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8-bit SX MCU Achieves 50 MHz, Runs Virtual Peripherals

Santa Clara, CA, August 6, 1997 -- Scenix Semiconductor, Inc. today announced the world's fastest family of 8-bit microcontrollers (MCUs). Running at up to 50 MHz and able to execute most instructions in a single clock cycle, SX Flash EEPROM MCUs deliver up to 50 MIPs, 10-50X the performance of typical 8-bit MCUs.
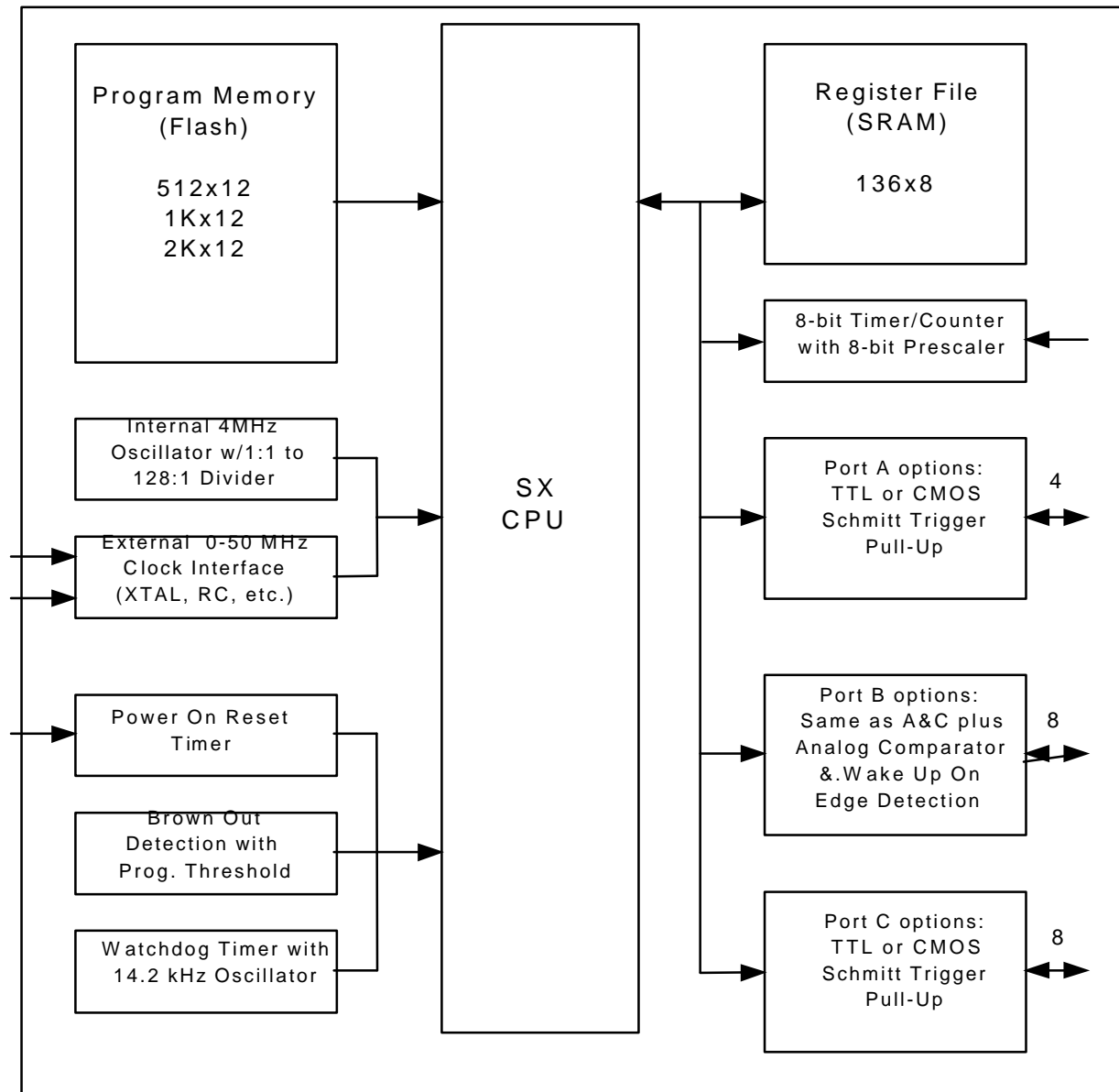
Besides offering an upgrade path for all 8-bit MCU users, a key capability of the SX is the ability to create "Virtual Peripherals". Made possible by the unprecedented performance of the SX, Virtual Peripherals are the implementation in software of functions formerly requiring dedicated and costly hardware (such as timers, PWMs, and serial ports).

To complement the Virtual Peripherals concept, the on-chip features of the SX provide enhancements over ordinary 8-bit MCUs as well. Included are features such as an internal 4 MHz programmable oscillator, programmable three level brown-out reset, Power-On Reset (POR), a Watchdog Timer (WDT) with it's own on-chip RC oscillator, Multi-Input Wakeup with optional interrupts, and Flash EEPROM program memory.

The SX's Flash EEPROM memory provides an in-system programming capability, increasing flexibility by allowing software revisions at any stage in the production flow, or even remotely via modem or other communication link when software revisions are required. It also eliminates the additional time, cost, equipment, handling, and wasted product associated with OTP (One Time Programmable, i.e. EPROM-based) MCUs.

Advancements are not limited to just silicon with the SX. Eliminating the need for bulky and high cost tools such as an ICE, Parallax Inc. is introducing their SX Key development system concurrent with this SX announcement. The SX Key provides a complete, non-intrusive, in-circuit programming and debugging tool for $249.

The SX meets the form factor and cost constraints of the highest volume consumer, office automation, telecom, automotive, and industrial applications, with prices starting at $3.49 (1000 units) for the 2048 word (x12) device, and packaged in tiny 18- and 28-pin packages (DIP, SSOP and SOIC). In addition, power consumption is extremely low (ex: 12 mA active, 10 uA standby @ 50 MHz) making the SX well suited for portable battery powered designs. Though initial parts are specified at 3.3 -6.25V, the company will offer lower voltage versions (1.8 - 3.5V operation) within the next 6 months.

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│  ┌────────────────────┐      ┌────────┐      ┌────────────────────┐        │
│  │ Program Memory     │      │        │      │ Register File      │        │
│  │ (Flash)            │─────▶│        │◀────▶│ (SRAM)             │        │
│  │                    │      │        │      │                    │        │
│  │ 512x12             │      │        │      │ 136x8              │        │
│  │ 1Kx12              │      │        │      └────────────────────┘        │
│  │ 2Kx12              │      │        │      ┌────────────────────┐        │
│  └────────────────────┘      │        │      │ 8-bit Timer/Counter│◀──     │
│                              │        │─────▶│ with 8-bit Prescaler│        │
│  ┌────────────────────┐      │  SX    │      └────────────────────┘        │
│  │ Internal 4MHz      │      │  CPU   │      ┌────────────────────┐        │
│  │ Oscillator w/1:1 to│      │        │      │ Port A options:    │  4     │
│  │ 128:1 Divider      │      │        │─────▶│ TTL or CMOS        │◀─▶     │
│  ├────────────────────┤      │        │      │ Schmitt Trigger    │        │
│  │ External 0-50 MHz  │      │        │      │ Pull-Up            │        │
│  │ Clock Interface    │      │        │      └────────────────────┘        │
│  │ (XTAL, RC, etc.)   │      │        │      ┌────────────────────┐        │
│  └────────────────────┘      │        │      │ Port B options:    │  8     │
│                              │        │      │ Same as A&C plus   │◀─▶     │
│  ┌────────────────────┐      │        │─────▶│ Analog Comparator  │        │
│  │ Power On Reset     │      │        │      │ &.Wake Up On       │        │
│  │ Timer              │      │        │      │ Edge Detection     │        │
│  ├────────────────────┤      │        │      └────────────────────┘        │
│  │ Brown Out          │      │        │      ┌────────────────────┐        │
│  │ Detection with     │      │        │      │ Port C options:    │  8     │
│  │ Prog. Threshold    │      │        │─────▶│ TTL or CMOS        │◀─▶     │
│  ├────────────────────┤      │        │      │ Schmitt Trigger    │        │
│  │ Watchdog Timer with│      │        │      │ Pull-Up            │        │
│  │ 14.2 kHz Oscillator│      └────────┘      └────────────────────┘        │
│  └────────────────────┘                                                    │
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Historically Popular Architecture, Modern Implementation

Of the more than two billion 8-bit MCUs shipped annually the company estimates fully half the volume is comprised of a handful of historically popular MCU families. According to Steve Leung, President of Scenix, the challenge was to determine a way to "achieve a performance breakthrough without forcing customers to face the hurdles and uncertainties of an unknown architecture."

Of these popular architectures, the Microchip PIC® was deemed most worthy of further consideration. A key advantage is that a CPU with a small repertoire of fixed-length instructions and Harvard organization (separate instruction and data memory) is most amenable to upgrade with modern CPU design techniques. Thus, the SX is an object-code superset of the PIC16C5x® series, designed to work in applications, and be familiar to designers, using those chips.

Proven Pipeline, Speedy Memory

Besides a RISC-like instruction set and Harvard memory organization, pipelining has long been recognized as the most expedient path to higher performance. The SX four-stage pipeline is designed to deliver superior throughput while meeting the demands of cost sensitive and real time applications.

The pipeline consists of four stages; instruction fetch, data fetch, execute and result. Though avoiding esoteric and costly extremes, the SX pipeline does incorporate critical features such as 'bypassing' (sending the output of the result stage directly to the ALU to allow the next instruction to execute immediately) proven to deliver good results without compromising cost.

The benefits of pipelining and high clock rate can only be achieved if the memory can keep up. A notable breakthrough for the SX is the development of an extremely fast (tACC = 12 ns) EEPROM (2048x12) program memory, matched with equally high-speed SRAM (136 bytes) register file for data. EEPROM endurance is rated for 10,000 cycles. In addition, code memory is run-time readable, key factors for both lookups and meeting UL 1998 requirements.

Real Real-Time

Detecting and responding to real-world events in a timely fashion is key for most MCU applications. That's most certainly the case for 'Virtual Peripherals' in which SX software must deliver the fast and precise timing of dedicated hardware.

Here, the advantages of the SX RISC-like architecture over other MCUs are most apparent. Most of the older popular MCUs have CISC instruction sets in which instruction execution times are variable. Thus, interrupt response time for these chips is not predictable, varying from dozens to more than a hundred clocks depending on the instruction being executed when an interrupt occurs. This introduces unavoidable 'jitter' into the system timing, fundamentally limiting performance (i.e. resolution and S/N ratio).

By contrast, all SX instructions are fixed length (12-bits) and most execute in a single clock. As is usual in pipelined designs, branches take longer (3 clocks) since the pipeline must be refilled. However, the SX avoids even this small amount of uncertainty by simply canceling or 'annulling' partially executed instructions, allowing immediate response if an interrupt is detected.

Often older MCUs must further save critical registers before handling the interrupt and then restore them upon completion. To avoid this bottleneck, the SX includes dedicated stack locations and automatic state, save and restore.

The bottom line is that the SX responds more quickly and predictably (3 clocks for an internal interrupt request, 5 clocks external) than other 8-bit MCUs. In fact, according to Leung, "The deterministic, sub-100 ns interrupt response of the SX is superior to that offered by much higher priced 16-bit MCUs and DSPs".

Practical, Flexible I/O

Besides speed and real-time response, another key characteristic of embedded MCU applications is connection to a variety of sensors, actuators, communication ports and other ICs. To serve the widest range of applications, the SX offers an extremely versatile complement of I/O modes.

Each I/O line can be configured as input or output. Inputs can further be defined as either TTL or CMOS compatible, the latter offering symmetric switching (i.e. threshold is one half the power supply) that eases analog interfacing. Individually enabled on-chip pull-up resistors are provided for each line as well, eliminating the need to add them externally.

Since many real-world interfaces are characterized by noise and glitches, input lines can also be configured to use built-in Schmitt triggers that improve noise immunity and simplify external signal conditioning logic. Four of the lines feature large P-transistors designed to drive inductive loads such as speakers and ultrasonic transducers when configured as outputs.

Up to eight of the lines can be configured as external interrupt requests, allowing full exploitation of the SX high-speed interrupt capabilities. Besides redirecting program flow, the lines can also be used to wake-up the chip from power-down mode.

Minimizes System Cost

The advantages of the SX aren't diluted by the need for extra chips or components, thanks to the inclusion of the support logic functions required in typical applications.

An 8-bit timer with 8-stage exponential prescaler (i.e. divide by 1, 2, 4,...,128) provides a high-resolution timebase for the system while a dedicated watchdog timer, power-on-reset circuit and low voltage detection (with programmable threshold) protect the system without the need for an external 'supervisor' IC.

Though the SX accommodates a variety of external clock sources (i.e. crystal oscillator or resonator), it also generates an internal 4 MHz clock (+/- 8% Accuracy) which also minimizes EMI. Note that even at this low clock rate, the multi-MIPs performance of the SX exceeds that of older MCUs running at high frequency (ex: 12-33 MHz) since they require many clocks (ex: 12 for an 8051) to execute a single instruction.

Popular and widely used analog parts such as potentiometers and temperature sensors are accommodated by an on-chip analog comparator. Designers can exploit various hardware (ex: resistor ladder configured as a DAC, analog mux) and software (ex: oversampling, dithering) techniques to best utilize the comparator in light of the speed and accuracy required by their application.

Innovative Tools

The philosophy of the SX - superior performance, cost effectiveness and ease of use - are further reflected in the initial development tool offerings.

Parallax Inc. (Rocklin, CA; (916) 624-8333; www.parallaxinc.com) is offering a development system for the SX which includes hardware for in-circuit programming and emulation, PC-based assembler and debugger, demonstration board, two SX chips and an instruction manual.   According to Chip Gracey, President of Parallax, "The tool simply plugs onto four pins while the SX is in-circuit for a non-intrusive connection that doesn't compromise performance." The Parallax SX Key development kit sells for $249 and is scheduled for introduction in October 1997.

Byte Craft Limited (Waterloo, Ontario; (519) 888-6911; www.bytecraft.com) provides a C compiler (SXC) with a built in Assembler for the SX MCU. Byte Craft has had considerable experience providing software development tools for 8-bit embedded systems. The C compiler for the Scenix MCU was designed to take advantage of the architectural instruction set. The DOS version sells for $795.00 and the Windows / NT version sells for $1,595.00. Both versions of the C compiler will be available in September 1997.

Price & Availability

The first versions of the SX to be released have 2048 words (x12) of Flash EEPROM program memory is being offered in 18-pin (12 I/O) and 28-pin (20 I/O) packages starting at $3.49 (1000 units). Samples will be available in early October 1997 with production starting in late Q4 1997.

Scenix Semiconductor, Inc. is located in Santa Clara, California. The firm's mission is to deliver high-performance, cost-effective, easy to use single-chip solutions for embedded systems. The company, founded in 1996, is privately held. Scenix Semiconductor, Inc. can be found on the web at http://www.scenix.com.

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