Fraunhofer
IBP

Test Report P-BA 231/2016e

Sound reduction index of a vacuum window pane acc. to DIN EN ISO 10140:2010

Institution for testing, supervision and certification, officially recognized by the building supervisory authority. Approvals of new building materials, components and types of construction

Directors
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Client: EAGON WINDOWS & DOORS Co., Ltd.,
402-060, 91, Yeomjeon-Ro, Nam-Gu, Incheon, Korea

Test Specimen: Vacuum window pane (Test specimen S 10991-02)

Content:

Assembly, place and date of the measurements:

Delivery:	on September, 2016 by Euko Logistics Germany GmbH
Assembly:	on September 14, 2016 by an authorized company
Test:	on September 14, 2015 in the laboratory of the Fraunhofer Institute of Building Physics in Stuttgart.

Stuttgart, November 16, 2016

Test Engineer: Head of the test laboratory:

Dipl.-Ing. D. Branstetter M.Sc. Dipl.-Ing. (FH) S. Öhler

FRAUNHOFER-GESELLSCHAFT ZUR FÖRDERUNG DER ANGEWANDTEN FORSCHUNG E.V. Fraunhofer IBP

The test was carried out in laboratory facilities of the IBP which is accredited according to DIN EN ISO/IEC 17025 by the Dakks. The accreditation certificate is DP-PL-11140-01. Measurement performance and scope comply with the principles of the working group of the acoustic testing laboratories approved by the building authorities in accordance with the certification guidelines of the DIBt and the NABau, subcommittee NA 005-55-76 AA.

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ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-11140-11-01

Sound reduction index acc. to DIN EN ISO 10140:2010	**P-BA 231/2016e**
Client: EAGON WINDOWS & DOORS Co., Ltd., 402-060, 91, Yeomjeon-Ro, Nam-Gu, Incheon, Korea	Results 1

Test Specimen:

Vacuum window pane (Test specimen S 10991-02) consisting of:

5 mm	Float glass pane
12 mm	Space, gass filling: Air
5 mm	Float glass pane with IR-Layer
0.25 mm	Space with pillar (grid dimension ca. 40 mm x 40 mm) and vacuum, edge sealing circular 12 mm
5 mm	Float glass pane

Differing from the principles of the working group of the accredited acoustic test laboratories in Germany, the rule schedule of DiBt and NABau, subcommittee NA 005-55-76 AA according to customers request a gas analysis was not carried out. The filling gas inside the space is not known (specification of manufacturer: Air).

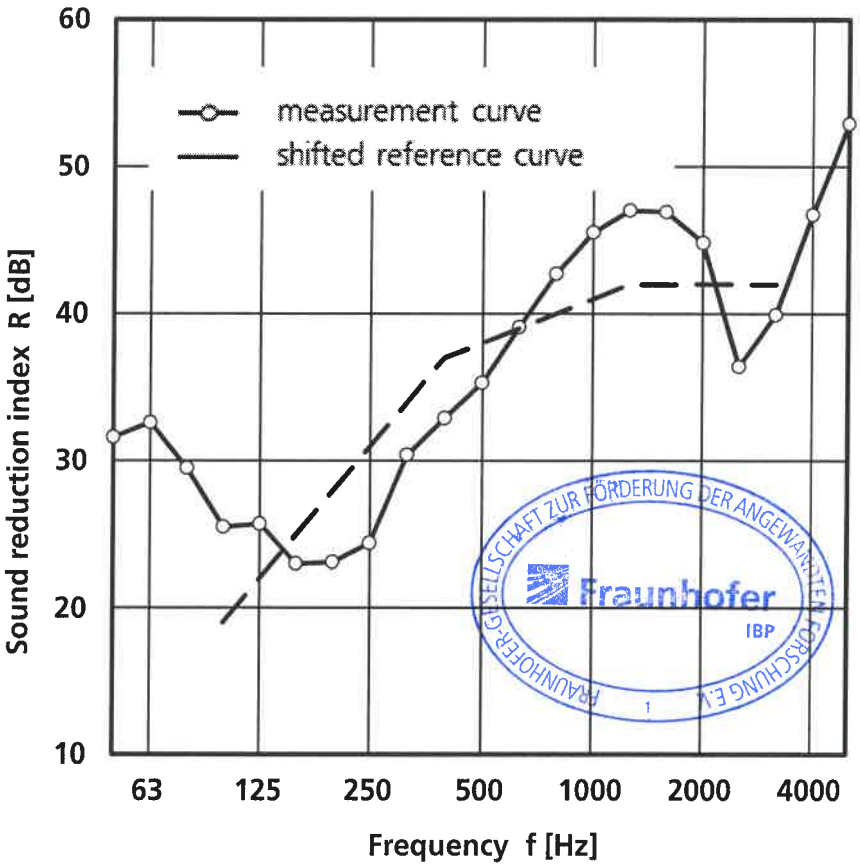
Spacer consists of metal hollow profile

Sealed at the spacer with butyl, at the edge with polysulfide

Total thickness in the middle of the pane:	25.5 mm
Total thickness at the rim of the pane:	26.0 mm
Size of the pane:	1230 mm x 1480 mm
Mass per unit area:	35.9 kg/m².

Test area:	1.875 m²
Test lab.:	P4
Volumes:	V_S = 67.0 m³
	V_E = 57.0 m³
Rel. humidity:	57 ± 2 %
Temperature	23 ± 0.3 °C
Stat. pressure:	995 ± 1 hPa
Noise:	Pink noise
Measurement date:	Sep. 14, 2016

f [Hz]	R [dB]
50	31.6
63	32.6
80	29.5
100	25.5
125	25.7
160	23.0
200	23.1
250	24.4
315	30.4
400	32.9
500	35.3
630	39.1
800	42.7
1000	45.5
1250	47.0
1600	46.9
2000	44.8
2500	36.4
3150	39.9
4000	46.7
5000	52.9



Sound reduction index acc. to. DIN EN ISO 717-1:2013

R_w (C; C_{tr}; $C_{100-5000}$; $C_{tr,100-5000}$) = 38.0 ±1.2 (-2; -5; -1; -5) dB

Fraunhofer IBP

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Stuttgart, November 16, 2016

Head of the test laboratory:

Test Method

The measurement was performed according to DIN EN ISO 10140:2010 in frequency intervals of thrid octaves. Pink noise served as noise impulse. The spatial averaging of the sound pressure level in the test rooms was conducted by an inclined circular movement of the microphones. For further details on generation and scanning of the sound field see the attached laboratory description.

The sound reduction index was determeined according to:

$$R = L_1 - L_2 + 10 \lg (S/A) \text{ dB}.$$

Where:

- R = sound reduction index
- L_1 = sound pressure level in source room
- L_2 = sound pressure level in receiving room
- S = testing area (total area test specimen)
- A = equivalent absorption area in receiving room
  Calculation based on measurements of the reveberation time.

Explanations of the table indicating the measurement results on the summary sheet

Results marked by "≥" reveal that the signal-to-noise ratio or the difference between limiting insertion loss and measured sound reduction index is less or equal 6 dB. This means that the actual sound insulation of the test specimen exceeds the measured value, however cannot be determined in more detail by the applied test facility. In the second case the limiting insertion loss is given in brackets.

Explanations of the single value specifications

Explanation of the weighted sound reduction index specified in the test report

In the present test report the weighted sound reduction index is indicated according to the current decision of the commision of the building authorities approved acoustic testing laboratory as

$$R_w = 54.7 \pm 1.2 \text{ dB}$$

(example) with 0,1 dB precision and measurement uncertainty. The R_w-value was calculated with an accuracy of 0.1 dB according to DIN EN ISO 717-1:2013 by moving the reference curve in increments of 0.1 dB instead of integer increments. The indicated measurement uncertainty presents the average standard deviation for test laboratory measurements according to DIN EN ISO 12999-1:2012 (draft). For the adaption values to sound specter C and C_{tr}, the indication of the decimal place has been omitted, as there exists no standardised calculation method so far.

For the verification of the sound insulation requirements approved by the building authorities according to DIN 4109:1989 and for the product declaration (e.g. CE marking) an integer value of the evaluated sound reduction index is to be used. This value results from the value indicated in the test report rounded down to the next smaller integer number (in the example above $R_w = 54.7$ dB thus becomes $R_w = 54$ dB).

The above explanations also apply mutatis mutandis for the single value specifications generated analogously to R_w. An example for this is the weighted standardized sound level difference $D_{n,w}$.

Measurement equipment

Measurement equipment used:

Microphone:	G.R.A.S. 1225 S/N 157330
Microphone:	G.R.A.S. 1225 S/N 157348
Preamplifier:	G.R.A.S. 1209 S/N 15126
Preamplifier:	G.R.A.S. 1209 S/N 15383
Calibrator:	Norsonic 1251 S/N 33639
Analyzer:	Norsonic 850/1; twice type 140: Ch.A: S/N 1405224; Ch.B: S/N 1405225
Amplifier:	Norsonic Typ 235 S/N 22591
Loudspeaker:	Lanny MLS 87

The analyzer used in the test was an analyzer of accuracy grade 1. The measuring chain had a valid calibration.

Test facility

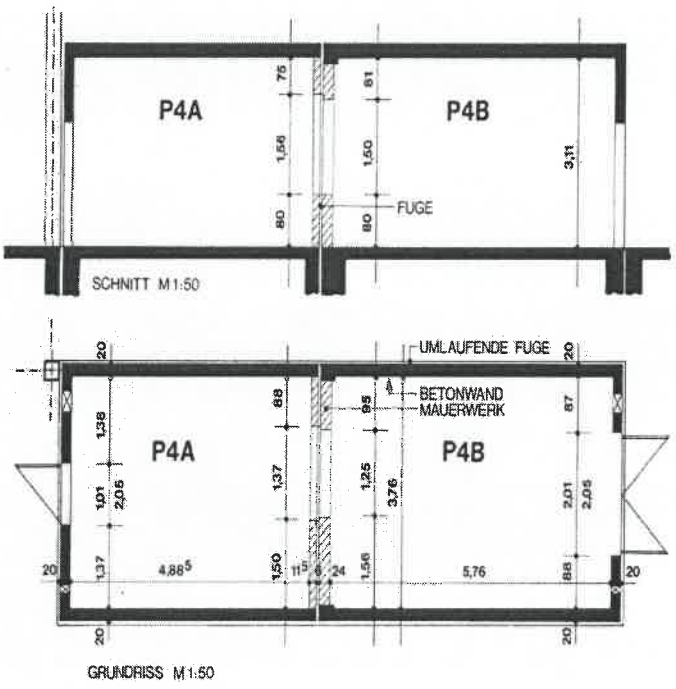
The measurements were performed in the window test facility of the Fraunhofer Institute for Building Physics. The test faciliy meets the requirements of DIN EN ISO 10140-5:2010. Walls and ceilings are made of concrete. A circumferential joint is placed between source room and receiving room to suppress flanking transmission.

Dimensions of the test laboratories*:	
source room (l x w x h):	5.74 m x 3.75 m x 3.11 m; V = 67 m³
receiving room (l x w x h):	4.85 m x 3.74 m x 3.11 m; V = 57 m³
test opening (w x h):	1.25 m x 1.50 m; S = 1.875 m²

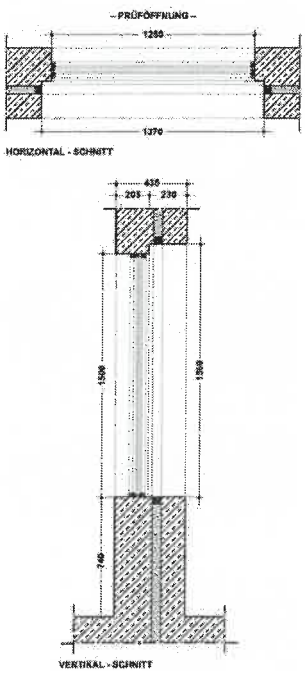
* The specifications are valid for the empty test facility. The exact room volume with integrated test specimen can be seen in the attached results sheet.

For the spatial and temporal averaging of the sound pressure level in the test laboratories the loudspeaker (dodecahedron form) is moved pneumatically on an inclined straight path in the source room. The microphones are swiveled on inclined circular paths through the room.

Section and ground plan of the test facility



Horizontal and vertikal section of the test opening (dimensions in mm)



The maximum weighted sound reduction index of the test facility is R'w,max = 72 dB (related to the test opening area).