Technical Paper

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Measuring High and Low Currents with One Sensor

Background:

We get frequent enquiries from customers wanting to measure some hundreds of amps and then with the same sensor measure tens of milliamps.

Practically with traditional sensors this is not possible. The closest option is closed-loop flux-gate but these sensors cost many hundreds of dollars which makes them not practical for most applications.

There are two important reasons that make an economic sensor impractical:

1. Signal to noise ratio. If the sensor is to have any sort of frequency response, installed noise will probably be over 5mV. Now if the available output swing is 2500mV we have a dynamic range of 2500/5 = 500:1. So if we want to measure 500 amps, trying to read 1 amp with any sort of certainty will be difficult.

2. If we pretend that we can filter noise, the next hurdle is the A/D resolution. The highest practical is 14 bit or 1 part in 16,000. Again if the maximum current is 500 amps, 500/16,000 = ~30mA. This is better than 1 amp but still not a few milliamps that some applications demand.

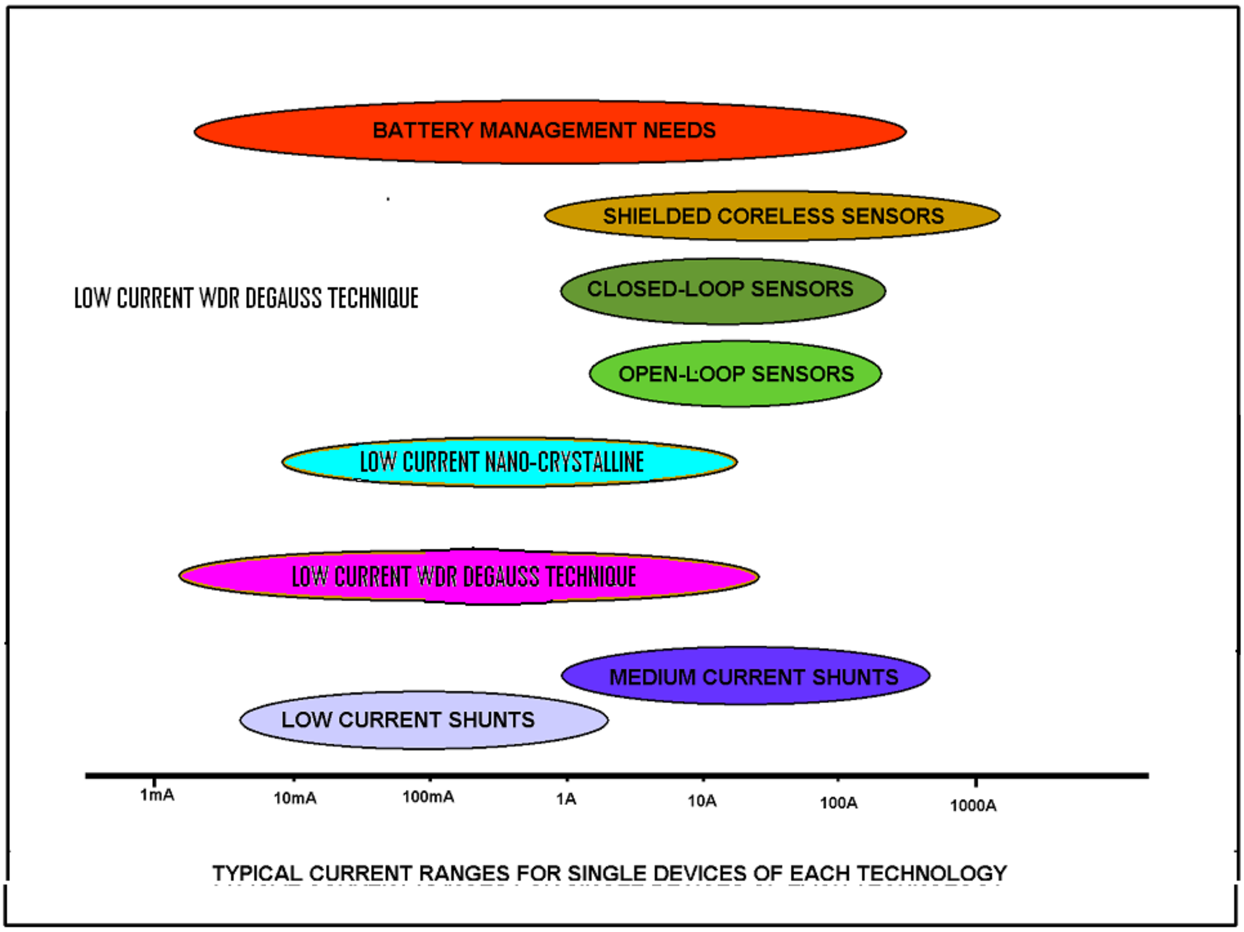
A Solution:

The best answer is to have a dual range system – a low current sensor for measuring up to say 10 amps and a traditional high current sensor for say 5 amps upwards.

What sensor to use for the low current range:-

It is important that the low current sensor is not damaged and that its output does not get permanently biased by high currents. Flux-gate and traditional closed-loop sensors are not good in this regard. It is best to use open-loop sensors which incorporate degaussing or a nano-crystalline core. Nano cores can have a current equivalent of about 20mA subsequent to high overload which is satisfactory for most applications.

If less than 20mA is required, then degaussing could work. Raztec has solutions.



Challenges:

Low currents mean very low levels of flux. Low flux means that stray interfering flux becomes a big issue. Without any protective measures, even the Earth's magnetic field represents about 500mA, so some form of flux concentration or shielding is a must. The most common flux concentrator is a magnetically permeable core. The higher the permeability of the core material the better the shielding effect. Nano-crystalline material has very high permeability so again is a good choice.

However, the necessary air gap to inset the magnetic field sensor degrades the core permeability. It is essential to keep the gap as small as possible. A common this sensor is 1mm thick, so a 1mm gap becomes possible. This results in good immunity to stray fields but if a customer has very close spacing between current carrying conductors, Raztec has solutions available.

An additional challenge is that at low currents, signal levels are small and can be corrupted by thermally induced offset drifts in the magnetic field sensor. Over the last few years there have been dramatic improvements in sensor performance. Some sensors offer programmable compensation. Another option is to actively stabilize the output. Again, Raztec has some solutions available.

The traditional challenge is cost. Nano-crystalline cores are expensive. If the primary conductor is big, the core will be expensive and remainence effects tends to be greater. If possible, the primary conductor could be necked down for a short length and a core fitted over the necked down portion. This has a double benefit in the cost is reduced and low current performance is superior.