SOLUTION
BROCHURE

Battery Test System

ni.com

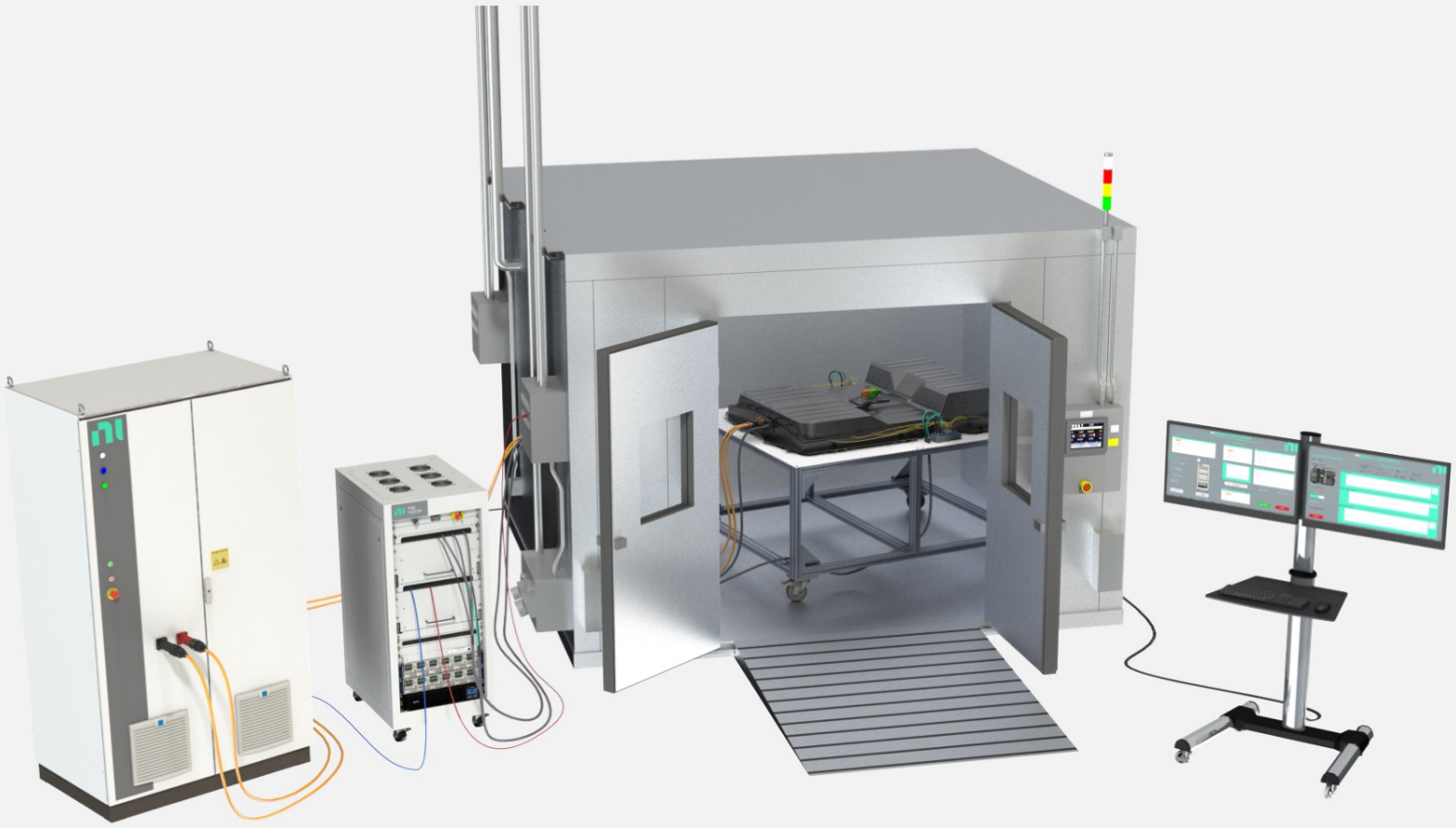

Table of Contents

Battery Test System Overview

The Battery Test System (BTS) is designed to give test teams the ability they need to respond to rapidly changing test requirements, pressing timelines, and limited resources. The BTS is built on a flexible system architecture, with a hardware abstraction layer for adding devices, system simulation to validate test sequences with equipment models, and enterprise data and systems management tools for large scale deployments. The BTS can help you deliver better batteries, at lower cost of test, faster.

BTS Advantages

Reduce Test Development and Configuration Times

- Out-of-the-box functionality and a system architecture that effectively scales and adapts from single test cells to large scale, distributed battery test labs.
- Simplified test definition, implementation, and management with standardized interfaces between hardware-, application-, user-, and facility-level software.
- Standardized cycler, chamber, and other device/instrument interfaces with a hardware abstraction layer to rapidly switch in and out different equipment.

Increase Test Efficiency

- Unified software with out-of-the-box functionality to accelerate the process of configuring equipment, programming, and monitoring test, collecting data, and reporting results.
- Enterprise-level software with data, system, and facility management capability to optimize OpEx, improve test cell utilization, and reduce overall CO_2 footprint.
- Single point of contact for battery test and measurement across labs and test installations to reduce inefficiencies and improve collaboration.

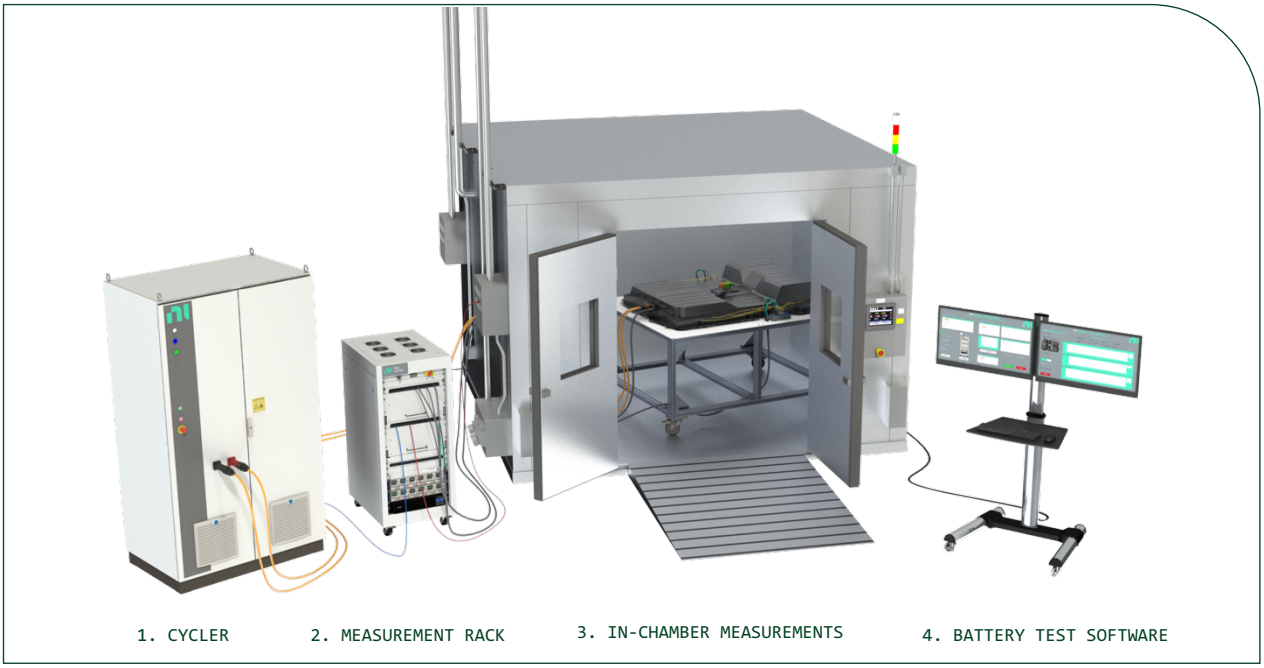

FIGURE 01. THE NI BATTERY TEST SYSTEM

Battery Pack and Module Test Challenges

The battery pack is the single most costly component in Electric Vehicles (EV) and has the largest impact on design and performance (size, weight, acceleration, range, charge time, and vehicle life). It also carries a high warranty liability risk due to the potential for catastrophic field events and high replacement cost in the event of a recall. Getting the design right is critical to avoiding these issues and ensuring program success. EV battery teams must minimize cost while maximizing performance—and do it fast while ensuring the pack operates and fails safely every time, all the time, over the life of the vehicle and beyond. EV battery teams must validate their design against requirements for:

Safety

The battery must be safe under all specified operating conditions. If it fails, it must fail safely in all failure modes, whether due to a manufacturing defect such as a faulty cell or weak weld, or due to a crash that punctures or otherwise damages the battery.

Performance

The battery must meet performance design goals such as charge time, peak energy transfer rates, and thermal stability over its lifetime.

Longevity

The battery must maintain a certain capacity over a number of cycles defined by expected usage behavior and vehicle life (e.g., 80 percent of original capacity remaining after 2,500 charge cycles).

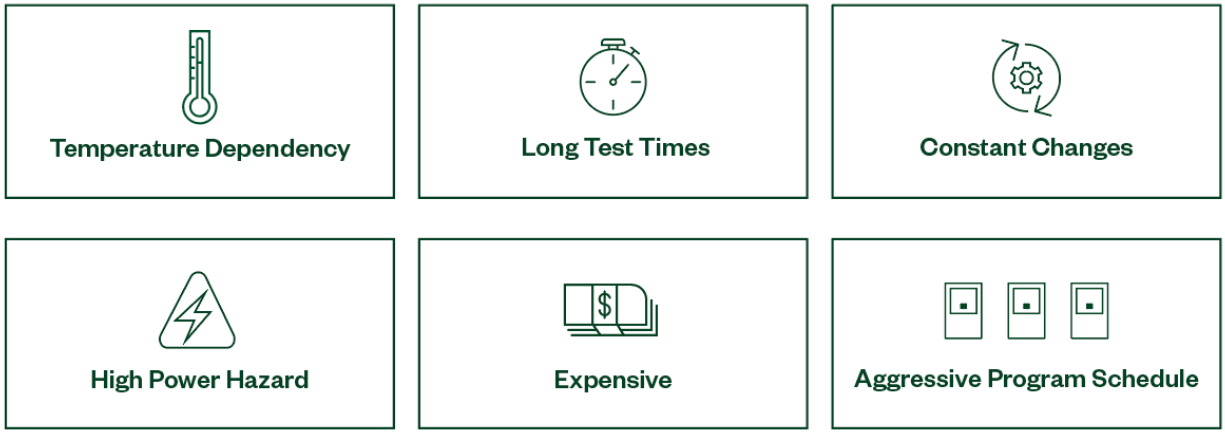

FIGURE 02. EV BATTERY CHARACTERISTICS LEAD TO TESTING CHALLENGES

EV battery characteristics (Figure 2) lead to large numbers of duplicate test cells running long-term tests that are difficult to accelerate, which introduces challenges in managing the systems, the test lab, and the data they produce. Rapidly changing test needs mean that closed, vendor-dependent test systems are a risk for time-to-market and cost, so test teams benefit from having more ownership of their test system and avoiding unnecessary dependency, leading to better control over their test strategy.

While SAE, ISO, IEC, and UL provide a baseline for test requirements, these must be augmented by the test team to ensure designs are validated properly and in compliance with automaker, government, and other expectations, further increasing the importance of owning and having true control over the test systems and overall strategy.

COMMON DESIGN REQUIREMENTS	COMMON TEST METHODS
Capacity	Coulomb counting
Current collector performance	Drive-cycle testing
Internal resistance	Protection system test
Fuse reliability and accuracy	Temperature cycling
Cooling system performance	Hipot and pressure decay
Functional operation	Functional test

TABLE 01. BATTERY TEST METHODS TO MEET COMMON DESIGN REQUIREMENTS

Test System Design Challenges

The challenges to test EV batteries lead to many considerations that need to be taken into account for designing test systems for this complex, expensive, and hazardous EV component. NI's BTS is designed to help teams step up to the challenge, and do it in an optimized way by focusing on openness, flexibility, and software that optimizes the way design and test teams work together.

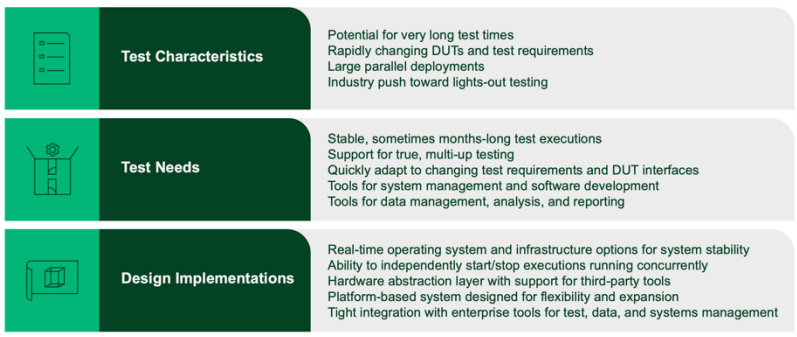

FIGURE 03. BTS DESIGN IS DRIVEN FROM BATTERY TEST NEEDS AND CHARACTERISTICS

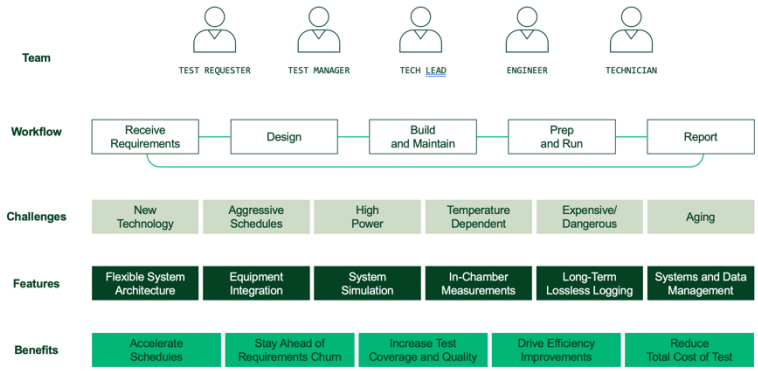

FIGURE 04. BTS SOFTWARE IS DESIGNED TO OPTIMIZE THE EV BATTERY TEST WORKFLOW

Battery Test System Benefits

To design the BTS, NI leveraged decades of experience in test, measurements, data acquisition, signal conditioning, and modular hardware. NI's approach of designing open, platform-based systems contrasts with closed solutions that create a vendor dependency as well as fully customized systems that increase cost and time exponentially.

On NI's platform, the BTS hardware and software can shape-shift to meet any specification and requirement of system footprint, budget, scalability, number of channels, and developing experience.

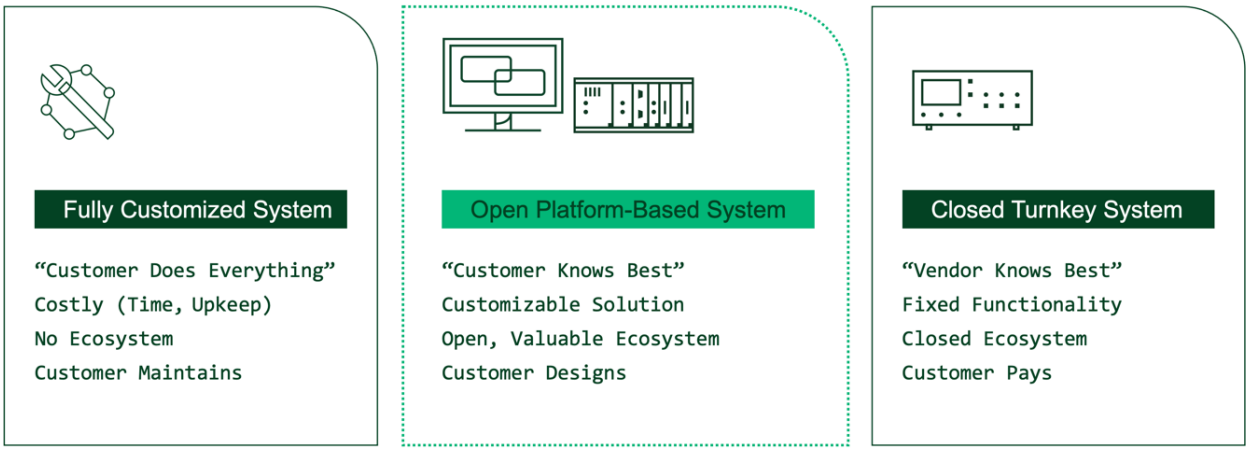

FIGURE 05. NI'S APPROACH PROVIDES SPEED AND FLEXIBILITY FOR BATTERY TEST

Scale Faster with a Flexible, Open System Architecture

- Aliases and channel mapping: Simplify test setup and customization; easily switch out equipment as needed without accidentally breaking any other functionality.
- Modular and expandable I/O: Add measurement channels to expand with minimum incremental cost per channel, and quickly add mixed measurements.
- Power electronics and instrument add-ons: Integrate NI or third-party battery cyclers such as NH Research, Heinzinger Automotive, Elektro-Automatik and others, using an instrument abstraction layer without the need to modify the rest of the test system.
- In-chamber measurements: Use rugged, synchronized, IP-rated measurement modules and thermal chamber control for temperature and humidity profile test execution, as well as other DUT measurements like strain, voltage, current, or vibration.
- System simulation: Decouple software development from hardware availability to validate test scripts without equipment present, to speed up development and de-risk system deployments.

Manage Battery Testing Facilities

- Data and system management dashboards: Create customized data dashboards with the right information, to the right people, so they can take the right actions to maximize utilization and uptime, manage the test facility, optimize energy usage, and reduce CO2 footprint.
- Datalogger and black box recorder: Reliably log all data without loss, using with configurable options to capture, report on, and learn from critical events during the longest test times, and avoid test reruns because of data loss.
- Mass system configurator: Increase operational efficiency and decrease system commissioning time using BTS software for mass system configuration, continuous remote monitoring, and test database management.

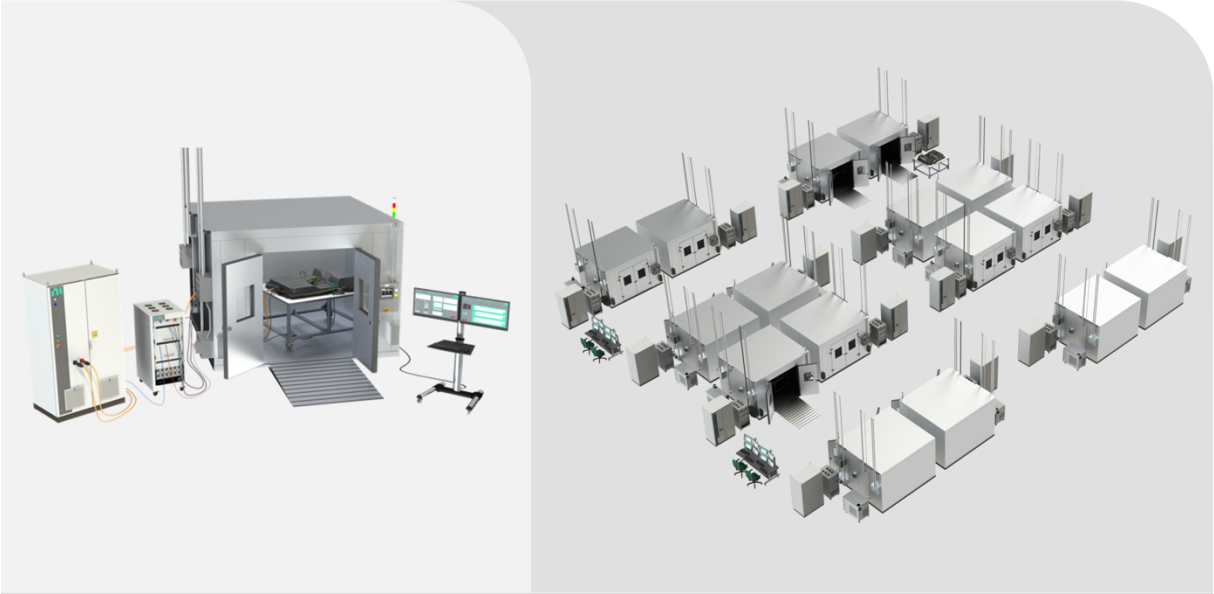

FIGURE 06. THE OPEN ARCHITECTURE OF THE BTS EFFECTIVELY SCALES FROM SINGLE TEST CELLS TO LARGE-SCALE BATTERY TEST DEPLOYMENTS

Battery Test System Software Architecture

To provide flexibility and ability to scale, the BTS software combines industry-proven software (VeriStand, TestStand) with out-of-the-box functionality for battery test, including plugins, device drivers, and analysis/test IP. Additionally, BTS software integrates with SystemLink for enterprise-level system and data management and lifecycle analytics.

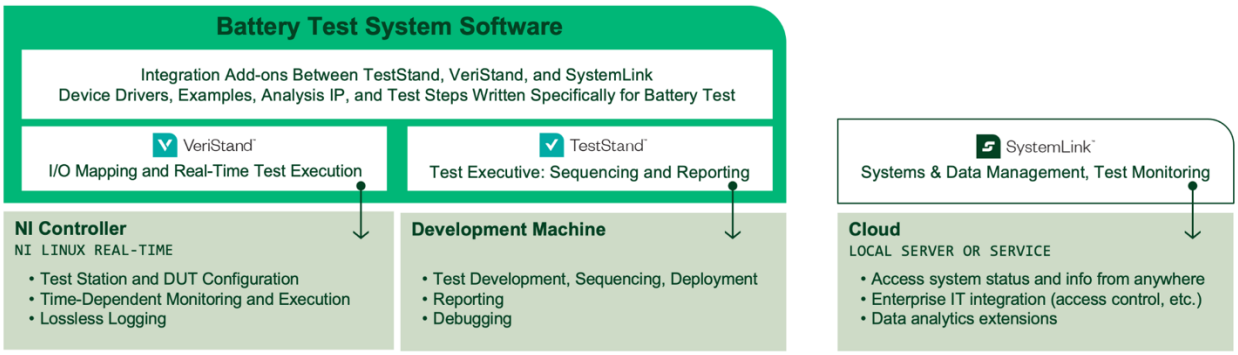

FIGURE 07. THE BATTERY TEST SYSTEM SOFTWARE ARCHITECTURE

Battery Test System Software Advantages

The BTS software is designed to solve challenges at different levels of the battery test workflow. From test cell and DUT definition to facility management, the BTS software connects design and test engineering tasks to request, define, write, run, monitor, and report on any test needed, without the need of major software reconfigurations.

1. Focus on Test, Not Distractions

   Get to test faster with the out-of-the-box functionality, combined with customization capabilities to quickly implement test plans to meet any test need, with any test configuration—saving time from low-level implementation details.

2. Disencumber Test Engineering

   Reduce development overhead through the unified software toolchain for requesting, implementing, executing, and monitoring tests, and reporting on test results with customizable UIs for different roles and users.

3. Keep Up with Scale and Budget

   Lower total cost of test by using BTS software to seamlessly connect new or existing equipment and scale to large tester fleet deployments, preserving your ability to make fast, data-driven decisions from test results.

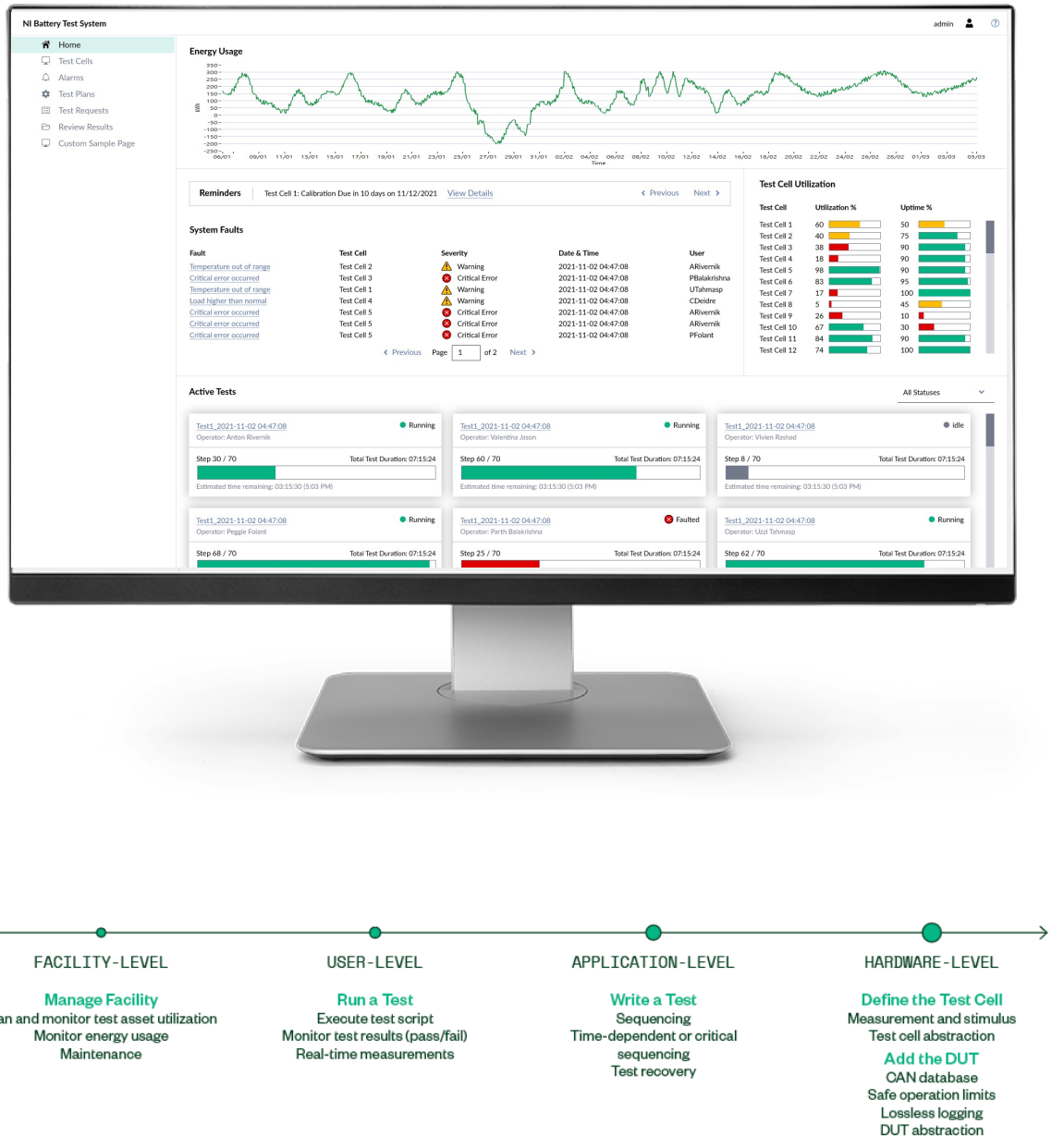

FIGURE 08. THE BTS SOFTWARE PROVIDES A UNIFIED SOFTWARE EXPERIENCE TO CONNECT THE BATTERY TEST WORKFLOW FROM HARDWARE TO FACILITY

Battery Test System Software

The Battery Test System Software provides add-ons, device drivers, examples, and analysis IP that integrate VeriStand, TestStand, and SystemLink software into a workflow purpose-built for EV battery test.

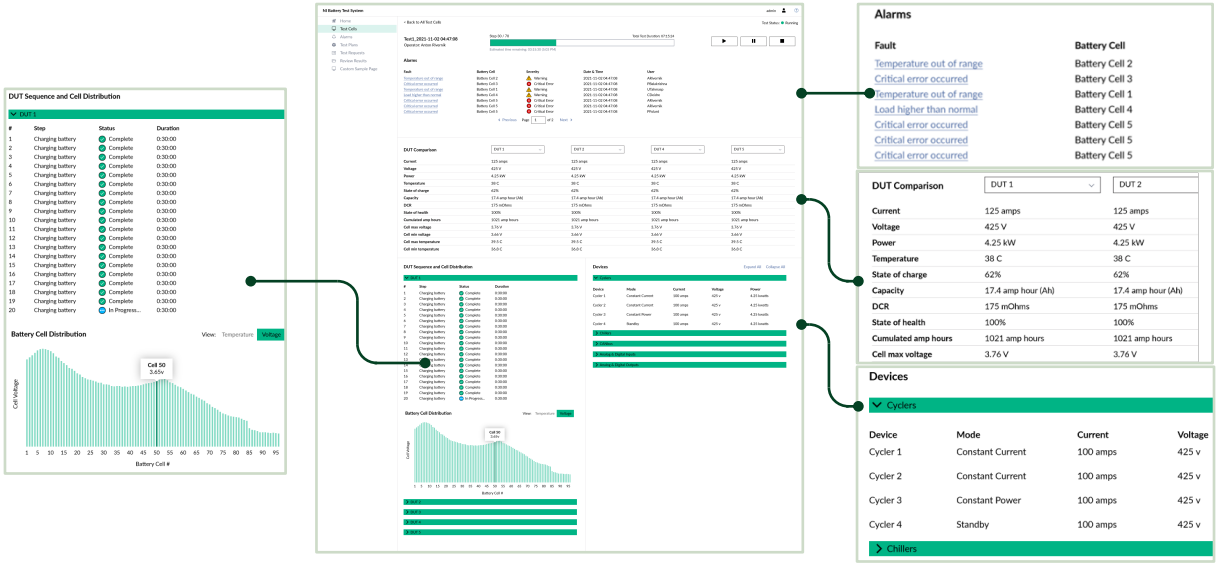

FIGURE 09. EXAMPLE USER INTERFACE FOR TEST CELL MANAGEMENT AND MONITORING

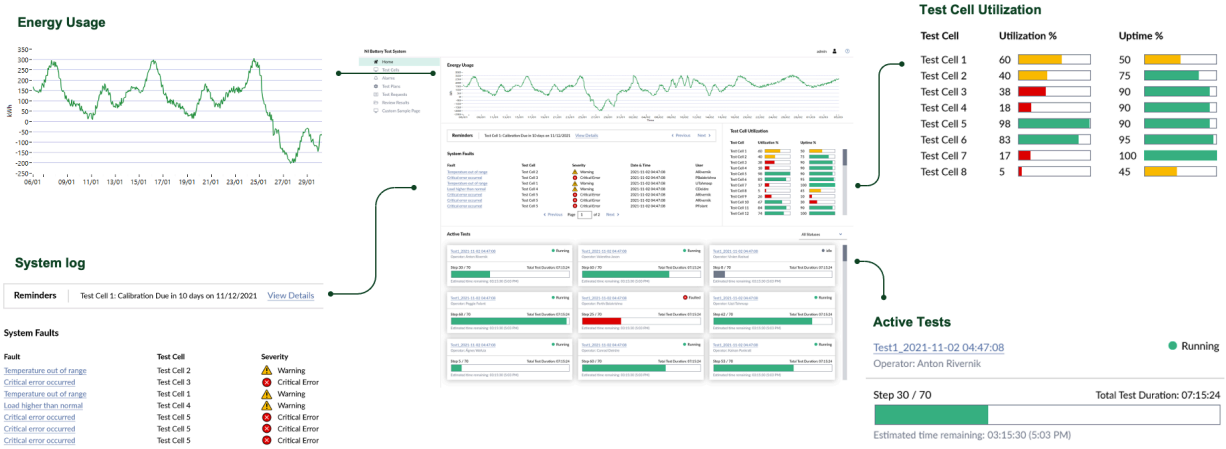

FIGURE 10. EXAMPLE USER INTERFACE FOR MULTI-CELL LAB/FACILITY MANAGEMENT

Battery Test System Measurement Rack and I/O

The BTS Measurement Rack prioritizes modularity and expansion to connect to a variety of different equipment, to the enterprise, and to run long-term automated tests.

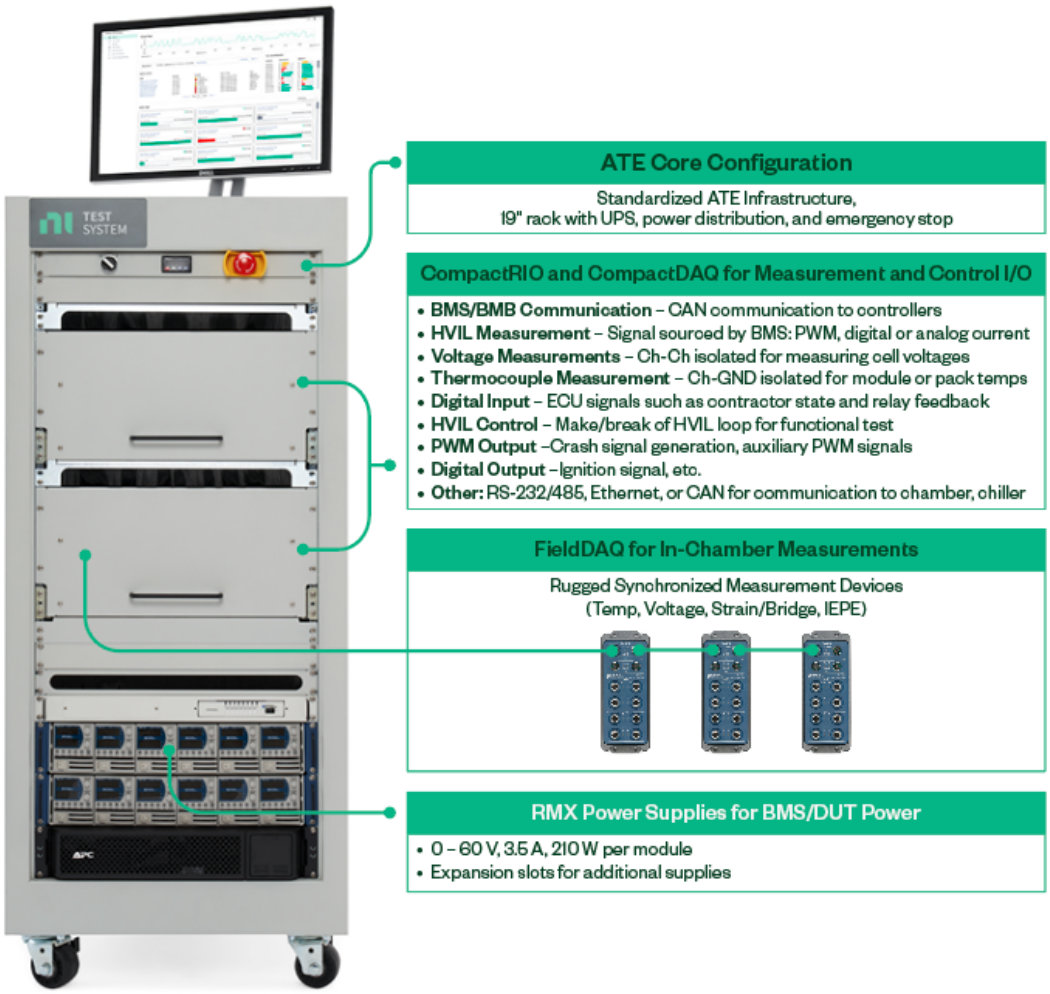

FIGURE 11. BATTERY TEST SYSTEM MEASUREMENT RACK AND COMPONENTS

Measurement Rack Configuration Options

Scale your test system by changing measurement mix and channel counts to meet evolving test requirements. Common system configurations include:

- Voltage input (range vs. density)
- Temperature measurements (isolation vs. density vs. remote IO)
- HVIL signal type (digital input, PWM input, current input)
- DIO (range vs. density)

BTS Components

COMPONENT	DETAIL
Core Rack	24U, 19" equipment rack with UPS, internal power and network distribution, and emergency power-off circuitry
0 – 60 V DC Output	Redundant supply circuits on DUT
CAN Outputs	Interface with additional test hardware or DUTs
RS232 or RS485	Interface with temperature chambers, chillers, cyclers, or other test hardware
GPIB	Interface with temperature chambers, chillers, cyclers, or other test hardware
Cell Voltage	Direct measurement of individual, stacked cell voltages in a module (up to 250 V)
Module Voltage	Direct measurement of individual module voltages in a pack (up to 600 V)
Local Temperature	Rack-based thermocouple measurement
Remote Temperature	In-chamber thermocouple measurement
Digital I/O	DI/DO/PWM options for ECU signal emulation
HVIL Monitoring	DI/PWM/analog options for monitoring an existing High Voltage Interlock Loop
Relay Output	Controlling a High Voltage Interlock Loop

TABLE 02. CORE BTS MEASUREMENT RACK COMPONENTS

Battery Cycler Integration

The BTS can integrate battery cyclers from NI-owned or any vendor through an instrument abstraction layer that allows you to easily swap the equipment in and out, regardless of vendor and models, without modifying the rest of your test system. This ability to quickly integrate, swap, and reconfigure cyclers, without investing time in reprogramming or remapping the test software, is critical to meeting deadlines. This is especially beneficial if the test facility is handling concurrent test for multiple programs with different battery voltage levels and design goals.

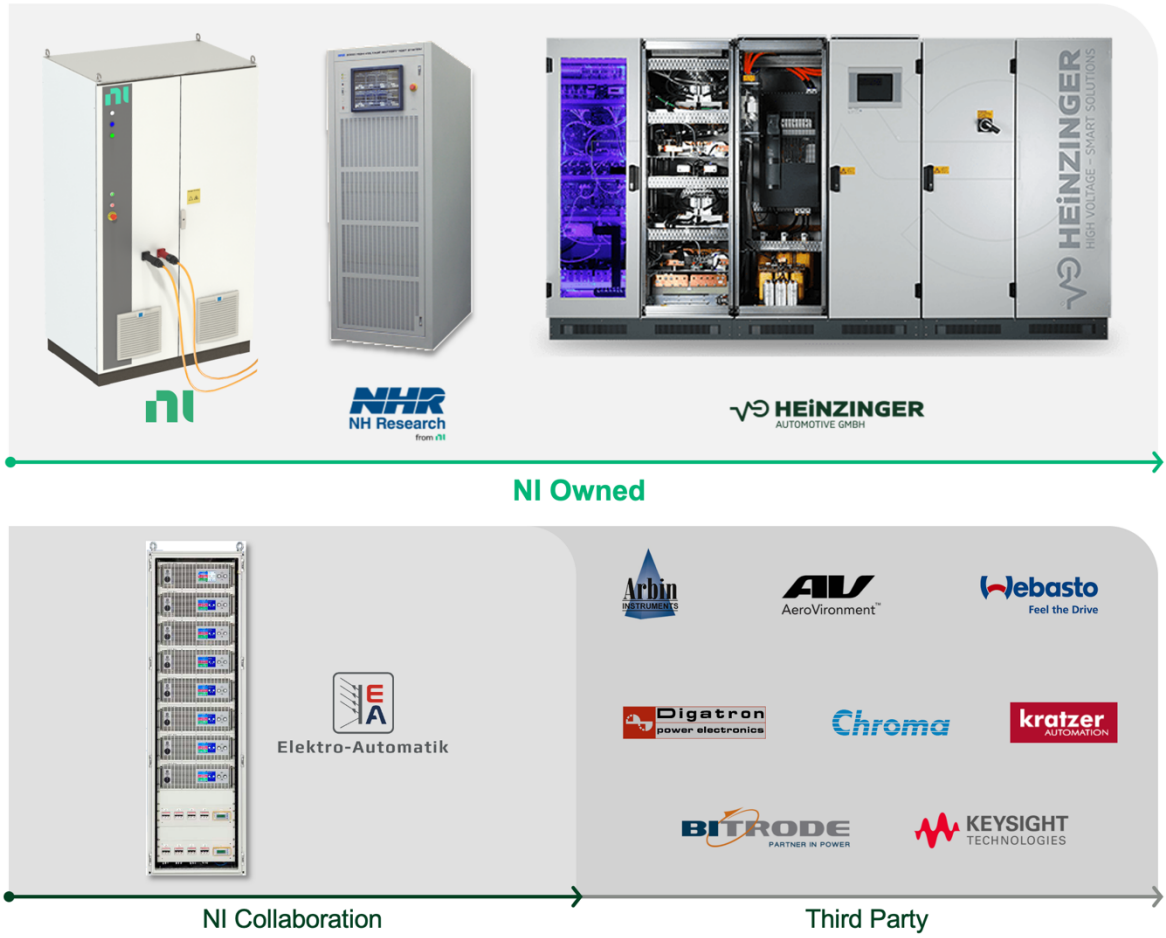

FIGURE 12. NI'S POWER ELECTRONICS PORTFOLIO AND THIRD-PARTY COMPATIBILITY

Other Equipment Integration (Chamber, Chiller, Instrumentation)

The Battery Test System also makes it simple to support a variety of equipment brands and models through instrument add-ons, making it easy to switch out instrumentation and quickly reconfigure a test station for different tests and requirements with new equipment. Instrument add-ons provide a standardized way to talk to any instrument that has a supported communication protocol like CAN, LIN, Serial, GPIB, or UDP (SCPI or custom), using NI's drivers. Once configured, the equipment can be used in any test station configuration by simply loading the correct instrument add-on. In this way, you can write and maintain your own library of instrument plugins to support your unique mix of equipment.

System Simulation

With the Battery Test System, you can use models to simulate devices and test equipment to write and validate test sequences and software without the hardware being present. This decouples development from hardware availability and allows you to easily switch between model-based simulation and real equipment by switching projects in the BTS software.

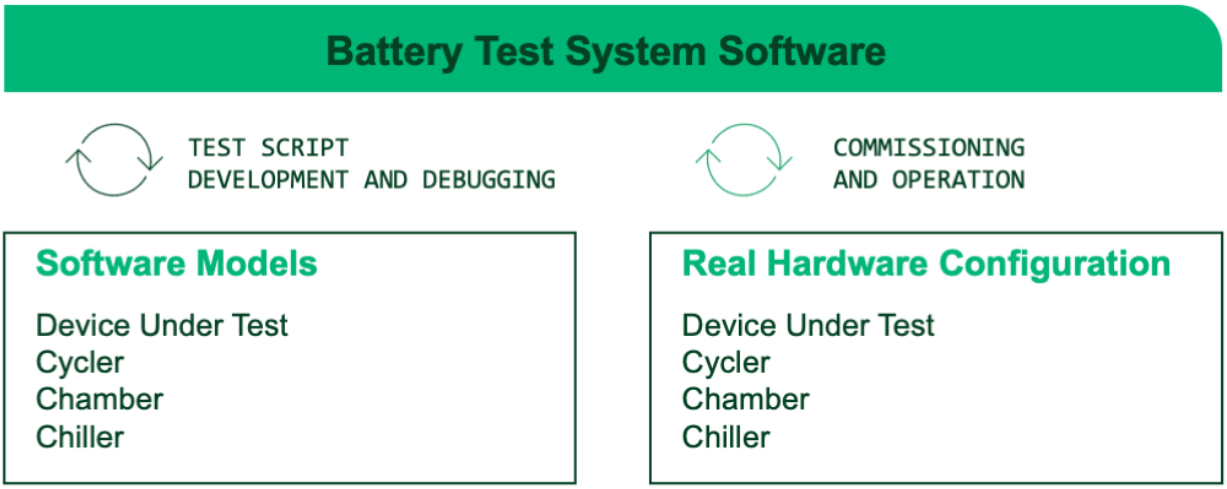

FIGURE 13. UTILIZE SYSTEM SIMULATION TO ACCELERATE TESTING BY DECOUPLING DEVELOPMENT FROM HARDWARE AVAILABILITY AND DE-RISKING DEPLOYMENTS.

Large-Scale Test System Deployments

To meet the needs of scaling and testing more batteries effectively, NI built specific features to make large-scale test deployments more efficient:

Supervisory UI for Remote Monitoring and Alarming

- Manage multiple, distributed test stations through a unified software experience
- Constantly monitor system status and test state, health, utilization, data trending, and other variables

Test Results Database

- Automatically prepare your data from multiple sources for queries and analysis
- Quickly access and search measurement data across test systems and facilities
- Intelligently analyze test results and related files, and generate reports automatically

Systems Management

- Efficiently replicate and deploy test systems with the right test software packages
- Centrally manage distribution software and control access
- Perform remote device configuration and diagnostics
- Manage system performance health with alarms management, notifications, and calibration reporting

System Maintenance and Upkeep

You expect NI systems to help you solve some of the most challenging engineering problems; expect the same level of capability in our services. With every BTS deployment, NI and our partners work with you to determine the level of service that best meets your application needs and ensures long-term success.

Obtain peace of mind through support from BTS experts to accompany your in-house maintenance operations. Three years of our Basic Service Program is included with every BTS, with the option to reduce or increase the program duration.

	BASIC	CUSTOM
Software Support Access to updates and bug fixes	Access to Software Updates	Scope to be defined with customer on a case-by-case basis
Repair and Replacement Minimize downtime	3 – 5 Days Replacement	
Technical Support Resolve issues quickly	Technical Support 8x5	
Field and Remote Services Fixed maintenance cost		
Life Cycle Management Mitigate obsolescence risk	Standard Product Notifications	
On-Demand Training Ensure user success	Online Operator and Maintenance Training	

	OPTIONS
Calibration Quality measurements and traceability	Laboratory Calibration On-site Calibration Calibration Replacement
Bring-Up Assistance Hassle-free commissioning	On-site or Remote Tester Bring-Up
Training Ensure user success	Private Classroom (On-site or virtual) for Operator and Maintenance Training
Professional Services	Integration Services, Technology Refresh, Upgrade Assistance Consulting Services Resident Engineer

TABLE 03. SYSTEM MAINTENANCE AND UPKEEP OPTIONS

NI Services and Support

Additional to services specific to BTS, NI offers a variety of solution integration options customized to your application-specific requirements. You can use your own internal integration teams for full system control or leverage the expertise of our worldwide network of NI Partners to obtain a turnkey system.

Contact your account manager or call or email us to learn more about how NI can help you increase product quality and accelerate test timelines at (888) 280-7645 or info@ni.com.

NI Services and Support

- Consulting, Integration, Resident Engineering
- Turnkey Solution Delivery and Support
- Repair and Calibration
- Global Support
- Prototype and Feasibility
- Training and Certification

ni.com/transportation