



In-Vehicle Noise Data Collection

1 Scope

Note: Nothing in this standard supersedes 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. This procedure develops the Impulse Response and Noise Collection components of Voice Recognition Performance testing.

1.2 Foreword. In-Vehicle Noise Data Collection is the precursor to the OnStar Automated Speech Recognition Test GMW16082. This procedure must be completed before performing GMW16082.

The terms Impulse Response and Transfer Function are used interchangeably with respect to voice recognition testing. Completing of the In-Vehicle Noise Data Collection procedure will result in the development of the Impulse Response (or Transfer Function).

1.3 Applicability. This testing is to be performed on vehicle lines that will receive OnStar.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW16082

2.3 Additional References.

Microphone documentation, supplied with the nominal microphone sample used for this procedure.

3 Resources

3.1 Facilities.

3.1.1 The Impulse Response portion of procedure should be performed in a quiet room. See 4.3.10.

3.1.2 The Noise Collection portion of procedure should be conducted at a test facility with representative roads that allows for city and highway speed driving. See 4.3.12.

3.2 Equipment.

3.2.1 Head and torso simulator (HATS).

3.2.2 Crown power amplifier.

3.2.3 Sound pressure level meter (SPLM).

3.2.4 B&K 2670 6.25 mm (¼ in) microphone.

3.2.5 B&K conditioning amplifier.

3.2.6 B&K binaural microphones.

3.2.7 Power strip.

3.2.8 Power inverter 12 VDC to 120 VAC.

3.2.9 Cabling and connectors.

3.2.10 Adobe Audition software.

3.2.11 Laptop computer.

3.2.12 VCP (OnStar Module) microphone breakout harness.

3.2.13 Echo audio interface unit (AIU).

3.2.14 B&K 6.25 mm (¼ in) microphone calibrator.

3.3 Test Vehicle/Test Piece. Vehicle must be production intent.

3.4 Test Time.

Calendar time: 2 days

Test hours: 12 hours

Coordination hours: 4 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. The performance engineer performing this testing must have familiarity with sound recording and Automated Speech Recognition (ASR) testing requirements.

4 Procedure

4.1 Preparation.

4.1.1 All windows, sunroof/moon roof, slide covers, doors, hood, and trunk should be closed.

4.1.2 All sun visors should be placed up.

4.1.3 All passenger seats should be in an upright position.

4.1.4 Heating Ventilation and Air Conditioning (HVAC) and radio should be turned off during this procedure.

4.2 Conditions. For the Impulse Response of the testing, the vehicle needs to be in a quiet room.

The Noise Collection portion of the testing must be done on a cement test track with little traffic and minimal outside noise influence.

4.2.1 Environmental Conditions. The Noise Collection portion of the testing should be done in dry and calm conditions.

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. All attempts should be made to maintain similar condition for all testing.

4.3 Instructions. Impulse Response Development.

4.3.1 Start documentation of the testing on Data Sheet A1 in Appendix A. Fill in the appropriate information.

4.3.2 Replace the In-Vehicle Microphone (IVM) with a nominal sensitivity microphone, and record microphone information on Data Sheet A1 in Appendix A.

4.3.3 Sit in the driver's seat and adjust the steering wheel, rearview mirror and seat back to a comfortable position.

4.3.4 If the driver's seat can be adjusted in the vertical direction, set the vertical position in the middle of the up/down travel.

4.3.5 Place the HATS in the front driver's seat.

4.3.6 Set the angle of HATS Positioning Frame at an angle of 5 degrees (i.e., tilting slightly forward).

4.3.7 Set the height adjustment of the HATS Positioning Frame to a value of 69 cm (27 in).

4.3.8 Move the seat forward or backward in the seat track until the measured distance from the center of the steering wheel to the center of the HATS mouth is 483 mm (19 in). This is considered the Medium mouth position.

4.3.9 Make the following measurements for the Medium mouth position (mark on Data Sheet A1 in Appendix A):

- Distance from mouth to center of steering wheel.
- Vertical distance from mouth to roof.
- Horizontal distance from mouth to left driver window.
- Distance from mouth to microphone.

4.3.10 Set Up the Amplifier and Recording Equipment and Develop Impulse Response.

4.3.10.1 Reference Appendix A, Figure A1, Profiling Hardware Setup for high-level setup details.

4.3.10.2 Mount the Mouth Reference Point Microphone (MRPM) at an angle of 90 degrees to the MRP, 25 mm (1 in) straight out from the HATS mouth plane.

4.3.10.3 Connect the MRPM to the microphone Nexus preamplifier.

4.3.10.4 Verify the following settings for the channel in use on the Nexus preamplifier.

4.3.10.5 Amplifier Setup.

4.3.10.5.1 Set the Filters and Output Sensitivity and Gain for the amplifier as follows:

4.3.10.5.1.1 Low Pass: 20 Hz.

4.3.10.5.1.2 High Pass: 22.4 kHz.

4.3.10.5.1.3 Out: 100 mV/Pa.

4.3.10.5.2 Transducer Setup.

4.3.10.5.2.1 Sensitivity: 4.200 mV/Pa.

4.3.10.5.2.2 Mode: 4939 (User).

4.3.10.5.3 Transducer Supply.

4.3.10.5.3.1 Supply: 14 V.

4.3.10.5.3.2 Pol: 200 V.

4.3.10.5.3.3 Length: 0 m.

4.3.10.6 Connect the pre-amplified MRPM output signal to the AIU. The Recording software is set up for left channel 3 for this input, however, any inputs may be used, but setup must be changed to accommodate.

4.3.10.7 Use the VCP microphone breakout harness to interface between the VCP and vehicle body harness (J2 connection to module). This taps the IVM signal.

4.3.10.8 Connect the IVM output signal through a DC isolator to the AIU.

4.3.10.9 Connect the AIU to the laptop.

4.3.10.10 Connect a line Output of the AIU to the Crown power amplifier.

4.3.10.11 Connect the output of the Crown power amplifier to the HATS mouth (red and black terminals).

4.3.11 Power on all components (Nexus, Crown power amplifier, AIU, and then Laptop last).

4.3.11.1 Open "GEN 'Current' Profiles" folder.

4.3.11.2 Create a new subdirectory for the program under test (e.g., GMT900).

4.3.11.3 Copy contents of "Templates" subdirectory into new program specific directory.

4.3.11.4 Turn the vehicle to accessory power mode (turn headlights OFF to reduce power consumption). To avoid noise infusion, do not have a battery charger charging during the recording

sessions. If needed, a battery charger may be used only between readings.

4.3.11.5 Open "Audition Templates" and then open the "01 TF noise Source.ses".

4.3.11.6 Play noise source file and select infinity icon to loop audio.

4.3.11.7 Adjust the gain of the Crown power amplifier such that the sound pressure level measured with the SPLM at the mouth reference point (MRP) is approximately 100 dB (A-weighted, fast).

4.3.11.8 Monitor the AIU recording levels in the Echo Console of IVM and MRPM inputs while playing back the noise signal "tf noise source.wav". If the inputs do not register, troubleshoot software/hardware until inputs can be monitored with the Echo Console.

4.3.11.9 Ensure the Echo Console is set correctly for each input by ensuring the inputs are set to -10 db.

4.3.11.10 Close Audition.

4.3.11.11 Open "01 TF Noise Source.ses".

4.3.11.12 Under the mrpm-ivm track, verify that the AIU is set to the desired input/output channels and that the "Input options" are set to "Stereo", 16-bit.

4.3.11.13 Record for approximately 60 s the MRPM and IVM signals with all windows and doors closed and only the HATS unit in the vehicle.

4.3.11.14 Save this stereo recording as "mrpm-ivm tf noise source.wav" in the appropriate directory. Do not save sessions.

4.3.11.15 Close Audition, do not save anything else.

4.3.11.16 Open "Audition Templates", then open the "02 Artificial Voices.ses".

4.3.11.17 Under the mrpm-ivm track, verify that the AIU is set to the desired input/output channels and that the "Input Options" are set to Stereo and 16-bit.

4.3.11.18 Record the MRPM and IVM signals for 20 s.

4.3.11.19 Save this stereo recording as "mrpm-ivm artificial voices.wav" in the appropriate directory. Do not save sessions.

4.3.11.20 Close Audition.

4.3.11.21 Listen to the recordings to double check the recording is good.

4.3.11.22 Additional seat positions may be tested for evaluation and development.

4.3.11.23 MRPM Calibration Measurement.

4.3.11.23.1 Open "Audition Templates", then open the "03MRPM Calibration.ses". Verify that the AIU

is set to the desired input/output channels and that the "Input options" are set to left and 16-bit.

4.3.11.23.2 Remove the MRPM from the HATS.

4.3.11.23.3 Using a calibrated signal generator placed on a solid surface, record the signal through the MRPM using the same cables and setup as used in the vehicle recording process.

4.3.11.23.4 Turn on the calibrator and insert the microphone.

4.3.11.23.5 Record the calibration tone for approximately 30 s.

4.3.11.23.6 Save this recording as "mrpm cal.wav". Save this file in the directory corresponding to the short seat position that was created in the GEN "Current" profiles directory under the specific program. Do not save sessions.

4.3.11.23.7 Close Audition.

4.3.11.23.8 Remove the MRPM from the calibrator, put away.

4.3.11.24 In-Vehicle Microphone (IVM) Calibration Measurement.

4.3.11.24.1 Disconnect the DC isolator from the IVM breakout harness. Connect the DC isolator to the output of the Nexus channel 2 with a short lead.

4.3.11.24.2 Use the Nexus to generate and playback a 1 kHz sine tone of amplitude 1 Vrms.

4.3.11.24.3 Open "Audition Templates", then open "04 IVM Calibration.ses".

4.3.11.24.4 Record the calibration signal for 60 s.

4.3.11.24.5 Save this recording as "ivm cal.wav" in the directory corresponding to the Medium seat position that was created in the profiles directory under the specific vehicle program. Do not save sessions.

4.3.11.25 Complete "Compute Impulse Response" under the Data and calculations section of this procedure.

4.3.11.26 Continue to Noise Collection after satisfactory results are computed from Data Calculations for Impulse Response.

4.3.12 Noise Collection.

4.3.12.1 The Noise Collection Process is completed on the tracks at the Milford Proving Ground. Every effort should be made to perform testing on dry roads and with low wind conditions while recording. The HVAC modes, speeds, and road surfaces to record are listed in Appendix B. Only the following modes will be used in the official validation test:

- Idle-Bi-level Low Fan
- City-Bi-Level Low Fan

- City-Bi-level 80% Fan
- Highway-Bi-level Low Fan
- Highway-Defrost High Fan

4.3.13 Obtain a Sound Pressure level (SPL) measurement for each of the above listed conditions.

4.3.14 Conduct the preliminary sound level readings.

4.3.14.1 The test conductor will sit in the test vehicle and take preliminary noise measurements while the vehicle is running and in idle. Set the sound pressure meter to A-weighting and slow response when taking ambient noise readings.

4.3.14.2 The HVAC fan mode is to be set to manual and bi-level. The fan settings are to be manually adjusted from the lowest setting, to the maximum fan setting. At each fan setting, the sound pressure level is to be measured 2.5 cm (1 in) below the production intent microphone location.

4.3.14.3 Repeat this process with the fan mode set to Defrost.

4.3.14.4 After this data is taken, find the fan setting for bi-level and defrost that has the highest decibel (dB) output. Multiply this number by 0.80 to find the decibel (dB) setting that is 80% of the maximum decibel (dB) output of the HVAC unit. Find the fan setting in bi-level mode that is closest to this decibel (dB) value. This is the fan setting that will be used for the city 56.33 km (35 mph) 80% fan portion of the test.

Note: The 80% bi-level should be one setting below maximum. Idle-LF is defined as when the fan mode is in bi-level and the fan setting is at the lowest possible setting. Highway-LF is defined as when the fan mode is in bi-level and the fan setting is at the lowest possible setting. Highway-HF is defined as when the fan mode is in Defrost and the fan setting is at the highest possible setting. All sound pressure measurements are to be recorded.

4.3.15 Record in-vehicle noise for multiple driving conditions/modes. Ambient noise is recorded through the in-vehicle microphone (IVM) and binaural stereo microphones worn by the driver. At a later time, the IVM noise files are mixed with speech files to simulate actual speech taken in the vehicle. The binaural noise recording derived from the stereo microphones is used to map the current vehicle operation mode under test with the most appropriate Lombard level.

4.3.15.1 Reference Appendix A, Figure A2 for a high level schematic of noise collection hardware to set up in the vehicle.

4.3.15.2 Route the IVM cable to the sound card and connect. This will be used to develop the Impulse Response.

4.3.15.3 Connect the preamplifier outputs from the conditioning amplifier to an input channel pair of the sound card. Be sure to observe proper stereo connection. By convention, all odd-numbered channels (1, 3, 5, etc.) are Left Channels on sound cards. Ensure all hardware settings are appropriate for the equipment being used.

4.3.15.4 Using a portable power supply (battery), hook up an inverter to power the equipment used for testing. Locate the inverter as far rear in the vehicle as reasonable so as to not cause a noise issue with the recording equipment and environment.

4.3.15.5 Connect a power strip to the inverter and then plug all AC devices into the power strip. Route all cords trying to keep them away from any signal lines. This will help to reduce noise.

4.3.15.6 Start the Laptop computer.

4.3.15.7 Open "Audition Templates", then open "05 Ambient Noise Recording Template.ses".

4.3.15.8 Verify that the "r" is pressed for both "Left Right Binaural Recordings" and "IVM Recording". Verify that the input device for the Binaural Recordings maps to the Layla24 3-4 Analog In or other input if desired. The Input Options should be set to Stereo, 16-bit. Verify that the input device for the IVM maps to the Layla 5-6 Analog In or other input if desired. The Input Options should be set to Left Channel.

4.3.15.9 Begin testing on the Circular Test Track using Appendix B as a guide to the conditions to record. Save each recording of 1:00 minute over the existing files in the Gen 7.0 Profiles > Vehicle Under Test > Vehicle Profile Data > Noise Recordings > IVM or Binaural Mics.

4.3.15.10 After acquiring each recording, use the "Save All" option to save each file. Audition will automatically prompt you to save each track separately. First will be the IVM file. Make sure "Save extra non-audio information" is unchecked. Make sure directory of IVM files is selected, select file labeled with applicable noise condition and click Save – OK to overwrite.

4.3.15.10.1 Navigate to the Binaural Mics directory, select file labeled with applicable noise condition and click Save. (Click OK to overwrite, OK to read only, Cancel new file name save, do not save sessions.)

4.3.15.10.2 Beyond the basic validation modes, these recordings are all placed in one subdirectory labeled "Non-Validation".