

Tektronix

KEITHLEY
A Tektronix Company

Battery Testing

From portable embedded to electrified mobility



**Battery
Tech
Expo**

Andrea Vinci – Senior Technical Marketing EMEA

Silverstone UK, Battery Test Expo 2023

Accelerate Progress Together

COMPANY AND PRESENTER

The Tektronix logo features the word "Tektronix" in a bold, sans-serif font. The letter "k" is stylized with a blue diagonal stroke.

Hall 2
B40-41

- Test & Measurement company committed to **performance** and compelled by possibilities
- Design and manufacture solutions to **break through the walls of complexity**, and **accelerate global innovation**
- Andrea Vinci - Technical Marketing **Tektronix**
- “Battery MBA” from Battery Associates

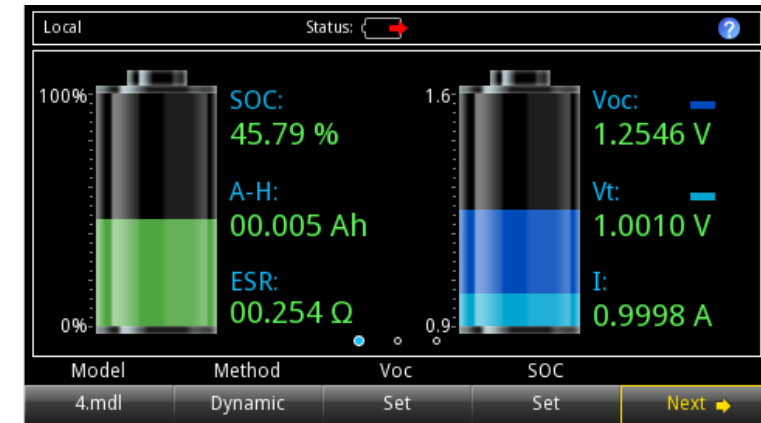
Agenda

FEW TEST PROBLEMS WE'LL DISCUSS ABOUT

1) Predicting key battery characteristics and potential degradation, accurately and reliably



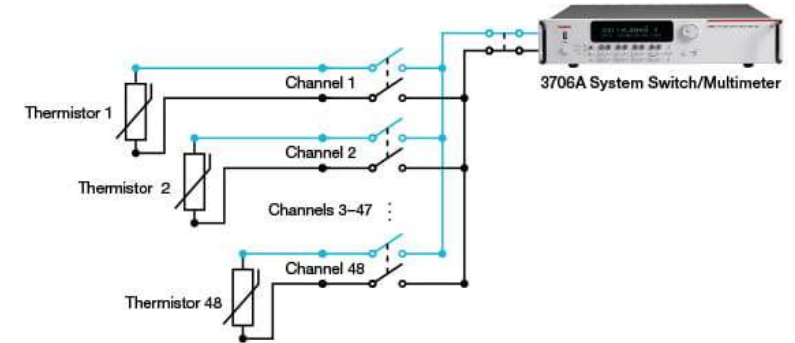
2) Modeling and Simulating batteries in a fast and simple way



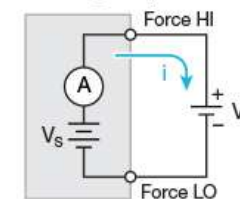
EV Battery Production Use Cases

A SHORT SUMMARY OF ADDRESSED PAIN POINTS

- Battery Grading with Open Circuit Voltage Testing
- Quantifying Battery Self-Discharge with Open Circuit Voltage Testing
- Ensuring Battery Quality with DC Internal Resistance
- Battery Tab and Busbar Weld Checking with Resistance Measurements
- Check Electrode Contact Quality with Low Resistance Measurements
- Environmental and Safety Testing using Temperature Keep Batteries Isolated by Measuring Insulation Resistance
- Datalogging
- Formation, Aging and Battery Cycling



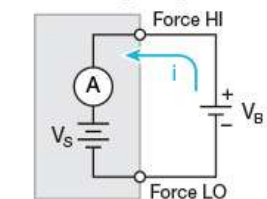
Charge Cycle



2450 or 2460 SourceMeter

SourceMeter in Source Mode
 $V_S > V_B$
SourceMeter functions
as Power Supply
Charge Current (*i*) is Positive

Discharge Cycle



2450 or 2460 SourceMeter





SourceMeter in Sink Mode
 $V_S < V_B$
SourceMeter functions
as Electronic Load
Discharge Current (*i*) is Negative

Solution Example: Industry Leading 7.5 digits DMM/DAQs



Pain Points	Solution Value
Testing takes a long time	<ul style="list-style-type: none">•High density solutions mean you can test more devices at once•High precision solutions like 7.5 digit DMMs and SMUs can detect smaller changes and are more accurate
Errors during testing cause tests to have to be redone	<ul style="list-style-type: none">•Automating the test setup using software like Kickstart or custom scripts using TSP reduce errors
Batteries can be hazardous	<ul style="list-style-type: none">•Automated testing reduces possibility of dangerous errors and human contact
Battery testing requires a lot of equipment	<ul style="list-style-type: none">•Flexible solutions such as the 3706A DMM and switching means that you can take different kinds of measurements with 1 box, and measure more devices with 1 box
Data collection, analysis and management is time consuming	<ul style="list-style-type: none">•Software like Kickstart can help collect and visualize data

Cell-to-Pack Testing Solutions

Test:	Cell-Tab Welding	Open-Circuit Voltage	Bus-Bar Welding	Temperature / Environmental
Problem:	An incorrect weld can generate excessive heat and result in battery underperformance and failure. The weld imperfection cannot be visually seen.	An incorrect weld can generate excessive heat and result in battery underperformance and failure. The weld imperfection cannot be visually seen.	An incorrect weld can generate excessive heat and result in battery underperformance and failure. The weld imperfection cannot be visually seen.	Battery packs are exposed to a wide range of environmental conditions and need to be tested for performance. Defective cells can also overheat and cause thermal runaway
Solution:	4-Wire resistance measurement of weld joint with Keithley SMU or SMU+DMM.	Measure the open-circuit voltage of the battery cell with a high accuracy Keithley 7.5 digit DMM to detect defects faster.	4-Wire resistance measurement of weld joint with Keithley SMU or SMU+DMM.	Temperature measurements (thermocouples or thermistors) using a multichannel DMM to monitor every cells.
Recommended Products^[1]:	 <p>2460 SMU 3706 DMM</p>	 <p>DMM7510 DMM3706</p>	 <p>2460 SMU 3706 DMM</p>	 <p>DMM3706 DMM7510</p>
	Keithley 2460 Source and Measure Unit (SMU) and 3706 Digital Multimeter	Keithley 7510 or 3706 Digital Multimeter	Keithley 2460 Source and Measure Unit (SMU) and 3706 Digital Multimeter	Keithley 3706A System Switch and DMM7510 multimeter
Resources:	APPLICATION NOTE	APPLICATION NOTE	APPLICATION NOTE	APPLICATION NOTE

[1] - Keithley solutions are highly configurable for the voltage, current, and overall needs of the testing application. Please consult with your sales representative to determine the best product fit for your needs.

IoT Design Use Case: Flexible Modeling and Simulation

- Dynamic **Battery Simulator** and **Precision DC Bench Power Supply**
- Upload and run battery models
- Retrieve consumption profiles
- Simulate/vary SOC over time, represent visually VOC, V_t , SOC, ESR, current, capacity
- Up to 60A **DC Electronic Load** to Run a battery discharge test



Keithley Battery Test Application

2281S-20-6

Mode **Simulate Battery** **Model Browser**

Available Models **B** **Import Model File**

SOC(%)	Open Voltage(V)	ESR(Ω)
12	3.667	421e-3
13	3.675	417e-3
14	3.683	414e-3
15	3.69	411e-3
16	3.697	408e-3
17	3.704	405e-3
18	3.711	403e-3

Save Model **Edit Model** **Delete Model File**

2281S-20-6

Mode **Simulate Battery** **Model Browser**

Selected Model **A** Method **Dynamic**

Voc **4.198 V** SOC **100 %**

Full V **4.198 V** Empty V **3 V**

OVP **21 V** Resistance Offset **0 Ω**

OCP **1 A** Capacity **180 mAh**

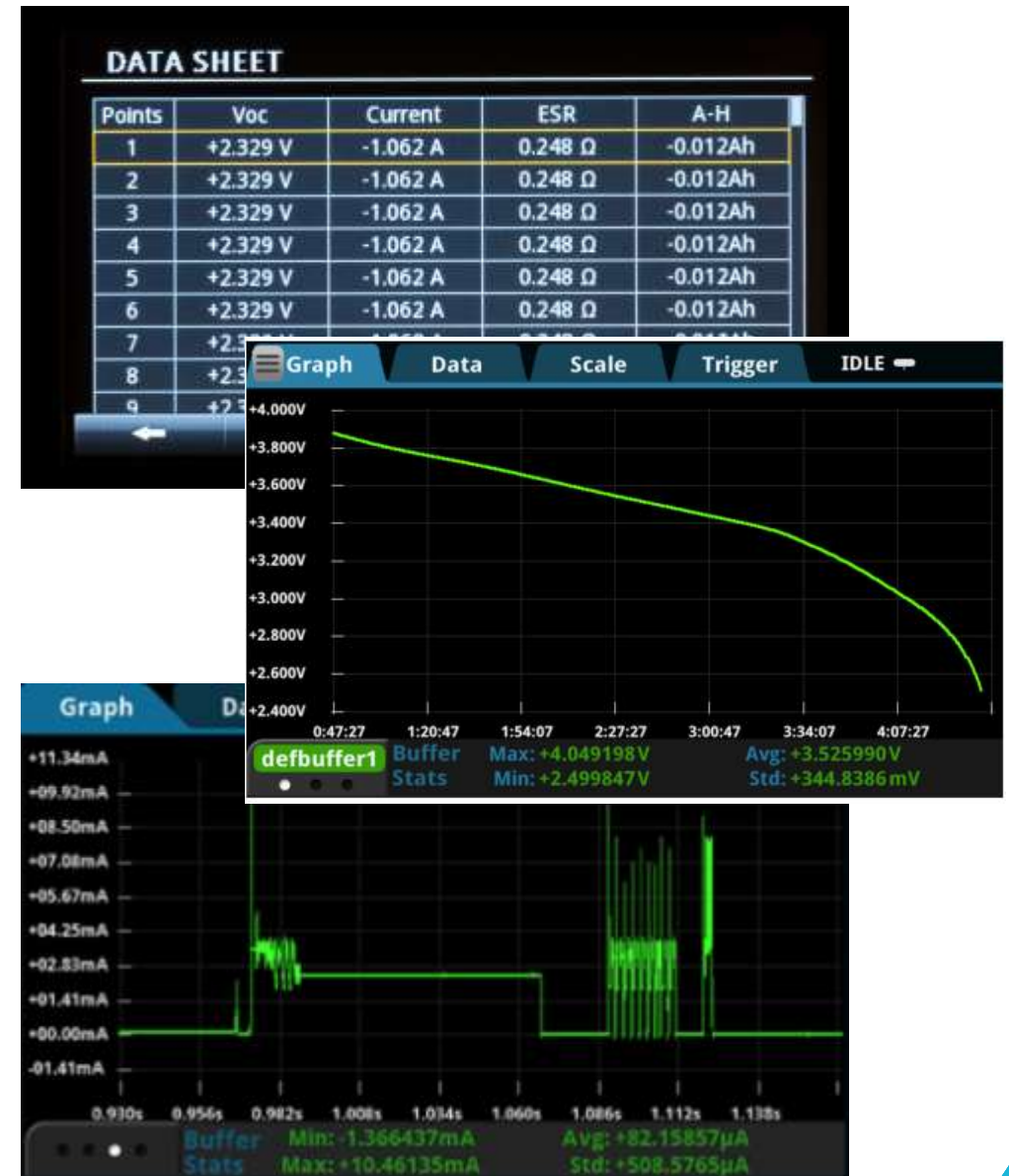
Sample Interval **33 ms** Current Limit **500 mA**

SOC(%)	Open Voltage(V)	ESR(Ω)
3	3.54	455e-3
4	3.572	451e-3
5	3.588	449e-3
6	3.602	445e-3
7	3.615	441e-3
8	3.628	437e-3
9	3.639	432e-3

Summary

WRAP UP

- Gigafactories, Battery Cell Design, System Integrators in EV OEMs Supply chain
- Scalable and reliable **signals logging on a modular setup** with sufficient resolution accuracy and stability. Remote control
- Semiconductor IC Design in IoT, PMICs (power managing systems) development , energy harvesting low energy devices. Optimize embedded design performance with regards to battery life, decrease test time, faster GTM.
- **Generate** and **run** battery **models**, short learning curve, ready to use scripts



Come visit us at MDL booth (HALL 2 B40/41)

- Check out our [Web Site](#)
- See all this LIVE
- Share your pain points
- Suggest improvements
- Request FREE on site setup demo

Thanks!

The screenshot displays the Tektronix website's 'EV Battery Testing' page. The main heading is 'EV Battery Production Testing – A New World of Challenges'. Below this, there is a 'Learn how to:' section with a list of topics: Battery Gridding, Battery Test and Measurement, Environmental and Packaging, Quantifying Battery Voltage Testing, Formulation, Aging, and Drawing Battery. Three product cards are featured: the DMM7510 7.5 Digit Graphical Sampling Multimeter, the Keithley 3700A Systems Switch/Multimeter, and the Keithley 2400 Graphical Touchscreen Series SMU. Each card includes key specifications and a 'View Product' link. At the bottom, three application note cards are shown: 'Measuring Battery Cell Open Circuit Voltage with the Keithley DMM7510 Digital Multimeter', 'Measuring the Open Circuit Voltage of a Battery Cell with a Keithley DMM7510', and 'Monitoring Battery Cell Temperature with a Keithley 3706A System Switch and Multimeter'. Each application note card has an 'Application Note' button.