



H632 General Purpose Digital Computer System

**Honeywell**

 **COMPUTER CONTROL**  
DIVISION

MH CRANK



## INTRODUCING HONEYWELL SERIES 32



### **Computer systems with the golden touch. . . that work for pennies**

The H632, first in the Honeywell Series 32 family of compatible 32-bit I/C computer systems, provides a price/performance ratio that can't be matched by any other machine in its class. The high-speed, high-performance H632 is ideal for real-time scientific and control applications.

An advanced concept of modular system integration and coordination permits special processor capabilities to be used in multiprocessor/multiprogrammable configurations.

The modular H632 is as flexible as a computer can be. You can start with a minimum system and expand easily as your requirements grow.

It is as reliable as a computer can be, too, thanks to our in-house capability in integrated-circuit technology that has resulted in our highly reliable line of I/C logic modules, magnetic core memories, and DDP-416, -516, -124, and -324 digital computers. All our latest I/C developments are incorporated into the H632, just as they will be in future members of the Honeywell Series 32 family. Also, our 32-bit machines are data compatible with our 16-bit machines, so they can be used in the same computer complex.

Add up the H632's performance, flexibility, reliability, compatibility, state-of-the-art technology, and low cost per instruction — you have a computer system that is ideal for a wide variety of small-to-large-scale real-time scientific and control applications . . . a computer system that can be tailored to your particular requirements . . . a computer system that lends a "golden touch" to problem solving . . . and does so for pennies.

**The H632 system offers you all these advantages . . .**

- Fastest performance, lowest cost per instruction in its class
- Extensive software package
- Complete line of peripheral equipment
- Multiprocessing / multiprogramming capabilities
- Multiaccess memory
- Full support services
- Parallel machine organization for moderate-speed circuitry and wide reliability performance margins
- All monolithic I/C logic modules
- Expandability through modular system construction

**and all these features . . .**

**SYSTEM**

- Up to four central processors
- Up to four I/O processors
- Up to four memory banks

**MEMORY**

- 32-bit word
- 850-nanosecond cycle time
- Expandability from 8,192 to 131,072 words using plug-in modules

**CENTRAL PROCESSOR**

- Word oriented
- Direct addressing of 65,536 32-bit words or 131,072 16-bit half words
- 16 high-speed general-purpose 32-bit flip-flop registers may be used as accumulators, index registers (7) or as mask registers (1)
- Multilevel indexing and indirect addressing
- 144 high-speed instructions
- Bit, hex digit, byte, halfword, word, doubleword and immediate operand addressing
- Many options — floating-point hardware, mask and byte operations, additional interrupt levels, direct read/write

**I/O PROCESSOR**

- Simultaneous independent operation with central processor on a cycle-stealing basis
- Direct path between memory and peripheral devices
- Programmable real-time I/O with command and data-chaining capability
- High-speed, word-oriented 200 kHz word transfer rate
- Eight channels standard, expandable to 16
- Multiplexer/selector capability
- Many options — Additional I/O channels, higher speed I/O Processors

**SOFTWARE**

- Basic operating system
- Loaders
- Macro assembler
- Fixed- and floating-point math libraries
- Extended FORTRAN IV
- Test and maintenance package
- Program debug package
- Media conversion and system editor
- Unit record control and I/O drivers
- Trap package

**PERIPHERALS AND SUBSYSTEMS**

- Card readers
- Card punch
- Magnetic tapes
- Keyboard I/O
- Paper tape I/O
- Line printers
- Disc systems
- Analog I/O
- Communications subsystems
- Displays
- H632-DDP-416/516 adapter

**PRICE**

\$97,000 buys the basic H632 system: central processor with 8,192 words of memory, 16 general registers, independent I/O processor with eight channels and KSR-35 I/O typewriter. \$2,700 rents it for a month with a one-year lease, \$2,200 rents it for a month with a four-year lease.



# ADVANCED SYSTEM ORGANIZATION

An H632 System combines advanced hardware elements to provide outstanding large-scale operational advantages in a medium-scale computer. The system consists of one or more central processors, I/O processors, and banks of memory; systems coordination elements — memory access director and multiprocess controller; system control panel; and selected peripheral equipment.

**Primary Storage (Core Memory)** — The standard core memory module for the H632 is a high-speed, random-access memory with 8,192 32-bit words. The memory can be easily expanded from the basic 8,192 words to 131,072 words, and can be organized in banks containing one or more modules, with each bank containing separate access electronics to which one or more processors may be connected.

**Memory Access Director (MAD)** — The memory access director controls the access requests made on the core memory by the processors. The MAD resolves conflicts arising from simultaneous memory access requests issued by two or more processors for the same memory bank.

Depending on the MAD unit selected, memory can be organized into both private and shared banks.

**Central Processor (CP)** — The central processor is a general-purpose, word-oriented, scientific data processor. It performs all data manipulation; arithmetic, logical, and comparison operations; and issues orders to the multiprocess controller, requesting changes in the activity states of the various program levels.

The CP has a repertoire of 144 high-speed systems-optimized instructions. The H632 CP structure allows the user to work directly with various data sizes: words (32 bits), halfwords (16 bits), bytes (eight bits), hexadecimal fields (four bits), single bits, and doublewords (64 bits).

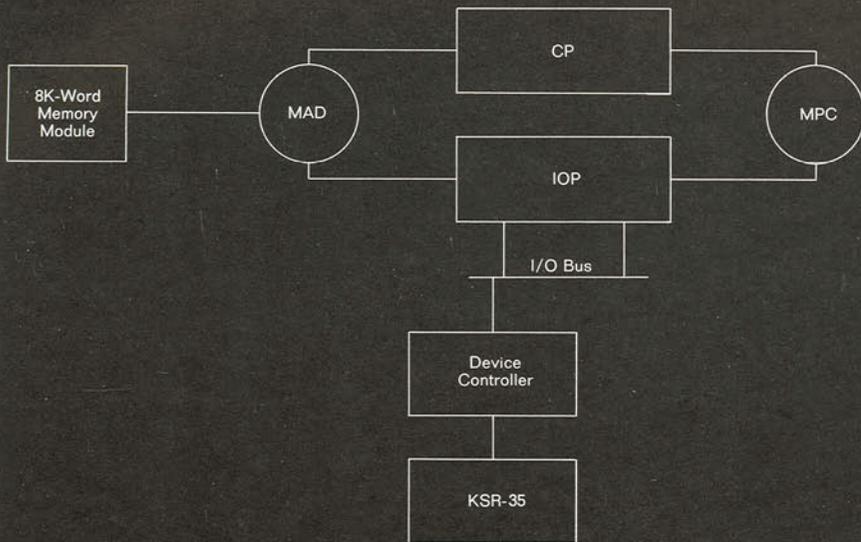
The CP allows for these operations:

- *Storage-to-register* — e.g., add a word in memory to a word in a register and place the result back in the register
- *Register-to-storage* — e.g., add a word in memory to a word in a register and place the result back in memory
- *Register-to-register*
- *Immediate operand*

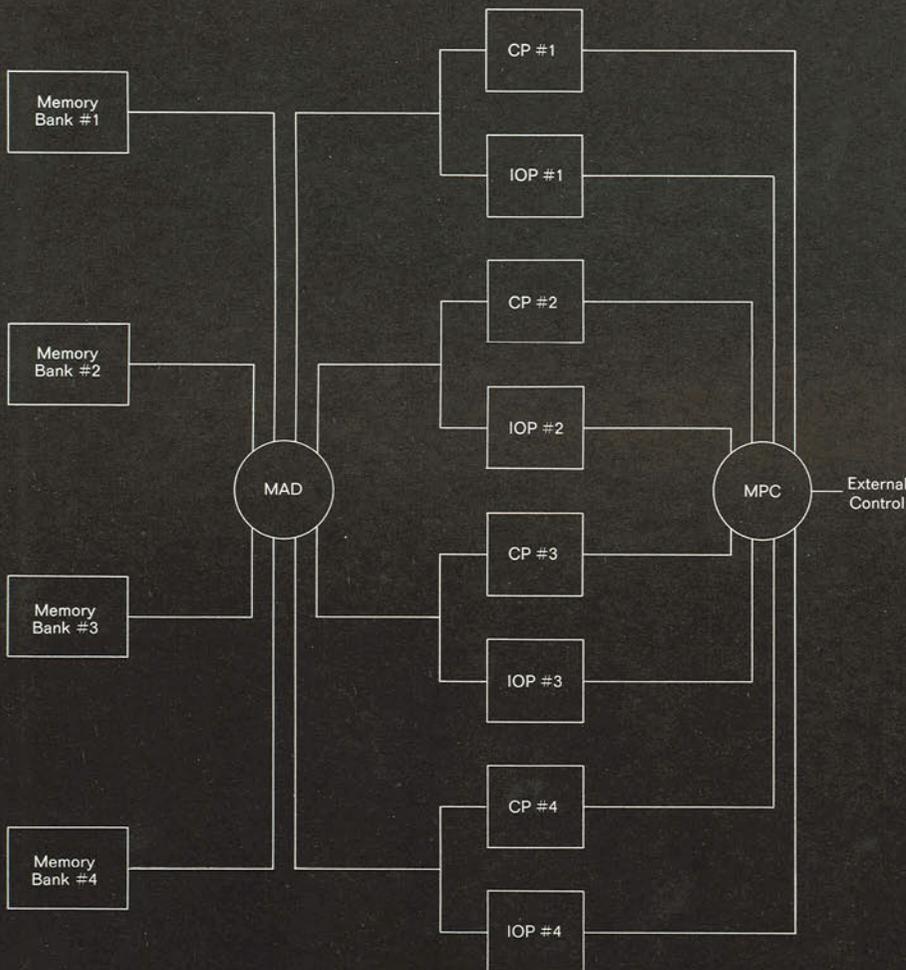
There are eleven classes of instructions:

1. Load/Store
2. Logical
3. Fixed-Point Arithmetic
4. Compare
5. Shift
6. Bit
7. Jump and Execute
8. Control
9. Floating Point (optional)
10. Mask and Byte (optional)
11. Direct Read/Write (optional)

### BASIC SYSTEM



### MAXIMUM SYSTEM



**Input/Output Processor (IOP)** — The IOP is an independent, high-speed, word-oriented processor with highly developed I/O facilities. The IOP provides direct interpretation of I/O commands fetched from memory concurrently with CP operation. Data is also transferred directly between memory and the selected peripheral devices without CP intervention.

In the basic H632 System, the CP and IOP cycle-share the memory system. In a multiple memory-bank system, fully simultaneous CP/IOP operations can take place. The IOP can transfer words, halfwords, or bytes of data and can perform word forming — all under the direction of the active device controller.

Up to 16 devices can be connected to the basic IOP, with any eight being able to run simultaneously. Optionally, eight additional channels can be added to the IOP, allowing all 16 devices to run simultaneously.

**Multiprocess Controller (MPC)** — Each processor — CP or IOP — can be timeshared among several programs. The multiprocess controller coordinates the processes (operating) in all systems processors.

Control of the activity states of the various processes (CP Program Levels and IOP Channel Activity) is accomplished through orders issued to the MPC either by IOP commands, CP instructions, or by signals received from device controllers. An external interrupt source may also be used to initiate or modify CP activity.

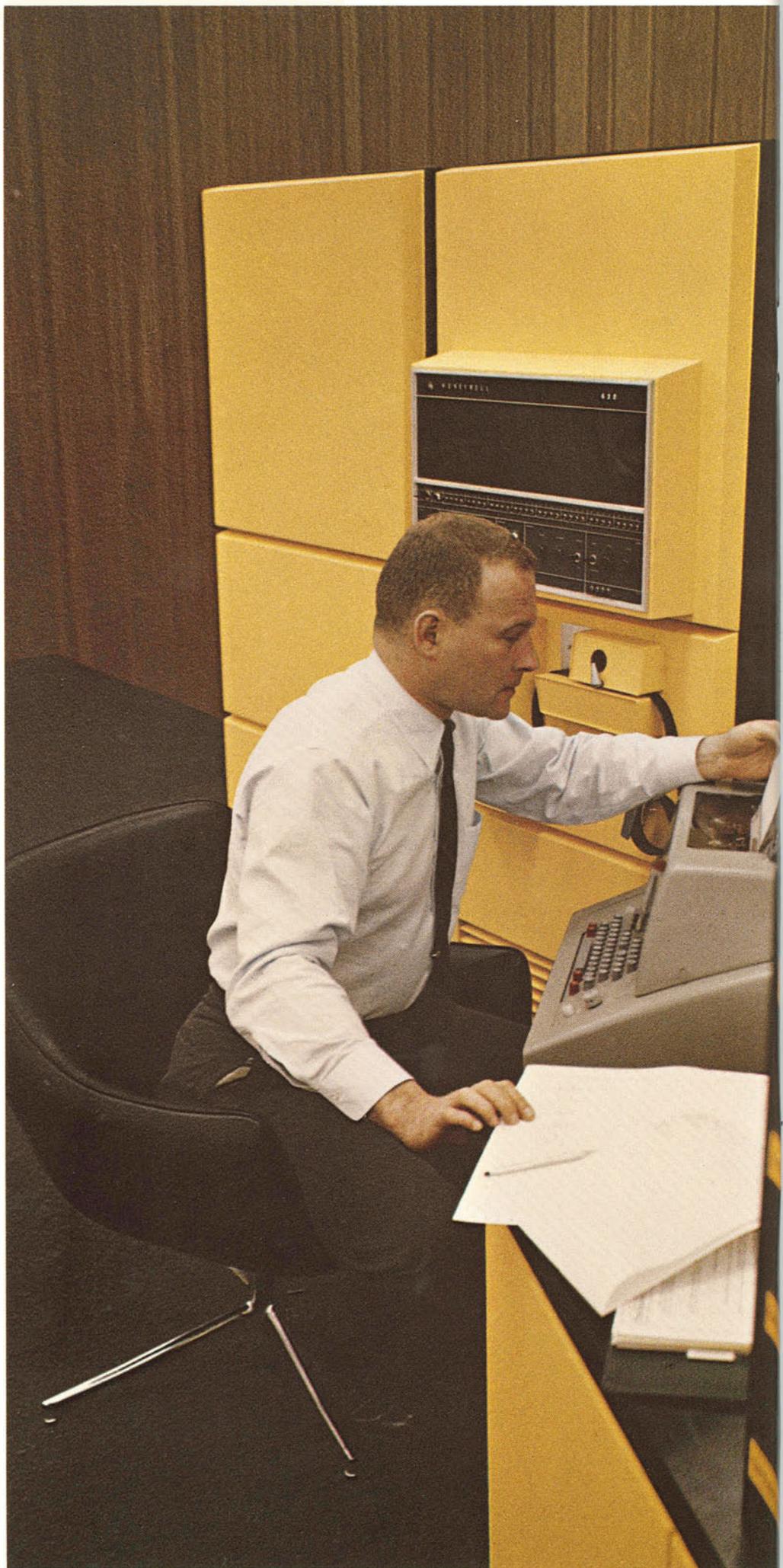
**Loader Program** — This relocatable program loads and links main memory with hexadecimal information in absolute or relocatable format. It can load the main program, subroutines called by the main program, and subroutines called by other subroutines. The program then completes linkage between the main program and external subroutines. The loader is optionally capable of producing a fully linked, relocatable object module as an output, and is also used to set up linkages to the Debug Program.

**Debug Program** — A relocatable program provided to:

- Type memory in hexadecimal or symbolic
- Type corrections into memory and start at a specified location
- Return to breakpoint and continue with program being debugged
- Clear memory to zero with limits
- Search memory for a value within specified limits
- Insert program patches

**Trap Package** — This set of routines is used to simulate all unimplemented optional instructions such as byte, mask and floating-point operations in a fast, efficient manner.

**Media Conversion Program** — This program allows the conversion of data from one form of physical storage to various other forms of physical storage. It manipulates input from cards, paper tape, magnetic tape, or disc; gives output on cards, paper tape, magnetic tape, disc, or line printer; and provides data formatted in binary, USASCII, and hexadecimal.





## MATHEMATICAL LIBRARY

Subroutines	Fixed Point			Floating Point	
	Complex	Single Precision	Double Precision	Single Precision	Double Precision
Square Root	■	■	■	■	■
Cos	■	■	■	■	■
Sin	■	■	■	■	■
Tan		■	■		■
Arc Tan		■	■	■	■
Log Base e	■	■	■	■	■
Log Base 2		■	■		■
Log Base 10		■	■	■	■
Exponential Base e	■	■	■	■	■
Exponential Base 2	■	■	■	■	■
Exponential Base 10	■	■	■	■	■
Add	■			□	■
Subtract	■			□	■
Multiply	■		■	□	■
Divide	■		■	□	■
Maximum Value				■	■
Minimum Value				■	■
Absolute Value	■			■	■
Remaindering				■	■
Hyberbolic Tan		■	■	■	■
Complex Conjugate	■				
Two's Complement			■		
Truncate to Integer				■	■
Sign Transfer				■	■
Positive Difference				■	

□ Are trapped to simulation routines unless hardware options are implemented.

# COMPLETE LINE OF PERIPHERALS AND SUBSYSTEMS

## STANDARD PERIPHERALS

### Printer/Keyboard

Combined printer and keyboard for input/output

Speed: ten characters/second

Standard KSR-35 character set of 64 characters

Standard ASCII Code

### Paper Tape

32-5000 — Paper tape reader and punch  
Reader — Photoelectric unit reads eight-level tapes at rates up to 300 characters/second

Punch — Punches eight-level tapes at rates up to 110 characters/second

### Card Readers

32-5100 — Reads 400 cards per minute

32-5150 — Reads 800 cards per minute

### Card Punch

32-5200 — Punches 100 to 400 cards/minute

## Direct Access Storage Devices

32-4600 — Disc control unit

32-4621 — Disc storage unit

Each control unit can handle up to eight storage units

Capacity of each storage unit — 1.8 million words

Average access time — 12.5 ms

Minimum seek time (one track) — 30 ms

Maximum seek time (200 tracks) — 165 ms

Transfer rates of 39,000 words/second

Removable disc packs for unlimited off-line storage

### Printer

32-7050 — 300 lines/minute, 120 columns per line

### Magnetic Tapes

32-4100 — Magnetic tape control unit, seven level

Data rates from 7,200 to 64,000 characters/second

Recording densities — 200, 556, and 800 characters/inch

One to four tape units attachable to a single controller

### Low-Speed Paper Tape

32-5025 — Expands the capability of the basic printer/keyboard to include a ten-character/second reader and a ten-character/second punch

### Off-Line Tape Preparation Unit

K-700 — Basic seven-channel Keytape keyboard to magnetic tape device. Includes 80-character memory, 556 bpi density

## CUSTOM OPTIONS

### Adapters

For interfacing either a DDP-416 or DDP-516 with an H632 system

### High-Performance Peripherals

Nine-level magnetic tapes

Magnetic tape systems with transfer rates up to 120,000 characters/second

Line printers, 600 and 1,000 lpm

### Process I/O Subsystems

Analog input

Analog output

Digital input

Digital output

### Communications

Single-line controllers — For full duplex operation of high-speed (>9600 bps), medium-speed (300-4800 bps), and low-speed (<200 bps) serial data lines.

Multiline controllers — *Low capacity subsystem* for up to 64 full-duplex lines. *High-capacity subsystem* for up to 128 full-duplex lines.

Medium-speed subsystem — For mixed synchronous and asynchronous lines using up to 32 lines at 2400 bps.

### Fast Access Disc Unit

Fixed head

Capacities from 49,000 to 399,000 words per unit

Average access time — 8.5 milliseconds

Transfer rate — 44,000 words/second



### **Displays**

Alphanumeric CRT/keyboard  
Graphic

High speed, high resolution  
High speed, low resolution  
Low speed, high resolution

#### Options:

Vector generation  
Character generation  
Circle/arc  
Buffer memory  
Keyboard  
Light pen

### **Modules**

A standard line of compatible  $\mu$ -PAC logic modules is available for the person who wants to build his own subsystem for use with the H632.

### **Specials**

Through our Systems Engineering Department, quotes can be obtained for developing and interfacing special subsystems into Honeywell computers.

# WIDE VARIETY OF APPLICATIONS

In the past 14 years, we have designed and developed a wide variety of digital systems, ranging from relatively simple free-standing units for scientific computation to complex configurations for real-time simulation systems. Success in building such a wide range of digital systems is due to our ability to provide both building blocks and complete systems using the same digital logic modules throughout.

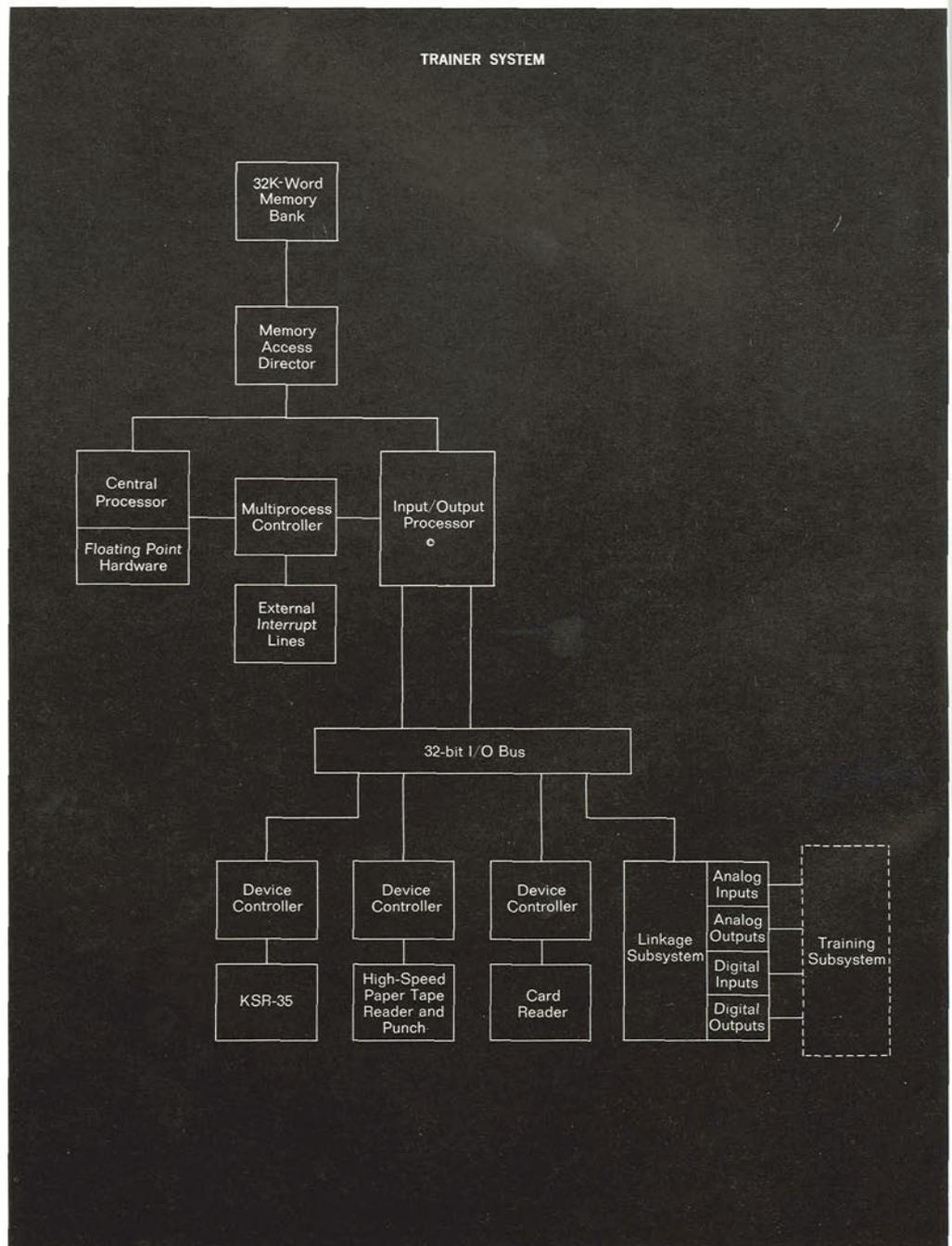
The H632 Computer System, with its advantages of long word length, high speed, extensive software, and highly reliable integrated circuitry, is an excellent performer where computational accuracy, flexibility, and control are important.

The system has been designed to meet the needs of a wide range of applications: trainers/simulators, general-purpose scientific, ground support/check-out, hybrid computation, message switching/data retrieval, research, physical sciences, tracking/navigation, traffic control, industrial control, data concentration, graphics, biomedical, and more.

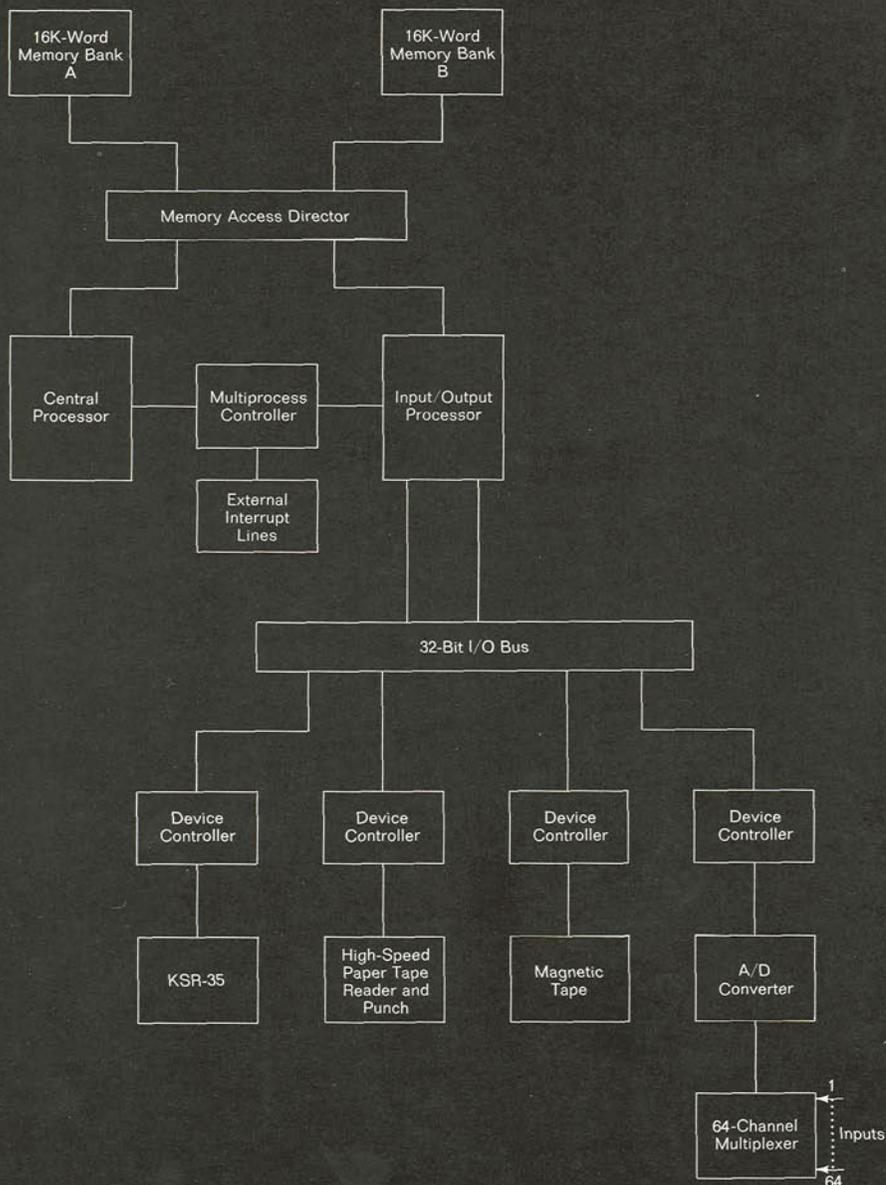
The illustrations on these pages present details of typical H632 System configurations.

**Trainer System** — This system is optimized for the solution of a typical trainer problem, namely, the complete simulation of the real-world environment the trainee will encounter when operating the actual vehicle, whether it be an airplane, spacecraft, automobile, submarine, etc.

The H632 Central Processor is optimized to solve the simulation equations needed to provide this complete and realistic simulation. The CP can directly address the various data lengths (words, halfwords and bits) normally encountered in this type of system.



### HIGH-SPEED DATA ACQUISITION



The CP possesses an instruction repertoire of 144 high-speed instructions tailored for the solution of the simulation equations. Consider the following:

- One-word floating-point arithmetic
- Word, halfword and bit operations
- High-speed shift operations
- Interval comparison operations
- High-speed fixed-point arithmetic operations
- Extensive set of branch operations

Transfer of data between the training device and the H632 takes place via the IOP. The independent word oriented IOP allows for the high-speed transfer of data between memory and the linkage system without CP intervention.

A powerful macro assembler allows for the total utilization of H632 hardware capabilities.

**High-Speed Data Acquisition** — If your requirement involves acquiring high-speed data, processing of the data and recording it on mag tape, consider the advantages of the configuration shown:

The expanded Memory Access Director (MAD) allows the two processors to run simultaneously as long as they are accessing separate memory banks. This means that the IOP can transfer data to and from memory at its maximum rate (200 kHz words, 400 kHz halfwords or 800 kHz bytes) while the CP is running at its maximum rate.

With proper coding, a ping-pong arrangement can be set up so that data transfers, on a block or record basis, take place first with memory bank A and then with memory bank B. While data transfer was taking place with memory A the CP could be processing the data in memory bank B and vice versa, thereby achieving maximum system throughput.

**General-Purpose Scientific Data Processing** — If your requirement is for a free-standing scientific computer system, consider the advantages offered by the H632:

High-speed central processor with floating-point instructions

Independent I/O processor imposing minimum loading on the system for I/O operations

Complete line of peripheral equipment

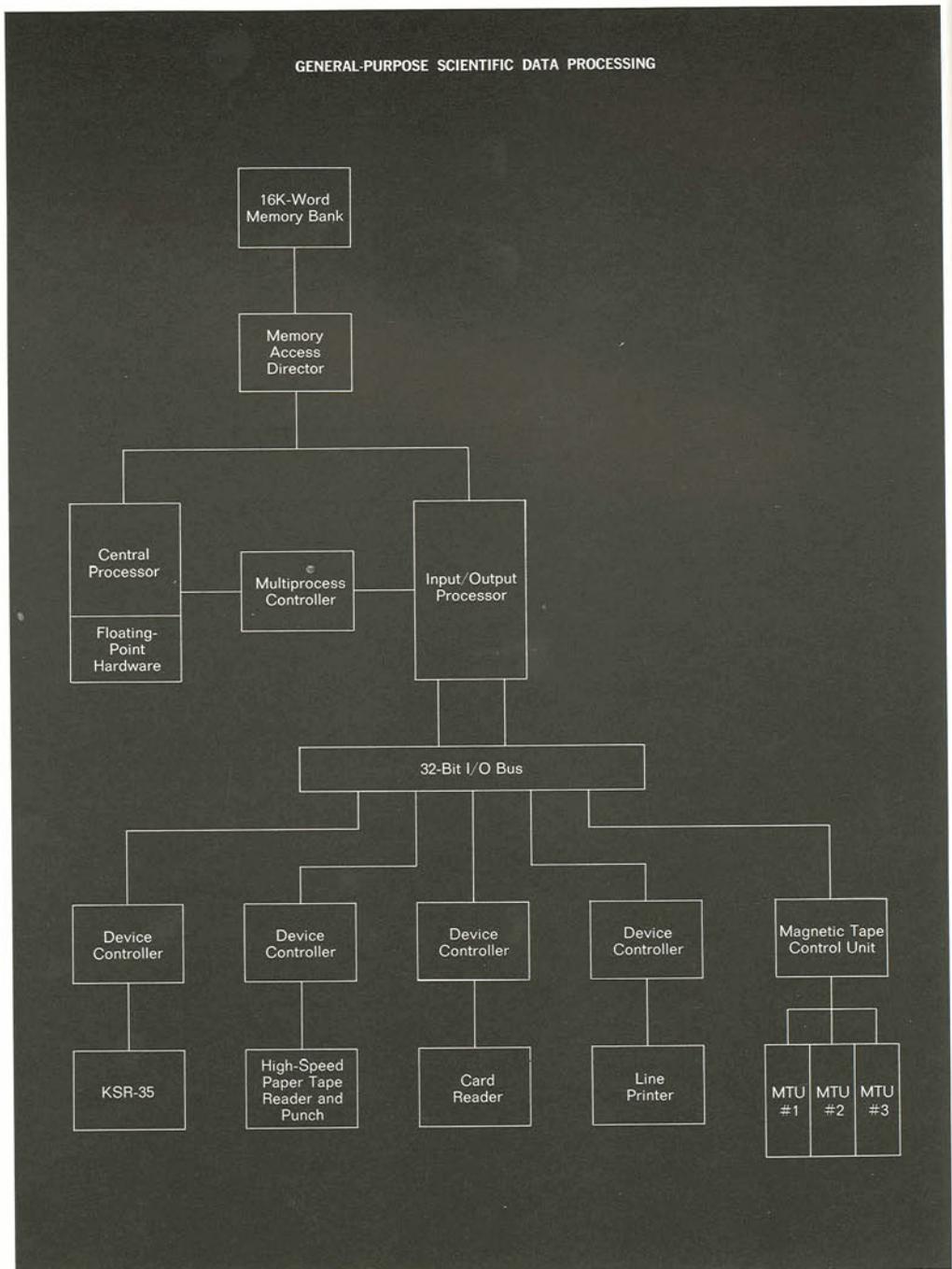
Comprehensive software package —

Extended FORTRAN IV Compiler

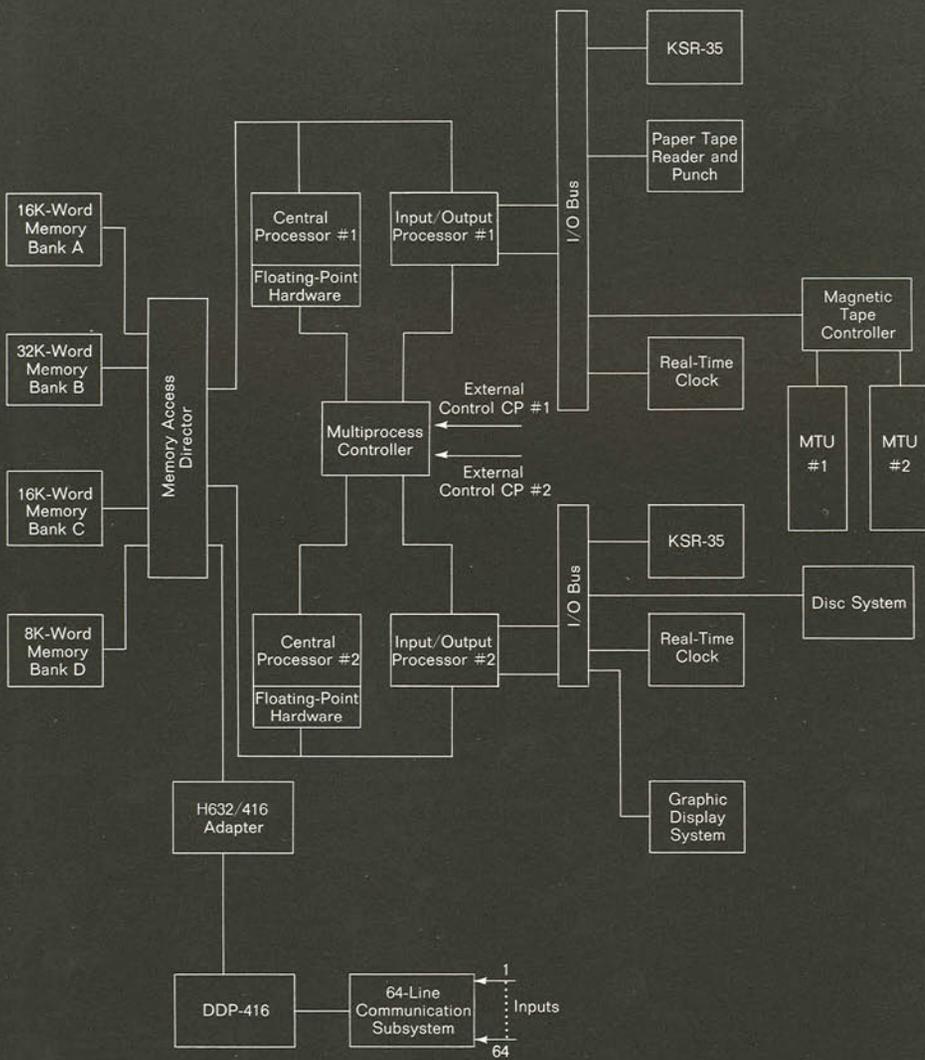
Powerful MACRO Assembler

Fixed- and floating-point math libraries

Basic Operating System



RESEARCH COMPUTING FACILITY



**Research Computing Facility** — If your requirement is such that extremely high processing and input/output is necessary, consider the advantages of the configuration shown:

With the expanded Memory Access Director, one can run all four processors simultaneously, provided they are all accessing different memory banks.

All memory banks are accessible by all processors, allowing for the sharing of common programs and data.

The multiprocess controller (MPC) represents a new and unique concept in multiprocessor systems. The MPC is the focal point of control for all systems processors. Via the MPC any processor can initiate activity on all other processors in the system.

## FULL SUPPORT SERVICES

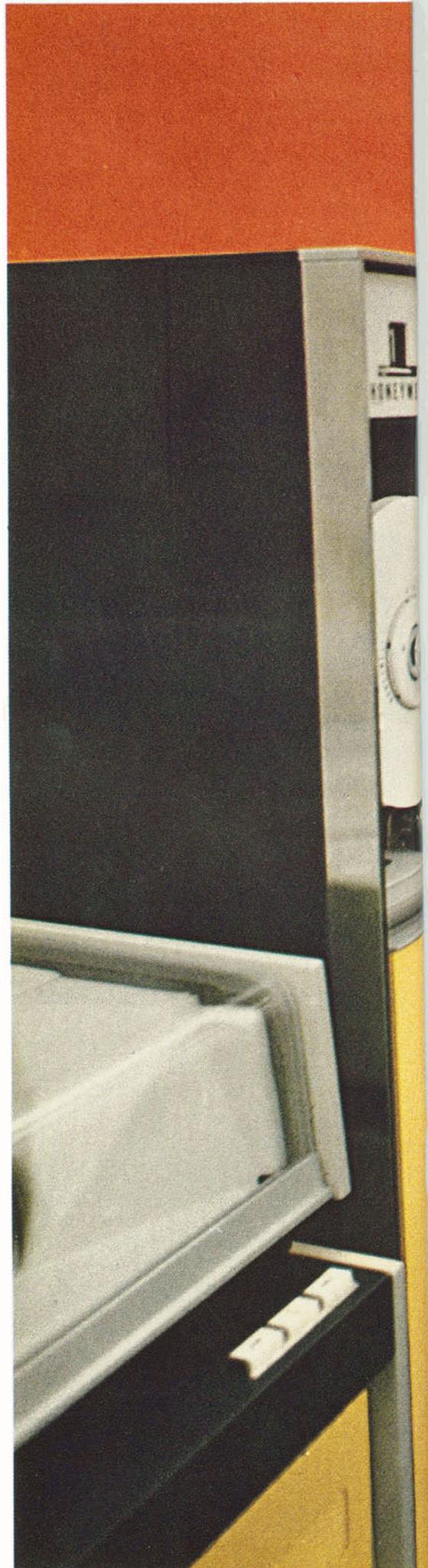
- Automation partner philosophy
- Pre- and post-sale applications support on a local basis
- Active users group
- Maintenance and programmer training courses
- Logistic support program
- Field service and installation

When you buy a Honeywell 632 computer system, you gain an "automation partner". We work closely with you to get your system operating as quickly and smoothly as possible. Our automation partner philosophy — where the user provides the in-depth knowledge of his processes and operating objectives, and we supply the hardware, software, and control know-how — has proven to be a most successful way to get systems on-line with the fewest problems.

As your automation partner, we offer you assistance in field service and installation, programming, hardware maintenance, and application engineering . . . all from Honeywell people in your area. We offer a logistic support program that keeps your system up-to-date. This program includes statistical compilation of field operating experience, technical notes on system hardware and software modifications, spare parts provisioning, and stocking of programming forms and paper tapes.

There is a programming/software course oriented to experienced programmers. It reviews assembly language, input/output, and real-time programming; provides an introduction to, and instruction in, H632 programming; and instruction in H632 operation. A logic/maintenance course includes instruction in H632 operation, logic design, diagnostic procedures, diagnostic routines, and preventative maintenance.

Finally, there is an active and valuable users group that meets periodically for exchange of ideas and helpful information.





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## STANDARD H632 PRICE SCHEDULE

Effective April 9, 1968, subject to change without notice

Model Number	Item	Purchase Price	Monthly Lease Price* Including Maintenance
632-0001	H632 system including central processor with eight program levels (interrupts), I/O processor with eight channels, 8,192 word memory module, memory access director, multiprocess controller, and KSR-35 I/O typer	\$ 97,000	\$ 2,700
632-0500	Power failure interrupt	1,000	30
632-0510	Real time clock	750	20
632-0520	Watchdog timer	1,000	30
632-1101	8,192 word memory module	35,000	975
632-1105	Parity for an 8,192 word memory module (not field expandable)	2,400	70
632-2101	Floating point hardware	8,000	225
632-2105	Mask & byte instructions	2,000	60
632-2120	External control of eight standard CP program levels (interrupts)	1,500	40
632-2125	Four additional CP program levels (interrupts) with external control	1,500	40
632-2200	Address halt feature for systems control panel	500	15
632-3105	Eight additional I/O processor channels	4,000	110
632-3150	Direct read/write	2,500	70
632-3160	Parallel input channel	1,100	30
632-3165	Parallel output channel	1,100	30
632-3170	Output control pulse group — six lines	750	20
632-3171	Six additional OCP lines — (maximum number of lines per group — 30)	500	15
632-3180	Sense line group — 16 lines	1,000	30

### STANDARD SERIES 32 PERIPHERAL PRICE SCHEDULE

32-4100	Magnetic tape control unit, seven level, controls up to four transports of similar speed and density	12,000	335
32-4130	36 ips, Magnetic tape transport, 200/556 bpi	13,225	370
32-4131	36 ips, Magnetic tape transport, 200/800 bpi	16,900	470
32-4132	36 ips, Magnetic tape transport, 556/800 bpi	16,900	470
32-4140	80 ips, Magnetic tape transport, 200/556 bpi	21,150	590
32-4141	80 ips, Magnetic tape transport, 200/800 bpi	25,300	700
32-4142	80 ips, Magnetic tape transport, 556/800 bpi	25,300	700
32-4600	Controller for High Capacity Disc Store for up to eight disc storage units	14,400	400
32-4621	Disc storage unit for 1.8 million words	24,600	685
32-4622	Additional disc pack for disc storage unit	965	30
32-5000	Paper tape reader (300 cps) & paper tape punch (110 cps)	9,000	250
32-5025	Low speed paper tape feature (not field expandable)	2,000	60
32-5100	Card reader, 400 cpm	14,500	405
32-5150	Card reader, 800 cpm	21,000	585
32-5200	Card punch, 100-400 cpm	27,500	765
32-7050	Line printer, 300 lpm	25,000	695
32-9001	Table, custom option (requires special quotation)	---	---
32-9003	Color option for KSR-35 (requires special quotation)	---	---

\* Based on one year lease. Four year lease terms also available.

# Honeywell


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