What do LAeq and LAFmax mean?

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LAeq and LAFmax are a couple of the many labels used to describe sound and noise level values. But what exactly do they mean? When are these labels being used and what exactly do they refer to? In this article I want to give a basic explanation of the most commonly-use of the labels. Also, I am going to show what's behind the word composition.

To start, let's distinguish between the words "audio" and "acoustic". "Audio" is used in this article to refer to sound that travels electronically through cables and audio components. This is distinguished from the word "acoustic", a term that is also broadly used in the field of sound measurement. "Acoustic" is used in this article to refer to "sound that travels through air".

So, on with the labels. As an example, we'll look at the label LAFmax.

1. Labels

Beginning on the left, the first letter is a capital "L".

For labels, the first letter is always an "L". This simply stands for "Level", as in the sound pressure level (acoustic) measured through a microphone or the signal level (audio) measured at the output from an audio component, such as a mixing desk.

2. Frequency Weighting

The second letter in our example is the capital letter "A".

For labels, the second letter is commonly "A", "C" or "Z". This is called the "frequency weighting" and indicates that some frequencies within the audio spectrum are, in some cases, given a weighting. i.e. the level of these frequencies is reduced or increased in the measurement.

The reason these frequencies are reduced has to do with our hearing ability. Humans are better at hearing mid-range frequencies than high or low frequencies. The following three sound samples demonstrate this. Each of these samples is recorded with the same level. Yet when you play them, you will perceive that the low (125 Hz) and the high (10 kHz) are softer. (If you are in the slightly older group, you may not even be able to hear the 10 kHz signal – with age we all start to lose things, and one of those things is our ability to hear high frequencies)

http://blog.nti-audio.com/wp-content/uploads/2018/03/125.mp3

Audio File: 125 Hz

http://blog.nti-audio.com/wp-content/uploads/2018/03/1000.mp3

Audio File: 1000 Hz

http://blog.nti-audio.com/wp-content/uploads/2018/03/10000.mp3

Audio File: 10.000 Hz

Caution: There are many things that can influence your perception of loudness; high-frequency sounds may be more annoying and may thus appear louder, sound reflecting on surfaces (such as your table) may make low frequencies sound louder, size and/or quality of the loudspeakers may compromise low and high frequencies, your system may compress the signal if you play back too loud. Taking all these things into account, to experience the A-Weighting effect, I further recommend that you rather play these files softly through speakers, not headphones!

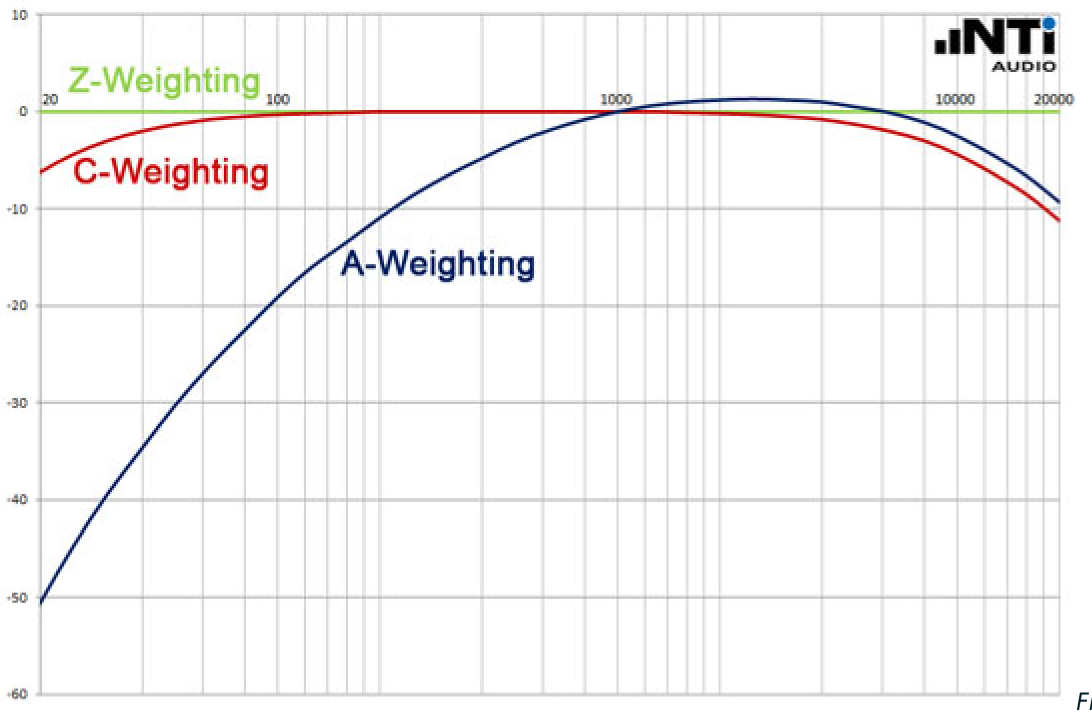
If we were to play these three samples through one of the channels of an audio mixing desk, because, for example, we wanted to test how the channel responds to each frequency, then we would measure the frequency response of the channel using an audio analyzer a flat response or no frequency weighting. With “Z”, all frequencies are treated equally. i.e. no frequency weighting is applied.

If we were then to play these three samples through a loudspeaker to test how the speaker will be heard by humans, we may want to reduce the high and low frequencies measured by the sound level meter so as to represent what humans hear. In this case, we apply an “A” weighting to the frequencies. In our example, we would then measure LA.

When sound levels get loud (above 100 dB), humans become more sensitive to both the high and the low frequencies. To represent this in a sound level meter measurement, we apply the “C” frequency weighting. In our example, we would then measure LC.

In summary, the basic rule for frequency weighting is, use unweighted (or “Z”) for all audio and acoustic measurements where you do not want to consider the human hearing perception, such as testing the response of a loudspeaker across the entire frequency range. Use “A” for all acoustic measurements under 100 dB. Where sound levels are above 100 dB, use “C”.

In our example, the options for frequency weighting are **LZ**, **LA,** and **LC.**



Frequency Weightings

(Click image to enlarge)

3. Time Weighting

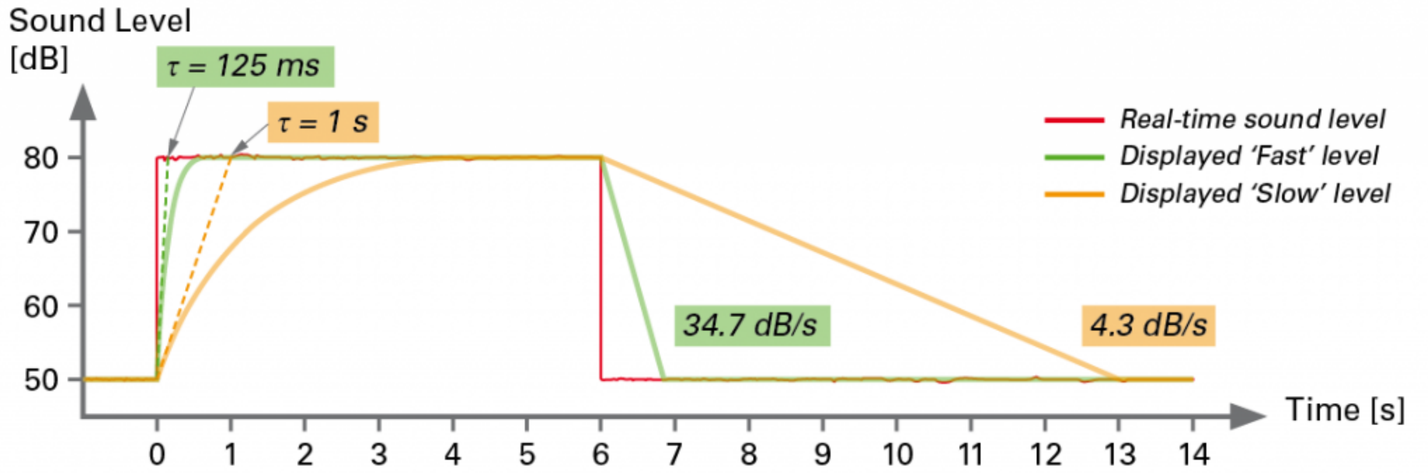
The third letter in our example is the capital letter “F”.

The third letter is often “F”, “S” or “I”. This is called the “time weighting”. F = Fast, S = Slow, I = Impulse. Historically, the time weighting was applied so that levels measured were easier to read on a sound level meter. The time weighting dampens sudden changes in levels, thus creating a smoother display.

The graph below indicates how this works. In this example, the input signal suddenly increases from 50 dB to 80 dB, stays there for 6 seconds, then disappears just as suddenly.

An LAF measurement (green line) will take approximately 0.6 seconds (attack time) to reach 80 dB and just under 1 second (decay time) to drop back down to 50 dB.

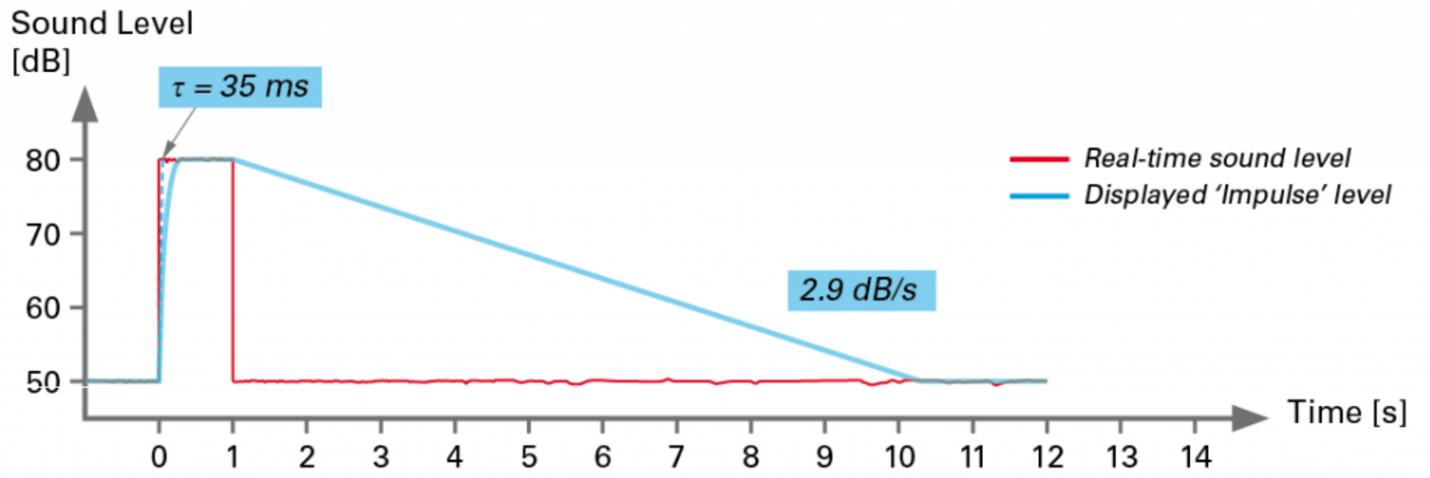
An LAS measurement (yellow line) is slower to react. It will take approximately 5 seconds to reach 80 dB and around 6 seconds to drop back down to 50 dB.



F S time weighting

(Click image to enlarge)

An LAI measurement (blue line) will take approximately 0.3 seconds to reach 80 dB and over 9 seconds to drop back down to 50 dB.



I time weighting

(Click image to enlarge)

For the mathematicians among us, the line described is exponential in the attack and linear in the decay. The initial tangent of the attack dissects the new level, in this case, 80 dB, at specific intervals from the initial impulse. These are 1 second for Slow, 125 ms for Fast and 35 ms for Impulse.

For the non-mathematicians, we'll just move quickly along.

When measuring averages, S may be appropriate when measuring a signal that oscillates quickly. F may be more suitable where the signal is less impulsive. The decision to use Fast or Slow is often reached by what is prescribed in a standard or a law.

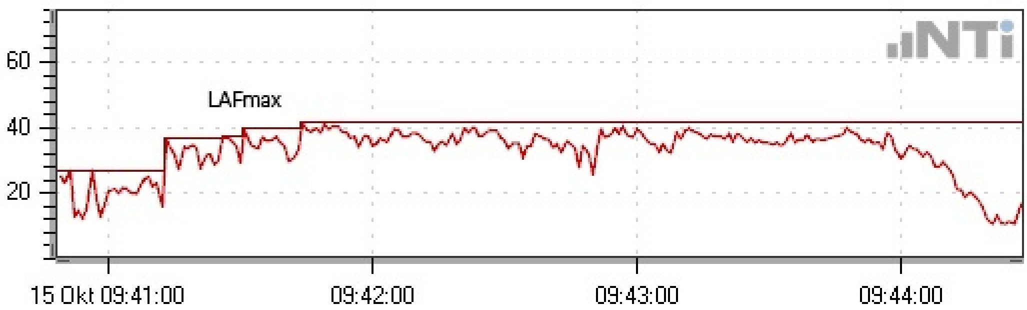
The impulse weighting, LAI can be used in situations where there are sharp impulsive noises, such as when measuring fireworks or gunshots.

In our example, the options for time weighting are **LAF**, **LAS,** and **LAI.**

4. More Parameters

The word "max" makes up the rest of the label.

This is simply the maximum value measured over a certain period of time. Similarly, "min" gives us the minimum value.



LAFmax

(Click image to enlarge)

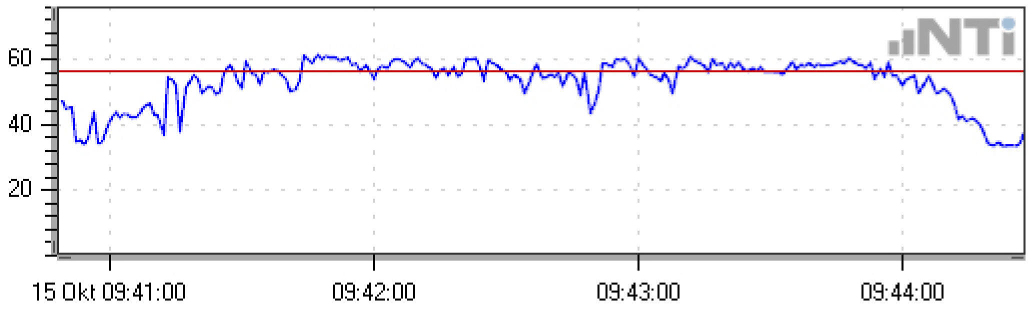
Applied to our example, we have **LAFmax** and **LAFmin**

5. LAeq

Finally, another common label used is LAeq.

“eq” = equivalent. The equivalent sound level corresponds to the average received sound energy over time, and is easier to read on a display than the instantaneous sound level.

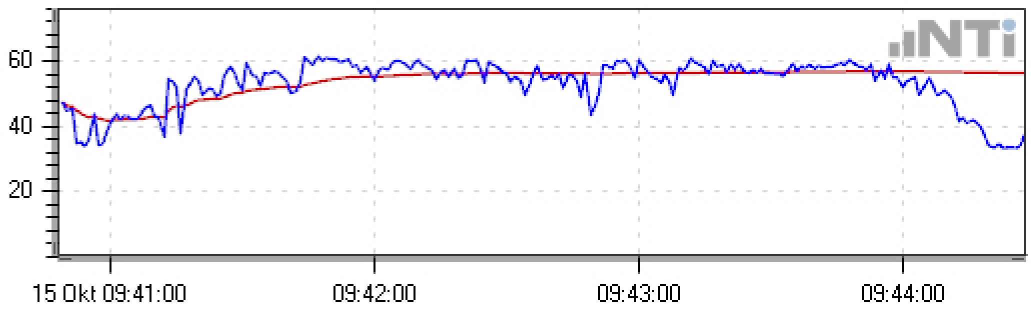
If you look at the following graph of sound level over time, the area under the blue curve represents the energy. The horizontal red line drawn to represent the same area under the blue curve gives us the LAeq. That is **the equivalent value** or average of the energy over the entire graph.



LAeq measurement over 5 minutes

(Click image to enlarge)

LAeq is not always a straight line. If the LAeq is plotted as the equivalent from the beginning of the graph to each of the measurement points, the plot looks like this.



Continuous LAeq

(Click image to enlarge)

Links relevant to this topic:

- LAFmax
- LAeq