The end of region-specific TV designs?

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Consumer electronics manufacturers must develop completely different television receiver product designs for different countries or regions. The standards and technologies for television reception vary considerably so it has been impractical to consider a single flexible design covering multiple standards or regions. However, new technologies are emerging which will make it possible to have a single product design address multiple countries or regions.

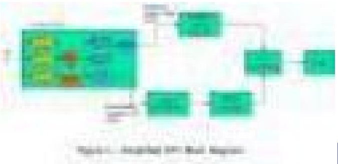

Figure 1: Simplified digital television block diagram (click to enlarge)

Television standards

Different television broadcast technology standards are used in different countries and geographical regions. In the United States, the NTSC standard has defined analog television requirements and more recently the ATSC standard has defined digital broadcast technology. NTSC and ATSC are considerably different from the standards used elsewhere. In most of the rest of the world PAL and SECAM are the two analog standards and they each have several sub-variants used in different countries. There are significant technical differences between NTSC, PAL, and SECAM making it impossible for traditional TV receiver designs to accommodate more than one of them in a given hardware design. DVB-T is the digital television broadcast standard for most of the rest of the world and is considerably different from ATSC. See Table 1 for a summary of the fundamental differences between the major TV standards.

Examining the simplified digital television block diagram in figure 1 we can see why different hardware designs are required. The first block dealing with TV signal reception is the tuner. The tuner must select and amplify the desired television channel from within a very wide spectrum, roughly 50MHz to 800MHz, reject all other channels (some of which may have much higher signal power), down-convert the desired signal to a lower Intermediate Frequency (IF) and perform analog demodulation providing a baseband video output. For digital channels the signal is output as an Intermediate Frequency signal to the digital demodulator. The major blocks inside a tuner are: input filter and amplifier, mixer/oscillator, IF amplifier/filter and demodulator. Television tuners have traditionally been implemented as a module or "can" consisting of 100-200 passive and active components mounted on a small circuit board inside a metal shield enclosure with an RF connector extending from one end for direct connection to an antenna or cable. The front-end filtering and amplification has traditionally been implemented with two or three parallel passive filter/amplifier sections, one of which is selected depending on the frequency of the desired channel. An active mixer down-converts the desired channel to the intermediate frequency, defined by the programmed oscillator frequency. Discrete IF amplifiers and filters further boost the signal and reject unwanted signals and noise, then a combination of SAW filters and a demodulator chip will extract the baseband video and audio from the signal.

The hardware design of the can tuner module defines the television standard compatibility for that particular model. Tuner modules must be designed to address the different channel bandwidths (typically 6, 7, or 8 MHz) in addition to different analog television waveform standards (e.g. NTSC, PAL, SECAM and their variants). The hardware-based inductor-capacitor(LC) or surface acoustic wave (SAW) filters inside a can tuner module are fixed in bandwidth and signal-handling capability making a flexible multi-standard design impossible.

As an alternative to can tuner modules, some TV-related products such as cable set-top boxes and digital video recorders make use of so-called "silicon tuners" instead of the can modules. However, most silicon tuners simply follow the can tuner architecture and are fixed hardware-based designs, not able to address different standards.

More recently, modified silicon tuner architectures have emerged, consisting of classical RF hardware front-end elements combined with modern digital signal processing (DSP) capabilities, offering the flexibility to address multiple standards with a single silicon tuner-based reference design.

The block diagram shown in figure 2 indicates how a "smart tuner" utilizes DSP to perform digital filtering and in analog mode, the actual demodulation function. After the RF signal is down-converted by the RF mixer, an analog-to-digital converter digitizes the signal and presents it to an optimized low-power digital signal processor. After digital filtering or demodulation the signal is passed to digital-to-analog converters. This allows the tuner to be completely flexible and can handle almost any worldwide digital or analog TV standard.

Ultimately, this trend may lead to true Software Defined Radio architectures (also known as Cognitive Radio), but for now the architecture shown is the optimum blend of classical RF front-end architecture with "smart tuner” DSP capabilities providing the performance of hardware-based designs with the flexibility of "software defined” filtering and demodulation.

In addition to the tuner, for analog systems, TV SOC vendors must also accommodate the varying baseband video standards in their analog video decoding sections. Again, modern digital IC process technologies make it feasible to integrate multi-format capabilities into these blocks.

TV sets designed for use in digital television systems such as the ATSC system in North America or the DVB-T system used in Europe must also include a digital demodulator following the tuner as shown in the TV block diagram. Just as in the case of the "can” tuner modules, most digital demodulator implementations are defined by hardware and are inflexible for addressing multiple regional standards.

However, digital demodulator designs are becoming more advanced, and shrinking process geometries enable integration of more and more digital functions on a single chip. Thus, some companies are able to provide flexible digital demodulator designs capable of addressing both the 8-level vestigial sideband (8-VSB) signal for North America as well as the Coded Orthogonal Frequency Division Multiplex (CODFDM) waveform of DVB-T. The ability to combine these technologies on a single chip will be particularly important in China where the new digital television standard includes both types of waveform. This trend will continue and in the near future TV system-on-chip designs will be completely universal in terms of the television system standard with which they are compatible.

Digital television systems have almost all adopted the MPEG-2 digital video coding standard. Thus, for digital television designs, the major blocks following the demodulator (MPEG decoder, video/audio processor, scaler) can be common among designs for different regions.

Totally flexible multi-standard complete television receiver hardware platforms are not readily available today, but they are coming soon. However, multi-standard tuner solutions are readily available today in the form of advanced "smart tuner" monolithic RF ICs combining high performance RF sections with powerful DSP capabilities.

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