

Energy harvesting power management circuit technology for IoT sensor

Energy Harvesting Power Management IC for IoT Sensor

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Patent title Energy harvesting-based smart sensor and operation method thereof

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Authority status Filed

Technicality

Technology overview

The technology is an energy harvesting power management circuit technology for IoT sensors. The technology is for applying an energy harvester to devices, such as sensors and IoT devices, which consume a lot of load currents. IoT sensors which consume a lot of load currents during initial system booting can be stably operated through a load connection device that can detect an output voltage of an energy harvesting device and accurately detect the charge state of an energy storage device on the basis thereof, and a smart sensor that enters a boot mode.

Development background and problem to be solved

- When an energy harvesting device is used as a power supply device for a smart sensor, if a current consumed during the initial system booting of the sensor is greater than an energy harvester production current, it is difficult not only to drive the sensor but also to charge an energy storage device.
- Therefore, it is necessary to stably drive smart sensors that consume a lot of load currents during initial system booting.

Excellence and discrimination of technology

Excellence of technology

- The state of charge of an energy storage device can be accurately detected.
- Stable system booting is possible even when the output voltage of an energy harvesting device is very low.
- A power management circuit technology can apply an energy harvester to a device that consumes a lot of load currents.
- The application range of energy harvesters is expanded by achieving energy harvesters that can be applied to any load device.

Discrimination of technology

- An energy harvester output voltage is sensed, and the state of charge of an energy storage device is detected on the basis of a sensed output voltage.
- A load device that consumes more currents than a harvester's production current can be operated by connecting an energy storage device and a load device when the energy storage device is fully charged, and by disconnecting the connection when the energy storage device is discharged.
- The output voltage of an energy harvesting device is monitored, and system booting initiates after maintaining a sleep mode when the output voltage is lower than a threshold voltage for system booting.

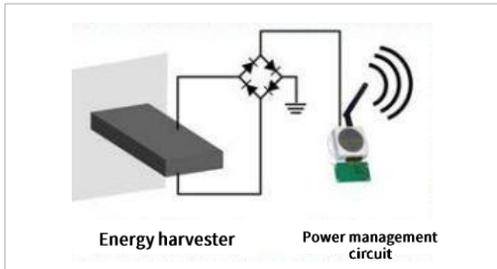
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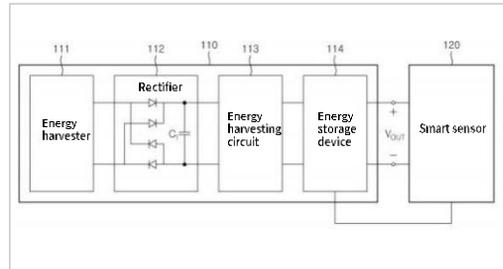
Implementation method

According to the present invention,

- Included are: an energy harvester, a rectifier, an energy storage device, and an energy harvesting circuit.
- The output voltage of an energy harvesting device is monitored. Then, a sleep mode is maintained and then a system is booted if the output voltage is less than a preset threshold voltage.
- System booting is performed without a sleep mode when an output voltage is greater than or equal to a threshold voltage.



Picture 1 Energy harvester power management circuit



Picture 2 Configuration of an energy harvesting system for an IoT sensor

Degree of technology completion (TRL)

Degree of technology completion: TRL5 (implementation environment application experiment stage)

TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Technical principle presentation	Technology concept setting	Technology concept verification	Lab Scale prototype development	Implementation environment application experiment	Full Scale prototype development	Quasi-commercial product development	Commercial product development	Commercial product implementation

Utilization

Utilization field and applied product

Utilization field

- Power device for driving a sensor/emergency lighting
- Energy harvesting power management circuit



Picture 1 Power device for driving an emergency lighting

Applied product

- Power facility diagnosis sensor
- IoT sensor for a smart factory



Picture 2 IoT sensor for a smart factory

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Technology trend

- Due to the expansion of the wearable and IoT device markets, the need for a power management integrated circuit (PMIC) technology for the miniaturization and long-term use of batteries is constantly being raised.
- Globally, low-area and high-efficiency PMICs are being developed to reduce a standby current and occupy less space on a printed circuit board (PCB) and a long-term operation of IoT devices.
- In Korea, electronics companies such as LG and Samsung Electronics are leading the market and gradually expanding the scope to automobile- and IoT-related fields, but the development of PMIC exclusively for IoT devices is still slow.
- Texas Instrument (TI), MAXIM, and the like are representative system semiconductor IC manufacturers and continue to introduce PMIC products for IoT devices.

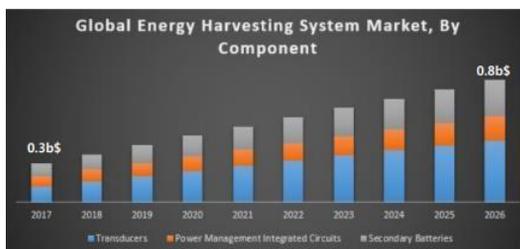
Family patent status

Application nation	Application No. (Application date) / Registration No.	Title of the invention
KOR	KR 10-2019-0105108 (2019.08.27)	Load connection device for energy harvester
KOR	KR 10-2019-0148472 (2019.11.19)	Battery charging device for energy harvesting
KOR	KR 10-2020-0044100 (2020.04.10)	Energy harvesting-based smart sensor and operation method thereof

Market prospect

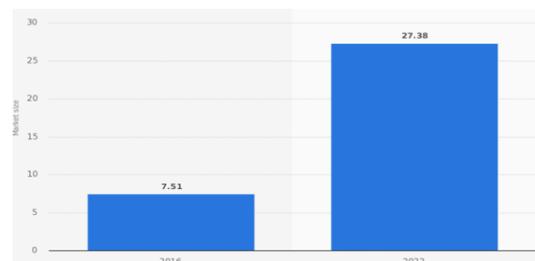
Target market size and prospect

The energy harvesting device market is expected to grow from USD 300 million in 2017 to USD 800 million in 2026, of which the power management circuit market accounts for about 20%. Meanwhile, the global IoT sensor market size is expected to increase from about USD 7.5 billion in 2016 to about USD 27.4 billion in 2022 at a CAGR of 24.1%.



Graph 1 Energy harvesting device market

<Data: markets and markets analysis_2020>



Graph 2 IoT sensor market

<Data: Zion Market Research_2017>

Technology transfer query

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Technology transfer process

