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EECS Seminar Series

Dr. Ronald J. Gutmann

Professor Emeritus Department of Electrical, Computer and Systems Rensselaer Polytechnic Institute

"Smart Power Delivery using Three-Dimensional (3D) IC Technology with Arrays of Monolithic DC-DC Point-of-Load (PoL) Converters"

Friday, March 6, 2009 • 1:30 p.m. • Harris Center (HEC) 101

Wafer-level three-dimensional (3D) integration offers the potential of enhanced performance and increased functionality, combined with the low manufacturing cost inherit from monolithic IC processing. This technology is both an extension of the IC back-end-of-the-line (BEOL) to enhance interconnectivity and a significant enhancement to present-day wafer level packaging (WLP). The presentation address the problem of power delivery in high-performance ICs with a wafer-level 3D technology platform that includes a stratum of a cellular array of completely monolithic DC-DC converters to provide power locally to the signal electronics. This monolithically integrated, power distribution architecture enables a point-of-load (PoL) DC-DC converter capable of fine-grain power control (both spatially and temporally) for future microprocessors, application specific ICs (ASICs) and system-on-chip (SoC) implementations.

The seminar will consist of two parts. First, a review of 3D technology platforms that enable this power delivery architecture is presented, highlighting the advantages and challenges of such implementations. The Rensselaer research on adhesive bonding (using benzocyclobutene or BCB) and metal-adhesive (or hybrid) bonding with copper and BCB is emphasized. Second, the advantages and generic capabilities of the power delivery architecture are presented, with the design and implementation of a prototype converter cell described. A prototype completely-monolithic, two-phase, PoL buck converter cell fabricated with a 180 nm SiGe BiCMOS foundry process is presented, emphasizing the design approach and electrical performance (both static and dynamic). Technologies and designs offering improved power converter performance, specifically conversion efficiency and output current density (output current per unit chip area), are discussed.

Dr. Ronald J. Gutmann

Ronald J. Gutmann received the B.E.E. degree from Rensselaer Polytechnic Institute (RPI) in 1962, the M.E.E. degree from New York University in 1964 and the Ph.D. degree in Electrophysics from RPI in 1970. From 1962 to 1966, he was a Member of the Technical Staff at AT&T Bell Laboratories, where he worked on the development of microwave components and systems for radar applications. From 1966 to 1970, he was at Lockheed Electronics Company, working on beam-steering techniques for phased arrays, and both RPI and Rensselaer Research Corporation, developing novel semiconductor control devices. From 1970 through 2005, Dr. Gutmann was on the faculty at RPI, a Professor in the Electrical, Computer, and Systems Engineering Department with teaching and research activities in semiconductor devices, microwave/RF circuit design and integrated circuit (IC) interconnect technology. He has published 350 refereed papers in journals and international conference digests, presented more than thirty invited talks at professional conferences and is a Fellow of the IEEE for contributions in microwave semiconductor technology. He has coauthored three books on IC interconnect technology and recently co-edited a research book titled "Wafer Level 3D IC Process Technology" (Springer, 2008). His recent research activities have been in three-dimensional (3D) IC platforms (process technology and circuit design), copper interconnect technology, thermophotovoltaic (TPV) devices, silicon carbide (SiC) power devices and characterization of recombination processes using microwave photoconductivity decay (M-PCD).

From 1989 to 1994 he served as Director of the Rensselaer Center for Integrated Electronics, involving 50 faculty with programs in electronic materials, processing techniques, semiconductor devices, characterization techniques and IC design. Dr. Gutmann has served on university advisory boards for SEMATECH and the SRC and has received both the Rensselaer Alumni Association Outstanding Faculty Award (1990) and the Rensselaer William H. Wiley Distinguished Faculty Award (2000). As Professor Emeritus, Dr. Gutmann has continued research in redistribution layer bonding for 3D integration and design of high-performance 3D-enabled power delivery circuits. His present focus includes unique IC designs enabled by 3D integration. He serves as a consultant and expert witness, in areas of semiconductor processing, 3D integration and semiconductor devices. He is on the Board of Directors of the Literacy Council of Upper Pinellas (LCUP), which offers one-on-one adult literacy programs, and an active member of MentorNet.

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