H632 General Purpose Digital Computer System

Honeywell
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 tape
- 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.
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)
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
- 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
- Hyperbolic Tan
- Complex Conjugate
- Two's Complement
- Truncate to Integer
- Sign Transfer
- Positive Difference

### Table

<table>
<thead>
<tr>
<th>Subroutines</th>
<th>Fixed Point</th>
<th>Floating Point</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Complex</td>
<td>Single Precision</td>
</tr>
<tr>
<td>Square Root</td>
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<tr>
<td>Cos</td>
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<td>Arc Tan</td>
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<td>Log Base e</td>
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<td>Log Base 2</td>
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<tr>
<td>Log Base 10</td>
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<tr>
<td>Exponential Base e</td>
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<td>Exponential Base 2</td>
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<tr>
<td>Positive Difference</td>
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</table>

**Note:** 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 μ-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.
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/checkout, 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.
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

![Diagram of H632 system architecture](image)
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.
# STANDARD H632
## PRICE SCHEDULE

Effective April 9, 1968, subject to change without notice.

### Model Number

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

### STANDARD SERIES 32 PERIPHERAL PRICE SCHEDULE

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

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

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

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