Ivium Electrochemical Note IEN3

Noise reduction

Noise is usually undesirable. This note discusses how to avoid noise, and when it is unavoidable to reduce its impact.

First step is always to avoid or reduce noise. Move away from noise sources when possible: motors, computers, etc. Use shielding on cabling and the cell itself. The cell can usually be shielded with a Faraday cage. To shield against capacitive noise (50/60Hz mains), any conducting shield will do, even thin aluminium foil. However, to shield against magnetic noise, one needs a more robust metal shield.

When the practical situation cannot be improved further, the best we can do is to reduce the impact of the noise. The measurement apparatus usually consists of an analog part, and an analog-digital converter. Noise can be reduced by lowering the bandwidth as much as is allowed without affecting the measurement result. For the analog part:

- Reduce Stability (speed of applied signal).
- Reduce Filter (speed of analog signal filters).

After analog digital conversion, the data is in numerical format and can be processed real time by internal instrument software. This has the effect of digital filtering or averaging. The signal is internally sampled at a very high rate and averaged by an embedded fast processor to a real time result. In order to make this process more efficient:

- For Transients select interval time as long as possible. For LSV/CV select Estep, Istep as large as possible. The real time averaging works better over longer integration times.
- Select interval time 0.1s or higher: the reason is that 50/60Hz mains noise can effectively be removed, which is commonly the main source of noise.

Sometimes, it is suggested to first sample points at a higher speed or shorter step size and average the data post-measurement. This is usually not good advice. Real time averaging is more effective for noise reduction than post-measurement processing. Also, the automatic analog filter settings are optimized for the base sampling rate.

Although digital filtering and averaging has become very powerful, it cannot fully replace analog signal processing. The role of bandwidth reduction and analog filtering remains essential:

- If the signal would clip against the maximum device limits due to high short-noise peaks, the averaged digital conversions would be erroneous. Thus, the range would have to be widened to avoid clipping, affecting accuracy and resolution. A reduction of the analog bandwidth would lower (flatten) such peaks.
- The so called "Nyquist criterium" demands that the sampling rate must be at least 2x the bandwidth of the signal, or the result cannot accurately be captured. Therefore, we need an analog filter in the signal path **before** we convert it to a digital format.