THE PUBLICATION FOR DESIGN ENGINEERS

DENA

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HALLOWEEN HORRORS?

HARDWARE, SOFTWARE, ANALOG, DIGITAL, DESIGN, AND TEST

DON'T BE AFRAID, WE'VE GOT YOU COVERED!

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EDITOR'S WORD

Scary, scarier, scariest

It's getting to be a scary world out there, and not only because we are in the season of Halloween. As it is said in a traditional Scottish prayer: "From ghoulies and ghosties and long-leggedy beasties and things that go bump in the night, Good Lord, deliver us!"

On the one hand, for example, generative artificial intelligence tools like ChatGPT offer the promise of making our jobs easier, helping with architectural evaluation, design, verification, and decision-making tasks. On the other hand, many people are becoming increasingly concerned that these tools may ultimately take our jobs away.

Personally, I'm a glass-half-full type of guy. Having said this, I'm reminded of the little boy who tells his dad, "I'm an optimist because my glass of milk is half empty." Chuckling, the father replies, "That's not the way it works, son. If you see the glass as being half empty, then you're a pessimist. If you're an optimist, you see the glass as being half full." The boy looks meaningfully at his dad and says, "It all depends on if you like milk… and I don't!" (You can't argue with logic like that.)

We are living in interesting times. The best we can hope is that they don't become too interesting. But turn that frown upside down into a smile because—no matter what the future holds and however scary it gets—all of us at DENA are here to help guide you on your way.

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ecia
Connect. Influence. Optimize

Obtaining unprecedented signal-to-noise using SigmaSense Sigma-Delta sensing

Self-biased sensing innovation enables breakthrough capabilities for impedance sensing

High sensitivity impedance sensing that delivers high speed data extracted from within a sea of noise is a challenge for every sensing circuit. Concurrent, self-biased sensing delivers superior results that eliminate most design challenges of the past.

Self-biasing background

Self-biased sensing circuits, also known as self-biased current mirrors or self-biased current sources, offer several advantages that make them an essential component in various electronic applications. These circuits use feedback to automatically adjust their biasing, which leads to enhanced performance, stability, and reliability.

Self-biased sensing circuits maintain a stable biasing condition regardless of process variations, temperature changes, and supply voltage fluctuations. This stability ensures consistent and accurate operation, which is crucial in precision applications such as instrumentation, sensing, and control systems. By reducing the impact of external factors, these circuits can provide reliable and repeatable results over a wide range of operating conditions.

Compared to traditional sensing circuits that rely on fixed biasing, self-biased circuits can significantly reduce power consumption. Since they continuously adjust their biasing levels, they only consume the necessary current required to maintain the desired output, minimizing wasted power. This advantage is particularly valuable in battery-operated devices and energy-efficient applications, where power optimization is essential to prolong battery life and reduce overall energy consumption.

Self-biased sensing circuits exhibit a wide dynamic range, allowing them to accurately sense and amplify signals of varying magnitudes. This feature makes them well-suited for applications that require the processing of weak or strong input signals without sacrificing accuracy or linearity. Consequently, these circuits find use in signal conditioning, audio processing, and communication systems where a diverse range of input amplitudes may be encountered.

In integrated circuit (IC) manufacturing, process variations can lead to differences in transistor characteristics, which can adversely affect the performance of traditional sensing circuits. Self-biased sensing circuits, however, are inherently less sensitive to process variations due to their feedback-based biasing mechanism. As a result, these circuits provide higher yield and reliability during the IC fabrication process, reducing production costs and improving overall performance.

Temperature fluctuations can alter the performance of electronic circuits, impacting their accuracy and stability. Self-biased sensing circuits can incorporate temperature compensation techniques that adjust the biasing currents in response to temperature changes. This compensation ensures consistent operation over a wide temperature range, making them suitable for applications in harsh environments where temperature variations are significant.

These sensing circuits can be designed with a smaller number of components compared to traditional biasing techniques. This simplicity not only reduces the overall complexity of the circuit but also results in a smaller physical footprint. This compact size is particularly advantageous in ICs, where real estate is at a premium, allowing for higher levels of integration

Shawn Gray, Founder, Chief Innovations Officer, SigmaSense LLC

and more functionality within the same chip.

Self-biased sensing circuits, due to their inherent ability to adapt to changing conditions, are more robust and reliable compared to circuits with fixed biasing. The feedback mechanism ensures that the circuit operates within its desired range, minimizing the risk of component stress, saturation, or other operational failures. This reliability is essential in safety-critical applications, automotive electronics, and aerospace systems, where any failure could have severe consequences.

SigmaDrive

This novel simultaneous drive and sense implementation encompasses all four primary analog and digital functions

(AFE, ADC, DAC, and DSP) integrated into each channel on a single pin! What? No multiplexing? SigmaDrive fundamentally exceeds the capabilities of the customary sigma-delta designs by using self-excitation and self-biasing, as well as a current feedback loop on every channel for concurrent sensing functions.

It's all about Tau

Tau is the time constant of an RC circuit that it takes to change from one steady state condition to another steady state condition when subjected to a step change input condition. Why is this relevant? Electronic circuits are not always in a stable or steady state condition but can be subjected to sudden step changes in the form of changing voltage levels or input conditions. For example, the opening or closing of an input or output switch.

However, whenever a voltage or state change occurs, a circuit with capacitive and/or inductive elements cannot respond instantaneously and will require time to reach a stable state. The change of state from one stable condition to another generally occurs at a rate determined by the time constant of the circuit, which itself will be an exponential value with an exponential decay. The time constant of the circuit will define how the transient response of the currents and voltages are changing over a set period.

Sensor arrays such as switched capacitive touch systems can only run as fast as the system can switch, settle, and sample. The SigmaDrive architecture operates continuously on every channel mitigating the effects of system RC timing constraints providing for higher performance and ease of sensor design. No longer is there need for uniform impedance sensors or equal length traces. Concurrent sensing of all nodes simultaneously enables advanced noise cancellation techniques, further improving signal-to-noise results.

Conclusion

SigmaSense has redefined analog sensing. With the development of a reimagined Sigma-Delta architecture, radical improvements are made in sensitivity and signal-to-noise ratio (SNR). These consequential improvements are a result of a four-fold approach: a redefinition of the Sigma-Delta architecture, removal of quantization noise inherent in Sigma-Delta techniques, aggressive narrowband DSP filtering, and dynamic noise avoidance made possible through spectral analysis. Furthermore, our direct-to-digital frequency domain approach removes the additional power-hungry analog pre-processing circuitry found in typical AFEs leading to a 90% digital chip that is smaller, lower cost, and lower power.

While technologies exist for general sensing applications, manufacturers today need new sensing capabilities to solve difficult problems and enable better outcomes for the manufacturer and the end user. For system designers, sensitivity, noise rejection, high SNR, and low power consumption are paramount. SigmaDrive is the solution to all these challenges.

New user experiences require new sensing features that are not available today. The extensive capabilities of SigmaSense's technology makes possible future devices that deliver on designer needs and facilitate innovative user experiences.

www.sigmasense.com

"SigmaSense's technology makes possible future devices that deliver on designer needs and facilitate innovative user experiences"

SigmaDrive single pin block diagram