U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA

DOT HS 813 607

August 2024

Special Crash Investigations: On-Site Rollover Crash Investigation; Vehicle: 2022 Hyundai Tucson; Location: Pennsylvania; Crash Date: February 2022

This page intentionally left blank.

DISCLAIMER

Suggested APA Format Citation:

Crash Research & Analysis, Inc. (2024, August). *Special Crash Investigations: On-site rollover crash investigation; 2022 Hyundai Tucson; Location: Pennsylvania; Crash Date: February 2022*. (Report No. DOT HS 813 607). National Highway Traffic Safety Administration.

This page intentionally left blank.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 813 607		

4. Title and Subtitle	5. Report Date
Special Crash Investigations: On-Site Rollover Crash Investigation; Vehicle: 2022 Hyundai Tucson; Location: Pennsylvania; Crash Date: February 2022	August 2024
	6. Performing Organization Code

7. Author(s)	8. Performing Organization Report No.
Crash Research & Analysis, Inc	CR22004

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Crash Research & Analysis, Inc. PO Box 302 Elma, NY 14059	11. Contract or Grant No. 693JJ919C000004

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Highway Traffic Safety Administration 1200 New Jersey Avenue SE Washington, DC 20590	Technical Report
	14. Sponsoring Agency Code

15. Supplementary Notes

Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was submitted.

16. Abstract

This report documents the on-site investigation of the rollover crash of a 2022 Hyundai Tucson in Pennsylvania in February 2022. The police report stated that the belted 64-year-old female driver was distracted by the vehicle's infotainment system and failed to negotiate a left curve on a two-lane roadway. The Hyundai left the roadway and went into a drainage ditch, where it rolled over for approximately 11 m (36 ft) before coming to rest on its roof at the bottom of the ditch. The driver was transported by ambulance to a local hospital where she was treated for police-reported suspected minor (B-level) injuries.

17. Key Words	18. Distribution Statement
rollover, road departure, distracted, air bag, deployment	Document is available to the public from the USDOT, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, https://crashstats.nhtsa.dot.gov.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	80	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

This page intentionally left blank.

Table of Contents

This page intentionally left blank.

Special Crash Investigations
On-Site Rollover Crash Investigation
Case Number: CR22004
Vehicle: 2022 Hyundai Tucson
Location: Pennsylvania
Crash Date: February 2022

Background

This report documents the on-site investigation of the rollover crash of a 2022 Hyundai Tucson (Figure 1). The Hyundai was traveling northbound on a two-lane roadway. The police crash report (PCR) stated that the belted 64-year-old female driver was distracted by the vehicle's infotainment system and failed to negotiate a left curve in the roadway. The Hyundai departed from the right side of the roadway into a drainage ditch, where it rolled over for approximately 11 m (36 ft) before coming to rest on its roof at the bottom of the ditch. There were several supplemental restraints that deployed as a result of the crash. The driver was transported by ambulance to a local hospital where she was treated for police-reported suspected minor (B-level) injuries. The vehicle was towed to a secure location due to disabling damage, where it remained for this investigation.

Figure 1. Front view of damage to the Hyundai

The crash was identified by the National Highway Traffic Safety Administration's Crash Research Sampling System in March 2022 and the PCR was forwarded to the Crash Investigation Division. The Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., was notified and assigned an on-site investigation of the crash in March 2022. The SCI team received cooperation from the insurance adjustor who had custody of the vehicle. An inspection of the Hyundai was conducted in March 2022 to measure exterior deformation, interior damage and intrusion, documentation of interior occupant contact, and assessment of the manual and supplemental restraint systems. The Hyundai had an event data recorder (EDR), which was imaged during the inspection process with the Global Information Technologies Hyundai EDR tool. The crash site was also photographed, documented, and measured by total station. The driver was contacted but refused an interview.

This page intentionally left blank.

Crash Summary

Crash Site

The crash occurred during the day on an undivided two-lane north/south directional roadway. At the time of the crash the National Weather Service reported conditions as fair, -1.6 °C (29 °F), 54 percent humidity, and south-southeast winds at 14.4 km/h (9 mph). The dry bituminous roadway alignment consisted of a large radius curve to the left that terminated into a straight segment. The posted speed limit was 72 km/h (45 mph). The roadway was 7.3 m (24.0 ft) wide with lanes measuring 3.6 meters (11.8 ft) wide. The lanes were separated by a solid double yellow centerline and bordered by a white edge line. The east shoulder of the roadway was 1.5 meters (4.9 ft) wide and transitioned into a drainage ditch. The ditch was 2.9 meters (9.5 ft) wide and 0.8 meters (2.6 ft) deep. A utility pole was positioned 20.7 meters (67.9 ft) north from where the vehicle departed the roadway and 4 meters (13.1 ft) from the roadway edge. Figures 2 and 3 show the roadway curvature and the departure into the drainage ditch.

Figure 2. North view of the Hyundai's approach

Figure 3. North view of the roadway departure (Event 1) indicated by the cones on the left

Pre-Crash

The Hyundai was traveling north along the roadway at an EDR-reported average speed of 80 km/h (49.7 mph). The EDR reported that the driver had the smart cruise control (SCC) feature of the Hyundai turned on, set at 82 km/h (51 mph). According to the Hyundai's quick reference guide, SCC allows the driver to program the vehicle to maintain a constant speed without holding the accelerator pedal.[1] The SCC feature also allows the driver to program a follow distance when approaching other vehicles and will automatically slow the vehicle to maintain the following distance from other vehicles.

As the Hyundai entered the straight segment of the road, it continued in its prior trajectory and tracked off-road to the right (Figure 3), denoted by the yellow cones. The steering angle did not change significantly until just prior to impact. The steering input recorded by the EDR indicated the driver's attempt to redirect the Hyundai back to the roadway as a crash avoidance maneuver. There was a momentary fluctuation of the master cylinder pressure for the brake system that was attributed to the stability control engaging at algorithm enabled (AE).

Crash

The Hyundai departed from the right side of the road, traveled 11.4 meters (37.4 ft) into the ditch, and struck the outer embankment of the ditch with its front-right corner (Event 1). The damage was located immediately outside the bumper beam and continued rearward involving the right-front wheel assembly, driveline, and suspension. The Hyundai ramped up the ditch bank incline and initiated a left-side-leading rollover (Event 2). The Hyundai struck the ditch bank closest to the road with its right D-pillar. The ditch acted as a guide directing the vehicle northward for approximately 11 meters (36 ft) from the initial impact coming to final rest adjacent to the utility pole. The Hyundai rolled a total of two-quarter turns and came to final rest facing north on its roof.

Post-Crash

According to the PCR, a witness to the crash notified the emergency response system and reported the location of the crash. The witness further reported that the Hyundai was not swerving but appeared to drive off the roadway. The police and EMS personnel responded to the scene. The driver was removed from the vehicle by EMS personnel due to perceived injuries through the left-front door and was transported by ambulance to a nearby hospital where she was evaluated, treated for a minor severity abrasion, and released.

The Hyundai was up-righted and towed due to damage it sustained during the crash. It was taken to an insurance salvage yard where it was located for this investigation.

[1] The Hyundai Tucson Hybrid: Quick Reference Guide. https://owners.hyundaiusa.com/content/dam/hyundai/us/myhyundai/manuals/glovebox-manual/2022/tucson-hybrid/2022-Tucson-Hybrid-QRG.pdf

2022 Hyundai Tucson

Description

The 2022 Hyundai Tucson was a four door SUV (Figure 4) manufactured in June 2021 and identified by Vehicle Identification Number 5NMJCCAE8NHxxxxxx. It was constructed on a 267 cm (105.1 in) wheelbase and powered by a 2.5-liter, inline 4-cylinder, gasoline engine linked to an 8-speed automatic transmission with four-wheel drive. The service brakes were a power-assisted four-wheel disc system. Steering was set up as a speed-sensitive electric rack and pinion system. The Hyundai had an antilock braking system, electronic stability control, traction control, automatic crash notification, crash imminent braking, forward collision warning, pedestrian automatic emergency braking, blind spot detection, lane departure warning, lane keeping assist (LKA), lane follow assist (LFA), daytime running lights, and SCC.

Figure 4. Left front oblique view of the Hyundai

According to the Hyundai owner's manual, the LKA system is designed to help detect lane markings or road edges while the driver is operating the vehicle at a particular speed (over 64.4 km/h or 40 mph). The vehicle's system will warn the driver if the vehicle leaves the lane without the activation of a turn signal or will automatically assist the driver's steering to help prevent the vehicle from departing the lane. LKA is limited and will not operate properly if there are faded lane lines, sharp bends in the roadway, or inclement weather present. The LFA system detects lane markers on the roadway using the front camera mounted on the windshield. LFA helps to assist the driver steering to help keep the vehicle centered in the lane. The SCC, LKA, and LFA must be activated by the driver. The status of the LKA or LFA being active at the time of the crash is unknown due to the driver's refusal of an interview.

The vehicle manufacturer's recommended tire size was P235/55R19 front and rear with a recommended cold tire pressure of 240 kPa (35 psi). At the time of the SCI inspection, the Hyundai had Michelin Primacy A/S tires of the recommended size and mounted on OEM aluminum alloy wheels. All tire tread depths were 6 mm (8/32 in). The Hyundai had two rows of seats for seating five occupants. At the time of the SCI inspection, the driver's seat was reclined approximately 20° aft of vertical. All seating surfaces were leather. All seat positions had 3-point-lap and shoulder seat belts for manual restraints. Supplemental restraints were provided by front seat retractor and lower anchor pretensioners, driver's and passenger's frontal air bags, outboard seat-mounted side impact air bags, and dual sensing (side impact and rollover) roof rail side inflatable curtain (IC) air bags.

Vehicle History

According to its Carfax report, the Hyundai was purchased new by the driver in July 2021. There was no recorded work or suspected post manufacturer modifications on the vehicle.

NHTSA Recalls and Investigations

Searches of the NHTSA database website www.nhtsa.gov/recall using the Hyundai's VIN at the time of assignment in March 2022 and again in June 2024, revealed no open or unrepaired recalls.

Exterior Damage

The Hyundai sustained damage at the front-right corner area from initial contact with the ditch bank (Event 1) (Figures 5 and 6). The direct contact damage began 59 cm (23.2 in) right of the bumper fascia centerline and extended 21 cm (8.2 in) to the right corner. The direct contact damaged continued along the right plane 223 cm (87.8 in). Due to the nature of this corner type impact, no front structural component of the Hyundai contacted the ditch bank. The direct contact damage from Event 1 involved the right bumper fascia, headlight components, right-front wheel assembly, and passenger's right door panel. Most of the force associated with this event was absorbed by the right-front tire and suspension, which led to the separation of the wheel/suspension assembly from the CV joint and the associated ball joints/steering rods. This corner impact was outside the scope of the barrier algorithm of the WinSMASH program. The collision deformation classification (CDC) assigned to the damage pattern for Event 1 was 01FREE8.

Figure 5. Right side view of damage associated with Event 1

Figure 6. Front plane view of damage associated with Event 1

The Hyundai sustained moderate damage during the rollover (Event 2). The Hyundai landed on its right D-pillar, crushing it into the greenhouse space 15 cm (5.9 in) vertically and 15 cm (5.9 in) laterally. There were several heavy surface abrasions (Figures 7 and 8) across the entire vehicle as well as minor trim damage. The left side mirror was missing from the vehicle and the right mirror was dangling from its sensor wires. The abrasions and mirror damage are attributed to the Hyundai sliding through the ditch to its final rest on its roof top. The CDC assigned to this event is 00TZZO3.

Figure 7. Right side view of damage associated with Event 2

Figure 8. Rear view of damage associated with Event 2

Event Data Recorder

The Hyundai had an air bag control module (ACM) that monitored and controlled the diagnostic, sensing, and deployment commands for the vehicle's supplemental safety systems. The module had EDR capabilities. It was imaged with the tool version E-N-H-01-00-0048 of the Global Information Technologies Hyundai EDR tool software. During the on-site inspection, the vehicle's key fob was not available; therefore, with insurance company approval, the EDR was removed from the Hyundai for a desktop direct-to-module imaging process by the SCI investigator. The insurance company did not require the SCI investigator to return the EDR to the vehicle. The imaged data reported with EDR002-R01 of the software is attached as an appendix at the end of this report.

The EDR could store up to two crash events, termed either non-deployment or deployment events. Non-deployment events occur when the recording trigger threshold is met or exceeded. Data from non-deployments can be overwritten by subsequent events. Deployment events cannot be overwritten from the ACM. This ACM also categorizes non-air bag deployment events when there is an event in which non-air bag devices, such as pretensioners, have actuated. This type of event can be overwritten given a subsequent air bag deployment event. Associative to each reported event was a 5.0-second pre-crash buffer. Several data points were recorded on a recurring basis of 0.5 seconds, including: vehicle speed, engine rpm, engine throttle (% full), accelerator pedal (% full), master cylinder pressure, service brake status, ABS activity, stability control activity, and steering input. Two locked frontal events were recorded by the EDR. It was determined that the data was consistent with the SCI investigation.

First Record

The ignition cycle count was 665 at the time of the recording and 667 at the time of imaging. The air bag warning lamp was off. The driver's seat belt was reported as on (fastened) and front passenger's seat belt was reported as off (unfastened). A part of the 5.0-second pre-crash data of the overlapped events is included in Table 1.

Table 1. Pre-Crash data for Events 1 and 2

Time (sec) Ev.1	Time (sec) Ev.2	Vehicle Speed km/h (mph)	Engine rpm	Accelerator Pedal % Full	Master Cylinder Pressure (bar)	Service Brake (on/off)	ABS Activity	Stability Control (on/off/ engaged)	Steering wheel Angle (deg.) (+L)
-5.0	-	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
-4.5	-	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
-4.0	-	80 (49.7)	1,300	31	0.6	OFF	OFF	ON	0
-3.5	-5.0	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
1-3.0	-4.5	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
-2.5	-4.0	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	-5
-2.0	-3.5	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
-1.5	-3.0	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
-1.0	-2.5	80 (49.7)	1,300	32	0.6	OFF	OFF	ON	0
-0.5	-2.0	80 (49.7)	1,300	31	0.6	OFF	OFF	ON	-5
0.0 AE 1	-1.5	80 (49.7)	1,300	16	0.9	OFF	OFF	Engaged	10
-	-1.0	54 (49.7)	1,000	0	15.1	OFF	OFF	Engaged	-85
-	-0.5	25 (49.7)	1,200	100	1.5	OFF	OFF	Engaged	250
	0.0 AE 2	24 (49.7)	2,400	0	0.2	OFF	OFF	Engaged	30

The EDR was also capable of capturing forward collision alert status, warning level, and fail information. For the entire pre-crash time segment the forward collision alert was on, showed no warnings, and a fail status of normal. In addition to this information the EDR recorded the Hyundai set to a cruise control speed of 82 km/h (51 mph) and engaged for the duration of the pre-crash time segment.

The EDR reported that the Hyundai traveled at 80 km/h (49.7 mph) and continued to do so for the entire pre-crash data until there was a slight fluctuation of the master cylinder pressure, with stability control engaged and steering indicating a pre-crash avoidance maneuver from the driver. Reconstruction of the crash determined that the Hyundai struck the ditch's outer bank (Event 1) at the 0-second interval and initiated AE. Actuation of the driver's frontal air bag, seat belt pretensioners, and passenger's seat belt pretensioner occurred 130 milliseconds into AE. The driver's anchor pretensioner actuated 135 milliseconds into AE. The driver's frontal air bag second stage disposal actuated at 280 milliseconds into the AE. The maximum longitudinal delta V of this impact was -33 km/h (-20.5 mph) at 300 milliseconds with a lateral maximum delta V of -21 km/h (-13 mph) at 265 milliseconds.

Second Record

This EDR record was consistent with the rollover (Event 2). The EDR recorded roll angle data for both Events 1 and 2. When analyzing the combined data, the event AEs were separated by 1.6 seconds. The recorded data indicated the Hyundai initially rolled to the right (positive roll angle) as it traveled down the ditch into Event 1. After this, the data trends to a left-side-leading rollover (negative roll angle). It was noted that the reported roll angle was less than two quarter-turns for undetermined reasons. Table 2 shows the roll angle of the Hyundai (page 62 and 63 of Appendix A) for Event 2 in half second intervals.

Table 2. Roll angle for Event 2

Time (sec)	Roll angle (degree)
-1.0	39
-0.5	36
0	24
0.5	-46
1.0	-62
1.5	-60
2.0	-59
2.5	-57
3.0	-56
3.5	-55
4.0	-54
4.5	-53
5.0	-52

Reconstruction of the crash determined that the Hyundai came down on its right D-pillar during the rollover (Event 2). Actuation of the driver's outboard seat-mounted side impact air bag, IC air bag, and seat belt pretensioner occurred 2 milliseconds into this AE and the passenger's outboard seat-mounted side impact air bag, IC air bag and anchor pretensioner actuating at 348 milliseconds into AE. The maximum longitudinal delta V was 5.0 km/h (3.1 mph) at 295 milliseconds with a lateral maximum delta V component of 9 km/h (5.5 mph) at 120 milliseconds.

Interior Damage

There was minor interior damage that was associated with air bag deployment and occupant contacts for this crash. There were no intrusions to the front row of the interior (Figures 9 and 10). The driver contacts consisted of scuffs to the polymer knee bolster/lower instrument panel at the base of the steering column. Blood evidence that probably occurred post-crash was noted to the sunroof window cover. The driver's IC air bag had been cut by the EMS personnel and placed in the rear cargo area. The Hyundai's cargo area was significantly reduced in size as a result of the rollover (Event 2).

Figure 9. Oblique overview of the front row

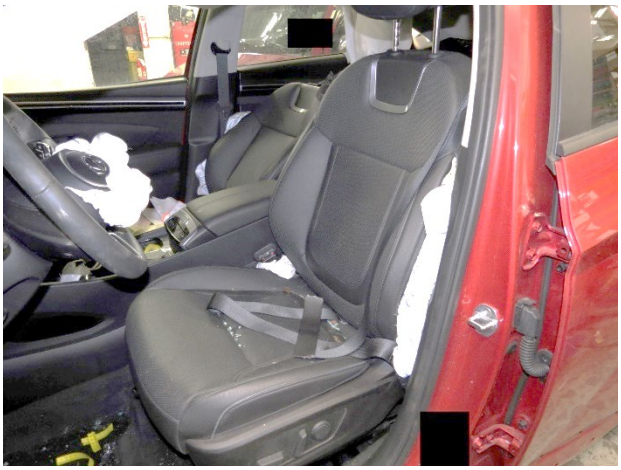


Figure 10. Oblique overview of the driver's seat

Manual Restraint Systems

The Hyundai had 3-point continuous loop lap and shoulder seat belts for each of the five seat positions. The front row used sliding latch plates and adjustable D-rings. Both front seat positions had retractor and lower anchor pretensioners. Both pretensioners actuated as a result of the crash (Figure 11). The belted driver was the sole occupant of the vehicle during the crash.

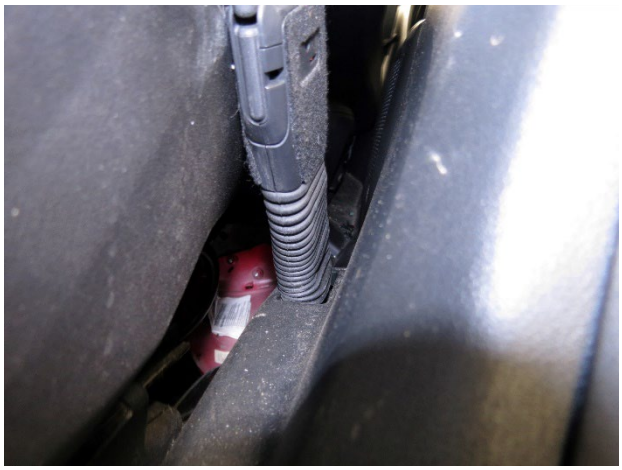


Figure 11. Driver's seat belt anchor showing signs of actuation

At the time of the SCI inspection, it was observed that the driver's seat belt was hanging loose from the D-ring with the retractor locked. The D-ring position was full up. The seat belt had been cut twice by EMS personnel post-crash (Figure 12). The first cut was made 70 cm (27.5 in) below the adjustable D-ring. The second cut was 24 cm (9.4 in) below the first cut with the remaining 85 cm (33.4 in) of webbing extending to the lower anchor. The latch plate was still positioned in the buckle. Frictional abrasions were present on the polymer surface of the latch plate (Figure 13) that resulted from driver loading during the crash.

Figure 12. View of the driver's seat belt as found

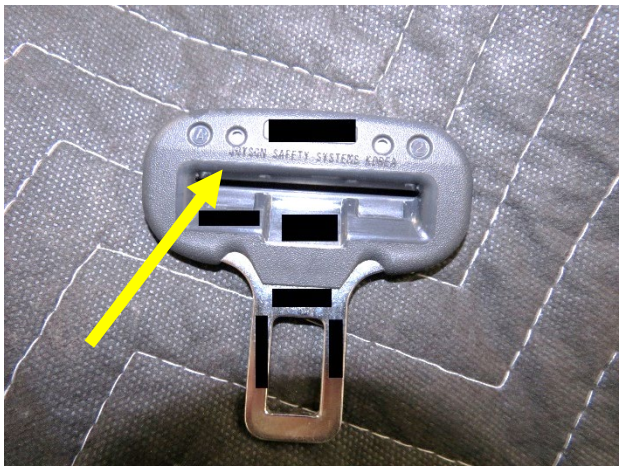


Figure 13. Driver seat belt latch plate with friction burns denoted by yellow arrow

Figure 14. Driver's frontal air bag

Supplemental Restraint System

The Hyundai had dual-stage driver's and passenger's frontal air bags, outboard seat-mounted side impact air bags, and IC air bags. The driver's frontal steering wheel mounted air bag deployed (Figure 14). Both front seat side impact air bags (Figures 15 and 16) and both IC air bags (Figures 17 and 18) also deployed. At the time of the SCI investigation, it was observed that the left IC air bag had been cut out by EMS personnel post-crash.

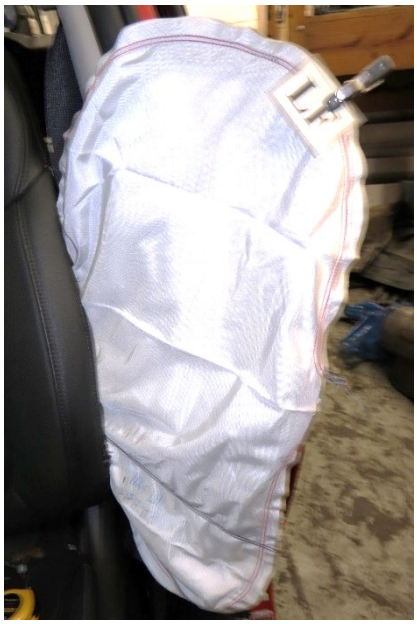


Figure 15. Driver's seat-mounted side impact air bag

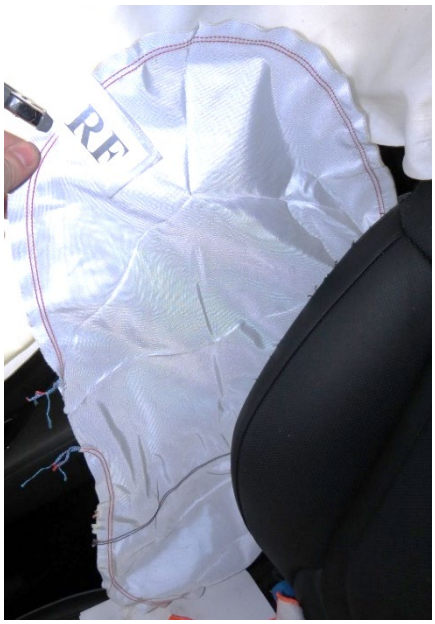


Figure 16. Front passenger's seat-mounted side impact air bag

Figure 17. Driver's IC air bag cut out

Figure 18. Front passenger's IC air bag

2022 Hyundai Tucson Occupant

Driver Demographics

Age/sex:	64 years/female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Forward-facing bucket seat with adjustable head restraint
Seat track position:	Between middle and rear most track position
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection, EDR, PCR
Air bags:	Driver's frontal, seat-mounted side impact, and IC air bags available; all deployed
Alcohol/drug involvement:	No test performed
Egress from vehicle:	Removed from vehicle due to perceived serious injuries
Transport from scene:	Ambulance to a local hospital
Type of medical treatment:	Treated and released

Driver Injuries

Injury No.	Injury	AIS 2015	Injury Source	Confidence
1	Small abrasion right anterior forehead	210202.1	Driver's frontal air bag	Probable

Source: Emergency room records

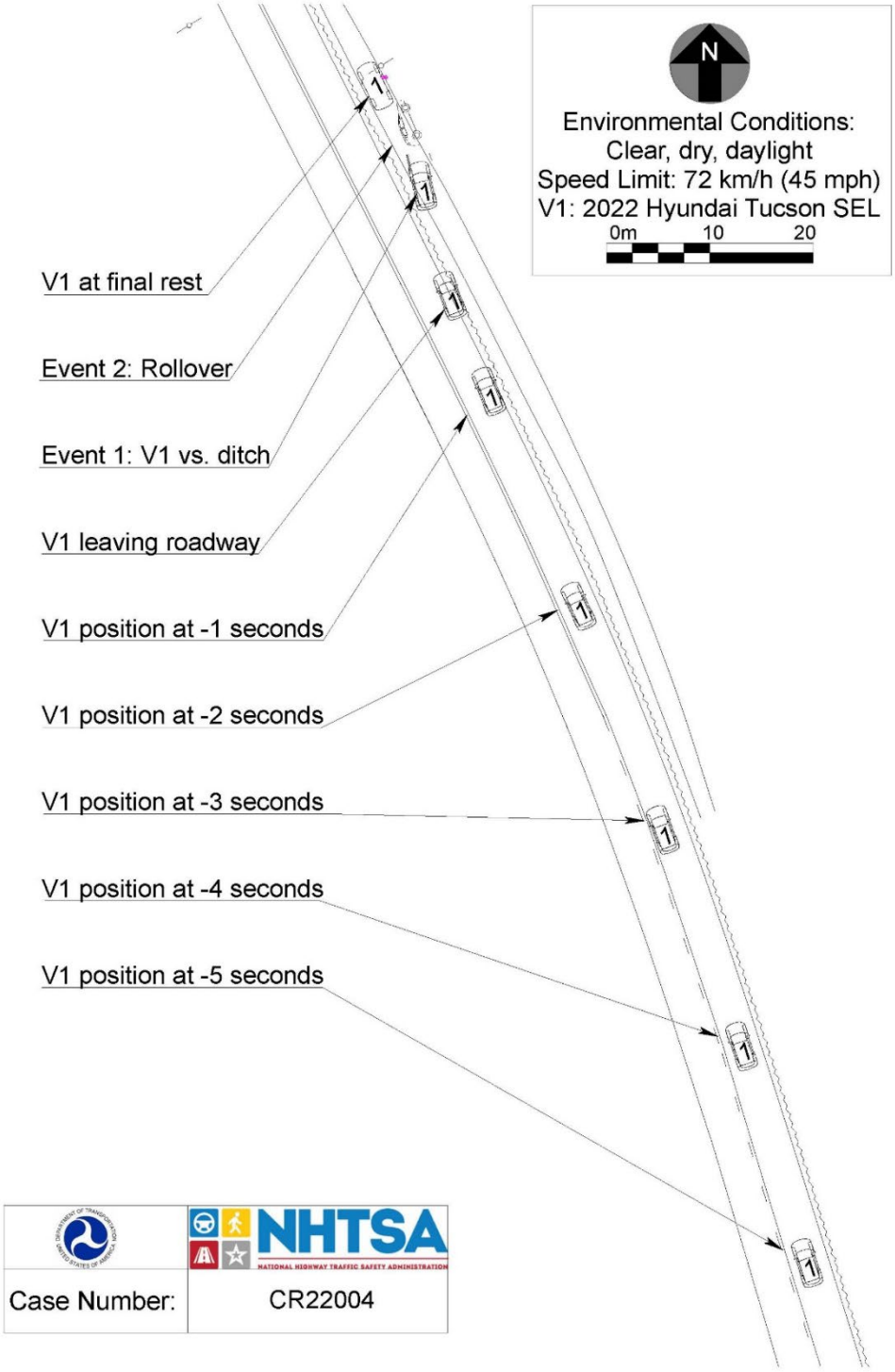
Drivers Kinematics

At the time of the crash, the driver was restrained by the lap and shoulder seat belt and the seat track position appeared to be set between the middle and rear most positions. The initial non-horizontal impact with the outer embankment of the drainage ditch displaced her forward within her seat belt where she contacted the deployed driver's frontal air bag. Her knees contacted and scuffed the knee bolster below the steering column. As the Hyundai mounted the embankment the driver was then displaced rearward into her seat back. As the Hyundai entered the rollover event the driver remained restrained in her seated position by her seat belt. When the Hyundai landed on its right D-pillar, the inverted occupant was displaced downwards loading her seat belt. The driver sustained a small abrasion to her right forehead as a result of the driver's frontal air bag deployment. No injury occurred from the bolster contact.

The driver remained in the vehicle as it came to rest against the ditch bank with the left side tilted upward. EMS personnel arrived on-scene and opened the left-front door and cut the left IC air bag and seat belt webbing to remove her from the vehicle. She was transported by ambulance to a local hospital where she was treated for her injury and released.

This page intentionally left blank.

Crash Diagram



This page intentionally left blank.

Appendix A: 2022 Hyundai Tucson Event Data Recorder Report[2]

[2] The EDR was imaged during the SCI vehicle inspection with the Global Information Technologies Hyundai EDR tool and the current version of the software available at the time of the inspection. The imaged data has been sanitized to remove potential personally identifiable information.

EDR

Vehicle Information

HYUNDAI | TUCSON(NX4A) | 2022 | AIRBAG SYSTEM	
VIN as Programmed into EMS	

Additional Information

User-entered VIN	5NMJCCAE8NH
User Name	NHTSA
Case Number	
Crash Date	
Saved-on Date	2022-03-29 09:56
EDR Tool Version	E-N-H-01-00-0048
EDR Report Version	EDR002-R01
Tire Size(s)	
Memo	

Data Limitation

General Information:

Tools for downloading and interpreting the EDRs in Hyundai vehicles have been developed for vehicles produced after September 1, 2012. Currently, there is no tool for downloading and accurate interpreting data from the EDRs in Hyundai vehicles produced prior to this date.

The EDR Report requires Adobe Reader Version 9.00 or higher to open.

EDR(Event Data Recorder):

- The EDR function is part of the Airbag Control Unit(ACU).

- ACU can store up to two events.

- Event means a crash or other physical occurrence that causes the trigger threshold to be met or exceeded, or any non-reversible deployable restraint to be deployed, whichever occurs first:

  1. Deployment Event:
     1) the event which is recorded if an airbag is commanded to deploy.
     2) the event is locked and cannot be overwritten.

  2. Non-deployment Event:
     1) the event which is recorded, but in which an airbag is not commanded to deploy
     2) the event is not locked and can be overwritten by a subsequent event (Deployment or Non-deployment event), for example, Pretensioner(s) only deployment
     3) An example of a non-deployment event is a pretensioner-only deployment with no airbag deployments

- Ignition cycle count will increment by 1 in the following cases

  1. the power mode change from OFF/Accessary to IGN ON/RUN

  2. EDR data download by tools

- The ACU can record data for all or some of the following events. But, depending on the vehicle's configurations, data for side crash and/or rollover crash(event) may not be recorded.

- If power supply to the ACU is lost during an event, all or part of the data may not be recorded.

Data Limitation

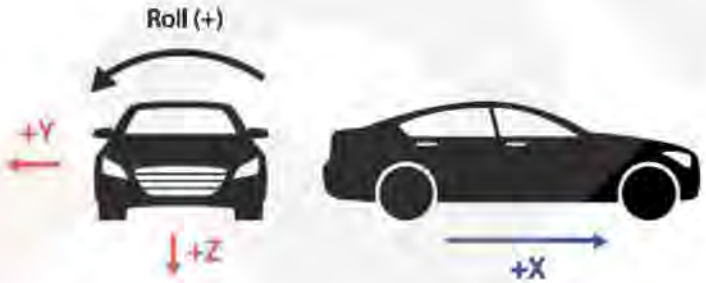
Data Element Sign Convention:

The following table provides an explanation of the sign notation for data elements that may be included in the EDR report. Directional references to sign convention are from the point of view of the driver.

Data element name	Positive sign	Note
* Longitudinal acceleration	Forward direction	+X at the figure 1
Delta V, longitudinal	Forward direction	+X at the figure 1
Lateral acceleration	Left to Right direction	+Y at the figure 1
Delta V, lateral	Left to Right direction	+Y at the figure 1
Normal(vertical) acceleration	Downward direction	+Z at the figure 1
Vehicle roll angle	Clockwise about the longitudinal axis	Roll(+) at the figure 1
Steering input	Counterclockwise rotation	-

* The forward direction of longitudinal acceleration for front side impact sensor may be different for each vehicle

Figure 1. Sign Conventions



Data Sources:

Many EDR data elements are sourced from other control modules in the vehicle.

1. Most of them can be measured and calculated by the ACU. For example, Delta-V and Rollover angle can be calculated from internal sensors in the ACU (if applicable).

2. The following pre-crash data can be transmitted to the ACU via the vehicle's communication network.
   - Vehicle Speed
   - Engine RPM
   - Engine Throttle
   - Acceleration Pedal
   - Service Brake
   - ABS Activity
   - Stability Control
   - Steering Input Angle

   *Note) Depending on the vehicle's configuration and the conditions described above, some items may not be recorded.

3. Pre-crash data is recorded in discrete intervals. Due to different refresh rates within the vehicle's electronics, the data recorded may be asynchronous to each other.

Data Limitation

Data Definitions:

- Data recorded by the ACU and imaged by the EDR tool is displayed relative to Time zero(T0). Time zero(T0) is not typically the time at which the vehicle made contact with another vehicle or object.
- Time zero (T0) means whichever of the following occurs first
  1. For systems with ''wake-up'' air bag control systems, the time at which the occupant restraint control algorithm is activated; or
  2. For continuously running algorithms,
     1) The first point in the interval where a longitudinal cumulative delta-V of over 0.8 km/h (0.5 mph) is reached within a 20msec time period; or
     2) For vehicles that record ''delta-V, lateral,'' the first point in the interval where a lateral cumulative delta-V of over 0.8 km/h (0.5 mph) is reached within a 5msec time period; or
  3. Deployment of a non-reversible deployable restraint.
- Multi-event crash means the occurrence of 2 events, the first and last of which begin not more than 5 seconds apart. If an event is not part of a multi-event crash, the value of this data element will be "1".
- Service brake, on or off means the status of the device that is installed in or connected to the brake pedal system to detect whether the pedal was pressed. The device can include the brake pedal switch or other driver-operated service brake control,
- Engine RPM means
  1. For vehicles powered by internal combustion engines, the number of revolutions per minute of the main crankshaft of the vehicle's engine, and
  2. For vehicles not entirely powered by internal combustion engines, the number of revolutions per minute of the motor shaft at the point at which it enters the vehicle transmission gearbox.
- Engine Throttle is a measure of the throttle position.
- Accelerator Pedal is a measure of the accelerator pedal value.
- Seat belt status is determined by whether the buckle switch is open or closed.
- Delta-V means the cumulative change in velocity, and is calculated from internal sensors in the ACU
- 'Invalid data' means
  1. The data sources sent invalid data
  2. The data sources did not send data
  3. The data does not be recorded depending on design standard
  4. The data could not be recorded in some conditions such as the loss of power in vehicle
- 'Not supported' means : The system is not applied in that vehicle

EDR Information

Part No. (EOL Code) as programmed into ACU	95910-CW000(HU01)
ECU SW Version as programmed into ACU	1.00
EDR Version as programmed into ACU	0422

< Event 1 >

Event Status at Event

Multi-event, Number of Event (1 or 2)	1 event
Time from Event 1 to 2 [msec]	0
Completed File Recorded (Yes or No)	YES
Ignition cycle, crash [cycle]	665
Ignition cycle, download [cycle]	667

Pre-Crash Information 1(-5 ~ 0 sec)

Time (sec)	Vehicle Speed [kph]	Engine RPM [rpm]	Engine Throttle [%]	Acceleration Pedal [%]	Master cylinder pressure [bar]	Service Brake [on/off]	ABS Activity [on/off]	Stability Control [on/off/engaged]	Steering Input [degree]
-5.0	80	1300	8	32	0.6	OFF	OFF	On	0
-4.5	80	1300	8	32	0.6	OFF	OFF	On	0
-4.0	80	1300	8	31	0.6	OFF	OFF	On	0
-3.5	80	1300	8	32	0.6	OFF	OFF	On	0
-3.0	80	1300	8	32	0.6	OFF	OFF	On	0
-2.5	80	1300	8	32	0.6	OFF	OFF	On	-5
-2.0	80	1300	8	32	0.6	OFF	OFF	On	0
-1.5	80	1300	8	32	0.6	OFF	OFF	On	0
-1.0	80	1300	8	32	0.6	OFF	OFF	On	0
-0.5	80	1300	8	31	0.6	OFF	OFF	On	-5
0.0	80	1300	2	16	0.9	OFF	OFF	Engaged	10

Pre-Crash Information 2 (-5 ~ 0 sec)

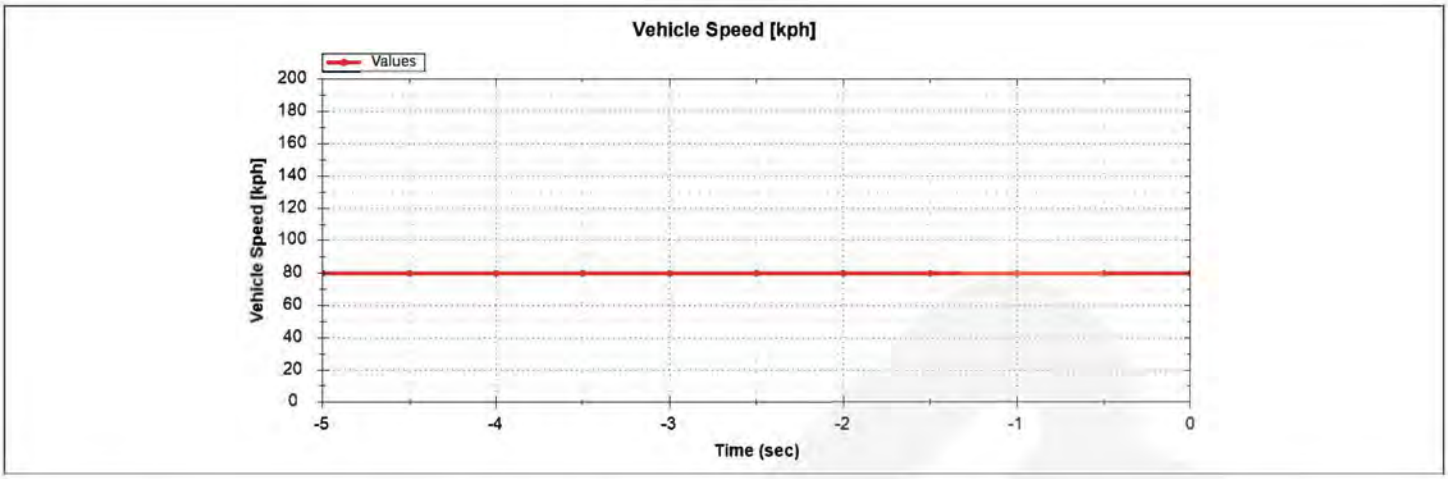
Time (sec)	Gear shift selector display	SCC information (Main switch status)	SCC information (Set Speed)	SCC information (SPEED UNIT)	SCC information (Mode status)	SCC information (Fail info)
-5.0	D	On	51	MPH	Engaged	System without Error
-4.5	D	On	51	MPH	Engaged	System without Error
-4.0	D	On	51	MPH	Engaged	System without Error
-3.5	D	On	51	MPH	Engaged	System without Error
-3.0	D	On	51	MPH	Engaged	System without Error
-2.5	D	On	51	MPH	Engaged	System without Error
-2.0	D	On	51	MPH	Engaged	System without Error
-1.5	D	On	51	MPH	Engaged	System without Error
-1.0	D	On	51	MPH	Engaged	System without Error
-0.5	D	On	51	MPH	Engaged	System without Error
0.0	D	On	51	MPH	Engaged	System without Error

Pre-Crash Information 3 (-5 ~ 0 sec)

Time (sec)	FCA (Function status)	FCA (Warning Level)	FCA (Fail info)	Time (sec).	FCA (Function status).	FCA (Warning Level).	FCA (Fail info).
-5.0	On	No Warning / Invalid or Not supported	Normal	-2.5	On	No Warning / Invalid or Not supported	Normal
-4.9	On	No Warning / Invalid or Not supported	Normal	-2.4	On	No Warning / Invalid or Not supported	Normal
-4.8	On	No Warning / Invalid or Not supported	Normal	-2.3	On	No Warning / Invalid or Not supported	Normal
-4.7	On	No Warning / Invalid or Not supported	Normal	-2.2	On	No Warning / Invalid or Not supported	Normal
-4.6	On	No Warning / Invalid or Not supported	Normal	-2.1	On	No Warning / Invalid or Not supported	Normal
-4.5	On	No Warning / Invalid or Not supported	Normal	-2.0	On	No Warning / Invalid or Not supported	Normal
-4.4	On	No Warning / Invalid or Not supported	Normal	-1.9	On	No Warning / Invalid or Not supported	Normal
-4.3	On	No Warning / Invalid or Not supported	Normal	-1.8	On	No Warning / Invalid or Not supported	Normal
-4.2	On	No Warning / Invalid or Not supported	Normal	-1.7	On	No Warning / Invalid or Not supported	Normal
-4.1	On	No Warning / Invalid or Not supported	Normal	-1.6	On	No Warning / Invalid or Not supported	Normal
-4.0	On	No Warning / Invalid or Not supported	Normal	-1.5	On	No Warning / Invalid or Not supported	Normal
-3.9	On	No Warning / Invalid or Not supported	Normal	-1.4	On	No Warning / Invalid or Not supported	Normal
-3.8	On	No Warning / Invalid or Not supported	Normal	-1.3	On	No Warning / Invalid or Not supported	Normal
-3.7	On	No Warning / Invalid or Not supported	Normal	-1.2	On	No Warning / Invalid or Not supported	Normal
-3.6	On	No Warning / Invalid or Not supported	Normal	-1.1	On	No Warning / Invalid or Not supported	Normal
-3.5	On	No Warning / Invalid or Not supported	Normal	-1.0	On	No Warning / Invalid or Not supported	Normal
-3.4	On	No Warning / Invalid or Not supported	Normal	-0.9	On	No Warning / Invalid or Not supported	Normal
-3.3	On	No Warning / Invalid or Not supported	Normal	-0.8	On	No Warning / Invalid or Not supported	Normal
-3.2	On	No Warning / Invalid or Not supported	Normal	-0.7	On	No Warning / Invalid or Not supported	Normal
-3.1	On	No Warning / Invalid or Not supported	Normal	-0.6	On	No Warning / Invalid or Not supported	Normal
-3.0	On	No Warning / Invalid or Not supported	Normal	-0.5	On	No Warning / Invalid or Not supported	Normal
-2.9	On	No Warning / Invalid or Not supported	Normal	-0.4	On	No Warning / Invalid or Not supported	Normal
-2.8	On	No Warning / Invalid or Not supported	Normal	-0.3	On	No Warning / Invalid or Not supported	Normal
-2.7	On	No Warning / Invalid or Not supported	Normal	-0.2	On	No Warning / Invalid or Not supported	Normal
-2.6	On	No Warning / Invalid or Not supported	Normal	-0.1	On	No Warning / Invalid or Not supported	Normal
-2.5	On	No Warning / Invalid or Not supported	Normal	0.0	On	No Warning / Invalid or Not supported	Normal

< Event 1 >

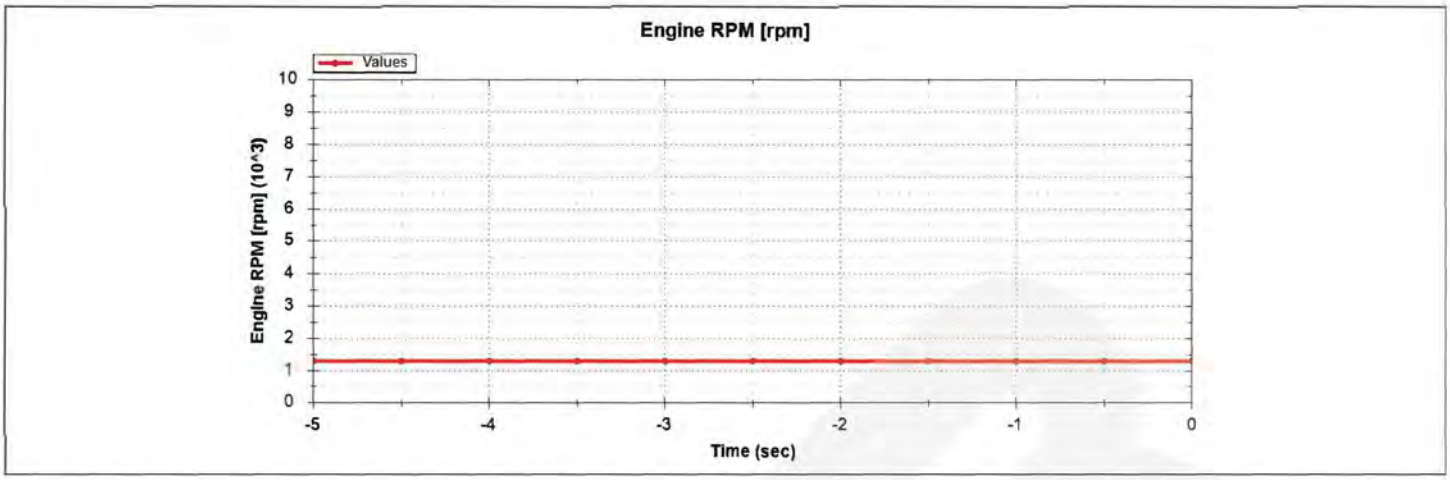
Vehicle Speed



Num	Time (sec)	Vehicle Speed [kph]
1	-5.0	80
2	-4.5	80
3	-4.0	80
4	-3.5	80
5	-3.0	80
6	-2.5	80
7	-2.0	80
8	-1.5	80
9	-1.0	80
10	-0.5	80
11	0.0	80

< Event 1 >

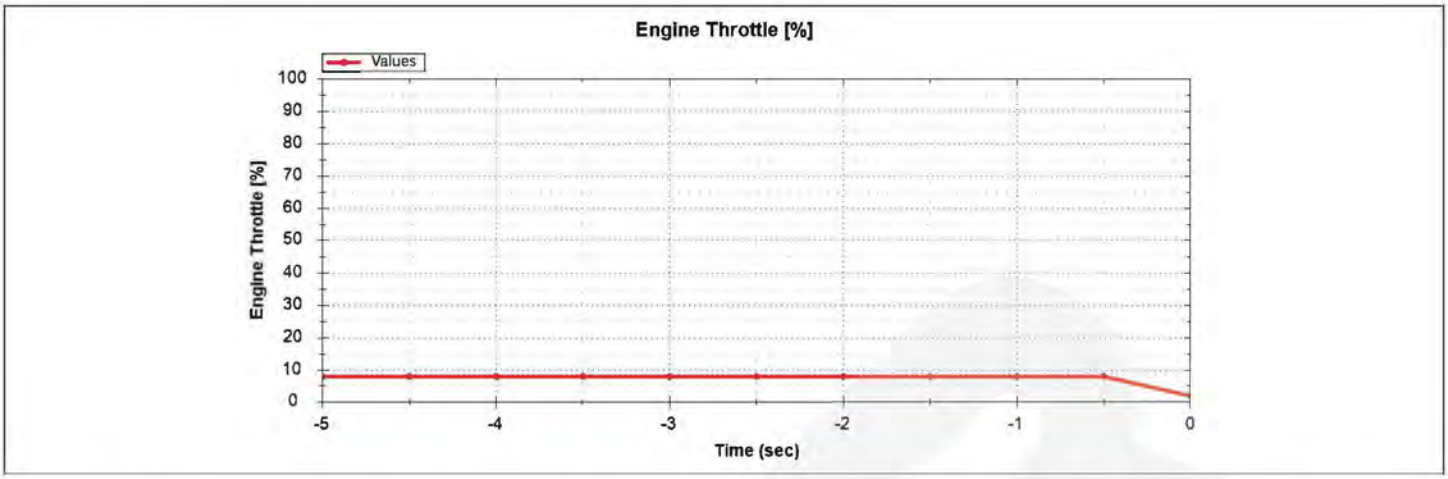
Engine RPM



Num	Time (sec)	Engine RPM [rpm]
1	-5.0	1300
2	-4.5	1300
3	-4.0	1300
4	-3.5	1300
5	-3.0	1300
6	-2.5	1300
7	-2.0	1300
8	-1.5	1300
9	-1.0	1300
10	-0.5	1300
11	0.0	1300

< Event 1 >

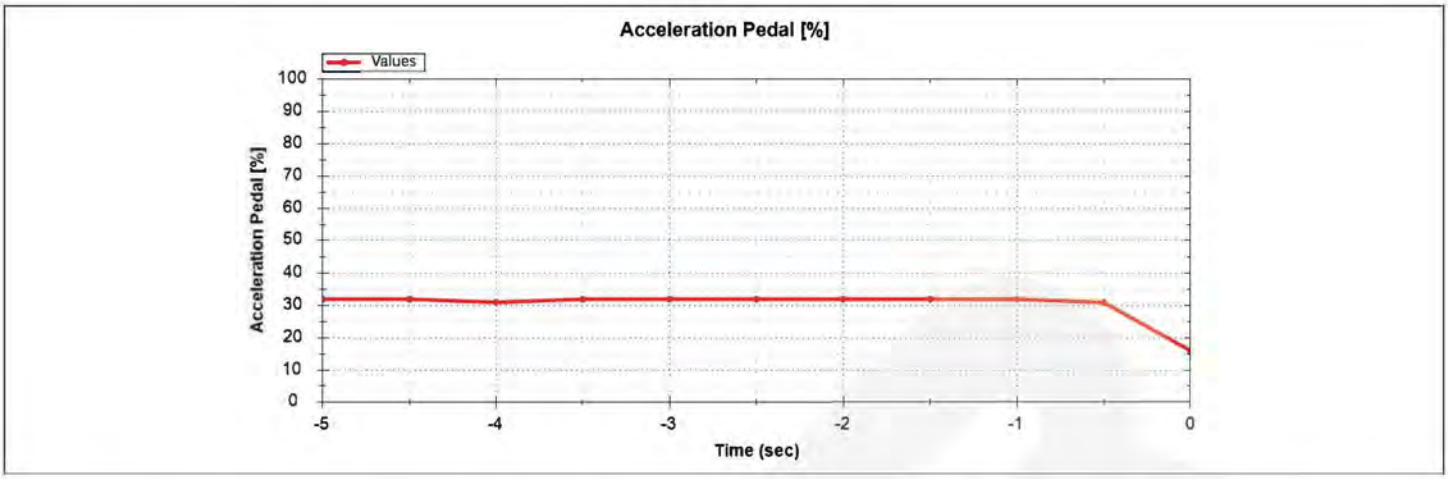
Engine Throttle



Num	Time (sec)	Engine Throttle [%]
1	-5.0	8
2	-4.5	8
3	-4.0	8
4	-3.5	8
5	-3.0	8
6	-2.5	8
7	-2.0	8
8	-1.5	8
9	-1.0	8
10	-0.5	8
11	0.0	2

< Event 1 >

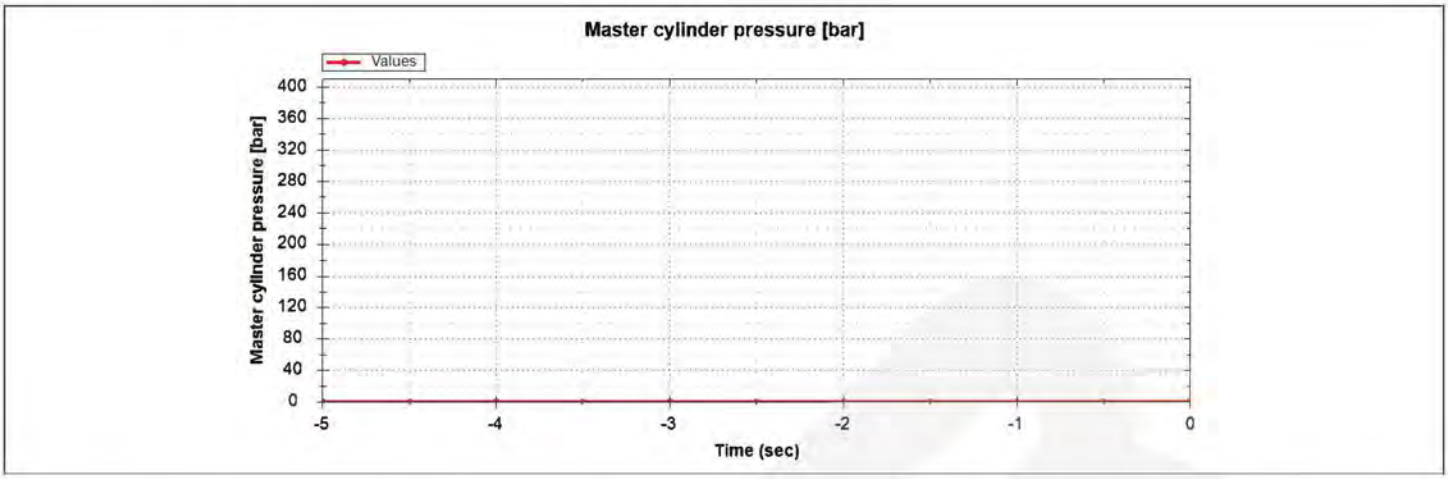
Acceleration Pedal



Num	Time (sec)	Acceleration Pedal [%]
1	-5.0	32
2	-4.5	32
3	-4.0	31
4	-3.5	32
5	-3.0	32
6	-2.5	32
7	-2.0	32
8	-1.5	32
9	-1.0	32
10	-0.5	31
11	0.0	16

< Event 1 >

Master cylinder pressure



Num	Time (sec)	Master cylinder pressure [bar]
1	-5.0	0.6
2	-4.5	0.6
3	-4.0	0.6
4	-3.5	0.6
5	-3.0	0.6
6	-2.5	0.6
7	-2.0	0.6
8	-1.5	0.6
9	-1.0	0.6
10	-0.5	0.6
11	0.0	0.9

< Event 1 >

Service Brake

Num	Time (sec)	Service Brake [on/off]
1	-5.0	OFF
2	-4.5	OFF
3	-4.0	OFF
4	-3.5	OFF
5	-3.0	OFF
6	-2.5	OFF
7	-2.0	OFF
8	-1.5	OFF
9	-1.0	OFF
10	-0.5	OFF
11	0.0	OFF

ABS Activity

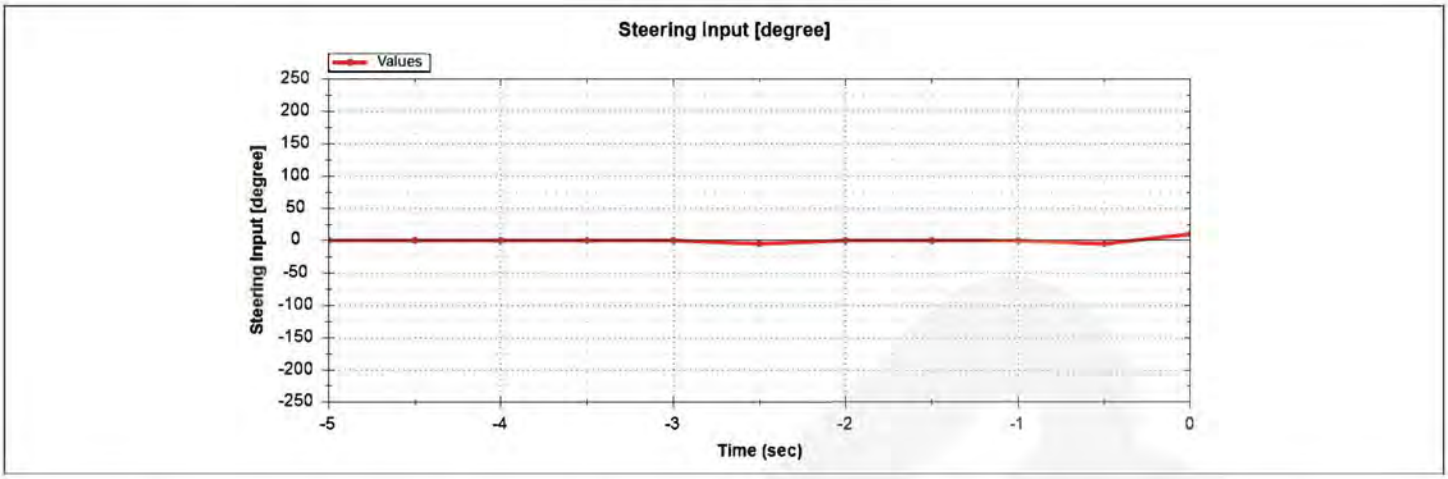
Num	Time (sec)	ABS Activity [on/off]
1	-5.0	OFF
2	-4.5	OFF
3	-4.0	OFF
4	-3.5	OFF
5	-3.0	OFF
6	-2.5	OFF
7	-2.0	OFF
8	-1.5	OFF
9	-1.0	OFF
10	-0.5	OFF
11	0.0	OFF

Stability Control

Num	Time (sec)	Stability Control [on/off/engaged]
1	-5.0	On
2	-4.5	On
3	-4.0	On
4	-3.5	On
5	-3.0	On
6	-2.5	On
7	-2.0	On
8	-1.5	On
9	-1.0	On
10	-0.5	On
11	0.0	Engaged

< Event 1 >

Steering Input



Num	Time (sec)	Steering Input [degree]
1	-5.0	0
2	-4.5	0
3	-4.0	0
4	-3.5	0
5	-3.0	0
6	-2.5	-5
7	-2.0	0
8	-1.5	0
9	-1.0	0
10	-0.5	-5
11	0.0	10

Note) Positive value(CCW), Negative value(CW)

< Event 1 >

System Status at Event

Airbag warning lamp on/off	OFF
Safety seat belt status, driver	ON
Safety seat belt status, passenger	OFF
Seat track position switch foremost status, driver	Not Supported
Seat track position switch foremost status, passenger	Not Supported
Occupant size classification, driver (5% female or larger)	Not Supported
Occupant size classification, passenger (child)	YES

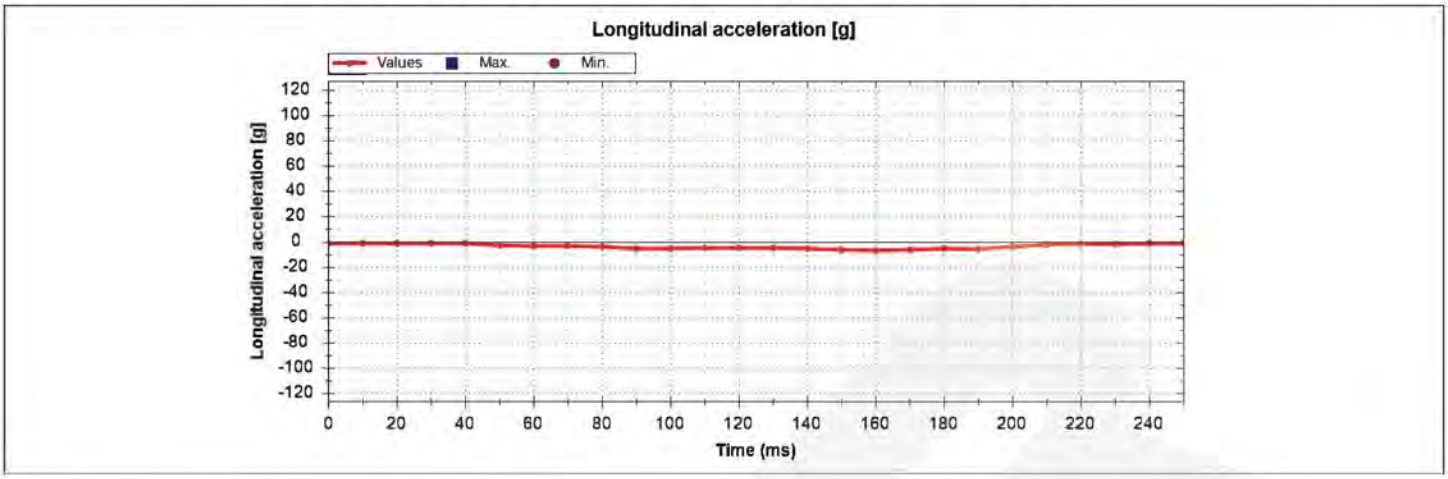
Deployment Command Data at Event

Front airbag deployment time, driver (first stage) [msec]	130
Front airbag deployment time, passenger (first stage) [msec]	No deployment
Front airbag deployment time, driver (second stage) [msec]	280
Front airbag deployment time, passenger (second stage) [msec]	No deployment
Front airbag deployment time, driver (third stage) [msec]	Not supported
Front airbag deployment time, passenger (third stage) [msec]	Not supported
Front airbag deployment time, passenger (4th stage) [msec]	Not supported
Front airbag disposal deployment, driver (second stage) (Yes or No)	YES
Front airbag disposal deployment, passenger (second stage) (Yes or No)	NO
Front airbag disposal deployment, driver (third stage) (Yes or No)	NO
Front airbag disposal deployment, passenger (third stage) (Yes or No)	NO
Front airbag disposal deployment, passenger (4th stage) (Yes or No)	NO
Knee airbag deployment time,driver [msec]	Not supported
Knee airbag deployment time,passenger [msec]	Not supported
Front side airbag deployment time, driver [msec]	No deployment
Front side airbag deployment time, passenger [msec]	No deployment
Rear side airbag deployment time,driver [msec]	Not supported
Rear side airbag deployment time,passenger [msec]	Not supported
Curtain airbag deployment time, driver [msec]	No deployment
Curtain airbag deployment time, passenger [msec]	No deployment
Rear curtain airbag deployment time,driver [msec]	Not supported
Rear curtain airbag deployment time,passenger [msec]	Not supported
Seat belt pretensioner deployment time, driver [msec]	130
Seat belt pretensioner deployment time, passenger [msec]	130
Rear belt pretensioner deployment time,driver [msec]	Not supported

Rear belt pretensioner deployment time,passenger [msec]	Not supported
Anchor pretensioner deployment time,driver [msec]	135
Anchor pretensioner deployment time,passenger [msec]	Not supported
Adaptive load limiter deployment time,driver [msec]	Not supported
Adaptive load limiter deployment time,passenger [msec]	Not supported
Front Center side airbag deployment time [msec]	Not supported

‹ Event 1 ›

Longitudinal crash pulse_acceleration (g, 0 ~ 250msec)

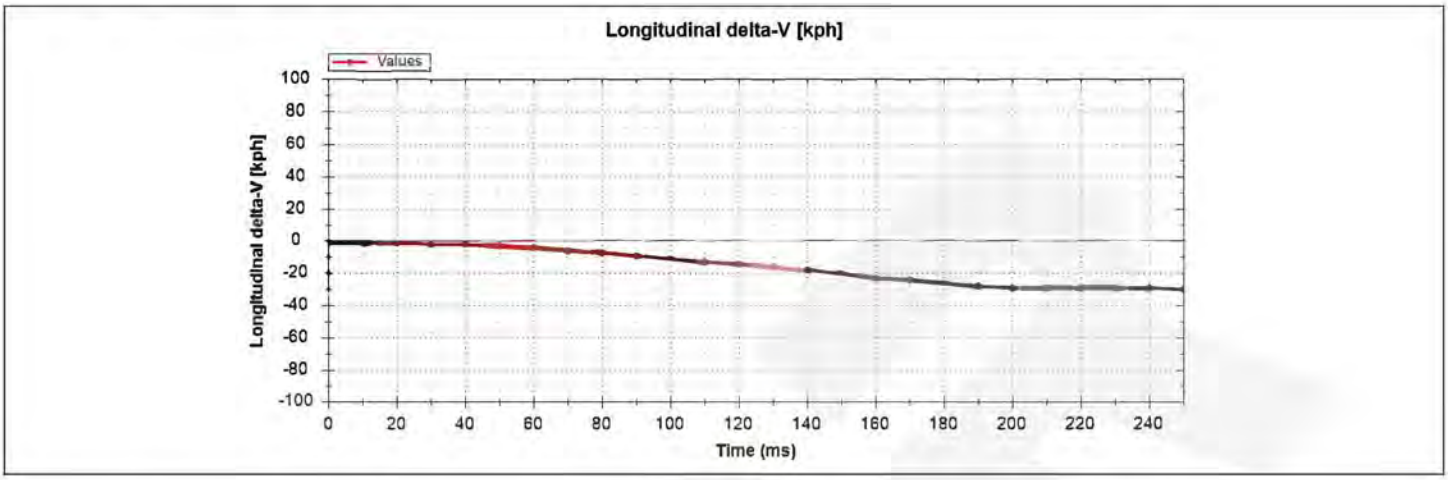


Num	Time (ms)	Longitudinal acceleration [g]
1	0.0	-1.0
2	10.0	-1.0
3	20.0	-1.0
4	30.0	-1.0
5	40.0	-1.0
6	50.0	-2.5
7	60.0	-3.0
8	70.0	-3.0
9	80.0	-3.5
10	90.0	-5.0
11	100.0	-5.0
12	110.0	-4.5
13	120.0	-4.5
14	130.0	-4.5
15	140.0	-5.0
16	150.0	-6.0
17	160.0	-6.5
18	170.0	-6.0
19	180.0	-5.0
20	190.0	-5.5
21	200.0	-3.5
22	210.0	-2.0
23	220.0	-1.5
24	230.0	-1.5
25	240.0	-1.0
26	250.0	-1.0

‹ Event 1 ›

Longitudinal crash pulse_delta-v (kph, 0 ~ 250msec)

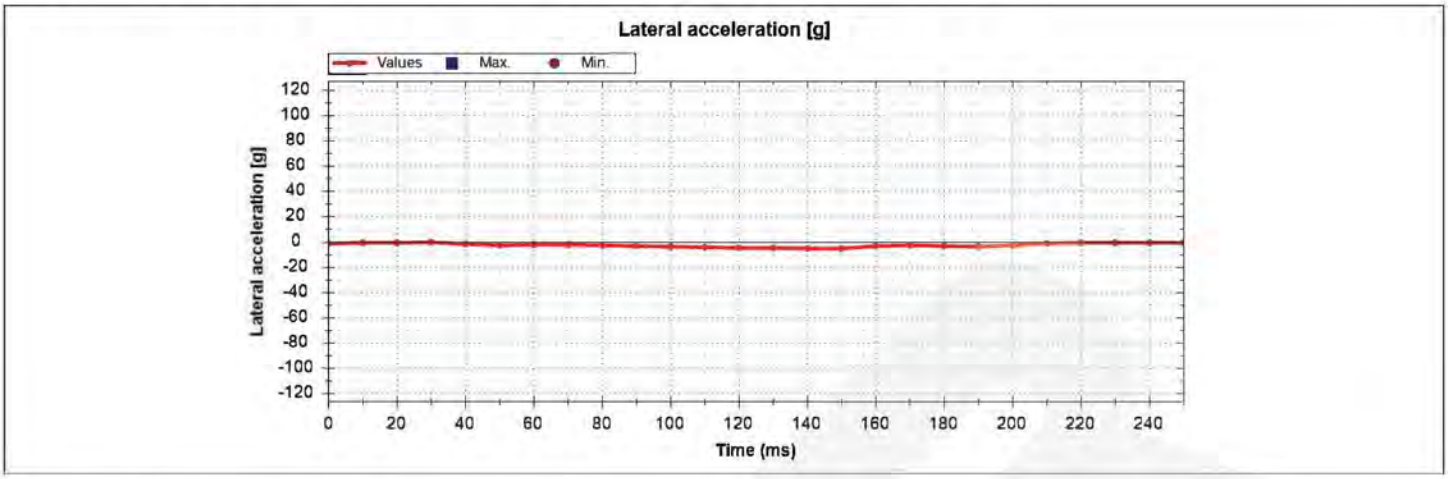
Max. delta-V [kph]	-33
Time, Max. delta-V [msec]	300.0



Num	Time (ms)	Longitudinal delta-V [kph]
1	0.0	-1
2	10.0	-1
3	20.0	-1
4	30.0	-2
5	40.0	-2
6	50.0	-3
7	60.0	-4
8	70.0	-6
9	80.0	-7
10	90.0	-9
11	100.0	-11
12	110.0	-13
13	120.0	-14
14	130.0	-16
15	140.0	-18
16	150.0	-20
17	160.0	-23
18	170.0	-24
19	180.0	-26
20	190.0	-28
21	200.0	-29
22	210.0	-29
23	220.0	-29
24	230.0	-29
25	240.0	-29
26	250.0	-30

< Event 1 >

Lateral crash pulse_acceleration (g, 0 ~ 250msec)

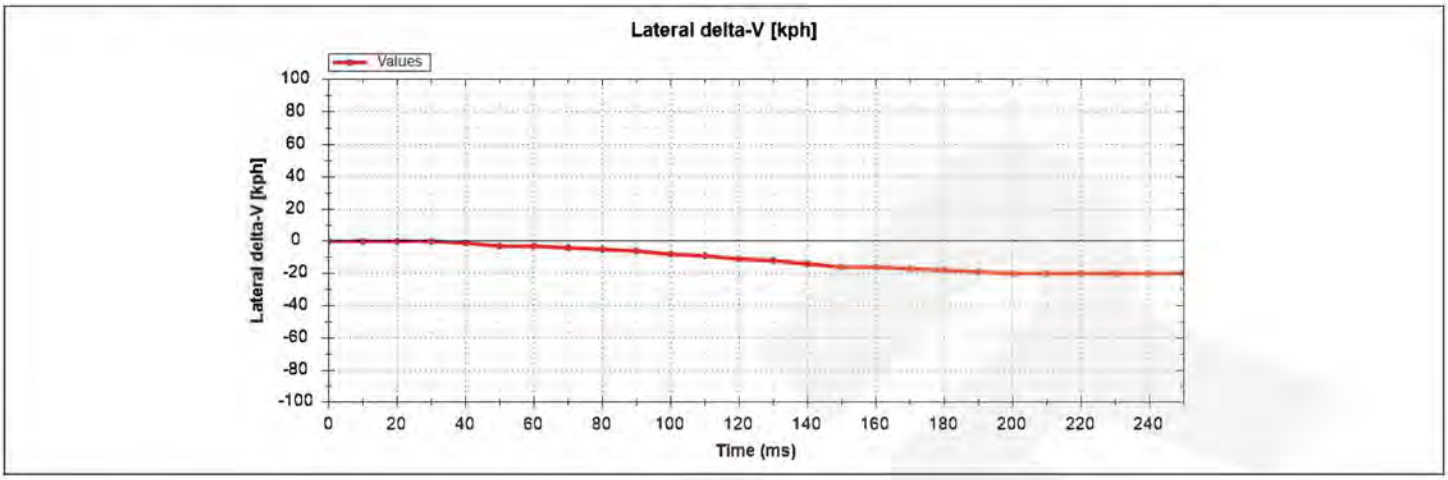


Num	Time (ms)	Lateral acceleration [g]
1	0.0	-1.0
2	10.0	-0.5
3	20.0	-0.5
4	30.0	0.0
5	40.0	-1.5
6	50.0	-2.5
7	60.0	-2.0
8	70.0	-2.0
9	80.0	-2.5
10	90.0	-3.0
11	100.0	-3.5
12	110.0	-4.0
13	120.0	-4.5
14	130.0	-4.5
15	140.0	-5.0
16	150.0	-5.0
17	160.0	-3.0
18	170.0	-2.5
19	180.0	-3.0
20	190.0	-3.5
21	200.0	-2.5
22	210.0	-1.0
23	220.0	-0.5
24	230.0	-0.5
25	240.0	-0.5
26	250.0	-0.5

< Event 1 >

Lateral crash pulse_delta-v (kph, 0 ~ 250msec)

Max. delta-V [kph]	-21
Time, Max. delta-V [msec]	265.0



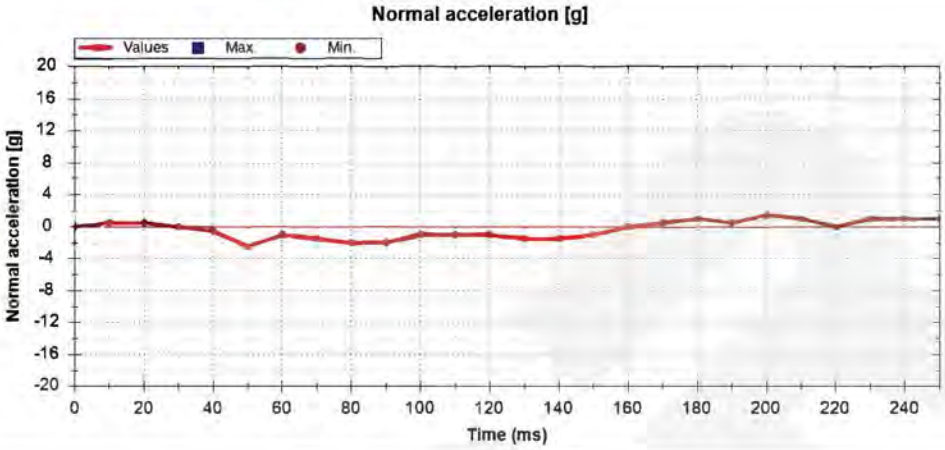
Num	Time (ms)	Lateral delta-V [kph]
1	0.0	0
2	10.0	0
3	20.0	0
4	30.0	0
5	40.0	-1
6	50.0	-3
7	60.0	-3
8	70.0	-4
9	80.0	-5
10	90.0	-6
11	100.0	-8
12	110.0	-9
13	120.0	-11
14	130.0	-12
15	140.0	-14
16	150.0	-16
17	160.0	-16
18	170.0	-17
19	180.0	-18
20	190.0	-19
21	200.0	-20
22	210.0	-20
23	220.0	-20
24	230.0	-20
25	240.0	-20
26	250.0	-20

< Event 1 >

Crash pulse Resultant, Time_Max. delta-V resultant (0 ~ 300 msec)

Time, Max. delta-V, resultant [msec]	300.0

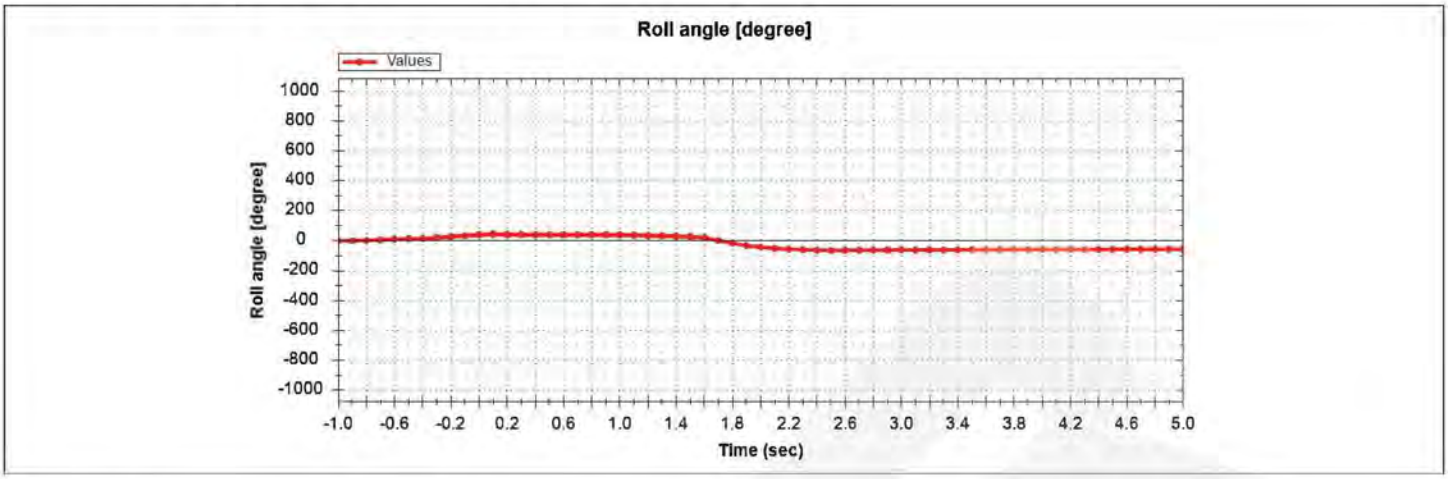
Normal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Normal acceleration [g]
1	0.0	0.0
2	10.0	0.5
3	20.0	0.5
4	30.0	0.0
5	40.0	-0.5
6	50.0	-2.5
7	60.0	-1.0
8	70.0	-1.5
9	80.0	-2.0
10	90.0	-2.0
11	100.0	-1.0
12	110.0	-1.0
13	120.0	-1.0
14	130.0	-1.5
15	140.0	-1.5
16	150.0	-1.0
17	160.0	0.0
18	170.0	0.5
19	180.0	1.0
20	190.0	0.5
21	200.0	1.5
22	210.0	1.0
23	220.0	0.0
24	230.0	1.0
25	240.0	1.0
26	250.0	1.0

< Event 1 >

Roll angle (degree, -1 ~ 5sec)

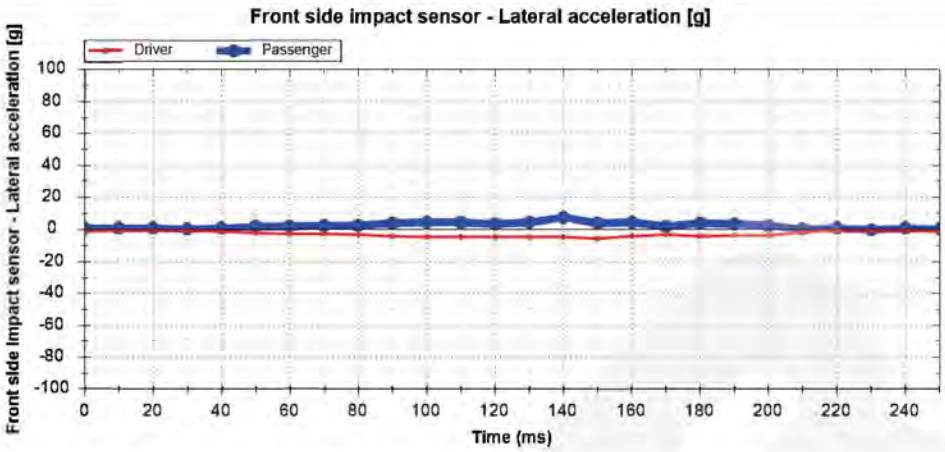


Num	Time (sec)	Roll angle [degree]
1	-1.0	1
2	-0.9	2
3	-0.8	4
4	-0.7	7
5	-0.6	12
6	-0.5	15
7	-0.4	16
8	-0.3	21
9	-0.2	27
10	-0.1	33
11	0.0	39
12	0.1	43
13	0.2	41
14	0.3	40
15	0.4	40
16	0.5	39
17	0.6	39
18	0.7	39
19	0.8	39
20	0.9	39
21	1.0	38
22	1.1	37
23	1.2	34
24	1.3	32
25	1.4	29
26	1.5	26
27	1.6	21
28	1.7	3
29	1.8	-14
30	1.9	-31
31	2.0	-41

32	2.1	-49
33	2.2	-55
34	2.3	-58
35	2.4	-61
36	2.5	-63
37	2.6	-62
38	2.7	-61
39	2.8	-61
40	2.9	-61
41	3.0	-60
42	3.1	-60
43	3.2	-60
44	3.3	-60
45	3.4	-59
46	3.5	-59
47	3.6	-59
48	3.7	-58
49	3.8	-57
50	3.9	-57
51	4.0	-57
52	4.1	-57
53	4.2	-57
54	4.3	-57
55	4.4	-57
56	4.5	-56
57	4.6	-56
58	4.7	-55
59	4.8	-55
60	4.9	-55
61	5.0	-55

‹ Event 1 ›

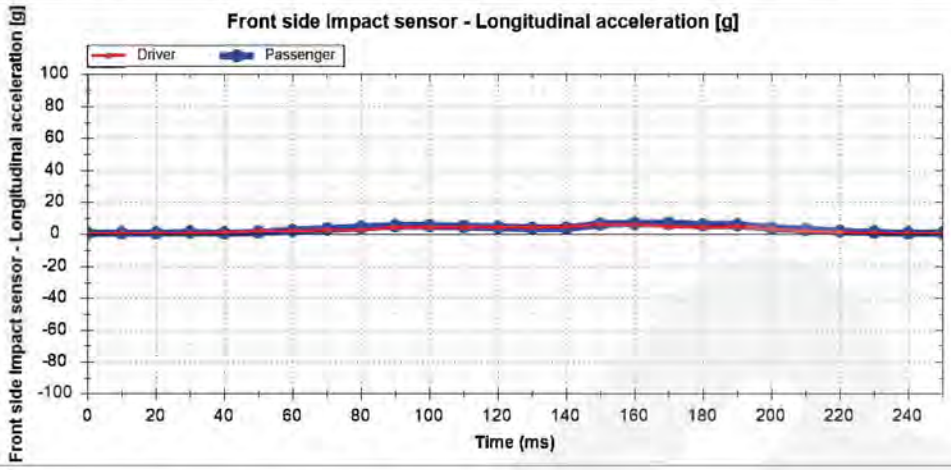
Front side impact sensor - Lateral acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Front driver side impact sensor - Lateral acceleration [g]	Front passenger side impact sensor - Lateral acceleration [g]
1	0.0	-0.5	1.0
2	10.0	-0.5	1.0
3	20.0	-0.5	1.0
4	30.0	-0.5	0.5
5	40.0	-1.0	1.0
6	50.0	-2.0	2.0
7	60.0	-2.5	2.0
8	70.0	-2.5	2.5
9	80.0	-3.0	2.5
10	90.0	-4.0	4.0
11	100.0	-4.5	4.5
12	110.0	-4.5	4.5
13	120.0	-4.5	3.5
14	130.0	-4.5	4.5
15	140.0	-4.5	7.5
16	150.0	-5.5	4.0
17	160.0	-4.0	4.5
18	170.0	-3.0	2.0
19	180.0	-4.0	4.0
20	190.0	-3.5	3.5
21	200.0	-3.5	2.5
22	210.0	-1.5	0.5
23	220.0	-0.5	1.0
24	230.0	-0.5	0.0
25	240.0	-0.5	1.0
26	250.0	-1.0	0.5

< Event 1 >

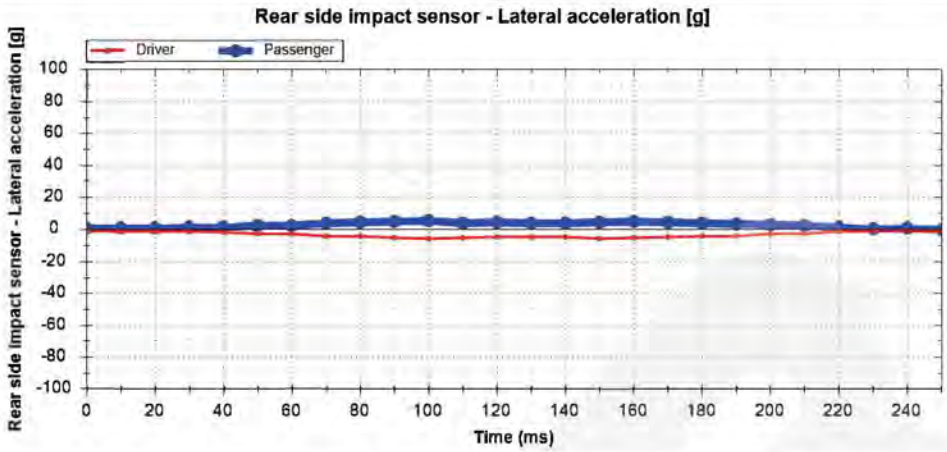
Front side Impact sensor - Longitudinal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Front driver side Impact sensor - Longitudinal acceleration [g]	Front passenger side Impact sensor - Longitudinal acceleration [g]
1	0.0	1.0	1.0
2	10.0	1.0	1.0
3	20.0	1.0	1.0
4	30.0	1.0	1.5
5	40.0	1.5	1.0
6	50.0	2.5	1.5
7	60.0	2.5	2.5
8	70.0	3.0	3.5
9	80.0	3.0	4.5
10	90.0	4.5	5.5
11	100.0	4.5	5.5
12	110.0	4.5	5.0
13	120.0	4.5	4.5
14	130.0	4.5	4.0
15	140.0	5.0	4.0
16	150.0	6.0	6.5
17	160.0	6.0	7.0
18	170.0	5.0	7.0
19	180.0	4.5	6.0
20	190.0	5.0	6.0
21	200.0	3.5	4.0
22	210.0	2.0	3.0
23	220.0	1.5	2.0
24	230.0	1.0	1.5
25	240.0	1.0	1.0
26	250.0	1.0	1.0

‹ Event 1 ›

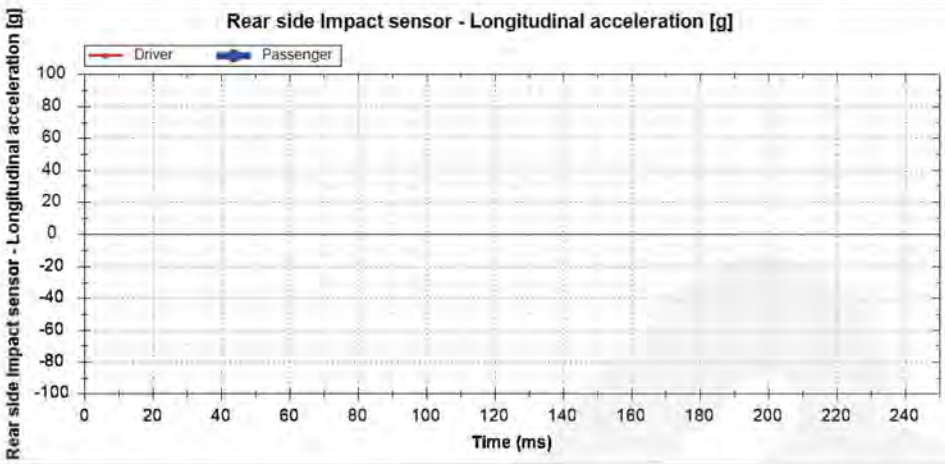
Rear side impact sensor – Lateral acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Rear driver side impact sensor – Lateral acceleration [g]	Rear passenger side impact sensor – Lateral acceleration [g]
1	0.0	-0.5	1.0
2	10.0	-1.0	1.0
3	20.0	-1.0	1.0
4	30.0	-1.0	1.5
5	40.0	-1.5	1.5
6	50.0	-2.5	2.5
7	60.0	-2.5	2.5
8	70.0	-4.0	4.0
9	80.0	-4.0	4.5
10	90.0	-5.0	5.0
11	100.0	-5.5	5.5
12	110.0	-5.0	4.0
13	120.0	-4.5	4.5
14	130.0	-4.5	4.0
15	140.0	-4.5	4.0
16	150.0	-5.5	4.5
17	160.0	-5.0	5.0
18	170.0	-4.5	4.5
19	180.0	-4.0	4.0
20	190.0	-4.0	3.5
21	200.0	-2.5	3.0
22	210.0	-2.5	2.5
23	220.0	-1.0	1.5
24	230.0	-0.5	0.5
25	240.0	-0.5	1.0
26	250.0	-1.0	0.0

< Event 1 >

Rear side Impact sensor - Longitudinal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Rear driver side Impact sensor - Longitudinal acceleration [g]	Rear passenger side Impact sensor - Longitudinal acceleration [g]
1	0.0	Not supported	Not supported
2	10.0	Not supported	Not supported
3	20.0	Not supported	Not supported
4	30.0	Not supported	Not supported
5	40.0	Not supported	Not supported
6	50.0	Not supported	Not supported
7	60.0	Not supported	Not supported
8	70.0	Not supported	Not supported
9	80.0	Not supported	Not supported
10	90.0	Not supported	Not supported
11	100.0	Not supported	Not supported
12	110.0	Not supported	Not supported
13	120.0	Not supported	Not supported
14	130.0	Not supported	Not supported
15	140.0	Not supported	Not supported
16	150.0	Not supported	Not supported
17	160.0	Not supported	Not supported
18	170.0	Not supported	Not supported
19	180.0	Not supported	Not supported
20	190.0	Not supported	Not supported
21	200.0	Not supported	Not supported
22	210.0	Not supported	Not supported
23	220.0	Not supported	Not supported
24	230.0	Not supported	Not supported
25	240.0	Not supported	Not supported
26	250.0	Not supported	Not supported

‹ Event 1 ›

Raw Data

Hexadecimal deleted due to potential personally identifiable information

< Event 2 >

Event Status at Event

Multi-event, Number of Event (1 or 2)	1 event
Time from Event 1 to 2 [msec]	0
Completed File Recorded (Yes or No)	YES
Ignition cycle, crash [cycle]	665
Ignition cycle, download [cycle]	667

Pre-Crash Information 1(-5 ~ 0 sec)

Time (sec)	Vehicle Speed [kph]	Engine RPM [rpm]	Engine Throttle [%]	Acceleration Pedal [%]	Master cylinder pressure [bar]	Service Brake [on/off]	ABS Activity [on/off]	Stability Control [on/off/engaged]	Steering Input [degree]
-5.0	80	1300	8	32	0.6	OFF	OFF	On	0
-4.5	80	1300	8	32	0.6	OFF	OFF	On	0
-4.0	80	1300	8	32	0.6	OFF	OFF	On	-5
-3.5	80	1300	8	32	0.6	OFF	OFF	On	0
-3.0	80	1300	8	32	0.6	OFF	OFF	On	0
-2.5	80	1300	8	32	0.6	OFF	OFF	On	0
-2.0	80	1300	8	31	0.6	OFF	OFF	On	-5
-1.5	80	1300	2	16	0.9	OFF	OFF	Engaged	10
-1.0	54	1000	1	0	15.1	On	OFF	Engaged	-85
-0.5	25	1200	36	100	1.5	OFF	OFF	Engaged	250
0.0	24	2400	0	0	0.2	OFF	OFF	Engaged	30

Pre-Crash Information 2 (-5 ~ 0 sec)

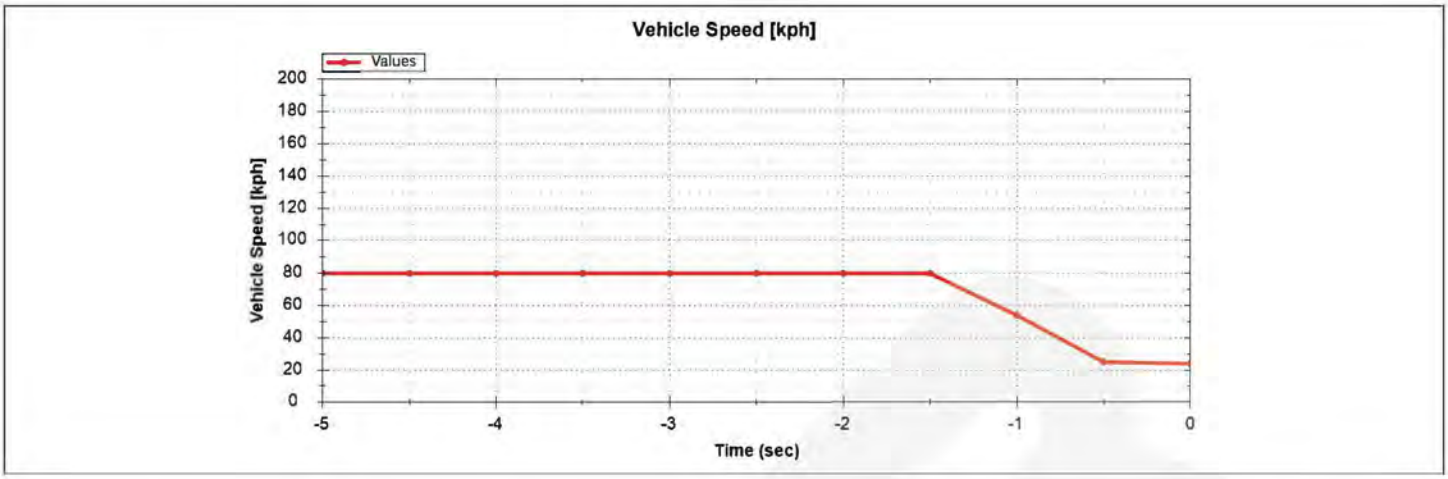
Time (sec)	Gear shift selector display	SCC information (Main switch status)	SCC information (Set Speed)	SCC information (SPEED UNIT)	SCC information (Mode status)	SCC information (Fail info)
-5.0	D	On	51	MPH	Engaged	System without Error
-4.5	D	On	51	MPH	Engaged	System without Error
-4.0	D	On	51	MPH	Engaged	System without Error
-3.5	D	On	51	MPH	Engaged	System without Error
-3.0	D	On	51	MPH	Engaged	System without Error
-2.5	D	On	51	MPH	Engaged	System without Error
-2.0	D	On	51	MPH	Engaged	System without Error
-1.5	D	On	51	MPH	Engaged	System without Error
-1.0	D	On	51	MPH	Canceled	System without Error
-0.5	D	On	51	MPH	Canceled	System without Error
0.0	D	On	51	MPH	Canceled	System without Error

Pre-Crash Information 3 (-5 ~ 0 sec)

Time (sec)	FCA (Function status)	FCA (Warning Level)	FCA (Fail info)	Time (sec).	FCA (Function status).	FCA (Warning Level).	FCA (Fail info).
-5.0	On	No Warning / Invalid or Not supported	Normal	-2.5	On	No Warning / Invalid or Not supported	Normal
-4.9	On	No Warning / Invalid or Not supported	Normal	-2.4	On	No Warning / Invalid or Not supported	Normal
-4.8	On	No Warning / Invalid or Not supported	Normal	-2.3	On	No Warning / Invalid or Not supported	Normal
-4.7	On	No Warning / Invalid or Not supported	Normal	-2.2	On	No Warning / Invalid or Not supported	Normal
-4.6	On	No Warning / Invalid or Not supported	Normal	-2.1	On	No Warning / Invalid or Not supported	Normal
-4.5	On	No Warning / Invalid or Not supported	Normal	-2.0	On	No Warning / Invalid or Not supported	Normal
-4.4	On	No Warning / Invalid or Not supported	Normal	-1.9	On	No Warning / Invalid or Not supported	Normal
-4.3	On	No Warning / Invalid or Not supported	Normal	-1.8	On	No Warning / Invalid or Not supported	Normal
-4.2	On	No Warning / Invalid or Not supported	Normal	-1.7	On	No Warning / Invalid or Not supported	Normal
-4.1	On	No Warning / Invalid or Not supported	Normal	-1.6	On	No Warning / Invalid or Not supported	Normal
-4.0	On	No Warning / Invalid or Not supported	Normal	-1.5	On	No Warning / Invalid or Not supported	Normal
-3.9	On	No Warning / Invalid or Not supported	Normal	-1.4	On	No Warning / Invalid or Not supported	Normal
-3.8	On	No Warning / Invalid or Not supported	Normal	-1.3	On	No Warning / Invalid or Not supported	Normal
-3.7	On	No Warning / Invalid or Not supported	Normal	-1.2	On	No Warning / Invalid or Not supported	Normal
-3.6	On	No Warning / Invalid or Not supported	Normal	-1.1	On	No Warning / Invalid or Not supported	Normal
-3.5	On	No Warning / Invalid or Not supported	Normal	-1.0	On	No Warning / Invalid or Not supported	Normal
-3.4	On	No Warning / Invalid or Not supported	Normal	-0.9	On	No Warning / Invalid or Not supported	Normal
-3.3	On	No Warning / Invalid or Not supported	Normal	-0.8	On	No Warning / Invalid or Not supported	Normal
-3.2	On	No Warning / Invalid or Not supported	Normal	-0.7	On	No Warning / Invalid or Not supported	Normal
-3.1	On	No Warning / Invalid or Not supported	Normal	-0.6	On	No Warning / Invalid or Not supported	Normal
-3.0	On	No Warning / Invalid or Not supported	Normal	-0.5	On	No Warning / Invalid or Not supported	Normal
-2.9	On	No Warning / Invalid or Not supported	Normal	-0.4	On	No Warning / Invalid or Not supported	Normal
-2.8	On	No Warning / Invalid or Not supported	Normal	-0.3	On	No Warning / Invalid or Not supported	Normal
-2.7	On	No Warning / Invalid or Not supported	Normal	-0.2	On	No Warning / Invalid or Not supported	Normal
-2.6	On	No Warning / Invalid or Not supported	Normal	-0.1	On	No Warning / Invalid or Not supported	Normal
-2.5	On	No Warning / Invalid or Not supported	Normal	0.0	On	No Warning / Invalid or Not supported	Normal

< Event 2 >

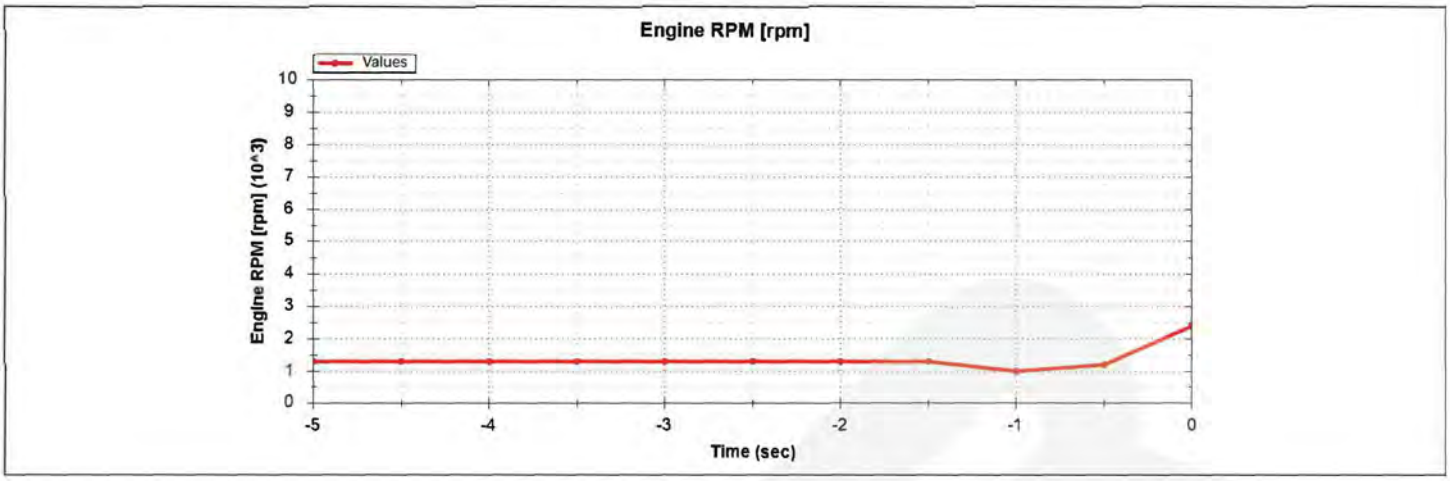
Vehicle Speed



Num	Time (sec)	Vehicle Speed [kph]
1	-5.0	80
2	-4.5	80
3	-4.0	80
4	-3.5	80
5	-3.0	80
6	-2.5	80
7	-2.0	80
8	-1.5	80
9	-1.0	54
10	-0.5	25
11	0.0	24

< Event 2 >

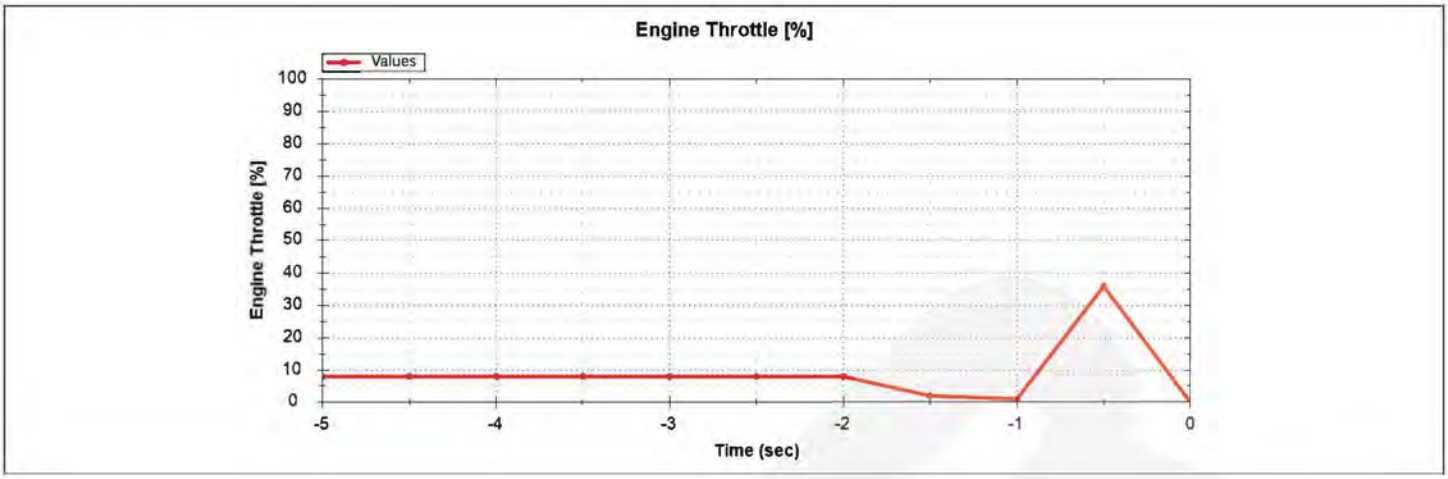
Engine RPM



Num	Time (sec)	Engine RPM [rpm]
1	-5.0	1300
2	-4.5	1300
3	-4.0	1300
4	-3.5	1300
5	-3.0	1300
6	-2.5	1300
7	-2.0	1300
8	-1.5	1300
9	-1.0	1000
10	-0.5	1200
11	0.0	2400

< Event 2 >

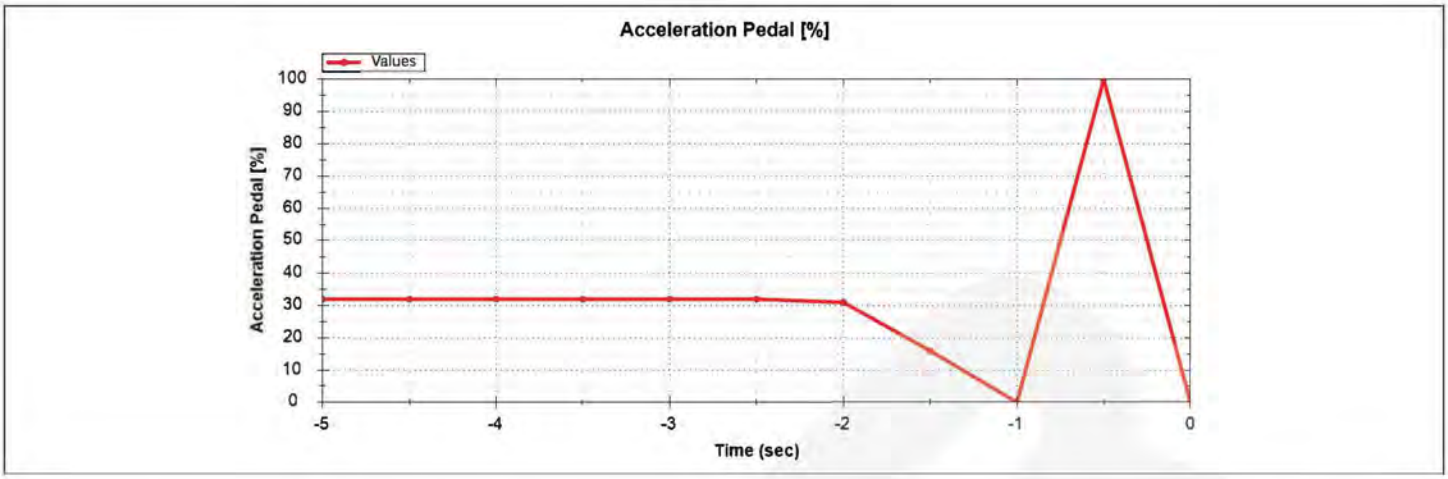
Engine Throttle



Num	Time (sec)	Engine Throttle [%]
1	-5.0	8
2	-4.5	8
3	-4.0	8
4	-3.5	8
5	-3.0	8
6	-2.5	8
7	-2.0	8
8	-1.5	2
9	-1.0	1
10	-0.5	36
11	0.0	0

< Event 2 >

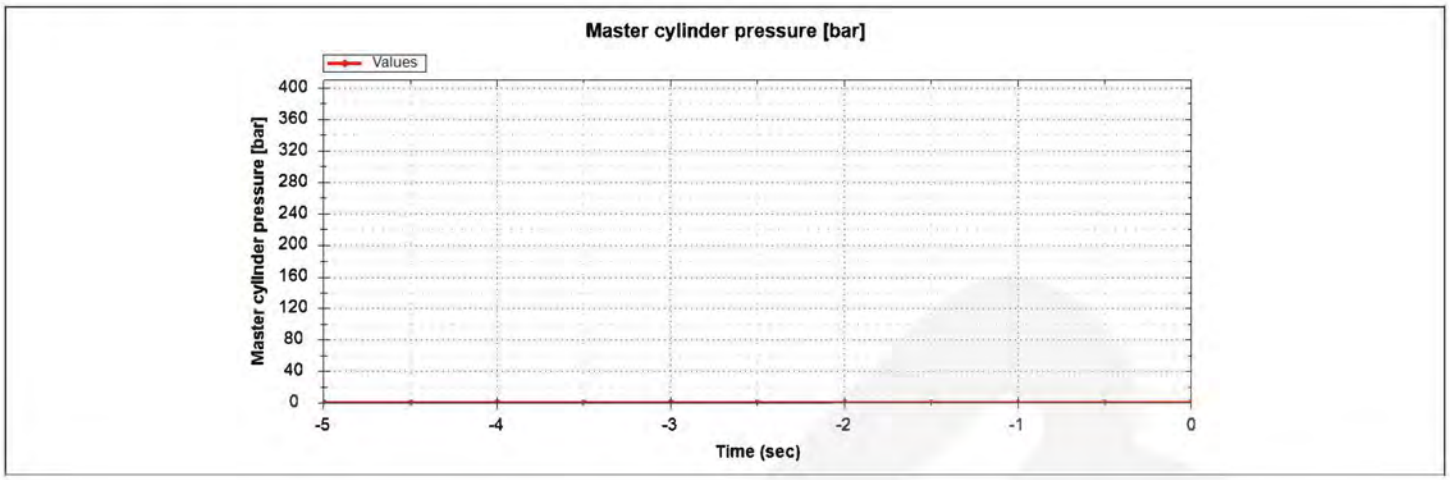
Acceleration Pedal



Num	Time (sec)	Acceleration Pedal [%]
1	-5.0	32
2	-4.5	32
3	-4.0	32
4	-3.5	32
5	-3.0	32
6	-2.5	32
7	-2.0	31
8	-1.5	16
9	-1.0	0
10	-0.5	100
11	0.0	0

‹ Event 2 ›

Master cylinder pressure



< Event 2 >

Service Brake

Num	Time (sec)	Service Brake [on/off]
1	-5.0	OFF
2	-4.5	OFF
3	-4.0	OFF
4	-3.5	OFF
5	-3.0	OFF
6	-2.5	OFF
7	-2.0	OFF
8	-1.5	OFF
9	-1.0	ON
10	-0.5	OFF
11	0.0	OFF

ABS Activity

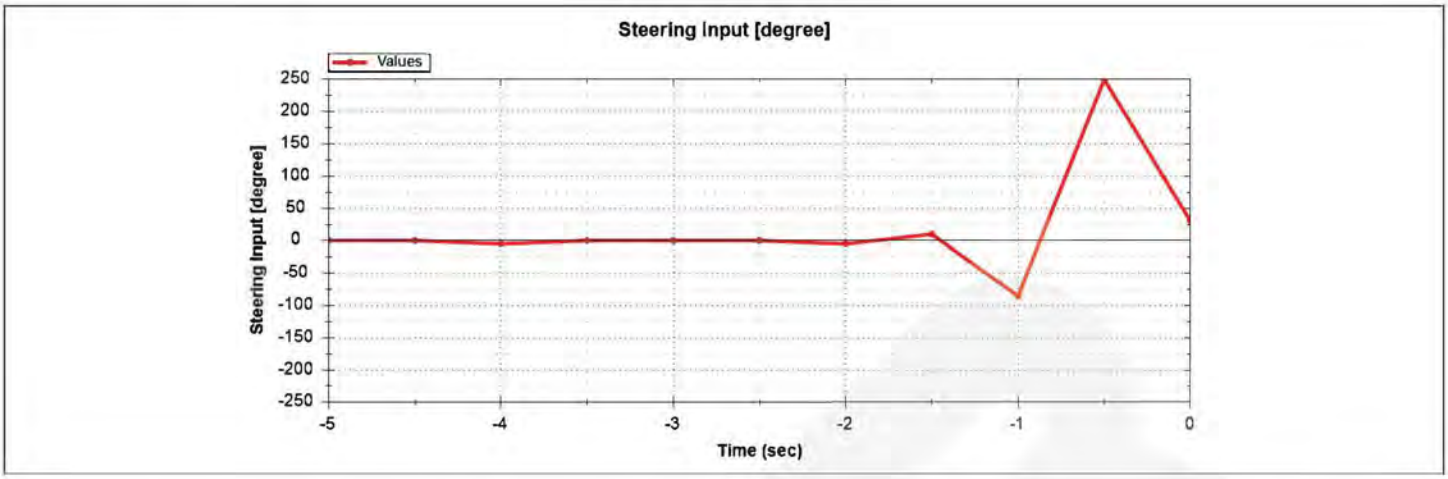
Num	Time (sec)	ABS Activity [on/off]
1	-5.0	OFF
2	-4.5	OFF
3	-4.0	OFF
4	-3.5	OFF
5	-3.0	OFF
6	-2.5	OFF
7	-2.0	OFF
8	-1.5	OFF
9	-1.0	OFF
10	-0.5	OFF
11	0.0	OFF

Stability Control

Num	Time (sec)	Stability Control [on/off/engaged]
1	-5.0	ON
2	-4.5	ON
3	-4.0	ON
4	-3.5	ON
5	-3.0	ON
6	-2.5	ON
7	-2.0	ON
8	-1.5	Engaged
9	-1.0	Engaged
10	-0.5	Engaged
11	0.0	Engaged

< Event 2 >

Steering Input



Num	Time (sec)	Steering Input [degree]
1	-5.0	0
2	-4.5	0
3	-4.0	-5
4	-3.5	0
5	-3.0	0
6	-2.5	0
7	-2.0	-5
8	-1.5	10
9	-1.0	-85
10	-0.5	250
11	0.0	30

Note) Positive value(CCW), Negative value(CW)

< Event 2 >

System Status at Event

Airbag warning lamp on/off	ON
Safety seat belt status, driver	ON
Safety seat belt status, passenger	OFF
Seat track position switch foremost status, driver	Not Supported
Seat track position switch foremost status, passenger	Not Supported
Occupant size classification, driver (5% female or larger)	Not Supported
Occupant size classification, passenger (child)	YES

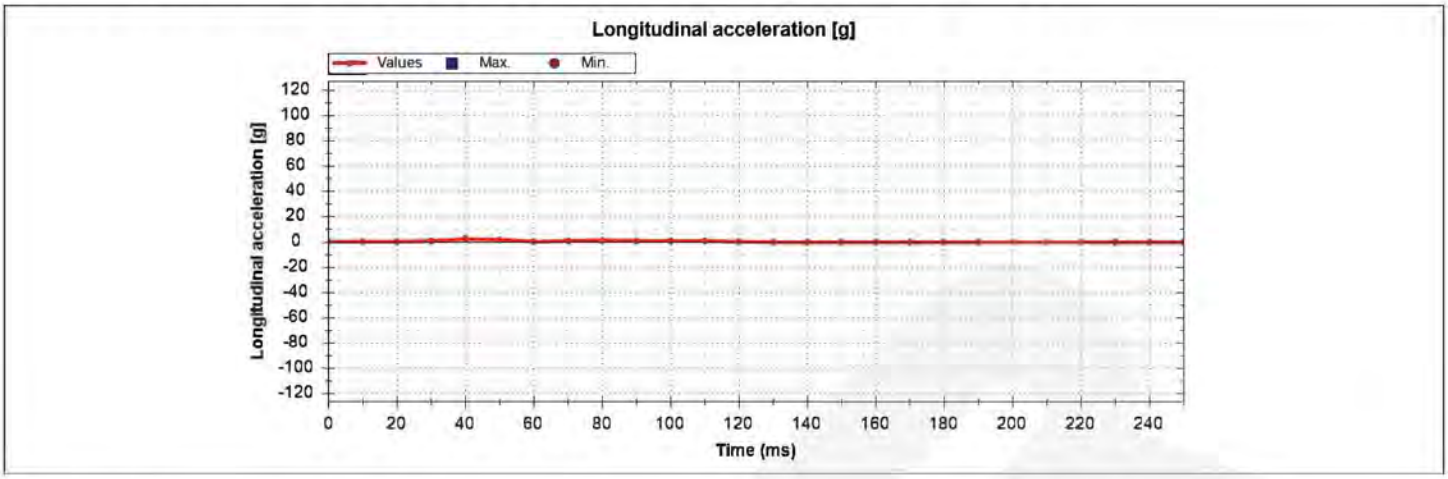
Deployment Command Data at Event

Front airbag deployment time, driver (first stage) [msec]	No deployment
Front airbag deployment time, passenger (first stage) [msec]	No deployment
Front airbag deployment time, driver (second stage) [msec]	No deployment
Front airbag deployment time, passenger (second stage) [msec]	No deployment
Front airbag deployment time, driver (third stage) [msec]	Not supported
Front airbag deployment time, passenger (third stage) [msec]	Not supported
Front airbag deployment time, passenger (4th stage) [msec]	Not supported
Front airbag disposal deployment, driver (second stage) (Yes or No)	NO
Front airbag disposal deployment, passenger (second stage) (Yes or No)	NO
Front airbag disposal deployment, driver (third stage) (Yes or No)	NO
Front airbag disposal deployment, passenger (third stage) (Yes or No)	NO
Front airbag disposal deployment, passenger (4th stage) (Yes or No)	NO
Knee airbag deployment time,driver [msec]	Not supported
Knee airbag deployment time,passenger [msec]	Not supported
Front side airbag deployment time, driver [msec]	2
Front side airbag deployment time, passenger [msec]	348
Rear side airbag deployment time,driver [msec]	Not supported
Rear side airbag deployment time,passenger [msec]	Not supported
Curtain airbag deployment time, driver [msec]	2
Curtain airbag deployment time, passenger [msec]	348
Rear curtain airbag deployment time,driver [msec]	Not supported
Rear curtain airbag deployment time,passenger [msec]	Not supported
Seat belt pretensioner deployment time, driver [msec]	2
Seat belt pretensioner deployment time, passenger [msec]	2
Rear belt pretensioner deployment time,driver [msec]	Not supported

Rear belt pretensioner deployment time,passenger [msec]	Not supported
Anchor pretensioner deployment time,driver [msec]	348
Anchor pretensioner deployment time,passenger [msec]	Not supported
Adaptive load limiter deployment time,driver [msec]	Not supported
Adaptive load limiter deployment time,passenger [msec]	Not supported
Front Center side airbag deployment time [msec]	Not supported

‹ Event 2 ›

Longitudinal crash pulse_acceleration (g, 0 ~ 250msec)

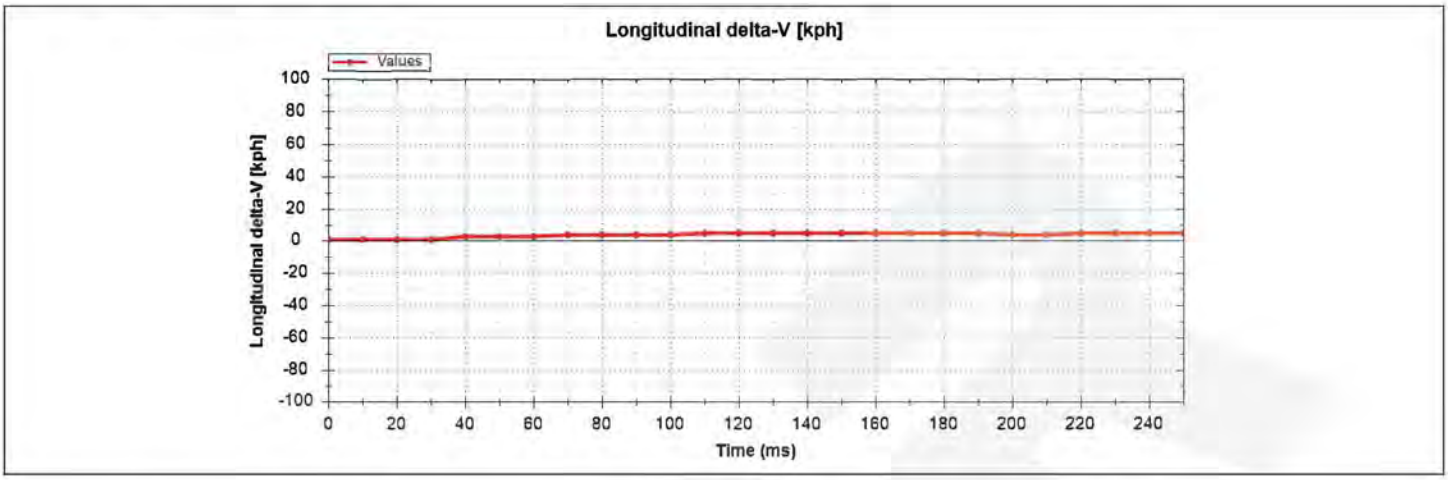


Num	Time (ms)	Longitudinal acceleration [g]
1	0.0	0.5
2	10.0	0.5
3	20.0	0.5
4	30.0	1.0
5	40.0	2.5
6	50.0	2.0
7	60.0	0.5
8	70.0	1.0
9	80.0	1.5
10	90.0	1.0
11	100.0	1.0
12	110.0	1.0
13	120.0	0.5
14	130.0	0.0
15	140.0	0.0
16	150.0	0.0
17	160.0	0.0
18	170.0	0.0
19	180.0	0.0
20	190.0	0.0
21	200.0	0.0
22	210.0	0.0
23	220.0	0.0
24	230.0	0.0
25	240.0	0.0
26	250.0	0.0

‹ Event 2 ›

Longitudinal crash pulse_delta-v (kph, 0 ~ 250msec)

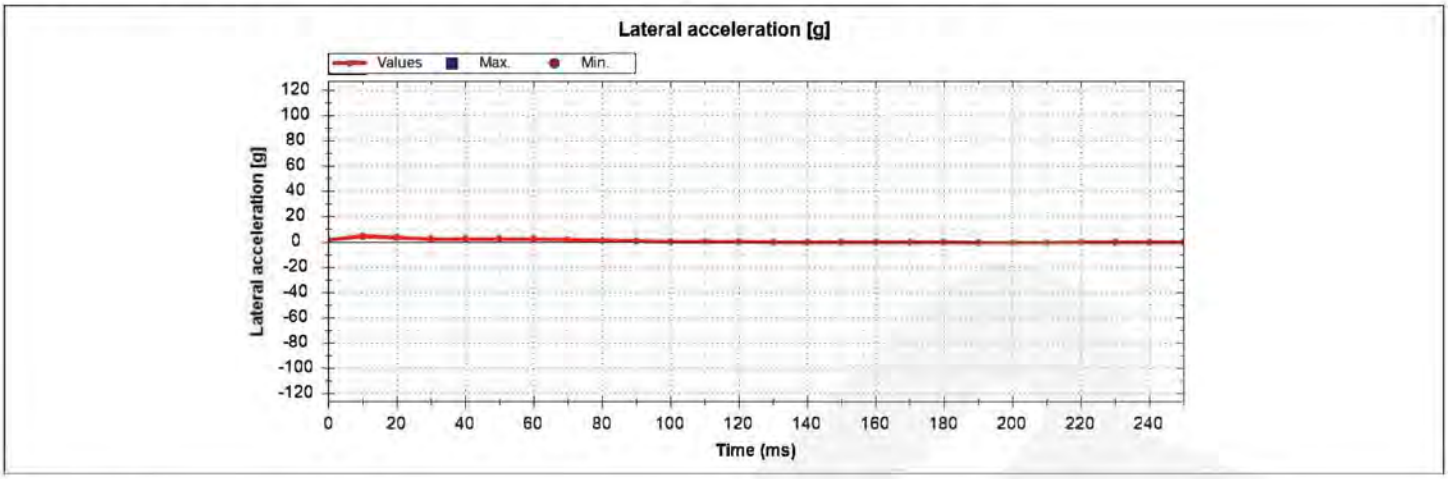
Max. delta-V [kph]	5
Time, Max. delta-V [msec]	295.0



Num	Time (ms)	Longitudinal delta-V [kph]
1	0.0	1
2	10.0	1
3	20.0	1
4	30.0	1
5	40.0	3
6	50.0	3
7	60.0	3
8	70.0	4
9	80.0	4
10	90.0	4
11	100.0	4
12	110.0	5
13	120.0	5
14	130.0	5
15	140.0	5
16	150.0	5
17	160.0	5
18	170.0	5
19	180.0	5
20	190.0	5
21	200.0	4
22	210.0	4
23	220.0	5
24	230.0	5
25	240.0	5
26	250.0	5

‹ Event 2 ›

Lateral crash pulse_acceleration (g, 0 ~ 250msec)

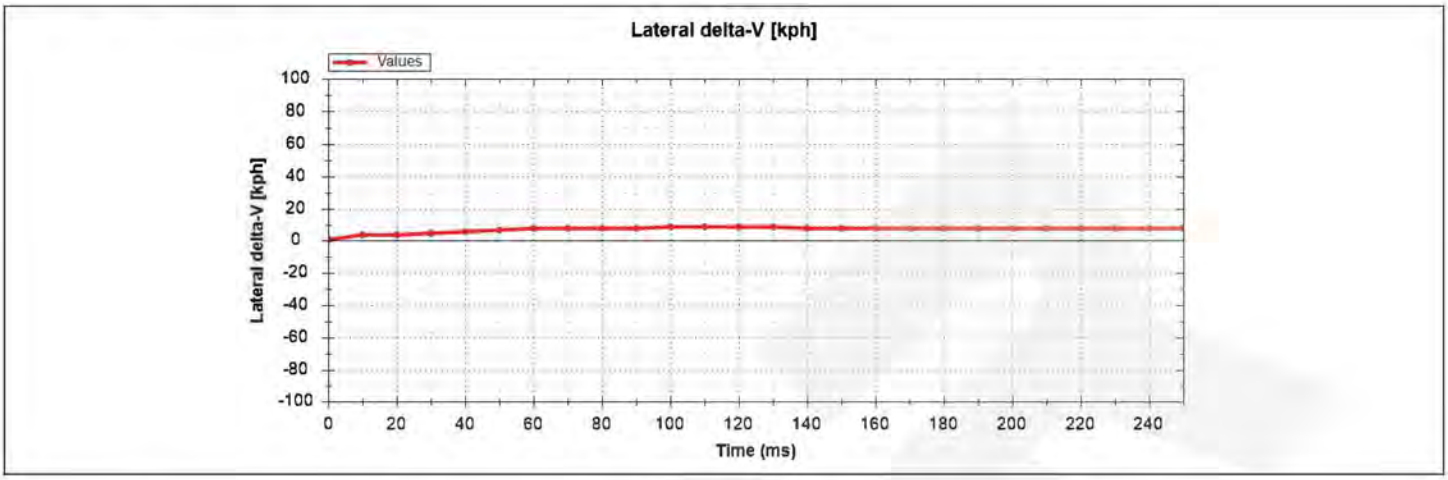


Num	Time (ms)	Lateral acceleration [g]
1	0.0	2.0
2	10.0	4.5
3	20.0	3.5
4	30.0	2.5
5	40.0	2.5
6	50.0	2.5
7	60.0	2.5
8	70.0	2.0
9	80.0	1.5
10	90.0	1.0
11	100.0	0.5
12	110.0	0.5
13	120.0	0.5
14	130.0	0.0
15	140.0	0.0
16	150.0	0.0
17	160.0	0.0
18	170.0	0.0
19	180.0	0.0
20	190.0	-0.5
21	200.0	-0.5
22	210.0	-0.5
23	220.0	0.0
24	230.0	0.0
25	240.0	0.0
26	250.0	0.0

< Event 2 >

Lateral crash pulse_delta-v (kph, 0 ~ 250msec)

Max. delta-V [kph]	9
Time, Max. delta-V [msec]	120.0



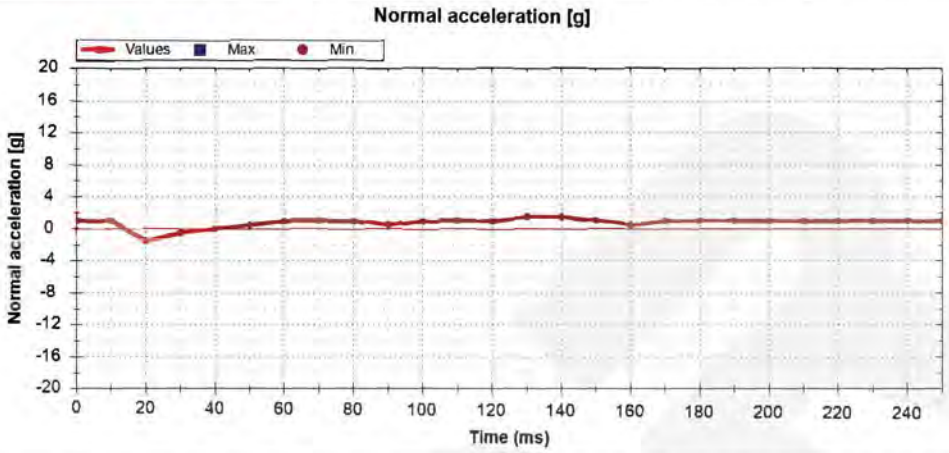
Num	Time (ms)	Lateral delta-V [kph]
1	0.0	1
2	10.0	4
3	20.0	4
4	30.0	5
5	40.0	6
6	50.0	7
7	60.0	8
8	70.0	8
9	80.0	8
10	90.0	8
11	100.0	9
12	110.0	9
13	120.0	9
14	130.0	9
15	140.0	8
16	150.0	8
17	160.0	8
18	170.0	8
19	180.0	8
20	190.0	8
21	200.0	8
22	210.0	8
23	220.0	8
24	230.0	8
25	240.0	8
26	250.0	8

‹ Event 2 ›

Crash pulse Resultant, Time_Max. delta-V resultant (0 ~ 300 msec)

Time, Max. delta-V, resultant [msec]	120.0

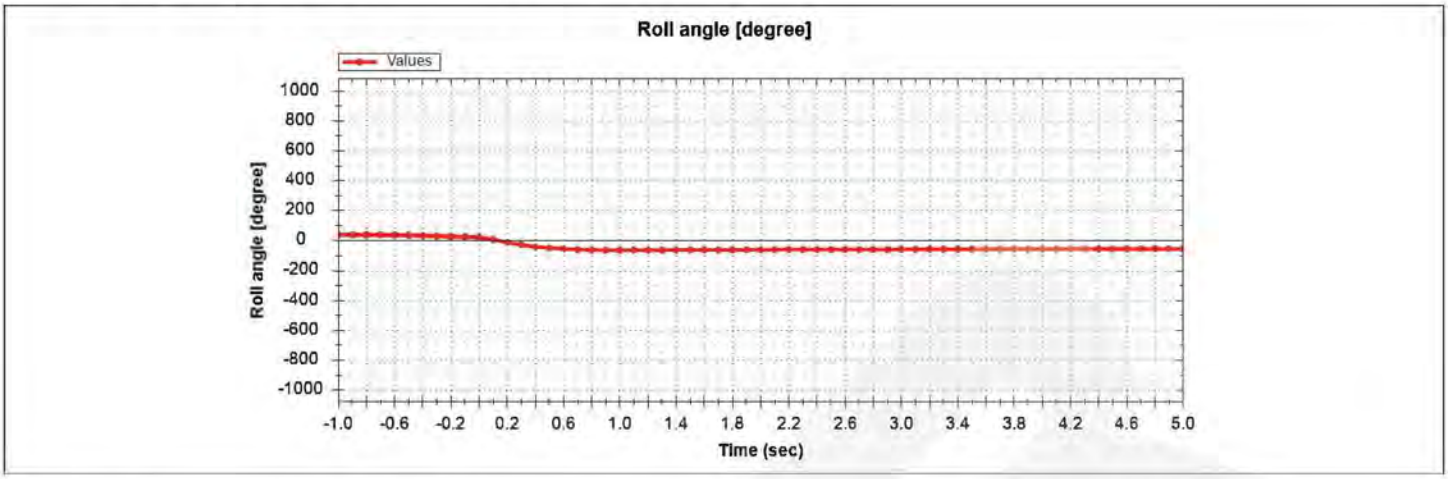
Normal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Normal acceleration [g]
1	0.0	1.0
2	10.0	1.0
3	20.0	-1.5
4	30.0	-0.5
5	40.0	0.0
6	50.0	0.5
7	60.0	1.0
8	70.0	1.0
9	80.0	1.0
10	90.0	0.5
11	100.0	1.0
12	110.0	1.0
13	120.0	1.0
14	130.0	1.5
15	140.0	1.5
16	150.0	1.0
17	160.0	0.5
18	170.0	1.0
19	180.0	1.0
20	190.0	1.0
21	200.0	1.0
22	210.0	1.0
23	220.0	1.0
24	230.0	1.0
25	240.0	1.0
26	250.0	1.0

‹ Event 2 ›

Roll angle (degree, -1 ~ 5sec)

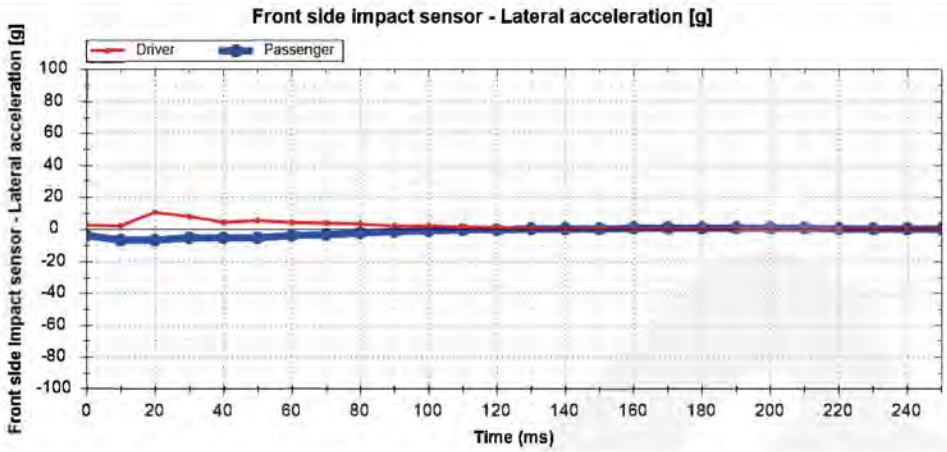


Num	Time (sec)	Roll angle [degree]
1	-1.0	39
2	-0.9	39
3	-0.8	39
4	-0.7	39
5	-0.6	38
6	-0.5	36
7	-0.4	34
8	-0.3	31
9	-0.2	28
10	-0.1	25
11	0.0	24
12	0.1	10
13	0.2	-9
14	0.3	-25
15	0.4	-39
16	0.5	-46
17	0.6	-53
18	0.7	-57
19	0.8	-60
20	0.9	-62
21	1.0	-62
22	1.1	-61
23	1.2	-61
24	1.3	-61
25	1.4	-60
26	1.5	-60
27	1.6	-60
28	1.7	-60
29	1.8	-60
30	1.9	-59
31	2.0	-59

32	2.1	-58
33	2.2	-57
34	2.3	-57
35	2.4	-57
36	2.5	-57
37	2.6	-57
38	2.7	-57
39	2.8	-57
40	2.9	-57
41	3.0	-56
42	3.1	-56
43	3.2	-55
44	3.3	-55
45	3.4	-55
46	3.5	-55
47	3.6	-55
48	3.7	-54
49	3.8	-54
50	3.9	-54
51	4.0	-54
52	4.1	-54
53	4.2	-53
54	4.3	-53
55	4.4	-53
56	4.5	-53
57	4.6	-53
58	4.7	-52
59	4.8	-52
60	4.9	-52
61	5.0	-52

‹ Event 2 ›

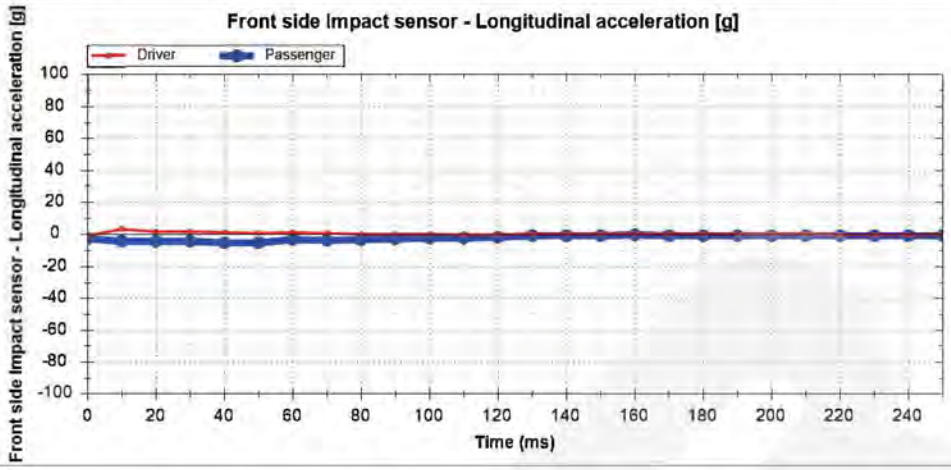
Front side impact sensor - Lateral acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Front driver side impact sensor - Lateral acceleration [g]	Front passenger side impact sensor - Lateral acceleration [g]
1	0.0	3.0	-3.5
2	10.0	2.5	-6.5
3	20.0	10.5	-6.5
4	30.0	8.0	-5.0
5	40.0	4.5	-5.0
6	50.0	5.5	-5.0
7	60.0	4.5	-3.5
8	70.0	4.0	-3.0
9	80.0	3.5	-2.0
10	90.0	2.5	-1.0
11	100.0	2.5	-0.5
12	110.0	2.0	0.0
13	120.0	1.5	0.0
14	130.0	1.0	0.5
15	140.0	0.5	0.5
16	150.0	1.0	0.5
17	160.0	0.5	1.0
18	170.0	0.5	1.0
19	180.0	0.5	1.0
20	190.0	0.5	1.0
21	200.0	0.0	1.0
22	210.0	0.0	1.0
23	220.0	0.5	0.5
24	230.0	0.5	0.5
25	240.0	0.5	0.5
26	250.0	0.5	0.5

‹ Event 2 ›

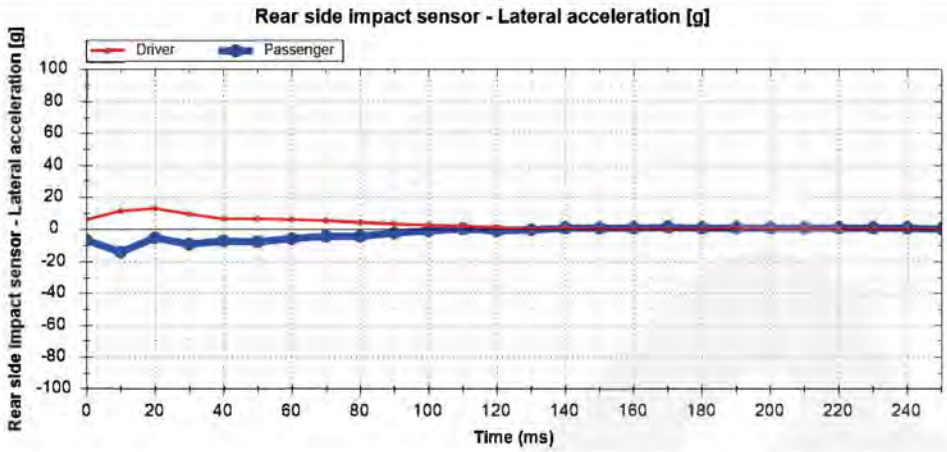
Front side Impact sensor – Longitudinal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Front driver side Impact sensor – Longitudinal acceleration [g]	Front passenger side Impact sensor – Longitudinal acceleration [g]
1	0.0	-0.5	-2.5
2	10.0	3.5	-4.0
3	20.0	2.0	-4.0
4	30.0	2.0	-4.0
5	40.0	1.5	-5.0
6	50.0	1.0	-5.0
7	60.0	1.5	-3.0
8	70.0	1.0	-3.5
9	80.0	0.5	-3.0
10	90.0	0.5	-2.5
11	100.0	0.5	-2.0
12	110.0	0.0	-2.0
13	120.0	0.0	-1.5
14	130.0	0.5	-0.5
15	140.0	0.5	-0.5
16	150.0	0.5	-0.5
17	160.0	0.5	0.0
18	170.0	0.5	-0.5
19	180.0	0.5	-0.5
20	190.0	0.5	-0.5
21	200.0	0.5	-0.5
22	210.0	0.5	-0.5
23	220.0	0.0	-0.5
24	230.0	0.0	-0.5
25	240.0	0.0	-0.5
26	250.0	0.0	-0.5

‹ Event 2 ›

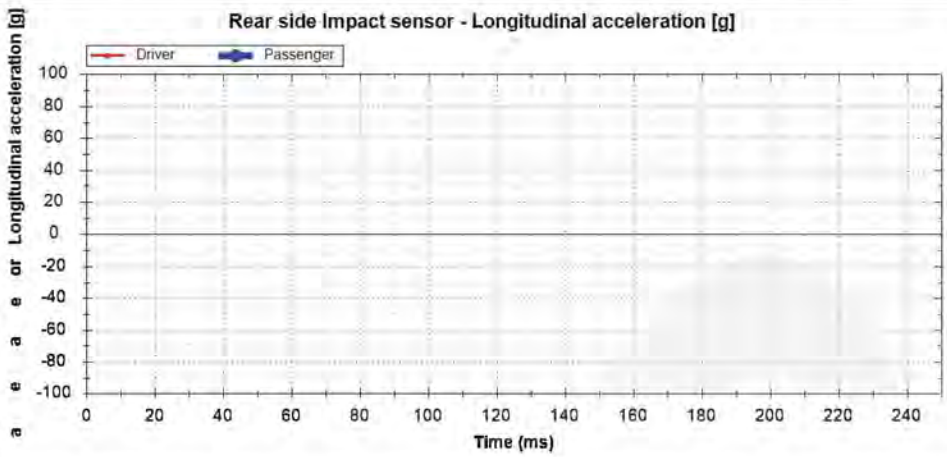
Rear side impact sensor – Lateral acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Rear driver side impact sensor – Lateral acceleration [g]	Rear passenger side impact sensor – Lateral acceleration [g]
1	0.0	6.0	-6.5
2	10.0	11.5	-14.0
3	20.0	13.0	-5.0
4	30.0	9.5	-9.0
5	40.0	6.5	-7.0
6	50.0	6.5	-7.5
7	60.0	6.0	-5.5
8	70.0	5.5	-4.0
9	80.0	4.5	-4.0
10	90.0	3.5	-2.0
11	100.0	3.0	-0.5
12	110.0	2.5	0.5
13	120.0	1.5	-0.5
14	130.0	0.5	0.0
15	140.0	1.0	1.0
16	150.0	0.5	1.0
17	160.0	0.5	1.0
18	170.0	0.5	1.5
19	180.0	0.5	1.0
20	190.0	1.0	1.0
21	200.0	0.5	1.0
22	210.0	0.5	1.0
23	220.0	0.5	1.0
24	230.0	0.5	1.0
25	240.0	0.5	1.0
26	250.0	0.5	0.5

‹ Event 2 ›

Rear side Impact sensor - Longitudinal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Rear driver side Impact sensor - Longitudinal acceleration [g]	Rear passenger side Impact sensor - Longitudinal acceleration [g]
1	0.0	Not supported	Not supported
2	10.0	Not supported	Not supported
3	20.0	Not supported	Not supported
4	30.0	Not supported	Not supported
5	40.0	Not supported	Not supported
6	50.0	Not supported	Not supported
7	60.0	Not supported	Not supported
8	70.0	Not supported	Not supported
9	80.0	Not supported	Not supported
10	90.0	Not supported	Not supported
11	100.0	Not supported	Not supported
12	110.0	Not supported	Not supported
13	120.0	Not supported	Not supported
14	130.0	Not supported	Not supported
15	140.0	Not supported	Not supported
16	150.0	Not supported	Not supported
17	160.0	Not supported	Not supported
18	170.0	Not supported	Not supported
19	180.0	Not supported	Not supported
20	190.0	Not supported	Not supported
21	200.0	Not supported	Not supported
22	210.0	Not supported	Not supported
23	220.0	Not supported	Not supported
24	230.0	Not supported	Not supported
25	240.0	Not supported	Not supported
26	250.0	Not supported	Not supported

‹ Event 2 ›

Raw Data

DOT HS 813 607
August 2024

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

16342-082224-v3