R&S® SMB100A, NRP, FSW-K6, ZVL Radar Educational Videos

Application Note

Radar Educational Videos – 1MA209_0e

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Application Note

ROHDE&SCHWARZ

Contents

1 Motivation

Welcome to our short video tutorials on how to test radars using Rohde & Schwarz test equipment. Access to most information about radar tests is pretty restricted, as many radar applications are military or secretive industrial research. To show some basic radar tests we have created radar demo tools, which functions at a frequency of 2.45 GHz, which is in the unlicensed 2.4 GHz Industrial, Scientific and Medical (ISM) band. So tests can be performed in unshielded rooms. The frequencies are also used by radar operating in the ITU "S"-band from 2.3 to 2.5 GHz for air traffic control, weather and marine radar. Based upon various R&S products the new set of videos consists of following five tutorials:

Contents	Playing Time (min:secs)	File
Radar-Basics, short demo using ZVL	6:32	RadarTutorial01_Basics.mp4
Pulse-Generation and /-Evaluation using SMB100A and NRP-Z81	5:33	RadarTutorial02_PulseNRPZ81.mp4
Pulse-Evaluation using FSW-K6	5:22	RadarTutorial03_PulseFSWK6.mp4
RADAR Antenna-Polar-Pattern using SMB100A and NRP-Z81	3:18	RadarTutorial04_PolarPattern.mp4
AESA-demo using SMB100A, OSP and NRP-Z81	6:25	RadarTutorial05_AESA.mp4

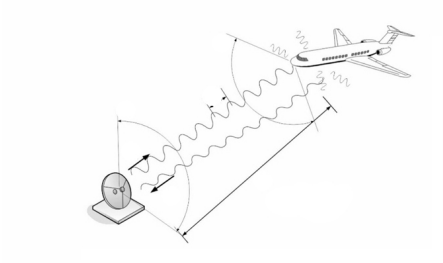
The videos are suitable for 'from-the-scratch' introduction of R&S RADAR test equipment. They can also be used for plain introduction to the RADAR principle.

2 Learning Objectives

The next chapters provide a short summary, an excerpt of still pictures, the playing time and the target group for each of the five videos.

2.1 Radar-Basics, short demo using a vector network analyzer (6:32)*

Using the radar equation this video explains the basic principle of radar.



Learning Objectives:

1. How radar works
2. Simple radar demo using ZVL
3. Why do we need pulses?

*) Playing time in minutes:seconds

Using a R&S® ZVL and a Transmit/Receive (Tx/Rx) antenna pair the radar functionality is demonstrated by moving a reflecting metal plate in front of the antennas, simulating a moving target, eg. an aircraft. A point in the polar diagram can be seen, turning in relation to the movements of the target. Based upon this experiment the radar equation is explained using animated graphics. The radar equation finally describes the amount of power needed to detect small objects in large distances. Using animated graphics the need of pulsed signals is finally explained.

This video is intended as a first-time introduction to radar for everyone who wants to become familiar with this subject on a first approach.

2.2 Pulse-generation & /-evaluation using a signal generator and a power probe (5:33)

Using the Tx/Rx antennas and the reflector some basic tests with pulsed signals are shown using a signal generator and a USB power probe.

Learning Objectives:

1. Simple configuration for radar tests
2. Pulse evaluation using a peak power meter
3. Reduction of noise effects

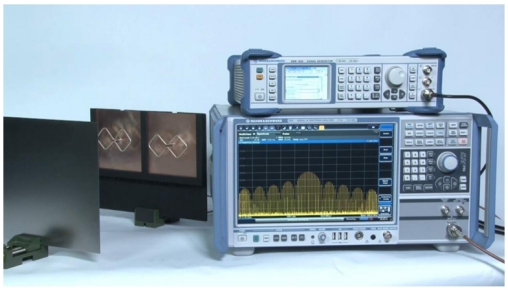
By means of this configuration it is shown how to transmit and to receive pulsed radar signals over the air. The pulse evaluation capabilities of the R&S® NRP-Z81 peak power probe are demonstrated, for instance how to reduce noise effects by averaging. The pulse shapes are varied at the signal generator and can be observed at the PC which is evaluating signals coming from the peak power probe via USB.

This video gives ideas how to perform radar experiments using pulsed signals. It shows the basic equipment needed, and induces ideas how to perform more advanced radar experiments by using more complex pulse shapes and Matlab for data evaluation.

Target groups are students and engineers not familiar with radar test technology and equipment.

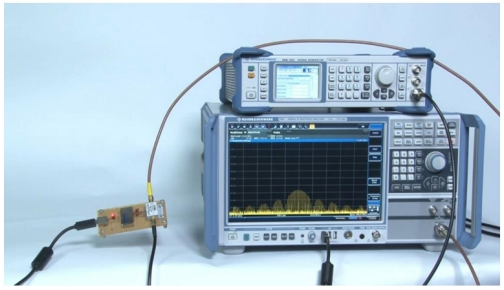
2.3 Pulse-Evaluation using a spectrum analyzer and dedicated pulse analysis (5:22)

By means of a spectrum analyzer advanced pulse evaluations are shown of transmitted radar signals. Additionally an amplifier is tested regarding output spectrum and pulse timing.



Learning Objectives:

1. Pulse evaluation using SAs
2. Basic functions of FSW-K6
3. Pulsed amplifier test

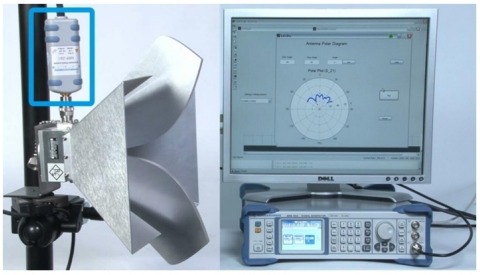


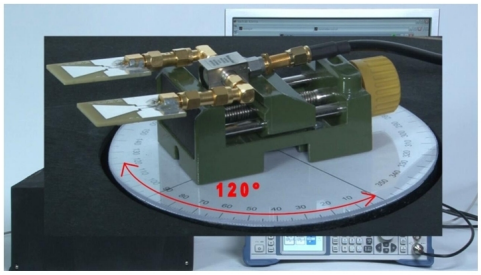
More advanced radar tests using lower signal levels compared to the previous videos are shown. Various pulse evaluation capabilities of the FSW spectrum analyzer's pulse evaluation option R&S® FSW-K6 are demonstrated. Finally a small amplifier is tested with respect to its behaviour on spectrum and pulse evaluation. Various basic pulse shapes are set at the signal generator and its effect on the spectrum analyzer is shown.

This video is suitable for all users who intend to use spectrum analyzers in the radar laboratory. Additionally it is targeting students who would like to learn about the benefits of spectrum analyzers used in a radar test environment.

2.4 Antenna-polar-pattern evaluation using CW generator and power probe (3:18)

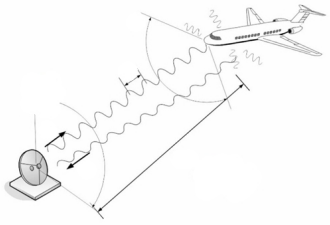
The significance of antenna polar pattern is explained based upon the radar equation. Using a remote controlled turn table device and a high gain receiving antenna the polar pattern aquisition of an experimental X-band antenna is demonstrated.





Learning Objectives:

1. What is antenna gain good for?
2. How to determine polar diagrams?
3. Radar test equipment
4. Test example of a X-Band antenna
5. Matlab's usage for test & control

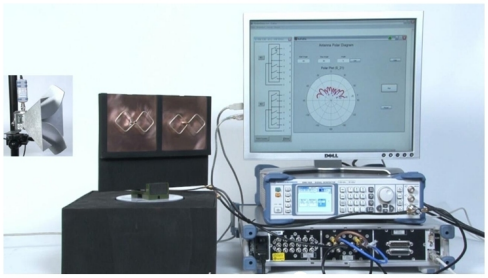


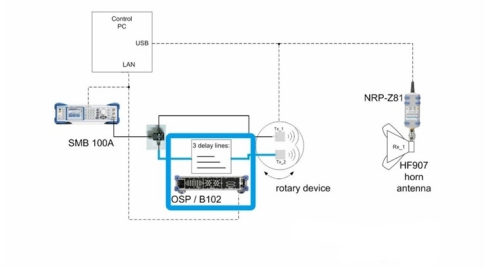
The experiment shows a simple setup to determine the polar diagram of a radar X-band antenna. The antenna to be tested is fed by a 10.5 GHz CW-signal. With a output power of typically more than 20 dBm the R&S® SMB100A signal generator provides sufficient output to perform such short range transmission tests in the laboratory environment. On the other end the NRP-Z81 power sensor directly connected to a fix-positioned high gain horn antenna. Turning the DUT-antenna the received signal power is measured for each stop position of the rotary device using a small Matlab control and evaluation program.

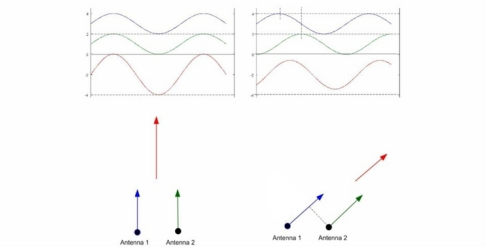
This video is suitable for all who are planning radar antenna test and polar pattern aquisition. This can apply to universities as well as to companies who want to get hints how to setup a basic bench with standard laboratory equipment.

2.5 AESA-demo using generator, power probe and a switch matrix (6:25)

This video addresses the importance of today's digitally controlled beam steering in radar technology. By means of animated graphics the physical principle of beamforming is explained. An experiment based upon measurement equipment demonstrates the effects.







Learning Objectives:

1. Meaning and purpose of AESA
2. Principle of digital beamforming
3. How to use OSP for phase-shifts
4. Verifying beamforming effects

This experiment is performed by using a carrier wave. The NRP Z81 power probe is used. The Signal Generator SMB100A is providing the 2.45 GHz signal, equating the radar S-Band. Using a power splitter two antennas are fed with the same signal. One path is directly connected to one of the two identical antennas. The other path is lead to a set of three phase programmable delay-lines using the switch matrix R&S® OSP. The beamforming effects are demonstrated by changing the delay lines, while taking the polar pattern and comparing the results.

Target groups are engineering students and others who want to learn about the principle of digital beamforming and its application in a possible simple laboratory.

3 Video Location and Usage

3.1 Access via R&S homepage

Goto "www.rohde-schwarz.com/appnote/1ma209" and download the videos along with the Application Note at hand.

3.2 Access via YouTube

Access via YouTube will be available from March 2014.

3.3 How to use the videos on portable devices

Regarding resolution the videos are prepared to be watched on small screens, for instance on iPod or smartphones. This is possible because of the intense zoom approach when showing even small objects.

Following text gives a guideline how to get and playback the videos on an iPod:

** Download the five MP4 files from R&S Intranet to your local PC

** Connect iPod to USB and open "iTunes"-software

** Within iTunes select menue item "Files Add files to Mediathek" (or similar)

** Select the five MP4-files using the file selection window within iTunes and press 'open'

** Either pull the files from the Mediathek-Window to the iPod-Device symbol using ...

... the mouse or start "synchronize iPod with Mediathek"

** Pull off the iPod from USB and play the videos offline

4 Appendix

4.1 References

[1] Naseef, Minihold, Bednorz, 2013, "Testing S-Parameters on Pulsed Radar Power Amplifier Modules", R&S Application Note Nr. 126, available from http://www. rohde-schwarz.com, search topic "1MA126", video available for download

[2] Bues, Minihold, 2012, "Overview of Tests on Radar Systems and Components", R&S Application Note Nr. 127, available from http://www. rohde-schwarz.com, search topic "1MA127"

[3] Minihold, Bues, 2012, "Introduction to Radar System and Component Tests", R&S Application Note Nr. 207, available from http://www. rohde-schwarz.com, search topic "1MA207"

[4] Heuel, 2013, "Radar Waveforms for A&D and Automotive Radar", White Paper, R&S Application Note Nr. 239, available from http://www. rohde-schwarz.com/appnote/1MA239