



THE

9000

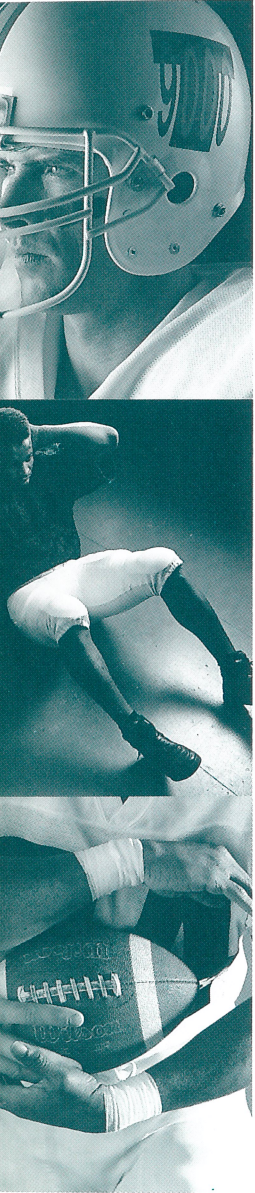
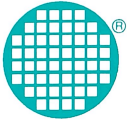
TRANSPUTER

DEVELOPMENT  
SYSTEMS

=



INMOS is a member of the SGS-THOMSON Microelectronics Group



- The T9000 transputer is a high performance 32-bit CMOS microprocessor from INMOS. It is the first member of a new generation of transputers, extending the transputer range and providing a new dimension of performance and multiprocessing capability.
- The T9000 offers exceptional single processor peak performance of 200 MIPS and 25 MFLOPS, and its dedicated on-chip communications processor and high speed serial communications links give access to virtually unlimited multiprocessing power.
- System evaluation and development with the T9000 could not be easier. The INMOS *iq* systems product family provides a complete range of TRAMs (TRANsputer Modules). These board-level components simply plug together on motherboards, allowing the developer to evaluate, benchmark and prototype T9000 applications quickly and easily.
- The T9000 is supported by a wide range of industry standard software tools, including compilers, windowing debuggers, real-time kernels, and operating systems, enabling quality products to be developed in minimum time and with minimum effort, for maximum effect.

## Multiprocessing made simple

No other microprocessor has the combination of exceptional single processor performance and complete support for practical multiprocessing solutions that the T9000 transputer offers.

Programming a network of multiple T9000 transputers is as simple as programming a single T9000 because of the on and off-chip communications support.

Transputers use the same instructions for communication between software processes on a single processor, as between processes on different processors. This allows code to be developed independently of the destination hardware so that a programmer can write multiprocessing software on a single transputer, and then allocate the processes onto an optimum number of transputers at a later stage.

Communication between processes on T9000 transputers takes place over virtual channels, with multiple virtual channels multiplexed onto each physical link by the T9000's on-chip Virtual Channel Processor (VCP).

The C104 packet routing switch acts as a telephone exchange on a single chip, routing messages to the appropriate T9000 in a network. The user is therefore able to develop software on a single processor, and then to easily map the software processes onto any processor in the network, allowing any one process to communicate to any other in a system. It is of no consequence whether the process is on the same processor, on a neighbouring processor, or on a processor on the other side of the network.

The combination of virtual channels and the C104 packet routing switch gives a new dimension of flexibility in developing multiprocessor systems with the T9000 transputer, making it possible to develop several product variants with differing performance figures (and hence with differing price tags) all based on the same software.



## TRAMS

The *iq* systems range of TRAnsputer Modules (TRAMs) provides complete system construction flexibility.

TRAMs exploit the transputer's communications capability and high level of integration to enable compact transputer systems to be easily built, such as a T805 transputer with 4 MBytes of DRAM on a board smaller than a credit card. A large variety of transputer/memory/special purpose configurations is available.

TRAMs can be mounted on a variety of motherboards, providing an interface to a range of host computer systems. Communication between TRAMs takes place over transputer links, so that multiple TRAMs can be mounted onto each motherboard, and motherboards can be connected together to build large multiprocessor systems.

The modular TRAM concept has been extended to exploit the new and enhanced features of the T9000 transputer. T9000 modules are available that conform to the existing TRAM standard, allowing the processing power of the T9000 to be utilised immediately within an existing TRAM network. In addition, a new complementary standard has been developed to exploit the increased performance of the T9000 links, which provide a total of 80 MBytes/s bidirectional bandwidth. Products that conform to this new standard are denoted HyperTRAMs (HTRAMs).

The ability to mix TRAMs and HTRAMs on motherboards means that an extensive range of performance and I/O products are available in a compact, flexible architecture. For application based TRAMs there is a comprehensive list of support software including SCSI and GPIB libraries as well as graphics software and a full TCP/IP implementation.

For networking and operability within a mixed host environment, *iq* systems provides the ability to share powerful and scalable multiprocessor networks between users running different operating systems and application programmes.

The TRAM standard has been adopted by many third party developers, extending the range of compatible systems products for the whole transputer family. Details of these products can be found in the Transputer White Pages (available from INMOS).

In summary, TRAMs and *iq* systems give significant benefits in all stages of a product's life cycle:

- Development

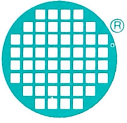
The ability to achieve multi-user development across a variety of hosts.

- Prototyping

The ability to experiment and evaluate designs rapidly, utilising the extensive range of compute and I/O products.

- System integration

High quality system components allow the system builder to supply a variety of upgradable products with different processing power and I/O configurations, all from one common design. This gives benefits in initial design investment, minimising stock requirements and extending product life cycles.



## INMOS toolset products

To enable the user to program, test and debug single and multiple transputer systems, INMOS supplies the Transputer Toolset. Each INMOS Toolset is a collection of software tools containing an ANSI C, ANSI FORTRAN 77, C++ or occam 2 compiler, plus host servers, configurer and collector, simulator, symbolic debugger, and windowing debugger.

### Host server

A server program written in ANSI C runs on the host computer connected to the transputer network. It can be used to load programs on the transputer network and begins automatically once the network has been loaded. The server provides access to the host computer terminal and file system from the transputer network; the source of the server is also provided. INMOS and third parties support a variety of host computers including IBM PC, NEC PC, VAX and SUN3/SUN4.

### Configurer and collector

To produce a multi-transputer program, the required mapping of processes to processors is described in a configuration description file. The configurer checks the description and passes the results to the collector, indicating how the program code and data should be mapped onto the network. The collector creates the bootstrap and routing information necessary to load the entire network, and stores this with the compiled application code in a program code file. The program code file can then be used to load the complete network. ANSI C, C++, FORTRAN and occam 2 processes may be mixed freely when configuring a program.

### Simulator

The simulator tool allows the programmer to simulate a network of T9000 processors connected to a host workstation running the server program. The simulator runs on T4xx and T8xx transputers and provides machine level debugging of T9000 code.

### Symbolic debuggers

The *interactive debugger* provides source level interactive debugging across networks of all transputer types. Breakpoints can be set at the source or machine level, on any processor in the network. The state of any halted process can be examined and/or altered symbolically. If a process is waiting on a channel, it is possible to jump through the channel and inspect the state of the waiting process, even if it is on another transputer. The debugger will switch automatically between source code languages when debugging a mixed language program.

The *post-mortem debugger* works with exactly the same code as will run in the final product. It supports cases where the program works under simulation, and with the debugging kernel compiled in, but fails when debugging support is removed. After a program has halted or been interrupted by the programmer, the state of the network can be preserved so that the post-mortem debugger can be utilised. The post-mortem debugger supports direct analysis of the network, or allows the state of the network to be saved in a dump file for subsequent investigation. The post-mortem debugger supports the same symbolic and machine level browsing functions as the interactive debugger.

### Windowing debugger

The windowing debugger is the latest addition to the software tools family. Using OSF/Motif on a SUN-based X-Window System, the debugger integrates multiprocess and multiprocessor debugging into the X-desktop metaphor. Inexperienced users will find that the intuitive interface considerably reduces their learning time, whilst more experienced users will benefit from easier access to the more advanced commands, and reduced time spent debugging. The windowing system provides the ideal debugging environment, using multiple windows to provide multiple viewpoints onto the separate program parts, giving the user independent control over the processes.



## Programming languages

For fast development time, the T9000, like all transputers, is supported by a range of industry standard compilers which allow processes running on one or more transputers to be written in any mixture of languages. This gives the user complete flexibility to develop software using the optimum choice of languages for the application requirements.

All these compilers provide minimised code size, resulting in cost savings and speed increases for real-time embedded applications.

The mathematical libraries provided with each are generated from the same source, ensuring identical results and accuracy.

### Optimising ANSI C

The optimising ANSI C compiler supports the full standard language as defined in X3.159-1989, and has been independently validated against this standard by the British Standards Institute (BSI) using the Plum Hall test suite. The compiler implements a wide range of optimising techniques and supports all transputer types through the use of command line switches. A full set of ANSI libraries is provided, as well as a reduced C library. Support for parallelism is also achieved through the use of library calls. A powerful assembler insert facility is provided for programming critical code at the machine level.

### C++

The C++ language combines the benefits of object orientated programming with the efficiency of C. The INMOS C++ product offering is the result of a strategic partnership with Glockenspiel, the first company to licence C++ from AT&T. Conforming to the C++ 2.0 specification, it includes a native C++ compiler and a C++ cross-compiler, and is able to generate code for all transputer types. These compilers have been designed to work with the ANSI C Toolset, giving access to the full range of INMOS multiprocessor development tools.

### ANSI FORTRAN 77

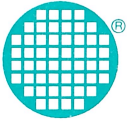
The ANSI FORTRAN 77 compiler supports the full standard language as defined in X3.9-1978 plus a number of VAX and IBM FORTRAN extensions. A reduced FORTRAN 77 run-time system minimises code size. This library is appropriate for processes which do not need access to host operating system facilities. The ANSI FORTRAN 77 compiler supports parallelism on individual transputers, and across networks of transputers, thus supporting farming, pipelines and data parallelism over arrays of processors.

### occam 2

occam 2 is a secure, structured language which supports the design and implementation of concurrent systems on networks of processors. The occam 2 model consists of parallel processes communicating through channels, and as such it maps directly onto the transputer architecture, extending the use of formal methods to software development. It is equally suitable for optimising transputer performance in real-time or massively parallel computing applications. The occam 2 compiler is able to generate code for all transputer types, and supports the full occam 2 language as defined in the occam 2 Reference Manual, published by Prentice-Hall, ISBN 0-13-629312-3.

### ADA (available from Alslys)

The Alslys ADA transputer cross-compiler offers a complete production quality ADA environment suitable for the development of real-time embedded systems. In addition to the ADA compiler, other development tools are provided, including two optimisers, a run-time executive and a source-level symbolic debugger.



## Third party products

The T9000 has a range of system software support available from third party companies which enables it to effectively meet the demands of applications in the embedded systems market.

### VRTX (from Ready Systems)

VRTX32 for transputers (VRTX32/T) is a multitasking executive designed for real-time embedded computer applications. VRTX32 works on all transputers, including the T9000, without modification, and since VRTX32 has been extensively tested, developers can begin to work on the end application immediately. Within the VRTX32/T model, extensions are provided which allow VRTX32/T tasks on different transputers to communicate over channels. The VRTX32 implementation on transputers is fully compatible with the INMOS ANSI C compiler, allowing VRTX32/T applications to be written in ANSI C.

### C-Executive (from JMI Software Consultants)

C-Executive for the transputer has been specifically developed to facilitate the design and implementation of transputer-based real-time embedded systems. It provides services such as fully pre-emptive scheduling, interprocess communication and optional access to a filesystem for all transputer types including the T9000. C-Executive is written in ANSI C and assembler, providing a standard C programming environment whilst maintaining fast response times for interrupt handling and context switching. C-Executive can be compiled, assembled and linked using the INMOS ANSI C compiler in the same way as application programs.

### CHORUS/MiX (from Chorus Systemes)

The CHORUS family of operating systems is centred around a small, real-time distributed nucleus which provides a minimal set of essential services. The CHORUS/MiX operating system, running on the T9000, incorporates this nucleus as well as a standard UNIX interface (System V) which is transparently extended to support distributed processing and real-time environments. In particular, CHORUS/MiX supports dynamically re-configurable systems and applications.

### Behavioural simulation models (from Logic Automation)

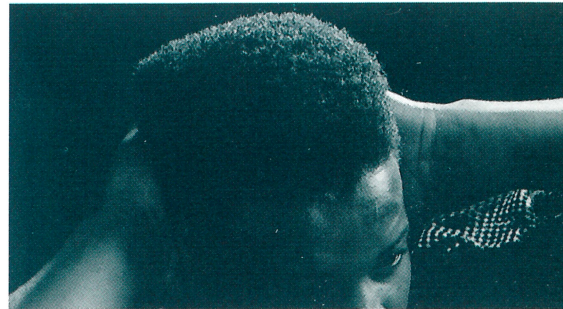
Logic Automation offers a behavioural language model that simulates transputer bus cycles. The model is controlled by the designer through the Logic Automation Processor Control Language (PCL), permitting board-level simulations that aid the development, debugging and optimisation of transputer based designs.

### Transputer analysis package (from Biomation)

The Biomation CLAS 4000 transputer analysis package is based on a very high speed logic analysis system. Passive interfaces bring the transputer signals directly to high impedance data probes. The captured data can be viewed in several windows, with each window displaying different data formats such as timing diagrams, decoded mnemonics, HEX, binary etc. User defined trigger patterns make it easy to specify which samples are captured.

### Logic analyser inverse assembler (from Hewlett Packard)

Hewlett Packard is able to supply an inverse assembly package based on the HP16500 Logic Analyser. The samples taken from the T9000 address and data buses are disassembled by software running on the logic analyser to give the designer a view of the instructions that are being executed. The inverse assembler takes the form of a pop-up menu within the existing analyser software, giving the user access to the comprehensive range of data capture facilities.





## INMOS Software Products

	PC	NEC PC	PS/2	SUN3	SUN386i	SUN4	VAX
ANSI C Toolset	IMS D7314	IMS D7314	IMS D7314	IMS D5314	IMS D7314	IMS D4314	IMS D6314
C++ Compiler	IMS D7217	IMS D7217	IMS D7217	IMS D5217	IMS D7217	IMS D4217	IMS D6217
FORTRAN Toolset	IMS D7316	IMS D7316	IMS D7316	IMS D5316	IMS D7316	IMS D4316	IMS D6316
occam 2 Toolset	IMS D7305	IMS D7305	IMS D7305	IMS D5305	IMS D7305	IMS D4305	IMS D6305
Windowing Debugger				IMS D5318		IMS D4318	

## INMOS Hardware Products (advance information)

### T9000 TRAMs

T9000 TRAMs have been developed to allow immediate integration within existing TRAM development systems. These use the standard TRAM link technology for communication. There is also an option in this format that allows evaluation of the full T9000 link performance at 100 MBits/s. These products are indicated in the table opposite by a 'Yes' in the 'HTRAM Links' column.

Memory	TRAM Size	HTRAM Links	Part Number
4Mbyte	2	No	IMS B450-18
4Mbyte	4	Yes	IMS B451-18
16Mbyte	2	No	IMS B452-18
16Mbyte	4	Yes	IMS B453-18

### HTRAMs

A new range of T9000 modules are planned based on the new HTRAM format. The first HTRAM products to be provided are shown in the table opposite.

Memory	HTRAM Size	Part Number
4Mbyte	2	IMS B902-1
16Mbyte	4	IMS B904-1

### Motherboards

TRAMs can be mounted on a variety of motherboards, providing an interface to a number of host computers. To complement the existing range of TRAM motherboards, the T9000 is supported by a new range of motherboards based on the new HTRAM standard. The complete family of motherboards is shown opposite.

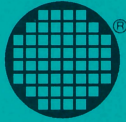
Format	No. of TRAM Slots	No. of HTRAM Slots	Part Number
IBM PC-AT	10	0	IMS B008-1
NEC-PC	5	0	IMS B015-1
IBM PS/2	4	0	IMS B017-1
VMEbus (6U)	8	0	IMS B014-1
IBM PC-AT	tbc	tbc	IMS B108-1
S-Bus	0	tbc	IMS B101-1

### Further information

INMOS is a member of the SGS-THOMSON Microelectronics Group, and supplies high performance microprocessors, systems products and colour graphics devices worldwide. The company has sales offices throughout the world,

supported by a network of experienced Field Application Engineers to assist with the design-in of the T9000. For further details please contact your local SGS-THOMSON Microelectronics sales office.





SALES OFFICES

EUROPE

Denmark

2730 HERLEV  
Herlev Torv, 4  
Tel. (45-42) 94.85.33  
Telex: 35411  
Telefax: (45-42) 948694

Finland

LOHJA SF-08150  
Karjalankatu, 2  
Tel. 12.155.11  
Telefax: 12.155.66

France

94253 GENTILLY Cedex  
7, Avenue Gallieni - BP 93  
Tel. (33-1) 47.40.75.75  
Telex: 632570 STMHQ  
Telefax: (33-1) 47.40.79.10

67000 STRASBOURG

20, Place des Halles  
Tel. (33) 88.75.50.66  
Telex: 870001F  
Telefax: (33) 88.22.29.32

Germany

6000 FRANKFURT  
Gutleutstrasse, 322  
Tel. (49-69) 237492  
Telex: 176997 689  
Telefax: (49-69) 231957  
Teletex: 6997689=STVBP

8011 GRASBRUNN  
Bretonischer Ring, 4  
Neukerloh Technopark  
Tel. (49-89) 46006-0  
Telex: 528211  
Telefax: (49-89) 4605454  
Teletex: 897107=STDISTR

3000 HANNOVER 1  
Eckenerstrasse, 5  
Tel. (49-511) 634191  
Telex: 175118418  
Telefax: (49-511) 633552  
Teletex: 5118418 csfbeh

8500NÜRNBERG20  
Erlenstegenstrasse, 72  
Tel. (49-911) 59893-0  
Telex: 626243  
Telefax: (49-911) 5980701

5200 SIEGBURG  
Frankfurter Str. 22a  
Tel. (49-2241) 660 84-86  
Telex: 889510  
Telefax: (49-2241) 67584

7000 STUTTGART  
Oberer Kirchhaldenweg, 135  
Tel. (49-711) 692041  
Telex: 721718  
Telefax: (49-711) 691408

Italy

20090 ASSAGO (MI)  
V.le Milanofiori - Strada 4 -  
Palazzo A/4/A  
Tel. (39-2) 89213.1 (10 lines)  
Telex: 330131 - 330141 SGSAGR  
Telefax: (39-2) 8250449

40033 CASALECCHIO DI RENO (BO)  
Via R. Fucini, 12  
Tel. (39-51) 591914  
Telex: 512442  
Telefax: (39-51) 591305

00161 ROMA  
Via A. Torlonia, 15  
Tel. (39-6) 8443341  
Telex: 620653 SGSATE I  
Telefax: (39-6) 8444474

Netherlands

5652 AR EINDHOVEN  
Meerenakkenweg, 1  
Tel. (31-40) 550015  
Telex: 51186  
Telefax: (31-40) 528835

Spain

08021 BARCELONA  
Calle Platon, 6 4<sup>th</sup> Floor, 5<sup>th</sup> Door  
Tel. (34-3) 4143300 - 4143361  
Telefax: (34-3) 2021461

28027 MADRID  
Calle Albacete, 5  
Tel. (34-1) 4051615  
Telex: 27060 TCEE  
Telefax: (34-1) 4031134

Sweden

S-16421 KISTA  
Borgarfjordsgatan, 13 - Box 1094  
Tel. (46-8) 7939220  
Telex: 12078 THSWS  
Telefax: (46-8) 7504950

Switzerland

1218 GRAND-SACONNEX (GENEVA)  
Chemin François-Lehmann 18/A  
Tel. (41-22) 7986462  
Telex: 415493 STM CH  
Telefax: (41-22) 7984869

United Kingdom and Eire

MARLOW, BUCKS SL7 1YL  
Planar House, Parkway  
Globe Park  
Tel. (44-628) 890800  
Telex: 847458  
Telefax: (44-628) 890391

AMERICAS

Brazil

05413SÃO PAULO  
R. Henrique Schaumann 286-CJ33  
Tel. (55-11) 883-5455  
Telex: (391) 11-37888 "UMBR BR"  
Telefax: 11-551-128-22367

Canada

NEPEAN, ONTARIO  
301, Moodie Drive  
Suite 307  
Tel. (1)-(613) 8299944  
Telefax: (1)-(613) 8298994

USA

NORTH & SOUTH AMERICAN  
MARKETING HEADQUARTERS  
1000, East Bell Road  
Phoenix, AZ 85022  
(1)-(602) 867-6100

SALES COVERAGE BY STATE

ALABAMA  
Huntsville - (205) 533-5995

ARIZONA  
Phoenix - (602) 867-6340

CALIFORNIA  
Santa Ana - (714) 957-6018  
San Jose - (408) 452-8585

COLORADO  
Boulder (303) 449-9000

ILLINOIS  
Schaumburg - (708) 517-1890

INDIANA  
Kokomo - (317) 459-4700

MASSACHUSETTS  
Lincoln - (617) 259-0300

NEW JERSEY  
Voorhees - (609) 772-6222

NEW YORK  
Poughkeepsie - (914) 454-8813

NORTH CAROLINA  
Raleigh - (919) 787-6555

TEXAS  
Carrollton - (214) 466-8844

ASIA/PACIFIC

Australia

NSW 2027 EDGECLIFF  
Suite 211, Edgecliff Centre  
203-233, New South Head Road  
Tel. (61-2) 327.39.22  
Telex: 071 126911 TCAUS  
Telefax: (61-2) 327.61.76

Hong Kong

WANCHAI  
22nd Floor - Hopewell Centre  
183, Queen's Road East  
Tel. (852-5) 8615788  
Telex: 60955 ESGIES HX  
Telefax: (852-5) 8656589

India

NEW DELHI 110001  
Liaison Office  
62, Upper Ground Floor  
World Trade Centre  
Barakhamba Lane  
Tel. 3715191  
Telex: 031-66816 STMI IN  
Telefax: 3715192

Korea

SEOUL 121  
8th Floor Shinwon Building  
823-14, Yuksam-Dong  
Kang-Nam-Gu  
Tel. (82-2) 553-0399  
Telex: SGSKOR K29998  
Telefax: (82-2) 552-1051

Malaysia

PULAU PINANG 10400  
4th Floor, Suite 4-03  
Bangunan FOP, 123D Jalan Anson  
Tel. (04) 379735  
Telefax: (04) 379816

Singapore

SINGAPORE 2056  
28 Ang Mo Kio - Industrial Park, 2  
Tel. (65) 48214 11  
Telex: RS 55201 ESGIES  
Telefax: (65) 4820240

Taiwan

TAIPEI  
12th Floor  
571, Tun Hua South Road  
Tel. (886-2) 755-4111  
Telex: 10310 ESGIE TW  
Telefax: (886-2) 755-4008

JAPAN

TOKYO 108  
Nisseki Takanawa Bld. 4F  
2-18-10 Takanawa  
Minato-ku  
Tel. (81-3) 3280-4125  
Telefax: (81-3) 3280-4131