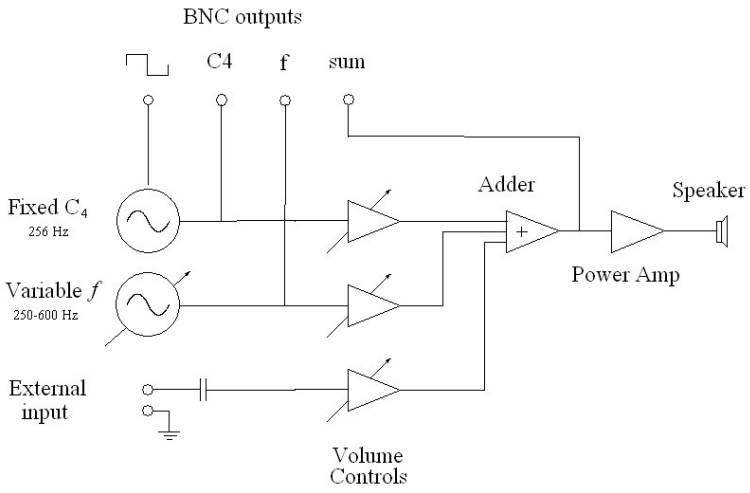
Audio Beats and Consonance

Consonance Generator (Rear Panel)

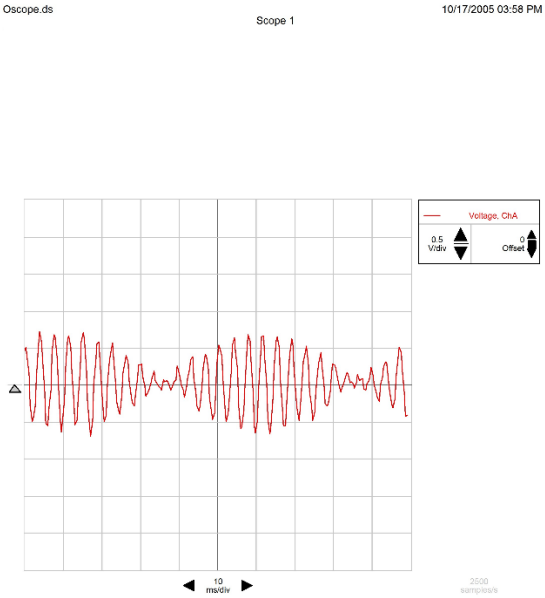


Block Diagram

Purpose: Demonstrates audio beats and the experience of consonance and dissonance.

This demo consists of a ‘consonance generator,’ a speaker box containing two oscillators, one fixed at (approximately) middle-C and the other variable over the octave C4-C5.

By tuning the variable oscillator near to the fixed oscillator, students can experience audio beats. The experience is enhanced if the Audio Oscilloscope is running up on the big screen; they can see and hear the wave packets simultaneously.



Sample output screen of oscilloscope

(Musical) Notes:

It seems that we find the sound of two musical notes played together as pleasing when their frequencies are (small) integer multiples of each other (Pythagoras 550 B.C.). Helmholtz related this fact to the phenomena of beats. He claimed that unpleasant sounds (dissonance) arise from our perception of audio beats (≈ 30 Hz), which disappear when we have commensurate frequencies. See what you think.

Any two notes with commensurate frequencies are possibilities for making a musical scale. Here are some, along with the cryptic music jargon:

Frequency Ratio		**Ratio and Interval**
1:1	1	Unison
9:8	1.125	major 2nd
6:5	1.200	major 3rd
5:4	1.250	major 3rd
4:3	1.333	4th
3:2	1.500	5th
5:3	1.666	major 6th
15:8	1.875	major 7th
2:1	2	octave

Various musical scales are built up by differing schemes of selecting notes to fill the octave. The Pythagorean Scale is built on fitting as many perfect fourths and fifths into the octave as possible, with the disadvantage that thirds are far from perfect. The Just Scale is based on major triads, with frequency ratios of 4:5:6. This scale has troubles too, with some imperfect fourths and fifths.

Usually the ‘Equal Temperament’ scale is used (everything is imperfect), where we take the octave and chop it up into 12 equally-spaced notes. For reference, the equal temperament scale starting at middle C is

n	note	Freq. (Hz)	Ratio & Approx. Interval
0	C_4	256	1
1	C#	271.2	
2	D	287.4	1.122 (2^{nd})
3	D#	304.4	
4	E	322.5	1.260 (3^{rd})
5	F	341.7	1.335 (4^{th})
6	F#	362.0	
7	G	383.6	1.498 (5^{th})
8	G#	406.4	
9	A	430.5	1.682 (6^{th})
10	A#	456.5	
11	B	483.3	1.888 (7^{th})
12	C_5	512	2 octave

Note: Note that musical standards have settled on A_4 = 440 Hz (concert A). The ‘scientific’ tuning with C_4 = 256 Hz is still used a lot with physics demo equipment, particularly tuning forks. I tuned the consonance generator this way, too.

Extra Equipment: Audio oscilloscope if desired.

Location: Shelf D4