

# Approaches for Charger Testing



## Introduction

Chargers manage voltage and current to refill, or recharge a battery according to the manufacturer's specifications. While simple in concept, a charger may be required to change its output characteristics, detect and test batteries before or during charge, or even require communication with the battery or the utility company. Chargers range from a simple charger which provides only a constant current (CC), constant power (CP), or constant voltage (CV) output all the way up to a grid-managed charger which changes how it charges the battery based on utility, battery, and additional conditions. This application note provides a basic description for testing each type of charger.



*A simple charger*

## Always On Chargers

Always on chargers typically provide a fixed output. For example, a lead acid trickle charger provides only a small constant current (CC) output. This type of charger can be verified by using an electric load with either constant voltage (CV) or constant resistance (CR).



*4350 Series  
Air Cooled Load*

In rare cases, this type of charger may provide either CC or CV during the charge profile. In this case, the electronic load can still be used by using a constant resistance (CR) loading.

All NH Research (NHR) loads support CC, CV, CP, and CR allowing maximum flexibility in evaluating always on chargers.

## Waking up a Charger

Battery chargers may not provide an output voltage or current until it first detects the voltage from the battery, an external interlock is closed, or both. The charger may even use these battery detection conditions in order to determine how to safely start charging the battery. For example, the charge profile may wait until the temperature reaches an acceptable level or contain additional pre-charge steps to recover deeply discharged batteries.

In these cases, the test fixture may contain a small power supply, diodes, or relays needed to “wake-up” the charger. All NHR air-cooled loads provide digital I/O allowing additional test fixture devices to be managed by the load.

We provide connections that allow a turn-on signal to be used for a charger or a small power supply. Or control a relay/switch to connect the power supply to the charger to start it up then disconnect it later.

### Examples:



## Chargers that “Test” the Battery During Charge

Chargers may “test” the battery during charge by reducing or even drawing power from the battery itself. Some types of batteries require these “tests” for the charge to be properly accepted, to reduce internal pressure, or to re-absorb chemicals within the battery itself. Alternatively, some chargers do these “tests” in order to safely charge the battery, to determine the health of the battery, or for self-calibration of the charger itself. How the charger “tests” the battery and what the charger expects to see in a normal battery determine the approach used in validation.

Combining an NHR load with a power supply along with a control application on a PC is a very cost effective solution for low power chargers (<6kW) especially when the charger does not require a quick response from the simulated battery. In this case, the PC adjusts the power supply and load to simulate the increasing battery voltage as it is being charged.

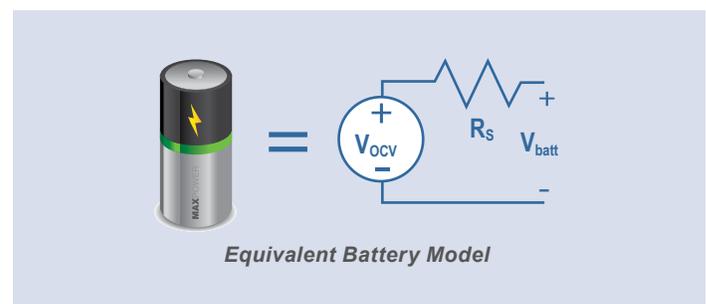
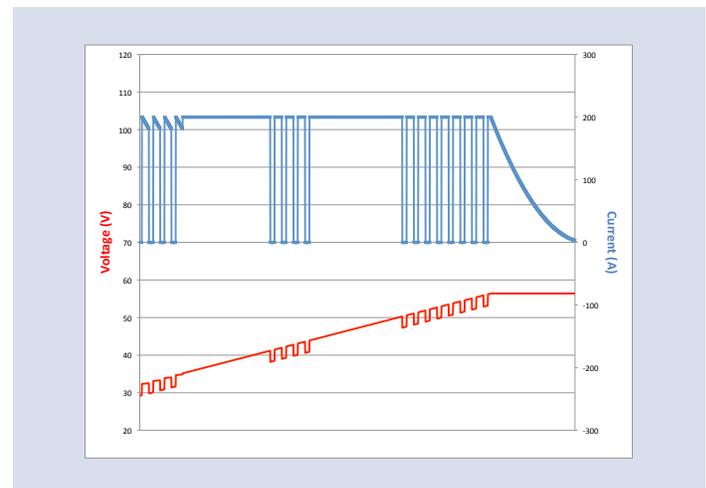
The PC can be programmed to control the power supply and load to emulate how a battery actually behaves any time the charger performs a “test” of the battery. In this case, the PC continuously measures the voltage and current being delivered by the charger and adjust the power supply and load to emulate the battery’s response. This process is then repeated throughout the entire simulated charge profile.

A more direct approach can be implemented by first understanding why a battery changes its voltage due to changes in charge current.

The voltage seen at the terminals of a battery decreases slightly as a charger reduces, or even reverses the charge current. Similarly, the voltage at the terminals of a battery increases slightly as the charger supplies additional current. Both of these effects are caused by the internal resistance of the battery chemistry and the wire connections.

The NHR 9200 and 9300 Battery Test System provides a battery mode allowing programming the series resistance ( $R_s$ ) and a no-load open circuit voltage ( $V_{ocv}$ ). When programmed, the system automatically adjusts the output terminal voltage based on the direction and level of current flowing to, or from, the charger.

The adjustment is handled in the hardware improving the simulation speed, removing the integration complexity, and allowing the PC to focus on the test. In addition, the charger remains in control of the terminal voltage and current at all times even when it changes between CC, CP, or CV.



$$V_{batt} = V_{ocv} + R_s \cdot I_{charge}$$

## Charger Output Controlled by BMS Data

A charger will change its output to meet the manufacturers charge specifications to ensure that a battery is charging properly. Many chargers today communicate with the battery, utility company, or both. Charging stations may enable power flow from the vehicle to grid (V2G) in order to assist the grid by stabilizing frequency, reducing peak demand spikes, or providing temporary backup.

The charger communicates with the battery management system (BMS) will adjust its output based on the battery data information returned. This approach is found in chargers of all sizes including laptop, in-vehicle chargers, and wireless power transfer systems. The test station needs to emulate the battery and provide a communication interface such as I2C, SMBUSS, or CAN to communicate with the charger-under-test.

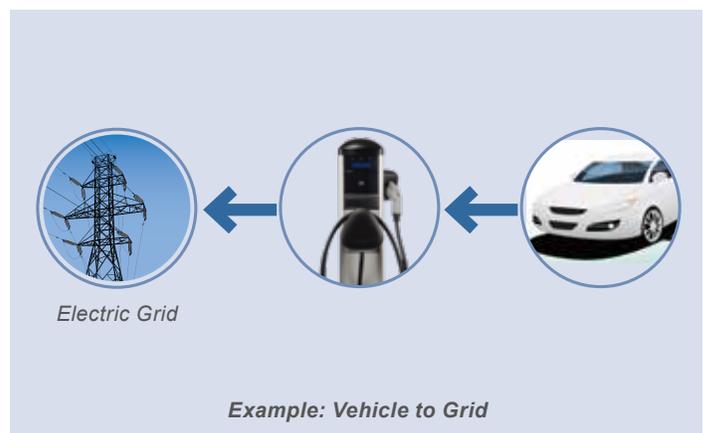
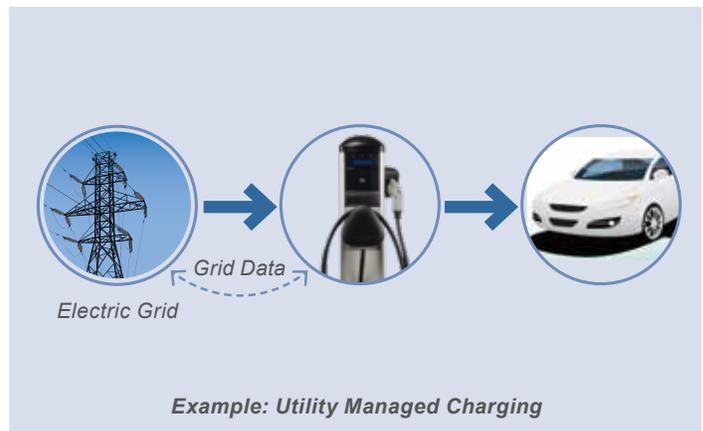
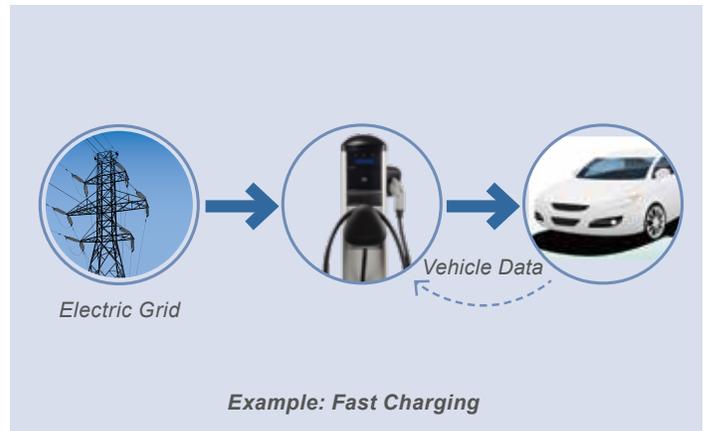
## Charger Output Modified by Grid Use

Charger output may also change due to current electric grid utilization. These grid-aware chargers may adjust its output, reducing, pausing, or even delaying charging. These chargers are able to communicate with a smart grid using standard based protocols like the smart energy profile (SEP).

## Vehicle to Grid Power Transfer

There are a number of initiatives for using vehicles as local backup power or to assist the utility company during periods of peak demand. In this case, the charger is reversed and acts as a distributed generator taking power from the battery and supplementing the electric grid to address a short-term power shortages, frequency shifts, or other grid issues.

NHR supplies software packages and fully documented drivers allowing them to be added to test setups for any of these applications.





## NHR 9200 & 9300 Battery Test System

- Simple chargers
- Chargers with battery detection
- Chargers with battery testing functions
- Advanced chargers

*Can operate as a power supply, load, or directly emulate a battery.*

*Available from 12 kW to 100 kW+*

**9200 Series:** 12 kW up to 252 kW

**9300 Series:** 100 kW up to 2.4 MW



## NHR 4700 & 4760 Air Cooled Loads

- Simple chargers
- Chargers with battery detection (with additional power supply)
- Chargers with battery testing functions (paired with power supply)

*Available from 1 kW to 36 kW*

*Contact factory for higher power level options*



## NHR 4350 Air Cooled Loads

- Simple chargers
- Chargers with battery detection (with additional power supply)
- Chargers with battery testing functions (paired with power supply)

*Available from 150 W to 600 W*

*Contact factory for higher power level options*

**Contact NH Research for more information  
or to discuss your charger testing needs!**