


Pseudo-random binary sequence techniques for analysing batteries

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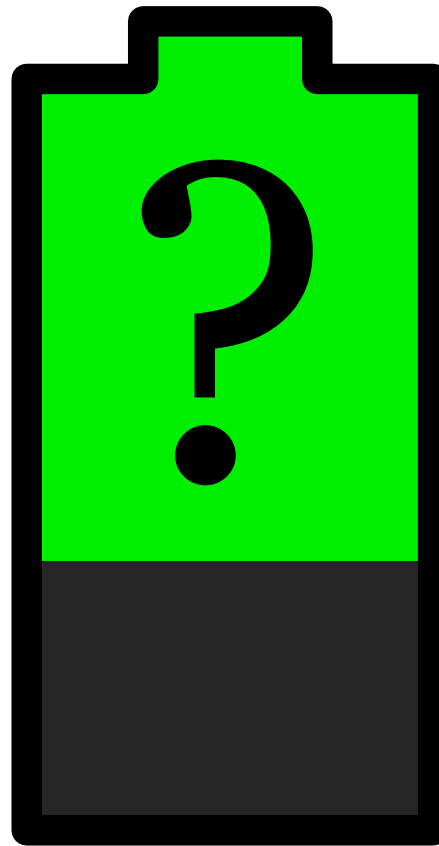
Supervisor: Dr D A Stone



Why do we care so much about batteries?

- Batteries are required for the alternative energy future of local green microgeneration.
- Telling how much energy is left in a battery is a real headache.
- Knowing how much is left is very important.

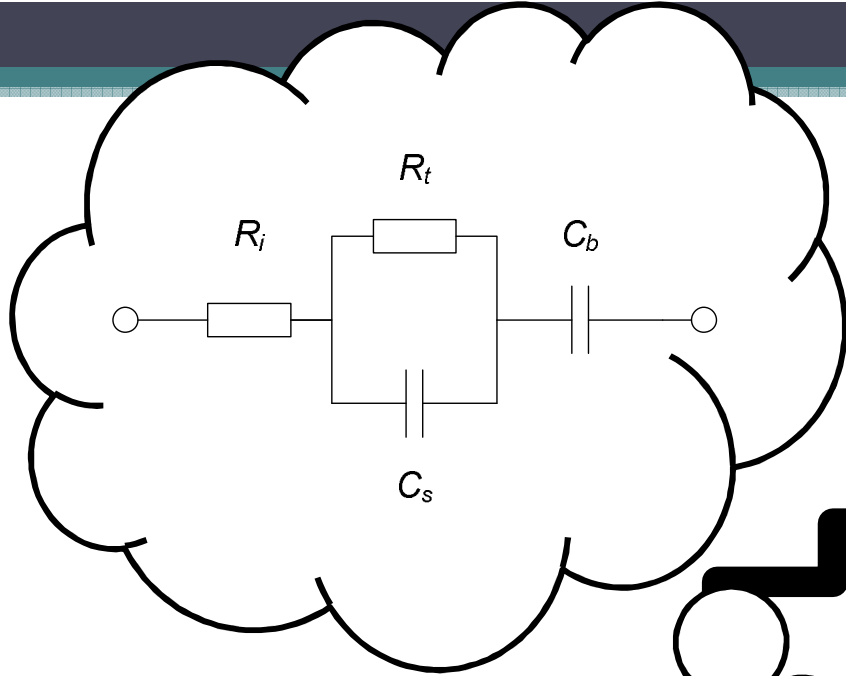
Illustration



Impedance and frequency

- Impedance is the property of a battery to oppose electrical current.
- The impedance changes with frequency of electrical current.
- Think of a sponge....



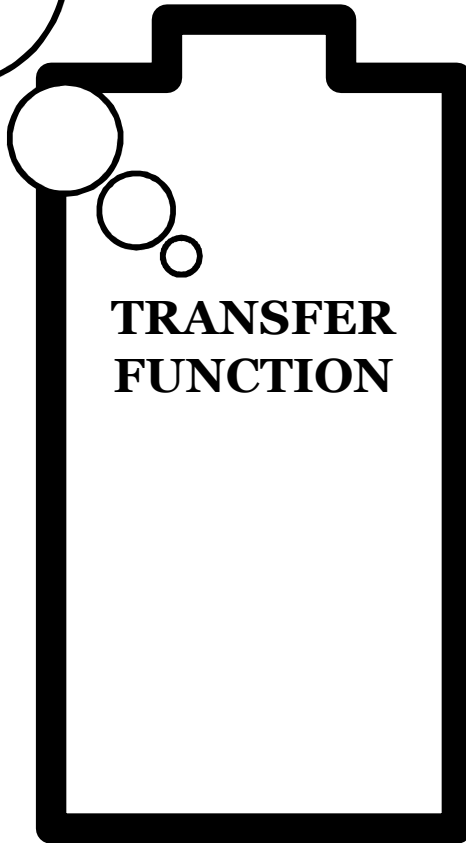


ry as a black box

CURRENT



TRANSFER
FUNCTION



VOLTAGE





A laboratory based approach?

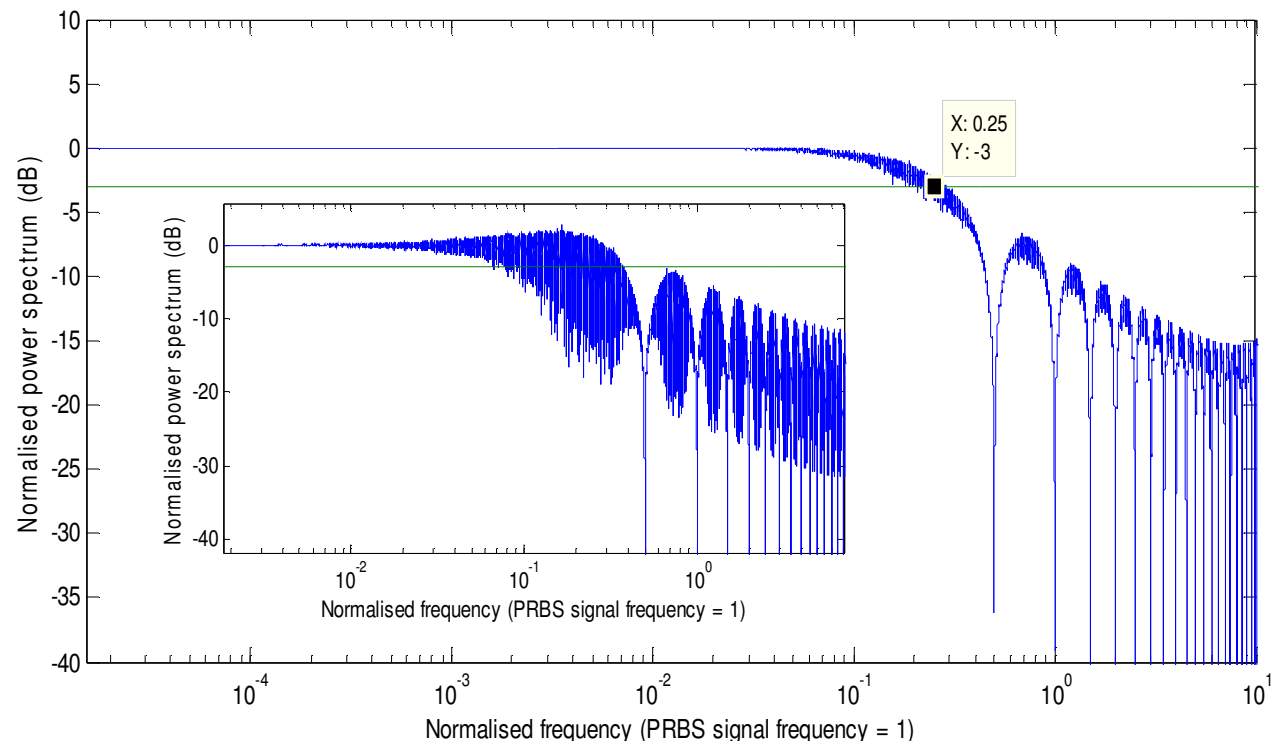
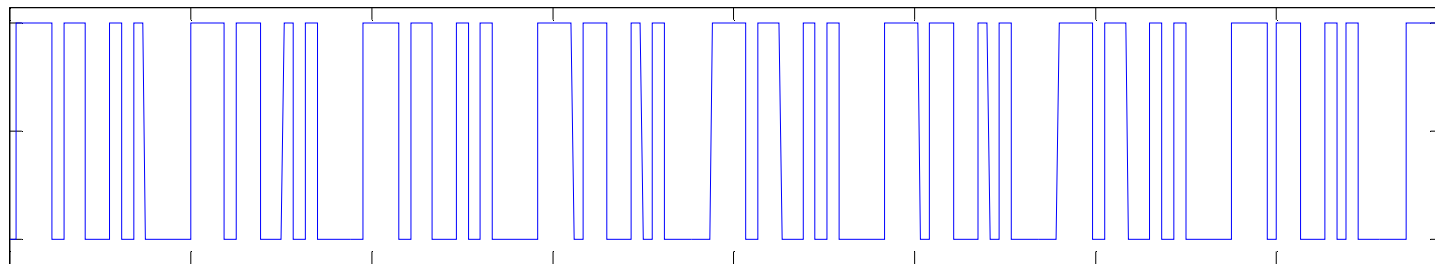
- Expensive laboratory equipment can be used to inject a fixed alternating current and precisely measure the impedance.
- This is impedance spectroscopy.
- Each frequency requires its own experiment time. At 1 mHz that's a long wait!

A cheap and cheerful approach

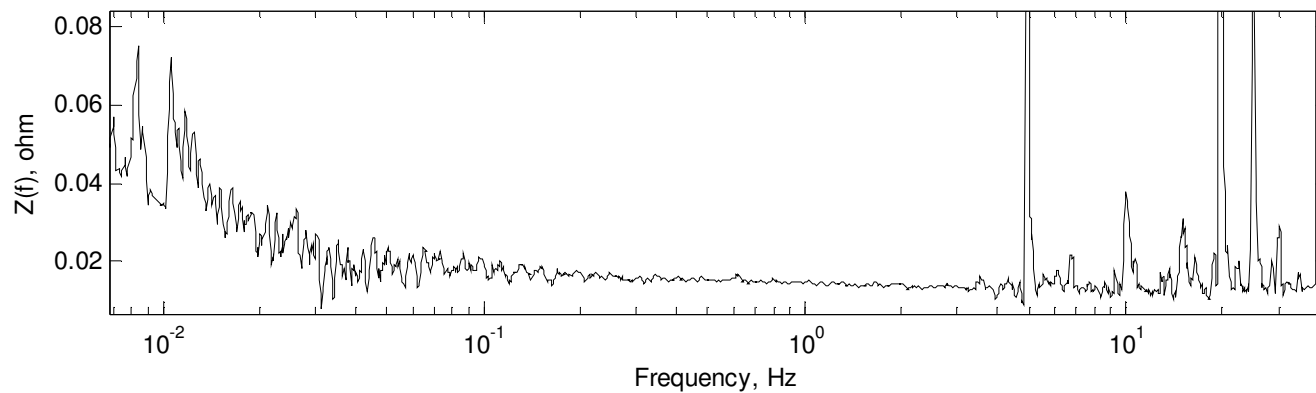
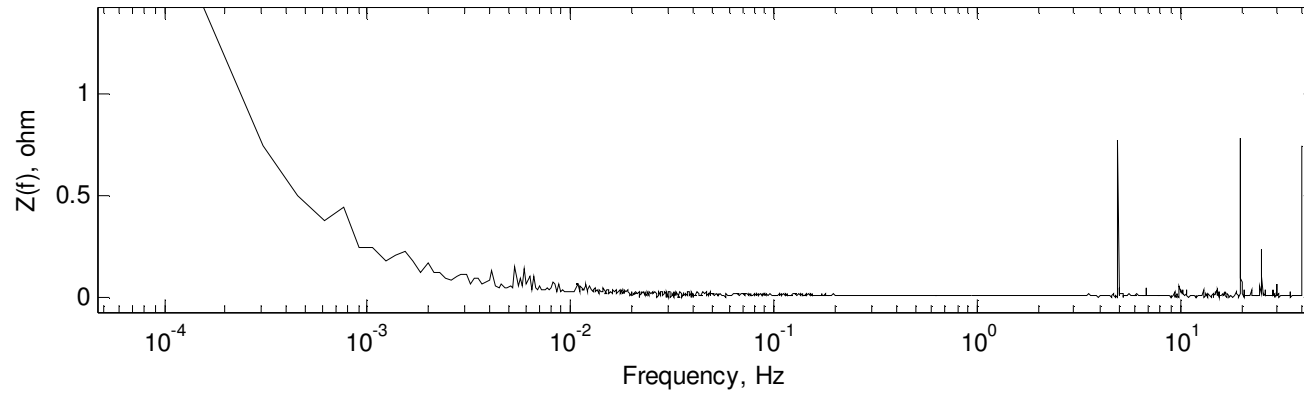
- Apply all frequencies to the battery at once!
- Use pseudo-random binary sequences – like a computer does.

```
01101110111000101001100110110000101010100101110000000010
00110111111100110100111111010100010111110000011000111101
11101011011100111000010011010110111001010000100110100001
11001010001110110100001101100100011101001010011011000100
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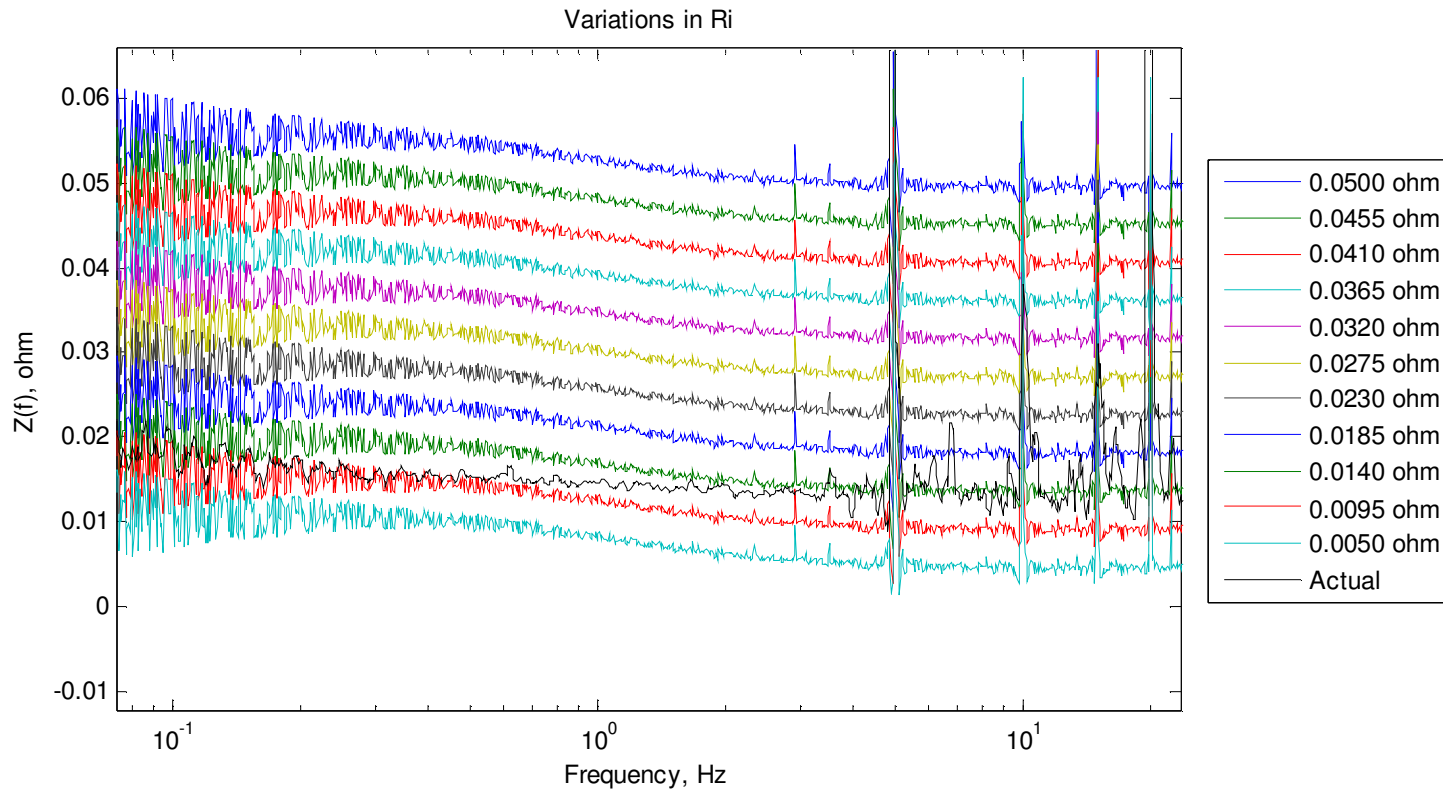
The technical bits: PRBS spectrum



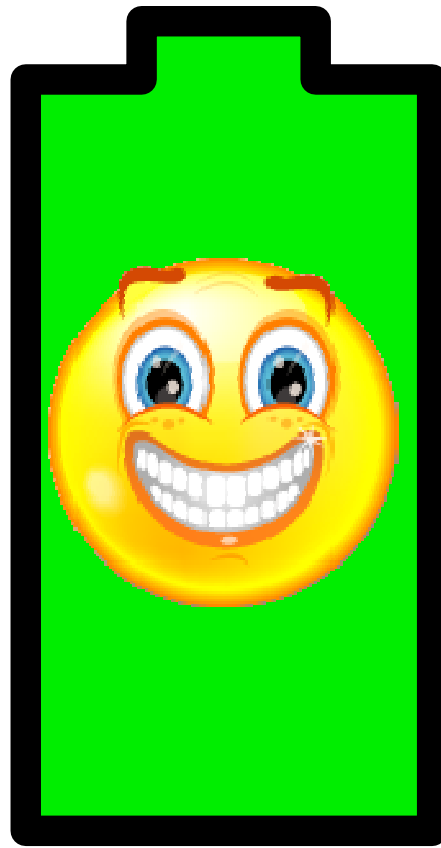
The technical bits: Battery spectra



The technical bits: Battery spectra



The outcome





The outcome

- A cheap and easy-to-implement method has been proven.
- Batteries have been analysed and match a simple model.



So what's next?

- Confirm validity of results using established laboratory procedures.
- Address the problem of analysing while in use.
- Use a more complicated (and better) model.
- Link model parameters to capacity and charge of batteries.

The end

Questions?

Jonathan Davidson