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Potassium Magnetometers – Major Benefits

By Dr. Ivan Hrvoic

Potassium is the only optically pumped magnetometer that operates on a single, narrow electron spin resonance (ESR) line in contrast to other alkali vapour magnetometers that use an irregular, composite and wide spectral line (and Helium with an inherently wide spectral line). Narrow line widths, along with relatively higher Lamour frequency (7Hz / nT), are a basis for the unique features and major benefits that Potassium magnetometers offer.

Major Benefits

Major benefits of these types of magnetometers include:

- Highest sensitivity. Potassium is the only commercially available magnetometer that breaks the 1pT / $Hz^{1/2}$ level of sensitivity. Sensitivities as high as 0.03pT / $Hz^{1/2}$ are available in different designs of the instrument.

- Highest absolute accuracy. Single regular spectral line operation guarantees an absolute accuracy matching or surpassing Proton and Overhauser magnetometer's absolute accuracies. Departure from the highest accuracy can only be caused by an erroneous measurement of Lamour frequency and parasitic phase shifts in the sensor electronics (about 10pT per degree of phase shift). Higher absolute accuracy is beneficial in operation of gradiometers and especially multi-sensor gradiometers. There is no need for calibration, alignment etc.

- Faster sampling rates. Highest sensitivity offers also higher sampling rates. Standard potassium magnetometers operate at 20 readings per second. Higher speeds are available optionally.

- Lower heading error. While composite spectral line of other alkali vapour magnetometer changes its shape in function or orientation of the sensor in magnetic field, resulting in an enormous heading error, Potassium single line has virtually no dependence on sensor – field geometry. No special adjustments are necessary. In practice, less than 0.1nT changes in readings are easily and effortlessly achieved.

Low maintenance costs. Being of very uncritical design Potassium sensors need not be aligned or ever realigned in operation. Users may replace the Potassium lamp in the field if and when it reaches the end of its life. No other part of the sensor ever needs a replacement.

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Other Benefits

Other benefits include:

- Fully interchangeable sensors. Non-critical design allows sensor – sensor electronic interchangeability, sometimes-valuable feature while operating in remote areas.

- Excellent field tracking. Bandwidth of Potassium magnetometers is set to some 700Hz. This allows the system to track the field changes very fast without a loss of lock. Tracking of some 5000 – 10,000nT per second is a standard feature of our Potassium magnetometers.

- Fast start-up and recovery. Potassium is a passive system (in contrast to self-oscillating one) where voltage controlled oscillator frequency gets locked to Potassium Lamour frequency signal. Locking is acquired by sweeping the VCO frequency over a range of fields. First lock and / or relocking in case of a loss of lock is fast. Only few seconds are needed to perform this operation.

- Various sensor options. The user may specify his required sensitivity and we will provide it by a custom sensor design. Standard size of sensor cell is 7cm. Smaller and larger cells are available to achieve special effects: higher sensitivity by increasing the size of cell or conveniently smaller size of sensor for higher gradient tolerance or other purposes.

Ground Differential Global Positioning Satellite Options

A number of various GPS boards are available for integration into signal processor electronics. The user then only sees and handles a GPS antenna. The signal processor is capable of storing all the information for post processing for DGPS. On-line DGPS is available with radio modems.