From Bag Phone to Video Phone

By Alastair Upton, RF Micro Devices, Inc.
Smaller, lighter, cheaper, better &#151 a familiar pattern within the consumer electronics industry that leads to products with much greater functionality at the same cost, or the same functionality at a much lower cost. For wireless handset and IC manufacturers, this same trend is leading to smaller and smaller products, with a significant reduction in the number of internal components. Size reduction and the use of fewer internal components, are achieved either by using advanced RF system architectures, or by integrating passive components, such as resistors, capacitors, filters, etc., with the RF integrated circuits (RFICs).
At the recent Mobile Silicon Conference in London, a couple of references were made to the electronic calculator paradigm. If you open up a modern calculator you will most likely see a single integrated circuit with two capacitors. This low bill of materials (BOM) leads to very low assembly cost, higher throughput and greater product reliability. While it is a stretch of the imagination to think this trend will happen soon in wireless handsets, it is noteworthy.
This is a very active time for wireless handset manufacturers and IC suppliers. Due to constant increases in production volumes, there is tremendous pressure to eliminate components and reduce cost, while also adding multiple frequency capabilities and multiple modes of operation. These product enhancements are adding wireless web access, and eventually, multimedia and video capabilities to wireless handsets. At the component level, there is an ever present desire for higher performance, be it greater power amplifier efficiency, lower receive current consumption or lower noise figure, to improve talk time and enhance reception from faraway base stations. Compared with phones from five years ago, today's handsets are roughly five times smaller, have a battery life that is five times longer, can send and receive e-mail, can communicate with short messaging service (SMS) and have no external antennas as well.
Nowhere is the trend towards smaller, cheaper and better phones more apparent than in the GSM markets in Europe and Asia. There are very few, if any, GSM handsets being designed today that operate at a single frequency &#151 even those that are built for operation in countries that only have GSM 900 MHz coverage. It is often more economical to use the same platform design for multiple handset models than to have separate models. There is also a customer perception that a dual band handset is better than a single band handset. More and more, GSM handsets are becoming triple band units that add the PCS 1900 MHz band used in the United States as well as the GSM 900 MHz and 1800 MHz used in Europe and most of Asia. With the recent announcement from AT&T Wireless to evolve from TDMA to GSM/GPRS, the design of multi-frequency GSM handsets is set to accelerate even further, with 850 MHz or even 700 MHz capability being added.

Figure 1. Compared with a 1995 model Nokia 232, the latest Nokia 8260 is roughly five times smaller and has far greater capabilities including e-mail and SMS, as well as fits neatly into a shirt pocket or purse.

In response, handset component and chipset suppliers are offering more integrated functions in the form of modules. The most common example of handset modules include the power amplifier function whereby all matching and bias components, as well as dual band or triple band RFICs, are manufactured in a single unit. The power amplifier is typically the most difficult RF component to get to work in a handset, which makes the power amplifier module (PAM) attractive to handset manufacturers because most of the matching has already been done and the only requirement is to optimize the power control. Clearly, RF semiconductor suppliers are continually evolving and optimizing these designs, not only to stay one step ahead of the competition, but also to anticipate customer needs for the next model. Today, most PAMs also include a CMOS power control IC to turn these modules into "smart PAs." The receiver components of handsets are now getting a lot of attention, where the low noise amplifier and mixer matching elements are contained on a single module. Similar to the case of the power amplifier module, a receive module allows a handset manufacturer to have greater flexibility in the phone board layout and he or she does not have to be concerned with the selection of the external matching components and performance optimization. Receive modules, or front end modules, are now available that include duplexers, receive band SAW filters and antenna switches. These units significantly reduce the size of the latest dual band and triple band phones. Even further size reductions are possible by burying passive components such as resistors, capacitors and simple filters, into multi-layer low temperature co-fired ceramic (LTCC) substrates. It now appears possible to integrate the power amplifier functions within these front end modules to create a highly integrated component that will save a significant amount of board space when compared with individual, discrete components. In the future, it is expected that micro electro mechanical systems (MEMS) and printed thin film resonators will lead to even further size and cost reductions for switches and filters within these front end modules.

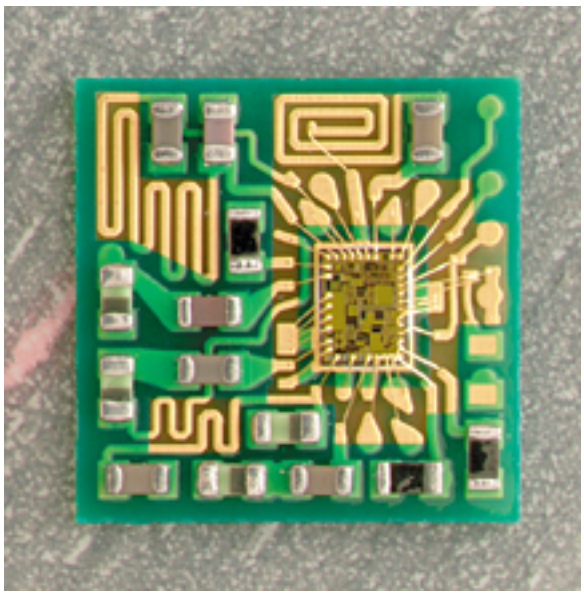

Figure 2. Significant size reductions can be achieved using module technology to integrate passive matching and bias components. The above unit is a dual band LNA/mixer with all RF matching for the two LNAs and two mixers contained in a single 7 &#215 7 mm package.&quot

A similar revolution is ongoing within the RF transceiver section of the phone, where more and more designs are migrating toward direct modulation and direct conversion. Traditionally, these approaches to RF transceivers have posed significant system-level problems, as they strive to eliminate as many filters as possible. However, with the advancements in silicon germanium (SiGe) and CMOS process technologies, it is now possible to design receivers with very high input IP2, and to incorporate low current consumption analog-to-digital converters into the back-end circuitry. Direct conversion, or very low IF, receivers are expected to account for 60 percent of all handset designs in 2002. This is being driven by the fact that more and more phones are multi-frequency and multi-standard. Without direct conversion, these phones would have multiple IF filters with differing bandwidth characteristics making them both size and cost prohibitive. In fact, even for low-cost GSM/GPRS solutions, it is considered necessary to have direct conversion/modulation transceivers to reach the (less than) 200 components and (less than) $30 BOM cost targets that some manufacturers now have for the total handset &#151 including RF, DSP/ microprocessor, memory, battery, plastic &#151 the whole nine yards.

For those of us who remember the &quotbag phone&quot of the 1985 era, it seems incredible to realize that we have advanced from bulky, expensive and immobile phones to palm-size phones that are now able to receive messages and connect to the Internet, wherever we are in the country &#151 and soon the world. In what is probably the most advanced example of miniaturization, the Samsung concept phone, SCH-M220, incorporates a 1.8-inch TV in a folding-type handset. The video phone, that fifteen years ago was considered science fiction, is not only here today, but is really setting the stage for a whole new generation of advanced products. Smaller, lighter, cheaper, better &#151 the cycle continues.

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