1. Experimental Contents

1) Study the relationship between the resistance change $\Delta R/R_0$ of an InSb sensor and the applied magnetic field intensity B to find the empirical formula.
2) Plot the relationship curve of InSb sensor resistance versus magnetic field intensity.
3) Study the AC characteristics of an InSb magnetoresistive sensor under a weak magnetic field (frequency doubling effect).

2. Experimental Procedure

1) Remain power off. Connect the output of the constant current source (**Const. I**) to the input of the InSb magnetoresistive sensor at the lower left of the panel. Connect the two ends of the voltmeter (yellow and blue sockets) to terminals **V+** and **V-** of the digital voltmeter. Connect the DC power supply (**DC Magnet I**) to the electromagnet. Set DC current to minimum by turning the DC current knob "Adj" count-clockwise to end.

   When the black switch is toggled to the side of the magnetoresistive sensor (upper), the reading on the digital voltmeter is the voltage on the magnetoresistive sensor; when the black switch is toggled to the 300 Ω resistor (lower), the reading on the voltmeter is the voltage on the 300 Ω resistor.

2) Turn on power. Adjust the constant-current source to get 300 mV voltage on the 300 Ω resistor (the current through the InSb sensor should be 1 mA now) while measuring the voltage of the sensor to calculate the resistance value R_0 of the sensor in the absence of an external magnetic field.
3) When DC current to the electromagnet is set at minimum, zero the Teslameter reading using the knob below the Teslameter. Adjust the DC current to the electromagnet while recording the magnetic field intensity of the electromagnet from the Teslameter and measuring the voltage on the two ends of the sensor. Calculate resistance R_B at different magnetic field intensities. Find the relationship between $\Delta R/R_0$ and B.
4) **Turn off power**. Connect the AC power supply (**AC Magnet I**) to the electromagnet. Connect terminals CH1 (the signal applied to the electromagnet) and CH2 (the output signal of the sensor) to an oscilloscope. **Turn on power**. Set the current through the InSb

sensor at 2.5 mA by getting voltmeter reading at 750 mV when the black switch is toggled to the side of 300 Ω resistor. Observe the Lissajous graph on the oscilloscope as shown in Figure 3. Verify that a magnetoresistive sensor has an alternating frequency doubling characteristic under a weak sine-wave magnetic field.

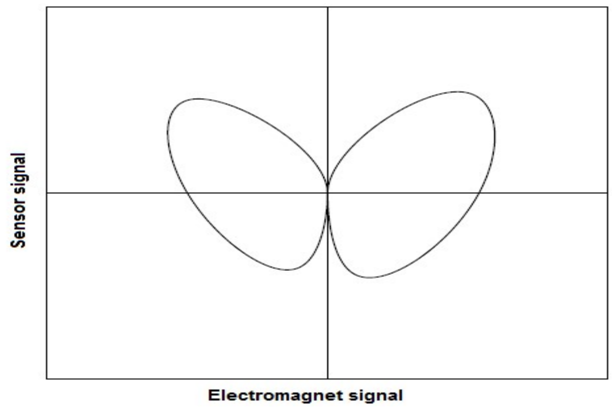

Figure 3 Lissajous graph observed on oscilloscope

3. Example of Data Recording and Processing

Note: Following data are for reference purposes only, not the criteria for apparatus performance:

Sampling resistor: 300 Ω with applied voltage of -300 mV, so the current through the sensor is 1.0 mA.

Table 1 Measurement data for magnetoresistive effect

B/mT	U_R/mV	R/Ω	△R/R_0	B/mT	U_R/mV	R/Ω	△R/R_0
0	338.0	338.0	0.0000	95	486.3	486.3	0.4388
5	338.9	338.9	0.0027	100	493.2	493.2	0.4592
10	341.0	341.0	0.0089	105	499.4	499.4	0.4775
15	344.6	344.6	0.0195	110	504.7	504.7	0.4932
20	349.4	349.4	0.0337	120	514.2	514.2	0.5213
25	355.3	355.3	0.0512	125	518.7	518.7	0.5346
30	362.2	362.2	0.0716	130	522.8	522.8	0.5467
35	370.0	370.0	0.0947	135	526.8	526.8	0.5586
40	378.5	378.5	0.1198	140	530.7	530.7	0.5701
45	387.8	387.8	0.1473	145	534.6	534.6	0.5817
50	397.6	397.6	0.1763	150	538.6	538.6	0.5935
55	407.7	407.7	0.2062	155	542.1	542.1	0.6038
60	418.3	418.3	0.2376	160	545.8	545.8	0.6148
65	429.3	429.3	0.2701	165	549.2	549.2	0.6249
70	440.1	440.1	0.3021	170	552.4	552.4	0.6343
75	450.7	450.7	0.3334	175	555.5	555.5	0.6435
80	460.9	460.9	0.3636	180	558.5	558.5	0.6524
85	470.2	470.2	0.3911	185	561.3	561.3	0.6607
90	478.7	478.7	0.4163	190	564.3	564.3	0.6695

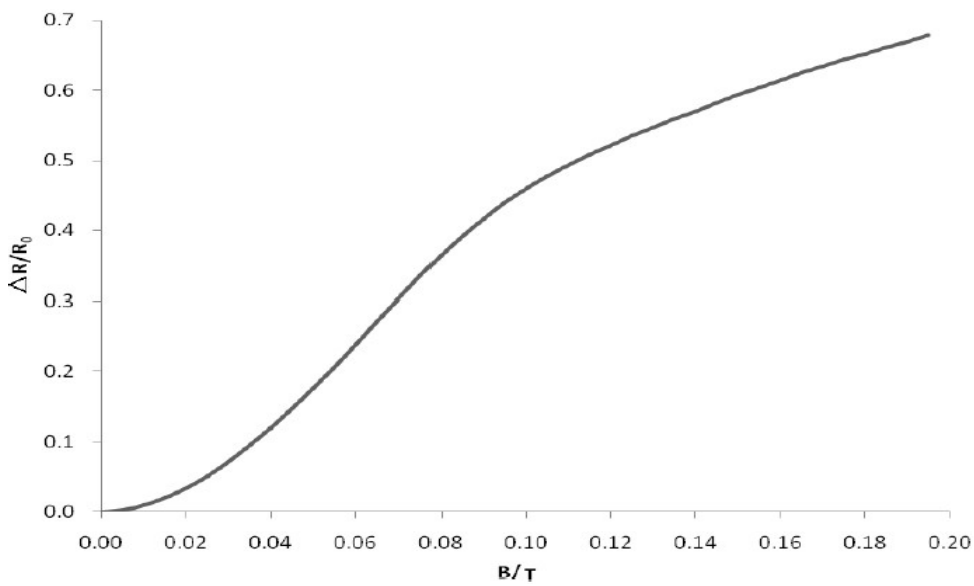

Figure 4 Relationship between magnetic field intensity and magnetoresistive sensitivity

By doing curve fitting to the curve in Figure 4 at the segments of weak and strong magnetic field, respectively, we get the following results

1) When B<0.05 T (under the case of a weak magnetic field), $\Delta R/R_0=59.4B^2+0.694B-0.003$. The curve-fitting correlation coefficient is R^2=0.9998.

When B>0.13 T (under the case of a strong magnetic field), $\Delta R/R_0=1.988B+0.294$. The curve-fitting correlation coefficient is R^2=0.9965