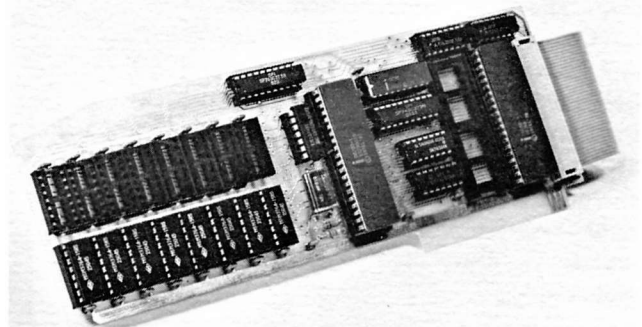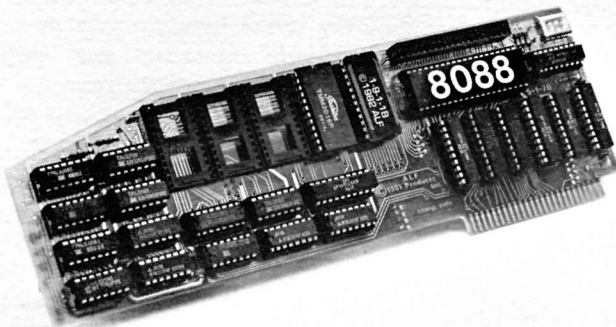# AD8088 PROCESSOR CARD

THE 8088 PROCESSOR

ALF's Processor Card doubles your Apple's processing capability by adding an independent second processor. The Processor Card's 8088 processor runs programs in its on-board memory or expansion memory at full speed while the Apple's 6502 processor simultaneously runs programs in its memory at full speed.

The modern 8088 processor features an advanced instruction set, several 16-bit registers, segment registers for easy program relocation and 1024K addressing capability, and full compatibility with the 8086 instruction set. The 8088 has extensive arithmetic instructions for both 8-bit and 16-bit numbers, including multiply and divide. (Plus, the optional 8087 Numeric Data Processor adds 32-bit, 64-bit, and 80-bit integer and floating-point operations directly to the instruction set.) The 8088 has numerous conditional branch instructions, including iteration branches. Its memory move and string compare instructions handle blocks of either bytes or words.

THREE MEMORY AREAS

The unique design of the AD8088 allows programs to be located in any of three memory areas: the Apple's memory, the on-board memory, and the optional AD128K memory.

The entire memory area of the Apple, including the I/O area, is available to the 8088. The 8088 can access data or run programs stored in the Apple's memory, or can directly control peripherals plugged into the expansion slots. The disadvantages of using the Apple's memory are that it is not in one continuous block and it is not fast. The 8088 must wait until the Apple bus is available, then access the relatively slow memory. The Apple's processor must wait about 1 μS during the access.

The on-board 4K ROM (read-only memory) and 2K RAM (read/write memory) are very fast, and are accessed directly by the 8088. Programs using these memories run at a full 5 MHz (over 12% faster than the IBM Personal Computer). Three sockets on the card allow 2K memory chips to be added, expanding the RAM to 4K, 6K, or 8K.

Larger programs can make use of the optional AD128K Memory Card, which adds 64K or 128K of fast memory, also directly accessible by the 8088. There is some speed loss compared to the on-board RAM since the large memory chips used require occasional "refresh" cycles. The minimum speed is 96% of full speed (still 8% faster than the IBM PC). Unlike standard Apple memory expansion cards which use several small "bank-selected" blocks, the memory of the AD128K card is in one continuous 64K or 128K block. This allows very large programs to be run or large data areas to be accessed quickly.

SOPHISTICATED DESIGN

The AD8088 and AD128K cards are carefully designed using modern circuits for low power operation. The Processor Card with full 8K RAM and the AD128K with full 128K RAM each draw less power than Apple's ROM card (considerably less than a typical 80-column card). The unique design, separating the processor and expansion memory on two cards, allows a low-cost minimum system for many applications and easy expansion for applications requiring large memory. The AD8088's expansion port connector allows for further expansion with future products.

TRUE MULTIPROCESSING

Since the 8088 and the Apple's 6502 both run simultaneously, complex problems can be split into two algorithms and processed in parallel. Several AD8088 cards can be used in one Apple, all running simultaneously and passing data to each other through the Apple's memory. Each Processor Card can access peripheral cards plugged into the Apple, or external peripherals plugged directly into the card's expansion port connector.

ALF

THE 8087 NUMERIC DATA PROCESSOR

A socket on the AD128K Memory Card accepts the Intel 8087 NDP chip. The 8087 features add, subtract, multiply, divide, square root, and other operations (including transcendental functions) for IEEE standard single and double precision floating-point numbers. Integer operations are also available. An eight register stack (with 80-bit registers) simplifies expression evaluation.

FORMULA TRANSFER LINK

Programs can be rewritten to take full advantage of the 8088's processing speed, but rewriting is not always desirable. FTL, the Formula Transfer Link, is a simple program which speeds up math operations in unmodified Applesoft BASIC programs. FTL is set up simply by typing RUN FTL. Applesoft is moved into your Language Card (or other 16K RAM Card) unless it is already present, and then various math routines are replaced by calls to 8088 math routines. Multiply, divide, exponentiate, SQR, LOG, EXP, COS, SIN, TAN, and ATN are then handled by the fast 8088 routines. Applesoft programs can be run in the usual manner—no modifications are needed. FTL remains in memory until the Language Card is erased or deselected (by turning the Apple off, booting DOS 3.3, or accessing Integer BASIC on an Apple II-plus).

Because the changes to the Applesoft language are so simple, FTL is compatible with virtually every Applesoft program—even programs containing embedded assembly language routines. Math operations in programs compiled with compilers such as TASC™ and Expediter II™ also run faster. The amount FTL speeds up a program depends on the number of times the various math operations are executed and the particular numbers used. Since Applesoft and FTL use different algorithms, their results may differ slightly.

Program to compute prime numbers from 2 to 1000.

```
10 PRINT "2 3 ";
20 FOR B = 5 TO
   1000 STEP 2
30 FOR C = 3 TO
   SQR (B) STEP 2
40 IF B/C = INT
   (B/C) THEN 70
50 NEXT
60 PRINT B;" ";
70 NEXT B
```


execution time in seconds
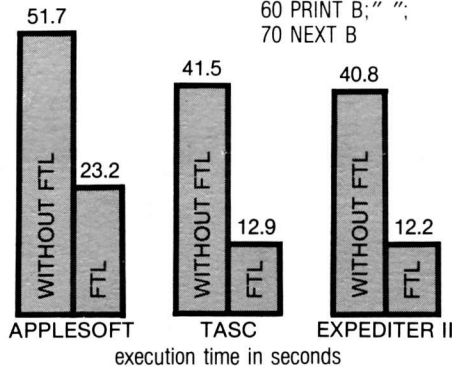
MULTIPLE EVENT TIMER

MET is a program which allows the Processor Card to be used as an event timer. It can store the time duration between more than 450 events (over 1100 with 4K on-board RAM, 1800 with 6K, or 2500 with 8K) along with a reference number (0-255) for each event. A program in the Apple signals an event to the MET program simply by writing the reference number to a particular memory address (for example, with STA $C0B1 in assembly language or POKE −16207,0 in BASIC). MET can be set for any of 8 resolutions from 50 microseconds to 100 milliseconds, with maximum durations per event ranging from 3.276 seconds to over 1 hour 49 minutes. Timings are based on the 8088's crystal oscillator, which has an accuracy of plus or minus 0.01%.

MET can be used to time critical routines in your programs regardless of what language they are written in. Its smallest resolution is so precise even individual BASIC statements can be timed to evaluate the performance of various techniques.

ON-BOARD ROM PROGRAMS

The 8088 can be used as a floating-point processor for your own 6502 programs. The on-board ROM contains a complete set of math functions. A random number generator is also included which can be read from assembly language or BASIC programs. Other functions include set memory and move memory, and user-programmed functions can also be added. The memory move function can access both Apple memory and 8088 memory, allowing 8088 programs to be placed in Apple memory and then moved to the on-board RAM or AD128K RAM for faster execution.

CP/M-86® AND MS-DOS®

The Processor Card is designed to be compatible with operating systems like CP/M-86 and MS-DOS. (MS-DOS is called PC-DOS on the IBM PC.) CP/M-86 includes an 8088 assembler, which allows you to easily write programs for the 8088 processor. And of course, you can use the numerous programs available which run under CP/M-86. MS-DOS, a similar operating system, allows you to run the growing number of IBM PC programs. Working closely with ALF, Clone Software Corporation has written an implementation of CP/M-86 especially for the AD8088, and is working on an implementation of MS-DOS. ALF will be distributing both implementations.

SYSTEM REQUIREMENTS

A 64K Apple (48K plus Language Card equivalent) with a disk drive is required. The AD8088 can be plugged into any slot, and AD128K in any nearby slot. An empty slot or cooling fan may be required if the 8087 chip is used since it draws more power than most chips.

ORDERING INFORMATION

AD8088 Processor Card, order number 10-5-7. Suggested U.S. price: $345.00. Includes the Processor Card, FTL and MET programs on disk, and owner's manual. Owner's manual is available separately for $7, order number 11-1-7.

AD128K Memory Card, order number 10-5-11. Suggested U.S. price: $295.00. Includes the Memory Card and owner's manual. Also order one or two 64K RAM Chip Sets, order number 10-1-4 ($75) and/or one 8087 NDP Chip, order number 1-5-3 ($195).

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