

WFD (IMS) Friday 08:00 – 17:00 BCEC Room 153AB
Emerging Applications of RF-MEMS
Full-day workshop reviewed by MTT-21, MTT-8, IMS09

Organizer(s):

Pierre Blondy, XLIM - CNRS - Université de Limoges; MTT-21, MTT-8, IMS TPC.
Gabriel Rebeiz, University of California at San Diego; MTT-21, IMS TPC.

RF-MEMS are entering a maturing phase, where several companies are currently developing or proposing components that can be integrated into microwave systems. The workshop will first address the system level applications in an introductory talk, followed by the presentation of the latest results and development of several industrial switches. The technical development of high reliability RF-MEMS switches for microwave applications will be discussed in detail, from several developing companies in the US and Europe. In the afternoon, the workshop will focus on academic development and new and emerging areas in the field. Recent advances in high-Q tunable microwave cavities will be presented, with the latest results from US and Europe.

Speakers:

1. Brandon Pillans, Raytheon
“Defense Applications of RF MEMS Technology”

Radio frequency microelectromechanical systems (RF MEMS) technology offers a low-cost, high-performance switching solution with less than 0.1 dB insertion loss through 40 GHz and practically no power consumption or intermodulation products. These low-loss switches enable very low-loss phase shifter (true time delay) circuits that can be used in phased array antenna applications such as radar systems and comm-on-the-move arrays. This presentation will show the latest packaged RF MEMS phase shifter results at X-band, Ku-band, K-band and Ka-band. Because of these low-loss circuits, substantial costs can be saved by using one T/R function to drive 8 to 16 individual phase shifters instead of the traditional 1:1 approach. In addition, the latest RF MEMS tunable filter results and associated applications will be shown.

2. Julio Costa, RFMD
“RF-MEMS Switch Technology for Radio Front End Applications”

Hand held devices continue to evolve into complex communication platforms. New applications and proliferation of air interface standards require more complex radio front end architectures. It is desirable to simplify the hardware implementation without compromising the performance of the radios. RF-MEMS switches make possible the development of adaptive RF front ends with significantly reduced complexity, size and cost. At the same time the RF performance can be improved. In this presentation we will cover RFMD’s RF-MEMS switch technology for front end applications. The fabrication flow and key MEMS switch parameters will be discussed. After that we will address different possibilities for MEMS switch insertion in the front end architecture and the

related cost/benefit tradeoffs. Finally, we will present examples of adaptive MEMS circuits and compare their performance with existing solutions.

3. Jeroen Bielen, EPCOS Netherlands

“RF-MEMS Design for Reliability in Smart RF Communication Systems”

One promising application area for RF-MEMS capacitive switches is for tunable RF circuits in mobile communication. We will show latest results on how advanced multi-physics modeling using finite element implementations, including large signal fluid-mechanical-electrostatic coupling, is employed to predict 0-hr static and dynamic performance, robustness & sensitivities towards process spread as well as lifetime under realistic stress conditions associated to the specific application. Ultimately, these physics of failure based models are employed as key design tool for topological and geometrical optimization and selecting appropriate materials which has lead to significant reliability improvements. EPCOS' RF-MEMS are now ready to fulfil the user reliability requirements of tunable RF systems for hand held applications of which an example will be discussed.

4. Tauno Vaha Heikkila, VTT Finland

“Reconfigurable RF MEMS Tuning Networks from Handset to Millimeter Wave Applications”

The focus of this presentation is in reconfigurable matching networks and impedance tuners. Reconfigurable matching networks can be applied for several different end applications from handset radios to sub-millimeter wave scientific experiments. Impedance tuners are mostly suitable for measurement systems. Low losses and high linearity are very important properties needed both in impedance tuners and matching networks. From this reason, both matching networks and impedance tuners are some of the most promising application areas of RF MEMS. RF MEMS has both of these properties and the technology can be easily used in wide frequency range.

5. Art Morris, wiSpry

“Tunable RF Modules for Mobile Applications”

Commercial wireless applications continue to diversify leading to an increasingly unwieldy set of RF hardware implementations and design compromises. These limitations increase the size, limit the performance and lengthen the design cycle of every platform. Adding tunability to RF front end elements is a key enabler to reversing this trend and providing a flexible platform for tomorrow's systems. WiSpry is developing a high-performance tunable RF capability based on wafer-level sealed RF-MEMS monolithically integrated with mixed-signal high voltage and RF CMOS. System applications and constraints for high-volume markets will be discussed. Performance and reliability data will be presented for arrays of tunable capacitors and for module-integrated tunable sub-systems.

6. Matthieu Chatras, XLIM - CNRS - Université de Limoges
“Development of High-Q MEMS Tunable Filters”

This paper deals with tunable high Q cavity resonators. Two resonators are presented in this paper, one at 5 GHz and the other at 13GHz. They exhibit a Q0 between 450 and 800 and a tuning range over 10%

7. Dimitrios Peroulis, Purdue University
“Evanescent Cavity-Based Tunable RF MEMS Filters”

Tunable filters are essential components for the next generation reconfigurable wireless communication systems that can operate over multiple standards and frequency bands with smaller size/weight, lower power consumption and lower cost. Current tunable filter technologies are limited by their low Quality Factor (Q). Evanescent mode cavity-based tunable RF MEMS filters have been shown to be a promising technique for making high-Q, high tuning range filters. The success of these filters will have a significant impact on the design of next generation reconfigurable radio front-ends. This workshop presents recent progress with state-of-the-art performances and discusses in detail the techniques of the design and fabrication of RF MEMS based tunable evanescent mode cavity filters.

8. Gabriel Rebeiz, University of California at San Diego
“Development of High-Q Evanescent Mode Tunable Filters and Planar Ceramic Tunable Filters for 1.5-6.0GHz Applications”

This talk summarizes the recent work on high-Q RF MEMS tunable filters at UCSD

9. Raafat Mansour, University of Waterloo
“Realization and Design of High-Q Tunable Filters”

The presentation will address the following: -The Motivation and Challenges of high-Q Tunable Filters -Limitations of Existing 3D MEMS Tunable Filter Designs -Possible Structures for the Realization of High-Q 3D MEMS Tunable Filters -Possible Techniques for Increasing the Q of MEMS CMOS-Based Lumped-Element Tunable Filters