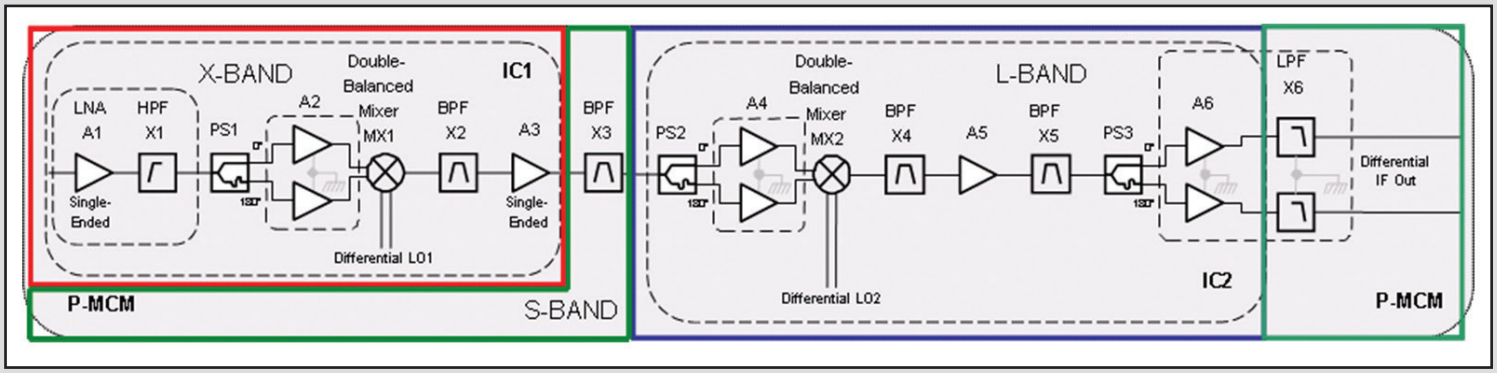
Self-Healing Circuits Boost Performance, Cut Costs



As part of supporting a Defense Advanced Research Projects Agency effort to create self-healing integrated circuitry, AFRL sensors scientists oversaw development of a wideband, 6-18 GHz receiver-on-a-chip with baseband outputs, the architecture of which is illustrated. (Air Force image)

In supporting the Defense Advanced Research Projects Agency's (DARPA) pursuit of affordable high-performance electronics, AFRL sensors scientists are addressing the tendency of high-frequency integrated circuits to become increasingly smaller and, further, more costly due to mounting difficulties in achieving totally defect-free parts. The diminishing yields of quality circuits, which are critical components of every major military weapons system, are caused by environmental and process-related effects—or more specifically, defects—that combine to limit circuit performance. To combat this issue, the research team recently demonstrated on-chip sensors and actuators designed to automatically adjust a given circuit's performance to negate defect-induced degradation. Essentially, these self-healing, mixed-signal integrated circuits, or HEALIC, adjust to existing conditions in order to maintain the desired level of functionality.

As part of aiding the DARPA effort to realize this self-healing capability, sensors scientists managed the development of a wideband, 6-18 GHz receiver-on-a-chip with baseband outputs. Concept chip fabrication occurred via an advanced, 65 nm CMOS (complementary metal oxide semiconductor) technology, with the subsequent demonstration activity presenting the integrated designs containing this self-healing circuitry. The newly-concept-demonstrated chips will next undergo test with and without self-healing algorithms in order to demonstrate their capacity to maintain performance parameters without significant increases to the size or power consumption of the integrated circuit in which they reside.

The Phase I goal is to achieve greater than 75% performance yield and less than 10% power consumption overhead, whereas Phase II will demonstrate a complete HEALIC with greater than 95% performance yield and less than 5% power consumption overhead. Ultimately, the self-healing technology will have a major impact on the defense community's access to economical military electronic systems offering extended lifetimes and high performance even in extreme mission conditions.