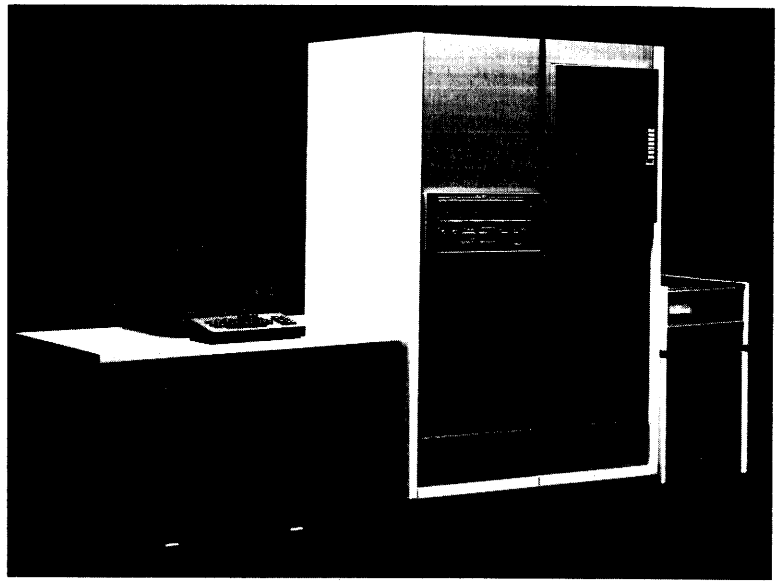
HARRIS 100

Computer System



FEATURES

- **Hardware supported virtual memory system**
- **Over 6 million bytes of virtual memory**
- **High-speed, central system bus architecture**
- **Interleaved, error correcting main memory**
- **Multiple, concurrent functions**
  - **—Interactive time-sharing**
  - **—Multi-stream batch**
  - **—Multiple Remote Job Entry (Host and Workstation)**
  - **—Sensor-based/real-time processing**

HARRIS 100 COMPUTER

The Harris 100 is the entry level member of the Harris family of software compatible, virtual memory computers which include the Harris 500 and Harris 800 computer systems.

Features of the Harris 100 include:

- Maximum of 19 million bytes per second system bus transfer rate
- Over 6 million bytes of virtual memory space
- Over 768 K bytes of real memory
- Optional, hardware floating point unit
- Hardware supported virtual memory system
- Up to 32 interactive user terminals
- Error correcting main memory
- Field-proven hardware

The Harris 100 is offered with a complete line of peripherals and maintenance support.

MULTI-USE AND MULTIPLE USERS

The Harris 100 is a general purpose supermini computer designed for scientific and engineering use together with business applications. These applications require multiple, high-level languages, a multi-use environment, and the capability for remote and local operations. The Harris 100 system is a unique combination of hardware and software designed to meet these challenging multi-use applications.

The Harris 100 is designed for multiple user applications including interactive program development, time-sharing, multi-stream batch, multiple remote job entry and real-time processing. The Harris operating system, VULCAN, is reentrant, thus permitting one copy to be shared by all users. The VULCAN language processors, (except the overlay versions) are also reentrant and, compiler-generated code optionally can be reentrant.

The Harris 100 multi-use and multiple user system is an ideal solution to the processing requirements of a multi-disciplined organization.

CENTRAL PROCESSOR

The Harris 100 computer is designed around a very fast central system bus for maximum system performance in a multiprogramming environment.

The system bus is capable of an aggregate transfer rate of 19 million bytes per second. The system bus has 48 lines for data transfers and 18 lines for addressing. The address bits allow the full 768 K bytes of main memory to be accessed by any subsystem using the bus. On writes to main memory, the system bus transfers the memory address together with 24 or 48 data bits in one bus cycle. Typically, input/output operations transfer 48 data bits at one time between main memory and discs or tapes on the Universal Block Channel via the system bus.

The Harris 100 central processor overlaps instruction fetch with execution. While one instruction is being executed, the next sequential instruction is fetched from main memory. The instruction set is compatible with both the Harris 500 and Harris 800 computers.

An Operator Console CRT (OPCOM) provides for communications between the operating system—VULCAN and the system operator.

SCIENTIFIC ARITHMETIC UNIT (SAU)

The Harris 100 features an optional, hardware floating point processor. The Scientific Arithmetic Unit provides concurrent floating point arithmetic operations independent of the central processor. Double-precision (48-bit) floating point employs an 8-bit signed exponent and 39-bit signed mantissa resulting in over 11 decimal digits of precision.

MEMORY SYSTEMS

Virtual Memory

Ease of use is a primary benefit of a virtual memory system. On the Harris 100, users can write programs that are larger than the real memory of the system. Over six million bytes of logical address space are available for running application programs regardless of the physical memory available.

The Harris 100 is a demand-paged system supported by the VULCAN virtual memory management operating system. Hardware supporting VULCAN's virtual memory capabilities includes a variety of registers to decrease the burden of housekeeping requirements.

The Harris virtual memory system provides hardware and software memory protection. Every program page in memory is protected against access or inadvertent destruction by another concurrently executing program. In addition, pages containing instructions and constants, as opposed to variable data, are hardware write-protected, even within the same program.

Virtual memory allows programs to execute with only part of the code in real memory. Demand-paging causes the system to load blocks or "pages" of code and data into memory as required by a program to continue executing. In the Harris 100 system, a program "page" is 3072 bytes.

Another feature of the Harris 100 virtual memory system is efficient use of real memory. A program need not occupy contiguous memory pages. Any physical page not occupied by the operating system can hold any logical page. Memory, therefore, never needs reorganizing or compacting.

A combination of hardware and software features serve to minimize the amount of swapping that may occur in a high system usage environment. The Harris virtual memory hardware includes Virtual Usage Registers and Virtual Not-modified Registers. These registers are used by the VULCAN swapping algorithm to identify the most eligible memory pages for swapping.

The Harris systems have high-speed program loading. Program loading is simply and quickly accomplished by copying program pages directly from disc into memory with no address modification. The Harris virtual memory hardware associates each logical address in the program page with its physical location.

Main Memory

The main memory of the Harris 100 is expandable to over 768 K bytes. Each memory module has its own timing and control logic and reads or writes 48 data bits plus error correcting bits in one memory cycle. The memory cycle time for 48 bits is 450 nanoseconds with an access time of 300 nanoseconds. A 48-bit central system bus data path is used for high-speed, direct memory access input/output between each memory module and the Unversal Block Channels.

Interleaved memory provides additional system performance. The Harris 100 memory is 2- or 4-way interleaved, depending on the memory configuration.

I/O CHANNELS

The Harris 100 has several types of input/output channels which interface the central system bus to the device controllers. The system supports up to 24 logical I/O channels.

Universal Block Channel (UBC)

The Universal Block Channel is a block-mode, direct memory access channel for high-performance peripheral controllers such as those for discs and magnetic tapes. The UBC has two operating modes—the scan mode and the scan-lock mode. In the scan mode, a UBC supports two concurrent input/output operations. In the scan-lock mode, the UBC operates as a single direct memory access channel. In addition to direct memory operations, the UBC also functions as a programmed I/O channel transferring data under CPU/program control between a CPU register and the channel. The UBC contains a 48-bit data buffer for each logical channel.

Integral Block Channel (IBC)

The IBC is a block-mode, direct memory access channel for interfacing the card reader to the system. The card reader controller plugs onto the IBC module.

Programmed I/O Channel (PIOC)

The PIOC is a channel for interfacing slow speed devices to the system. It supports up to four plug-in controllers for devices such as a line printer, operator communications terminal, and user terminals. Input/output to these devices proceeds under program control through a CPU register.

External Block Channel (XBC)

The XBC is a specialized direct memory access channel for user-designed and developed controllers and devices.

Direct Memory Access Communications Processor (DMACP)

The DMACP is a direct memory access communications processor for interfacing various terminals to the system. The DMACP supports both synchronous and asynchronous communications.

SOFTWARE

A comprehensive set of software is available for use with the Harris 100 computer system.

VULCAN Operating System

The Harris Virtual Memory Operating System is a priority structured, demand-paged, multiprogramming operating system. VULCAN concurrently supports:

- Multi-stream batch processing
- Interactive time-sharing
- Data base management
- Remote job entry
- Real-time operations

In addition to its operating features, VULCAN works in conjunction with the paging hardware to monitor and direct memory allocation. VULCAN virtual memory operation is totally transparent to the user – while providing the advantage of efficient memory management, extensive user memory space, complete program protection, system security, and a wide selection of system services.

Support Software

The field-proven VULCAN operating system supports nine languages, five support programs, a programmable interactive command language, five remote job entry and two remote batch terminal packages, and TOTAL, a data base management system with T-ask,™ an information retrieval system.

Languages

- Extended BASIC Language Processor
- FORTRAN IV Compiler
- FORTRAN 77 Compiler
- Extended 1974 ANSI COBOL Compiler
- APL Interpreter
- RPG II Compiler
- Harris Macro Assembler
- SNOBOL 4 Interpreter
- FORGO (Load-and-Go FORTRAN Compiler)

Support Programs

- Sort/Merge Package
- VULCAN Indexed Sequential Package (VISP)
- System Accounting (ACUTIL)
- Cross Reference
- VULCAN Symbolic Debugger (VBUG)

Remote Job Entry (RJE) Support Packages

- CDC 200 UT
- IBM 2780
- IBM 3780
- IBM HASP II Multi-leaving
- UNIVAC 1004

Remote Batch Terminal (RBT) Host Packages

- IBM 2780
- IBM HASP II Multi-leaving

Interactive Terminal Package

- IBM 3270

Data Base Management System (DBMS)

- TOTAL Central
- T-ask™ Information Retrieval

Harris Transaction Processor (HTP)

HARRIS 100 CENTRAL PROCESSING UNIT

Type	Microprogrammed, general-purpose, digitial computer. Multi-access central system bus.
Arithmetic	Parallel, binary, two's complement fixed and floating point; optional hardware floating point processor.
CPU Microcycle Time	300 nanoseconds
CPU Word Length	24 bits

MEMORY SYSTEM

Main Memory

Type	N-Channel MOS, with error correction.
Minimum size	196,608 Bytes
Maximum Size	786,432 Bytes
Increment	48 K Bytes or 192 K Bytes (K=1024)
Word Length	48 bits
Cycle Time	450 nanoseconds (per 48 bits)
Access Time	300 nanoseconds (per 48 bits)

ADDRESSING

Mapped to 768 K Bytes

INPUT/OUTPUT

Programmed Transfers	Transfers 8- or 24-bits between a CPU register and the PIOC.
Direct Memory Access Transfers	Transfers 24- or 48-bits between main memory and either the IBC, UBC, DMACP or XBC channels.
Aggregate Maximum Throughput	Input—Up to 19.0 MB per second Output—Up to 7.9 MB per second

Single Channel Maximum Transfers Rates (per second)

	Input	Output
IBC	80 KB	80 KB
XBC		
(no CPU contention)	2.4 MB	2.0 MB
(with CPU contention)	1.4 MB	1.2 MB
UBC (with 30 ft. peripheral cable)	3.2 MB	2.5 MB

PRIORITY INTERRUPT STRUCTURE

Internal	Eight executive traps. Multi-level, vectored structure.
External	8 levels, standard. Optionally expandable to 24.
Control	External Priority Interrupts may be individually armed, disarmed, enabled, inhibited or triggered under program control.

POWER FAIL PROTECTION

Power fail alarm, standard.

ELECTRICAL REQUIREMENTS

(For CPU, memory and channels contained in a one cabinet configuration.)

Voltage	230 VAC or 208 VAC ± 10%. Single-phase, 4-wire (standard) 220/240 VAC, single-phase, 3-wire (optional).
Frequency	60 ± 3 Hz, (50 ± 3 Hz, optional)
Current	19 Amps RMS at 230V (maximum)
Power	4000 watts

ENVIRONMENTAL REQUIREMENTS

(For CPU, memory and channels)

Temperature	
Operating	50° F to 113° F (10° C to 45° C), ambient air
Storage	32° F to 122° F (0° C to 50° C), ambient air
Humidity	
Operating	20% to 80%, relative (non-condensing)
Storage	20% to 90%, relative (non-condensing)
Altitude	
Operating	-1,000 to 6,000 ft. (-305 to 1,829 m)
Storage	-1,000 to 15,000 ft. (-305 to 4,572 m)
Cooling	Forced air provided by internal fans on each chassis.

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COMMUNICATION AND INFORMATION PROCESSING

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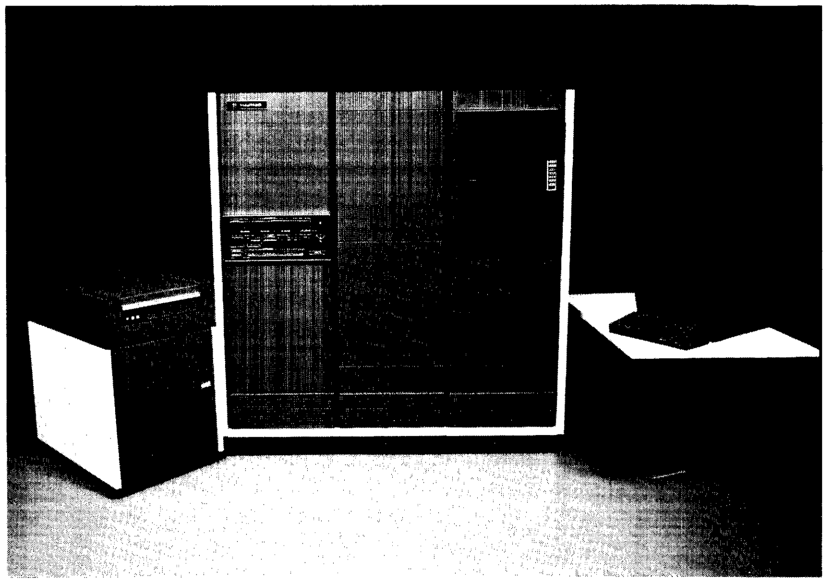
HARRIS 500

Computer System



FEATURES

- **Hardware supported virtual memory system**
- **Over 3 million bytes of main memory**
- **High-speed central system bus**
- **Field-proven hardware and software**
- **Multiple, concurrent functions**
  - **—Interactive time-sharing**
  - **—Multi-stream batch**
  - **—Multiple Remote Job Entry (Host and Workstation)**
  - **—Sensor-based/real-time processing**

HARRIS 500 COMPUTER

The Harris 500 is the middle member of the Harris family of software compatible, virtual memory computers which include the Harris 100 and Harris 800 computer systems.

Features of the Harris 500 include:

- Maximum of 19 million bytes per second system bus transfer rate
- Over 3 million bytes of directly addressable real memory
- Over 12 million bytes of virtual memory space
- Optional, hardware floating point arithmetic
- Hardware supported virtual memory system
- Up to 64 interactive user terminals
- Error correcting main memory
- 6 K bytes high-speed, bipolar cache memory
- Field-proven hardware

The Harris 500 is offered with a complete line of peripherals and maintenance support.

MULTI-USE AND MULTIPLE USERS

The Harris 500 computer system is designed for high performance in a wide range of uses encompassing scientific or engineering applications together with business applications. These processing requirements demand multiple languages, the accommodation of many users, and both local and remote operations. Harris has developed a unique synergy of computer hardware and software to meet these needs.

The Harris 500 computer system supports concurrent users doing interactive program development, time-sharing, multi-stream batch, multiple remote job entry and real-time processing. The Harris operating system, VULCAN, is reentrant, thus permitting one copy to be shared by all users. The VULCAN language processors, (except the overlay versions) are also reentrant and, compiler-generated code optionally can be reentrant.

The Harris 500 multi-use and multiple user system is an ideal solution to the processing requirements of a multi-disciplined organization.

CENTRAL PROCESSOR

The Harris 500 computer is designed around a very fast central system bus for maximum system performance in a multiprogramming environment.

The system bus is capable of an aggregate transfer rate of 19 million bytes per second. The system bus has 48 lines for data transfers and 20 lines for addressing. The address bits allow the full 3072 K bytes of main memory to be accessed by any subsystem using the bus. On writes to main memory, the system bus transfers the memory address together with 24 or 48 data bits in one bus cycle. Typically, input/output operations transfer 48 data bits at one time between main memory and discs or tapes on the Universal Block Channel via the system bus.

The Harris 500 central processor overlaps instruction fetch with execution. While one instruction is being executed, the next sequential instruction is fetched from main memory. The instruction set is compatible with the Harris 100 and Harris 800 computers.

An Operator Console CRT (OPCOM) provides for communications between the operating system—VULCAN and the system operator.

SCIENTIFIC ARITHMETIC UNIT (SAU)

The Harris 500 features an optional, hardware floating point processor. The Scientific Arithmetic Unit provides concurrent floating point operations independent of the central processing unit. The SAU interface transfers 48 bits to or from main memory on the system bus. Double-precision (48-bit) floating point employs an 8-bit signed exponent and 39-bit signed mantissa, resulting in over 11 decimal digits of precision.

MEMORY SYSTEMS

Virtual Memory

Ease of use is a primary benefit of a virtual memory system. On the Harris 500, users can write programs that are larger than the real memory of the system. Over 12 million bytes of logical address space are available for running application programs regardless of the physical memory available.

The Harris 500 is a demand-paged system supported by the VULCAN virtual memory management operating system. Hardware supporting VULCAN's virtual memory capabilities includes a variety of registers to decrease the burden of housekeeping requirements.

The Harris virtual memory system provides hardware and software memory protection. Every program page in memory is protected against access or inadvertent destruction by another concurrently executing program. In addition, pages containing instructions and constants, as opposed to variable data, are hardware write-protected, even within the same program.

Virtual memory allows programs to execute with only part of the code in real memory. Demand-paging causes the sytem to load blocks or "pages" of code and data into memory as required by a program to continue executing. In the Harris 500 system, a program "page" is 3072 bytes.

Another feature of the the Harris 500 virtual memory system is efficient use of real memory. A program need not occupy contiguous memory pages. Any physical page not occupied by the operating system can hold any logical page. Memory, therefore, never needs reorganizing or compacting.

A combination of hardware and software features serve to minimize the amount of swapping that may occur in a high system usage environment. The Harris virtual memory hardware includes Virtual Usage Registers and Virtual Not-modified Registers. These registers are used by the VULCAN swapping algorithm to identify the most eligible memory pages for swapping.

The Harris sytems have high-speed program loading. Program loading is simply and quickly accomplished by copying program pages directly from disc into memory with no address modification. The Harris virtual memory hardware associates each logical address in the program page with its physical location.

Main Memory

The main memory of the Harris 500 is expandable to over three million bytes (3,145,728 bytes) in 192 K byte modules. Each memory module has its own timing and control logic, and reads or writes 48 bits plus error correcting bits in one memory cycle. The memory cycle time for 48 bits is 400 nanoseconds, and access time is 290 nanoseconds. To achieve high system throughput, each memory module transfers 48 data bits on the system bus to the central processor, cache memory, and some input/output channels.

Cache Memory

The Harris 500 computer includes 6 K bytes of high-speed cache memory. The cache memory cycle time is 150 nanoseconds with an access time of 70 nanoseconds. Although the effectiveness of cache is dependent on the nature of the executing programs, typically, the cache hit ratio will be 90% or better.

The cache memory is partitioned, allocating 3 K bytes for operands and 3 K bytes for instructions. The cache reads or writes 48-bit data fields in one cache memory cycle. Each 48-bit data field has two additional bits to indicate the validity of the stored data. I/O writes to main memory are not written in the cache, however, the cache monitors these write operations and uses the validity bits to indicate a change has occurred in main memory (i.e., the contents of a field in cache are not valid).

Shared Memory

A Shared Memory System is available for multiple processor configurations requiring rapid access to

Languages

- Extended BASIC Language Processor
- FORTRAN IV Compiler
- FORTRAN 77 Compiler
- Extended 1974 ANSI COBOL Compiler
- APL Interpreter
- RPG II Compiler
- Harris Macro Assembler

- SNOBOL 4 Interpreter
- FORGO (Load-and-Go FORTRAN Compiler)

Support Programs

- Sort/Merge Package
- VULCAN Indexed Sequential Package (VISP)
- System Accounting (ACUTIL)
- Cross Reference
- VULCAN Symbolic Debugger (VBUG)

Remote Job Entry (RJE) Support Packages

- CDC 200 UT
- IBM 2780
- IBM 3780
- IBM HASP II Multi-leaving
- UNIVAC 1004

Remote Batch Terminal (RBT) Host Packages

- IBM 2780
- IBM HASP II Multi-leaving

Interactive Terminal Package

- IBM 3270

Data Base Management System (DBMS)

- TOTAL Central
- T-ask™ Information Retrieval

Harris Transaction Processor (HTP)

TECHNICAL SPECIFICATIONS

HARRIS 500 CENTRAL PROCESSING UNIT

Type	Microprogrammed, general-purpose, digital computer. Multi-access central system bus.
Arithmetic	Parallel, binary, two's complement fixed and floating point; optional hardware floating point processor.
CPU Microcyle Time	300 nanoseconds

MEMORY SYSTEM

Main Memory	
Type	N-Channel MOS with error correction.
Minimum size	196,608 Bytes
Maximum Size	3,145,728 Bytes (with optional Extended Memory)
Increment	192 K Bytes (K=1024)
Word Length	48 bits
Cycle Time	400 nanoseconds (48 bits)
Access Time	290 nanoseconds (48 bits)

(Performance of memory may differ from above when used in Expanded or Shared Memory configurations.)

Cache Memory	
Type	Bipolar RAM
Size	6 K Bytes
Word Length	48 bits
Cycle Time	150 nanoseconds (48 bits)
Access Time	70 nanoseconds (48 bits)
Organization	3 KB for operands 3 KB for instructions
Shared Memory (Optional)	
Type	Uses Main Memory modules in a Shared memory chasis.
Number of Ports	6
Number of Shared Memories interfaced per CPU (maximum)	4
Port Access	Asynchronous, ring priority

ADDRESSING

Direct, indirect, or indexed to 3072 K Bytes

INPUT/OUTPUT

Programmed Transfers	Transfers 8- or 24-bits between a CPU register and the PIOC.
Direct Memory Access Transfers	Transfers 24- or 48-bits between main memory and either the IBC, UBC, DMACP or XBC channels.
Aggregate, Maximum Throughput	Input rate – Up to 19.0 MB per second Output rate – Up to 7.9 MB per second

Single Channel Maximum Transfers Rate (per second)

	Input	**Output**
IBC	80 KB	80 KB
XBC		
(no CPU contention)	2.4 MB	2.0 MB
(with CPU contention)	1.4 MB	1.2 MB
UBC (with 30 ft. peripheral cable)	3.2 MB	2.5 MB

PRIORITY INTERRUPT STRUCTURE

Internal	Eight executive traps. Multi-level, vectored structure.
External	16 levels, standard. Optionally expandable to 48.
Control	External Priority Interrupts may be individually armed, disarmed, enabled, inhibited or triggered under program control.

POWER FAIL PROTECTION

Power fail alarm, standard.

ELECTRICAL REQUIREMENTS

(For CPU, memory and channels contained in a two cabinet configuration.)

Voltage	120/208, 115/230 VAC, 4-wire (standard), or 220/240 VAC, single-phase, 3-wire (optional).
Frequency	60 ± 3 Hz. (50 ± 3 Hz. optional)
Current	24 Amps., maximum.

ENVIRONMENTAL REQUIREMENTS

(For CPU, memory and channels)

Temperature	
Operating	50° F to 113° F (10° C to 45° C), ambient air
Storage	32° F to 122° F (0° C to 50° C), ambient air
Humidity	
Operating	20% to 80%, relative (non-condensing)
Storage	20% to 90%, relative (non-condensing)
Altitude	
Operating	−1,000 to 6,000 ft. (−305 to 1,829 m)
Storage	−1,000 to 15,000 ft. (−305 to 4,572 m)
Cooling	Forced air provided by internal fans on each chassis.

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TECHNICAL SPECIFICATIONS
HARRIS 500 CENTRAL PROCESSING UNIT

Type	Microprogrammed, general-purpose, digital computer. Multi-access central system bus.
Arithmetic	Parallel, binary, two's complement fixed and floating point; optional hardware floating point processor.
CPU Microcyle Time	300 nanoseconds

MEMORY SYSTEM

Main Memory	
Type	N-Channel MOS with error correction.
Minimum size	196,608 Bytes
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Number of Ports	6
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Port Access	Asynchronous, ring priority

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POWER FAIL PROTECTION

Power fail alarm, standard.

ELECTRICAL REQUIREMENTS

(For CPU, memory and channels contained in a two cabinet configuration.)

Voltage	120/208, 115/230 VAC, 4-wire (standard), or 220/240 VAC, single-phase, 3-wire (optional).
Frequency	60 ± 3 Hz. (50 ± 3 Hz, optional)
Current	24 Amps., maximum.

common data. Up to six ports are available, permitting as many as six processors to be connected to over three million bytes of memory. The combined main and shared memory available to a single computer is three million bytes.

I/O CHANNELS

The Harris 500 has several types of input/output channels which interface the central system bus to the device controllers. The system supports up to 24 logical I/O channels.

Universal Block Channel (UBC)

The Universal Block Channel is a block-mode, direct memory access channel for high-performance peripheral controllers such as those for discs and magnetic tapes. The UBC has two operating modes—the scan mode and the scan-lock mode. In the scan mode, a UBC supports two concurrent input/output operations. In the scan-lock mode, the UBC operates as a single direct memory access channel. In addition to direct memory operations, the UBC also functions as a programmed I/O channel transferring data under CPU/program control between a CPU register and the channel. The UBC contains a 48-bit data buffer for each logical channel.

Integral Block Channel (IBC)

The IBC is a block-mode, direct memory access channel for interfacing the card reader to the system. The card reader controller plugs onto the IBC module.

Programmed I/O Channel (PIOC)

The PIOC is a channel for interfacing slow speed devices to the system. It supports up to four plug-in controllers for devices such as a line printer, operator communications terminal, and user terminals. Input/output to these devices proceeds under program control through a CPU register.

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VULCAN Operating System

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- Multi-stream batch processing
- Interactive time-sharing
- Data base management
- Remote job entry
- Real-time operations

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Support Software

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Languages
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Remote Batch Terminal (RBT) Host Packages
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Data Base Management System (DBMS)
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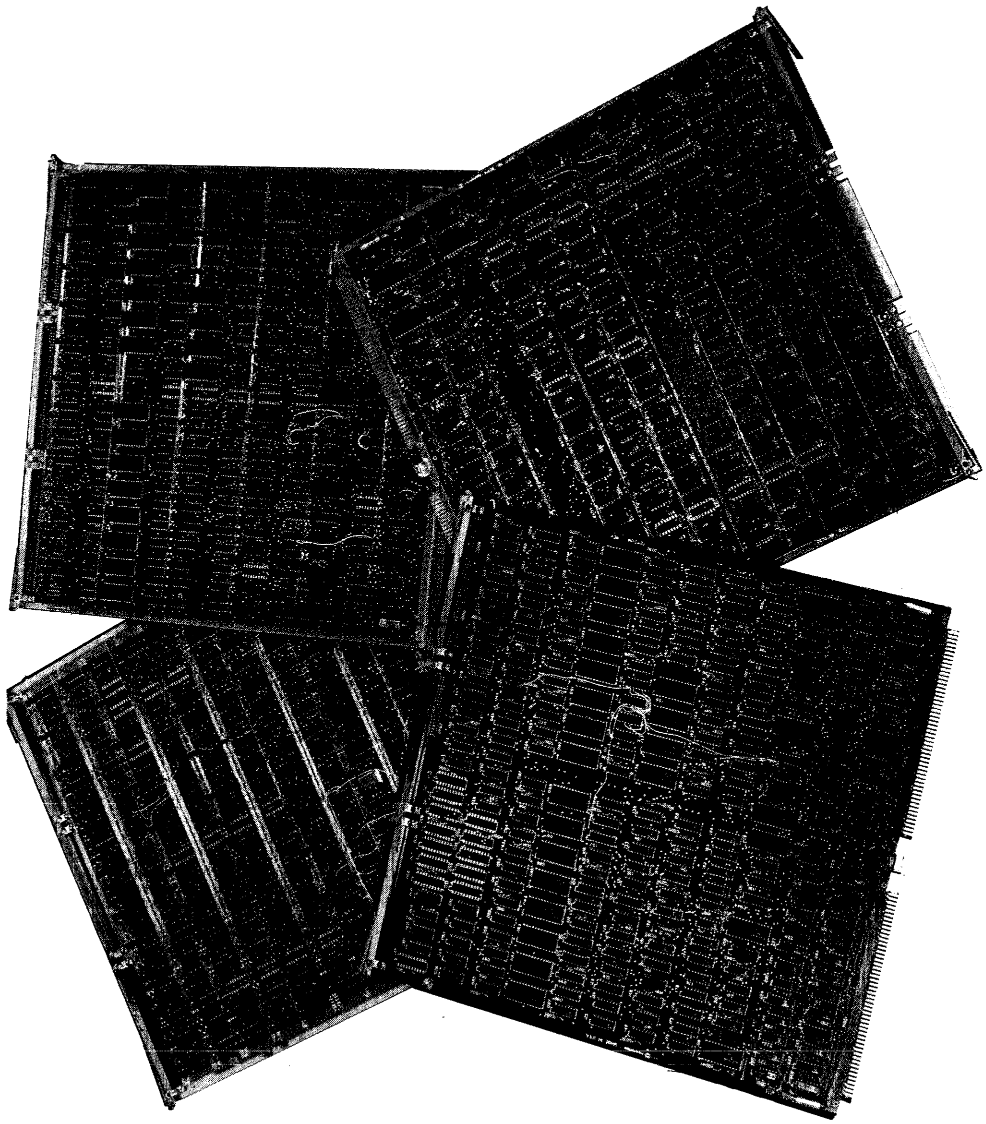
Harris Transaction Processor (HTP)



SCIENTIFIC ARITHMETIC UNIT

FEATURES

- 47 Individual Operations
- High-performance Double-Precision
- Square and Square Root Functions
- Inverse Function
- Fixed/Floating Point Conversion

HARRIS
COMPUTER SYSTEMS

SCIENTIFIC ARITHMETIC UNIT

The Harris Scientific Arithmetic Unit (SAU) is a hardware, floating point processer designed to enhance the performance of its associated CPU by eliminating the need for software-performed, floating point processing. It is well suited for users that demand high performance along with extended precision in their scientific applications. Typical processing applications benefiting from the SAU are theoretical chemistry, optical design, civil engineering, numerical analysis, real-time control, and aerospace simulation.

SAU models are available as options on most Harris SLASH Series and the Series 100/200/500 Virtual Memory Computer Systems. Each model executes the same instruction set—consisting of 47 additional instructions unique to the SAU—to provide upward software compatability. The instruction set, listed in Table 1, is divided into five functional groups: arithmetic, branch, compare, interrupt and transfer. These instructions implement full mathematical manipulations as well as branch and transfer functions.

Formats of floating point numbers are illustrated on Figure 1. Double-precision numbers (integer or floating point) are transferred from the CPU to the SAU in single-word increments (24 bits at a time). The Series 500 Systems employ a dual-word system bus that transfers a full 48-bit double-word between the SAU and the CPU.

HARDWARE

Hardware for each model SAU consists of a series of printed-circuit boards and the appropriate chassis and backplane assemblies. Hardware functions included are: a bidirectional, high-speed scaler, various accumulators, a condition code register, and the necessary timing and control logic.

The high-speed scaler is capable of shifting either right or left from one to 38 places using a single clock pulse. This insures that the instruction times for add and subtract functions are absolute times (i.e., extra software cycles for exponent alignment and result normalizing are not required). The scaler is also used to convert single-precision integers from the CPU to floating point numbers since all SAU arithmetic operations are performed in the double-precision, floating point format. A 39-bit mantissa and an eight-bit exponent are used to provide 11 + decimal digits of accuracy.

REGISTERS

Three registers in the SAU are accessable to the programmer:

X Register—	39 bits (contains mantissa and sign)
W Register—	8 bits (contains exponent and sign)
Y Register—	5 bits (contains status of last operation and SAU interrupt status)

The W Register is the least-significant, eight-bit portion of the X Register. Either part of the X Register (mantissa or exponent) can be modified or manipulated simultaneously with or independent of the remaining part of the register. Results of SAU instruction execution, i.e.; positive, negative, zero, or overflow are reflected in the Y (Condition) Register. Execution of any SAU instruction results in the setting of the overflow bit as well as one or more of the remaining bits should an error occur during the SAU operation. The fifth bit reflects the status (enabled/disabled) of the SAU executive trap interrupt. The state of these five status bits can be displayed on the Programmer's Control Panel as part of the A Register contents.

Data transfers can occur between the CPU's A Register, D Register, or Memory and the SAU's X Register, W Register, or Y Register. Data can be in the form of eight-bit or 24-bit, single-precision integers or 48-bit, double-precision, floating point numbers. Single-precision integers are normalized (converted to floating point format) by the SAU before any arithmetic operation is performed. Arithmetic operations performed on non-normalized numbers would produce an invalid result.

OVERLAP/CONCURRENCY

Concurrent operation of the CPU and SAU is possible for several SAU instructions. These instructions allow the CPU to be released from SAU operations so as to continue CPU processing. Table 2 lists examples of SAU instruction execution times. The times listed are for SAU operation only and do not consider synchronization or memory access times. Actual times and maximum concurrent operation are dependent on the instruction mix. The proper intermix of CPU and SAU instructions will insure the maximum number of concurrent cycles and most efficient utilization of the SAU.

STATUS

Data and condition code information can be displayed on the Programmer's Control Panel on selectable, shared indicators. Switches on the panel allow data to be transferred to/from either of three available SAU registers.

TRAP

An executive trap interrupt is provided to signal the detection of overflow/underflow conditions resulting from any SAU operation. An interrupt request will then be issued to the CPU only if the executive trap for the SAU is enabled. Note that the SAU executive trap interrupt can be selectively enabled/disabled under CPU program control.

SOFTWARE

SAU operation is available under the DMS (all SLASH Series Computers except SLASH 5) or Vulcan (all Virtual Memory Computers except S115) operating systems. An SAU-oriented FORTRAN Library is used to provide a significant performance improvement over non-SAU or software floating point subroutines. For example, a double-precision complex divide subroutine requires 145 machine cycles for an SAU equipped system versus 406 machine cycles for a non-SAU equipped system.

Table 1. SAU Instruction Set

ARITHMETIC	
Mnemonic	**Description**
AAX	Add A Register to X Register
ADX	Add D Register to X Register
AMX	Add Memory to X Register
AOW	Add Operand to W Register
AOX	Add Operand to X Register
DAX	Divide A Register into X Register
DDX	Divide D Register into X Register
DMX	Divide Memory into X Register
DOX	Divide Operand into X Register
FAX	Floating normalize of A Register to X Register
FXA	Fix of X Register to A Register
INX	Inverse of X Register
MAX	Multiply A Register and X Register
MDX	Multiply D Register and X Register
MMX	Multiply Memory and X Register
MOX	Multiply Operand and X Register
NXX	Negative of X Register to X Register
PXX	Positive of X Register to X Register
SAX	Subtract A Register from X Register
SDX	Subtract D Register from X Register
SEX	Square X Register
SMX	Subtract Memory from X Register
SOX	Subtract Operand from X Register
SRX	Square Root of X Register

COMPARE	
Mnemonic	**Description**
CDX	Compare D Register to X Register
COW	Compare Operand to W Register
CZX	Compare Zero to X Register

BRANCH	
Mnemonic	**Description**
BNR	Branch on Negative Reset
BNS	Branch on Negative Set
BOR	Branch on Overflow Reset
BOS	Branch on Overflow Set
BOX	Branch on SAU Ready
BPR	Branch on Positive Reset
BPS	Branch on Positive Set
BZR	Branch on Zero Reset
BZS	Branch on Zero Set

INTERRUPT	
Mnemonic	**Description**
HSI	Hold SAU Overflow Interrupt
RSI	Release SAU Overflow Interrupt

TRANSFER	
Mnemonic	**Description**
IDX	Interchange D Register and X Register
TDX	Transfer D Register to X Register
TMX	Transfer Memory to X Register
TOW	Transfer Operand to W Register
TOY	Transfer Operand to Y Register
TXD	Transfer X Register to D Register
TXM	Transfer X Register to Memory
TYA	Transfer Y Register to A Register
TZX	Transfer Zero to X Register

Table 2. Execution Times

Instruction Type	SLASH 4 and Series 1X0	SLASH 6 and Series 1X5/Series 123	SLASH 7 and Series 2X0	Series 5X0, etc.
Arithmetic				
Add/Subtract	0.75 to 2.25	2.73	1.8	0.6 to 1.2
Multiply	5.25	6.23	5.91	4.4
Divide	12.0	11.43	11.16	8.7
Square Root	9.75	8.53	10.11	7.8
Compare	0.75 to 2.25	2.43	1.80	0.6 to 1.0
Transfers	0.75 to 2.25	0.75	1.80	0.6

*Times are for prefetched execution of instructions.

SPECIFICATIONS

ELECTRICAL REQUIREMENTS

Each model SAU is supplied power by its associated CPU.

ENVIRONMENTAL REQUIREMENTS

Temperature
- Operating: 50°F to 113°F (10°C to 45°C), ambient air
- Storage: 32°F to 122°F (0°C to 50°C), ambient air

Humidity
- Operating: 20% to 80%, relative (non-condensing)
- Storage: 20% to 90%, relative (non-condensing)

Altitude
- Operating: −1000 to 6000 ft. (−305 to 1829m)
- Storage: −1000 to 15,000 ft. (−305 to 4572m)

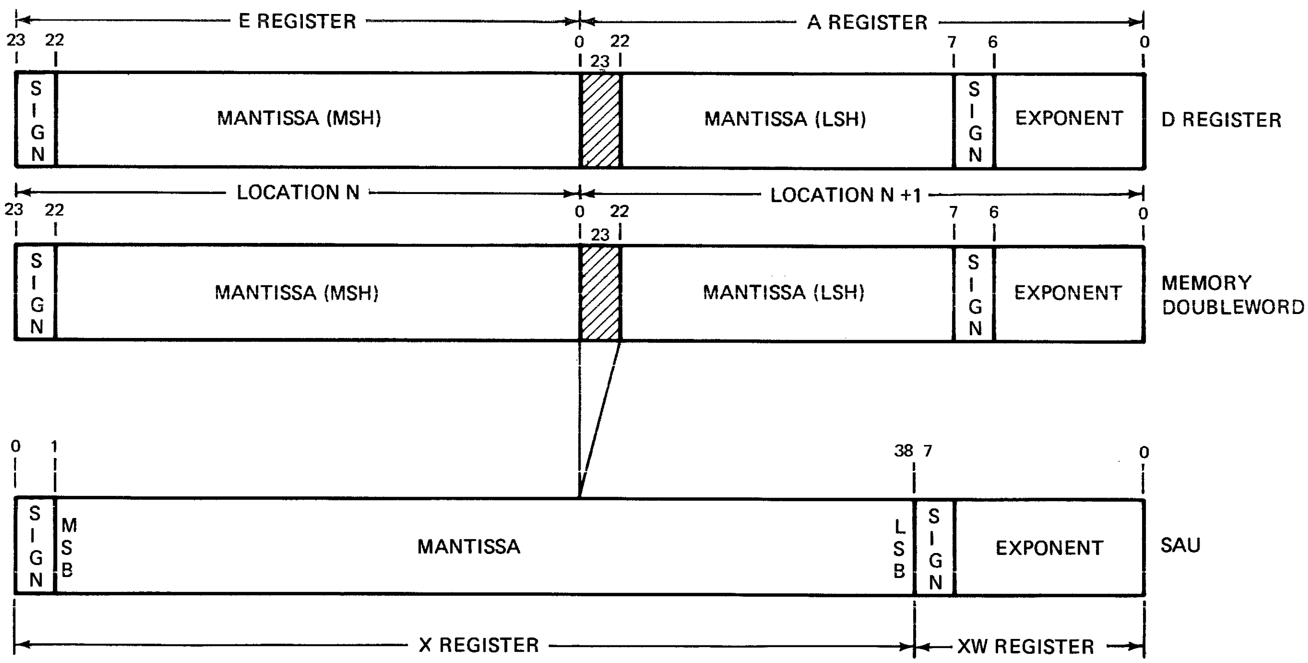


Figure 1. Floating-Point Formats

Specifications subject to change without written notice.

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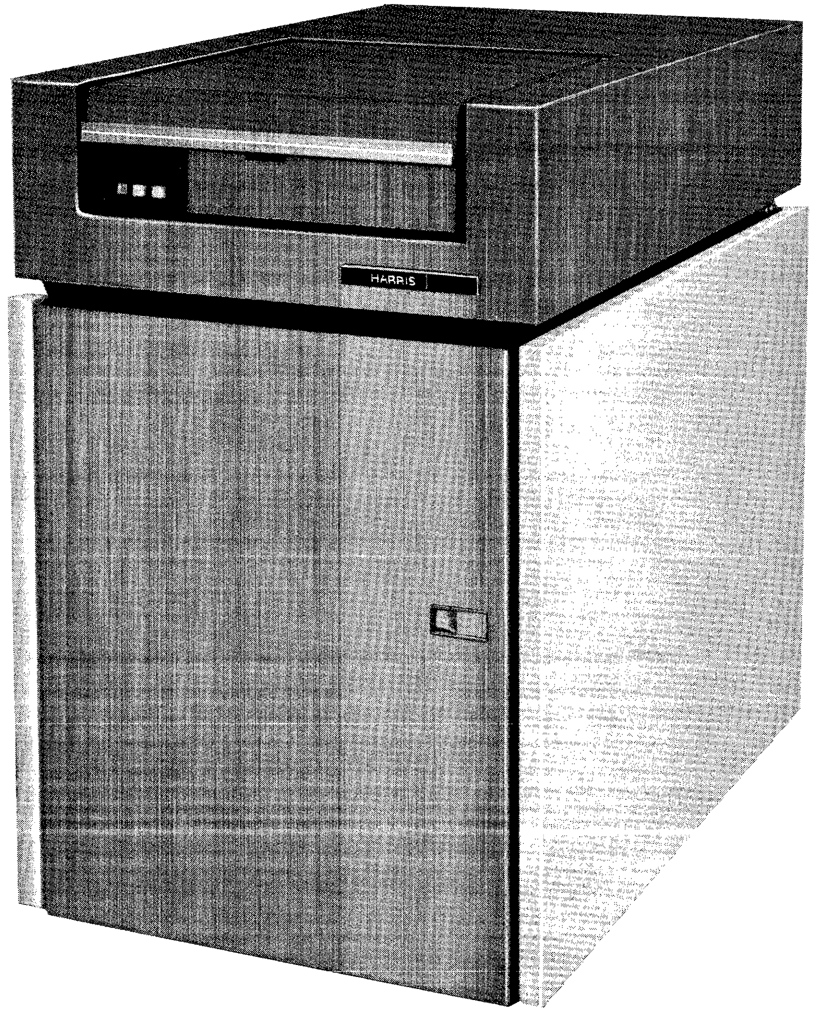


SERIES 5500
HIGH-CAPACITY STORAGE MODULE DRIVE

FEATURES
- 300M Byte Capacity
- Removable Disk Pack
- High Transfer Rate
- Acoustic Cabinet

HARRIS
COMPUTER SYSTEMS

HIGH CAPACITY STORAGE MODULE DRIVE

These high-capacity discs are the latest additions to the Harris Series 5500 Storage Module Drive systems. With storage capacities to 600M Bytes per controller and an average access time of only 38 milliseconds; these large disc systems provide high-performance, high-capacity, random-access disc storage for Harris Computer System users having large data base requirements. Configurations up to 1.8G Bytes per computer system are practical with these devices.

The Series 5500 High-Capacity Storage Module Drive (HCSMD) systems are available in two sizes: Model 554X with 150M Bytes and Model 555X with 300M Bytes per drive. Since these HCSMD systems are practically identical, most of the information in this product bulletin pertains to both. However, where specification differences exist; the data presented first refers to the 150M Byte unit, followed by data [in brackets] pertinent to the 300M Byte unit.

STORAGE MODULE DRIVE

The HCSMD consists of a disc pack spindle and associated drive motor, flying heads and servo positioning mechanism, speed and position sensing devices, an air supply and filtration system and the electronic circuitry necessary for reading, writing, positioning, control and interface. A shroud cover on the drive allows access to the spindle for disc pack installation or removal. During operation, this cover seals the disc shroud area so the air filtration system can maintain clean airflow past the disc pack. A separate enclosure cover provides access to the read/write electronics, heads and servo mechanism for maintenance purposes. Front and rear cabinet doors provide access to the power supplies, servo electronics and air filtration system. The controller electronics is housed in a (optional) peripheral cabinet.

The read/write heads, attached to a carriage assembly, are driven by a voice-coil linear actuator. Position feedback information is provided by the pre-recorded servo tracks on the installed disc pack. Data is recorded by the write-compensated, modified frequency modulated (MFM) method. A phase-locked oscillator provides read data recovery.

DISC PACK

The model 5555 Disc Pack consists of twelve discs stacked vertically on a common hub. The disc pack is stored and transported in a protective container when not in use. The container handle is used to lift, load and lock the disc pack onto the HCSMD spindle. The top and bottom discs provide physical protection for the ten magnetic oxide-coated center discs. Nineteen of the 20 surfaces provided are used for data storage. The twentieth surface contains 411 [823] pre-recorded servo tracks that define the recording track positions and also provide timing signals. Each recording Head, when correctly positioned, defines a Track. The nineteen vertical recording Tracks define a Cylinder. The primary tracks are located on Cylinders 0 through 403 [807]. There are seven [fifteen] spare tracks on each surface that may be used as an alternate for any primary track that is defective. Each track is addressed by a cylinder and head address number; which is pre-recorded (during pack initialization) in the Header Address Word of each sector.

CONTROLLER

The Extended Disc Controller (EDC) performs all functions required to operate the HCSMD on-line with Harris CPUs. In operation, the EDC communicates with the computer through a Chain Block Channel (CBC) or a Universal Block Channel (UBC) Input/Output Channel (IOC). Commands establish the operation mode, special conditions and also specify the Drive, Cylinder, Head and Sector addresses.

In the Write mode, 24-bit parallel output data words are converted to a bit-serial data stream and transmitted to the drive. The EDC automatically formats this data into sectors and generates a preamble and postamble for each sector. A checksum technique is used for error detection.

In the Read mode, the bit-serial data received from the disc is stripped of the preamble and postamble information and converted into parallel 24-bit data words for transfer to the I/O Channel. All read/write transfers are of the Direct Memory Access (DMA), block mode category. Sector, Head and Cylinder address "spills" are automatically implemented by the controller during read, write or search operations.

One additional Model 5541 [5551] HCSMD may be operated by the controller supplied with the Model 5540 [5550] HCSMD. Status information from the HCSMD and EDC is transferred to the CPU upon command. An interrupt request is generated by the controller logic in response to error conditions or at the end of read, write or motion-type commands.

SOFTWARE

A diagnostic program is supplied with each HCSMD system to verify the operation of the controller and exercise the drive. The Harris HCSMD system is supported by the Series 100/200 Virtual Memory Manager (VULCAN) operating system.

SPECIFICATIONS

HIGH-CAPACITY STORAGE MODULE DRIVE (HCSMD) — MODELS 5540/5541 [MODELS 5550/5551]

Positional Access
- Single Seek: 6 m sec (maximum) between adjacent tracks
- Average Seek: 30 m sec (average) for all possible combinations
- Maximum Seek: 55 m sec (maximum) from track 0 to 410 [0 to 822]

Spindle Speed: 3600 RPM; +2.5% −3.5%

Rotational Access
- Average Latency: 8.33 m sec at 3600 RPM, nominal
- Maximum Latency: 17.3 m sec at 3474 RPM (3600 RPM −3.5%)

Number of Heads: 19 recording and 1 servo
Recording Method: Modified Frequency Modulation (MFM)

Data Transfer Rates
- Serial Bit Stream: 9.677 MHz, nominal
- 8-bit Bytes: 1.2 M Byte/second
- 24-bit Words: 403,200 words/second, burst rate within a Sector
  342,720 words/second, formatted rate within a Cylinder

DISC PACK — MODEL 5555

Number of Discs: 10 recording and 2 cover plates
Recording Surfaces: 19 data and 1 servo

Recording Density
- Outer Track: 4038 BPI, nominal
- Inner Track: 6038 BPI, nominal
- Track Spacing: 192 Tracks/inch [384 Tracks/inch]
- Tracks/Surface: 404 plus 7 spares [808 plus 15 spares]
- Bits/track: 161,280, nominal (unformatted)

Dimensions
- Diameter: 14.0 in (35.6 cm)
- Height: 7.0 in (17.8 cm)
- Weight: 16.0 lb (7.3 kg)

Formatted Data Capacity

e.g.; 3 bytes/word
112 words/sector
51 sectors/track

BYTE	3	336	17,136	325,584	131,535,936	263,071,872
WORD		112	5,712	108,528	43,845,312	87,690,624
SECTOR			51	969	391,476	782,952
TRACK				19	7,676	15,352
CYLINDER					404	808
					150 MB HCSMD	[300 MB HCSMD]

CONTROLLER — MODELS 5540 and 5550

Logic: TTL Integrated Circuits

Interface
- Controller to HCSMD: Differential line drivers/receivers
- Controller to IOC: Single-ended line drivers/receivers
- Operating Control: On-line with Harris Computer Systems via DMA I/O Channel (IOC)

IOC Requirements
- Series 100/200: CBC/SE/24-IOC or UBC/SE/24-IOC
- Configuration: Model 5540/5550 includes the controller. One additional HCSMD may be connected to this controller.
- Formatting: The controller formats the data into the standard 112 words/Sector and 51 Sectors/Track. A Sector is comprised of a Preamble, 112 24-bit data Words and a Postamble (including the Checksum).
- Interrupt: An interrupt is generated at the end of Read, Write and motion-type commands or if an error condition is detected.

ELECTRICAL REQUIREMENTS

HCSMD (all Models)	Domestic	Export
Voltage (nominal)	208 VAC (230 VAC, optional)	220 VAC (240 VAC, optional)
Voltage Tolerance	198-246 VAC (179-222 VAC, optional)	195-235 VAC (213-257 VAC, optional)
Frequency	59.0 to 60.6 Hz	49.0 to 50.5 Hz
Current		
@208VAC/60Hz	8.0A RMS, run (38A, surge)	
@230VAC/60Hz	7.2A RMS, run (39A, surge)	
@220VAC/50Hz		9.5A RMS, run (40A, surge)
@240VAC/50Hz		8.7A RMS, run (41A, surge)
Phase	Single phase, 3-wire, polarized connector type L6-20P	
Power		
@60Hz	PF=0.70; 1200 Watts, nominal	
@50Hz	PF=0.59; 1300 Watts, nominal	

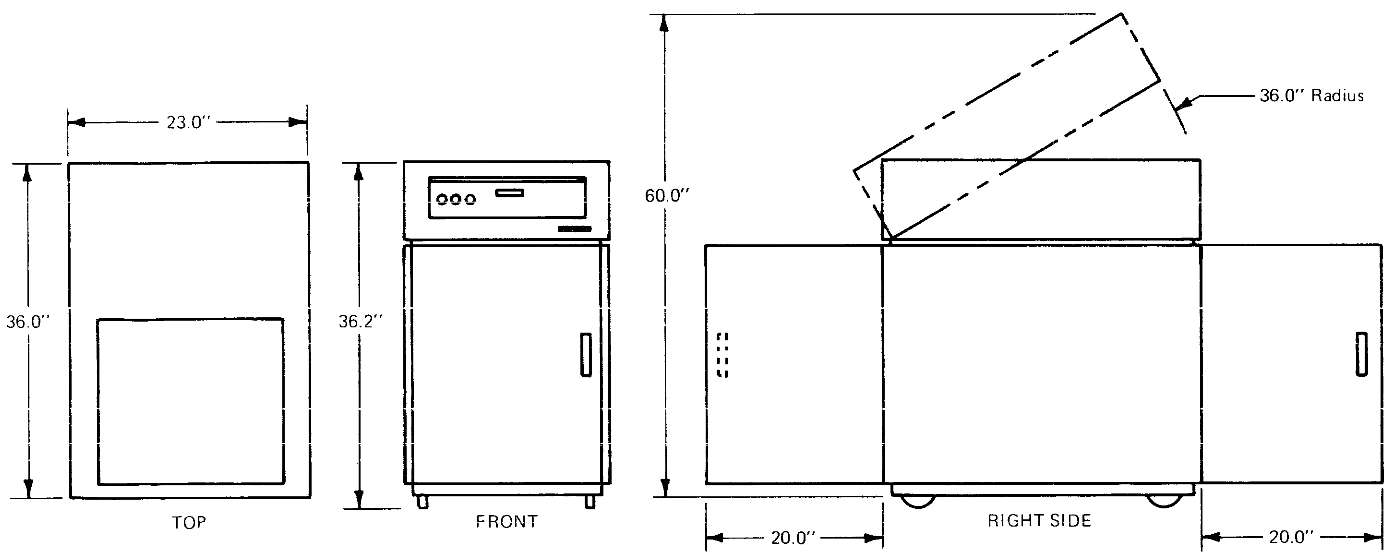
Controller (Models 5540/5550)	Domestic	Export
Voltage (nominal)	115VAC (230VAC, optional)	220VAC
Voltage Tolerance	105-125VAC (210-250VAC, optional)	210-250 VAC
Frequency	47 to 400 Hz	47 to 400 Hz
Current		
@115VAC/60Hz	2.0A RMS	
@230VAC/60Hz	1.0A RMS	
@220VAC/50Hz		2.0A RMS
Phase	Single phase, 3-wire, polarized connector	
Power		
@60Hz	230 Watts, nominal	
@50Hz	240 Watts, nominal	

ENVIRONMENTAL REQUIREMENTS

Temperature	
Operating	60°F to 90°F (16°C to 32°C), ambient air
Storage	−30°F to 150°F (−34°C to 65°C), ambient air
Humidity	
Operating	20% to 80%, relative (non-condensing)
Storage	5% to 95%, relative (non-condensing)
Thermal Shock	
Operating	12°F/hour (7°C/hour), maximum
Storage	36°F/hour (20°C/hour), maximum
Altitude	
Operating	−1000 ft to 6500 ft (−305m to 2000m)
Storage	−1000 ft to 15,000 ft (−305m to 4572m)
Heat Dissipation	
Domestic	4200 BTU/hour (1000 kg-cal/hour), nominal
Export	4500 BTU/hour (1100 kg-cal/hour), nominal
Cooling	Centrifugal fan, approximately 200 CFM

DIMENSIONS

Height	36.2 in (91.9 cm)
Width	23.0 in (58.4 cm)
Depth	36.0 in (91.4 cm)
Weight	550 lb (250 kg)
Installation and Access	See Below.



High Capacity Storage Module Drive

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SERIES 5500
STORAGE MODULE DRIVE

FEATURES
- Removable Disc Pack
- 80 MByte Capacity
- Minimal Latency Time
- High Transfer Rate

HARRIS
COMPUTER SYSTEMS

STORAGE MODULE DRIVE

Featuring an average access time of only 38 milliseconds and a transfer rate of 9.68 MHz, the Harris Series 5500 Storage Module Drive Systems provide high-performance, medium-capacity, random-access storage for Harris Computer Systems. The Storage Module Drive (SMD) consists of a disc pack spindle and associated drive motor, flying heads and servo positioning mechanism, speed and position sensing devices, an air supply and filtration system and the electronic circuitry for reading, writing, positioning, control and interface.

The Series 5500 SMD systems are offered with two capacities: the 40 M Byte module and the 80 M Byte module. Since these SMDs are practically identical, most of the information in this product bulletin pertains to both. However, where differences exist, the data presented first refers to the 40 M Byte module, followed by data (in parentheses) pertinent to the 80 M Byte module.

A shroud cover on the drive allows access to the spindle for disc pack installation or removal. During operation, this cover seals the disc shroud area so that the air filtration system can maintain clean airflow past the disc pack. A separate enclosure cover provides access to the electronics, heads and servo mechanism for maintenance purposes. Cabinet doors provide access to the interface controller and controller power supplies in the SMD.

The read/write heads, attached to a carriage assembly, are driven by a voice-coil linear actuator. Position feedback information is provided by the servo surface of the installed disc pack. Data is recorded by the write-compensated modified frequency modulation method. A phase-locked oscillator provides read data recovery.

DISC PACK

The Model 5515 (5535) Disc Pack consists of five discs stacked vertically on a common hub. The disc pack is enclosed in a protective container when not in use. The container handle is used to lift, load and lock the disc pack onto the SMD spindle. The top and bottom discs provide protection for the three magnetic oxide coated center discs. Five of the six surfaces provided are used for data storage. The sixth surface contains 411 (823) pre-recorded servo tracks that define the recording track positions and provide timing signals. Each recording Head, when correctly positioned, defines a Track. The five vertical recording tracks define a Cylinder. The primary tracks are located in Cylinder (0 through 403 (807). There are seven (15) spare tracks on each surface that may be used as an alternate for any primary track that is defective. Each track is accessed by a cylinder and head address number which is pre-recorded in the Header Address Word of each sector.

CONTROLLER

The interface controller provides all functions required to operate the SMD on-line with the CPU. In operation, the controller communicates through a Chain Block Channel (CBC), a Universal Block Channel (UBC), or an Automatic Block Channel (ABC) I/O Channel. The commands establish the operational mode and special conditions and also specify the drive, cylinder, head and sector addresses. In the Write mode, 24-bit parallel output data words are converted to a bit-serial data stream and transmitted to the drive. The controller automatically formats this data into sectors and generates a preamble and postamble for each sector. A checksum comparison technique is used for error detection. In the Read mode, the bit-serial data received from the drive is stripped of the preamble and postamble and converted to parallel 24-bit data words for transfer to the I/O channel. Sector, head, and cylinder address "spills" are performed automatically by the controller during read, write or search operations.

Up to three additional Model 5511 (5531) drives may be operated by the controller in the Model 5510 (5530) SMD. Status information from the SMD and controller is transferred to the CPU upon command. An interrupt request is generated by the controller logic in response to error conditions or at the end of read, write or motion-type commands. A diagnostic program is supplied with each system to verify the operation of the controller and exercise the drive.

SPECIFICATIONS

STORAGE MODULE DRIVE	**MODELS 5510/5511**	**MODELS 5530/5531**
Spindle Speed	3600RPM;+2,-3%	
Positional Access		
Single Seek	10 m sec, maximum; between adjacent tracks	
Average Seek	30 m sec; average for all possible combinations	
Maximum Seek	55 m sec, maximum; from track 0 to track 410	(0 to track 822)
Rotational Access		
Average Latency	8.33 m sec at 3600 RPM, nominal	
Maximum Latency	17.2 m sec at 3492 RPM (3600 RPM-3%)	
Number of Heads	5 recording and 1 servo	
Recording Method	Modified Frequency Modulation (MFM)	
Data Transfer Rates		
Serial Bit Stream	9.6768 MHz, nominal	
24 bit Words	403,200 words per second; burst rate within a sector. 342,720 words per second; formatted rate within a Cylinder.	

DISC PACK	**MODEL 5515**	**MODEL 5535**
Number of Discs	3 recording and 2 cover plates	
Recording Surfaces	5 data and 1 servo	
Recording Density		
Outer Track	4038 BPI, nominal	
Inner Track	6038 BPI, nominal	
Track Spacing	192 Tracks per inch	(384 Tracks per inch)
Tracks/Surface	404 plus 7 spares	(808 plus 15 spares)
Bits/Track	161,280, nominal (unsectored)	
Dimensions		
Diameter	14.0 in (35.6 cm)	
Height	4.0 in (10.2 cm)	
Weight	6.3 lbs (2.9kg)	

Formatted Data Capacity

e.g.: 8 bits/byte
3 bytes/word
24 bits/word

BIT	8	24	2688	137,088	685,440	276,917,760	553,835,520
BYTE		3	336	17,136	85,680	34,614,720	69,229,440
WORD			112	5,712	28,560	11,538,240	23,076,480
SECTOR				51	255	103,020	206,040
TRACK					5	2,020	4,040
CYLINDER						404	808
						40M BYTE DISC PACK	80M BYTE DISC PACK

CONTROLLER	
Logic	TTL Integrated Circuits
Interface	
Controller to SMD	Differential line drivers/receivers
Controller to IOC	Single-ended line drivers/receivers
Operating Control	On-line with Harris Computer Systems via blocked Input/Output Channels
IOC Requirements	UBC/SE/24-IOC for use with Harris SLASH 6/S115, S123, S125 and S135 Computer Systems. ABC/SE/24-IOC for use with Harris SLASH 5 Computer Systems. CBC/SE/24-IOC for use with Harris SLASH 4/S110, S120, S130, S140 and S150 or SLASH 7/S210, S220, S230 and S240 Computer Systems.
Configuration	Model 5510 (5530) SMD includes the controller. Up to three additional Model 5511 (5531) SMD s may be connected to this controller.
Formatting	The controller formats the data into the standard 112 Words per Sector and 51 Sectors per track. A Sector is comprised of a Preamble, 112 24-bit data Words and a Postamble (including the Checksum).
Interrupt	An interrupt is generated at the end of Read, Write and motion-type commands or if an error condition is detected.

ELECTRICAL REQUIREMENTS

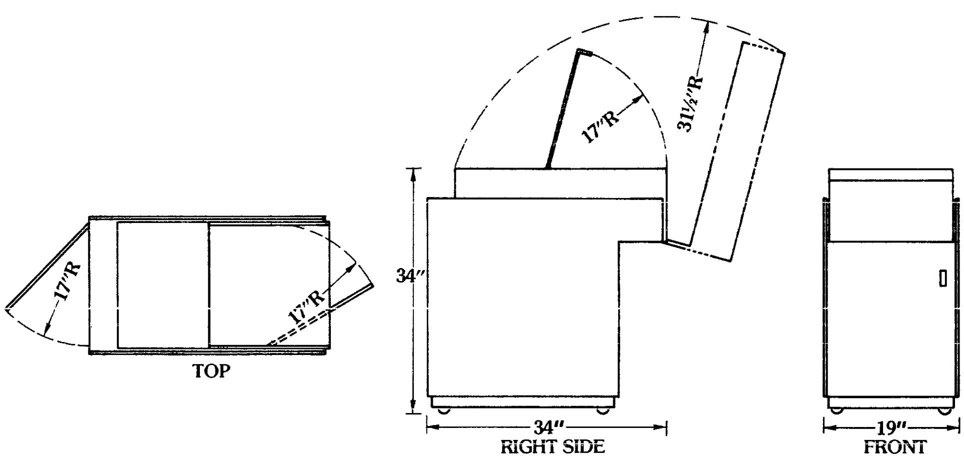
Voltage	102 to 128 VAC (195 to 235 VAC, optional)
Frequency	59.0 to 60.6Hz (49.0 to 50.5 Hz, optional)
UL Listing	All models are listed per document 478 for EDP equipment
Current	
@120VAC/60Hz	8.0Amps RMS, run (up to 30 Amps RMS, surge)
@220VAC/50Hz	5.5/Amps RMS, run (up to 23 Amps RMS, surge)
Phase	Single Phase, 3 wire, polarized connector
Power	PF=0.77 @60Hz (0.60 @50Hz); 740 Watts, nominal

ENVIRONMENTAL REQUIREMENTS

Temperature	
Operating	60°F to 90°F(16°C to 32°C), ambient air
Storage	−30°F to 150°F(−34°C to 65°C), ambient air
Humidity	
Operating	20% to 80%, relative (non-condensing)
Storage	8% to 80%, relative (non-condensing)
Thermal Shock	
Operating	12°F/hour(7°C/hour), maximum
Storage	20°F/hour(11°C/hour), maximum
Altitude	
Operating	−1000 ft to 6000 ft (−305 m to 1829 m)
Storage	−1000 ft to 15000 ft (−305 m to 4572 m)
Heat Dissipation	2523 BTU/hour (636 kg-cal/hour), nominal
Cooling	Centrifugal fan, approximately 70 CFM

DIMENSIONS

Height	34.0 in (86.4 cm)
Width	19.0 in (48.9 cm)
Depth	34.0 in (86.4 cm)
Weight	218 lbs (99kg)



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HARRIS CORPORATION Computer Systems Division

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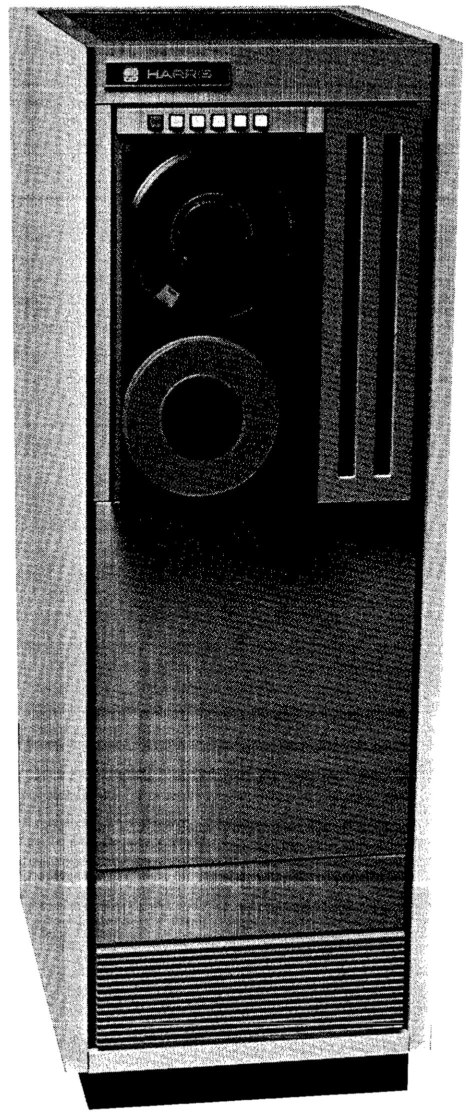


SERIES 6700 HIGH-DENSITY MAGNETIC TAPE SUBSYSTEMS

FEATURES

- 6250 BPI/1600 BPI Dual-Density Format
  - Improved Data Integrity
  - Increased File Compaction
  - High Data Transfer Rate (470 KBytes/Second)
- ANSI Compatible

HARRIS
COMPUTER SYSTEMS

MAGNETIC TAPE SUBSYSTEMS

Harris Series 6700 High-Density Magnetic Tape Subsystems (HDMTS) feature 6250/1600 BPI (dual-density) read/write capability using the Group Coded Recording (GCR)/Phase-Encoded (PE) format at a tape speed of 75IPS. These subsystems provide temporary or permanent mass storage of digital data for Harris Computer Systems users. They are well suited for data base storage, high-speed backup of disc subsystems and high-density accumulation of scientific data for subsequent processing. Additional advantages of the HDMTS are increased throughput (in excess of 468 kilobytes/second), improved data integrity, compacted data files, and reduced tape volume and handling costs.

The HDMTS consists of a tape transport mechanism with a vacum-column, single-capstan tape handling system; read/write/erase heads and associated electronics; and a formatter/controller which consists of the electronic circuits required for formatting, data integrity, tape positioning and control. The entire tape subsystem is mounted in an EIA standard 19″ peripheral equipment cabinet.

TAPE TRANSPORT

Each tape transport contains a take-up reel and a quick release hub for mounting either full size 10½″ or 7″ ANSI standard file reels. Surround cartridges may also be used. Gentle tape handling is assured by the single-capstan, vacuum column drive. Either a manual (with a removable take-up reel) or an automatic (with a fixed take-up reel) tape loading feature is available. NOTE: Auto-load capability is not available with 7″ file reels. As part of the vacuum column design, a vacuum assisted tape cleaner is provided in the tape path slightly ahead of the head assembly. Sensors for both BOT and EOT are employed to allow automatic control of these functions.
Completing the transport mechanism are full pneumatic and power supply facilities within the transport assembly.

FORMATTER/CONTROLLER

The formatter/controller contains all the logic required to read/write 6250 or 1600 BPI magnetic tapes in the GCR or PE format, respectively. Generation of inter-record gaps (IRG) and the BOT/EOT functions are automatically performed by the formatter/controller. To insure data integrity, advanced technology error detection/correction circuits are employed. Each formatter/controller can control up to four radially connected tape transports. A tape transport mechanism and formatter/controller may be installed in the first peripheral equipment cabinet. Add-on tape transports may be configured one or two per additional peripheral equipment cabinet.

GROUP CODED RECORDING FORMAT

The formatter/controller performs all the data manipulation necessary to write digital data on tape in the GCR format. From the received data, it produces all of the preliminaries, preambles, groups and subgroups, data blocks, error correction characters (ECC), resync bursts, and postamble/end of tape information.

Inherent advantages of the GCR format are a three-to-one data compaction, increased data integrity and almost a four-fold increase in throughput over other tape systems of comparable size and speed. Data integrity is ensured by the use of numerous ECC codes such as parity, Cyclic Redundancy Check (CRC) codes, and a unique error correction character. The use of these ECC codes provides a two-track error detect/correct capability.

PHASE ENCODED FORMAT

The formatter/controller generates the identification burst, preamble, phase-encoded data, postamble and file mark patterns common to PE recording. It performs complete recovery of read data including: identification burst detection, preamble/postamble detection and stripping, data decoding, error and file mark detection as well as single-track error detection/correction.

DATA INTEGRITY

Integrity of all digital data is ensured for either recording format. In addition to the standard provisions of the PE format, the formatter/controller develops a unique character during write that assures that the data recorded on tape is precisely the data which the tape transport was instructed to write. Error detection and single-track error correction are standard features for the PE format. An additional PE error correction capability is also provided to detect and correct certain read errors that forced dead-tracking to the end of the data blocks in other systems. This allows multiple tracks in error to be corrected.

A simultaneous two-track error correction is used for the GCR format to provide immediate correction of single- or double-track errors. Errors can be corrected in any of the nine tracks to ensure greater data reliability. Additionally, CRC characters are verified during all read and write operations.

MAINTAINABILITY

The HDMTS' simplicity of design results in minimal corrective maintenance. Should maintenance be required, access to the tape transport is accomplished by swinging open the hinged transport casting which provides access to the interior assemblies. Easy access is also provided for the formatter/controller assembly. It is slide mounted and can be tilted upward for service of the printed-circuit boards, power supplies and cooling assembly.

Extensive use of MSI/LSI circuits, coupled with a conservative design philosophy ensure a high MTBF and a low MTTR which provides an outstanding up-time and reliability. Harris diagnostics, supplied with each system, further ensure operational availability.

SYSTEM CONFIGURATIONS

High-Density Magnetic Tape Subsystems can be configured to all Harris SLASH Series Computers and the Series 100/200/500 Virtual Memory Computer Systems. Up to four radially connected tape transports can be connected to a single formatter/controller—I/O Channel combination. Models 671X and 672X can be intermixed on the same formatter/controller. Each transport is separately cabled (not daisy-chained) to allow one or more transports to be placed off-line without affecting the status of the remaining on-line unit(s). A typical configuration is illustrated in Figure 1. Table 1 lists the variety of available models of the 6700 Series, along with their distinguishing characteristics.

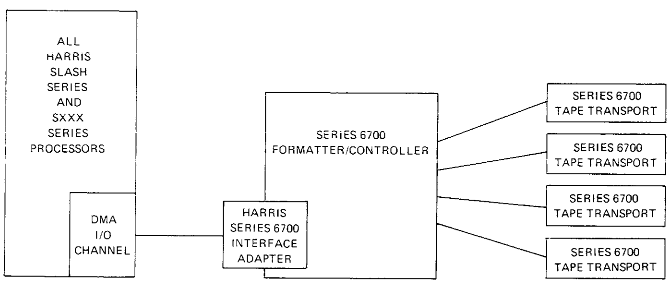


Figure 1. Typical HDMTS Configuration

TRANSPORT TYPE	SPEED (IPS)	TRACKS	RECORDING DENSITY (BPI)	RECORDING METHOD	TAPE LOADING	MODEL NUMBER MTU WITH FORMATTER	ADD-ON MTU
VACUUM-COLUMN	75	9	1600	PE	MANUAL	6710	6711
			6250	GCR			
			1600	PE	AUTO	6720	6721
			6250	GCR			

Table 1. Series 6700 HDMTS Model Number /Configuration

TECHNICAL SPECIFICATIONS

MAGNETIC TAPE SUBSYSTEM

Speed (IPS)	75
Recording Density (BPI)	1600 (PE)/6250 (GCR)
Transfer Rates (KBytes/second)	120@ 1600 BPI (PE) 470@ 6250 BPI (GCR)
Start/Stop Time (mSEC)	2.67 (nominal)
Rewind Speed (IPS)	200 (nominal)
Number of Tracks	9
Tape Specifications	ANSI Standard X3.39-1973 Compatible, 3200 FCI Certified
Head	Dual gap with full-width erase head.
Reels	7" or ANSI Standard 10½" (with or without surround cartridge)
Inter-Record Gap (inches)	0.6 PE 0.3 GCR Read 0.4 GCR Write
Tape Threading	Manual or Auto-Load

ELECTRICAL REQUIREMENTS

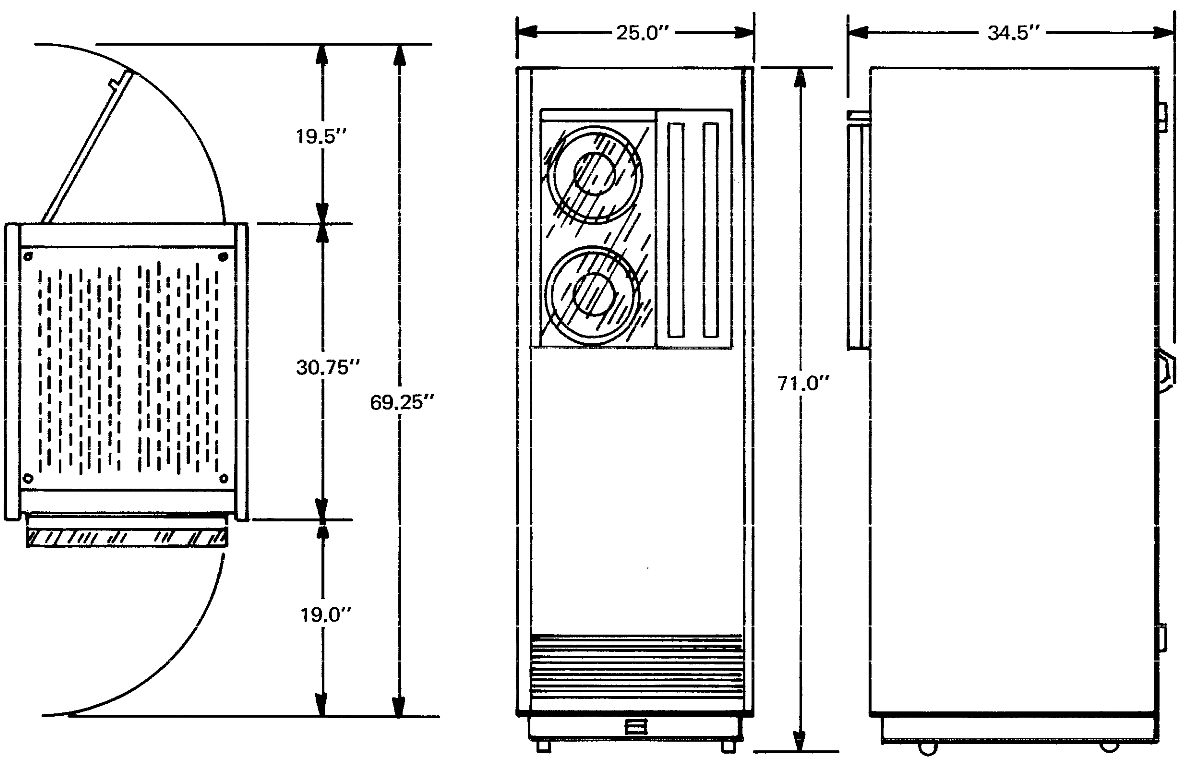
Voltage	**Tape Transport**	**Formatter/Controller**
Standard	115 VAC± 10%	115 VAC± 10%
Optional	230 VAC± 10%	230 VAC± 10%
Current		
@115VAC	10 amps	6 amps
@230VAC	5 amps	3 amps
Power	1150 watts	700 watts
Frequency		
115VAC	60	60
230VAC	50	50
Phase	Single Phase, 3-wire, polarized connector	
Heat Dissipation (BTU)	3300	2000

ENVIRONMENTAL REQUIREMENTS

Temperature	**Operating**	**Non-Operating**
Tape Transport	61°F to 90°F (16°C to 32°C)	–40°F to 158°F (–40°C to 70°C)
Formatter/Controller	61°F to 90°F (16°C to 32°C)	–40°F to 90°F (–40°C to 32°C)
Humidity (non-condensing)		
Tape Transport	20% to 80%	10% to 90%
Formatter/Controller	20% to 80%	20% to 90%
Altitude	0 to 4000 ft. (Standard) 4000 to 7000 ft. (Optional)	

PHYSICAL DESCRIPTION

Magnetic Tape Subsystem	
Height	71.0 inches (180 cm)
Width	25.0 inches (63.5 cm)
Depth	34.5 inches (87.5 cm)
Weight	425 pounds (193 kg)
Tape Transport	
Height	24.5 inches (62.2 cm)
Width	19.0 inches (48.3 cm)
Depth	20.0 inches (50.8 cm)
Weight	170 pounds (77.1 kg)
Formatter/Controller	
Height	10.5 inches (26.7 cm)
Width	19.0 inches (48.3 cm)
Depth	21.0 inches (53.3 cm)
Weight	75 pounds (34 kg)
Installation and Access	See Below



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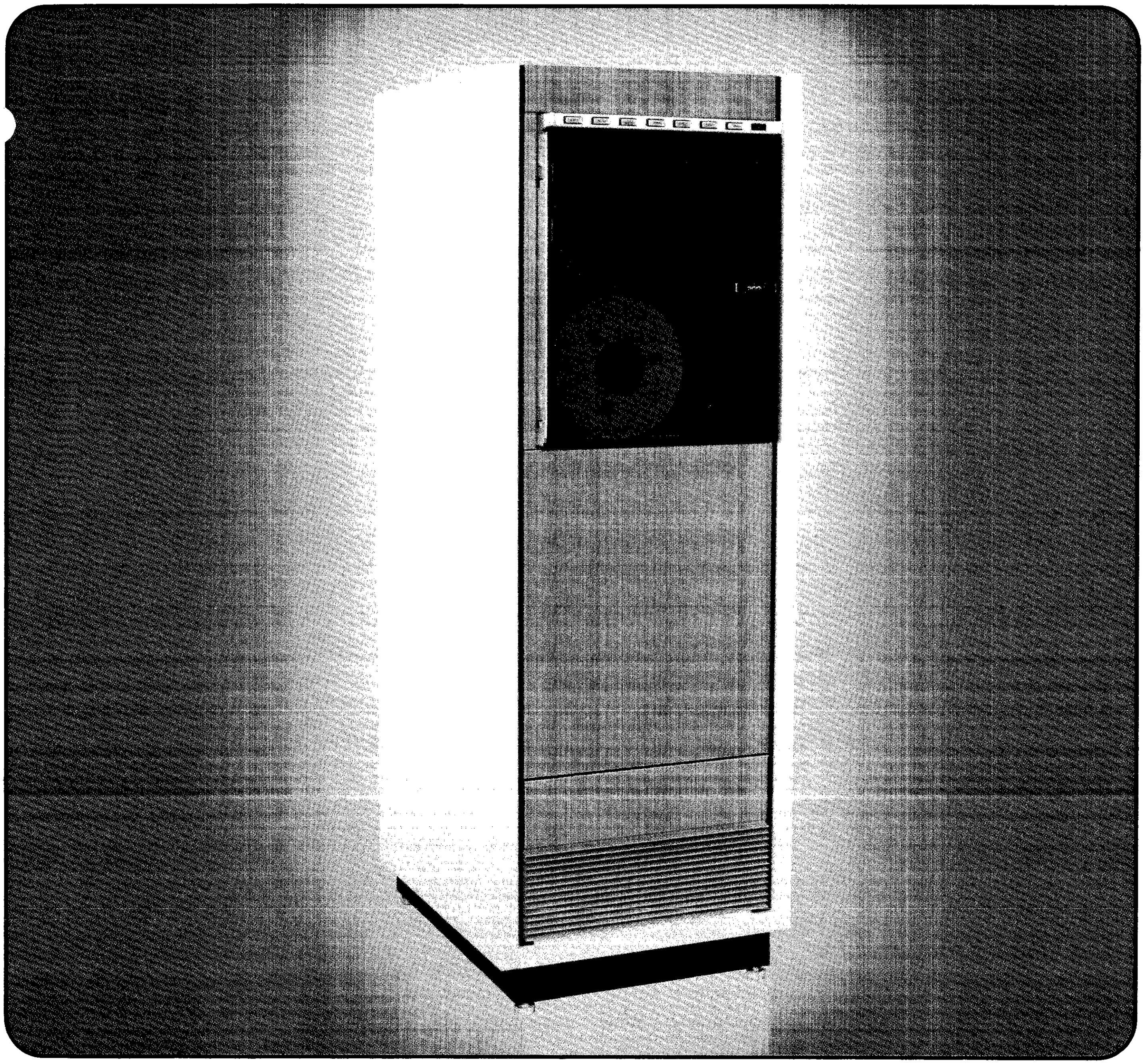


SERIES 6600
LOW-SPEED
MAGNETIC TAPE
SYSTEMS

FEATURES

- Single Capstan Drive
- ANSI Compatible
- NRZI/PE Formatting
- Vacuum Column or Tension Arm Models

PRODUCT BULLETIN

HARRIS
COMMUNICATIONS AND INFORMATION HANDLING

MAGNETIC TAPE SYSTEM

Featuring data transfer rates to 120,000 characters per second, the Harris Series 6600 Low Speed Magnetic Tape Systems (LSMTS) provide temporary or permanent mass storage of digital data for Harris Computer System users. The LSMTS consists of the transport servomechanism; either a tension arm or vacuum column tape handling system; the read/write/erase heads and electronics; power supplies; and the electronic circuitry required for formatting, tape positioning, control and interface. The entire system is contained in a castor-mounted peripheral equipment cabinet. Access is provided by the hinged tape deck and a rear cabinet door.

TAPE TRANSPORT

Two types of transport mechanisms are available in the Series 6600 LSMTS. The tension arm units feature automatic servo arm retraction, optical sensing of servo arm position and a straight forward tape threading path. The vacuum column units feature straight-line tape threading, self-loading vacuum chambers and a long-life brushless vacuum motor. Both mechanisms have front panel control switches, IBM head guide spacing, quick-action tape reel latches, direct reel drive, single capstan drive and long-life tape cleaners.

FORMATTER

The formatter contains all the logic required to read/write IBM-compatible 556/800 BPI NRZI or 800/1600 BPI NRZI/PE (phase-encoded) magnetic tapes. The generation of the inter-record gap (IRG) and the BOT, EOF and EOT detection functions are performed automatically by the formatter. It also contains logic to provide status information for the computer. Each formatter can control up to four tape transports. The third and fourth transports are installed in a second, identical equipment cabinet.

NRZI

The NRZI formatter generates the cyclic redundency check (CRC) characters, parity (VRC) bits, longitudinal redundency check (LRC) characters and file marks for recording. During read, the formatter checks CRC, VRC and LRC and detects the file marks. The NRZI formatter can control 7- or 9-track tape drives of one preselected tape speed and either of two programmed densities.

PHASE ENCODED

The PE formatter generates the identification burst, preamble, phase-encoded data, postamble and file mark patterns for recording. It performs complete recovery of read data including; identification burst detection, preamble and postamble detection and stripping, data decoding, error and file mark detection and limited error correction. The PE formatter can control tape drives of one preselected tape speed.

CONTROLLER

The interface controller implements all of the functions required to operate the LPMTS on-line with Harris' computers. In operation, the controller communicates through a Chain Block Controller (CBC) or Automatic Block Controller (ABC) I/O Channel. Commands from the CPU select the transport, establish the operational mode and specify special conditions.

In the write mode, the 24-bit output data words are buffered (up to 4 words), disassembled (1, 2, 3 or 4 characters per word) and transferred to the formatter for recording at the selected density (556, 800 or 1600 characters per inch). In the read mode, the data characters (6 or 8 bits per character) from the formatter are buffered and assembled into 24-bit data words for transfer to the CPU.

Status information from the transport, formatter and controller is transferred to the CPU upon command. An interrupt request is generated by the controller logic in response to command completion, load point detection, trouble conditions and at the end of read, write or motion-type commands. A diagnostic program is supplied with each system to verify the operation of the controller, formatter and to exercise the transport mechanism.

LSMTS MODEL NUMBER/CONFIGURATION CHART

CONFIGURATION					MODEL NUMBER	
XPORT TYPE	SPEED (IPS)	TRACKS	DENSITY (BPI)	RECORDING METHOD	MTU WITH CONTROLLER	ADD-ON MTU
TENSION ARM	45	7T	556/800	NRZI	6630	6631
		9T	800		6640	6641
			800/1600	NRZI/PE	6650	6651
VACUUM COLUMN					6660	6661
	75				6690	6691

MAGNETIC TAPE TRANSPORT

Response Times	45 IPS	75 IPS
Start/Stop (m sec)	8.8	5.3
Rewind speed (IPS)	150	200

Recording

Format	7 or 9 Track, including parity
Method	7 or 9 Track NRZI and 9 Track PE
Density	7 Track 556/800 BPI 9 Track 800 BPI 9 Track 800/1600 BPI
Speed	45 or 75 IPS
Gap	IBM and ANSI compatible

Transfer Rates

Characters/second × 1000

SPEED	DENSITY (BPI)		
(IPS)	556	800	1600
45	25.0	36.0	72.0
75	—	60.0	120.0

MAGNETIC TAPE

Type	½ inch wide, 1½ mil thick polyester computer grade tape up to 2400 ft. long.
Reel	Up to 10½ inch. ANSI-compatible hub with file protect ring.

INTERFACE CONTROLLER

Logic	TTL integrated circuits
Interface	Single-ended line drivers/receivers
Operating Control	On-line with Harris Computers by means of blocked Input/Output Channels (ABC- or CBC-IOC).
Configuration	Model 66X0 MTU includes the controller and formatter. Up to three additional Model 66X1 MTUs may be connected to this formatter.
IOC Requirements	ABC/SE/24-IOC for use with Harris SLASH 1, 3, 5 and 5R Computer Systems. CBC/SE/24-IOC for use with Harris SLASH 4, SLASH 7, Series 100 and Series 200 Computer Systems.
Formatting	The controller/formatter performs the data word buffering and disassembly/assembly, character encoding/decoding and deskewing, check character generation/checking, error detection/correction, file mark and inter-record gap generation functions required to write/read NRZI or PE ANSI-compatible tapes.
Interrupts	Ready Interrupt, Trouble Interrupt and BOT Interrupt. These interrupts are selected/enabled under program control.

ELECTRICAL REQUIREMENTS

	TENSION ARM	VACUUM COLUMN	FORMATTER
Voltage			
Standard	110-125 VAC±10%	90-125 VAC±10%	115 VAC±10%
Optional	220-250 VAC±10%	180-250 VAC±10%	220 VAC±10%
Current			
@115 VAC	2.3 amps	8.5 amps	1.5 amps
@220 VAC	1.2 amps	4.2 amps	0.8 amps
Power	260 W	950 W	175 W
Frequency (all)	48-62 Hz		
Phase (all)	Single phase, 3 wire, polarized connector		

ENVIRONMENTAL REQUIREMENTS

Temperature

Operating Tension Arm	40°F to 90°F (5°C to 41°C), ambient air
Vacuum Column	60°F to 90°F (16°C to 41°C), ambient air
Formatter	32°F to 122°F (0°C to 50°C), ambient air
Storage (all)	-30°F to 140°F (-35°C to 60°C), ambient air

Humidity (all)

Operating	20% to 80%, relative (non-condensing)
Storage	15% to 95%, relative (non-condensing)

Altitude

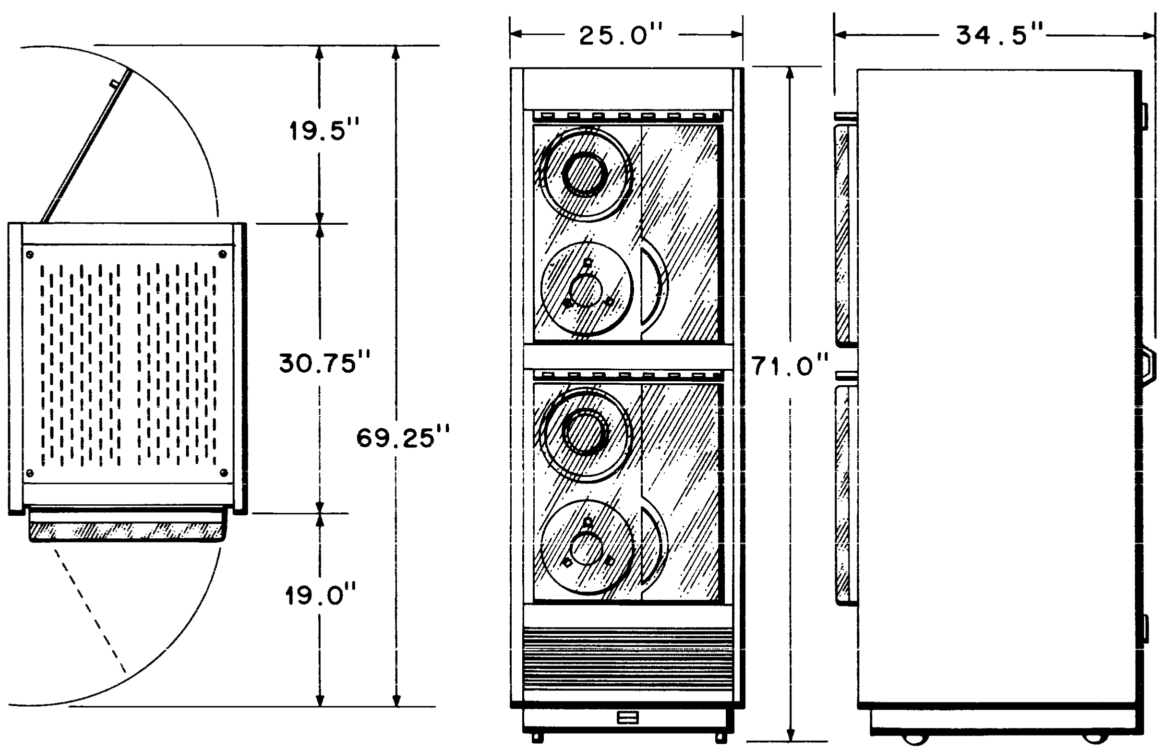
Vacuum Column	0 to 5000 ft (0 to 1525 m)
Tension Arm	0 to 20,000 ft (0 to 6100 m)

Heat Dissipation

Tension Arm	900 BTU/hour (230 kg-cal/hour)
Vacuum Column	3300 BTU/hour (830 kg-cal/hour)
Formatter	600 BTU/hour (150 kg-cal/hour)

DIMENSIONS

Height	71.0 inches (180 cm)	
Width	25.0 inches (63.5 cm)	
Depth	34.5 inches (87.5 cm)	
Weight	TENSION ARM	VACUUM COLUMN
Basic	300 lbs. (140 kg)	360 lbs. (165 kg)
Add-on	400 lbs. (180 kg)	520 lbs. (240 kg)
Installation and Access	See below.	



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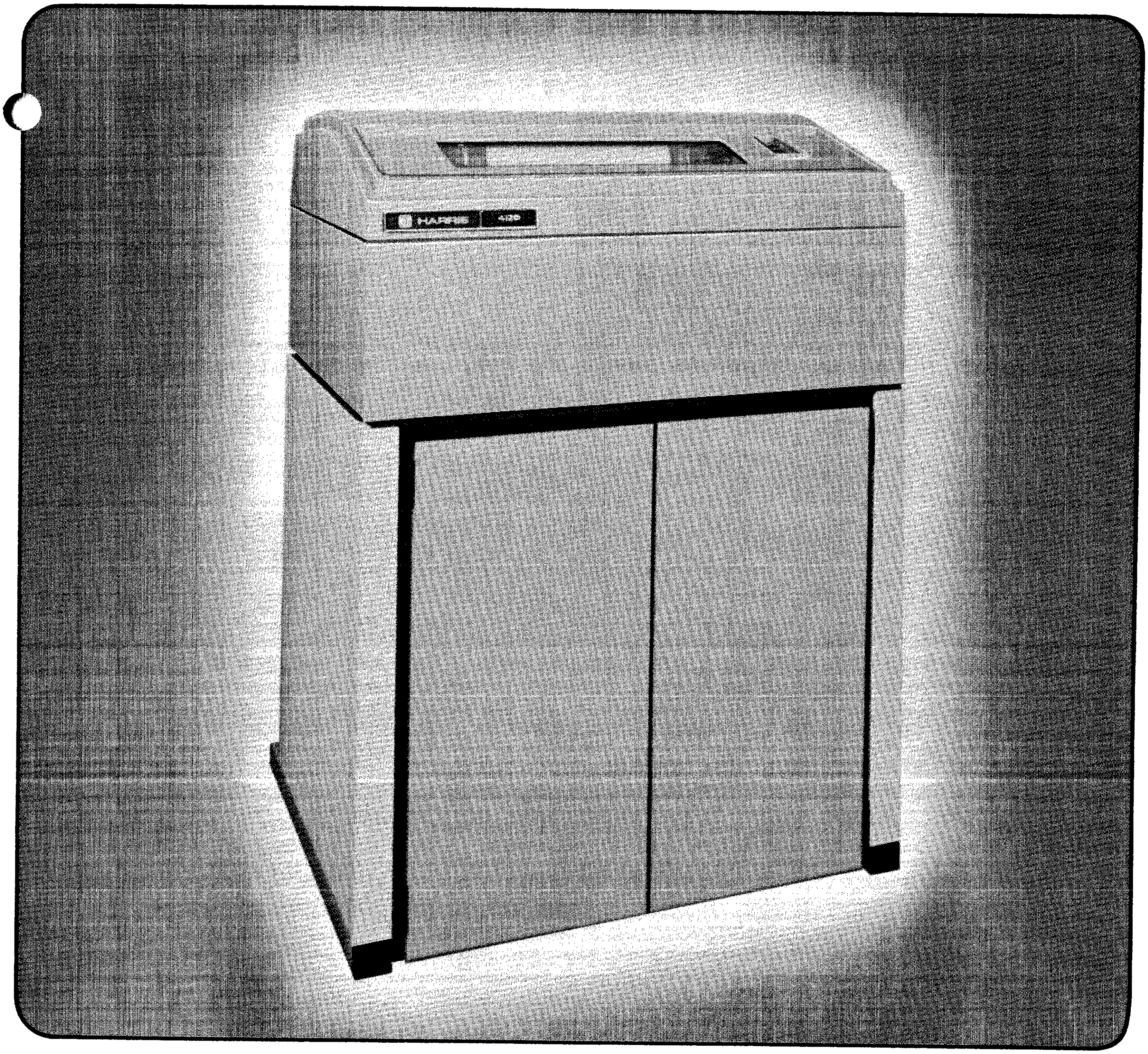


SERIES 4100
LINE PRINTER
SYSTEMS

FEATURES
- 64 or 96 Character Set
- Acoustically Damped Cabinet
- Fully Buffered
- 12 Channel VFU

PRODUCT BULLETIN

HARRIS
COMPUTER SYSTEMS

LINE PRINTER SYSTEM

The Harris Series 4100 Line Printer Systems consist of six models, featuring printing rates up to 900 lines per minute, that provide reliable, medium-to-high-speed, hard copy printout of information from Harris Computer Systems. The Series 4100 Line Printer Systems use fully buffered, 136 column, impact type, drum printing mechanisms to print a Modified ASCII 64 (or 96) character set.

The entire printer mechanism, paper supply, electronics and related power supplies are housed in an acoustically damped cabinet. A windowed canopy provides access to the paper tractor mechanism, vertical format unit, and the yoke; which can be unlatched to expose the print drum, ribbon and hammer bank. The front doors provide access to the paper supply. A rear panel permits access to the printer electronics, motor, power supplies and connectors.

CONTROLLER INTERFACE

The controller interface provides all functions required to operate the character-oriented printer on-line with the CPU. The controller is connected to either an 8-bit IOC-IC or, for dual CPU configurations, a Remote 8-bit IOC-IC which has a daisy-chain connector. One byte is transferred for each output instruction.

During operation, the controller receives commands and data from the I/O channel (IOC) and generates the appropriate signals to the line printer vertical format unit (VFU) and print head logic. The controller also provides status information to the IOC indicating the current operating conditions of the line printer and controller. This status information is transferred to the computer upon command.

The controller can also generate two interrupt requests to the CPU: Print Complete and Trouble interrupt. The Print Complete interrupt occurs at the end of a print cycle. The Trouble interrupt is developed as the result of one (or more) trouble condition(s) in the line printer. A diagnostic program is supplied with each Line Printer System to verify correct I/O operation of the controller and line printer electronics.

OPERATING CYCLES

The Series 4100 Line Printer Systems have two operating cycles: Slew/Data and Print cycle. During the Slew/Data cycle, data is transferred from the CPU to the line buffer in the printer. The first byte in the line buffer is always recognized as the format command, which controls the operation of the line counter and VFU. The line counter implements the line spacing functions (e.g., suppress space, single space, etc.) and the VFU implements the form positioning functions (e.g., TOF, BOF, etc.). Paper motion (if any) starts immediately after the format command has been decoded. While the paper is being advanced (Slew), the line buffer can accept up to a full line of characters (Data) from the CPU. This line may be truncated, at any time, by executing a Print command.

The receipt of the Print command initiates the actual Print cycle when the paper motion has stopped. Characters in excess of the column capacity of the printer (one format command plus 136 data bytes) are accepted by the controller but not stored or printed. If a short line is received, the remaining column positions are automatically filled with blank characters.

PRINTER MECHANISM

The printer mechanism implements ribbon motion, paper advance and printing. A complete character set (letters, numerals and symbols) is engraved in longitudinal rows on the print drum. The rotational rate of this drum determines the printer speed (LPM). The contents of a shift register buffer is compared to the position of the print drum. If one or more character codes in the buffer correspond to the upcoming character row on the drum, the print hammers for the respective columns are selected. As the characters reach the printing position, the selected hammers fire to strike the paper and inked ribbon against the characters on the drum. The foregoing is repeated up to 63 (or 95) times for each line printed, depending upon the character content of the line.

SERIES 4100 LINE PRINTER MODEL NUMBER / CONFIGURATION CHART

MODEL NUMBER	CONFIGURATION	
	CHARACTERS	SPEED (LPM)
4110	64	300
4115	96	240
4120	64	600
4125	96	436
4130	64	900
4135	96	660

SPECIFICATIONS

	MODELS 4110/4115	MODELS 4120/4125	MODELS 4130/4135
LINE PRINTER			
Printing Rates			
64 character	300 LPM	600 LPM	900 LPM
96 character	240 LPM	436 LPM	660 LPM
Paper Advance Times			
Single Line	50 m sec	25 m sec	20 m sec
Slew Rates	20 inches/sec	25 inches/sec	30 inches/sec
Columns	136 characters/line		
Character Set	63 or 95 characters plus space Modified ASCII, open gothic DPC-A font		
Horizontal Pitch	10 characters/inch		
Vertical Pitch	6 or 8 lines/inch, switch selectable		
Line Controller	Programmable 2-bit Line Counter: Suppress Space, Single Space, Double Space and Triple Space		
Vertical Format Unit	Programmable 12 channel VFU Tape: Top of Form (TOF), Bottom of Form (BOF) and 10 user-defined channels. IBM-compatible carriage tapes.		
Operator Controls	On/Off-line and Alarm/Clear switch indicators. Paper Step and Top of Form switches. Power On and Ready indicators.		
Paper Forms			
Single Copy	Minimum weight 15 lb. bond		
Multiple Copy	Up to 6 part forms with 12 lb. bond and 7 lb. carbon		
Dimensions	Standard fan-fold, edge-punched continuous forms 4.0 to 16.75 inches wide		
Paper Receptacle	Free-standing basket collects paper exiting printer		
Ribbon Dimensions	15 inches wide by 15 yards long and 5 mils thick		

CONTROLLER	
Logic	TTL integrated circuits
Interface	
Controller to LP	Differential line drivers/receivers for cables up to 1000 ft. long.
Controller to IOC	Single-ended line drivers/receivers on integrated controller.
Operating Control	On-line with any Harris computer
IOC Requirements	8-bit IOC-IC (single CPU) or Remote 8-bit IOC-IC (multi-CPU)
Operating Mode	Character Mode: one byte per output transfer
Interrupts	Print Complete interrupt and Trouble interrupt. These interrupts are selected/enabled under program control.
ELECTRICAL	
Voltage	110 VAC±10% (220 VAC±10%, optional)
Frequency	60 Hz±2% (50 Hz±2%, optional)

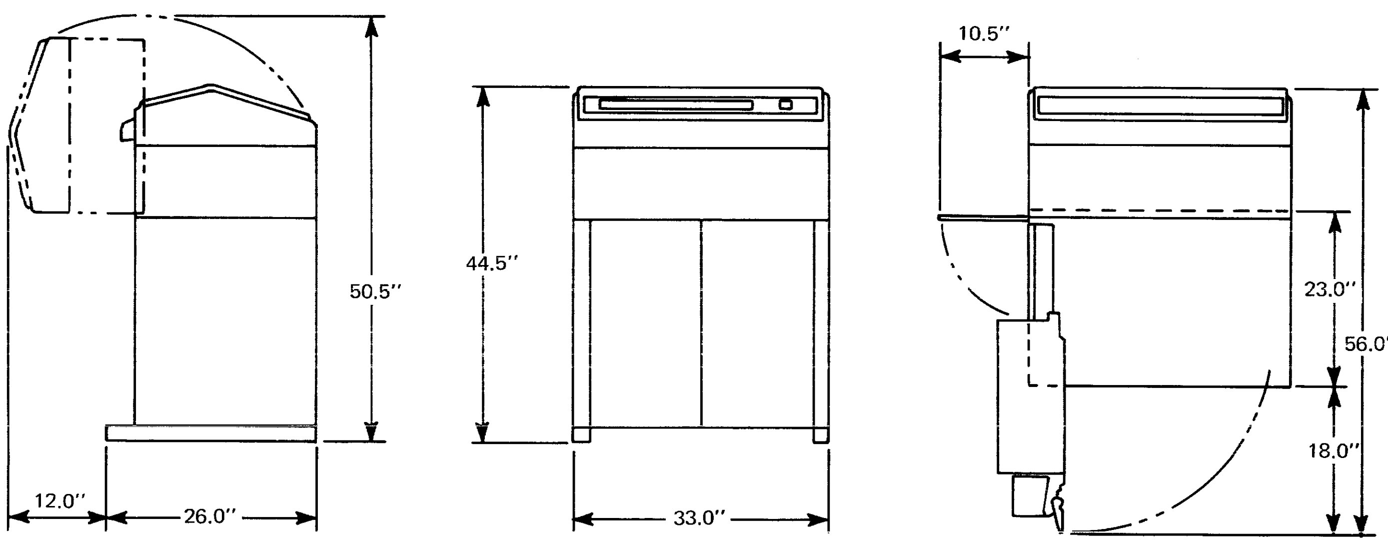
	MODELS 4110/4115	MODELS 4120/4125	MODELS 4130/4135
Power	525 W	680 W	825 W
Phase	Single phase, 3-wire line cord, polarized connector		

ENVIRONMENTAL	
Temperature	
Operating	50°F to 100°F (10°C to 37°C), ambient air
Storage	0°F to 150°F (−18°C to 66°C), ambient air
Humidity	
Operating	30% to 80%, relative (non-condensing)
Storage	5% to 95%, relative (non-condensing)

Altitude			
Operating	0 to 10,000 ft (3048 m)		
Storage	0 to 40,000 ft (12,192 m)		
Thermal Shock			
Operating	The unit must stabilize at ambient for 15 minutes before operation		
Storage	30°F/minute (17°C/minute), maximum		
	MODELS 4110/4115	**MODELS 4120/4125**	**MODELS 4130/4135**
Heat Dissipation, nominal	1800 BTU/hour (450 kg-cal/hour)	2320 BTU/hour (580 kg-cal/hour)	2800 BTU/hour (675 kg-cal/hour)
Sound Pressure Level, Quiet Cabinet	70db (A), nominal within 3.5 ft. from enclosure		

DIMENSIONS

Height	45 in (114.3 cm)
Width	33 in (83.8 cm)
Depth	26 in (66 cm) (excluding stacker)
Weight	
Models 4110/4115	340 lbs. (154 kg)
Models 4120/4125	370 lbs. (168 kg)
Models 4130/4135	420 lbs. (190 kg)
Installation	See Below



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HARRIS FORTRAN 77 COMPILER

FEATURES

- Extended Precision
- Character Data Types
- Structured Programming
- I/O Extensions
- Extensive Optimization
- Software Development Aids

```
PROGRAM FORTRAN 77 EXAMPLE
IMPLICIT DOUBLE PRECISION*12 (A-H, O-Z)
For A=1,10          !FIND SQUARE ROOT OF NUMBERS 1-10
.  SQUARE ROOT=1 ! USING NEWTON'S ITERATIVE METHOD
.  DO
.  . SQUARE ROOT=(SQUARE ROOT+A/SQUARE ROOT)/2
.  UNTIL (ABS(A=SQUARE ROOT**2) .LE. .1E-18)
.  PRINT '(20X, I4,2(F23.19))',NINT(A), SQUARE ROOT, SQUARE ROOT**2
ENDFOR
END
 1  1.0000000000000000000  1.0000000000000000000
 2  1.4142135623730950488  2.0000000000000000000
 3  1.7320508075688772935  3.0000000000000000000
 4  2.0000000000000000000  4.0000000000000000000
 5  2.2360679774997896964  5.0000000000000000000
 6  2.4494897427831780982  6.0000000000000000000
 7  2.6457513110645905905  7.0000000000000000000
 8  2.8284271247461900976  8.0000000000000000000
 9  3.0000000000000000000  9.0000000000000000000
10  3.1622776601683793320 10.0000000000000000000
```

FORTRAN 77 COMPILER

Harris FORTRAN 77 is a multi-pass, reentrant compiler that fully exploits the user-oriented power of the Harris VULCAN virtual memory computer systems. It incorporates the latest ANSI standards, along with a variety of other features, extensions, and enhancements to provide the user with an effective problem-solving and software development tool.

ANSI STANDARD CONFORMITY

The Harris FORTRAN 77 Compiler is based on the full language definition of American National Standards Institute (ANSI) FORTRAN X3.9-1978. This standard defines a number of added capabilities not included in the 1966 standard. Some of these are:

- Structured programming support with the IF-THEN-ELSE statements
- Character data types
- Array enhancements; including up to seven dimensional arrays, adjustable dimensions, negative subscripts, and subscript range specification
- Multiple RETURN definition
- IMPLICIT statement
- ENTRY statement
- INTRINSIC statement to permit the use of the symbolic name of an intrinsic function (e.g. SQRT, SIN) to be used as an actual argument in a function reference or sub routine call
- Enhanced I/O capabilities; including direct access and list-directed I/O, OPEN, CLOSE, and INQUIRE statements, internal files, I/O statement keyword parameters, and FORMAT statement extensions
- PARAMETER statement
- New format editing descriptors

HARRIS EXTENSIONS

In addition, Harris FORTRAN 77 provides the user with many capabilities not included in the 1977 standard, such as:

- Additional structured programming features; including FOR, LOOP, WHILE, and DO-UNTIL blocks
- Indentation of structured programs listings
- In-line assembly code
- Support for large software systems through use of MONITOR COMMON and DATAPOOL
- Additional data types:
  - INTEGER*1 One-byte integer
  - INTEGER*6 Extended-precision integer
  - LOGICAL*6 Extended-precision logical
  - DOUBLE PRECISION*12 Extended-precision real
- Symbol names of up to 63 characters
- Support for lower case characters in symbol names
- Continuation lines not limited to 19
- Conditional compilation of blocks of statements
- Asynchronous I/O (BUFFER IN/BUFFER OUT)
- Additional logical operators; including XOR (exclusive OR), SHIFT (logical shift), and ROTAT (logical rotate)
- Support for Hollerith as well as character data
- Comments on same line as FORTRAN statements
- Maximum formatted record length of 336 characters
- Formatted direct access I/O
- Indexed sequential I/O
- In-line compiler control statements
- Conditional compilation of DEBUG statement
- Extensive subroutine libraries
- T(ab) FORMAT specification

HARRIS FORTRAN 77 COMPILER

REENTRANT PROGRAMS

Harris FORTRAN 77 generates reentrant code and is, itself, reentrant. Reentrant programs can be shared concurrently by different users. This sharing of programs has two advantages. It minimizes memory requirements by eliminating the need for multiple copies of the same machine instructions or fixed data. This leads to a compound saving of time—unnecessary program loading is eliminated and less memory page swapping is required.

EXTENDED-PRECISION

With the Harris FORTRAN 77 Compiler, the programmer can declare a data type of 12-byte real when extra accuracy is required. The first three bytes contain the exponent (23 bits plus the sign bit) and the remainder contains the mantissa (69 bits plus the sign bit). The basic operations retain 67 bits of precision to yield 20 decimal digits of precision. A compile-time option is also available to automatically process REAL*6 entities as DOUBLE PRECISION*12 numbers.

CHARACTER DATA TYPES

A variable name, an array name, the symbolic name of a constant, an external function name, or a statement function name may be declared to be of type character. Character data consists of a string of from 0 to 1023 ASCII characters.

A character substring within a character entity may be referenced by specifying the leftmost and rightmost character positions of the substring. For example, if CHARS is a type character array, and CHARS (1) contains:
'ALL COWS EAT GRASS'
then the following substring reference will produce the sequence 'COWS EAT GRASS':
CHARS(1) (5:18)
Two intrinsic functions are provided for use with character strings. INDEX returns the starting location of a substring in a specified string. LEN returns the length of a character entity. Null character strings and concatenation of character strings are also supported.

STRUCTURED CONTROL STATEMENTS

An important feature provided by Harris FORTRAN 77 is the use of structured control statements. These statements enable the program developer to write programs that are readily understood and, therefore, are easy to debug and maintain.

Structured control statements are enhanced by the Indented Listing option. Together they show the flow of the program through the source listing and provide built-in documentation that was previously available only on flow charts. The following example (and the program listing on the front) illustrate several Harris FORTRAN 77 structured control statements.

```
SUBROUTINE BINARY SEARCH (SEARCH KEY, RESULT)
COMMON SORTED LIST(1000,2)
LOW=1
IHIGH=1000
DO
.  I=LOW+(IHIGH-LOW)/2
.  IF (SORTED LIST (I,1) .GT. SEARCH KEY) THEN
.  . IHIGH=I
.  ELSE
.  . LOW=I
.  ENDIF
UNTIL (SORTED LIST(I,1) .EQ. SEARCH KEY)
RESULT=SORTED LIST(I,2)
RETURN
END
```

The IF-THEN-ELSE statements are part of the ANSI standard. Harris enhancements include the additional structured programming features provided by use of the FOR, LOOP, WHILE, and DO-UNTIL blocks.

I/O ENHANCEMENTS

File Management

New OPEN, CLOSE, and INQUIRE statements provide the FORTRAN 77 programmer with increased file management capabilities. The OPEN statement may be used to connect an existing file to a FORTRAN 77 logical file number (LFN), create a new file, or change certain specifics of a connection between a file and a LFN. Temporary work files can be created by use of the OPEN statement and, when the corresponding CLOSE statement is executed, the temporary files will be eliminated. The OPEN statement is necessary for use of direct access files, but is implicitly executed if omitted for sequential files.

The CLOSE statement may be used to direct the disposition of a file on closing. For example, a DELETE specification will direct that a file be eliminated from the VULCAN catalog after closing.

The INQUIRE statement may be used to inquire about the characteristics of an external file.

Direct Access Files

FORTRAN 77 supports direct (random) access as well as sequential access files. Records in direct access files are identified by record number and may be written or read in any order. Direct access files may be accessed by formatted, as well as unformatted, I/O statements.

List-Directed I/O

List-directed (free-format) I/O permits data on one or more records to be read or written until all items in an output list are satisfied. The programmer does not if the order or content of a common block is changed. In large systems, the time-savings can be significant.

IN-LINE ASSEMBLY CODE

This extension allows in-line assembly language to be embedded within a FORTRAN 77 main program, subroutine, or function subprogram. This code format is the same as the Harris Macro Assembler source code. In-line assembly code is entered and exited through the use of a single control statement, which may be freely interspersed throughout the user program. The assembly code may reference variables, constants and statements established within the FORTRAN 77 source code. It also may create variables, constants and statement numbers that may be referenced by the FORTRAN 77 source code.

COMPATIBILITY

Harris FORTRAN 77 provides upward compatibility with Harris FORTRAN IV. Compile-time options are provided to accept source files created using IBM 026 character code and to cause character constants to be processed as Hollerith constants. Hollerith constants may be used in FORMAT, CALL, DATA, or assignment statements.

Although the OPEN statement is the ANSI statement for defining files, the DEFINE FILE statement is also provided by FORTRAN 77 to ensure compatibility with earlier versions of Harris FORTRAN. Similarly, ENCODE and DECODE statements are supported; although internal files are the ANSI-specified means of memory-to-memory data transfer and conversion.

OPTIMIZATION

The compiler performs an analysis of the source statements and uses the extensive instruction set of the Harris computers to optimize the generated object code for minimum processing time and storage requirements.

Some examples of the optimization process are:

- On Arithmetic and Logical IF statements, branch paths are examined, and superfluous conditional and unconditional branches are eliminated.
- The Harris computers provide an intensive set of immediate-type instructions. Their use by FORTRAN 77 yields fewer memory accesses, since the constant is part of the instruction and does not need to be independently fetched. Also, there is a reduction in storage space, since the constants do not need to be stored separately.
- FORTRAN 77 is generally able to recognize the repeated appearance of identical expressions. In these cases, the compiler generates the code necessary to evaluate the common (sub) expression only once. Subsequent occurrances cause retrieval of the precomputed value from either a register (if still in a register) or from memory. This minimizes the unnecessary duplication of code, which saves memory space and reduces the execution time.
- Expressions which are constant (e.g., multiple constant subscripts of an array) are evaluated at compilation time. Constant portions of subscripts are absorbed into the array base address and require no additional operations during execution.
- Whenever possible, array references are accomplished through the index registers. This yields storage and time saving for several reasons. An indirect reference does not need to be made to the calculated element address, thus saving time and the storage of the calculated value. When calculating the subscript value, the array base need not be added since it is incorporated within the indexed reference. Different arrays accessed with the same subscript may use the same index register. This is also due to the incorporation of the array base address into the array referencing instruction.
- Many intrinsic functions are converted into in-line instructions, thereby reducing execution time. Statement functions are also expanded in-line to avoid CALL overhead.
- For load/store operations, a register "memory" is maintained to eliminate redundant load, store, and register-to-register transfer operations.
- Compile-time TYPE conversion saves both time and space. It is performed if the compiler can determine the value of operands in a mixed-mode expression.
- FORTRAN 77 recognizes several opportunities to save execution time by performing some simplifying strength reductions at the machine instruction level. For example, raising to a power of 2 is performed by multiplication; integer multiplication by a power of 2 is performed by a left shift.
- FORMAT statements are converted to a tabular form for rapid interpretation. At compile-time an executable instruction sequence is generated.

COMPREHENSIVE RUN-TIME SUPPORT

An extensive set of FORTRAN-callable subroutines is available to provide indexed-sequential file support, real-time support, and Sort/Merge utilities.

VULCAN Indexed Sequential Package

The VULCAN Indexed Sequential Package (VISP) can be called by Harris FORTRAN 77 programs to provide the ability to access records on a disc file either sequentially or indexed directly by key. VISP keeps records arranged logically by the collating sequence of one or more key fields contained within each record. A tree structure of pointers is maintained to allow the user to add, change, delete, or query selected records of the file.

This structure also allows sequential processing (i.e., in increasing order of one of the keys) of the file.

Operating System Services

Subroutines are available to support FORTRAN 77 program access to VULCAN operating system services. Among the services provided through these subroutine calls are:

- File Maintenance (including creating, updating, and dynamic assignment of fields)
- File Spooling
- JOB Initiation
- Execution of Operator Commands
- Support for Software Interrupts
- Transmitting/Receiving Messages to/from other users
- Wall Clock and CPU timing
- Chain loading, a feature which allows a FORTRAN 77 program to "chain" to another executable program and then have control returned to itself

Real-Time Services

Subroutines are provided to allow a FORTAN 77 programmer to control real-time programs under the VULCAN operating system. Services provided include program initiation/termination; interrupt connecting, enabling, disabling and releasing; timer scheduling and timer-program suspension.

Support is also provided for the ISA suggested standards for Executive Interface, Process I/O, and Bit Manipulation. The Process I/O subroutines perform input and output operations on analog and digital I/O devices. These routines use Harris Real-Time Processor (RTP) equipment and the VULCAN RTP Handler for system I/O.

Sort/Merge Package

Sort/Merge subroutines may be called by FORTRAN 77 programs to sort or merge an input or output file dynamically (i.e., during the execution of the program). The package sorts and merges files on any medium and of arbitrary size. It can handle up to ten ascending and descending fields at a time.

OPERATING ENVIRONMENT

FORTRAN 77 runs under the Harris VULCAN Virtual Memory Manager operating system. Use of indexed sequential I/O requires the VULCAN Indexed Sequential Package (VISP). Use of the sort/merge capability requires the Sort/Merge Package. The minimum hardware configuration needed to run the Harris FORTRAN 77 Compiler is a Harris 100, 500 or 800 Computer System. The 100 and 500 systems require the optional Scientific Arithmetic Unit (SAU) to perform the DOUBLE PRECISION*12 arithmetic operations.

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have to provide FORMAT statements, since data editing is performed by FORTRAN 77 according to the data types of the items encountered in the list.

Internal Files

Output may be written to (or read from) files in main storage. These internal files are a convenient means to convert data from one form to another (e.g., from numeric to character form). A READ or WRITE statement specifying a character variable, an array, an array element, or a substring as the LFN is used in conjunction with a format specification to edit and convert the data.

Buffer In/Buffer Out

The BUFFER IN and BUFFER OUT statements permit records of arbitrary length and format to be read or written asynchronously. Asynchronous I/O is much faster that conventional I/O because the program can continue executing while the I/O is being performed. BUFFER IN and BUFFER OUT perform input or output using data stored as either ASCII characters (symbolic) or as binary data.

BUFFER IN and BUFFER OUT permit complete program control of data, thereby enabling magnetic tapes or punched cards containing binary data produced by non-Harris machines or by foreign programs to be processed using the Harris FORTRAN 77 Compiler. Also, BUFFER IN and BUFFER OUT can be used in conjunction with internal fields to process formatted records that are more than 336 characters long.

DEVELOPMENT AND MAINTENANCE FEATURES

Parameter Statement

The PARAMETER statement is used to give a symbolic name to a constant. Once defined in a PARAMETER statement, the name of the constant can be used wherever the constant can be used (except in a FORMAT specification). For example, a PARAMETER statement can be used to generalize array and character length declarations so that an array or character entity can be expanded or contracted simply by changing the value of the symbolic constant.

Generic Function Selection

The generic name of an intrinsic function (e.g. ABS) may be used in place of all specific names for the function (e.g. IABS, ABS, DABS, QABS, CABS). The generic name permits arguments of any type allowed by FORTRAN 77 to be used in the function reference. Based on the data type of the arguments, the compiler references the appropriate function by its specific name. Use of the generic name for a function is helpful if the data type of the function needs to be changed later.

DEBUG Lines

Debugging lines are a tool for producing a diagnostic version of a program. A source input line having a "D" in column 1 is defined as a debug line. If the DEBUG option is specified at compile-time, every source line containing a D in column 1 is treated as a normal FORTRAN statement. If the DEBUG option is not specified at compile-time, the debugging lines are treated as comments and are ignored by the compiler.

Conditional Compilation

Using the :SKFS, :SKFZ, and :ESKP statements; a block of source lines may be either compiled or skipped depending on flags set with the FLAG compile-time parameter. Conditional compilation may be used to produce different versions of a program, with each version having different capabilities and characteristics. This is an important tool for producing diagnostic versions of a program.

SUPPORT FOR LARGE SOFTWARE SYSTEMS

Harris FORTRAN 77 provides several extensions to aid in the development of complex software systems.

Monitor Common

The MONITOR COMMON statement declares a named common block to be a Monitor Common block. A Monitor Common block is a special file that can be randomly and simultaneously referenced by many programs in a multi-programming environment. The data is stored on disc and is either paged into memory as needed by the executing programs or the data can be declared memory resident. Any number of Monitor Common blocks can be generated and any number can be used by an individual program. Any number of programs can share a single Monitor Common block and all can have concurrent update access.

DATAPOOL STATEMENT

A DATAPOOL statement identifies a disc area (datapool) containing the FORTRAN specification statements to be compiled when the object program is link-edited. The memory locations of each variable or array in the DATAPOOL statement are defined when the program is link-edited and not at compile-time.

The use of datapools aids the development of large-scale software systems because the definition of global or shared data values can be centralized in a single memory area. The advantage of a datapool is that recompilation of all subprograms is not required if the order or content of a common block is changed. In large systems, the time-savings can be significant.

IN-LINE ASSEMBLY CODE

This extension allows in-line assembly language to be embedded within a FORTRAN 77 main program, subroutine, or function subprogram. This code format is the same as the Harris Macro Assembler source code. In-line assembly code is entered and exited through the use of a single control statement, which may be freely interspersed throughout the user program. The assembly code may reference variables, constants and statements established within the FORTRAN 77 source code. It also may create variables, constants and statement numbers that may be referenced by the FORTRAN 77 source code.

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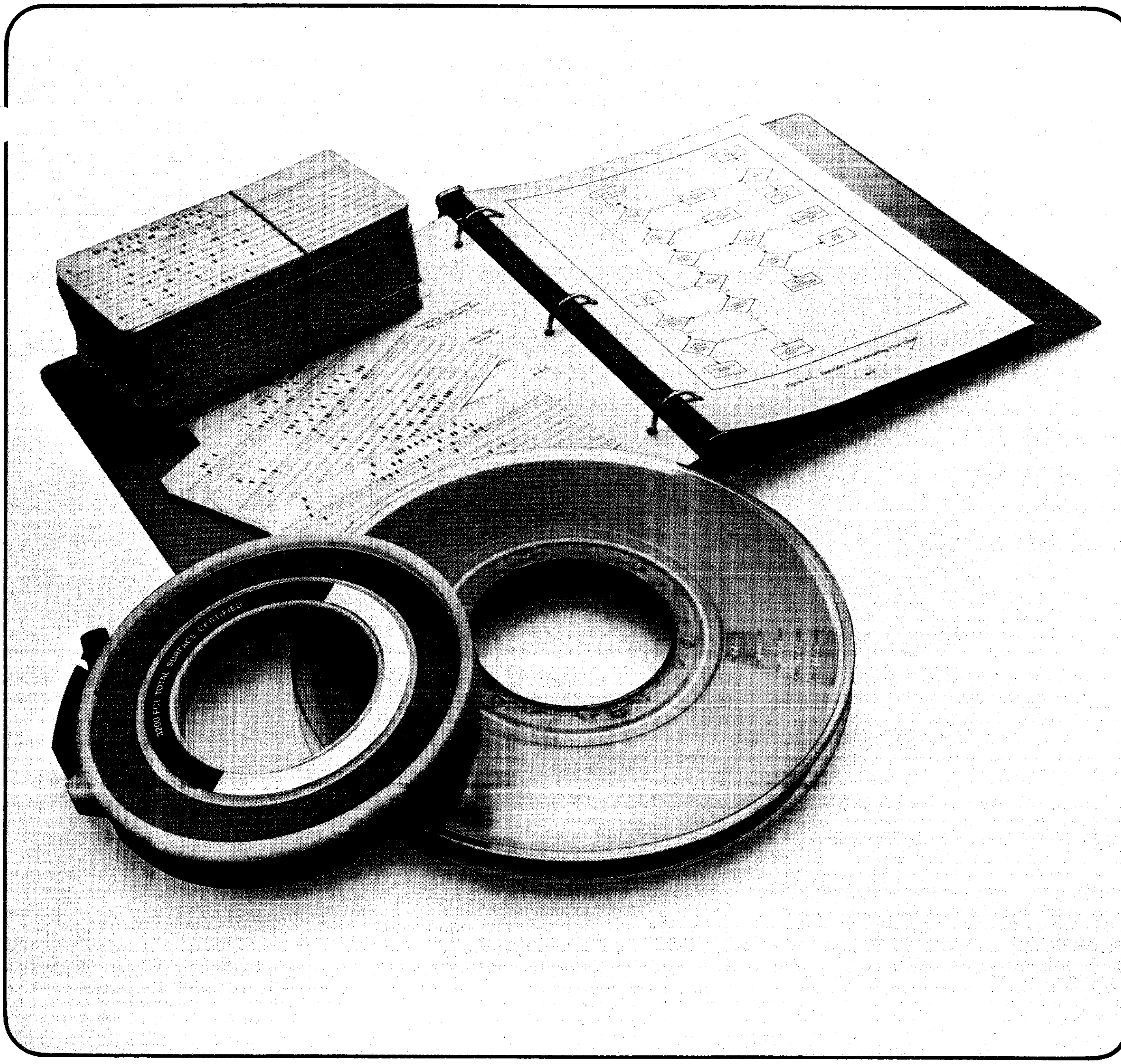

HARRIS BASIC-V LANGUAGE PROCESSOR

FEATURES

- Dual Language Processor System
- Integer, Floating-Point, Complex and String Data Types
- Dynamic Strings
- Multi-Dimensional Arrays
- Multi-Character Variable Names

HARRIS
COMPUTER SYSTEMS

HARRIS BASIC-V

Harris BASIC-V ("V" as in Virtual) is a powerful, high-level programming language processor for educational, scientific and business applications. Of all the computer languages available, BASIC is one of the easiest to learn and to use. BASIC-V is an interactive, conversational language processor that uses simple English words, abbreviations and familiar mathematical symbols to define and control programming operations. Harris BASIC-V is a superset of ANSI BASIC Standard X3.60-1978.

Harris BASIC-V is particularly well suited for time-sharing applications because the processor is reentrant and it generates reentrant code. This means that BASIC-V permits many users to share one copy of the language processor and also that many users can concurrently execute one copy of an application program. Reentrancy improves the VULCAN operating system response since multiple copies of reentrant programs are not loaded—resulting in less page swapping.

MODES OF OPERATION

BASIC-V is a language processor system consisting of two, separate language processors. These language processors provide two modes of operation—incremental and compiler.

Incremental Mode

In the incremental mode, each line is analyzed for syntactic errors as it is entered. If a statement is entered without a line number, BASIC-V executes the statement immediately. This immediate incremental mode is useful as a "super calculator" and also to query or modify variables.

The incremental mode is useful for the interactive development of programs since BASIC-V has extensive debugging facilities. The incremental compiler technique used produces code that executes 10 to 15 times faster than most commercially available BASIC interpreters. However, as with interpreter, changes to large programs can be performed rapidly.

Compiler Mode

In the compiler mode, BASIC-V generates link-ready code like that of the other standard Harris processors. This permits the BASIC-V programmer to call routines written in FORTRAN, COBOL and Assembler. The VULCAN Indexed Sequential Package (VISP), Sort/Merge and TOTAL Data Base Management System can also be assessed by the BASIC-V programs.

Once the user has developed a BASIC-V program in the incremental mode, more efficient use of memory space and maximum execution speed can be obtained by processing the program in the compiler mode. Programs processed in the compiler mode execute three to four times faster than those processed in the incremental mode.

NAMING CONVENTIONS

Names for variables and functions may be combinations of letters and digits—up to 31 characters in length—beginning with a letter. The usual restriction of using names consisting of a letter followed by an optional digit is not imposed.

MULTIPLE STATEMENTS PER LINE AND LINES PER STATEMENT

Multiple statements per line are permitted by separating each statement from the next with a colon. Multiple lines per statement are permitted by breaking the statement with a —> symbol at the end of the line. Multiple statements per line and multiple lines per statement may also be combined. Therefore, loops can be written in a single line and complex statements may be broken across several lines to reflect the structure of the statement.

COMMON, SPECIAL COMMON AND MONITOR COMMON

There are three types of shared storage that can be used to communicate with other routines and programs: COMMON, SPECIAL COMMON and MONITOR COMMON. BASIC-V programs utilize these storage areas to pass arrays and variables to COBOL, FORTRAN and Assembly language programs. Data in large arrays may be stored in SPECIAL COMMON. Concurrently executing programs can share data through the use of MONITOR COMMON.

LANGUAGE ELEMENTS

There are two kinds of BASIC-V language elements: system commands and executable statements. System commands are used to control the environment in which BASIC-V operates and also to communicate with the operating system. Executable statements are the language elements used to construct programs.

System Commands

System commands are not usually used in the body of a program. They are used for file control, program execution and program editing.

BASIC-V SYSTEM COMMANDS	
NEW [AREANAME]	CLEARS THE PRESENT PROGRAM AND NAMES THE NEW PRESENT PROGRAM.
SAVE [AREANAME]	STORES THE PRESENT PROGRAM ON THE DISC UNDER THE NAME GIVEN.
OLD AREANAME	CLEARS THE PRESENT PROGRAM AND MAKES A PREVIOUSLY SAVED PROGRAM THE PRESENT PROGRAM.
REPLACE [AREANAME]	SIMILAR TO SAVE, BUT FOLLOWED BY AN AREANAME OF AN EXISTING AREA.
JS AREANAME	INSERTS ANOTHER BASIC-V PROGRAM INTO THE PRESENT PROGRAM.
RNAME AREANAME1, AREANAME2	RENAMES A PROGRAM OR ANOTHER DISC AREA.
GENERATE AREANAME	GENERATES A NEW DISC AREA.
ELIMINATE AREANAME	ELIMINATES A DISC AREA AND RETURNS THE SPACE TO THE SYSTEM.
RUN [LINE]	CAUSES THE PRESENT PROGRAM TO BE EXECUTED.
RUNH [LINE]	SIMILAR TO RUN, BUT THE HEADER INFORMATION IS OUTPUT.
LIST [LINE]	LISTS ALL, OR SELECTED PARTS, OF THE PRESENT PROGRAM.
LISTH [LINE]	SIMILAR TO LIST, BUT THE HEADER INFORMATION IS OUTPUT.
DELETE [LINE]	DELETES ONE OR MORE LINES FROM THE PRESENT PROGRAM.
HELP	PRINTS ERROR MESSAGE FOR THE LAST ERROR ENCOUNTERED.
BYE	EXIT BASIC-V. IF THE PRESENT PROGRAM HAS NOT BEEN STORED WITH SAVE OR REPLACE, BASIC-V WILL QUERY THE USER.

NOTE: PARAMETERS IN BRACKETS ARE OPTIONAL.

Executable Statements

BASIC-V EXECUTABLE STATEMENTS

```
100 LET ABC,DEFG(INDEX%)=ABC**2
200 NUMBER1, NUMBER2=1

100 GOTO 999999

100 ON INDEX% GO TO 200,300,400,500

100 FOR INDEX%=1 TO 100 STEP 5
200 ARRAY(INDEX%)=-1
300 NEXT INDEX%

100 WHILE INDEX%<=500
200 ARRAY(INDEX%)=-1 : INDEX%=INDEX%↑2 : ELIHW

100 REPEAT : ARRAY(INDEX%)=-1 : INDEX%=INDEX%**2 : UNTIL INDEX%>=200

100 IF A<B AND C<>D THEN 200 ELSE 300
200 IF INDEX%<>10 OR A<C THEN INDEX%=10
300 IF A$="ABCDEF" THEN PRINT "TRUE" ELSE PRINT "FALSE"

100 IF A$="ABCDEF" THEN DO
200 PRINT "TRUE"
300 GOSUB 1000
400 ELSE
500 PRINT "FALSE"
600 GOSUB 2000
700 DOEND
```

I/O STATEMENTS

Input and output under BASIC-V can be transacted with the terminal, other physical devices, or disc areas. Under VULCAN, all I/O is transacted by specifying the Logical File Number (LFN) of the I/O device. LFNs are assigned prior to program execution—thereby maintaining independence between the program and the physical environment.

File Manipulation

Several commands are available in BASIC-V to allow the user to manipulate files in order to transact I/O operations.

BASIC-V FILE MANIPULATION COMMANDS

```
100 ASSIGN #100="FILE1",#200="FILE2"
200 RWIND #200
300 OPEN #100,INPUT
400 CLOSE #100,#200
```

Input Statements

Input may take place within the program, between the program and the user's terminal, or between the program and logical files.

BASIC-V INPUT STATEMENTS

```
100 READ I,ARRAY(I),STRINGARRAY$(INDEX%)
200 DATA 10,-9,"THIS IS A STRING"
300 RESTORE
400 INPUT #100,NAME$,AGE%
500 INPUT "WHAT IS YOUR NAME",NAME$
600 INPUT LINE,LINE$
```

Output Statements

Output in BASIC-V is performed with variations of the PRINT command. The output may be directed to the user's terminal, to a file,or to a physical device. Expressions may be output in a specified format with the PRINT USING statement. The format specified is an exact image (picture) of the output line.

BASIC-V OUTPUT STATEMENTS

```
100 PRINT #100 USING "### ### ###" INT1%,INT2%,INT3%
200 PRINT A; TAB(10); B; TAB(20); C;
300 PRINT USING FORMAT$, A%, S$, R#
400 PRINT #43,A,B,C
```

Record I/O

Record I/O deals with the handling of records composed of fixed-length fields, as COBOL I/O does. With certain statements the user can manipulate portions of the I/O buffer directly to provide very powerful I/O capabilities.

BASIC-V RECORD I/O STATEMENTS

```
100 FIELD #100 10 AS FIRST$, 10 AS SECOND$, 20 AS THIRD$
200 GET #100, RECORD 20, COUNT 80
300 LSET FIRST$="1234567890"
400 RSET SECOND$[3:2] = "YES"
500 PUT #100, RECORD 20, COUNT 80
```

FUNCTIONS AND SUBROUTINES

Functions cause a complicated instruction, or a series of instructions, to be executed with a single statement. In addition to the many functions provided by BASIC-V, the user can define functions for special purposes.

A CALL statement is available to permit communication with externally compiled subroutines. The subroutines called can include: FORTRAN or Assembly language libraries; System Services; or special file handling routines such as VISP, Sort/Merge, and TOTAL DBMS.

BASIC-V USER FUNCTION AND SUBROUTINE STATEMENTS

```
100 DEF FNROUNDINTEGER%(ARGUMENT) = INT(ARGUMENT+0.5)
200 GO SUB 99999
300 ON INDEX GO SUB 1010,1020,1030
400 RETURN
500 CALL EXT "SUBR" (ARG1,ARG2%)
```

DEBUGGING STATEMENTS

A number of statements are available to assist in the development and debugging of a user program.

An executing program can be interrupted with CTRL X or ∧X. When the program halts, the message "USER INTERRUPT @ LINE nn" is printed. The user may, in the immediate mode, print variables or change values and modify program output; then the program may continue with the next, or any other, statement.

BASIC-V DEBUGGING STATEMENTS

```
    TRACE ALL            ! TRACE EXECUTION OF EVERY STATEMENT IN THE PROGRAM.
    TRACE 100,1000-2000  ! TRACE LINE 100 AND LINES 1000 THROUGH 2000.
    UNTRACE ALL          ! TAKE ALL OF THE TRACING AWAY.
    BREAK ALL            ! BREAK AT EVERY STATEMENT.
    BREAK 100,200        ! BREAK AT LINES 100 AND 200.
    UNBREAK 100          ! TAKE THE BREAK AT LINE 100 AWAY.
    CONTINUE             ! CONTINUE EXECUTION AFTER A BREAK, STOP OR USER INTERRUPT.
    CO 100               ! CONTINUE EXECUTION AT LINE 100.
100 ON ERROR GO TO 1000  ! GO TO ERROR ROUTINE AT LINE 1000 WHEN ERROR HAPPENS.
200 RESUME               ! RESUME EXECUTION AT START OF LINE ERROR HAPPENED IN.
300 RESUME 500           ! RESUME EXECUTION AT LINE 500.
```

MATHEMATICAL AND STRING OPERATIONS

BASIC-V supports both numeric and string data types. Numeric data types may be stored as floating point, integer or complex numbers. All standard arithmetic and relational operators are supported for all numeric data types. String storage is dynamic—the length is limited only by the program size. Relational operators and concatenation are supported for string data types.

Floating Point Functions

Twenty BASIC-V mathematical functions are used extensively with floating point (real) numbers:

BASIC-V FLOATING POINT FUNCTIONS

```
Y= RND        RETURNS A RANDOM NUMBER BETWEEN
              0 AND 1 INCLUSIVELY.
Y= ABS(X)     RETURNS THE ABSOLUTE VALUE OF X.
Y= SGN(X)     RETURNS THE SIGN OF X; -1, 0, +1.
Y= SQR(X)     RETURNS THE SQUARE ROOT OF X.
Y= FRAC(X)    RETURNS FRACTIONAL PORTION OF X; Y= X-FIX(X).
Y= EXP(X)     RETURNS THE VALUE e↑X,e=2.71828.
Y= LOG(X)     RETURNS THE NATURAL LOGARITHM OF X; Y= LOGeX.
Y= LOG10(X)   RETURNS THE BASE 10 LOGARITHM OF X; Y= LOG10X.
Y= PI(X)      RETURNS PI*X, PI=3.14159.
Y= SIN(X)     RETURNS THE SINE OF X RADIANS.
Y= COS(X)     RETURNS THE COSINE OF X RADIANS.
Y= TAN(X)     RETURNS THE TANGENT OF X RADIANS.
Y= ASN(X)     RETURNS THE ARCSINE OF X.
Y= ACS(X)     RETURNS THE ARCCOSINE OF X.
Y= ATN(X)     RETURNS THE ARCTANGENT OF X.
Y= SNH(X)     RETURNS THE HYPERBOLIC SINE OF X.
Y= CSH(X)     RETURNS THE HYPERBOLIC COSINE OF X.
Y= TNH(X)     RETURNS THE HYPERBOLIC TANGENT OF X.
Y= DEG(X)     RETURNS DEGREE VALUE OF X RADIANS.
Y= RAD(X)     RETURNS RADIAN VALUE OF X DEGREES.
```

Integer Functions

Five BASIC-V mathematical functions are used extensively with integers:

BASIC-V INTEGER FUNCTIONS	
Y%= ABS(X)	RETURNS THE ABSOLUTE VALUE OF X.
Y%= INT(X)	RETURNS THE GREATEST INTEGER IN X WHICH IS LESS THAN OR EQUAL TO X.
Y%= SGN(X)	RETURNS A POSITIVE OR NEGATIVE 1 BASED ON THE SIGN OF X.
Y%= FIX(X)	RETURNS THE TRUNCATED VALUE OF X, Y%= SGN(X)*INT(ABS(X)).
Y%= MOD(X,Y)	RETURNS THE VALUE X MODULO Y, Y%= REMAINDER OF FIX(X)/FIX(Y).

Complex Functions

Complex numbers have a real and an imaginary part, each of which may assume any value that a floating point number may have. Six BASIC-V mathematical functions are used extensively with complex numbers:

Exponentiation is permitted for a complex base to a complex power, complex base to a real power, and a real base to a complex power. Relational operations permitted on complex numbers are equality and inequality.

BASIC-V COMPLEX FUNCTIONS	
Y# =CONJ (X#)	RETURNS THE COMPLEX CONJUGATE OF X#, (X - iY)=CONJ (X+iY).
Y# =PLR (X,Y)	RETURNS THE COMPLEX NUMBER FROM THE POLAR COORDINATES X=RADIUS, Y=ANGLE IN RADIANS.
Y =ABS (X#)	RETURNS THE ABSOLUTE MAGNITUDE, IE. THE RADIUS VECTOR LENGTH OF POINT X# FROM POINT (0+i0).
Y =ANG (X#)	RETURNS THE ANGLE, IN RADIANS, FORMED BY THE POSITIVE REAL AXIS AND THE RADIUS CONNECTING (0+i0) AND X#. 0 ⩽ Y < 2π.
Y =REAL (X#)	RETURNS THE REAL PART OF X# AS A FLOATING POINT NUMBER.
Y =IMAG (X#)	RETURNS THE IMAGINARY PART OF X# AS A FLOATING POINT NUMBER.

String Functions

Strings are a series of characters usually representing alphabetic character codes. Strings may be concatenated by the symbols + or &. Seventeen BASIC-V string functions are available:

BASIC-V STRING FUNCTIONS	
Y%= ASCII(A$)	RETURNS THE ASCII VALUE OF THE FIRST CHARACTER IN THE STRING A$.
Y$= CHR$(X%)	RETURNS A ONE BYTE STRING CONSISTING OF THE LOW EIGHT BITS OF X%.
Y%= LEN(A$	RETURNS THE LENGTH IN BYTES OF A$ INCLUDING TRAILING BLANKS.
Y= VAL(A$)	RETURNS THE NUMERIC VALUE OF NUMERIC CHARACTER STRING A$.
Y$= NUM$(I%)	RETURNS A STRING OF NUMERIC CHARACTERS FOR THE VALUE OF I%.
Y$= LEFT(A$,N%)	RETURNS A SUBSTRING OF A$ FROM THE FIRST THROUGH N%TH BYTE.
Y$= RIGHT(A$,N%)	RETURNS A SUBSTRING OF A$ FROM THE N%TH THROUGH LAST BYTE.
Y$= MID(A$,N1%,N2%)	RETURNS A SUBSTRING OF A$ STARTING WITH THE N1%TH BYTE WITH LENGTH N2% BYTES.
Y%= INSTR(N%,A$,B$)	RETURNS THE STARTING POSITION OF B$ IN A$ AFTER POSITION N%; 0 IF B$ NOT IN A$, 1 IF B$ IS NULL.
Y$= SPACE$(N%)	RETURNS A STRING OF N% BLANKS.
Y$= STRING$(L%,N%)	RETURNS A STRING OF LENGTH L% WHOSE BYTES HAVE VALUE CHR$(N%).
Y$= CVT%$(I%)	RETURNS A THREE BYTE STRING EQUIVALENT TO THE INTEGER I%.
Y$= CVTF$(X)	RETURNS A SIX BYTE STRING EQUIVALENT TO THE SPECIFIED FLOATING POINT NUMBER.
Y$= CVT$%(A$)	RETURNS AN INTEGER EQUIVALENT TO THE FIRST THREE BYTES OF A$.
Y= CVT$F(A$)	RETURNS A FLOATING POINT NUMBER EQUIVALENT TO THE FIRST SIX BYTES OF A$.
Y$= CVT$$(A$,I%)	RETURNS A$ CONVERTED ACCORDING TO THE VALUE OF I%.
Y$= XLATE(A$,B$)	RETURNS A TRANSLATION OF A$ BY MEANS OF THE TABLE STRING B$.

Logical Operations

BASIC-V has six logical operators for use with the integer data type.

BASIC-V LOGICAL OPERATORS	
NOT	LOGICAL NEGATION
AND	LOGICAL PRODUCT
OR	LOGICAL SUM
XOR	LOGICAL EXCLUSIVE OR
IMP	LOGICAL IMPLICATION
EQV	LOGICAL EQUIVALENCE

The use of octal constants (specified by a trailing B) provides the capability of manipulating integers on a bit-by-bit basis.

```
100 REMARK STORE INT1% IN THE UPPER 12
    BITS AND INT2% IN THE LOWER 12 BITS.
200 TWOINTEGERS% = INT1% * 10000B
    OR INT2%
300 LOW3BITS% = VARIABLE% AND 7B ! GET
    THE LOW 3 BITS OF VARIABLE%
```

ARRAYS AND MATRICES

Array is a generic name for any ordered set of data: vector, matrix and higher-order arrays.

Arrays may be of any single data type. Array and matrix handling is greatly extended in BASIC-V. The size of the array is *limited only by the maximum virtual memory storage.* An array may have *up to 255 dimensions.*

Array Calculations and Functions

Numeric arrays may be added, subtracted, multiplied and divided—on an element-by-element basis—with the standard BASIC-V mathematical operators. The cross product of two conformable matrices can also be taken. The matrix receiving the cross product is implicitly redimensioned to the number of rows of the first matrix by the number of columns of the second matrix.

Two BASIC-V functions are available to transpose arrays and invert matrices. The TRN statement is used to transpose an array of any number of dimensions—which is useful when an array must be read by a FORTRAN routine. Square matrices may be inverted. Both transposing and inverting of matrices may be done in place.

BASIC-V ARRAY MANIPULATION

```
100  DIM REALARRAY(-100:100), INTEGERARRAY%(1000:1500), STRINGRAY$(100)
200  REDIM INTEGERARRAY%(-30:0), REALARRAY(10)
300  MAT READ REALARRAY
400  MAT INPUT #100, STRINGRAY$(5)
500  MAT PRINT #100 USING "###.###" REALARRAY(10);
600  MAT REALARRAY = ZER
700  MAT INTEGERARRAY% = CON(5)
800  MAT SQUAREARRAY = IDN
900  MAT ARRAY1 = ARRAY1+ARRAY2       ! ELEMENT BY ELEMENT ADD.
1000 MAT ARRAY1 = ARRAY1-ARRAY2       ! ELEMENT BY ELEMENT SUBTRACT.
1100 MAT ARRAY1 = ARRAY2/ARRAY3       ! ELEMENT BY ELEMENT DIVIDE.
1200 MAT ARRAY1 = ARRAY2 (*) ARRAY3   ! ELEMENT BY ELEMENT MULTIPLY.
1300 MAT ARRAY1 = ARRAY1 * ARRAY2     ! CROSS PRODUCT OF CONFORMABLE MATRICES.
1400 MAT ARRAY1 = (A*B) * ARRAY1      ! MULTIPLY EACH ELEMENT OF ARRAY1 BY A SCALAR.
1500 MAT ARRAY1 = TRN(ARRAY1)         ! TRANSPOSE ARRAY1 IN PLACE.
1600 MAT ARRAY1 = INV(ARRAY1)         ! INVERT ARRAY1 IN PLACE.
```

Specifications subject to change without written notice.

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SORT / MERGE PACKAGE

FEATURES

- A Utility Program Directly Accessible by Job Control
- Subroutines Directly Accessible by User Programs
- Logical File Oriented; Does Not Require a Fixed Configuration
- Initial Input May be Multiple Files
- I/O May be Passed to or From User Subroutines for Immediate Processing.

HARRIS
COMPUTER SYSTEMS

The versatile Harris SORT/MERGE PACKAGE (HSMP) arranges items in an ordered sequence with a set of library subroutines, which can be accessed by a Harris utility program or user program calls. This easy-to-use package offers the flexibility to efficiently answer many data processing requirements of installations having disc or tape storage devices.

With the Logical File Numbers specified in the calls, the HSMP provides many different sorting or merging operations according to control information specified by the user. Subroutines may be called by means of Harris's FORTRAN, RPG II, or Assembly language programs.

These functions are called by using appropriate names and augments such as:

SORT

Logical File Number(s) of the input device(s).
Logical File Number of the output device.
The intermediate work files (any mix of disc files or magnetic tape transports).
The locations, sequences, and lengths of the key fields on the sort.
The length of the records to be sorted.

MERGE

Logical File Numbers of the input device(s).
Logical File Number of the output device (for the merged file).
The locations, sequences, and lengths of the key fields for the merge.
The length of the records to be merged.

HSMP reveals several extensions over customary SORT/MERGE packages, providing considerable flexibility in data structures for the HSMP user, as well as extended ease of use. For example, initial input to the sort or merge may be multiple files, ascending and descending key fields may be mixed in one sort or merge, and buffers are automatically allocated, eliminating the need to define work areas. Additional extensions enable input or output data to be passed to or from user subroutines instead of files, thereby enabling the user to process it immediately.

Sorting time may be reduced by specifying additional intermediate work files up to a maximum of 15. Mass storage savings are accented by the ability to designate an input file as permanent or as an intermediate work file. An operator may also designate input as being the output from a user-defined subroutine that enables input records to be generated according to user requirements.

A utility program, accessed via Job Control Statements, provides the user with sort/merge functions at the system level without having to write programs for simple sort/merge operations.

These specifications indicate one input, one output and two work files, a record length of 80 columns, and two sort fields. The sort fields are in column 1 through 5 and 6 through 10. The first field is ascending; the second field is descending; and the first field has precedence over the second for sorting.

An example of the utility program commands that perform a simple sort is given below.

```
$$*MSUTIL
SORT
FILE IN, 10
FILE WORK, 11
FILE WORK, 12
FILE OUT, 13
RECORD 80
FIELD 1, 5, ASCENDING
FIELD 6, 10, DESCENDING
BEGIN
```


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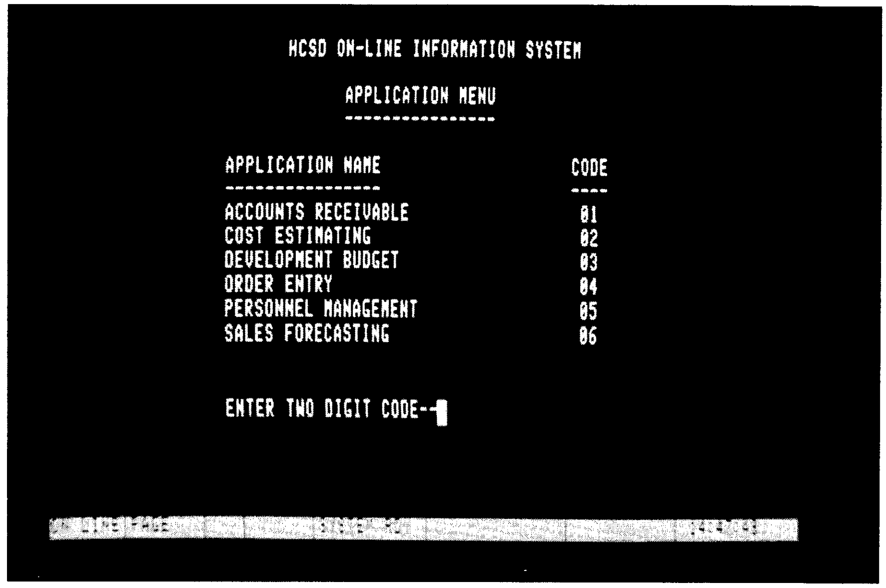
HARRIS TRANSACTION PROCESSOR (HTP)

FEATURES

- Network Management
- Device Independence
- Interactive Screen Building
- Sign-on and Security
- Menu Processing
- Automatic Editing
- Format and Message Scheduling
- Network and Database Recovery
- Operating Statistics
- Self-documenting



Harris Transaction Processor (HTP)
The Harris Transaction Processor (HTP) is a proprietary software product designed for efficient development, operation, management, and maintenance of on-line transaction processing on Harris Computer Systems. Because it operates in conjunction with VULCAN, Harris' powerful virtual memory operating system, HTP may function concurrently with other functions such as interactive timesharing, remote job entry, batch computation, etc.

HTP is based on the highly successful TAPS product developed by Decision Strategy Corporation (DSC). This insures ready transportability of applications previously written under TAPS on other systems, such as IBM mainframes, to Harris Systems. However, since HTP was based on a cooperative development effort between DSC and Harris, its internal structure has been uniquely designed for efficient operation in conjunction with VULCAN. In addition, VULCAN itself has been specifically enhanced for HTP.

HTP includes two logically separate operating modules complemented by support utilities. These operating modules are the HTP Communications Monitor and the HTP Application Manager. The Communications Monitor owns or "resources" the terminal network thereby insuring efficient use of system resources. It manages network buffers, calls (or schedules) the Application Manager to process incoming messages and receives raw messages for outbound transmission.

The Application Manager, through the use of tables, service routines and macros replaces the conventional root program in managing the processing of transactions. It performs virtually all functions which are generic to online transaction processing eliminating the need to imbed such coding in user written application programs. This not only reduces the time to develop and maintain on-line transaction processing applications, but isolates these programs from both the operating system and the network as well.

The Application Manager provides the capability for application modules to access any data files normally available on VULCAN systems (including Total Database files) either directly or through the HTP facility known as "I/O Sons." The I/O Son capability allows user programs to perform I/O to files which are owned by HTP, eliminating the overhead associated with frequent opening and closing of files by individual application modules.

HTP TABLES
HTP uses three tables, all of which may be built interactively by the user.

Environmental Table—describes the terminal network, the operators who are permitted to use the system and the passwords for each operator. Security is based upon both the logical device(s) that can be used by each operator and what systems they can access on each device.

Screen Table—contains all the message or screen formats that will be used in the system. The table has a message map for each format containing prompting messages, and control information (including editing, display characteristics and cursor control).

The screen table also contains a description and unique identifier for each Data Element used in the application.

HARRIS TRANSACTION PROCESSOR (HTP)

Transaction Table—each transaction within a system is defined in this table as a processing sequence with Screen Formats and Applications Modules.

HTP FEATURES

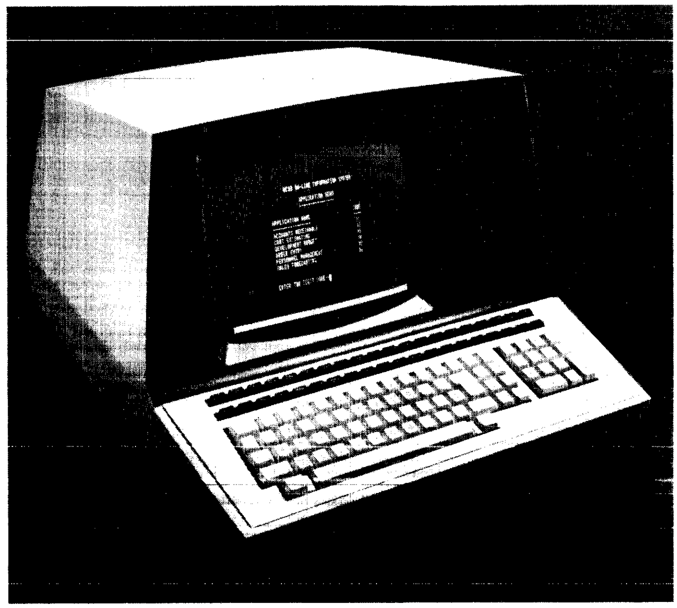
Sign-on and Security
HTP provides an automatic sign-on feature, which the developer can implement as desired. The Environmental Table will then be accessed to determine what type of terminal is transmitting, and how to map the physical message. The Environmental Table also provides three-dimensional network security: First, is the operator permitted to use that physical device? Second, when the operators select an application, are they permitted to perform that application? On that specific device?

Menu Processing
If an operator is permitted on a physical device, HTP returns an Application Menu. The menus provide complete prompting procedures, which the developer can customize for each location. Once an application is selected, HTP will automatically provide a second level menu, which will be a list of applicable transactions.

A terminal operator may by-pass menus by keying in a transaction code.

Operator Interrupt
The automatic Operator Interrupt facility permits the terminal operator to restart a transaction, go to any of the menus, go directly to another transaction, or sign-off. Operator Interrupt can also permit the terminal operator to call upon a user written HELP subsystem.

Format and Message Scheduling
HTP dynamically schedules the screen formats, automatic functions and user application modules which make up a transaction by referring to the Transaction Table. The sequence of events which make up a transaction can therefore by altered without the need to modify user code. It also precludes the need to store redundant copies of identical code which may be used in different transactions. This is particularly useful in training terminal operators, since training or instructional screen formats may be inserted or deleted from a transaction without modifying user code.



HTP also reduces line loading by only transmitting those data elements which have been modified whenever a screen format is being presented to the operator for the second or subsequent successive time. (i.e. During editing)

Automatic Editing
HTP automatically provides for the editing of operator entered data in those areas not specifically related to the application or data base such as Numeric Data, number of decimal places, left justification, imbedded blanks, etc. When an error is detected on input, HTP automatically returns the screen to the terminal operator highlighting the incorrect entry and requests retransmission. This process is repeated until the input is correct.

Device Dependent Code Generation
HTP allows the user to specify screen formats in generic terms. HTP then maps these formats into the appropriate device's specific output buffers appending and inserting the appropriate device control and attribute characters. By isolating the application from

the physical device, programming productivity is increased. In addition the same application code can be used to support different terminal types thereby allowing the user to take advantage of new terminal offerings as they became available from Harris without the need to reprogram.

Dynamic Message Control
HTP provides standard message formats via the Screen Table. While a message is being processed it is sometimes desirable to change the visual attributes of any of the data elements on a screen or change the beginning cursor position. (This is common in returning errors to the operator for corrections.) The 'Change Attribute' and 'Change Cursor' macros give this facility to the programmer.

Automatic Data Storage
HTP provides automatic Temporary Data Storage. The developer can code the Screen Table so that after an inbound transmission has been edited one or more data elements will automatically be stored in the Transaction Work Area. An outbound transmission can likewise have data automatically retrieved by HTP from the storage area and placed in the transmission. A user module also can store or retrieve data by executing a CALL.

HTP RECOVERY FACILITIES

Network Recovery
HTP will automatically recover from a line or terminal failure. Once the connection is reestablished, the operator transmits 'TAPR' and HTP retrieves the last transmission from the Transaction Work Area and resends it to the operator. The recovered message will be identical to the message the operator had received prior to the failure.

Data Base Recovery
HTP logs all transmissions to a single external log (either tape or disk). HTP has a recovery driver which will accept the log and drive the production HTP system updating a 'check-pointed' data base. This All Purpose Recovery can be used with all types of access methods and/or the Total DBMS.

HTP UTILITY FUNCTIONS

Interactive Screen And Table Building
HTP BLDR is an interactive facility which allows the developer to completely define the screen and table parameters that drive HTP in its on-line mode. As such it is significantly more capable than just a screen building facility by itself. Using BLDR not only allows screens to be "painted" interactively on line; it provides for interactive input of terminal and operator parameters, Data Element parameters and transaction parameters as well.

Statistics
The HTP Statistics package provides operator loads, line loads, arrival rates, and skewed arrival rates by time of day. Internal statistics reports include system, transaction and message usage rates, response times and time-skewed response time.

Documentation
HTP provides complete reports specifying the network terminal characteristics, operators and passwords, transaction sequences, Data Elements and screen formats. This significantly reduces the amount of documentation the developer must originate; limiting it to a description of the application modules, the database and whatever system level and clarifying information the developer deems necessary.

ENVIRONMENT
HTP will function on any Harris Virtual Memory Computing system having at least 192K Bytes of real memory. Terminal support in HTP encompasses the Harris 8610, 8630 and 8680 (all models). Specific configuration requirements to support satisfactory levels of performance will be a function of user requirements, the application code, data base organization, line speed, number of terminals, concurrent non-HTP activity, etc. Consultation with the appropriate Harris sales and technical representatives is therefore required in selecting an HTP hardware configuration.

HTP user application modules are typically written in Harris ANSI COBOL 74. However FORTRAN, Harris Basic V or RPG II may also be used to create application modules which run under HTP.

HARRIS

COMMUNICATION AND
INFORMATION PROCESSING

HARRIS CORPORATION Computer Systems Division, 2101 Cypress Creek Road, Fort Lauderdale, FL 33309 Telephone (305) 974-1700

1/1/80 (1) PB61162-00

```
)LOAD REPORT
SAVED 16 MAY 79 15:49:07 – REPORT
)FNS
ABSTRACT        REPLACE        HEADLINE
∇HEADLINE[⎕]∇
∇ INPUT HEADLINE N;I;TOPICS
[1]   N←(~N=¯1)/N
[2]   N←N[⍒N]
[3]   TOPICS←⎕FREAD 47 2
[4]   BH←UNTIENEWS     ⍝ FLAG FILE
[5]   →LOOP×⍳0≠+/N
[6]   N←(0<INDEX[;1])/,INDEX[;1]
[7]   LOOP:I←,((1↑N)=INDEX[;1]) ⌿ INDEX
[8]   PRINT: ⍞←'ITEM',(⍕I[1]), 12↑,TOPICS[I[5];]
[9]   ENDLOOP:→LOOP×⍳0≠⍴N←1↓N
```

HARRIS APL INTERPRETER

FEATURES

- Full-Function Interpreter
- Large Mainframe Performance
- Enhanced File I/O
- Shared Variables
- Extended Security Facilities

HARRIS
COMPUTER SYSTEMS

HARRIS APL INTERPRETER

APL is a concise, conceptual, programming language for a variety of business, scientific, educational and engineering applications. Harris APL maximizes programmer productivity and provides large-mainframe performance, resulting from an excellent implementation on a computer very well suited for the APL language.

The APL language is intuitive and consistent—qualities that make it easy to learn. The language has few constraints and requires minimal control structures because its primitive functions manipulate data as collections. These data-manipulating functions make APL easy and practical to use in all application areas.

APL programs are short. The power and flexibility of the built-in functions cut APL program size and minimize design time. The language's highly interactive nature, giving the programmer control over his programming and execution environments, reduces coding and debugging efforts dramatically.

PERFORMANCE

Harris APL achieves large-mainframe performance through function optimization, efficient memory allocation, and semi-compiling interpretation. Most primitive functions are "special-cased" to optimally handle the varying characteristics of APL program data. References to data, including function calls, are made with pointers to existing data elements—eliminating the need to copy arrays except on write operations. This reduces memory requirements and saves execution time.

The first time a Harris APL program is executed a compilation pass is performed. This produces a stack of semi-compiled source lines that execute quickly. Production systems have little interpretation overhead because the semi-compiled code is saved and re-executed whenever that function is re-invoked. As a consequence, Harris systems consistently outperform larger computers doing APL work.

FULL FUNCTIONALITY

Harris APL is full function: if offers all the standard primitive functions and operators plus the extensions common to the latest, most-widely used, large-mainframe implementations.

These extensions include:

- Shared variables
- Domino and format functions
- Scan operator
- A complete file system
- In-line execution of system commands
- Error trapping
- Security enhancements
- Compound statements
- Editor enhancements
- Same-line comments
- Concurrent interactive and batch operation
- The ability to use APL at terminals not equipped with the APL character set.

The powerful VULCAN operating system and multi-use architecture of Harris computer systems add to APL's flexibility, reliability, and performance.

ENVIRONMENT

Harris APL executes as a reentrant program under the VULCAN virtual memory operating system. VULCAN is a multi-use, multi-lingual executive that allows concurrent interactive time sharing, multi-level batch, and real-time processing. VULCAN excels at communications, providing multiple remote job entry with concurrent remote job hosting. In addition to APL, seven other programming languages are supported, including FORTRAN 77, Government-certified COBOL and extended BASIC.

A workspace is an APL user's immediate environment. VULCAN's virtual memory management allows a Harris APL workspace to grow to a maximum of three million bytes. The Harris APL programmer has less to do to manage his working area, even when faced with changing usage and increased storage requirements. Each user may store, retrieve and manage his workspaces in private or public libraries. Users may password-protect workspaces when they are saved.

SECURITY

Additional security mechanisms in Harris APL help insure against accidental mishaps: functions can be locked; a workspace can be sealed as a unit, allowing its use as an application system while preventing any direct access to the programs and data it contains; stop controls, trace vectors, and editing functions can be inhibited; also, interactive interrupts can be disabled to further protect executing programs.

In some applications a programmer may wish to bypass standard error procedures by substituting his own messages or instituting corrective actions. Harris APL uses system variables to handle error trapping. This adds to system-design flexibility while providing yet another contribution to overall system security.

SHARED VARIABLES

Shared variables are user data that are shared by two or more active workspaces. Under VULCAN, this facility provides for inter-user program communication. Associated with each shared variable is an access control vector which effectively coordinates references between the users.

FILE I/O SYSTEM

The Harris APL file I/O system provides support for both APL files and sequential files. An APL file is a collection of APL arrays organized so that the file may be sequentially extended component-by-component. Existing components may be accessed (read, re-written, or deleted) randomly. Sequential files on disc or magnetic tape are directly compatible with sequential files used by other programming languages under VULCAN. This permits data sharing between APL programs and those written in other languages.

APL files may be concurrently shared between multiple users with automatic coordination and security. All files on disc are dynamically allocated and maintained in a manner to insure the highest integrity in the event of a user abort.

ASCII TERMINAL SUPPORT

An APL user normally works at a terminal keyboard which contains numbers and alphabetics, common symbols, and special APL characters. Harris APL supports most APL terminals that use a standard ASCII interface. It additionally supports APL usage on devices (both CRT and teletype-compatible) which do not have the APL character set.

Operational convenience is provided by the option for interactive or batch execution. Whereas the interactive mode is advantageous for program development and inquiry, the batch mode may be useful when long execution time or voluminous output is required.

HARRIS APL FUNCTIONS

SCALAR MONADIC FUNCTIONS

- +Y Identity
- -Y Negate
- ×Y Signum
- ÷Y Reciprocal
- ⋆Y Exponential
- ⌈Y Ceiling
- ⌊Y Floor
- |Y Absolute Value
- ⍟Y Natural Log
- !Y Factorial
- ○Y Pi Times
- ?Y Random Number
- ~Y Not

SCALAR DYADIC FUNCTIONS

- X+Y Addition
- X-Y Subtraction
- X×Y Multiplication
- X÷Y Division
- X⋆Y Power
- X⌈Y Maximum
- X⌊Y Minimum
- X|Y Residue
- X⍟Y Base-X Log
- X!Y Combinatorial
- X○Y Trig Functions
- X<Y Less Than
- X≤Y Less Than Or Equal
- X=Y Equal
- X≥Y Greater Than Or Equal
- X>Y Greater Than
- X≠Y Not Equal
- X∨Y Or
- X∧Y And
- X⍱Y Nor
- X⍲Y Nand

PRIMITIVE MIXED FUNCTIONS

- XρY Reshape
- ρY Size
- X[Y] Subscript
- X⍳Y Index
- ⍳Y Index Generator
- X∊Y Membership
- X⊤Y Encode
- X⊥Y Decode
- X?Y Random Deal
- X⌽Y Rotation
- X⊖Y Rotation 1st Axis
- ⌽Y Reversal
- ⊖Y Reversal 1st Axis
- X⍉Y Transpose by X
- ⍉Y Transpose
- X,Y Catenate
- X⍪Y Catenate 1st Axis
- ,Y Ravel
- X↑Y Take
- X↓Y Drop
- X←Y Specify
- ⍋Y Grade Up
- ⍒Y Grade Down
- X/Y Compression
- X⌿Y Compression 1st Axis
- X\Y Expansion
- X⍀Y Expansion 1st Axis
- X⌹Y Matrix Divide
- ⌹Y Matrix Inverse
- ⍎Y Execute
- X⍕Y Format by X
- ⍕Y Free Format

OPERATORS

- (fcn)/Y or (fcn)⌿Y Reduction
- (fcn)\Y or (fcn)⍀Y Scan
- X (fcn) . (fcn) Y Inner Product
- X ∘ . (fcn) Y Outer Product

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HARRIS COMMUNICATION AND INFORMATION PROCESSING

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HARRIS
COMPUTER SYSTEMS

APL COMPARISON CHART

May 16,1979

```
VL←1=1 0 1 1 0 0 0 1
MI←10 10ρ VI←(500ρ0 1 0 0 1)/ι500
MR←10 10ρ VR←VI+.1
MC←26 26ρ VC←'ABCDEFGHIJKLMNOPQRSTUVWXYZ'
```

		CPU EXECUTION (MILLISECONDS)				
		HARRIS S123	HARRIS S550	HARRIS S850	IBM 370/158	IBM 370/168
Plus Reduction	`Z←+/VI`	1.9	1.3	.6	.9	.3
Logical Reduction	`Z←∨/VL`	.7	.4	.2	.5	.2
Maximum Reduction	`Z←⌈/[1]MI`	2.3	1.6	.8	1.1	.5
Exponentiation	`Z←VI*.5`	57.2	39.8	25.4	42.7	9.0
Absolute Value	`Z←∣VR`	3.6	2.2	1.5	3.5	1.5
Indexing	`Z←VR[VI[ι20]]`	5.3	3.6	2.1	1.1	.4
Sorting	`Z←VI[⍋VI]`	52.9	34.8	19.5	14.7	4.7
Take	`Z←¯2 1↑MR`	1.0	.6	.4	.9	.4
Membership	`Z←VI∊VI`	38.9	19.4	17.2	61.5	23.5
Transposition	`Z←2 1⍉MC`	138.5	96.7	46.9	4.2	1.3
Outer Product, Characters	`Z←VC∘.=VC`	21.1	14.7	6.4	5.7	2.0
Outer Product, Integers	`Z←(ι50)∘.+ι50`	53.9	37.7	23.6	22.3	6.9
Inner Product, Real Numbers	`Z←VR⌊.+VR`	7.0	4.7	2.3	4.1	1.0
Matrix Division	`Z←MR⌹10↑VR`	10.0	6.9	4.0	5.2	1.5
Fibonacci Series	`Z←1 1` `L:→(100>ρZ←Z,+/¯2↑Z)/L`	349.4	264.0	159.8	196.7	79.6

CPU EXECUTION (MILLISECONDS)

DECSYSTEM 2020	DECSYSTEM 2040	DECSYSTEM 2050	HP 3000 Series II	CDC Cyber 73	CDC Cyber 74	BURROUGHS B7700	APL*PLUS® Amdahl 470V/6
3.5	2.5	1.2	50.6	2.0	.9	4.6	1.0
6.8	5.1	2.3	5.4	.5	.3	.8	.1
5.3	4.6	1.9	39.3	1.7	.8	1.7	.6
103.9	43.1	18.7	654.7	40.4	9.0	25.4	4.0
8.1	6.2	3.1	101.7	1.8	.8	1.6	.4
5.4	4.3	1.6	34.4	4.5	1.9	3.2	.4
56.0	56.0	14.8	288.1	40.4	21.0	32.8	4.9
2.8	2.2	1.0	5.1	.9	.5	1.3	.1
504.3	441.2	111.0	3871.0	263.6	142.3	17.4	80.7
82.1	37.4	14.8	11.9	11.3	4.6	24.8	.7
35.8	18.6	5.8	306.9	7.0	3.0	3.2	7.8
54.6	47.8	16.9	1193.8	37.1	16.8	13.2	12.1
12.3	7.7	3.2	95.3	6.6	3.2	9.9	1.4
33.6	11.4	5.3	104.3	6.4	2.4	31.7	1.0
1534.6	1162.7	486.1	2373.4	319.0	155.8	271.4	55.0

NOTES:

1. Each comparison benchmark was executed 100 times, averaged, and run twice again for a total of 300 executions. This procedure was repeated for each expression for each machine listed. The only exception was on the Hewlett Packard 3000 where the frequency was reduced for exponentiation, membership, outer product and the Fibonacci Series.

2. The following functions were used to derive the timings:

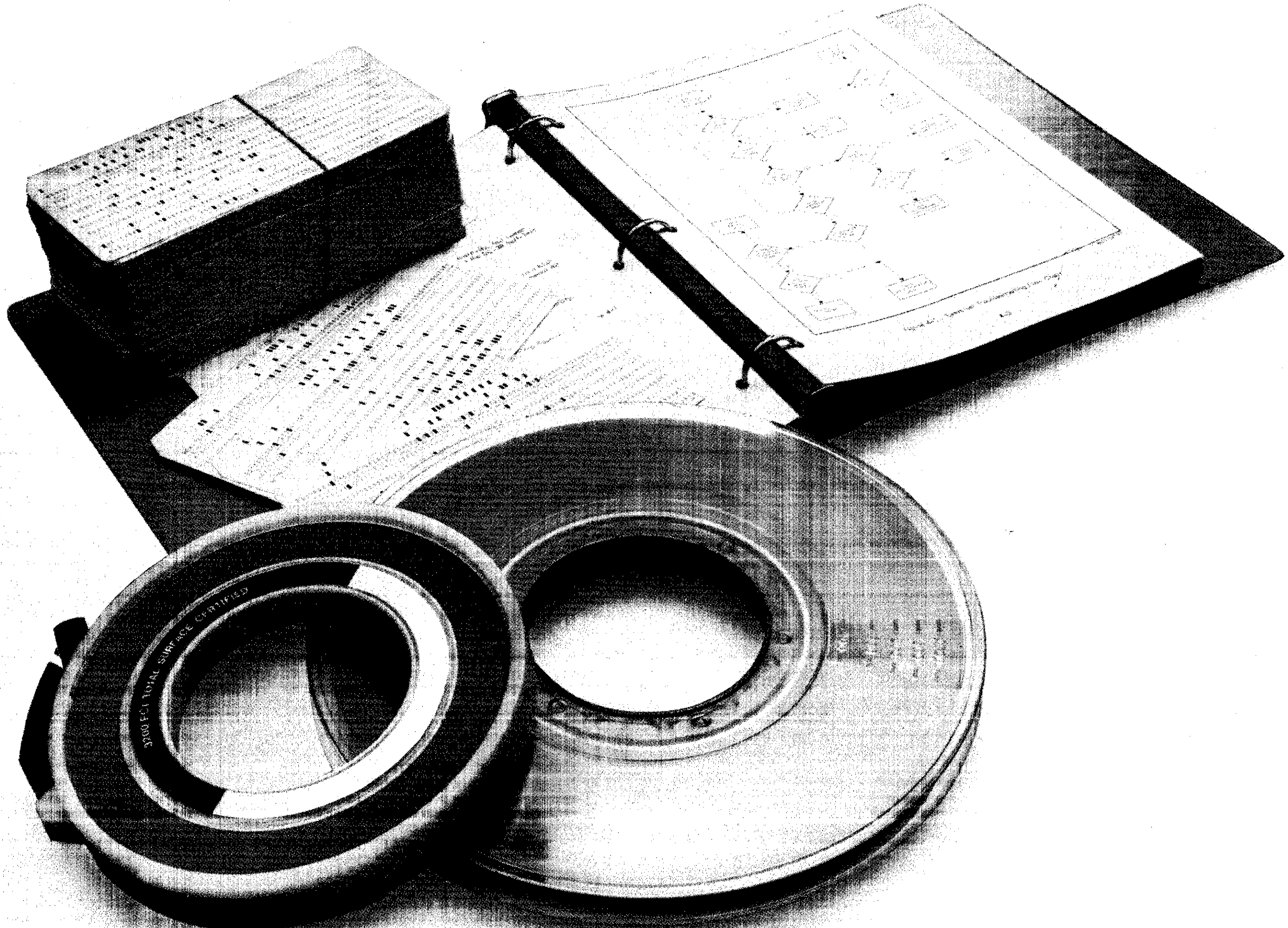
```
        ∇SETTIME
[1]     T←⎕AI[2]
        ∇
        ∇TEST
[1]     I←0
[2]    L: (Test Expression)
[3]     →(100>I←I+1)/L
        ∇
        ∇Z←POSTTIME
[1]     Z←⎕AI[2]-T
[2]     Z←Z-ADJ
        ∇
```

   To adjust for the CPU time spent in incrementing and looping, the value of *ADJ* was determined by:

```
        ∇SETADJ
[1]     SETTIME
[2]     I←ADJ←0
[3]    L:
[4]     →(100>I←I+1)/L
[5]     ADJ←POSTTIME
        ∇
```

   In all cases, the functions were run once before each benchmark to allow for any compilation which may occur.

3. The DECSYSTEMs used APL-SF. The HP 3000 used APL\3000. APL*PLUS is the APL service offered by Scientific Time Sharing Corporation, Bethesda, Marland. VSAPL was used on the IBM Systems.



HARRIS TOTAL DATA BASE MANAGEMENT SYSTEM

FEATURES
- Data Independence
- Modular And Evolutionary in Design and Use
- Non-Redundant Data
- Data Integrity and Security
- Easy Implementation

HARRIS COMPUTER SYSTEMS

TOTAL DATA BASE MANAGEMENT SYSTEM

TOTAL is the most widely used Data Base Management System in the world — having more installations than any other data base management system. Harris TOTAL combines the power and ease of use of this exceptional product with the proven line of Harris hardware and software. Harris TOTAL is multi-threaded to provide efficient memory utilization; to permit concurrent updating of the same file; and to facilitate control and standardization of the data base.

TOTAL is designed to encompass the following philosophies and criteria — which are essential for an effective Data Base Management System:

- Modular and Evolutionary in Design and Use — applications can be added and modified as needed. The most important applications can be up and running while other applications are still being designed; consequently, the impact of changes to existing applications is significantly reduced.
- Data Independence — application programs and data are independent from one another. New data elements ("fields"), new data sets ("files") and new data relationships may be added to the data base in order to respond to changing requirements without affecting current operational programs.
- Non-Redundant Data — each data element is stored only once. Besides eliminating the problem of "multiple versions of the truth," less file space is required, accuracy is increased, and maintenance costs are reduced.
- Data Relatability—TOTAL's flexibility means that the data base can be structured the way your organization does business. The user does not have to change operations to accommodate the data base.
- Data Integrity and Security — data has password protection to the "field" level. Also, TOTAL's internal checking functions ensure that programmers cannot inadvertantly destroy files, lose records or make any other errors that could adversely impact operational systems. Backup and recovery capabilities are provided.
- Equipment, Language and Environmental Independence — users can take advantage of new computer, disc and software technology without modifications to the data bases or the programs that use it.
- Optimum Performance and Efficiency — traditionally, these two vital factors tend to oppose one another. However, the TOTAL integrated data base approach provides you with the benefits of both.

THE TOTAL CONCEPT

The TOTAL system embodies a "network structure" philosophy. There is no hierarchial overhead. Indexes, directories and overflow areas are eliminated. Almost all disc space is available to the user for storing prime data. It is possible to establish virtually an unlimited number of direct network structured relationships. There is no limit to the number of data bases which may be developed. The TOTAL system features the highest possible performance in the areas of disc and memory utilization and in retrieval speeds.

TOTAL is, in effect, two systems in one:

- A system that provides for the initial generation of a data base module and all subsequent modifications and expansions to this data base in an English-like language. This phase is called Data Base Definition.
- A system that interfaces between the data base, the Harris VULCAN operating system and the application program. In this phase, TOTAL functions with the host language (COBOL, BASIC-V, FORTRAN, RPG II and Assembler), for all types of communication with the data base. This phase is called Data Base Manipulation.

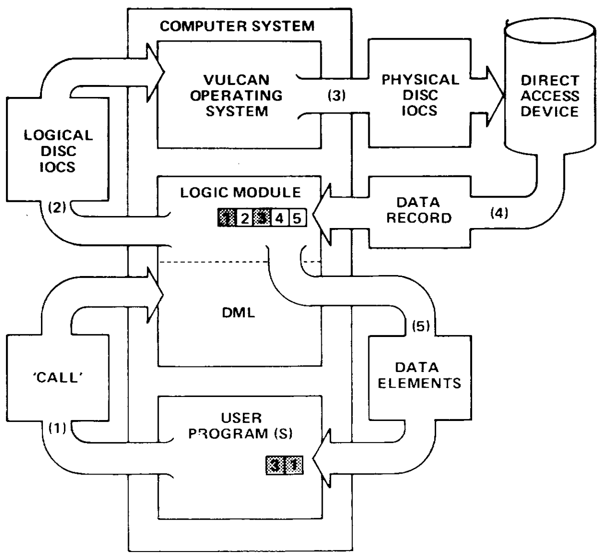
At all times and in both phases, the user is in complete control with TOTAL.

DATA BASE DEFINITION LANGUAGE

TOTAL Data Base Definition Language (DBDL) is the language used to describe a data base. This is done in terms of names and types of data sets, data records, data elements and the relationships between them. After being defined, the data base description is assembled and linked to the application programs.

The TOTAL DBDL uses an extremely high level, English-like code. A user can be fully trained within hours and will then be capable of defining and developing complex data bases.

In order to modify either an operational subsystem data base or the entire data base, it is only necessary to define the changes, reassemble the data base and re-link the application programs. The compute time is only a few minutes.



How Total Interfaces With VULCAN and With Applications Programs

DATA MANIPULATION LANGUAGE

TOTAL Data Manipulation Language (DML) is the language which the programmer uses to communicate between the program and the data base. It relies on a host language to furnish a framework and to provide the procedural capabilities required to manipulate data in primary storage.

TOTAL DML functions in conjunction with the host language through a CALL statement, or its equivalent. The user's application program, then, is a mixture of host language commands and CALLs to DML functions TOTAL DML interacts with the data base, since it is the manipulative language for the data base. All CALLs to and from the data base to retrieve, add, delete or modify data are defined in TOTAL DML.

TOTAL DML features comprehensive safeguards and analytical capabilities to assure proper processing. Diagnostic status codes are provided which indicate the successful execution of a function, or why an unsuccessful operation failed. For example, TOTAL DML will indicate that such a record already exists if the user attempts to add a duplicate master record to the data base.

TOTAL functions at the element level. An element is defined as one or more of the "fields" that comprise a logical record. Upon the execution of a TOTAL DML command, one or more elements as specified by the user's element list are passed to or from the user host program in the stated sequence of that element list. After the host language program has received the data, the application program uses the host language for whatever arithmetic or manipulative processing is required. The user is not required to do any further manipulation as to the sequencing, positioning, inclusion or omission of elements. TOTAL features an extremely powerful and comprehensive repertoire of data base manipulation commands.

Since the TOTAL system is capable of manipulating data at the element level, subsequent expansions of the record for additional elements or relationships have no effect on programs which use the originally defined record.

TYPES OF DATA SETS

In order to effectively handle the many varieties and categories of data types, TOTAL provides two types of files or "data sets": Master (Single Entry) and Detail (Variable Entry).

MASTER DATA SETS

These data sets are organized and managed according to a user-selected control key. Each master record has a unique control key which is unrestricted as to length or content. Within each record in the data set, the number of "data elements" and their individual sizes are limited only by the size of the logical record itself. Master data sets are relatively stable and predictable as to record content and number of records. They may be thought of as existing because the "company is *in* business." Each record within the data set may be directly related to up to 2,500 variable entry data sets.

In normal maintenance, TOTAL Master Data Sets are self-optimizing and never require reorganization. As a record is deleted, the space is immediately available for reuse by the system. TOTAL Master Data Sets are reloaded only if the user wishes to reformat the basic record or if the physical storage limits have been exceeded. In both instances, only the affected data set need be processed.

All other-data sets in the data base are unaffected and do not require reorganization, processing or updating of any type. This is true irrespective of the number of data sets that may be directly related to the Master Data Set being reorganized. Data retrieval performance is extremely high and does not degrade as the number of relationships to other data sets increases.

VARIABLE ENTRY DATA SETS

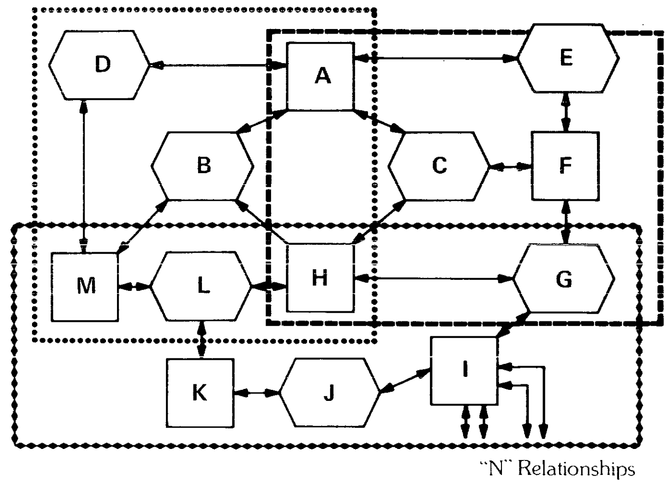
In a Variable Entry Data Set, a variable number of records may be associated with each control key in one or more master data sets. Further, they contain a variable (and often volatile) number of data records. The data records may have variable formats and a variable number of record types within each format. The data sets and data records may have unique relationships based on user-specified attributes.

It can be said the Variable Entry Data Sets exist because the "company is *doing* business." They reflect the business functions as they occur and are interactive and interrelated with the Master Data Sets. There may be up to 2,500 different record types within one Variable Entry Data Set. Each type may have any number of unique relationships to other data sets.

TOTAL NETWORK STRUCTURE

Following is illustrated a TOTAL "Network Structured" data base which is made up of several integrated data bases. It is important to note that the evolutionary concept of TOTAL makes it easy to add new data to records, new data sets and data relationships without impacting the present systems. The illustrated data base could grow over time to include hundreds of new relationships with little, if any, impact to operational programs.

- The data sets within the ······· comprise a unique data base.
- The data sets within the ---- comprise a unique data base.
- The data sets within the •-•-•- comprise a unique data base.



Total — Network Structure

K = Master data set (Single Entry)

J = Detail data set (Variable Entry)

Note that several data sets appear in more than one data base and that data set "H" appears in all data bases so that any change to data set "H" by any program from any data base will immediately be "known" by all other programs.

HARRIS T-ask

The Harris TOTAL Data Base Management System is complemented by the Harris T-ask Information Retrieval System—available under TOTAL on any Harris processor supporting the VULCAN operating system. T-ask allows non-programmers to extract information stored in the TOTAL database by means of a simple, English-like, non-procedural information retrieval language. Frequently used inquiries may also be saved (cataloged) for re-use at a later time—a feature that makes T-ask an effective, powerful decision-making tool for the user.

Specifications are subject to change without written notice.

HARRIS — COMMUNICATIONS AND INFORMATION HANDLING

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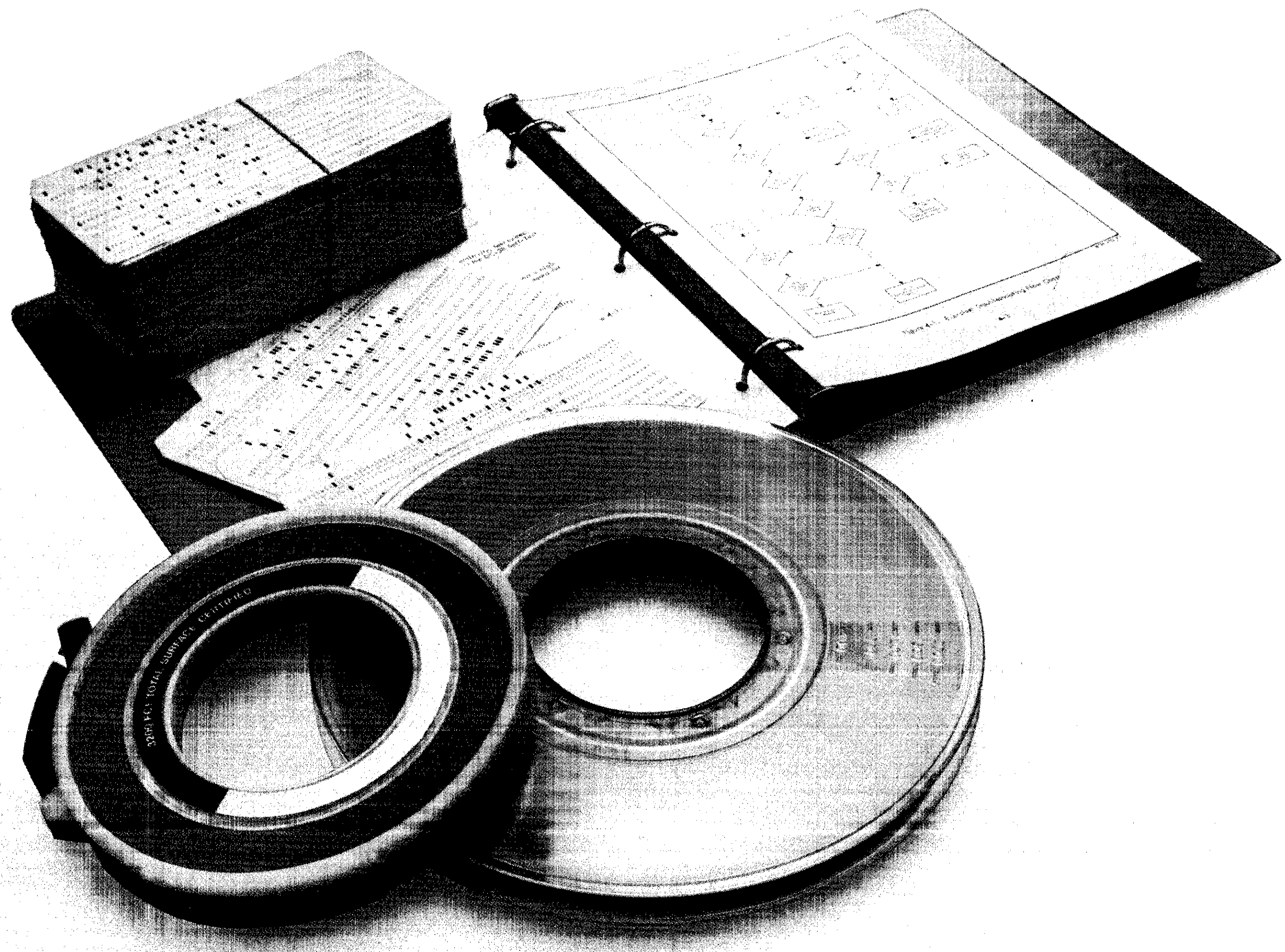

HARRIS T-ask™ INFORMATION RETRIEVAL SYSTEM

FEATURES
- Spontaneous Inquiry
- User-Oriented
- Time-Saving
- Centralized Security
- Rapid Installation

HARRIS
COMPUTER SYSTEMS

T-ask Information Retrieval System

Harris T-ask is a sophisticated inquiry package that takes the time, energy and frustration out of everyday database information retrieval. No longer must database information gathering depend upon inquiry programs written for each new project. Now, through an information retrieval language simple enough for non-programmers to learn in less than an hour, TOTAL users have easy, direct and spontaneous on-line inquiry to any Harris TOTAL database. The T-ask system is used with the Harris TOTAL Data Base Management System—tailored to operate in a VULCAN Virtual Memory operating system environment.

User-Oriented

As well as being easy to use, T-ask incorporates many innovative ideas. Gone are the difficult traditional short element names. In their place, T-ask supplies longer, more meaningful synonyms—up to 18 character datanames that provide simple, clear labeling. The availability of both dollar signs and decimal points for editing displayed numerical data is another plus. Assigning edit pictures to data display formats enhances recognition by the operator. Such built-in conveniences enable the terminal user to concentrate on relevant data rather than waste time deciphering unfamiliar names and data formats.

Spontaneous Time-Saver

The most significant aspects of T-ask are spontaneity and time-saving. As a management tool, T-ask greatly assists in decision making. It offers quick and easy handling of management information requests that are often unanticipated. No time is lost developing one-time programs to retrieve data that are required immediately. The T-ask information retrieval language is designed to satisfy impromptu information requests regardless of when they are needed. A further advantage is that once established, inquiries may also be saved (cataloged) for re-use at a later date—a characteristic that makes this system a powerful, effective decision-making instrument.

Centralized Control and Security

As with any data processing, security is important. In a T-ask environment, the data processing department uses security codes to control user access to the database. Each user is issued an access code which relates to a particular set of datanames. This control extends even to the data field (sub-element) level. Access to any portion of the database can be gained only through prior arrangements with the database administrator who is solely responsible for creating and assigning access codes. Thus, security is well maintained. Each access code is normally associated with one set of datanames and one set of cataloged procedures. However, datanames and procedures may also belong to multiple access codes.

T-ask consists of three program modules:

- The Data Directory Creation program (DDCREATE)
- The Data Directory Maintenance program (DDMAINT)
- The T-ask Module

Data Directory Modules

DDCREATE runs at system initialization time and allows the database administrator to define system parameters and to create both the data directory and its work files. DDMAINT is used by the database administrator for on-line definition, modification or deletion of information such as datanames, edit pictures, access codes, etc., that is stored in the directory work files. This program runs on demand.

The T-ask Module

The T-ask Module is an application program that controls all on-line access to the database and provides the English-like syntax for the system's end-user. It determines appropriate access strategy for each request, retrieves the information from the database, formats each answer on the screen and permits cataloging of any inquiry generated through its use.

The T-ask Module operates in either the Inquiry Mode or the Catalog Mode. In Inquiry Mode, spontaneous inquiries are keyed directly into the database. In Catalog Mode, previously cataloged inquiries are used. Here are a few examples.

Inquiry Mode

Under the Inquiry Mode, the user enters an access code which triggers a display of datanames available to that access code. From this list, specific datanames are selected by reference to their associated numbers. For example:

(01) CUSTOMER-NO
(02) CUSTOMER-NAME
(03) CUSTOMER-ADDRESS

The process of selecting datanames by number, defines the output records. If the name and address of customer 1000 are required, datanames 2 and 3 are selected and the following statements entered:

CUSTOMER-NO EQ 1000
END

T-ask then finds the information, formats the output with headings and displays the appropriate name and address.

To produce a display of names and addresses for all customers whose customer numbers fall between 1000 and 1999, the following statements are used:

CUSTOMER-NO GE 1000
AND CUSTOMER-NO LT 2000
END

If the datanames EMPLOYEE-NO and HOURLY-WAGE are available, the following statements will calculate and display the weekly wage for employee 1056:

EMPLOYEE-NO EQ 1056
HOURLY-WAGE *40=*WEEKLY-WAGE
END

T-ask can calculate totals and averages, too. The average hourly wage and total weekly wages for employees making less than $10.00 an hour will be as follows:

HOURLY-WAGE LT 10.00
HOURLY-WAGE *40=*WEEKLY-WAGE
AVERAGE HOURLY-WAGE
TOTAL *WEEKLY-WAGE
END

To produce a hard copy of any output, the word PRINT is entered before END.

Catalog Mode

When the Catalog Mode is selected, procedure names available under the specified access code are displayed on the screen. As with datanames, each procedure name has an associated number which is entered to execute the procedure.

Prompting is automatic for procedures that are entered from the terminal. For example, if the statements that displayed the name and address associated with a customer number have been cataloged, as soon as the number is selected, T-ask automatically prompts:

ENTER CUSTOMER-NO

After the operator enters the number, the answer is displayed on the screen. However, not all procedures require input from the terminal. If, for example, the statements to calculate the average hourly wage and the total weekly wages are cataloged, the average and total can be obtained by entering just the procedure number.

CRT Processing Notes

If the volume of data to be displayed on a screen by the T-ask system exceeds the size of one screen, the last line of each display will always appear as "**MORE**" instead of "*END DATA*." "*END DATA*" signifies the end of information requested by the previous inquiry. The next transmission by the user will result in the redisplay of "SELECT DATANAMES." Processing may then continue.
If at any time, a situation develops where the user is unsure of the next step, he can always enter "HELP." The system will then provide appropriate user support messages.

Installation And Operation

The complete T-ask system can be both taught and installed in one day. The system operates in conjunction with Harris TOTAL on any Harris processor supporting the VULCAN operating system. T-ask is designed for operation on both CRT and teletype (or equivalent) devices.

In every aspect, T-ask is designed to give the user simple, spontaneous, cost-effective processing that is safe, flexible and easy to use. It is today's answer to tomorrow's problems; and, as such, is the true end-user interface to the modern database.

Specifications are subject to change without written notice.

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