Functional Verification of an FPGA-Based Electronic Module designed for an Aeronautic Application (DO-254 DAL-A)

The Challenge

Designing a fully automated test bench, qualified for testing complex electronic modules (FPGAs) developed in an aeronautic environment, with a built-in self-test capability is challenging. On the top of this challenge, the test also needed to be integrated in the verification process in line with the recommendations of the DO-254 standard, level A.

The Solution

Using the NI PXI platform with a customized test interface board driven by a PC running an application developed with NI LabVIEW system design software and NI DIAdem data management software to design the system. The whole system provides acquisition and management of the module signals as well as analysis, verification, and automatic report creation.

Figure 1: The test bench with the PXI platform.

As a DO-254 methodology expert, Oxytronic developed an automated test bench to achieve the functional verification of a complex electronic module (FPGA) that was designed for an aeronautic application. This verification had to be performed according to the recommendations of the DO-254 methodology at level A. This test bench also needed to integrate an analysis engine as well as a reporting engine following acceptation criteria defined by the user.

Automated and More Reliable Tests

In the original solution, tests were manually performed and analyzed and corresponding results were reported. The new system we developed allows for the optimization of the time required to execute and analyze the tests and it minimizes the risks of making mistakes when reporting the verification results. This new approach provides better integrity of results and analysis and ensures, at a lower cost, the non-regression of the FPGA after the various specification modifications that are typical in such projects.

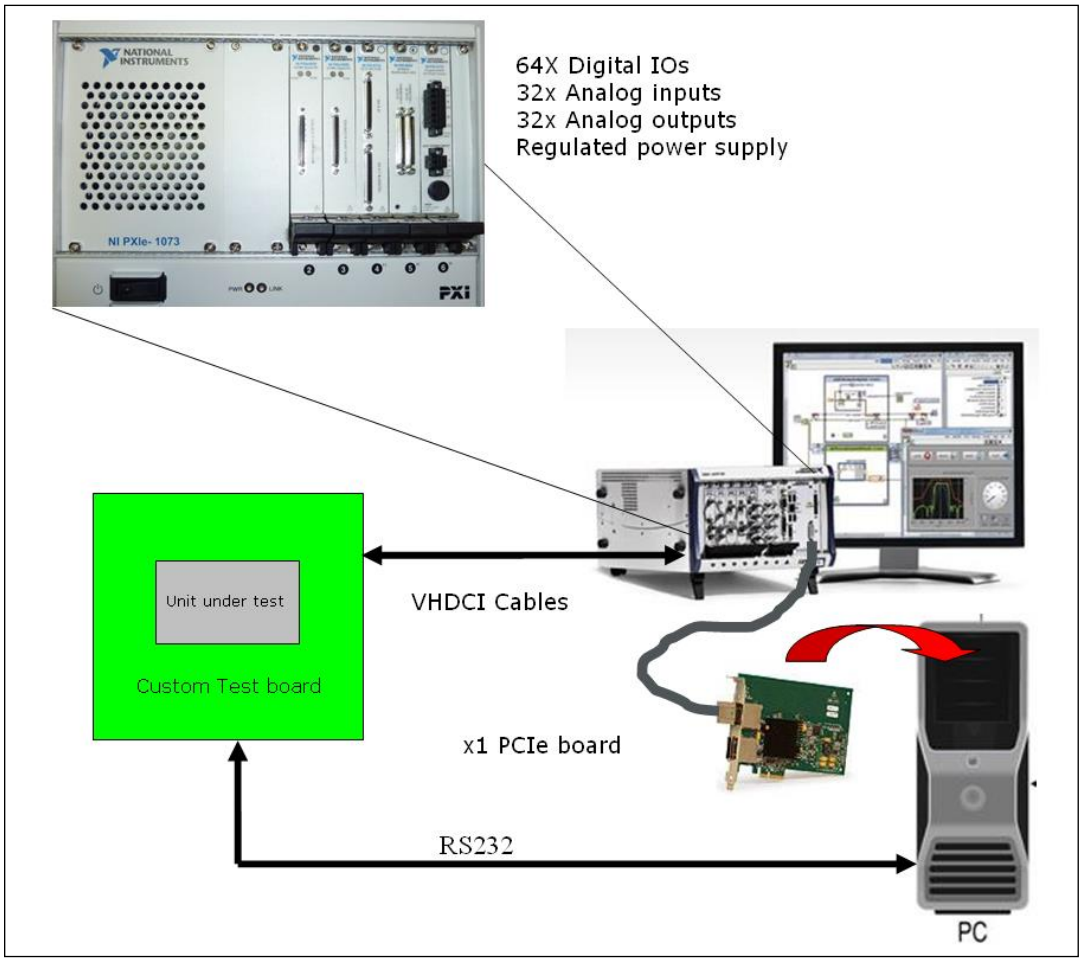

Figure 2: The test bench is made of a PXI chassis equipped with five analog and digital I/O boards

Different Types of Data at I/O

The module being tested is simultaneously handling analog and digital signals driven by the FPGA both at the inputs and outputs. For this reason, the test bench is made of an NI PXIe-1073 chassis equipped with five NI modules: two NI PXIe-6535 high-speed digital I/O, one NI PXI-6224 M Series DAQ, one NI PXI-6723 analog output, and one NI PXI-4110 programmable, triple-output precision DC power supply.

Data is centralized on a PC via a specific application that manages all collected and produced data. A custom board integrating the module being tested is also driven by this application, thanks to an RS232 link with the PC. The board is connected to the PXI chassis via a set of custom cables.

A Synchronous System to Guarantee Traceability

The boards used here offer different features. This is the case for the sampling frequencies, both for the acquisition and generation signals. The DO-254 flow requires the traceability of the verification tests, making it mandatory to “start” all boards simultaneously. The PXI platform, which integrates the trigger and “hardware” clock lines that connect the various boards, ensures synchronization of all the signals produced by the test bench.

Automated Management of Test Procedures

The document that describes all actions for each test procedure and the corresponding expected results was translated into scripts that are directly usable by the application software. Therefore, a specific instruction set was integrated within the application. The documentation describing the different procedures also uses this instruction set. The documentation is closed to the scripts used by the test application, which facilitates its review and minimizes the time needed for the adaptation or the development of these procedures.

Starting from these scripts, the application fully automates the sequencing and the execution of these procedures on the test bench, the analysis of the various tests, and, finally, the verification of the results. The results are provided as reports for each procedure: the verified requirements, the realized tests, the expected results, the actual results, and the associated status (OK, NOK). It then becomes easy to guarantee the traceability of the results as required by the DO-254 methodology.

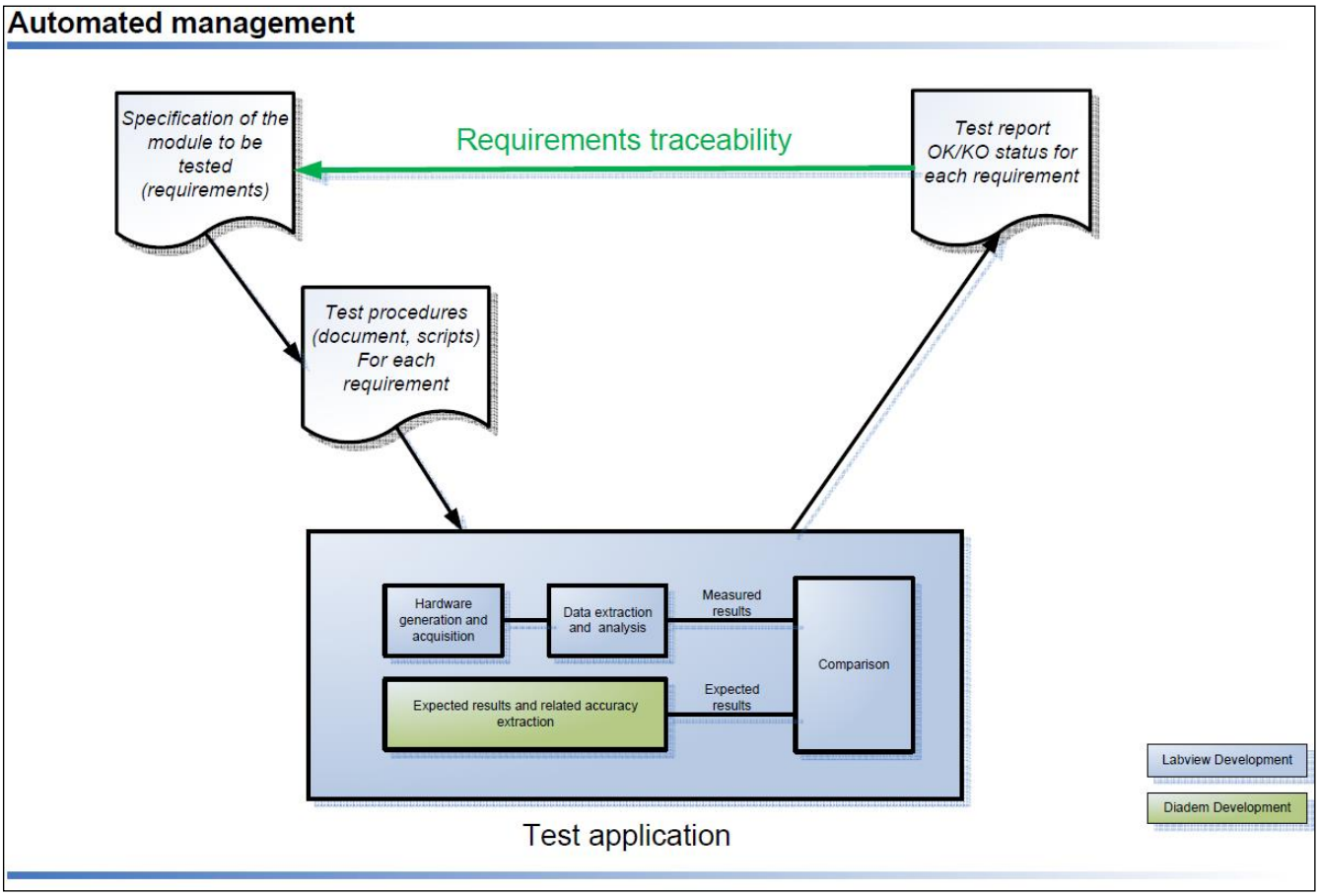

Figure 3: For each test process, actions and corresponding expected results are written with scripts directly executed by the application.

A Qualified System

The calibration certificates of the various NI boards ensure the technical features of the hardware. Given the automatic feature of the test bench, a set of dedicated test sequences using all self-verification mechanisms was developed to prove its integrity. The qualification file obtained with these two points helps us to justify the coherence of the verification results.

Taking Advantage of Development Tools

The verification application was developed using LabVIEW software to configure the PXI platform and set up the various hardware synchronization devices for data acquisition and generation. Many examples on the web and technical support greatly facilitated this process. For the results verification, we used DIAdem software, driven by LabVIEW, to reduce development time and simplify the manipulation and analysis of data coming from several sources with several sampling frequencies.

Conclusion: Successful Optimization Despite Constraints

The realization of this test bench optimized the time and resources needed to execute the tests, especially for the evolution of the functionality of the module to be verified, to ensure its non-regression. These optimizations are compatible with the constraints imposed by the DO-254 standard level A because of result coherence and traceability.

About Oxytronic

Oxytronic is an electronics equipment design and manufacturing company for the Aerospace, Defense, Nuclear and Industry area. With the acquisition of Barco Silex France in 2017, we now have a strong expertise and over 10 years of experience in ASIC and FPGA development under DO-254 guidance for prestigious clients such as Airbus, Safran, Thales, etc.

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