Leapfrog: Industry First

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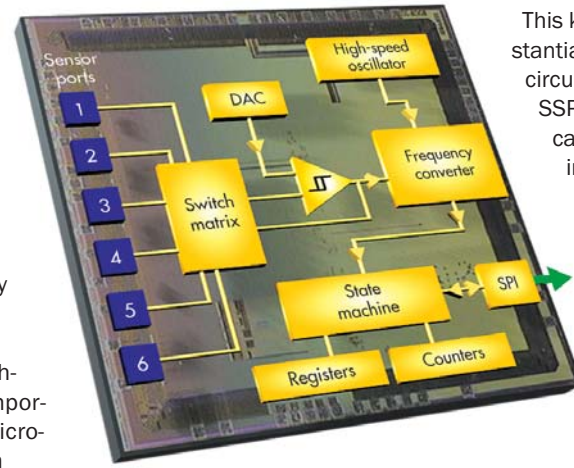
Six-Channel, Low-Power IC Makes Sense Of Sensing Interfaces

Designed for deeply embedded applications, this user-configurable chip accepts resistive, capacitive, inductive, piezoresistive, and pulse-count sensor signals.

The cost-competitive climate of the consumer, medical, industrial, and automotive markets has perpetuated a marked rise in sensor applications, prompting greater use of "deeply embedded" functions. As a result, the user hardly ever or even never interfaces with the embedded function, which is very tightly coupled with the environment around it.

In many of these applications, high-level code reconfigurability is less important than lower costs. A full-blown microcontroller unit (MCU) sometimes can be considered overkill. This is what Sensor Platforms had in mind when it developed its SSP1401 multichannel sensor interface IC.



1. Inductive, capacitive, resistive, and pulse-count sensor signals all can easily interface to Sensor Platform's SSP1401 multichannel sensor interface IC. It comes in a 28-pin package or in bare-die form. ***(courtesy of Stephen M. Traversi, FootHill Media)***

The device targets products with deeply embedded functions that require the signal conditioning of different sensor signals. Designers of these products typically don't have the time or budget to develop a sensor-interface product.

"The SSP1401 provides the technologies that both reduce the cost and time of sensor-application development and improve sensor performance," says George Hsu, Sensor Platforms' chief technology officer.

READY FOR ANYTHING • The SSP1401's six user-configurable I/O channels can drive (up to 63 mA) and measure most types of sensor elements, including resistive, capacitive, inductive, piezoresistive, and pulse-count devices *(Fig. 1)*. Falling under that umbrella are resistive, capacitive, and inductive accelerometers; capacitive pressure sensors; resistive and inductive magnetometers; and inductive linear variable differential transformer (LVDT) and velocity sensors.

In addition, the IC handles resistive temperature sensors, capacitive viscometer sensors, capacitive and resistive liquid-level sensors, capacitive dielectric-measurement sensors, capacitive touch sensors, and resistive conductivity measurement sensors. Sensors oscillating from 1 Hz to 1 MHz are compatible with the SSP1401's input.

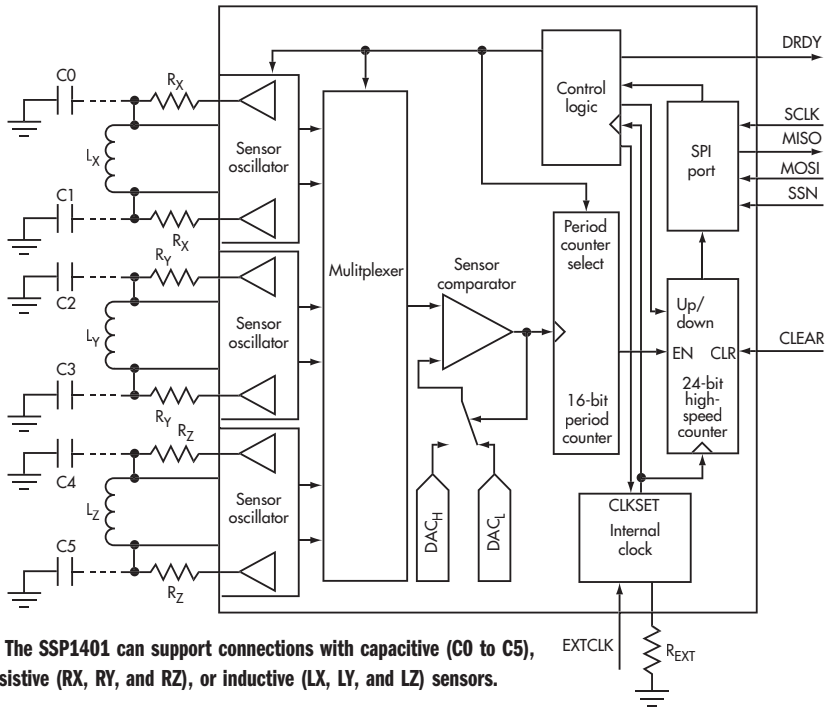
This kind of sensor "fusion" can substantially simplify the sensor-interface circuitry. For example, a single SSP1401 can interface with two capacitive pressure sensors, two inductive magnetic-resonance sensors, and two resistance-temperature detectors (RTDs). Many other combinations are possible.

Fully integrated, the SSP1401 only requires three discrete components besides the sensor element. It operates from a low-voltage (1.6 to 3.6 V) source and dissipates low operating current (less than 0.5 mA, depending on the sensor load and the sampling rate). In sleep mode, it dissipates less than 200 nA. The chip's dynamic range is 24 bits, and its effective number of bits rating is 13.

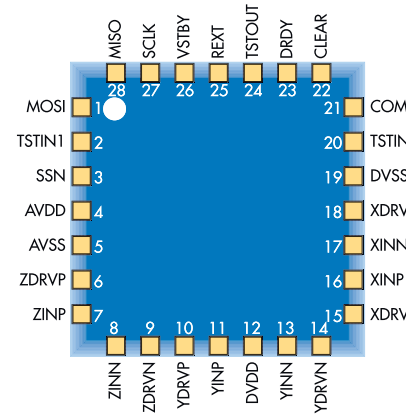
Furthermore, the SSP1401 operates from −40°C to 125°C. Its signal-to-noise ratio is rated at more than 13 bits. A 20-MHz internal clock allows for precise smaller measurements, and there's support for a 15- to 25-MHz external clock. An optional count-up and subtract-down capability supports back-to-front sensor measurements.

A CLEVER INPUT DESIGN • The SSP1401 truly enables fusion sensing applications. "Given the SSP1401's uniquely flexible frequency-mode interface technology, it is a natural fit for multi-sensor applications," says Kevin A. Shaw, director of business development at Sensor Platforms.

"For example, think of it driving a pair of magneto-resistive (MR) magnetic sensors for implementing an electronic compass function on a wristwatch while at the same time being able to drive a capacitive pressure sensor to provide altitude information," he continues. "This is a particularly interesting example since watch-based applications also benefit tremendously from the SSP1401's low operating voltage and power performance as well."



2. The SSP1401 can support connections with capacitive (C0 to C5), resistive (RX, RY, and RZ), or inductive (LX, LY, and LZ) sensors.



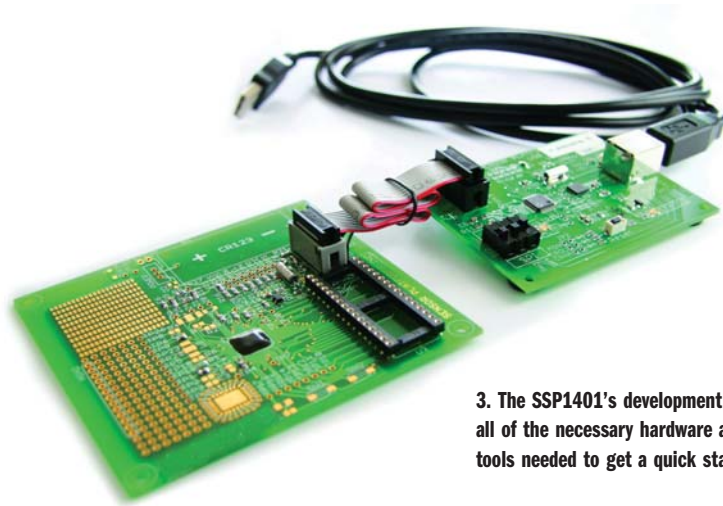
4. The SSP1401 comes in bare die form or in a 5- by 5-mm, 28-lead MLF/QFN package.

The interface IC's frequency-based analog front end is combined with an efficient, flexible, and deeply embedded state machine that brings high levels of control and operating configurability. Also, it doesn't require costly general-purpose MCUs and their attendant system overheads.

RELAXATION OSCILLATOR • The input circuit uses a relaxation oscillator incorporating LR or RC networks. It directly converts sensor signal values into digital form without the usual need for an analog-to-digital converter (ADC), cost-effectively delivering greater flexibility and performance *(Fig. 2)*. A six-input multiplexer circuit feeds sensor signals to a sensor comparator, which in turn feeds the signals to a 16-bit period counter.

Two adjustable input digital-to-analog converters (DACs)—a high DAC and a low DAC—allow for independent adjustment of high- and low-voltage swings. As a result, bias adjustments can be made on each sensor and the setting of a trigger point. Adjustable measurement times can be short, depending on the power budget. Short measurements mean less power consumption, while longer measurements create better resolution.

All communications between the sensor and the SSP1401 are performed via a digital serial peripheral interface (SPI) bus. To measure a given sensor, a request is sent via the SPI bus, and the interface chip's state machine and analog block are turned on. The sensor signal is measured, the results are stored in a register for later retrieval, and all non-SPI functions are returned to the sleep mode. Measurement completion is indicated by both a station register and a data ready (DRDY) pin, which can function as an interrupt trigger.



3. The SSP1401's development kit includes all of the necessary hardware and software tools needed to get a quick start.

A HARDWARE DEV KIT • The SSP1401's development kit features a simple touchscreen demo, which shows the chip's capabilities and simplifies hardware development *(Fig. 3)*.

The kit also contains a USB interface communications board, replete with an ARM7 processor housing 256 kbytes of memory code space, as well as a data-acquisition board with breakout ports. Its sensor board boasts six touchscreen capacitive buttons and an Eclipse-based integrated development environment (IDE) with data-acquisition and control system analysis tools.

The SSP1401 comes in bare die form or in a 5- by 5-mm, 28-lead plastic microlead-frame/quad flat no-lead (MLF/QFN) package that's compatible with the European Union's Restrictions on Hazardous Substances *(Fig. 4)*. It costs $2.24 each in 1000-unit lots (packaged part). Sample quantities will be available in the third quarter. Production quantities are scheduled for the fourth quarter.

Sensor Platforms
www.sensorplatforms.com

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