Interoffice

AIPS MEMO NO. 9

National Radio Astronomy Observatory

Charlottesville, Virginia

April 1, 1982

To: Distribution

From: R. Escoffier

Subject: Proposed NRAO Image Storage Unit

I have attached a writeup on the proposed NRAO image storage unit. I would like to have another telephone conference to get everyone's opinion on this unit as described. I would also like to get an idea as to if and when and how many to build. I would suggest Tuesday, April 13, 1500 EST, for the teleconference meeting. If this time is agreeable to everyone, I'll set up the meeting.

Attachment

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PROPOSED NRAO IMAGE STORAGE UNIT

The purpose of this memo is to update everyone interested in the state of the design of the I^2S image storage system. I have settled, for the most part, on the major design features and feel that some discussion is in order to help define our future course.

I have gone through a fair part of a paper design and think I can state the performance that can be reached with my approach with some certainty. The image storage medium will be four 5-1/4" Winchester discs which will yield an image storage capacity of 128 512 x 512 byte pictures and a playback rate of 4 to 6 pictures per second depending on which disc I use. I have narrowed selection of the discs down to two: one made by Irwin International and one made by MPI, Inc. The MPI unit is a little faster, a lot cheaper, but not available until late summer.

I have also planned on somewhat more host computer control than was indicated in our last discussion which will require somewhat more software support in AIPS and hence may not be acceptable. But for the sake of discussion, I will describe my present plans.

I have dropped some features, such as being able to digitize monitor images and playback RGB pictures on low resolution home TV sets since I can see no advantages to this ability over color photographs.

I have identified only four operations that the image storage system must support:

1. Store a picture or sequence of pictures onto disc from an I^2S memory plane (including look-up tables, max-min reg., host supplied picture ID, etc.). This operation will be initiated via the AIPS CRT and will be under host computer control.

2) Play back a picture sequence (endless film clip) from disc to the I^2S. This operation, together with the picture order, will be initiated via the AIPS CRT. The picture order may include images stored in the I^2S image planes and hence blink comparison can be made by playing a two-picture clip with one picture stored on disc and the other in an I^2S plane. The film clip rate and direction will be controlled by the operator using a "joystick" control. Two film clip modes are possible, one in which the LUT's are supplied with the pictures and a second in which the LUT's can be dynamically controlled via AIPS as in normal image processing. Thus, full zoom, roam and processing will be possible during playback of a film clip.

   Film clip playback can be in either sequential order with a slightly faster playback rate or in operator specified image order.

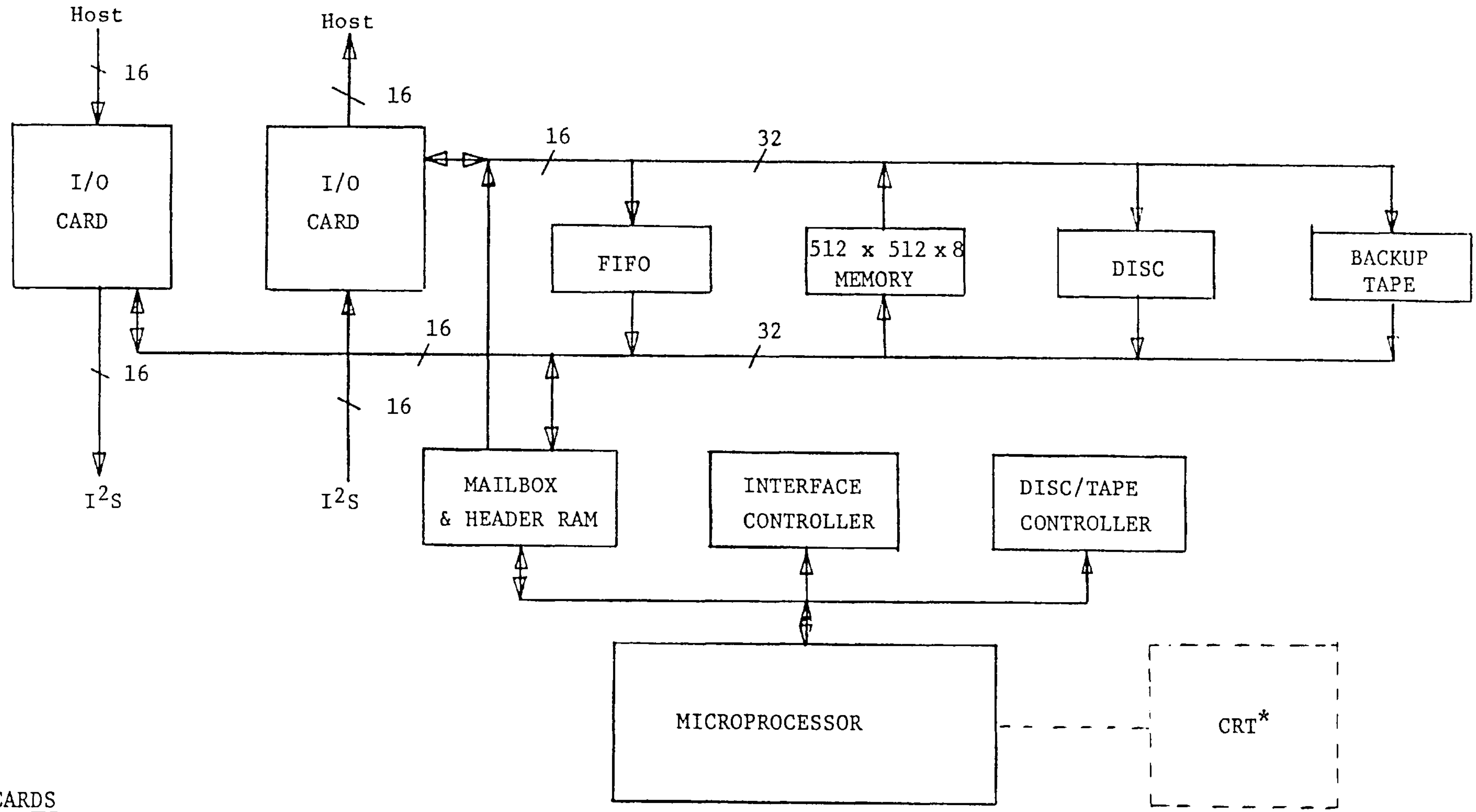
3) Dump the disc stored images (or some subset) together with LUT's and ID's onto a backup tape cartridge upon AIPS initiation.

4) Restore dumped images from backup tape back into disc upon AIPS initiation.

I suppose a fifth mode could be to simply playback image X into image plane Y and stop.

I also suppose that a film clip of 256 x 256 byte images can be provided using the I^2S roam capability to raise the clip rate by a factor of 4.

Figure 1 is a block diagram of the proposed system. The image storage system would share the I^2S's host interface by supplying a "T" connection onto it. Communication of host-I^2S, I^2S-host, host-image storage, image storage-host, image storage-I^2S, and I^2S-image storage would be possible. As far as protocol is concerned, the image storage system would appear to be an I^2S to the I^2S host and a host to the I^2S. Bus contention would be resolved by the image storage



PC CARDS

I/O	2
I/O Control	1
Microprocessor	1
Disc Control	4
Misc.	1
	9

*software development only.

FIGURE 1

system. It will monitor the bus and wait until it is available to start a transaction. The host need not be aware of any possible contention. If it wants to start a transaction while the image storage system is using the bus, it will output the first header word as normal. This first header word will be stored by the image storage system and a busy condition given to the host. Upon normal completion of the image storage system bus transaction, the host header word will be recalled, given to the I^2S and the transaction will continue normally. A possible alternate approach, which would be more expensive but more foolproof, would be to provide a large FIFO memory to store the host's transaction until the bus is available.

Commands to the image storage system from the host will be via a 256 to 1024 word mailbox supplied by the image storage system. Unused bits in the first word of the host header would be used by the host to flag a transaction to the image storage system's attention.

The two I/O cards of Figure 1 accomplish this "T" connection. A large (512 x 512 byte) memory will pipeline the picture information between the I^2S image plane and the disc. A small FIFO memory will provide the interface between the disc clock and the I^2S I/O clock.

A microprocessor will control the operation of the image storage system but since it is not capable of keeping up with the data transfer rate required, two bit slice controllers will be required. A RAM is supplied in which the microprocessor can pre-assemble header words for the controllers and can also function as the host/image storage system mailbox.

As mentioned earlier, two discs are under consideration for this application. Irwin International makes a fast 12.3M byte (unformatted) 5-1/4" Winchester with integral backup tape unit for $3,000 each. Sometime later this year they will come out with an identical unit except without the tape backup. Thus, since we need only one tape unit, we can use one unit with and three units without tape backup to optimize cost. If we want to go ahead immediately to building a prototype unit, I can use 4 units with tape backup and exchange them later if we build more image storage systems. A total of 8 cartridges will be required to back up all 128 pictures. The Irwin units will support a clip rate of four pictures per second in random sequence or five per second in sequential order.

The MPI unit is a 14.66M byte unit that, at $1,250 each, is a little lower in technology (1/2 the bit density but twice the platters) but its speed is a little higher for this application. It will produce five pictures per second in random sequence or six pictures per second in sequential order. We would need to find a backup tape unit, but this would be of some advantage since I could then locate the tape unit next to the AIPS CRT. The Irwin will be in the I^2S rack and an operator must go into it in order to insert his tape cartridge. In all, I prefer the MPI unit although I still need to talk to both companies and their references before I decide. The main problem I see with the MPI unit is that specs (and prices) may be somewhat preliminary and we will have to wait until late summer (if they don't slip) before units are available.

The image storage system will be packaged in an Art Shalloway standard 8-3/4" panel height chassis that will fit nicely in the I^2S rack. All power, except the disc motor power, can be stolen from the I^2S. The only remote hardware will be the operator joystick which I think I can strap to the track ball unit and maybe the backup tape unit. Thus, the chassis will hold all four discs, the disc motor power supply, and the nine wirewrap cards.

I have estimated below the cost of one image storage system for each of three approaches:

1) MPI discs and a backup tape drive

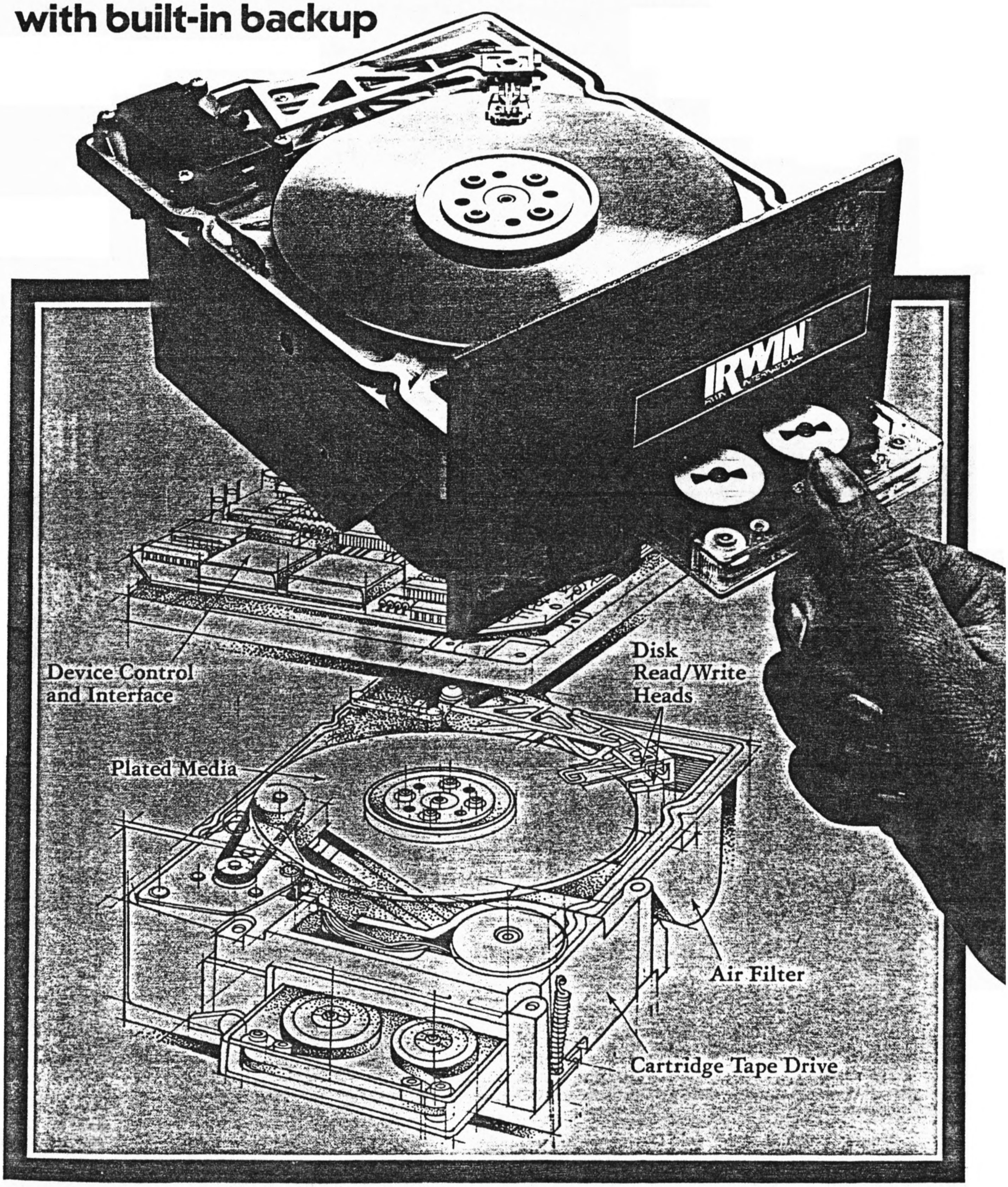
2) Irwin discs with 4 tape drives

3) Irwin discs with only 1 tape drive

Item	(1)	(2)	(3)
9 PC cards including IC's	$ 2,380	$ 2,380	$2,380
8-3/4" panel 19" chassis	500	500	500
Disc motor power supply	820	820	820
4 discs	5,000	12,000	9,000 (est)
Backup tape drive	2,000 (est)	-	-
Misc. (estimated)	2,500	2,500	2,500
	$ 13.2 k	$ 18.2 k	$ 15.2 k

THE IRWIN 510™

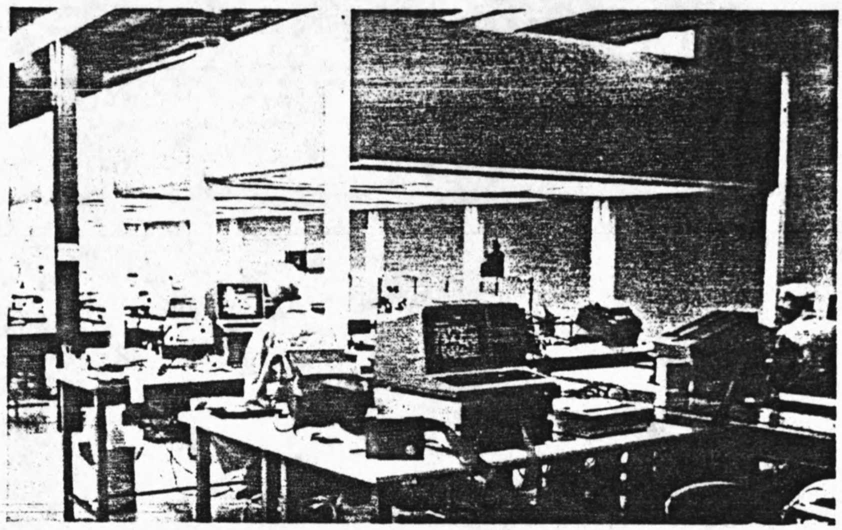
high-performance 5¼-inch Winchester with built-in backup



Innovative manufacturing and financial strength assure volume production, delivered on schedule

Irwin International has put together a manufacturing facility that is unsurpassed anywhere in the industry. Located near the corporate headquarters and engineering center in Ann Arbor, Michigan, this 32,000 square foot plant includes all the latest production and test equipment needed to produce 40,000 Irwin 510 units per year.

With the 5¼-inch Winchester market facing incredible growth rates, relatively few companies have the financial resources to ramp up production in step with the demand. Irwin International is one of those few... and has already demonstrated its commitment by beginning a second manufacturing facility in Traverse City, Michigan. This 48,000 square foot plant, with a capacity of more than 60,000 Irwin 510 units per year, is scheduled to begin operation late in 1982.



Where better production methods are needed, Irwin leads the industry in implementing innovative techniques. One example is the modular air curtain system, which provides Class 100 clean room conditions for disk drive assembly—without walls —in a readily expandable configuration. Tape drives, which require less stringent conditions, are assembled outside the air curtain.

The Irwin 510™ Specifications

Disk Drive

Performance

Capacities	Formatted	Unformatted
Per Drive	10.0 M bytes	12.3 M bytes
Per Surface	5.0 M bytes	6.17 M bytes
Per Track	8,192 bytes	10,080 bytes
Per Sector	256 bytes	315 bytes

Access Time (includes settling time):

Single Track . . . . . . 8 ms
Average . . . . . . 25 ms
Maximum (612 tracks) . . . . . . 55 ms
Latency (average) . . . . . . 8.3 ms

Functional

Platter Speed . . . . . . 3605 rpm ±.1%
Platter Size:
Inside Diameter . . . . . . 40 mm
Outside Diameter . . . . . . 130 mm
Thickness . . . . . . 1.9 mm
Number of Sectors/Track 32
Number of Cylinders 612
Number of Tracks 1224
Track Density . . . . . . 900 tpi
Track Spacing (center-to-center) . . . 1.1 mil
Recording Density . . . . . . 9,124 bpi
Flux Density . . . . . . 9,124 fci
Recording Method . . . . . . MFM
Disk Data Transfer Rate . . . 5.4 M bits/sec
Disk Spin-up Time . . . . . . 10 seconds

Tape Drive

Performance

Formatted Capacity

Per Drive . . . . . . 10.2 M bytes
Per Track . . . . . . 1.5 M bytes
Per Block . . . . . . 8,192 bytes
Track-to-Track Seek (max) . . . . . . 1 second
Dump/Restore Time . . . . . . 3½ minutes

Functional

Tape Speed . . . . . . 60 ips
Media Size:
Width . . . . . . 0.150 inch
Length . . . . . . 140 feet
Thickness . . . . . . 0.65—0.75 mil
Number of Blocks/Track 178
Number of Tracks 7
Track Density . . . . . . 55.5 tpi
Track Spacing (center-to-center) . . . . 18 mil
Recording Density . . . . . . 10,000 bpi
Flux Density . . . . . . 10,000 fci
Recording Method . . . . . . MFM
Tape Data Transfer Rate . . . 600 K bits/sec

Environmental

Operating

Temperature . . . . . . 0° to 40°C
32° to 104°F
Relative Humidity (non-condensing) . . 20% to 80%
Altitude . . . . . . −300 to 3000 meters
−1000 to 10,000 feet
Vibration . . . . . . 0.15G at or below 55 Hz

Non-Operating

Temperature . . . . . . −10° to 60°C
14° to 140°F
Relative Humidity (non-condensing) . . . 5% to 95%
Altitude . . . . . . −300 to 12,000 meters
−1000 to 40,000 feet
Vibration . . . . . . 1G at or below 4 Hz

Reliability

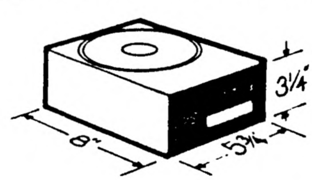
Mean Time Between Failure (MTBF)
. . . 8000 power-on hours (normal usage)
Mean Time to Repair (MTTR) 30 minutes
Component Life:
System . . . . . . 5 years
Tape Head . . . . 500 hours of tape motion
Disk Error Rates:
Soft Errors . . . . . . 1 in 10^{10} bits read
Hard Errors . . . . . . 1 in 10^{12} bits read
Tape Error Rates:
Soft Errors . . . . . . 1 in 10^{8} bits read
Hard Errors . . . . . . 1 in 10^{10} bits read

Requirements

DC Voltage (typical)
Electronics + 5VDC ± 5%; 1.4 amps
+ 12VDC ± 5%; 0.2 amps
− 12VDC ± 5%; 0.5 amps
Motor . . . . . . + 12VDC ± 10%;
1.8 amps nominal
4.0 amps peak
AC Voltage . . . . . . None required
Heat Dissipation 37 watts (127 BTU/hour)

Mechanical

Height . . . . . . 3.25 in. (83 mm.)
Width . . . . . . 5.75 in. (146 mm.)
Depth . . . . . . 8.00 in. (203 mm.)
Weight . . . . . . 5.5 lb. (2.5 kg.)



IRWIN™
IRWIN INTERNATIONAL

IRWIN INTERNATIONAL, INC.
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Document Number 1505010 10/81

Litho in U.S.A.

MPI Model 10 Super-Micro Winchester™ Disk Drive

THE QUALITY COMPANY

MICRO PERIPHERALS INC.

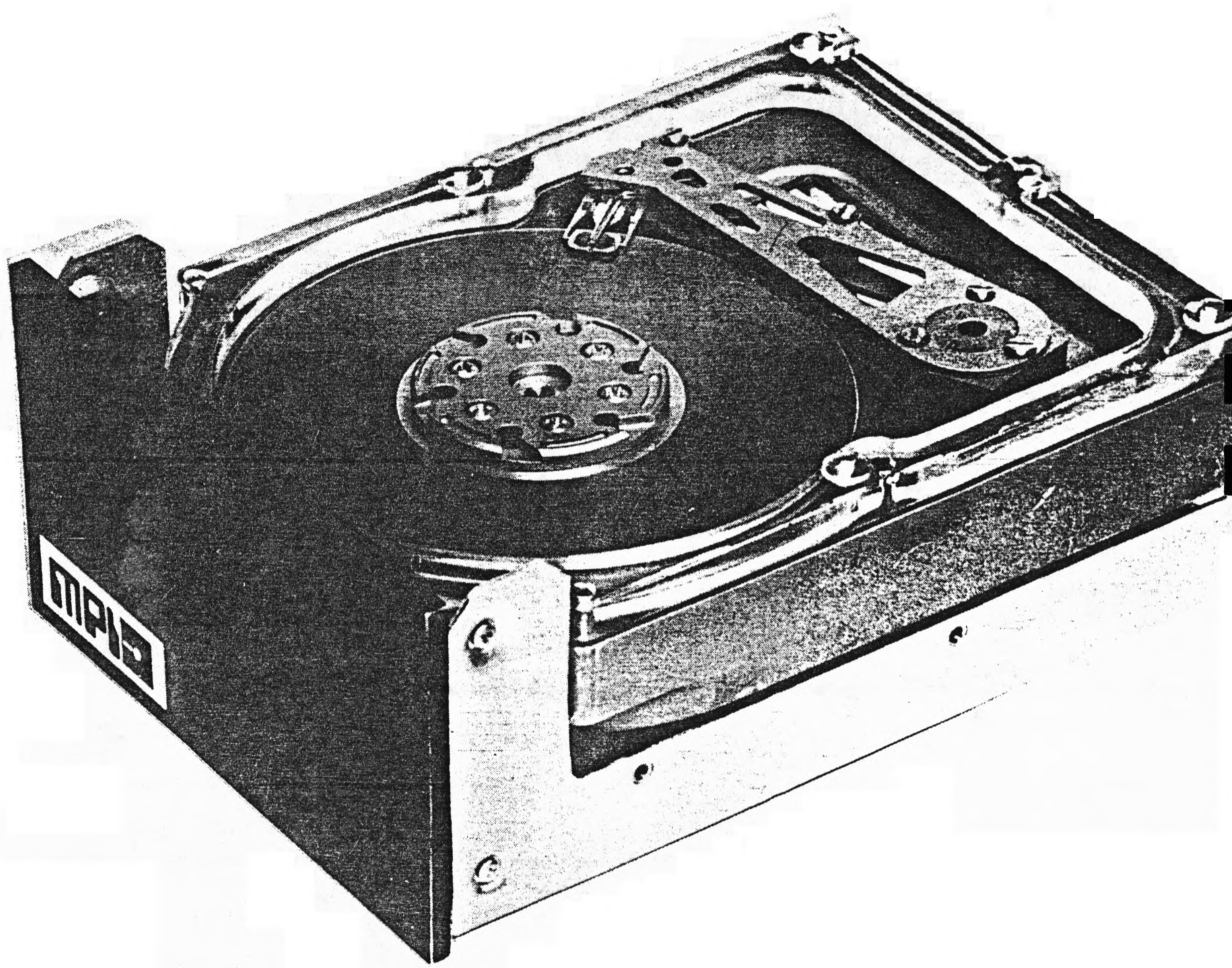
Features

- 14.66 megabytes, unformatted
- 11.53 megabytes, formatted
- Access Time:
  - Track-to-Track: 3 msec
  - Average: 25 msec
  - Maximum: 40 msec
- 2.0 msec Head Settle Time
- Swing Arm Head Positioner
- Advanced Thermal Compensation
- Intelligent Micro-Stepping

First in the family of second generation 5¼-in. Winchester disk drives, the MPI Model 10 provides 11 megabytes of formatted storage capacity. Other members of the family will provide 20 megabytes and 40 megabytes . . . in the same 5¼-in. package.

High performance in the Model 10 is obtained by combining swing arm positioning with intelligent micro-stepping, resulting in access times 300-400% faster than other Winchesters. This positioning system allows higher track density, making it possible to store 14 megabytes of unformatted data on only two platters.

The MPI Super-Micro Winchester™ is truly a design for today . . . and the future.



MPI Model 10
Super-Micro Winchester™

Characteristics

SYSTEM PERFORMANCE

Unformatted Capacity:	
Per Drive	14.66 megabytes
Per Surface	3.66 megabytes
Per Track	10416 bytes
Formatted Capacity:	
Per Drive	11.53 megabytes
Per Surface	2.88 megabytes
Per Track	8192 bytes
Per Sector	256 bytes
Sectors Per Track	32
Transfer Rate	5.0 megabits/sec
Access Time:	
Track-to-Track	3.0 msec
Average	25.0 msec
Maximum	40.0 msec
Settling Time	2.0 msec
Latency (Average)	8.33 msec
Interface	ST 506, SA1000

FUNCTIONAL

Rotational Speed	3600 rpm
Recording Density	8818 bits/in.
Flux Density	8818 flux changes/in.
Track Density	371 tracks/in.
Cylinders	352/surface
Tracks	1408
Read/Write Heads	4
Disks	2
Index	1

RELIABILITY

MTBF	11,000 power-on hours
MTTR	30 minutes
Unit Life	5 years

ERROR RATES

Soft	1 in 10^{10} bits read
Hard	1 in 10^{12} bits read
Seek	1 in 10^{6} seeks

POWER REQUIREMENTS

D.C.	+12-V ± 10% @ 1.8-3.3 A
	+5-V ±5% @ 1.5 A (typical)
Heat Dissipation	30 W (100 BTU/hour)

ENVIRONMENTAL

Ambient Temperature (Operating)	50° to 115°F
Relative Humidity (Non-Condensing)	8 to 80%

MECHANICAL

Height	3.25-in. (82.5 mm)
Width	5.75-in. (146.0 mm)
Depth	8.00-in. (203.2 mm)

Shock-Mounted Drive

AIR FILTRATION

Class 100, 95% Hepa Filtration
Class 100, 99% Crossambient
Transitions: 90/min

SEALS

Ferrofluid
Buna "S" Contact

MEDIA

Ferrous Oxide

HEAD

Manganese Zinc

Contact:

MICRO PERIPHERALS INC.

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Chatsworth, CA 91311

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TWX: 910-494-1213