

# FPGA-Centric Design Concepts for Advanced Test and Measurement Systems

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**Abstract**—Today, measuring instruments are essentially measurement computers, and automated test systems would be inconceivable without computers. Many measurement methods can only be implemented economically through internal device information processing. While sequential controls can still be implemented with simple microcontrollers, measurement data processing sometimes requires powerful signal processors or even real-time processing. Due to their flexibility and inherent parallel processing potential, Field Programmable Gate Arrays (FPGAs) are increasingly being used in measurement and test technology. In this article, the author will present his own previous work as well as future-oriented concepts. One example is the Cyber Physical Test System (CPTS), which offers small and medium-sized enterprises a low-cost perspective for the production testing of embedded systems. CPTS is essentially based on an integrated circuit (IC), namely a so-called FPGA platform IC, and uses the concept of synthetic measuring

instruments or, more briefly, synthetic instruments (SI). By partially configuring the FPGA with SIs on a case-by-case basis, comparatively "small" FPGAs can be used, thus saving costs. From a cost perspective, simulated sensors can also be integrated using the same principle. Even more conceptual is the idea of a Digital Twin (DT) emulating units under test (UUTs) in real time using FPGAs, thus enabling the early creation and evaluation of test programs before a physical UUT even exists. Behavioral failure modes can be emulated even before the structure of a UUT is known. Finally, the concept of DT is "turned around" to the emulation of automatic test equipment (ATE) with the goal of "ATE-agnostic" execution of test programs.

**Keywords**—FPGA, Automatic Test Equipment, Synthetic Instrument, Digital Twin