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A multi-sine excitation signal optimization strategy for rapid measurement of battery impedance spectrum in time domain

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Purpose

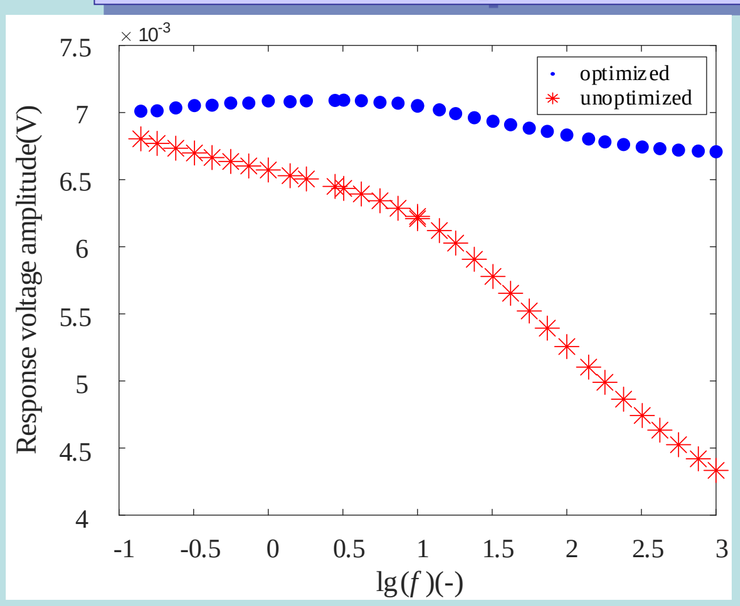
- ✓ Reduce the peak value of superposition sinusoidal signal by amplitude optimization and phase optimization
- ✓ Reduce the stress of measuring equipment
- ✓ Improve the measurement accuracy

Method

- ✓ Amplitude optimization: The amplitude optimization strategy is to calculate the corresponding frequency excitation amplitude, given uniform response amplitude at various frequencies, by using the impedance values measured before optimization.
- ✓ Phase angle optimization: Genetic algorithm is used to find the best phase combination of sinusoidal signals of each frequency, so that the peak value after superposition is minimum

Results

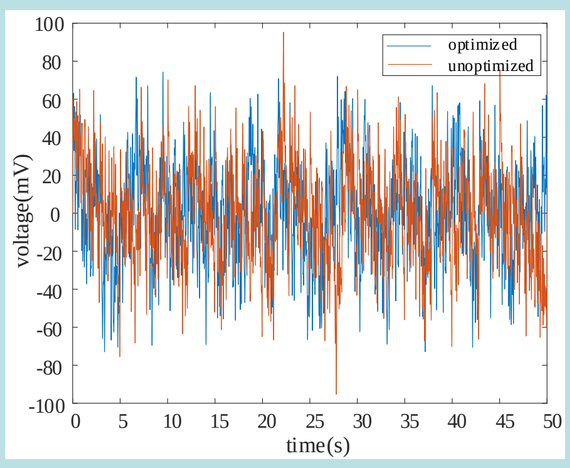
amplitude

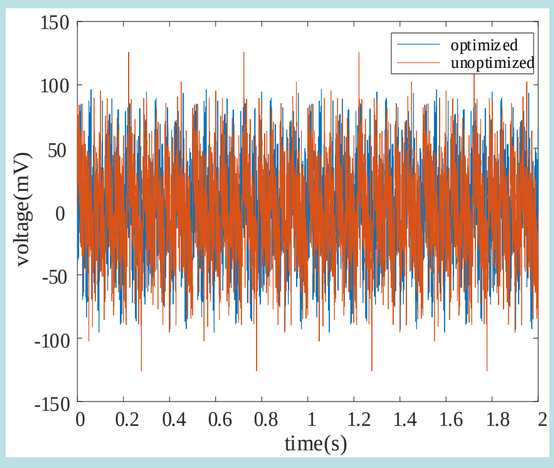


Mean square error of response voltage reduces by 82.6%.

Improved linear consistency inside the battery

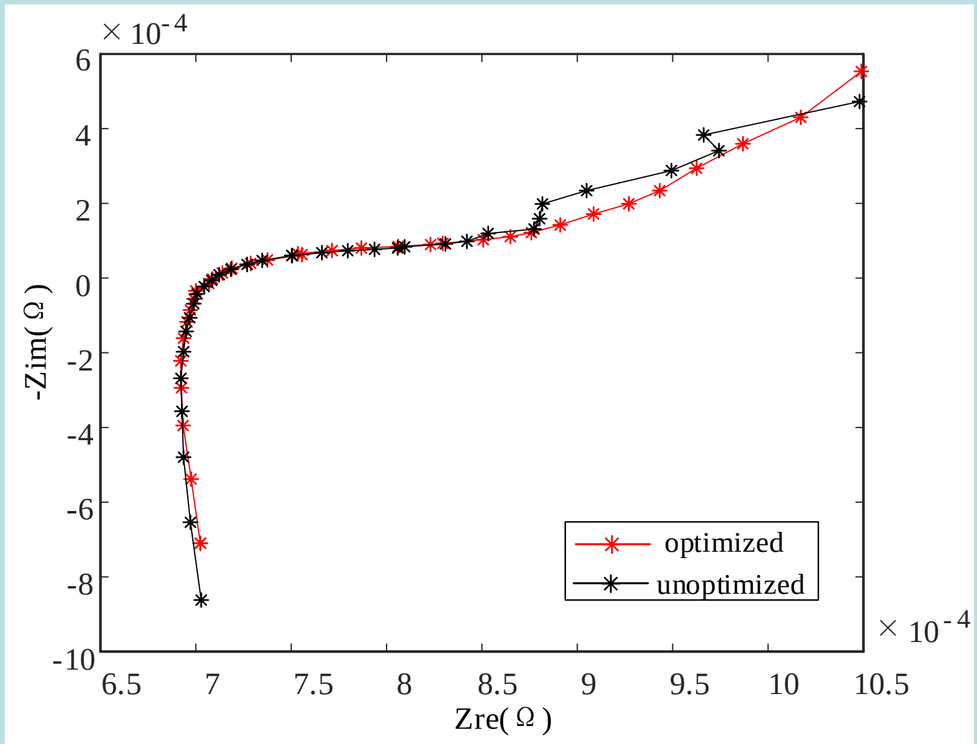
Phase angle





The peak amplitude of the current excitation over frequency bands of 0.1Hz-10Hz and 10Hz-1000Hz is reduced by 22.7% and 23.9% respectively

Measure result



It can be seen from the figure that the optimized measured impedance spectrum curve is smoother and the measurement results are more accurate.

Summary

This work proposes methods for optimizing the current excitation when measuring the impedance spectrum of battery. Results show that after the amplitude and phase angle optimizations, the mean square error of the voltage response is reduced by 82.6% at most. The peak amplitude of the current excitation over frequency bands of 0.1Hz-10Hz and 10Hz-1000Hz is reduced by 22.7% and 23.9% respectively, which improves the linear uniformity and avoids the excitation distortion of the impedance measurement.