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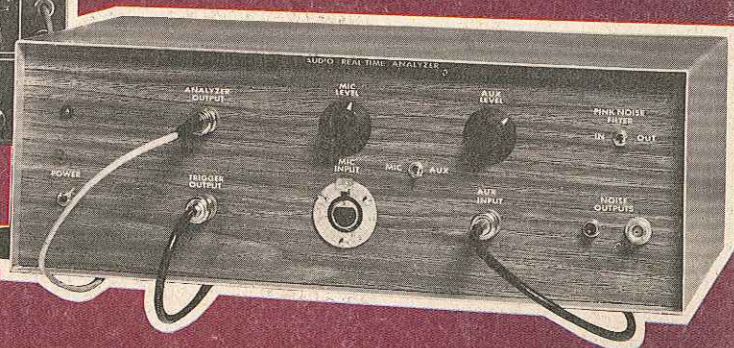
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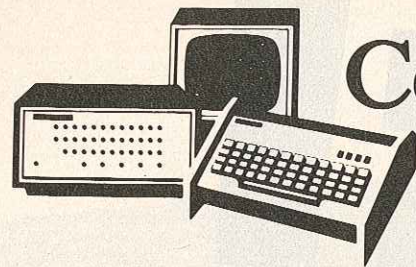
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# Computer Bits

By Hal Chamberlin

## UPDATE ON MICROPROCESSOR DEVELOPMENTS

OVER THE past year, there has been a flood of new microprocessor IC's and related peripheral IC's coming on the market. Many have been rumored in the past but are now finally available. These new IC's are important to casual as well as advanced computer hobbyists because they will show up shortly in new hobbyist-oriented equipment offerings.

One obvious overall trend in microprocessor IC's has been toward true single-chip central processing units or even complete computers. With today's CPU chips, one merely adds memory, address decoding, and bus buffering to have a complete, expandable computer. The newest "computers on a chip" have the CPU, erasable read-only memory, read-write memory, and a couple of input-output ports all in one IC! Although these are not as easily expanded, they are ideal for use in terminals or intelligent game machines.

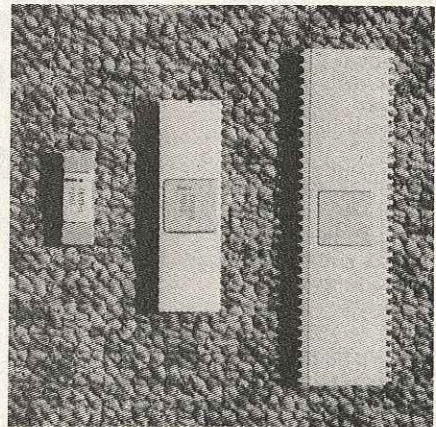
Another trend is toward I/O systems on a single chip. The TMS5501 IC from Texas Instruments, for example, combines a complete UART with baud-rate generator for serial I/O, a parallel input port, a parallel output port, 5 (count them) interval timers, and a vectored interrupt system into one IC! Another example is the MCS6530 from MOS Technology (now part of Commodore) and Synertek. This IC offers 1k bytes of read-only memory, 64 bytes of read-write memory, two *bidirectional* (programmable for input or output) parallel ports, and a very versatile interval timer. As a matter of fact, two of these are used in the KIM-1 to hold the monitor and provide its extensive I/O capabilities.

Complete peripheral controllers are also appearing in chip form. Most notable is the fact that no fewer than three different floppy-disk controller IC's are now available. Most of them are flexible enough to handle the disk formats in common use by hobbyists as well as the

"standard" and more complex IBM format for which the chips were designed. Another IC that has been announced but is not yet available is a video display chip with *programmable* line length and number of lines. Even the character read-only memory is built-in.

Memory developments certainly have not taken a vacation either. Static 4k memory chips have become cost effective alternatives to the common 1k 2102 chips and are now appearing in 16k-byte memory boards for the hobbyist. Earlier problems with dynamic memory chips have been overcome by correct board design and will be emerging as the price-performance leader in memory for the hobbyist since 4k dynamic memory chips are now selling for as little as \$2.70 in large quantities. Finally, the availability of 16k dynamic memory IC's makes possible the single-board "full gallon" (64k) memory system. In fact, IMSAI has announced a 64k memory board for its systems.

**The 8080 Field.** Even though the 8080 is the most popular microprocessor chip for hobbyist systems and has also enjoyed considerable success in



Size of microprocessors grows in proportion to sophistication of internal logic. Left to right, an 8008, 8080, and the latest 16-bit micro, a 9900 IC.

commercial systems, many significant improvements in the family have become available in the last year. Improved versions of the original 8080 that run at higher speeds are now available. The fastest is the 8080A-1 which can run at a clock speed of 3.125 MHz or over 60% faster than the standard 8080. Of course these higher speeds require faster memory to be of any benefit but many of the newer memory boards run fast enough.

To most people however, the most significant development is of course the Z-80. This microprocessor chip was introduced by Zilog, a spinoff company from Intel, the originators of the 8080. The Z-80 is fast; selected versions run at 4-MHz which is twice as fast as the 8080. Additionally, some instructions require fewer clock cycles to execute than the 8080 equivalents. The main attraction of the Z-80 for hobbyists however has been its extended instruction set. Besides all of the 8080 instructions, the Z-80 has many new ones. The most impressive class is the block search and move instructions. A single instruction, after the proper parameters have been loaded into registers, can perform a function that normally requires an entire subroutine. Besides the obvious savings in memory space, the block instructions execute much faster than the subroutine would. Other improvements are indexed addressing modes which simplify some types of programming and a duplicate set of registers which eliminates the need to save registers during interrupt.

One of the newest developments from Intel is designated the "MCS-85" family. Central to this family of chips is the 8085 microprocessor. This chip essentially combines the CPU, clock generator, and system bus controller functions onto one IC. In addition, 4 individually maskable vectored interrupts are included right on the CPU chip thus solving a bad problem with the original 8080. One of the most significant improvements is relaxed bus timing specifications. At equivalent throughput speeds, the 8085 allows memory access to stretch out as long as 1025 ns whereas the 8080 allows only 570 ns thus requiring a memory almost twice as fast. Even when the 8085 is sped up 50% to 3 MHz, the 575 ns allowed for memory access is longer than an 8080 at normal speed thus allowing a faster system without faster memory. Even with all of these improvements, the 8085 will execute all 8080 programs without changes.

**Other 8-Bit Processors.** Of course

the other microprocessor manufacturers have not twiddled their thumbs over the past year. Motorola has just announced faster versions of its popular 6800. The MC68A00 runs 50% faster at 1.5 MHz and the MC68B00 runs fully twice as fast at 2 MHz. Likewise, the 6502 microprocessor from MOS Technology is available in higher speed versions. The A suffix part is twice as fast at 2 MHz, the B suffix runs at 3 MHz, and the "dash C" part smokes at 4 MHz. Remember when comparing clock speeds that the above chips generally accomplish about as much in one clock cycle as an 8080-type chip does in three clock cycles.

National Semiconductor's SC/MP microprocessor has also been improved. It is now an n-channel MOS chip which means easier interfacing and a single 5-volt power supply. Additionally the speed has been doubled to 4 MHz (which is divided by 4 internally). Even with these improvements, its price remains the same.

The F-8 microprocessor originated by Fairchild normally requires at least two chips to make a complete CPU. However Mostek has recently announced a single chip F-8 that combines memory, an interval timer, and I/O ports all on the same chip.

**16-Bit Microprocessors.** To many people the ultimate hobby computer simply must have a full 16-bit minicomputer style instruction set. Accordingly, recent developments in 16-bit microprocessors are of great interest. A significant trend with the 16-biters has been to try to get it all on one chip even if it means a larger IC package as shown in the photo.

The PACE was the first single-chip 16-bit microprocessor to be introduced. Although National Semiconductor has not made any significant improvements in the chip itself, the price has improved considerably. From an initial figure of nearly \$200 (in 100 quantity), the price has recently fallen to only \$20.

Speaking of price reductions, the CP1600 processor by General Instruments has been recently repriced at \$8! The architecture is somewhat strange but the price is hard to beat and it is a 16-bit device.

Another 16-bit processor which has been rumored for awhile is now available. It is the 9900 from Texas Instruments. This IC is unique in many respects. Most striking is the 64-pin package which looks more like a small printed circuit board with leads than a ceram-

ic IC. The instruction set in many ways resembles that of a DEC PDP-11, a very popular minicomputer. An interesting design innovation is that the "registers" are not in the CPU but are in regular read-write memory. Another feature is the inclusion of real multiply and divide instructions which take only about 20 microseconds to execute. The standard 9900 requires a 16-bit wide memory but a "soon-to-be-introduced" version (the 9980) can work with an 8-bit data bus and memory while retaining the same extensive 16-bit instruction set. This means that CPU boards using the 9980 might be compatible with the S-100 bus structure. The 9980 will also be packaged in a more conventional 40-lead package.

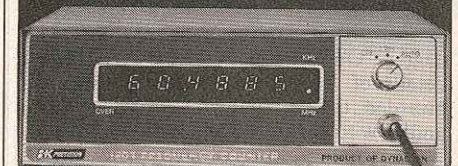
**Bipolar Bit Slices.** While not really microprocessor chips, the bipolar bit slices are building blocks that can be used to design custom computers and instruction sets with much less effort and far fewer parts than would be required with standard logic. Since they are made with high-speed Schottky transistors rather than MOS transistors, the speed of a system constructed with bipolar slices is much greater. Major innovations in this area are sharply lower prices and the availability of 4-bit wide units along with a host of support chips. Of significance to the hobbyist is the fact that a couple of hobbyist manufacturers are readying CPU boards made with the bit slices. These will be compatible with the S-100 bus and immediately provide the user with a vastly superior CPU while still using the rest of the existing system. Since the bit slices are *micro-programmed*, it is possible that a standard feature would be an *emulation mode* in which the instruction set of a popular microprocessor such as the 8080 would be recognized as well as the improved instruction set offered with the new CPU.

Bipolar bit slices will probably also show up in specialized floating-point arithmetic units. The purpose of these is to execute the arithmetic operations needed by BASIC language systems much faster than typical software routines do.

If the past is any indication, new microprocessor developments will continue to be made at an ever accelerating pace.

**Correction.** In last month's column, the price of the Heathkit H9 CRT terminal was given as \$350. It should have been \$530. ◇

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