MEASURING THE MAGNETIC FIELD SPECTRUM WITH THE FM300

INTRODUCTION

This application note describes how you can use the FM300 in combination with the FM300 Front Panel software and Microsoft Excel to determine the frequency content of the measured magnetic field.

CAPTURING DATA

The FM300 has three ways to collect magnetic field data: Snapshot, Record and Manual. The FM300 Front Panel program, which comes with the FM300, adds a fourth method. The FM300 Front Panel can be used to sample and record FM300 data at sample intervals from two (2) seconds up. Once this data is recorded, you can save it in a disc file that can be read by a spreadsheet or math program where the data can be processed further.

If you are only going to measure the field at a single point, you can use the FM300 keypad controls to capture the data and then transfer the data to a computer file at a later time. But if you plan to measure the field at many points, you will want to connect the FM300 to a PC and use the FM300 Front Panel software to control the capturing and storage of the data.

The PC you use can be a desktop type, but a portable laptop or notebook would be better for field use. Regardless of what PC you use, it must have one unused COM port that can be connected to the FM300.

The following procedures assume you are using the FM300 Front Panel software to capture the data samples.

ACQUIRING DATA SAMPLES

After connecting the FM300 to the PC and starting up the FM300 Front Panel program, use the following procedure to capture, display and store each data sample.

1. Place the sensor in the desired location. Secure it so that it does not move while the data is being collected.

2. Set the FM300 to the desired measurement mode (*Absolute* or *Relative*).

3. Set the FM300 into the *Remote* mode and open the COM port by clicking on the appropriate COM port control of the FM300 Front Panel screen.

At this point you are ready to collect data. If you want to monitor the field over a long period of time, use the FM300 Front Panel strip chart controls to acquire the data. You should collect at least 512 samples before stopping the strip chart.

For a short duration sample, click on either the *Snapshot* (7.5 sec.) or the *Record* (30 sec.) buttons on the FM300 Front Panel display and click on the Get button once the controls are reenabled.

With the data you want to analyze on the screen, use the following procedure to save it to a disc file:

1. Click on the right mouse button.

2. In the pop-up menu, choose *Save chart*.

3. In the dialog box that appears enter a file name. Use the *.prn* suffix (e.g., *data1.prn*) so that it will be recognized by a spreadsheet program.

4. Click on the *Save* button. Your data will be saved to the file you just created.

Repeat the above procedure at all of the desired measurement locations.

PROCESSING THE DATA

Now that you have the data on disc files, you are ready to compute and display the magnetic field spectrum. The following procedures assume that you have captured the data using

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the *Snapshot* function and that you are using Microsoft Excel to process the data.

Loading the Data into Excel

Use the following procedure to load the data into an Excel worksheet:

1. From the *File* menu, select *Open*.

2. In the *Open File* dialog box, change the file type to *Text files*, select the file you wish to load into the worksheet and click on the *Open* button.

3. In the *Text Import* dialog box that appears, select the *Delimit* as the *Original data type* and click on the *Next* button.

4. In the next dialog box, check the *Tab* and *Comma* boxes, then click on the *Finish* button.

At this point the data will be loaded into the worksheet. Below is an example of what the worksheet will look like for *Snapshot* data:

File Name: D:\FM300\fpd01.prn

Type: Snapshot

Started: unknown

Stopped: unknown

Comp1: Abs

Comp2: Abs

Comp3: Abs

Interval: 0.01439 seconds

Points: 526

Components: Rectangular

Sample	X	Y	Z
0	-21861	-38793	46649
1	-21861	-38793	46649
2	-21862	-36792	46652

etc.

Fourier Analysis

Use the following procedure to compute the Fast Fourier Transform of the data of one of the vector components:

1. Select *Data Analysis* from the *Tools* menu.

2. Select *Fourier Analysis* from the *Analysis Tools* list and click on the OK button.

3. In the *Fourier Analysis* dialog box, enter the data input range or click on the wizard button to the right of the box and select the data from the worksheet. Select only 512 points (the number of points must be a power of 2).

4. If the data label was included in the first row of the data column, check the *Label in First Row* box.

5. Click on the OK button. The results of the Fourier analysis will appear on a new worksheet. The first column lists the double sided values of the complex Fourier Transform. Only the first 256 values (assuming 512 data points) will be plotted since the second half of the spectrum mirrors the first half.

Plotting the Spectrum

You are now ready to create a plot of the spectrum. Use the following procedure to compute and graph the root-mean-square (rms) single sided spectrum.

1. In the B1 cell of the worksheet containing the Fourier Transform values, enter 0.

2. In the C1 cell enter the following formula: =IMABS(A1)/512.

3. In the B2 cell enter the formula: =B1+1/(0.01439*512).

4. In the C2 cell enter the formula: =IMABS(A2)*SQRT(2)/512.

5. Copy the formulas in cells B2 and C2 of row 2 into their associated rows 3 through 256. Column B contains the spectrum frequencies and column C the magnitudes of the magnetic field spectrum.

6. From the *Insert* menu, select *Chart*.

7. Choose the *XY (Scatter)* chart type and any desired sub-type. Click on the *Next* button.

8. In the *Data range* edit box enter =$B$1:$C$256. Click on the *Columns* button.

9. Select the *Series* tab. In the *Name* edit box, type in a name for the series. Click on the *Next* button.

10. In the *Chart Options* dialog box, enter Frequency (Hz) in the *X Axis text* box and

nT rms in the *Y Axis text* box. Click on the *Next* button.

11. Accept the default in the next dialog box and click on the Finish button.

You now have a plot of the magnetic field spectrum similar to the one below.
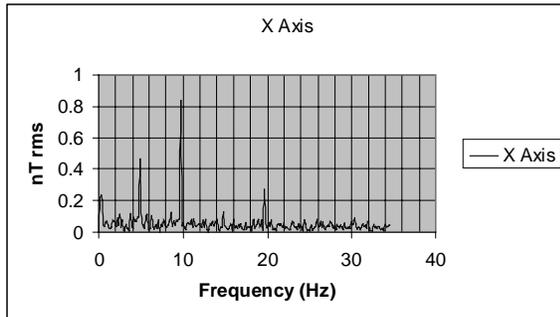
Note the FM300 frequency response for processed data is DC to 10 Hz, therefore, spectrum data values beyond 10 Hz will be lower than the actual values.

If you used the *Record* function to acquire the data, change 0.01439 in the above formula to 0.05747. If the data was collected using the FM300 Front Panel strip chart function, change 0.01439 in the above formula to the actual sample interval.

If the actual number of data points used to compute the Fourier Transform was not 512, change the 512 in the above formulas to the actual number of points processed.

Strip Chart Data Analysis

The FM300 has a 10 Hz low pass antialias filter in front of its analog-to-digital converter. If you used the FM300 Front Panel strip chart functions to collect the data, then aliasing is possible if the magnetic field spectrum includes frequencies that are greater than the Nyquist frequency established by the following formula:

Nyquist Frequency = 1/(2*(sample interval)).

SUMMARY

This application note has described how you can use the FM300 to measure the frequency content (spectrum) of a magnetic field. Although the frequency spectrum is restricted to the DC to 10 Hz frequency range, the high resolution of the FM300 allows the detection of low magnitude low frequency spectrum components

in the presence of a large static field such as the Earth's field.

A spreadsheet program was used to demonstrate how to compute and display the spectrum, but it is not the only program that can be used for this purpose. The FM300 Front Panel stores the data in a text file format that is compatible with mathematics programs such as MATHCAD by MathSoft.

REFERENCES

A good explanation of Fourier analysis can be found in the following reference:

J. S. Bendat, A. G. Piersol 1986. *Random Data Analysis and Measurement Procedures*, N. Y.: John Wiley & Sons, Inc.