

# Installing a Fluxgate Magnetometer

## Site requirements:

- A 120 V / 60 Hz electrical power supply
- The recording house for the computer system should have a temperature between 0-30 degrees C and a humidity between 10-80%.
- The sensor should be placed at the location in the site with minimum magnetic field gradient and environment noise level. Pick a site away from roads, railroads, buried pipes, and other magnetic contaminants.

## Parts:

- A complete magnetometer system should include the following components:
  1. A sensor (including the tube, a plastic cap, and the hose)
  2. A circuit board (to be inserted into a PC's slot; See Figure 1)
  3. A GPS antenna
  4. An extension cord for the GPS antenna (Optional)
  5. A ribbon cable (for connecting to PC's COM 1 port)
  6. A PC (not slower than a low-end Pentium; must have an ISA slot available)



Figure 1. The circuit board.

- Some useful but optional accessories are:
  1. A regular phone line and a modem for data collection
  2. Power protection circuitry and/or a UPS

3. Portable data collection unit (e.g., a ZIP disk drive)

## Installation Procedure:

### A. The PC:

1. Install the software package "SMALL". Turn off the PC and unplug the power.
2. Install the circuit board into an ISA slot in PC.
3. There are three connectors on the side of the circuit board (See Figure A1). Use the provided ribbon cable to connect the top connector and the COM 1 port on PC.
4. Connect the GPS antenna to the second connector.
5. Connect the hose from the sensor to the third connector (DB25).

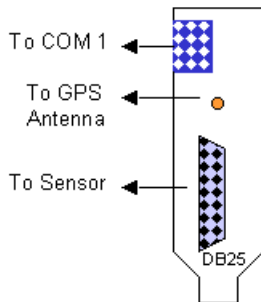


Figure A1. Side view of the circuit board.

### B. The GPS Antenna:

1. Place the GPS antenna outdoor. If the cable is not long enough, use the provided extended cord for the GPS antenna. The antenna's field of view should be as wide as possible, or it may not be able to see enough GPS satellites for proper reception.

### C. The Sensor:

- **Precautions:** The sensor should not be exposed to any large magnetic fields. In addition, the sensor should be shielded from direct sunlight to minimize heating, which might cause dimensional changes.
1. **Connecting the tube:** Connect the two tube components and seal them with duct tape (See Figure C2). Bend the hose and put the cap on the top of the tube. Make use of the groove on the tube surface so the hose can go out easily. (Note: The sensor has been made waterproof already.)

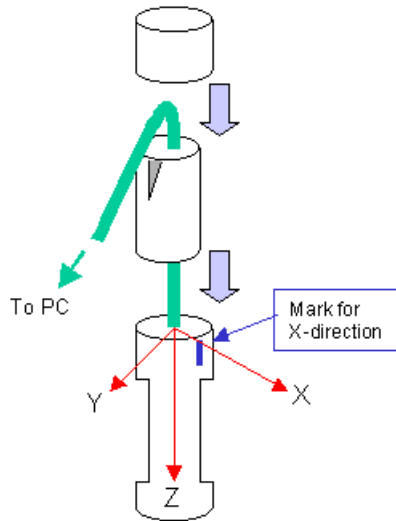


Figure C2. The sensor tube.

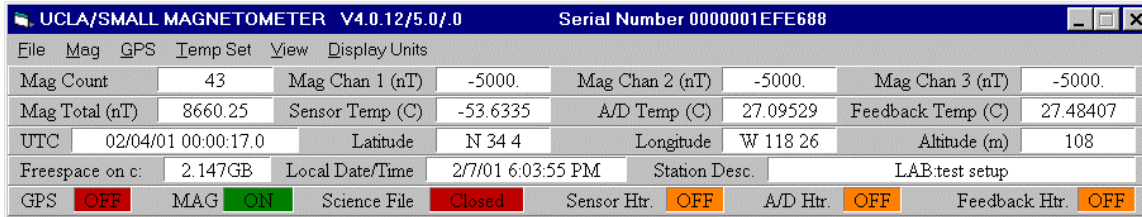
2. **Laying out sensor and cable:** Lay out sensor and cable. The hose should be laid out so it will not be disturbed by cars or foot traffic.
3. **Installing sensor in the ground:** The sensor is designed to be installed with a 15 cm power auger with 2 auger extensions 91 cm long. Hole for sensor is 140 cm deep, 15 cm in diameters and vertical within 3 cm top to bottom. Place the tube vertically with the hose going out from the top of the tube. The vertically downward direction (into the ground) is the Z direction. Sensor top should be 10 to 15 cm above ground level, and add sand until sensor reaches proper height. Remove all magnetic contaminants near the sensor.
4. **Zeroing out the east-west field:** Turn on the PC and the data acquisition program will start up automatically. A window displaying the time series of data should also appear on the screen (Further software setup is required later; see "D. The Software" for details). If two persons are installing the magnetometer, one can go outside for the sensor alignment and the other examines the PC to monitor the magnetic field measurements. To align the sensor with the ambient magnetic field, first look for a mark on the tube surface (see Figure C2). The X (or H) direction is from the center of the tube to the mark. Align the mark to the magnetic north. Rotate the tube in small increments while still maintaining a vertical alignment of the tube, until the east-west field (BY) is zeroed out. The magnetic field in the other two components (X and Z) should now be in the range of measurements.
5. **Filing in the hole:** Fill in the hole and the tube with sand. If level moves off center, stop and relevel, continue filling. Cable can be laid on the ground or buried below ground. A final alignment may be necessary after the sensor has been filled.

## D. The Software:

1. When the PC is turned on, the magnetometer program will start up automatically and a

status panel will appear on the screen as in Figure D1. Some parameters on the panel may not show correct values because GPS is inactive at this point. The display units for magnetic field and temperature can be either "Volts" or "nT & Deg" by clicking **Display Units**. The local time shows the time from the PC clock. The indicator lights on the bottom line of the panel show the status of some important components of the system.

Figure D1.



- Go to **File** and then **Setup** for setting up the station name, measurement ranges of the three channels, and the directory for data storage. Presently all UCLA magnetometers should use the range "5000" (i.e., 5000 nT) for all three channels. If this is the setup for the first time, one should create a directory, usually named "SmallData", in the chosen hard disk (usually the C: drive). Click **OK** after everything is done.

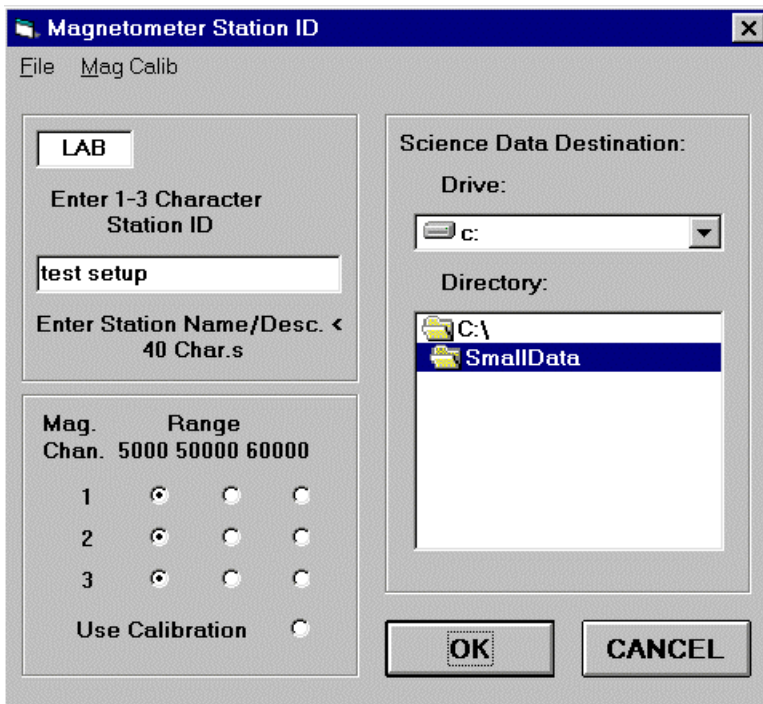


Figure D2.

- Now go to **Mag** and then **Mag Calibration** for setting up more magnetometer parameters. Refer to the *Scale Factors* provided for your magnetometer. The *Gain* means the amount of magnetic field in nT for every Volt in measurement. Roughly speaking, each channel measures +/-5000 nT with its +/-2.5 V range, so the gain value is approximately 2000. Use the calibrated values provided for your instrument to obtain the most accurate conversion. The *Offset* means the magnetic field in nT already added in the

system to compensate the ambient magnetic field. The picture below shows an example for a magnetometer in the Los Angeles area. Other fields in this window do not need to be changed.

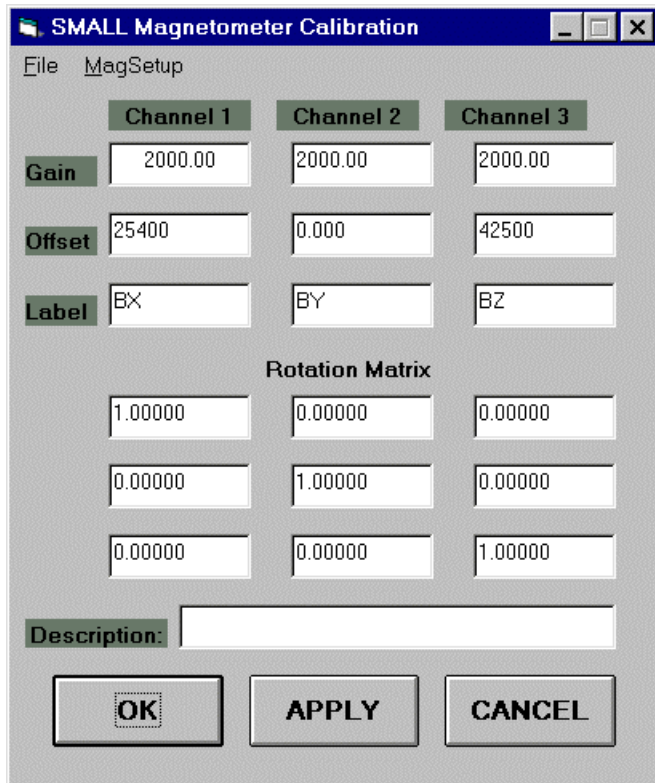


Figure D3.

4. Now go to **GPS** and then **GPS Init** for setting up and initializing the GPS system. Change the *Time Difference* between the Local Time and the Universal Time. An approximate value would be sufficient, but a value too different from reality may cost the system up to days to lock the GPS signals. Also provide approximate *Latitude* and *Longitude* values. Click **OK** and initialize the GPS function.

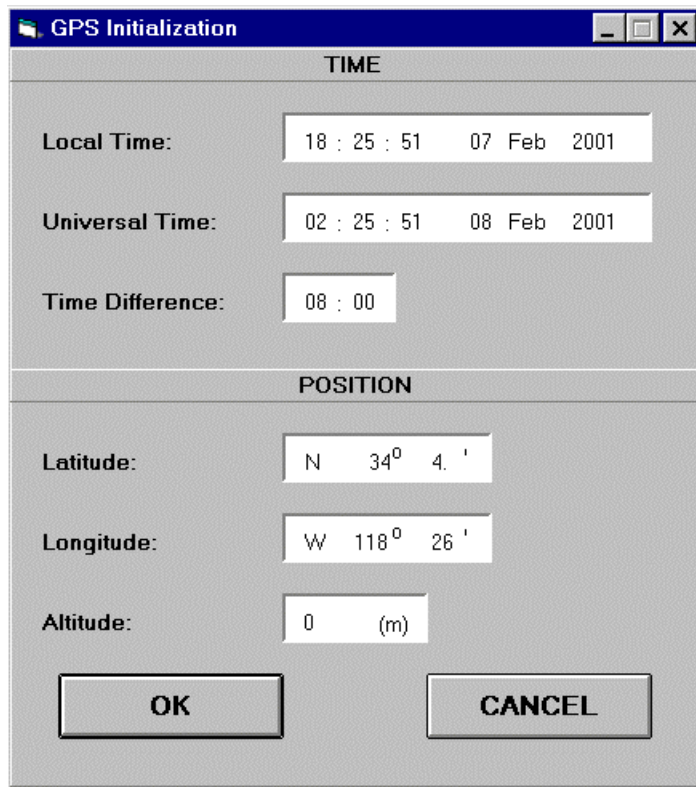


Figure D4.

5. The next step is to set up the three different types of temperature. For each type of temperature, the three buttons, **APPLY**, **RESET**, and **OFF**, mean modifying values, resetting to default values, and turning off the heater, respectively, for a particular temperature measurement. First make sure that all the fields for *Slope* should be -394 and all the fields for *Offset* should be 19000, although the default values for the sensor temperature might be different. Then input the *Setpoint* temperature, which should be 2-3 degrees higher than the highest ambient temperature possible. An initial guess should be provided during setup and see if the provided value is reasonable after several days of operation (See Section E for details).

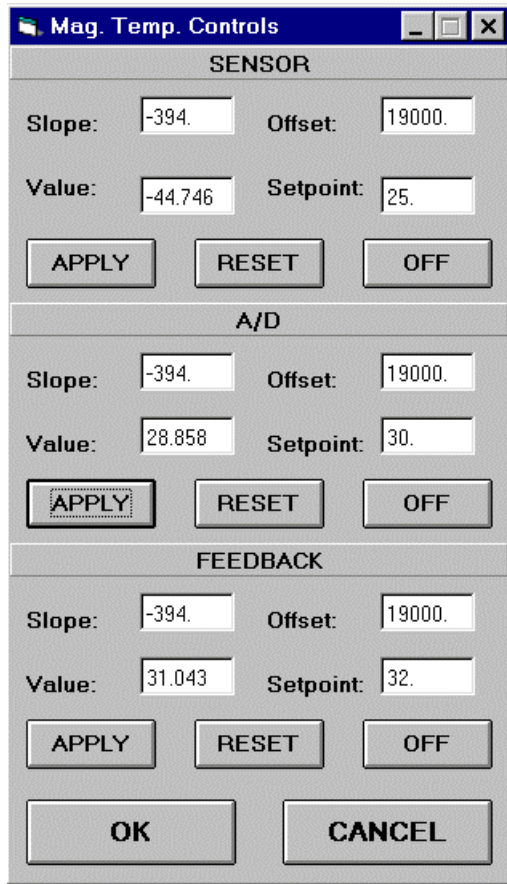


Figure D5.

- The above settings should make the system ready for measurements. Now go to **File** and then **Science Data File Open** to start data recording. The panel should look like the following figure. A green GPS light means that the system is locked into the GPS NAVigation mode. The three heater lights (for Sensor, A/D, and Feedback) may change their colors with time according to the different operation modes.

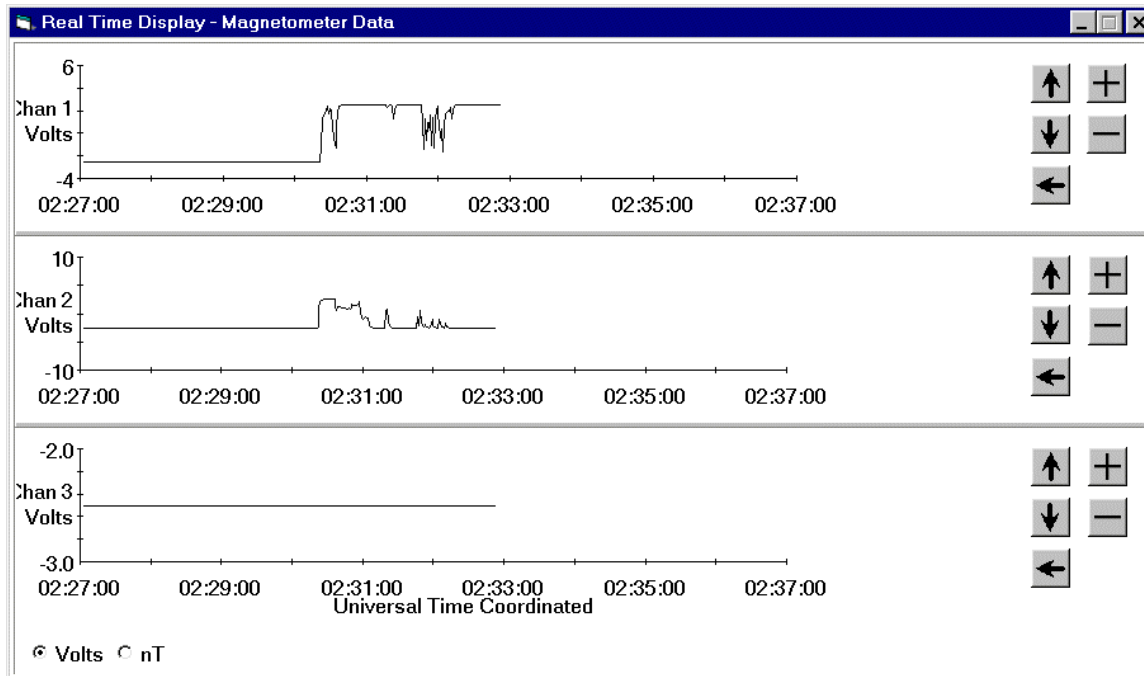
Figure D6.

The screenshot shows a software status panel titled "UCLA/SMALL MAGNETOMETER V4.0.12/5.0/1.8". It displays various system parameters in a table format. The status bar at the bottom shows "GPS NAV" (green), "MAG ON" (green), "Science File Open" (green), "Sensor Htr. 719" (red), "A/D Htr. .281" (yellow), and "Feedback Htr. 375" (green).

File	Mag	GPS	Temp Set	View	Display Units
Mag Count	1686	Mag Chan 1 (nT)	4631.27	Mag Chan 2 (nT)	-4999.99
Mag Total (nT)	8452.73	Sensor Temp (C)	-44.74609	A/D Temp (C)	30.37148
Feedback Temp (C)	32.02878	UTC	02/08/01 02:31:17.0	Latitude	N 34.4
Longitude	W 118.26	Altitude (m)	121	Station Desc.	test setup
Freospace on c:	2.15GB	Local Date/Time	2/7/01 6:31:14 PM	Sensor Htr.	719
A/D Htr.	.281	Feedback Htr.	375		

- In addition to the status panel, the time series of magnetic field data is displayed on the terminal. One can use the buttons on the right to modify the X-scale and the Y-scale, or choose the preferred unit by clicking the radio buttons. The measurement range in for each channel is +/-2.5 V. A constant value at either +2.5 V or -2.5 V suggests that the magnetic field is beyond the measurement range.

Figure D7.



## E. Post-installation adjustments

- Temperature Control:** The magnetometer system maintains constant temperature of the sensor, the A/D component, and the FeedBack component by heating the system when the temperature drops below the *Setpoint* (see Section D.5). If the setpoint value is too low, the heater will not be turned on when the ambient temperature is higher than the setpoint, and the temperature data will show a diurnal variation. If the setpoint value is too much higher than the ambient temperature, the heater will draw an excessive amount of power from PC and even so it may not be able to maintain a constant temperature in an extreme case. Therefore, an ideal setpoint is about 2-3 degrees higher than the highest ambient temperature possible. Note that the Sensor, A/D, and FeedBack do not necessarily have the same temperature, and therefore the three setpoints can be different.