[Leapfrog: Industry First]

Signal-Conditioning IC: A Low-Cost ASIC Alternative

Looking to penetrate high-volume applications, this standard part offers smart-sensor and multisensor compatibility.

Roger Allan
ED Online ID #10888
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Sensors are ubiquitous, providing the signals that feed our computer-centric world. The outputs for these sensors, though, must be signal-conditioned for computer use. This depends not only on the application involved, but also on the type of sensing technology employed.

As a result, many OEMs turn to expensive ASICs and their embedded codes, which can take one to two years and cost $1 million to $2 million to develop. The cost factor becomes more noticeable with the spread of sensor technology to mass-market applications like consumer electronics, as sensor-element pricing continues to tumble.

To combat those problems, Sensory Platforms Inc. developed the SSP1492 universal signal-conditioning IC. The chip provides smart-sensor and multisensor compatibility at a fraction of the cost of ASIC approaches. Essentially a standard ASIC-like solution for high-volume OEM applications, it eliminates lengthy development times and drastically cuts down on custom-chip costs.

"We're offering production quantities of this device with pricing in the $3 range for 1k lots, and $2 for 10k lots, using our present 0.35-µm process. Going to a 0.18-µm process will allow us to bring the chip's price down to under a dollar," says George Hsu, Sensor Platforms' president and CEO.

"We're initially targeting the consumer electronics sector, offering it as a viable signal-conditioning platform in cell-phone, PDA, and gaming designs," he adds.

The chip's die size is 18.6 mm^2. The company expects to scale it down to 4 mm^2 with next-generation processes.

The SSP1492 sensor-signal-processor chip consists of a standard IC core that contains the processing circuitry needed to interface directly with a wide variety of sensors. These include sensors based on operating principles of pulse, voltage, current, inductance, capacitance, and resistance *(Fig. 1)*. Up to 15 separate sensor input channels are available for highly flexible multisensor configurations, especially where applications call for collaborative processing of multiple and mixed-sensor inputs.

The signal-conditioning chip works with all types of sensors, including microelectromechanical systems (MEMS) and bulk-based devices. There are no active external components and only a minimum number of external passive components. It comes in either a 4-mm^2 bare die or in 80-pin land-grid-array (LGA) and micro-leadframe (MLF) packages.

A STANDARD APPLICATION PLATFORM

Based on the popular pipelined 8051 processor, the chip can function as a standalone sensor system controller or as a development platform for a wide variety of sensing and control applications. "The lack of a standard sensor application development environment has significantly restrained greater growth in the sensor industry," says Hsu. "Our chip will change all that."

A host of powerful signal-processing tools are featured on-chip. These include two integrated math engines for vector and scalar calculations, such as trigonometric, inverse trigonometric, geometric, absolute-magnitude, long-integer, and scaled fraction multiply, divide, add, and subtract functions *(see the table)*.

The chip's high-speed pipelined 8051 microcontroller runs at over 14 MIPS. A frequency-mode data converter brings scalable dynamic range, accuracy, and speed features. The converter consists of two stages: a sensor oscillator stage that's modulated by the sensor element's electrical properties and a period counter stage that demodulates the signal directly into a digital value.

Maximum resolution is virtually infinite with a native combination of internal registers at 16 bits and a default ROM containing routines for 32-bit sensor measurements as part of the chip's firmware. Note that 32-bit resolution is equivalent to one part in 4,294,967,296!

Two industry-standard serial interfaces, a serial peripheral interface and an I^{2}C interface, are available. There's also a programmable I/O for custom interfaces and controls.

The SSP1492 operates from a 3-V power supply, and 5-V-tolerant inputs offer compatibility with legacy and currently available sensor systems. Maximum current is 11 mA while operating, and 1 µA is dissipated in the static sleep mode.

The use of a 3-V power supply minimizes power consumption and addresses the need of IC manufacturers who power their products from standard batteries—an important consideration for consumer electronic products.

Applications for the SSP1492 sensor signal-processor IC are wide and varied. For example, the chip could work with a bridge-based piezoresistive pressure sensor *(Fig. 2)*. Each of the four piezoresistors of the sensor's bridge circuit are individually selected and connected with an external capacitor to the sensor's oscillator section using the configurable analog switches on the SSP1492.

Another application involves working with a tri-axial capacitive-type accelerometer (*Fig. 3*). Here, the eight sensing capacitors connect in parallel to the chip's CAP1 pin of the sensor's oscillator section. The output drivers of the SSP1492's general-purpose IO section selectively ground each capacitor so it can be switched into the oscillator section.

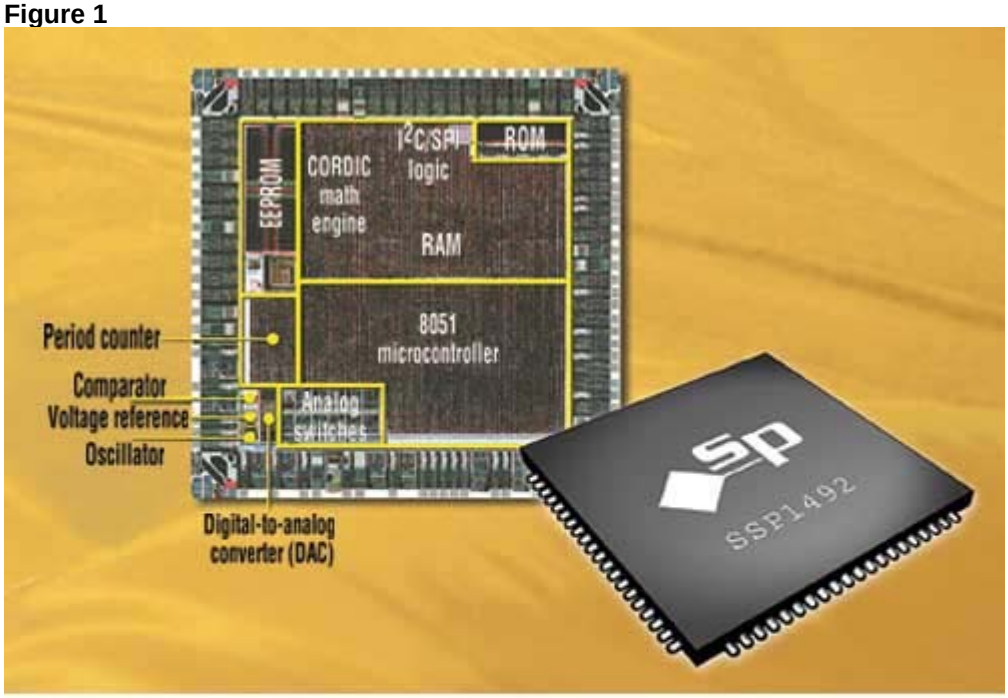
The company will offer an analog version of the SSP1492 without the digital circuits like the microcontroller. "This should bring large-quantity chip prices down to about $0.35," says Hsu.

A $395 development environment is also available with a USB interface, a serial EEPROM burner, and development/system analysis tools. The end user supplies the sensor and as few as three external passive components to Sensor Platforms. An evaluation can be made within a few hours.

To entice sensor manufacturers to work with them, the company has a special offer. "Any sensor manufacturer can use our sample program where they send us their sensors," says Hsu. "We hook them up to our development board and run them, then send the board back to them at no cost for the development environment."

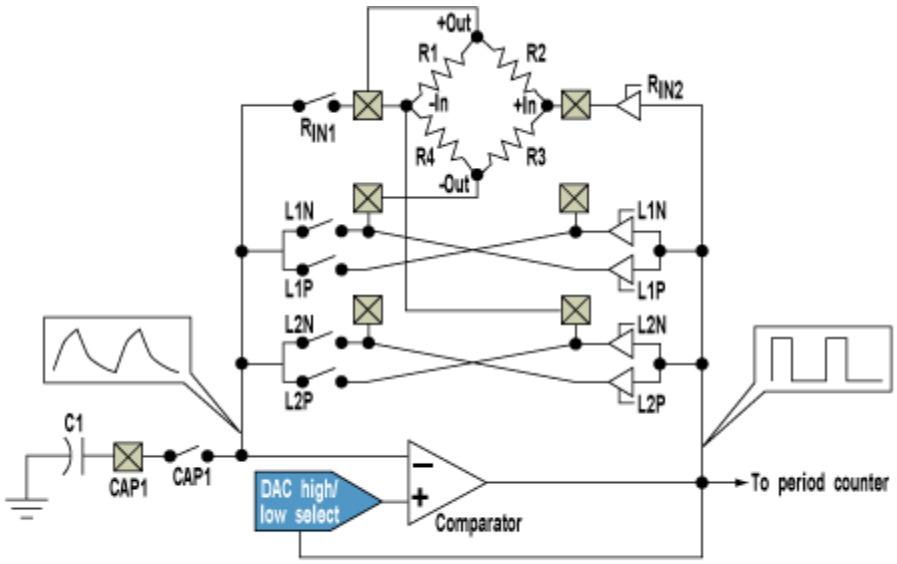
Sensor Platforms Inc.
www.sensorplatforms.com

Figure 1



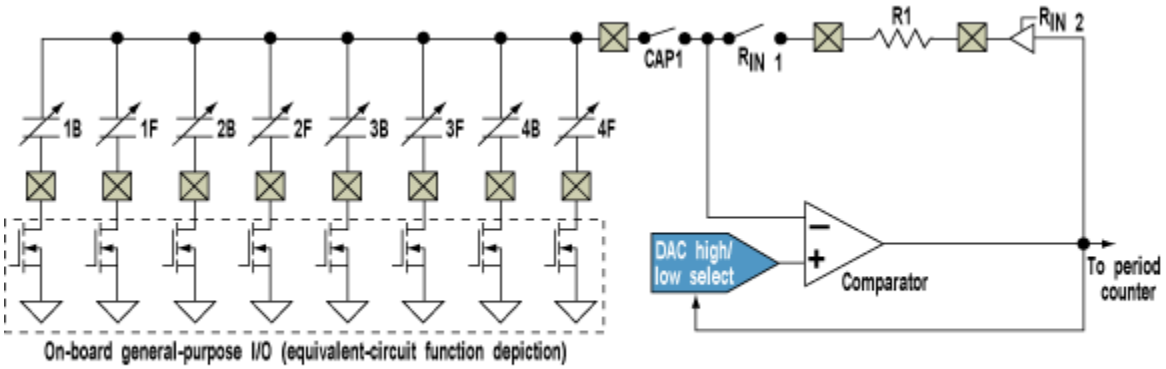
1. The SSP1492 can be used as a universal sensor signal-conditioning chip. It offers OEMs a low-cost, quick-turnaround option for multisensor inputs.

Figure 2



2. This basic bridge-based piezoresistive pressure sensor works with the SSP1492 universal signal-conditioning IC.

Figure 3



3. The SSP1492 signal-conditioning IC can be used with a tri-axial capacitive accelerometer.

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Table 1

MATHEMATICAL FUNCTIONS SUPPORTED BY THE SSP1492

Addition	Sine
Multiplication	Tangent*
Division	Arc cosine*
Square root	Arc sine
Exponent*	Arc tangent

Natural log (ln)	Hyberbolic cosine
Magnitude	Hyperbolic sine
Cosine	Hyperbolic tangent* Hyberbolic arctangent

*This function can be derived from the basic set of CORDIC functions

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