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# LM5 & LM5D

LOUDNESS RADAR METERS

**t.c. electronic**<sup>®</sup>

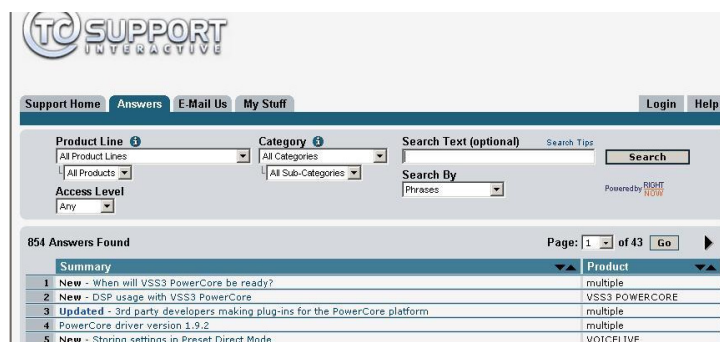
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# INTRODUCTION

## LM5 and LM5D Radar Loudness Meter

LM5 represents a quantum leap away from simply measuring audio level to measuring perceived loudness. The old level method is responsible for unacceptable level jumps in television, for music CDs getting increasingly distorted, and for different audio formats and program genres becoming incompatible: Pristine music tracks from the past don't co-exist with new recordings, TV commercials don't fit drama, classical music or film and broadcast doesn't match. The most fundamental audio issue of all – control of loudness – every day makes millions of people adjust the volume control over and over again.

LM5 is part of a universal and ITU standardized loudness control concept, whereby audio may easily and consistently be measured and controlled at various stages of production and distribution.

LM5 works coherently together with other TC equipment, or with equipment of other brands adhering to the same global standard. Follow the guidelines given to allow audio produced for different purposes to be mixed, without low dynamic range material such as commercials or pop CD's always emerging the loudest.

## FEATURES

- Realtime loudness meter adhering to ITU-R BS.1770.
- Loudness History Radar display.
- True-peak Bargraph display.
- Universal Descriptors (LM5D)
- Supports mono, stereo and 5.1.
- Presets for use in Broadcast, Music, Post and Film.

## SYSTEM REQUIREMENTS

- Mac OS X (10.4 or higher) / Windows XP
- Pro Tools TDM 7.2 software (or higher)
- Pro Tools HD or HD Accel hardware
- iLok USB key
- iLok.com account and internet access required for product authorization
- System must meet Digidesign's system requirements for Pro Tools TDM systems!

Since 1998, TC has performed listening tests and evaluation of loudness models; and therefore holds an extensive, Universal Database of loudness, based on ten thousands of assessments. The database covers all sorts of broadcast material, music, commercials, feature film and experimental sounds, and is verified against other independent studies.

The Universal Database is authoritative from an academic as well as a practical point of view. It has been indispensable when designing the LM5 meter, because it provided the missing link between short-term and long-term loudness, and enabled the statistically founded Universal Descriptors of LM5D.

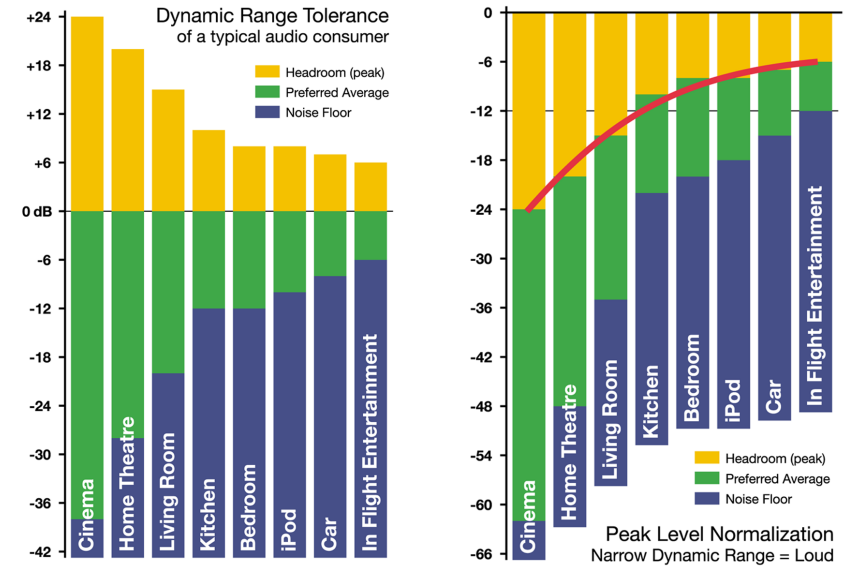


Fig 1. Left: DRT for consumers under different listening situations

Right: Peak level normalization means that material targeted low dynamic range platforms gets loud.

The chart of Dynamic Range Tolerance in Fig 1 is a side-effect of the studies mentioned: Consumers were found to have a distinct Dynamic Range Tolerance (DRT) specific to their listening environment. The DRT is defined as a Preferred Average window with a certain peak level Headroom above it. The average sound pressure level, which obviously is different from one listening condition to another, has to be kept within certain boundaries in order to maintain speech intelligibility, and to avoid music or effects from getting annoyingly loud or soft.

Audio engineers instinctively target a certain DRT profile when mixing, but because level normalization in broadcast and music production is based on peak level measures, low dynamic range signatures end up the loudest as shown by the red line in Fig 1, right. Audio production is therefore trapped in a downwards spiral, going for

ever decreasing dynamic range. By now, the pop music industry is “right of” In Flight Entertainment in the illustration.

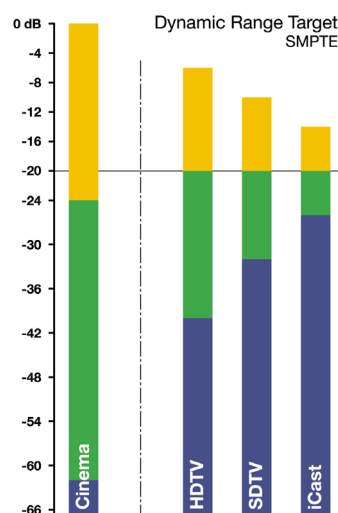
LM5 offers a standardized option: The visualization of loudness history and DRT in combination with long-term descriptors from production onwards, is a transparent and well sounding alternative to our current peak level obsession. Not only for music, but also in production for broadcast or film. The engineer, who may not be an audio expert, should be able to identify and consciously work with loudness developments within the limits of a target distribution platform, and with predictable results when the program is transcoded to another platform.

LM5 therefore color codes loudness so it's easy to identify target level (green), below the noise floor level (blue), or loud events (yellow), see Fig 2.

*Fig 2, Color coding and target loudness for selected broadcast platforms based on a consumer's Dynamic Range Tolerance, DRT.*

*The aim is to center dynamic range restriction around average loudness, in this case the -20 dB line, thereby automatically avoiding to wash out differences between foreground and background elements of a mix.*

*Note how different the broadcast requirements are from those of Cinema.*



When production engineers realize the boundaries they should generally stay within, less dynamics processing is automatically needed during distribution, and the requirement for maintaining time-consuming metadata at a broadcast station is minimized. In broadcast, the goal is to use the same loudness measure for

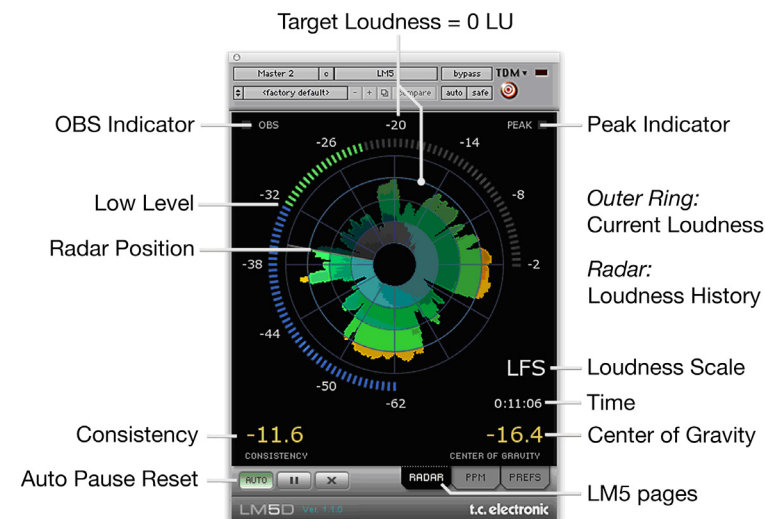
- Production,
- Ingest,
- Linking
- Master Control Processing
- Logging

thereby ensuring better audio quality not only in DTV audio, but across all broadcast platforms. LM5 and TC processing can co-exist with PPM meters, VU meters or Dolby's LM100 meter. LM5 greatly increases the usability of LM100 in production environments because it provides running status, and gives a standardized indication of both dialog and non-dialog program.

## BASIC USE

LM5 makes use of a unique way of visualizing short-term loudness, loudness history, and long-term statistical descriptors (LM5D only). It may be used with mono, stereo and 5.1 material for any type of program material.

Press the “Radar” key to bring up the Radar page. This page will probably be used most of the time. The basic functionality of the Radar page is shown in Fig 3.



*Fig 3, Radar page features of LM5D.*

*Target Loudness is displayed at 12 o'clock of the outer ring, and at the bold, concentric circle of the radar. The Universal Descriptors, Consistency and Center of Gravity (LM5D only), are the yellow numbers in the lower part of the display. Press the “X” key to reset Radar and Descriptors.*

The “Transport Controls”, Auto, Pause and Reset, are used to make the radar and descriptor measurements run, pause and reset. When “Auto” is pressed, run (green) and pause (yellow) follows the ProTools transports.

Press the “PPM” key to bring up the PPM page as shown in Fig 6. The PPM display is used to inspect balance between channels, overload of channels etc.

Press the “Prefs” key to bring up the Preferences display as shown in Fig 8. Note that you can “zoom” in time or radar resolution, as long as the history is not reset. For instance, change between 4 min per revolution to 1 hour per revolution, or 6 dB per division to 10 dB per division.

Presets can be stored specifying target loudness, noise floor, overload conditions etc.

## RADAR PAGE

### Current Loudness: Outer Ring

The outer ring of the Radar page displays current loudness. The 0 LU point (i.e. Target Loudness) is at 12 o'clock, and marked by the border between green and yellow, while the Low Level point is marked by the border between green and blue. The "0 LU Equals" and "Low Level Below" parameters are found on Prefs page. For instance, if 0 LU is set at -20 LFS, and Low Level is set at -12 LU, the color coding of Fig 3 applies.

The user should be instructed to keep the outer ring in the green area, and around 12 o'clock on the average. Excursions into the blue or the yellow area should be balanced, and not only go in one direction.

The numbers associated with the outer ring may be referenced at either maximum loudness, or have a zero point set somewhere mid-scale. Choose "LFS" or "LU" at the Loudness Scale selection on the Prefs page depending on your preference. Either way of looking at loudness is valid. LFS reading is in line with how peak level is typically measured in a digital system, and with Dolby LM100, while the LU approach calls for a certain Target Loudness to have been predetermined, like e.g. a VU meter.

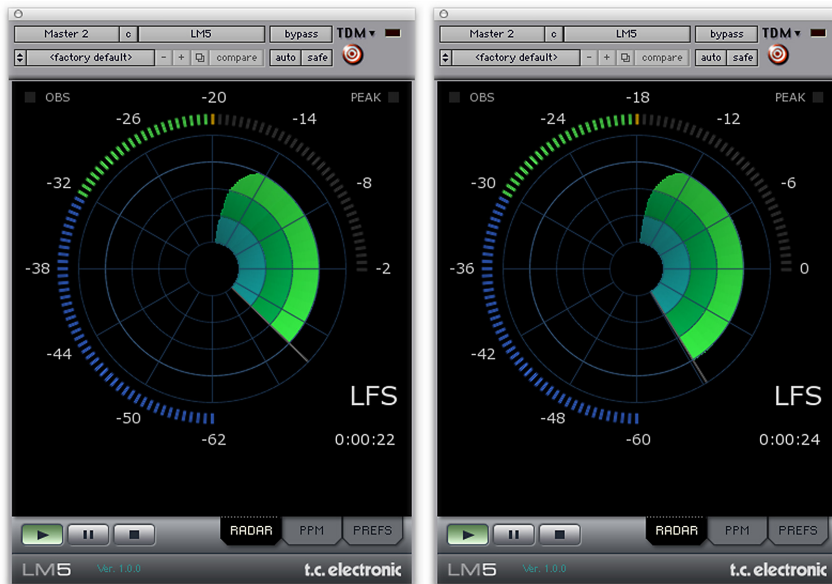


Fig 4, Radar page displaying calibration tones.

Left meter: Standard NAB preset. 1 kHz, stereo sine at -20 dBFS.

Right meter: Standard EBU preset. 1 kHz, stereo sine at -18 dBFS.

## LOUDNESS HISTORY: RADAR

The Loudness Radar shows a history of loudness over time. The loudness "landscape" may be used to judge if loudness emphasis is put where you want it to be: If dialog segments are balanced against action parts, if the chorus of a song has a lift against the verse, if the audience is too loud in a gameshow, or maybe as a target to aim for during a live transition etc.



Fig 5, Different types of program shown on the Radar.

Left: 5.1 movie:

Pirates of the Caribbean on a 12 minute per revolution Radar: Low Consistency.

Center:

German news broadcast on a 4 minute per revolution Radar: Medium Consistency.

Right:

Madonna's Hung Up pop on a one minute per resolution Radar: High Consistency.

The duration of one radar revolution may be set between 1 minute and 24 hours. The Radar has 3, 4, 6, 8, 10 or 12 dB between each concentric circle, while the 0 LU point is always marked as the border between green and yellow at the bold concentric circle, see Fig 3. The 0 LU point is set on the Prefs page, typically between -12 and -24 LFS.

The "Transport Controls" (lower left on the display) are used to make the Radar run, pause or reset. Note that these controls in LM5D appear as shown in Fig 3.

The OBS indicator is lit to show certain inter-channel anomalies. Such conditions may be defined on the Prefs page. The OBS indicator would typically trigger the operator to switch to PPM page for a closer look of what's going on.

The Peak indicator is lit to show that at least one channel is exceeding its true-peak max. The threshold of the Peak Indicator is defined on the Prefs page, and recalled with an LM5 preset.



## Universal Descriptors (LM5D only)

Additional to the short-term loudness (outer ring) and loudness history (radar), LM5D displays long-term statistical descriptors that describe an entire program, film or music track. Unlike concepts that measure only dialog, LM5D may measure any type of audio.

Center of Gravity (CoG) indicates the average loudness of a program, and is directly operational. If, for instance, a broadcast station is operated at an average loudness level of -22 LFS, and a commercial has its Center of Gravity measured at -19.5 LFS, the program should be attenuated by 2.5 dB before transmission for a best fit.

Consistency indicates the loudness variations inside a program. At one extreme, a steady tone displays a Consistency of 0.0 LU. Broadcast programming typically comes out with a Consistency between -2 and -5 LU, while classical music or a feature film can show more negative readings, for instance a Consistency of -10 LU or lower. The number predicts how much loudness correction in LU (cut and boost) is needed to have a program or music track played without frequent loudness variations.

Center of Gravity ranges from -80 LFS to +12 LFS, while Consistency ranges from -40 to 0 LU. Examples of typical Consistency / CoG values:

Cinema movie: -6 to -15 LU / -22 to -30 LFS

Classical music on CD: -5 to -12 LU / -15 to -30 LFS

Broadcast: -2 to -5 LU / -18 to -24 LFS

Commercials: -0.5 to -2 LU / -15 to -22 LFS

Pre 1995 pop/rock CD: -1.5 to -5 LU / -14 to -20 LFS

Hyper-compressed pop/rock CD: -1 to -3 LU / -5 to -8 LFS

Note: If you're involved with music mastering, please observe that you enter red light district for CoG values closer to zero than -12 LFS, and that you're well inside that zone if you pass the -10 LFS mark. Everything you do to make music even louder will end up getting counteracted in iTunes or at the broadcast station – but the distortion you add to go higher will remain.

The same warning may be given for TV commercial production. Don't aim at max values, but allow Consistency to go down a bit to let the program breathe. Look at the radar to put audio focus where you want it to be. When loudness gets normalized, that's what will give your message attention.

Universal Descriptors are rooted in Leq(K) as referenced in ITU-R BS.1770, and have been designed for robustness against moderate gain offsets around normal broadcast operating levels. If a program exhibits a Consistency of -3.5 LU, and the gain is offset by 10 dB, its Center of Gravity reading is shifted by 10 dB, while Consistency remains unchanged. Please find more information about Universal Descriptors in the Tech Library of the TC website.

## Long-term measurements (LM5D only)

Universal descriptors may be used to make program-duration measurements, or you may "spot-check" regular dialog or individual scenes as required. It is recommended

not to measure programs of a shorter duration than approximately 10 seconds, while the maximum duration may be 24 hours or longer.

Before a new measurement, press the "X" (Reset) key. This resets the descriptors, the radar and the true-peak meters. Run the audio, and watch the radar and descriptor fields update accordingly. It is normal that the descriptors wait five seconds into the program before showing the first readings, while the radar updates instantly. The first five seconds of a program are included in the descriptor calculations, even though they are not shown instantly.

LM5D incorporates an intelligent gate, which discriminates between foreground and background material of a program. Consequently, a measure doesn't start before audio has been identified. It also pauses the measurement during periods of only background noise, and in the fade-out of a music track.

## Universal Descriptors and Dolby LM100

Unlike methods that measure dialog only, LM5D may be used with any type of audio – which includes dialog, of course. If you wish to measure dialog, it's recommended to do a manual spot check of a program or a film. Find 10-30 seconds of regular dialog and measure it with LM5D. Where dialog may be soft, regular or loud, and shift by more than 15 dB inside a film, regular dialog tends to be less ambiguous and more consistent across a program.

Note: For compatibility with a proprietary measure such as Dolby LM100, only some of these meters are updated to use ITU-R BS.1770 and Leq(K) while others are locked at Leq(A). The software version of LM100 should be 1.3.1.5 or higher in order for it to comply with BS.1770, and to have its average loudness reading be compatible with Center of Gravity in LM5. Even used just on speech, Leq(A) is not a precise approximation to perceived loudness, so please update the unit to BS.1770 to obtain similar readings and predictable results.

To measure dialog with LM5D in ProTools the same way as Dolby LM100 set to dialog, also solo the Center channel during a spot check to momentarily disable the channel weighting specified in BS.1770, if you're working on a 5.1 stem.

## Universal Descriptors and AC3 Metadata

The "Dialnorm" parameter in AC3 metadata should indicate the average loudness of a program.. Basic dynamic range and level control that rely on this parameter may take place in the consumer's receiver. Therefore, its value should not be far off target, or the results become highly unpredictable.

Center of Gravity in LM5 is directly compatible with Dialnorm in AC3. Most broadcast stations work against a fixed dialnorm setting, for instance -23 LFS. This would then be the CoG value to aim a program at. If the program isn't only dialog, the best consumer listening results are achieved if you aim Center of Gravity somewhat higher than the actual goal. For a music program, for instance, the aim should be approximately 3 LU higher.

## PPM PAGE

Press the "PPM" key to bring up the PPM display, Fig 6. The PPM page is used to inspect balance between channels, headroom, overload of channels etc.

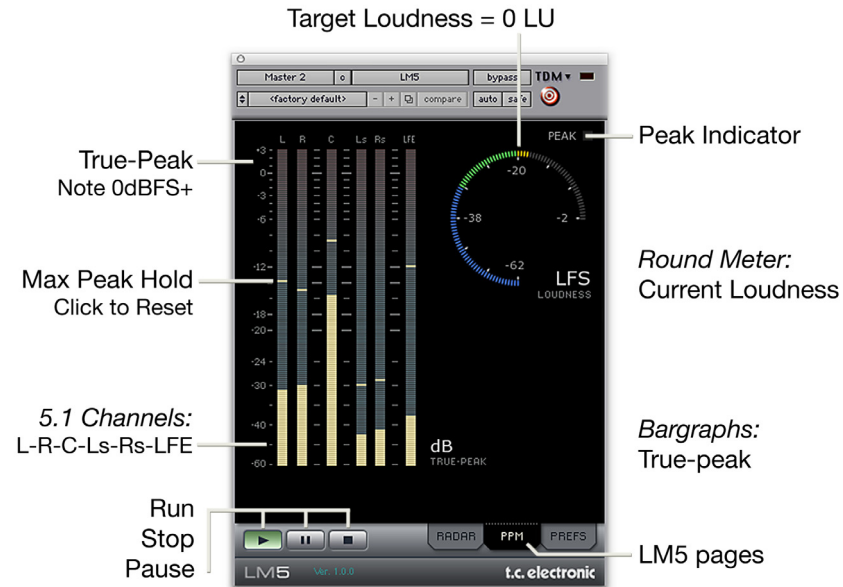


Fig 6, PPM True-peak meter features.

Bargraph PPM meters are shown next to the round Current Loudness display, which is identical to the Outer Ring of the Radar page. The True-peak meters operate regardless of the status of the Run/Stop/Pause controls. Click on the bargraphs to reset the peak history.

The peak meters of LM5 display true-peak as specified in ITU-R BS.1770. True-peak meters give a better indication of headroom and risk of distortion in downstream equipment such as sample rate converters, data reduction systems and consumer electronics than digital sample meters used e.g. in CD mastering.

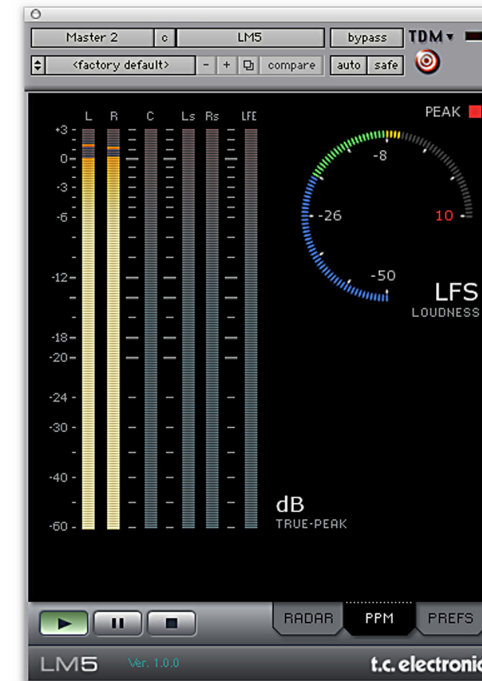


Fig 7, PPM True-peak meter example showing Madonna's Hung Up.

Note the extreme peak level way above 0 dBFS, which is typical of hyper-compressed program. This track will distort heavily when played on a consumer CD player or if it's data reduced.

Note that the meter scale is extended above 0 dBFS. Most consumer equipment distorts if you see readings above 0. With data reduced delivery, -3 dBFS should be regarded as max level without too much distortion. To be on the safe side with regard to broadcast linking and transmission, -6 dBFS should not be exceeded often. Please remember that excessive peak level may generate noticeable distortion and listener fatigue.

When you enter the PPM page, the bargraph meters show the highest peak level registered since the Radar or Peak Level history was reset.

## PREFERENCES PAGE

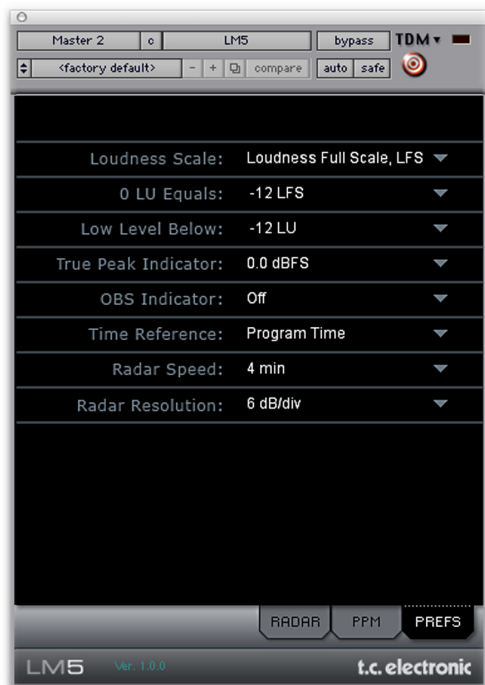


Fig 8, LM5 Prefs page.

Preferences may be stored as Presets, thereby having suitable settings for different conditions easily at hand.

*Loudness Scale* can be set to either “Loudness Units, LU” or “Loudness Full Scale, LFS”. Because LM5 uses the BS.1770 loudness model, LFS is the same as LKFS.

When “LFS” is selected, the numbers of the outer ring of the Radar page shown in Fig 3 apply. When “LU” is selected, the outer ring “hours” are marked in LU units instead.

*0 LU Equals* sets the loudness required to obtain a 12 o'clock reading on the outer ring, which is the same as the border between green and yellow on the Radar page. 0 LU is the reference to aim at.

*Low Level Below* determines where the shift between green and blue happens in the outer ring. It indicates to the engineer that level is now at risk of being below the noise floor.

*True Peak Indicator* sets the level at which the Peak indicator lights up.

OBS Indicator sets the conditions for the OBS indicator to light up. Turn it off, if you don't want warnings.

*Time Reference* can take two values: “Actual Computer Time” or “Program Time”. The first is synchronized to the realtime clock of the computer, the latter to when a new measure was started, i.e. when the “run” key was pressed. Note: The meter history resets when you switch between Time Reference settings.

*Radar Speed* controls how long time each radar revolution takes. Select from 1 minute to 24 hours. You may “zoom” between the settings, as long as the history isn't reset. Pressing the “X” key, or changing the Time Reference, resets the meter and descriptor history.

*Radar Resolution* sets the difference in loudness between each concentric circle in the Radar between 3 and 12 dB. Choose low numbers when targeting a platform with a low dynamic range tolerance. You may “zoom” between the settings, as long as the history isn't reset. Pressing the “X” key, or changing the Time Reference, resets the meter and descriptor history.



## PRESETS

The following presets have been loaded as factory defaults. Factory presets all use the LFS scale, Program time and 4 minutes per Radar Revolution. You may store new presets with a ProTools session based on your own preferences.



*You may switch between presets on the fly without resetting the Radar, thereby easily changing scale, zoom etc.*

### Broadcast HD

0 LU Equals: -22 LFS  
Low Level Below: -18 LU (Equals -40 LFS in this case).  
Radar Resolution: 6 dB per division  
True-peak Indicator: -6 dBFS

### Broadcast SD

0 LU Equals: -20 LFS  
Low Level Below: -12 LU (Equals -32 LFS in this case).  
Radar Resolution: 6 dB per division  
True-peak Indicator: -6 dBFS

### Film Mix

0 LU Equals: -24 LFS  
Low Level Below: -24 LU (Equals -48 LFS in this case).  
Radar Resolution: 10 dB per division  
True-peak Indicator: -3 dBFS

### Mastering Pop

0 LU Equals: -12 LFS  
Low Level Below: -12 LU (Equals -24 LFS in this case).  
Radar Resolution: 4 dB per division  
True-peak Indicator: 0 dBFS

### Mastering Wide

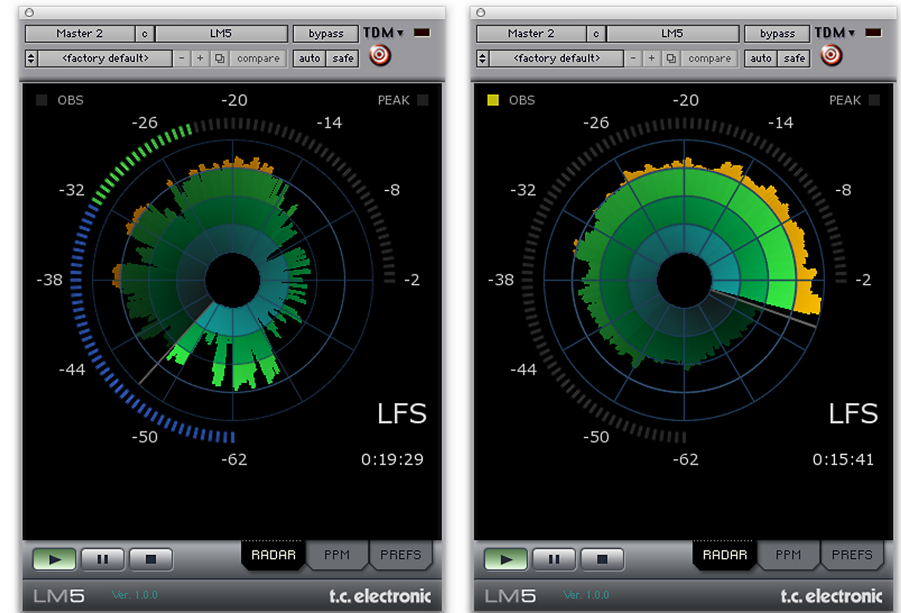
0 LU Equals: -20 LFS  
Low Level Below: -24 LU (Equals -44 LFS in this case).  
Radar Resolution: 10 dB per division  
True-peak Indicator: 0 dBFS

### Standard EBU

0 LU Equals: -18 LFS  
Low Level Below: -9 LU (Equals -27 LFS in this case).  
Radar Resolution: 4 dB per division  
True-peak Indicator: -6 dBFS

### Standard NAB

0 LU Equals: -20 LFS  
Low Level Below: -9 LU (Equals -29 LFS in this case).  
Radar Resolution: 4 dB per division  
True-peak Indicator: -6 dBFS



*Fig 9, Examples of 5.1 movie left (Matrix) and stereo, classical music right (Bolero). Both examples are shown on a 12 minute per revolution Radar with 10 dB between divisions.*

## Level versus Loudness

When level normalization in audio distribution is based on a peak level measure, it favors low dynamic range signatures as shown in Fig 1. This is what has happened to CD.

Quasi-peak level meters have this effect. They tell little about loudness, and also require a headroom in order to stay clear of distortion. Using IEC 268-18 meters, the headroom needed is typically 8-9 dB.

Sample based meters are also widely used, but tell even less about loudness. Max sample detection is the general rule in digital mixers and DAWs. The side effect of using such a simplistic measure has become clear over the last decade, and CD music production stands as a monument over its deficiency. In numerous TC papers, it has been demonstrated how sample based peak meters require a headroom of at least 3 dB in order to prevent distortion and listener fatigue.

The only type of standard level instrument that does not display some sort of peak level is the VU meter. Though developed for another era, this kind of meter is arguably better at presenting an audio segment's center of gravity. However, a VU meter is not perceptually optimized, or ideal for looking at audio with markedly different dynamic range signatures.

Unlike electrical level, loudness is subjective, and listeners weigh its most important factors - SPL, Frequency contents and Duration - differently. In search of an “objective” loudness measure, a certain Between Listener Variability (BLV) and Within Listener Variability (WLV) must be accepted, meaning that even loudness assessments by the same person are only consistent to some extent, and depends on the time of day, her mood etc. BLV adds further to the blur, when sex, culture, age etc. are introduced as variables.

Because of the variations, a generic loudness measure is only meaningful when it is based on large subjective reference tests and solid statistics. Together with McGill University in Montreal, TC Electronic has undertaken extensive loudness model investigation and evaluation.

The results denounce a couple of Leq measures, namely A and M weighted, as generic loudness measures. In fact, a quasi-peak meter showed better judgement of loudness than Leq(A) or Leq(M). Even used just for speech, Leq(A) is a poor pick, and it performs worse on music and effects. An appropriate choice for a low complexity, generic measurement algorithm, which works for listening levels used domestically, has been known as Leq(RLB).

Combined loudness and peak level meters exist already, for instance the ones from Dorrroughs, but BS.1770 now offers a standardized way of measuring these parameters.

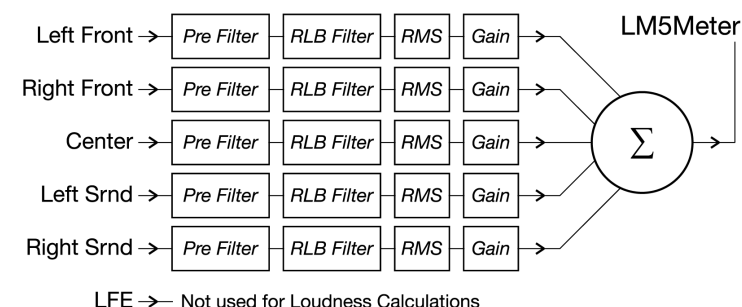
In 2006, ITU-R Working Party 6J drafted a new loudness and peak level measure, BS.1770, and the standard has subsequently come into effect. It has been debated if the loudness part is robust enough, because it will obviously get exploited where possible. However, with a variety of program material, Leq(RLB) has been verified in independent studies to be a relatively accurate measure, and correlate well with human test panels. It therefore seems justified to use Leq(RLB) as a baseline measure for loudness, especially because room for improvement is also built into the standard. The final BS.1770 standard included a multichannel annex with a revised weighting filter, R2LB – now known as “K” weighting - and a channel weighting scheme. These two later additions have been less verified than the basic Leq(RLB) frequency weighting.

The other aspect of BS.1770, the algorithm to measure true-peak, is built on solid ground. Inconsistent peak meter readings, unexpected overloads, distortion in data reduced delivery and conversion etc. has been extensively described, so in liaison with AES SC-02-01, an over-sampled true-peak level measure was included with BS.1770. In conclusion, BS.1770 is an honorable attempt at specifying loudness and peak level separately, instead of the simplistic (sample peak) and mixed up measures (quasi-peak) in use today. The loudness and peak level measurement engine of LM5 follows the standard precisely. Possible updates to the ITU standard may be released as LM5 updates, provided that processing requirements doesn't exhaust the system. Technical papers from AES, SMPTE, NAB and DAFX conferences with more information about loudness measurement, evaluation of loudness models, true-peak detection, consequences of 0 dBFS+ signals etc., are available from the TC website. Visit the Tech Library at [www.tcelectronic.com/techlibrary.asp](http://www.tcelectronic.com/techlibrary.asp) for details.

## ITU-R BS.1770 PRIMER

ITU-R BS.1770 standardizes the measurement of long-term loudness and of true-peak level. LM5 displays both parameters, and additionally offers a consistent way of breaking up long-term loudness into a coherent, running measure of instant loudness and of loudness history.

A block diagram of the loudness detection part of the BS.1770 measure is shown in Fig 10. The way channels are summed (means square), to some extent mimic s speaker summing in a the real world. Therefore, BS.1770 gives a meaningful indication of loudness, regardless if the input format is mono, stereo or 5.1.



*Fig 10, ITU-R BS.1770 Loudness Measure Block Diagram.*

*Note how an extra filter has been added in front of the original RLB filter, and that the LFE component is disregarded completely in the measure.*

The three front channels - L, C, R - employ the same channel weighting, while the measure is 1.5 dB more sensitive to surround channel signals. The reading of a signal entered into a surround channel is therefore 1.5 dB higher than if the same signal was entered into a front channel. The LFE channel is completely disregarded by the BS.1770 loudness measure.

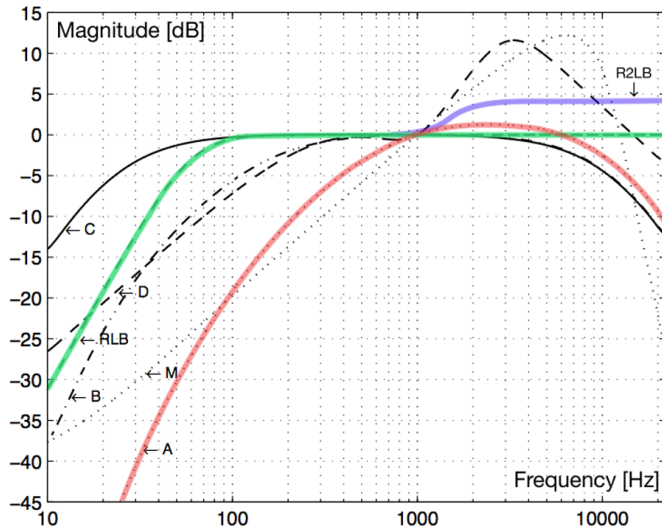


Fig 11, Frequency weighting used with selected Leq measures.

Red curve: A weighting.  
 Green curve: RLB weighting.  
 Blue curve: R2LB weighting, AKA "K" weighting.

The frequency weighting employed in the loudness part of BS.1770 is shown in fig 11. It means that you cannot perform a calibration tone sweep and expect the reading to stay the same, see below.

## METER CALIBRATION

Because of the frequency and channel weighting, and of the way channels sum, only specific tones and input channels should be used for calibration.

The most transparent results are obtained using a 1 kHz sine tone for calibration. Other frequencies or types of signal may be used (square wave, noise etc.), but don't expect similar results. The beauty of the system lies in its RMS foundation, so this is a feature, not an error. The same feature enables the loudness measure to identify overly hot CDs or commercials, and to take out of phase signals into account just as much as signals that are in phase.

If we stick to standard methods for measuring peak audio level in a digital system, where a sine wave (asynchronous of the sample rate) with digital peaks at 0 dBFS, is regarded a 0 dBFS tone, BS.1770 and LM5 output these results:  
 One front channel fed with a -20 dBFS, 1 kHz sine tone => Reading of -23,0 LFS.  
 Two front channels fed with a -20 dBFS, 1 kHz sine tone => Reading of -20,0 LFS.  
 All 5.1 channels fed with a -20 dBFS, 1 kHz sine tone => Reading of -15,4 LFS.  
 See Fig 4 as examples of calibration tone Radar displays.

## DISPLAY

LM5 may use either the measurement unit of LU (Loudness Units) or LFS (Loudness Full Scale). LU and LFS are measurements in dB, reflecting the estimated gain offset to arrive at a certain Reference Loudness (LU) or Maximum Loudness (LFS) as defined in BS.1770. Since a common reference point for LU has not been agreed on at the time of writing (February, 2008), LFS (or "LKFS", pointing specifically to the Leq(R2LB) weighting of BS.1770), might be favored initially to avoid ambiguous use of the term LU.

The effectiveness of any loudness meter depends on both the graphical appearance and dynamic behavior of its display, as well as on its underlying measurement algorithms. A short-term loudness meter also relies on the measurement algorithm's ability to output pertinent loudness information using different analysis windows, for instance, 200-800 ms for running realtime updates. It should be noted how the optimum size of this window varies from study to study, possibly because the objective of a running display hasn't been fully agreed upon.

Formal evaluation of a visualization system is challenging: First of all, one or more metrics must be defined by which the display should be evaluated. The correspondence between the sound heard and the picture seen is one aspect to be evaluated. Another metric could characterize the speed of reading the meter reliably. In LM5, short-term, mid-term and long-term of loudness measurements are tied together coherently, and displayed in novel ways (angular reading and radar) that were preferred in its development and test phases. However, we remain open to suggestions for further improvement of the visualization of loudness.

## POST SCRIPT

Control of loudness is the only audio issue that has made it to the political agenda. Political regulation is currently being put into effect in Europe to prevent hearing damage and disturbances from PA systems, and to avoid annoying level jumps during commercial breaks in television. In Australia, something similar may happen.

Many years of research into loudness of not only dialog, but also of loudness relating to any type of audio programming, has brought TC to the forefront of companies in the world to perform realtime loudness measurement and control. Therefore, TC has taken active part in loudness standardization efforts in Japan, the United States, Europe and other areas.

In broadcast, digitization is driving the number of AV channels and platforms up, while the total number of viewers remains roughly the same. On the sound production side, it is therefore important that delivery criteria can be easily specified and met, even by people not primarily concerned with audio: Journalists, musicians, video editors, marketing professionals etc.

Using only dialog based audio measurements in digital broadcast, has led to ambiguous level management, more level jumps between programs, and extra time spent on audio production and management in general. Non-dialog based level jumps are currently creating havoc in digital TV, and LM5 helps correct that situation. The LM5 Loudness Meter can be used to control level and improve sound, not only in Dolby AC3 based transmissions, but also on other broadcast platforms, such as analog TV, mobile TV and IPTV.

To summarize: LM5 is part of a holistic and universal approach to loudness control, starting at the production or live engineer. When she realizes the dynamic range at her disposal, less processing is needed at later stages of a distribution chain. The chain ends with the capability of quality controlling everything upstream by applying the same loudness measure for logging purposes: A closed loop.

Welcome to a new, standardized world of audio leveling. Across genres, across formats, across the globe.

## PRESET MANAGEMENT NOTE

LM5 and LM5D uses the standard Pro Tools preset handling.

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