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Motorola Cellular DSP Does It All

DSP56690 Integrates M-Core MPU, Supports Multiple Wireless Standards

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Jet-setters who want to stay in touch won't have to keep packing more cell phones than shoes much longer. Motorola's new DSP56690 is a highly integrated embedded processor that supports all of the most common wireless standards likely to be encountered on a globe-hopping journey.

For the first time, a single chip handles analog cellular as well as a plethora of digital standards: code-division multiple access (CDMA), time-division multiple access (TDMA), global system for mobile communications (GSM), integrated digital enhanced network (iDEN), general packet radio service (GPRS), and even the Iridium satellite network. That covers all of the first-, second-, and so-called 2.5-generation wireless-telephony standards worldwide.

But despite the initial excitement over the dream of a universal wireless phone—Motorola's announcement received widespread press coverage and the company's stock jumped 5% in one day—even Motorola doubts there's a large enough market for such a product. The extra memory required to store the software for every standard would inflate the phone's cost, and relatively few people are obsessively connected globetrotters. Instead, Motorola sees the DSP56690 as a malleable platform for a multitude of future cell phones. Motorola can tailor the processor for a single standard or any combination of standards by adding or removing on-chip peripherals.

The first DSP56690-based phone from Motorola's wireless-products group will likely be a GSM-only device when it debuts in 2H00. Later, Motorola may introduce a GSM/TDMA or GSM/CDMA combo model, which would still cover a lot of bases in Europe and the U.S. But Motorola will probably leave it to another vendor to use the DSP56690 as the Rosetta stone of wireless telephony.

A Dual-Core Processor

As Figure 1 shows, the DSP56690 integrates a Motorola 56600 DSP core with an M-Core 210 microcontroller, on-chip memory for both cores, and a vast array of peripherals. In terms of both integration and performance, it goes well beyond two related cellular-baseband chips from Motorola, the DSP56651 and the DSP56652.

The new chip's DSP core runs at a clock frequency of 104 MHz, while the microcontroller core runs at 52 MHz. The core voltage can range from 1.8 to 2.7 V (2.2 V is nominal), and the I/O voltage can range from 1.8 V to 3.3 V. Motorola will manufacture the initial chips in its 0.25-micron CDR-3 process and migrate to the 0.18-micron HiPerMOS-6 (see MPR 9/14/98, p. 1) process later next year.

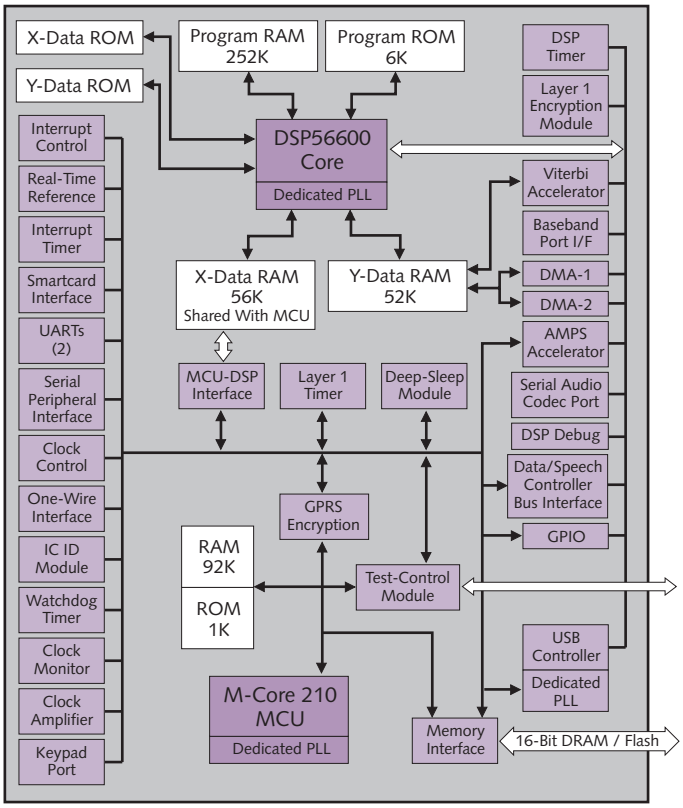

Figure 1. Light-purple blocks show the DSP56690's on-chip peripherals, some of which can be removed to customize the chip.

Motorola declined to release the die size and power-consumption figures for the DSP56690, because the only numbers available are rough estimates. Although Motorola is currently sampling the chip, the samples are development parts that substitute RAM for the on-chip ROM, so they are larger and consume more power than production chips will. Production samples will be available next quarter. They will be packaged in a 225-contact plastic BGA that's 15 × 15 mm.

The DSP is a 16-bit fixed-point core with two blocks of program memory (ROM and RAM) and two blocks of data memory (ditto). The microcontroller core also has two blocks of on-chip ROM and RAM. These memory blocks can vary in size, depending on the needs of the customer and the specific application. The memory sizes in the block diagram are based on early development samples; production chips will have slightly different configurations.

Although the DSP56690 has a large number of intgrated peripherals—highlighted in light purple in the figure—Motorola says it can easily remove some of the blocks to customize the processor. Some of the peripherals, such as the interrupt controllers, UARTs, watchdog timer, keypad port, and general-purpose I/O (GPIO) ports, are common in embedded processors.

Many other peripherals are directly related to wireless communications. Among them are the layer-1 encryption module, which handles radio-channel timing between the phone and the base station; the Viterbi accelerator, which speeds data decoding for GSM protocols; the GPRS encryption module, which supports GSM as well as GPRS; the AMPS accelerator module for analog phones; the baseband-port interface, for full-duplex serial I/O; the serial audio-codec port, for connecting to external codecs; and the data/speech controller bus interface, for receiving and transmitting GSM signals.

This is a more integrated solution than commonly used today. About 70% of all digital cell phones have an ARM-based microcontroller, and many of them use a separate DSP. Integrated chip sets are available from such suppliers as DSP Communications, which Intel is acquiring (see MPR 11/15/99, p. 14), but they don't support as many wireless standards as the DSP56690.

Arm recently began working with TI to design an integrated chip for wireless phones—a chip that will combine one of TI's DSPs with a next-generation ARM core beyond the ARM10—but it won't be ready before 2001 at the earliest. For the next year or so, it's likely that no other vendor will have a chip as versatile as the DSP56690.

The Incredible Shrinking Phone

Lilliputian cell phones are status symbols, and it's practically a ritual at some business meetings to see who's got the smallest toy. A highly integrated chip like the DSP56690 will enable vendors to make even smaller devices.

The DSP56690 should provide longer battery life than discrete solutions. This is not only because both cores are on a single die, but also because the integrated peripherals keep most of the I/O signals on chip, and I/O pins require relatively large amounts of power to drive.

Motorola hasn't announced pricing, so we can't fairly compare the DSP56690 with other solutions by that metric. The price of merchant parts will depend on volume, how the chip is configured, and the customer's negotiating skills. But if customers can make an acceptable deal, the do-it-all DSP56690 should be very competitive on technical grounds.

The most significant indicator of the chip's success will be how extensively it's adopted by Motorola's most important customer: Motorola. Corporate synergy notwithstanding, the wireless-products group won't use the DSP56690 unless it makes good business sense to do so, because Motorola's mobile-phone division is too vital for the company's bottom line to be merely a captive customer for the semiconductor group's silicon. Motorola's dual-band GSM V3688 phone currently uses an ARM7-based MPU and a TI DSP instead of an M-Core chip and Motorola DSP.

To keep more of that business in house, Motorola hopes the DSP56690 will be the fundamental building block for its future phones up to the 2.5 generation. Beyond that, the so-called 3G or third-generation phones will require a more powerful DSP core to handle the more complex software protocols. Motorola's roadmap foresees an eventual successor to the DSP56690 that substitutes a StarCore DSP (see MPR 5/10/99, p. 13) for the 56600 core. But for the next three to five years, Motorola is wagering that the DSP56690 will be the prime solution for the company's wireless-phone products. Considering the chip's high integration and flexibility, this appears to be a wise bet. M

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