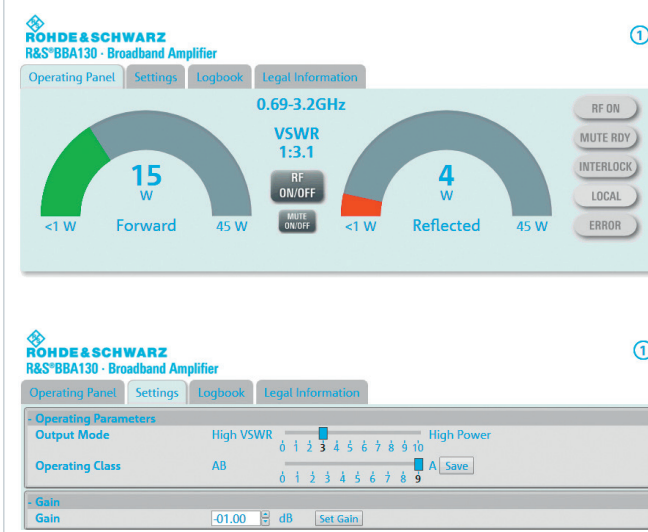




RF components such as filters, switches and amplifier modules, for example, often need a rather high RF input signal level for these tests, and that can only be achieved using an amplifier as a booster downstream of the signal generator. Depending on the properties of the test signal (CW or pulsed, with or without crest factor) and the test setup (the DUT can be well matched or not), different amplifier properties are needed to assure an optimal test signal for the DUT. The R&S®BBA130 family of amplifiers is designed to provide the versatility required from an amplifier for these kinds of tests. During operation, the user can stepwise change the operating point from Class A to class AB to optimize amplifier performance for CW or pulsed signals. It is also possible to choose between high mismatch tolerance and high output power.



### Screenshots of the R&S®BBA130 Web GUI





# Electromagnetic compatibility (EMC): when field strength and VSWR tolerance matter





The R&S®BBL200 and R&S®BBA150 broadband amplifier families are designed for EMC applications and cover frequencies from 9 kHz to 6 GHz and can deliver up to 10 kW RF power. Designed specifically for mismatch tolerance, the amplifiers gradually fold back to about half the nominal output power for high mismatch and deliver this output power even if there is an open or short at their output.

All electronic components have to meet certain electro-magnetic susceptibility (EMS) and electromagnetic interference (EMI) specifications. This is especially important due to the increase in electronic devices and wireless technologies. Rohde&Schwarz offers more than just test equipment. It also offers turnkey and custom test systems to perform EMI and EMS measurements in line with all major EMC standards.

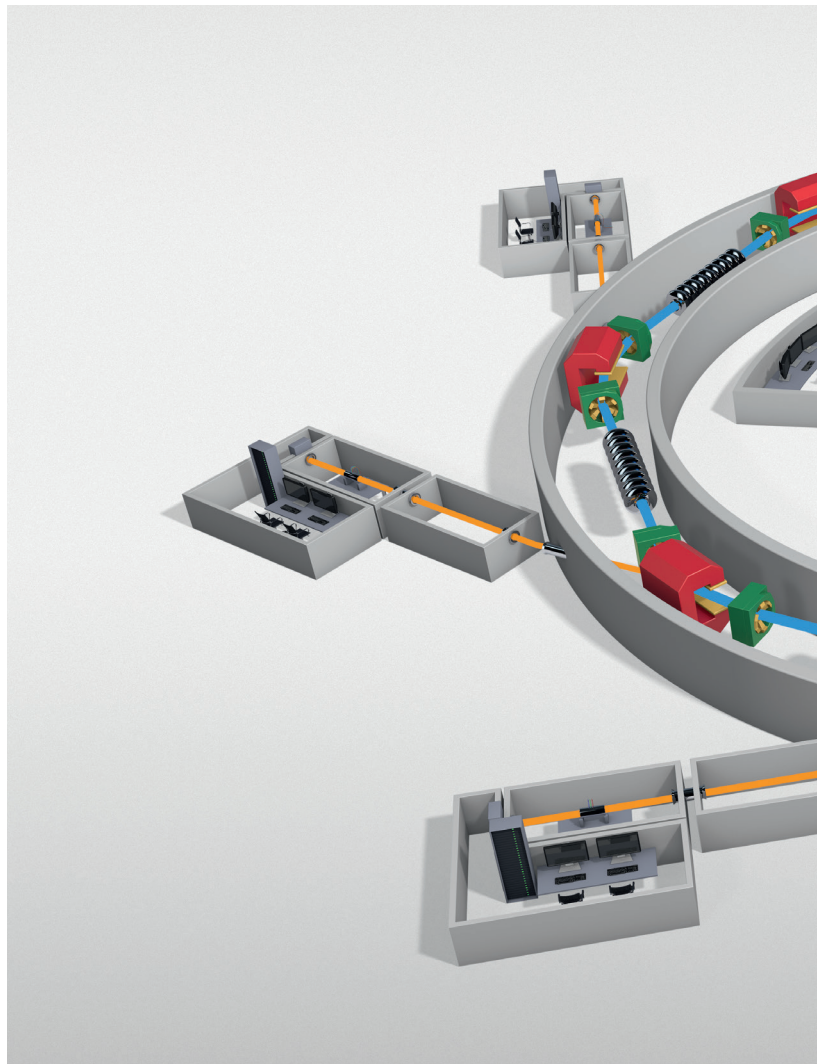
As part of the EMC test procedure, susceptibility tests are performed on the device under test (DUT). During these tests, the DUT is subjected to an electromagnetic field and checked to determine if it still operates properly and is therefore immune to disturbances from external sources, such as signals from broadcast transmitters or mobile phone base stations. The required field strength for these tests is specified by the relevant commercial, automotive or military test standard. The electromagnetic fields need to be generated by linear broadband amplifiers that deliver the requested output power and are robust against mismatch. The mismatch seen at the amplifier output can be caused by the current clamp or the broadband antenna used as well as by the DUT itself or be due to the properties of the test chamber in which the test is being performed.





# Industrial, scientific and research applications: when high power and bandwidth matter

Industrial, scientific and research applications demand a multitude of different amplifier properties. Whether your challenge lies in elementary particle research, particle therapy applications, material characterization or in providing service in fields such as high-energy particle acceleration, precise beamforming or reliable and safe particle storage, Rohde&Schwarz is your reliable long-term partner with proven solutions to address these highly sophisticated requirements.

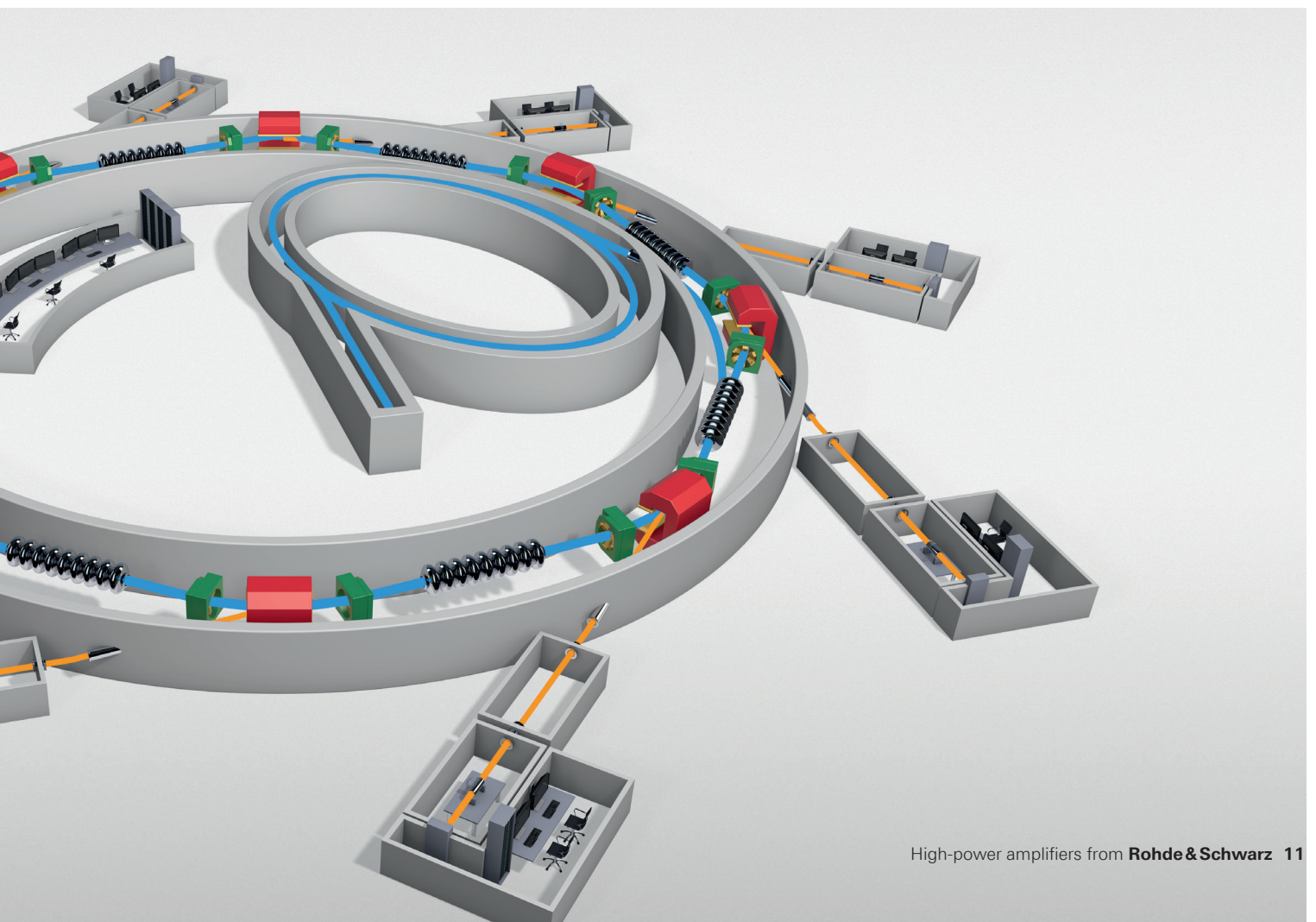






© Roger Eriksson / ESS

When considering solutions for particle accelerators, precision and efficiency in RF signal amplification in particular are in high demand. In a linear accelerator (LINAC), circular accelerator, storage ring or feedback loop for beam stabilization, it takes robust, reliable RF amplifiers with high phase stability and low phase noise to apply the necessary kinetic energy to accelerate electrons, protons and ions in order to compensate for the energy loss due to synchrotron radiation or to refocus the particle bunches. The R&S®THx9 high-power amplifier family meets these challenges. It is based on the Rohde&Schwarz portfolio of highly efficient broadcast transmitters and offers an output power of up to 100 kW and more. For feedback loops, R&S®BBA broadband amplifiers with moderate output powers can be used. Both amplifier families have a small footprint and modular design.





# The product portfolio

## R&S®BBA130

### Air-cooled broadband amplifiers from 80 MHz to 6 GHz that you can tune

The R&S®BBA130 broadband amplifiers offer a variety of setting options so you can optimally tune the output signal to your specific application. During operation, you can adjust the operating class for transistors between Class A and Class AB as well as choose between maximum output power or higher mismatch tolerance at the output.

The primary area of application for R&S®BBA130 broadband amplifiers is design and product validation and verification testing during RF component development, production and quality assurance.

The R&S®BBA130 broadband amplifiers feature a lightweight, modular design that is optimized for the specific frequency range. The broadband amplifiers are available as a desktop and a rack model. The low-power amplifiers are 4 HU, 19" desktop models that can also be installed in a rack. Devices with higher power are rack models. The amplifiers can be operated via the display and buttons, via a remote control interface (automated operation) or via a web browser.

The modular design allows you to later upgrade the power and frequency range.

### Key facts

- Three frequency ranges: 80 MHz to 1.0 GHz, 0.69 GHz to 3.2 GHz, 2.5 GHz to 6.0 GHz
- Output power from 22 W to 4200 W
- Operating class for transistors adjustable between Class A and Class AB
- Choice between maximum output power or higher mismatch tolerance
- Suitable for amplitude, frequency, phase and pulse modulation
- Worldwide service network, three-year warranty and service level agreements available





# R&S® BBA150

## Air-cooled broadband amplifiers from 9 kHz to 6 GHz with high mismatch tolerance

The R&S®BBA150 broadband amplifier family generates power in the 9 kHz to 6 GHz frequency range. The compact amplifiers are rugged and feature high availability. They are ideal for amplitude, frequency, phase and pulse modulation. Extensive switching options for input, output and sample ports are available for different applications.

The R&S®BBA150 broadband amplifiers can be used to address a variety of applications, including the various standards for EMS measurements up to 6 GHz. In the industry environment, the R&S®BBA150 broadband amplifiers are suitable for development and product validation tests where load tolerance and linearity are required. Other application fields include research, physical engineering and communications.



### Key facts

- Frequency bands: 9 kHz to 250 MHz, 80 MHz to 1.0 GHz, 0.69 GHz to 3.2 GHz, 2.5 GHz to 6.0 GHz
- Output power from 15 W to 3000 W
- 100 % mismatch tolerance
- Suitable for amplitude, frequency, phase and pulse modulation
- Worldwide service network, three-year warranty and flexible service level agreements



# R&S®BBL200

## Broadband liquid-cooled amplifiers for high power requirements

The R&S®BBL200 broadband amplifiers are ideal for EMC and various scientific applications that require high RF power and broad bandwidth. The R&S®BBL200 broadband amplifiers generate 3 kW, 5 kW and 10 kW of power in a frequency range from 9 kHz to 225 MHz. They are liquid-cooled, solid-state, highly rugged, quiet and efficient. Precise monitoring of all runtime parameters ensures maximum robustness and reliability.

Especially in EMC environments, the R&S®BBL200 broadband amplifiers easily fulfill typical requirements as specified by relevant standards or resulting from the physical characteristics of the antennas being used. This includes outstanding performance at 1 dB compression and high mismatch tolerance. The amplifiers are designed for continuous operation and deliver constant power even under severe mismatch conditions, for example through antennas or injection clamps.



### Key facts

- Frequency range from 9 kHz to 225 MHz
- 3000 W, 5000 W and 10 000 W output power
- 100 % mismatch tolerance
- Designed for continuous operation even under mismatch conditions, fold back to minimally 50 % of the nominal output power depending on the amplitude and phase; no switch-off
- Suitable for amplitude, frequency, phase and pulse modulation
- Worldwide service network, three-year warranty and flexible service level agreements



# R&S®THx9

## Narrowband liquid-cooled amplifiers for high power requirements

For applications, where high power and a relatively narrow bandwidth are required, Rohde&Schwarz offers amplifiers based on our high-power broadcast transmitters. These amplifiers are slightly modified standard products. Our customers benefit from our well-engineered and tested broadcast products that are manufactured in volume. Spare parts availability are not a concern.

R&S®THx9 high-power solid-state amplifiers deliver 100 kW and more output power and can therefore replace tube-based solutions. The solid-state solution has an efficiency comparable to that of tube amplifiers, but without their main weakness: the tubes. Solid-state amplifiers are less complicated to service than tube amplifiers since high voltages are not required. When solid-state amplifiers are operating at reduced power, high efficiency can be achieved by adjusting the voltages on the semiconductor, which is not possible with tube-based solutions. The operator's electricity bill is much less when operating a solid-state amplifier at reduced power than for a tube amplifier.

### Key facts

- Frequency ranges:
  - 87.5 MHz to 108 MHz, up to 80 kW output power
  - 170 MHz to 254 MHz, up to 50 kW output power
  - 470 MHz to 862 MHz, up to 100 kW output power
- Hot-pluggable amplifier modules
- Worldwide service network and flexible service level agreements available





# Product matrix



R&S®BBA130



R&S®BBA150

Amplifier families	Frequency bands	Power classes	Cooling concept	Operating class
<b>R&amp;S®BBA130</b>	80 MHz to 1 GHz 690 MHz to 3,2 GHz 2,5 GHz to 6 GHz	100 W to 4200 W 45 W to 1200 W 22 W to 280 W	Air cooled	A, A/B adjustable in steps
<b>R&amp;S®BBA150</b>	9 kHz to 250 MHz 80 MHz to 1 GHz 690 MHz to 3,2 GHz 2,5 GHz to 6 GHz	125 W to 2500 W 70 W to 3000 W 30 W to 800 W 15 W to 400 W	Air cooled	A
<b>R&amp;S®BBL200</b>	9 kHz to 225 MHz	3 kW to 10 kW	Liquid cooled	A
<b>R&amp;S®THx9</b>	87,5 MHz to 108 MHz 170 MHz to 254 MHz 470 MHz to 862 MHz	up to 80 kW up to 60 kW up to 100 kW	Liquid cooled	C A/B A/B





R&S®BBL200



R&S®THx9

VSWR tolerance	Interlock loop	Misc	Applications
Adjustable between high VSWR tolerance and high output power	yes	Extensive switching options	Design and product verification and validation, scientific and research
Highly tolerant	yes	Very load tolerant, extensive switching options	EMC, scientific and research
Highly tolerant	yes	Extremely load tolerant	EMC, scientific and reasearch
up to VSWR 2:1	yes	Can handle high peak power	Scientific and reasearch



# Safeguard your business objectives with services from Rohde & Schwarz

To ensure operational readiness of your systems and plannable budgeting for operational expenditures, Rohde&Schwarz offers R&S®Service Level Agreements for your amplifier systems. These agreements allow you to concentrate on your core business. We take care of the service you require to succeed with your business model.

### Why is it beneficial to have a service level agreement?

- Higher availability of the amplifiers thanks to guaranteed reaction times and on-site service in case of problems. This minimizes delays and loss of orders/profit for your organization.
- Calculable operational expenses for the amplifiers. This is especially useful when it takes time or is very difficult to gain budget approval for unscheduled expenses in your organization.
- Transparency in technical customer support communications through the Rohde&Schwarz Support Desk (ticketing system).

A comprehensive service concept and global availability of spare parts put your mind at ease and provide security. With an extensive service network around the globe, we can provide 24-hour assistance whatever your time zone. We take care of your requests quickly and reliably, in our 70 locations worldwide or directly on site.

Every customer has different system and service requirements. A service level agreement pays off, especially when you need the highest level of reliability from your systems.

Talk to us. We will work with you to develop the service strategy that best suits your business.

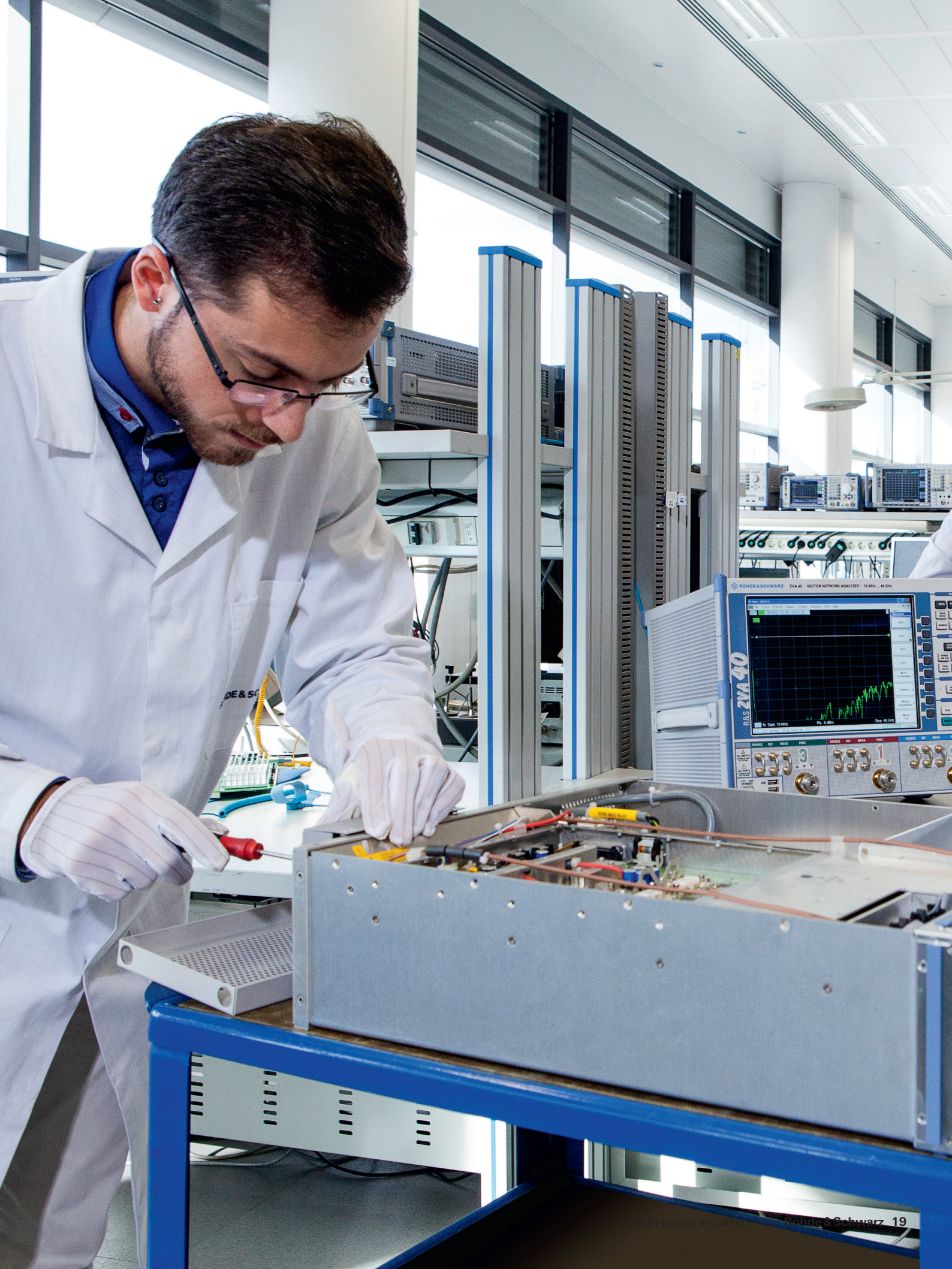
### Benefits at a glance:

- Maximum availability
- On-site service
- Fast turnaround for off-site service
- Calculable operating expenses

R&S®Service Level Agreement	Basic Cost control for your system	Advanced Flexible support for your system (option-based) *	Premium Maximum service for your system *
Repair coverage	•	•	•
Ensured support and response times		•	•
On-site service			•

\* Subject to regional availability







## Service that adds value

- Worldwide
- Local and personalized
- Customized and flexible
- Uncompromising quality
- Long-term dependability

## Rohde & Schwarz

The Rohde & Schwarz electronics group offers innovative solutions in the following business fields: test and measurement, broadcast and media, secure communications, cybersecurity, monitoring and network testing. Founded more than 80 years ago, the independent company which is headquartered in Munich, Germany, has an extensive sales and service network with locations in more than 70 countries.

## Sustainable product design

- Environmental compatibility and eco-footprint
- Energy efficiency and low emissions
- Longevity and optimized total cost of ownership

Certified Quality Management

**ISO 9001**

Certified Environmental Management

**ISO 14001**

## Rohde & Schwarz GmbH & Co. KG

[www.rohde-schwarz.com](http://www.rohde-schwarz.com)

## Rohde & Schwarz training

[www.training.rohde-schwarz.com](http://www.training.rohde-schwarz.com)

## Regional contact

- Europe, Africa, Middle East | +49 89 4129 12345  
[customersupport@rohde-schwarz.com](mailto:customersupport@rohde-schwarz.com)
- North America | 1 888 TEST RSA (1 888 837 87 72)  
[customer.support@rsa.rohde-schwarz.com](mailto:customer.support@rsa.rohde-schwarz.com)
- Latin America | +1 410 910 79 88  
[customersupport.la@rohde-schwarz.com](mailto:customersupport.la@rohde-schwarz.com)
- Asia Pacific | +65 65 13 04 88  
[customersupport.asia@rohde-schwarz.com](mailto:customersupport.asia@rohde-schwarz.com)
- China | +86 800 810 82 28 | +86 400 650 58 96  
[customersupport.china@rohde-schwarz.com](mailto:customersupport.china@rohde-schwarz.com)

R&S® is a registered trademark of Rohde & Schwarz GmbH & Co. KG  
Trade names are trademarks of the owners  
PD 5215.2689.62 | Version 01.00 | July 2017 (md)  
High-power amplifiers from Rohde & Schwarz  
Data without tolerance limits is not binding | Subject to change  
© 2017 Rohde & Schwarz GmbH & Co. KG | 81671 Munich, Germany



5215268962