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Research News

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FASTER, SMALLER & MORE VULNERABLE?
BUILT-IN-TEST ROUTINES ANALYZE CHIP
SUSCEPTIBILITY TO INTERFERENCE

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Photography Available

As integrated circuit (IC) devices become smaller, faster and more complex, they also become more vulnerable to electromagnetic interference. Under contract to the U.S. Air Force, researchers at the Georgia Institute of Technology have developed a time-saving method for analyzing the electromagnetic susceptibility of integrated circuits using the test sequences now built into many chips.

Susceptibility data on advanced technology ICs is crucial for ensuring that military electronic systems will successfully operate in their intended electromagnetic environments. The new test method provides a cost-effective way of gathering that data, and could help manufacturers meet electromagnetic interference standards likely to be imposed in the future -- without substantially raising the cost of integrated circuits or affecting the time required to test the devices.

"The newer technology devices have been greatly enhanced from a performance standpoint," said John Daher, senior research engineer at the Georgia Tech Research Institute (GTRI). "Unfortunately, the changes that help chips perform better functionally also tend to make the devices more susceptible to interference."

New VLSI and VHSIC devices use smaller geometries to allow placement of more gates on a single chip. Wider bandwidth devices are used to obtain higher data rates, while smaller signal levels cut power needs and reduce heat dissipation requirements.

But the smaller internal components offer less resistance to burnout from radio frequency (RF) energy; the wider bandwidths make the ICs susceptible to a wider range of interference, and the lower operating voltages make it more difficult for the devices to distinguish between data signals and interference, said Daher.

The growing complexity of integrated circuits has also made quality assurance testing more difficult and expensive, accounting for up to a third of the cost of new electronic components. In an effort to control those costs, most VLSI manufacturers now build self-testing capabilities into their chips.

The built-in-test capability is designed to determine whether the circuit functions properly, but the GTRI researchers have demonstrated that the capability can also be adapted to measure the circuit's susceptibility to interference.

"Built-in-test allows the susceptibility of a very complex device to be tested with little more than a function generator, oscilloscope, power supply and a source of RF energy," said Daher. "We have demonstrated that by using built-in-test procedures, one can obtain susceptibility data which is essentially identical to data obtained using conventional test procedures -- which are more difficult and costly."

While operating in a self-test mode, the chips typically isolate themselves from external inputs, which limits the number of pins that can be tested. But Daher's group found that the circuit's response to electromagnetic interference could be accurately assessed by studying the response of the clock pin, which is always accessible for susceptibility testing.

Electromagnetic interference can cause two types of problems in digital integrated circuits. The devices may be susceptible to "stuck at" faults, in which the device output is unable to switch from a high logic state to a low logic state, or vice-versa. Integrated circuits may also suffer from "timing jitters," which can cause circuit operations to occur at irregular sequences, Daher explained.

Electromagnetic interference can affect all electronic components, but the problem is more severe for the military, which must counter hostile jamming threats and operate multiple electronic systems on the same platform.

"On a typical military aircraft, several very high powered transmitters must operate with sensitive electronics on board," he noted. "You can end up inadvertently jamming yourself."

The growing problem of electromagnetic interference has led to discussion of standards that would mandate minimum levels of immunity. If such standards are imposed on manufacturers of integrated circuits, the GTRI test method should prove attractive because it allows measurements to be made quickly using relatively inexpensive test equipment.

"What we are doing will make the imposition of specifications more cost-effective and tolerable to the manufacturers," said Daher. "It would be self-defeating to impose standards that would make the cost of chips too high."

With additional support from the Air Force's Rome Air Development Center, GTRI engineers have recently begun a third phase of the project: exploring the electromagnetic susceptibility of interface devices used to electronically modulate optical signals.

Fiber-optic components offer several advantages over their electronic counterparts. One important advantage is relative immunity to interference -- but that immunity may not be complete.

"People are beginning to realize that photonic components aren't necessarily immune to interference because at any electronic interface, the potential exists for interference to be coupled into the circuit," Daher explained. "No systems in operation today are totally optical."

That portion of the project, assessing electro-optic, acousto-optic and magneto-optic components, will continue for approximately two years.

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