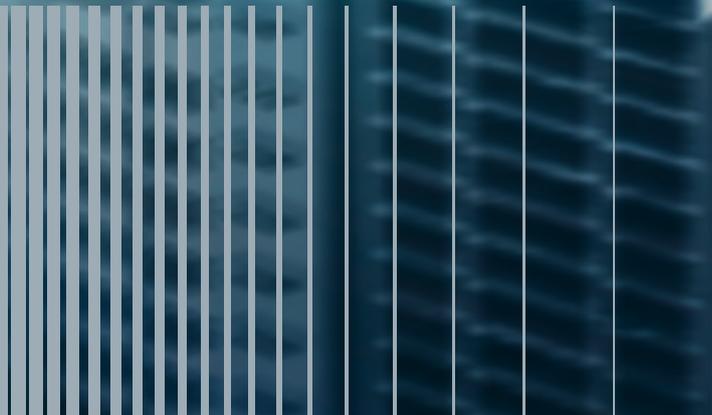


# Drone detection

RF monitoring, GNSS and radar test solutions for ensuring safe and secure commercial UAV operation



# Your challenge

With recent advances in both technology and public interest, the number of commercial unmanned aerial vehicles (UAV) – or drones – and their applications are rising dramatically. According to estimates, more than 600 types of drones are in use today and the aggregated number of drones will reach 7 million by 2020.

While drones provide numerous advantages in applications such as aerial surveillance, high-resolution imaging/mapping and facility inspections, there is a growing need to ensure their safe and secure operation and to counter unauthorized, criminal or even terrorist activities.

# Our solution

Rohde&Schwarz offers unique solutions for the challenges involved in designing UAV detection and classification systems that merge multiple sensors and information to provide consistent and reliable threat analysis. With special emphasis on radar detection and RF monitoring of small UAVs, this brochure provides an overview of solutions for the following applications: Radar testing for small UAV detection, RF monitoring and countermeasures as well as GNSS testing.

## RF monitoring and countermeasures

RF monitoring capabilities provide a perfect match for the radar sensor in any given UAV detection system. With the ability to capture unauthorized activity from the moment the drone is switched on, precise geolocation of the drone and – often more important – of the controlling operator can be obtained. Rohde&Schwarz provides an integrated system solution for drone detection, classification, direction finding and countermeasures.

## Radar testing for detection of small UAVs

With the advantage of extended range and all-weather operability, radar is typically the first choice for drone detection sensors. However, detecting a small UAV flying at slow speed and low altitude demands special requirements regarding the frequency band used, the signal-to-noise ratio (SNR) and phase noise coherence. In addition, deployment in the congested electromagnetic environments of highly populated urban areas places stringent requirements on system robustness e.g. against LTE interference. Rohde&Schwarz provides high-end instruments and solutions for designing, testing and validating radar systems.

## GNSS testing

Most of today's UAV applications are unthinkable without the widespread use of precision geopositioning using global navigation satellite systems (GNSS) such as GPS, Galileo, BeiDou and GLONASS. Rohde & Schwarz offers a comprehensive range of GNSS simulation solutions for designing, testing and validating high-precision on-board devices.

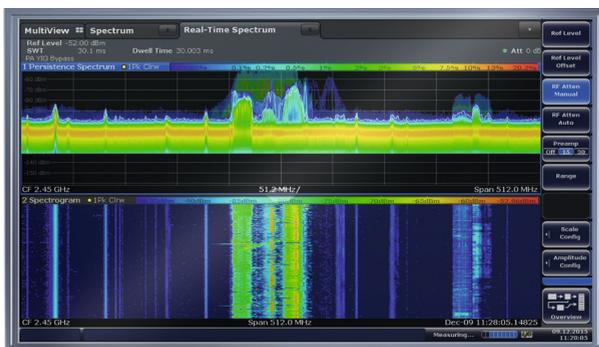


# Radar test solutions

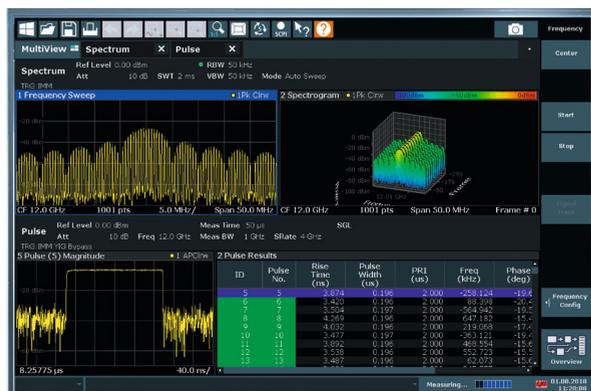
Due to their small size, low altitudes and slow speeds, reliably detecting drones is a key challenge for modern radar systems. Radar sensors have to quickly scan large volumes of data with great sensitivity, eliminate nuisance alarms from birds and reliably discriminate UAVs from ground targets. Key factors for designing a drone detection radar can be summarized as follows:

- Radar operating frequency
- Scan coverage and response time
- Resolution and environmental considerations
- Classification capability

## Realtime spectrum analysis



## Radar pulse analysis



## Radar operating frequency

Operating frequency is qualified by a number of considerations, including propagation efficiency, scanned terrain and environment, desired detection range and the minimum detectable radar cross section (RCS).

Supporting the general system design considerations and validations, Rohde&Schwarz offers a wide range of signal generator and spectrum analyzer solutions covering all relevant frequency bands (e.g. X/Ka/Ku band) with advanced functionalities for precise analysis of e.g. pulse form, bandwidth, spectrum, linearity and complex waveforms.

## Scan coverage and response time

With many applications requiring full 360° azimuth coverage, scanning requirements range from monitoring large volumes of data with high refresh rates to the ability to illuminate contacts for classification and countermeasure initiation. For further classification with secondary sensors (e.g. optical, audio), accurate information regarding range, bearing and height often demands complex 3D capabilities.

For determining the needed performance level at the component, module or subsystem level, Rohde&Schwarz offers a unique choice of instruments ranging from sophisticated network analyzers and power meters to full-featured oscilloscopes. These solutions cover all relevant measurements for e.g. power output, antenna pattern, spectral emission mask and interface performance.

In addition, Rohde&Schwarz offers market-leading phase noise analyzer solutions to determine the phase noise performance level of phased-locked loop (PLL) based microwave signal generator assemblies.

## Resolution and environmental considerations

Radar resolution should make it possible to resolve multiple simultaneous threats, perform 3D measurements of intruder positions, detect low Doppler MDVs and accurately discriminate and eliminate ground targets as well as sources of clutter.

For verifying the system performance level for these tasks, Rohde&Schwarz offers a unique target generator solution that integrates the excellent performance of the R&S®SMW signal generator and R&S®FSW spectrum analyzer. The radar target generator solution from Rohde&Schwarz combines the two instruments and provides highly customizable threat scenarios to reliably test and determine detection performance, accuracy and resolution.

## Classification capability

With the objective to minimize nuisance alarms, classification algorithms have the complex task of applying RCS analysis, behavioral analysis, micro-Doppler analysis and Doppler filtering in order to eliminate clutter in realtime. Complex environmental scenarios for training algorithm based analysis are crucial to enhancing system performance levels and minimizing false alarm rate.

The R&S®PulseSequencer solution provides reproducible and highly deterministic environmental scenarios, including complex radar emitters and antenna diagrams, realistic propagation loss and RF power levels as well as real-world interference and coexistence simulations.

## Solutions for radar testing

Test system for interference, TRM, phase coherent signals  
R&S®TS6600



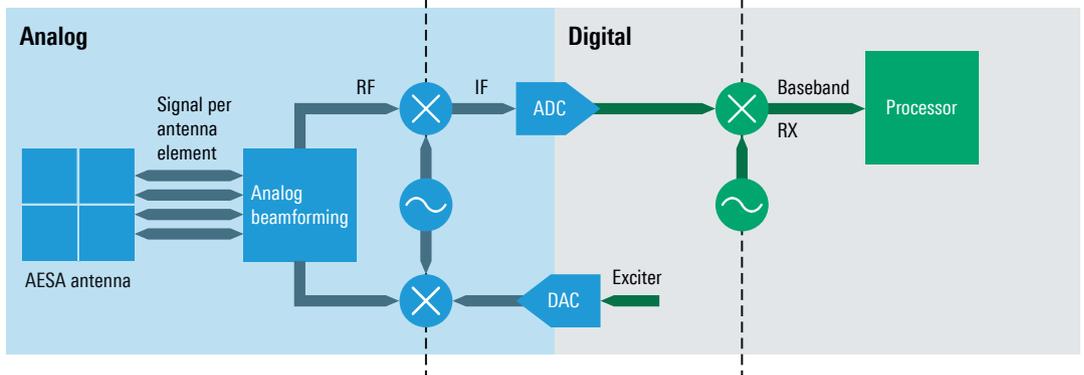
Spectrum analyzer  
R&S®FSW



Signal generator  
R&S®SMW200A



Oscilloscopes  
R&S®RTO/RTP



Test system for environmental simulation  
R&S®DF8000



Network analyzer  
R&S®ZVA/ZVB/ZNT



Power meter  
R&S®NRP



Phase noise analyzer  
R&S®FSWP



Signal generator  
R&S®SMA100A

# RF monitoring

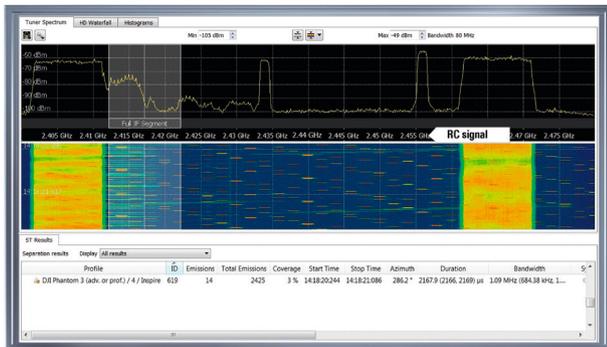
## RF signal detection and classification

Since the majority of commercial drones are controlled via direct radio links, the R&S®ADRONIS RF sensors continuously scan through all relevant frequency bands and exploit these specific emissions to reveal the presence of a drone and automatically classify the type and manufacturer.

## RF signal direction finding

Utilizing the direction finding capabilities of the R&S®DDF550 Wideband direction finder, the R&S®ADRONIS software solution can determine the direction of the drone and the location of the operator controlling it. The ability to detect drone-specific radio emissions as soon as the drone's remote controller is turned on provides law enforcement and security personnel with a unique amount of prewarning time and situation awareness.

Reliable RC signal classification in densely occupied ISM band (e.g. Wi-Fi, Bluetooth®, video signals)



## RF countermeasures

One of the safest and most reliable ways to prevent unauthorized drone activities is to use R&S®WSE RF jammer solution to disrupt the control signal. Loss of the control link usually triggers the failsafe mode of the drone, causing it to land or return to its take-off position safely. The R&S®WSE smart jammer capabilities make it possible to follow even the most advanced frequency hopping schemes of modern drone control units. Combined with the low-power approach for classified drone types, this provides the clear benefit of precise selective jamming with minimal impact on other signals and adjacent frequency bands. Of course, other operating modes such as wideband jamming, barrage jamming and a sweep jamming mode may also be applied.

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R&S®ADRONIS system solution

# GNSS testing

GNSS receiver test solutions from Rohde & Schwarz provide the most realistic GNSS scenario simulations (GPS/GLONASS/BeiDou/OZSS) for satellite orbit, signal propagation and electromagnetic environment characteristics and include modeling of the drone's movement. The clear benefit of this approach is the unmatched repeatability and scalability of the conducted test and validation scenario.

The R&S®SMBV100A vector signal generator is the ideal GNSS signal source for single-frequency receiver tests. To simulate even more complex multifrequency GNSS signal scenarios, the R&S®SMW200A can generate signals from all important GNSS constellations and frequency bands simultaneously.



R&S®SMW200A vector signal generator for multifrequency GNSS signal simulation

## Service that adds value

- | Worldwide
- | Local und personalized
- | Customized and flexibel
- | Uncompromising quality
- | Long-term dependability

## About 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

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