App-Based Multichannel Measurement

Acoustic measurements in the railway sector are often complex, time-consuming, and technically demanding. This use case demonstrates how multiple railcar sections can nevertheless be captured simultaneously, wirelessly, and in full compliance with relevant standards, opening up entirely new possibilities in terms of efficiency and flexibility.

The Situation

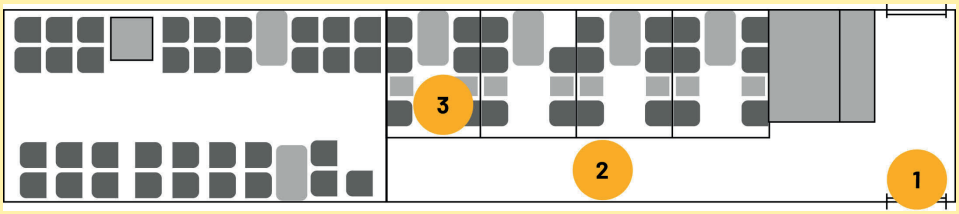
Acoustic measurements in railway environments cover a wide range of scenarios: from interior noise and pass-by measurements to the analysis of track characteristics or unwanted noise sources. Particularly challenging are tasks requiring multiple measurement points to be recorded simultaneously, such as assessing sound insulation measures or evaluating passenger comfort across different railcar sections. In practice, such tasks are typically performed using wired multichannel systems or with sequential single-channel measurements taken at different times. Both approaches are technically reliable but labor-intensive, inflexible, and only partially viable in mobile environments such as a moving train. Organisationally, the setup often exceeds the effort of the measurement itself: specialists must travel to the site, installations need to be prepared and adapted to changing operating conditions, and last-minute modifications in train operations further complicate planning. Data organisation introduces additional limitations: measurement data and metadata are frequently recorded separately, stored locally, and only merged later in a time-consuming process. Against this backdrop, the question arose whether a fully wireless yet precisely synchronised multichannel measurement inside a moving train could be realised, allowing compliant acoustic metrics and spectral analyses to be captured simultaneously at different railcar sections and compared reliably. This challenge forms the basis of the present use case.

. The solution is based on three elements: mobile high-precision hardware, an intuitive measurement application, and a cloud infrastructure

The Solution

To enable a fully wireless and synchronized multichannel measurement in a moving train, a solution was implemented that combines high-precision measurement technology with modern digital tools. The objective was to capture multiple measurement positions simultaneously and to derive standards-compliant acoustic metrics and spectral analyses without the complexity of a conventional wired multichannel system. The solution is based on three core components: mobile, high-precision hardware; an intuitive

Positioning of the measurement setups



measurement application; and—when performing multi-channel measurements—a cloud infrastructure for system control, data storage, and further processing. Within the acoust IQ measurement system, these components are combined into a modular platform. At its core is the specially developed acoust IQ app installed on an iPhone or iPad with a USB-C interface, together with a Class-1 microphone featuring a digital preamplifier from Microtech Gefell. The measurement project was set up in the PAK cloud and was therefore automatically accessible to all three devices. Measurements could be started centrally via the cloud and monitored throughout the journey. Start and stop points were defined precisely, and acoustic events were marked using markers. The application provided real-time visualization of level-time histories, narrowband and third-octave spectra, as well as single-number metrics such as L_{Aeq}, L_{AFmax}, and L_{Cpeak}.

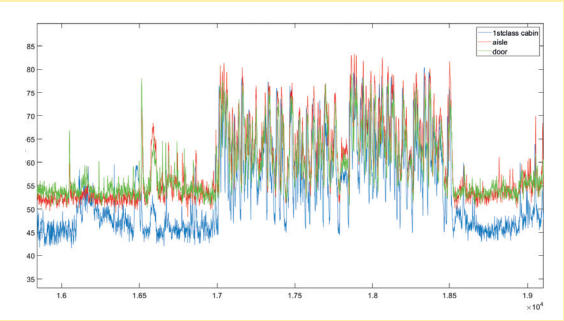
At the same time, the app captured metadata including GPS positions, timestamps, images, and notes. The raw data from all three measurement positions were transmitted live to the cloud during the measurement, where they were available across projects and could be analyzed directly in a web browser. This enabled export of the datasets in ATFX format and organization of the data in an ASAM ODS-compliant structure. The data were subsequently further processed in MATLAB, allowing efficient, continuous evaluation of the complete dataset across all measurement positions without media discontinuities.

The three measurement positions were located at different points within the railcar:

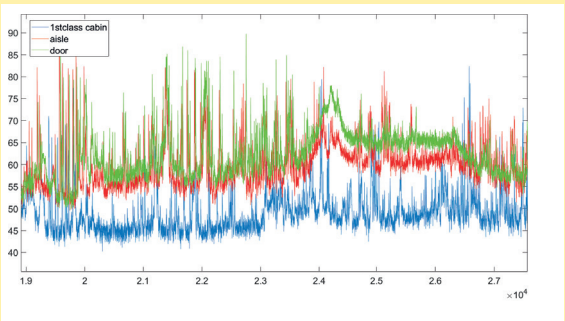
(1) the entrance area near the door,
(2) the central aisle of the first-class open-plan section, and (3) a closed first-class compartment.

Each measurement position consisted of the acoust IQ app installed on an iPhone connected to a Class-1 microphone. The devices operated as autonomous measurement stations with battery runtimes of several hours. Synchronization was achieved through the devices' precise internal timestamps, resulting in a temporal accuracy of approximately 0.01 seconds—without any physical connection between the measurement points. During the journey, each device recorded sound pressure at a sampling rate of 48 kHz. The identical time references enabled direct comparison of acoustic events such as door warning signals, passenger boarding and alighting, public address announcements, and typical operational noise. The raw data were stored locally on each device and asynchronously uploaded to the cloud.

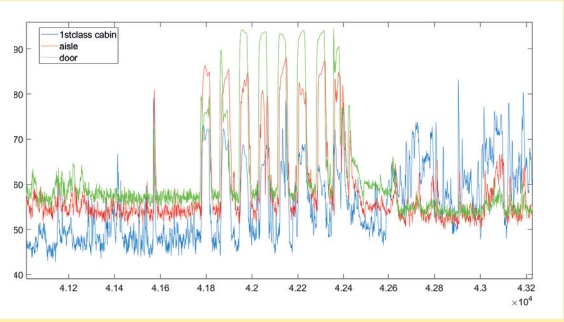
Announcement



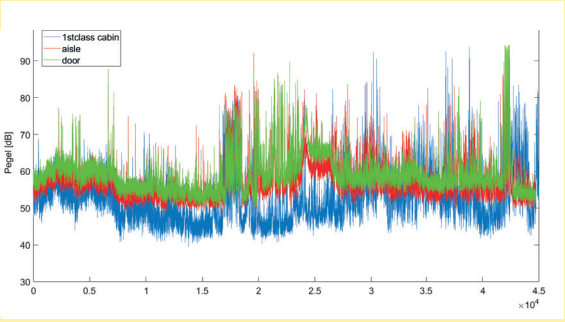
Passenger boarding



Door warning signal during door closing



Level–time history (A-weighted and Fast-weighted)



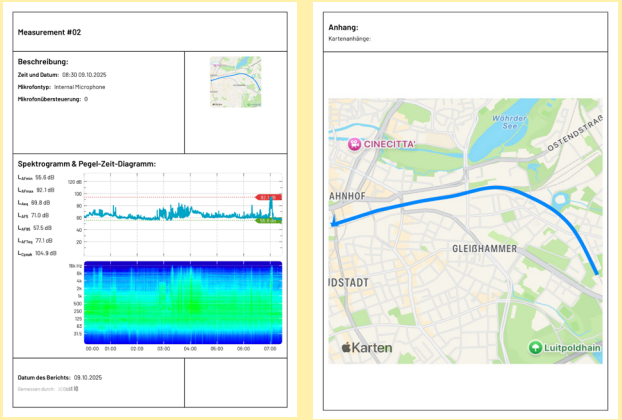
This use case demonstrates that acoust IQ enables reliable, wireless, synchronized, and standards-compliant multichannel measurements under real operating conditions. The combination of mobile hardware, app-based measurement control, and cloud-supported data analysis significantly reduces organizational and technical effort while enabling precise, reproducible, and directly comparable measurements at multiple positions within the railcar.

The Outcome

The use case demonstrates that acoust IQ enables a fully wireless and precisely synchronised multichannel measurement inside a moving train with high technical reliability. The three measurement nodes captured all relevant acoustic quantities simultaneously, allowing events such as door warnings, boarding and alighting operations, or announcements to be compared with positional accuracy. Temporal deviations between measurement points remained below 0.01 seconds, fully within the limits required for unrestricted standards-compliant evaluation. The quality of the acquired data allowed the analysis of level-versus-time histories, as well as the calculation of all common single-number ratings and spectral representations. Differences between railcar sections such as higher maximum levels in the entrance area, variations in signal-to-noise ratios, or differing audibility of announcements were clearly identifiable and could be documented reproducibly. This confirms the suitability of acoust IQ for comfort assessments, analysis of door warning signals according to DIN EN 17285, or the investigation of operational noise events along a route. Beyond data quality, the results highlight the practical benefits of the system.

The entire setup operated without cabling, drastically reducing preparation time and increasing flexibility when positioning measurement points. Devices were configured and started within minutes – without additional hardware, complex logistics, or the typical constraints of classical multichannel systems in mobile environments. Since all nodes operated autonomously, measurement points could be distributed freely within the railcar or, in future applications, even across larger distances. From an organisational standpoint, the integrated capture of measurement data, metadata, and images eliminated the need to merge disparate files later on. Cloud processing provided immediate access to all datasets, regardless of participants' locations. Automated reports compiled the results of the three nodes in a structured manner, producing directly usable documentation suitable for integration into testing workflows without further post-processing. Overall, the outcome illustrates that acoust IQ not only proves the technical feasibility of wireless, synchronised multichannel measurement, but also streamlines the entire measurement process significantly. Time expenditure is reduced, the need for on-site specialist personnel decreases, and digital continuity minimises potential error sources. At the same time, flexibility increases as measurement points can be adapted or expanded with ease.

Door-position report generated using the report generator directly within the acoust IQ app.



For engineering consultancies, manufacturers, suppliers, operators, and testing organizations, this means that acoustic measurements in railway environments can be performed faster, more easily, and still fully compliant with standards, yielding reproducible results and greatly simplified documentation.

acoust IQ
by MÜLLER-BBM

Discover acoust IQ – the innovative solution that makes high-quality acoustic measurements simpler, more precise, and more efficient. With a unique combination of a Class 1 microphone, cloud integration, an iOS app, and a web application, acoust IQ takes acoustic measurement to the next level. acoust IQ is more than just a measuring device – it is a comprehensive platform that enhances, simplifies, and redefines conventional acoustic measurement methods.

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