



AGH University of Science and Technology

Faculty of Mechanical Engineering and
Robotics

Department of Mechanics and Vibroacoustics



***Measurement of absorption coefficient in reverberation chamber
according to PN-EN ISO 354:2005, ISO 20189:2018***

Report title:

**Measurement of sound absorption:
CELL 1600x800**

Client:

**MARBET Sp. z o.o.
ul. Chochołowska 28, 43-346 Bielsko-Biała**

Contract numer:

5.5.130.197

Kraków June 2020

Institution conducting the research:	AGH University of Science and Technology Faculty of Mechanical Engineering and Robotics Department of Mechanics and Vibroacoustics	
Subject:	Measurement of sound absorption: CELL 1600x800	
Client:	MARBET Sp. z o.o. ul. Chochołowska 28, 43-346 Bielsko-Biała	
Date of order:	22.06.2020	
Number of acceptance of the offer:	24.06.2020	
Date of acceptance of the offer:	WIMiR/KMiW/0154-27/2020	
Contract numer:	5.5.130.197	
Project manager:	dr hab. inż. Tadeusz Kamisiński, prof. AGH	Signature:
Technical specialist:	dr inż. Artur Flach dr inż. Adam Pilch dr inż. Jarosław Rubacha mgr inż. Jacek Frączek	
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Stamp:		

The results presented in this report refer only to measured samples.

Results in this report refer only to the tested sample.

*It is forbidden to change the content or make incomplete copies of the report
without prior written permission from the head of the department conducting the measurements.*

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1. Introduction

1.1. Base of the report

The report is based on the order from 22.06.20 and confirmation of acceptance of the order number WIMiR/KMiW/0154-27/2019 from 23.06.2020.

Standards:

- ISO 354:2003 - *Acoustics – Measurement of sound absorption in a reverberation room*
- ISO 20189:2018 - *Acoustics - Screens, furniture and single objects intended for interior use - Rating of sound absorption and sound reduction of elements based on laboratory measurements*

1.2. Subject, aim and scope of the study

The aim of the study was to make a measurement of sound absorption coefficient and equivalent sound absorption area of elements delivered by the customer. The measurements were made according to ISO 354:2003 and ISO 20189:2018.

The scope of the study was to:

- prepare measurement station,
- make measurements of the acoustic parameters,
- create the report,

2. Description of the specimen

Description of the specimen	
Name:	CELL 1600x800
Description:	Thermoformable Felt
Specimen area S [m ²]:	7.9 The total exposed surface
Element size [mm]:	1600x800
Element number:	3
Sample mounting	
Mounting method:	Type II mounting accordig to annex E ISO 20189:2018



Fig. 1. View of the sample in reverberation chamber

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3. Measurement conditions, methodology and test station

Measurement conditions	
Temperature with the sample [°C]:	23.5
Temperature without the sample[°C]:	23.5
Humidity with the sample [%]:	47.9
Humidity without the sample [%]:	48.3
Description of the measurement method:	
Measurement method:	Measurements and calculations of absorption coefficient were made according to PN-EN ISO 354:2005 and ISO 20189:2018. Reverberation time $T1$ and $T2$ was determined using impulse response integration method based using B&K 7841 Dirac 5.0 software.
Measurement signal:	<p><u>Empty reverberation chamber:</u> type: sweep sine no. averages (cycles): 3 cycle length: 10.92 s sampling rate: 48 kHz</p> <p><u>Reverberation chamber with sample:</u> type: sweep sine no. averages (cycles): 3 cycle length: 10.92 s sampling rate: 48 kHz</p>

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Test station:	
Chamber volume [m³]:	180.4
Walls area [m²]:	193.6
Number of diffusers in reverberation chamber:	5
Measurement devices	
Sound sources:	No. loudspeakers: 2 (stationary) Type: ZGWK1, ZGWK2 Class: 12-face omnidirectional sound source
Microphones:	Type: G.R.A.S. 46AQ No. microphones: 6 (stationary)
Number of independent measurement positions:	12
Recorder/analyser:	NI PXI-1082e measurement system: Measurement cards NI PXI-4461, NI PXIe-4496 Industrial computer NI PXI-8108 with LabView 2011 and B&K 7841 Dirac 5.0 software
Thermo-hygrometer:	LB-701 with LB-705 panel

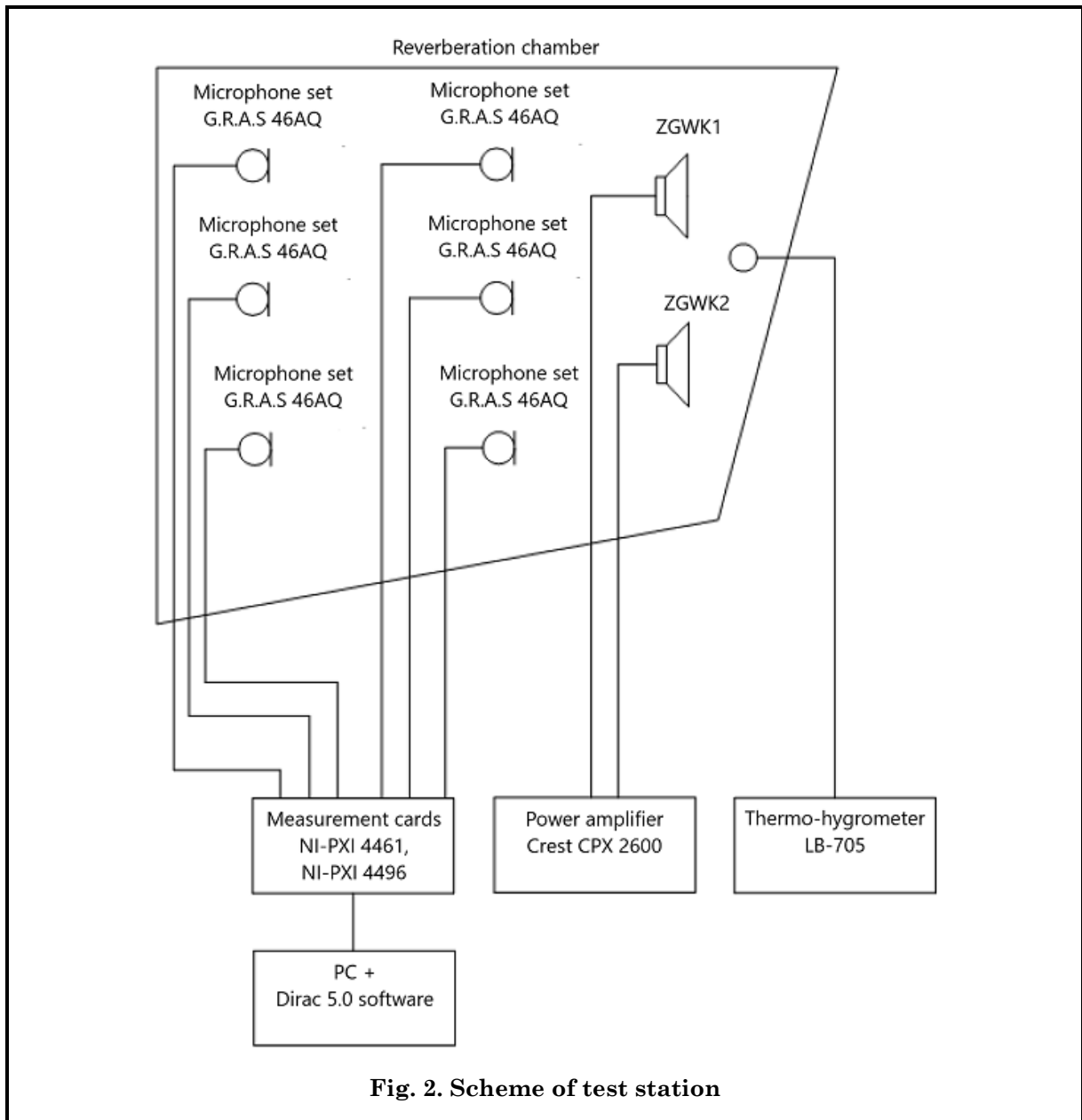


Fig. 2. Scheme of test station

4. Measurement results

The sound absorption of the object is given as the equivalent sound absorption area A_{obj} , in the 1/3-octave bands between 100 Hz and 5000 Hz and in the octave bands 125 Hz to 4000 Hz calculated as arithmetic mean of 1/3-octave bands within each octave band.

According to ISO 2189:2018 the single object sound absorption coefficient in the octave band k , $\alpha_{obj,k}$ is defined as:

$$\alpha_{obj,k} = A_{obj,k} / S$$

where

$A_{obj,k}$ – is the equivalent sound absorption area in octave bands,

S – is the total exposed surface area of the simplified acoustic representation of the single object for actual mounting condition



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**Measurement of sound absorption coefficient in a reverberation room
 according to PN-EN ISO 354:2005, ISO 20189:2018**

Sample: CELL 1600x800 **Test Date:** 24.06.2020

CELL 1600x800

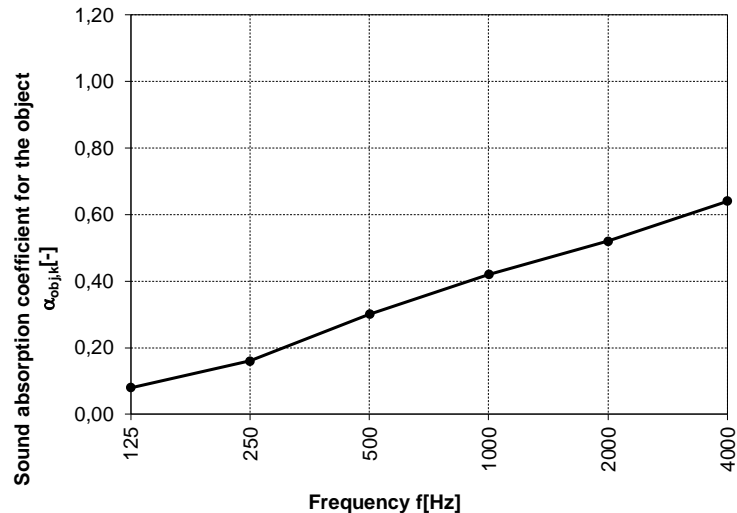
Producer:
MARBET Sp. z o.o.
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 43-346 Bielsko-Biala

Conditions:
 Element size [mm]: 1600x800
 Elements number: 3
 Exposed surface area of the object [m²]: 2,6
 Total exposed surface area [m²]: 7,9
 Mounting method: **Type II mounting
 accordig to annex E
 ISO 20189:2018**

Sample scheme:
 Thermoformable Felt

Temperature with sample *t* [°C]: 23,5
 Temperature without sample *t* [°C]: 23,5
 rel. humidity with sample *h* [%]: 47,9
 rel. humidity without sample *h* [%]: 48,3
 Microphone positions: 6
 Loudspeaker positions: 2
 Diffusors number: 5
 Chamber Volume *V* [m³]: 180,4
 Walls area [m²]: 193,6

<i>f</i> [Hz]	<i>T</i> ₁ [s]	<i>T</i> ₂ [s]	$\alpha_{obj,k}$
100	11,12	9,69	0,08
125	7,79	6,74	
160	8,38	6,49	
200	9,06	6,90	0,16
250	9,74	6,97	
315	9,76	6,41	
400	9,14	5,79	
500	8,07	4,88	0,30
630	8,07	4,52	
800	7,35	4,12	0,42
1000	6,77	3,87	
1250	5,98	3,43	
1600	5,01	3,02	
2000	4,52	2,75	0,52
2500	4,00	2,50	
3150	3,58	2,27	0,64
4000	2,90	1,94	
5000	2,42	1,67	



$\alpha_{obj,k}$

Sound absorption coefficient for the object according to ISO 20189:2018

T_1, T_2

Reverberation time of the empty chamber and with sample according to PN-EN ISO 354:2005

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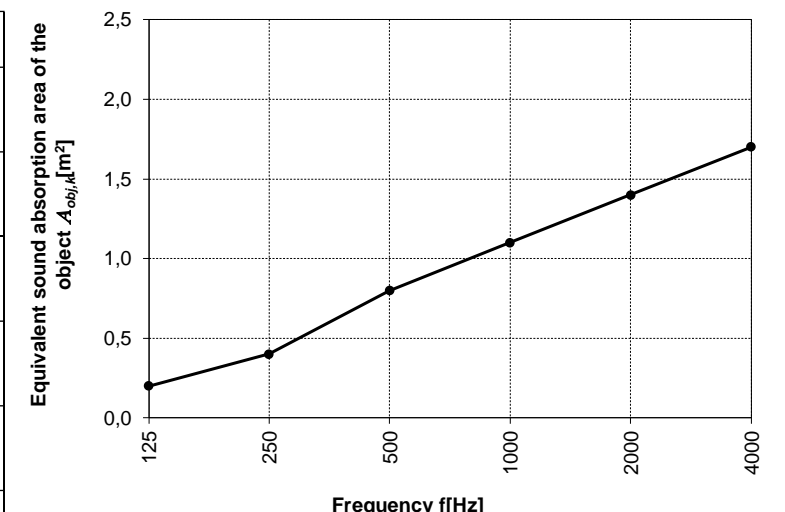
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Sample scheme:
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 Microphone positions: **6**
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 Diffusors number: **5**
 Chamber Volume V [m³]: **180,4**
 Walls area [m²]: **193,6**

f [Hz]	T_1 [s]	T_2 [s]	A_{obj} [m ²]	$A_{obj,k}$ [m ²]
100	11,12	9,69	0,1	
125	7,79	6,74	0,2	0,2
160	8,38	6,49	0,3	
200	9,06	6,90	0,3	
250	9,74	6,97	0,4	0,4
315	9,76	6,41	0,5	
400	9,14	5,79	0,6	
500	8,07	4,88	0,8	0,8
630	8,07	4,52	0,9	
800	7,35	4,12	1,0	
1000	6,77	3,87	1,1	1,1
1250	5,98	3,43	1,2	
1600	5,01	3,02	1,3	
2000	4,52	2,75	1,4	1,4
2500	4,00	2,50	1,4	
3150	3,58	2,27	1,6	
4000	2,90	1,94	1,7	1,7
5000	2,42	1,67	1,8	



A_{obj} Equivalent sound absorption area in 1/3 octave bands according to ISO 20189:2018
 $A_{obj,k}$ Equivalent sound absorption area in octave bands according to ISO 20189:2019
 T_1, T_2 Reverberation time of the empty chamber and with sample according to PN-EN ISO 354:2005

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