2. FEBRUAR 2020

Which angle is correct for the measuring microphone?

Do you know this situation? You arrive at a new venue and are greeted warmly by your client. You take a look at the loudspeaker system, clarify your connection options for electricity, audio and network. And when you really want to get started and turn away to your equipment case, there is a small but fine obituary: “By the way, that's Tom. He is at your side all day today and can support you!” Yes, it starts well!

You show him the measuring microphones, tripods and cables and roughly sketch the positions in the hall where he can set up the microphones for the first measurement. This will occupy him for half an hour, and you can build up your laptop and your interface and prepare access to the system. Half an hour? Happy too early. The first query comes after 5 minutes!

"How should I align the microphones? To the ceiling? Or to the speaker? Or does it not matter?"

This question always comes up. And rightly so! (That is why I am now trying to give the answer at the introduction ..) Have you ever thought about this? If not, then this post is exactly right. And you can confidently give your next assistant an answer!

"Doesn't it matter how you align it with an omnidirectional characteristic, since it is equally sensitive from all sides?"

For the ideal microphone, more precisely the ideal pressure receiver (in contrast to the pressure gradient receiver), this is absolutely correct in theory. And our technology today is not that far from this ideal. However, there is a slight deviation in practice.

Our listening range covers the range from roughly 20Hz to 20kHz. This is a full 10 octaves! The range of the corresponding wavelengths ranges from 17m (at 20Hz) to 1.7cm (at 20kHz). It's a miracle anyway that this huge area can be measured by a single tiny microphone.

The microphone manufacturers sometimes offer diagrams that can be used to read the directional dependency. But today I do not want to explain to you the diagrams that I did not make myself and which we both do not know whether you can trust them. I find it much more exciting and convincing when we look at the directional dependency in practice, based on the application for which we actually use the measurement microphones: for measuring loudspeakers.

So that the findings can be reasonably generalized, I carried out the experiment one after the other with three different measurement microphones:

- Behringer ECM8000 (Thomann *)
- Beyerdynamic MM1 (Thomann *)
- iSEMcon EMX-7150 (Manufacturer)

If you have a different measurement microphone, the tendency is certainly similar to these three. Nevertheless, I can only encourage you to do the experiment yourself in a quiet minute.

THE EXPERIMENTAL SETUP

It doesn't really matter which speaker you use. Since we want to look at the high frequencies in particular, the speaker should play at least up to 10 kHz. We should also be in the direct sound field of the speaker. A measurement at a far distance will probably not reveal the microphone properties that we want to look at today, since at a great distance diffuse sound hits the microphone from all sides in addition to direct sound. A change of direction of the microphone would then have less impact than at a short distance.

I used the Kali Audio LP-6 (Thomann *) studio monitor for the measurement. I chose 75cm as the distance between the microphone and the loudspeaker, in order to pick up only the direct sound and as little wall / ceiling reflections as possible. The back wall behind the speaker is also equipped with broadband absorbers.

The absolute frequency response of the speaker is not relevant to our experiment. It can still have a few dB deviations. We are only interested in the difference in changing the angle.

First we point the microphone directly at the speaker. With 2-way speakers, you should make sure that the microphone is between the two individual speakers so that both arrive at the microphone at the same time.

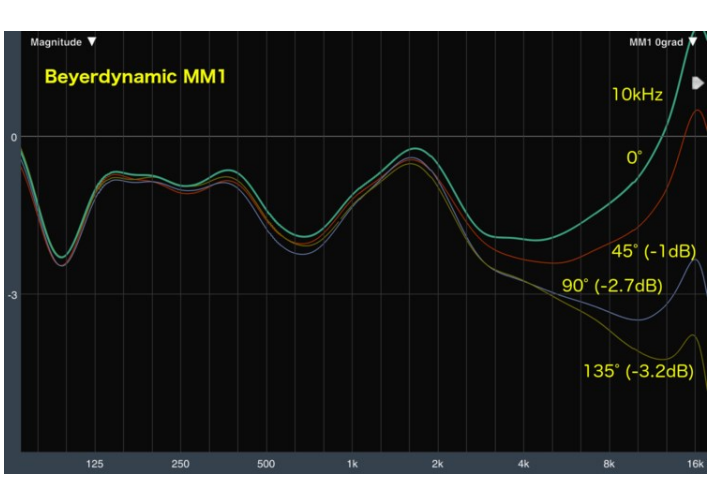
We save this first curve with the name 0 degrees. It now serves as a reference curve with which we compare the following measurements. I then carried out and saved a measurement for 45, 90 and 135 degrees. Simply changing the angle is not very precise because it changes both the height and the distance. You should therefore always adjust the height and distance after setting the new angle. The easiest way to do this is to hang a string from the ceiling for the exact microphone position.

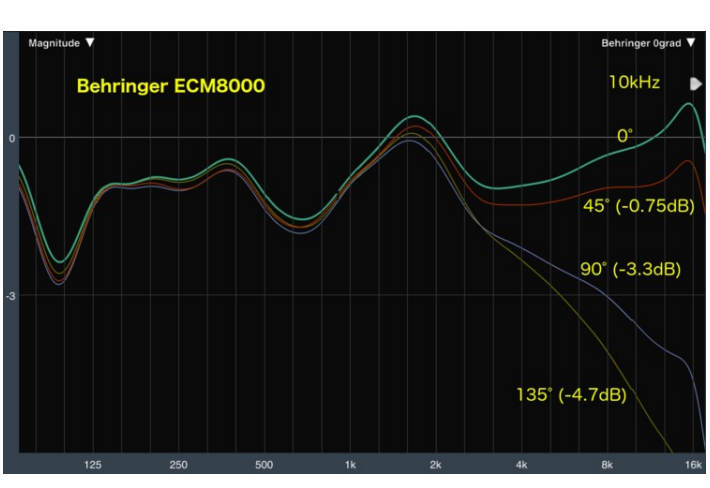
THE RESULTS

Since our reference curve is not absolutely straight, it is advisable to use a fairly strong smoothing for the frequency curve. I used an octave smoothing for my curves so that we can easily see the differences between the different measurements.

At this point I would like to emphasize again that the bumps in the frequency response come primarily from the loudspeaker. The purpose of this experiment is only to determine the differences when the angle changes, but not to generally assess the bumps in the microphone frequency response. I will examine this in a separate blog post.

There are no significant differences below 2 kHz in any of the three microphones. Only then does the directionality become noticeable. At 4kHz the deviation is only 0.5dB with the EMX-7150, with the Behringer ECM8000 it is 1.2dB at 90 degrees and 1.4dB at 135 degrees. The MM1 is exactly in between.





At 8kHz the differences between 0 degrees and 90 degrees range between 1.3dB for the EMX-7150 and 2.7dB for the ECM8000. At 10kHz the deviation grows to 3.3dB, at 12kHz to 4.0dB with the ECM8000, and with the EMX-7150 1.75dB at 10kHz and 2.2dB at 12kHz.

DOES IT MAKE A DIFFERENCE?

If you turn the EQ at 10kHz, does it make a difference to you whether you turn 3dB more or less? I bet my favorite CD that you do not care if I just turn 3dB out of your speakers!

What about 2dB or just 1.5dB? Well, it is getting more difficult here, but I regularly discuss with colleagues whether we should change 1 or 2 dB. It doesn't matter to most people until 0.5dB.

First of all, the knowledge: Not every microphone is equally sensitive to the change in angle. The EMX-7150 is the most tolerant here. But still, a difference of 90 degrees for all microphones has an impact on the measurement and thus probably on the EQ, which you will adjust based on the curve. Even with a omni directional microphone, you should not choose the orientation arbitrarily, but (usually) aim the microphone in the direction of the speaker. A deviation of a few degrees has only a minor impact, so that with a stereo setup, we can aim exactly in the middle of the two speakers.

If we measure a surround setup and do not want to convert between measurements, then (and only then) I would recommend aligning it with the ceiling. However, it must always be kept in mind that the measurement results will show a drop at high frequencies. Some manufacturers even provide their microphones with correction files that can be loaded into the measurement software. My EMX-7150, for example, have files for 0 degrees and 90 degrees on a USB stick for the Smaart software. If you are sure that you always want to measure at an angle of 90 degrees today, you can load these correction values and then get a straight frequency curve again.

It gets complicated when you actually want to measure loudspeakers from the ceiling, as they are used in many theaters. If you do not realign the measuring microphone for the different speakers, you always have to be careful that you interpret the results correctly and remember at what angle the speakers hit the microphone and what correction values you may have loaded in the morning.

A little note: even if the common measurement microphones have a free field equalization (i.e. they are as linear as possible at 0 degrees), there are also omnidirectional microphones with diffuse field equalization (e.g. also the Beyerdynamic MM1 and in my opinion the Behringer ECM8000, see this blog article). These are set so that they achieve a linear frequency response with uniform sound from all sides. This manifests itself when used as a measurement microphone with a slight elevation at 0 degrees.

HOW DO WE ANSWER OUR ASSISTANT'S QUESTION?

My personal preference is: always align the measurement microphones in the direction of the speaker. This leads to the goal in 95% of my jobs, both for the main sound system and for the delay speakers. And with this rule, every assistant can also set up the measurement microphones.

With microphones with diffuse-field equalization, on the other hand, you have to consider how in a free-field situation (and most of the time we measure loudspeakers in the free-field, i.e. direct sound field), you can compensate for the increase in height.

The easiest way is to load corresponding correction values into the measurement software and then use the microphone in the direction of the speaker like a free-field equalized microphone.

It gets more complicated if your measurement software does not offer a function for microphone correction. Then you can either try to subtract 2-3dB in the treble with each frequency response measurement. Your target curve has a slight elevation.

Or you don't point your measuring microphone directly at the speaker, but tilt it about 50-60 degrees past it. At this angle, a diffuse-field-equalized microphone usually has a fairly linear frequency response comparable to a free-field-equalized microphone. Admittedly, this method is not trivial, especially if you want to instruct a new assistant for every job.

I hope that my little experiment could make you a little more sensitive to the alignment of your measurement microphone. Ultimately, of course, your ear will tell you how many heights you would like to hear. But it can't hurt if the measurement of the frequency response is as meaningful as possible.

If you would like to know which equipment I take with me for my calibration jobs, you are welcome to download my current equipment list!

Name Email DOWNLOAD NOW!

Blog-article: How cheap can a measurement microphone be? (Behringer ECM800 vs iSEMcon EMX-7150)

* These are affiliate links, where you have no disadvantage and I get 1-2% commission credited when you buy the article. Even if it's only a few cents each, I'm really happy about every little thing that supports me on this blog!

ZURÜCK
Before and after comparison of broadband absorbers (part 1)

WEITER
DIY broadband absorbers