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July 2024

Special Crash Investigations: On-Site Reported Lane Keeping Assist Issue/Air Bag Non-Deployment Investigation; Vehicle: 2020 Kia Niro; Location: California; Crash Date: November 2021

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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 published.

16. Abstract

This on-site investigation documents the reported lane keeping assist (LKA) issue/air bag non-deployment in a 2020 Kia Niro involved in a two-vehicle crash. The crash occurred on an afternoon in November 2021 in California. The crash site was an undivided highway. The Kia was being driven northbound in the right lane by a belted 17-year-old female with LKA reported by the driver to be activated. A 2012 Subaru Outback driven by a belted 65-year-old female was traveling southbound. According to the Kia driver, she changed lanes to the left and then the vehicle abruptly veered to the left. She attributed the unwanted motion to the LKA system. The vehicle crossed the double yellow center lines into the opposing travel lanes. The front plane of the Kia struck the right rear quarter panel of the Subaru. The Kia went out of control, departed the roadway and struck a no parking sign and a chain link fence. After the impact with the Kia, the Subaru rotated clockwise, tripped left-side-leading, rolled two quarter turns, and came to rest on its roof. Based on available interview information, it appears that LKA was probably activated while the Kia was traveling along the curved roadway. The driver responded to the perceived steering assist by sharply steering/overcorrecting in the opposite direction and entered the opposing lane of travel into the path of the Subaru. No air bag deployed in the Kia. LKA activation could not be verified by Kia representatives due to a previous inspection of LKA features by a mechanic hired by the owner.

17. Key Words	18. Distribution Statement
lane keeping assist, air bag non-deployment, rollover	This document is available to the public from the DOT, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, https://crashstats.nhtsa.dot.gov.

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On-Site Reported Lane Keeping Issue/Air Bag Non-Deployment Investigation
Office of Defects Investigation
Case Number: DS22004
Vehicle: 2020 Kia Niro
Location: California
Crash Date: November 2021

Background

This on-site investigation documented the lane keeping assist (LKA) issue/air bag non-deployment in a 2020 Kia Niro involved in a two-vehicle crash. This investigation was initiated by the Office of Defects Investigation (ODI) in response to a driver notification via a Vehicle Owner's Questionnaire. The National Highway Traffic Safety Administration's Special Crash Investigation (SCI) group assigned the case to Dynamic Science, Inc., in January 2022. The Kia was inspected in February 2022. Present at the inspection were a NHTSA staff member and two Kia representatives. The Kia was supported by GIT[1] Kia event data recorder (EDR) Tool. Kia staff imaged the vehicle's EDR during the inspection and provided a PDF copy of the recorded data. The imaged EDR data was related to a previous crash and did not have any lane-keeping assist (LKA) data. The complete police report and on-scene images were obtained in June 2022.

The crash occurred in an afternoon in November 2021 in California. The crash site was an undivided highway. The Kia was driven northbound in the right lane by a belted 17-year-old female with LKA reported by the driver to be activated. A 2012 Subaru Outback driven by a belted 65-year-old female was traveling southbound. According to the Kia driver, she changed lanes to the left, and then the vehicle abruptly veered to the left. The driver attributed the unwanted motion to the LKA system. The vehicle crossed the double yellow center lines into the opposing travel lanes. The front right plane of the Kia (Figures 1 and 2) struck the right rear quarter panel of the Subaru (Figure 3). The Kia went out of control, departed the roadway and struck a no parking sign and a chain link fence. The Subaru rotated in a clockwise direction, tripped and rolled two-quarter turns, and came to rest on its roof (Figure 4). Both vehicles were towed from the scene.

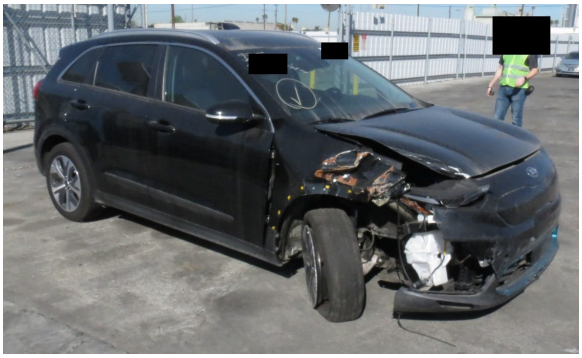

Figure 1. 2020 Kia Niro, front-plane damage

[1] GIT America, Inc., Irvine, CA, a subsidiary of GIT Co., Ltd., Chuncheon, Gangwon Province, South Korea.

Figure 2. 2020 Kia Niro, front-plane damage

Figure 3. 2012 Subaru Outback, right-plane damage

Figure 4. 2012 Subaru Outback (police photo)

Based on available interview information, it appears that LKA was probably activated while the Kia was traveling along the curved roadway. LKA activation could not be verified by Kia representatives due to a previous inspection of LKA features by a mechanic hired by the owner. The driver responded to the perceived steering assist by sharply steering in the opposite direction and entered the opposing lane of travel into the path of the Subaru. There were no air bag deployments in the Kia. This was a low delta V crash with damage outboard of structural components. Air bag deployments would not be expected. The original equipment manufacturer agreed with this assessment.

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Summary

Crash Site

The crash site was in the southbound lanes of a four-lane undivided highway. The roadway had two northbound lanes and two southbound lanes each measuring approximately 3.3 m (11 ft) separated by double solid yellow painted lines. The travel lanes were separated by dashed white painted stripes. The asphalt roadway curved to the right in the northbound direction and was bordered to the right by a solid white fog line, an asphalt shoulder, a low curb, a dirt/rock shoulder, and a chain link fence. The radius of curve for the northbound roadway was 194.0 m (636.5 ft) with a 2-percent positive grade and a 3-percent superelevation. The roadway was bordered to the left by a solid white fog line and a low curb. The pavement and lane lines were in good condition.

The posted speed limit was 72 km/h (45 mph). There were yellow 48 km/h (30 mph) curve warning signs approaching the area of impact in both directions. The weather at the nearest reporting station was 22ºC (72ºF), 57 percent humidity, and the winds were variable at 5 km/h (3 mph). Conditions at the time of the crash were daylight and dry. A crash diagram is included at the end of this technical report.

Pre-Crash

The Kia was initially traveling northbound in the right lane and was changing lanes to the left (Figure 5). The Subaru was traveling southbound in the left lane (Figure 6). A witness parked in a driveway north of the crash reported that he saw the Kia swerve into the southbound lane, then back into the northbound lane and then back into the southbound lane. The driver of the Subaru stated that she steered to the left to avoid the Kia but remained in her lane.

Figure 5. Northbound approach

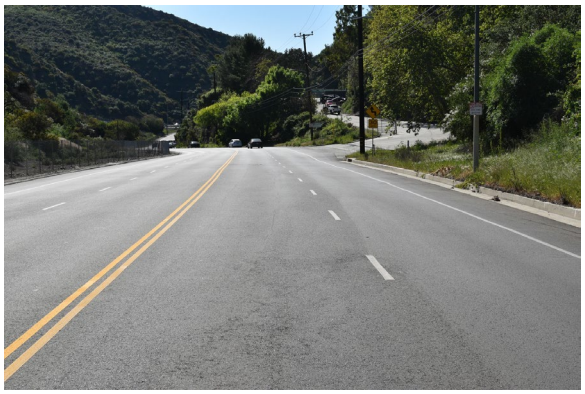

Figure 6. Southbound approach

Crash

The front right bumper of the Kia struck the right plane of the Subaru near the right rear wheel (Event 1). For the Kia in Event 1, the standard algorithm of WinSMASH calculated a total delta V of 12 km/h (8 mph), a longitudinal delta V of -12 km/h (-8 mph), a lateral delta V of -2 km/h (-1 mph) and a barrier equivalent speed (BES) of 14 km/h (9 mph). The results fit the collision model and are considered reasonable. For the Subaru in Event 1, WinSMASH calculated a total delta V of 15 km/h (9 mph), a longitudinal delta V of -14 km/h (-9 mph), a lateral of -3 km/h

(-2 mph) and a BES of 14 km/h (8 mph). The results fit the collision model and are considered reasonable.

The Subaru went into a clockwise rotation, tripped and began a left-side-leading rollover (Event 2). The Subaru rolled two-quarter turns and came to rest on its roof in the right northbound lane (Figure 7). The Kia was re-directed in a clockwise direction and departed the roadway to the right where it struck a no parking signpost (Event 3) and a chain link fence (Event 4). The vehicle came to rest off-road in contact with the fence (Figure 8).

Figure 7. Final rest, 2012 Subaru Outback, looking north (police photo)

Figure 8. Final rest, 2020 Kia Niro, looking north (police photo)

Post-Crash

The Kia driver was able to exit the vehicle under her own power. She was not injured. The driver of the Subaru remained belted in an upside-down position. Passersby responded to the crash. At first, they didn't want to move the driver but after she began panicking, they assisted her from the vehicle. She was able to stand and walk after exiting the vehicle. She reported a loss of consciousness post-crash. EMS arrived on the scene and transported her by ambulance to a local trauma center where she was treated and released.

Both vehicles were towed from the scene.

2020 Kia Niro

Description

The 2020 Kia Niro EX Premium was identified by the VIN KNDCE3LG1L5xxxxxx. The build date was July 2020. The Kia was a 5-door, front-wheel-drive electric compact SUV. The power train was a 201 hp electric motor, a 64.0-kWh 356v lithium-ion battery pack, and an automatic transmission. It had active safety technologies including forward collision avoidance assist, LKA, and blind spot collision warning. The vehicle manufacturer recommended size P215/55R17 tires for the front and rear. It was configured with Michelin Primacy tires of the recommended size.

The Kia had seating for five in two rows. In the front a pair of forward-facing bucket seats with adjustable head restraints that featured electronic seat track and seatback recline adjustments. The second row had a split bench seat with a folding back and integral head restraints for the outboard positions. A center console with an armrest and storage space was located between the two front seats. All seat positions had three-point lap and shoulder seat belts for manual restraints. Supplemental restraint was provided by front seat belt pretensioners, a frontal air bag system, front outboard seat-mounted side-impact air bags, and inflatable curtain air bags. There were no air bag deployments or pretensioner actuations.

The 2020 Kia Niro Electric SUV did not have a rating in NHTSA's New Car Assessment Program for frontal impacts.

The Kia had been in a previous crash in May 2021. According to the owner, her daughter was traveling along a curve and the vehicle tugged to the right and struck a curb. The front right wheel and strut assembly were replaced at a Kia dealership. A copy of the repair order is attached as Appendix A.

Exterior Damage

The Kia sustained light front-plane damage from the impact with the right plane of the Subaru (Figure 9). The direct damage associated with this impact appears to begin at the front right bumper corner and extended 35 cm (13.7 in) to the left. A portion of the fascia at the right bumper corner was torn away. The direct damage extended 61 cm (24.0 in) along the right side. The field L extended from bumper corner to bumper corner and measured 160 cm (62.9 in). Nineteen measurements were taken at the bumper level using the Nikon total station and the AutoCrush tool calculated six crush measurements as follows: C1=0 cm, C2=0 cm, C3=0 cm, C4=0 cm, C5=0 cm, C6=5 cm (1.9 in). The collision deformation classification (CDC) was 12FREE3.

There was a narrow impact pattern associated with the no parking sign (Figure 10). The CDC was 12FREN1.

There was scuffing on the bumper that began 16 cm (6.2 in) right of the bumper center line and extended 91 cm (35.8 in) to the right. There was additional scuffing on the left bumper fascia that was located 8 cm (3.1 in) right of the left bumper corner and extended 23 cm (9.0 in) to the right. The scuffing was related to the fence impact. The CDC was 12FDEW1.

Figure 9. 2020 Kia Niro front-right damage

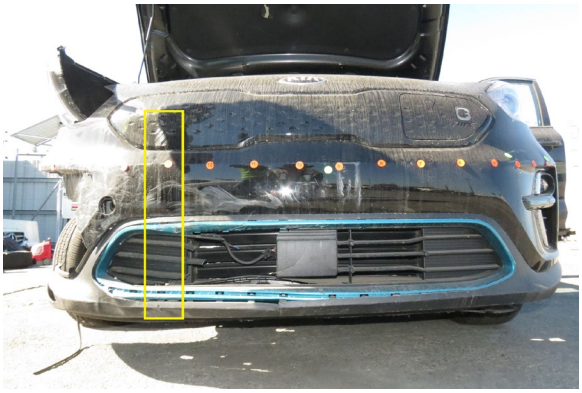

Figure 10. 2020 Kia Niro front-plane damage (pole impact highlighted)

Event Data Recorder

The Kia had a restraints control module with EDR capability to record up to two events. The pre-crash data would include vehicle speed, engine rpm, engine throttle, accelerator pedal, service brake, stability control, and steering input angle. The EDR does not record crash avoidance features such as LKA. The Kia was supported by the GIT Kia EDR Tool and Kia staff imaged the vehicle's EDR twice during the inspection. The ignition cycle for the first images was 1444 and 1446 for the second. One event was recovered but it did not appear to be related to this crash (based on the lack of any longitudinal delta V, an older ignition cycle for the crash, and the owner's statement about a previous crash). EDR showed the crash at ignition cycle 97 for both reports. The EDR report is included as an appendix at the end of this report.

Interior Damage

The Kia did not sustain any interior damage. All the doors remained closed and operational.

Manual Restraint Systems

The front row had driver and front passenger lap and shoulder seat belts. The right passenger's seat belt had continuous loop belt webbing, a sliding latch plate, a switchable emergency locking retractor/automatic locking retractor, and an adjustable upper anchor in the full-up position. According to the interviewee, the driver was wearing the lap and shoulder belt. The vehicle had lap and retractor seat belt pretensioners for the front row. There were no pretensioner actuations.

Supplemental Restraints System

The Kia had driver's and passenger's frontal air bags, outboard seat-mounted side-impact air bags for the front row, and inflatable curtain air bags for the first and second rows. There were no air bag deployments in this crash. This was a low delta V crash with damage outboard of structural components. Air bag deployments would not be expected. The OEM representative agreed with this assessment.

Powertrain

The Kia was a 5-door front-wheel drive electric vehicle. According to the owner's manual, the power train included a 201 hp electric motor, a 64.0-kWh 356 v lithium-ion battery pack, and an automatic transmission. The Kia had a 12-volt auxiliary battery for vehicle features like lights and wipers.

Federal Motor Vehicle Safety Standard No. 305 Compliance

Federal Motor Vehicle Safety Standard (FMVSS) No. 305, Electric Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection, is the standard applied to vehicles that use more than 48 nominal volts of electricity as propulsion and whose speed on a level paved surfaceis more than 40 km/h (25 mph). FMVSS No. 305 specifies performance requirements of electrolyte spillage, retention of propulsion batteries, and electrical isolation of the chassis from the high-voltage system during a crash event. The vehicle manufacturer has certified that this vehicle is compliant with FMVSS No. 305.

The Kia did not sustain any damage to frontal electrical components or the battery case. There was no electrolyte spillage and no fire.

LKA System Discussion

According to the owner's manual, the LKA system detects the lane markers and road edge with a front view camera at the front windshield and assists the driver's steering to help keep the vehicle in lanes. When the system detects the vehicle straying from its lane or road, it alerts the driver with a visual and audible warning, while applying a slight counter-steering torque, trying to prevent the vehicle from moving out of its lane. It is unknown if the driver used the turn signal when changing lanes. The driver did not report any visual or audible warnings. She did report that the wheel jerked to the left.

LKA Operation

Activation: With the ignition switch in the ON position, LKA turns on automatically and the indicator on the cluster display will initially illuminate white. According to a notice in the owner's manual "Even though the steering is assisted by the system, the driver

may control the steering. The steering wheel may feel heavier when the steering wheel is assisted by the system than when it is not."

Deactivation: Pressing the LKA button on the left instrument panel will turn off LKA and indication will turn off.

Display (Figure 11): White (sensor does not detect the lane marker or vehicle speed is less than 60 km/h (37 mph). Green (sensor detects the lane marker and the system is able to control the steering).

Figure 11. Cluster display, 2020 Kia Niro

LKA Function Change

The driver can change LKA to lane departure warning (LDW). LDW alerts the driver with a visual and acoustic warning when the system detects the vehicle leaving the lane. In this mode the steering wheel will not be controlled.

It should be noted that the vehicle had been inspected prior to the SCI inspection by a mechanic hired by the owner and it is unknown what functions may have been activated or deactivated during that inspection. Kia representatives said that LKA was not activated at the time of the SCI vehicle inspection. This was based on observations of the various menu settings at the time of the inspection. Based on the earlier inspection activities, the Kia representatives could not determine if the LKA was turned on at the time of the crash.

Vehicle History

The driver's mother/vehicle owner was interviewed. She reported that there were previous incidents where the steering would unexpectedly jerk to one side or the other. She stated that this happened to both her and her husband.

She also reported that the Kia had been involved in a previous crash with no police report taken. The driver was the owner's 17-year-old daughter, and that crash took place on a curved road on the first day the vehicle was in the family's possession. The vehicle had traveled to the right and struck a curb, causing damage to the right wheel. The low delta V crash EDR data imaged during the vehicle inspection was probably from this crash. Based on that data it would appear that the vehicle was traveling 71 km/h (44

mph) with a right steering input of -35[2] to the right 5 seconds prior to impact. The steering input was all gradual to the right until time 0. At -2.5 seconds, the acceleration pedal dropped to 0 percent. At -2.0 seconds, the driver braked. At time 0, stability control engaged, and the steering input changed to 160 to the left.

The driver's mother also reported that she requested that a mobile mechanic go to the salvage yard to obtain any diagnostic error codes. The mechanic reported that "the LKA error code isn't something that can be diagnosed because it's a software issue."

NHTSA Recalls and Investigations

VIN-based queries in August 2022 and May 2024 using the Kia's VIN revealed one unrepaired recall. NHTSA recall number 22V899 was issued after this crash and was related to potential coolant leakage near the power control unit.

[2] Positive sign, counterclockwise rotation. Steering ratio 13.9:1. Steering input -35, wheel angle -2.5. Steering input 160, wheel angle 11.5.

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2020 Kia Niro Occupant

Driver Demographics

Age/sex:	17 years/female
Height:	155 cm (61 in)
Weight:	41 kg (90 lbs)
Eyewear:	Sunglasses
Seat type:	Bucket with adjustable head restraint
Seat track position:	Unknown
Manual restraint usage:	Lap and shoulder seat belt used
Usage source:	Interview
Air bags:	Frontal, seat-mounted side impact, and inflatable curtain available; none deployed.
Alcohol/drug data:	None
Egress from vehicle:	Exited under own power
Transport from scene:	None
Type of medical treatment:	None

Driver Injuries

The driver was not injured.

Driver Kinematics

The driver stated that she was displaced forward at impact but did not recall the restraint system actually holding her in place.

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2012 Subaru Outback

Description

The 2012 Subaru Outback was identified by VIN 4S4BRBACXC3xxxxxx. The build date was August 2011 and the vehicle mileage was 318,666 km (198,010 mi). The Subaru was a 5-door SUV. It had a 2.5-liter 4-cylinder gasoline engine, an automatic transmission and all-wheel drive. The vehicle manufacturer recommended size P215/70R16 tires for the front and rear. It had Goodyear Assurance tires of the recommended size.

Exterior Damage

The Subaru sustained light right-plane damage from the impact with the front plane of the Kia (Figure 12). The direct damage began 222 cm (87.4 in) aft of the right front axle and extended 140 cm (55.1 in) rearward. The Field L began 197 cm (77.5 in) aft of the right front axle and extended 160 cm (62.9 in) rearward. Eighteen measurements were taken at bumper level using the Nikon total station and the AutoCrush tool calculated crush measurements as follows: C1=14 cm (5.5 in), C2=13 cm (5.1 in), C3=8 cm (3.1 in), C4=5 cm (1.9 in), C5=0 cm, C6=0 cm. The maximum crush was located at the right rear bumper corner and measured 15 cm (5.9 in). The CDC was 12RZEW2.

Figure 12. 2012 Subaru Outback, right plane damage

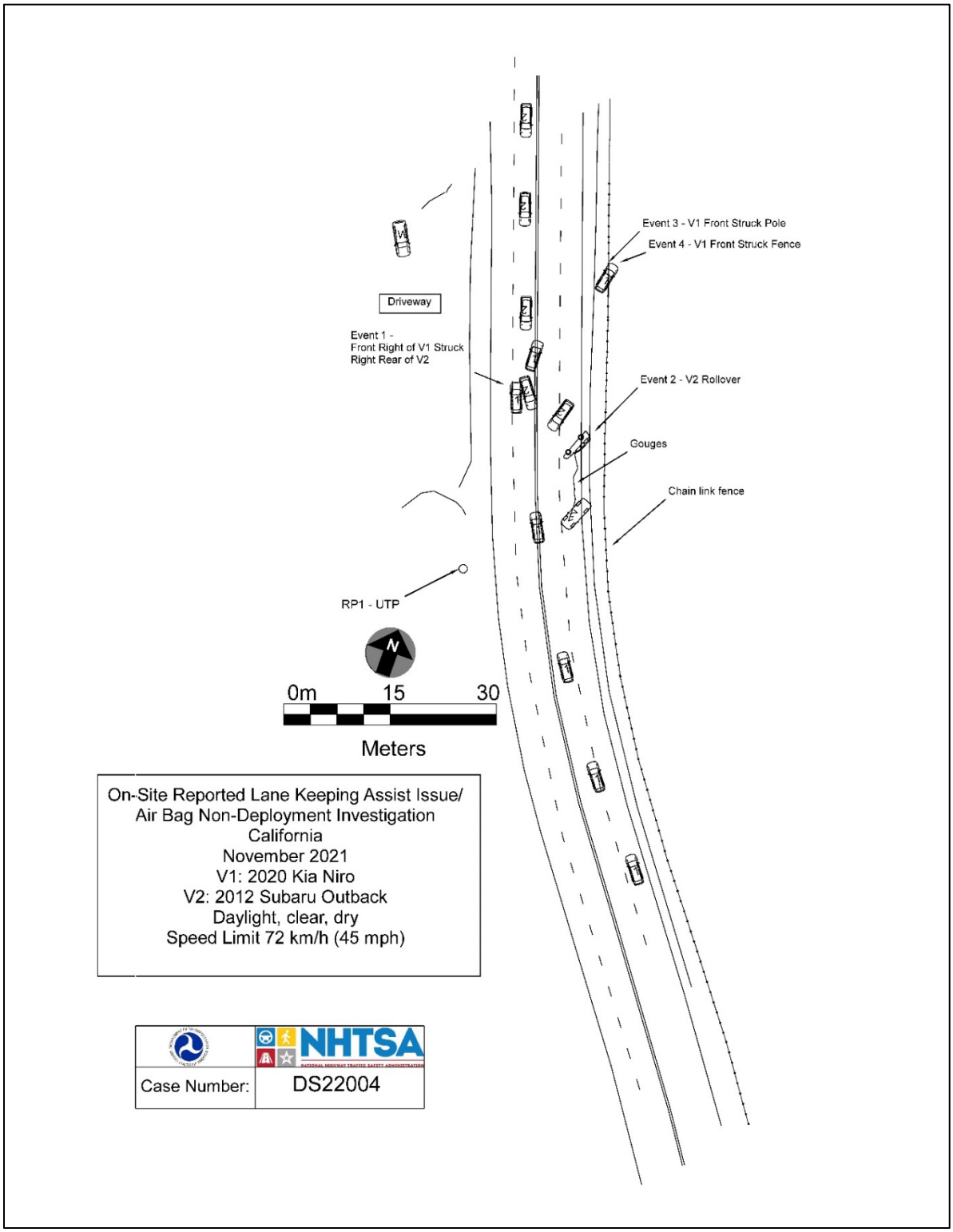
Figure 13. 2012 Subaru Outback, roof damage

The vehicle sustained moderate top plane damage from the rollover (Figure 13). The direct damage began at the front hood edge and extended rearward 225 cm (88.5 in) onto the roof. The damage width was 127 cm (50.0) extending from roof side rail to roof side rail. The maximum crush was located on the roof and measured 8 cm (3.1 in). The CDC was 00TYDO2.

Occupant Data

The belted 65-year-female driver sustained minor injuries consisting mainly of seat belt-related abrasions. She reported several instances where she lost consciousness. She was extricated from her vehicle by passersby, examined by responding EMS personnel, and then transported by ambulance to a local trauma center where she was treated and released.

Crash Diagram



Appendix A: Repair Order – 2020 Kia Niro

[redacted]

PARTS HOURS:
Monday thru Friday
7:00 AM - 7:00 PM
Saturday
7:00 AM - 5:00 PM
Sunday
Closed

[redacted]

THANK YOU FOR YOUR BUSINESS!!

[redacted]

CUST. NO.	TAX EXEMPT NUMBER	CUST. P. O. NO.	SHIP VIA	PAY	SOLD BY	INVOICE DATE	INVOICE
[redacted]				CASH	[redacted]	05/03/21	[redacted]

BILL TO
[redacted]

SHIP TO

QUANTITY SHIP	QUANTITY B. O.	PART NUMBER / DESCRIPTION		BIN	LIST	NET	AMOUNT
1	0	52910-Q4100	WHEEL ASSY-ALUM	SPORD	758.00	505.33	505.33
1	0	54661-Q4010	STRUT ASSY-FR,R	SPORD	290.00	210.00	210.00
1	0	54501-G2100	ARM COMPLETE-FR	C08	461.07	407.38	407.38
1	0	56500-Q4000	GEAR ASSY-STEER	SPORD	912.27	708.18	708.18
1	0	28637	215/55R17	SPORD	208.48	208.48	208.48
1	0	96005-G5000	COVER-RAIN SENS	SPORD	50.90	50.90	50.90
1	0	96011-G5000	COVER-RAIN SENS	SPORD	46.03	46.03	46.03
1	0	99211-Q4000	UNIT ASSY-FR VI	SPORD	1988.00	1425.33	1425.33

14 Hours of labor at 220 per hour
Labor is 3.080

- NO RETURNS AFTER 30 DAYS
- 20% HANDLING CHARGE ON ALL RETURNS
- ABSOLUTELY NO RETURNS ON ELECTRICAL PARTS
- ABSOLUTELY NO RETURNS ON SPECIAL ORDERS
- NO RETURN ON ANY PART WITHOUT ORIGINAL UNDAMAGED PACKAGING
- POSITIVELY NO RETURNS WITHOUT THIS DOCUMENT
- PURCHASE MADE BY CHECK WILL REQUIRE A 10 DAY CLEARING PERIOD.
- NOT RESPONSIBLE FOR ITEMS NOT PICKED UP WITHIN 90 DAYS

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SUBTOTAL	3561.63
RESTOCK CHARGE	0.00
TAX	338.35
FREIGHT	0.00
PAY THIS AMOUNT	~~3899.98~~

The Reynolds and Reynolds Company EPAINTPYCE CC745176 Q (08/20)

13:45:26 CUSTOMER COPY ** PRICE QUOTE ** NET556 PAGE 1 OF 1

Appendix B: EDR 2020 Kia Niro[3]

[3] The Kia EDR Report contained in this technical report was imaged by the OEM. Only a PDF copy of the Kia EDR Report was provided and the hexadecimal data contained in the report has been deleted due to the potential personal identifiable information (vehicle identification number) contained in the report.

Vehicle Information

KIA | NIRO(DE EV) | 2020 | AIRBAG SYSTEM	
VIN as Programmed into EMS	

Additional Information

User-entered VIN	KNDCE3LG1L5xxxxxx
User Name	Kia
Case Number	14504433
Crash Date	xxxx
Saved-on Date	2022-02-03 11:03
EDR Tool Version	E-N-K-01-00-0037
EDR Report Version	EDR001-R01
Tire Size(s)	215/55R17
Memo	xxxxx

Data Limitation

General Information:

Tools for downloading and interpreting the EDRs in Kia 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 Kia 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.

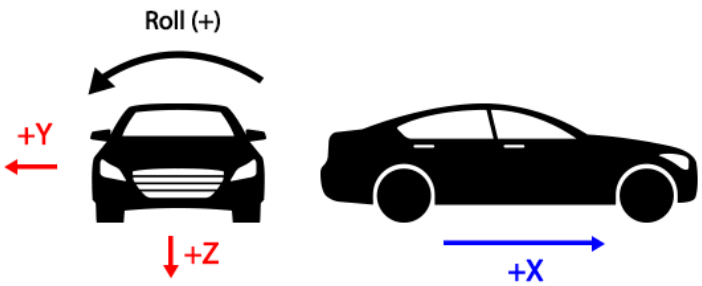
Data Limitation

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	-

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

EDR Information

Part No. (EOL Code) as programmed into ACU	95910-Q4000(Q401)
ECU SW Version as programmed into ACU	1.00
EDR Version as programmed into ACU	

< Event 1 >

Event Status at Event

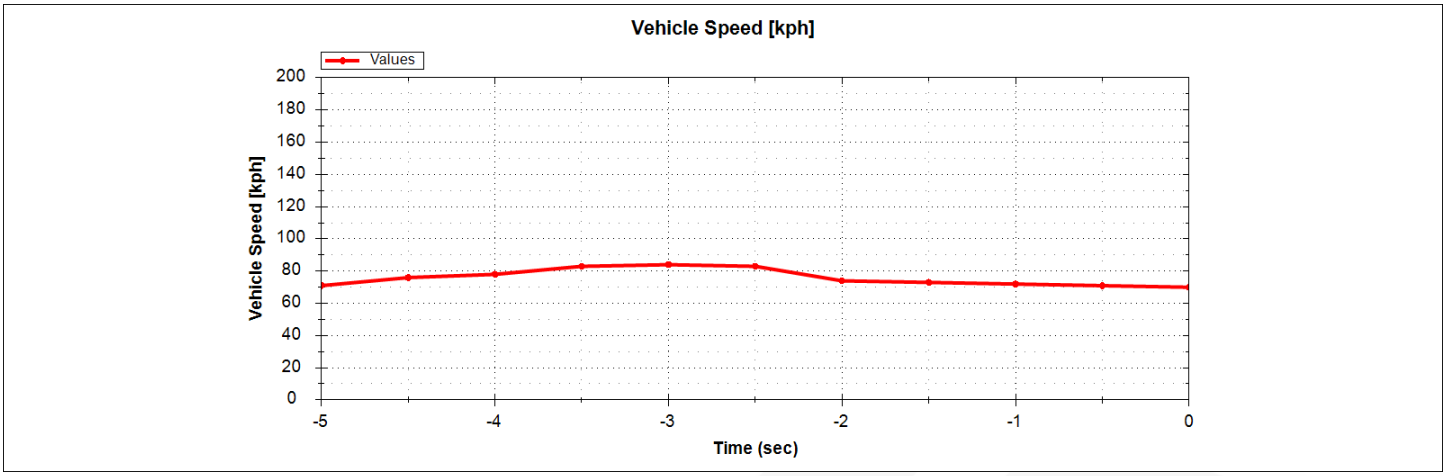
Multi-event, Number of Event (1 or 2)	1 event
Time from Event 1 to 2 [msec]	0
Completed File Recorded (Yes or No)	YES
Ignition cycle, crash [cycle]	97
Ignition cycle, download [cycle]	1444

Pre-Crash Information (-5 ~ 0 sec)

Time (sec)	Vehicle Speed [kph]	Engine RPM [rpm]	Engine Throttle [%]	Acceleration Pedal [%]	Service Brake [on/off]	ABS Activity [on/off]	Stability Control [on/off/engaged]	Steering Input [degree]
-5.0	71	4600	Invalid data or Not Supported	99	OFF	OFF	ON	-35
-4.5	76	4900	Invalid data or Not Supported	99	OFF	OFF	ON	-35
-4.0	78	5000	Invalid data or Not Supported	99	OFF	OFF	ON	-35
-3.5	83	5300	Invalid data or Not Supported	99	OFF	OFF	ON	-45
-3.0	84	5400	Invalid data or Not Supported	93	OFF	OFF	ON	-25
-2.5	83	5400	Invalid data or Not Supported	0	OFF	OFF	ON	-20
-2.0	74	4900	Invalid data or Not Supported	0	ON	OFF	ON	-40
-1.5	73	4800	Invalid data or Not Supported	0	OFF	OFF	ON	-10
-1.0	72	4700	Invalid data or Not Supported	30	OFF	OFF	ON	-5
-0.5	71	4600	Invalid data or Not Supported	0	OFF	OFF	ON	0
0.0	70	4400	Invalid data or Not Supported	30	OFF	OFF	Engaged	160

‹ Event 1 ›

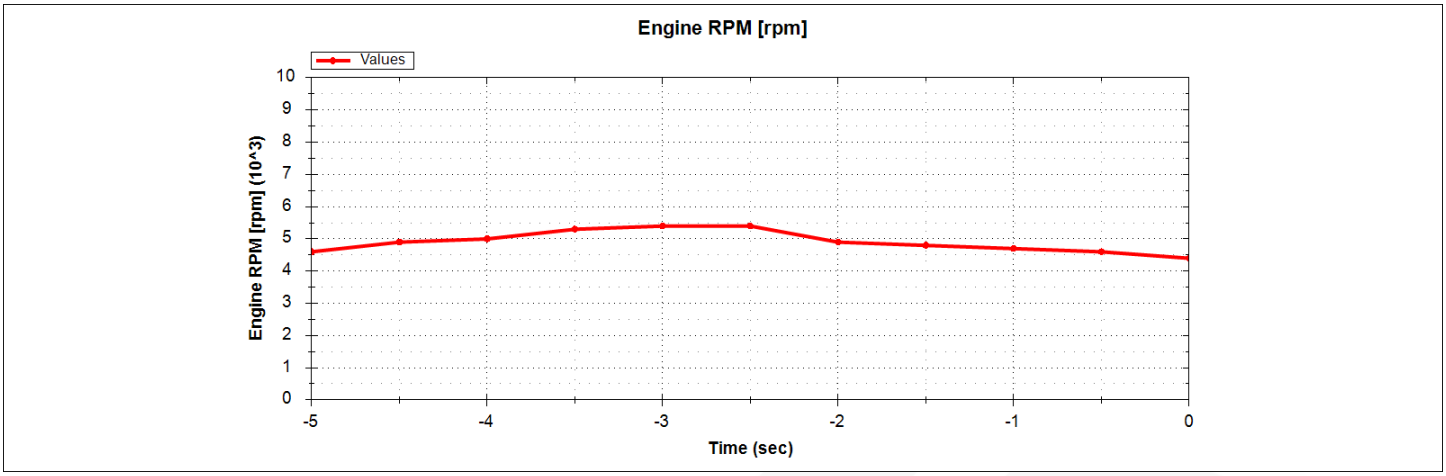
Vehicle Speed



Num	Time (sec)	Vehicle Speed [kph]
1	-5.0	71
2	-4.5	76
3	-4.0	78
4	-3.5	83
5	-3.0	84
6	-2.5	83
7	-2.0	74
8	-1.5	73
9	-1.0	72
10	-0.5	71
11	0.0	70

‹ Event 1 ›

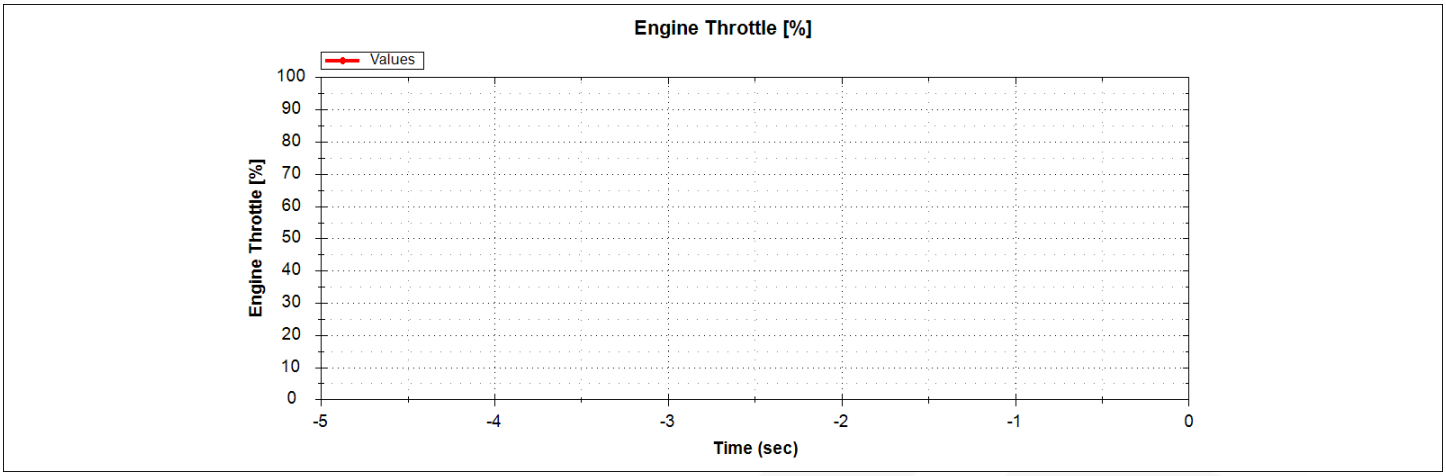
Engine RPM



Num	Time (sec)	Engine RPM [rpm]
1	-5.0	4600
2	-4.5	4900
3	-4.0	5000
4	-3.5	5300
5	-3.0	5400
6	-2.5	5400
7	-2.0	4900
8	-1.5	4800
9	-1.0	4700
10	-0.5	4600
11	0.0	4400

‹ Event 1 ›

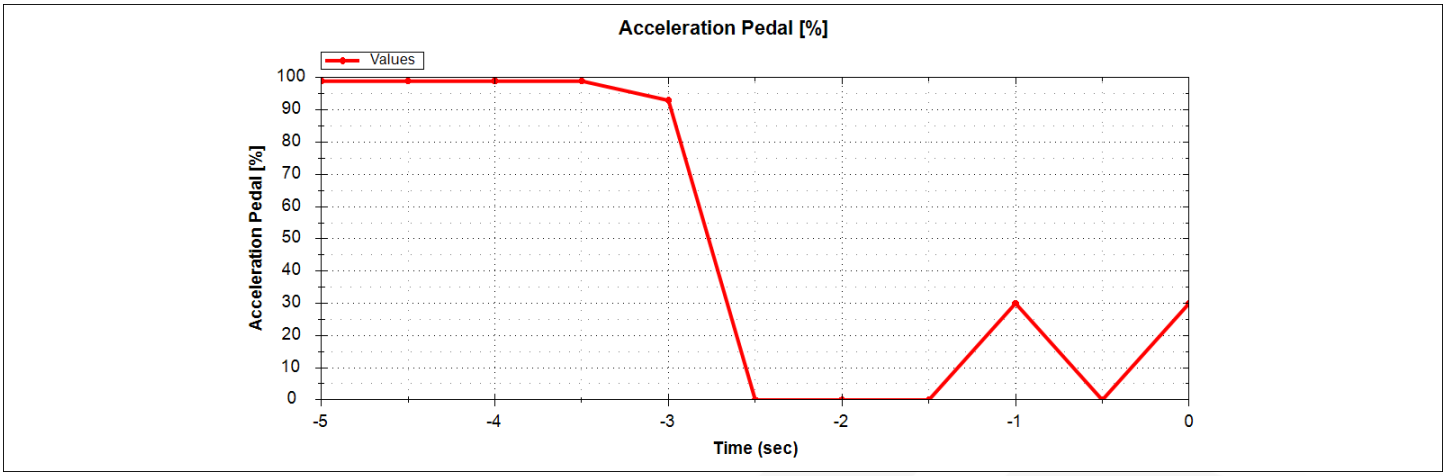
Engine Throttle



Num	Time (sec)	Engine Throttle [%]
1	-5.0	Invalid data or Not Supported
2	-4.5	Invalid data or Not Supported
3	-4.0	Invalid data or Not Supported
4	-3.5	Invalid data or Not Supported
5	-3.0	Invalid data or Not Supported
6	-2.5	Invalid data or Not Supported
7	-2.0	Invalid data or Not Supported
8	-1.5	Invalid data or Not Supported
9	-1.0	Invalid data or Not Supported
10	-0.5	Invalid data or Not Supported
11	0.0	Invalid data or Not Supported

< Event 1 >

Acceleration Pedal



Num	Time (sec)	Acceleration Pedal [%]
1	-5.0	99
2	-4.5	99
3	-4.0	99
4	-3.5	99
5	-3.0	93
6	-2.5	0
7	-2.0	0
8	-1.5	0
9	-1.0	30
10	-0.5	0
11	0.0	30

< 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	ON
8	-1.5	OFF
9	-1.0	OFF
10	-0.5	OFF
11	0.0	OFF

ABS Activity

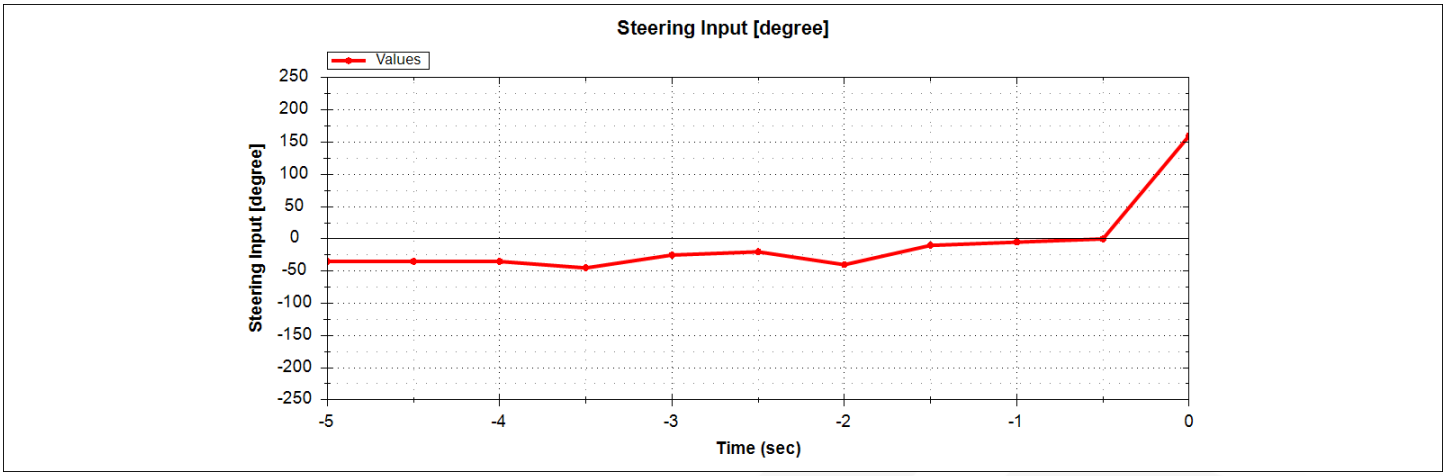
Num	Time (sec)	ABS Activity [on/off]
1	-5.0	OFF
2	-4.5	OFF
3	-4.0	OFF
4	-3.5	OFF
5	-3.0	OFF
6	-2.5	OFF
7	-2.0	OFF
8	-1.5	OFF
9	-1.0	OFF
10	-0.5	OFF
11	0.0	OFF

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	-35
2	-4.5	-35
3	-4.0	-35
4	-3.5	-45
5	-3.0	-25
6	-2.5	-20
7	-2.0	-40
8	-1.5	-10
9	-1.0	-5
10	-0.5	0
11	0.0	160

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

‹ Event 1 ›

System Status at Event

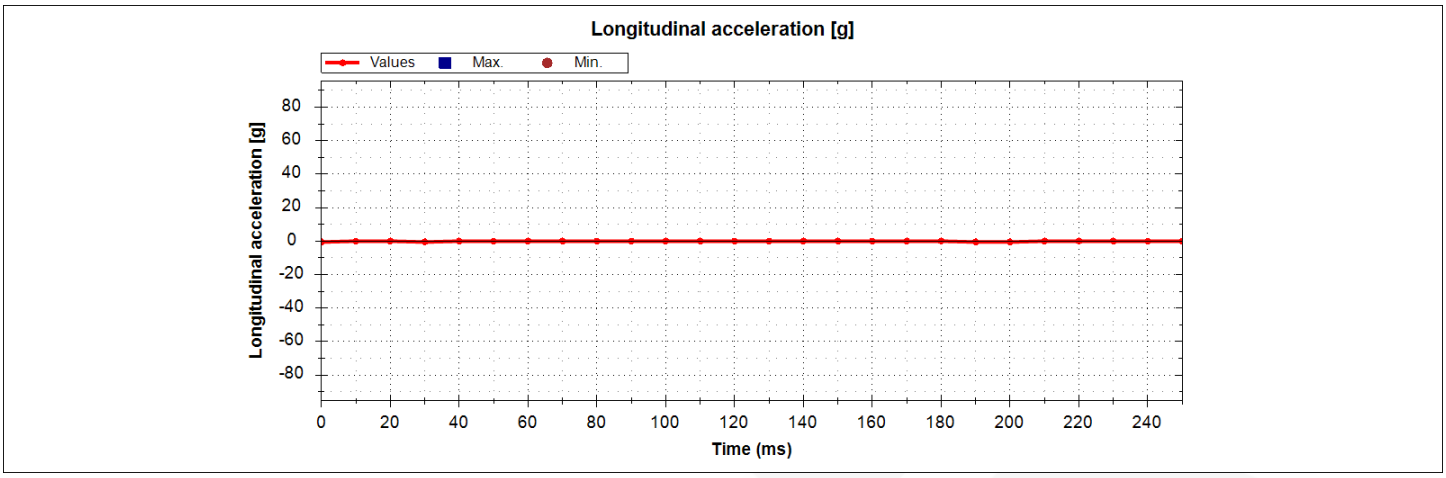
Airbag warning lamp on/off	OFF
Safety seat belt status, driver	ON
Safety seat belt status, passenger	ON
Seat track position switch foremost status, driver	Not Supported
Seat track position switch foremost status, passenger	Not Supported
Occupant size classification, driver (5% female or larger)	Not Supported
Occupant size classification, passenger (child)	NO

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 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 side airbag deployment time, driver [msec]	No deployment
Front side airbag deployment time, passenger [msec]	No deployment
Curtain airbag deployment time, driver [msec]	No deployment
Curtain airbag deployment time, passenger [msec]	No deployment
Seat belt pretensioner deployment time, driver [msec]	No deployment
Seat belt pretensioner deployment time, passenger [msec]	No deployment

‹ Event 1 ›

Longitudinal crash pulse_acceleration (g, 0 ~ 250msec)

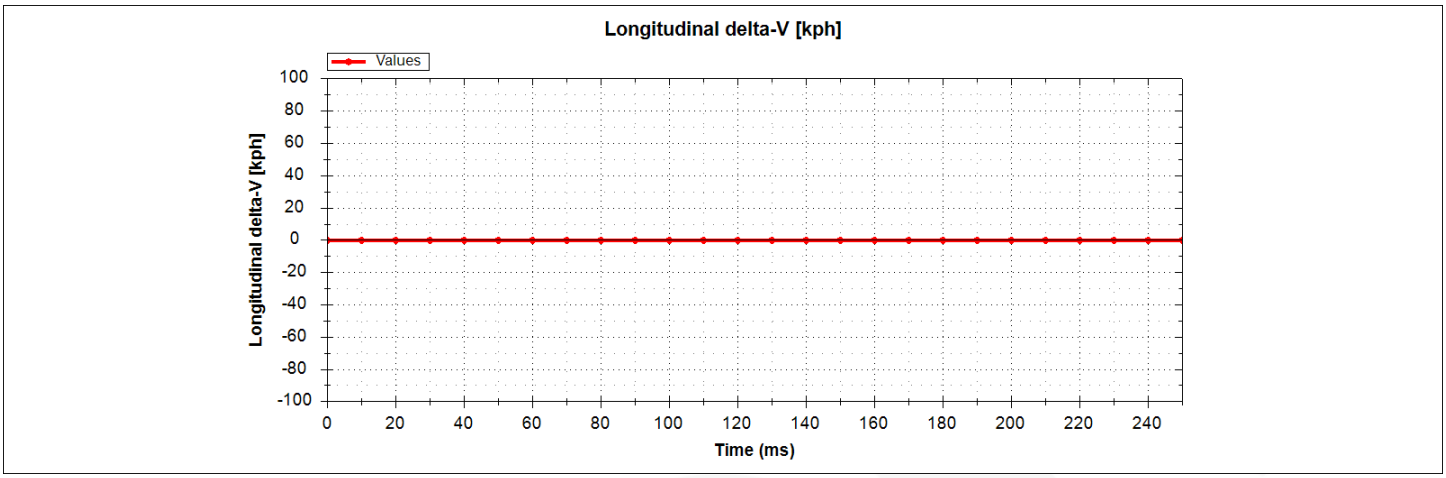


Num	Time (ms)	Longitudinal acceleration [g]
1	0.0	-0.5
2	10.0	0.0
3	20.0	0.0
4	30.0	-0.5
5	40.0	0.0
6	50.0	0.0
7	60.0	0.0
8	70.0	0.0
9	80.0	0.0
10	90.0	0.0
11	100.0	0.0
12	110.0	0.0
13	120.0	0.0
14	130.0	0.0
15	140.0	0.0
16	150.0	0.0
17	160.0	0.0
18	170.0	0.0
19	180.0	0.0
20	190.0	-0.5
21	200.0	-0.5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

‹ Event 1 ›

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

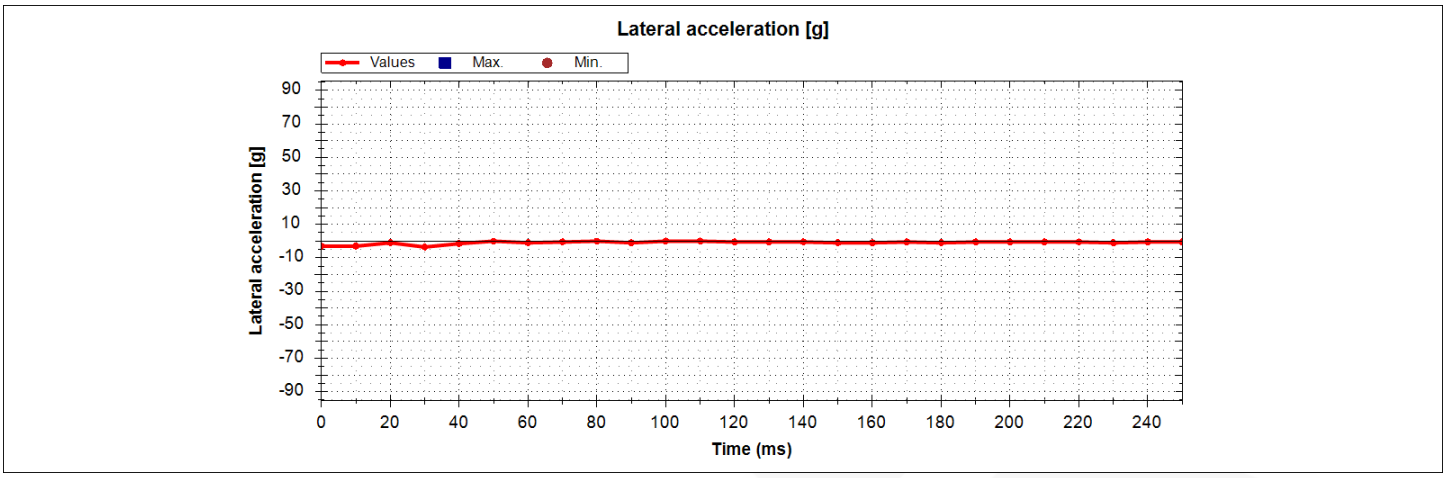
Max. delta-V [kph]	0
Time, Max. delta-V [msec]	197.5



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

‹ Event 1 ›

Lateral crash pulse_acceleration (g, 0 ~ 250msec)

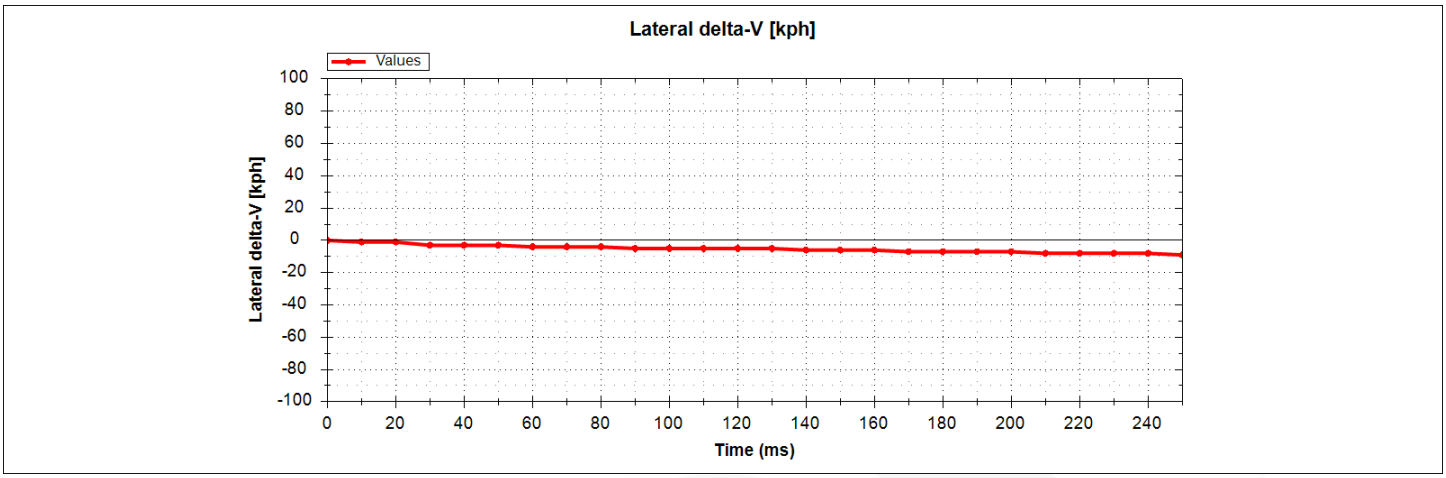


Num	Time (ms)	Lateral acceleration [g]
1	0.0	-3.0
2	10.0	-3.0
3	20.0	-1.0
4	30.0	-3.5
5	40.0	-1.5
6	50.0	0.0
7	60.0	-1.0
8	70.0	-0.5
9	80.0	0.0
10	90.0	-1.0
11	100.0	0.0
12	110.0	0.0
13	120.0	-0.5
14	130.0	-0.5
15	140.0	-0.5
16	150.0	-1.0
17	160.0	-1.0
18	170.0	-0.5
19	180.0	-1.0
20	190.0	-0.5
21	200.0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

‹ Event 1 ›

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

Max. delta-V [kph]	-10
Time, Max. delta-V [msec]	297.5



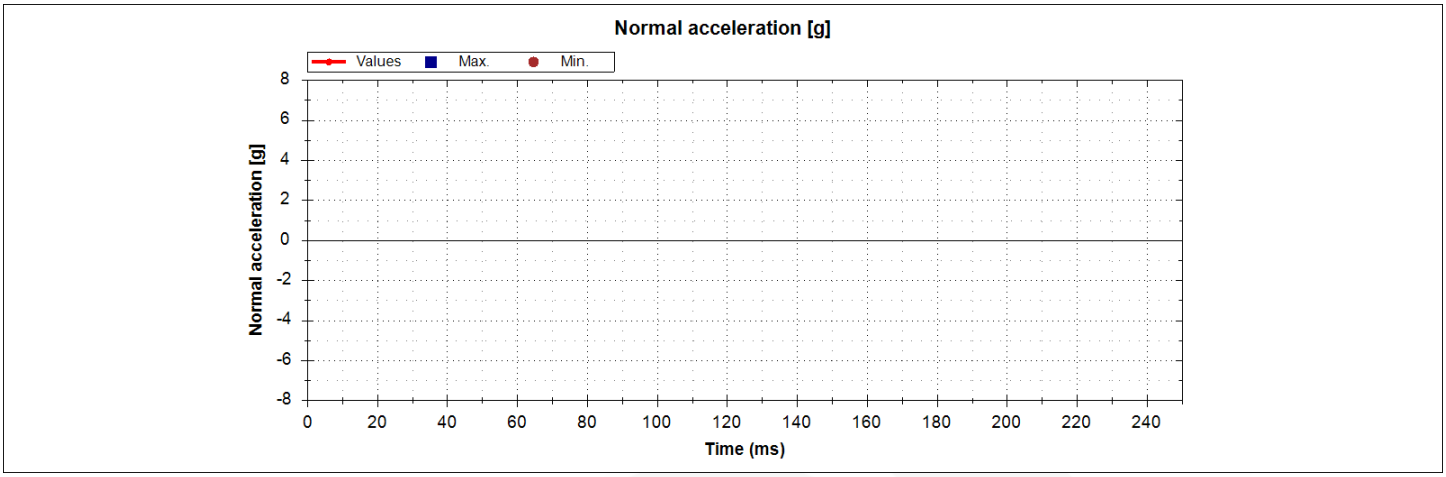
Num	Time (ms)	Lateral delta-V [kph]
1	0.0	0
2	10.0	-1
3	20.0	-1
4	30.0	-3
5	40.0	-3
6	50.0	-3
7	60.0	-4
8	70.0	-4
9	80.0	-4
10	90.0	-5
11	100.0	-5
12	110.0	-5
13	120.0	-5
14	130.0	-5
15	140.0	-6
16	150.0	-6
17	160.0	-6
18	170.0	-7
19	180.0	-7
20	190.0	-7
21	200.0	-7
22	210.0	-8
23	220.0	-8
24	230.0	-8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

< Event 1 >

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

Time, Max. delta-V, resultant [msec]	297.5

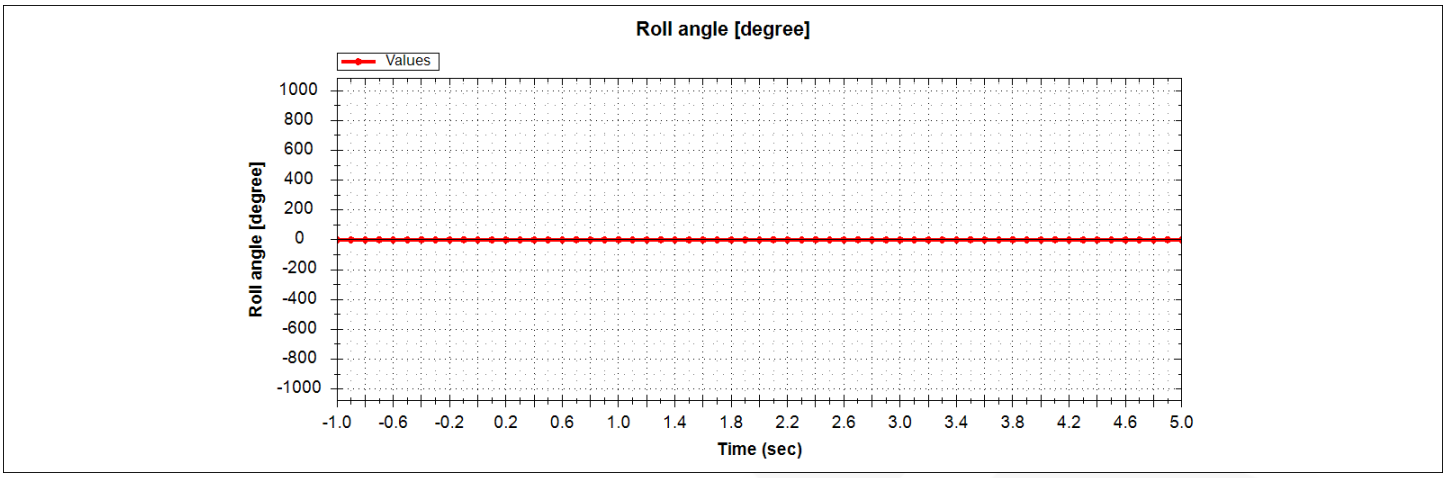
Normal acceleration (g, 0 ~ 250msec)



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

< Event 1 >

Roll angle (degree, -1 ~ 5sec)



Num	Time (sec)	Roll angle [degree]
1	-1.0	0
2	-0.9	0
3	-0.8	0
4	-0.7	0
5	-0.6	0
6	-0.5	0
7	-0.4	0
8	-0.3	0
9	-0.2	0
10	-0.1	0
11	0.0	0
12	0.1	0
13	0.2	0
14	0.3	0
15	0.4	0
16	0.5	0
17	0.6	0
18	0.7	0
19	0.8	0
20	0.9	0
21	1.0	0
22	1.1	0
23	1.2	0
24	1.3	0
25	1.4	0
26	1.5	0
27	1.6	0
28	1.7	0
29	1.8	0
30	1.9	0
31	2.0	0

32	2.1	0
33	2.2	0
34	2.3	0
35	2.4	0
36	2.5	0
37	2.6	0
38	2.7	0
39	2.8	0
40	2.9	0
41	3.0	0
42	3.1	0
43	3.2	0
44	3.3	0
45	3.4	0
46	3.5	0
47	3.6	0
48	3.7	0
49	3.8	0
50	3.9	0
51	4.0	0
52	4.1	0
53	4.2	0
54	4.3	0
55	4.4	0
56	4.5	0
57	4.6	0
58	4.7	0
59	4.8	0
60	4.9	0
61	5.0	0

‹ Event 2 ›

There is no recorded event.

DOT HS 813 608
July 2024

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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