MEMS-Based Multi-Layer Piezoelectric Ceramic Actuator Characterization System

By

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Category: Control

NI Products Used
NI-SCXI-1000 Chassis with NI-USB-1357 kit
NI-SCXI-1127 Multiplexer/Matrix (3)
NI-SCXI-1332 Terminal Block (3)
NI-PCI-GPIB Communications Interface
LabVIEW 7.1

The Challenge
The increasing demand for MEMS (Micro Electro-Mechanical System) based piezoelectric ceramics required the industry leading supplier of these devices to increase throughput of its test system. By making the process faster and expanding the number of devices under test (DUTs) per test cycle the increased throughput could be achieved. The challenge required an intimate knowledge of the physics of the devices in order to select the most appropriate hardware and develop a high performance software solution. The developed software would need to give pass/fail indication of the different tests being conducted, store the test data into an organized file structure, and display historical statistics of the test results.

The Solution
The solution was the creation of a scalable, high performance automated test system that provided batch testing of twenty devices. The system provided real time updates of individual device measurements as well as pass/fail indications and provided a flexible method to adjust the tolerance limits for the tests.

The Abstract
Multilayer piezoelectric actuators accurately generate micron level movements. These complex devices are the enabling technology in research and commercial systems such as inkjet and laser printers, ultrasonic cleaners, and high resolution video projection systems. By using multiple layers of thinner ceramics, the power requirements are reduced, but the manufacturing constraints become tighter making them more universally usable and the accuracy of production testing much more critical.

Introduction
Data Science Automation (DSA) was selected to develop software to automate the test procedure for the ceramic devices in order to meet the demanding throughput requirements. The hardware selected was required to augment the client's legacy test system which utilizes an Agilent 4284 LCR Meter, a Guardian Hi Put Tester, and a Keithley 6517 Electrometer with minimal additional hardware. DSA selected three SCXI-1127 Multiplexer/Matrix cards in a SCXI-1000 chassis. The user interface displays which tests passed with an LED and also displays the corresponding value of the measurement. The front panel also contains configuration settings and statistics of a device's test history.

Figure 1. Batch Test Results

The Details

The National Instruments hardware used in this application was a key component to its development and success. First, the SCXI-1000 chassis was extremely easy to interface with the PC because of the USB-1359 kit. Secondly, the ability to expand the matrix of the SCXI-1127 using expansion cables made setting up the text fixture much simpler. The software switches through the 20 DUTs first taking a capacitance and dissipation measurements comparing them to limits (Figure1), updating the user interface with measurement values and pass/fail results. The system then charges all twenty devices under test (DUTs) to a specified voltage and switches through them again taking an insulation resistance (IR) measurement. If all three measurements are within the limits then a larger LED indicates that it passed the acceptance test. The limits can also be saved to and read from an .ini file organized by part number, along with the charge voltage values (Figure 3)..

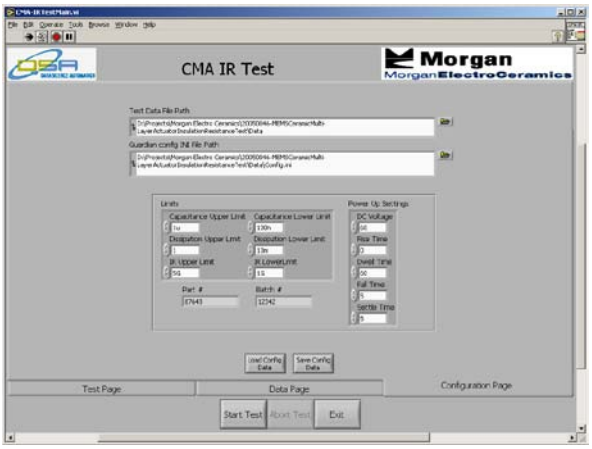

Figure 2. Configuration Page

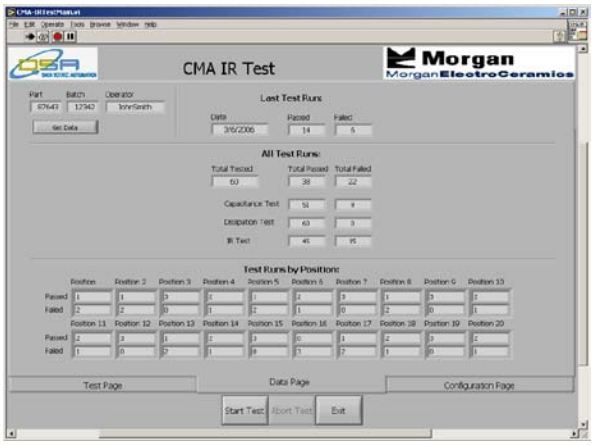

Figure 3. Historical Test Results

After a test run completes the data acquired are stored in four different test files. For each manufacturing lot, separate files accumulate the measurements for each of the three measurement types (capacitance, dissipation, and insulation resistance). A fourth file accumulates the overall summary results for batches of twenty DUTS from the results shown on the user interface in Figure 3.. These test files can be read to display the last overall test pass/fail number, the total pass/fail number for each of the three tests as well as overall test, and the total overall test pass/fail quantities based on each position in the test fixture. This allows characterization of not only the DUTs but also of the fixture to identify possible degradation of electrical contacts.

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Summary

The application developed by Data Science Automation using LabVIEW is able to conduct tests in approximately 5 percent of time it took using the previous manual test process. This would not have been made possible without NI's switch cards and easy to use NI SWITCH VI library. The solution exceeded the clients expectations on its performance, ease of use, flexibility, and scalability Instead of testing one device at a time by hand, all the operator has to do is simply click on a button and within minutes 20 devices are tested with the results displayed and archived.

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