megabyte version $506 (or cheaper if you buy and install your own chips)—an unusually competitive price for Apple.

As mentioned here in October (page 73), Apple's card uses an addressing scheme that is completely different from any other card on the market. Applied Engineering's RamWorks and similar cards are organized as a series of additional 64K auxiliary memory banks. Apple's card, on the other hand, is organized as a one-byte peephole.

You read from or write to Apple's card by peeking or poking at byte 49283 + (SLOT*16). (In hex that's C083 + S0, where S is the slot number). You can transfer a sequential group of bytes between the card and memory faster than you can transfer the same group from one part of memory to another. This is because hardware on the card automatically increments to the next byte. Your program just keeps peeking or poking at the same peephole.

A disadvantage with this scheme, however, is that it's impossible to run a program while it's on the card. Programs must be moved into main memory first. This isn't a major disadvantage, however, since it's *almost* impossible to run a program stored in multiple auxiliary memory banks, too. Very little software actually uses the additional memory on cards like RamWorks to execute code. Most such software simply uses the additional banks as memory storage areas.

As simply a storage device, Apple's card is very clever. You tell the card what byte you want to appear in the peephole by placing that byte's address in 49280-49282 (+ SLOT*16), low-byte first. It uses any standard slot except slot 3, which means it works with a II-Plus as well as a IIe. It won't interfere with interrupts as auxiliary-memory RAM cards sometimes do. Nice card. Too bad the auxiliary-memory cards have already set a standard in this area.

Bus School

Mix and match your 5¼" drives

by Tom Vier

Contrary to what Apple would have you believe, all of its 5¼ inch disk drives—the older Disk II, the 5¼ inch UniDisk, the two-drive DuoDisk, and the IIc external drive—are essentially the same. Within certain guidelines you can mix and match Disk IIs, the IIc external drive, and the 5¼ inch UniDisk (but not the newer 3½ inch UniDisk) all you want, though some combinations require modifying the connector plug.

The controller card Apple is selling with the 5¼ inch UniDisk and the DuoDisk is like an old VW Beetle with a Continental kit. It's nothing more than a classic Disk II interface card with a new connector hanging off the back. The major difference is that the Disk II interface has two 20-pin header connectors, one for each drive, while the UniDisk/DuoDisk/IIc interface has a single, female DB-19 connector.

The drives themselves are also similar, except for the wrappers. The UniDisk/DuoDisk/IIc drives are standard ¾-height drives in Apple's latest designerware cases. The UniDisk has a permanent cable that terminates in a male DB-19 connector. On the back of each UniDisk there is also a female DB-19 connector. If you have two UniDisks, you plug the first one into the interface card and the second one into the back of the first. The IIc external drive is similar to a UniDisk, but since it will always be the second drive, it doesn't have the female connector on the back. The DuoDisk has a single female connector on the back and comes with a separate cable that has male DB-19 connectors on each end. One end of the cable plugs into the interface card, the other into the DuoDisk.

The DB-19 connectors on the UniDisk, DuoDisk, and IIc external drives all share functionally the same electronic signals, or pinout. And these are equivalent to what's found on the Disk II's 20-pin header connector. The following chart shows what's where:

Apple II disk drive pinouts

signal	use	Uni-DuoDisk	IIc external	Disk II
GND	ground reference	1-4	1-4	1,3,5,7
-12	-12 volts DC	5	5	9
+5	+5 volts DC	6,16	6	11,12
+12	+12 volts DC	7-8	7-8	13,15,17,19
WRPROT	write protect	10	10	20
PH 0-3	stepper motor phases	11-14	11-14	2,4,6,8
WRREQ	write request	15	15	10
ENBL	drive enable (low)	17,(9)	17	14
RDDATA	read data	18	18	16
WRDATA	write data	19	19	18
EXTINT	external interrupt	NA	9	NA
	not connected	NA	16	NA

The two 20-pin connectors for drive 1 and drive 2 on the old Disk II interface card are identical. All pin-pairs, in fact, always carry the same signals except pin 14. This pin activates the drive—a Disk II drive ignores all signals until pin 14 tells it to pay attention.

Unlike the Disk II interface, the UniDisk/DuoDisk/IIc interface has only one connector. If more than one drive is used, the drives are connected in a daisy-chain. Pin 17 carries the signal that enables the first drive in the chain. The interface card sends the signal that enables the second drive on pin 9. Inside a UniDisk, the signal from pin 9 is routed to the daisy-chain connector's pin 17. Consequently, all of the newer drives are electronically the same—each looks for its own activation signal on pin 17.

The IIc, of course, supports only one external drive. Pin 9 on the IIc is used for external interrupts. Pin 16, which otherwise carries a 5 volt supply of power, is unused on the IIc. This makes no difference because there is a second source of 5 volts on pin 6—and inside all Disk II drives these two lines are tied together.

All this means that any Disk II compatible add-on drive, with a IIc adapter, can be daisy-chained off of a UniDisk or plugged directly into a UniDisk/DuoDisk controller or a IIc. IIc adapters are readily available from several mail order houses (see the August issue, page 61, for the address of one). In addition, a IIc external drive plugs right into a UniDisk or a UniDisk/DuoDisk controller, and a UniDisk plugs into a IIc.

You can use the newer drives with an old-style interface card. This set-up would be most useful to people with special, non-Apple disk controller cards, such as those with diagnostic routines on them.

While the pinout table given earlier makes it appear that building an adapter to go between the DB-19 and 20-pin header connectors would be a complicated soldering job, everything literally falls into place. The accompanying diagram shows how to make an adapter that converts a Disk II controller into a UniDisk/DuoDisk controller. Be forewarned, however, that a wrong connection could be very unhealthy for your system. Success would also be limited by your tolerance for the potential Radio Frequency Interference that could find its way around your house if you use unshielded cable, and by your ability to buy the relatively rare DB-19 connector.