Self-Healing Circuits: A Living Immune System for ICs

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One of the challenges of working with integrated circuits is as designers try to make ICs faster, the transistors become smaller and can’t handle as much voltage and the amount of variation grows. Plus, a single fault in the IC could mean a useless chip, bringing projects and products to sudden jarring halt.

Consequently, for the last five years or so, a team of researchers at the California Institute of Technology has been working to create self-healing ICs. Earlier this year, researchers from the High-Speed Integrated Circuits laboratory in Caltech’s Division of Engineering and Applied Science, demonstrated the self-healing abilities of the chip. The team use a laser to destroy parts of a chip and allowed the chip to assess the damage and reconfigure itself to work without the destroyed parts.

“It’s a biologically inspired system with sensors that can detect functionality and modify remaining circuits,” says Ali Hajimiri, PhD, a professor of Electrical Engineering at CalTech. “We needed a system that could identify and correct as it goes.”

To test the system in the case of partial and total transistor failure, the team cut out parts of an amplifier—first half of the CH transistor, followed by half of the CG transistor and then the entire stage—allowing for self-healing at each level, according to the paper published in IEEE Transactions on Microwave Theory and Techniques.

They found that although the performance degraded, the ability to heal the degradation increased.

The system acts similarly to an immune system, says lead designer Steven Bowers, a graduate student in Electrical Engineering at Caltech. Though the initial aim for the project was to use the digital processing strengths of foundries to maintain very aggressive high-performance analog designs, self-healing is also a solution for that issue.

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