# **Fuel Cell Test**

**Agilent Technologies and LXinstruments** 

# Achieve comprehensive characterization of your fuel cell technology

Research into the development of fuel cell technology requires exhaustive characterization of devices in both stacked and segmented configurations using electrochemical impedance spectroscopy. In a stacked configuration multiple fuel cells are connected in series and measurements are made across each cell. In a segmented configuration the fuel cells are connected to a common anode and then measurements are made at each cathode in turn.

The characterization of both of these configurations requires multi-channel measurements to be made under variable loads, and under controlled environmental and gas conditions. The LXinstruments fuel cell test system uses the Agilent L4534A LXI (LAN eXtension for Instrumentation) digitizer with four differential floating inputs to provide the multi-channel measurement capability required. The LXI digitizers provide 20 MHz simultaneous acquisition with floating AC coupled measurements for increased resolution. Agilent's N3302A electronic loads, modulated with the Agilent 33220A function/arbitrary waveform generator, are used to provide synchronized, variable load conditions.

The system is controlled by a personal computer that includes a software implementation of a lock-in amplifier. The lock-in algorithm allows accurate

# • Modular and affordable fuel cell test system

- Electrochemical impedance spectroscopy measurements
- For stacked and segmented fuel cell configurations
- Uses Agilent LXI digitizers, electronic loads and waveform generator
- Proprietary software implements lock-in amplifier algorithm
- Comprehensive characterization of fuel cell technology





### Electrochemical Impedance Spectroscopy

Fuel cells, in common with other electrochemical cells, exhibit complex impedance characteristics that result in a non-linear voltage/ current relationship. In order to measure electrochemical impedance, an AC current is applied to the cell and the resulting voltage is measured. The response is an AC voltage signal that is out of phase with the applied current. To ensure that the cell's response is pseudolinear a small input signal is used that constrains the output range to the linear portion of the curve.

The analysis of the response requires frequency and phase components to be extracted. This is commonly undertaken using fast Fourier transforms or a lock-in amplifier and is displayed with Nyquist Plots. Electrochemical impedance spectroscopy measurements have traditionally required specialized test equipment that is high cost and limited in channel count. The LXinstruments fuel cell test system overcomes this by utilizing commercial off-the-shelf test equipment and a software implementation of a lock-in amplifier.





## Fuel Cell Test



Fuel cell in segmented configuration

measurement of frequency and phase and eliminates the need for a hardware-based implementation using digital signal processing. The LXI connectivity provided by the L4534A digitizers allows communication between the system and the controlling computer over an industry standard Ethernet LAN. This supports the fast transfer of the large blocks of data necessary to calculate the frequency and phase response of the individual cells. The LXinstruments fuel cell test system uses standard equipment from Agilent Technologies together with proprietary software to provide a fully modular and affordable system for making electrochemical impedance spectroscopy measurements on fuel cells. The system allows you to achieve comprehensive characterization of your fuel cell technology in both stacked and segmented configurations. To learn how this solution can address your specific needs please contact Agilent's solutions partner, LXinstruments.

#### www.agilent.com/find/lxinstruments



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**LXinstruments** provides test solutions and consulting services for functional test and data acquisition.

#### www.lxinstruments.com

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LXXI LAN eXtensions for instrumentation

Product specifications and descriptions in this document subject to change without notice.

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## System Components

#### **Agilent Technologies**

L4534A	4 ch, 20 MSa/s digitizer
N3300A	Electronic load mainframe
N3302A	Electronic load
33220A	Function/arbitrary waveform generator

#### **LXinstruments**

#### System Design & Engineering Services

- Customized fuel cell test system with 19" rack, integrated industrial PC and internal wiring
- Customized fuel cell test software (functionality based on customer requirements)
- On-site installation, customer education, and uptime support services



## **Agilent Technologies**