

## Fast 3-Component Variometer Based On A Cesium Sensor

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New compact and fast three-component variometer measuring the total terrestrial magnetic field intensity in  $20\div 65\mu\text{T}$  range and two transverse components in  $\pm 1\mu\text{T}$  range is presented. The reproducibility of the field components measurements is  $0.15\text{nT}$ , the noise-limited sensitivity is  $0.01\text{nT r.m.s.}$  or  $0.25''$  at  $0.1\text{ sec}$  sample rate.

The variometer constitutes a scalar Cesium sensor placed into the center of 3D coil system aligned along terrestrial field  $H_0$ . The coil system produces DC magnetic field  $H_{ZC}$  compensating  $\sim 95\%$  of  $H_0$ , magnetic field  $H_{XY}$  rotating at  $160\div 640\text{Hz}$  in the plane perpendicular to  $H_0$ , and DC magnetic fields  $H_{XC}$  and  $H_{YC}$  compensating variations of transverse Earth field components. The scalar sensor measures the total magnetic field  $H$  which is the vector sum of the fields listed above. If  $H_0$  deviates from  $Z$  oscillating components appear in  $H$ ; these components are used as signals for the X-Y feedback systems.

Partial compensation of Z-field down to  $3\div 5\mu\text{T}$  allowed us to decrease transverse rotating field amplitude, increasing at the same time X-Y channels sensitivity. A Cesium optically pumped sensor was chosen as the most appropriate for low magnetic field range scalar device.

A quartz cubic frame with  $21.5\text{cm}$  side was designed for holding the windings.

For generating of AC and DC currents feeding the coil system, we use processor-controlled DACs; radio-field resonant to the Cs magnetic transition is produced by frequency synthesizer referenced to the stable quartz oscillator. The detection of X-Y error signals is realized on micro-processor level, allowing to reduce X-Y feedback response time down to one field rotation period ( $6\text{ ms}$ ) with full suppression of the second harmonic.

Long-term stability of the device is mostly determined by the coil system; the procedures of calibration of X,Y,Z coil constants and their cross-coefficients are also implemented on micro-processor level, and they do not require any external magnetometric equipment.