

# NATIONAL TRANSPORTATION SAFETY BOARD

Vehicle Recorder Division  
Washington, D.C. 20594

December 15, 2017

## Recorders

### Specialist's Factual Report by Jane Foster

#### 1. EVENT

Location: Chattanooga, Tennessee  
Date: November 21, 2016  
Vehicle: 2008 Thomas Built Industries School Bus  
Operator: Durham School Services LP of Warrenville, IL  
NTSB Number: HWY17MH009

For a summary of the crash, refer to the *Crash Summary Report* in the docket for this investigation.

#### 2. DETAILS OF INVESTIGATION

The National Transportation Safety Board (NTSB) Vehicle Recorder Division received the following devices:

Device 1: Cummins Engine Control Module (ECM)  
Device 1 Serial Number: 2150DH132372  
Device 2: Zonar Data file  
Device 2 Serial Number: n/a  
Device 3: iPhone  
Device 3 Serial Number: n/a  
Device 4: Meritor Wabco Brake Module  
Device 4 Serial Number: 123857

##### 2.1. Cummins ECM Device Description

The Cummins ECM is an electronic control and data storage system for Cummins engines. The ECM stores vehicle parameters and has the capability to record sudden deceleration and last stop records and trip activity including daily, monthly, and lifetime engine data. The ECM interfaces with many onboard sensors that help monitor and perform its functions.

##### 2.1.1. Cummins ECM Data Recovery

The electrical system of the school bus was compromised so Cummins ECM could not be imaged on the vehicle. The crash ECM was removed from the crash bus and placed

in a surrogate bus. This prevents additional fault codes that appear on a bench top download. The Cummins ECM that was removed from the crash bus is shown in Figures 1 and 2. Cummins' software was used to image both the crash ECM and the surrogate ECM.

**Figure 1. Front of crash ECM after removal from vehicle.**



**Figure 2. Back of crash ECM after removal from vehicle.**



### **2.1.2. Cummins ECM Data Description**

The surrogate ECM was imaged first and no active fault codes were present on the surrogate ECM. This initial imaging was conducted to prevent faults on the surrogate vehicle from showing up on the crash ECM. The crash ECM was then installed on the surrogate vehicle and then the crash ECM was imaged through the J1939 off-board diagnostic connector.

The ECM was first imaged using Cummins Power Spec 6.1 software. The sudden deceleration records captured three events. The first event occurred at ECM time 3595:13:02 (Hours:Minutes:Seconds). The second event occurred at ECM time 3595:15:17, about two minutes after the first event. The third event occurred at ECM time 3594:35:45. These events do not seem to be crash related.

The crash ECM had one active fault code which was described as “Engine Oil Rifle Pressure - Data Valid But Below Normal Operating Range - Most Severe Level”. The image of the ECM included four versions of an Engine Trip Report which contained the max vehicle speed of 70 miles per hour. The Feature Settings Report showed a governed global road speed enabled with a maximum of 93 miles per hour. Idle shutdown was enabled and cruise control was disabled. Additional information is included in the full

download of the data. For more detail, see Recorders Attachment 1, Cummins ECM – Power Spec.

The ECM was then imaged again using Cummins INSITE software. An initial ECM image and a final ECM image were taken. These images gave a snapshot of the engine when a fault code was produced. The snapshot was crash pertinent for the active fault code, “Engine Oil Rifle Pressure - Data Valid But Below Normal Operating Range - Most Severe Level”. For more detail, see Recorders Attachment 2, Cummins ECM - INSITE.

## 2.2. Zonar Data File Description

Zonar is a telematic GPS system that transmits latitude, longitude, and other data from motor vehicle. It is used for fleet tracking. Data is transmitted to an external server and is not stored on the device.

### 2.2.1. Zonar Data File Recovery

The Zonar System data was collected by the Hamilton County Department of Education and a copy was given to the NTSB. Files from the past two months were included in the report. These files contained date, time, speed, heading, log reason, distance traveled, latitude, longitude, zone, address, and source that was sampled every 18 seconds or when motion stopped or started. The files were given in .xls, .kml, and .shp formats.

### 2.2.2. Zonar Data File Data Description

The data extracted included 51 track logs from September 6, 2016<sup>1</sup> through November 21, 2016. The crash drive was recorded starting 15:09:52 EST and ending 15:20:14 EST on November 21, 2016.

### 2.2.3. Zonar Data File Parameters Provided

Table 1 describes data parameters provided by the device. Date, Time, Latitude, Longitude, and Log Reason are recorded by the device. Speed, Heading and Distance are derived from the recorded parameters.

**Table 1: GPS Data Parameters**

Parameter Name	Parameter Description
Date	Date for recorded data point (MM/DD/YYYY)
Time	Time (EST) for recorded data point (HH:MM:SS)
Latitude	Recorded Latitude (degrees)
Longitude	Recorded Longitude (degrees)
Heading	Direction of the vehicle
Speed	Average derived groundspeed (knots)
Log Reason	Average derived true course (degrees)
Distance Traveled	Distance traveled for the day (miles)

<sup>1</sup> All dates and times are referenced to in Eastern Standard Time (EST)



## 2.2.4. Zonar Data File Overlays and Tabular Data

Figure 3 is a graphical overlay generated using Google Earth for the trip. The weather and lighting conditions in Google Earth are not necessarily the weather and lighting conditions present at the time of the recording.

The bus departed the school at approximately 15:13:24 EST. The last recorded parameter was at 15:20:14 EST on November 21, 2016, with a speed of 0 mph. Due to data buffering on the GPS unit, the data recording may have ended before the event.

For more detail, see Recorders Attachment 3, Zonar. This attachment is provided in electronic comma-delimited (.CSV) format.

**Figure 3. Google Earth plot showing crash trip.**



## 2.3. iPhone Device Description

The Apple iPhone is a touch-screen smart-phone capable of voice calling, text messaging, email, photo/video recording, audio (music) playback, and numerous other specialized functions depending on configuration. Specialized functions are supported by additional user-installed program applications (Apps). Application data is stored in non-volatile memory<sup>2</sup> and may include call logs, text messaging logs, image, video, and position location information. In addition, the specialized application data may be stored in a proprietary file structure using numerous file formats. The amount and type of data stored varies based on the software version and configuration of the specific device.

<sup>2</sup> Non-volatile memory is semiconductor memory that does not require power for data retention

### 2.3.1. iPhone Data Recovery

The phone was imaged using forensic software by the Chattanooga Police Department and a copy of the image was provided to the NTSB. The phone belonged to the driver of the school bus.

### 2.3.2. iPhone Data Description

Table 2 shows the cell phone activity from November 19, 2016 through November 21, 2016. There was an incoming call at 15:17:20 EST that had a duration of 3 minutes 50 seconds. The night before the crash, the last text message was accessed at 1:32:42 EST.

The police received the first report of the accident at 15:20:25 EST. The driver's call was terminated at 15:21:10 EST. The driver was on the phone during the crash sequence.

In Table 2, there are different types of data to correspond to different activities. SMS messages are text messages. MMS messages are multimedia messages. Internet is the use of data or wifi for any application. Web history is the use of the internet browser. Emails corresponds to receipt of an email message. Call Log is for outgoing and incoming calls. When an incoming call has a duration other than 00:00:00 then the call was answered, and an incoming call with a duration of 00:00:00 means the call was missed.

**Table 2: Driver's cell phone activity.**

Type	Direction	Date and Time (EST)	Duration
SMS Messages	Incoming	11/19/2016 12:31:09 AM(UTC-5)	
SMS Messages	Outgoing	11/19/2016 6:40:49 AM(UTC-5)	
SMS Messages	Incoming	11/19/2016 7:17:28 AM(UTC-5)	
SMS Messages	Incoming	11/19/2016 7:17:30 AM(UTC-5)	
Internet		11/19/2016 7:26:18 AM(UTC-5)	
Internet		11/19/2016 7:26:26 AM(UTC-5)	
Internet		11/19/2016 7:26:31 AM(UTC-5)	
Internet		11/19/2016 7:26:31 AM(UTC-5)	
Internet		11/19/2016 8:12:15 AM(UTC-5)	
SMS Messages	Incoming	11/19/2016 8:50:21 AM(UTC-5)	
SMS Messages	Incoming	11/19/2016 8:50:41 AM(UTC-5)	

Internet		11/19/2016 8:58:27 AM(UTC-5)	
Emails		11/19/2016 9:00:15 AM(UTC-5)	
Internet		11/19/2016 9:10:17 AM(UTC-5)	
Internet		11/19/2016 9:10:18 AM(UTC-5)	
Web History		11/19/2016 10:05:09 AM(UTC-5)	
Web History		11/19/2016 10:05:15 AM(UTC-5)	
Emails		11/19/2016 10:09:18 AM(UTC-5)	
Web History		11/19/2016 11:01:23 AM(UTC-5)	
Web History		11/19/2016 11:02:06 AM(UTC-5)	
Web History		11/19/2016 11:02:08 AM(UTC-5)	
SMS Messages	Outgoing	11/19/2016 11:03:53 AM(UTC-5)	
SMS Messages	Incoming	11/19/2016 11:05:31 AM(UTC-5)	
SMS Messages	Outgoing	11/19/2016 11:06:06 AM(UTC-5)	
SMS Messages	Incoming	11/19/2016 11:06:55 AM(UTC-5)	
Web History		11/19/2016 11:07:51 AM(UTC-5)	
Web History		11/19/2016 11:07:58 AM(UTC-5)	
Web History		11/19/2016 11:08:00 AM(UTC-5)	
Web History		11/19/2016 11:08:17 AM(UTC-5)	
Web History		11/19/2016 11:08:41 AM(UTC-5)	
Web History		11/19/2016 11:09:51 AM(UTC-5)	
Web History		11/19/2016 11:13:16 AM(UTC-5)	
Web History		11/19/2016 11:13:49 AM(UTC-5)	
Emails		11/19/2016 4:07:35 PM(UTC-5)	

Emails		11/19/2016 4:07:57 PM(UTC-5)	
Internet		11/19/2016 4:29:57 PM(UTC-5)	
Internet		11/19/2016 4:30:06 PM(UTC-5)	
Internet		11/19/2016 4:31:07 PM(UTC-5)	
Call Log	Outgoing	11/19/2016 4:50:41 PM(UTC-5)	00:01:00
Internet		11/19/2016 4:58:28 PM(UTC-5)	
Internet		11/19/2016 4:59:39 PM(UTC-5)	
Internet		11/19/2016 5:07:44 PM(UTC-5)	
Instant Messages	Outgoing	11/19/2016 5:22:40 PM(UTC-5)	
Instant Messages	Incoming	11/19/2016 5:23:43 PM(UTC-5)	
Instant Messages	Outgoing	11/19/2016 5:23:57 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 6:34:31 AM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 6:54:22 AM(UTC-5)	
SMS Messages	Incoming	11/20/2016 7:03:19 AM(UTC-5)	
SMS Messages	Incoming	11/20/2016 7:05:38 AM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 7:07:34 AM(UTC-5)	
SMS Messages	Incoming	11/20/2016 7:08:05 AM(UTC-5)	
SMS Messages	Incoming	11/20/2016 7:10:37 AM(UTC-5)	
SMS Messages	Incoming	11/20/2016 8:02:41 AM(UTC-5)	
SMS Messages	Incoming	11/20/2016 8:05:47 AM(UTC-5)	
Call Log	Incoming	11/20/2016 12:52:03 PM(UTC-5)	00:00:00
Instant Messages	Incoming	11/20/2016 12:52:12 PM(UTC-5)	
Emails		11/20/2016 12:53:37 PM(UTC-5)	



SMS Messages	Incoming	11/20/2016 12:55:07 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 12:55:18 PM(UTC-5)	
Call Log	Incoming	11/20/2016 12:58:37 PM(UTC-5)	00:00:00
SMS Messages	Outgoing	11/20/2016 1:22:22 PM(UTC-5)	
Emails		11/20/2016 1:53:32 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 2:02:30 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 2:03:09 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 2:03:42 PM(UTC-5)	
Internet		11/20/2016 2:06:37 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 3:40:21 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 3:40:42 PM(UTC-5)	
Images		11/20/2016 4:36:19 PM	
MMS Messages	Outgoing	11/20/2016 5:01:38 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:01:50 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:02:19 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:02:51 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:03:45 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:04:04 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:04:14 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:04:43 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:05:21 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:05:44 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:06:35 PM(UTC-5)	

Emails		11/20/2016 5:06:53 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:08:14 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:09:40 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:26:57 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:27:04 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:27:25 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:27:27 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:27:39 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:28:47 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:31:23 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:32:07 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:33:31 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:34:34 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 5:38:23 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 5:41:49 PM(UTC-5)	
Call Log	Incoming	11/20/2016 5:42:18 PM(UTC-5)	00:00:02
Instant Messages	Incoming	11/20/2016 5:42:31 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 6:06:05 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 6:21:40 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 6:30:10 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 6:50:23 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 6:51:08 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 6:54:01 PM(UTC-5)	

SMS Messages	Incoming	11/20/2016 6:54:09 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 6:54:42 PM(UTC-5)	
SMS Messages	Incoming	11/20/2016 6:55:03 PM(UTC-5)	
SMS Messages	Outgoing	11/20/2016 6:55:11 PM(UTC-5)	
Internet		11/20/2016 6:55:55 PM(UTC-5)	
Call Log	Incoming	11/20/2016 7:08:18 PM(UTC-5)	00:00:00
SMS Messages	Incoming	11/20/2016 7:19:56 PM(UTC-5)	
Internet		11/20/2016 7:23:45 PM(UTC-5)	
Internet		11/20/2016 7:23:45 PM(UTC-5)	
Internet		11/20/2016 7:37:49 PM(UTC-5)	
Internet		11/20/2016 7:53:55 PM(UTC-5)	
Call Log	Outgoing	11/20/2016 7:54:10 PM(UTC-5)	00:01:37
Call Log	Incoming	11/20/2016 7:59:08 PM(UTC-5)	00:00:00
Call Log	Outgoing	11/20/2016 7:59:24 PM(UTC-5)	00:00:59
Instant Messages	Incoming	11/20/2016 8:07:35 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:07:51 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:07:58 PM(UTC-5)	
Instant Messages	Outgoing	11/20/2016 8:14:45 PM(UTC-5)	
Emails		11/20/2016 8:15:26 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:15:30 PM(UTC-5)	
Instant Messages	Outgoing	11/20/2016 8:16:05 PM(UTC-5)	
Instant Messages	Outgoing	11/20/2016 8:16:22 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:18:20 PM(UTC-5)	

Internet		11/20/2016 8:18:23 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:19:00 PM(UTC-5)	
Call Log	Outgoing	11/20/2016 8:19:33 PM(UTC-5)	00:01:40
Instant Messages	Incoming	11/20/2016 8:21:35 PM(UTC-5)	
Call Log	Incoming	11/20/2016 8:22:41 PM(UTC-5)	00:00:30
Instant Messages	Incoming	11/20/2016 8:23:22 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:25:00 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:25:19 PM(UTC-5)	
Call Log	Incoming	11/20/2016 8:36:10 PM(UTC-5)	00:00:40
Call Log	Incoming	11/20/2016 8:39:50 PM(UTC-5)	00:00:00
Instant Messages	Incoming	11/20/2016 8:39:59 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:40:17 PM(UTC-5)	
Internet		11/20/2016 8:44:41 PM(UTC-5)	
Web History		11/20/2016 8:44:44 PM(UTC-5)	
Web History		11/20/2016 8:44:45 PM(UTC-5)	
Internet		11/20/2016 8:44:49 PM(UTC-5)	
Web History		11/20/2016 8:44:58 PM(UTC-5)	
Web History		11/20/2016 8:45:00 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 8:47:25 PM(UTC-5)	
Call Log	Incoming	11/20/2016 8:49:15 PM(UTC-5)	00:00:00
Instant Messages	Incoming	11/20/2016 8:50:01 PM(UTC-5)	
Internet		11/20/2016 8:50:27 PM(UTC-5)	
Call Log	Outgoing	11/20/2016 8:56:04 PM(UTC-5)	00:00:05

Instant Messages	Incoming	11/20/2016 8:58:00 PM(UTC-5)	
Internet		11/20/2016 9:05:59 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 9:07:24 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 9:10:22 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 9:11:52 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 9:11:59 PM(UTC-5)	
Instant Messages	Incoming	11/20/2016 9:13:56 PM(UTC-5)	
Call Log	Incoming	11/20/2016 10:06:47 PM(UTC-5)	00:19:45
SMS Messages	Incoming	11/20/2016 11:09:28 PM(UTC-5)	
Instant Messages	Incoming	11/21/2016 1:27:24 AM(UTC-5)	
Emails		11/21/2016 1:32:56 AM(UTC-5)	
Call Log	Incoming	11/21/2016 5:37:42 AM(UTC-5)	00:00:29
Emails		11/21/2016 5:53:43 AM(UTC-5)	
Internet		11/21/2016 5:54:38 AM(UTC-5)	
Internet		11/21/2016 6:50:07 AM(UTC-5)	
Internet		11/21/2016 6:50:08 AM(UTC-5)	
Internet		11/21/2016 6:52:45 AM(UTC-5)	
Web History		11/21/2016 7:05:26 AM(UTC-5)	
Web History		11/21/2016 7:06:07 AM(UTC-5)	
Web History		11/21/2016 7:06:15 AM(UTC-5)	
Web History		11/21/2016 7:11:17 AM(UTC-5)	
Web History		11/21/2016 7:13:10 AM(UTC-5)	
Internet		11/21/2016 8:53:09 AM(UTC-5)	



Internet		11/21/2016 8:54:29 AM(UTC-5)	
Internet		11/21/2016 9:10:00 AM(UTC-5)	
Web History		11/21/2016 2:46:59 PM(UTC-5)	
Web History		11/21/2016 2:47:04 PM(UTC-5)	
SMS Messages	Incoming	11/21/2016 3:08:45 PM(UTC-5)	
Call Log	Incoming	11/21/2016 3:17:20 PM(UTC-5)	00:03:50
SMS Messages	Incoming	11/21/2016 3:21:59 PM(UTC-5)	
Call Log	Outgoing	11/21/2016 3:25:31 PM(UTC-5)	00:00:05
Call Log	Outgoing	11/21/2016 3:25:58 PM(UTC-5)	00:00:04
Internet		11/21/2016 3:26:07 PM(UTC-5)	
Internet		11/21/2016 3:26:09 PM(UTC-5)	
Internet		11/21/2016 3:26:09 PM(UTC-5)	
Call Log	Outgoing	11/21/2016 3:26:25 PM(UTC-5)	00:01:41
Call Log	Incoming	11/21/2016 3:29:41 PM(UTC-5)	00:00:29
Call Log	Outgoing	11/21/2016 3:31:50 PM(UTC-5)	00:00:04
Call Log	Outgoing	11/21/2016 3:32:07 PM(UTC-5)	00:00:34
Call Log	Outgoing	11/21/2016 3:33:05 PM(UTC-5)	00:00:41
Call Log	Incoming	11/21/2016 3:42:11 PM(UTC-5)	00:00:36
Call Log	Incoming	11/21/2016 3:55:27 PM(UTC-5)	00:00:00
Emails		11/21/2016 3:55:28 PM(UTC-5)	
Call Log	Incoming	11/21/2016 4:01:14 PM(UTC-5)	00:00:00
SMS Messages	Incoming	11/21/2016 4:02:06 PM(UTC-5)	
SMS Messages	Outgoing	11/21/2016 4:22:03 PM(UTC-5)	

Instant Messages	Outgoing	11/21/2016 4:24:25 PM(UTC-5)	
Instant Messages	Outgoing	11/21/2016 4:38:26 PM(UTC-5)	
Call Log	Incoming	11/21/2016 5:00:19 PM(UTC-5)	00:16:38
Call Log	Incoming	11/21/2016 5:11:14 PM(UTC-5)	00:00:00
Call Log	Incoming	11/21/2016 5:11:48 PM(UTC-5)	00:00:00
Instant Messages	Incoming	11/21/2016 5:23:12 PM(UTC-5)	
Instant Messages		11/21/2016 5:23:12 PM(UTC-5)	
Instant Messages	Incoming	11/21/2016 5:23:50 PM(UTC-5)	
SMS Messages	Incoming	11/21/2016 5:27:40 PM(UTC-5)	
Call Log	Incoming	11/21/2016 5:31:15 PM(UTC-5)	00:01:50
Instant Messages	Incoming	11/21/2016 5:39:25 PM(UTC-5)	
Internet		11/21/2016 5:44:14 PM(UTC-5)	
Call Log	Incoming	11/21/2016 6:01:06 PM(UTC-5)	00:00:00
Call Log	Incoming	11/21/2016 6:06:17 PM(UTC-5)	00:00:00
Call Log	Incoming	11/21/2016 6:11:48 PM(UTC-5)	00:00:00
Instant Messages	Incoming	11/21/2016 6:12:05 PM(UTC-5)	
Instant Messages	Incoming	11/21/2016 6:12:18 PM(UTC-5)	
Instant Messages	Incoming	11/21/2016 6:14:44 PM(UTC-5)	
Instant Messages	Incoming	11/21/2016 6:23:23 PM(UTC-5)	
Internet		11/21/2016 6:25:41 PM(UTC-5)	
Call Log	Incoming	11/21/2016 6:27:42 PM(UTC-5)	00:00:00
Internet		11/21/2016 6:27:48 PM(UTC-5)	

## 2.4. Wabco Brake Module Device Description

The Wabco ABS-E Brake Module combines the ABS with an Electronic Stability Program (ESP). In addition to monitoring the brake application and improving brake characteristics, the ESP enhances vehicle stability by reducing engine throttle and applying vehicle braking based on the computed vehicle dynamics. The module receives information from sensors, processes data and sends signals to modulators and active braking valves.

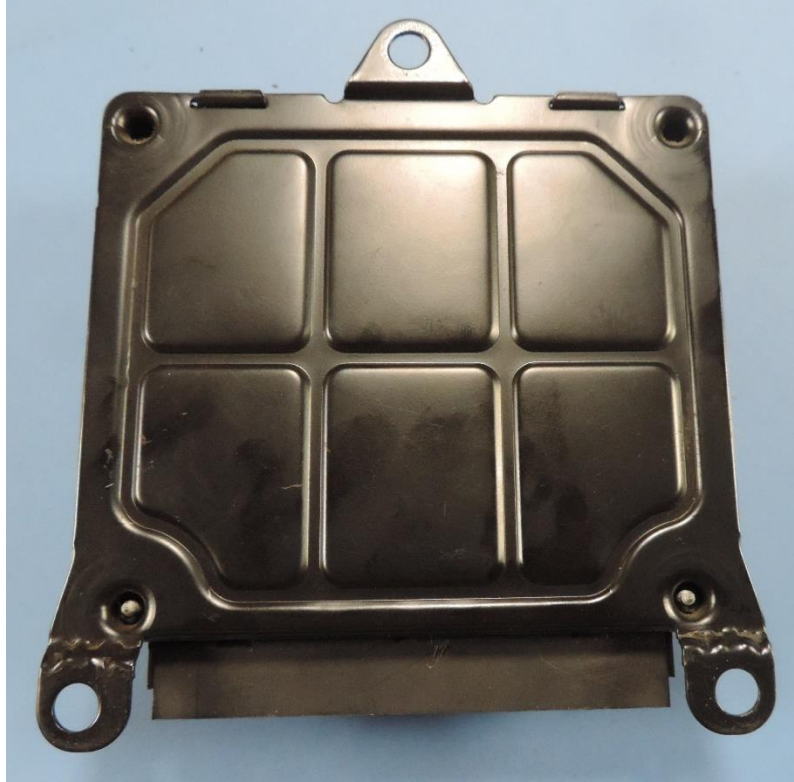
### 2.4.1. Wabco Brake Module Data Recovery

The Wabco brake module was attempted to be imaged normally, but a persisting communication error prevented imaging. The module was removed from the vehicle and brought to a Wabco facility for imaging. Figures 4 and 5 show the Wabco brake module.

Figure 4. Wabco brake module as received.



**Figure 5. Wabco brake module as received.**



### **2.4.2. Wabco Brake Module Data Description**

Wabco successfully imaged the module, but the data could not be correlated to the crash because there was no timestamp on the device. No crash related data was recovered from the device.