Find hex-code values for microcontroller's ADC voltages

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This Design Idea is for low-end, eight-pin, flash-memory, 8-bit microcontrollers, such as the MC68HC908QT4A from Freescale (www.freescale.com), but it would apply to any 8-bit microcontrollers that use the ADC feature. In a nutshell, the ADC converts an input-analog-voltage level to a digital-signal format. The digital-signal format has an 8-bit hex-code value, such as \$00. The microcontroller "sees" the input-analog-voltage level from its ADC ports ranging from \$00 at V_{SS} to \$FF at V_{DD}. Based on those hex-code values, there are a total of 256 ticks. The input voltages between V_{SS} and V_{DD} represent a straight-line linear conversion. In other words, the higher the input voltage, the higher the hex-code value.

The difficulty is that a programmer who needs to write assembly code for a programming algorithm must know what the hex-code value is for a different input-analog-voltage level—1.6V, for example. Referring to the microcontroller's specs and even contacting its manufacturers do not yield satisfactory answers.

However, this Design Idea presents a solution to the problem. Given the microcontroller's power operating-voltage source, V_{DD}, use the following simple formula to obtain the hex-code value corresponding to an identified input-analog-voltage level: $V_{IN} \times V_{IN}/(V_{DD}/255)$=result value=hex code. Note that you must round off the result value to a whole number before converting to a hex-code value for better accuracy. The following sample calculation finds the hex-code value for a measured input-analog-voltage level of 1.6V when using a known microcontroller's V_{DD} of 5V: 1.6V/(5V/255)=81.6=82, or \$52. EDN

Cheap and easy inductance tester uses few components

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In the absence of expensive test equipment, the circuit in **Figure 1** offers a simple and rapid alternative method of measuring inductance. Its applications include verifying that an inductor's value falls close to its design parameters and characterizing magnetic cores of unknown parameters that accumulate in the "junk box." As designed, the circuit tests most inductors for use in power supplies and many inductors for RF circuits.

The circuit comprises two cascaded common-emitter-amplifier stages that form a nonsaturating, cross-coupled flip-flop. A common-emitter stage performs a phase inversion, and two cascaded stages form a noninverting feedback amplifier with gain that produces regeneration. Without the presence of the inductor that is undergoing test, L, regeneration occurs at dc, and the circuit behaves as a bistable flip-flop that assumes either of two stable states. Connecting the inductor reduces the dc positive feedback to below the regeneration level. Thus, regeneration can occur only at ac, and the circuit becomes an astable oscillator.

Keeping the transistors out of saturation speeds the circuit's operation by minimizing the transistors' storage time. Although virtually any type of high-speed, small-signal RF transistor provides adequate switching speed, lower frequency devices also work but decrease the low-inductance-measurement range. The circuit's frequency of oscillation is inversely proportional to the inductance that is undergoing test, and you can use either a frequency counter or an oscilloscope to measure the frequency of oscillation.

Figure 2 shows the waveform produced by an inductor with a value of approximately 100 µH. The frequency of oscillation depends on the L/R time

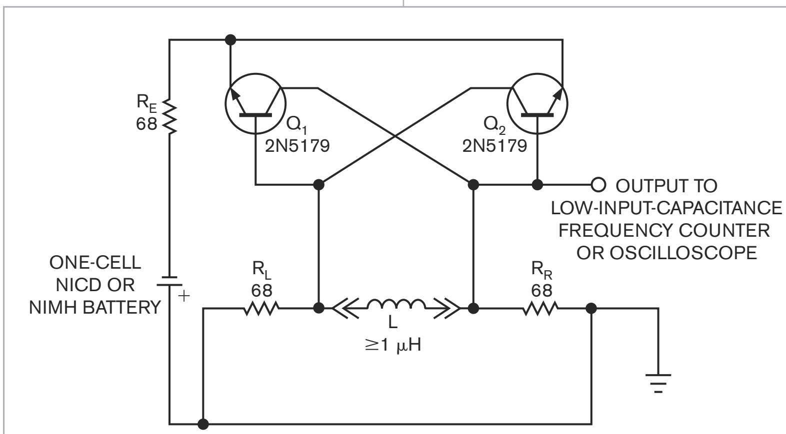

Figure 1 An inductance-test oscillator comprises two transistors and a few passive components. (Editor's note: For best results, minimize the lengths of all components' leads.)

constant comprising the inductance under test and resistors R_L and R_R. The time the waveform takes to change its state is directly proportional to the inductance, and, for one-half cycle, it approaches T_{HALF}=L/100. The period of a full oscillation cycle is twice that amount, or T_{FULL}=L/50. Solving for the inductance yields L=50×T_{FULL}. As an alternative, the frequency is inversely proportional to the inductance, or f_{OSC}=50/L. Using a frequency counter allows measurement of inductance as L=50/f_{OSC}.

The circuit's finite switching speed of approximately 10 nsec imposes a lower floor of 1 μH on its measurement range. You can measure a small inductance by connecting it in series with a larger inductance, noting the reading, measuring the larger inductance alone, and subtracting the two measurements.

Although the circuit imposes no upper limit on inductance values, when the inductor's ESR (equivalent-series resistance) exceeds approximately 70Ω, the circuit stops oscillating and reverts to bistable operation. The circuit measures values of all inductors and transformer windings except for small, low-frequency iron-core devices that present a high ESR. For greatest accuracy, use a low-input-capacitance instrument to measure the frequency of oscillation.

A single NiCd (nickel-cadmium) or NiMH (nickel-metal-hydride) rechargeable cell provides power for the circuit. These cells present a relatively flat voltage-versus-time discharge characteristic that enhances the circuit's measurement accuracy. The circuit consumes approximately 6 mA during operation.EDN

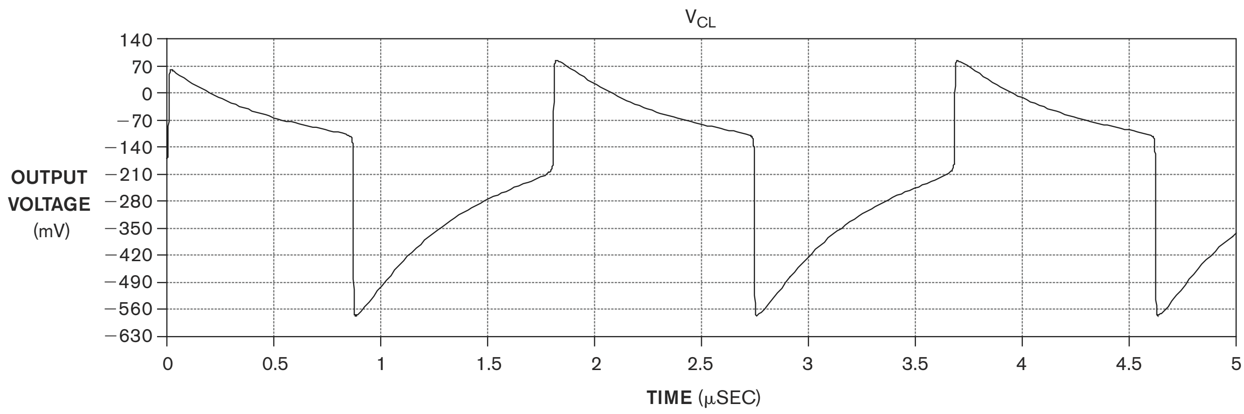

Figure 2 Testing an inductor with a value of approximately 100 μH produces this output waveform.