T 7.5.1 Ultrasonic Radar

Experiment setup for the ultrasonic radar with corner reflector and transponder. Important experiments are the measurements of radar cross sections (RCS) for different reflector types.

Topics

1. Introduction
- Course operation
- Course content
- History
- Theoretical fundamentals
- Technical implementation

2. Experiment Setup
- Equipment for the
- Ultrasonic radar
- Ultrasonic radar
- Radar targets
- First steps
- System control and signal

3. Radar Physics
- Emitted pulses in the time domain
- Echo pulses in the time domain
- Echo representation in the A-Scope
- Measurement of pulse train frequency
- RCS of a quadratic reflector
- RCS of a corner reflector
- RCS of a spherical reflector
- Comparing scatterers
- RCS values
- Verification of the radar equation
- Measuring the average pulse power
- Range resolution
- Visibility
- Stealth
- Artificial disturbers

4. Target Positioning
- Radar displays
- False alarm rate
- Classical radar
- Digital radar
- Sector scanning
- Representing clutter
- Determining range
- Background noise

5. Secondary Radar
- Radar marker
- Radar beacon
- Transponder
- Collision detection
- Interferences in SSR

6. Target Tracking
- The principle of target tracking
- Experiment setup
- Interpretation

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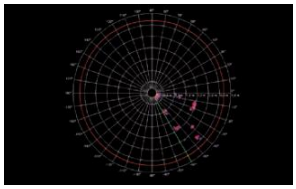
Detecting Targets & Measuring Distances

The sonar base and sonar pulse generator constitute the ground station for a monostatic, ultrasonic pulse radar. In monostatic systems, the transmitter and receiver are combined in one station and make use of the same aerial. The measurement data is transferred to the PC and radar control via wireless Bluetooth technology. The PC takes care of the radar image processing as well, generating the echo representation on the monitor in the well-known form of A-Scope and PPI. There are test sockets available for measurements at the radar duplexer, e.g. for representing echo signals, emitted pulses, echo delay measurements etc. An external CASSY-Interface can be connected to the test sockets.



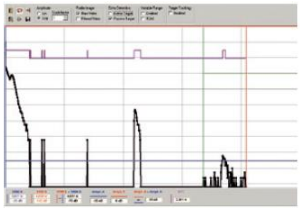
Close-range radar
The ultrasonic radar is a high-resolution surveillance system for close range that allows target objects to be located at a distance of up to approx. 10 m with a precision in the cm-range.

EQUIPMENT LIST T 7.5.1

Ultrasonic Radar

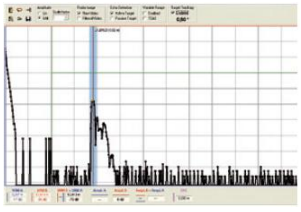
Quantity	Cat. No.	Description
1	737 60	COM3LAB-Course: Radar Technology I
		The 737 60 package content includes:
1		Sonar base rotating panel with Bluetooth data transfer, including power supply, battery charger, cable, accessories and control software, parabolic dish aerial
1		Sonar Pulse Generator, incl. Bluetooth data transfer,
1		Set of Passive Targets
2		Transponder
1		Tripod
1		Plug in Power Supply 230 V AC
1		Universal Recharger
8		NiMH Mignon cell, AA 1.2 V 1800 mA
2		Storage Tray
5		Partition
		Accessories required
1	524 013S	Sensor-CASSY 2 Starter

An actual material list including accessories is available on request.



Radar displays
The analysis and representation of echo signals takes place on the PPI or A-Scope. Active and passive targets are studied (transponder).

- Binary Target Extractor (violet)
- STC (green)
- Distance Marker (red)
- Decision Threshold (blue)



Target tracking
Inside the blue sector, the radar immediately tracks the target movement. Recognized targets are marked.

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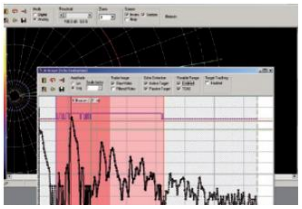
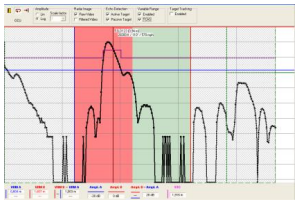
More Experiments

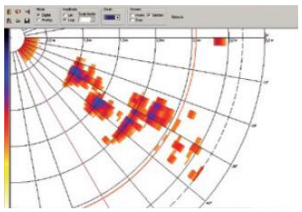
Experiment on false alarm rate
The digital monitor is the most common display unit used for radar systems. It is combined with a computer, which is able to display additional information as well as the familiar target representation in PPI form. From the monitor the radar can be interactively controlled.



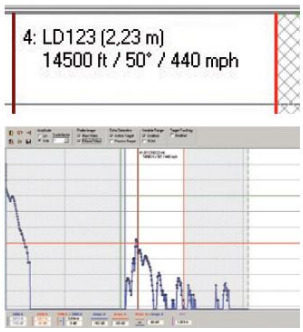
Collision avoidance (TCAS)
After crossing the green warning zone, the opponent target object has just penetrated the red security zone. A warning notice is triggered.



Ambiguities due to lab clutter
In small labs, wall reflections can produce ghost images that show false targets behind the walls.



Experiment on secondary radar (SSR)
For the transponder, target identifications can be entered. In addition, a random data generator can produce flight data that is superimposed on the screen. The transponder also operates as a radar beacon or in IFF mode.



Ultrasonic Radar

	TECHNICAL DATA
Principle	Monostatic ultrasonic pulse sonar
Radar type	Multiprocessor based incoherent radar
Operating frequency	Carrier frequency 40 kHz ADC sampling rate: 20 kHz
Range	> 10 m
Range Resolution	< 1 cm
Radar aerial	Parabolic dish, 400 mm, 29 dB
Aerial resolver	Angular resolution: 0.5°/1°/2° Data transfer: Bluetooth
Transmitter	Pulse power: 120dBSPL
Receiver	Echo resolution: max 500 measuring points Quantisation of echoes 17 bit
Duplexer	PC-controlled
Gate generator	Duty cycle: 1 % Number of carrier oscillations, adjustable: n =1…32
Logarithmic amplification	Dynamic > 100 dB
Display mode / display unit	Radar image processor with binary target extractor Display Unit A-Scope: Logarithmic 0...-100 dB Linear 100% ...0.001% PPI: Classic with decision threshold Digital: color-coded echo amplitude measurement PPI plot with offset representation and echo zoom PPI display: monochrome, color
Primary radar (PR)	Modes of operation: Tracking, scanning (sector scan, full scan) manual positioning
Secondary Radar (SSR)	Transponder with automatic switch-off delay (15 min.) Modes of operation: Radar beacon, friend/foe recognition (IFF) Editable transponder list with flight data simulator for altitude, course, speed Collision avoidance: TCAS with two-zone surveillance Target tracking
Instruments	Binary anti-clutter gain control (STC) with close/far range Discriminator. Fire control radar with optical and acoustic lost/found detector
System Platform	PC, Intel IV
Operating system	Windows XP or higher
Operating voltage	Sonar base: selectable plug-in power supply 230 V / 115 V 50 – 60 Hz
Displays / Analysis	Mobile marker: decision threshold, VRM, STC, distance, differential distance, amplitude, differential amplitude Position indication in m Amplitude indication lin in % or log in dB
Mechanical dimensions	Weight: approx. 5 kg 400 mm x 400 mm x 600 mm
Documentation	Interactive multimedia training software with extensive glossary Languages: german/english/french/spanish

COM3LAB Course
Radar Technology I

Ultrasonic Radar

Kilowatt and Kilovolt
Microwave powers in the kilowatt range are indispensable for commercial applications, but there is no place for them in the classroom. RF sources represent a serious danger for all performers and jeopardize operations. And what happens if the system gets out of control?