FGA Logger Sensor Calibration Procedure

Important notice: sensor calibration procedure is only available for fw version 1.02 or later.

Why do we need to calibrate flux-gate sensors?

1. Offset (Zero-Field Error)

Even in a zero magnetic field, a fluxgate outputs a non-zero signal due to:

- Core remanence
- Electronics offsets
- Asymmetries in the sensing coils

Effect if uncalibrated:
The measured field is shifted, producing a constant heading or field error.

Calibration fixes:
Subtracting the DC offset so zero field really reads zero.

Notice: Since a true zero magnetic field is difficult to achieve, this document proposes a simpler calibration method. The method is based on comparing measurements taken with different sensor axis orientations. In an ideal case, the measured magnetic field magnitude should be identical regardless of which axis orientation is used.

Any observed differences are therefore used to estimate and correct sensor offsets errors.

Offset error can be fixed using parameters S1_X_OFFSET, S1_Y_OFFSET and S1_Z_OFFSET.

2. Scale Factor Errors (Gain Mismatch)

Each axis (X, Y, Z) has slightly different sensitivity because of:

- Manufacturing tolerances
- Core permeability variation
- Analog gain differences

Effect if uncalibrated:
The field magnitude is distorted and headings become elliptical instead of circular when rotating the sensor.

Calibration fixes:
Normalizing gains so all axes respond equally to the same field.

Gain error can be fixed using parameters S1_X_GAIN, S1_Y_GAIN and S1_Y_GAIN.

Notice: While offset calibration can be performed using the method described here, proper gain calibration requires professional equipment and is not addressed in this document.

It is important to understand that the FG Logger provides the capability to compensate both sensor offset and gain using this formula.

S1_X = (X_VAL - S1_X_OFFSET)* S1_X_GAIN

How to apply calibration parameters to FG logger?

1.) Make sure SD card is FAT32 formatted

2.) Make sure there is config.txt file on the SD card with calibration parameters content:

Example of calibration parameters with default / ideal values:

S1_X_OFFSET=10000

S1_X_GAIN=1.0

S1_Y_OFFSET=-10000

S1_Y_GAIN=1.0

S1_Z_OFFSET=0

S1_Z_GAIN=0.5

S2_X_OFFSET=40

S2_X_GAIN=1.4

S2_Y_OFFSET=50

S2_Y_GAIN=1.5

S2_Z_OFFSET=60

S2_Z_GAIN=1.6

3.) Hold multifunctional button and power device ON. LEDs will indicate that SD card configuration has been loaded by lighting on/off in sequence.

4.) Serial console will output information with parameters value that were red from SD card – this is a validation that procedure succeeded.

Config: reading from SD card

config.txt found.

Input 1: Offset(x,y,z): 0, 0, 0 Gain(x,y,z): 1.00000000, 1.00000000, 1.00000000

Input 2: Offset(x,y,z): 0, 0, 0 Gain(x,y,z): 1.00000000, 1.00000000, 1.00000000

Timestamp_ms,B1x_nT,B1y_nT,B1z_nT,B1v_nT,B2x_nT,B2y_nT,B2z_nT,B2v_nT,Lat_deg,Lon_deg,Alt_m,SIV,Fix,HDOP_m

9648,64555.26,-23249.89,2992.34,68679.64,109.97,-1852.41,2666.81,3248.91,0.0000000,0.0000000,0.000,0,0,0.00

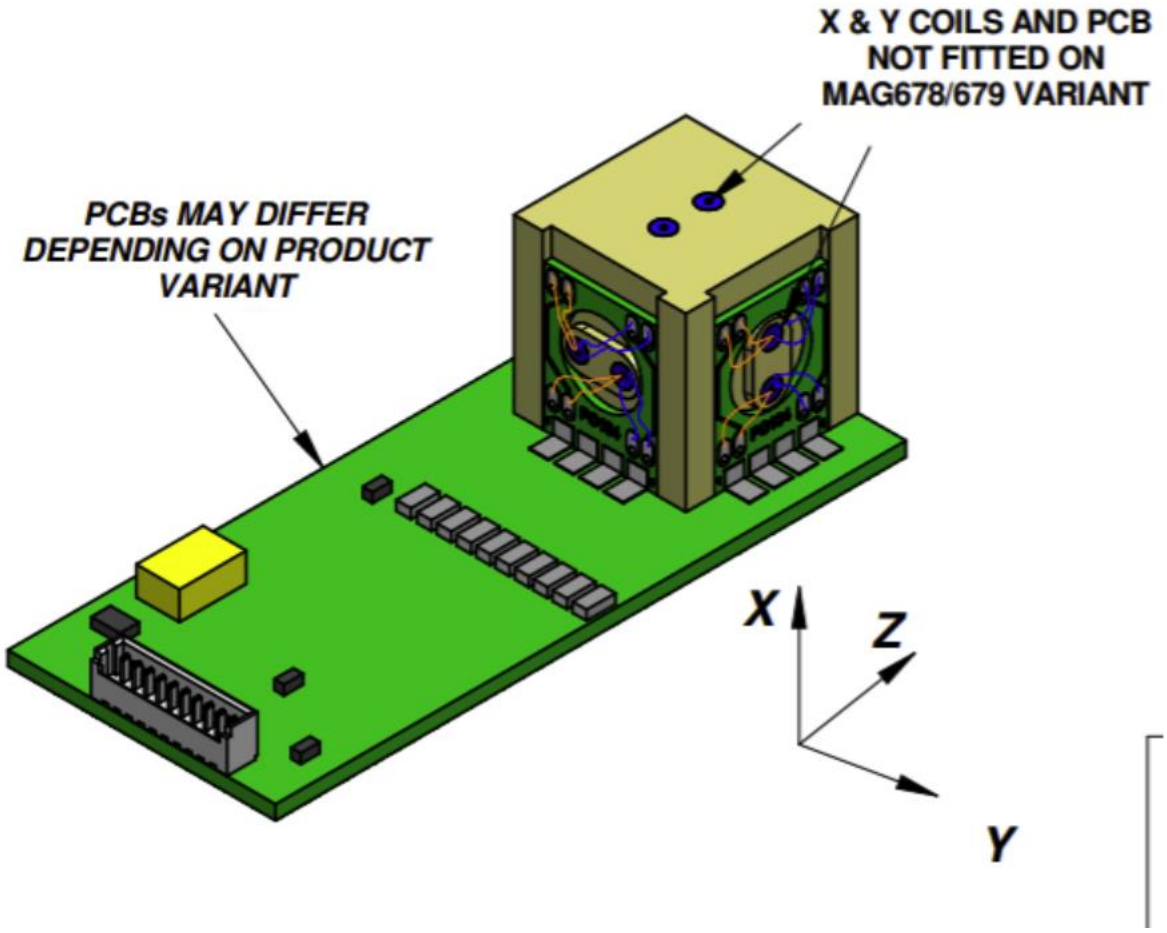
Notice that calibration parameters are stored permanently into FG logger device.

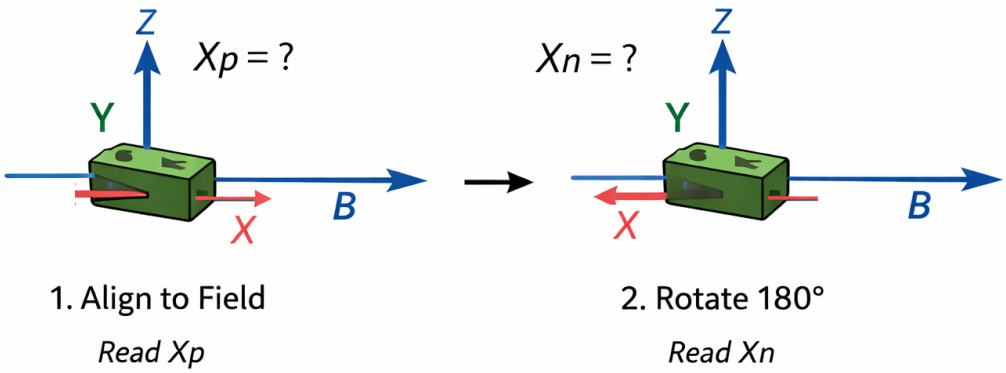
How to calibrate sensors?

1.) Before starting calibration make sure that calibration parameters on FG logger are set to default values. Follow instructions -> **How to apply calibration parameters to FG logger?**

2.) Use this procedure to get sensor calibration parameters for each axis.

Sensor image and axis orientations.





1. Align to Field

Read Xp

2. Rotate 180°

Read Xn

Axis X

Place flu-gate magnetometer sensor in magnetic field, align it to get decent response on axis X and read Xp value.

29905,27553.65,1053.99,22170.34,35381.33,129.06,-862.71,1946.27,2132.81,0.0000000,0.0000000,0.000,0,0,0.00

30005,27547.41,1055.65,22166.55,35374.14,132.94,-856.23,1947.11,2131.20,0.0000000,0.0000000,0.000,0,0,0.00

30105,27547.66,1054.99,22169.61,35376.23,140.33,-859.27,1951.11,2136.55,0.0000000,0.0000000,0.000,0,0,0.00

30205,27540.91,1050.56,22167.12,35369.29,127.82,-852.80,1949.90,2132.07,0.0000000,0.0000000,0.000,0,0,0.00

30305,27549.23,1053.85,22167.19,35375.91,129.55,-859.27,1951.29,2136.04,0.0000000,0.0000000,0.000,0,0,0.00

Then rotate sensor at same position for 180 degrees so that the X axis is “inverted” and read Xn.

66605,-27296.96,516.04,21844.24,34965.14,134.51,-857.42,1935.65,2121.32,0.0000000,0.0000000,0.000,0,0,0.00

66705,-27295.70,510.82,21839.32,34961.01,136.99,-858.80,1937.14,2123.40,0.0000000,0.0000000,0.000,0,0,0.00

66805,-27298.24,493.04,21844.23,34965.80,142.55,-859.81,1942.51,2129.07,0.0000000,0.0000000,0.000,0,0,0.00

66905,-27307.43,488.12,21846.38,34974.25,131.56,-858.33,1936.94,2122.68,0.0000000,0.0000000,0.000,0,0,0.00

67005,-27300.68,485.41,21843.88,34967.39,136.64,-855.19,1932.84,2117.99,0.0000000,0.0000000,0.000,0,0,0.00

Offset
67105,-27300.97,493.03,21845.02,34968.43,143.95,-855.36,1937.79,2123.06,0.0000000,0.0000000,0.000,0,0,0.00

X_offset=(Xp+Xn)/2=(27553-27296)/2=257/2=128.5

3.) Now set parameter on SD card.

S1_X_OFFSET=128.5

4.) Repeat same process for X and Z axis of sensors S1 and then for S2 at input 2 if necessary.

5.) Apply parameters to FG logger. Follow instructions -> **How to apply calibration parameters to FG logger?**