

## Automated Testing of Analog Neural Network IC Devices Using LabVIEW



NIWeek  
Paper Finalist

by Allen C. Smith, ACSIS Development

**The Challenge:** Developing flexible instrumentation to test experimental neural network devices.

**The Solution:** Using LabVIEW and DAQ boards to create a PC-based virtual instrumentation test system.

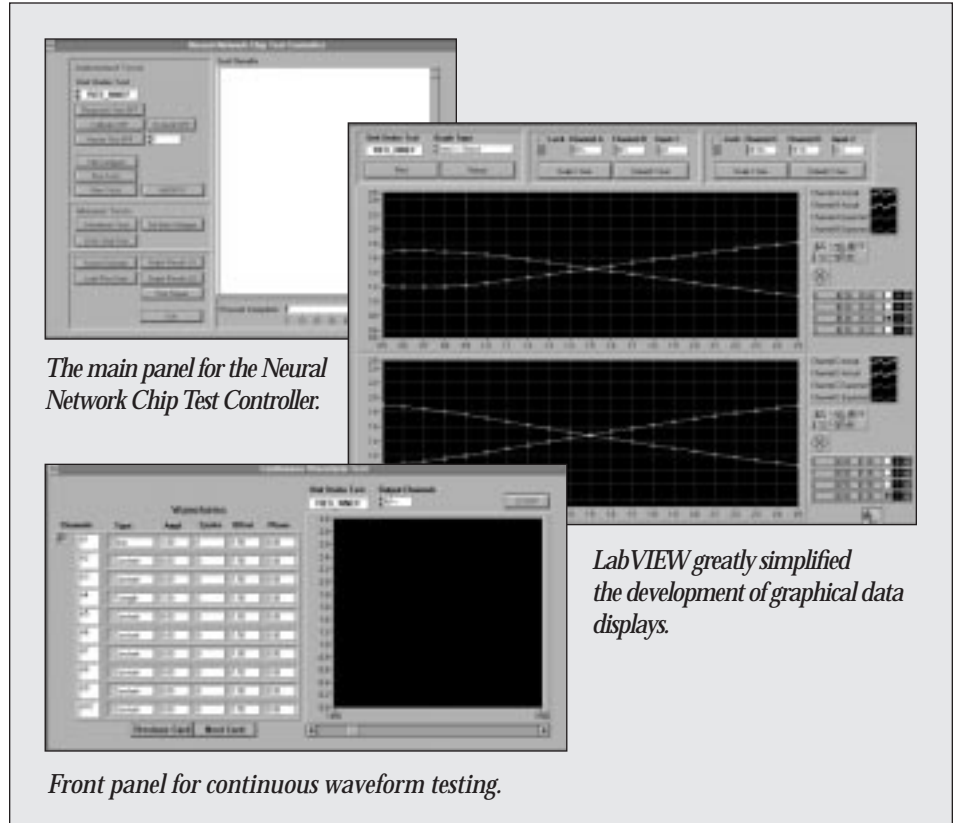
We developed the Neural Network Chip Test Controller for Lawrence Livermore National Laboratory to test prototype analog neural network chips, devices which use analog circuits to replicate neural network systems.

These circuits are characterized by a high number of inputs and outputs, and are therefore difficult to fabricate and test. Testing the Livermore devices, for example, requires driving 70 inputs and sampling 64 outputs. Previously, the group responsible for this project conducted device testing by hand, with researchers using oscilloscopes to monitor a few channels at a time. With the fabrication of a new batch of several hundred devices, the lab clearly needed to overhaul its test apparatus.

AC SIS Development was tasked with developing a suite of testing tools for the project. The client chose LabVIEW as a

*The client chose LabVIEW as a development platform because it promised reduced system development time, resulting in significant cost savings to his department.*

development platform because it promised reduced system development time, resulting in significant cost savings to his department. The latest version of this software includes a series of automated tests to facilitate quick testing of a large batch of devices as well as several general-purpose manual tests for performing diagnostics. LabVIEW also provided a



*The main panel for the Neural Network Chip Test Controller.*

*LabVIEW greatly simplified the development of graphical data displays.*

*Front panel for continuous waveform testing.*

flexible programming environment so that we could develop and integrate several new tests to meet diagnostic needs that came to light as the work progressed.

### System Hardware

The test controller is based on a single 486/100 MHz PC running Windows 3.1 and equipped with several plug-in data acquisition (DAQ) boards. Device outputs are sampled using an AT-MIO-16X multipurpose board with an AMUX-64T multiplexer. Eight AT-AO-10 analog output boards drive the devices and control biasing voltages. With nine DAQ boards controlled by a single PC, we expected to spend a significant amount of time resolving hardware conflicts. This proved not to be the case, however, as the NI-DAQ® software and the design of the DAQ boards greatly simplified the installation task.

To make the devices accessible for computer testing, the lab provided a Topaz probe station and fanout panel. The devices to be tested included two chip types of significantly different pin configurations and a custom interconnect panel built

to route computer connections to the proper fanout panel pins. By coding several DAQ configurations in software, we were able to use the same I/O hardware to test both of these distinct devices.

### Automated Testing

By automating the test series, operators can rapidly test a large volume of devices. The goal of these tests is to have the operator quickly determine if the device under test performs as expected.

First, the device is tested for basic responsiveness – the software bumps each input from the lowest allowed voltage to highest. If this bump test cannot drive a change in any of the device outputs, then the input is considered defective. The software checks outputs at the same time; if no input can drive a change in an output, that output is also suspect.

Next, the software calibrates the chip, with a different procedure for each type of device. For one of our devices, this consists of determining output gains, so that we can properly scale results of the tests. For the other device, calibration

consists of finding proper voltages for six offset bias channels to ensure that output signals are not clipped.

Finally, the device is subject to a series of "vector tests." The system reads input voltage levels in the form of a 64-element

*Synchronization of the output boards was obviously crucial, but was made possible thanks to the RTSI® bus included on the AT-AO-10 board.*

vector from a spreadsheet file provided by the operator. The system applies these voltages to the device, and then measures the output voltage. Because a vector test file contains several such vectors, operators may record device response to complex and arbitrary waveforms with high precision. A spreadsheet file containing test results is saved to disk, and we calculate an error for each output channel if the operator has provided a set of expected values.

Results are compiled into a test report, which is available on screen and as hard copy. This report includes the results of response testing and calibration as well as the errors of each output. Operators can also graphically display vector test results.

### Manual Testing

Because this is new technology, a need clearly exists for more general-purpose diagnostic tools that give researchers the ability to isolate problems with devices detected by automated testing. The principal tool we developed gives operators the ability to send different waveform types (sine, square, sawtooth, ramp, and user-defined waveforms, as well as constant signals) to all 70 inputs, with maximum frequencies of approximately 10 kHz. Operators can select different parameters for each channel, including waveform type, frequency, amplitude, offset, and phase.

Synchronization of the output boards was obviously crucial, but was made possible thanks to the RTSI bus included on the AT-AO-10 board. This tool, difficult and

expensive to implement in hardware but straightforward as a LabVIEW virtual instrument, gives researchers a ready means to explore in detail the response of any given device.

### Conclusions

The Neural Network Chip Test Controller has provided the client with a valuable tool for rapid testing of devices, freeing up resources for further chip development. Our LabVIEW virtual instrument has proved extremely helpful in identifying defective devices and the causes of those defects. This, in turn, has given researchers the ability to properly focus their efforts on the elements of the production process most in need of improvement, moving them closer to the goal of bringing this emerging technology to market. ▶

**For more information, contact Allen Smith, ACSIS Development, 1977 Pleasant Valley Ave., Suite 2, Oakland, CA 94611, tel: (510) 653-7910, e-mail: [bladerunner@acsis.com](mailto:bladerunner@acsis.com).**



**U.S. Corporate Headquarters** • Tel: (512) 794-0100 • Fax: (512) 794-8411 • [info@natinst.com](mailto:info@natinst.com) • [www.natinst.com](http://www.natinst.com)

**Branch Offices:** Australia 03 9879 5166 • Austria 0662 45 79 90 0 • Belgium 02 757 00 20 • Canada 905 785 0085 • Denmark 45 76 26 00 • Finland 09 527 2321  
France 01 48 14 24 24 • Germany 089 741 31 30 • Hong Kong 2645 3186 • Israel 03 5734815 • Italy 39 6 5729961 • Japan 03 5472 2970 • Korea 02 596 7456 • Mexico 5 520 2635  
Netherlands 0348 433466 • Norway 32 84 84 00 • Singapore 2265886 • Spain 91 640 0085 • Sweden 08 730 49 70 • Switzerland 056 200 51 51 • Taiwan 02 377 1200 • U.K. 01635 523545