3.1.6 RF Systems

Module title: RF Systems

Module summary
Module code: EITM 230I
Module coordinator: Prof. Dr. Serdal Ayhan
Credits (ECTS): 6 CP workload: in lecture 90 h, independent study time 90 h
Semester: 1st or 2nd semester
Pre-requisites with regard to content: RF-Technique, Semiconductors
Pre-requisites according to the examination regulations: none
Competencies: Upon successful completion, • the students know how modern measurement equipment works • the students can estimate the limits of modern RF measurement equipment • the students are able to operate modern RF measurement equipment even under challenging conditions • the students know how RF waves are propagating under terrestrial conditions • the students can design modern communication receivers • the students can estimate benefits and malfits of different receiver design architectures
Assessment: Assessment is done by a written exam including exercises at the measurement equipment (90 minutes) and an oral examination (20 minutes).
Usability: *General:* The module provides an overview over todays RF application and measurement problems. It is definitely not the goal to present a paradise of well-functioning equipment in a world of lucky engineers. Instead, real world problems and real world limits are presented. The students are to overcoming limits towards new RF-shores. That is what it takes to develop new equipment in a competitive world. *Connection with other modules:* The module RF technique in the bachelor course presents the theoretical background within ideal conditions. Noise, fading and intermodulation are effects to be neglected. These subjects are now treated. In addition, students learn how to correctly measure all the effects learned in RF-technique.

Course: RF Systems
Module code: EITM 231I
Lecturer: Prof. Dr. Serdal Ayhan
Contact hours: by arrangement
Semester of delivery: yearly, summer semester
Type/mode: lecture 2h/week; mandatory in the study field Information technology, optional in the other study fields of the program
Language of instruction: English or German; the course language will be announced at the beginning of the semester
Content: • noise - description, reasons, noise figure, calculation of noise figures, simulation of stationary noise

• non-linear small signal theory, 2nd order and 3rd order intercept-point, calculation and simulation of intercept points • principles of receiver design (straight through receiver up to superheterodynamic design, direct conversion receivers) • mixer stages. Ideal and non-ideal behaviour of mixers, intermodulation in mixer stages, noise conversion • propagation of radio waves (atmospheric noise, cosmic noise, ionospheric reflection, multipath and fading effects)
Recommended reading: N.N.: *Spectrum Analysis Basics*, Agilent Application Note 150, August 2006 N.N.: *Making Spectrum Measurements with Rohde & Schwarz Network Analyzers*, Rohde&Schwarz Application Note, January 2012 Christoph Rauscher: *Grundlagen der Spektrumanalyse*, Rohde & Schwarz GmbH, München, 2. Auflage, 2004 Robert A. White: *Spectrum and Network Measurements*, Prentice Hall, Englewood Hills, New Jersey, 1991, ISBN 0-13-826959-0 Ovidiu Stan: *High Power RF Instrumentation Techniques: Design Considerations for High Accuracy*, *High Power RF Instrumentation,* Vdm Verlag Dr. Müller, 2008. ISBN 383647414X Greiner, Günther: *Funktechnik*. Fachverlag Schiele und Schön, Berlin, 1990, ISBN 3-7949-0519-9B Schieck, Burkhard: *Grundlagen der Hochfrequenz-Messtechnik*, Springer-Verlag, 1999, ISBN 3540649301 M. Thumm, W. Wiesbeck, S. Kern: *Hochfrequenz-Messtechnik*, Teubner-Verlag, ISBN 3519163608 Gerdsen, Peter: *Hochfrequenz-Messtechnik*, Teubner-Verlag 351900092X Voges, E.: *Hochfrequenztechnik, Bd. 1.,* Hüthig-Verlag, Heidelberg, 1986, ISBN 3-7785-1269-2 Pietsch, Hans-Joachim: *Kurzwellen-Amateurfunktechnik*, Franzis-Verlag 1979. ISBN 3-7723-6591-4
Comments: -

Course: RF Instrumentation
Module code: EITM 232I
Lecturer: Prof. Dr. Serdal Ayhan
Contact hours: by arrangement
Semester of delivery: yearly, summer semester
Type/mode: lecture and lab 2h/week; mandatory in the study field Information technology, optional in the other study fields of the program
Language of instruction: English or German; the course language will be announced at the beginning of the semester
Content: *Lecture RF-Instrumentation:* • use of oscilloscopes in the field of RF • spectrum analyser (what is inside, how it works and how it is to operate) • RF-signal generators (what is inside, how it works and how it is to operate, especially in terms of phase noise) • network-analyser (what is inside, how it works and how it is to operate, especially in terms of the calibration process) • measurement of noise figures *Laboratory RF-Instrumentation:*

• CAD in the field of RF (simulation of real transfer functions, noise figures and intercept-points) • FM-receiver (single signal characteristic, blocking behaviour, intermodulation behaviour, adjacent channel rejection, image rejection) • network analyzer • mixer stages (Gilbert Cell mixer, Diode Mixer and a new type of mixer, called “Kafemix”, is compared in terms of gain, LO-rejection, intermodulation behaviour) • LC-Oscillator (students have to select an oscillator circuit, compute the oscillation conditions, simulate the oscillation and finally build it up and align it)
Recommended reading: See above
Comments: -