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The Bernoulli Box A220H



Before Iomega became known for Zip drives it produced a very high quality removable cartridge storage system known as the Bernoulli Box. At a time when floppy drives held only 360KB or 1.44MB of data and hard drives only held 10 to 30MB of data the Bernoulli Box offered data storage limited only by the amount of removable cartridges you wanted to own. The cartridges were very robust and withstood abuse well, making them a pricey but ideal format for large scale removable storage.



The Bernoulli Box cartridge was fairly large at 11 long and 8 inches wide. Inside the cartridge was a flexible disk that would spin at 1500 RPM. While the disk was flexible like a floppy disk it did not operate like a floppy disk. A floppy disk drive presses the drive heads directly against the media to read and record data; the Bernoulli Box spins the disc at five times the speed of a floppy disk and relies on airflow (the Bernoulli principle) to draw the flexible disk close to, but not in contact with the drive heads. This made for a system that was nearly crash proof - a disruption in power or disturbance in the airflow caused by dust or a sudden thump would cause the flexible disc to "fall away" from the drive head, resulting in a temporary failure with no physical damage. Contrast this to hard disk systems which use rigid platters and have the drive heads "fly" just above the platter - a good thump can plow the drive heads into the platter causing physical damage.

I came across this A220H last summer in bad shape - it had been in storage quite a while and had accumlated a bit of dust and grime. There were no cartridges with it, no interface board and no documentation - just the bare drive. I had never seen a Bernoulli Box before, making this an interesting project.

After a few months of experimenting and looking for parts here is what I have learned:

- The controller board in the drive is SCSI, but it is an early revision. My Adaptec 2940AU and a Buslogic 445BT were able to talk to it but I am not sure how completely or correctly the drive implements SCSI. (That is going to require more experiments.)
- The drive uses 256 byte sectors. Other magnetic media generally uses 512 byte sectors. This is not a problem with the right device drivers, but newer flavors of Linux are not well equipped to deal with this odd sector size.
- The drive will read 10MB cartridges but not write to them. If you want to read and write data you need to have 20MB cartridges.
- 10MB cartridges seem to be more readily available than 20MB cartridges. To be more accurate, 20MB cartridges are nearly impossible to find.
- Having a cleaning cartridge is a must. Despite having a filter system that provides positive air pressure to the case the drives still require a bit of cleaning. (This might be an artifact of the way mine was stored - it has taken a lot of cleaning to get it usable, and I am sure that I am not done.)



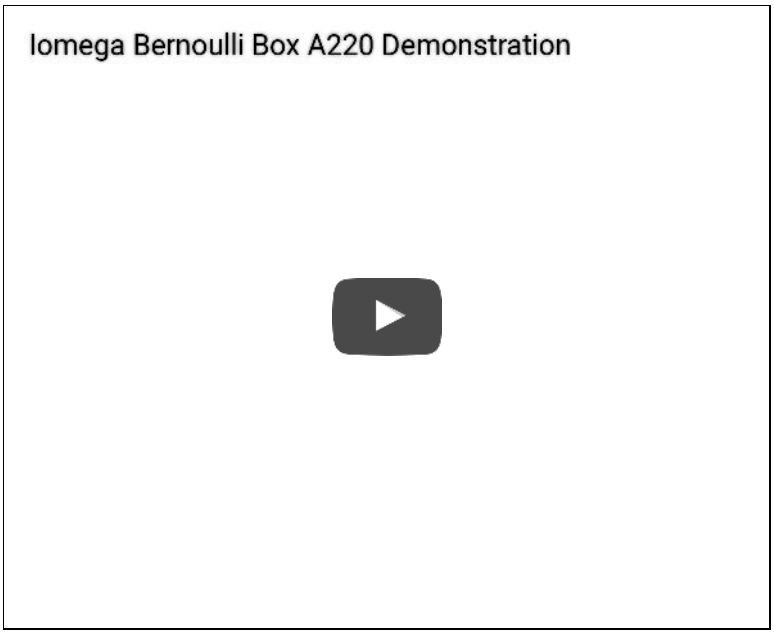
I am using an Iomega PC2B controller which is an 8 bit controller card that works in the IBM PC, XT or AT. The "B" in the model number indicates that this card has a BIOS extension that allows the machine to

boot from the Bernoulli Box if a properly prepared cartridge is loaded. The card is capable of DMA or PIO operation and can support a Bernoulli Box with one or two drives in it. While it has a connector for an internal SCSI chain, I have not been brave enough to experiment with it yet.



Software provided with the card allows one to format and partition cartridges, test the surface of the media for errors, run diagnostics, duplicate cartridges, etc. While the machine can boot from a Bernoulli Box it requires a device driver to be able to write data and use the utilities. Without the device driver your machine runs as though it has a read-only hard drive.

Using the drive is fairly straightforward. Turning on the unit starts the fan which drawns air across a replacable filter into the drive. It is intended to provide positive air pressure in the case to avoid contamination of the cartridges. To load a cartridge you insert the cartridge and and turn a latch to lock it in place. Once loaded the drive will spin the cartridge up to speed and the cartridge will come online. A green light will indicate the cartridge is online. To remove a cartridge press the grey button and wait for the drive to spin the cartridge down. Once the process is complete the green light will go out, signalling that you can unlatch and remove the cartridge. A mechanical interlock keeps you from trying to remove the cartridge too early but I wouldn't test it too vigorously. During operation a red light will signal data transfers.



Although the magnetic media never comes in direct contact with the drive heads, cartridges are still subject to wearing out and have to be replaced after a few hundred hours of use, sooner if dust contamination is an issue.

While the drives were very reliable their nature requires periodic cleanings. A special cleaning cartridge with replaceable cleaning pads was available. Cleaning was a very manual process - the operator would turn off power, open the cleaning cartridge, apply the liquid solvent to the cleaning pad, close the cartridge, insert the cartridge, and then manually move a lever back and forth 25 time times. The lever was connected to a mechanism that moved the cleaning pad back and forth under the drive head. Contrast this to a floppy disk cleaning system, where the drive spins the cleaning medium at normal speed in direct contact with the floppy drive heads.

Older versions of the Bernoulli Box are supposed to be slow. This version of the Bernoulli Box offered improved performance over its predecessors. Track-to-track access time was 10ms and average access time was 55ms. The drive spins at 1500 RPM which is slower than most hard drives of the time but still five times faster than a floppy drive. With an interleave factor of 4 set at format time the drive is capable of reading and writing at 123KB/second on a standard 4.77Mhz PC XT. Smaller interleave factors are possible on faster machines. Using the PIO mode instead of DMA dramatically reduces the data transfer speed.

InfoWorld reviewed this very same drive in the June 8th, 1987 issue. At the time of the review this particular dual drive unit was selling for $2595. A single drive unit was $1795. Cartridges cost $140 and the interface board was another $280. This was far more expensive than a conventional hard drive, and more expensive than many PC clones at the time. But if you needed removable storage this was the best solution available.

Not too long after this drive was available Iomega introduced the Bernoulli Box II using a smaller cartridge based on the same principle. The smaller cartridges initially started at 20MB and eventually maxed out at 230MB. After that Iomega discontinued the Bernoulli Box line in favor of the Zip line, which resembled more conventional floppy disk technology.

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