G Systems Designs Flexible Semiconductor Test Executive with LabVIEW and NI TestStand

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NI Products Used:
NI TestStand, LabVIEW, and PCI-GPIB

Pull Quote
This custom system solution saved more than $100,000 when compared to buying an entry-level commercially available mixed-signal tester.

The Challenge
Designing and implementing a custom functional test system for producing many types of semiconductor hybrids. The system should provide a flexible test architecture, easy-to-use development environment, intuitive production graphical interface, instrument and product interchangeability, reduced maintenance cost, and the ability to archive product test data.

The Solution
Creating a custom test executive with user-configurable step types. With this architecture, the user can quickly assemble and configure new custom test sequences for different hybrid semiconductor component production testing. The NI TestStand executive executes the test sequences, performs test step pass-fail evaluation, and archives the final test results for future analysis.

Software Architecture that Affords Quick Test Application Development
Our challenge in designing a flexible production test system was to provide a software architecture with which to quickly develop test applications for many different products. We could easily migrate NI TestStand and LabVIEW test sequences developed for one product into many new products. By abstracting the instrument drivers and building configurable step types in NI TestStand, the system supports a variety of test hardware configurations and allows dynamic test parameter configuration, resulting in a flexible production test system that meets the ever-changing requirements of today’s manufacturing environments.

For this project, Micropac Industries, Inc. performed an internal cost study on many commercial off-the-shelf solutions and decided to use an architecture based on National Instruments NI TestStand and LabVIEW. The cost study showed that by combining NI TestStand and LabVIEW to create custom test solutions, the system would pay for itself in approximately one year. It would be easy for the technicians to understand the LabVIEW module functions, perform test module modification, and use the modified code to create new product applications. So we replaced the manual hybrid component testing process using bench instruments with NI TestStand, LabVIEW, and a VXI-based automated test equipment (ATE) system.

Designing the Custom, Configurable System
The system instrument abstraction layer is comprised of several instrument classes for instrument interchangeability using interchangeable virtual instrument classes and drivers. Where interchangeable virtual instrument drivers do not exist, a “wrapper” class calls existing plug-and-play instrument drivers, and abstracts instrument functionality for each class. The instrument classes automatically detect hardware models and provide a high-level interface for seamless code integration.

The “ini” file structure provides instrument ID extraction through the instrument’s name (e.g., [DMM1], [PS1]). The user can configure system instruments simply by editing the “ini” file, without modifying the low-level code. The LabVIEW instrument manager VI makes up the instrument communication core. The instrument manager internal cache shift registers (LabVIEW GOOP technique) store the instrument information.

With the configurable test step, the user can configure test parameters during sequence editing without additional programming. Configurable test steps provide the user with a graphical user interface (GUI) to configure the test parameters. When users configure a test step, they can set test parameters while visualizing how those parameters affect the pass/fail test status.

We built custom configurable steps for each instrument. Based on the test plan, we developed several configurable test step types for performing measurements. These custom configurable steps give the user the flexibility of scripting new test sequences for testing hybrid circuits.

For debugging and testing a new UUT model, the NI TestStand Sequence Editor executes the test sequence and process model. The sequence editor is easy to use during new product development because it offers the flexibility to change test parameters, modify execution flow, and view watch variables in a debug mode.

The Active X GUI controls the NI TestStand engine for loading sequence files and executing tests and provides centralized run-time memory space for shared data. Using NI TestStand API calls (UI messages), data transfers between NI TestStand and the custom operator interface. The NI TestStand property loader loads the test limits and parameters based on the temperature at which the component is being tested.

The test system process model behavior is subdivided into five main subsequences. During model PreUUTLoop, the process model identifies, initializes, and configures each instrument. Model PreUUT sets the temperature, makes the connections to the unit under test, and performs the recurring initialization tasks. MainSequence performs the main sequence of test steps while evaluating results against test limits. Model PostUUT increments the temperature index. The system calls Model PostUUTLoop during shutdown to close instrument handles and perform other necessary shutdown functions.

The system triggers this call only when the main step record results indicate property is enabled. The system sets a precondition to log the data when the data-logging function is enabled and the step type is a custom numeric limit or pass/fail test.

With the configuration entry point – a LabVIEW GUI – the user enters the part and lot number, limits file and data-saving directory paths, tests temperature selection to be executed, and sets the data saving enable-disable option.
G Systems, Inc. developed the GUI in LabVIEW by customizing the example run-time operator interface that ships with NI TestStand. We used the example code shipped from National Instruments as a baseline, which greatly reduced the GUI development time by initially providing most of the required test executive features.

The ATE system tested many of the hybrid’s component sections for proper functionality at different temperatures. The system took specific measurements, including reference, oscillator, output, error amplifier, pulse width modulation, under voltage lock out, and soft-start section testing.

It also performed tests such as input bias/offset current and voltage measurement, common mode rejection ratio, power supply rejection ratio, clock high and low, threshold, rise time, fall time, TON, and TOFF.

**Quick, Flexible Test with Reduced Costs**

Utilizing National Instruments NI TestStand and LabVIEW applications, G Systems, Inc. quickly created a user-configurable hybrid semiconductor functional test system. This custom system solution saved more than $100,000 when compared to buying an entry-level commercially available mixed-signal tester. The system greatly reduces the product test-cycle time versus the previous method of manual test. It provides a flexible test architecture, an easy-to-use development environment, an intuitive production graphical interface, instrument and product interchangeability, custom configurable instruments and test steps, reduced maintenance costs, and the ability to archive product test data.

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