ME1500
Radar Principles and Systems Courseware

dream CATCHER
~Complete Resources for Lecturers~
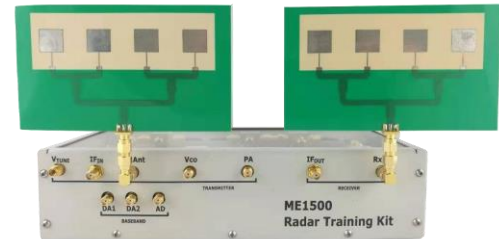
Teaching slides	Training kit
• Editable Microsoft® PowerPoint® slides • Covers 45 hours of teaching	• Radar system hardware kit • Lab sheets & model answers • Problem-based assignments • Covers 24 hours of labs
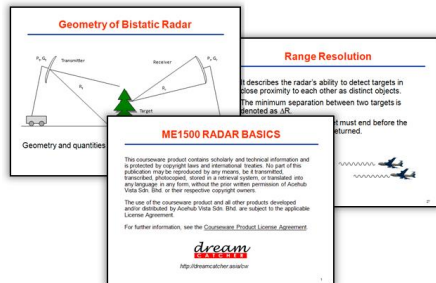
Target university subject	Target year of study	Prerequisite(s)
Radar System and Design Radar Signal Processing and Analysis	3rd year or final year undergraduate	Electromagnetic Theory Antenna and Propagation

The ME1500 is a ready-to-teach package in 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 the 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

➢ Students can test and analyze radar signals from commonly found configurations such as CW, FMCW, pulsed, and SFCW signals generated by the onboard radar signal generator module.

➢ Provides fundamentals through hands-on exercises to understand advanced applications such as car collision avoidance, vehicle counting, object identification, and imaging.

➢ Flexibility for user-defined radar signals to be downloaded to the baseband module or generated from an arbitrary waveform generator for real-time implementation and testing.

➢ The teaching slides and assignments include radar system design examples, allowing students to develop further and test various types of modern radar systems using the hardware kit.

➢ Modern electronic design automation tool (SystemVue) is introduced in the lab experiments to enhance students' understanding and prepare them for designing radar systems.

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Teaching Slides

More than 400 editable Microsoft PowerPoint teaching slides are provided, covering 45 hours of teaching for one semester. 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 demonstrates 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.*

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

User-Defined Baseband
➤ User-defined baseband signal can be fed into the IF port of the transceiver module to create own radar systems.
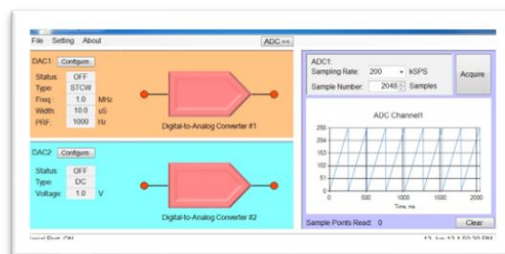
Radar Waveform Synthesizer Software

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

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Keysight SystemVue EDA Software for Radar System Simulation - optional

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.
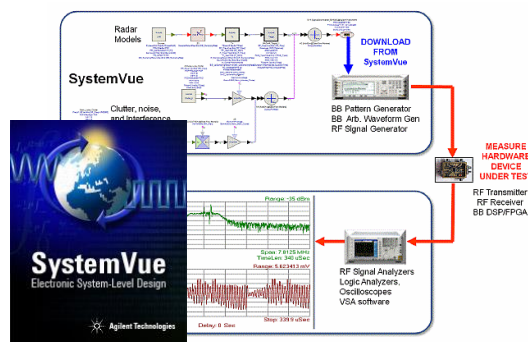
Lab sheets

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 using 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 in 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[3]	Minimum 6GHz Spectrum Analyzer
Digital Oscilloscope[4]	Minimum 200 MHz Oscilloscope
SystemVue Software (optional simulation exercises)	W1461BP SystemVue Comms Architect or equivalent W1905EP SystemVue Radar Model Library or equivalent

[1] Refer to the Lab sheets section for the instrument selection.
[2] Other models with equivalent performance may be used with alterations 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.

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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
IF		
Baseband signal		0.1MHz – 500MHz
Pulse Repetitive Frequency		Max. 2000Hz
Pulse Width		Min. 1uS
IF Power & Input voltage		Max. 50mW & +/- 1.5 Vpp
Digital		
FGPA	Altera Cyclone III	
Analog-to-digital converter (ADC)	10-bit	
Sampling frequency	105 MHz	
Digital-to-analog converter (DAC)	14-bit	
Sampling frequency	125MHz	
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

Note: Pictures in this document are for illustration purposes only and may differ from the actual product.

Training courses related to subject matter are available on request. Visit dreamcatcher.asia for details.

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