

R&S® BBA 130: the chameleon among broadband amplifiers

The R&S® BBA 130 is the world's first amplifier whose transmission characteristics can be changed to match the application, even during operation.

Amplifier requirements

RF power amplifiers must fulfill a wide variety of requirements based on the application. For example, amplifiers for mobile base stations have different characteristics than those used for broadcast or radar applications – and each of the amplifiers is optimized for its specific purpose and cannot be modified.

However, for development, manufacturing and quality assurance tests on RF components such as filters, switches and amplifier modules, it should be possible to adjust the characteristics of RF power amplifiers to the respective test scenario, since they are influenced by multiple parameters:

Envelope of the input signal

The envelope determines whether the amplifier must retain power reserves for

the signal peaks. A distinction is made between signals with a:

- **Constant envelope**
e.g. CW signals or FM-, PM- and PSK-modulated signals
- **Slowly varying envelope**
e.g. AM or two-tone signals
- **Very rapidly varying amplitude**
single and multicarrier signals with high-quality phase and/or amplitude modulation, e.g. OFDM signals with a high crest factor

Time-domain behavior of the input signal

Faithful amplification of an input signal (continuous or pulsed) requires a suitable amplifier bias point.

Transmission characteristics of the amplifier itself

These characteristics affect the amplifier's linearity, harmonics and

intermodulation products and are an indication of whether the amplifier can be operated to its saturation point for the test. Depending on the application, an amplifier must either faithfully amplify the input signal with high spectral purity or the focus is on high output power and the time behavior and spectrum of the output signal are of secondary importance.

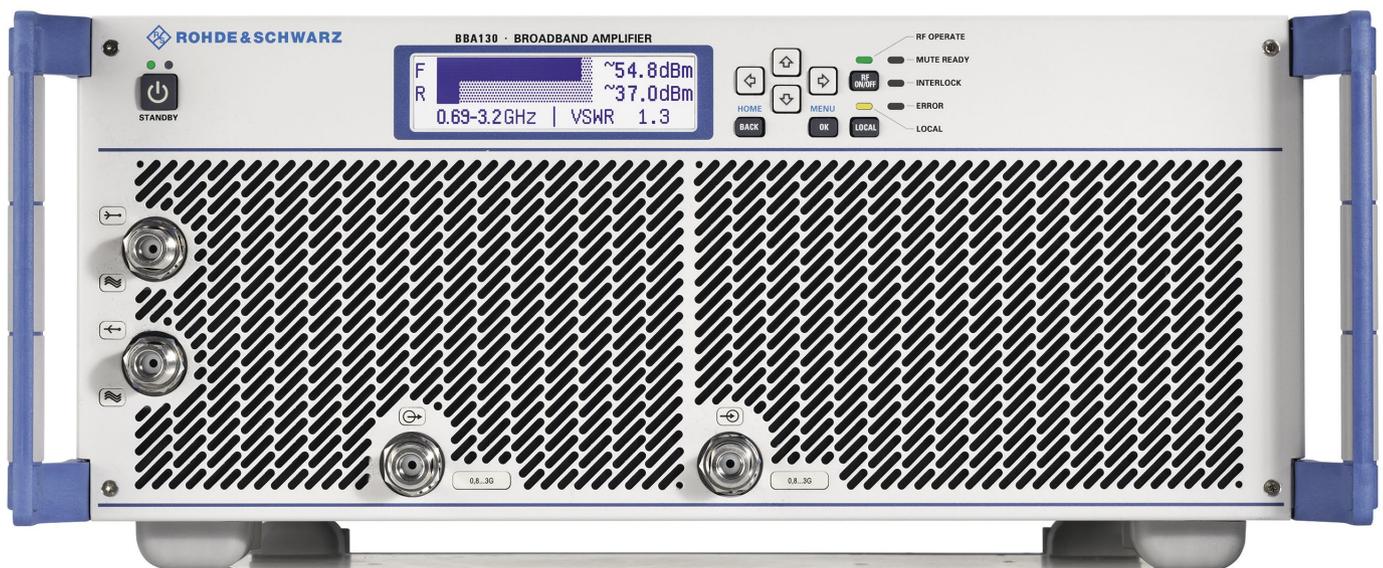
Impedance matching of DUT to amplifier output

The impedance matching of the DUT determines the amplifier's power reduction behavior and influences the design of the amplifier circuit. In practice, a distinction is made between:

- **Applications with good impedance matching (insignificant deviation from 50 Ω)**

The amplifier is allowed to reduce power to protect itself if the imped-

Fig. 1: R&S® BBA 130 power amplifiers allow users to adjust (while the amplifier in operation) the transistor operating class between Class A and Class AB as well as to choose between maximum output power or higher mismatch tolerance at the output.



Test	Amplifier requirements
<ul style="list-style-type: none"> ▮ Intermodulation tests, e.g. PIM tests ▮ Multitone tests ▮ Peak-to-average ratio tests 	A highly linear amplifier is required so that the DUT is supplied with a spectrally pure input signal. DUTs are typically well matched. If a mismatch occurs, the DUT must be defective and the amplifier is allowed to reduce its power or switch off entirely to protect itself.
<ul style="list-style-type: none"> ▮ Destructive tests ▮ Ruggedness tests ▮ Burn-in 	High output power is needed; spectral purity and faithful amplification of the input signal are secondary. The DUT is normally well matched. If a mismatch occurs, the DUT must be defective and the amplifier is allowed to reduce its power or switch off entirely to protect itself.
<ul style="list-style-type: none"> ▮ Tests with pulsed signals 	The amplifier must faithfully amplify the input signal.
<ul style="list-style-type: none"> ▮ Scientific applications ▮ EMC tests 	The test setups or antennas connected to the amplifier during EMC testing are often poorly matched and therefore require an amplifier that is tolerant against mismatch and that is slow to reduce or switch off power. The requirements for spectral purity and the faithful replication of the input signal differ depending on the application.

Fig. 2: Requirements placed on RF power amplifiers for various tests.



ance matching deteriorates due to a defect in the DUT.

▮ Applications with poor impedance matching (in extreme cases, short circuit or open circuit)

The amplifier should continue to produce RF power and not reduce power or switch itself off.

Flexible amplifiers are not only needed for the parameters listed above. They are also needed for the various tests performed as part of development, manufacturing and quality assurance of RF components. Fig. 2 lists some of these tests and the requirements that have to be met for each test.

R&S®BBA130 – one amplifier for many requirements

The R&S®BBA130 amplifiers (Figs. 1 and 3) are the first amplifiers that allow the user to configure the transmission characteristics to meet a specific

application. The family covers three frequency ranges: 80 MHz to 1.0 GHz, 0.69 GHz to 3.2 GHz and 2.5 GHz to 6.0 GHz at output power levels from 22 W to 4200 W. Two powerful control parameters allow users to optimize the output signal: a continuously variable bias point between Class A and Class AB and a choice between maximum output power and higher mismatch tolerance. It is possible to change the setting of both parameters during operation directly on the amplifier, for instance if the signal waveform changes or if different requirements are placed on the output signal during testing. This can be done manually on the amplifier, via the browser interface or via remote control commands.

With just one amplifier, it is now possible to measure if a DUT is within specifications (a test that requires a highly linear amplifier) and determine its load limit (only the output power counts here).

Continuously adjustable bias point

Being able to continuously vary the bias point affects the characteristics of the output signal. A bias point in Class A has very good linearity, resulting in pure output signals – ideal for generating clean CW signals. A Class AB bias point enables precise amplification of pulsed signals and improves efficiency (Fig. 4).

Fig. 3: Example configuration: The R&S®BBA130-BC1500D1200 amplifier system in a 35 HU 19" rack contains power amplifiers for 80 MHz to 1 GHz (1500 W) and 690 MHz to 3.2 GHz (1200 W), input switch, output switch and sample port switch.

Maximum output power versus higher mismatch tolerance

The R&S®BBA130 allows users to choose between high maximum output power with good impedance matching (maximum VSWR approx. 2:1) and higher mismatch tolerance with a subsequent reduction in power (VSWR starting at about 6:1) (Fig. 5). Impedance matching at the amplifier output is typically good during design and product validation tests. Good matching is ensured with DUTs developed for a 50 Ω system or when a circulator is inserted between the amplifier and the DUT. The amplifier power margin is then fully used. Mismatch can only be the result of a defective DUT or circulator. In this case, the amplifier can reduce its power to protect itself since the test has to be stopped.

For EMC applications involving poorly matched antennas or for DUT measurements with an input impedance that deviates significantly from 50 Ω, the amplifier must continue to produce the desired output power for as long as possible and therefore cannot reduce its power to protect itself (unless there is a very large mismatch).

Compact, modular design

The design of the R&S®BBA130 broadband amplifier is optimized for the greatest flexibility and a small footprint. Due to its lightweight design with a special aluminum-copper heat sink, the instrument weighs only half as much as conventional amplifiers in the same power class. An RF output power of up to 750 W below 1 GHz and up to 300 W above 1 GHz in just four height units means excellent power density. The amplifier family allows the setup of highly integrated systems based on 19" rack units (Fig. 3). The frequency and power of these rack units can be flexibly configured.

Amplification of a 2 ms pulse

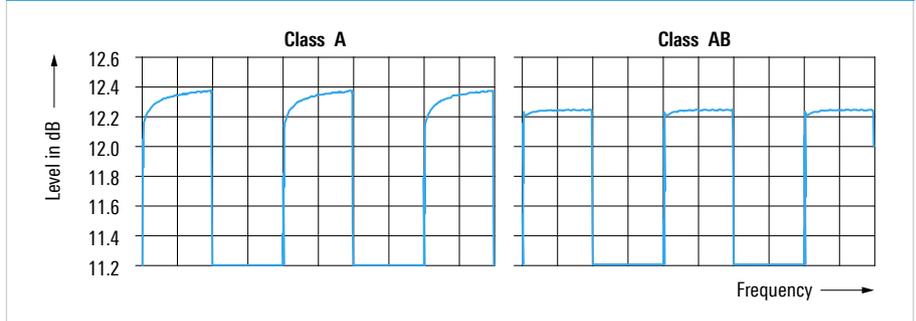


Fig. 4: Left: During the pulse, the power increases by 0.2 dB to 0.3 dB because the power transistor's junction temperature drops when RF is applied, thereby increasing the amplification. Right: The power change during the pulse is less than 0.05 dB because the junction temperature barely changes in AB mode.

R&S®BBA130 D300 power settings

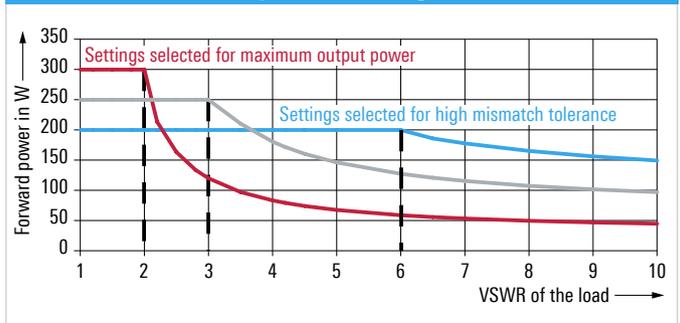


Fig. 5: Example of impact of settings on the R&S®BBA130 D300.

Twin-band and dual-band amplifier in only four height units

A 4 HU desktop unit can accommodate amplifiers for two frequency ranges in a twin-band or dual-band configuration. A twin-band configuration consists of two amplifiers that operate in parallel, both with the same frequency band. This configuration is ideal for two-tone measurements and for applications that require the same test setup for multiple tests in a small space. A dual-band configuration contains two amplifiers for different frequency bands, and only one of these amplifiers is active at any given time. This configuration covers the frequency ranges from 80 MHz to 3.2 GHz and from 690 MHz to 6 GHz. The optional switches for this option are integrated into the housing.

Summary

R&S®BBA130 amplifiers are the first in the world to allow users to change the transmission characteristics during operation to match the specific application. Now only one amplifier is needed to optimally handle different test scenarios. Output powers of 22 W to 4200 W are available in the frequency range from 80 MHz to 6 GHz. The compact, modular design permits flexible dual-band and twin-band configurations. Because the frequency and power can be upgraded, the R&S®BBA130 offers users investment security and the flexibility to upgrade the system to meet new requirements at a later date.

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