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**GLOBAL MOBILE TV STANDARD MAKES IT POSSIBLE
TO TUNE IN DIGITAL TV SIGNALS ON THE MOVE**

**By Mike Womac, Staff IC Designer, Microtune®, Inc .
June, 2005**



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Thanks to the DVB-H standard and some clever engineering on the part of tuner and demodulator manufacturers, handset designers can enable their new designs to receive reliable, high-quality broadcast TV signals.

By: Mike Womac, Staff IC Designer, Microtune[®], Inc.

Multimedia capability in mobile handsets has grown to include data, audio, video, and now real-time, digital television programming. Currently, there are three approaches to delivering a TV signal to a handheld device (Figure 1): TV over cellular, TV over satellite, and TV over broadcast. Of these, the latter holds the greatest promise for delivering high-performance, low-power, real-time digital broadcast television to mobile handsets.

Figure 1. Techniques for Delivering TV to Mobile Handsets

TV OVER CELLULAR	Example: MobiTV Low-quality, low frame rate, 'stop and go' motion
TV OVER SATELLITE	Standard: S-DMB Improved quality but depends on line-of-sight transmission
TV OVER BROADCAST	<ul style="list-style-type: none">♦ Open Standard: DVB-H♦ High-quality, full-motion real-time broadcast♦ Superset of DVB-T digital standard♦ Supported by handset manufacturers (Nokia, Motorola, Samsung); IC suppliers (Microtune, DiBcom, Freescale, Philips, TI) and operators (Cingular, Crown Castle, France Telecom, O2, T-Mobile, T-Systems)

TV over cellular is the technology choice for MobiTV[®] (Sprint, Cingular, Midwest Wireless, and Verizon International) and Verizon's V-Cast in the U.S. However, this approach is limited by low resolution and low-frame rates, which result in jerky, 'stop-and-go' motion. Even more importantly, high-quality TV requires around 10 times the data rate compared with voice service. So if many users were to use TV services simultaneously, the cellular network could easily run short of capacity causing dropped calls or "network busy" error messages to occur. This means that, ultimately, cellular networks will not be able to provide a range of TV services to each user. Furthermore, TV services typically carry a monthly subscription fee of about \$10 while fees for voice services are often several times larger. TV services offered over cellular are a good way for mobile operators to generate an incremental revenue stream as long as the services do not

become too popular. In that case, the operators' higher-value, core voice business could become at risk.

TV over satellite has been implemented in trials and early rollouts in Korea. Based on the Satellite Digital Multimedia Broadcasting (S-DMB) standard, this approach offers improved video quality and avoids increased congestion on the cellular network, but is fundamentally hampered because it requires a direct line-of-sight to the satellite. As a result, users of this technology cannot receive TV signals when obstructions such as bridges come between themselves and the satellite. Even receiving the signal within a building is problematic. To supplement the satellite's signal, a network of terrestrial repeaters can be used to improve coverage, but, in that case, it may be more economical to deploy a broadcast TV network.

TV over broadcast, based on the open Digital Video Broadcasting-Handheld (DVB-H) standard is just such a broadcast TV network and allows for high-quality, real-time, full-motion TV. It offers greatly improved quality as compared to TV services over cellular networks, and it does not impact network capacity for voice services.

DVB-H: Method for Broadcasting TV to Mobile Handsets



Digital Video Broadcasting-Television (DVB-T), the open industry standard for digital broadcasting in Europe and other global markets, was published in 1997. While it was not intended for use in battery-powered devices, experience revealed its promise for use in mobile reception.

As a result, the DVB Project drafted and ratified the DVB-Handheld (DVB-H) standard, a superset of the DVB-T standard, in April 2004. DVB-H addresses high-speed, high data-rate reception of IP-based services for handheld devices, which have unique power, screen size, coverage and reliability requirements. The standard also introduces a number of features and modifications, among them time-slicing and forward error correction techniques, to enable TV reception in mobile, handheld devices.

In November 2004, DVB-H was adopted as a European Telecommunications Standards Institute (ETSI) standard. Since then, it has attracted significant worldwide interest and has led to heightened industry activity, including product and service development, launches, and field trials.

Tuner Technical Issues

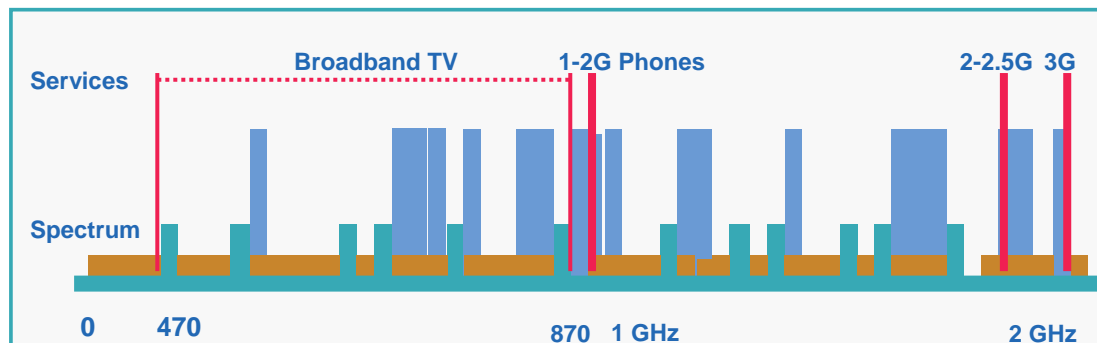
Designers adding high-quality broadcast TV capability to handheld devices need to overcome technical challenges, many of which are related to the tuner. The key RF technical challenges of a tuner when receiving broadcast digital TV signals in a handheld, battery-powered device include frequency response, interference, power, and maintaining low cost.

Frequency Response

A cellular receiver has to process only a very narrow range of frequencies. For instance, a typical GSM receiver only needs to cover 25 or 30 MHz. In contrast, the first DVB-H tuners will need to tune across the UHF band IV-V frequencies 470-to-890 MHz range with 6-, 7-, or 8-MHz channel separation in Europe/Asia and/or the L-band 5MHz channel 1670-to-1675 MHz range in North America (Figure 2).

Figure 2. DVB-H Cell Phones Bring Broadband TV into a Narrowband System

DVB-H tuners must tune over a wider frequency range, as illustrated below by the European UHF band. The tuner must retain high-signal integrity, while preserving battery life.



Such a broad frequency response affects two major sections of the receiver design: frequency generation, or, more specifically, the phase-locked loop (PLL) synthesizer, and the amplification blocks. The main issue for the PLL synthesizer is the fundamental ability to generate the different frequencies while maintaining the small form factor and low-power consumption required for portable devices. Another major concern is meeting lock time requirements—how long it takes to acquire the frequency. For the amplification blocks, the major design concern is susceptibility to a broader range of interfering signals, which can easily result in distortion.

Interference

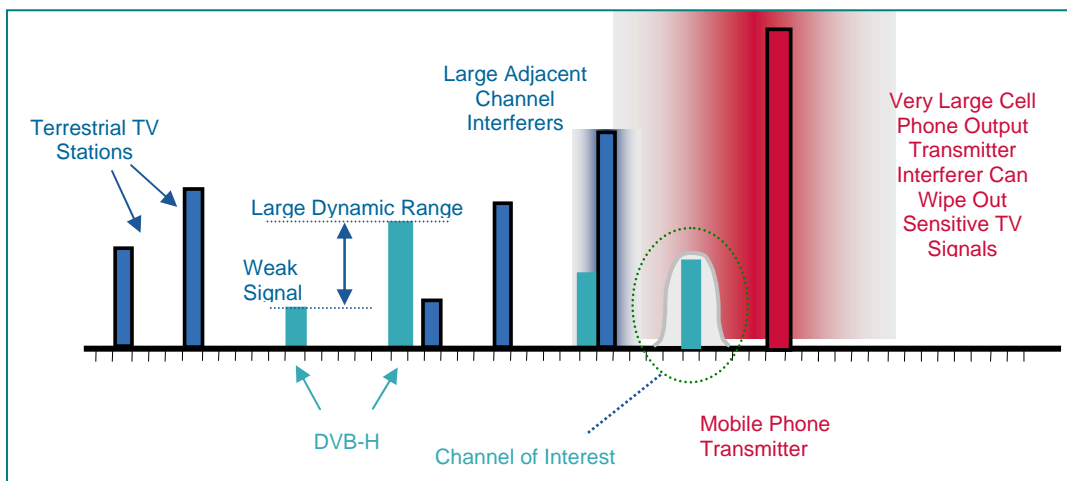
Cellular phone receivers operate in narrow frequency bands, typically 25 to 35 MHz. To reduce interference in these systems, designers can put a filter in front of the receiver and effectively eliminate potential interferers across a broad spectrum. In contrast, a TV receiver has a wide band. As a result, it is not possible to use a single fixed filter and reject the interferers. In

stationary TV sets, this was overcome with specialized filtering techniques and/or increasing linearity significantly, and the resulting tuner consumed >1W of power.

For the DVB-H standard, the tuner must select either a single 5-, 6-, 7-, or 8-MHz channel out of the entire band of channels (example: countries using an 8-MHz channel separation will have a total of 48 channels present in the pass band of the tuner for UHF band IV-V). The rest of the frequency spectrum in the UHF band IV-V will be made up of an unknown combination of analog (ex. PAL), and/or DVB-T television signals at potentially large amplitudes relative to the desired DVB-H signal.

All of these other television signals are seen as interfering signals in the receiver (Figure 3.). Depending on where the cellular subscriber is, the receive system will need to adjust and be able to pick up the

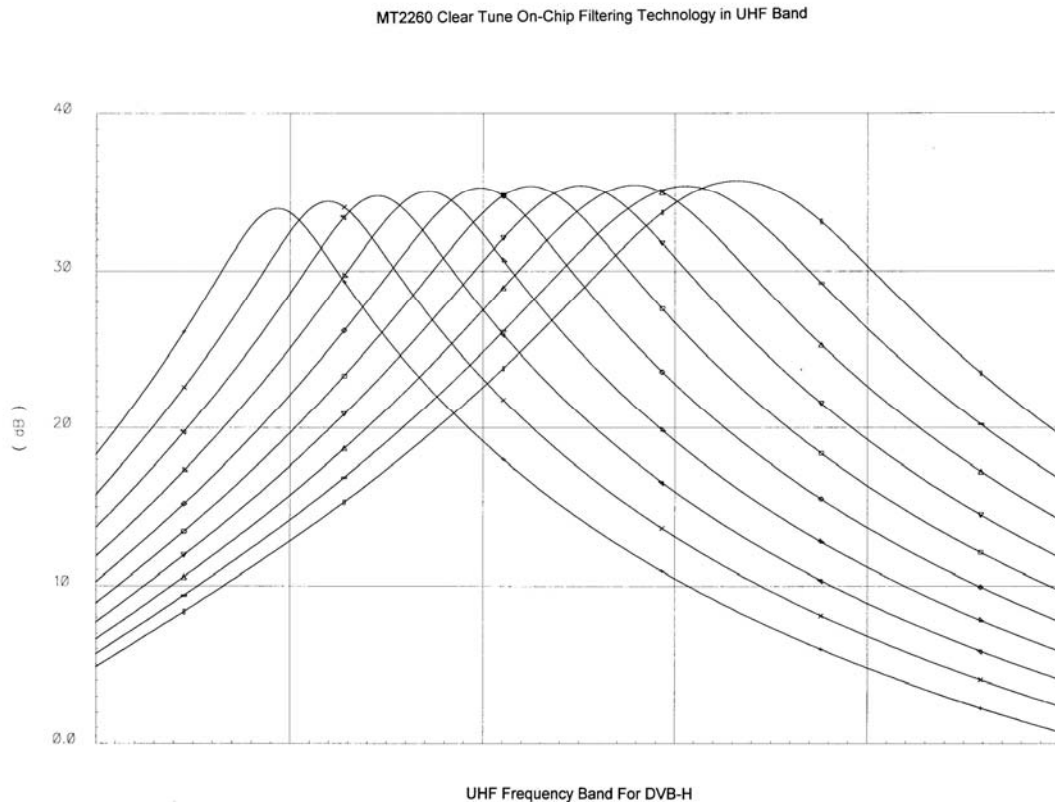
Figure 3: Multiple Interferers, Including the Cell Phone Power Amp, Impact Mobile TV Performance



maximum signal level, which could be -25 dBm or maybe even higher, as well as picking the minimum signal level right out of the noise floor, then amplifying it, and passing it through the system in the presence of many other distorting signals that could be much stronger than the desired minimum signal level signal. The relative undesired signal power to the desired signal power ratio can be >45 dB and as much as 56 dB for certain conditions. This means that the receiver needs to be able to amplify the desired signal in the presence of an interfering signal that is >45 dB higher.

To meet this challenge, tuner designers have had to develop some new techniques. At Microtune, Inc., the company calls its process ClearTune™ technology, which was developed out of the company's expertise in cable set-top box, traditional TV, and automotive TV systems.(Figure 4.)

Figure 4: Microtune ClearTune Technology



Microtune's patent-pending ClearTune Technology provides significant immunity to interfering signals. This technology will provide immunity to in-band interfering signals within the UHF bands IV-V and add to the rejection of any external filtering that may be developed for the input of the chip to be placed on the printed circuit board. It is noteworthy to mention that this technology will significantly reduce the impact of the cell phone GSM 900-MHz power amplifier signal that generates a blocking signal inside the phone that will be a major interferer for the tuner. This technology will not add any benefit for close-in interfering signals but for far-away interfering signals (i.e. >50-MHz), an aspect that is overlooked in the industry. This technology will show its benefit in real-world applications where the spectrum is not controlled as in laboratory settings. The phones that have that have Microtune's ClearTune technology will perform better in the customer's environment.

Power

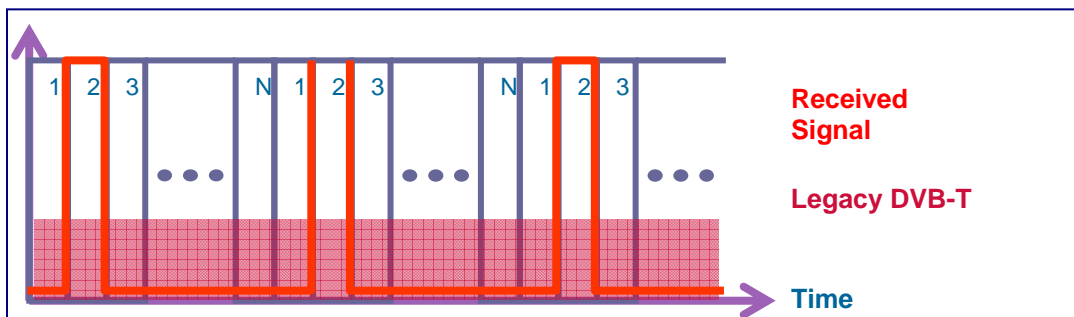
While $>1W$ of power in a tuner is considered low for a stationary TV, it is not low enough for use in a handset. The challenge, then, is to handle the interferers of broadcast TV by using a limited amount of power. The DVB-H standard begins to address this challenge with its "time-slicing" technique. When this technique is combined with careful block-by-block optimization, it is possible to achieve adequate linearity without sacrificing the power budget.

DVB-H Takes on Power

In order to support a range of TV content without severely draining the battery or impacting the ability to receive cellular calls, DVB-H uses a technique called "time slicing," which allows up to 10 hours of TV viewing on a single battery charge. With time slicing, each TV program is broadcast at a different point in time, so, when a user selects a program, the handset only receives that TV signal and can power down in between transmissions of that channel's content.

With time slicing, the terrestrial transmitter is always on, sending different programs that are staggered in time. First it broadcasts program #1, then #2, then #3, up until n programs, then the cycle repeats. The receiver knows when its program is being transmitted and is only turned on when the desired program is being sent. By doing this, the receiver can be powered down for the majority of the time (Figure 5).

Figure 5. Time slicing enables low-power operation and the transmission of multiple channels



For example, the standard channel bandwidth in a European DVB-H system is 8 MHz, and the expected modulation type is 16-QAM. This bandwidth and modulation scheme results in about a 30 Mbits/s raw data rate. After accounting for Reed Solomon encoding, interleaving, forward error correction, and so on, the remaining data "payload" is left approximately 10 Mbits/s. (In the US,

the 1670-to-1675 MHz system has a 5-MHz channel width, so the result would be approximately 6 Mbits/s.)

Keep in mind that a handheld screen measures approximately 2 to 4 in. (5 to 10 cm) and features quarter VGA (320 x 240) resolution. This means that it requires approximately 320 kbits/s to receive good quality audio/video. Therefore, with time slicing, it is possible to get up to 27 programs multiplexed (multiple programs staggered in time) with the tuner selecting only the desired program, turning on only when needed, and resulting in a savings of up to 90% of the power consumption. A system with a 5-MHz channel width, then, could accommodate about 15 multiplexed programs.

While the time-slicing technique reduces power consumption, it does not directly solve the problems of interference, both from other transmissions in the bandwidth or from the nearby cellular power amplifier (PA). Time slicing, however, does make it possible for tuner manufacturers to develop a device that addresses these interferers, meets the Mobile and Portable DVB-T/H Radio Access Interface Specification (MBRAI) DVB specification, and works within the power budget.

DVB-H Takes on Interference

In addition to time slicing, the use of coded orthogonal frequency division multiplexing modulation (COFDM) in DVB-H is of great importance. COFDM uses subcarriers which are responsible for transmitting small amounts of information. So, if one carrier is lost or destroyed during transmission due to some type of interferer, then only a small amount of the signal payload is lost. The more subcarriers used, the greater the immunity to interference.

In traditional COFDM, designers could select from 2000 or 8000 subcarriers. With the DVB-H standard, system designers can now select 2000, 4000, or 8000 subcarriers. Using 8000 carriers offers greater resistance to interference, but with the 2000 carriers, there is greater protection from Doppler shift because the frequency spacing between the subcarriers is larger. Doppler shift is crucial for mobile TV signals, because subscribers will want to receive signals while they are in fast moving vehicles. So, DVB-H has to be functional at autobahn speeds of 100 to 120 mph or perhaps even higher. As a result, early designers of the DVB-H standard proposed 4000 carriers as a compromise between the two original COFDM scenarios.

Designers of DVB-H systems, then, have a lot of choice and flexibility. They can select which level of COFDM subcarrier they want to use. And, they can select from several different code rates, guard intervals, and modulation types (including QPSK, 16QAM and 64QAM).

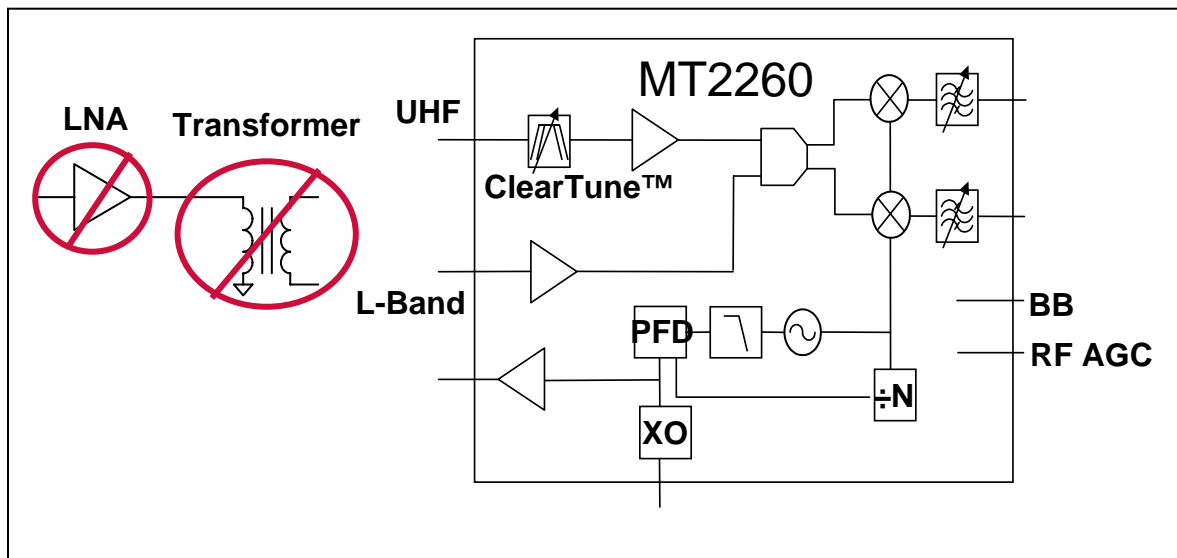
Cost

For mobile TV functionality in portable devices, cost is essentially a bill of materials issue. By selecting a highly integrated solution, handset designers can save on cost, footprint, and reduce the number of required external components.

Most current tuner offerings for DVB-H include a discrete design which uses an external low noise amplifier (LNA) and transformer balun. Microtune recently introduced a single-chip integrated silicon tuner, the MT2260, that requires neither and can be used to receive broadcast DVB-H TV signals in either the 470-to-890 MHz range in Europe and Asia or 1670-to-1675 MHz range in North America (Figure 6.).

Figure 6. Microtune MT2260 Multiband DVB-H Tuner

Highly integrated, patent pending architecture eliminates need for external LNA and transformer balun that add size, cost, and power consumption



Interface to Demodulator

When selecting a tuner, it is important to consider complete bill of materials (BOM) costs, footprint, and flexibility in handling the two frequency ranges currently in use for DVB-H. In addition, it is important to select a tuner and demodulator that can interface with each other. For instance, some key questions include: Can the tuner provide the intermediate frequency (IF) that the demodulator requires? Can the designer direct couple or AC couple? How is the automatic gain control (AGC) circuitry functioning between the demodulator and tuner?

By selecting a direct-conversion architecture, it is possible to simplify the receiver design by eliminating the need for external filtering. In a direct-conversion scenario, the tuner converts the desired channel down to 0 Hz and passes it directly to the demodulator. This allows for a streamlined demodulator design that does not need on-chip frequency down conversion and only needs to handle low sampling frequencies (for low power consumption).

TV on Mobile Phones: Emerging DVB-H Marketplace

Participants in the DVB-H standards development process continue to work together to ensure interoperability of their devices and to promote new services using this open global standard. Successful launch and uptake of DVB-H requires mobile phones with DVB-H functionality, available programming content, content aggregators, and cellular operators that support the service. As progress continues on the technological and product front, there is a growing need for content providers and companies that can supply the infrastructure and engineering services required to deliver the content to the cellular handset. Many of the major broadcasting companies are working to develop content, and infrastructure and engineering service companies in Europe, Asia, and North America are already heavily immersed in the technology.

In the meantime, designers looking to integrate broadcast TV into their mobile designs already have tuners available to them that were specifically optimized to satisfy the DVB-H standard and the unique concerns of mobile TV.

Author Bio

Michael Womac is veteran of the United States Navy with 6 years of active duty and 3 years in active reserves, serving from 1984 through 1993. He then attended the University of Tennessee at Knoxville for his Bachelor and Master's Degree in Electrical Engineering in 1995 and 1996 respectively. He was first employed at Bell Laboratories at Lucent Technology in Reading, Pennsylvania from 1996 through 1999 where he designed Low Noise Amplifiers for a tri-band cellular transceiver IC. Since 1999, he has been at Microtune, Inc. in Plano, Texas where he has designed VCOs, up-converter transmitter signal paths, and direct conversion chip architecture definition as well as circuit design for the receive signal path.

For further reference:

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