

## Microwave Sensors for Industrial Applications

Microwave sensors find a continuously increasing number of applications for in-line sensing of material properties and industrial process control. The first part of the tutorial will focus on the implementation of the latest two-parameter microwave sensors for the rapid determination of material properties. Two classes of two-parameter sensors will be presented. Main applications are the determination of moisture content and the determination of mass. In the second part of the session multi-parameter sensors will be introduced. With such sensors, dielectric spectra of materials are interrogated over wide frequency ranges at distinct spot frequencies. The most advanced sensors of the latter kind, working either in the frequency domain or in the time domain, and based on ultra-wideband (UWB) bandwidths, will be shown. Special applications will be presented, such as the determination of material composition, history, freshness or the presence of foreign bodies in streams of natural materials. The presentation will explain the fundamentals of sensor operation, the construction of specific sensors and their application in production environments.

### Reinhard H. Knoechel – Biography



Reinhard Knoechel received the Dipl.-Ing. in Electrical Engineering in 1975, and the Dr.-Ing. in 1980 from the Technical University, Braunschweig, Germany. From 1980 to 1986 he was a principal scientist at the Philips Research Laboratory, Hamburg, Germany. In 1986 he joined the Technical University Hamburg-Harburg, where he was a Full Professor in Microwave Electronics until November 1993. Since December 1993 he has held the Chair in Microwave Engineering at the University of Kiel, Kiel, Germany. Presently he is Dean of the Department. His research interests include active and passive microwave components, ultra-wideband technology, microwave measurement techniques, industrial microwave sensors and radar.

Dr. Knoechel is active in the IEEE. He serves on the TPRC of the IEEE Microwave Symposium (IMS), and is the chair of the Technical Committee MTT-16 on Microwave Systems. He was the General Chairman of the “German Microwave Conference 2008”. Dr. Knoechel is a Fellow of the IEEE “for contributions to microwave systems and sensors for industrial process control”. He has published more than 240 papers in reviewed journals and at scientific conferences. He was Guest Editor of the book “Sensors Update”, Vol.7 (Wiley-VCH), and the special issue on ultra-wideband of the IEEE Trans. on Microwave Theory and Techniques, vol. 54, April 2006. He has authored 39 patent families. He is a member of URSI Commission A, and a member of the German Institute of Electrical Engineers VDE-ITG. He was recipient of the VDE best-paper award in 1978, the European Microwave Prize in 1980 and the TSH-Technology Transfer Award in 2003.