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Progress Report

Prototype for an Expendable Infrasound Sensor (ExIS 1.0)

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Introduction

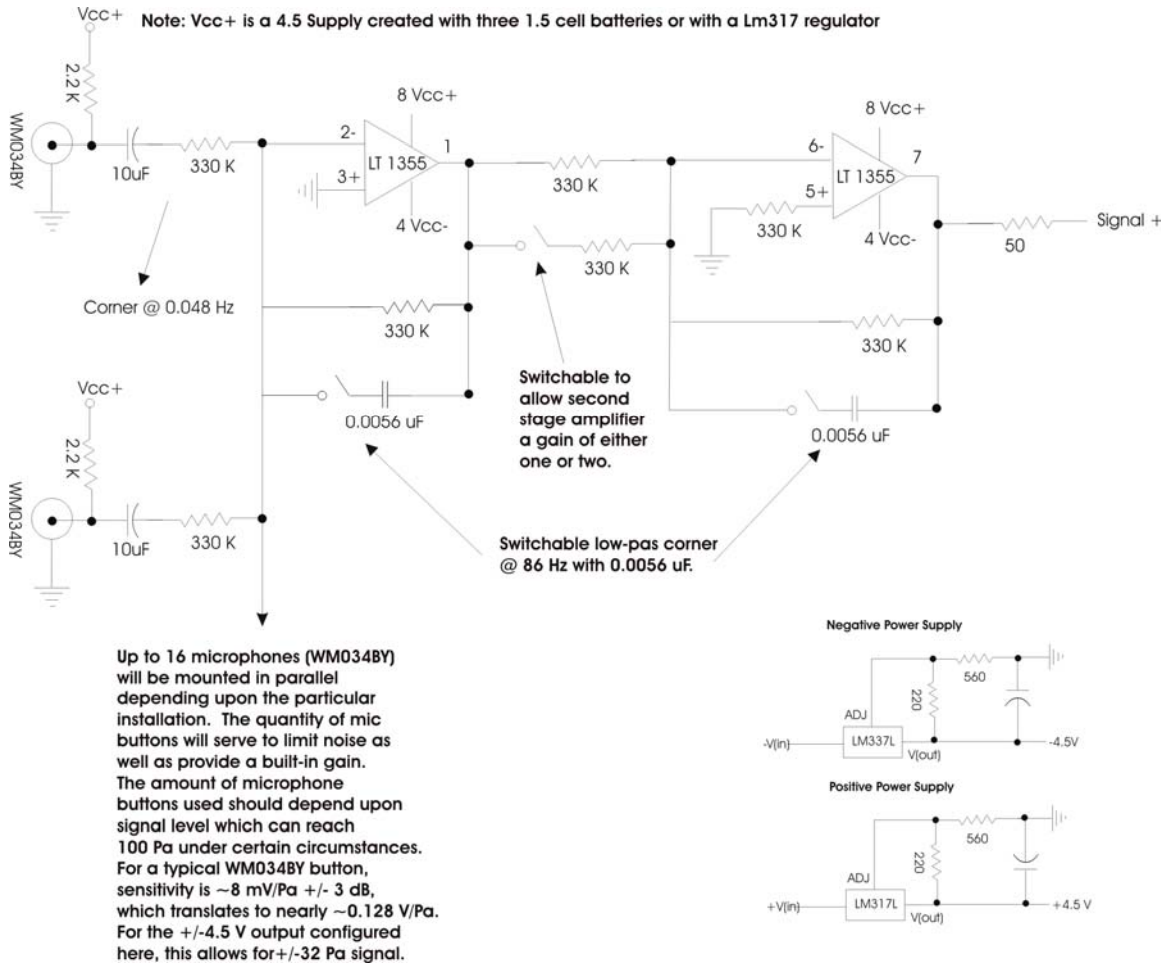
Building on sensor designs developed at the Southern Methodist University and the University of Washington, we are constructing expendable, modular, low-cost multi-element electret condenser microphones that are sensitive to infrasound and low-frequency sound. Our first prototype of the Expendable Infrasound Sensor (ExIS 1.0) should provide improvements over previous designs in the following areas:

1) Enhanced signal-to-noise – 16 individual WM034BY electret condenser sensors can provide a 12dB improvement over single-element models. Circuitry which includes low noise op-amps and power supply regulation will serve to reduce associated electronic noise
2) Wider bandwidth – WM034BY elements are sensitive to frequencies as low as 0.05 Hz (corner frequency ~0.4 Hz). Our amplifier circuit provides an additional single-pole high-pass filter at 20 Hz with optional (switchable) low-pass two-pole filtering at 80 Hz.
3) Power consumption – Current drain is approximately 16 mA for 16 individual sensors. This allows for microphones to be operated with commercial AA batteries for more than one week.
4) Modular enclosure – instrument housing (PVC pipe and caps) allows for efficient removal and/or replacement of microphone elements, amplifier circuitry, and power supply. Power can be housed either within the microphone enclosure or delivered to the microphone from a separate source.
5) Flexibility – individual microphone elements can be easily tested, re-calibrated, or replaced.
6) Low cost – estimated cost of enclosure, power source, and electronics (for 16 element microphone) will be about US $90. This cost may be reduced with mass production.

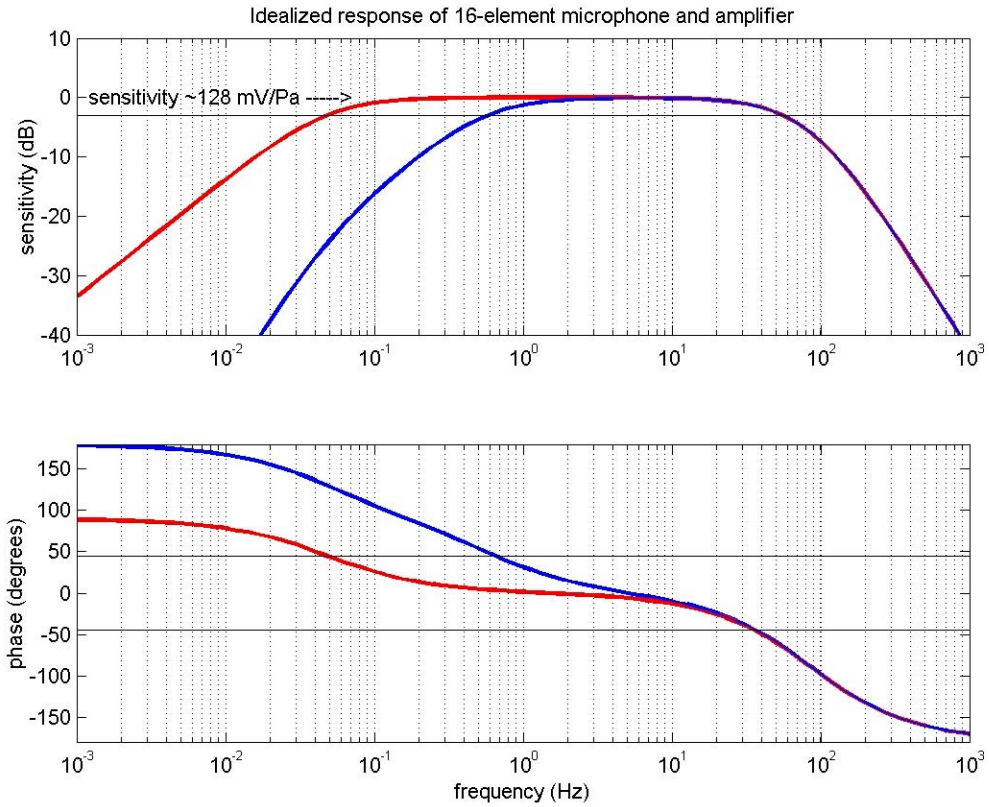
Prototype Circuitry

Our summing amplifier takes current input from up to 16 isolated microphone circuits. Each of these circuits includes a WM034BY microphone in series with a 2200 Kohm resistor and output through an RC high-pass filter with a corner at 0.048 Hz. This signal is then conditioned through two op-amp stages (LT1355) which allow two switchable anti-aliasing filters at 86 Hz. Another switch provides an optional gain of two on the second stage op-amp. The buffered output swings +/- 4.5 V and is connected in series to a small resistor. Total output impedance is less than 100 ohms. The circuit accepts either

+/- 4.5 V battery packs or higher voltages that will be regulated down to +/-4.5 V with LM317 and LM337 adjustable regulators. The entire circuit will be soldered to printed IC boards of dimension 2 inches by 4 inches.



The idealized response of the circuit (red curve) and circuit with microphones (blue curve) is shown in the figure below. Nominal gain for 16 WM034BY microphones is 128 mV/Pa with amplification set to unity. However this sensitivity and absolute transfer function is dependent upon the summed characteristics of the individual microphone elements (manufacturer specifies +/- 2dB sensitivity per microphone at 4.5 V). Also the low-frequency response of each individual element will probably deviate slightly from the single-pole roll-off discovered in previous tests. It will thus be necessary to calibrate each completed 16-element microphone prior to installation.



Packaging

The prototype microphone housing will consist of a modular two-chamber enclosure that provides weather protection for the circuitry / power supply while allowing exposure to the atmosphere for the sensing elements. A two-inch PVC pipe will be capped on the back end with a four-conductor plug (Vcc+, Vcc-, GND, Signal Out) and fitted on the front end with the sensor module. The sensor module is connected to a garden hose that will provide wind filtering. The sensing elements are accessible via a screw-on PVC cap. Total length of the cylindrical enclosure will be approximately eight inches (not including garden hose). The final sensor packaging may be further compacted by separating power supply and electronics packaging, using a wider PVC schedule, and could be modified to incorporate wireless data transmission in open field environments.