

RA60

205-Mbyte Removable-Media Disk Drive

digital



Removable-Media Convenience with Winchester-like Capabilities.

The RA60 may change your impression of removable-disk drives. Remember when removables were bulky and slow and seemed to require constant field service attention? Giving up the convenience of removable media for the capacity, speed, and dependability of the new Winchester disks probably seemed like a small sacrifice. Well, the RA60 is different.

Through a number of engineering innovations we have packed 205 Mbytes of dependable, removable, user-accessible data into the same form factor as our industry-leading RA81 Winchester disk drive. Like the RA81, the RA60 fully implements the Digital Storage Architecture (DSA) and uses the Standard Disk Interconnect (SDI) as its controller interface. That buys you some of the best performance optimizations and most advanced data-integrity, availability, and maintainability features you can get in any disk drive—including Winchesters.

Working with one of the DSA intelligent controllers, the RA60 sets a new standard for removable-media disk drives.

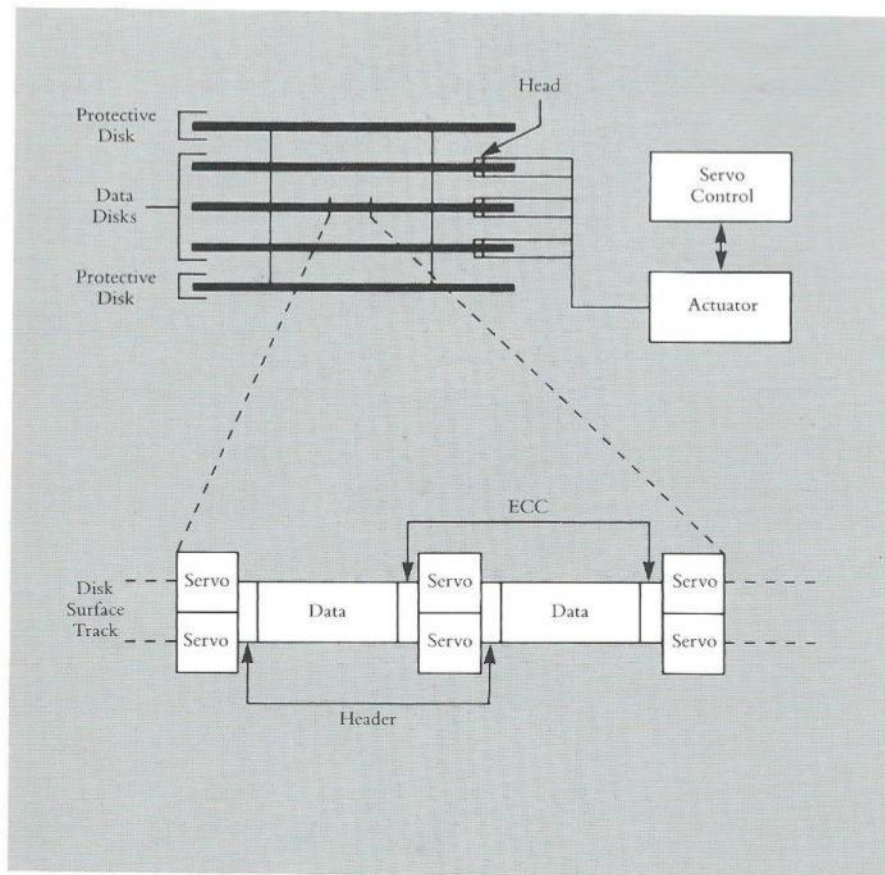
Highlights

- 205 Mbytes of user-accessible data storage—615 Mbytes in a single three-drive cabinet.
- A unique embedded servo provides exceptionally high areal density, which means cost-effective, space-efficient data storage.
- Innovative subsystem design provides unsurpassed data integrity and availability.
- Standard dual access facilitates data sharing and increases volume availability.
- Digital Storage Architecture offers the flexibility to configure with any of the SDI controllers and in combination with other RA60 drives or with RA-series Winchesters.
- The high quality of design, engineering, and manufacturing leads to low cost of ownership.

The Removable-Disk Drive has Just Made a Comeback.

Winchester technology caused a fixed-media revolution. Removable technology seemed to be a thing of the past. But some applications still require the high security and fast, reliable data interchange that can only come from removable-disk technology. And more users would consider removables an attractive alternative if only they could approach the capabilities of the fixed disks. Digital has engineered the answer.

The RA60 lifts removable technology into the '80s. It has an areal density higher than that of some Winchesters, so it can offer 205 Mbytes of user data and cut the form factor to a 10.5-inch-high rack-mount unit. It includes pioneering head-positioning technology—a fully embedded servo—for unprecedented media interchange reliability and almost no preventative maintenance. Its advanced technologies, such as on-board microprocessors and radial controller interconnect, offer unprecedented levels of performance and data integrity. And most important, the RA60 adds the option of removability to the Digital Storage Architecture (DSA), the clear leader in mass-storage solutions.



The RA60's "fully embedded servo" positioning system frees you from routine maintenance and ensures that a disk pack written on one drive can be read on any other.

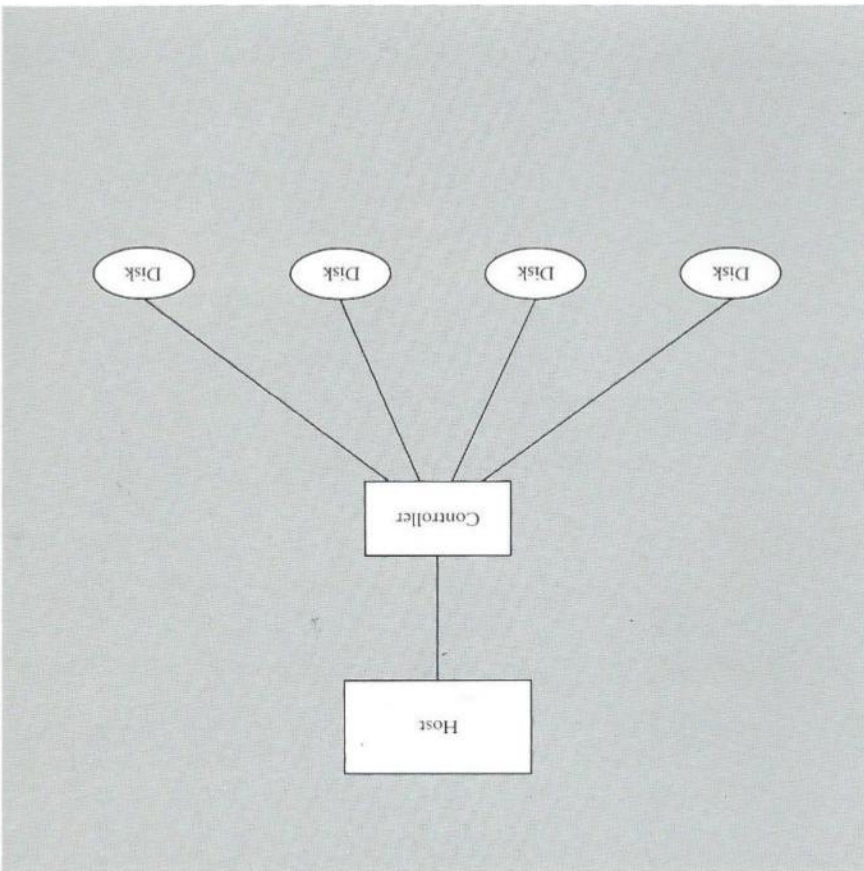
Areal Density: the Greater It Is, the Better Off You Can Be.

The term "areal density" applies to the amount of data that can be contained within a specified surface area on a disk platter. It is the key factor in determining the cost effectiveness of a disk product. More bits per square inch mean fewer or smaller disk platters for a given storage capacity. With fewer platters, you need fewer read/write heads and less power to run the drives. So you can enjoy the benefits of more compact packaging, increased economy of operation, and greater reliability for less money.

Recording at high densities on removable packs is a challenge because minute particles in the environment limit the flying height of the read/write heads. And mechanical tolerance build-ups can make packs incompatible between drives.

Despite these limitations, the RA60 achieves high densities with two important innovations. We increased the linear density—that is, the amount of data along the tracks of the disk—with a new, more efficient recording code. And we increased the radial, or track, density with an ingenious head-positioning mechanism called an embedded servo.

Each DSA drive is radially connected to its controller, eliminating the device interdependencies characteristic of more conventional connection schemes (such as the daisy-chain).



ability, and sure-fire pack interchange of the RA60, we had to break some new ground.

One major challenge was to improve head stability. Accurate tracking was critical at the unheard-of densities we wanted for the RA60's removable packs. An innovative adaptation of a conventional head design with four air-bearing surfaces gave it superior aerodynamic stability. Coupled with the highest-quality oxide media available today and a special spinup purge cycle, these heads permit recording at nearly 8 million bits per square inch. That's Winchester territory.

Major Advancements in

Electromechanical Engineering Work To Your Advantage.

The RA60 is loaded with engineering innovations. It had to be. To build a removable-disk drive with the capacity, data integrity, subsystem avail-

By embedding positioning information between sectors on the data surface, the head position is determined by the read/write head itself, so it's extremely accurate. It means that the RA60 can offer a density never before attainable in a removable-disk drive. It also means that any pack written on one RA60 can be read on any other. No problem. And head alignment maintenance procedures that used to haunt the removables are now a thing of the past.

The RA60's mechanical innovations make it the most maintenance-free removable drive in the industry. Disk drives used to require regular adjustment and alignment procedures. The RA60's positioner assembly and drive spindle are precision-mounted, so you don't need periodic alignment of the positioner with the spindle any more. And since our embedded servo got rid of head alignments, the only preventive maintenance the RA60 needs is changing of the air supply filter. And that's an *annual* operation, typically.

How did we fit the RA60 into such a compact form factor? Part of the solution was to use a unique brushless dc motor that actually forms part of the drive spindle assembly. Direct driving of the spindle also has the advantage of increasing reliability by eliminating belts and pulleys. Further packaging efficiency and reliability are achieved by incorporating an impeller into the motor spindle instead of using a separate fan to direct airflow within the drive during operation.

The RA60 has one more thoughtful touch. We gave it a universal power supply with independent switching for line voltage and frequency so that a single model with the appropriate power cord will work anywhere in the world.

Part of an Intelligent Approach to Mass Storage.

The RA60 is designed to be an integral part of an overall Digital storage solution. As such, it implements the Digital Storage Architecture (DSA) and the Standard Disk Interconnect (SDI) for connecting drives to controllers.

The SDI connects each drive directly to its controller through a radial connection scheme rather than the conventional daisychain. By using a radial connection in conjunction with transformer coupling, an RA60 can be serviced while the remainder of the subsystem keeps running. The result is improved availability: with daisychain configurations, one malfunctioning drive can bring all the others down.

The RA60 contains two microprocessors—that's more processing power than some controllers have. One of the microprocessors controls seeking and servo positioning. The other communicates with the controller, transfers data, monitors drive state, runs the RA60's 10 Kbytes of onboard diagnostics, and supervises overall drive operations.

Another significant feature of the SDI and RA60 is dual access. It lets you attach one RA60 to two controllers, thereby providing the redundant paths to user data required by high-availability applications. (It does not provide simultaneous access to a drive by two controllers.)

Most importantly, since SDI is an architectural standard, any SDI drive can be connected to any SDI controller. This gives you unsurpassed flexibility. You can add to or reconfigure your systems with current storage products, including RA81, RA80, or RA60 disk drives and HSC50 or UDA50 controllers. And you can easily incorporate new technology with future SDI products.

The Performance to Enhance Your Application.

In evaluating disk drive performance, you should consider two factors:

- *Seek time*, the time required to move read/write heads to the desired cylinder.
- *Rotational latency*, the time spent waiting for the desired data to move under the read/write heads.

Nearly all applications require random access to data. In such cases, seek time can account for as much as 75 percent of total access time. And latency can account for another 20 percent. The time spent actually transferring data is usually a small component of overall access time.

The RA60 and DSA controllers, working together, minimize average seek times by using a reordering algorithm. They minimize rotational latency by allocating the data channel to the on-cylinder drive closest to its desired sector. And they perform both functions without incurring any overhead to the host CPU. Taken together, these optimizations mean that the RA60 will usually perform even better than the drive's hardware specifications would suggest.

In addition, the SDI controllers perform seek overlapping internally—again without host-computer overhead. They also contain ample buffering to smooth the bursts of data from the drives for presentation to the host bus.

The RA60 Sets the Pace in Data Integrity, Reliability, and Maintainability.

In designing the RA60, Digital engineers have made every effort to ensure that the integrity of your data is preserved, that system uptime is maximized, and that repair time is kept to a minimum.

The RA60 implements Digital Storage Architecture data integrity features, including the most advanced Error Correction Code (ECC) in the industry. It's capable of finding and fixing as many as 80 bits of error in a single sector. Quadruplicate header recording provides positive sector location, even in the presence of media defects. Most important for system management, a reallocation and revectoring scheme will, when supported by the host operating system, make media defects—even those occurring during normal use—completely transparent to applications and file-system software on the host.

The RA60 drive comprises several major subassemblies, such as the motor-and-spindle subassembly, which are called Field Replaceable Units (FRUs). The FRUs are stocked and replaced by Digital Field Service as units, eliminating lengthy and expensive repairs or preventive maintenance procedures onsite.

The philosophy of functional components with well-defined interfaces is basic to the RA60 design. Fewer components mean higher reliability. Modularity means quicker repair.

Engineered for Efficiency and Economy.

If you are looking for the most cost-effective product to meet your mass-storage needs, you should compare the *total cost* of owning the RA60 to that of any other product.

First consider initial cost. The RA60's price per Mbyte is competitive with any other removable-disk drive in the industry. With each additional RA60 disk attached to an SDI controller, the subsystem cost becomes even more attractive.

Then consider maintenance costs. The RA60's basic monthly maintenance service charge is among the lowest in the industry. Since maintenance pricing is based on expected frequency of repair, the low maintenance price of the RA60 reflects its high reliability.

Finally, consider space efficiency. With skyrocketing costs for commercial and industrial space, you need to think carefully about the "footprint" occupied by your mass-storage subsystems. With three RA60 disks in a single cabinet, you get 112 Mbytes per square foot—unmatched by any other removable disk drive on the market.

The RA60 is Built and Serviced By a Major Force in the Mass-Storage Market: Digital.

Digital is not only the second largest computer company, we're one of the largest makers of storage products, with manufacturing facilities operating worldwide.

And Digital stands behind its products. Our worldwide customer services organization comprises thousands of highly skilled people. Their goal—to answer your questions and provide service when you need it, the way you want it.

Out of our many service packages, there's a plan that's just right for your needs. Full service is available anywhere—any time or within specified hours. If less is better for you, there's per-call service. The choice is yours.



Digital's engineering and manufacturing facility in Colorado Springs, Colorado produces high-end disk drives and intelligent controllers. Over 70,000 disk drives are built in this plant every year.



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Specifications

Performance*

Peak transfer rate	1.98 MB/s
Seek time	42 ms avg, 75 ms max
Rotational latency	8.3 ms
Average access time	50.3 ms
Head switch time (typical)	7.0 ms
Start/stop time	60 s/40 s

Media Characteristics (Removable Pack)

Formatted capacity	205 MB (16-bit), 208 MB (18-bit)
Tracks per inch	779 radial
Bits per inch	9,668 linear
Rotational speed	3,600 r/min
Number of data surfaces	6
Number of heads per surface	1

User Data Organization	16 Bit	18 Bit
Sectors per track	42	38
Bytes per sector	512	576
User-accessible cylinders	1,588	1,588

Power Requirements	120V	240V
Frequency (single phase)	50 Hz/60 Hz	50 Hz/60 Hz
Starting current	6.5A	3.25A
Running current (typical)	6.5A	3.25A

Operational Environment

Temperature Range	16-40°C (60-104°F)
Derating for altitude	1.8°C/1,000 m (1°F/1,000 ft)
Relative Humidity	8-80%, noncondensing
Max wet bulb	26°C (79°F)
Heat dissipation	2,200 Btu/h (650 watts)
Altitude	2,438 m (8,000 ft)

Physical Characteristics	Drive alone	In cabinet
Height	26.7 cm (10.5 in)	106.6 cm (42.0 in)
Width	44.5 cm (17.5 in)	54.2 cm (21.3 in)
Depth (with bezel on)	85.1 cm (33.0 in)	91.4 cm (36.0 in)
Weight (without pack)	70.5 kg (155.0 lb)	168.0 kg (370.0 lb)
Disk pack weight	2.85 kg (6.3 lb)	

*All performance data reflects raw drive hardware capability and does not include improvements due to controller optimizations.