

### LTSPICE AUDIO SIMULATION: A LOUDNESS CONTROL

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## EQUAL-LOUDNESS CONTOUR

Equal-loudness contour is a measure of sound pressure (dB SPL), over the frequency spectrum, for which the human ear perceive the same loudness when presented with pure steady tones (unit is the phon).



Contours of equal loudness (from the Radiotron Designers Handbook).

For more info . . .

http://www.sfu.ca/sonic-studio/handbook/Equal\_Loudness\_Contours.html

### A LOUDNESS CONTROL



A loudness control is used as an attempt to restore extreme low and high frequencies. As the sound level decreases, the ear becomes less sensitive to both extreme low and high frequencies. Thus, when listening at reduced levels, if the frequency response of your system is maintained flat, you will not hear those extremes as well.



### THE LOUDNESS CONTROL VS. EQUAL-LOUDNESS CONTOUR



Frequency response of the loudness control (simulation) is compared to the equal-loudness contour.



### Loudness Control vs. Flat Volume

PSpice PARAMETERS: RVOL = 500k VOL = 0.0245





#### LOUDNESS CONTROL





### Loudness Control vs. Flat Volume





LOUDNESS CONTROL RESPONSE

FLAT VOLUME RESPONSE





#### LTspice Simulation: .WAV IN/OUT Loudness Control



Loudness Control with .WAV input and output



Simulation result: input and output signal



#### LTspice Simulation: .WAV IN/OUT Flat Volume



Flat Volume with .WAV input and output



Simulation result: input and output signal



### WAV FILES LOCATION







Using audio signal (WAVE file) as an input voltage for LTSpice could be done by replace the voltage expression of the voltage source with a WAVE-file expression: wavefile="file location" chan=0 (as seen in the example below)



"chan" refers to the respective channel in the WAVE file used for the simulation, can be a number between 1 and 65535 – although usually channel 0 refer to the left channel and channel 1 refers to the right channel

A loudness control and its frequency response (example)

# USING WAVE FILE (.WAV) AS OUTPUT

Exporting an output signal as an audio signal (WAVE file) could be done by adding SPICE directive as: .wave="file location" 16 44100 Output (as seen in the example below)

.wave "C:\Program Files\LTC\LTspicelV\examples\WAV\out1.wav" 16 44100 Output

"16" refers to the bitrate, 44100 is the sampling frequency and Output is referring to a label in circuit.

A loudness control and its frequency response (example)





.wave "C:\Program Files\LTC\LTspiceMexamples\WAVlout3.wav" 16 44100 Output .tran 0 2 0





Simulation result: input and output signal



LTspice Simulation: music01.WAV IN/OUT Flat Volume



Flat Volume with music01.WAV input and output



Simulation result: input and output signal



### WAV FILES LOCATION



### **VIDEO DEMONSTRATION**



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