The past decade delivered an unprecedented and multi-front evolution of television broadcasts and receivers - including stereo audio, HDTV, flat-screen technology using LCD and plasma and television receivers integrated into personal computers.

TV manufacturers depend on tuners to get the best picture quality. With only minor advancements in design over the years, can tuners are the common convention and often considered the only solution. Utilizing numerous external passive components, many of which require manual tuning on the production line, can tuners are not able to provide the quality consumers and manufacturers demand and are physically unacceptable for use in modern applications such as PCTVs, flat screens and mobile TV devices due to size limitations.

In the past, there have been attempts by silicon manufacturers to reduce the number of external components required for a can tuner in order to integrate them into a silicon chip. Unfortunately, performance of the resulting silicon tuners fell short of that of existing can tuners. A major challenge was how to integrate the essential functions previously served by external filters while maintaining or improving the overall tuner performance.

The compulsory use of discrete semiconductors in tuner design prevented integration. Without the ability to assimilate, there was an impenetrable barrier past which cost-saving integration was impractical—if not impossible.
Consistently high price tags and the intricacies of high-quality signal reception continued to hamstring progress. A mere two years ago, lacking the recent advancements in design technology, today’s high performance silicon tuner chip would have been impossible to build.

Today’s products result from several converging factors—advancements in BiCMOS, Silicon Germanium (SiGe), and 0.18-micron process technology, combined with new architectures and innovative design techniques.

**Benefits of Silicon Tuners**

**Size**

As TVs become more versatile and diverse, bulky tuners are growing to be obsolete; size will soon be the determining factor. While can tuners are usually the size of a deck of cards, silicon tuners are smaller than a dime. These miniscule dimensions allow silicon tuners to fit into all forms of television screens. Can tuners, on the other hand, are often so big that many small, flat screen TVs cannot use them. Because silicon tuners are “one-size-fit-all,” manufacturers using silicon tuners do not have to purchase a variety of TV tuners to fit different products.
Can tuner next to Xceive Silicon Tuner

**Sensitivity**

In addition to being small and efficient, silicon TV tuners have an extremely high standard of performance. Silicon tuners are exceptionally sensitive to signals, well beyond the sensitivity of a can tuner. The following graph compares the sensitivity of silicon tuners to that of can tuners.
The green A-74 line represents the Advanced Television Systems Committee’s (ATSC) sensitivity specification for digital television and is the result of a collaboration of broadcasters, consumer electronics manufacturers, semiconductor manufacturers and other ATSC member’s recommendations. Well-performing tuners stay below the agreed target line of -83 dBm. Putting a silicon tuner from Xceive Corporation to the test, the silicon tuner outperformed both can tuner examples.

**Variance**

Due to the nature of semiconductors and design, silicon tuners have a lower degree of variability and tighter tolerances than can tuners, which means when you purchase two silicon TV tuners of the same type, they will have almost the exact same performance. The following graph compares the tolerances of a silicon TV tuner with that of a high end can tuner.
**Fabrication**

Fabrication process selection is essential to building an IC, as it dictates characteristics such as performance, power dissipation and product reliability. Silicon germanium (SiGe) provides improved margins for optimizing noise, gain, linearity and power consumption over standard processes. SiGe creates faster transistors, greater power efficiency, and improves noise characteristics compared with traditional silicon. Given its improved speed and electrical properties, SiGe is expected to gain wider adoption during the next several years.

**Architecture and Design challenges**

A vast majority of RF research and design efforts focus on technologies that use a narrowband tuner, such as cell phone receivers for code-division multiple access (CDMA) and global system for mobile communication (GSM) devices. With narrowband devices, tunable bandwidth range is close to the device’s center of frequency. Unfortunately, architectural approaches for performance enhancement, cost cutting and power reduction used for narrowband, do not migrate readily to broadband systems.

Most receiver designs cover a relatively small frequency range. The tuner in a cellular phone tunes about 500 kHz of bandwidth. A television receiver, by
comparison, must tune about 860 MHz – three orders of magnitude more bandwidth. This increases design challenges more than a normal receiver (see Figure 1). The fact that broadband systems generally run at high data rates further exacerbates the situation because every aspect of the receiver design must meet stringent requirements on distortion, phase noise, and handling of spurious signals.

Figure 1. Broadband vs. Narrowband Tuning

**Design Innovation**

The effective design of a single-chip RF next-generation receiver requires the integration of oscillators, mixers, low-noise amplifiers and other sensitive analog circuits, with substantial high-speed digital logic. Many design challenges must be overcome to ensure performance, yield and power efficiency.

To meet the architectural challenges, and to break the broadband versus narrowband barrier, Xceive Corporation, a developer of the fully integrated multi-standard RF-to-baseband transceiver ICs, created a new family of RF functions comprised of high-performance functional blocks. A systematic, iterative approach was used to overcome each barrier, resulting in Xceive’s
unique high-performance architecture (See Figure 3).

Figure 3. XC3028 Architecture

Xceive’s single-chip RF receivers include:

- Wideband tunable filters
- Image rejection filter
- Programmable channel filter
- Wideband voltage controlled oscillator (VCO)

The blocks required to build the world’s first fully integrated silicon tuner break from the traditional textbook approach to RF signal reception. Focused on dynamic range, the sources of non-linear degradations are identified and compensated for by carefully designed non-linear counteracting sources, which is observed as colliding waves of opposite phases cancel each other out. The validation of such non-linear functional operators requires adequate circuit simulators that perform accurate analyses in the frequency domain. Xceive tuners give users small size AND performance.

Summary

Can tuners, full of discrete components, are close to extinct. TV signals, whether analog or digital, are finding their way into a myriad of consumer electronics – increasing the prevalence of silicon technology. Hand-held portable consumer entertainment devices and high-definition flat screens will
benefit as enabling technologies such as Xceive’s RF single-chip tuners are adopted.

Xceive’s Silicon TV Tuners are considered the best in the industry. Xceive’s products include an active tracking filter technology, as well as, a micro-controller inside to monitor the quality of the signal among other key blocks. By loading the appropriate firmware to the XC2028 and XC3028 devices, Xceive’s silicon tuner is also able to receive different TV standards around the world without changing any external components. Typically, can tuners are regional based which means a different can is needed for each TV standard.

The television industry is evolving rapidly and the demands are becoming increasingly complex. Xceive’s silicon TV tuners are exceeding these challenges and have proven to be the tuners of tomorrow.

About the author

Alvin Wong is the Vice President Marketing for Xceive Corporation. Mr Wong is an accomplished Silicon Valley veteran with more than 16 years of management experience in the Semiconductor industry. Previously at Infineon Technologies, he was responsible for building strategies and running the operations of the Wireless Division in North America. Prior to that he was with Philips Semiconductors and held a number of key leadership roles. He can be reached at wong@xceive.com