TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

General Dynamics
Buffalo, NY 14225

GENERAL DYNAMICS ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS) INVESTIGATION
SCI TECHNICAL SUMMARY REPORT

CASE NO. CA03-032

VEHICLE – 2001 FORD CROWN VICTORIA POLICE INTERCEPTOR

LOCATION - STATE OF NEW JERSEY

CRASH DATE – MAY 2003

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 the performance of the Advanced Occupant Protection System (AOPS) that was present in a 2001 Ford Crown Victoria Police Interceptor (CVPI). The vehicle was a marked police unit that was equipped with dual-stage frontal air bags for the driver and front right passenger positions, front seat retractor pretensioners, a seat track position sensor for the driver's seat track, and an Event Data Recorder (EDR). The CVPI **(Figure 1)** was involved in an intersection collision with a 1996 Ford Mustang at a residential four-leg intersection. The front of the CVPI struck the left side aspect of the Mustang and the impact was sufficient to deploy the frontal air bag system in the CVPI. The driver's seat track was adjusted to 10.2 cm (4.0") rear of the full-forward position and 14.0 cm (5.5") forward of the full-rear position at the time of the crash and the driver was unrestrained. The safety system therefore, provided a first-stage frontal air bag deployment. The driver of the CVPI stated that she was restrained at the time of the crash, and sustained a fractured right big toe, a left knee contusion, and a left anterior forearm burn. She was transported in the cab of an ambulance to a local hospital where she was treated for her injuries and released.			
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BACKGROUND

This on-site investigation focused the performance of the Advanced Occupant Protection System (AOPS) that was present in a 2001 Ford Crown Victoria Police Interceptor (CVPI). The vehicle was a marked police unit that was equipped with dual-stage frontal air bags for the driver and front right passenger positions, front seat retractor pretensioners, a seat track position sensor for the driver's seat track, and an Event Data Recorder (EDR). The CVPI **(Figure 1)** was involved in an intersection collision with a 1996 Ford Mustang at a residential four-leg intersection. The front of the CVPI struck the left side aspect of the Mustang and the impact was sufficient to deploy the frontal air bag system in the CVPI. The driver's seat track was adjusted to 10.2 cm (4.0") rear of the full-forward position and 14.0 cm (5.5") forward of the full-rear position at the time of the crash and the driver was unrestrained. The safety system therefore, provided a first-stage frontal air bag deployment. The driver of the CVPI stated that she was restrained at the time of the crash, and sustained a fractured right big toe, a left knee contusion, and a left anterior forearm burn. She was transported in the cab of an ambulance to a local hospital where she was treated for her injuries and released.

Figure 1. Police photograph of damaged CVPI

This crash was reported to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) by the driver's police sergeant. The notification was forwarded to the General Dynamics SCI team on June 13, 2003 and assigned as an on-site investigative effort. The on-site investigation was performed on June 19, 2003. The Ford Mustang had been released to the owner who denied the SCI request to inspect the vehicle. Photographs of the damaged vehicles were obtained which provided the basis for the damage assessment of the Mustang.

VEHICLE DATA – 2001 Ford CVPI

The 2001 Ford CVPI was identified by the Vehicle Identification Number (VIN): 2FAFP71W21X (production sequence omitted). At the time of the vehicle inspection, the CVPI was partially disassembled for repair and the odometer read 107,274 km (66,659 miles). The CVPI was configured with the Police Interceptor package which included a 4.6L overhead cam SEFI V8 engine, an electronically controlled automatic transmission with overdrive and transmission oil cooler, heavy duty frame, steering gear, body mounts and suspension, power 4-

wheel disc brakes with anti-lock braking system (ABS), power, speed sensitive steering, variable assist and power steering oil cooler and an AOPS which included dual-stage front air bags, safety belt pretensioners, and a driver's seat track position sensor. The CVPI was equipped with Goodyear Eagle RS A P225/60R16 tires on each wheel. The vehicle manufacturer recommended front and rear tire pressure was unknown. The specific tire data is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	272.3 kpa (39.5 psi)	8 mm (10/32")	No	None
LR	251.7 kpa (36.5 psi)	8 mm (10/32")	No	None
RF	248.2 kpa (36.0 psi)	7 mm (9/32")	No	None
RR	251.7 kpa (36.5 psi)	8 mm (10/32")	No	None

The CVPI was a departmental vehicle and was used continuously for all three shifts within a 24-hour period (seven days per week). It had been involved in two previous crashes. Approximately two years prior to this crash, the CVPI was struck on the right side in an intersection crash, which required the replacement of both right side doors. Approximately 10 months prior to this crash, the CVPI struck a pole with the rear aspect. The frontal air bag system did not deploy in either of the previous crashes. The driver reported that the Anti-lock Braking System (ABS) light had been illuminated on the instrument panel and that the vehicle was previously written up for service due to the ABS system not working. The ABS had not been evaluated prior to this crash. At the time of this SCI vehicle inspection, the air bag light on the instrument panel was illuminated, but there were no other warning lights illuminated. The EDR "System Status At Deployment" output indicated that there were no active faults at the time of the crash.

The CVPI was configured with front bucket seats with adjustable head restraints. The driver's seat track was adjusted to 10.2 cm (4.0") rear of the full-forward position and 14.0 cm (5.5") forward of the full-rear position at the time of the crash. The total seat track travel measured 24.1 cm (9.5"). The distance between the steering wheel hub and the seat back measured 48.9 cm (19.3") at that seat track position. The front right seat was adjusted to the full-rear track position. The rear seating positions were configured with a bench seat. A full-width safety cage was installed between the front seat backs and the rear seating area.

The interior of the CVPI was configured with police radios, radar equipment, a laptop computer module, and vertically-mounted firearm holders between the front bucket seats. The radar equipment was mounted to the top aspect of the instrument panel by brackets with setscrews anchored through the bottom aspect of the top lip of the instrument panel. A center console was mounted to the floor between the front seats and housed two-way radio equipment, siren controls, and emergency light controls.

An after-market armrest was mounted on the driver's side of the center console, which protruded outward from the console into the path of the driver's seat back **(Figure 2)**. The armrest was vertically adjustable by slots in the mounting brackets and was located on the rear aspect of the console. Due to the location of the armrest, the driver's seat back engaged the rear aspect of the armrest when the driver's seat was positioned at the mid-track position, and impeded the seat track adjustment forward of the mid-track position. The driver's seat track was located 10.2 cm (4.0") rear of the full-forward position at the time of the crash, and the driver stated that she could not adjust the driver's seat farther forward due to the engagement of the armrest.

Figure 2. After-market armrest against the driver's seat back

There was no significant cargo weight in the CVPI at the time of the crash. The trunk contents were stored in a large plastic tub and included the following items: a hard-shell plastic oxygen kit, a hard-shell plastic first-aid kid, an OEM jack (not secured), a fire extinguisher (not secured), and multiple flares. The OEM spare tire had been removed from the vehicle per departmental procedures.

VEHICLE DATA – 1996 FORD MUSTANG

The 1996 Ford Mustang was identified by the reported VIN: 1FALP4041TF (production sequence omitted). The vehicle was a two-door couple that was equipped with a 3.8 liter, V-6 engine, power steering, power brakes, and 38 cm (15") wheels. The owner of the Mustang refused to give permission for an inspection of the vehicle. Photographs of the damaged Ford Mustang were provided by the investigating police agency.

CRASH SITE

This two-vehicle crash occurred during the nighttime hours of May 2003 in the state of New Jersey. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred at a four-leg intersection of a two local roadways **(Figure 3)**. The north/south roadway was configured with one travel lane in each direction that were separated by a double-yellow centerline and bordered by concrete curbs. The east/west roadway was configured with one travel lane in each direction, had no lane markings, and was bordered by concrete curbs. Traffic flow through the intersection was controlled by stop signs for east/west traffic. The roadside environment consisted of concrete sidewalks and private residences. The posted speed limit for both roadways was 40 km/h (25 mph). The scene schematic is included as **Figure 15** of this report.

Figure 3. Overall view of intersection from the southeast corner

CRASH SEQUENCE

Pre-Crash

The 23-year-old female driver was operating the Ford CVPI southbound on the two-lane roadway. She was responding as a back-up unit to a call-in-progress. The driver approached a four-leg intersection one block north of the crash scene that was controlled by overhead three-phase traffic signals. As the CVPI approached the intersection, the traffic signal was in the red phase for north/south traffic. After she stopped at the intersection, she activated the CVPI's emergency lights and proceeded against the red traffic signal through the intersection. She turned off the emergency lights and continued southbound on approach to the four-leg intersection where the crash occurred. As the CVPI approached the intersection **(Figure 4)**, the 19-year-old female driver of the Ford Mustang that was traveling eastbound, approached the intersection and stopped at the stop sign **(Figure 5)**. The driver of the Mustang proceeded into the intersection across the path of the approaching CVPI. The driver of the CVPI detected the Mustang traveling into the intersection and applied the brakes in full lockup. Due to the inoperative ABS system, the ABS did not engage. The pre-crash braking resulted in a left front tire mark that measured 24.9 m (81.5') in length and a right front tire mark that measured 17.4 m (57.0') in length (**Figure 6**). The equivalent velocity loss due to braking was 66.6 km/h (41.4 mph). The driver of the Mustang did not attempt any avoidance maneuvers. The driver of the CVPI estimated that she was operating the vehicle approximately one minute prior to the crash, as she had only traveled four blocks from her point of origin.

Figure 4. Southbound approach for the CVPI

Figure 5. Westbound approach for the Mustang

Figure 6. Police photograph of pre-impact tire marks from the CVPI showing deflection points and final rest

Crash

The front of the CVPI impacted the left rear side aspect of the Ford Mustang. The impact resulted in minor damage to the CVPI, moderate damage to the Mustang, and was sufficient to deploy the first-stage of the dual stage frontal air bag system in the CVPI. The direction of force was in the 1 o'clock sector for the CVPI and in 10 o'clock sector for the Mustang. The damage algorithm of the WinSMASH program computed a delta-V for the CVPI of 14.0 km/h (8.7 mph) and a delta-V of 20.0 km/h (12.4 mph) based on the

documented frontal crush profile of the CVPI and estimated crush profile of the Mustang (from photographs). The EDR recorded a maximum cumulative longitudinal delta-V of 14.7 km/h (9.1 mph). The impact to the left rear side of the Mustang caused the left rear wheel to fracture from the axle. The wheel came to rest on the west leg of the intersection near the north roadside. The forward momentum of the Mustang deflected the CVPI in a slight counterclockwise direction and the front wheels remained locked as the CVPI as it traveled to final rest, evidenced by tire marks. The CVPI came to rest on the southeast quadrant of the intersection 5.2 m (17.1') southeast of the point of impact. Since the CVPI struck the Mustang rear of its center of gravity, the Mustang rotated 210 degrees in a CCW direction, traveled over the curb, and came to rest on the southeast corner of the intersection.

Post-Crash

Both drivers exited the vehicles under their own power. The driver of the CVPI stated that the driver's door was difficult to open due to the rearward displacement of the left front fender. The driver called the dispatcher on a portable radio to alert emergency personnel of the crash. The driver of the Mustang was transported by ambulance to a local hospital for treatment of minor injuries. Her admission status was not reported. The driver of the CVPI was transported in the same ambulance (in the cab) to a local hospital where she was treated for her injuries and released.

VEHICLE DAMAGE

Exterior Damage – 2001 CVPI

The 2001 Ford CVPI sustained minor frontal damage as a result of the impact with the Ford Mustang. The direct damage began at the front right corner **(Figure 7)** and involved the entire width of the front bumper fascia. The bumper fascia and bumper beam were deflected laterally 10.2 cm (4.0") to the left. The top aspect of the bumper fascia was separated and the left side aspect of the fascia was fractured. Red paint transfers were present on both corners of the bumper fascia from contact with the Mustang. The bumper beam **(Figure 8)** was crushed rearward and the maximum crush measured 12.2 cm (4.8") and was located 18.4 cm (7.3") to the right of the centerline. The static left bumper Energy Absorption Device (EAD) piston travel measured 0.6 cm (1/4") and the static right EAD piston travel measured 0.3 cm (1/8") at the time of the inspection. The combined direct and induced damage measured 139.7 cm (55.0") across

Figure 7. Right side view of damaged CVPI

Figure 8. Frontal view showing damaged/shifted bumper beam

the front bumper beam. The left front fender was displaced rearward slightly, and the hood was buckled rearward. The Collision Deformation Classification (CDC) for the impact with the Ford Mustang was 01-FDEW-1. Six crush measurements were documented along the front bumper beam and were as follows: C1 = 0.0 cm, C2 = 1.3 cm (0.5”), C3 = 4.8 cm (1.9”), C4 = 10.8 cm (4.3”), C5 = 7.9 cm (3.1”), C6 = 3.5 cm (1.4”).

Interior Damage – 2001 CVPI

The 2001 Ford CVPI sustained minor interior damage **(Figure 9)** as a result of the frontal impact. The video camera that was mounted on the windshield header was slightly displaced. The top half of the accelerator pedal was deflected forward, although it was not known if the damage was crash-related. The lower instrument panel was slightly deformed to the right of the knee bolster, but it did not appear to be crash related.

Figure 9. View of interior from the driver's door

Exterior Damage – 1996 Ford Mustang

The 1996 Ford Mustang sustained moderate left side damage **(Figure 10)** as a result of the impact with the CVPI. The owner of the Mustang refused to give permission for an inspection of the vehicle; therefore damage was estimated from police photographs. The direct damage began approximately 102 cm (40”) rear of the left front axle, extended rearward 191 cm (75”), and terminated 36 cm (14”) rear of the left rear axle. The left door and left rear quarter panel were crushed laterally from direct contact. White paint transfers and abrasions were also present on the left side aspect of the Mustang. The direct contact between the vehicles resulted in the complete separation of the left rear wheel of the Mustang. The brake rotor was fractured and the rear axle was fractured at the outboard aspect of the left rear axle housing. The combined direct and induced damage began at the leading edge of the left front door, extended rearward approximately 270 cm (106”), and terminated approximately 30 cm (12”) forward of the left rear bumper corner. The CDC for the impact with the CVPI was 10-LZEW-2. Six crush measurements were estimated along the left side plane and were as follows: C1 = 0 cm, C2 = 10 cm (4”), C3 = 18 cm (7”), C4 = 25 cm (10”), C5 = 15 cm (6”), C6 = 0 cm.

Figure 10. Left side damage to the Ford Mustang

MANUAL RESTRAINT SYSTEMS – 2001 Ford CVPI

The 2001 Ford CVPI was equipped with manual 3-point lap and shoulder belts for all outboard seating positions. The rear center safety belt was completely removed from the vehicle prior to the crash. The front seat safety belts were configured with continuous loop webbing, sliding latch plates, and adjustable D-rings. The driver's D-ring was located at the full-down position and the front right D-ring was located in the full-up position at the time of the inspection. The driver's safety belt was configured with a belt-sensitive, Emergency Locking Retractor (ELR) and the remaining safety belts were configured with belt-sensitive, switchable ELR/Automatic Locking Retractors (ALR). The rear outboard restraints retracted into the inboard aspects of the C-pillars. The driver's safety belt webbing **(Figure 11)** exhibited minor stretching which began 64.1 cm (25.3") above the lower anchor and extended 77.5 cm (30.5") along the webbing. There were no abrasions present on the plastic latch plate cover or driver's D-ring to support loading of the restraint. Abrasions were present on the face of the latch plate, which supported regular use; however, due to the frequent operation of the vehicle by multiple drivers and the vehicle's mileage, no conclusions could be drawn from this evidence regarding belt usage by any particular driver.

Figure 11. View of driver's safety belt

ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS) – 2001 CVPI

The 2001 Ford CVPI was equipped with an AOPS that included dual-stage frontal air bags for the driver and front right passenger positions, front seat retractor pretensioners, a seat track position sensor for the driver's seat track, and an Event Data Recorder (EDR). The air bag system was equipped with a sensor on the driver's seat track that was designed to adjust the deployment of the driver's air bag based on crash severity, the driver's seat track position, and safety belt usage. The EDR output is included as **Appendix A** of this report.

The dual-stage frontal air bag system deployed as a result of the impact with the Ford Mustang. The driver's air bag was housed in the center of the steering wheel hub with a single cover flap design. The cover flap was hinged at the top aspect and measured 14.0 cm (5.5") in width and 11.1 cm (4.4") in height. The driver's air bag **(Figure 12)** measured 61.0 cm (24.0") in diameter. The air bag was vented by two circular ports located on the rear aspect of the air bag at the 11 and 1 o'clock positions, located 5.1 cm (2.0") inboard of the circumferential seam. The vent ports measured 2.5 cm (1.0") in diameter. The air bag was tethered by two internal straps that measured 6.4 cm (2.5") in width and were located at the 12 and 6 o'clock positions of the center of the air bag. There was no evidence present on the driver's air bag from occupant contact.

Figure 12. Deployed driver's air bag (removed from vehicle post-crash)

The dual-stage front right passenger's air bag deployed from a mid-mount module located on the right instrument panel. The module cover flap was rectangular in shape, hinged at the forward aspect, and measured 39.4 cm (15.5") in width and 15.2 cm (6.0") in height. The front right passenger's air bag **(Figure 13)** measured 50.8 cm (20.0") in width and 55.9 cm (22.0") in height. The air bag was vented by a single circular port located at the bottom aspect of the inboard side panel of the air bag. The vent port measured 5.1 cm (2.0") in diameter. The air bag was not tethered. Although there was no damage or contact evidence on the front right passenger's air bag, the stainless steel backing plate for the vehicle's laptop computer overlapped the left aspect of the air bag by 2.5 cm (1.0").

Figure 13. Deployed front right passenger's air bag

The front safety belts were equipped with retractor pretensioners that were designed to fire in conjunction with the frontal air bag system. The pretensioners did not actuate in this crash.

Figure 14. Non-actuated driver's safety belt pretensioner

The EDR "System Status At Deployment" section showed an air bag "Fire" command for Unbelted Stage 1 and a "No Fire" for Belted Stage 1. This indicated that the system would not have deployed the frontal air bag system if restraint usage were detected. The output also indicated that the driver's seat track was in a forward position, which was defined as being positioned within the first 10.2 cm (4.0") of the seat track. This supported the driver's seat track location of 10.2 cm (4.0") rear of the full-forward track position at the time of the inspection. Although the driver of the CVPI stated that she was restrained, the EDR output did not support restraint use by the driver in this crash. According to the EDR parameters, the first stage of the frontal air bag system deployed at 28.8 milliseconds from system wake-up (time =zero) and the second stage was disposed at 128.8 milliseconds, which supported the EDR logic of an Unbelted Stage 1 deployment. "The System Status At Deployment" section of the EDR summary also displayed the status of both pretenioners as "Fire," but the pretensioner parameters listed both pretensioners as "None". Analysis of the Crash Pulse Data contained within the EDR report indicated that the system wake-up (t=0) appeared to be defined as the time when the longitudinal deceleration crossed the 3 g threshold. The physical impact of the vehicles occurred approximately 6 to 14 milliseconds prior to wake-up as denoted by the beginning of the change in the recorded longitudinal acceleration.

This indicated that if the occupants were belted, the pretensioners would have actuated, but since the system did not detect restraint use, there was no pretensioner actuation for either safety belt.

Inspection of the driver's **(Figure 14)** and front right passenger's retractor pretensioners verified no pretensioner actuation.

OCCUPANT DEMOGRAPHICS – 2001 CVPI

Driver

Age/Sex:	23-year-old female driver
Height:	160 cm (63")
Weight:	67 kg (148 lb)
Seat Track Position:	10.2 cm (4.0") rear of full-forward
Manual Restraint Use:	Unrestrained
Usage Source:	Vehicle inspection, EDR output
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance (in front right position in the cab) to a local hospital where she was treated for her injuries and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Fractured right big toe	Minor (853602.1,1)	Loading to the brake pedal in response to the frontal impact
*Burn on the left anterior forearm, described as 'softball sized'	Minor (792000.1,2)	Driver's air bag/exhaust gases
Left knee contusion	Minor (890402.1,2)	Knee bolster

Injury source: Driver interview (no medical records)
*Driver stated that the hospital described the injury as a "chemical burn"

Driver Kinematics

The 23-year-old female driver of the Ford CVPI was seated in an upright posture with the seat track adjusted slightly forward of the mid-track position. She was wearing a police uniform with short sleeves and was also wearing steel toe duty boots. She stated that her hands were positioned at the 10 and 2 o'clock positions on the steering wheel rim. As she detected the Ford Mustang traveling across the path of the CVPI, she applied the brakes in full-lockup. She stated that only the top aspect of her foot engaged the brake pedal. The foot loading on the brake pedal due to the response to the frontal impact resulted in a fractured right big toe. At impact with the Mustang, the frontal air bag system deployed and the unrestrained driver initiated a forward trajectory. The expansion of the driver's air bag displaced her arms from the steering wheel rim and she sustained a hospital-reported burn on the left anterior forearm as a result of the air bag interaction and possible discharge from the air bag vent port. The hospital reported the burn as chemical in nature, but if it was most likely thermal if it resulted from air bag exhaust gases. It was possible that the injury to the left anterior forearm may have been a frictional abrasion from interaction with the deploying air bag, but this could not be confirmed. She loaded the knee bolster, which resulted in a left knee contusion. She subsequently loaded the deployed driver's air bag, which mitigated additional contact with the steering wheel and instrument panel. After the vehicles came to rest, she exited the CVPI under her own power through the driver's door.

Although there was no power loss to the vehicle, she radioed the police dispatcher for assistance on a portable police radio and proceeded to assist the driver of the Mustang. She was transported by ambulance (in the front right seat of the cab) to a local hospital. She was treated for her injuries and released.

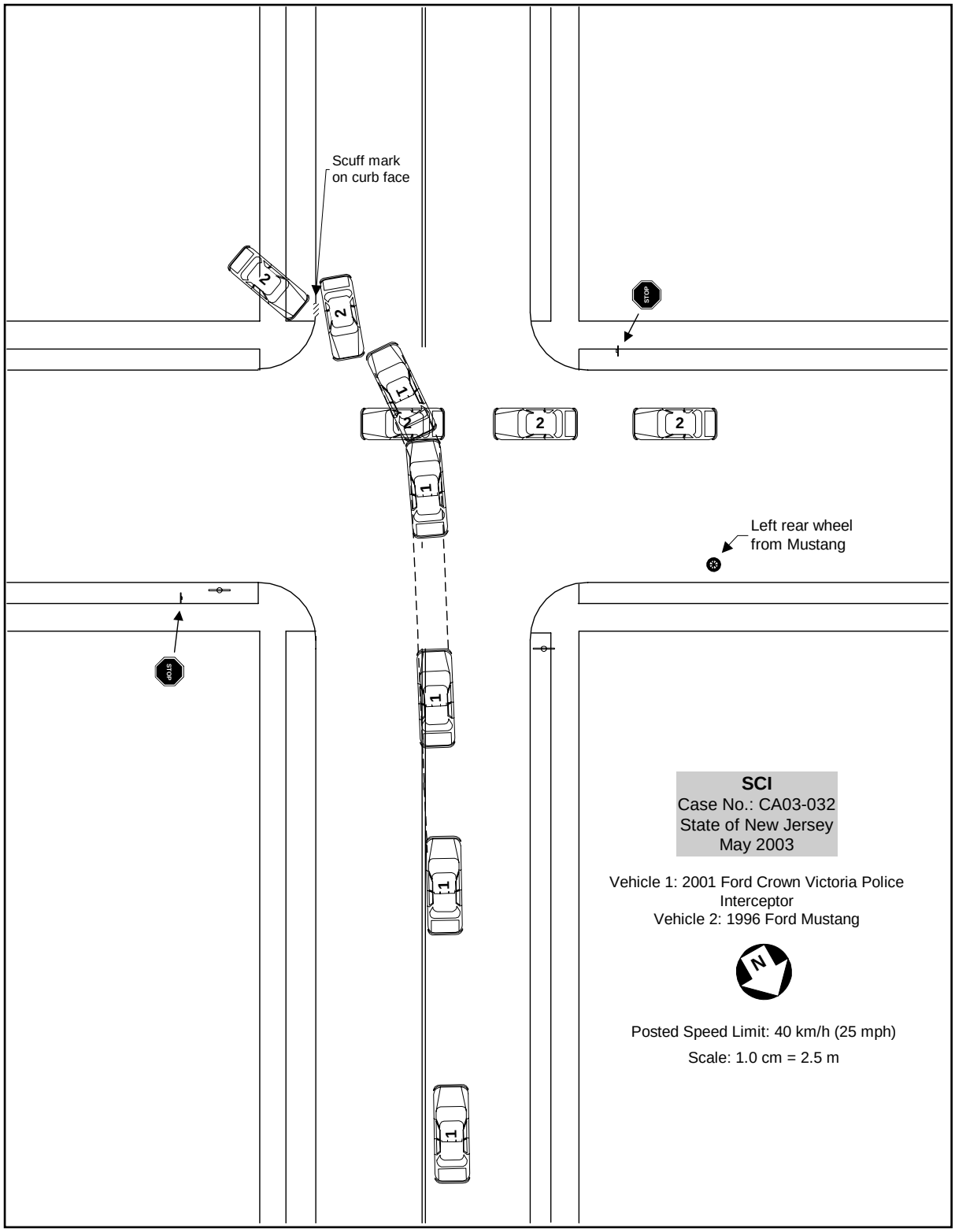


Figure 15. Scene schematic

APPENDIX A: EDR Report

CDR File Information

Vehicle Identification Number	2FAFP71W21Xxxxxxx
Investigator	[redacted]
Case Number	CA03-032
Investigation Date	6/19/03
Crash Date	
Filename	CA03-032 EDR OUTPUT.CDR
Saved on	6/19/2003 10:34:29 AM
Data check information	B05FA164
Collected with CDR version	Crash Data Retrieval Tool 2.00
Collecting program verification number	A31D1C76
Reported with CDR version	Crash Data Retrieval Tool 2.00
Reporting program verification number	A31D1C76
Event(s) recovered	Pretensioner Deployment

Module Information

The retrieval of this data has been authorized by the vehicle's owner, or other legal authority such as a subpoena or search warrant, as indicated by the CDR tool user on June 19, 2003, at 10:34 AM.

Important Limitations on Vetronix Crash Data Retrieval (CDR) Tool Capabilities.

Disclaimer: This Restraint Control Module (RCM) records longitudinal deceleration data for the purpose of understanding the input data the Restraint Control Module used to determine whether or not to deploy restraint devices. This module does not record vehicle speed, throttle position, brake on-off, and other data, which may be recorded in some 1999 model year and later General Motors modules. The deceleration data recorded by Ford's module during a crash can subsequently be mathematically integrated into a longitudinal Delta-V. Delta-V is the change in velocity during the recording time and is NOT the speed the vehicle was traveling before the accident, and is also not the Barrier Equivalent Velocity. The Vetronix CDR Tool will read and interpret both acceleration in G's and Delta-V in mph. RCM's in Ford vehicles that can be read by the Vetronix CDR tool are listed in the Vetronix Help Files.

Important

If there is any question that the restraint system did not perform as it was designed to perform, please read the system only through the diagnostic link connector. The Vetronix CDR kit provides an RCM interface cable to plug directly into the restraint control module. The Vetronix CDR RCM Interface Cable connects only power, ground, and memory read pins to the relevant vehicle restraint control module. The other RCM pins normally connect to inputs, such as sensors, and outputs, such as airbags, are not connected when you use the RCM Interface Cable to plug directly into the module. Since the vehicle restraint control module is constantly monitoring airbag system readiness, it will detect that the sensors and airbags are not connected. The restraint control module may record a new diagnostic trouble code into memory for each device that is not connected. These new diagnostic trouble codes may record over previously written diagnostic trouble codes present prior to the accident and spoil evidence necessary to determine if the restraint system performed in the accident as it was designed to perform. Not only could this prevent Ford from being able to determine if the system performed as it was designed to perform, but, regardless of innocent inadvertence, you could raise issues of evidence spoliation in any litigation that may arise out of the accident. If you cannot read the module via the diagnostic link connector, and if you suspect improper system performance, contact Ford Motor Company and request their assistance to read the module with a proper vehicle simulator attached. If you choose to read via the module connector, Ford recommends that you do so in the vehicle and that you leave the second large connector plugged into the vehicle wiring harness to minimize the number of new diagnostic trouble codes created.

While data stored in RCM's is accurate, accident reconstructionists must be aware of the limitations of the data recorded in Ford's control modules and should compare the recorded data with the physical evidence at the accident scene using professional accident reconstruction techniques (i.e. vehicle crush characteristics, skid marks, etc) before making any assumptions about the import and validity of the data recorded in the module with respect to the crash event being analyzed. The following describes specific limitations that must be considered when analyzing recorded data. Investigators should obtain permission of the vehicle owner prior to reading any data.

1. There may be no deceleration data recorded in the module.
Loss of power (cut wires, damaged battery, crushed fuse box) to the module during or immediately after the crash may prevent the crash data from being recorded. A backup power supply within the module has sufficient power to continue to analyze the deceleration data and deploy restraint devices if needed, but there is no backup power for recording.

If the deceleration input does not create a vehicle longitudinal Delta-V above 4 mph within 100 milliseconds, there may not be any data recorded.

2. In unusual circumstances, deceleration data stored in the module may be from a crash other than the one you are currently analyzing.
The module will record data from some non-deploy events. If, after the module has recorded data from a non-deploy event, and there is a subsequent event in which there is a loss of power and no new recording is made for that subsequent event, the deceleration data in the module's memory may be from the prior event. If the new, subsequent event is a deploy event and recording has occurred, the deployment times should be recorded. If there are no deployment times recorded, but airbags or other restraint devices are observed to have deployed, the recorded data that you read are most likely from a prior event.

Once an airbag or other restraint device has been commanded to deploy, the data recorded in connection with that deployment are "locked", and subsequent crashes cannot be recorded.

If a vehicle is being repaired, the RCM should be replaced after any crash in which restraint devices deploy. Early printed shop manuals refer to re-using modules by clearing the "crash data memory full" code, but this is no longer true and the latest on-line electronic shop manual directs that modules be replaced.

Crashes that involve multiple impacts will record only one of the impacts. If there is a deployment, the deployment event will be recorded and locked. If no restraint device is commanded to deploy, the recorded data are not "locked", and subsequent impacts may record over any previous recorded data. Further analysis will be required to determine which of the events was actually recorded.

3. The computed longitudinal Delta-V may understate the total Delta-V

Many real-world crashes can last longer than the memory has the capacity to record. Therefore, the actual Delta-V of the event may be higher than the Delta-V calculated and displayed by the Vetronix CDR System output. Review the end of the longitudinal acceleration/deceleration pulse - if it has not settled to zero G's by the end of the recording, the vehicle longitudinal Delta-V is most likely understated. If there is a clear decaying trend line you may choose, at your own risk, to estimate the total Delta-V by extrapolating the decay trend to zero and to calculate the additional Delta-V not captured.

Under some circumstances where power is interrupted, during the recording of data, or the module re-sets during the recording of data, a partial recording may occur. This will be shown as "no data" in the data table and will not be plotted on the graph of acceleration. The "no data" sections may be at the beginning, in the middle, or at the end(s) - it will not be consistent from one occurrence to another. When some portion of the acceleration data is not recorded, the Delta-V during that time cannot be calculated. A Delta-V will be calculated for the points that are valid, but the user must be aware that the partial Delta-V calculated will further underestimate the actual event total Delta-V. Restraint device deployment times are recorded first in to memory, and the acceleration data is recorded last. Thus, even with partial acceleration traces, deployment times are valid.

4. This module records only longitudinal acceleration/deceleration of the vehicle. You must compute lateral or resultant total acceleration based on your estimated Principal Direction of Force (PDOF).

5. Vertical acceleration/decelerations are not recorded. Vehicle spin about a point not centered on the Restraints Control Module sensor may add or subtract from bulk vehicle motion.

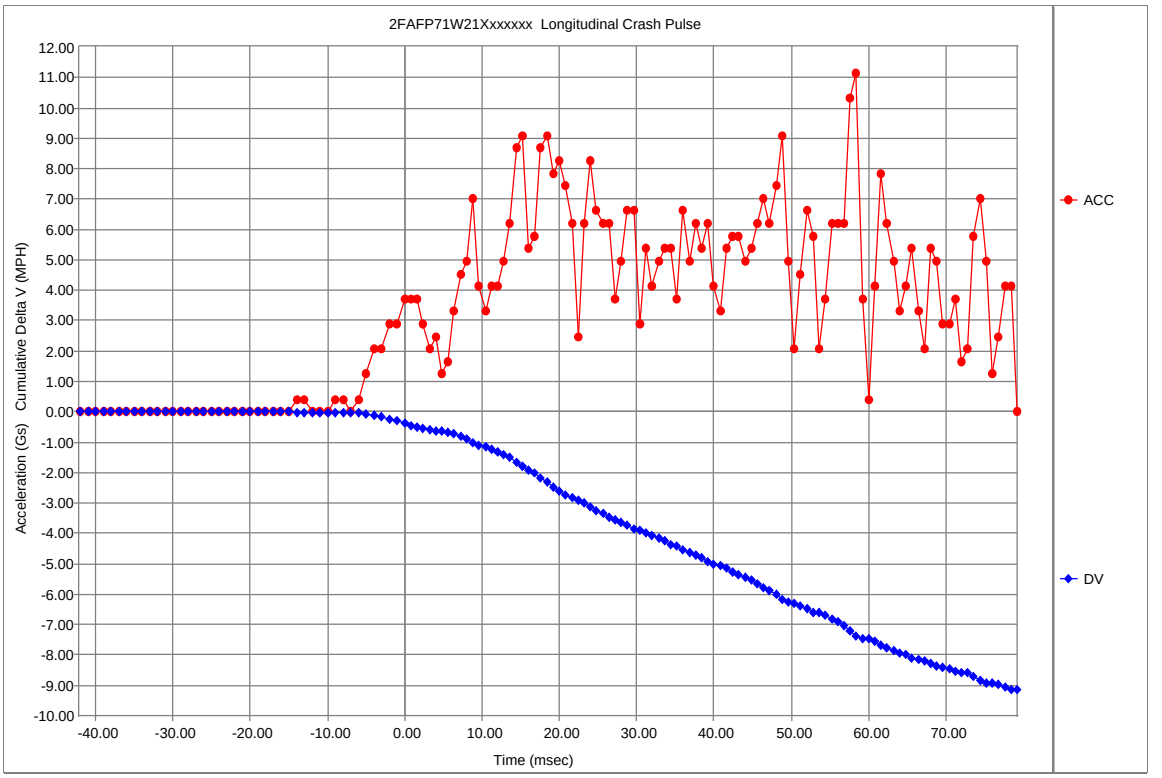
6. This module is not intended to record acceleration/deceleration in a side-impact event. If the side impact generates a longitudinal deceleration component sufficient to wake up the frontal deployment algorithm, there may be a recording of longitudinal deceleration in a side impact event.

Any Longitudinal Delta-V determined by using data read from the air bag module should be verified with physical evidence from the crash (such as vehicle crush, skid marks) and assumed accident sequence. Multiple impacts, angular collisions, side impacts, vehicle spin, etc should be considered in addition to the data read from the air bag module.

System Status At Deployment

Ford Part Number Prefix	1W7A
Number Of Active Faults	0
Driver Seat Belt Buckle	Unbuckled
Passenger Seat Belt Buckle	Unbuckled
Driver Seat Track In Forward Position	Yes
Occupant Classification Status Value	Dual Stage
Unbelted Stage 1	Fire
Unbelted Stage 2	No Fire
Belted Stage 1	No Fire
Belted Stage 2	No Fire
Driver Pretensioner	Fire
Passenger Pretensioner	Fire

Parameter	Driver	Passenger
Pretensioner Time (milliseconds)	NONE	NONE
First Stage Time (milliseconds)	28.8	28.8
Second Stage Time (milliseconds)	128.8	128.8


2FAFP71W21Xxxxxxx Longitudinal Crash Pulse
Acceleration (Gs) Cumulative Delta V (MPH)
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
-10.00
-40.00
-30.00
-20.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
Time (msec)
ACC
DV

Crash Pulse Data

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
-42.0	0.00	0.00
-41.0	0.00	0.00
-40.0	0.00	0.00
-39.0	0.00	0.00
-38.0	0.00	0.00
-37.0	0.00	0.00
-36.0	0.00	0.00
-35.0	0.00	0.00
-34.0	0.00	0.00
-33.0	0.00	0.00
-32.0	0.00	0.00
-31.0	0.00	0.00
-30.0	0.00	0.00
-29.0	0.00	0.00
-28.0	0.00	0.00
-27.0	0.00	0.00
-26.0	0.00	0.00
-25.0	0.00	0.00
-24.0	0.00	0.00
-23.0	0.00	0.00
-22.0	0.00	0.00
-21.0	0.00	0.00
-20.0	0.00	0.00
-19.0	0.00	0.00
-18.0	0.00	0.00
-17.0	0.00	0.00
-16.0	0.00	0.00
-15.0	0.00	0.00
-14.0	0.41	-0.01
-13.0	0.41	-0.02
-12.0	0.00	-0.02
-11.0	0.00	-0.02
-10.0	0.00	-0.02
-9.0	0.41	-0.03
-8.0	0.41	-0.04
-7.0	0.00	-0.04
-6.0	0.41	-0.05
-5.0	1.24	-0.07
-4.0	2.06	-0.12
-3.0	2.06	-0.16
-2.0	2.89	-0.23
-1.0	2.89	-0.29
0.0	3.72	-0.37
0.8	3.72	-0.44
1.6	3.72	-0.50
2.4	2.89	-0.55
3.2	2.06	-0.59
4.0	2.48	-0.63
4.8	1.24	-0.65
5.6	1.65	-0.68
6.4	3.30	-0.74

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
7.2	4.54	-0.82
8.0	4.95	-0.91
8.8	7.02	-1.03
9.6	4.13	-1.10
10.4	3.30	-1.16
11.2	4.13	-1.23
12.0	4.13	-1.31
12.8	4.95	-1.39
13.6	6.19	-1.50
14.4	8.67	-1.65
15.2	9.08	-1.81
16.0	5.37	-1.91
16.8	5.78	-2.01
17.6	8.67	-2.16
18.4	9.08	-2.32
19.2	7.85	-2.46
20.0	8.26	-2.60
20.8	7.43	-2.73
21.6	6.19	-2.84
22.4	2.48	-2.89
23.2	6.19	-2.99
24.0	8.26	-3.14
24.8	6.61	-3.26
25.6	6.19	-3.36
26.4	6.19	-3.47
27.2	3.72	-3.54
28.0	4.95	-3.62
28.8	6.61	-3.74
29.6	6.61	-3.86
30.4	2.89	-3.91
31.2	5.37	-4.00
32.0	4.13	-4.07
32.8	4.95	-4.16
33.6	5.37	-4.26
34.4	5.37	-4.35
35.2	3.72	-4.41
36.0	6.61	-4.53
36.8	4.95	-4.62
37.6	6.19	-4.73
38.4	5.37	-4.82
39.2	6.19	-4.93
40.0	4.13	-5.00
40.8	3.30	-5.06
41.6	5.37	-5.15
42.4	5.78	-5.26
43.2	5.78	-5.36
44.0	4.95	-5.44
44.8	5.37	-5.54
45.6	6.19	-5.65
46.4	7.02	-5.77
47.2	6.19	-5.88
48.0	7.43	-6.01
48.8	9.08	-6.17

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
49.6	4.95	-6.26
50.4	2.06	-6.29
51.2	4.54	-6.37
52.0	6.61	-6.49
52.8	5.78	-6.59
53.6	2.06	-6.62
54.4	3.72	-6.69
55.2	6.19	-6.80
56.0	6.19	-6.91
56.8	6.19	-7.02
57.6	10.32	-7.20
58.4	11.15	-7.39
59.2	3.72	-7.46
60.0	0.41	-7.47
60.8	4.13	-7.54
61.6	7.85	-7.68
62.4	6.19	-7.78
63.2	4.95	-7.87
64.0	3.30	-7.93
64.8	4.13	-8.00
65.6	5.37	-8.10
66.4	3.30	-8.15
67.2	2.06	-8.19
68.0	5.37	-8.28
68.8	4.95	-8.37
69.6	2.89	-8.42
70.4	2.89	-8.47
71.2	3.72	-8.54
72.0	1.65	-8.57
72.8	2.06	-8.60
73.6	5.78	-8.70
74.4	7.02	-8.83
75.2	4.95	-8.91
76.0	1.24	-8.94
76.8	2.48	-8.98
77.6	4.13	-9.05
78.4	4.13	-9.12
79.2	0.00	-9.12

Hexadecimal Data

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

```
0000:  16 BB F2 00 0B 00 00 32 0E 22 0E 2B 38 55 18 06
0010:  00 7D 0C 19 0C 19 05 CC 31 57 37 41 02 03 71 7D
0020:  61 00 35 31 33 36 38 42 45 38 00 00 00 00 00 00
0030:  00 00 00 00 00 00 00 00 00 00 32 31 33 38 38 31
0040:  33 37 00 00 00 00 00 00 00 00 27 02 4C 80 55 02
0050:  4C 80 09 04 01 80 42 6C 05 80 17 00 0E 00 00 00
0060:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0070:  00 00 00 40 01 00 01 00 00 00 20 00 04 00 33 01
0080:  90 8D 89 8B 8E 89 86 8E 8D 88 88 8A 85 86 8F 92
0090:  8D 84 87 8B 8B 81 81 81 81 81 81 81 81 81 81 81
00A0:  81 81 81 81 81 81 81 81 81 81 81 81 81 81 81 81
00B0:  81 81 82 82 81 81 81 82 82 81 82 84 86 86 88 88
00C0:  8A 8A 8A 88 86 87 84 85 89 8C 8D 92 8B 89 8B 8B
00D0:  8D 90 96 97 8E 8F 96 97 94 95 93 90 87 90 95 91
00E0:  90 90 8A 8D 91 91 88 8E 8B 8D 8E 8E 8A 91 8D 90
00F0:  8E 90 8B 89 8E 8F 8F 8D 8E 90 92 90 93 97 8D 86
0100:  8C 91 8F 86 8A 90 90 90 9A 9C 8A 82 8B 94 00 24
0110:  00 A1 00 24 00 A1 00 00 00 00 00 17 19 1B 19 1B
0120:  00 00 00 09 00 24 00 00 00 63 00 63 16 15 81 21
0130:  01 33 8E 03 02 6C 0A 0C 02 02 0E 85 07 43 09 AE
0140:  01 00 00 00 05 05 03 04 05 05 03 FE 00 24 00 5E
0150:  00 61 00 DF 00 A9 00 00 00 C2 09 AE 01 5C 00 F9
0160:  00 ED 00 FE 01 2A 01 1B 00 80 01 8F 00 C6 01 8F
0170:  00 8C 01 2A 01 1B 00 D0 00 E3 02 B2 01 F0 01 6D
0180:  01 99 00 F9 00 94 00 BF 00 C6 00 A9 00 ED 00 85
0190:  FF FE FF FE 00 6D FF FE 00 72 00 B3 00 BD 00 00
01A0:  00 BD 07 02 0A 02 02 6C 04 D7 13 5C 09 AE 00 00
01B0:  00 01 03 0A 03 06 04 04 05 04 00 63 00 C2 00 79
01C0:  01 83 00 C2 00 3D 00 49 00 91 09 AE 01 F0 00 2C
01D0:  00 63 00 C6 00 63 00 F7 00 63 00 A2 00 50 01 3F
01E0:  FF FE 02 2F 01 0D 00 94 01 0D 01 E9 01 8F 00 C6
01F0:  00 79 00 B6 00 DF 00 96 00 C4 00 C6 29 00 8A A5
```