

## Measuring standard for external door warning signals

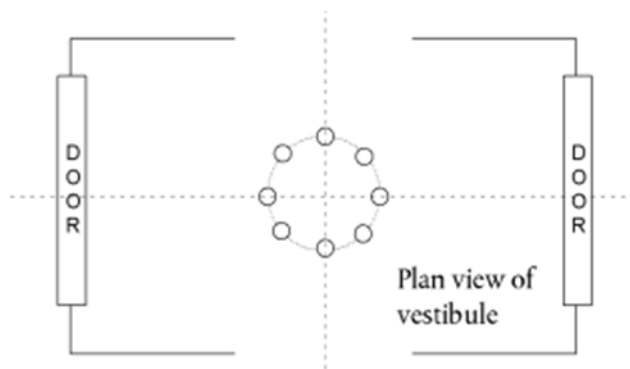
Christian Czolbe<sup>1</sup>

<sup>1</sup> PROSE AG, 8400 Winterthur, christian.czolbe@prose.one

### Introduction

For European train homologation beside others the TSI PRM demands the assessment of door warning signals in terms of audibility. In the door area small devices or beepers generate intermitted tonal sound for door opening and closing operation. For audibility the frequency range is fixed and a certain sound level should be present interior of a rail vehicle and exterior on the platform.

In 2008 the TSI PRM first named the door audible signals and provides a measuring method. The current method using eight circular distributed microphones and leads to inadequate high engineering effort on site and for post processing.



**Figure 1:** Horizontal microphone array setup according to annex G of TSI PRM [2]

Beside the latest version of TSI PRM 2014 [2] two other measuring standards exists containing similar measuring methods:

- EN 16584-2 TSI PRM for use 2017 [3]
- EN 14752 door standard of 2015 [4]

The railway acoustic expert group of CEN/TC 256 WG03 was asked to provide a new measuring standard to assess internal and external door warning signals on trains.

### Door Warning Signals requirements

For door opening operation the acoustical warning signals shall be audible according to:

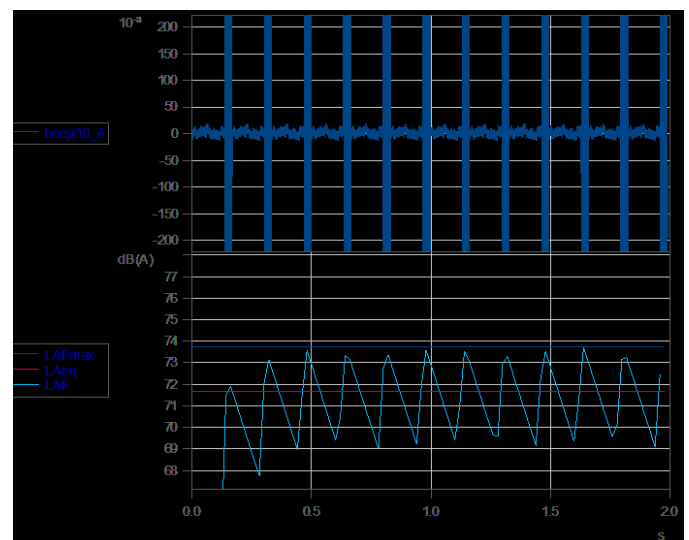
- Two intermitting pulses of
- Two pulses per second
- Frequency 2200 Hz +/- 100 Hz
- Frequency 1760 Hz +/- 100 Hz
- LAeq,T for adaptive signals min 5 dB above the background noise up to max 70 dB LAeq,T (+6, -0)
- LAeq,T for non-adaptive signals at 70 dB LAeq,T (+6, -0)

- Internal in the centre of the vestibule at 1,5m height
- External at 1,5m distance to the door and 1,5m height above the platform
- Starting 3s before door movement

For door closing operation the signals shall be:

- Six-ten pulses per second
- Frequency 1900 Hz +/- 100 Hz
- LAeq,T for adaptive signals min 5 dB above the background noise up to max 70 dB LAeq,T (+6, -0)
- LAeq,T for non-adaptive signals at 70 dB LAeq,T (+6, -0)
- Starting 3s before door movement

It can be seen there are a quite a lot of parameters to check for door warning signal to be TSI PRM conform.



**Figure 2:** intermitted tones on door warning signals lead to different values on LAFmax and LAeq

### Scope of the new standard

The standard provides methods to assess external door warning signals according TSI PRM. Therefore the number of vestibules for the tests are selected according room acoustical parameters. Test setups to measure interior and exterior sound levels are defined with the aim to simplify the measuring effort and costs. A coherent test method for adaptive signals is provided.

### Initial investigations

The presence of a platform has a minimal impact on the external sound level due to ground reflections. But according to the short distance and height above the platform of 1,5m

and the accuracy in the microphone position the impact is neglectable.

Long trains may have a large number of vestibules to assess the sound levels. It can be assumed that vestibules with similar geometry and interior design do not differ in room acoustical properties. Hence, only vestibules with clearly different design and room acoustical behaviour shall be selected for the test to represent the train set.

It would be nice to move cost effective on-site tests to the laboratory. But room acoustical parameters as well as the final door beeper installation can only be tested in the train. But manufacturers shall have the opportunity to check sound levels, adaptive control and frequencies in a workshop environment for product testing or individual changes.

### Content of the draft

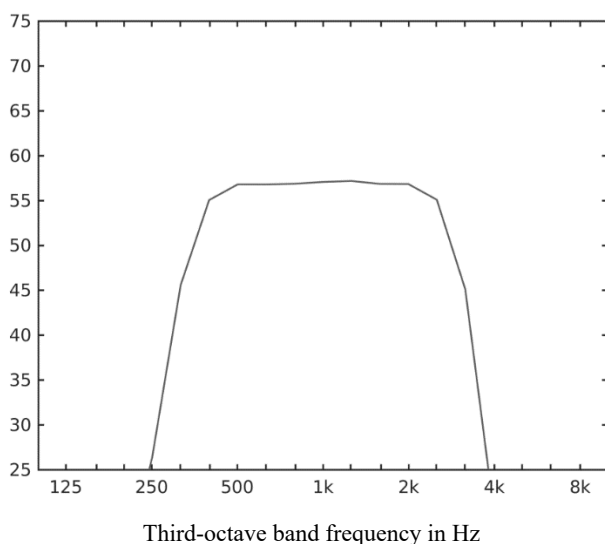
The measuring standard for door warning signals currently in the European enquiry process. It provides separate chapters for interior and exterior tests.

For the microphone position two alternative arrangements are provided.

Arrangement one uses one microphone in a certain area in the centre of the vestibule. It is possible to use simple sound level meters to directly read out the test value.

Arrangement two uses an eight microphone in a circle of 50cm diameter to measure the sound levels simultaneously according TSI PRM approach.

For adaptive signals a separate annex is drafted which contents the measuring quantities, the test noise and test setup. It can be done using one sound level meter with third-octave band analysis. The background noise consisting of octave band filtered (500, 1k, 2k Hz) pink noise and can be easily generated using small speakers from the consumer electronic.



**Figure 3:** band-pass filtered pink noise for background signals to test adaptive door warning signals.

### Discussion on the measuring quantity

From the acoustical point of view the measuring quantity LAeq,T is not the best choice to assess intermitting tonal pulses. It can be assumed that pulses of sinus tones with 50 to 150ms duration lead to similar LAFmax values. Whereas the LAeq,T may differ from the LAFmax depending on the ratio of pulse and noise duration.

Using LAeq,T for the measuring quantity leads to high sound levels for door warning signals which can disturb passengers as well as residents.

From our experience the audibility of door warning signals in the given frequency range and pulse ratios is present if LAFmax values are equal or even less than the background noise LAeq level.

In future TSI PRM the requirements for the sound level of door warning signals shall be connected rather to the LAFmax. Door finding signals are planned to implement on future standards which may be a related issue of the presented measuring standard draft.

### Publications

- [1] TSI PRM 2008/164/EC, concerning the technical specification for interoperability 'people with reduced mobility' for the trans European conventional and high-speed train system
- [2] TSI PRM 1300/2014/EU concerning the technical specification for interoperability 'people with reduced mobility' for the trans European conventional and high-speed train system
- [3] EN 16584-2 TSI PRM for use, 2017
- [4] EN 14752 railway applications - external door operation and properties standard 2015