

IVASA

ASEAN NCAP Intelligent Vehicle Advanced Safety Assessment Program

Test Protocol for Intelligent Cabin Interaction

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IVASA Test Protocol for Intelligent Cabin Interaction

1 Scope

This document specifies the test methods for the intelligent cabin interaction component of IVASA under the ASEAN NCAP Intelligent Vehicle Advanced Safety Assessment Program.

2 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

2.1

Driver Monitoring System (DMS)

A system that monitors the driver's state and determines whether the driver is distracted or fatigued.

2.2

Distraction

Any activity that diverts the driver's attention from the primary task of driving or controlling the vehicle.

2.3

Warning response time

The time interval from the moment the distraction or fatigue warning threshold is reached to the onset of the system warning.

2.4

Speech wakeup; Voice trigger

The process by which an in-vehicle intelligent voice interaction system detects a specified wakeup word or event while monitoring the audio stream and transitions to wakeup word recognition or continuous speech recognition.

2.5

Wakeup Success Rate

The percentage of valid wakeup attempts that successfully activate the in-vehicle intelligent voice interaction system. The wakeup success rate shall be calculated using Equation (1).

$$\rho = \frac{n}{N_\rho} \times 100\% \quad (1)$$

where:

ρ — wakeup success rate;

n — number of successful wakeups;

N_ρ — total number of valid wakeup attempts.

2.6

Background-noise reproduction

The reproduction of recorded vehicle noise to create an in-cabin acoustic environment representative of tyre and wind noise for assessing the voice interaction system's response time and success rate under noise interference.

3 Test Requirements

3.1 Requirements for the Test Site, Test Environment, and Test Personnel

3.1.1 Test Site

The test road shall be straight and at least 1 km long. The vehicle shall travel in a straight line during the test.

3.1.2 Test Environment

- a) The driver monitoring system test shall be conducted during daytime at an illuminance greater than 2,000 lx and less than 10,000 lx, with no significant reflections from external light sources inside the cabin.
- b) During the voice interaction test, the background noise outside the vehicle shall not exceed 40 dB.

3.1.3 Test Personnel

The driver shall be an adult without facial or ocular impairments and shall meet the requirements of GB/T 10000 for stature, seated eye height, and head/face dimensions for persons aged 18 to 60 years.

3.2 Test Equipment

3.2.1 Eye Tracker

The eye tracker shall meet the following requirements:

- a) The sampling rate for recording the driver's gaze shall be at least 60 Hz;
- b) Gaze-tracking accuracy: $\pm 0.5^\circ$;
- c) Head-angle tracking accuracy: $\pm 0.5^\circ$;
- d) Eyelid-closure recognition accuracy: ± 0.1 cm.

Secure the eye-tracker cameras below the vehicle's windscreen using mounting fixtures. Install Cameras 1 and 3 on the instrument panel near the left and right A-pillars, and Camera 2 on the instrument panel directly below the rear-view mirror. The exact positions may be adjusted to suit the instrument-panel design of the vehicle. Orient each camera lens toward the driver's face and ensure that the driver's face remains within the camera's field of view. The eye-tracker installation positions are shown in Figure 1.

The eye tracker shall record the driver's gaze region and output the corresponding region label. The software shall count the number of frames associated with each label and convert the frame counts into gaze durations for the corresponding regions.

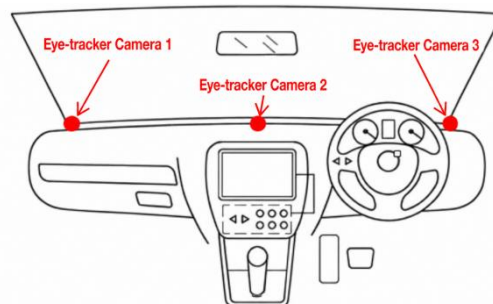


Figure 1 Eye-tracker installation positions

3.2.2 Cameras and Microphones

3.2.2.1 Cameras

The cameras shall meet the following requirements:

- a) Resolution: $\geq 1080p$;
- b) Frame rate: ≥ 30 fps.

3.2.2.2 Microphones

The microphones shall meet the following requirements:

- a) Frequency response: 20 Hz to 20 kHz;
- b) Signal-to-noise ratio: ≥ 80 dB.

3.2.2.3 Camera and Microphone Installation

Secure the cameras inside the vehicle using mounting fixtures. The lens planes shall be parallel to the centre display or instrument display used by the driver monitoring system to present visual warnings, and the relevant display shall be fully within each camera's field of view. The microphones shall be integrated into the cameras and shall clearly record the audible warning signals issued by the vehicle's driver monitoring system.

3.2.3 Artificial Head and Artificial Mouth

Install the artificial head and artificial mouth at the centre of the driver's head restraint, 40-50 cm from the roof and 60-80 cm from the steering wheel, with the steering wheel adjusted to its highest and most forward position. The installation position is shown in Figure 2.

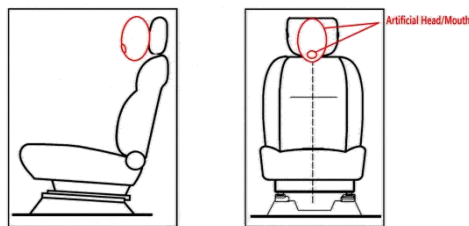


Figure 2 Artificial-mouth installation position

3.2.4 Background Noise Reproduction Loudspeakers

The background-noise reproduction system shall simulate noise using four high-fidelity active loudspeakers and one low-frequency loudspeaker. Place the high-fidelity active loudspeakers inside the vehicle near the left and right A/B-pillars, and place the low-frequency loudspeaker at the centre of the rear seat. The loudspeaker positions are shown in Figure 3.

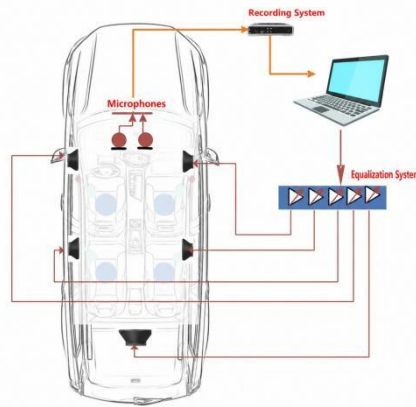


Figure 3 Background Noise Reproduction System Installation Positions

3.3 Vehicle Preparation

3.3.1 System Initialisation

If necessary, initialize the in-vehicle intelligent voice interaction system and the in-vehicle information system before testing, including calibration of microphones and other sensors.

3.3.2 Vehicle Condition Confirmation

Before testing, the vehicle under test shall meet the following requirements:

- a) The vehicle under test shall be a new vehicle with an odometer reading of no more than 5,000 km;
- b) After the vehicle is started, its in-vehicle systems shall operate normally;
- c) The vehicle shall be in good condition, with no disassembly or modification of the interior or exterior trim;
- d) Before testing, adjust the driver's seat to a suitable position, provide the mobile internet services required by the system, and ensure that the vehicle network is activated and remains connected throughout the test.

3.3.3 Function Check

Before testing, verify that all cabin functions of the vehicle under test operate normally, and check the function buttons and display modes. The driver's seat, steering wheel, windows, and rear-view mirrors may be adjusted to the manufacturer's recommended positions. If no positions are recommended, the driver shall adjust them to suitable positions so that the driver monitoring system can recognize the driver's face and operate normally.

Conduct a pre-test using the trigger conditions of each function included in the driver monitoring system to confirm that all functions operate normally.

3.4 Data Processing and Recording Requirements

3.4.1 Data to Be Recorded

The following test data shall be recorded:

- a) Ambient sound pressure level at the test site;
- b) Speech sound pressure level at the artificial mouth inside the vehicle.

3.4.2 Data Processing Requirements

Test data shall be processed as follows:

For repeated tests, the arithmetic mean shall be calculated and rounded to one decimal place.

3.4.3 Test Photography Requirements

The following photographs shall be taken:

- a) Before installing the test equipment, photograph the vehicle from the front-left at 45° and photograph the vehicle identification plate;
- b) After installing the test equipment, photograph the test equipment inside and outside the vehicle.

4 Test Methods

4.1 Driver Monitoring System Test Methods

4.1.1 Distraction Monitoring Test

Test procedure:

- a) Set the system under test to standby. Calibrate the eye tracker for the driver and ensure that the recorded gaze point corresponds to the actual gaze point;
 - b) The driver shall start the vehicle and increase the vehicle speed to the activation speed required by the vehicle driver monitoring system's distraction monitoring function;
 - c) Following the prescribed distraction-gaze procedure, the driver shall look at each distraction-point region in turn while the cameras and microphones record the system's visual and audible warning responses. The three distraction points shall comprise the large in-vehicle infotainment display, the front-passenger footwell, and either the mobile-phone charging area or the centre armrest area. Figure 4 shows the distraction points;
 - d) The test engineer shall conduct each test scenario three times. A test is successful if the system issues a warning within the time threshold specified below.
- Distraction duration: the driver shall look at the distraction-point region for 5 s.

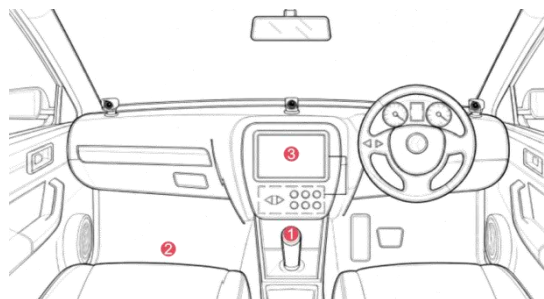


Figure 4 Distraction-point locations

4.1.2 Fatigue Monitoring Test

Test procedure:

- a) Set the system under test to standby. Calibrate the driver's eyelid closure and ensure that the measured eyelid closure is 0 mm when the driver's eyes are closed;
 - b) The driver shall start the vehicle and increase the vehicle speed to the activation speed required by the vehicle driver monitoring system's fatigue monitoring function. The driver shall then close both eyes to perform the fatigue action.
 - c) The test engineer shall conduct the test scenario three times. A test is successful if the system issues a warning within the time threshold specified below.
- Fatigue monitoring: the driver shall keep both eyes closed for 5 s.

Note 1: During the distraction and fatigue monitoring tests, each action shall be maintained for an additional 2 s after the warning threshold is reached. This prevents the system from determining that the abnormal action has ended and cancelling the warning. If the system issues a warning within the specified threshold time, the test shall still be considered successful.

Note 2: While performing a distraction or eye-closure action, the driver's head angles (heading, roll, and pitch) shall each remain within 20°.

4.2 Voice Interaction Test Methods

4.2.1 Functional Support Test

4.2.1.1 Wakeup-word-free voice interaction

Navigate to the vehicle settings menu, locate the wakeup-word-free voice interaction setting, enable it, and verify whether the system supports wakeup-word-free voice interaction.

4.2.1.2 Continuous dialogue

Navigate to the vehicle settings menu, locate the continuous dialogue setting, enable it, and verify whether the system supports continuous dialogue.

4.2.2 English-Language Test

4.2.2.1 Voice Interaction Performance Test

The speech recognition performance test shall be conducted under reproduced background noise conditions. In-cabin background noise shall be collected under the specified test conditions using recording microphones with the same number as those equipped in the vehicle under test. Each recording microphone shall be placed near the corresponding microphone of the vehicle under test. The requirements for background noise and speech input are provided in Table 1.

Table 1 — Background-noise scenario and voice-input requirements

Vehicle speed	Air-conditioning and fan settings	Windows	Speech sound pressure level at the artificial mouth
100 ± 5 km/h	Medium fan speed; fresh-air mode; only the front face-level vents open; all other vents closed; vent direction set midway between the horizontal and vertical angles.	Closed	80 ± 5 dB(A)

- a) Wakeup Success Rate

Set the system under test to standby, reproduce the background noise specified in Table 1, and use the artificial mouth to play the wakeup word. Conduct 100 trials. Record the number of successful wakeups and calculate the wakeup success rate.

b) Speech Recognition Rate

Set the system under test to standby, reproduce the background noise specified in Table 1, and use the artificial mouth to play the utterance-recognition test command. Conduct 100 trials. Record the number of successful recognitions and calculate the speech recognition rate.

c) Interaction Response Time

Set the system under test to standby, reproduce the background noise specified in Table 1, and use the artificial mouth to play the interaction test commands. Test three function commands—play music, open navigation, and turn on the air conditioning—three times each. For each trial, record the interval from the end of the spoken interaction command to the moment the user interface (UI) begins to change. Use the mean of the nine results as the system's interaction response time. The interaction response time T_I shall be calculated as follows:

$$T_I = T_{IE} - T_{IS} \quad (2)$$

T_{IE} — the time at which the voice input of the interaction command ends;

T_{IS} — the time at which the UI begins to change.

4.2.2.2 Voice-Controlled Vehicle Safety Test

a) Headlamp Control

Drive the vehicle along a road at 30 km/h with the headlamps or automatic headlamps switched on. An occupant shall issue the voice control command: “Turn off the headlamps/turn off the automatic headlamps.” Repeat the test three times and verify the vehicle's response.

b) Driver's Seat Adjustment

Drive the vehicle along a road at 30 km/h. An occupant shall issue the voice control command: “Move the driver's seat rearward.” Repeat the test three times and verify the vehicle's response.

c) Deactivation of the Driver Monitoring System

Drive the vehicle along a road at 30 km/h with the driver monitoring system enabled. An occupant shall issue the voice control command: “Turn off the driver monitoring system”. Repeat the test three times and verify the vehicle's response.

4.2.3 Local-Language Test

4.2.3.1 Voice Interaction Performance Test

The speech recognition performance test shall be conducted under reproduced background noise conditions. In-cabin background noise shall be collected under the specified test conditions using recording microphones with the same number as those equipped in the vehicle under test. Each recording microphone shall be placed near the corresponding microphone of the vehicle under test. The requirements for background noise and speech input are provided in Table 1.

a) Wakeup Success Rate

Set the system under test to standby, reproduce the background noise specified in Table 1, and use the artificial mouth to play the wakeup word. Conduct 100 trials. Record the number of successful wakeups and calculate the wakeup success rate.

b) Speech Recognition Rate

Set the system under test to standby, reproduce the background noise specified in Table 1, and use the artificial mouth to play the utterance-recognition test command. Conduct 100 trials. Record the number of successful recognitions and calculate the speech recognition rate.

c) Interaction Response Time

Set the system under test to standby, reproduce the background noise specified in Table 1, and use the artificial mouth to play the interaction test commands. Test three function commands—play music, open navigation, and turn on the air conditioning—three times each. For each trial, record the interval from the end of the spoken interaction command to the moment the user interface (UI) begins to change. Use the mean of the nine results as the system's interaction response time. Calculate the interaction response time T_1 using Equation (2).

4.2.3.2 Voice-Controlled Vehicle Safety Test

a) Headlamp Control

Drive the vehicle along a road at 30 km/h with the headlamps or automatic headlamps switched on. An occupant shall issue the voice control command: “Turn off the headlamps/turn off the automatic headlamps.” Repeat the test three times and verify the vehicle's response.

b) Driver's Seat Adjustment

Drive the vehicle along a road at 30 km/h. An occupant shall issue the voice control command: “Move the driver's seat rearward.” Repeat the test three times and verify the vehicle's response.

c) Deactivation of the Driver Monitoring System

Drive the vehicle along a road at 30 km/h with the driver monitoring system enabled. An occupant shall issue the voice control command: “Turn off the driver monitoring system”. Repeat the test three times and verify the vehicle's response.