



Key On and Key Off Noise Evaluation Procedure

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. Define the process of quantifying vehicle level interior noise during key on and key off events.

1.2 Applicability. This procedure applies to vehicle tests for all hybrid passenger cars, multi-purpose passenger vehicles, minibuses and light commercial vehicles.

1.3 Remarks. This procedure is a guideline for measuring the noise emission from system actuated components, such as, the energy storage system (ESS) contactors during key on and key off events.

The noise of the system actuated components during key on and key off shall not be noticed as disturbing.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ANSI S3.36 DIN 45631/A1 IEC TR 959

2.2 GM Standards/Specifications.

GMW14172 GMW16178

2.3 Additional References.

- ArtemiS SUITE software solution available at www.head-acoustics.de/eng/nvh_artemis_suite.htm
- HEAD Acoustics hardware/software available at <https://www.head-acoustics.de/eng/>
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. All measurements shall be performed in a hemi-anechoic test room free from interfering noises or outdoors in a free-field area. Unless otherwise specified, the maximum Zwicker specific loudness of the background noise is not to exceed 0.2 sones/bark from 0 bark to 5 bark and 0.1 sones/bark at any frequency greater than 5 bark, and the overall Zwicker loudness is not to exceed 1.2 soneGF. Background noise is considered to include room or test cell ambient noise and room support equipment noise.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.2 Equipment.

3.2.1 Data Acquisition System (DAS). A microphone regionally accepted for vehicle interior measurements with data acquisition hardware (see GMW16178) or an artificial head complying with ANSI S3.36 (IEC TR 959) with a binaural recording system with at least 16 bit quantization at a sample rate of 44.1 kHz, such as, the HMS III Binaural Recording Head by HEAD Acoustics is required. (Preferred settings for HMS III: 94 dB range, HP1 filter, ID equalization, 24 bit recording, and 44.1 kHz sampling rate).

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3.2.2 Data Analysis System. For noise data processing, Artemis sound quality analysis program by HEAD Acoustics or an equivalent analysis program is required. All equivalent programs must be correlated to Artemis results.

3.3 Test Vehicle/Test Piece. The tests shall be performed on a vehicle which represents the current part release status. Deviations (e.g., obvious faults) shall be eliminated or recorded.

3.4 Test Time.

Calendar time: 1 day

Test time: 4 hours

Coordination time: 4 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. To complete this test, one (1) engineer or qualified technician skilled in acoustic data acquisition, analysis, equipment use and test setup is required.

4 Procedure

4.1 Preparation. Check the vehicle according to 3.3. Eliminate any inappropriate content. Verify and note the status of all hardware relative to the current release status.

4.2 Conditions.

4.2.1 Environmental Conditions. Not applicable.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.3 Standard Test Conditions.

4.2.3.1 Key On and Key Off Event for Push Button Start Vehicles. Push the start button to initiate vehicle start. Allow time to reach a steady state sound level such that all system actuated events have taken place. Once the vehicle is at a steady state operating condition push the stop button to initiate the vehicle stop sequence. Allow time to reach to a steady state sound level at the end of the stop sequence.

4.2.3.2 Key On and Key Off Event for Keyed Start Vehicles. Turn the key from the off position to the accessory position. Allow the vehicle to come to a steady operating condition. Turn the key from the accessory position to the run position. Again, allow the vehicle to come to a steady operating condition. Finally turn the key from the run position to the start position and allow the vehicle to reach a steady operating condition. Repeat the process in reverse for the key off sequence, going from the run position, to the accessory position, and to stop position allowing time to come to a steady operating condition in between.

4.3 Instructions.

4.3.1 Calibration Verification. Check equipment for valid calibration date. Replace out of date equipment. Perform microphone calibration verification. Record calibration tone, if applicable (see GMW14172).

4.3.2 Install Data Acquisition Equipment. Install microphone or binaural recording device in location as specified in Appendix A, Figures A1 and A2. Standard measurement location for left hand drive vehicles is left front (LF) seat.

4.3.3 Vehicle Setup. Allow the vehicle to acclimate to the environmental conditions in the test cell or garage area for an appropriate time to allow the vehicle systems to reach test room temperature before the test.

The vehicle should be unloaded except for the driver and test equipment as required. Adjust seats and headrests according to Appendix B.

- Close all doors, windows, sliding roof, sunroof, and sunscreen. Roll up sun shields and roller load compartment shields. Remove all loose items from the interior of the vehicle.
- Turn off the radio, heating and ventilation blower and other electronic devices.
- Eliminate or reduce sounds not associated with the component or system being tested as feasible. Note on the test log any modifications required.
- Install brake pedal adaptor and mass to fully depress brake pedal, as needed.

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4.3.4 Data Acquisition. Set the controls of the digital recording system to the smallest range that allows all of the sounds for a particular operating condition to be recorded without overloading. Document the equipment settings and transducer sensitivities in the test log as needed.

Acquire time data at a sampling rate of 44.1 kHz starting with 2.0 s to 5.0 s of background noise followed by cycling through the appropriate key on and key off event from 4.2.3 and ending with an additional 2.0 s to 5.0 s of background noise. Repeat the data acquisition sequence three (3) times.

If the noise event being measured is corrupted by noise from another system, it may be necessary to use a controller to operate the subsystem being measured without the influence of other subsystems.

Record at least 20 s of background noise during the recording session to permit verification of the requirements of the test facility. If using a digital audio tape (DAT) recorder, digitally transfer the recordings to computer files in preparation for analysis.

5 Data

5.1 Calculations.

5.1.1 Perform listening based trimming of the sound time histories and preliminary analysis to select the most representative of the three key on and key off events to use for the calculations.

Note: Sound files intended for analysis using Zwicker Loudness must allow a minimum of 0.2 s of quiet before the sound of the event being analyzed. If the sound event is an impulse, the length of the sound file must be at least 1.0 s. The 0.2 s of quiet before the event will allow the Zwicker Loudness analysis to stabilize at the background noise level to ensure that the beginning of the sound event is properly analyzed. When the desired sound event has been selected using the mark editor in ArtemiS, save the selected sound event as a separate file before performing the analysis.

5.1.2 Calculate loudness versus time for the representative sound file. Follow DIN 45631/A1 method (labeled "DIN 45631 / A1" in ArtemiS).

For binaural head or other two-microphone recording devices, the left and right channel results are averaged for all calculations.

5.1.3 Display the Zwicker Loudness time history, as shown in Appendix C, Figure C1.

5.1.4 Determine the maximum loudness from the key on event and the key off event. If the maximum loudness is not easily obtained using the analyzer or sound quality software, use the data exported to MS-Excel and the MAXIMUM function to determine the maximum loudness that occurred during each event. Record the maximum loudness levels for both the key on and the key off events in a table of results.

5.2 Interpretation of Results. Compare both the key on and key off maximum loudness levels to the target levels. The maximum loudness levels must be equal to or less than the target values.

5.3 Test Documentation. Standardized formats contained in the global VTS template shall be used to view data.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary.

SoneGF: For Identification, a suffix is added to the unit "Sones". In this case "G" (from the German for Critical Band) identifies that Zwicker's method was used and "F" identifies the sound field as Frontal.

Zwicker Loudness Method: A phrase used to indicate that the process used to calculate a loudness value generally follows some version of the method invented by E. Zwicker.

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