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**Special Crash Investigations:
On-Site Pretensioner Malfunction
Crash Investigation;
Vehicle: 2021 Hyundai Elantra;
Location: North Carolina;
Crash Date: September 2021**

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Special Crash Investigations
On-Site Pretensioner Malfunction Crash Investigation
Office of Defects Investigation
Case Number: CR21023
Vehicle: 2021 Hyundai Elantra
Location: North Carolina
Crash Date: September 2021

Background

This report documents the on-site investigation of the offset frontal crash of a 2021 Hyundai Elantra and 2018 Honda Ridgeline (Figures 1 and 2). The force of the impact caused the actuations and deployments of the supplemental restraint systems in both vehicles. It was reported to NHTSA that a belted 14-year-old female in the Hyundai's second-row left position suffered a left leg injury requiring surgery because the driver retractor pretensioner ruptured. This caused metal fragments to penetrate the left B-pillar trim, entering the space behind the driver's seat and striking the 14-year-old in the leg, fracturing her left fibula in mid-shaft.



Figure 1. Right front oblique view of the Hyundai



Figure 2. Front view of the Honda

NHTSA was notified by an attorney representing the vehicle manufacturer in September 2021, which was forwarded to the Special Crash Investigations (SCI) group. An on-site investigation was assigned to the SCI team at Crash Research & Analysis, Inc. A multi-party inspection of the vehicle took place in October 2021 and was attended by representatives for the Hyundai manufacturer, the restraint system manufacturer, the vehicle owner, and SCI.

The crash occurred on an east/west two-lane roadway in a suburban setting. A commercial business and parking lot were located on the north side of the road. The Hyundai was traveling east and attempted to turn left into the parking lot, crossing the path of the westbound Honda. The front plane/center aspect of the Honda struck the front plane/right aspect of the Hyundai (Event 1). The force of the crash reversed the direction of the Hyundai and rotated it counterclockwise approximately 140 degrees. The Honda was deflected to its right, departed the roadway, struck a brick pillar that supported a wood fence (Event 2), and came to rest on the roadside. A dislodged brick from the pillar struck a parked/unoccupied 2018 Chevrolet Cruze (Event 3).

The Hyundai had safety systems that included front seat belt retractor pretensioners, frontal air bags, front-seat-mounted side impact air bags, and inflatable curtain (IC) air bags. The retractor pretensioner actuated at impact and the frontal, right seat, and right IC air bags deployed. A belted adult male driver, a belted adult female front passenger, the 14-year-old belted female second-row left passenger, and a belted female (unknown age) second-row right passenger occupied the vehicle. The police crash report stated that all occupants of the Hyundai sustained non-incapacitating (B-level) injuries. EMS transported the Hyundai driver, front passenger, and the 14-year-old passenger by ambulance to the hospital. The belted second-row right passenger was not transported. The Honda's belted male driver and belted female passenger also sustained B-level injuries. Only the passenger was transported to a hospital.

The on-site investigation included inspections of the Hyundai to measure exterior deformation, interior damage and intrusion, documented the interior occupant contact, and assessed the manual and supplemental restraint systems. Specific attention was directed to the driver retractor pretensioner and outcome. This component was removed from the vehicle, inspected, and retained by the claimant's attorney. The Hyundai had an event data recorder (EDR), which was imaged by the Hyundai manufacturer using the Global Information Technologies Hyundai/Kia scan tool. The imaged data was shared with all participants at the inspection and the data is included as an appendix to this report. Additional activities included inspections of the Honda and the crash site.

Summary

Crash Site

The crash occurred in the afternoon in September 2021. The police reported environmental conditions were clear, daylight, and dry. The National Weather Service reported a temperature of 26.7 °C (80 °F), 59 percent relative humidity, 4 km/h (7 mph) east-southeast winds, and fair sky conditions. The east/west road (Figures 3 and 4) where the crash occurred consisted of two lanes divided by a double yellow centerline. Each traffic lane measured 3.2 m (10.4 ft) and was bordered by a solid white fog line with a 0.6 m (1.9 ft) shoulder. A commercial business, parking lot, and driveway were located on the north roadside. There was a wood fence supported by brick pillars along the property. The fence was located 5.6 m (18.4 ft) north of the road edge. The brick pillars measured 38 cm (14.9 in) wide, 38 cm (15.0 in) long, and 114 cm (44.9 in) tall. The pillars were spaced 4.2 m (13.8 ft) apart. The posted speed limit was 72 km/h (45 mph). A gouge mark adjacent to the north fog line evidenced the impact. The second brick pillar in the fence was struck by the Honda and had been rebuilt prior to the scene inspection. Evidence of roadway construction was also present at the crash scene, hampering the identification of the post-impact trajectory of the Honda.



Figure 3. Crash scene eastbound



Figure 4. Crash scene westbound, V2 at POI

Pre-Crash

The Hyundai was traveling east at an EDR-recorded speed of 55 km/h (34 mph) 5 seconds prior to algorithm enable (AE). The Hyundai was driven by a belted male with three belted female passengers. The injured 14-year-old female occupied the second-row left position. The Honda was traveling west at an EDR-recorded speed of 75 km/h (47 mph) 5 seconds prior to AE, driven by a belted male and a belted female front passenger.

As the Hyundai approached the parking lot and driveway, the driver began to brake. At the 2-second pre-crash interval, the Hyundai had slowed to 32 km/h (20 mph) and its driver began to steer left to enter the parking lot. Steering and braking continued as the Hyundai began to cross the centerline and enter the westbound lane. The Honda driver saw the Hyundai turn across its path, and he began a braking- and right-steering avoidance maneuver at the 1-second pre-crash interval. Portions of the pre-crash data for each vehicle are included below in Table 1.

Table 1. Pre-Crash Data for V1 and V2

Seconds Pre-Crash	Hyundai			Honda		
	Speed km/h (mph)	Brake Status	Steering Positive Left	Speed km/h (mph)	Brake Status	Steering Positive Left
-5.0	55 (34)	On	0	75 (47)	Off	0
-4.0	51 (31)	On	0	73 (45)	Off	0
-3.0	42 (26)	On	0	73 (45)	Off	0
-2.0	32 (20)	On	15	72 (45)	Off	0
-1.0	22 (14)	On	110	71 (44)	On	-40
0.0	18 (11)	Off	250	71 (44)	On	-95

Crash

The crash occurred in the westbound lane where the center/front of the Honda struck right/front of the Hyundai (Event 1). A gouge mark identified the area of the impact near the white fog (Figure 4 above). The supplemental restraint systems in both vehicles actuated/deployed. The force of the impact reversed the momentum of the Hyundai and rotated it 140 degrees counterclockwise. The Hyundai came to rest facing west in the westbound lane approximately 10 m (33 ft) from the point of the impact. The Honda was deflected to its right, departed the road, traveled through the roadside, and struck the second brick pillar supporting the fence (Event 2). The Honda came to rest in contact with the fractured pillar approximately 8.5 m (28 ft) from the vehicle-to-vehicle impact facing north. Its impact with the pillar dislodged a brick into the parking lot where it struck a parked/unoccupied Chevrolet Cruze (Event 3).

Post-Crash

Police and EMS responded to the crash site. An ambulance transported the Hyundai driver, front passenger, and the 14-year-old passenger to a local hospital's emergency room. The 14-year-old was taken into surgery to remove metal fragments from her left lower leg. A non-displaced fracture of the fibula was identified. The driver and front passenger were examined and released. The female passenger of the Honda was also transported by ambulance to a hospital where she was examined and released. The Honda driver and the Hyundai second-row right passenger were not transported. Tow services removed both vehicles from the crash site and were deemed total

losses by their insurance companies. The vehicles were transferred to an insurance vehicle salvage facility, where they were inspected by SCI.

2021 Hyundai Elantra

Description

The 2021 Hyundai Elantra (Figure 5) was manufactured in March 2021 and identified by the VIN KMHLS4AG2MUxxxxxx. The odometer reading was 3,079 km (1,913 miles). The Hyundai was a front-wheel-drive platform with the SEL trim and the convenience package. It was powered by a 2.0-liter, inline 4-cylinder, gasoline engine linked to an automatic transmission. Its service brakes were power-assisted 4-wheel disc with antilock brakes. Additional features included traction control, stability control, tire pressure monitoring, a rear-view camera, and the manufacturer's crash avoidance technology package that included forward collision warning, lane departure warning with steering assist, blind spot warning, advanced headlights, and adaptive cruise control. The gross vehicle weight rating (GVWR) was 1,750 kg (3,858 lb), with gross axle weight ratings of 1,030 kg (2,271 lb) front and 950 kg (2,094 lb) rear. The vehicle manufacturer's recommended tire size was P205/55R16, with recommended cold tire pressures of 235 kPa (34 PSI) front and 215 kPa (31 PSI) rear. At the time of the SCI inspection the Hyundai had Continental Pro-Contact tires of the vehicle manufacturer's recommended size at all four axle positions. All four tires had adequate tread.



Figure 5. Front view of the 2021 Hyundai Elantra during the SCI vehicle inspection

The Hyundai interior had seating for five occupants (2/3), with front-row bucket seats and a second-row bench seat with split forward-folding seatbacks. The front-row seats were equipped with adjustable head restraints, while the three second-row positions each featured an integral head restraint. All seating surfaces were cloth.

Manual restraint systems in the Hyundai included 3-point lap and shoulder seat belts for all five seat positions. Supplemental restraint systems included front seat belt retractor pretensioners and six inflatable supplemental restraints.

Exterior Damage

The front and right planes of the Hyundai were damaged (Figure 5) in the impact (Event 1). The bumper fascia and grille separated in the impact. The direct damage began 52 cm (20.5 in) right of center and extended 8 cm (3.1 in) to the right corner. The damage pattern then wrapped

around the corner onto the forward aspect of the right plane and extended 76 cm (29.9 in) rearward. The right front wheel assembly was displaced 5 cm (2.0 in) rearward and was tilted inward. The front crush was measured along the front bumper reinforcement on a 119 cm (46.9 in) field L. The residual crush was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 0 cm, C4 = 0 cm, C5 = 3 cm (1.2 in), C6 = 10 cm (3.9 in). The direction of the impact force was in the 2 o'clock sector (50 degrees). The collision deformation classification (CDC) was 02FREN1. The crash severity (total delta V) calculated by the WinSMASH program was 18 km/h (11mph). The longitudinal and lateral delta Vs were -12 km/h (-7 mph) and -14 km/h (-7 mph). Analysis of the collision fit the model; however, the results were considered low. For comparison, the longitudinal delta V recorded by the EDR was -27 km/h (-17 mph) at 147.5 milliseconds and the lateral delta V was -27 km/h (-17 mph) at 65.0 milliseconds.



Figure 6. Right oblique view of the Hyundai's frontal damage

Event Data Recorder

The Hyundai Elantra had an air bag control unit that had event data recording capabilities. The EDR data was imaged by a representative for the vehicle manufacturer who used the Hyundai/Kia scan tool via a connection to the vehicle's diagnostic link connector. The imaged data was shared with SCI and NHTSA in a PDF. The PDF has been sanitized for personally identifiable information and included as Appendix A.

The Hyundai EDR had the capability to record tri-axial acceleration and roll data and had the capacity to store two events. These events could be a deployment or a non-deployment event type. A deployment event is recorded if an air bag is commanded to deploy. This event type is locked and cannot be overwritten. A non-deployment event is a physical occurrence that reaches the level to require recording, but does not deploy air bags, i.e., a pretensioner-only actuation. Non-deployment events are not locked and can be overwritten. A 5-second buffer that records various pre-crash vehicle operational parameters (such as speed, brake, steering, etc.) was stored and linked to each record.

The imaged data reported one stored deployment event imaged on ignition cycle 306. The stored data was recorded on ignition cycle 305 and was related to the crash under investigation. Both front seat belts were reported "On" and the air bag warning lamp was off. The maximum longitudinal delta V was -27 km/h (-17 mph) at 147.5 milliseconds. The maximum lateral delta

V was -27 km/h (-17 mph) at 65 milliseconds. The actuation/deployment times are presented in Table 2.

Table 2. Actuation/Deployment Times for V1

Device	Time after AE milliseconds	Device	Time after AE milliseconds
Driver pretensioner	46	Passenger pretensioner	46
Driver air bag stage 1	46	Passenger air bag stage 1	46
Driver air bag stage 2	49	Passenger air bag stage 2	49
		Passenger IC air bag	60
		Passenger side air bag	60

The pre-crash data (Table 1 above on page 4) indicated the vehicle speed was 55 km/h (34 mph) at the -5.0-second interval with a reduction in speed throughout the pre-crash period. The service brakes were on from -5.0-second to -1.0-second interval, and the speed reduced to 22 km/h (14 mph). The left steer maneuver was initiated at the -2.0-second interval with increasing steering angle to AE. At AE, the speed was 18 km/h (11 mph).

Interior Damage

The interior damage to the Hyundai consisted of occupant contact to the interior and the deployment/actuation of the supplemental restraints. There was no intrusion into the occupant compartment. All doors remained closed during the crash and were operational post-crash. The driver's seat was adjusted to a rear track position 2 mm (0.1 in) forward of full rear at the time of inspection. The seatback was upright. Contact scuffs from the driver's knees were observed on the bottom surface of the steering column and at the junction of the center console and the left lower instrument panel.

The right front seat was also adjusted to a rear track position with an upright seatback. At the right front occupant space, a scuff to the right lower instrument panel/glove box door was observed which was attributed to the passenger's left knee. A right arm/hand contact was noted at the forward upper quadrant of the right front door panel. Contact from the passenger's right flank was observed on the right seat-mounted air bag.

Manual Restraint Systems

The Hyundai had 3-point continuous loop lap and shoulder seat belt systems for all five seat positions. They all used sliding latch plates, and the front systems were configured with adjustable D-rings. The driver's seat belt retracted onto an emergency locking retractor (ELR), while the four other systems used switchable ELR/automatic locking retractors (ALR). Both front seat belt systems were equipped with retractor pretensioners. Based on the inspections of the seat belts at the four occupied positions, it was apparent that all the occupants were belted. Each seat belt displayed useage evidence. Both front seat belt retractor pretensioners actuated.

Details regarding the inspections of the driver's seat belt and retractor pretensioner are presented in a separate section below.

Supplemental Restraint Systems

The Hyundai had dual-stage driver's and passenger's frontal air bags, front-seat-mounted side impact air bags, and roof side rail-mounted IC air bags for the front and second row. Additionally, the vehicle had retractor pretensioners.

During Event 1, the driver and passenger frontal air bags, right front seatback air bag, and right IC airbags deployed.

Driver Seat Belt and Retractor Pretensioner

Observation of the driver seat belt found the webbing locked and extended, lying on the driver seat due to pretensioner actuation. The locked/extended webbing measured 165 cm (65.0 in) from the floor anchor to the D-ring, which was adjusted to its full-up position. Examination of the webbing revealed contact and loading from the driver's chest during the crash evidenced by a linear, colored fiber transfer to the webbing (Figure 7). The 12 cm (4.7 in) long transfer was located over the central aspect of the driver's chest 54 cm (21.3 in) below the D-ring. There was a 3 cm (1.2 in) abrasion at the D-ring. The latch plate hardware was also abraded by belt loading.

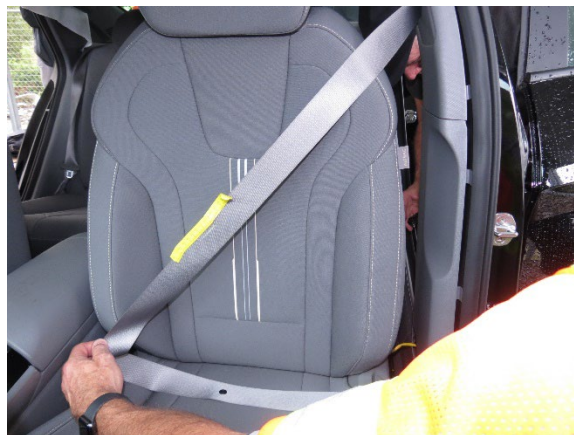


Figure 7. Image of the Hyundai driver's seat belt and transfer to the webbing

The actuated driver pyrotechnic retractor pretensioner was located 18 cm (7.1 in) above the floorboard and centered in the left B-pillar. During actuation, the pretensioner's gas generator and end cap structure separated from the main tube, propelling plastic and metal shrapnel through the driver's B-pillar trim panel (Figure 8) and into the floorboard area of the second-row left position.

The separated/fragmented pretensioner components (Figure 9) struck and penetrated the left leg of the second-row left passenger, fracturing her fibula in mid-shaft. The shrapnel was surgically removed at a nearby trauma center. These components were then retained by the family and its legal counsel.



Figure 8. Holed left B-pillar



Figure 9. LF pretensioner gas generator and shrapnel removed from left-rear passenger's leg

During the vehicle inspection, the driver's seat belt and retractor were removed from the vehicle in a stepwise manner and all attending parties imaged and documented the components. The initial step was removing the B-pillar trim panel. Its lower aspect was holed 8 cm (3.1 in) in diameter. Exhaust gas residue was observed on the back side of the panel. A webbing guide molded into the panel 16 cm (6.3 in) below the D-ring was abraded by contact from the webbing.

The two bolts securing the retractor to the B-pillar were removed and the retractor (Figure 10) was inspected. The retractor was manufactured by Samsung Industries Co., LTD, Seoul, Korea,¹ and identified by the part number A29L 88810AA500YFR. The pretensioner mechanism was attached to the forward side of the assembly (with respect to the vehicle). Adjacent to the retractor's spool, the pretensioner tubing extended vertically and wrapped around the outer portion of the retractor body in a U-shape pattern. At its termination, the tubing faced the interior to the vehicle. For comparison purposes, legal counsel provided an exemplar retractor (Figure 11).

¹ Editor's note: Not to be confused with Samsung.

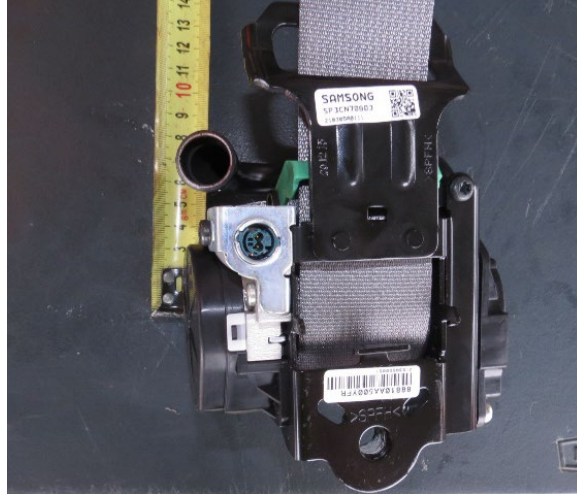


Figure 10. Removed driver's retractor pretensioner

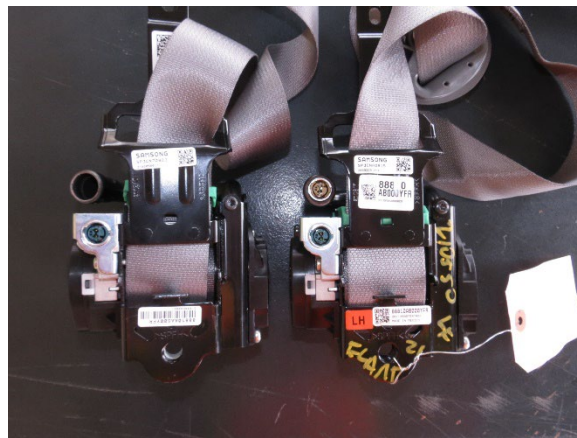


Figure 11. Comparison view driver's retractor and an exemplar (right)

The end of the tube expanded to an approximate diameter of 15 mm (0.6 in) to fit to the body of the gas generator. It appears that a holed end cap was then pressed over the end of the tube and peened at two points 180 degrees (Figures 12 and 13) from each other to secure the end cap and gas generator to the tubing wall. The SCI investigator noted that while examining the gas generator (Figures 14 and 15) and the tubing interior (Figures 16 and 17) only one set of peens were evident although two peening indents were visible on the exterior of the tubing.



Figure 12. Tube top exterior peen marking

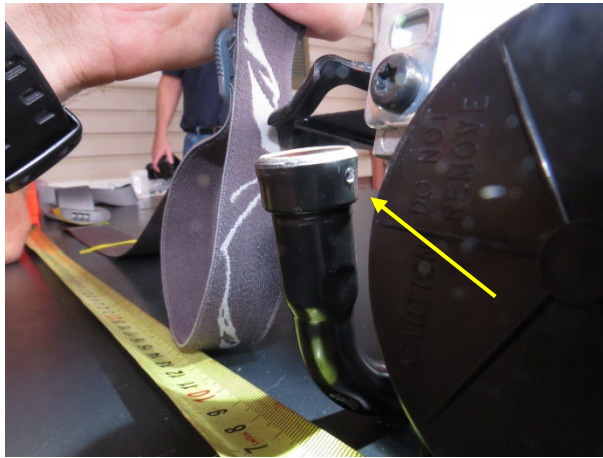


Figure 13. Tube bottom exterior peen marking



Figure 14. Top view of gas generator



Figure 15. Bottom view of gas generator



Figure 16. Interior top (no peening markings)

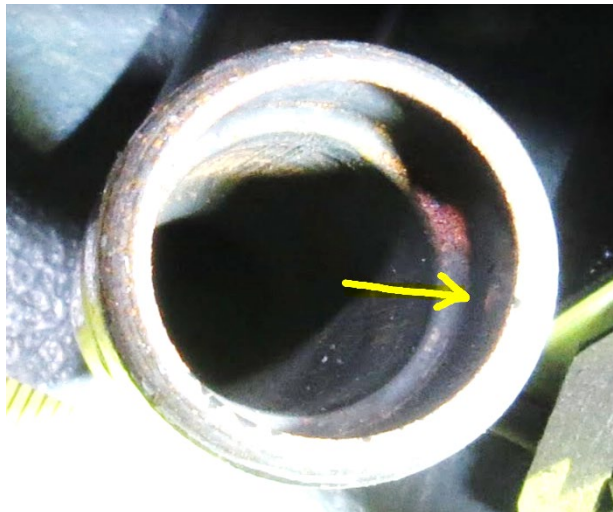


Figure 17. Interior bottom (peening mark visible)

The force of the explosion caused the gas generator to separate from the end cap and hole the B-pillar trim panel. The tube portion of the pretensioner recoiled approximately 10 degrees clockwise (Figure 18) into the B-pillar structure. The back side of the tube contacted the ends of two exposed bolts in the pillar, causing two indents to be formed in the tube structure (Figure 19).

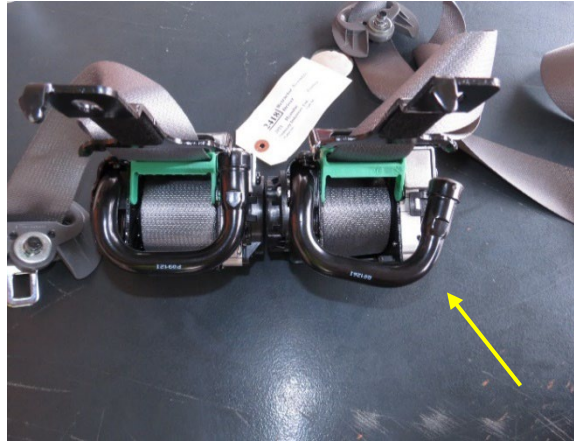


Figure 18. Exemplar pretensioner (left) and damaged pretensioner (right), note the recoiled tube

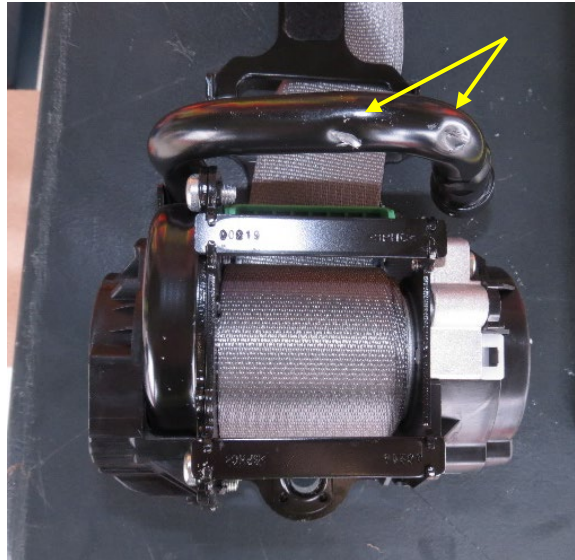


Figure 19. Damaged tube of the removed retractor pretensioner

At the end of the inspection, the right front retractor assembly was also removed from the vehicle. These components were retained by the legal counsel for the vehicle owner and further testing and forensic examination may be scheduled.

2020 Hyundai Elantra Occupants

Driver Demographics

Age/sex: 16 years/male
 Height: 173 cm (68 in)
 Weight: 59 kg (130 lb)
 Eyewear: Unknown
 Seat type: Forward-facing bucket seat with adjustable head restraint
 Seat track position: Rear track, 2mm (0.1 in) forward of full rear
 Manual restraint usage: Lap and shoulder belt
 Usage source: Vehicle inspection, EDR and interview
 Air bags: Frontal, seat-mounted, and IC air bags available; frontal deployed
 Alcohol/drug involvement: No alcohol/drug involvement
 Egress from vehicle: Exited from vehicle under own power
 Transport from scene: EMS ambulance transport
 Type of medical treatment: Treated and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Seat belt abrasion across chest	410202.1	Isolated Interior – Shoulder portion of belt restraint	Certain
2	Right shoulder abrasion	710202.1	Isolated Left Air Bag – Steering wheel hub	Possible
3	Air bag abrasion to right wrist	710202.1	Isolated Left Air Bag – Steering wheel hub	Certain
4	Air bag abrasion to left wrist	710202.1	Isolated Left Air Bag – Steering wheel hub	Certain
5	Seat belt abrasion to right anterior superior iliac crest area	810202.1	Isolated Interior – Lap portion of belt restraint	Certain
6	Seat belt abrasion to left anterior superior iliac crest area	810202.1	Isolated Interior – Lap portion of belt restraint	Certain

Source: emergency room record

Driver Kinematics

The 16-year-old driver was belted and seated in a normal posture with a rearward seat track adjustment. He was in control of the vehicle and had initiated a left turn toward the parking lot entrance at the time of the crash.

At impact, his seat belt pretensioner actuated and the driver’s frontal air bag deployed. The driver initiated a forward and rightward trajectory in response to the 2 o’clock direction of force. The driver loaded the tensioned/locked seat belt with his torso and pelvis and then the deployed air bag. The seat belt loading resulted in abrasions to his chest and across his hips. The deployed driver’s frontal air bag abraded his wrist and possibly his right shoulder. The driver rode down the force of the crash through his combined loading of these safety systems. He rebounded back into his seat and came to rest. He exited the vehicle through the left front door under his own power and subsequently transported by ambulance to a local trauma center, where he was treated and released.

Front-Row Right Passenger Demographics

Age/sex: 42 years/female
 Height: 155 cm (61 in)
 Weight: 102 kg (225 lb)
 Eyewear: Unknown
 Seat type: Forward-facing bucket seat with adjustable head restraint
 Seat track position: Full rear
 Manual restraint usage: Lap and shoulder belt
 Usage source: Vehicle inspection, EDR and interview
 Air bags: Frontal, seat-mounted, and IC air bags available; all deployed
 Alcohol/drug involvement: No alcohol/drug involvement
 Egress from vehicle: Exited vehicle under own power
 Transport from scene: EMS ambulance transport
 Type of medical treatment: Treated and released

Front-Row Right Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Fracture to right mid-clavicle, mildly displaced	750651.2	Isolated IPC Interior – Shoulder portion of belt restraint	Certain
2	Right chest wall contusion adjacent to the clavicle	410402.1	Isolated Interior – Shoulder portion of belt restraint	Certain
3	Left knee bruising	810402.1	Isolated Front – Right lower instrument panel (includes knee bolster)	Certain

Source: emergency room record

Front-Row Right Passenger Kinematics

The front passenger was belted and seated with a rear seat track adjustment. At impact, the seat belt pretensioner actuated and the passenger front-seat-mounted side impact, and IC air bags deployed. The passenger initiated a forward and rightward trajectory in response to the 2 o’clock direction of the impact and loaded the tensioned/lock seat belt with her torso and pelvis. Her seat belt loading resulted in a right clavicle fracture and chest contusion. Her lower extremities

contacted the glove box, resulting in a right knee contusion. Her right flank loaded the deployed seat-mounted side impact air bag.

The passenger rebounded back into her seat and came to rest. She exited the vehicle through the right front door under her own power and was transported by ambulance to a local trauma center where she was treated and released.

Second-Row Left Passenger Demographics

Age/sex: 14 years/female
 Height: 168 cm (66 in)
 Weight: 54 kg (120 lb)
 Eyewear: Unknown
 Seat type: Bench seat with split forward-folding seatback and integral head restraint
 Seat track position: Non-adjustable
 Manual restraint usage: Lap and shoulder belt
 Usage source: Vehicle inspection and interview
 Air bags: IC air bag available; not deployed
 Alcohol/drug involvement: No test given
 Egress from vehicle: Exited with assistance by EMS
 Transport from scene: EMS ambulance transport
 Type of medical treatment: Hospitalized for 1 day

Second-Row Left Passenger Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Comminuted open minimally displaced left fibular diaphyseal fracture with metallic foreign body in soft tissue posterior to fracture	854472.2	Isolated IPC Interior - Other interior objects (specify): Fragment from LF pretensioner	Certain

Source: emergency room record

Second-Row Left Passenger Kinematics

The 14-year-old second-row left passenger was belted and seated with a normal posture. Her legs were extended forward, resting in the footwell of the second-row left position. At impact, the emergency mode of the seat belt retractor locked the spool of the webbing. The passenger initiated a forward/rightward trajectory and loaded the locked webbing with her chest.

During the actuation of the driver seat belt pretensioner, the gas generator separated from the assembly and was projected into the interior of the vehicle. This fragment holed the left B-pillar trim panel and struck the left leg of the passenger. The fragment embedded into her leg, fracturing her left fibula in mid-shaft.

The passenger rebounded from the impact back into her seat in her seat belt. She was assisted from the vehicle by EMS and transported by ambulance to a local trauma center. She was evaluated and underwent a procedure to remove the pretensioner fragment. She was hospitalized for one day and released with a walking boot.

Second-Row Right Passenger Demographics

Age/sex: 14 years/female
 Height: Unknown
 Weight: Unknown
 Eyewear: Unknown
 Seat type: Bench seat with split forward-folding seatback and integral head restraint
 Seat track position: Non-adjustable
 Manual restraint usage: Lap and shoulder belt
 Usage source: Vehicle inspection, police crash report
 Air bags: IC air bag available; deployed
 Alcohol/drug involvement: No test given
 Egress from vehicle: Exited under own power
 Transport from scene: None
 Type of medical treatment: None

Second-Row Right Passenger Injury

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Not injured	N/A	N/A	N/A

Second-Row Right Passenger Kinematics

The 14-year-old second-row right passenger was belted and seated with a normal posture. At impact, the emergency mode of the seat belt retractor locked the spool of the webbing. The passenger initiated a forward/rightward trajectory and loaded the locked webbing with her torso. She rode down the force of the crash and rebounded back into the seat. This occupant exited the vehicle under her own power and was not injured nor transported.

2018 Honda Ridgeline

Description

The 2018 Honda Ridgeline RTL-E (Figure 20) was identified by the VIN 5FPYK3F7XJBXXXXXX. The odometer reading was 70,299 km (43,683 miles). The Honda's powertrain consisted of a 3.5-liter, V6 gasoline engine linked to an automatic 6-speed transmission with 2- or 4-wheel-drive selection modes. Standard equipment included antilock braking system, electronic stability control, traction control, crash imminent braking, forward collision warning, dynamic brake support, lane departure warning, lane keeping assistance, and adaptive cruise control. The GVWR for this vehicle was 2,730kg (6,020 lb) with 1,420 kg (3,131 lb) front and 1460 kg (3,219 lb) rear. At the time of the crash the Honda had Firestone Destination 245/60R18 tires of the vehicle manufacturer's recommended size at all four axle locations.

The interior of the Honda was configured for seating for five occupants with the front-row bucket seats and a three-passenger rear bench. The driver's seat was adjusted in a rear track position. The front-row right seat was adjusted mid-track. All seating surfaces were leather. The head restraints in the front row were adjusted full down. Manual restraint was provided by 3-point lap and shoulder seat belts. The front seat belt had retractor pretensioners. Supplemental restraint consisted of dual stage frontal and seat mounted side impact air bags for the driver and front-row right position and IC air bags for the second-row positions.



Figure 20. Right front view of the Honda



Figure 21. Overhead view of the Honda's overlapping frontal damage

Exterior Damage

The front plane of the Honda was damaged in the crash sequence. The damage pattern extended across entire 171 cm (67.3 in) end width with overlapping damage from events 1 and 2 (Figure 21). The direct damage from the event 1 crash began 15 cm (5.9 in) right of center and extended 63 cm (24.8 in) to the left corner. The CDC associated to this Event 1 damage pattern was 11FDEW1 (PDOF = 330 degrees).

In the frontal deformation, a distinct 26 cm (10.2 in) pattern from the impact with the brick pillar was evident. The center of this pattern was located 21 cm (8.3 in) left of the vehicle's centerline. The CDC of this Event 2 damage pattern was 12FYEN1 (PDOF = 0 degrees).

A single crush profile was measured along the front bumper reinforcement on a field 136 cm (53.5 in). The residual crush was as follows: C1 = 4 cm (1.6 in), C2 = 14 cm (5.5 in), C3 = 21 cm (8.3 in), C4 = 7 cm (2.8 in), C5 = 0 cm (0 in), C6 = 0 cm (0 in). Maximum crush was located 8 cm (3.1 in) left of center.

The total delta V calculated by the WinSMASH program using the overlapping profile was 14 km/h (9 mph). The longitudinal and lateral delta V components were -12 km/h (7 mph) and 7 km/h (4 mph). These results were considered low. For comparison, the maximum longitudinal and lateral delta V components recorded by the EDR for the Event 1 vehicle-to-vehicle impact were -24 km/h (-15 mph) and 13 km/h (8 mph).

Event Data Recorder

The Honda had an air bag control module mounted to the center tunnel of the vehicle beneath the center instrument stack. The control unit monitored three-dimensional acceleration and roll rate, and commanded the actuation or deployment of pretensioners and inflatable restraint systems. The module also had EDR capabilities. During the SCI vehicle inspection the Honda EDR data was imaged using the Bosch CDR tool and software version 21.2.1, via a connection to the diagnostic link connector and onboard battery power. The imaged data is included in Appendix B of this report and reported with CDR version 21.5.1.

The requirements for event recording included a change in longitudinal or lateral velocity of 8 km/h (5 mph) or greater over a 150-millisecond timeframe, or commandment of a non-reversible restraint device (air bag). The EDR typically would record only one event, unless the time zero values for multiple events occurred within 5 seconds of one another. In this manner, a non-deployment event could be recorded and locked if it occurred within 5 seconds of a deployment event. By definition, a deployment event was any recognized event in which the control unit commanded deployment of an air bag system. A non-deployment event did not deploy air bags but could include pretensioner actuation-only commanded events. The module had the capacity to record two events.

System status data, inclusive of reported diagnostic trouble codes (DTCs), safety belt usage of front-row occupants, and vehicle ignition cycle at the time of the event were recorded. Associated to the recording of each respective event was an asynchronous 5 second pre-crash buffer that recorded various vehicle parameters in 0.5-second intervals. Data recorded included

vehicle speed, accelerator pedal percentage, service brake status, ABS activity, stability control activity, steering input, and engine speed.

The EDR was imaged on ignition cycle 5,778 and the file contained two recorded events, which occurred 1.0 seconds apart. Both events occurred on ignition cycle 5,772 and the data sets were completely recorded. These events were associated to SCI crash Events 1 and 2.

Event Record 1

This event was a deployment event triggered by the impact with the Hyundai. The air bag warning lamp was off. The maximum recorded longitudinal and lateral delta Vs were -24 km/h (-15 mph) and 13 km/h (8 mph). The retractor and anchor pretensioners actuated at 14 and 22 milliseconds. Driver’s frontal air bag stage one and two deployed at 33 and 63 milliseconds while the passenger air bag stage one and two deployed at 23 and 53 milliseconds. The seat-mounted side impact and IC air bags deployed at 40 milliseconds. The associated pre-crash data is presented in Table 3.

Table 3.V2 Pre-crash Data

Time (sec)	Speed (km/h [mph])	Accel. Pedal (%)	Service Brake	ABS Activity	Steering Input	Engine rpm
-5.0	75 [47]	14	Off	Off	0	1,200
-4.5	74 [46]	14	Off	Off	0	1,200
-4.0	73 [45]	16	Off	Off	0	1,200
-3.5	73 [45]	18	Off	Off	0	1,300
-3.0	73 [45]	19	Off	Off	-5	1,300
-2.5	72 [45]	20	Off	Off	-5	1,300
-2.0	72 [45]	25	Off	Off	-5	1,300
-1.5	72 [45]	28	Off	Off	0	1,400
-1.0	71 [44]	0	On	Off	-40	1,200
-0.5	71 [44]	0	On	Off	-110	900
0.0	71 [44]	0	On	Off	-95	900

The data trends indicated the vehicle approached the crash site at a steady speed. The driver perceived the Hyundai cross its path and reacted by steering right and braking. This avoidance maneuver was recorded at the 1.0-second pre-crash interval.

Event Record 2

This event was associated to the Honda’s impact with the brick pillar (SCI event 2). At the time of the event, the air bag warning lamp was on. Although the maximum longitudinal delta V was only -5 km/h (-3 mph), the sudden deceleration of the pillar impact was considered severe enough by ACM to warrant air bag deployment; however, the air bags had previously deployed during event 1 of the sequence. The impact could be termed a deployment level event. The pretensioners and frontal air bags would have deployed. The speed of the Honda at AE was 30 km/h (19 mph).

Occupant Data

The Honda was driven by a male with a female front passenger. The police report indicated both occupants were belted, confirmed by the observations of the SCI vehicle inspection and the

imaged EDR data. The retractor and lower anchor pretensioners of both front seat belts were actuated and the webbing was observed in the extended/worn position. The police report coded both occupants with B-level (non-incapacitating) injuries although only the passenger was transported to a hospital. The extent of their injuries is not known.

2018 Chevrolet Cruze

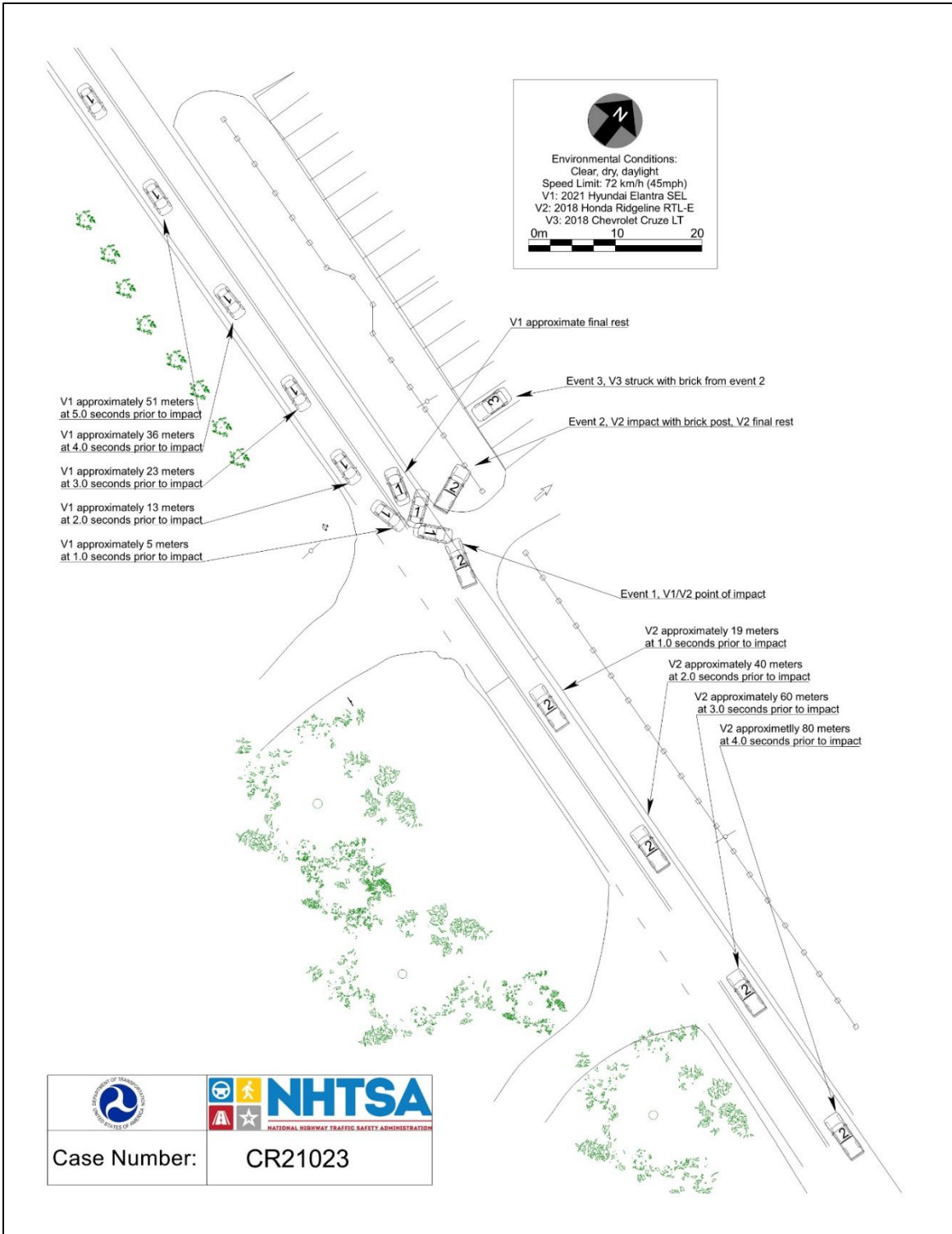
Description

The 2018 Chevrolet Cruze was identified by the VIN 3G1BE6SM8JSXXXXXX. The Chevrolet was not available for inspection.

Exterior Damage

According to the police report, the Chevrolet was parked and unoccupied in the parking lot that ran parallel with the road. The Chevrolet was struck by a brick as a result of Event 2. Extent of the damage is unknown.

Crash Diagram



Appendix A: 2020 Hyundai Elantra Event Data Recorder Report²

² The EDR report contained in this technical report was imaged by the vehicle manufacturer during the vehicle inspection using the Hyundai/Kia EDR tool. The EDR report has been sanitized to remove potential personal identifiable information.



Vehicle Information

HYUNDAI ELANTRA(CP7) 2021 AIRBAG SYSTEM	
VIN as Programmed into EMS	KMHLS4AG2MU

Additional Information

User-entered VIN	KMHLS4AG2MU
User Name	
Case Number	
Crash Date	--
Saved-on Date	2021-10
EDR Tool Version	E-P-H-01-00-0044
EDR Report Version	EDR002-R01
Tire Size(s)	--
Memo	Through DLC

▫ 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/Accessory 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.

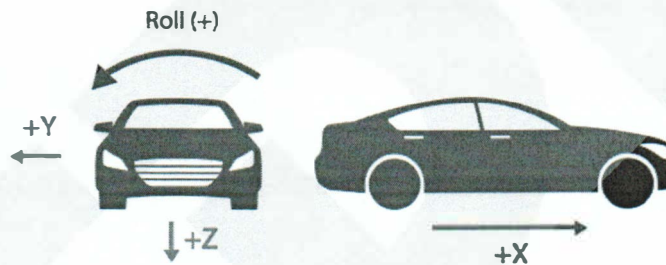
Data Limitation

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.

- 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).
- 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.
- 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-AA100(AA02)
ECU SW Version as programmed into ACU	1.01
EDR Version as programmed into ACU	0420

< 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]	305
Ignition cycle, download [cycle]	306

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	55	2500	0	0	4.7	ON	OFF	ON	0
-4.5	53	2900	0	0	1.5	ON	OFF	ON	0
-4.0	51	3400	0	0	5.5	ON	OFF	ON	0
-3.5	47	3700	0	0	9.3	ON	OFF	ON	0
-3.0	42	4400	0	0	17.7	ON	OFF	ON	0
-2.5	38	4100	0	0	21.3	ON	OFF	ON	0
-2.0	32	3500	0	0	27.4	ON	OFF	ON	15
-1.5	27	2900	0	0	25.7	ON	OFF	ON	80
-1.0	22	2500	0	0	21.1	ON	OFF	ON	110
-0.5	19	2000	0	0	0.0	OFF	OFF	ON	250
0.0	18	1900	0	0	0.0	OFF	OFF	ON	250

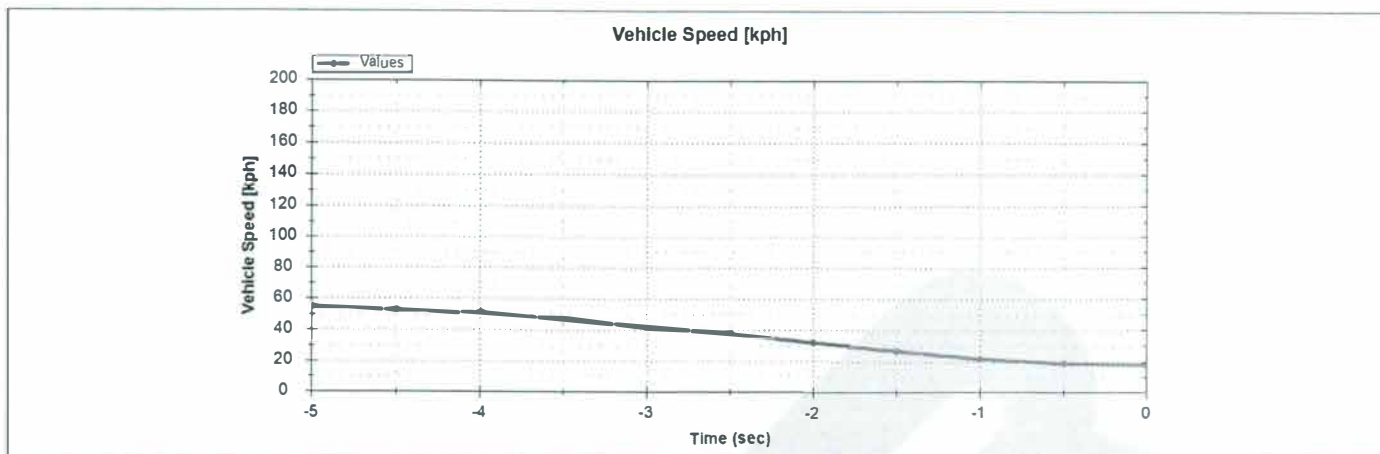
Pre-Crash Information 2 (-5 ~ 0 sec)

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	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-4.5	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-4.0	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-3.5	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-3.0	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-2.5	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-2.0	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-1.5	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-1.0	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
-0.5	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error
0.0	Sports Mode / Manual Shift / Paddle Shift	ON	53	MPH	Canceled	System without Error

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

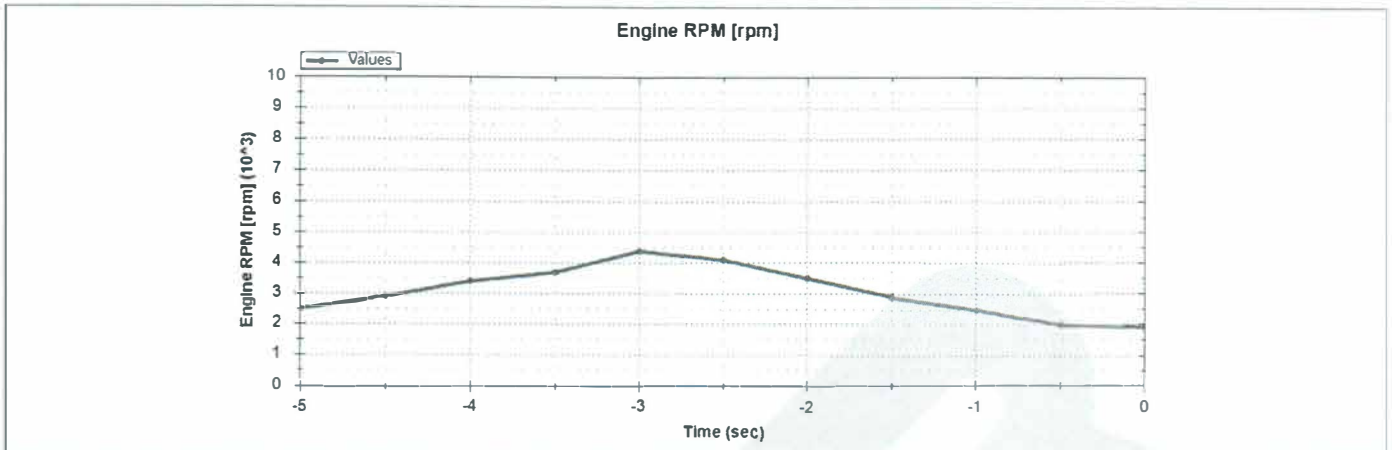
Time (sec)	FCA (Function status)	FCA (Warning Level)	FCA (Fail info)	Time (sec)	FCA (Function status)	FCA (Warning Level)	FCA (Fail info)
-5.0	ON	No Warning / Invalid or Not supported	Normal	-2.5	ON	No Warning / Invalid or Not supported	Normal
-4.9	ON	No Warning / Invalid or Not supported	Normal	-2.4	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 1 >
 Vehicle Speed



Num	Time (sec)	Vehicle Speed [kph]
1	-5.0	55
2	-4.5	53
3	-4.0	51
4	-3.5	47
5	-3.0	42
6	-2.5	38
7	-2.0	32
8	-1.5	27
9	-1.0	22
10	-0.5	19
11	0.0	18

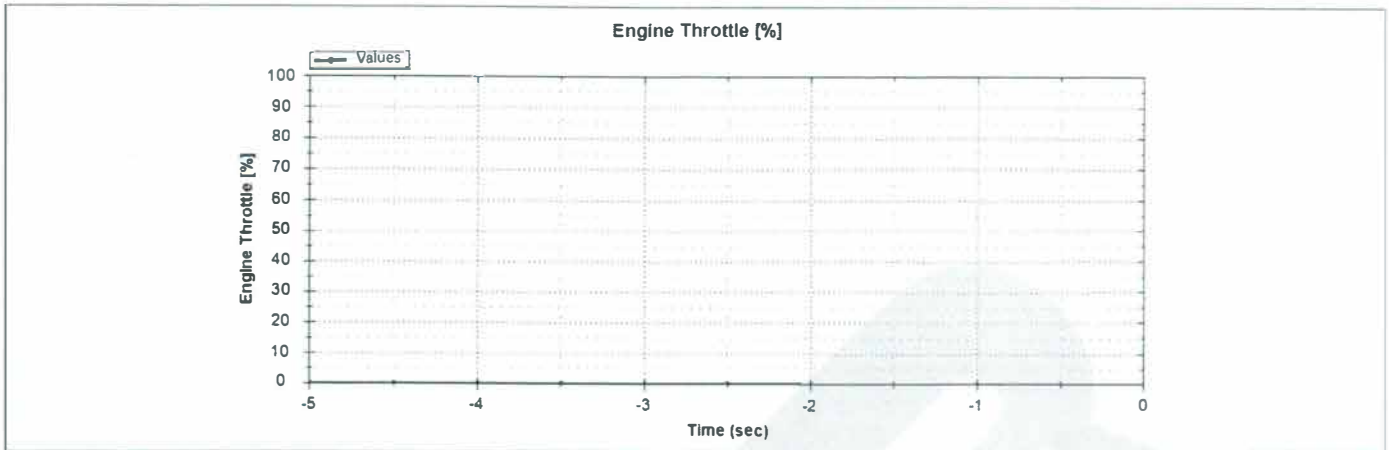
< Event 1 > Engine RPM



Num	Time (sec)	Engine RPM [rpm]
1	-5.0	2500
2	-4.5	2900
3	-4.0	3400
4	-3.5	3700
5	-3.0	4400
6	-2.5	4100
7	-2.0	3500
8	-1.5	2900
9	-1.0	2500
10	-0.5	2000
11	0.0	1900

< Event 1 >

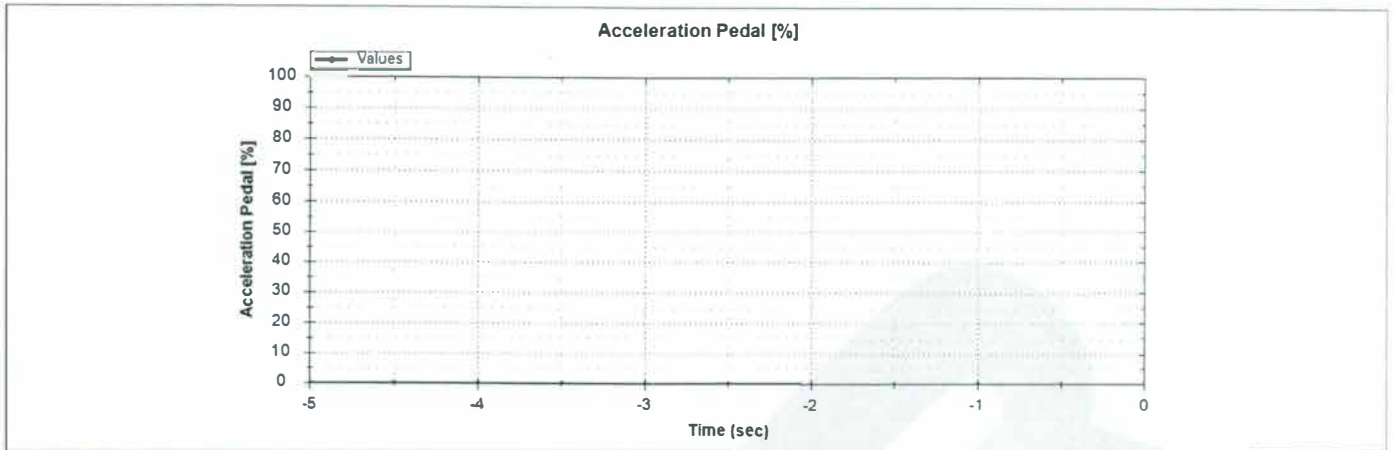
Engine Throttle



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

< Event 1 >

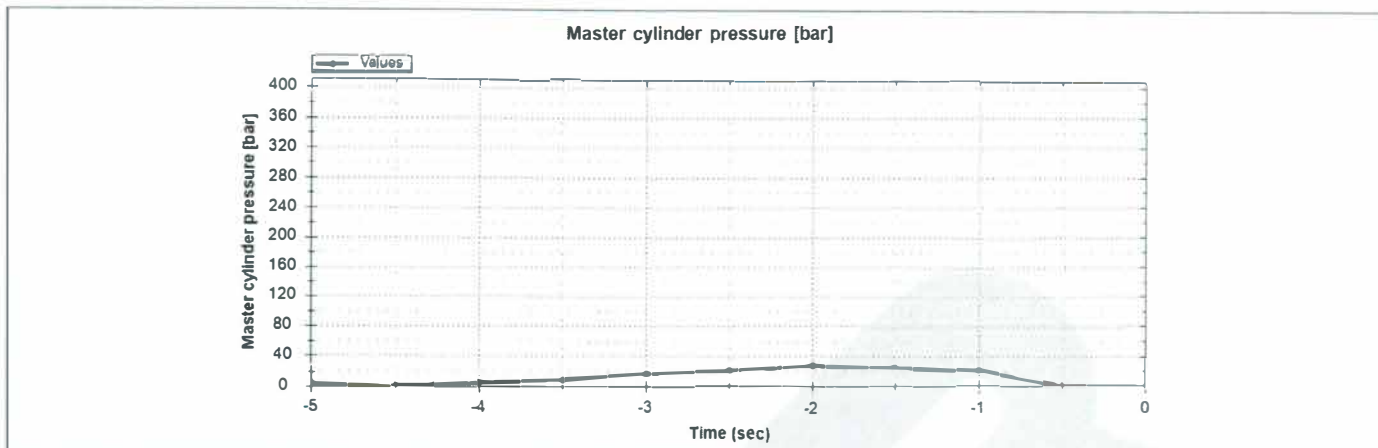
Acceleration Pedal



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

< Event 1 >

Master cylinder pressure



Num	Time (sec)	Master cylinder pressure [bar]
1	-5.0	4.7
2	-4.5	1.5
3	-4.0	5.5
4	-3.5	9.3
5	-3.0	17.7
6	-2.5	21.3
7	-2.0	27.4
8	-1.5	25.7
9	-1.0	21.1
10	-0.5	0.0
11	0.0	0.0

< Event 1 >

Service Brake

Num	Time (sec)	Service Brake [on/off]
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	OFF
11	0.0	OFF

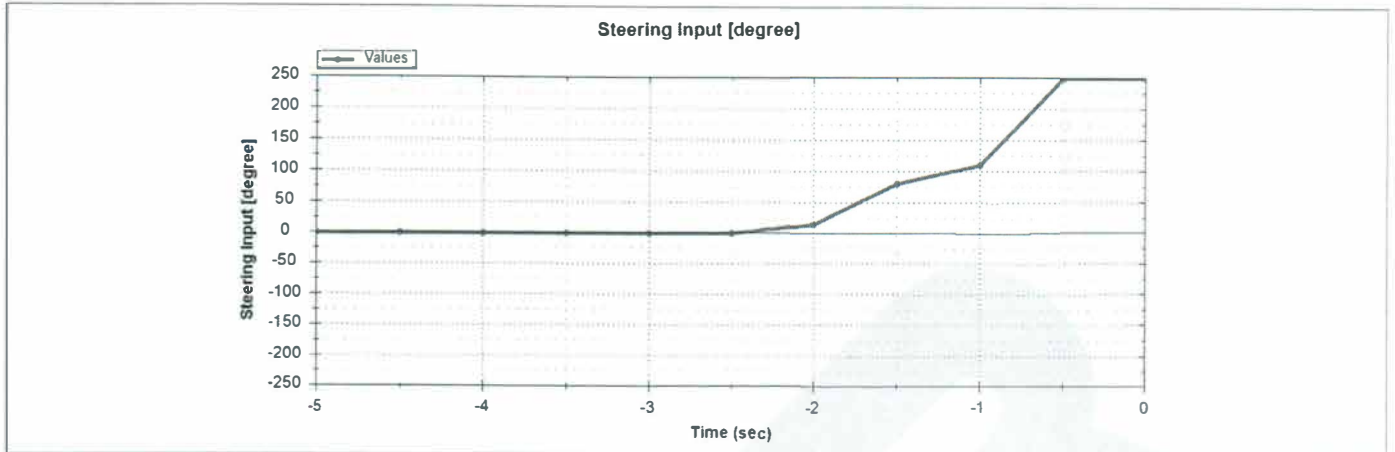
ABS Activity

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	ON

< 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	0
7	-2.0	15
8	-1.5	80
9	-1.0	110
10	-0.5	250
11	0.0	250

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

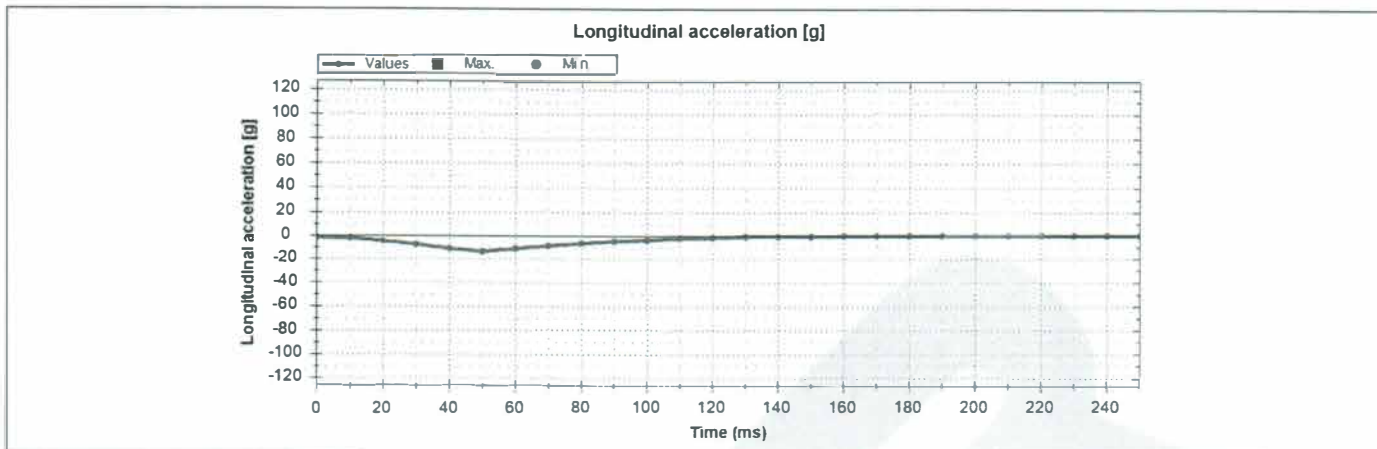
Front airbag deployment time, driver (first stage) [msec]	46
Front airbag deployment time, passenger (first stage) [msec]	46
Front airbag deployment time, driver (second stage) [msec]	49
Front airbag deployment time, passenger (second stage) [msec]	49
Front airbag deployment time, driver (third stage) [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]	No deployment
Front side airbag deployment time, passenger [msec]	60
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]	60
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]	46
Seat belt pretensioner deployment time, passenger [msec]	46
Rear belt pretensioner deployment time, driver [msec]	Not supported

Rear belt pretensioner deployment time,passenger [msec]	Not supported
Anchor pretensioner deployment time,driver [msec]	Not supported
Anchor pretensioner deployment time,passenger [msec]	Not supported
Adaptive load limiter deployment time,driver [msec]	No deployment
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)

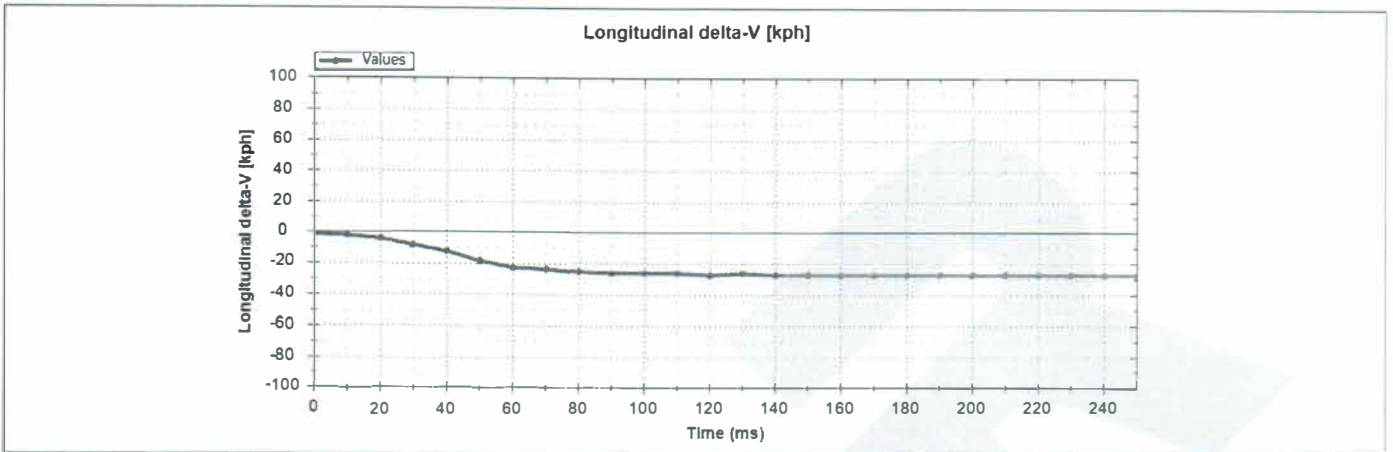


Num	Time (ms)	Longitudinal acceleration [g]
1	0.0	-1.5
2	10.0	-2.0
3	20.0	-4.5
4	30.0	-7.5
5	40.0	-11.0
6	50.0	-13.5
7	60.0	-11.0
8	70.0	-8.5
9	80.0	-6.5
10	90.0	-4.5
11	100.0	-3.5
12	110.0	-2.0
13	120.0	-1.5
14	130.0	-0.5
15	140.0	-0.5
16	150.0	-0.5
17	160.0	0.0
18	170.0	0.0
19	180.0	0.0
20	190.0	0.0
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 1 >

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

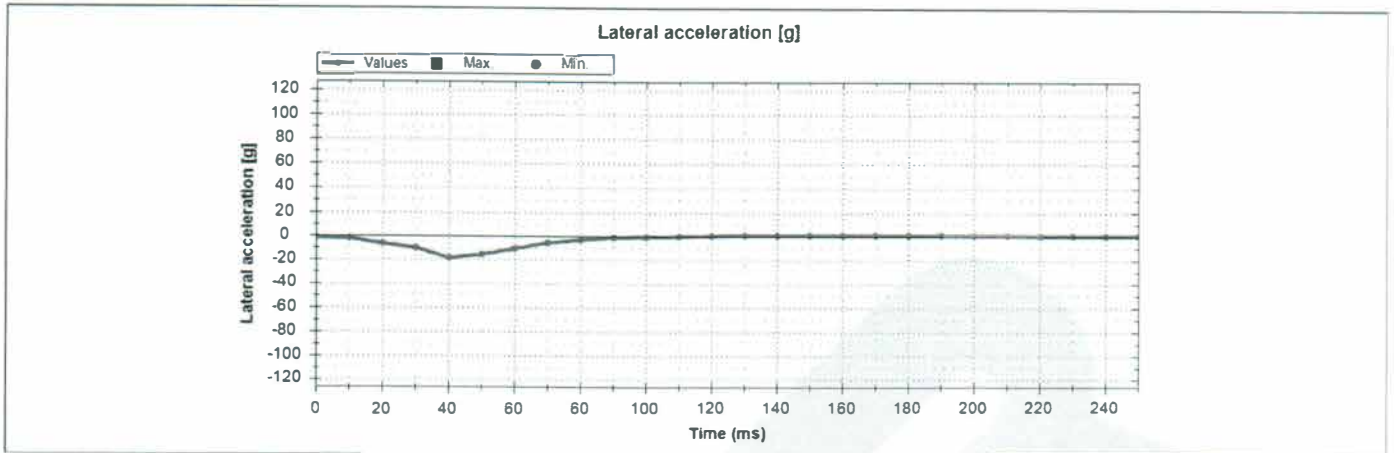
Max. delta-V [kph]	-27
Time, Max. delta-V [msec]	147.5



Num	Time (ms)	Longitudinal delta-V [kph]
1	0.0	-1
2	10.0	-2
3	20.0	-4
4	30.0	-8
5	40.0	-12
6	50.0	-18
7	60.0	-22
8	70.0	-23
9	80.0	-25
10	90.0	-26
11	100.0	-26
12	110.0	-26
13	120.0	-27
14	130.0	-26
15	140.0	-27
16	150.0	-27
17	160.0	-27
18	170.0	-27
19	180.0	-27
20	190.0	-27
21	200.0	-27
22	210.0	-27
23	220.0	-27
24	230.0	-27
25	240.0	-27
26	250.0	-27

< Event 1 >

Lateral crash pulse_acceleration (g, 0 ~ 250msec)

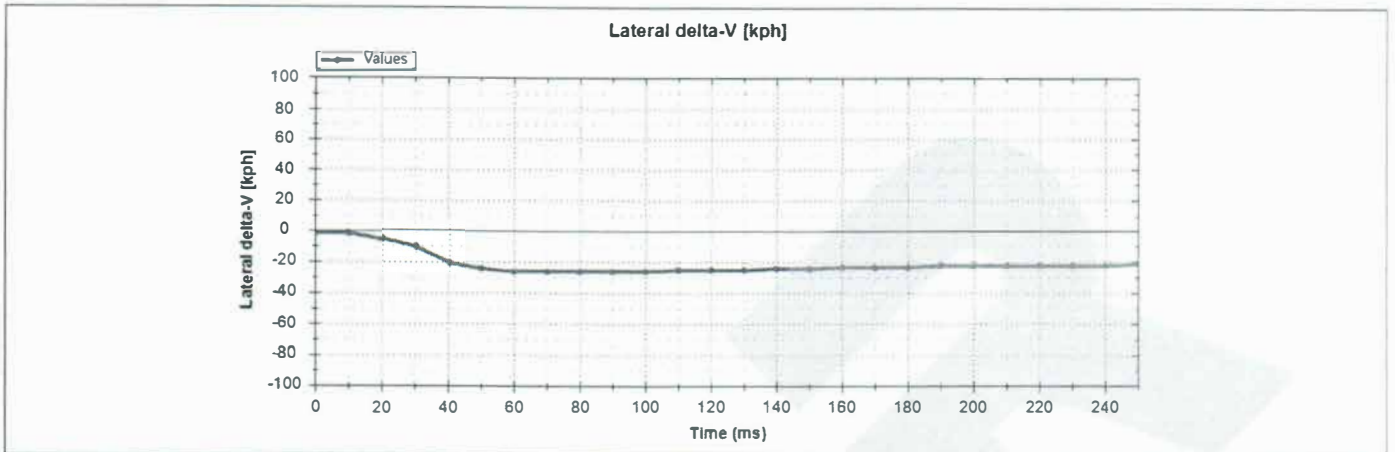


Num	Time (ms)	Lateral acceleration [g]
1	0.0	-1.5
2	10.0	-2.0
3	20.0	-6.5
4	30.0	-10.0
5	40.0	-18.5
6	50.0	-15.5
7	60.0	-10.5
8	70.0	-5.5
9	80.0	-3.0
10	90.0	-1.0
11	100.0	-0.5
12	110.0	0.0
13	120.0	0.5
14	130.0	1.0
15	140.0	1.0
16	150.0	1.0
17	160.0	1.0
18	170.0	1.0
19	180.0	1.0
20	190.0	1.0
21	200.0	1.0
22	210.0	1.0
23	220.0	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]	-27
Time, Max. delta-V [msec]	65.0



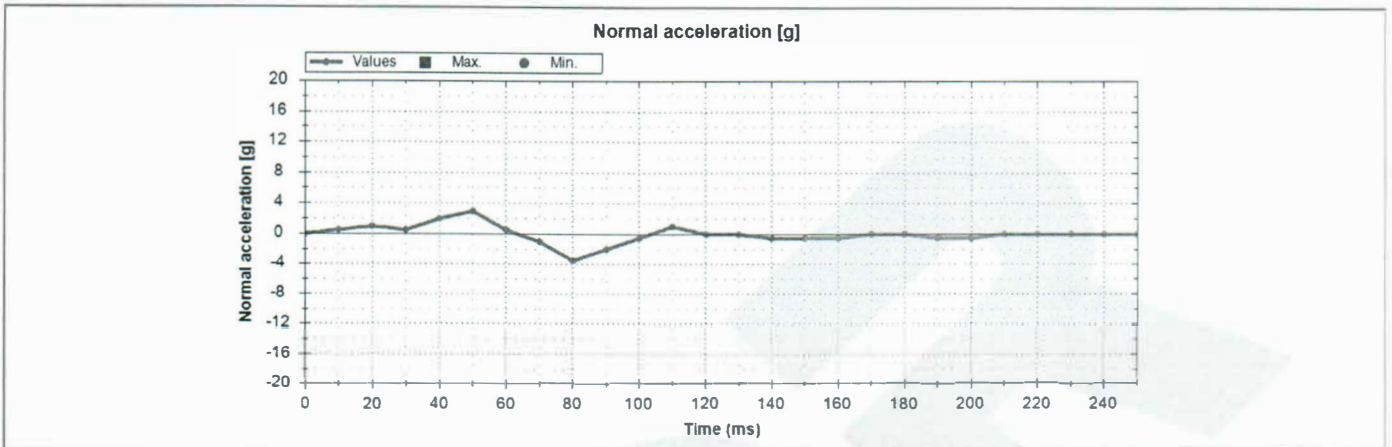
Num	Time (ms)	Lateral delta-V [kph]
1	0.0	-1
2	10.0	-1
3	20.0	-5
4	30.0	-10
5	40.0	-20
6	50.0	-24
7	60.0	-26
8	70.0	-26
9	80.0	-26
10	90.0	-26
11	100.0	-26
12	110.0	-25
13	120.0	-25
14	130.0	-25
15	140.0	-24
16	150.0	-24
17	160.0	-23
18	170.0	-23
19	180.0	-23
20	190.0	-22
21	200.0	-22
22	210.0	-22
23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

< Event 1 >

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

Time, Max. delta-V, resultant [msec]	100.0
--------------------------------------	-------

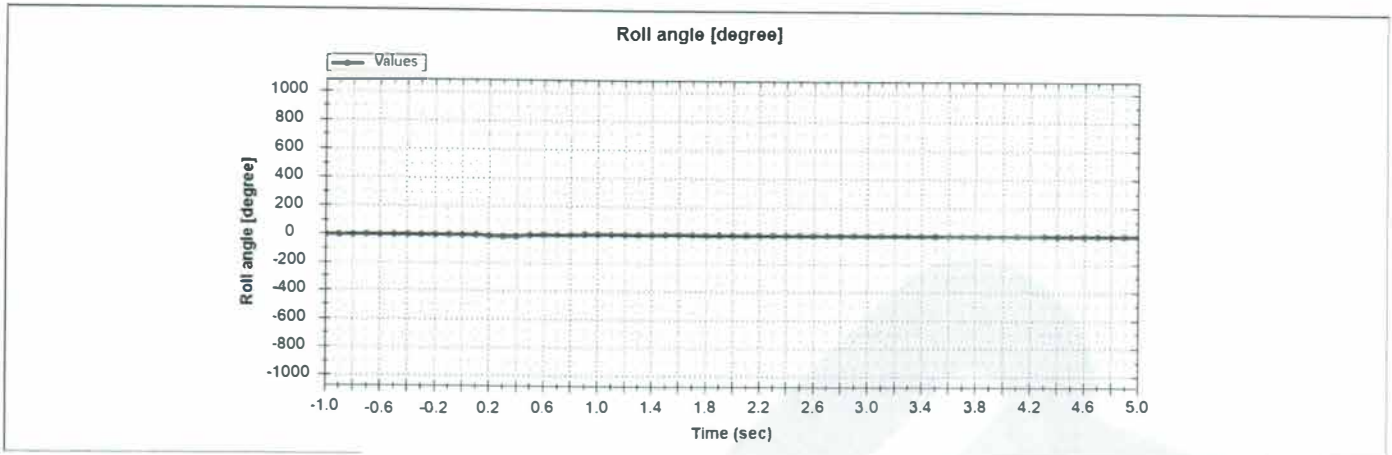
Normal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Normal acceleration [g]
1	0.0	0.0
2	10.0	0.5
3	20.0	1.0
4	30.0	0.5
5	40.0	2.0
6	50.0	3.0
7	60.0	0.5
8	70.0	-1.0
9	80.0	-3.5
10	90.0	-2.0
11	100.0	-0.5
12	110.0	1.0
13	120.0	0.0
14	130.0	0.0
15	140.0	-0.5
16	150.0	-0.5
17	160.0	-0.5
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 >

Roll angle (degree, -1 ~ 5sec)

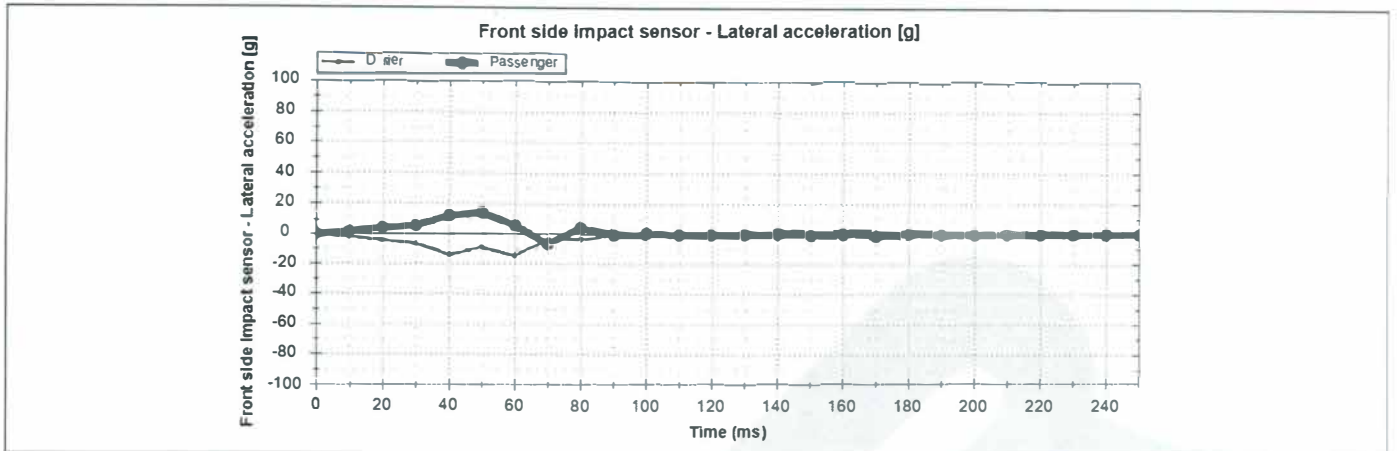


Num	Time (sec)	Roll angle [degree]
1	-1.0	-1
2	-0.9	-2
3	-0.8	-1
4	-0.7	0
5	-0.6	0
6	-0.5	0
7	-0.4	0
8	-0.3	0
9	-0.2	0
10	-0.1	0
11	0.0	0
12	0.1	0
13	0.2	-6
14	0.3	-10
15	0.4	-7
16	0.5	-1
17	0.6	3
18	0.7	2
19	0.8	2
20	0.9	5
21	1.0	6
22	1.1	6
23	1.2	6
24	1.3	5
25	1.4	5
26	1.5	6
27	1.6	7
28	1.7	5
29	1.8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

32	2.1	4
33	2.2	4
34	2.3	4
35	2.4	4
36	2.5	4
37	2.6	4
38	2.7	3
39	2.8	3
40	2.9	3
41	3.0	3
42	3.1	2
43	3.2	2
44	3.3	2
45	3.4	2
46	3.5	1
47	3.6	1
48	3.7	1
49	3.8	1
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 1 >

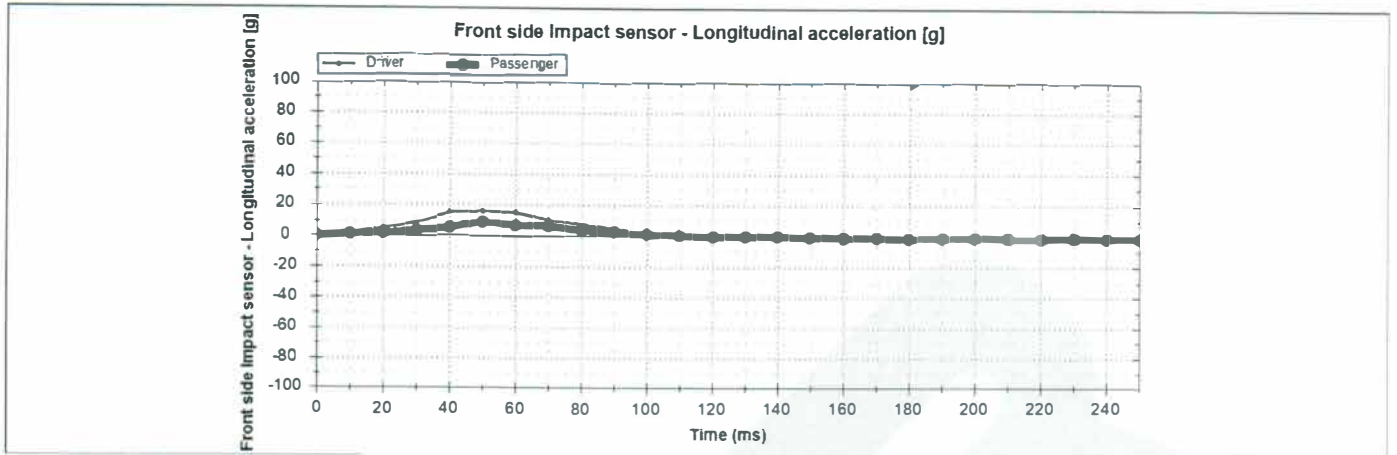
Front side impact sensor - Lateral acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Front driver side impact sensor - Lateral acceleration [g]	Front passenger side impact sensor - Lateral acceleration [g]
1	0.0	-0.5	0.5
2	10.0	-1.5	2.0
3	20.0	-4.0	4.5
4	30.0	-6.0	6.0
5	40.0	-13.5	12.5
6	50.0	-9.0	14.5
7	60.0	-14.0	6.0
8	70.0	-3.5	-6.5
9	80.0	-3.0	4.5
10	90.0	0.0	0.5
11	100.0	0.5	1.0
12	110.0	1.5	0.0
13	120.0	1.5	0.0
14	130.0	1.5	0.0
15	140.0	2.0	0.0
16	150.0	2.0	-0.5
17	160.0	2.0	-0.5
18	170.0	2.0	-0.5
19	180.0	2.0	0.0
20	190.0	2.0	0.0
21	200.0	2.0	0.0
22	210.0	2.0	0.0
23	220.0	2.0	0.0
24	230.0	1.5	0.0
25	240.0	1.5	0.0
26	250.0	1.5	0.0

< Event 1 >

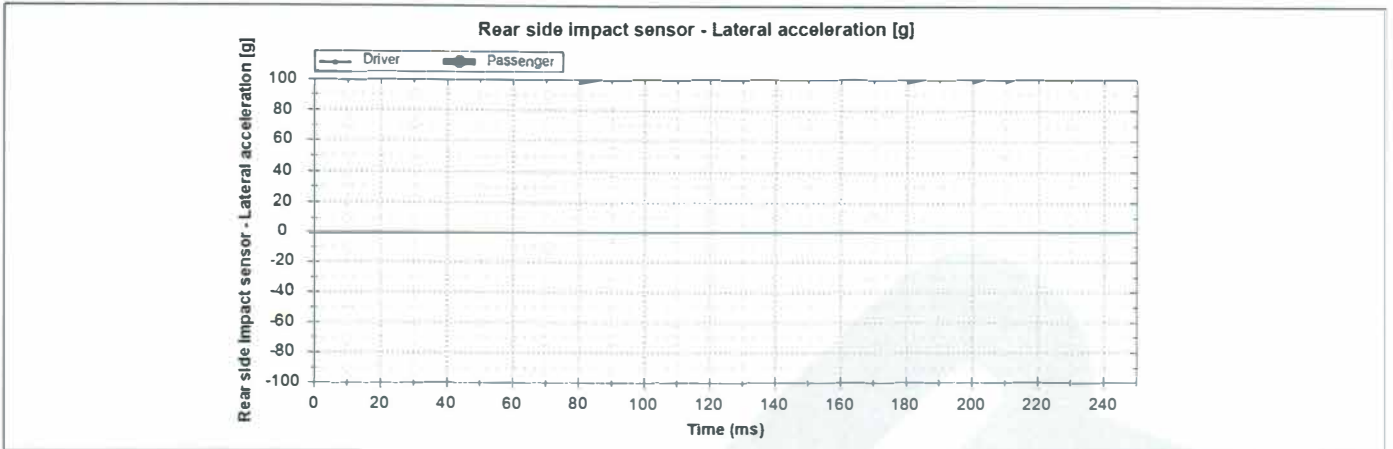
Front side Impact sensor - Longitudinal acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Front driver side Impact sensor - Longitudinal acceleration [g]	Front passenger side Impact sensor - Longitudinal acceleration [g]
1	0.0	0.5	0.5
2	10.0	3.0	1.5
3	20.0	5.5	2.0
4	30.0	9.0	4.0
5	40.0	15.5	5.5
6	50.0	16.5	9.5
7	60.0	16.0	7.5
8	70.0	11.0	7.0
9	80.0	8.0	4.0
10	90.0	5.0	3.0
11	100.0	2.5	2.0
12	110.0	1.0	1.0
13	120.0	0.0	0.5
14	130.0	-0.5	0.0
15	140.0	-0.5	0.0
16	150.0	-0.5	0.0
17	160.0	-1.0	-0.5
18	170.0	-1.0	-1.0
19	180.0	-1.0	-1.0
20	190.0	-1.5	-0.5
21	200.0	-1.5	-0.5
22	210.0	-1.5	-1.0
23	220.0	-1.5	-1.0
24	230.0	-1.0	-0.5
25	240.0	-1.0	-1.0
26	250.0	-1.5	-1.0

< Event 1 >

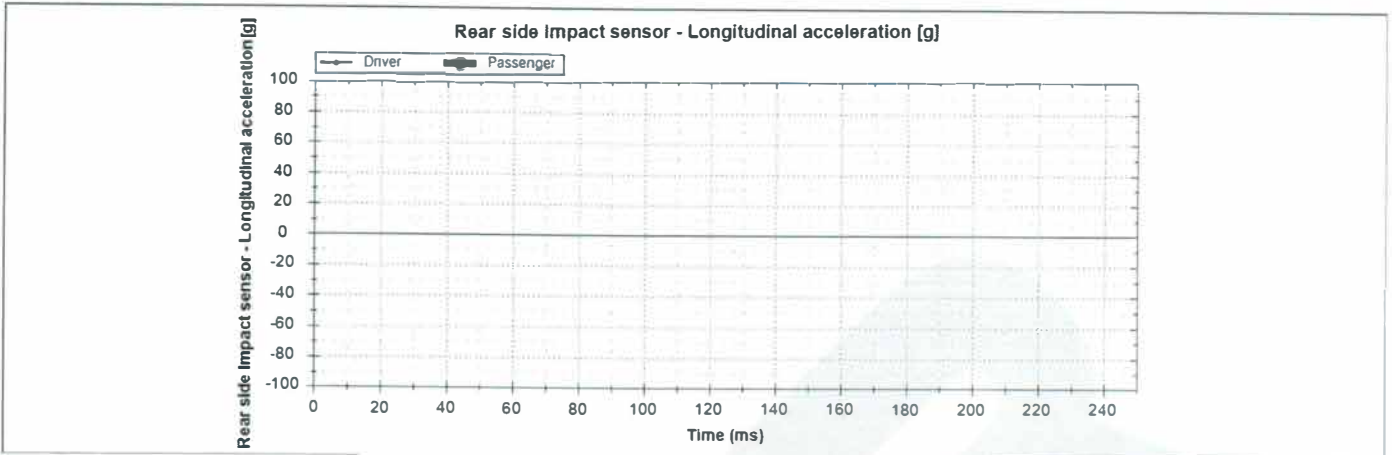
Rear side impact sensor – Lateral acceleration (g, 0 ~ 250msec)



Num	Time (ms)	Rear driver side impact sensor - Lateral acceleration [g]	Rear passenger side impact sensor - Lateral acceleration [g]
1	0.0	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 >

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

Hexidecimal data was deleted in order to remove potential personal identifiable information

Hexidecimal data was deleted in order to remove potential personal identifiable information

Hexidecimal data was deleted in order to remove potential personal identifiable information

Hexidecimal data was deleted in order to remove potential personal identifiable information



< Event 2 >

There is no recorded event.

ELANTRA

Appendix B: 2018 Honda Ridgeline Event Data Recorder Report³

³ The EDR report contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the vehicle inspection. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	5FPYK3F7XJB*****
User	
Case Number	
EDR Data Imaging Date	10/07/2021
Crash Date	
Filename	CR21023_V2_ACM.CDRX
Saved on	Thursday, October 7 2021 at 14:58:31
Imaged with CDR version	Crash Data Retrieval Tool 21.2.1
Imaged with Software Licensed to (Company Name)	NHTSA
Reported with CDR version	Crash Data Retrieval Tool 21.5.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	2

Comments

No comments entered.

Data Limitations

General Information:

These limitations are intended to assist you in reading the event data that has been imaged from the vehicle's SRS control unit. They contain general information and are not specific to this particular event. Event data should be considered in conjunction with other available physical evidence from the vehicle and scene.

Honda and Acura passenger vehicles designated as 2013 or later model year production are designed to be compatible with the Bosch CDR tool. Only some 2012 model year vehicles are compatible with the Bosch CDR tool.

Recorded Crash Events:

Data for front, side, rear and rollover events can be recorded as either non-deployment or deployment events. Both types of events can contain pre-crash and crash data.

- A non-deployment event is recorded if the change in longitudinal or lateral velocity equals or exceeds 8km/h over a 150ms timeframe or another type of non-reversible deployable restraint device other than a front, side, or side curtain airbag (e.g. seatbelt pretensioner) is commanded to deploy. Except as indicated below, non-deployment events are not locked into memory and can be over-written by subsequent non-deployment or deployment events.
- A deployment event is recorded if front airbag(s), side airbag(s), or side curtain airbag(s) are commanded to deploy. Deployment events are locked into memory and cannot be over-written.

The SRS control unit typically records only one event. Two events can be recorded if the T0 (time zero) values for each event occur within 5 seconds of each other. Therefore, a non-deployment event can be recorded and locked if it occurs within 5 seconds of a deployment event.

T0 is established by whichever of the following occurs first: (1) the change in longitudinal velocity at the SRS control unit equals or exceeds 0.8km/h over a 20ms timeframe; or (2) the change in lateral velocity at the SRS control unit equals or exceeds 0.8km/h over a 5ms timeframe; or (3) the occupant restraint control algorithm is activated; or (4) a commanded deployment of any type of non-reversible deployable restraint device (e.g. airbag or seatbelt pretensioner). If the time to deploy equals 0, then the command to deploy occurred at T0 or the device was not commanded to deploy during the event.

TEnd (end of event) is established by whichever of the following occurs first: (1) the change in longitudinal and lateral Delta V equals or falls below 0.8km/h over a 20ms timeframe; or (2) the occupant restraint control algorithm resets; or (3) time from T0 exceeds 300ms.

Data:

- Data recorded by the SRS control unit and imaged by the CDR tool is displayed relative to T0, not the time at which the vehicle made contact with another vehicle or object.
- Pre-crash data is recorded at 2 samples per second within the 5 seconds before T0. The sampling point at 0.0 is taken at T0 and is asynchronous with the other sample points. The time between -0.5 and 0.0 is not recorded and is between 1 and 500ms.
- Delta V data is recorded at 100 samples per second from T0 to 250ms or T0 to TEnd plus 30ms.
- Acceleration data is recorded at 100 samples per second from T0 to 250ms.
- Delta V, longitudinal reflects the change in velocity that the SRS control unit experienced in the longitudinal direction during the recorded portion of the event and is not the speed the vehicle was traveling before the event.

- Depending on the severity of the event and the accelerometer characteristics, saturation of the SRS control unit longitudinal or lateral accelerometers may occur, decreasing the recorded Delta V value.
- Time, accelerometer range exceeded is recorded if saturation of the SRS control unit longitudinal, lateral and/or normal (vertical) accelerometer occurs. The recorded data is the time at which the sensor range is first exceeded.
- The maximum recording capability of Deployment Command Data is 254ms or 255ms depending on vehicle model. A recorded value of 254ms or 255ms may indicate that the recording maximum was exceeded. In this case, the deployment command may have occurred between the recorded time and TEnd.
- Speed, vehicle indicated data is the speed indicated to the driver by the speedometer, not actual vehicle ground speed. Data accuracy can be affected by various factors, including but not limited to the following:
 - Significant changes in tire size from the factory setting
 - Wheel lockup or spin
 - Data latency or filtering and hysteresis within the speedometer module
- Accelerator pedal position, percent full is the ratio of accelerator pedal position compared to the fully depressed position.
- PCM (Powertrain Control Module) derived accelerator pedal position, percent full may differ from the accelerator pedal position, percent full under circumstances such as brake override activation or cruise control system engagement. These circumstances are based on vehicle equipment application and vary by model.
- Steering input angle is recorded in 5 degree increments.
- Side air bag suppression system status, right front passenger is recorded when the vehicle is equipped with the Occupant Position Detection System (OPDS).
- Occupant size classification, right front passenger airbag suppressed data is recorded as yes (suppressed) if the front passenger seat weight sensor system determined the passenger seat was empty or occupied by a child-size occupant.
- EV mode data records the vehicle powertrain status, not a driver selected operation mode. EV mode is recorded as On when the vehicle is moving and the internal combustion engine is not operating. EV mode may be recorded as On or Off when the vehicle is stopped.
- If power to the SRS control unit is lost during an event, all or part of the data may not be recorded.

Roll Rate Data:

- Vehicle roll rate data is recorded separately from the non-deployment and deployment events as described above. Therefore, the T0 for the roll rate data may differ from the T0 for the other data in this report.
- Roll rate recording trigger (T0) is established by whichever of the following occurs first: (1) a rollover algorithm ON judgment (SRS control unit decision to command deployment); or (2) a change in relative roll angle at the SRS control unit equal to or exceeding 30 degrees (roll angle is not measured, but is calculated from the roll rate data); or (3) the rollover algorithm is activated.
- Once a recording trigger has been met, roll rate data is recorded for one rollover event at 10 samples per second from 1 second before to 2 seconds after T0. If a roll angle trigger is satisfied without a rollover algorithm ON judgment, the recorded roll rate data is unlocked and can be over-written by a subsequent rollover event. Roll rate data triggered by or recorded during a rollover algorithm ON judgment is locked into memory and cannot be over-written.
- If roll rate is detected at the SRS control unit during a non-deployment or deployment event but the recording trigger has not been satisfied, no roll rate data will be recorded. A graph of roll rate data will only be present in this report if roll rate data is recorded.

Data Element Sign Convention:

Except as noted below, all data is displayed in SAE J211 sign convention. The following table provides an explanation of the sign notation for data elements that may be included in this CDR report. All directional references to sign notation are from the perspective of the driver when seated in the vehicle facing the direction of forward vehicle travel.

Data element name	Positive sign indicates
Longitudinal Acceleration	Forward direction acceleration
Delta-V, Longitudinal	Forward direction acceleration
Lateral Acceleration	Left to right direction acceleration
Delta-V, Lateral	Left to right direction acceleration
Normal (Vertical) Acceleration	Downward direction acceleration
Vehicle Roll Rate*	See roll rate graph and data (if recorded)
Steering Input Angle*	Left Turn

*Not SAE J211 sign convention

Data Source:

All recorded data is measured and calculated within the SRS control unit except for the following parameters (if applicable) which are transmitted via the vehicle's communication network to the SRS control unit:

- Speed, vehicle indicated
- Accelerator pedal position, percent full
- Service brake
- ABS activity
- Stability control
- Steering input angle
- Engine RPM
- PCM derived accelerator pedal position, percent full
- EV mode
- Forward Collision Warning
- Collision Mitigation Braking System information
- Lane Keeping Assist System information
- Lane Departure Warning
- Road Departure Mitigation information
- Cruise Control status

- Adaptive Cruise Control status

Depending on vehicle feature content, capability, or conditions described above, the following items may not be recorded. If these items are not recorded, they will not be present in this document.

- EV mode
- Forward Collision Warning
- Collision Mitigation Braking System information
- Lane Keeping Assist System information
- Lane Departure Warning
- Road Departure Mitigation information
- Cruise Control status
- Adaptive Cruise Control status

Hexadecimal Data:

All data that has been specified for imaging is shown in the hexadecimal data section of this report. However, not all of this data is translated by the CDR tool. The SRS control unit may contain additional data that is not retrievable by the CDR tool.

Data Imaging:

If the SRS control unit is imaged outside of the vehicle, ensure that it is not moved, tilted or turned while connected to the CDR tool. Also, after imaging is complete, wait 3 minutes after removing the CDR tool before moving the SRS control unit. Not following this guideline could cause current non-deployment event data to be overwritten and a new event to be recorded. Current fault status could also be altered if the SRS control unit is imaged outside of the vehicle.

04002_HondaSRS_GEN2_r002

System Status at Retrieval

EDR Version	1.3.2.0
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System Status at Event (Event Record 1)

Multi-Event, Number of Events (1, 2)	1
Complete File Recorded (Yes/No)	Yes
Ignition Cycle, Download	5778
Maximum Delta-V, Longitudinal (MPH [km/h])	-15 [-24]
Time, Maximum Delta-V, Longitudinal (msec)	125.0
Maximum Delta-V, Lateral (MPH [km/h])	8 [13]
Time, Maximum Delta-V, Lateral (msec)	100.0
Time, Maximum Delta-V, Resultant (msec)	112.5
Time, Accelerometer Range Exceeded, Longitudinal (msec)	0
Time, Accelerometer Range Exceeded, Lateral (msec)	0
Time, Accelerometer Range Exceeded, Normal (msec)	0

Deployment Command Data (Event Record 1)

Pretensioner Deployment, Time to Fire, Driver (msec)	14
Pretensioner Deployment, Time to Fire, Right Front Passenger (msec)	14
Lap Pretensioner Deployment, Time to Fire, Driver (msec)	22
Lap Pretensioner Deployment, Time to Fire, Right Front Passenger (msec)	22
Frontal Air Bag Deployment, Time to Deploy First Stage, Driver (msec)	33
Frontal Air Bag Deployment, Time to Deploy First Stage, Right Front Passenger (msec)	23
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (msec)	63
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (msec)	53
Side Air Bag Deployment, Time to Deploy, Driver (msec)	40
Side Air Bag Deployment, Time to Deploy, Right Front Passenger (msec)	0
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Driver Side (msec)	40
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Right Side (msec)	0
Frontal Air Bag Deployment, 2nd Stage Disposal, Driver (Yes/No)	No
Frontal Air Bag Deployment, 2nd Stage Disposal, Right Front Passenger (Yes/No)	No

Pre-Crash Data -1 sec (Event Record 1)

Safety Belt Status, Driver	On
Safety Belt Status, Right Front Passenger	On
Seat Track Position Switch, Foremost, Status, Driver	No
Occupant Size Classification, Right Front Passenger Airbag Suppressed (Yes/No)	No
Frontal Air Bag Warning Lamp (On, Off)	Off
Ignition Cycle, Crash	5772

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 1) - Table 1 of 3

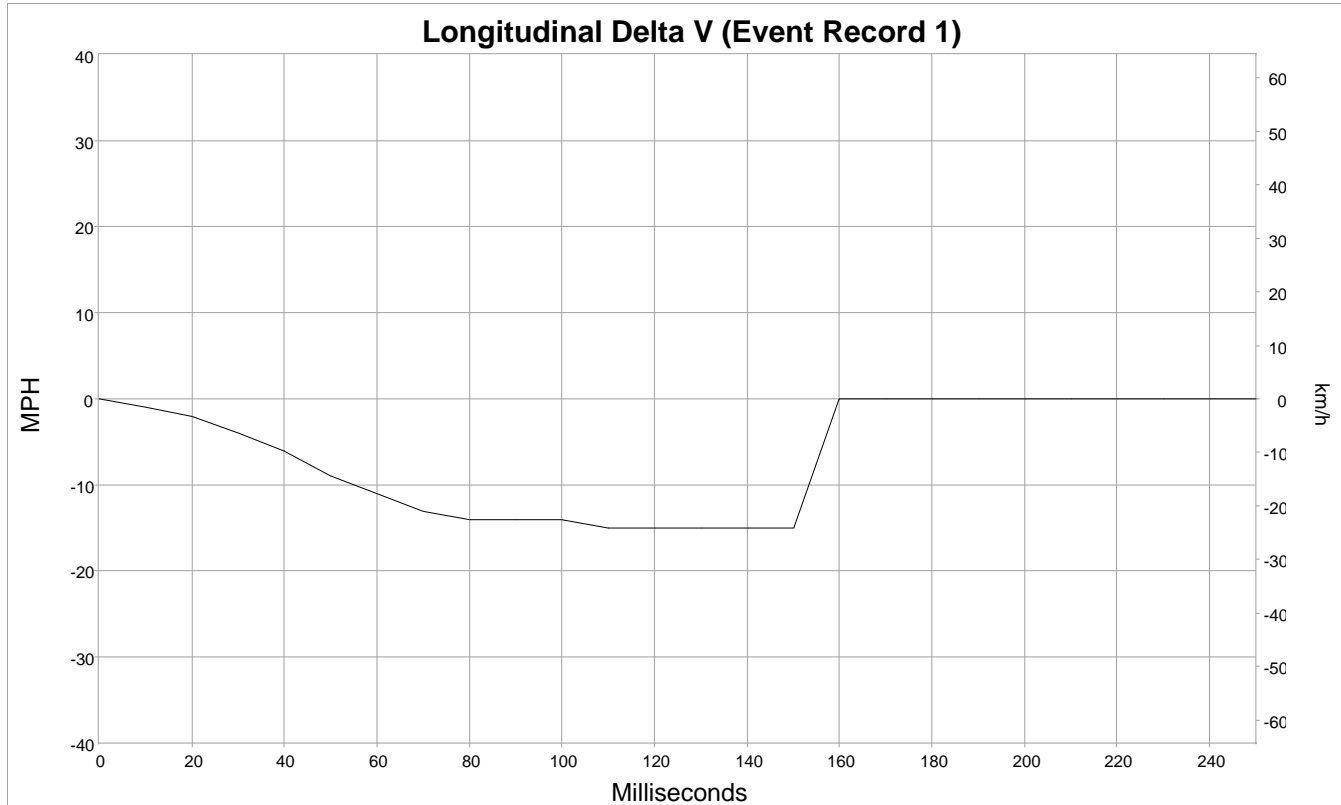
Time Stamp (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal Position, % full	Service Brake (On, Off)	ABS Activity (On, Off)	Stability Control (On, Off, Engaged)	Steering Input (deg)	Engine RPM
-5.0	47 [75]	14	Off	Off	On Non-Engaged	0	1,200
-4.5	46 [74]	14	Off	Off	On Non-Engaged	0	1,200
-4.0	45 [73]	16	Off	Off	On Non-Engaged	0	1,200
-3.5	45 [73]	18	Off	Off	On Non-Engaged	0	1,300
-3.0	45 [73]	19	Off	Off	On Non-Engaged	-5	1,300
-2.5	45 [72]	20	Off	Off	On Non-Engaged	-5	1,300
-2.0	45 [72]	25	Off	Off	On Non-Engaged	-5	1,300
-1.5	45 [72]	28	Off	Off	On Non-Engaged	0	1,400
-1.0	44 [71]	0	On	Off	On Non-Engaged	-40	1,200
-0.5	44 [71]	0	On	On	On Non-Engaged	-110	900
0.0	44 [71]	0	On	On	On Non-Engaged	-95	900

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 1) - Table 2 of 3

Time Stamp (sec)	PCM Derived Accelerator Pedal Position, % full	Forward Collision Warning (Not Warning/ Warning)	Collision Mitigation Braking System (Not Engaged/ Engaged)	Collision Mitigation Braking System, Forward Collision Warning (On/Off)	Lane Departure Warning (Not Warning/ Warning)	Road Departure Mitigation (Not Engaged/ Engaged)	Road Departure Mitigation, Lane Departure Warning (On/Off)
-5.0	14	Not warning	Not engaged	On	Not warning	Not engaged	On
-4.5	14	Not warning	Not engaged	On	Not warning	Not engaged	On
-4.0	16	Not warning	Not engaged	On	Not warning	Not engaged	On
-3.5	18	Not warning	Not engaged	On	Not warning	Not engaged	On
-3.0	19	Not warning	Not engaged	On	Not warning	Not engaged	On
-2.5	20	Not warning	Not engaged	On	Not warning	Not engaged	On
-2.0	25	Not warning	Not engaged	On	Not warning	Not engaged	On
-1.5	28	Not warning	Not engaged	On	Not warning	Not engaged	On
-1.0	0	Not warning	Not engaged	On	Not warning	Not engaged	On
-0.5	0	Not warning	Not engaged	On	Not warning	Not engaged	On
0.0	0	Not warning	Not engaged	On	Not warning	Not engaged	On

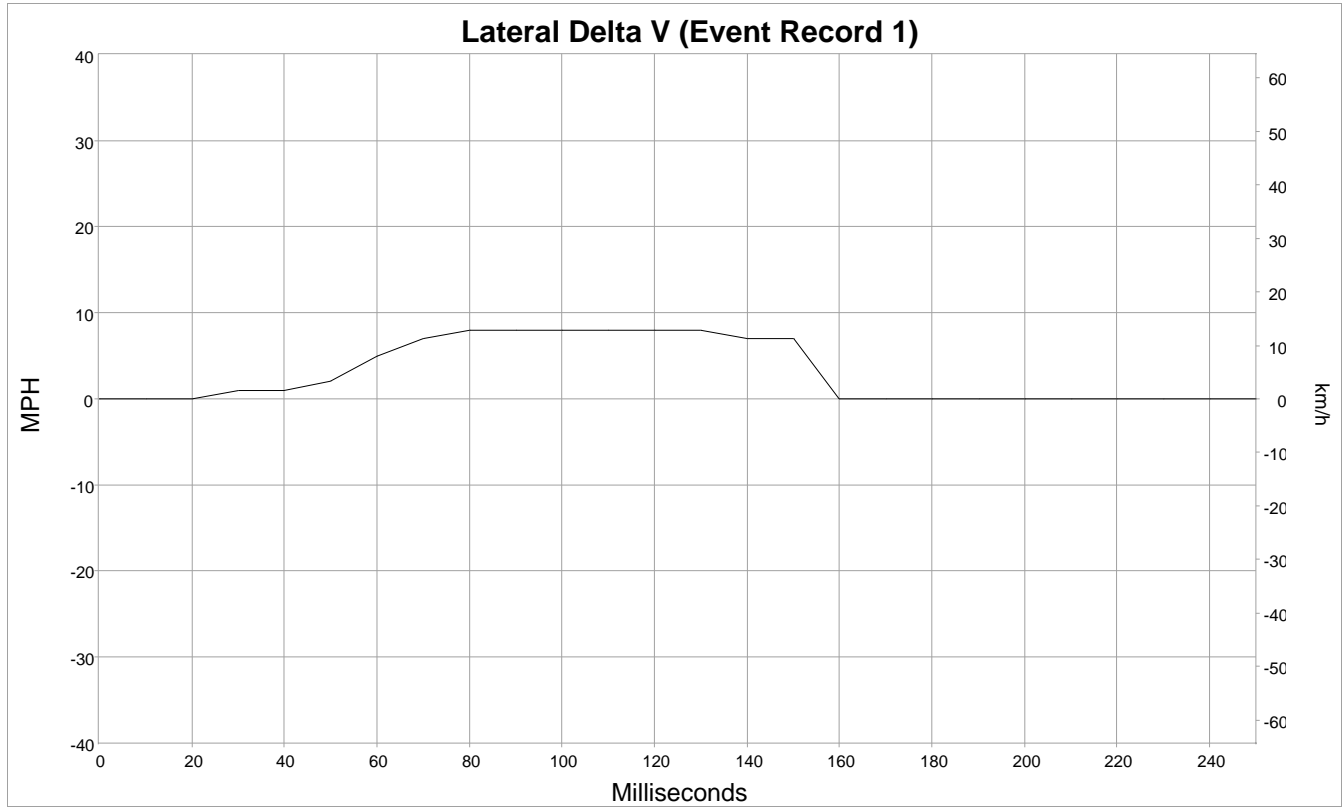
Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 1) - Table 3 of 3

Time Stamp (sec)	Adaptive Cruise Control (Not Engaged/ Engaged)	Adaptive Cruise Control (On/Off)	Lane Keeping Assist (Not Engaged/ Engaged)	Lane Keeping Assist (On/Off)	Cruise Control (Not Engaged/ Engaged)	Cruise Control (On/Off)
-5.0	Not engaged	On	Not engaged	On	Not Engaged	On
-4.5	Not engaged	On	Not engaged	On	Not Engaged	On
-4.0	Not engaged	On	Not engaged	On	Not Engaged	On
-3.5	Not engaged	On	Not engaged	On	Not Engaged	On
-3.0	Not engaged	On	Not engaged	On	Not Engaged	On
-2.5	Not engaged	On	Not engaged	On	Not Engaged	On
-2.0	Not engaged	On	Not engaged	On	Not Engaged	On
-1.5	Not engaged	On	Not engaged	On	Not Engaged	On
-1.0	Not engaged	On	Not engaged	On	Not Engaged	On
-0.5	Not engaged	On	Not engaged	On	Not Engaged	On
0.0	Not engaged	On	Not engaged	On	Not Engaged	On



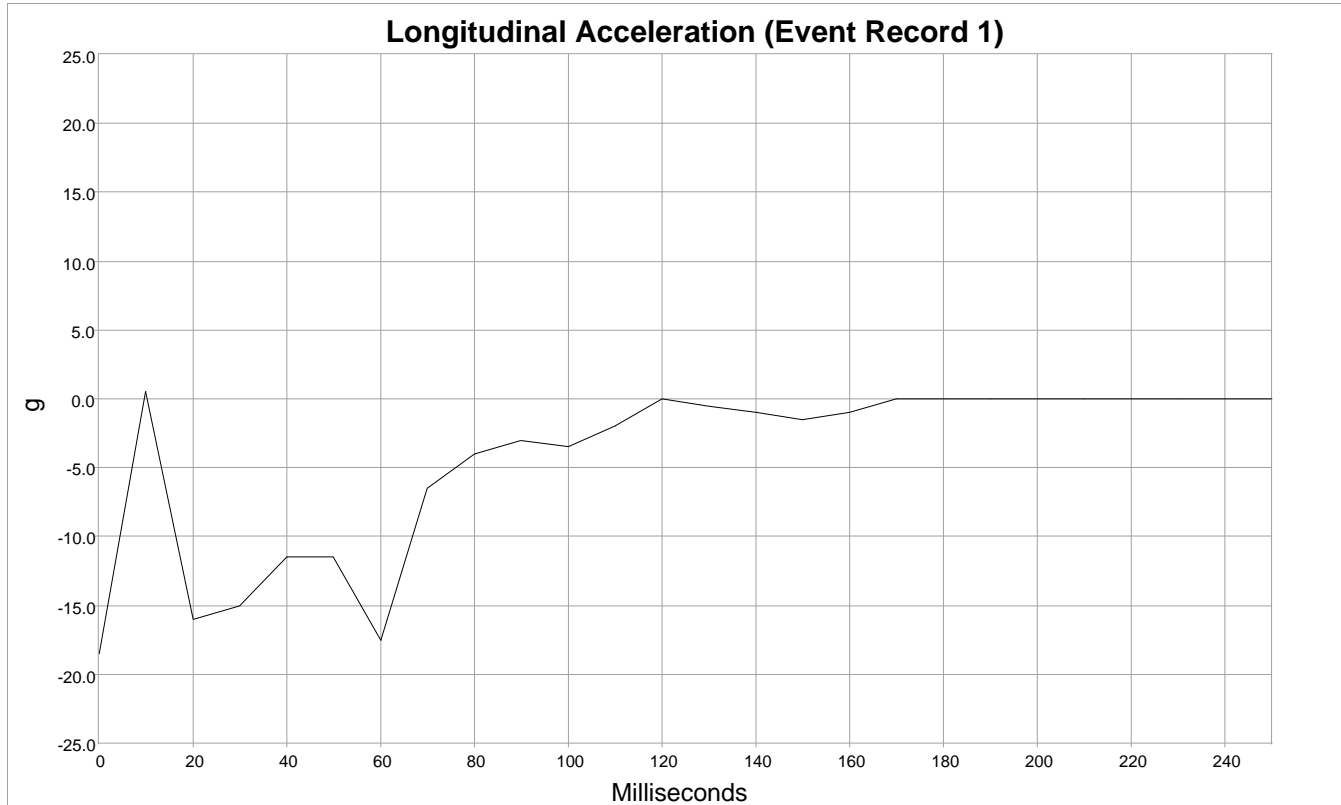
Longitudinal Delta V (Event Record 1)

Time (msec)	MPH [km/h]
0	0 [0]
10	-1 [-1]
20	-2 [-4]
30	-4 [-6]
40	-6 [-9]
50	-9 [-14]
60	-11 [-18]
70	-13 [-21]
80	-14 [-22]
90	-14 [-23]
100	-14 [-23]
110	-15 [-24]
120	-15 [-24]
130	-15 [-24]
140	-15 [-24]
150	-15 [-24]
160	0 [0]
170	0 [0]
180	0 [0]
190	0 [0]
200	0 [0]
210	0 [0]
220	0 [0]
230	0 [0]
240	0 [0]
250	0 [0]



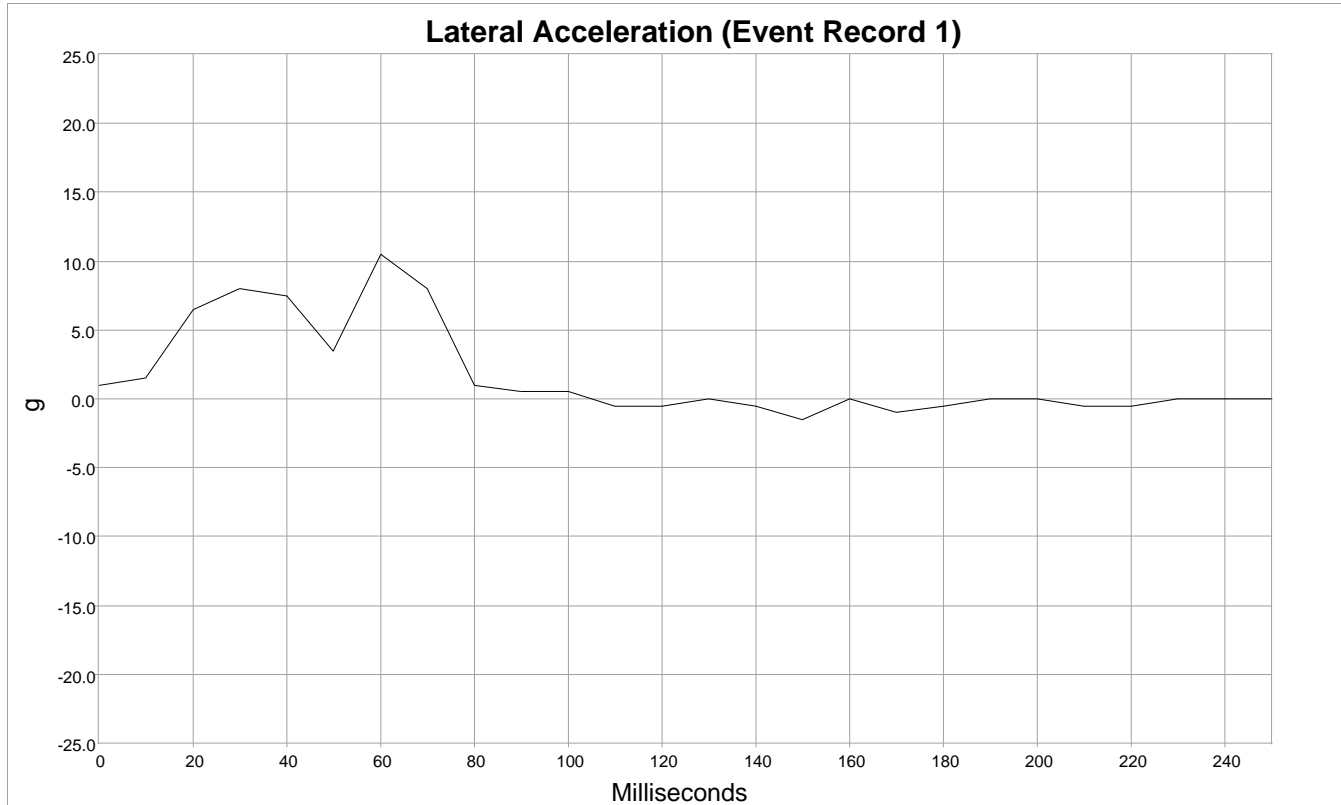
Lateral Delta V (Event Record 1)

Time (msec)	MPH [km/h]
0	0 [0]
10	0 [0]
20	0 [0]
30	1 [1]
40	1 [2]
50	2 [4]
60	5 [8]
70	7 [11]
80	8 [13]
90	8 [13]
100	8 [13]
110	8 [13]
120	8 [13]
130	8 [13]
140	7 [12]
150	7 [12]
160	0 [0]
170	0 [0]
180	0 [0]
190	0 [0]
200	0 [0]
210	0 [0]
220	0 [0]
230	0 [0]
240	0 [0]
250	0 [0]



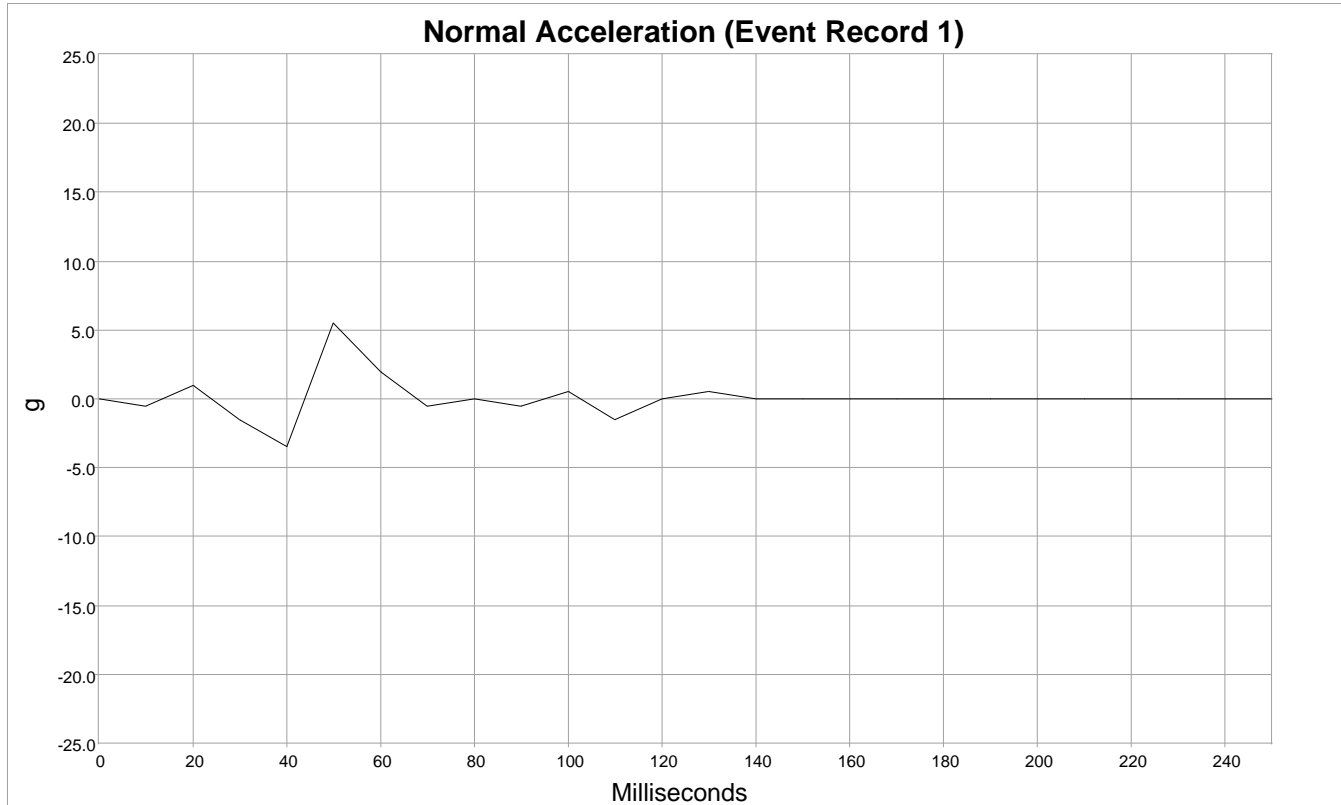
Longitudinal Acceleration (Event Record 1)

Time (msec)	g
0	-18.5
10	0.5
20	-16.0
30	-15.0
40	-11.5
50	-11.5
60	-17.5
70	-6.5
80	-4.0
90	-3.0
100	-3.5
110	-2.0
120	0.0
130	-0.5
140	-1.0
150	-1.5
160	-1.0
170	0.0
180	0.0
190	0.0
200	0.0
210	0.0
220	0.0
230	0.0
240	0.0
250	0.0



Lateral Acceleration (Event Record 1)

Time (msec)	g
0	1.0
10	1.5
20	6.5
30	8.0
40	7.5
50	3.5
60	10.5
70	8.0
80	1.0
90	0.5
100	0.5
110	-0.5
120	-0.5
130	0.0
140	-0.5
150	-1.5
160	0.0
170	-1.0
180	-0.5
190	0.0
200	0.0
210	-0.5
220	-0.5
230	0.0
240	0.0
250	0.0



Normal Acceleration (Event Record 1)

Time (msec)	g
0	0.0
10	-0.5
20	1.0
30	-1.5
40	-3.5
50	5.5
60	2.0
70	-0.5
80	0.0
90	-0.5
100	0.5
110	-1.5
120	0.0
130	0.5
140	0.0
150	0.0
160	0.0
170	0.0
180	0.0
190	0.0
200	0.0
210	0.0
220	0.0
230	0.0
240	0.0
250	0.0

System Status at Event (Event Record 2)

Multi-Event, Number of Events (1, 2)	2
Complete File Recorded (Yes/No)	Yes
Ignition Cycle, Download	5778
Time from Event 1 to 2 (sec)	1.0
Maximum Delta-V, Longitudinal (MPH [km/h])	-3 [-5]
Time, Maximum Delta-V, Longitudinal (msec)	82.5
Maximum Delta-V, Lateral (MPH [km/h])	0 [0]
Time, Maximum Delta-V, Lateral (msec)	87.5
Time, Maximum Delta-V, Resultant (msec)	82.5
Time, Accelerometer Range Exceeded, Longitudinal (msec)	0
Time, Accelerometer Range Exceeded, Lateral (msec)	0
Time, Accelerometer Range Exceeded, Normal (msec)	0

Deployment Command Data (Event Record 2)

Pretensioner Deployment, Time to Fire, Driver (msec)	20
Pretensioner Deployment, Time to Fire, Right Front Passenger (msec)	20
Lap Pretensioner Deployment, Time to Fire, Driver (msec)	28
Lap Pretensioner Deployment, Time to Fire, Right Front Passenger (msec)	28
Frontal Air Bag Deployment, Time to Deploy First Stage, Driver (msec)	45
Frontal Air Bag Deployment, Time to Deploy First Stage, Right Front Passenger (msec)	31
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (msec)	75
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (msec)	61
Side Air Bag Deployment, Time to Deploy, Driver (msec)	0
Side Air Bag Deployment, Time to Deploy, Right Front Passenger (msec)	0
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Driver Side (msec)	0
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Right Side (msec)	0
Frontal Air Bag Deployment, 2nd Stage Disposal, Driver (Yes/No)	No
Frontal Air Bag Deployment, 2nd Stage Disposal, Right Front Passenger (Yes/No)	No

Pre-Crash Data -1 sec (Event Record 2)

Safety Belt Status, Driver	On
Safety Belt Status, Right Front Passenger	On
Seat Track Position Switch, Foremost, Status, Driver	No
Occupant Size Classification, Right Front Passenger Airbag Suppressed (Yes/No)	No
Frontal Air Bag Warning Lamp (On, Off)	On
Ignition Cycle, Crash	5772

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 2) - Table 1 of 3

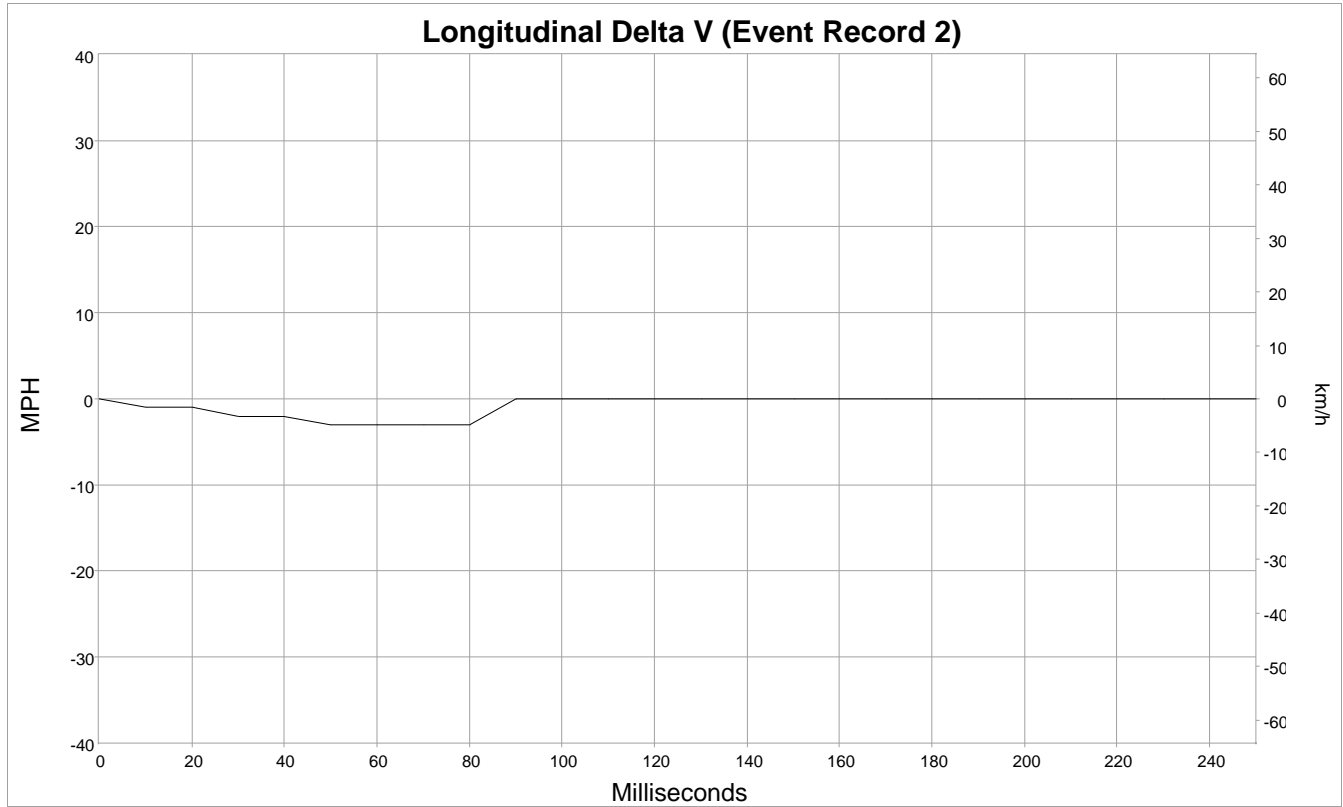
Time Stamp (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal Position, % full	Service Brake (On, Off)	ABS Activity (On, Off)	Stability Control (On, Off, Engaged)	Steering Input (deg)	Engine RPM
-5.0	45 [73]	16	Off	Off	On Non-Engaged	0	1,200
-4.5	45 [73]	18	Off	Off	On Non-Engaged	0	1,300
-4.0	45 [73]	19	Off	Off	On Non-Engaged	-5	1,300
-3.5	45 [72]	20	Off	Off	On Non-Engaged	-5	1,300
-3.0	45 [72]	25	Off	Off	On Non-Engaged	-5	1,300
-2.5	45 [72]	28	Off	Off	On Non-Engaged	0	1,400
-2.0	44 [71]	0	On	Off	On Non-Engaged	-40	1,200
-1.5	44 [71]	0	On	On	On Non-Engaged	-110	900
-1.0	34 [55]	0	On	On	On Engaged	-160	800
-0.5	19 [30]	0	On	On	On Non-Engaged	-15	1,000
0.0	19 [30]	0	On	On	On Non-Engaged	10	1,000

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 2) - Table 2 of 3

Time Stamp (sec)	PCM Derived Accelerator Pedal Position, % full	Forward Collision Warning (Not Warning/ Warning)	Collision Mitigation Braking System (Not Engaged/ Engaged)	Collision Mitigation Braking System, Forward Collision Warning (On/Off)	Lane Departure Warning (Not Warning/ Warning)	Road Departure Mitigation (Not Engaged/ Engaged)	Road Departure Mitigation, Lane Departure Warning (On/Off)
-5.0	16	Not warning	Not engaged	On	Not warning	Not engaged	On
-4.5	18	Not warning	Not engaged	On	Not warning	Not engaged	On
-4.0	19	Not warning	Not engaged	On	Not warning	Not engaged	On
-3.5	20	Not warning	Not engaged	On	Not warning	Not engaged	On
-3.0	25	Not warning	Not engaged	On	Not warning	Not engaged	On
-2.5	28	Not warning	Not engaged	On	Not warning	Not engaged	On
-2.0	0	Not warning	Not engaged	On	Not warning	Not engaged	On
-1.5	0	Not warning	Not engaged	On	Not warning	Not engaged	On
-1.0	0	Not warning	Not engaged	On	Not warning	Not engaged	On
-0.5	0	Not warning	Not engaged	On	Not warning	Not engaged	Off
0.0	0	Not warning	Not engaged	On	Not warning	Not engaged	Off

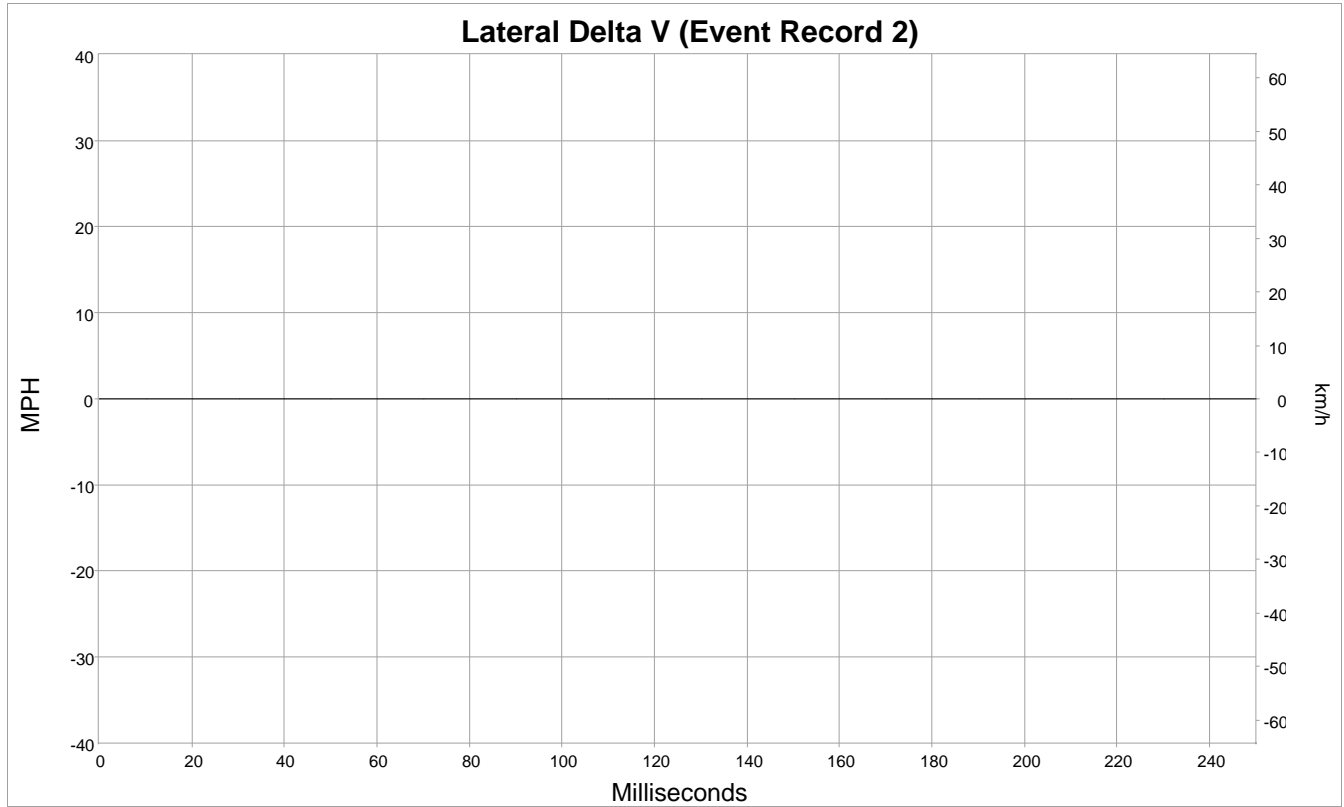
Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 2) - Table 3 of 3

Time Stamp (sec)	Adaptive Cruise Control (Not Engaged/ Engaged)	Adaptive Cruise Control (On/Off)	Lane Keeping Assist (Not Engaged/ Engaged)	Lane Keeping Assist (On/Off)	Cruise Control (Not Engaged/ Engaged)	Cruise Control (On/Off)
-5.0	Not engaged	On	Not engaged	On	Not Engaged	On
-4.5	Not engaged	On	Not engaged	On	Not Engaged	On
-4.0	Not engaged	On	Not engaged	On	Not Engaged	On
-3.5	Not engaged	On	Not engaged	On	Not Engaged	On
-3.0	Not engaged	On	Not engaged	On	Not Engaged	On
-2.5	Not engaged	On	Not engaged	On	Not Engaged	On
-2.0	Not engaged	On	Not engaged	On	Not Engaged	On
-1.5	Not engaged	On	Not engaged	On	Not Engaged	On
-1.0	Not engaged	On	Not engaged	On	Not Engaged	On
-0.5	Not engaged	On	Not engaged	On	Not Engaged	On
0.0	Not engaged	On	Not engaged	On	Not Engaged	On



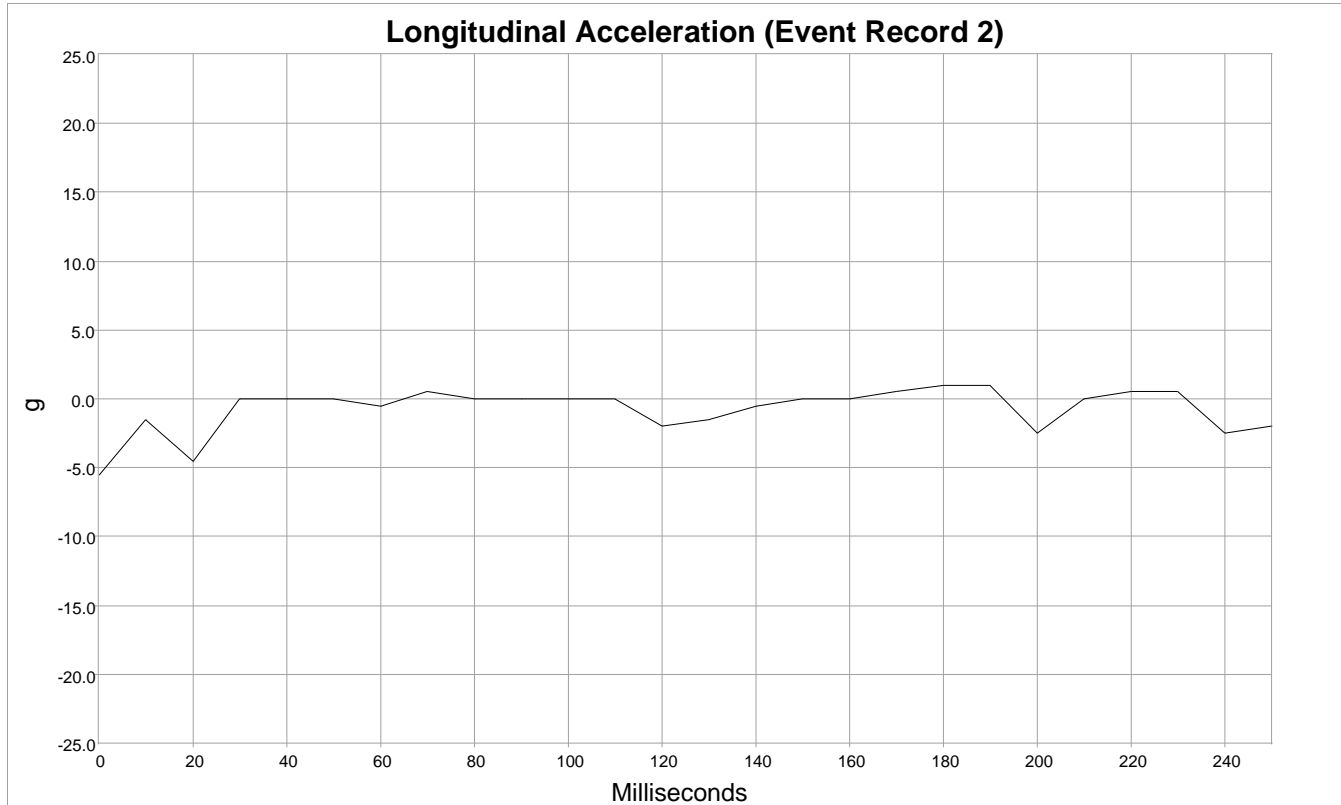
Longitudinal Delta V (Event Record 2)

Time (msec)	MPH [km/h]
0	0 [0]
10	-1 [-1]
20	-1 [-2]
30	-2 [-3]
40	-2 [-4]
50	-3 [-5]
60	-3 [-5]
70	-3 [-5]
80	-3 [-5]
90	0 [0]
100	0 [0]
110	0 [0]
120	0 [0]
130	0 [0]
140	0 [0]
150	0 [0]
160	0 [0]
170	0 [0]
180	0 [0]
190	0 [0]
200	0 [0]
210	0 [0]
220	0 [0]
230	0 [0]
240	0 [0]
250	0 [0]



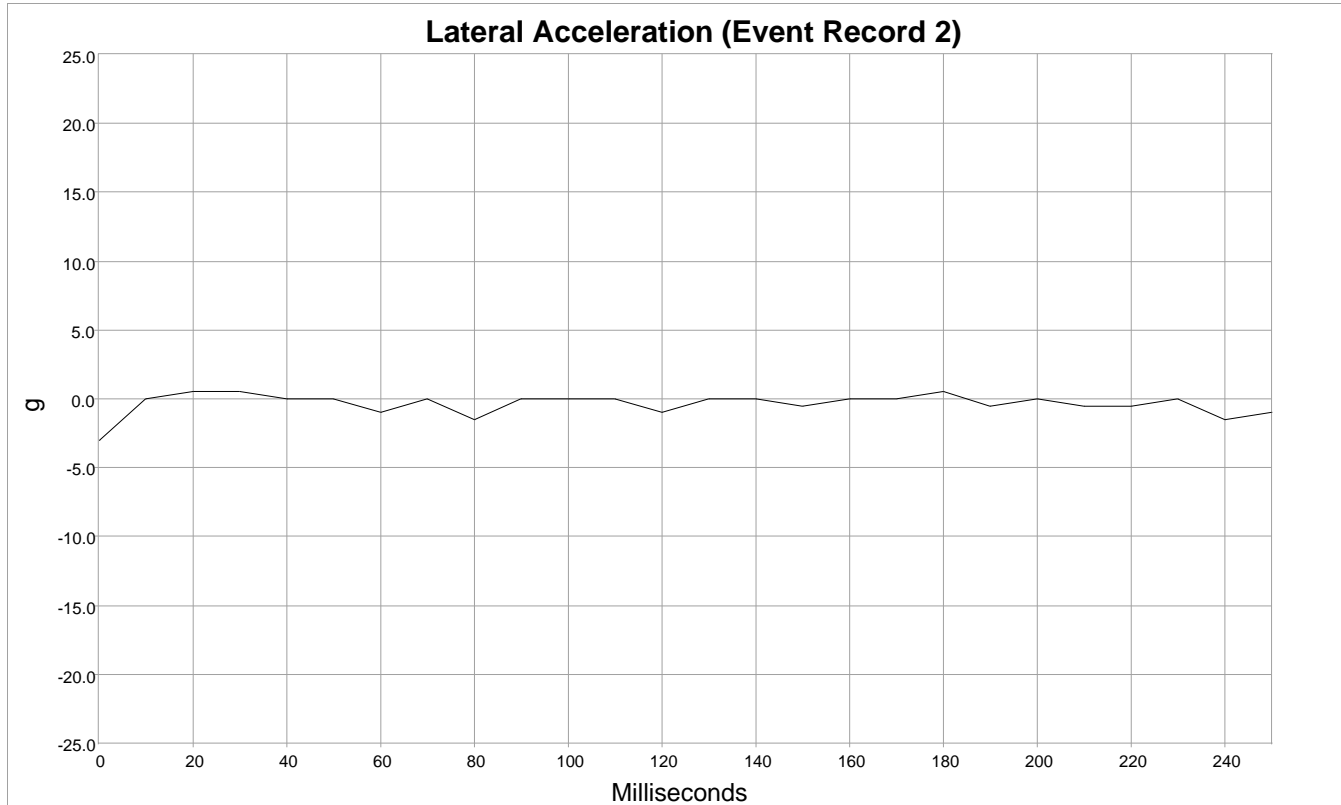
Lateral Delta V (Event Record 2)

Time (msec)	MPH [km/h]
0	0 [0]
10	0 [0]
20	0 [0]
30	0 [0]
40	0 [0]
50	0 [0]
60	0 [0]
70	0 [0]
80	0 [0]
90	0 [0]
100	0 [0]
110	0 [0]
120	0 [0]
130	0 [0]
140	0 [0]
150	0 [0]
160	0 [0]
170	0 [0]
180	0 [0]
190	0 [0]
200	0 [0]
210	0 [0]
220	0 [0]
230	0 [0]
240	0 [0]
250	0 [0]



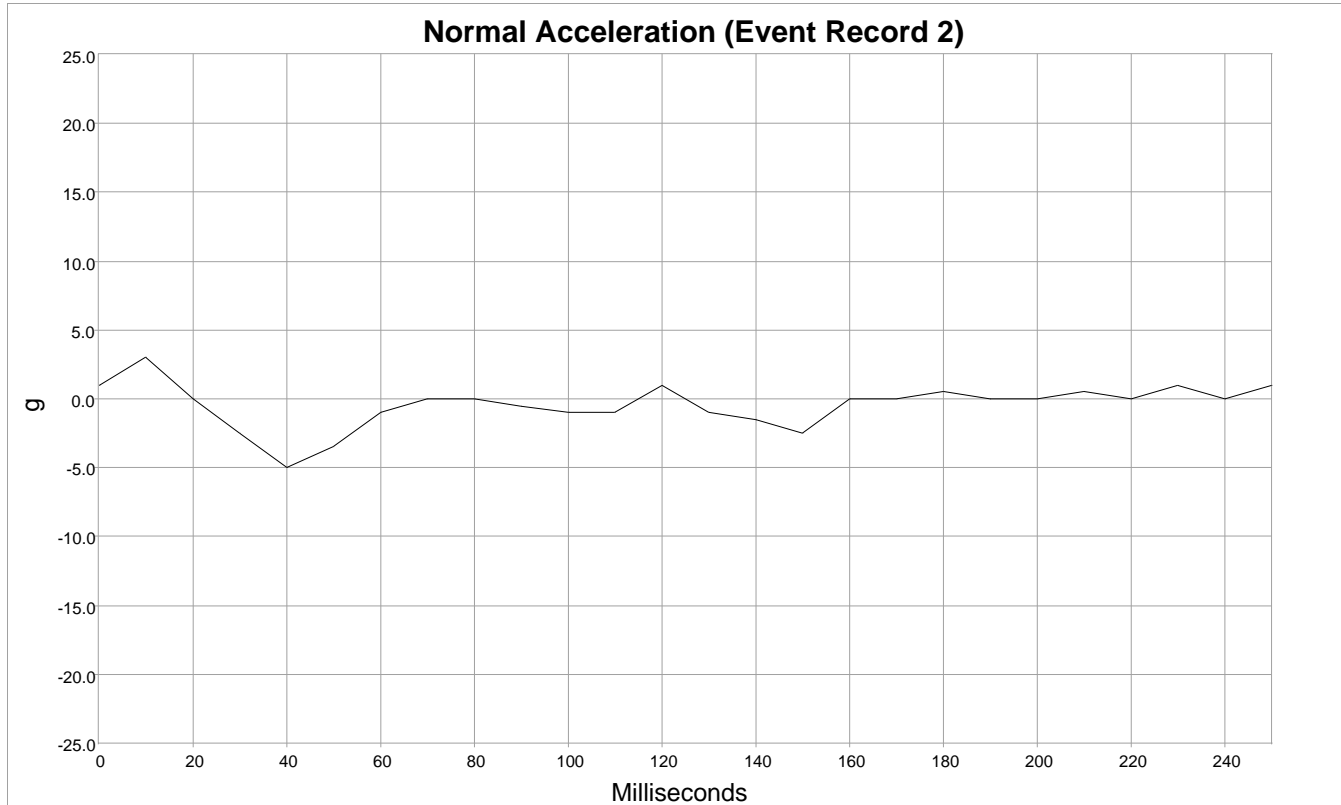
Longitudinal Acceleration (Event Record 2)

Time (msec)	g
0	-5.5
10	-1.5
20	-4.5
30	0.0
40	0.0
50	0.0
60	-0.5
70	0.5
80	0.0
90	0.0
100	0.0
110	0.0
120	-2.0
130	-1.5
140	-0.5
150	0.0
160	0.0
170	0.5
180	1.0
190	1.0
200	-2.5
210	0.0
220	0.5
230	0.5
240	-2.5
250	-2.0



Lateral Acceleration (Event Record 2)

Time (msec)	g
0	-3.0
10	0.0
20	0.5
30	0.5
40	0.0
50	0.0
60	-1.0
70	0.0
80	-1.5
90	0.0
100	0.0
110	0.0
120	-1.0
130	0.0
140	0.0
150	-0.5
160	0.0
170	0.0
180	0.5
190	-0.5
200	0.0
210	-0.5
220	-0.5
230	0.0
240	-1.5
250	-1.0



Normal Acceleration (Event Record 2)

Time (msec)	g
0	1.0
10	3.0
20	0.0
30	-2.5
40	-5.0
50	-3.5
60	-1.0
70	0.0
80	0.0
90	-0.5
100	-1.0
110	-1.0
120	1.0
130	-1.0
140	-1.5
150	-2.5
160	0.0
170	0.0
180	0.5
190	0.0
200	0.0
210	0.5
220	0.0
230	1.0
240	0.0
250	1.0

Hexadecimal Data

DID #	Data
\$8000	21 47 14 15 01 33 00 55 00 55 00 00 11 33 80 00 20 0F 00 E9 02 05 00 00 00 00 00 00 00 00 00 00 11 11 00 8C
\$8020	01 03 00 00 00 00 00 00 00 00 00 00 00 00 00 FC
\$8021	AA 00 01 02 00 0A 00 00 00 00 00 49 16 92 AA AA
\$8022	AA 00 CC 78 66 00 00 00 0E 0E 00 00 16 16 00 00 00 21 17 3F 35 00 00 00 00 28 00 00 00 28 00 11 00 00 00 00 00 00 00 00 00 00 00 00 00 00 57
\$8023	AA 00 CC 78 66 00 00 00 14 14 00 00 1C 1C 00 00 00 2D 1F 4B 3D 00 11 00 00 00 00 00 00 00 00 00 00 00 00 00 00 67
\$8024	AA 00 FF 00 00 40 43 03 12 02 11 00 16 8C 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0A
\$8025	AA 00 FF 00 00 40 43 03 12 02 11 01 16 8C 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 09
\$8026	AA 01 FC D0 35 00 00 77 33 00 30 00 00 00 00 00 4B 0E 00 0C 0E 00 00 00 00 00 00 00 00 00 00 00 4A 0E 00 0C 0E 00 00 00 00 00 00 00 00 00 00 00 49 10 00 0C 10 00 00 00 00 00 00 00 00 00 00 00 49 12 00 0D 12 00 00 00 00 00 00 00 00 00 00 00 49 13 FF 0D 13 00 00 00 00 00 00 00 00 00 00 00 00 48 14 FF 0D 14 00 00 00 00 00 00 00 00 00 00 00 00 48 19 FF 0D 19 00 00 00 00 00 00 00 00 00 00 00 00 48 1C 00 0E 1C 00 00 00 00 00 00 00 00 00 00 00 00 47 00 F8 0C 00 01 00 00 00 00 00 00 00 00 00 00 00 47 00 EA 09 00 05 00 00 00 00 00 00 00 00 00 00 00 47 00 ED 09 00 05 00 00 00 00 00 00 00 00 00 00 CE
\$8027	AA 01 FC D0 35 00 00 77 33 00 30 00 00 00 00 00 49 10 00 0C 10 00 00 00 00 00 00 00 00 00 00 00 49 12 00 0D 12 00 00 00 00 00 00 00 00 00 00 00 49 13 FF 0D 13 00 00 00 00 00 00 00 00 00 00 00 00 48 14 FF 0D 14 00 00 00 00 00 00 00 00 00 00 00 00 48 19 FF 0D 19 00 00 00 00 00 00 00 00 00 00 00 00 48 1C 00 0E 1C 00 00 00 00 00 00 00 00 00 00 00 00 47 00 F8 0C 00 01 00 00 00 00 00 00 00 00 00 00 00 47 00 EA 09 00 05 00 00 00 00 00 00 00 00 00 00 00 37 00 E0 08 00 25 00 00 00 00 00 00 00 00 00 00 00 1E 00 FD 0A 00 05 00 00 01 00 00 00 00 00 00 00 00 1E 00 02 0A 00 05 00 00 01 00 00 00 00 00 00 00 56
\$8028	AA 00 00 FF FC FA F7 F2 EE EB EA E9 E9 E8 E8 E8 E8 E8 00 E8 32 00 00 00 00 00 41
\$8029	AA 00 00 FF FE FD FC FB FB FB FB 00 FB 21 00 00 00 00 00 58

\$802A AA 00 00 00 00 01 02 04 08 0B 0D 0D 0D 0D 0D 0D
0C 0C 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 0D 28 00 2D 00 00 00 74

\$802B AA 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 23 00 21 00 00 00 12

\$802C AA 01 DB 01 E0 E2 E9 E9 DD F3 F8 FA F9 FC 00 FF
FE FD FE 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 36

\$802D AA 01 F5 FD F7 00 00 00 FF 01 00 00 00 00 FC FD
FF 00 00 01 02 02 FB 00 01 01 FB FC 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 7B

\$802E AA 01 02 03 0D 10 0F 07 15 10 02 01 01 FF FF 00
FF FD 00 FE FF 00 00 FF FF 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 FF

\$802F AA 01 FA 00 01 01 00 00 FE 00 FD 00 00 00 FE 00
00 FF 00 00 01 FF 00 FF FF 00 FD FE 00 00 00 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 68

\$8030 AA 01 00 FF 02 FD F9 0B 04 FF 00 FF 01 FD 00 01
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