

R&S® Series 4100 HF RADIO SYSTEM

Shortwave ATC communications solution



Product Brochure
Version 02.00

CERTIUM®
Security by design. Safety by culture.

ROHDE & SCHWARZ

Make ideas real



AT A GLANCE

Shortwave communications are essential for radio coverage on beyond-line-of-sight links over oceans and uninhabited areas. The R&S®Series4100 adds long-range coverage to the CERTIUM® ecosystem for a high-quality integrated solution.

IP-ready, future-proof

Modern air traffic control (ATC) systems are evolving toward flexible and scalable IP architectures based on EUROCAE ED-137 standardized network elements. CERTIUM® components utilize all the advantages of the IP technology, such as high flexibility and network resilience. The R&S®Series4100 employs highly reliable technology to give an IP ATC network shortwave capabilities, which improve the network's availability and versatility. The R&S®Series4100 can be seamlessly integrated into a range of IP based infrastructures, but its functions achieve their full potential when combined with other CERTIUM® products.

Going the distance

In areas where VHF coverage is insufficient to support a radio communications link over an air route's full length due to range limitations, the use of HF frequencies becomes necessary. These frequencies provide long-range radio link coverage for air-ground voice communications over major world air route areas (MWARAs) and regional and domestic air route areas (RDARAs) above oceans, deserts and other unpopulated territories. Since shortwave radio can sustain a radio channel beyond line of sight (BLOS), it enables safe monitoring of air traffic through an uninterrupted radio link.

Software defined radio

The R&S®Series4100 HF radios are innovative and versatile software defined radios (SDR) that belong to the popular Rohde&Schwarz radio family. As such, the R&S®Series4100 is variably configurable in terms of auxiliary features.

Cost-effective solution

The R&S®Series4100 enables the user to reduce logistical and operating costs. As a software defined radio, costs for spare parts and maintenance are lower. Having fewer internal hardware components further helps boost reliability compared to conventional radios.

Flexible platform

The R&S®Series4100 is a powerful and flexible radio platform that can be extended at any time. The modular design at both a device and system level allows Rohde&Schwarz to present an objective-tailored solution, addressing the specific application and use case. In line with the platform's flexible nature, the R&S®Series4100 radios can be scaled for remote operation. Different radio sites can thus be centrally managed from a remote location via IP. Together with minimal maintenance, this makes for an optimized process.

Meeting the standards

The R&S®Series4100 complies with the established EUROCAE ED-137C industry standard. The platform is a dependable tool with which the user can, in turn, offer a safe and standardized service. The R&S®Series4100 also conforms to the ICAO Annex 10 (Aeronautical Telecommunications), which further ensures worldwide compatibility.

Universal globally, modular locally

One of the greatest advantages of the R&S®Series4100 is that it is fully flexible and modularly customizable, but also offers a broad range of features as standard. Built-in features of the R&S®Series4100 would otherwise need to be provided externally by third parties. This tried-and-true approach from Rohde&Schwarz makes for a strong basic configuration. Thanks to its native IP support, for example, the R&S®Series4100 does not require an additional gateway. The broad Rohde&Schwarz peripheral portfolio, though, offers an end-to-end solution at the system level, for example the range of HF antennas and accompanying antenna tuning units (ATU) that harmonize optimally with the radio.

Flexible R&S®Series4100 radio as exciter

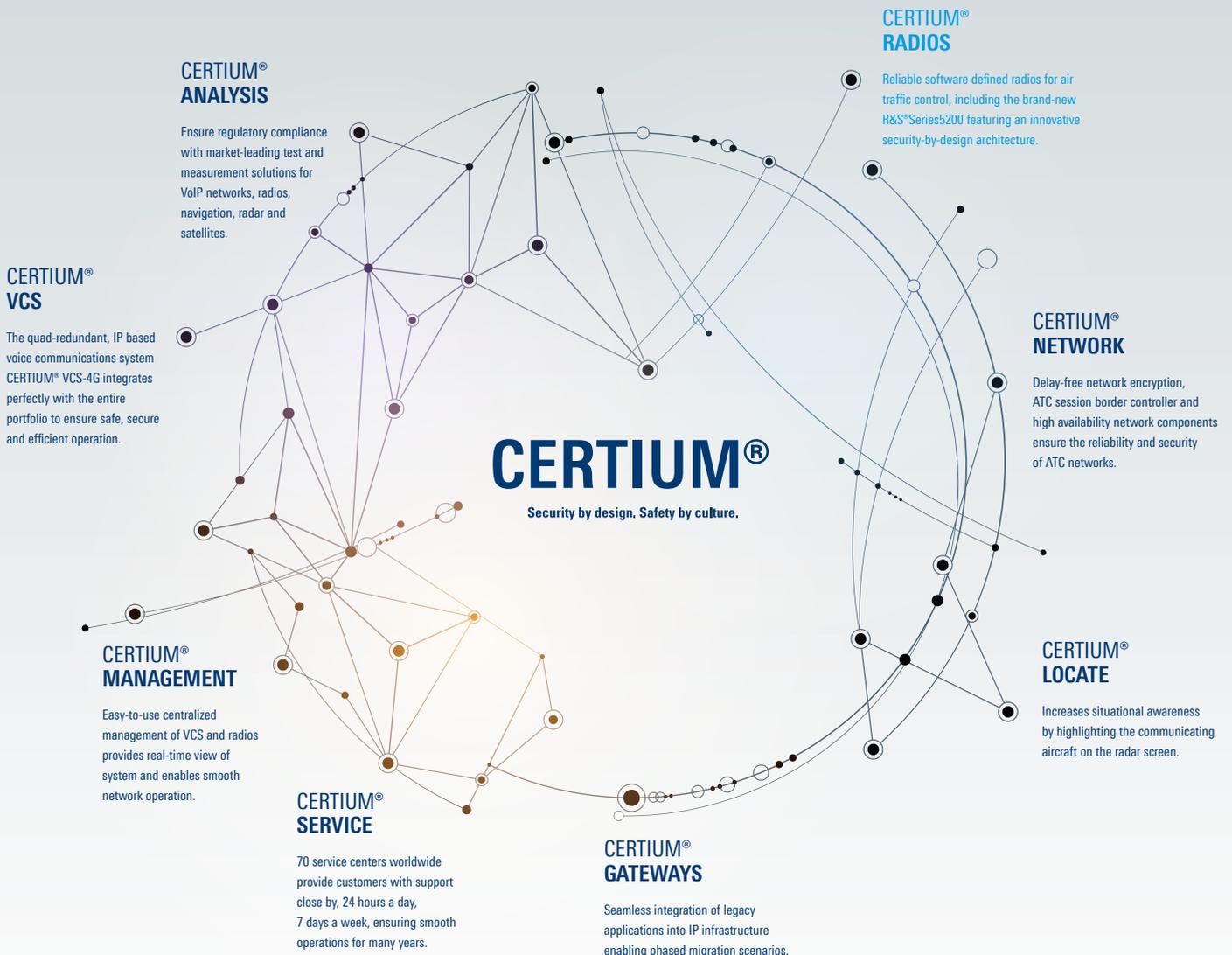
The R&S®GX4100A exciter, based on the R&S®Series4100 radio, is a key component of the revolutionary R&S®SK4105 HF high-power transmitter. The R&S®SK4105 features a compact design, excellent performance, maximum availability and liquid cooling.

Place in the CERTIUM® ecosystem

CERTIUM® is an advanced ATC communications suite from a single source that increases safety and efficiency beyond existing standards.

All CERTIUM® products are seamlessly integrated into a single portfolio. Using the R&S®Series4100 in combination with other CERTIUM® system components promotes deeper system integration, greater interoperability and easier centralized monitoring and management. Cross-integration between the individual subsystems has been thoroughly tested to ensure flawless and reliable operation.

The individual elements of the CERTIUM® suite harmonize with each other to provide integrated functionality. CERTIUM® VCS is particularly well suited to the R&S®Series4100, since it provides access to its extended features such as selective calling (SELCAL). The CERTIUM® MANAGEMENT centralized control unit turns an already capable radio into a comprehensive ATC solution. The CERTIUM® NETWORK, CERTIUM® ANALYSIS and CERTIUM® SERVICE units round off the platform by maximizing operating safety and efficiency and providing easy and intuitive operation.



BENEFITS OF THE R&S® Series 4100 HF RADIO SYSTEM

HF high-power transmitters with maximum availability

▶ [page 5](#)

Superior HF radio for ATC

▶ [page 6](#)

Safe around the globe

▶ [page 8](#)

Full system integration

▶ [page 10](#)

Prime quality pays off

▶ [page 14](#)

Rohde & Schwarz has developed a state-of-the-art generation of communications systems designed to take HF radio to the next level.



HF HIGH-POWER TRANSMITTERS WITH MAXIMUM AVAILABILITY

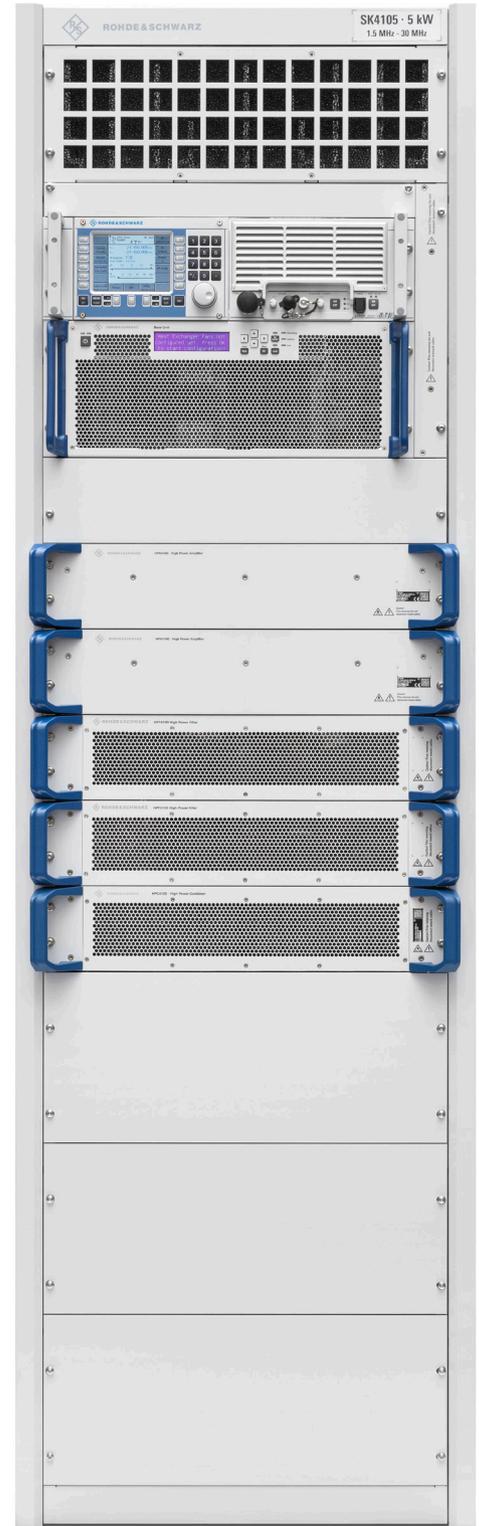
The R&S®SK4105 HF high-power transmitter, based on an exciter from the R&S®Series4100 HF radio family, meets the requirements for advanced long-range communications with maximum reliability. The innovative cooling concept minimizes operating costs.

- ▶ HF wideband ready
- ▶ Liquid-cooled amplifier – unique worldwide
- ▶ High output power
- ▶ Compact and quiet – even when operated 24/7
- ▶ Built-in redundancy for high reliability
- ▶ Outstanding HF performance

Rohde&Schwarz has been successfully building liquid-cooled amplifiers for many decades. There are many thousands of installations worldwide and hundreds of satisfied customers rely on Rohde&Schwarz technology. The amplifier of the R&S®SK4105 HF high-power transmitter is the product of this expertise. The high power is generated by an amplifier adapted to the frequency range.

The output power of 5 kW generated by the R&S®SK4105 HF high-power transmitter is sufficient to allow even advanced wideband HF waveforms to deliver the expected data rates with adequate spectral power density. The HF high-power transmitter is a future-proof investment. Thanks to an innovative liquid cooling concept, the R&S®SK4105 is optimized for minimal total cost of ownership (TCO).

The system consists of a software based exciter from the R&S®Series4100 HF radio family and a liquid-cooled high-power amplifier. The R&S®SK4105 transmits in the shortwave band in the frequency range from 1.5 MHz to 30 MHz. It is supplied complete with a heat exchanger and pump unit.



R&S®SK4105 HF high-power transmitter
with 5 kW output power.

SUPERIOR HF RADIO FOR ATC

The excellent HF performance of the R&S®Series4100 extends CERTIUM® quality to the HF band.

- ▶ Frequency range for long-distance coverage:
 - 1.5 MHz to 30 MHz (transmission)
 - 10 kHz to 30 MHz (reception)
- ▶ Transmission powers of 1 kW, 2 kW, 4 kW or 5 kW
- ▶ Voice compressor
- ▶ Noise blanker
- ▶ Supports SELCAL
- ▶ Supports H2B modulation

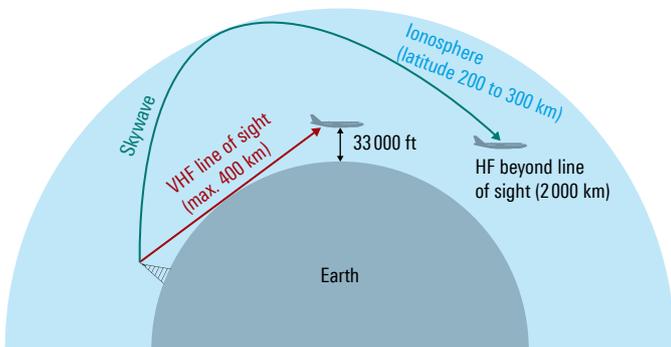
Shortwave propagation

Due to the physical nature of shortwave (i.e. HF) propagation, it is possible to transmit or receive messages well beyond line of sight, which is otherwise the limiting factor of VHF/UHF. This is shortwave radio's key application advantage, making it an ideal choice for monitoring or coverage of vast areas where dense ground infrastructure is impossible or infeasible to deploy, e.g. over deserts and oceans. ATC benefits greatly from this in terms of safety, since the radio link between the aircraft and controller can be maintained throughout the flight, regardless of distance, duration and terrain.

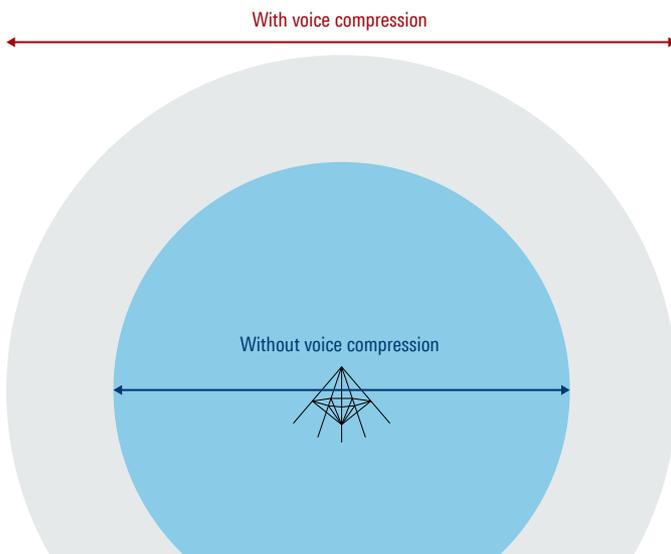
Enhancing reach

The voice compressor is a vastly practical solution implemented as a standard feature on the R&S®Series4100 radio that improves speech comprehension and transmission range. Loudness equalization creates signals that are louder in terms of audio and stronger in terms of equivalent transmission power. The increased mean level of the compressed signal means that the system's transmitting power is better utilized, effectively achieving the transmission range of a system with up to double the equivalent power.

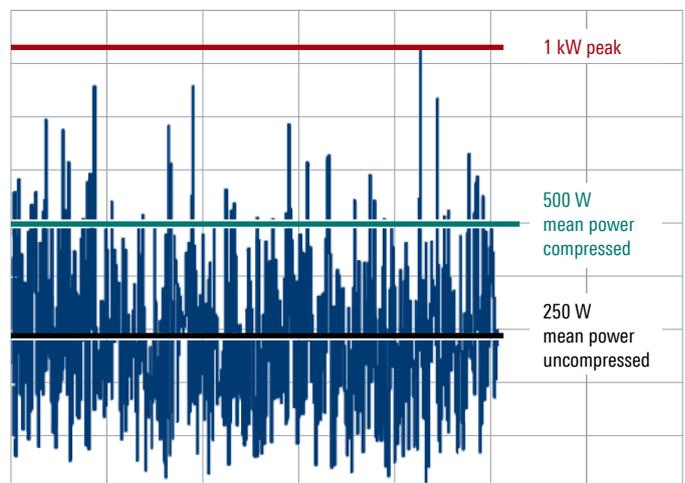
Skywave or "skip" propagation



Increased transmission range



Higher equivalent mean transmission power



Noise blanker

Another useful feature, available as standard, is the noise blanker, which blocks various undesired reception signals including noise, electromagnetic interference and emission pollution from long power lines or electric fences. Given the large coverage area of shortwave radio, the negative impact of such interference sources could easily compromise the radio link's integrity.

Power classes

Various application scenarios call for various output power levels. Thanks to its modular architecture, the HF radio system can be set up in different output power configurations ranging from 150 W to 5 kW. The modular structure – a design philosophy of the CERTIUM® ecosystem – ensures maximal flexibility at all levels of the communications system and gives the user the freedom to choose what fits best.

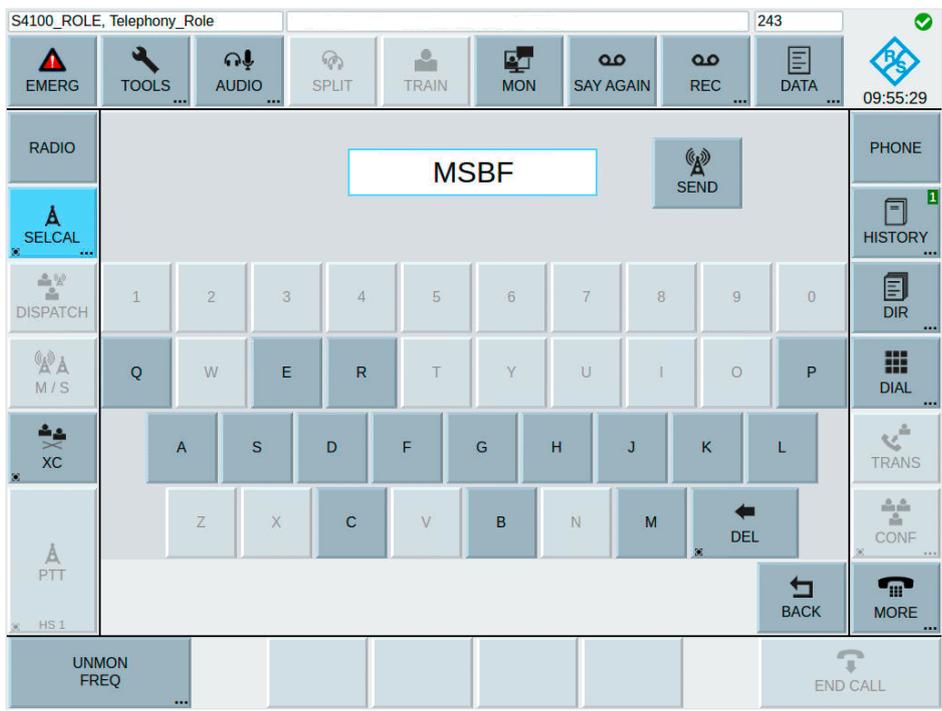
SELCAL

The selective-calling radio system (SELCAL) is used to alert pilots that a controller wants to communicate, even when the aircraft's radio has been muted. With SELCAL, the transmission of four specifically coded audio tones to the aircraft informs the pilots of an incoming call over HF. The R&S®Series4100 fully supports the generation and transmission of the characteristic SELCAL tones. Additionally, the CERTIUM® VCS system generates the tones and both SELCAL and SELCAL32 are supported.

Efficient antennas and matching ATUs

Rohde&Schwarz offers a range of HF antennas to cover the particular frequency range and power level requirements. Moreover, Rohde&Schwarz provides corresponding planning and installation services to create a customized solution based on specific terrain and radiation pattern requirements. To complement the antennas and ensure harmonic system integration, Rohde&Schwarz additionally offers a wide range of antenna tuning units (ATU) that dynamically match the transmitter to the antenna.

SELCAL signaling



SAFE AROUND THE GLOBE

Your recent transatlantic flight probably relied on the R&S®Series4100. The CERTIUM® range has established Rohde&Schwarz as a leading global ATC infrastructure provider.

- ▶ Well-established in service worldwide
- ▶ High availability and georedundancy
- ▶ Beyond line of sight (BLOS)
- ▶ MWARAs and RDARAs support

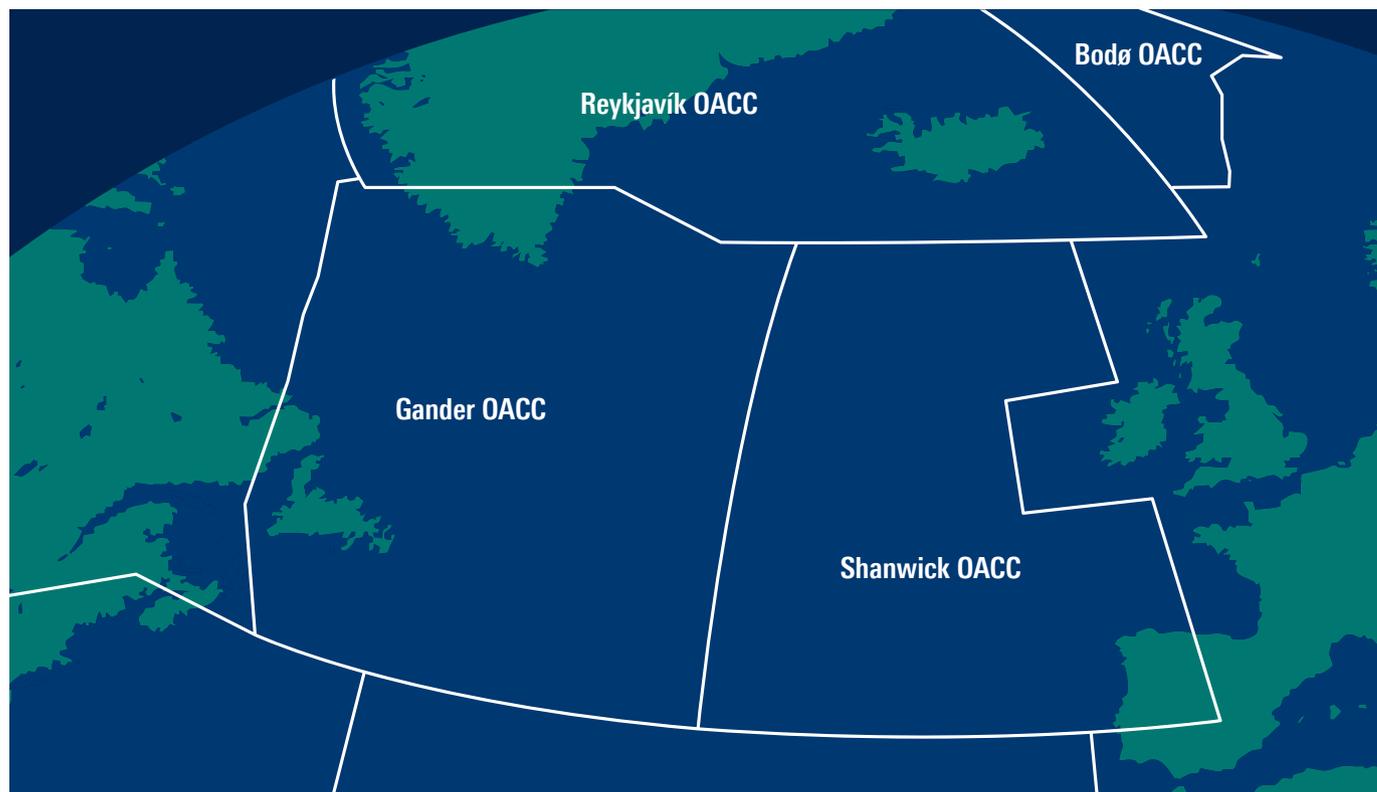
Highways in the sky

The airspace of the North Atlantic (NAT) is easily the busiest oceanic airspace in the world. Rohde&Schwarz is glad to have provided the HF radio infrastructure used for ATC coverage of the Shanwick, Gander, Reykjavík and Bodø OACCs. Together with the CERTIUM® VCS in virtual center mode between Shanwick and Reykjavík, the R&S®Series4100 radio is responsible for supporting the HF link on all tracks of the North Atlantic Organized Track System from end to end, thereby playing a key role in enabling safe ATC.

Experience counts

Rohde&Schwarz has made a name for itself with its HF expertise and tradition of quality service. ATC is no exception – a point proven by the deployment of the R&S®Series4100 on MWARAs and RDARAs around the world.

Coast-to-coast coverage



Where oceans meet

At the border between the Indian and the Pacific Oceans, the Philippines oversees the air traffic in a large airspace over parts of the South China Sea, the Philippine Sea, the Sulu Sea and the Celebes Sea using R&S®Series4100 radios. With further applications in India, Indonesia and New Zealand, Rohde&Schwarz plays an elemental role in supporting safe air travel and enabling international ATC through HF coverage over all the Earth's oceans.

Long-haul support

In the world of ATC, safety is of critical importance. Rohde&Schwarz therefore offers a responsible and forward thinking service. For ATC and business alike, Rohde&Schwarz is there for the long haul, providing communications solutions to ensure you get where you want to go safely.

Competent guidance every step of the way



FULL SYSTEM INTEGRATION

Although perfectly capable as a standalone unit, the R&S®Series4100 achieves its full potential within the CERTIUM® ecosystem.

- ▶ Remote and split-site operation
- ▶ EUROCAE ED-137B/C and ICAO Annex 10
- ▶ Full integration within CERTIUM®
- ▶ Matching range of HF equipment
- ▶ IP connectivity and VoIP support

IP connectivity

The R&S®Series4100 radio family comes equipped with an IP interface as standard, which can be used for remote control, configuration and transmission of digital voice to and from the radio. Thanks to this IP interface, the radio can be easily integrated into systems using a single cable. Furthermore, local VoIP domains can be interconnected.

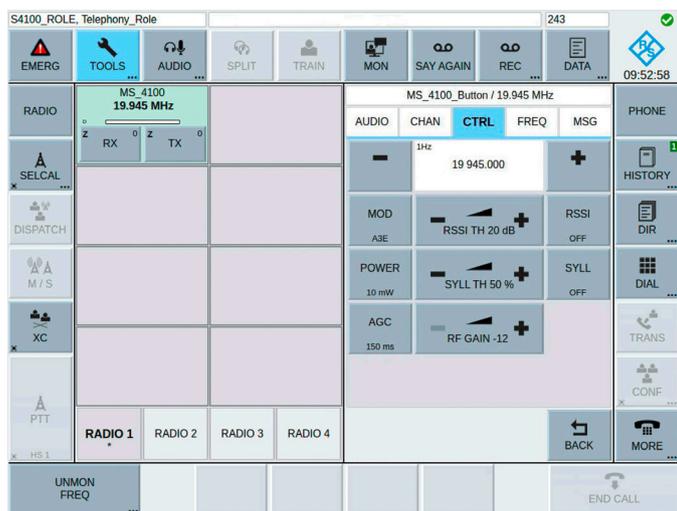
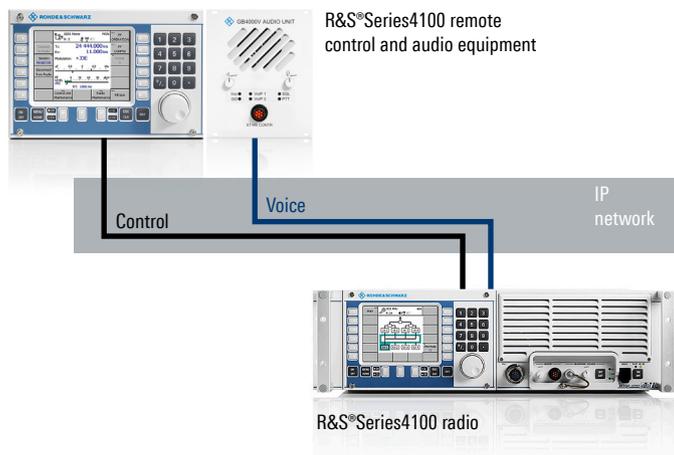
EUROCAE ED-137B/C

The R&S®Series4100 complies with the established EUROCAE ED-137B/C standard, which makes it fully compatible with any compliant IP based voice communications system. Using the R&S®Series4100 together with other systems of the CERTIUM® portfolio, however, gives the user maximum functionality.

CERTIUM® VCS integration

Tried and tested integration between the R&S®Series4100 radio and CERTIUM® VCS provides the controller with unique functionality. The CERTIUM® VCS acts as a central control hub that simultaneously brings individual channels together – various band radios, phones and peripheral accessories. The controller can see the status of the radio and change the frequency and other parameters such as modulation. Furthermore, CERTIUM® VCS enables essential functions such as SELCAL and role management.

Radio remote control via IP network



Access the R&S®Series4100 HF radio with the R&S®GB5400 controller working position.



Remote operation with CERTIUM® MANAGEMENT.

Seamlessly harmonized

Any network is only as strong as its weakest link. Rohde & Schwarz carefully assembles compatible system modules with particular attention to the interfaces connecting the system's different portfolio elements. With a range of HF antennas, corresponding antenna tuning units (ATU) and application-specific radio site planning and installation, Rohde & Schwarz ensures the safety of the air route by making sure that the message gets across from the controller working position through the antenna and into the airspace.

Rohde & Schwarz offers a broad range of auxiliary HF equipment such as the R&S®HX002 antenna.



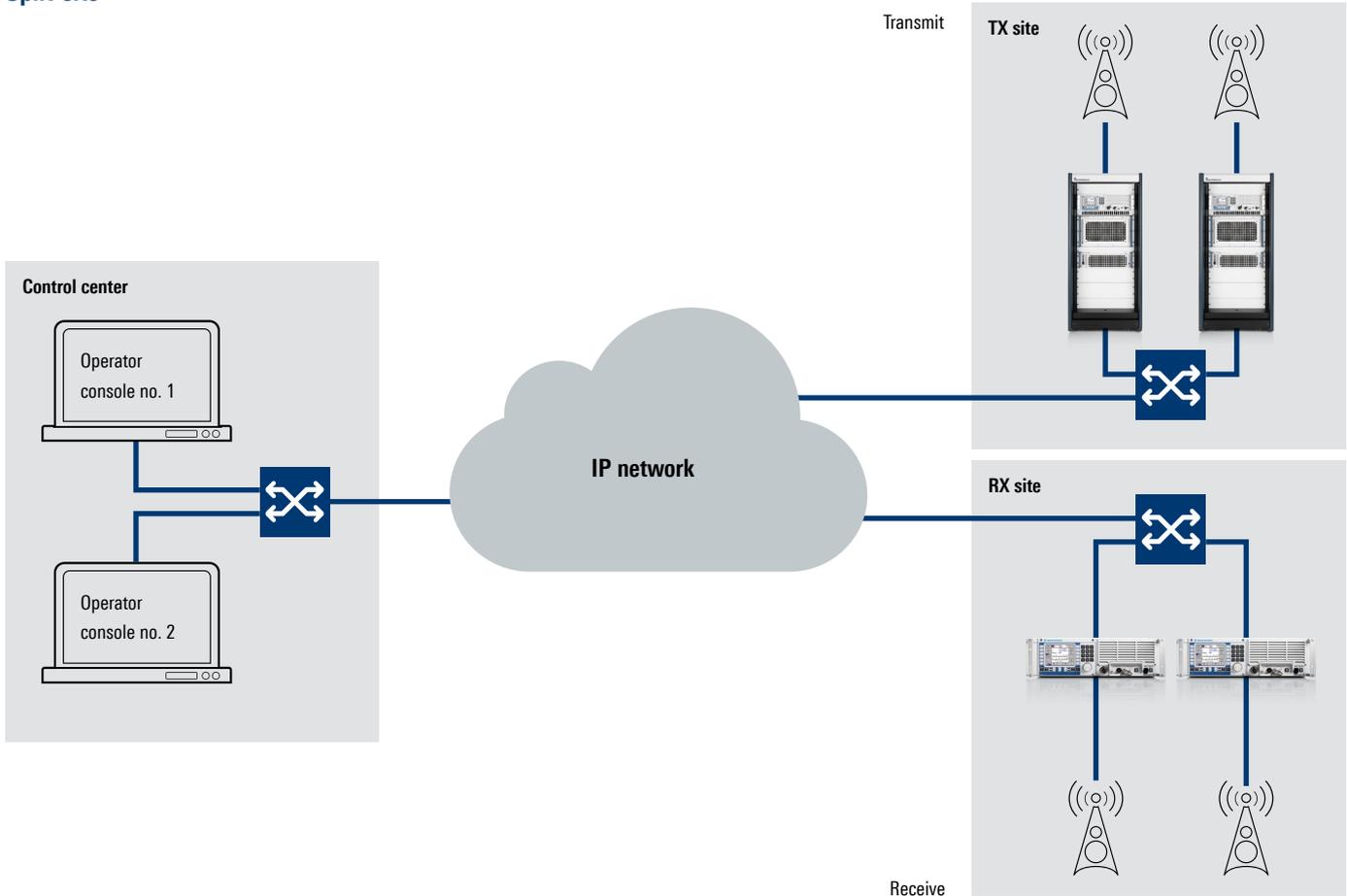
Remote and split-site operation

Thanks to VoIP connectivity, the user has the freedom to plan and lay out their network to maximize efficiency for their application. Through remote operation, control personnel do not need to be physically located at the radio site. Rather, with the help of the CERTIUM® VCS platform, a remote control center can remotely manage one or more separate radio sites, thus optimizing workforce resources and improving service quality. Additionally, the split-site functionality of the R&S®Series4100 enables spatial separation between transmission and reception radio sites to further improve crosstalk and intermodulation immunity.

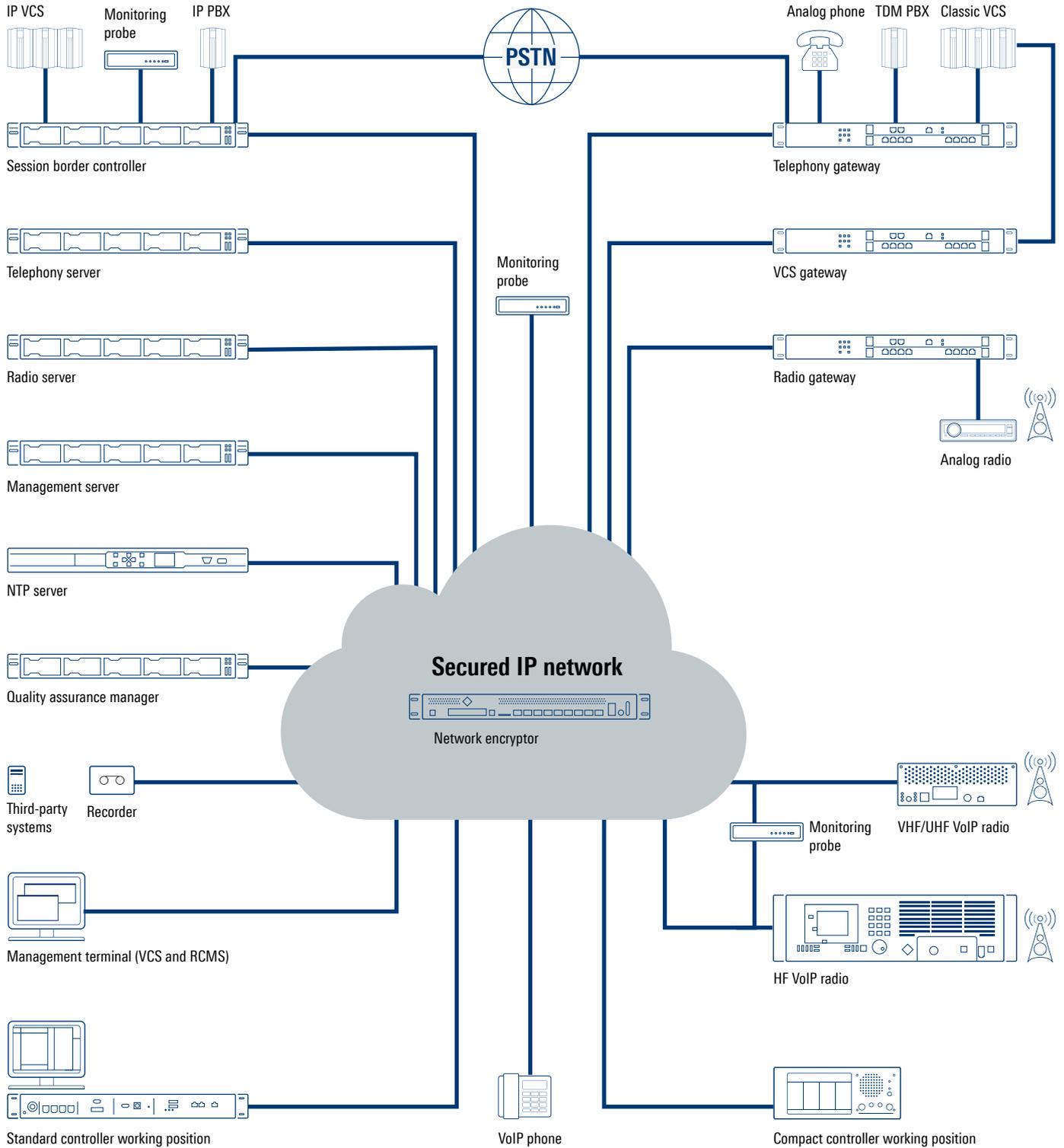
User-tailored

The R&S®CERTIUM® ecosystem is designed so that the user can flexibly and efficiently choose relevant system modules to best fit their requirements, including for single components such as the R&S®Series4100. This increases the customizability of an already comprehensive portfolio.

Split-site



Fully IP based CERTIUM® environment



PRIME QUALITY PAYS OFF

The R&S®Series4100 helps you sustainably optimize your processes by lowering maintenance and lifetime costs.



- ▶ Turnkey solution
- ▶ Rugged and environment-resistant design
- ▶ Minimal maintenance
- ▶ Modular design

Built to last

The R&S®Series4100 has a rugged and durable design in a 19" rackmount form factor. Conforming to accepted standards for operating temperature, mechanical influences and electromagnetic compatibility, the R&S®Series4100 is proven to withstand a wide range of environmental conditions. This design enhances the radio's reliability and operability. Illustrated on the left is the 2 kW transceiver configuration in a single 19" rack.

Minimal maintenance

A variety of control and monitoring functions have been implemented to reduce the need for intervention. Built-in test functions allow service and maintenance to be much more targeted and efficient. Remote analysis eliminates the need for on-site service, which further reduces maintenance requirements.

A turnkey solution

With the CERTIUM® ecosystem design concept, Rohde & Schwarz provides a complete end-to-end solution throughout the entire system lifecycle from a user-specific design to its integration and the long-term support service.

Increased availability

With mean times between failures in the tens of thousands of hours for its individual components, the R&S®Series4100 provides exceptional availability beyond industry acknowledged standards. In practical terms, this means expected uninterrupted operation for a few years and a mean repair time of a few hours.

The sturdy 19" rack provides a solid chassis for the 2 kW setup shown here.

Self-regulation

In line with the measures taken to minimize maintenance, the R&S®Series4100 radio employs a number of automatic self-regulatory mechanisms to prevent operation under unfavorable conditions in the first place. For example, when the ambient temperature is not in the specified -20°C to $+55^{\circ}\text{C}$ range, the transmitter automatically decreases its output power to maintain operation. When the temperature returns to the specified range, it reverts back to steady operation without any manual intervention.

Modular design

The Rohde&Schwarz CERTIUM® ecosystem prioritizes scalability and configurability. On the one hand, this gives the user more choice when setting up a particular configuration. On the other, it leaves more scope for extension or customization down the line. The R&S®Series4100 follows this concept and continues the modular structure approach at the device level. All RF modules can be exchanged without recalibrating the radio, which saves time and effort.



Custom configuration and straightforward maintenance.

Service that adds value

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

Rohde & Schwarz

The Rohde&Schwarz technology group is among the trail-blazers when it comes to paving the way for a safer and connected world with its leading solutions in test & measurement, technology systems and networks&cybersecurity. Founded more than 85 years ago, the group is a reliable partner for industry and government customers around the globe. The independent company is headquartered in Munich, Germany and has an extensive sales and service network with locations in more than 70 countries.

www.rohde-schwarz.com

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

Certified Information Security Management

ISO 27001

Rohde & Schwarz training

www.training.rohde-schwarz.com

Rohde & Schwarz customer support

www.rohde-schwarz.com/support

