News & Reviews

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HBK 2255 with Building Acoustics Partner

The HBK 2255 sound level meter allows you to take all measurements with a Wi-Fi remote control

Abstract: The day-to-day acoustic performance measurements according to the standard ABNT NBR 15575:2021 require light and robust equipment with integrated solutions that facilitate service and reduce the possibility of errors. Considering such needs, HBK has developed a product line focused on the daily life of construction sites. The HBK 2255 sound level meter integrated into the *Building Acoustics Partner* assists decision-making during measurement with predefined steps for measuring and real-time data visualization. The HBK 2255 can be controlled remotely via Wi-Fi or Bluetooth, eliminating the need for cables. Using the HBK 2755 amplifier, the entire measurement can be controlled remotely via the App. Data from field measurements can be transferred to the office via cloud storage. Together with the *Building Acoustics Partner*, it enables quick reporting, accelerating work and increasing productivity from start to finish.

HBK 2255 com Building Acoustics Partner

Resumo: O dia a dia de medições de desempenho acústico segundo a ABNT NBR 15575:2021 exige equipamentos leves, robustos e com soluções integradas que facilitem o serviço e reduzam as possibilidades de ocorrência de erros. Considerando tais necessidades, a HBK desenvolveu uma linha de produtos com foco no dia a dia dos canteiros de obras. O sonômetro HBK 2255 integrado ao Building Acoustics Partner auxilia na tomada de decisão durante as medições com passos pré-definidos para a medição e visualização dos dados em tempo real. O HBK 2255 pode ser controlado remotamente via Wi-Fi ou Bluetooth, eliminando a necessidade de cabos, e, utilizando o amplificador HBK 2755, toda a medição pode ser controlada remotamente via aplicativo. Os dados das medições de campo podem ser transferidos ao escritório via armazenamento na nuvem, o que, juntamente com o Building Acoustics Partner, permite a geração de relatórios rápidos, agilizando o trabalho e aumentando a produtividade do início ao fim.

1. Introduction to room and building acoustics

Building acoustics concerns the transmission of noise between different rooms, focusing primarily on the acoustic performance of partitions and their sound insulation levels, Figure 1. The transmission of noise present in a dwelling can be divided into two main paths: airborne and structure-borne sound.

Figure 1: The HBK 2255 sound level meter offers features to facilitate the daily routine of acoustic measurements in civil construction.

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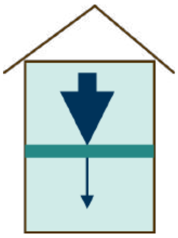
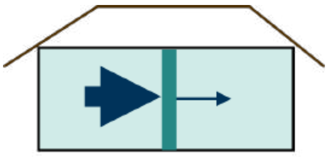
Impact noise is generated by the direct contact of an object upon a building's surface, which means that excitation occurs directly on the structure or partition, see Figure 2 (a). A building's acoustic performance to impact noise is assessed through its "weighted standardized impact sound pressure level" ($L'_{\mathrm{n}T,\,\mathrm{w}}$), measured only in the receiving room with known and standardized excitation.

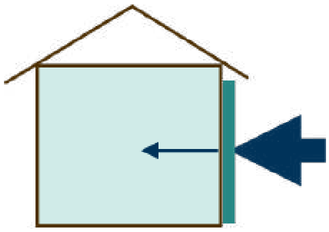
Acoustic performance to airborne noise can be subdivided according to the structure under assessment. For internal structures (refer to Figure 2 (b)), the "weighted standardized level difference" ($D_{\mathrm{n}T,\,\mathrm{w}}$) is used. For this, noise is generated without any direct contact with the building, meaning that a sound source releases energy into the air in the emitting room. That energy then transfers to the receiving room through the building's internal partitions. The third case is the "weighted standardized level difference at 2 meters (from the façade)" ($D_{2\mathrm{m},\,\mathrm{n}T,\,\mathrm{w}}$), used to assess the acoustic performance of external partitions (see Figure 2 (c)). In both impact and airborne cases, it is necessary to measure the sound pressure level in the emitting room and the receiving room to obtain the level differences. For façade assessments, the emitting room is the exterior part of the building.



(a) Impact noise.



(b) Airborne noise.



(c) Façade noise.

Figure 2: Types of noises found in buildings.

To obtain the three aforementioned parameters in order to assess the acoustic performance of building structures, it is necessary to measure the Reverberation Time (RT) in the reception room in order to standardize the results due to the presence (or absence) of absorbing elements in the space (for example, furniture, curtains, and finishes). The acoustic performance of internal walls, external walls, or slabs is a topic of current interest in the global scenario of building acoustics, as the preservation of privacy and acoustic comfort can increase the added value of a property. This subject has gained prominence in the Brazilian national market due to the publication of the standard ABNT NBR 15575:2021 [1], which defines categories of acoustic performance for residential buildings. Thus, the acoustic performance of a dwelling can be classified according to the criteria of "minimum", "intermediate", and "superior", for both external and internal partitions and for airborne and impact noises.

2. Measuring Sound Pressure Level

Sound pressure is a scalar acoustic quantity that occurs in a physical medium from an excitation in that medium. The *Sound Pressure Level* (SPL) is the logarithmic relationship between the sound pressure in the environment and a reference sound pressure (20 µPa), given on a dB scale. Its measurement is quite sensitive because of the wide range of phenomena that can influence it. External interferences can invalidate and discredit a measurement when there is the occurrence of strong winds, rain, and/or high residual noise, for example. Technical non-conformities also influence the results of SPL measurements, such as proximity to surfaces, the use of incorrect microphones, or even proximity between the operator and the sensor.

Measurements under the influence of strong winds or rain can completely mischaracterize the measured signal, and factors such as temperature and humidity directly influence the speed of sound wave propagation in the medium, as well as sound absorption. Nearby surfaces can generate acoustic phenomena such as reflection, diffraction, and even acoustic shadows, depending on the ratio between the size of the surface and the wavelength being analyzed. To avoid such occurrences, it is recommended to position the microphone at a minimum distance of one meter (1.0 m) from the nearest surfaces and 1.5 m from the ground. In cases where it is necessary to spatially average the SPL, a minimum spacing of 0.7 m between measurement points is also recommended [2].

In various situations in building acoustics, it is necessary to excite the room under analysis using a sound source. In these cases, the use of an omnidirectional source is mandatory to excite the room in an approximately uniform manner and not favor any particular region of space [2]. The omnidirectional B&K Type 4292-L source uses a cluster of 12 loudspeakers mounted on the pentagonal face of an icosidodecahedron, thus capable of evenly radiating sound with a spherical distribution, as can be seen in Figure 3. All twelve loudspeakers are connected in a parallel network to ensure in-phase operation and an impedance suitable for the power amplifier. The entire set weighs no more than 8 kg and, together with the HBK Type 2755 amplifier, is capable of generating 122 dB of sound power level. This high sound power is very useful for measurements in large rooms and with high residual noise.

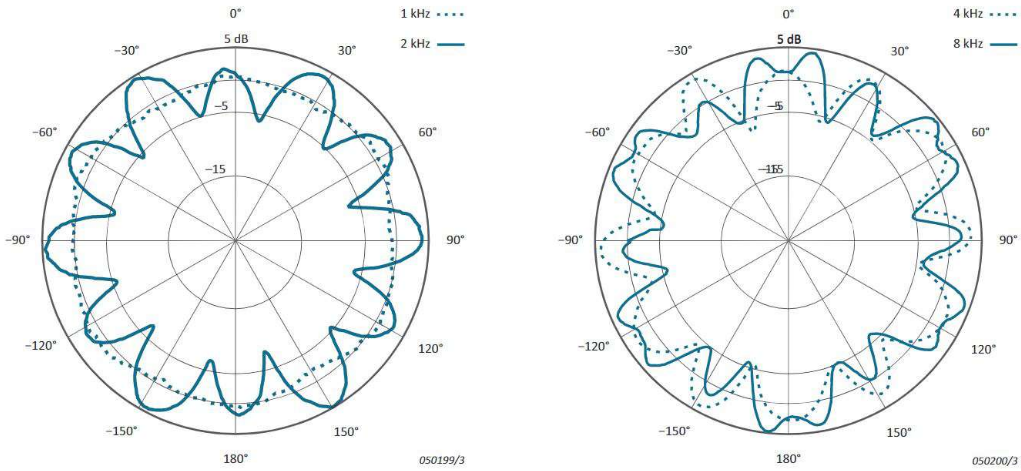


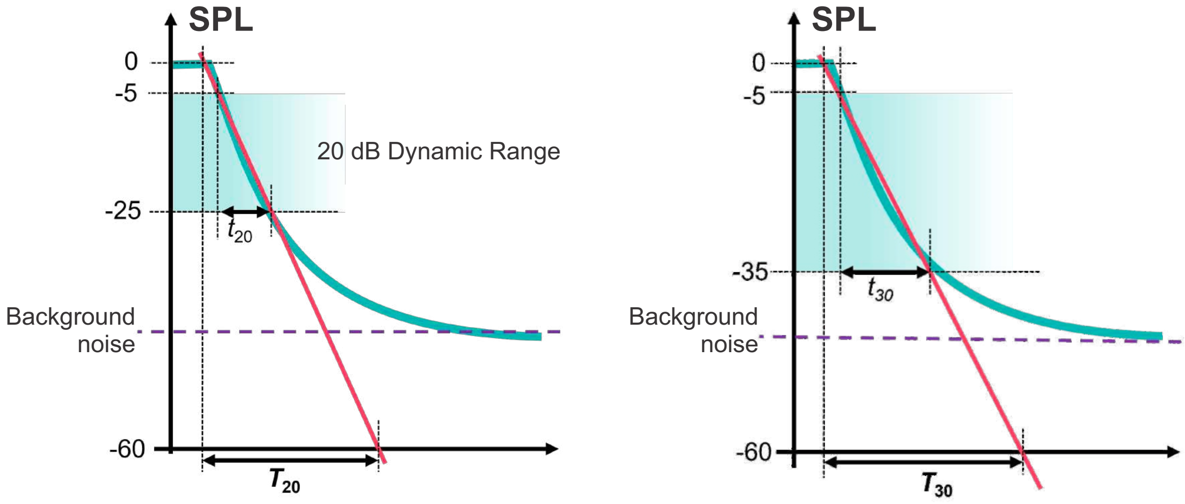
Figure 3: Polar distribution of sound energy radiated by the B&K Type 4292-L sound source

3. Measuring the Reverberation Time of a room

The Reverberation Time (RT) of a room is given in seconds and represents the time required for the sound energy density inside a room to decay to one millionth (10^{-6}) of its initial value after the cessation of a stationary sound excitation in the environment. This value is equivalent to a 60 dB decay (20 μPa), giving rise to the popular name of this objective parameter, (T_{60}). In addition to (T_{60}), there are also times (T_{30}) and (T_{20}), for example, which are estimates for (T_{60}) from the extrapolation of experimental decay in the dynamic range of 30 dB and 20 dB, respectively. Values with decays less than 60 dB are used in cases where there are difficulties in meeting the desired dynamic range [3].

Observe Figures 4 (a) and 4 (b) and note that, due to the difference between the maximum level (here adopted as 0 dB) generated by the source and the background noise (in dashed purple line), it is not possible to measure a 60 dB decay, and therefore, only a decay[1] of 20 dB or 30 dB is used. A linear fit (in red) is employed for the interval between -5 dB and -25 dB for T_{20} or -5 dB and -35 dB for T_{30} and extrapolated beyond the decay curve to obtain the equivalent RT for -60 dB.

[1] In summary, the RT denoted T_{20} calculated from t_{20} represents the equivalent time required for a 60 dB decay estimated from a 20 dB decay. The same logic applies to T_{30}.



(a) (T_{20}). **(b)** (T_{30}).

Figure 4: RT obtained from decays less than 60 dB.

Obtaining RT can be carried out in different ways; in this insert, we will address the interrupted noise method and the impulsive signal method. In the interrupted noise method, it is necessary to excite the room with a stationary signal (usually white or pink noise) at a level that meets the dynamic range of interest and then abruptly interrupt the sound source. After the interruption, the time required for the decay to the desired level is measured, whether it be 20 dB, 30 dB, or 60 dB. The second method, uses an impulsive signal, such as a starter's pistol shot, for example, to excite the room. In this method, it is sufficient to generate the impulse and assess whether it reaches the dynamic range of interest — note: this is the one with the greatest uncertainty, due to the difficulty of achieving repeatability and adequate dynamic ranges at low and high frequencies. The new HBK 2255 sound level meter has electronic triggers to detect both impulsive signals and interrupted noise, allowing the measurement to start at the right time and reducing the possibility of recording errors. The HBK 2255 also has data processing tools to calculate RT immediately after the measurements are completed.

4. Measuring the acoustic performance of partitions

In building acoustics, specifically, the instructions for the correct performance of measurements are determined by the standards ABNT NBR ISO 16283-1:2021 [2], ABNT NBR ISO 16283-2:2021 [4], and ABNT NBR ISO 16283-3:2018 [5], for airborne, impact, and façade noise, respectively. In summary, it can be said that the basic guidelines to be respected for correct measurement are related to climatic factors (such as wind, rain, temperature, and humidity) and the spacing between the microphone and nearby surfaces.

4.1 Airborne noise isolation

To evaluate the acoustic performance of internal partitions against airborne noise sources, it is necessary to measure the standardized level difference D_{nT}, obtained from the difference in SPLs measured in the rooms separated by the partition. For this, a sound source is first used to excite the emitting room, where an SPL (L_1) is measured. Then, the source is turned on again in the emitting room, but the SPL (L_2) is now assessed in the receiving room. The standardized level difference that characterizes the acoustic performance of the partition can be obtained using the relationship

$$D_{nT} = L_1 - L_2 + 10\log\left(\frac{T}{T_0}\right), \tag{1}$$

where T is the reverberation time in the receiving room and T_0 is the reference reverberation time of 0.5 s [2].

When measuring airborne noise, certain precautions must be taken, such as the correct positioning of the microphones at the various measurement points, respecting a minimum distance of 1.0 m from nearby surfaces, 0.7 m between microphone positions, and 1.5 m from the floor. The use of a source with a response considered flat across the frequency range of interest and omnidirectional is also important for this type of measurement. The omnidirectional HBK Type 4292-L source meets the requirements mentioned by the standards ABNT NBR ISO 16283-1:2018 [2] and ABNT NBR ISO 3382-1:2017 [3] and was designed to be lightweight and robust. More details can be seen in its *data sheet*. The system is complete with the new HBK Type 2755 amplifier. Finally, the excitation kit with source, amplifier, and tripod weighs less than 15 kg — see the demonstration in Figure 5.

Figure 5: Example of measurement, the HBK 2255 sound level meter and HBK 2755 amplifier can be operated (wirelessly) via *smartphone*.

4.2 Airborne Noise Isolation for Façades

To assess the acoustic performance of external partitions, the airborne noise isolation of the façade is analyzed, which, as with internal partitions, is based on a difference in sound pressure level. The external sound pressure level $(L_{1,\,2m})$ is measured at a distance of 2 m from the façade, and the source should be placed as elaborated in the standard ABNT NBR ISO 16283-3:2021 [5]. The SPL (L_2) is measured inside the building at a minimum distance of 1 m from the partitions. One can then use the relationship

$$D_{2\mathrm{m},\,\mathrm{n}T} = (L_{1,\,2\mathrm{m}} - L_2) + 10\log\left(\frac{T}{T_0}\right), \tag{2}$$

to obtain the airborne noise isolation of the façade [5].

The façade isolation subject to airborne noise should be measured with the openings (such as doors and windows) of the room under analysis closed to prevent the incidence of noises from other rooms. This requirement, in many cases, complicates the measurement process due to the need to interconnect the various equipment used with cables to form the appropriate measurement chain. For this reason, the new HBK products, Type 2255 and Type 2755 — see the kit in Figure 6 —, have a wireless connection via Wi-Fi to interconnect and remotely control the equipment. The signal generator with preloaded signals in the amplifier allows only two cables to be used throughout the chain: the power cable for the amplifier and the connection cable between the amplifier and the sound source. Integrated with the Building Acoustics Partner, the entire measurement can be controlled via smartphone, and the primary analysis of the results can be performed immediately after the measurements, either by the measurement quality indicator present in the HBK 2255 or by the initial results presented in the mobile app.

Figure 6: Omnidirectional B&K Type 4292-L source, HBK 2255 sound level meter, and HBK 2755 amplifier — the latter two can be controlled via Wi-Fi (wirelessly).

4.3 Impact noise isolation

In cases where it is necessary to evaluate the isolation from impact noise, a standardized impact source (*tapping machine*) is used, which must meet a standard of force, frequency, and spatial distribution, as the B&K Type 3207 does. The source is placed in the emitting room, and the impact noise is measured only in the receiving room, due to the fact that the transmission of impact noise is mostly structural, which makes the acoustic propagation through the air in the emitting room negligible. Since the source generates standardized impacts, only the SPL in the receiving room can be evaluated and taken as comparative data, since the only change in the measurement chain would be the slab under test and analysis.

According to ABNT NBR 15575-1:2021 [1], slabs in general must meet an $L'_{nT,\,w}$ of 80 dB for the minimum performance required in Brazil for floor systems separating housing units. This means that with the impact machine on, the maximum $L'_{nT,\,w}$ measured on the receiving floor must be less than 80 dB. It should be noted that this data does not only deal with the SPL measured on the lower floor, but it is directly influenced by the reverberation time of the lower room, as presented in the equation

$$L_{nT,\,w} = L_2 + 10\log\left(\frac{T}{T_0}\right). \tag{3}$$

This type of test is widely used to analyze the acoustic performance of slabs of various types. As it is a type of measurement carried out between different floors of a building, activating the source and the recorder can become laborious, as can processing the collected data. To facilitate the daily routine of measurements, HBK developed the Building Acoustics Partner, a software that allows remote control of the sound level meter both via Bluetooth and Wi-Fi. In addition to allowing remote control of the sound level meter, the software performs post-processing of the collected data, allowing for the analysis of results and the generation of performance reports for different partitions and RT. according to current standards.

5. Getting to know the HBK 2255 Sound Level Meter with Building Acoustics Partner

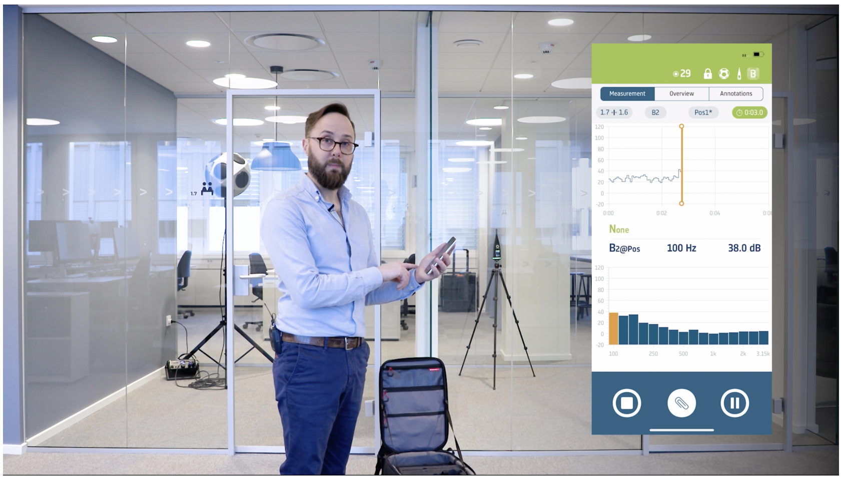
The HBK 2255 sound level meter was developed with a focus on building acoustics measurements. With advanced single-channel technology, the HBK 2255 and its accessories were designed to be lightweight, robust, and suitable to withstand water, dust, and debris commonly found at a construction site, achieving IP 54 certification (IEC 60529:1989/AMD2:2013/COR1:2019 [6]). This sound level meter has a dynamic measurement range of 15.8 dB(A) to 140.9 dB(A), allowing it to measure a wide variety of signals without prior knowledge of their characteristics. Moreover, it meets the specifications of the current international family of standards for Class 1 sound level meters (IEC 61672:2013 [7]) and for octave and third-octave filters (IEC 61620:2014 [8]).

For greater convenience, the HBK 2255 sound level meter features wireless connections via Wi-Fi and Bluetooth, which allow for remote control of measurements and facilitate data transfer, observe Figure 7. The sound level meter has 16 GB of internal storage, which allows for long-duration measurements (and audio file recording), with a battery that lasts up to 13 hours with Wi-Fi turned on. Additional information can be found on the product's *data sheet*.

Furthermore, when using the HBK 2255 sound level meter together with the HBK 2755 amplifier, the entire measurement can be remotely controlled from the palm of your hand using a smartphone. This is possible thanks to the gain adjustment via Wi-Fi connection and the optimized signal generator for HBK sources, both present in the HBK 2755 amplifiers. The HBK 2755 amplifier is lightweight (2.2 kg), has a USB port that can be directly connected to a computer, and a BNC port that allows direct connection to microphones. For more information, visit the *data sheet* of HBK 2755.

With the Building Acoustics Partner license activated, the HBK 2255 is equipped to perform a full range of measurements, ranging from acoustic isolation in 1/1 or 1/3 octave bands to the analysis of reverberation time using interrupted noise or impulsive signals. The measurement process can be remotely controlled when connected to the Building Acoustics Partner mobile app, providing full workflow support. By informing the steps to be followed for each type of measurement and performing assessments immediately after the measurement is completed, the app reduces the chances of having to return to the construction site to redo the tests.

(a) Remote access.



(b) Data analysis.

Figure 7: Illustrations of using the HBK 2255 via *smartphone*.

The computer application helps in analyzing the measurements taken, generating a quick report for easy verification of the collected data. In the application, the user can define objective parameters that best suit their needs, such as RT or acoustic performance data ($D_{nT,\,\mathrm{w}}$, for example), to be presented in the report, which is automatically generated. To understand the complete measurement process, from setup to report, access the demonstration videos on the product page.

Extra: The HBK 2255 is also a complete solution for environmental noise measurements. When used in conjunction with HBK's Enviro Noise Partner software, data are easily organized, evaluated, and processed, providing assistance from the beginning to the end of the measurement process. The HBK 2255 provides analyses in octave (1/1 and 1/3) and narrow frequency bands, temporal logs, and recording of the measurement's audio [9]. Thus, HBK tools provide a complete solution for the acoustic analysis of real estate developments, from the local noise class to the performance of partitions.

6. Final remarks

In conclusion, this document has presented detailed methodologies and technical specifications for the measurement of various acoustic parameters in building environments. The importance of adhering to international standards and using precision equipment like the HBK 2255 sound level meter and its accessories has been emphasized. The integration of these tools with advanced software solutions, such as the Building Acoustics Partner, demonstrates the evolution of acoustic measurement, facilitating efficient, accurate, and user-friendly processes.

As the field of building acoustics continues to evolve, the need for accurate and reliable measurements becomes ever more critical. The technologies and methodologies discussed here provide the basis for such assessments, providing information so that the acoustic performance of buildings can meet the necessary standards and contribute positively to human comfort and well-being.

It is hoped that the information provided will serve as a valuable resource for professionals in the field, aiding in the pursuit of better acoustic environments. As we move forward, continuous advancements in technology and methodology are anticipated, which promise even greater precision, accuracy, and ease in the important work of acoustic measurement and analysis.

Acknowledgments

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