A Surface Acoustic Wave (SAW)-Based Sensor for VLSI Circuits

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The George Washington University researchers have published several research articles describing surface acoustic wave (SAW) devices with various characteristics. This summary relates to a Circular SAW Device based on CMOS fabrication, with interdigital transducers (IDT) that are in a specific concentric shape. Because the IDTs are in a circular shape, the device has a significantly lower insertion loss when compared with conventional SAW devices. The input IDT sends acoustic waves via a piezoelectric material to output IDT from the outer circle to the inner circle, and deliver the information by the phase or frequency shift in output electrical signal. Since the input IDT is much larger than the output IDT, smaller amount of input power is needed to generate same acoustic wave as the conventional rectangular device. Further, the circular design allows for concentration of sound wave, which reduces the insertion loss of SAW device.

Being a microelectromechanical system (MEMS) based device, it can be easily integrated with other digital signal processors (DSP) that are based on CMOS technology. Circular SAW Device can be incorporated into various electronic systems, systems-on-chip (SOC) products or components that can be mass-produced at a low cost and provide a better performance and potentially replace various existing sensors. The Circular SAW Device has a built-in heater to keep the sensor at a stable temperature; it can therefore work in a varied temperature environment with less interference.

A number of temperature sensors can be upgraded or miniaturized using the Circular SAW Device into various SOC products including devices like Very-Large-Scale Integrated (VLSI) circuits or central processing units (CPU). The sudden increase in temperature of VLSI circuits makes them unstable, which can potentially destroy the chip. The on-chip circular SAW sensor in this application is envisioned to monitor all kind of CMOS packaged chip temperature while processing feedback signal with low insertion loss. Therefore, all kinds of CMOS system can be monitored for temperature information with this invention.

The device can also be used as a mass sensor; depending on the size of the device, it can detect up to nano-gram of mass.

The device could be used as liquid concentrator for delivering drops of liquid which is useful for drug delivery or other liquid transportation, the device is useful for detecting properties of liquid.

The device can prove itself very useful as resonator, which is an important component of receiver/transmitter systems for wireless communication.
The unique property of this device is using all the material of the standard CMOS technology thus it is easily integrated with the electronics to produce smart device at low cost.

**Applications:**

- The Circular SAW Device can be incorporated as an integrated component in VLSI circuits and DSP units and fabricated as a part of the system-on-chip to perform various functions as stated above.

**Advantages:**

- Simple and low cost integrated CMOS sensor that is capable of performing multiple functions;
- Useful in various semiconductor devices