

Monday, 6 June 2011

8:00 AM - 5:20 PM

SC-4A: Low Phase Noise Oscillators: Theory, Design, and Laboratory

Instructor: Jeremy Everard, University of York
Jeffrey Pawlan, Pawlan Communications
Min Xu, University of York

- Topics:**
- Feedback and negative resistance oscillator phase noise theory
 - Optimum operating conditions
 - Flicker noise effects: modeling, measurement and reduction
 - Oscillator tuning and its effect on phase noise
 - Generic design rules for low noise oscillators
 - Oscillator designs: LC, crystal, helical, coplanar, SAW, CRO, DRO
 - Phase noise measurements: phase detector, cross correlation and direct digital measurement
 - Lab class using provided lab kit to perform five experiments
 - non-contact measurement of unloaded Quality Factor, Q_o
 - resonator design for correct Q_i/Q_o
 - simulate and measure the open loop resonator on PCB
 - close oscillator loop, measure phase noise, compare with theory
 - convert to VCO and measure phase noise

This full-day theory and laboratory course was so popular in 2009 and 2010 that it is being offered this year with new material. In the morning the theory, underlying principles, and latest techniques for the design of state-of-the-art low-noise oscillators are presented. Five experiments using a battery-powered kit will apply the morning's theory and techniques in the afternoon laboratory. The number of students is limited, so please register early.

Detailed design discussions will cover oscillators with exceptional performance operating from 10MHz to 10GHz using a variety of different resonators: LC, crystal, SAW, helical, printed-helical, coplanar, ceramic transmission line (CRO), and dielectric (DRO). Material new to this year's course includes simplified accurate phase noise theory for negative resistance oscillators, new demonstrations of other types of oscillators using the laboratory kit including a phase-locked loop (PLL), and a longer description of measurement systems and a cross correlation system with a noise floor below -200dBc. Students will be provided with a copy of the presentation and a disk containing the specific complete software required for simulation of the resonator (including parasitics) and simulation of phase noise. Students will also be provided with a battery-powered lab kit enabling them to design, simulate, build, and measure 100MHz fixed-frequency and tunable-frequency low-noise oscillators. The lab kit includes a low noise regulator, a discrete transistor low residual flicker noise amplifier and a directional coupler to enable accurate measurement of the RF power in the oscillator and a biased potentiometer for the VCO. External connection of the lab kit to a PLL will be demonstrated and the phase noise inside and outside the PLL loop bandwidth will be shown. Students should bring a laptop computer (with a recent Java Runtime installed) to the afternoon lab class to do designs and simulations in class. Students will measure the performance of their designs using the latest equipment from Agilent, Rohde & Schwarz, and Symmetricom. Students of the course will be eligible for a significant discount from Wiley on the purchase of Prof. Everard's book "Fundamentals of RF Circuit Design: with Low Noise Oscillators," on which much of this course is based.

Jeremy K. A. Everard obtained his PhD from the University of Cambridge in 1983 and currently holds the BAE Systems/Royal Academy of Engineering Research Professorship in Low Phase Noise Signal Generation at the University of York. He has been designing low noise oscillators for over 30 years at Marconi Research Laboratories, Philips Research, MA-COM, the Universities of London and York. His group has now developed a number of oscillator designs offering some of the best performance available in the world. For example: 10MHz SC cut crystal oscillators with -123dBc/Hz at 1Hz and -149dBc/Hz at 10Hz and L-band (1.25GHz) DR oscillators with -173dBc/Hz at 10kHz, -180dbc/Hz at 50kHz offset and a noise floor below -186dBc/Hz.

Jeffrey Pawlan, of Pawlan Communications, and Min Xu, a graduate student at the University of York, will assist Prof. Everard with the laboratory portion of the course in the afternoon.