PRODUCT DATA

PULSE Acoustic Material Testing in a Tube — Type 7758

PULSE™ Acoustic Material Testing in a Tube Type 7758 is software for determining the acoustical properties of noise control materials whether used to absorb airborne sound or to reduce airborne sound transmission. It works in conjunction with Impedance Tube Kits Type 4206 and Type 4206-A, Transmission Loss Tube Kit Type 4206-T and any other custom measurement tube.

USES AND FEATURES

USES

- To develop noise control products
- To verify compliance with specifications
- To benchmark competitive products
- To help select the most adequate treatment
- To provide materials' acoustic properties for validating and calibrating computational methods

FEATURES

- Comprehensive solution for evaluating both normal incidence sound absorption and sound transmission properties
- Determination of normal incidence sound absorption coefficient and normal surface impedance based on ISO 10534-2 and ASTM E1050
- PULSE platform ensures exceptional measurement accuracy
- Scalable solution

Brüel & Kjær

Introduction

With growing demands for quieter vehicle cabin noise, cabin acoustic comfort has become a major concern for automotive manufacturers. Optimisation of the sound absorption and transmission loss performance has been given a more prevalent role in the design process. Prediction at an early stage of the development process of, for example, the acoustical impact of trim lining headliners, seats or multi-panel systems is a desirable methodology for reaching the intended acoustic comfort, as well as minimising extra production costs of prototypes.

Similarly, in the aeronautical industry, there have been significant efforts in reducing the interior noise in aircraft. Low cabin noise has become a main parameter in the commercial success of an airliner.

Moreover, the need for a better fuel consumption economy is pushing the industry to experiment with the use of new, lighter structures for weight reduction, whose acoustical properties have to be thoroughly studied. The goal is to reduce noise and weight at the same cost level.

Protection against external noise in dwellings and addressing excessive noise at the workplace that not only reduces productivity, but can also put workers' health at risk, puts some of the highest demands on the construction industry today. As a result, most buildings increasingly use acoustic treatments, whose effectiveness greatly depends on the appropriate selection of the noise control materials.

The acoustic performance of noise control materials can be characterised in different ways depending on their end-use and scope of the investigation. Treatments applied to an interior surface to absorb airborne sound are typically porous materials; they dissipate acoustical energy largely by the interaction of their solid and fluid phases. They are typically characterised by the random or normal incidence absorption coefficients. Barriers and partitions are high-density materials or multi-panel systems consisting of high-density structural panels lined with layers of porous materials. They can be characterized by the random or normal incidence transmission loss.

Directly measuring random incidence quantities in accordance with well-established, standard methods requires the use of expensive testing facilities. Measuring the random incidence sound absorption requires a reverberation room. Measuring the random incidence transmission loss requires a chamber suite, which typically consists of a reverberation room, an adjacent anechoic space and an aperture between the two rooms in which the test material is inserted.

On the other hand, normal incidence quantities can be determined using a standing wave tube. At frequencies below the cut-off frequency for the first dispersive mode (which is determined by its cross-sectional area), only plane waves can propagate in the tube. This technique guarantees a highly reproducible testing condition. Moreover, it provides a very convenient testing setup, especially when it is impractical to procure large samples for accurate random-incidence measurements in a reverberation room. Moreover, for locally reacting materials only, estimates of the random incidence absorption coefficients can be obtained by integrating the appropriately weighted normal incidence absorption coefficient over all possible angles of incidence.

Description of Type 7758

Two different PULSE templates are provided. This section explains features and functionalities, which are specific for each project template.

Normal Incidence Sound Absorption

This solution provides measurement and calculation procedures for the determination of the normal incidence sound absorption coefficient and related acoustic properties of a sample using a two-microphone impedance tube (for example, Type 4206 or Type 4206-A). It is based on

ISO 10534-2 and ASTM E1050 and includes transfer function calibration to eliminate the effects of phase and amplitude mismatches between the two measurement channels.

Prior to testing, the signal-to-noise ratio (SNR) can be determined at each microphone position to ensure accurate results. The measured SNR values are automatically compared to a user-defined threshold (for example, background noise) and, if this is exceeded, a warning is shown.

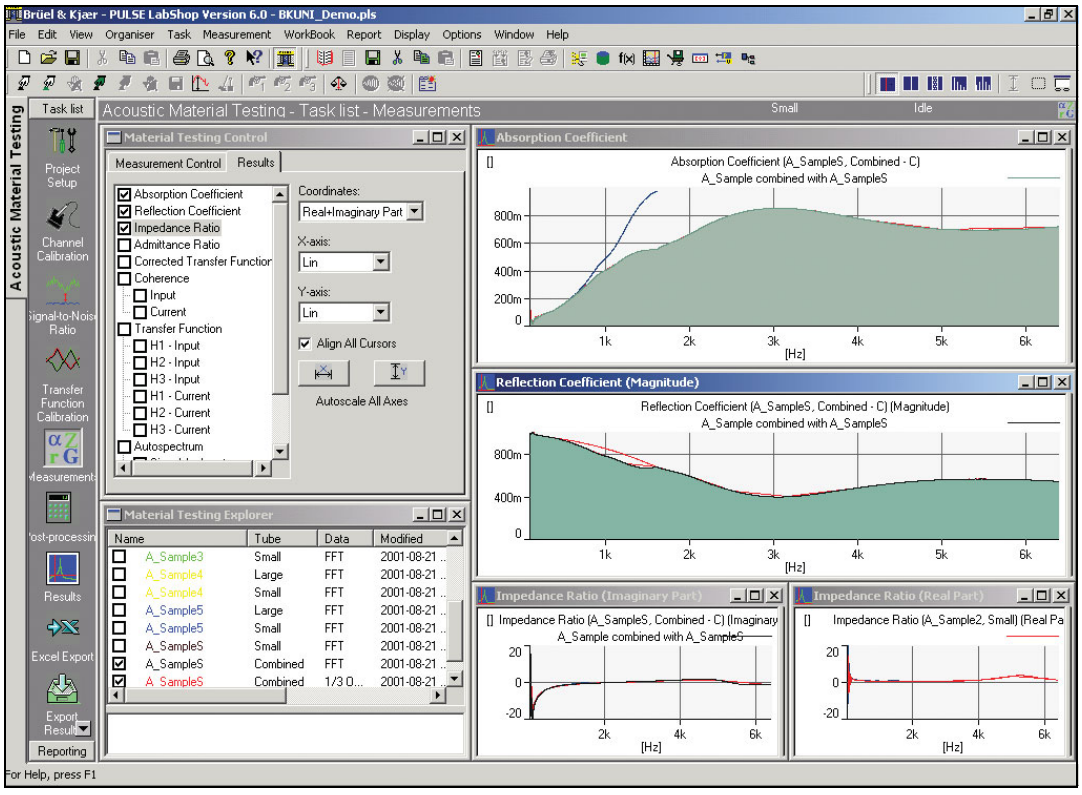

Fig. 1
The PULSE™ Material Testing Program's task-oriented user interface provides step-by-step guidance through all stages of the measurement process

Intermediate results can be examined to validate your data thoroughly before accepting it. In addition, the program issues automatic warnings during measurement if parameter levels fall out of compliance with predefined settings, for example, if there is too large a difference between the maximum and minimum sound pressure level inside the tube.

Powerful batch measurement functionality allows you to configure up to 250 items prior to measurement. Measurement results can be averaged to compensate for variations in the test samples. It is possible to combine measurements from different tube types to cover a broader frequency range and extract 1/n-octave frequency information.

Measurement data and results are saved in the project in which they were originally generated. However, the Export/Import Results task lets you save data in dedicated files and load it into another project based on the Normal Incidence Sound Absorption project template.

A convenient tool (Material Testing Explorer) is provided for keeping track of measurement data. All measurements that have been executed, post-processed or imported are displayed in an easy-to-read table format.

Normal Incidence Transmission Loss

This solution provides the determination of the normal incidence sound transmission loss and related acoustic properties of a sample using a four-microphone standing wave tube (for example, Type 4206-T).

A transfer matrix representation, which has been widely used in the past in a large body of scientific literature, is adopted. Its elements are used to determine the normal incidence trans-

mission loss of the sample as well as a variety of other acoustical properties: for example, the normal incidence absorption coefficient for the case of an anechoic termination, the ratio of dissipated energy within the sample to the incident energy, and the surface normal impedance of the sample for the case of an anechoic termination.

Although the sound power transmitted through the sample generally depends on both its properties and the tube termination conditions, the method provides the normal incidence transmission loss as if the sample were backed by a perfectly anechoic termination independent of the actual tube termination conditions used during the measurements. That is, the solution does not require a perfectly anechoic termination, which would be difficult to realise and, therefore, very expensive.

The transfer matrix is estimated from two measurements with two different tube termination (or loading) conditions, which typically are open and approximately anechoic terminations. When the sample under test is symmetric front-to-back a procedure which requires only a single measurement is implemented (one-load method).

When the sample is a porous material that can be modelled as an effective fluid (like glass fibres and fibrous materials), the material's characteristic impedance and the complex wave number can also be determined along with associated quantities such as the complex density and complex sound speed. These quantities are most often required when validating and calibrating computational methods.

Data can be stored in a dedicated database, increasing the efficiency of browsing and comparing data. Using PULSE Data Manager Type 7767, statistical quantities can be calculated on batch measurements stored in the database (such as mean and standard deviation).

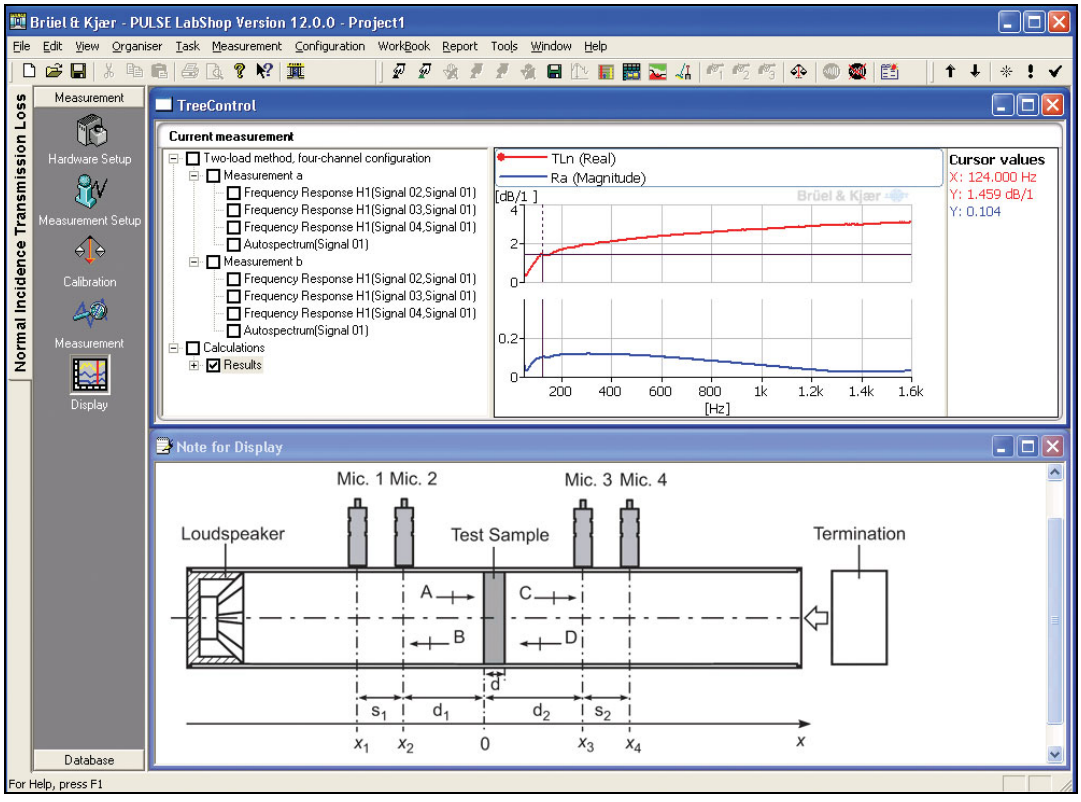

Fig. 2
Example measurement of normal incidence transmission loss and normal incidence anechoic reflection coefficient

Specifications – PULSE Material Testing Program Type 7758

Type 7758 is a software application for use with PULSE, the Multi-analyzer System Type 3560[a]

System Requirements

PULSE hardware with one generator output channel (full generator functionality)
The PC requirements for PULSE, the Multi-analyzer System Type 3560 must be fulfilled (see the System Data BU 0229)

Minimum license requirement:
- PULSE FFT Analysis, 2-ch. license Type 7770-N2 (for Normal Incidence Absorption)
- PULSE FFT Analysis, 4-ch. license Type 7770-N4 (for Normal Incidence Transmission Loss)
- Microsoft® Office 2000 or 2003

Screen resolution of 1400 × 1050 pixels (or better) is recommended

a. For PULSE specifications, see System Data BU 0229 (software) and System Data BU 0228 (hardware)

CALIBRATION
Calibration is performed using PULSE's integrated Calibration Master, which automatically initiates calibration while moving the calibrator from one microphone to the next. The full calibration history for a transducer can be retained in the Transducer Database, which allows monitoring calibration data variations over a period of time. Global calibration allows building up a calibration database that is shared across all PULSE projects

Normal Incidence Absorption

STANDARDS
ISO 10532–2: Determination of sound absorption coefficient and impedance in impedance tubes – Part 2: Transfer-function method
ASTM E1050: Standard test method for impedance and absorption of acoustical materials using a tube, two microphones and a digital frequency analysis system

SUITABLE APPARATUS
- Impedance Tube Kit (50 Hz – 6.4 kHz) Type 4206
- Impedance Tube Kit (100 Hz – 3.2 kHz) Type 4206-A
- Any other custom two-microphone impedance tube. Up to three different user-defined tube setups can be used in a single project

MEASUREMENT
- Transfer function of the two microphone signals
- Sound pressure level at each microphone position with generator off (background noise) and on

A group or batch of measurements can be made in a project and measurements from previous projects can be imported into the current project

CALCULATION
- Normal incidence absorption coefficient
- Normal incidence sound pressure reflection coefficient
- Normal surface impedance ratio
- Normal surface admittance ratio
- Transfer function of the two microphone signals corrected for channel mismatch

VALIDATION
- Signal-to-Noise Ratio (SNR) at each microphone position
- User-defined SNR threshold level
- Coherence

STATISTICS
Mean of any measured or calculated quantity on batch measurements (max. 250 items)

ADDITIONAL POST-PROCESSING ANALYSIS
- Combination of measurements from two different tubes
- Extraction of 1/n-octave frequency information

Normal Incidence Transmission Loss

SUITABLE APPARATUS
Transmission Loss Tube Kit (50 Hz – 6.4 kHz) Type 4206-T
Any other custom four-microphone transmission loss tube

MEASUREMENT
- Autospectrum of reference signal
- Frequency response function between the complex sound pressure at i-th microphone position and the complex reference signal

CALCULATION
- Complex amplitudes of plane progressive waves travelling in opposite directions in both the up- and downstream tube sections, whose phases are defined relative to reference signal
- Sound pressure on the upstream and downstream face of the sample
- Normal acoustic particle velocity on the upstream and downstream face of the sample
- Transfer matrix elements
- Normal incidence pressure transmission coefficient for the case of an anechoic termination
- Normal incidence pressure reflection coefficient for the case of an anechoic termination
- Normal incidence, power transmission coefficient for the anechoically terminated sample
- Normal incidence, power reflection coefficient for the anechoically terminated sample
- Normal incidence absorption coefficient for the case of an anechoic termination
- Normal incidence dissipation coefficient for the case of an anechoic termination
- Surface normal incidence impedance for the case of an anechoic termination
- Normal incidence pressure reflection coefficient for the hard backing case
- Normal incidence transmission loss, TL_n
- Complex wave number of the material under test
- Complex characteristic impedance of the material under test
- Normalized complex sound speed of the material under test
- Normalized phase speed of the material under test
- Normalized complex density of the material under test

VALIDATION
- Coherence of the frequency response functions as a function of source level

STATISTICS[b]
Mean and standard deviation of any measured or calculated quantity on batch measurements

b. PULSE Data Manager Type 7767 license required

Ordering Information

Type 7758-N	PULSE Material Testing

Recommended Accessories

Type 3560-B-130	5/1-ch Input/Output PULSE Data Acquisition Unit (Dyn-X) – Generator – LEMO connectors
Type 7770-N5	FFT Analysis, 5-ch. license
Type 7767	PULSE Data Manager
Type 2716-C	Power Amplifier (includes input and output cables WL-324 and WL-1325)
Type 4206[a]	Impedance Tube Kit (50 Hz – 6.4 kHz)
Type 4206-A	Impedance Tube Kit (100 Hz – 3.2 kHz)
Type 4206-T	Transmission Loss Tube Kit (50 Hz – 6.4 kHz)
Type 4231	Sound Calibrator
DP-0775	Adaptor for 1/4″ Microphones (for Type 4231)
AO-0479-D-001	7-pin Lemo to BNC Cable (0.1 m) (for connecting generator output to input channel)
JJ-0152	BNC T-connector

a. For a complete specification of the Impedance Measurement Tubes, see Product Data BP1039

BP 1870 – 16 2007-10 Rosendahls Bogtrykkeri

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