Digital waveform generator provides flexible frequency tuning for sensor measurement

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Variable-resistance sensors convert a fixed dc excitation voltage or current into a current or voltage that's a straightforward function of the quantity undergoing measurement. In another class of sensors, moving objects or fluids produce a sensor signal by altering an LC circuit's inductance or capacitance. Figure 1 shows a basic ac-driven tuned-circuit proximity sensor, L and C, and sampling resistor, R. Under static conditions, L and C resonate and provide maximum impedance at one frequency. As an object approaches the sensor, the value of L or C varies and alters the circuit's resonant frequency. You can derive the object's position by exciting the sensor with a fixed frequency and measuring changes in the phase or amplitude of output voltage $V_2$ with respect to excitation voltage $V_1$. However, this approach limits the sensor's dynamic range and resolution.

As an alternative, you can drive the sensor with a swept-frequency ac source that tracks the sensor's resonant-frequency variation. Figure 2 shows one approach in which IC$_1$, a DDS (direct-digital synthesis) device, produces a sine-wave excitation voltage. Lowpass filter IC$_2$ removes clock artifacts and harmonics, and amplifier IC$_3$ drives the sensor. Amplifier IC$_4$ boosts the sensor's output voltage, $V_2$, and drives IC$_5$, a dual-channel, 12-bit ADC, which simultaneously samples and digitizes reference voltage $V_1$ and IC$_4$'s output. IC$_5$, a DSP-capable microcontroller, analyzes the sensor output's amplitude and phase, setting the frequency of IC$_1$ via alternate programming of either of IC$_1$'s dual frequency-control registers. One of IC$_6$'s serial ports delivers position data to an external controller. Using a DDS/DSP combination offers considerable flexibility when using various types of sensors. For example, certain sensors require a relatively narrow but high-resolution range of excitation frequencies, and others may work best with broadly swept excitation.

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