## BERKELEY SENSOR & ACTUATOR CENTER TECHNOLOGY SEMINAR

## **Dr. Richard Ruby**

Director of Technology, Broadcom

April 3, 2018 | 2:00 PT Banatao Auditorium Sutardja Dai Hall



## **Non-Filter Applications for FBAR Resonators and Devices**

Although FBAR has had large success in filters, both enabling and leading the aggressive mobile phone applications for 4G and 5G LTE, FBAR the resonator could enable other non-filter applications. Dr. Ruby will present two broad areas where FBAR might be useful and perhaps, one day, make a profound contribution.

The first area is low power radios. FBAR-enabled radios can reduce the amount of power relative to more traditional radios by eliminating the phase-locked loop (PLL) and using direct modulation at high frequencies. A niche where this is most useful is the ISM band at 2400 to 2480 MHz. Along with low power radios are the applications of extremely low noise oscillators with jitter measured in the single digit femtoseconds. Beyond radios, there is the possibility of circulators and all-digital phase-locked loop (ADPLL) spread-spectrum clocks.

The second broad area is sensors. Here, the jury is still out. As a mass sensor, temperature sensor, pressure sensor, particle detector, etc., the FBAR is quite attractive. The issue is the FBAR is very sensitive to all environmental variables and the challenge will be to determine the one environmental parameter of interest and ignore all other environmental parameters.

Richard Ruby is an electrical engineer who received his BS, MSEEE, and PhD from UC Berkeley. He started his career at Hewlett-Packard Labs and subsequently transitioned from HP to Agilent Laboratories, then to Avago Technologies (now Broadcom) where he is currently Fellow, Director of Technology, and Manager of the Orthogonal Markets Team. Dr. Ruby has been recognized as the founder of the manufacturable FBAR process and design and has since won numerous awards including the Applied Industrial Physics Award by the American Institute of Physics, the CBSawyer Award by the International Frequency and Control Community, the Hewlett Award, the Barney Oliver Award, the Samuel Silver Award and most recently the Distinguished Alumni Award from the EECS Department of U.C. Berkeley. He is an IEEE Fellow and a Fellow of Broadcom and leads a small team on novel resonators and non-filter applications.

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