Liquid Crystal on Silicon Test System
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Category: Consumer Electronics

Products Used:
- LabVIEW version 6.0
- PCI-6035E E-Series Multifunction DAQ Board
- BNC-2110 Accessory E Series Devices
- PCI-7344, 4 axis Servo/Step motion controller
- MID-7604, 4 axis Integrated Stepper Driver Power Unit, 115V
- UMI-7764, 4 axis motion wiring connectivity module

The Challenge:
Implementing a test system for Liquid Crystal on Silicon (LCOS) panels, that provides control to the user of test variables as well as the acquisition and analysis of test data. The system must provide the flexibility required by a research and development environment.

Abstract:
A large consumer electronics manufacturer is developing a projection system based on Liquid Crystal on Silicon (LCOS) micro-display panels. Rather than the current method of using three separate cathode ray tubes (CRT) that need to be aligned to a pixel on the projection screen in the final product, the LCOS concept uses a single silicon chip to produce the three (Red, Green and Blue) (RGB) images required.

To evaluate the quality of the panels, the research team requires measuring the optical response and the brightness of the light reflected by them.

Data Science Automation developed a computer based test system using LabVIEW which combines Motion Control, Data Acquisition (DAQ), and RS-232 instrument control with Virtual Instrumentation Software Architecture (VISA) to perform the required measurements and control external variables such as the position of the panel under test, color filtering, and drive signal that influence the test results.

Controlling the Test Components:
The LCOS unit under test (UUT), mounted in an XY stage, receives polarized light and reflects it with different intensities depending on the amplitude and frequency of a drive signal supplied to it. The reflected light is filtered through a second polarizer and a color filter, and enters into an integration sphere where sensors measure the brightness and spectral data.

Data Science Automation developed a LabVIEW application that allows the research engineer to control the different variables that need to be configured to perform the tests. The user interface of the software allows the engineer to select the desired position of the UUT, the angles of the polarizers, and the color filter using National Instruments Motion Control. The LabVIEW application communicates with two 4-Axis PCI-7344 plug and play motion controller boards plugged into the PCI slots of the PC. The first PCI-7344 controls the XY stage and the angle of the polarizers using an MID-7604 Motion Driver Unit, and the other one controls the position of a wheel with six windows, each containing a different color filter using a third party drive and a National Instruments UMI.
A National Instruments Multifunction DAQ board is used to provide the required drive signal to the UUT. The software allows the engineer to specify the amplitude and frequency required for the test, as well as increments in amplitude to generate a ramping pattern needed in some types of tests. The application utilizes the waveform generation Virtual Instruments (VI) shipped with LabVIEW to build the drive signal waveform and communicates with the plug-in DAQ board to produce the signal from one of its analog output channels.

The new computer-based system improves the precision of the variables and saves valuable engineering time, therefore, increasing the efficiency and reliability of the tests. The system replaces the manual positioning of the UUT, the manual rotation of the polarizers, and the color filter window swapping. An external function generator that had to be manually configured controlled the drive signal. Replacing the function generator with a plug-in DAQ board instead of controlling the external instrument programmatically was an effective approach saving development time.

Figure 1. LCOS Automated Test System Configuration Screen
Measuring Critical Variables:
An important part of the test is measuring the brightness versus voltage (BV) curve, optical response, and spectral data of the reflected data inside the integrating sphere mentioned earlier. The BV curve is the average intensity of the reflected light during several cycles of the drive signal at constant amplitude, throughout a number of different ramping amplitudes. The optical response is defined as the intensity of the light in one cycle of the drive signal at specified amplitude.

A transducer inside the integrating sphere measures intensity and is read using an analog input channel of the DAQ board. The software combines and synchronizes analog input and output to acquire the intensity and obtain the optical response and the BV curve.

The spectral data is measured using an external standalone instrument from Photo Research (PR-650 spectra scan) controlled via RS-232 from the PC using the LabVIEW VISA functions. Data Science Automation developed a limited instrument driver for the PR-650 instrument that handles the configuration and allows the acquisition of the spectral data. The instrument driver is used in the test software to integrate the spectral data measurements into the system.
## Conclusion:
The automation of the LCOS tests involved different parameters to be controls and the acquisition of data from different sources. The project has been successfully completed and is being used by the research engineers to perform their required tests. They are also able to make modifications to the application without being LabVIEW experts. LabVIEW made it very easy for us to integrate multi-axis motion control, Data Acquisition input and output, and instrument control in one application to achieve the demands of our customer.