The Loudness Factbook

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1 Audio Measurement

Audio monitoring has been around for a relatively long period of time. The first dedicated instruments (volume meters) were first developed in 1940 in the United States and were held as the industry standard for many years. Simultaneously Peak Program Meters were developed in Europe as a more reliable method of measuring high volume peaks in audio.

In order to understand the processes by which audio is monitored and its 'loudness' perceived and measured the fundamental concepts of audio must be understood. An audio signal is an electronic representation of a sound wave comprising of qualities that allow a large range of sounds to be defined. These variables are voltage, current and power; the amplitudes of these variables dictating the nature of the signal in question. For example, a loud noise would have a large voltage and consequently have a large power value.

In order to quantify an audio signal to allow for comparison a simplistic universal scale has been adopted: the decibel scale. Due to the logarithmic nature in which the human ear operates it is natural to adopt a scale that mimicked this. This logarithmic scale allows the magnitude of audio signals to rate the voltage/power magnitude of the sound and nothing else. There are a number of traditional methods that have been used over the years to better quantify the level of sounds that an audio signal possesses.

1.1 Volume Meter (Volume Units)

The volume meter allows users to have a visual representation of the volume of a signal. The device features an analogue scale running from -20VU to +3VU with 0VU being the reference value. The needle moves up and down the scale according to the magnitude of the signal being received and has a rise time of 300ms. This relatively slow reaction time means that the meter can act more as a moving average, ignoring large peaks with very small duration. This is partly due to the mechanical inertia of the device and serves the purpose of making the meter easier to read, preventing the needle from moving too rapidly to be of any use.

However, this latency meant that the actual peaks of a signal could be anything between 6dB-12dB larger than the values displayed. Older equipment amplified the displayed signal to take account of this discrepancy – although as the volume meter has largely fallen out of use as a measurement device this modification has been removed. Volume meters today are most commonly used as level calibration devices.

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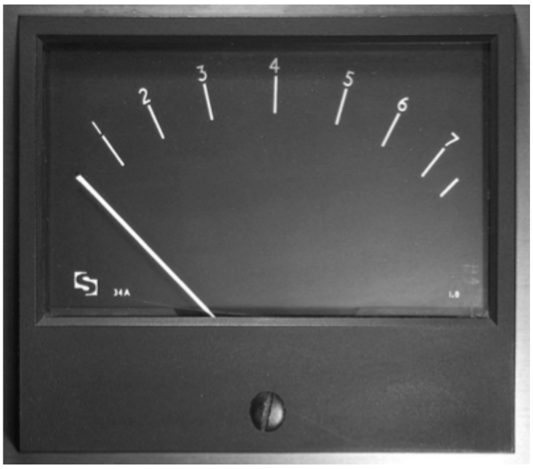
VU Meter: A needle based audio level display

1.2 Peak Program Meter (PPM)

The concept behind a peak program meter is fairly simple; a very short rise time and a slow fall time. This means that the meter will rapidly rise to show a peak value and then slowly fall, clearly displaying the peak value achieved. The PPM values are measured and displayed to both Type I Ballistics (used by DIN and Nordic Scales) and Type II Ballistics (used by BBC and EBU Scales). Often there is a minimum duration requirement for peaks, which means that short but loud sounds (such as a gunshot) do not register fully on the meter.



PPM: Traditional BBC scale running from 0-7 with an analogue needle

With the transition into digital signals the issue of sampling error has arisen. The true value of peaks can often be missed as the peak falls in between two samples taken and so the peak is not registered. This is resolved by using true-peak measurement whereby the signal is over-sampled by 4x. Both of these methods give an indication of how the volume of the signal will be perceived. However, they are not a very good indication of the 'loudness' of the sound. In order to quantify that a more complex approach is required.

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1.3 Measurement Monitoring Methods

The current industry measurement method to ensure quality control and compliance is to run the audio sample through a PPM meter and have an operator watch the resultant movement on the meter, ensuring that the levels do not exceed those permitted. This is both time-consuming and very inefficient with respect to man-hours. It is evident that in the digital age a new, more efficient method must be employed.

1.4 Software based Loudness Measurement, Compliance and Normalisation

Software based systems can exist which are designed to measure the loudness of file-based media. Additionally, the digital nature of such applications means that files can be analysed faster than in real time and the results can be displayed as a graph. Such applications could also allow for correction as well as measurement. Files that are too loud can be attenuated to meet the target loudness. There are instances where the file may be too loud or not loud enough, in which case, the file can be 'normalised' by applying an appropriate amount of attenuation or gain. Loudness normalisation has enormous applications in areas such as digitising archives or collating a large volume of audio files from different sources and automatically normalising them.

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2 Loudness

2.1 Why do we need to measure Loudness?

It is all very well being able to quantify the volume of a signal, however, what is important is how loud it is perceived to be. The human ears' perception of sound changes depending on a whole host of factors such as frequency, duration or the direction the sound is coming from. In addition, our interpretation of loudness is highly individual and circumstantial; a gunshot in a library would sound much louder than near a motorway during rush hour even though the actual volume of the audio signals could be comparable. Therefore it is necessary to have a quantifiable measurement that can relate to how loud a sound will be perceived.

2.2 How do we measure Loudness?

The International Telecommunications Union has set out a standard algorithm, defining a clear method of calculating loudness in ITU-R BS. 1770-1/2. This algorithm consists of a frequency weighting followed by a mean square calculation. The channels are given different channel weightings and then summed to give an overall loudness value. This allows for determination of loudness depending on the power carried by the signal, the signal length and several other factors. Loudness can be displayed on a scale where 1 loudness unit (LU) is comparable to 1dB.

There are a number of different methods of calculating loudness as well as different units for measurement, as defined by different regulation bodies; these will be described below. For example, the European Broadcast Union has its own specification (R128) that is based on the core algorithms defined in BS.1770-1/2.

2.3 How do we compensate for Loudness?

Once the appropriate algorithm has determined the loudness of the system, the signal can be altered to ensure that it is not too loud. The very best method is always to remix the sound track. Usually though, the source material is not available, and in any case remixing can be prohibitively expensive. So the next best method, in particular for small excursions from the target, is automated compliance adjustment. For example, if a signal has a peak loudness of -20LUFS it needs to be reduced by 3LU to comply to a target of -23LUFS. As a 1LU change is equivalent to a 1dB change we can reduce the whole signal by 3dB, and this will make it compliant.

2.4 What is Gating?

Some audio clips may have a prolonged period of silence or low volume sound, which can skew the loudness calculation, resulting in any sound in the clip being altered to be too loud. For example, a nature documentary may have long periods of silence where animals are shown. These extended quieter periods would lead to the loudness being calculated as quite

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low, so that gain would be applied to make the audio compliant. This risks making noisier sections of the soundtrack have an excessively high volume.

In order to combat this, a gating concept to filter out low volume sounds or silence was adopted within ITU BS.1770-2. This concept works in two stages: firstly using an absolute threshold of -70LKFS and secondly using a relative threshold that is 10LU below the absolute loudness calculation. The file is divided into 400ms sampling blocks each with a 75% overlap to the previous and following section in order to obtain the best sample of the audio signal. If the loudness of the sample block is below the absolute threshold of -70LKFS then it is discarded. The loudness of the remaining blocks is calculated and a relative threshold defined -10LU below this. Any blocks below this relative threshold are discarded and the loudness is calculated over the entire file.

2.5 True Peak

One of the drawbacks of using digital processing of an analogue signal is the loss of the true peak of a sample due to sampling errors. If a peak falls between two samples values, the true value of this peak will not be detected. In order to ensure that the correct peak values are sampled the signal is oversampled.

2.6 Loudness Range

The loudness range is a concept introduced by the EBU R128 that describes the difference between the loudest and quietest levels in the sample. This is calculated in 3 second overlapping blocks, using an absolute gate value of -70LUFS and a relative gate value of

-20LU. The loudness of the remaining blocks are then calculated, the loudness range being the difference between the loudness of the 95^{th} percentile and the 10^{th} percentile.

2.7 PPM Vs Loudness: Complications

Loudness gives the user a much better idea of how loud a sample will be perceived, although PPM is still widely used as a better recognised measure of sound. Measurements for loudness and PPM are closely related and it should be noted that changing one would alter the other, possibly causing it to be raised above its threshold value. Therefore it is vital that both measurements be considered when any file is fixed.

2.8 File based software applications for Audio Loudness Compliance and Normalisation

Audio loudness compliance and normalisation software should allow users to do just that – normalise audio files and ensure compliance with regulations. Software can also be used as an analysis tool, allowing users to view an overview of levels throughout the file. The implications in quality control and efficiency are profound; no longer does the sample have to be monitored in real time to ensure both compliance and lack of anomalies.

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Digitising archives is itself a very time-consuming process and can be made easier using a watch or drop folder workflow, which will automatically analyse files to set them to a predefined level and remove the possibility of wildly varying loudness between different files.

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3 Standards

3.1 The drive towards standards

Loudness standards are needed because commercials were frequently louder than material either side, and has become the leading source of consumer complaints. This issue has been long acknowledged and has resulted in legislation for loudness compliance. Standards are intrinsically required to provide a framework for such legislation.

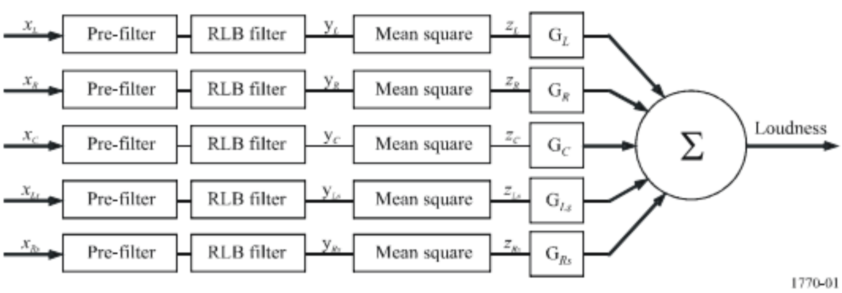
Many countries are adopting loudness standards voluntarily, where legislation is not in place or currently planned for. Suppliers of content to broadcasters now have to comply with this legislation. There can be heavy fines that may be imposed for non-compliance.

There are a number of standards that are used to calculate loudness. Although they all use a very similar algorithm, there are small discrepancies and requirements that cause them to differ.

3.2 ITU BS. 1770-1

Proposed by the International Telecommunications Union, this standard introduced the basic accepted algorithm used in loudness calculations. The algorithm consists of a frequency weighting followed by a mean square calculation. The channels are given a different channel weighting and then summed to give an overall loudness value.

Block diagram of multichannel loudness algorithm



This standard simply contains the algorithm rather than any recommendations as to what restrictions should be applied with regards to the loudness of a clip. No thresholds or sampling times are given.

The ITUR BS.1770-1 standard defines its units as LKFS or Loudness K weighted Full Scale, which is a loudness unit weighed with a 'K-filter' (pre weighting and RLB weighting value) with reference to the full scale. These are comparable to Loudness Units, and a 1 LKFS change is equivalent to a 1dB change.

3.3 ITU BS. 1770-2

This release adds to the 1770-1 documentation by proposing the gating principle described earlier; the algorithm remains unchanged. Note that neither 1770-1 nor 1770-2 give recommendations as to what levels should be adhered to.

The algorithm consists of -

- 'K' frequency weighting; mean square calculation for each channel;
- Channel-weighted summation (surround channels have larger weight, and the LFE channel is excluded);
- Gating of 400 ms blocks (overlapping by 75%), where two thresholds are used:
- The first at a low level;
- The second at a higher level, and relative to the level measured after application of the first threshold.

3.4 ITU BS. 1771

This document outlines requirements for a loudness meter. The standard introduces the concept of applying a reference offset to the base LKFS measurements, such that the target threshold has a value '0'. To differentiate this from the measurements defined in BS1770, the measurements taken when a reference offset is applied are measured in LU.

For example, if the target loudness using BS1770 were -18LKFS, then an offset of 18 would be applied, so the target loudness would therefore be 0LU. This is intended to make a real time meter easier to correctly read.

3.5 EBU R128

The European Broadcasting Union recommendation is that Program Loudness Range and Maximum True Peak Level shall be used to characterise an audio signal, and that the Program Loudness Level shall be normalised to a Target Level of -23.0 LUFS. The measurement includes a gating method as specified in ITU-R BS.1770-2.

A tolerance of +- 0.5 LU is included in the specification and this is designed to cover meter tolerances. Hence closed files should continue to target exactly -23.0 LUFS. A larger tolerance of +- 1LU is defined as being acceptable in Live environments only.

Although R128 builds upon BS1770-1/2/3, it should be noted that the measurement units are changed to LUFS (Loudness Units, Full Scale) to make the units more consistent with other standards.

R128 also specifies an absolute maximum True Peak measurement of -1 dBTP. Note that many use cases set a normal True Peak not to exceed -3 dBTP in typical use, whilst the higher level is the maximum permitted. Note that True Peak should be treated as a maximum **threshold** and is not a target.

EBU R128 includes the concept that some material in rare specific circumstances should have a Program Loudness level that is deliberately lower than -23 LUFS. Although the

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inclusion of metadata to indicate this is being discussed, currently this is not defined in any specifications, so the use of such material requires manual intervention.

EBU R128 is very clear that the entire duration of the content is measured to determine compliance, unlike some other specifications that permit measurement of dialog only.

3.6 EBU R128 – Tech 3342 – Loudness Range

This document specifies a Loudness Range measurement that may be used to supplement the main R128 measurements. Loudness range is, in essence, the range between the loudest and quietest sound in the sample. The algorithm calculates this in 3 second overlapping blocks, using an absolute gate value of -70LUFS and a relative gate value of -20LU. The loudness of the remaining blocks is then calculated - the loudness range being the difference between the loudness of the 95^{th} percentile and the 10^{th} percentile.

3.7 EBU R128 – Tech 3341 – EBU Mode

This supplementary document includes EBU definitions of the time scales used when using the EBU methodology, known as 'EBU mode'. These are:

- Momentary loudness (M): using a small time window of 0.4s. This measurement is not gated.
- Short-term loudness (S): using a time window of 3s. This measurement is not gated.
- Integrated loudness (I): operates over the total time of the sample and is gated.

3.8 R128S1

Supplementary standard R128 S1 (version 2.0) was published in January 2016, and specifies a special set of loudness parameters for short form content. This version puts emphasis on the use of maximum Short Term Loudness, and no longer specifies a maximum Momentary loudness as had been previously described.

The term 'Short Form' is defined to mean content up to two minutes in duration, although is considered to be typically up to 30 seconds.

The maximum permitted Short Term Loudness level is -18 LUFS.

R128 S1 continues to specify an absolute maximum True Peak of -1 dBTP.

Loudness range is not used for short form content.

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3.9 ATSC A/85

This is the standard as defined by the Advanced Television Systems Committee in the United States. Based on the ITU R BS.1770-1, it differs to ITU specifications, which do not specify any threshold by actually defining a threshold of -24LKFS.

ATSC A/85 was defined whilst BS.1770-2 was in draft form, and so does not make any requirement for gating, although it recognises that gating may be applied without breaching the standard's recommendations.

3.10 ARIB TR – B32

This is the standard as defined by the Association of Radio Industry and Businesses in Japan.

Similar to the US ATSC A/85 standard it is based on the original ITU R BS.1770 recommendations, though, unlike ATSC A/85, the ARIB TR-B32 standard is based around ITU R BS.1770-2 so does take gating into account.

The Loudness threshold is defined as -24LKFS – the same as the US ATSC A/85 standard.

Gating settings: absolute gate at -70LKFS, relative gate at -10LU and 400ms sample blocks.

3.11 OP – 59

Operational Practice OP-59 is the published recommendation of FreeTV Australia (FTVA), the country's industry body, representing free-to-air television broadcasters for the Measurement and Management of Loudness in Soundtracks for Television Broadcasting.

OP-59 recommends that television programs not employing metadata (AC3/Dolby Digital) be normalized to -24 LKFS as measured with the ITU-R BS.1770 algorithm.

OP-59 does not specify gating, making references only to ITU R BS.1770. Similar to the US ATSC A/85 standard, gating may be applied without breaching the scope of the principle recommendations.

3.12 Leq (A)

Leq(A) is a method of measuring loudness that predates the current ITU defined method.

The Leq(A) metering algorithm is essentially an A-weighted average of the audio signal. The A-weighting takes into account the changing sensitivity of the human ear as a function of audio frequency.

Leq(A) was considered useful for matching speech levels across different tracks. However as EBU R128 is increasingly being adopted very widely, and the use of Leq(A) is now significantly diminishing.

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3.13 DPP (Digital Production Partnership)

Within the UK, the DPP have defined an audio broadcast standard based upon EBU R128. Version 4.3 of their specification, published in 2014, defines that audio should be measured to R128, with Program Loudness to be targeted as -23.0 LUFS, with a metering tolerance of +- 0.5 LU for non live content, and with a tolerance of +- 1 LU for live content. The maximum recommended True Peak is -3 dBTP, but the absolute maximum permitted True Peak is -1 dBTP.

The Loudness Range for DPP compliant content should not typically exceed 18 LU, although a wider range is permitted where required for creative reasons.

To help ensure clarity of dialog within factual programmes, then the Loudness Range should not exceed 6 LU for speech content.

The DPP specification permits the broadcast of intentionally quiet material, that is, where the content has been deliberately mixed to a level lower than -23 LUFS and where it would be inappropriate to increase the level up to -23 LUFS. The use of intentionally quiet material requires manual processing and discussion between supplier and broadcast so that it is not inadvertently altered.

3.14 DPP – HD Promotions

In July 2016, the DPP published delivery specifications for HD Promotions content. To their main specification this adds a requirement that the content has a Short Term loudness not exceeding -18 LUFS.

3.15 DPP – HD Commericals

In July 2016 the DPP also published delivery specifications for HD Commercials. The audio loudness and true peak requirements are identical to that for HD Promotions.

3.16 Korea

Within Korea there is a modified requirement for Loudness processing. The targets and thresholds follow BS1770, but the standard includes continuous data logging as part of compliance.

4 The need for Loudness Tools

Loudness has gained significance as a major issue, with increasing complaints from consumers, and has long become accepted as a problem that needs to be addressed. The emergence of loudness standards both legislated and voluntary has in turn driven the need for effective loudness tools.

Suppliers of content to broadcasters now have to comply with these legislated or voluntary standards. There are heavy fines that can be imposed for non-compliance.

This has generated an urgent requirement for cost effective, digitized products for the attenuation and normalization of audio.

What should a Loudness Tool do?

4.1 Measurement

First of all any loudness compliance tool must be measured to see whether or not it complies. But complies with what?

Broadcasters are incorporating loudness compliance in their delivery specifications. Every Broadcaster bases the delivery specification around locally required standards. Note that standards continue to develop, and, as an example, short form content that complied with R128 may not comply with the newer R128S1.

There are additional challenges to international content providers to provide deliverables not just to standards, but also national variance within the application of those standards.

Any tool should therefore have the flexibility to create custom profiles based around the required standards.

4.2 Reporting

It is frequently useful to generate a report, which shows the measurements and attributes of the content.

The report should be either or both of:

a) A written detailed report defining metrics for the specific file

b) A graphical representation for the specific file

4.3 Correction

As well as measurement it is desirable for the compliance tool to correct the detected errors.

Industry feedback suggests that:

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- Fixing should be strictly attenuation or normalisation. The audio fixing process must maintain the integrity of the original mix.

- The fixing or processing of audio essence embedded within video files must NOT affect the integrity of the video or metadata essence.

- We should consider delays in start of real essence (tone & bars, black & silence) and duration.

The requirement is to be able to analyse the audio, check for compliance and attenuate/normalise without any degradation of audio quality, and where audio is embedded within a video source signal or file, video is in no way degraded.

4.4 Operational Considerations

- Measurements and corrections must be unimpeachable and beyond doubt.

- Tools must be as simple to use as possible.

- There should be 'low touch' minimal human interaction.

- There should be fast processing per file.

- It should be capable of 'watch folder' operation for high volume workflows or API integration.

- Pricing should be accessible enough to ensure universal adoption within Production, Post-Production and Broadcast facilities.

4.5 Environment

Loudness QC is required at each and every stage from Production, Audio and Video Post Production to Broadcast playout. Each stage needs to be confident that generated, received and delivered audio files are compliant with loudness standards, and further that the loudness standard is appropriate to both domestic and international client requirements. These requirements are becoming increasingly driven by legislative statute in individual countries.

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5 Glossary of terms

ARIB TR-B32

The standard as defined by the Association of Radio Industry and Businesses in Japan. It uses the BS.1770-2 algorithm and defines a threshold of -24LKFS.

ATSC A/85

This is the standard as defined by the Advanced Television Systems Committee in the United States.

Using the algorithm defined in BS.1770-1, it defines a threshold of -24LKFS. It was implemented due to the introduction of the C.A.L.M act in 2010, which aimed at regulating the loudness of advertisements in broadcasting.

BBC PPM

Used primarily within the UK this scale ranges from 0 to 7, with a traditional threshold of 6. It is important to note that each BBC unit represents 4dB. BBC PPM uses type II ballistics.

dB

The decibel is commonly used in acoustics to quantify sound levels relative to a 0dB reference, which has been defined as a sound pressure level of 0.0002 microbar or 20 micropascals.

dBu

This is an absolute measurement of analogue sound, with 0dBu being 0.775V.

BFS

This is an absolute unit used to describe a sample level in a digital domain. This sets the value of 0 as the highest level in the sample and all other values are referenced to this 0 value.

DIN PPM

This scale runs parallel to the dB scale, with 1 unit being equal to 1dB. However, it has its reference value at 6dBu and runs from +5 to -50. This meter uses type I ballistics to display the signal.

EBU Mode

A dedicated mode that loudness meters can operate in - it defines the maximum loudness as -23LUFS. EBU meters can operate with two scales, either the EBU +9 scale or the EBU +18 scale. EBU mode defines sampling timescales for: Momentary loudness – 400ms ungated; Short term loudness – 3s ungated and Integrated loudness, which operates over the entire length of the sample and is gated.

EBU +9 Scale

An EBU defined scale running from +9LU to -18LU. The loudness threshold is defined as 0LU. This scale is primarily used as a default by meters operating in EBU mode.

EBU +18 Scale

An alternative to the +9 scale running from +18LU to -36LU, with 0LU being the loudness threshold. This is an alternative scale used by EBU meters.

EBU PPM

A scale defined by the European Broadcasting Union for use within the European Union. This scale runs between -12 and +12dB. This meter uses type II Ballistics.

EBU R128

An audio guideline defined by the European Broadcast Union using the loudness algorithm defined in ITU-BS1770. It defines levels of Program Loudness, Loudness Range and Maximum True Peak used to characterise an audio signal. It uses LUFS (Loudness Unit, Full Scale) as its measurement scale

The EBU also introduces the concept of a loudness range, which describes the range between the loudest and quietest sound in the sample. It also defines sample timescales used (EBU mode) –Momentary, Short term and Integrated loudness - which operate over the total time of the sample.

Gated Loudness

A gating concept to filter out low volume sounds or silence was adopted within ITU BS.1770-2. This concept works in two stages: First, the file is divided into 400ms blocks with a 75% overlap. The loudness of each block is calculated, and if loudness is less than -70LKFS then it is discarded. A relative threshold is calculated using the remaining blocks. It is defined as -10LU (relative gate) below the overall loudness of the non-discarded blocks. Secondly, if the loudness is less than the relative threshold it is discarded. The overall loudness of the remaining blocks is then discarded.

Intentionally Quiet

The term 'Intentionally Quiet' material is often used to refer to content that has been deliberately mixed to have a loudness level noticeably lower than the -23 LUFS defined in EBU R128, or in the DPP specification. If a soundtrack consists only of gentle atmospheric recordings, it may be completely inappropriate to increase the level of the audio up to -23 LUFS. Specification documents now mean that such material can remain at the original low level, but normally a manual discussion and process must be instigated with the Broadcaster to permit this.

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ITU R BS.1770-1

Proposed by the International Telecommunications Union, this standard introduced the basic accepted algorithm used in loudness calculations. The algorithm allows for calculation of loudness for a variable time period and can display a real time value for loudness. This standard simply contains the algorithm rather than any recommendations as to what restrictions should be applied with regards to the loudness of a clip.

This standard defines its units as LKFS or Loudness K weighted Full Scale which is a loudness unit weighted with a 'K-filter' (pre weighting and RLB weighting value) with reference to the full scale. These are comparable to Loudness Units - a 1 LU change is equivalent to a 1dB change.

ITU R BS.1770-2

This release adds to the 1770-1 documentation by proposing the gating principle described earlier; the algorithm remains unchanged although the concept of gated loudness has been introduced. Note that neither 1770-1 nor 1770-2 give recommendations as to what levels should be adhered to.

ITU R BS.1771

This document outlines requirements for a loudness meter. The standard introduces the concept of applying a reference offset to the base LKFS measurements, such that the target threshold has a value '0'. To differentiate this from the measurements defined in BS1770, the measurements taken when a reference offset is applied are measured in LU. For example, if the target loudness using BS1770 were -18 LKFS, then an offset of 18 would be applied, so the target loudness would therefore be 0LU. This is intended to make a real time meter easier to read accurately.

K-Weighting

A frequency weighted system that assists in modelling loudness. Using K weighting, low frequencies are assigned a lower importance in their contribution to the loudness calculation than high frequencies. The cut-off between low and high frequencies approximately 1 KHz.

LEQ

This is a method of measuring loudness that predates the current ITU defined method. Although rendered obsolete by the new BS.1770 algorithm, LEQ remains in-use in the industry.

LKFS

LKFS or Loudness K weighted Full Scale is a loudness unit weighted with a 'K-filter' (pre weighting and RLB weighting value) with reference to the full scale. These are comparable to Loudness Units and a 1 LKFS change is equivalent to a 1dB change.

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Loudness

Loudness is the perceptual property of sound. Several physical and psychological factors contribute to the sensation of loudness such as frequency, relative levels within a sample and various individual variables. The need to measure loudness has originated from increasingly contentious issues that have arisen as broadcasting moves into a digital age. One such example of where loudness monitoring is highly applicable is the advertising sector. Techniques can be used to make a clip appear to be within limits when in reality, the advert is perceived as very loud. This is used in order to grab the attention of the audience due to the sudden increase in volume. In addition to the globalisation of the broadcast industry audio files are imported from a variety of locations and companies, each with their own methods of volume control which means that standardising loudness levels for large numbers of files is necessary.

Loudness Range

Loudness Range (LRA) is based on BS.1770 and is defined in EBU R128. Loudness Range is measured in LU and measures the difference between the loudest and quietest parts of a sample. This is done by measuring the loudness of each section of the file (defined by the integration time) and ordering these values sequentially. The loudness range is then defined as the range between the 95th and 10th percentiles.

LU

Loudness units (on a relative scale). 1LU is equivalent to 1dB. The scale runs from either +9LU to -18LU or -18LU to -36LU. This is used by meters running in EBU Mode.

LUFS

Abbreviation of Loudness Unit, Full Scale. A unit of loudness on an absolute scale. 1 LU is equivalent to 1dB.

Momentary Loudness(EBU)

An EBU R128 defined term for loudness calculated using the BS1770-1/2 algorithm with an integration of 400ms.

Nordic PPM

This scale is used by the various Nordic broadcasters and has a range than runs from -36 to +12. This method uses type I ballistics and has units equivalent to the dB scale.

Peak Program Meter

A more advanced method of measuring the intensity of a signal. The needle on the analogue display rises to the maximum value and then falls back to the reference value. This meter is characterised by a fast rise and slow fall (integration) time helping the meter show a more average value for the sample. The integration times used depend on the type of ballistics used in the meter. The scales displayed are logarithmic in nature to mimic the human

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perception of sound, as is the decay, helping the meters display peaks better. Some meters have a maximum value needle, which is dynamically set to the highest value achieved. PPMs have a number of different scales depending on where they are employed. These are BBC, EBU, Nordic, DIN and dBFS. PPMs are used to give a real time visual representation of the audio levels in a sample. A digital analysis can be made of an audio sample in digital format to give a graphical representation of the levels over the entire sample. See the various scales for examples of these graphs.

True Peak

An absolute measure used to describe the true-peak level of a digital signal. The true-peak level of a digital signal may be 3 or more dB higher than the sample peak level of the same signal. Contrary to sample-peak level, true peak is a valuable estimate of the headroom required to handle a signal without clipping. True peak is achieved by using a minimum of 4x oversampling for a 48kHz* tone to reduce the error during signal reconstruction.

Type I/II Ballistics

These are classes of meters defined by the IEC (International Electrotechnical Commission) including DIN and Nordic variants for type I, and BBC PPM and EBU for type II. The only difference between type I and type II is the rise and fall times.

Short-term Loudness

Defined by the EBU as a loudness calculation using the BS1770-1/2 algorithm with a fixed integration time of 3s.

Volume Meter

The original method of measuring the volume of a signal. An analogue needle moves up and down the scale (ranging from -20VU to +3VU) depending on the intensity of the signal.

* Note: four times oversampling as referenced in B.S.1770 for 48khz

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