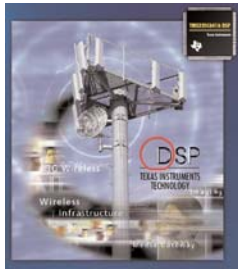# TMS320TCI100Q DSP Delivers the Industry's Fastest Performance for 3G Wireless Base Stations

Abstract

Today wireless multimedia is moving from vision to reality. Service providers are deploying third-generation (3G) wireless base stations that enable callers to surf the web, check e-mail, conduct videoconferences and access a wide range of new services from their wireless devices. Users are already beginning to enjoy these services, as well as making voice calls from a much wider range of indoor and outdoor environments.

Underlying 3G innovations is Wideband Code Division Multiple Access (WCDMA) technology, which is pushing the expectations of wireless networks far beyond previous limitations. To deliver on the promise of WCDMA, 3G base stations must handle greater capacity, process higher data rates, and support multimedia standards, while at the same time reducing size, cost and power consumption. The technology that enables WCDMA is high-performance digital signal processing, which provides the processing power and design flexibility required to implement 3G wireless base stations.

The new TMS320TCI100Q digital signal processor (DSP) from Texas Instruments (TI) builds on the performance leadership established by TI's TMS320C64x™ DSP generation. Operating at 850 Megahertz (MHz), the TCI100Q DSP is designed specifically for high-performance, multichannel 3G wireless base stations. It enables a high degree of flexibility while dramatically reducing development and bill of materials costs and speeding time-to-market.

The TCI100Q DSP extends TI's performance leadership, which began with TI's TMS320C6203 DSP and continued with the TMS320C6416 DSP. Both the TMS320C62x™ and C64x™ DSPs are being used today by the majority of the top 3G cellular infrastructure original equipment manufacturers (OEMs). These OEMs can quickly and easily redesign their first- and second-generation systems to improve performance and reduce power consumption and cost because the TCI100Q DSP offers complete code compatibility with the previous generation C64x DSPs.

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A Leap Ahead in Wireless Technology

Third-generation standards like WCDMA (Japan), Universal Mobile Telecommunications System (UMTS) (Europe), CDMA2000 (U.S.) and Time Division Synchronous CDMA (TD-SCDMA) (China) place intense demands on the processing power and flexibility of base stations. To accommodate the simultaneous transmission of voice, data and video, transmissions must be scaled on a call-by-call basis so the channel bandwidth matches that of the application. A video call, for instance, needs a great deal more bandwidth than an ordinary voice call, and a data transfer can use a varying amount of bandwidth as it becomes available. As a result, the WCDMA roadmap requires support for a wide range of data rates – up to 384 kilobits per second (kbps) in mobile applications and up to two megabits per second (Mbps) in stationary applications. Adding to the complexity, new systems using WCDMA must be able to coexist across all continents, and must be backward compatible with wireless standards deployed today.

The outstanding performance of TI's TCI100Q DSP allows OEMs to implement compute-intensive algorithms that maximize use of the full frequency band for WCDMA's spread spectrum transmission and scalable channels. High performance also enables improvements to the underlying technology, such as enhanced voice compression algorithms that allow more efficient use of bandwidth. In addition, performance allows OEMs to introduce more channels to their systems, helping them keep per-channel costs low in the highly competitive wireless market.

Wireless 3G base stations are appearing in new applications that require a small footprint and demand as much processing per channel as traditional large units. For these systems, high channel density must be accompanied by low power consumption. Components that consume less power dissipate less heat and can thus be packed more densely. They also are more reliable, keeping maintenance costs down. These requirements place great demands on the performance, scalability, programmability and power efficiency of 3G base stations. The programmable TCI100Q
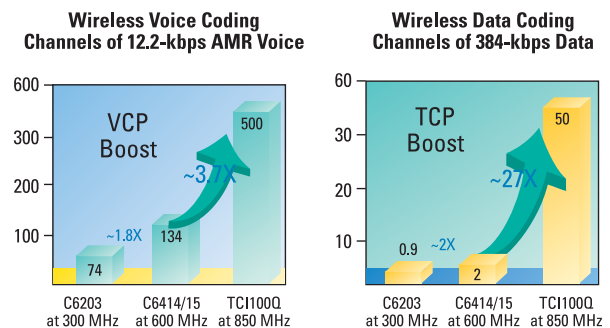
DSP offers the flexibility needed for new standard implementations like WCDMA/UMTS/CDMA2000/TD-SCDMA, allowing standard evolution, quick modification and faster time-to-market.

The Right DSP Technology for 3G Base Stations

The TCI100Q DSP leverages the advanced very-long-instruction-word (VLIW) architecture of its C64x™ DSP core with hardware innovations specifically designed to meet the demands of 3G wireless base stations. The core's eight functional units include four multiply accumulate (MAC) units to achieve maximum parallelism in processing 3G algorithms.

The TMS320C6000™ DSP architecture is capable of scaling to speeds faster than one Gigahertz (GHz) and performance nearing 9,000 million instructions per second (MIPS) for single-core devices. The architecture is also flexible enough to support additional features and multi-core designs for use in future, more powerful 3G wireless base stations.

Two hardware accelerators that were first available on the C6416 DSP also are present on the TCI100Q DSP to provide dedicated co-processing that dramatically speeds-up the operation of key 3G algorithms and frees the C64x CPU core to function more flexibly and efficiently on other operations. One accelerator, a Turbo coprocessor, performs convolutional encoding for the symbol-rate processing used in 3G, while the other accelerator, a Viterbi coprocessor, performs 3G error correction. The versatile C64x architecture, used in the TCI100Q DSP, offers a cost-effective way to introduce different accelerators that can speed up the execution of other algorithms in future devices in the family.

Wireless Voice Coding
Channels of 12.2-kbps AMR Voice

VCP Boost

600
300
200
100

500
~3.7X
134
~1.8X
74

C6203 at 300 MHz   C6414/15 at 600 MHz   TCI100Q at 850 MHz

Wireless Data Coding
Channels of 384-kbps Data

TCP Boost

60
30
20
10

50
~27X
2
~2X
0.9

C6203 at 300 MHz   C6414/15 at 600 MHz   TCI100Q at 850 MHz

System-Level Integration for Communications

System-level functionality on the TCI100Q DSP speeds up development and enables OEMs to achieve the full performance entitlement of the device. To sustain data supply to the ultra-fast DSP core cost-efficiently, the TCI100Q DSP employs a two-level cache memory with 16-kilobyte (KB) Level 1 data, 16-KB Level 1 program, and 1024-KB Level 2 unified data and program caches. For greater flexibility, there are four options for programming the Level 2 cache (up to 256 KB) to serve as direct-mapped memory blocks. A 32-channel enhanced direct-memory access (EDMA) controller provides efficient management of more than two gigabytes per second (GBps) of data input/output (I/O) from system memory. Integrated peripherals that ease system configuration include an interface to the widely used peripheral component interconnect (PCI) bus for host computers, and a Utopia II interface for Asynchronous Transfer Mode (ATM) in telecommunications.

Best-in-Class Performance, Power Efficiency

While the C6416 DSP can support more than 64 voice channels simultaneously, the TCI100Q DSP will deliver greater performance for support of more channels or more features, and offers a reduced level of power consumption.

The TCI100Q DSP is based on TI's C64x™ DSP architecture, which was designed to provide high performance while maintaining power efficiency. TI has employed many of the power-saving techniques it created for the ultra-low-power TMS320C55x™ DSP in the development of the TCI100Q DSP. Built in TI's state-of-the-art 90 nanometer (nm) CMOS process, the TCI100Q DSP operates with a typical power consumption of less than one watt, still the best power-to-speed ratio in this class of DSP. In 3G base stations, this excellent power efficiency will enable OEMs to pack more channels in less space, saving cost in both manufacturing and operation.

Fast Software Development From Existing Designs

Because the TCI100Q DSP instruction set is a super-set of the C62x™ DSP instruction set, OEMs can reuse software they developed for earlier-generation designs. The outstanding efficiency of the C64x C compiler enables developers to create new code and modify existing code quickly, an important capability in the rapidly evolving 3G wireless field. In addition, TI's Code Composer Studio™ integrated development environment offers the industry's most complete and advanced set of tools to ease the implementation of DSP code.

The TCI100Q DSP allows designers to develop differentiated 3G wireless technology through software instead of hardware. This emphasis helps speed up system development by allowing rapid response to changes in design requirements, and permits developers to port their technology more easily to new systems. In addition, DSP-based systems can be reprogrammed more readily in the field so that service providers can keep their equipment up to date as standards evolve. All devices in the C64x DSP generation are object code compatible with earlier C62x DSPs and TMS320C67x™ DSPs, so software initially compiled for previous devices, such as the C6203 DSP, also will run on the TCI100Q DSP.

Performance for Tomorrow's Wireless Multimedia

Wireless 3G telecommunications are being deployed today using TI DSP technology, and TI's new TCI100Q DSP will help OEMs drive 3G base stations to new levels of channel density and low per-channel costs. More than ever, 3G base station designs require high performance and efficiencies of cost, space and power consumption. As the fastest DSP available today for 3G wireless base stations, the TCI100Q DSP offers all of these advantages, enabling wireless OEMs to build the base stations that will support tomorrow's multimedia applications.

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