

## Standstill Measurements on Open Track

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### Introduction

Since the entry into force of the Technical Specification for Interoperability of Conventional Rolling Stock - Subsystem Noise (short TSI NOI), the homologation process of new vehicles includes a test of their noise emission. TSI Noise specifies in particular limits for stationary noise, starting noise, pass-by noise and driver's cab noise. These requirements are intended to force the whole system (standstill) as well as traction equipment (start) and running gear (pass-by) to be designed as silent as possible.

The conformity of rolling stock to TSI NOI has to be assessed within type testing measurements. TSI measurements have to be carried out following the preliminary standard prEN ISO 3095:2001. This paper suggests a possible strategy to include the standstill measurements in the pass-by and acceleration measurement procedure to collect valid standstill measurement results with a minimum effort.

### TSI NOI

The verification of conformity to technical TSI requirements basically consists of a type testing module SB giving evidence for one vehicle to be tested and a production quality audit module SD confirming the manufacturers ability to produce a series of vehicles with equal acoustic performance.

### Type test

Within the type testing module the vehicle conformity to requirements has to be checked for the following operational conditions:

- Standstill  $L_{pAeq,T}$ , energy mean of meas. positions according to figure 2,
- Run-up  $L_{pAF,max}$ , 0 - 30 km/h,
- Pass-by  $L_{pAeq,Tp}$ , at 80km/h and at  $v_{max}$ ,
- Interior noise  $L_{pAeq,60s}$ , at  $v_{max}$ ,
- Warning horn  $L_{pAeq}$ , mean of positions.

Pass-by noise measurements have to be carried out on a reference track [1] with strictly defined acoustic characteristics concerning the running surface roughness and the lateral and vertical track decay rates. Additionally the TSI requirements have to be tested with the vehicle including all traction equipment in a constant operational mode for at least 60 seconds prior to the passage

at the reference track. Therefore a straight track without irregularities like slopes or change of sleeper type is recommended.

This forces the dynamic part of the type test to be performed at special locations; usually these are monitored sections of open track or commercial test sites. Accessorily stringent requirements of the prEN ISO 3095:2001 regarding surroundings have to be fulfilled: The surroundings of the test site shall enable free sound propagation, i.e. an area around the microphones having a radius which is at least three times the measurement distance shall be free of large reflecting objects like barriers, hills, rocks, bridges or buildings. Furthermore the ground has to be flat and there shall be no tracks between microphone and vehicle.



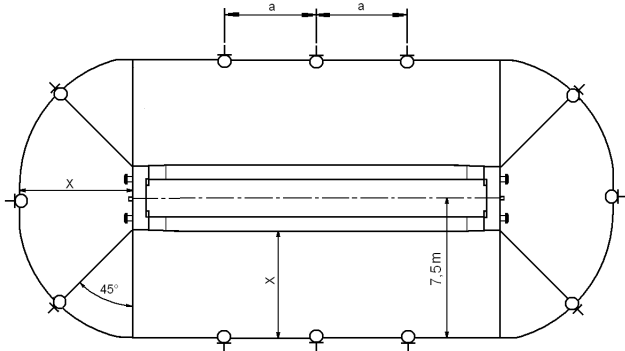
Figure 1: Side view of the setup during a measurement at open track.

### Standstill Measurements

Modern vehicles developed under consideration of the TSI requirements may present a quite low noise emission. In particular the noise levels measured at each end of the vehicle are often very low. Since the background noise has to be at least 10 dB lower than the vehicle noise emission at the measuring position (approx. 6 m away from the car body), the test sites has to be chosen carefully. Hence most of the usual test sites (especially depots) do not comply with this requirement. Indeed the type test is not only intended to check if the noise emission of a certain vehicle is below a given limit but also to assess the exact noise emission.

As illustrated in Figure2 standstill measurements have to be carried out at several equidistant positions around the rolling stock. In practice this measurement is performed with one set of microphones at one position and the vehicle is moved stepwise from one position to the

other. In the case of long multiple units like e.g. Alstom Coradia Continental these measurements are very time-consuming. In consequence they used to be carried out in depots or at company sites.



**Figure 2:** Measurement setup for standstill tests according to prEN ISO 3095:2001.

The low-floor vehicle platforms Alstom Coradia Continental and Nordic have been designed to fulfil ambitious noise targets. The noise emissions of all noise sources like transformer, auxiliary converter and air conditioning unit were reduced to a minimum. In consequence the background noise level  $L_{pA}$  shall not exceed 40 dB at the test site to achieve valid measurements. This excludes depots and any other urban area from the possible test sites. On this account the test site used for the pass-by noise measurements on the conventional double track line Augsburg-Donauwörth was identified as the best choice for standstill measurements also. Only one of the tracks is qualified as a reference track. Thus the returns on the other track can be used to carry out acceleration, braking or even stationary measurements. The latter case can however only be achieved by measuring all the positions at one vehicle side simultaneously.

one time slot of 60 s.

The corresponding setup for the Coradia Continental with 18 microphones is shown in figure 3.

Executing the standstill measurements affords some additional preparations regarding the schedule of train operations. Instead of a test run at constant speed, the measurement site has to be approached as fast as possible to enable a sufficient standstill time of not less than 60 s plus the time needed to adjust all auxiliary devices to the requested operational conditions. The calculation of the schedule for this test run shall consider additional time for a second brake, the measurement time slot and acceleration procedure. The procedure works properly if the schedule is planned for a run at low speed.

### Conclusion

Since the entry into force of the TSI NOI the conformity of new rolling stock to the technical requirements has to be assessed by noise measurements.

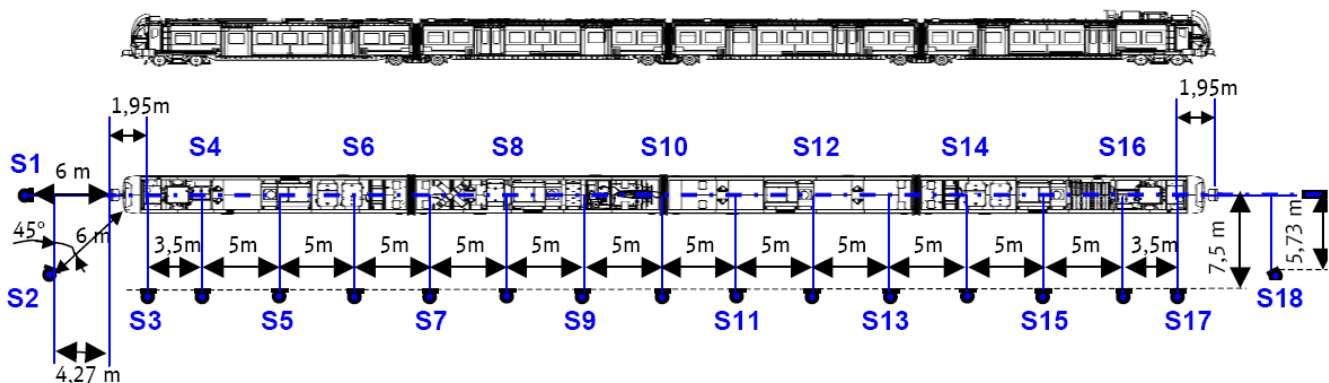
Especially in the case of standstill measurements the test conditions settled in the prEN ISO 3095 are very stringent concerning the background noise level. For that reason formerly preferred test sites at depots cannot be used anymore.

Within type testing of Alstom Coradia Continental multiple units the Reference Track maintained and monitored by DB Systemtechnik proved to be an appropriate test site allowing to perform all the tests (pass-by, acceleration and standstill) simultaneously in an efficient way.

### Reference

[1] N. Meunier, C. Gerbig: Das TSI-Lärm Referenzgleis: Hintergründe, Notwendigkeit und Anwendung bei der DBAG, DAGA 2008

### EMUCoradia Continental Standstill Measurement - Microphone Positions



**Figure 3:** Measurement setup for standstill tests.

This increases the preparation effort on the one hand but allows at the same time to shorten the measuring campaign by a day and as a matter of fact to save costs for drivers and test team. Another advantage is that the vehicle condition has only to be maintained constant for