

Широкополосный усилитель Ku-диапазона PKU100



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AT A GLANCE

The powerful R&S®PKU100 Ku band satellite uplink amplifier family combines unparalleled RF performance with excellent efficiency in a compact design. The amplifiers are designed for a product life of at least 15 years, ensuring reliable operation for teleport and satellite operators and system integrators.

Broadcasting over satellite is an essential component of today's global media landscape. can look back on many years of experience in this field, starting from the time the first commercial satellite was launched in 1962. All of the company's expertise went into the development of the R&S®PKU100 amplifier family. Amplifiers from are rugged and built for high availability. They are series produced at the Teisnach plant in Germany – one of Europe's most advanced production facilities.

The GaN based R&S®PKU100 amplifiers operate in the frequency bands from 12.75 GHz to 13.25 GHz and 13.75 GHz to 14.5 GHz with RF peak power of 400 W and 750 W. They are available as indoor and antenna-mounted outdoor models.

The R&S®PKU100 Ku band satellite uplink amplifiers are the first solid-state power amplifiers (SSPA) to offer adaptive digital linearization at the RF level. This enables characteristics previously only attained by tube amplifiers and brings the advantages of SSPAs to operators with very high demands regarding size, weight and linearity.

The unique adaptive digital linearization feature allows the solid-state power amplifiers to be operated with high efficiency. Plus, it significantly improves signal quality in the satellite uplink both inside and outside the carrier bandwidth. As a result, this feature provides many benefits with regard to size, weight, efficiency, signal quality and linear output power level.

The innovative amplifiers feature self-monitoring and an integrated system control for redundancy systems. In combination with the intuitive web GUI and an SNMP interface, the Ku band satellite uplink amplifiers are the smartest available.

Outdoor model, 750 W.



KEY FACTS

- ▶ Frequency ranges from 12.75 GHz to 13.25 GHz and 13.75 GHz to 14.5 GHz
- ▶ Indoor and outdoor models with RF peak power of 400 W or 750 W
- ▶ GaN technology
- ▶ Convenient power supply redundancy
- ▶ Upconverter for L band signal feeding
- ▶ Excellent efficiency of 20% and higher
- ▶ Smart functions, simple to operate

BENEFITS

Combined benefits of solid-state and tube technologies

- ▶ Resilient design
- ▶ Optimized for efficient operation
- ▶ Compact and lightweight
- ▶ [page 4](#)

Unparalleled RF performance

- ▶ Adaptive linearization for excellent signal quality
- ▶ Extremely high output frequency accuracy
- ▶ [page 6](#)

Flexible options for diverse applications

- ▶ Upconverter for L band signal feeding
- ▶ Air ducting kit for R&S®PKU100 indoor models
- ▶ Convenient power supply redundancy and optional DC power supply
- ▶ Innovative amplifier redundancy options
- ▶ [page 7](#)

Versatile control options

- ▶ Operation via web GUI over Ethernet
- ▶ Remote control over Ethernet using SNMP
- ▶ Configurable parallel remote interface
- ▶ RS-232 and RS-485 serial interfaces
- ▶ [page 9](#)

Indoor model, 400 W.



COMBINED BENEFITS OF SOLID-STATE AND TUBE TECHNOLOGIES

Thanks to their solid-state design, the R&S®PKU100 amplifiers offer all of the well-known advantages of transistor over tube technology:

- ▶ Ready for use within a minimum of time
- ▶ Energy-efficient amplifier redundancy since the standby amplifier need not be operated in hot-standby mode
- ▶ Stable despite temperature fluctuations, long lifetime
- ▶ Reliable and easy to put into operation

Resilient design

R&S®PKU100 amplifiers will continue operating even if individual transistors fail – a distinct advantage over tube amplifiers. If individual transistors fail, the amplifier will continue operating at reduced output power. For example, if one of its power transistors fails, the R&S®PKU100 will still deliver more than 75%, or 85% respectively, of its maximum output power. The output power is automatically adjusted to the maximum possible output power. If the required output power is less than the maximum possible output power after a transistor failure, the amplifier's performance will not be affected at all.

Outdoor model, 750 W, rear view.



Optimized for efficient operation

The R&S®PKU100 amplifiers deliver outstanding efficiency – even compared to tube amplifiers. Peak efficiency is higher than 20%. QPSK efficiency is typically > 14% at linear output power. These values refer to the efficiency of the amplifier as a whole. They are calculated as the ratio of the RF output power present at the flange to the AC power consumed (including the power required for the fans and control unit). For conventional amplifiers, efficiency is commonly specified as the efficiency of a single transistor or tube stage – without taking into account the losses incurred in the power combiners, power supplies, fans and control unit.

Compact and lightweight

The R&S®PKU100 amplifiers are just as compact and lightweight as tube amplifiers. The 400 W and 750 W indoor models for installation in 19" racks are only three rack units high. Weighing just 18.3 kg and 25 kg, respectively, they are considerably lighter and more compact than comparable solid-state amplifiers.

The compact 400 W and 750 W outdoor models, weighing 23 kg and 35 kg, respectively, can be mounted directly on the antenna. They are rugged and weatherproof in line with IP65. They offer the same advantages as the indoor models over tube amplifiers and conventional solid-state amplifiers.

Both models contain redundant, hot-swappable fans. If a fan fails, the amplifier can continue operating within a limited temperature range. Depending on the ambient temperature and the required output power, the output power may be momentarily reduced when a fan is replaced.

Indoor model, 400 W, rear view.



UNPARALLELED RF PERFORMANCE

Adaptive linearization for excellent signal quality

The R&S®PKU100 amplifiers are the first of their kind to offer adaptive linearization at the RF level. This option makes it possible to achieve previously unattained spectral purity, allowing full exploitation of the amplifier's potential.

The unique adaptive digital linearization feature allows operation of the SSPAs as class AB amplifiers. Plus, it significantly improves the signal quality in the satellite uplink both inside and outside the carrier bandwidth. As a result, this feature provides many benefits – with regard to size, weight, efficiency, signal quality and linear output power level.

Compared to known technologies, adaptive linearization significantly enhances signal quality, specifically for the following parameters:

- ▶ Spectral regrowth of less than -35 dB
- ▶ Intermodulation (IM3) of less than -30 dBc
- ▶ Error vector magnitude (EVM) of less than 4% and modulation error ratio (MER) better than 30 dB
- ▶ Improved adjacent channel leakage ratio (ACLR)

Adaptive digital linearization allows the R&S®PKU100 to provide the power and signal quality required by teleport operators. It delivers value in terms of significantly lower lifecycle costs, improved efficiency and reduced energy costs, ease of maintenance and management, new capabilities and access to new markets.

Thanks to adaptive linearization, R&S®PKU100 amplifiers are well suited for use with the higher-order modulation schemes defined in the DVB-S2X standard.

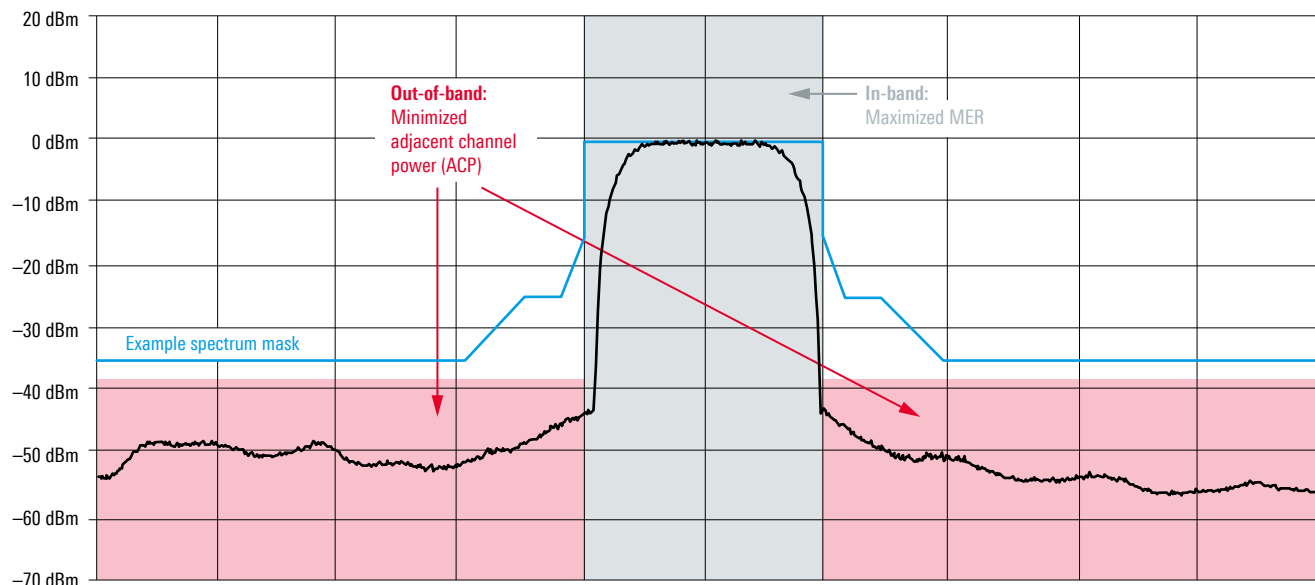
If adaptive linearization is active, linearization automatically adapts in the event of an output power or frequency change. The adaptive linearization option can be used for signal bandwidths up to 100 MHz and is available for Ku band and L band signal feeding.

Extremely high output frequency accuracy

When signals are fed in the L band, a reference frequency is required for upconversion to the Ku band. An external 10 MHz reference signal can be supplied, or an optional oven-controlled crystal oscillator (OCXO) can be used. If available, the OCXO is synchronized to the external 10 MHz reference signal to ensure consistently high stability of the output frequency even in the event the external reference fails.

Excellent signal quality

The R&S®PKU100 is well suited for use with higher-order modulation schemes. The adaptive linearization feature from seamlessly improves the purity of the RF output signal.



FLEXIBLE OPTIONS FOR DIVERSE APPLICATIONS

Upconverter for L band signal feeding

Line losses are relatively high in the Ku band owing to the high frequencies. Consequently, signals are typically fed to the amplifier in the L band, which involves lower losses. An optional upconverter, which is available for all amplifier models, converts the frequency to the Ku band.

Air ducting kit for R&S®PKU100 indoor models

The R&S®PKx-B100 air ducting kit provides the amplifier with a controlled air supply from an independent air intake system at the customer's site. It also enables the controlled discharge of heated exhaust air into an independent exhaust air system. Further elements such as auxiliary fans and cooled intake air must be provided on site.

The air ducting kit is designed for installation in commercial 19" racks and intended for stationary use only. It is supplied as a separate item and is attached on site to the R&S®PKU100 and connected to the customer's ventilation system.

Convenient power supply redundancy and optional DC power supply

Power supply redundancy is offered as an option. The power supplies can be fed individually from different power networks. If a power network or power supply fails, the R&S®PKU100 continues to run at full power without interruption. Thanks to the quick-release connections, defective power supplies in the indoor models can be replaced quickly and easily without interrupting amplifier operation.

The R&S®PKU100 can also be operated from a 48 V DC source. This is important for mobile applications or when the amplifier needs to be temporarily powered from a battery.

Air ducting kit for installation in 19" racks.



The air ducting kit is firmly attached to the R&S®PKU100.



Innovative amplifier redundancy options

The R&S®PKU100 offers two innovative redundancy options:

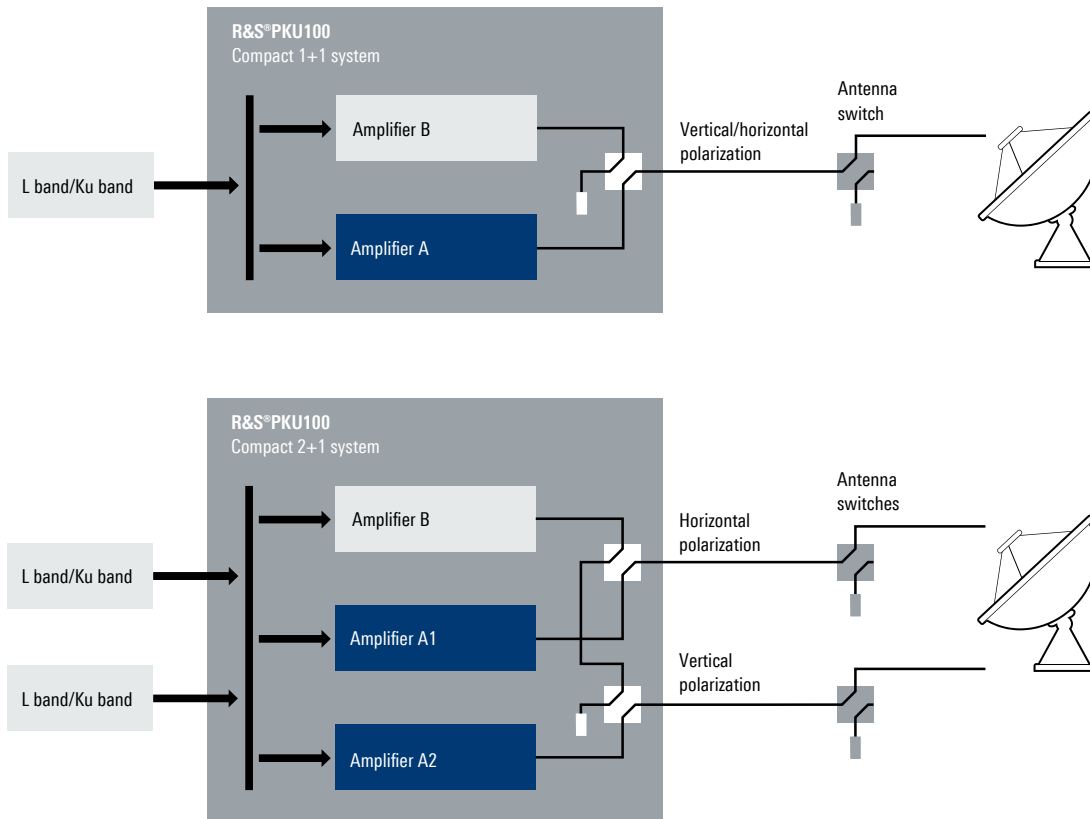
- ▶ Compact 1+1
- ▶ Compact 2+1

In a Compact 1+1 system, two R&S®PKU100 operate in a fully symmetrical 1+1 configuration. The two units monitor each other, making extra hardware for system monitoring and control unnecessary. Virtualized distributed system intelligence running on both amplifiers eliminates the risk of a single point of failure. Compact 1+1 systems are considerably less complex and easier to deploy than conventional 1+1 systems, which require the integration and configuration of an external control unit.

Compact 2+1 is an enhanced version of the well-known 2+1 system, providing integrated system monitoring and control. These functions are performed by the standby amplifier. The standby amplifier in a Compact 2+1 system is automatically adjusted to the settings of the active amplifiers. If an active amplifier fails, the standby amplifier takes over within milliseconds. Likewise, in the event a standby amplifier needs to be replaced, the new standby amplifier reads the settings from the active amplifiers, which continue operating.

Both Compact 1+1 and Compact 2+1 systems support control of 12 V, 24 V and 48 V waveguide switches. In addition, the R&S®PKU100 is able to control antenna waveguide switches to simplify antenna maintenance.

R&S®PKU100 amplifier redundancy options



VERSATILE CONTROL OPTIONS

Operation via web GUI over Ethernet

The integrated web GUI is accessed via LAN using a web browser (Chrome recommended). The graphical user interface allows convenient operation from a laptop connected directly to the amplifier or from a PC at a remote workstation.

Remote control over Ethernet using SNMP

The amplifiers can be integrated into a network management system using SNMP. The IP network address can be set manually or assigned via DHCP.

Configurable parallel remote interface

The parallel remote interface enables communications with the amplifiers using three messages and six commands. The messages and commands available on the interface can be individually configured.

RS-232 and RS-485 serial interfaces

The amplifiers come with RS-232 and RS-485 serial interfaces for data communications.

Amplifier status display in web based GUI.



SPECIFICATIONS

	400 W models	750 W models
RF specifications		
Output frequency		
Frequency range 1	12.75 GHz to 13.25 GHz	
Frequency range 2	13.75 GHz to 14.5 GHz	
Input frequency, SSPB (BUC)		
Frequency range 1	950 MHz to 1450 MHz (local oscillator frequency: 11.8 GHz)	
Frequency range 2	950 MHz to 1700 MHz (local oscillator frequency: 12.8 GHz)	
Output power at RF output (at flange)		
P_{sat}	≥ 400 W, typ. 500 W	≥ 750 W, typ. 1000 W
P_{lin}	≥ 180 W	≥ 350 W
Gain		
Large signal at P_{lin}	min. 78 dB	min. 81 dB
Gain attenuator range	25 dB ± 0.5 dB, continuous	
Gain stability over 24 h	max. ±0.25 dB; with BUC or linearizer: max. ±0.4 dB	
Gain stability over specified temperature range		
Indoor model	max. ±1.5 dB; with BUC or linearizer: max. ±2.0 dB	
Outdoor model	max. ±2.5 dB; with BUC or linearizer: max. ±3.0 dB	
Spectral regrowth at P_{lin} (QPSK at 1 symbol rate offset)	< -25 dB; with linearizer: typ. < -40 dB	
EVM with adaptive linearization	< 4%	
Intermodulation at P_{lin} (for the sum of 2 equal carriers 50 MHz apart)	typ. < -25 dBc; with linearizer: typ. < -35 dBc	
Power stability (in constant power mode)		
Within indoor temperature range	±0.5 dB	
Within outdoor temperature range	±1 dB	
Frequency response over full frequency band	±3 dB	
Frequency response in RF channel (36 MHz bandwidth)	±0.3 dB	
Input power	-20 dBm to 0 dBm	
Maximum input power, P_{lin}	≤ +13 dBm	
VSWR at L band input, $Z_0 = 50 \Omega$	< 1.5:1	
VSWR at Ku band input, $Z_0 = 50 \Omega$	< 2:1	
Load VSWR at P_{lin}	≤ 1.3:1; power reduction starting at (1.6 ± 0.3):1	
AM/PM conversion	< 2°/dB	
Coupling factor for RF monitor output at center of band referred to RF output power, exact value stored in amplifier	-43 dB	-46 dB
Noise power density		
In transmit band	< -65 dBm (1 Hz)	
In receive band (10.7 GHz to 11.7 GHz)		
Frequency range 1	< -150 dBm (1 Hz)	
Frequency range 2	< -160 dBm (1 Hz)	
Group delay		
Linear	0.025 ns/MHz	
Parabolic	0.015 ns/MHz	
Ripple within 72 MHz	1 ns (peak-to-peak)	
Ripple over full frequency band	2 ns (peak-to-peak)	

	400 W models	750 W models
SSPB (BUC)		
Spurious	< -65 dBc	
Phase noise (internal reference)		
10 Hz	< -50 dBc, typ. < -60 dBc	
100 Hz	< -65 dBc, typ. < -70 dBc	
1 kHz	< -75 dBc, typ. < -78 dBc	
10 kHz	< -85 dBc, typ. < -90 dBc	
100 kHz	< -95 dBc, typ. < -100 dBc	
1 MHz	< -105 dBc, typ. < -115 dBc	
Required reference frequency	10 MHz with external bias tee, alternatively internal reference OCXO	
RF and monitor interfaces		
RF output	waveguide, WR75	
RF input (Ku band and L band)	type N connector	
RF monitor output	type N connector	
Operation		
Local operation	via front panel	
Web GUI over Ethernet	RJ-45, 10/100 Mbit/s, autosense, half/full duplex	
Network management via SNMP and Ethernet	RJ-45, 10/100 Mbit/s, autosense, half/full duplex	
Parallel remote interface (optional)	floating contacts for 6 commands and 3 messages, configurable	
Serial interfaces	RS-232, RS-485, full duplex	
General data		
Operating voltage	100 V to 240 V AC + 10%, single phase; 50 Hz to 60 Hz + 6%; optional: -48 V DC, -40 V to -57 V	
Power consumption at P_{in}	nom. < 1500 VA, typ. 1300 VA	nom. < 2800 VA, typ. 2500 VA
Efficiency at P_{in}	nom. > 13%, typ. > 14%	nom. > 12.5%, typ. > 13.5%
Peak efficiency at P_{sat}	> 20%	
Dimensions (W × H × D)		
Indoor models	19" × 3 RU × 550 mm (19" × 3 RU × 21.7 in)	
Outdoor models	355 mm × 171 mm × 638 mm (14.0 in × 6.7 in × 25.1 in)	515 mm × 171 mm × 638 mm (20.3 in × 6.7 in × 25.1 in)
Weight (without backup power supply)		
Indoor models	18.3 kg (40.3 lb)	25 kg (55 lb)
Outdoor models	23 kg (51 lb)	35 kg (82 lb)
Ambient conditions		
Temperature range		
Operating temperature	+1 °C to +45 °C (at 2000 m above sea level) +1 °C to +40 °C (at 3000 m above sea level)	-40 °C to +65 °C (at 2000 m above sea level) -40 °C to +60 °C (at 3000 m above sea level)
Storage temperature	-40 °C to +85 °C	
Humidity	max. +40 °C at 95% rel. humidity, noncondensing: 100%	
Height above sea level	up to 3000 m	up to 3000 m
Protection class	IP40	IP65
Shock	40 g/11 ms, in line with MIL-STD-810E method 516.4	
Vibration, random	10 Hz to 300 Hz, acceleration 1.2 g (RMS)	
Vibration, sinewave	5 Hz to 150 Hz, max. 1.8 g at 55 Hz, max. 0.5 g at 55 Hz to 150 Hz, in line with EN60068-2-6, EN61010-1	

ORDERING INFORMATION

Designation	Type	Order No.
Indoor base unit, 400 W, 3 RU rack model	R&S®PKU-I400	2510.7005.41
Outdoor base unit, 400 W, outdoor housing	R&S®PKU-O400	2510.8001.41
Indoor base unit, 750 W, 3 RU rack model	R&S®PKU-I750	2510.7005.81
Outdoor base unit, 750 W, outdoor housing	R&S®PKU-O750	2511.6002.81
Hardware options		
Adaptive linearization for amplifier with Ku band input, indoor model, 400 W	R&S®PKU-B040	2510.9420.40
Adaptive linearization for amplifier with Ku band input, outdoor model, 400 W	R&S®PKU-B040	2511.6925.40
Adaptive linearization for amplifier with Ku band input, indoor model, 750 W	R&S®PKU-B075	2510.9420.75
Adaptive linearization for amplifier with Ku band input, outdoor model, 750 W	R&S®PKU-B075	2511.6925.75
Upconverter for amplifier with L band input, indoor models	R&S®PKU-B200	2510.9420.02
Upconverter for amplifier with L band input, outdoor model, 400 W	R&S®PKU-B200	2511.6925.02
Upconverter for amplifier with L band input, outdoor model, 750 W	R&S®PKU-B250	2511.6925.50
RF monitor output, rear	R&S®ZRK-SR	2510.9466.00
RF monitor output, front	R&S®ZRK-SF	2510.9437.00
Air filter for indoor model	R&S®PKx-B110	2510.9495.02
Air ducting kit, intake and exhaust air, indoor model, 400 W	R&S®PKx-B100	2513.1008.02
Air ducting kit, intake and exhaust air, indoor model, 750 W	R&S®PKx-B100	2513.1008.03
Air ducting kit, exhaust air, indoor model, 400 W	R&S®PKx-B100	2513.1008.04
Air ducting kit, exhaust air, indoor model, 750 W	R&S®PKx-B100	2513.1008.05
Air filter for air ducting kit	R&S®PKx-B111	2513.1708.02
Hardware option for control of waveguide relays up to 48 V DC	R&S®PKx-B50	2514.8935.02
Software options		
OCXO	R&S®PKU-K01	2510.9772.02
Adaptive linearization for amplifiers with L band input, 400 W	R&S®PKU-K40	2510.9789.02
Adaptive linearization for amplifiers with L band input, 750 W	R&S®PKU-K75	2510.9795.02
Software option for amplifier redundancy switching, required per R&S®PKU100	R&S®PKx-K10	2514.8941.02

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