Microflown Technologies
Charting sound fields

Datasheet V3.0

IN-SITU ABSORPTION SETUP

IMP-PA-PM/PT/PI-SCT2

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IN-SITU ABSORPTION

A truly in situ method to accurately measure acoustic properties of materials

Nondestructive testing of any surfaces without additional measurement facilities

The usage of a PU probe, allows not only for a direct calculation of the acoustic intensity, but also the acoustic impedance, obtained from the ratio of both magnitudes: pressure and particle velocity. With the In-situ Absorption setup, acoustic impedance, absorption and reflection coefficients can be measured directly - taking into account not only the first layer of materials, but the whole damping structure.

This system offers a great alternative to traditional methods such as the Kundt's tube, or the reverberant room. And it can even be extended in frequency with the PU- Kundt's tube option included as a side calculation method. Main advantages of the In-Situ absorption system, lay in the nondestructive character of the measurement (no need to alter the measured samples), and the fact that measurements can be carried out virtually anywhere.

The software interface includes a series of filters that are designed to remove the influence of the room, in which measurements are taken. Moreover, these filters can account for reflections from nearby obstacles, ensuring that the acquired data is free from any parasitic excitation. These features coupled with the properties of the PU probe, make the in-situ absorption system usable even in a noisy office space environment.

The software is built around a very intuitive tab-based user interface that allows the pre-definition of a working routine. Even pre-setting the amount of samples and number of averages is possible.

In-situ absorption setup can also be used in combination with the Scan & Paint Add-on, which will allow to visualize the spatial distribution of the absorption, or reflection coefficients.

I. IN-SITU ABSORPTION WORKING PROCEDURE

SELECT WORKING ROUTINE

Measurements can be taken in a certain pre-defined working routine. Due to this fact, the user only needs to configure the full measurement session once – before commencing the data acquisition process.

- Single test mode: the system will store one set of calibration data, and one set of measurement data per each sample. After one of each type is stored, the system requires further instructions to continue measuring.
- Average test mode: the software will store all data acquired over the tested surface under the same sample (multiple measurements over the same material). First measurement is used as calibration, and the rest as test captures.

The user can select between two measurement procedures, PU- Kundt's tube and In-situ impedance method. Kundst tube is in the system as an accesory so it is not explained in depth in this manual.

SELECT A MODEL

Different mathematical models can be applied to the measured data, in order to calculate the material properties:

- Image source model with plane wave reflection coefficient. The simplest model, it assumes that the material under test is exposed to a plane wave of normal incidence, which gives rise to a reflected plane wave.
- Mirror source: slightly more complicated model than the plane wave one. It combines the concept of an image source with the plane wave reflection factor. The plane-wave reflection factor depends only on the impedance of the material.
- Q term: takes into account the fact that the reflection has a spherical reflection coefficient Q, unless the source is unrealistically far from the surface.

CAPTURE

Record and store the captures following the predefined working procedure, which automatically re-groups them into material samples.

SMOOTH DATA

In case the room reflections have a random character, the moving average filters present in the software can be applied. Remove the room effect by applying these smoothing filters, following two strategies:

- Linear scaling: the value at every point is the mean value of a defined amount of frequency points.
- Logarithmic scaling: at lower frequencies less FFT points are used for calculation, while at higher frequencies the smoothed values are calculated from a wider frequency range.

II. COMPATIBLE PROBES

Probe type	Diameter	Maximum level range		Temperature range
		Pressure	Velocity	
PU mini	12.7 mm	110 dB	125 dB	-17 to 63
				
PU match packaged	12.7 mm	110 dB	135 dB	-17 to 63
				
		*SPL ref: 20 e-5 Pa	*PVL ref: 50 nm/s	

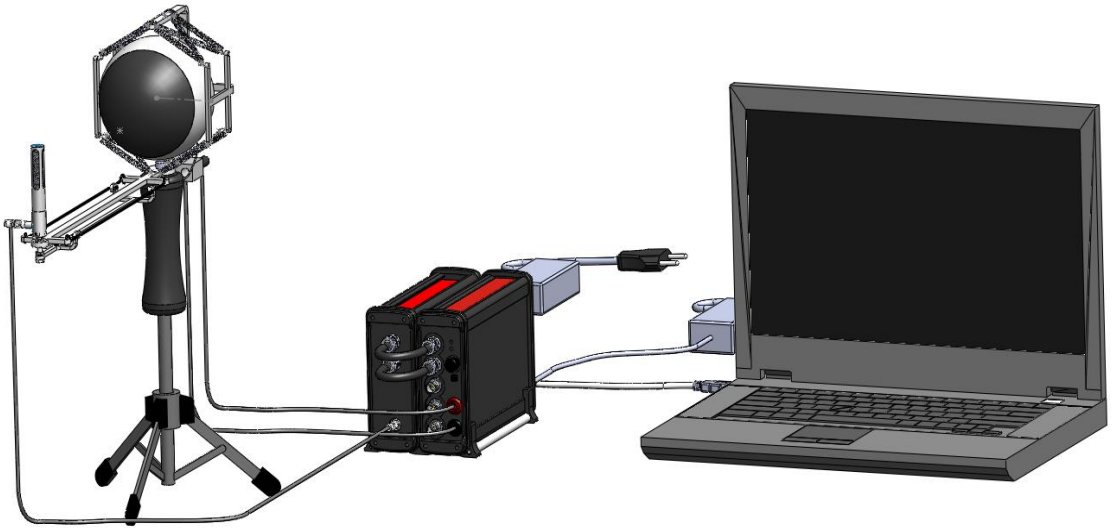
More specifications can be found on the probes datasheets.

III. COMPATIBLE FRONTENDS

Frontend	Nr. Channels		Max Fs (KHz)	Bits	IEPE
	Input	Output			
Scout422 	4 analog inputs 1 tachometer input 1 trigger input	1 amplified output 1 analog output	52	24	Yes
MFDAQ 	2analog input	1 analog output	48KHz	16 bits	No
DIC24 	24 input, expandable		350 Hz to 50 kHz	24 bits	yes

IV. CONFIGURATIONS & CONNECTIONS

Standard system configuration:



V. SYSTEM COMPONENTS

SENSOR	1x PI/PM
CONDITIONER	1x MFPA-2
FRONTEND	1x Scout V2
ACCESSORIES	
Speaker with metal suspension	1x
Foam handle	1x
Table Tripod	1x
Feet	1x (for Scout and MFPA)
CABLES	
Probe-Conditioner	1x CAB-LEMO-2.5*74
Scout-MFPA	2x BNC
Scout-PC	1x USB cable (white)
Scout- speaker	1 x Banana cable
POWER SUPPLIES	
MFPA	1x19V
Scout	1x19V
FILES	
Calibration report	1x printed and USB (...:\Calibration*Serial.pdf)
Product manual	1x USB (...:\Software\Microflown SW)
PELICAN CASE	1x

VI. ACCESSORIES

- SCAN & PAINT ADD-ON (SP-ADD): In-situ absorption setup can be combined with Scan & paint software and camera, in order to map the distribution of impedance, absorption and reflection coefficients.

- REMOTE HANDLE (RH-01): for easy operation, the in-situ absoption setup measurement process can be managed from the remote handle. Thanks to the handle there is no need for the operator to go back to the pc during the data acquisition stage.

- BATTERY PACK (ACC-BAT): new PowerGorilla battery pack is made compatible with In-situ absorption setup to make it more portable.

Please consult our sales department (info@microflown.com) for suitable accessories and add-ons for your measurement setup.

VII. F.A.Q

SYSTEM FREQUENCY RANGE

The typical usable frequency range is from 300 Hz to 10.000Hz. These limits depend on the material type and modelling applied, being:

- In most of absorbing materials extended in the low frequency region.
- In most reflective materials compromised in the high frequency region. The response in this region is typically improved by using the PI probe with the setup.

With the new PU- Kundt's tube software accessory the resulted frequency range can be prolonged, being the extended frequency region dependent on the dimensions of the tube itself.

SAMPLE SIZE

2 strategies to calculate this factor

- If the sample needs to be characterized as it is mounted on a structure then the sample size cannot be changed and the measurement result will display the absorption value of the structure with the mounted layers and sizes.

- If the material absorption needs to be characterized, it is recommended to use samples of at least 30 x 30 cm.

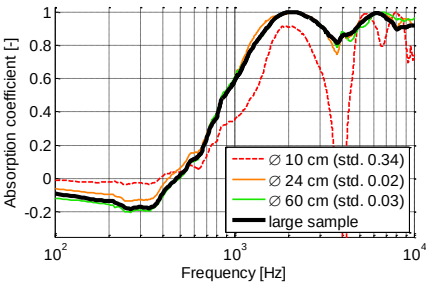


Figure7. Polyuretan

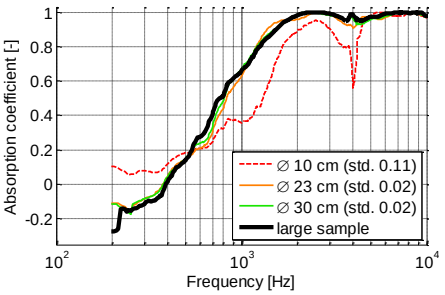


Figure 8. Stone wool measurements

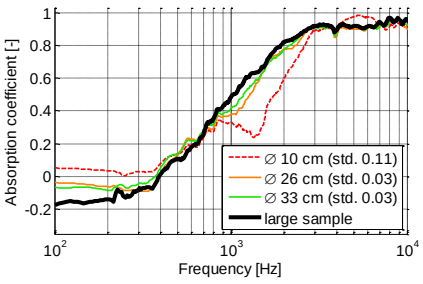


Figure 9. Measurements on Flamex

DISTANCE PROBE-SAMPLE

Depending on (distance probe-sample) the results can present discrepancies at low frequencies. In simple models like “mirror source” near field effects of waves inside the sample are not considered.

Small deviations for larger values of “h” at high frequencies are caused by interferences of incoming- and reflected sound waves.

Nevertheless, in practical situations it is hard to perform measurements with probe sample distances larger than 30 mm to 50 mm because of difficulties with limited sample sizes, background noise, parasitic reflections from other objects, and because the sound that is reflected from the sample becomes weaker compared to the incoming sound.

For these matters, the probe should be always placed as close as possible to the measured surface.

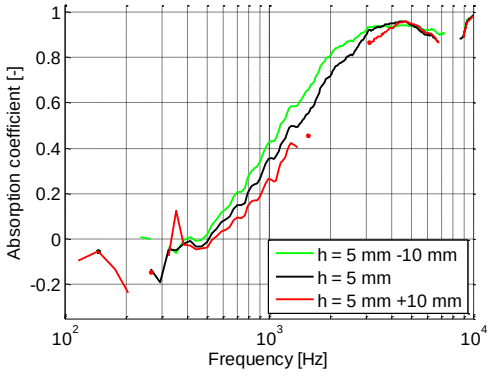


Figure 10. Misestimating the probe-sample distance: h = 5 mm ± 10 mm.

MEASUREMENT ENVIRONMENT

The effect of the background noise in the absorption estimation error can depend on:

- The absorption values of the sample: being less affected the measurements taken in samples with a high absorption values than very reflective samples
- The distance probe- sample: being less affected the closer the measurement is taken

- The angle noise-setup: its effect is very low as the noise not only travels via the air but also via the sample itself.
- The frequency range: more deviations in high frequencies and where strong reflections appear.

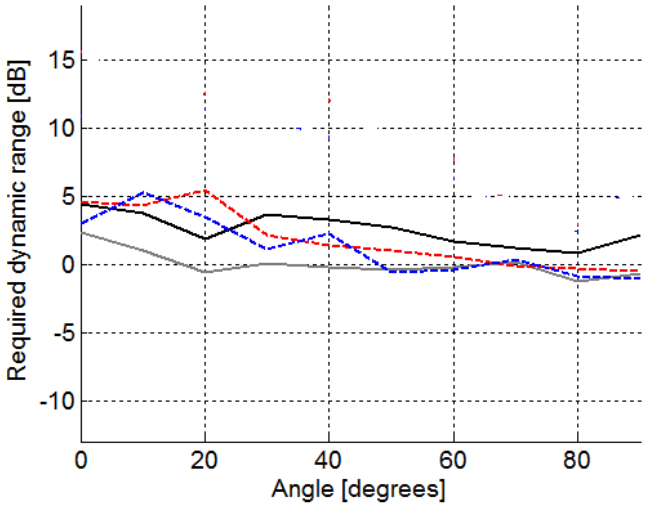


Figure11.Required dynamic range S/N with Mirror model for a maximum error of 0,1 for different samples

The loudspeaker level should sufficiently exceed the background noise level, being a difference of 10 dB sufficient enough to achieve good absorption estimation.

Reflected waves can introduce small variations in the calculated response. To reduce these deviations use the smoothing options.

ABSORPTION MODELLING

To calculate the actual impedance/absorption/reflection coefficients, the system is considered as a radiating point source. Several corrections are applied to take into account the near field effects and spherical wave fronts, in order to obtain the plane wave impedance/reflection or absorption that we are mostly familiar with. To extract the plane wave absorption properties, 3 models are proposed in the software. The following table presents the pros and cons of each of the models:

Model	Plane wave	Mirror source	Q-term
Bandwidth	-	+	+
Speed	+	+	+/-
Robustness	+	+	-
Accuracy	-	+/-	+/-
Main disadvantage	Low frequency errors	Negative absorption values are found because only plane sound waves inside the same are considered	

NOTE: *FOR A DEEP UNDERSTANDING OF THE MATHEMATICS BEHIND THE MODELS PLEASE READ:*
HTTP://WWW.MICROFLOWN.COM/FILES/MEDIA/LIBRARY/BOOKS/MICROFLOWN_EBOOK/EBOOK_6_IMPEDANCE.PDF

RESULT ACCURACY

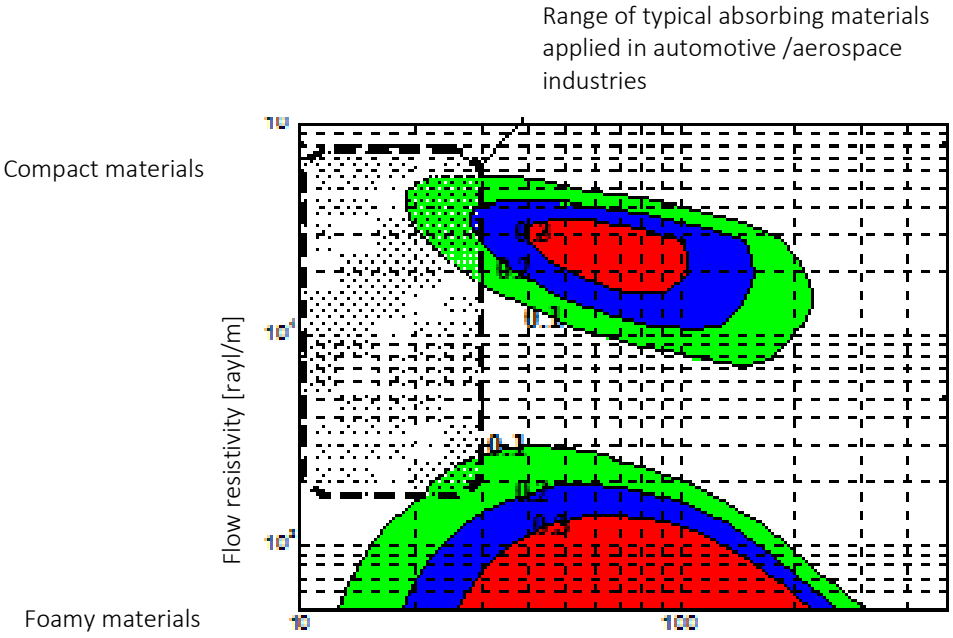


Figure 1. Maximum deviation between absorption results

MEASUREMENTS UNDER AN ANGLE

Measurements performed under an angle different to normal incidence are possible, but the probe should be rotated in the same angle for both measurement steps: the free field calibration and material test.

Further investigation needs to be carried out in order to assess the maximum usable incidence angle.

AIRFLOW EFFECT

The velocity sensor response is affected by airflow being able to withstand DC flow of up to 2 m/s.

For wind speeds above this value, special wind caps manufactured by Microflown technologies can be used to protect the sensor.

These wind protectors are usable with the In-situ Absorption setup as long as there are kept on the probe for booth measurement steps: free field calibration and material testing.

VIII. USAGE AND PRECAUTIONS

- Do not submerge the electronics in water as this will lead to permanent damage.
- Only use the cables supplied with the kit. Any modifications to these cables or the use of cables of a different brand or type may result in permanent damage to the probes or the rest of the electronics.
- The probes must be powered via a Microflown™ signal conditioner, the new MFPA series or the prior MFSC/ Router. Do not power the sensors with any other device; this might cause permanent damage to the system.
- Access exposure to dust/dirt particles could damage the Microflown™ sensor.

IX. TECHNICAL SUPPORT

For any problem or doubt with your equipment, please contact Microflown™ Technologies Customer service:

- Mail: cs@microflown.com
- Skype: cs.microflown
- Telephone: +31(0) 88 001 08 11 Monday to Friday, from 9:00 to 17:00 (UTC+1).

X. WARRANTY POLICY, REPAIRS AND REPLACEMENTS

WARRANTY AND REPLACEMENT OR SUBSTITUTION

During the first two years (24 months) the seller offers a warranty on all its products, except for trading items and third party manufactured items. The seller warrants that all products will be free from defects in materials and workmanship for this period of two years. During this two year period, the seller will repair or replace defect products free of charge. Products damaged by accident, abuse, misuse, natural disaster or by any unauthorized disassembly, repair or modification are not covered by this warranty. The incurred transportation costs of returning

the products to seller will be borne by the buyer. The logistical cost for returning the products back to the buyer will be borne by the seller. Several products come with a “VOID if seal is broken” sticker, the warranty is void at all times when this sticker is broken.

GRACE PERIOD (YEAR 3 AND 4)

During the third and fourth year the seller offers a grace period. In the grace period the products purchased at an earlier date can be replaced by completely new state of the art products of the same scope of the original purchase. This applies only for the products known as standard probes and signal conditioners. In the first year of the grace period, (year 3) customers have an option to replace their products for 25 % of the actual ex works end-user price. The full freight and packaging charges apply.

In the second year of the grace period, (year4) customers have an option to replace their products for 50 % of the actual ex works end-user price. The full freight and packaging charges apply.

The new products are accompanied by a new warranty. Both the two years warranty and grace period become applicable again from the date of invoice.

REPAIRS OUTSIDE WARRANTY POLICY

Replaced/repaired parts come with a six month warranty under the same conditions as the two year warranty.