

# Knowledge Guide

## Room Acoustic Design with Free-Hanging Units



## 1. Sound absorbing free-hanging units

The use of free-hanging units provides flexibility and a multitude of acoustical solutions to acoustical design. Free-hanging units are an efficient way to add absorption into a room. Where free-hanging units are used to improve poor acoustics, solitary units give the benefit of sound distributed around the panels meaning that a larger area of the absorbing patches being exposed to the sound field.

In large, noisy environments such as open-plan areas, restaurants, shopping centres etc., free-hanging units can be installed close to working areas or other locations where acoustical treatment is needed in order to achieve suitable conditions for communication, concentration or recovery. Free-hanging units contribute to create specific, localised sound environment inside large premises. Such premises can be, for instance, reception and information counters or refreshment areas, included in larger, noisy spaces.

In premises where, for various reasons, an overall ceiling cannot be used, e.g. where temperature is regulated via concrete slabs (thermally activated building systems, TABS) or where there are large areas of glass, absorbent islands is one way of creating good acoustic environments. The absorbent islands can be designed as horizontally suspended units or as baffles.

Absorbing islands can also be used in environments where absorbing ceilings do not provide sufficient absorption. By supplementing with suspended horizontal absorbers or baffles, the acoustic environment can be improved with a reduction of the sound level and a diminishing of sound propagation in the room.

Around a free-hanging unit, the acoustical effect is manifested as:

- Noise reduction in the vicinity of free-hanging units
- Increased speech clarity
- Shorter reverberation time
- Increased directional hearing

In open-plan spaces, free-hanging units can be used as a complement to wall-to-wall acoustical ceilings. Installing free-hanging units above workplaces will, in addition to the effects listed above, reduce sound propagation across large distances and contribute to increased privacy between working groups.

The subjective effects of free-hanging units are:

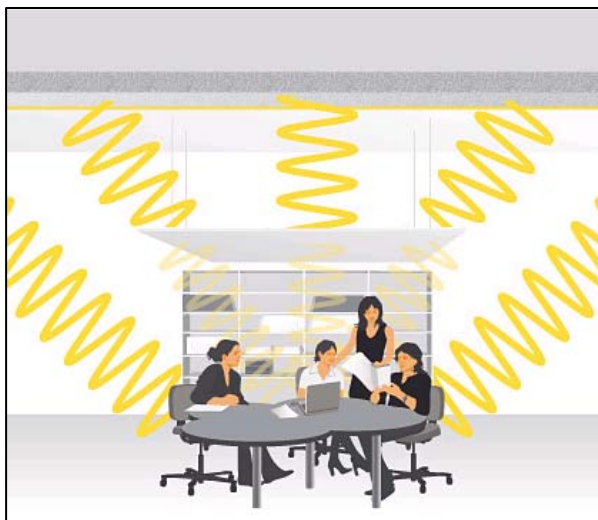
- Increased speech and listening comfort
- Reduced stress and stress-related symptoms
- Less vocal effort
- Easier to concentrate

**Note:** A complete ceiling wall-to-wall is from an acoustically point of view generally a better solution than free-hanging units. This is especially emphasized at low frequencies.

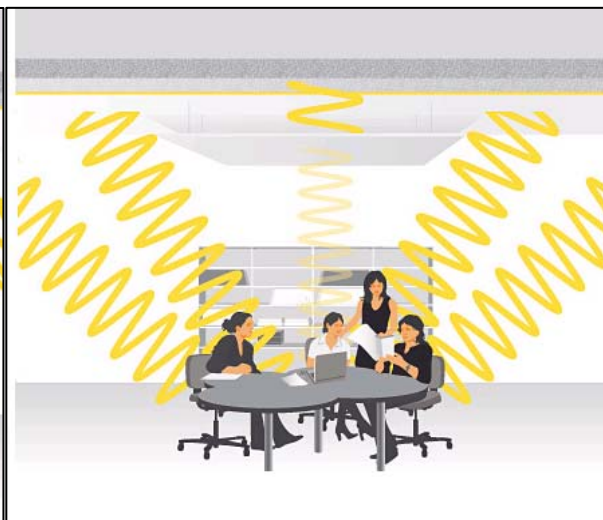
## 2. Acoustic design with free-hanging units

- In cases where the free-hanging units are used as solitary islands above workplaces, the absorbers should be installed as close to the workplace as possible, thus shielding the diffuse background noise as much as possible. The free-hanging units should cover the working area, preferably with a slight overlap.
- When using free-hanging units as a complement to wall-to-wall acoustical ceiling, it is often better to split the free-hanging units into smaller patches and distribute these over the total ceiling area than to use larger free-hanging units irregularly over the ceiling. Division into smaller patches such as Ecophon Solo will contribute to a more diffuse sound field which generally is perceived as a positive acoustic quality.
- If a workplace is near reflecting walls, the recommendation is to use wall absorbers as a complement to the Ecophon Solo free-hanging units.
- Free-hanging units increase the ability to localise sound sources in the vicinity of a workplace. This will increase the sensation of control and create a less stress-induced environment.

Low installation



High installation



The installation of free-hanging units can significantly improve the acoustic conditions in reverberant rooms. The improvement depends on the number of units as well as on the placement of the panels.

If the free-hanging units are mounted in an array (cluster) the absorption area per free hanging unit will depend on the distance between the units. Putting the panels very close to each other will somewhat decrease the absorption area per unit. At distances of approximately 500 mm or more between the units in an array, the absorption area per unit will correspond to a single unit and there will be no reducing effect due to the array mounting



Ceiling	No ceiling Exposed structure	Ecophon Solo 30 % covering of ceiling area	Ecophon Solo 60 % covering of ceiling area	Full ceiling Master A/alpha
		41 pieces 1200 x 1200 or 20 pieces 1200 x 2400	83 pieces 1200x1200 or 41 pieces 1200 x 2400	
Reverberation time	3.0 s	0.9 s	0.6 s	0.5 s
Reverberation time improvement	ref	70%	80%	83%
Speech Clarity (Definition)	21%	54%	68%	75%
Noise reduction in room	ref	- 5 dB	- 6 dB	- 8 dB

The effect of different covering with Ecophon Solo products compared to a complete ceiling is shown in the table. The values in the table refer to an average of the mid frequencies 500 Hz and 1000 Hz. The volume of the room is height x width x length = 4m x 10m x 20m. A complete ceiling is advantageous concerning the absorption at low frequencies. As a complement to free-hanging units, Ecophon Wall Panels is therefore recommended.

### 3. Sound absorption and different shape of Ecophon Solo

On the acoustic characterization of Ecophon Solo and similar free-hanging units the procedure differs from that used for planar acoustic ceilings. The practical absorption coefficient commonly used for wall-to-wall ceilings is not appropriate for characterisation of the absorbing efficiency of free-hanging units. The main reasons for this are:

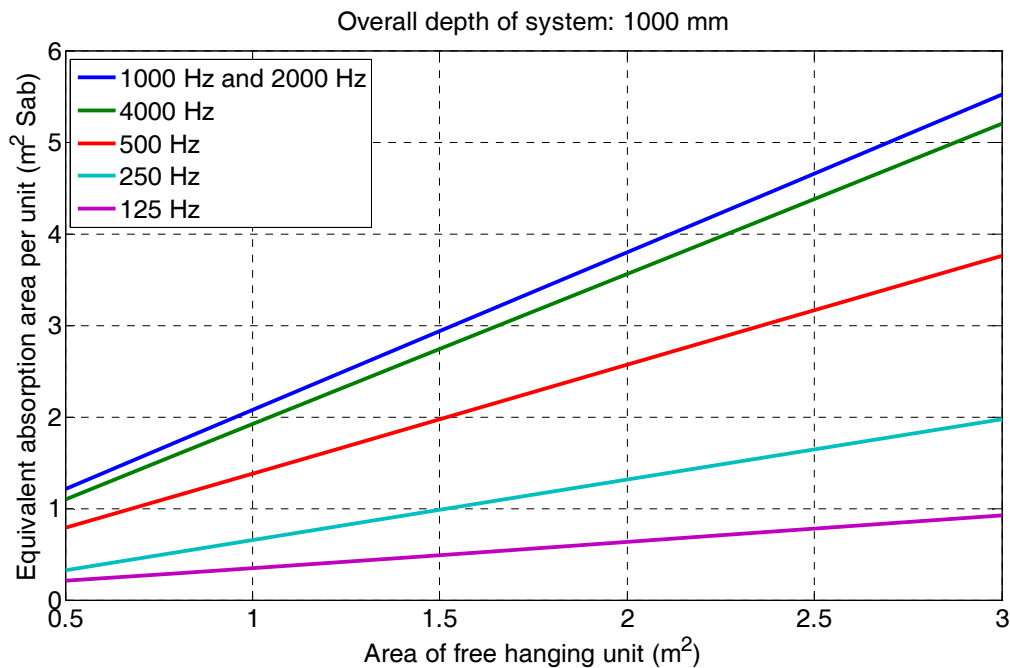
- All surfaces of an Ecophon Solo unit are more or less exposed for sound. Since it's difficult to determine to which degree different surfaces are exposed for sound it's not evident how to define the exposed area. To calculate a practical absorption coefficient it's necessary to be able to determine the area exposed for sound. This is easy for a planar absorbent ceiling since only one side is exposed for sound incidence.
- The Ecophon Solo units exist for a large range of sizes and shapes. Normally the sizes of free-hanging units are small compared to acoustic ceilings and this causes diffraction phenomena that make the use of practical absorption coefficient inappropriate. The absorbing efficiency of the free-hanging unit will depend on the area and to some degree of the shape of the tiles. This is not the case for planar absorbent ceilings which are specified by the absorption coefficient that are assumed independent of the ceiling area.

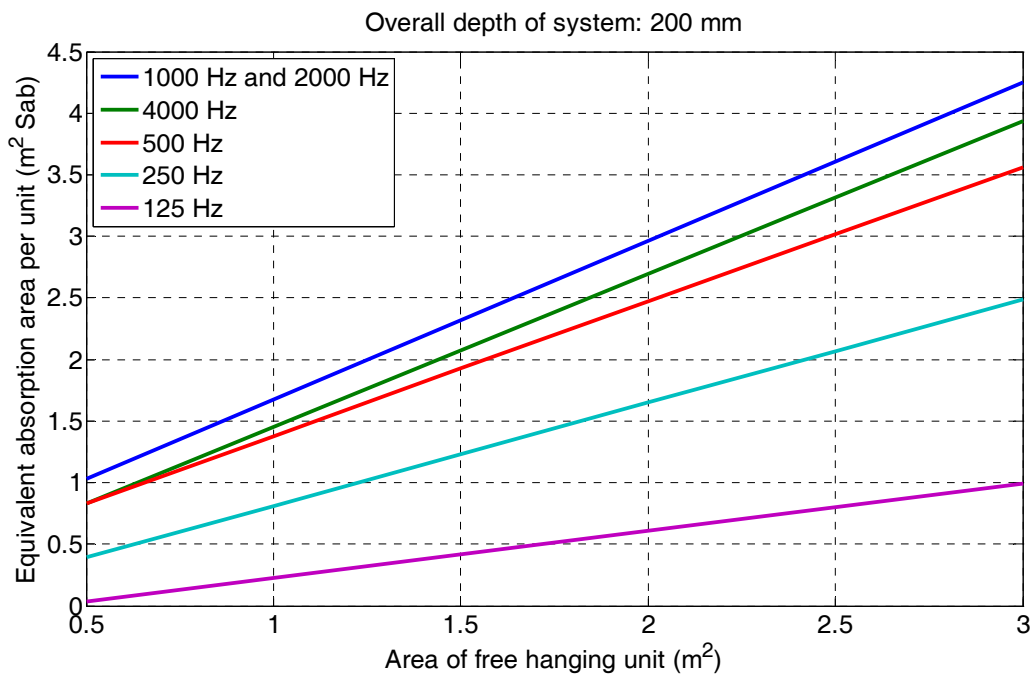
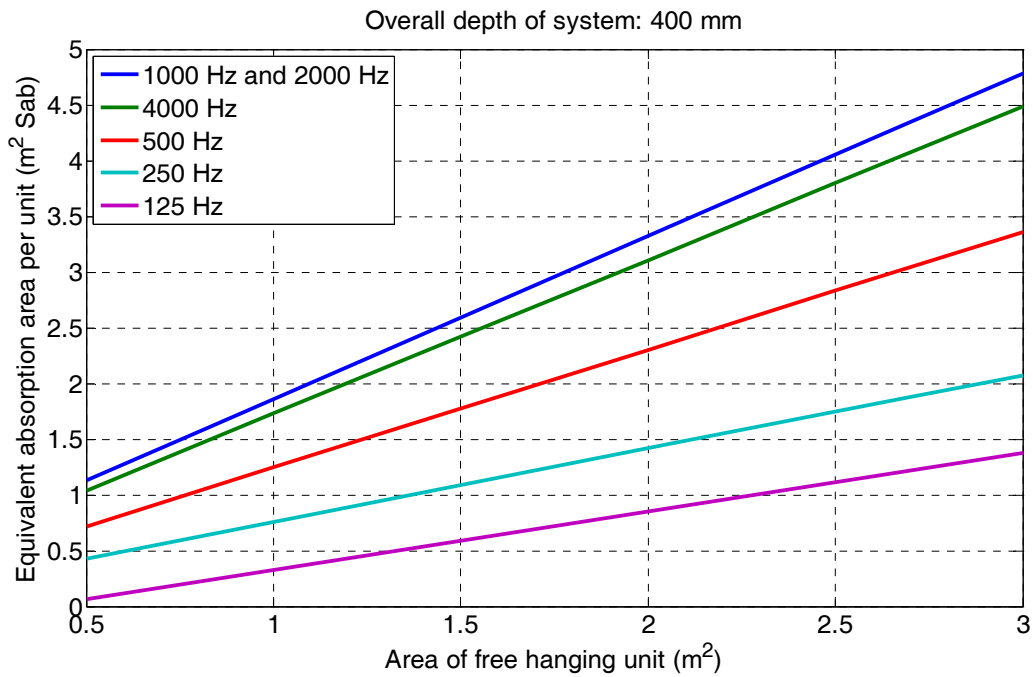
According to ISO 354 the absorbing efficiency of discrete objects like Ecophon Solo are characterised by the equivalent absorption area denoted  $A$ . The unit is  $\text{m}^2$ . Sometimes the unit is expressed as  $\text{m}^2 \text{Sab}$  or  $\text{m}^2 \text{Sabin}$  just to emphasize that there is a difference between the equivalent absorption area and the real physical area of the object. The measure is emanating from the classical Sabine formula which explains the extension Sab or Sabin. The equivalent absorption area corresponds to an area with an absorption coefficient of 1 i.e. totally absorbent, that absorbs the same amount of sound energy as the actual object. This is the reason why the equivalent absorption area sometimes is called 'open window' area referring to that an open window absorbs all incident sound energy. For example a free-hanging unit with an equivalent absorption area of  $1 \text{ m}^2 \text{Sab}$  absorbs the same amount of sound energy as an open window with an area of  $1 \text{ m}^2$ . Observe, depending on the absorbing efficiency of the free-hanging unit, the actual area of the unit could differ from  $1 \text{ m}^2$ .

Normally, the equivalent absorption area for free-hanging units is given for the octave bands from 125 Hz to 4000 Hz.

For the range of free-hanging products offered from Ecophon some general statements concerning the acoustic behaviour can be determined. The absorption area of an Ecophon Solo unit depends on the distance between the ceiling and the unit. Increasing the distance between the ceiling and the Ecophon Solo unit will normally increase the absorption area at medium and high frequencies i.e. between 500 Hz and 4000 Hz. At a certain distance, approximately 1 meter, there is no additional effect of increased distance and the maximum absorption area is reached.

Besides the distance from the ceiling, the absorption area is mainly dependent on the size of the free-hanging unit. The shape is generally of minor importance. An estimated relation between the panel area and the equivalent absorption area is shown in the diagrams.





**Example:** Estimate the equivalent absorption area per unit for an Ecophon Solo panel with the area 2 m<sup>2</sup> and an overall depth of 1 meter.

The top figure gives the following result.

Frequency	125 Hz	250 Hz	500 Hz	1000 Hz	2000 Hz	4000 Hz
A, m <sup>2</sup> Sab	0.6	1.3	2.6	3.8	3.8	3.6



A SOUND EFFECT ON PEOPLE

*Ecophon dates back to 1958, when the first sound absorbers from glass wool were produced in Sweden to improve the acoustic working environment. Today the company is a global supplier of acoustic systems that contribute to good room acoustics and a healthy indoor environment with the focus on offices, education, health care and industrial manufacturing premises. Ecophon is part of the Saint-Gobain Group and has sales units and distributors in many countries.*

*Ecophon's efforts are guided by a vision of earning global leadership in acoustic ceiling and wall absorber systems by providing superior end user value. Ecophon maintains an ongoing dialogue with government agencies, working environment organisations and research institutes, and is involved in formulating national standards in the field of room acoustics where Ecophon contributes to a better working environment wherever people work and communicate.*

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