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***INSIDE:***

# EXPLORATION AND VALIDATION OF THE DUCATI DATA ANALYZER

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## INTRODUCTION

Event data recorders (EDRs) provide invaluable collision data to assist reconstructionists in their task of determining how a collision occurred. As of 2016, 99% of available automobiles have some sort of EDR that can be interrogated using a publically available tool such as Bosch's CDR system, or the Subaru, Hyundai, or Kia diagnostic tools [1].

Unfortunately, to date, this technology has not been widely adopted by motorcycle manufacturers. Currently, only select 2013+ Kawasaki motorcycles are equipped with a true EDR [2]. As such, in the vast majority of cases the analyst will not have access to information captured by a motorcycle EDR.

However, data loggers provide another source of potential data to reconstructionists. These devices are installed at the choice of the owner and may be produced by aftermarket vendors, or the original manufacturer. Devices such as the Woolrich Racing "Log Box," which is available for integration with several motorcycle makes, requires mild modification of the wiring system, but can be installed relatively easily and has the ability to access a plethora of data from the vehicle's ECU. The data available depends on the specific motorcycle, but could include: wheel speed, throttle position, brake switch status, transmission gear position, engine speed, and other potentially useful parameters. Captured data is stored on a micro SD card, allowing for straightforward retrieval.

A similar device, the HP Race Datalogger, became available from BMW in 2009 [3]. Much of the same data can be captured by the HP device, which also has the ability to record GPS information. This system can be plugged directly into the original wiring harness of certain BMWs, but again, the owner must choose to install the device.

Some more technologically advanced motorcycles, such as Yamaha's 2015+ YZF-R1M, are equipped with GPS-enabled onboard data acquisition systems and have the ability to pair with smartphones and tablets [4]. In addition, motorcycles equipped with GPS or infotainment systems may store useful data. For instance, Harley-Davidson's Boom! Box infotainment system has the ability to record and export GPS trip history to an external USB drive. However, reports from the field indicate the recording option is disabled by default, and must be enabled by the rider. Reconstructionists should be aware of the potential presence of such data and preserve any devices where it might be stored.

The subject research focuses on Ducati's data logger, the Ducati Data Analyzer (DDA). First introduced in 2007, the initial system was comprised of a single component resembling a USB drive (Figure 3), with the ability to log: vehicle speed, engine speed (RPM), engine temperature, throttle aperture (opening), gear position (calculated value), engine temperature, and total distance traveled. Ducati introduced a GPS-enabled version of the device in June 2012, which adds a GPS sensor (usually mounted behind the windscreen) to record vehicle position data [5].

Currently, no published investigation has been performed to establish the nature or validity of the data captured by the DDA. Furthermore, it is not currently known when the system will log data, and what events might terminate capture. The subject research seeks to provide insight into the workings of the system and determine if the data recorded by the DDA is reliable.

## PROCEDURE

A 2008 Ducati 848 equipped with an early version of the DDA (part number: 28620401A) was used for the subject testing, which was conducted in Laguna Hills, California, in April of 2017 (Figure 4). The motorcycle was equipped with tires consistent with the manufacturer's recommended sizing (120/70ZR17 and 180/55ZR17) [6].

The Ducati was ridden for varying lengths while performing different maneuvers. The data captured by the DDA was compared to that recorded by a VBOX Sport, a GPS data acquisition device with a sampling rate of 20 Hz (Racelogic, Farmington Hills, MI).

To initiate data capture on the test motorcycle, the DDA system must be inserted into a wiring harness located in a compartment in the tail of the motorcycle, as is common with other Ducatis as well. Upon installation of the device, and with the engine running, the user must toggle a Mode switch on the left handlebar until the dash displays the words "USB OFF," which is the default reading upon starting the engine. After holding the Mode switch for a few seconds, the display changes to "USB ON," at which point data capture begins and will continue until the motorcycle is turned off,


*Figure 1. Woolrich Racing's Log Box.*

*Figure 2. BMWs HP Race Datalogger.*


*Figure 3. Early version of the Ducati Data Analyzer.*

**Table 1: Sampling frequency and precision for each parameter captured by the DDA system.**

| Parameter | Frequency (Hz) | Precision |
|---|---|---|
| Speed | 10 | 0.25 km/h |
| Engine Speed | 50 | 1 RPM |
| Throttle Aperture | 20 | 1% |
| Gear Position | 10 | 1 |
| Engine Temp. | 1 | 0.2° F |
| Total Distance Travelled | 1 | 1 km |

*Figure 4. 2008 Ducati 848 used for testing.*

*Figure 5. Dash display once DDA recording has commenced.*

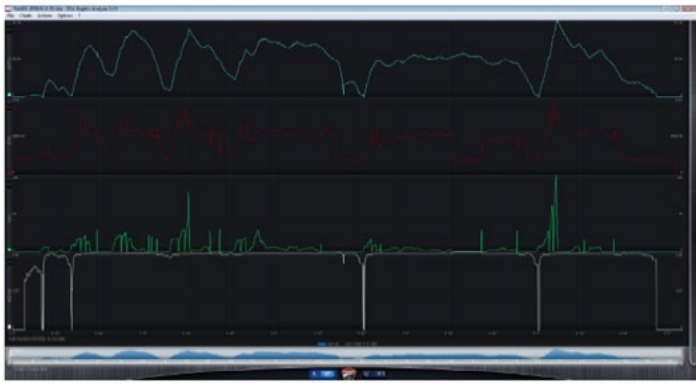

*Figure 6. Screenshot of data review using DDA Graphic Analyzer.*

or the rider holds the Mode switch to turn the device off (Figure 5).

Upon completion of the test runs, the DDA was removed from the motorcycle and plugged into a laptop running a 32-bit version of Windows XP (required for this version of the DDA) for data download. To perform this operation, the DDA Graphic Analyzer application must be installed. The software can be downloaded for free at dda.prosa.com. Upon successful retrieval, the data can be viewed using the same software (Figure 6).

## RESULTS

As previously mentioned, the subject DDA has the ability to capture: vehicle speed, engine speed (RPM), engine temperature, throttle aperture, gear position (calculated value), engine temperature, and total miles travelled. Once the DDA file is opened (file extension of .dda), there is a small icon beside each channel that gives the user the ability to examine several parameters of the data including the min, max, and average values. Most notably though, the sampling frequency is reported here. The frequency for each parameter is reported in Table 1.

The DDA software package does not have the ability to export the recorded data into a text format, as would be convenient for analysis in a spreadsheet program like Microsoft's Excel. As such, an application called DDA Converter (Version 1.5.0), designed for use with Droid devices, was utilized for conversion. Data acquired using the VBOX Sport was exported to text format using the manufacturer's PerformanceBox Tools software package (Version 1.8.2, Build 012). Upon exportation,

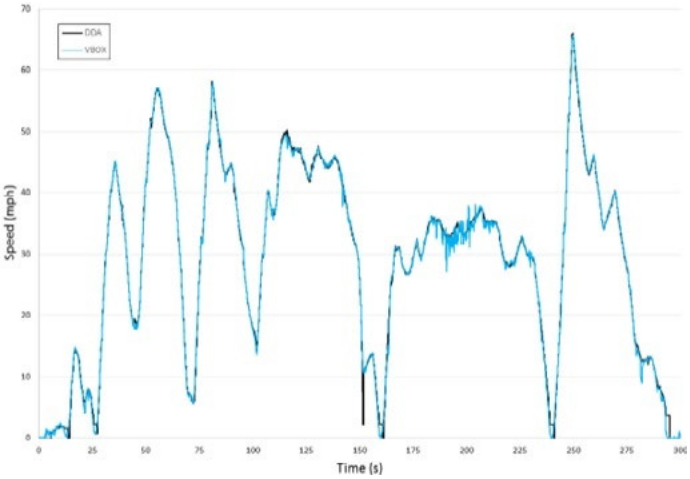


*Figure 7. DDA (black) vs. VBOX (blue) speed data for Run 01.*

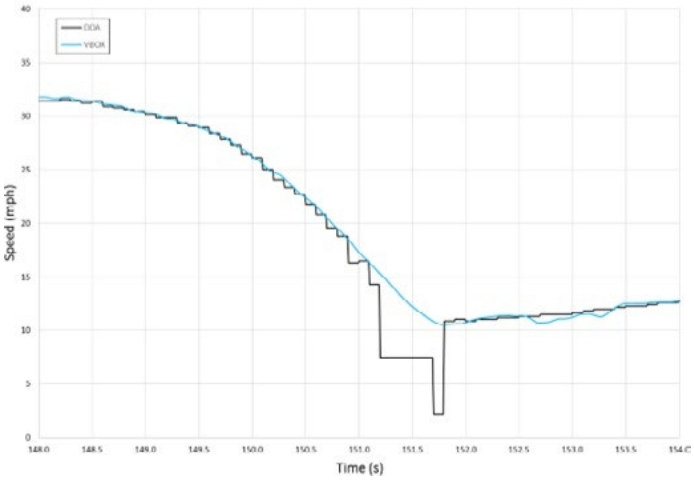


*Figure 8. DDA (black) vs. VBOX (blue) speed data for Run 01, during the rear-tire skid.*

the DDA data was then compared to the VBOX data in Excel.

Five runs were performed on relatively urban streets with traffic signals, stop signs, and elevation changes.

**Run 01**

This dataset was generated over a five-minute ride with speeds varying from 0 to 65 mph. The rear tire was intentionally locked for approximately one second during the trip to determine how the DDA would report the incident (Figure 7).

The DDA and VBOX data aligned very well, with little disparity. As seen in Figure 7, there was a bit of noise in the VBOX data around the 200-second mark, perhaps due to brief loss of satellite link. However, the speed trend was consistent with that of the DDA report. Interestingly, when the rear tire of the Ducati was locked, the speed reported by the DDA did not drop to zero, as would be expected if the speed data was being generated from a rear-wheel speed sensor. Further, the speed did not simply drop to half of the actual speed, as might be expected if the system was monitoring the front and rear wheel speeds and averaging them.

**Run 02**

This dataset was generated over an approximately sixminute ride with speeds varying from 0 to 58 mph. The rear tire was locked twice (at 100 s and 195 s) for a short period of time. The DDA and VBOX speed data aligned very well, aside from when the rear tire was locked, as shown in Figure 9.

**Run 03**

This dataset was generated over an approximately 17minute ride with speeds varying from 0 to 76 mph. A hard acceleration from 0 to 76 mph, with full-throttle application, was performed and the speed traces are shown in Figure 10. At low speeds there were small disparities in the data. Elsewhere, however, the DDA data aligned very well with that reported by the VBOX system.

**Run 04**

This dataset was generated over an approximately 6minute ride with speeds varying from 0 to 62 mph. The rear tire was locked for over three seconds during this run to further examine the DDA's response to a locked wheel (Figures 11 and 12). As with Run 01, the speed reported by the DDA system does not fit any obvious pattern, except that it is always less than the travel speed of the motorcycle.

**Run 05**

This dataset was generated over an approximately three minute ride with speeds varying from 0 to 47 mph. During this run, the key of the Ducati was turned to the off position while riding at a speed of 34 mph to determine how the DDA data would be affected (Figures 13 and 14).

When power to the system was removed, the DDA ceased to write data, but any prior data remained in the system memory and the file was downloaded and could be viewed without issue.

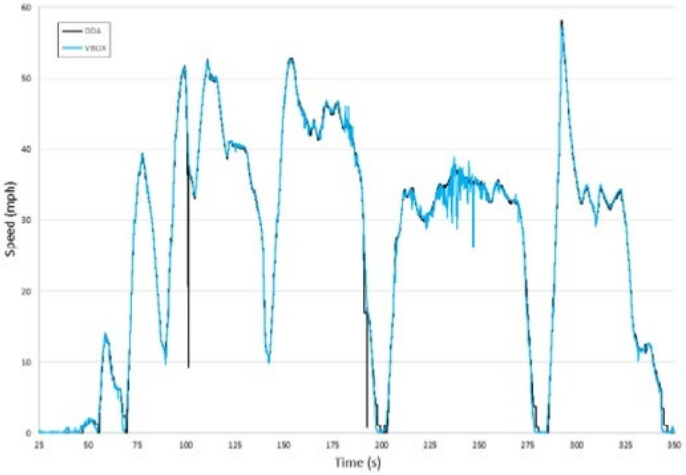


*Figure 9. DDA (black) vs. VBOX (blue) speed data for Run 02.*

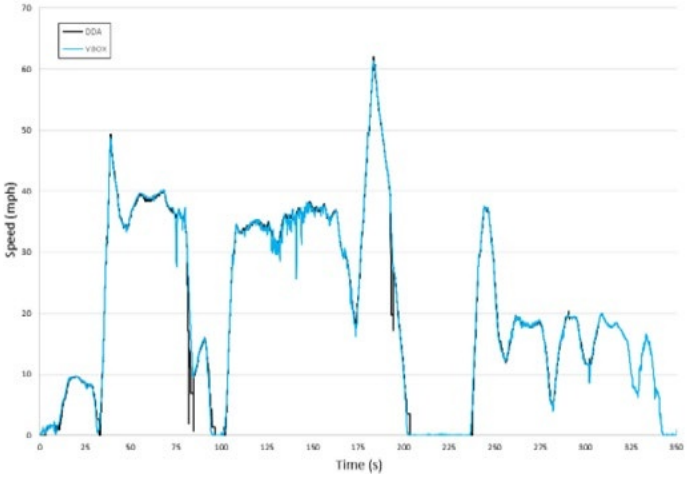


*Figure 11. DDA (black) vs. VBOX (blue) speed data for Run 04.*

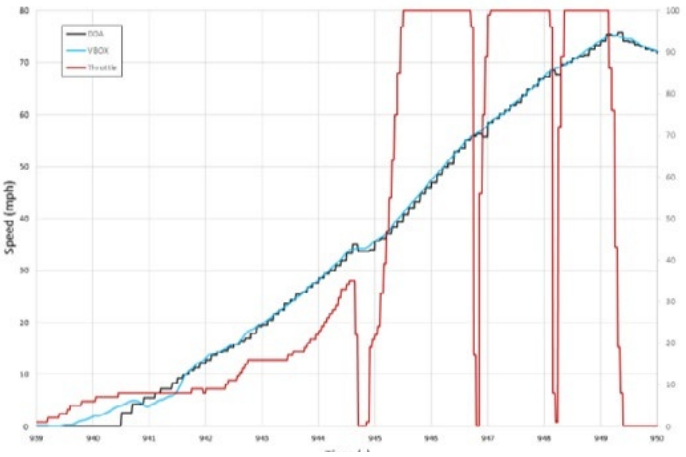


*Figure 10. DDA (black) vs. VBOX (blue) speed data for Run 03, including engine throttle position (red).*

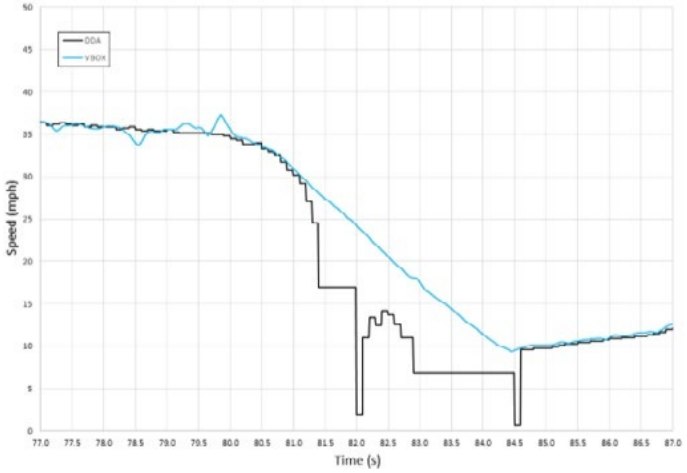


*Figure 12. DDA (black) vs. VBOX (blue) speed data for Run 04, during the prolonged rear-tire skid.*

## DISCUSSION

The DDA has the ability to capture and store a great deal of data that would be useful to collision reconstructionists including Speed, Engine speed (RPM), Throttle aperture, Total distance traveled, and Gear position

The vehicle speeds reported by the DDA during the course of this study were found to be accurate and aligned very well to those reported by the VBOX Sport. When the rear wheel of the Ducati was locked by applying the rear brake, there was a notable discontinuity in the speed trace reported by the DDA, as was expected. When such a discontinuity is observed, the analyst should be alerted to the possibility that the front or rear brake of the motorcycle was locked during the collision sequence. Of course, physical evidence should be analyzed to corroborate any suspicion of a locked wheel. Since the subject testing was performed using a rented motorcycle, on public roads, the author refrained from locking the front wheel. Doing so though, would lead to further information regarding the operation of the speed-sensing mechanism.

Recall, when the rear tire was locked via braking, there was a sudden, noticeable drop in the reported vehicle speed. However, the speed did not drop to zero as might be expected if the system was simply monitoring the rear-wheel speed. Nor did the speed drop to half of the actual speed, as might be expected if the system was monitoring both front and rear wheel speeds. It seems as though the DDA is monitoring both wheel speed(s) and the rotational speed of a driveline components. Further testing is required to determine the specific workings of that portion of the system.

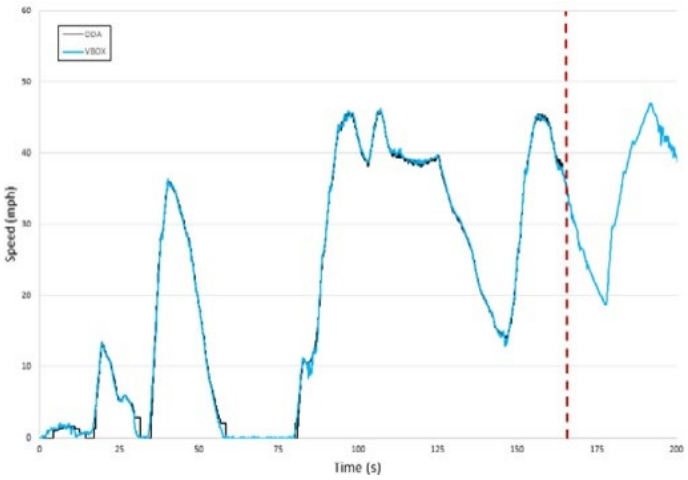


*Figure 13. DDA (black) vs. VBOX (blue) speed data for Run 05. Power was interrupted at 166 s, as indicated by the vertical line.*

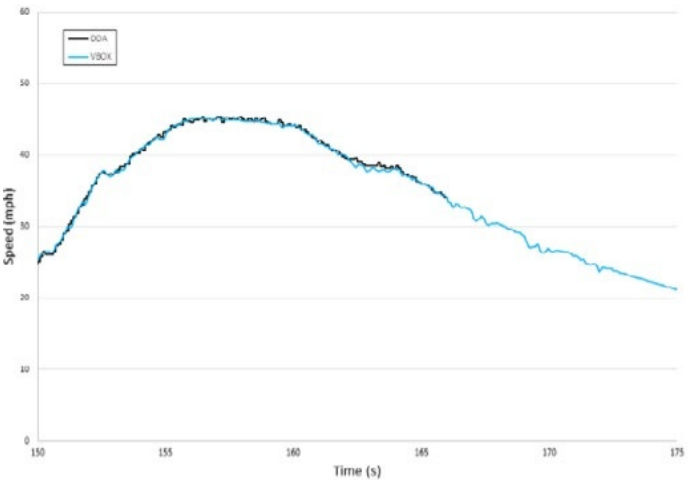


*Figure 14. Closer view of the DDA and VBOX data surrounding the power loss.*

The accuracy of the DDA-reported speed was the focus of the subject study. As such, engine speed, throttle aperture, and gear position were not monitored via an independent data acquisition system. However, the values reported by the DDA system were consistent with what the rider observed during testing, and the reported speeds of the motorcycle. Interestingly, the DDA reports a parameter called "DIST" with the description "Covered distance." Here, the reported value was consistent with the odometer reading. The availability of this parameter may be invaluable to a reconstructionist, when attempting to relate any recovered data to a specific event. Similarly useful, of course, would be any location information recorded by a GPS-equipped DDA.

Considering the limited validation testing that has been performed to date, the analyst should perform traditional reconstruction analyses to evaluate the validity of any data captured by the DDA. It should also be noted that any alterations in sprocket or tire sizing would likely affect reported speeds. As such, it is important to document the tires installed on the subject motorcycle for comparison to the originally equipped tires and sprockets.

## REFERENCES

[1] Ruth, R., "Event Data Recorder Update 2017," Presentation at IPTM Traffic Safety Symposium, May. 2017.

[2] Fatzinger, E., Landerville, J., "An Analysis of EDR Data in Kawasaki Ninja 300 (EX300) Motorcycles," SAE Technical Paper 2017-01-1436, 2017, doi: 10.4271/2017-01-1436.

[3] BMW Motorrad International, "More Knowledge, Ride Faster – The HP Race Data Logger," http://www.bmw-motorrad.com, accessed Oct. 2017.

[4] 2017 Yamaha YZF-R1 / YZF-R1M Owner's Manual, Yamaha Motor Co., Ltd., Nov. 2016.

[5] Prosa, "Ducati Data Analyzer," http://www.prosa.com, accessed Oct. 2017.

[6] 2008 Ducati 848 Use and Maintenance Manual, Ducati, September 2007.

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## ON THE COVER

Three motorcycles were traveling in close formation when an automobile pulled into their path, colliding with two. The third bike went down while evading the auto. - *Submitted by George Tardiff*