One Button Test Strategy for Volume Manufacturing

Introduction

Implement a one button PASS/FAIL circuit board test strategy in a single day! Kozio's hardware validation test suite provides an integrated and automated solution delivering at-speed functional test running on the device under test (DUT) coupled with powerful test management software.

The latest **kDiagnostics™ Manufacturing Suite** offering from Kozio allows engineers to create automated processes that dramatically reduce the cost of testing products by increasing fault coverage and throughput while minimizing test development efforts.

What's Inside

Integrated Solution

Functional tests form the nucleus of this innovative test platform. They are connected by remote communications over high-speed interfaces and a programmatic interface, encased by an easy to set up test sequence and easy to use operator interface. The core is topped off with an integrated database for test tracking and a report generator that a manager, engineer or operator can use from anywhere on the network.

In the past, managers and engineers were faced with the difficult decision of how to automate the testing of their circuit boards while insuring product quality. While they usually developed a solution from scratch, using custom functional test software and a variety of host-based tools, significant cost went into creating, debugging, maintaining, documenting and transferring their solution.

Kozio presents a flexible solution that automates production test and delivers the following benefits:

- Increased fault coverage with the included, comprehensive, at-speed functional component tests
- Integrated development tools for extending test capabilities to meet custom requirements
- Remote interactive access for executing tests and monitoring test operations
- Flexible test sequencing allowing the implementation of unique test processes
- Time saving feature for fast and safe downloads of any DUT binary files
- Advanced in-system programming works with all programmable devices (NAND, FPGA)
- Historical tracking of test results accessible from anywhere on the network

Added all together, you achieve the lowest up-front cost, quickest ramp to production ready test, and a return on investment realized in just a few months.

Increased Fault Coverage

The hardware validation solution provided by Kozio goes beyond structural and emulated testing by providing focused functional test coverage, stress testing, and feature coverage. The focus testing insures that a hardware component is operational and functional. Stress testing increases coverage by using advanced processor features to move data from component to component, transferring data off-board, and validating all packet contents. Stress testing ferrets out timing, noise, and frequency issues. Feature coverage looks at a given controller and performs additional testing to address advanced features. As an example, one of the SATA tests uses Native Command Queuing (NCQ) to increase data throughput testing and performance analysis.

The table below provides a very truncated look at how the at-speed Kozio solution addresses fault isolation down to specific traces.

Component	Fault Isolation	Down To	Notes
SDRAM SRAM	Separate test cases for focus and stress testing using advanced processor operations.	1 trace line	Tests work for all accessible memory sources: on-board, across busses, off-board, and on other ICs (FPGA, Video Controller, etc.).
10/100 Ethernet Gigabit Ethernet	Separate test cases cover: control path, data path, traces to the PHY, on-board and off-board loopback.	2 trace lines	Test automatically runs through all interface speeds to isolate issues pertinent to 10, 100 or 1000.
PCI – Data	Test cases to verify general operation of the PCI bus, discover all attached devices, and automatically configure the memory and I/O areas for each device found.	1 trace line	Tests work with PCI, PCI-X, and PCI Express. These commands support multiple PCI busses attached directly to the processor (multiple primary busses). A PCI test card is available for purchase allowing complete PCI testing in 2 seconds.
PCI – Address		1 trace line	
PCI – Control		8+ trace lines	
Serial – Differential	Separate commands to verify data path, on-board, and off-board, using interrupts or polling.	2 trace lines	These commands verify the data path to and from UART devices and verify the interrupt connection back to the core processor.
Serial – Non-Differential		1 trace line	

Integrated Development Tools

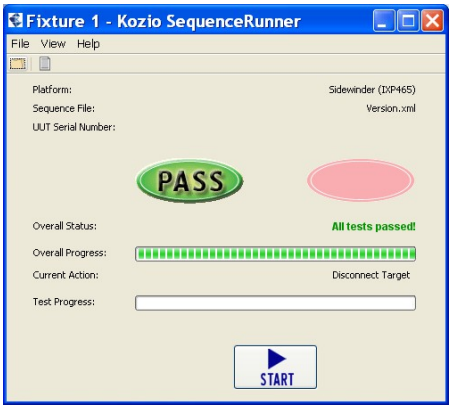
Kozio provides the tools and an automated build environment allowing you to create easily new test binaries for your configured platform. The initial configuration is delivered ready-to-run on your custom platform. No development effort is required to run **kDiagnostics**, unless you choose to extend the test capabilities for proprietary devices.

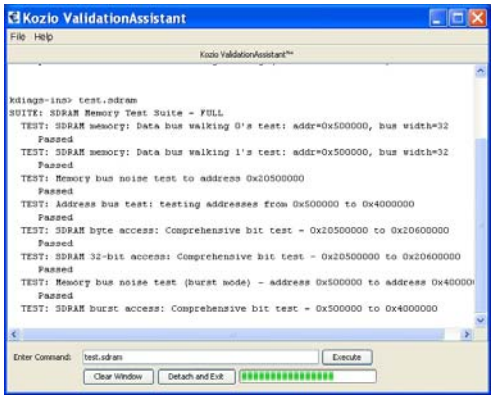
Kozio exposes a diagnostics API (application programming interface) for creating customized test routines, menus, and test flows. With this development kit, you leverage the existing test framework and stable test platform to create quickly new test routines supporting proprietary devices. Most basic tasks, such as device discovery, memory management, test operations, timings, and others, are included with the test framework, requiring you to only write low-level driver code specific to your proprietary device. This development kit comes standard with **kDiagnostics**.

Diagnostics over a LAN Connection

The latest release of **kDiagnostics** provides the capability of communicating over any standard network. You have the choice of using a serial or Ethernet connection on the DUT. With the DUT running **kDiagnostics**, and the remote interface enabled, the DUT programmatically communicates with the host-based test management tools. The primary host tools for communicating remotely with the DUT are **SequenceRunner™** and **ValidationAssistant™**. A command line interface (CLI) program is provided for integration with other test executives such as TestStand, LabVIEW, or Vee.

SequenceRunner™ is a graphical user interface providing an easy-to-use operator interface for volume testing of circuit boards. Test selection and set up can be completed in a few hours. This tool allows an operator to load a test sequence, select start, and kick off an automated test sequence. All test results and test logs are tracked in an integrated database. Numerous operator actions can be quickly added to a textual sequence file, such as operator prompting, device programming, database lookups, system command calls, and other common production line needs.





The **ValidationAssistant™** user interface provides remote access to diagnostics and functional tests running directly on the circuit board. This product works with Kozio's **kDiagnostics** embedded test application to provide test access to a circuit board anywhere on the network. Use the command shell or menu to execute tests. Tests are provided for the CPU, memory, caches, busses, peripherals, I/O, and all CPU connected devices. Use **ValidationAssistant** to monitor all exchanges between **SequenceRunner** and the DUT. The screen shot on the left displays an SDRAM test sequence executed using **ValidationAssistant**.

Flexible Test Sequencing

Most design teams have unique manufacturing process requirements. Their fault coverage requirements vary in what tests they want to execute, the order of tests, and various other test parameters. They may have unique requirements for scanning labels on a DUT, running other test programs, working with a BDM/JTAG debug interface, programming new technologies such as NAND flash devices, and custom operator interactions.

Kozio uses XML (extensible markup language) technology for creating test sequence files allowing you to create, validate, and test new test sequences in minutes. Provided are numerous actions which allow you to create a test process that matches your requirements. Here is a brief sample of possible actions:

Test Action	Description
Download Image	Download a binary file from the host to the target over the LAN connection and store it in the indicated memory location. All files are CRC checked to detect potential corruption.
Download Script	Download a test script file to the target over the LAN connection. This allows a customer to define there exact test sequence to be executed on the DUT. Scripts also provide a convenient means of performing fast in-system programming of any programmable device.
Execute Command	Execute a test command on the target. Commands are descriptive verbs such as "test USB".
Operator Comment	Prompt the operator to enter a comment that is stored in the database. This is very useful for storing a comment only if a DUT fails functional testing.
Prompt	Prompt the operator for input data. Display photographs of the DUT and use HTML for text formatting. Values are easily passed from action to action.
Scan Barcode	Receive input data from a barcode reader and use it for tracking DUT test results.
System Command	Execute any host-based application accessible on the computer. You can choose to call Perl scripts or external programs.

Fast and Safe Downloads

Many manufacturing processes require that the latest application software release be programmed into the DUT. This process allows the latest release to be used without changing the overall DUT test and serialization process. In addition, a process may dictate the downloading of many other items such as EEPROM data, boot loaders, operating systems, file system data and DUT unique items such as serial number and MAC address.

Using **kDiagnostics** and **SequenceRunner**, your manufacturing process can use a single action to send any binary file to the target and have it programmed into any programmable device. Each binary image is transferred with a cyclic redundancy check so that its content are verified before programming, eliminating the unfortunate event of programming a corrupt image that prevents the DUT from booting.

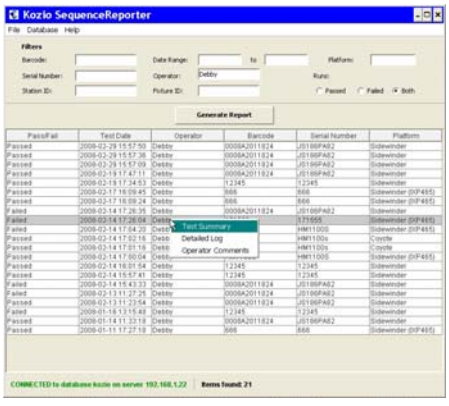
Advanced In-System Programming

A number of modern devices pose complicated requirements for component programming. A prime example is the use of NAND flash devices. Although these devices provide a per unit economical value, they pose boot and programming challenges due to the potential for bad blocks.

Your process can load and run **kDiagnostics** from RAM allowing you to program more challenging components. A single **SequenceRunner** action can use a BDM/JTAG interface to load **kDiagnostics** into RAM. Once running **kDiagnostics**, you use a single command to transfer images and program any device, including NAND flash. This method provides a very fast and reliable means of transferring binary images and programming NAND or any other device.

Test Results Tracking

All manufacturing test processes can benefit from tracking DUT test results. Your process may call for shipping a printed report that summarizes tests run and other pertinent information. For faulty boards, pulled off the production line or returned from a customer, you can also benefit from quickly pulling up a history of all testing for a given DUT. As a manager, you may want to periodically check on various test stations and get a count of boards passed and failed. You most likely would prefer to do this from your desk.



SequenceReporter™ allows you to generate, save, and print reports for publishing from any LAN connection. Given the right networking set up, you can also check on contract manufacturers test results over a WAN connection. The **SequenceReporter** user interface allows an engineer or manager instant access to test results. Generate queries to see full circuit board test results. Report data includes board type, serial number, test date, operator, station, operator notes, and a complete test summary.

Customer Challenge Met

An existing Kozio customer recently upgraded from using only **kDiagnostics** to using the **kDiagnostics Manufacturing Suite**. The Kozio engineering team provided an upgraded functional test release along with the host-based test management software. The goals achieved were:

- Significantly reduced the learning curve for an operator when testing circuit boards

- Eliminated slow flash programming steps
- Simplified the process by using a barcode reader to scan a serial number
- Eliminated the error prone step of manually using serial numbers
- Used kDiagnostics to program the EEPROM with the device's unique serial number
- Used kDiagnostics to program Flash memory with Linux and application executables

The following ROI (return on investment) calculations are based on the customer producing 1,000 boards the first year, with an estimated volume increase of 20% per year for subsequent years. Fifteen (15) minutes of test time was saved per board. This was measured by testing 25 DUTs before and after the upgrade. The fully burdened labor cost for the technician was $28 US Dollars. Larger volumes dramatically increase the ROI.

The cumulative savings over five years, based solely on labor costs, totals $45K. This amount includes the cost of the test management software, which is purchased once and reused. The customer saved $2,700 the first year.

Conclusion

Kozio provides a factory test solution that integrates and automates the steps required for circuit board testing and serialization. Your scripted test process begins with a single button producing a straightforward PASS or FAIL result to the operator.

The Kozio functional test solution provides excellent fault coverage for full data path testing, on and off board. You choose which tests to run along with the desired test parameters to meet your quality requirements. Additional networked tools provide a LAN connection to device diagnostics and custom report generation capabilities.

Use the **Manufacturing Suite** to set up one or more production test lines in a single day. The entire solution is easily deployed to a Contract Manufacturer (CM). Increase your test throughput, decrease operator interaction, and eliminate error prone activities. Reduce your cost and effort to produce a test strategy with greater fault coverage.

Company Information

Kozio provides the integrated solution presented in this paper under the banner of the kDiagnostics™ Manufacturing Suite. For information please call or email us.

KOZIO™

Trusted Hardware Validation

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