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M56 910/11 msg/mol

**Curtain fabric Colorama 1,  
folded arrangement with  
100 % allowance,  
wall distance 200 mm,  
Manufacturer Silent Gliss**

**Measurement of  
sound absorption acc. to EN ISO 354**

**Test Report No. M56 910/11**

Client:	Silent Gliss Fabrics & Components GmbH Rebgartenweg 5 D-79576 Weil am Rhein
Consultant:	M. Eng. Philipp Meistring Jan-Lieven Moll
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## 1 Task

On behalf of the Silent Gliss Fabrics & Components GmbH, D-79576 Weil am Rhein, the sound absorption of the curtain fabric Colorama 1 had to be measured according to EN ISO 354 [1] in the reverberation room. The fabric was tested in a folded arrangement (100 % allowance) with a distance to the reflecting wall of 200 mm. The results are to be evaluated according to EN ISO 11654 [2] and ASTM C 423-09a [3].

## 2 Basis

This test report is based on the following documents:

- [1] EN ISO 354 „Acoustics – Measurement of sound absorption in a reverberation room.“ 2003
- [2] EN ISO 11654 „Acoustics – Sound absorbers for use in buildings – Rating of sound absorption.“ 1997
- [3] ASTM C 423-09a: Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method. Revision: 09a. October 2009
- [4] ISO 9613-1 “Acoustics; Attenuation of sound during propagation outdoors; part 1: calculation of the absorption of sound by the atmosphere.” 1993

## 3 Test object and measurement conditions

### 3.1 Measurements conditions

The test construction was mounted as type G-200 according to EN ISO 354 [1], Appendix B.

The installation of the test objects was carried out by employees of the test laboratory in the reverberation room of Müller-BBM.

### 3.2 Test object

The tested material can be is described as follows:

- curtain fabric type: *Colorama 1*, color 400 (white)
- material: 100 % Trevira CS
- thickness:  $t = 0.34$  mm
- area specific mass:  $m'' = 134$  g/m<sup>2</sup>
- specific airflow resistance acc. to EN 29053:  $R_S = 19$  Pa s/m

The specification about thickness, mass and air flow resistance were determined by the test laboratory. Test of air flow resistance was performed according to EN 29053.

For the test assembly in mounting type G-200 according to EN ISO 354 [1] one curtain height x width = 3000 mm x 7000 mm was used.

The curtain fabric was installed without any extra pre-stressing in a folded arrangement with 100 % allowance. The fabric was fixed directly underneath the ceiling, suspended on a rail (height 50 mm). The clear distance to the wall was 200 mm.

The test construction was without enclosing frame. The total dimensions of the test surface were: width x height = 3.50 m x 2.95 m =  $S = 10.33 \text{ m}^2$  (starting at the lower boarder of the rail).

Further information on the test assembly are included in the test certificate in Appendix A. Appendix B shows figures of the test assembly.

#### 4 Execution of the measurements

The measurements were executed and evaluated according to EN ISO 354 [1].

The test procedure, the test stand and the test equipment used for the measurements are described in Appendix C.

#### 5 Evaluation

The sound absorption coefficients  $\alpha_s$  were determined in one third-octave bands between 100 Hz and 5000 Hz according to EN ISO 354 [1].

In addition to the sound absorption coefficients the following characteristic values were determined according to EN ISO 11654 [2] .

- practical sound absorption coefficient  $\alpha_p$  in octave bands
- weighted sound absorption coefficient  $\alpha_w$  as single value  
The weighted sound absorption coefficient  $\alpha_w$  is determined from the practical sound absorption coefficients  $\alpha_p$  in the octave bands of 250 Hz to 4000 Hz.

According to ASTM C 423-09a [3] the following characteristic values were determined:

- noise reduction coefficient *NRC* as single value:  
Arithmetical mean value of the sound absorption coefficients in the four one-third-octave-bands 250 Hz, 500 Hz, 1000 Hz and 2000 Hz; mean value rounded to 0.05
- sound absorption average *SAA* as single value:  
Arithmetical mean value of the sound absorption coefficients in the twelve one-third-octave-bands between 250 Hz and 2500 Hz; mean value rounded to 0.01


#### 6 Measurement results

The sound absorption coefficients  $\alpha_s$  in one third-octave bands, the practical sound absorption coefficients  $\alpha_p$  in octave bands and the single values ( $\alpha_w$ , *NRC* and *SAA*) are indicated in the test certificate in Appendix A.

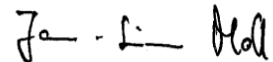
## 7 Remarks

The determined test results only refer to the test specimens and prevailing conditions on the day of measurements.

This test report may only be published and copied as a whole including all of its appendixes. The publishing of extracts requires the prior written consent of Müller-BBM GmbH.



M. Eng. Philipp Meistring



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**MÜLLER-BBM**  
Accredited Testing Laboratory  
according to DIN EN ISO/IEC 17025



DGA-PL-2465.10

# Sound absorption coefficient ISO 354

## Measurement of sound absorption in reverberation rooms

**Client:** Silent Gliss Fabrics & Components GmbH,  
Rebgartenweg 5, D-79576 Weil am Rhein

**Test specimen:** Curtain fabric Colorama 1  
folded arrangement, allowance 100 %, wall distance 200 mm

- Fabric:**
- manufacturer Silent Gliss
  - curtain fabric type "Colorama 1", color 400 (white)
  - 100 % Trevira CS (polyester)
  - area specific mass app.  $m'' = 134 \text{ g/m}^2$
  - specific airflow resistance  $R_s = 19 \text{ Pa s/m}$
  - thickness  $t = 0,34 \text{ mm}$

- Test arrangement:**
- mounting type G-200 acc. EN ISO 354, test arrangement without enclosing frame
  - folded arrangement with 100% allowance, distance to the wall 200 mm
  - curtain 7000 mm x 3000 mm mounted at a rail underneath the ceiling (height of the rail 50 mm)
  - test surface  $H \times W = 2950 \text{ mm} \times 3500 \text{ mm}$

Room: E  
Volume: 199.60 m<sup>3</sup>  
Size: 10.33 m<sup>2</sup>  
Date of test: 2012-01-13

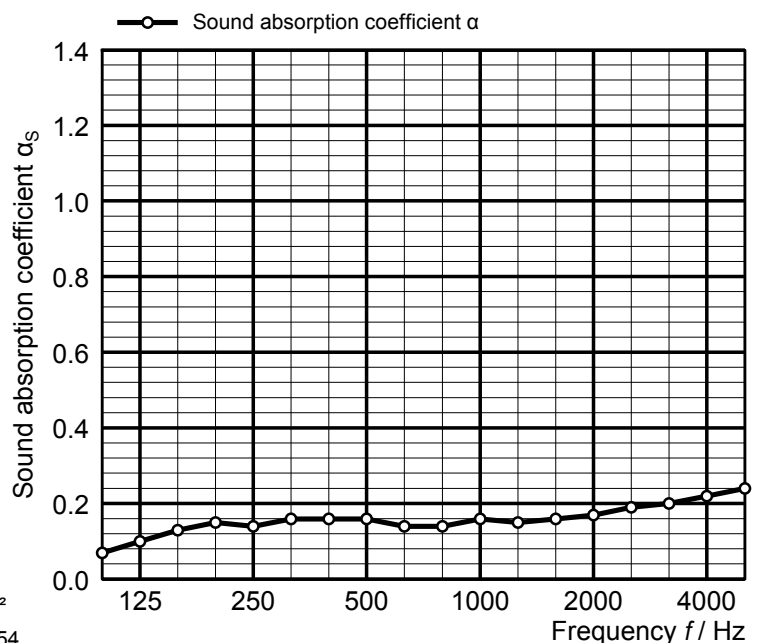
	$\theta$ [°C]	r. h. [%]	$B$ [kPa]
without specimen	18.6	33.6	95.9
with specimen	18.8	33.1	95.9

Accredited testing laboratory according to ISO/IEC 17025



DAP-PL-2465.10

Frequency [Hz]	$\alpha_s$ 1/3 octave	$\alpha_p$ octave
100	0.07	0.10
125	0.10	
160	0.13	
200	0.15	0.15
250	0.14	
315	0.16	
400	0.16	0.15
500	0.16	
630	0.14	
800	0.14	0.15
1000	0.16	
1250	0.15	
1600	0.16	0.15
2000	0.17	
2500	0.19	
3150	0.20	0.20
4000	0.22	
5000	0.24	



◦ Equivalent sound absorption area less than 1.0 m<sup>2</sup>  
 $\alpha_s$  Sound absorption coefficient according to ISO 354  
 $\alpha_p$  Practical sound absorption coefficient according to ISO 11654

Rating according to ISO 11654: <b>Weighted sound absorption coefficient</b> $\alpha_w = 0.15$ Sound absorption class: E	Rating according to ASTM C423: <b>Noise Reduction Coefficient NRC = 0,15</b> <b>Sound Absorption Average SAA = 0,16</b>
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Appendix A  
Page 1

**Curtain fabric Colorama 1, folded arrangement with  
100 % allowance, 200 mm wall distance, Manufacturer Silent Gliss**



**Figure B.1.** Test object mounted in the reverberation room



**Figure B.2.** Test object mounted in the reverberation room

## Description of the test procedure for the determination of the sound absorption in a reverberation room

### 1 Measurand

The sound absorption coefficient  $\alpha$  of the test object was determined. For this purpose the mean value of the reverberation time in the reverberation room with and without the test object was measured. The sound absorption coefficient was calculated using the following equation:

$$\alpha_S = \frac{A_T}{S}$$

$$A_T = 55,3 V \left( \frac{1}{c_2 T_2} - \frac{1}{c_1 T_1} \right) - 4 V (m_2 - m_1)$$

With:

- $\alpha_S$  sound absorption coefficient;
- $A_T$  equivalent sound absorption area of the test object in  $m^2$ ;
- $S$  area covered by the test object in  $m^2$ ;
- $V$  volume of the reverberation room in  $m^3$ ;
- $c_1$  propagation speed of sound in air in the reverberation room without test object in m/s;
- $c_2$  propagation speed of sound in air in the reverberation room with test object in m/s;
- $T_1$  reverberation time in the reverberation room without test object in s;
- $T_2$  reverberation time in the reverberation room with test object in s;
- $m_1$  power attenuation coefficient in the reverberation room without test object in  $m^{-1}$ ;
- $m_2$  power attenuation coefficient in the reverberation room with test object in  $m^{-1}$ .

The different dissipation during the sound propagation in the air was taken into account according to paragraph 8.1.2 of EN ISO 354 [1]. The dissipation was calculated according to ISO 9613-1 [4]. The climatic conditions during the measurements are indicated in the test certificates.

Information on the repeatability and reproducibility of the test procedure are given in EN ISO 354 [1].

## 2 Test procedure

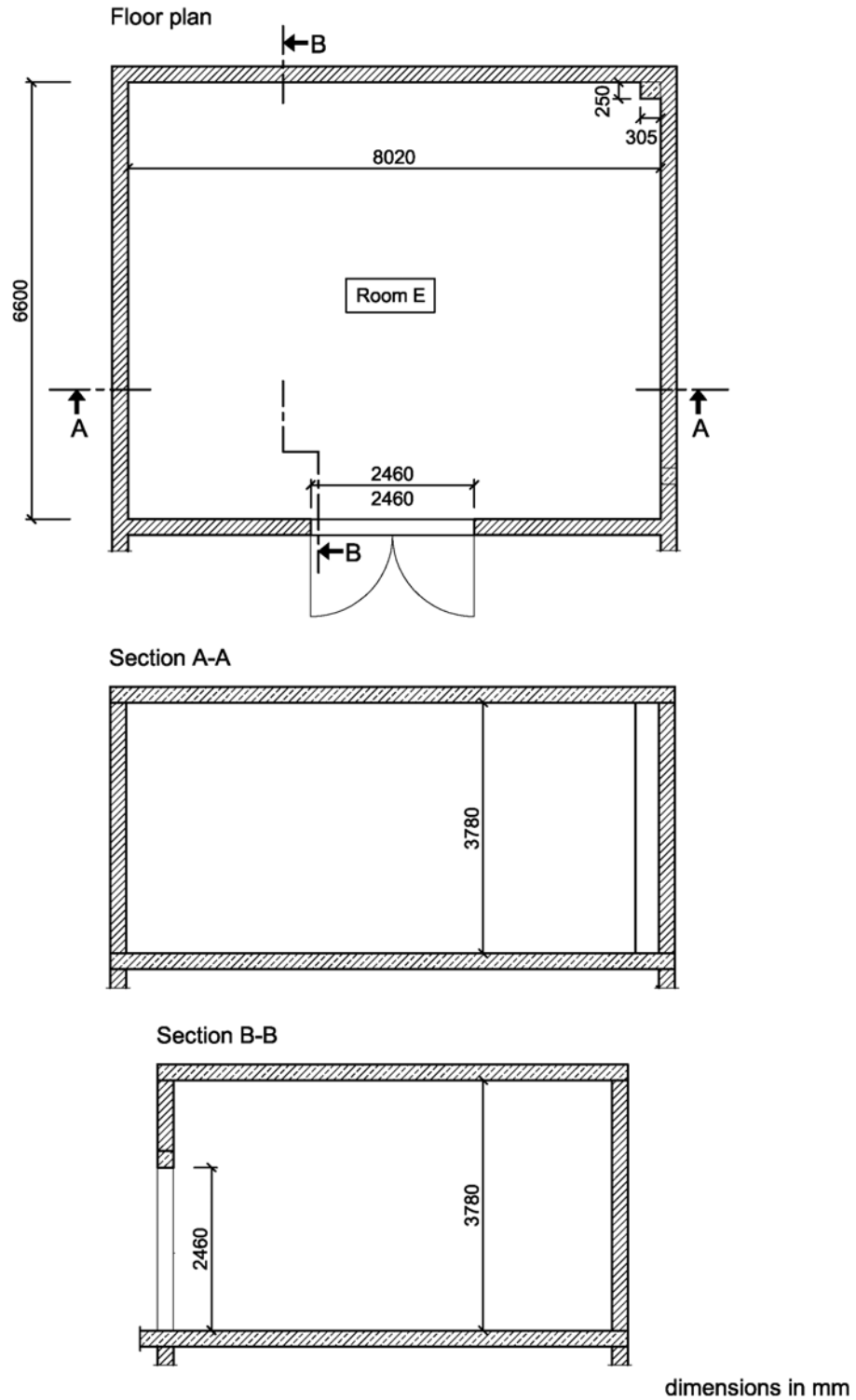
### 2.1 Description of the reverberation room

The reverberation room complies with the requirements according to EN ISO 354 [1]. The reverberation room has a volume of  $V = 199.6 m^3$  and a surface of  $S = 216 m^2$ . Six omni-directional microphones and four loudspeakers were installed in the reverberation room.



In order to improve the diffusivity, six composite sheet metal boards (1.2 m x 2.4 m) and six composite sheet metal boards (1.2 m x 1.2 m) were suspended curved and irregularly.

Figure C.1 shows the drawings of the reverberation room.



**Figure C.1.** Plan view and sections of the reverberation room

## 2.2 Measurement of reverberation time

The determination of the impulse responses were carried out according to the indirect method. In all tests, a sinusoidal sweep with pink noise spectrum was used as test signal. In the reverberation room with and without test objects each 24 independent combinations of loudspeakers and microphones were measured. The reverberation time was evaluated according to EN ISO 354 [1], using a linear regression for the calculation of the reverberation time  $T_{20}$  from the level of the a backward integrated impulse response.

The determined reverberation times in the reverberation room with and without test object are indicated in table C1.

**Table C.1.** Reverberation times

frequency in Hz	Reverberation time $T$ in s	
	$T_1$ (without test object)	$T_2$ (with test object)
100	4,90	4,39
125	4,60	4,00
160	4,96	4,14
200	5,24	4,19
250	5,11	4,17
315	5,09	4,06
400	5,47	4,30
500	5,43	4,28
630	5,36	4,30
800	5,24	4,24
1000	5,39	4,25
1250	5,31	4,22
1600	5,02	3,98
2000	4,40	3,55
2500	3,66	2,98
3150	2,86	2,42
4000	2,15	1,86
5000	1,59	1,41

### 2.3 List of test equipment

The test equipment used is listed in table C.2

**Table C.2.** List of test equipment

Name	Manufacturer	Type	Serial-No.
Sound card	RME	Multiface II	22460388
Amplifier	APart	Champ One	09070394
Dodecahedron	Müller-BBM	DOD130B	265201
Dodecahedron	Müller-BBM	DOD130B	265202
Dodecahedron	Müller-BBM	DOD130B	265203
Dodecahedron	Müller-BBM	DOD130B	265204
Microphone	Microtech	M360	1783
Microphone	Microtech	M360	1785
Microphone	Microtech	M360	1786
Microphone	Microtech	M360	1787
Microphone	Microtech	M360	1788
Microphone	Microtech	M360	1789
Hygro-/Thermometer	Testo	Saveris H1E	01554624
Barometer	Lufft	Opus 10	030.0910.0003.9. 4.1.30
Digital caliper	Mitutoyo	CD-15PPR	07019377
Balance	Kern	440-49N	WC0633572
Software for measurement and evaluation	Müller-BBM	Bau 4	Version 1.6