

# RS/6000 7044 Model 170

## Technical Overview and Introduction

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## RS/6000 7044 Model 170 Technical Overview

The IBM RS/6000 family is a scalable, software-compatible line of RISC UNIX workstations, servers, and supercomputers powered by IBM's AIX operating system. On February 7, 2000, IBM announced two exciting additions to this family, the 44P Models 170 and 270.

This paper provides a brief history, a general description, and a technical overview of the 44P Model 170 including: the 64-bit copper technology of the POWER3-II processor, the error checking and correcting (ECC) memory subsystem, the advanced packaging design, the built-in service processor, the sophisticated graphics support, and other selected features.

### History

The original 43P Model 140 graphics workstation and entry-level workgroup server was introduced on October 8, 1996. This uniprocessor system offered a variety of processing speeds and features. The 43P Model 240, introduced at the same time, was the first RS/6000 workstation/workgroup server to offer expandability to 2-way symmetric multiprocessing (SMP). On October 5, 1998, IBM introduced both the 43P Model 150 and the Model 260. The Model 150 offered enhanced performance over the Model 140. The Model 260 is a 1- or 2-way SMP system utilizing the 64-bit 200 MHz POWER3 processor.

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### General Description

The RS/6000 44P Models 170 and 270 extend the IBM line of powerful and affordable workstation/workgroup servers with state-of-the-art, 64-bit, copper POWER3-II processors. The 44P server family, manufactured in Rochester, Minnesota, USA and Santa Palomba, Italy, offers ideal solutions for both high-performance 2D or 3D CAD/CAM users and companies that require a compact system for commercial computing solutions, such as Lotus Notes, business intelligence, Web server applications, software development, and firewall applications.

### Minimum Configuration and Optional Features

The Model 170 minimum configuration includes a single POWER3-II 64-bit processor with a choice of either a 333 MHz processor with 1 MB of Level 2 (L2) cache or a 400 MHz processor with 4 MB of L2 cache. Currently, the 400 MHz processor option is the fastest POWER3-II processor available in the RS/6000 product family. Each processor is equipped with 64 KB of data and 32 KB of instruction Level 1 (L1) cache. A 10/100 Mbps Ethernet controller, one Ultra SCSI controller, one external Ultra2 SCSI controller, and the service processor are integrated on the system planar.

In addition, the Model 170 has 256 MB of ECC synchronous dynamic random access memory (SDRAM), three disk bays, three media bays, a 9.1 GB 1" Ultra SCSI disk drive, six PCI slots, a 32X CD-ROM drive, a 1.44 MB 3.5-inch diskette drive, and an operator panel. The operator panel has a 2 x 16 backlit LCD for system status and diagnostic information. Microphone and headphone jacks are built into the operator panel. The following ports are included: keyboard, mouse,

Ethernet (AUI and RJ45), parallel, two serial (9-pin D-shell), tablet (for use with legacy input devices), Ultra2 SCSI VHDC, and stereo/audio.

To connect external SCSI devices to the Ultra2 SCSI adapter's VHDC, order # 2118 (mini-68 pin VHDC to 68 pin). This 0.3 m long cable (P/N 76H0518) is not included with the minimum system configuration.

The Model 170 offers many optional features. The media bay can hold a second CD-ROM device, a 4 mm or 8 mm tape drive, or a SCSI disk drive. A media bay mounting kit is required to install a SCSI disk drive in the media bay. A variety of optional input devices are offered including: keyboard, mouse, Spaceball 3D input device, and a Magellan 3D (Spacemouse) input device.

## Physical Package

The 44P Model 170 has an elegant and compact mini-tower design that was originally created for the PC IntelliStation desktide mini-tower, then revised for RS/6000 duty. The system dimensions are 19.25" H x 7.9" W x 20.25" D (490 mm x 200 mm x 515 mm). The system weight ranges from 39 lbs to 45 lbs (17.7 kg to 20.4 kg). This system is not available in a desktop or rack mounted package. Operating environment requirements are available in announcement information.

Figure 1 shows an internal view of the system with the side cover and cover support bridge removed. The CD-ROM drive, diskette drive, and one disk drive are preinstalled with each system. The remaining 5.25" media bay and two 3.5" disk bays are available for system expansion. Also, a keylock is located on the back of each system.

To open the side cover, unlock, pull the cover detent away from the rear of the unit, then slide the cover toward the front of the system unit to release the tabs.

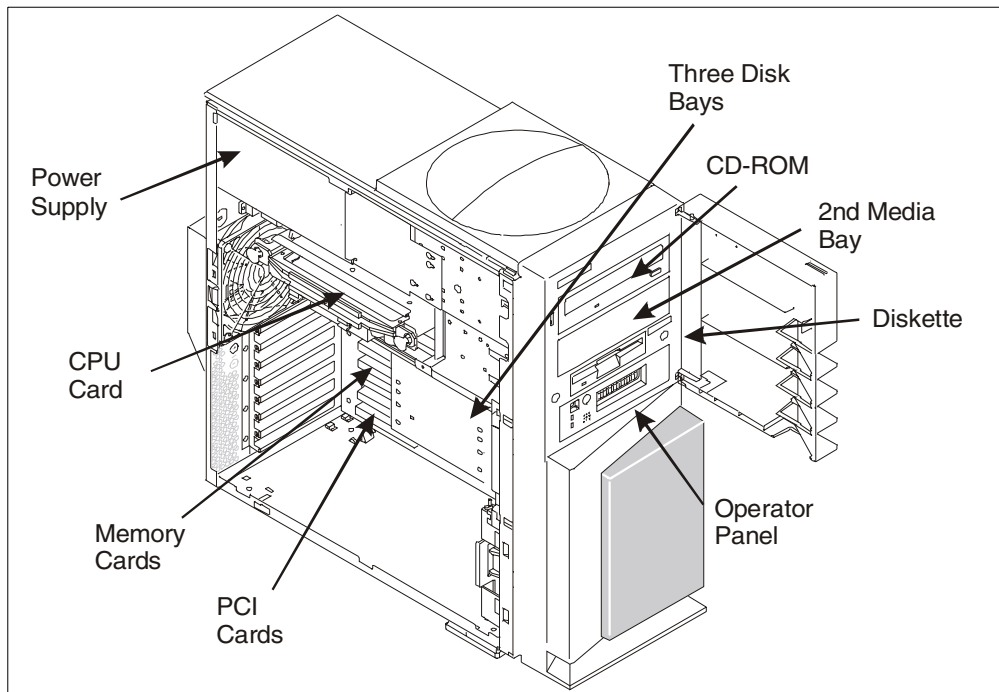


Figure 1. 7044 170 - Mechanical View

## System Upgrade

There are no system model upgrade conversions available for the 44P Model 170. Processor and memory expansion options are available for this system. The Model 170 is designed for customer setup of the machine and for the subsequent addition of most features (adapters and devices).

## Architecture and Technical Information

A diagram of the system architecture and logic flow for a 400 MHz system is shown in Figure 2. The 333 MHz system differences and a general discussion of this diagram is provided in the following sections.

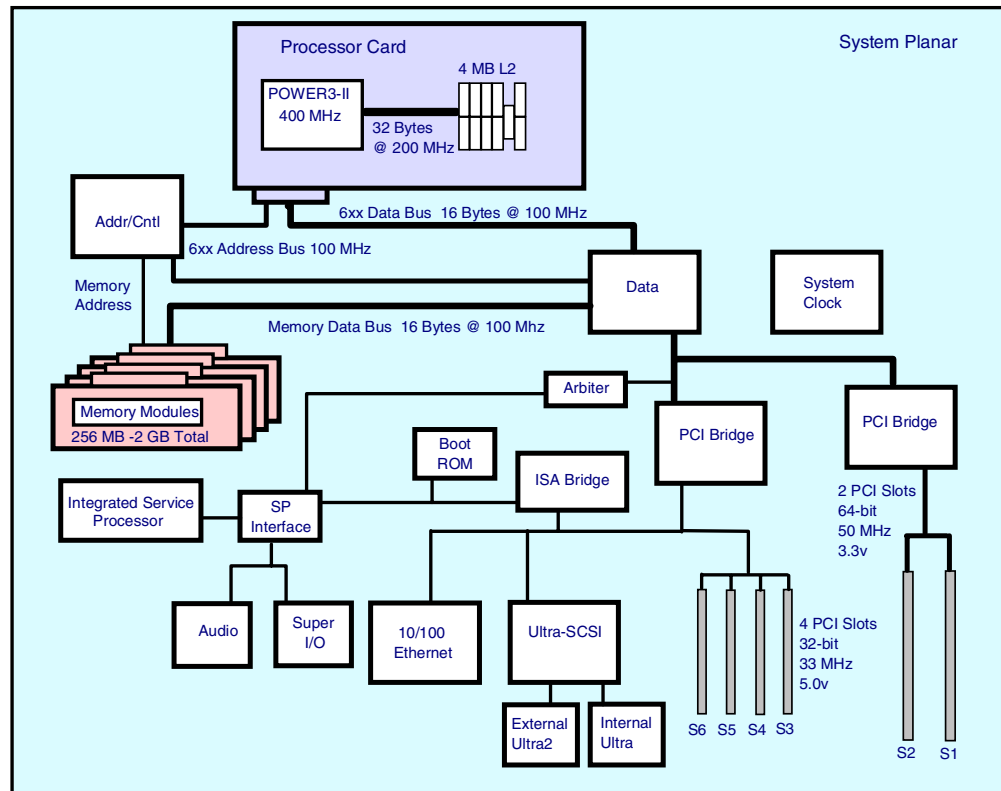


Figure 2. Model 170 - System Logic Flow Diagram

## Processor and Cache

The 44P Model 170 is the most affordable 64-bit system that IBM has introduced and uses the POWER3-II processor. The POWER3-II processor is designed for high-performance commercial and graphical computing applications. The processor allows for concurrent operation of up to eight instructions per cycle (three fixed-point instructions, two floating point instructions, two load/store instructions, and one branch instruction). Increasing the number of simultaneously executed instructions results in better system performance especially with applications that are optimized to take advantage of this capability.

Figure 3 is a diagram of the functional components of this processor, shown attached to the cache and bus configuration of a 400 MHz Model 170.

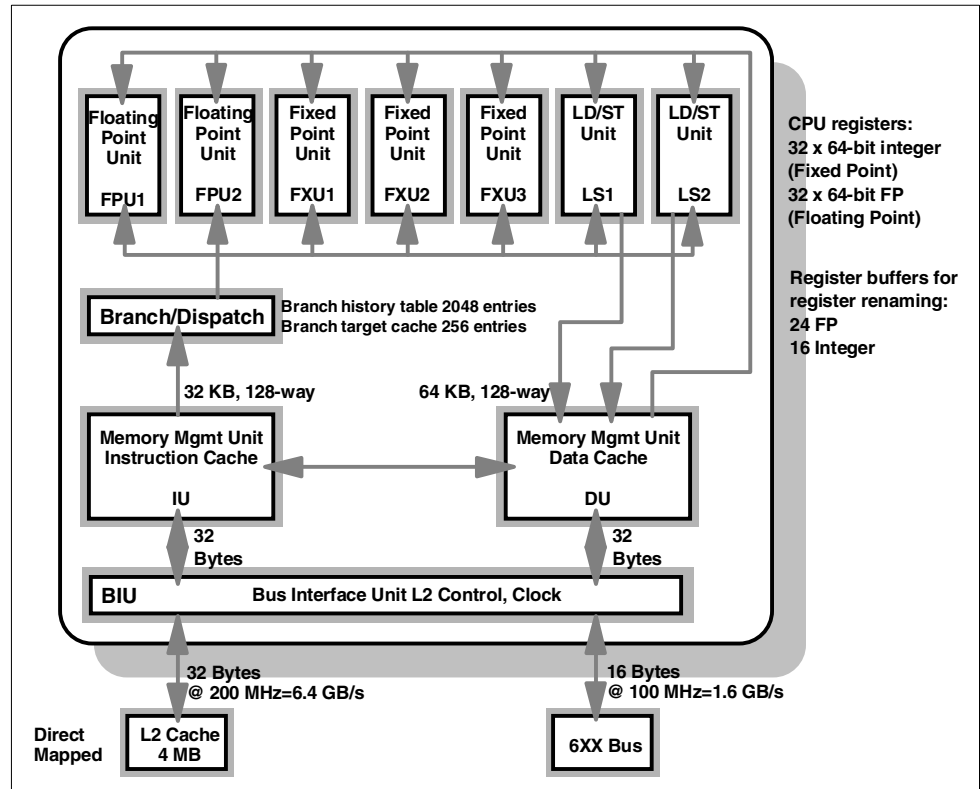


Figure 3. Model 170 - POWER3-II 400 MHz Block Diagram

### POWER3 Versus POWER3-II Processors

The processor functional diagram of the POWER3 and the POWER3-II are similar; however, the use of copper in the POWER3-II represents a new generation of processing power. A single POWER3-II chip contains about 400 meters of copper wiring. Table 1 lists some of the differences between the POWER3 and the POWER3-II processors. Also, the chart indicates the direction being taken by this technology.

Table 1. Differences between POWER3 versus POWER3-II

Description	POWER3	POWER3-II
Chip Die Size	270 mm <sup>2</sup>	163 mm <sup>2</sup>
Transistors	15 million	23 million
Power Avg/Max	39/46W@200 MHz	28W/36W@400 MHz
CMOS Technology	6S2, 5 layers metal	7S, 6 layers metal, copper interconnect
Lithography	0.25 μm	0.22 μm

## Copper and CMOS Technology

The use of copper in chip design addresses several of the aspects that inhibit performance: power load, generated heat, clock signal distribution, and chip size.

The complexity of the chip design (roughly equated to the number of transistors) when combined with the lithography process determines the size of the die. The maze of interconnects between the circuitry over a large die, the voltage required to drive the circuits, and the clock speed of the chip (how often a circuit changes state) determines the power load and the heat generated. Heat affects the life of the chip. Specific areas of a chip, for example, an execution unit, can become hotter than other areas that operate less frequently and require extensive cooling. Also, the larger the chip, the more difficult it is to strobe a clock signal over the entire chip (electricity travels at the fixed speed of light). Because larger chips also require more area on a wafer, they are more expensive to produce.

Copper is a superior conductor of electricity, compared with the standard aluminum used previously. This equates to lower electrical resistance (40 percent less) and allows a smaller wire (interconnects) to handle the same electrical load. The smaller interconnects within the chip decrease the distance between components, reduce the heat generated, and decrease the clock skew over the chip making it possible to raise the clock speed without affecting reliability. This is particularly useful on the POWER3-II which is an advanced and complex chip with twice the number of transistors as in a Pentium II.

However, copper does not work well with silicon, the base material of semiconductor chips. If copper is put directly on silicon, copper atoms migrate into the silicon, making it virtually useless. IBM researchers found a way to put a microscopic barrier between the copper and silicon in a way that keeps the copper from contaminating the silicon, while actually reduces the number of steps needed to complete a chip. With this development, IBM is able to reduce the widths of copper wires to about 0.2-microns from the current 0.35-micron width - a feat far more difficult to achieve with aluminum.

This technology, called CMOS 7S, is the first to use copper instead of aluminum to create the circuitry on silicon wafers. This translates into an increased speed of up to 15 percent in processors that contain copper wires.

## CPU Clock Rate

The different processor cards and the processor speeds can be identified by the SMS Display Configuration menu or by the following AIX command:

```
lscfg -vp | more
```

Page down to the `Processor Card` entry and search for the `Product Specification (ZC)` entry. This gives detailed information about:

<b>PS</b>	Processor Clock Speed in Hz, ASCII coded hexadecimal
<b>LB</b>	L2 Bus Speed in Hz, ASCII coded hexadecimal
<b>SB</b>	System Bus Speed in Hz, ASCII coded hexadecimal
<b>NP</b>	Number of Processors on Card, ASCII coded hexadecimal
<b>L2</b>	L2 Size in number of Kilobytes, ASCII coded hexadecimal

Following is an example of the processor card information for a 333 MHz Model 170:

```
Processor Card:
Part Number.....11K0857
EC Level.....D72830
Serial Number.....L200016008
FRU Number.....00P2180
Manufacture ID.....1980
Version.....RS6K
Product Specific. (ZC) .....PS=0013D92D40, LB=0009EC96A0,
                               SB=0005ABC3C9, NP=01, L2=01024,
                               PF=711, SV=3, VR=2, ER=0000
Product Specific. (ZB) .....BC=30602, SG=
Physical Location: P1-C1
```

PS shows the processor speed in hex-number digit (0x0013D92D40 = 333000000 Hz = 333 MHz).

Following is an example of the processor card information for a 400 MHz Model 170:

```
Processor Card:
Part Number.....11K0864
EC Level.....D72830
Serial Number.....L200016010
FRU Number.....00P2181
Manufacture ID.....1980
Version.....RS6K
Product Specific. (ZC) .....PS=0017D78400, LB=000BEBC200,
                               SB=0005F5E100, NP=01, L2=04096,
                               PF=7D4, SV=3, VR=2, ER=0000
Product Specific. (ZB) .....BC=30602, SG=
Physical Location: P1-C1
```

PS shows the processor speed in hex-number digit (0x0017D78400 = 400000000 Hz = 400 MHz).

### Level 1 Cache

The Model 170 uses a 64 KB data and 32 KB instruction 128-way set associative L1 cache. The size of both data and instruction cache reduces the number of cache misses, results in more cache hits, and maximizes performance. Both data and instruction cache are parity protected.

### Level 2 Cache

The 44P Model 170 processor card has either 1 MB (333 MHz) or 4 MB (400 MHz) of L2 cache located on the processor card. L2 cache is used to lower the time spent accessing memory data and increase performance. The L2 cache extends L1 cache benefits by adding more cache to the memory pipeline.

The speed of the L2 cache is dependent upon the processor speed. The L2 cache speed for the 333 MHz processor is 167 MHz (2:1 ratio) and for the 400 MHz processor is 200 MHz (2:1 ratio).

The L2 cache uses a direct mapped cache methodology. There is a dedicated external interface to the L2 cache not shared with the 6XX bus. This allows concurrent access to both the L2 cache and the 6XX bus.

## Memory

The system supports from 256 MB to 2 GB of ECC SDRAM using a 128-bit wide memory bus. Memory bus speed varies dependent upon processor selection. The enhanced memory controller uses a 95.1 MHz memory bus speed on the 333 MHz system and a 100 MHz memory bus speed on the 400 MHz system.

There are four memory slots available in the 44P Model 170. The Dual Inline Memory Modules (DIMMs) are ordered and installed in pairs. The following options are currently available:

- 256 MB (2 X 128 MB) SDRAM DIMMs (# 4110)
- 512 MB (2 X 256 MB) SDRAM DIMMs (# 4119)
- 1024 MB (2 X 512 MB) SDRAM DIMMs (# 4121)

SDRAM DIMMs are used in most of the RS/6000 systems currently available. Reference current feature codes and part numbers to determine if DIMMs may be interchanged between systems. Figure 4 shows the memory slot location for this system.

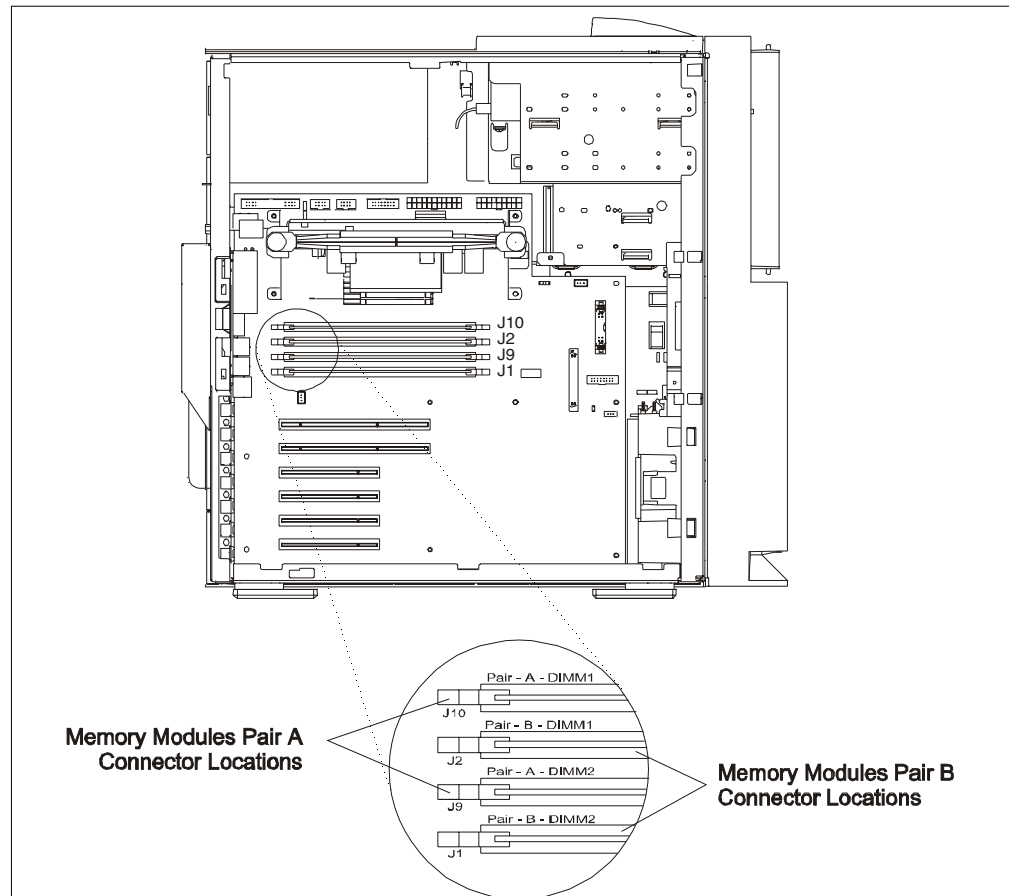


Figure 4. 7044 170 - Memory Location Diagram

Memory modules must be installed in pairs using the correct slot configuration. Slots J1 and J2 are a pair and slots J9 and J10 are a pair.

### Memory Boot Time Deconfiguration

Memory boot time deconfiguration is a function implemented in the service processor firmware to remove a memory segment or DIMM from the system configuration at boot time. The objective is to minimize system failures or data integrity exposure due to faulty memory hardware.

The memory segment or DIMMs that are deconfigured remain offline for subsequent reboots until the faulty memory hardware is replaced. This requires powering off the system. Then, this function gives the user the option to manually deconfigure or re-enable a previously deconfigured memory segment/DIMM using the service processor menus.

Memory can also be decreased through AIX using the `imss` command. This is useful for certain benchmark simulations.

#### Note

Memory cards should be physically removed only when the power is turned off to the entire system.

## System Buses

The system bus is controlled by a highly specialized set of custom chips. One handles addressing and synchronization, the other moves data to and from the processor (the 6XX bus), memory (memory bus), and the I/O (I/O bus). The 6XX bus is a 128-bit bus running at a clock speed of either 100 MHz, a 4:1 ratio, when featured with a 400 MHz processor (which results in a peak data throughput of 1600 MB per second) or 95.1 MHz, a 7:2 ratio, when featured with a 333 MHz processor.

The 6XX bus is optimized for high-performance and multiprocessing performance. The bus is fully parity checked and each memory request is range checked and positively acknowledged for error detection. Any error will cause a machine check condition and is logged in the AIX error log.

The 6XX and memory buses operate at the same speed, 128-bit width, and have the same throughput. Their speed is automatically determined by the speed of the processor installed. Data and address buses operate independently in true split transaction mode and are pipelined so that new requests may be issued before previous requests are completed.

## PCI Bus, Slots, and Adapters

The Model 170 is compliant with Revision 2.1 of the peripheral component interconnect (PCI) specifications and implements dual PCI bridge chips in a peer configuration. One PCI bridge chip provides a 32-bit interface operating at 33 MHz for four PCI slots and the other PCI bridge chip implements a 64-bit bus operating at 50 MHz for two PCI slots. Slots one and two are 64-bit, 50 MHz, 3.3v slots and slots three, four, five, and six are 32-bit, 33 MHz, 5.0v slots. All slots in the Model 170 accept full-sized PCI adapters. The 64-bit slots are physically keyed to accept either universal or 3.3v cards only. 5.0v cards will not seat in the card slots. Detailed information is available in the announcement information for this system.

A variety of PCI adapter, controller, graphics accelerator, SCSI, LAN, WAN, asynchronous, and SSA cards, to name a few, may be installed in the 44P Model 170. Specific information on selected adapters is provided in the following sections:

### **LAN Adapters**

The Model 170 can be connected through the LAN. It supports the following types of PCI adapters, which are all supported for NIM installations (use `chrp` as platform type):

- 25/155 Mbps ATM
- Gigabit Ethernet
- 10/100 Mbps Ethernet
- 4/16 Mbps token ring (100 Mbps token ring is not available at time of publication)

### **Graphics Accelerators**

A choice of three graphics accelerators are offered for the Model 170. The GXT130P is an entry-price 2D adapter suitable for business graphics or Internet applications.

The GXT4500P and GXT6500P are full 24-bit capable accelerators and support the simultaneous execution of both graPHIGS and OpenGL applications. Currently, the GXT6500P is the most powerful graphics accelerator available.

The maximum number of graphics accelerators supported in this system is four (the GXT6500P is limited to a maximum of two). Refer to the limitations section of the announcement for details on limitations associated with graphic accelerators for this system.

A graphics accelerator is not required in the minimum configuration. In order to attach an ASCII display, either # 3926 or both # 2934 and # 3925 must be ordered to provide connection. A 9-25 pin serial connector is not included by default. Determine if the ASCII display you wish to install requires an interposer, adapter, or both to avoid installation problems.

### **SSA Adapters**

The Advanced SerialRaid Plus Adapter (# 6230) is available for the Model 170. Optional features include the 128 MB DRAM Option Card (# 6231) and the 32 MB Fast-Write Cache Option Card (# 6235).

### **Hot Plug PCI Adapters Capabilities**

Hot plug PCI adapter capabilities are not supported on the Model 170.

Hot plug PCI capabilities are, however, available within the RS/6000 product line. The RS/6000 SP Expansion I/O Units support hot plug for selected PCI adapters. This function enables the maintenance of these adapters without powering off the SP Expansion I/O Unit or the associated SP POWER3 SMP High Node. This function requires AIX Version 4.3.3 with APAR IY06844.

## Internal Disk Bays and Media Bays

The disk bays provide from 9.1 GB to 72.8 GB of internal storage space and are populated with a combination of the following disk drives:

- 9.1 GB 1" Ultra SCSI Hard Disk Drive (# 2908)
- 18.2 GB 1" Ultra SCSI Hard Disk Drive (# 2909)
- 9.1 GB 10 K RPM Ultra SCSI Hard Disk Drive (# 3027)
- 18.2 GB 10 K RPM Ultra SCSI Hard Disk Drive (# 3102)

### Note

The 18.2 GB 10 K RPM Ultra SCSI disk drive is not supported for installation in the media bay, but is allowed in the disk bay.

## Service Processor

The Model 170 includes an integrated service processor that is designed to provide an immediate means to diagnose, check status, and sense operational conditions of a remote system, even when the main processor is unavailable.

The service processor is a Motorola 68307 microprocessor. The flash memory used for the storage of the service processor programs is 1 MB and 512 KB of SRAM memory is used for program execution.

### Selected Service Processor Functions

Additional informational is provided for the following selected functions:

#### ***Fast Boot***

Selecting Fast Boot results in several diagnostic tests being skipped and reduces the time for booting. This function has to be activated through the Service Processor menu. (The SXX series of enterprise servers use the operator panel to enable/disable Fast Boot.)

There is a easy way to check if Fast Boot is enabled without entering the Service Processor menu. If Fast Boot is enabled no spinner will appear at the Service Processor checkpoint E0B0. With the Slow Boot enabled, a spinner appears at E0B0. A spinner is a single text position on the operator LCD that cycles through the characters |, /, -, and \ symbolically representing the passage of time.

#### ***Memory Boot Time Deconfiguration***

Memory Boot Time Deconfiguration gives you the option of deconfiguring memory without removing it physically. For more detailed information, see the section on "Memory Boot Time Deconfiguration" on page 8.

#### ***Boot Mode Menu***

The Boot Mode menu allows selection of the following boot options:

- Boot to SMS Menu
- Service Mode Boot from Saved List
- Service Mode Boot from Default List
- Boot to Open Firmware

## Miscellaneous

The following general information is included for convenience:

### DVD Support

Currently, Digital Versatile Disc (DVD) drives are not supported in RS/6000 systems.

### ISA Support

The Model 170 does not support industry standard architecture (ISA) adapters.

### USB Support

The Model 170 does not have integrated Universal Serial Bus (USB) support and no USB adapters are currently available for use in RS/6000s.

### Boot Options and Limitations

Detailed information about boot options for internal and external storage devices is included in the subsequent sections:

#### *Internal Devices*

Boot support is available for every internal SCSI disk.

#### *External Devices*

Table 2 provides a map that enables you to determine if boot is supported in external storage devices.

Table 2. Boot Support - External Devices

Does the PCI card have RAID functionality?		
yes	no	
Card is seen as a controller <b>no boot support</b>	Card is seen as a adapter	
	Does the external device have RAID functionality?	
	yes	no
	<b>no boot support</b> (except Advanced SerialRAID Plus Adapter <sup>1</sup> )	<b>boot support</b>

#### ***Boot Support and Limitations of Storage Adapters for the Model 170***

The following adapters support external boot capabilities for the Model 170:

- PCI Universal Differential Ultra SCSI Adapter (# 6204)
- PCI Dual Channel Ultra2 SCSI Adapter (# 6205)
- PCI Single-Ended Ultra SCSI Adapter (# 6206)
- Advanced SerialRAID Plus Adapter (# 6230)<sup>1</sup>

<sup>1</sup> SSA boot is possible from an Advanced SerialRAID Plus Adapter (# 6230), provided a non-RAID SSA disk is included as part of the configuration. Other disks associated with the adapter can be RAID but at least one disk must be a non-RAID SSA disk. The non-RAID SSA disk can be located under the covers of a processor unit or in an external SSA storage unit. If your system is running with AIX 4.3.3 or later software, native boot capability is supported.

For factory system orders with AIX preload requested, an internal SCSI disk drive will be preloaded as the native boot disk even if internal SSA disk drive(s) are present.

The RS/6000 PCI 3-Channel Ultra2 SCSI RAID Adapter (# 2494) does not provide boot support from external devices.

### ***Fast Boot***

The Model 170 offers a Fast Boot option. For more detailed information, refer to "Selected Service Processor Functions" on page 10.

## **Security**

To prevent the system from unauthorized booting from a CD-ROM device, a power-on-password (POP) or a privileged-access password (PAP) may be used. The keylock on the back of the Model 170 may be used to protect the system from unauthorized removal of the battery (which deletes both the POP and the PAP).

## **Software Requirements**

AIX 4.3.3 plus APAR IY06844 (AIX 4330-02 Recommended Maintenance Level for AIX 4.3.3) is required for the Model 170. The GA date is February 18, 2000.

If you are purchasing new RS/6000 systems, the AIX update should be phased in to new systems starting February 14, 2000. It will be available for download at:

<http://techsupport.services.ibm.com/rs6k/fixes.html>

In North America, you can order CDs by calling (800) 879-2755 or by ordering on the Web at <http://service2.boulder.ibm.com/swdelivery/>. In other geographies, ask your IBM Business Partner or IBM Representative to place a single refresh System Program Order for 5692-AIX.

For select customer requirements, there is a limited availability of AIX Version 4.3.2 support on the Model 170: PRPQ P91183, *AIX 4.3.2 Workstation Support*.

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## **Reference**

The following sections provide lists of additional resources useful for further research.

## **System Documentation**

For more detailed information, refer to the following documents:

- *44P Series Model 170 Setup Instructions*, SA38-0561
- *44P Series Model 170 User's Guide*, SA38-0559
- *44P Series Model 170 Service Guide*, SA38-0560
- *RS/6000 Diagnostics Information for Multiple Bus Systems*, SA38-0509
- *RS/6000 Adapters, Devices and Cables information for Multiple Bus Systems*, SA38-0516
- *PCI Adapter Placement Reference Guide*, SA38-0538

## **IBM Redbooks**

The following redbooks are available for additional information:

- *RS/6000 Systems Handbook*, SG24-5120

- *RS/6000 43P 7043 Models 150 and 260 Handbook*, SG24-5144
- *RS/6000 SMP Enterprise Servers Architecture and Implementation*, SG24-2583
- *AIX 4.3 Differences Guide*, SG24-2014
- *Understanding IBM RS/6000 Performance and Sizing*, SG24-4810

## Internet Links

For more detailed information, see the following Web sites:

<http://www.rs6000.ibm.com/>  
<http://www.rs6000.ibm.com/hardware/workstations/>  
[http://www.rs6000.ibm.com/resource/hardware\\_docs/index.html](http://www.rs6000.ibm.com/resource/hardware_docs/index.html)  
[http://www.rs6000.ibm.com/cgi-bin/ds\\_form](http://www.rs6000.ibm.com/cgi-bin/ds_form)  
<http://www.rs6000.ibm.com/support/micro/>  
<http://www.ibm.com/servers/aix/>  
<http://www.chips.ibm.com/>  
<http://www.research.ibm.com/topics/serious/chip/>  
<http://www.storage.ibm.com/>  
<http://www.hursley.ibm.com/~ssa/rs6k/>  
<http://www.redbooks.ibm.com/>

## Sources

The following materials were used in the creation of this publication:

- IBM RS/6000 7044 Model 170 - Announcement Letter
- IBM RS/6000 44P Model 170 Workstation - Spec Sheet (G221-7126-01)
- IBM RS/6000 44P Model 170 Server - Spec Sheet (G221-7130-01)
- Blue Logic - CMOS 5SF Technology (G522-0269)
- Blue Logic - CMOS 6SF Technology (G522-0261)
- Blue Logic - CMOS 7SF Technology (G522-0357)

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## Biographies

**Volker Haug** is an Advisory I/T Specialist. He has more than 13 years of experience in the I/T industry, the last 10 of which he has devoted to RS/6000 and AIX systems. He holds a degree in Business Management from the Berufsakademie in Stuttgart. Volker is the technical leader supporting IBM sales, Business Partners, and customers with pre-sales consultation and implementation of client/server environments. His areas of expertise include RS/6000 workstations and workgroup servers, graphics, MCAD applications, and AIX systems management. Based in Stuttgart, Germany, he is currently working for the Web Server Sales RS/6000 and NUMA-Q technical support organization covering the IBM Europe, Middle East, and Africa Central Region.

**Jeanine Indest** is an I/T Specialist with the Techline RS/6000 Sales Support Team, part of the Web Server Sales Americas Organization. She has more than six years of experience in the I/T industry, the last four of which she has devoted to RS/6000 and AIX systems. She holds a B.S. degree and a M.A. degree in Economics from the University of New Orleans. Her current area of expertise is technical marketing support for Business Partners in the United States for RS/6000 and NUMA-Q systems.

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