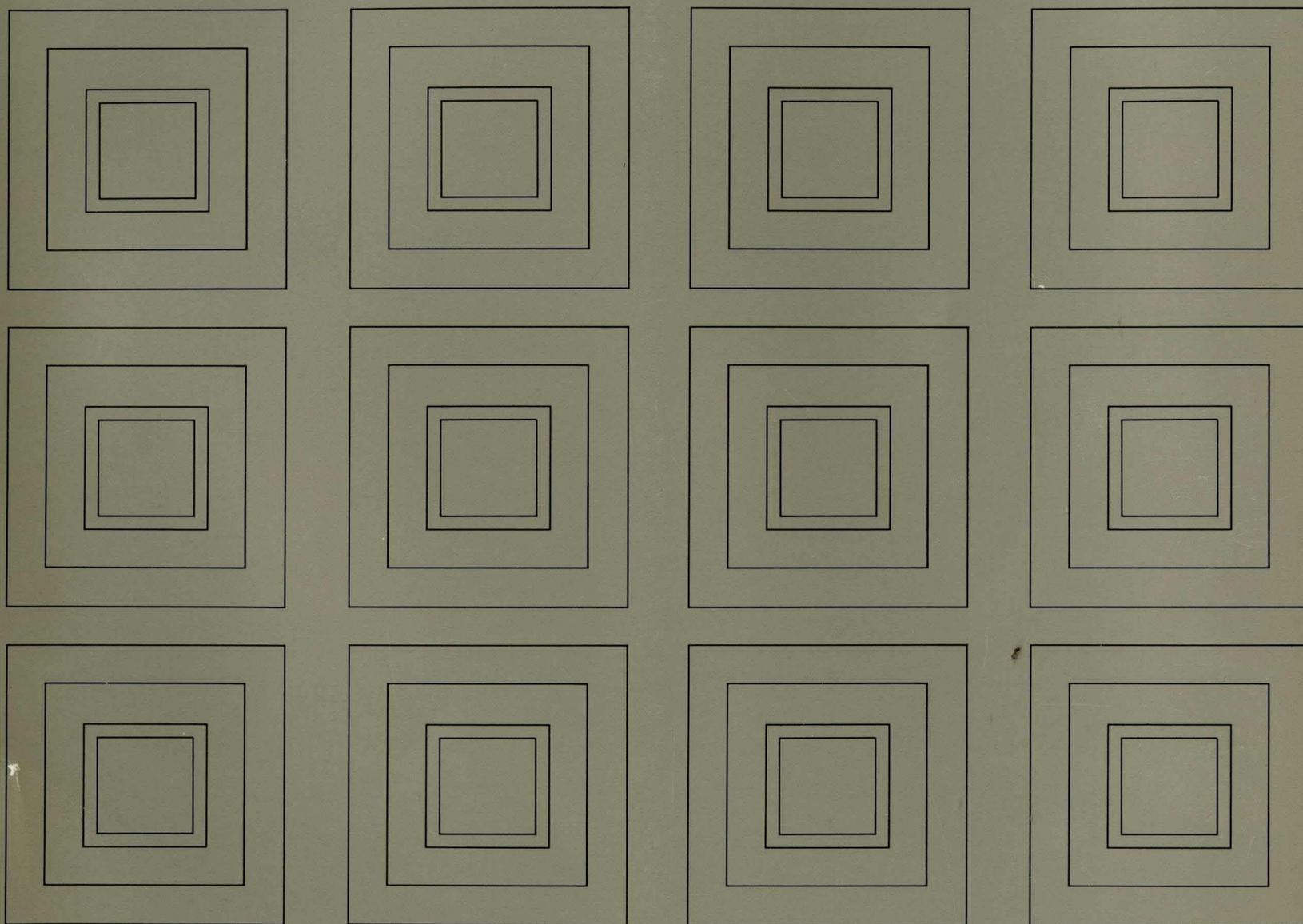


IBM'S 4381 PROCESSOR FAMILY: STEPS FORWARD IN TECHNOLOGY



THE IBM 4381 STORY CONTINUES

The IBM 4381 processors contain some of the most advanced and innovative technology available from IBM to provide new levels of performance and reliability.

IBM engineers have developed the BM 4381 to provide more performance than earlier intermediate systems. The 4381 provides from nearly two to over five times the internal throughput of the 4341 Model Group 2, for example. At the same time, the IBM 4381 processors require less floor space and service clearance and weigh less than the 4341 processors. In addition, the air-cooled 4381 requires no *specially* cooled air. Because of its compact size and use of room-temperature air for cooling, the IBM 4381 can be located in virtually any work environment.

Engineering innovation and creativity were the key to the successful design of the BM 4381. For example, Large Scale Integrated (LSI) chips, containing thousands of microscopic integrated circuit elements, are used for both processing and memory applications. New packaging, also developed by IBM takes full advantage of the power these advanced logic and memory chips contain. High-density logic chips, for example, are joined to multi-chip modules, designed for improved heat dissipation. These in turn are mounted on circuit boards and individually cooled by a patented technique (called impingement cooling) using room-temperature air. Multi-chip modules and logic chips were developed in plants and laboratories in

East Fishkill and Endicott, N Y. Memory chips including the latest 256K-bit chip technology were produced in Burlington, Vt. The BM 4381 with its novel air-cooling and state-of-the-art circuit boards were developed in Endicott, N Y. The new components are assembled in IBM plants in Endicott, N Y, Valencia, Spain; and Sumare, Brazil.

The IBM 4381 family of processors represents some of the most advanced technology now in production anywhere in the world. Their innovations add up to unparalleled performance and value in IBM intermediate systems.



IBM 4381 DESIGN

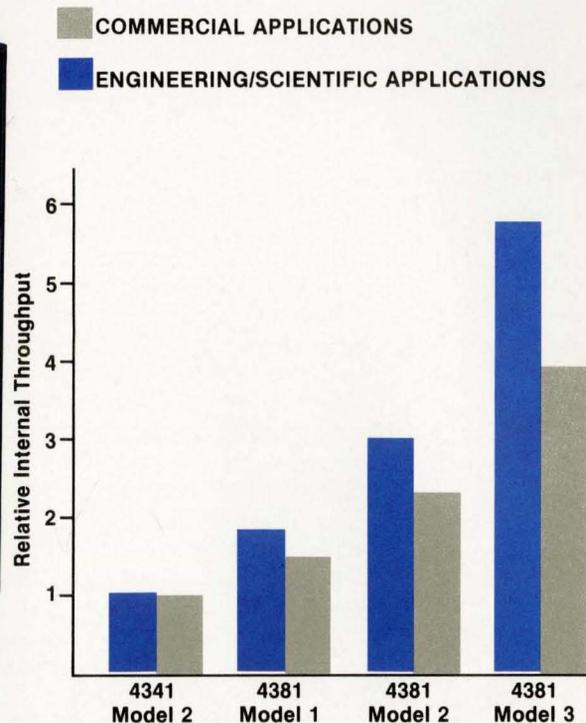
The evolution of computing power and performance in IBM's intermediate systems continues with its 4381 family of processors.

The IBM 4381 provides an exciting new solution for commercial and engineering/scientific applications that require central site, end user, or distributed processing. The IBM 4381 satisfies these diverse requirements through the integration of the best of both IBM 4341 and 308X technologies, including high

performance, high density multi-chip module circuit packaging, and a new design for increasing the efficiency of air cooling. Design improvements in the IBM 4381 combine to give it an internal throughput up to 5 times faster than the IBM 4341 Model Group 2.



The most recent member of the 4381 family, the Model Group 3 Dual Processor, contains two processor boards. Each of the two integrated central processors has its own channels and high speed buffer. The engineering/scientific performance of the 4381 Dual Processor is up to 90% greater than the 4381 Model Group 2 Uniprocessor.



Relative Internal Throughput of the IBM 4381 Compared to the IBM 4341 Model Group 2

IBM
4381

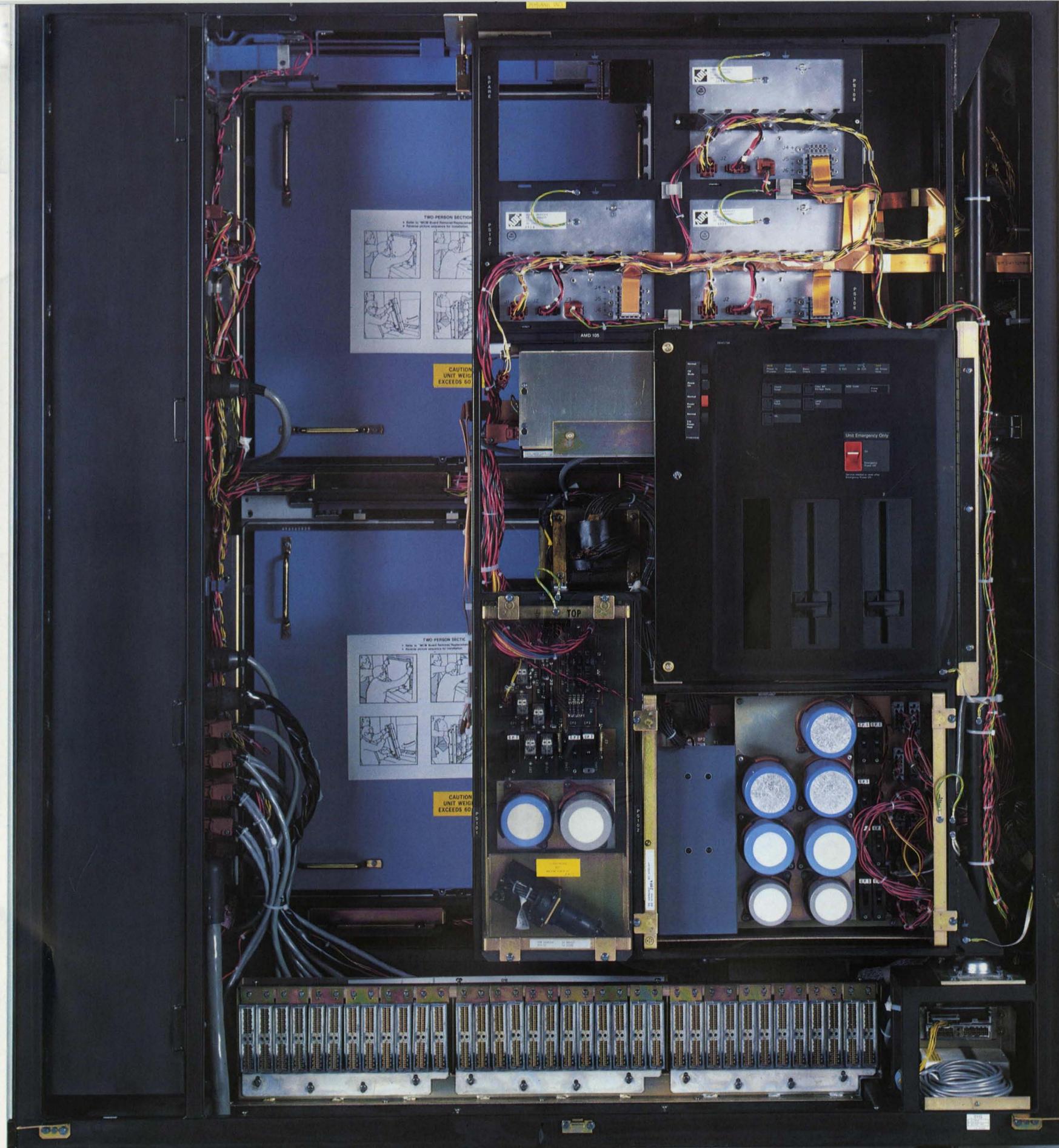


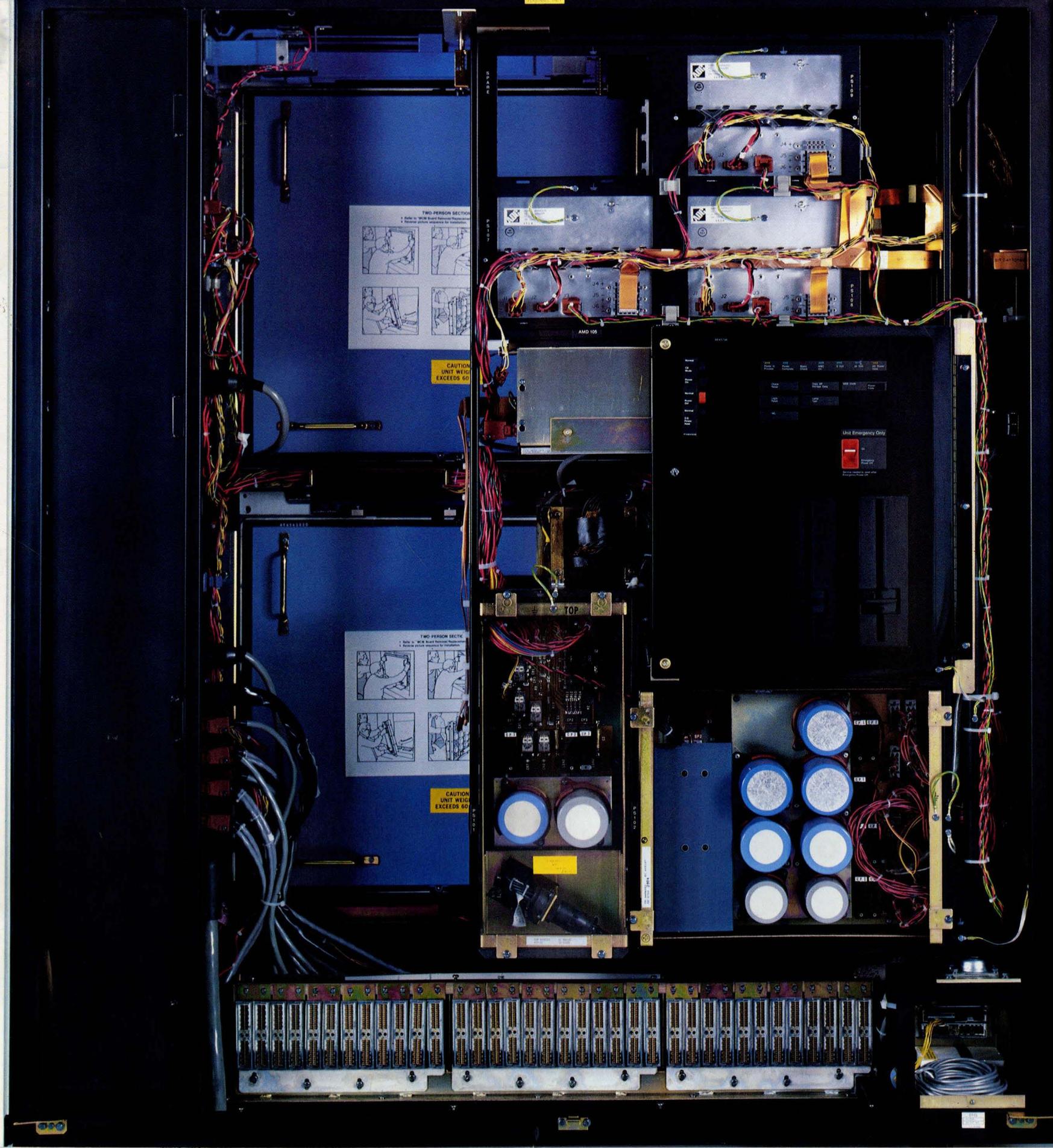
**Open the covers
of the IBM 4381
and look into the
exciting world of
technology.**

IBM 4381	Model Group 1	Model Group 2	Model Group 3 Dual Processor ¹
Processor Storage Million bytes (MB)	4, 8, 6	4, 8, 16, 24, 32	8, 16, 24, 32
Channels	6 + 6 optional (for a maximum instantaneous aggregate data rate of 22MB w/data streaming)		12 + 6 optional (for a maximum inst. aggregate data rate of 32MB w/data streaming)
	1 byte mpx + 1 optional		2 byte mpx + 2 optional
	Up to 11 block mpx, 4 w/data rates up to 3MB in data streaming mode		Up to 16 block mpx, 8 w/data rates up to 3MB in data streaming mode
Control storage arrays	1	1	2
Processor boards	1	1	2
High speed buffers (cache), for SCPs using: 2k pages 4k pages	4k 8k	16k 32k	n/a Two 32k
Assists	Preferred Machine Assist (For MVS as a VM guest)		
	Engineering Scientific assists: • Multiply and Add Facility • Square Root Facility ²		
	• Mathematical Function Facilities ² including: – Common Logarithm – Exponentiation – Natural Logarithm		
	VM/HPO Assist		
Internal throughput performance compared w/IBM 4341 Model Group 2:			
• Commercial • Engineering/Scientific (w/o assists)	Up to 1.5 times Up to 1.8 times	Up to 2.3 times Up to 3 times	Up to 3.9 times ³ Up to 5.7 times ³

Notes:

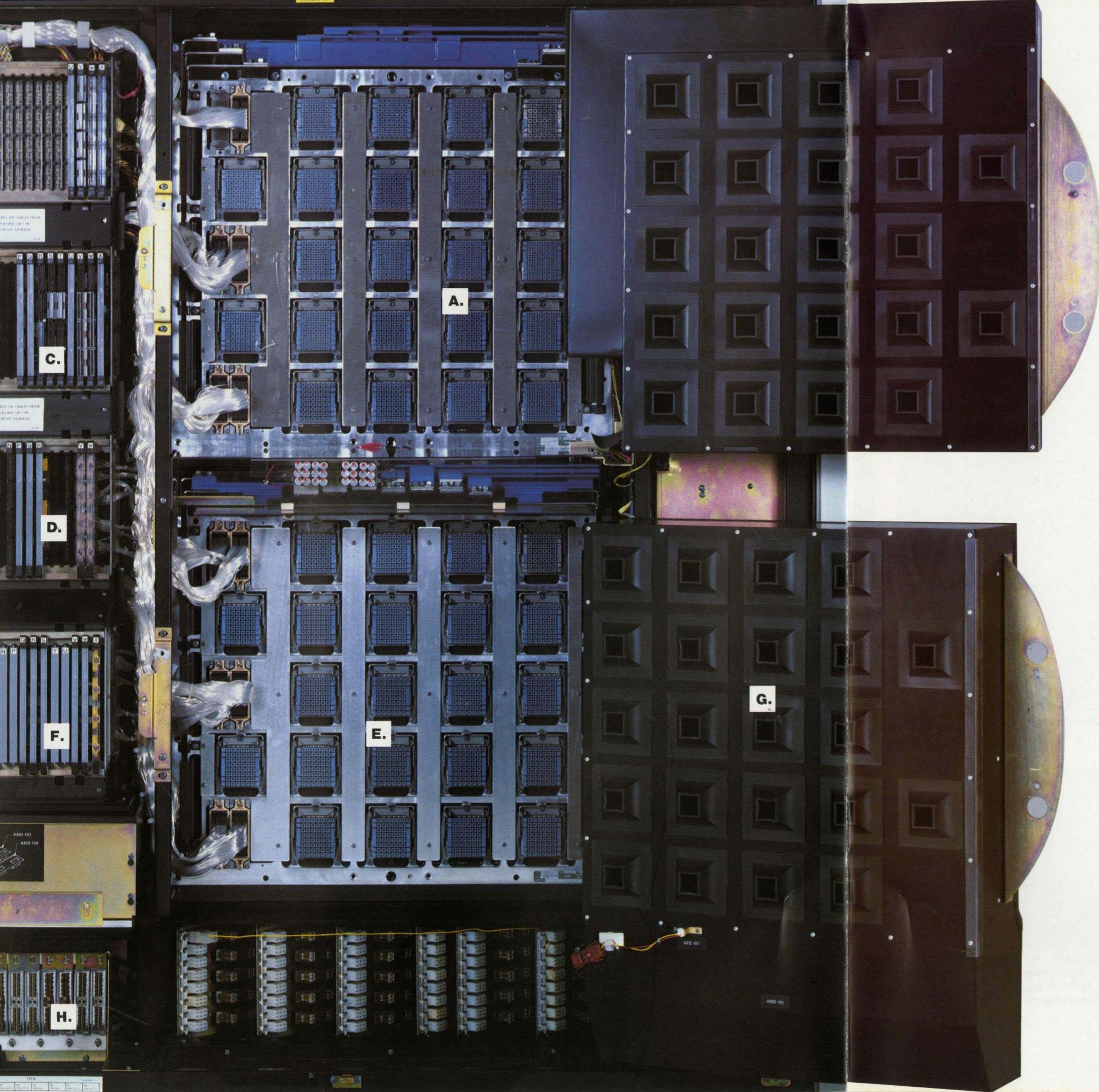
- 1 Statistics shown here are total quantities on the Dual Processor; quantities are equally divided between the two processors.
2. Designed for use with the Elementary Math Library, program number 5799-BTB.
3. Represents 1.7 times the commercial performance and 1.9 times the scientific performance of the IBM 4381 Model Group 2.





IBM 4381 PROCESSOR FEATURES

- Upright design to minimize floor space
- Unique air cooling technique
- Up to 32 million byte processor storage depending on model
- Dense one and two million byte memory cards
- New 64mm multi-chip logic modules
- New module packaging
- 68 nanosecond internal processor cycle time
- 8-byte wide data flow within the processor and between the processor's high-speed buffer (cache) and channels.
- 16-byte wide data flow between the high-speed buffer and processor storage and between the dual processors' high-speed buffers.
- Alternative use of a standard block multiplexer channel as a second byte multiplexer channel
- Six optional block-multiplexer channels
- Optional Channel-to-channel adapter
- Attach support for a broad spectrum of IBM and OEM terminals and work stations
- Two modes of operation:
 1. System/370 Extended Architecture (370-XA) Mode, support provided by:
 - MVS/XA
 - VM/XA Migration Aid
 2. System/370 (S/370) Mode, support provided by operating systems:
 - MVS/SP
 - VM/SP with or without VM/SP High Performance Option
 - DOS/VSE with VSE/Advanced Functions and VSE/SP (Native on Model Groups 1 and 2; as VM guests on Model Groups 1, 2 and 3)
 - OS/VS1 with OS/VS1 Basic Programming Extensions (Native on Model Groups 1 and 2; as VM guests on Model Groups 1, 2 and 3)
 - ACP/TPF1 or ACP/TPF2 (except Model Group 3)
- Extended Control Program Support (ECPS) for MVS/370 and VM/370
- Enhancements to ECPS:MVS for MVS/SP
- Preferred Machine Assist
- Engineering Scientific Assists
- Remote Support Facility (RSF) with Remote Operator Console Facility (ROCF)
- Problem Analysis routines
- Optional 3205 console(s) with 4381 Operator Control Panel

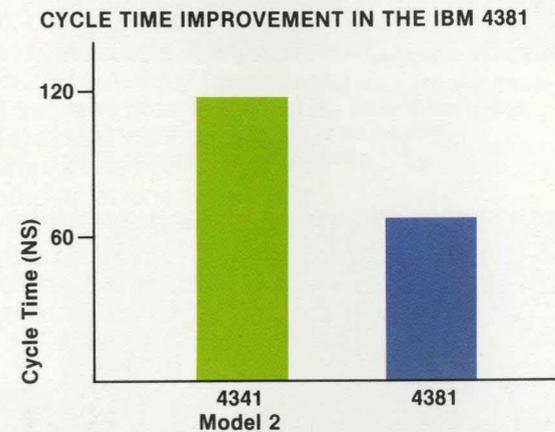


IBM 4381 PACKAGING

The impressive performance of the IBM 4381 is due in part to its 68 nanosecond internal processor cycle time.

New packaging in the IBM 4381 reduces the number of levels through which electronic signals must travel. Each packaging level causes delay in the signal. Fewer levels mean less delay. The card-on-board technology of the IBM 4341 consists of four levels — a chip, in a module, on a card, plugged into a board. Thus, in the IBM 4341, a signal traveling between processor boards may have to cross as many as eight packaging levels, incurring delays at each level.

In the IBM 4381 more chips are packaged per module (possible because of its new cooling technique), and the module plugs directly into the circuit board. By eliminating use of the card, and packaging the equivalent processor logic on a single board, the IBM 4381's module-on-board technology reduces "packaging delay" to approximately one-half that of the IBM 4341. Fewer levels and less delay improve internal cycle time and increase processing power. In addition, fewer components and connections mean better reliability.



Fast chips and new packaging enable the IBM 4381 internal cycle time to be nearly twice as fast as the cycle time in the IBM 4341 Model 2.

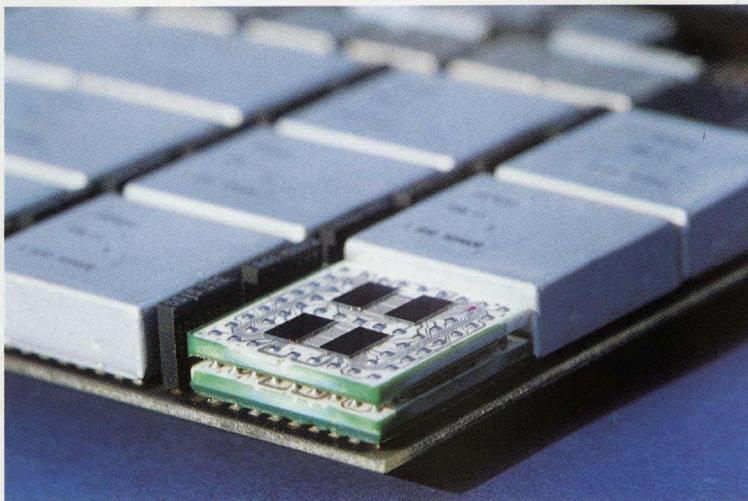
Following is a description of the IBM 4381 system and its innovative design features which together offer intermediate system users new levels of price/performance, availability and reliability and an exciting new growth path through the 1980's.

- A. MULTI-CHIP MODULE BOARD (Model Group 3 only)**
- B. CHANNEL-TO-CHANNEL ADAPTER**
- C. MAINTENANCE SUBSYSTEM/SUPPORT PROCESSOR**
- D. CHANNEL DRIVERS/RECEIVERS**
- E. MULTI-CHIP MODULE BOARD (all Model Groups)**
- F. PROCESSOR STORAGE**
- G. IMPINGEMENT NOZZLES for cooling**
- H. CHANNEL-TO-CHANNEL INTERFACE CONNECTORS**

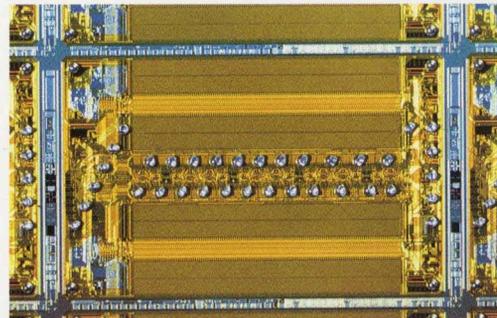
IBM 4381 TECHNOLOGY

64K-bit and highly advanced 256K-bit MOSFET memory chips are used for main storage where high density is a key requirement.

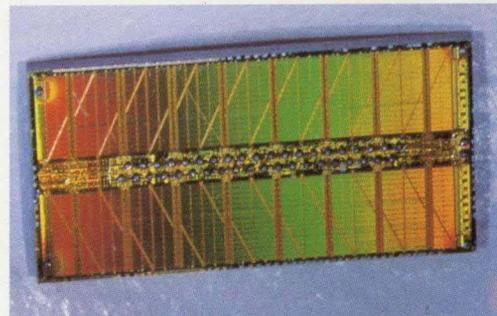
New, dense IBM 256K-bit MOSFET (Metal Oxide Semiconductor Field Effect Transistor) memory chips have been developed since the introduction of the IBM 4381 family. They are the results of careful improvements to the proven SAMOS (Silicon and Aluminum Metal Oxide Semiconductor) process which IBM introduced in 1978. These new chips allow the IBM 4381 Model Groups 2 and 3 to double memory size to thirty-two megabytes with no increase in storage space requirements.



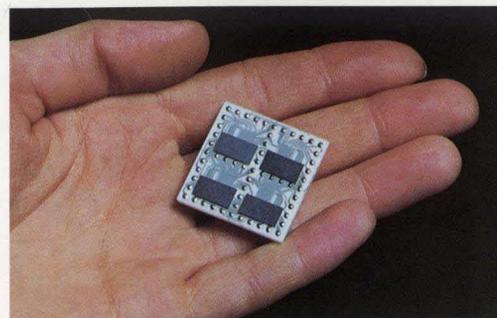
A complete, encapsulated 24mm² (one inch square) stacked module contains eight 64K-bit MOSFET chips with up to 524,288 bits of memory for high density, speed and reliability.



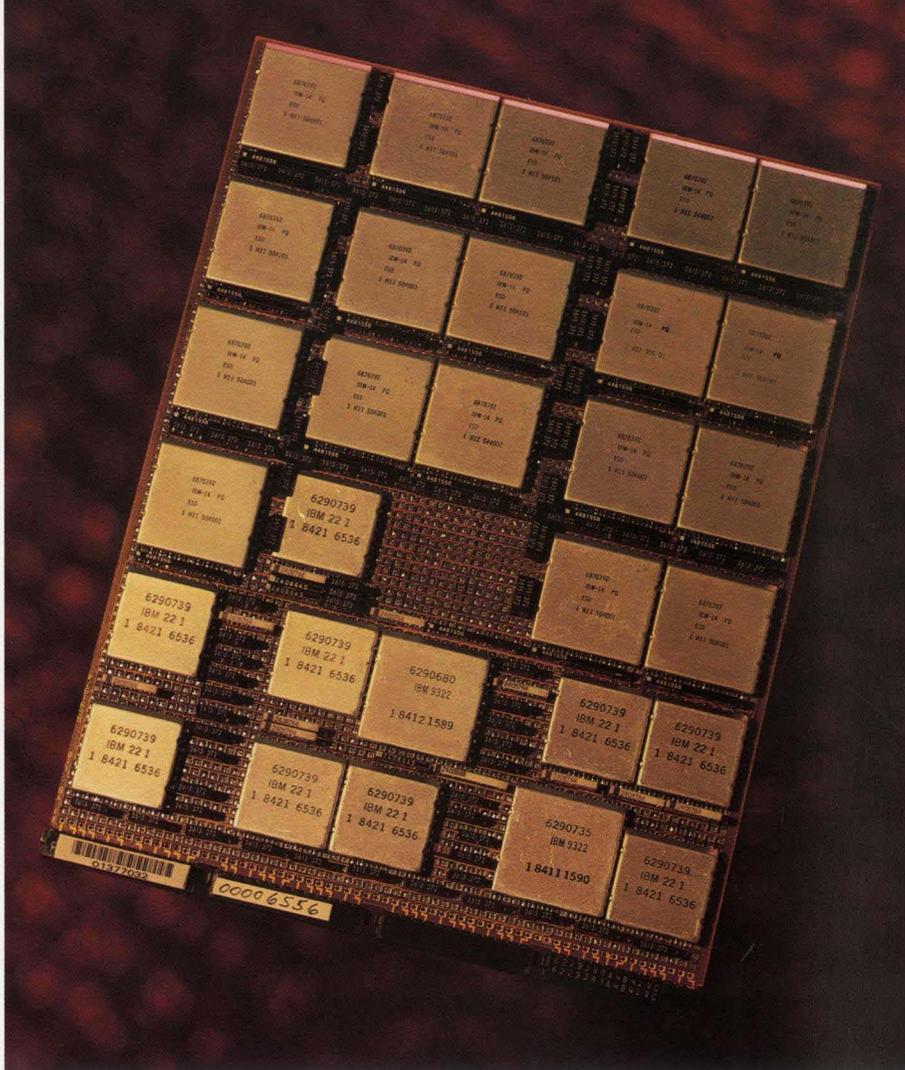
64K-bit MOSFET chips are used for main memory of up to 16 megabytes.



Advanced IBM 256K-bit MOSFET chips are used for main memory of up to 32 megabytes.

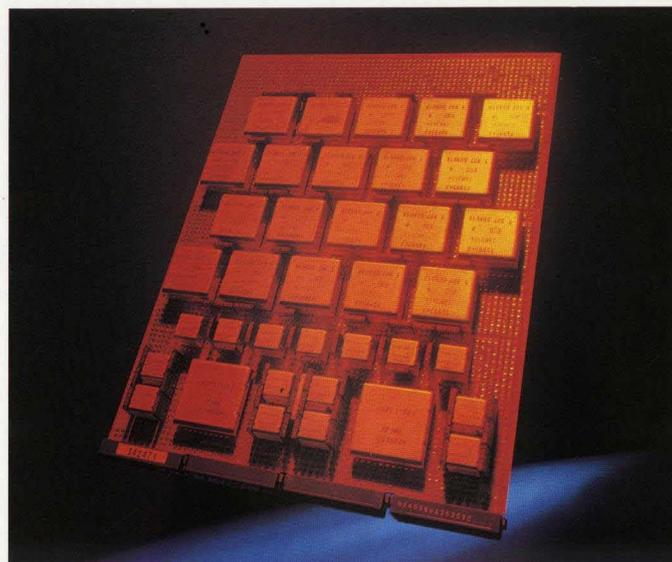


New 28mm² (slightly over one inch square) module contains four 256K-bit MOSFET chips with over one million bits of memory for applications where high density is a key requirement.

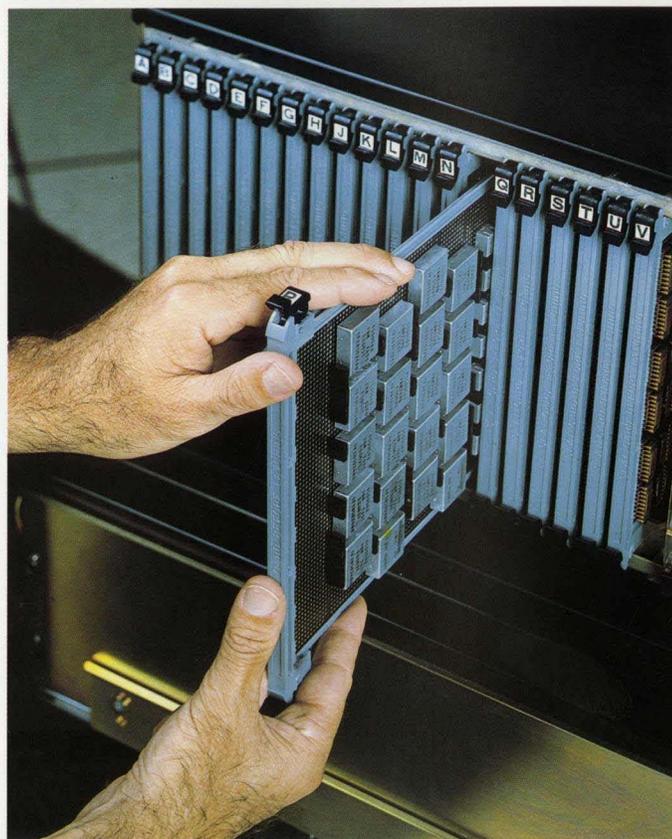


Two million bytes of main storage are packaged on this single card. Up to 32 million bytes of storage can be provided on the Model Groups 2 and 3 with only sixteen cards and no increase in space requirements.

Main storage capacity is often a vital factor in performance. The IBM 4381 is designed to allow the right balance of processing power and storage size with an entry level capacity of 4 or 8 million bytes, expandable to 16, 24, or 32 million bytes, depending on model. One or two million bytes of main storage are packaged on a single card using 64K-bit or 256K-bit chips. Memory upgrades are accomplished simply by adding or exchanging cards. Up to 32 million bytes of storage can be provided on Model Groups 2 and 3 with sixteen, two million byte cards.



One million bytes of main storage are packaged on this single card. 16 million bytes of storage can be provided on IBM 4381 models with 16 cards.



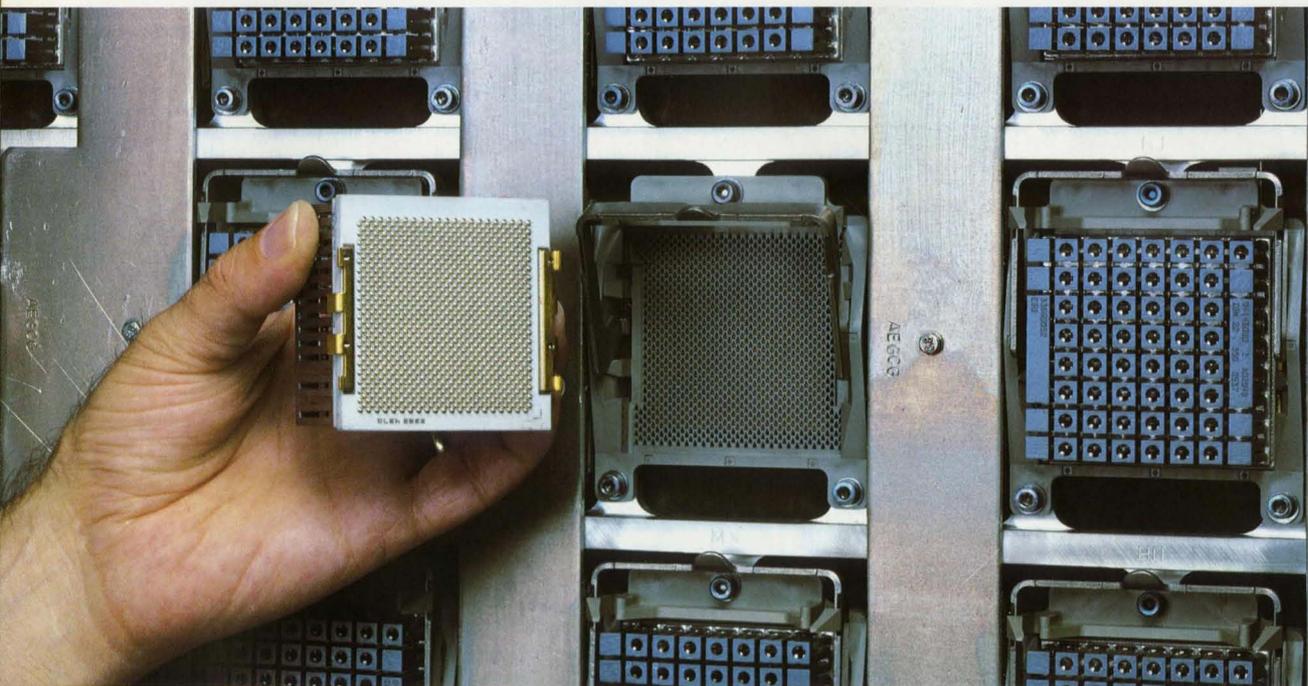
Memory upgrades are accomplished simply by adding or exchanging cards. This Field Replaceable Unit (FRU), for example, contains two million bytes of memory.

IBM 4381 INNOVATIONS

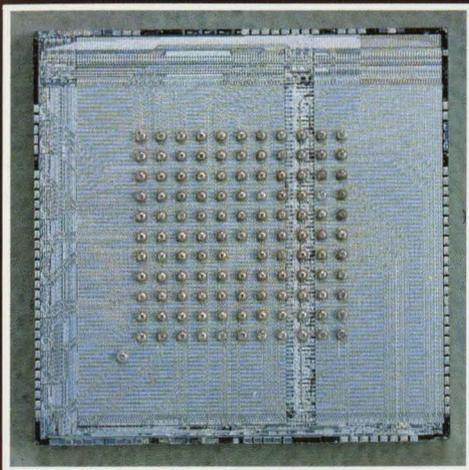
The IBM 4381 combines 704-circuit bipolar chips with a reliable, innovative packaging design to offer dense logic packaging.

Performance, reliability, availability, and serviceability are all strongly influenced by the advanced, LSI components and packaging used in the IBM 4381. Its design is centered around its new 64mm, (2.5 inch) multi-chip modules (MCM) utilizing IBM's proven bipolar chips for main processor logic. The new MCMs, which can contain up to thirty-six high-speed logic and array chips used for processing and channel control, represent an exciting breakthrough for LSI packaging. The IBM 4381's dense packaging reduces the distance between

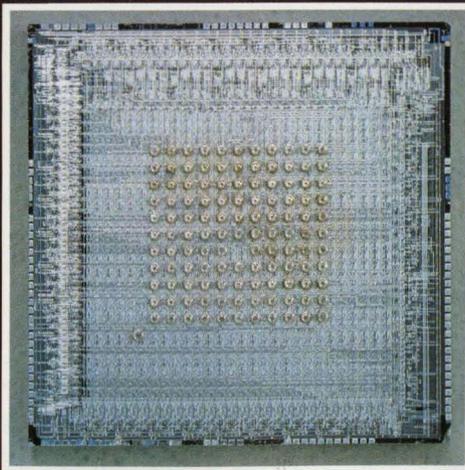
circuits and improves internal performance. Use of this high-density is possible because of newly-developed techniques for heat dissipation and air cooling of the individual MCMs. Twenty-two MCMs are packaged on a board which measures only 600mm (24 inches) in length by 700mm (28 inches) wide. This high-density board containing approximately 250,000 circuits, constitutes the system's main processor logic. Two such boards are used in the powerful Model Group 3 Dual Processor



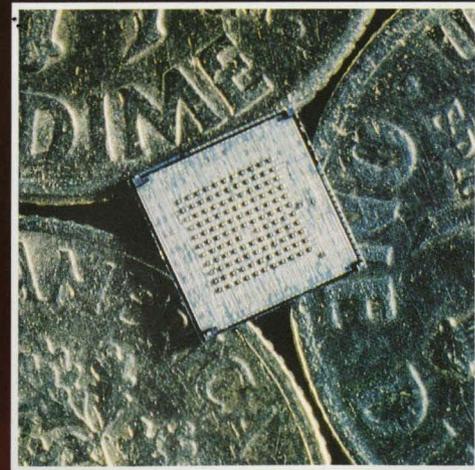
Underside view of hand-held MCM. The pluggable 64mm MCM is a field replaceable unit (FRU) which provides fast and easy maintenance.



9K-bit Bipolar Array Chip. This special high-performance, static RAM (random-access memory) bipolar chip used in the high speed buffer storage module on the processor board can store more than 9,000 bits of information.

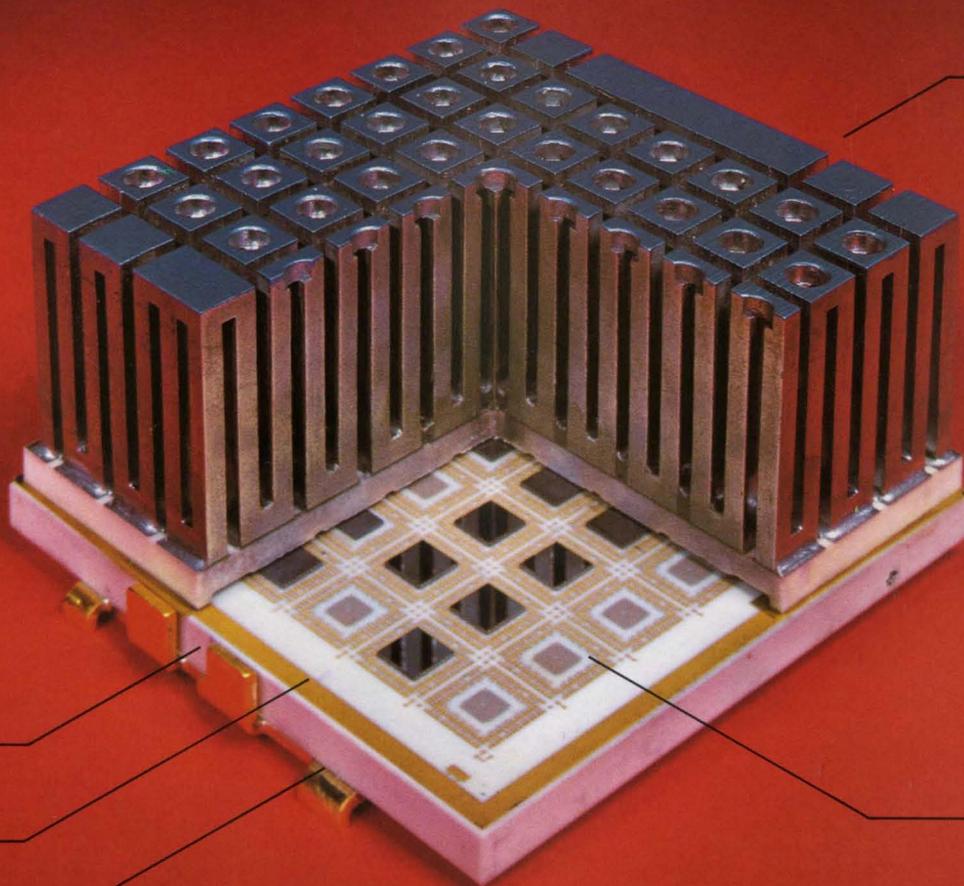


1100 Circuit Multiplier Chip. Multiplication operations are performed on this custom bipolar chip. The chip's circuitry offers a 10-fold density improvement over conventional designs. This significantly improves the speed of the multiply function and allows it to be packaged on one module which enhances serviceability.



704 Circuit Logic Chip. High speed bipolar chips less than 5mm (1/5 inch) square, containing up to 704 logic circuits are used in the IBM 4381 for processing and channel control where fast performance is needed.

New 64mm Module. This cut-away view of the 64mm MCM reveals the aluminum heat-sink, high-speed logic chips, and multi-layer ceramic substrate. In the 64mm MCM each chip is joined to the substrate with 121 solder pads using the special IBM-patented controlled collapse chip connection (C4) process for high interconnection reliability. Heat is conducted away from the densely packed chips through the specially designed aluminum heat-sink, with its enlarged surface area for improved heat dissipation. Each of the twenty-two MCMs on a board is independently and evenly cooled by another specially developed technique using forced air.



ALUMINUM HEATSINK

CERAMIC CAP

HERMETIC SEAL

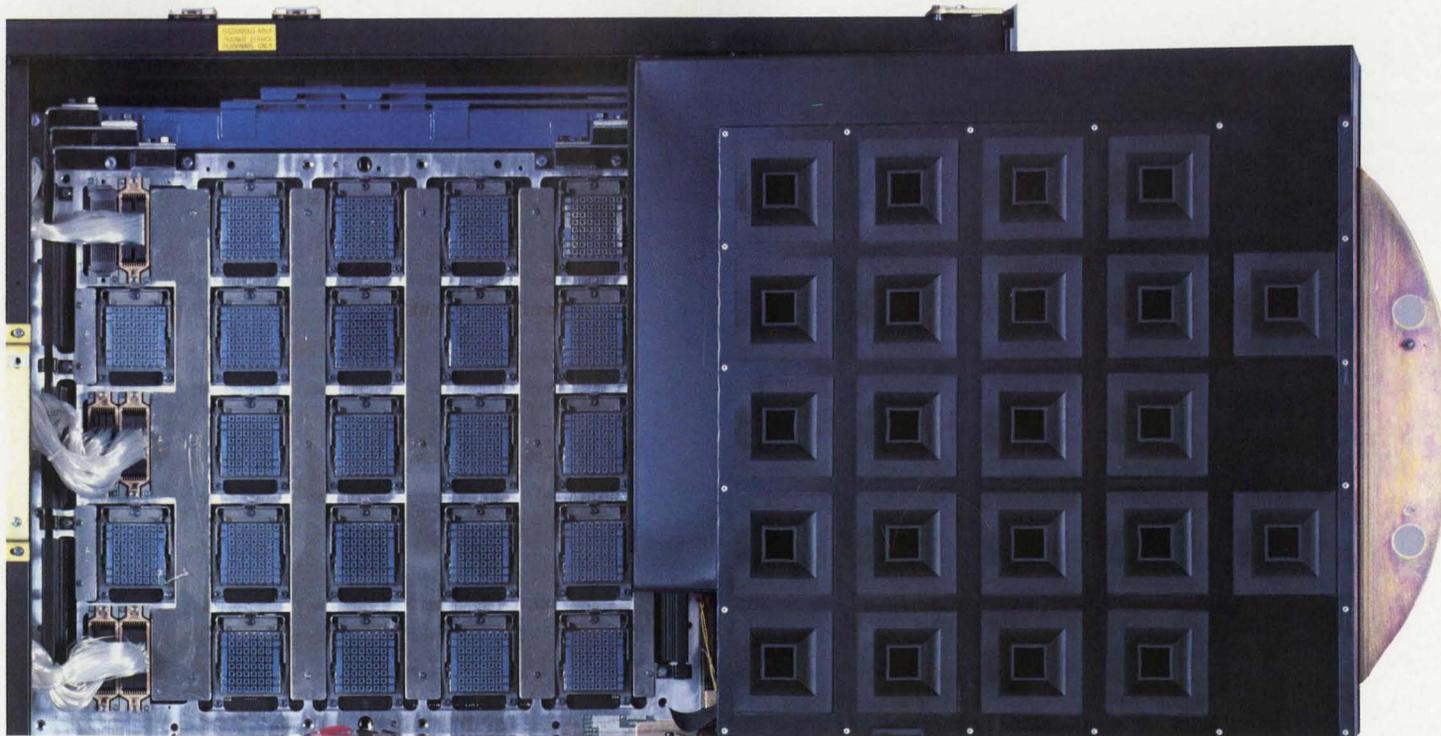
INPUT/OUTPUT PINS

704-CIRCUIT LOGIC
OR ARRAY CHIP (36 max)

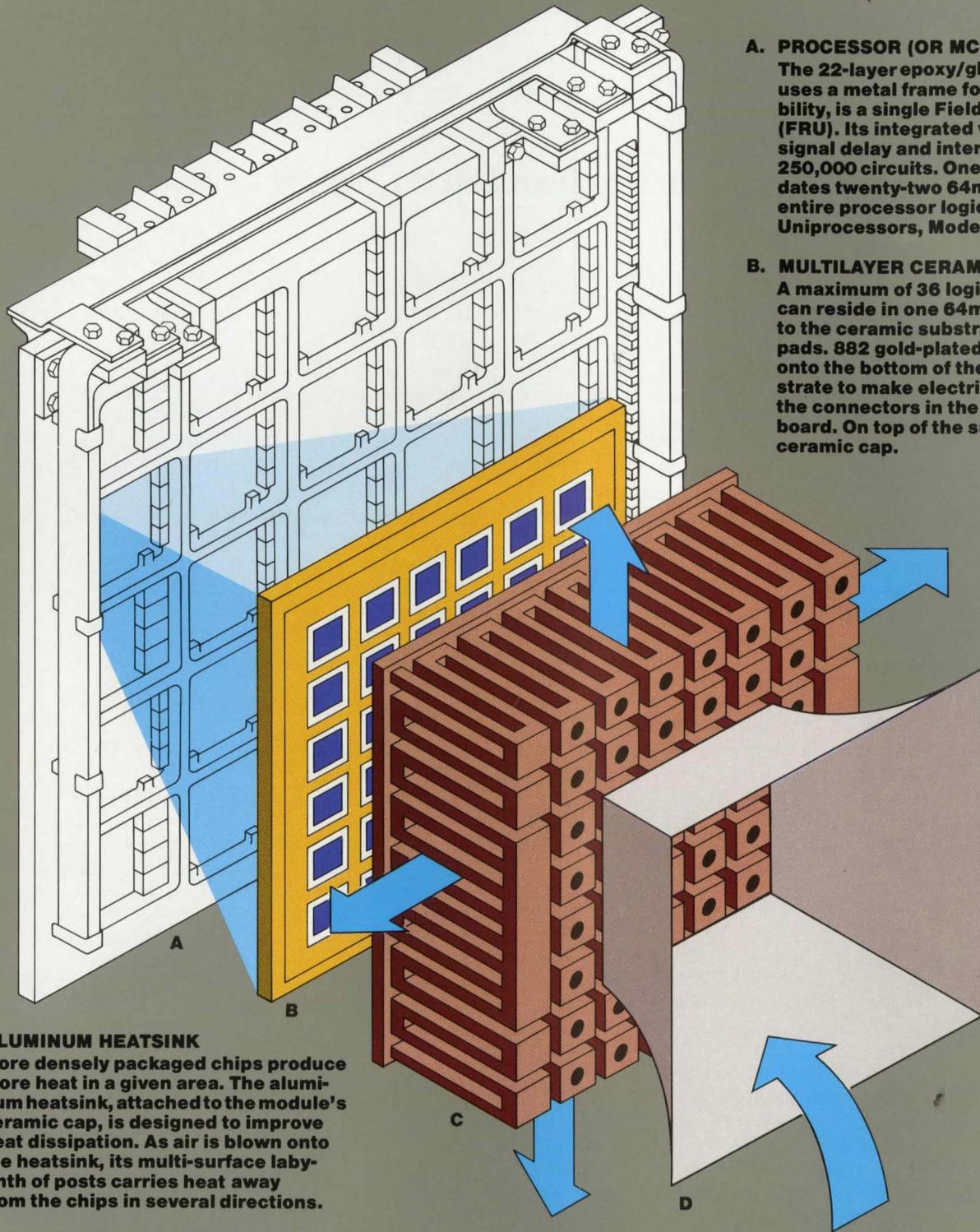
IBM 4381 AIR COOLING FOR ADDED RELIABILITY

An IBM-patented technique, called impingement cooling, is used to reduce heat and produce added reliability. This technique ensures even cooling by cooling logic modules individually at a uniform temperature and rate. This offers significant advantages over conventional serial air-cooling in other processors. In a serial-cooled processor, air is usually blown over modules from the bottom to the top of the processor. This produces temperature gradients at various levels as the dissipated heat rises. In this environment, engineers must

position heat-sensitive electronic circuits for even heat distribution. The result leads to longer processor cycle times since electronic signals may have to travel greater distances to perform useful functions. Free from the constraints of serial cooling, modules in the IBM 4381 can be positioned on the processor board to optimize performance. Modules can be placed next to one another, thus reducing the distance a signal must travel. This leads to improved performance and reliability.



Impingement cooling employs a "plenum" that fits over the MCM board. The plenum consists of an air chamber, high-speed blower, and twenty-two rubber impingement nozzles. The blower forces a steady stream of high-velocity, room-temperature air onto each of the processor board's 64mm MCMs.



A. PROCESSOR (OR MCM) BOARD

The 22-layer epoxy/glass board, which uses a metal frame for mechanical stability, is a single Field Replaceable Unit (FRU). Its integrated wiring minimizes signal delay and interconnects nearly 250,000 circuits. One board accommodates twenty-two 64mm MCMs — the entire processor logic of the IBM 4381 Uniprocessors, Model Groups 1 and 2.

B. MULTILAYER CERAMIC SUBSTRATE

A maximum of 36 logic or array chips can reside in one 64mm MCM, joined to the ceramic substrate by solder pads. 882 gold-plated pins are brazed onto the bottom of the ceramic substrate to make electrical contact with the connectors in the processor board. On top of the substrate is a ceramic cap.

C. ALUMINUM HEATSINK

More densely packaged chips produce more heat in a given area. The aluminum heatsink, attached to the module's ceramic cap, is designed to improve heat dissipation. As air is blown onto the heatsink, its multi-surface labyrinth of posts carries heat away from the chips in several directions.

D. IMPINGEMENT NOZZLE

A high-speed blower forces air through the twenty-two impingement nozzles. The nozzles serve as air ducts to direct air onto the center of each MCM where the air passes through the heatsink.

BUILT-IN RELIABILITY, AVAILABILITY, SERVICEABILITY (RAS)

The IBM 4381 is designed to be defect-free on delivery and to provide maximum availability throughout its working life.

New manufacturing processes and new circuit board designs result in greater reliability and shorter production cycles, which reduce the risk of introducing defects during the manufacturing process. These designs also enhance the ability to inspect and test the product. Components, circuit cards and modules are also subjected to "burn-in" procedures as well as actual machine test. All of these measures have as their objective the goal of delivering a defect-free product to you.

Fault tolerance is a key feature of the IBM 4381 design. In main storage, for example, all single-bit errors are detected and corrected. Even rare double-bit errors are detected and, as is often the case, where one bit of the two is failing intermittently, newly-designed circuits will allow for correction of both.

For added RAS, in every IBM 4381 processor there is a separate Support Processor that is continuously monitoring its operation. If a failure occurs, the Support Processor is invoked, and, in many cases, its actions allow system operation to continue. It can automatically substitute failing components in vital processor and channel storage arrays using "built-in" spare circuits. Failing instructions can be re-executed, under control of the Service Processor, which analyzes and records all such events on the system diskette for subsequent review by IBM Customer Engi-

neers. The dual processor (Model Group 3), can continue as a uniprocessor after some single processor failures.

In the case of a system failure, the Support Processor can be used by the operator to analyze or correct a problem. The Problem Analysis facility provides routines for use by the operator to verify IBM 4381 operations. Console messages (available in seven languages) assist the operator with appropriate actions to correct or bypass the problem and to identify failing components. This allows IBM to dispatch a trained Customer Engineer with the necessary part to effect a fast, "first-call" repair. For intermittent problems, Problem Analysis routines record status information for follow-up diagnosis.

Another feature of the IBM 4381 — the Remote Support Facility (RSF) — can be used for remote diagnosis and resolution of a problem. This facility allows the data stored by Problem Analysis to be sent over a telephone link to an IBM service representative (without disruption in your normal system operations). It also allows the service representative, if necessary and with your permission, to recreate the problem on your system for "hands-on" diagnosis. RSF is one of the most powerful diagnostic tools that has ever been made available to your IBM Customer Engineer. It may never be needed, but it is reassuring to know that specialist support from an IBM Product Support Location, Manufacturing Plant, or Development Laboratory can be brought virtually "on-site" in the time it takes to make a telephone call.



Problem Analysis, in conjunction with Remote Support Facility (RSF), allows the remote specialist to analyze problems remotely without interfering with normal system operations.

A SYSTEM FOR NOW AND TOMORROW

IBM's 4381 family offers exciting systems solutions for today's data processing problems while its advanced technology and software will allow it to grow with your organization. Its unique packaging technology for both logic and storage subsystems is the result of many years of development in IBM plants and labs throughout the world. These technology advances allow the BM 4381 to offer intermediate users the functions formerly available only in very large high-performance systems. Ask your IBM Marketing Representative for more details about the IBM 4381 today





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