A MEMS Technology Update

Micro Electromechanical Systems (MEMS) represent one of today's most active areas in research and development. This report offers a summary of what type of MEMS components are being developed for high frequency applications, along with news of recent business and technology activities among companies involved with this technology.

Miniature Structures and Machines

Briefly, MEMS is an extension of the photolithographic techniques used in electronic integrated circuits, but with en emphasis on physical construction rather than electrical functions. As we know, many electronic components have their performance determined by physical parameters such as contact resistance, dielectric constant of materials, electrode size and spacing, conductor size and resistance, etc.

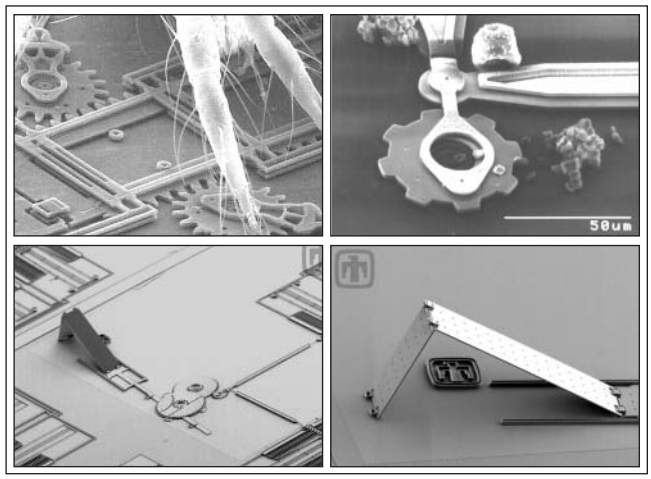
Another physical factor is overall size relative to wavelength, which involves effects such as skin depth, parasitic inductance and capacitance, transmission line behavior and radiation. The adverse effects of these frequency-dependent factors are reduced as the size of components gets smaller.

The majority of current RF/microwave MEMS products include four types of components:

Switches—Compared to a semiconductor switch (FET or PIN diode), an electromechanical switch has far less resistance, resulting in lower loss and less power dissipation. The small mass of MEMS switch actuators require very little operating power, and some designs use electromagnetic latching to remove actuator power after making the switch transition.

Varactors—A MEMS varactor closely resembles a traditional variable capacitor. In a MEMS varactor, the distance between capacitor plates is varied with a control voltage, changing the capacitance. Because air or inert gas is the dielectric, the capacitors can have a very high Q factor.

Inductors—A known limitation of semiconductor-based on-chip spiral inductors is low Q due to lossy substrate materials. A MEMS inductor can be constructed with increased height above the substrate, reducing stray capacitance, and with more air surrounding it, reducing dielectric losses. Research reports indicate that MEMS inductors can have both increased inductance values and greatly improved Q over traditional chip inductors.



The images above demonstrate the scale of MEMS technology. At the upper left, the legs of a spider mite dwarf the gears of a rack-and-pinion drive system. At the upper right, pollen grains and several coagulated red blood cells provide a comparison of size for a gear and its hold-down spring. The lower two photos show a moveable mirror assembly, which changes the position of a mirror using a sliding actuator and a hinged silicon mirror. *Photos courtesy Sandia National Laboratories, SUMMiT™ Technologies, www.mems.sandia.gov*

Resonators—Resonators based on mechanical vibrations using MEMS technology can be used in oscillators and filters, with a physical size much smaller than any current technology. Also, resonators can be integrated onto the same chip as the supporting circuitry for oscillators and switched filters. This is a developing area that will see a lot of attention in the near future because of its potential to dramatically reduce the size of many wireless products.

Summary

The promise of miniaturization using MEMS is seems closer to science fiction than every day use. Yet, the air bag system in your new car probably uses a MEMS accelerometer as the collision sensor. Such high-volume applications will soon appear in RF/microwave products as well.

The following pages provide news of MEMS-related business and technology activity.

From March 2003 *High Frequency Electronics*

MEMS Business News

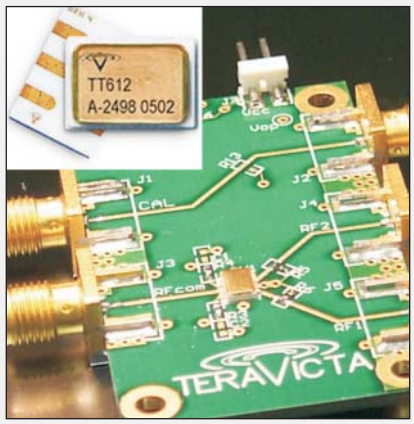
Radant MEMS Inc. has been awarded a contract by the U.S. Defense Advanced Research Projects Agency (DARPA) to participate in the agency's radio frequency micro-electromechanical systems (MEMS) improvement program. The program is aimed at delivering RF MEMS switches and related components for a variety of military and commercial applications. The program is scheduled to run for two and a half years but the duration and value of the contract were not disclosed. The company has selected **Advanced Micro-Sensors Inc.** (AMS) to supply MEMS foundry services in support of the DARPA contract.

Coventor Inc. and **OnStream MST B.V.** are operating in partnership to produce RF MEMS for the wireless and broadband communications marketplace. The partnership leverages Coventor's RF MEMS design expertise and OnStream's high-volume commercial manufacturing capabilities. OnStream expects is beginning volume production of Coventor's RF MEMS switches at this time.

Coventor has established an alliance with **Cadence Design Systems** to offer design tools for developing MEMS products and systems. The companies will offer a tools that integrates Coventor's MEMS-specific design libraries and analysis tools with mixed-signal IC design software from Cadence.

Agilent Technologies, Inc. has announced that its **Agilent Ventures** investment arm has participated in the Series B Preferred Stock funding round for **MEMEX, Inc.**, a privately held company that commercializes MEMS-based solutions for the communications and medical industries. MEMEX is an early-state startup founded in 2000 as a spin-off from **Sandia National Laboratories**.

Discera, Inc. offers MEMS-based micro-resonator technology, and has developed resonator and oscillator demonstration products. Discera is a fabless company that develops licensable designs for miniaturization of hardware for IC, module and system-on-chip integrated components.



Dow-Key Microwave offers MEMS switches from **Teravicta Technologies.** The switches provide low-loss performance of 0.1 dB at 1 GHz, 0.3 dB at 6 GHz, with a frequency response down to 300 kHz. The small size and superior performance of MEMS switches will find applications in communications, test, military and aerospace systems.

According to a new study by German-based consulting firm **WTC** (www.wtc-consult.de), "The RF MEMS Market 2002-2007: Analysis, Forecasts & Technology Review," the market will grow rapidly over the next few years and will reach over 2.8 billion units and a turnover of over US$1 billion in 2007. WTC forecasts that the market will be dominated by the high-volume low-price communications applications, that include mobile telephony, GPS and WLAN, with low volume applications such as military, space and instrumentation sharing the remainder.

Corning IntelliSense Corp., a division of Corning Inc., is working with **Northrop Grumman Corp.** to demonstrate the reliability of radio frequency MEMS switches for defense applications, according to a news release. The joint effort, sponsored by the **Air Force Research Laboratory** and **Defense Advanced Research Projects Agency**, will boost development of MEMS for military and wireless communication applications.

APLAC has introduced a simulation library for MEMS. The library enables concurrent simulation of MEMS and analog and RF circuit components, making it possible to design a MEMS device and its related control and interface circuitry at once. The Library comprises four component block categories (mass-spring systems, electromechanical capacitive transducers, gas dampers, and limiters and electromechanical contacts), including sample devices built from multiple-component block models. All models are implemented as electrical-equivalent circuits so they are valid in any APLAC analysis mode.

Microlab Inc. plans to go to market with its electromagnetic RF MEMS switch early in 2003. Although raising money for investment remains a challenge, the management believes Microlab's

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core technology will attract support. The technology was developed by founder and former CEO Jun Chen. The electromagnetic force opens or closes Microlab's MagLatch switch, and remains latched without consuming additional power. Microlab said that **PHS MEMS** will produce its line of radio frequency (RF) MEMS switches, according to the company's news release.

MEMSCAP and **Dolphin Integration** have announced the launch of MEMSMaster, bundled with SMASH, creating a dedicated front-end solution for behavioral level modeling and simulation of MEMS. The combination is a cost-effective solution, enabling designers to capture and simulate designs quickly, avoiding duplication of work by capturing schematics as layouts. MEMS designs can be exported as a VHDL-AMS model and simulated with IC circuitry. MEMSCAP also offers the MEMS Pro CAD tool suite for MEMS functional design, including a layout editor and SPICE-based simulator, 3D model generation and visualization, mask layout capability and links to finite element analysis packages.

MEMS Events

April 11, 2003 — College Park, MD
MEMS Alliance Special Topics Symposium: Materials and Fabrication Technologies for MEMS and NEMS
Information: Conferences & Visitors Services, University of Maryland
Tel: 301-314-7884
Fax: 301-314-6693
http://www.conferences.umd.edu/MEMS/

June 8-12, 2003 — Boston. MA
Transducers '03 – The 12th International Conference on Solid-State Sensors, Actuators and Microsystems
Program includes short courses on MEMS:
Introduction to the Packaging of MEMS
Introduction to MEMS and Micromachining
Analog Circuit Design for Sensor Interfaces
MEMS for RF/Wireless Communications
Optical MEMS in Communications and Sensing
Biomedical MEMS
Simulation of Micro and Nanosystems
Information: Preferred Meeting Management
Tel: 612-232-9499
Fax: 612-232-0799
E-mail: info@transducers03.org
http://www.transducers03.org/