

Details

ON SIGNAL PROCESSING

INSIDE

'C6x Development Tools Emphasize Software	3
VelociTI Architecture Key for Parallel Performance	5
New Third-Party Hardware and Software	6

MARCH 1997

ISSUE 47



1600 MIPS DSP

The new TMS320C6x DSP generation from TI opens up virtually unlimited possibilities for system designers. Just as the microprocessor revolution introduced mainframe computing power in the size of a notebook, 'C6x technology will enable whole new classes of previously unreachable real-time products in the personal and data communications world.

For example, the 'C6x stands to be a key solution for unclogging

'C6201 unleashes highest level of DSP price/performance

Lowest cost per channel ever for communications systems

The TMS320C6201, the most powerful general-purpose programmable fixed-point DSP ever built, is the first DSP in the industry to adopt TI's new VelociTI™ architecture, an advanced Very Long Instruction Word (VLIW) implementation that delivers an unprecedented 1600 MIPS at 200 MHz.

With its 5-ns cycle time, the 'C6201 can complete a 1,024-point complex Fast-Fourier Transform (FFT) in only 70 microseconds. The 'C6201 also incorporates innovative instruction packing techniques that reduce code size, program-fetch overhead, and power consumption, and the chip's 100% conditional instructions reduce costly branching and increase parallelism for higher sustained performance.

Key 'C6201 features include dual data paths from eight functional units including two multipliers and six arithmetic units allowing the chip to execute up to eight 32-bit instructions per cycle delivering up to 10 times the performance of previous DSPs. Other device features include 3.3-volt operation for I/O and 2.5-volt core operation, 16-bit multiplies, and 32-/40-bit arithmetic.

The 'C6201's memory and peripheral mix provides 1 Mbit of on-chip RAM (512K bits program, 512K bits data), and a 32-bit glueless external memory interface that supports SDRAM, SBSRAM,

Continued on page 2

Continued on page 4

1600 MIPS DSP

(Continued from page 1)

the bandwidth-starved Internet. What took 10 minutes to download from the Internet, will now take less than five seconds with 'C6x-enabled throughput—an increase of 120 times the speed of today's fastest modems. "This DSP solution will change the way we live," said Mike Hames, TI Semiconductor Group vice president and worldwide DSP manager. "We know this performance will eliminate 'busy signals' for the web user, but it's also not farfetched to see this revolution translate to radical changes like wireless base stations the size of a calculator, a total redefinition of medical diagnostics, and cars that can offer the ultimate in cruise control with radar-based collision avoidance and global positioning systems (GPS) to map the route to your destination."

The TMS320C6x DSP generation offers 10 times the MIPS performance of any DSP in history and debuts with a world-class C compiler that cuts software development time in half. The C compiler, in addition to the complete development toolset available now, will allow developers to bring highly-differentiated products to market quickly. This major advance represents a whole new level of productivity and efficiency for systems designers, and reduced system cost for multi-channel and multi-function voice and data communications applications.

For less than US \$100 (25K units), or US \$0.06-per-MIPS, the 'C6x processing abilities, exceptional ease-of-use, and affordable pricing make it the optimum solution for the communication industry's hottest applications, including pooled modems, wireless base stations, remote access servers (RAS), digital subscriber loop (xDSL) systems, cable modems, and voice mail systems. A single 'C6x generation DSP will replace multiple current-generation DSPs, including today's highest performance DSP offerings throughout the industry. In terms of traditional DSP benchmarks, the 'C6201 can execute 400 million multiply-accumulates (MACs) per second, and can perform a 1,024-point

complex Fast Fourier Transform (FFT) in 70 microseconds.

New VLIW architecture

The 'C6x is the first DSP in the industry to adopt VelociTI™, an advanced Very-Long-Instruction-Word (VLIW) architecture. TI's worldwide position as the leader in DSP firmly establishes advanced VLIW as the architecture-of-choice for achieving very high performance at low cost. "Our primary goal was to make this DSP quick and easy to program," said Ray Simar, 'C6x chief architect and program manager. "We expect to put the 'C6x in the hands of a very broad pool of application programmers,

DSP Solutions

TMS320C6x



most of whom will need only a very basic understanding of the chip's architecture."

Lowest price per function and price per channel of any DSP

The 'C6x generation gives developers the lowest price per function and price per channel of any DSP today. The 'C6x generation's first available product, the fixed-point TMS320C6201 DSP, will be priced at US \$96 in quantities of 25,000 units. The 200 MHz, five-level metal, 0.25-micron 'C6201 is available for sampling immediately in an advanced-release version. A production release version will be available from TI and authorized distributors and is scheduled to sample in the second quarter of 1997, followed by volume production scheduled for the third quarter of 1997.

Cuts software development time in half

To drive fast time-to-market for 'C6x-based product designs by cutting software development time in half, the new DSP generation is immediately supported by a complete set of optimized development tools for both PC and Sun host platforms. The tools include a 'C6x C compiler that is three times more efficient than any DSP compiler on the market today, the world's first Assembly Optimizer for simplified assembly-language programming and scheduling, and a Windows™-based debugger interface for improved visibility into source code execution characteristics.

The 'C6x code generation tool set, including the C compiler, Assembly Optimizer, and assembler/linker, is available now from TI and authorized distributors and is priced at \$2,495 for the PC and \$3,995 for the Sun workstation version. The 'C6x simulator is also available now for US \$495 (PC) or \$995 (SPARC). A hardware emulation board, compatible with TI's XDS510 JTAG emulator interface is scheduled to be available in March 1997. TI DSP third parties supporting 'C6x with tools include Ariel Corporation, CHEOPS Bildverarbeitungs GmbH & Co KG, D2 Technologies, DSP Research, Inc., DSP

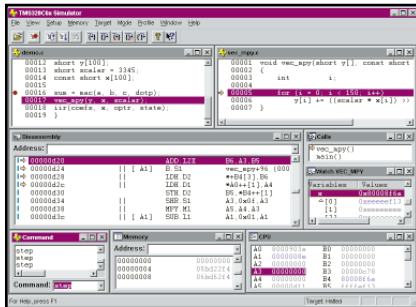
Software Engineering, Inc., Eonic Systems, GO DSP Corporation, HotHaus Technologies, Innovative Integration, Loughborough Sound Images (LSI), Pentek, Signals & Software Ltd., ViaDSP, Inc., and White Mountain DSP. See the third-party section in this issue for more information.

Future 'C6x generation members, both fixed and floating point, will include devices fabricated with TI's new 0.18-micron, five-level-metal process, and will operate at speeds beyond 250 MHz. These DSPs will be disclosed throughout 1997 and beyond.

For more information on the TMS320C6x, request the 'C6x Brochure from your regional Literature Response Center or www.ti.com/sc/c6x. ■

'C6x development tools emphasize software techniques

Intimate knowledge of DSP architecture is no longer necessary to get maximum code performance



Understand applications with multiple views of code and data

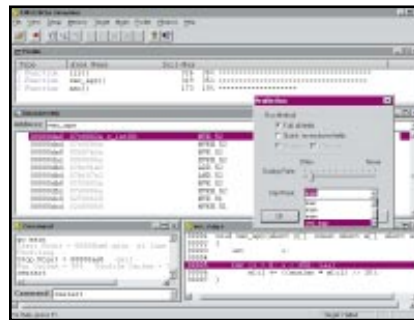
To support the industry's most powerful line of DSP Solutions, TI has introduced an equally powerful development environment. The easy-to-use 'C6x tool set allows software engineers to write applications in high-level C code, and even write critical sections in assembly language, all without concern for the mechanics of the underlying processor architecture. The optimization capabilities of the C compiler and the unique new Assembly Optimizer produce highly efficient code without time-consuming hand optimization. Even designers with little DSP experience or understanding of the underlying architecture can be very productive in a short time. The result is faster time-to-market for new applications by cutting software development time in half.

As the architectures of the TMS320 DSP family have developed more parallelism and deeper pipelining, compiler technology has kept pace enabling ever faster application code execution. For the 'C6x, the new C compiler generates code providing a 3 \times improvement in compiler efficiency over other fixed-point DSP compilers. Also, the advanced Very Long Instruction Word (VLIW) VelociTI architecture provides instruction-level parallelism that allows up to eight new instructions to be dispatched in every cycle. Parallel execution of many of these instructions—as organized by the C compiler and the Assembly Optimizer—is the key to the 'C6x's unmatched code efficiency.

For application development, the developer can use the 'C6x tools in a sequence to achieve the level of code efficiency required. As a first step, the code resulting from an initial compilation can be ana-

lyzed with dynamic profiling and cycle counting tools that are part of the development environment. The developer can then determine whether sufficient optimization has been achieved by the compiler's optimization procedures—an outcome that would achieve the fastest time-to-market and lowest product development costs.

As a next step, the developer can use several command-line options, a library of extremely fast functions, and some suggested programming techniques—all of which take advantage of the VelociTI



Easily set up powerful dynamic profiling

architecture. The analysis tools can also help to determine whether the product can achieve its performance goals with minimal additional development time and cost.

Finally, hot spots—critical program sections such as computationally-intensive software loops—can be written for the Assembly Optimizer in linear assembly, which does not require attention to parallel instructions, instruction latencies, or register usage. The Assembly Optimizer schedules the instructions honoring 'C6x latency requirements, maximizing parallel code, and allocating registers to produce an unri-

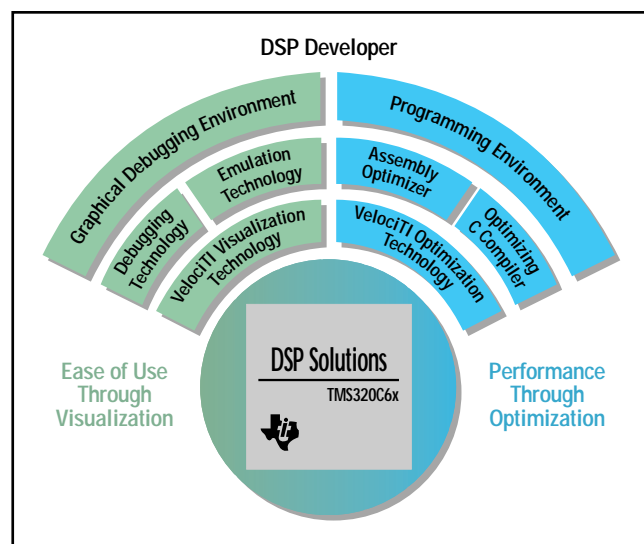
valued level of code performance.

Debugging efficiency is another significant factor in reducing time-to-market for new applications. The 'C6x development environment provides a new Windows-based Graphical User Interface (GUI) for debugging that is intuitive and user-friendly, yet fully compatible with existing TMS320 DSP debuggers. A dynamic profiler that helps users analyze code performance by identifying bottlenecks within the code is included.

The complete 'C6x code generation development tool set is available now and includes the C compiler, Assembly Optimizer, and linker. US suggested resale pricing for the code generation tools is \$2,495 (PC version) and \$3,995 (SPARC). The 'C6x simulator is also available now at a suggested resale price of US \$495 (PC), and \$995 (SPARC).

TI also plans to release a 'C6x test and evaluation board in 2Q97. This board will provide new debugger software that will allow the 'C6x to communicate with existing XDS510 emulators, so no new emulator will be required to use the test and evaluation board.

For more information, request the
TMS320C6x Development Tools Product
Bulletin from your regional Literature
Response Center or see
www.ti.com/sc/c6x. ■



The 'C6x development environment simplifies high-performance designs through visualization and optimization.

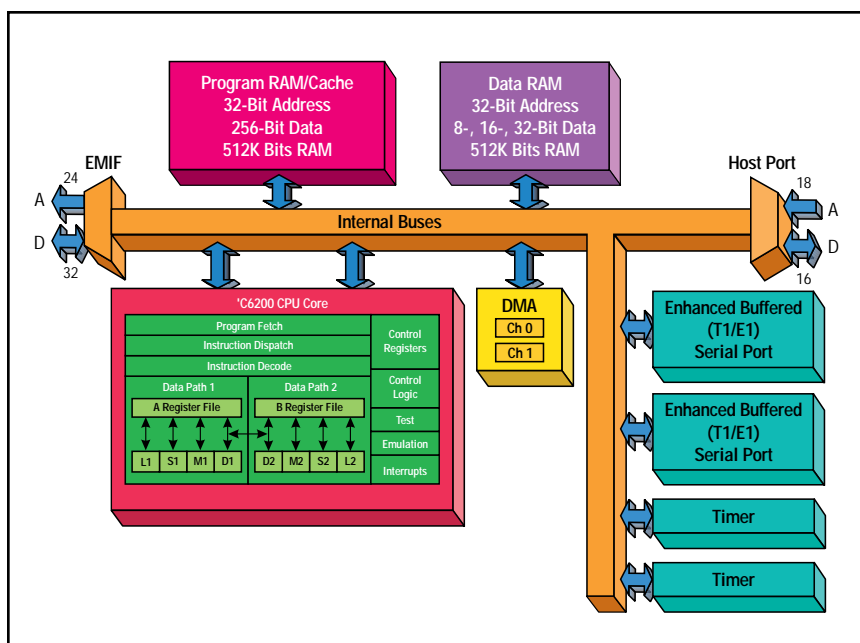
'C6201: unleashes highest DSP performance

(Continued from page 1)

and SRAM. Two direct memory access (DMA) channels with bootloading capability provide efficient access to external memory and peripherals while minimizing CPU interrupts. A 16-bit host access port, two enhanced buffered serial ports (T1/E1), and two 32-bit timers complete the design.

The 'C6201, packaged in an ultra-thin 352-lead ball grid array, represents entirely new levels of performance and savings for communications applications. In these applications, such as V.34 modems or wireless base stations, the 'C6201 can increase the number of communication channels per DSP or raise the throughput capacity of a single channel.

For example, the 'C6201 can allow remote access server designers to provide more modems in less space. The power of a single 'C6201 can implement 10 to 15 V.34 modems at a cost of about US \$6 per modem. Previous DSPs could only achieve one modem per DSP, at about US \$18 per modem.



The 'C6201's VelociTI architecture, which helps to enable maximum code performance, is the key to executing up to eight 32-bit instructions per cycle.

cost per channel, it also reduces chip count and system space. Now a 128-channel base station, which required up to 24 DSPs, can be implemented on four 'C6201s.

floating-point, will be disclosed throughout 1997 and beyond and will include devices using TI's new 0.18-micron process, operating at speeds beyond 250 MHz.

Device	Internal Cycle Time	Nominal Voltage	On-Chip RAM		Synchronous Memory Interface	Host Port	EBSP	DMA	Package
TMS320C6201	5 ns	2.5/3.3 V	512K	512K	(1) 32-bit	(1) 16-bit	2	2	352-lead BGA

For base stations, a single 'C6201 can implement 30 enhanced full-rate (EFR) voice channels at US \$3-per-channel, versus five voice channels at US \$7-per-channel for previous DSPs. Not only does the 'C6201 provide a 50 percent lower

US pricing for the 0.25 micron, five-level metal 'C6201 is \$96 (25K units). An advanced-release version is now sampling, with a production release scheduled to begin sampling in 2Q97. Future 'C6x members, both fixed- and

For more information on the TMS320C6201, request the 'C6201 Product Bulletin from your regional Literature Response Center or see www.ti.com/sc/c6x. ■

- ☐ Wireless base stations
- ☐ Digital Subscriber Loop (xDSL) systems
- ☐ Cable modems
- ☐ Central office switches
- ☐ Private branch exchanges (PBX)
- ☐ Digital imaging
- ☐ Advanced multifunction wireless personal digital assistants (PDAs)
- ☐ Call processing
- ☐ Real-time voice mail
- ☐ Personal multifunction peripherals
- ☐ Radical new phone features
- ☐ Redefined medical diagnostics
- ☐ Personal home base stations
- ☐ Intelligent cruise control

The 'C6201 energizes the high-performance, real-time applications of today and tomorrow.

New VelociTI architecture key for parallel performance

TI's powerful new TMS320C6x DSP marks the first time an off-the-shelf DSP has used an advanced Very Long Instruction Word (VLIW) architecture to achieve high performance through increased instruction-level parallelism. The new architecture, called VelociTI, consists of multiple execution units running in parallel to perform multiple instructions during a single clock cycle. This level of parallelism is the key to extremely high performance at extremely low cost, taking the 'C6x DSPs well beyond the performance capabilities of traditional superscalar designs.

VelociTI's advanced features include instruction packing, 100 percent conditional instructions, and pre-fetched branching, all of which eliminate the problems traditionally associated with historical implementations of VLIW machines. Instruction packing, for example, fetches eight instructions per cycle and executes from one to eight instructions per cycle for reduced code size, program fetches, and power consumption. Also, the architectural streamlining and compiler intelligence that implement instruction scheduling at compile time allow the 'C6201 to be fabricated using only 550,000 logic transistors. In contrast, Intel's Pentium™ requires about five million logic transistors.

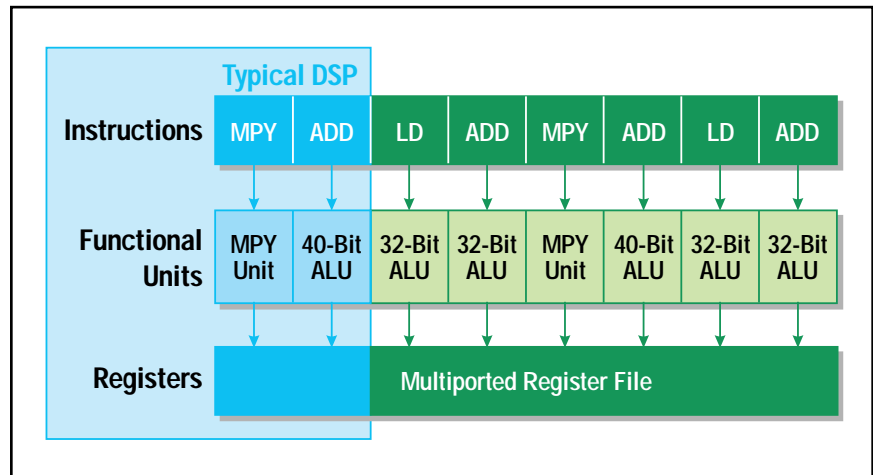
As a highly deterministic architecture, VelociTI has very few restrictions on how

or when instructions are fetched, executed, or stored. It is this architectural flexibility that enables unprecedented levels of efficiency and ease of use. "The beauty of this advanced VLIW architecture is really its elegant simplicity," said Ray Simar, TI's 'C6x chief architect and program manager. "It moves complexity from the hardware to the compiler, allowing for a simpler, easier-to-program, faster processor at a lower cost."

The 'C6x compiler strings together large groups of independent operations into very long instruction words in a way that uses all the on-chip function units efficiently during each instruction cycle.

The compiler resolves data-dependent instructions by moving them around (scheduling) until only data-independent instructions are executed simultaneously.

The net result of VelociTI and its compiler-centric focus is that programmers using 'C6x DSPs can take a big step up from the hardware and its complexities, to focus on application code while still extracting maximum performance. VelociTI-based 'C6x product development becomes a far more software-oriented set of tasks than ever before, resulting in significant development-time reductions. ■



The eight functional units of the 'C6x core provide the compiler and Assembly Optimizer with many execution resources.

Industry perspectives on the 'C6x

"The possibility of multi-channel, multi-function systems is one of the major advantages of DSP, but this feature has not been exploited up to now because of limited hardware performance. It looks like TI is breaking this performance barrier. The chip itself is a big step forward, but the ease of use will make it functional to the user."

Ronald W. Schafer, Institute Professor
The School of Electrical and Computer Engineering
Georgia Institute of Technology

"TI once again demonstrates its DSP leadership by being first to market with the highest performance DSP ever. My mind boggles at all of the applications that will become practical with the unprecedented 1600-MIPS performance of the 'C6x. For starters, the new DSP will meet a huge market demand for exploding datacom and telecom applications at a price that will seal the deal on many designs. It's also impressive that TI is delivering both the silicon and the support today."

Will Strauss, President
Forward Concepts

"The new TI processor and architecture have dramatically changed the landscape in digital signal processing power, permitting new vistas of applications in storage (magnetic and optical), wireless LANs, and digital subscriber lines, particularly ADSL to be considered with off-the-shelf DSP components."

John M. Cioffi, Associate Professor
Department of Electrical Engineering
Stanford University

NEW THIRD-PARTY HARDWARE AND SOFTWARE



Texas Instruments is working closely with its third parties to offer a complete package of support for the new TMS320C6x generation of digital signal processors. In addition to the solutions listed, more third-party support is currently under development.

Hardware

VME64 platform

A family of high-performance board-level platforms focusing on the COTS military market. Other TMS320C6x-based computer telephony products will follow.

Ariel

Ariel Corporation
2540 Route 130
Cranbury, NJ 08512
Tel: (609) 860-2900
Fax: (609) 860-1155
E-mail: ariel@ariel.com
www.ariel.com/cots_oem/c6x/c6x_01.htm

Imaging hardware

RAMSES3 is an off-the-shelf PCI-based board with add-on modules. Well-suited for industrial and medical imaging, as well as high-speed/high-resolution videoconferencing.



CHEOPS Bildverarbeitungs
GmbH & Co KG
Klammspitzstr. 53
D-86956 Schongau
Tel: 49 8861 2369 0
Fax: 49 8861 2369 69
E-mail: email@cheops-bv.de

Development boards

The new TMS320C6x development boards will support voice compression, modem, and other telephony application development, further extending the existing line of TIGER boards.



DSP Research
1095 E. Duane Ave., Suite 203
Sunnyvale, CA 94086
Tel: (408) 733-1042
Fax: (408) 736-3451
E-mail: info@dspr.com
www.dspr.com/pr/c6x.htm

PCI bus card

PCI6201 DSP coprocessor for telecom, communications and data acquisition applications. Features the TMS320C6x DSP, 64M-bytes SDRAM, and a complete software development system.



INNOVATIVE INTEGRATION
DATA Acquisition • DSP • Embedded Computers

Innovative Integration
31352 Via Colinas #101
Westlake Village, CA 91362
Tel: (818) 865-6150
Fax: (818) 879-1770
E-mail: techsprt@innovative-dsp.com
www.innovative-dsp.com

VMEbus multiprocessor board

The Pentek Model 9134 is a scalable multiprocessor board with optional PCI messanine card site. It is well-suited for modems, echo cancellation, switches, and multimedia systems.



Pentek, Inc.
One Park Way
Upper Saddle River, NJ 07458-2311
Tel: (201) 818-5900
Fax: (201) 818-5904
E-mail: news@pentek.com
www.pentek.com

Intelligent telephony codecs and gateways

InvisiLink™ will include software and firmware for high-density computer telephony boards focused on applications requiring solutions such as base stations, switches, and central site WAN access equipment.



ViaDSP, Inc.
336 Baker Avenue
Concord, MA 01742
Tel: (508) 369-0048
Fax: (508) 369-4868
E-mail: dpenny@viadsp.com
www.viadsp.com

Development board and telecom platform

The PCI/C6200 signal-processing platform offers a TMS320C6x DSP, with a PCI bus, high-speed applications memory, and extensive I/O facilities.

The PCI/C6220 telecommunications platform is well-suited for telephony systems builders.



Loughborough Sound Images
Loughborough Park
Ashby Road
Loughborough,
Leicestershire, England LE11 3NE
Tel: 44 0 1509 634300
Fax: 44 0 1509 634333
www.lsi-dsp.co.uk/c6x

Software

Embedded Voice Processing (EVP™)

Software for small business telephony systems as well as large telco and call center systems. EVP software for the TMS320C6x family will allow EVP-based products to quadruple the number of telephone channels on the same space.



D2 Technologies, Inc.
104 W. Anapamu St.
Santa Barbara, CA 93101
Tel: (805) 564-3424
Fax: (805) 966-2144
E-mail: sales@d2tech.com

Multi-channel V.34bis soft-modem and telecom software

Key markets will include V.34bis soft-modem banks and wireless base stations. Supported telecom algorithms include V.34bis, V.32bis, and V.22bis modems, G.723, G.728, and G.729 vocoders, DTMF, Call Progress, and Caller ID telephone functions.



DSP Software Engineering, Inc.

DSP Software Engineering Inc.
175 Middlesex Turnpike
Bedford, MA 01730
Tel: (617) 275-3733
Fax: (617) 275-4323
E-mail: info@dspse.com
www.dspse.com/PRESSREL/c6x_0297.htm

Real-time operating systems (RTOS)

Virtuoso Nano™ is a small and fast multi-tasking kernel ideal for asynchronous dataflow applications.

Classico™ includes pre-emptive kernel and more than 100 services.

MicroLite™ is an entry-level RTOS for parallel processor systems.



Eonic Systems, Inc.
12210 Plum Orchard Dr.
Silver Spring, MD 20904
Tel: (301) 572-5000
Fax: (301) 572-5005
E-mail: info@eonic.com
www.eonic.com/products/c62.htm

In Europe:
Eonics Systems, NV
Nieuwlandlaan 9
3200 Aarschot - Belgium
Tel: (+32) 16 62 15 85
Fax: (+32) 16 62 15 84
E-mail: info@eonic.com
www.eonic.com/products/c62.htm

Development software

Code Composer™ is a fully integrated development environment that offers code editing, incremental and background compiling, debugging, DSP project management, as well as sophisticated signal analysis and file I/O.

Code Maestro™ is an integrated, turnkey DSP development solution with a completely open architecture. It includes real-time debugging capabilities, a System Explorer to manage the entire DSP system, and a real-time application framework that is user-configurable via intelligent Wizards without limitations.



GO DSP Corporation
260 Richmond St. West, Suite 501
Toronto, Ontario, Canada M5V 1W5
Tel: (416) 599-6868
Fax: (416) 599-7171
E-mail: sales@go-dsp.com
http://www.go-dsp.com

Telecommunications software

HausWare is the first complete DSP software architecture for embedded telecom-

munications applications. It provides DSP algorithms within a framework that includes a multi-tasking kernel, a resource manager and a DSP application programming interface.



HotHaus Technologies
150-4611 No. 6 Road
Richmond, British Columbia, Canada V6V2L3
Tel: (604) 278-4300
Fax: (604) 278-4317
E-mail: info@hothaus.com
www.hothaus.com

Emulation and debug support

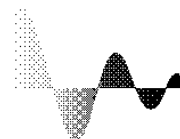
The Mountain-510 universal emulator series will support the 'C6x generation with ISA bus PC platforms, SBus Sun platforms, and PCMCIA card platforms.



White Mountain DSP
410 Amherst St. Suite 325
Nashua, New Hampshire 03063
Tel: (603) 883-2430
Fax: (603) 882-2655
E-mail: info@wmdsp.com

Modem software solution

Signals & Software will offer a very high-density ISP modem solution, well-suited for multi-channel Internet service providers.



Signals And Software Ltd.
Signals & Software Ltd.
3 Jardine House
Harrovia Business Village
Bessborough Road
Harrow, Middlesex HA13EX
Tel: 44 0 181-426 9533
Fax: 44 0 181-869 1182
E-mail: sasl.demon.co.uk
www.sasl.demon.co.uk ■