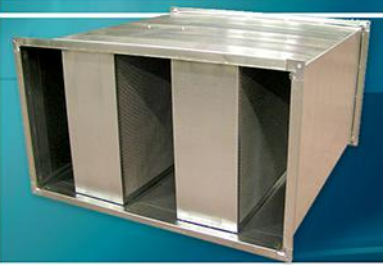


SIDLAB[®]

Propagation of Sound in Ducts



Acoustics Simulation

Flow Simulation

Acoustics HF Simulation

Measurement & Acquisition Software

Muffler Performance Test

- Automotive Exhaust & Intake Systems
- After Treatment Devices
- Power Generation
- Engine-powered machines
- HVAC Systems
- Chimneys
- Gas & Steam Turbines
- Oil & Gas Pipeline Networks

■ Sound in Pipes & Ducts

■ Analysis & Design of Low Noise Systems

www.sidlab.se

Ver.: 4

2017



Overview

SIDLAB Suite is a combination of software and hardware solutions for the analysis and measurement of sound generation and propagation inside duct networks. This can be applied to Intake and Exhaust systems, Power generation, Oil & Gas pipe networks and HVAC systems.

It offers a complete characterization of the system, including both simulation & validation measurements. SIDLAB Acoustics and SIDLAB Flow design the system to have a good acoustic performance keeping the pressure drop low enough. The results are then validated using SIDLAB Measurement or SIDLAB Acquisition in the SIDLAB Rig.

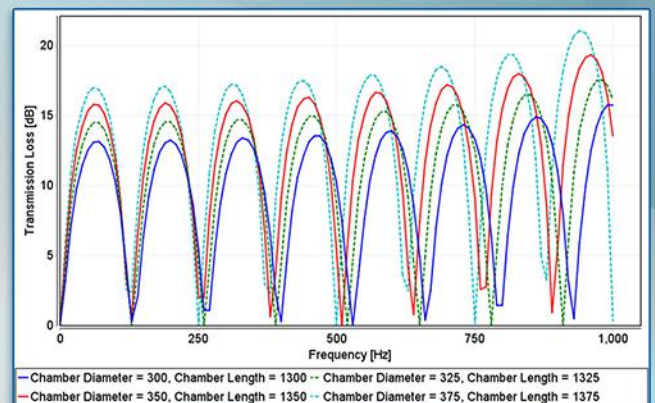
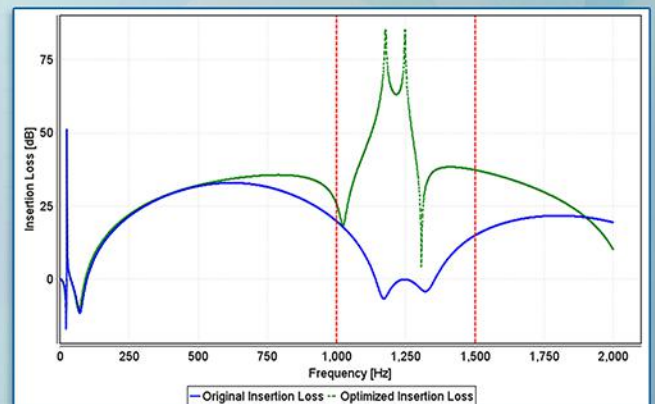
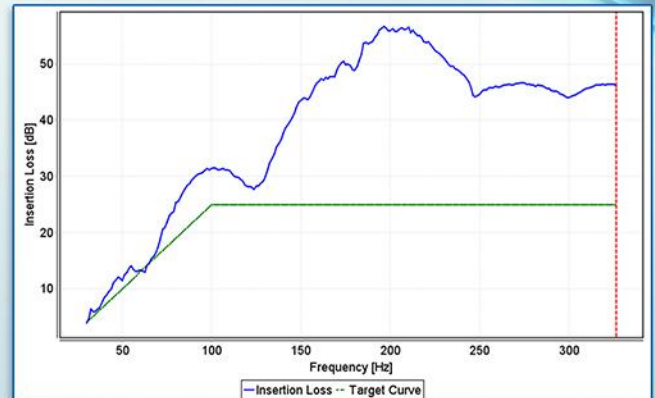
SIDLAB Optimization and Parameterization tools offer larger possibilities for an efficient design. SIDLAB calculations are done in MATLAB, and the source code is offered. This is a good advantage for advanced users to perform their custom analyses. Calculation time is typically a few seconds on a normal PC. Post-processing within SIDLAB is simple and straightforward, with the possibility to save the results in different formats. SIDLAB compiles a long experience and know-how of accurate modeling for all types of duct acoustic applications in research, teaching and consulting.



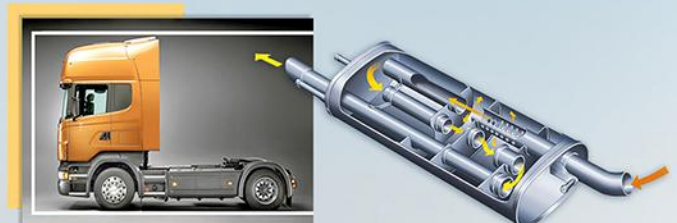
SIDLAB Optimization is the best tool to save time and money. It offers a straight forward interface to optimize the performance of your system. It enhances the acoustic performance according to a pre-set criterion and keep the pressure drop below the allowable limit.

Any length parameter in any element can be optimized given two limits and an initial value. You can specify complex constraints linking several optimized parameters together. The optimization criterion can be one of the following:

1. Exceed a certain performance curve.
2. Maximize the performance at a single frequency
3. Maximize the performance at a range of frequencies.



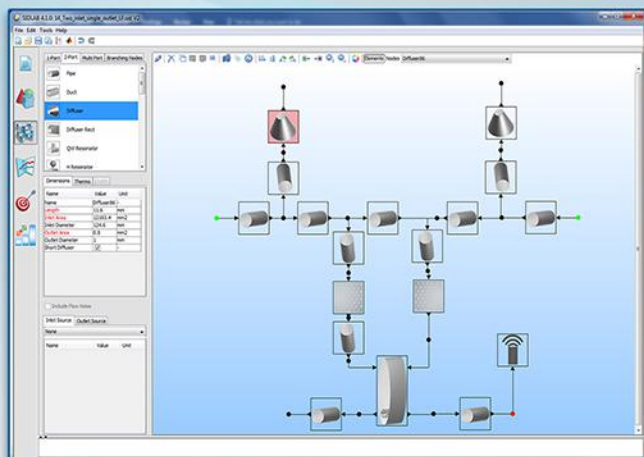
SIDLAB Parameterization is an easy way to monitor the effect of change a parameter on the result. Choose the property that you want to manipulate and identify the parameterization limits and incremental step. The results of each single change will be compared together in the plotting window.



This module models the generation and propagation of low frequency sound in complex duct networks. The frequency range is limited to the plane wave region in the connecting pipes. It is based on linear acoustic theory and all elements, e.g., a complex muffler, are reduced to two-ports while terminations and sources are represented as one-ports. A number of standard elements representing common duct and pipe elements as well as basic muffler types are available as building blocks, which can be connected to form a network. All standard element models are validated and are based on the best and most recent models published in the literature. The users have the possibility to add their own elements as user defined elements.

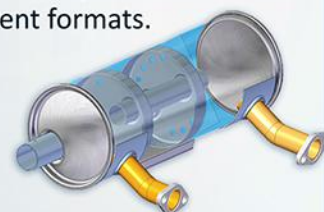
SIDLAB Acoustic calculates:

1. Transmission Loss and Insertion Loss in dB
2. Noise Reduction in dB, narrow band, octave and third octave.
3. System Resonances
4. The elements of the Transfer and Scattering Matrices for each element and for the full network.
5. Sound Pressure RMS and phase at each node in the network. (Pa or dB, narrowband, octave and third octave).
6. Sound Power exchange to and from the network at each node. (W or dB, narrowband, octave and third octave).
7. Sound Pressure RMS outside the network at a predefined receiver position. (Pa or dB, narrowband, octave and third octave).
8. Transfer Function between any two nodes in the network.



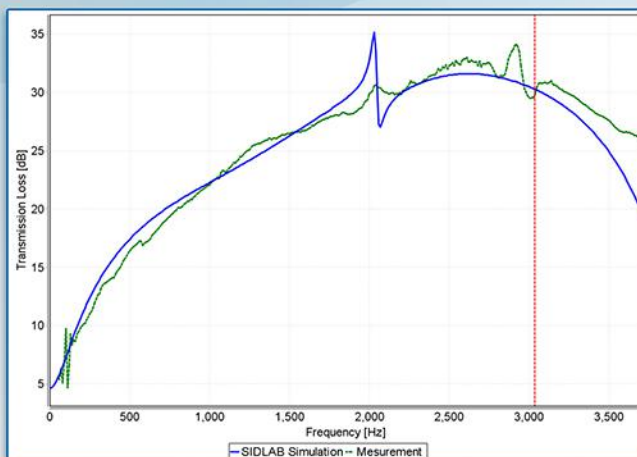
SIDLAB Acoustic capabilities:

- Work with different unit systems to define the dimensions of the network: m, mm and inch.
- Save different versions of the design in the same project.
- The fluid medium can be a perfect gas or a liquid. Available editable library of common fluids.
- Element Manager: Add new elements, delete elements, and modify their list of properties.
- The system network can be drawn in 2D or 3D with a variety of drawing and editing tools. Drawing the network in 3D has no influence on the calculation. 3D Networks are only for visualization purposes.
- Several convenient ways to manipulate the results and export them in different formats.

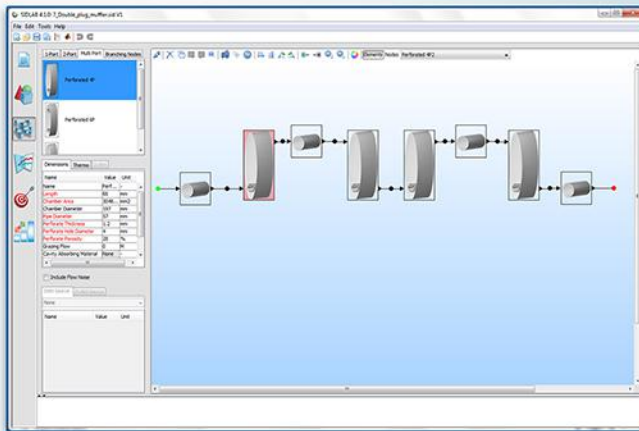


SIDLAB Acoustics special calculations:

- **Engine order vs. Engine RPM calculation:** The frequency vector is calculated automatically. Extra needed input data is the inlet flow and temperature at each RPM.
- **Optimization:** Optimize the system performance (TL – IL – radiate pressure) for a range of frequencies using any number of variables. Define equality and non-equality dimensional constraints. Possible to include the allowable pressure drop as a constraint.
- **Parameterization:** Choose a single parameter inside the network, perform a parametric analysis by varying the value of this parameter within a specified range with a specified step. The results are shown for all values of the parameter simultaneously.

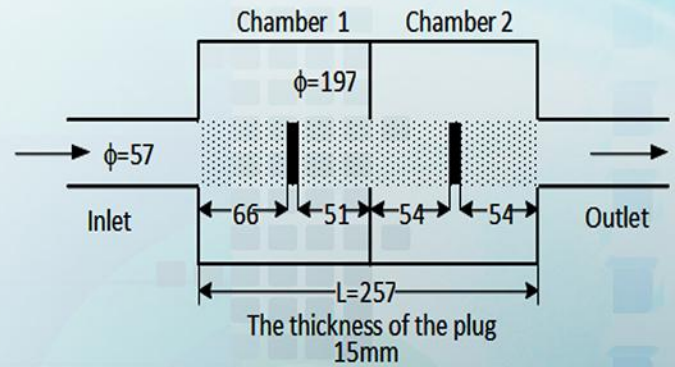
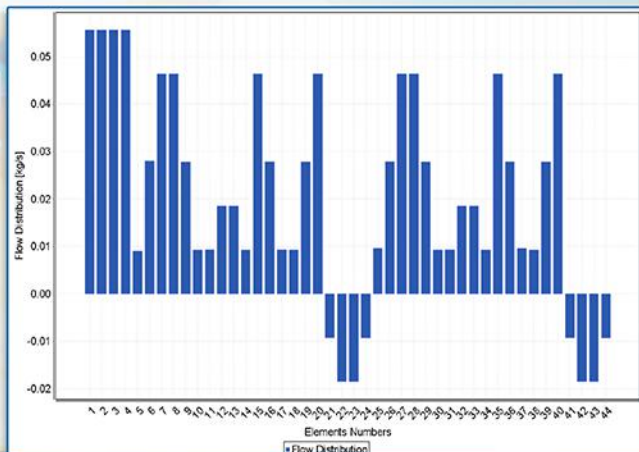


This module is an add-on to SIDLAB Acoustics. This is a very quick 1D tool to calculate the pressure drop introduced by the designed muffler system. It calculates the flow distribution and pressure drop inside the network using a two-port formulation, and feeds the results into the acoustic calculation either in low or high frequency. The acoustic performance of some elements like perforates is very dependent on the amount of flow inside the element. SIDLAB Flow uses the same network built in SIDLAB Acoustics or SIDLAB Acoustics HF.



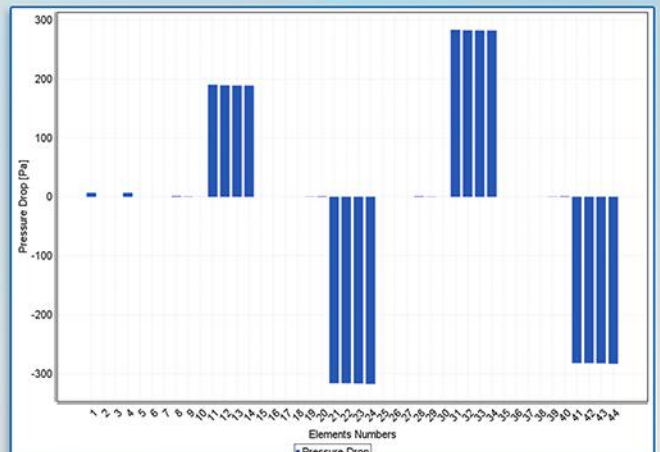
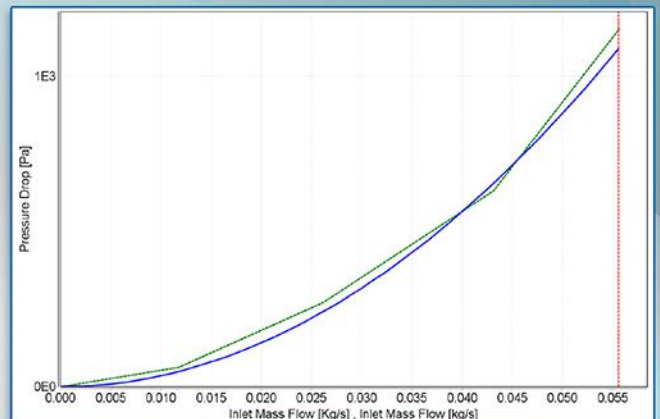
The flow can be introduced into the network in two ways:

1. A prescribed flow source at one inlet of the network. Inlet flow can be defined as:
 - Mass flow in kg/s
 - Flow velocity in m/s
 - Flow Mach number
2. Several external static pressure sources connected to different inlets/outlets in the network.



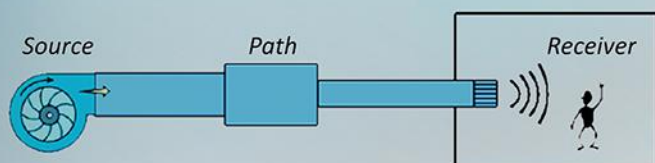
SIDLAB Flow calculates:

1. Flow distribution: how much flow in kg/s is going through each element.
2. Pressure drop across each element in the network for the given inlet mass flow.
3. Flow Mach numbers in each element.
4. Flow – pressure drop curve for the system.
5. The total pressure drop for the whole muffler.



This new module models the propagation of sound inside ducts in the high frequency range using power method. It is hard to specify accurately at which frequency this range starts but it is assumed that high frequency region begins from double to three times of cut-off frequency of the first mode, in this range a large number of modes are exists and wave length is very small so that sound is propagate as rays and there is no coupling between a source and a system and the acoustic power equals the free field value. In this range, the power based methods can be used, this implies that each source is described by its power and each duct element by its transmission coefficient.

The standard procedure is to use power based calculation models. These models are often based on measurements. All sources are associated with a sound power based on a standardized measurement. This sound power is then assumed to propagate through a pipe system and to behave like a semi-diffuse field, and as traditional assumption in HVAC calculation the effect of reflections at junctions, bends and cross section sudden change are neglected. This model is similar to the classical power based models used for room acoustics.



In power based techniques, the source-path-receiver model is used, see Figure 1. In this model, the source is the sound-generating device; the path comprises everything that affects the sound as it travels from the source to the receiver, and the receiver is typically the site where a person hears that sound. The term element collectively describes the source, receiver, and path components. The receiver location hears the sum of all sound traveling to that location. Depending on the application, there may be several sources of sound, and the sound from each source may travel to the receiver along one or more paths. Regardless of the number of sound sources and paths, each path is analyzed individually; then the superposition of all paths is considered. This model is widely used in HVAC applications.

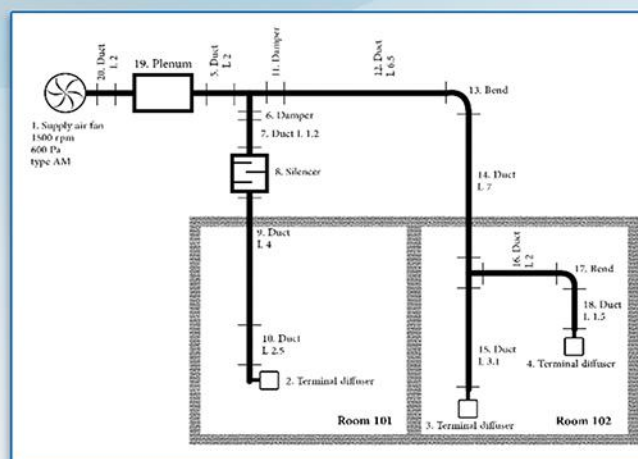
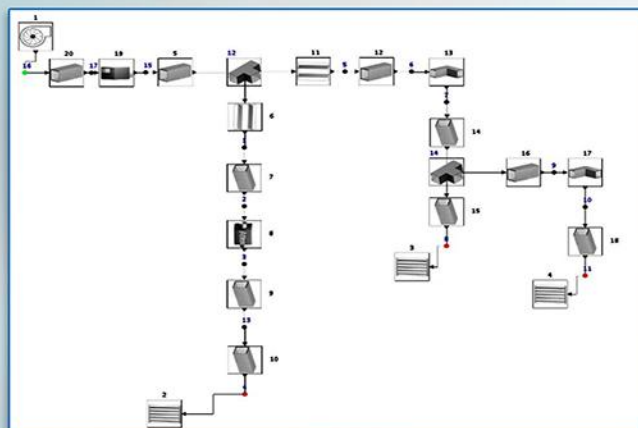
The path is analyzed by adding and subtracting the regenerated and attenuated power to this path sum at each Octave or Third Octave frequency band.

It is usually assumed that reflections are minor and therefore their effect is neglected. Moreover, elements that produce backward reflections, are considered as attenuation without affecting the elements connected to it.



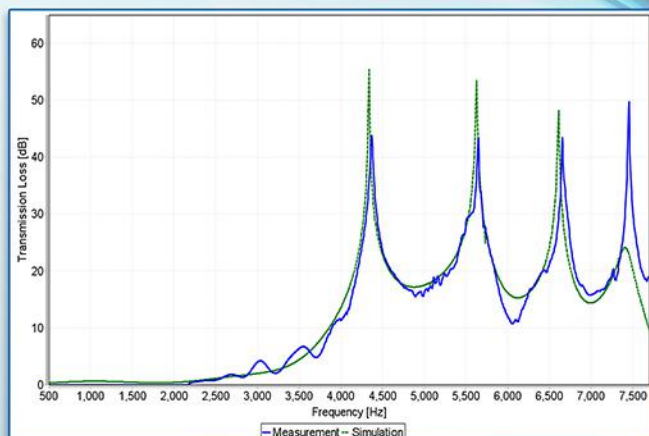
SIDLAB Acoustics HF calculates:

1. Insertion Loss in Octave bands (dB and dBA), for any combination of inlet/outlet of the system.
2. Pressure outside the network, either radiated in free field or inside Rooms

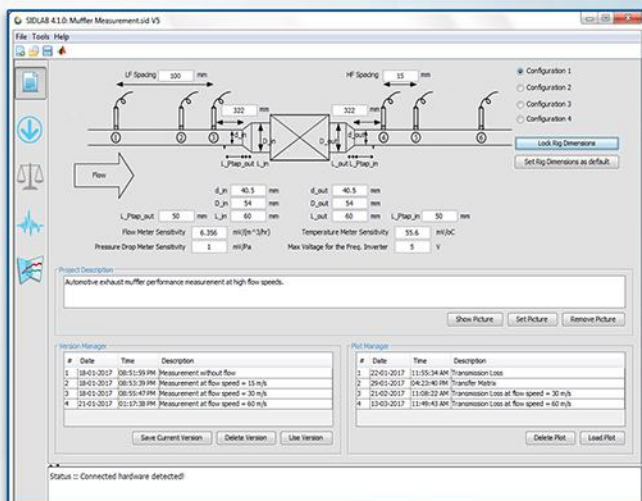


SIDLAB Acquisition is used to acquire the measurement data needed to characterize the passive acoustic properties (e.g. Transmission Loss) of two-port elements (e.g. exhaust or intake mufflers). SIDLAB Acquisition is provided together with a Data Acquisition System and the measurement microphones. It automates the measurement procedures accounting for different theoretical and practical considerations. Different excitations (random or stepped sine) can be used. The results are stored in different formats compatible to SIDLAB Acoustics and can be used to simulate a complete system.

SIDLAB Acquisition is very useful for companies and research institutes, who perform this measurement as a standard measurement which is repeated frequently throughout the design process.



It is very common to perform this test with flow through the pipe. SIDLAB Acquisition has an optional add-on to control the fan speed (providing the flow) through the same interface. Flow speed and temperature are also measured automatically and used in the calculation.

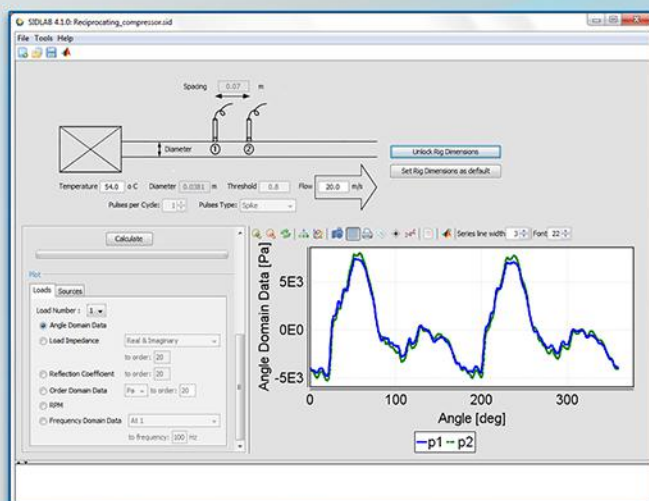


SIDLAB Acquisition has the following advantages over other Data Acquisition systems:

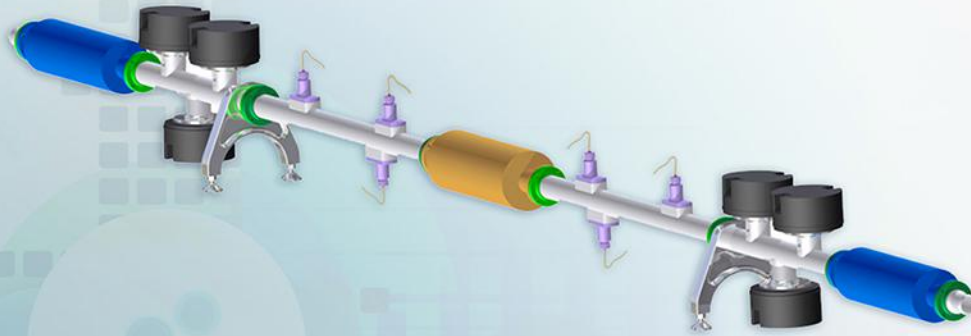
1. It supports stepped sine capabilities which provide better results, especially with flow. High Signal to Noise Ratio, easier to extract the loudspeaker signal from the flow noise.
2. It is easier to use and faster to do repeated measurements.
3. It has all functionalities integrated in one place.

Source Characterization (Strength and Impedance):

It is very important to characterize the properties of your source. A sound source can be described as a one-port and is described by source impedance and source strength. These two properties can be obtained using an indirect method. This is based on measuring the radiated sound pressure of the source under several acoustic loads. Using a least-square technique, the source characteristics can be obtained. This measurement is performed in the angle domain, and the results are shown in the order domain. These properties can be then used in SIDLAB Acoustics to predict the radiated noise level from the whole system.



This is the test rig for the measurement of the acoustic properties of mufflers for different exhaust/intake and HVAC applications. We offer 3 standard inner diameter sizes of 25, 50, and 100 mm. Other pipe sizes are available upon request. The rig can handle flow up to 100 m/s and air temperature up to 100°C. It can be further modified for higher flows, higher temperatures, and specific gases.



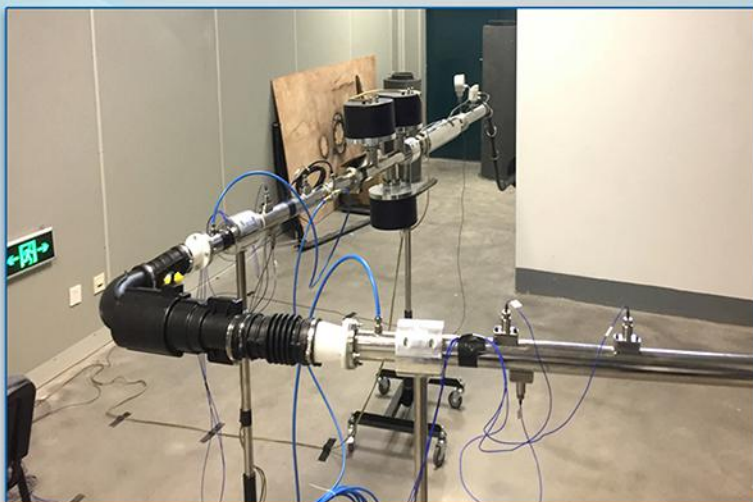
The SIDLAB Acquisition Rig solution consists of:

1. 2x Measurement pipes, holding the microphones.
2. 2x Loudspeaker pipes, holding the loudspeakers.
3. 2x Termination mufflers.
4. 4x Rig supports.
5. 6x Microphone holders.
6. 6x loudspeakers.
7. 1x Two-channel Amplifier.
8. Two adaptors for the connections to the test objects. More adaptors can be manufactured by the user based on different sizes.

Optional add-on: Fan to provide the flow, and a frequency inverter to change the fan speed.

To facilitate the measurement with flow, the rig is equipped with extra sensors that are connected to the same data acquisition system. The rig is connected to a fan to provide the flow, and a frequency inverter to change the fan speed. The fan speed can be controlled from the SIDLAB Acquisition Software, and all the sensor readings are fed automatically into the software.

It is also required to measure the pressure drop across the test objects and plot the pressure drop curve at different speeds. This can be done by varying the fan speed, and measuring the differential pressure between the inlet and outlet of the test object. The loss coefficient of the muffler can be calculated by the software.



SIDLAB Flow Kit includes:

1. Mass Flow measurement sensor measuring the flow rate at the inlet of the rig.
2. Temperature measurement sensor of the flow temperature at the inlet of the rig.
3. Differential pressure measurement sensor measuring the pressure drop across the test object.
4. Control the speed of the fan producing the flow into the rig in order to provide different flow speeds.
5. All necessary cabling.



Licensing Options

License Validity

Monthly Lease:

One month access to all SIDLAB Modules, Compiled version. Full technical support is included.

Permanent:

Lifetime access to the purchased modules. Maintenance subscription is included for one year.

License Use

CPU Locked Single User License:

SIDLAB may be installed and operated on up to 2 individual computers, provided it is only accessible to, and operated by, a single licensed user.

CPU Locked Multiple User Licenses:

Special discounts are available for purchasing more than one user. The second user onwards gets 50% discount.

Floating Network License:

Licensed per concurrent user. SIDLAB can be installed on as many machines on the same network (or VPN). SIDLAB runs on local computers, with the network used only for license authentication. SIDLAB FNL Manager is installed on a server and provides this authentication.

Access to source code

Full License:

Possible access to the MATLAB Source codes.

Compiled License:

No access to the MATLAB source codes.



Support

Maintenance Subscription

- Includes technical support and free upgrades.
- Is included with the Monthly Lease.
- Is included for one year for free for the permanent licenses.
- Optional maintenance subscription against a fee.
- If the customer stays on subscription for 3 consecutive years, a special discount is offered.

Consultancy

We offer several services related to the analysis and development of muffler solutions. This can involve modeling and experimental testing to support the design and prototype stages or simply to improve an existing installation. Our experience covers all types of applications ranging from vacuum cleaners to large stationary gas turbines.

Training

We organize several training sessions throughout the year, often associated with Acoustics Conferences. We also offer on-site training for special customer needs. Our training covers but not limited to the following: Sound in pipes and ducts, Acoustic design of mufflers, Training on SIDLAB simulations, and Training on SIDLAB measurements hardware.

Tutorial materials and resources

Visit our website for lots of materials, theories, tutorial models, validation case studies, and Frequently Asked Questions.

<http://sidlab.se/support/>

Download SIDLAB now:

<http://sidlab.se/download/>

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