

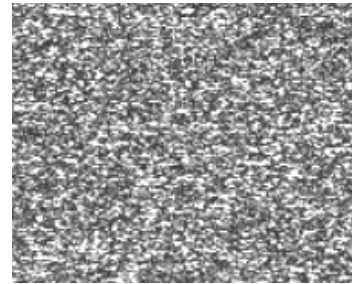
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## Instrumentation Noise

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### What is Noise?

Noise is unwanted pickup (typically sinusoidal), noise disturbs, swamps and masks a signal being measured. For an example of noise - imagine two people talking to each other in the middle of a quiet park (low noise), then the same two people talking inside a busy bar (high noise), the high level of interference inside a bar forces the people to raise their voices, sadly this also happens in electrochemical testing, signal levels are increased in order to measure something stable. A laboratory is a high noise environment, noise is created from any electrical, or electronic source.



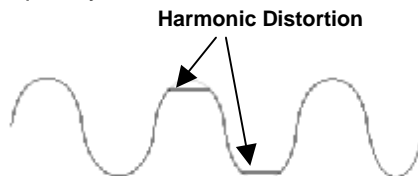
### Types of Noise

- **Mains Electromagnetic Radiation** – a main source of noise, Electromagnetic Radiation comes from the two components of an AC signal, electrical part from changing voltage and a magnetic part from Alternating Current. The electrical element can be for the most part screened, faraday cages (connected to instrument ground) and instrument cases (connected to mains earth) made from metal. The second part of Electromagnetic interference is the magnetic part, typical metal shielding will not remove magnetic induction, magnetic field is defined as:

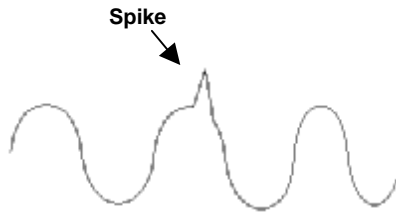
$$\text{Magnetic field (H Field)} = \frac{\text{Current Source}}{\text{Distance from Source}}$$

The further away an instrument from a magnetic source, the better. A magnetic field induces an unwanted voltage into a circuit, cable or cell.

- **Mains Harmonic Distortion** – comes from other devices drawing power at the harmonic as well as the fundamental of mains frequency, more a problem in industrial plants. Such distortion of mains frequency will lessen the effectiveness of mains rejection measurement systems.



- **Mains Spikes** – or transients occur when there is a large switch in, or out of current on a nearby circuit, rise times (of the spike) are no more than a few nanoseconds, fast indeed and will cause little trouble for an analogue circuit, but can play havoc on digital circuits, in the worst case causing microprocessors to 'crash' from erroneous data.



### Sources of Noise

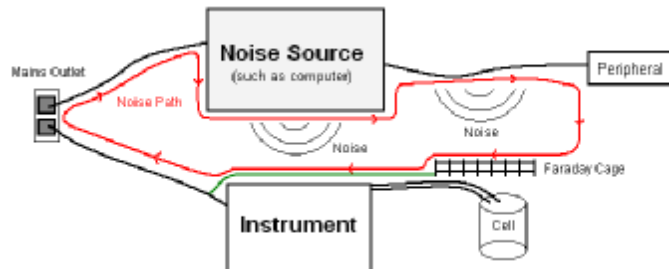
As already mentioned anything electrical or electronic:

- **Computers** – an enormous source of interference, lets start with the power supply on a computer. Computer have Switched mode power supplies, out of all different types of power supplies switched mode creates the most magnetic interference.
- **Heaters & Stirrers** – mains power and noise taken right to the cell with these two.
- **Long cell cable runs** – imagine this, for good radio reception a long arial is required, a long cable run acts just the same picking noise. A high impedance reference cable is particularly susceptible.

### Limiting Noise

Noise can be reduced by these surprisingly simple steps:

- **Shielding** – it helps, both instrument shielding and around the cell, example of faraday cage shielding:



- **Mains Filters** – either built into the instrument or a filter mains plug, these filter mains spikes,
- **Short cables** – the golden rule, keep cables short and the instrument as close as possible to cell,
- **Positioning** – careful planning of a lab can place the instrument and cells away from high noise sources. Plug the instrument into a different mains socket than used by noisy appliances,



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- **Grouping** - group each wire of an electrode cable together, so if a cable experiences any noise, the noise will be present on all wires of the same cable and will cancel out.
- **Heaters & Stirrers** – make sure the reference electrode is placed directly into the bulk solution, if noise is a problem try a 'Noise reducing electrode' ([www.potentiostat.com](http://www.potentiostat.com) >> Applications >> Noise Reducing Electrode, try it, it really does work).

### Instrumentation Purchase Checklist

Looking for new instrumentation? this checklist will help you choose an instrument that is not susceptible to noise:

- Fully shielded instrument, eliminating electric induction,
- Mains rejecting measurement,
- Floating Ground,
- Can the instrument be placed away from high noise sources (such as computers) and close as possible to cells?
- Instrument power converter (in order of preference): Torroidal transformer, non-torroidal transformer. In no circumstances go for a 'switched mode' power source (as found in computers),
- Mains supply filters,
- Isolated either electrically or optically from PC,
- Self calibrating instrument, to remove thermal drifts.



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