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Measurement of the velocity level difference according to the Tonpilz method and DIN EN ISO 10846-4

MP-U-I 33-37

Report No. M160095/01

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1 Task

In order to identify the velocity level difference as a measure for the noise mitigation capability of pipe clamps equipped with rubber inlays, measurements according to the Tonpilz method and the DIN EN ISO 10846-4 [1] standard were conducted. The boundary conditions are defined and correspond to the usual mounting conditions. The vibration transmission factors in the form of velocity level differences measured by this method can be used as product information for manufacturers, suppliers and users.

2 Documents and references

[1] DIN EN ISO 10846-4: Acoustics and vibration – Laboratory measurement of the vibro-acoustic transfer properties of resilient elements – Part 4: Dynamic stiffness of elements other than elastic supports for translatory motion. 2004-02.

[2] DIN ISO 5348: Mechanical vibration and shock – Mechanical mounting of accelerometers. 1999-07.

[3] DIN EN ISO 3822-1: Prüfung des Geräuschverhaltens von Armaturen und Geräten der Wasserinstallation im Laboratorium – Teil 1: Messverfahren. 2009-07.

3 Test procedure

The measurements shall be performed according to the Tonpilz method in conjunction with the indirect method according to the ISO 10846-4 [1] standard.

According to the ISO 10846 standard, part 4, the vibration transmission factor shall be measured in the form of the velocity level difference. This measurement's objective is to demonstrate the relative vibrational insulation characteristics of the pipe clamp at the given boundary conditions for the chosen test situation and can therefore only be used for comparison purposes, tested under the same systemic conditions as described below.

The measured components shall be mounted between two masses of 30 kg, each. An adapter is used to fix the test component between the two masses. One measurement is considered as reference. Here the rubber inlay of the clamp is removed and the pipe clamp is mounted on a pipe dummy. Then the rubber inlay is returned onto the clamp and the same measurement is repeated again. After that, both transfer curves can be compared and the relative insulation capability can be formed.

The mass on the shaker side is excited in the longitudinal direction with a discretely increasing sinusoidal signal of constant velocity amplitude. Vibrations are transmitted through the test object to the blocking mass (receiver side). The acceleration levels are measured in the axial (excitation) direction on both masses. The measured acceleration shall be integrated into velocity and the difference between the excitation and receiver side shall be calculated.

In order to eliminate disturbances during the measurements, the vibration system shall be suspended on ropes as shown in Figure 1.

The measurement method is limited to the measuring range up to 2 kHz. Above this limit, the difference between useful and interfering signal on the receiving side is insignificantly small and the clear evaluation of the signal is not possible.

The investigations were carried out in the frequency range from 10 Hz to 2 kHz. The measurement configuration is depicted in Figure 1.

Figure 1. Test configuration (exemplary).

4 Conduct of test

4.1 Time, place and involved personnel

The vibration measurements were carried out on 27th and 29th October 2020 at the test bench of Müller-BBM GmbH in Planegg by Vladimir Opryschko from Müller-BBM.

4.2 Test object

Designation:	Hilti MP-U-I 33-37 (three samples)
Manufacturer:	Hilti
Condition:	New
Clamping range:	33 – 37 mm,
Material:	Steal, galvanized
Inlay:	Thermoplastic rubber
Thread connection:	M8 treaded rod
Tightening torque:	1 Nm
Pipe dummy diameter without inlay:	Ø 42.0 mm
Pipe dummy diameter with inlay:	Ø 33.7 mm

The test object is a pipe clamp consisting of two steal bows that are connected by a snap mechanism on the one and a tightening screw on the other side. Both bows are equipped with an inlay of rubber material for insulation purposes. One bow is equipped with an internal M8 thread for connection purposes. (Photos are added in Appendix B.)

4.3 Ambient conditions

Temperature:	approx. 20 °C
Relative humidity:	approx. 60 %

4.4 Measurement equipment

The calibration of the measurement equipment used and listed below was checked and found to be fully operational. Within the scope of the quality management system, the measurement equipment is reviewed within regular intervals and calibrated according to national standards (DAkkS calibration laboratory).

Table 1. Compilation of the used measurement equipment.

Measuring device	Type	Serial no.	Manufacturer
4-Chanel-analyzer	35670A	3928A04219	Hewlett&Packard
Electrodynamic shaker	52216-LS	043/04	Tira
Amplifier	BAA 1000	B1000E01A0 3K0050	Tira
Charge amplifier, excitation side	2635	1422945	Brüel & Kjaer
Charge amplifier, response side	2635	1422946	Brüel & Kjaer
Accelerometer, excitation side	4371	958265	Brüel & Kjaer
	4371	976137	Brüel & Kjaer
	4371	916150	Brüel & Kjaer
	4371	2296687	Brüel & Kjaer
Accelerometer, response side	4381	984902	Brüel & Kjaer
	4381	985057	Brüel & Kjaer
	4381	1354558	Brüel & Kjaer
	4381	1354552	Brüel & Kjaer

The accelerometers on the excitation and response side were applied on the two masses according to DIN ISO 5348, Mechanical vibration and shock – Mechanical mounting of accelerometers [2].

5 Results

The structure-borne sound insulation effect in the form of the Δ*L* value of the pipe clamp can be read off by the difference between the two transfer functions of the reference measurement without the resilient inlay and the measurement with the inlay.

Table 2. Structure-borne sound insulation effect identified within the test bench compared to the reference configuration and the averaged difference.

Object	Sample Nr.	ΔL_{500Hz}	Mean Δ_{L500Hz}
		in [dB]	
Reference (without inlay)	1	15.5	**15.3**
	2	15.3	
	3	15.3	
MP-U-I 33-37	1	34.1	**34.7**
	2	34.4	
	3	35.5	
Mean Difference ΔL_{500Hz}			**19,4**

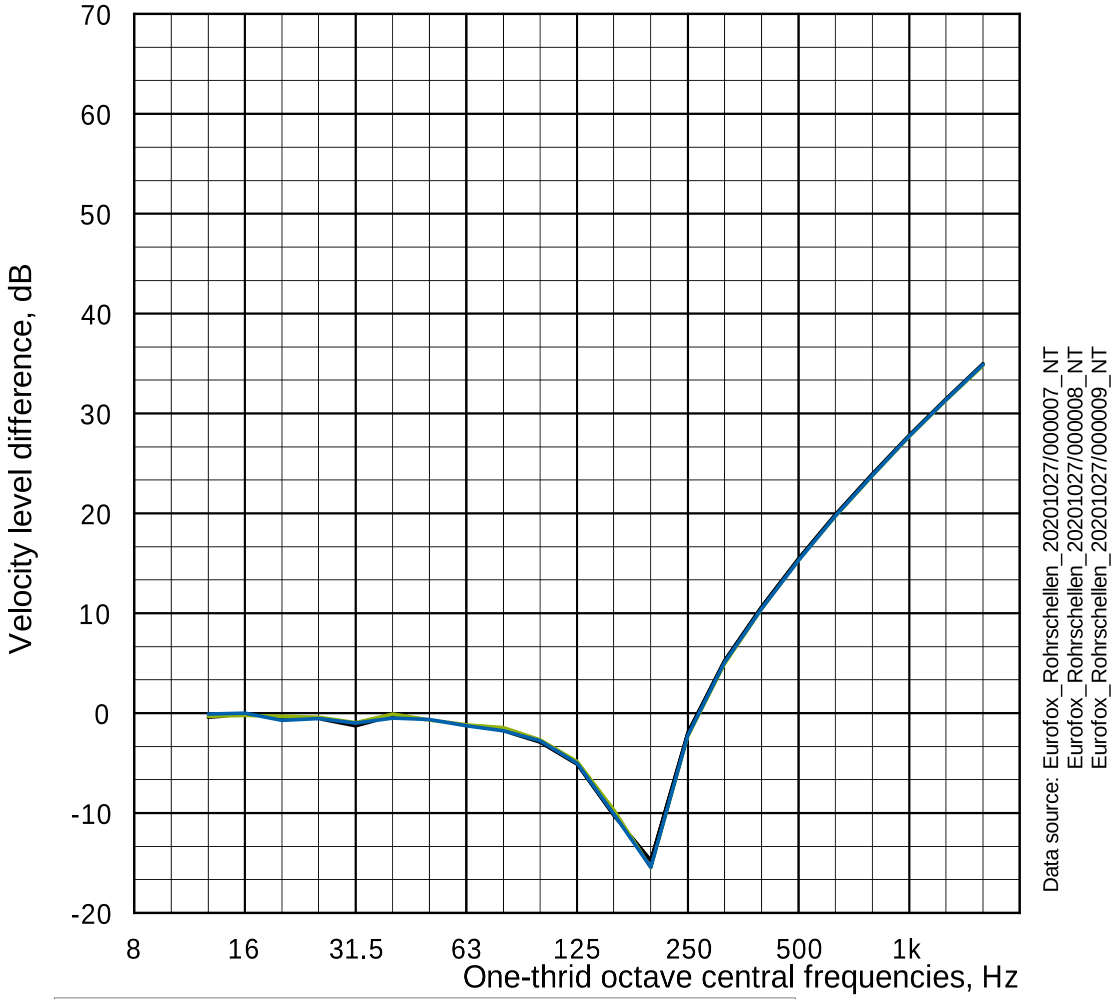
M.Sc. Vladimir Opryschko

Appendix A

Plots

Structure-borne insulation capability

according to the *Tonpilz method* and DIN EN ISO 10846
MP-U-I 33-37

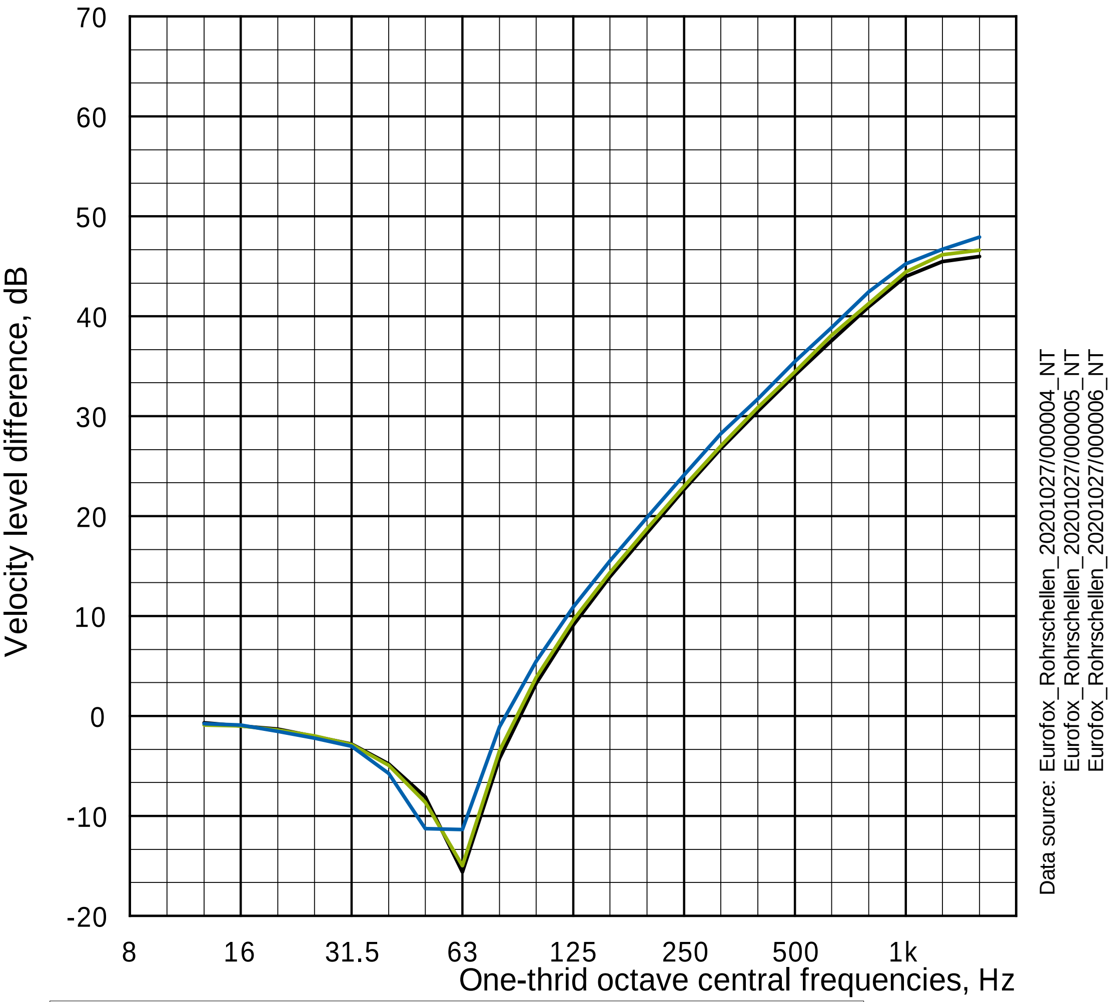


Legende	Specimen	ΔL (500Hz)
— (black)	Reference Clamp 1	15.5
— (green)	Reference Clamp 2	15.3
— (blue)	Reference Clamp 2	15.3

Appendix A 1.

Structure-borne insulation capability

according to the *Tonpilz method* and DIN EN ISO 10846
MP-U-I 33-37



Legende	Specimen	ΔL (500Hz)
— (black)	MP-U-I 33-37 Sample 1	34.1
— (green)	MP-U-I 33-37 Sample 2	34.4
— (blue)	MP-U-I 33-37 Sample 3	35.5

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Appendix A 2.

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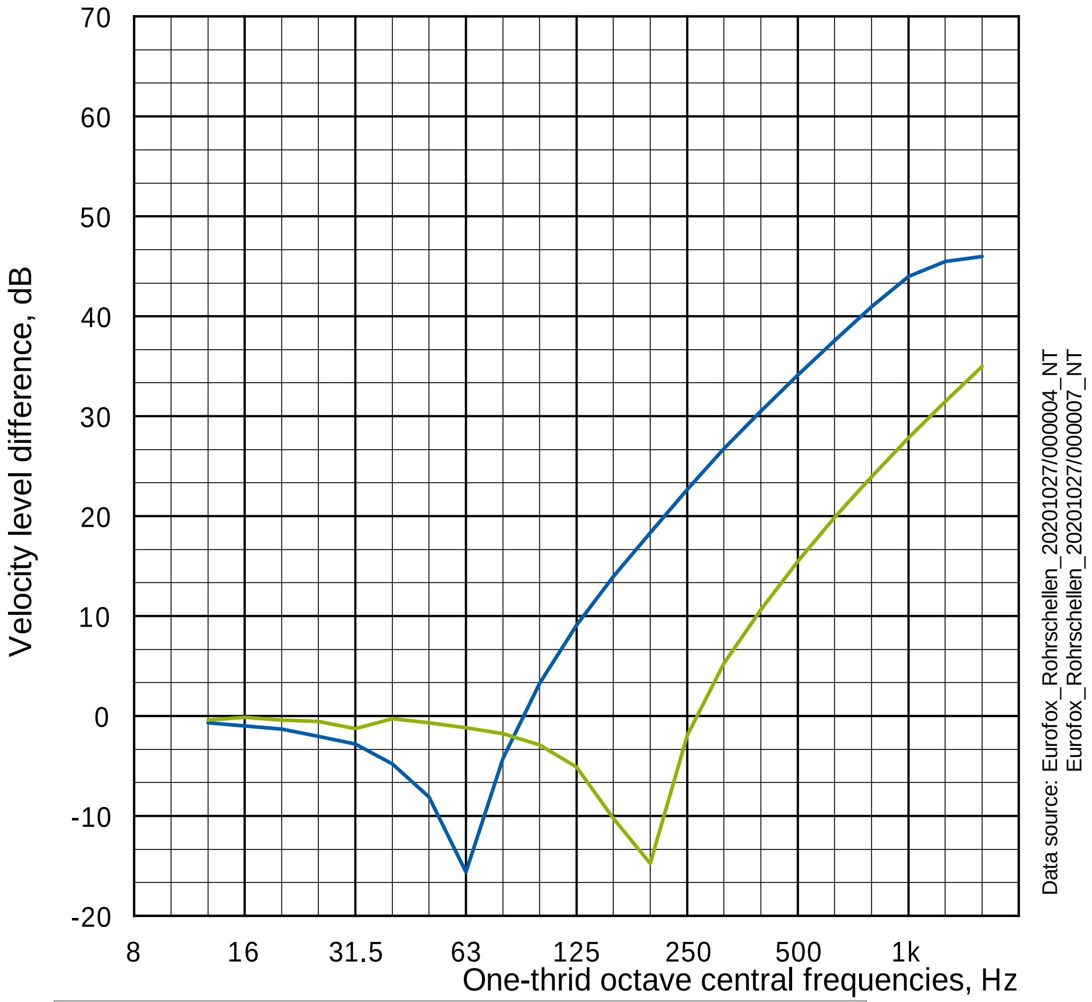
Structure-borne insulation capability

according to the *Tonpilz method* and DIN EN ISO 10846
MP-U-I 33-37

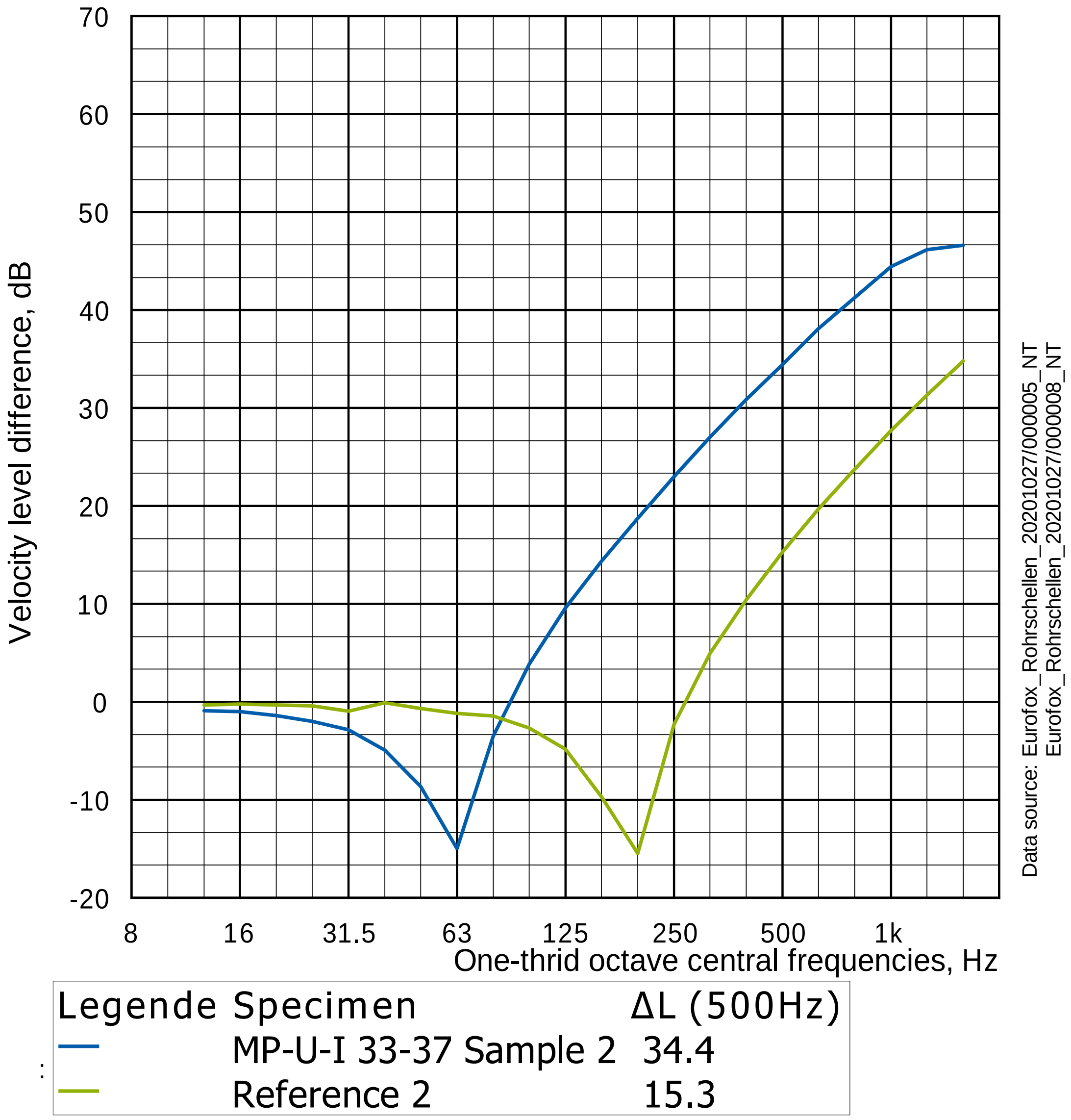


Legende	Specimen	ΔL (500Hz)
(blue line)	MP-U-I 33-37 Sample 1	34.1
(green line)	Reference 1	15.5

Appendix A 3.

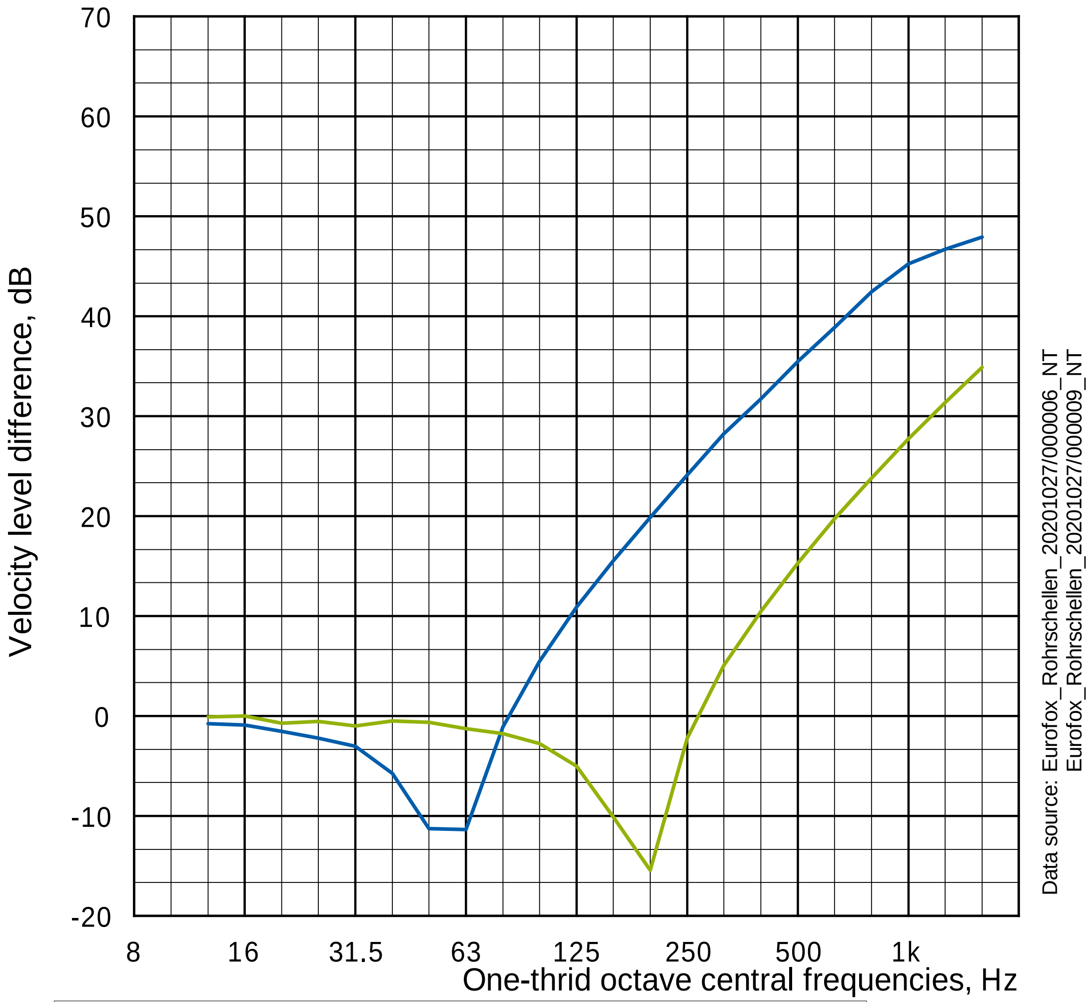
Structure-borne insulation capability

according to the *Tonpilz method* and DIN EN ISO 10846
MP-U-I 33-37



Appendix A 4.

Structure-borne insulation capability
according to the *Tonpilz method* and DIN EN ISO 10846
MP-U-I 33-37

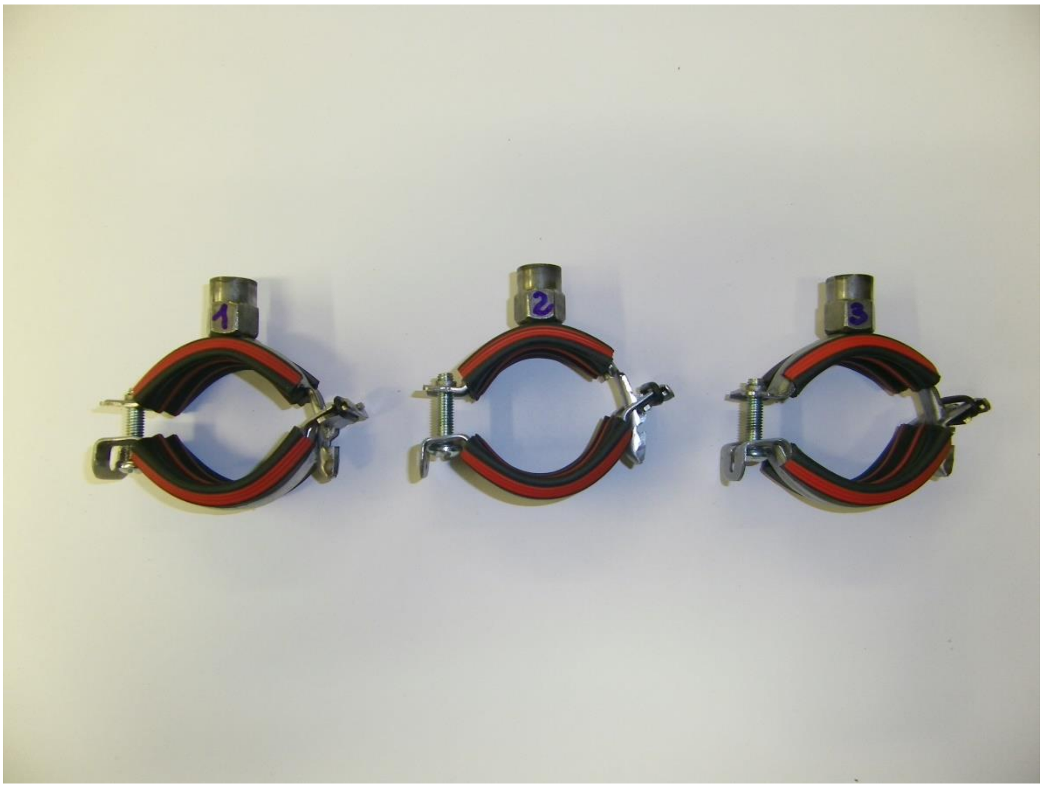


Legende	Specimen	ΔL (500Hz)
— (blue)	MP-U-I 33-37 Sample 3	35.5
— (green)	Reference 3	15.3

Appendix A 5.

Appendix B

Photo documentation



Appendix B 1. Three test samples of MP-U-I 33-37.

Appendix B 2.

Appendix B 3.