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How a Fieldmeter Works

By Christopher Janson, NRD LLC

Most fieldmeters consist of two assemblies: a probe and a main meter assembly. Handheld units house both assemblies together, while more sophisticated units may have the probe wired to a meter at some distance away (See Figure 1).

An electric field exists between objects charged to different surface potentials. Over the surface of an object, an electric field mirrors the charge distributed on the object. Measuring the field's magnitude and polarity provides an estimate of the object's surface charge distribution, and its potential for causing or aiding in static discharge.

Electric fields behave in ways that are not obvious to most people. Take, for example, the field from a surface charge on a plastic film web that is trapped by the grounded surface of a steel roller. Measuring the field on the film at the roller will not provide an accurate indication of how much charge is present on the film. But once the film web is free from the roller, the field will define itself in relation to the fieldmeter, giving a true measure of the surface charge present.

It's important to remember that the field being measured must exist because of the difference in potential between the object of interest, e.g., the film web in free space, and the fieldmeter doing the measuring. Charged objects or grounded surfaces that add to or subtract from the field on the object being measured will distort the measurement. For example, unwound rolls of highly charged film, rubber or steel rollers, metal tabletops, machine frames, and plastic guideways are each potential sources of fields that could distort measurements on a material or component being processed.

In addition to the "other object" phenomenon mentioned, it is also possible for simple, inexpensive fieldmeters to be thrown off by an ionization system. Because ionizers are a source of charge in the form of air ions, they can potentially skew a field reading by delivering charge to the capacitively- coupled sense element of the fieldmeter probe. The charge from the ionizer becomes a current flow in a simple meter, causing the meter to read a "field" where one does not exist. In essence, these meters will significantly drift about the true field readings when in the presence of ionizers.

In the environments where ionizers are in use, it's critical that the fieldmeter be designed to overcome the inherent drift found in the simple capacitively-coupled meters. Specifically, the fieldmeter should have a field-nulling, actively driven front end sensor that shields the sensitive measuring surface from charges generated by ionizers.

Taking the measurement

To measure the electric field using a field-nulling fieldmeter, the probe end of the meter should be positioned at the meter's calibrated distance from the surface. For example, a fieldmeter calibrated to read in kilovolts per inch should be held at a distance of one inch. A reading of 0.865 kilovolts from a meter held at one inch means that 865 volts of charge reside on and around the object being measured. A reading of 13.08 kilovolts indicates that 13,080 volts are being sensed by the probe.

The field between the meter and the object is sensed by an oscillating electrode moving behind an aperture plate which limits the view sensed by the sensor. The characteristic hum heard when a field-nulling meter is turned on is caused by the vibrating sensor, often tuned at around 1000 hertz.

The meter directs the capacitively-coupled field signal through a phase-sensitive demodulator, drawing out the rectified field signal. The demodulated signal then drives an integrator stage to produce a signal that is the average value of the input signal, and opposite in polarity. This integrated signal is then fed back to the sensor until the net signal sensed by the sensor is nulled, and equilibrium is reached. The voltage required to null the field is then read as the field

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strength in kilovolts per unit of distance, e.g., per inch.

The reading in the example above of 13,080 volts is a measure of the field created by the difference of potential between the surface being measured and the person holding the fieldmeter. Since the person is essentially at ground potential, the fieldmeter gives a good indication of the potential on the object being measured. Thus, the reading in volts of surface potential at one inch tells the measurer how much surface charge is present. Since charge is the presence or absence of electrons, and electrons are the precursor to current flow in the form of a spark or ESD event, the user gets a feeling for the static threat that exists.

When you want the reading to yield "volts of surface potential," spacing is extremely critical. If the distance between meter and object is doubled to two inches, the field reading will drop to approximately one-half. Similarly, reducing the distance to a one-half inch spacing will double the field reading.

In general, with a good quality, reliable fieldmeter, it is possible to quantify the static charge present in a machine or work environment. The fields measured are not obvious, so a basic understanding of what you are measuring is vital. The spacing is critical, and so is an understanding that the meter looks out a window at the fields surrounding it. Point the wrong way, and the reading will show you fields that are not relevant to the object of interest. All in all, however, a fieldmeter is an extremely useful and important tool to have at hand for measuring static, locating possible sources of static problems, and maintaining a static-free work environment.

Inside an Electrostatic Fieldmeter

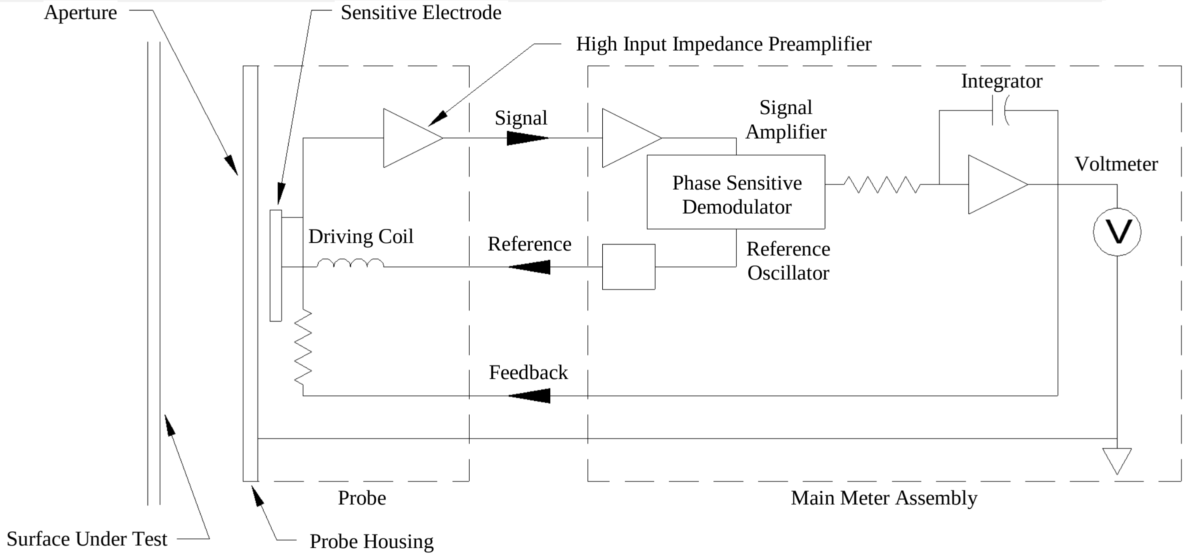

Figure 1

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