

## SEMINAR

Room 1003 ETB

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### A CMOS Fully Integrated PLL-Based Complex Dielectric Spectroscopy System

by

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**Abstract:** Broadband dielectric spectroscopy (BDS) is the study of the frequency profile of the complex relative permittivity  $\epsilon_r^* \triangleq \epsilon_r' - j\epsilon_r''$  of a material. The use of BDS for biosensing applications at radio and microwave frequencies has been demonstrated, e.g. probing biological samples on the cellular and molecular length scales. BDS is also a valuable technique for industrial applications in material characterization at radio and microwave frequencies, e.g. detection of concentration, bulk density, structure, moisture content, etc. The instruments used in the mentioned biomedical and industrial applications are bulky and expensive, while also requiring a large sample size. The potential system cost and size reduction possible motivates the development of fully integrated BDS systems on CMOS for point-of-care medical diagnosis platforms and for lab-on-chip industrial sensors.

This work presents a self-sustained, fully-integrated PLL-based BDS system. The system utilizes two ring oscillators, one loaded with an on-chip sensing capacitor and the other serving as a reference, for precise permittivity measurement over a broad frequency range. A circuit technique that employs an amplitude locked loop (ALL) is also proposed to enable quantitative detection of *both* real and imaginary permittivity components over 0.7-6 GHz using only a simple digital counter for frequency shift measurements.

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**Osama Elhadidy:** received the B.Sc. and M.Sc. degrees in electrical engineering from Ain Shams University, Cairo, Egypt, in 2004 and 2009, respectively, and is currently working toward the Ph.D. degree in electrical and computer engineering at Texas A&M University, College Station, TX, USA.

From 2005 to 2010, he was a Development Engineer with Mentor Graphics, Cairo, Egypt. In summer 2012, he was a Design Intern with Rambus, Chapel Hill, NC, USA. In summers of 2013 and 2014, he was an Intern with Texas Instruments, Dallas, TX, USA. His research interests include frequency synthesizers and high-speed mixed-signal IC design.