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TV Quality on Mobile Handsets that Meets or Beats Consumer Expectations

Phil Spruce, Handheld Marketing Manager, Microtune, Inc.

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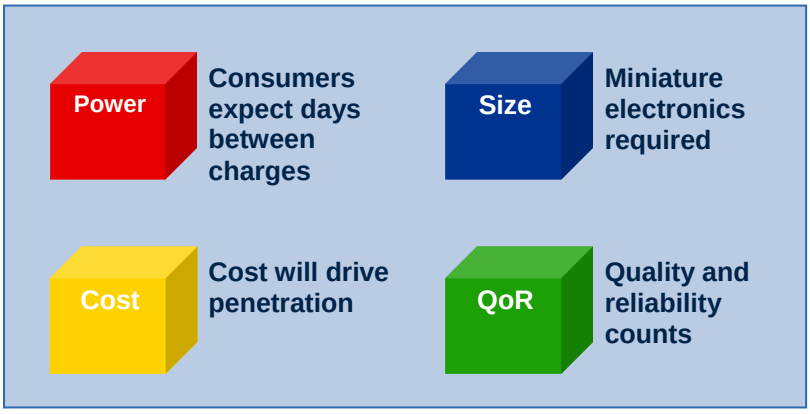
Mobile TV is hot, and consumers are growing more interested as vendors begin to advertise and promote mobile phones with TV capability. For manufacturers, however, considerable technical issues need to be taken into account when adding mobile TV capability to handsets and portable devices. For example, it is imperative to have a constant picture and audio, regardless of environmental interference factors, and the TV receiver must operate at low power. The digital video broadcast-handheld (DVB-H) standard has made an effort to address the issues of low signal levels, interference and power, but still more issues remain. For instance, in order to meet consumer expectations for mobile TV, the service must offer high reliability and quality, and meet the cost expectations of the market.

Design Selection Checklist

There are four key design criteria for a successful mobile TV platform:

1. Power consumption
2. Size of the complete solution
3. Quality of reception (QoR): ensuring that mobile TV always has a picture and sound
4. Cost

Building Blocks for a Successful DVB-H Device



Performance

The issue facing handset manufacturers is that there is no one standard that specifies the necessary performance for mobile TV in the real world. For instance, The Mobile and Portable DVB-T Radio Access Interface Specification (MBRAI) for DVB-H addresses how mobile TV reception will work, but does little more than specify conditions for laboratory testing.

The MBRAI specification covers general radio performance, but does not address performance issues in the real world. For instance, for quality mobile TV reception, the tuner needs at least 20-dB additional rejection at higher frequencies to reject a mobile phone's own GSM carrier. This performance issue is not adequately addressed by any standard. MBRAI simply restricts the number of higher frequency channels that can be used. It is up to the tuner manufacturers to identify and solve these technical issues, and it is up to the handset vendors to ensure that they select the tuner with the right level of quality to ensure a successful mobile TV application.

So, what does all of this mean for the technical parameters of the tuner and demodulator that are the heart of the mobile TV functionality? And, how do you select the technology that will make or break the mobile TV application?

POWER AND INTERFERENCE

In the early stages of mobile TV development, the key technical concerns were interference and power. In response, the industry worked to develop the DVB-H standard to address these first hurdles. Based on the pervasive Digital Video Broadcasting-Television (DVB-T) open industry standard for digital broadcasting, DVB-H uses time slicing, modulation techniques and error correction to overcome issues of power and interference[1].

Enabling up to 5 hours of TV viewing on a single battery charge, time slicing allows the handset to support a range of TV content without severely draining the battery or impacting the ability to receive cellular calls. 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. In the end, the mobile handset will have three modes of operation: communications, TV, and standby. All will drain the battery to some degree, so, all need to be optimized for low power. Current industry estimates expect consumers to use their portable devices for 2 to 4 hours of talk, 2 to 4 hours of TV viewing, and a few days of standby time on a single charge. In the end, the biggest drain on the power budget for mobile TV is now the backlight on the screen, which can consume between 200 and 300 mWatts.

In addition to time slicing, the DVB-H standard specifies the use of coded orthogonal frequency division multiplexing modulation (COFDM). COFDM uses sub carriers 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. Error correction specified in MBRAI will enable the lost data to be recovered. However, if the received signal is very small or the local interferes are very large, then many of the carriers

[1] For more on the power of DVB-H, see Womac, Mike. "Delivering low-power, real-time digital broadcast TV signals to mobile handsets," *RF Design*, July 1, 2005. http://rfdesign.com/mag/507RFDF3.pdf

can be lost. In this instance the error correction will not be able to reconstruct the lost data. A high-performance tuner will greatly improve the chances that a transmitted signal will be decoded by the receiver, but at the expense of slightly higher tuner power. It is left to individual vendors to choose a receiver that will function in a challenging operating environment that is crowded with interferers. The quality level of the tuner and demodulator has a direct impact on reliability, signal quality, and cost. And, it ultimately can determine the success or failure of the application.

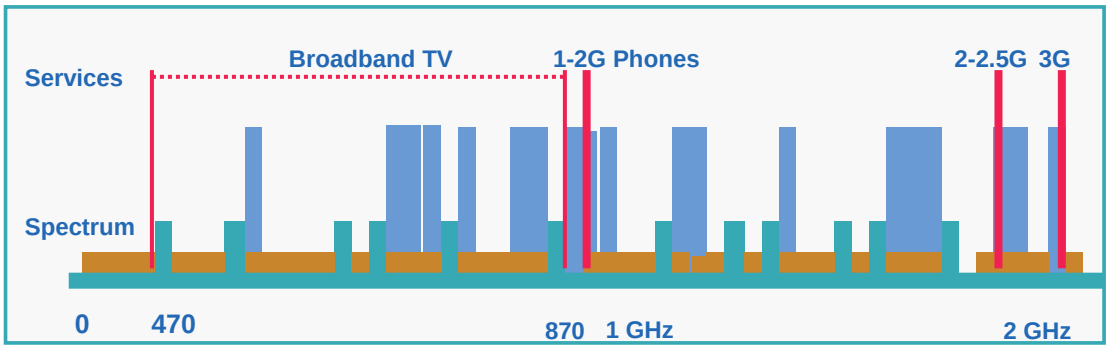
RELIABILITY

In the early days of mobile phones, dropped calls were annoying but accepted as a limitation on the system. Technology has moved on. Today it has become unacceptable to drop calls. With mobile TV, consumers will expect the same quality of reception and high reliability as a conventional TV. They will not accept picture corruption or audio drop-out, so the TV signal reception must be constant, regardless of whether the user is on a train, downtown, or at home.

One challenge to mobile TV reliability is the operating environment. Depending on where the handset is located, it may receive a very large or very small signal; both can be challenging for a tuner to discriminate. To be successful, the tuner needs to have a broad dynamic range and have the ability to discriminate the wanted signal from adjacent TV channels or other in-band interference, which could even be a mobile phone's own transmissions.

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.

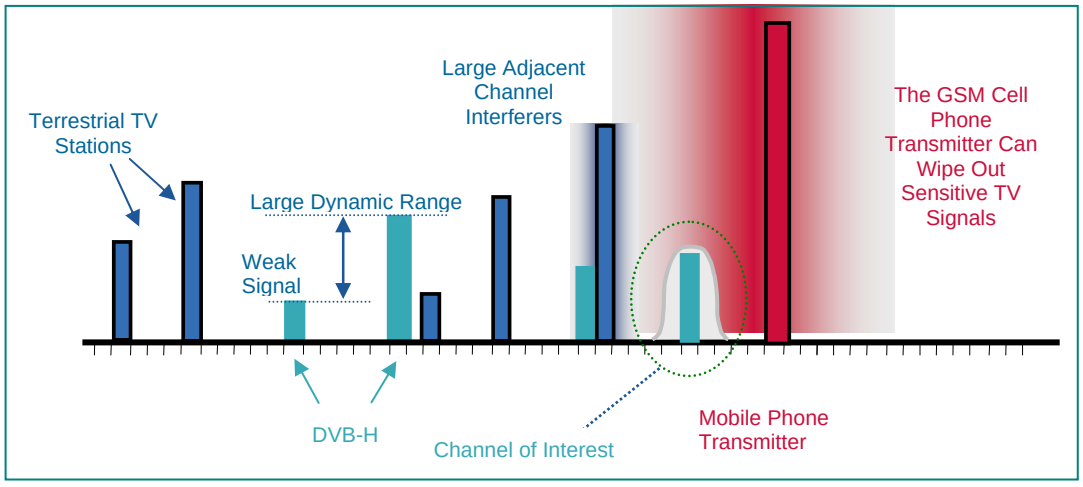


Mobile phone receivers operate in narrow frequency bands, typically 60 to 80 MHz. To improve reliability in these systems, designers can put a narrow band filter in front of the receiver and effectively eliminate potential interferers across a broad spectrum. In contrast, a mobile TV receiver has a wider bandwidth. The first DVB-H tuners will need to tune across the UHF band IV-V frequency range (470 MHz to 860 MHz) with 6-MHz, 7-MHz or 8-MHz channel bandwidths in Europe and the L-band 5-MHz channel at 1670-MHz to 1675-MHz in North America. The situation is particularly challenging in Europe, where the spectrum is fragmented by country, and cellular transmitters are often spread into the same bands as mobile TV.

As a work around, the DVB-H standards committee has reduced the usable bandwidth for mobile TV within the allocated band up to 702-MHz, but there are a number of companies that would like to use the higher frequencies. Clearly, truncating the available spectrum is only a short-term fix, and a new tuning technology is needed.

For signal reliability, handset manufacturers need to select a tuner with the ability to discriminate the desired DVB-H signal. That in itself is quite a challenge for any application. One way to improve tuning for mobile TV is to use new on-chip filtering techniques. Developed using expertise in cable set-top box, traditional television, and automotive TV systems, Microtune's ClearTune technology, which is implemented in its Mobile MicroTuner™ chips, offers in-band rejection of an undesired signal that cannot be stopped by the external filters. It works in conjunction with the external filters that attenuate the out of band carriers. A technology like ClearTune enables in-band filtering on both sides of the band of the carrier, and it will significantly reduce the impact of the mobile phones GSM 900-MHz power amplifier (PA) signal that generates a blocking signal inside the phone. It can reject the GSM carrier, suppress other unwanted signals, and provide improved performance. By attenuating large nearby signals, the tuner can better decode the desired signals. And, in a situation with multi-path issues, it can ensure that neither audio nor video signals are lost, which has a direct impact on perceived quality.

MULTIPLE INTERFERERS, INCLUDING THE CELL PHONE POWER AMP, IMPACT MOBILE TV PERFORMANCE



QUALITY

Quality of the mobile TV experience may not be very important for a user of a low-tier handset, where voice calls are the priority and an added feature that works marginally well is acceptable to the customer. However, for the consumer who wants mobile TV, maintaining the picture and audio quality will be critical to the application's success. Typical users of high-end smart phones

expect their features to work well. For designers and vendors working in the mobile TV space, satisfying these discerning customers will be critical to the application's ultimate success or failure. In this case, the picture quality must be very good, and the performance must meet or exceed the hype. As a result, it is important to select a high-quality tuner and demodulator for this type of high-end application, anything less would risk failure.

To comply with the DVB-H standard, the tuner must select either a single 5-MHz, 6-MHz, 7-MHz 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 passband 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 and/or DVB-T TV signals at potentially large amplitudes relative to the desired TV signal. The receive system in the handset will need to handle maximum signal levels up to -25dBm or higher without distortion as well as amplifying signals near to the thermal noise floor. The tuner must handle this large dynamic range of desired signals in the presence of many other distorting signals that could be much stronger than the desired minimum signal level. The 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. If it cannot do that, the tuner cannot deliver the performance necessary to ensure a quality end-user experience.

Cost

As with all applications, the total solution price for mobile TV functionality is expected to drop with market penetration. Early bill of materials (BOMs) range from $14 to $18, with the industry looking for the cost to drop to $5 by 2008, when DVB-H is likely to be a standard feature in most handset.

Size

Reducing the footprint of the mobile TV functionality will impact cost, but it is also necessary due to the shrinking real estate inside of next-generation handsets. In order to support additional features, these handsets might have more Flash memory, a hard drive, MP3 capability, PVR functionality, location services, WiFi, Bluetooth, and FM radio.
Any new function has to be small. The complete DVB-H function needs to be squeezed into a space smaller than 10x10mm.

Design Checklist for the Tuner

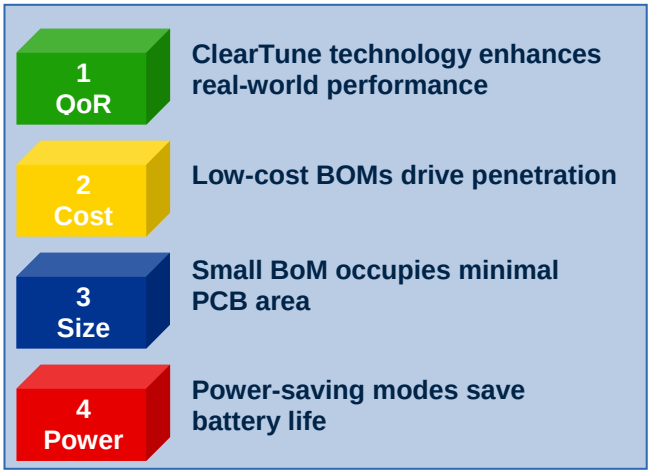
When selecting a tuner for mobile TV, manufacturers need to look for one that was specifically designed for this application, and make sure it was designed with on-chip filters and low noise amplifiers that prevent interference. The main priorities (in order of importance) when selecting a tuner should be:

1. Quality of reception is most important of all. If the application performance is weak in the early years of mobile TV launch, it can lead to poor adoption, criticism from the

media and users, and ultimately, delayed penetration into the high volume mobile phone market.

2. Cost must be low in order to enable penetration into low-end handset markets.
3. Size: Look for a tuner that offers small size and low height.
4. Power consumption (the power consumption of the tuner is very low compared to other functions, and does not have a big impact on the power budget.

BUILDING BLOCKS FOR A SUCCESSFUL DVB-H TUNER



Skimping on tuner quality could be a fatal mistake for handset designers adding mobile TV functionality to next-generation devices. Dropped TV programs, loss of picture and audio are the likely outcome for users of mobile TV applications that use a low-end tuner. Fortunately, tuner manufacturers like Microtune have already developed the metrics, technology, and performance that is necessary to ensure high-quality user experiences of mobile TV.