Audio loudness–or why commercials can be annoying

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Overview

You are sitting there quietly watching your favorite show on TV when all of a sudden the commercial comes on – BAM, WAM, BUY, BUY ... screams at you. The purpose of the commercial is to grab your attention in the few seconds of the spot. The recording engineers in the commercials production agency will turn up the sound levels into the red for maximum impact and effect to shake you out of your slumbers. However, the effect can be to intensely annoy the viewer who reaches for the channel change, or worse, calls the TV company to complain.

Audio loudness is one of the most common causes of complaints to broadcasters. So much so that it is being increasingly subjected to legislation in many countries including North America, UK, Europe and Australia. The US 'Commercial Advertisement Loudness Mitigation Act' (CALM) seeks to require the Federal Communications Commission to regulate the audio of commercials from being broadcast at louder volumes than the program material they accompany. The EBU in Europe have issued R128 loudness recommendations.

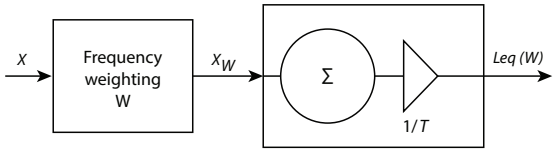
So how can broadcasters control the levels of commercials they receive so that loudness levels are consistent from program to commercial to trailer to program? They could play out every commercial and program, to subjectively listen to them, adjust or turn down the levels and re-encode the file, but this is usually impractical and loudness is not the same as levels.

The human ear perceives loudness as a combination of the sound pressure and the dynamics of the sound. Short sudden peaks of sound level sound much louder than the same high levels when heard continuously for longer periods. The sensitivity of the human ear changes as a function of frequency, so loudness is also related to the frequency of the sound. A volume control on a professional music amplifier will alter the frequency response with loudness level to correspond approximately with that of the response characteristics of the human ear.

Loudness is a combination of audio level, dynamics and frequency, and there are many variations of algorithms that seek to combine these to match the physiology of the human ear. A commonly used family of curves in audio loudness or noise measurement is known as A-weighting, relating to the measurement of sound pressure level.

Loudness is also relative to the surrounding ambient sound level or reference level. Someone speaking at normal levels in your room at home may be perfectly audible but speaking at the same level in the middle of a rock concert would be inaudible. Dolby uses a 'Dialog Norm' reference level in their AC3 audio compression which is a measure of the A-weighted average level of dialog within a presentation against a normal speaking level. It ranges in integer values from 31, where decoder gain remains at unity, to a value of 1, where decoder gain is reduced by 30 dB.

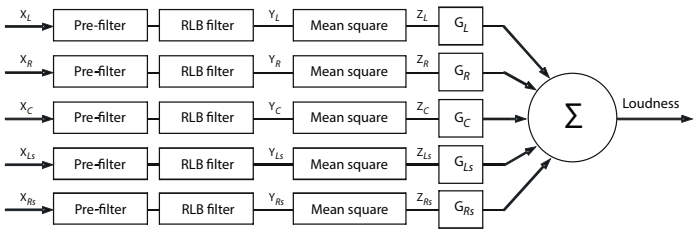
In the broadcast world ITU-R BS.1770 specifies 'Algorithms to measure audio program loudness and true-peak audio level' and aims to ensure that 'for the purpose of program exchange, it is essential to have a single recommended algorithm for objective estimation of subjective loudness'. It recommends the following Leq(RLB) measurement algorithm – where Leq(W) the frequency weighted sound level measure, Xw is the signal at the output of the weighting filter, XRef is the reference level, and T is the length of the audio sequence.



$$Leq\,(W) = 10\log_{10}\left[\frac{1}{T}\int_0^T \frac{x_W^2}{x_{Ref}^2}\,dt\right] \quad \text{dB}$$

Subjective testing was carried out by the Audio Perception Lab of the Communications Research Center, Canada, using program materials from television and radio broadcasts from around the world, as well as from CDs and DVDs. The sequences included music, television and movie dramas, sporting events, news broadcasts, sound effects and commericals. The reference signal used was a level of 60 dBA, a level found to be a typical listening level for television viewing in actual homes.

However this is for a single mono channel. In multi-channel loudness measurement, the loudness of each of the individual audio channels is measured independently by the Leq(RLB) algorithm before taking the mean square and summing them together. Pre-filtering is applied to each channel prior to the measure.



The weighting applied to each channel depends on the number and positioning of channels. Two channels of stereo can be combined with the same weighting, but with surround sound the different channels are weighted as follows:

Channel	Weighting, G_i
Left (G_L)	1.0 (0dB)
Right (G_R)	1.0 (0dB)
Centre (G_C)	1.0 (0dB)
Left surround (G_{Ls})	1.41 (~ +1.5 dB)
Right surround (G_{Rs})	1.41 (~ +1.5 dB)

So when Joe viewer calls to complain about the sound levels in the commercial, and the broadcast engineer checks the levels and says 'hey none of the channels ever exceeded –5 dBFS', there is more to it than just the peak levels that Joe was hearing as the loudness that awoke him from his slumbers.

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