TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CERTIFIED ADVANCED-208 COMPLIANT VEHICLE CRASH INVESTIGATION

SCI CASE NO. – CA05-052

SUBJECT VEHICLE – 2005 GMC SIERRA

LOCATION - STATE OF PENNSYLVANIA

CRASH DATE – JULY 2005

Contract No. DTNH22-01-C-17002

Prepared for:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. Abstract This on-site investigation focused on the Certified Advanced-208 Compliant (CAC) safety system in a 2005 GMC Sierra pickup truck. A CAC vehicle is certified by the manufacturer to be compliant to Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS 208) No. 208. The safety system included dual stage frontal air bags, seat track position sensors for the front seats, an occupant detection sensor for the front right seat, and safety belt buckle switch sensors. In addition, the GMC was equipped with an Event Data Recorder (EDR) that was downloaded during the on-site investigative effort. The EDR printout is included as **Attachment A** of this report. The GMC was occupied by an unrestrained 19-year-old male driver, unrestrained 13-year-old female front center passenger, unrestrained 13-year-old female front right passenger, and an unrestrained 18-year-old male front right passenger. The GMC was involved in a run-off-road collision with several objects. As a result of the crash sequence, the driver's frontal air bag deployed in the GMC. The driver and 18-year-old male front right passenger of the GMC sustained police reported moderate severity injuries and were transported to a hospital. A follow-up telephone conversation with the investigating officer revealed that the driver was not injured during the crash. The two 13-year-old female passenger's sustained police reported severe injuries and were transported to a hospital. The GMC sustained moderate frontal damage and was towed from the crash site.			
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BACKGROUND

This on-site investigation focused on the Certified Advanced-208 Compliant (CAC) safety system in a 2005 GMC Sierra pickup truck **(Figure 1)**. A CAC vehicle is certified by the manufacturer to be compliant to Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS 208) No. 208. The safety system included dual stage frontal air bags, seat track position sensors for the front seats, an occupant detection sensor for the front right seat, and safety belt buckle switch sensors. In addition, the GMC was equipped with an Event Data Recorder (EDR) that was downloaded during the on-site investigative effort. The EDR printout is included as **Attachment A** of this report. The GMC was occupied by an unrestrained 19-year-old male driver, unrestrained 13-year-old female front center passenger, unrestrained 13-year-old female front right passenger, and an unrestrained 18-year-old male front right passenger. The GMC was involved in a run-off-road collision with several objects. As a result of the crash sequence, the driver's frontal air bag deployed in the GMC. The driver and 18-year-old male front right passenger of the GMC sustained police reported moderate severity injuries and were transported to a hospital. A follow-up telephone conversation with the investigating officer revealed that the driver was not injured during the crash. The two 13-year-old female passenger's sustained police reported severe injuries and were transported to a hospital. The GMC sustained moderate frontal damage and was towed from the crash site.

Figure 1. Subject vehicle 2005 GMC Sierra.

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA) that identified CAC vehicles that had been involved in crashes. The list was forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The GMC was located at an insurance auction facility and cooperation was established with the facility to inspect the vehicle. An on-site investigation was assigned to the Calspan SCI team on September 8, 2005. The vehicle and crash site were inspected on September 13, 2005.

SUMMARY

Crash Site

This run-off-road crash occurred during the early morning hours of July 2005. At the time of the crash, the weather was clear and the asphalt road surface was dry. The crash occurred off the east and west roadsides of a north/south roadway. The roadway was configured with one through lane in each direction. The northbound lane curved to the left prior to the crash site, which terminated at the on-set of the first road departure location. The east roadside consisted of a grass embankment, tree stump, and utility poles. The west roadside consisted of a grass embankment with a decline, a tree line, and several shrubs. The posted speed limit for the roadway was 72 km/h (45 mph). The scene schematic is included as **Figure 11** of this report.

Vehicle Data – 2005 GMC Sierra

The 2005 GMC Sierra was identified by the Vehicle Identification Number (VIN): 1GTEK14V05 (production sequence omitted). The odometer reading at the time of the inspection was unknown due to lack of power to the vehicle. The vehicle was a single cab pickup truck that was equipped with a 4.8-liter, V8 engine, 4-speed automatic transmission, four-wheel drive, power-front disc and rear drum brakes with anti-lock, power steering, and a tilt steering wheel. The GMC was configured with Goodyear Wrangler ST tires size, P265/70R17. The manufacturer recommended front and rear tire pressure was 241 kPa (35 PSI). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	255 kPa (37 PSI)	8 mm (10/32)	No	None
LR	62 kPa (9 PSI)	6 mm (8/32)	No	None
RF	0 kPa	8 mm (10/32)	Yes	Cut sidewall
RR	255 kPa (37 PSI)	6 mm (8/32)	No	None

The seating positions in the GMC were configured with a cloth upholstered three-passenger front split-bench seat with height adjustable head restraints for the outboard seats. The front seat head restraints were both adjusted to the full-down positions at the time of the vehicle inspection.

Crash Sequence

Pre-Crash

The unrestrained 19-year-old male driver of the 2005 GMC Sierra was operating the vehicle northbound **(Figure 2)** on the two-lane roadway negotiating the left curve. The EDR Non-Deployment event was determined to be the first event recorded based on the recording time. The EDR Non-Deployment data indicated that the vehicle speed was 93 km/h (58 mph) five-seconds prior to

Figure 2. Pre-crash travel direction for the GMC.

Algorithm Enable (AE). The EDR showed that the driver of the GMC applied the throttle which was recorded at 100 percent at five, four, and three seconds prior to AE. The speed of the vehicle increased from 93 km/h (58 mph) to 106 km/h (66 mph) one second prior to AE. Additionally, the brake switch status was record as off for the five-second pre-crash recording. As the driver continued his northbound travel, he relinquished directional control of the vehicle and departed the right (east) roadside. The GMC traversed two private driveways and then ascended the grass embankment. The vehicle traveled on the east roadside an approximate distance of 33 meters (108 feet). (Note: The roadway contained two skid marks that occurred from a previous crash.)

Crash

The right side at the area of the right front door of the GMC struck and overrode a tree stump on the embankment **(Figure 3)**. The tree stump was located 3.4 meters (11.1 feet) from the road edge and ranged from 25-80 cm (9.8-31.5") in diameter. The GMC sustained minor damage from this impact. The WINSMASH damage algorithm was used to calculate a delta-V for this impact. The total delta-V was 10 km/h (6.2 mph). The longitudinal and lateral components were -10 km/h (-6.2 mph) and 0 km/h, respectively. This impact resulted in the Non-Deployment recording of the EDR. The EDR maximum-recorded delta-V for this impact was -3 km/h (-1.94 mph), at 222.5 millisecond from AE.

Figure 3. Area of impact with the tree stump.

Following the tree stump impact, the driver applied a left steering input, which redirected the vehicle in a westerly direction. The GMC reentered the road and traversed the north and southbound travel lanes and departed the west roadside approximately 15 meters (49.0 feet) from the reentry point. The GMC traveled on the west roadside in a northerly direction and struck two fawns with the frontal aspect. The off-road travel was on uneven and rough terrain, which produced significant vertical movement of the passengers. This movement is discussed in the ***Occupant Kinematics*** section of this report. The GMC rotated clockwise approximately 20 degrees and came to rest near the point of impact. These impacts were minor and did not produce damage to the vehicle.

Figure 4. Impact with the hemlock tree branches.

The GMC struck several branches of a hemlock tree approximately 53.0 meters (173.9 feet) from the fawn impacts **(Figure 4)**. This impact sequence was minor and did not alter the vehicle's trajectory or result in deceleration.

Figure 5. Point of impact wit the 20 cm (7.9") diameter tree.

The GMC continued an additional 8.5 meters (27.9 feet) north where the front right aspect of the vehicle struck a 20 cm (7.9") diameter apple tree **(Figure 5)**. This impact was the highest severity and resulted in the deployment of the driver's frontal impact. The EDR (Deployment file) recorded delta-V for this impact was -46.9 km/h (-29.18 mph) at 210 milliseconds from AE. The WINSMASH damage algorithm was used to calculate a delta-V for this impact. The total calculated delta-V was 39 km/h (24.2 mph) with longitudinal and lateral components of -39 km/h (-24.2 mph) and 0 km/h.

Post-Crash

The driver and 18-year-old male front right passenger of the GMC sustained police reported moderate severity injuries and were transported to a hospital. A follow-up telephone conversation with the investigating officer revealed that the driver was not injured during the crash. The two 13-year-old female passenger's police reported sustained severe severity injuries and were transported to a hospital. The GMC sustained moderate frontal damage and was towed from the crash site.

Vehicle Damage

Exterior Damage

The 2005 GMC Sierra sustained minor damage from the right side impact with the tree stump **(Figure 6)**. The direct contact damage began 110 cm (48.5") forward of the rear axle and extended to 122 cm (48.0") forward. The total direct damage length was 122 cm (48.0"). The maximum crush was 20 cm (6.3") and was located on the sill 159 cm (62.7") forward of the right rear axle. Although the impact produced vertical and lateral deformation, a lateral crush profile was document to represent the damage to this location. The crush profile consisted of six equidistant points along the sill of the GMC and were as follows: C1 = 3 cm (1.2"), C2 = 7 cm (2.8"), C3 = 16 cm (6.3"), C4 = 20 cm (7.8"), C5 = 20 cm (7.8"),

Figure 6. Right side damage from the tree stump impact.

C6 = 11 cm (4.3”). The Collision Deformation Classification (CDC) for this impact was 12-RPEW-2.

The second, third, and fourth impacts from this crash sequence involved two fawns, and tree branches that the GMC struck with the frontal aspect. These impacts were minor and yielded no damage to the vehicle. The CDC’s for these three impacts were 12-F999-9 (9 = unknown).

The GMC sustained moderate severity frontal damage from the impact with the apple tree **(Figures 7 and 8)**. The maximum crush measured 77 cm (30.3”) and was located at the front right corner of the metal bumper. The direct contact damage measured 53 cm (20.9”) and began 47 cm (18.5”) right of the vehicle’s centerline and extended to the front right corner. A crush profile was documented of the residual damage along the front bumper using a combined direct and induced damage width of 142 cm (56.0”) and was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 5 cm (1.9”), C4 = 32 cm (12.6”), C5 = 70 cm (27.5”), C6 = 77 cm (30.3”). The CDC for this impact was 12-FREW-3.

Figure 7. Overall view of the frontal damage.

Figure 8. Lateral view of the frontal crush.

The GMC’s windshield was fractured from contact with the rear right hood edge, and the front right glazing was disintegrated. The backlight remained intact and the front doors were operational.

Interior Damage

The 2005 GMC Sierra sustained moderate interior damage as a result of occupant contacts and passenger compartment intrusion. **Figure 9** in an overall view of the occupant contact points. The driver contact points consisted of his right foot deforming the gas pedal to the left. The driver loaded through the deploying air bag and compressed the steering wheel flange resulting in approximately 1 cm (0.3”) of compression. This compression did not

Figure 9. Overall view of the occupant contact points.

translate further as the shear capsules were in the original mounted positions.

The front center 13-year-old female passenger was displaced forward and contacted the extension panel of the left sun visor, which was evidenced by hair and a scuffmark. She contacted the rearview mirror, which was fractured and displaced. The center instrument panel was also contacted by this occupant, which was evidenced by the fractured plastic trim panels at the top and lower aspects. Additionally, she contacted and deformed the steering column mounted gear selector and the floor mounted 4x4 gear selector.

The occupant contact points from the 13-year-old female that was sharing the center and right seating position were overlapped and could not be separated.

The 18-year-old male front right passenger's contact points consisted of a black colored transfer that began on the roof and terminated on the sun visor which measured 27 cm (10.5"). A spider web fracture pattern was noted to the windshield just below the header from contact with his head. The instrument panel mounted grab handle was deformed upward and the right instrument panel was deformed forward from contact with his lower torso and right knee. Also noted was a scuffmark on the right edge of the glove box door.

The passenger compartment intrusion consisted of the front right tow pan that was intruded approximately 8 cm (3.0"). This resulted from the engine contacting and deforming the firewall of the engine compartment.

Certified Advanced 208-Compliant Safety System

The 2005 GMC Sierra was equipped with a Certified Advanced 208-Compliant frontal safety system. The manufacturer of this vehicle has certified that this 2005 GMC Sierra meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS 208) No. 208. The system consisted of dual stage frontal air bags, seat track positioning sensors for the front seats, an occupant presence sensor for the front right seat, and safety belt buckle switch sensors to monitor belt usage.

A Sensing and Diagnostic Module (SDM) controlled the system. The SDM measures and predicts crash severity and monitors seat track position, belt status, and occupant presence to deploy the appropriate safety system. In the subject crash, the SDM commanded a dual stage deployment of the driver air bag at 10 and 17.5 milliseconds from AE, respectively.

The driver's air bag was located in the center of the steering wheel hub **(Figure 10)**. Two symmetrical I-configuration cover flaps concealed the air bag. Both cover flaps measured 11 cm (4.5") in height at the center tear seam and 8 cm (3.3") in width. The air bag membrane was 58 cm (23.0") in diameter in its deflated state and was vented by two vent ports that were located on the rear aspect

Figure 10. Driver's frontal air bag.

of the air bag at the 11 and 1 o'clock positions. Two wide band tethers at the 9 and 3 o'clock positions tethered the driver's air bag. Although the driver loaded through the deploying air bag, there were no occupant contact points present on the air bag membrane. Dirt transfers were present on the rear panel from post-crash handling.

The front right passenger air bag was a mid-mount design in the right instrument panel. The front right air bag was suppressed during this crash sequence. The suppression of the front right air bag is discussed in the ***Event Data Recorder*** section of this report.

Event Data Recorder

The 2005 GMC Sierra was equipped with an Event Data Recorder (EDR). The EDR was downloaded during the SCI inspection and the printout is included as **Attachment A** of this report. The EDR was downloaded through the SDM that was located under the driver's seat using the Vetronix Crash Data Retrieval tool. The battery was damaged during the crash; therefore the SCI investigator applied power to the SDM using an external battery.

The downloaded data consisted of two events, a Deployment and Non-Deployment events. The Non-Deployment data file was recorded first which was related to the tree stump impact. The EDR indicated that the front safety belts were unbuckled at the time of AE and the front right seat was in a rearward track position. The maximum-recorded delta-V for this event was -3 km/h (-1.94 mph), at 222.5 millisecond from AE. The EDR data indicated that the vehicle speed was 93 km/h (58 mph) five-seconds prior to AE. The EDR showed that the driver of the GMC applied the throttle which was recorded at 100 percent at five, four, and three seconds prior to AE, which increased the speed of the vehicle from 93 km/h (58 mph) to 106 km/h (66 mph) one second prior to AE. Additionally, the brake switch status was off for the five-second pre-crash recording.

The Deployment event indicated both stages of the driver's frontal air bag were commanded to deploy at 10 and 17.5 milliseconds, respectively. The front right air bag was suppressed during this crash sequence as indicated by the EDR data. This probably resulted as a result of two possible scenarios:

1. The off-road travel on the uneven and rough terrain displaced the passengers upward while the safety system was cycling. The system was possibly in the "Off" cycle, which would have caused the SDM to not register the front right passengers; thus suppressing the air bag.

2. The front center and front right passengers were seated on the bolsters of the front right seat and did not apply sufficient pressure to the bladder to register a passenger, thus suppressing the air bag. The second scenario was applied to an exemplar vehicle using two adult males weighing an average of 91 kgs (200 lbs) seated on the bolsters of the front right seat. With the front right door open the male subjects were positioned to the far most aspects of the seat bolsters and passenger air bag indicator light remained in the "Off" position. With door closed and the male subject's positioned on the inboard aspects of the bolsters the

indicator light was in "On" position. However, the exact posture of the passengers was unknown at the time of the crash.

Manual Restraint Systems

The 2005 GMC Sierra was equipped with integrated manual 3-point lap and shoulder safety belts for front outboard seating positions. The front center safety belt was configured with a 2-point manual lap belt. The driver's safety belt was configured with a sliding latch plate, and an Emergency Locking Retractor (ELR). The driver did not utilize his safety belt in the crash, which was supported by the occupant contact evidence and lack of witness marks on the safety belt system. Furthermore the EDR indicated that the front safety belts were unbuckled at the time of AE.

The front right safety belt was configured with a sliding latch plate and a switchable ELR/Automatic Locking Retractor (ALR). The front center safety belt was configured with a locking latch plate and no retractor. The front center and front right safety belts were not used during this crash, which was supported by occupant motion and resulting occupant contact points.

Occupant Demographics

Driver

Age/Sex:	18-year-old/Male
Height:	Not available
Weight:	Not available
Seat Track Position:	Full rear
Manual Restraint Use:	Not used
Usage Source:	Vehicle inspection
Eyewear:	Not available
Type of Medical Treatment:	Transported to a local hospital

Driver Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Not injured	Not injured	Not injured

**Medical information obtained from the investigating police officer.*

Driver Kinematics

The 18-year-old male driver of the 2005 GMC Sierra was seated in a presumed upright posture with the seat adjusted to a rear track position. The driver did not utilize the integrated manual 3-point lap and shoulder safety belt in the crash. The impacts with the tree stump, two fawns, and tree branches were minor and resulted in minimal displacement of the driver.

The off-road travel on the uneven and rough terrain probably resulted in vertical movement by the driver. At impact with the apple tree the driver's frontal air bag deployed and the driver initiated a forward trajectory in response to the 12 o'clock direction of force. The driver loaded through the deploying frontal air bag and

compressed the steering wheel flange resulting in approximately 1 cm (0.3") of compression. The driver's right foot contacted and deformed the gas pedal to the left.

The driver was transported by ambulance to a local hospital for treatment of possible injuries. A follow-up telephone conversation with investigating police officer revealed that driver was not injured during the crash.

Front Center Passenger

Age/Sex:	13-year-old/Female
Height:	Not available
Weight:	Not available
Seat Track Position:	Full rear
Manual Restraint Use:	Not used
Usage Source:	Vehicle inspection
Eyewear:	Not available
Type of Medical Treatment:	Transported to a local hospital

Front Center Passenger Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Skull Fracture, NFS	Moderate (150402,8)	Rearview mirror
Humerus Fracture, NFS	Moderate (752600.2,9)	Center instrument panel
Ankle contusion, NFS	Minor (890402.1,9)	Floor mounted 4x4 selector
Back Pain, NFS	Not coded under AIS	Impact forces

**Medical information obtained from the investigating police officer.*

Front Center Passenger Kinematics

The unrestrained 13-year-old female front center passenger was seated in a presumed upright posture adjacent to the driver. The impacts with the tree stump, two fawns, and tree branches were minor and resulted in minimal displacement of this passenger.

The GMC traveled off-road on uneven and rough terrain, which resulted in vertical movement by the 13-year-old female. At impact with the apple tree, she initiated a forward trajectory in response to the 12 o'clock direction of force. As the GMC crushed, the front pitched downward which allowed her to contact the extension panel of the left sun visor, which was evidenced by hair and a scuffmark. She contacted the rearview mirror, which was fractured and displaced and resulted in the skull fracture. The 13-year-old female passenger contacted and loaded the center instrument panel, which was evidenced by the fractured plastic trim panels at the top and lower aspects. This contact resulted in the humerus fracture. Additionally, she contacted and deformed the steering column mounted gear selector and floor mounted 4x4 gear selector. The contact to the 4x4 selector probably resulted in the ankle contusion. This passenger was transported by ambulance to a local hospital for treatment.

Female Front Right Passenger

Age/Sex:	13-year-old/Female
Height:	Not available
Weight:	Not available
Seat Track Position:	Full rear
Manual Restraint Use:	Not used
Usage Source:	Vehicle inspection
Eyewear:	Not available
Type of Medical Treatment:	Transported to a local hospital

Female Front Right Passenger Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Pelvis fracture, NFS	Moderate (852600.2,9)	Right instrument panel
Fracture tooth, NFS	Minor (251499.1,9)	Right instrument panel

**Medical information obtained from the investigating police officer.*

Female Front Right Passenger Kinematics

A second 13-year-old female occupied the GMC, she was presumed to be seated in an upright posture and sharing the center and right front seats. She was probably not displaced from the initial impacts with the tree stump, two fawns, and tree branches.

The off-road travel on the uneven and rough terrain probably resulted in vertical movement by the 13-year-old female on approach to the apple tree impact. At impact with the apple tree, she was displaced forward where she contacted and loaded the center and right instrument panel. The occupant contact points from this passenger were overlapped and could not be separated. However, she sustained the above listed injuries from probable contact with the right instrument panel. Additionally, she was sharing the center and front right seats during the crash, which resulted in the suppression of the front right air bag. She was transported by ambulance to a local hospital for treatment.

Male Front Right Passenger

Age/Sex:	18-year-old/Male
Height:	Not available
Weight:	Not available
Seat Track Position:	Full rear
Manual Restraint Use:	Not used
Usage Source:	Vehicle inspection
Eyewear:	Not available
Type of Medical Treatment:	Transported to a local hospital

Male Front Right Passenger Injuries

Injury	Injury Severity AIS90/Update 98	Injury Source
Liver lacerations, NFS	Moderate (541820.2,1)	Right instrument panel
Fractured right ankle, NFS	Minor (850299.1,9)	Intruding toe pan

Facial laceration, NFS	Minor (290600.1,9)	Windshield
Lung contusions, NFS	Cannot be coded without medical record data	Right instrument panel

**Medical information obtained from the investigating police officer.*

Male Front Right Passenger Kinematics

The 18-year-old male front right passenger of the 2005 GMC Sierra was seated in a presumed upright posture with the seat adjusted to a rear track position. He did not utilize the integrated manual 3-point lap and shoulder safety belt in the crash. The minor impacts with the tree stump, two fawns, and tree branches resulted in minimal movement of this passenger.

The off-road travel on the uneven and rough terrain probably resulted in vertical movement and the suppressing of the front right air bag. At impact with the apple, tree he initiated a forward trajectory in response to the 12 o'clock direction of force. As the GMC crushed, the front of the vehicle pitched downward which allowed the passenger to contact the right front roof area, which was evidenced by a black colored transfer that began on the roof and terminated on the sun visor.

He continued forward and contacted the windshield, which resulted in the facial laceration. His lower torso contacted the instrument panel mounted grab handle that was deformed upward and to the right. This contact resulted in the liver laceration and lung contusions. The instrument panel was deformed forward from contact with his right knee and was evidenced by a scuffmark on the right edge of the glove box door. In addition he sustained a fractured right ankle which probably occurred from loading the intruding toe pan. The 18-year-old male front right passenger was transported by ambulance to a local hospital for treatment.

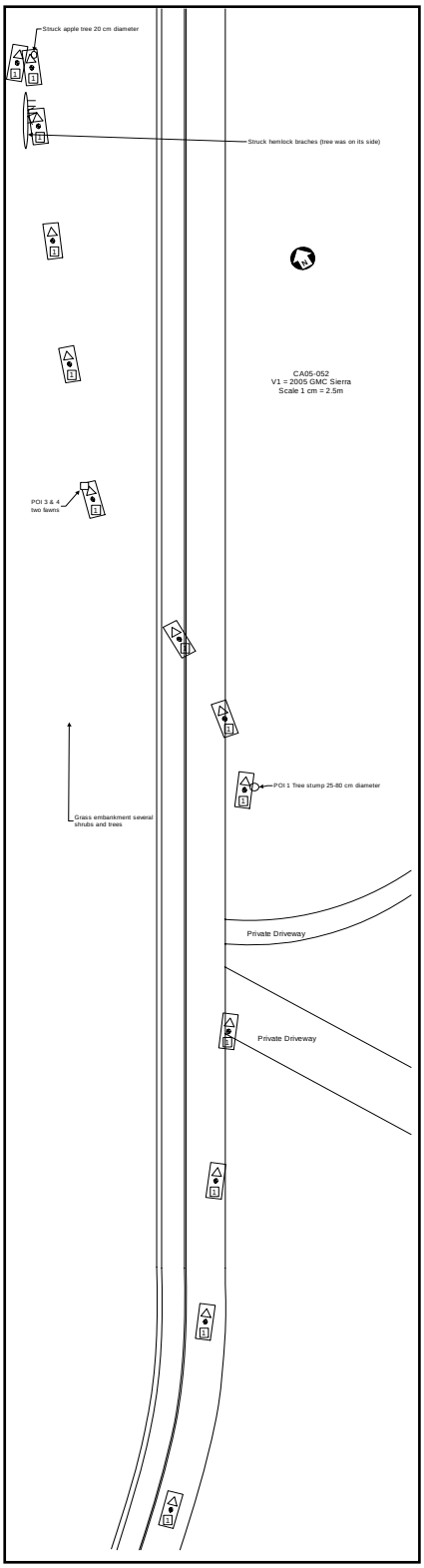


Figure 11. Scene schematic

Attachment A: GMC Sierra EDR Printout

CDR File Information

Vehicle Identification Number	1GTEK14V05Z******
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	WITHOUTVIN.CDR
Saved on	Tuesday, September 13 2005 at 11:51:25 AM
Collected with CDR version	Crash Data Retrieval Tool 2.70
Collecting program verification number	70812808
Reported with CDR version	Crash Data Retrieval Tool 2.800
Reporting program verification number	9238B95E
Interface used to collected data	Block number: 00 Interface version: 41 Date: 11-04-04 Checksum: 9E00
Event(s) recovered	Deployment Non-Deployment

SDM Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within 25.4 seconds of one another. Deployment Events cannot be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the Non-Deployment Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event. If multiple Non-Deployment Events occur within 5 seconds prior to a Deployment Event, then the most severe Non-Deployment Event will be recorded and locked. If multiple Non-Deployment Events precede a Deployment Event, and multiple Non-Deployment Events occur within 5 seconds of each other (but not necessarily all within 5 seconds of the Deployment Event), and subsequent Non-Deployment Events are less severe than prior Non-Deployment Events, and the last of the multiple Non-Deployment Events occurs within 5 seconds of a Deployment Event, then the most severe of the Non-Deployment Events (which may have occurred more than 5 seconds prior to the Deployment Event) will be recorded and locked.

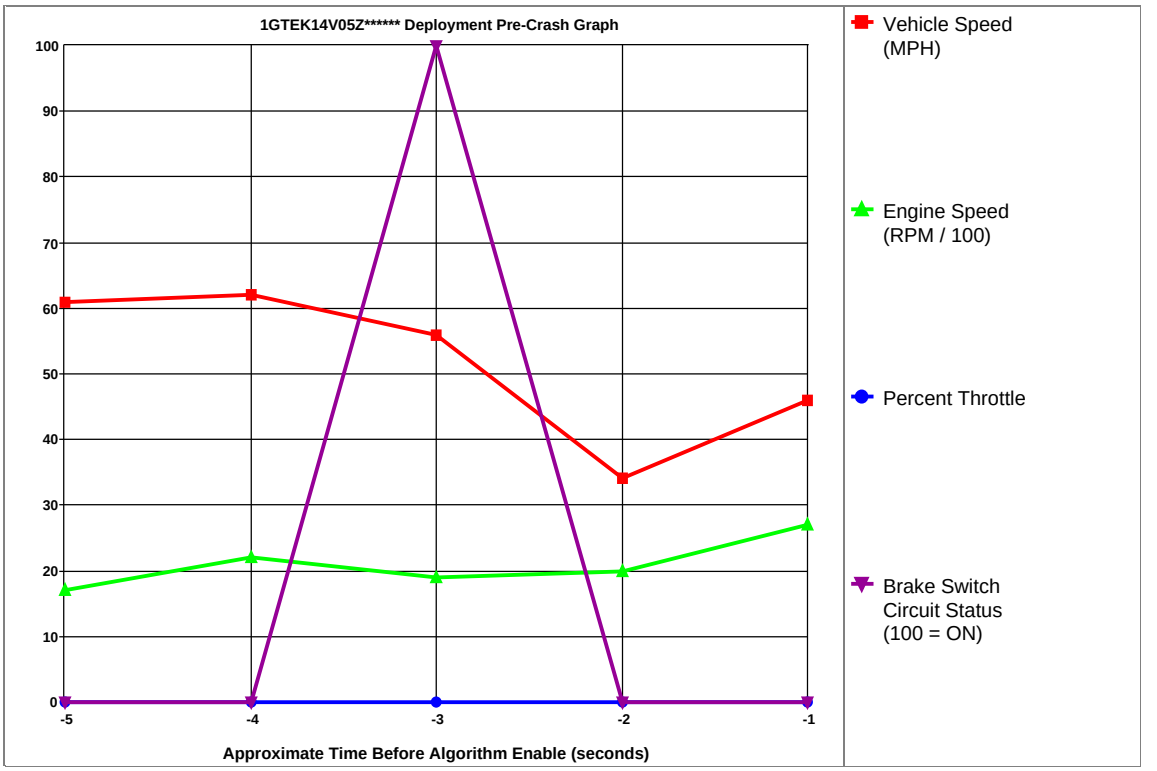
SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For Deployment Events and Deployment Level Events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM will record the first 150 milliseconds of data after algorithm enable.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM receive an invalid message from the module sending the pre-crash data.
-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Belt Switch Circuit may be reported other than the actual state.
-The Time Between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than 25.4 seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-Multiple Events Associated with this Record: This parameter will indicate whether one or more associated events preceded the recorded event.
-One or More Associated Events Not Recorded: If a single event is recorded, this parameter will indicate whether one or more associated events, prior to the recorded event, was not recorded.
If two associated events are recorded, this parameter for the first event will indicate whether one or more associated events, prior to the first event, was not recorded.

If two associated events are recorded, this parameter, for the second event, will indicate whether one or more associated events, between the first and second events, was not recorded.

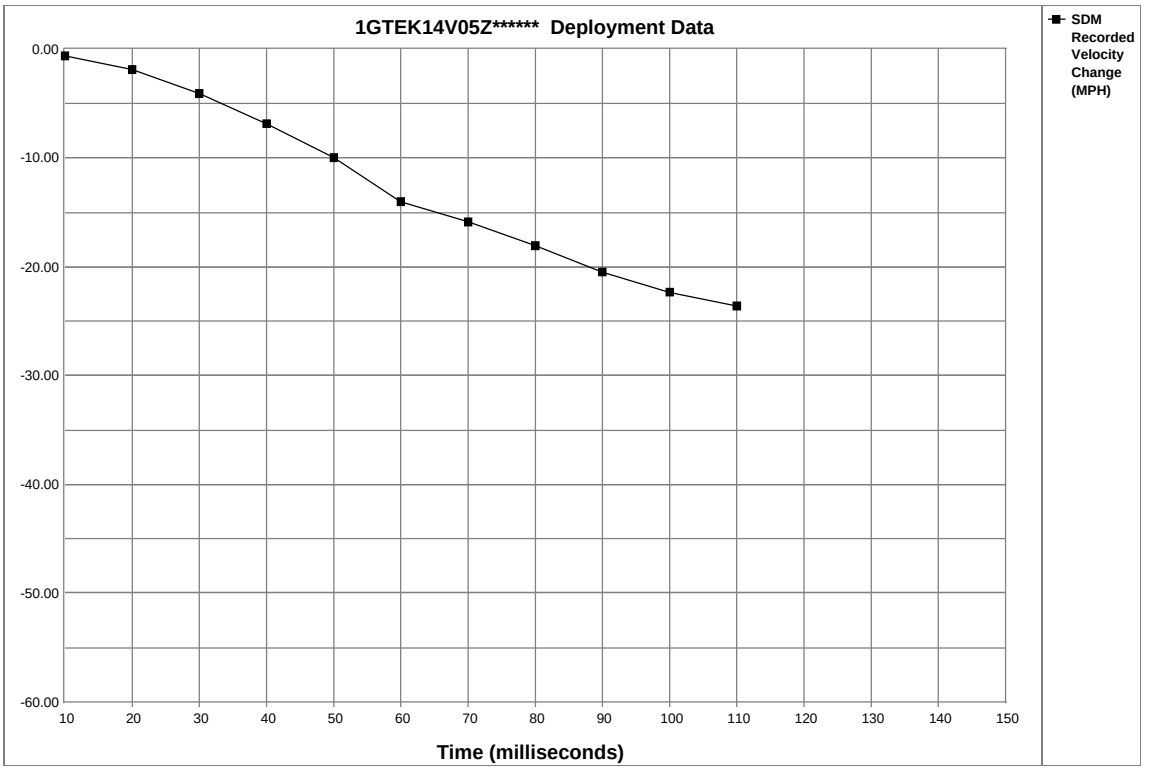
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Passenger Seat Position Switch Circuit Status	Rearward
Ignition Cycles At Deployment	256
Ignition Cycles At Investigation	258
Maximum SDM Recorded Velocity Change (MPH)	-29.18
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	210
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	10
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	17.5
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	Suppressed
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	Suppressed
Time Between Non-Deployment And Deployment Events (sec)	4.7
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	Yes
One Or More Associated Events Not Recorded	Yes



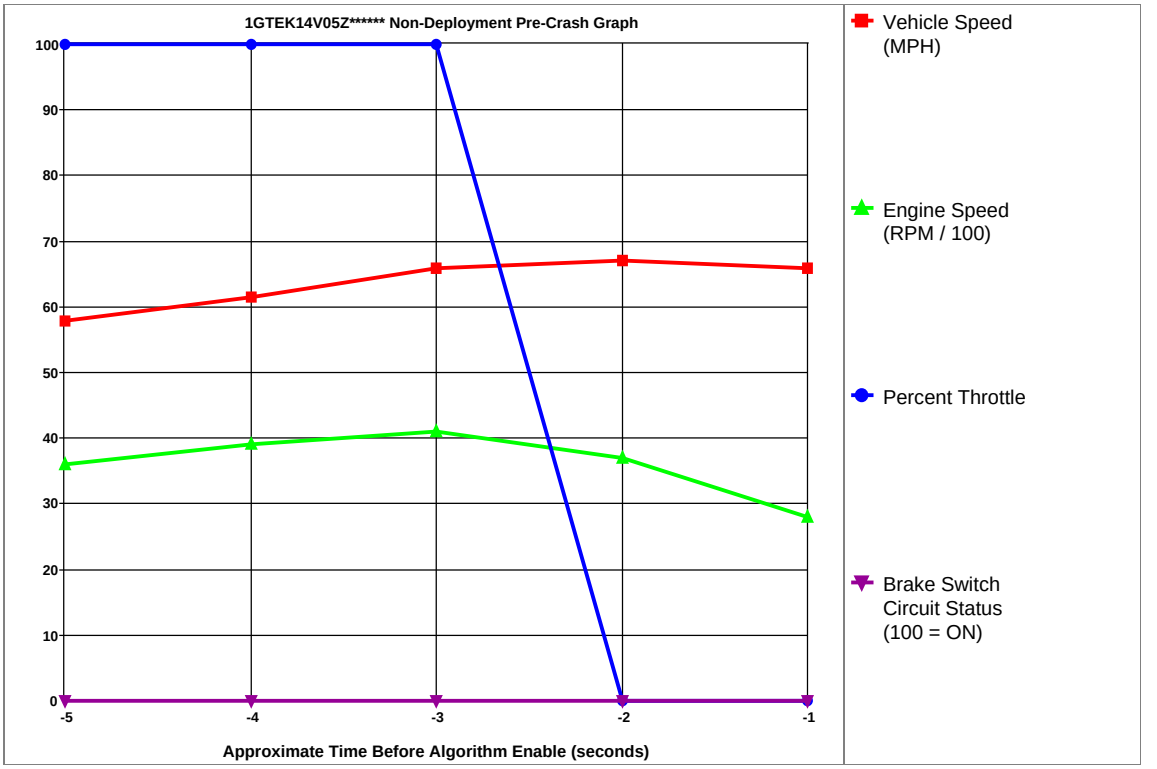
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	61	1664	0	OFF
-4	62	2176	0	OFF
-3	56	1920	0	ON
-2	34	1984	0	OFF
-1	46	2688	0	OFF



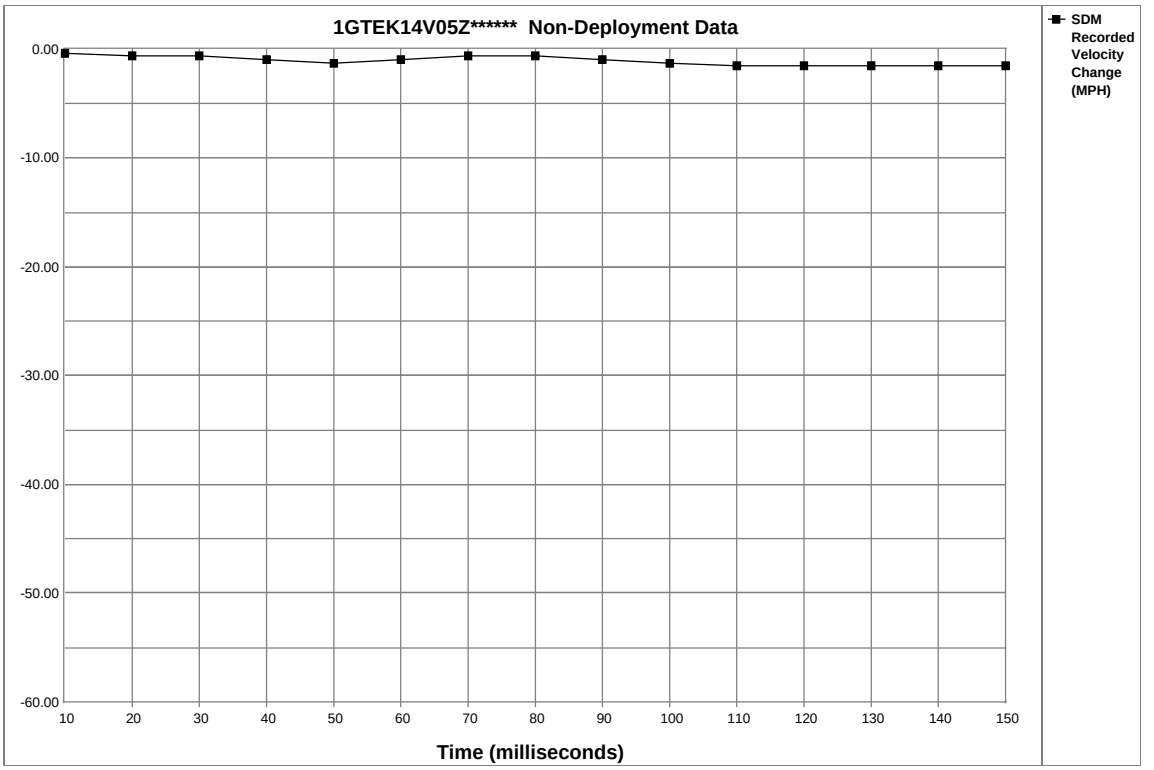
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.62	-1.86	-4.03	-6.82	-9.92	-13.95	-15.81	-17.98	-20.46	-22.32	-23.56	N/A	N/A	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Passenger Seat Position Switch Circuit Status	Rearward
Ignition Cycles At Non-Deployment	256
Ignition Cycles At Investigation	258
Maximum SDM Recorded Velocity Change (MPH)	-1.94
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	222.5
Crash Record Locked	Yes
Event Recording Complete	Yes
Multiple Events Associated With This Record	Yes
One Or More Associated Events Not Recorded	Yes



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	58	3648	100	OFF
-4	62	3904	100	OFF
-3	66	4096	100	OFF
-2	67	3712	0	OFF
-1	66	2816	0	OFF



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.31	-0.62	-0.62	-0.93	-1.24	-0.93	-0.62	-0.62	-0.93	-1.24	-1.55	-1.55	-1.55	-1.55	-1.55

Hexadecimal Data

This page displays all the data retrieved from the air bag module.
It contains data that is not converted by this program.

```
$01  F0 3C E3 42 AE 8E
$02  F1 F1 00 00 A8 00
$03  41 53 35 31 33 37
$04  4B 37 52 30 36 31
$05  00 00 00 00 00 00
$06  21 99 26 27 00 00
$07  00 00 00 00 00 00
$08  00 00 00 00 00 00
$09  00 00 00 00 00 00
$0A  00 00 00 00 00 00
$0B  00 00 00 00 00 00
$0C  00 00 00 00 00 00
$0D  00 00 00 00 00 00
$0E  00 00 00 00 00 00
$0F  00 00 00 00 00 00
$10  FF DF FC 00 00 00
$11  81 80 83 7D 7C 7E
$12  88 78 78 20 20 11
$13  FF 02 00 00 00 00
$14  03 03 00 00 6C 00
$15  FA FA FA FA FA FA
$16  FA FA FA FA FA FA
$17  FA FA 00 00 00 00
$18  00 0F 05 EC F5 00
$19  09 00 0A 00 00 64
$1A  00 00 00 00 00 00
$1B  00 00 00 00 00 00
$1C  00 0C 00 00 00 00
$1D  00 00 00 00 00 00
$1F  FE 00 00 00 00 00
$20  9E FE 00 00 FF FF
$21  FF FF FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF FF FF FF FF FF
$24  00 00 64 00 59 0C
$25  06 00 00 00 00 00
$26  01 02 02 03 04 03
$27  02 02 03 04 05 05
$28  05 05 05 00 FF DF
$29  FF A5 FF FF FF FF
$2A  FF FF FF FF FF FF
$2B  FF FF FF FF FF FF
$2C  FF FF FF FF FF FF
$2D  FF FF 00 00 00 00
$30  BE FD 00 00 FF FF
$31  FF FF FF FF FF FF
$32  FF FF FF FF FF FF
$33  FF FF FF FF FF FF
$34  00 00 35 09 04 07
$35  00 00 00 00 00 00
$36  55 0E 07 03 00 00
$37  00 00 00 05 E0 55
$38  54 07 7A 40 D0 00
$39  05 00 00 00 00 07
$3A  02 06 0D 16 20 2D
$3B  33 3A 42 48 4C 00
$3C  00 00 00 0B FF DF
$3D  FF A5 00 00 00 00
$40  6A 6C 6A 63 5D 00
$41  00 00 00 00 FF FF
$42  FF 00 2C 3A 40 3D
$43  39 00 1F 80 00 00
```

$44	4A	37	5A	64	62	00
$45	20	00	00	00	00	00
$46	00	00	2A	1F	1E	22
$47	1A	00	1F	80	00	00
$48	FF	FF	FF	FF	FF	FF
$49	FF	FF	FF	FF	FF	FF
$4A	FF	FF	FF	FF	FF	FF
$4B	FF	FF	FF	FF	00	00
$4C	FF	FF	FF	FF	FF	FF
$4D	FF	FF	FF	FF	FF	FF
$4E	FF	FF	FF	FF	FF	FF
$4F	FF	FF	FF	FF	00	00
$50	FF	FF	FF	FF	FF	FF
$51	FF	FF	FF	FF	FF	FF
$52	FF	FF	FF	FF	FF	FF
$53	FF	FF	FF	FF	FF	FF
$54	FF	FF	FF	FF	FF	FF