AMD's Elan Puts 386 PC in Pocket

386SC Contains All Logic for Handheld PC in One Chip

by Linley Gwennap

Promising smaller, more powerful, handheld PCs, AMD presented its Am386SC at the recent Microprocessor Forum. The new device is the first to combine, on a single chip, a 386 CPU with all of the system logic and interfaces required to support DOS and Windows software.

The 386SC, the first member of AMD's Elan family, also offers several features to extend battery life. The CPU core operates at 3.3 V, even at 33 MHz, and the chip can connect to either 3.3-V or 5-V peripherals. The static processor core can operate at any clock speed and retains its state even if the clocks are stopped. A built-in power manager implements a variety of power-saving modes.

While the initial product is aimed at subnotebook and handheld PCs, AMD's Customer Specific Products Division (CSD) is poised to quickly develop derivative products for other markets, according to Gary Baum, the CSD Director of Marketing. PDAs or "smart phones" might not need all of the DOS-compatible logic in the 386SC; these blocks could be removed. Baum said that CSD can also add interfaces for a pen digitizer, audio, infrared, and wired or wireless communications, as they are needed by various customers.

The 386SC will use a 0.8-micron, two-metal CMOS process. AMD would not reveal the die size, as first silicon has not yet been built. The company says the chip will be in production in 2Q94 at a price of $49. Derivative products will have an upfront design fee and may cost more or less than the 386SC depending on the modifications. AMD expects the first system using the 386SC to begin shipping by the middle of next year.

Am386SXLV Core Provides Low Power

The 386SC core is derived from AMD's 386SXLV CPU core, which has been shipping for about two years. The SXLV is a 3.3-V, static 386SX with system-management mode (SMM) added. AMD's SMM is similar to that of Intel *(see **060204.PDF**)*. This core is proven to operate at up to 33 MHz at 3.3 V, keeping performance high with low power consumption.

AMD's chip has a separate power-management unit (PMU) that monitors system activity and can trigger SMM when the processor shifts to a new power mode. For example, when the PMU detects system activity, it places the processor into a full-speed mode.

The chip offers various low-power modes with programmable timing. If a specified duration passes without activity, the PMU reduces the CPU clock speed to 2–18 MHz to save power. After a longer interval, the PMU stops the CPU clock entirely and slows the clocks to the peripherals. Later, the processor can completely shut down after peripheral state is saved in memory.

Baum estimates that the chip will consume a maximum of about 650 mW when operating at full speed with a reasonable bus load. Power usage will be much lower in the power-saving modes. Overall power consumption will depend on the percentage of time that the processor operates at full speed; if the PMU is configured appropriately, this percentage should be small.

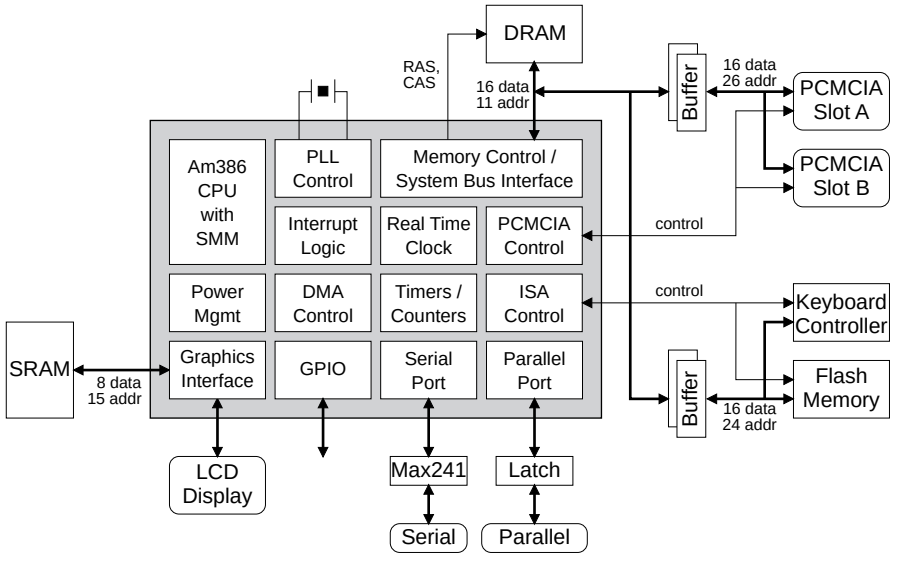

Figure 1. The AMD 386SC combines all the system logic and interfaces required for a complete DOS-compatible PC with up to two PCMCIA slots; only a handful of buffer chips, a few memory chips, and a keyboard controller are needed to complete the system.

Complete Set of System Logic

As shown in Figure 1, the 386SC includes a memory controller, real-time clock, and the equivalent of an 82C206 for DOS compatibility. Some of this logic was licensed from a third party, rumored to be Taiwanese chip-set vendor Tidalwave. The chip does not support an on-chip or an external cache, but 70-ns

DRAMs provide zero wait states at 33 MHz, reducing the need for a cache.

The memory controller supports a 16-bit data path to DRAM or SRAM with no external buffers required. While this memory width will offer performance comparable to a typical 386SX, the lack of a 32-bit memory path will leave the Elan processor below 386DX performance levels. The new chip can handle up to 16M of memory in two banks; a low-end design can use a single 1M × 16 DRAM for a 2M memory system.

Two standard I/O interfaces are included: a bidirectional parallel port and a serial port, both compatible with DOS standards. The parallel port requires only a single external component between the 386SC and the connector. Similarly, a simple buffer chip interfaces the processor to the serial connector. Alternatively, the serial port can connect to a digitizer or a modem.

The AMD processor supports two PCMCIA 2.0 slots. Most handheld devices today implement one or two PCMCIA slots for add-in memory and/or peripheral cards. By including control for these devices on-chip, the 386SC eliminates the need for external PCMCIA interfaces. These slots are driven from the memory address and memory data buses through logic buffers, as shown in Figure 1. Additional voltage buffers are needed for hot insertion of add-in cards, but many portable devices rely on a physical interlock instead.

AMD's Gary Baum describes how the new Am386SC can be customized for specific applications.

The 386SC provides a set of ISA control signals for adding functions using standard ISA peripheral chips. As with PCMCIA devices, ISA devices are connected through buffers. The Elan processor also generates chip-select signals for a keyboard controller and a non-volatile memory device such as a flash ROM.

The AMD chip includes a basic LCD controller that is 6845-compatible and supports panels up to 640 × 400 pixels. It provides CGA emulation for DOS compatibility. An external SRAM contains the graphics frame buffer. This memory is connected internally to the processor local bus, permitting fast data transfers. For systems that require higher graphics performance, the frame buffer can be replaced by an external graphics-accelerator chip; in this configuration, the 386SC provides a 16-bit local bus interface.

The Elan chip does not provide pulse-width modulation (PWM) outputs to control the brightness and contrast of the LCD display. These aspects can be adjusted by physical controls (potentiometers) in the system packaging; if software control is desired, an external digital-to-analog converter must be added.

Price and Availability

AMD expects the Am386SC to sample in 1Q94, with volume production in 2Q94. In a 208-pin PQFP, the processor costs $49 in volumes of 10,000. For more information, contact AMD's Customer Specific Products Division, 5900 East Ben White Blvd., Austin, TX 78741; 800.292.9263, x3 or 512.462.5651.

Customized System-on-a-Chip

While the 386SC is not the first complete PC on a chip—Chips & Technologies' PC/Chip (see MPR 10/2/91, p. 1) takes that honor—it's the first one with a 386 core, giving it much better performance than the 8086-compatible PC/Chip. The new AMD part will bring 386 performance to even the smallest handheld devices. Systems such as HP's 100LX are now using 8086-type chips.

The AMD processor was announced at nearly the same time as two other highly integrated 386 products, Intel's 386EX *(see **071405.PDF**)* and the Intel/VLSI Polar chip set *(see **071302.PDF**)*. The similarity of the processor cores, however, masks the fact that all three parts are aimed at different markets. Intel's 386EX does not include the graphics and PCMCIA interfaces of the AMD chip, making it more suitable for embedded applications.

Polar is intended for PDAs running Microsoft's At Work software and is not even DOS-compatible. Polar includes a graphics accelerator as well as a 2K cache that will improve performance on ROM-based code. These two large blocks force Polar to a two-chip design. Furthermore, VLSI chose to leverage an existing PCMCIA chip rather than integrate this interface; thus, Polar requires a total of four chips to match the two-PCMCIA-slot configuration of the single Elan chip.

These examples show how design tradeoffs that were made by system designers are now made in the silicon itself, as cost, power, and size limitations drive many portable devices to combine one or two logic chips with a handful of buffers and analog components.

AMD has recognized these trends and created CSD to take advantage of them. While the 386SC is a good product for handheld PCs, it could easily be adapted for PDAs or embedded applications by changing or removing peripherals. In fact, the chip can be customized for a specific system design. This capability positions AMD well to compete for the multitude of portable "smart" devices that are coming in the future. ♦

