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Sensor Report

Metal Detector

The metal detector sensor is used to detect nearby metal. It is based on a beat frequency oscillator (BFO) design. An RLC circuit is amplified so that it resonates at a specific frequency. Another RLC circuit is designed to match that frequency. These circuits are compared, and any difference in the frequencies of the two circuits is amplified and sent to an audio device, such as a speaker or headphones. The inductor in the first RLC circuit is the search loop and the inductor in the second RLC circuit is the reference coil. When metal comes into proximity of the search coil, the inductance and the frequency change. This can be heard as a tone from the headphones or speaker. A search coil was created by winding 20 turns of 22 gauge wire around a 4" diameter loop.

I modified this design by only using one RLC circuit and amplifying the oscillator. The output is then fed through a 74'HC04 digital inverter to produce a good digital signal for the microprocessor and as a buffer in the case that the amplifier was designed incorrectly and would burn out the digital chip it is connected to.

The output of the sensor is connected to a microprocessor's asynchronous counter input pin. The sensor is read by clearing the count value and then waiting a specific length of time. For my design, waiting a tenth of a second produced good results. After waiting, the count value needs to be read and stored in global variables. A 16-bit count value is required unless a prescalar is used to divide the frequency or a shorter sample time is used. Two readings need to be taken -- a normal reading and a "metal present" reading. This will calibrate the metal detector. Once these two readings have been taken, the midpoint between them can be calculated and stored. Subsequent readings can then be compared to the midpoint to determine if it is likely metal or not likely metal.

This sensor is good because it is very cheap -- only the cost of a few simple electronic parts like a transistor, resistors, and capacitors. However, this sensor is also very inaccurate and difficult to calibrate. Software can be used to

take multiple samples and average them for better results, as well as requiring several positive results in a row before deciding that metal is indeed present. There seemed to be more trouble with false positives than false negatives, although both do happen. Mostly these results are due to bad calibration.

Metal Detector Circuit