

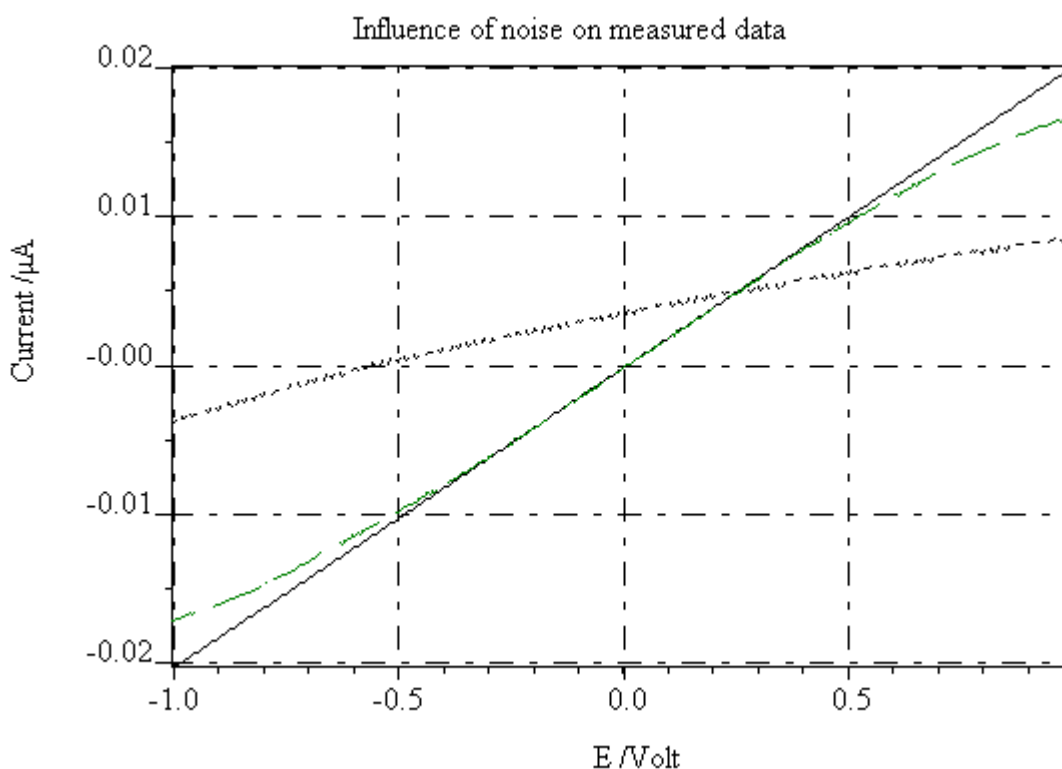
## Application note PalmSensPC

### App 1. : Noise reduction and galvanic isolation

#### 1. Influence of noise on measurement results

When performing highly sensitive measurements, it is important to minimize noise. The PalmSens instrument applies several methods that remove the effects of noise. If the recording speed allows it, the instrument will perform multiple measurements and calculate the statistical average. Thus PalmSens is able to extract meaningful data from very noisy signals.

Nevertheless the capability of the PalmSens instrument, it is worthwhile to minimize noise as much as possible. There are limits to noise reduction by averaging. If the noise levels exceed the dynamic range of the instrument, the averaging will lead to erroneous results, see **Figure 1**. Please note that all curves appear smooth.



**Figure 1. Data affected by noise;** Linear sweep, scanrate=0.1V/s, E\_step=5mV, Current range= 10nA, cell=50Mohm:

- Solid black line: measurement in Faraday cage à correct result
- Dashed green line: in unshielded environment à incorrect near max. currents (+/-20nA)
- Dotted black line: in unshielded environment, nearby to a strong noise emitter à incorrect result

In **Figure 1**, every single datapoint is calculated from the average of ca 1000 measurements that were obtained within a 20ms time interval (50Hz mains). This works well if the datapoints remain within the dynamical range of the instrument. The noise levels in the worst case depicted in Figure 1 exceeded 20nA (verified by an independent measurement) and most values are "out of range". The average calculated from such a dataset is not correct<sup>[1]</sup>. This problem can be corrected by increasing the current range, but that would decrease the sensitivity of the measurement. It is preferable to tackle the problem at the source: decrease the noise.

To improve noise performance, take the following steps:

- Place the Cell in a metal enclosure, "a Faraday cage", and connect the enclosure to the gnd (green) electrode cable.
- Keep the electrode cables close together. If self-made (non-standard) cables are used, twist them together if possible.
- Choose an optimal point to "ground" the instrument. The optimal location depends on the used configuration. Usually, performance will improve if the PalmSens gnd-cable is connected to the protective-earth from the electrical socket in which the power adapter is plugged.
- Be careful not to create so-called "ground-loops", by using multiple grounding points.

## 2. Application of the Ivium galvanic isolator

The Ivium galvanic isolator can be beneficial in the following situations:

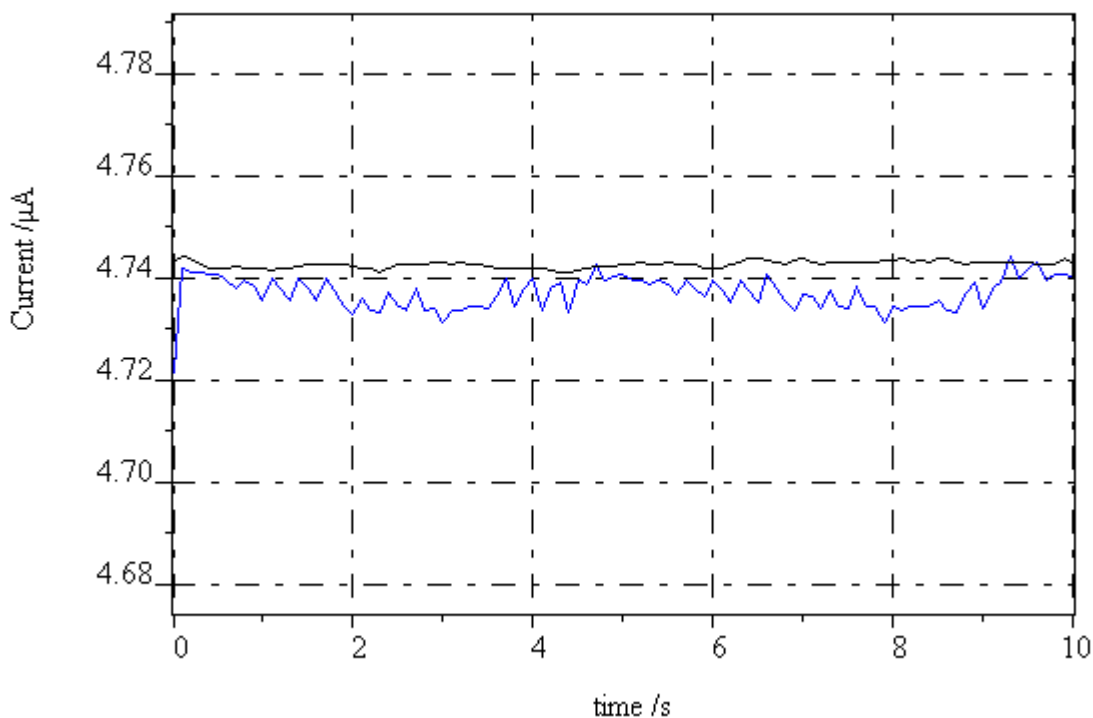
- a** The connected pc is introducing noise via the USB communication (gnd) lines, which does affect high sensitivity measurements with the PalmSens instrument.
- b** In configurations where the electrodes are in electrical contact with an electronic device, directly or via a conducting electrolyte, galvanic isolation is required for proper operation.

### Connecting the isolator:

- The isolator requires a 5 Volt power source. This can be derived from the PalmSens itself (mini-din plug), or from an external source. The IPAQ power supply is suitable, and when available, can be plugged straight into the isolator power socket. Also, another 5V supply can be applied using the included dc-connector-cable. Please note that the core should be connected to +5Volt. **Incorrect connection of the power supply may result in damage to the isolator.**
- The isolator can be connected in 2 configurations: powered from PalmSens or from an external supply. The attached power connector has common ground with the communications connector at the same side. When using external power, the isolator should be supplied from the computer-side, whereas the PalmSens mini-din power is used, the isolator should be powered from the PalmSens side.
- Connect the isolators' cables to both the USB cable and the PalmSens device, as described above for the applicable configuration.

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Effect of the galvanic Isolator



**Figure 2; Noise reduction with the galvanic isolator;** chrono amperometry, 0.250V, CR=10nA, 0.1s interval , cell=50Mohm, all measurements were performed in a grounded Faraday cage;

- Solid blue line: USB directly connected to PalmSens
- Solid black line: connected via the galvanic isolator.

Please consider shielding and grounding carefully when the isolator is used. Improper use may increase noise levels. Some pc's have a "protective earth" (3-pins power socket) that is connected to the USB cable-shield. The isolator will sever this connection. Therefore the straight insertion of the galvanic isolator might potentially increase the observed noise, because the shield is "lost". Of course, this can be easily be corrected by applying proper shielding and grounding to the instrument.

In specific situations, the galvanic isolator can be an effective tool for noise reduction, because it allows a free choice for device-gnd, instead of being tied to the pc-gnd.

[\[1\]](#) The operator cannot be misled with incorrect results, because the PalmSensPC software will indicate a large numbers of overloads for such a scan.