Wirelessly Interrogated Position or Displacement Sensors

These sensors could be used in harsh environments.

Langley Research Center, Hampton, Virginia

Two simple position or displacement sensors based on inductance-capacitance resonant circuits have been conceived. These sensors are both powered and interrogated without use of wires and without making contact with other objects. Instead, excitation and interrogation are accomplished by means of a magnetic-field-response recorder — an apparatus previously reported in "Magnetic-Field-Response Measurement-Acquisition System" (LAR-16908), *NASA Tech Briefs*, Vol. 30, No. 6 (June 2006), page 28. To recapitulate: The magnetic-field-response recorder generates an alternating magnetic field that excites oscillations in the resonant circuit, measures the magnetic response of the circuit, and determines the resonance frequency from the response.

Both of the present position or displacement sensors consist essentially of variable rectangular parallel-plate capacitors electrically connected in series with fixed inductors. In the first sensor, (see Figure 1), the perpendicular distance, x, between the plates is variable and is the distance that one seeks to measure; alternatively, a change in this distance is the displacement that one seeks to measure. From the basic equations for the resonance angular frequency ω of an inductance-capacitance circuit and a first order approximation (fringing field neglected) of a parallel-plate capacitor, it can readily be shown that the distance is related to the resonance frequency by

$$x = \frac{L\varepsilon_0 lw}{\omega^2}$$

where L is the inductance, ε_0 is the vacuum permittivity, and l and w are the dimensions of the capacitor plates as indicated in Figure 1.

In the second sensor (see Figure 2), capacitor plates are constrained to remain at a perpendicular distance d, and one of the plates is free to slide parallel to the other one. The space between the plates is filled with a dielectric material of relative permittivity κ. In this case, the distance, x, that one seeks to measure is the length by which the plates overlap. Using the same approximations as those for the first sensor, it can be shown that the overlap length is related to the resonance frequency by

$$x = \frac{d}{\omega^2 L\kappa\varepsilon_0 lw}$$

Simple inductance-capacitance circuits of the type used in these sensors are inherently robust; their basic mode of operation does not depend on maintenance of specific environmental conditions. Hence, these sensors can be used under such harsh conditions as cryogenic temperatures, high pressures, and radioactivity.

This work was done by Stanley E. Woodard of Langley Research Center and Bryant D. Taylor of Swales Aerospace. For further information, contact the Langley Innovative Partnerships Office at (757) 864-8881. LAR-16617-1

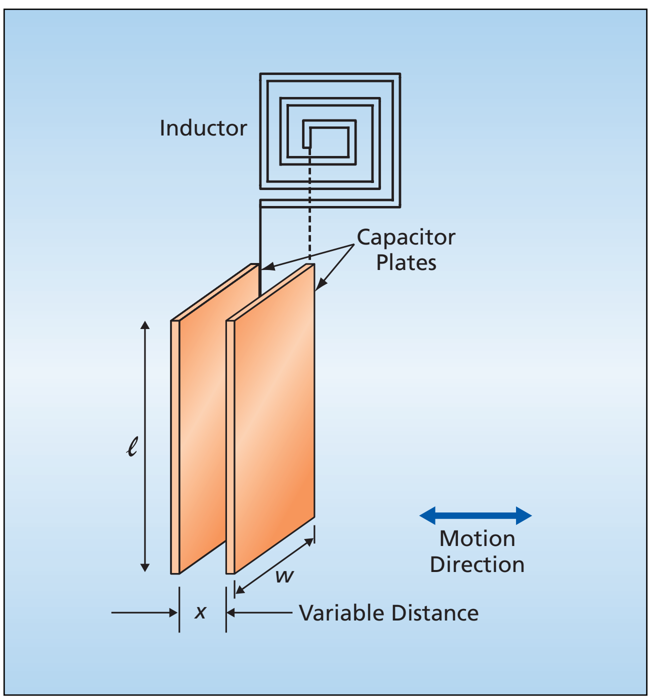

Figure 1. The **Distance Between the Plates** of a capacitor in a capacitor-inductor resonant circuit is varied. The distance can be calculated as a known function of the measured resonance frequency.

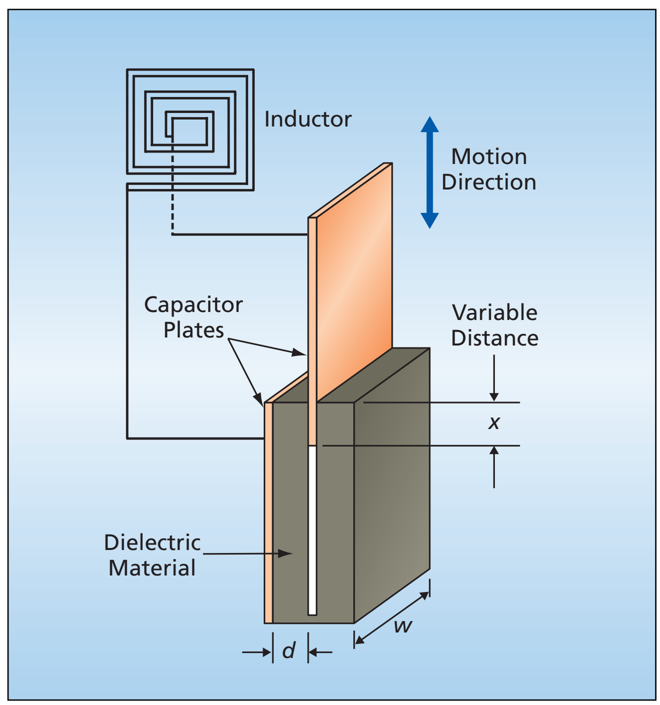

Figure 2. The **Length of Overlap of the Plates** of a capacitor in a capacitor-inductor resonant circuit is varied. As in the case of Figure 1, this length can be calculated as a known function of the measured resonance frequency.