Key advantages of Midtronics' patented conductance method

vs. impedance or resistance methods

1. Midtronics conductance technique uses a specific periodic AC signal that results in fast, accurate, and repeatable measurements in a variety of environments and overcomes external noise problems as well as cable inductance interference by using these periodic AC test signals at carefully chosen frequencies.

2. Another advantage of using Midtronics' periodic AC conductance test signal is that this analysis includes the ability to identify parts of battery that behave like capacitor:

- Testers measuring at DC (f = 0) are unable to make such determinations.
- In addition, high frequency testers (f > 100 Hz) that do not analyze Conductance as a function of frequency, G(f), may contain measurement errors due to cabling *particularly in higher amp hour batteries*.

3. The conductance technique employed by Midtronics allows for the smallest effective signal to be used; advantages of using a small signal include:

- The test process disrupts/changes the battery as little as possible (it is the least invasive method)
- As compared to a DC resistance measurements, conductance minimizes those changes created by a DC resistance test:
  - The battery's state of charge is decreased as a result of a DC resistance test
  - The battery's voltage can change, potentially causing battery string imbalance in online applications.
  - The battery may become polarized during the test which could cause results to vary both during and after the test and testing becomes less repeatable than the AC conductance test

4. An additional differentiated advantage of the Midtronics conductance technology vs. impedance/DC resistance:

- Because of the measurement techniques used in Conductance testing, an accurate result is obtained *on even the highest amp hour batteries*—this may not be the case with other methods
- High amp hour batteries typically have higher conductance.
- In order to obtain accurate results on these batteries, it is necessary to resolve very small voltage measurements.
- Midtronics data acquisition circuitry is sensitive to such measurements and is designed with this in mind; this circuitry is similar to what is used in precision medical instruments such as Electrocardiograms (ECG/EKG).

5. Further, Midtronics has presented the largest amount of technical data in public scientific forums subject to critical peer review of any competitor.