ECSE 471 Lab #13 Ultrasonic Ranging Sensor

Design, build, and test, an ultrasonic "time-of- flight" sensor that provides a DC voltage proportional to the distance from a hard-surface target. A zero to 6V output will correspond to 0 to 60 inches. The minimum range will be about 6 inches. The size of the reflective target will be approximately 6" x 6". Your design should be entirely analog. You will be provided with two identical 40KHz ultrasonic transducers.

Your circuit will measure distance through the use of a pair of ultrasonic transducers. The transmitter will be driven by repetitive bursts of approximately 5 pulses at a frequency of 40 kHz. The ultrasonic sound wave will be reflected by the target and received by a similar receiver transducer. Your circuit will process the signal and determine time-of-flight corresponding to a target distance of 0 to 60 inches. Accuracy should be within +/- 3% of the measured distance. See the drawing and waveforms below. Operate on a 12VDC bench supply.

Your circuit will also contain an alarm feature and setpoint "training" with memory.

A setpoint will be programmed which will represent a specified distance from the target to the sensor. Should the distance from the sensor to the target be less than the setpoint, a beeper will sound continuously.

The setpoint will be programmable as follows: the operator will physically move the target to the desired setpoint distance (~6" to 60"). A momentary pushbutton on the sensor circuit will be briefly pressed, and the desired setpoint distance will be "learned" and stored in memory; programming is then complete, and the operator will be notified by the flash of an LED. The output voltage will continue to be proportional to the target distance as described above. However, should the distance to the target be less than the programmed setpoint (~ +/- 3 inches), the beeper will sound as long as this condition exists.

Memory: you may choose one of the following approaches:

1. Mechanical analog memory consisting of a motor-driven potentiometer; use the assembly that is part of the laser tracking servo. This is a form of non-volatile memory (as long as the motor doesn't spuriously rotate at power-up or power -down).

2. Analog stored-charge memory consisting of a large, low-leakage (film) capacitor connected to the gate of a small-signal MOSFET (2N7000 or equiv). After the capacitor is charged to the appropriate voltage, MOSFET source-drain current will remain relatively constant for several minutes. This is enough time to demonstrate the principle.

In in a digital system, this concept is used in non-volatile, stored-charge memory, such as EPROM or FLASH. If the charge is only stored for short time (a few milliseconds), it is volatile and must be refreshed, as in DRAM.

3. A digital D/A approach, which will store the setpoint value in a 4- bit counter driving a D/A resistor network. This will be volatile memory, since the supply voltage must be maintained.

This is the approach taken used in SRAM, where a backup battery is necessary for non-volatile applications.