LCR Meters in Aerospace Applications

LCR meters are designed to measure and display a wide variety of electrical parameters including capacitance, resistance, ESR, DF, tan delta and inductance to name a few. The traditional use of an LCR meter was to measure the characteristics of components such as capacitors, resistors and inductors. Today however LCR meters are used in a variety of unique and varied applications. This article will touch on some of the applications that LCR meters have been used for in aerospace applications.

The Capacitive Fuel Probe

Capacitive fuel probes or gauges are used in a variety of applications from aerospace to marine. A capacitive fuel probe determines the amount of fuel in present in the fuel tank by measuring the capacitance between an electrically conductive inner tube that is surrounded by an outer tube or cylinder. The sensor is placed vertically in the tank so that as the fuel level goes up and down, more or less of the probe is immersed in fuel. This changes the amount the capacitance between the two tubes which is measured and displayed as amount of fuel in the tank.

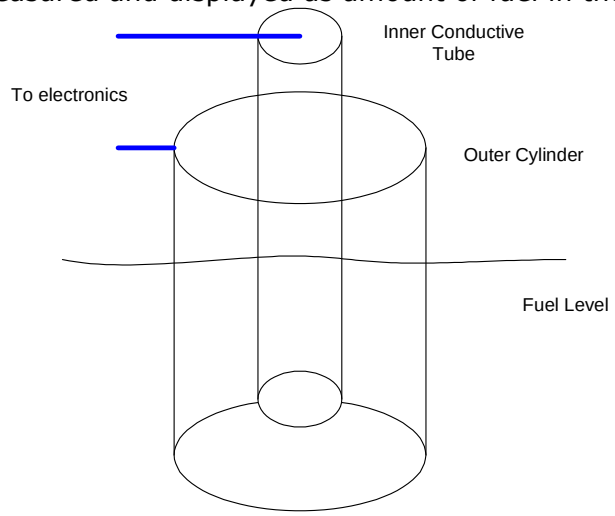

Figure 1. Capacitive Fuel Probe

The principle of operation is very similar to measuring the dielectric constant of materials. Measurement of the dielectric constant of materials and liquid uses a dielectric cell or liquid cell that acts as a capacitors. An LCR meter is then used to measure the capacitance in air and with the

material or liquid in the cell. The ratio of the two capacitance gives dielectric constant. The liquid cell is very similar and uses the formula $\text{Capacitance} = \frac{e_o e_r A}{d1}$. In the formula eo, A and d1 are constants which do not change. The value er is the relative permittivity of the material between the center tube and other cylinder which does change based upon the ratio of tube in air versus fuel.

LCR meters such as the 1920 Precision LCR Meter have been use by numerous manufacturers of capacitive fuel probes and sensor during production for calibration and quality control. The 1920 is ideally suited to integration into automatic test systems or standalone applications with standard RS232, handler and IEEE interfaces.

Dielectric Constant Measurements of Liquids

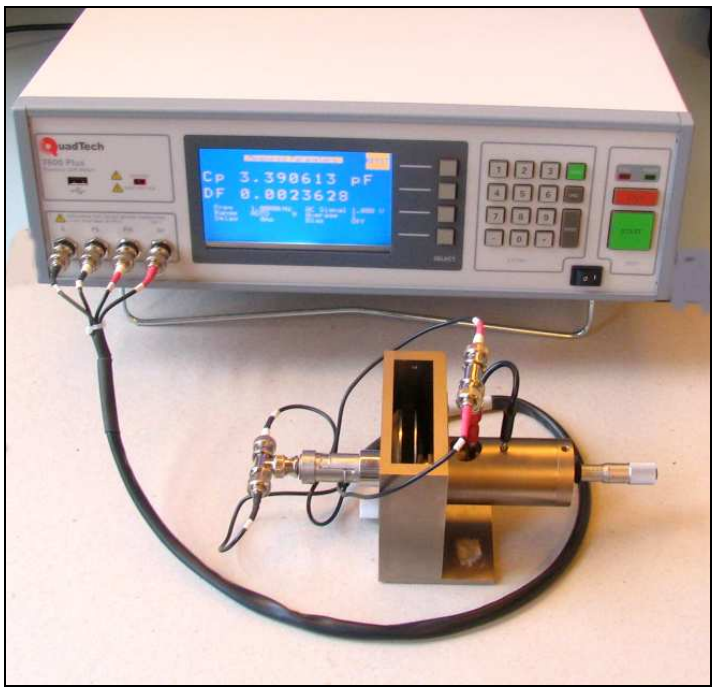

Figure 2. 7600 Precision LCR Meter with Rigid Dielectric Cell

The dielectric constant measurement, also known as relative permittivity is one of the most popular methods of evaluating insulators such as rubber, plastics, powders and other materials. It is used to determine the ability of an insulator to store electrical energy. Dielectric constant measurements can be performed easier and faster than chemical or physical analysis techniques making them an excellent material analysis tool. The dielectric constant is defined as the ratio of the capacitance of the material to the capacitance of air.

A complete system for dielectric constant measurements includes an LCR meter for capacitance and dissipation factor measurements, the dielectric cell, and the connecting cables and adapters. This system allows rapid, precise measurements over a wide frequency range.

A measurement of capacitance Cp is performed at the desired test frequency both with and without the test material in the dielectric cell. Dielectric constant is then calculated using the formula

k'=Cx/Co where k'= dielectric constant, Cx= capacitance with a dielectric material and Co = capacitance without a material.

Dielectric cells are manufactured by a number of companies. The dielectric cells shown in this application note are manufactured by Dielectric Products Company of Watertown, MA. QuadTech LCR Meters have been tested with these dielectric cells. The dielectric cells and LCR meters described in this application note are available directly from QuadTech. Please see www.quadtech.com for ordering information.

Figure 3: Typical Liquid Cell
Courtesy Dielectric Products Watertown, MA

