Quantum Design

*PPMS Application Note 1084-202*

# Using the ACMS Coil Set with an Antistatic Shield

The ACMS option for the Physical Property Measurement System (PPMS) measures both the DC and AC magnetic properties of a sample. Both types of measurements are based on inductive techniques in which the sample produces a changing magnetic flux in the detection coils. This changing flux induces a voltage across the detection coils, which the ACMS measures and uses to calculate the magnetic moment of the sample.

A DC moment measurement involves moving the sample quickly through the detection coils, then returning the sample to the initial position. Each time the sample is moved, the sample holder slides along the inner radius of the ACMS coil set. During this up-and-down sequence, the sample holder might accumulate a small amount of static charge. The capacitance between the sample holder and the ACMS coil set allows this static charge to create a slight voltage across the coil set. When this voltage becomes relatively large, it could be coupled into the detection electronics and introduce an error into DC measurements. Any such buildup of static charge on the sample holder will manifest itself as an offset in the DC magnetic moment or as a drift in the magnetic moment.

The drift in magnetic moment will be linear with the number of DC extractions performed. When pauses are inserted between measurements, the charge bleeds away and the effect is less noticeable. However, when the DC moment of a sample is measured continuously, the static charge will build, which might cause a drift in the moment. Such effects are typically on the order of $10^{-4}$ emu over several hundred extractions and the ACMS has differential sensitivity around $2.5 \times 10^{-5}$ emu. Hence, the effect of static buildup can have a noticeable effect on the data.

Note that there are other causes of drift, so it is important to characterize the nature of your measurement errors before you attempt to correct them. For example, magnetic field drift can cause effects of similar magnitude (as above) when you use the palladium calibration sample that is supplied with the ACMS ($\chi_{Pd} = 5.25^{-6}$ emu/Oe-g). (You can minimize this field drift by using the "oscillate" mode to charge the PPMS magnet.) Drift can also be caused by sample-space contamination.

To improve the overall reliability of DC measurement data, Quantum Design has designed an antistatic shield that prevents static charge from accumulating on the sample holder. The shield creates an equipotential surface between the sample holder and the coil set, eliminating the mechanism by which static charge couples to the detection electronics. As is explained in the instructions section, this antistatic shield is easy to insert and remove.

The shield is available from Quantum Design free of charge.

## The ACMS Shield

The antistatic shield (part no. 4084-077) is constructed from a piece of 0.002" thick beryllium copper foil that slides snugly into the sample space of the ACMS coil set. The shield is made by forming the foil into a tube with a lengthwise slit, which reduces eddy currents that can be induced during AC measurements.

## Measurement Considerations

You will find the antistatic shield most useful when you are making DC measurements of moments near $10^{-4}$ emu or lower, when you are concerned about static buildup due to repeated extractions, or when you require high resolution (e.g., $< 10^{-4}$ emu) DC moment data. Further, you can leave the antistatic shield in the coil set when you are performing AC susceptibility measurements that do not demand highly accurate determination of the phase at frequencies above 3 kHz.

The antistatic shield has a small effect on AC measurements, due to induced eddy currents. Precision AC measurements will be affected slightly at high frequencies. For a 10 kHz measurement at low temperatures, the shield will introduce roughly 1 degree of phase lag in AC measurements and a change in the AC moment of less than 1%.

The effects of the shield diminish at lower frequencies because the magnitude of the induced eddy currents is proportional to the frequency. The effects of the shield also are small enough that you will not need to recalibrate the ACMS when you install or remove the shield. If you prefer to recalibrate the ACMS, see *Quantum Design Service Note 1084-302*, which contains calibration procedures that use palladium and dysprosium oxide samples.

Note that the antistatic shield will make it difficult to use the ACMS sample-holder buckets supplied by Quantum Design. Due to dimensional tolerances, these buckets tend to catch on the top of the shield when you insert them into the ACMS coil set. To prevent this, we suggest that you open the top of the shield as widely as possible when you install it. Flare out the top of the shield too, if it is possible. Alternatively, you can use a plastic drinking straw as the sample holder. These straws are narrower than the ACMS sample-holder buckets, so they are somewhat easier to insert when the shield is being used.

Instructions for installing and removing the antistatic shield are provided below. Please read all the steps before you start the procedures so that you will know about the proper orientation and location of the parts.

**C A U T I O N !**

Handle the ACMS coil set carefully—it is a delicate piece of precision equipment.

## Installing the Antistatic Shield

To install the shield, you will first separate the ACMS coil set from the baffled G10 tube (Figure 1).

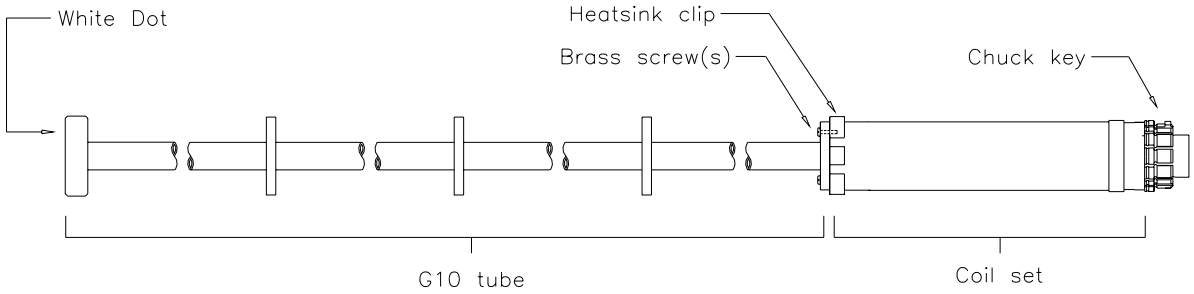


Figure 1. ACMS coil set assembly

1. Unscrew the six brass screws that pass through the base of the G10 tube and the heatsink clip and screw into the coil set.
2. Note the orientation of the heatsink clip, which is sandwiched between the base of the G10 tube and the coil set.
3. Separate the coil-set assembly from the G10 tube and heatsink clip.
4. Remove the heatsink clip from the G10 tube.
5. Inspect the inside of the coil set, G10 tube, and antistatic shield. If they appear contaminated, clean the inner surfaces with a swab that has been dipped in isopropyl alcohol.

**C A U T I O N !**

In the next steps, you will be working with the antistatic shield, which is delicate and easily bent. Take care not to use excessive force when you insert the shield into the coil set. Also, avoid catching the sample on the shield when you insert it into the coil set.

6. Using extreme care not to bend the antistatic shield or catch it on the sleeve of the coil set, remove the shield from its protective plastic tube.
7. Slide the shield into the ACMS coil set so that the hole in the shield is near the opening of the coil set.
8. Test the size of the coil-set opening by inserting a sample. If the sample will not fit smoothly, gently manipulate the top of the shield so that it flares outward.
9. Place the heatsink clip back on the coil set.
10. Verify that the three vent holes located near the inner radius of the coil set are aligned with those on the heatsink clip (see Figure 2). These vents must be aligned for the gas to flow properly.

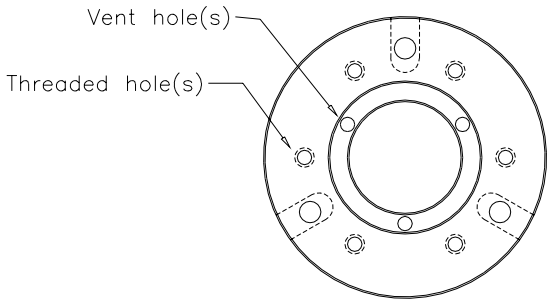


Figure 2. ACMS coil (top view)

11. Loosely attach the coil set to the G10 tube by inserting the brass screws through the G10 base and screwing them into the coil-set assembly, using the following guidelines:

    a. Align the white dot at the top of the G10 tube with the chuck key on the bottom of the coil set.

    b. Verify that the three vent holes in the base of the G10 tube are aligned with the vent holes of the coil set (see Figure 2).

    c. Loosely place all six screws into the coil set, but *do not* tighten them yet.

    d. To ensure that the coil set will be aligned with the G10 tube, *carefully* tighten the screws, proceeding from one to the next in a star pattern. Use of this pattern will ensure that the G10 tube remains flush against the heatsink clip.

    **Important:** Take care that each screw rotates very smoothly into the threads on the coil set. If there is resistance to a screw, back it completely out and reinstall the screw. Otherwise, you could damage the coil set threads.

## Removing the Antistatic Shield

The procedures for removing the antistatic shield are identical to those for installing it, except you will substitute the steps below for Installation Steps 5–8:

1. Insert a hooked instrument into the hole in the antistatic shield, working carefully so that the shield is not bent or torn.
2. Gently pull the shield out from the coil set.
3. Inspect the inside of the coil set, G10 tube, and antistatic shield. If they appear contaminated, clean the inner surfaces with a swab that has been dipped in isopropyl alcohol.
4. Place the shield inside the protective plastic tube that was shipped with it.
5. Complete Installation Steps 9–11.

If you have any questions regarding the installation or removal of the antistatic shield, please contact Customer Service at Quantum Design (1-800-289-6996).