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A sensitive all-optical portable scalar ^{87}Rb atomic gradiometer operating in Earths field[1] MARK LIMES, JILL FOLEY, TOM KORNACK, Twinleaf, LLC, SETH CALIGA, STERLING MCBRIDE, ALAN BRAUN, SRI International, WONJAE LEE, VITO-GIOVANNI LUCIVERO, MIKE ROMALIS, Princeton University — We present a portable all-optical atomic gradiometer with two ^{87}Rb vapor cells separated by 3 cm. A Bell-Bloom style optical pumping polarizes ^{87}Rb into an $F = 2$ edge state in a plane transverse to Earths field, in order to suppress Rb-Rb spin-exchange relaxation typically dominant at Earth's field. A detuned probe laser measures ^{87}Rb free-precession frequencies, giving our sensor the large dynamic range and sub-ppb resolution necessary for a sensitive magnetometer operating in Earths field. The bandwidth is set by our shot-to-shot repetition rate of 300 Hz. All lasers are contained within the sensor head, and using state-of-the-art micro-fabricated vapor cells with advanced thermal insulation and custom electronics, we reduce the system power to 5 W and run the sensor from a laptop. We find unshielded sensitivity of 16 fT/cm/Hz$^{1/2}$ in Earths field and 10 fT/cm/Hz$^{1/2}$ at 50 μT in mu-metal shielding, close to our theoretical predictions. We use the sensor for unshielded MEG and MCG, demonstrating sensitive all-optical atomic magnetometers working unshielded in Earth-scale fields, which will prove useful for a variety of applications.

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