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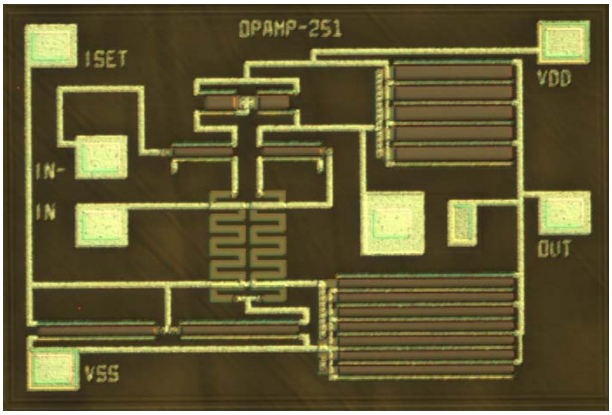
Development of CMOS Integrated Circuit Technology Utilizing Heat- and Radiation-Resistant Silicon Carbide (SiC)

- Combined with Sensors to Realize Edge Computing in Harsh Environments -



External view of a prototype SiC-CMOS integrated circuit (operational amplifier)

Tokyo, September 14, 2017 --- Hitachi, Ltd. (TSE: 6501, Hitachi) today announced the development of CMOS(1) integrated circuit technology that utilizes silicon carbide (SiC), a material that is highly resistant to heat and radiation. This SiC-CMOS technology enables highly-precise signal processing of data sensed in harsh environments, such as those that may be found in the automotive, manufacturing, nuclear power, and aerospace industries. By combining this technology together with sensors, Hitachi aims to realize the stable operation of highly reliable edge computing across a range of environments.

In an IoT(2) society, there is a need to process data sensed in a wide variety of environments with a high level of precision, and to collaborate with various systems. Further, in industries such as nuclear power plants and aerospace, there is also the expectation that IoT implementation will contribute to greater enhancement of equipment maintenance quality and safety. Currently, silicon-based CMOS integrated circuits are in main stream use for signal processing of sensed data. Their susceptibility to the influence of temperature and radiation however carries stability issues for harsh environments where they would be exposed to high temperature and high radiation. Extra measures such as distancing or shielding the circuit become necessary but these also raise further challenges such as data deterioration due to long distance transmission and environmental restrictions on where the circuits can be placed.

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In response to this challenge, Hitachi used SiC which has a high resistance to heat and radiation to develop SiC-CMOS integrated circuit technology that enables stable signal processing in harsh environments. CMOS integrated circuits consist of two types of MOSFETs,(3) n-channel (n-MOS)(4) and p-channel (p-MOS).(5) Previous attempts to develop SiC-CMOS had stalled for various reasons including the inferior performance of the p-MOS compared to the n-MOS. Applying processing techniques developed for Hitachi's power semiconductor business such as injection of impurities into the SiC and heat treatment, Hitachi was able to develop a high performance p-MOS, and apply it in integrated circuit for signal processing. Further, in order to increase the circuit's resistance to radiation, a device structure was adopted in which a protective electrode mitigating the effects of radiation was inserted into the insulating film that electronically protects the integrated circuit. Such developments realized the stable performance of a SiC-CMOS integrated circuit in harsh environments subject to high heat and high radiation exposure. A prototype SiC-CMOS operational amplifier(6) that amplifies signal data from sensors was created using this technology. The radiation resistance of this prototype was verified through stable operation at the required level of signal processing performance under radiation levels of up to 30 kGy(7). This represents a performance level equivalent to one hundred times that of a traditional silicon operational amplifier, and indicates that the prototype is appropriate for use in industries such as nuclear power and aerospace.

In the future, Hitachi intends to build-up its edge computing system for harsh environments where there is exposure to high temperature and high radiation, as part of efforts to enhance the reliability of social infrastructure.

This research result will be presented at ICSCRM (International Conference on Silicon Carbide and Related Materials), to be held from 17th to 22nd September 2017, in Washington, D.C., U.S.A.

(1) CMOS: Complementary metal-oxide-semiconductor
(2) IoT: Internet of Things
(3) MOSFET: Metal-oxide-semiconductor field-effect transistor
(4) n-MOS: MOSFET in which voltage is conducted by electrons
(5) p-MOS: MOSFET in which voltage is conducted by protons
(6) Operational amplifier: An integrated circuit that amplifies weak signals
(7) Gy (gray): A unit expressing the amount of radiation energy absorbed by matter

About Hitachi, Ltd.

Hitachi, Ltd. (TSE: 6501), headquartered in Tokyo, Japan, delivers innovations that answer society's challenges. The company's consolidated revenues for fiscal 2016

(ended March 31, 2017) totaled 9,162.2 billion yen ($81.8 billion). The Hitachi Group is a global leader in the Social Innovation Business, and it has approximately 304,000 employees worldwide. Through collaborative creation, Hitachi is providing solutions to customers in a broad range of sectors, including Power / Energy, Industry / Distribution / Water, Urban Development, and Finance / Government & Public / Healthcare. For more information on Hitachi, please visit the company's website at http://www.hitachi.com.

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