The ‘How & Why’ a Deceptively Simple Acoustic Resonator Became the Basis of a Multi-Billion Dollar Industry

Abstract

The ability to achieve ubiquitous connectivity and run powerful ‘apps’ on today’s smart phones requires a front-end radio able to handle tremendous data rates and that requires access to the full bandwidth owned by service providers. Once, the front-end radio consisted of a single power amplifier (PA), a filter/duplexer, a switch and a low noise amplifier (LNA). Early on, a cell phone might be able to access 2 or 3 frequency bands. Today, the iPhone 7 accesses 23 to 24 GSM, CDMA and LTE frequency bands, while the Galaxy flag ship phones from Samsung have 16 bands (not counting the GPS, Wi-Fi, Bluetooth and NFC radios).

Power amplifier, low noise amplifier and switch functions can be combined – important for cost and size—but proliferation of usable bands has driven up the filter count. New bands are being created (opening up more frequency spectrum) and, even more challenging, existing bands are being combined in what is called Carrier Aggregation. This requires better performance from the filter and also drives filters to become smaller as handset manufacturers struggle to add more filters into a limited space. This has created (in just a few years) a whole new billion dollar industry focused on building high quality ultra-miniature filters.

Speaker's Bio

Rich Ruby IEEE Fellow obtained his B.S., MS., and PhD at the University of California, Berkeley in ’77, ’81, ’84 respectively. After his graduate work, he joined HP Labs (later to become Agilent Labs, Avago Technologies, and now Broadcom). In 1993, he started work on Free Standing Bulk Acoustic Wave Resonator devices (FBAR) and has stayed with that technology since. He has made many contributions to the development with innovations centered on the acoustic properties, manufacturability and the packaging of FBAR filters and duplexers. Rich commercialized the first FBAR duplexers HPMD7901 and the 7904 back in 2001 to 2003. The first all-silicon, chip-scale packaged FBAR duplexer was introduced in 2004. He was made Avago Fellow in 2002 and holds that title as well as Director of Technology at Avago/Broadcom. Rich was also awarded Barney Oliver Prize, the Bill Hewlett Award, and the CB Sawyer Award for his work on FBAR technology and was made IEEE Fellow in 2010. Rich was awarded the IAP Prize for 'Industrial Applications of Physics‘ in 2015 Rich has over 80 patents in the area of FBAR devices and has given numerous invited papers. FBAR has since won several industrial awards. Today, Broadcom now ships many Billions of FBAR filters per year.