

the toroid and thus not be picked up by the sense winding.

Figure 3 shows us how a second quadrature sense winding can be added, giving us a sine and cosine output of the horizontal field component. We can now work with the ratio of those two signals and can often be more accurate.

Solid-state compasses

A fluxgate magnetometer seems to be the best approach today to building your own solid-state digital compass. Options include working direct or at the second harmonic of the drive frequency,

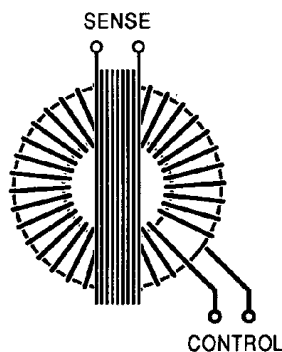


FIG. 2—A FLUXGATE magnetometer is built by using a control winding to alternately saturate and unsaturate a toroidal core. As Earth's magnetic field gets sucked into and out of the core, it induces pulses in the sense winding. All of the introduced pulses are proportional to the strength and the direction of Earth's magnetic field.

CORE: Magnetics 50086-2F
 CONTROL: 143 turns #30
 SENSE: 1000 turns #35

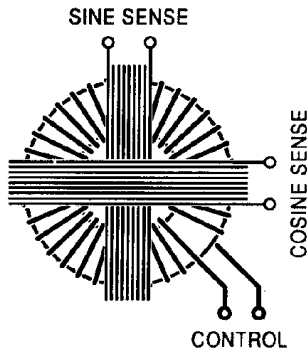


FIG. 3—ADDING A NEW quadrature sense winding will give you both the sine and cosine of the field strength. When one is weak, the other will be strong. The final magnetic bearing is found by dividing the sine output by the cosine output. A list of possible winding details are also shown.

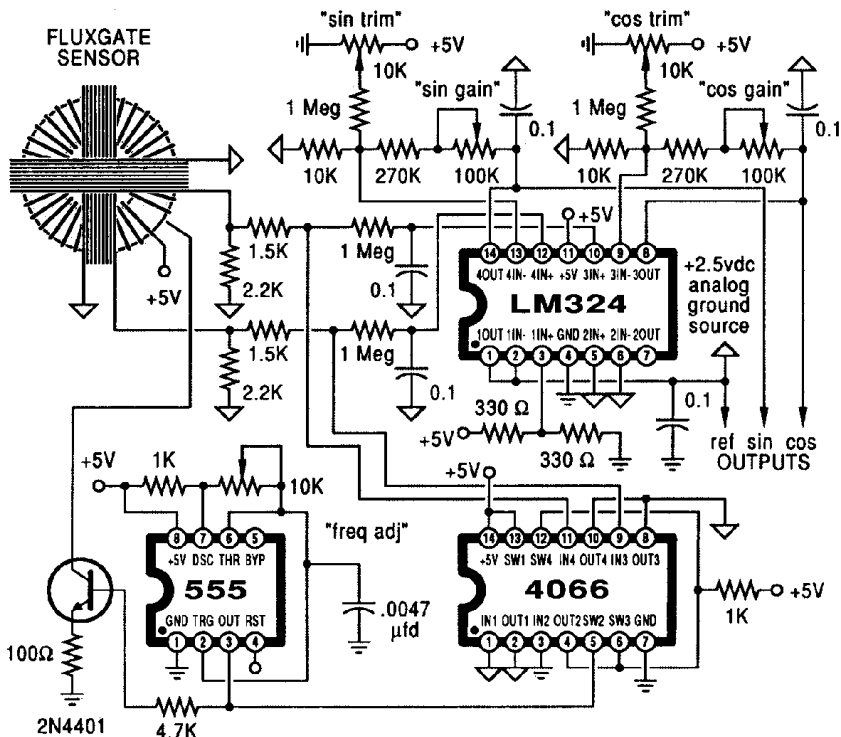


FIG. 4—A SIMPLIFIED SCHEMATIC of a solid-state digital compass. The outputs are A/D-converted and then routed to a microprocessor that handles the bearing calculations and a suitable digital display.

or of using a single or double quadrature sense winding, and of either working with nulls (by rotating the sensor) or by using absolute amplitudes.

In aircraft or radio-control model applications, one single fluxgate magnetometer can replace both the traditional compass and its backup gyro. At the same time, a compensation winding can be added so as to minimize any northerly turning-error problems.

That new approach to navigation is ridiculously cheaper and simpler than others. Figure 4 shows you the circuitry that is involved. What you have here on the driver is a 60-kHz square-wave generator that drives both the magnetometer and a pair of output-sensing gated half-wave demodulators and amplifying integrators.

The two quadrature DC-output signals are proportional to the sine and cosine of the amplitude of Earth's magnetic field. They can be routed through an A/D converter and sent to a microprocessor for further processing. Surprisingly, only a few hundred bytes of very simple code are needed to produce a complete digital compass.

One source of prewound and ready-to-use flux gate cores is *Precision Windings*. Circuit boards and complete kits are available from *Electronics Research*. Further info on licensing for resale or commercial use is available through *Doug Garner*.

For more details on building your own digital compass, see the NASA Tech Brief LAR-13560 on *An Improved Flux-Gate Magnetometer*, and *A Magnetic heading Reference for the Electro/Fludic Autopilot* from the December 1981 and January 1982 issues of *Sport Aviation*. Updates to that earlier design are once again available through *Doug Garner*. Ask for the "Oshkosh 1987" and "Sensors Expo 1987" reprints.

Solid-state compasses are also becoming commercially available from other sources at reasonable prices. Do check out your boating-supply store for more details.

Those that I have looked at so far are British made and cost around \$90. Unfortunately, they are not quite accurate enough for cave surveying and they lack a built-in level and inclinometer.

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