Design and Acoustics

Brought into Harmony

Acoustics Brochure
Sound absorption values
# Acoustic Ceilings

## Acoustics and sound absorption

### General principles

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Understanding acoustics

How does an acoustic design ceiling actually work? What is the meaning behind the technical term of sound absorption? How do you optimize room acoustics? You will find answers to these and many other theoretical questions around the subject "Acoustics in rooms" on the following pages.

This brochure will give you a small impression of what is behind a partial aspect of our motto "Design, colour and function": the highly effective sound absorption with Vogl acoustic design ceilings.

Sound absorption – range of applications

Sound absorption is the most important tool in the acoustic design of rooms. Absorbing and reflecting surfaces determine the acoustic behaviour of a room. There is no such thing as "good" or "bad" absorption, which is why standard requirements pertaining to the absorption of individual surfaces do not exist.

Only the knowledge of the structural conditions, the furnishing, the room volume and the planned utilisation can result in the "right" sound absorption. Depending on the different goals envisaged, there are three fields of application for absorption material:

Room acoustic design

When designing large rooms with sophisticated acoustics (opera, concert hall, theatre, lecture hall, ...), the precise arrangement of reflecting and absorbing surfaces is, in addition to the adequate quantity of absorption, of major significance. The room impression is determined not only by direct sound, but also, very essentially, by the relationship between early and late reflections (clarity index) and their input direction (lateral fraction). General conclusions to a "good" or "bad" absorption are not possible. The acoustician must treat every single project individually.

Noise reduction

The noise intensity in a room depends upon acoustic source and sound absorption. High noise loads, e.g. in factories or open-plan offices, call for as high an absorption as possible. The suitable absorption depends on the type of disturbing noise, with the reasonable amount usually being determined by a cost-benefit assessment.

Control of reverberation time

Music and speech should reach our ears in the same state they have been sent by the acoustic source (mouth, loudspeaker). This requires the same amount of absorption for every pitch. The required total amount is determined by room volume and room utilisation (library, office, classroom, ...).

In practice, most surfaces are already firmly installed before the acoustical design takes place. To add to this existing absorption, wall and ceiling cladding with different absorption behaviour is required. Usually, the existing absorption is low in the lower frequencies, but close to sufficient in high frequencies – which calls for surfaces providing more absorption in lower and less absorption in higher frequencies.
Pitch – frequency

Sound is mechanical vibration in the air, or a propagating change in air pressure. The distance between two points of the same phase is referred to as wavelength \( \lambda \) and the oscillations per second as frequency \( f \).

<table>
<thead>
<tr>
<th>Speed of sound in air ( c ) at -20 ºC</th>
</tr>
</thead>
<tbody>
<tr>
<td>( c = \lambda \cdot f = 343 \text{ m/s} = 1235 \text{ km/h} )</td>
</tr>
</tbody>
</table>

The frequency corresponds to the pitch perceived, with low-pitched tones having a low frequency and high-pitched tones a high frequency. The frequency range relevant in acoustics is broken down into 18 thirds (6 octaves).

<table>
<thead>
<tr>
<th>18 thirds (6 octaves) of room acoustics</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bottom third</strong></td>
</tr>
<tr>
<td><strong>Third / octave</strong></td>
</tr>
<tr>
<td><strong>Upper third</strong></td>
</tr>
</tbody>
</table>

All acoustic processes highly depend on the frequency. The fact that, in the past, calculations were only conducted at 500 or 1000 Hz is owed to a disproportionately high computational effort necessary for a frequency-dependent consideration, and by no means to any desired weighting. Nowadays, computer programs allow effortless calculations in third or octave steps.

If a sound wave hits a surface, part of the energy is reflected, and the other part is absorbed (converted to heat). This loss of energy is referred to as sound absorption.

The absorption coefficient indicates the relationship between absorbed and impacting energy, with a value of zero meaning total reflection, and the value of one meaning total absorption.

If you multiply the absorption coefficient \( \alpha \) of a material with its surface \( S \), you get the equivalent sound absorption area \( A \):

<table>
<thead>
<tr>
<th>Equivalent sound absorption area:</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A = \alpha \cdot S ) [m²]</td>
</tr>
</tbody>
</table>

Objects that do not have a clearly defined surface (furnishings, people) are characterized by their equivalent sound absorption area.

The total absorption \( A_{\text{total}} \) present in the room consisting of the absorption of surfaces (Wall, Floor, Ceiling) as well as the absorption of furnishings \( A_{\text{FU}} \), people \( A_{P} \) and air \( A_{A} \):

| Total equivalent sound absorption area \( A_{\text{total}} \):
<table>
<thead>
<tr>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_{\text{total}} = S_{W} \cdot \alpha_{W} + S_{F} \cdot \alpha_{F} + S_{C} \cdot \alpha_{C} + A_{\text{FU}} + A_{P} + A_{A} ) [m²]</td>
</tr>
</tbody>
</table>

Sound-absorbing elements in a room

Sound absorption

Absorption and reflection of surfaces

Absorption e.g. 75%

Reflection e.g. 25%
The total sound absorption $A_{\text{total}}$ divided by the total surface $S_{\text{total}}$ results in the average sound absorption coefficient $\bar{\alpha}$.

**Sabine equation**

The reverb time is the oldest and best-known criterion of room acoustics. It is defined as the time required for the sound pressure level to decrease by 60 dB after the acoustic source has been turned off.

In 1920 already, W. C. Sabine published an article on the fundamental relationship between reverb time $T$, room volume $V$ and equivalent absorption area $A$:

$$ T = 0.163 \frac{V}{A} = 0.163 \frac{V}{\bar{\alpha} \cdot S_{\text{total}}} \quad [\text{S}] $$

**In other words**: A decrease by 60 dB means a reduction of the acoustic energy to one millionth. Consequently, the reverb time approximately corresponds to the time it takes for a loud clapping to decay to inaudibility (in quiet rooms). The Sabine equation forms the basis for room acoustic calculations.

A precondition for the validity of this equation is a diffuse sound field, i.e. a uniform distribution of the sound energy throughout the room. It is fulfilled if:

- the sound absorption is distributed relatively evenly on all surfaces
- the existing average sound absorption is not too high ($\bar{\alpha} \leq 0.25$)
- the deviations from a cube-shaped room are not too great (aspect ratio up to approx. $1 : 5$)
- the room volume is smaller than 2000 m$^3$

**Diffusers**: If no diffuse sound field exists, diffusers can be used to create a diffuse sound field. In practice, it is usually furnishings and people - if present in adequate number - that ensure diffusivity. If the existing diffuse sound field is inadequate, the reverb time measured in the room can significantly deviate from the calculation.

Nowadays, computer software is available that simulates acoustic processes accurately. However, such software programs are very elaborate and are usually applied only for large rooms with complex acoustic requirements (opera houses, theatres, lecture halls, ...).

**Reverb time**

The reverb time is a general measure for the acoustic quality of a room because it allows conclusions to sound intensity and tone colour, clarity and transparency, reverberance and spatial impression.

For every room, there is a desirable reverb time depending on its purpose of use and its volume. The correlation between reverb time and equivalent absorption areas results in the requirement for absorption.

The total sound absorption $A_{\text{total}}$ divided by the total surface $S_{\text{total}}$ results in the average sound absorption coefficient $\bar{\alpha}$.

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For every room, there is a desirable reverb time depending on its purpose of use and its volume. The correlation between reverb time and equivalent absorption areas results in the requirement for absorption.
Note: High absorption does not necessarily have the effect of a better acoustic quality or intelligibility. In fact, the absorption of the individual surfaces must be harmonised with the desirable reverb time taking into account furnishings and number of people.

### Single number ratings

Single number ratings, i.e. mean values, are often necessary for practical reasons (but are inadequate for meaningful acoustic designs).

**The following three variations are commonly used in practice:**

**Arithmetic mean (i.M.) value \( \alpha_{i.M.} \)**
The 18 third values (6 octave values) are added and divided by 18 (6).

**Noise Reduction Coefficient NRC**
The US standard ASTM C 423 "Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method" corresponds to the standard DIN EN ISO 354 "Measurement of sound absorption in a reverberation room". ASTM C 423 additionally includes the determination of a single number:

The 4 third values at 250, 500, 1000 and 2000 Hz are added and divided by 4. The result is rounded in increments of 0.05.

**Rated sound absorption \( \alpha_W \)**
As opposed to the US standard ASTM C 423, the German standard DIN EN ISO 354 does not contain any single number ratings. Since 1997, DIN EN ISO 11654 "Sound absorption for application in buildings" exists, which forms a single number from the measured values (according to DIN EN ISO 354):

First, the three third values of each octave are averaged and rounded in increments of 0.05. The resulting six values, practical absorption coefficient \( \alpha_P \), replace the measured values.

Then, the reference curve (see example) is shifted downwards (in increments of 0.05) until the total of values below the reference curve is smaller than or equal to 0.10. The rated absorption coefficient \( \alpha_W \) is the value of the reference curve at 500 Hz. If \( \alpha_P \) in one (or more) frequencies is above the shifted reference curve by 0.25 or more, \( \alpha_W \) must be supplemented by one (or more) shape indicators: L (low) at 250 Hz, M (middle) at 500 or 1000 Hz, H (high) at 2000 or 4000 Hz. The (informative) Appendix B of DIN EN ISO 11654 includes a classification of the single number rating, i.e. \( \alpha_W \) is broken down into absorption classes:

| Classification of absorbers as per DIN EN ISO 11654 |
|-----------------|-----------------|
| Class           | \( \alpha_W \)  |
| A               | 0.90 ... 1.00   |
| B               | 0.80 ... 0.85   |
| C               | 0.60 ... 0.75   |
| D               | 0.30 ... 0.55   |
| E               | 0.15 ... 0.25   |
| n.c.            | 0.00 ... 0.10   |

n.c.: not classified

**Example:** Cotton curtain (stretched), \( h = 70 \) mm:

<table>
<thead>
<tr>
<th>Frequencies [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean values</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \alpha_{i.M.} )</td>
<td>0.50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NRC</td>
<td>0.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( \alpha_W )</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Order service** 05/12

Vogl Deckensysteme GmbH Industriestrasse 10, D-91448 Emskirchen, Germany, Phone +49(0)9104-825-0, Fax +49(0)9104-825-250 Phone +49(0)9104-825-121, Fax +49(0)9104-825-252, info@vogl-ceilingsystems.com
Good speech intelligibility is the prerequisite for an agreeable communication between teacher and pupils. Poor speech intelligibility requires increased concentration, diminishes performance and reduces the effectiveness of lessons.

The requirement for good speech intelligibility is an appropriate reverb time. DIN 18041 "Acoustic quality in small to medium-sized rooms" contains the relevant guideline values.

The reverberation that people subjectively perceive as pleasant depends on the size of the room. The smaller the room, the shorter the reverb time should be. In larger rooms, we also expect a greater reverb time.

From the required reverb time $T$ and room volume $V$, the necessary absorption $A$ can be calculated:

$$ A = 0.163 \cdot \frac{V}{T} \quad [m^2] $$

Absorption $A$ results from the total partial surfaces (Wall, Floor, Ceiling) multiplied with their absorption factor $\alpha$ as well as the absorption of furnishings $A_{FU}$, people $A_p$ and air $A_a$:

$$ A_{total} = S_w \cdot \alpha_w + S_f \cdot \alpha_f + S_c \cdot \alpha_c + A_{FU} + A_p + A_a \quad [m^2] $$

**Conclusion:** A high absorption coefficient does not necessarily lead to better room acoustics or intelligibility. In fact, the absorption of the individual surfaces must be harmonised with the desirable reverb time taking into account existing furnishings and number of people.
In large lecture halls (exceeding 80 m² / 250 m³ / 50 people), the following measures should be taken:

- Absorbing design of the ceiling frieze as well as of the upper areas of side and rear walls
- Reflecting ceiling plan to allow the sound to be directed towards the rear of the room
- Additional reflectors on front and rear wall

Only the ceiling is left to optimise the reverberation. The selection of an optimum ceiling is based on the required reverb time, the fixed room volume and the existing basic equipment. Measuring results from a classroom (see graphic) give impressive evidence of this.

In small classrooms (< 60 m² / 200 m³ / 30 children), i.e. if the distance between teacher and pupils is smaller, you may cut down on acoustic details in order to save costs:

- Absorbers on rear and side walls may be omitted if, in turn, the entire ceiling surface is designed with absorbing features
- Reflectors may be omitted in view of the small distance

Due to the large number of people, lecture halls have a small requirement of additional absorption in the high frequency range. Therefore, high-absorption ceilings are sensible in case of low frequencies, and vice versa.

Virtually all classrooms have the same basic equipment in terms of acoustics:

- **Floor:** PVC, linoleum, wood
- **Walls:** plaster, wallpaper, glass
- **Furnishings:** Tables and chairs of wood, plastic and/or metal

With the curve of absorption being ideal for the classroom, the reverberation is reduced to the right balance. At the same time, the high frequencies essential for intelligibility are adequately reflected in the rear area of the classroom.

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**Arrangement of sound absorption**

Ceiling

Rear wall

Floor

**Positioning of reflectors**

Arrangement in small rooms

---

**Measured reverb time in the classroom**

Smooth ceiling: w/o children 24 children

Acoustic ceiling: w/o children 24 children

Recommended reverb time, DIN 18041

---

**Absorption of ceiling**

α [-] Smooth ceiling Acoustic ceiling

Reflection of high frequencies by drop in curve
## Sound absorption in the laboratory

The measurement is performed in a so-called reverberation room. This room is equipped with diffusers such that a diffuse sound field results. Diffusers normally consist of slightly curved metal plates 1 to 3 m² in size, distributed throughout the room in random arrangement.

Measuring procedure and room characteristics are standardized worldwide according to DIN EN ISO 354. The sound absorption is determined in three steps:

- Measuring the reverb time in the empty room
- Measuring the reverb time with test specimen
- Calculating the absorption from the difference of the two measurements

The sound absorption is calculated based on the Sabine equation because the diffusion given is optimal – and the reverb time is changed only through the test specimen.

**Note:** The test specimen is usually located on the floor, no matter whether it is a wall or ceiling cladding, or flooring. This facilitates the installation and has no impact on the measured value.

## Sound absorption in construction work

The reverb time is measured according to DIN EN ISO 3382 "Measuring of reverberation time in rooms with reference to other acoustic parameters". The total absorption in the room can be calculated from the measured reverb time. However, the absorption coefficient of each of the partial areas can only be roughly estimated. The precision of these estimations can vary greatly, for which there are three reasons:

- Within a room, there are numerous different kinds of surfaces, i.e. the determination of the absorption of a specific surface area requires that the absorption of all other surfaces is either negligibly small, or sufficiently well known (which is actually often the case in practice!).
- The sound field is not sufficiently diffuse. Often enough, one room direction (ceiling – floor) is much more strongly damped than the others, i.e. an even distribution of the absorption is not ensured. An inaccuracy of almost random size can result from this fact.
- The reverb time is measured according to DIN EN ISO 3382 in the ready-for-use state (with or without people). However, the absorption of the furnishings is usually neither negligibly small nor sufficiently known. If the measurements are carried out in an (almost) empty room (which is often the case in practice) the problem is mostly insufficient diffusivity.
Acoustic Ceilings
Sound absorption
Acoustic design panel 6/18R

- Determination of the sound absorption coefficient as per DIN EN ISO 354
- Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 9.10 \text{ kg/m}^2 \)
Perforated area: \( 8.7 \% \)
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Octave centre frequency [Hz]  125  250  500  1000  2000  4000
Sound absorption coefficient \( \alpha_s \)  0.32  0.43  0.56  0.51  0.49  0.50

Octave centre frequency [Hz]  125  250  500  1000  2000  4000
Sound absorption coefficient \( \alpha_s \)  0.36  0.47  0.55  0.55  0.54  0.54

Back of panel laminated with
Acoustic fleece AV 2010
Rated sound absorption \( \alpha_w = 0.55 \)
sound absorption class D
(absorbing)

Single number rating as per ASTM C 423: SAA = 0.51
Classification as per ASTM E 1264: NRC = 0.50
Air gap: 200 mm

Back of panel laminated with
Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm
Rated sound absorption \( \alpha_w = 0.55 \)
sound absorption class D
(absorbing)

Single number rating as per ASTM C 423: SAA = 0.53
Classification as per ASTM E 1264: NRC = 0.55
Air gap: 200 mm

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Phone +49(0)9104-825-121, Fax +49(0)9104-825-252, info@vogl-ceilingsystems.com
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: th = 12.5 mm
Mass per unit area: 8.50 kg/m²
Perforated area: 15.5 %
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with
Acoustic fleece AV 2010
Rated sound absorption $\alpha_w = 0.70$
sound absorption class C
(highly absorbing)
Single number rating as per ASTM C 423: SAA = 0.67
Classification as per ASTM E 1264: NRC = 0.65
Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient $\alpha_s$</td>
<td>0.31</td>
<td>0.61</td>
<td>0.74</td>
<td>0.67</td>
<td>0.63</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Back of panel laminated with
Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm
Rated sound absorption $\alpha_w = 0.75$
sound absorption class C
(highly absorbing)
Single number rating as per ASTM C 423: SAA = 0.72
Classification as per ASTM E 1264: NRC = 0.70
Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency (Hz)</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient $\alpha_s$</td>
<td>0.38</td>
<td>0.66</td>
<td>0.74</td>
<td>0.73</td>
<td>0.74</td>
<td>0.75</td>
</tr>
</tbody>
</table>
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 8.50 \text{ kg/m}^2 \)
Perforated area: \( 14.8\% \)
Material class as per DIN 4102: A2, “non-inflammable”
Fire behaviour as per DIN EN 13501: A2-s1, d0

Octave centre frequency [Hz] | 125 | 250 | 500 | 1000 | 2000 | 4000
---|---|---|---|---|---|---
Sound absorption coefficient \( \alpha_s \) | 0.31 | 0.60 | 0.72 | 0.63 | 0.61 | 0.61

Octave centre frequency [Hz] | 125 | 250 | 500 | 1000 | 2000 | 4000
---|---|---|---|---|---|---
Sound absorption coefficient \( \alpha_s \) | 0.37 | 0.63 | 0.71 | 0.71 | 0.72 | 0.72
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 8.20 \text{ kg/m}^2 \)
Perforated area: \( 18.1\% \)
Material class as per DIN 4102: A2, "non-inflammable"  
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with
Acoustic fleece AV 2010

Rated sound absorption \( \alpha_w = 0.70 \)
sound absorption class C  
(highly absorbing)

Single number rating as per ASTM C 423: \( SAA = 0.69 \)
Classification as per ASTM E 1264: \( NRC = 0.70 \)

Air gap: 200 mm

Octave centre frequency [Hz]  
\[ \begin{array}{cccccc}
125 & 250 & 500 & 1000 & 2000 & 4000 \\
\hline
0.31 & 0.63 & 0.77 & 0.67 & 0.66 & 0.52 \\
\end{array} \]

Back of panel laminated with
Acoustic fleece AV 2010 backed with glass wool
Mineral wool panel SSP 1, 30 mm

Rated sound absorption \( \alpha_w = 0.80 \)
sound absorption class B  
(extremely absorbing)

Single number rating as per ASTM C 423: \( SAA = 0.75 \)
Classification as per ASTM E 1264: \( NRC = 0.75 \)

Air gap: 200 mm

Octave centre frequency [Hz]  
\[ \begin{array}{cccccc}
125 & 250 & 500 & 1000 & 2000 & 4000 \\
\hline
0.37 & 0.69 & 0.76 & 0.75 & 0.79 & 0.69 \\
\end{array} \]
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654
Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 8.00 \text{ kg/m}^2 \)
Perforated area: \( 19.6\% \)
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with
Acoustic fleece AV 2010

Rated sound absorption \( \alpha_w = 0.75 \)
sound absorption class C
(highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.69
Classification as per ASTM E 1264: NRC = 0.70

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.30</td>
<td>0.63</td>
<td>0.79</td>
<td>0.69</td>
<td>0.63</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Back of panel laminated with
Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm

Rated sound absorption \( \alpha_w = 0.80 \)
sound absorption class B
(extremely absorbing)

Single number rating as per ASTM C 423: SAA = 0.77
Classification as per ASTM E 1264: NRC = 0.75

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.37</td>
<td>0.70</td>
<td>0.80</td>
<td>0.77</td>
<td>0.82</td>
<td>0.76</td>
</tr>
</tbody>
</table>
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: th = 12.5 mm
Mass per unit area: 8.70 kg/m²
Perforated area: 13.1 %
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with Acoustic fleece AV 2010
Rated sound absorption αw = 0.65
sound absorption class C
(highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.62
Classification as per ASTM E 1264: NRC = 0.60
Air gap: 200 mm

Octave centre frequency [Hz] | 125 | 250 | 500 | 1000 | 2000 | 4000
Sound absorption coefficient αs | 0.32 | 0.57 | 0.67 | 0.60 | 0.56 | 0.51

Back of panel laminated with Acoustic fleece AV 2010 backed with glass wool
Mineral wool panel SSP 1, 30 mm
Rated sound absorption αw = 0.70
sound absorption class C
(highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.66
Classification as per ASTM E 1264: NRC = 0.65
Air gap: 200 mm

Octave centre frequency [Hz] | 125 | 250 | 500 | 1000 | 2000 | 4000
Sound absorption coefficient αs | 0.38 | 0.58 | 0.68 | 0.68 | 0.68 | 0.62
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 8.00 \text{ kg/m}^2 \)
Perforated area: 19.6 %
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with Acoustic fleece AV 2010
Rated sound absorption \( \alpha_w = 0.70 \)
sound absorption class C
(highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.69
Classification as per ASTM E 1264: NRC = 0.70

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.30</td>
<td>0.63</td>
<td>0.81</td>
<td>0.70</td>
<td>0.59</td>
<td>0.60</td>
</tr>
</tbody>
</table>

Back of panel laminated with Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm
Rated sound absorption \( \alpha_w = 0.80 \)
sound absorption class B
(extremely absorbing)

Single number rating as per ASTM C 423: SAA = 0.77
Classification as per ASTM E 1264: NRC = 0.75

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.37</td>
<td>0.71</td>
<td>0.81</td>
<td>0.80</td>
<td>0.73</td>
<td>0.74</td>
</tr>
</tbody>
</table>
- Determination of the sound absorption coefficient as per DIN EN ISO 354
- Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( \text{th} = 12.5 \text{ mm} \)
Mass per unit area: \( 8.00 \text{ kg/m}^2 \)
Perforated area: \( 19.8\% \)
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with
**Acoustic fleece AV 2010**

Rated sound absorption \( \alpha_w = 0.75 \)
sound absorption class C
(highly absorbing)

Single number rating as per ASTM C 423: \( \text{SAA} = 0.72 \)
Classification as per ASTM E 1264: \( \text{NRC} = 0.70 \)

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.29</td>
<td>0.65</td>
<td>0.83</td>
<td>0.69</td>
<td>0.69</td>
<td>0.70</td>
</tr>
</tbody>
</table>

Back of panel laminated with
**Acoustic fleece AV 2010**
backed with glass wool
**Mineral wool panel SSP 1, 30 mm**

Rated sound absorption \( \alpha_w = 0.85 \)
sound absorption class B
(extremely absorbing)

Single number rating as per ASTM C 423: \( \text{SAA} = 0.80 \)
Classification as per ASTM E 1264: \( \text{NRC} = 0.80 \)

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.37</td>
<td>0.73</td>
<td>0.83</td>
<td>0.80</td>
<td>0.84</td>
<td>0.84</td>
</tr>
</tbody>
</table>
• Determination of the sound absorption coefficient as per DIN EN ISO 354
• Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( \text{th} = 12.5 \text{ mm} \)
Mass per unit area: 7.70 kg/m²
Perforated area: 23.0 %
Material class as per DIN 4102: A2, “non-inflammable”
Fire behaviour as per DIN EN 13501: A2-s1, d0

Octave centre frequency [Hz]  125  250  500  1000  2000  4000
Sound absorption coefficient \( \alpha_s \)  0.29  0.68  0.82  0.70  0.72  0.66

Octave centre frequency [Hz]  125  250  500  1000  2000  4000
Sound absorption coefficient \( \alpha_s \)  0.37  0.72  0.85  0.82  0.92  0.85

Back of panel laminated with
Acoustic fleece AV 2010
Rated sound absorption \( \alpha_w = 0.75 \)
sound absorption class C
(highly absorbing)
Single number rating as per ASTM C 423: SAA = 0.74
Classification as per ASTM E 1264: NRC = 0.75
Air gap: 200 mm

Back of panel laminated with
Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm
Rated sound absorption \( \alpha_w = 0.90 \)
sound absorption class A
(extremely absorbing)
Single number rating as per ASTM C 423: SAA = 0.83
Classification as per ASTM E 1264: NRC = 0.85
Air gap: 200 mm
Determination of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \(\text{th} = 12.5 \text{ mm}\)
Mass per unit area: \(9.10 \text{ kg/m}^2\)
Perforated area: \(9.5\%\)
Material class as per DIN 4102: \(\text{A2, "non-inflammable"}\)
Fire behaviour as per DIN EN 13501: \(\text{A2-s1, d0}\)

Back of panel laminated with
Acoustic fleece AV 2010

Rated sound absorption \(\alpha_w = 0.55\)
sound absorption class \(\text{D}\)
(absorbing)

Single number rating as per ASTM C 423: \(\text{SAA} = 0.52\)
Classification as per ASTM E 1264: \(\text{NRC} = 0.50\)
Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient (\alpha_s)</td>
<td>0.32</td>
<td>0.48</td>
<td>0.58</td>
<td>0.54</td>
<td>0.44</td>
<td>0.43</td>
</tr>
</tbody>
</table>

Back of panel laminated with
Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm

Rated sound absorption \(\alpha_w = 0.60\)
sound absorption class \(\text{C}\)
(highly absorbing)

Single number rating as per ASTM C 423: \(\text{SAA} = 0.54\)
Classification as per ASTM E 1264: \(\text{NRC} = 0.55\)
Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient (\alpha_s)</td>
<td>0.37</td>
<td>0.49</td>
<td>0.57</td>
<td>0.57</td>
<td>0.52</td>
<td>0.51</td>
</tr>
</tbody>
</table>
Determinative of the sound absorption coefficient as per DIN EN ISO 354
Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 8.90 \text{ kg/m}^2 \)
Perforated area: \( 11.0\% \)
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with
Acoustic fleece AV 2010
Rated sound absorption \( \alpha_w = 0.55 \)
Sound absorption class D (absorbing)

Single number rating as per ASTM C 423: SAA = 0.55
Classification as per ASTM E 1264: NRC = 0.55

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.31</td>
<td>0.53</td>
<td>0.66</td>
<td>0.52</td>
<td>0.42</td>
<td>0.41</td>
</tr>
</tbody>
</table>

Back of panel laminated with
Acoustic fleece AV 2010
backed with glass wool
Mineral wool panel SSP 1, 30 mm
Rated sound absorption \( \alpha_w = 0.60 \)
Sound absorption class C (highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.58
Classification as per ASTM E 1264: NRC = 0.55

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.37</td>
<td>0.54</td>
<td>0.63</td>
<td>0.60</td>
<td>0.53</td>
<td>0.50</td>
</tr>
</tbody>
</table>
- Determination of the sound absorption coefficient as per DIN EN ISO 354
- Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 7.9 \text{ kg/m}^2 \)
Perforated area: \( 21.5\% \)
Material class as per DIN 4102: A2, "non-inflammable"
Fire behaviour as per DIN EN 13501: A2-s1, d0

Back of panel laminated with
**Acoustic fleece AV 2010**

Rated sound absorption \( \alpha_w = 0.70 \)
Sound absorption class C  
(highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.71
Classification as per ASTM E 1264: NRC = 0.70

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.29</td>
<td>0.69</td>
<td>0.86</td>
<td>0.65</td>
<td>0.60</td>
<td>0.63</td>
</tr>
</tbody>
</table>

Back of panel laminated with
**Acoustic fleece AV 2010 +**  
backed with glass wool
**Mineral wool panel SSP 1, 30 mm**

Rated sound absorption \( \alpha_w = 0.85 \)
Sound absorption class B  
(extremely absorbing)

Single number rating as per ASTM C 423: SAA = 0.83
Classification as per ASTM E 1264: NRC = 0.85

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.42</td>
<td>0.78</td>
<td>0.88</td>
<td>0.82</td>
<td>0.85</td>
<td>0.83</td>
</tr>
</tbody>
</table>
Acoustic Ceilings
Sound absorption
Acoustic plaster system panel 12/25Q

- Determination of the sound absorption coefficient as per DIN EN ISO 354
- Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( \text{th} = 12.5 \text{ mm} \)
Mass per unit area: \( 7.7 \text{ kg/m}^2 \)
Perforated area: \( 22.9 \% \)
Material class as per DIN 4102: A2, “non-inflammable”
Fire behaviour as per DIN EN 13501: A2-s1, d0

System structure: Wall papered with plaster base fleece on site and finished with VoglToptec® acoustic plaster Nano SF

Back of panel laminated with Acoustic fleece AV 2010

Rated sound absorption \( \alpha_w = 0.75 \)
sound absorption class C
(highly absorbing)

Single number rating as per ASTM C 423: SAA = 0.73
Classification as per ASTM E 1264: NRC = 0.70

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.29</td>
<td>0.68</td>
<td>0.87</td>
<td>0.64</td>
<td>0.67</td>
<td>0.75</td>
</tr>
</tbody>
</table>

Back of panel laminated with Acoustic fleece AV 2010 + Mineral wool panel SSP 1, 30 mm

Rated sound absorption \( \alpha_w = 0.90 \)
sound absorption class A
(extremely absorbing)

Single number rating as per ASTM C 423: SAA = 0.85
Classification as per ASTM E 1264: NRC = 0.85

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_s )</td>
<td>0.42</td>
<td>0.79</td>
<td>0.91</td>
<td>0.83</td>
<td>0.90</td>
<td>0.88</td>
</tr>
</tbody>
</table>
Acoustic Ceilings

Sound absorption

Ultrasonic panel 12/25R DLV

- Determination of the sound absorption coefficient as per DIN EN ISO 354
- Rating of sound absorption as per DIN EN ISO 11654

Panel thickness: \( th = 12.5 \text{ mm} \)
Mass per unit area: \( 6.5 \text{ kg/m}^2 \)
Perforated area: \( 35.3 \% \)
Material class as per DIN 4102: A2, “non-inflammable”
Fire behaviour as per DIN EN 13501: A2-s1, d0

System structure: Wall-pasted with plaster base fleece on site and finished with VoglToptec\textsuperscript{®} acoustic plaster Nano SF

### Ultrasonic Panel 12/25R DLV

Back of panel laminated with

**Acoustic fleece AV 2010**

Rated sound absorption \( \alpha_w = 0.80 \)

Sound absorption class B

(Extremely absorbing)

Single number rating as per ASTM C 423: \( \text{SAA} = 0.75 \)

Classification as per ASTM E 1264: \( \text{NRC} = 0.75 \)

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_S )</td>
<td>0.24</td>
<td>0.65</td>
<td>0.87</td>
<td>0.67</td>
<td>0.74</td>
<td>0.80</td>
</tr>
</tbody>
</table>

Back of panel laminated with

**Acoustic fleece AV 2010 + Mineral wool panel SSP 1, 30 mm**

Rated sound absorption \( \alpha_w = 0.95 \)

Sound absorption class A

(Extremely absorbing)

Single number rating as per ASTM C 423: \( \text{SAA} = 0.91 \)

Classification as per ASTM E 1264: \( \text{NRC} = 0.90 \)

Air gap: 200 mm

<table>
<thead>
<tr>
<th>Octave centre frequency [Hz]</th>
<th>125</th>
<th>250</th>
<th>500</th>
<th>1000</th>
<th>2000</th>
<th>4000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sound absorption coefficient ( \alpha_S )</td>
<td>0.41</td>
<td>0.81</td>
<td>0.94</td>
<td>0.90</td>
<td>1.00</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Acoustic Ceilings

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I have a specific project. Could your project consultant please contact me to arrange an appointment.

I would like to register for the free e-mail newsletter. The newsletter can be cancelled at any time.

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Postcode/Town/City
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Fax
E-mail

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info@vogl-ceilingsystems.com
www.vogl-ceilingsystems.com

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