

# Details

## ON SIGNAL PROCESSING

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## TI DSP wins IEEE award

**T**he Institute of Electrical and Electronics Engineers (IEEE) has recognized TI DSP as the recipient of the 1996 Corporate Innovation Recognition for technical excellence in the design and application of digital signal processors.

The award is presented for outstanding contributions which have resulted in a major advancement of the arts and sciences of electrotechnology. IEEE will present TI with the award at its annual ceremony on June 22, 1996 in Montreal, Quebec, Canada. ■

## TI announces winner of \$100,000 DSP Solutions Challenge

### 'C40-based film restoration captures prize

On May 7, 1996, Texas Instruments announced that Dilip Krishnan and Showbhik Kalra, both students at Singapore's Nanyang Technological University (NTU), will share the US \$100,000 grand prize in TI's DSP Solutions Challenge, a contest that encourages engineering students to use DSPs for new applications.

The Challenge, the first ever world-wide contest of its kind, received entries from more than 230 teams representing more than 700 students in 26 countries. The three finalist teams were from NTU, the University of Maryland in the United States, and Ecole Francaise d'Electronique et d'Informatique (EFREI) of France.

"Every country, without exception, produced visionary projects," said Torrence Robinson, TI's North American university program manager. "The success of the Challenge shows that, equipped with raw technology, students can design amazing new applications and learn DSP fundamentals in the process."

Challenge teams were judged on overall design creativity and applicability to real world needs that affect the way people live, learn, work, and play.

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## TI acquires Tartan

See page 3

## DSP Solutions Challenge

(Continued from page 1)

### Nanyang Technological University, Singapore

Challenge winners Dilip Krishnan and Showbhik Kalra are second-year computer engineering students at Nanyang Technological University (NTU), in the southwest of Singapore. Using parallel processing techniques on a network of TMS320C40 DSPs, the pair developed a motion-picture restoration system which erases damaged areas of old movie film, automatically filling in the resulting empty space with information captured from elsewhere in the film. Because movie image frames do not change significantly from one frame to the next, frames preceding and succeeding a damaged image provide enough comparative information to enable the system to detect degraded areas, mathematically model the image region, and fill in the degraded region with a restored image.

The restoration of a classic motion picture is a labor-intensive, costly undertaking. For example, the restoration of *Snow White* took 18 weeks with 60 workstation operators using 40 workstations in three shifts a day, seven days a week. NTU's DSP-based system will allow more advanced techniques that could handle such projects in a fraction of the time, at much less cost, and with far fewer people.

Both students said that this project will not end with the DSP Challenge competition: they plan to continue their work, and have been authorized to pursue

the restoration of color film. Faculty adviser to the Singapore team, Dr. Chong Man Nang, leads the parallel processing group at NTU's School of Applied Science. His research interests encompass parallel and distributed processing, scientific visualization, and multimedia signal processing.

### University of Maryland, College Park, MD

The finalists from the University of Maryland used TI's quad-TMS320C40 Parallel Processing Development System (PPDS) tool to design and implement a real-time system that compresses video signals for transmission over narrowband communication channels such as existing telephone lines. The system uses the DSPs to decompose video signals into discrete frequency bands, identifying bands that carry critical information and discarding bands that carrying non-essential data. Developed by students Hamid Jafarkani, Ruplu Bhattacharya, and Jerome Johnson, the system currently reduces video signals by a compression ratio of up to 100.

While many real-time video compression systems currently use custom-designed VLSI technology to solve specific applications, such systems are expensive and time consuming to design. Furthermore, custom-designed hardware is algorithm specific and cannot be reprogrammed to accommodate new algorithms or standards.

In contrast, the system developed by the Maryland team uses TI DSPs to provide fast real-time processing of large data sets, and to implement a fully programmable

video compression system that can handle a variety of algorithms and applications.

Nariman Farvardin, faculty adviser to the Maryland team, is chair of the school's department of electrical engineering. Farvardin has previous experience with the Ecole Nationale Supérieure des telecommunications in Paris, AT&T Bell Laboratories, and the National Institute of Standards and Technology.

### Ecole Francaise d'Electronique et d'Informatique, Paris, France

Finalists Xavier Gilles, Sylvain Marques, and Pierre-Henry Dezaux, undergraduate engineering students at the Ecole Française d'Electronique et d'Informatique (EFREI) outside Paris, developed a multi-processor DSP system for advanced Doppler radar tracking. Doppler weather radar, for example, is used to detect tornadoes, wind shear, and other dangerous weather conditions.

The team's DSP-based Doppler front end will be used in a new generation of small, light, and programmable tracking radar called AXIR. Because the system is based on conventional DSPs, the AXIR radar system will also cost far less than today's radar systems, making it affordable for small civilian airports and air clubs.

Equipped with four 16-bit 'C50 DSPs, the team's design provides computing power of more than 100 MIPS for sampling multiple antenna channels and executing pulse-compression correlation and adaptive Doppler filtering algorithm code.

Louis M. Fourdan, adviser to the EFREI team, received his degree from Ecole Supérieure d'Electricité, and has more than 35 years experience in Doppler radar research and design. Since 1961, he has served as a radar designer for Thomson CSF while conducting DSP, radar, and antenna courses at several engineering schools in France and Turkey.

For more information on TI's University Program, request the University Program brochure from your regional TI Literature Response Center (see back cover). ■



NTU team members Dilip Krishnan and Showbhik Kalra and advising professor Dr. Chong Man Nang with the result of their design of a 'C40-based motion picture restoration system.

# TI acquires Tartan, Inc.

## *Expands DSP development support capabilities*

TI has announced the acquisition of Tartan Inc., a leading independent provider of software tools for developers of DSP applications. The business will be merged into the TI Software Development Systems (SDS) organization as part of the SC Group's DSP solutions business. Most Tartan employees will become TIers, and continue working at their current locations. No TI jobs are affected. Tartan's primary offices will remain in Pittsburgh, Pennsylvania.

"Tartan is a clear technical leader in DSP tools, and this acquisition shows our commitment to providing the best DSP development support available in the industry," said Mike Hames, SC Group vice president and worldwide DSP manager. "TI will be able to take advantage of Tartan's expertise and technology to dramatically accelerate DSP technology development and to provide the best customer application support in the industry. By combining the technical expertise of Tartan and TI will strengthen TI's leadership position in digital signal processing

solutions and provide a technology base we can leverage throughout the rest of the decade and beyond."

"We are looking forward to increasing benefits to DSP applications designers as a result of merging Tartan's and TI's complementary expertise," said Jaime Ellertson, Tartan CEO. "DSP designers will be able to choose from a broader and more advanced range of software technology for their increasingly complex applications. Providing customers with a single source for all of their tool support will dramatically reduce their time-to-market for DSP solutions."

Tartan is a 15-year-old company with more than 80 professionals who support an integrated product line for DSP application development. Tartan's product line includes a variety of software and hardware tools that designers use to develop DSP-based products. The company was the first to develop a DSP compiler for C++ and Ada. Tartan is considered the DSP industry leader for these compilers. ■

## 1996 TMS320 Educators Conferences

### *Dates, locations announced for North America and Europe*

In recognition of the growing importance of digital signal processing and the crucial role played by teachers and researchers in stimulating this industry, TI is organizing conferences in Paris, France, and Houston, Texas. Both conferences will feature TI DSP engineers and designers presenting the state-of-the-art in DSP technology, some of the latest applications, and future trends. TMS320 Third Parties will also be on-hand for presentations and questions. Admission to the conference is free to all members of the academic community.

The Sixth Annual TMS320 Educators Conference will be held on August 8-9 at the Crowne Plaza Hotel in Houston, Texas.

The DSP Education and Research Conference, the first of its kind in Europe, will be held September 25-26 at Ecole Supérieure d'Ingenieurs en Electrotechnique et Electronique in Paris, France.

For further information and a registration form, please use the appropriate address below.

#### **For North America:**

Torrence H. Robinson  
Sixth Annual TMS320 Educators Conference  
Texas Instruments  
P.O. Box 1443, M/S 722  
Fax: (713) 274-2573  
e-mail: [univ@msg.ti.com](mailto:univ@msg.ti.com)  
<http://www.ti.com/sc/docs/dsp/univprog/edreg.htm>

#### **For Europe:**

Armelle Prie  
TI DSP Education and Research Conference  
800 Pavilion Drive, MS 14  
Northampton NN4 7YL, UK  
Fax: (+44) 1604 663107  
e-mail: [apri@msg.ti.com](mailto:apri@msg.ti.com) ■

## TMS320 WORKSHOPS

The Texas Instruments technical training organization offers hands-on workshops designed to help speed designs into production.

To register or for more information, call central registration at (214) 644-5580. Course descriptions can be found on the TI worldwide web site (see back cover).

West Coast, Canada  
(Beth Rea) (408) 383-2363  
Northeast and Southeast  
(Kim Rutherford) (617) 895-9185  
Mid-America  
(Ron Birkett) (214) 917-3894

USA WORKSHOP SCHEDULE			
City	'C2xx	'C5x	'C54x
Dallas	8/13	8/27	
Denver	7/16		
Irvine	8/20	7/23	7/30
San Jose	7/23	8/6	
City	'C3x	'C4x	'C8x
Boston	7/23	7/9 9/17	8/13
Dallas	7/30	7/9 9/24	7/23 9/17
Irvine	7/9		
San Jose	9/10		8/27

TI also provides excellent training support in Europe. For more information, send inquiries to the European customer training fax helpline at +49 8161 804010.

EUROPEAN WORKSHOP SCHEDULE			
City	'C2xx	'C5x	'C54x
Freising	10/29	7/16 9/24	10/8
Milano		10/1	
Northampton		9/10	
Paris	10/1	10/22	
City	'C3x	'C4x	'C8x
Freising	7/9 10/15	9/17	7/22 9/10
Milano			10/15
Northampton	10/1		
Paris	9/24	10/15	



## New TMS320-based flash DTAD processors

TI's new family of processors for digital telephone answering devices (DTADs) doubles message recording time to 28 minutes. This new product family of DTAD processors enables full-duplex speakerphone, caller ID, and caller ID on call waiting functions.

The TMS320 DSP-based family of DTAD processors offer advanced speech compression software and interface directly to Samsung and Toshiba NAND flash memory. The MSP58C81x and MSP58C83x families offer 45 I/O lines, an 8-bit A/D convertor with 3 multiplexed input lines, 20k words of internal ROM, 1.3k words of internal RAM, all built around a standard TMS320C25 DSP core. The MSP58C81X allows 14 minutes of record time with 4 MB of memory while the MSP58C83X family recording time climbs to 28 minutes with 4 MB of memory. Both families provide NAND flash interface.

Complete software modules for advanced features such as caller ID, caller ID on call waiting, and full-duplex speakerphone are also available. With these software modules, as well as customer-developed software, additional features and system control functionality can be masked into on-chip ROM. Also, by integrating system-control software onto the

DSP, a microcontroller device that might otherwise be used for system control can be eliminated entirely, reducing significantly the system's hardware costs. Custom-developed software also offers DTAD vendors the opportunity to incorporate differentiated capabilities into their systems.

The MSP58C83X family of DTAD processors is compatible with TI's advanced MELP (Mixed Excitation Linear Prediction) voice compression algorithm that is capable of recording times of 28 minutes with 4 MB of ARAM or NAND flash memory. Unlike competing vocoders (voice coder/decoder software) that use silence compression to achieve unpredictable recording times, MELP uses fixed-rate compression at 2.4K bps to achieve 28 minutes of very high quality voice recording.

The MSP58C83X is available in 100-pin quad flat packs (QFP) at US \$6.85 in 100,000-unit pricing, while the MSP58C81X, also in 100-pin quad flat packs (QFP), is US \$6.35 in 100,000-unit pricing.

For more information, request the MSP58C80 User's Guide and the MSP58C81 addendum from your regional TI Literature Response Center (see back cover). ■

## 'C8x Software Toolkit price reduction

Effective May 1, the price for the 'C8x Software Toolkit for Sun™ workstations (part # TMDX3248555-67) was reduced from US \$12,500 to US \$10,000. The toolkit includes a Master Processor (MP) optimizing C compiler, a Parallel Processor (PP) optimizing C compiler, source debuggers, MP and PP algebraic assemblers, and a linker. The 'C8x Software Toolkit is available from TI and its authorized distributors. ■

## 'C203-based reference design kit *Hamilton Hallmark's Spectralizer makes it easy!*

Hamilton Hallmark, distributor of semiconductors, connectors, passive components, and computer peripherals, has recently announced the Spectralizer, a combination 20-band (10-band stereo) spectrum analyzer and equalizer designed to demonstrate how the TMS320C203 can easily interface to SRAM, flash, PLD, CODEC, RS-232 serial interface, and more.

The reference design incorporates the processor, CODEC, SRAM, flash EPROM, LED decoder, and the bar graph display. The inputs to Spectralizer are left and right stereo audio line level signals and a mono microphone, which can be used to capture pink noise generated for environment spectral correction. The serial interface is used to control and/or display the output of the Spectralizer via a personal computer, if desired. The Spectralizer's left and right outputs are fed back into the audio source signal path after spectral correction.

Each Reference Design Kit is composed of design applications notes, a complete set of supplier data sheets, schematic drawings, a parts list, plus a 3.5-inch PC disk containing the schematic drawings, parts list, and Gerber plot. To order a 'C203 Spectralizer kit, contact Hamilton Hallmark at (800) 605-3294, ext. H231. ■

## 8-bit, 40-MSPS A/D convertor

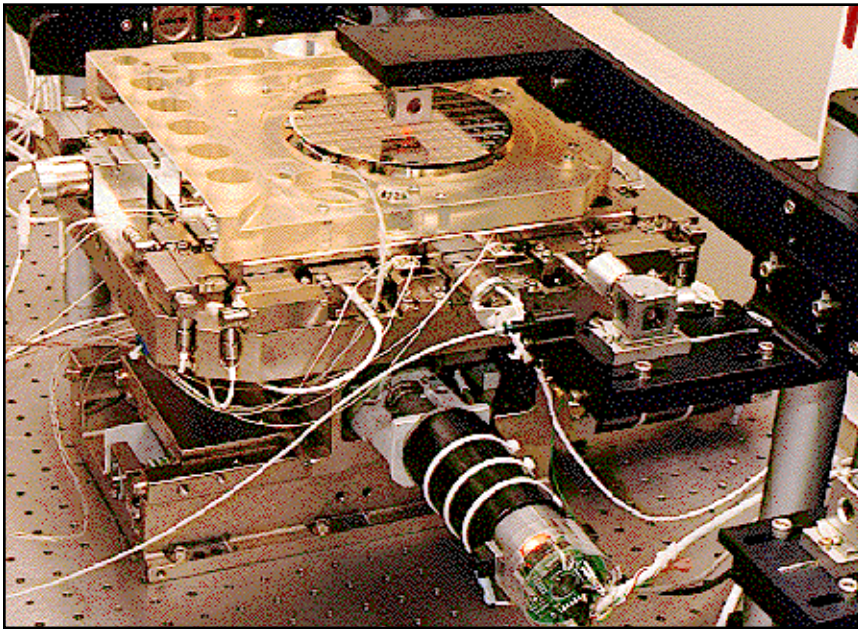
TI has announced the TLC5540 A/D convertor (ADC) which digitizes high bandwidth analog signals with 8-bit resolution at a minimum conversion rate of 40 MSPS. This product combines high speed performance with low power consumption and cost to create a new price/performance point for high-speed ADCs. Features include an analog bandwidth of 75 MHz (greater than Nyquist), internal sample and hold, internal self-bias reference network, and three-state outputs. Fabricated in a CMOS process, the TLC5540 requires a single 5-V supply for operation and dissipates only 85 mW of power typically at FS = 40 MSPS.

The TLC5540, in a 24-pin SOIC, can also be used for traditional Nyquist-based DSP applications. Specified with both static and dynamic characteristics, the TLC5540 delivers 7.5 effective bits with sampling rate of 20 MSPS and 6.9 effective bits with 40 MSPS. Differential non-linearity is specified at  $\pm 0.75$  LSB and integral non-linearity at  $\pm 1.0$  LSB. Spurious free dynamic range (SFDR) is typically 46 dBc at 20 MSPS and 44 dBc at 40 MSPS. US pricing is \$4.43.

For more information, request the TLC5540 data sheet from your regional TI Literature Response Center (see back cover). ■

# Multiple 'C40s control deep sub-micron lithography

## *TI DSPs now used for maglev positioning*



To meet the advanced requirements of deep sub-micron semiconductor production, researchers at Sandia National Laboratories (Livermore, CA) have developed a frictionless, nanometer-accurate wafer positioning system. The system uses magnetic levitation (maglev) technology controlled by a total of six TI TMS320C40 DSPs. Until recently, the nonlinear nature and computational requirements of maglev positioning has made the technology impractical for commercial wafer stepper applications, but by leveraging the processing power of multiple DSPs, the approach has now become viable.

Conventional fine-resolution wafer-positioning systems use piezoelectric, linear, or DC motors which must be physically coupled to a wafer holder through lead screws and friction drives. Maglev positioning completely eliminates this physical coupling, greatly increasing positioning flexibility and accuracy. The Sandia system uses the TI DSP-based maglev positioning to enable an advanced form of projection lithography, known as extreme ultraviolet lithography (EUVL). Already, developers of the technology are experimenting with 0.1-micron gate sizes, and commercial production processes based on EUVL technology are expected within the next ten years.

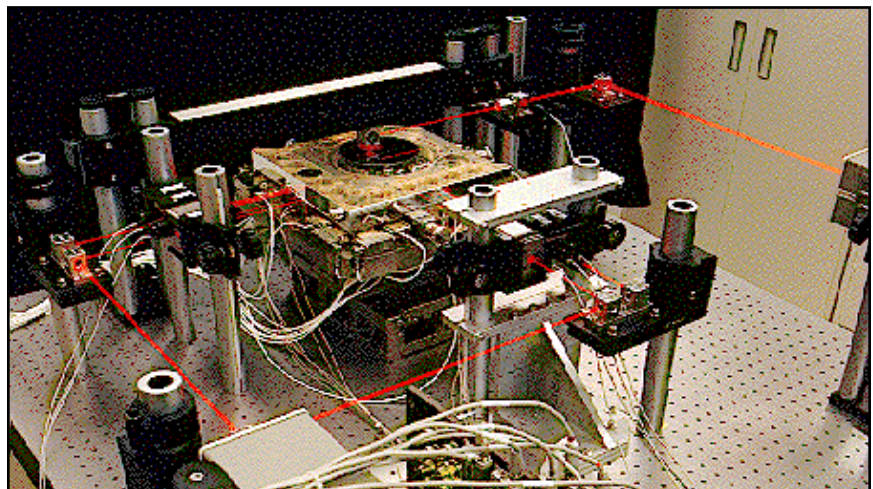
Sandia's experimental system, based on a Hydra quad-TMS320C40 VMEbus™ board from Ariel Corporation (Cranbury, NJ), controls the position of a magnetically levitated wafer holder by using data from capacitive sensors and laser interferometers.

The Hydra board, coupled with a pair of Ariel's 'C40-based CommIO-IP data acquisition cards, serves as a master controller for the maglev system. Each CommIO-IP card contains one A/D IndustryPack™ module to acquire sensor data, and three D/A IndustryPack mod-

ules to drive the actuators. The Hydra board communicates with the CommIO-IP boards via 12 'C40 comm ports, and a 'C40 on each CommIO-IP routes data between IndustryPack modules and the 'C40 comm ports. The Hydra board also acquires laser interferometry position information from seven Hewlett Packard laser axis interferometry boards.

On the Hydra board, 'C40 #1 handles host communications and provides a synchronization trigger to the laser interferometer cards. 'C40 #3 runs a real-time PID (Proportional Integral Derivative) control loop algorithm to calculate the magnetic forces needed to position the wafer holder. 'C40s #2 and #4 then compute real-time, force-to-current conversions, deriving outputs for the 16 D/A channels to drive the electromagnetic actuators. 'C40s #2 and #4 also handle data collection and status monitoring for the interferometer cards.

Although Sandia's designers developed the 'C40-based maglev wafer positioning system to meet the requirements of an EUVL application, the system's ultra-fine resolution and simplicity also makes it ideal for other wafer processing systems. Integrated Solutions Inc. (Tewksbury, MA), for example, is currently using the Sandia maglev fine positioning stage and an Ariel 'C40-based control system to upgrade their own stepper in a conventional projection lithography system. ■



Ariel's 'C40 Hydra board and laser interferometers are used for wafer positioning.



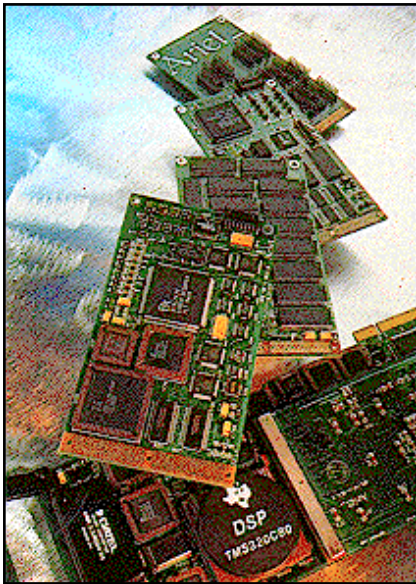
## NEW THIRD-PARTY HARDWARE AND SOFTWARE



*This section features new development and application support available through TMS320 Third Parties.*

### Image processing modules for the 'C80

Ariel has announced a GMI Module which includes a digital camera interface, video input/output modules, a family of DRAM expansion modules, and prototyping and debug modules. The modules are available for the Griffin P100, Ariel's PCI bus image-processing plug-in card based on the 'C80.



Ariel Corporation's GMI module with digital camera interface

The digital camera interface, GMI-DCAM, supports line- and area-scan cameras. The video input module, known as GMI-NTSC-IN, supports Y/CR/CB, RGB, and monochrome video modes. The output module, known as GMI-NTSC-OUT, enables Griffin to output video to cameras, VCRs, television monitors and virtual reality glasses.

Griffin is also available for prototyping with the GMI-CUSTOM module and debug with the GMI-DEBUG module that simplify the design of custom modules. DRAM and SDRAM modules are also available.

US pricing for the modules is: \$1,500 for the GMI-DCAM, \$895 for the GMI-NTSC-IN, and \$1,495 for the GMI-NTSC-OUT. The GMI-CUSTOM module and GMI-DEBUG module are \$495.

Ariel Corporation  
Phone: + (609) 860-2900  
e-mail: ariel@ariel.com

### Fiber optic 'C40 comm port extender

Pentek, Inc. has released a flexible, low-cost fiber optic 'C40 communication port extender for remote digital signal processing and data acquisition applications.

The Model 6110 is a general-purpose 'C40 comm port adapter that provides high-speed, long-distance connections between Pentek's DSP product and compatible peripherals including A/D and D/A converters, digital telecom, SCSI, and digital receivers. The 6110 'C40 comm port adapter is available for US \$2,495.

Pentek Incorporated  
Phone: + (201) 767-7100  
e-mail: info@pentek.com

### 'C44 TIM-40 modules

Transtech Parallel Systems has added new low-cost TMS320C44-based TIM-40 modules designed for parallel DSP applications such as image processing, machine vision, multi-channel speech processing, and sonar.

All the modules in the series are size 1 (107 × 64 mm) and carry up to two processors with a wide variety of memory

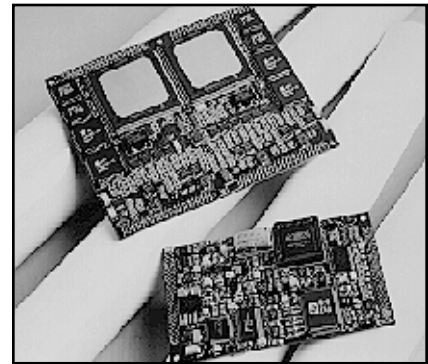


'C44-based modules from Transtech

options from 128 Kbytes of SRAM to 8 Mbytes of zero-wait-state EDROM. They are compatible with PC/AT™, PCI, and VME DSP motherboards.

For pricing information contact:  
Transtech Parallel Systems, Ltd.  
Phone: + 44 (0)1494 464303  
Fax: + 44 (0)1494 463686

### 'C44-based DDR module set



MDC44DDC and MD70MAI modules from Spectrum Signal Processing, Inc.

Spectrum Signal Processing, Inc. has announced a Narrow Band Receiver Set (NBR) consisting of the MDC44DDC and the MD70MAI modules which are based on the TMS320C44. The module set is designed for sophisticated military and C3I (Command, Control, Communications and Intelligence) applications.

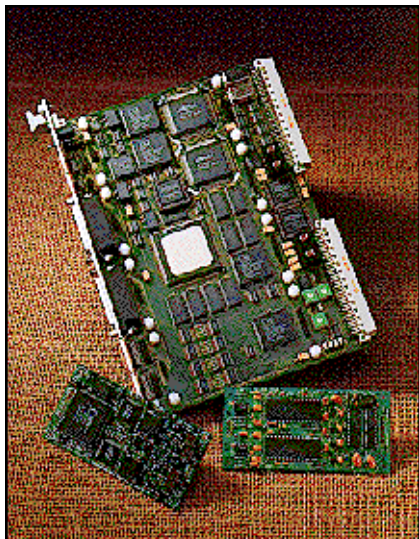
The module set features eight DDCs and four 'C44 DSPs in a single 6U VME or ISA slot, along with a 10-bit 70-MS/s A/D module. Also included is a 1.25 Gbit/sec Glink serial bus for communication between unlimited daisy-chained modules.

The MDC44DDC Narrow Band Receiver module is now available and priced in single quantities for US \$7,900. The MD70MAI Analog Input module is US \$2,900 in single quantities.

Spectrum Signal Processing  
Phone: + (604) 421-5422  
Fax: + (604) 421-1764

### Multi-channel 'C44 audio board

Loughborough Sound Images has announced the DBV41, a single VME™



The DBV41 with 50-MHz 'C44s for VME applications

board with a 50-MHz 'C44 DSP coupled with a complete I/O subsystem. It features sites for up to four analog daughter modules for up to 16 I/O channels.

The DBV41 will also provide 16 inputs at 50 kHz for multi-channel audio applications, or 12-bit, 1-MHz operation with eight inputs for instrumentation equipment.

For pricing information contact:  
Loughborough Sound Images plc  
Phone: + 44 (0) 1509 634300  
Fax: + 44 (0) 1509 634333

### 'C5x G.729 implementation

Castleton Network Systems Corp. has announced a G.729 ITU voice compression standard for use on the TMS320C5x DSP in a wide range of applications including wireless communications, digital satellite systems, packetized speech, and digital leased lines. The software is C callable, fully re-entrant, and offers toll-quality, full-duplex operation.

For pricing information, contact:  
Castleton Network Systems Corp.  
Phone: + (604) 293-0039  
e-mail: inquire@castleton.com

### PCMCIA TMS320 emulator

White Mountain DSP has released the Mountain 510/LT, a universal Type III PCMCIA emulator that provides mobile emulation support for the TMS320C2xx, 'C3x, 'C4x, 'C5x, 'C54x, and 'C8x DSP

generations.

The Mountain 510/LT is compatible with most popular debuggers for TI DSPs, including TI's C/assembly source debugger, White Mountain's Vista-MP™, Tartan's C/C++, and Code Composer™ from GO DSP.

Pricing is US \$2,995 for the PCMCIA card and the appropriate emulation pod. Debugger software may be purchased separately.

White Mountain DSP  
Phone: + (603) 883-2430  
e-mail: info@wmdsp.com

### 'C542 DSP development board

DSP Research has announced the TIGER 542/PC, a TMS320C542-based development system for wireless communications applications that features 256 Mbytes of zero-wait-state SRAM, two 16-bit, 50-kHz CD-quality I/O, a standard RJ-11 telephone interface, and an RS-232 UART.

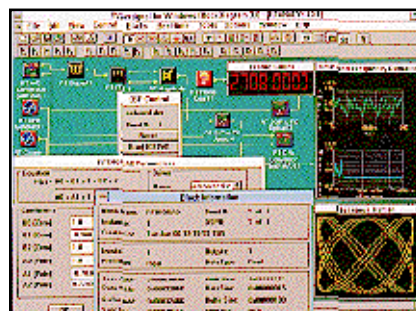
Software offerings include the TI Optimizing C Compiler, Assembler, Linker and Loader, and the DB5xx C Source Level Debugger. Included with the 542/PC is the TIGER QuickSTART operating environment which includes device drivers, DSP memory allocation, buffer handling, and standard I/O to the host.

US pricing for the TIGER 542/PC starts at \$1,695, while complete software packages and board start at \$3,295.

DSP Research  
Phone: + (408) 773-1042  
e-mail: info@dspr.com

### DSP development environment

Hyperception has announced its Hypersignal® Real-time Integrated Development Environment (RIDE), a



Hyperception's RIDE visual environment for DSP algorithm development

visual environment for design, implementation, and analysis of DSP algorithms and systems.

RIDE capabilities include full-featured COFF support, heterogeneous multiple processor support, full environment information, Block Wizard support, and real-time DSP application export.

Hypersignal RIDE is available for US \$3,995. An automatic C code generator can be purchased with RIDE for US \$5,000. Bundled software and hardware packages are also available.

Hyperception, Inc.  
Phone: + (214) 343-8525  
e-mail: info@hyperception.com

### Modem data pump software

AlgoTron Ltd. has developed modem data pump software for the TMS320C2x, 'C2xx, and 'C5x DSPs at various ITU data modem V-series implementations, transfer rates, and duplex modes. V-series implementations range from V.17 to V.32bis and V.33 at data rates up to 14.4 kbps. Also, techniques have been incorporated to maintain performance under noisy or poor line conditions.

Contact AlgoTron for pricing information on software licenses.

AlgoTron Ltd.  
Phone: + (0) 181 246 6706

### MPEG audio encoder module

Atlanta Signal Processors, Inc., has released an audio encoder module that implements ISO MPEG audio compression. It includes a stereo 16-bit A/D converter and a glueless interface to digital audio receiver chips, and produces compressed audio in either a bit-serial or byte-parallel format.

Pricing for the MPEG module starts at US \$1,250.

Atlanta Signal Processors, Inc.  
Phone: + (404) 892-7265  
Fax: + (404) 892-2512  
e-mail: info@aspi.com ■