Georgia Institute of Technology
School of Electrical and Computer Engineering
ECE 4435 Op Amp Design Laboratory Fall 2005

Design Project 1, Preliminaries
A White Noise and Pink Noise Generator

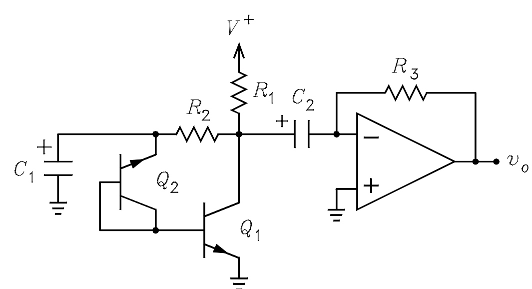
Introduction

Loudspeaker systems in professional audio applications are normally set up by equalizing their frequency response with graphic and/or parametric equalizers. The equalization requires a test signal that is called pink noise. Pink noise is generated from white noise by filtering it with a filter that has a frequency response that varies inversely with the square root of the frequency over the audio frequency band. White noise is noise which has a flat spectral density. That is, it has equal voltage per unit frequency. In contrast, pink noise has equal voltage per octave or per any fraction of an octave. The object of this design project is to design a white noise source and a filter which will convert the white noise output into pink noise.

Preliminary Procedure

The first step in the lab is to assemble a white noise source. The circuit shown in the figure is suggested. There is no theoretical way to design this circuit. It must be optimized experimentally. The transistor can be either a 2N4401 or 2N3904. The two capacitors can be assumed to be signal short circuits so that no signal voltage appears across them. The circuit shows Q_2 operated as a diode with its base connected to its collector. The emitter-base junction is operated at the onset of breakdown in its reverse breakdown region where it generates a great deal of noise that is called microplasma avalanche noise. Q_2 should have a breakdown voltage of 4 V to 5 V. Q_1 is a common-emitter stage which amplifies the noise generated by Q_2. The op amp is connected as a current-to-voltage converter. It forces the small-signal collector current in Q_1 to flow through R_3 so that $v_o = i_{c1} R_3$.

Suggested circuit values are $R_1 = 5.6\,\text{k}\Omega$, $R_2 = 56\,\text{k}\Omega$, $C_1 = C_2 = 10\,\mu\text{F}$. The value of R_3 can be adjusted experimentally to vary the level of the output voltage. The noise output voltage should peak at approximately ± 1 V on the oscilloscope. A small capacitor in parallel with R_3 can be used to limit the bandwidth of the noise. It should be limited to a value of about 100 kHz. The value of the capacitor is given by $C = (2\pi f R_3)^{-1}$, where $f = 100$ kHz. The op amp should be an LF351, a TL071, or a TL081. Do not use a 741 op amp because it has limited bandwidth and slew rate.



You should turn on the 20 MHz bandwidth limit on the oscilloscope when observing the noise waveform. With Dr. Brewer's assistance, the noise spectrum of your noise generator can be measured and documented.

This is only the first part of this experiment. Further details will be posted. In particular a suggested circuit for converting the white noise into pink noise will be given with its design formulas.