

R&S®M3AR

Software Defined Radios

VHF/UHF

transceiver family for
airborne communications



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Note: Frequencies are rounded to full MHz for better reading.
For detailed frequencies, see the respective data sheet.
Some of the pictures show options.

R&S®M3AR

Software Defined Radios

At a glance

The software defined, multiband-capable airborne transceivers of the R&S®M3AR family feature a modular design and state-of-the-art technology. This leads to high MTBF values and a long life. The compact and lightweight transceivers offer high performance, making them suitable for operation in all types of aircraft, including unmanned aerial vehicles. Different waveforms are available, which can be installed at any time to provide interoperability in a variety of operational scenarios.

The R&S®M3AR family is the product of decades of experience, especially in the design and development of airborne radio equipment and software defined radio technology. The R&S®M3AR multiband, multimode, multirole radio is the solution of choice for the reliable transmission of mission-critical information, whether for jet or propeller aircraft, helicopters or unmanned aerial vehicles.

Rohde & Schwarz satisfies the most demanding requirements of a multitude of airborne platforms. The R&S®M3AR transceivers are in operation around the world and feature high reliability even under extreme environmental conditions. The outstanding MTBF values ensure low maintenance effort and high availability.

A variety of optional EPM (ECCM) methods are available. For instance, the R&S®SECOS frequency hopping method with integrated encryption can be installed in parallel with HAVE QUICK I/II.

The R&S®M3AR family consists of the R&S®MR6000A in an ARINC 600 housing and the R&S®MR6000R/ R&S®MR6000L, both of which are ARC-164 form and fit compatible. The R&S®MR6000L is equipped with a local control panel while the R&S®MR6000R is remotely controlled. All R&S®M3AR radios can be remotely controlled via the MIL-STD-1553B data bus, as well as by the R&S®GB6500 control unit. The R&S®MR6000R or R&S®MR6000L can serve as a form, fit and function (F3) replacement for legacy AN/ARC-164 radios.

Key facts

- Frequency range from 30 MHz to 400 MHz
- Compact and lightweight with high transmit power (up to 20 W in AM mode and up to 30 W in FM mode)
- EPM (ECCM): HAVE QUICK I/II, SATURN, R&S®SECOS
- Approved for jet and propeller aircraft as well as helicopters and unmanned aerial vehicles
- Embedded NATO or R&S®SECOS encryption
- Suitable for communications with military and civil air traffic control (e.g. 8.33 kHz channel spacing or offset carrier receive operation)

R&S®M3AR software defined radios



R&S®M3AR

Software Defined Radios

Benefits and key features

Outstanding radio characteristics

- ▮ Excellent RF parameters
- ▮ Frequency bands from 30 MHz to 400 MHz
- ▮ Outstanding RF characteristics on a single platform with the R&S®MR6000A

Secure communications

- ▮ EPM (ECCM) methods for anti-jam communications
- ▮ Tap- and spoof-proof communications through integrated encryption
- ▮ Wideband interface for external encryption devices (e.g. ELCRODAT 4-2, KY58, KY100)

Flexible range of applications

- ▮ High power for secure communications even during very low level flights and higher altitude instrument flying
- ▮ Preset concept permits flexible participation in various networks through simple change of the preset
- ▮ Suitable for fixed-wing or rotary-wing aircraft operated by the air force, army and navy
- ▮ Flexible integration through different interfaces (MIL-STD-1553B data bus, RS-485) or front panel control
- ▮ Safety aspects in line with civil specifications (R&S®MR6000A)
- ▮ Very compact and lightweight (R&S®MR6000L/R)

Low maintenance effort

- ▮ Powerful built-in tests (BIT) for error detection and diagnostics
- ▮ High reliability due to robust design and high-quality components

Future-ready investment

- ▮ Highly accelerated life testing (HALT)
- ▮ State-of-the-art technology ensures long product life

Radios from Rohde&Schwarz for the army, air force and navy.



Outstanding radio characteristics

Excellent RF parameters

Despite its compact design, the R&S®M3AR radio family offers excellent RF characteristics, even under harsh environmental conditions. The R&S®M3AR transceivers are compatible with common military and civil communications standards.

The receiver features excellent sensitivity, high crossmodulation immunity, selectivity and suppression of strong interference signals. The transmitter is optimized for low spurious emissions and the suppression of wideband noise.

Frequency bands from 30 MHz to 400 MHz

The aviation sector has special applications that must be supported by radiocommunications systems. Civil aviation requires the following frequency ranges:

- 108 MHz to 117.975 MHz, AM (receive only)
- 118 MHz to 136.975 MHz, AM, with additional 8.33 kHz channel spacing

In military aviation, the following frequency ranges are important:

- 30 MHz to 87.975 MHz, FM
- 225 MHz to 399.973 MHz, AM and FM

Civil maritime communications require the FM frequency range from 156 MHz to 173.975 MHz.

The range from 137 MHz to 155.975 MHz is used, for example, for a variety of mobile radio services in both AM and FM.

The R&S®M3AR family of transceivers covers all of these frequency ranges in AM and/or FM, depending on the application. Without multiband capability, a separate transceiver would be needed for each frequency band, which would create not only additional costs but also significantly more integration effort.

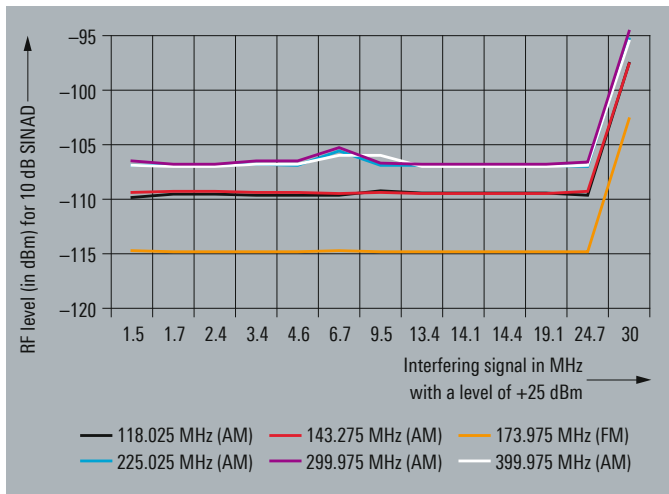
Outstanding RF characteristics on a single platform with the R&S®MR6000A

If several transceivers are used simultaneously in an aircraft (co-site operation), there is a risk of mutual interference. For example, this is true especially on large airborne platforms used for air surveillance. More than 20 radio systems can be installed on such a platform. Jets or helicopters featuring a relatively small fuselage also need to be equipped with a large number of antennas. Antennas are not only required for VHF/UHF and HF radios, but also for air navigation and sensors. Transceiver emissions, for example, must not disturb localizer and glideslope reception during an instrument landing approach.

The RF parameters of airborne transceivers must meet extremely demanding requirements to ensure reliable transmission and reception. Besides high sensitivity and selectivity, the receiver's large-signal immunity is also crucial. This applies especially under challenging conditions such as parallel radio operation on the same platform or in the vicinity of powerful broadcast transmitters. The interfering signals that occur in such a scenario should have a relatively low influence on the effective usable sensitivity.

Some important radio characteristics will now be described in detail:

Immunity to interference: Even with an interference level of 25 dBm in the HF range (1.5 MHz to 24 MHz), the sensitivity of the R&S®MR6000A transceiver in the VHF/UHF frequency range is barely affected.



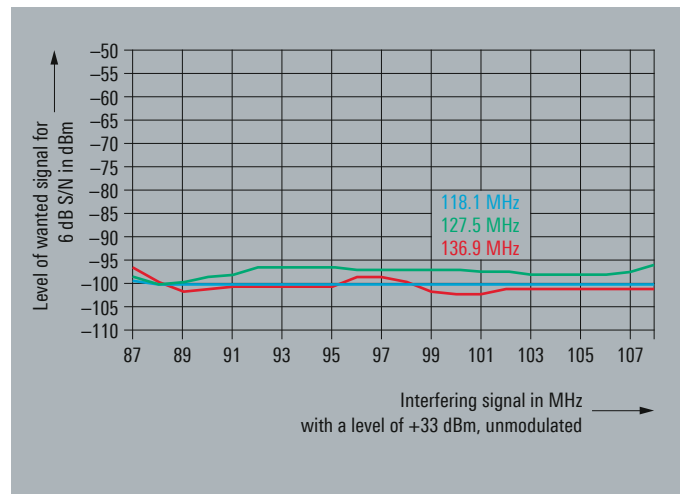
Robust protection against strong external signals

At low altitudes, airborne transceivers are commonly exposed via their antennas to high field strengths produced by broadcast transmitters or radar equipment. The radios must not be damaged even in the presence of an interference level amounting to a few watts at the antenna. Moreover, they must still provide adequate sensitivity under the influence of interfering signals exhibiting a few hundred milliwatts of power at the receiver input. Of course, immunity to high frequency (HF) and VHF FM audio broadcasting is also very important.

The R&S®MR6000A transceiver has demonstrated its immunity to all of these interference types. The immunity to interference figure shows the effective usable sensitivity of the transceiver under the influence of an HF interfering signal with a level of +25 dBm during reception in the VHF/UHF range from 118 MHz to 399.975 MHz. Thanks to the integrated highpass filter that suppresses HF interfering signals, a sensitivity of about 1 μ V (-107 dBm) is achieved.

The FM immunity figure illustrates the effect of the FM immunity filter used in the R&S®MR6000A to suppress radiated signals from VHF FM audio broadcast transmitters. Even with an interference level of 2 W (+33 dBm), the 5 μ V (-93 dBm) receiver sensitivity specified in the ICAO and EUROCAE standards is still met with a large margin. The sensitivity is an important factor that affects the audio quality and achievable range.

FM immunity: With its integrated FM immunity filter, the R&S®MR6000A ensures effective usable sensitivity in line with the EUROCAE ED-23C civil standard even in the presence of very strong VHF FM audio broadcast transmitter signals (2 W) and enables a range of approx. 370 km (approx. 200 NM).

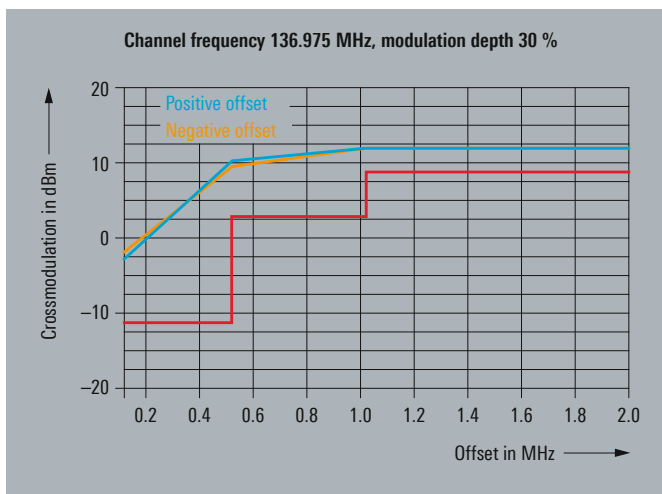


In practice, however, high sensitivity is available without limitations only if the radio exhibits both appropriate large-signal suppression capability and selectivity. In addition to the above-mentioned integrated filters that protect against HF and VHF FM signals, the R&S®MR6000A also has built-in frequency-agile co-site filters that are capable of effectively suppressing interfering signals in the same frequency band

Crossmodulation immunity against strong AM interfering signals

Crossmodulation occurs whenever a strong interfering signal with amplitude modulation (AM) overdrives the receiver's input amplifiers or first mixer. Problematic crosstalk effects of this type are largely independent of the strength of the wanted signal. Such effects also occur when the aircraft is close to the called ATC station. The R&S®MR6000A easily manages such challenges since it was developed based on the ARINC 716 US standard which specifies high crossmodulation immunity for VHF airborne transceivers. Accordingly, the transceiver tolerates interfering signals at a level of +10 dBm, for example, with an offset of 500 kHz from the receive frequency, exceeding the standard's requirements by far (crossmodulation immunity figure).

Crossmodulation immunity: The red curve shows the requirements specified in the VHF ARINC 716 standard while the two other curves represent the behavior of the R&S®MR6000A transceiver.

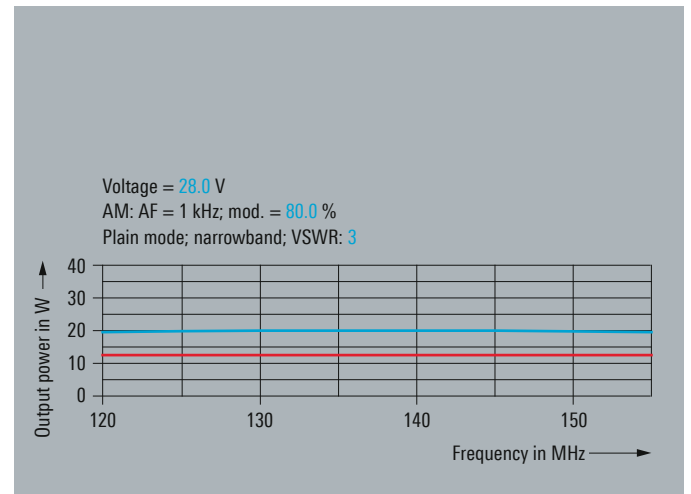


High transmit power under real-world conditions

Antennas usually exhibit some degree of mismatch to the 50 Ω impedance used in aircraft installations. This depends on the antenna bandwidth, for example. As a result, the voltage standing wave ratio (VSWR) of aircraft antennas is typically in the range from 1.5 to 2.5, which means that the airborne transceiver's output stage is terminated by an unmatched load impedance. Depending on the phase angle (cable length), the transmitter's efficiency will be degraded, the current drain will increase and the output power will decrease.

The R&S®MR6000A has a specified transmit power of 20 W AM (carrier) and 30 W FM. The power output stage has a large margin and was designed to be highly insensitive to the load impedance. The transmit power figure below shows the results of a measurement in the VHF range. It can be seen that the radio outputs approx. 20 W RF power over the entire frequency range even with a VSWR of 3.

Transmit power: Even at a VSWR of 3, the R&S®MR6000A's transmit power remains at approx. 20 W (blue line) which is well over the specified limit (red).



Secure communications

EPM (ECCM) methods for anti-jam communications

Electronic protective measures (EPM) protect radio links from electronic countermeasures (ECM) such as jamming. Frequency hopping is an EPM (ECCM) method that is available as an option in all R&S®M3AR radios. The NATO frequency hopping method HAVE QUICK I/II and the state-of-the-art SATURN method are integrated in the R&S®M3AR family in line with STANAG 4246 and STANAG 4372. These methods ensure a jam-free radio link.

Rohde&Schwarz also developed the R&S®SECOS frequency hopping method, which provides reliable protection against active jamming even at high air speeds. It can also encrypt voice and data transmissions up to 16 kbit/s. R&S®SECOS has been tried and tested around the world for many years. This method can be integrated in Rohde&Schwarz transceivers in parallel with HAVE QUICK I/II, providing the flexibility to participate in national and international missions. When using the R&S®SECOS or SATURN frequency hopping method, voice communications are compressed by means of a CVSD vocoder and then transmitted digitally.

Tap- and spoof-proof communications through integrated encryption

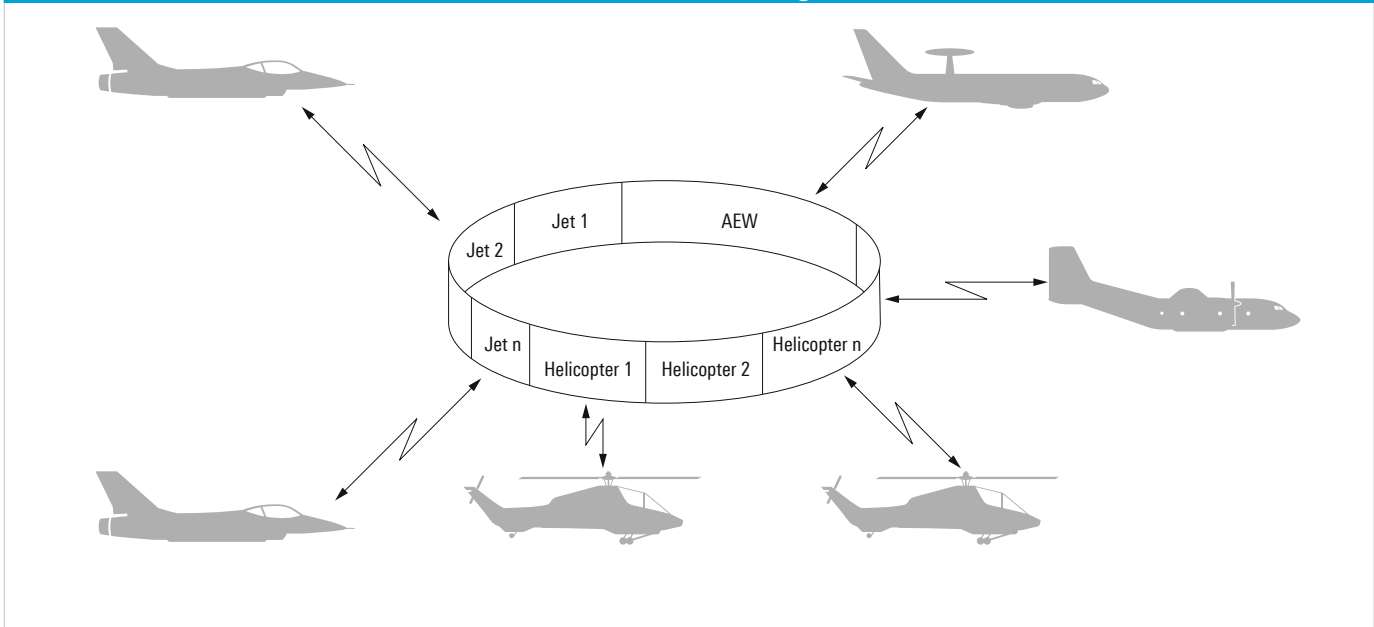
To protect radio links from tapping and spoofing, the information being transmitted can be encrypted. With the R&S®MR6000A from the R&S®M3AR family, Rohde&Schwarz was the first manufacturer to offer embedded NATO encryption. This eliminates the need for an additional external encryption device. The R&S®MR6000A therefore saves space, reduces weight and is easy to install in the aircraft. The R&S®MR6000A is interoperable with external crypto devices such as the KY57, KY58, KY99, KY100 and ELCRODAT 4-2.

The powerful R&S®SECOS encryption method developed by Rohde&Schwarz is available for all transceivers in the R&S®M3AR family. When using the R&S®SECOS method, the encryption keys can be encrypted and transmitted over non-secure lines (black key loading). For NATO encryption keys, the R&S®MR6000A with integrated crypto module uses the DS-101 interface for black key loading.

Wideband interface for external encryption devices (e.g. ELCRODAT 4-2, KY58, KY100)

All R&S®M3AR radios conform to STANAG 4204 and STANAG 4205 and can be connected to external encryption devices. This permits the use of state-of-the-art frequency hopping methods with legacy encryption devices, so that systems such as the KY58, which is widely used by NATO, can be combined with HAVE QUICK I/II for instance. Besides world-class airborne transceivers, Rohde&Schwarz also offers encryption devices that are certified for the highest German and NATO classification levels. The ELCRODAT 4-2 and the R&S®MMC3000 are external encryption devices that can be used with all R&S®M3AR radios for establishing secure radio links.

Reliable and secure communications in TDMA data mode using R&S®SECOS



Flexible range of applications

High power for secure communications even during very low level flights and higher altitude instrument flying

Especially with helicopters, high transmit power is important because of the need for effective communications between two-aircraft formations and flights during tactical flying missions near the ground.

When flying under instrument flight rules, long distances occur between the aircraft and the air traffic control stations. In this case, the receiver must be able to detect and process even weak radio signals and output them with good audio quality.

Although lightweight and compact, R&S®M3AR transceivers deliver outstanding transmit power of up to 20 W in AM mode and up to 30 W in FM mode. This ensures quality communications links for aircraft operating near the ground, as well as between transmitters and receivers that are located far apart. During formation flying and for on-ground radio checks however, the transmit power can be stepped down in order to reduce self-generated electromagnetic radiation and as a result minimize susceptibility to reconnaissance.

Preset concept permits flexible participation in various networks through simple change of the preset

Presets are used to save the operational parameters (e.g. frequencies and encryption keys) that are required to participate in an encrypted network such as R&S®SECOS. Prior to a mission, the required presets can be set up using the R&S®RNMS3000 network management software from Rohde&Schwarz. This PC-based, centralized planning and preparation of operational parameters ensures consistent presets among individual radio network participants and well-organized frequency management.

The operational parameters are loaded via a fill interface. The desired preset is selected via the MIL-STD-1553B data bus, for example.

The R&S®M3AR radios contain two separate memory areas, each of which can hold 100 presets, so that a sufficient number of presets is available even for longer missions.

Due to the preset concept, simply changing the preset number provides error-free switching between radio networks during flight, even in critical situations.

Depending on how the transceiver is integrated in the aircraft (e.g. operation through a central unit via the MIL-STD-1553B data bus), the presets can be identified by intuitive, recognizable names such as "EDDM TWR" or "Squad A" that are shown on the display of the radio and remote control unit.

R&S®MR6000L – intuitive, simple operation



Suitable for fixed-wing or rotary-wing aircraft operated by the air force, army and navy

Military aircraft place a variety of demands on the radio with respect to environmental impacts such as g-force, vibration and temperature range. Furthermore, army, air force and navy airborne platforms must sometimes support special applications in the various frequency ranges. The R&S®M3AR offers a wide bandwidth to support a variety of applications.

For the navy for example, a Link 11 interface in line with STANAG 5511 was integrated in the R&S®MR6000A, as well as sonobuoy functionality and a guard receiver for monitoring channel 70 of the Global Maritime Distress Safety System (GMDSS), so that digital selective call (DSC) signals can be received.

The tactical VHF range, including a 40.5 MHz guard receiver, was integrated in the entire R&S®M3AR product family for communications with ground troops. The high transmit power of up to 30 W in FM mode and the excellent receiver characteristics ensure reliable communications links even during very low level flights.

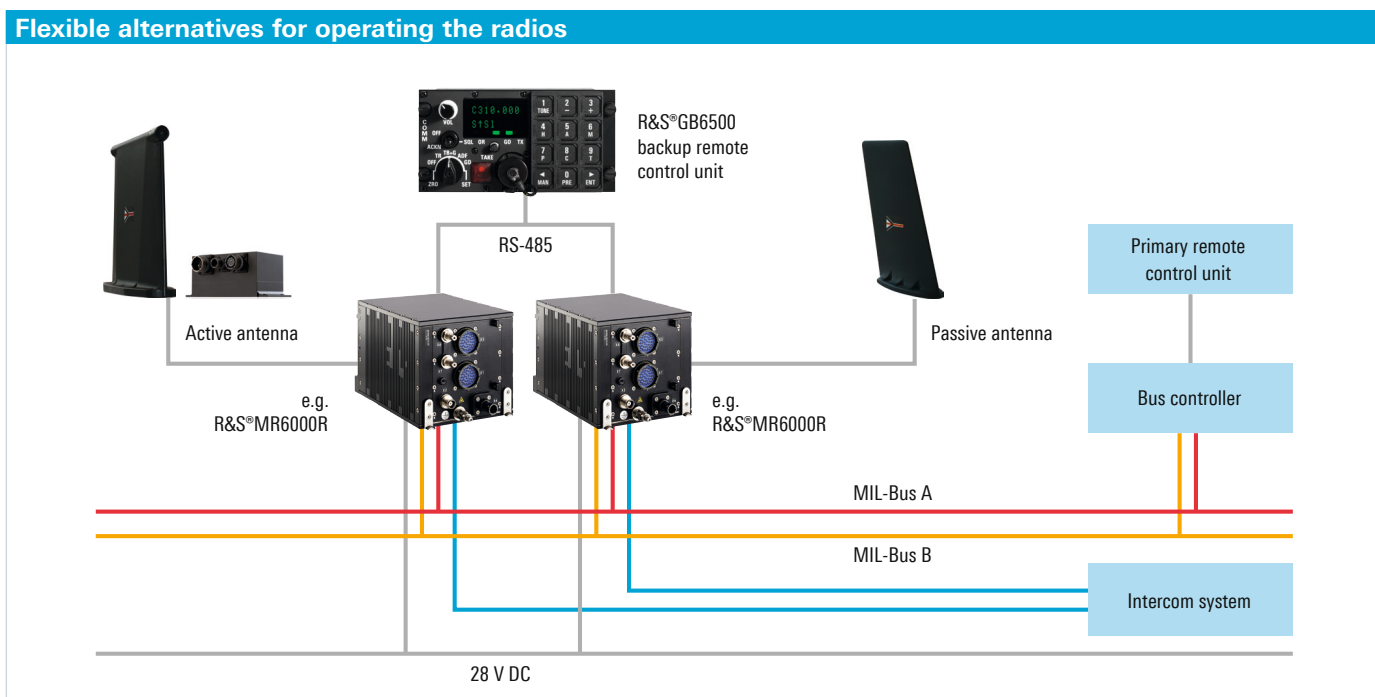
Flexible integration through different interfaces (MIL-STD-1553B data bus, RS-485) or front panel control

The R&S®M3AR radio family can be flexibly integrated in an aircraft. The R&S®MR6000L with local control panel is easily installed directly in the cockpit.

Alternatively, the R&S®MR6000L offers remote control capability via the MIL-STD-1553B data bus, through the R&S®GB6500 control unit or using an RS-485 serial interface in conjunction with the applicable Rohde&Schwarz protocol.

The R&S®MR6000A and R&S®MR6000R series are designed for installation in the avionics bay. They can be remotely controlled via the MIL-STD-1553B data bus or by using the R&S®GB6500 control unit via the RS-485 interface. A maximum of three R&S®GB6500 units can control up to five R&S®M3AR transceivers over a system bus. This provides the flexibility to implement a variety of operational concepts that are optimized for the aircraft, which improves crew resource management (CRM).

The R&S®MR6000L and R&S®GB6500 displays are suitable for conventional night flights as well as flying with night vision goggles (NVG).



Safety aspects in line with civil specifications (R&S®MR6000A)

Approval by civil aviation safety authorities requires the use of development processes in line with the civil avionics standards for software (RTCA/DO-178B, level C) and for hardware (RTCA/DO-254, design assurance level C). This is a great challenge, especially for airborne transceivers where waveforms and a large number of functions are mapped by software. As part of these processes, the specific requirements to be met by the software and hardware components are derived, starting from the equipment level, and then validated and verified. All process steps are subject to permanent quality control in line with DO-178B / DO-254. This procedure minimizes the risk of malfunctions described in the specifications for level C failure classification and ensures top functional safety.

Besides the civil standards for software (RTCA/DO-178B) and hardware (RTCA/DO-254), immunity to cosmic radiation is equally important:

High-energy ionizing neutrons can cause disruptions in electronic components that lead to software errors, thereby potentially endangering the operation of a transceiver. Cosmic radiation increases with altitude and reaches its maximum at an altitude of approx. 18 000 m (60 000 ft). The R&S®MR6000A is highly immune to such radiation, making it a good choice for safe, reliable operation in transport aircraft and jets.

Very compact and lightweight (R&S®MR6000L/R)

Airborne platforms have very limited weight and space resources. Especially when retrofitting, new equipment usually must not be larger and heavier than the equipment it replaces. The purpose of retrofits is to meet civil specifications (e.g. 8.33 kHz channel spacing) or tactical military requirements (e.g. encrypted communications). The R&S®MR6000L/R airborne transceivers come in the very compact ARC-164 housing and offer integrated frequency hopping methods (e.g. with SATURN) and encryption for secure tactical radiocommunications (e.g. with R&S®SECOS) in addition to 8.33 kHz channel spacing. The radios of the R&S®MR6000L/R series offer excellent performance although they are lightweight (less than 4 kg) and require little space.

Low maintenance effort

Powerful built-in tests (BIT) for error detection and diagnostics

The three types of built-in tests (PBIT, CBIT and IBIT) aid the user in checking the functionality of the device and determining if, and where appropriate, what type of errors exist. BIT results can be viewed on the display or polled via the MIL-STD-1553B data bus.

The power-on BIT (PBIT) is a short self-test that is executed each time the device is powered on.

The continuous BIT (CBIT) checks the functionality and performance of the radio during operation. This test continuously polls the status messages of the individual modules.

Automatic and reliable testing of airborne transceivers with the R&S®UCS226XB test system.



The initiated BIT (IBIT) is activated by the user and runs a complete transmit and receive test loop. Because this test interrupts operation of the radio, it is usually carried out only during maintenance activities.

Two types of status messages are provided to guide the user as to what action to take. If a warning is generated, the radio can still be operated, but should be checked as soon as possible. Error messages indicate that the radio can no longer be operated and must be serviced.

If one of the built-in tests identifies a defective module, the device should be sent to an authorized service center for maintenance or repair. As a final step, the device is tested in accordance with the applicable specifications to make sure it functions properly. The R&S®UCS226XB is a system for carrying out corrective maintenance and automatic test runs (I-level support and test equipment). It therefore provides a fast and cost-effective way to keep the R&S®M3AR family of transceivers up and running. Because Rohde&Schwarz can incorporate its worldwide leading know-how from the field of test and measurement into the area of airborne transceivers, customers have a first-class solution from a single source.

High reliability due to robust design and high-quality components

The R&S®M3AR family of transceivers features a robust design and high-quality components. The result is high MTBF. The R&S®M3AR transceivers are tested in accordance with various military and civil standards such as MIL-STD-461, MIL-STD-810 and RTCA/DO-160. For instance, Rohde&Schwarz airborne transceivers can be operated in temperatures ranging from -40°C to $+71^{\circ}\text{C}$. To prevent damage, the devices automatically continue to operate at reduced power if overheating occurs. When the temperature normalizes, the device automatically returns to the original power level without manual intervention.

The military aviation sector demands a high level of device reliability, particularly in extreme environmental conditions. Whether they are exposed to high g-forces in jet aircraft or to heavy vibrations in helicopters and transport aircraft, R&S®M3AR transceivers were designed for such operating environments. This is a key reason why the R&S®M3AR is deployed by air force, army and navy airborne units around the world.

Future-ready investment

Highly accelerated life testing (HALT)

This procedure involves gradually increasing mechanical and thermal stressing of the device under test (i.e. R&S®M3AR transceiver). The stress applied will exceed the ambient conditions normally to be expected during the life of the device under test. As a consequence, weaknesses in the electrical and mechanical design are detected, which would otherwise only result in failures attributable to wear after a long period of operation. HALT will identify weaknesses in the design in an accelerated manner, which allows redesign to improve reliability where shown to be economically feasible.

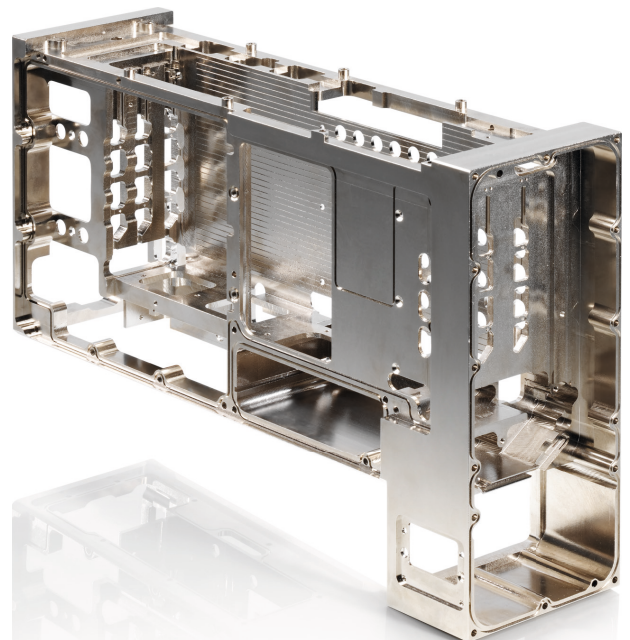
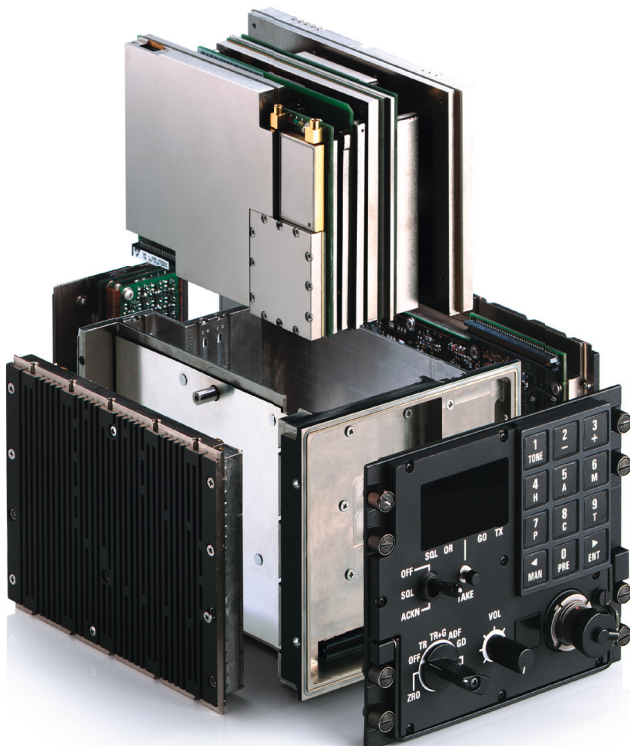
HALT did not identify any improvements that should be made to the transceiver. The test system reached its limits and did not damage the transceiver. Temperature limits were +120°C / -100°C and vibration limits 50 g RMS.

State-of-the-art technology ensures long product life

The R&S®M3AR family of transceivers features a modular design and is manufactured with SMD technology. The high quality and workmanship of the components that are used ensure a high MTBF and in general a long product life cycle. This minimizes the impact of discontinued components, reduces stockkeeping and streamlines logistics.

The multiband, multimode and multirole capabilities of the R&S®M3AR provide the flexibility to deploy the device in various frequency ranges with different waveforms, as well as in a multitude of scenarios and missions. Instead of multiple radios to support different applications, only one device is required. Logistics and training effort is significantly reduced as a result.

Modular design and high-grade components ensure outstanding quality and long product life.



Series of the R&S®M3AR family

The R&S®MR6000A, which comes in a standard housing in line with ARINC 600, is the most powerful radio in the R&S®M3AR family.

The R&S®MR6000R, one of the world's most compact and lightweight airborne transceivers, is designed for installation in the avionics bay and can be remotely controlled.

The R&S®MR6000L, extremely powerful despite its compact dimensions, can be installed in the cockpit as a replacement for legacy AN/ARC-164 radios with local control panel, for example.

The R&S®MR6000E is an "L-shape" radio developed especially for the Eurofighter Typhoon. It is remotely controlled and has an optical interface.

The Airbus A400M is equipped with the R&S®MR6000A transceiver from Rohde&Schwarz.



R&S®MR6000A

The R&S®MR6000A, the most powerful radio in the R&S®M3AR family, features RF power of up to 20 W in AM mode or 30 W in FM mode. It is a radio with an integrated crypto module and embedded NATO encryption algorithms. The elimination of the external encryption device and cabling saves valuable space and weight in the aircraft.

The integrated pre-/postselector minimizes susceptibility to interference and improves co-site behavior. This is particularly important since there is limited space for antennas on aircraft fuselages. In addition, the antennas are usually very difficult to decouple. The solution integrated in the R&S®MR6000A saves the cost of additional approvals and integration of external filters.

The radio software was developed in line with RTCA/DO-178B, level C, and the radio hardware in line with RTCA/DO-254, DAL C. This made it possible to certify that the aircraft in which the radio is integrated meets civil aviation requirements. The certification was carried out by the European Aviation Safety Agency (EASA).

R&S®MR6000A.



In addition, the R&S®MR6000A is marked by numerous integrated features designed to support a multitude of applications:

- Choice of frequency hopping methods: HAVE QUICK I/II, SATURN or HAVE QUICK I/III and R&S®SECOS in a single device
- In addition to the mandatory functions defined in STANAG 4372 (SATURN), the following are also available: ATEC, PTEC, TOD beacon (TX, RX), system messages, data modes, hailing, relay (clear and cipher voice and data), transmitter break-in, time delay compensation, split synchronization, data message, etc.
- Embedded NATO or R&S®SECOS encryption
- Link 11 interface in line with STANAG 5511 and MIL-STD-188-203-1A
- Additional guard receiver for the 40.5 MHz, 121.5 MHz, 243.0 MHz distress frequencies; dedicated guard receiver for the digital 156.525 MHz or analog 156.8 MHz distress frequency (depending on radio configuration)
- Integrated pre-/postselector
- Tactical VHF frequency range for communications with ground troops (i.e. expanded frequency range from 30 MHz to 399.975 MHz)
- Sonobuoy command
- Direction finding and homing support for locating transmitters in the VHF and UHF ranges
- Option of loading encrypted NATO encryption keys via the DS-101 interface (black key loading)
- Option of loading encrypted R&S®SECOS encryption keys (black key loading)
- Immunity to VHF broadcast transmitter interference in line with ICAO and ED-23B
- Low noise figure for excellent receiver sensitivity in AM and FM mode
- High transmit power of at least 20 W (AM) and 30 W (FM)
- High dynamic range and crossmodulation immunity in line with ARINC 716
- Ideal selectivity and spurious response immunity
- Remote control via MIL-STD-1553B data bus, RS-485 interface and applicable Rohde & Schwarz protocol (used by the R&S®GB6500 for example) or a combination of both
- Development processes in line with RTCA/DO-178B, level C, for software and RTCA/DO-254, DAL C, for hardware

R&S®MR6000R and R&S®MR6000L

These two radios, which come in ARC-164 housings, differ in that the R&S®MR6000R is designed for installation in the avionic bay and is remotely controlled, while the R&S®MR6000L is installed in the cockpit and is controlled via a local control panel. Despite weighing less than 4 kg, the R&S®MR6000R and R&S®MR6000L series offer outstanding reception and transmission performance.

The R&S®MR6000L display comes with a choice of white, red or NVG-compatible illumination.

The R&S®MR6000R/L series have the following features:

- Choice of frequency hopping methods: HAVE QUICK I/II, SATURN or HAVE QUICK I/II and R&S®SECOS in a single device
- Embedded R&S®SECOS encryption
- Additional guard receiver for the 40.5 MHz, 121.5 MHz and 243.0 MHz distress frequencies
- Tactical VHF frequency range for communications with ground troops (i.e. expanded frequency range from 30 MHz to 399.975 MHz)
- Direction finding and homing support for locating transmitters in the VHF and UHF ranges
- Option of loading encrypted R&S®SECOS encryption keys (black key loading)
- Immunity to VHF broadcast transmitter interference
- High transmit power of at least 10 W (AM) and at least 15 W (FM)
- Remote control via MIL-STD-1553B data bus, RS-485 interface and applicable Rohde&Schwarz protocol (used by the R&S®GB6500 for example) or a combination of both

R&S®MR6000R (left) and R&S®MR6000L (right).



Accessories

R&S®GB6500 remote control unit

The R&S®GB6500 can operate all series of the R&S®M3AR family and connects to the radio via the RS-485 interface. In a typical installation, e.g. for a tandem cockpit, two radios are operated by two R&S®GB6500 remote control units. The radios can also be controlled via the MIL-STD-1553B data bus. The R&S®GB6500 can serve as a backup in this case and can therefore be connected in addition to the MIL-STD-1553B data bus.

The remote control unit is suitable for installation in cockpits in line with MS 25212. Like the R&S®M3AR transceivers, the R&S®GB6500 remote control unit was qualified in line with military environmental and EMC standards such as MIL-STD-461 and is therefore suitable for use in aircraft.

The R&S®GB6500 display is suitable for conventional night flights as well as flying with night vision goggles (NVG).

The R&S®GB6500 user interface is identical to that of the R&S®MR6000L, which simplifies crew training.

R&S®GB6500.



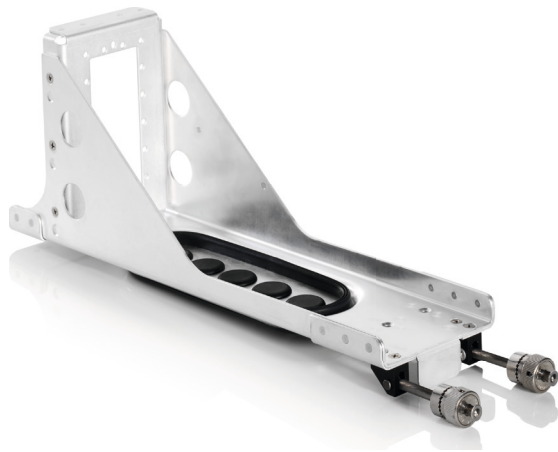
Mounting trays and mating connector sets

The mounting trays for the R&S®MR6000A and R&S®MR6000R series optimize the mechanical integration of the radios in the aircraft and make it easy to install and remove the radios. There are two versions of the R&S®KR6010 for the R&S®MR6000R: mounting tray (standard) and cooling tray. The cooling tray improves the heat dissipation of the radio, which is important at higher operating temperatures and longer transmit cycles.

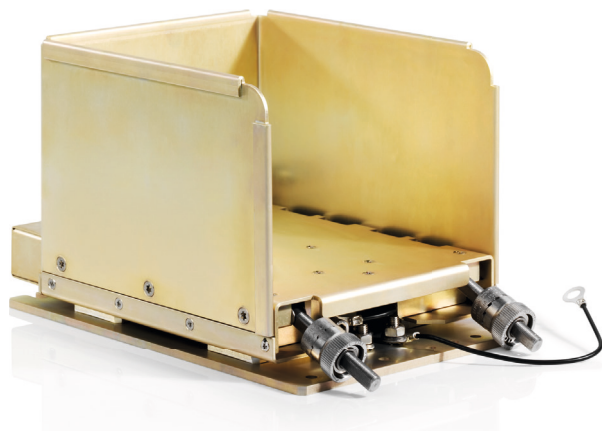
Since the R&S®MR6000L is installed directly in the cockpit, a mounting tray is not required.

To connect the radios to the cable harness in the aircraft, Rohde&Schwarz offers the appropriate mating connector set for each series of the R&S®M3AR family.

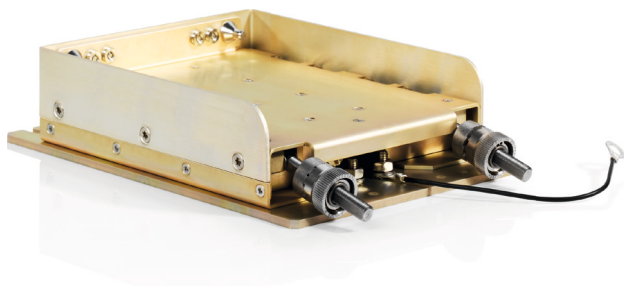
R&S®KR6000A mounting tray for the R&S®MR6000A.



R&S®KR6010 cooling tray for the R&S®MR6000R.



R&S®KR6010 mounting tray for the R&S®MR6000R.



Service and maintenance tools

R&S®BA6000 base station adapter.



R&S®BA6000 base station adapter

The base station adapter comes in two versions: the R&S®BA6000L for the R&S®MR6000L radio with local control panel, and the R&S®BA6000R for the remotely controlled R&S®MR6000R radio. The base station adapter is used for demonstration and training purposes, as well as for test and verification applications in the lab. It features the following interfaces:

- Low-temperature connector for 100 V to 240 V AC power supply
- Connector for 28 V DC power supply
- Two MIL-STD-1553B data bus connectors
- One RS-232 interface
- One 37-pin X1 and one 37-pin X3 interface
- Antenna connector
- NF 7 connector for a microphone or headset on the front side of the adapter
- Integrated loudspeaker

The base station adapter also has a fan for cooling the radio.

Rear panels of the R&S®ZK6000 maintenance connection boxes.



R&S®ZK6000 maintenance connection box

The R&S®ZK6000 maintenance connection box enables operation of the R&S®M3AR transceivers outside the aircraft for performing tests and maintenance. The maintenance connection box provides access to the radio functions via standard interfaces. This allows easy and flexible configuration of the radio without requiring special mating connectors and additional cabling. Basic functions such as switching the radio on/off, assigning radio addresses as well as PTT/tone transmit are already integrated in the R&S®ZK6000. The maintenance connection box is available in two versions: the R&S®ZK6000A with connectors for the R&S®MR6000A, and the R&S®ZK6000L/R for the R&S®MR6000L and R&S®MR6000R series.

Identical front panel of the R&S®ZK6000 maintenance connection boxes.



R&S®CP6000 radio commander

The R&S®CP6000 radio commander is PC software that serves as a tool for integrating airborne transceivers into aircraft. This program can be used to control the radio via the MIL-STD-1553B data bus or the RS-485 interface. For control via the MIL-STD-1553B data bus interface, a suitable PCMCIA card is necessary. Rohde & Schwarz can recommend a specific model upon request.

R&S®ZS6001 PC maintenance tool software

The R&S®ZS6001 PC maintenance tool software allows the synthesizer to be calibrated during maintenance. The calibration interval depends on different factors and is described in the transceiver operating manual. In addition, the IBIT can be activated and the result displayed. The software communicates with the radio via an RS-232 interface that can be accessed using the R&S®ZK6000, for example.

Fields of deployment and applications

Flexibility during training exercises and missions

During a mission, military jets, helicopters and propeller aircraft must communicate with a variety of partners that use different frequency ranges. This requires flexible radio systems that can reliably support flight crews in all phases of a mission, from start to landing. By using airborne transceivers from Rohde&Schwarz, crews have a reliable partner on board at all times.

Civil and military air traffic control as well as information services (108 MHz to 136.975 MHz and 225 MHz to 399.975 MHz, AM)

Military aircraft must be equipped with appropriate communications systems to enable them to also fly in international civil airspace without any restrictions.

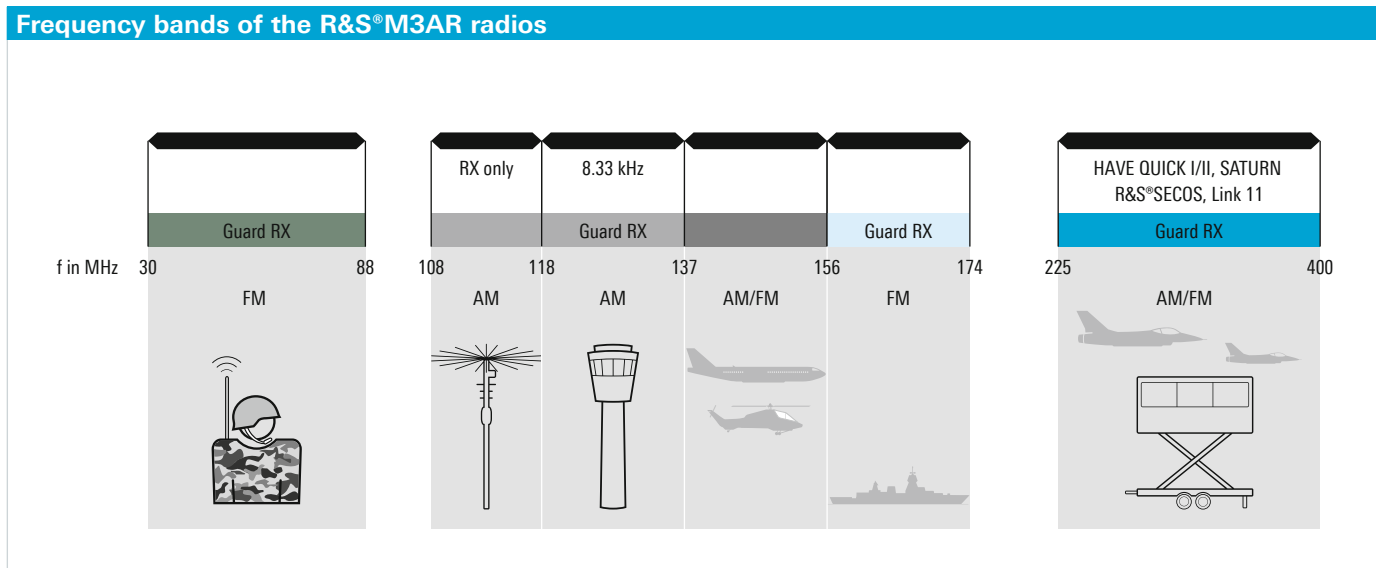
The R&S®M3AR transceivers are developed and tested in line with military and civil standards. The excellent receiver sensitivity and the high transmit power consistently ensure high-quality radio links with civil or military air traffic control.

In the upper airspace in various countries, an additional 8.33 kHz channel spacing is required, which in the future has to be implemented in offset carrier mode like the 25 kHz spacing already used. This places high demands on the radios, particularly when signals are weak. Apart from excellent receiver characteristics, the R&S®M3AR features a flexible carrier override option, which can be set via the MIL-STD-1553B data bus. This improves sensitivity in offset mode when flying at high altitudes.

Information services such as automatic terminal information service (ATIS) can be received in the 108 MHz to 136.975 MHz frequency range. To avoid incorrect operation, for air navigation services the 108 MHz to 117.975 MHz frequency range is receive only and the 108 MHz to 136.975 MHz frequency range can only be used in AM mode.

Military air traffic control uses the 225 MHz to 399.975 MHz frequency range with 25 kHz channel spacing. To enable unrestricted movement in civil and military airspaces, both frequency ranges are required.

The R&S®M3AR transceivers offer the flexibility to use civil as well as military air traffic control frequencies with the corresponding channel spacing. Furthermore, reception is also possible in offset carrier mode with 25 kHz and 8.33 kHz channel spacing. An additional guard receiver makes it possible to monitor not only the 121.5 MHz and 243 MHz distress frequencies of civil and military aviation, but also the 40.5 MHz distress frequency of the tactical VHF band. The R&S®MR6000A can also monitor the 156.525 MHz or 156.8 MHz maritime distress frequency. The guard receiver has a mode for constantly scanning the frequencies and locking onto the corresponding receive frequency.



VHF combat net radio (30 MHz to 87.975 MHz, FM)

Ground forces use this frequency range to send and receive tactical information in the form of voice or data messages. To enable aircraft, particularly army helicopters, to provide effective support to forces on the ground, they must be equipped with an interoperable communications system.

The R&S®M3AR family supports the 30 MHz to 87.975 MHz tactical VHF frequency range and can switch to a specific frequency in this range when required. The R&S®MR6000A also features embedded NATO encryption for interoperability with NATO partner combat net radio equipment.

Maritime radio (156 MHz to 173.975 MHz, FM)

This frequency range is particularly important for naval aircraft, to enable communications with civil boats, ships and harbor authorities. All R&S®M3AR series support the maritime band in line with international and U.S. frequency tables. When needed, the R&S®MR6000A also monitors the maritime distress frequency on channel 70 of the GMDSS (156.525 MHz) or on channel 16 (156.8 MHz).

Military airborne radiocommunications (225 MHz to 399.975 MHz, AM and FM)

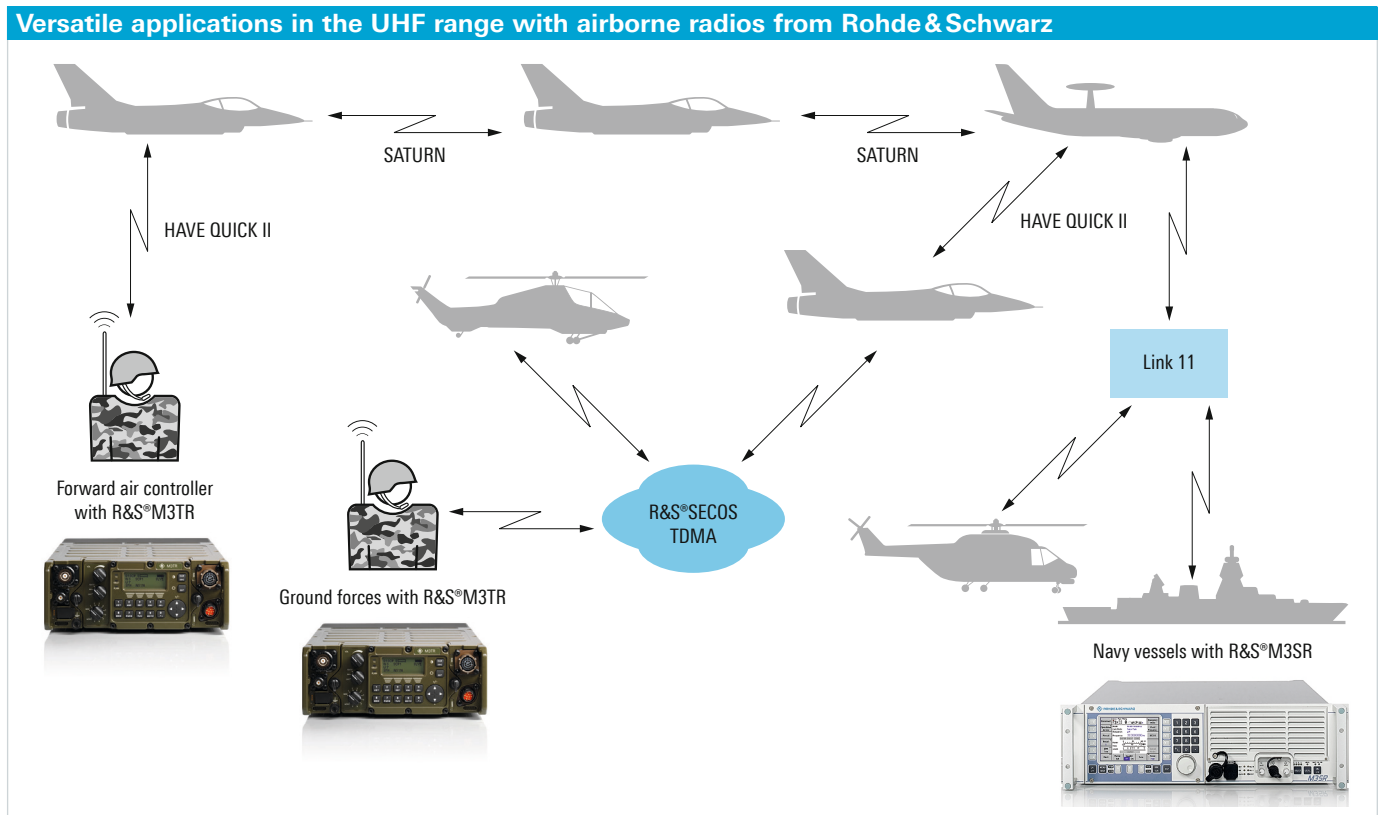
Military aircraft rely on the UHF radio band for air-to-air as well as air-to-ground communications for exchanging tactical information with various units.

Military operations are increasingly reliant on radio data capability. Aircraft crews also require mission-critical information in digital form in order to significantly improve situational awareness, for instance. The R&S®M3AR transceivers support radio data transmission with up to 16 kbit/s in different waveforms.

NATO uses the HAVE QUICK I/II and SATURN frequency hopping methods in the UHF range, which can be optionally combined with encryption. These NATO methods can be integrated in the R&S®M3AR transceivers upon request to ensure international interoperability.

R&S®SECOS can operate on any number of frequencies in the entire UHF range. Up to 128 participants can exchange information over a TDMA network. R&S®SECOS supports both voice and data, features embedded encryption and can optionally be installed in parallel with HAVE QUICK I/II. Switching between the methods is made possible by simply changing the preset.

The R&S®MR6000A features a Link 11 interface for participating in tactical data links in the UHF range in line with STANAG 5511 and MIL-STD-188-203-1A.



R&S®RNMS3000 radio network management system

Utilization planning, radio network configuration and data distribution

Increased significance for a radio network management system

In today's world, information exchange via voice and data is indispensable for military forces to fulfill their increasing mission requirements. Handling all these communications demands with their complex waveforms requires an extended network management system. By offering R&S®RNMS3000, Rohde & Schwarz provides such a radio network management system. It enables military leaders to turn their Rohde & Schwarz combat radio equipment into a robustly networked communications system based on mission demand and on complex hierarchical structures, especially in joint or combined missions. In the past, many parameters had to be adjusted on the radios, which required highly skilled users. In future, the configuration complexity will be dealt with during the preparative configuration of a management system.

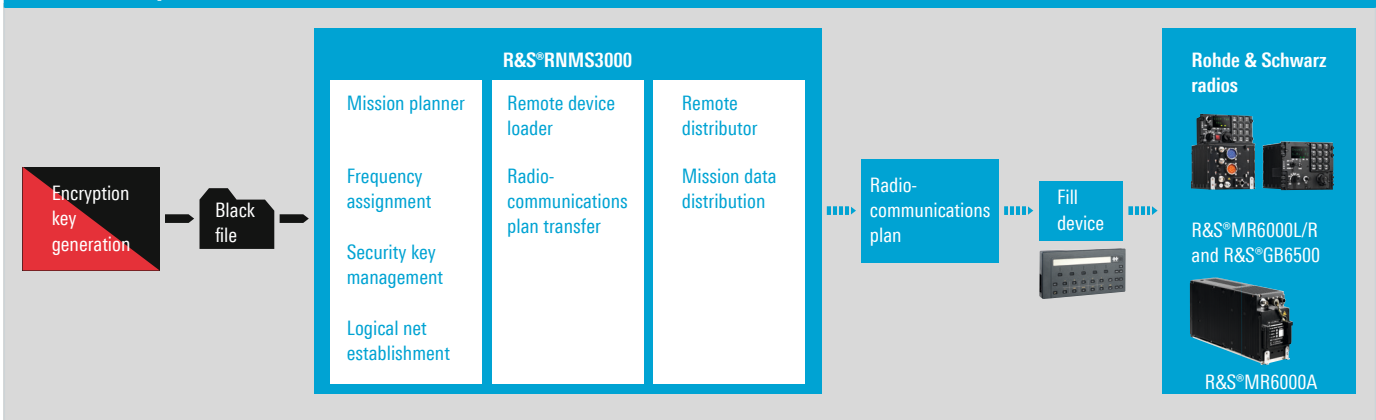
R&S®RNMS3000 – the convenient way to empower the capabilities of Rohde & Schwarz radios in networks

The R&S®RNMS3000 software supports the centralized network management, where one central organizational unit performs the complete mission planning, as well as the decentralized management, where the various configuration steps are accomplished at different military hierarchical levels. The R&S®RNMS3000 software suite, consisting of the mission planner, the remote device loader and the remote distributor, offers the following functions for proprietary waveforms from Rohde & Schwarz, such as R&S®SECOS:

- Management of security keys
- Frequency assignments
- Establishment of logical nets
- Distribution of mission files (presets)

Only radios with a multi-application such as R&S®SECOS and HAVE QUICK installed allow mission planning (creation of presets) for the HAVE QUICK waveform as well. The R&S®RNMS allows mission planning for all radios of the R&S®M3xR family, i.e. R&S®M3AR/M3TR/M3SR in order to achieve joint networking.

Process sequence



Rohde & Schwarz, the leader in radio- communications for decades

Rohde & Schwarz is a leading global supplier of professional HF, VHF and UHF radios. For decades, governments and military organizations have put their trust in products from Rohde & Schwarz to ensure reliable and secure voice and data communications.

Rohde & Schwarz has been developing airborne transceivers for demanding radiocommunications applications since 1968. Many of these analog transceivers are still being deployed today by scores of armed forces. After decades, they continue to provide reliable radiocommunications as proof of the quality, reliability and robustness of Rohde & Schwarz products. The R&S®M3AR family of products has been deployed around the world since 2000 and has proven its value.

As a supplier of highly secure radiocommunications systems as well as versatile test and measurement equipment for all aspects of radiocommunications, Rohde & Schwarz possesses the comprehensive expertise to meet any test requirement, from conventional analog communications systems to state-of-the-art digital R&S®M3AR transceivers.

Radios from Rohde & Schwarz in the JAS-39 GRIPEN.



References

As a supplier of airborne transceivers for the following platforms (extract), Rohde & Schwarz boasts extensive experience at the international level:

- ▮ A109 LUH
- ▮ A400M
- ▮ AL-X Super Tucano
- ▮ CH-53
- ▮ EMB-145 AEW&C
- ▮ EC-725
- ▮ Eurofighter Typhoon
- ▮ F-16
- ▮ FENNEC
- ▮ JAS-39 GRIPEN
- ▮ KC-390
- ▮ MI-8, MI-17, MI-24, Mi-35
- ▮ MIRAGE III, MIRAGE V
- ▮ SEAKING
- ▮ SOKOL W-3A
- ▮ SU-30 MKM
- ▮ SUPER LYNX
- ▮ TIGER and NH 90 helicopters
- ▮ TORNADO

Product overview

R&S®MR6000A (examples of available equipment)

ARINC 600 housing – remote control

Designation	Type
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; fixed frequency; interfaces: RS-485, MIL-STD-1553B trafo coupling; audio output: 150 Ω or 600 Ω	R&S®XM6023
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; audio output: 150 Ω or 600 Ω	R&S®XM6123
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): R&S®SECOS 5/16 voice and data, HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; audio output: 150 Ω or 600 Ω	R&S®XM6423D
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): R&S®SECOS 5/16 voice and data; interfaces: RS-485, MIL-STD-1553B trafo coupling; audio output: 150 Ω or 600 Ω	R&S®XM6523D
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): SATURN, HAVE QUICK I/II; COMSEC: embedded NATO; interfaces: RS-485, MIL-STD-1553B trafo coupling; audio output: 150 Ω or 600 Ω	R&S®XM6923L

R&S®MR6000L (examples of available equipment)

ARC-164 housing – local control

Designation	Type
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; fixed frequency; interfaces: RS-485, MIL-STD-1553B trafo coupling; illumination: NVG (green A); display: green; audio output: 150 Ω or 600 Ω	R&S®XM6012
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; illumination: NVG (green A); display: green; audio output: 150 Ω or 600 Ω	R&S®XM6112
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): R&S®SECOS 5/16 voice and data, HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; illumination: NVG (green A); display: green; audio output: 150 Ω or 600 Ω	R&S®XM6412D
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): R&S®SECOS 5/16 voice and data; interfaces: RS-485, MIL-STD-1553B trafo coupling; illumination: NVG (green A); display: green; audio output: 150 Ω or 600 Ω	R&S®XM6512D
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): SATURN, HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; illumination: NVG (green A); display: green; audio output: 150 Ω or 600 Ω	R&S®XM6912

The following control panel illumination is available for the R&S®MR6000L:

- NVG (green A); display: green
- White; display: red
- Red; display: red

R&S®MR6000R (examples of available equipment)

ARC-164 housing – remote control

Designation	Type
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; fixed frequency; interfaces: RS-485, MIL-STD-1553B trafo coupling; fill interface; audio output: 150 Ω or 600 Ω	R&S®XM6013
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; fill interface; audio output: 150 Ω or 600 Ω	R&S®XM6113
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): R&S®SECOS 5/16 voice and data, HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; fill interface; audio output: 150 Ω or 600 Ω	R&S®XM6413D
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): R&S®SECOS 5/16 voice and data; interfaces: RS-485, MIL-STD-1553B trafo coupling; fill interface; audio output: 150 Ω or 600 Ω	R&S®XM6513D
Frequency bands: 30 MHz to 88 MHz, 108 MHz to 174 MHz, 225 MHz to 400 MHz; EPM (ECCM): SATURN, HAVE QUICK I/II; interfaces: RS-485, MIL-STD-1553B trafo coupling; fill interface; audio output: 150 Ω or 600 Ω	R&S®XM6913

Accessories

Designation	Type
Mating Connector for R&S®MR6000R	R&S®ZR6000
Mating Connector Set for R&S®MR6000A	R&S®ZR6000A
Mating Connector Set for R&S®GB6500	R&S®ZR6500
Remote control units (R&S®M3AR)	
Remote Control Unit; control interface: RS-485; illumination: white; display: yellow	R&S®GB6500
Remote Control Unit; control interface: RS-485; illumination: white; display: red	
Remote Control Unit; control interface: RS-485; illumination: NVG (green A); display: green	
Remote Control Unit; control interface: RS-485; illumination: red, display: red	
Remote Control Unit; control interface: RS-485; illumination: NVG (green B); display: green	
Trays (R&S®M3AR)	
Mounting Tray for R&S®MR6000A	R&S®KR6000A
Mounting Tray for R&S®MR6000R	R&S®KR6010
Cooling Tray for R&S®MR6000R	R&S®KR6010
Service and maintenance tools (R&S®M3AR)	
Base Station Adapter for R&S®MR6000L (local control)	R&S®BA6000L
Base Station Adapter for R&S®MR6000R (remote control)	R&S®BA6000R
Maintenance Connection Box for R&S®MR6000A	R&S®ZK6000A
Maintenance Connection Box for R&S®MR6000L/R	R&S®ZK6000L/R
Radio Commander	R&S®CP6000
PC Maintenance Tool Software	R&S®ZS6001
Radio network management system (R&S®RNMS)	
Mission Planner	R&S®DS3100M
Remote Device Loader	R&S®DS3300D
Remote Distributor	R&S®DS3321D
Test system for radio equipment of the R&S®M3xR family	
Base System; mobile rack version; complete set of radio test equipment including system racks and base software suite	R&S®UCS226XB
R&S®M3AR BASE; System Interface Base; radio adaption box and cabling set; including specific radio test software package	R&S®UCS-B31

The radio systems described are hardware- and software-configurable.
The system delivered has the configuration as confirmed in the order.

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

Certified Quality Management

AQAP-2110

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R&S®M3AR Software Defined Radios

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