A Wi-Fi Antenna Rotator Compass

Build a precise smartphone readout compass for your rotatable antenna.

Giovanni Carboni, IZ5PQT

Figure 1 — The magnetic compass is mounted on rotatable mast.

This antenna-mounted magnetic compass system is inexpensive and easy to implement (see Figure 1). Two basic components are used — a Honeywell HMC5883L magnetic field sensor and an Arduino MKR WiFi 1010 microcontroller board. The HMC5883L is a surface-mount, multi-chip module with an I2C serial interface designed for low-field magnetic sensing. It includes the high-resolution HMC118X series magneto-resistive sensor, and an application-specific integrated circuit (ASIC) containing amplification, automatic degaussing strap drivers, offset cancellation, and a 12-bit analog-to-digital converter (ADC) that enables 1- to 2-degree compass heading accuracy.

The HMC5883L sends its data about the Earth's magnetic field to the MKR 1010 board via an I2C serial bus. The MKR 1010 decodes the data and provides the compass readout through its built-in Wi-Fi module and antenna. The MKR 1010 board is powered with 5 V and then provides 3.3 V to the HMC5883L. The total current drain at 5 V is 115 mA. The wiring diagram is shown in Figure 2.

The compass is mounted inside a 4 × 4 × 2-inch plastic waterproof electrical junction box (see Figure 3). The two boards attach to the inside of the cover. The MKR 1010 board plugs into two female header strips whose pins are soldered to a scrap breadboard that is fastened to the cover with hot glue. Ensure that the MKR 1010 board's USB connector is not obstructed. The HMC5883L is held in place with double-sided tape. Four wires connect the MKR 1010 and HMC5883L boards — V_{CC}, GND, SDA, and SCL (all clearly marked on the MKR 1010 pins). I used a breakout board made by Olimex (available from **mouser.com**), so I wouldn't have to solder to the HMC5883L chip. I did not use the supplied ribbon cable. I just plugged short jumper wires into the connector pins. The dc input comes through a SO-239 socket mounted on the box. A 7805 regulator and single-pole, double-throw (SPDT) switch mount inside the box. The switch permits operation from either a higher voltage external power supply using a LM7805 regulator, or 5 V directly from a cell

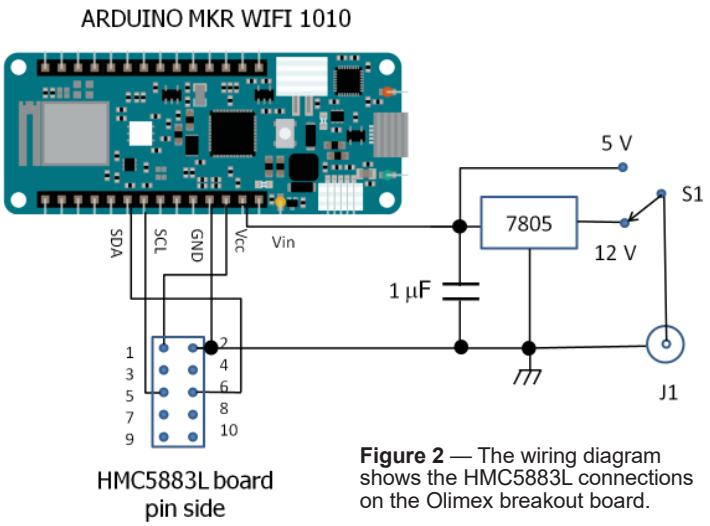
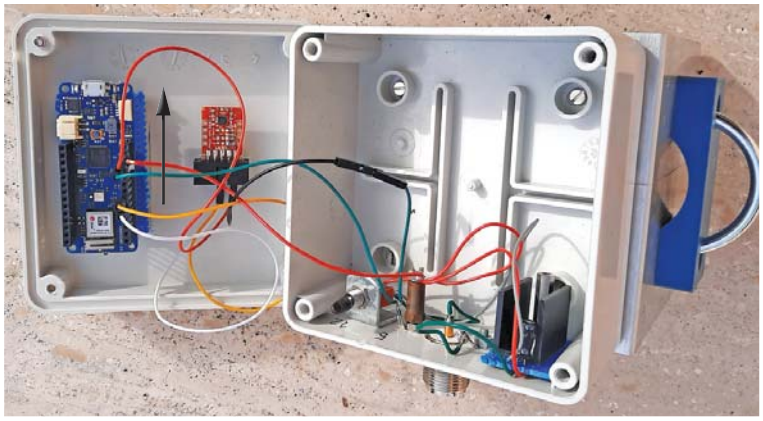


Figure 2 — The wiring diagram shows the HMC5883L connections on the Olimex breakout board.



◀ **Figure 3** — The MKR1010 (mounted on scrap perf board) and the HMC5883L boards are attached to the cover. The LM7805 regulator with the heatsink and the toggle switch are mounted in the main box. An SO-239 is the dc supply connector. The arrow indicates the compass orientation.

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*** WIFI COMPASS ***
Heading: 308°
Heading: 309°
Heading: 309°
Heading: 309°
Heading: 308°
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▲ **Figure 4** — The compass headings are displayed on the smartphone screen using the Termius terminal app.

phone power pack or charger. The LM7805 needs a small heatsink, as it dissipates about 0.8 W at 12 V.

The box is attached to a 4 × 6-inch, **L**-shaped aluminum plate (iron or steel plates would distort the compass reading). A **U**-bolt allows fastening the box to the antenna mast, as you can see in Figure 1.

Software

Download the software from **https://www.televideo.ws/index.php/wifi-magnetic-compass**. The program (or *sketch*, in Arduino-speak) *MKR_Telnet_Compass.ino* is a cut-and-paste of two existing pieces of software. The program setup section configures and starts the Telnet server. With the server enabled, the code obtains the compass data from the routine *getHeading()* and continuously writes it to the server for transmission. To install the sketch, open the Arduino IDE on your PC. Go to the **BOARDS MANAGER** and search for and install **ARDUINO AVR BOARDS**. Then install *Arduino SAMD (32-bits ARM Cortex-M0+) Boards.* From the menu, click **ARDUINO MKR WIFI 1010**. Connect the Arduino to your PC via a USB cable and select the proper COM port. Open the sketch *MKR_Telnet_Compass.ino* and install **WIFININA**, **ADAFRUIT HMC5883 UNIFIED**, and **ADAFRUIT UNIFIED SENSOR** via the **LIBRARY MANAGER**. Now configure the Wi-Fi network in the sketch. In the IDE, click on the **ARDUINO_SECRETS.H** tab. Choose a name for your Wi-Fi network and load the sketch into the Arduino.

Now, scan for local Wi-Fi networks with your smartphone and check that *mkr-net* is on air. The IP address should default to 192.168.4.1 port 23. The USB cable can now be disconnected. The sketch allows correction of the compass reading to compensate for the magnetic declination or misalignment of the of the antenna with the HMC5883 board. Because I mounted the HMC5883L upside down on the underside of the cover, I reversed one of the axes in the software decoding routine.

Using the Wi-Fi Antenna Rotator Compass

The compass heading is transmitted over the network using the Telnet protocol. Your phone's Wi-Fi must be connected to *mkr-net* and have a Telnet terminal app installed. For dedicated use, you may wish to use an old smartphone. I use Termius for Android phones, and iTerminal for iPhones. Configure the terminal app to use Telnet (not SSH), connecting with IP address 192.168.4.1:23. Once you hit **CONNECT**, the compass heading will scroll continuously on the screen (see Figure 4).

I tested the compass on the mast of a three-element HF beam at an RF power level of 200 W, with no RFI problems noted. But be warned — with higher powers, your results may vary.

The MKR Wi-Fi 1010 has a range of about 300 feet outdoors. However, if the receiving smartphone is inside a building, the range will be reduced. In this case, I had very good success with a Wi-Fi range extender, which was strategically placed in sight of both the compass and the shack.

All photos by the author.

Giovanni Carboni, IZ5PQT, was first licensed in 2009. After serving many years as a researcher in experimental high-energy physics, he became a professor of physics at Tor Vergata University in Rome. Now retired, Giovanni lives in Pisa, where he enjoys operating digital modes, VHF meteor scatter, and experimenting with antennas and wide-spectrum homebrewing. You can reach Giovanni at **iz5pqt@gmail.com**.

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