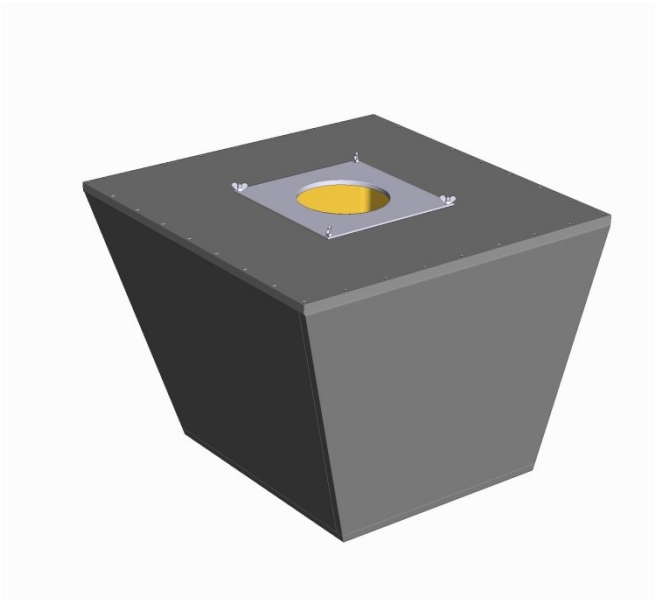
How to make a test box for QC? AN46

Application Note to the KLIPPEL ANALYZER SYSTEM (Document Revision 1.1)

A robust and stable test enclosure should be used for the online test of drive units and small audio systems.

Benefits are:

- reproducible results
- attenuation of ambient noise
- suppressed standing waves
- minimized rattling
- cost-effective construction
- dedicated design to match with test microphone specification for highest Rub&Buzz sensitivity



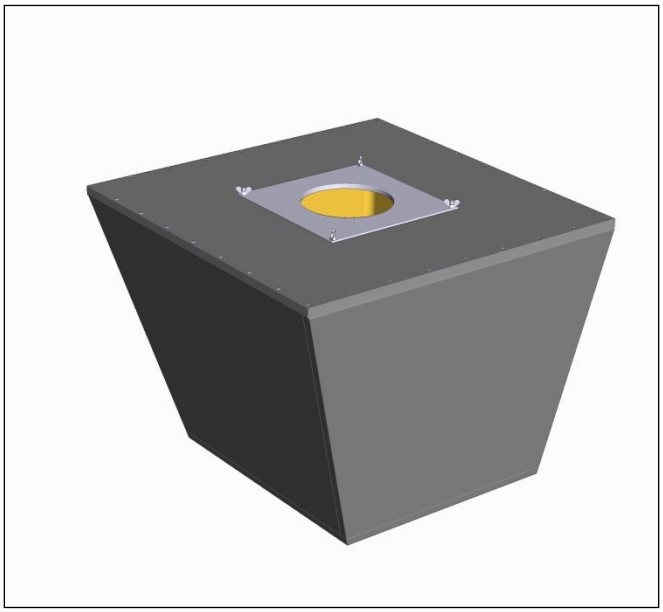
CONTENT

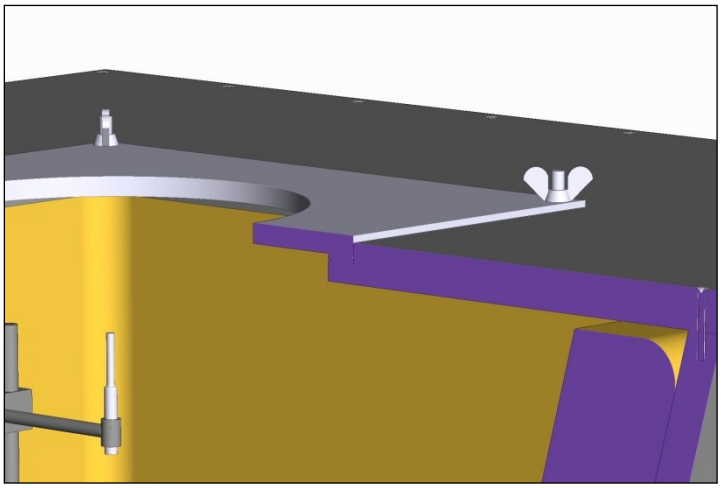
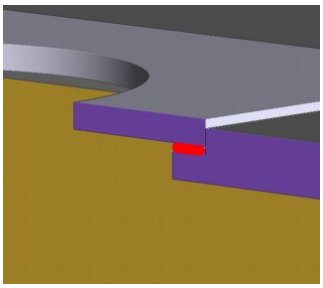
1 Background

Defined test conditions	Typical QC applications in the first place require test results, which are highly reproducible. Hence, a fixed environment including a defined microphone and DUT position is crucial for quality control to ensure comparability. The absolute results may be different from R&D measurements according to standards, which typically require very specific and complex measurement conditions.
Repeatability and Reproducibility (R&R)	Standardized Reproducibility and Repeatability Studies (R&R) identify the most significant causes of production variation. Typical causes under investigation are different test types, different operators and repeated measurements. R&R studies on acoustical DUTs show the highest impact caused by the fixture, the operation and the “soft” parts of loudspeakers. The influence from the actual measurement device is rather negligible. A well-designed box and dedicated test adapters improve the R&R result

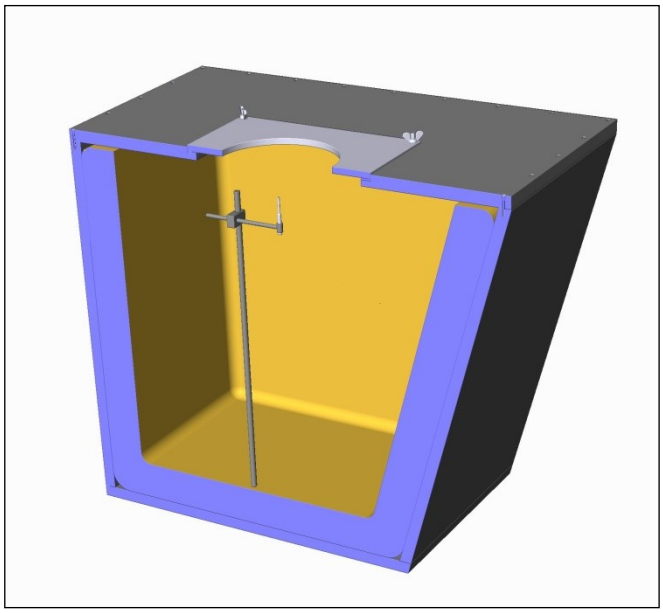
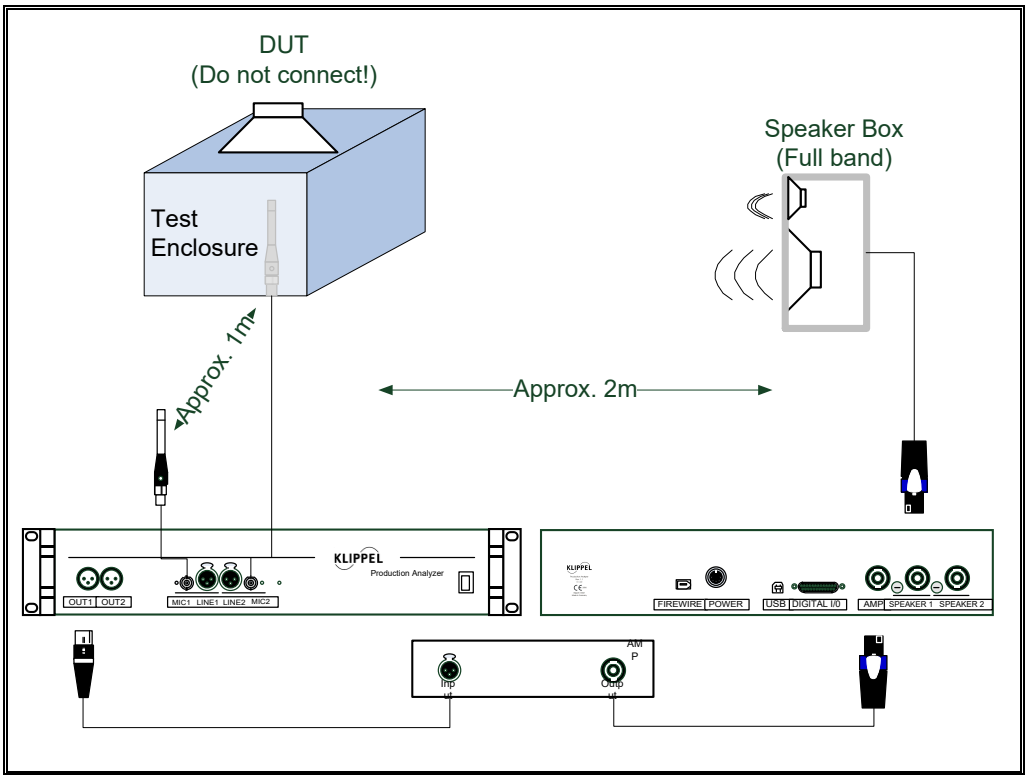
	considerably. If the aspects of this note are considered for designing a new test station, the remaining dominant variable for an R&R test will be the soft parts of the test object itself.
Noise Attenuation	Audible Rub&Buzz distortion may be 80 dB below the fundamental (frequency response). Production noise can easily exceed those low Rub&Buzz defects and thus needs to be attenuated for maximal sensitivity. Although a good test box can have >40 dB noise attenuation, it is not sufficient to provide 100 % Noise Immunity. Especially high-level impulsive noise events (falling parts, driving nails) will distort the test and hence reduce the yield rate (classifying good DUTs as bad). A combination of a good test enclosure and the *Noise Immunity Option* will provide 100 % Noise Immunity. Excessive ambient noise events are reliably detected using a second microphone and tests are repeated and spliced to ensure minimal testing time.

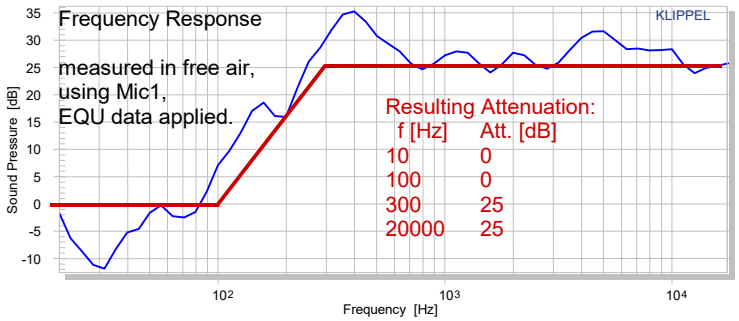
2 Mechanics

Material	MDF (Medium density fiberboard) of sufficient thickness (>=30 mm) or metal is recommended for the outer walls of the body. The mass of the box is the dominant property to attenuate low frequencies. All edges should be carefully sealed. Use screws every 10cm to ensure stable connections. For optimal sealing, all connections should be glued and screwed together. Check the reference at the end of this note for recommended sealing tape for reversible sealing of small holes (e.g., cable outlets).
Size / Volume	 The volume of the test box can be derived using a two-step chart-based procedure. Please refer to *How to calculate the peak SPL inside the box?* below. The optimal size depends on the displaced volume of the DUT and the peak SPL capability of your test microphone (see below).

DUT Adapter	 To test different types of drivers, an adaptor board is recommended. Make sure that the adaptor can be tightened onto the box without any leakage. The adaptor should be stiff and robust for reproducible tests and frequent exchange. Metal or thick MDF is recommended. Between the box and adaptor, the sealing tape should be used. 
Geometry	The best results can be obtained when any parallel walls are avoided. Thus, standing waves are strongly attenuated and mechanical vibration is reduced. It is sufficient to design 10°-15° off. The minimal volume requirement is defined by the low frequencies, where the displacement of the DUT is high. Since the wavelength is usually larger than the geometrical dimensions, the volume can be shaped according to usability and space restrictions. It does not need to be a cube-like box. For bigger test boxes inner struts should be considered to stiffen the walls.
Microphone holder	Make sure that the holder is not vibrating or rattling. If needed, bandage the parts with damping material. Make sure, that the microphone cable outlet is sealed (see reference for recommended material).
Usability	Design your test box to be compliant with safety restrictions and allow an efficient mode of operation. The operation mode of the operator (standing or sitting) should be considered.

3 Acoustics

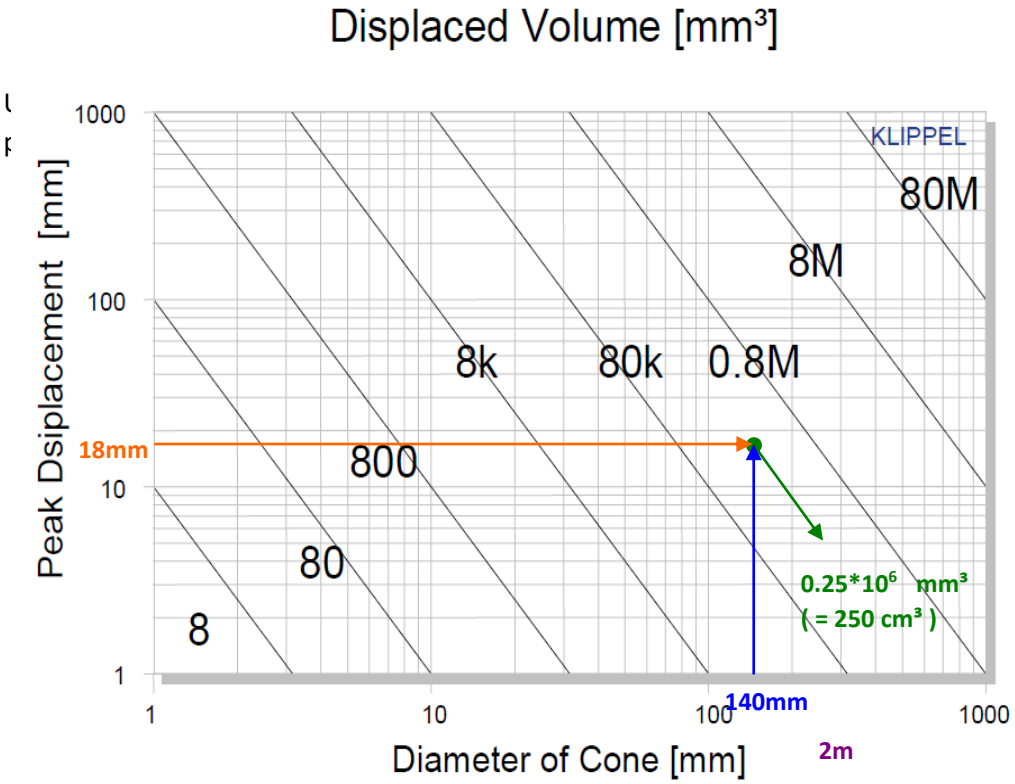
Damping	 All walls should be equipped with sound-attenuating foam of about 10 cm thickness to attenuate high-frequency noise.
Measure Ambient Noise Attenuation	

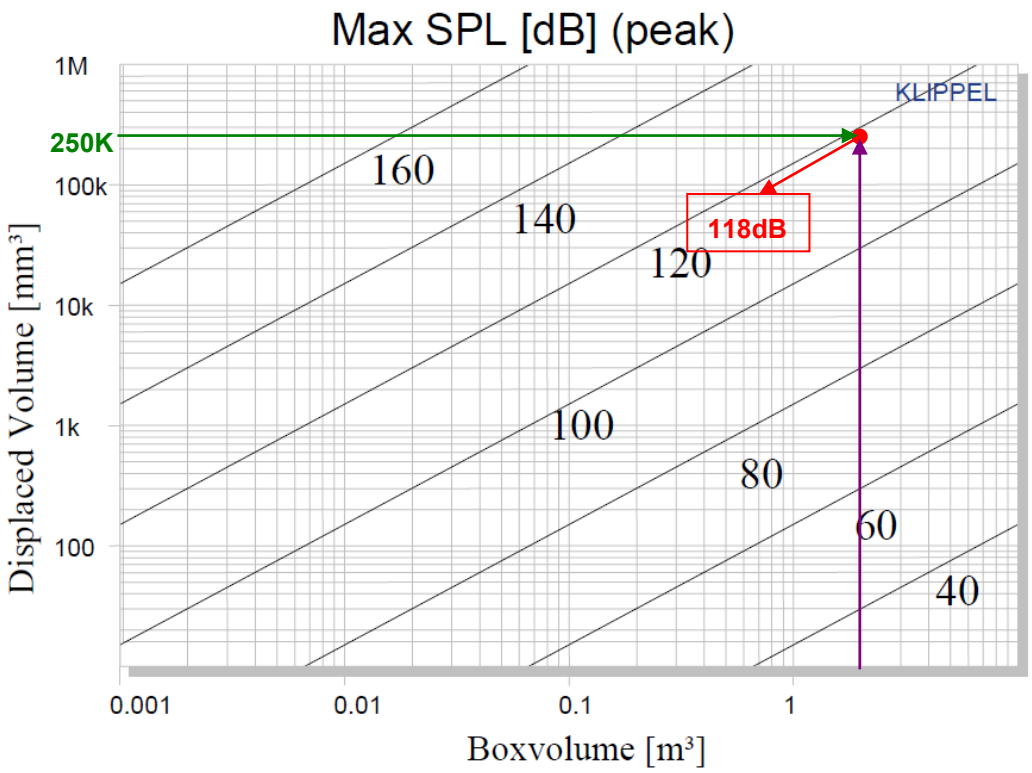


See the *QC user manual* in the *section Optimizing Performance / SPL Tests / How to cope with ambient noise? / How to measure Box attenuation?* on how to calculate the specific ambient noise attenuation of the test box and how to set up the test setup considering this attenuation.

Note that an external source is required. Do not use the DUT as an ambient sound source.

How to calculate the peak SPL inside the box?





The figures above show an example of testing a subwoofer with a diameter of 140 mm and 18 mm peak displacement. The resulting peak SPL is about 118 dB. An optimal microphone for this application is the MIC255 (AN 2400-009) ½" type.

Microphone Position	The microphone should be positioned coaxially and facing toward the DUT. The distance should be approximately the same as the diameter of the DUT.
Microphone Selection	The microphone type should be selected according to the peak SPL inside the box. Please refer to *A4 – Spec Microphones* for available microphones from Klippel and an application guide at the end of this specification. Select a microphone with sufficient but not too large headroom for all expected test levels. Thus, the dynamic range can be fully used for the most accurate and sensitive detection of the smallest Rub&Buzz defects. If drivers of very different sizes and displacements are to be tested, consider making two test boxes or using dedicated microphones. If a 3rd party microphone is used, please note that the specified peak levels usually refer to clipping the fundamental component. A considerable increase in THD and Rub&Buzz (higher harmonic distortion) starts at about 10 dB or even more below the specified level. If in doubt, compare the results of a test microphone with a high-level reference microphone (which can be borrowed from R&D sometimes…).

4 Electrical domain

Connection	Loose connections in the electrical domain (broken cables) are reliably detected using the Rub&Buzz analysis. However, to avoid those rejects, which are not related to the quality of the DUT, the plugs/sockets for the electrical connection to the DUT should be replaced regularly and before they become brittle or broken.
4 wire connector	Klippel provides 4 wire speaker cables for accurate voltage monitoring of the DUT directly at the terminals. This requires a true 4-wire connection up to the connection point of the DUT. **Do not extend the speaker cable with a 2-wire cable!**

5 More Information

References	QC User Manual (QC Version 2.8 or higher) QC Noise Immunity Specification A4 – Spec Microphones W. Klippel, "End-Of-Line Testing" Book Contribution in: "Assembly Line - Theory and Practice" ISBN 978-953-307-995-0, edited by Waldemar Grzechca (2011). download here: http://www.intechopen.com/articles/show/title/end-of-line-testing
Automation	If a fully automated production is the target, Klippel recommends a German supplier of automated equipment: www.xenon-dresden.de
Sealing plasticine	To temporarily seal holes (e.g., for cable outlets) we recommend sealing tape for vehicles, for instance WÜRTH Art.Nr.: 890 100 032 or 033. Please ask your local Würth supplier.
Testing probes	A German supplier of high-quality test probes. Also doing customized, automated probes for speaker/system testing as well as standard connectors (USB, Ethernet). http://www.ingun.de
Professional Test Box	ADMess, a German distributor of test equipment is also providing self-designed test enclosures at moderate prices. Please contact Klippel QC support for more information.

Find explanations for symbols at:
http://www.klippel.de/know-how/literature.html
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