ME1500

Radar Principles and Systems Courseware

~Complete Resources for Lecturers~

KEYSIGHT TECHNOLOGIES
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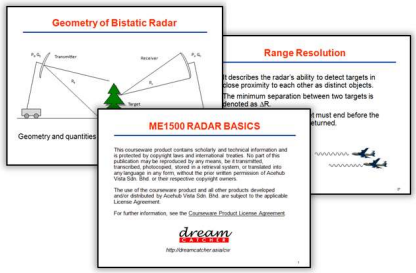
Extending our solutions to meet your needs

Teaching slides

- Editable Microsoft® PowerPoint® slides
- Covers 45 hours of teaching



Training kit

- Radar system hardware kit
- Lab sheets & model answers
- Problem-based assignments
- Covers 24 hours of labs

Target university subject	Target year of study	Prerequisite(s)
Radar System and Design Radar Signal Processing and Analysis	3rd year or final year undergraduate	Electromagnetic Theory Antenna and Propagation

The ME1500 serves as a ready-to-teach package in the area of radar systems and analysis, including CW, Doppler, FMCW, pulsed and imaging radars. This is a lecturer resource consisting of teaching slides, training kits, lab sheets, and problem-based assignments.

Learning Outcomes

Upon completion of this course, students would be able to:

- Explain principles of radar operations
- Distinguish various radar configurations
- Explain and analyze modern radar systems
- Apply signal processing techniques for radar analysis
- Evaluate radar signals using industrial grade test and measurement instruments

Benefits of the ME1500 courseware

- The radar system hardware kit consists of a radar baseband module and a radar transceiver module, allowing students to understand various working principles and techniques used in today's radar systems.
- Students are able to test and analyze radar signals from commonly found configurations, such as CW, Doppler, FMCW and pulsed signals generated by the onboard radar signal generator module.
- User-defined radar signals can also be downloaded to the baseband module for real-time implementation and testing. Alternatively, radar signals can be generated from an Arbitrary Waveform Generator and fed into the IF port of the transceiver module.
- Each lab exercise highlights the basic radar configuration, its working principles, and methods to analyze and interpret the radar received signals.
- Examples of radar system design are included in the teaching slides and assignments, allowing students to further develop and test various types of modern radar systems using the hardware kit.
- Modern electronic design automation tool (SystemVue) is introduced in the lab experiment, enhancing students' understanding in various radar principles and configurations.

Teaching Slides

More than 400 editable Microsoft Power Point teaching slides, covering 45 hours of teaching for one full semester are provided. The slides cover the following topics:

- Radar Basics
- CW and FM Radars
- MTI and Pulsed Doppler Radars
- Tracking Radars
- Imaging Radars
- Radar Cross Section
- Radar Detection
- Clutter Analysis
- Introduction to EDA software(Keysight SystemVue)

Training Kit

The radar system hardware kit is used to demonstrate various working principles and operations of modern radars.

Hardware kit

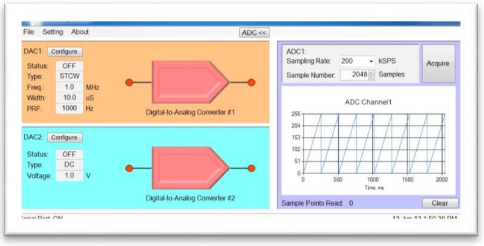
Radar Transceiver Module

The basic setup of the radar transceiver module contains a VCO (voltage controlled oscillator), an up-convert mixer, a power amplifier, and a down-convert mixer to form a super-heterodyne system. A pair of micro-strip patch antennas operating at 5.3 GHz is also included for in-door experiments.

Radar Transceiver Module

Radar Baseband Module

The radar baseband module consists of a FPGA-based high-speed signal generator and data acquisition unit, with built-in 14-bit DAC (125MSPS) and 10-bit ADC (105MSPS).
It can also generate user-defined radar signals from imported waveform file.


Radar Waveform Synthesizer Software

A PC-based software is also provided, allowing user to configure the radar baseband for various operations, such as:

- To generate Short Pulse, Linear FM Pulse, Continuous Waves
- To acquire radar received signal at various sampling rates

Radar Calibration Kit

A 133 ns delay line is provided for internal calibration purposes. In addition, a foldable corner reflector and a rotating metal fan are included as external man-made targets for radar measurements.

Accessories

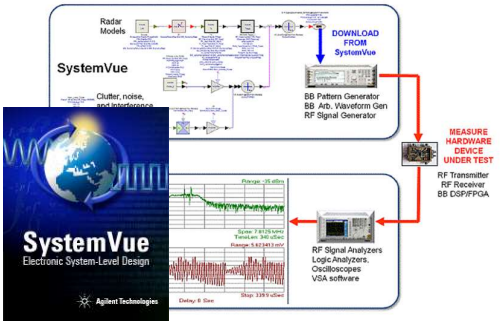
The following accessories are provided with the training kit.

Item	Quantity
Power adapter, 15Vdc, 1 A	1
SMA(m)-to-SMA(m) jumper cable, 0.18 m	6
SMA(m)-to-SMA(m) coaxial cable, 1 m	2
SMA(m)-to-BNC(m) coaxial cable, 1 m	2
BNC(m)-BNC(m) cable, 1 m	1
Delay Line (RG316)	1
50 Ω terminator, SMA(m)	6
BNC T plug to jack adaptor	1
SMA connectors	5
Foldable corner reflector	1
Rotating metal fan	1
JTAG cable, USB cable	1


Delay Lines, Corner Reflectors and Metal Fan

Keysight SystemVue EDA Software for Radar System Simulation

SystemVue is a dedicated electronic design automation (EDA) environment for electronic system-level (ESL) design. It is used in this courseware to perform radar system simulation and radar signal analysis.



Lab sheets

The training kit includes 8 lab sheets in editable Microsoft Word format. Each lab requires 3 hours to complete. Model answers are provided with all lab sheets. The required instruments for the labs are listed below.

Lab Sheet	Required Items[1]		
	Hardware Kit	Spectrum Analyzer & Digital Oscilloscope	Keysight SystemVue
Introduction to Radar Training Kit	√	√	√ [2]
Basic Radar Operations	√	√	√ [2]
CW and Doppler Radar Operations	√	√	√ [2]
FMCW Radar Operations	√	√	√ [2]
Linear Chirp Pulsed Radar Operations	√	√	√ [2]
Radar Cross Section Measurements	√	√	√ [2]
Radar Signal Generation using SystemVue	√	√	√
Radar System Analysis using SystemVue			√
Stepped-Frequency Continuous Wave (SFCW) Radar Operations	√	√	

[1] All labs required the use of Radar System Hardware Kit (Radar Digital Module and Basic Transceiver Module). A personal computer is also required to run the experiments.
[2] SystemVue is needed at the last section of the lab exercise to perform simulation and analysis

Problem-based assignments

The problem-based assignments below allow students to enhance their problem-solving skills.

- Design of a Ground-based Scatterometer System
- FMCW Radar System Design and Simulation using SystemVue

Instruments

The recommended instruments and software from Keysight Technologies, to be purchased separately, are listed below.

Instrument / Software[1]	Model[2]
Spectrum Analyzer	Minimum 6GHz Spectrum Analyzer: - N9342CHandheldSpectrum Analyzer[3],7GHz - or N9322C Basic Spectrum Analyzer[3], 7 GHz
Digital Oscilloscope	Minimum 200 MHz Oscilloscope: DSOX2022A[4]
SystemVue Software	W1461BP SystemVue Comms Architect[5] [6] W1905EP SystemVue Radar Model Library[5] [6]

[1] Refer to the Lab sheets section for the instrument selection.
[2] Other models with equivalent performance may be used with alteration to the lab procedures.
[3] These instruments are also the recommended models for the ME1000, ME1020, ME1200 and ME1400.
[4] These instruments are also the recommended models for the ME1400, ME3000, ME3100 and ME3200.
[5] Recommended PC configurations are: Windows 7 Ultimate SP1, 64-bit, Quad-core CPU, 10 GB free space, 4 GB RAM, LAN (for software security) and internet connection (for software update).
[6]The Keysight EEsof EDA University Support Program provides software for educational purposes at deeply discounted prices. Please go to http://Keysight.com/find/eesof-university or contact your local Keysight EEsof EDA field engineer for details.

Training Kit Hardware Specifications

	Radar Digital Module	Radar Transceiver Module
RF		
Carrier frequency, f_c		5300 MHz
Operating bandwidth		$f_c \pm$ 40 MHz
Transmitter power		0 dBm (typical)
Mixer type		Single ended
Delay lines		133 ns, −30dB
Antenna frequency range		5260 MHz – 5340 MHz
Antenna type		Microstrip
Digital		
FGPA	Altera Cyclone III	
Analog-to-digital converter (ADC)		
Sampling frequency	105 MHz	
Resolution	10-bit	
Number of channel	1	
Digital-to-analog converter (DAC)		
Sampling frequency	125MHz	
Resolution	14-bit	
Number of channel	2	
PC-interface	Serial	
General		
Input voltage	Regulated 5 V DC	Regulated 15 V DC
Input current	0.25 A(typical)	0.25 A(typical)
EMC designed to		CISPR11:1990/EN55011:1991 IEC801-2:1984/EN50082-1:1992 IEC61010-1:1990+A1
Warranty		1 year

Ordering Information

Description	Package	Product Number
Teaching Slides	1 user license	ME1500-100
Training Kit	1 set	ME1500-200
Teaching Slides + Training Kit	1 user license + 1 set	ME1500-300
Instruments	where applicable	Purchase separately from Keysight or its distributor

Note: Pictures in this document are for illustration purposes only, and they may be different from the actual product.