

STATE OF CALIFORNIA  
 DEPARTMENT OF CALIFORNIA HIGHWAY PATROL  
**MULTIDISCIPLINARY ACCIDENT INVESTIGATION TEAM NARRATIVE/DIAGRAM**  
 CHP 558D (Rev. 9-08) OPI 065 (MAIT use only)

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**IL-030-18**

Riverside Area

**MAIT SUPPLEMENTAL**

This investigation was conducted by the California Highway Patrol (CHP) Inland Division Multidisciplinary Accident Investigation Team (MAIT).



**MAIT PERSONNEL**

- Sergeant L. Berns, ID 15244, Inland Division MAIT Team Leader
- Officer M. Seruga, ID 13311, Inland Division MAIT Investigator
- Officer J. Snider, ID 15406, Border Division MAIT Investigator
- Officer P. Gray, ID 16186, Inland Division MAIT Investigator
- Officer W. Bozyk, ID 16901, Inland Division MAIT Investigator
- Officer C. Hitchcock, ID 18964, Inland Division MAIT Investigator
- Sergeant S. Parent, ID 16159, Inland Division Associate MAIT Investigator\*
- Motor Carrier Specialist I T. Nazikoglu, ID A15922, Inland Division MAIT

\*Denotes primary investigator

**SUBPOENAS FOR MAIT PERSONNEL SHOULD BE DIRECTED TO:**

California Highway Patrol  
 Inland Division Special Services Command – MAIT  
 847 E. Brier Drive  
 San Bernardino, California 92408  
 Attention: Sergeant L. Berns

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## **FACTS – INTRODUCTION**

### **MAIT Notification**

On Thursday, May 24, 2018, Lieutenant D. Yokley, ID 13852, of the CHP Riverside Area, requested CHP Inland Division MAIT assistance with the investigation of a fatal collision that had occurred on [REDACTED]. MAIT assistance was authorized by CHP Inland Division executive management the same day as the request.

The collision occurred on [REDACTED] in the city of Eastvale within the county of Riverside. The collision involved the following vehicles and parties:

- 2018 Toyota Corolla, driven by [REDACTED] and occupied by [REDACTED] (right-front passenger)
- 2017 Ford Expedition, driven by [REDACTED] and occupied by [REDACTED] (right-front passenger), [REDACTED] (right-rear passenger), and [REDACTED] (3rd row right-rear passenger)
- 2016 Freightliner in combination with a 2017 semi-trailer, driven by [REDACTED]

As a result of this collision, [REDACTED] sustained [REDACTED], [REDACTED] sustained [REDACTED].  
[REDACTED].

### **Scope of Investigation**

The scope of this MAIT investigation was limited to the following investigative responsibilities:

- Imaging and analysis of data recorded by the airbag control modules (ACM) installed in the Toyota and Ford
- If possible, determine the reason why the supplemental restraints installed in the Toyota failed to deploy
- Velocity reconstruction

Throughout this report, unless otherwise indicated, all times, speeds, and measurements are approximate, and date references are for the year 2018. Vehicle-based direction references are oriented from the driver's seat of the vehicle looking forward.

### **Materials Reviewed**

#### **CHP Riverside Area**

The following materials were received from the CHP Riverside Area and reviewed by MAIT Investigators:

- Traffic Collision Report #9 [REDACTED] prepared by CHP Riverside Area Officer J. Tronti, ID 17546
- 82 digital images taken at the collision scene by Sergeant Parent while working in the capacity as the on-scene supervisor for the CHP Riverside Area
- 42 digital images taken at the collision scene by CHP Riverside Area Officer R. Breeding, ID 20210

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**FACTS – INTRODUCTION**

**Investigative Overview**

Tuesday, May 29

At 1000 hours, Sergeant Parent and Investigator Seruga arrived at the impound facility of Auto Aide Towing [845 West Nance Street, Perris] to document the condition of the Toyota and image the ACM. The imaging of the ACM was unsuccessful due to an inability of the Bosch CDR hardware/software to establish communication with the ACM. The ACM was removed from the Toyota for further analysis.

Wednesday, May 30

At 1600 hours, Investigator Bozyk arrived at E.M. Auto Body [2075 South Riverside Avenue, Rialto] to document the condition of the Ford and image the ACM.

Wednesday, June 6

At 0900 hours, Sergeant Parent, Investigators Seruga and Gray, and MCS-I Nazikoglu met with Nick Evans (Product Engineer at Toyota Motor North America), Tsutomu Katsumata (Senior Coordinator at Toyota Motor North America), and Raymond Hughes (Automotive Engineering Consultant at RJ Hughes Engineering, Inc.) at Auto Aide Towing.

Mr. Hughes, consulting for Toyota North America, attempted a “desktop” imaging of the ACM removed from the Toyota utilizing Bosch CDR hardware and software. Mr. Hughes was also unable to establish communication with the module and his attempt was unsuccessful.

Mr. Hughes, Mr. Evans, and Mr. Katsumata inspected and photographed the Toyota under the supervision of MAIT investigators.

Wednesday, June 27

Investigator Seruga received an exemplar ACM, to be utilized as a surrogate for an electrically erasable programmable read-only memory (EEPROM) transplant, from Toyota North America.

Monday, July 9

Border Division MAIT Investigator Snider met with Sergeant Parent and Investigators Seruga and Gray at the Inland Division MAIT office where Investigator Snider performed an EEPROM transplant (“chip swap”). This was accomplished by first imaging the surrogate ACM received from Toyota North America. Next, the EEPROM from the ACM removed from the Toyota was removed and transplanted onto the circuit board of the surrogate ACM.

Once transplanted, Investigator Seruga successfully imaged the surrogate ACM utilizing Bosch CDR hardware/software.

Tuesday, September 11

Sergeant Berns signed out from evidence and transferred custody of both ACMs (surrogate and the one removed from the Toyota) to National Highway Traffic Safety Administration (NHTSA) Investigator James Perry for further analysis.

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**FACTS – PHYSICAL EVIDENCE LOG**

As part of this investigation, seven items of evidence were collected by MAIT Investigators (Table 1). The items were booked into evidence at the CHP Riverside Area. Requests regarding the items of evidence listed below should be made directly to:

California Highway Patrol, Riverside Area  
8118 Lincoln Avenue  
Riverside, California 92504  
951-637-8000

Table 1

*Physical Evidence Collected by MAIT Investigators*

Date	Description [Location]
05/29/2018	Optical disc containing 61 images of the Toyota, taken by Sergeant Parent [Auto Aide Towing, 845 W. Nance Street, Perris]
05/29/2018	The ACM removed from the Toyota by Sergeant Parent; Toyota part number 89170-02K90; TRW part number 236155-101; and serial number PTZHAU004T [Auto Aide Towing]
05/30/2018	Optical disc containing 17 images of the Ford, taken by Investigator Bozyk [E.M. Auto Body Towing, 2075 South Riverside Avenue, Rialto]
05/30/2018	Optical disc containing data retrieved by Investigator Bozyk from the ACM installed in the Ford [E.M. Auto Body Towing]
06/06/2018	Optical disc containing 5 digital videos of the Toyota, taken by Investigator Gray [Auto Aide Towing]
06/27/2018	An exemplar ACM received from Toyota; Toyota part number 89170-02K90; TRW part number 236155-101; and serial number PTZGAI00R1
07/09/2018	Optical disc containing data retrieved from the EEPROMs from the surrogate ACM and ACM removed from the Toyota [Inland Division MAIT office]
07/09/2018	Optical disc containing 16 digital images taken by Investigator Gray during the EEPROM transplant procedure [Inland Division MAIT office]

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**FACTS – DIGITAL FILES LOG**

During the course of this investigation a total of 94 digital images and 5 digital videos were taken or recorded by MAIT investigators (Table 2). All digital files were transferred from the memory card of the respective recording device/camera to a recordable optical disc and booked into evidence.

Requests regarding the digital image files listed below should be made directly to:

California Highway Patrol, Riverside Area  
8118 Lincoln Avenue  
Riverside, California 92504  
951-637-8000

Table 2

*Digital Images Taken During the Course of this Investigation*

Images	Date	Description [Location]
DSC00567 to DSC00627	05/29/2018	61 images of the Toyota, taken by Sergeant Parent between 1026 and 1305 hours [Auto Aide Towing]
DSC_2513 to DSC_2529	05/30/2018	17 images of the Ford, taken by Investigator Bozyk between 1622 and 1624 hours [E.M. Auto Body Towing]
00027.MTS to 00031.MTS	06/06/2018	5 videos recorded by Investigator Gray between 0920 and 1017 hours during an inspection of the Toyota by representatives from Toyota.
DSC_0001 to DSC_0016	07/09/2018	16 digital images during the EEPROM transplant procedure, taken by Investigator Gray between 1021 and 1129 hours [Inland Division MAIT office]

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***ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS***

**Overview**

The Toyota and Ford were equipped with airbag control modules (ACM), with event data recorder (EDR) capability. An ACM is responsible for performing diagnostic checks of the various occupant protection devices installed in the vehicle and collecting and analyzing vehicle acceleration data to predict collision severity. This information is used by the ACM to make decisions related to the deployment of supplemental restraints (airbags and/or seatbelt pretensioners) when necessary to protect the occupants of the vehicle in a collision. As a secondary function, the ACM may record data related to deployment and/or non-deployment events into non-volatile memory after a deployment decision has been made. Once recorded by the ACM, deployment data may not be overwritten; however, unlocked non-deployment data may be overwritten by subsequent events. 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.

**2018 Toyota Corolla**

**Pre-Imaging Condition**

The pre-imaging condition of the Toyota is depicted in the following images taken by Sergeant Parent on May 29 at Auto Aide Towing.



Figure 1. Front of the Toyota.



Figure 2. Front and right side of the Toyota.

Visual inspection of the Toyota revealed the following:

- The Toyota sustained significant frontal damage consistent with an underride impact (Figure 1 and Figure 2). The intrusion above the front bumper was deeper than that at the bumper level.
- The tires mounted on the vehicle were the original size,<sup>1</sup> as noted on the tire and loading information label on the base of the left B-pillar.
- None of the supplemental restraints had deployed.
- There were obvious signs of safety belt use observed on the components of the driver and right-front passenger seatbelts. Additionally, Sergeant Parent arrived at the collision scene moments after it occurred and observed both occupants utilizing their respective seatbelt.

<sup>1</sup> P205/55R16 for all positions.

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**ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS**

**2018 Toyota Corolla**

**ACM Imaging**

On May 29, Investigator Seruga attempted to image the data recorded on the ACM installed in the Toyota. This was accomplished by connecting a Bosch Crash Data Retrieval (CDR) system interface module directly to the ACM (while still installed in the Toyota) in accordance with CDR system guidelines. Investigator Seruga made several attempts to image the data; however, each attempt failed to establish communication with the ACM. The ACM was removed from the Toyota for later analysis.

On June 6, Nick Evans (Product Engineer at Toyota Motor North America), Tsutomu Katsumata (Senior Coordinator at Toyota Motor North America), and Raymond Hughes (Automotive Engineering Consultant at RJ Hughes Engineering, Inc.) met with MAIT investigators at Auto Aide Towing to inspect the Toyota and attempt to image the ACM. Mr. Hughes, consulting for Toyota North America, attempted a “desktop” imaging of the ACM removed from the Toyota utilizing Bosch CDR hardware and software. Like Investigator Seruga, Mr. Hughes was unable to establish communication with the ACM and no image was obtained.

On June 27, Investigator Seruga received an exemplar ACM from Toyota North America to be used as a surrogate module for an EEPROM transplant. An EEPROM transplant is accomplished by removing the EEPROM from the circuit board of the ACM installed in the vehicle under investigation and transplanting it onto the circuit board of the surrogate module.

On July 9, Border Division MAIT Investigator Snider, who had successfully conducted an EEPROM transplant twice before, assisted Inland Division MAIT in conducting the EEPROM transplant. Prior to commencing with the transplant, Investigator Seruga successfully imaged the surrogate module utilizing Bosch CDR hardware and software. Availability of a report (Annex A) in the CDR system software indicated a valid image was copied from the ACM.

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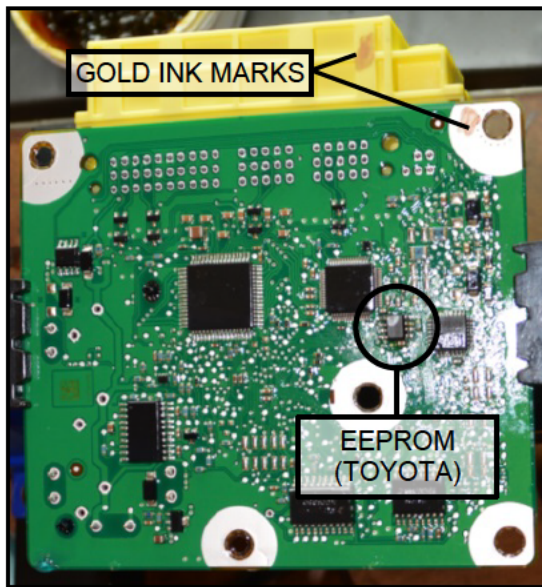
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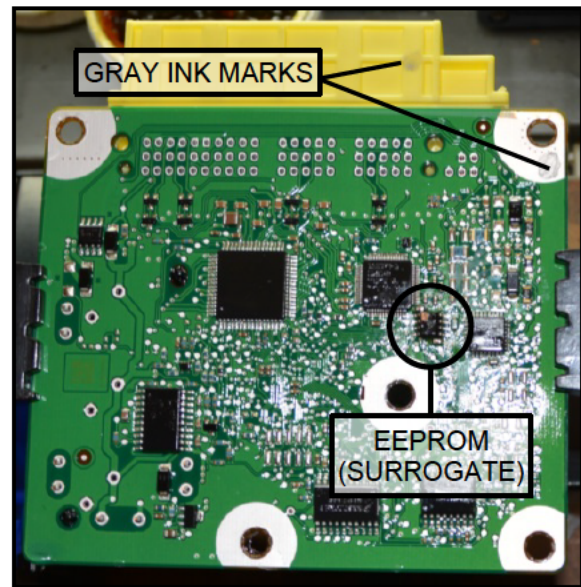
***ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS***

**2018 Toyota Corolla – ACM Imaging**

The circuit boards and EEPROMs of both ACMs were distinctly marked. The circuit board (Figure 3) and EEPROM (Figure 4) of the surrogate ACM were marked with gold ink. The circuit board (Figure 4) and EEPROM (Figure 3) of the ACM removed from the Toyota were marked with gray ink. Once marked, Investigator Snider removed both EEPROMs from their respective circuit boards. The EEPROM from the circuit board of the ACM removed from the Toyota was transplanted onto the circuit board of the surrogate ACM (Figure 3). The EEPROM from the circuit board of the surrogate ACM was transplanted onto the circuit board of the ACM removed from the Toyota (Figure 4).



*Figure 3.* Circuit board of the surrogate ACM with the transplanted EEPROM from the ACM installed in the Toyota.



*Figure 4.* Circuit board of the ACM removed from the Toyota with transplanted EEPROM from the surrogate ACM.

With both EEPROMs transplanted, the ACMs were imaged by connecting a CDR system interface module directly to each ACM in accordance with CDR system guidelines. The surrogate ACM (with the EEPROM from the ACM installed in the Toyota) was successfully imaged. Availability of a report (Annex B) in the CDR system software indicated a valid image was copied from the ACM. Investigator Seruga attempted to image the ACM from the Toyota with the transplanted EEPROM from the surrogate ACM; however, he was unable to establish communication with the ACM. This suggested a fault with the circuit board of the ACM removed from the Toyota.

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**ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS**

**2018 Toyota Corolla**

Analysis

The CDR report generated during the imaging of the surrogate ACM with the transplanted EEPROM from the ACM removed from the Toyota was analyzed. Although not inclusive of all data in the CDR report, the following information was noted:

- There were no events recorded.
- The recording status was recorded as “complete,” indicating a state in which all recorded event data had been fully written into the non-volatile memory.
- The freeze signal was reported as OFF, indicating a state in which the non-volatile memory could be overwritten or deleted by the ACM and any subsequent events would be written.
- The ignition cycle at the time the data was imaged by Investigator Seruga was recorded as 883, indicating there had been 883 power cycles applied to the Toyota’s ACM between the first use of the ACM and the time of imaging.

ECU Part Number	89170-02K90
EDR Generation	13EDR
Complete File Recorded	Yes
Freeze Signal	OFF
Freeze Signal Factor	None
Diagnostic Trouble Codes Exist	No
Ignition Cycle ,Download (times)	883
Multi-event, number of events (times)	N/A
Time from event 1 to 2 (s)	N/A
Time from Previous Pre Crash TRG (msec)	0
Latest Pre-Crash Page	0
Contains Unlinked Pre-Crash Data	No

Figure 5. Summary of events recorded on the ACM at the time of data retrieval.

Safety Recalls

A safety recall is defined as a recall by the manufacturer (or governmental agency) due to an immediate safety hazard with the involved vehicle. A recall is initiated when a motor vehicle or item of motor vehicle equipment (including tires) does not comply with a Federal Motor Vehicle Safety Standard (FMVSS), or when there is a safety-related defect in the vehicle or equipment.

A search of safety recalls by vehicle identification number was conducted through the National Highway Traffic Safety Administration (NHTSA) [1]. There were no open recalls associated with the vehicle identification number assigned to the Toyota.

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***ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS***

**2017 Ford Expedition**

On May 30, Investigator Bozyk accessed the data contained within the ACM of the Ford by connecting a Bosch CDR system interface module to the ACM through the Diagnostic Link Connector (DLC) of the Ford, in accordance with CDR system guidelines. Availability of a report in the CDR system software indicated a valid image was copied from the ACM (Annex C). The original data remained unaltered on the ACM, which remained installed in the vehicle.

As part of this investigation, Sergeant Parent conducted an analysis of the information contained within the CDR report.

**Pre-Imaging Condition**

The pre-imaging condition of the Ford is depicted in the following images taken by Investigator Bozyk on May 30 at E.M. Auto Body.



Figure 6. Rear of the Ford.



Figure 7. Rear and left side of the Ford.

Visual inspection of the Ford revealed the following:

- The Ford sustained significant rear damage consistent with an underride impact (Figure 6 and Figure 7). The majority of the intrusion to the rear occurred below the license plate.
- The tires mounted on the vehicle were the original size,<sup>2</sup> as noted on the tire and loading information label on the base of the left B-pillar.
- None of the supplemental restraints had deployed.

<sup>2</sup> 275/65R18 for all positions.

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**ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS**

**2017 Ford Expedition**

**Analysis**

There was one unlocked non-deployment event recorded by the ACM installed in the Ford (Figure 8).

Recording Status	Record Unlocked
Complete File Recorded (Yes, No)	Yes
Multi-Event, Number of Events	1
Time From Event 1 to 2 (msec)	N/A
Lifetime Operating Timer at Event Time Zero (sec)	4,409,740
Key-On Timer at Event Time Zero (sec)	2,030
Vehicle Voltage at Time Zero (V)	13.122
Energy Reserve Mode Entered During Event (Yes, No)	No

Figure 8. System Status at Event (First Record), as reported in the CDR report.

Although not inclusive of all data reported in the “System Status at Time of Retrieval” and “System Status at Event (First Record)” section of the CDR report, the following information was noted:

- The recording status was reported as “Record Unlocked,” indicating the event was not locked and could be overwritten.
- A complete file was recorded; indicating the recorded event had been fully written to the ACM memory.
- The ignition key had been in the ON position for 2,030 seconds (33.8 minutes) prior to the event.
- The ignition cycle at the time Investigator Bozyk imaged the ACM was reported as 3,502.

Various deployment data<sup>3</sup> were recorded by the ACM at the time of the event (Figure 9).

Maximum Delta-V, Longitudinal (MPH [km/h])	20.38 [32.80]
Time, Maximum Delta-V Longitudinal (msec)	89
Maximum Delta-V, Lateral (MPH [km/h])	-0.30 [-0.49]
Time, Maximum Delta-V Lateral (msec)	300
Longitudinal Delta-V Time Zero Offset (msec)	8.0 ms
Lateral Delta-V Time Zero Offset (msec)	8.0 ms
Roll Angle Time Zero Offset (msec)	48.0 ms

Figure 9. Deployment Data (First Record), as reported in the CDR report.

Although not inclusive of all data reported in the “Deployment Data (First Record)” section of the CDR report, the following information was noted:

- The maximum recorded longitudinal velocity change was 20.38 miles per hour and was achieved in 89 milliseconds. Since the recorded velocity change was positive, the longitudinal component of the principal direction of force (PDOF) was from rear to front.
- The maximum recorded lateral velocity change was –0.30 mile per hour and was achieved in 300 milliseconds. Since the recorded velocity change was negative, the lateral component of the PDOF was from right to left.

<sup>3</sup> “Time zero,” also referred to as the beginning of the event, is defined as the first algorithm wake up during the event and all pre-crash, at-event, delta-V data, and deployment times are relative to “time zero.”

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**ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS**

**2017 Ford Expedition – Analysis**

Various pre-crash data were recorded by the ACM one second prior to the event (Figure 10).

Ignition Cycle, Crash	3,493
Frontal Air Bag Warning Lamp, On/Off	Off
Safety Belt Status, Driver	Buckled
Seat Track Position Switch, Foremost, Status, Driver	Forward
Safety Belt Status, Front Passenger	Buckled
Brake Telltale	Off
ABS Telltale	Off
ESC/TC Telltale	Off
ESC/TC Off Telltale	Default
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL) Telltale	Off

Figure 10. Pre-Crash Data -1 sec (First Record), as reported in the CDR report.

Although not inclusive of all data reported in the “Pre-Crash Data -1 sec (First Record)” section of the CDR report, the following information was noted:

- The ignition cycle was reported as 3,493, which is nine ignition cycles less than the 3,502 reported at the time Investigator Bozyk imaged the ACM, indicating the ignition key had been cycled to the ON position nine times after the collision.
- The safety belt status for the driver and passenger was reported as “Buckled;” indicating there was a latch plate inserted into the buckle for the driver and right-front passenger seating position.
- The frontal airbag warning lamp was reported as OFF; indicating there were no faults with the airbag system prior to the event.
- The brake, ABS, ESC/TC, powertrain wrench, and powertrain MIL telltales were reported as OFF; indicating there were no faults with the brake system, electronic stability control, or powertrain of the Ford prior to the event.

Various pre-crash data were recorded by the ACM during the five seconds prior to the event and were reported in the CDR report (Figure 11).

Times (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % Full	Service Brake, On/Off	Engine RPM	ABS Activity (Engaged, Non-Engaged)	Brake Powertrain Torque Request
- 5.0	7 [11]	0.0	On	678	non-engaged	No
- 4.5	6 [9]	0.0	On	684	non-engaged	No
- 4.0	5 [8]	0.0	On	698	non-engaged	No
- 3.5	4 [6]	0.0	On	778	non-engaged	No
- 3.0	2 [4]	0.0	On	756	non-engaged	No
- 2.5	1 [2]	0.0	On	720	non-engaged	No
- 2.0	1 [1]	0.0	On	672	non-engaged	No
- 1.5	0 [0]	0.0	On	674	non-engaged	No
- 1.0	0 [0]	0.0	Off	670	non-engaged	No
- 0.5	1 [1]	0.0	Off	710	non-engaged	No
0.0	1 [2]	5.1	Off	752	non-engaged	No

Figure 11. Pre-crash data table, as reported in the CDR report.

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***ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS***

**2017 Ford Expedition – Analysis**

Although not inclusive of all data reported in the pre-crash data table, the following information was noted:

- Between 5.0 and 1.5 seconds prior to the event, the indicated vehicle speed decreased from 7 to 0 miles per hour. During the final second prior to the event, the indicated vehicle speed increased from 0 to 1 mile per hour.
- The accelerator pedal remained at 0.0 percent of full until time zero, at which time it increased to 5.1 percent of full.
- Between 5.0 and 1.5 seconds prior to the event, the service brake remained ON, an indication there was enough force applied to the brake pedal to activate the brake switch.<sup>4</sup> During the final second prior to the event, the brake switch remained OFF, an indication there was insufficient force applied to the brake pedal to activate the brake switch.
- Although not included in the table depicted in Figure 11, a separate pre-crash table in the CDR report contained steering wheel angle data, which reported the steering wheel angle in a neutral (straight) position for the five seconds prior to the event.

A graph of the longitudinal change in velocity was reported in the CDR report (Figure 12).

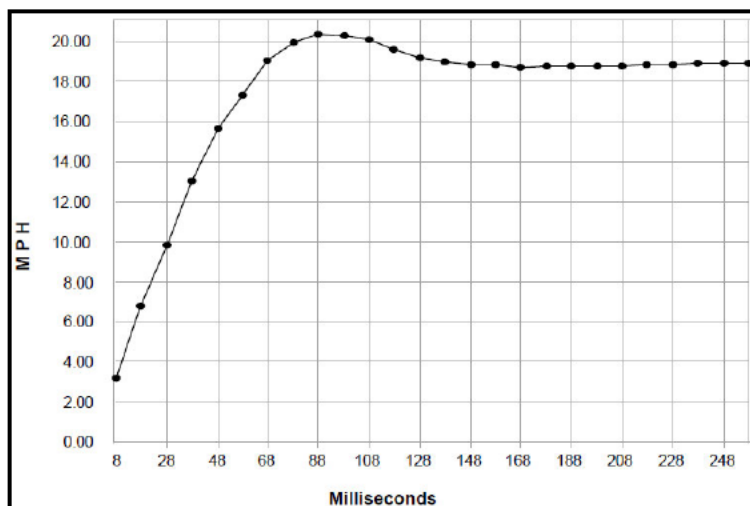


Figure 12. Longitudinal change in velocity graph.

Although not inclusive of all data reported in the longitudinal change in velocity graph, the following information was noted:

- The graph increased with no unusual reversals achieving a cumulative longitudinal change in velocity of 20.38 miles per hour, before decreasing to 18.91 miles per hour where it leveled off.

<sup>4</sup> Activating the brake switch would, in turn, activate the stop lamps.

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**ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS**

**2017 Ford Expedition – Analysis**

**Safety Recalls**

A search of safety recalls by vehicle identification number was conducted through the National Highway Traffic Safety Administration (NHTSA) [1]. There were no open recalls associated with the vehicle identification number assigned to the Ford.

**Conclusions**

**2018 Toyota Corolla**

The ACM, or event data recorder (EDR), installed in the Toyota was regulated by Title 49 of the Code of Federal Regulations (CFR), Part 563. According to 49 CFR 563.9, the EDR must capture and record the data elements for events in accordance with the following conditions and circumstances:

- (a) In a frontal air bag deployment crash, capture and record the current deployment data. In a side or side curtain/tube air bag deployment crash, where lateral delta-V is recorded by the EDR, capture and record the current deployment data. The memory for the air bag deployment event must be locked to prevent any future overwriting of the data.*
- (b) In an event that does not meet the criteria in § 563.9(a), capture and record the current event data, up to two events, subject to the following conditions:
  - (1) If an EDR non-volatile memory buffer void of previous-event data is available, the current event data is recorded in the buffer.*
  - (2) If an EDR non-volatile memory buffer void of previous-event data is not available, the manufacturer may choose to either overwrite any previous event data that does not deploy an air bag with the current event data, or to not record the current event data.*
  - (3) EDR buffers containing previous frontal, side, or side curtain/tube air bag deployment-event data must not be overwritten by the current event data.**

According to 49 CFR 563.5(b), “event” is defined as:

*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.*

According to 49 CFR 563.5(b), “trigger threshold” is defined as:

*A change in vehicle velocity, in the longitudinal direction, that equals or exceeds 8 km/h within a 150 millisecond interval. For vehicles that record “delta-V, lateral,” trigger threshold means a change in vehicle velocity in either the longitudinal or lateral direction that equals or exceeds 8 km/h within a 150 millisecond interval.*

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***ANALYSIS AND OPINION – AIRBAG CONTROL MODULE ANALYSIS***

**Conclusions – 2018 Toyota Corolla**

The ACM installed in the Toyota did not command deployment of any supplemental restraints, nor did it record a non-deployment event as a result of this collision. Per 49 CFR 563, the ACM installed in the Toyota was required, at a minimum; to record a non-deployment “event” as long as the “trigger threshold” (longitudinal change in velocity of 5 miles per hour within a 150 millisecond interval) was met. Given the damage sustained to the front of the Toyota, and the fact it impacted a vehicle that was nearly twice as heavy, it would be expected that at the very least, a non-deployment event would have been recorded by the ACM installed in the Toyota.

This opinion is further supported by the fact the ACM installed in the Ford experienced a maximum cumulative longitudinal change in velocity of 20.38 within 89 milliseconds. Given this duration and magnitude of longitudinal change in velocity of a much heavier vehicle, the ACM in the Toyota should have met the trigger threshold and recorded an event per 49 CFR 563.9(b)(1).

Due to this apparent failure of the ACM installed in the Toyota to comply with federal regulations, on September 11, NHTSA Investigator Perry took custody of the surrogate ACM and the ACM removed from the Toyota for further testing and analysis.

**2017 Ford Expedition**

The data imaged from the ACM installed in the Ford were related to this collision based upon the following: a) a complete file was recorded, b) the maximum cumulative longitudinal velocity change was consistent with the damage to the rear of the Ford, and c) the low number of ignition cycles between the collision and time of imaging by Investigator Bozyk.

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**ANALYSIS AND OPINION – CALCULATIONS**

**Symbols and Units**

- $\varepsilon$  - Coefficient of restitution [*dimensionless*]
- fps* - Feet per second
- mph* - Miles per hour
- $v$  - Velocity [*fps* or *mph*]
- $w$  - Weight [*lbs*]
- $\Delta$  - Change in

**Equations and Formulas**

1. The following equations were used to convert feet per second to miles per hour or miles per hour to feet per second:

$$mph = \frac{(fps)(3,600)}{5,280} \qquad fps = \frac{(mph)(5,280)}{3,600}$$

2. The following equation was used to calculate the change in velocity of the Toyota, based upon the change in velocity recorded by the ACM installed in the Ford and the weight of each vehicle:

$$\Delta v_{Toyota} = \Delta v_{Ford} \left( \frac{w_{Ford}}{w_{Toyota}} \right)$$

3. The following equation was utilized to calculate the closing velocity between the Toyota and Ford based on the change in velocity of each vehicle and the coefficient of restitution:

$$v_c = \left[ \frac{1}{1 + \varepsilon} \right] (\Delta v_{Ford} + \Delta v_{Toyota})$$

4. The following equation was utilized to calculate the at-impact velocity of the Toyota based on the closing velocity and at-impact velocity of the Ford:

$$v_{Toyota} = v_c + v_{Ford}$$

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**ANALYSIS AND OPINION – CALCULATIONS**

**Introduction**

The following calculations were performed to determine the at-impact and change in velocity of the Toyota.

**Methodology**

In order to determine the at-impact velocity of the Toyota, the closing velocity between the Toyota and the Ford was calculated. Closing velocity is defined as the relative velocity (the magnitude of the velocity difference) of the two vehicles at the time of impact. In order to calculate the closing velocity, the change in velocity recorded by the ACM installed in the Ford was utilized to determine the change in velocity experienced by the Toyota. With the changes in velocity of each vehicle known, it was possible to calculate the closing velocity between the two vehicles.

In reconstructing any collision, the uncertainty in the analysis must be properly accounted for. One commonly utilized method of examining and quantifying the uncertainty within an analysis is the use of the Monte Carlo Analysis (MCA). An MCA allows the reconstructionist to consider the uncertainties in more than one measurement at the same time by evaluating the essential equations of an analysis many times. This series of trials generates a group of possible results (a population), from which the mean and standard deviation of the population can be determined. Once the population is generated, it is possible to evaluate virtually all of the possible combinations and permutations of all variables for many crashes in such a way as to allow the determination of a result to a specific level of confidence.

Based on fundamental statistics, using the resulting frequency distribution, one can determine the level of confidence to ascribe to a particular range [2]. One can be 68% confident the true value is within one standard deviation of the mean. The minimum and maximum values generated by this method are theoretically possible, but are very unlikely, and certainly not within a reasonable degree of certainty.

For this analysis, the uncertainties were a) the change in velocity of both vehicles, b) the total weight of each vehicle, and c) the coefficient of restitution. In order to conduct an MCA, it was necessary to determine a range of values for these uncertainties.

**Monte Carlo Analysis**

**Change in Velocity**

The ACM in the Ford recorded a nominal longitudinal velocity change of 20.38 miles per hour. Research indicates the accuracy of change in velocity is  $\pm 10$  percent [3]. A range of change in velocity for the Ford was calculated as follows:

$$\Delta v_{\text{Ford}} = \Delta v_{\text{ACM}}(1 \pm 0.10)$$

$$\Delta v_{\text{Ford}} = (20.38)(1 \pm 0.10) = [22.42, 18.34] \text{ mph}$$

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**ANALYSIS AND OPINION – CALCULATIONS**

**Monte Carlo Analysis**

Vehicle Weights

The uncertainty in the weight of each vehicle was predominately based upon the cargo in each vehicle. The [REDACTED] family had been returning from an out of state trip and most likely had cargo consisting of clothing and miscellaneous items. It was estimated that each occupant had 20 pounds of cargo for a total of 80 pounds. Cargo in the occupant compartment of the Toyota was limited to personal items and was estimated to be 10 pounds. According to research conducted by Russell Smith from the U.S. Department of Transportation, as cited by Bartlett and Fonda, a weight variance (one standard deviation) of 65 pounds was reasonable for “medium uncertainty” [4]. The calculated total vehicle weights are presented in Table 3.

Table 3  
*Calculated Total Weights of the Vehicles*

Data	Weight [pounds]	
	Ford	Toyota
Vehicle curb weight	5,562 <sup>a</sup>	2,870 <sup>a</sup>
Cargo	80	10
Driver	136 <sup>b</sup>	135 <sup>c</sup>
<u>Passenger</u>		
[REDACTED] [right-front]	190 <sup>d</sup>	
[REDACTED] [right-front]	N/A	102 <sup>b</sup>
[REDACTED] [right-rear]	130 <sup>d</sup>	N/A
[REDACTED] [3rd row]	135 <sup>d</sup>	N/A
<b>Total</b>	<b>6,233±65</b>	<b>3,117±65</b>

Note. <sup>a</sup>Based on weight provided by DataOne Software as reported by Berla [5]. <sup>b</sup>Based on weight declared on California driver license. <sup>c</sup>Based on weight at the time of autopsy. <sup>d</sup>Based on weights verbally provided by [REDACTED].

For the purpose of the calculations, a range of weight for the Ford was 6,168 to 6,298 pounds and the Toyota was 3,052 to 3,182 pounds.

Coefficient of Restitution

With measurable crush profiles, coefficient of restitution values are typically less than 0.30 and in high relative impact velocities typical values are between 0.05 and 0.15 [6]. Given the high relative impact velocity during this collision, a range between 0.05 and 0.15 was utilized for the coefficient of restitution.

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**ANALYSIS AND OPINION – CALCULATIONS**

**Monte Carlo Analysis**

Calculations

An MCA was performed using a series of equations to calculate the closing velocity between the Toyota and the Ford. The MCA was conducted utilizing RC Monte Carlo for Excel [7]. RC Monte Carlo for Excel was used to generate 15,000 random numbers, uniformly distributed for each of the three uncertainties in Table 4. Thus, 75,000 random numbers were generated. In essence, the MCA takes a random number between each range of each input variable and utilizes that value in the series of equations to ultimately calculate the closing velocity. Accordingly, each equation is solved 15,000 times.

Table 4  
*Range of Values Utilized During the Monte Carlo Analysis*

Uncertainty	Vehicles	
	Ford	Toyota
Change in velocity ( $\Delta v$ ) [mph]	18.34 to 22.42	Calculated
Vehicle weight (w) [lbs]	6,168 to 6,298	3,052 to 3,182
Coefficient of restitution ( $\epsilon$ ) [dimensionless]	0.05 to 0.15	

The following calculations were conducted in the following order within the MCA and solved utilizing the generated random numbers based upon the ranges presented in Table 4 to ultimately solve for the closing velocity.

Calculation 1

The first calculation was performed to determine the change in velocity of the Toyota. This was accomplished by utilizing the recorded range of velocity changes for the Ford and range of vehicle weights for the Ford and Toyota in the following equation:

$$\Delta v_{\text{Toyota}} = \Delta v_{\text{Ford}} \left( \frac{w_{\text{Ford}}}{w_{\text{Toyota}}} \right)$$

Within a reasonable degree of certainty (one standard deviation from the mean), the range of the change in velocity of the Toyota based upon the 15,000 calculated values was between 37.98 and 43.59 miles per hour (mean value of 40.78 miles per hour).

Calculation 2

The final calculation was performed to determine the closing velocity between the Toyota and the Ford. This was accomplished by utilizing the change in velocity of the Toyota calculated in Calculation 1, the corresponding random change in velocity value of the Ford, and the random value of coefficient of restitution in the following equation:

$$v_c = \left[ \frac{1}{1 + \epsilon} \right] (\Delta v_{\text{Ford}} + \Delta v_{\text{Toyota}})$$

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**ANALYSIS AND OPINION – CALCULATIONS**

**Monte Carlo Analysis**

**Results**

Based upon 15,000 calculated values for the closing velocity between the Toyota and the Ford, the following frequency distribution (Figure 13) and cumulative probability (Figure 14) was developed:

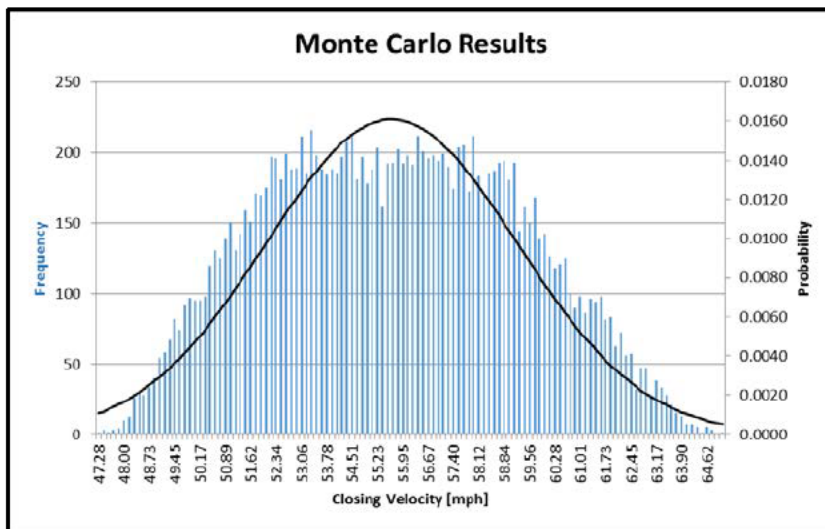


Figure 13. Frequency distribution for the closing velocity between the Toyota and Ford.

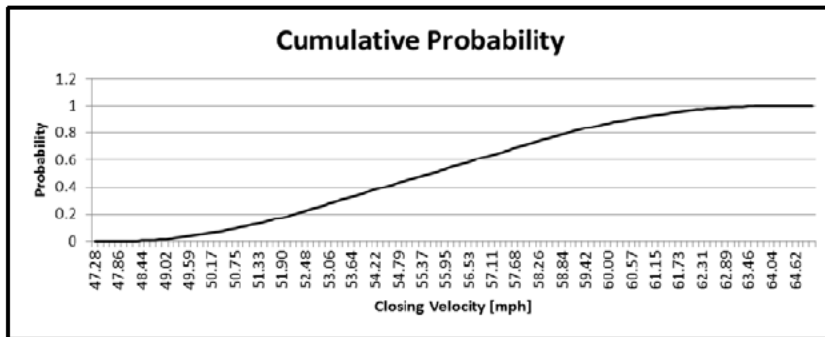


Figure 14. Cumulative probability for the closing velocity between the Toyota and Ford.

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**ANALYSIS AND OPINION – CALCULATIONS**

**Monte Carlo Analysis – Results**

Based upon fundamental statistics and the resulting frequency distribution presented in Figure 13, the statistical results of the MCA for the closing velocity between the Toyota and Ford are presented in Table 5.

Table 5  
*Statistical Results of the Closing Velocity Frequency Distribution  
Developed During the Monte Carlo Analysis*

Data	Velocity [mph]
Mean	55.63
Median	55.59
Standard Deviation $\sigma$	3.58
Minimum	47.28
Maximum	65.05
Range	17.77
68% Confidence Interval	51.74 to 59.51

**At-Impact Velocity**

Ford Expedition

The ACM installed in the Ford recorded an indicated velocity of 1 mile per hour at time zero, which was considered as the time of impact with the Toyota.

Toyota Corolla

The calculated closing velocity between the Ford and Toyota represented the combined speed at which the two vehicles approached each other; therefore, the magnitude and direction of each vehicle’s velocity vector must be accounted for. Within a reasonable degree of certainty ( $\pm$  one standard deviation), the closing velocity between the Ford and Toyota was between 51.74 and 59.51 miles per hour. For the purpose of the calculations, the pre-impact direction of the Ford and Toyota was considered to be the positive direction.

Utilizing an at-impact velocity of one mile per hour for the Ford and the calculated range of closing velocities (between 51.74 and 59.51 miles per hour), a range of at-impact velocities of the Toyota was calculated as follows:

$$\begin{aligned} \begin{bmatrix} v_{c(\min)} \\ v_{c(\max)} \end{bmatrix} &= v_{\text{Toyota}} - (v_{\text{Ford}}) \\ v_{\text{Toyota}} &= \begin{bmatrix} v_{c(\min)} \\ v_{c(\max)} \end{bmatrix} + v_{\text{Ford}} \\ v_{\text{Ford}} &= \begin{bmatrix} 51.74 \\ 59.51 \end{bmatrix} + 1.0 = \begin{bmatrix} 52.74 \\ 60.51 \end{bmatrix} \text{ mph} \end{aligned}$$

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***ANALYSIS AND OPINION – CALCULATIONS***

**Conclusions**

Based on the velocity reconstruction, which included analyses of data recorded by the ACM installed in the Ford and a Monte Carlo Analysis, the following conclusions were reached:

- Within a reasonable degree of certainty, the change in velocity of the center of mass of the Toyota was between 38 and 44 miles per hour (mean velocity of 41 miles per hour).
- Within a reasonable degree of certainty, the closing velocity between the Toyota and Ford was between 51 and 60 miles per hour (mean closing velocity of 56 miles per hour).
- Within a reasonable degree of certainty, the at-impact velocity of the Toyota was between 52 and 61 miles per hour.

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**CONCLUSIONS – SUMMARY**

**Overview**

The following conclusions were based on the totality of this MAIT investigation. The investigation included such elements as a review of the Traffic Collision Report prepared by CHP Riverside Area Officer Tronti, analysis of data imaged from the ACMs installed in the Toyota and Ford, and a velocity reconstruction.

**Airbag Control Module**

- The data imaged from the ACM installed in the Ford were related to this collision.
- The EEPROM removed from the circuit board of the ACM (removed from the Toyota) and transplanted onto the circuit board of an exemplar ACM (surrogate) was successful. There were no events recorded on the EEPROM from the Toyota’s ACM; however, at the time of imaging there had been 883 ignition cycles recorded on the EEPROM.
- Based upon the collision impulse recorded on the Ford’s ACM (89 milliseconds) and magnitude of the calculated longitudinal change in velocity of the Toyota (38 to 44 miles per hour), the ACM should have commanded deployment of supplemental restraints, despite the underride nature of the impact. The ACM was regulated by 49 CFR 563 and at least should have recorded a non-deployment event. It is indeterminate as to the reason the ACM failed to command deployment of supplemental restraints or record a non-deployment event.
- NHTSA took possession of both ACMs related to the Toyota for further testing and analysis. As of publication of this MAIT supplemental report, the findings of the testing and analysis conducted by NHTSA have not been completed.

**At-Impact**

- The Ford was traveling [REDACTED] [REDACTED] [REDACTED] at one mile per hour when it was impacted from behind by the Toyota Corolla, which was traveling at a velocity between 52 and 61 miles per hour.

**Post-Impact**

- The Ford Expedition was accelerated in a southerly direction, experiencing a change in velocity of nearly 21 miles per hour. The Toyota Corolla experienced negative acceleration and was slowed by 38 to 44 miles per hour.

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***ANNEX A: CDR REPORT – SURROGATE ACM***

This annex contains the 7-page EDR report generated from data imaged from the surrogate ACM received from Toyota North America.

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/Frame Number	[REDACTED]
User	M. Seruga
Case Number	[REDACTED]
EDR Data Imaging Date	07/09/2018
Crash Date	[REDACTED]
Filename	[REDACTED]
Saved on	Monday, July 9 2018 at 09:46:53
Imaged with CDR version	Crash Data Retrieval Tool 17.7.1
Imaged with Software Licensed to (Company Name)	California Highway Patrol
Reported with CDR version	Crash Data Retrieval Tool 17.7.1
Reported with Software Licensed to (Company Name)	California Highway Patrol
EDR Device Type	Airbag Control Module
Event(s) recovered	None

### Comments

Surrogate/exemplar airbag ECU imaging at Inland MAIT office

### Data Limitations

#### CDR Record Information:

- Due to limitations of the data recorded by the airbag ECU, such as the resolution, data range, sampling interval, time period of the recording, and the items recorded, the information provided by this data may not be sufficient to capture the entire crash.
- Pre-Crash data is recorded in discrete intervals. Due to different refresh rates within the vehicle's electronics, the data recorded may not be synchronous to each other.
- Airbag ECU data should be used in conjunction with other physical evidence obtained from the vehicle and the surrounding circumstances.
- If any of the front passenger seat airbags, side airbags, or Curtain Shield Airbags have deployed, data will not be overwritten or deleted by the airbag ECU following that event. If none of the airbags have deployed, the data of that event may be overwritten by a following event even if other airbags (pretensioner, rear seat airbag, etc.) have deployed.
- If power supply to the airbag ECU is lost during an event, all or part of the data may not be recorded.
- "Diagnostic Trouble Codes" are information about faults when a recording trigger is established. Various diagnostic trouble codes could be set and recorded due to component or system damage during an accident.
- The airbag ECU records only diagnostic information related to the airbag system. It does not record diagnostic information related to other vehicle systems.
- The TaSCAN, Global Tech Stream, or Intelligent Tester II devices (or any other Toyota genuine diagnostic tool) can be used to obtain detailed information on the diagnostic trouble codes from the airbag system, as well as diagnostic information from other systems. However, in some cases, the diagnostic trouble codes of the airbag system recorded by the airbag ECU when the event occurred may not match the diagnostic trouble codes read out when the diagnostic tool is used.

#### General Information:

- The data recording specifications of Toyota's airbag ECUs are divided into the following categories. The specifications for 12EDR or later are designed to be compatible with NHTSA's 49CFR Part 563 rule.
  - 00EDR / 02EDR / 04EDR / 06EDR / 10EDR / 12EDR / 13EDR / 15EDR / 17EDR
- The airbag ECU records data for all or some of the following accident types: frontal crash, rear crash, side crash, and rollover events. Depending on the installed airbag ECU, data for side crash and/or rollover events may not be recorded.
- This airbag ECU records record pre-crash data and post-crash data.
  - If a single event occurs independently, the data for that event is recorded on a one-to-one basis.
  - If multiple events occur successively (within a period of approximately 500ms), the establishment of the recording trigger for the first event is defined as the "pre-crash recording trigger". Pre-crash data for the first event and post-crash data for each successive event is then recorded.
- The airbag ECU has two recording pages (memory maps) to store pre-crash data. Additionally, to store post-crash data, the airbag ECU has two recording pages for each accident type: two pages for frontal and rear crash, two pages for a side crash, and two pages for rollover event.
- The data recorded by the airbag ECU includes correlating information between each previously occurring event (i.e., information that clarifies the collision event sequence. This correlation information consists of the following items.
  - Time from Previous Pre-Crash TRG
  - Linked Pre-Crash Page
  - Time from Pre-Crash TRG
  - TRG Count
  - Previous Crash Type
- In frontal and rear collision events, the first point where a longitudinal cumulative delta-V of over 0.8 km/h (0.5 mph) is reached is regarded as time zero for the recorded data. In side impact collision and rollover events, the point in time at which the recording trigger is established is

- regarded as time zero for the recorded data.
- The recording trigger judgment threshold value differs depending on the collision type (i.e., frontal crash, rear crash, side crash, or rollover event).
- Some of the data recorded by the airbag ECU is transmitted to the airbag ECU from various vehicle control modules by the vehicle's Controller Area Network (CAN).
- In some cases, the airbag ECU part number printed on the ECU label may not match the airbag ECU part number that the CDR tool reports. The part number retrieved by the CDR tool should be considered as the official ECU part number.
- In frontal and rear collision events, the record time varies depending on the period during which a longitudinal cumulative delta-V of over 0.8 km/h (0.5 mph) is reached, and time series data is recorded for up to 250 ms. The record time described above is indicated as "Length of Delta-V". "Delta-V, Longitudinal" outside the record time is indicated by area shaded in the table, and not indicated in the graph.


**Data Element Sign Convention:**

The following table provides an explanation of the sign notation for data elements that may be included in this CDR report.

Data Element Name	Positive Sign Notation Indicates
Maximum Delta-V, Longitudinal	Forward
Delta-V, Longitudinal	Forward
Lateral Acceleration for Frontal/Rear Crash, Floor Sensor	Left to Right
Lateral Acceleration, Side Satellite Sensor 1	Left to Right
Lateral Acceleration, Side Satellite Sensor 2	Left to Right
Lateral Acceleration, Side Satellite Sensor 3	Left to Right
Lateral Acceleration, Side Satellite Sensor 4	Left to Right
Lateral Acceleration for Side Crash, Floor Sensor	Left to Right
Roll Angle Peak	Clockwise Rotation
Roll Angle at the Time of TRG	Clockwise Rotation
Roll Rate	Clockwise Rotation
Lateral Acceleration for Rollover, Floor Sensor	Left to Right
Longitudinal Acceleration , VSC Sensor	Forward
Yaw Rate	Left Turn
Steering Input	Left Turn

**Data Definitions:**

- The "ON" setting for the "Freeze Signal" indicates a state in which the non-volatile memory can not be overwritten or deleted by the airbag ECU. After "Freeze Signal" has been turned ON, subsequent events will not be recorded.
  - "Recording Status" indicates a state in which all recorded event data has been written into the non-volatile memory, or a state in which this process was interrupted and not fully written into the non-volatile memory. If "Recording Status" is "Incomplete", recorded event data may not be valid.
  - If the "Occupant Size Classification, Front Passenger" displays "Child" or "Not Occupied", "Side Air Bag Deployment, Time to Deploy" and "Pretensioner Deployment, Time to Fire" may indicate a time even if deployment did not occur on the for following part no's:  
- 89170-07280, 35400, 35410, 35470, 42660, 0R120, 0R080, 0R081, 0R150
  - "Engine RPM" indicates the number of engine revolutions, not the number of motor revolutions. The recorded value has an upper limit of 12,800 rpm. Resolution is 100 rpm and the value is rounded down and recorded. For example, if the actual engine speed is 799 rpm, the recorded value will be 700 rpm.
  - If the electric vehicle is using a calculated/virtual engine RPM for drivetrain control, "Engine RPM" may be recorded, but should not be used during data analysis.
  - The upper limit for the recorded "Vehicle Speed" value is 200 km/h (125mph). Resolution is 1km/h (0.6mph) and the value is rounded down and recorded. The accuracy of the "Vehicle Speed" value can be affected by various factors. These include, but not limited, to the following.
    - Significant changes in the tire's rolling radius
    - Wheel lock and wheel slip
  - "Accelerator Pedal" has two recording specifications. Both the recorded value increases as the driver depresses the accelerator.
    - Percentage of accelerator pedal depressed (recorded as 0-100(%)).
    - Output voltage of accelerator pedal module (recorded as 0-5(V)).
  - If M/T transmission vehicle of some limited model, "Shift Position" may display "Drive" regardless of the actual shift position.
  - Depending on the type of occupant sensor installed in the vehicle, one of the following three recording formats for "Occupant Size Classification, Front Passenger" will be utilized.
    - Occupied / Not Occupied
    - AM50 / AF05 / Child / Not Occupied
    - AM50 / AF05 / Child or Not Occupied
  - "Cruise Control Status" indicates whether the cruise control system is actuated or not. OFF indicates that the cruise control system is not actuated, but can also indicates that the vehicle is not equipped with the system.
  - "Air Bag Warning Lamp, On/Off", "Ignition Cycle, Crash", "Seat Track Position Switch, Foremost, Status, Driver", "Occupant Size Classification, Front Passenger", "Safety Belt Status, Driver", "Safety Belt Status, Front Passenger", "Frontal Air Bag Suppression Switch Status, Front Passenger", and "RSCA Disable Switch" indicate the state approximately 1 second before time zero. They may not always indicate the state at the moment of collision.
  - The upper and lower limits for the recorded value of "Motor RPM" is 17,500 rpm and -7,500 rpm respectively. Resolution is 100 rpm and the value is rounded down and recorded.
  - "Brake Oil Pressure" has an upper limit of 12.14 Mpa. In the case of the vehicle that has not VSC system, "0 Mpa" or "Invalid" may be displayed.
  - "Longitudinal Acceleration , VSC Sensor" has upper and lower limits for the recorded value of 8.973 m/s<sup>2</sup> and -8.973 m/s<sup>2</sup> respectively. This acceleration sensor does not sense collisions.
  - "Sequential Shift Range" displaying "Undetermined" indicates the shift range is undetermined or was not being used.

- Some vehicles will not be equipped with all "Drive Mode" types indicated in the "Drive Mode" table. If some or all drive modes are not applicable to vehicle, "OFF" or "Invalid" may be displayed. The item in the "Drive Mode" table may not match the name of switch or indicator that equipped the vehicle.
  - The upper and lower limits for the recorded value of "Steering Input" is 375 deg and -375 deg respectively. Resolution is 1.5 deg and the value is rounded down and recorded.
  - Resolution of the "Air Bag Warning Lamp ON Time Since DTC was Set" is 15 minutes, and the value is rounded down and recorded.
  - "Delta-V, Longitudinal" indicates the change in forward speed after time zero. This does not refer to vehicle speed, and it does not include the change in speed during the period from the start of the actual collision to establishment of the time zero.
  - "Location of Side Satellite Sensor" shows the outline of a typical sensor position. Sensory location can be confirmed using the repair manual.
  - "Time from Previous Pre-Crash TRG" indicates the time between the establishment of an event's pre-crash recording trigger to the establishment of a more recent event's pre-crash recording trigger. The upper limit for the recorded value is 16,381 milliseconds. In the event of establishment of the first pre-crash recording trigger after the ignition is switched ON, the upper limit value(max value) is recorded.
  - "TRG Count" indicates a calculated value of the number of times recording triggers have been established for all crash types. The sequence in which each event occurred can be verified from the "TRG Count". The smaller the "TRG Count" value, the older the data. The upper limit for the recorded value is 65,533 times. When more than one event reaches the upper limit, the actual "TRG Count" may be greater than what is displayed for that event.
  - "Linked Pre-Crash Page" is used to link 'paged" pre-crash data with 'paged" post-crash data. When old pre-crash data is overwritten by new pre-crash data, the "Linked Pre-Crash Page" value may record a page number that is not actually linked.
  - Resolution of the "Time from Pre-Crash to TRG" is 50 [ms], and the value is rounded up and recorded.
  - "Roll Angle at the Time of TRG" and "Roll Angle Peak" do not represent the actual roll angle of the vehicle. These values are used internally by the airbag ECU for sensing a rollover.
- 

### System Status at Time of Retrieval

ECU Part Number	89170-02K90
EDR Generation	13EDR
Complete File Recorded	Yes
Freeze Signal	OFF
Freeze Signal Factor	None
Diagnostic Trouble Codes Exist	No
Ignition Cycle ,Download (times)	1
Multi-event, number of events (times)	N/A
Time from event 1 to 2 (s)	N/A
Time from Previous Pre Crash TRG (msec)	0
Latest Pre-Crash Page	0
Contains Unlinked Pre-Crash Data	No

### Event Record Summary at Retrieval

Events Recorded	TRG Count	Crash Type	Time (msec)	Pre-Crash & DTC Data Recording Status	Event & Crash Pulse Data Recording Status
None	N/A	N/A	N/A	N/A	N/A



```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
73 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 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
74 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 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
80 00 00 00 01
A0 0C 00 DF 81
A5 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 00 00 00 00 00 00 00 00 00
A6 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 00 00 00 00 00 00 00 00 00
B4 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00
B5 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00
B6 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00
B7 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00
B8 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
B9 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
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The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION TEAM NARRATIVE/DIAGRAM**

CHP 558D (Rev. 9-08) OPI 065 (MAIT use only)

DATE OF COLLISION (MONTH-DAY-YEAR)	TIME (2400)	NCIC	OFFICER I.D.	NUMBER	MAIT CASE NUMBER	PAGE
[REDACTED]	0106	9840	17546	[REDACTED]	[REDACTED] 8	B1

***ANNEX B: CDR REPORT – SURROGATE ACM WITH EEPROM FROM THE TOYOTA***

This annex contains the 7-page EDR report generated from data imaged from the EEPROM from the Toyota transplanted onto the circuit board of the surrogate ACM.

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/Frame Number	[REDACTED]
User	M. Seruga
Case Number	[REDACTED]
EDR Data Imaging Date	07/09/2018
Crash Date	[REDACTED]
Filename	[REDACTED].ACM.CDRX
Saved on	Monday, July 9 2018 at 11:15:02
Imaged with CDR version	Crash Data Retrieval Tool 17.7.1
Imaged with Software Licensed to (Company Name)	California Highway Patrol
Reported with CDR version	Crash Data Retrieval Tool 17.7.1
Reported with Software Licensed to (Company Name)	California Highway Patrol
EDR Device Type	Airbag Control Module
Event(s) recovered	None

### Comments

Surrogate airbag ECU with subject ECU EEPROM chip; at Inland MAIT office

### Data Limitations

#### CDR Record Information:

- Due to limitations of the data recorded by the airbag ECU, such as the resolution, data range, sampling interval, time period of the recording, and the items recorded, the information provided by this data may not be sufficient to capture the entire crash.
- Pre-Crash data is recorded in discrete intervals. Due to different refresh rates within the vehicle's electronics, the data recorded may not be synchronous to each other.
- Airbag ECU data should be used in conjunction with other physical evidence obtained from the vehicle and the surrounding circumstances.
- If any of the front passenger seat airbags, side airbags, or Curtain Shield Airbags have deployed, data will not be overwritten or deleted by the airbag ECU following that event. If none of the airbags have deployed, the data of that event may be overwritten by a following event even if other airbags (pretensioner, rear seat airbag, etc.) have deployed.
- If power supply to the airbag ECU is lost during an event, all or part of the data may not be recorded.
- "Diagnostic Trouble Codes" are information about faults when a recording trigger is established. Various diagnostic trouble codes could be set and recorded due to component or system damage during an accident.
- The airbag ECU records only diagnostic information related to the airbag system. It does not record diagnostic information related to other vehicle systems.
- The TaSCAN, Global Tech Stream, or Intelligent Tester II devices (or any other Toyota genuine diagnostic tool) can be used to obtain detailed information on the diagnostic trouble codes from the airbag system, as well as diagnostic information from other systems. However, in some cases, the diagnostic trouble codes of the airbag system recorded by the airbag ECU when the event occurred may not match the diagnostic trouble codes read out when the diagnostic tool is used.

#### General Information:

- The data recording specifications of Toyota's airbag ECUs are divided into the following categories. The specifications for 12EDR or later are designed to be compatible with NHTSA's 49CFR Part 563 rule.
  - 00EDR / 02EDR / 04EDR / 06EDR / 10EDR / 12EDR / 13EDR / 15EDR / 17EDR
- The airbag ECU records data for all or some of the following accident types: frontal crash, rear crash, side crash, and rollover events. Depending on the installed airbag ECU, data for side crash and/or rollover events may not be recorded.
- This airbag ECU records record pre-crash data and post-crash data.
  - If a single event occurs independently, the data for that event is recorded on a one-to-one basis.
  - If multiple events occur successively (within a period of approximately 500ms), the establishment of the recording trigger for the first event is defined as the "pre-crash recording trigger". Pre-crash data for the first event and post-crash data for each successive event is then recorded.
- The airbag ECU has two recording pages (memory maps) to store pre-crash data. Additionally, to store post-crash data, the airbag ECU has two recording pages for each accident type: two pages for frontal and rear crash, two pages for a side crash, and two pages for rollover event.
- The data recorded by the airbag ECU includes correlating information between each previously occurring event (i.e., information that clarifies the collision event sequence. This correlation information consists of the following items.
  - Time from Previous Pre-Crash TRG
  - Linked Pre-Crash Page
  - Time from Pre-Crash TRG
  - TRG Count
  - Previous Crash Type
- In frontal and rear collision events, the first point where a longitudinal cumulative delta-V of over 0.8 km/h (0.5 mph) is reached is regarded as time zero for the recorded data. In side impact collision and rollover events, the point in time at which the recording trigger is established is

- regarded as time zero for the recorded data.
- The recording trigger judgment threshold value differs depending on the collision type (i.e., frontal crash, rear crash, side crash, or rollover event).
- Some of the data recorded by the airbag ECU is transmitted to the airbag ECU from various vehicle control modules by the vehicle's Controller Area Network (CAN).
- In some cases, the airbag ECU part number printed on the ECU label may not match the airbag ECU part number that the CDR tool reports. The part number retrieved by the CDR tool should be considered as the official ECU part number.
- In frontal and rear collision events, the record time varies depending on the period during which a longitudinal cumulative delta-V of over 0.8 km/h (0.5 mph) is reached, and time series data is recorded for up to 250 ms. The record time described above is indicated as "Length of Delta-V". "Delta-V, Longitudinal" outside the record time is indicated by area shaded in the table, and not indicated in the graph.


#### Data Element Sign Convention:

The following table provides an explanation of the sign notation for data elements that may be included in this CDR report.

Data Element Name	Positive Sign Notation Indicates
Maximum Delta-V, Longitudinal	Forward
Delta-V, Longitudinal	Forward
Lateral Acceleration for Frontal/Rear Crash, Floor Sensor	Left to Right
Lateral Acceleration, Side Satellite Sensor 1	Left to Right
Lateral Acceleration, Side Satellite Sensor 2	Left to Right
Lateral Acceleration, Side Satellite Sensor 3	Left to Right
Lateral Acceleration, Side Satellite Sensor 4	Left to Right
Lateral Acceleration for Side Crash, Floor Sensor	Left to Right
Roll Angle Peak	Clockwise Rotation
Roll Angle at the Time of TRG	Clockwise Rotation
Roll Rate	Clockwise Rotation
Lateral Acceleration for Rollover, Floor Sensor	Left to Right
Longitudinal Acceleration , VSC Sensor	Forward
Yaw Rate	Left Turn
Steering Input	Left Turn

#### Data Definitions:

- The "ON" setting for the "Freeze Signal" indicates a state in which the non-volatile memory can not be overwritten or deleted by the airbag ECU. After "Freeze Signal" has been turned ON, subsequent events will not be recorded.
  - "Recording Status" indicates a state in which all recorded event data has been written into the non-volatile memory, or a state in which this process was interrupted and not fully written into the non-volatile memory. If "Recording Status" is "Incomplete", recorded event data may not be valid.
  - If the "Occupant Size Classification, Front Passenger" displays "Child" or "Not Occupied", "Side Air Bag Deployment, Time to Deploy" and "Pretensioner Deployment, Time to Fire" may indicate a time even if deployment did not occur on the for following part no's:  
- 89170-07280, 35400, 35410, 35470, 42660, 0R120, 0R080, 0R081, 0R150
  - "Engine RPM" indicates the number of engine revolutions, not the number of motor revolutions. The recorded value has an upper limit of 12,800 rpm. Resolution is 100 rpm and the value is rounded down and recorded. For example, if the actual engine speed is 799 rpm, the recorded value will be 700 rpm.
  - If the electric vehicle is using a calculated/virtual engine RPM for drivetrain control, "Engine RPM" may be recorded, but should not be used during data analysis.
  - The upper limit for the recorded "Vehicle Speed" value is 200 km/h (125mph). Resolution is 1km/h (0.6mph) and the value is rounded down and recorded. The accuracy of the "Vehicle Speed" value can be affected by various factors. These include, but not limited, to the following.
    - Significant changes in the tire's rolling radius
    - Wheel lock and wheel slip
  - "Accelerator Pedal" has two recording specifications. Both the recorded value increases as the driver depresses the accelerator.
    - Percentage of accelerator pedal depressed (recorded as 0-100(%)).
    - Output voltage of accelerator pedal module (recorded as 0-5(V)).
  - If M/T transmission vehicle of some limited model, "Shift Position" may display "Drive" regardless of the actual shift position.
  - Depending on the type of occupant sensor installed in the vehicle, one of the following three recording formats for "Occupant Size Classification, Front Passenger" will be utilized.
    - Occupied / Not Occupied
    - AM50 / AF05 / Child / Not Occupied
    - AM50 / AF05 / Child or Not Occupied
  - "Cruise Control Status" indicates whether the cruise control system is actuated or not. OFF indicates that the cruise control system is not actuated, but can also indicate that the vehicle is not equipped with the system.
  - "Air Bag Warning Lamp, On/Off", "Ignition Cycle, Crash", "Seat Track Position Switch, Foremost, Status, Driver", "Occupant Size Classification, Front Passenger", "Safety Belt Status, Driver", "Safety Belt Status, Front Passenger", "Frontal Air Bag Suppression Switch Status, Front Passenger", and "RSCA Disable Switch" indicate the state approximately 1 second before time zero. They may not always indicate the state at the moment of collision.
  - The upper and lower limits for the recorded value of "Motor RPM" is 17,500 rpm and -7,500 rpm respectively. Resolution is 100 rpm and the value is rounded down and recorded.
  - "Brake Oil Pressure" has an upper limit of 12.14 Mpa. In the case of the vehicle that has not VSC system, "0 Mpa" or "Invalid" may be displayed.
  - "Longitudinal Acceleration , VSC Sensor" has upper and lower limits for the recorded value of 8.973 m/s<sup>2</sup> and -8.973 m/s<sup>2</sup> respectively. This acceleration sensor does not sense collisions.
  - "Sequential Shift Range" displaying "Undetermined" indicates the shift range is undetermined or was not being used.

- Some vehicles will not be equipped with all "Drive Mode" types indicated in the "Drive Mode" table. If some or all drive modes are not applicable to vehicle, "OFF" or "Invalid" may be displayed. The item in the "Drive Mode" table may not match the name of switch or indicator that equipped the vehicle.
  - The upper and lower limits for the recorded value of "Steering Input" is 375 deg and -375 deg respectively. Resolution is 1.5 deg and the value is rounded down and recorded.
  - Resolution of the "Air Bag Warning Lamp ON Time Since DTC was Set" is 15 minutes, and the value is rounded down and recorded.
  - "Delta-V, Longitudinal" indicates the change in forward speed after time zero. This does not refer to vehicle speed, and it does not include the change in speed during the period from the start of the actual collision to establishment of the time zero.
  - "Location of Side Satellite Sensor" shows the outline of a typical sensor position. Sensory location can be confirmed using the repair manual.
  - "Time from Previous Pre-Crash TRG" indicates the time between the establishment of an event's pre-crash recording trigger to the establishment of a more recent event's pre-crash recording trigger. The upper limit for the recorded value is 16,381 milliseconds. In the event of establishment of the first pre-crash recording trigger after the ignition is switched ON, the upper limit value(max value) is recorded.
  - "TRG Count" indicates a calculated value of the number of times recording triggers have been established for all crash types. The sequence in which each event occurred can be verified from the "TRG Count". The smaller the "TRG Count" value, the older the data. The upper limit for the recorded value is 65,533 times. When more than one event reaches the upper limit, the actual "TRG Count" may be greater than what is displayed for that event.
  - "Linked Pre-Crash Page" is used to link 'paged" pre-crash data with 'paged" post-crash data. When old pre-crash data is overwritten by new pre-crash data, the "Linked Pre-Crash Page" value may record a page number that is not actually linked.
  - Resolution of the "Time from Pre-Crash to TRG" is 50 [ms], and the value is rounded up and recorded.
  - "Roll Angle at the Time of TRG" and "Roll Angle Peak" do not represent the actual roll angle of the vehicle. These values are used internally by the airbag ECU for sensing a rollover.
- 

### System Status at Time of Retrieval

ECU Part Number	89170-02K90
EDR Generation	13EDR
Complete File Recorded	Yes
Freeze Signal	OFF
Freeze Signal Factor	None
Diagnostic Trouble Codes Exist	No
Ignition Cycle ,Download (times)	883
Multi-event, number of events (times)	N/A
Time from event 1 to 2 (s)	N/A
Time from Previous Pre Crash TRG (msec)	0
Latest Pre-Crash Page	0
Contains Unlinked Pre-Crash Data	No

### Event Record Summary at Retrieval

Events Recorded	TRG Count	Crash Type	Time (msec)	Pre-Crash & DTC Data Recording Status	Event & Crash Pulse Data Recording Status
None	N/A	N/A	N/A	N/A	N/A



```
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
73 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
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
74 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
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
80 00 00 00 01
A0 0C 00 DF 81
A5 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 00
00 00 00 00 00 00 00 00 00 00 00 00
A6 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 00
00 00 00 00 00 00 00 00 00 00 00 00
B4 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00
B5 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00
B6 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
B7 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
B8 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
B9 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
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The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

**MULTIDISCIPLINARY ACCIDENT INVESTIGATION TEAM NARRATIVE/DIAGRAM**

CHP 558D (Rev. 9-08) OPI 065 (MAIT use only)

DATE OF COLLISION (MONTH-DAY-YEAR)	TIME (2400)	NCIC	OFFICER I.D.	NUMBER	MAIT CASE NUMBER	PAGE
[REDACTED]	0106	9840	17546	[REDACTED]	[REDACTED]	C1

***ANNEX C: CDR REPORT – 2017 FORD EXPEDITION***

This annex contains the 18-page EDR report generated from data imaged from the ACM installed in the 2017 Ford Expedition.

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	[REDACTED]
User	W. BOZYK
Case Number	[REDACTED]
EDR Data Imaging Date	05/30/2018
Crash Date	[REDACTED]
Filename	[REDACTED].ACM.CDRX
Saved on	Wednesday, May 30 2018 at 16:38:47
Imaged with CDR version	Crash Data Retrieval Tool 17.7.1
Imaged with Software Licensed to (Company Name)	California Highway Patrol
Reported with CDR version	Crash Data Retrieval Tool 17.7.1
Reported with Software Licensed to (Company Name)	California Highway Patrol
EDR Device Type	Airbag Control Module
ACM Adapter Detected During Download	No
Event(s) recovered	Event Record 1

### Comments

DOWNLOAD AT E.M. AUTO BODY 2075 S. RIVERSIDE AVE RIALTO, CA. CONSENT OF ENTERPRISE RENTAL. TIRES 275 65R18 WRANGLER GOODYEAR X4. DOWNLOAD VIA DLC. BOZYK PRESENT.

### Data Limitations

#### Data Imaging:

**CAUTION:** When imaging data directly from the RCM on a bench top, make sure the RCM is placed on a flat surface without any movement (static) while connected to and powered by the CDR interface. Not following the above guideline for bench top imaging could risk inducing new events to be recorded in the RCM and possibly overwriting a Non airbag deployment.

Note that the RCM Adapter Detected during Download parameter equal to "Yes" indicates that the EDR data was collected directly from the RCM. When equal to "No", it indicates that the EDR data was collected through the OBD II from the vehicle.

#### Restraints Control Module (RCM) Recorded Crash Event(s):

The RCM can store up to two crash events. Event types are categorized as follow:

1. Non deployment trigger event is an event in which EDR recording trigger threshold is met or exceeded (minimum of 5 mph (8kph) Accumulated Delta Velocity within 150ms interval), but no device(s) have deployed. The data from such event can be overwritten by subsequent events.
2. Airbag deployment event is an event in which frontal, side or curtain airbags have deployed. Note that such event cannot be overwritten or cleared from the Restraints Control Module (RCM). Once the RCM has deployed any airbag device(s), the RCM must be replaced.
3. Some RCM may also categorize Non airbag deployment event. This type is an event in which non airbag devices such as pretensioners, knee bolster etc... have deployed. Note that such event can be overwritten given a subsequent "deployment" event.

"Time zero" or Event Beginning of any event (First Record or Second Record) is defined as the first Algorithm wake up during that event. So all the Pre-Crash, At Event, Delta V Data, deployment times etc... are relative to "Time zero".

It is possible that conditions in a crash may result in an incomplete event data record.

## **EDR Data Elements Overview/Interpretation in CDR Report:**

### **Under CDR File Information Section**

- Event(s) recovered indicates if an event was detected and recorded by RCM. If no event is detected, it will indicate "none". If a trigger or non airbag deployment event is detected, it will indicate "unlocked event". If an airbag deployment is detected, it will indicate "locked frontal event", or "locked side event", or "locked rollover event".

### **Under System Status at Event Section**

- Complete file recorded indicates if data from the recorded event has been fully written to the RCM memory.
- If the RCM detected a peripheral crash sensor was lost during an event, the crash sensor would be identified as well as the time it was lost during that event relative to Time zero. If no loss of a peripheral crash sensor, nothing would be displayed. Note in some vehicles, loss of a peripheral crash sensor may lead to the loss of another peripheral crash sensor due to shared communication.

### **Under Deployment Data Section**

- If the RCM commanded a deployment during an event, the deployment device(s) would be identified as well as the time the RCM commanded its deployment relative to Time zero. If no device was commanded to deploy by the RCM, nothing (no deployment device(s)) would be displayed.

### **Under Pre-Crash Data -5 to 0 sec**

- Steering Wheel Angle if Applicable: positive value indicates left turn, and negative value would indicate right turn.
- Stability Control Lateral Acceleration if Applicable: Lateral Acceleration (Y-direction) is the acceleration along the lateral axis of the vehicle, reported as positive when accelerating to the left.
- Stability Control Longitudinal Acceleration if Applicable: Longitudinal Acceleration (X-direction) is the acceleration along the longitudinal axis of the vehicle, reported as positive when accelerating in a forward direction.
- Stability Control Yaw Rate if Applicable: The Yaw Axis is the vertical axis of the vehicle, generally perpendicular to the plane of the road. A positive Yaw Rate is counter-clockwise when observing the vehicle from above.
- Stability Control Roll Rate if Applicable: The Roll Axis is the longitudinal axis of the vehicle, generally aligned with the primary axis of motion of the vehicle. A positive Roll Rate is counter-clockwise when observing the vehicle from the front.

### **Under Longitudinal Crash Pulse**

- Delta-V, longitudinal: SAE J211 sign convention, negative value generally indicates a front crash and positive value generally indicates a rear crash. Longitudinal delta-V reflects the change in forward velocity that the sensing system experienced from Time zero. It is not the speed the vehicle was traveling before the event. Note that the vehicle speed is recorded separately. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle longitudinal delta-V.

### **Under Lateral Crash Pulse**

- Delta-V, lateral: SAE J211 sign convention, Positive value generally indicates a driver side crash and negative value generally indicates a passenger side crash.

### **Under Rollover Sensor Data (if Applicable)**

- Vehicle roll angle if applicable: The Roll Axis is the longitudinal axis of the vehicle, generally aligned with the primary axis of motion of the vehicle. A positive Roll Angle is counter-clockwise when observing the vehicle from the front.

### **Data Sources:**

The Restraints Control Module (RCM) contains all recorded data on any event. Data collected from the RCM comes from multiple sources:

1. Internal to the RCM such as internal sensors for delta Velocity data, rollover angle data if applicable, etc... which are measured, calculated and stored internally.
2. External to the RCM but with a direct connection such as buckle switches, peripheral crash sensors, seat track switch(s) etc... which are measured, calculated and stored internally.
3. External Modules to the RCM such as Powertrain Control Module, Brake Control Module, etc... These modules communicate to the RCM via Vehicle Communication Network. The RCM stores the received data internally.

### System Status at Time of Retrieval

VIN As Programmed into RCM at Factory	1FMJU1JT9HEA55631
Current VIN from PCM	1FMJU1JT9HEA55631
Ignition Cycle, Download (First Record)	3,502
Ignition Cycle, Download (Second Record)	N/A
Restraints Control Module Part Number	FL1T-14B321-BB
Restraints Control Module Serial Number	702944323020000
Restraints Control Module Software Part Number (Version)	DG13-14C028-BA
Driver Side/Center Frontal Restraints Sensor Serial Number	00182A4F
Driver, Row 1, Side Restraint Sensor 1 Serial Number	00000032
Driver, Row 2, Side Restraint Sensor 2 Serial Number	00322900
Passenger Frontal Restraints Sensor Serial Number	00000000
Passenger, Row 1, Side Restraint Sensor 1 Serial Number	00000050
Passenger, Row 2, Side Restraint Sensor 2 Serial Number	20290000

### System Status at Event (First Record)

Recording Status	Record Unlocked
Complete File Recorded (Yes, No)	Yes
Multi-Event, Number of Events	1
Time From Event 1 to 2 (msec)	N/A
Lifetime Operating Timer at Event Time Zero (sec)	4,409,740
Key-On Timer at Event Time Zero (sec)	2,030
Vehicle Voltage at Time Zero (V)	13.122
Energy Reserve Mode Entered During Event (Yes, No)	No

**Faults Present at Start of Event (First Record)**

No Faults Recorded



**Deployment Data (First Record)**

Maximum Delta-V, Longitudinal (MPH [km/h])	20.38 [32.80]
Time, Maximum Delta-V Longitudinal (msec)	89
Maximum Delta-V, Lateral (MPH [km/h])	-0.30 [-0.49]
Time, Maximum Delta-V Lateral (msec)	300
Longitudinal Delta-V Time Zero Offset (msec)	8.0 ms
Lateral Delta-V Time Zero Offset (msec)	8.0 ms
Roll Angle Time Zero Offset (msec)	48.0 ms

**Pre-Crash Data -1 sec (First Record)**

Ignition Cycle, Crash	3,493
Frontal Air Bag Warning Lamp, On/Off	Off
Safety Belt Status, Driver	Buckled
Seat Track Position Switch, Foremost, Status, Driver	Forward
Safety Belt Status, Front Passenger	Buckled
Brake Telltale	Off
ABS Telltale	Off
ESC/TC Telltale	Off
ESC/TC Off Telltale	Default
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL) Telltale	Off

**Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record, table 1 of 2)**

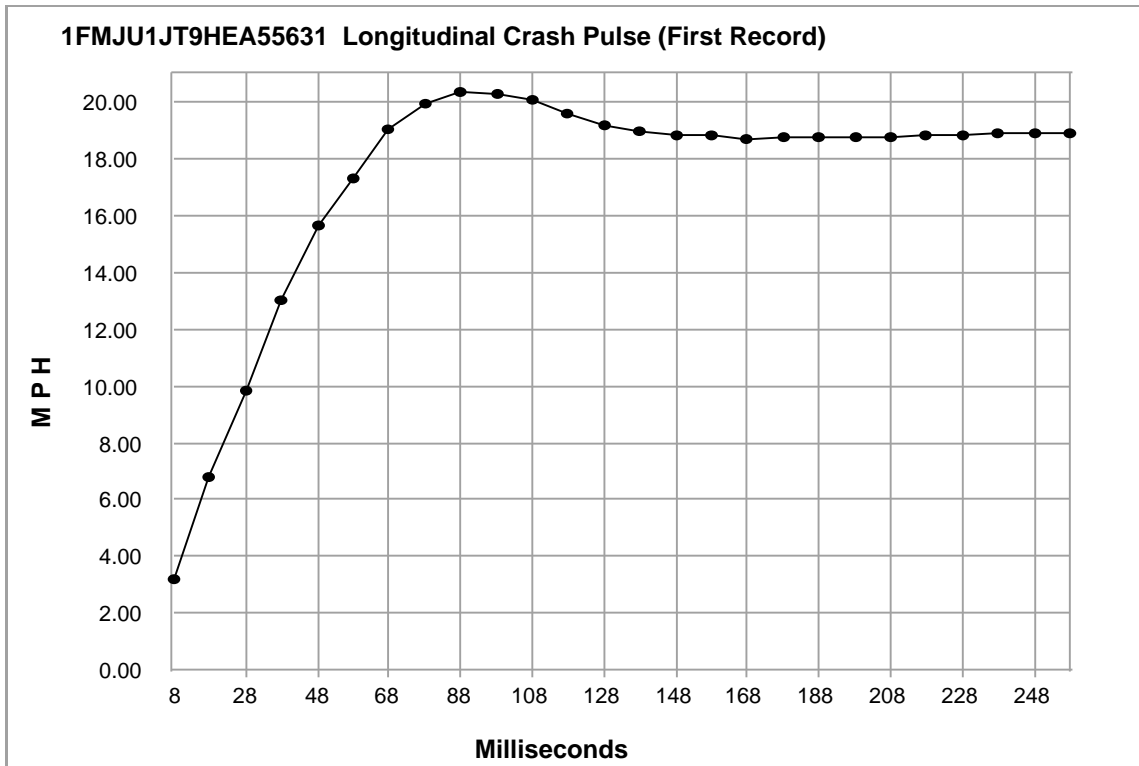
Times (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % Full	Service Brake, On/Off	Engine RPM	ABS Activity (Engaged, Non-Engaged)	Brake Powertrain Torque Request
- 5.0	7 [11]	0.0	On	678	non-engaged	No
- 4.5	6 [9]	0.0	On	684	non-engaged	No
- 4.0	5 [8]	0.0	On	698	non-engaged	No
- 3.5	4 [6]	0.0	On	778	non-engaged	No
- 3.0	2 [4]	0.0	On	756	non-engaged	No
- 2.5	1 [2]	0.0	On	720	non-engaged	No
- 2.0	1 [1]	0.0	On	672	non-engaged	No
- 1.5	0 [0]	0.0	On	674	non-engaged	No
- 1.0	0 [0]	0.0	Off	670	non-engaged	No
- 0.5	1 [1]	0.0	Off	710	non-engaged	No
0.0	1 [2]	5.1	Off	752	non-engaged	No

**Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record, table 2 of 2)**

Times (sec)	Driver Gear Selection	Traction Control via Brakes	Wheel Torque (Nm)	Speed Control Telltale
- 5.0	Drive	non-engaged	56	Off
- 4.5	Drive	non-engaged	56	Off
- 4.0	Drive	non-engaged	128	Off
- 3.5	Drive	non-engaged	164	Off
- 3.0	Drive	non-engaged	172	Off
- 2.5	Drive	non-engaged	108	Off
- 2.0	Drive	non-engaged	168	Off
- 1.5	Drive	non-engaged	224	Off
- 1.0	Drive	non-engaged	296	Off
- 0.5	Drive	non-engaged	264	Off
0.0	Drive	non-engaged	520	Off

**Pre-Crash Data -5 to 0 sec [10 samples/sec] (First Record)**

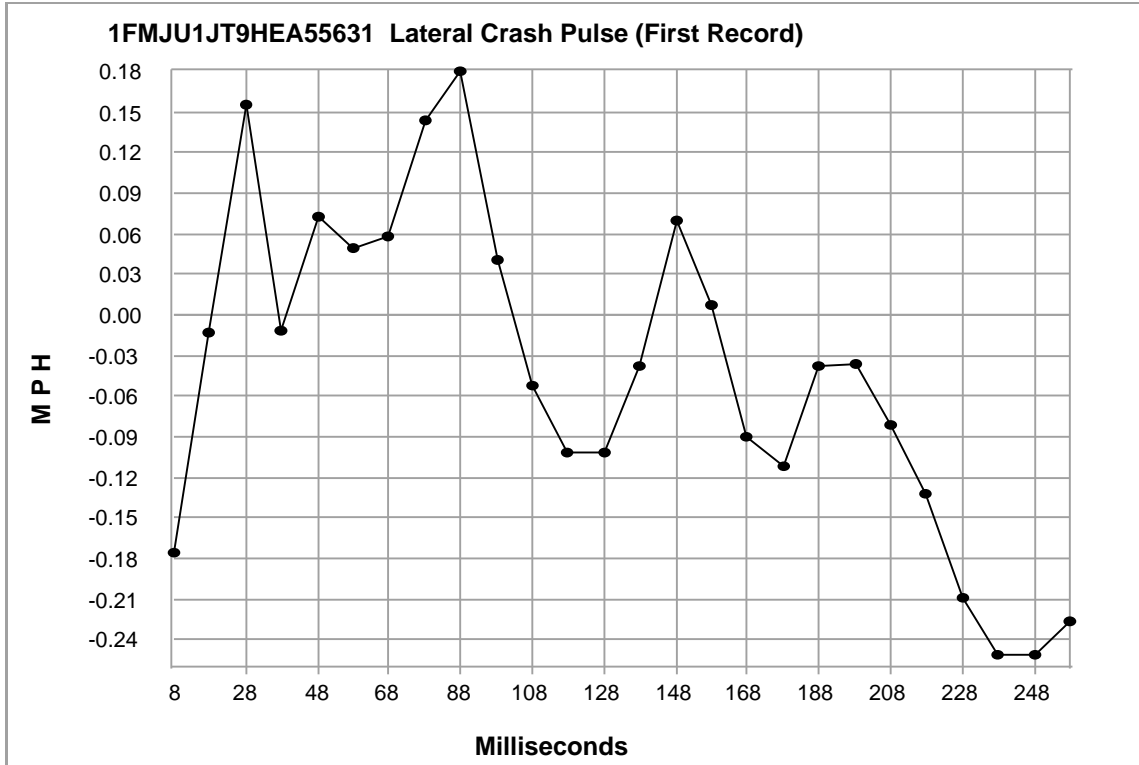
Times (sec)	Steering Wheel Angle (degrees)	Stability Control Lateral Acceleration (g)	Stability Control Longitudinal Acceleration (g)	Stability Control Yaw Rate (deg/sec)	Stability Control Roll Rate (deg/sec)
- 5.0	0.0	0.002	-0.119	-0.38	0.84
- 4.9	0.2	0.004	-0.109	-0.27	0.8
- 4.8	-0.3	0.004	-0.097	-0.22	1.08
- 4.7	0.2	0.013	-0.097	-0.36	0.56
- 4.6	0.0	0.01	-0.086	-0.45	0.92
- 4.5	0.0	-0.002	-0.093	-0.4	0.68
- 4.4	0.0	0.001	-0.09	-0.34	0.84
- 4.3	0.0	0.004	-0.093	-0.36	0.76
- 4.2	-0.3	0.002	-0.088	-0.38	0.96
- 4.1	0.0	-0.002	-0.097	-0.34	1.08
- 4.0	0.0	0.009	-0.09	-0.31	0.8
- 3.9	0.0	0.012	-0.095	-0.31	0.84
- 3.8	0.0	-0.002	-0.093	-0.27	0.88
- 3.7	-0.3	-0.008	-0.093	-0.34	0.84
- 3.6	0.0	0.004	-0.094	-0.4	1.04
- 3.5	0.2	0.007	-0.093	-0.38	1.0
- 3.4	0.0	0.004	-0.094	-0.27	0.92
- 3.3	0.0	0.0	-0.098	-0.29	0.8
- 3.2	0.0	0.002	-0.099	-0.38	0.84
- 3.1	0.0	0.003	-0.099	-0.36	0.92
- 3.0	0.0	0.0	-0.103	-0.34	1.08
- 2.9	0.0	0.005	-0.099	-0.31	0.92
- 2.8	0.2	0.008	-0.102	-0.36	0.8
- 2.7	0.0	0.004	-0.102	-0.4	0.88
- 2.6	0.0	-0.002	-0.1	-0.34	0.88
- 2.5	0.0	-0.001	-0.094	-0.36	0.92
- 2.4	0.0	0.01	-0.102	-0.4	0.96
- 2.3	0.2	0.002	-0.093	-0.4	0.88
- 2.2	0.0	0.004	-0.096	-0.38	0.8
- 2.1	0.0	0.001	-0.085	-0.34	0.88
- 2.0	0.0	0.004	-0.079	-0.34	0.84
- 1.9	0.0	0.002	-0.052	-0.38	0.88
- 1.8	0.0	0.005	-0.023	-0.45	0.8
- 1.7	0.0	0.004	0.007	-0.4	0.76
- 1.6	0.0	0.003	0.029	-0.4	0.84
- 1.5	0.0	0.004	0.042	-0.38	0.88
- 1.4	0.0	0.004	0.043	-0.36	0.96
- 1.3	0.0	0.002	0.041	-0.29	0.92
- 1.2	0.0	0.004	0.039	-0.4	0.88
- 1.1	0.0	0.002	0.041	-0.43	0.84
- 1.0	0.0	0.004	0.04	-0.38	0.92
- 0.9	0.0	0.004	0.041	-0.31	0.88
- 0.8	0.0	0.005	0.044	-0.31	0.84
- 0.7	0.0	0.003	0.047	-0.34	0.92
- 0.6	0.0	0.004	0.05	-0.4	0.88
- 0.5	0.0	0.001	0.053	-0.38	0.88
- 0.4	0.2	0.003	0.05	-0.34	1.04
- 0.3	0.0	0.004	0.053	-0.4	0.84
- 0.2	0.0	0.006	0.051	-0.43	0.92
- 0.1	0.0	0.002	0.054	-0.4	0.8
0.0	0.0	0.001	0.063	-0.31	0.8



**Longitudinal Crash Pulse (First Record)**

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
8.0	3.16	5.08
18.0	6.80	10.94
28.0	9.82	15.80
38.0	13.05	21.00
48.0	15.68	25.24
58.0	17.33	27.89
68.0	19.03	30.62
78.0	19.96	32.12
88.0	20.36	32.77
98.0	20.27	32.63
108.0	20.12	32.38
118.0	19.65	31.62
128.0	19.19	30.88
138.0	18.98	30.55
148.0	18.88	30.39
158.0	18.87	30.37
168.0	18.70	30.09
178.0	18.76	30.20
188.0	18.80	30.26
198.0	18.81	30.28
208.0	18.81	30.27
218.0	18.82	30.30
228.0	18.87	30.36
238.0	18.91	30.44
248.0	18.91	30.43
258.0	18.91	30.43

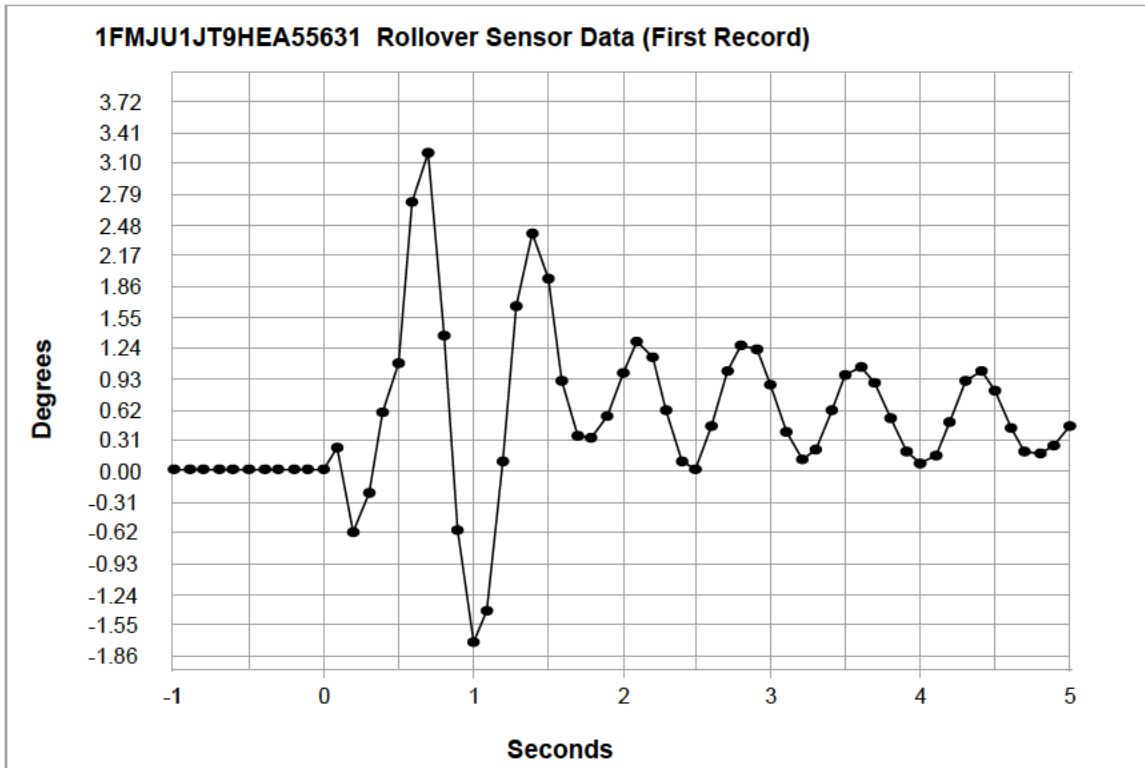




**Lateral Crash Pulse (First Record)**

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
8.0	-0.18	-0.28
18.0	-0.01	-0.02
28.0	0.16	0.25
38.0	-0.01	-0.02
48.0	0.07	0.12
58.0	0.05	0.08
68.0	0.06	0.09
78.0	0.14	0.23
88.0	0.18	0.29
98.0	0.04	0.07
108.0	-0.05	-0.08
118.0	-0.10	-0.16
128.0	-0.10	-0.16
138.0	-0.04	-0.06
148.0	0.07	0.11
158.0	0.01	0.01
168.0	-0.09	-0.14
178.0	-0.11	-0.18
188.0	-0.04	-0.06
198.0	-0.04	-0.06
208.0	-0.08	-0.13
218.0	-0.13	-0.21
228.0	-0.21	-0.34
238.0	-0.25	-0.40
248.0	-0.25	-0.40
258.0	-0.23	-0.37





**Rollover Sensor Data (First Record)**

Time (sec)	Vehicle Roll Angle (deg)
-1.0	0.02
-0.9	0.02
-0.8	0.02
-0.7	0.02
-0.6	0.02
-0.5	0.02
-0.4	0.02
-0.3	0.02
-0.2	0.02
-0.1	0.02
0.0	0.02
0.1	0.24
0.2	-0.62
0.3	-0.22
0.4	0.6
0.5	1.08
0.6	2.7
0.7	3.2
0.8	1.37
0.9	-0.6
1.0	-1.73

Time (sec)	Vehicle Roll Angle (deg)
1.1	-1.4
1.2	0.11
1.3	1.66
1.4	2.4
1.5	1.94
1.6	0.91
1.7	0.35
1.8	0.33
1.9	0.56
2.0	0.99
2.1	1.31
2.2	1.15
2.3	0.62
2.4	0.11
2.5	0.02
2.6	0.46
2.7	1.01
2.8	1.27
2.9	1.23
3.0	0.86
3.1	0.4

Time (sec)	Vehicle Roll Angle (deg)
3.2	0.12
3.3	0.21
3.4	0.62
3.5	0.97
3.6	1.06
3.7	0.89
3.8	0.53
3.9	0.2
4.0	0.08
4.1	0.15
4.2	0.5
4.3	0.9
4.4	1.01
4.5	0.82
4.6	0.44
4.7	0.19
4.8	0.17
4.9	0.26
5.0	0.45

## Hexadecimal Data

Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR system.

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44 47 31 33 2D 31 34 43 30 32 38 2D 42 41 00 00 00 00 00 00 00 00 00 00

00 18 2A 4F 35 9D 64 00 00 00 00 00 00 00 00 00

00 00 00 32 3E C9 12 00 00 00 00 00 00 00 00 00

00 32 29 E2 95 8D 64 00 00 00 00 00 00 00 00 00

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00 00 00 50 6C C9 12 00 00 00 00 00 00 00 00 00

00 20 29 E4 F2 83 86 00 00 00 00 00 00 00 00 00

31 46 4D 4A 55 31 4A 54 39 48 45 41 35 35 36 33 31

31 46 4D 4A 55 31 4A 54 39 48 45 41 35 35 36 33 31 00 00 00 00 00 00 00

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### **Disclaimer of Liability**

The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

