Quantum Design

Application Note 1084-311

Format of ACMS Measurement Data Files

This document expands on the information in the ACMS User Manual. Below are the quantities that are reported in the .DAT file created by the ACMS option followed by a brief technical description for each. The quantities are relevant to both AC and DC magnetization data unless otherwise noted.

1. **Comment**: PPMS text comment.
2. **Time Stamp (sec)**: absolute time stamp from the Model 6000, in seconds.
3. **Temperature (K)**: average value of ACMS coil set thermometer temperature during the measurement.
4. **Magnetic Field (Oe)**: average magnetic field during the measurement.
5. **Frequency (Hz)**: (AC only) frequency of applied excitation field.
6. **Amplitude (Oe)**: (AC only) peak amplitude of applied excitation field.
7. **M-DC (emu)**: (DC only) dc moment inferred from extraction of sample.
8. **M-Std.Dev. (emu)**: error bar on the measurement of the moment, defined as the standard error of the regression of the composite data waveform to the ideal waveform, expressed in units of moment. The composite data curve is the averaged curve produced by overlaying all individual extractions (DC) or cycles (AC) of the measurement. The ideal waveform is the reference waveform saved in the dc-emu.cal file in the case of DC measurements, and a sine wave in the case of AC measurements.
9. **M' (emu)** $= \chi' \cdot Amplitude(Oe)$: (AC only) real, "in-phase" component of the magnetic susceptibility χ' multiplied by the a.c. excitation. A positive (negative) value indicates paramagnetism (diamagnetism). Note that "in-phase" describes the sample response relative to a paramagnetic material -- due to Faraday's Law our detection circuitry introduces a 90 degree phase shift, so a paramagnetic sample's response in our circuit will be about 90 degrees out of phase with the drive signal.
10. **M'' (emu)** $= \chi'' \cdot Amplitude(Oe)$: (AC only) imaginary, "out-of-phase" component of the magnetic susceptibility χ'' multiplied by the a.c. excitation. This term indicates energy dissipation in the material.
11. **Moment (emu)**: (AC only) total magnitude of the a.c. moment = $\sqrt{(M')^2 + (M'')^2}$
12. **Phase (deg)**: (AC only) phase of the sample response relative to the paramagnetic calibration coil signal. Phase = 0 indicates paramagnetism in the sample.
13. **M'[x] (emu)**: (AC only) refers to the in-phase component of the x^{th} harmonic (relative to the fundamental drive frequency) of the sample's magnetic response. The user can request to save up to the 10th harmonic.
14. **M''[x] (emu)**: (AC only) x^{th} harmonic which is 90 degrees out of phase with the M'[x] signal.
15. **Moment[x] (emu)**: (AC only) total magnitude of the x^{th} harmonic a.c. moment.

16. **Phase[x] (deg)**: (AC only) phase of the x^{th} harmonic response relative to the calibration coil.
17. **Calcoil' (emu**): (AC only) in-phase component of the calibration coil signal. This signal will generally be positive and essentially only in-phase (i.e., the calibration coil looks paramagnetic).
18. **Calcoil'' (emu)**: (AC only) out-of-phase component of calibration coil signal.
19. **Calcoil (emu)**: (AC only) total magnitude of calibration coil signal.
20. **CC Phase (deg)**: (AC only) phase of calibration coil response relative to a paramagnetic response. This number will be close to zero.
21. **Count**: number of waveforms that were averaged to produce this data point.
22. **Gain**: total gain applied to sample response. See Table 3-2 in the *PPMS AC Transport Option User's Manual.*
23. **Measure Type**: (AC only) measurement mode, where 5-point (bottom-top-bottom-center-center) is the default.
24. **Elapsed (sec)**: total time required to collect this data point.
25. **Sample Center (cm)**: sample location as determined by the last centering operation. The scale correlates with motor position, with the origin being the ideal location for a sample. Note that this value will not change in a data file, unless a centering operation is performed and a different sample center is determined from the curve fit to the data.
26. **Max.Signal (V)**: maximum peak-to-peak signal seen at the detection coils.
27. **PPMS Status (code)**: defined in Appendix A of *PPMS Firmware Manual*. This can also be decoded in MultiVu under "Utilities > Status Calculator..."
28. **DSP Status (code)**: a value of zero indicates the measurement completed without any errors or warnings. If it is nonzero, consult the ACMS status log for more information on the errors that accompanied the measurement.
29. **Min.Temperature (K)**: minimum temperature during the measurement.
30. **Max.Temperature (K)**: maximum temperature during the measurement.
31. **Min.Field (Oe)**: minimum field during the measurement.
32. **Max.Field (Oe)**: maximum field during the measurement.
33. **DC Position (cm)**: (DC only) sample location inferred from curve fit to the extraction waveform where the position of the sample is a fit parameter. For more information, see Application Note 1084-310: *ACMS DC Analysis Centering Techniques: Linear vs. Nonlinear Modes*
34. **PPMS Temperature (K)**: temperature of the PPMS thermometer located at the bottom of the sample chamber.
35. **Map 25 ()**: ACMS coil set thermometer temperature.