

Accuracy of Selected 2008 Chrysler Airbag Control Module Event Data Recorders

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ABSTRACT

This paper reports test results for accuracy of pre-crash speed, brake, and accelerator pedal data recorded in selected 2008 model year Chrysler ACM EDR's under steady state speed conditions. The authors drove two test vehicles at two different speeds, 56 and 113 km/h (35 and 70 mph), and artificially created EDR events so pre-crash events would be stored. The authors collected ACM EDR data after each run. A differential Global Positioning System (GPS) based Racelogic VBOX III (100Hz) was used to measure vehicle speed and record brake on/off and accelerator pedal voltage real time. Maximum error, average error, and 98% confidence intervals are reported for EDR to VBOX. Accelerator pedal position accuracy and brake on/off reporting latency versus auxiliary sensor taps are documented.

INTRODUCTION

Prior papers have assessed the accuracy of pre-crash speed data in automotive event data recorders such as General Motors Sensing and Diagnostic Modules (SDM's). Chidester (1999) stated the accuracy was 4%. Lawrence (2003) tested vehicles using a 5th wheel and found SDM speed to be over reported by 1.5 km/h at low speeds and under reported by 3.7 km/h at high speeds up to 150 km/h. Niehoff (2005) reported on 28 crash tests from 40 to 64 km/h and determined the average error in pre-impact speed was 1.1% with a maximum error of 3.7%. Ruth and Reust (2008) assessed the

accuracy of the speed data in the Ford Powertrain Control Module to be within 1%.

The Chrysler Airbag Control Module (ACM) tested is a new design for the 2008 model year. It is found in the 2008 Jeep Commander and Dodge Dakota among other vehicles. The rear wheel drive 2008 Commander and 2008 Dakota vehicles were both tested. This module creates EDR recordings only if deployment criteria are met. The event data recorder in these vehicles records pre-crash data including vehicle speed, brake on/off, and accelerator pedal position for 5 seconds at 0.1 second intervals, which is a much higher frequency than Ford or GM EDR's. Speed data is stored in km/h in the module.

The test procedure consisted of accelerating the vehicle to speeds of 56 to 113 km/h (35 to 70 mph), stabilizing the speed, and then applying brakes suddenly to simulate a panic stop situation. Approximately 2.5 seconds into the braking a deployment event was created on the test Airbag Control Module such that pre-crash data would be recorded. Factory replacement ACM units were used for the tests.

For the Dakota, the test ACM was mounted to a fixture held in the passenger's lap. The fixture had a slide with springs attached. The passenger pulled back on the slide and then released it, such that the springs accelerated the module forward. The slide would then strike the end of the fixture and create a negative acceleration sufficient to create a deployment event. The fixture slide also contained a front crash sensor wired into the ACM.

For the Commander the deployment event was induced by rotating the test module 90 degrees to simulate a rollover event.

A special wiring harness adaptor was built connecting the vehicle power, ground, and CAN bus to the test module, while deliberately not connecting the vehicle airbags so as not to deploy them when the deployment event was created.

Vehicle speed was recorded by a Racelogic VBOX III system operating at 100Hz. The VBOX has a stated accuracy of 0.1 km/h. An additional tape pressure switch was mounted to the brake pedal to provide an auxiliary brake activation indication. The VBOX was also set up to record vehicle accelerator pedal sensor voltage from a tap into the vehicle sensor wires. The test procedure was designed to permit verification that when the accelerator pedal was released and the brake applied that the EDR correctly recorded the accelerator pedal release and the brake application. Subsequent to each run the EDR was read out using the Bosch CDR system and the VBOX data reviewed to insure a proper recording was made.

While speed data was gathered in both the steady state pre-brake application period and during the dynamic simulated panic braking, the scope of this paper is limited to assessing the accuracy of speed information during the steady state period.

During the 2008 Commander tests, six runs were made each at or near target speeds of 56.4 km/h (35 mph), and 112.7 km/h (70mph). Actual speeds for each test run varied slightly. Each Airbag Control Module was capable of storing up to 3 events, so a total of 4 different airbag control modules had to be used to get the 12 total tests on the Commander (five modules counting setup runs). The 2008 Dakota was tested similarly but was also tested at 80.5 km/h (50mph) because additional test modules were available

Typical CDR Output example

Pre-crash data (Most Recent Event - table 1 of 5)

Time Stamp (sec)	Vehicle Event Recorder Status	Engine RPM	Vehicle Speed (MPH (KPH))	Relative Throttle (%)	Relative Pedal (%)	Raw Manifold Pressure (volts)	Brake Switch #1 Status	Brake Switch #2 Status	Brake Lamps On
-5.0	Complete	1,088	35 (56)	4.7	3.1	1.02	Open	Open	No
-4.9	Complete	1,088	35 (56)	4.3	3.1	1.02	Open	Open	No
-4.8	Complete	1,088	35 (56)	4.3	3.1	1.02	Open	Open	No
-4.7	Complete	1,088	35 (56)	4.7	3.1	1.02	Open	Open	No
-4.6	Complete	1,088	35 (56)	4.7	3.1	1.02	Open	Open	No
-4.5	Complete	1,088	35 (56)	4.7	3.1	1.02	Open	Open	No
-4.4	Complete	1,088	35 (56)	4.7	3.1	1.02	Open	Open	No
-4.3	Complete	1,088	35 (56)	4.7	3.5	1.02	Open	Open	No
-4.2	Complete	1,088	35 (56)	4.7	3.5	1.02	Open	Open	No
-4.1	Complete	1,088	35 (56)	4.7	3.5	1.02	Open	Open	No
-4.0	Complete	1,088	35 (56)	4.7	3.5	1.02	Open	Open	No
-3.9	Complete	1,088	35 (56)	4.7	3.9	1.04	Open	Open	No
-3.8	Complete	1,088	35 (56)	4.7	3.9	1.04	Open	Open	No
-3.7	Complete	1,088	35 (56)	4.7	3.9	1.05	Open	Open	No
-3.6	Complete	1,088	35 (56)	4.7	3.9	1.05	Open	Open	No
-3.5	Complete	1,088	35 (56)	4.7	3.9	1.07	Open	Open	No
-3.4	Complete	1,088	35 (56)	4.7	3.9	1.07	Open	Open	No
-3.3	Complete	1,088	35 (56)	4.7	3.9	1.07	Open	Open	No
-3.2	Complete	1,088	35 (56)	4.7	3.9	1.09	Open	Open	No
-3.1	Complete	1,088	35 (56)	4.7	3.9	1.09	Open	Open	No
-3.0	Complete	1,088	35 (56)	4.7	3.9	1.09	Open	Open	No
-2.9	Complete	1,088	35 (56)	4.7	3.9	1.11	Open	Open	No
-2.8	Complete	1,088	35 (56)	4.7	3.9	1.11	Open	Open	No
-2.7	Complete	1,088	35 (56)	4.7	3.9	1.11	Open	Open	No
-2.6	Complete	1,088	35 (56)	3.8	0.0	1.09	Open	Open	No
-2.5	Complete	1,120	34 (55)	2.8	0.0	0.92	Open	Open	No
-2.4	Complete	1,216	35 (56)	2.4	0.0	0.92	Open	Open	Yes
-2.3	Complete	1,152	34 (55)	2.0	0.0	0.82	Closed	Closed	Yes
-2.2	Complete	1,120	34 (55)	2.0	0.0	0.82	Closed	Closed	Yes

. Figure 1 – Typical CDR Output

RESULTS

2008 JEEP COMMANDER ACM EDR VEHICLE SPEED VS. RACELOGIC VBOX III AT 100HZ - A typical single test run is shown in **Figure 2** displaying ACM EDR vs. VBOX speed data taken.

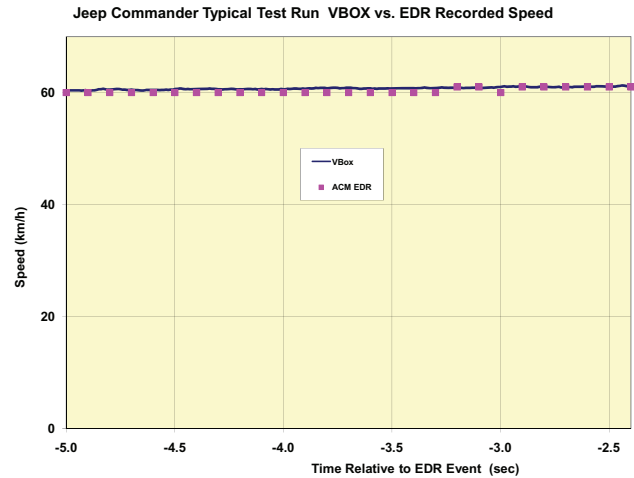


Figure 2 – Typical Test Run Speed vs. Time

The scope of this paper is limited to analyzing steady state speed data. The speed data points prior to braking targeting 56 km/h (35 mph) were compiled together and are displayed in **Figure 3**.

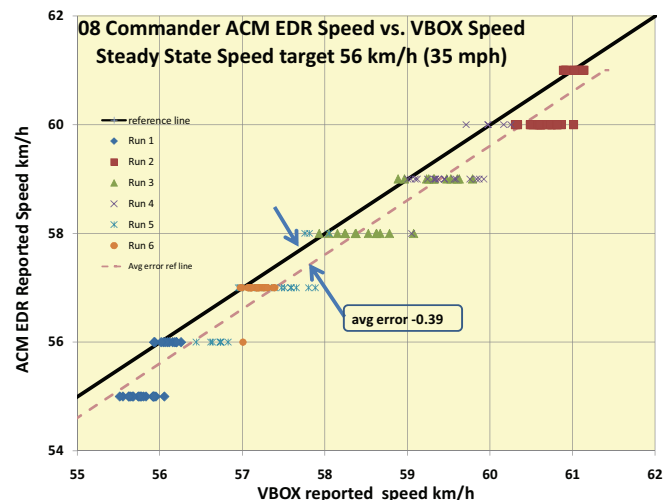


Figure 3 – VBOX v EDR targeting 56 km/h (35 mph)

At 56 km/h (35 mph), the maximum difference between the VBOX and the ACM speed was -1.08 km/h (-0.67 mph) or -1.8%. The average difference was -0.39 km/h (-0.24 mph) or -0.7%.

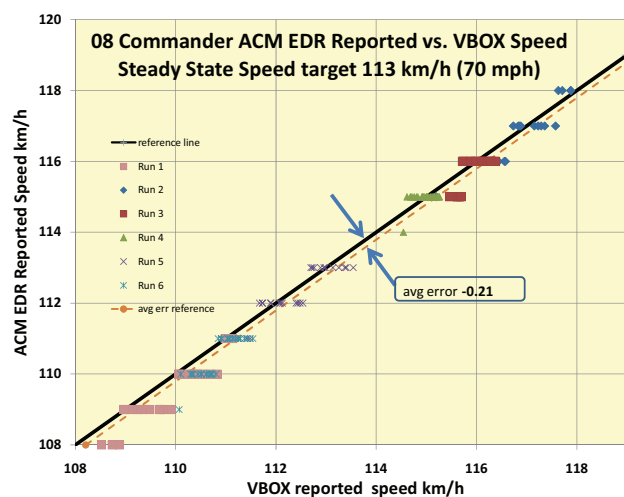


Figure 4 VBOX v EDR targeting 113 km/h (70 mph)

The data for the 6 runs targeting 113 km/h (70 mph) is shown in **Figure 4**. The maximum difference between the VBOX and the ACM speed was -1.07 km/h (-0.67 mph) or -0.9%. The average difference was -0.21 km/h (-0.13 mph) or -0.2%.

The small errors can be seen in greater resolution if error (instead of EDR speed) is plotted versus VBOX speed. Statistical analysis was performed for the data set at each speed range and the 98% confidence interval (± 3 sigma limits, assuming a normal distribution) are displayed in **Figure 5**.

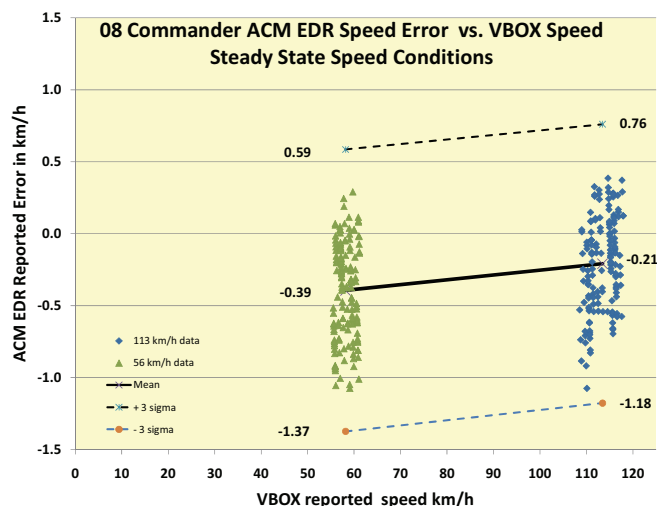


Figure 5 Commander EDR Error v Speed

At 56 km/h (35 mph), the standard deviation was 0.33 km/h (0.20 mph) and the 3 Sigma range was -1.37 to +0.59 km/h (-0.85 to +0.36 mph). At 113 km/h (70 mph), the standard deviation was 0.32 km/h (0.20 mph) and the 3 Sigma range was -1.18 to +0.76 km/h (-0.73 to +0.47 mph).

2008 COMMANDER BRAKE SWITCH REPORTING LATENCY - Analysis of synchronized VBOX auxiliary brake switch data to EDR brake indication was tabulated for the Commander data and is displayed in **Figure 6**. The VBOX data was synchronized to the EDR data by matching the point where the accelerator pedal was released. Since the EDR reports every 0.1 second, the precision of the match can be no closer than ± 0.05 second. There are 12 data points in this distribution. The shortest latency was 0.01 second and the longest latency observed was 0.14 second. The average was 0.09 second.

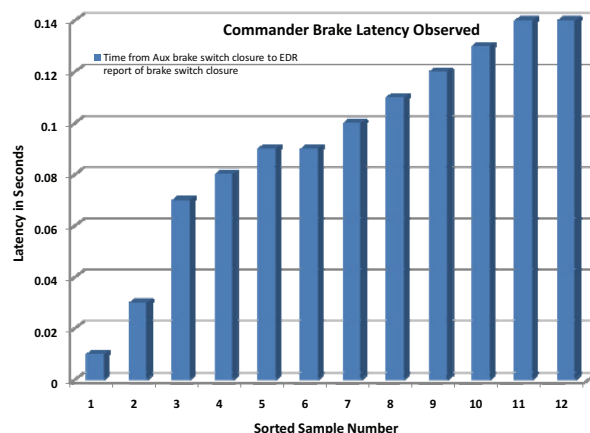


Figure 6 Brake #1 Reporting Latency

The same data can also be displayed as a cumulative distribution in **Figure 7**.

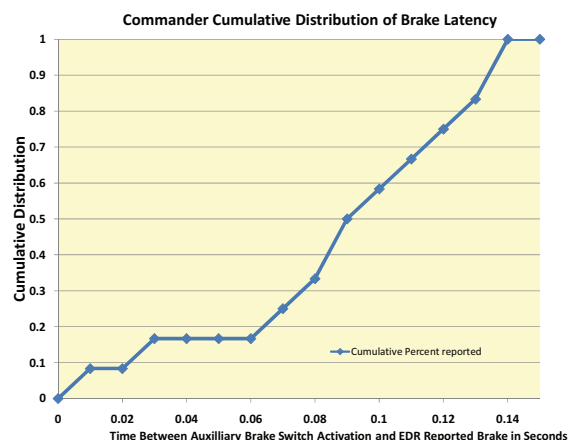


Figure 7 Brake Reporting Distribution

2008 DAKOTA ACM EDR VEHICLE SPEED VS. RACELOGIC VBOX III - Targeting 56 km/h (35 mph), the average difference was -1.17 km/h (-0.72 mph) or -2.0%. The maximum difference between the measured VBOX speed during steady state condition was -2.09