Loudness control

— at the television playout stage

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This article on Loudness control – while representing the views of the author – is based on a discussion paper submitted to the 5th Meeting of EBU Project Group P/AGA (Advisory Group on Audio), held at BBC R&D in December 2003.

Viewer complaints about loud television commercials reach back at least 40 years in the UK and, in the USA, serious attempts were made to automatically control Loudness at CBS during the early 1970s. However, it was not until the advent of all-digital transmission chains that it actually became possible to accurately control broadcast audio signals. This was partly because the analogue levels along the signal chain varied to some extent, but especially because the signal processing (including simple equalization) that was frequently applied at different stages would have led to inconsistent Loudness measurements.

When the UK adopted NICAM sound and digital audio distribution in the late 1980s, Thames Television (in conjunction with the ITC) developed a Loudness control system which operated at the ingest stage. This installation was interrupted by the loss of their franchise in 1992, but there are some technical papers from that period to be found on www.bpr.org.uk. Nowadays all current DVB, digital satellite and cable systems provide an essentially transparent digital audio chain right through into the home, and consistent comparisons of Loudness can therefore be made at any point in that signal chain (and indeed across all the available channels). Unfortunately that is just what the viewers do as they zap between programme channels. The availability of radio channels on DVB and satellite sources appears to make the situation worse for television, as these radio stations tend to have well-controlled "themed" Loudness profiles.

A Loudness adapter

The ITU-R started working on a "question" about the measurement of programme Loudness in 2001. This appears to be the second time that this subject has been studied and, although some of the test material still exists, it has so far not been possible to find substantial conclusions from the first project (which took place in the study period from 1966 until 1969).

Meanwhile Broadcast Project Research (BPR Ltd) in the UK has set up a series of practical broadcast tests using Loudness "adapters". The key features of these adapters are:

- They produce a continuous 1 kHz tone at the measured Loudness level, so Loudness can be displayed on existing programme meters of any form.
- The readings are gated and held, allowing instant comparison of programme material whatever the silence-to-speech ratio.

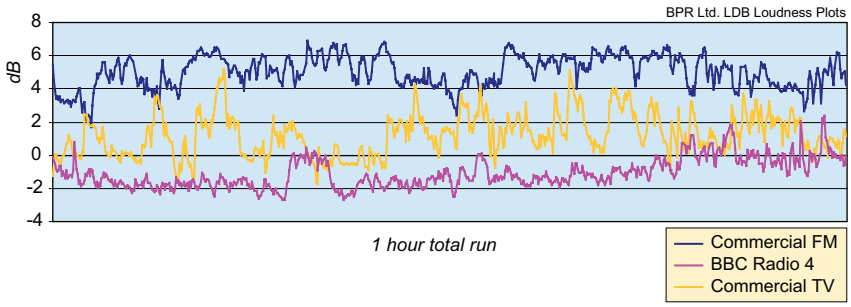
- Simple computer logging facilities allow long-term assessment of channel Loudness against multitudes of other sources.
- Gain controllers may be directly driven from the adapter.

The Loudness algorithm is incorporated in a plug-in card so that it can be up-dated if desired when a standard emerges.

The most important point about any algorithm is that, once standardized, the Loudness can be objectively quoted in the form of numerical "Leq" (Loudness equivalent) measurements in dB below digital Full-Scale Deflection (FSD). This will give an absolute fix to what were essentially comparative measurements in the past. Leq can be thought of as the level of 1 kHz tone below FSD that would produce the same sensory Loudness as the programme material. Leq should carry a suffix showing how the programme material was filtered; for example, Leq(A) involves the "A" weighting filter being applied to the programme material.

Loudness logging

Current software and hardware developments would suggest focusing on a simple 20+ channel-logging system, based around any basic PC. This will produce real-time charts and Excel spreadsheets such as the one illustrated here.



This chart shows a random hour of BBC Radio 4 programming, a commercial "pop" FM station, and a digital commercial TV drama with advertising breaks. The "Permitted Maximum Levels" of all three programmes are aligned – all three peaking to 6¼ on a BBC PPM (IEC type IIA)) – and the gated dialogue Loudness is shown in a Leq form, although the 0 on the dB scale has no special significance here.

Note the greater Loudness variance of the TV channel, compared to the "themed" and therefore relatively consistent values on the two radio channels.

Real-time controller

The controller output from the Loudness adapter could also serve the purpose of feeding a low-latency gain controller. This ideally would operate on the AES/EBU (or SDI embedded) signal feed, and experience so far indicates that it would only require a control range of some ±3dB for all reasonable broadcastable audio sources – *provided that the peak programme levels were not wildly out of specification*. This latter proviso has begun to show some significance lately, as digital "finished" material on CD and DVD is carefully optimized to come within a fraction of a dB of FSD, whilst broadcast material – because of its essential live nature – must conform to the ITU Permitted Maximum Level (the maximum modulation level for analogue transmitters), even in the all-digital transmission world.

Where to apply Control in the signal chain

So far, there has been some adverse comment from studio sound operators. This is likely to prove valid comment, as any form of Loudness constraint at the studio capture stage may be undesirable for three main reasons:

- It is not desirable during capture to use too much signal processing, as it cannot be undone at a later stage. Clean capture at the correct signal levels is therefore a most desirable aim at the studio stage.
- Different outlet channels will probably want to impose different Loudness "profiles" on the programme anyway.
- Changing the recording techniques and hence the artistic intentions of any existing show, would also create the practical problem of matching earlier episodes and archive material in the interim period.

Indeed it was these types of problems, arising during feature-film production, that led to the use of a "dialnorm" value being recorded in DVD metadata [1]. However, where audio material from different sources needs to be butted together (as is the case in any television channel), one consistent dialogue-based Loudness level should be considered desirable.

The next stage in the television programme chain at which Loudness control might be employed is dubbing. However, the following stage of programme ingest into a particular "Channel" would appear to be the best point to impress a Loudness "profile" to suit that particular Channel. Any later in the transmission stages, and the correction will have to be automated.

Loudness meter readings used as a "guide", rather than a statutory guideline, could however be considered at all stages of the production process, although objective and standardized descriptions will need to be established for purposes of comparison.

Current guidelines

Current UK guidelines are based on BBC PPM (IEC Type IIA) readings, using the recommendations outlined below:-

Material	Normal Peaks	Dynamic Range
Speech, Talks, News, Drama, Documentaries, Panel Games, Quiz Shows, Announcements.	5	1 - 6
Music, Variety, Dance Music	4.5	2 - 6
Brass Bands, Military Bands	4	2 - 5
Orchestral Concerts	6	1 - 6
Light Music	5.5	1 - 6
Pop Music	5	2 - 5
Programmes containing a high degree of compression	4	2 - 4
Commercials containing a high degree of compression	4	2 - 4

Notice that PPM 6¼ represents the ITU Permitted Maximum Level in the UK. The style of these material descriptors indicates that these guidelines were established at least 40 years ago. However, the method is still workable, given sufficient Quality Control staff and procedures. There is indeed only one implication in the fact that such a measured Loudness variation actually exists off-air and across all broadcast outlets today, and that is that these guidelines are not being followed to any great extent. Indeed, all the evidence points to them not being referred to, or used, for over a

1. In the cinema, dialnorm is never used: the programme Sound Pressure Level in the auditorium is traceable, and therefore reproduced as intended by the Film Director.

decade. For example, in the UK, both Radio 1 and Radio 2 (Pop and Light Music channels) appear to peak both music and dialogue to PPM 6¼ (M3, Sum signal or mono), whilst Radio 4 (speech) peaks to 6¼ both in acquisition and in transmission.

Similarly in Television post-production, if a commercial was supplied peaking to PPM 4, the chances are that it would be rejected by the broadcaster as having low audio levels or, if transmitted, the client would want to know why it was aired at so low a level. Pragmatically then, the safest approach in post-production has been to maintain audio peaking to PPM 6, regardless of content. Indeed, the subjective identification of "compression" within a programme or commercial remains a difficult decision, and certain well-known Radio "voices" possess a remarkable degree of natural compression, without any electronic processing being applied.

Summing up ...

- In all digital systems, Loudness guidelines can be based on an objective measurement such as Leq(?) with respect to the digital FSD.
- In practice, Loudness control needs to be linked with the general overall Quality Control (QC) of the audio signal levels. The measured levels of Loudness variation on one terrestrial bouquet of Radio and Television was an expected 6 dB, but the variation of Permitted Maximum Level found on the same bouquet was no less than 12 dB.
- An automated controller could assist both Loudness and Level issues (provided input levels are not too far out of normal). However, a human-based audio QC check at the ingest stage, assisted by a Loudness meter, would still appear to be the most desirable solution.

Other articles on this topic

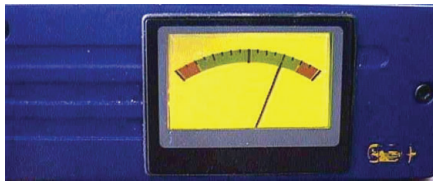
[1] Tony Spath: **Loudness and Dynamic Range in broadcast audio — the Dolby solution**
EBU Technical Review, No. 293, January 2003.

[2] John Emmett: **Audio levels — in the new world of digital systems**
EBU Technical Review, No. 293, January 2003.

[3] Gerhard Spikofski and Siegfried Klar: **Levelling and Loudness — in radio and television broadcasting**
EBU Technical Review, No. 297, January 2004.

Appendix: The "Aunt Sally" test adapter

- Fits in-line with analogue audio feeds to programme Level meter(s).
- Delivers a continuous 1 kHz tone output at the mean gated dialogue Loudness level – for instant Loudness display on any conventional programme meter.



- Backlit LCD meter displays Loudness on a simple ±4 dB scale, either in absolute Leq readings with respect to FSD, or against a locally set Leq “zero” reference.

Desirable features:

- Plug-in Loudness algorithm module.
- Gating for holding accurate level readings during periods of silence.
- CD-A and BWAV files of reference and test programmes.
- Simple low-cost logging software for multiple channels.
- Simple low-cost levelling gain controller to be driven directly.