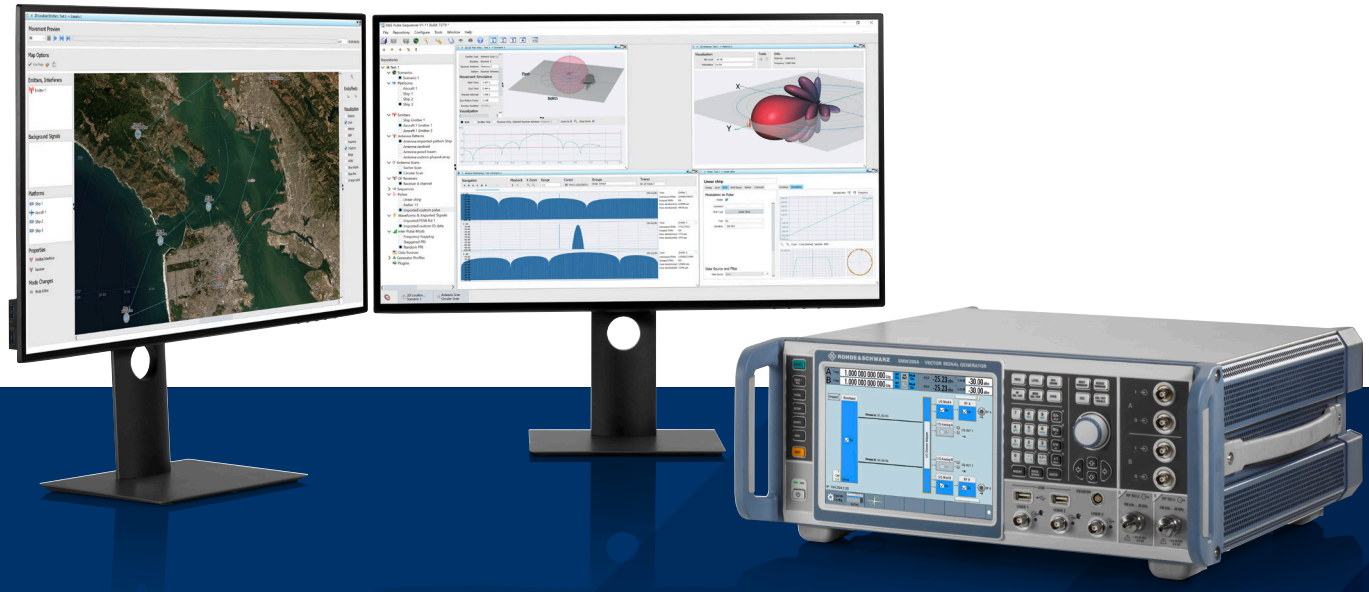
RADAR SIMULATION WITH MODERN VECTOR SIGNAL GENERATORS



Application Brochure
Version 01.00

ROHDE&SCHWARZ
Make ideas real

Testing radar warning equipment in realistic scenarios is crucial to reliable field performance. This typically involved dedicated instruments or test systems. Commercial vector signal generators (VSG) such as the R&S®SMW200A from Rohde & Schwarz have become a very attractive alternative thanks to their increased available bandwidth and processing power.

Modern concepts

Modern vector signal generators allow playback of a nearly unlimited variety of signals, from simple unmodulated radar pulses to radar signals with complex modulation schemes and modulation on pulse (MOP). A modern vector signal generator can generate a realistic and dense RF environment with a high modulation bandwidth enabling simulation of modern frequency agile radars. Engineers can share a signal source among different applications from simple vector signal generation to high-end radar simulation and benefit from outstanding RF performance. Using a single source for many different applications also reduces costs and provides users with increased flexibility.

Test like it's real

The Rohde & Schwarz R&S®SMW200A vector signal generator offers a suitable solution for testing radar warning equipment in realistic scenarios. The generator together with the PC-based R&S®Pulse Sequencer software deliver a powerful radar simulator, providing everything needed for thorough testing (Figure 1). The simulator generates densely packed scenarios with multiple complex, high-resolution radar signals for use in all equipment test phases – from early design tests in the lab and integrated system tests to field testing and maintenance tests. The radar simulator can generate all current and future radar signals.

The heart of the solution is the vector signal generator. It supports all typical radar bands up to 44 GHz. The digital hardware's flexibility with 2 GHz internal I/Q bandwidth enables simulation of pulse-on-pulse situations with up to six overlapping pulses in instruments with a single RF port and a maximum pulse density of up to six times 3.3 MPulses/s.

Radar warning receivers use input signals from multiple antennas to determine the direction of arrival (DOA) of an emitted signal. This function can also be tested in the lab. Multiple generators are coupled and the signals applied to each antenna element are calculated and played synchronously according to the required angle of arrival (AoA).

Compact, powerful radar simulator for the lab

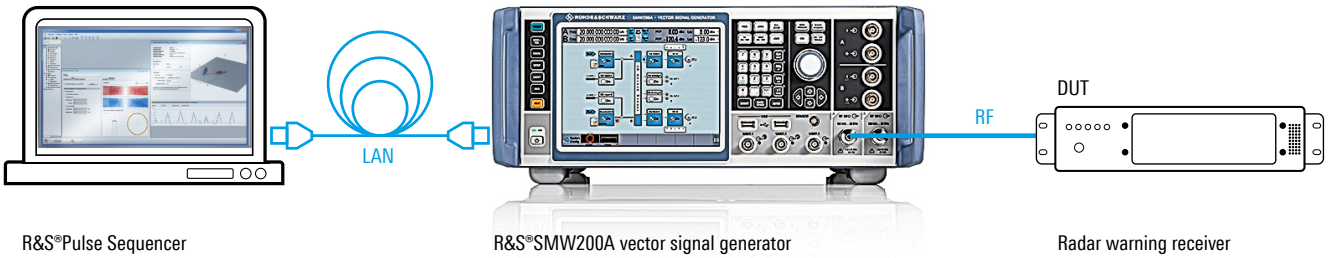


Figure 1: The setup consists of an R&S®SMW200A vector signal generator and PC based R&S®Pulse Sequencer software

Powerful scenario editor

In all stages of the development cycle, from initial functional testing to final operational testing, engineers need realistic test cases that reflect what radar warning receivers actually experience when in operation. Engineers can use the R&S®Pulse Sequencer software package to define a wide range of radar scenarios that extend from simple pulses to dense multi-emitter RF environments. The software enables the use of smart pulse interleaving algorithms with optimized, user-defined priority schemes and the lowest drop rates as a standard feature.

The user can also simulate truly realistic pulse-on-pulse situations, without any pulse dropping. Engineers can configure all typical radar types, including CW radars, FMCW radars or pulsed radars (wide bandwidth, frequency agile radars with complex interpulse modulation (IPM) or modulation-on-pulse (MOP)). To make the simulation as realistic as possible, emitters and receivers can move along predefined or imported trajectories with six degrees of freedom.

Usability is a core software requirement. The software offers 3D previews and graphical live visualization of configured scenarios to quickly familiarize users with it (see the example in Figure 2).

Calculation results of complex multi-emitter scenarios are also made quickly available, keeping waiting times for results to a minimum and enabling the user to conveniently optimize test cases.

Alternatively, customers can stream their own pulse descriptor words (PDW) from their source to the R&S®SMW200A.

High speed PDW streaming

When streaming PDWs via LAN to the vector signal generator, it takes on the role of an agile RF signal source. This enables ultra-long scenario play times and real-time simulation changes. The vector signal generator supports classical unmodulated radar pulses, pulses with shaped edges, Barker-coded pulses, frequency modulated continuous wave (FMCW) signals, or any kind of I/Q modulation on pulse, simulating state-of-the-art, low probability of intercept (POI) radars. The R&S®SMW200A supports PDW rates of up to 12 MPDW/s.

Live preview of 3D flight scenario with moving emitter and receiver

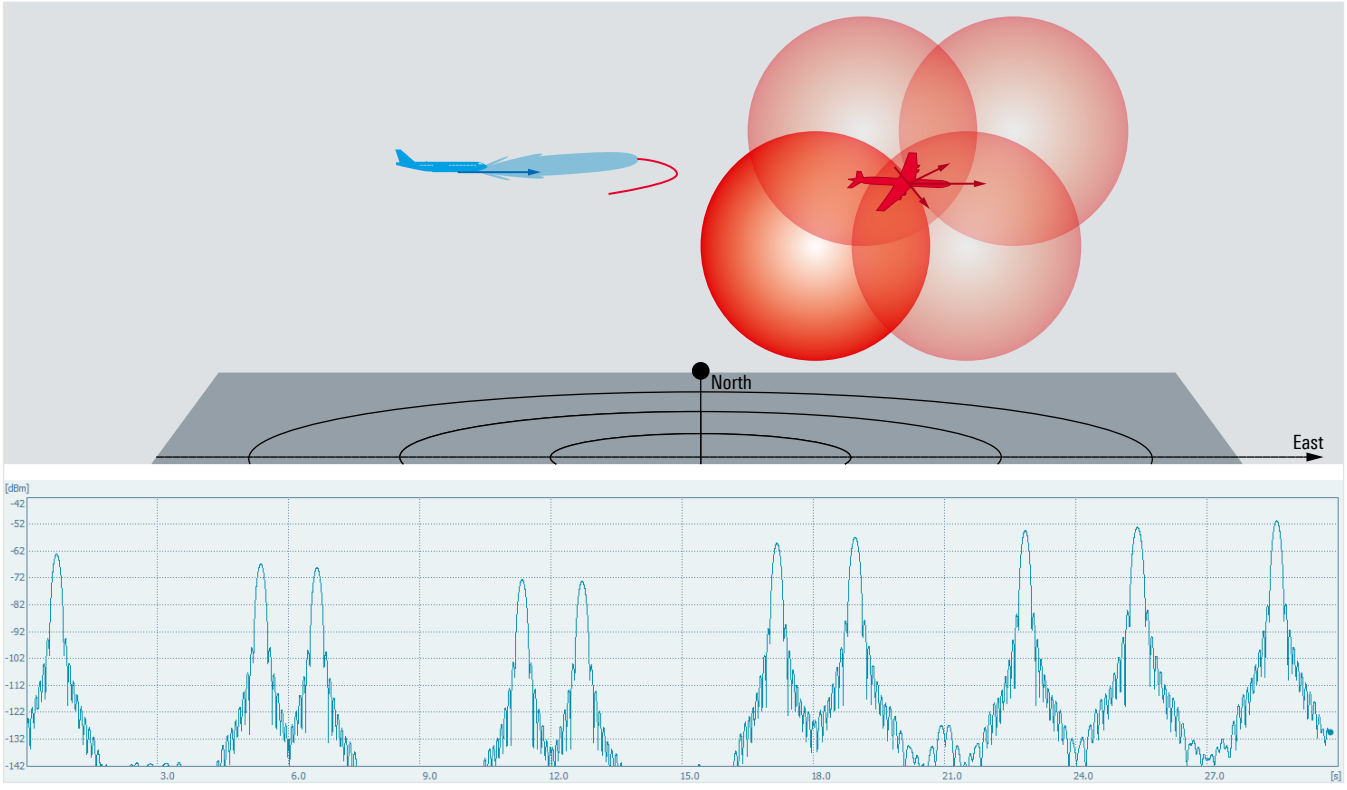


Figure 2: Live preview of 3D flight scenario with moving emitter and receiver

Live field demonstrations

At the 2019 EW Live event in Tartu, Estonia, a radar simulator from Rohde&Schwarz was demonstrated live in an over-the-air (OTA) setup covering a free-space distance of 1.3 km to the ELINT and radar warning receivers (Figure 3).

The signal source was an R&S®SMW200A vector signal generator with two RF paths up to 20 GHz. It was controlled by the R&S®Pulse Sequencer software. Four compact R&S®SGT100A RF sources were also integrated into the system to simulate additional radars below 6 GHz. This setup allowed the creation of scenarios involving ten simultaneous radar emitters.

Figure 4 shows a simulator signal plan. The R&S®SMW200A vector signal generator's large internal modulation bandwidth of 2 GHz makes it possible to generate radar signals from multiple emitters in a single RF path. In this scenario, the R&S®SMW200A generates six radar signals simultaneously (three in RF path A and three in RF path B). Each R&S®SGT100A generates one additional radar signal.

Signals from radar systems with operating frequencies between 5 GHz and 6 GHz were simulated in RF path A, while RF path B was used to generate radar signals in the 9 GHz range. Splitting radar signal generation between two paths makes it is possible to create very realistic scenarios, including those with colliding pulses and highest dynamic range.

The signal plan defines different radar signal types, from simple, unmodulated pulses to complex I/Q modulated pulses (e.g. AMOP, FMOP, PMOP, chirps and Barker coded pulses). Diverse interpulse modulation profiles such as pulse repetition interval (PRI) staggering and frequency hopping are also used. Also included is a complex multimode radar featuring frequency agile and time agile operations as well as diverse antenna patterns and scans.

For the EW Live demonstration, the R&S®SMW200A and R&S®SGT100A vector signal generators turned into a full-featured radar simulator, thanks to their flexibility and powerful performance. The vector signal generators are standard commercial-off-the-shelf products. They enable high performance field tests at relatively low cost and with little effort. Added benefits include quick and easy installation anywhere and performance verification for the systems to be tested.

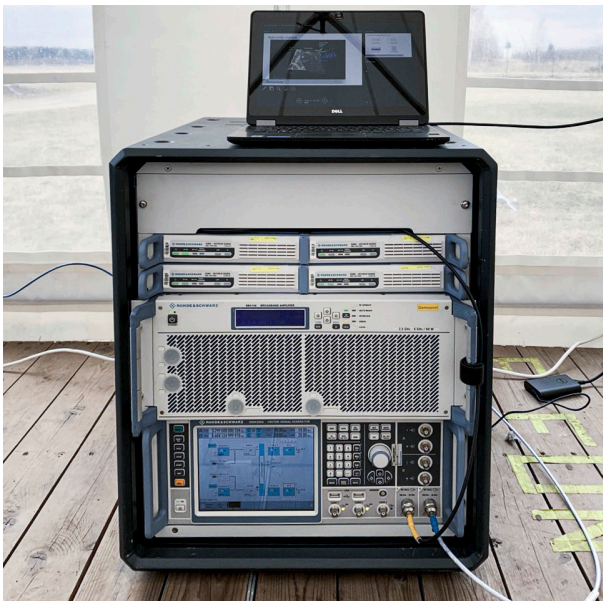


Figure 3: OTA live demonstration at Tartu Airport in Estonia: The signal generators and the amplifier fit into a small rack. The R&S®Pulse Sequencer software runs on a commercial laptop.

Example signal plan for the EW Live 2019 in Tartu

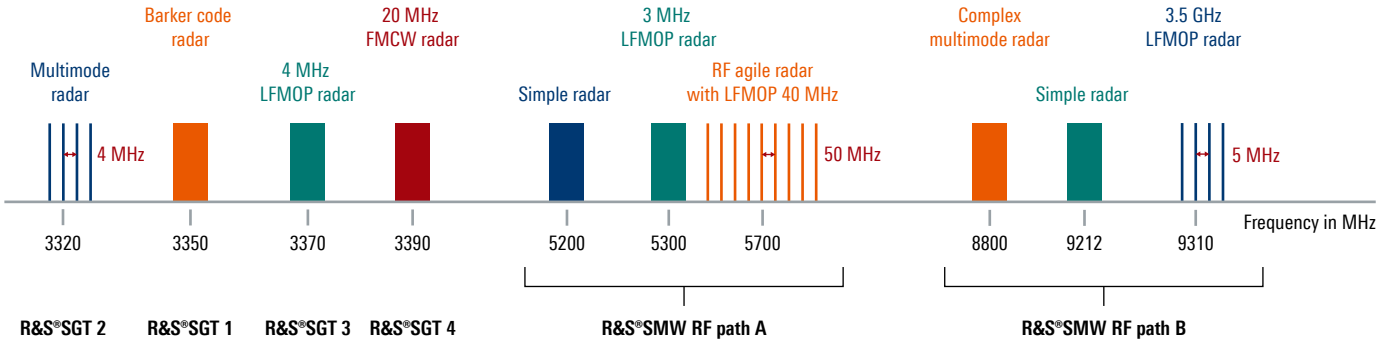


Figure 4: The two RF paths of the R&S®SMW200A generator simulate six radar emitters of different complexity in two frequency ranges. Each R&S®SGT100A generates one additional radar signal.

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