# EEI-KOLLOQUIUM

## QFN based Packaging Concepts for Millimeter-Wave Transceivers

**Prof. Dr. Thomas Zwick**
Institute of Technology (KIT), Karlsruhe

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Cauerstr. 9, Tietze-Schenk-Saal, Raum 4.14

**Diskussionsleitung: Prof. Dr.-Ing. R. Weigel**

During the last years the speed and also the level of integration of monolithic microwave integrated circuits (MMICs) increased drastically. Today's circuits are able to operate at frequencies up to the sub-millimeter-wave range (≥ 300 GHz) and combine highly sophisticated systems within one single chip (System on Chip, SoC). These chips have to be encapsulated in packages or modules to make their features available for the clients. Due to the fact that most of those systems require RF interconnections for external antennas or succeeding systems their packages have to fulfill very high requirements at machining and alignment as well as the used packaging materials. For frequencies beyond 100 GHz this normally involves high-quality but expensive and bulky waveguides and machined metal housings. RF modules out of metal offer a very high quality but are very expensive and result in a low level of integration. Due to the huge efforts for the creation of the packages, the price for a module is no longer limited by the inserted MMICs but by the packaging costs. To address a mass market for MMICs operating in the high millimeter-wave range such metal modules are not feasible and have to be replaced by cheaper packaging materials, which, however, come with a couple of additional problems. The plastic packaging materials are quite lossy and the RF interconnection of such a package is limited due to the lead and wire-bond inductances of approximately 1 nH/mm, which prohibit a frequency above 20 GHz.

This presentation introduces the idea of a low-cost fully integrated surface-mountable millimeter-wave radar sensor. Different packaging topologies are compared with the potential of integrating the whole radar frontend together with the antennas into a single QFN (Quad-Flat-No-Lead)package. If no high frequency RF interconnect on/off the package is necessary the standard plastic packages come with another advantage, which is their usability within low-cost Surface Mount Technologies (SMTs). A highly complex system in package (SiP) can be picked and placed and finally soldered automatically onto the surface of a printed circuit board (PCB). This however makes it necessary to integrate the antenna together with the MMIC into a single package. In that case only DC and baseband signals have to be conducted through the package-to-board interconnections and thus the requirements for these interconnections are greatly relaxed. Different options how a fully integrated millimeter-wave system can be realized within a surface mountable package will be presented with measurements and different concepts for a low cost surfacemountable 120GHz radar sensor in a QFN package will be compared.