FOR IMMEDIATE RELEASE

Hitachi Announces to Begin Volume Production of Semiconductor Strain Sensors for IoT

-- Automotive technologies to be rolled out in a wide range of fields, including power systems, industry, and infrastructures --

Tokyo, Japan, **July 3, 2015 ---** Hitachi, Ltd. (TSE:6501, "Hitachi") and Hitachi Automotive Systems, Ltd. today announced that they have developed a semiconductor strain sensor that combines a sensor element and control circuit in a single chip, along with an original bonding technology, and have begun full-scale volume production of the new strain sensor.

The strain sensor can be installed in automotive devices, industrial devices, various infrastructure buildings and facilities, to accurately measure physical changes in strain resulting from forces exerted on those devices and structures. In this way, it will be possible to efficiently manage and control status of those, for example to enable the smooth operation of devices, and to diagnose the signs of potential failures. Furthermore, an original metal bonding technology incorporated into the strain sensor minimizes deterioration in the junction segments, achieving outstanding reliability in the long term.

The Hitachi Group will produce these strain sensors using the volume production platforms and high durability technologies that it has cultivated through the development of automotive components. At the same time, by utilizing these technology platforms in the future, it will roll out the strain sensors in a broad range of fields, including automotive, power systems, and industrial devices, aiming to create applications in solution services targeting the "Internet of Things" (IoT).

In recent years, new trends have arisen in the field of IT, as exemplified by M2M (Machine to Machine) technologies and the IoT. As more and more things become connected via networks, data that had not been used in the past is now creating new value. In the Social Infrastructure field, which includes automotive devices, industrial devices, and various infrastructure buildings and facilities, using sensors to measure and analyze physical changes in strain volumes is an effective way of ensuring that those devices, equipment, and various infrastructure buildings and facilities can be used with stability over many years. In many social infrastructure fields, however, sensors must operate for long periods of time in harsh environments characterized by high temperatures and high humidity. This places a huge burden on the sensors, and it becomes difficult to use conventional strain gauges, which are currently the mainstream, for extended periods of time, because the organic materials in the junction segments tend to deteriorate. In addition, depending on the type of object being measured, as in the case of motors, sensors are affected by electromagnetic noise, making it difficult to measure the data accurately. This has given rise to a demand for high functioning, high reliability, long-lasting sensors that can be used in a broad range of applications.

Hitachi Automotive Systems has now begun volume production of a strain sensor that uses an original heat-resistant, low-creep(*1) metal junction technology, enabling highly accurate measurements over long periods of time in heat environments with temperatures ranging from -40°C to +120°C(*2). Using a common sensor element, the sensor can measure changes in a wide range of physical quantities such as weight, pressure, torque, tension, and shear force, and can also continuously measure gradual changes, for example in low frequency vibrations. As such, it can be used in a wide range of fields, such as fluid volume measurement or the leveling(*3) of precision devices. The strain sensor incorporates CMOS(*4) processes, so it is compact and energy efficient, and by adopting a miniaturized sensor element, the effects of electromagnetic noise have been minimized as well. For this reason, it can be used not only in large infrastructure buildings and facilities, but also in small medical devices, where sensor installation had been difficult in the past.
To give one example of an application for strain sensors, Hitachi Automotive Systems has been shipping torque sensors since the end of 2012 as a mechanical component in battery assisted bicycles. The sensor measures the torque generated in the shaft when the rider pedals, enabling optimum motor drive to ensure smooth control in the pedal assist function.

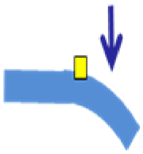
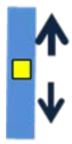
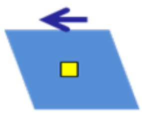
Recently, the Hitachi Group has begun research targeting the application of strain sensors in collaboration with industry and academia in the machinery, medical, construction, and civil engineering fields. Sensor technologies are expected to become a core technology contributing to increased competitiveness in Japanese industry. In the future, the Hitachi Group will roll out strain sensors not only in automotive applications, but also in Hitachi’s own power systems, construction machinery, industrial devices, medical devices, and infrastructure facilities. By connecting these and other devices via networks, Hitachi will strive to create applications in solution services to meet new needs in the era of the IoT.

The main features of the strain sensors are as follows.

(1) Accurately measures a broad range of physical changes

Hitachi Automotive Systems developed a sensor element using an original metal bonding technology and the high durability technologies that it has cultivated up to now, and using silicon CMOS processes, it has integrated the sensor element with control circuits, amplifier circuits, and an A/D converter[(*5)] in a single chip. The strain sensor uses a modular form, and so can measure a broad range of physical changes, including weight, pressure, torque, tension, shear force, and low frequency vibrations. The control circuits can also correct errors in the measurement data resulting from temperature changes, and the unit consumes 1/1,000th of the electric power consumed by conventional strain gauges, while enabling 25,000 times the sensitivity[(*6)], with measurements on the level of 1 microstrain (one millionth of a "strain unit")[(*7)].

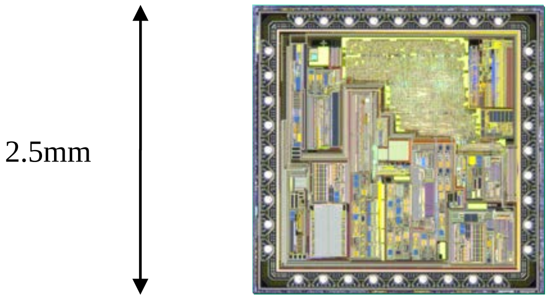
Semiconductor strain sensor

Physical changes / Detection load	Weight/pressure	Torque	Tension	Shear force	Low frequency vibrations (static strain measurement)
Module shape					
Typical applications	- Load/center of balance measurement - Precision device leveling	- Measurement of torque in rotating devices - Valve opening/closing detection	- Wire tension measurement - Overhead wire tension measurement	- Tank strain measurement - Plant monitoring	- Security - Flow measurement

Applicable shapes of the strain sensor

(2) Combination with high durability metal bonding technology achieves outstanding long-term reliability

The strain sensor can be attached to the object being measured using high melting point soldering, so even under harsh conditions characterized by high temperature and high humidity, the sensor can be used for long periods of time with no deterioration in the solder joint. Hitachi has also developed an original heat-resistant, low-creep metal bonding technology with less than 1/1,000th the creep volume at +140°C compared to AuSn[(*8)] joints, which are commonly used in high melting point solder. Because the entire surface of the sensor can be bonded to the object being measured, it is resistant to peeling, and thus achieves even greater reliability.



External view of the strain sensor

*1 Creep: Increased deformation occurring over time

*2 In continuous strain load testing (500 microstrain load applied continuously for 8,000 hrs.) under temperature environments ranging from -40°C to +120°C, output variance was 1% or less.

*3 Leveling: Precision devices such as semiconductor manufacturing equipment require a leveling accuracy on the scale of several microns (1/1,000th of a millimeter)

*4 CMOS: Complementary Metal Oxide Semiconductor

*5 A/D converter: Electronic circuits for converting analog signals into digital signals

*6 When using 1,000 times internal amplification

*7 1 microstrain: A strain unit representing deformation relative to the same object in a non-deformed state. For example, the strain volume when an object measuring 1 km expands or contracts by 1mm.

*8 AuSn: Gold-tin solder

About Hitachi, Ltd.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges with our talented team and proven experience in global markets. The company's consolidated revenues for fiscal 2014 (ended March 31, 2015) totaled 9,761 billion yen ($81.3 billion). Hitachi is focusing more than ever on the Social Innovation Business, which includes power & infrastructure systems, information & telecommunication systems, construction machinery, high functional materials & components, automotive systems, healthcare and others. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

About Hitachi Automotive Systems, Ltd.

Hitachi Automotive Systems, Ltd. is a wholly owned subsidiary of Hitachi, Ltd., headquartered in Tokyo, Japan. The company is engaged in the development, manufacture, sales and services of automotive components, transportation related components, industrial machines and systems, and offers a wide range of automotive systems including engine management systems, electric power train systems, drive control systems and car information systems. For more information, please visit the company's website at http://www.hitachi-automotive.co.jp/en/.

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