

ME458 Noise Control Laboratory Exercise #1

Outdoor Noise Measurements and Hemispherical Divergence

Objectives:

1. Measure sound levels outdoors
2. Verify free field behavior of point source (hemispherical divergence)
3. Sum octave band measurements to determine overall sound levels

Background: In this experiment, you will gain an understanding of how the sound pressure level generated by a noisy machine varies as one moves away from it. A spherical or point sound source should exhibit the inverse square law (6 dB decay per doubling of distance). To behave as an ideal spherical source, a source should be compact (small in dimension compared to a wavelength), in a free field (no reflecting surfaces other than the ground plane) and the ground should be a perfect reflector (no attenuation of sound energy). While these criteria are seldom perfectly met, most sources will "look like" a point source if you are far enough away ($>$ one wavelength, or twice the largest dimension of the source).

Procedure:

Find two noise sources around campus that approximate these conditions and measure how the SPL varies with distance. Set the SLM for "all pass" (no weighting filter), slow averaging. Calibrate your SLM with the pistonphone before **and after** taking all measurements. Record your data and observations on the attached data sheet.

- Calibrate your microphone
- Sketch the position of the machine relative to other obstacles around it.
- Record the background noise level (if it is possible to turn off the machine)
- Measure the SPL versus distance from the machine (in individual octave bands and overall level). A logarithmic distance scale is recommended (such as 1,2,4,8,16).
- Plot the SPL vs. distance for the overall level and at least three octave bands (63, 500, 4000 Hz for example). I recommend a spreadsheet program, like Excel for doing the plots. Use a logarithmic scale for range.
- At one (at least) measurement point, verify that the individual octave band levels add up to the overall measured sound level
- Comment on your results - if you did not observe a -6 dB/doubling behavior, explain why.

Suggested noise sources - a car horn, boom box tuned to static, tape player playing a pure tone, lawn mower, chain saw, portable power generator, etc.

Lab 1 – Hemispherical Divergence – Data Sheet

Date:	Time:
Team Members:	
Description of test:	
Weather conditions:	
Equipment used (include serial numbers):	
SLM settings: <i>Meter Range:</i> <i>Response:</i> Fast Slow <i>Weighting:</i> A C Lin	

Sketch of test layout:

Measured Divergence Data:

Range (ft)	Overall dBA	Overall dBLin	Octave Center Frequency - Hz				

Check of overall level at range= _____

Freq	32	64	125	250	500	1000	2000	4000	8000	dBA	dBLin
Ambient											
Machine running											

Summation of dB levels = _____ dBA _____ dBLinear

On your own:

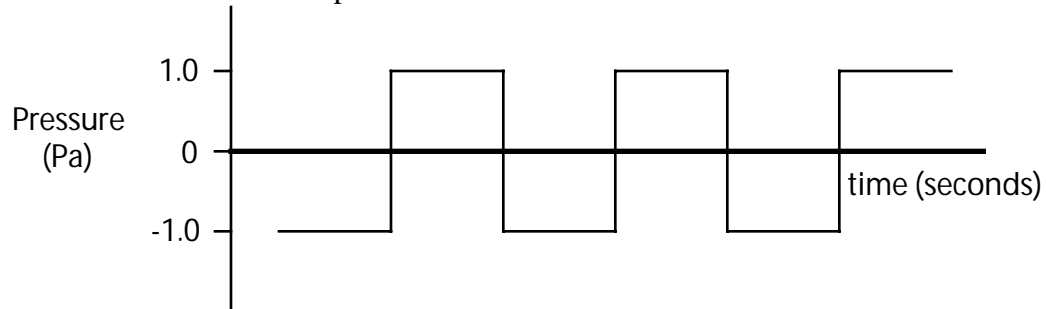
To get a feel for sound levels, take a SLM home and measure a variety of environments.

Description	dBA	dBLin

Reporting Requirements: Thoroughly document your test procedure, instrumentation, calculations, results, observations and conclusions in a full-length, professional quality report.

Homework Problem: (hand in separately)

Find the SPL in dB of a square wave by adding its spectral components. Is there another way to calculate the total SPL of this signal for verification? The fundamental frequency of the square wave is 60 Hz and its amplitude is 1 Pa.



Hint: the Fourier coefficients of a square wave are:

$$P(t) \approx \sum_{n=1}^{\infty} a_n \sin n\omega t$$

$$a_n = \frac{4}{n\pi} \quad \text{for } n = 1, 3, 5, \dots$$

$$a_n = 0 \quad \text{for } n = 2, 4, 6, \dots$$