Elektrotechnisches Kolloquium

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Thema: Design of an Electrical Interferometer at 120 GHz for Contactless Permittivity Characterization

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Abstract:
Permittivity measurement is an important technique to inspect food quality, conducting material tests and research as well as monitoring cell cultivation progress. In many cases, optical observation methods are applied having the need for optical markers and hence contact to the medium under test. The development of an electrical interferometer using a differential approach along with a resonant technique for high sensitivity is presented. The demonstrated approach renders contactless and label-free permittivity characterization of fluids feasible being a potential low cost and compact solution for cell cultivation monitoring. First structures have been fabricated on a printed circuit board (PCB) for experiments around 7 GHz. Investigations in much higher frequency spectrums above 100 GHz with a continuous wave spectrometer indicate that the target method is applicable also at mm- and sub-mm-waves. It is revealed that the phase of a signal propagating through the medium under test is affected by a change in the real part of the sample permittivity which highly depends on cell concentration or the content of alcohol for example. Finally these investigations result in the design of an integrated electrical interferometer working at 120 GHz providing direct digital readout. The key components of the system are a Wilkinson power splitter, a ring-hybrid coupler and slow-wave transmission line phase shifters featuring 256 phase states on a single chip. The demonstrated design was fabricated in IHP’s 130 nm SiGe process providing ft/fmax of 300/500 GHz. Eventually a system concept for automated permittivity monitoring of fluids is proposed.