Postprint: Application of Loudness Control Technology in the News Comprehensive Channel of Fuzhou Television Station

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Abstract

This article presents the application of loudness control technology in the broadcast control system of Fuzhou Radio and Television Station's News Comprehensive Channel, covering the necessity of loudness control, broadcast-end loudness control solutions, parameter settings of loudness controllers, and evaluation of usage effects.

Full Text

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Abstract: This paper introduces the application of loudness control technology in the broadcast control system of Fuzhou Radio and Television Station's News Comprehensive Channel, covering the necessity of loudness control, broadcast-end loudness control solutions, parameter settings for loudness controllers, and performance evaluation.

Keywords: loudness control; target loudness value; Multi-band; AGC (Automatic Gain Control)

1. Concept of Loudness

Loudness is a metric for measuring sound energy when electrical signals are converted into acoustic vibrations. It is essentially a measurement standard based on human perception of different sounds. Loudness depends not only on the amplitude of sound but also on its frequency. Sounds with the same sound

pressure level but different frequencies are perceived as having different loudness levels. The curve relationship derived from combining sound pressure, frequency, and human auditory perception is called the "equal-loudness contour," as shown in Figure 1 [Figure 1: see original paper].

2. Application Methods of Loudness Control Technology in Broadcasting

Loudness fluctuations can arise from various causes, including inconsistent equipment standards or failure to reference the GY/T 282-2014 standard during program recording and editing. Processing loudness at the broadcast end offers advantages because program materials are centralized, involving fewer departments and links, making it easier to achieve processing objectives. Based on where loudness control devices function within the broadcast chain, they can be categorized into real-time signal stream loudness control and non-real-time file-based loudness control.

2.1 Real-Time Signal Stream Loudness Control Equipment

Real-time signal stream loudness control processes the SDI signal from the PGM digital video distribution by de-embedding it, processing the extracted AES audio for loudness, and then re-embedding the digital AES audio back into the SDI stream. During processing, the audio gain is adjusted based on feedback from detectors measuring the audio loudness, maintaining loudness within a specified range. This approach typically alters the dynamic range of the audio sequence and affects sound quality, with the average output loudness not always perfectly matching the target value. These loudness controllers operate separately from the broadcast control system and feature power-fail bypass functionality. Their effectiveness depends on the dispersion of input loudness; improper parameter settings can degrade audio quality. Furthermore, when the difference between input audio signals and target loudness exceeds the device's correction range, broadcast loudness will still exceed standards. Additionally, since audio and video are processed separately in loudness controllers, special attention must be paid to audio-video synchronization.

2.2 Non-Real-Time File-Based Loudness Control Equipment

File-based loudness control standardizes the loudness of broadcast server materials through loudness servers and processing software. Materials from the ingest server are first migrated to the loudness server, where the software performs loudness scaling and dynamic range control on the audio, generating new audio and repackaging it into complete materials before migrating them to the broadcast server for playback. File-based loudness processing provides precise loudness alignment, particularly effective for controlling advertisement volumes, and can achieve accurate loudness range control through multi-pass processing. This approach is embedded within the broadcast control system as

part of pre-broadcast preparation, with strong dependence on the existing system. It can only process hard disk materials and cannot handle live broadcasts, relay signals, or video recorder sources. Critical considerations for broadcast safety and stability include: where to place file-based loudness control in the ingest-migration workflow, what material transcoding methods to adopt, how to implement consistent management, and what manual intervention strategies to employ for time-sensitive news emergency ingest materials that cannot undergo loudness processing. Therefore, a safe and reliable loudness processing protocol must be established.

3. Usage of Loudness Control Equipment in Our Station's News Comprehensive Channel

Before the high-definition upgrade of the news comprehensive channel, all channels at our station operated in standard definition using non-real-time file-based loudness control. This method was time-consuming, and when program delivery occurred close to broadcast time, the loudness processing step was often skipped, with materials being directly migrated to the broadcast server. Consequently, these materials were broadcast with their original loudness levels, leaving no adjustment possible at the broadcast end.

To avoid this issue during the channel's HD upgrade, we implemented a solution considering overall system cost-effectiveness, practical results, and safety redundancy. We installed one Linear Acoustic AERO.one loudness controller after each of the main and backup switchers in HD. The processed signals serve as HD output on one path, while the other path is converted for the SD switcher, enabling a single loudness controller to simultaneously process both HD and SD broadcast signals in real time. The main signal processing flow is illustrated in Figure 2 [Figure 2: see original paper].

4. Processing Methods and Parameter Settings of the AERO.one Loudness Controller

The AERO.one loudness controller employs Multi-band processing, dividing the audio into five frequency-crossover bands for dynamic processing before recombining them. This processing mode uses cutting-edge algorithms that deliver superior audio processing results, better preserving audio details that might otherwise be filtered out.

The frequency crossover distribution is as follows: - **Band 1 (Low Bass):** 20 Hz - 60 Hz - **Band 2 (Mid Bass):** 30 Hz - 200 Hz - **Band 3 (Low Mid):** 170 Hz - 1.15 kHz - **Band 4 (High Mid):** 950 Hz - 6.1 kHz - **Band 5 (Brilliance):** 5.2 kHz - 24 kHz

Parameter setting from scratch is extremely time-consuming, requiring extensive listening and debugging across massive amounts of material, including various types of news, talk shows, music, and TV dramas. Based on exten-

sive engineering practice, manufacturers have completed this work and provide several presets based on their listening experience and user feedback. According to our channel's program characteristics and with manufacturer assistance, we selected the preset broadly suitable for Chinese television programs: TV_{{{5B}}_{{AIR}}} – TV.

In accordance with the GY/T 282-2014 standard "Technical Requirements for Average Loudness and True-Peak Audio Level of Digital Television Programs," we set the target average loudness value for output programs at –24LKFS. The digital audio signal reference level is -20dBFS, the freeze value is set at -31dBFS, the operating level at -14dBFS, and the final limiter threshold at -8dBFS.

5. Performance Evaluation

Monitoring of processed programs revealed that for TV dramas, due to relatively standardized production, overall loudness control was good, with the loudness control equipment successfully maintaining loudness within the comfort zone. For in-house programs, although production standardization was lower than for dramas and overall loudness tended to be higher, the differences were generally not substantial, and loudness control processing could also maintain the loudness range within the comfort zone.

However, a small number of programs still exhibited sudden loudness changes, primarily occurring in commercials or advertisements embedded within in-house programs. Due to excessive loudness differences in these segments, even real-time loudness processing could not eliminate sudden volume changes, with loudness variations exceeding the comfort zone range.

Regarding the comfort zone, ITU-R BS.1864 recommends that the tolerable loudness variation for listeners is a "comfort zone" representing a "loudness window deviating from the ideal loudness by approximately +3 to -5 dB." Beyond this zone, viewers experience noticeable increases or decreases in volume.

6. Conclusion

The implementation of real-time loudness control equipment in our station's news HD channel aligns well with the channel's focus on live programs, news and political content, and time-sensitive material, significantly ensuring broadcast quality while reducing staff workload and achieving twice the result with half the effort. The ultimate goal of loudness control is to improve broadcast quality and enhance viewer experience, but this is not solely the responsibility of the broadcast department. Loudness control equipment represents only the final control measure in the program production and broadcast workflow and cannot completely improve broadcast audio quality. This approach also alters program dynamic range and affects audio quality. To fundamentally improve program loudness, coordinated efforts are required across both production and transmission ends with corresponding standards and specifications. At the pro-

duction end, whether in pre-recording or post-editing, generated programs must strictly maintain average loudness around -24LKFS. At the transmission end, since link gain is a primary cause of TV audio loudness variation in China, gain control in the transmission link is more urgent than loudness control in production and broadcasting. The goal for transmission link gain control is to achieve zero gain in the transmission chain.

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Note: Figure translations are in progress. See original paper for figures.